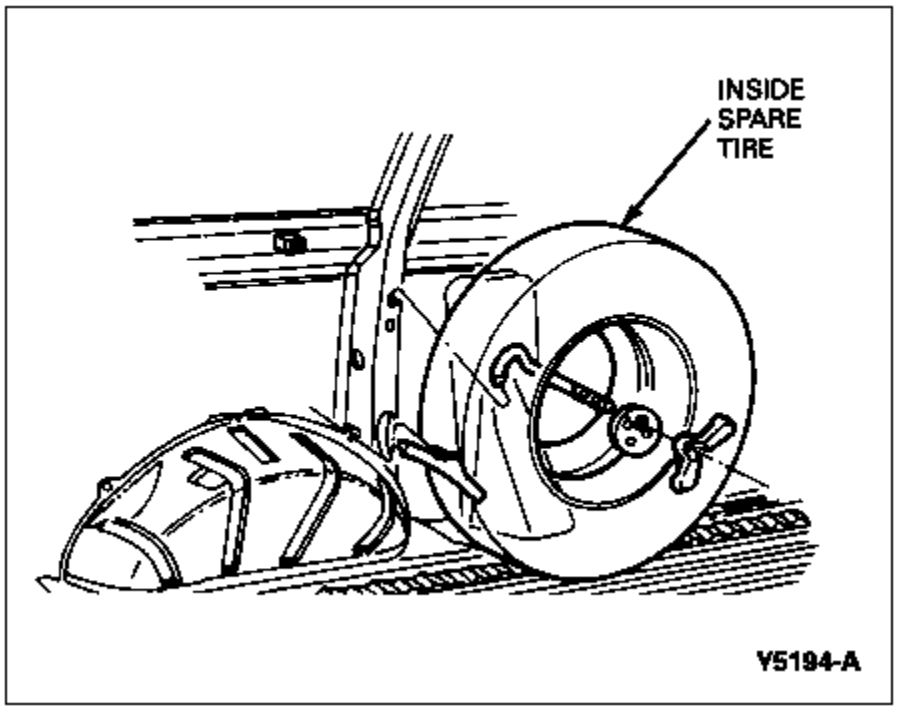
Tire, Spare, Inside, Aerostar

Removal

If the Aerostar is a standard length vehicle the spare tire is mounted inside to a carrier at the left rear quarter panel. To remove the spare tire, remove the wing nut and plate. A flat tire can be temporarily stowed in the same location.



If the Aerostar is the bus with a standard length body or extended length (all models), the temporary spare tire is stowed at the rear of the vehicle under the body.

The Aerostar standard length E-4WD bus spare tire is mounted on the floor.

1. Insert lug nut wrench into the actuator hole and turn counterclockwise until the cable extends to allow the spare tire to be pulled rearward from under the vehicle.

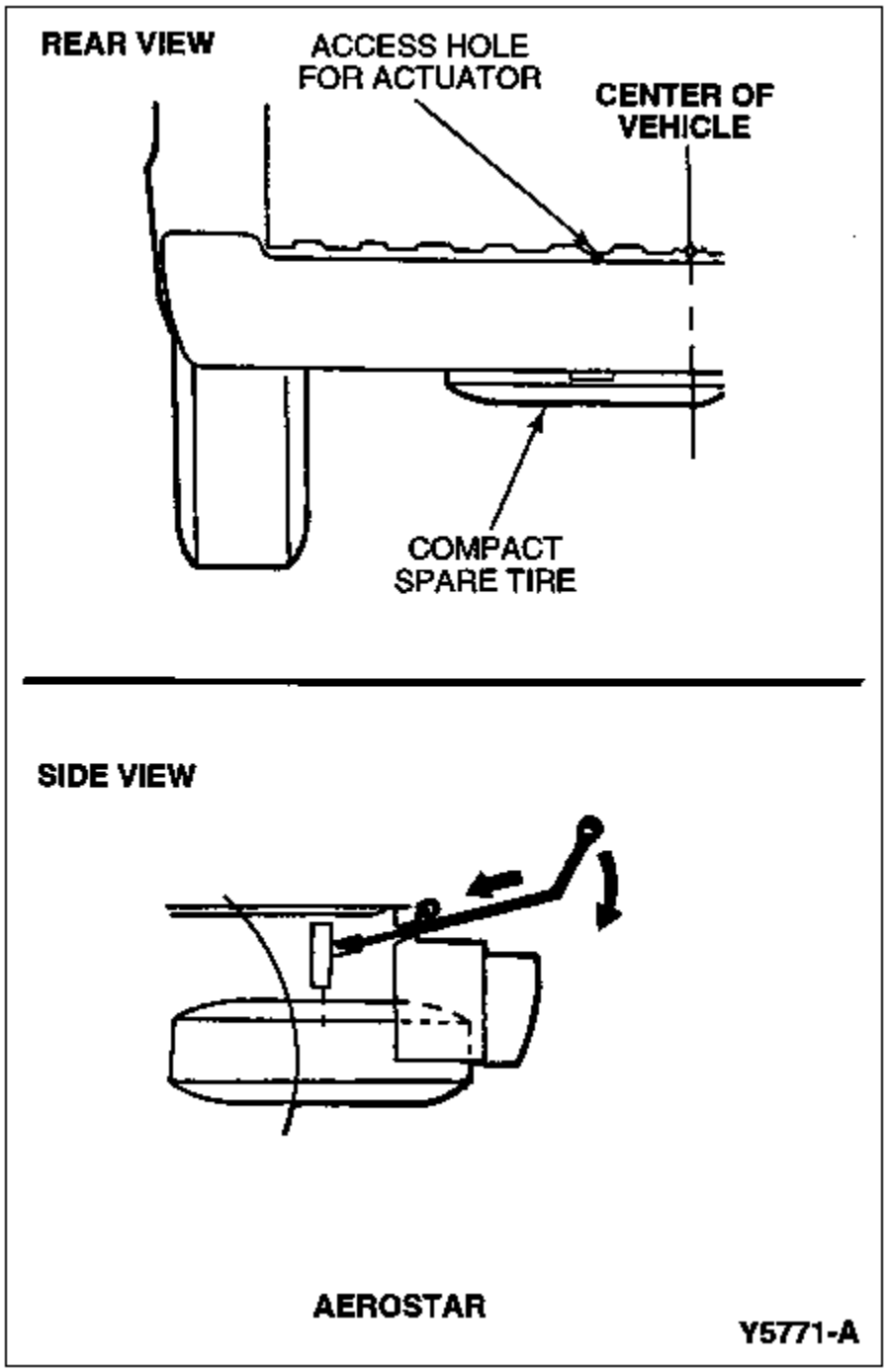
2. Slide spare tire to the rear and remove the retainer from the wheel.

3. To stow cable/retainer with spare tire removed, insert cable fitting into carrier rear wall slot, place wheel retainer against the carrier, and turn lug nut wrench clockwise until slack is removed.

Tire, Spare, Under Vehicle, Aerostar

Removal

1. Open the liftgate and insert drive section of the jack handle through hole above rear bumper.
2. Turn handle counterclockwise until tire can be slid rearward and cable is slack.
3. Slide retainer through center of wheel.


REAR VIEW
ACCESS HOLE FOR ACTUATOR
CENTER OF VEHICLE
COMPACT SPARE TIRE
SIDE VIEW
AEROSTAR
Y5771-A

Tire, Spare, Temporary

WARNING: IF YOU USE THE TEMPORARY SPARE TIRE CONTINUOUSLY OR DO NOT FOLLOW THESE PRECAUTIONS, THE TIRE COULD FAIL, CAUSING YOU TO LOSE CONTROL OF THE VEHICLE AND POSSIBLY INJURE YOURSELF OR OTHERS.

CAUTION: Continuously using a spare tire other than a conventional spare tire on vehicles equipped with Traction-Lok® rear axles could cause damage to the Traction-Lok® differential.

NOTE: Extended use of other than matching size spare tires on a Traction-Lok® rear axle could result in a permanent reduction in effectiveness. This loss of effectiveness does not affect normal driving and should not be noticeable to the driver.

The temporary spare tire is smaller than a regular tire and is designed for emergency use only. This spare tire is marked with the words TEMPORARY USE ONLY.

Tire, Spare, Carrier, Aerostar (Base Vehicle)

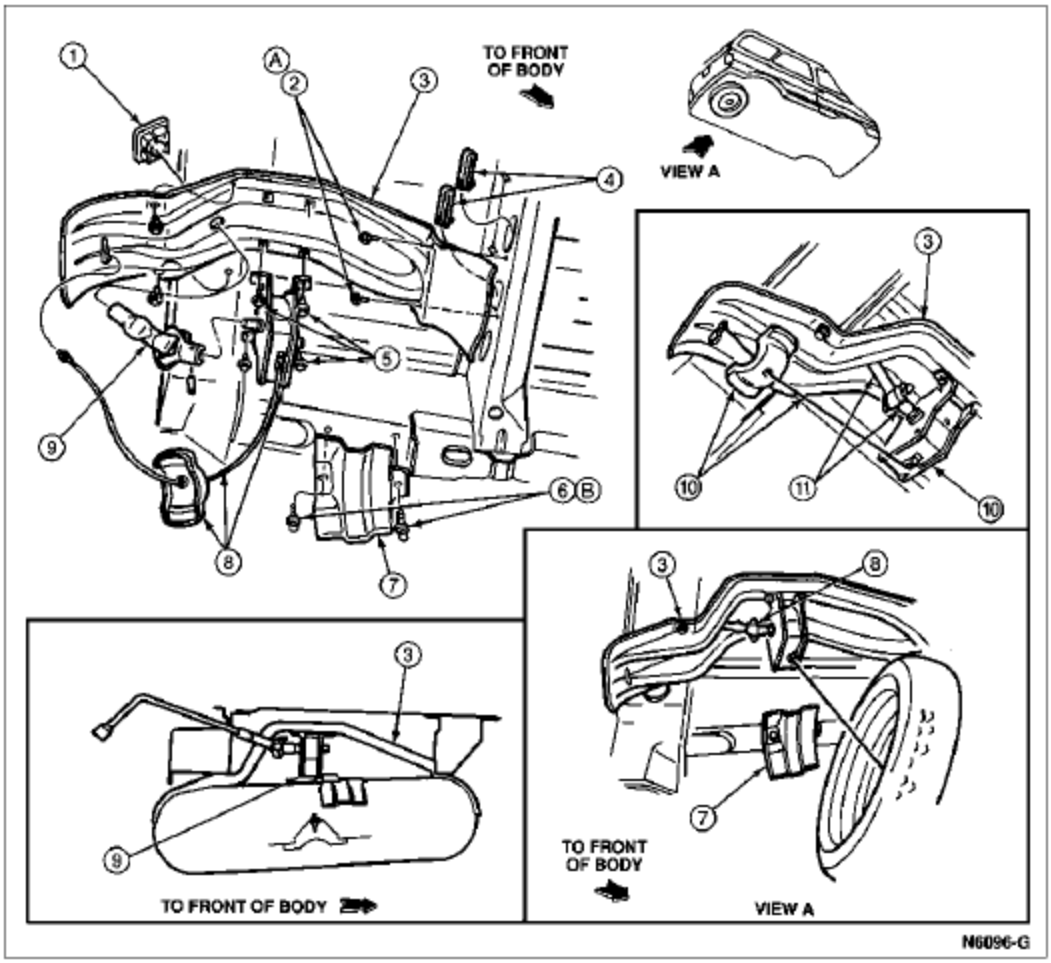
Removal

1. Remove the two screws and remove the spare wheel bracket support from the underbody.
2. Remove the four screws and remove the spare wheel carrier lift assembly and the spare wheel carrier lift gear assembly from the underbody.
3. Remove the four screws and remove the spare wheel carrier mounting bracket from the underbody.

Installation

1. Position the spare wheel carrier mounting bracket on the underbody and install the four retaining screws. Tighten to 9-14 Nm (7-10 lb-ft).
2. Position the spare wheel carrier lift assembly and the spare wheel carrier lift gear assembly on the underbody. Install the four retaining screws and tighten to 9-14 Nm (7-10 lb-ft).
3. Position the spare wheel bracket support on the underbody. Install the retaining screws and tighten to 3.2-4.0 Nm (28.3-35 lb-in).

Spare Tire Carrier, Aerostar



Item	Part Number	Description
1	N804402-S	Grommet (1 Req'd)
2	N606688-S53	Screw
3	1A376	Spare Wheel Carrier Mounting Bracket Assembly
4	N801595-S53	U-Nut
5	N606676-S36	Screw (4 Req'd)
6	N800312-S36	Screw (2 Req'd)
7	1A409	Spare Wheel Bracket Support
8	1A480	Spare Wheel Carrier Lift Assembly
9	1A480	Spare Wheel Carrier Lift Gear Assembly
10	1A131	Spare Wheel Carrier Lift Assembly
11	1A132	Spare Wheel Carrier Lift Gear Assembly
A	—	Tighten to 23-24 Nm (17-25 Lb-Ft)
B	—	Tighten to 3-4 Nm (28-35 Lb-In)

Tire, Spare, Carrier, Aerostar (Extended Vehicle)

Removal

1. Remove the four screws and remove the spare wheel carrier mounting bracket assembly from the underbody.

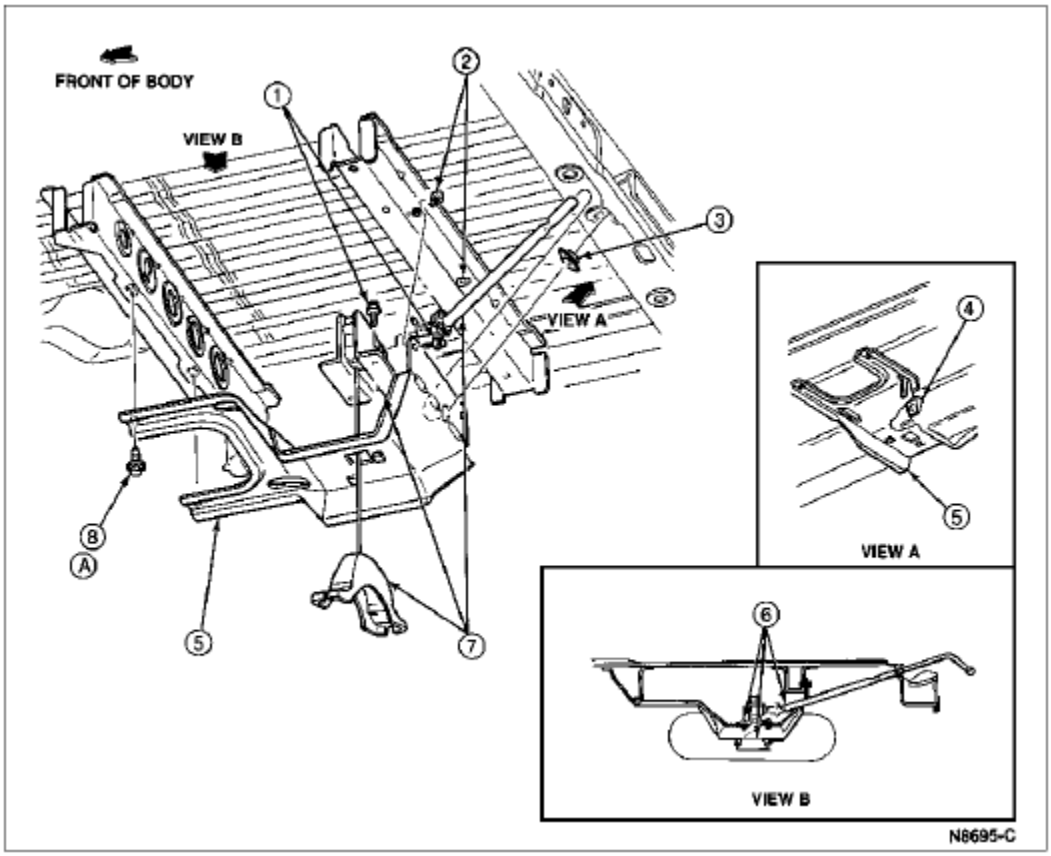
2. Remove the two screws and remove the lift and gear assembly from the spare wheel carrier mounting bracket assembly.

Installation

1. Position the lift and gear assembly on the spare wheel carrier mounting bracket assembly. Install the two retaining screws and tighten to 9-14 Nm (7-10 lb-ft).

2. Position the spare wheel carrier mounting bracket assembly on the underbody. Install the four retaining screws and tighten to 23-34 Nm (17-25 lb-ft).

Spare Tire Carrier, Aerostar Extended Vehicle



Item	Part Number	Description
1	N606688	Screw and Washer
2	N623343	U-Nut
3	N806110-S	Grommet
4	N608110	Grommet
5	1A376	Spare Wheel Carrier Mounting Bracket
6	1A480	Lift and Gear Assembly
7	1A480	Lift and Gear Assembly
8	N606688	Screw and Washer (2 Req'd)
A	—	Tighten to 23-34 Nm (17-25 Lb-Ft)

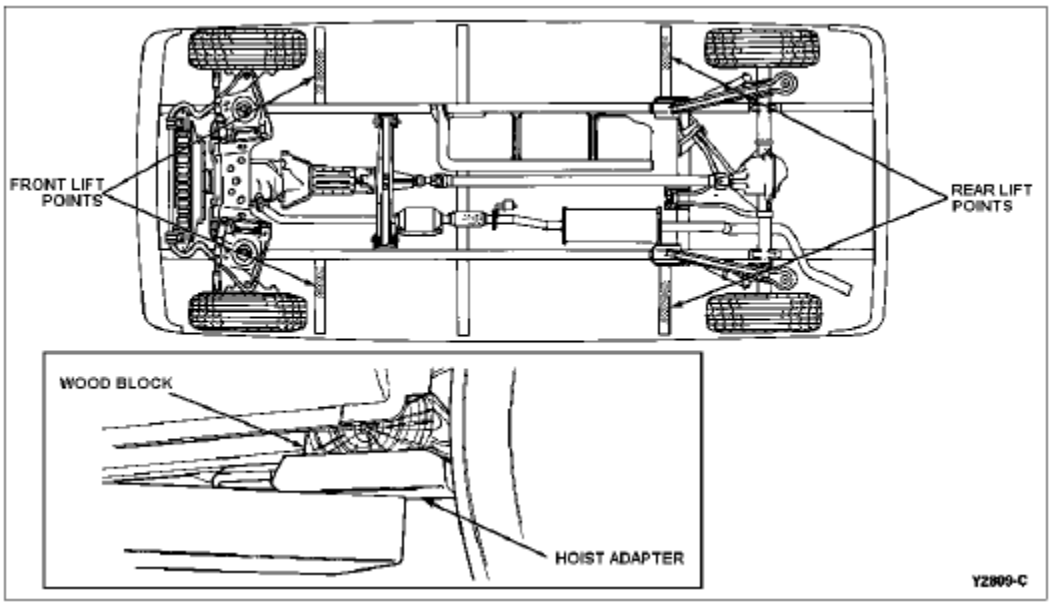
Lifting Instructions

Refer to manufacturer's operating manual for proper lifting procedures.

Hoist, Single Post

CAUTION: When raising a vehicle on a single-post hoist, place a wood block between the frame lift point and hoist adapter. This provides adequate clearance to prevent damaging the lower body.

Hoist Lift Points, Single-Post Hoist



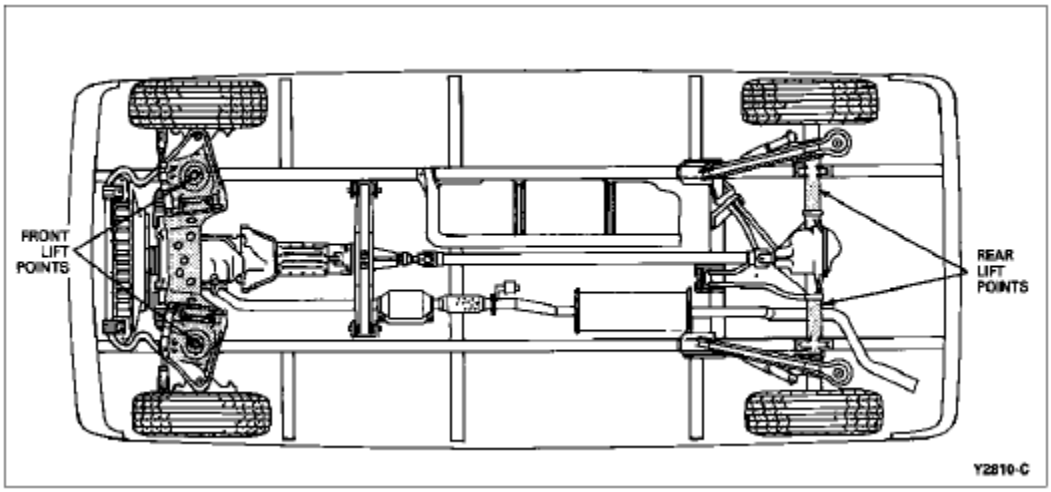
Hoist, Twin Post

WARNING: DO NOT LIFT VEHICLE USING TORSION BARS.

CAUTION: Damage to suspension, rear axle cover or steering linkage components may occur when positioning hoist adapters. Front adapter pads should be positioned carefully at 45 degrees, down and forward to ensure maximum contact under the center of lower suspension arms or spring supports as near wheels as practical. Rear suspension hoist adapters (forks) should be placed vertically under rear axle tubes, but adapters must not interfere with lower control arm mounting brackets or hydraulic brake lines.

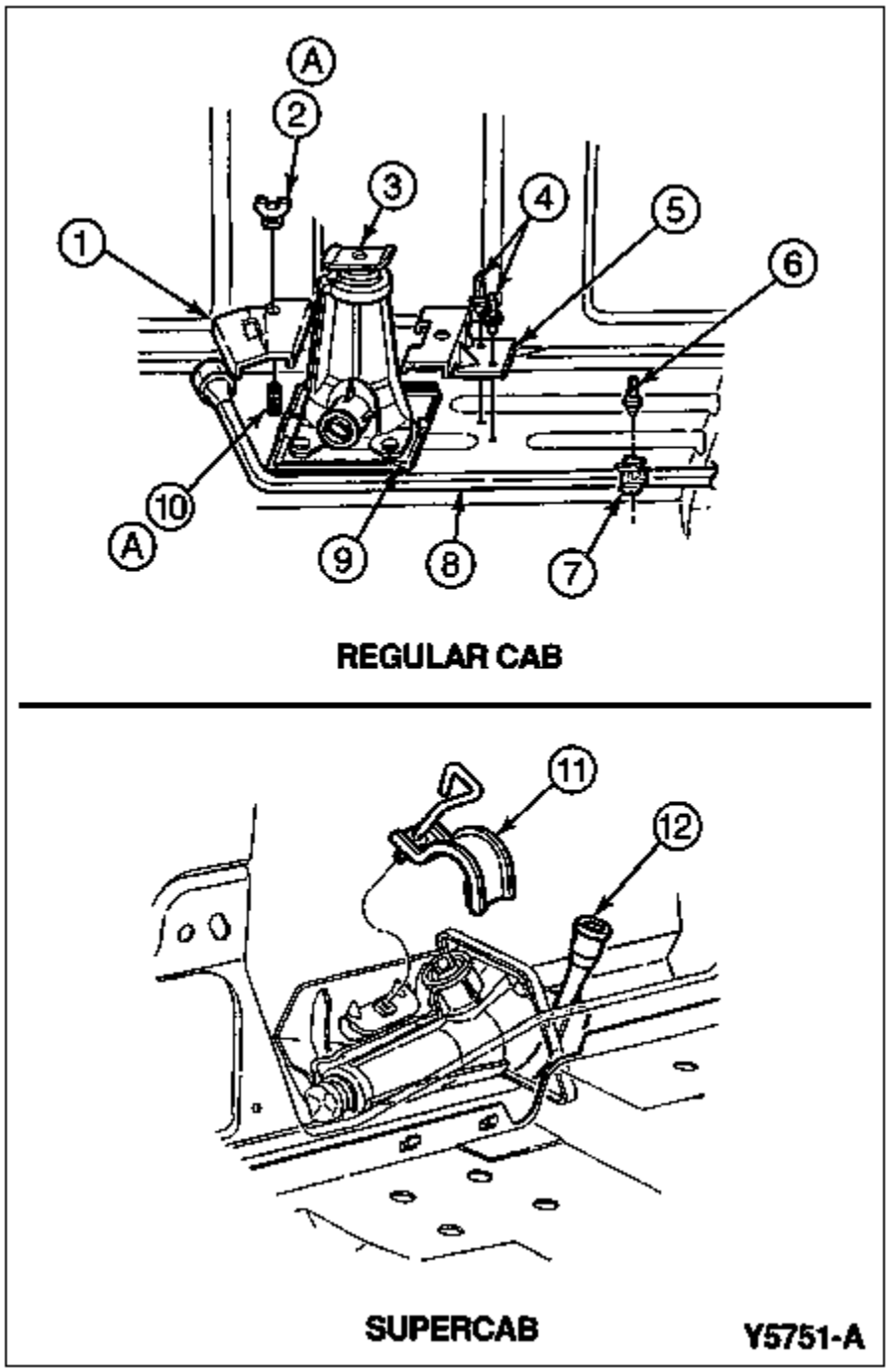
CAUTION: When raising a vehicle on a twin-post hoist, care should be taken to position the vehicle so that the hoisting adapters (forks) do not damage the axle carrier casting or rear cover, or contact the front stabilizer bar or brackets.

Hoist Lift Points, Twin-Post Hoist, Aerostar



Jack, Floor

The Ranger jack (17080) is located behind the passenger seat. The SuperCab jack is located in the side panel storage area behind the passenger seat.



Item	Part Number	Description

1	17A053	Bracket — Wheel Nut Wrench Hold Down
2	N808711-S	Nut
3	17080	Jack
4	380098-S8	Rivet (2 Req'd)
5	17A056-A	Bracket — Jack Hold Down
6	380098-S8	Rivet (1 Req'd)
7	351027-S2	Clip (1 Req'd)
8	17035	Wheel Nut Wrench
9	17A124	Insulator Jack Stowage
10	—	Stud (Part of 17080)
11	17A059	Bracket Assembly — Jack Hold
12	17035	Wheel Nut Wrench
A	—	Tighten to 2-3 Nm (18-27 Lb-In)

WARNING: TO MINIMIZE THE RISK OF PERSONAL INJURY, DO NOT PUT ANY PORTION OF YOUR BODY UNDER THE VEHICLE WHILE THE VEHICLE IS ON THE JACK. THE JACK IS PROVIDED FOR EMERGENCY WHEEL AND TIRE CHANGING ONLY. IF THE VEHICLE IS TO BE SERVICED, SUPPORT THE VEHICLE ON JACK STANDS. NEVER START THE ENGINE WHILE THE VEHICLE IS SUPPORTED ON THE JACK.

WARNING: ON VEHICLES EQUIPPED WITH A TRACTION-LOK® AXLE, NEVER RUN THE ENGINE WITH ONE WHEEL OFF THE GROUND, SUCH AS WHEN CHANGING A TIRE. THE WHEELS STILL ON THE GROUND COULD CAUSE THE VEHICLE TO MOVE.

WARNING: WHEN LIFTING A VEHICLE WITH THE VEHICLE JACK OR ANY FLOOR JACK, SET THE PARKING BRAKE AND BLOCK THE DIAGONALLY OPPOSITE WHEEL TO PREVENT VEHICLE FROM MOVING.

WARNING: POSITION FLOOR JACKS UNDER AXLES AS CLOSE TO THE WHEELS AS POSSIBLE. DO NOT SET FLOOR JACK UNDER SHOCK ABSORBER. IT IS IN AN UNSTABLE LIFT POSITION. REFER TO THE FOLLOWING ILLUSTRATIONS.

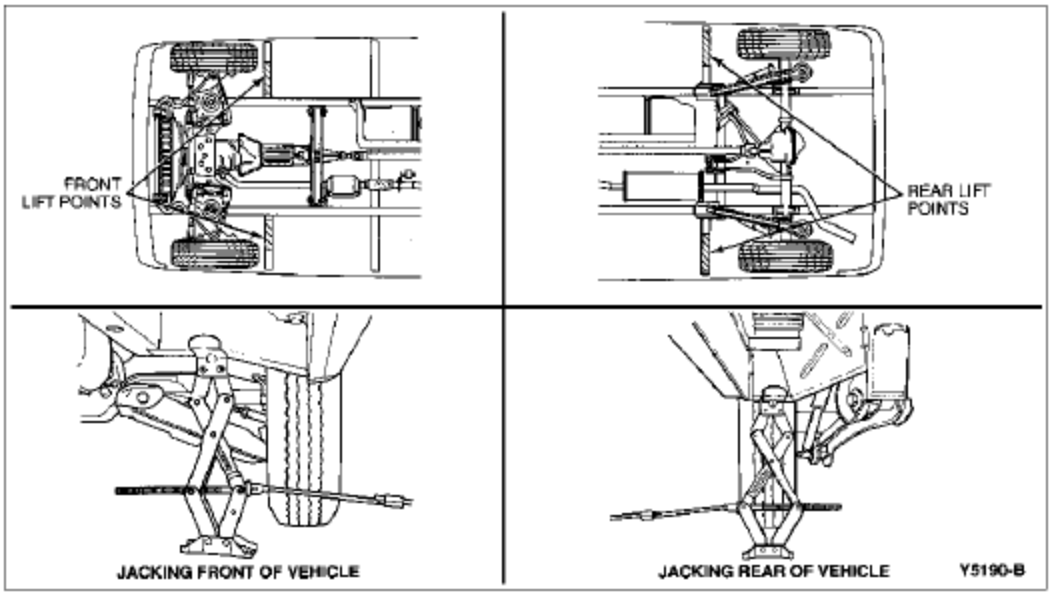
CAUTION: Do not use the differential housing as a lift point. Leaks or damage to the rear axle cover and adjoining differential housing surface may occur if a floor jack or any lifting device is allowed to contact the cover at any point where the cover joins the housing.

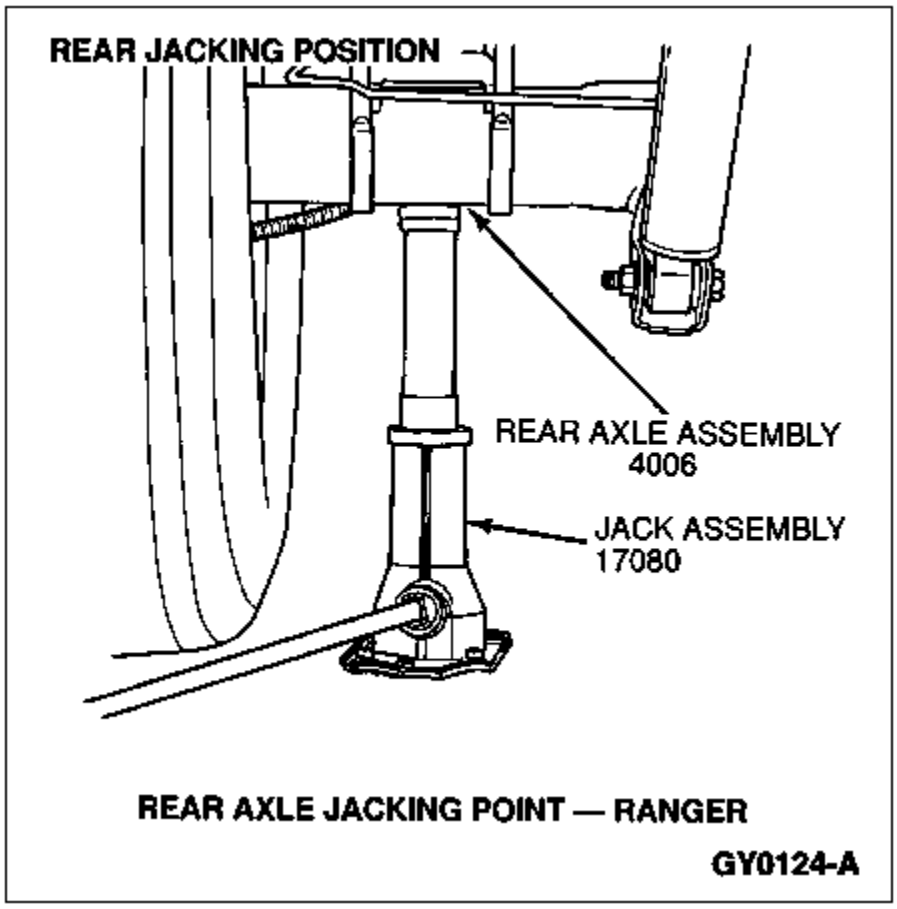
CAUTION: On vehicles equipped with an under-chassis mounted spare tire, remove the tire, wheel or tire carrier from the vehicle before it is placed in a high lift position in order to avoid sudden weight release from the chassis.

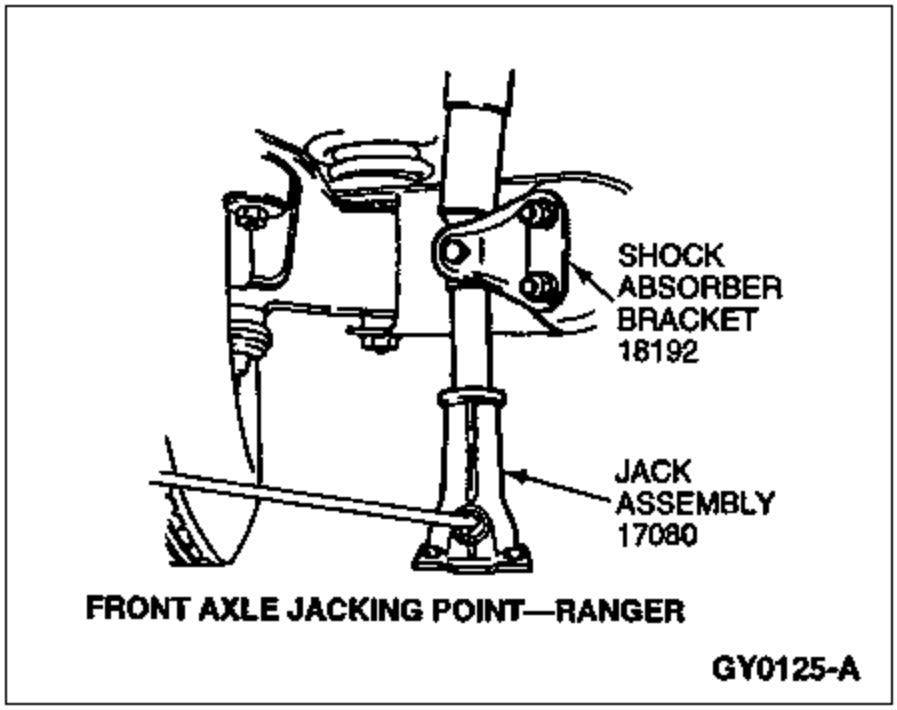
CAUTION: With transfer case in N (NEUTRAL), neither the automatic transmission P (PARK) nor the manual transmission R (REVERSE) position will hold the vehicle stationary. Do not leave the vehicle unattended with the transfer case (if so equipped) in N (NEUTRAL). When one rear wheel is lifted off the ground, neither the automatic transmission P (PARK) position nor the manual transmission R (REVERSE) position will prevent the vehicle from moving and possibly slipping off the jack, even if those positions are properly engaged. To prevent inadvertent vehicle movement while changing a tire, always set the parking brake fully and always block the wheel diagonally opposite the wheel being changed.

Position the scissors-type emergency jack as shown in the following illustrations.

Jacking Points, Aerostar


FRONT
LIFT POINTS
REAR LIFT
POINTS
JACKING FRONT OF VEHICLE
JACKING REAR OF VEHICLE
Y5190-B


REAR JACKING POSITION
REAR AXLE ASSEMBLY
4006
JACK ASSEMBLY
17080
REAR AXLE JACKING POINT — RANGER
GY0124-A



1. Automatic transmission: place shifter in P position. Manual transmission: place shifter in reverse. Four-wheel drive: place transfer case in 2H, 4H or 4L.
2. Set parking brake and block both sides of diagonally opposite wheel.
3. Remove jack, jack handle sections, lug wrench and spare tire.
4. Remove wheel cover (if equipped) with plastic coated tip of lug wrench.
5. Loosen wheel nuts with lug wrench. Do not remove wheel nuts.
6. Raise jack to desired height by using the thumb wheel.
7. Position jack under the correct jacking point as shown on the front bracket on lower suspension arm or rear axle.
8. Remove wheel nuts.
9. Remove tire and install spare tire.
10. Replace wheel nuts and hand-tighten.
11. Lower vehicle.
12. Tighten wheel nuts with lug wrench to 115-156 Nm (85-115 lb-ft).
13. Restow flat tire.
14. Unblock wheel.
15. Restow jacking equipment.

SPECIFICATIONS

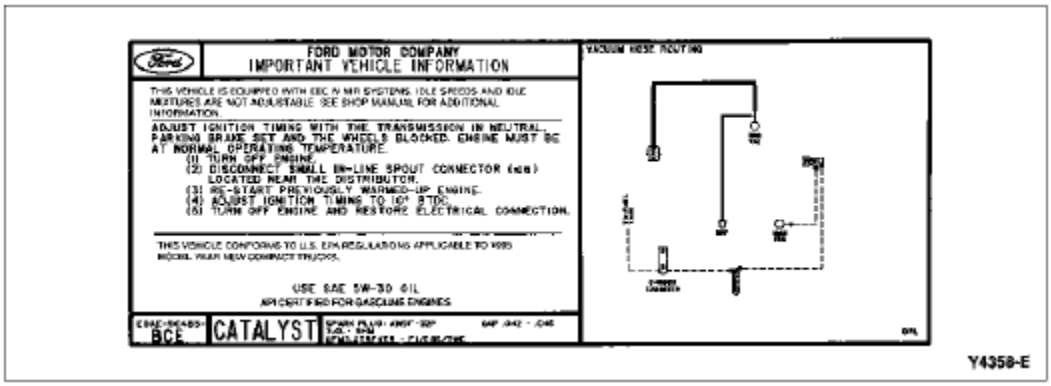
TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Ranger			
Nut, Support to Frame and Bracket	40-54	30-40	—
Nut, Retainer to Support and Channel	20-30	15-22	—
Nut, Hinge to Rear Crossmember	40-54	30-40	—
Eyebolt, Tire to Channel Assembly	8-10	70-80	—
Bolt, Hinge to Channel	28-42	21-30	—
Bolt, Spare Tire Support Carrier	28-42	21-30	—
Aerostar			
Screw, Spare Wheel Carrier Mounting Bracket to Underbody	9-14	7-10	—
Screw, Spare Wheel Carrier Lift Assembly and Lift Gear Assembly to Underbody	9-14	7-10	—
Screw, Spare Wheel Bracket Support to Underbody	3.2-4.0	—	28.3-35

Vehicle Emission Control Information (VECI) Decal

Vacuum hoses on the engine (6007) use a color stripe to aid in hose routing checks. The stripe will usually be the same color as on the vehicle emission control information (VECI) decal, but the correct vacuum hose routing must be verified by using the correct component connections shown on the VECI decal.

Typical VECI Decal



Scheduled Maintenance — Emissions

The Emission Systems Required Maintenance Schedule lists the items required to maintain the vehicle emission systems at levels determined by the Federal Government (Environmental Protection Agency). Also printed is an index to a number of maintenance procedures, each of which is related to an item listed on the maintenance schedule. Use these procedures to perform the required emission system maintenance items listed on the maintenance schedules.

Maintenance service adjustments must conform to specifications contained here, listed in the specifications manual or shown on the Vehicle Emission Control Information Decal, or the emissions system may become inoperative.

As a safety precaution, before starting the engine (6007) to perform maintenance, ensure that the gearshift lever (7210) is in PARK (P) (automatic transmission) or NEUTRAL (N) (manual transmission), the parking brake control (2780) is set and the wheels are blocked.

Refer to the appropriate sections of the Powertrain, Drivetrain Manual and the Powertrain Control/Emissions Diagnosis Manual for the maintenance procedures, which are related to the items listed in the maintenance schedule. Use these procedures to perform the required emission system maintenance items listed in the maintenance schedules.

CAUTION: TO ENSURE THE DURABILITY OF THE VEHICLE AND ITS EMISSION CONTROL SYSTEMS, IT IS NECESSARY THAT SCHEDULED MAINTENANCE BE PERFORMED AT THE DESIGNATED INTERVALS.

CAUTION: FORD RECOMMENDS THE USE OF GENUINE FORD REPLACEMENT PARTS. THE MAINTENANCE, REPLACEMENT, OR REPAIR OF THE EMISSIONS CONTROL DEVICES AND SYSTEMS (THE COST OF WHICH IS NOT COVERED BY WARRANTY) MAY BE PERFORMED BY ANY AUTOMOTIVE REPAIR ESTABLISHMENT OR INDIVIDUAL AND MAY USE OTHER THAN FORD SERVICE PARTS FOR SUCH MAINTENANCE OR REPAIR. IF OTHER THAN FORD OR MOTORCRAFT PARTS OR FORD AUTHORIZED REMANUFACTURED PARTS ARE USED FOR MAINTENANCE REPLACEMENTS OR THE SERVICE OF COMPONENTS AFFECTING EMISSIONS CONTROL, THE OWNER SHOULD ASSURE HIMSELF THAT SUCH PARTS ARE WARRANTED BY THEIR MANUFACTURER TO BE EQUIVALENT TO GENUINE FORD MOTOR COMPANY PARTS IN PERFORMANCE AND DURABILITY. PLEASE CONSULT THE WARRANTY BOOKLET FOR COMPLETE WARRANTY INFORMATION.

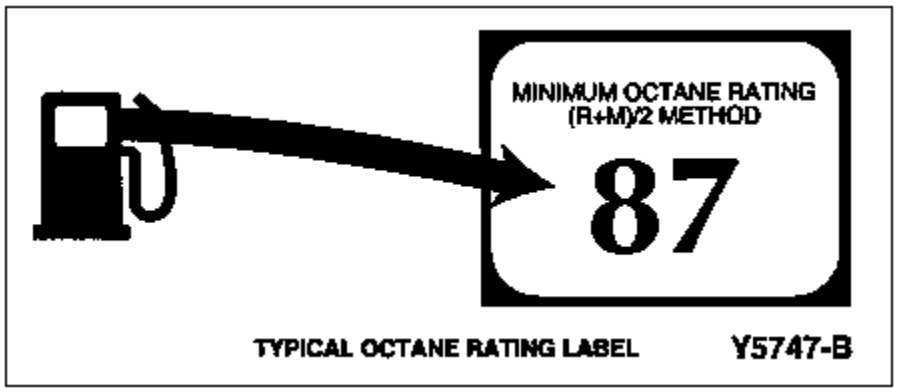
NOTE: The positive crankcase ventilation (PCV) valve is a critical emissions component. The dealer will replace the valve at no cost at 60,000 miles (96,000 kilometers) (except Canada and California vehicles).

Any modification of the emission control systems could create liability under federal law (U.S.) if made prior to the first sale and registration, and under the laws of some states if made thereafter. Further, federal law prohibits vehicle manufacturers, dealers and other persons engaged in the business of repairing, servicing, selling, leasing, or trading motor vehicles as well as fleet operations from knowingly removing or rendering an emission control system inoperative after sale and delivery to an ultimate purchaser. In Canada, modifications of the emission control system could create liability under applicable federal or provincial laws.

Gasoline Octane Rating

This vehicle is designed to use regular unleaded fuel with an octane rating of 87. At service stations, the octane rating is displayed in a label on the pumps.

Using a fuel with a lower octane rating can cause persistent and heavy knocking, which can damage the engine (6007).



TYPICAL OCTANE RATING LABEL Y5747-B

Engine Oil Viscosity

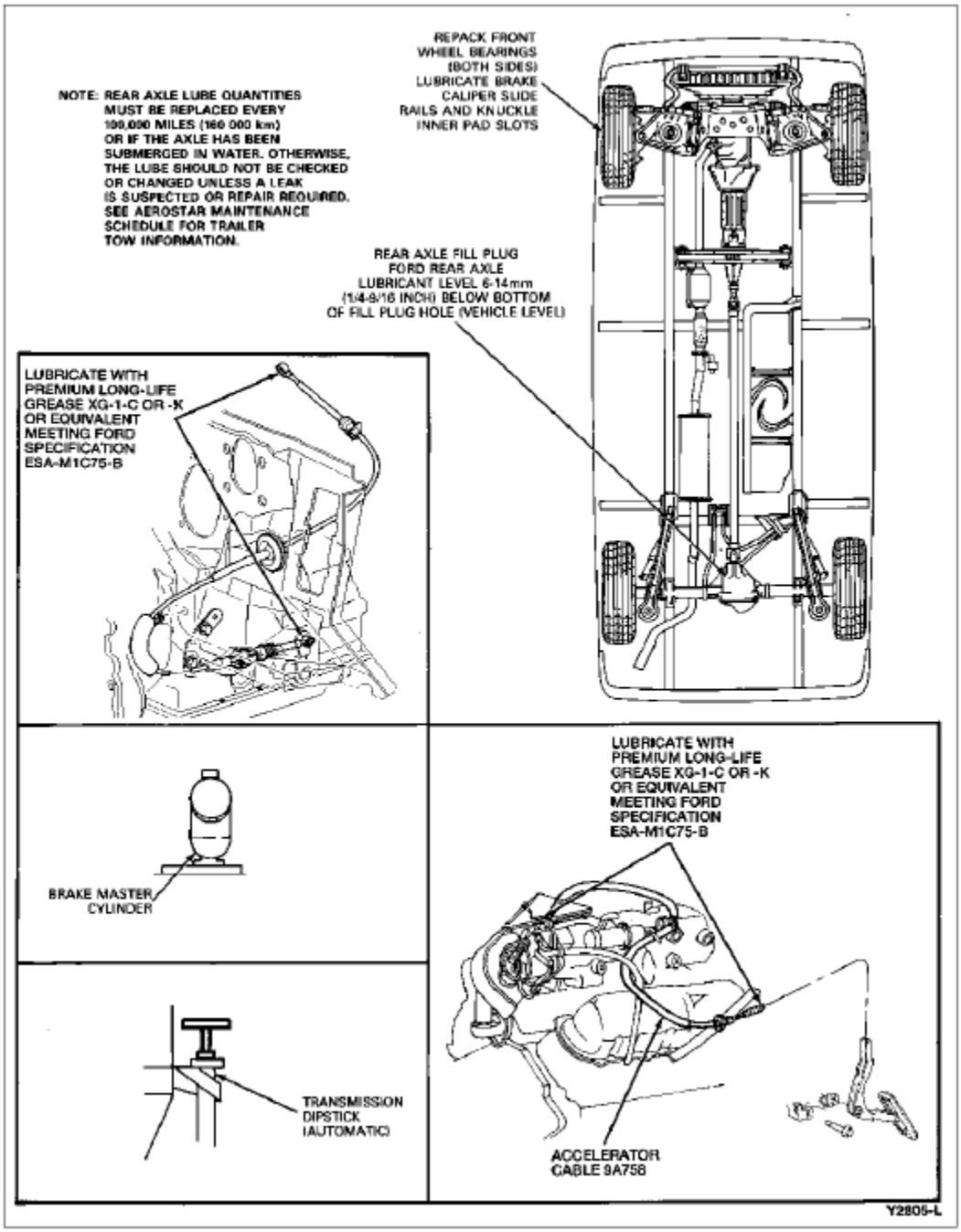
WARNING: CONTINUOUS CONTACT WITH USED MOTOR OIL HAS CAUSED SKIN CANCER IN LABORATORY MICE. PROTECT YOUR SKIN BY WASHING WITH SOAP AND WATER.

NOTE: All compact truck engines are filled with SAE 5W-30 oil at the factory.

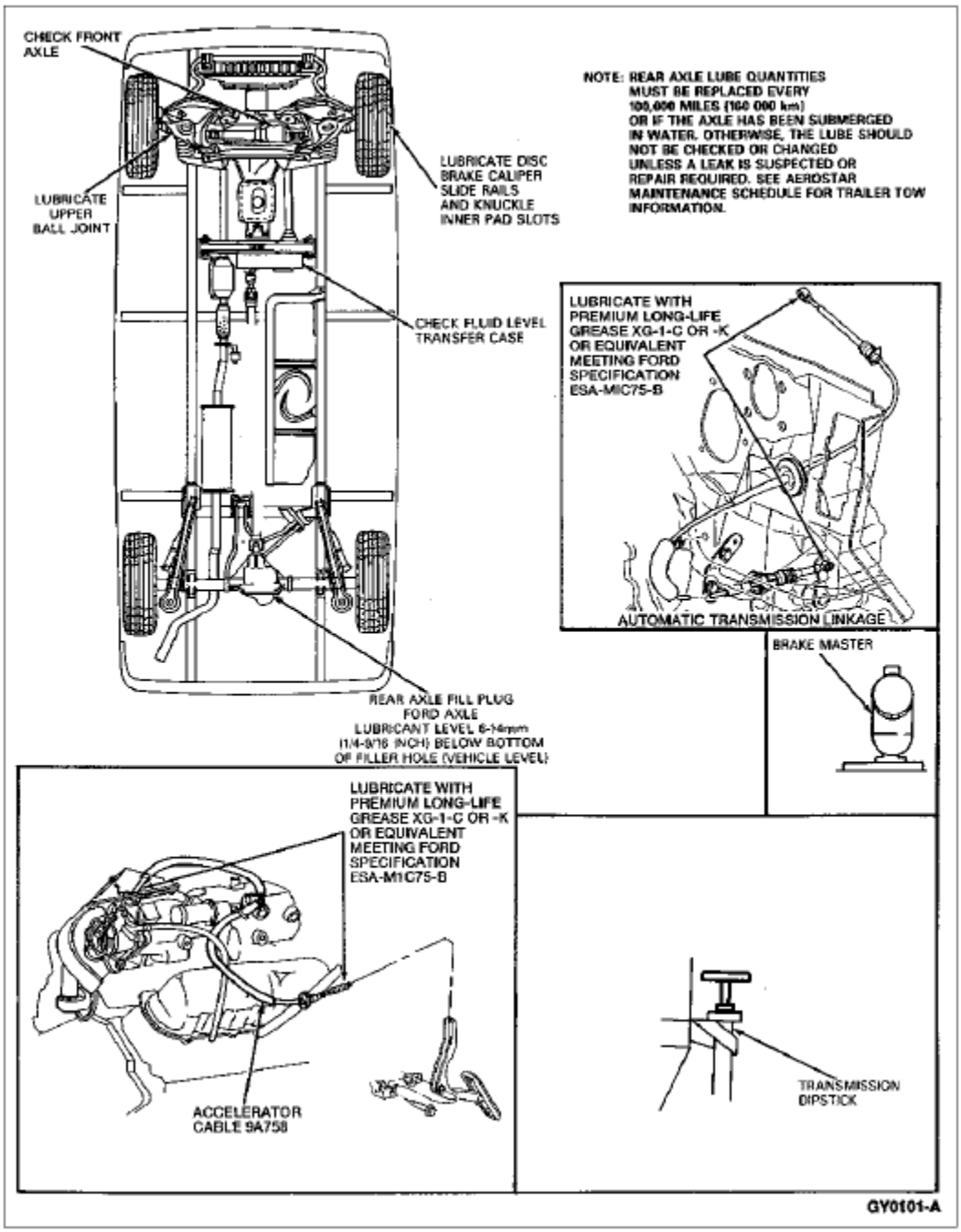
Engine oils with an SAE 5W-30 viscosity are PREFERRED for your vehicle. They provide the best engine performance, fuel economy and engine protection for all climates down to -25°C (-15°F).

Lubrication Points

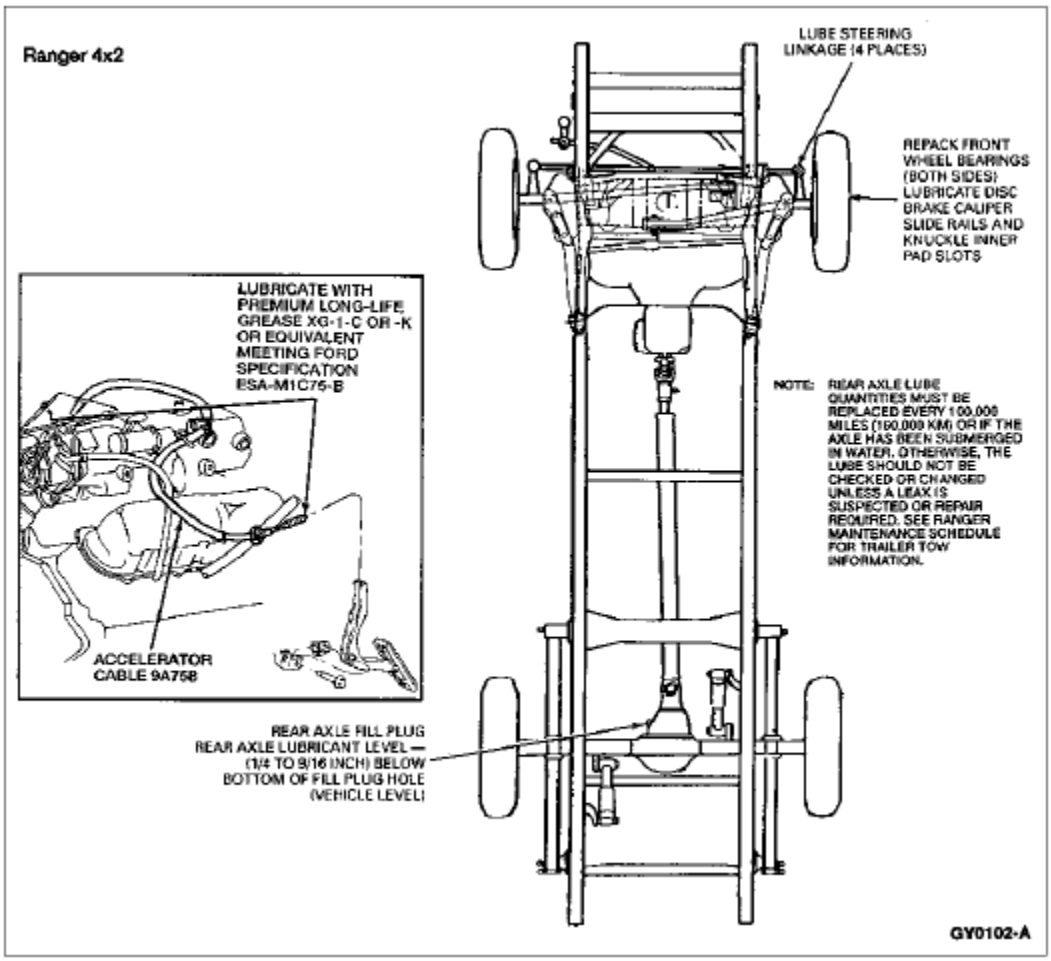
Aerostar 4x2



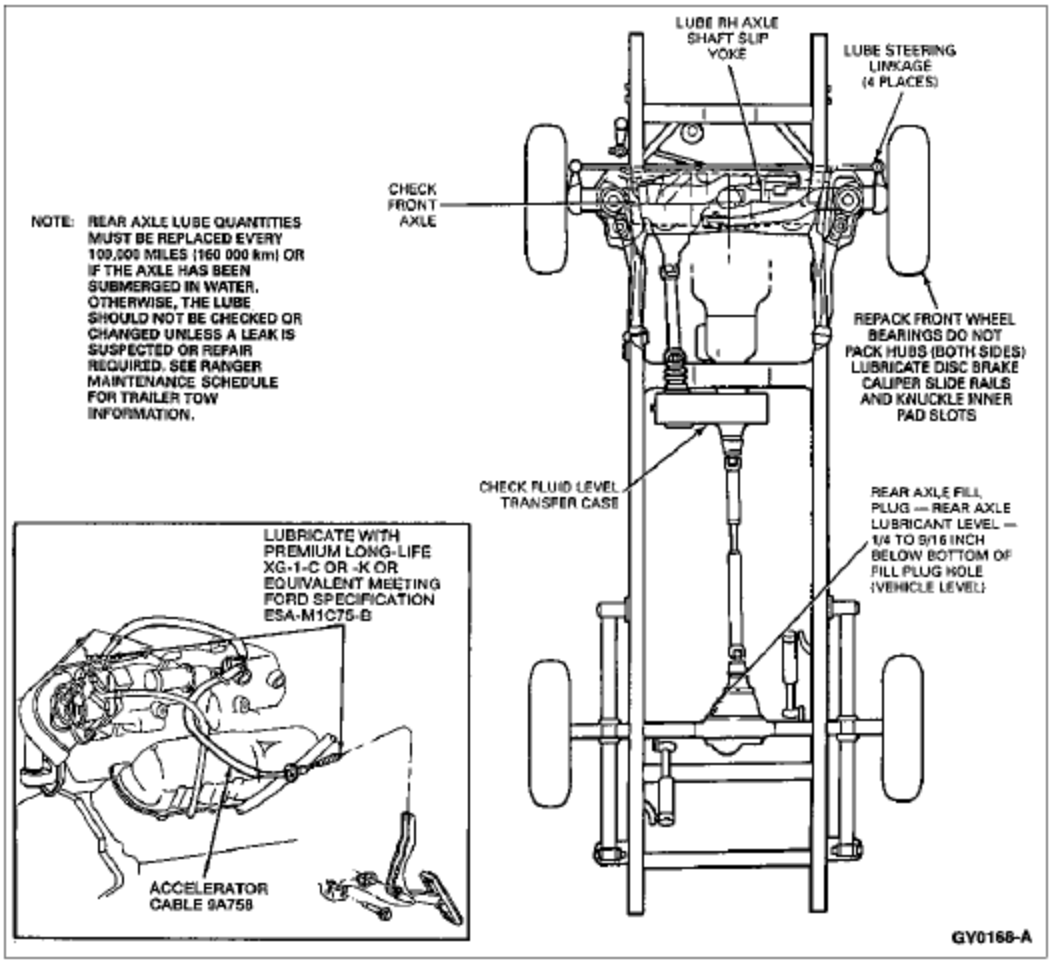
Aerostar E-4WD Chassis



Ranger

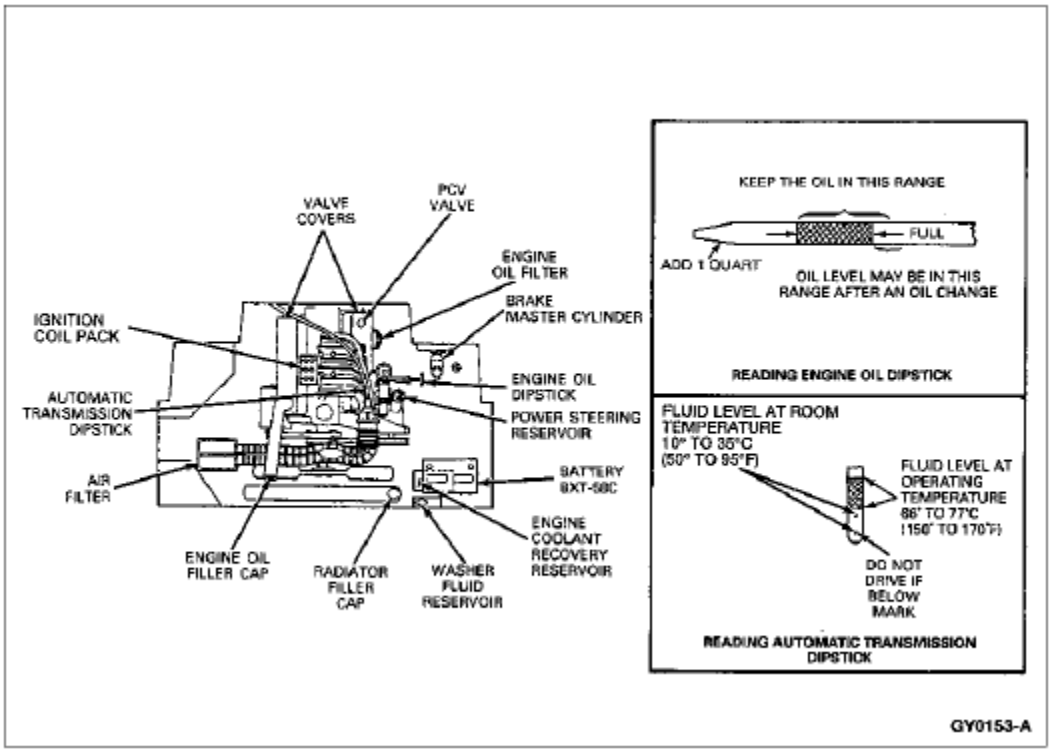


Ranger 4x4 Chassis

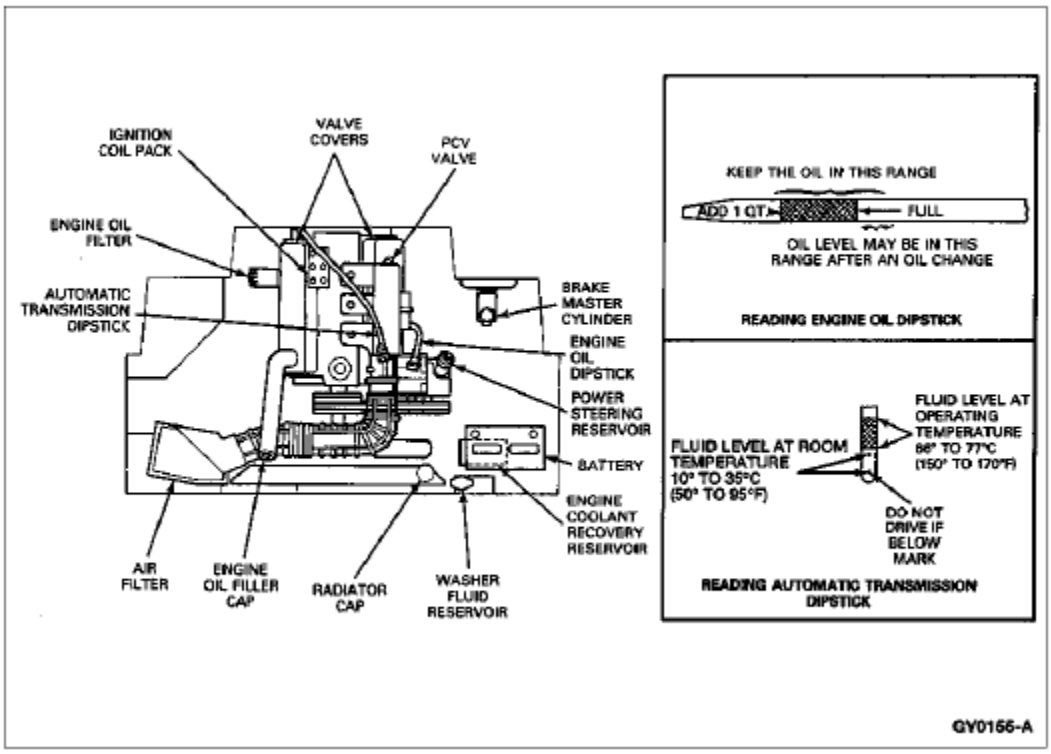

LUBE RH AXLE SHAFT SLIP YOKE
LUBE STEERING LINKAGE (4 PLACES)
CHECK FRONT AXLE
NOTE: REAR AXLE LUBE QUANTITIES MUST BE REPLACED EVERY 100,000 MILES (160 000 km) OR IF THE AXLE HAS BEEN SUBMERGED IN WATER. OTHERWISE, THE LUBE SHOULD NOT BE CHECKED OR CHANGED UNLESS A LEAK IS SUSPECTED OR REPAIR REQUIRED. SEE RANGER MAINTENANCE SCHEDULE FOR TRAILER TOW INFORMATION.
REPACK FRONT WHEEL BEARINGS DO NOT PACK HUBS (BOTH SIDES) LUBRICATE DISC BRAKE CALIPER SLIDE RAILS AND KNUCKLE INNER PAD SLOTS
CHECK FLUID LEVEL TRANSFER CASE
REAR AXLE FILL PLUG — REAR AXLE LUBRICANT LEVEL — 1/4 TO 9/16 INCH BELOW BOTTOM OF FILL PLUG HOLE (VEHICLE LEVEL)
LUBRICATE WITH PREMIUM LONG-LIFE XG-1-C OR -K OR EQUIVALENT MEETING FORD SPECIFICATION ESA-M1C75-B
ACCELERATOR CABLE 9A758
GY0168-A

Service Points Engine Compartment

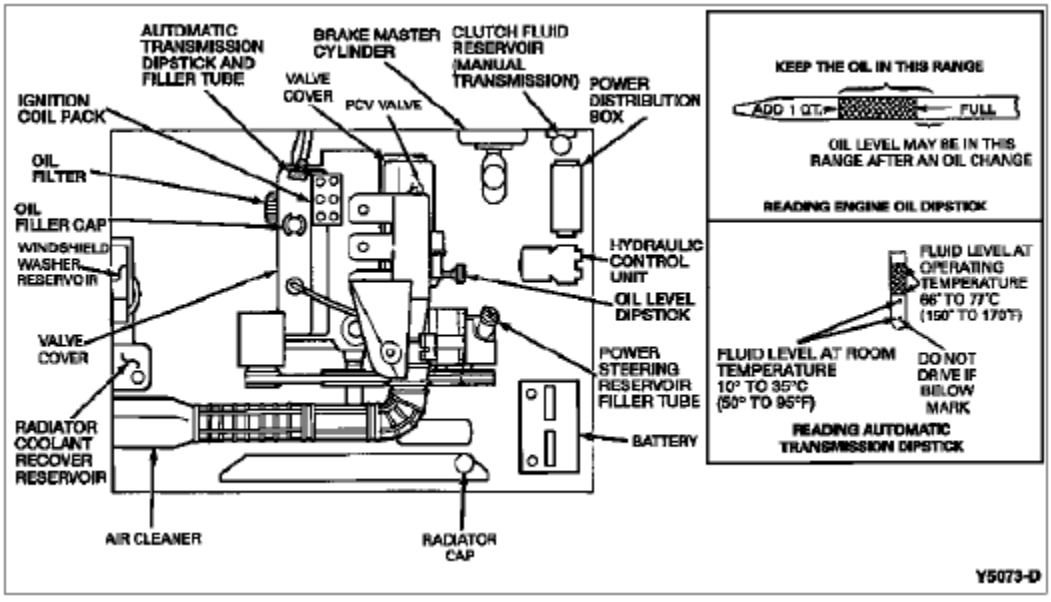
Aerostar — 3.0L Engine



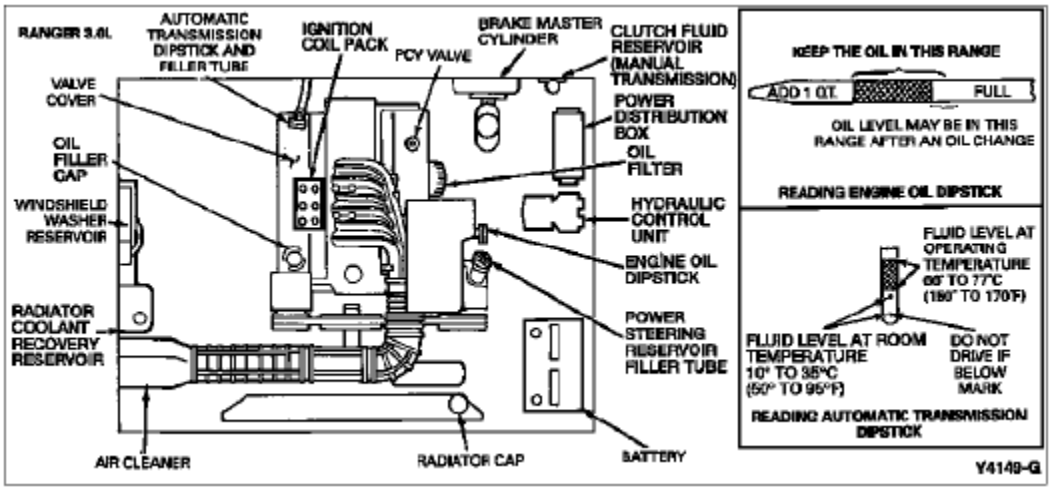
Aerostar — 4.0L Engine



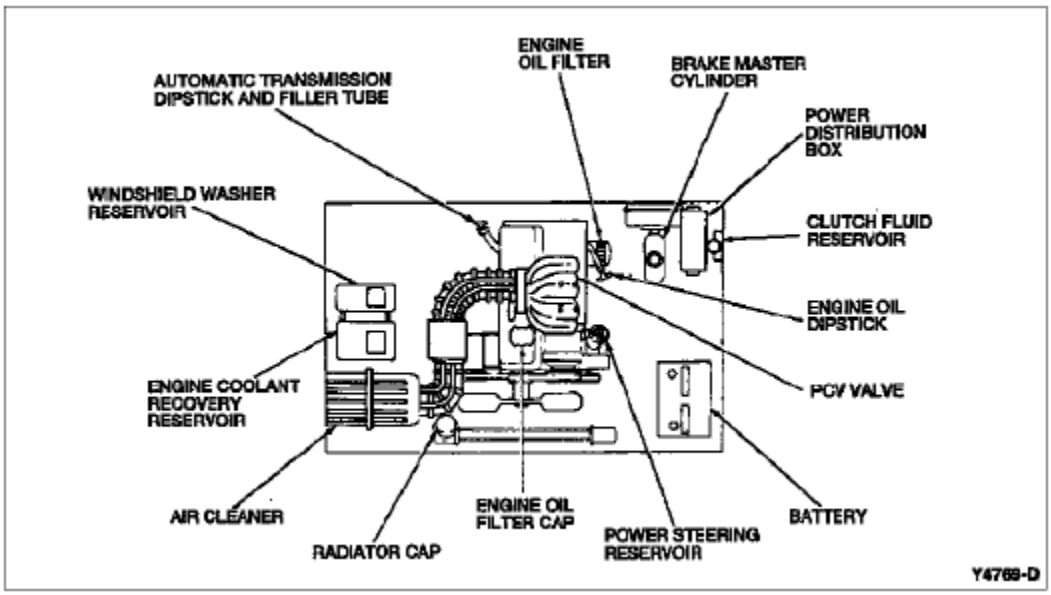
Ranger — 4.0L Engine



Ranger — 3.0L Engine



Ranger — 2.3L Engine



Inspection and Verification

Leaks

Visually inspect for dust and water leaks. Any unsealed crevice or small opening in the lower section of the body will permit dust and water to be drawn into the body.

To determine the exact location of a dust/water leak, remove the following trim from the vehicle:

- Cowl trim panel. Refer to Section 01-05A or Section 01-05B .
- Quarter trim panel.
- Rear seat back and seat cushion. Refer to Section 01-10 .
- Carpet and side trim panel. Refer to Section 01-05A or Section 01-05B .
- Spare tire.
- Center pillar trim. Refer to Section 01-05A or Section 01-05B .
- Scuff plates. Refer to Section 01-05A or Section 01-05B .

After removing the trim, the location of most leaks will be evident. The entrance of dust is usually indicated by a pointed shaft of dust or silt. Seal these leaks, then road test the vehicle on a dusty road to make sure all leaks are sealed.

Noise

Wind noise, rattles and their sources are detected by driving the vehicle at highway speeds in four different directions. Listen for sources of noise with all windows closed, radio off, heater and air conditioner blower motor turned off and ventilation ducts open. A stethoscope can be used to pinpoint the source of wind noise.

Most wind noise-producing leaks will occur at the door and window seals or at sheet metal joints in the door or the door opening in the body.

tomsn048@gmail.com

tomsn048@gmail.com

Symptom Chart — Body Service

BODY SERVICE

Condition	Possible Source	Action
• Dust Leak	• Cowl trim panel, kick pads, and floor mats.	• REMOVE trim. CHECK for leaks and SEAL with appropriate sealer. ROAD TEST for leaks. RECHECK trim for leaks, or USE light under vehicle with trim removed. CHECK interior of body at joints and weld lines.
• Dust/Water Leaks at Floorpan and Grommets	• Missing or damaged plugs and/or grommets.	• CHECK plugs for proper installation.
• Drain Holes Collecting Water	• Holes clogged with mud or road tar.	• CHECK drain holes regularly. CLEAN drain holes of dirt and foreign material with a punch or screwdriver.
• Wind Noise, Air Entering Vehicle Through Small Holes in Body	• Leaks at door and window seals or sheet metal joints in doors or door openings.	• SEAL leaks with RTV sealant and foam tape. ROAD TEST, or USE Vacuum Leak Detector 164-R0256 or equivalent to obtain a water leak reading. RECHECK for leaks using detector. ROAD TEST.
• Rattles	• Loose screws, nuts, bolts, small pieces of body deadener in door wells, pillars, and quarter panels.	• CHECK doors by carefully striking underside of door with a mallet. LISTEN for loose objects in door. REPAIR. TIGHTEN body bolts and screws.
	• If tightening bolts and screws does not eliminate rattle, cause could be misalignment.	• REFER to Section 01-03 for adjustment and alignment procedures.
	• Weatherstripping and anti-squeak material has slipped out of position.	• APPLY additional cement or other adhesive; INSTALL in proper location to eliminate rattle.

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Dust and Water Leaks

After trim removal has revealed the location of leaks, seal these leaks, and road test the vehicle on a dusty road to make sure all leaks are sealed. Dust entry is usually indicated by a pointed shaft of dust or silt at the point of entrance. After the road test, check for indications of a dust pattern around the door openings, cowl panel, and cowl side panel.

Sometimes leaks can be located by putting bright lights under the vehicle, with the above components removed, and checking the interior of the body at joints and weld lines. The light will show through where leaks exist. The Vacuum Leak Detector 164-R0256 or equivalent can locate dust and water leaks.

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Wind Noise

Seal all leaks with RTV sealant foam tape or by positioning or replacing the seals. Road test the vehicle to make sure all leaks have been adequately sealed.

An alternate method of verifying corrective actions involves the use of Rotunda Combination Engine EAR/Chassis EAR 107-R2102 or equivalent. After identifying the leak point through a drive evaluation, obtain a meter reading by using the leak detector. A check with the leak detector after repairing the leak will verify the effectiveness of the corrective action. A final test drive may still be advisable to make sure other objectionable leaks, not noticed because of a major leak, do not exist.

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Rattle Elimination

All bolts and screws should be tightened periodically. In the event that tightening the bolts and screws, located on such assemblies as the doors, hood and door does not eliminate the rattles. Refer to Section 01-02 and Section 01-03 .

Rattles and squeaks are sometimes caused by weatherstripping and anti-squeak material that has slipped out of position. Apply additional cement or other adhesive.

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Body Sealant Locations

The body sealant locations are as follows:

- front floorpan and rear floorpan
- quarter wheelhouse inner panel and quarter wheelhouse outer panel
- dash panel
- running boards
- door openings
- roof side drip rail

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Body Side Stone Protection Vinyl, Lower

Materials Required

- Abrasion Resistant Coating available from paint companies and other aftermarket coating manufactures.
- Color Coat Paint System
- Silicone and Wax Remover
- Multi-Purpose Paint Precleaner (Spray Gun Cleanup) VC-542-A

Equipment, Suggested

- Rotunda Spray Gun 085-R1626 (No. 63 Air Cap, No. SS Fluid Tip, No. 363 AN needle) or equivalent
- Rotunda Detached Pressure Cup 085-R1617, 1.89 liter (2 quarts), with Air-Adjusting Gauge or equivalent
- Rotunda Dual Action Sander 107-R1619 or equivalent
- Rotunda Heat Gun 107-R0300 or equivalent
- No. 180-Grit Paper
- Lint-Free Cloth
- Tack Cloth
- Regular Masking Tape
- No. 80 Disc for Disc Sander
- No. 220/240 Disc

A large area resulting from peeling or damage will necessitate removal of the factory sprayed-on vinyl coating. The following procedure is suggested.

NOTE: Where sheet metal is damaged to the extent that fender, door or quarter panel replacement is required (or in initial installation), disregard Steps 1 and 2.

NOTE: Approximately 1.89L (2 quarts) is required for an initial installation on a vehicle similar to a factory-applied system. The specified dry film thickness of 15 to 20 mils will require at least three, or possibly four, applications of coating material, with flash-off time allowed between coats. As with painting, spray coat the complete lower panel.

As the adherence of this coating to properly prepared sheet metal is excellent, the necessity of prime painting the sheet metal prior to protective coating is eliminated. However, adhesion will be adversely affected unless the sheet metal area to be covered (either repaired or new) is prepared in accordance with the following procedure.

1. Using Rotunda Heat Gun 107-R0300 or equivalent, or lamp, soften the vinyl coating until it is pliable. Scrape off the softened vinyl with a putty knife or similar tool. If necessary, sand off any hard-to-remove vinyl coating using an orbital disc sander (No. 80 disc). (Abrasion resistant coating is not suitable for "spot" corrections.)

2. Perform the necessary repairs to correct the sheet metal damage.

Vehicle, Masking

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Suitable covers should be installed over the wheels. Mask off all upper exterior body sheet metal. Remove wheel opening stone shields and mask mouldings.

NOTE: If the vehicle has lower body side mouldings above the "turn under" of the rocker panel, the moulding can serve as the upper margin of the area to be coated. If the vehicle does not have suitable mouldings, a sculpture or break line in the sheet metal can be used. However, the method used in masking off the upper coating margin line will depend on the presence or absence of mouldings in this area.

Masking tape should be positioned so that the moulding lower side is also covered. However, do not cover the sheet metal immediately below the moulding.

It is not necessary to mask off the body door openings in the coating area, as they will be uniformly coated where the door margins allow the coating to enter. However, these door opening areas should be cleaned to make sure of coating adherence.

Sheet Metal

Sheet Metal, Serviced

1. Scuff sand (No. 180 grit paper) the glossy surface of the painted areas to be coated.
2. Remove sanding dust using a lint-free tack cloth and compressed air.
3. Using a clean, lint-free cloth, solvent wipe the area to be coated with Multi-Purpose Paint Precleaner VC-542-A or equivalent, or wax and grease remover, and allow to flash-off.

Sheet Metal, New

1. The glossy surface of the paint in the coating area must be ground off with an air-driven D/A sander such as Rotunda Dual Action Sander 107-R1619 or equivalent. A 220/240 grit-disc does a good, fast job. **Do not** sand through the primer.
2. Scuff sand (No. 180 grit paper) the primer. Do not sand through the primer.
3. Remove sanding dust using a lint-free tack cloth and compressed air.
4. Using a clean, lint-free cloth, solvent wipe the area to be coated with Multi-Purpose Paint Precleaner VC-542-A or equivalent, and allow to flash-off.

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Coating Spray Procedure

The coating must be applied by an experienced automotive painter. The coating must be thoroughly agitated and used without thinning. As the material is reasonably heavy-bodied, a pressure cup equipped spray gun is recommended or appropriate equipment recommended by the coating manufacturer. Satisfactory coating appearance (minimal orange peel and sag) has resulted with gun air pressures of approximately 207 kPa (30 psi) and cup pressures of approximately 103 kPa (15 psi).

To protect the lower exposed painted fender, rocker, and quarter panel down flanges, the vehicle must be elevated high enough so that the painter can spray this area effectively. When an initial installation is to be made, a remote 1.89L (2-quart) capacity pressure cup makes a much more efficient tool, as the spray gun can be used closer to the floor. The spray gun, fluid hose and/or cup must be cleaned immediately after use. While lacquer thinner can be used when the suggested cleanup material is unavailable, the Multi-Purpose Paint Precleaner or equivalent is quicker and much more efficient. With the spray gun at 207 kPa (30 psi) and pressure feed cup at 103 kPa (15 psi) follow this procedure:

1. Apply a wet, sag-free coat. Allow three to five minutes flash-off time.
2. Apply the second wet, sag-free coat. Allow three to five minutes flash off-time.
3. Apply the third wet, sag-free coat. Allow three to five minutes flash off-time.
4. Apply the final wet, sag-free coat. Allow three to five minutes flash-off time and pull off the fine line tape, exposing the raw upper edge of the coating.
5. Immediately clean the spray equipment using Multi-Purpose Paint Precleaner VC-542-A or equivalent.
6. Allow at least two hours drying time at approximately 21°C (70°F).

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Color Coat

The complete coated area, as well as the upper raw edge, must be covered with color coat. Mask off the upper margin line using fine line tape positioned 1.59mm (1/16 inch) above coating edge. Using appropriate repair paint and application procedures (to include both prime and color coat), the protective coating area can now be finish painted.

If damaged sheet metal extends above the protective coating area, normal prime/color paint procedures should be followed.

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Bumpers, Plastic

Where substrate material has not been removed, cuts and cracks to the radiator grille opening panel or rear bumper covers can be repaired using the approved service material: 3M P.R.O. Fill EZ-Sand, No. 05895 or equivalent.

The following repair procedures can be used for either the radiator grille opening panel or the rear bumper covers.

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Bumpers, Polypropylene

The following three types of damaged bumpers are considered repairable:

- A bumper with a hole less than 50mm (1.97 inches) in diameter.
- A bumper with a crack less than 100mm (3.94 inches) in length.
- A bumper with a crack less than 100mm (3.94 inches) in length that is less than half of the width of the bumper.

Although a bumper which has been damaged greater than this could also be repaired, it should be replaced with a new one. This is because such repair would detract from the beauty and quality of the bumper due to the decrease of the adhesive strength, etc. In addition, such repair is not considered reasonable in terms of work load.

Repair polypropylene bumpers having flaws that have reached the surface of the polypropylene and are too serious to be restored by painting.

1. Cut the rough edges around the flaw with a knife to make it smooth. Sand the area with a sander to make an angle of about 45 degrees.

2. **NOTE: Heat only the shaded area to melt it.**

   Weld damaged area.

   - For repair of a cracked area, melt the crack together using Rotunda Airless Plastic Welder 107-01250 or equivalent.
   - For repair of a hole, degrease the area and the reverse side of the damaged area. Install aluminum tape on reverse side of damaged area.

3. **CAUTION: Do not move the welding rod until the welded part cools.**

   NOTE: Take care not to excessively melt the welding rod. If the part is welded with the welding rod melted like jelly, the welding strength will be lowered.

   Melt the polypropylene welding rod with Rotunda Airless Plastic Welder 107-01250 or equivalent, and deposit it in the cracked area. Operate a heat gun 2-51mm (.5-2.0 inches) away from the part that will be welded.

4. **NOTE: Do not sand part continuously.**

   Sand the surface of the polypropylene little by little, since it is easily melted even by the abrasion heat. If melted, remove the melted area. Sand the areas to which repair agent will be applied.

5. Apply polypropylene primer uniformly to an area larger than the re paired area with a brush. It will take about 10 minutes to dry at 20°C (68°F).

6. **NOTE: When mixing the main and stiffening agents, be careful not to allow bubbles to form.**

   NOTE: Since the repairing agent hardens fast (about five minutes), proceed with the work

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immediately after mixing the agents.

It will take about 30 minutes to dry at 20℃ (68°F) before it can be sanded.

Mix the main agent and the stiffening agent in a ratio of one to one. Apply the mixed repair agent to the damaged area.

7. **NOTE: If excessive force is applied to the area when sanding, the surface will not become smooth.**

   NOTE: If there is fuzz around the repaired area, melt it by heating it slightly with a heat gun.

   Sand the area with No. 180-No. 240 sandpaper.

8. **NOTE: Polypropylene primer will dissolve, even after drying, if it is wiped with solvent. Use only water to clean.**

   Degrease the painted surface.

9. Dry the part.

10. Add the flex agent to the urethane primer surfacer and spray it on the repair.

11. Air dry at 20℃ (68℉) for eight hours.

    Force dry at 60℃ (140℉) for one hour.

12. Lightly sand the area on which the primer surfacer is sprayed and the complete surface of the bumper with No. 400-No. 600 sandpaper. Do not expose the surface of the polypropylene. Wet sanding or dry sanding is acceptable.

13. **CAUTION: Use only polypropylene primer for a polypropylene bumper.**

    Wipe the complete surface of the bumper with degreasing agent. Quickly wipe the surface with a clean rag to degrease it.

14. Apply a matching coat of paint to the polypropylene bumper.

15. Force dry at 60℃ (140℉) for one hour. Air dry at 20℃ (68℉) for eight hours.

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Bumper Covers Plastic, Flair Mouldings

Where substrate material has not been removed, cuts and cracks to the bumper covers can be repaired using the approved service material: 3M P.R.O. Fill EZ-Sand, No. 05895 or equivalent.

The following repair procedures can be used for bumper covers.

Procedure 1 — Substrate Cuts or Cracks

Substrate Material Not Removed

1. Wipe repair area with silicone and wax remover, to ensure clean surfaces.

2. Apply a thin coating of Instant Adhesive E8AZ-19554-A or equivalent meeting Ford specification WSK-M2G402-A4 to one surface of the cut or crack. Position the surfaces very carefully together in their original position. Quickly and firmly press the two surfaces together for at least one minute. Good bond strength is developed after one minute but maximum strength requires 3 to 12 hours cure time. **Note the precautions on adhesive container.**

3. If the part did not have paint damage and the part was properly positioned, painting may not be required. However, if painting is necessary, proceed as follows:

    a. Scuff-sand the repair area with a sanding block and No. 400 paper. Be careful not to sand through the color coat surface. Usually dulling the surface is sufficient. Wipe off or clean the repair area with a clean, dry cloth or an air gun.
    b. Wipe the sanded surface with silicone and wax remover or equivalent.
    c. Refinish as described in this section under Refinishing Flexible Exterior Parts.

Procedure 2 — Substrate Holes, Gouges and Tears

Substrate Material Removed

1. Clean the repair with soap and water. Next, use Multi-Purpose Paint Precleaner VC-542-A or equivalent to remove grease and tar.

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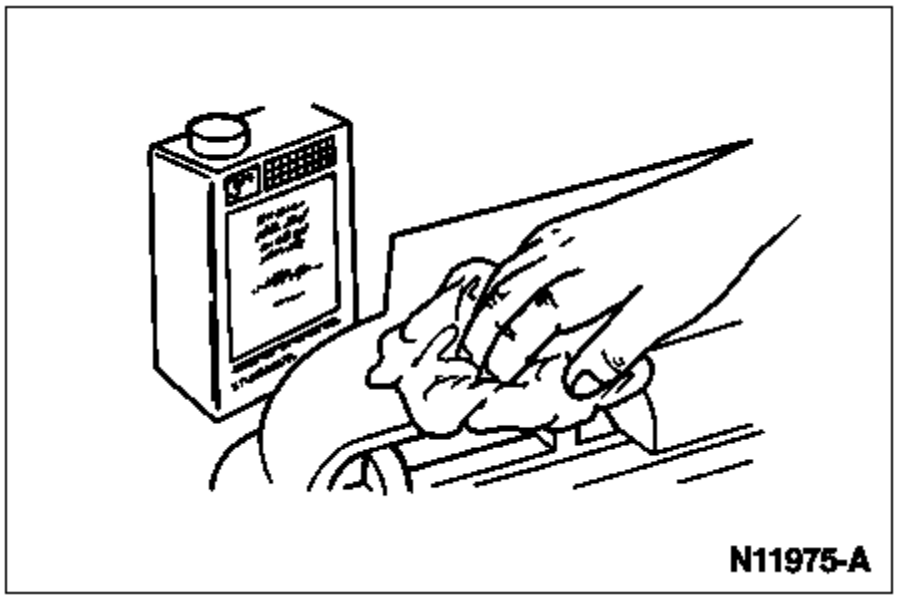
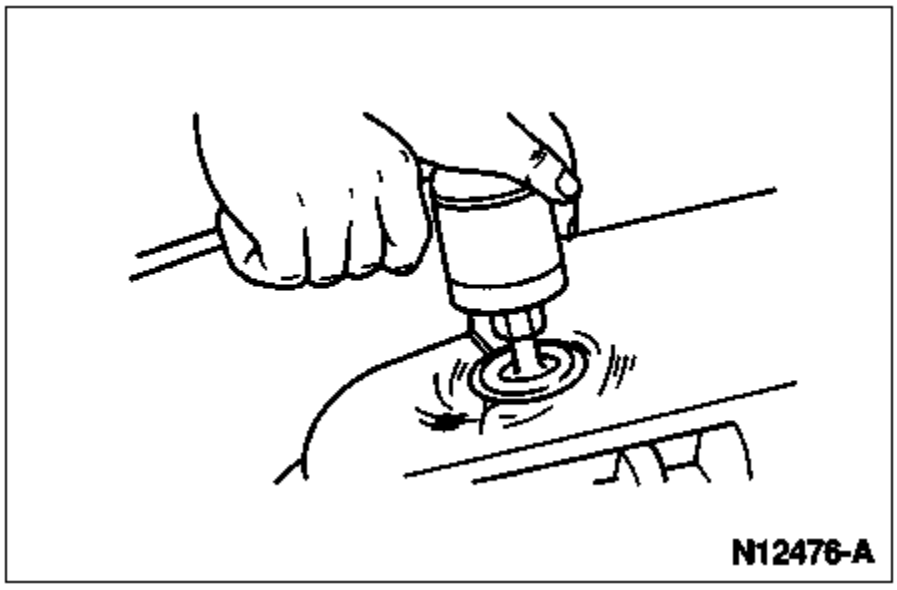


2. Grind the surface of the repair with a grade 36 disc or coarse abrasive paper. Grind about 38mm (1-1/2 inches) around the actual damage to obtain a taper for best adhesion.



3. Featheredge the paint around the repair with grade 180A sandpaper. Wipe with a clean dry rag and blow off with an air hose.

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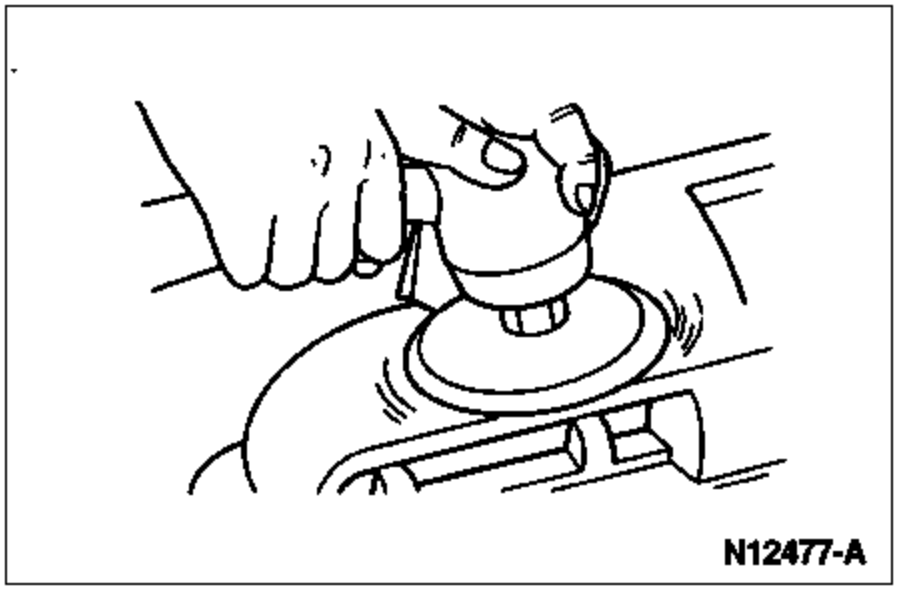
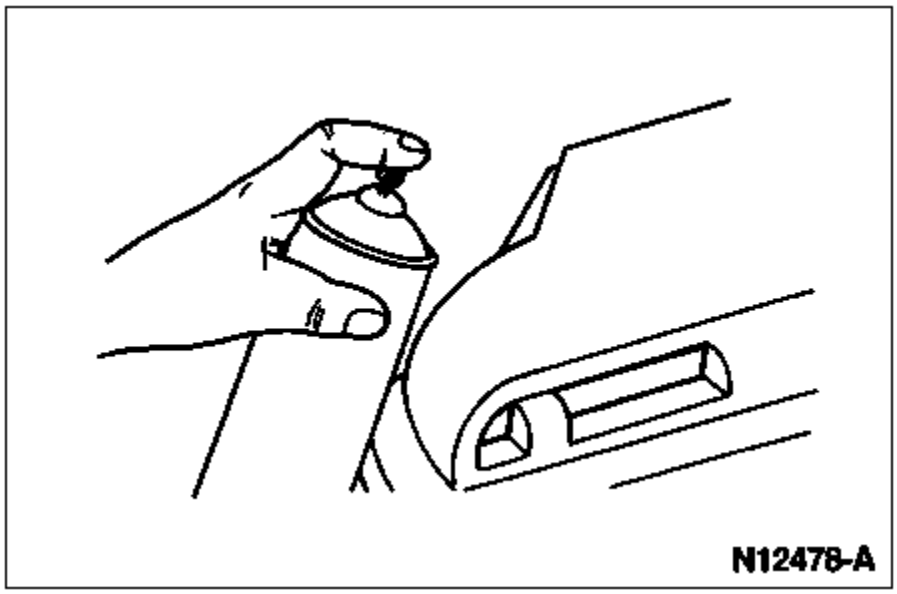


4. **NOTE: It will be necessary to reapply polyolefin adhesion promoter after any sanding step.**

   Apply one wet coat of polyolefin adhesion promoter over the sanded surface and allow to dry for 10 minutes.



5. Mix 3M P.R.O. Fill EZ-Sand repair material according to instructions and apply to the repair with a squeegee. Apply the material, building it up higher than the undamaged area. Allow it to cure for 20-30 minutes at 18°-21°C (60-80°F).

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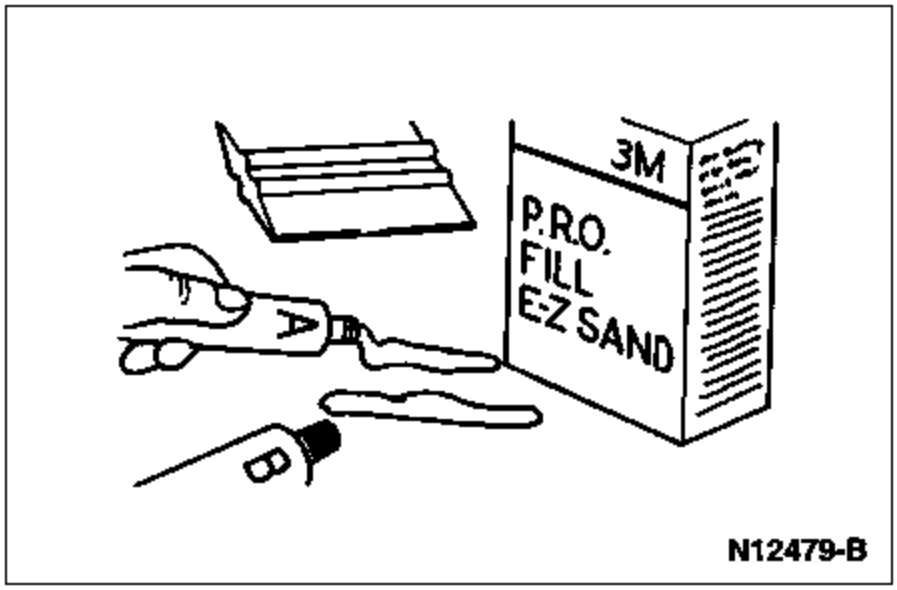
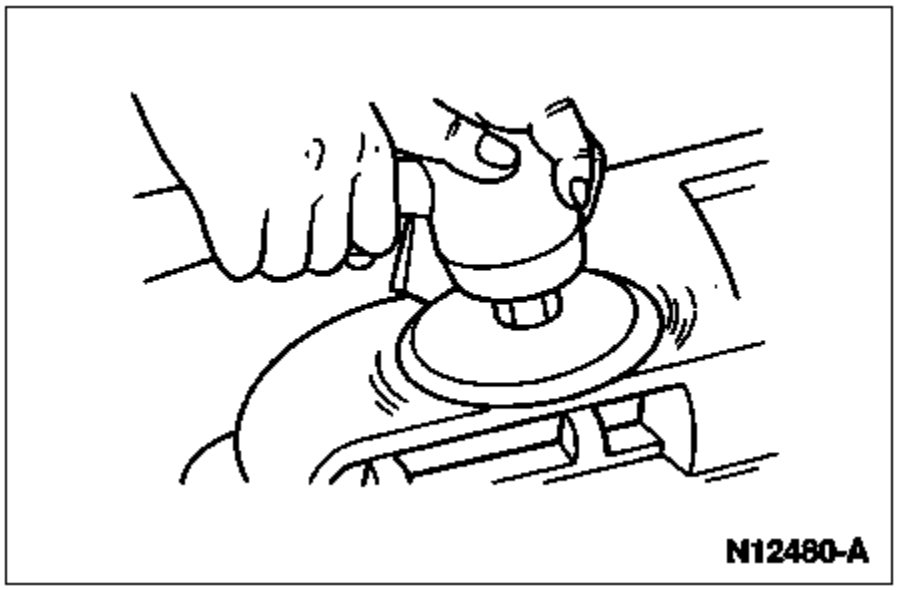


6. After curing, sand with grade 180A sandpaper, followed by grade 240A discs.



7. Reapply polyolefin adhesion promoter and let dry.

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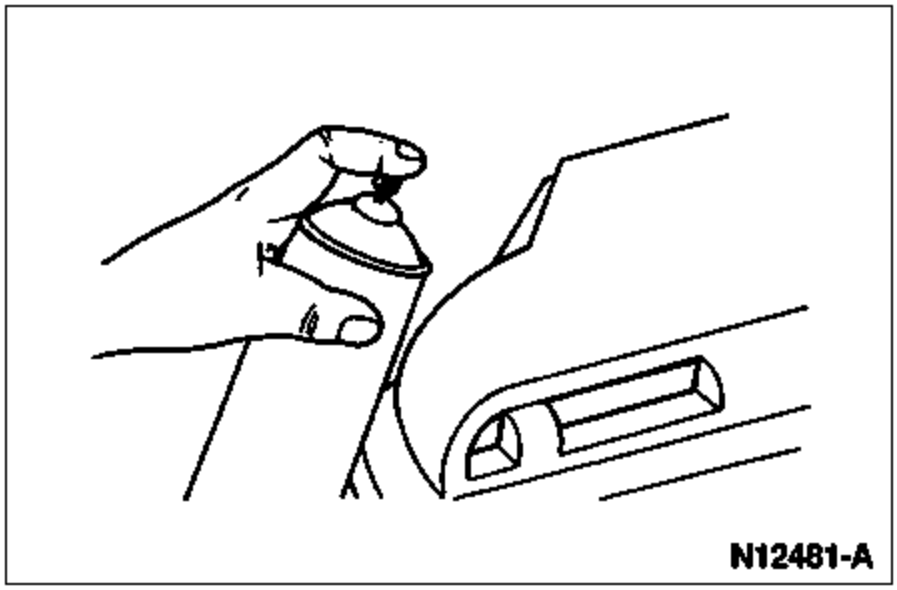
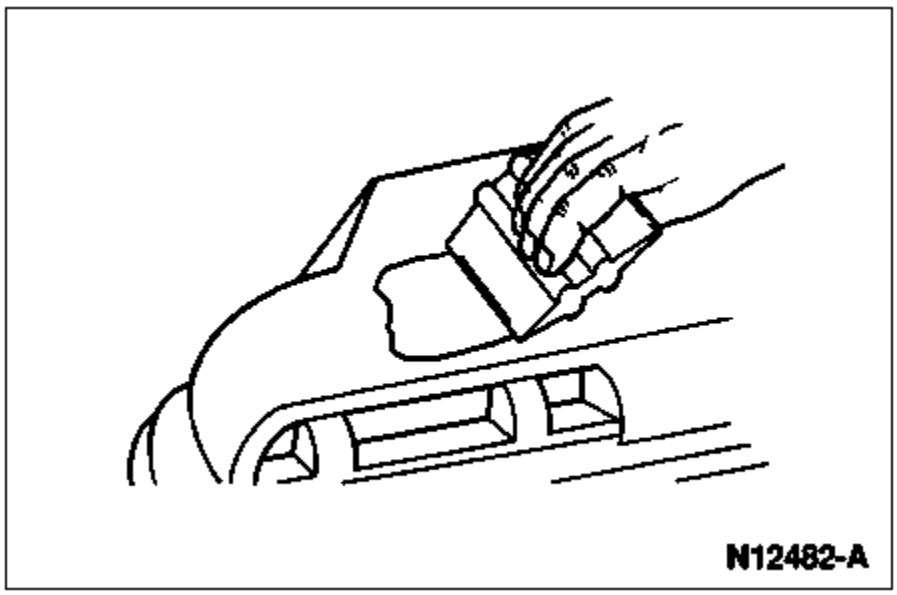


8. Sand scratches and pinholes must be filled with a skin coat of 3M P.R.O. Fill EZ-Sand repair material. Do not use flexible parts putty. After curing, sand with grade 320A sandpaper.



9. Reapply polyolefin adhesion promoter and let dry.

10. Apply a double wet coat of 3M P.R.O. Fill EZ-Sand coating. After a 10 minute flash time, apply a second double coat. Let dry for 45 minutes and lightly scuff sand the coating with grade 320A sandpaper. Apply color coats recommended for plastic body parts.

Bumper Covers, Reinforcement Procedure

If minor holes or punctures are large enough to allow the flexible parts repair material to escape, apply

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autobody repair tape to the underside of the repair.

If holes, punctures or cracks are extensive and require permanent reinforcement, follow this procedure:

1. Scuff the backside with grade 180 abrasives. Apply Adhesion Improving Sealer D7AZ-19000-C or equivalent, meeting Ford specification ESR-M2P93-A.

2. Cut a glass cloth patch to cover repair area.

3. Mix a quantity of 3M P.R.O. Fill EZ-Sand repair material. Lay glass cloth on a clean surface. Use a squeegee to force the 3M P.R.O. Fill EZ-Sand repair material into the glass cloth.

4. Apply glass cloth patch to backside of repair area.

5. Apply additional 3M P.R.O. Fill EZ-Sand repair material over surface of glass cloth patch.

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Exterior Parts, Flexible — Refinishing

Elastomeric flex additive is intended for use with air dry service paints to refinish flexible parts.

This material adds flexibility to air dry repair paints so that the same paint with additive can also be used for repair of soft, plastic type parts. The use of non-flexed service automotive finishes on flexible parts is impractical as these finishes form a rigid coating when paint cures. This additive allows the paint coating to adhere to the part when flexed or compressed and return to normal appearance as the part recovers to its original shape.

WARNING: THE ADDITIVE MUST BE HANDLED WITH CAUTION. IT IS INTENDED FOR INDUSTRIAL USE ONLY BY QUALIFIED PERSONNEL AND IS NOT INTENDED FOR THE GENERAL PUBLIC. THE PRODUCT LABEL PROVIDES INFORMATION ON RECOMMENDED SAFETY PRECAUTIONS AND PROPER APPLICATION. THE ELASTOMERIC ADDITIVE SHOULD NOT BE USED UNTIL THIS INFORMATION IS READ AND UNDERSTOOD. OBSERVE ALL APPLICABLE PRECAUTIONS.

THE VAPOR AND MIST SPRAY CAN BE HARMFUL. WHEN MIXED, IT SHOULD BE, IF POSSIBLE, USED IN A SPRAY BOOTH WITH ADEQUATE RESPIRATOR PROTECTION. THE RECOMMENDED PROTECTION IS A NIOSH-APPROVED POSITIVE PRESSURE AIR-SUPPLIED RESPIRATOR. IF THIS IS NOT AVAILABLE, USE A VAPOR/PARTICLE RESPIRATOR SUCH AS 3M MODEL NO. 6984 OR ITS EQUIVALENT, RECOMMENDED BY THE MANUFACTURER AS EFFECTIVE FOR VAPORS AND MIST. RESPIRATOR PROTECTION IS RECOMMENDED FOR USE DURING THE WHOLE TIME OF SPRAYING AND UNTIL ALL VAPOR AND MIST IS GONE. THE 3M RESPIRATOR PACKAGE HAS SPECIFIC FITTING AND USAGE INSTRUCTIONS THAT MUST BE FOLLOWED TO ENSURE MAXIMUM PROTECTION WITH THE RESPIRATOR.

The additive should be kept away from water or moist air because it may react with water and form a gel-like material which can make the product useless. The flexibility of the coating may be adversely affected if relative humidity of air is high during application. The container must be kept closed when not in use.

To avoid waste of material, mix only the quantity required. Clean all spray equipment with solvent immediately after use. Allow part to cure two to four hours after final coat before handling. After curing for 24 hours, the coating can be rubbed out by hand to improve the finish. Do not use a machine for rubbing; it may cause burring.

Surface Preparation

If the flexible part is preprimed, no special priming is required. It only requires cleaning with a silicone and wax remover and scuff sanding with 400-grit paper to remove gloss. The conductive black primer coating applied in the factory requires only light sanding to promote adhesion of the air dry service paints.

Mixing and Application

The additive is highly recommended for use with urethanes.

Apply full wet coats with 10 to 15 minutes flash time between coats or follow paint manufacturers label instructions for mixing and application procedures.

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Fiberglass Structural Repair

Fiberglass Repair

Safety Precautions

WARNING: ALWAYS WORK IN A WELL-VENTILATED AREA IN ORDER TO AVOID POSSIBLE TOXIC FUMES THAT MAY RESULT FROM USING RESIN MIXTURES. EXERCISE CARE SO AS NOT TO GET ANY RESIN ON CLOTHING.

CAUTION: Remove any resin from hands as soon as possible and particularly before the mixture starts to gel.

Always use rubber gloves or the special hand cream supplied with epoxy resin repair kits. Any resin that adheres to the hands may be removed with lacquer thinner followed by a thorough washing with soap and water.

Use a respirator when grinding the surface and use a vacuum attachment when operating a belt sander.

Keep all materials, utensils and the work area clean and dry as resin repairs involve chemical reactions. Any dirt, foreign material or moisture may upset the chemical reaction and result in an unsatisfactory repair.

Repair Procedure

Grind or sand away all loose or broken material at the damaged area. Scuff sand the surface approximately 25mm (1 inch) around the area to provide a good bonding surface. Make sure the surface to be repaired is clean, dry, oil and paint free.

For cracks, form a shallow V-shape along the crack with a file or grinder. Fill the area with a good quality body repair compound. Follow the manufacturer's directions with regard to mixing procedures. Allow the compound to harden and then sand smooth. If the surface is not level or smooth, use an additional filling and sand to a final smooth finish.

For larger broken areas use fiberglass cloth (five layers) impregnated with the resin, to cover the area. Overlap the damaged portion by 25-50mm (1-2 inches). When the material has hardened, file or grind and sand smooth. If low spots exist, fill them with resin mixture to which short fibers cut from the fiberglass cloth have been added. Add enough of the cloth to form a putty-like resin mixture.

Painting

After the desired repaired surface has been obtained, prime and paint the surface in the normal manner.

Repairs From Backside (Procedure A)

Components with large cracked or broken areas must be repaired from the backside first. Perform backside repairs following fiberglass repair procedure in this section.

When backside repair is completed, repeat operation on front side of component.

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Backside Not Accessible

Should vehicle component requiring backside repair not permit access to backside, it must be removed from vehicle to perform repair. Use extreme caution when repairing components while off the vehicle to ensure proper alignment when reinstalling repaired component on the vehicle.

Follow all procedures previously outlined in this section.

Cosmetic Repair (Procedure B)

Minor damage (damage which does not affect the structural integrity of the component) is considered a cosmetic repair and is performed on the exterior of the component only. Perform these repairs using the following procedure.

1. Grind or sand away all loose or broken material at the damaged area.
2. Remove all paint approximately 50mm (2 inches) around the area to provide a good bonding surface. Make sure the surface to be repaired is clean, dry and oil free.
3. Form a shallow V-shape along cracks with a file or grinder.
4. Fill the area with a good quality epoxy based body repair compound. Follow the manufacturer's guidelines for proper mixing procedures.
5. Allow the compound to harden and sand to the proper contour. Use additional compound if the surface is not smooth, level and to contour.
6. Prime and top coat following paint manufacturers label instructions.

Laminate Separation (Procedure C)

Occasionally fiberglass components may experience laminate separation damage. This condition can be repaired following the cosmetic repair procedures previously outlined providing the extent of laminate separation is not too severe. If the laminate separation condition is extensive it may be more practical to replace the component.

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Paint Damage from Airborne Materials

The following information gives detailed descriptions of paint damage caused by chemical or organic materials. If service is required, identify the source of the damage and follow the recommended service procedure.

Chemical

The effects of chemical airborne materials can be seen as:

- Dark blotches in the paint where the pigment in the paint surface has been attacked.
- Irregular spots that are cracked or etched around the edges and dull in the centers.
- Small orange colored spots caused by iron particles may appear on the paint surface.

Generally, materials that attack a paint film are either acidic or alkaline in nature.

Sulfuric and nitric acids, in general, cause extreme damage to automotive paint finishes. Even very small concentrations of the same materials can cause chemical spotting damage. Due to evaporation and condensation, these acids can create severe etching "spots" that may eventually crack or lift the paint film after some time in service.

Although some automotive finishes are more resistant than others, none are completely immune to these chemicals. The most resistant paints used today are the urethanes because their resin system is least likely to react with chemicals. Air-dry coatings are more susceptible to attack only when they are fresh. The longer the paint dries the more resistant it becomes.

Metallic colors are more intolerant to chemicals because aluminum flake is fairly reactive with either an acid or alkali.

The following pH chart shows the relationship between acidic and alkaline chemicals and their corresponding pH values. This chart is provided for informational reference only.

ACIDS/ALKALIES AND pH CHART

pH Scale Value	Examples
2.0 — Very Strong Acids	Hydrochloric, Nitric Sulfuric, Phosphoric, Hydrofluoric and Some Wire Wheel Cleaners
3.0 — Strong Acids	Citric, Chromic, Sulfonic, and Human Gastric Juices
4.0 — Acidic	Oxalic, Gluconic, Tartaric Fallout Remover
5.0 — Slightly Acidic	Lactic, Uric, Acid Rain
6.0 — Very Slightly Acidic	Carbonic
7.0 — Neutral	Blood, Most Body Fluids, Distilled Water
8.0 — Very Slightly Alkaline	Urine, Wash Concentrate
9.0 — Slightly Alkaline	Baking Soda

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10.0 — Alkaline	Soda Ash, Carb-Kleen
11.0 — Strong Alkaline	Lye, Potash, Tire Cleaner

Organic

Organic damage is generally easier to identify. Organic damage is mostly due to tree sap, bird and insect droppings, dead insects and pollen. Tree sap is easily identified by clear raised drops that may be hard or sticky. Bee or bug dropping spots may appear brownish or yellow in color, about 3-6mm (1/8 to 1/4 inch) in diameter. Dead and decomposing insect bodies are readily visible to the eye. Pollen deposits are small yellow clusters. Each of these items is potentially damage to any currently available paint system. Other noticeable traits of organic damage are spots that are raised (swelling), micro-crazing (cracked) and pitting due to pollen eating into the paint film. The active ingredients in most organic contaminants are tannic and formic acids. These acids are found in berries and bodily fluids of insects and birds.

Investigations completed at dealerships show that the bright lot lights tend to attract insects. The use of "soft lights" for display and storage lot illumination will help reduce damage resulting from decomposing bugs and droppings by decreasing the number of bugs attracted to these lights. Organic damage is accelerated by heat. During very hot weather conditions, it is important to wash vehicles more often.

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Chemical or Organic Damage Repair

Iron dust particles may imbed themselves into the paint film. On some light colored vehicles after some weathering, tiny dots of rust start to appear. They feel rough to the touch and are difficult to remove. The best way to remove these particles is by treating the finish with a multi-acid-detergent-water wash. Use the following procedure to perform this service repair.

NOTE: Acid washes are also prepackaged in various strengths under various brand names.

CAUTION: Do not use oxalic acid washes. This material will damage paint and trim if used incorrectly. Use only multi-acid washes such as Finish Kare for removal of iron particles. Follow manufacturers mixing instructions.

1. Wash and degrease the vehicle first, using Ford Multi-Purpose Cleaner Concentrate B8A-19523-B or equivalent meeting Ford specification ESR-M14P4-A, and a suitable wax and grease remover. If this does not remove all of the iron particles, proceed with the acid wash.

2. Apply this solution liberally to all affected surfaces of the vehicle with a large sponge. Keep the surface wet until the technician can no longer feel any surface roughness with bare or gloved fingertips. If this is not done thoroughly, staining may redevelop if iron particles are left behind.

3. **CAUTION: Failure to thoroughly rinse this surface could result in corrosion of anodized aluminum or stainless steel parts with prolonged contact.**

   Rinse the area with clean water.

4. If the iron particles are not totally removed after two washings, use one or both of the procedures listed for minor chemical contamination.

   The use of polishing (with wax), sanding with microfine sandpaper (1500 grit or greater) or buffing with very light compound should only be done as a last resort.

Wet Sanding — After Acid Wash

1. Clean the exterior surface of the vehicle with Ford Multi-Purpose Cleaner Concentrate B8A-19523-B or equivalent meeting Ford specification ESR-M14P4-A to remove all contamination.

2. Apply 1500 grit sandpaper to a rubber padded sanding block to sand the paint surface.

3. Use a squirt bottle filled with water to lubricate the 1500 grit sandpaper as you begin to sand only the damaged areas. Water is an abrasive as well as a lubricant in this step.

   If the damage has gone deeply into the paint film and it will not polish or sand out, then refinishing is required.

Paint Reconditioning

Acrylic urethane enamel base/clear paint systems should be painted by using the following procedure.

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1. Prepare the area as follows:

    a. Neutralize the affected areas with baking soda (sodium bicarbonate) and water.
    b. Rinse the surface off with plain water.
    c. Wash the panel with a mild soapy detergent.
    d. Dry the panel completely.

    If the damage is through the top coat finish and into the primers, the panel must be sanded down to bare metal or plastic and then refinished.

2. Apply a self-etching primer for **metal surfaces only** .

    A flex additive may be necessary when working with flexible plastics. Then proceed as follows:

    a. Apply a two component urethane primer surfacer. Let dry per instructions.
    b. Sand the surface with 400 grit sandpaper to get proper finish.
    c. Finish sanding with 600 grit sandpaper.

3. Solvent wash the panel with wax and grease remover. Tack wipe it.

    The use of acrylic urethane enamel is highly recommended for this type of repair.

4. Apply base coat or top coat material per applicable paint system.

5. Apply clear acrylic urethane if you are using a base/clear paint system.

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SPECIFICATIONS

BODY SERVICE PRODUCT SPECIFICATIONS

Item	Container	Ford Specification No.	Ford Part No.	Recommended Proprietary Brand
Caulking Cord		ESB-M4G32-A	D6AZ-19560-A	
Rubber Cement			8A-19552-B	
Weatherstrip Adhesive	5 Oz. Tube	ESB-M2G14-A	E8AZ-19552-A	
Liquid Butyl Sealer (Black)		ESB-M4G162-A	C9AZ-19554-B	
Extra Strength Tar and Road Oil Remover	16 Fl. Oz.	ESR-M5B106-A	B7A-19520-AA	
Silicone Lubricant	8 Oz. Tube	ESR-M13P4-A	C0AZ-19553-AA	
One Step Wash and Wax Concentrate	16 Fl. Oz.	ESR-M14P12-A	D6AZ-19523-AA	
Custom Silicone Gloss Polish	16 Fl. Oz.	ESR-M11B26-A	B7AZ-19530-AA	
Custom Clearcoat Polish	16 Oz.		F3AZ-19530-WA	
Custom Bright Metal Cleaner	16 Fl. Oz.	ESR-M5B194-B	8A-19522-A	
Multi-Purpose Cleaner Concentrate	1 Quart Bottle	ESR-M14P4-A	B8A-19523-AA	
Multi-Purpose Paint Pre-Cleaner			VC-542-A	
Ultra-Clear Spray Glass Cleaner	18 Oz. Aerosol Can	ESR-M14P5-A	E4AZ-19C507-AA	
Multi-Purpose Cleaner Concentrate	1 Gal. Jug	ESR-M14P4-A	B8A-19523-B	
Instant Adhesive	.06 Fl. Oz.	WSK-M2G402-A4	E8AZ-19554-A	
Adhesion Improving Sealer		ESR-M2P93-A	D7AZ-19000-C	
Abrasion Resistant Coating		ESB-M46221-A	D9AZ-19515-A	
RTV				
Ford Elastomeric Primer		ESB-M18P5-A		
Ford Elastomeric Thinner		ESB-M18P5-A		
Auto Body Repair Tape				3M Part No. 6930

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Structure Adhesive Tube Kit				3M Part No. 8101
Multi-Purpose Paint Precleaner (Spray Gun Cleanup)			VC-542-A	

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Inspection and Verification

Leaks

Visually inspect for dust and water leaks. Any unsealed crevice or small opening in the lower section of the body will permit dust and water to be drawn into the body.

To determine the exact location of a dust/water leak, remove the following trim from the vehicle:

- Cowl trim panel. Refer to Section 01-05A or Section 01-05B .
- Quarter trim panel.
- Rear seat back and seat cushion. Refer to Section 01-10 .
- Carpet and side trim panel. Refer to Section 01-05A or Section 01-05B .
- Spare tire.
- Center pillar trim. Refer to Section 01-05A or Section 01-05B .
- Scuff plates. Refer to Section 01-05A or Section 01-05B .

After removing the trim, the location of most leaks will be evident. The entrance of dust is usually indicated by a pointed shaft of dust or silt. Seal these leaks, then road test the vehicle on a dusty road to make sure all leaks are sealed.

Noise

Wind noise, rattles and their sources are detected by driving the vehicle at highway speeds in four different directions. Listen for sources of noise with all windows closed, radio off, heater and air conditioner blower motor turned off and ventilation ducts open. A stethoscope can be used to pinpoint the source of wind noise.

Most wind noise-producing leaks will occur at the door and window seals or at sheet metal joints in the door or the door opening in the body.

Symptom Chart — Body Service

BODY SERVICE

Condition	Possible Source	Action
• Dust Leak	• Cowl trim panel, kick pads, and floor mats.	• REMOVE trim. CHECK for leaks and SEAL with appropriate sealer. ROAD TEST for leaks. RECHECK trim for leaks, or USE light under vehicle with trim removed. CHECK interior of body at joints and weld lines.
• Dust/Water Leaks at Floorpan and Grommets	• Missing or damaged plugs and/or grommets.	• CHECK plugs for proper installation.
• Drain Holes Collecting Water	• Holes clogged with mud or road tar.	• CHECK drain holes regularly. CLEAN drain holes of dirt and foreign material with a punch or screwdriver.
• Wind Noise, Air Entering Vehicle Through Small Holes in Body	• Leaks at door and window seals or sheet metal joints in doors or door openings.	• SEAL leaks with RTV sealant and foam tape. ROAD TEST, or USE Vacuum Leak Detector 164-R0256 or equivalent to obtain a water leak reading. RECHECK for leaks using detector. ROAD TEST.
• Rattles	• Loose screws, nuts, bolts, small pieces of body deadener in door wells, pillars, and quarter panels.	• CHECK doors by carefully striking underside of door with a mallet. LISTEN for loose objects in door. REPAIR. TIGHTEN body bolts and screws.
	• If tightening bolts and screws does not eliminate rattle, cause could be misalignment.	• REFER to Section 01-03 for adjustment and alignment procedures.
	• Weatherstripping and anti-squeak material has slipped out of position.	• APPLY additional cement or other adhesive; INSTALL in proper location to eliminate rattle.

Dust and Water Leaks

After trim removal has revealed the location of leaks, seal these leaks, and road test the vehicle on a dusty road to make sure all leaks are sealed. Dust entry is usually indicated by a pointed shaft of dust or silt at the point of entrance. After the road test, check for indications of a dust pattern around the door openings, cowl panel, and cowl side panel.

Sometimes leaks can be located by putting bright lights under the vehicle, with the above components removed, and checking the interior of the body at joints and weld lines. The light will show through where leaks exist. The Vacuum Leak Detector 164-R0256 or equivalent can locate dust and water leaks.

Wind Noise

Seal all leaks with RTV sealant foam tape or by positioning or replacing the seals. Road test the vehicle to make sure all leaks have been adequately sealed.

An alternate method of verifying corrective actions involves the use of Rotunda Combination Engine EAR/Chassis EAR 107-R2102 or equivalent. After identifying the leak point through a drive evaluation, obtain a meter reading by using the leak detector. A check with the leak detector after repairing the leak will verify the effectiveness of the corrective action. A final test drive may still be advisable to make sure other objectionable leaks, not noticed because of a major leak, do not exist.

Rattle Elimination

All bolts and screws should be tightened periodically. In the event that tightening the bolts and screws, located on such assemblies as the doors, hood and door does not eliminate the rattles. Refer to Section 01-02 and Section 01-03 .

Rattles and squeaks are sometimes caused by weatherstripping and anti-squeak material that has slipped out of position. Apply additional cement or other adhesive.

Body Sealant Locations

The body sealant locations are as follows:

- front floorpan and rear floorpan
- quarter wheelhouse inner panel and quarter wheelhouse outer panel
- dash panel
- running boards
- door openings
- roof side drip rail

Body Side Stone Protection Vinyl, Lower

Materials Required

- Abrasion Resistant Coating available from paint companies and other aftermarket coating manufactures.
- Color Coat Paint System
- Silicone and Wax Remover
- Multi-Purpose Paint Precleaner (Spray Gun Cleanup) VC-542-A

Equipment, Suggested

- Rotunda Spray Gun 085-R1626 (No. 63 Air Cap, No. SS Fluid Tip, No. 363 AN needle) or equivalent
- Rotunda Detached Pressure Cup 085-R1617, 1.89 liter (2 quarts), with Air-Adjusting Gauge or equivalent
- Rotunda Dual Action Sander 107-R1619 or equivalent
- Rotunda Heat Gun 107-R0300 or equivalent
- No. 180-Grit Paper
- Lint-Free Cloth
- Tack Cloth
- Regular Masking Tape
- No. 80 Disc for Disc Sander
- No. 220/240 Disc

A large area resulting from peeling or damage will necessitate removal of the factory sprayed-on vinyl coating. The following procedure is suggested.

NOTE: Where sheet metal is damaged to the extent that fender, door or quarter panel replacement is required (or in initial installation), disregard Steps 1 and 2.

NOTE: Approximately 1.89L (2 quarts) is required for an initial installation on a vehicle similar to a factory-applied system. The specified dry film thickness of 15 to 20 mils will require at least three, or possibly four, applications of coating material, with flash-off time allowed between coats. As with painting, spray coat the complete lower panel.

As the adherence of this coating to properly prepared sheet metal is excellent, the necessity of prime painting the sheet metal prior to protective coating is eliminated. However, adhesion will be adversely affected unless the sheet metal area to be covered (either repaired or new) is prepared in accordance with the following procedure.

1. Using Rotunda Heat Gun 107-R0300 or equivalent, or lamp, soften the vinyl coating until it is pliable. Scrape off the softened vinyl with a putty knife or similar tool. If necessary, sand off any hard-to-remove vinyl coating using an orbital disc sander (No. 80 disc). (Abrasion resistant coating is not suitable for "spot" corrections.)

2. Perform the necessary repairs to correct the sheet metal damage.

Vehicle, Masking

Suitable covers should be installed over the wheels. Mask off all upper exterior body sheet metal. Remove wheel opening stone shields and mask mouldings.

NOTE: If the vehicle has lower body side mouldings above the "turn under" of the rocker panel, the moulding can serve as the upper margin of the area to be coated. If the vehicle does not have suitable mouldings, a sculpture or break line in the sheet metal can be used. However, the method used in masking off the upper coating margin line will depend on the presence or absence of mouldings in this area.

Masking tape should be positioned so that the moulding lower side is also covered. However, do not cover the sheet metal immediately below the moulding.

It is not necessary to mask off the body door openings in the coating area, as they will be uniformly coated where the door margins allow the coating to enter. However, these door opening areas should be cleaned to make sure of coating adherence.

Sheet Metal

Sheet Metal, Serviced

1. Scuff sand (No. 180 grit paper) the glossy surface of the painted areas to be coated.
2. Remove sanding dust using a lint-free tack cloth and compressed air.
3. Using a clean, lint-free cloth, solvent wipe the area to be coated with Multi-Purpose Paint Precleaner VC-542-A or equivalent, or wax and grease remover, and allow to flash-off.

Sheet Metal, New

1. The glossy surface of the paint in the coating area must be ground off with an air-driven D/A sander such as Rotunda Dual Action Sander 107-R1619 or equivalent. A 220/240 grit-disc does a good, fast job. **Do not** sand through the primer.
2. Scuff sand (No. 180 grit paper) the primer. Do not sand through the primer.
3. Remove sanding dust using a lint-free tack cloth and compressed air.
4. Using a clean, lint-free cloth, solvent wipe the area to be coated with Multi-Purpose Paint Precleaner VC-542-A or equivalent, and allow to flash-off.

Coating Spray Procedure

The coating must be applied by an experienced automotive painter. The coating must be thoroughly agitated and used without thinning. As the material is reasonably heavy-bodied, a pressure cup equipped spray gun is recommended or appropriate equipment recommended by the coating manufacturer. Satisfactory coating appearance (minimal orange peel and sag) has resulted with gun air pressures of approximately 207 kPa (30 psi) and cup pressures of approximately 103 kPa (15 psi).

To protect the lower exposed painted fender, rocker, and quarter panel down flanges, the vehicle must be elevated high enough so that the painter can spray this area effectively. When an initial installation is to be made, a remote 1.89L (2-quart) capacity pressure cup makes a much more efficient tool, as the spray gun can be used closer to the floor. The spray gun, fluid hose and/or cup must be cleaned immediately after use. While lacquer thinner can be used when the suggested cleanup material is unavailable, the Multi-Purpose Paint Precleaner or equivalent is quicker and much more efficient. With the spray gun at 207 kPa (30 psi) and pressure feed cup at 103 kPa (15 psi) follow this procedure:

1. Apply a wet, sag-free coat. Allow three to five minutes flash-off time.
2. Apply the second wet, sag-free coat. Allow three to five minutes flash off-time.
3. Apply the third wet, sag-free coat. Allow three to five minutes flash off-time.
4. Apply the final wet, sag-free coat. Allow three to five minutes flash-off time and pull off the fine line tape, exposing the raw upper edge of the coating.
5. Immediately clean the spray equipment using Multi-Purpose Paint Precleaner VC-542-A or equivalent.
6. Allow at least two hours drying time at approximately 21°C (70°F).

Color Coat

The complete coated area, as well as the upper raw edge, must be covered with color coat. Mask off the upper margin line using fine line tape positioned 1.59mm (1/16 inch) above coating edge. Using appropriate repair paint and application procedures (to include both prime and color coat), the protective coating area can now be finish painted.

If damaged sheet metal extends above the protective coating area, normal prime/color paint procedures should be followed.

Bumpers, Plastic

Where substrate material has not been removed, cuts and cracks to the radiator grille opening panel or rear bumper covers can be repaired using the approved service material: 3M P.R.O. Fill EZ-Sand, No. 05895 or equivalent.

The following repair procedures can be used for either the radiator grille opening panel or the rear bumper covers.

Bumpers, Polypropylene

The following three types of damaged bumpers are considered repairable:

- A bumper with a hole less than 50mm (1.97 inches) in diameter.
- A bumper with a crack less than 100mm (3.94 inches) in length.
- A bumper with a crack less than 100mm (3.94 inches) in length that is less than half of the width of the bumper.

Although a bumper which has been damaged greater than this could also be repaired, it should be replaced with a new one. This is because such repair would detract from the beauty and quality of the bumper due to the decrease of the adhesive strength, etc. In addition, such repair is not considered reasonable in terms of work load.

Repair polypropylene bumpers having flaws that have reached the surface of the polypropylene and are too serious to be restored by painting.

1. Cut the rough edges around the flaw with a knife to make it smooth. Sand the area with a sander to make an angle of about 45 degrees.

2. **NOTE: Heat only the shaded area to melt it.**

   Weld damaged area.

   - For repair of a cracked area, melt the crack together using Rotunda Airless Plastic Welder 107-01250 or equivalent.
   - For repair of a hole, degrease the area and the reverse side of the damaged area. Install aluminum tape on reverse side of damaged area.

3. **CAUTION: Do not move the welding rod until the welded part cools.**

   NOTE: Take care not to excessively melt the welding rod. If the part is welded with the welding rod melted like jelly, the welding strength will be lowered.

   Melt the polypropylene welding rod with Rotunda Airless Plastic Welder 107-01250 or equivalent, and deposit it in the cracked area. Operate a heat gun 2-51mm (.5-2.0 inches) away from the part that will be welded.

4. **NOTE: Do not sand part continuously.**

   Sand the surface of the polypropylene little by little, since it is easily melted even by the abrasion heat. If melted, remove the melted area. Sand the areas to which repair agent will be applied.

5. Apply polypropylene primer uniformly to an area larger than the re paired area with a brush. It will take about 10 minutes to dry at 20°C (68°F).

6. **NOTE: When mixing the main and stiffening agents, be careful not to allow bubbles to form.**

   NOTE: Since the repairing agent hardens fast (about five minutes), proceed with the work

immediately after mixing the agents.

It will take about 30 minutes to dry at 20°C (68°F) before it can be sanded.

Mix the main agent and the stiffening agent in a ratio of one to one. Apply the mixed repair agent to the damaged area.

7. **NOTE: If excessive force is applied to the area when sanding, the surface will not become smooth.**

   NOTE: If there is fuzz around the repaired area, melt it by heating it slightly with a heat gun.

   Sand the area with No. 180-No. 240 sandpaper.

8. **NOTE: Polypropylene primer will dissolve, even after drying, if it is wiped with solvent. Use only water to clean.**

   Degrease the painted surface.

9. Dry the part.

10. Add the flex agent to the urethane primer surfacer and spray it on the repair.

11. Air dry at 20°C (68°F) for eight hours.

    Force dry at 60°C (140°F) for one hour.

12. Lightly sand the area on which the primer surfacer is sprayed and the complete surface of the bumper with No. 400-No. 600 sandpaper. Do not expose the surface of the polypropylene. Wet sanding or dry sanding is acceptable.

13. **CAUTION: Use only polypropylene primer for a polypropylene bumper.**

    Wipe the complete surface of the bumper with degreasing agent. Quickly wipe the surface with a clean rag to degrease it.

14. Apply a matching coat of paint to the polypropylene bumper.

15. Force dry at 60°C (140°F) for one hour. Air dry at 20°C (68°F) for eight hours.

Bumper Covers Plastic, Flair Mouldings

Where substrate material has not been removed, cuts and cracks to the bumper covers can be repaired using the approved service material: 3M P.R.O. Fill EZ-Sand, No. 05895 or equivalent.

The following repair procedures can be used for bumper covers.

Procedure 1 — Substrate Cuts or Cracks

Substrate Material Not Removed

1. Wipe repair area with silicone and wax remover, to ensure clean surfaces.

2. Apply a thin coating of Instant Adhesive E8AZ-19554-A or equivalent meeting Ford specification WSK-M2G402-A4 to one surface of the cut or crack. Position the surfaces very carefully together in their original position. Quickly and firmly press the two surfaces together for at least one minute. Good bond strength is developed after one minute but maximum strength requires 3 to 12 hours cure time. **Note the precautions on adhesive container.**

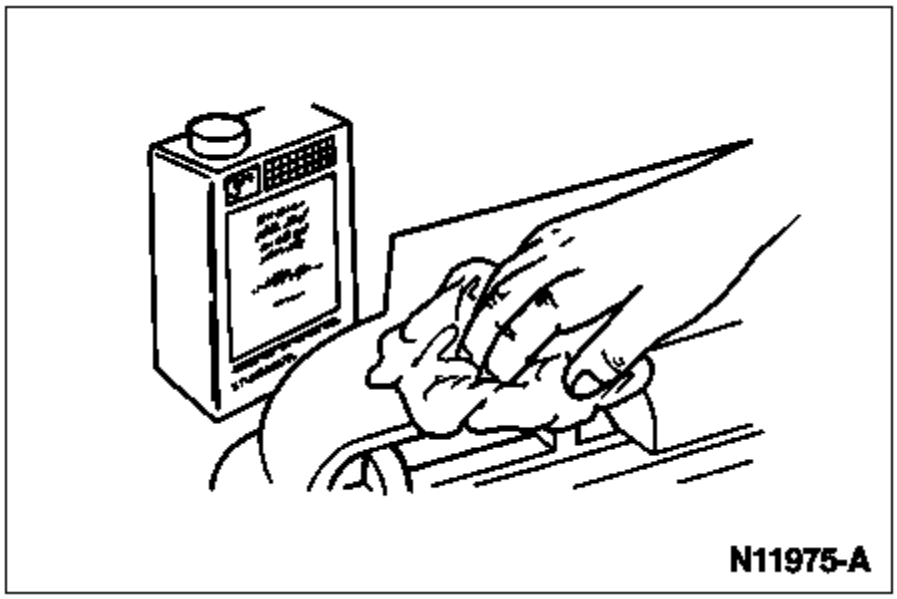
3. If the part did not have paint damage and the part was properly positioned, painting may not be required. However, if painting is necessary, proceed as follows:

    a. Scuff-sand the repair area with a sanding block and No. 400 paper. Be careful not to sand through the color coat surface. Usually dulling the surface is sufficient. Wipe off or clean the repair area with a clean, dry cloth or an air gun.
    b. Wipe the sanded surface with silicone and wax remover or equivalent.
    c. Refinish as described in this section under Refinishing Flexible Exterior Parts.

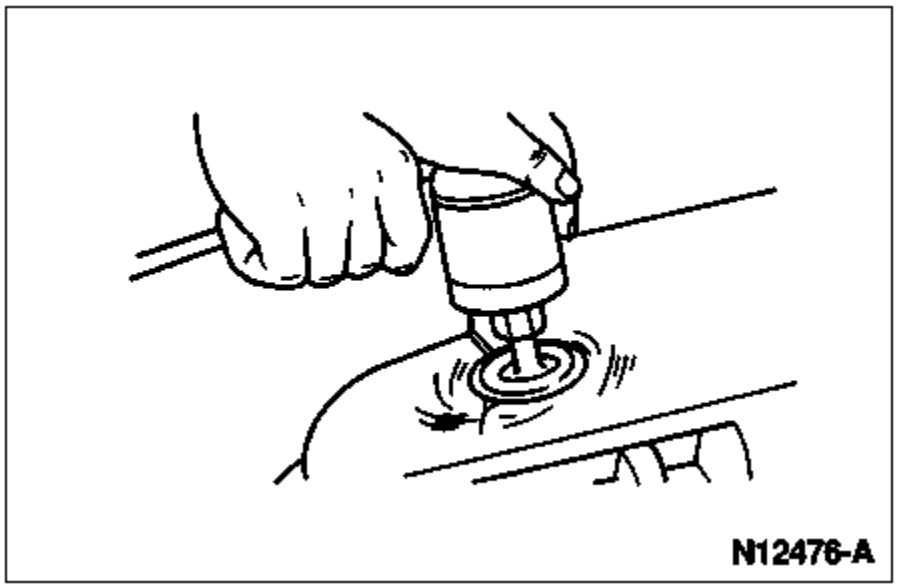
Procedure 2 — Substrate Holes, Gouges and Tears

Substrate Material Removed

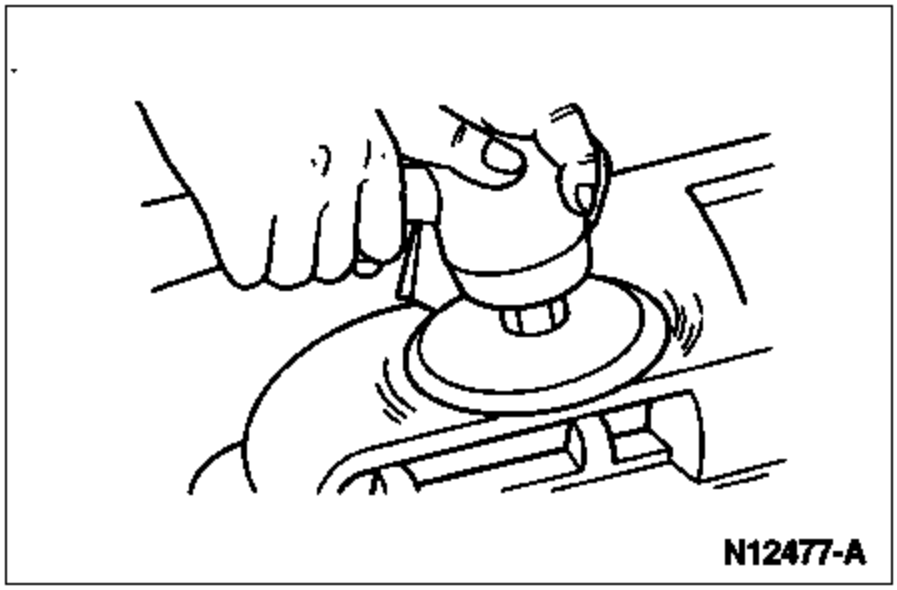
1. Clean the repair with soap and water. Next, use Multi-Purpose Paint Precleaner VC-542-A or equivalent to remove grease and tar.



2. Grind the surface of the repair with a grade 36 disc or coarse abrasive paper. Grind about 38mm (1-1/2 inches) around the actual damage to obtain a taper for best adhesion.

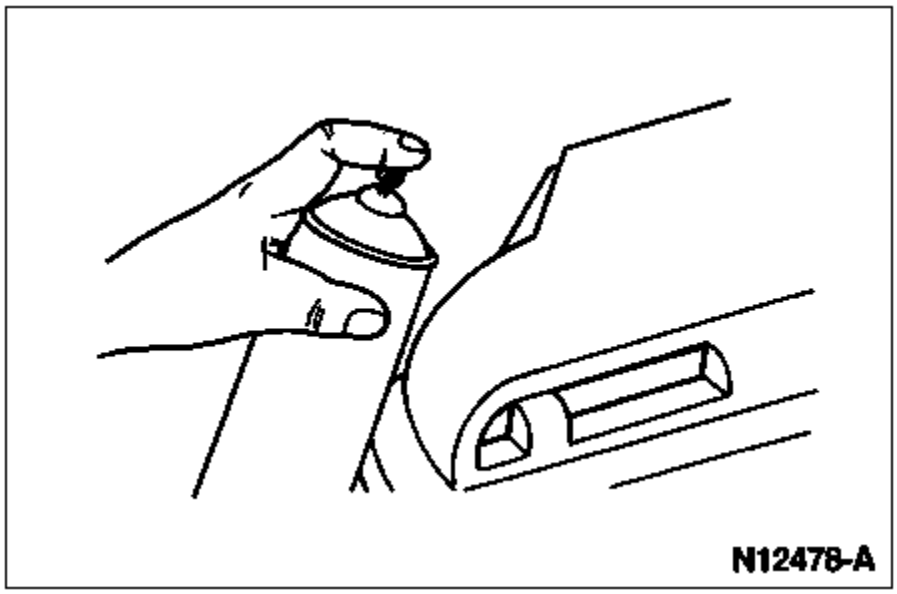


3. Featheredge the paint around the repair with grade 180A sandpaper. Wipe with a clean dry rag and blow off with an air hose.

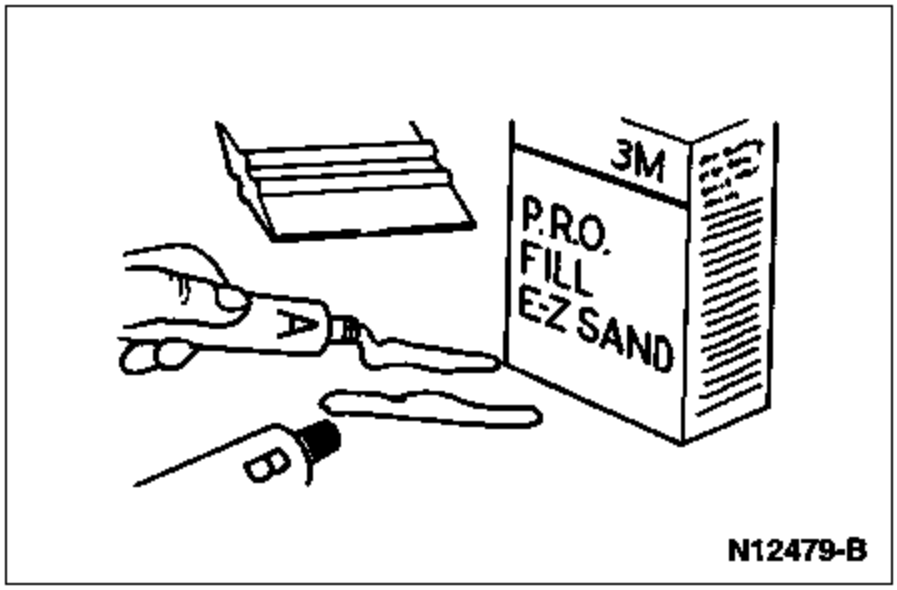


4. **NOTE: It will be necessary to reapply polyolefin adhesion promoter after any sanding step.**

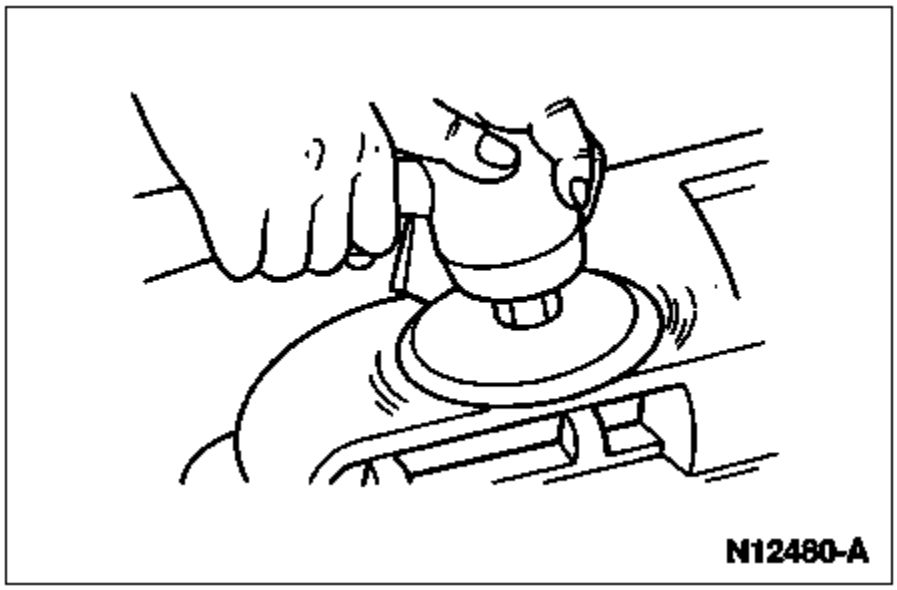
   Apply one wet coat of polyolefin adhesion promoter over the sanded surface and allow to dry for 10 minutes.



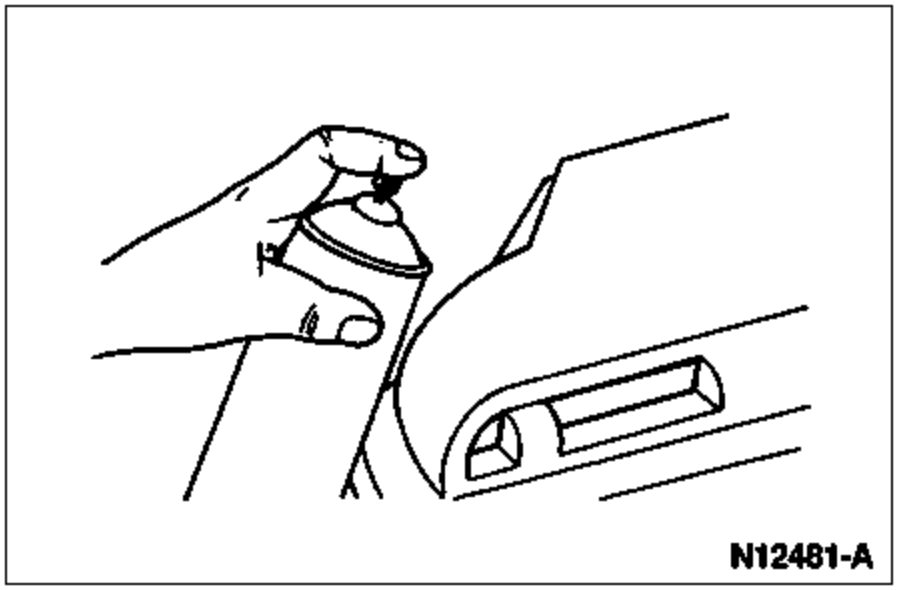
5. Mix 3M P.R.O. Fill EZ-Sand repair material according to instructions and apply to the repair with a squeegee. Apply the material, building it up higher than the undamaged area. Allow it to cure for 20-30 minutes at 18°-21°C (60-80°F).



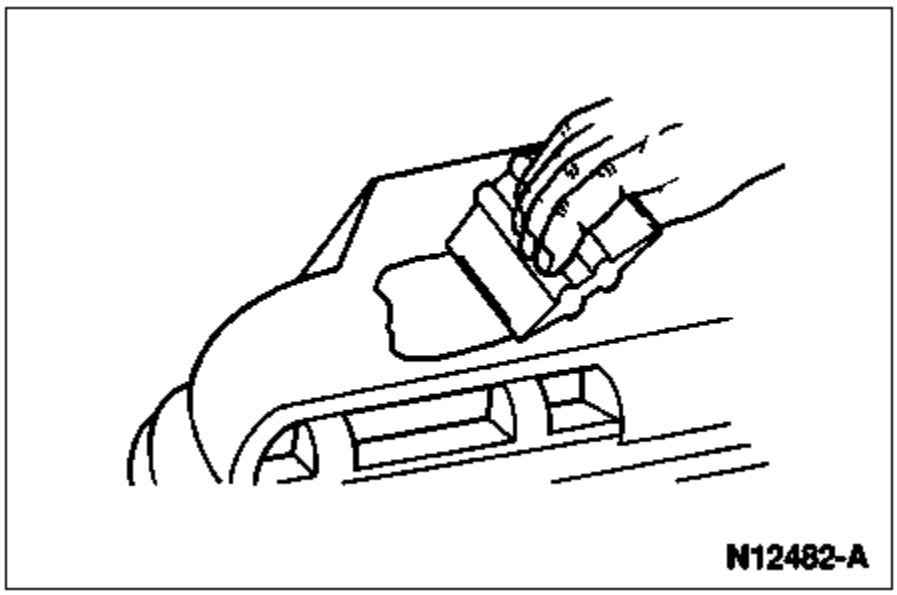
6. After curing, sand with grade 180A sandpaper, followed by grade 240A discs.



7. Reapply polyolefin adhesion promoter and let dry.



8. Sand scratches and pinholes must be filled with a skin coat of 3M P.R.O. Fill EZ-Sand repair material. Do not use flexible parts putty. After curing, sand with grade 320A sandpaper.



9. Reapply polyolefin adhesion promoter and let dry.

10. Apply a double wet coat of 3M P.R.O. Fill EZ-Sand coating. After a 10 minute flash time, apply a second double coat. Let dry for 45 minutes and lightly scuff sand the coating with grade 320A sandpaper. Apply color coats recommended for plastic body parts.

Bumper Covers, Reinforcement Procedure

If minor holes or punctures are large enough to allow the flexible parts repair material to escape, apply

autobody repair tape to the underside of the repair.

If holes, punctures or cracks are extensive and require permanent reinforcement, follow this procedure:

1. Scuff the backside with grade 180 abrasives. Apply Adhesion Improving Sealer D7AZ-19000-C or equivalent, meeting Ford specification ESR-M2P93-A.

2. Cut a glass cloth patch to cover repair area.

3. Mix a quantity of 3M P.R.O. Fill EZ-Sand repair material. Lay glass cloth on a clean surface. Use a squeegee to force the 3M P.R.O. Fill EZ-Sand repair material into the glass cloth.

4. Apply glass cloth patch to backside of repair area.

5. Apply additional 3M P.R.O. Fill EZ-Sand repair material over surface of glass cloth patch.

Exterior Parts, Flexible — Refinishing

Elastomeric flex additive is intended for use with air dry service paints to refinish flexible parts.

This material adds flexibility to air dry repair paints so that the same paint with additive can also be used for repair of soft, plastic type parts. The use of non-flexed service automotive finishes on flexible parts is impractical as these finishes form a rigid coating when paint cures. This additive allows the paint coating to adhere to the part when flexed or compressed and return to normal appearance as the part recovers to its original shape.

WARNING: THE ADDITIVE MUST BE HANDLED WITH CAUTION. IT IS INTENDED FOR INDUSTRIAL USE ONLY BY QUALIFIED PERSONNEL AND IS NOT INTENDED FOR THE GENERAL PUBLIC. THE PRODUCT LABEL PROVIDES INFORMATION ON RECOMMENDED SAFETY PRECAUTIONS AND PROPER APPLICATION. THE ELASTOMERIC ADDITIVE SHOULD NOT BE USED UNTIL THIS INFORMATION IS READ AND UNDERSTOOD. OBSERVE ALL APPLICABLE PRECAUTIONS.

THE VAPOR AND MIST SPRAY CAN BE HARMFUL. WHEN MIXED, IT SHOULD BE, IF POSSIBLE, USED IN A SPRAY BOOTH WITH ADEQUATE RESPIRATOR PROTECTION. THE RECOMMENDED PROTECTION IS A NIOSH-APPROVED POSITIVE PRESSURE AIR-SUPPLIED RESPIRATOR. IF THIS IS NOT AVAILABLE, USE A VAPOR/PARTICLE RESPIRATOR SUCH AS 3M MODEL NO. 6984 OR ITS EQUIVALENT, RECOMMENDED BY THE MANUFACTURER AS EFFECTIVE FOR VAPORS AND MIST. RESPIRATOR PROTECTION IS RECOMMENDED FOR USE DURING THE WHOLE TIME OF SPRAYING AND UNTIL ALL VAPOR AND MIST IS GONE. THE 3M RESPIRATOR PACKAGE HAS SPECIFIC FITTING AND USAGE INSTRUCTIONS THAT MUST BE FOLLOWED TO ENSURE MAXIMUM PROTECTION WITH THE RESPIRATOR.

The additive should be kept away from water or moist air because it may react with water and form a gel-like material which can make the product useless. The flexibility of the coating may be adversely affected if relative humidity of air is high during application. The container must be kept closed when not in use.

To avoid waste of material, mix only the quantity required. Clean all spray equipment with solvent immediately after use. Allow part to cure two to four hours after final coat before handling. After curing for 24 hours, the coating can be rubbed out by hand to improve the finish. Do not use a machine for rubbing; it may cause burring.

Surface Preparation

If the flexible part is preprimed, no special priming is required. It only requires cleaning with a silicone and wax remover and scuff sanding with 400-grit paper to remove gloss. The conductive black primer coating applied in the factory requires only light sanding to promote adhesion of the air dry service paints.

Mixing and Application

The additive is highly recommended for use with urethanes.

Apply full wet coats with 10 to 15 minutes flash time between coats or follow paint manufacturers label instructions for mixing and application procedures.

Fiberglass Structural Repair

Fiberglass Repair

Safety Precautions

WARNING: ALWAYS WORK IN A WELL-VENTILATED AREA IN ORDER TO AVOID POSSIBLE TOXIC FUMES THAT MAY RESULT FROM USING RESIN MIXTURES. EXERCISE CARE SO AS NOT TO GET ANY RESIN ON CLOTHING.

CAUTION: Remove any resin from hands as soon as possible and particularly before the mixture starts to gel.

Always use rubber gloves or the special hand cream supplied with epoxy resin repair kits. Any resin that adheres to the hands may be removed with lacquer thinner followed by a thorough washing with soap and water.

Use a respirator when grinding the surface and use a vacuum attachment when operating a belt sander.

Keep all materials, utensils and the work area clean and dry as resin repairs involve chemical reactions. Any dirt, foreign material or moisture may upset the chemical reaction and result in an unsatisfactory repair.

Repair Procedure

Grind or sand away all loose or broken material at the damaged area. Scuff sand the surface approximately 25mm (1 inch) around the area to provide a good bonding surface. Make sure the surface to be repaired is clean, dry, oil and paint free.

For cracks, form a shallow V-shape along the crack with a file or grinder. Fill the area with a good quality body repair compound. Follow the manufacturer's directions with regard to mixing procedures. Allow the compound to harden and then sand smooth. If the surface is not level or smooth, use an additional filling and sand to a final smooth finish.

For larger broken areas use fiberglass cloth (five layers) impregnated with the resin, to cover the area. Overlap the damaged portion by 25-50mm (1-2 inches). When the material has hardened, file or grind and sand smooth. If low spots exist, fill them with resin mixture to which short fibers cut from the fiberglass cloth have been added. Add enough of the cloth to form a putty-like resin mixture.

Painting

After the desired repaired surface has been obtained, prime and paint the surface in the normal manner.

Repairs From Backside (Procedure A)

Components with large cracked or broken areas must be repaired from the backside first. Perform backside repairs following fiberglass repair procedure in this section.

When backside repair is completed, repeat operation on front side of component.

Backside Not Accessible

Should vehicle component requiring backside repair not permit access to backside, it must be removed from vehicle to perform repair. Use extreme caution when repairing components while off the vehicle to ensure proper alignment when reinstalling repaired component on the vehicle.

Follow all procedures previously outlined in this section.

Cosmetic Repair (Procedure B)

Minor damage (damage which does not affect the structural integrity of the component) is considered a cosmetic repair and is performed on the exterior of the component only. Perform these repairs using the following procedure.

1. Grind or sand away all loose or broken material at the damaged area.
2. Remove all paint approximately 50mm (2 inches) around the area to provide a good bonding surface. Make sure the surface to be repaired is clean, dry and oil free.
3. Form a shallow V-shape along cracks with a file or grinder.
4. Fill the area with a good quality epoxy based body repair compound. Follow the manufacturer's guidelines for proper mixing procedures.
5. Allow the compound to harden and sand to the proper contour. Use additional compound if the surface is not smooth, level and to contour.
6. Prime and top coat following paint manufacturers label instructions.

Laminate Separation (Procedure C)

Occasionally fiberglass components may experience laminate separation damage. This condition can be repaired following the cosmetic repair procedures previously outlined providing the extent of laminate separation is not too severe. If the laminate separation condition is extensive it may be more practical to replace the component.

Paint Damage from Airborne Materials

The following information gives detailed descriptions of paint damage caused by chemical or organic materials. If service is required, identify the source of the damage and follow the recommended service procedure.

Chemical

The effects of chemical airborne materials can be seen as:

- Dark blotches in the paint where the pigment in the paint surface has been attacked.
- Irregular spots that are cracked or etched around the edges and dull in the centers.
- Small orange colored spots caused by iron particles may appear on the paint surface.

Generally, materials that attack a paint film are either acidic or alkaline in nature.

Sulfuric and nitric acids, in general, cause extreme damage to automotive paint finishes. Even very small concentrations of the same materials can cause chemical spotting damage. Due to evaporation and condensation, these acids can create severe etching "spots" that may eventually crack or lift the paint film after some time in service.

Although some automotive finishes are more resistant than others, none are completely immune to these chemicals. The most resistant paints used today are the urethanes because their resin system is least likely to react with chemicals. Air-dry coatings are more susceptible to attack only when they are fresh. The longer the paint dries the more resistant it becomes.

Metallic colors are more intolerant to chemicals because aluminum flake is fairly reactive with either an acid or alkali.

The following pH chart shows the relationship between acidic and alkaline chemicals and their corresponding pH values. This chart is provided for informational reference only.

ACIDS/ALKALIES AND pH CHART

pH Scale Value	Examples
2.0 — Very Strong Acids	Hydrochloric, Nitric Sulfuric, Phosphoric, Hydrofluoric and Some Wire Wheel Cleaners
3.0 — Strong Acids	Citric, Chromic, Sulfonic, and Human Gastric Juices
4.0 — Acidic	Oxalic, Gluconic, Tartaric Fallout Remover
5.0 — Slightly Acidic	Lactic, Uric, Acid Rain
6.0 — Very Slightly Acidic	Carbonic
7.0 — Neutral	Blood, Most Body Fluids, Distilled Water
8.0 — Very Slightly Alkaline	Urine, Wash Concentrate
9.0 — Slightly Alkaline	Baking Soda

10.0 — Alkaline	Soda Ash, Carb-Kleen
11.0 — Strong Alkaline	Lye, Potash, Tire Cleaner

Organic

Organic damage is generally easier to identify. Organic damage is mostly due to tree sap, bird and insect droppings, dead insects and pollen. Tree sap is easily identified by clear raised drops that may be hard or sticky. Bee or bug dropping spots may appear brownish or yellow in color, about 3-6mm (1/8 to 1/4 inch) in diameter. Dead and decomposing insect bodies are readily visible to the eye. Pollen deposits are small yellow clusters. Each of these items is potentially damage to any currently available paint system. Other noticeable traits of organic damage are spots that are raised (swelling), micro-crazing (cracked) and pitting due to pollen eating into the paint film. The active ingredients in most organic contaminants are tannic and formic acids. These acids are found in berries and bodily fluids of insects and birds.

Investigations completed at dealerships show that the bright lot lights tend to attract insects. The use of "soft lights" for display and storage lot illumination will help reduce damage resulting from decomposing bugs and droppings by decreasing the number of bugs attracted to these lights. Organic damage is accelerated by heat. During very hot weather conditions, it is important to wash vehicles more often.

Chemical or Organic Damage Repair

Iron dust particles may imbed themselves into the paint film. On some light colored vehicles after some weathering, tiny dots of rust start to appear. They feel rough to the touch and are difficult to remove. The best way to remove these particles is by treating the finish with a multi-acid-detergent-water wash. Use the following procedure to perform this service repair.

NOTE: Acid washes are also prepackaged in various strengths under various brand names.

CAUTION: Do not use oxalic acid washes. This material will damage paint and trim if used incorrectly. Use only multi-acid washes such as Finish Kare for removal of iron particles. Follow manufacturers mixing instructions.

1. Wash and degrease the vehicle first, using Ford Multi-Purpose Cleaner Concentrate B8A-19523-B or equivalent meeting Ford specification ESR-M14P4-A, and a suitable wax and grease remover. If this does not remove all of the iron particles, proceed with the acid wash.

2. Apply this solution liberally to all affected surfaces of the vehicle with a large sponge. Keep the surface wet until the technician can no longer feel any surface roughness with bare or gloved fingertips. If this is not done thoroughly, staining may redevelop if iron particles are left behind.

3. **CAUTION: Failure to thoroughly rinse this surface could result in corrosion of anodized aluminum or stainless steel parts with prolonged contact.**

   Rinse the area with clean water.

4. If the iron particles are not totally removed after two washings, use one or both of the procedures listed for minor chemical contamination.

   The use of polishing (with wax), sanding with microfine sandpaper (1500 grit or greater) or buffing with very light compound should only be done as a last resort.

Wet Sanding — After Acid Wash

1. Clean the exterior surface of the vehicle with Ford Multi-Purpose Cleaner Concentrate B8A-19523-B or equivalent meeting Ford specification ESR-M14P4-A to remove all contamination.

2. Apply 1500 grit sandpaper to a rubber padded sanding block to sand the paint surface.

3. Use a squirt bottle filled with water to lubricate the 1500 grit sandpaper as you begin to sand only the damaged areas. Water is an abrasive as well as a lubricant in this step.

   If the damage has gone deeply into the paint film and it will not polish or sand out, then refinishing is required.

Paint Reconditioning

Acrylic urethane enamel base/clear paint systems should be painted by using the following procedure.

1. Prepare the area as follows:

    a. Neutralize the affected areas with baking soda (sodium bicarbonate) and water.
    b. Rinse the surface off with plain water.
    c. Wash the panel with a mild soapy detergent.
    d. Dry the panel completely.

    If the damage is through the top coat finish and into the primers, the panel must be sanded down to bare metal or plastic and then refinished.

2. Apply a self-etching primer for **metal surfaces only** .

    A flex additive may be necessary when working with flexible plastics. Then proceed as follows:

    a. Apply a two component urethane primer surfacer. Let dry per instructions.
    b. Sand the surface with 400 grit sandpaper to get proper finish.
    c. Finish sanding with 600 grit sandpaper.

3. Solvent wash the panel with wax and grease remover. Tack wipe it.

    The use of acrylic urethane enamel is highly recommended for this type of repair.

4. Apply base coat or top coat material per applicable paint system.

5. Apply clear acrylic urethane if you are using a base/clear paint system.

SPECIFICATIONS

BODY SERVICE PRODUCT SPECIFICATIONS

Item	Container	Ford Specification No.	Ford Part No.	Recommended Proprietary Brand
Caulking Cord		ESB-M4G32-A	D6AZ-19560-A	
Rubber Cement			8A-19552-B	
Weatherstrip Adhesive	5 Oz. Tube	ESB-M2G14-A	E8AZ-19552-A	
Liquid Butyl Sealer (Black)		ESB-M4G162-A	C9AZ-19554-B	
Extra Strength Tar and Road Oil Remover	16 Fl. Oz.	ESR-M5B106-A	B7A-19520-AA	
Silicone Lubricant	8 Oz. Tube	ESR-M13P4-A	C0AZ-19553-AA	
One Step Wash and Wax Concentrate	16 Fl. Oz.	ESR-M14P12-A	D6AZ-19523-AA	
Custom Silicone Gloss Polish	16 Fl. Oz.	ESR-M11B26-A	B7AZ-19530-AA	
Custom Clearcoat Polish	16 Oz.		F3AZ-19530-WA	
Custom Bright Metal Cleaner	16 Fl. Oz.	ESR-M5B194-B	8A-19522-A	
Multi-Purpose Cleaner Concentrate	1 Quart Bottle	ESR-M14P4-A	B8A-19523-AA	
Multi-Purpose Paint Pre-Cleaner			VC-542-A	
Ultra-Clear Spray Glass Cleaner	18 Oz. Aerosol Can	ESR-M14P5-A	E4AZ-19C507-AA	
Multi-Purpose Cleaner Concentrate	1 Gal. Jug	ESR-M14P4-A	B8A-19523-B	
Instant Adhesive	.06 Fl. Oz.	WSK-M2G402-A4	E8AZ-19554-A	
Adhesion Improving Sealer		ESR-M2P93-A	D7AZ-19000-C	
Abrasion Resistant Coating		ESB-M46221-A	D9AZ-19515-A	
RTV				
Ford Elastomeric Primer		ESB-M18P5-A		
Ford Elastomeric Thinner		ESB-M18P5-A		
Auto Body Repair Tape				3M Part No. 6930

Structure Adhesive Tube Kit				3M Part No. 8101
Multi-Purpose Paint Precleaner (Spray Gun Cleanup)			VC-542-A	

Alignment, Unitized Body, Aerostar

CAUTION: Do not attempt to correct any serious misalignment with one jacking operation. This is particularly true if other sections of the body also require aligning. Align each section proportionately until the proper dimensions are obtained.

To align or square-up a body, take two opposite diagonal measurements between pillars. Use a measuring tram for these measurements. Take the measurements between reference points such as crease lines or weld joints which are diagonally opposite each other on the two pillars being measured. Since all measurements should be made from the bare metal, remove all interior trim from the checking points.

In some cases, it is difficult to obtain proper body alignment when repairing a body that is damaged on both sides. In these cases, horizontal and vertical measurements can be taken from a body of the same body style. Once these basic dimensions are taken and established on the damaged body, alignment can be made by diagonal measurements taken from points on two pillars.

Door openings are checked in the same manner as the body. Horizontal, vertical, and diagonal checking points are established on all four sides of the door opening that is being measured.

Exhaust System Shield

For removal and installation of exhaust system shield, refer to Section 09-00 .

SPECIAL SERVICE TOOLS/EQUIPMENT

ROTUNDA EQUIPMENT

Model	Description
077-00018	Car/Truck Stands
107-R0600	Blind Fastener Installation Tool
106-00053	MIG Wire Feed Welder
073-R0450	Complete Laser Measuring System

Straightening Operations

Misalignment can be corrected by straightening the out-of-line parts or by replacing the crossmembers, braces, or brackets if they are badly damaged.

Straightening should be attempted on frames that fail to meet specification of the diagonal checking method or where damage is visually apparent.

CAUTION: If heat is needed to straighten a frame member, keep the temperature below 649°C (1200°F) (a dull red glow). Excessive heat may weak en the metal and cause permanent damage.

However, to prevent internal stresses in the metal, straightening should be limited to parts which are not severely bent.

Underbody Heat Deflectors

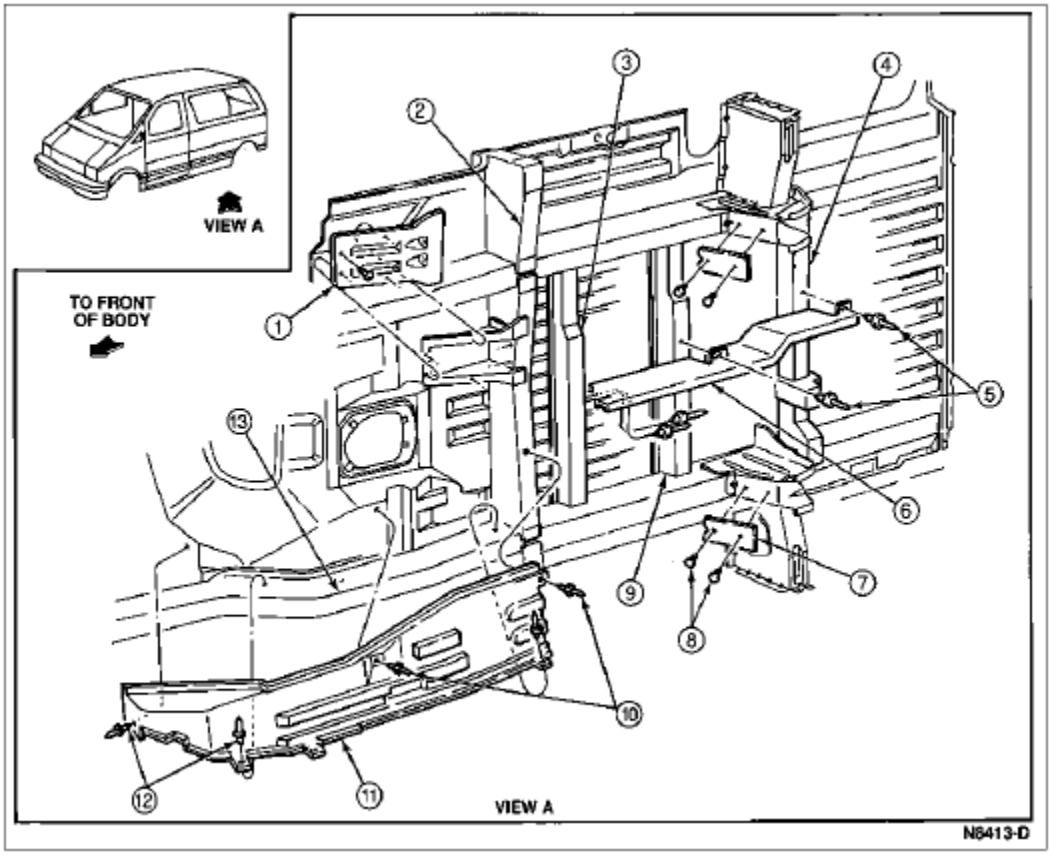
Removal

1. Raise the vehicle and secure with Rotunda Car/Truck Stands 077-00018 or equivalent.
2. Remove all components necessary to gain access to heat deflectors.
3. Using a correct size drill bit, drill out the heat deflector rivets.
4. Remove the heat deflectors.

Installation

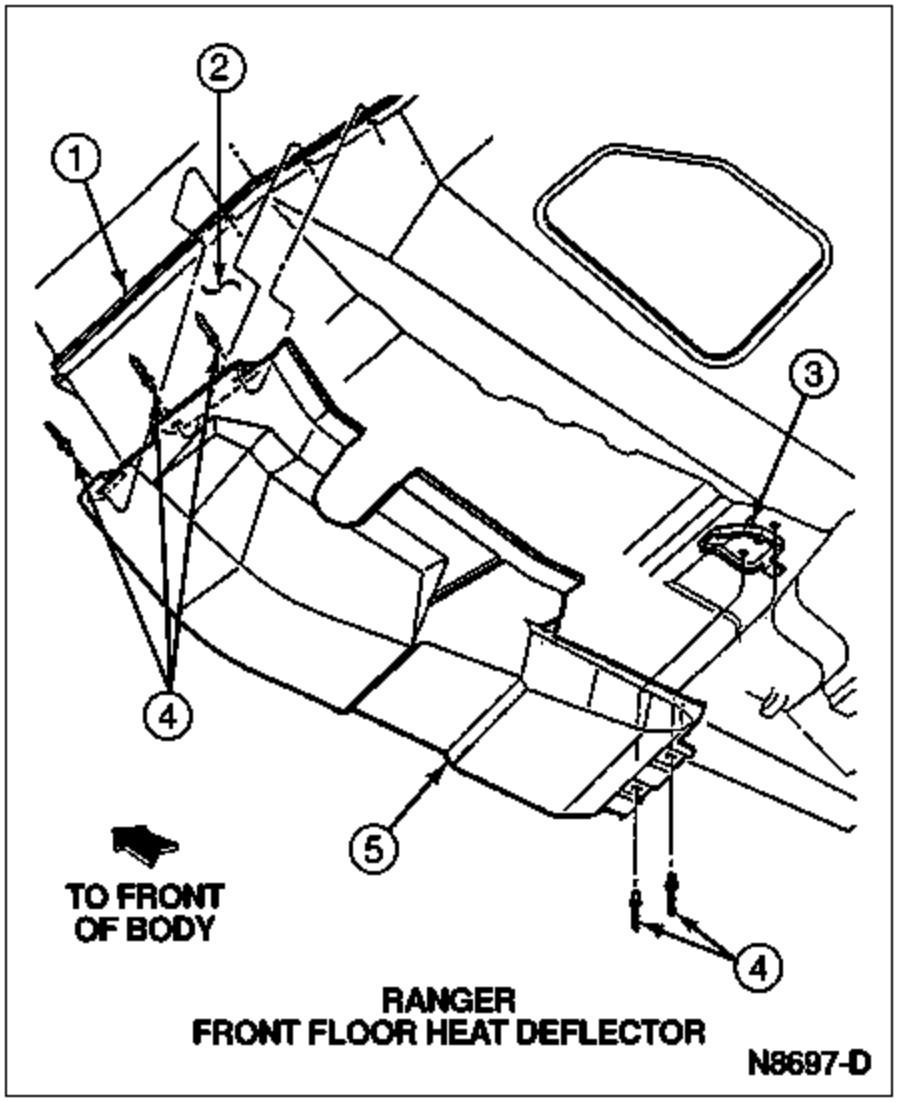
1. Align the heat deflector rivet holes with their corresponding holes.
2. Install rivets using Rotunda Blind Fastener Installation Tool 107-R0600 or equivalent. Make sure floor holes are properly sealed after rivets are installed.
3. Install components that were removed to access heat deflectors.
4. Remove the safety stands and lower the vehicle.

Underbody Heat Deflectors, Aerostar



Item	Part Number	Description
1	016B90	Parking Brake Opening Cover Plate
2	101C19	Front Floor Rear Crossmember Extension
3	11644	Rear Floor Front Crossmember
4	102A24	Rear Floor Center Crossmember
5	388869	Rivet (4 Req'd)
6	112B22	Rear Floor Heat Deflector
7	5A976	Rear Suspension Lower Arm Shield
8	N804379-S	Pushpin
9	10926	Rear Floor Intermediate Crossmember
10	388869	Rivet (6 Req'd)
11	11398	Front Floor Pan Heat Deflector
12	388869	Rivet (6 Req'd)
13	101A14	Rear Floor Side Member

Underbody Heat Deflectors, Ranger



Item	Part Number	Description
1	01610	Dash Panel
2	11135	Front Floor Pan
3	10617C50	Floor Pan Seat Track Reinforcement (Bucket Seats Only)
4	388869-S	Rivets
5	11398	Front Floor Pan Heat Deflector (Front RH Only)

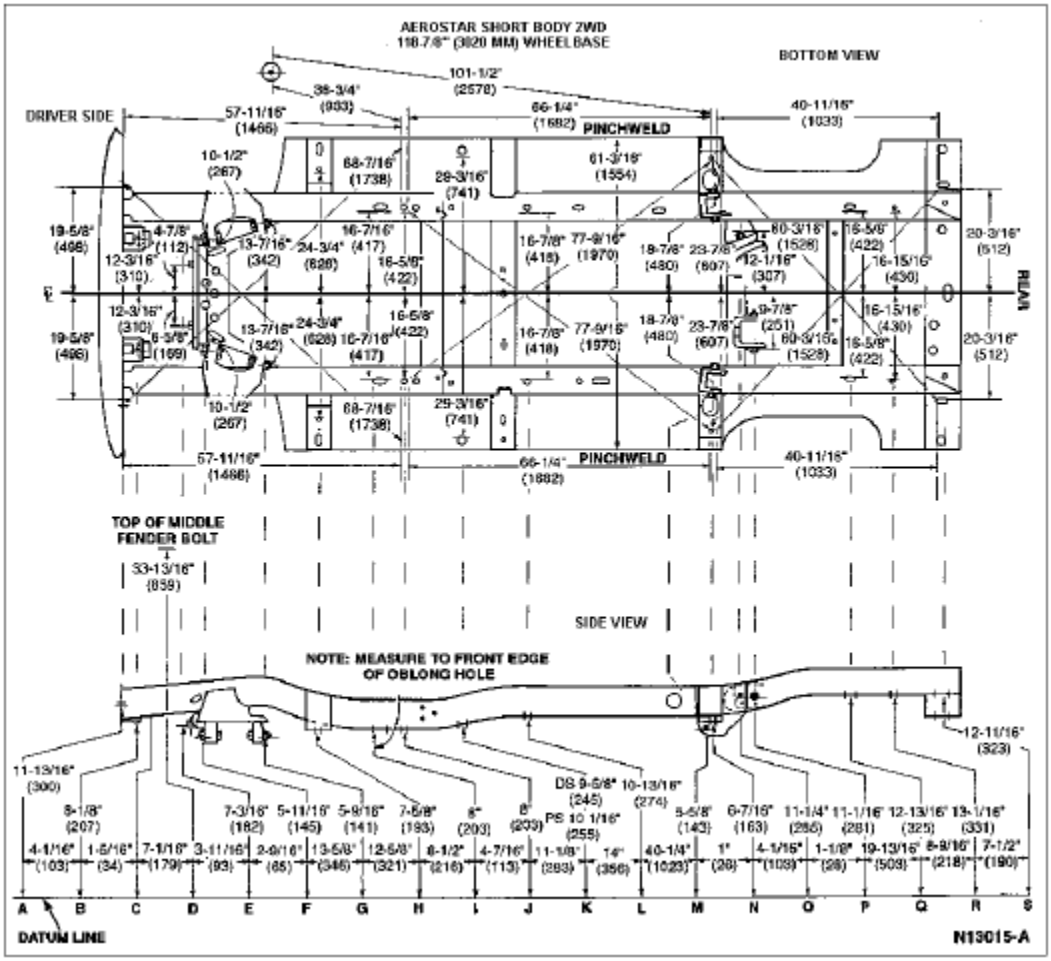
Underbody Misalignment Check

The dimensions of the underbody must be restored in repairing major body damage to provide correct front and rear wheel geometry. Refer to the following illustration for the underbody dimensions. Once the frame and suspension members are aligned, other operations in this section can be performed.

Underbody Dimensions

Underbody dimensions are shown in the following illustrations. Dimensions can be measured using Rotunda Complete Laser Measuring System 073-R0450 or equivalent.

Underbody Dimensions — Aerostar Short Body 2WD



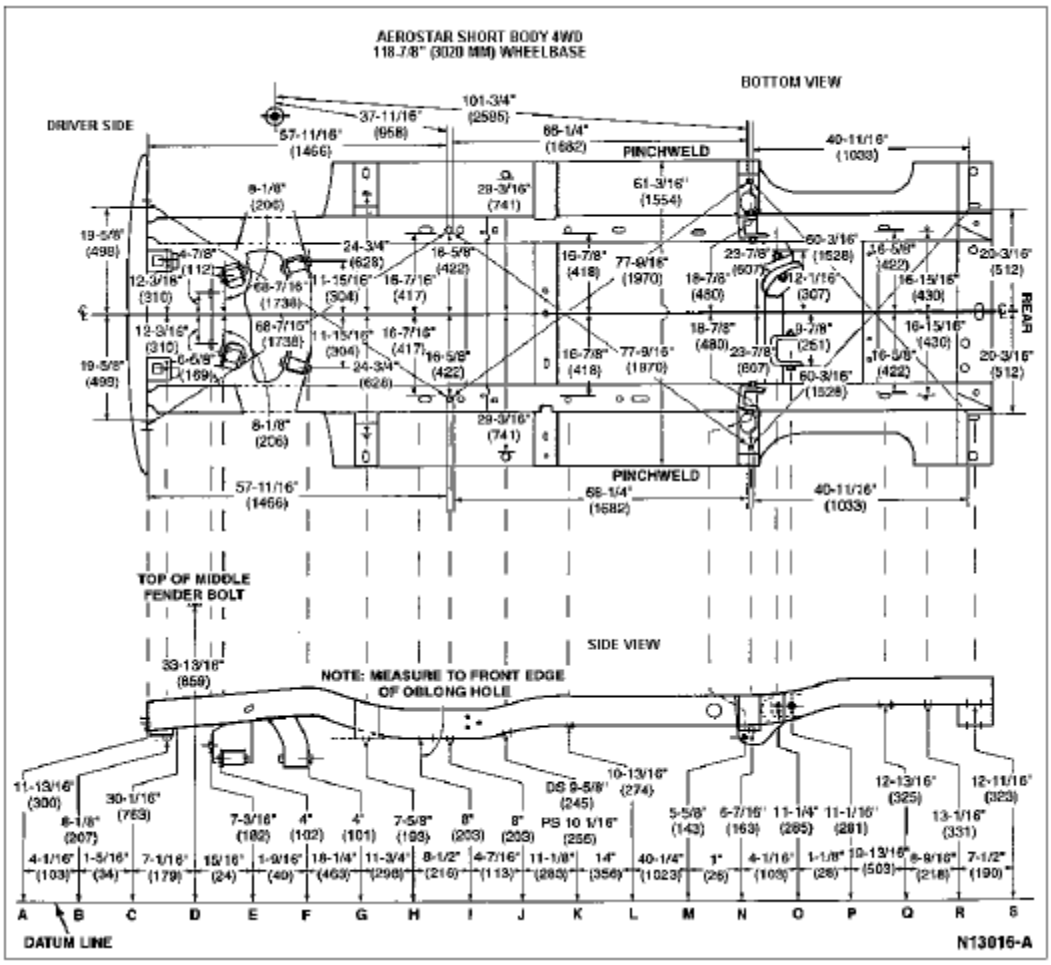
MEASURING POINTS

Item	Description
A	18 x 34mm (11/16 x 1-5/16 Inch) Hole

B	Bolt
C	Front Fender Bolt
D	Middle Fender Bolt
E	Bolt
F	Stud
G	Stud
H	13mm (1/2 Inch) Hole
I	26 x 40mm (1 Inch x 1-9/16 Inch) Hole
J	19mm (3/4 Inch) Hole
K	25mm (1 Inch) Hole
L	23mm (7/8 Inch) Hole
M	Stud
N	16mm (5/8 Inch) Hole
O	Stud
P	Bolt
Q	21 x 37mm (13/16 Inch x 1-7/16 Inch) Hole
R	10mm (3/8 Inch) Hole
S	20 x 34mm (13/16 Inch x 1-5/16 Inch) Hole
Overall Datum Lengths	
A to J	1470mm (57-7/8 Inch)
J to N	1688mm (66-7/16 Inch)
N to S	1042mm (41 Inch)

Note: Bolts and studs are measured to center. Holes are measured to closest edge. Datum height dimensions are perpendicular to datum plane. Datum length dimensions are parallel to centerline of vehicle, and are measured center to center.

Underbody Dimensions — Aerostar Short Body 4WD



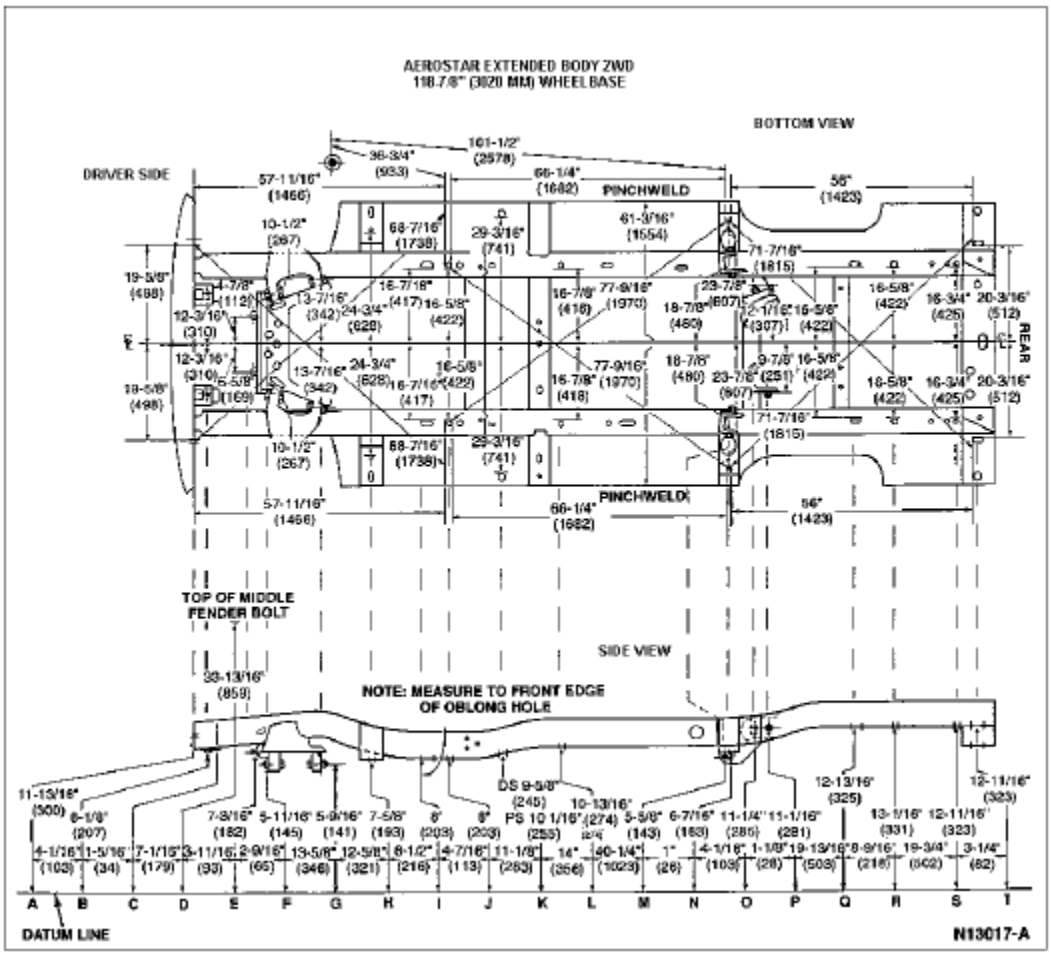
MEASURING POINTS

Item	Description
A	18 x 34mm (11/16 x 1-5/16 Inch) Hole
B	Bolt
C	Front Fender Bolt
D	Middle Fender Bolt
E	Bolt
F	Stud
G	Stud
H	13mm (1/2 Inch) Hole
I	26 x 40mm (1 Inch x 1-9/16 Inch) Hole
J	19mm (3/4 Inch) Hole
K	25mm (1 Inch) Hole
L	23mm (7/8 Inch) Hole
M	Stud

N	16mm (5/8 Inch) Hole
O	Stud
P	Bolt
Q	21 x 37mm (13/16 Inch x 1-7/16 Inch) Hole
R	10mm (3/8 Inch) Hole
S	20 x 34mm (13/16 Inch x 1-5/16 Inch) Hole
Overall Datum Lengths	
A to J	1470mm (57-7/8 Inch)
J to N	1688mm (66-7/16 Inch)
N to S	1042mm (41 Inch)

Note: Bolts and studs are measured to center. Holes are measured to closest edge. Datum height dimensions are perpendicular to datum plane. Datum length dimensions are parallel to centerline of vehicle, and are measured center to center.

Underbody Dimensions — Aerostar Extended Body 2WD

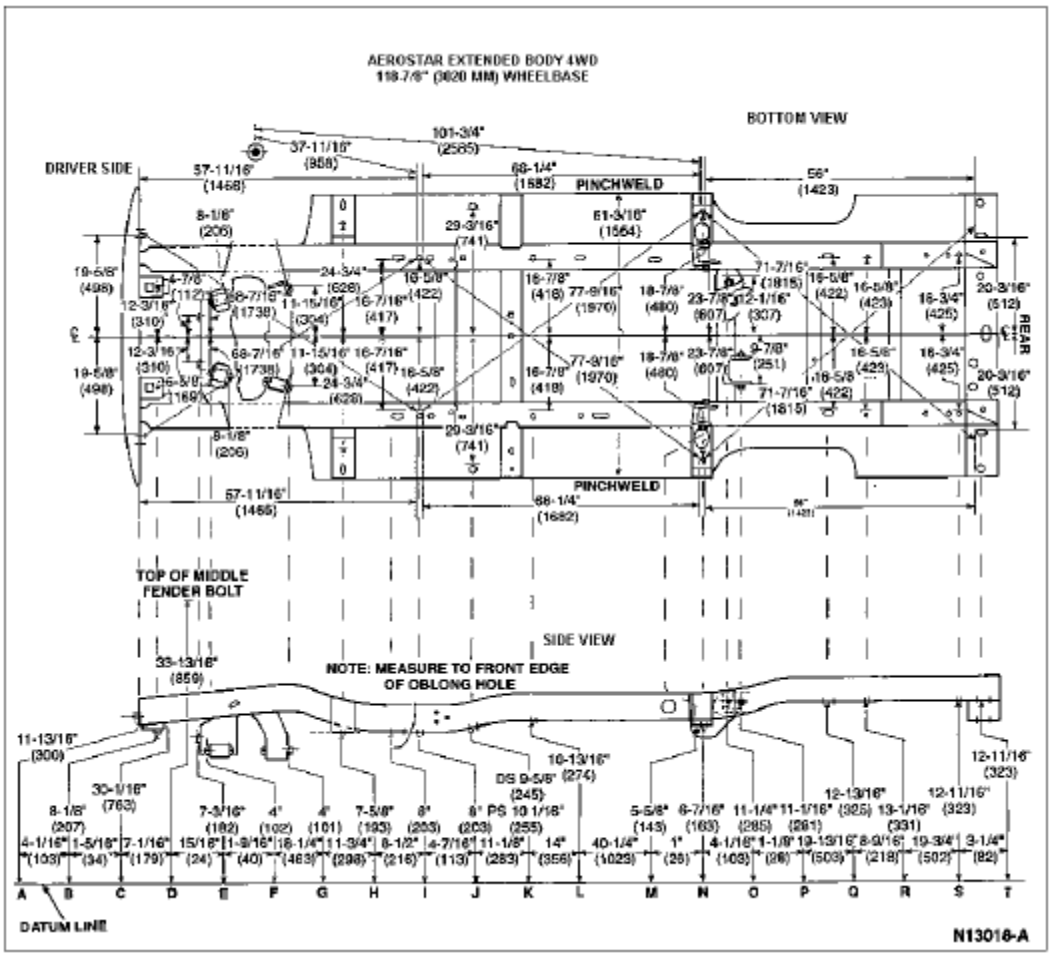


MEASURING POINTS

Item	Description
A	18 x 34mm (11/16 x 1-5/16 Inch) Hole
B	Bolt
C	Front Fender Bolt
D	Middle Fender Bolt
E	Bolt
F	Stud
G	Stud
H	13mm (1/2 Inch) Hole
I	26 x 40mm (1 Inch x 1-9/16 Inch) Hole
J	19mm (3/4 Inch) Hole
K	25mm (1 Inch) Hole
L	23mm (7/8 Inch) Hole
M	Stud
N	16mm (5/8 Inch) Hole
O	Stud
P	Bolt
Q	21 x 37mm (13/16 Inch x 1-7/16 Inch) Hole
R	25mm (1 Inch) Hole
S	16mm (5/8 Inch) Hole
T	20 x 34mm (13/16 Inch x 1-5/16 Inch) Hole
Overall Datum Lengths	
A to J	1470mm (57-7/8 Inch)
J to N	1688mm (66-7/16 Inch)
N to T	1436mm (56-9/16 Inch)

Note: Bolts and studs are measured to center. Holes are measured to closest edge. Datum height dimensions are perpendicular to datum plane. Datum length dimensions are parallel to centerline of vehicle, and are measured center to center.

Underbody Dimensions — Aerostar Extended Body 4WD



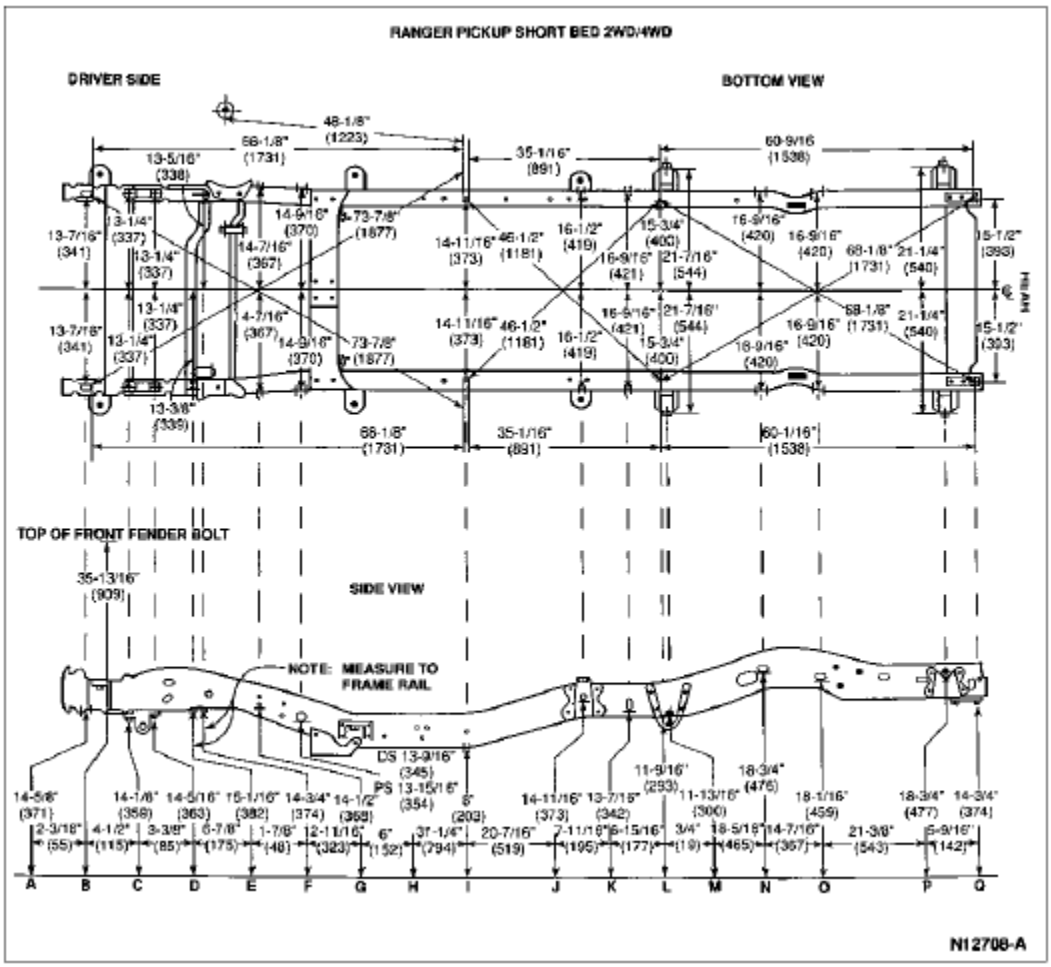
MEASURING POINTS

Item	Description
A	18 x 34mm (11/16 x 1-5/16 Inch) Hole
B	Bolt
C	Front Fender Bolt
D	Middle Fender Bolt
E	Bolt
F	Stud
G	Stud
H	13mm (1/2 Inch) Hole
I	26 x 40mm (1 Inch x 1-9/16 Inch) Hole
J	19mm (3/4 Inch) Hole
K	25mm (1 Inch) Hole
L	23mm (7/8 Inch) Hole
M	Stud
N	16mm (5/8 Inch) Hole

O	Stud
P	Bolt
Q	21 x 37mm (13/16 Inch x 1-7/16 Inch) Hole
R	25mm (Inch) Hole
S	16mm (5/8 Inch) Hole
T	20 x 34mm (13/16 Inch x 1-5/16 Inch) Hole
Overall Datum Lengths	
A to J	1470mm (57-7/8 Inch)
J to N	1688mm (66-7/16 Inch)
N to T	1436mm (56-6/16 Inch)

Note: Bolts and studs are measured to center. Holes are measured to closest edge. Datum height dimensions are perpendicular to datum plane. Datum length dimensions are parallel to centerline of vehicle, and are measured center to center.

Underbody Dimensions — Ranger Pickup Short Bed 2WD/4WD



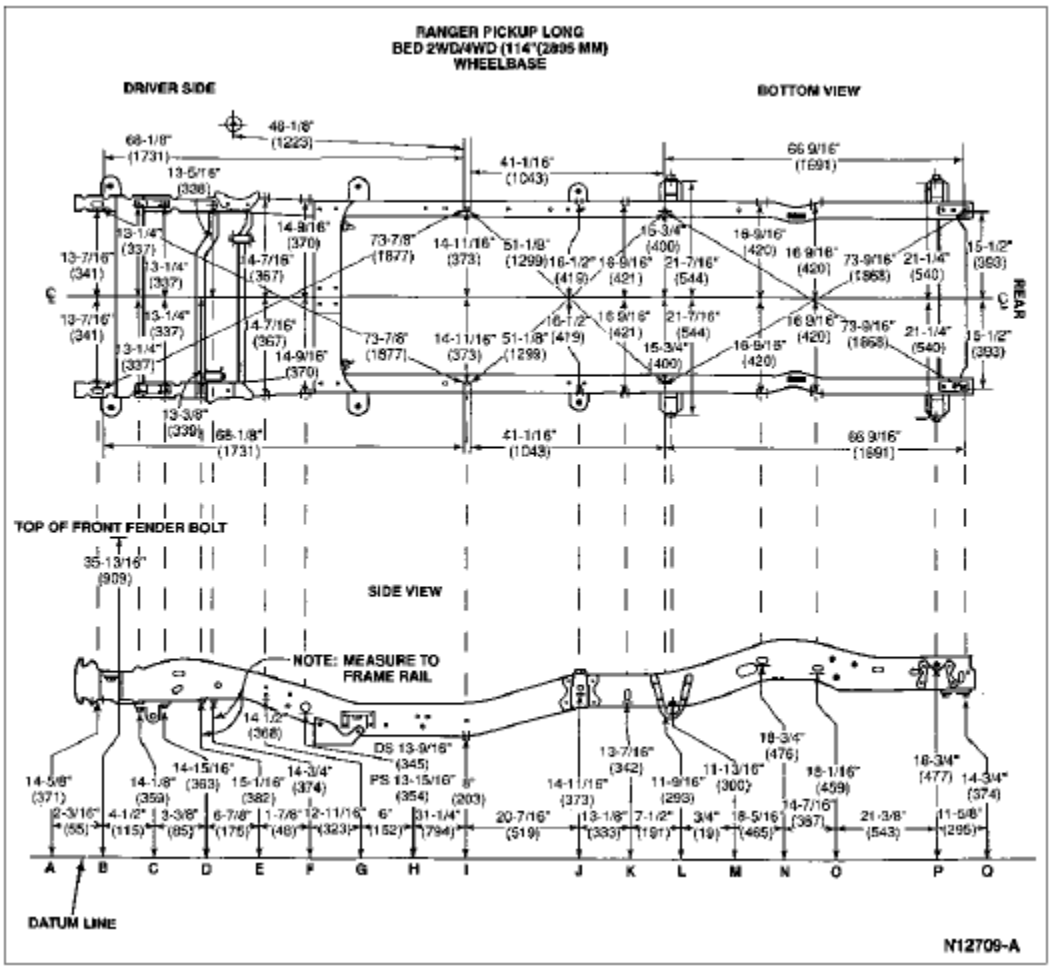
MEASURING POINTS

Point	Description
A	23 x 40mm (7/8 Inch x 1-9/16 Inch)
B	Front Fender Bolt
C	Bolt
D	Bolt
E	Bolt
F	Nut
G	16mm (5/8 Inch)
H	Driver Side 44mm (1-3/4 Inch) Passenger Side 25mm (1 Inch)
I	9mm (3/8 Inch)
J	16mm (5/8 Inch)
K	17 x 35mm (11/16 Inch x 1-3/8 Inch)
L	Pin
M	Bolt

N	16 x 25mm (5/8 Inch x 1 Inch)
O	16 x 25mm (5/8 Inch x 1 Inch)
P	Bolt
Q	Bolt
Overall Datum Lengths	
A to I	1747mm (68-3/4 Inches)
I to L	891mm (35-1/16 Inches)
L to Q	1536mm (60-1/2 Inches)

Note: Bolts and studs are measured to center. Holes are measured to closest edge. Datum height dimensions are perpendicular to datum plane. Datum length dimensions are parallel to centerline of vehicle, and are measured center to center.

Underbody Dimensions — Ranger Pickup Long Bed 2WD/4WD 114" (2896 MM) Wheelbase

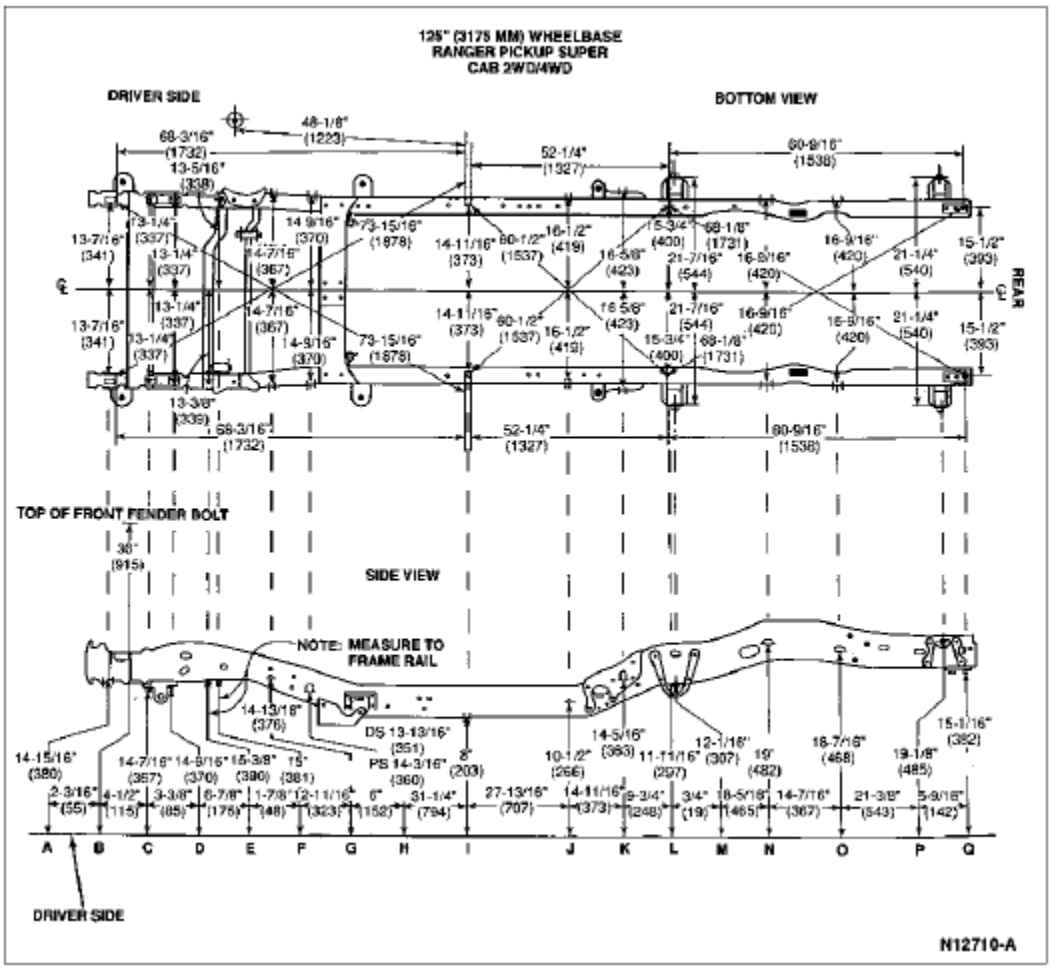


MEASURING POINTS

Point	Description
A	23 x 40mm (7/8 Inch x 1-9/16 Inch)
B	Front Fender Bolt
C	Bolt
D	Bolt
E	Bolt
F	Nut
G	16mm (5/8 Inch)
H	Driver Side 44mm (1-3/4 Inch) Passenger Side 25mm (1 Inch)
I	9mm (3/8 Inch)
J	16mm (5/8 Inch)
K	17 x 35mm (11/16 Inch x 1-3/8 Inch)
L	Pin
M	Bolt
N	16 x 25mm (5/8 Inch x 1 Inch)
O	16 x 25mm (5/8 Inch x 1 Inch)
P	Bolt
Q	Bolt
Overall Datum Lengths	
A to I	1747mm (68-3/4 Inches)
I to L	1043mm (41-1/16 Inches)
L to Q	1689mm (66-1/2 Inches)

Note: Bolts and studs are measured to center. Holes are measured to closest edge. Datum height dimensions are perpendicular to datum plane. Datum length dimensions are parallel to centerline of vehicle, and are measured center to center.

Underbody Dimensions — 125" (3175 MM) Wheelbase Ranger Pickup Super Cab 2WD/4WD



MEASURING POINTS

Point	Description
A	23 x 40mm (7/8 Inch x 1-9/16 Inch)
B	Front Fender Bolt
C	Bolt
D	Bolt
E	Bolt
F	Nut
G	16mm (5/8 Inch)
H	Driver Side 44mm (1-3/4 Inch) Passenger Side 25mm (1 Inch)
I	9mm (3/8 Inch)
J	16mm (5/8 Inch)
K	17 x 35mm (11/16 Inch x 1-3/8 Inch)
L	Pin
M	Bolt

N	16 x 25mm (5/8 Inch x 1 Inch)
O	16 x 25mm (5/8 Inch x 1 Inch)
P	Bolt
Q	Bolt
Overall Datum Lengths	
A to I	1747mm (68-3/4 Inches)
I to L	1328mm (52-5/16 Inches)
L to Q	1536mm (60-1/2 Inches)

Note: Bolts and studs are measured to center. Holes are measured to closest edge. Datum height dimensions are perpendicular to datum plane. Datum length dimensions are parallel to centerline of vehicle, and are measured center to center.

Frame Repairs/Alignment, Ranger

Frame misalignment is the result of damaged or loose frame components.

Before checking frame alignment, inspect the frame for damage and loose parts. Inspect all frame members for cracks, twists, or bends. Check all welded connections for cracks. Inspect all rivets, bolts, and body support brackets for looseness. Make all necessary repairs or replacements.

Welding

CAUTION: Disconnect the battery ground cable (14301) (14301) before using any electrical welding equipment.

Perform all welding using Rotunda MIG Wire Feed Welder 106-0053 or equivalent, and welding wire meeting AWS-E-70S specification.

Because more extensive panel deformation results from oxyacetylene welding than from MIG welding or spot welding, perform sectional welding using MIG welding or spot welding equipment only.

Perform spot welding operations in locations that are inaccessible with spot welding tongs using the plug weld method. Drill or punch 8mm (5/16-inch) holes in one side of the flange and weld.

Varying factors determine plate thickness, panel design, cross-sectionals and sizes, joining method, welding method, and welding locations during manufacturing. To apply the most suitable repair method, it is most important to completely understand the body design, concept, and construction.

It is essential that repair welds, particularly on load-bearing parts or parts contributing to the strength of the assembly, are equivalent to the originals in size, type, and strength.

Low-Alloy Steel Components

NOTE: When cutting salvage or repairable components, use a grinding disc, air chisel, or metal cutting saw.

NOTE: All welding should be done with a Rotunda MIG Wire Feed Welder 106-00053 or equivalent with welding wire meeting AWS-E-70S specification.

1. **CAUTION: Disconnect the battery ground cable before using any electric welding equipment.**

   Because of associated high heat buildup, do not use oxyacetylene when welding high-tensile or high-strength, low-alloy steel components. Use spot or MIG. During MIG welding, use a temperature-indicating crayon to ensure that the temperature does not exceed 750°C (1400°F).

2. Replace spot-welded components by spot welding where possible. If spot welding equipment is not available, or if the location is not accessible, plug weld the panels.

3. Use MIG welding rather than conventional arc welding when welding high-strength, high-tensile, or conventional mild steel. Use .024 or .030 diameter wire and conform to Classification AWS, E70S. MIG welding is also known as GMAW (Gas Metal Arc Welding).

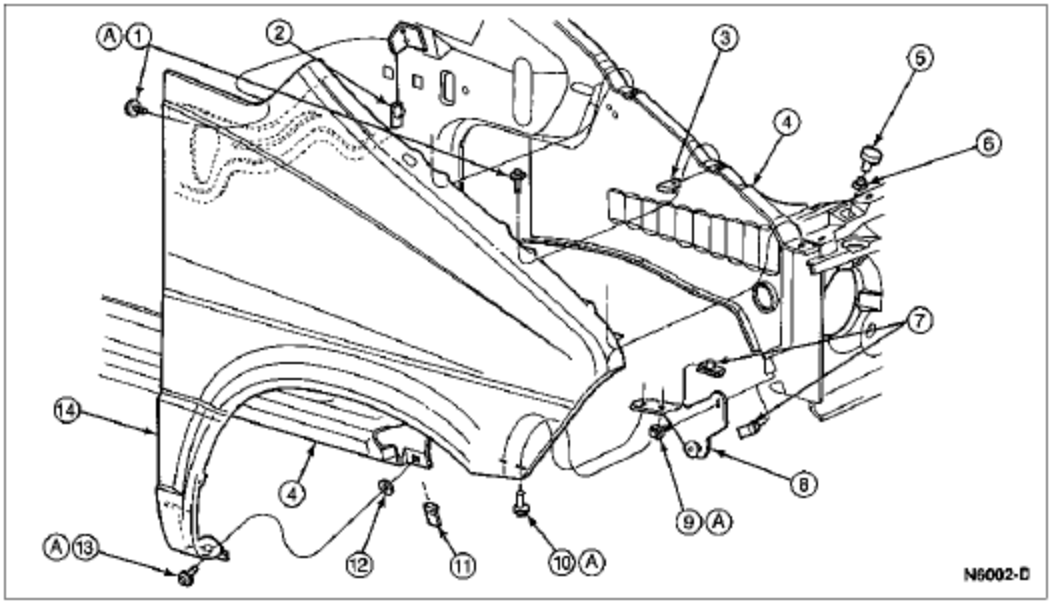
Front Fender, Aerostar

Removal

1. Clean all dirt from the radiator support (16138) attaching screws, bolts and nuts.
2. Remove bolts attaching the front of the front fender (16005) to the radiator support at upper and lower locations.
3. Remove one bolt attaching the rear lower end of the fender to the lower corner of the body side.
4. Remove one bolt (access by opening door) attaching the rear end of the fender to the cowl.
5. Remove the screws around the wheel opening attaching the front fender splash shield (16102).
6. Remove bolts along top of front fender splash shield attaching the front fender.
7. Remove the front fender.

For installation, follow removal procedures in reverse order. Install all fender attaching screw and washer assemblies hand-tight and align the front fender before tightening to specifications. Tighten all fender attaching screw and washer assemblies to 7-11 Nm (62-97 lb-in).

Front Fender, Aerostar

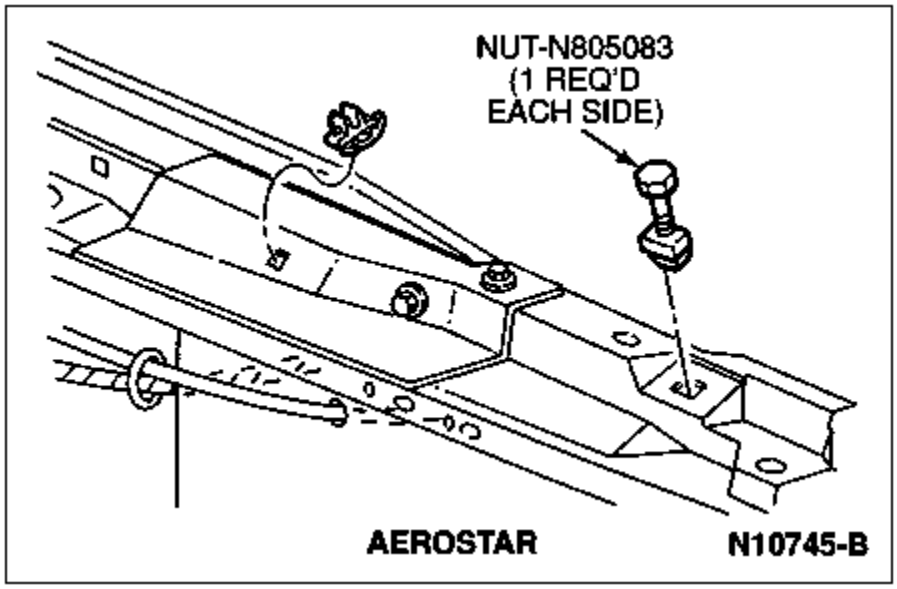


Item	Part Number	Description
1	—	Screw and Washer (8 Req'd Each Side) (Part of

		Fender Assembly)
2	N623342-S100	Spring Nut (8 Req'd Each Side)
3	N623342-S100	Spring Nut (8 Req'd Each Side)
4	10462	Body Side Assembly
5	N806044-S	Bumper Assembly
6	N800428-S	Nut and Retainer
7	N623342-S100	Spring Nut (8 Req'd Each Side)
8	17B749	Front Bumper Mounting Bracket
9	—	Screw and Washer (8 Req'd Each Side) (Part of Bumper Mounting Bracket)
10	—	Screw and Washer (8 Req'd Each Side) (Part of Bracket to Fender Assembly)
11	N800428-S	Nut and Retainer
12	389346-S	Flatwasher
13	—	Screw and Washer (8 Req'd Each Side) (Part of Fender to Body Side Assembly)
14	16005	Fender
A	—	Tighten to 7-11 Nm (62-97 Lb-In)

Hood Alignment

The hood (16612) can be adjusted fore and aft and side to side by loosening the hood-to-hinge attaching bolts and repositioning the hood. To raise or lower the hood, loosen the hinge hood-to-body attaching bolts and turn bumpers clockwise to lower or counterclockwise to raise.



Hood Bumpers

Hood bumpers (16758) located on the top RH and top LH surfaces of the radiator support (16138) can be adjusted up and down to provide a flush surface alignment of the hood (16612) with the front fenders (16005).

Hood Latch, Aerostar

Removal

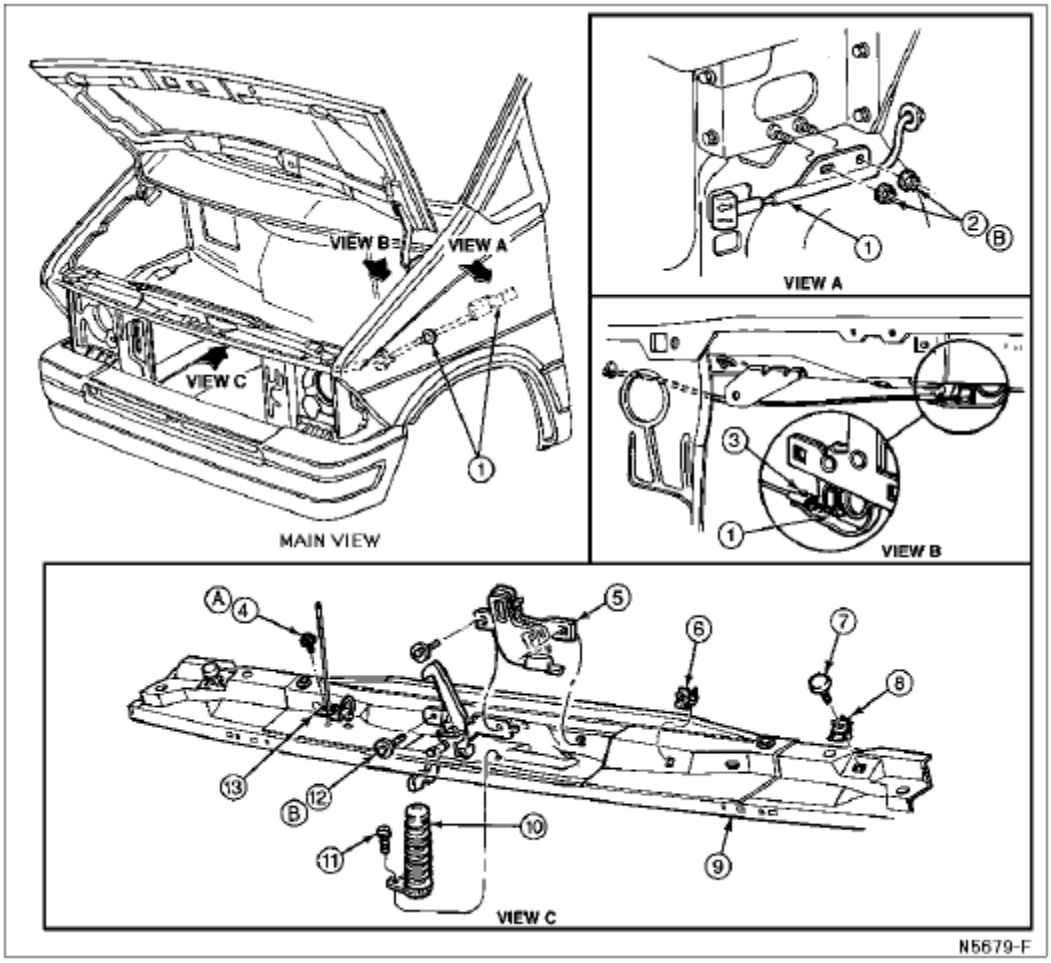
1. Mark location of bracket for installation.
2. Remove two hood latch attaching screws.
3. Disconnect cable from latch, routing cable and fitting through return spring.
4. Remove hood latch (16700).

Installation

1. Maneuver hood release cable terminal through curled return spring on back side of hood latch.
2. Locate square cable bushing tab in hood latch housing keyhole slot and fasten screw snug, but do not overtighten 1.8-2.6 Nm (16-23 lb-in).
3. Adjust the hood latch for positive engagement with the hood latch striker (16K689). Also, make sure that secondary hook engages hood latch striker smoothly. Tighten the latch attaching screws to 10-14 Nm (7-10 lb-ft).
4. **NOTE: Make sure lubricant has effectively worked into the pivot points and bearing surfaces.**

   Lubricate the latch handle pivot, catch pawls and spring with Multi-Purpose Grease spray D7AZ-19584-AA, or equivalent meeting Ford specification ESB-M1C106-B. Recheck the functional operation of the hood latch and safety latch by opening and closing the hood (16612) several times to make sure latch function is correct.

Hood Latch, Aerostar



Item	Part Number	Description
1	16916	Hood Latch Control Handle and Cable
2	N620481-S8	Nut
3	56930-S2	Screw
4	N606676-S55	Screw
5	16700	Hood Latch
6	16828	Hood Support Rod Retainer Clip
7	N806044-S	Bumper Assembly
8	N800428-S100	Nut and Retainer
9	16138	Radiator Support
10	16C644	Hood Assist Spring
11	56928	Screw
12	N802850-S55	Screw and Washer
13	16826	Hood Support Rod
A	—	Tighten to 9-14 Nm (7-10 Lb-Ft)
B	—	Tighten to 10-14 Nm

		(8-10 Lb-Ft)

Hood Latch

1. **NOTE: Before adjusting the hood latch (16700), make certain that the hood (16612) is properly aligned. The hood latch can be moved from side to side, up and down and laterally to obtain a snug fit.**

   Loosen the hood latch attaching screws just enough to move the hood latch.

2. Move the hood latch until it is aligned with the hood latch striker (16K689). Then, tighten the hood latch attaching screws. Check hood-to-fender fit.

3. Check the hood latch to make sure it makes full engagement with the hood latch striker. If the hood latch does not make full engagement with the hood latch striker, loosen the hood latch attaching screws and reposition the hood latch to obtain full engagement. Then, tighten the attaching screws.

4. **NOTE: Make sure lubricant has effectively worked into the pivot points and bearing surfaces.**

   Lubricate the latch handle pivot, catch pawls and spring with Multi-Purpose Grease spray D7AZ-19584-AA or equivalent meeting Ford specification ESB-M1C106-B. Recheck the functional operation of the hood latch mechanism and safety latch by operating and closing the hood several times to make sure function is correct.

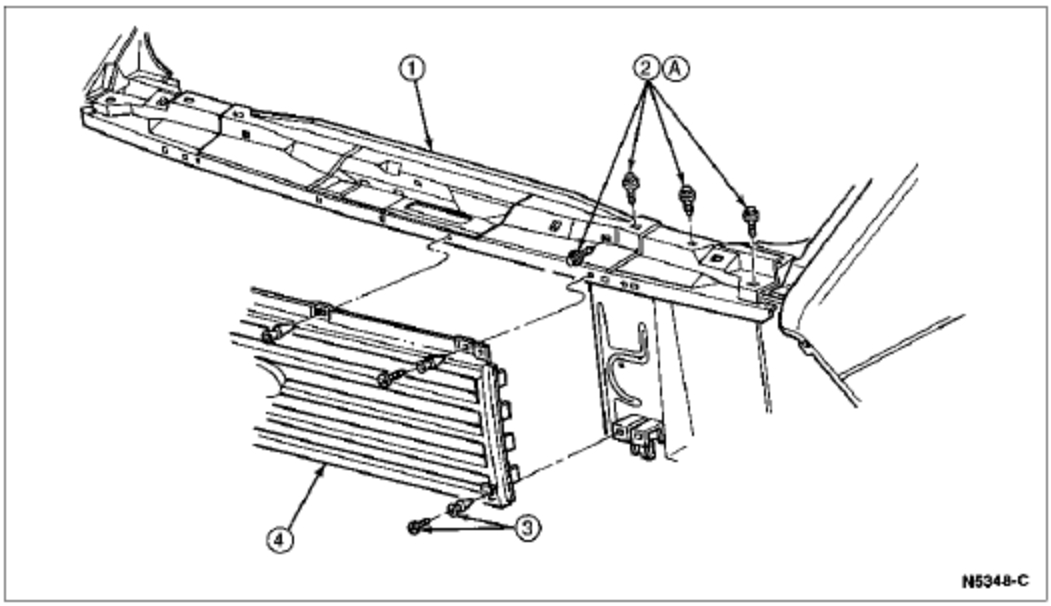
Radiator Grille, Aerostar

Removal and Installation

1. Open the hood (16612) of the vehicle.
2. Remove the six screws from the radiator grille (8200) and remove the radiator grille.

For installation, follow removal procedures in reverse order.

Radiator Grille, Aerostar



Item	Part Number	Description
1	8190	Radiator Grille Opening Panel
2	N606676-S55	Screw
3	N803494	Screw and Nut Assembly
4	8200	Radiator Grille
A	—	Tighten to 9-14 Nm (7-10 Lb-Ft)

SPECIFICATIONS

TORQUE SPECIFICATIONS

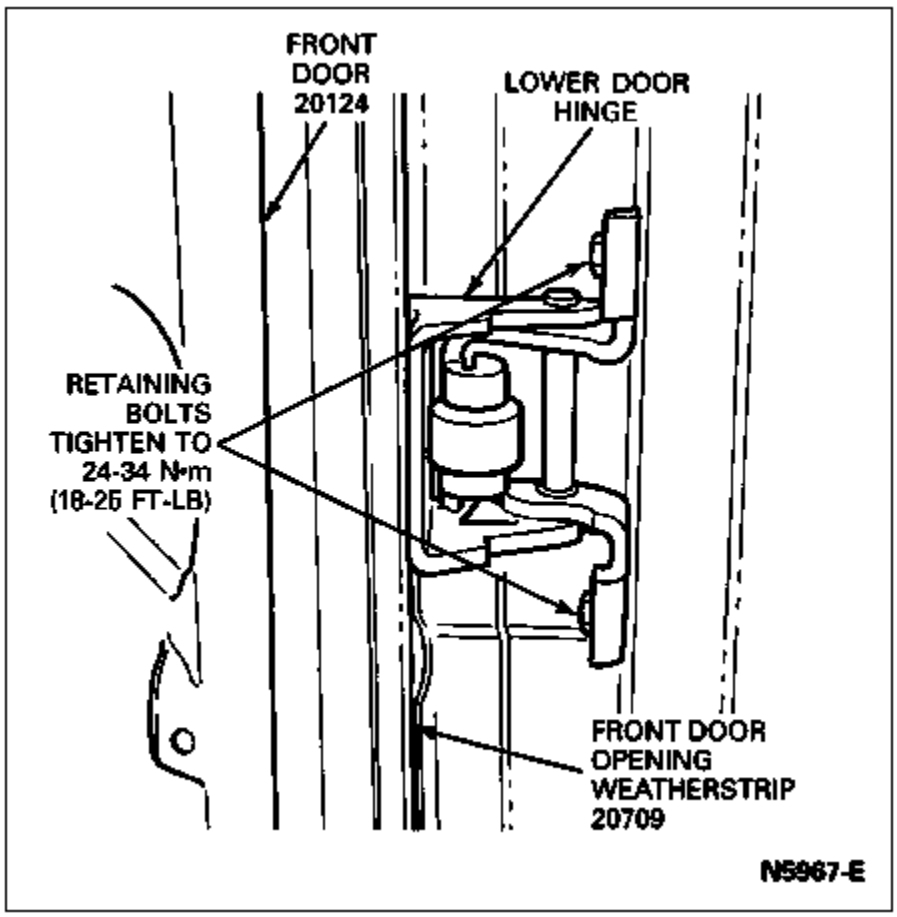
Description	Nm	Lb-Ft	Lb-In
Hinge-to-Hood Screw and Washer Assemblies, Aerostar	22-34	16-25	—
Hood Hinge-to-Body, Screw and Washer Assemblies, Aerostar	22-34	16-25	—
Hinge-to-Hood Screw and Washer Assemblies, Ranger	7-11	—	62-97
Hood Hinge-to-Body, Screw and Washer Assemblies, Ranger	7-11	—	62-97
Hood Latch Screw and Washer Assemblies, Aerostar	10.5-13.5	8-9	—
Hood Latch Release Cable-to-Latch, Screw and Washer Assembly, Ranger	1.8-2.6	—	16-23
Hood Support Rod Screw and Washer Assembly, Aerostar	9-14	—	80-123
Hood Support Rod Screw and Washer Assembly, Ranger	7-11	—	62-97
Hood Latch Support Screw and Washer Assemblies, Ranger	6-8	—	54-70
Hood Latch Control Screw and Washer Assemblies, Ranger	2.0-4.5	—	18-39
Hood Latch Control Nuts, Aerostar	10-14	8-10	—
Fender Screw and Washer Assemblies, Aerostar	7-11	—	62-97
Fender Screw and Washer Assemblies, Ranger	10-14	8-10	—
Fender Apron Screws, Aerostar	1.0-2.3	—	9-20
Fender Apron Screws, Ranger	10-14	8-10	—
Fog Lamp Brackets, Ranger	77-103	57-77	—

Doors

Front Doors

Removal and Installation

1. Open front door (20124) and support using Rotunda Flexi-Work Table 156-00070 or equivalent.
2. If installing a newfront door, remove all usable hardware, trim and glass parts from old door. Refer to Section 01-05A , Section 01-05B or Section 01-11 .
3. Remove the upper and lower hinge access hole cover plate, if so equipped, and mark the location of the hinge on the door and body.
4. Remove bolts retaining front door to lower hinge.



5. Remove bolts attaching front door to front door upper hinge (22800).

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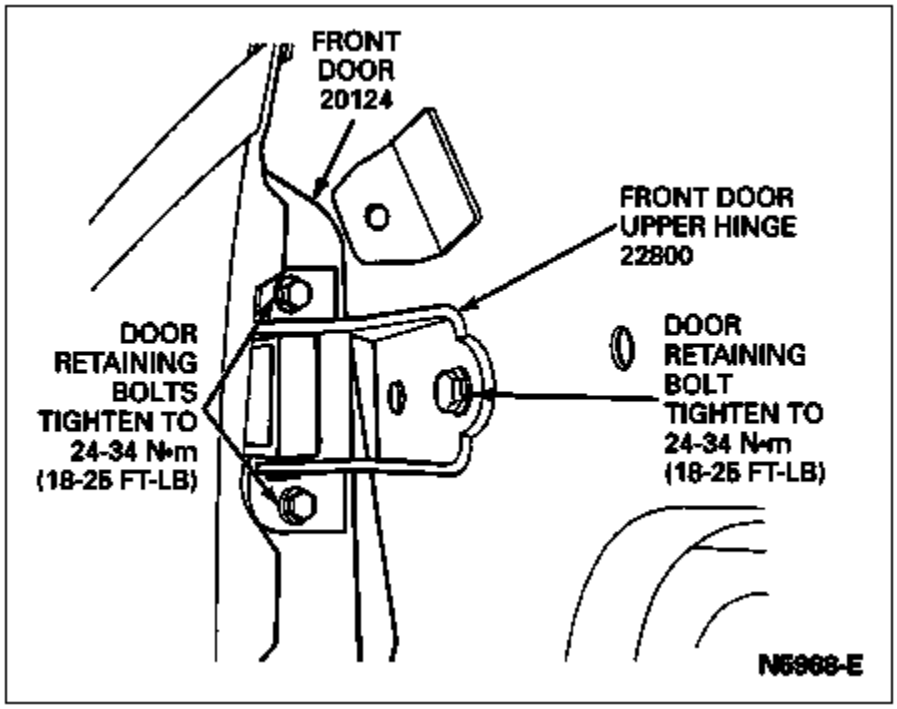

6. If a hinge is to be replaced, remove the bolts attaching hinge to pillar. Remove hinge.

7. For installation, follow removal procedures in reverse order.

8. Adhere thefront door opening weatherstrip (20709) in proper position on thefront door. Use Weatherstrip Adhesive E8AZ-19552-A or equivalent meeting Ford specification ESB-M2G14-A. Include the belt seals.

9. Adjust front door. Refer to Adjustments in this section.

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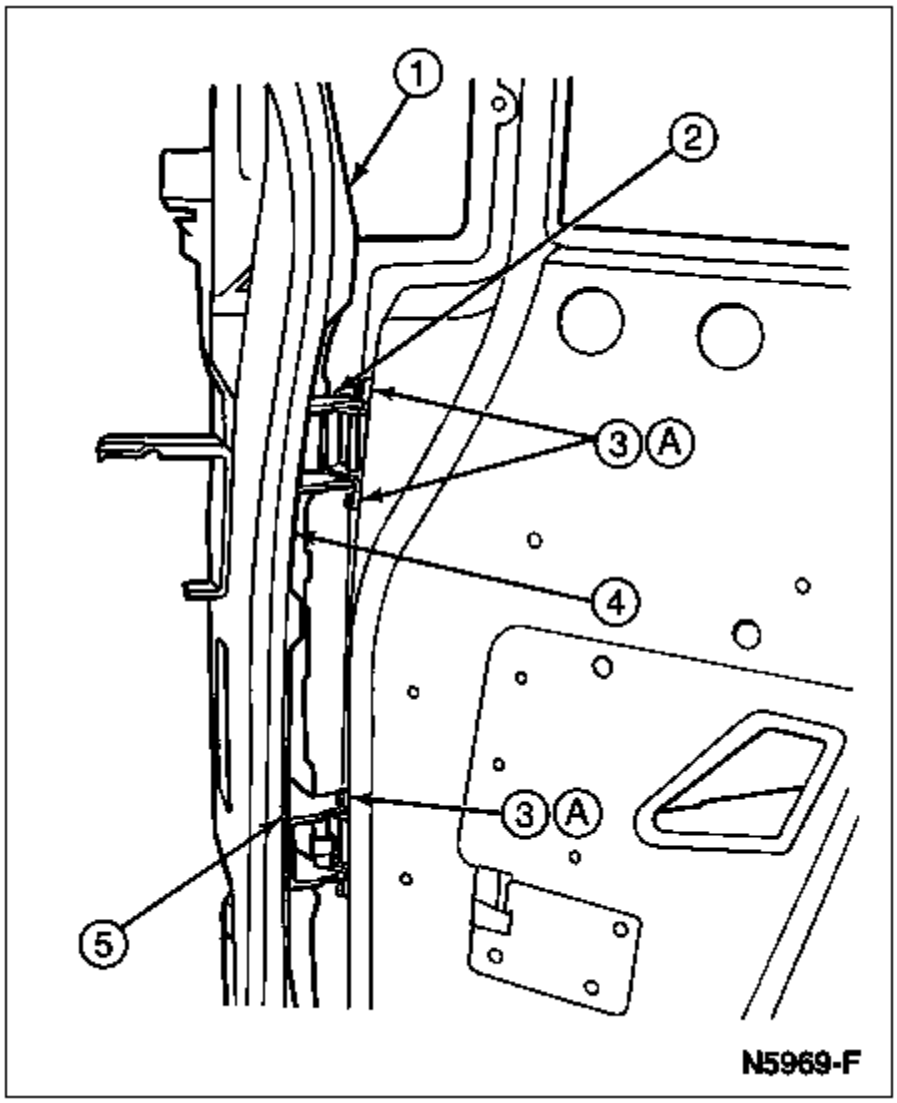

Item	Part Number	Description
1	20124	Front Door
2	22800	Front Door Upper Hinge
3	N800949-S2	Retaining Bolts
4	20709	Front Door Opening Weatherstrip
5	22806	Lower Hinge
A	—	Tighten to 25-35 Nm (18-26 Lb-Ft)

Sliding Side Door

Removal and Installation

1. Remove quarter trim panel (31012) or access hole cover plate. Refer to Section 01-05B .

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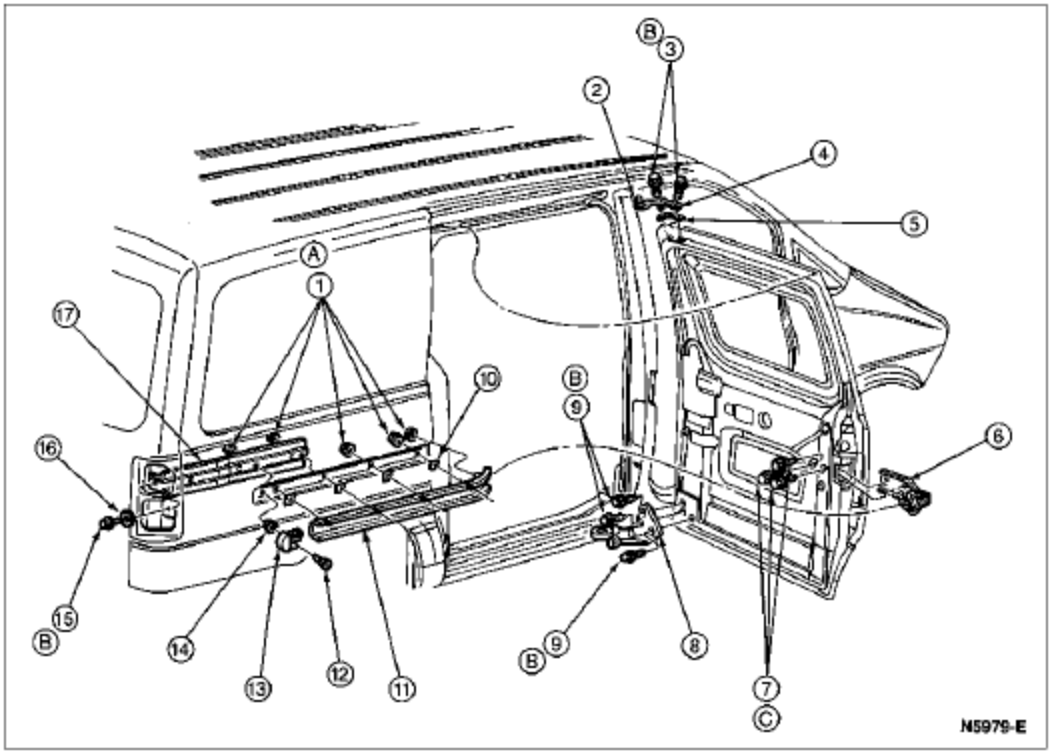
2. Mark the position of upper guide bracket, lower guide bracket and the body side hinge bracket.
3. Remove the three bolts holding the body side hinge bracket.
4. Release the door latch, pull the body side hinge from the door and swing the door straight out to the side.
5. While supporting the door, remove the upper guide bracket bolts.
6. Remove the lower guide bolts, and remove the door.

For installation, follow removal procedures in reverse order. Align upper and lower hinge brackets to disassembly marks. Tighten attaching bolts to 22-34 Nm (16-25 lb-ft).

Sliding Side Door



Item	Part Number	Description
1	N621926-S36	Nut
2	25028	Roller Assembly, Body Side Door, Upper Guide
3	N605907-S40	Bolt
4	24618	Bracket Assembly, Body Side Door, Upper Guide
5	26094	Shim, Body Side Door, Upper Guide
6	26800	Hinge Assembly, Body Side Door
7	N606688-S2	Screw and Washer Assembly
8	268A26	Guide Assembly, Body Side Door, Lower

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9	N605907-S101	Bolt
10	N99J291	Gasket
11	1126028	Track Assembly, Body Side Door, Center Track
12	N610022-S55	Screw
13	26868	Filler Assembly, Body Side Door, Center Track
14	383356-S100	Nut
15	N606688-S55	Bolt
16	N805825-S	Washer
17	1528458	Reinforcement (Extended Aerostar Only)
A	—	Tighten to 5-6 Nm (44-53 Lb-In)
B	—	Tighten to 22-34 Nm (16-25 Lb-Ft)
C	—	Tighten to 17-20 Nm (13-15 Lb-Ft)

Dual Rear Doors, Aerostar

Removal and Installation

1. Open and support the door with Rotunda Flexi-Work Table 156-00070 or equivalent.
2. Mark lower hinge to rear door (24630) location.
3. Remove three screw and washer assemblies retaining upper hinge torear door.
4. Remove two screw and washer assemblies retaining lower hinge torear door.
5. Slide rear door offsliding door hinge and roller (26800). Retain the back door hinge spacer(s) from sliding door hinge and roller to rear door.

For installation, follow removal procedures in reverse order. If adjustments are needed, refer to Door Hinge adjustment procedure in this section.

Hinges Dual Rear Door, Aerostar

NOTE: The lower hinge need not be removed to remove upper hinge and vice versa.

Upper Hinge

Removal and Installation

1. Open and support the door with Rotunda Flexi-Work Table 156-00070 or equivalent.
2. Mark location of upper and lower hinges on door and body.
3. Remove plug button for hinge mounting driver access holes in pillar-inner rear corner and remove nut and washer assembly.

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4. Remove five screw and washer assemblies retaining sliding door hinge and roller to door and body.
5. Slide upper hinge from vehicle. Retain door hinge spacer(s).

For installation, follow removal procedures in reverse order.

Lower Hinge

Removal and Installation

1. Remove five screw and washer assemblies retaining lower hinge to sliding door hinge and roller and body.
2. Slide lower hinge from vehicle.

For installation, follow removal procedures in reverse order.

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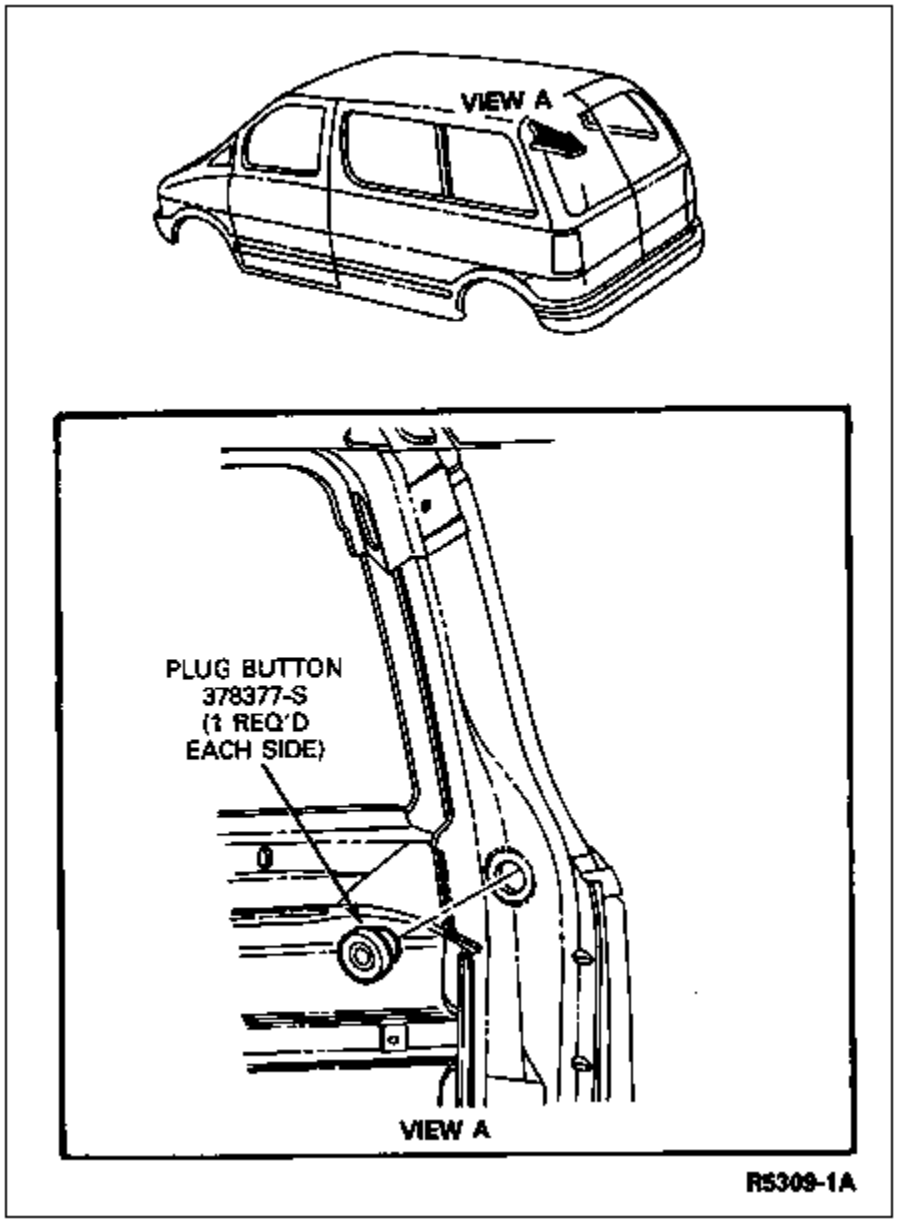
Dual Rear Door Alignment, Aerostar

CAUTION: Do not cover up poor rear door (24630) alignment with a latch striker adjustment.

1. From inside of vehicle, remove plug button for hinge mounting driver access holes in pillar rear cover.



2. From inside the vehicle, loosen hinge screw and washer assembly just enough to permit movement

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of the door with a padded pry bar. Retain sliding door hinge and roller (26800) to body for side-to-side or up-and-down adjustments.

3. Remove two screw and washer assemblies and loosen screw and washer assembly at the spacer slot location, retaining sliding door hinge and roller to rear door, to remove or insert backdoor hinge spacer(s) for fore and aft adjustments.

4. Loosen three screw and washer assemblies retaining lower hinge to body for up and down or fore and aft adjustment.

5. Loosen two screw and washer assemblies retaining lower hinge torear door for side to side adjustments.

6. Adjust rear door, as necessary. Tighten screw and washer assemblies, and nut and washer assembly.

7. Check the rear door fit to make sure there is no bind or interference with the adjacent panel.

8. Repeat operation until desired fit is obtained in terms of flushness and gap.

9. Check door latch striker plate (22008) alignment for proper rear door closing.

Dual Rear Doors, Aerostar

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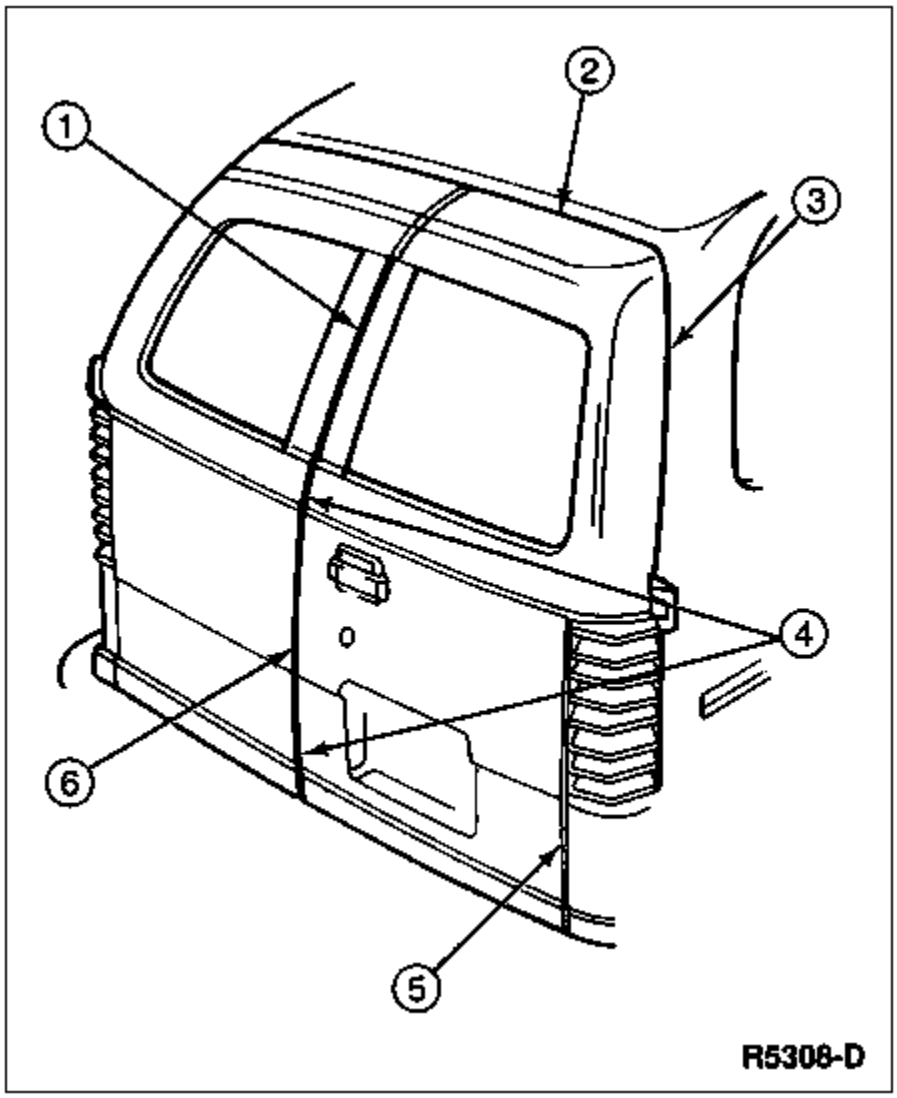

Item	Description	Flushness	Gap
1	Margin Between Window Modules	Flush ± 2.5mm (0.08 In.)	6mm ± 3.5mm (0.23 In. ± 0.13 In.)
2	Door Below Roof	1.5mm ± 2.5mm (0.05 In. ± 0.09 In.)	5.0mm ± 2.5mm (0.19 In. ± 0.09 In.)
3	Door Inboard	1.5mm ± 2.5mm (0.05 In. ± 0.09 In.)	5.0mm ± 2.0mm (0.19 In. ± 0.08 In.)
4	Character Line	Alignment ± 2.0mm (0.07 In.)	— —
5	Door Inboard Lower	Flush ± 2.5mm (0.08 In.)	5.0mm ± 2mm (0.19 In. ± 0.07 In.)
6	Margin Between Doors	Flush ± 2.0mm (0.07 In.)	6.0mm ± 2.5mm (0.23 In. ± 0.08 In.)

Note: Margins must be parallel within 1.5mm (0.06 in.).

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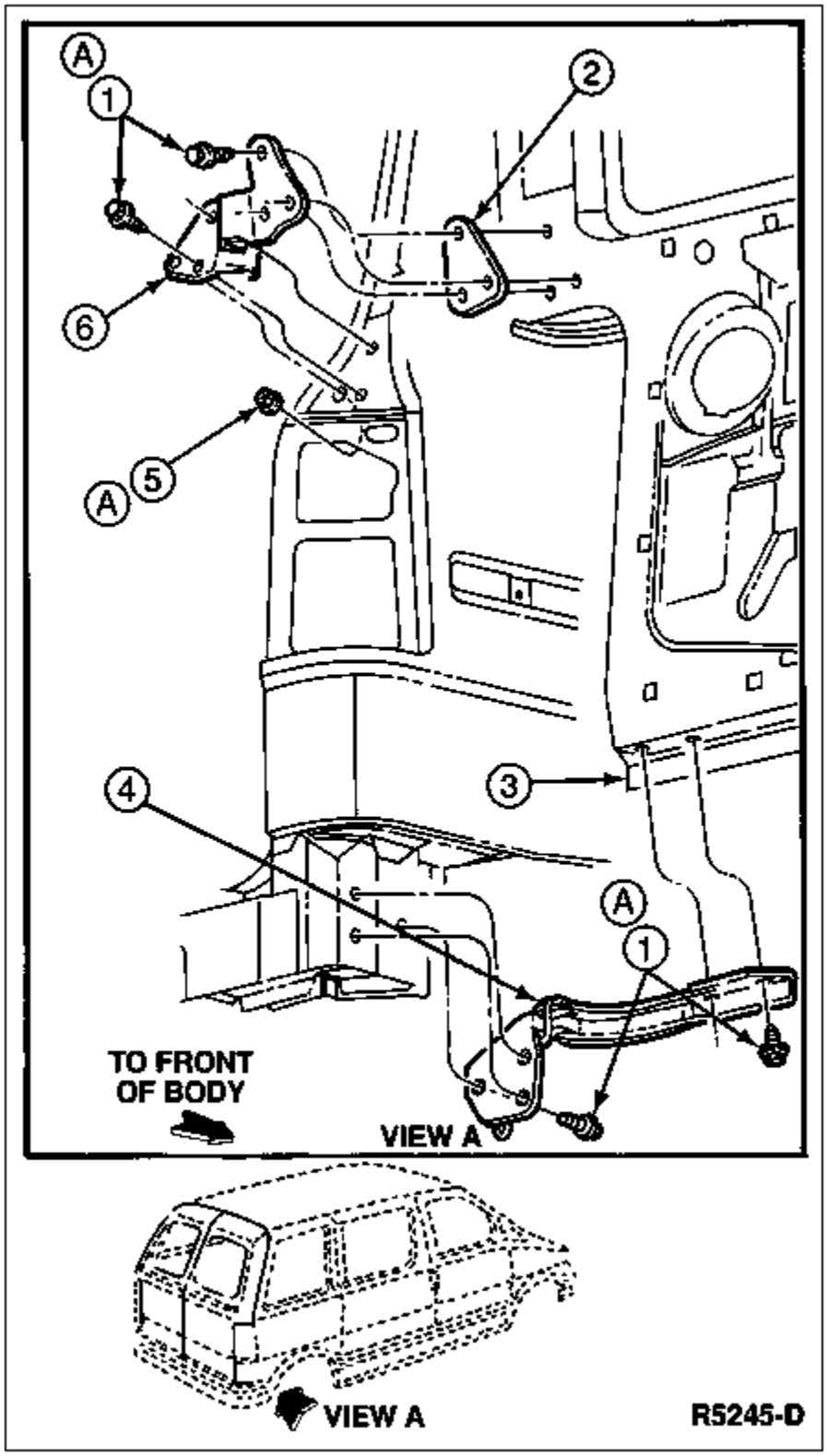

Item	Part Number	Description

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1	N804996-S36	Screw and Washer Assembly
2	44164	Rear Door Hinge Spacer
3	24630	Rear Door
4	42980	Lower Door Hinge
5	N804620-S36	Nut and Washer
6	42982	Upper Door Hinge
A	—	Tighten to 22-34 Nm (16-25 Lb-Ft)

Door Striker, Upper

NOTE: Use an M-11 socket to loosen or tighten the nut and washer assemblies which attach the upper striker assemblies.

The strikers can be adjusted laterally, and vertically, and shimmed fore and aft. Do not use more than four shims. To adjust striker, loosen attaching nuts so that striker can be moved around by hand. Close door firmly (thereby moving striker into proper position) and tighten retaining nuts.

Door Striker, Lower

NOTE: Use M-8 socket to loosen or tighten striker bolts.

CAUTION: No more than four shims should be used to adjust clearance.

The strikers can be adjusted fore and aft, and shimmed vertically. The latch striker should not be adjusted to correct door sag. The latch striker should be shimmed to achieve correct clearance between latch striker and latch. To check this clearance, close one door at a time and observe the alignment as the latch engages the striker. Move the striker assembly fore and aft to provide a flush fit at the door and the body.

Dual Rear Back Door, Left Side

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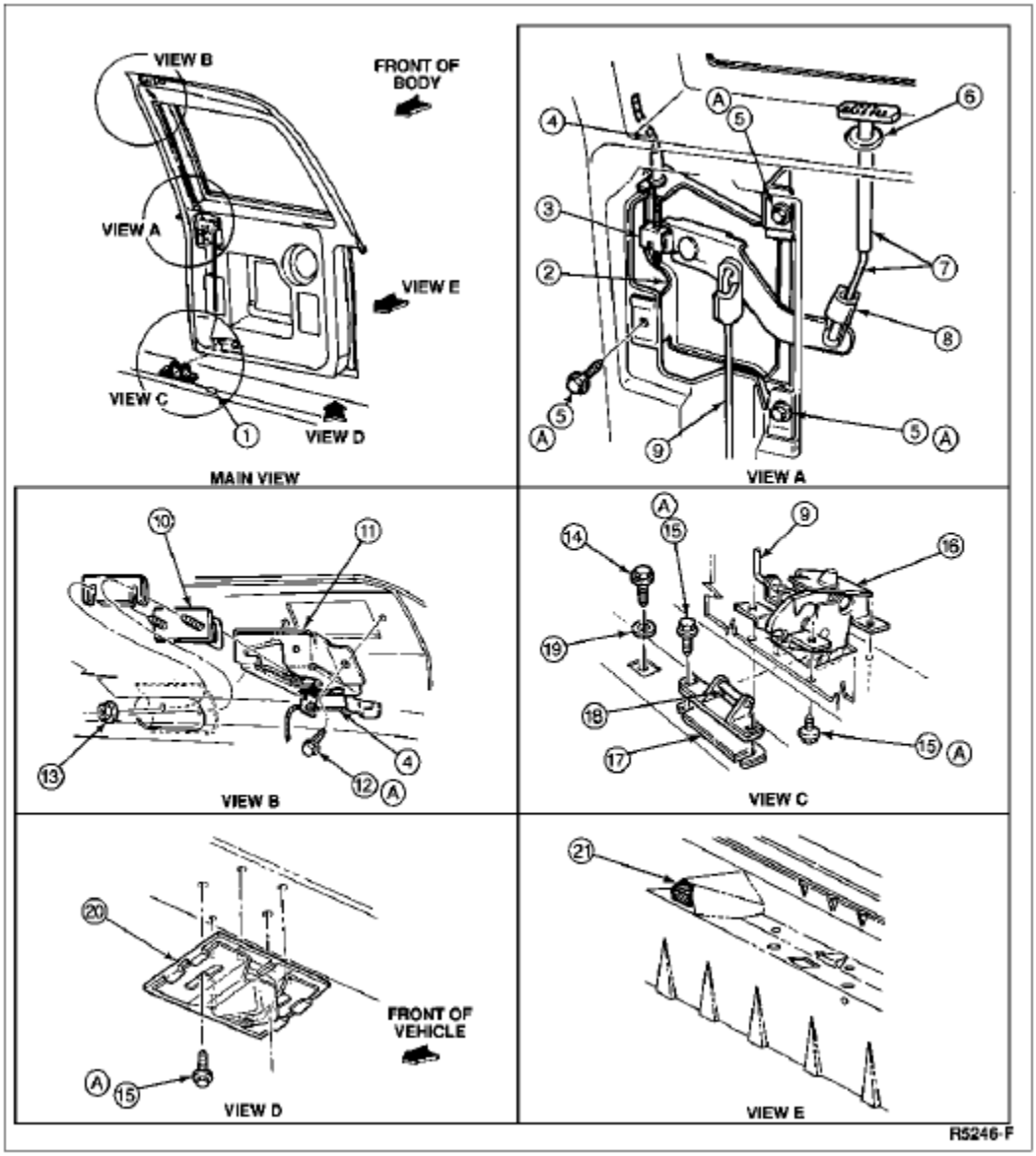

Item	Part Number	Description
1	11396	Shield
2	26404	Rear Door Latch Remote Control and Link
3	19A36	Door Latch Rod Retainer Assembly
4	31B43	Rear Door Upper Latch Release Cable Assembly
5	N605889-S36	Screw
6	21999	Door Latch Knob Grommet
7	431C02	Door Latch Control Rod Assembly
8	390522-S	Clip
9	43299	Rear Door Lower Latch Rod (Left Side)
10	4B147	Rear Door Latch Upper Striker (Left Side)
11	43287	Rear Door Upper Latch Assembly

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12	N602728-S55	Screw
13	N621927-S36M	Nut and Washer Assembly
14	N605918-S55	Bolt (to Fill Liftgate Striker Hole on Models with Dual Rear Doors)
15	N606676-S55	Bolt
16	43288	Rear Back Door Lower Latch Assembly
17	433A53	Back Door Latch Lower Striker Spacer
18	431L06	Back Door Latch Lower Striker
19	386659-S54B	Washer
20	40060	Rear Back Door Wedge and Plate Assembly
21	11396	Shield
A	—	Tighten to 7-11 Nm (62-97 Lb-In)

Dual Rear Back Door, Right Side

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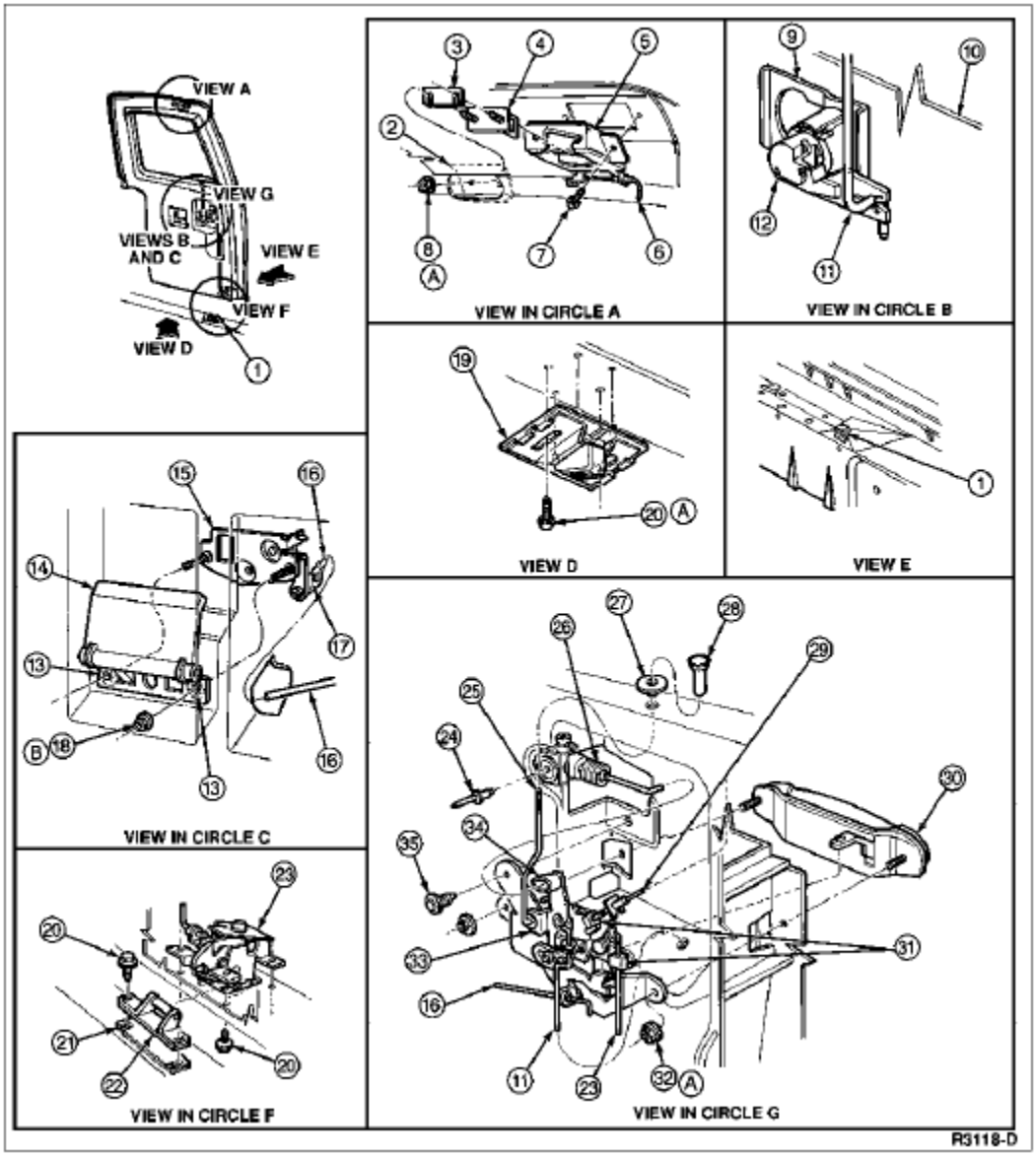

Item	Part Number	Description
1	11396	Shield
2	50202	Roof Panel
3	433A52	Spacer
4	431181	Latch Upper Striker
5	431B42	Upper Latch Assembly
6	43B421	Upper Latch Release Cable
7	N602728-S55	Screw
8	N621927-S36M	Nut and Washer Assembly
9	404B10	Door Lock Cylinder Retainer
10	—	Door Panel, Outer (Part of 24630)

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11	43186	Door Latch Remote Control Rod
12	22050	Lock Set
13	623481-S2	Push Nut
14	22600	Inside Door Handle
15	21818	Door Latch Remote Control
16	431B44	Latch Control Rod
17	389760-S	Clip
18	34653-S36	Nut and Washer Assembly
19	400601	Back Door Wedge and Plate Assembly
20	N606676-S55	Screw
21	44096	Spacer
22	431L06	Latch Lower Striker
23	43298	Lower Latch Assembly (Right Side)
24	N802034-S	Rivet
25	431B48	Push-button Rod
26	431A38	Rear Door Electric Latch Actuator
27	431A34	Door Latch Knob Grommet
28	431B48	Pushbutton
29	43286	Upper Latch Release Cable Assembly
30	43400	Outside Handle Assembly
31	54219A36	Door Lock Rod (2 Required)
32	N6020480-S2	Nut
33	26404	Rear Door Latch Remote Control and Link
34	389760-S	Rod End Push Rod Clip
35	388577-S	Pushpin
A	—	Tighten to 7-11 Nm (62-97 Lb-In)
B	—	Tighten to 2-3 Nm (18-27 Lb-In)

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Front Door Alignment

CAUTION: Do not cover up a poor door alignment with a latch striker adjustment.

1. Determine which hinge bolts must be loosened to move the door in the desired direction. Mark hinge with pen or pencil for reference point.
2. Loosen the hinge bolts just enough to permit movement of the door with a padded pry bar.
3. Move the front door (20124) the distance estimated to obtain the desired fit.
4. Tighten bolts to specifications.
5. Check the door fit to make sure there is no bind or interference with the adjacent panel.
6. Repeat the operation until the desired fit is obtained.
7. Check the striker plate alignment for proper door closing. Refer to Section 01-14A for striker adjustment.

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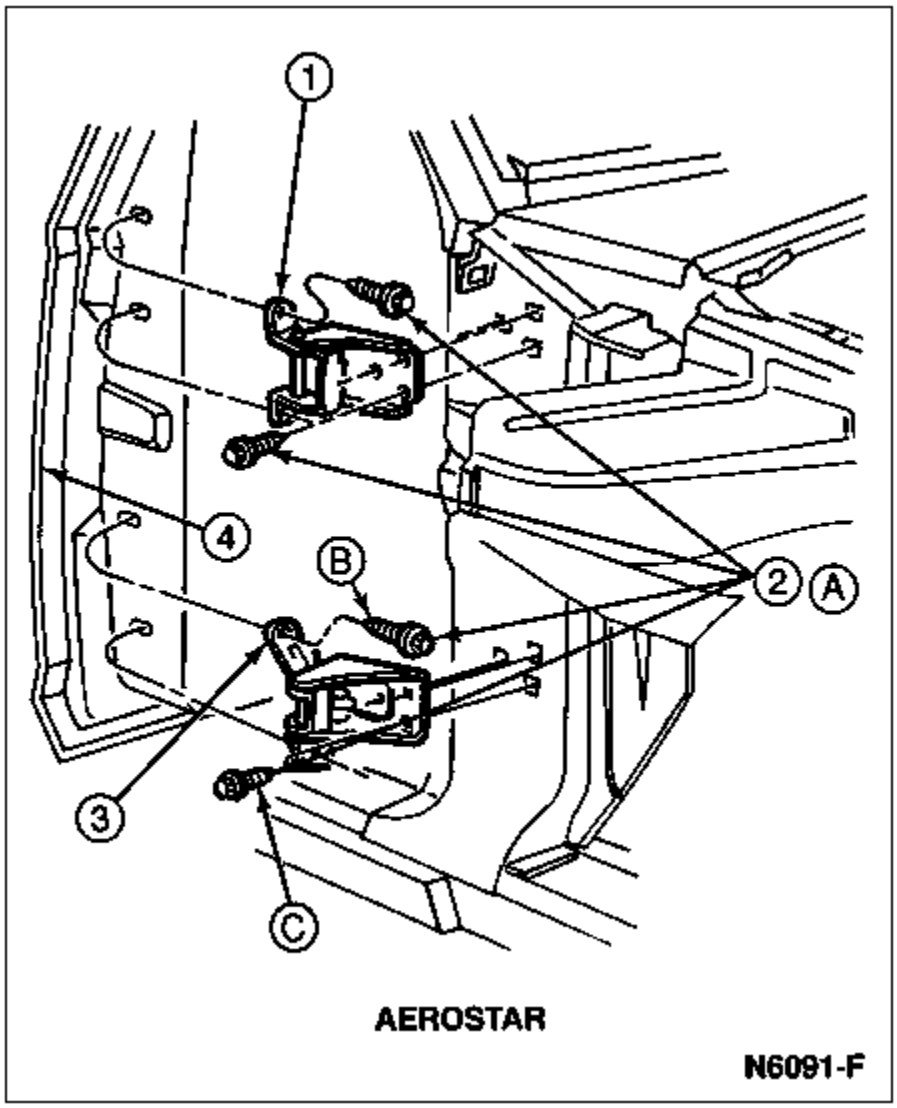

Item	Part Number	Description
1	22800	Upper Hinge
2	N800949-S100	Screw
3	22806	Door Hinge and Check
4	20124	Front Door
A	—	Tighten to 25-35 Nm (18-26 Lb-Ft)
B	—	Inboard/Outboard Adjustment
C	—	Forward/Rearward Adjustment

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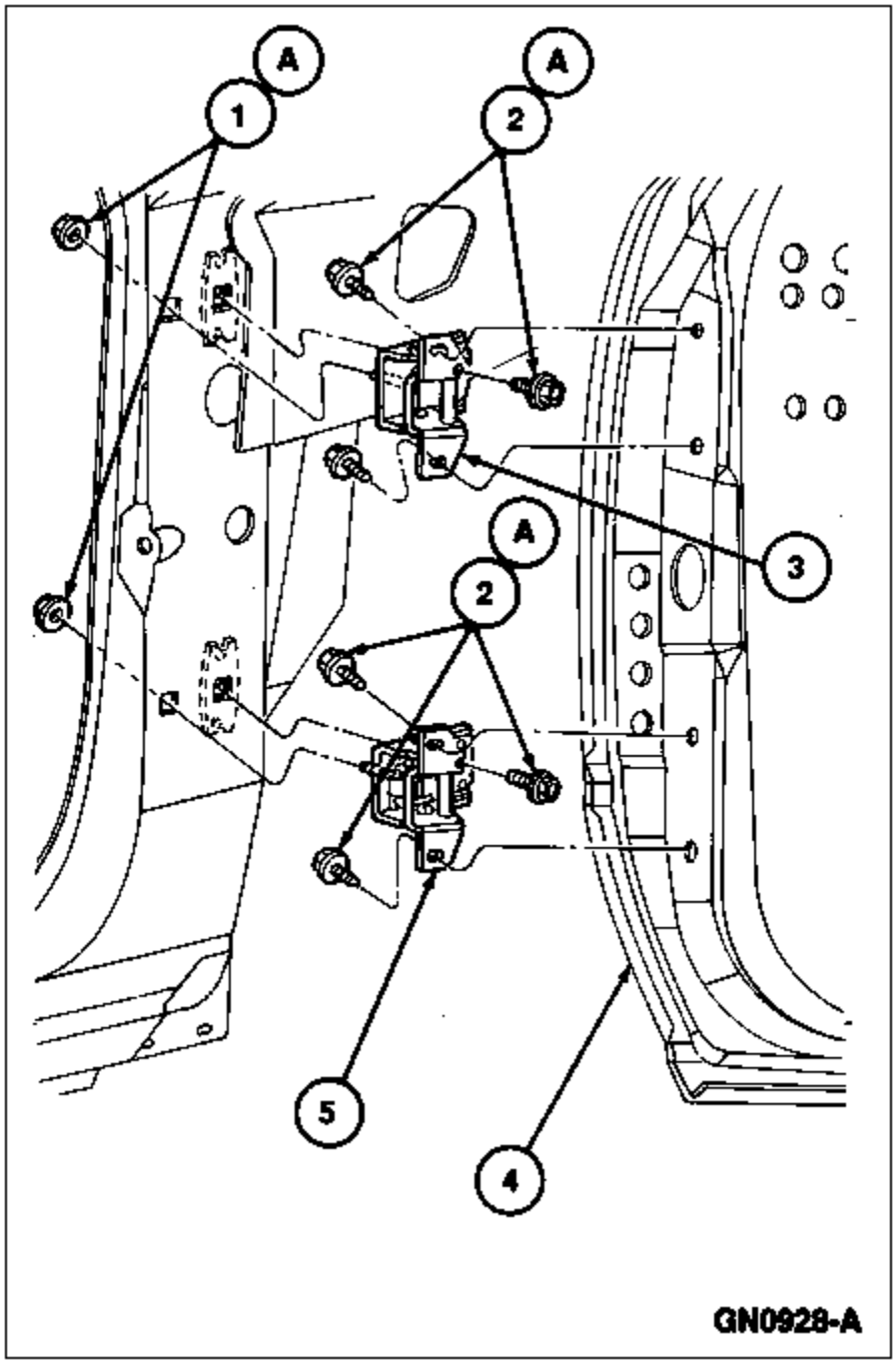

Item	Part Number	Description
1	N801193	Nut and Washer Assembly
2	N806738	Screw and Washer Assembly
3	22800	Front Door Upper Hinge
4	20124	Front Door
5	22806	Hinge and Check Assembly, Front Door, Lower
A	—	Tighten to 25-35 Nm (18-26 Lb-Ft)

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Guides and Wedges, Body Side Door, Aerostar

Guide Bracket and Roller, Upper

Removal and Installation

1. Open and support the door.
2. Mark the location of the upper bracket assembly to the door.
3. Remove the two bolts attaching the bracket assembly to the door. Remove roller assembly by backing it out of the track opening at the back.
4. If a new bracket assembly is being installed, transfer the roller assembly to the bracket assembly and set at the same location on brackets.
5. Position the roller assembly into the track. Set the new bracket assembly to the location marks. Install retaining bolts.
6. Adjust as described in this section.

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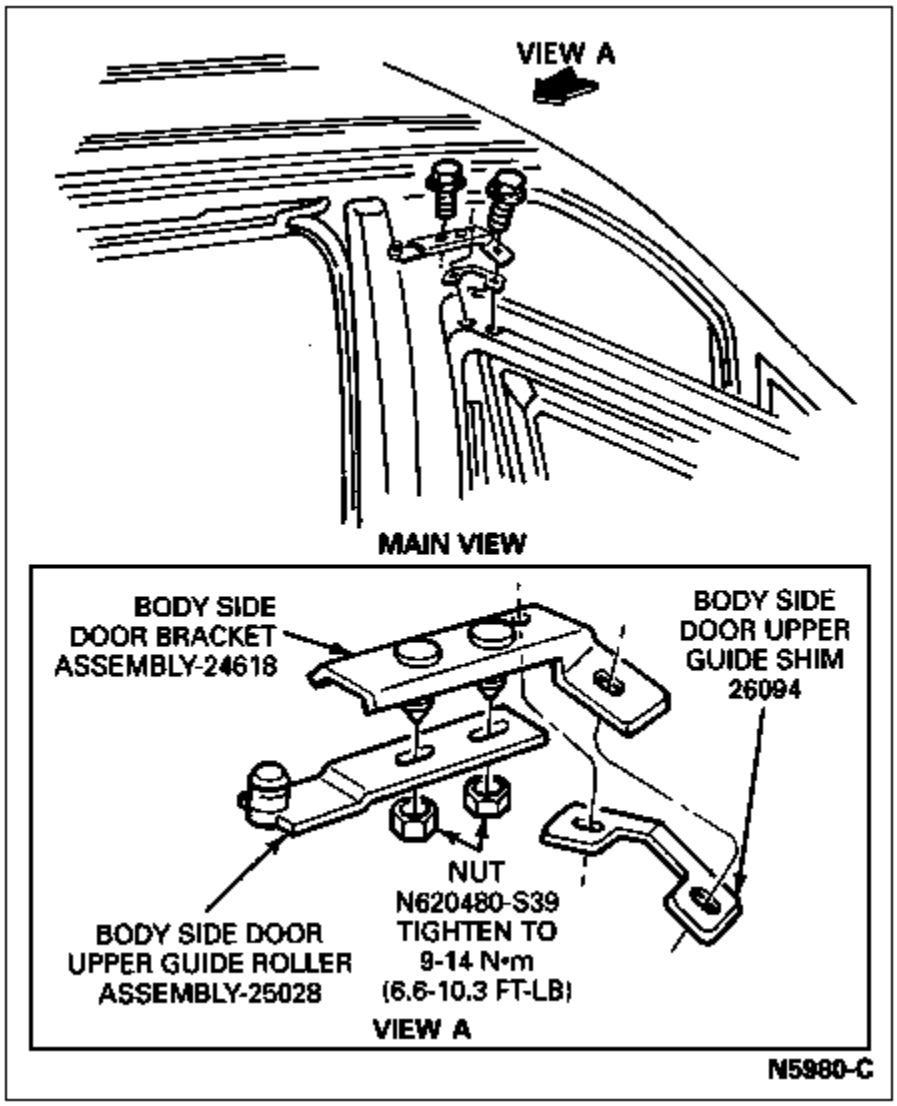

Guide, Lower

Removal and Installation

1. Open and support the door.
2. Mark the location of the lower guide bracket to the door. Remove three screws attaching guide.
3. Slide the guide forward in the track and tilt upward to remove from the front portion of the track.
4. Install new guide assembly into the front end of the lower track and slide guide to the door. Attach at the same location marks made in Step 2.
5. Adjust lower guide as described in this section.

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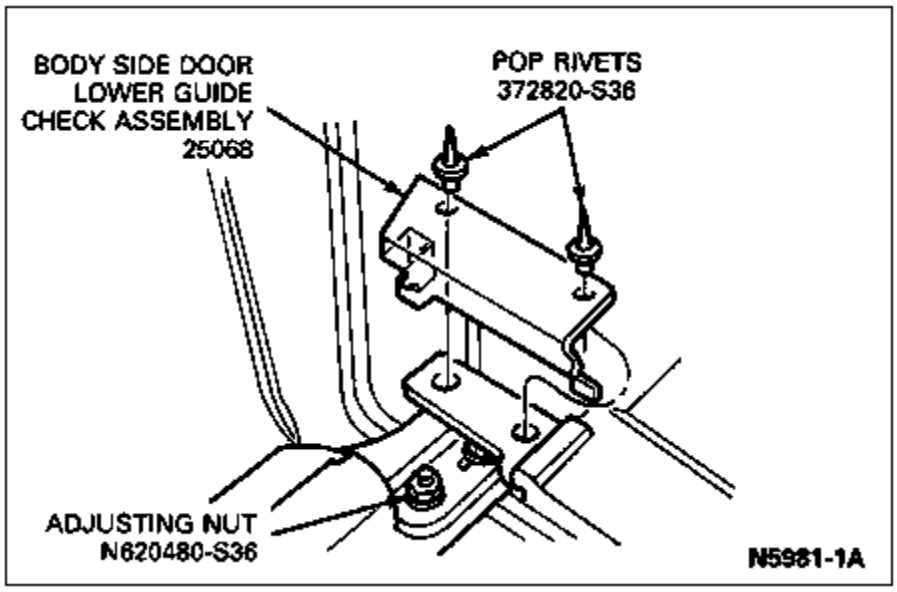

Wedge Striker Plate, Aerostar

CAUTION: For proper sliding door operation, it is critical that the door adjuster wedge (25342) and door latch striker, on the front face of the sliding door fit smoothly into the wedge pocket and door latch plate located in the B-pillar. If any of the following adjustments are made, realignment of the wedge and striker may be necessary.

Removal and Installation

1. Open sliding door and mark location of each wedge and striker located on sliding door.
2. Remove the two attaching screws to remove striker wedge. Remove striker by turning.

For installation, follow removal procedures in reverse order.

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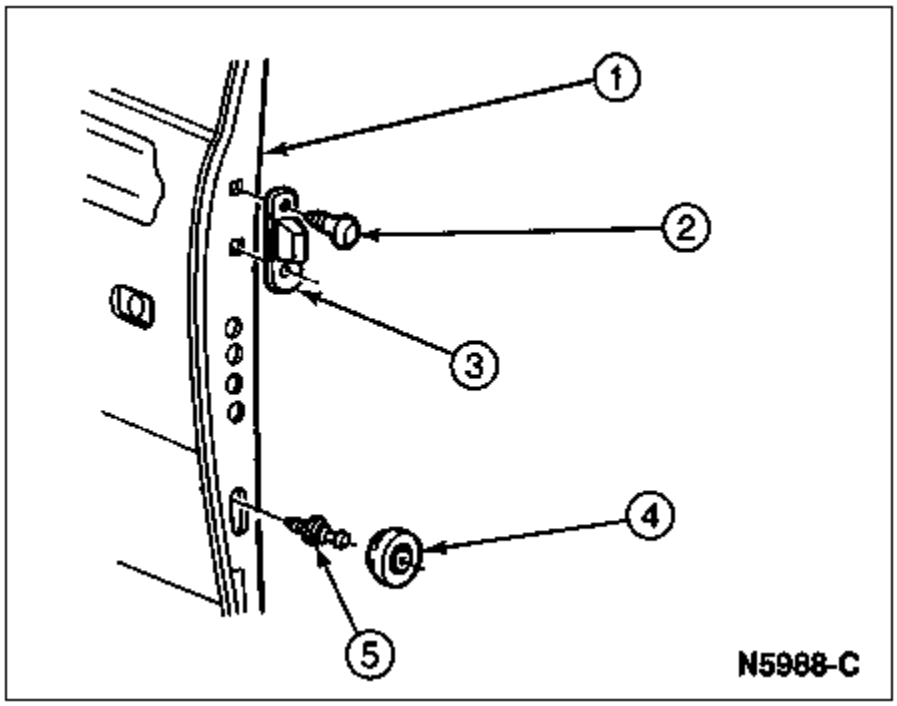

Item	Part Number	Description
1	24602	Body Side Door
2	N803756-S36	Screw
3	25318	Wedge Striker Plate
4	200A31	Plug
5	431C04	Striker

Wedge Pocket Plate, Aerostar

CAUTION: For proper sliding door operation, it is critical that the wedge and striker on the front face of the sliding door fit smoothly in the wedge pocket and plate located in the B-pillar. If any of the following adjustments are made, realignment of the wedge and striker may be necessary.

Removal and Installation

1. Open the sliding door.
2. Remove B-pillar trim panel or access hole cover plate.
3. Remove the two attaching screws and remove all hardware (plates, wedges, etc.)

For installation, follow removal procedures in reverse order.

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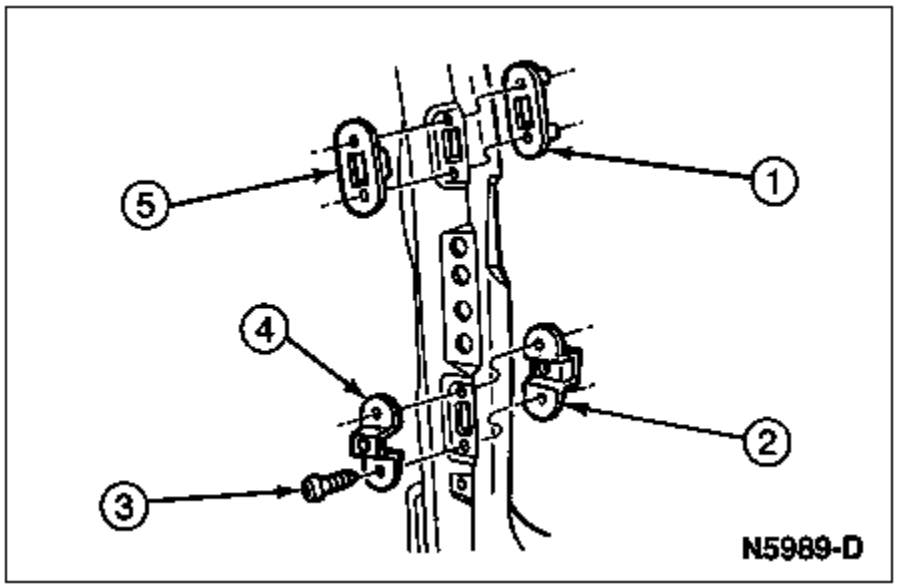

Item	Part Number	Description
1	N803762-S2	Nut Plate
2	211A66	Reinforcement
3	N803756-S39	Screw
4	264B54	Door Latch Plate
5	25342	Wedge

Center Body Side Track, Aerostar

Removal and Installation

1. Remove quarter trim panel (31012) or access hole cover plates.
2. Remove screw and nut attaching center track filler assembly at rear of center track.
3. Remove the five attaching nuts securing the center track assembly to the body. Remove track.

For installation, follow removal procedures in reverse order.

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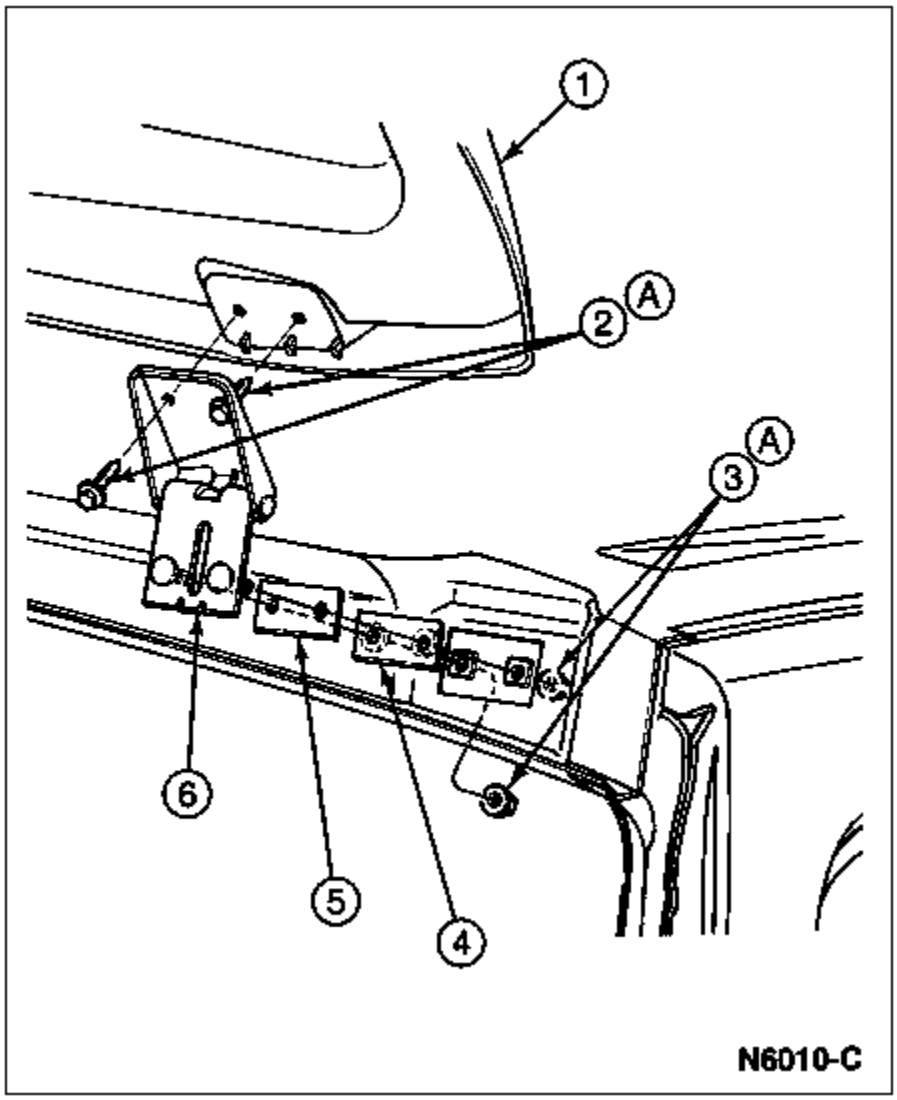
Liftgate Alignment, Aerostar

The liftgate (40010) can be adjusted side to side and up and down by loosening the bolt and washer attaching the liftgate hinge (42900) to the body to roof trim panel (51968). Adding spacers permits in/out adjustment as required. The liftgate should be adjusted for an even and parallel fit with the door opening. Tighten nuts to 17-27 Nm (13-20 lb-ft).



Item	Part Number	Description
1	40010	Liftgate
2	N605904-S	Screw and Washer
3	N802793-S	Nut and Washer
4	51968	Roof Trim Panel

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5	44384	Spacer
6	42900	Liftgate Hinge
A	—	Tighten to 17-27 Nm (13-20 Lb-Ft)

The liftgate/luggage compartment latch strikers (404A42) can be moved 4.0mm (5/32 inch) radially (side to side/back and forth) as necessary. After the adjustment, tighten fasteners to 40-60 Nm (30-44 lb-ft).

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Liftgate and Hinge, Aerostar

Removal and Installation

1. Open liftgate (40010).
2. Remove upper rear header moulding.
3. Support liftgate in open position.
4. Disconnect liftgate lift support cylinders as described in this section.
5. Move roof trim panel (51968) out of position. Remove nut attaching hinge to roof trim panel.
6. Remove retaining screws and washers from liftgate hinge (42900) on each side of the liftgate.
7. Remove liftgate hinge.

For installation, follow removal procedures in reverse order. Tighten fasteners to specifications.

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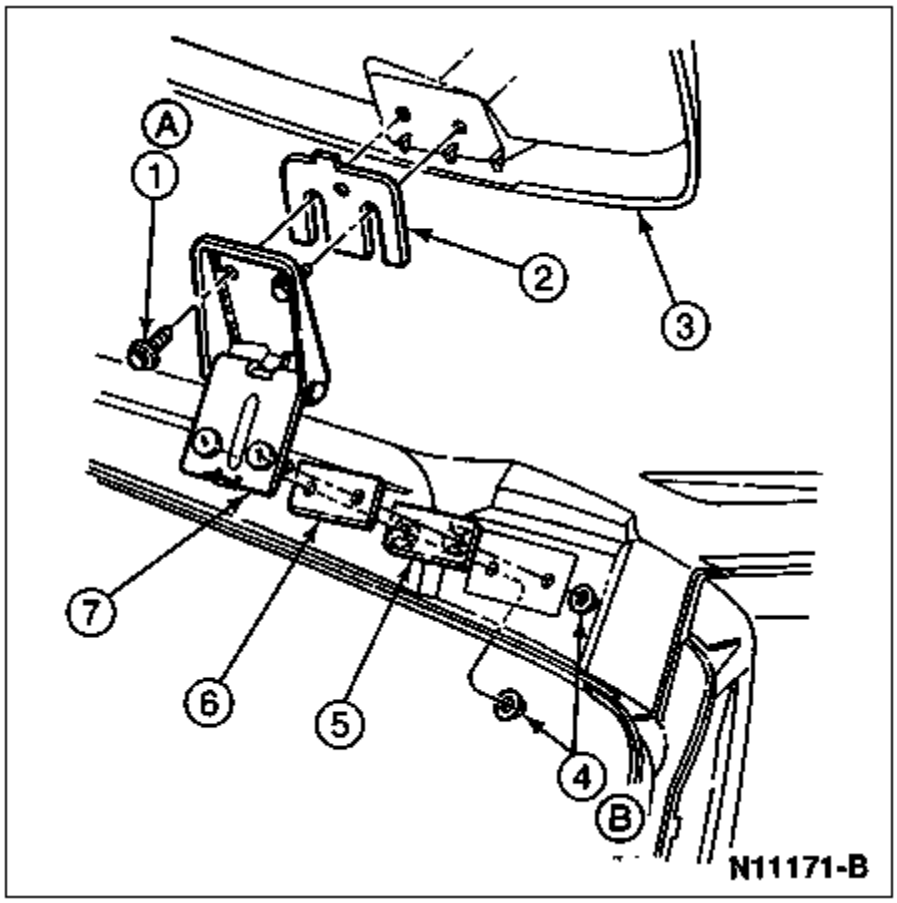

Item	Part Number	Description
1	N605906-S55	Screw and Washer Assembly (2 Req'd Each Hinge)
2	44834-B	Spacer, 4 Maximum
3	40010	Liftgate
4	N804620-S36	Nut and Washer Assembly (2 Req'd Each Hinge)
5	427A98	Pad Assembly
6	44834-A	Spacer, Liftgate Hinge on Body
7	42900	Liftgate Hinge
A	—	Tighten to 17-27 Nm (13-20 Lb-Ft)
B	—	Tighten to 22-34 Nm (16-25 Lb-Ft)

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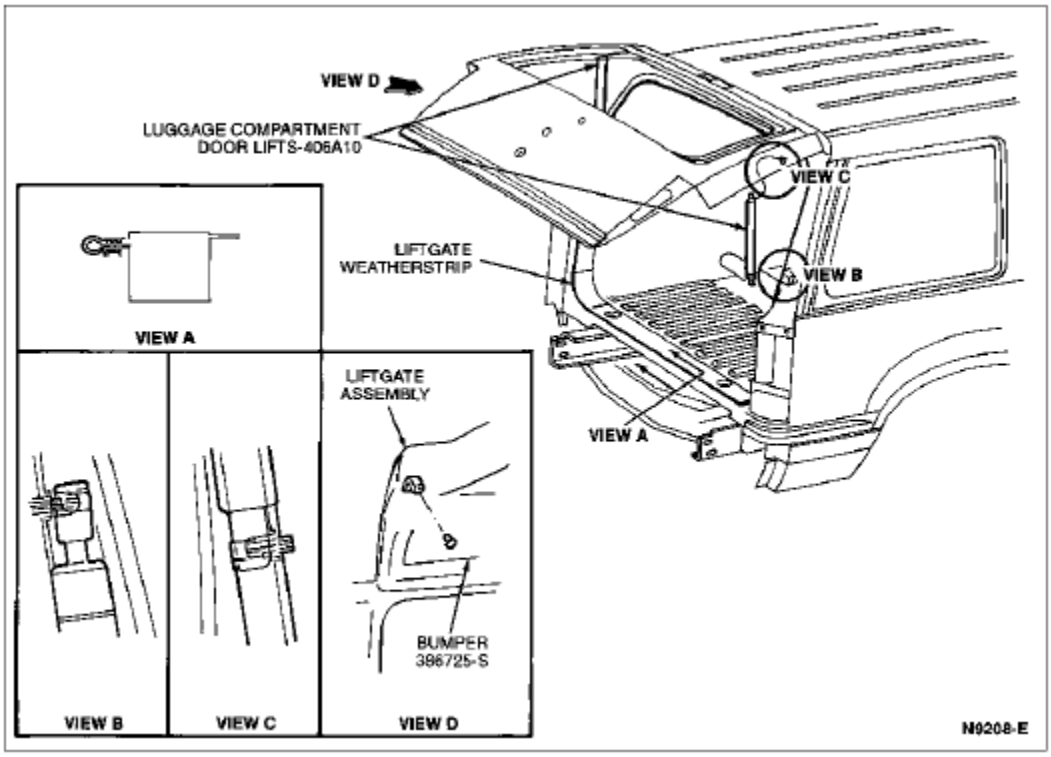
Liftgate Gas Cylinder Retainers, Aerostar

Removal and Installation

1. Open and support liftgate (40010).
2. Remove liftgate lift support cylinders as described in this section.
3. Remove retainer assembly.

For installation, follow removal procedures in reverse order. Tighten the retainers to 20-28 Nm (15-21 lb-ft).

Liftgate Gas Cylinder Retainers, Aerostar



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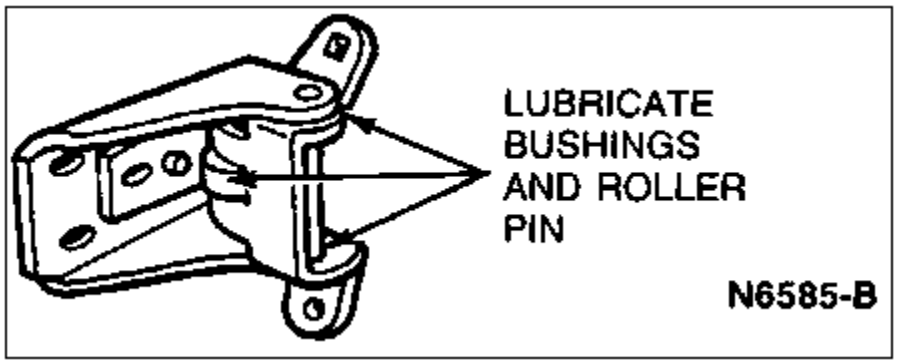
Lubricant

Weatherstrip, Door and Roof Side Rail

Use Silicone Lubricant C0AZ-19553-AA (Jelly) or D7AZ-19553-AA (Spray) or equivalent meeting Ford specification ESR-M13P4-A on the door and window weatherstrips. It is recommended that silicone lubricant be applied to the weatherstrips whenever necessary. Silicone lubricant helps avoid weatherstrip squeaks, and retards excess weatherstrip wear caused by chafing between the door glass upper frame and the weatherstrip. It also helps to retain door window alignment by reducing friction between the glass frame and the rubber weatherstrip.

Hinge, Door

Use Multi-Purpose Grease Spray D7AZ-19584-AA or equivalent meeting Ford specification ESB-M1C93-A to lubricate door hinges.



Hinge, Luggage Compartment Door

Multi-Purpose Grease Spray D7AZ-19584-AA or equivalent meeting Ford specification ESB-M1C93-A is used to lubricate luggage compartment door hinges. Apply an even coat to all movable hinge surfaces when a binding condition occurs.

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Sliding Door Alignment, Aerostar

CAUTION: For proper sliding door operation it is critical that the door adjuster wedge and striker on the front face of the sliding door fit smoothly into the wedge pocket and plate located in the B-pillar. If any of the following adjustments are made, re-alignment of the wedge and striker may be necessary.

In or Out Adjustment

NOTE: Support the sliding door to prevent up or down movement during adjustment.

Front Upper

1. To adjust the front of the sliding door, loosen two nuts retaining the body side door bracket assembly to the upper guide roller assembly.

2. Move the roller assembly in or out as required to obtain a flush fit of the door to body.

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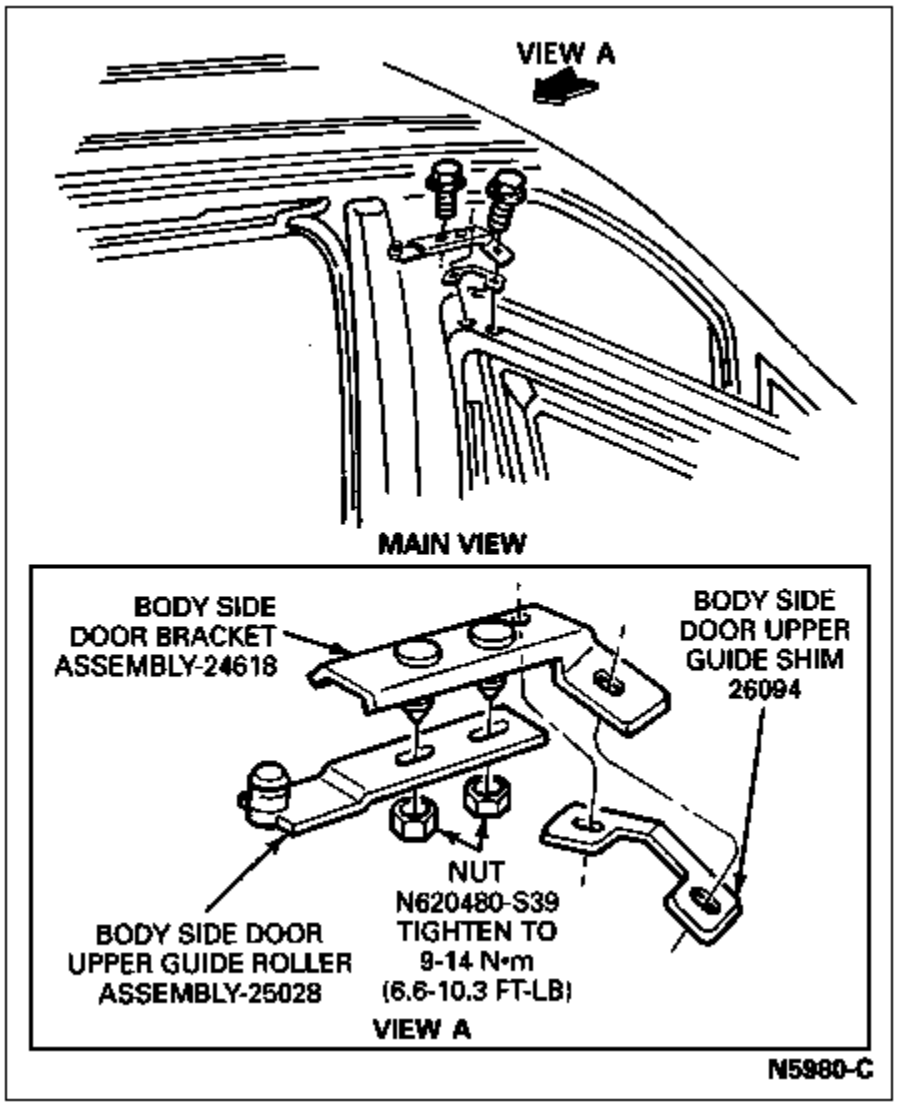

Front Lower

1. Mark surface before loosening adjusting nut. Adjust lower front edge of the sliding door by loosening the adjusting nut on the lower guide assembly and move the door in or out as required to obtain a flush fit. The lower guide vertical roller is a load bearing roller and should roll easily within the lower track as the sliding door is opened or closed.

2. Vertical adjustment of lower guide is accomplished by loosening three bolts and moving base of guide.

3. If vertical adjustment is made to lower guide, inspect the upper guide to make sure the upper guide does not contact the bottom of the track housing or the upper guide roller contacts the top of the upper track.

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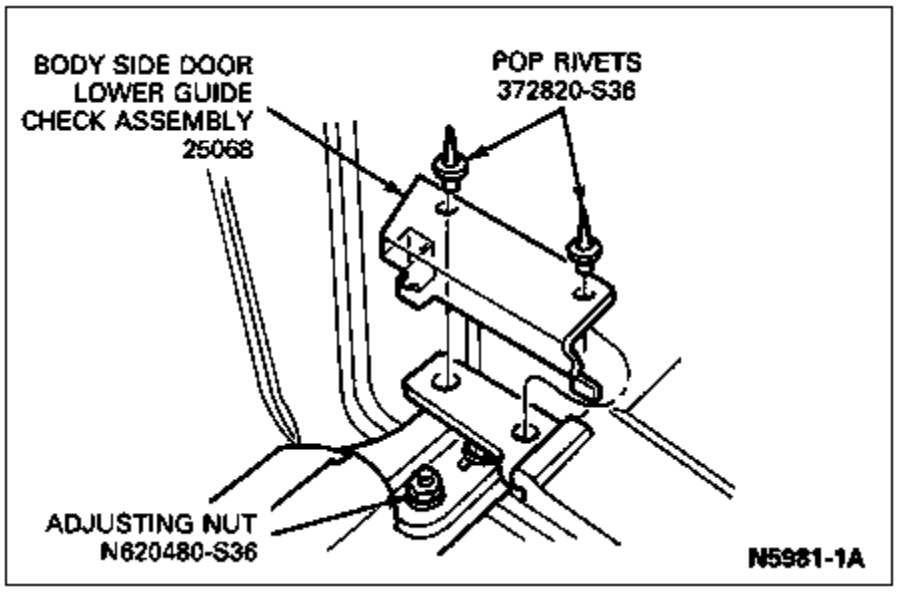
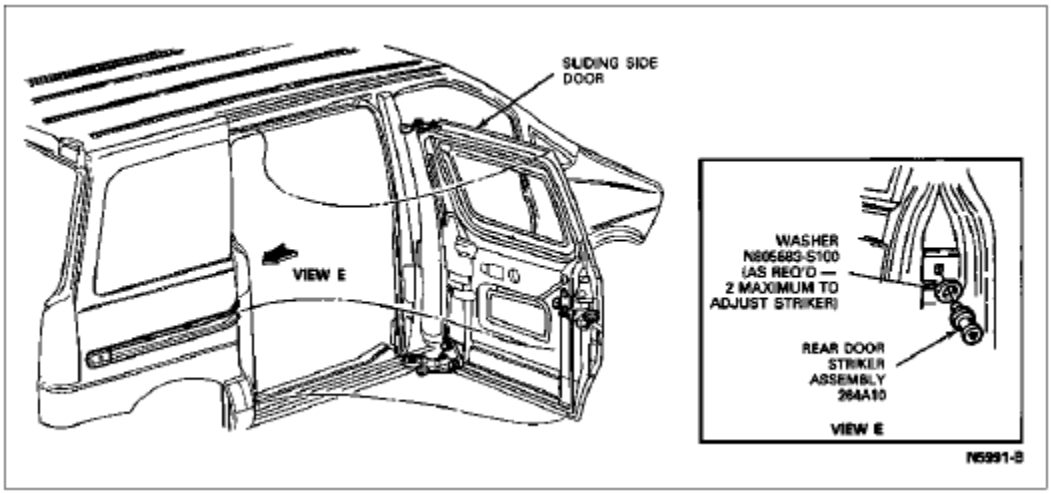


Striker Rear Latch

CAUTION: Striker adjusts in or out only. Up and down adjustment is obtained with rear hinge and lower front guide.

The sliding door latch is located at the rear of the door. When the door is closed the latch engages the striker which positions the rear of the door to the body. Adjusting the striker in or out will position the rear edge of the sliding door as required to obtain the proper fit to the body.

Striker Rear Latch, Aerostar



Hinge Assembly

To adjust the sliding door fore or aft, loosen three bolts retaining the center door hinge to the door and adjust

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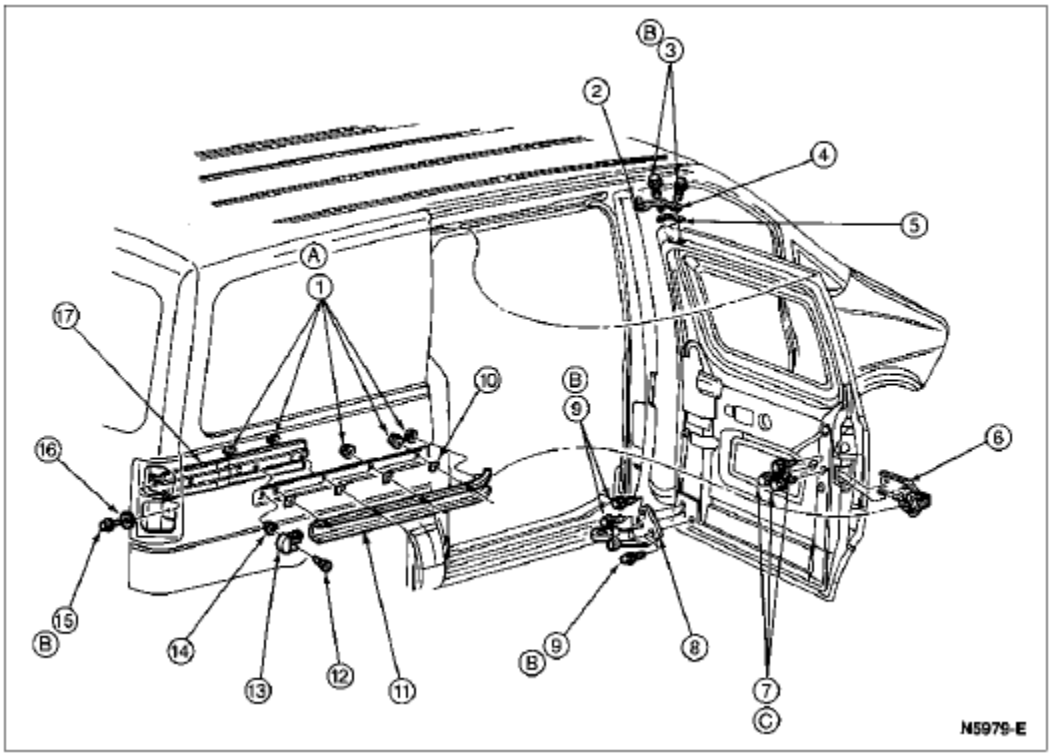
hinge fore or aft as required to secure a proper door fit.

Some up/down adjustment may be obtained from the center hinge by moving the center hinge strap up or down as desired prior to securing the retainer bolts.

The vertical hinge rollers within the body center track assembly must be parallel to the top of the track and maintain a minimum clearance of 1mm (0.040 inch) from the top of the track from smooth operation. If hinge is adjusted vertically, evaluate striker setting for fit and centering.

Sliding Side Door, Aerostar



Item	Part Number	Description
1	N621926-S36	Nut
2	25028	Roller Assembly, Body Side Door, Upper Guide
3	N605907-S40	Bolt
4	24618	Bracket Assembly, Body Side Door, Upper Guide
5	26094	Shim, Body Side Door, Upper Guide
6	26800	Hinge Assembly, Body Side Door
7	N606688-S2	Screw and Washer Assembly
8	268A26	Guide Assembly, Body Side Door Lower
9	N605907-S101	Bolt
10	N99J291	Gasket
11	1126028	Track Assembly, Body Side Door, Center
12	N610022-S55	Screw

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13	26868	Filler Assembly, Body Side Door, Center Track
14	N606688-S55	Bolt
15	N805825-S	Washer
16	383356-S100	Nut
17	1528458	Reinforcement (Extended Aerostar Only)
A	—	Tighten to 5-6 Nm (44-53 Lb-In)
B	—	Tighten to 22-34 Nm (16-25 Lb-Ft)
C	—	Tighten to 17-20 Nm (13-15 Lb-Ft)

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SPECIAL SERVICE TOOLS/EQUIPMENT

ROTUNDA EQUIPMENT

Model	Description
156-00070	Flexi-Work Table

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SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Nut and Washer Assembly, Screw and Washer Assembly, Front Door Hinge to Body	25-35	18-26	—
Nut, Sliding Door Guide Bracket, Upper	9-14	—	80-124
Striker, Sliding Door Latch (Round Post)	54-71	40-52	—
Sliding Door, Door Wedge Striker Screw, Wedge Screw, Door Latch Plate	9-14	7-10	—
Screw and Washer Assembly, Nut and Washer Assembly, Front Door Hinge, Rear Door Hinge to Body/Door	25-35	18-26	—
Screw and Washer Assembly, Liftgate Hinge to Liftgate	17-27	13-20	—
Screw, Tailgate Hinge to Body	41-54	30-40	—
Screw, Tailgate Striker, Cable Assembly, to Body	26-34	19-25	—
Screw, Tailgate Stop Assembly to Body	2-2.5	—	18-22
Striker Assembly, Tailgate	33-45	24-33	—
Screw, Tailgate Cable Assembly to Tailgate	22-34	16-25	—
Screw, Composite Pickup Box, Inner Panel, Retainer	6-10	—	53-89
Screw, Tailgate Roller Assembly to Body	27-40	20-30	—
Retainer, Liftgate Lift Assembly	20-28	15-21	—
Bolt and Washer Assembly, Liftgate Hinge	17-27	13-19	—
Nut and Washer Assembly, Liftgate Hinge	11-13	—	98-115
Screw and Washer Assembly, Liftgate Hinge	26-34	20-25	—
Nut, Body Side Center Track	5.5-6	—	48-53
Bolt, Sliding Door Bracket	22-34	16-25	—
Screw and Washer Assembly, Sliding Door to Hinge	17-20	13-15	—
Bolt, Sliding Door Guide Assembly, Lower, Reinforcement	22-34	16-	—

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		25	
Bolt, Liftgate Striker Assembly	40-60	30-44	—
Screw and Washer Assembly, Nut and Washer Assembly, Back Door Hinge, Upper and Lower to Body/Door	22-34	16-25	—
Fasteners, Back Door Latch, Upper and Lower Striker, Wedge Plate, Assemblies	7-11	—	62-97
Nut and Washer Assembly, Inside Back Door Handle	1.7-2.3	—	16-20

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Weatherstrips, Aerostar

Removal

1. Cut or separatefront door opening weatherstrip (20709) andrear door body weatherstrip (253A10) around opening at seam.
2. Loosen and pry away from body flange with a flat tool such as a putty knife or equivalent.
3. Pull front door opening weatherstrip and rear door body weatherstrip outward and away from flange working upward, along the top, and around the opening.

Installation

1. **NOTE: Do not stretch weatherstrip during installation.**

   Clean any residual adhesive or material from flange or body surface by scraping carefully with a flat tool such as a putty knife or wipe with a cloth using Extra Strength Tar and Road Oil Remover B7A-19520-AA or equivalent meeting Ford specification ESR-M5B106-A.
2. Start installation at the proper area indicated in the illustration. Compress the front door opening weatherstrip and rear door body weatherstrip onto the flange and continue working across or around the opening.
3. Insert sponge plug into loose end of front door opening weatherstrip and rear door body weatherstrip.
4. Cut front door opening weatherstrip andrear door body weatherstrip, if necessary, 6-12mm longer than required and butt ends together. Avoid overlapping.
5. To install roof side rail weatherstrip (51222), apply Weatherstrip Adhesive E8AZ-19552-A or equivalent meeting Ford specification ESB-M2G14-A to forward pushpin only if required.
6. Insert pushpin near front at paint mark, then work outward and rearward installing weatherstrip carrier onto flange.
7. Peel protective backing off adhesive tape at rear molded seal or where required.
8. Aerostar body lock pillar cover installation should be started at top, then down lock pillar with adhesive tape protective backing removed, ending above the rocker panel.
9. Installation of back door opening weatherstrip assembly is same as body door openings. Clean surfaces with alcohol before applying adhesives. Remove protective backing from adhesive tape where required and apply pressure to installed assembly at these areas.

Weatherstrips, Body Door Openings and Roof Side Rail, Aerostar

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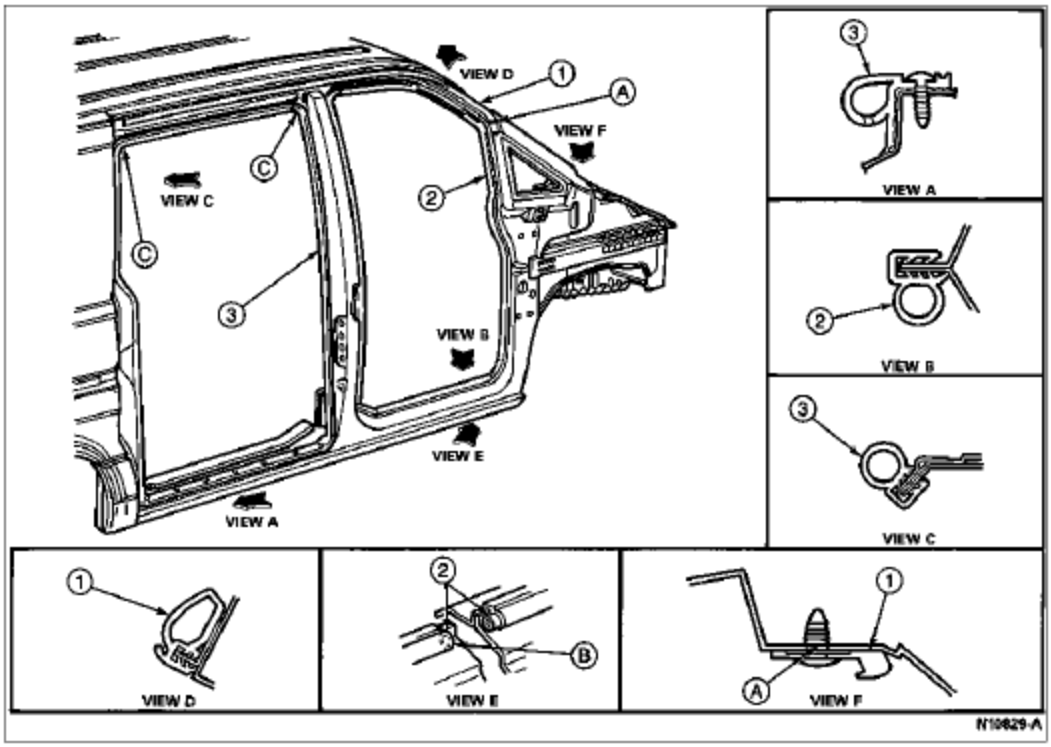

Item	Part Number	Description
1	51222	Roof Side Rail Weatherstrip
2	20709	Front Door Opening Weatherstrip
3	253A10	Rear Door Body Weatherstrip
A	—	Starting Point, Roof Rail Installation
B	—	Starting Point, Front Door Opening Weatherstrip Installation
C	—	Starting Points, Side Door Opening Weatherstrip Installation

Weatherstrips, Body Door Openings and Roof Side Rail, Ranger

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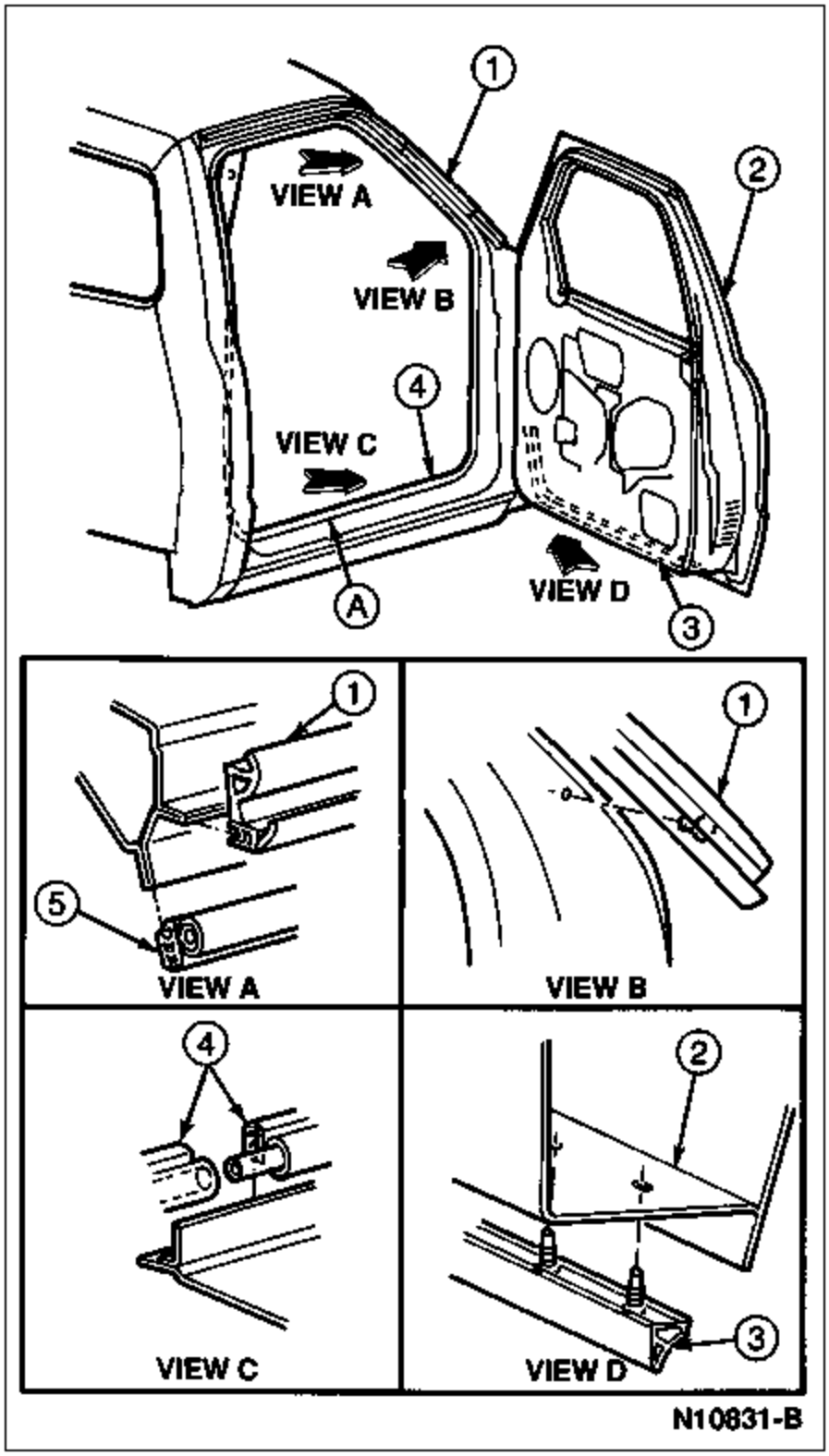

Item	Part Number	Description
1	51222	Roof Side Rail Weatherstrip

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2	20124	Front Door
3	20758	Front Door Lower Weatherstrip
4	20709	Front Door Opening Weatherstrip
5	—	Front Door Upper Weatherstrip
A	—	Starting Point, Body Door Opening Weatherstrip Installation

Weatherstrips, Dual Rear Doors

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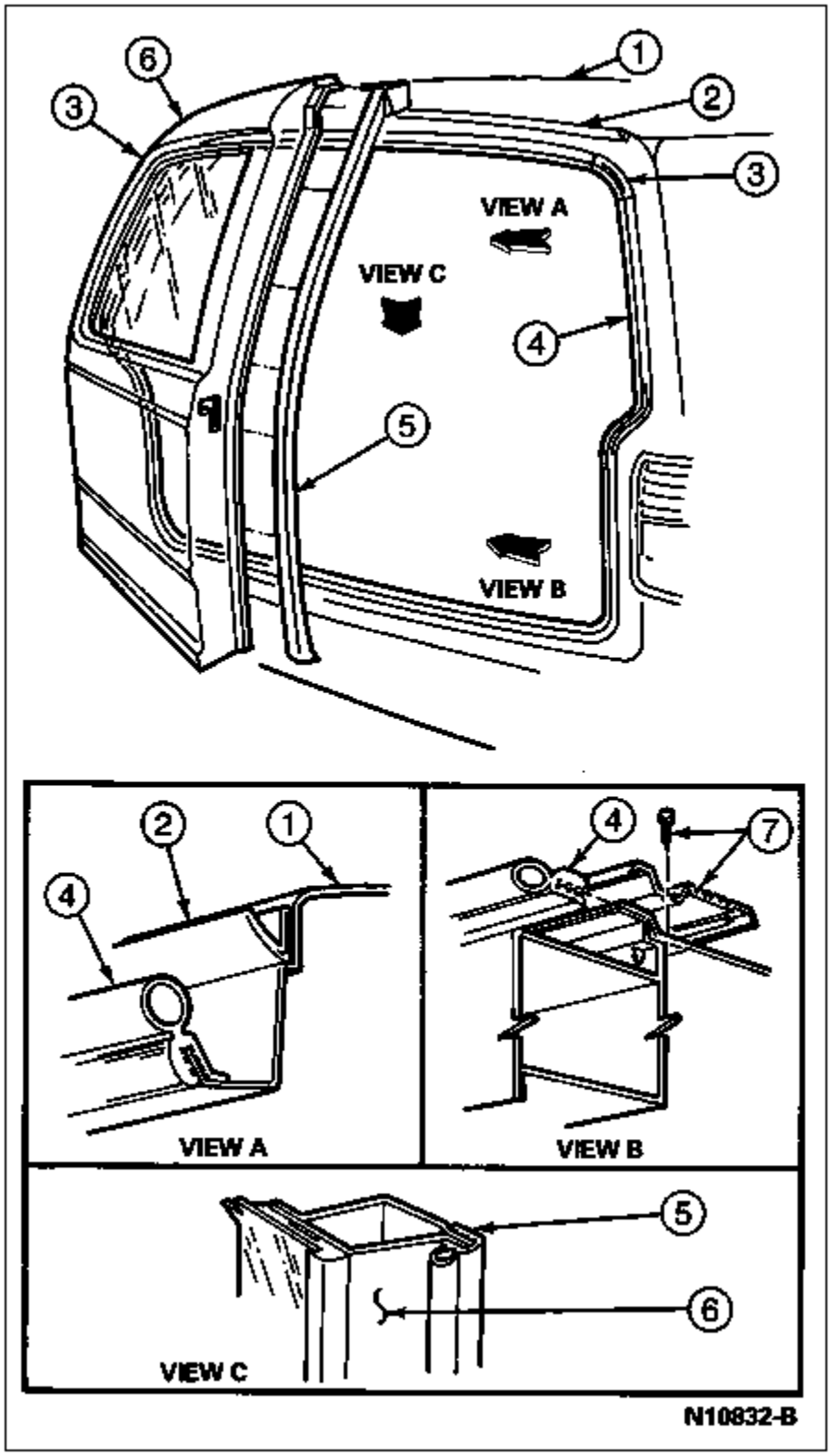

Item	Part Number	Description
1	50020	Panel, Roof
2	43772-B	Weatherstrip Assembly, Back Door

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3	M3G58-A	Adhesive Tape
4	43700	Weatherstrip Assembly, Back Door Opening
5	43722-A	Weatherstrip Assembly, Back Door
6	24630	Rear Door
7	13144	Scuff Plate

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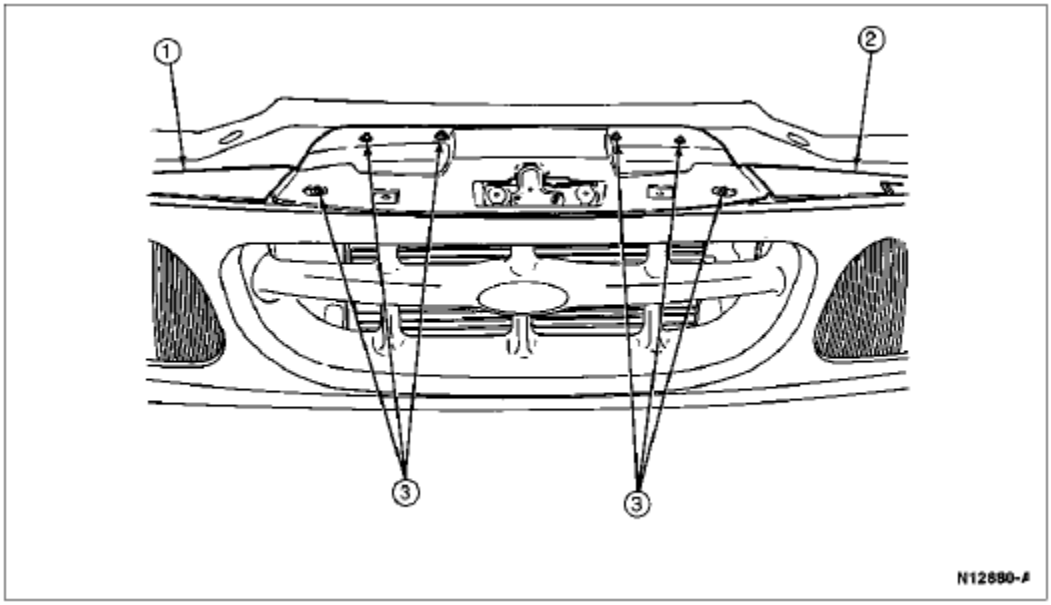
Door, Headlamp

Removal and Installation

NOTE: Headlamp doors are integral to the radiator upper sight shield (8C291).

1. Open vehicle hood.
2. Remove radiator upper sight shield assembly retainers.

Headlamp Door Assembly Retainer Removal



Item	Part Number	Description
1	—	Headlamp Door (RH) (Part of 8C291)
2	—	Headlamp Door (LH) (Part of 8C291)
3	—	Radiator Upper Sight Shield Retainers (Part of 8C291)

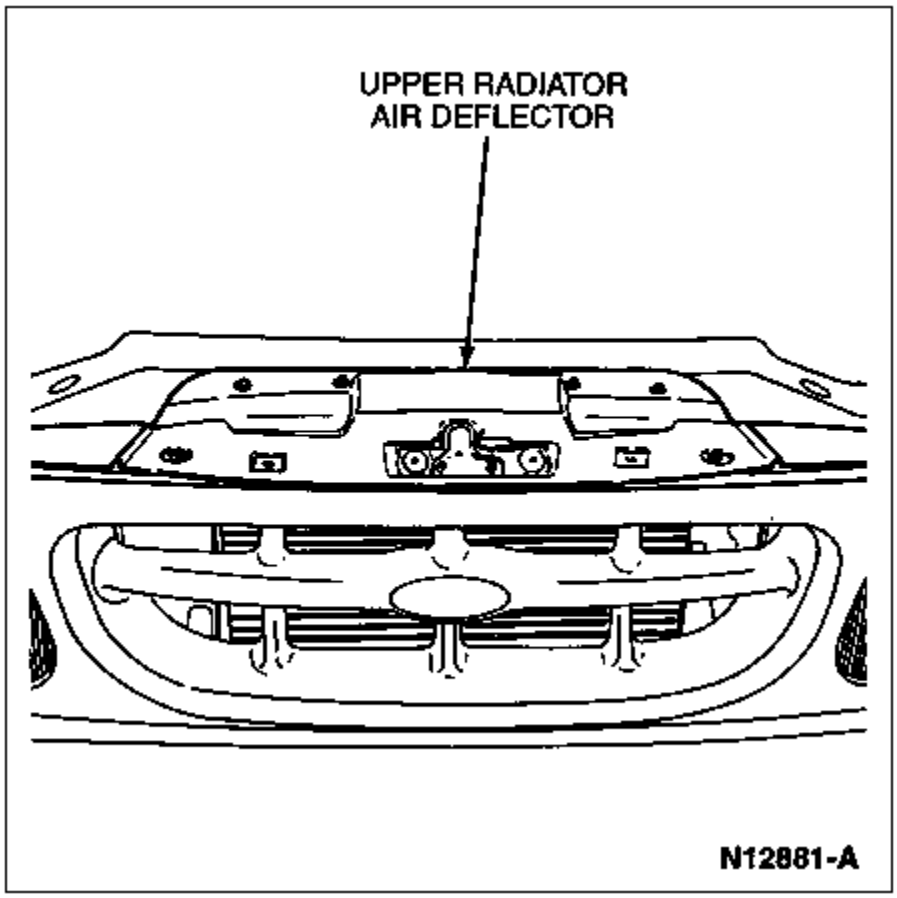
3. Remove radiator upper sight shield assembly.

For installation, follow removal procedure in reverse order.

Air Deflector, Radiator — Upper

Removal and Installation

1. Open vehicle hood.
2. Remove upper radiator air deflector retainers.



3. Remove upper radiator air deflector.

For installation, follow removal procedure in reverse order.

Cowl Top Vent Grille, Aerostar

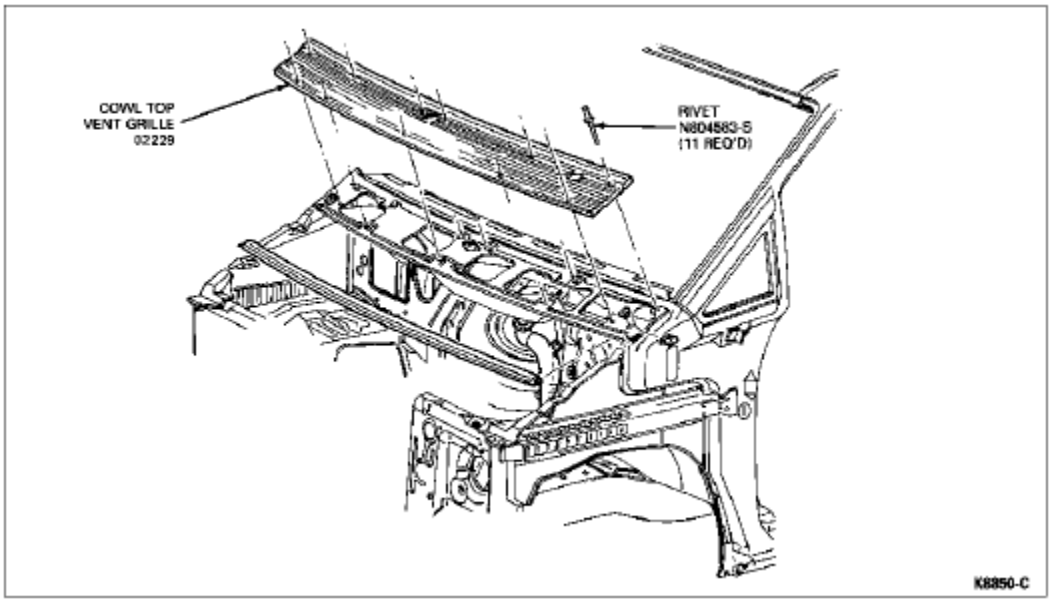
Removal and Installation

NOTE: The cowl top vent grille (02229) is held in place with plastic expansion rivets.

Remove expansion rivets by inserting a small punch in the rivet center hole, and carefully driving the pin out of the center.

Install the new rivets with Rotunda Blind Fastener Installation Tool 107-00600 or equivalent.

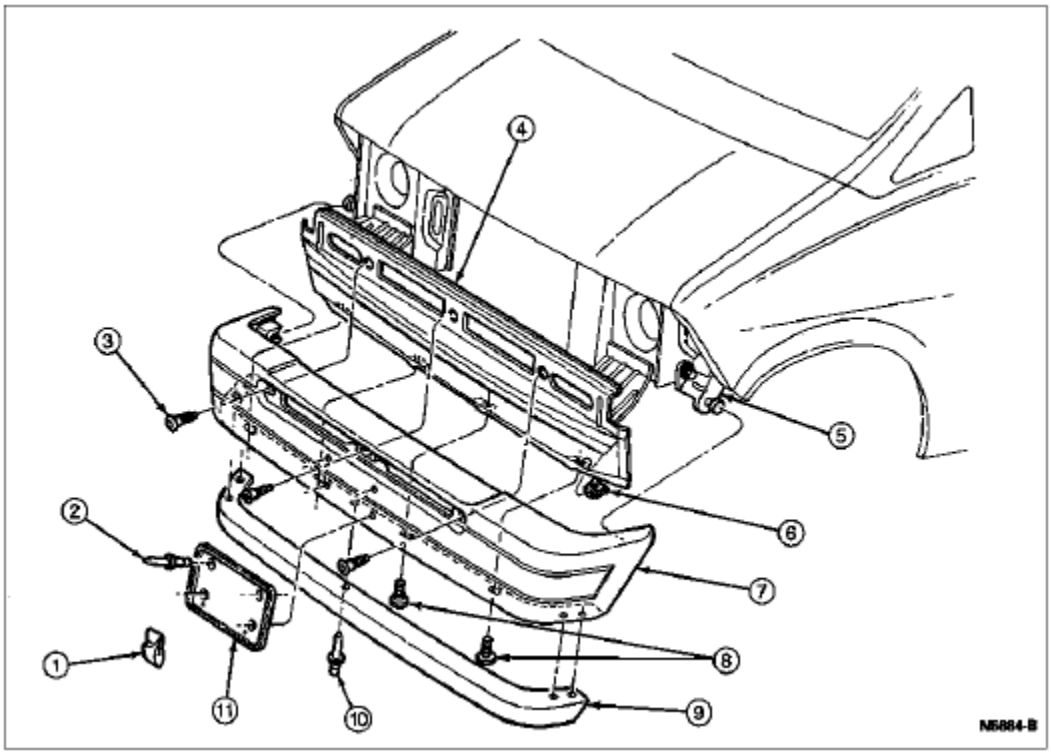
Cowl Top Vent Grille, Aerostar



Moulding, Lower Side and Front Valance

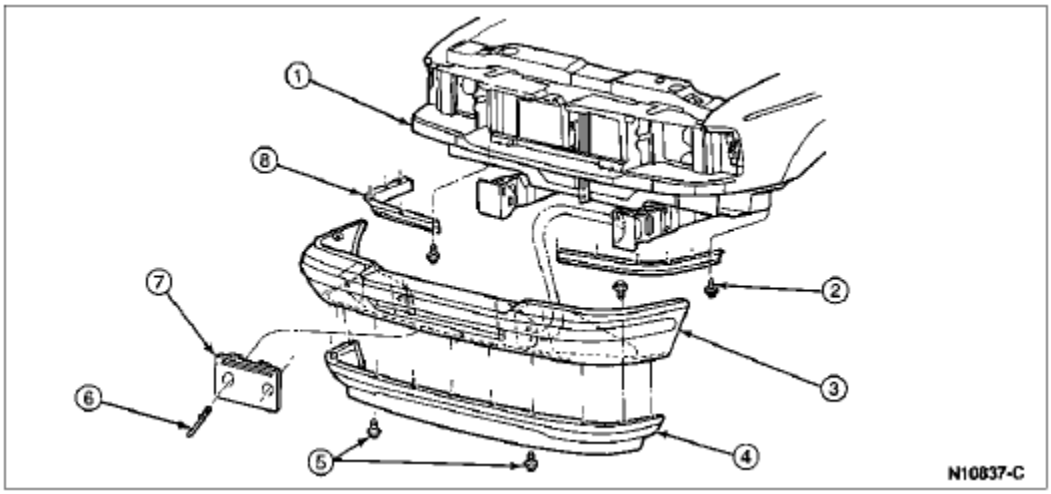
The Aerostar vehicle with XLS trim has a large plastic front valance panel (17626) and wide plastic lower body side mouldings. Ranger vehicles have a large plasticfront valance panel. The parts are moulded from TPO thermoplastic polyolefin.

Moulding, Lower Side and Front Valance, Aerostar



Item	Part Number	Description
1	17A386	Front License Plate Mounting Bracket
2	N803043	Plastic Rivet
3	N805070	Screw
4	—	Sponge Adhesive Tape
5	17B982	Front Bumper Bracket
6	N800852	Spring Nut (4 Req'd)
7	17D957	Front Bumper Cover
8	N803573	Shoulder Bolt
9	17626	Front Valance Panel
10	N803573	Pushpin
11	17A385	Front License Plate Mounting Bracket

Moulding, Lower Side and Front Valance, Ranger

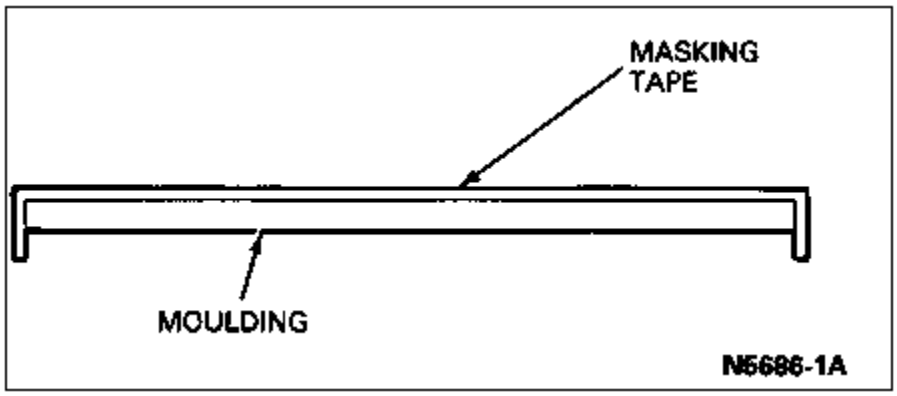


Item	Part Number	Description
1	8190	Radiator Grille Opening Panel
2	388577-S	Pushpin
3	17757	Front Bumper
4	17626	Front Valance Panel (4x2)
5	N807389-S	Pushpin
6	N803043-S	Rivet
7	17A385	Front License Plate Mounting Bracket
8	17626	Front Valance Panel

Adhesive Removal/Repair Body Side Mouldings/Nameplates

1. Completely clean sheet metal surface area around moulding using isopropyl alcohol and a clean soft cloth.

2. Before removing moulding, mark moulding location on top and each end of moulding with masking tape. Do not heat moulding or sheet metal surface; this only increases the adhesion. Temperatures of -18°C (0°F) and below allow easier removal of moul ding.



3. Using a nylon wedge tool, start at rear of door and wedge tool between moulding and door. At the same time, pull moulding away with steady tension. Remove and replace one moulding at a time.

4. Once a few inches of moulding are free, grip moulding with both hands and pull the moulding slowly toward the front of vehicle, being careful not to damage paint or sheet metal surface.

5. **NOTE: Not all of the tape will come off with moulding; white or gray acrylic tape is most easily removed by gently stretching.**

   Grip tape at one end, lifting and pulling away slowly about 12mm (0.5 inch) at a time; then grip and pull again. Small pieces can be removed by rolling with thumb across sheet metal surface.

6. When all tape is removed, wipe area with isopropyl alcohol and clean soft cloth, making sure all tape residue and road dirt is removed. A clean surface is required for application of new moulding. Should paint surface be damaged during moulding removal, surface should be repaired using paint repair procedure.

7. **NOTE: Mouldings should not be installed on vehicle unless sheet metal surface temperature exceeds 27°C (80°F) and moulding is at 21°C (70°F) minimum.**

   New moulding is now ready to be applied. Start at front of door moulding, pull back tape protective liner approximately 19mm (0.75 inch). Do not touch or contaminate tape surface. Line moulding up with marks on masking tape at rear of door and press gently forward on door, removing protective liner as you proceed forward. Be sure part is lined up correctly.

8. Remove masking tape and wipe area under masking tape with isopropyl alcohol to remove residue.

9. Press moulding on with hand roller applying a minimum of 138 kPa (20 psi) pressure to assure positive tape adhesion.

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Shoulder Bolt, Front Bumper Assembly	9-14	7-10	—
Shoulder Screw, Front Bumper Assembly	9-14	7-10	—
Screw and Washer, Front Bumper Assembly	4.5-6.0	—	40-53
Nut and Washer Assembly, Front Bumper Assembly	88-118	65-87	—
Screw, Grille Moulding and Hardware	1.5-2.0	—	14-17
Nut, Bolt, Splash Shield	17-27	13-19	—

SPECIAL SERVICE TOOLS/EQUIPMENT

ROTUNDA EQUIPMENT

Model	Description
107-00600	Blind Fastener Installation Tool 107-00600

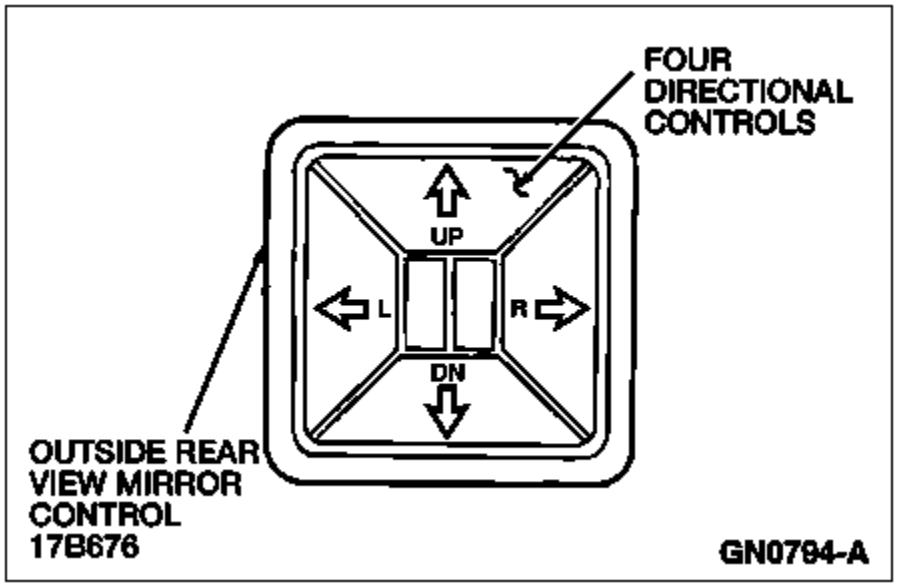
Mirror, Outside Rearview, Power

The outside rear view mirror control (17B676) for the dual electric mirrors is located in the upper front area of the front door trim panel (23942). The same outside rear view mirror control controls both the left and right outside rear view mirrors (17682).

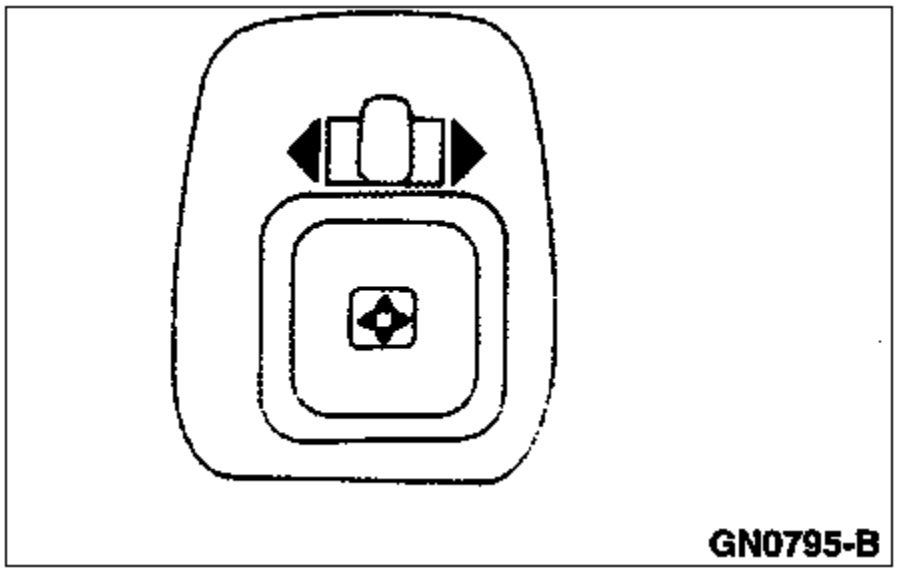
Mirror position may be adjusted by first moving the selector switch to the L or R position. Then, adjust the outside rear view mirrors by pressing the appropriate arrow.

When not adjusting, the outside selector switch should be kept in center OFF position to avoid inadvertent adjustment.

Aerostar

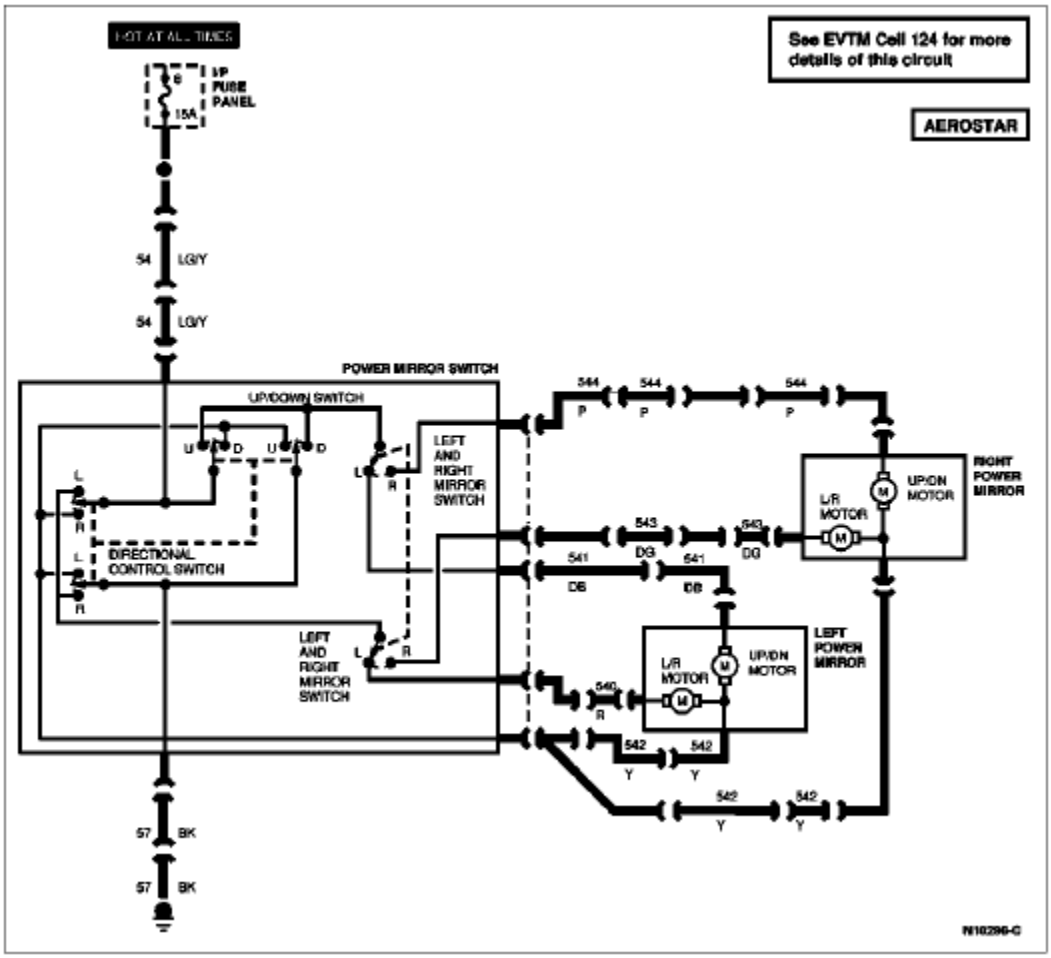


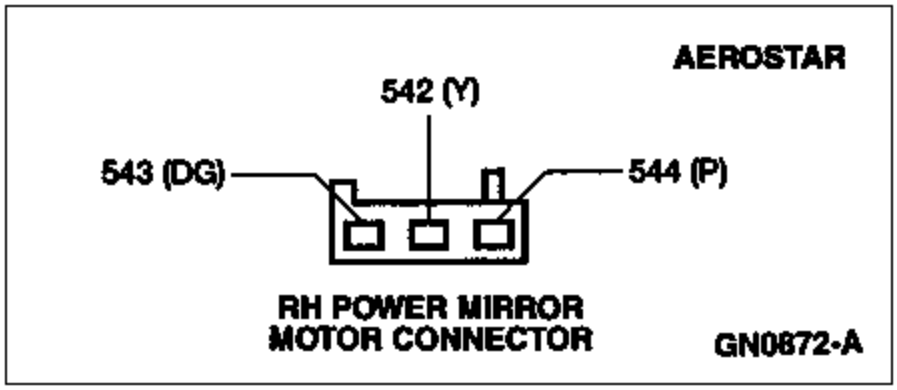
Ranger

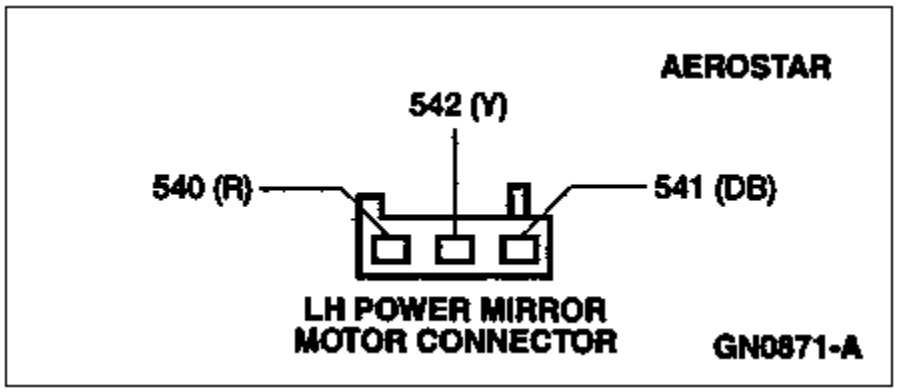

GN0795-B

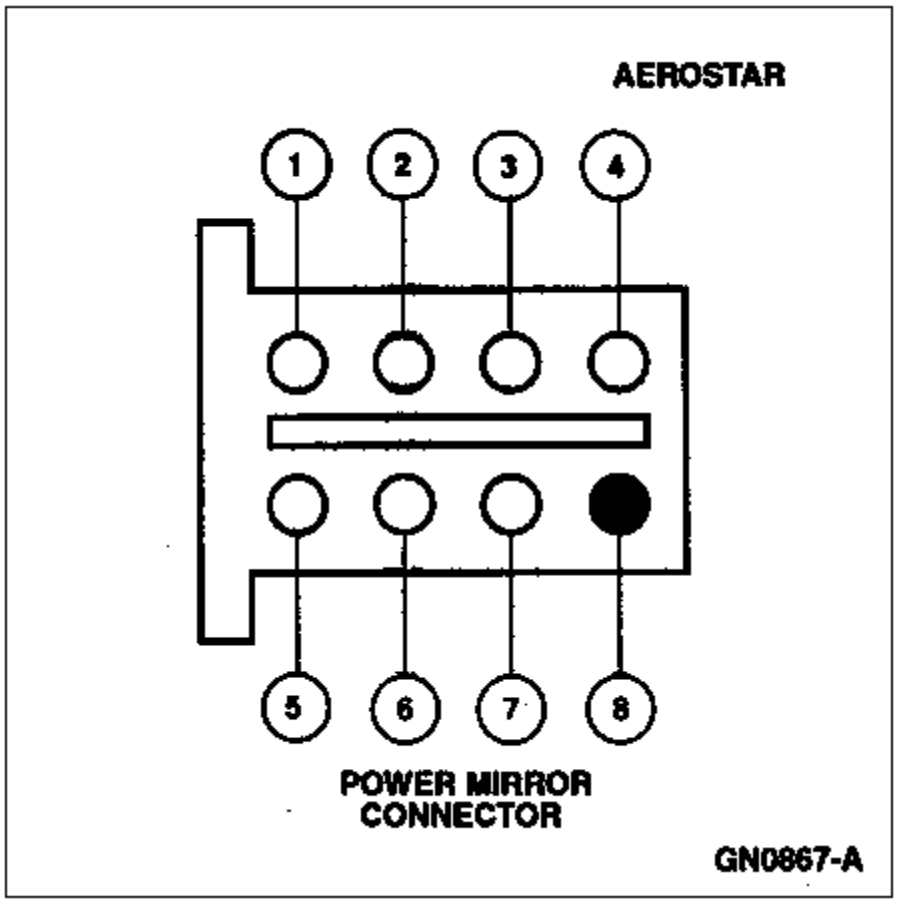
Electrical Schematics

Power Mirror, Aerostar



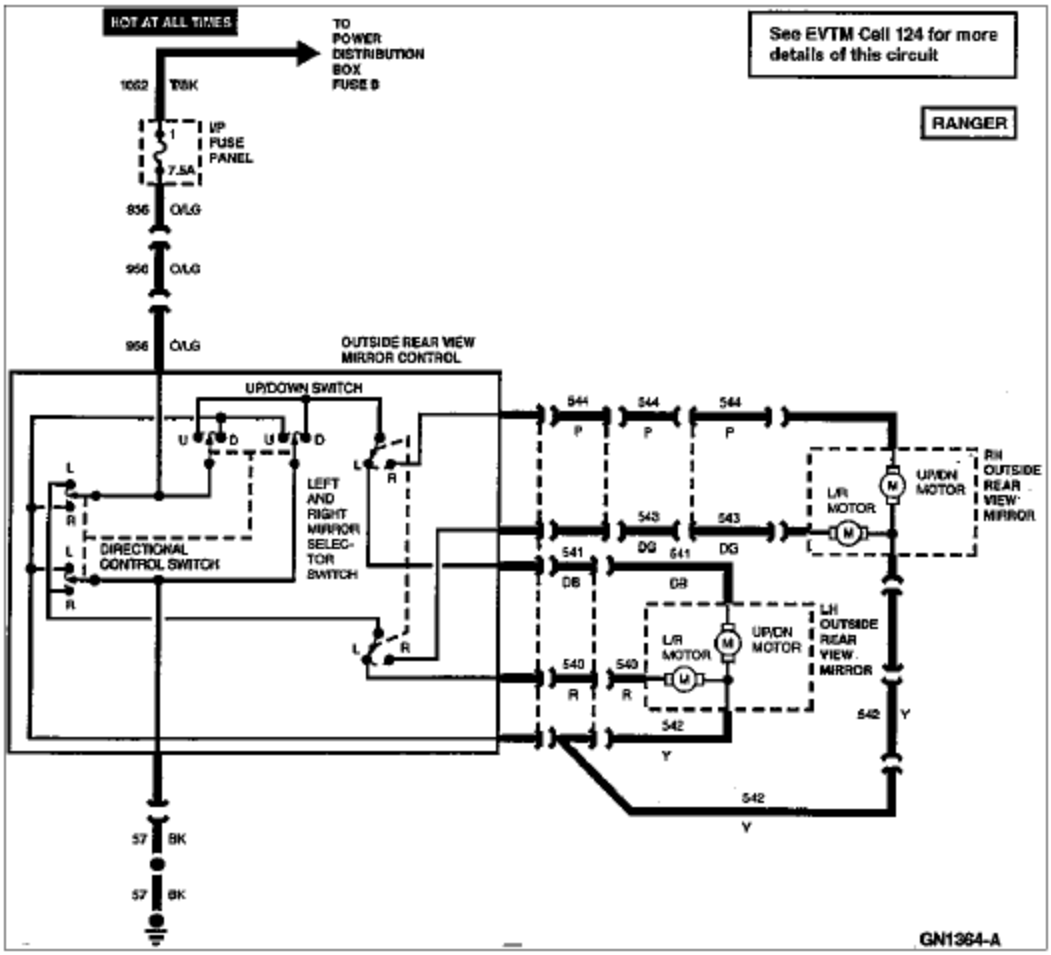

AEROSTAR
542 (Y)
543 (DG)
544 (P)
RH POWER MIRROR
MOTOR CONNECTOR
GN0872-A

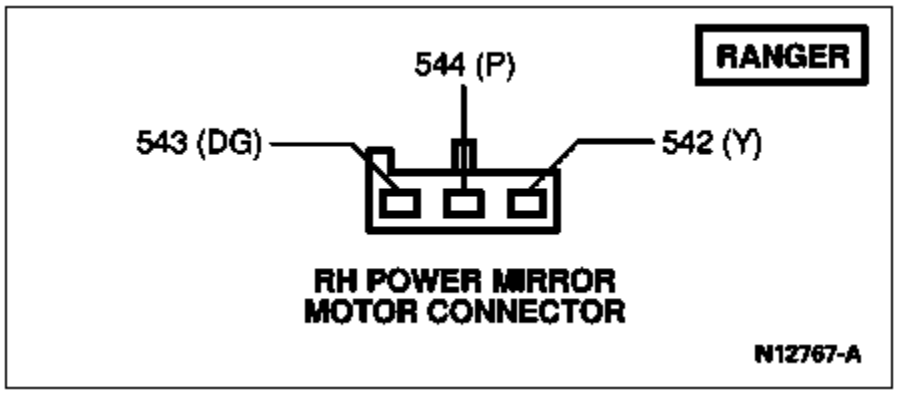

AEROSTAR
542 (Y)
540 (R)
541 (DB)
LH POWER MIRROR
MOTOR CONNECTOR
GN0871-A

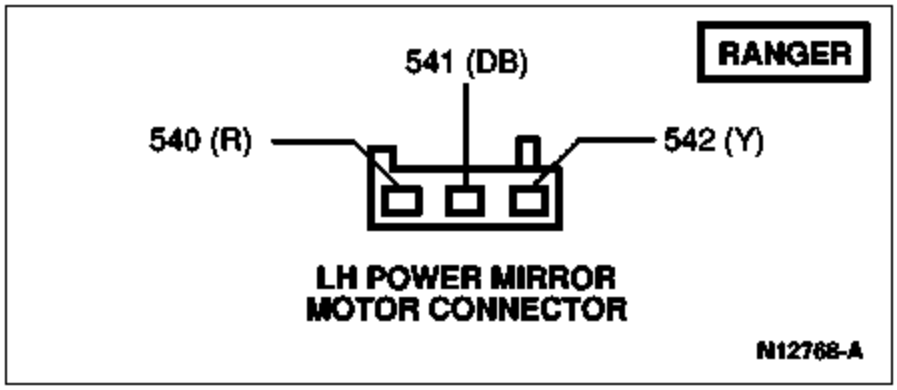


Pin Number	Circuit	Circuit Function
1	57 (BK)	Ground Circuit
2	540 (R)	LH Mirror L/R Motor Feed
3	543 (DG)	RH Mirror L/R Motor Feed
4	—	Not Used
5	542 (Y)	LH and RH Mirror Motor Common
6	541 (DB)	LH Mirror UP/DN Motor Feed
7	544 (P)	RH Mirror UP/DN Motor Feed
8	54 (LG/Y)	Hot At All Times Switch Feed

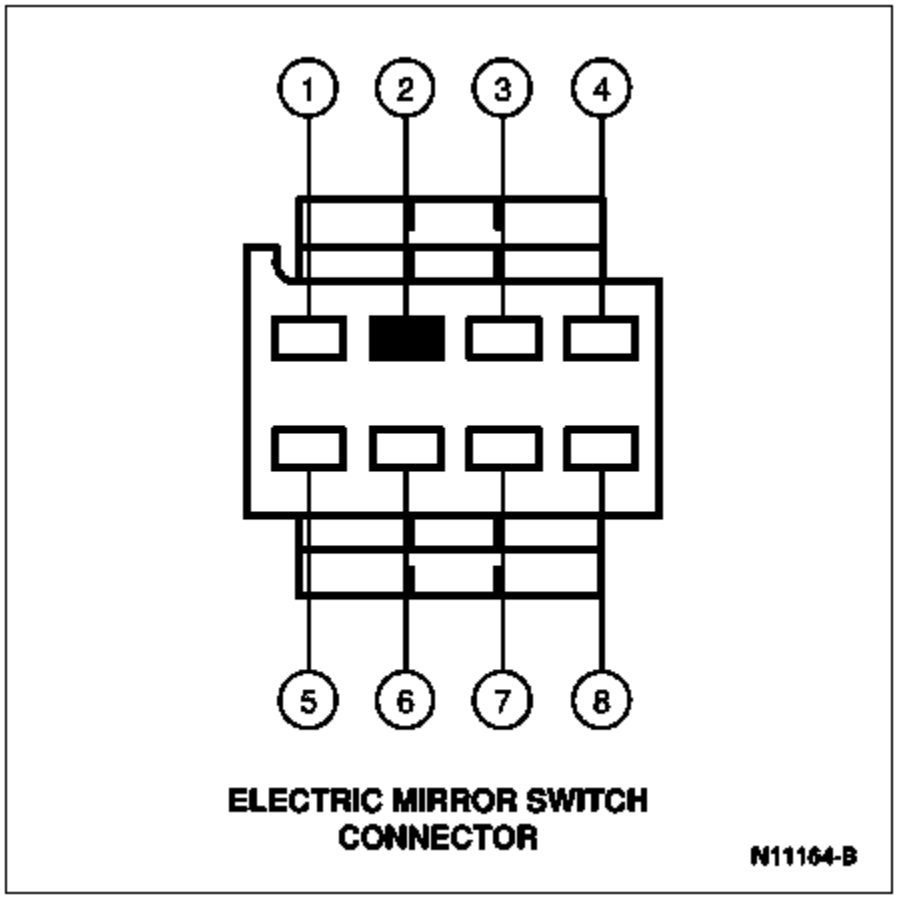
Power Mirrors, Ranger


HOT AT ALL TIMES
TO POWER DISTRIBUTION BOX FUSE 8
1062 T/BK
I/P FUSE PANEL
7.5A
856 O/LG
956 O/LG
956 O/LG
See EVTM Cell 124 for more details of this circuit
RANGER
OUTSIDE REAR VIEW MIRROR CONTROL
UP/DOWN SWITCH
U D U D
L R L R
DIRECTIONAL CONTROL SWITCH
LEFT AND RIGHT MIRROR SELEC-TOR SWITCH
544 P 544 P 544 P
543 DG 543 DG
541 DB 541 DB
540 R 540 R
542 Y 542 Y
542 Y
L/R MOTOR
UP/DN MOTOR
RH OUTSIDE REAR VIEW MIRROR
LH OUTSIDE REAR VIEW MIRROR
57 BK
57 BK
GN1364-A


RANGER
544 (P)
543 (DG)
542 (Y)
RH POWER MIRROR MOTOR CONNECTOR
N12767-A



Ranger



Pin Number	Circuit	Circuit Function
1	956 (O/LG)	Power Mirror Switch Feed Hot At All Times
2	—	Not Used

3	543 (DG)	RH Mirror Left/Right Motor (B+ = Right)
4	540 (R)	LH Mirror Left/Right Motor (B+ = Right)
5	57 (B/K)	Ground Circuit
6	542 (Y)	LH and RH Mirror Motor Common
7	541 (DB)	LH Mirror Up/Down Motor (B+ = Up)
8	544 (P)	RH Mirror Up/Down Motor (B+ = Up)

Inspection and Verification

1. Verify the concern by operating the outside rear view mirrors.
2. Visually inspect for obvious signs of mechanical and electrical damage; refer to the following chart.

VISUAL INSPECTION CHART

Mechanical	Electrical
• Damaged mirrors. • Damaged remote control mirror switch.	• Blown fuse: • No. 1 (7.5 Amp) (Ranger) • No. 8 (15A) (Aerostar) • Damage to wiring harness. • Loose or corroded connections.

3. If the visual inspection reveals no obvious concerns; refer to the following Symptom Chart.

Symptom Chart — Rearview Mirrors

NOTE: Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent to perform electrical Pinpoint Tests.

REARVIEW MIRRORS

Condition	Possible Source	Action
• Both RH and LH Mirrors Inoperative	• Fuse. • Circuitry open/shorted. • Damaged outside rearview mirror control.	• GO to Pinpoint Test A for Aerostar. • GO to Pinpoint Test B for Ranger.
• Single Mirror Inoperative	• Circuitry open/shorted. • Damaged outside rearview mirror control. • Damaged outside rearview mirror motor.	• GO to Pinpoint Test C for Aerostar. • GO to Pinpoint Test D for Ranger.
• Single Mirror Does Not Function with Switch Logic	• Circuitry open/shorted. • Damaged outside rearview mirror control. • Damaged outside rearview mirror motor.	• GO to Pinpoint Test E for Aerostar and Ranger.

Pinpoint Tests

PINPOINT TEST A: BOTH RH AND LH MIRRORS INOPERATIVE (AEROSTAR)

A1 CHECK FOR A BLOWN FUSE

- Key OFF.
- Remove fuse and inspect.

Is the fuse blown?

Yes	No
REPLACE and RETEST mirrors. If the fuse fails again, REPAIR Circuit 54 (LG/Y).	REINSTALL fuse. GO to **A2** .

A2 CHECK FOR VOLTAGE AT HARNESS CONNECTOR TO SWITCH

- Disconnect outside rear view mirror control.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check for voltage across Circuits 54 (LG/Y) and 57 (BK).

Is voltage present?

Yes	No
CHECK outside rear view mirror control. REFER to the Component Test in this section.	GO to **A3** .

A3 CHECK CIRCUIT 54 (LG/Y) FOR VOLTAGE

- Check for voltage between Circuit 54 (LG/Y) and ground.

Is there voltage?

Yes	No
GO to **A4** .	TRACE back through Circuit 54 (LG/Y) and REPAIR as required.

A4 CHECK FOR CONTINUITY OF CIRCUIT 542 (Y)

- Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent to check continuity of circuit 542 (Y) between the outside rear view mirrors and the outside rear view mirror control.

Does continuity exist?

Yes	No
GO to **A5** .	TRACE back through circuit 542 (Y) and REPAIR as required.

A5 CHECK FOR SHORT ON CIRCUIT 542 (Y)

- Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent to check circuit 542 (Y) for short to ground.

Is circuit shorted to ground?

Yes	No
TRACE back through circuit 542 (Y) and REPAIR as required.	TRACE back through circuit 57 (BK) and REPAIR as required.

PINPOINT TEST B: BOTH RH AND LH MIRRORS INOPERATIVE (RANGER)

B1 CHECK FOR A BLOWN FUSE

- Key OFF.
- Remove fuse and inspect.

Is the fuse blown?

Yes	No
REPLACE and RETEST mirrors. If the fuse fails again, REPAIR Circuit 956 (O/LG).	GO to **B2** .

B2 CHECK FOR VOLTAGE AT HARNESS CONNECTOR TO SWITCH

- Disconnect outside rear view mirror control.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check for voltage across Circuits 956 (O/LG) and 57 (BK).

Is voltage present?

Yes	No
CHECK outside rear view mirror control. Refer to Component Test in this section.	GO to **B3**.

B3 CHECK CIRCUIT 956 (O/LG) FOR VOLTAGE

- Check for voltage between Circuit 956 (O/LG) and ground.

Is there voltage?

Yes	No
GO to **B4**.	TRACE back through Circuit 956 (O/LG) and REPAIR as required.

B4 CHECK FOR CONTINUITY OF CIRCUIT 542 (Y)

- Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent to check continuity of circuit 542 (Y), between the outside rear view mirrors and the outside rear view mirror control.

Does continuity exist?

Yes	No
GO to **B5**.	TRACE back through circuit 542 (Y) and REPAIR as required.

B5 CHECK FOR SHORT ON CIRCUIT 542 (Y)

- Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent to check circuit 542 (Y) for short to ground.

Is circuit shorted to ground?

Yes	No
TRACE back through circuit 542 (Y) and REPAIR as required.	TRACE back through circuit 57 (BK) and REPAIR as required.

PINPOINT TEST C: SINGLE MIRROR INOPERATIVE (AEROSTAR)

C1 VERIFY THAT HARNESS IS CONNECTED TO MIRROR

- Key OFF.
- Remove front door trim panel and verify that outside mirror control wiring is connected.

Is harness connected?

Yes	No
GO to C2 .	CHECK outside mirror control wiring connector for damage and RECONNECT. CHECK outside rear view mirror for proper operation. If the concern remains, GO to C2 .

C2 CHECK CONTINUITY OF CIRCUITS IN HARNESS CONNECTOR

- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check continuity of Circuits 540 (R), 541 (DB) and 542 (Y) for left outside rear view mirror, 542 (Y), 543 (DG) and 544 (P) for right outside rear view mirror, in outside mirror control wiring connector to outside rear view mirror.

Do circuits have continuity?

Yes	No
REPLACE the outside rear view mirror.	TRACE circuits and REPAIR as required.

PINPOINT TEST D: SINGLE MIRROR INOPERATIVE (RANGER)

D1 VERIFY THAT HARNESS IS CONNECTED TO MIRROR

- Key OFF.
- Remove front door trim panel and verify that outside mirror control wiring is connected.

Is harness connected?

Yes	No
GO to D2 .	CHECK outside mirror control wiring connector for damage and RECONNECT. CHECK outside rear view mirror for proper operation. If the concern remains, GO to D2 .

D2 CHECK CONTINUITY OF CIRCUITS IN HARNESS CONNECTOR

- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check continuity of Circuits 540 (R), 541 (DB) and 542 (Y) for left outside rear view mirror, 542 (Y), 543 (DG) and 544 (P) for right outside rear view mirror, in outside mirror control wiring connector to outside rear view mirror.

Do circuits have continuity?

Yes	No
REPLACE the outside rear view mirror.	TRACE circuits and REPAIR as required.

PINPOINT TEST E: SINGLE MIRROR DOES NOT FUNCTION WITH SWITCH LOGIC (AEROSTAR AND RANGER)

E1 VERIFY THAT HARNESS IS CONNECTED TO MIRROR

- Key OFF.
- Remove front door trim panel and verify that outside mirror control wiring is connected.

Is harness connected?

Yes	No
GO to **E2** .	CHECK outside mirror control wiring connector for damage and RECONNECT. CHECK outside rear view mirror for proper operation. If the concern remains, GO to **E2** .

E2 CHECK CONTINUITY OF CIRCUITS IN HARNESS CONNECTOR

- Disconnect the outside rear view mirror control and the inoperative outside rear view mirror.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check continuity of Circuits 540 (R), 541 (DB) and 542 (Y) for left outside rear view mirror, or Circuits 542 (Y), 543 (DG) and 544 (P) for right or left outside rear view mirror, and outside rear view mirror control.

Do circuits have continuity?

Yes	No
GO to **E3** .	TRACE circuits to connector and REPAIR as required.

E3 CHECK OUTSIDE REAR VIEW MIRROR CONTROL

- Check the outside rear view control. Refer to the Component Test in this section.

Does outside rear view mirror control operate properly?

Yes	No
GO to **E4** .	REPLACE the outside rear view mirror control.

E4 CHECK CIRCUIT LOGIC AT SWITCH CONNECTOR

- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, verify that the outside rear view mirror motor is working properly. Refer to Component Test — Aerostar or Component Test — Ranger in this section.

Is logic OK at outside rear view mirror motor?

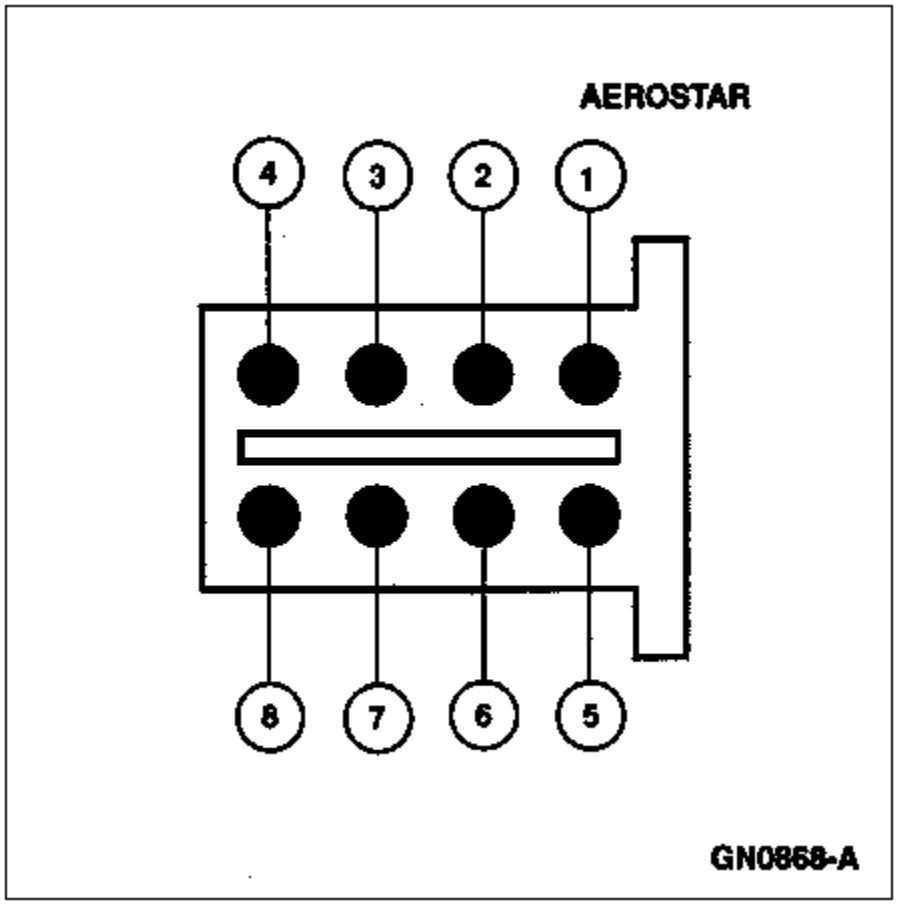
Yes	No
TRACE along outside mirror control wiring to DETERMINE where cross circuitry took place. REPAIR as required.	REPLACE the outside rear view mirror and RETEST mirror operation.

Component Test — Outside Rear View Mirror Control

Mirror Control

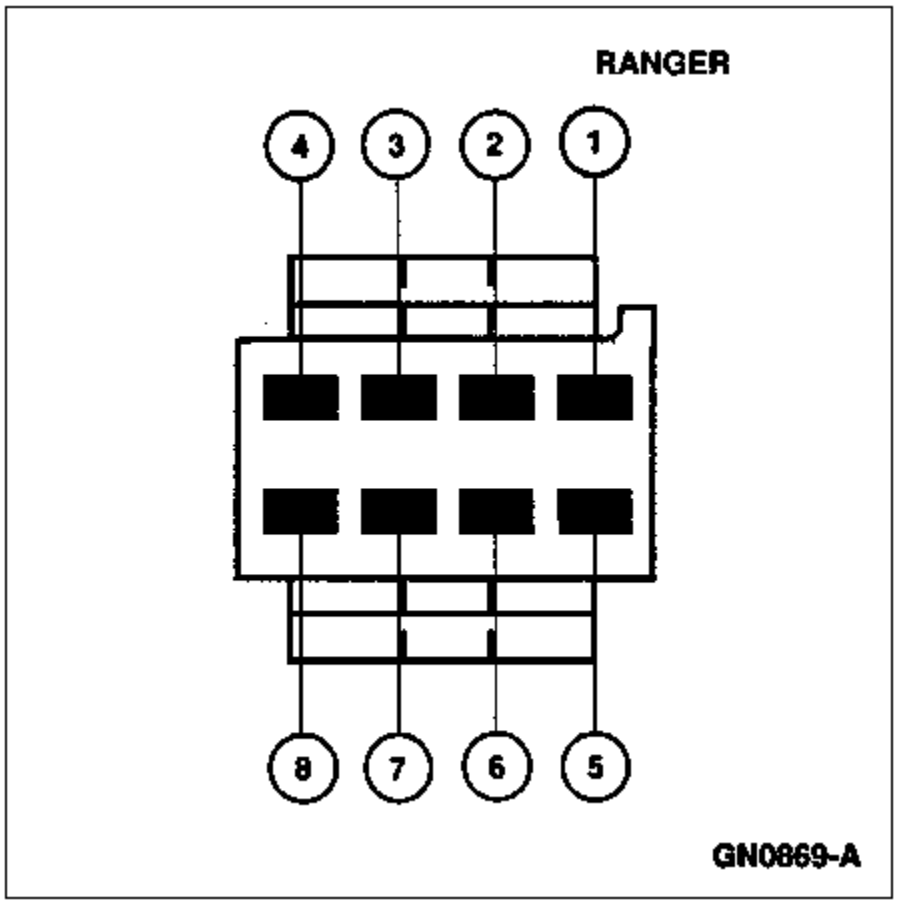
1. Key OFF.
2. Disconnect the outside rear view mirror control connector.
3. **NOTE: All resistances not specified in the chart for a switch position should be greater than 10,000 ohms.**

   Measure the resistance between the following terminals at the outside rear view mirror control under the following conditions:



OUTSIDE REAR VIEW MIRROR CONTROL

Mirror Select	Mirror Direction	Terminal From	Terminal To	Resistance
Left	Up	6 5	8 1	Less than 5 ohms
Left	Down	5 6	8 1	Less than 5 ohms
Left	Left	2 5	8 1	Less than 5 ohms
Left	Right	5 2	8 1	Less than 5 ohms
Right	Up	7 5	8 1	Less than 5 ohms
Right	Down	5 7	8 1	Less than 5 ohms
Right	Left	3 5	8 1	Less than 5 ohms
Right	Right	5 3	8 1	Less than 5 ohms



OUTSIDE REAR VIEW MIRROR CONTROL

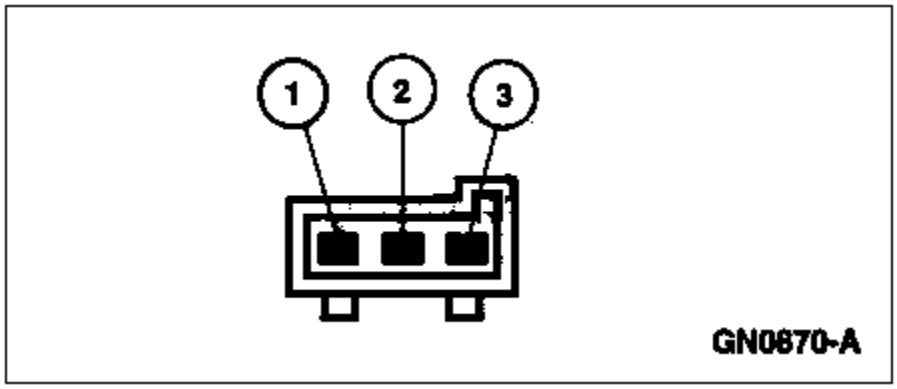
Mirror Select	Mirror Direction	Terminal From	Terminal To	Resistance
Left	Up	7 6	1 5	Less than 5 ohms
Left	Down	6 7	1 5	Less than 5 ohms
Left	Left	4 6	1 5	Less than 5 ohms
Left	Right	6 4	1 5	Less than 5 ohms
Right	Up	8 6	1 5	Less than 5 ohms
Right	Down	6 8	1 5	Less than 5 ohms
Right	Left	3 6	1 5	Less than 5 ohms
Right	Right	6 3	1 5	Less than 5 ohms

4. If the resistances are not as specified, replace the outside rear view mirror control. Otherwise, return to the Pinpoint Tests.

Component Test — Aerostar

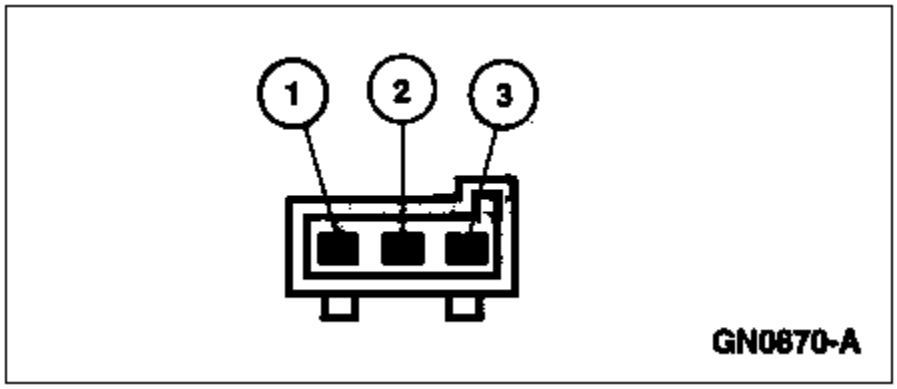
Power Outside Rear View Mirror Motor

1. Key OFF.
2. Disconnect the LH or RH power outside rear view mirror motor connector.
3. Apply 12 volts to the 2 terminal and ground to the following terminals and verify mirror operates in the specified direction.



Terminal	Mirror Direction
3	Right
1	Down

4. Apply ground to the 2 terminal and 12 volts to the following terminals and verify power outside rear view mirror operates in the specified direction.



Terminal	Mirror Direction
3	Left
1	Up

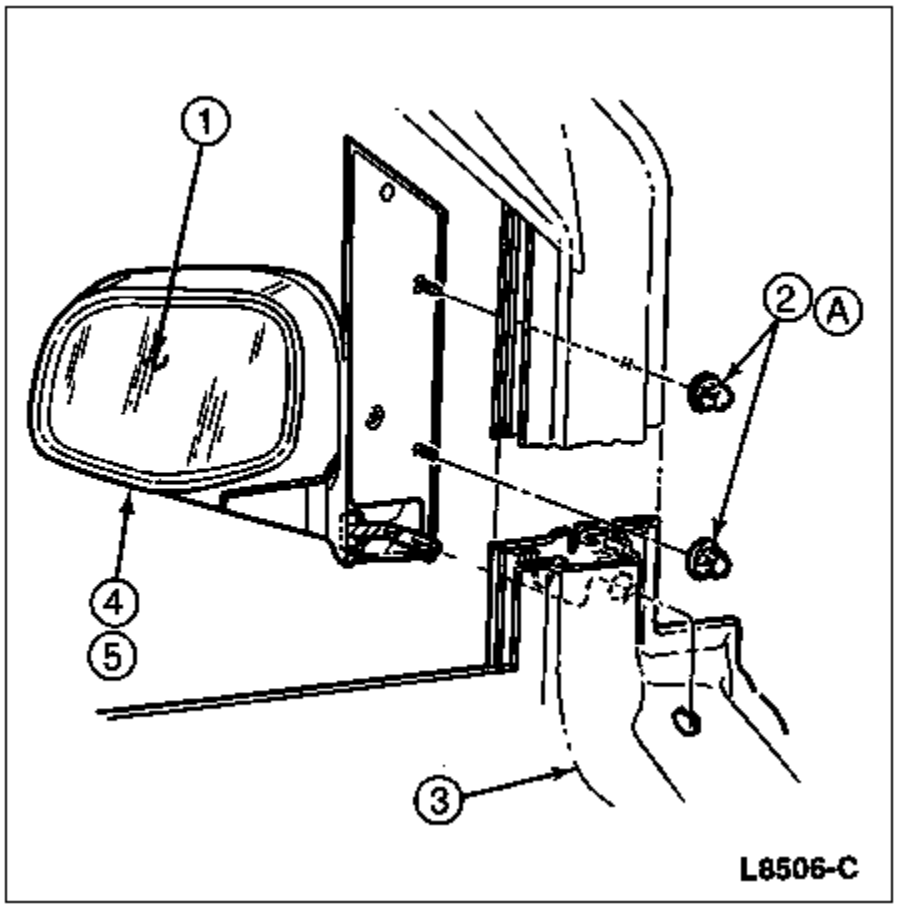
5. If the power outside rear view mirror does not operate as specified, replace the power outside rear view mirror in question. Otherwise, return to the Pinpoint Tests.

Mirror, Power, Outside Rearview, Aerostar

Removal and Installation

1. Disconnect wiring from behind outside rear view mirror (17682) with front door (20124) open.
2. Remove two nuts attaching outside rear view mirror to front door.
3. Remove outside rear view mirror from front door.

For installation, follow removal procedures in reverse order. Tighten mirror attaching nuts to 8-10 Nm (6-7 lb-ft).



Item	Part Number	Description
1	17K707	Outside Rear View Mirror Glass
2	N805169-S100	Nut
3	20124	Front Door
4	17682	Outside Rear View Mirror (LH)

5	17682	Outside Rear View Mirror (RH)
A	—	Tighten to 8-10 Nm (71-88 Lb-In)

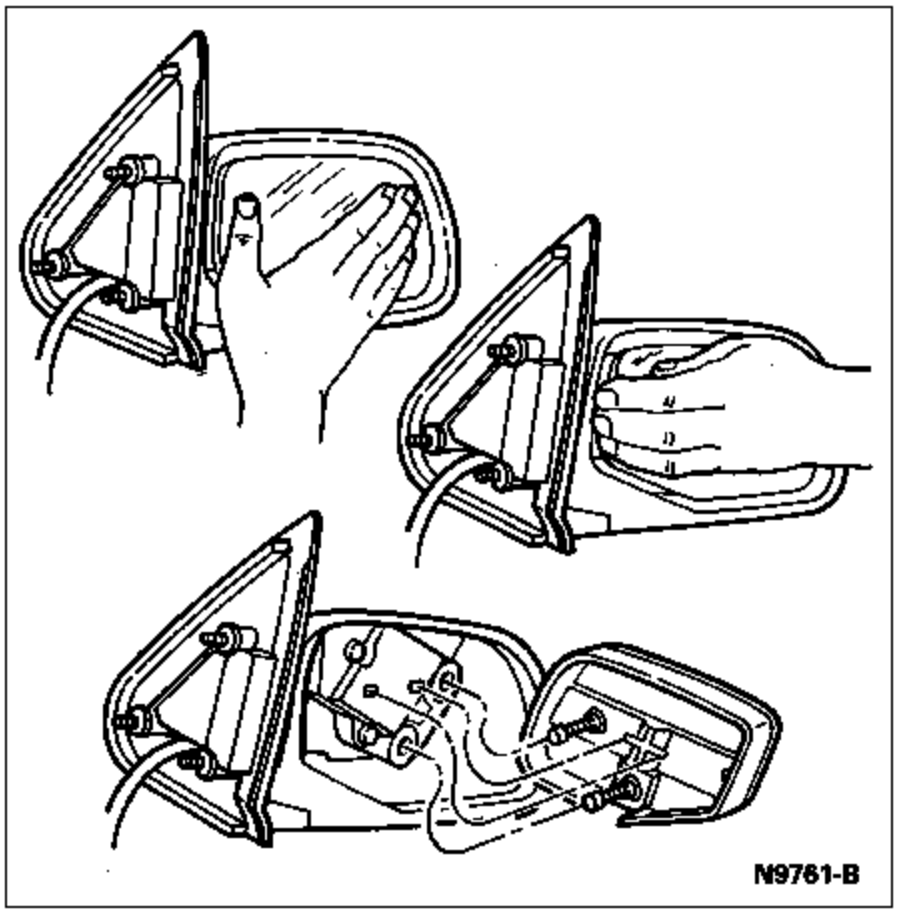
Glass, Outside Mirror, Aerostar and Ranger

Removal and Installation

1. Push outer edge of outside rear view mirror glass (17K707) into outside rear view mirror.
2. Grip inner edge of outside rear view mirror glass and pull out until outside rear view mirror glass snaps out of motor assembly.

   On some vehicles, the cross-tee pivot or drive screw(s) may remain attached to the outside rear view mirror motor (17D696) kit. In this case, carefully pry the pivot out of the outside rear view mirror motor kit and turn the drive screw(s) (counterclockwise) out of the outside rear view mirror motor kit.
3. Position the outside rear view mirror glass as shown. Firmly push the outside rear view mirror glass into place with the palm of the hand, until it locks.

Power Outside Mirror, Ranger Shown, Aerostar Similar



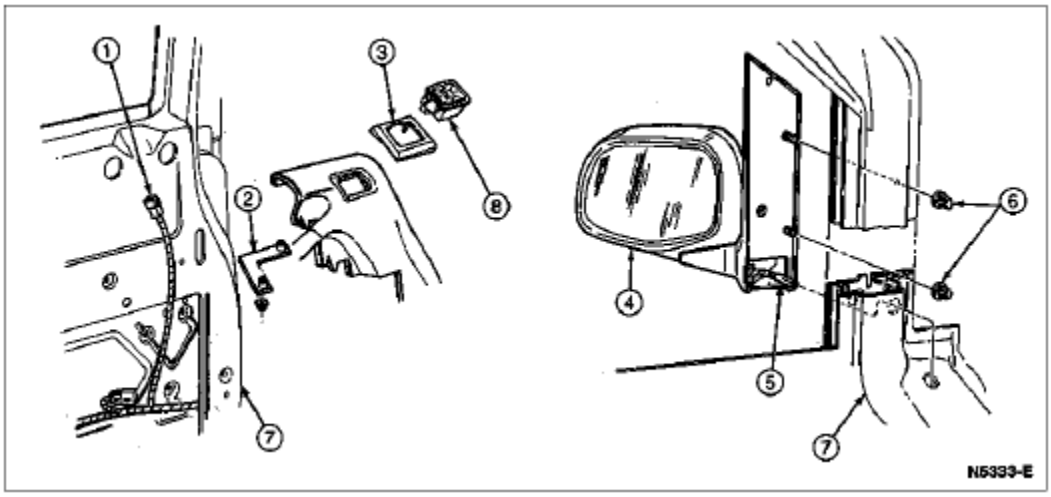
Mirror Control, Aerostar

Removal and Installation

1. Remove driver's side door trim panel with outside rear view mirror control (17B676) switch pigtail still attached to harness.
2. Reach around door trim panel and disengage switch harness from the main wire harness.
3. Using a putty knife, pry the outside rear view mirror control switch up from the bezel.
4. Remove outside rear view mirror control switch.

For installation, follow the removal procedures in reverse order.

Power Mirror Control Switch and Wiring, Aerostar



Item	Part Number	Description
1	17D708	Power Mirrors Wiring Assembly Connector
2	17K682	Mirror Control Retainer
3	17530	Outside Rear View Mirror Bezel
4	17682	Outside Rear View Mirror
5	17D708	Mirror Harness
6	N805169-S100	Nuts (2 Req'd)
7	20124	Front Door
8	17B676	Outside Rear View Mirror Control Switch

Mirror Control, Ranger

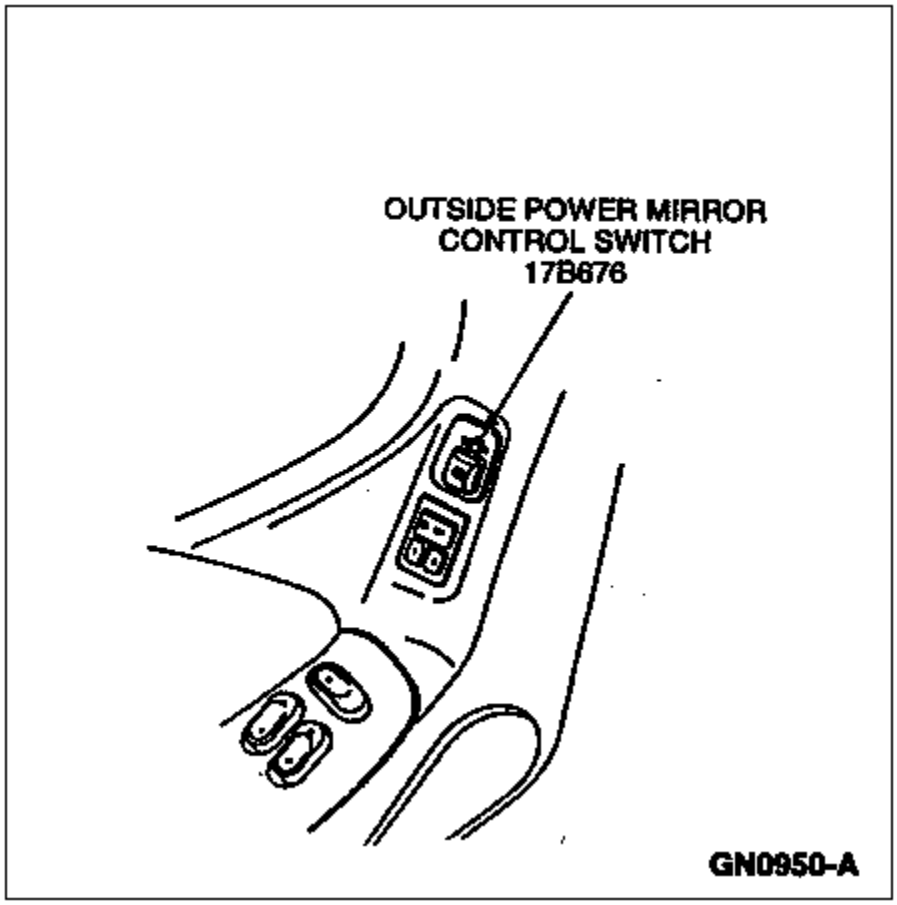
Removal

1. The outside rear view mirror control is held in place by snap action fingers. To remove the outside rear view mirror control, carefully pry the outside rear view mirror control from the top and left side with a putty knife.

2. With a thin-bladed screwdriver, lift connector retainer and disengage wire harness connector. Remove switch.

For installation, follow removal procedures in reverse order. The outside rear view mirror control is installed by pressing into place.

Power Mirror Control Switch, Ranger

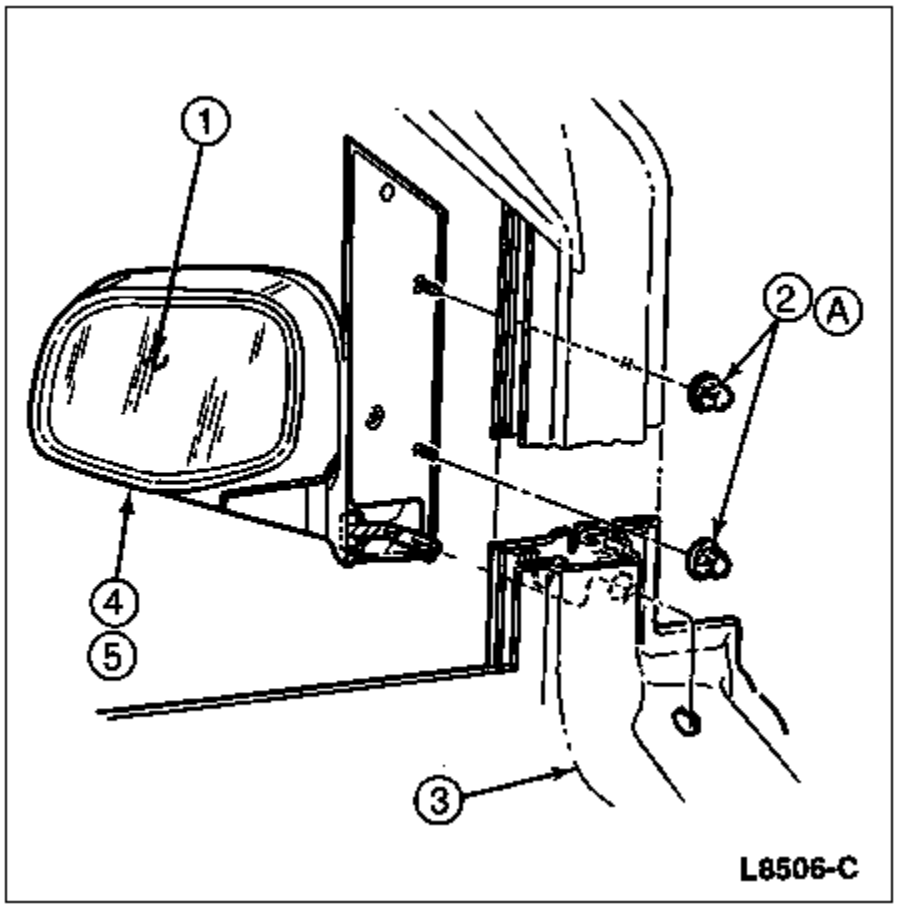


Mirror, Power, Outside Rearview, Aerostar

Removal and Installation

1. Disconnect wiring from behind outside rear view mirror (17682) with front door (20124) open.
2. Remove two nuts attaching outside rear view mirror to front door.
3. Remove outside rear view mirror from front door.

For installation, follow removal procedures in reverse order. Tighten mirror attaching nuts to 8-10 Nm (6-7 lb-ft).



Item	Part Number	Description
1	17K707	Outside Rear View Mirror Glass
2	N805169-S100	Nut
3	20124	Front Door
4	17682	Outside Rear View Mirror (LH)

5	17682	Outside Rear View Mirror (RH)
A	—	Tighten to 8-10 Nm (71-88 Lb-In)

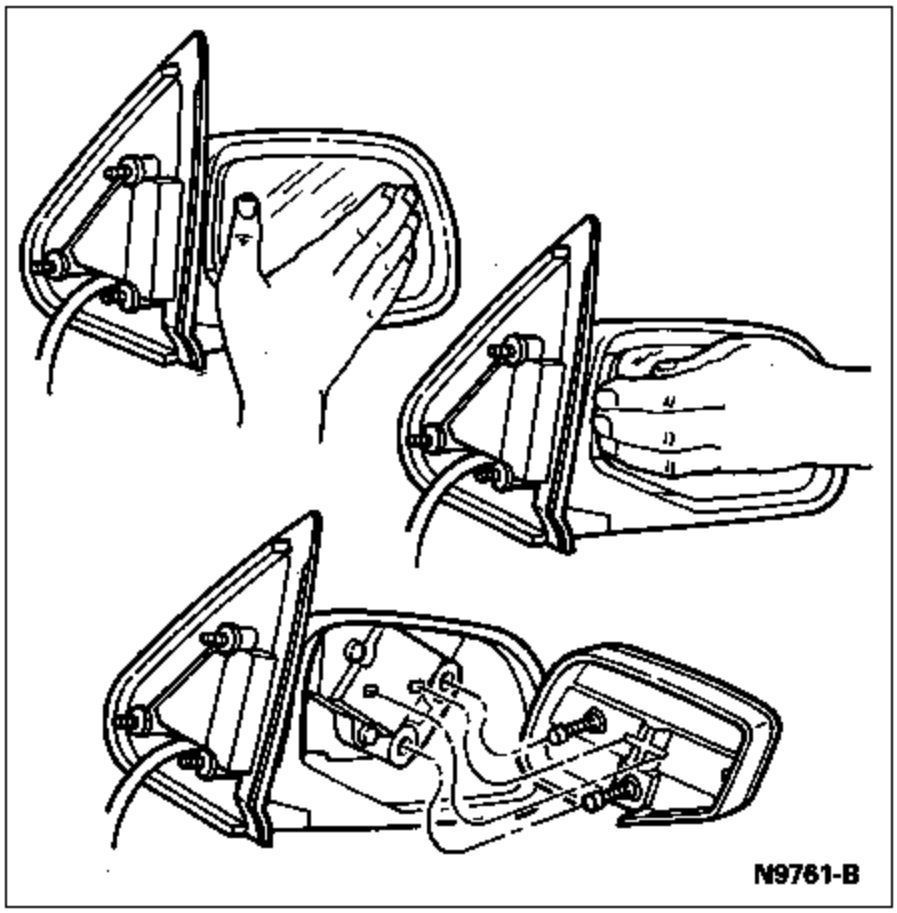
Glass, Outside Mirror, Aerostar and Ranger

Removal and Installation

1. Push outer edge of outside rear view mirror glass (17K707) into outside rear view mirror.
2. Grip inner edge of outside rear view mirror glass and pull out until outside rear view mirror glass snaps out of motor assembly.

   On some vehicles, the cross-tee pivot or drive screw(s) may remain attached to the outside rear view mirror motor (17D696) kit. In this case, carefully pry the pivot out of the outside rear view mirror motor kit and turn the drive screw(s) (counterclockwise) out of the outside rear view mirror motor kit.
3. Position the outside rear view mirror glass as shown. Firmly push the outside rear view mirror glass into place with the palm of the hand, until it locks.

Power Outside Mirror, Ranger Shown, Aerostar Similar



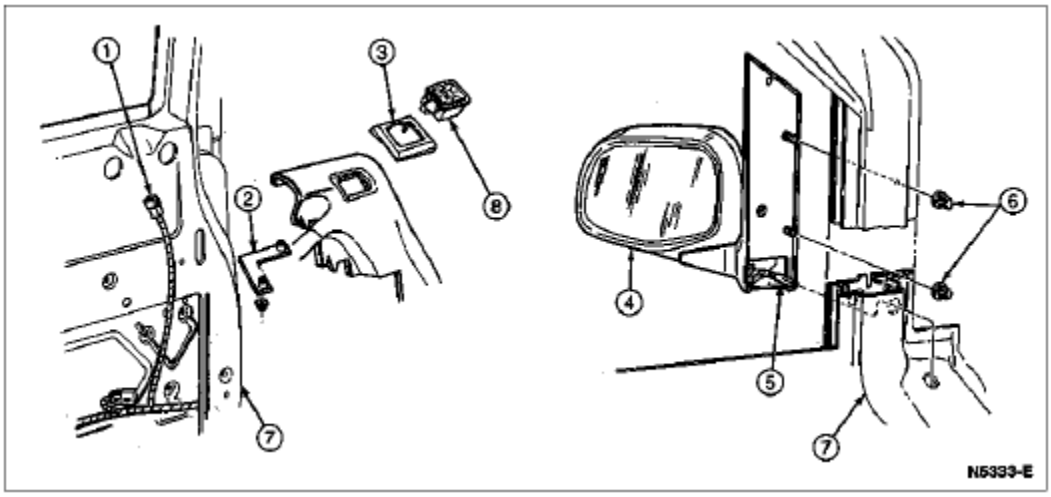
Mirror Control, Aerostar

Removal and Installation

1. Remove driver's side door trim panel with outside rear view mirror control (17B676) switch pigtail still attached to harness.
2. Reach around door trim panel and disengage switch harness from the main wire harness.
3. Using a putty knife, pry the outside rear view mirror control switch up from the bezel.
4. Remove outside rear view mirror control switch.

For installation, follow the removal procedures in reverse order.

Power Mirror Control Switch and Wiring, Aerostar



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7	20124	Front Door
8	17B676	Outside Rear View Mirror Control Switch

Mirror Control, Ranger

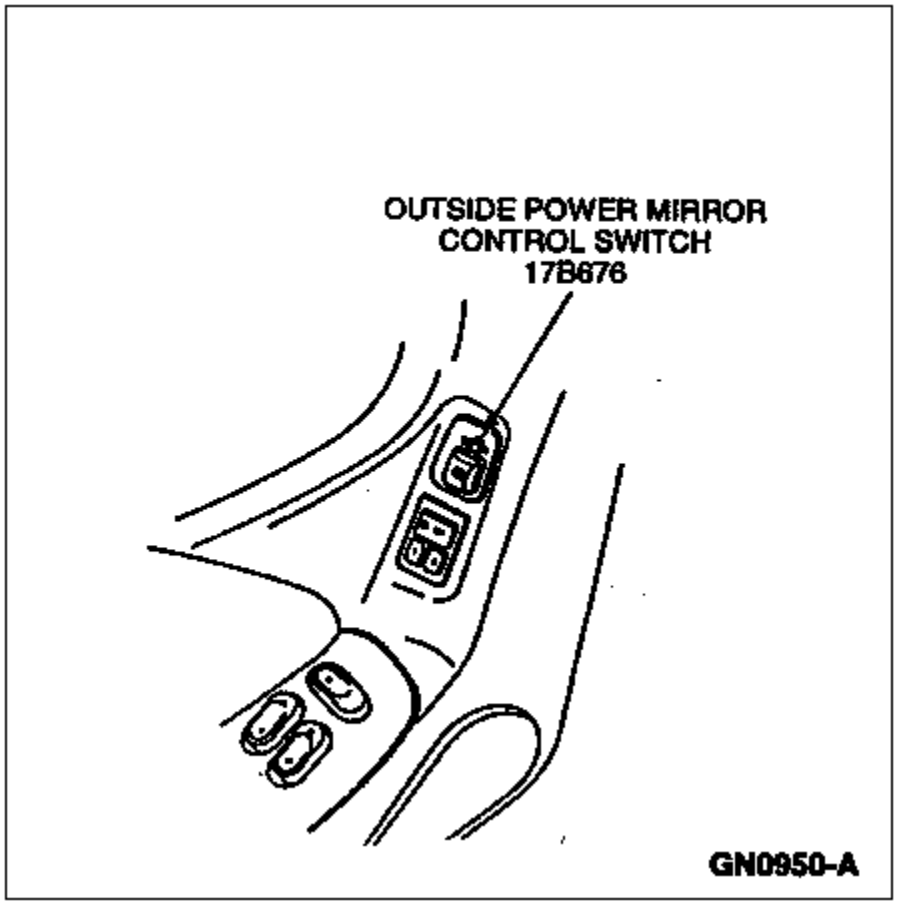
Removal

1. The outside rear view mirror control is held in place by snap action fingers. To remove the outside rear view mirror control, carefully pry the outside rear view mirror control from the top and left side with a putty knife.

2. With a thin-bladed screwdriver, lift connector retainer and disengage wire harness connector. Remove switch.

For installation, follow removal procedures in reverse order. The outside rear view mirror control is installed by pressing into place.

Power Mirror Control Switch, Ranger



Mirrors, Inside, Rearview

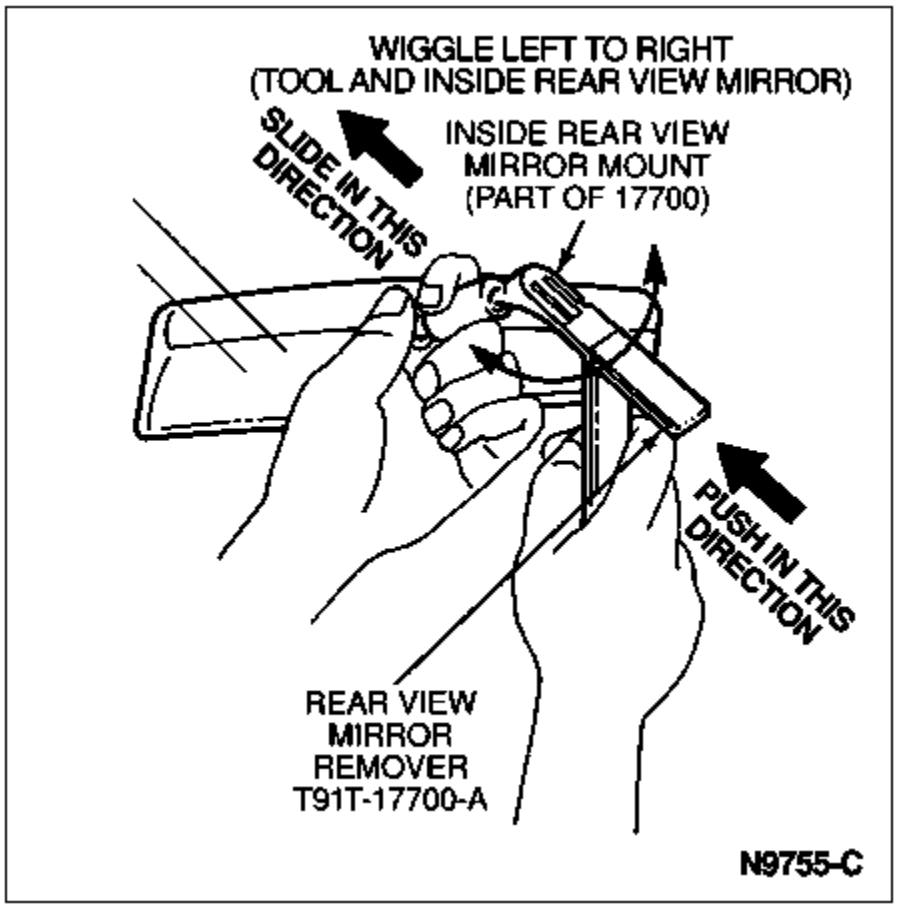
Manual

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Rearview Mirror Remover	T91T-17700-A

Removal

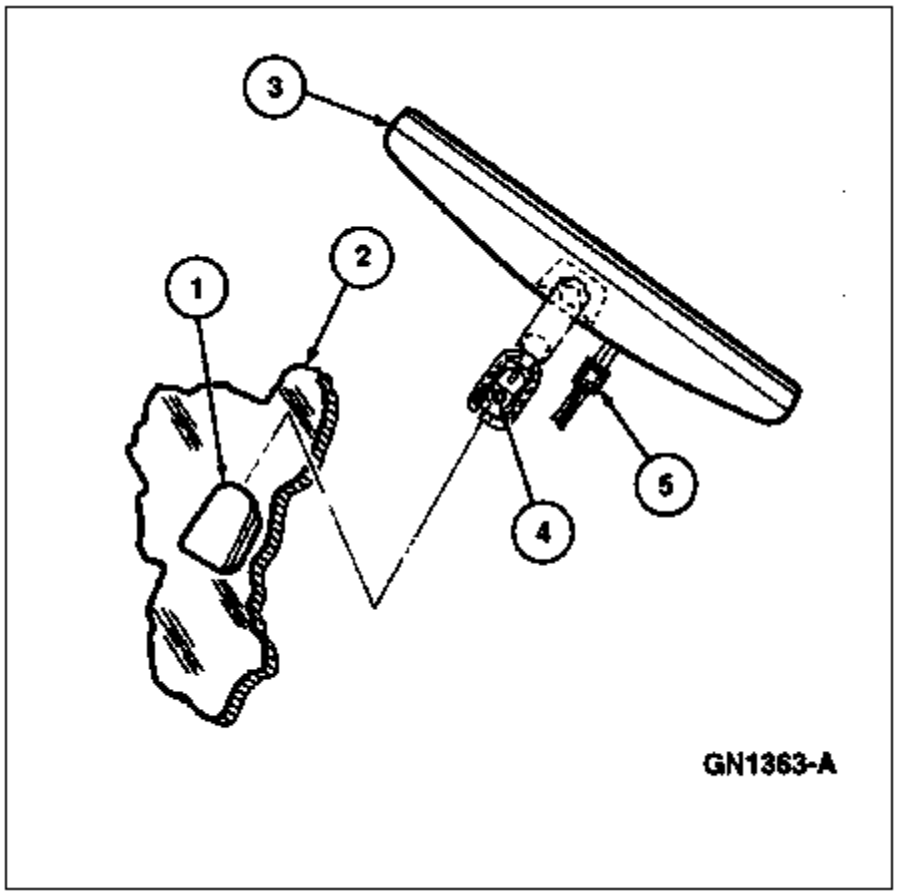
1. Grasp inside rear view mirror (17700) firmly as shown.
2. Insert Rearview Mirror Remover T91T-17700-A between inside rear view mirror windshield pad (17A720) and inside rear view mirror.
3. Slide tool completely in to release inside rear view mirror retainer (17C700).
4. Remove inside rear view mirror by using an upward force, while wiggling inside rear view mirror and Rearview Mirror Remover T91T-17700-A from left to right.



Optional Electrochromic

Removal

1. Disconnect the inside rear view mirror electrical connector.
2. Turn the inside rear view mirror to the vertical position.
3. Remove the inside rear view mirror by twisting the mirror horizontally until the tube assembly bottoms out and the spring releases off the mounting button.

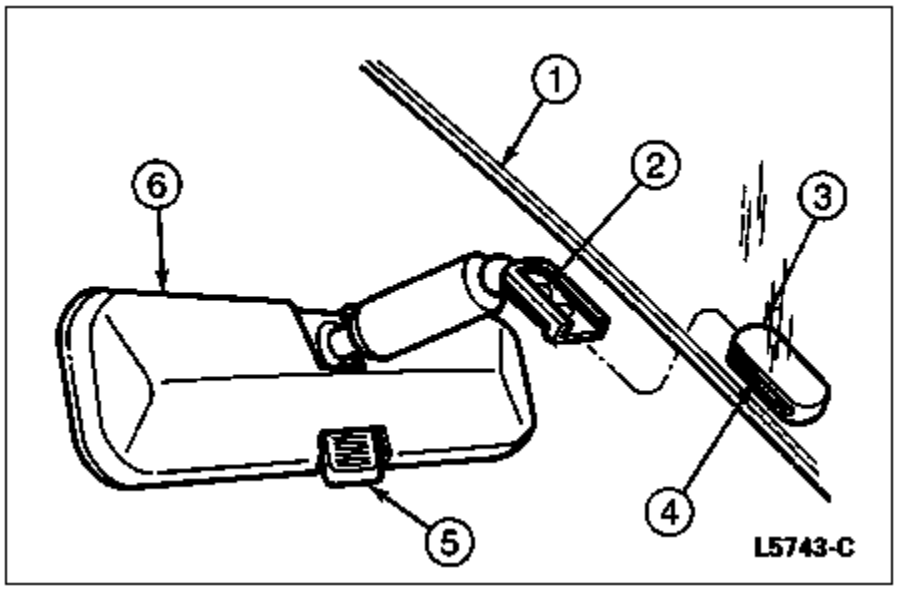


Item	Part Number	Description
1	17698	Inside Rear View Mirror Bracket
2	03100	Windshield Glass
3	17700	Inside Rear View Mirror
4	—	Spring Clip (Part of 17A694)
5	—	Electrical Connector

Installation

NOTE: The mirror mount is designed to detach from the button during air bag deployment. Excessive force or adjustment can cause the mirror to detach from the windshield.

1. Position the inside rear view mirror onto the mounting button.
2. Make sure the inside rear view mirror is parallel with the windshield glass and slide it onto the mounting button while applying holding force against the button until an audible click is heard.
3. Connect the inside rear view mirror electrical connector.
4. Check the inside rear view mirror for normal operation.



Item	Part Number	Description
1	03100	Windshield Glass
2	17698	Locking Tab
3	19554	Vinyl Pad
4	17698	Inside Rear View Mirror Bracket
5	—	Day/Night Lever (Part of 17700)
6	17700	Inside Rear View Mirror

Mirror Mounting Bracket, Inside Rearview Mirror

1. Locate and mark the location ofinside rear view mirror bracket (17698) on the outside surface of the windshield glass (03100) with a wax pencil.

2. If the clear vinyl wafer remained on the windshield glass, apply low heat (heat gun) until the wafer softens. Peel the vinyl wafer from the windshield glass taking care not to scratch or mar the windshield glass surface.

3. Thoroughly clean inside of the windshield glass with mild abrasive cleaning powder and clean cloth saturated in alcohol to remove old adhesive. Then, use a paper towel and remove all cleaner from the windshield glass. Do not contaminate clean area. Roughen the bonding surface of the inside rear view mirror bracket with fine grit sandpaper. Then, wipe the surface clean with a paper towel soaked in alcohol. Do not contaminate cleaned bracket.

4. If vinyl wafer is still adhered to theinside rear view mirror bracket, use low heat (heat gun) until the wafer softens and peel it off.

5. Use fine sandpaper on inside rear view mirror bracket to lightly scuff the surface. Wipe clean with alcohol-moistened cloth.

6. **CAUTION: Do not touch the mounting surfaces.**

   Using the applicator, apply a generous amount of Rearview Mirror Adhesive D9AZ-19554-CA or equivalent meeting Ford specification ESB-M2G176-A to the bonding surface of the inside rear view mirror bracket and the windshield glass. Allow the adhesive material to dry for three minutes.

7. Apply two drops of Rearview Mirror Adhesive D9AZ-19554-CA or equivalent meeting Ford specification ESB-M2G176-A to the mounting surface of the inside rear view mirror bracket. Using a clean toothpick or wooden match, quickly spread the adhesive evenly over the mounting surface of the inside rear view mirror bracket.

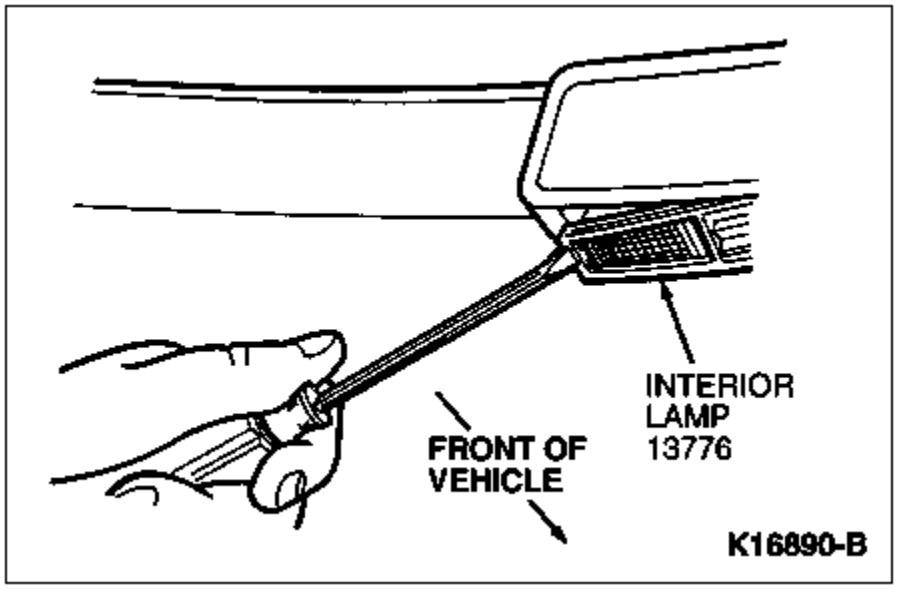
8. Quickly position the inside rear view mirror bracket on the windshield glass, using the locator marked on the outside of the windshield glass. The 9.525mm (3/8-inch) circular depression in the inside rear view mirror bracket must be down and toward the inside of the passenger compartment. Press the inside rear view mirror bracket against the windshield glass for about one minute.

9. Allow the adhesive to set for five minutes. Then remove any excess adhesive material from the windshield glass with an alcohol-dampened rag.

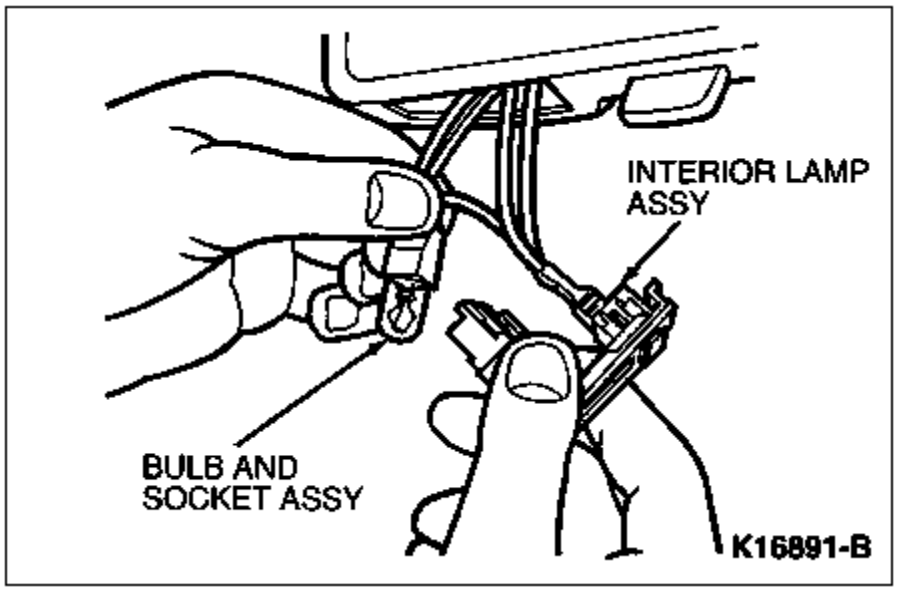
Bulb, Mirror Lamp

Removal and Installation

1. Carefully pry interior lamp (13776) out of bottom of inside rear view mirror (17700).



2. Disengage miniature bulb (13465) and socket assembly from interior lamp.
3. Replace miniature bulb (13466).
4. To install, reverse removal procedure.


INTERIOR LAMP ASSY
BULB AND SOCKET ASSY
K16891-B

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-In
Electronic Day/Night Inside Mirror Setscrew, Aerostar	1-2	9-18
Power Outside Rearview Mirror Attaching Nuts, Aerostar	8-10	71-89
Power Outside Rearview Mirror Attaching Nuts, Ranger	6-8	53-71

SPECIAL SERVICE TOOLS/EQUIPMENT

SPECIAL SERVICE TOOLS REQUIRED

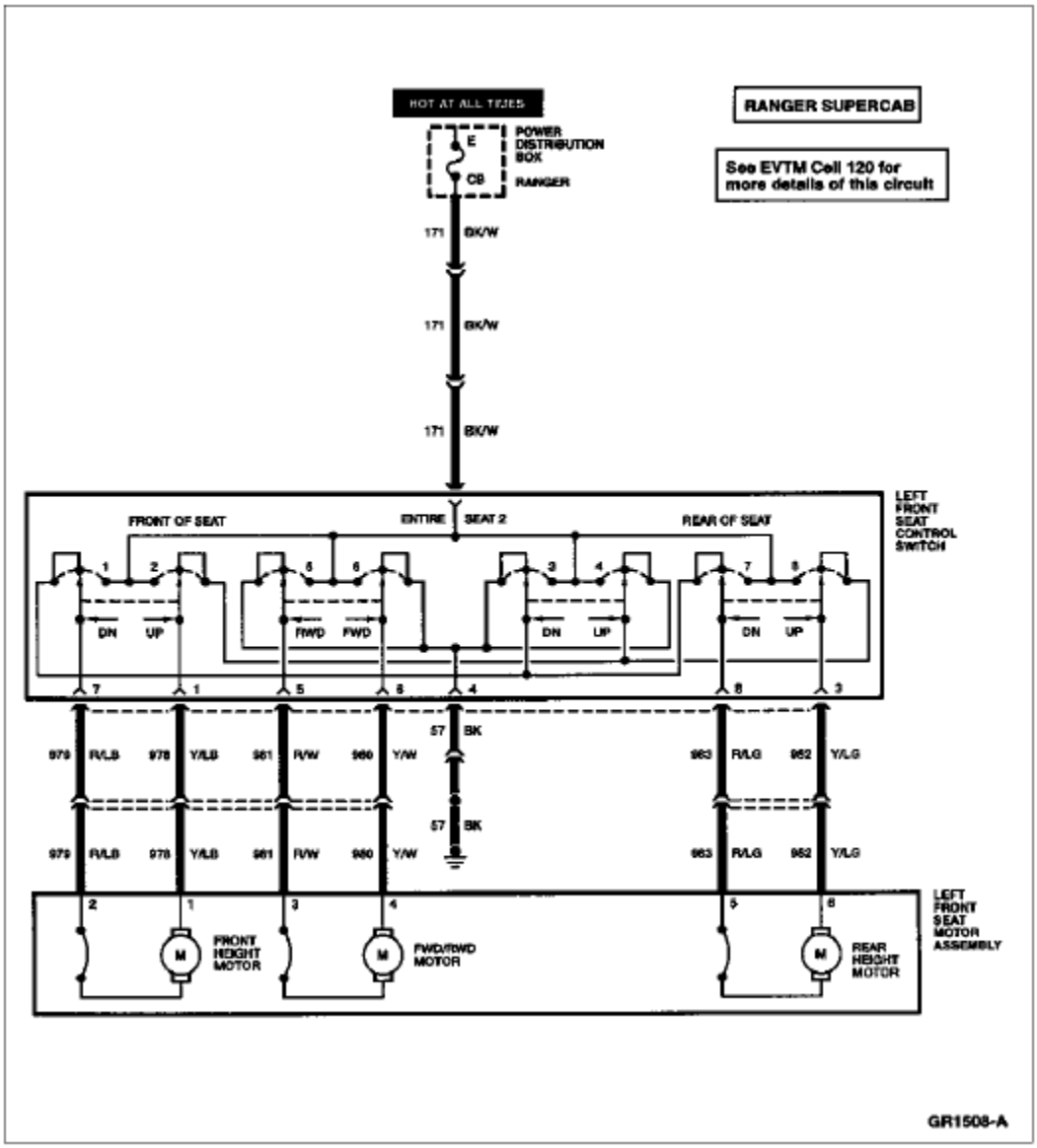
Tool Number/ Description	Illustration
T91T-17700-A Rearview Mirror Remover	

ROTUNDA EQUIPMENT

Model	Description
105-R0051	73 Digital Multimeter

Electrical Schematics

Power Six-Way Seat, Ranger



Lumbar Support

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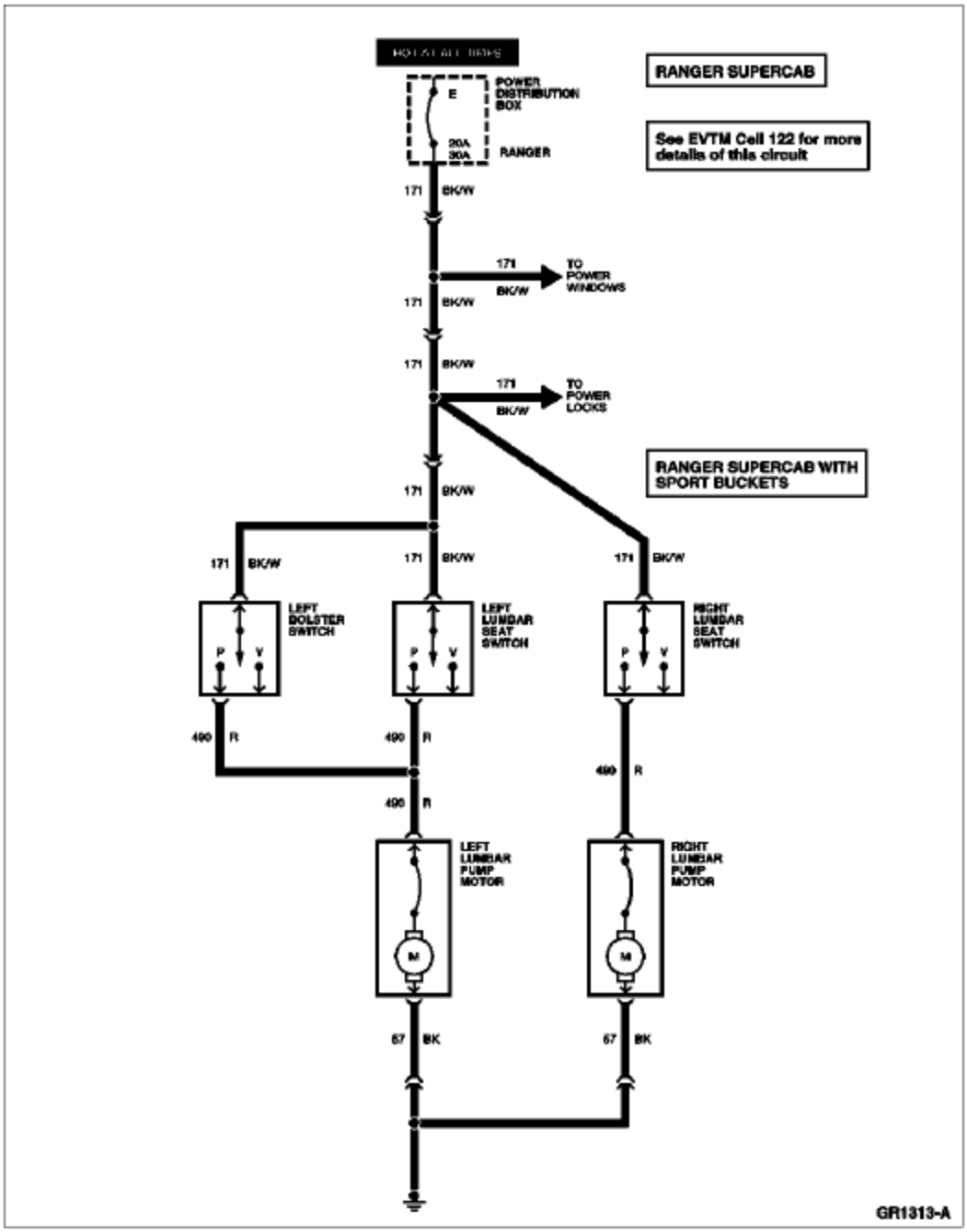

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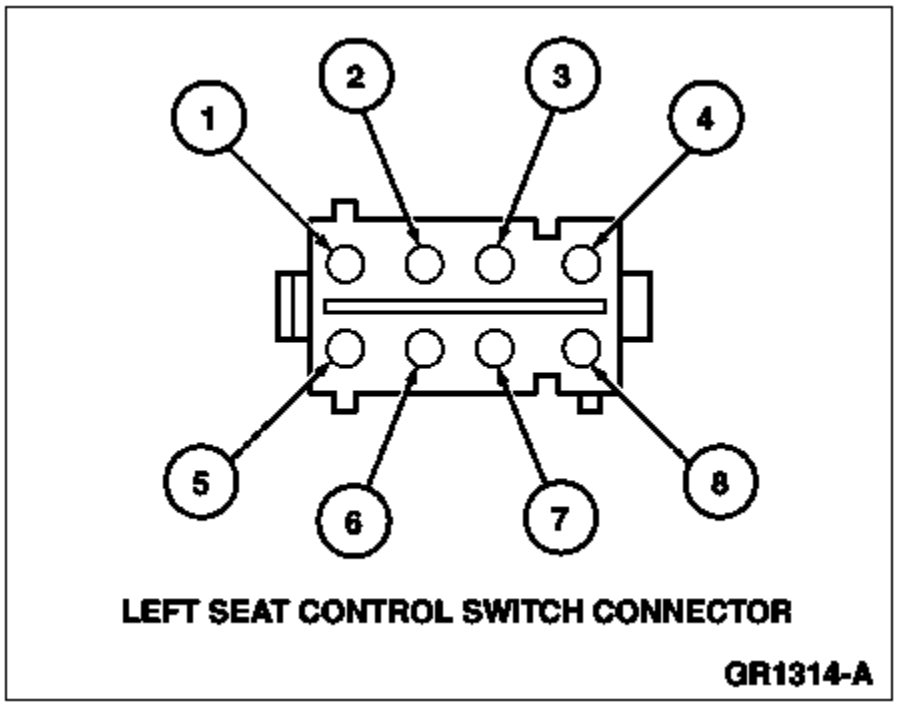

Pin Number	Circuit	Circuit Function
1	978 (Y/LB)	Seat Regulator Switch to Front Motor (LH)
2	171 (BK/W)	Circuit Breaker to Seat Latch Relay
3	982 (Y/LG)	Seat Regulator Switch to Rear Motor (LH)
4	57 (BK)	Ground Circuit
5	981 (R/W)	Seat Regulator Switch to Horizontal Motor (LH)
6	980 (Y/W)	Seat Regulator Switch to Horizontal Motor (LH)
7	979 (R/LB)	Seat Regulator Switch to Front Motor (LH)
8	983 (R/LG)	Seat Regulator Switch to Rear Motor (LH)

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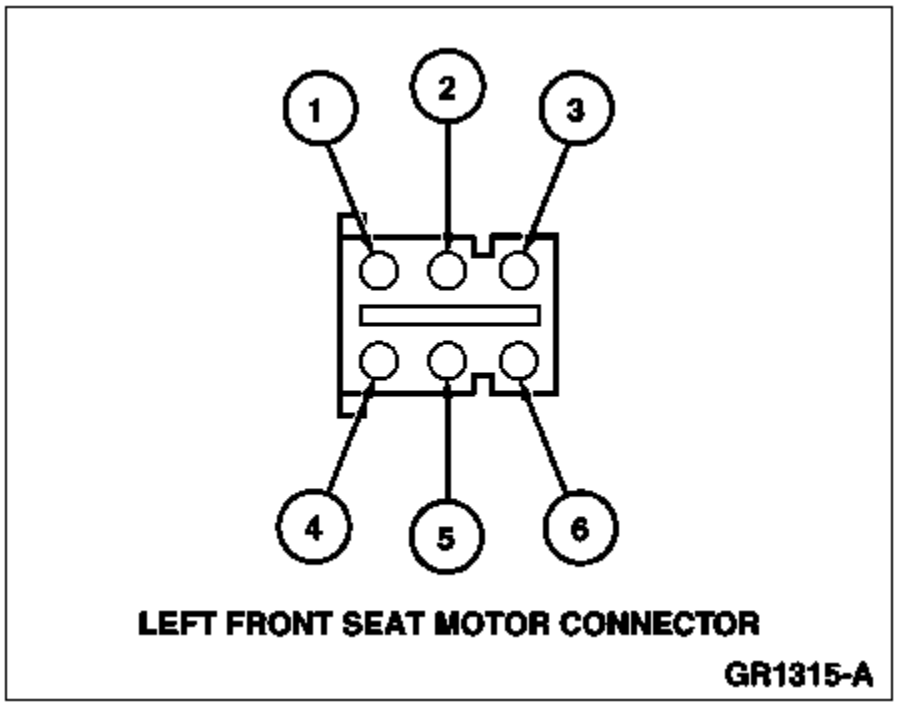

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4	980 (Y/W)	Seat Regulator Switch to Horizontal Motor (LH)
5	983 (R/LG)	Seat Regulator Switch to Rear Motor (LH)
6	982 (Y/LG)	Seat Regulator Switch to Rear Motor (LH)

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Inspection and Verification

1. Verify the vehicle owner's original concern by operating the power seat(s) to duplicate the vehicle owner's concern.

2. Inspect to determine if one of the following mechanical or electrical concerns apply:

VISUAL INSPECTION CHART

Mechanical	Electrical
• Seat tracks obstructed	• Open high current fuse 5 located in the power distribution box
• Seat at limit(s) of travel	
• Damaged front seat back pad adjusting hose	• Loose, corroded or damaged connectors
• Damaged seat regulator control switch • Damaged seat regulator motor	

3. If the concern(s) remains after the inspection, determine the symptom(s) and proceed to the following symptom chart.

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Symptom Chart — Power Seat Diagnosis

NOTE: Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent to perform electrical pinpoint tests.

POWER SEAT DIAGNOSIS

Condition	Possible Source	Action
• Power Seat Moves, Noisy Operation	• Dirty tracks. • Damaged seat regulator motor.	• CLEAN tracks. • REPLACE seat regulator motor. • GO to Pinpoint Test A .
• Power Seat Moves But Is Loose	• Loose attaching hardware. • Worn or damaged tracks.	• TIGHTEN attaching hardware. • REPLACE track unit. • GO to Pinpoint Test B .
• Power Seat Does Not Make Full Travel	• Obstructed track. • Wiring harness. • Motor(s). • Seat switch. • Ground(s).	• REMOVE obstruction. • GO to Pinpoint Test C .
• Power Seat Track Does Not Move Horizontally and/or Vertically	• Harness. • Seat switch. • Motor. • Grounds.	• GO to Pinpoint Test D .
• Power Seat Switch Does Not Function Properly	• Motor. • Circuit.	• GO to Pinpoint Test E .
• Front Seat Back Pad Adjusting Pump Inoperative	• Fuse burned out. • Loose electrical connections. • Worn or damaged motor. • Worn or damaged seat back control	• REPLACE fuse. If fuse blows again, CHECK for short circuit. • SECURE connections at front seat back pad adjusting pump, seat back control switch and floor harness. • REPLACE motor. • REPLACE front seat back control switch.

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	switch.	
• Front Seat Back Pad Adjuster Only Partially Inflates	• Loose air line connections.	• SECURE all connections as necessary.
	• Cuts in front seat back pad adjusting hoses or tubes.	• SERVICE or REPLACE as necessary.
	• Kinked front seat back pad adjusting hoses or tubes.	• ROUTE front seat back pad adjusting hoses or tubes as necessary.
	• Worn or damaged seat back control switch.	• REPLACE seat back control switch.
	• Worn or damaged front seat back pad adjuster.	• REPLACE bolster support bag.
	• Worn or damaged front seat back pad adjusting pump.	• REPLACE pump.
	• Air lines reversed at seat back control switch.	• REVERSE air lines at switch.
• Front Seat Back Pad Adjuster Will Not Maintain Inflated Position	• Improper tube/front seat back pad adjusting hose connections.	• Properly CONNECT all front seat back pad adjusting hoses.
	• Worn or damaged seat back control switch.	• REPLACE seat back control switch.
	• Worn or damaged front seat back pad adjuster.	• REPLACE front seat back pad adjuster.
• Seat Back Control Switch Inflates Lumbar	• Air lines reversed.	• REVERSE air lines where connected at front seat back.
• Front Seat Back Pad Adjuster Inflates but Does Not Deflate	• Worn or damaged seat back control switch.	• REPLACE seat back control switch.
	• Worn or missing front seat back pad adjuster return springs.	• REPLACE return springs.
		• Worn or damaged mechanism to front seat back pad adjuster.
		• REPLACE mechanism to front seat back pad adjuster.
	• Kinked air hoses or tubes.	• ROUTE front seat back pad adjusting hoses or tubes as necessary.

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• Front Seat Back Pad AdjusterDetaches from Front Seat Back	• Front seat back pad adjuster stops damaged.	• REPLACE mechanism.

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Pinpoint Tests

PINPOINT TEST INDEX

Symptom	Test
Power Seat Moves, Noisy Operation	A
Power Seat Moves but Is Loose	B
Power Seat Does Not Make Full Travel	C
Power Seat Track Does Not Move Horizontally and/or Vertically	D
Seat Regulator Control Switch Does Not Function Properly	E

PINPOINT TEST A: POWER SEAT MOVES, NOISY OPERATION

A1 CHECK FRONT SEAT OPERATION

- Operate power seat and listen for noise.

Is power seat noisy?

Yes	No
REPAIR or REPLACE front seat track assembly as required.	Power seat OK.

PINPOINT TEST B: POWER SEAT MOVES BUT IS LOOSE

B1 CHECK FRONT SEAT OPERATION

- Operate power seat and check for looseness.

Is power seat loose?

Yes	No
RETIGHTEN all attachment hardware. GO to **B2** .	Power seat OK.

B2 CHECK FOR CORRECTED CONDITION

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- Check if loose condition has been corrected.

Is loose seat condition corrected?

Yes	No
Power seat OK.	REPLACE front seat track.

PINPOINT TEST C: POWER SEAT DOES NOT MAKE FULL TRAVEL

C1 CHECK SEAT TRAVEL

- Operate power seat and verify that front seat does not make full travel.

Does seat make full travel?

Yes	No
Power seat OK.	GO to C2 .

C2 FRONT SEAT TRACK OBSTRUCTION

- Check for an obstruction in front seat track mechanism.

Is obstruction present?

Yes	No
REMOVE obstruction. REPEAT Step C1 .	REPAIR or REPLACE track assembly as required.

PINPOINT TEST D: POWER SEAT TRACK DOES NOT MOVE HORIZONTALLY/VERTICALLY

D1 CHECK FRONT SEAT OPERATION

- Operate power seat and verify condition.

Does power seat operate?

Yes	No
Power seat OK.	GO to D2 .

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D2 CHECK CABLE DEFLECTION

- Check power seat track drive cables for deflection when the seat control switch is activated.

Do cables deflect?

Yes	No
REPAIR or REPLACE front seat track as required.	GO to **D3** .

D3 POWER CHECK

- Check fuse. Disconnect seat motor leads from harness. Check for voltage at power seat harness when seat control switch is activated.

Is voltage present at power seat harness?

Yes	No
REMOVE and REPLACE front seat track. REPEAT Step **D1** .	GO to **D4** .

D4 CHECK SEAT REGULATOR MOTOR GROUND CONNECTIONS

- Check power seat motor for tight ground connections.

Are ground connections OK?

Yes	No
CHECK for damaged connectors, shorts or open circuit. SERVICE as necessary. GO to Pinpoint Test E .	TIGHTEN ground connection. REPEAT Step **D1** .

PINPOINT TEST E: SEAT REGULATOR CONTROL SWITCH DOES NOT FUNCTION PROPERLY

E1 CHECK VEHICLE

Are you troubleshooting the left seat control switch?

Yes	No
GO to **E2** .	System OK.

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E2 CHECK LEFT SEAT CONTROL SWITCH

- Disconnect seat motor connector and seat control switch connector.
- Using a Rotunda 73 Digital Multimeter 105-R0051 or equivalent check continuity between Pin 2 of seat control switch and all other pins.

Is continuity present?

Yes	No
Internal short circuit. REPLACE seat control switch.	GO to **E3** .

E3 CHECK LEFT FRONT MOTOR UP

- Depress the front of seat button to the UP position.
- Check continuity between Pins 2, 7 and Pins 1, 4 of the seat control switch.

Is continuity present?

Yes	No
GO to **E4** .	Internal open circuit. REPLACE seat control switch.

E4 CHECK LEFT FRONT MOTOR DOWN

- Depress the front of seat button to the DOWN position.
- Check continuity between Pins 1, 2 and Pins 4, 7 of the seat control switch.

Is continuity present?

Yes	No
GO to **E5** .	Internal open circuit. REPLACE seat control switch.

E5 CHECK LEFT REAR MOTOR UP

- Depress the rear of seat button to the UP position.
- Check continuity between Pins 2, 8 and Pins 3, 4 of the seat control switch.

Is continuity present?

Yes	No
GO to **E6** .	Internal open circuit. REPLACE seat control switch.

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E6 CHECK LEFT REAR MOTOR DOWN

- Depress the rear of the seat button to the DOWN position.
- Check continuity between Pins 2, 3 and Pins 4, 8 of the seat control switch.

Is continuity present?

Yes	No
GO to **E7** .	Internal open circuit. REPLACE seat control switch.

E7 CHECK LEFT LEVEL UP

- Depress the entire seat button to the UP position.
- Check continuity between Pins 2, 7, 8 and Pins 1, 3, 4 of the seat control switch.

Is continuity present?

Yes	No
GO to **E8** .	Internal open circuit. REPLACE seat control switch.

E8 CHECK LEFT LEVEL DOWN

- Depress the entire seat button to the DOWN position.
- Check continuity between Pins 1, 2, 3 and Pins 4, 7, 8 of the seat control switch.

Is continuity present?

Yes	No
GO to **E9** .	Internal open circuit. REPLACE seat control switch.

E9 CHECK LEFT HORIZONTAL MOTOR FORWARD

- Depress the entire seat button to the FWD position.
- Check continuity between Pins 2, 5 and Pins 4, 6 of the seat control switch.

Is continuity present?

Yes	No
GO to **E10** .	Internal open circuit. REPLACE seat control switch.

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E10 CHECK LEFT HORIZONTAL MOTOR REVERSE

- Depress the entire seat button to the RWD position.
- Check continuity between Pins 2, 6 and Pins 4, 5 of the seat control switch.

Is continuity present?

Yes	No
Seat control switch checks OK.	Internal open circuit. REPLACE seat control switch.

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Component Test

Folding Bench Seats with Inertia Latch Assemblies, Ranger

In the event the front seat back latch (62648) does not pass the functional check, the entire front seat back latch must be replaced. Service of the components is not acceptable and should not be attempted.

1. With the seat installed in the vehicle, push down and hold the adjuster handle. Tilt the front seat back latch forward until it is in a vertical position.

2. Grasp the front seat back (64811) and bounce it against its rear stop while holding the adjuster handle (62622) down (the front seat back will bounce forward from the stop, momentarily engaging the front seat back latch, and then return to its normal rearward position).

3. **NOTE: The following check verifies that the front seat back latch pawl (62606) is free to move and lock-up (for folding seat backs with inertia latch assemblies).**

   Hold the front seat back and jerk it forward as soon as it contacts and bounces from the rear stop. The front seat back will now be restricted from tilting full forward.

4. With the front seat cushion and with the front seat back latch removed from the vehicle and supported in a horizontal position, the upper portion of the front seat back latch should be free to rotate and not be engaged by the lower portion.

5. Rotate the front seat cushion with the front seat back latch forward 37 degrees from the horizontal, and rotate the movable portion of the front seat back latch up into the latched position.

6. The movable portion must engage the lower fixed portion of the front seat back latch and remain engaged.

Latch Sensitivity Test, Bench Seat with Inertia Latch

In the event the above checks cannot be satisfactorily performed, the following sensitivity test must be made prior to replacing suspect latch assemblies.

NOTE: For bench seat applications, remove the inboard safety belt attachments.

1. Remove the front seat (60012) and front seat track (61705) from the vehicle.

2. With the front seat and front seat track, positioned on a flat surface, slowly tilt the front seat forward enough to cause the front seat back to tilt forward (through gravity).

3. The front seat back latch should engage at this point (11 degrees from original front seat back position), restricting the front seat back from tilting to its full forward position.

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Seat, Driver, Front, Aerostar

Removal and Installation

1. Remove screw attaching front seat track (61705) to floor insulator.
2. Remove the three front seat-to-floor support attaching bolts and one seat belt bolt.
3. Remove the front seat (60012) from vehicle.
4. Position the front seat upside down on a clean bench.
5. Remove four nuts attaching seat support-to-front seat track. Remove seat support from front seat.
6. To remove the front seat track to floor insulator, disconnect the front set track latch tie rod from both front seat tracks.
7. Remove four attaching screws. Remove both front seat tracks from the front seat.

For installation, follow removal procedures in reverse order.

- Tighten screws that hold front seat track to floor insulator to front seat cushion frame (60326) 15-20 Nm (11-15 lb-ft).
- Tighten nuts attaching seat support to front seat track to 19-26 Nm (14-19 lb-ft).
- Tighten bolts attaching front seat to floor support to 19-26 Nm (14-19 lb-ft).

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Seat, Passenger, Front, Aerostar

Removal and Installation

1. Remove screw attaching front seat track (61705) to floor insulator.
2. Remove the three bolts attaching front seat to floor support and one seat belt bolt.
3. Remove the front seat (60012) from vehicle.
4. Position the front seat upside down on a clean bench.
5. Remove four bolts attaching seat support to front seat cushion frame attaching bolts. Remove the seat support from front seat.

For installation, follow removal procedures in reverse order.

- Tighten bolts attaching seat support to front seat cushion frame (60326) to 19-26 Nm (14-19 lb-ft).

Driver and Passenger Seat, Aerostar

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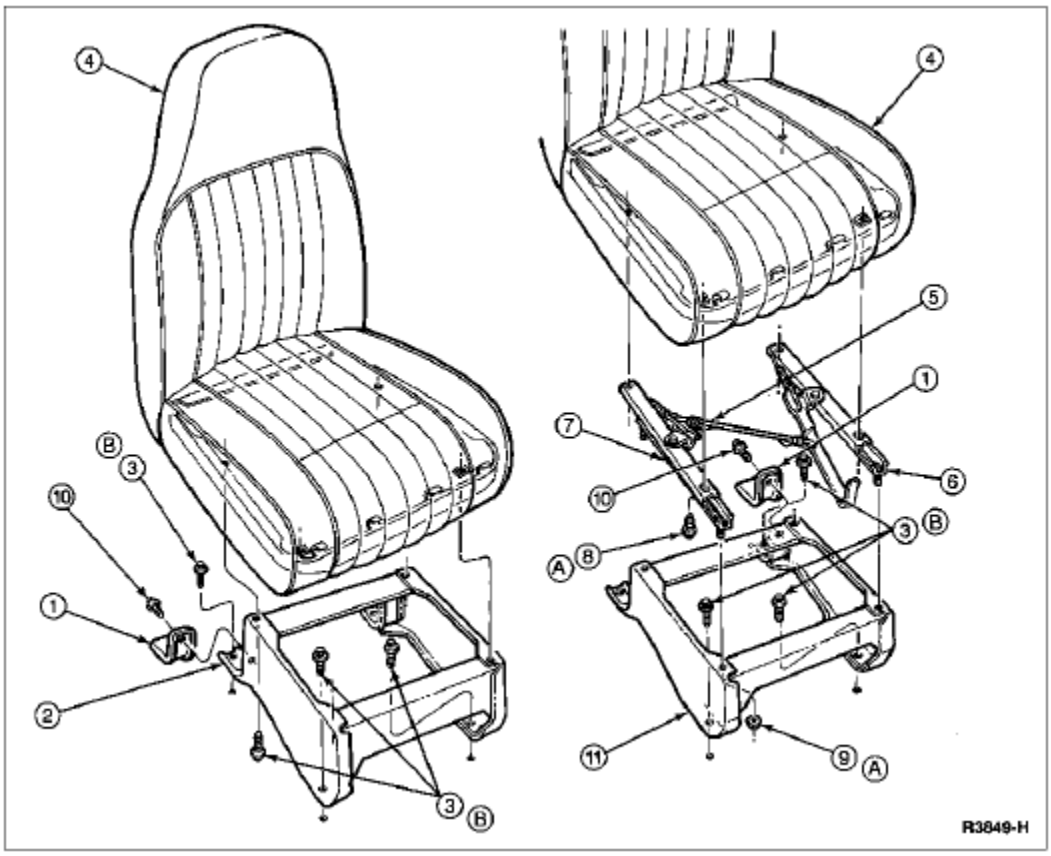

Item	Part Number	Description
1	161899	Insulator
2	162506	Support Assembly, Passenger Seat
3	N806528-S58	Screw
4	60012	Front Seat
5	61726	Front Seat Track Latch Tie Rod
6	61705	Front Seat Track
7	161704	Track Assembly, Front Seat, RH Side
8	N803263-S58	Screw
9	N800251-S2	Nut and Washer
10	381801-S58	Screw
11	60094	Support Assembly, Driver Seat
A	—	Tighten to 15-20 Nm (11-15 Lb-Ft)
B	—	Tighten to 19-26 Nm (14-19 Lb-Ft)

Captain's Chairs, Aerostar

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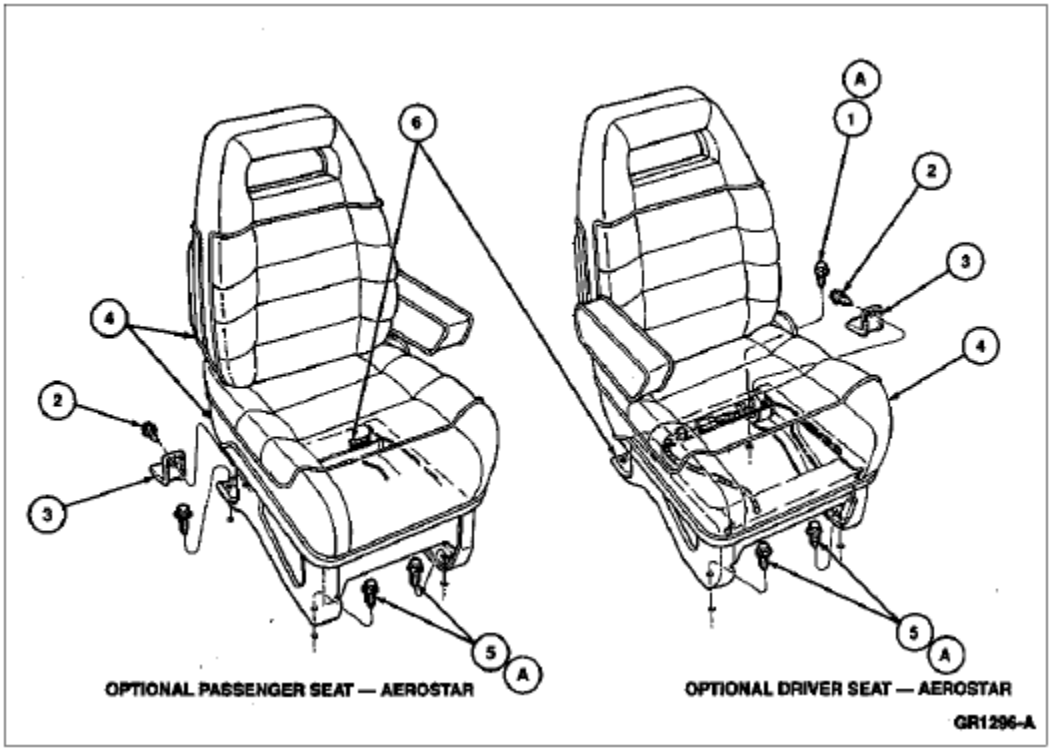

Item	Part Number	Description
1	N803263-S58	Screw
2	2381801-S58	Screw
3	161899	Insulator
4	63100	Front Seat Cushion Frame and Spring
5	N806528-S58	Screw
6	386273-S100	Bolt, Seat Belt
A	—	Tighten to 19-26 Nm (14-19 Lb-Ft)

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Seats, Rear Bucket, Aerostar

WARNING: KEEP FLOOR ATTACHING PLATE AREA FREE OF FOREIGN OBJECTS THAT WOULD PREVENT FRONT AND REAR FLOOR HOOKS FROM ENGAGING PROPERLY. NEVER ATTEMPT TO ADJUST THE SEAT LATCH WHILE THE VEHICLE IS IN MOTION. PRIOR TO OCCUPYING THE SEAT, CHECK TO SEE THAT THE HOOK END OF THE J-ROD HOOKS AND HANDLES ARE LATCHED SECURELY IN POSITION TO ENSURE PROPER SEAT RETENTION.

Removal and Installation

1. On left-hand seat, disengage the lap/shoulder seat belt from the seat by inserting a key or small screwdriver into the slot in the detachable anchor and lifting upward. Stow the tongue end of the detachable anchor as shown.

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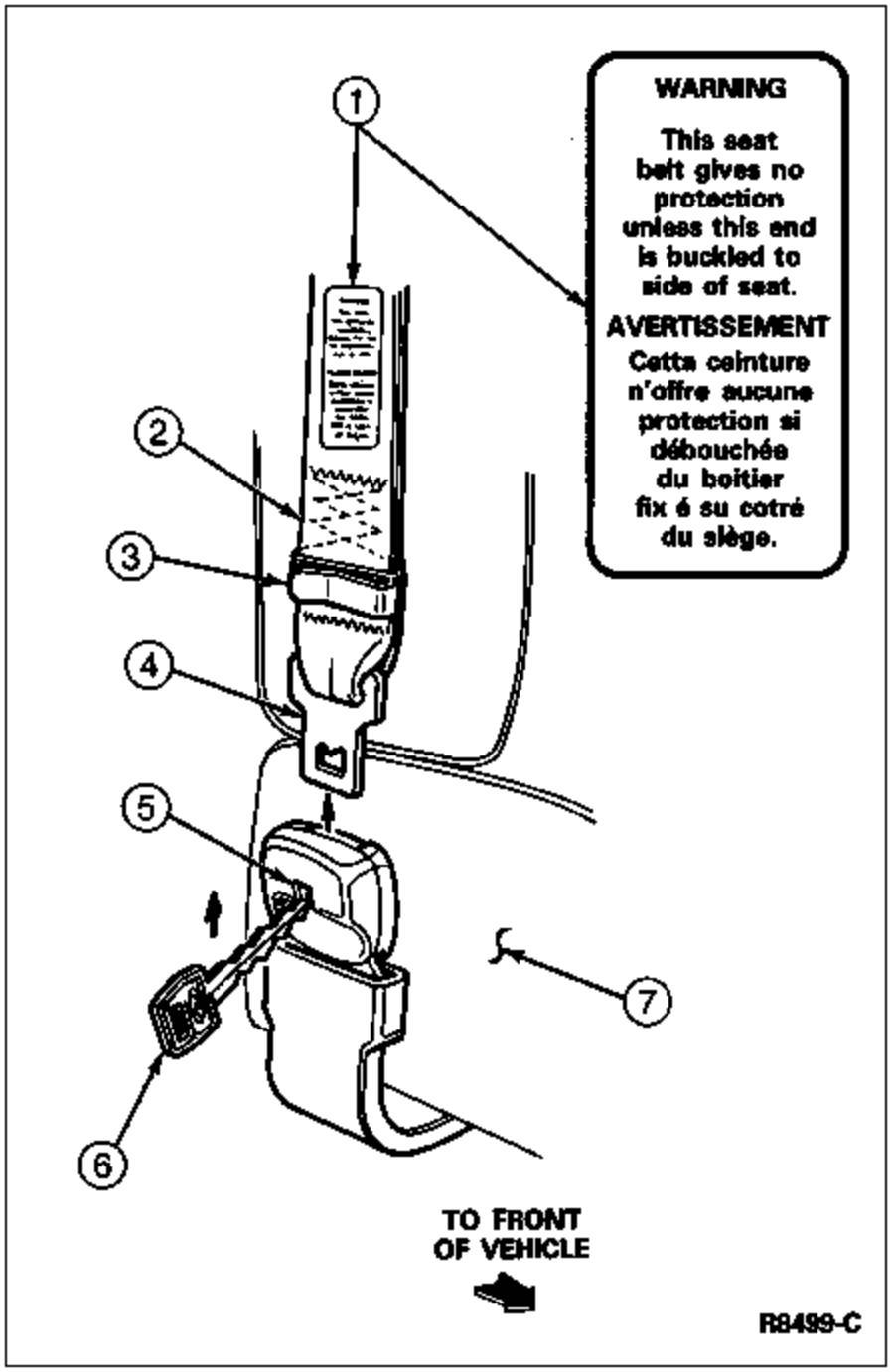

Item	Part Number	Description
1	—	Detachable Anchor Warning Label on Safety Belt
2	—	Rear Safety Belt (Detached Position)
3	—	Shoulder Safety Belt Stowage Retainer
4	—	Tongue End of Detachable Anchor
5	—	Slot in Detachable Anchor
6	—	Key or Small Screwdriver

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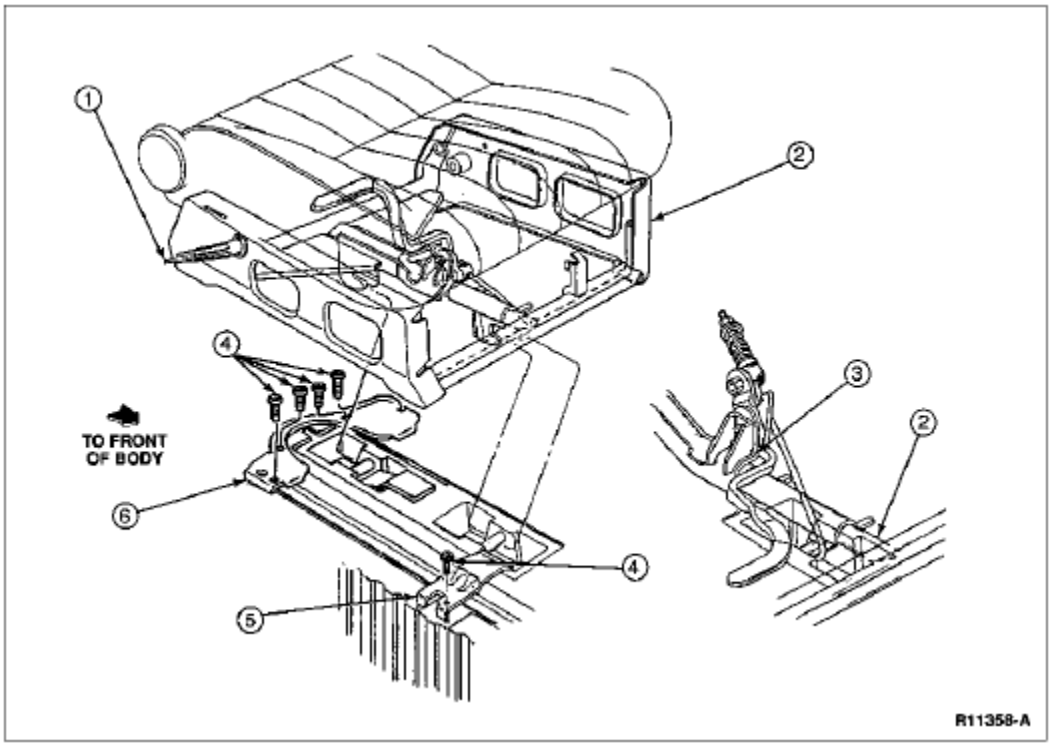
7	—	Rear Seat Cushion Frame

2. Lift and rotate the rear seat back latch handle (62418) rearward, causing the J-hook to disengage from the front floor well retainer.
3. Push seat rearward to disengage front and rear floor hooks.
4. Remove the seat assembly from the vehicle.

For installation follow removal procedure in reverse order. Continue rotation of rear seat back latch handle until it comes to a complete stop on the top of the tube. This causes the seat assembly to slide forward engaging the front and rear floor hooks with the floor well retainers.

Rear Bucket Seat, Aerostar



Item	Part Number	Description
1	624B22	EZ Access Handle
2	160026	Rear Bucket Seat Assembly
3	624B20-B	Upper Latch Kit
4	381801	Screw
5	625A64	Seat Support Reinforcement
6	625A90	Reinforcement

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Seats, Rear Two- and Three-Passenger Bench and Bed, Aerostar

Removal

1. Disengage the lap/shoulder seat belt from the seat by inserting a key or a small screwdriver into the slot in the detachable anchor and lifting upward. Stow the tongue end of the detachable anchor.
2. On bench seat, fold seat back forward and latch it in the down position.
3. Rotate the adjuster handles (located under seat near floor) upward simultaneously to disengage latch hooks from floor attachment.
4. Lift seat at rear and rotate about the forward attachment. When adjuster handles are clear of floor attachments, release the adjuster handles.
5. Pull the seat rearward to disengage it from the front floor pins.

Installation

CAUTION: Care should be taken when storing seats out of the vehicle so the latches are not damaged.

WARNING: WHEN REINSTALLING A REAR SEAT IN YOUR VEHICLE IT MUST BE PLACED IN ITS ORIGINAL POSITION. IMPROPER INSTALLATION OF THE SEAT WILL PREVENT CORRECT USE OF THE SAFETY BELTS AND COULD INCREASE THE RISK AND/OR SEVERITY OF INJURY IN AN ACCIDENT. REFER TO THE WARNING LABEL ON THE SAFETY BELT.

1. With the seat back in a folded and latched position (bench seat only), place the seat assembly in your vehicle and engage the front seat hooks onto the forward attachment pin in the floor wells.
2. Rotate the seat downward and engage the rear seat back latch handle (62418) into the rear floor attachment. Lifting of the adjuster handles is not required for installation.
3. Make sure that the adjuster handles are fully seated in the down position.
4. Before you engage the safety belt, be sure it is not twisted. Remove any twist, then insert the tongue end of the detachable anchor into the detachable anchor until you hear a "snap" and feel the latch engage.

Rear Safety Belt Assembly, Aerostar

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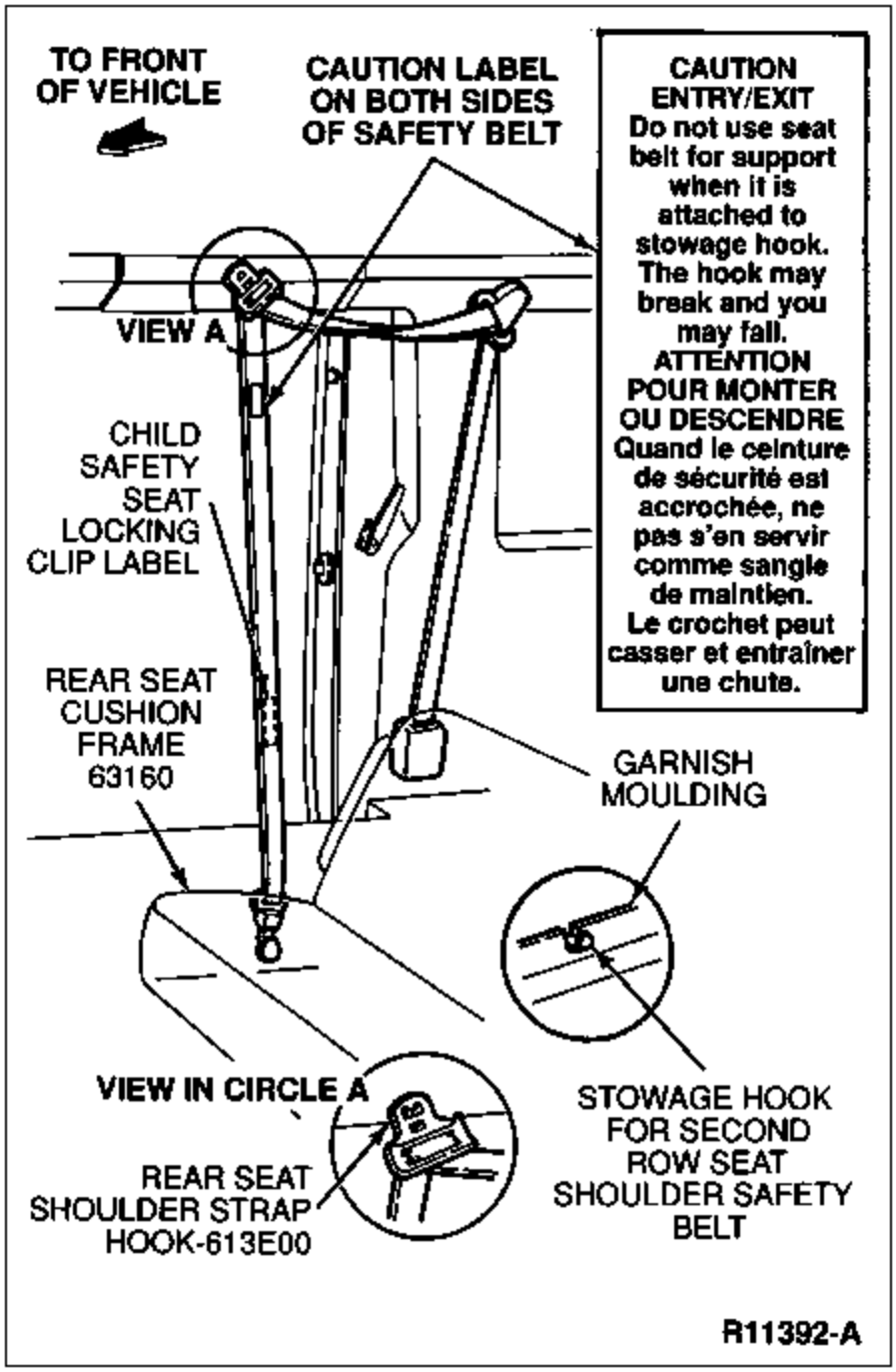

Rear Safety Belt Assembly, Three-Passenger, Aerostar

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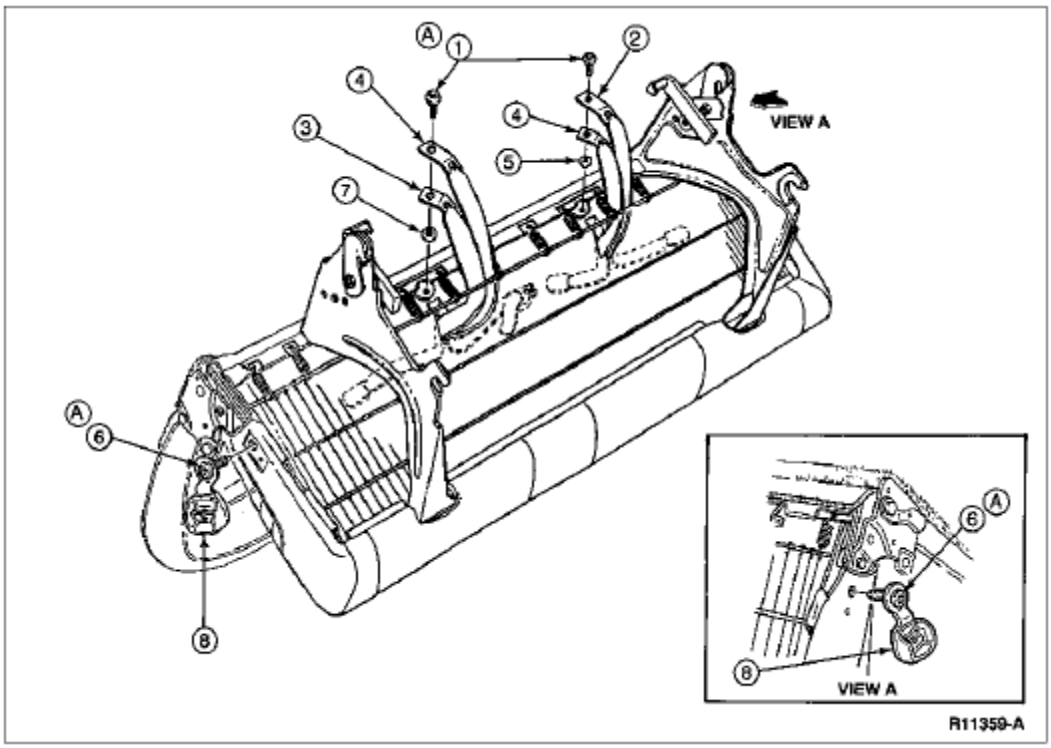

Item	Part Number	Description
1	386277	Bolt
2	613B84	Belt (LH)
3	613B85	Belt (RH)
4	611B66	Belt (Center)
5	354959-S	Washer
6	386276-S100	Bolt
7	388832	Washer
8	12601A90	Detachable Anchor
A	—	Tighten to 30-40 Nm (22-30 Lb-Ft)

Two- and Three-Passenger Seat Tracks, Aerostar

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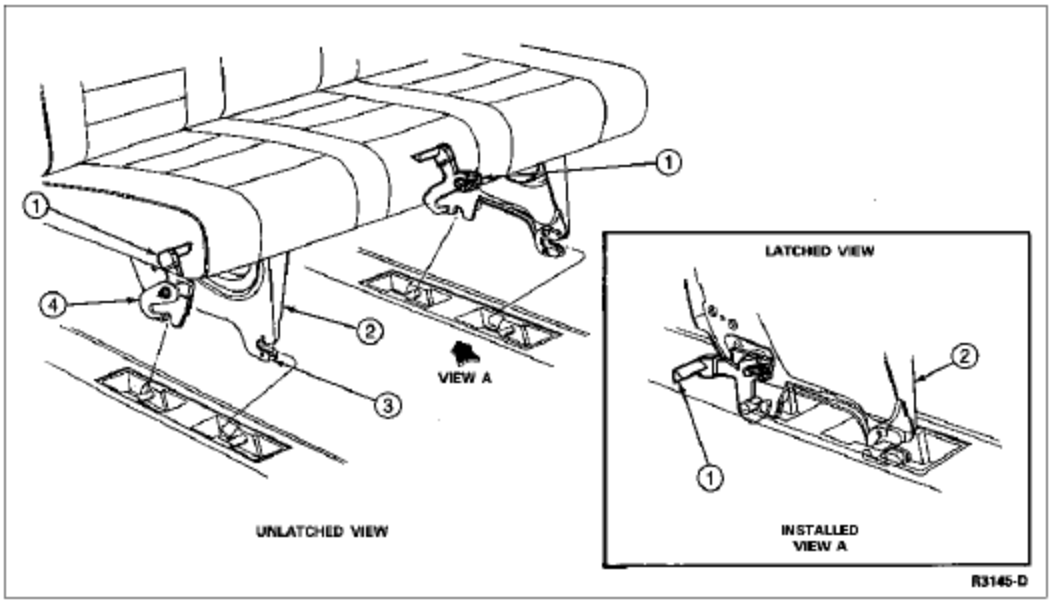

Item	Part Number	Description
1	62622	Front Seat Back Latch Handle (LH)
2	62526	Rear Bench Seat Support
3	—	Front Hook (Part of 62526)
4	624B18	J-Hook

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Folding Seat, Rear, Ranger SuperCab

Removal

1. Remove three screws retaining cover assembly to seat assembly.
2. Remove bolt retaining seat belt buckle assembly to floor.
3. Remove five screws retaining seat assembly to cab floor. Remove seat assembly.

For installation follow removal procedure in reverse order. Tighten seat belt buckle assembly bolt to 30-40 Nm (21-30 lb-ft).

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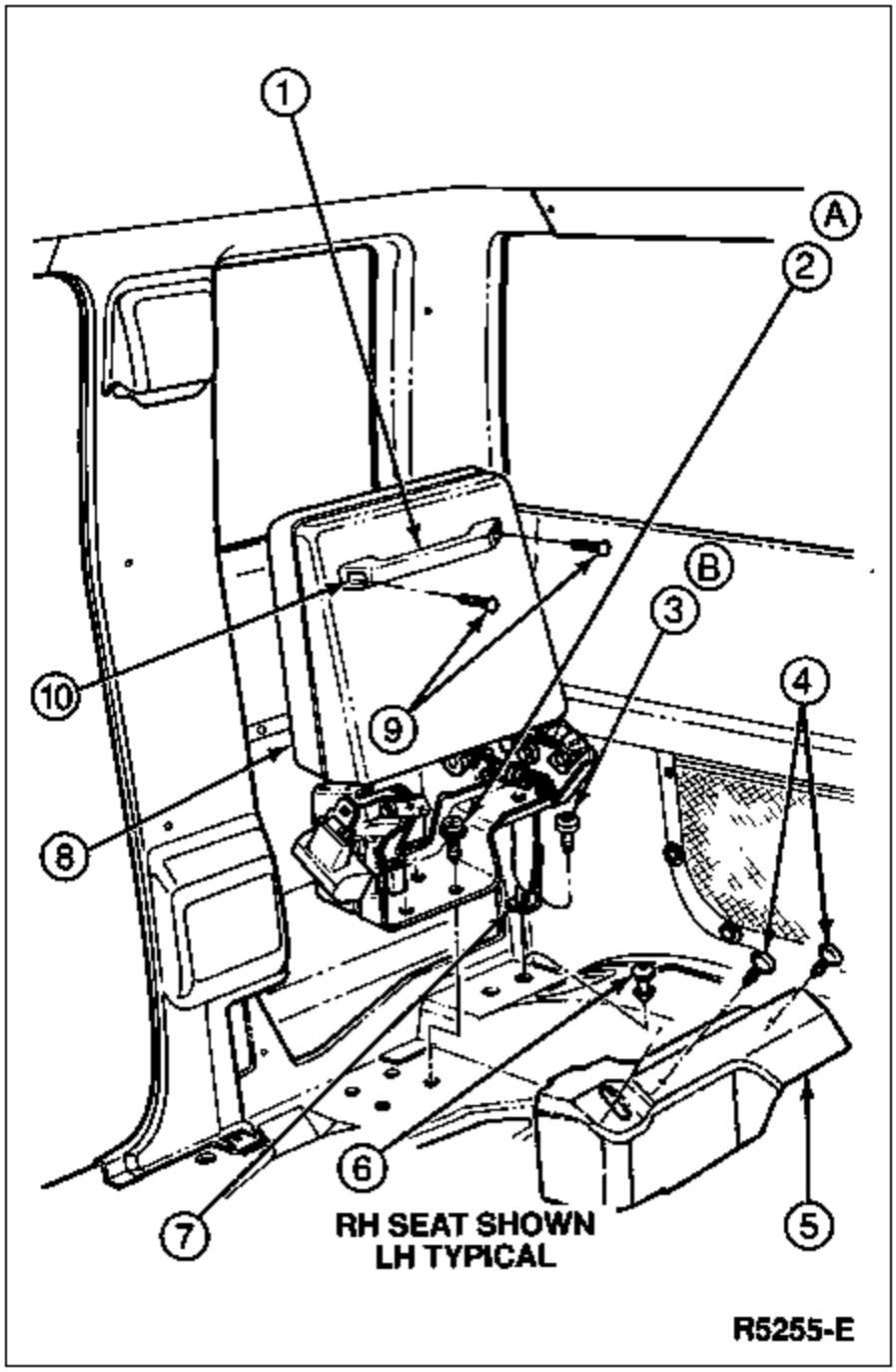

Item	Part Number	Description
1	31406	Seat Handle
2	81921-S2	Screw and Washer
3	3862272-S100	Bolt
4	388523-S	Plug Button (Restraint Hole Plug with Jump Seat Delete)
5	—	Cover (Part of 60026)

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6	N803867-S	Button (Used with Jump Seat Delete for Seat Bolt Holes)
7	613B84	Belt Assembly
8	60026	Seat Assembly
9	55885-S2	Screws (2 Req'd)
10	31458	Assist Handle Retainer Cover
A	—	Tighten to 19-25 Nm (14-18 Lb-Ft)
B	—	Tighten to 30-40 Nm (21-30 Lb-Ft)

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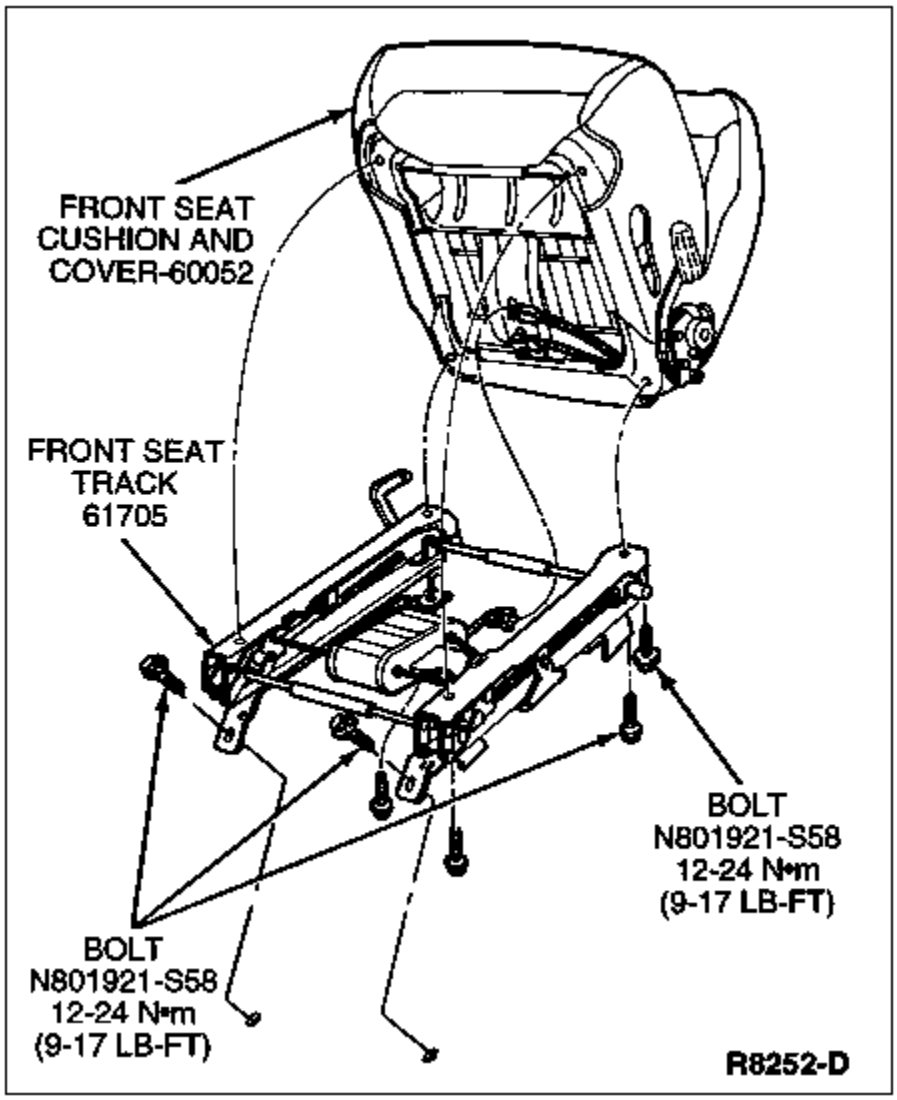
Seat Track, Power Six-Way, Ranger SuperCab

Removal

1. Remove heat shield covers to expose nuts from right rear of the front seat track (61705) by opening the locking tabs.
2. Position front seat track to full-up position.
3. Remove bolts retaining the front seat and front seat track to the floor.



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4. Remove plug to expose bolt securing slide bar to floorpan. Remove bolt and boot.

5. Disconnect the wire harness from under front seat cushion rear. Remove the front seat (60012) from the vehicle.

6. Place the front seat upside down on a clean bench.

Power Six-Way Seat Track and Frame

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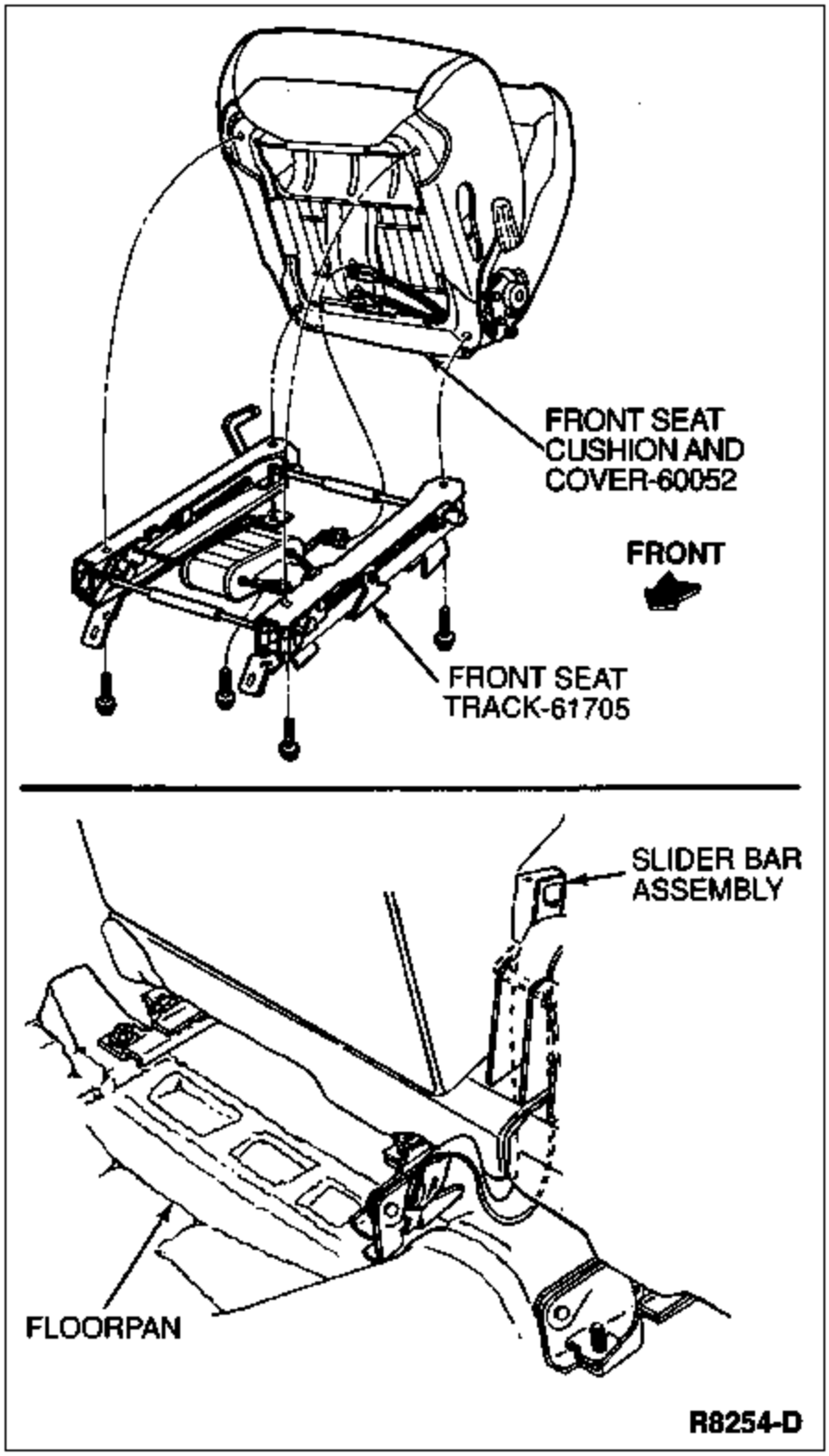

7. Remove bolt and nut attaching buckle slide bar to front seat track and remove slide bar and buckle assembly.

8. Disconnect the seat regulator motor (14547) from seat wiring harness.

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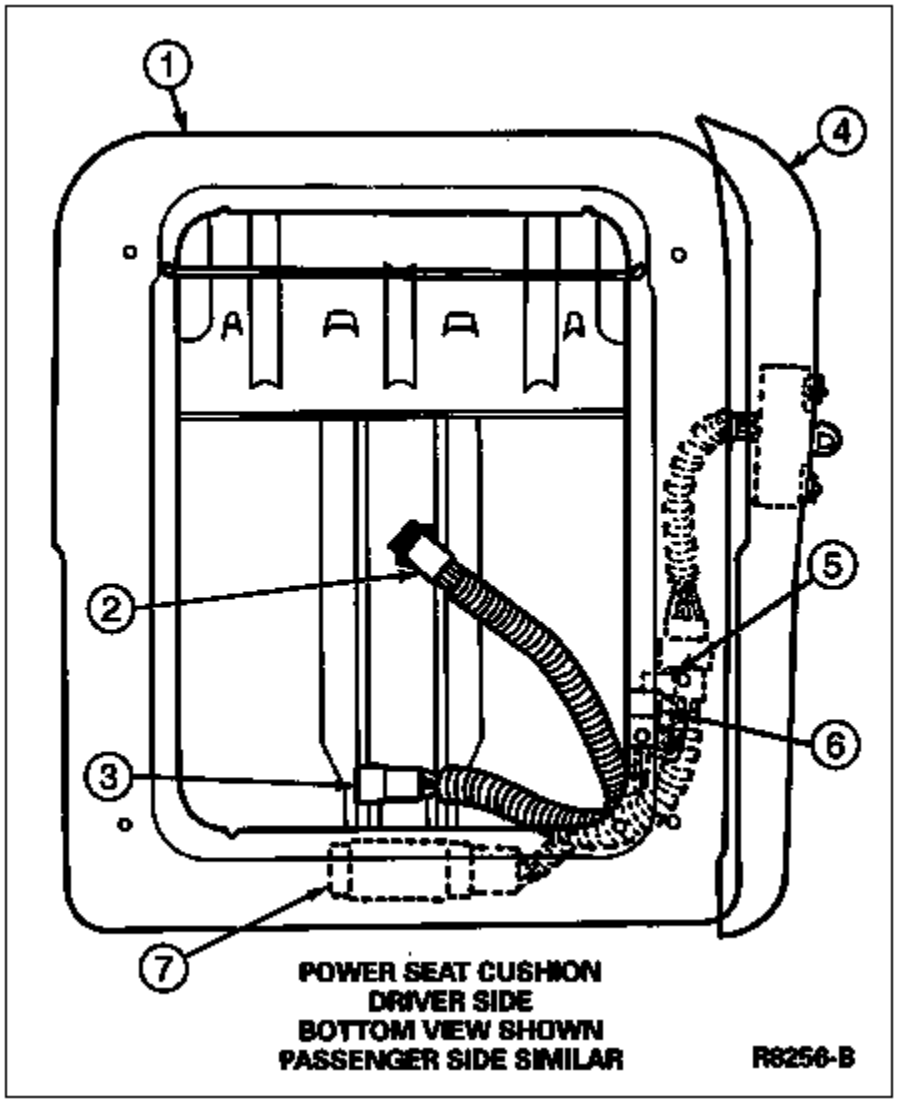

Item	Part Number	Description
1	63101	Seat Cushion Frame, Front
2	—	Wiring to Power Seat Motors (Part of 14C719)
3	—	Power Feed from Vehicle (No Connection) (Part of 14C719)
4	62187	Front Seat Cushion Side Shield
5	—	Wiring to Power Bolster Switch (Part of 14C715)
6	—	Wiring to Power Lumbar Switch (Part of 14C715)
7	65530	Front Seat Back Pad Adjusting Pump

9. Remove front seat cushion side shield (62186) from front seat back pad adjusting pump (65530) and disconnect front seat back pad adjusting hoses (65528) from seat back control switch.

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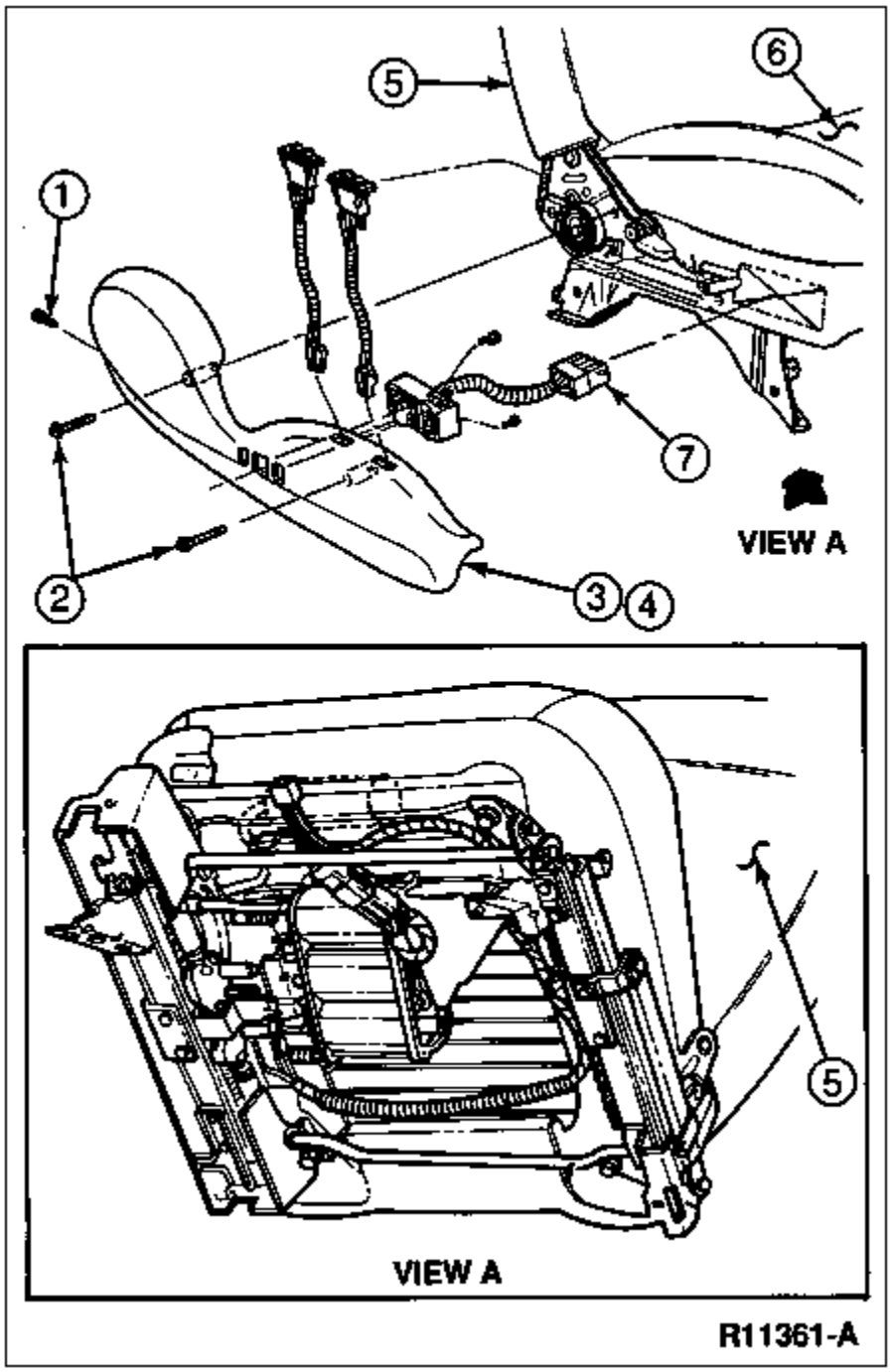
Side Shield Cover, Power Six-Way Seat



Item	Part Number	Description
1	56904-S2	Screw (1 Req'd)
2	383204-S2	Screw (2 Req'd)
3	62186	Front Seat Cushion Side Shield (RH)

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4	62187	Front Seat Cushion Side Shield (LH)
5	60136	Seat Back Cover and Pad
6	60052	Front Seat Cushion and Cover
7	14A701	Seat Regulator Switch Wiring (RH)

10. **CAUTION: Use care when handling front seat and front seat track. Dropping the assembly or sitting on front seat not secured in vehicle may result in damaged components.**

    Remove the four bolts retaining the front seat tracks to the front seat cushion frame and spring (63101). Remove the front seat track.

Installation

1. Position the front seat track to the front seat cushion frame and spring.
2. Secure the front seat track to the front seat cushion frame and spring using the four previously removed attaching bolts.Tighten the bolts to 17-23 Nm (12-17 lb-ft).
3. Secure inboard buckle and slide bar assembly to front seat track with previously removed bolt and nut.
4. Install seat regulator control switch (14A701) to front seat cushion side shield.
5. Reattach front seat back pad adjusting hoses to seat back control switch front seat cushion frame and spring.
6. Connect to seat wiring harness.

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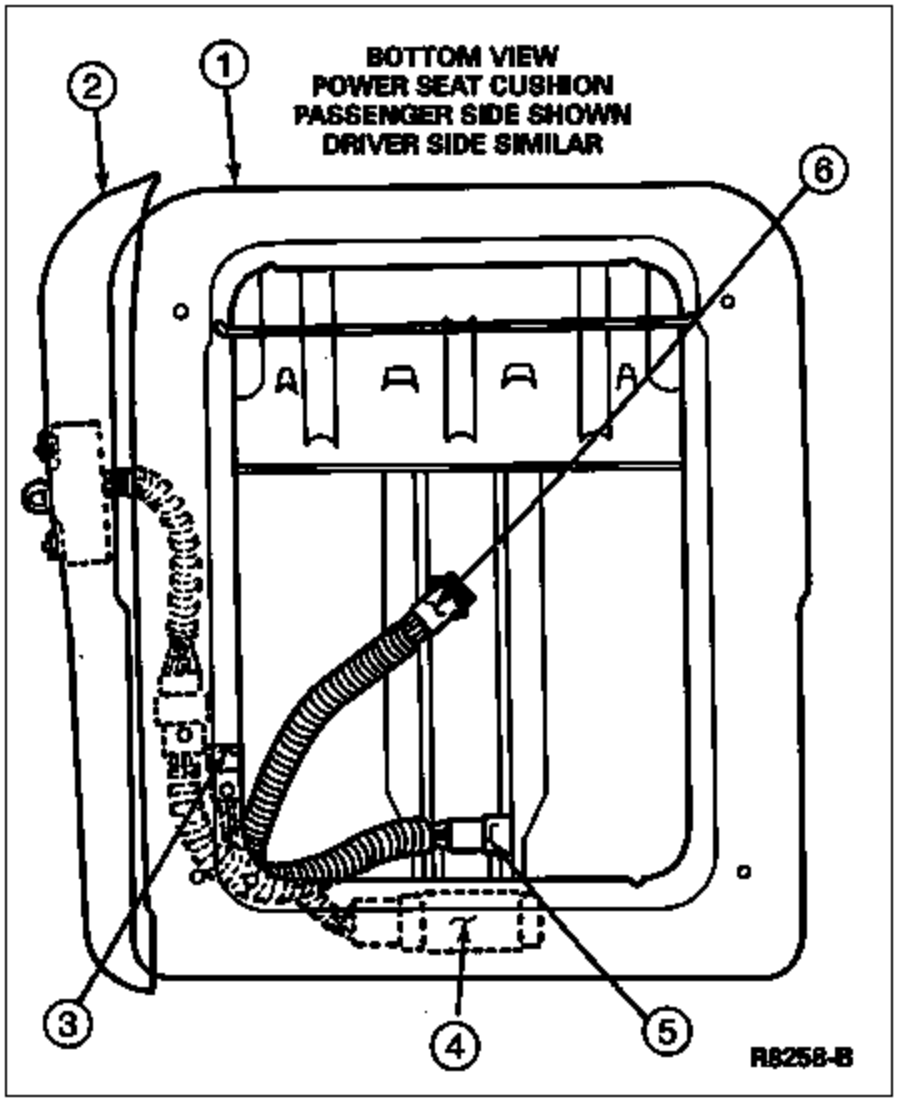

Item	Part Number	Description
1	63100	Seat Cushion Frame, Front
2	62186	Side Shield
3	—	Wiring to Power Lumbar Switch (Part of 14C719)
4	2875	Compressor
5	—	Power Feed from Vehicle (No Connection) (Part of 14C719)
6	—	Wiring to Power Seat Track Motors (Part of 14C719)

7. Install front seat cushion side shield to front seat cushion frame and spring using screws and fastener tab on cushion frame and side shield.

8. Position the front seat and front seat track in vehicle.

9. Connect wire harness.

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10. Install the seat track-to-floorpan front attaching bolts, then rear attaching bolts. Tighten the bolts to 19-26 Nm (14-19 lb-ft).
11. Install front seat cushion side shield.
12. Install boot to slide bar and secure slide bar to floorpan with bolt previously removed. Tighten to specification.
13. Install plug to slide bar boot.
14. Check front seat tracks for proper operation.

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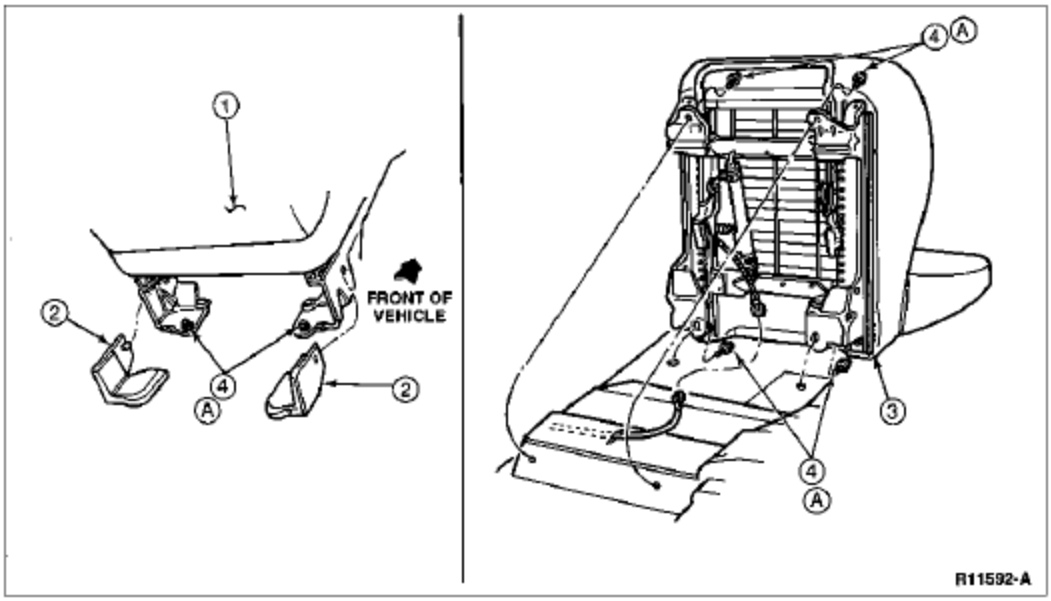
Support Assembly, Front Seat, Ranger SuperCab

Removal

1. Remove the two front bolts attaching the front seat to floor support (61708).
2. Lift the adjuster handle upward to tilt the front seat back latch forward, applying force at the lower central portion of the backrest. Push steadily forward.
3. Remove rear outboard shield to the front seat to floor support. Remove the rear outboard shield.

Seat, Tilt Slide, Ranger SuperCab



Item	Part Number	Description
1	63100	Front Seat Cushion and Frame
2	619C10/11	Front Seat Track to Floor Outer Insulator (RH)
	619C82/3	Front Seat Track to Floor Outer Insulator (LH)
3	62506	Front Seat Support
4	N801921-S58	Screw
A	—	Tighten to 19-25 Nm (14-18 Lb-Ft)

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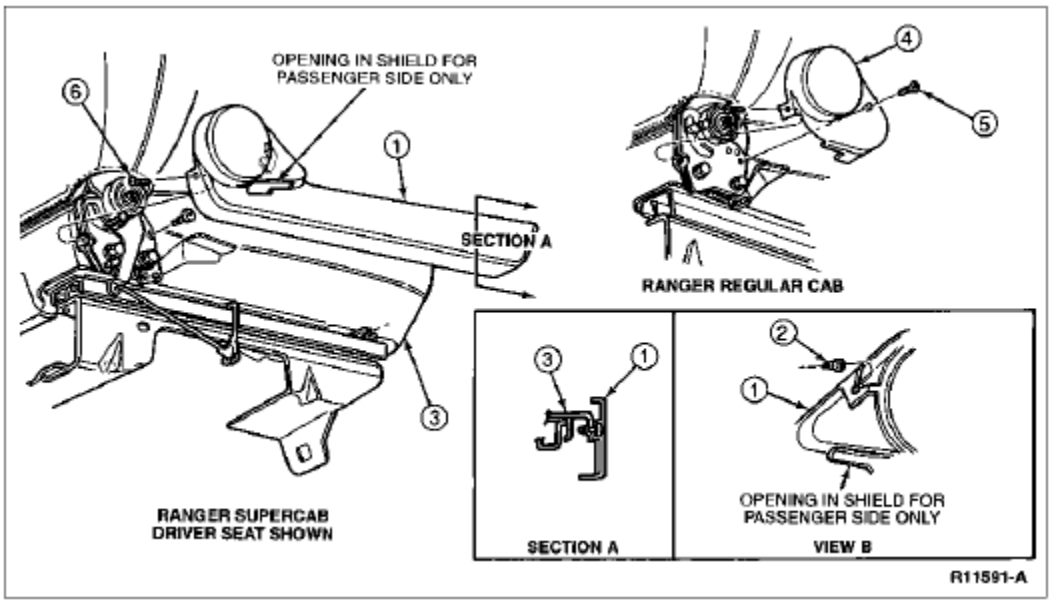
4. Remove one pushpin attaching the rear inboard shield to the front seat to floor support. Remove the rear inboard shield.
5. Remove the shoulder bolt attaching the slide bar to the support assembly bracket.
6. Remove the two rear bolts attaching the front seat to floor support.
7. Disconnect electrical connection for front seat back pad adjuster (65500), if so equipped.
8. Remove the front seat (60012) and front seat to floor support from the vehicle.
9. Unscrew the right rear screw on the back side of the seat side shield. Carefully pull the front edge of the side shield outward to remove the X-mas tree fastener, located behind the side shield. Once the right rear and front of the side shield is loose, pull the complete shield to the right rear to release the remaining hidden fastener.
10. Place front seat upside down on a clean bench.
11. Remove the front two screws attaching the front seat cushion frame and spring to the front seat to floor support.
12. Locating and holding the front seat firmly, push rear support forward until the latch clicks.
13. Rotate the rear clip attaching the rod-to-recliner mechanism downward.
14. Rotate (clockwise) the front clip attaching the rod to the front seat to floor support.
15. Remove the rod from the front seat to floor support and the front seat back latch (62648).

Front Seat, Ranger



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Item	Part Number	Description
1	62186	Shield Assembly, Front Seat Track, Upper (RH) (Ranger SuperCab)
2	N808578-S424	Screw
3	60012	Front Seat
4	62768	Cover, Front Seat Back Latch Cover (Ranger Regular Cab Only)
5	51764-S58	Screw
6	51764-S58	Screw

16. Remove the two rear screws attaching the front seat cushion frame and spring (63101) to the front seat to floor support.

Installation

NOTE: First install front inboard bolt attaching seat to floorpan. Then, install front outboard bolt. Next install rear inboard bolt, and finally install rear outboard. Always use this sequence when installing seats.

1. Place support on front seat. Make sure all latches are locked. Insert the two rear screws attaching the front seat to floor support to the seat cushion. Tighten to 17-23 Nm (13-17 lb-ft).

2. Insert one end of rod into the plastic clip. Rotate clip counterclockwise to lock rod in position. Insert other end of rod into recliner plastic clip. Rotate clip to lock rod. With right hand, activate recliner to dump front seat back latch forward.

3. Push the support fully rearward. Insert the two front screws attaching the front seat cushion frame and spring to the front seat to floor support. Tighten to 17-23 Nm (13-17 lb-ft).

4. Clip the side shield over the recliner shoulder bolt, and push the front edge of the shield X-mas tree fastener into the track mounting hole. Align back side of shield and install previously removed screw.

5. Place the front seat and front seat to floor support in the vehicle.

6. Install the two rear bolts attaching the front seat to floor support. Tighten to 17-23 Nm (13-17 lb-ft).

7. Push the seat cushion rearward until the latch clicks. Install two front bolts attaching the front seat to floor support. Tighten to 17-23 Nm (13-17 lb-ft).

8. Install shoulder bolt attaching the slide bar to support assembly bracket. Lift the recliner handle upward to tilt the front seat back latch forward. Applying force at the lower central portion of the front seat back latch, push steadily all the way.

9. Tighten the two rear seat screws to 17-23 Nm (13-17 lb-ft).

10. Install the rear inboard seat track shield in position. Install rear outboard seat track shield.

11. Push the front seat back latch rearward until the latch clicks.

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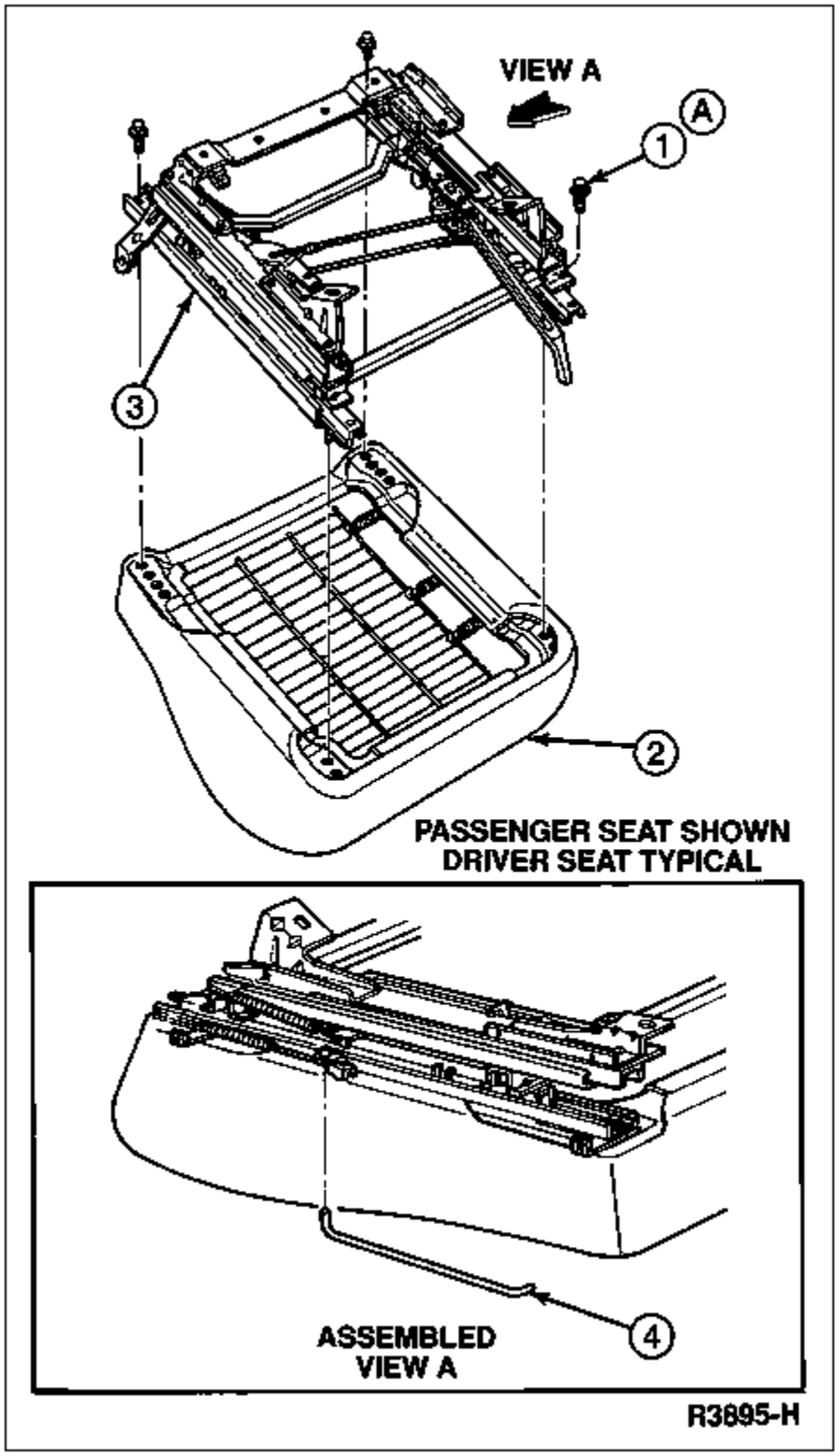
Seat Support Assembly, Ranger SuperCab



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Item	Part Number	Description
1	N801078-S2	Screw (4 Req'd)
2	60052	Front Seat Cushion and Cover
3	62506	Passenger Seat Support Assembly
4	617C72	Front Seat Adjuster Rod
A	—	Tighten to 17-23 Nm (13-17 Lb-Ft)

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Seat Track, Tilt and Slide

Removal and Installation

1. Remove seat from vehicle as described in this section.
2. Position seat upside down on a clean surface.
3. Remove screws attaching tilt slide track to seat cushion frame.
4. Separate tilt slide track from seat cushion frame.

For installation, follow removal procedure in reverse order. Tighten screws to 17-23 Nm (12-17 lb-ft).

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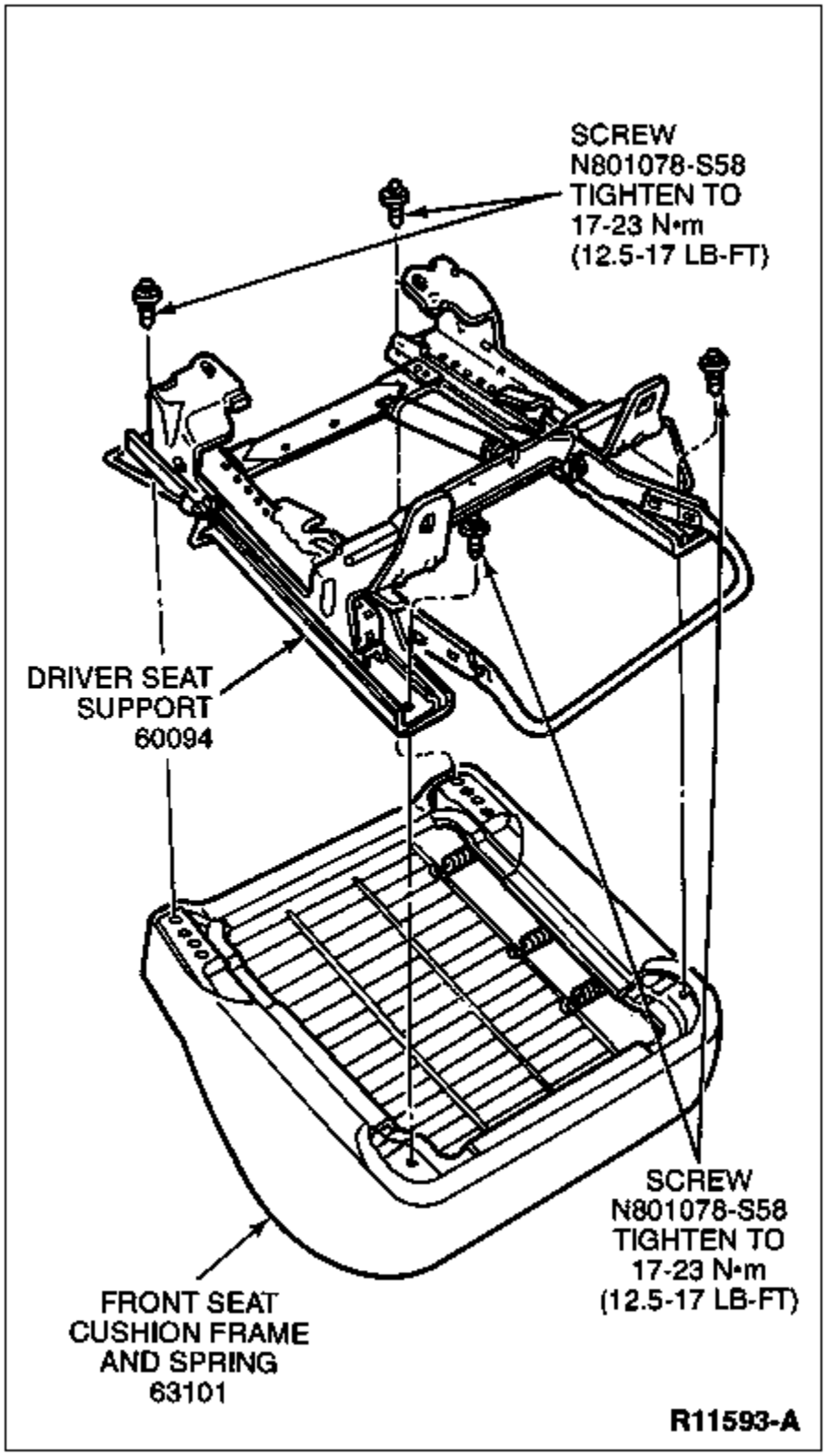

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Motor and Drive Assembly

Power seat motors are not serviceable. If the power seat motor is defective, the entire power seat track must be replaced.

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Storage Bin, Underseat, Aerostar

Removal and Installation

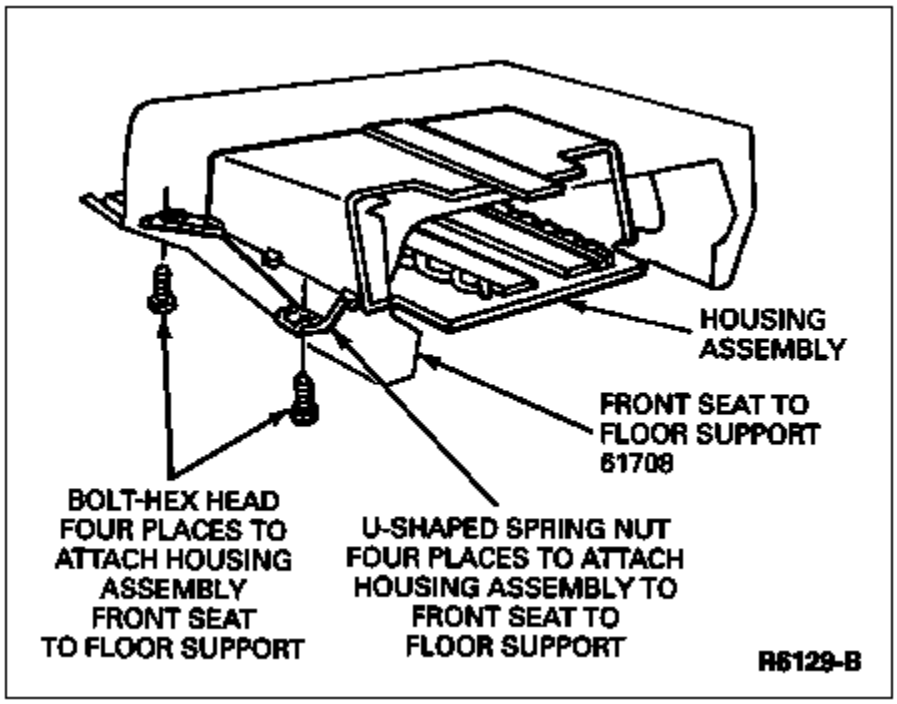
1. The passenger front seat to floor support must be removed to gain access to the storage bin housing assembly attaching bolts. To remove the passenger seat support assembly refer to Removal and Installation, Seat, Passenger, Front, Aerostar in this section.

2. **NOTE: Four U-shaped spring nuts are used to attach the storage bin housing bolts to the front seat to floor support.**

   Position the front seat (60012) and front seat to floor support (61708) on a bench with the bottom of the support facing up and remove the four bolts that attach the storage bin housing to the front seat to floor support.

3. Remove the storage bin housing from the front seat to floor support.

For installation, follow removal procedures in reverse order.



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Switch, Seat Control, Six-Way Power, Ranger SuperCab

Removal and Installation

1. Remove seat from vehicle as described in this section.
2. Remove side shield attachment.
3. Place seat assembly upside down on a clean table and remove two screws, located behind the shield, attaching the shield to the cushion frame.
4. Remove two screws securing seat control switch.
5. Disconnect the wiring to seat control switch.

For installation, follow removal steps in reverse order.

Seat Regulator Control Switch, Ranger SuperCab

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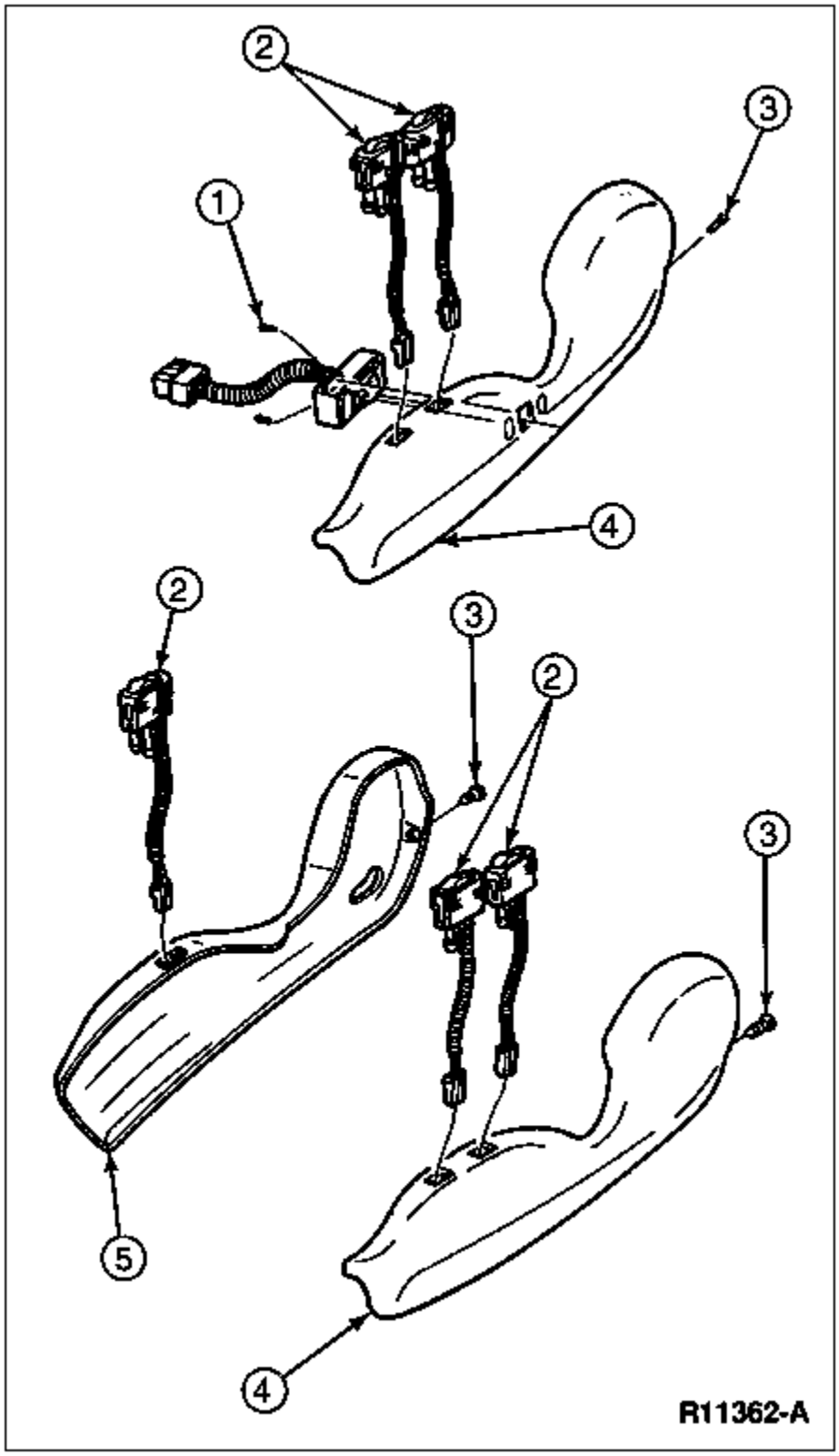

Item	Part Number	Description
1	—	Screw (Part of 14B722)
2	14B722	Pneumatic Control/Switch

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3	51764	Screw
4	62187	Front Seat Cushion Side Shield (LH)
5	62186	Front Seat Cushion Side Shield (RH)

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Lumbar Support Pad, Aerostar

Manual

Removal

1. Remove the front seat (60012) and front seat track (61705) from the vehicle. Refer to Removal and Installation Seat, Bucket in this section. Place front seat on a clean surface.
2. Remove front seat cushion and cover (60052) and disconnect front seat back pad adjusting cable.
3. Remove the front seat back cover and pad from the front seat back frame (61018).
4. Using a screwdriver or similar tool, pry the two lumbar support pad retaining hooks outward and lift the retainer wire from lower attachment holes. Remove the pad from the front seat back frame.

Installation

1. Position the front seat cushion pad to the front seat back frame and install the retaining hooks into the frame assembly.
2. Install the front seat cushion pad and front seat back cover.
3. Install the front seat cushion and cover and connect the front seat back pad adjusting cable. Tighten the inboard pivot screw to 19-27 Nm (15-19 lb-ft). Tighten the two outboard retaining screws to 44-60 Nm (33-44 lb-ft).
4. If the front seat is equipped with an inertia seat back latch, check the latch for proper operation (sensitivity test) before installing the seat as follows:
5. Install the front seat and front seat track.
6. Check the front seat tracks and safety belts for proper operation.

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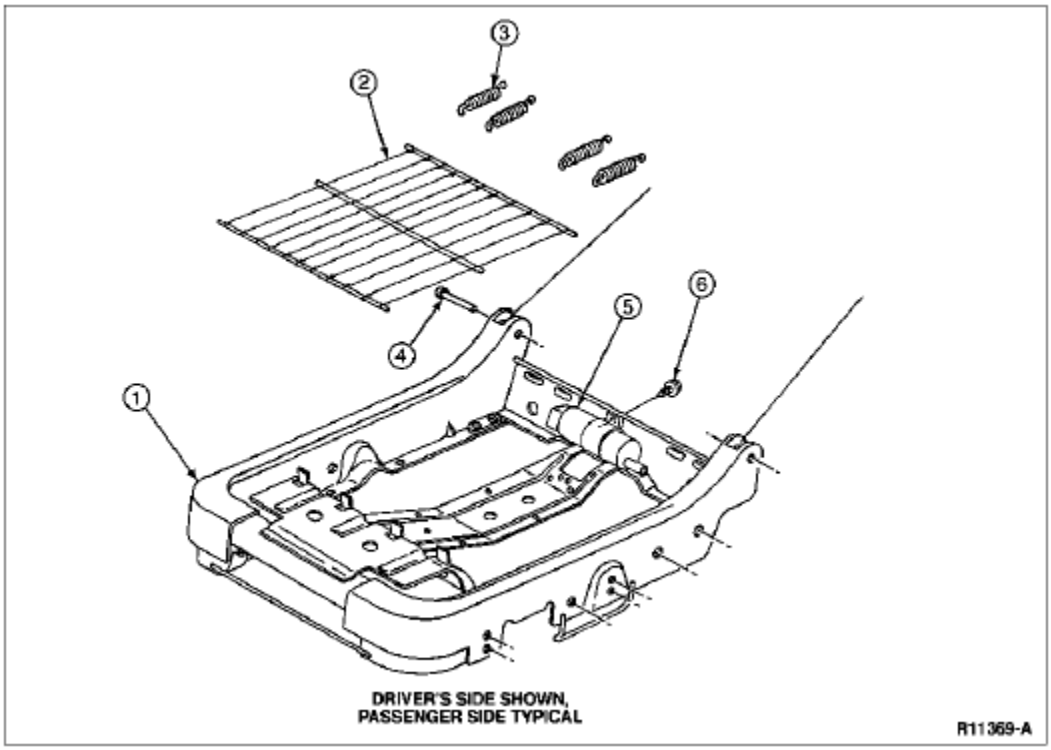
Pump, Front Seat Back Pad Adjusting

Removal and Installation

1. Remove seat support bolt insulator and front seat (60012) from vehicle.
2. Remove front seat to floor supports (61708) from front seat cushion cover, if so equipped.
3. Remove front seat cushion and cover (60052) as necessary to gain access to front seat back pad adjusting pump (65530) mounting screws.
4. Remove mounting screws, disconnect front seat back pad adjusting hose (65528) and seat back control wiring and remove front seat back pad adjusting pump.

For installation, follow removal procedures in reverse order. Tighten all mounting bolts to specifications. Check front seat to floor supports, if equipped, for proper operation.

Front Seat Back Pad Adjusting Pump, Ranger



Item	Part Number	Description
1	63101	Frame Assembly (LH)
2	—	Support Assembly (Part of 63101)

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3	—	Spring Coil (Part of 63101)
4	—	Pin, Spring (Part of 63101)
5	65500	Front Seat Back Pad Adjuster
6	—	Screw, Pan Head (Part of 63101)

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Seats and Tracks

Unless otherwise noted, the disassembly and assembly illustrations shown in this section are typical of all seats. If some of the steps do not apply to the particular vehicle being serviced, proceed to the next step and review the appropriate illustration shown.

Seat trim replacement requires removal and installation of seat components such as seat support bolt insulators, tracks and floor supports, and seat belts.

For safety belt removal and installation procedures, refer to Section 01-20A .

NOTE: Repairs to seat cushions or seat backs are performed out of the vehicle and are usually limited to replacement of torn or burned seat covers. In a few instances, the pads may be damaged and require replacement.

When installing new seats or cushions and covers, refer to the applicable illustration for the location of listing wires, hog rings, anti-squeak pads, and seat pad stack-up.

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Seat, Bench, Cushion Cover, Front

Disassembly and Assembly

1. Remove the front seat track (61705) from the vehicle.
2. Remove front seat back head restraint. Refer to Removal and Installation, Head Restraints, Front Seat Back in this section.
3. Remove the front seat back (64811) from the front seat cushion frame and spring (63101).
4. Cut the hog rings and/or disengage plastic retainers, and/or disengage hook-loop retaining the front seat cushion and cover to the front seat cushion frame and spring and remove the cover.
5. If the front seat cushion pad is being replaced, cut the hog rings that attach the front seat cushion pad to the front seat cushion frame and spring (63100). Remove the padding.
6. Position the new front seat cushion pad to the front seat cushion frame and spring and fasten it in place with hog rings.
7. Transfer the listing wires to the new front seat cushion frame and spring.
8. Position the front seat cushion frame and spring over the front seat cushion frame and spring. Fasten the front seat cushion frame and spring with hog rings and/or plastic retainers, and/or hook and loop.
9. Install the front seat back to the front seat cushion frame and spring.
10. Install the front seat (60012) and front seat track into the vehicle. Tighten the attaching screws and washers to specifications.

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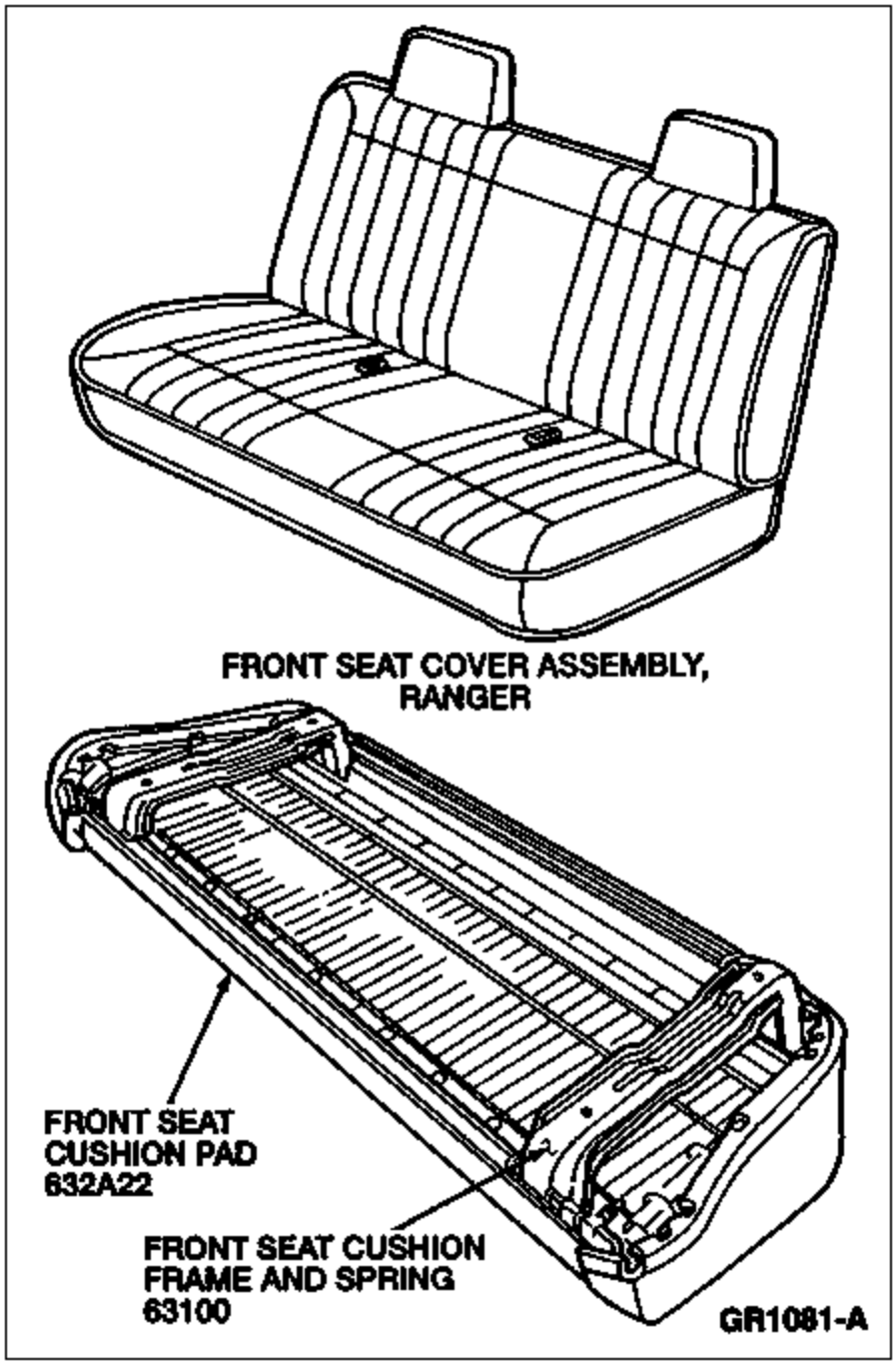

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Seat Bench, Cushion Cover and/or Pad, Rear

Disassembly

1. Remove seat support bolt insulator and seat assembly from vehicle.
2. Remove support from rear seat back latch cover (61349), if so equipped.
3. Remove seat back latch cover and remove screws attaching rear seat back frame (613A38) to rear seat back latch cover, if so equipped.
4. Cut hog rings from rear seat cushion cover (63804) and/or disconnect plastic retainers from cushion frame. Remove rear seat cushion cover.
5. Remove rear seat cushion pad, if necessary.
6. Transfer tiedown wires to new rear seat cushion cover.

For assembly, follow disassembly procedures in reverse order.

Tighten inboard seat back pivot screw to 19-26 Nm (14-19 lb-ft). Tighten the two seat back latch-to-seat cushion bolts to 47-63 Nm (34-46 lb-ft).

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Seat, Bench Back Cover, Rear

Disassembly and Assembly

1. **NOTE: The rear seat is easy to remove from the vehicle, allowing easier service.**

   Remove the rear seat back frame (613A38)-to-rear seat cushion frame (63160) mounting bolts. Separate the back from the rear seat cushion frame and lift the rear seat back frame out of the vehicle.

2. Unhook the hog rings and/or plastic retainers and/or hook and loop retainers attaching the rear seat cushion cover (63804) to the seat back. Remove the rear seat back cover.

3. Remove plastic retainers and rear seat back panel, if so equipped.

4. Transfer the listing wires to the new cover.

5. Position the new rear seat cushion cover over the rear seat back pad, pull the rear seat back cover tight, and fasten the rear seat back cover to the spring assembly with hog rings and J-retainers and/or hook and loop retainers.

6. Install rear seat back panel, if so equipped.

7. Install the rear seat back frame to the rear seat cushion frame assembly.

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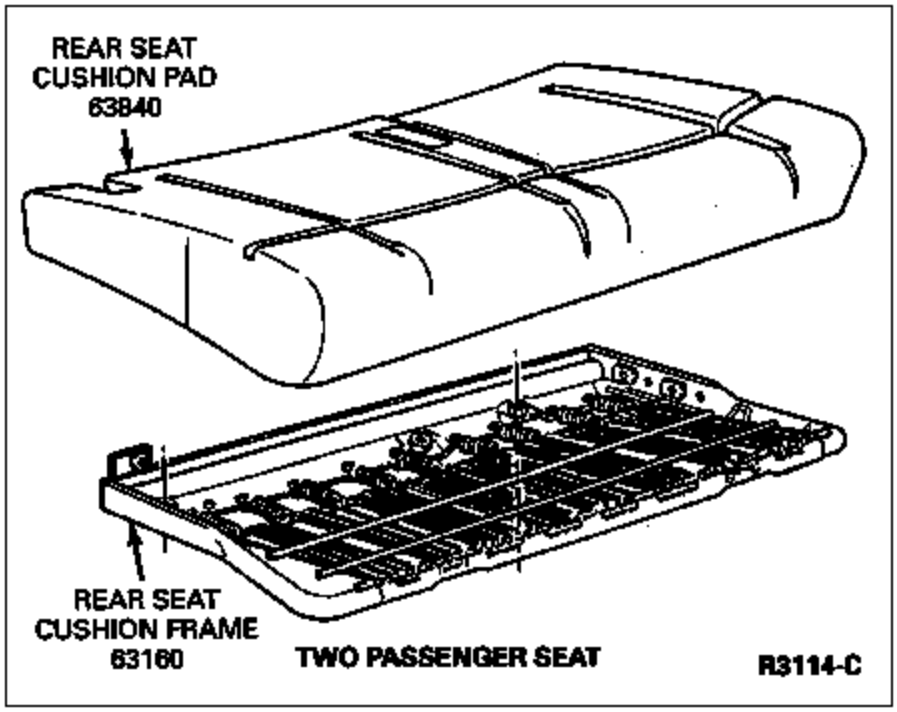
Seat, Bench, Rear Seat Cushion/Rear Seat Back, Aerostar

Disassembly

1. Remove the seat assembly from the vehicle as described in Removal and Installation, Seat, Rear, Bench in this section.
2. Remove the rear seat back frame (613A38)-to-rear seat cushion frame (63160).
3. Remove rear seat cushion frame and rear seat cushion pad from rear seat cushion frame.

Seat Cushion and Frame Assembly



Assembly

1. Install rear seat cushion pad and rear seat cushion cover (63804) on rear seat cushion frame.
2. Install bolts. Tighten to 30-43 Nm (22-32 lb-ft).
3. Install seat assembly in vehicle.

Rear Seat Cushion/Rear Seat Back, Aerostar

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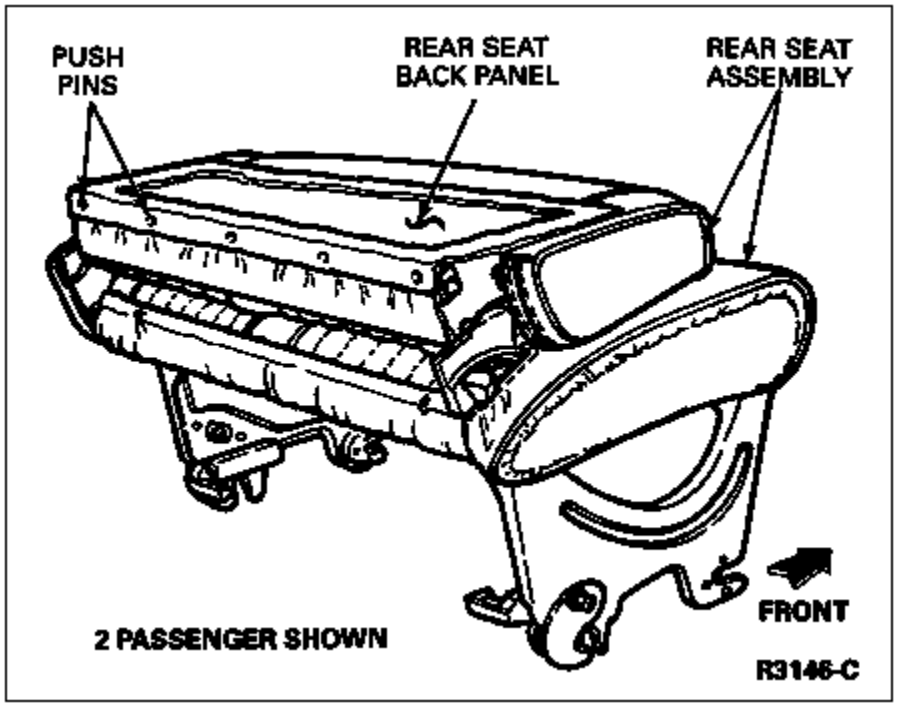

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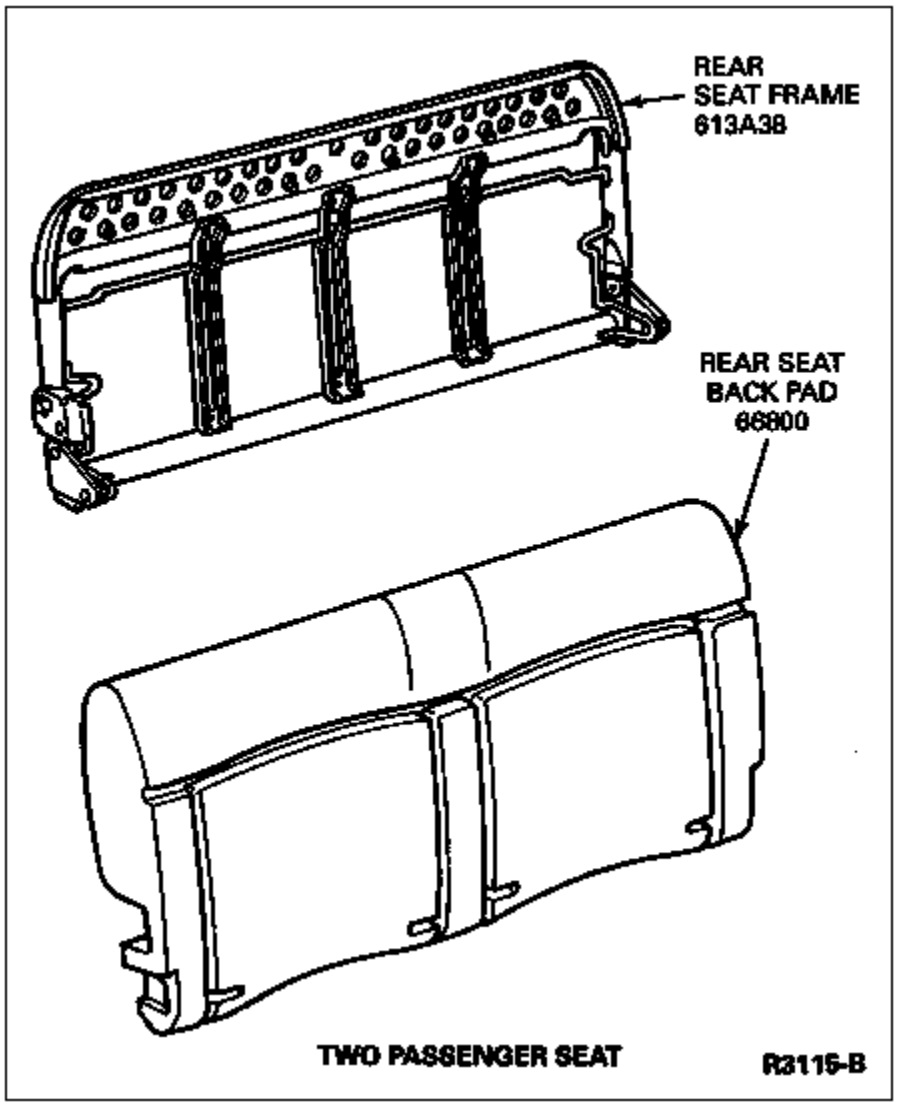

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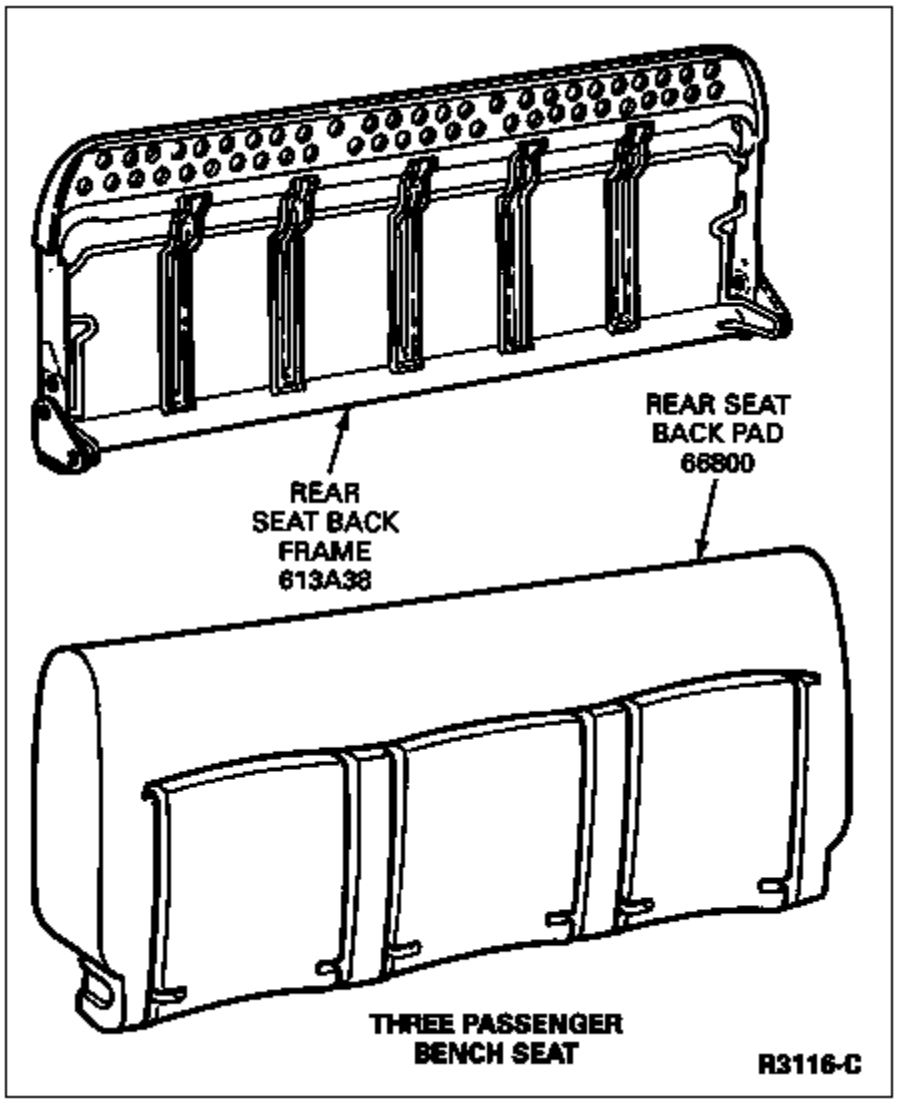

Seat Cushion and Frame Assembly

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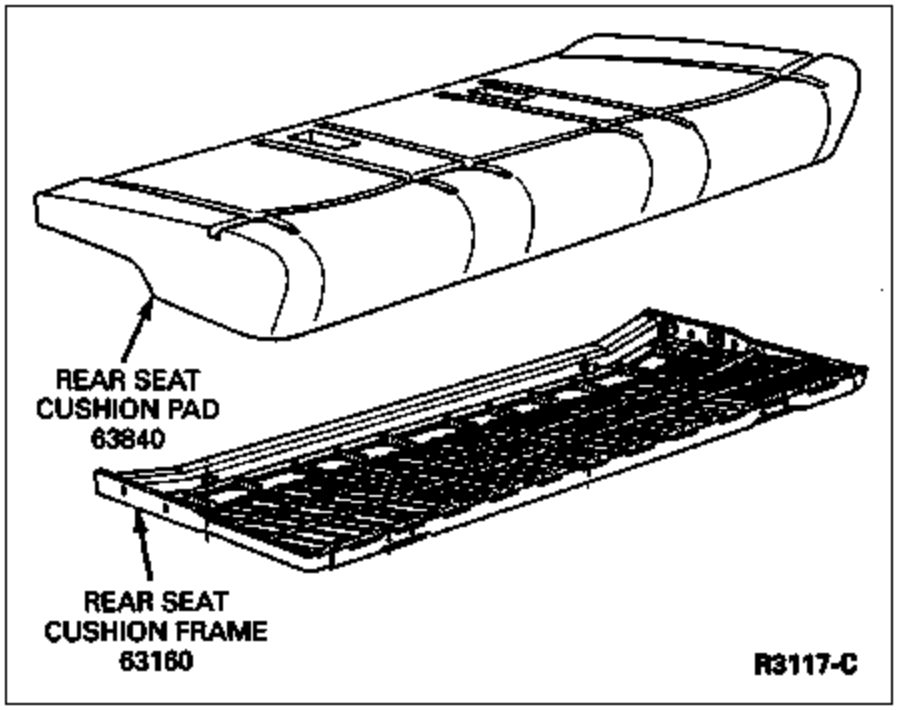

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Seat, Split Bench, Cushion Cover and Pad, Front

Disassembly

1. Remove seat support bolt insulator and front seat (60012) from vehicle.
2. Remove front seat tracks (61705)/support from front seat cushion and cover (60052).
3. Disconnect front seat back pad adjusting hose at lower portion of front seat back, if so equipped.
4. Remove front seat back latch lower cover and remove bolts attaching to front seat cushion and cover to front seat cushion and cover, if equipped.
5. Remove seat cushion side shield and disconnect wire connectors.
6. Cut hog rings from cushion trim cover and/or disconnect plastic retainers from front seat cushion frame and spring (63101) and remove front seat cushion and cover.
7. Remove front seat cushion pad, if necessary.
8. Transfer tiedown wires to new front seat cushion and cover.

Assembly

1. Install front seat cushion pad, if removed.
2. Position front seat cushion and cover on front seat cushion pad. Using hog rings and/or plastic retainers, secure front seat cushion and cover to front seat cushion frame (60326).
3. Install front seat cushion and cover on front seat cushion frame and spring. Tighten inboard seat back pivot bolt to 19-26 Nm (14-19 lb-ft). Tighten the two bolts attaching front seat back latch (62648) to front seat cushion frame and spring to 30-43 Nm (22-32 lb-ft).
4. Install front seat back side shield.
5. Install front seat tracks support to front seat cushion frame and spring. Tighten attaching nuts/bolts to specifications.
6. Install front seat and seat support bolt insulator in vehicle, as described in Removal and Installation, Seats, Front Bucket in this section. Tighten mounting bolts to specifications.

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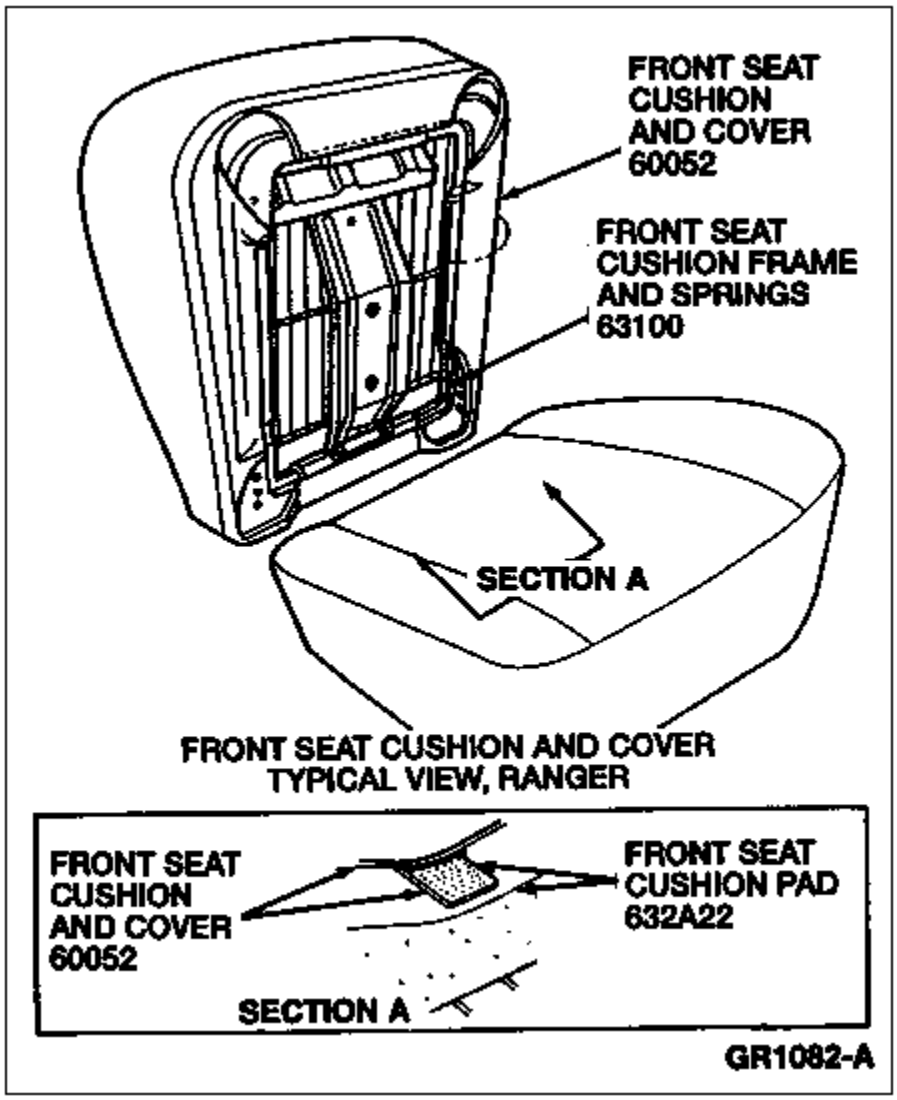

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Seat, Bucket, Back Cover, Front

Disassembly and Assembly

1. Remove the front seat back latch cover and pivot side inner cover.
2. Remove the bolts mounting front seat back (64811) to front seat back cover. Separate the front seat back from the front seat back cover and lift the seat back out of the vehicle.
3. Remove the armrest.
4. Remove plastic retainers and front seat back trim panel, if so equipped.
5. Unhook the hog rings and/or plastic retainers and/or hook and loop retainers attaching the front seat back cover to the front seat back or cushion spring assembly.
6. Remove the hog rings and the listing wires.
7. Remove the front seat back cover.
8. Position front seat back cover and front seat cushion pad and fasten to front seat cushion frame and spring (63101) with hog rings and J-retainers and/or hook and loop retainers.
9. Install listing wires and hog rings.
10. Install front seat back trim panel, if equipped.
11. Install the armrest.
12. Install the front seat back to the front seat back cover.
13. Install front seat back latch lower cover and pivot side inner cover.

Seat Back, Aerostar

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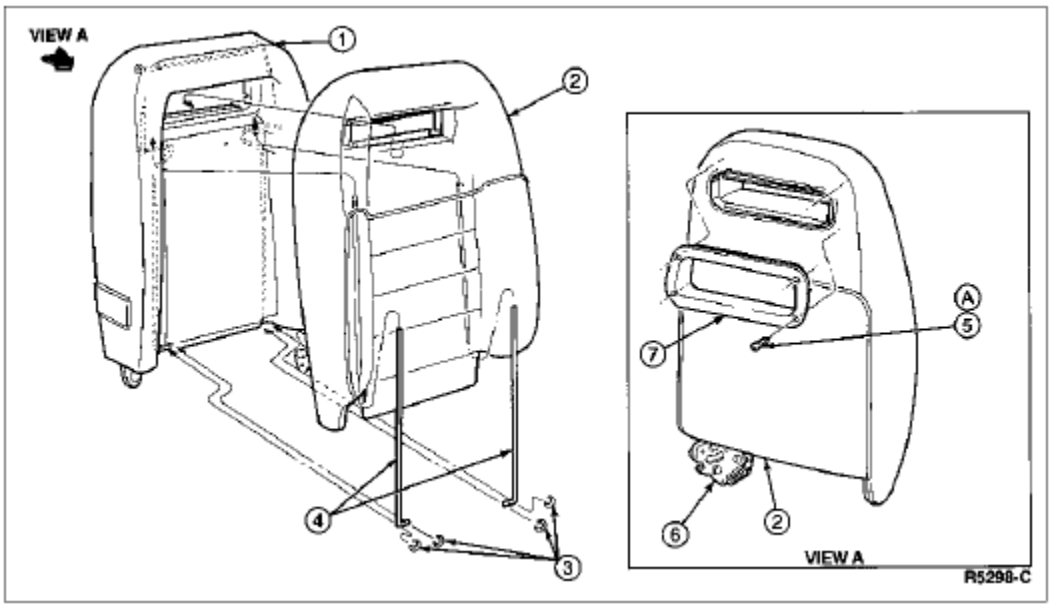

Item	Part Number	Description
1	64810	Pad, Front Seat
2	64416	Cover, Front Seat
3	—	Hog Rings (Part of 64416)
4	—	Retainer Side Wire (Part of 64416)
5	N803247-S2	Screw
6	617C04	Adjuster Assembly
7	616A86	Moulding
A	—	Tighten to 8-24 Nm (71-212 Lb-In)

Rear Seat Assembly, Aerostar

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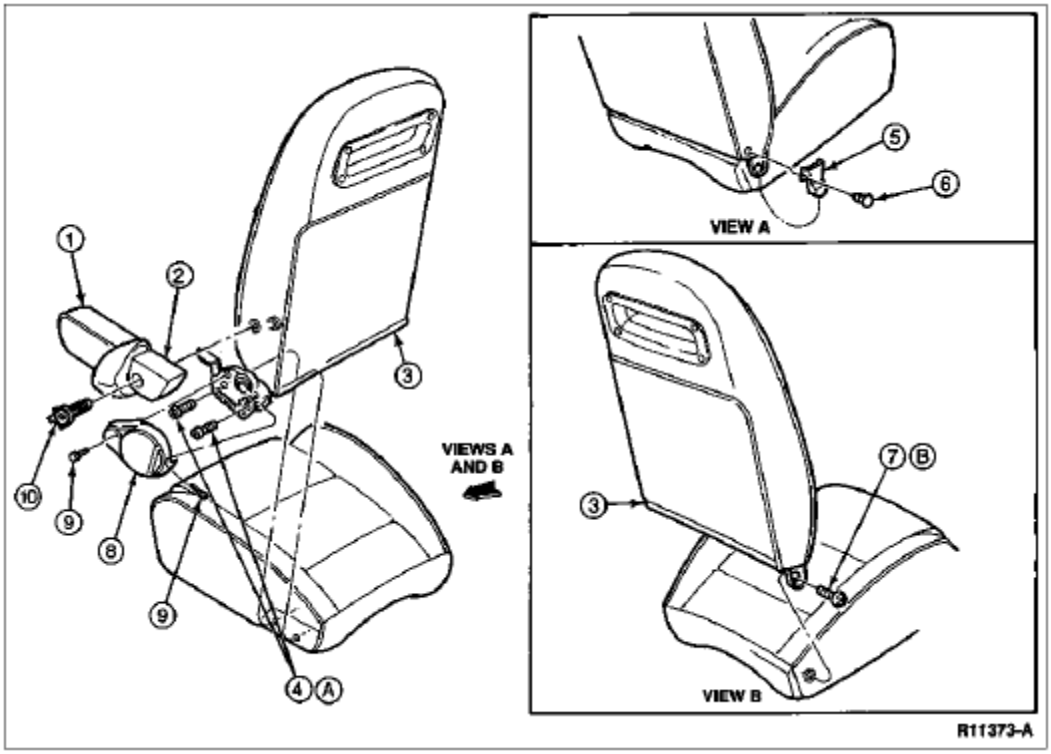

Item	Part Number	Description
1	64340	Cover Assembly, Armrest
2	64606	Pad Assembly, Armrest
3	64416	Seat Back Cover
4	N803463-S2	Screw
5	61692	Cover, Back Pivot Side Inner
6	390964-S	Pushpin
7	802280-S2	Screw
8	61348	Rear Seat Back Latch Cover
9	N610019-S58	Screw
10	391132-S58	Bolt and Retainer
A	—	Tighten to 47-63 Nm 34-46 Lb-Ft)
B	—	Tighten to 19-26 Nm (14-19 Lb-Ft)

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Seat, Back Cover and/or Pad, Bucket Seat, Rear, Aerostar

Disassembly

1. Remove seat support bolt insulator and seat assembly from the vehicle.
2. Remove seat support from rear seat cushion cover, if so equipped.
3. Remove rear seat back latch cover. Remove bolts attaching rear seat cushion frame (63160) to rear seat cushion cover.
4. Remove armrest, if so equipped.
5. Unzip rear seat cushion cover at bottom of rear seat cushion frame or unhook J-retainer at bottom of rear seat cushion frame.
6. Remove mouldings from rear seat cushion frame, if so equipped.
7. Cut hog rings from rear seat cushion cover and/or disengage plastic retainers from rear seat cushion frame. Remove rear seat cushion cover.
8. Remove rear seat cushion pad (63840) if necessary.
9. Transfer tiedown wires to new rear seat cushion cover.

Assembly

1. Install rear seat cushion pad assembly, if removed.
2. With the exception of the top portion (approximately 203.2mm [8 inches]), turn trim cover inside out.
3. Work rear seat cushion cover down until horizontal tiedown listing is aligned with retaining wire in rear seat cushion pad. Install tiedown wire in listing, then secure tiedown to pad.
4. Position remaining portion of rear seat cushion cover to rear seat cushion pad. Install vertical tiedown wires in listings, then secure ends of tiedown wires to pad assembly.
5. Zip rear seat cushion cover closed.
6. Install seat back mouldings, if so equipped.
7. Install seat back on rear seat back latch cover (61348). Tighten inboard seat back pivot bolt to 19-26 Nm (14-19 lb-ft). Tighten the two seat back latch-to-seat cushion bolts to 47-63 Nm (34-46 lb-ft).
8. Install rear seat back latch cover.
9. Install armrest, if so equipped.
10. Install support on rear seat back latch cover. Tighten attaching bolts/nuts to specifications.

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11. Install seat and seat support bolt insulator in vehicle as outlined in this section. Tighten mounting bolts/nuts to specifications.

12. Check seat backs for proper operation.

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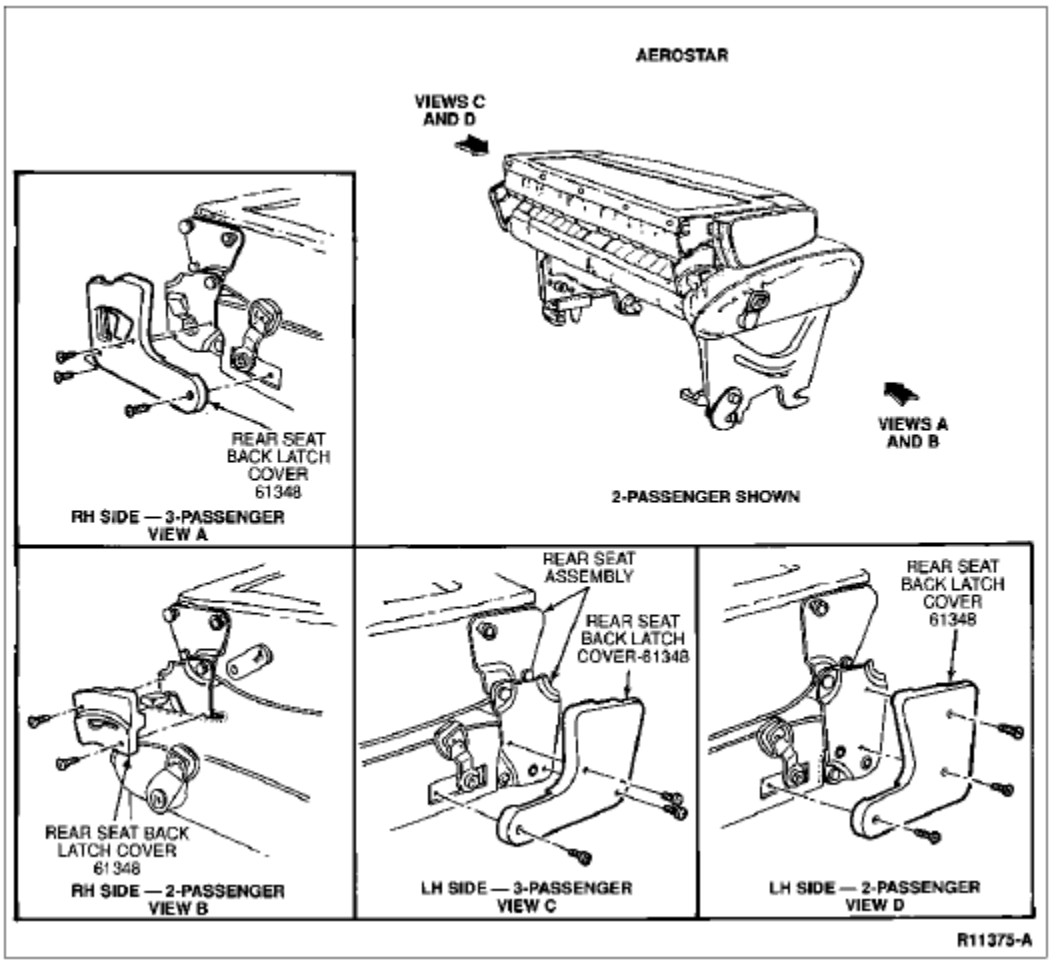
Seat, Rear, Folding, Aerostar

Disassembly and Assembly

1. Remove screws securing rear seat back latch covers (61348). Remove cover.
2. Position rear seat back latch covers and install mounting screws.

To assemble, reverse Steps 1 and 2.

Folding Bench Seat



Driver and Passenger Bucket Seat and 60/40 Split Bench, Front, Ranger

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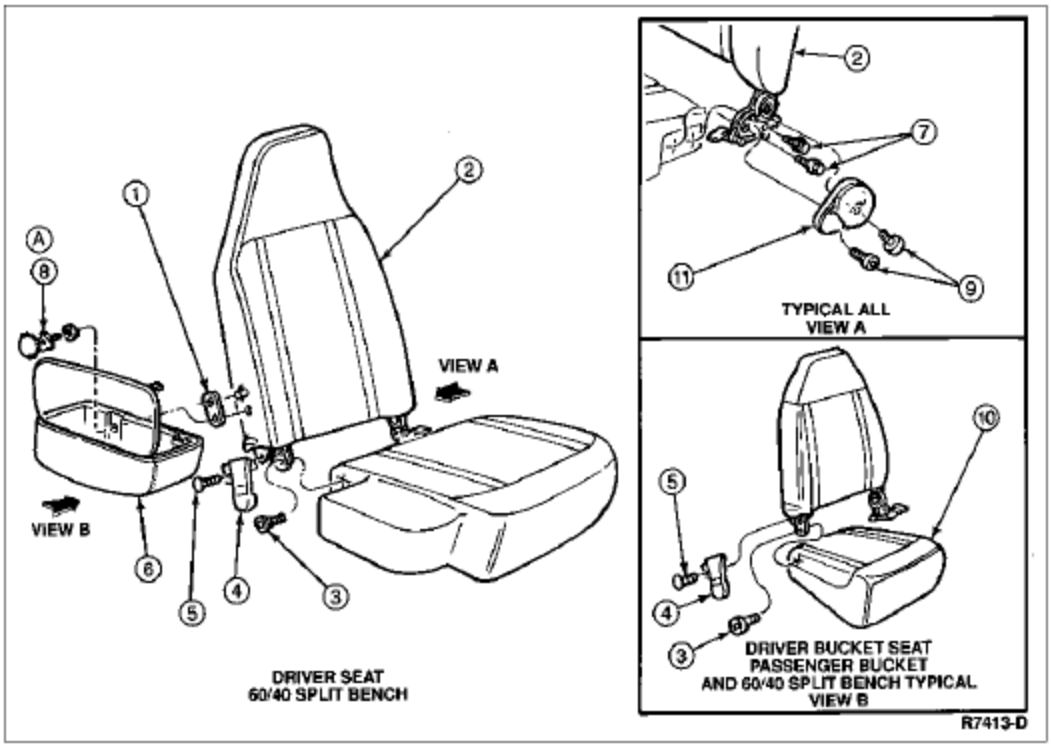

Item	Part Number	Description
1	64684	Link
2	64810	Front Seat Back
3	N802280-S58	Screw
4	861692	Cover, Front Seat Back Pivot
5	390964	Pushpin
6	644A22	Front Seat Center Armrest
7	N804850-S58	Screw
8	391716-S303	Bolt and Retainer
9	51764-S58	Screw
10	60052	Front Seat Cushion and Cover
11	62768	Front Seat Back Latch Lower Cover (RH)
A	—	Tighten to 30-35 Nm (22-26 Lb-Ft)

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Backrest Cover and Pad, Front

Disassembly

1. Remove seat support bolt insulator and front seat (60012) from the vehicle.
2. Remove front seat tracks (61705) and front seat to floor support (61708) from front seat cushion frame and spring (63101), if equipped.
3. Disconnect front seat back pad adjusting hose (65528) at the lower rear portion of front seat back (64810), if equipped.
4. Remove front seat back latch lower cover and remove bolts attaching front seat back to front seat cushion frame and spring.
5. Remove front seat center armrest (644A22), if so equipped.
6. Unzip trim cover at bottom of front seat back or unhook J-retainer at bottom of front seat back.
7. Remove mouldings from front seat back, if equipped.
8. Cut hog rings from front seat back cover and/or disengage plastic retainers from front seat back frame (61018). Remove front seat back cover.
9. Remove front seat cushion pad if necessary.
10. Transfer tiedown wires to new front seat cushion extender pad, if equipped.

Assembly

1. Install front seat cushion pad, if removed.
2. With the exception of the top portion (approximately 203.2mm [8 inches]), turn trim cover inside out.
3. Work front seat back cover down until horizontal tiedown listing is aligned with retaining wire in front seat cushion pad assembly. Install tiedown wire in listing, then secure tiedown to front seat cushion pad.
4. Position remaining portion of front seat back cover to front seat cushion pad. Install vertical tiedown wires in listings, then secure ends of tiedown wires to front seat cushion pad.
5. Clip/zip front seat back cover closed.
6. Install seat back mouldings, if so equipped.
7. Install front seat back frame on seat cushion assembly. Tighten inboard pivot bolt to 19-26 Nm (14-19 lb-ft). Tighten the two bolts attaching front seat back to front seat cushion frame and spring to 44-60 Nm (32-44 lb-ft).

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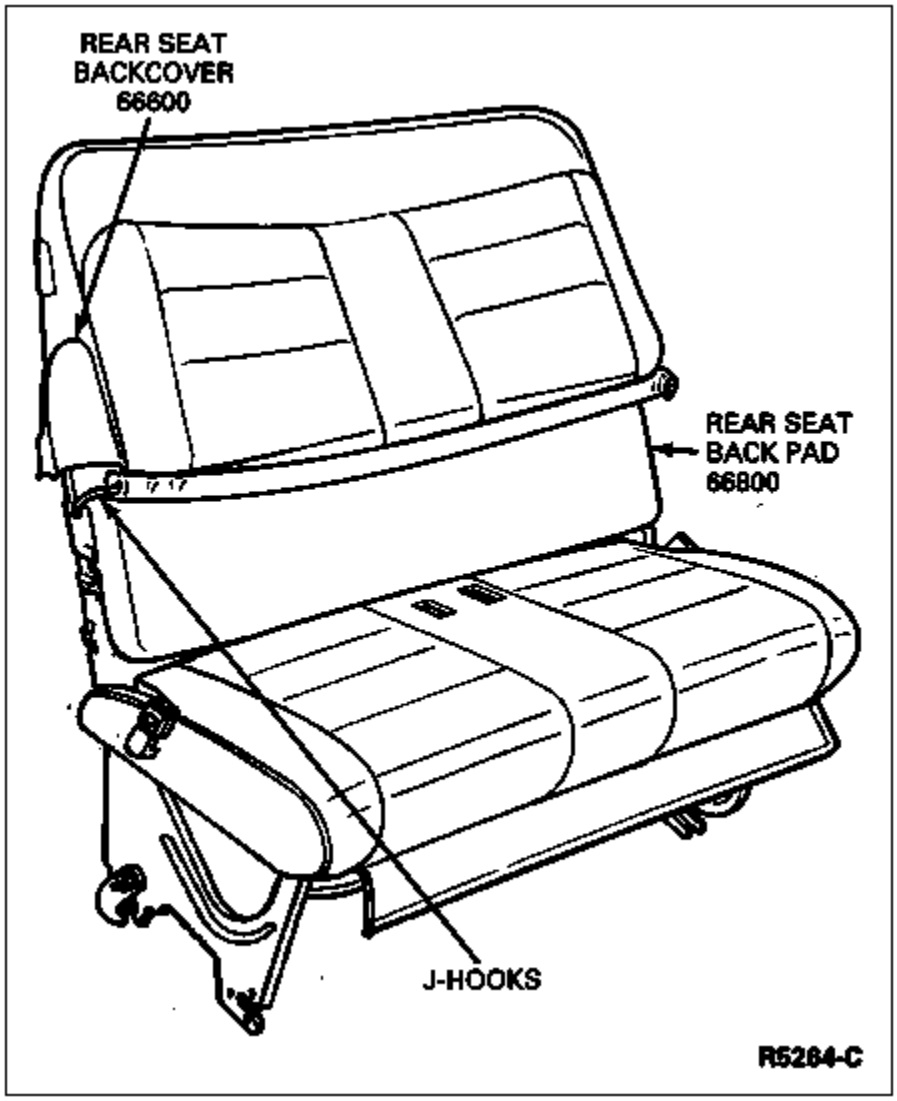
Backrest Cover and Pad, Rear, Aerostar

Disassembly and Assembly

1. Locate interlocking J-hooks at lower edge of backrest. Unhook interlocking J-hooks along entire length of backrest.

2. Gently lift rear seat back frame (613A38) upward and disengage from rear seat back cover.



3. **NOTE: Foam rear seat back pad may be retained to rear seat back frame with adhesive.**

   If necessary, disengage foam rear seat back pad from rear seat back frame.

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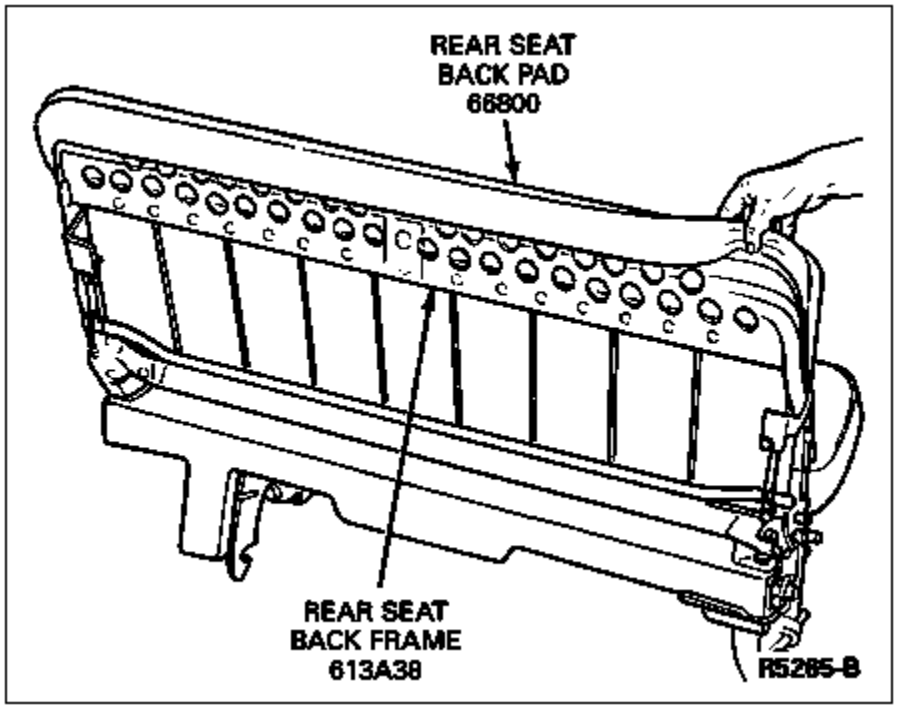
To assemble, follow disassembly procedures in reverse order.



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Backrest Frame, Aerostar Two-Passenger Bedseat

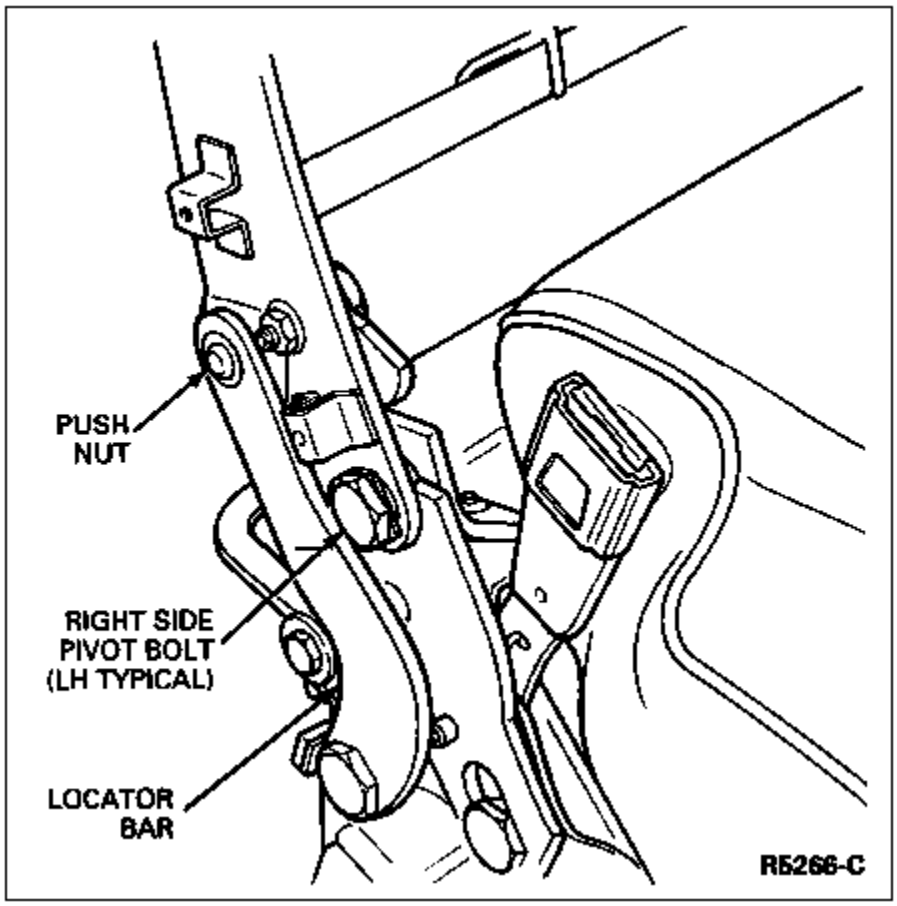
Disassembly and Assembly

1. Remove right pivot bolt, bushing, and wave washer from rear seat back frame using a socket wrench and a 1/2-inch combination wrench.

2. **NOTE: Use a 1/2-inch combination wrench to hold inboard nut retaining backrest pivot bolt.**

   Remove left pivot bolt, bushing and wave washer using a socket wrench and a 1/2-inch combination wrench.

3. Remove right pushnut retaining rear seat back frame to locator bar. Remove left pushnut retaining rear seat back frame to locator bar.



4. Detach locator bars from rear seat back frame by gently pulling forward.

5. Lift rear seat back frame away from rear seat back cover frame.

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To assemble, follow disassembly procedures in reverse order.

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Backrest Frame, Aerostar Two-Passenger Bedseat

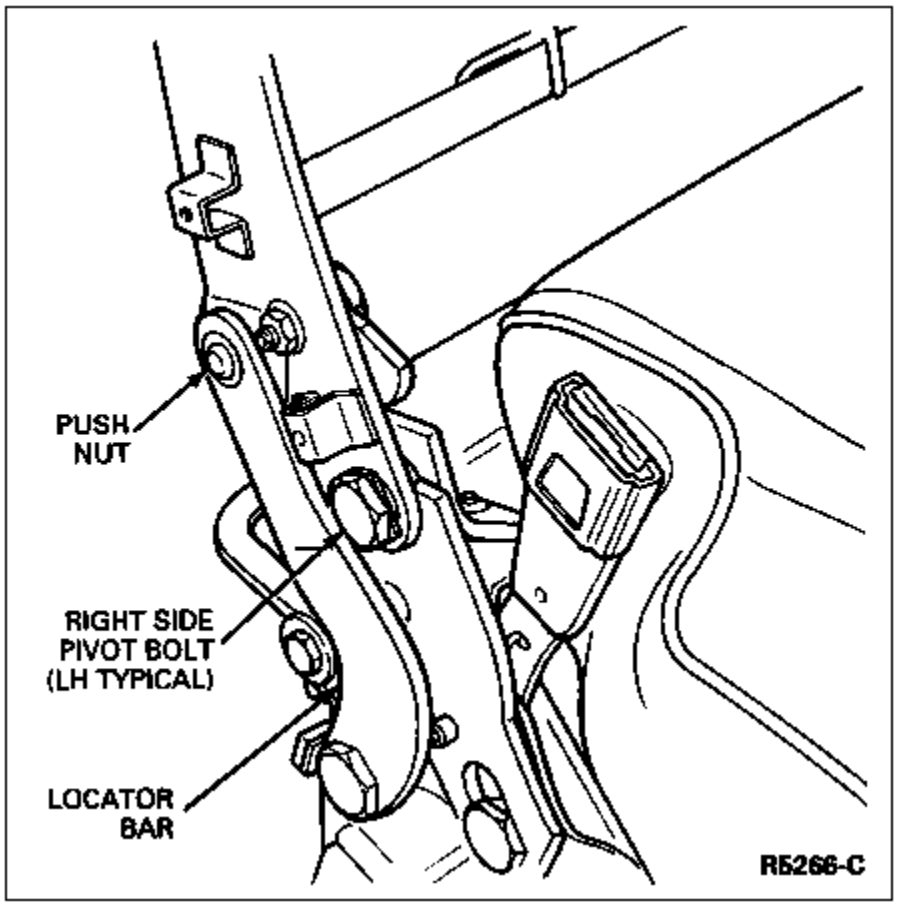
Disassembly and Assembly

1. Remove right pivot bolt, bushing, and wave washer from rear seat back frame using a socket wrench and a 1/2-inch combination wrench.

2. **NOTE: Use a 1/2-inch combination wrench to hold inboard nut retaining backrest pivot bolt.**

   Remove left pivot bolt, bushing and wave washer using a socket wrench and a 1/2-inch combination wrench.

3. Remove right pushnut retaining rear seat back frame to locator bar. Remove left pushnut retaining rear seat back frame to locator bar.



4. Detach locator bars from rear seat back frame by gently pulling forward.

5. Lift rear seat back frame away from rear seat back cover frame.

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To assemble, follow disassembly procedures in reverse order.

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Seat Cushion Locator, Rear

Disassembly and Assembly

1. Remove right and left rear seat cushion side trim.
2. Remove snap ring retaining upper end of right locator to rear seat back frame (613A38). Remove snap ring retaining left locator to rear seat back frame.
3. Remove right and left locator bar retaining bolts using a socket wrench.
4. Remove locator bar.

To assemble, follow disassembly procedures in reverse order.

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Seat Cushion Frame, Rear

Disassembly and Assembly

1. Remove rear seat cushion cover (7863804) and rear seat cushion pad (7863840) as described in Disassembly and Assembly, Seat, Rear Seat Cushion/Rear Seat Back, Aerostar in this section.
2. Remove two pivot bolts retaining rear seat back frame (78613A38) as described in Dissassembly and Assembly, Backrest, Aerostar (Three-Passenger Bed Seat) in this section.
3. Detach two seat belt and buckle assemblies from rear seat cushion frame (7863160) if required.
4. Remove flexilator, if necessary, as described in Disassembly and Assembly, Flexilator in this section.
5. Remove bolts, bushings and wave washers retaining seat cushion frame. Remove rear seat cushion frame.

To assemble, follow disassembly procedures in reverse order.

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Hook and Handle Assembly, Rear

Disassembly and Assembly

1. Remove handle and hook assembly pivot bolt using a T45 Torx® wrench.
2. Remove handle and hook assembly.

For assembly, follow disassembly procedures in reverse order.

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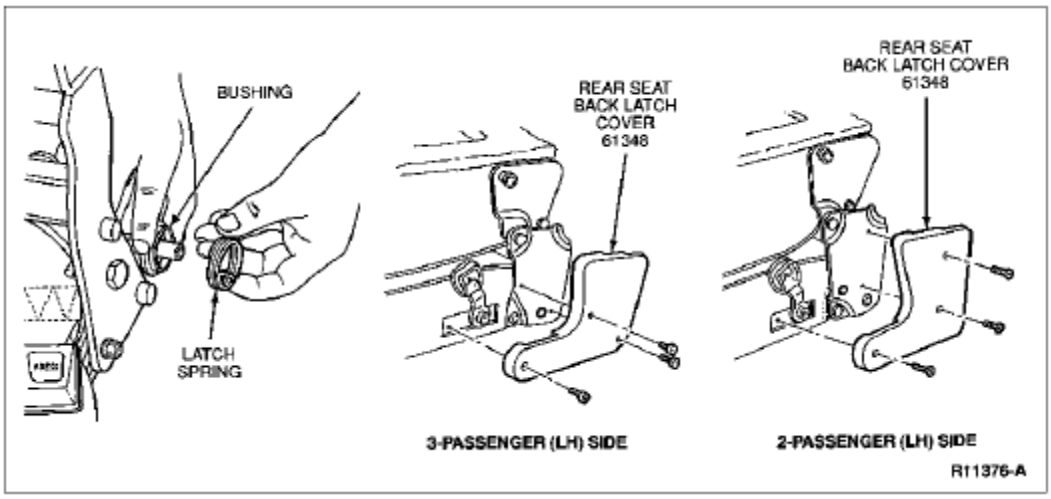
Latch and Handle Assembly, Aerostar

Disassembly and Assembly

1. Remove right and left rear seat back latch covers.
2. Remove pushnut, by cutting, retaining right rear seat back latch handle and rear seat cushion frame to rear seat back pivot. Remove right latch lever and rear seat cushion frame (63160), spring and bushing.
3. Remove pushnut, by cutting, retaining left rear seat back latch cover to latch lever pivot rod.
4. Remove left rear seat back latch cover.
5. Remove spring and bushing.

Rear Seat Back Latch Assembly, Aerostar



6. If necessary, slide latch lever pivot rod and insulator from rear seat cushion frame.

To assemble, follow disassembly procedures in reverse order. Install new pushnuts.

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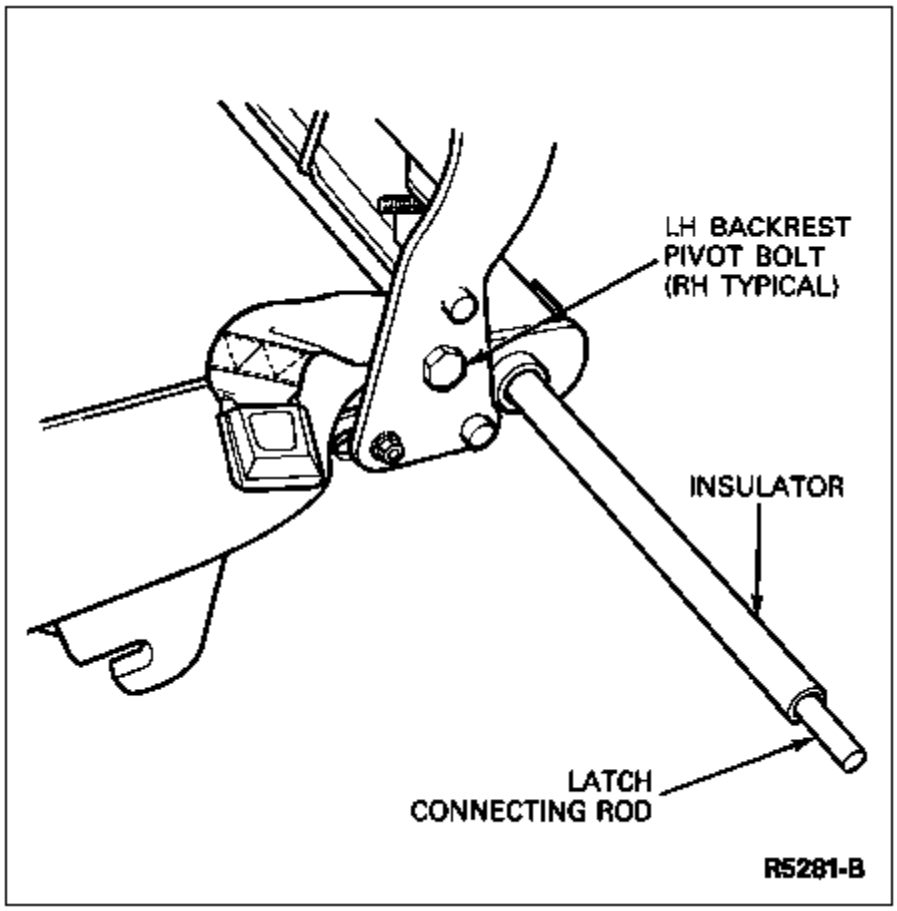

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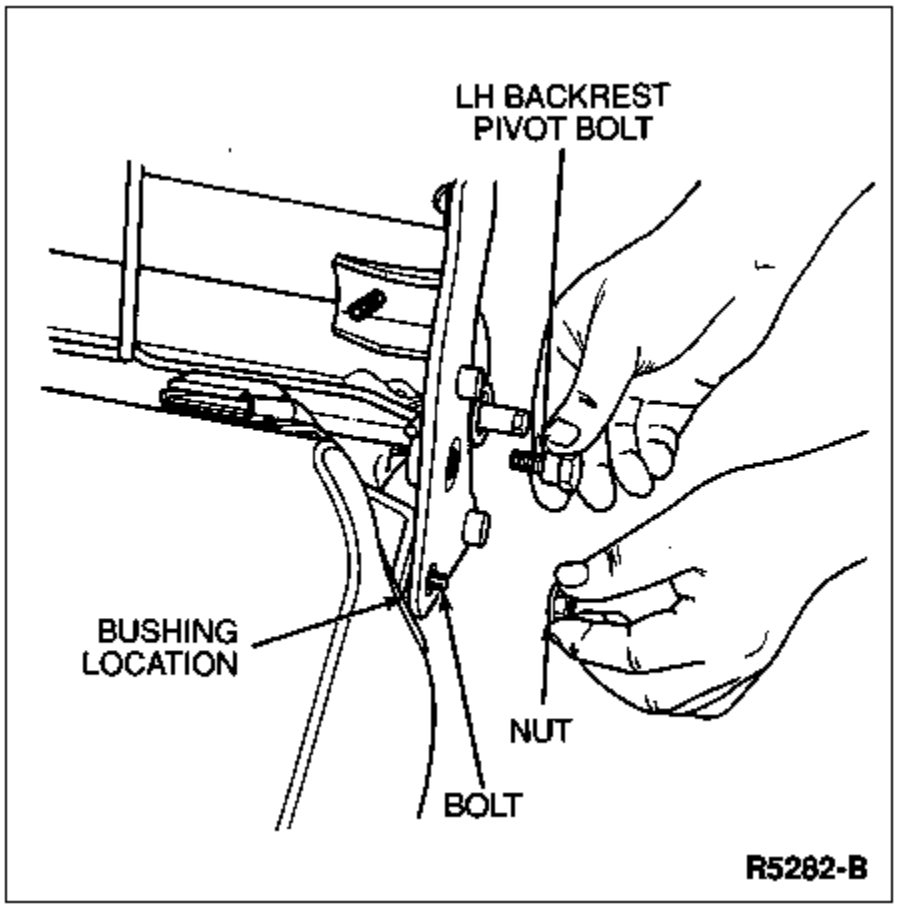
Backrest, Aerostar (Three-Passenger Bed Seat)

Disassembly and Assembly

1. Remove rear seat back latch cover (61348) as described in Removal and Installation in this section.
2. Remove left and right backrest pivot bolts from rear seat back frame (613A38) using a socket wrench.
3. Remove seat cushion elevator cam retaining bolt, bushing, and nut from rear seat back frame.



4. Remove rear seat back frame from rear seat cushion frame (63160).

To assemble, follow disassembly procedures in reverse order.

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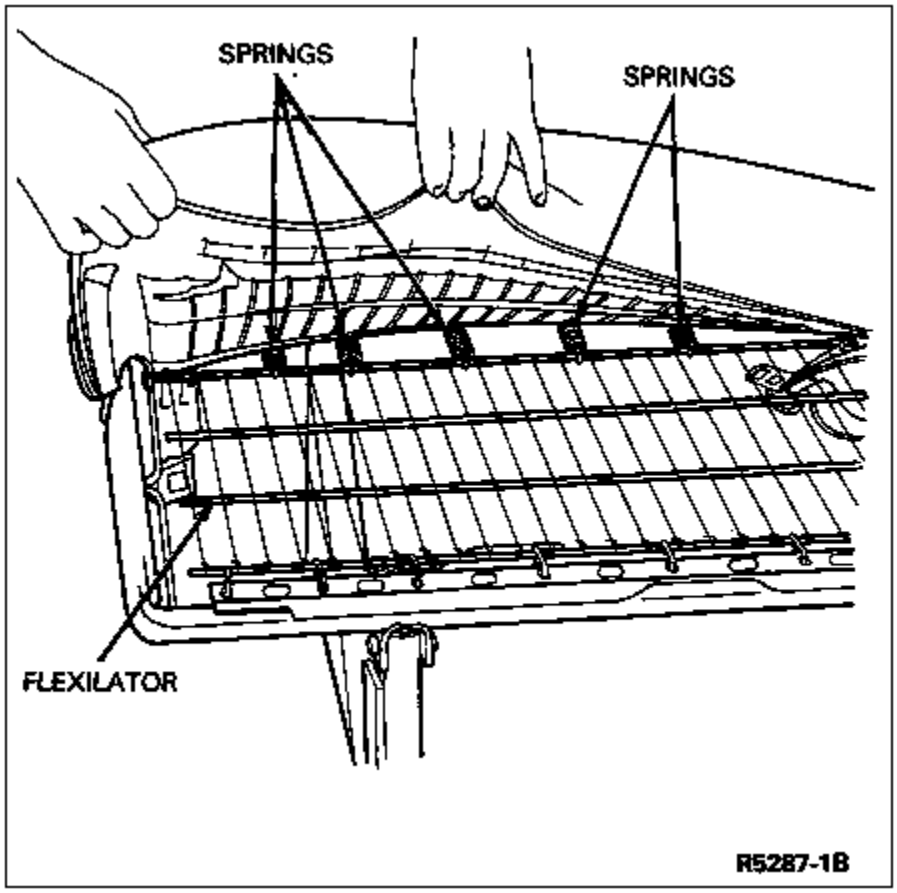
Flexilator

Disassembly and Assembly

1. Remove seat cushion cover as described in Disassembly and Assembly, Seat Cushion Cover, Bench, Rear in this section.
2. **NOTE: Flexilator J-hooks are readily detached by inserting fingers through flexilator wires, placing palm of hand against forward edge of seat cushion frame, and squeezing.**

   Disengage J-hooks from forward edge of flexilator.
3. Disengage springs retaining rear edge of flexilator to seat back cover.
4. Remove flexilator from seat back cover.

To assemble, follow disassembly procedures in reverse order.



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Storage Bin, Underseat, Aerostar

Disassembly

1. Remove the seat and support assembly from the vehicle as described in Removal and Installation, Seat, Passenger, Front, Aerostar in this section.
2. Remove the storage bin from the seat support assembly as described in Removal and Installation, Storage Bin, Underseat, Aerostar in this section.
3. Position the storage bin assembly on a bench with the bottom of the storage bin housing facing up.
4. **NOTE: The drawer front must be removed to gain access to the latch assembly.**

   Remove the four screws that retain the drawer front to the housing assembly.
5. Remove the latch assembly from the storage housing drawer assembly.

Assembly

1. Install the latch assembly in the storage housing drawer assembly.
2. Position the drawer front to the storage housing assembly and install the four screws that retain the front to the housing.
3. Install the storage bin assembly to the seat support as described in Removal and Installation, Storage Bin, Underseat, Aerostar in this section.

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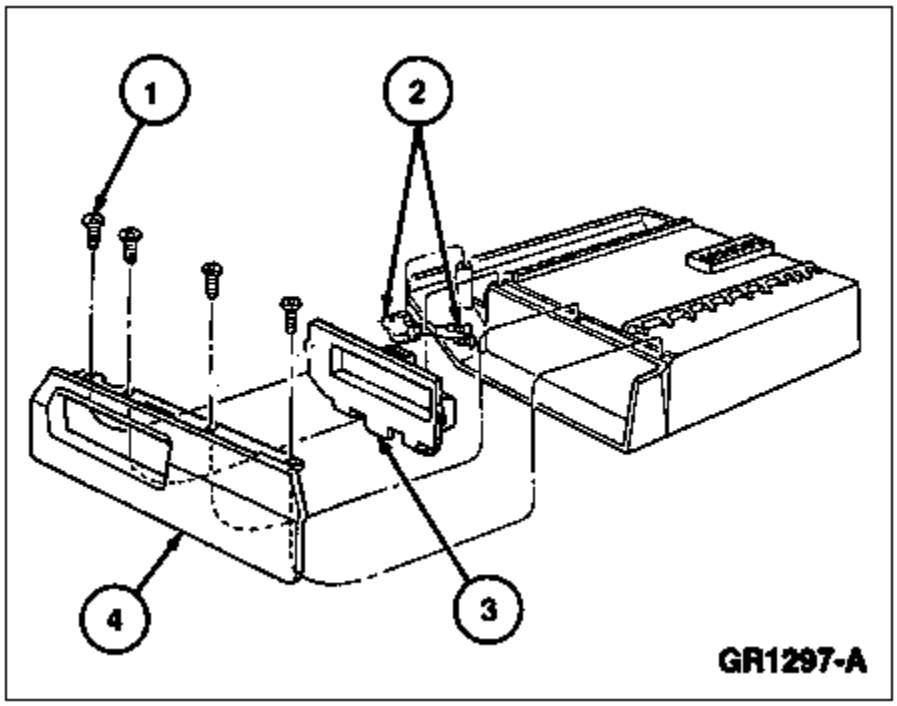

Item	Part Number	Description
1	—	Screw(s) (Part of 600A04)
2	—	Lockset Retainer and Retaining Screws (Part of 600A04)
3	600A06	Latch
4	—	Drawer Front (Part of 600A04)

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SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Screw, Seat Tracks to Cushion, Aerostar	15-20	11-15	—
Nut, Support to Seat Track, Support to Floorpan. Support to Seat Cushion, Passenger Seat. Seat Back Pivot Bolt, Seat Back to Adjuster Latch, Aerostar	19-26	14-19	—
Bolt, Seat Cushion to Adjuster Latch	47-63	34-46	—
Screw, Seat to Track, Track to Floor	17-23	13-17	—
Screw, Track to Floor, Ranger	20-25	15-18	—
Screw and Washer Assembly, Armrest, Ranger	30-40	22-30	—
Screw, Seat Back Pivot, Ranger	23-32	17-24	—
Seat, Cushion to Adjuster Latch, Ranger	47-63	35-46	—
Bolt, Power Seat Track to Cushion	12-24	—	106-212
Screw, Adjuster Latch Cover	1.6-2.2	—	15-19
Bolt and Retainer, Armrest	27-43	20-32	—
Screw, Link Arm Cover	11-23	—	98-203
Nut, Support Assembly to Floorpan, Rear Seat Back Bracket to Floorpan, Bolt, Seat Belts to Rear Seat Assembly	30-40	22-30	—
Bolt, Support Assembly to Rear Seat Cushion	9-10	—	80-89
Nut, Rear Seat Control	8-11	—	71-97
Bolt, Rear Safety Belt Buckle Assembly to Floor	21-30	15-22	—
Screw, Folding Rear Seat to Floorpan, Ranger	21-30	15-22	—
Bolt, Rear Seat Back to Cushion	30-43	22-32	—
Screw, Bucket Seat Back Latch	47-63	34-46	—
Screw, Bucket Seat Back Latch Cover	1.6-2.2	—	15-19

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Screw, Bucket Seat Pivot	19-26	14-19	—
Screw, Seat Back Frame to Seat Latch, Upper	23-32	17-24	—
Screw, Lower	47-64	35-47	—
Bolt, Seat Cushion Frame to Seat Back	40-60	30-44	—
Bolt, Center Seat Cushion Latch Hook	58-65	43-48	—
Seat Back Latch to Seat Back Frame	47-63	34-46	—
Bolt, Seat Cushion to Adjuster Latch	47-63	34-46	—
Screw, Seat to Track, Track to Floor	17-23	13-17	—
Screw, Track to Floor, Ranger	20-25	15-18	—
Screw, Track to Floorpan	19-26	14-19	—
Screw, Tilt-Slide Track	19-25	14-18	—
Bolt, Outboard Rear Seat	30-40	22-30	—
Nut, Rear Seat Track	30-40	22-30	—
Nut and Washer 60/40 Built-In Child Seat	40-55	29-40	—
Bolt, Built-in Child Seat	34-44	25-32	—
Nut, Seat Leg to Floorpan, 60/40	40-55	29-40	—
Nut, 50/50 Seat	30-40	21-30	—
Bolt, 50/50 Seat	8-11	—	60-80
Nut, Fold Down Seat Frame to Floorpan	19-25	14-18	—
Bolt, Fold Down Seat	30-40	21-30	—
Screw, Seat Cushion to Track	27-33	20-24	—
Bolt, Seat Track to Floorpan	12-24	9-17	—
Screw, Track to Floorpan	19-25	14-18	—
Screw, Front Seat Latch, Bench, Ranger	47-63	35-46	—

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Nuts, Front Seat Back Frame to Latch, Ranger	18-27	13-20	—
Screw, Front Seat Back Latch	23-32	17-18	—

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SPECIAL SERVICE TOOLS/EQUIPMENT

ROTUNDA EQUIPMENT

Model	Description
105-R0051	Rotunda 73 Digital Multimeter

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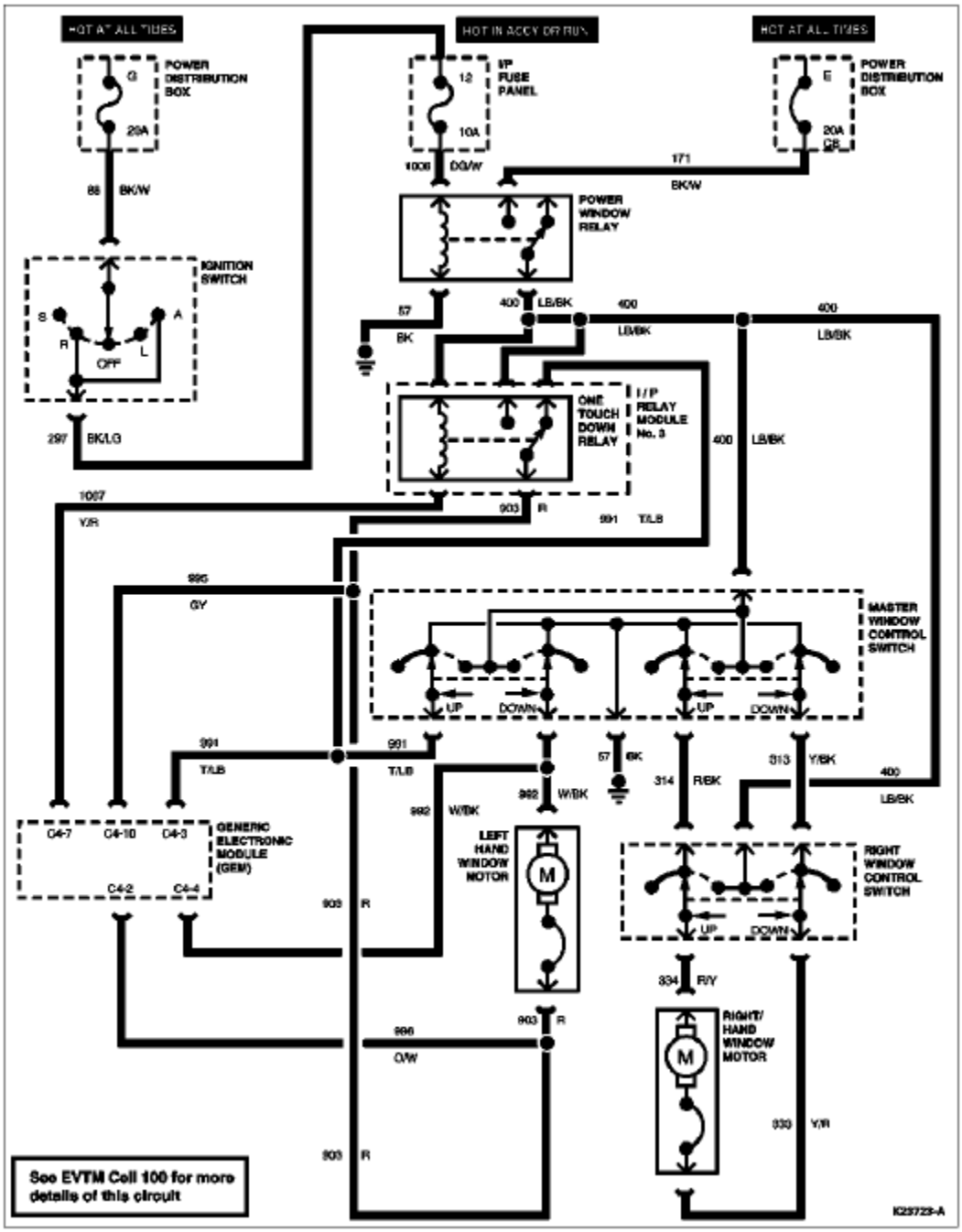
Electrical Schematics

Power Window Controls, Ranger



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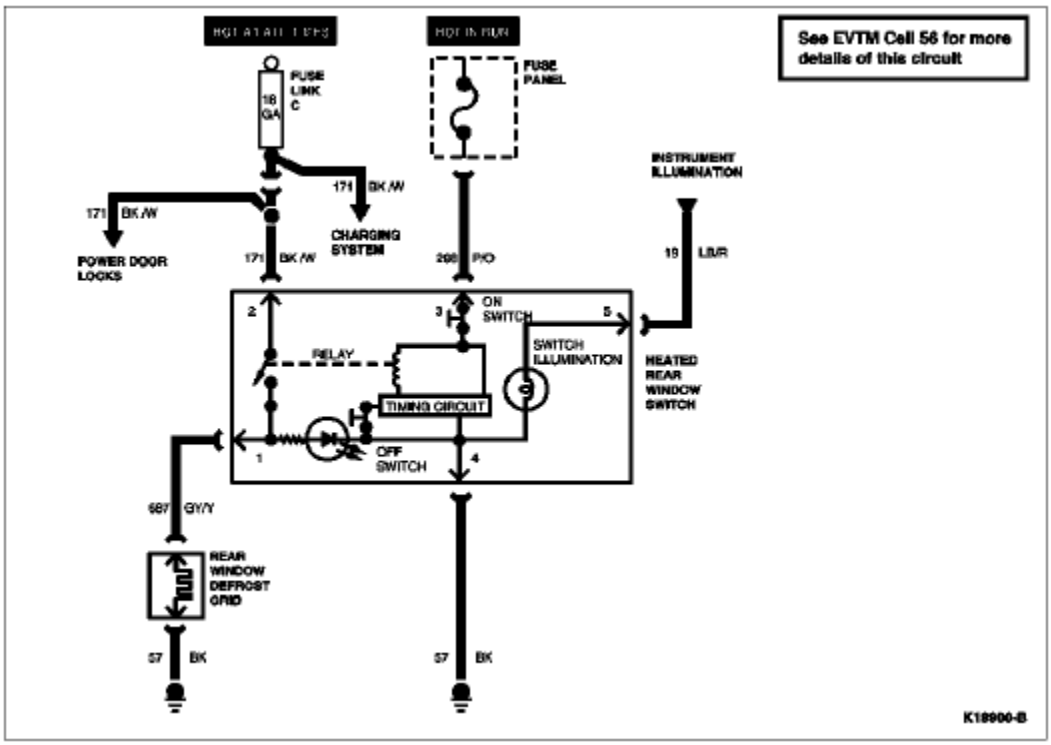
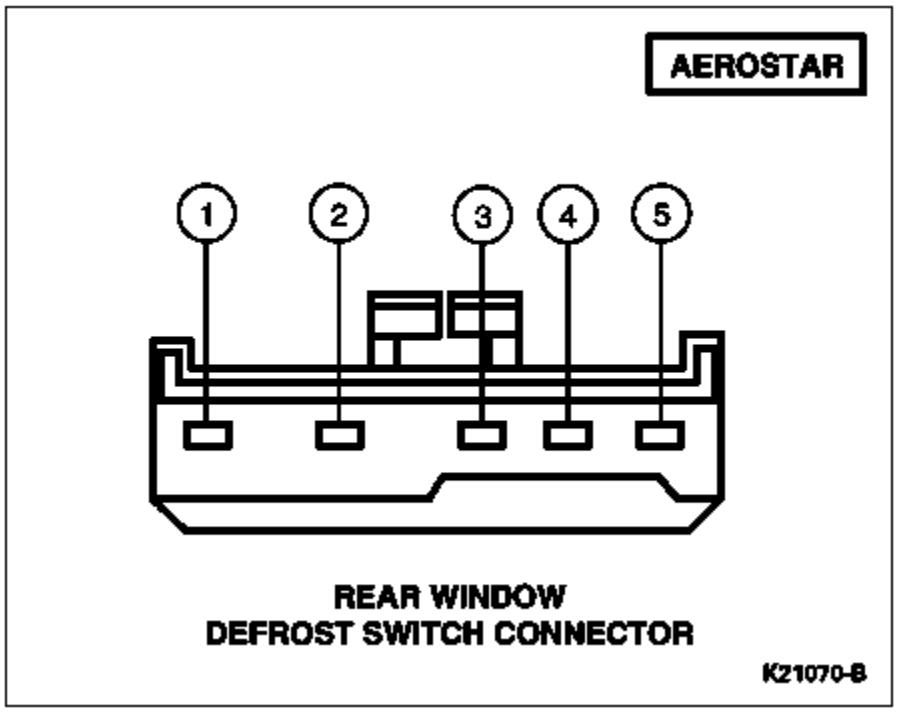
Rear Window Defrost, Aerostar





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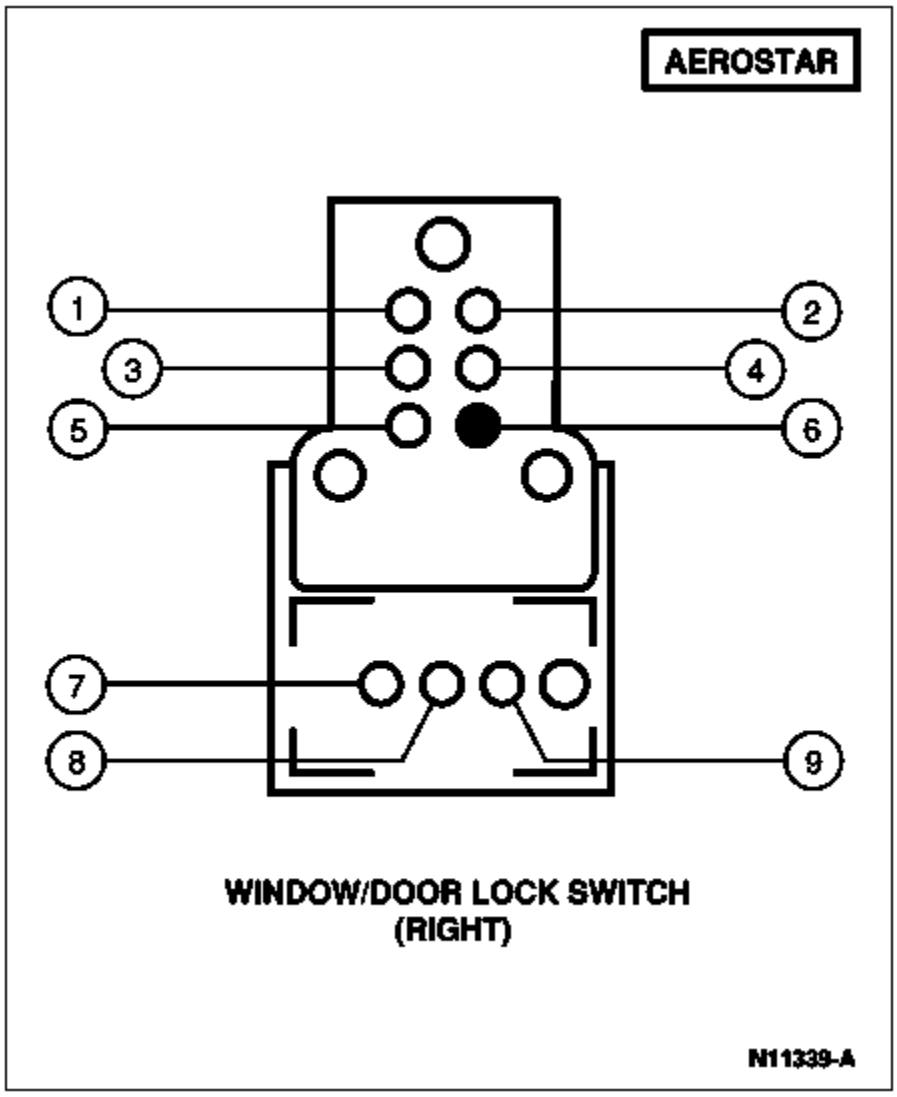
Pin Number	Circuit	Circuit Function
1	687 (GY/Y)	Accessory Feed
2	171 (BK/W)	Circuit Breaker to Seat Latch Relay
3	298 (P/O)	Fused Run Only Feed
4	57 (BK)	Ground Circuit
5	19 (LB/R)	Instrument Panel Lamps Feed



Pin Number	Circuit	Circuit Function
1	400 (LB/BK)	Safety Relay Load Terminal to Window Regulator Switch Feed

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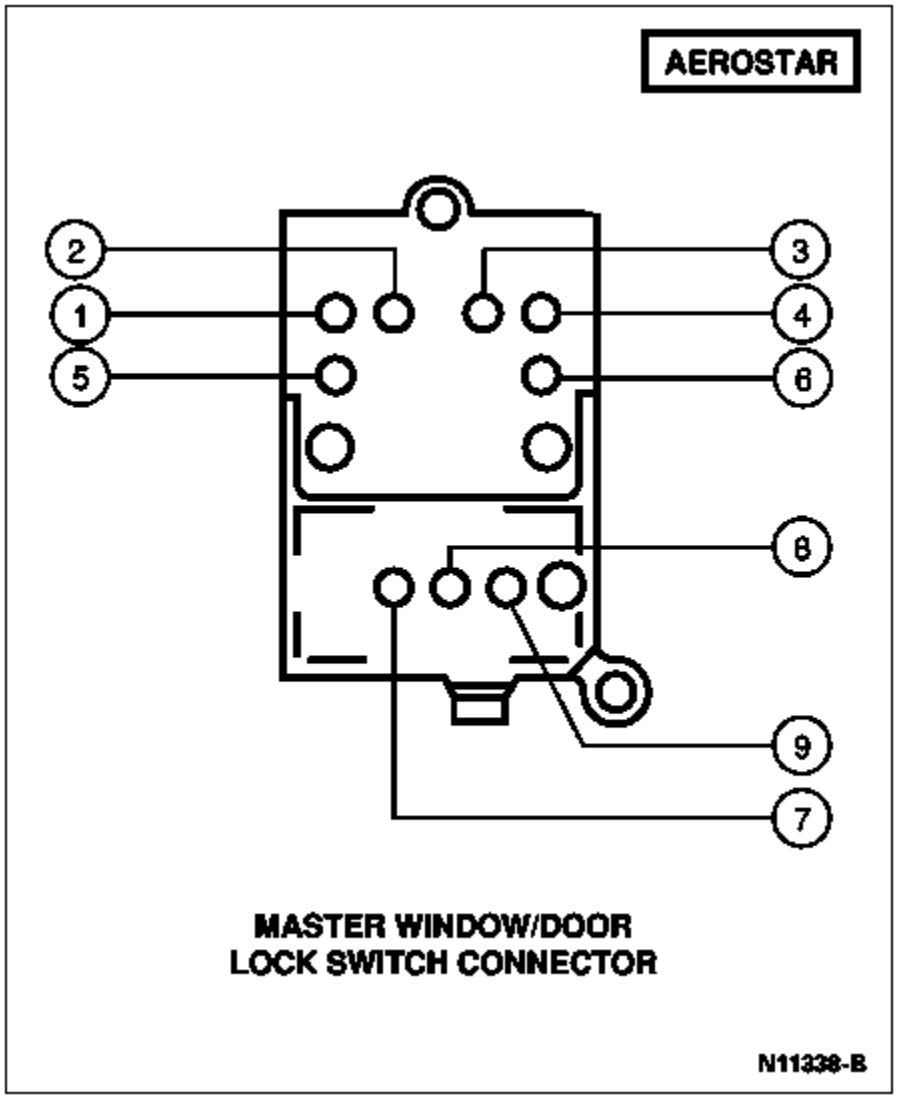
2	313 (W/Y)	LF Window Regulator Switch to LR Window Regulator Motor
3	334 (R/Y)	Window Regulator Switch to Window Regulator Motor
4	333 (Y/R)	Window Regulator Switch to Window Regulator Motor
5	314 (T/LB)	LF Window Regulator Switch to RF Window Regulator Motor
6	—	Not Used
7	120 (PK/LG)	Door Lock Switch (Unlock)
8	171 (BK/W)	Circuit Breaker to Seat Latch Relay
9	119 (PK/Y)	Door Lock Switch (Lock)



Pin Number	Circuit	Circuit Function
1	226 (W/BK)	LF Window Regulator Switch to LF Window Regulator Motor

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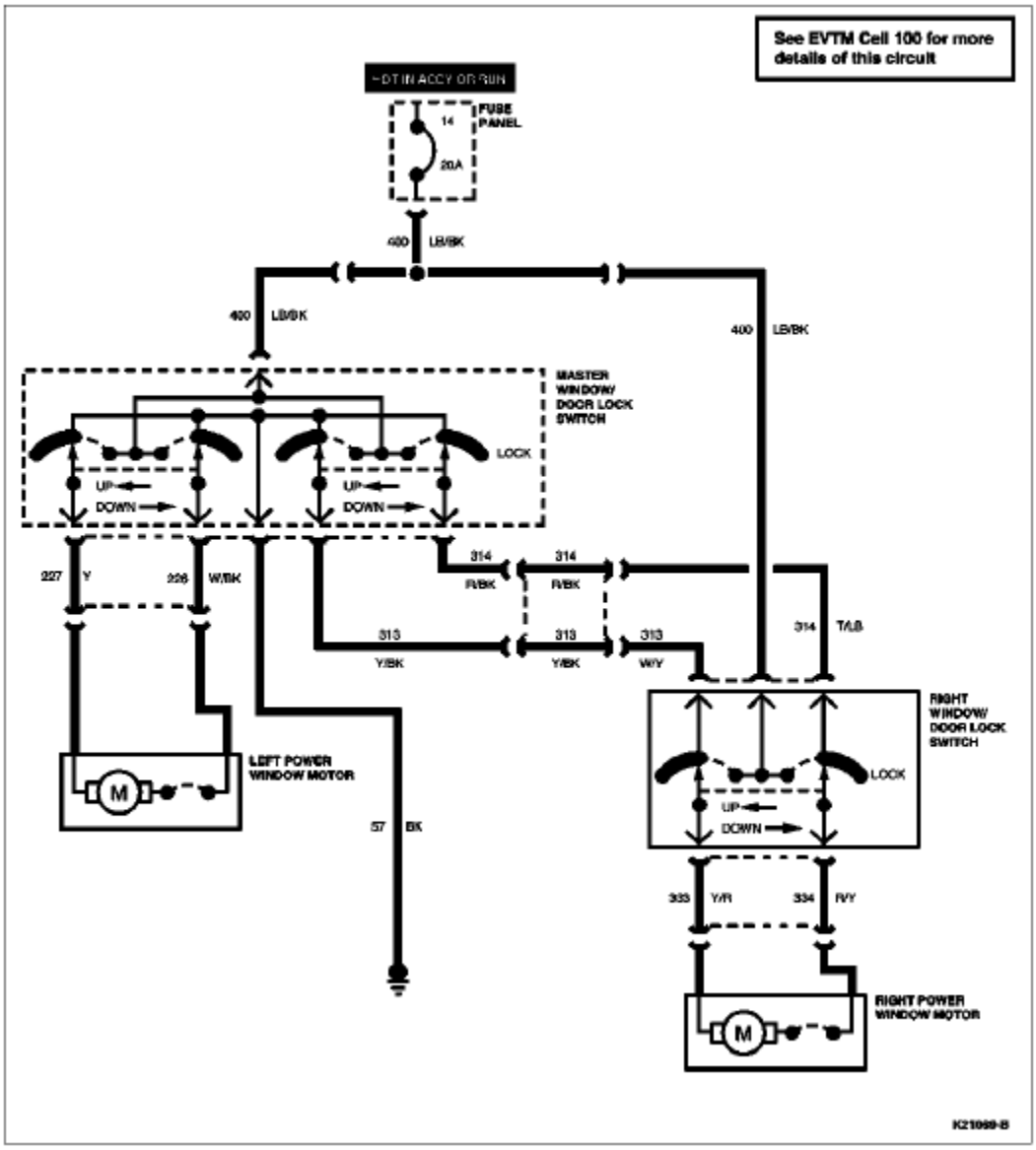
2	227 (Y)	LF Window Regulator Switch to LF Window Regulator Motor
3	314 (T/LB)	LF Window Regulator Switch to RF Window Regulator Motor
4	313 (W/Y)	LF Window Regulator Switch to LR Window Regulator Motor
5	57 (BK)	Ground Circuit
6	400 (LB/BK)	Safety Relay Load Terminal to Window Regulator Switch Feed
7	119 (PK/Y)	Door Lock Switch (Lock)
8	171 (BK/W)	Circuit Breaker to Seat Latch Relay
9	120 (PK/LG)	Door Lock Switch (Unlock)

Power Windows, Aerostar



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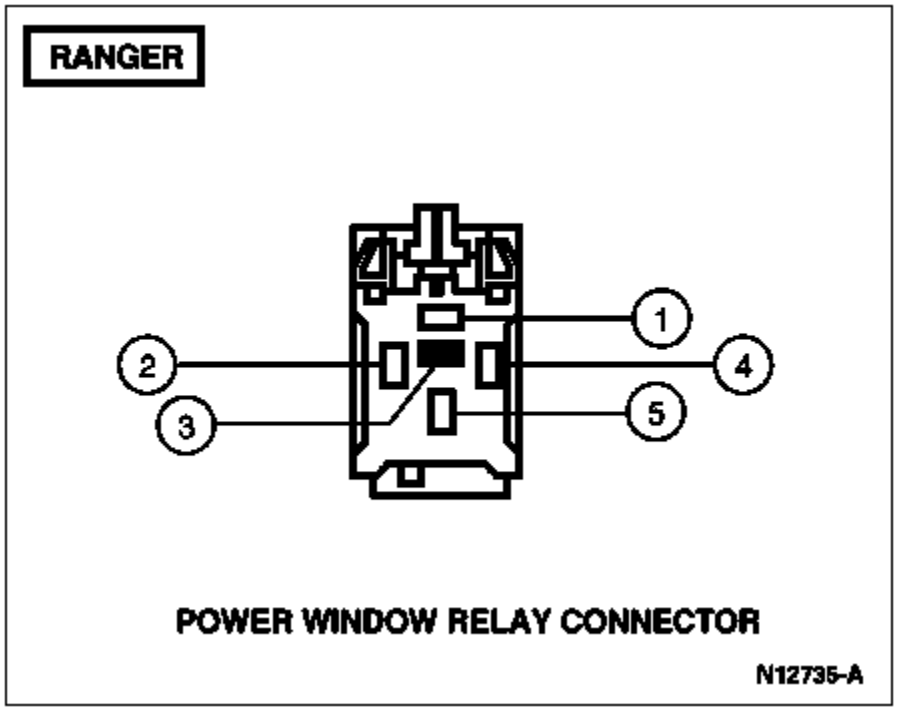

Pin Number	Circuit	Circuit Function
1	171 (BK/W)	Circuit Breaker to Seat Latch Relay
2	57 (BK)	Ground Circuit
3	—	Not Used
4	1006 (DG/W)	GEM — Battery Saver Relay Feed to Delayed Accessory Relay
5	400 (LB/BK)	Safety Relay Load Terminal to Window Regulator Switch Feed

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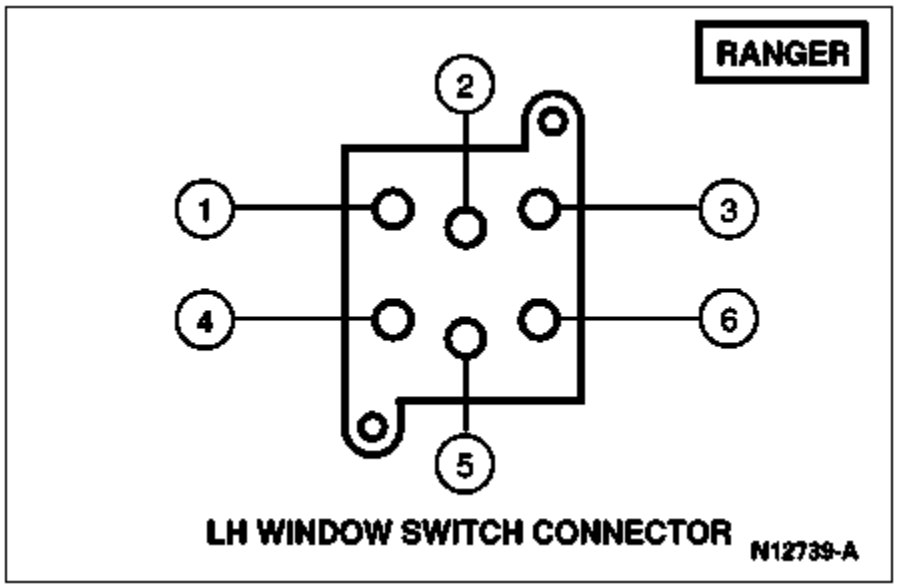
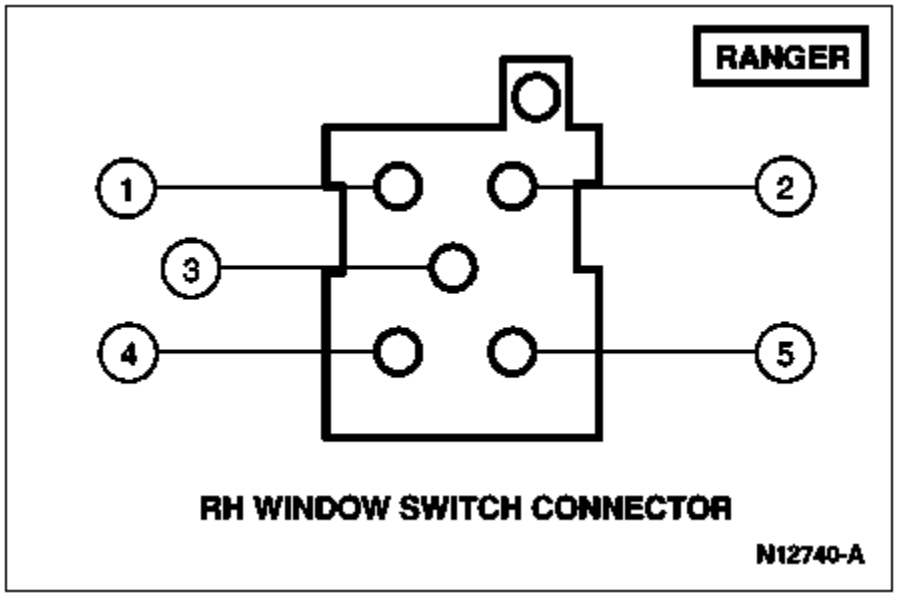


Pin Number	Circuit	Circuit Function
1	314 (T/LB)	LF Window Regulator to RF Window Regulator Motor
2	57 (BK)	Ground Circuit
3	991 (T/LB)	Master Window Control "Down" Command to GEM — Input
4	313 (W/Y)	LF Window Regulator Switch to LR Window Regulator Motor
5	400 (LB/BK)	Safety Relay Load Terminal to Window Regulator Switch Feed
6	992 (W/BK)	Master Window Control "Up" Command to GEM — Input



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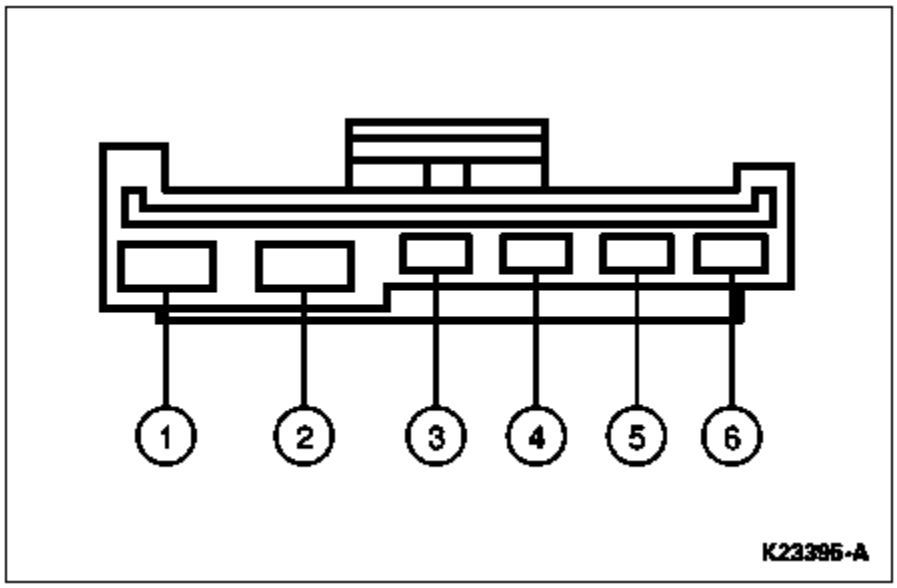
Pin Number	Circuit	Circuit Function
1	333 (Y/R)	Window Regulator Switch to Window Regulator Motor
2	314 (T/LB)	LF Window Regulator Switch to RF Window Regulator Motor
3	400 (LB/BK)	Safety Relay Load Terminal to Window Regulator Switch Feed
4	313 (W/Y)	LF Window Regulator Switch to LR Window Regulator Motor
5	334 (R/Y)	Window Regulator Switch to Window Regulator Motor

Pulse Width Dimmer Module Connector



Pin Number	Circuit	Circuit Function
1	705 (LG/O)	Battery Saver Lamp Feed
2	55 (BK/PK) 53 (BK/LB)	(Ranger Only) Cargo Lamp Switch to Cargo Lamp/Dome Lamp (Explorer Only) Cargo Lamp Switch to Cargo Lamp/Dome Lamp
3	1011 (T/O)	Pulse Width Dimmer Module — Fused Feed
4	19 (LB/R)	Instrument Panel Lamps Feed
5	235 (R/BK)	Lamp Return to Pulse Width Dimmer
6	57 (BK)	Ground Circuit

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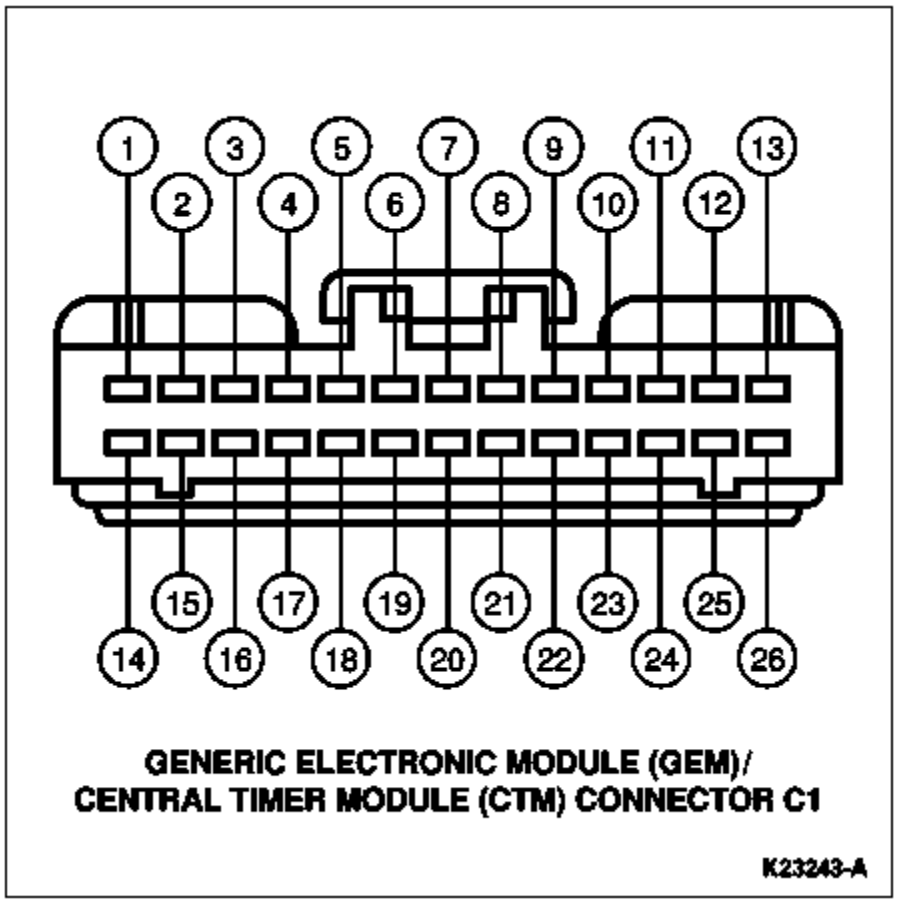

GENERIC ELECTRONIC MODULE (GEM)/ CENTRAL TIMER MODULE (CTM) CONNECTOR C1

Pin Number	Circuit	Circuit Function
1	1010 (LB/O)	Heated Backlite Switch to GEM — Input
2	209 (W/P)	Self Test Input to Module
3	930 (P/LG)	Door Handle Switches to GEM — Input
4	700 (W/P)	Liftgate Ajar Switches to GEM — Input
5	759 (LG/Y)	Left Rear Door Ajar Lamp to GEM — Input
6	760 (PK/LB)	Right Rear Door Ajar Lamp to GEM — Input
7	761 (GY/R)	Passenger Door Ajar Lamp to GEM — Input
8	765 (Y/PK)	Drivers Door Ajar Lamp to GEM — Input
9	627 (BK/O)	Open Door Warning Lamp to Open Door Warning Switch
10	158 (BK/PK)	Key Warning Switch
11	1032 (W/BK)	Park Lamp Switch to Module
12	871 (Y)	Seat Belt Indicator Lamp to Module
13	680 (LB/O)	Front Wiper Switch Relay/Wiper to GEM — Input
14	570 (BK/W)	Dedicated Ground
15	671 (BK)	Front Wiper Motor Status to GEM — Input
16	120 (PK/LG)	Door Lock Switch (Unlock)

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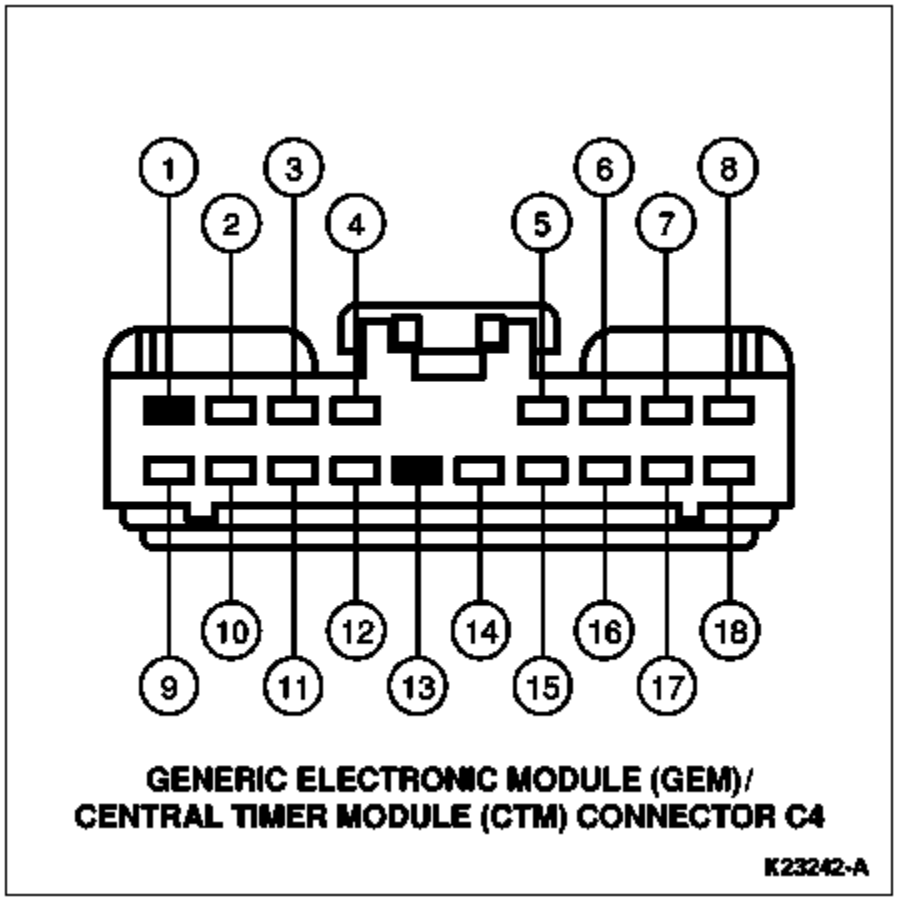
17	25 (DG/P)	Anti-Theft Switch Disarm
18	647 (GY/LB)	GEM to Front Wiper Speed Control Relay — Output
19	646 (Y/W)	GEM Front Wiper Run/Dynamic Brake Relay — Output
20	183 (T/Y)	Tone Request Input
21	359 (GY/R)	Sensor Signal Return
22	684 (PK/Y)	Front Wiper Switch Mode Select to GEM — Input
23	85 (BR/LB)	Seat Belt Warning Timer to LH Front Retractor Switch
24	686 (T/R)	GEM to Front Washer Pump Relay — Input
25	70 (LB/W)	Generic Electronics Module (GEM) ISO Link
26	570 (BK/W)	Dedicated Ground



Pin Number	Circuit	Circuit Function
1	—	Not Used
2	996 (O/W)	Window Motor Current Sense "Low" to GEM — Input (LH)
3	991 (T/LB)	Master Window Control "Down" Command to GEM — Input

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4	992 (W/BK)	Master Window Control "Up" Command to GEM — Input
5	1001 (W/Y)	Fused Battery Feed to GEM — Input
6	1003 (GY/Y)	Fused Ignition "Run" to GEM — Input
7	1007 (Y/R)	GEM to One-Touch "Down" Relay — Output
8	792 (T/Y)	Battery Saver Relay — Fused Feed
9	679 (GY/BK)	Vehicle Speed Sensor — Plus to EC Module
10	995 (GY)	Window Motor Current Sense "High" to GEM — Input (LH)
11	1001 (W/Y)	Fused Battery Feed to GEM — Input
12	1008 (LG/O)	GEM to Interior Lamp Control Relay — Output
13	—	Not Used
14	1000 (R/BK)	Fused Ignition "Start" to GEM — Input
15	1002 (BK/PK)	Fused Ignition "Run/Accessory" to GEM — Input
16	1009 (O/Y)	GEM to Heated Backlite Relay — Output
17	1004 (LB/R)	GEM to Delayed Accessory Relay — Output
18	57 (BK)	Ground Circuit

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Inspection and Verification

1. Visually inspect the components of the power window system to determine if any of the following electrical or mechanical concerns apply.

VISUAL INSPECTION CHART

Mechanical	Electrical
• Window alignment	• Blown fuse
• Window mounting (regulator and bracket) • Window frame interference	• Damage to wiring harness • Loose or corroded connections • Damaged switches

2. Check the wiring harness for obvious signs of shorts, opens, bad connections or damage.

3. If fault is not visually evident, determine the symptom and proceed to the Symptom Chart.

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Symptom Charts

ONE-TOUCH DOWN

Condition	Possible Source	Action
• Accessory Delay is Not Timing Out, DTC B1405, B1302	• Circuit.	• GO to Pinpoint Test A.
• One-Touch Down Feature Inoperative, DTC B1398, B1400, B1404, B1410	• Circuit. • One-touch relay. • Current sense resistor.	• GO to Pinpoint Test B.
• Power Windows Completely Inoperative, DTC B1302, B1398, B1404, B1405, B1408, B1410, B1478	• Fuse. • Circuit. • Control switch. • Delayed accessory relay. • One-touch relay. • Current sense resistor. • Power window motor.	• GO to Pinpoint Test C.
• Window Stuck/Binding	• Glass run channel. • Regulator and guides. • Power window motor.	• GO to Pinpoint Test D.

REAR WINDOW DEFROST

Condition	Possible Source	Action
• Rear Window Defrost Does Not Work, DTC B1345, B1347, B1349, B1355	• Battery. • Fuse. • Circuit. • Rear defrost grid. • Rear defrost relay.	• GO to Pinpoint Test E.
• Rear Window Defrost Will Not Shut Off, DTC B1345, B1347	• Circuit. • Rear defrost relay.	• GO to Pinpoint Test F.
• Rear Window Defrost/Relay Inoperative, DTC B1347, B1349	• Control switch. • Circuit. • Rear defrost relay.	• GO to Pinpoint Test G.

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• Rear Window Defrost Relay Open Circuit, DTC B1347 Self Test	• Circuit. • Rear defrost relay.	• GO to Pinpoint Test H.
• Ignition Run Circuit DTC B1355	• Circuit. • Fuse. • Ignition switch.	• GO to Pinpoint Test J.

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Pinpoint Tests

PINPOINT TEST A: ACCESSORY DELAY IS NOT TIMING OUT, DTC B1405, B1302

A1 PRELIMINARY CHECKS

- Check connections for clean, tight fit.
- Check for loose or damaged wires.

Are connections and wiring OK?

Yes	No
GO to **A2** .	SERVICE connectors and wiring as required. GO to **A2** .

A2 ON-DEMAND SELF TEST

- Connect Rotunda New Generation Star (NGS) tester 007-00500 or equivalent to data link connector (DLC).
- Retrieve continuous DTCs.
- Perform on-demand self test. Refer to Section 18-04A .

Is DTC B1405 retrieved?

Yes	No
GO to **A3** .	DTC B1302 self test and continuous — REPAIR ground short in Circuit 1004 (LB/R) between GEM and delayed accessory relay.

A3 CHECK POWER FEED CIRCUIT

- Disconnect battery negative cable.

  NOTE: Some abnormal drive symptoms may occur after the battery has been disconnected and reconnected. The vehicle may need to be driven 16 km (10 miles) or more to allow the powertrain control module to relearn the adaptive strategy.

- Check for short between battery B+ terminal and Circuit 400 (LB/BK) in power feed to window regulator control switch.

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Is circuit OK?

Yes	No
CHECK delayed accessory relay contacts for short. REPLACE window relay.	REPAIR battery short in Circuit 400 (LB/BK).

PINPOINT TEST B: ONE-TOUCH DOWN FEATURE INOPERATIVE, DTC B1398, B1400, B1404, B1410

B1 PRELIMINARY CHECKS

- Check connections for clean, tight fit.
- Check for loose or damaged wires.

Are connections and wiring OK?

Yes	No
GO to **B2** .	SERVICE connectors and wiring as required. GO to **B2** .

B2 ON-DEMAND SELF TEST

- Connect Rotunda New Generation Star (NGS) tester 007-00500 or equivalent to data link connector (DLC).
- Retrieve continuous DTCs.
- Perform on-demand self test. Refer to Section 18-04A .

Are any DTCs retrieved?

Yes	No
DTC B1398 self test and continuous — GO to **B3** . DTC B1400 self test and continuous, and B1475 self test — REPAIR battery short in Circuit 1007 (Y/R) between GEM and one-touch relay. DTC B1404 continuous — REPAIR open in Circuit 991 (T/LB) between GEM down window command input and SPLICE to master window regulator control switch and one-touch relay. DTC B1410 continuous — GO to **B5** .	CHECK for open in Circuit 996 (O/W) between GEM and LH front window motor. REPAIR as required.

B3 CHECK CIRCUIT 1007 (Y/R)

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- Read PID LFPWRLY.

Does tester indicate Off O-G?

Yes	No
REPAIR open in Circuit 1007 (Y/R) between GEM and one-touch relay.	GO to **B4** .

B4 CHECK CIRCUIT 400 (LB/BK)

- Check for open in Circuit 400 (LB/BK) between one-touch relay and master window regulator control switch.

Is circuit OK?

Yes	No
CHECK for open coil in one-touch relay. REPLACE one-touch relay.	REPAIR open in Circuit 400 (LB/BK) between one-touch relay and master window regulator control switch.

B5 CHECK CIRCUIT 995 (GY)

- Disconnect battery ground cable.

  NOTE: Some abnormal drive symptoms may occur after the battery has been disconnected and reconnected. The vehicle may need to be driven 16 km (10 miles) or more to allow the powertrain control module to relearn the adaptive strategy.

- Check for open in Circuit 995 (GY) between GEM and LH front window motor.

Is circuit OK?

Yes	No
CHECK circuits for intermittent condition. RETEST.	REPAIR open in Circuit 995 (GY) between GEM and LH front window motor.

PINPOINT TEST C: POWER WINDOWS COMPLETELY INOPERATIVE, DTC B1302, B1398, B1404, B1405, B1408, B1410, B1478

C1 PRELIMINARY CHECKS

- Check fuse.
- Check connections for clean, tight fit.
- Check for loose or damaged wires.

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Are connections and wiring OK?

Yes	No
GO to **C2** .	SERVICE connectors and wiring as required. If fuse is blown, GO to **C2** .

C2 ON-DEMAND SELF TEST

- Connect Rotunda New Generation Star (NGS) tester 007-00500 or equivalent to data link connector (DLC).
- Retrieve continuous DTCs.
- Perform on-demand self test. Refer to Section 18-04A .

Are any DTCs received?

Yes	No
DTC B1302 self test and B1398 continuous — GO to **C3** . DTC B1398 self test and continuous, and B1304 self test — REPAIR battery short in Circuit 1004 (LB/R) between GEM and delayed accessory relay. DTC B1398 self test and continuous — GO to **C5** . DTC B1398 self test and continuous and DTC B1404 continuous — REPAIR ground short in Circuit 1007 (Y/R) between GEM and one-touch relay. If fuse was open, REPLACE fuse. CLEAR all DTCs and RETEST. DTC B1404 continuous — GO to **C12** . DTC B1405 self test — GO to **C13** . DTC B1408 self test. Window regulator control switch stuck open. REPLACE window regulator control switch. DTC B1410 self test and continuous — GO to **C14** . DTC B1478 continuous — GO to **C3** . DTC B1408 self test — REPAIR battery short in Circuit 996 (O/W) between GEM and driver window motor.	GO to **C16** .

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C3 CHECK CIRCUIT 705 (LG/O)

- Check for B+ on Circuit 705 (LG/O) between battery saver relay and window relay.

Is B+ present?

Yes	No
GO to **C4** .	REPAIR open in Circuit 705 (LG/O).

C4 CHECK CIRCUIT 1004 (LB/R) FOR OPEN

- Disconnect window relay.
- Check relay coil for open.

Is relay OK?

Yes	No
REPAIR open in Circuit 1004 (LB/R) between GEM and delayed accessory relay.	REPLACE window relay.

C5 CHECK CIRCUIT 171 (BK/W) FOR BATTERY VOLTAGE

- Check for B+ on Circuit 171 (BK/W) between window relay and fuse panel.

Is B+ present?

Yes	No
GO to **C6** .	REPAIR open in circuit 171 (BK/W) between delayed accessory relay and fuse panel.

C6 CHECK OPEN CIRCUIT

- Check for open in circuit between fuse panel and power distribution box.

Is circuit OK?

Yes	No
GO to **C7** .	REPAIR open in circuit between fuse panel and power distribution box.

C7 CHECK POWER TO FUSE

- Check for B+ to fuse in power distribution box.

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Is B+ present?

Yes	No
GO to **C8** .	REPAIR open in power feed circuit to fuse in power distribution box.

C8 CHECK FOR GROUND SHORT

- Check for ground short in circuit between fuse panel and power distribution box.

Is circuit OK?

Yes	No
GO to **C9** .	REPAIR ground short in circuit between fuse panel and power distribution box.

C9 CHECK CIRCUIT 171 (BK/W)

- Check for ground short in Circuit 171 (BK/W) between fuse panel and window relay.

Is circuit OK?

Yes	No
GO to **C10** .	REPAIR ground short in Circuit 171 (BK/W) between fuse panel and delayed accessory relay.

C10 CHECK FOR OPEN IN CIRCUIT

- Check for open in Circuit 400 (LB/BK) between window relay and master window regulator control switch.

Is circuit OK?

Yes	No
GO to **C11** .	REPAIR open in Circuit 400 (LB/BK) between delayed accessory relay and master window control switch.

C11 CHECK FOR GROUND SHORT IN CIRCUIT

- Check for ground short in Circuit 400 (LB/BK) between window relay and master window regulator control switch.

Is circuit OK?

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Yes	No
GO to C12 .	REPAIR ground short in Circuit 400 (LB/BK).

C12 CHECK CIRCUIT 995 (GY) FOR OPEN

- Disconnect battery ground cable.

  NOTE: Some abnormal drive symptoms may occur after the battery has been disconnected and reconnected. The vehicle may need to be driven 16 km (10 miles) or more to allow the powertrain control module to relearn the adaptive strategy.

- Check for open in Circuit 995 (GY) between one-touch relay and LH front window motor.

Is circuit OK?

Yes	No
GO to C13 .	REPAIR open in Circuit 995 (GY) between one-touch relay and LH front window motor.

C13 CHECK ONE-TOUCH RELAY

- Disconnect battery ground cable.

  NOTE: Some abnormal drive symptoms may occur after the battery has been disconnected and reconnected. The vehicle may need to be driven 16 km (10 miles) or more to allow the powertrain control module to relearn the adaptive strategy.

- Check one-touch relay for shorted closed contacts.

Is one-touch relay OK?

Yes	No
GO to C14 .	REPLACE one-touch relay.

C14 CHECK CIRCUIT 992 (W/BK) FOR OPEN

- Check for open in Circuit 992 (W/BK) between window motor and master window regulator control switch.

Is circuit OK?

Yes	No
GO to C15 .	REPAIR Circuit 992 (W/BK) between window motor and master window regulator control switch.

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C15 VERIFY MOTOR OPEN WINDING

- Reconnect all connectors.
- Reconnect battery ground cable.
- Perform one-touch window functional test. Refer to Section 18-04A .
- Energize one-touch relay.

Does window go down?

Yes	No
WIGGLE connectors for all affected circuits to isolate any intermittent connections and RERUN self test for any DTCs.	CHECK window motor for open winding. SERVICE or REPLACE as required.

C16 CHECK CIRCUIT 991 (T/LB)

- Disconnect battery ground cable.

  NOTE: Some abnormal drive symptoms may occur after the battery has been disconnected and reconnected. The vehicle may need to be driven 16 km (10 miles) or more to allow the powertrain control module to relearn the adaptive strategy.

- Check for open in Circuit 991 (T/LB) between master window regulator control switch and one-touch relay.

Is circuit OK?

Yes	No
LOCATE open in Circuit 991 (T/LB) between one-touch relay and GEM. REPAIR as required.	REPAIR open in Circuit 991 (T/LB) between master window regulator control switch and one-touch relay.

PINPOINT TEST D: WINDOW STUCK/BINDING

D1 CHECK FOR OBSTRUCTION

- Inspect the glass run for foreign objects or debris.
- Inspect inside the door for possible obstruction of the window regulator movement.

Is there a door window glass obstruction?

Yes	No
REMOVE obstruction and RETEST.	GO to **D2** .

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D2 LUBRICATION CHECK

- Observe window movement to determine if condition is caused only by lack of lubrication: No obstructions, damaged, loose or misaligned parts.

Is there a lubrication concern?

Yes	No
LUBRICATE as necessary. REFER to the procedures in Lubrication in this section.	GO to **D3**.

D3 FRONT DOOR BELT LINE WEATHERSTRIP CHECK

- Inspect both front door belt line weatherstrip for proper installation.

Is there a weatherstrip concern?

Yes	No
ALIGN and INSTALL the weatherstrip and RETEST.	GO to **D4**.

D4 CHECK DOOR GLASS RUN RETAINERS AND WINDOW REGULATOR

- Inspect the door glass run retainers inside the door for proper installation and alignment.
- Inspect the window regulator for proper installation.

Is there a run retainer or regulator concern?

Yes	No
CORRECT installation or alignment as necessary. REFER to the procedures in Adjustments, Door Window Glass in this section.	DETERMINE the worn or damaged component and REPAIR or REPLACE as necessary.

PINPOINT TEST E: REAR WINDOW DEFROST DOES NOT WORK, DTC B1345, B1347, B1349, B1355

E1 PRELIMINARY TEST

- Make sure battery is fully charged.
- Check battery connections for clean tight fit.
- Check fuse or rear window defrost relay in power distribution box.
- Check fuse to rear window defrost relay in fuse panel.

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Do components check OK?

Yes	No
GO to **E2** .	SERVICE or REPLACE as required.

E2 ON-DEMAND SELF TEST

- Connect Rotunda New Generation Star (NGS) tester 007-00500 or equivalent to Data Link Connector (DLC).
- Retrieve continuous diagnostic trouble codes (DTCs).
- Run on-demand self test. Refer to Section 18-04A .
- Record DTCs.

NOTE: Perform the individual tests for each DTC retrieved during the on-demand self test.

Are any DTCs received?

Yes	No
DTC B1345 self test — GO to **G5** . DTC B1347 self test and continuous — GO to **G1** . DTC B1349 self test and continuous — GO to **G1** . DTC B1355 — GO to **J1** .	GO to **E3** .

E3 FUNCTIONAL TEST

- Energize rear window defrost relay.
- Check for B+ on Circuit 186 (BR/LB) between rear window defrost grid connector and rear window defrost relay.

Is B+ present?

Yes	No
GO to **E4** .	GO to **E5** .

E4 CHECK GROUND

- Check for continuity between rear window defrost grid (ground side) and ground.

Is there continuity?

Yes	No

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REPAIR or REPLACE rear window defrost grid.	REPAIR rear window defrost ground circuit.

E5 CHECK CIRCUIT 186 (BR/LB)

- Check continuity between rear window defrost grid connector and rear window defrost relay on Circuit 186 (BR/LB).

Is there continuity?

Yes	No
GO to **E6** .	REPAIR open in Circuit 186 (BR/LB).

E6 CHECK CIRCUIT 298 (P/O)

- Check continuity along circuit between rear window defrost relay and power I/P fuse panel.

Is there continuity?

Yes	No
Rear window defrost relay stuck open. REPLACE rear window defrost relay.	REPAIR open in Circuit 298 (P/O). If system is still inoperative, GO to Pinpoint Test J .

PINPOINT TEST F: REAR WINDOW DEFROST WILL NOT SHUT OFF, DTC B1345, B1347

F1 ON-DEMAND SELF TEST

- Connect Rotunda New Generation Star (NGS) tester 007-00500 or equivalent to Data Link Connector (DLC).
- Retrieve continuous diagnostic trouble codes (DTCs).
- Run on-demand self test. Refer to Section 18-04A .
- Record DTCs.

NOTE: Perform the individual tests for each DTC retrieved during the on-demand self test.

Are any DTCs received?

Yes	No
DTC B1345 self test — GO to **G5** . DTC B1347 self test and continuous — GO to **G1** .	GO to **F2** .

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F2 CHECK REAR WINDOW DEFROST RELAY CONTACTS

- Disconnect rear window defrost relay.
- Check for continuity between rear window defrost relay contact terminals 1 and 5.

Is there continuity?

Yes	No
REPLACE rear window defrost relay.	REPAIR battery short to rear window defrost Circuit 186 (BR/LB).

PINPOINT TEST G: REAR WINDOW DEFROST/RELAY INOPERATIVE, DTC B1347, B1349

G1 CHECK CIRCUIT 1009 (O/Y)

- Key OFF.
- Disconnect rear window defrost relay connector.
- Read PID RDEFRLY.

Does tester indicate OFF?

Yes	No
REPAIR battery short in Circuit 1009 (O/Y).	GO to G2 .

G2 CHECK CIRCUIT 186 (BR/LB)

- Key OFF.
- Check for battery short in Circuit 186 (BR/LB) between rear window defrost relay and fuse panel.

Is circuit OK?

Yes	No
GO to G3 .	REPAIR battery short in Circuit 186 (BR/LB).

G3 CHECK CIRCUIT 1010 (DB/O) FOR OPEN

- Disconnect rear window defrost relay connector.
- Check for continuity to ground in Circuit 1010 (DB/O).

Is there continuity?

Yes	No

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REPAIR open in Circuit 1010 (DB/O).	GO to **G4** .

G4 CHECK FOR INTERMITTENT SHORT

- Wiggle Circuit 1010 (DB/O) between rear window defrost relay and GEM.
- Wiggle Circuit 298 (P/O) between heated backlite relay coil and fuse panel.
- Rerun self test.

Is DTC B1347 set?

Yes	No
GO to **G5** .	Rear window defrost relay circuit OK.

G5 CHECK CIRCUIT 1010 (DB/O) FOR SHORT

- Disconnect rear window defrost switch and light from harness connector.
- Read PID RDEF-SW.

Does tester indicate rear window defrost switch and light ON?

Yes	No
REPAIR ground short in Circuit 1010 (DB/O).	REPLACE rear window defrost switch and light.

PINPOINT TEST H: REAR WINDOW DEFROST RELAY OPEN CIRCUIT, DTC B1347 SELF TEST

H1 DETERMINE IF CONDITION IS INTERMITTENT

- Compare continuous DTCs with on-demand self test DTCs.

Was DTC B1347 set during on-demand self test?

Yes	No
GO to **H2** .	GO to **H4** .

H2 CHECK REAR WINDOW DEFROST RELAY

- Disconnect rear window defrost relay.
- Check rear window defrost relay for open coil.

Is rear window defrost relay OK?

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Yes	No
GO to H3 .	REPLACE rear window defrost relay.

H3 CHECK CIRCUIT 298 (P10)

- Check for continuity in Circuit 298 (P10) between rear window defrost relay and fuse panel.

Is there continuity?

Yes	No
REPAIR open in Circuit 1009 (O/Y).	REPLACE open in Circuit 298 (P10).

H4 CHECK FOR INTERMITTENT OPEN

- Wiggle Circuit 1009 (O/Y) between rear window defrost relay and GEM.

Is DTC B1347 set?

Yes	No
GO to H2 .	Rear window defrost relay circuit OK.

PINPOINT TEST J: IGNITION RUN CIRCUIT DTC B1355

J1 CHECK FUSE 32

- Disconnect battery ground cable.

  NOTE: When the battery is disconnected, some abnormal drive symptoms may occur. The vehicle may need to be driven 16 km (10 miles) or more so the powertrain control module can relearn the adaptive strategy.

- Check fuse 32 to Circuit 186 (BR/LB).

Is fuse OK?

Yes	No
CHECK for continuity in Circuit 186 (BR/LB) between heated backlite relay and fuse panel. REPAIR as required. GO to J2 .	REPAIR short to ground in Circuit 186 (BR/LB) between fuse panel and rear window defrost relay. REPLACE fuse. GO to J2 .

J2 CHECK FUSE TO IGNITION SWITCH

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- Check fuse to ignition switch power feed Circuit 687 (GY/Y).

Is fuse OK?

Yes	No
CHECK continuity from fuse to ignition switch. REPAIR as required. GO to **J5** .	GO to **J3** .

J3 CHECK FOR GROUND SHORT IN CIRCUIT

- Disconnect harness from ignition switch.
- Check for ground short in circuit from fuse in power distribution box to ignition switch.

Is circuit OK?

Yes	No
GO to **J4** .	REPAIR ground short in circuit. REPLACE fuse. GO to **J5** .

J4 CHECK FOR GROUND SHORT

- Check for ground short in circuit from ignition switch to fuse in fuse panel.

Is circuit OK?

Yes	No
SERVICE or REPAIR ignition switch as required.	CHECK continuity from ignition switch to fuse panel. REPAIR as required. GO to **J5** .

J5 CHECK FUSE

- Check fuse to Circuit 298 (P/O).

Is fuse OK?

Yes	No
CHECK continuity in Circuit 298 (P/O) from fuse panel to heated backlite relay. REPAIR as required. RECONNECT battery.	CHECK for ground short in Circuit 298 (P/O) from fuse panel to heated backlite relay. SERVICE as required. REPLACE fuse. RECONNECT battery.

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Component Tests

Switch Tests, Window

Master Switch, Aerostar

Testing of the power window multiple switch should be performed with the switch removed from the vehicle. Refer to the appropriate procedures in this section. Use a self-powered test lamp or an ohmmeter such as Rotunda Digital Volt-Ohmmeter 014-00407 or equivalent.

1. Clip one test lead probe on Pin No. 6 which is grounded.
2. With both switches in the neutral position, Pins No. 1 through 4 should have continuity to Pin No. 6.
3. Push both window switches upward (toward window when in installed position). Both Pins No. 1 and 3 should have no continuity to Pin No. 6.
4. Push both window switches downward (away from window when in installed position). Both Pins No. 2 and 4 should have no continuity to Pin No. 6.
5. Remove the test lead from Pin No. 6 and connect to Pin No. 5 (hot feed pin). With both switches in the neutral position, Pin No. 5 should have continuity only with itself.
6. Push both window switches upward (toward the window when in installed position). Both Pins No. 1 and 3 should have continuity to Pin No. 5.
7. Push both window switches downward (away from the window when in installed position). Both Pins No. 2 and 4 should have continuity to Pin No. 5.
8. If any one switch does not test as stated, replace the complete switch assembly.

Power Window Multiple Pin Connections and Locations, Aerostar

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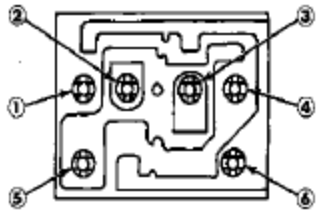
CONNECT ONE SIDE OF AN OHMMETER SELF-POWERED OR TEST LAMP TO TERMINAL NO. 5 (BATTERY TERMINAL) AND THE OTHER SIDE TO THE TERMINALS SHOWN BELOW.

WINDOW SWITCH POSITION	CONTINUITY BETWEEN TERMINALS
NEUTRAL	NO. 5
RIGHT FRONT — UP	NO. 3
RIGHT FRONT — DOWN	NO. 4
LEFT FRONT — UP	NO. 1
LEFT FRONT — DOWN	NO. 2

CONNECT ONE SIDE OF AN OHMMETER SELF-POWERED OR TEST LAMP TO TERMINAL NO. 6 (GROUND TERMINAL) AND THE OTHER SIDE TO THE TERMINALS SHOWN BELOW.

WINDOW SWITCH POSITION	CONTINUITY BETWEEN TERMINALS
NEUTRAL	NOS. 1, 2, 3, 4
RIGHT FRONT — UP	NOS. 1, 2 AND 4
RIGHT FRONT — DOWN	NOS. 1, 2 AND 3
LEFT FRONT — UP	NOS. 2, 3 AND 4
LEFT FRONT — DOWN	NOS. 1, 3 AND 4



1. LEFT FRONT "UP" TERMINAL
2. LEFT FRONT "DOWN" TERMINAL
3. RIGHT FRONT "UP" TERMINAL
4. RIGHT FRONT "DOWN" TERMINAL
5. HOT FEED WHEN IGNITION SWITCH IS "ON"
6. GROUND TERMINAL

N5031-2F

Master Switch, Ranger

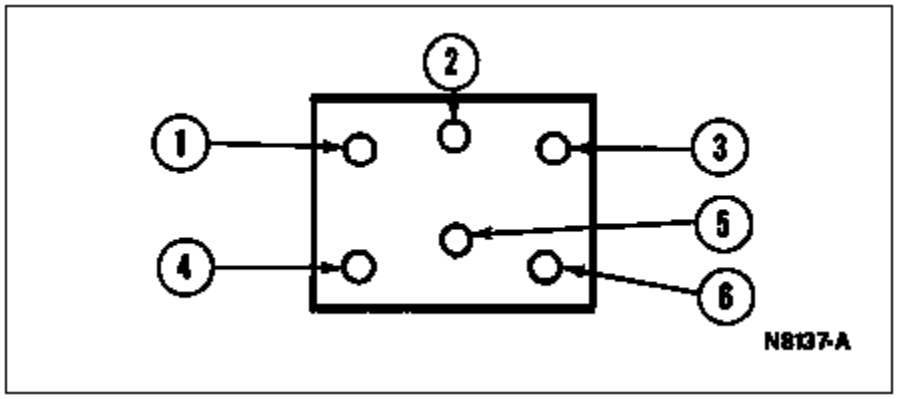
1. **NOTE: Use a self-powered test lamp or an ohmmeter such as Rotunda Digital Volt-Ohmmeter 014-00407 or equivalent to test the power window switch.**

   With the switch in the NEUTRAL position, there should be continuity between terminals 1, 3, 4, 5 and 6.

2. When the ribbed portions of the switch rocker knobs are pushed (to close the windows), there should be continuity between terminals 1, 2, and 3 and terminals 4, 5 and 6.

3. When the flat portions of the switch rocker knobs are pushed (to open the windows), there should be continuity between terminals 1, 3 and 5 and terminals 2, 4 and 6.

4. If the switch assembly does not test as outlined, replace the switch.



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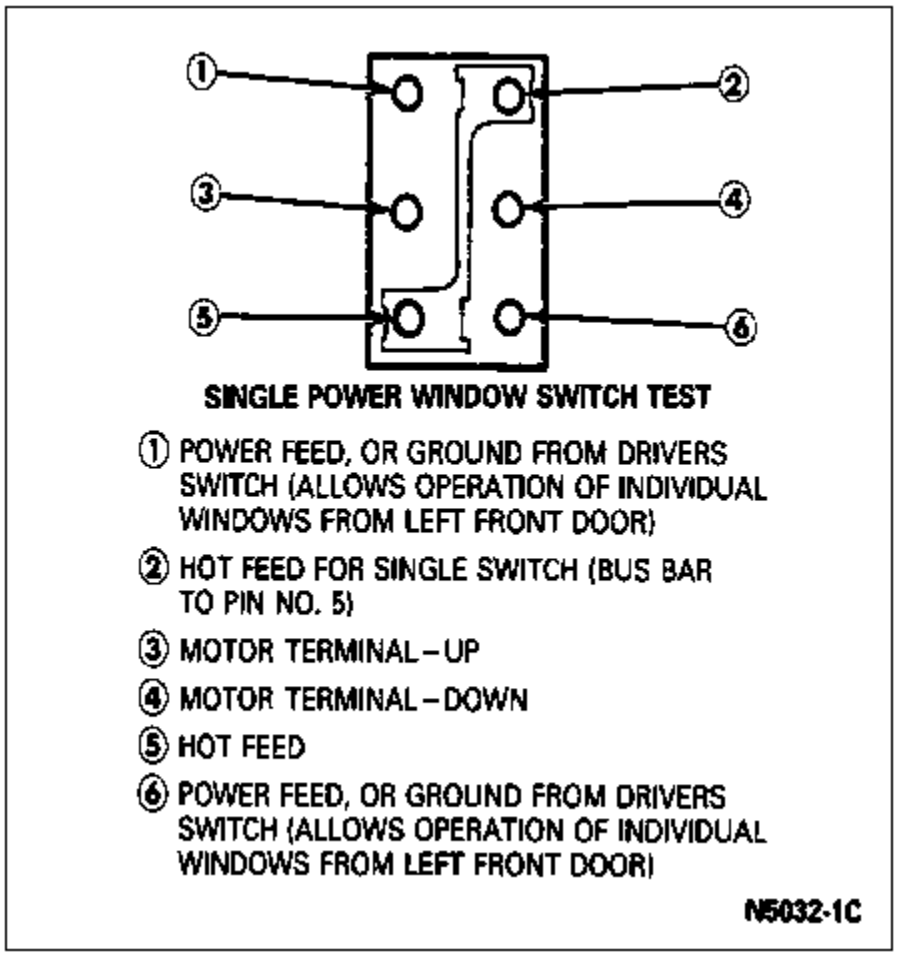
Single Switch

1. Use a self-powered test light or an ohmmeter such as Rotunda Digital Volt-Ohmmeter 014-00407 or equivalent to test the window regulator control switch.
2. With the switch in the neutral position, there should be continuity between terminals 1 and 3, 2 and 5 and 4 and 6.
3. With the toggle switch pushed downward, there should be continuity between terminals 2, 4 and 5, and 1 and 3. Terminal 6 should be disconnected from any other terminal.
4. With the toggle switch pushed upward, there should be continuity between terminals 2, 3 and 5, and 4 and 6. Terminal 1 should be disconnected from any other terminal.
5. If the window regulator control switch does not test as stated, replace the window regulator control switch.



SINGLE POWER WINDOW SWITCH TEST

① POWER FEED, OR GROUND FROM DRIVERS SWITCH (ALLOWS OPERATION OF INDIVIDUAL WINDOWS FROM LEFT FRONT DOOR)
② HOT FEED FOR SINGLE SWITCH (BUS BAR TO PIN NO. 5)
③ MOTOR TERMINAL – UP
④ MOTOR TERMINAL – DOWN
⑤ HOT FEED
⑥ POWER FEED, OR GROUND FROM DRIVERS SWITCH (ALLOWS OPERATION OF INDIVIDUAL WINDOWS FROM LEFT FRONT DOOR)

N5032-1C

Heated Back Window Switch and Light, Aerostar

1. Ground Pin 4 and connect a jumper wire between Pins 3 and 2. Connect a 12-volt test light between

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Pin 1 and ground.

2. Apply power to Pin 2. The test light and the ON indicator should **not** come on.

3. Momentarily push the right side of the rocker button to the ON position. The test light and the ON indicator should come on and stay on after the rocker button returns to the normal position.

4. The test light and the ON indicator should go off under one or more of the following conditions:

    - Left side of rocker button is moved to OFF position.
    - Approximately ten minutes have elapsed.
    - Jumper wire between Pin 3 and 2 is disconnected.

Window Regulator Electric Drive

To test the current draw of a power window motor, remove the door trim panel. Refer to Section 01-05A or Section 01-05B .

1. Disconnect the motor lead.

2. Disconnect the regulator mechanism from the motor.

3. Supply power to motor lead connector with an ammeter in series.

4. Operate the motor and observe the current draw. The current draw for the no-load test should not exceed four amps and should not fluctuate. Reversal of the motor wire connections will reverse the direction of motor rotation. Replace the motor if the current draw exceeds four amps.

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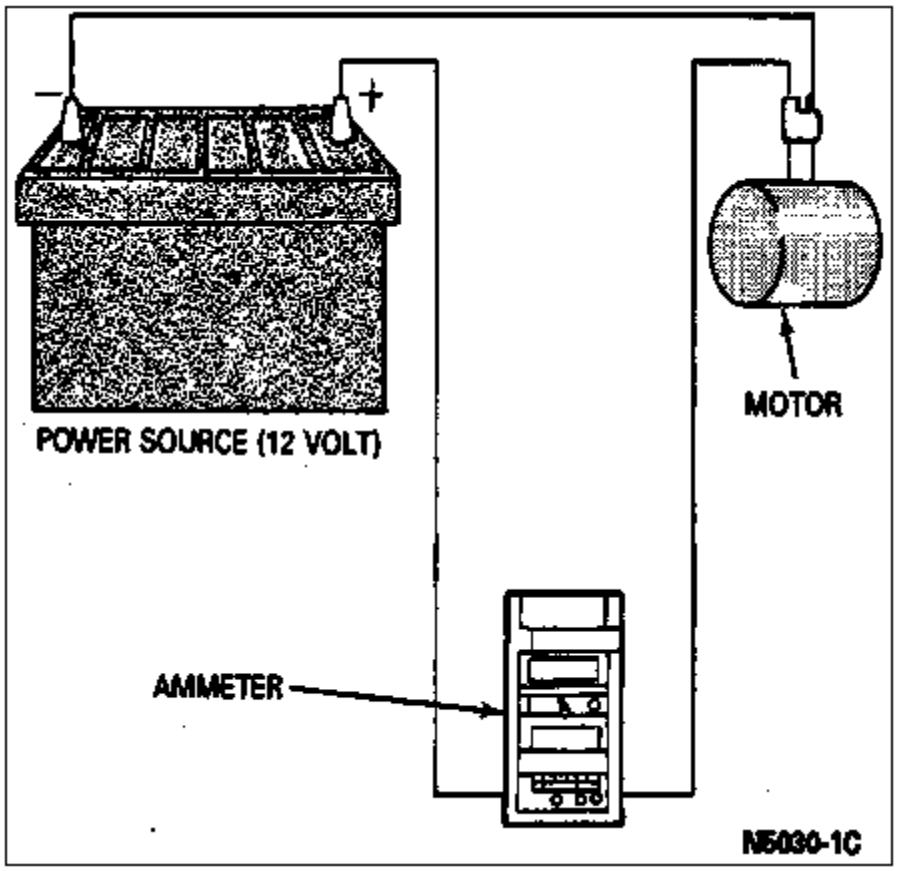

Heated Back Window Grid Wire Test, Aerostar

1. Using a strong light inside the vehicle, visually inspect the wire grid from the outside. A broken grid wire will appear as a brown spot.

2. Run the engine on idle. Set the control switch to ON. The indicator light should come on.

3. Working inside the vehicle with a 12-volt DC voltmeter, contact the broad red-brown strips (bus bars) on the rear window. (Positive lead to battery side and negative lead to ground side. The meter should read 10-13 volts. A lower voltage reading indicates a poor connection or a low battery.

4. Contact a good ground point with the negative lead of the meter. The voltage reading should not change.

5. With the negative lead of the meter grounded, touch each grid line of the heated rear window at its midpoint with the positive ground lead. A reading of approximately 6 volts indicates that the line is good. A reading of zero (0) volts indicates that the line is broken between the midpoint and the B+ side of the grid line. A reading of 12 volts indicates that the circuit is broken between the midpoint of the grid line and ground.

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Door Window Glass, Ranger, Aerostar

Removal

1. Remove front door trim panel (23942) and front door trim shield (237A04). Refer to Section 01-05A or Section 01-05B .
2. Raise front door window glass (21410) to full up position.
3. Remove rear glass run retainer from front door (20124).
4. Lower front door window glass to gain access to front door window channel bracket and glass retention rivets.
5. **NOTE: Use care when drilling not to damage glass bracket and spacer/retainers.**

   Remove center pin from the glass retention rivets using a drift punch. Then, use a 6.35mm (1/4-inch) diameter drill and drill out each rivet.
6. Remove the front door window glass through the door window opening.

Installation

1. Install spacer and retainer into glass retention holes.
2. Install front door window glass into front door through the door window opening.
3. Position the front door window glass to the front door window channel bracket and align with the retaining holes.
4. Install retaining rivets.
5. Raise front door window glass to full up position.
6. Install the rear glass run retainer.
7. Cycle front door window glass up and down to check operation.
8. Install front door trim shield and front door trim panel.

Front Door, Aerostar

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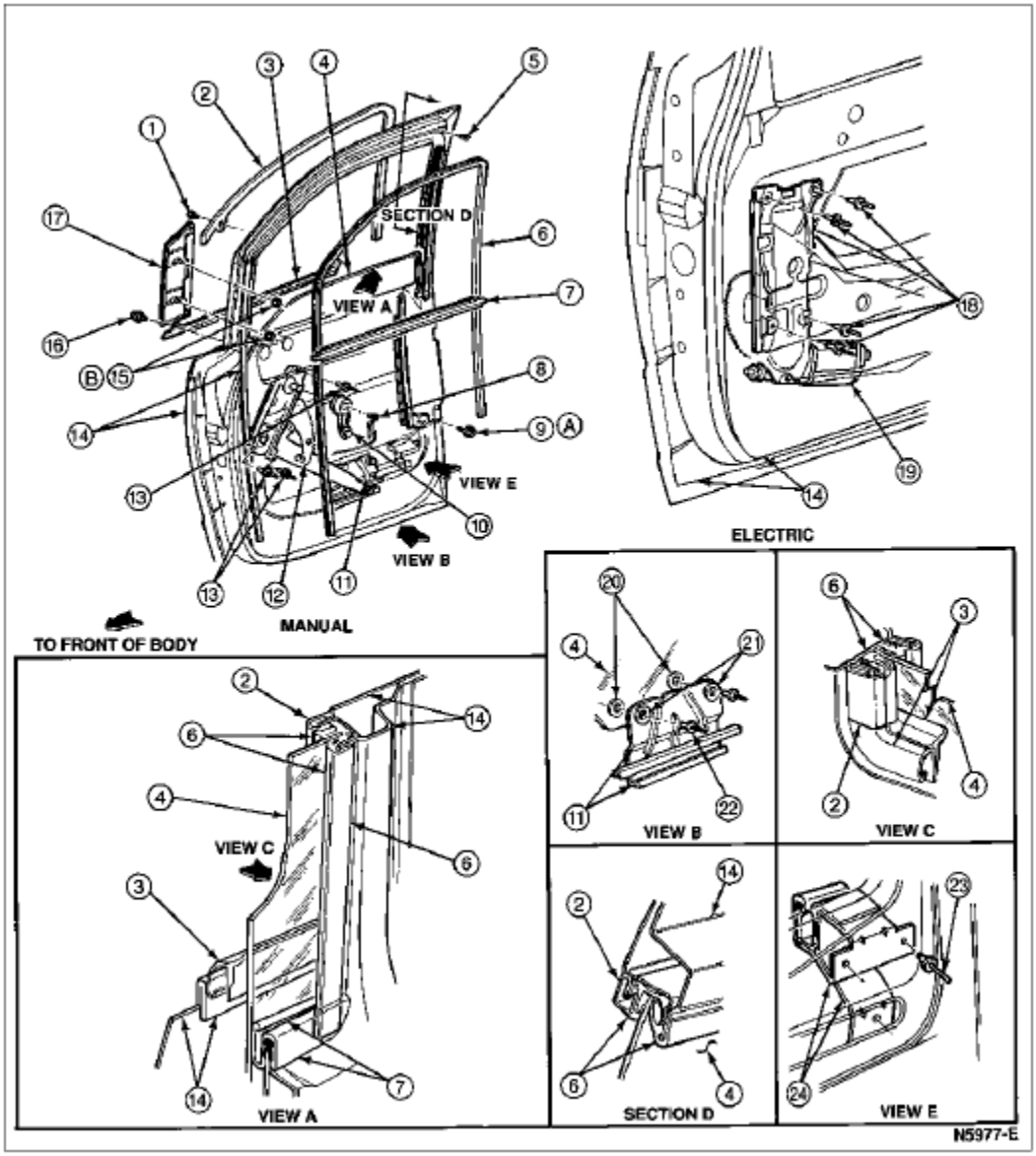

Item	Part Number	Description
1	N801775-S47	Screw, Drill Point
2	208A96	Front Door Outside Moulding, Top
3	21446	Front Door Bolt Line Outside Weatherstrip
4	21410	Front Door Window Glass
5	378744-5	Bumper (1 Req'd Each Side)
6	21596	Front Door Glass Top Run
7	21456	Front Door Belt Line Inside Weatherstrip
8	390334-S	Screw, Window Regulator Handle
9	N800510-S100	Screw and Washer, Front Door Glass Run Latch Side Retainer-to-Front Door

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10	23342	Window Regulator Handle
11	23288	Front Door Window Channel Bracket
12	23200	Front Door Window Regulator
13	385189-S100	Oval Rivet
14	20124	Front Door
15	N805169-S	Nut (2 Req'd Each Side)
16	N801775-S47	Screw
17	20550	Front Door Window Moulding
18	385189-S100	Oval Head Rivet (4 Req'd Each Side)
19	23394	Window Regulator Electric Drive
20	234A46	Retainer (2 Req'd Each Side)
21	234A44	Window Glass Spacer
22	385323-S100	Rivet (2 Req'd Each Side)
23	22380	Door Window Stabilizer
24	388047-S101	Rivet
A	—	Tighten to 7-11 Nm (62-97 Lb-In)
B	—	Tighten to 5-7 Nm (45-61 Lb-In)

Front Door Window Glass and Mechanisms, Ranger

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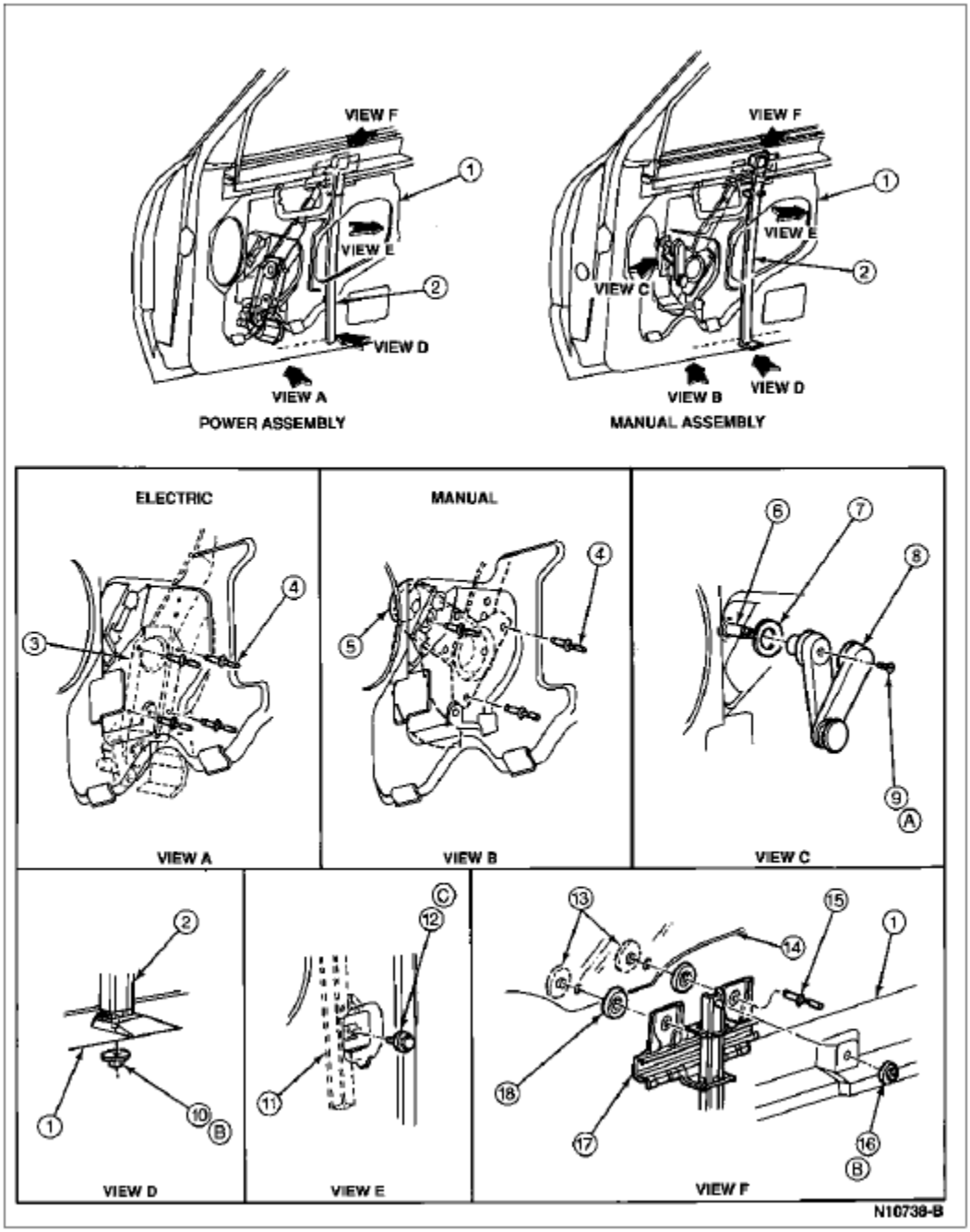

Item	Part Number	Description
1	20124	Front Door
2	21546	Door Glass Guide Track
3	23200	Front Door Window Regulator, Manual
4	W525172-S	Rivet, Window Regulator-to-Front Door
5	23200	Front Door Window Regulator, Power
6	—	Shaft, Front Door Window Regulator (Part of 23200)
7	23370	Plate, Window Regulator Handle

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8	23342	Handle, Window Regulator
9	390334-S7	Screw, Window Regulator Handle
10	N621907-S102	Nut, Door Glass Guide Track, Lower
11	222A00	Front Door Glass Run Latch Side Retainer
12	N800510-S36	Bolt, Latch Side Retainer-to-Front Door
13	234A46	Door Window Glass Channel Bracket Retainer
14	21410	Front Door Window Glass
15	385323-S100	Rivet, Front Door Window Channel Bracket-to-Front Door
16	N62107-S102	Nut, Door Glass Guide Track, Upper
17	23288	Front Door Window Channel Bracket
18	234A44	Door Window Glass Bracket Spacer
A	—	Tighten to 4-5 Nm (31-45 Lb-In)
B	—	Tighten to 8-10 Nm (68-92 Lb-In)
C	—	Tighten to 11-13 Nm (91-122 Lb-In)

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Window Regulator, Power, Manual, Ranger

Removal and Installation

1. **NOTE: Refer to illustration in Removal and Installation, Door Window Glass, Ranger, Aerostar .**

   If removing a power window regulator, disconnect the battery ground cable.

2. Remove the front door window glass (21410). Refer to the procedure in this section.

3. If equipped, disconnect the window regulator electric drive from the door wiring.

4. Drill out the window regulator-to-front door rivets (three for manual, five for electric).

5. Remove the upper and lower door glass guide track-to-front door nuts.

6. If removing the power window regulator, remove the window regulator electric drive and the power window regulator as an assembly.

7. Remove the window regulator from the vehicle.

8. If necessary, remove the window regulator electric drive from the power window regulator.

To install, use new rivets (or equivalent threaded fasteners), and reverse the removal procedure. Tighten window regulator fasteners to 11-13 Nm (91-122 lb-in).

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Window Regulator, Aerostar

Front Door

Removal

1. **NOTE: Refer to illustration in Removal and Installation, Door Window Glass, Ranger, Aerostar .**

   Remove the front door trim panel and front door trim shield. Refer to Section 01-05B .

2. If equipped with power windows, disconnect the wire from the window regulator electric drive.

3. Remove the front door window glass (21410) as described in this section.

4. Remove the front door glass run latch side retainer, if equipped (one screw), and remove it through the door window opening.

5. Remove the glass bracket assembly, from the front door (20124), sliding the bracket C-channel off the regulator arm side/roller.

6. **NOTE: Be careful not to damage sheet metal holes during drilling.**

   Remove the center pin from the regulator attaching rivets (three for manual, four for power) with drift punch. Then, drill out remainder of rivet heads using a 6.35mm (1/4-inch) drill.

7. Remove the window regulator from the front door.

Installation

1. Position the window regulator in the front door. Align retention holes to door inner panel.

2. Install three (four rivets for power window) rivets attaching the window regulator to door inner panel using Rotunda Blind Fastener Installation Tool or equivalent. Equivalent threaded fasteners may be used in place of rivets.

3. Assemble glass bracket to regulator arm slide.

4. Install front door window glass as described in this section.

5. Install the front door glass run latch side retainer. Make sure the front door window glass is seated in the retainer's C-channel.

6. Adjust the front door glass run latch side retainer so that the front door window glass can move freely but not loosely.

7. Tighten the front door glass run latch side retainer bolt to 7-11 Nm (62-92 lb-in).

8. Reconnect wire to regulator for power window if equipped.

9. Check operation of window regulator.

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10. Install front door trim shield and trim panel. Refer to Section 01-05B .

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Windshield Glass

Removal

1. Lift the lock tabs and remove the windshield wiper pivot arms (17526).
2. Remove windshield moulding, glass stops and retainers as described in this section.
3. Remove interior trim to prevent damage during windshield glass removal.
4. Remove inside visors (04100). Disconnect electrical connector to vanity mirror (17A679), if equipped.
5. Use a thin-bladed screwdriver to insert through access hole to remove inside rear view mirror (17700) from windshield glass (03100).
6. Loosen roof trim panel near windshield glass. Insert styrofoam blocks under roof trim panel to move it away from windshield glass and prevent damage.
7. Spray lubricant ECL-784 around urethane cutting area.
8. Insert a four-inch blade into a Rotunda Interior Auto Glass Cut-Out Knife Kit 164-R2450 or equivalent. From interior of vehicle, cut urethane beginning at upper center and continuing to lower driver side, then from center to passenger side.
9. **NOTE: Be careful to cut through urethane in corner of windshield glass, where urethane is thicker.**

   Insert a 12-inch blade into cutting tool and bend blade to match contour of dash. Cut around the bottom portion of the urethane sealant.

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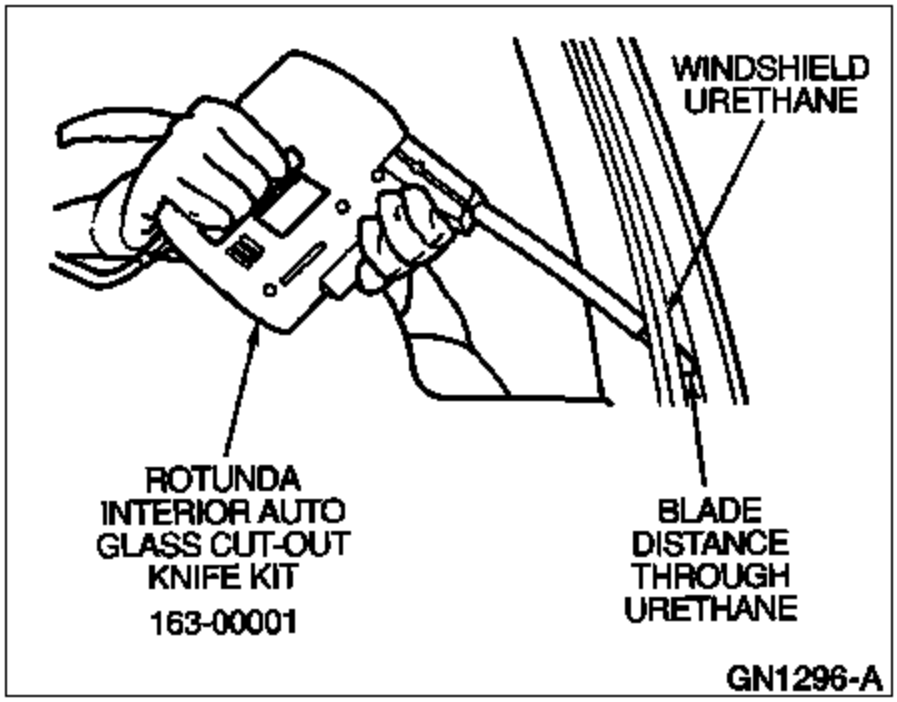

10. Using a long-handled razor knife, remove any remaining stringers.
11. Remove windshield glass.
12. Clean pinchweld. Do not damage dress moulding.

Installation

CAUTION: When replacing urethane-installed glass parts, the vehicle should not be driven until the urethane has cured. This will prevent the windshield from being jarred out of position.

NOTE: Refer to manufacturer's directions for exact cure time of urethane.

1. Leave front door window glass open to prevent movement of the windshield glass from pressure when closing front door (20124).
2. Remove any remaining urethane from windshield glass.
3. Using a mask or template apply primer Essex No. 3 around windshield glass.
4. Install foam dam onto pinchweld.
5. **CAUTION: To ensure correct windshield molding fit, maintain a maximum of 1mm (.04-inch) difference between side margins.**

   Apply Essex No. 4 urethane and position windshield glass on vehicle.
6. Install roof trim panel, inside visors (04104), trim, windshield moulding, glass stops and retainers.
7. Install windshield wiper pivot arms.

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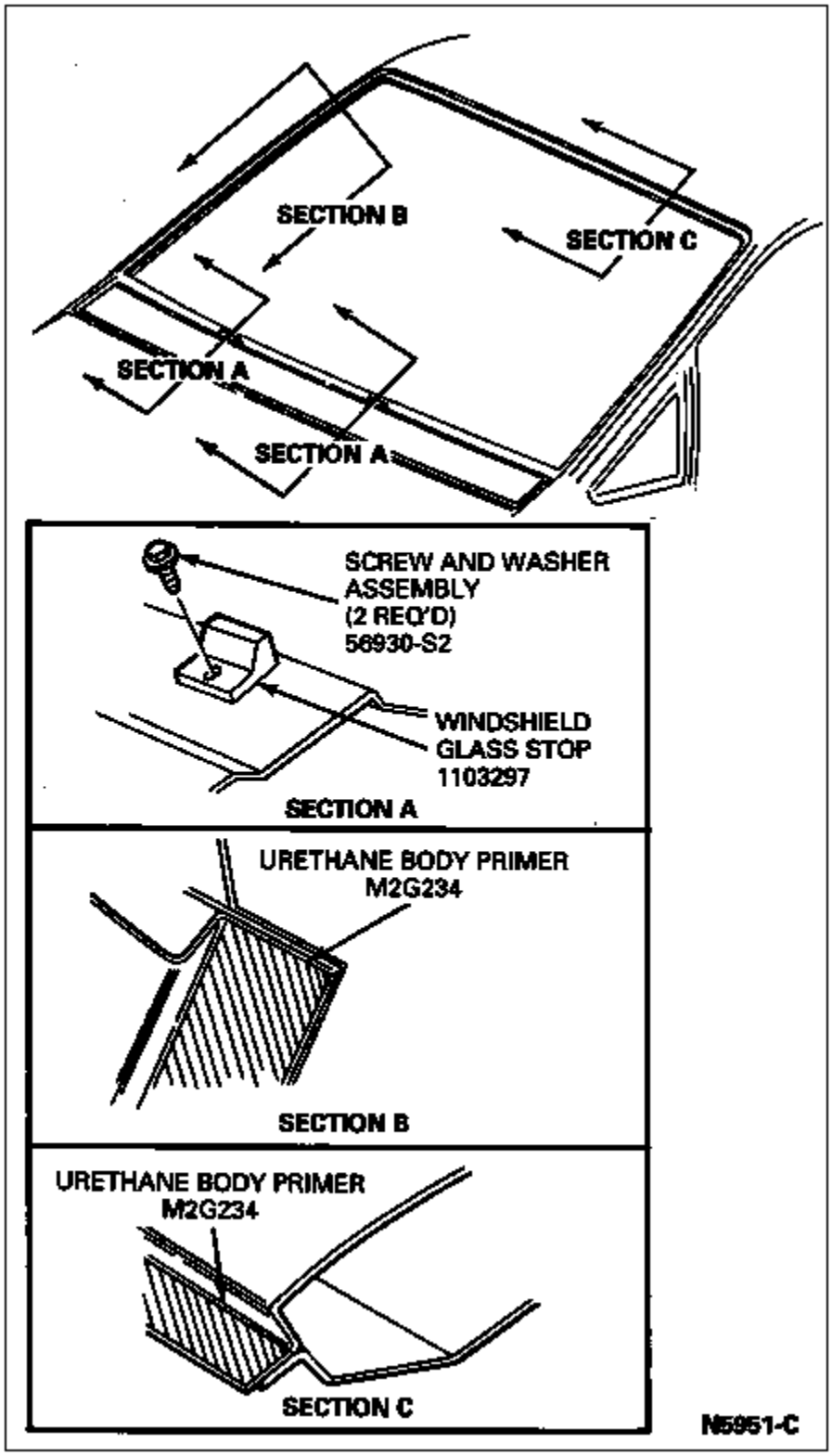
Urethane Primer Application, Aerostar



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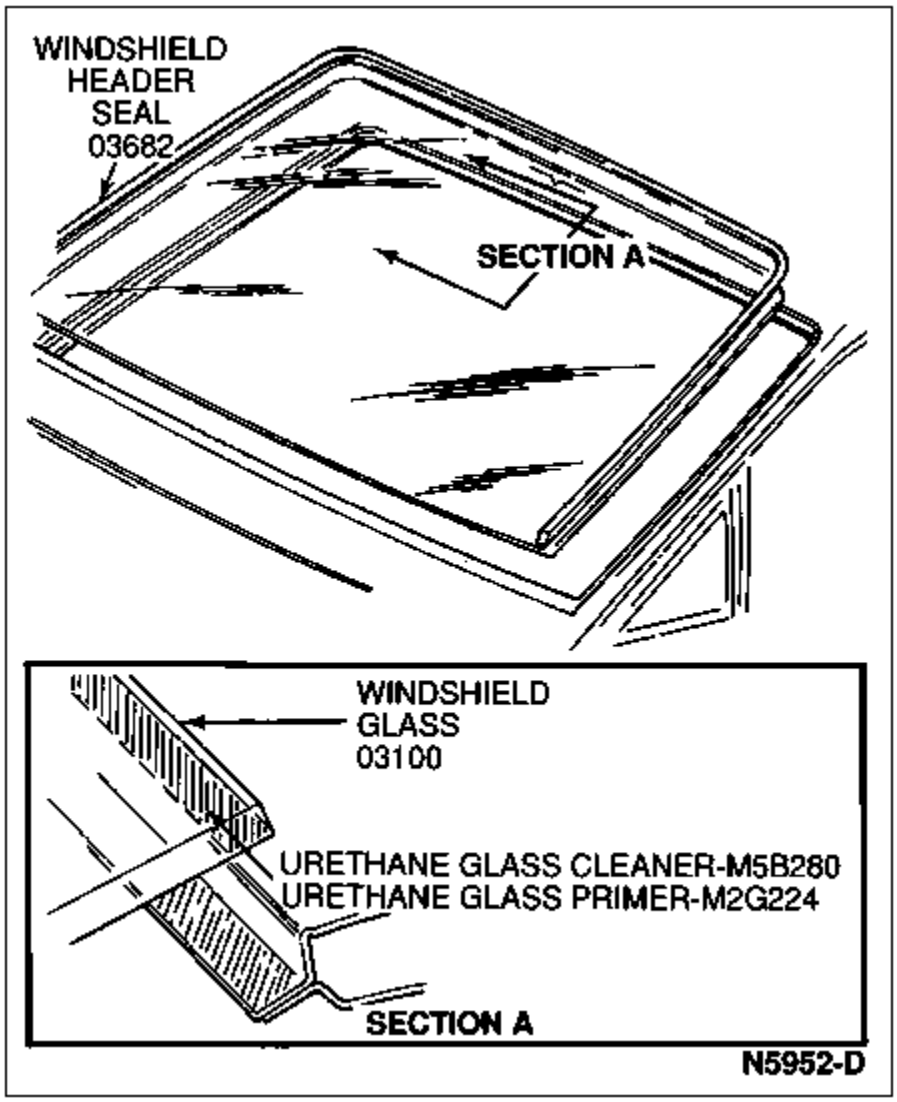
Windshield Glass Installation, Aerostar



Urethane Primer Application, Ranger

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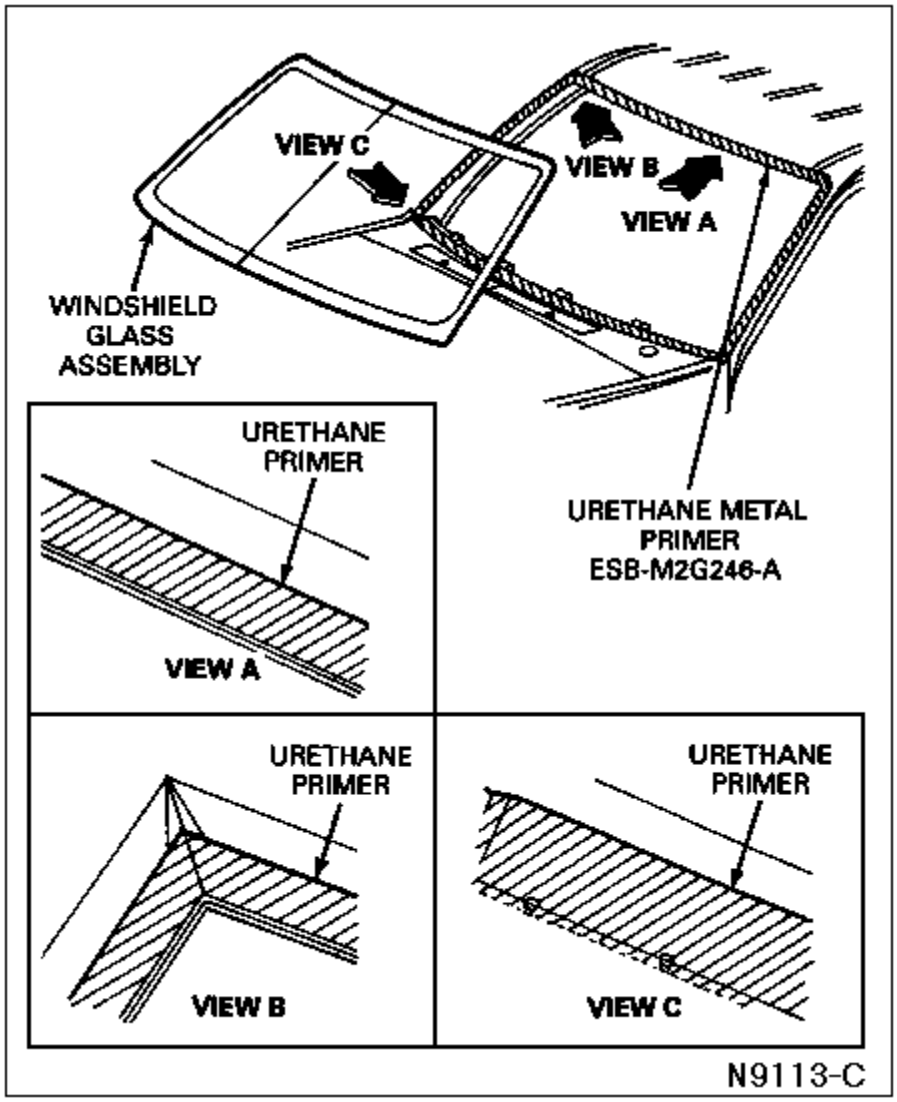
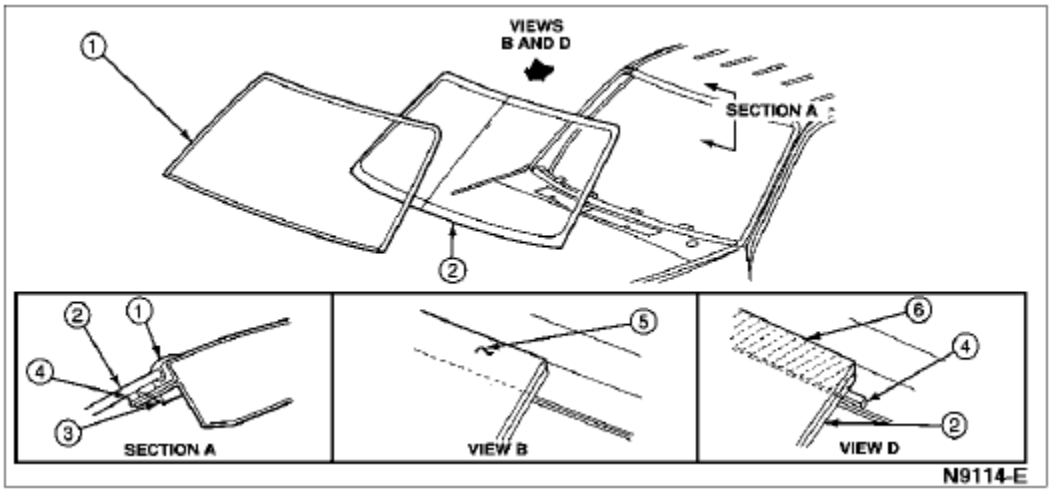


Windshield Glass Installation, Ranger



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Item	Part Number	Description
1	03045	Windshield Header Seal
2	03100	Windshield Glass
3	M2G316	Urethane High Viscosity Sealer
4	M3G137	Extruded Foam Dam
5	M5B280	Urethane Glass Cleaner
6	M2G314-B	Urethane Glass Primer

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Mouldings, Aerostar

The windshield header seal (03045) is made of a PVC material and is retained in the windshield opening by the urethane sealant.

NOTE: On Ranger, the windshield header seal is removed and installed in the Windshield Glass removal and installation procedure in this section.

Removal

1. Remove the cowl top vent panel (022A68).
2. **CAUTION: To prevent damage, do not pry against the windshield glass (03100). Use care not to damage the paint.**

   Pry out and discard the windshield header seal from the windshield glass opening. The windshield header seal cannot be reused.
3. With a sharp knife, remove sufficient urethane sealant to allow room for new urethane sealant.

Installation

CAUTION: When replacing urethane installed glass parts, the vehicle should not be driven until the urethane has cured. This will prevent parts from being jarred out of position.

NOTE: Refer to manufacturer's directions for exact cure time of urethane.

1. Replace the PVC windshield header seal with a new service moulding.
2. Apply urethane glass cleaner meeting Ford specification WSB-M5B280-C to the entire periphery of the windshield glass and wipe off immediately.
3. Apply urethane glass primer meeting Ford specification WSB-M2G314-B to the entire periphery of the windshield glass.
4. Apply a sufficient amount of high viscosity urethane adhesive meeting Ford specification WSB-M2G316-B to the entire periphery of windshield glass opening to retain the PVC windshield header seal.

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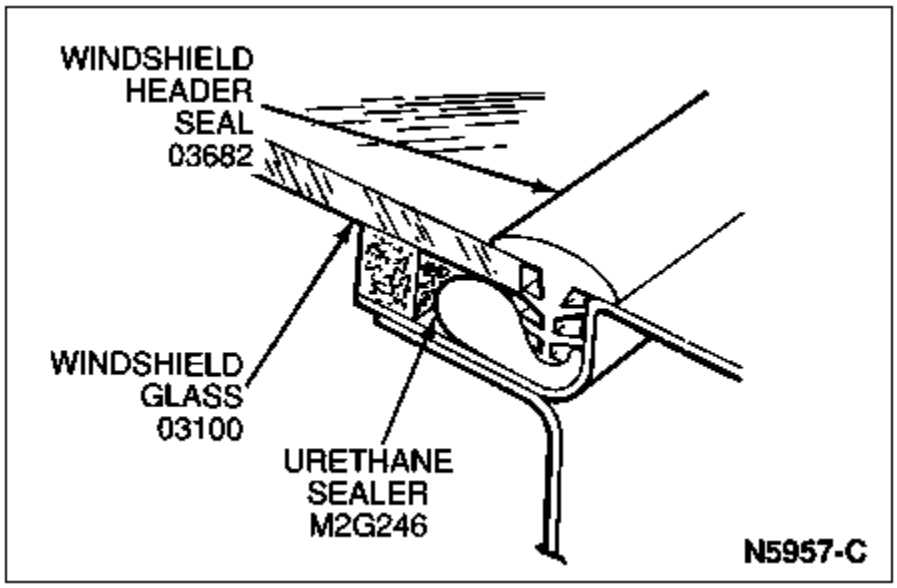

5. Align the centering notch of the PVC windshield header seal to the center mark in the ceramic paint at top and bottom of windshield glass.

6. Position the windshield header seal assembly into the windshield glass opening and press around entire periphery to seat.

7. Install the cowl top vent panel.

Door Window and Quarter Window, Front and Rear

Removal and Installation

The outside door window mouldings are attached with various fasteners, including nuts, rivets and clips. For removal, use a tool to suit the fastener and use care not to damage painted surfaces. Use care not to bend or otherwise damage the mouldings. For installation, use new fasteners as necessary and reverse the removal procedure.

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Back Window Glass, Fixed, Ranger

Removal

1. Remove the interior trim necessary to access the back window glass mounting area. Refer to Section 01-05A .
2. For Regular Cab, pull the back window glass weatherstrip away from the back window glass opening.
3. For SuperCab, remove the eight back window glass nuts.
4. With an assistant to prevent damage, push out the back window glass (42006) from the back window glass opening.
5. Clean all sealant from the back window glass weatherstrip and the back window glass opening.

Rear Window, Ranger

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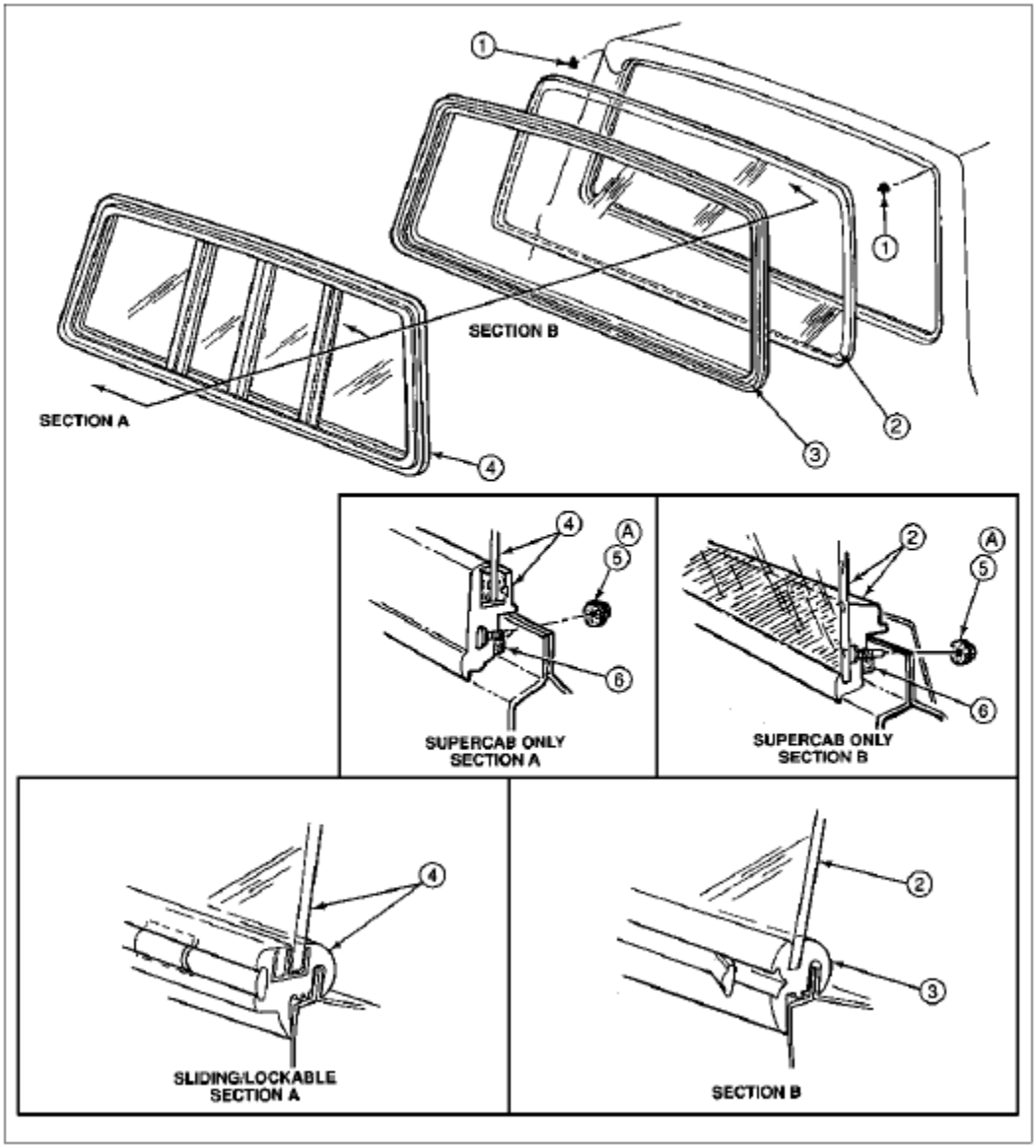

Item	Part Number	Description
1	ESB-M4G250-A	Sealer. Apply Before Glass Installation
2	42006	Back Window Glass, Fixed
3	42084	Weatherstrip, Back Window Glass
4	42006	Back Window Glass, Sliding
5	N621900-S2	Nut, Back Window Glass
6	—	Seal Tap (Part of 42006)
A	—	Tighten to 1-2 Nm (9-17 Lb-In)

Installation

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1. **NOTE: Green Soap ESB-M1B9-A or equivalent, diluted 10 to 1 with water, may be used to facilitate installation of back window glass weatherstrips and mouldings.**

   Install a draw cord all around the back window glass weatherstrip in the flange crevice, allowing the cord to overlap at the bottom center of the back window glass.

2. Coat the back window glass weatherstrip mounting surface with a rubber lubricant meeting Ford specification ESR-M99B135-A or ESA-M1B6-A or equivalent.

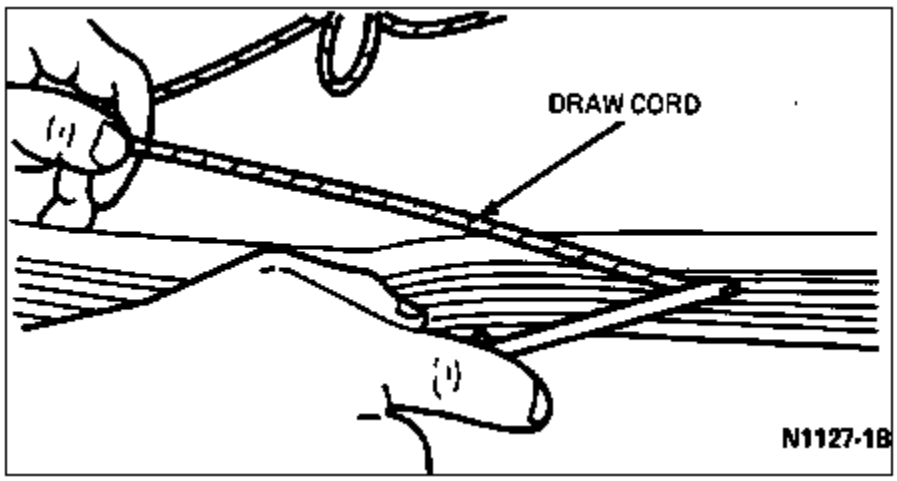
3. For SuperCab, position the back window glass in the back window glass opening and install the eight back window glass nuts. Tighten the nuts to 1-2 Nm (9-17 lb-in).

4. For Regular Cab, position the back window glass and back window glass weatherstrip to the window opening. With an assistant applying hand pressure from outside the cab, pull (from inside) the back window glass weatherstrip lip over the flange with the draw cord.

5. Pull back window glass weatherstrip over lower flange, pulling one end of the cord at a time. Then, pull the back window glass weatherstrip over the side flanges and upper flange.

6. Clean area aroundback window glass and remove all excess sealer.

7. Test for water leaks.



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Back Window Glass, Opening, Ranger

Removal

1. From the interior of the vehicle, pull down the back window glass weatherstrip lip along the window opening and with an assistant, push the sliding back window glass and weatherstrip assembly out of the back window glass opening from inside the cab.

2. Remove the back window glass weatherstrip from the back window glass (42006). Place the movable back window glass in the open position.

3. At the top of the sliding back window glass frame, remove the screw retaining each division bar.

4. Remove the two screws retaining anchor plate in the window track. Remove the plate.

5. Spread the sliding back window glass frame and work the movable portion of the back window glass out of its track. Remove the movable back window glass frame.

6. If the stationary panes of the sliding back window glass are to be replaced, remove the division bar lower retaining screw and remove the division bar.

7. Spread the sliding back window glass frame just enough to permit the stationary panes of the back window glass to be worked out of the frame.

Installation

1. If the stationary portion of the sliding back window glass is to be replaced, apply Silicone Lubricant C0AZ-19553-AA or equivalent meeting Ford specification ESR-M13P4-A to the back window glass weatherstrip and track.

2. **NOTE: Do not allow the back window glass weatherstrip within the sliding back window glass frame to bunch.**

   Spread the sliding back window glass frame slightly and slide the pane or panes into place in the sliding back window glass frame.

3. Position division bar in sliding back window glass frame. Install the lower retaining screw.

4. Spread the sliding back window glass frame slightly and install the movable back window glass in its track.

5. Position the anchor plate in the window track. Install the two retaining screws.

6. Install the division bar upper retaining screws.

7. Install the back window glass and frame assembly into the back window glass weatherstrip.

8. Install a draw cord all around the back window glass weatherstrip in the flange crevice, allowing the

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cord to overlap at the bottom center of the back window glass.

9. **NOTE: Green Soap ESB-M1B9-A or equivalent, diluted 10 to 1 with water, may be used to facilitate installation of back window glass and back window upper garnish moulding.**

   Position the back window glass to the window opening. With an assistant applying hand pressure from outside the cab, pull the back window glass weatherstrip lip over the window opening flange with the draw cord.

10. Pull the back window glass weatherstrip over the lower flange, pulling one end of the cord at a time. Then, pull the seal over the side flanges and upper flange.

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Body Side Window/Sliding Side Door Glass, Aerostar

CAUTION: Avoid damaging window assembly if it is to be reused.

Removal

1. Remove the quarter trim panel (31012). Refer to Section 01-05B .
2. Remove the retaining nuts from window module.
3. With an assistant to prevent damage, push the window out carefully.

Installation

1. Clean the window opening surface of all sealer.
2. Clean existing sealer from window module, if reusing.
3. Apply a continuous strip of 8-9mm (11/32 in.) bead of Liquid Butyl Sealer C9AZ-19554-B or equivalent meeting Ford specification ESB-M4G162-A.
4. Install the window module into the opening.
5. Install the retaining nuts. Tighten to 1-2 Nm (9-17 lb-in).
6. Test for water leaks.
7. Install quarter trim panel. Refer to Section 01-05B .

Sliding Side Door Glass, Aerostar

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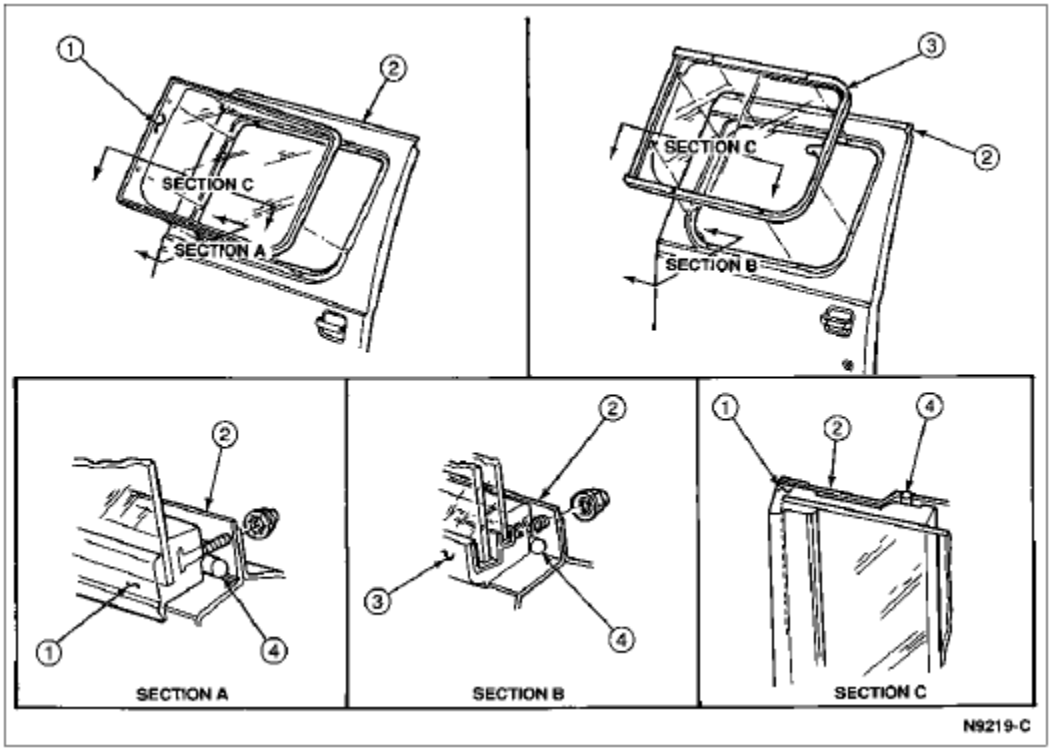

Item	Part Number	Description
1	25700	Sliding Door Window, Fixed
2	24602	Sliding Side Door
3	25700	Sliding Door Window, Opening
4	26954	Sealer, 8-9mm (11/32 In.) Bead

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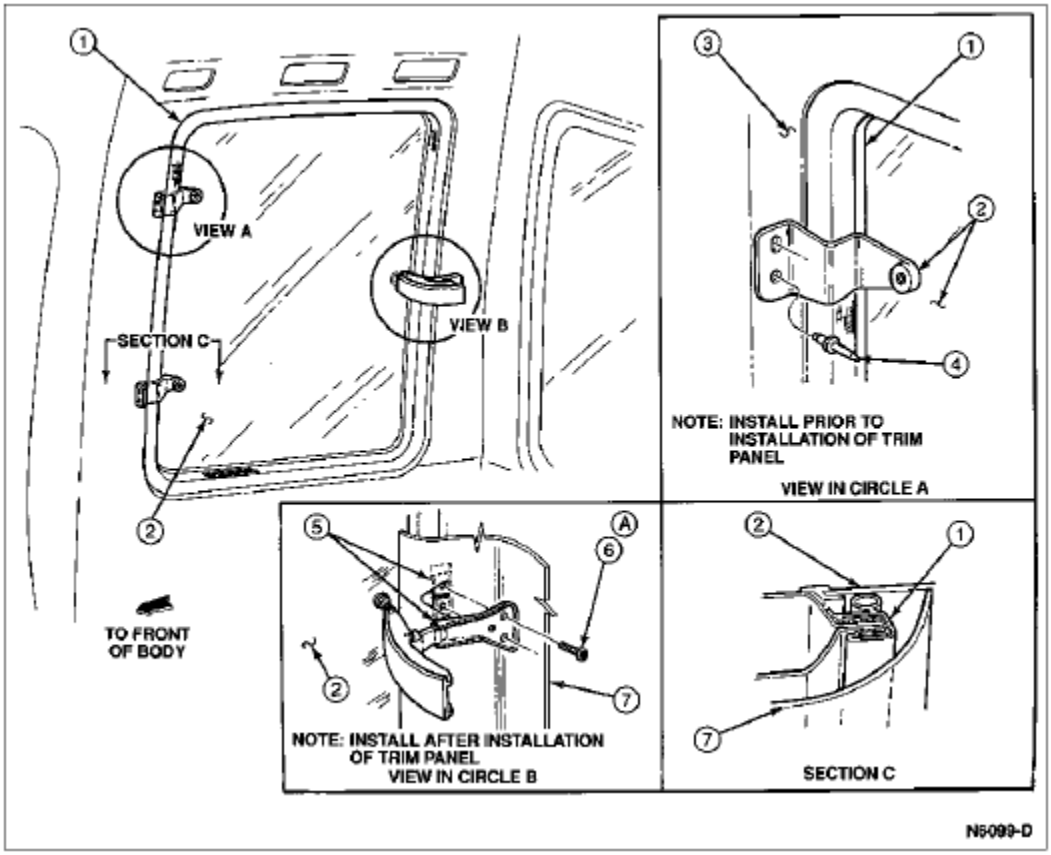
Body Side Window Assembly, Movable Glass, Ranger SuperCab

Removal and Installation

1. Open quarter window latch. Remove two screws attaching quarter window latch.
2. Remove the quarter trim panel. Refer to Section 01-05A .
3. Drill out the four rivets attaching the quarter window hinges to the body panel.
4. Remove body side window assembly.

For installation, follow removal procedures in reverse order.

Body Side Window, Ranger SuperCab



Item	Part Number	Description
1	29732	Quarter Window Glass Weatherstrip
2	29726	Quarter Window Glass
3	40252	Body Panel, Inside Quarter

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4	384432-S	Rivet
5	N803278-S100	U-Nut
6	N804549-S2	Screw, Quarter Window Latch-to-Body Panel
7	31012	Quarter Trim Panel
A	—	Tighten to 7-11 Nm (62-97 Lb-In)

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Body Side Window Assembly

Fixed Glass, Ranger SuperCab; Fixed or Movable Glass, Aerostar

Removal

1. **CAUTION: Avoid damaging or distorting window assembly.**

   Remove quarter trim panel. Refer to Section 01-05A .

2. From inside the vehicle, remove the nuts from inside the quarter window or rear quarter window.

3. With an assistant to prevent the rear quarter window glass from falling, remove glass assembly by pushing with enough pressure to separate the butyl seal.

4. Clean old seal from body recess and from the rear quarter window glass. All traces of old sealing material must be removed.

5. Inspect for sheet metal deficiencies. Check sealing surface of flange for chipped or missing paint. Repair as necessary.

Installation

1. If the rear quarter window glass replacement is not complete with sealer tape, then apply a continuous strip of 8.0 x 8.0mm (5/16 x 5/16 inch) Foam Core Butyl Tape ESB-M3G143-A2 or equivalent to the back of the rear quarter window glass. The start/stop joint must be at the bottom of the rear quarter window glass, between studs and overlap 24-50mm (1-2 inches).

2. Press the rear quarter window glass into place. Use enough pressure to seat window firmly in sealing material.

3. Install retaining nuts. Tighten to 1-2 Nm (9-17 lb-in).

4. Install the quarter trim panel. Refer to Section 01-05A .

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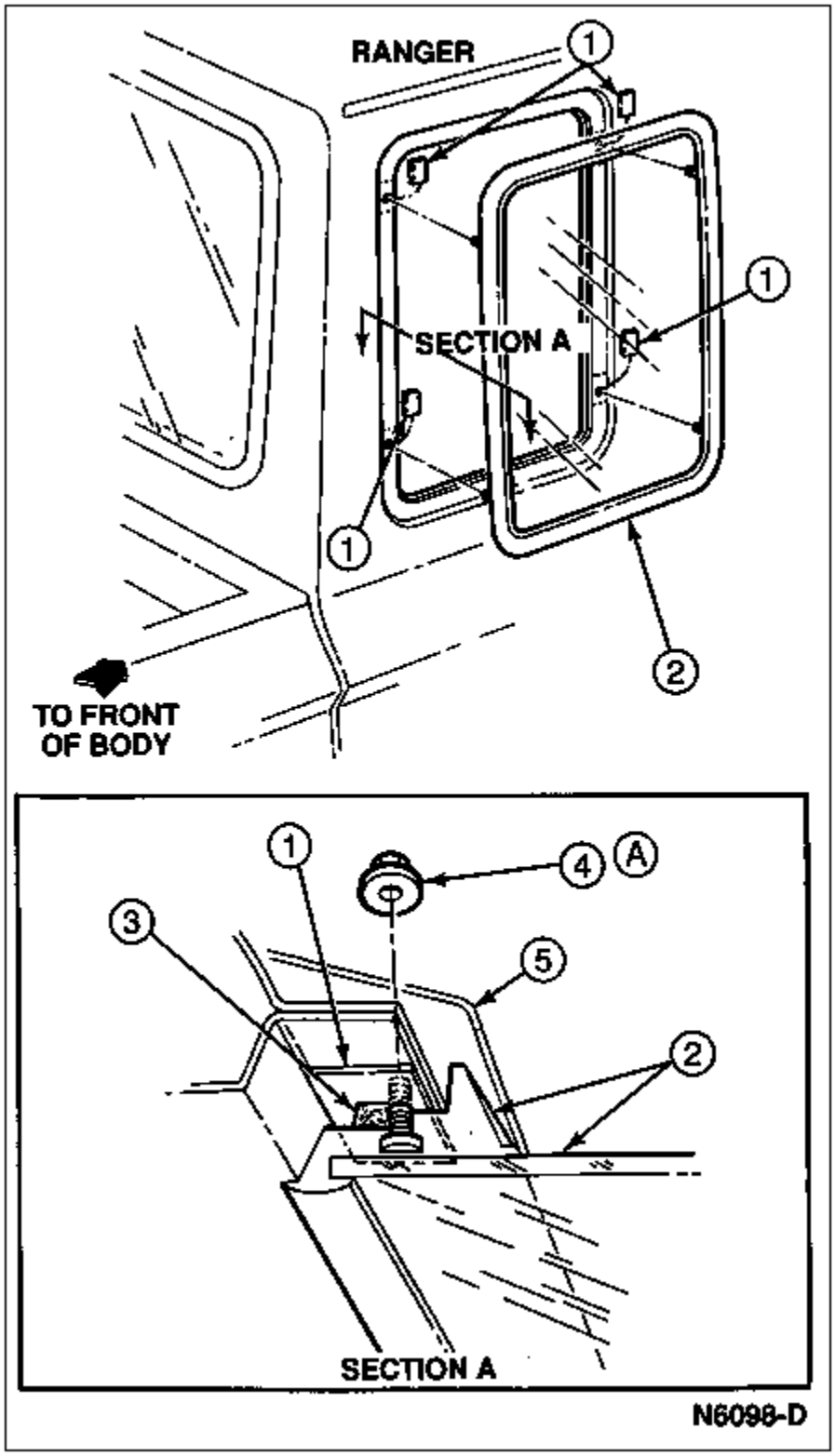

Item	Part Number	Description
1	280C10	Tape, 25 x 40mm (1 x 1.5 In.) to Seal Stud Holes

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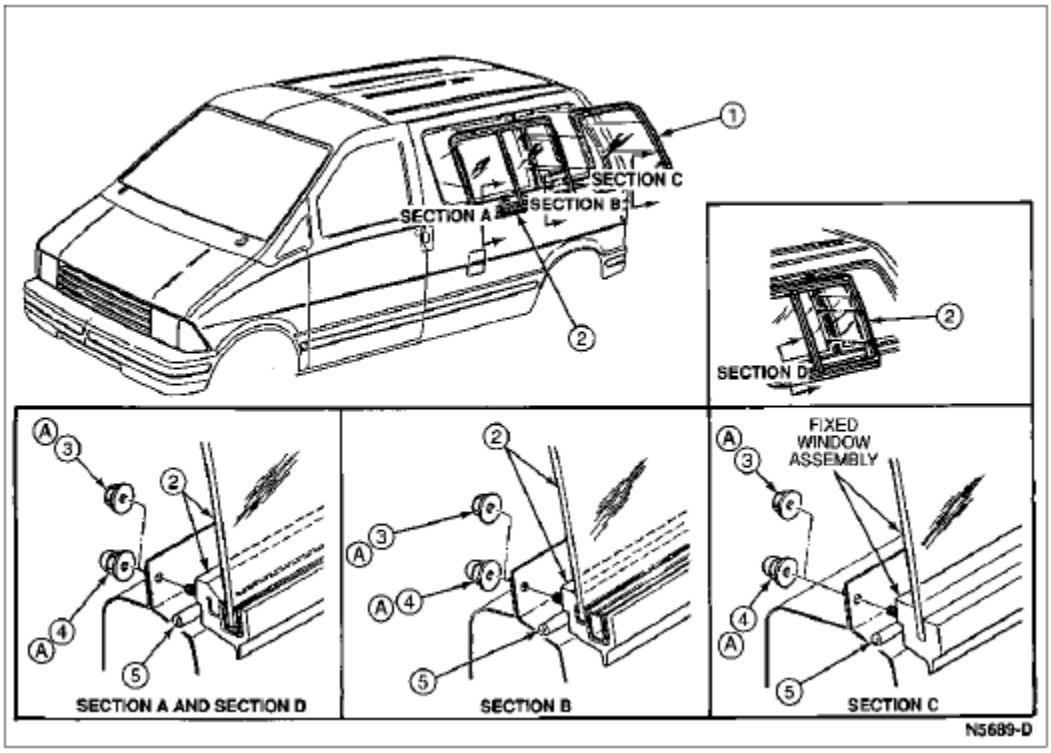
2	29726	Quarter Window, Fixed
3	—	Foam Tape (Part of 29726). Remove Backing Before Installation.
4	N621900-S2	Nut, Quarter Window-to-Body Panel
5	31012	Quarter Trim Panel
A	—	Tighten to 1-2 Nm (9-17 Lb-Ft)

Body Side Window, Aerostar



Item	Part Number	Description
1	29727	Body Side Window, Fixed
2	29701	Body Side Window, Sliding
3	N621901-S36	Nut, Body Side Window-to-Body, Uncapped
4	N804337-S36	Nut, Body Side Window-to-Body, Capped
5	26954	Butyl Sealer, 8-9mm (11/32-Inch) Bead
A	—	Tighten to 1.4-2 Nm (13-18 Lb-In)

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Weatherstrip, Door Glass Belt

Removal and Installation

1. Lower the door window glass to full down position.
2. Unsnap and remove belt weatherstrips from the door.

For installation, follow removal procedures in reverse order.

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Weatherstrip, Body Side Glass

Removal and Installation

The Aerostar rear quarter glass weatherstrips are bonded to the rear quarter window glass and are not separately serviceable. For removal and installation of the Ranger quarter window glass weatherstrips, use the following procedure.

1. Remove the body side window glass as described in this section.
2. Pull and remove the quarter window glass weatherstrip from the window opening.

For installation, follow removal procedure in reverse order. Use care not to bunch or stretch the weatherstrip.

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Window Regulator Control Switch, Aerostar

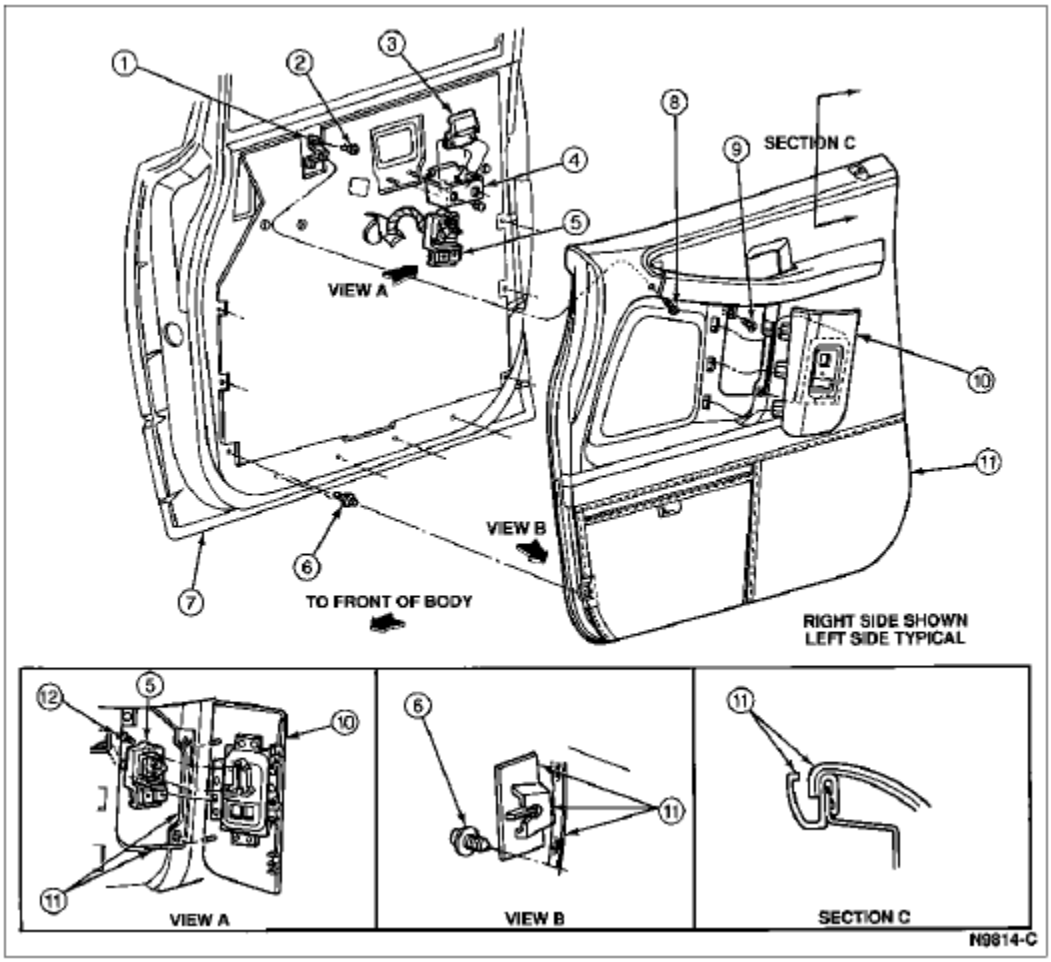
NOTE: The window regulator control switches are located on the front door trim panel.

Removal and Installation

1. Remove window regulator switch plate by carefully prying up with a flat-bladed tool.
2. Remove retaining nuts holding front window regulator wiring to the back of the window regulator switch plate. Using a thin-bladed screwdriver, carefully pry the window regulator control switch from the connector.

For installation, follow removal procedures in reverse order.

Window Regulator Control Switch, Aerostar



Item	Part Number	Description

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1	24116	Bracket
2	56902-S2	Screw
3	22600	Inside Door Handle
4	22634	Cup, Door Inside Handle
5	14529	Window Regulator Control Switch
6	N805155-S1	Pushpin
7	20124	Front Door
8	N800942-S58	Screw
9	381801-S58	Screw
10	14524	Door Trim Finish Panel
11	23868	Front Door Trim
12	56922-S2	Screw

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Window Regulator Control Switch

NOTE: The window regulator control switches are located on the front door trim panel (23942).

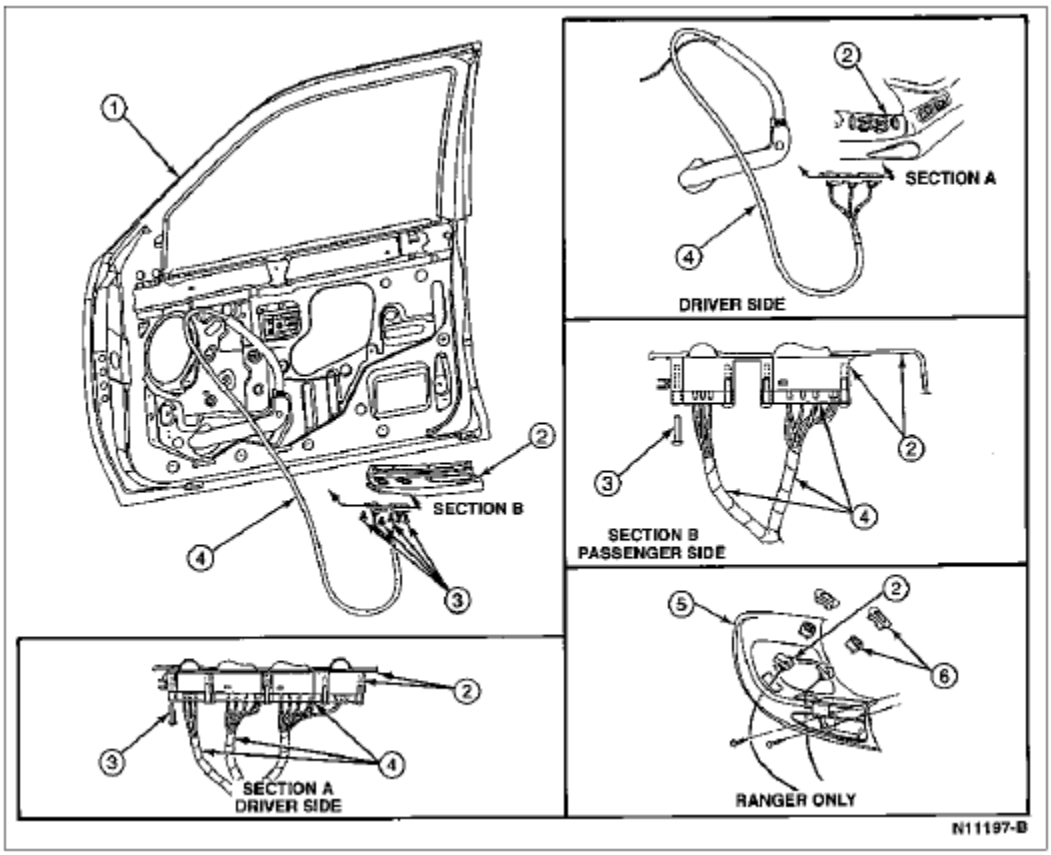
Removal and Installation

1. Using a thin-bladed tool, carefully pry up the rear of the window regulator switch housing and rotate the window regulator switch housing up and out of the armrest.
2. Remove the connector attaching screws from window regulator switch housing.
3. Carefully pry the window regulator control switches from the connector contact pins with a small screwdriver.

NOTE: The window regulator control switches are keyed to the connector and can only be installed one way.

For installation, follow removal procedures in reverse order.

Window Regulator Control Switch, Ranger



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Item	Part Number	Description
1	20124	Front Door
2	14524	Window Regulator Switch Plate
3	389404-S58	Screw, Switch Plate
4	14630	Door Wiring Assembly
5	—	Trim Insert (Part of 23942)
6	14B162	Door Lock Control Switch and Plate

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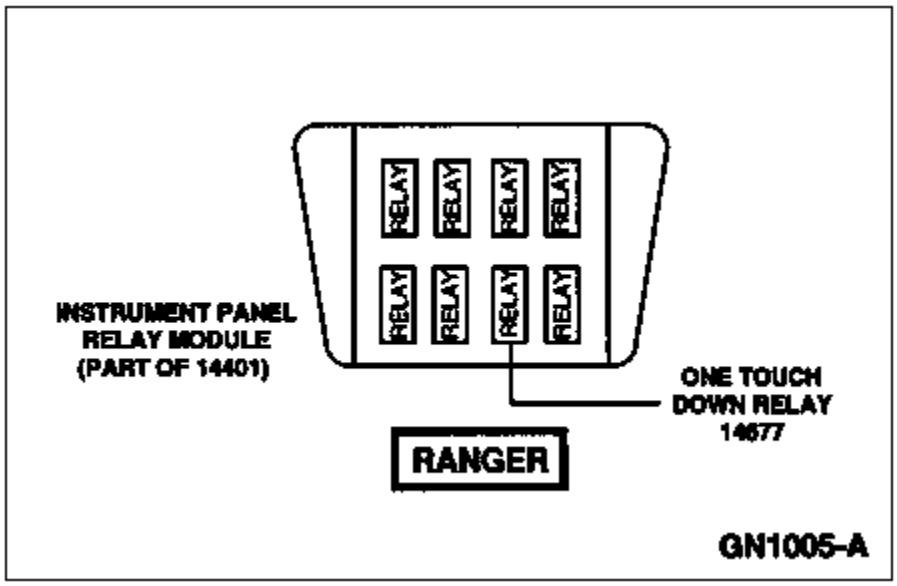
Module, One-Touch Window

Removal and Installation

Access the instrument panel relay module to the right of the steering column and pull the one-touch relay out of the relay module. For installation, follow removal procedures in reverse order.

One-Touch Relay, Ranger



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Circuit Breaker

Removal and Installation

1. Remove the cover from the power distribution box next to the battery tray.
2. Remove the power window circuit breaker from position number five.

For installation, follow removal procedures in reverse order.

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Window Regulator Electric Drive, Aerostar

Front Door

Removal

1. **NOTE: When the battery is disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

   Disconnect the battery ground cable (14301).

2. Remove the front door trim panel. Refer to Section 01-05B .

3. **NOTE: Check inside the front door (20124) to make sure front window regulator wiring is not in line with holes to be drilled in the door inner panel.**

   Disconnect front window regulator wiring connector.

4. Using a 12.7mm (1/2-inch) diameter drill bit, drill two holes in the front door trim shield at the drill dimples located opposite the two unexposed motor drive retainer screws.

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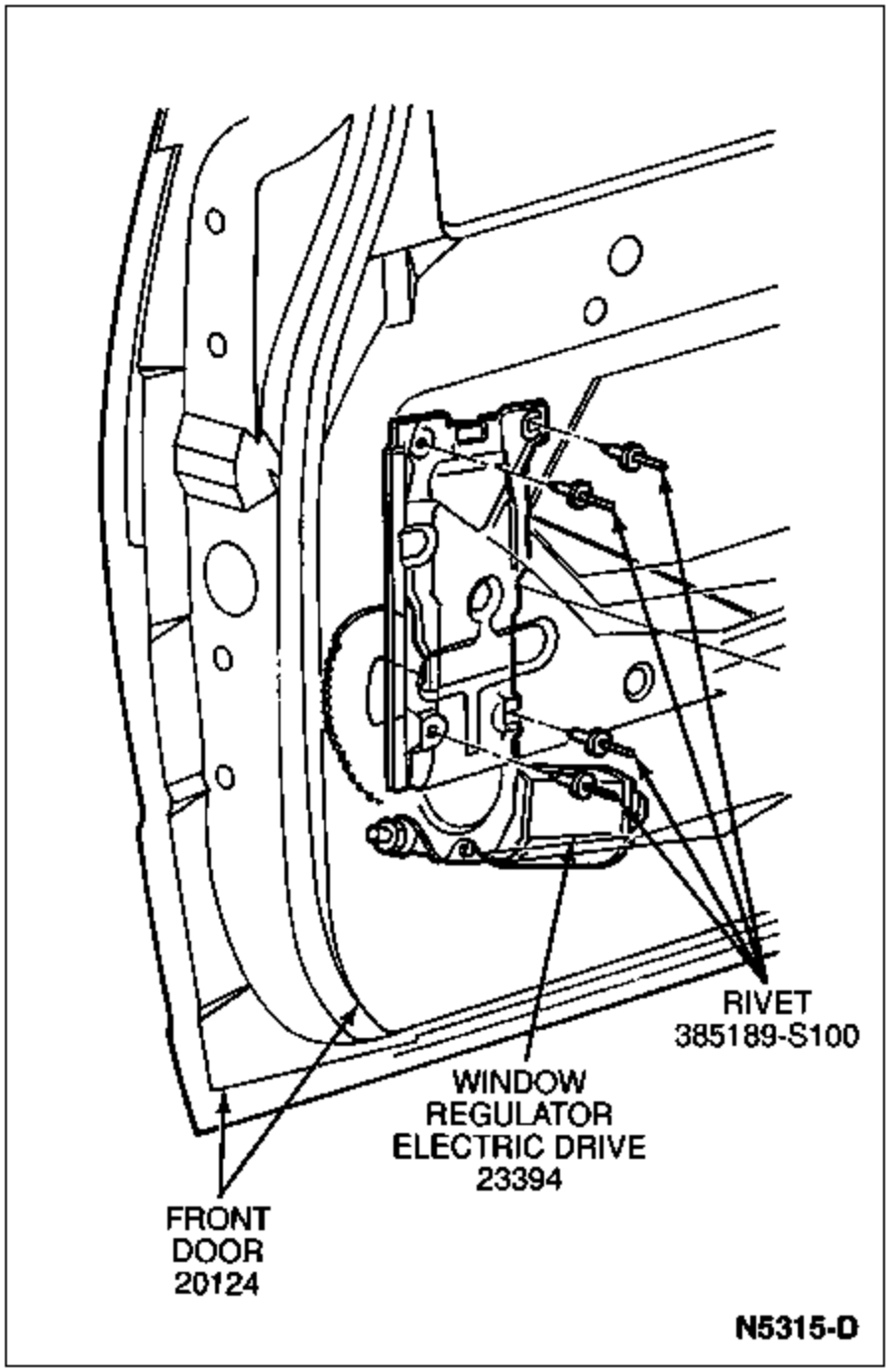

5. Remove three motor mount retainer screws, using two drilled holes and existing larger hole access to screw heads.

6. Push window regulator electric drive toward outside sheet metal to disengage window regulator electric drive and drive from the window regulator gear.

7. After the window regulator electric drive and drive are disengaged, prop the front door window glass (21410) in full up position.

8. **WARNING: AEROSTAR HAS A COUNTERBALANCED SPRING. WINDOW MUST BE IN UP**

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POSITION TO REMOVE POWER MOTOR OR BLOCKED TO PREVENT WINDOW FROM SUDDENLY RAISING, CAUSING POSSIBLE INJURY.

Remove window regulator electric drive and drive from inside front door.

Installation

1. Install a new window regulator electric drive. Tighten retaining screws to 6-9 Nm (50-84 lb-in).
2. Install two pieces for Pressure Sensitive Waterproof Tape D6AZ-19627-A or equivalent body tape 25.4mm (1 inch) square over drilled holes.
3. Connect front window regulator wiring and battery ground cable.
4. Remove front door window glass prop. Check front door window glass operation.
5. Make sure drain holes are open.
6. Install front door trim panel. Refer to Section 01-05B .

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Window Regulator Electric Drive, Ranger

Front Door

Removal

1. **NOTE: When the battery is disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

   Disconnect battery ground cable (14301).

2. Remove front door trim panel (23942) and front door trim shield (237A04). Refer to Section 01-05A .

3. Disconnect front window regulator wiring from wire harness connector.

4. Locate two of the three window regulator electric drive mounting screws, visible through existing holes.

5. Locate dimple in inner door panel, covering the third mounting screw. Drill a 1/2-inch hole to access third screw. Use care not to drill into door wiring.

6. Remove three screws retaining front door window regulator to window regulator electric drive.

7. Remove the window regulator electric drive through the access hole.

Installation

1. Install new window regulator electric drive to front door window regulator. Tighten motor retaining screws to 6-9 Nm (50-84 lb-in).

2. Connect front window regulator wiring and battery ground cable.

3. Check front door window regulator wiring operation.

4. Make sure door drain holes are open.

5. Cover drilled hole with pressure sensitive tape.

6. Install front door trim shield and front door trim panel. Refer to Section 01-05A .

Ranger

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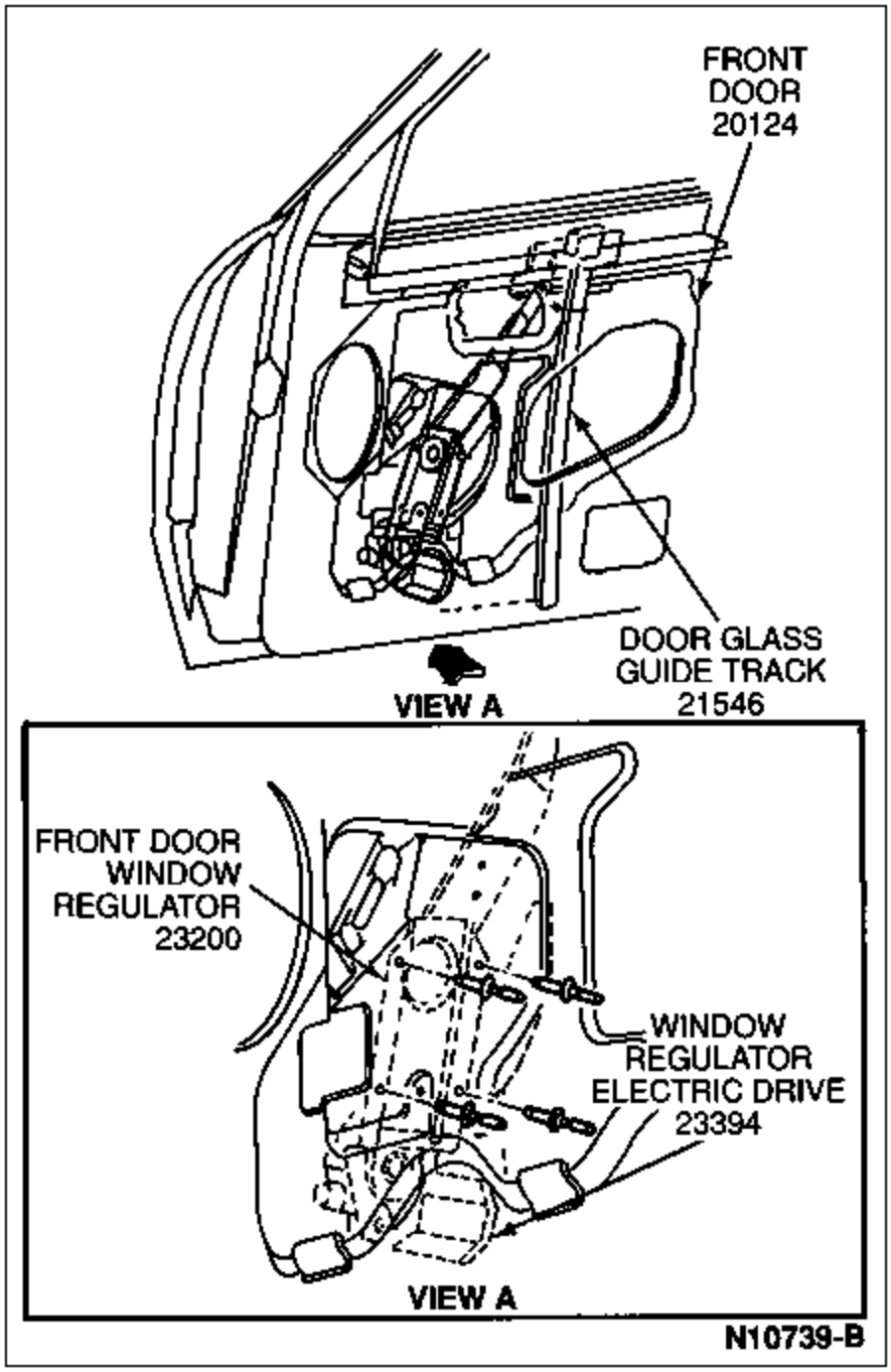

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Glass, Stationary, Rear Door, Aerostar

Removal

1. Remove the door trim panel. Refer to Section 01-05B .
2. On liftgate, disconnect rear window defroster wire leads at each end of window glass.
3. Remove the eight retaining nuts on dual rear door or liftgate back window glass, eight nuts per back window glass.
4. With an assistant to prevent damage, push the back window glass out.

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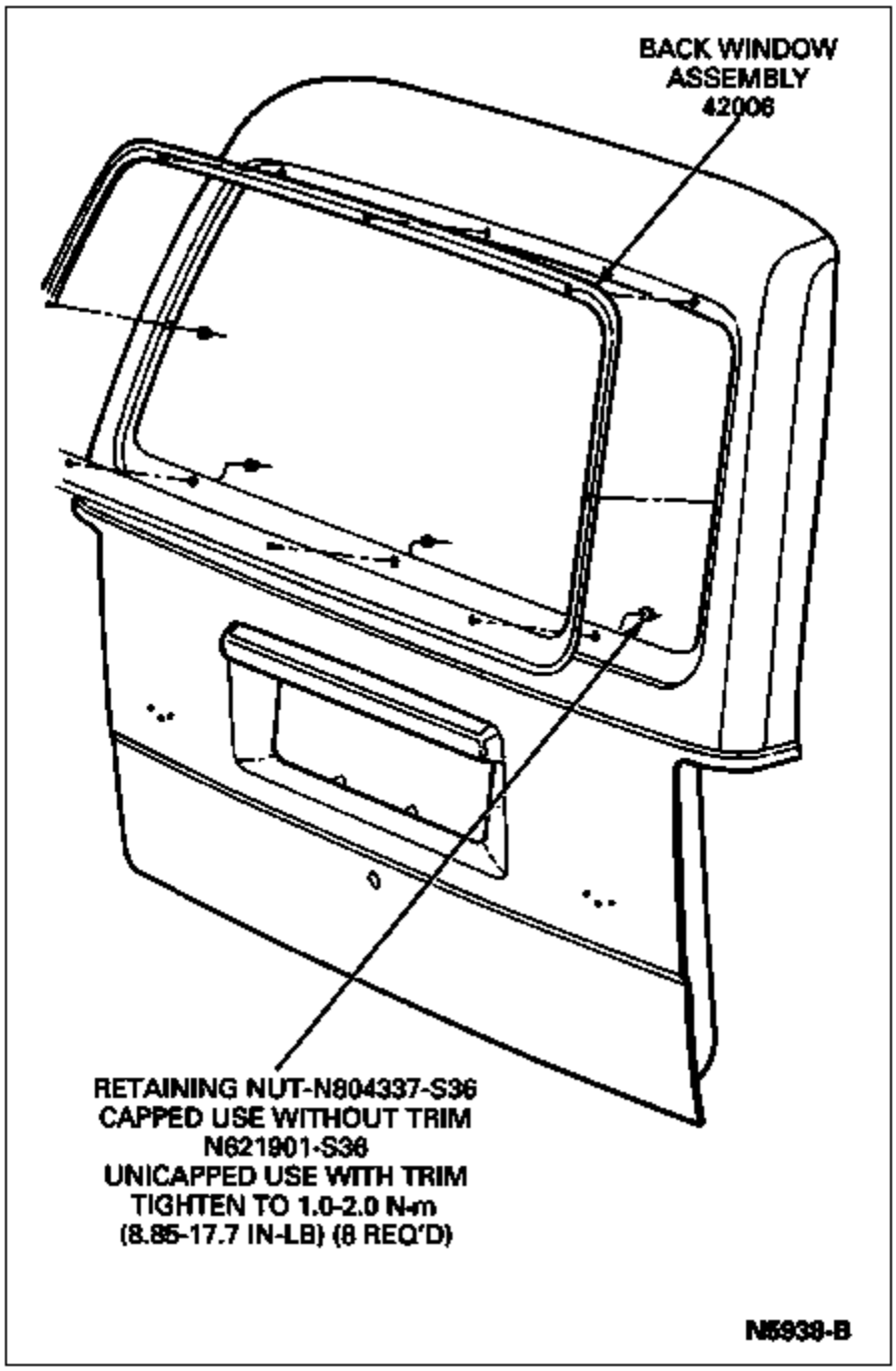

Installation

1. **CAUTION: Do not use a razor blade to clean sealer from heated rear window. Use of razor blades, steel wool or abrasive powders will damage the grid wires.**

   Clean the existing sealer from the back window glass if it is to be reused.

2. Clean the window opening surface of all sealer.

3. Apply a continuous 8-9mm (11/32 in.) bead of Liquid Butyl Sealer C9AZ-19554-B or equivalent

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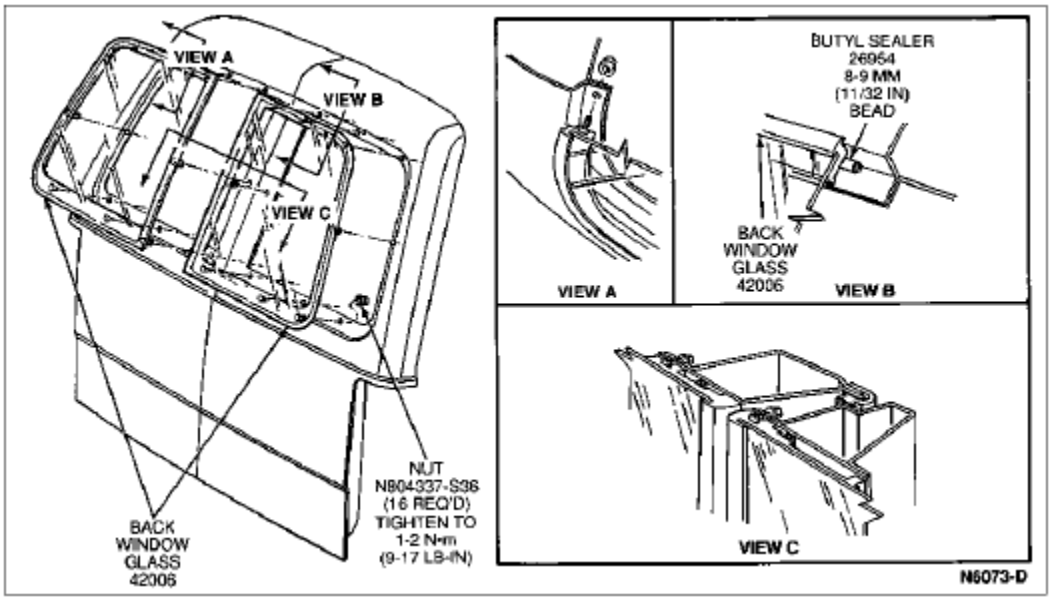
meeting Ford specification ESB-M4G162-A.

4. Install the back window glass into the opening.
5. Install the retaining nuts. Tighten to 1-2 Nm (9-17 lb-in).
6. Test for water leaks.
7. Install door trim panel. Refer to Section 01-05B .
8. Connect rear window defroster wire leads.

Rear Window, Aerostar



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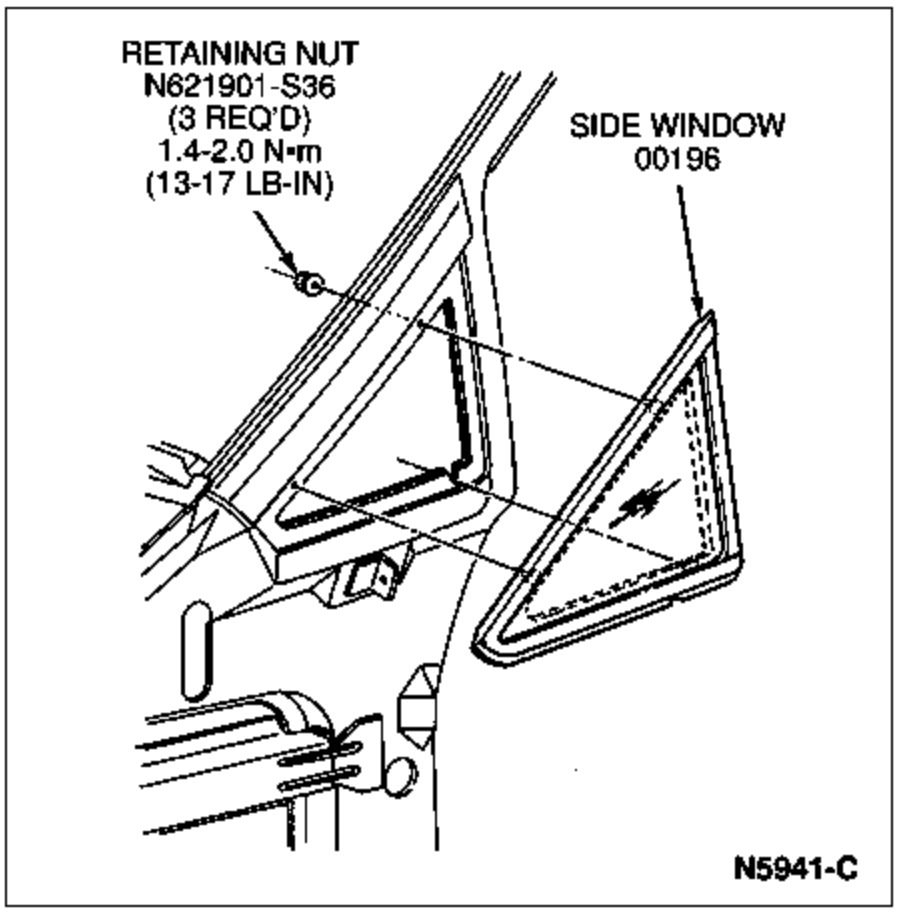
Side Window, Aerostar

Removal

1. Remove the interior trim. Refer to Section 01-05B .
2. Remove the three retaining nuts.
3. Push the side window module out.



Installation

1. Clean the window opening surface of all sealer.
2. Clean the existing sealer from the window module if it is to be reused.
3. Apply a continuous 8-9mm (11/32 in.) bead of Liquid Butyl Sealer C9AZ-19554-B or equivalent meeting Ford specification ESB-M4G162-A.

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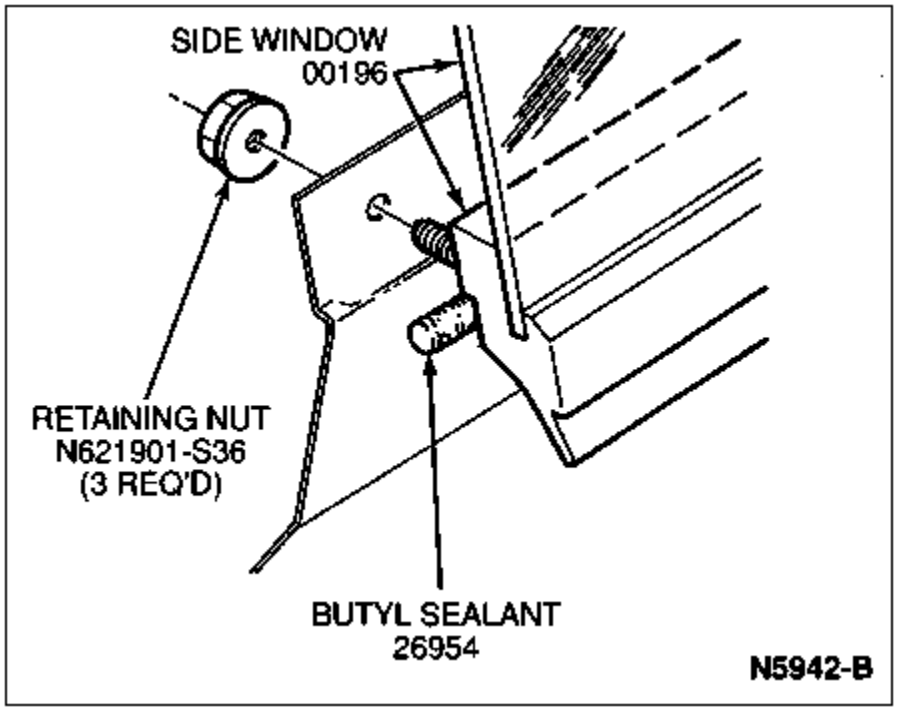
4. Install the side window module into the opening.
5. Install the three retaining nuts. Tighten to 1-2 Nm (9-17 lb-in).
6. Clean the area around the window to remove all the excess sealer.
7. Test for water leaks.
8. Install the interior trim. Refer to Section 01-05B .



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Latch, Rear Quarter Window, Ranger

Removal and Installation

1. Open the quarter window to relieve latch tension.
2. Remove the latch pin from the clamp and window pin.
3. Unscrew the window pin from the quarter window. Observe the part orientation.
4. Remove the two screws attaching the latch clamp to the inside body panel.
5. Remove the quarter window latch from the inside body panel.

For installation, follow removal procedures in reverse order. Tighten the latch-to-body screws to 7-11 Nm (62-97 lb-in).

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Latch, Sliding Body Side Window

Removal

1. Open the sliding body side window to relieve tension.
2. Remove the roll pin from the latch handle and latch base.
3. Remove the latch handle and spring.
4. Remove the two screws attaching the latch base to sliding body side window.
5. Remove the latch base from sliding window.
6. Clean adhesive from sliding body side window.

Installation

1. To install, reverse the removal procedure. Tighten latch base to sliding body sie window attaching screws to 2-3 Nm (18-27 lb/in).

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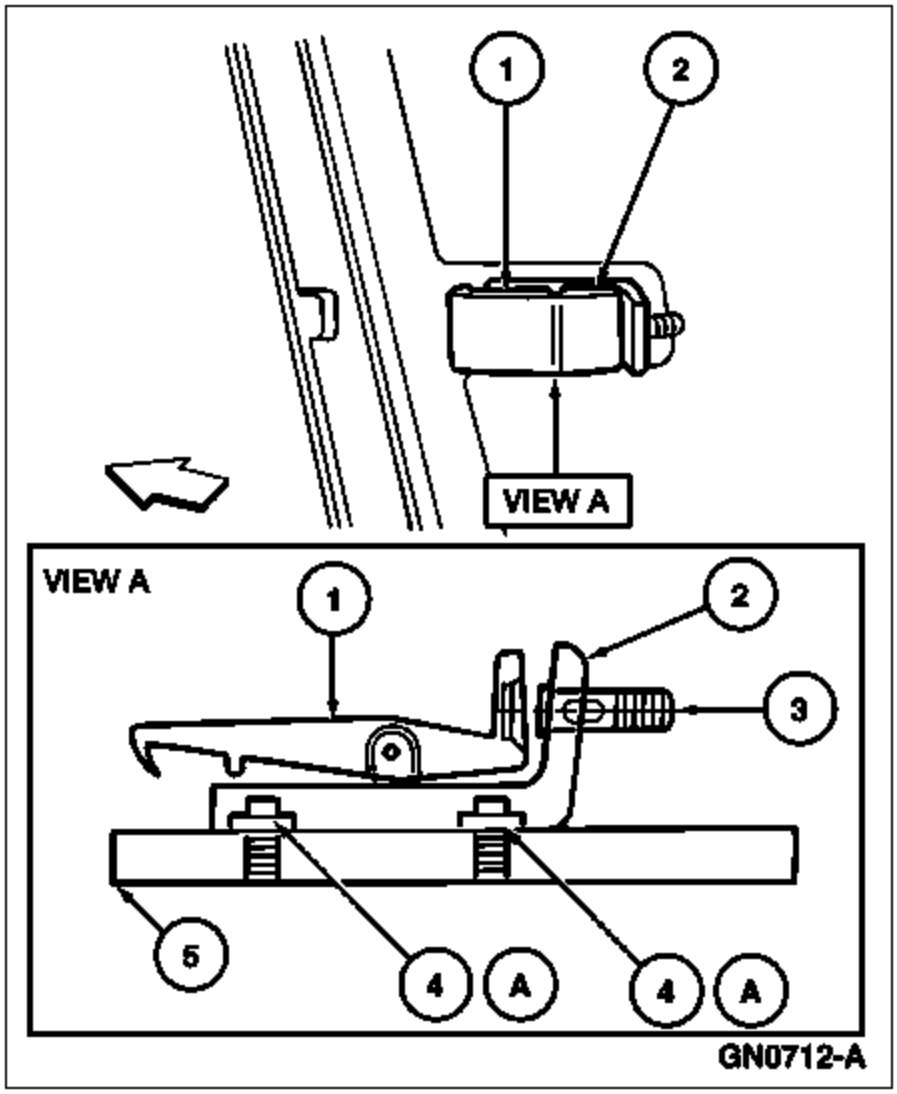

Item	Part Number	Description
1	—	Latch Handle
2	—	Latch Base
3	—	Latch Lock
4	—	Screws
5	29701	Body Side Window, Sliding
6	—	Roll Pin
7	—	Tighten to 2-3 Nm (18-27 Lb/In)

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Heated Back Window Switch and Light, Aerostar

Removal

1. Disconnect the battery ground cable (14301).
2. Remove instrument panel finish panel (044D70). Refer to Section 01-12 .
3. Remove connector from the heated back window switch and light.
4. Remove the heated back window switch and light from the instrument panel finish panel by pushing from the connector side until the snap-in mounting clips release.

Installation

1. Feed the electrical connector through the switch mounting hole on the instrument panel finish panel.
2. Install the electrical connector to the heated back window switch and light.
3. Install the switch in the instrument panel finish panel (snap-in).
4. Install instrument panel finish panel.
5. **NOTE: When the battery is disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.**

   Connect battery ground cable.
6. Check system operation.

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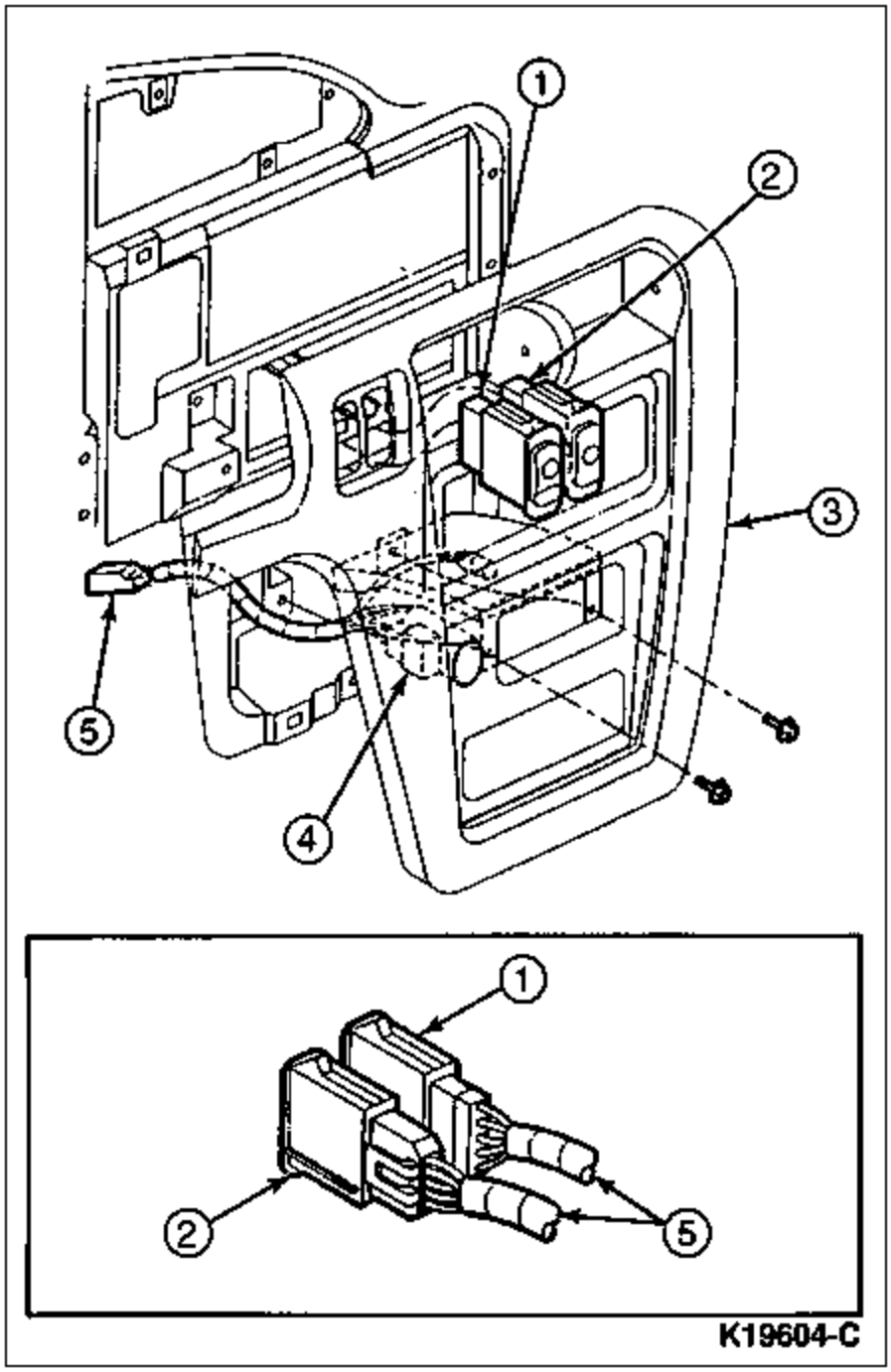

Item	Part Number	Description
1	17A406	Rear Window Wiper/Washer Switch
2	18C621	Heated Back Window Switch and Light
3	044D70	Instrument Panel Finish Panel
4	13776	Interior Lamp
5	14401	Main Wiring

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Grid Wire, Back Window

CAUTION: Any break in the grid longer than 25mm (1 inch) can not be serviced. The back window glass must be replaced. For breaks less than 25mm (1 inch) long, use the following procedure:

NOTE: If the first layer of the rear window grid (brown color) is damaged or missing it will be necessary to apply Brown Lacquer Touch-Up Paint AL81-5477-B or equivalent on the glass prior to applying the Rear Window Defroster Repair D8AZ-19562-AA or equivalent meeting Ford specification ESB-M4J58-A.

Inoperative grid wires on heated rear windows should be serviced by using Rear Window Defroster Repair D8AZ-19562-AA or equivalent meeting Ford specification ESB-M4J58-A.

NOTE: There are two methods for repairing terminal separation from back window glass and/or grid breaks. Method one involves soldering the terminal to the glass and method two uses an epoxy adhesive.

Method One

Surface Preparation

1. The vehicle should be brought inside and permitted to come to room temperature 16℃ (60℉) or above.

2. **CAUTION: Do not use scrapers, sharp instruments, or abrasive cleaners on the interior surface of the rear window as this may cause damage to the grid lines.**

   Clean the entire grid line service area with Ford Ultra Clear Spray Glass Cleaner E4AZ-19C507-AA or equivalent meeting Ford specification ESR-M14P5-A cleaning solvent to remove all dirt, wax, grease, oil or other foreign matter. It is important that the service area be clean and dry.

Mixing

Rear Window Defroster Repair D8AZ-19562-AA or equivalent meeting Ford specification ESB-M4J58-A and touch-up paint, if needed, must be at room temperature. Shake bottle for at least one minute for thorough mixing. Shake frequently during use.

Application

1. Mark the location of the break on the outside of the window.

2. Using cellulose tape, mask off the area directly above and below the grid break. The break area should be at the center of the mask and the tape gap must be no wider than the existing grid line.

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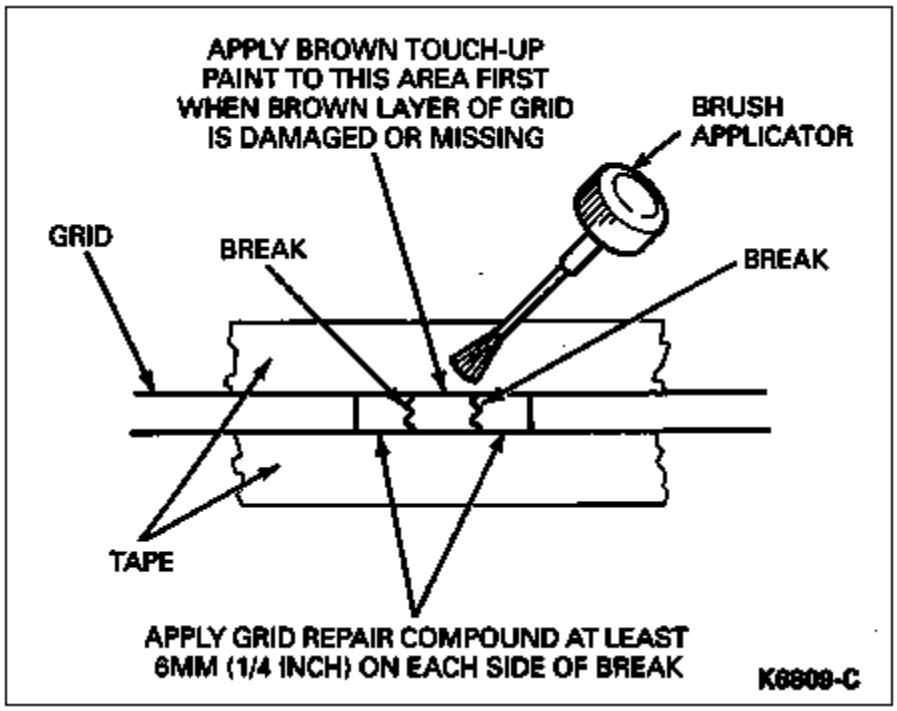

3. **NOTE: If both brown and silver layers of the grid are broken or missing, apply a coat of the brown touch-up paint across the break area first. Two coats may be necessary to obtain the proper color. Allow the touch-up paint to dry, then apply three coats of silver grid repair compound, allowing three to five minutes drying time between coats. The coating of the silver grid repair compound should extend at least 6mm (1/4 inch) on each side of the break area.**

   Apply the service coating in several smooth continuous strokes (allowing 3 to 5 minutes drying time between coats) across the break areas using the brush applicator in the cap. Extend the service coating at least 6mm (1/4 inch) on both sides of the break area.

4. Allow to dry for five minutes, then remove the mask.

5. **CAUTION: In the following procedure, be careful not to damage the grid line with the razor blade.**

   After removing the mask, check the outside appearance of the grid repair. If compound is visible above or below the grid, this excess should be removed. This can be done by placing a single-edge razor blade on the glass parallel to the grid and scraping gently toward the grid.

Curing

The service coating will air dry in approximately one minute and can be energized within three minutes. Optimum hardness and adhesion occurs after approximately 24 hours. At that time, the serviced area may be cleaned with a mild window cleaner.

Method Two

NOTE: This method requires a repair kit number 50-25-0584-0029 available from:

Marketing East Company

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No. 10 Liberty Street

North Andover, MA 01845

Attn: Sales

Phone: (978) 689-9565

Contact the manufacturer for the latest ordering information.

Terminal Repair

1. Following the manufacturer's instructions, apply conductive cement to the repair area.
2. Following the manufacturer's instructions, apply conductive cement to the repair area.

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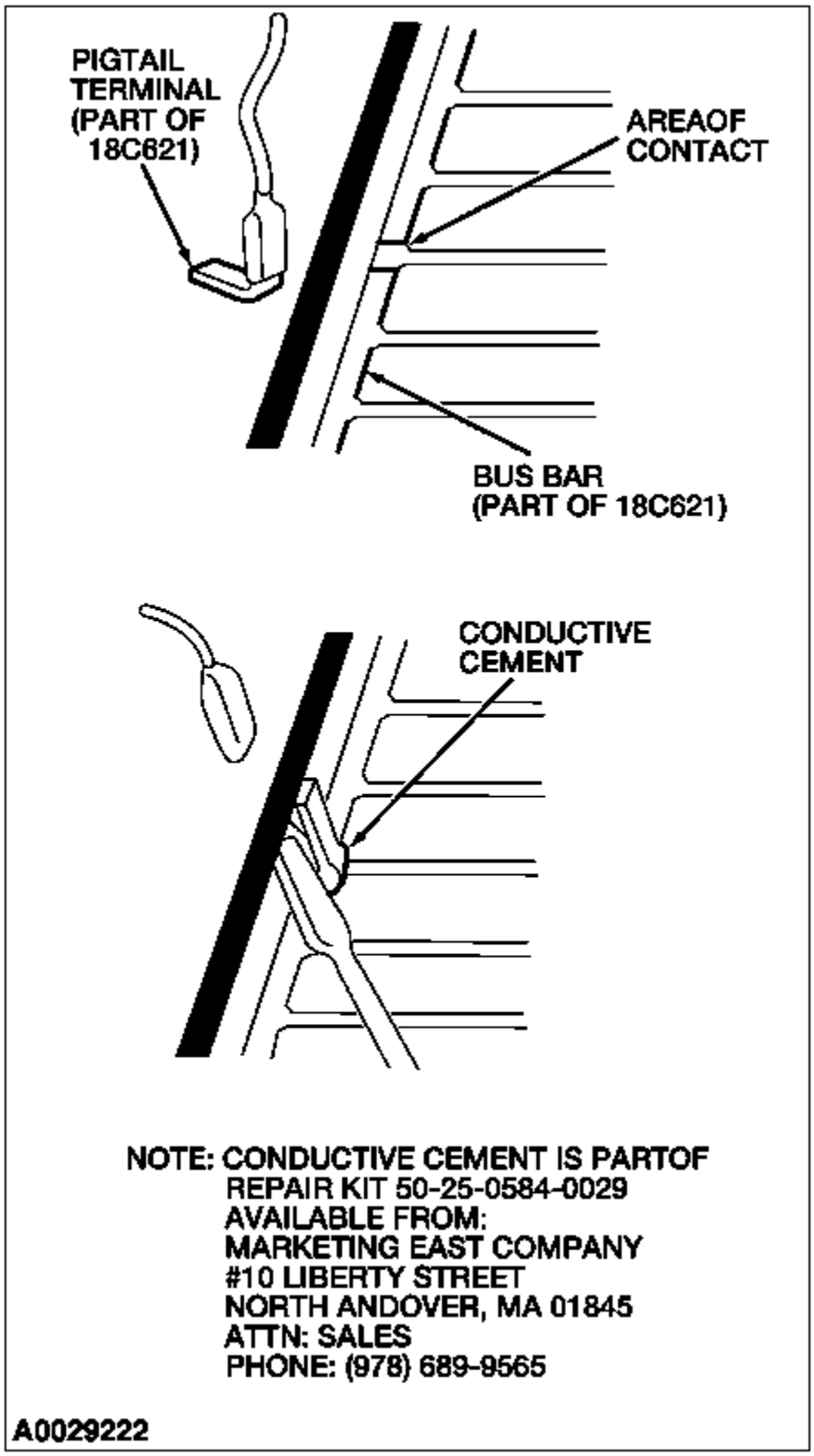

3. Following the manufacturer's instructions, position and hold the pigtail terminal on the conductive cement.

4. Following the manufacturer's instructions, apply heat to the repair area.

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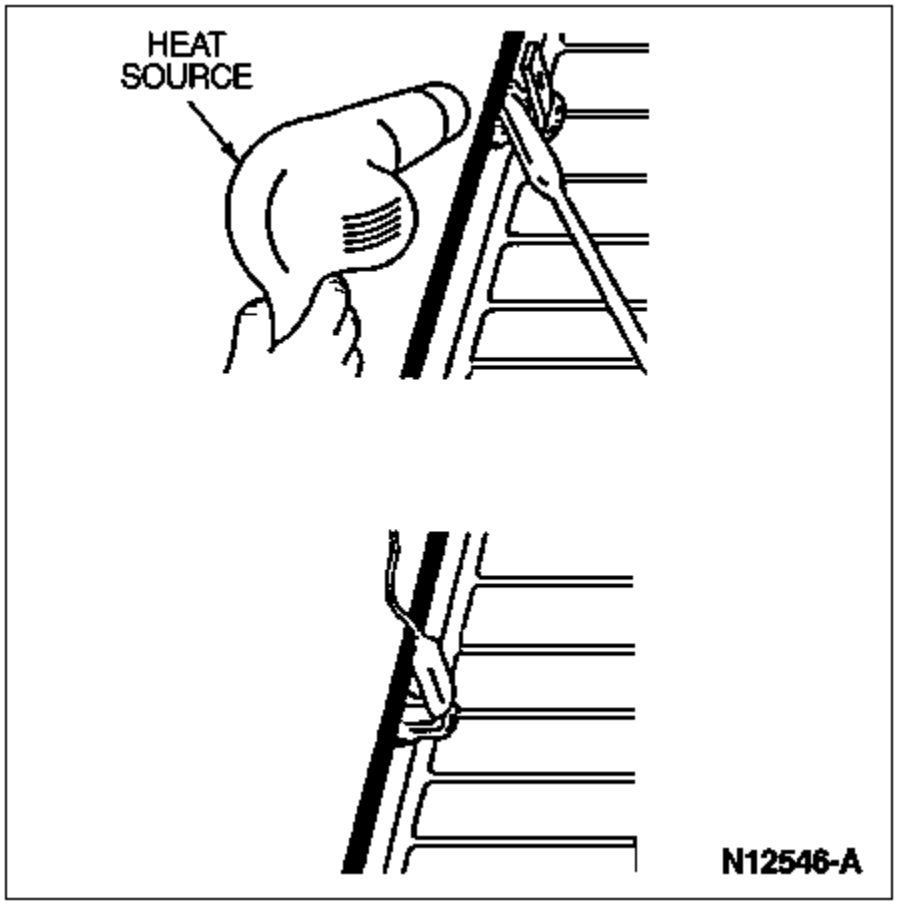

5. After allowing sufficient cure time, according to manufacturer's instructions, reconnect the heated back window switch and light connector to the pigtail terminal and retest the system.

Grid Line Repair

1. Following the manufacturer's instructions, clean and mask the repair area.

2. Following the manufacturer's instructions, apply conductive cement to the repair area.

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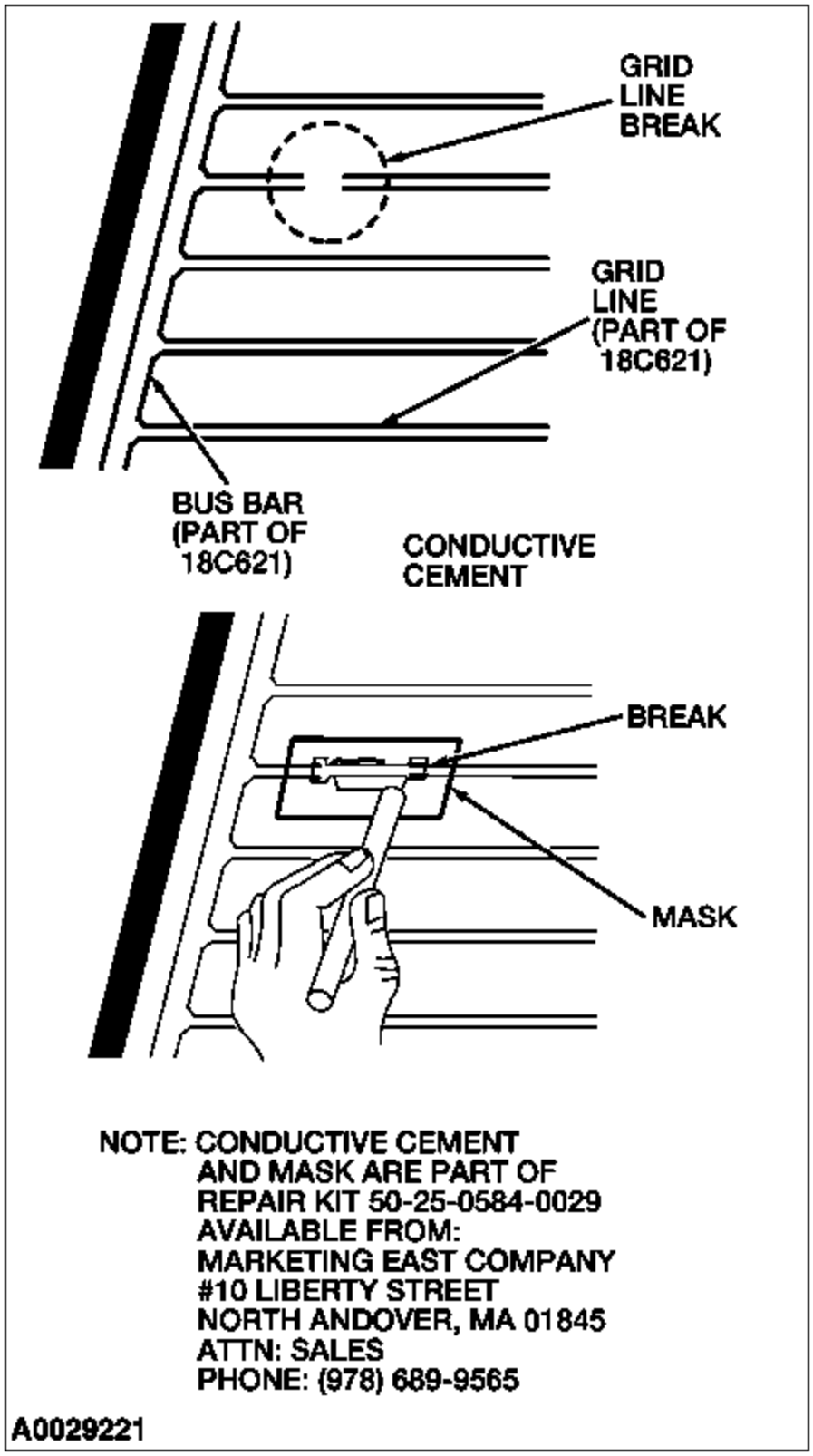

3. Following the manufacturer's instructions, apply heat to the repair area.

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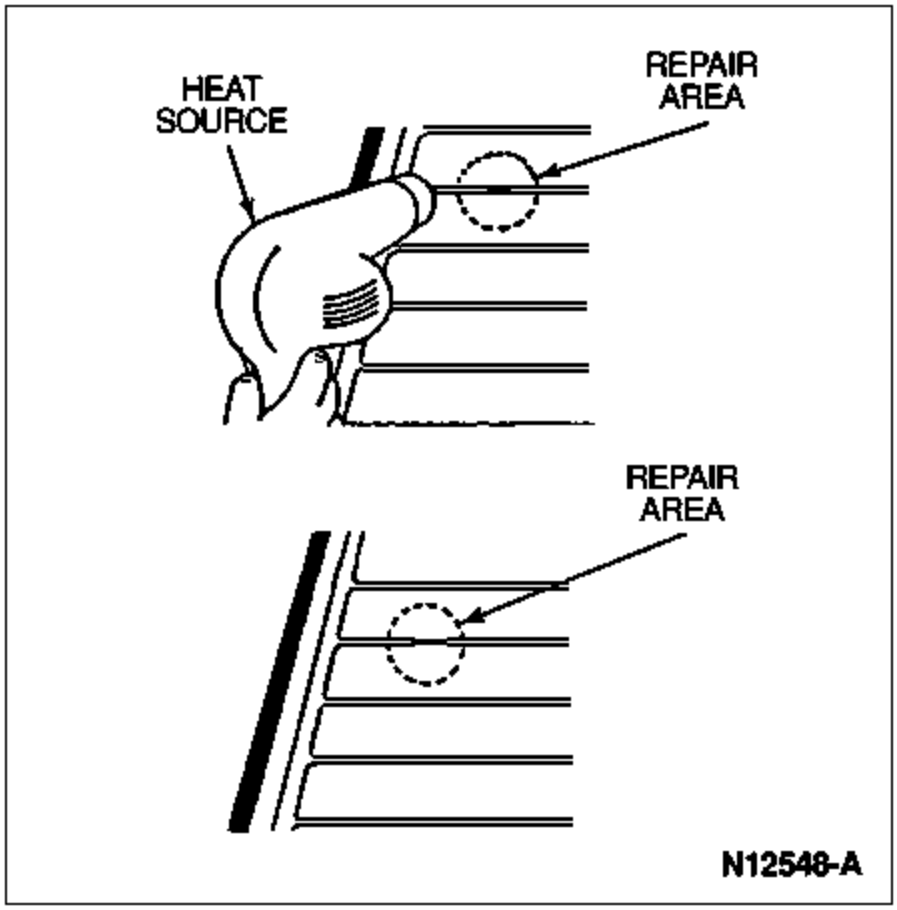

4. After allowing sufficient cure time, according to manufacturer's instructions, retest the system.

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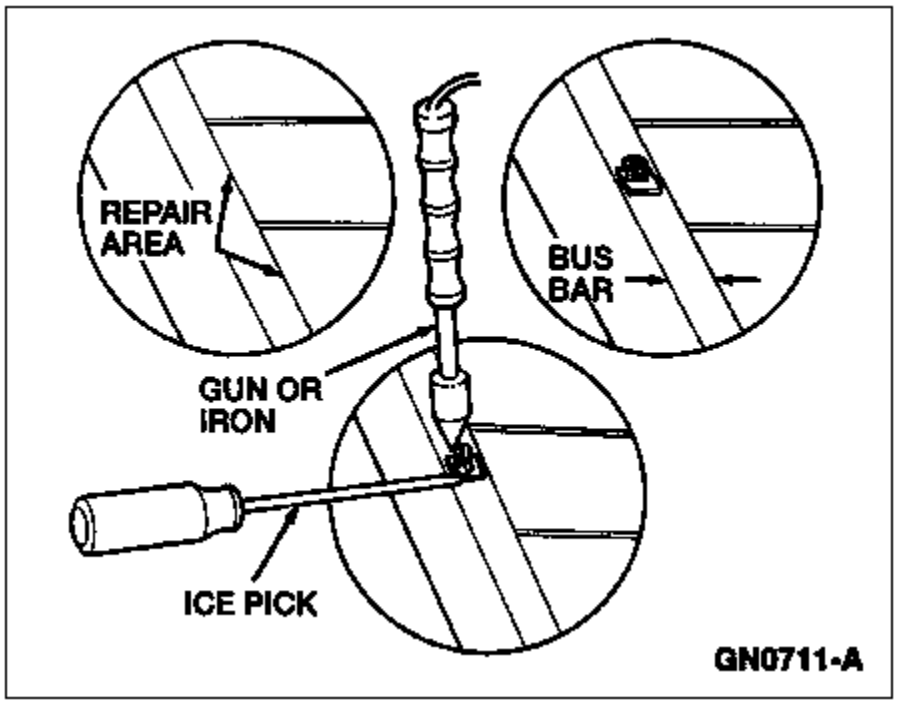
Lead Window Terminal Service

1. Allow the rear window to warm up to room temperature for one-half hour to one hour.
2. Clean the bus bar in the area to be serviced using fine steel wool (3/0 to 4/0 grade).
3. Restore the area where the bus bar terminal was originally attached by applying three coats of Rear Window Defroster Repair D8AZ-19562-AA or equivalent meeting Ford specification ESB-M4J58-A. Allow approximately ten minutes drying time between coats.
4. Working as quickly as possible to avoid overheating the glass, tin the bus bar with solder in the area where the terminal will be attached. To avoid damaging the bus bar, remove the soldering gun or iron as soon as the solder flows.
5. Using a heat lamp, preheat the glass in the solder area to 50°-60°C (120°-140°F) just prior to soldering the terminal on.
6. Position the terminal on the bus bar in the area that was tinned and hold it in place with an ice pick or screwdriver.
7. Apply soldering heat to the pad of the terminal unit until the solder flows.
8. Start the vehicle, turn the heated rear window on and leave it on for five minutes. Inspect the terminal and apply Rear Window Defroster Repair D8AZ-19562-AA or equivalent meeting Ford specification ESB-M4J58-A to the required area.



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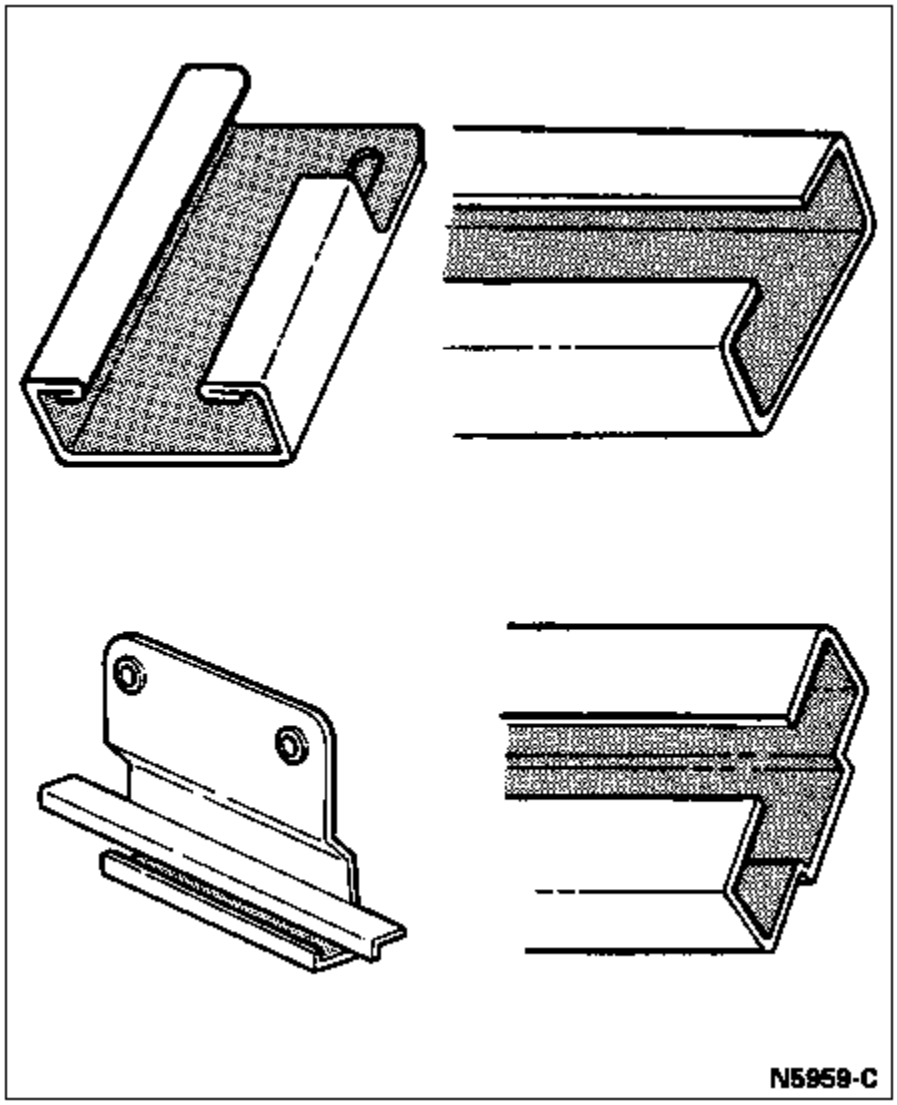
Window Regulator, Front Door, Power

The door window mechanism should be properly lubricated to provide ease of operation. The window glass mechanism should be lubricated whenever the glass channel or window regulators are removed or excessive effort is required to operate the windows. To lubricate a door window mechanism, apply an even coating of Premium Long-Life Grease XG-1-C or -K or equivalent meeting Ford specification ESA-M1C75-B to the window regulator rollers, shafts and the entire length of the roller guides as illustrated by the shaded areas.



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Counterbalance Spring

WARNING: IMPROPERLY REMOVED COUNTERBALANCE SPRINGS CAN CAUSE INJURY. BE SURE TO USE THE FOLLOWING PROCEDURE TO MINIMIZE RISK.

WARNING: THE COUNTERBALANCE SPRING IS PRETORQUED. CAREFUL HANDLING IS REQUIRED TO MINIMIZE RISK OF PERSONAL INJURY.

Removal

1. Remove the window regulator from the front door (20124) as described in this section.
2. Place the window regulator in the full-up position, if possible, to partially relieve the spring load.
3. Clamp the window regulator so that no rotational movement is possible.
4. **NOTE: Position spring center bar relative to slotted pivot pin for reassembly later.**

   Using locking pliers proceed as follows:

   a. Grip counterbalance spring hook at retaining pin.
   b. Carefully lift high enough to clear the pin.
   c. Allow the spring to unwind to a free position, about 1/3 to 1/2 turn.

5. Remove the window regulator electric drive from the mounting plate. The counterbalance spring can now be discarded.

Installation

1. Place the window regulator in the full-up position to ease assembly.
2. Reattach the window regulator electric drive to the mounting plate and clamp the window regulator so that no rotational movement is allowed.
3. Place the spring center bar on the slotted pivot pin.
4. **WARNING: THE SPRING MAY CAUSE INJURY IF NOT PROPERLY SEATED BELOW THE SHOULDER ON THE RETAINING PIN BECAUSE THE SPRING COULD SLIP OFF THE PIN.**

   NOTE: Make sure spring is properly seated below the pin shoulder.

   With locking pliers on the spring hook, carefully wind the spring to retainer pin.

5. Cycle the window regulator making sure the spring coils constrict as the window glass travels down. This ensures that the coil is in the proper position.
6. Replace the window regulator in the front door as described in this section.

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SPECIFICATIONS

WINDOW REGULATOR ELECTRIC DRIVE CURRENT DRAW

Specification	Condition
4 Amps Maximum with No Fluctuation	No Load

TORQUE SPECIFICATIONS

Description	Nm	Lb-In
Run Attaching Screws	7-14	62-123
Stabilizer Attaching Screws	9-14	80-123
Guide-to-Glass Bracket	7-14	62-123
Window Regulator Base Plate Nuts	9-14	80-123
Equalizer Bracket Nut	9-14	80-123
Regulator Inner Panel	9-14	80-123
Motor and Drive Screws	6-9	50-84
Belt Line Weatherstrip Nut	1.4-2.3	13-20
Body Side Window-to-Body Nuts	1-2	9-17
Belt Line Weatherstrip Nut	1.4-2.3	12-20
Window Regulator Electric Drive Screws	6-9	50-84
Back Window Glass Hinges Screws	3.7-4.3	28-38

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SPECIAL SERVICE TOOLS/EQUIPMENT

ROTUNDA EQUIPMENT

Model	Description
107-R0600	Blind Fastener Installation Tool
014-00407	Digital Volt-Ohmmeter
164-R2450	Interior Auto Glass Cut-Out Knife Kit
164-R2460	Tightwire Start-up Kit

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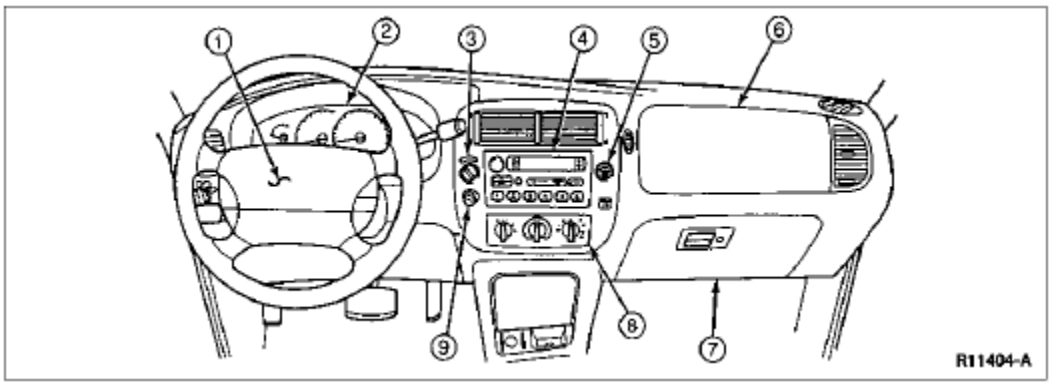
Instrument Panel and Console

The following illustration details the location of the main components found on the instrument panel.

Instrument Panel Components



Item	Part Number	Description
1	043B13	Driver Side Air Bag Module
2	10849	Instrument Cluster
3	14B166	Transfer Case Dual Power Control Switch (Electronic 4x4 Only)
4	18806	Radio Chassis
5	17A553	Rear Wiper/Washer Switch (If Equipped)
6	044A74	Passenger Side Air Bag Module
7	06024	Glove Compartment Door
8	19980	A/C Control
9	15052	Cigar Lighter Knob and Element

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Symptom Chart — Instrument Panel And Console

INSTRUMENT PANEL AND CONSOLE

Condition	Possible Source	Action
• Ash Receptacle Lamp Inoperative	• Short to ground. • Open to ground. • Open supply. • Open fuse.	• GO to Pinpoint Test A .

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Pinpoint Tests

NOTE: Use Rotunda Digital Volt-Ohmmeter 014-00407 or equivalent to perform electrical pinpoint tests.

PINPOINT TEST A: ASH RECEPTACLE LAMP (AEROSTAR ONLY)

A1 CHECK FUSE CIRCUIT NO. 7

- Ignition switch OFF.
- Check the 10A fuse No. 7 located in the instrument panel.

Is fuse No. 7 blown?

Yes	No
REPLACE fuse No. 7 and RETEST.	GO to **A2** .

A2 CHECK ASH RECEPTACLE LAMP ILLUMINATION

- Rotate pulse width module (PWM) rheostat until ash receptacle lamp illuminates.

Does ash receptacle lamp illuminate?

Yes	No
Not a circuit problem. System OK.	GO to **A3** .

A3 CHECK FOR SHORT TO GROUND

- Remove the 10A fuse No. 7.
- Disconnect the pulse width module connector.
- Measure the resistance of Circuit 1011 (T/O) between the RH terminal of fuse No. 7 and ground.

Is resistance less than 5 ohms?

Yes	No
SERVICE Circuit 1011 (T/O) between instrument panel, fuse junction panel and the pulse width module connector. RETEST.	GO to **A4** .

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A4 CHECK POWER SUPPLY TO ASH RECEPTACLE LAMP

- Disconnect the pulse width module (PWM) connector.
- Ignition switch in RUN or ACC.
- Measure the voltage of the Circuit 1011 (T/O) at the PWM connector.

Is voltage greater than 10 volts?

Yes	No
GO to **A5** .	SERVICE Circuit 1011 (T/O) between instrument panel, fuse junction panel and the PWM connector. RETEST.

A5 CHECK ASH RECEPTACLE LAMP

- Rotate PWM rheostat fully ON.
- Back probe PWM connector Circuit 235 (R/BR).

Does voltage read 10 or more volts?

Yes	No
REPLACE bulb in ash receptacle lamp. RETEST.	GO to **A6** .

A6 CHECK ASH RECEPTACLE LAMP GROUND

- Disconnect PWM connector.
- Measure the resistance of the Circuit 57 (BR) between the ash receptacle lamp connector and ground.

Is resistance less than 5 ohms?

Yes	No
REPLACE ash receptacle lamp element.	SERVICE Circuit 57 (BK) between ash receptacle lamp element and ground. RETEST.

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Instrument Panel and Console

CAUTION: Before performing any removal or installation on the Aerostar instrument panel, the battery to starter relay cable must be disconnected for a minimum of 60 seconds to discharge the air bag backup power supply.

NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.

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Ash Receptacle, Aerostar

Instrument Panel Mounted

Removal and Installation

1. Pull the instrument panel ash receptacle (04810) out to the stop.
2. Depress and hold the spring-loaded flap. Continue to pull the instrument panel ash receptacle from the instrument panel.
3. To install, depress the flap and slide the instrument panel ash receptacle into the instrument panel to full closed position.

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Ash Receptacle and Retainer, Ranger

Instrument Panel Mounted

Removal and Installation

1. Remove instrument panel ash receptacle (04810).
2. Remove the four (4) screws attaching instrument panel ash receptacle to instrument panel.
3. Apply pressure to sides of instrument panel ash receptacle to release clips.
4. Disconnect power point electrical connection (three electrical connections).

For installation, follow removal procedures in reverse order.

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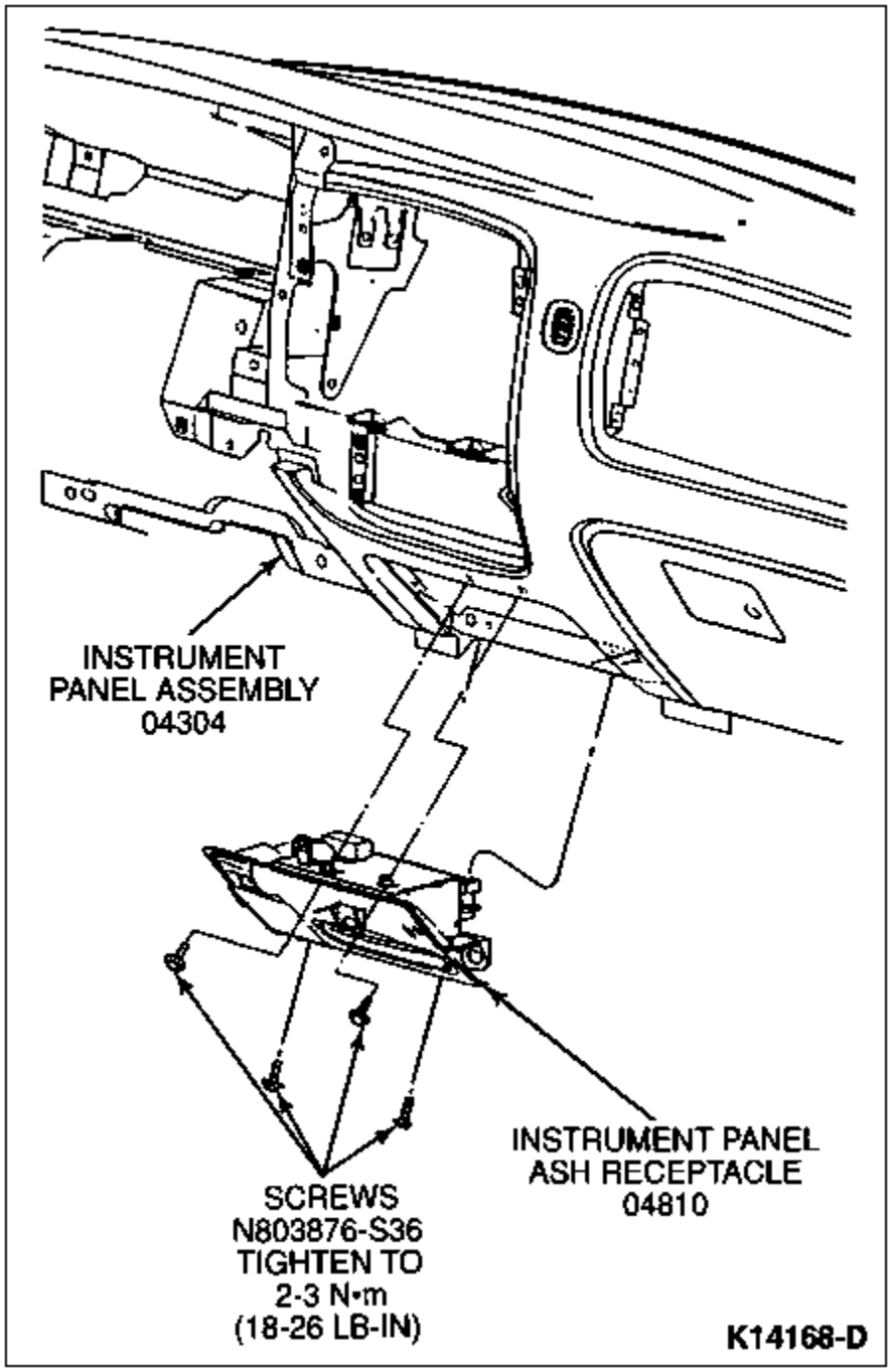

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Cigar Lighter, Aerostar

Instrument Panel Mounted

Removal and Installation

1. Disconnect battery to starter relay cable.
2. Remove cigar lighter knob and element (15052).
3. Remove instrument panel finish panel (044D70) as described in Removal and Installation, Instrument Cluster Finish Panel, Aerostar in this section.
4. Unscrew the cigar lighter socket and retainer (15055) and remove from the finish panel.

For installation, follow removal procedures in reverse order.

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Cigar Lighter, Ranger

Instrument Panel Mounted

Removal and Installation

1. Disconnect battery ground cable (14301).
2. Remove center finish panel. Refer to procedure in this section.
3. Disconnect cigar lighter wire from base.
4. Unscrew cigar lighter socket and retainer (15055).

For installation, follow removal procedures in reverse order.

When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.

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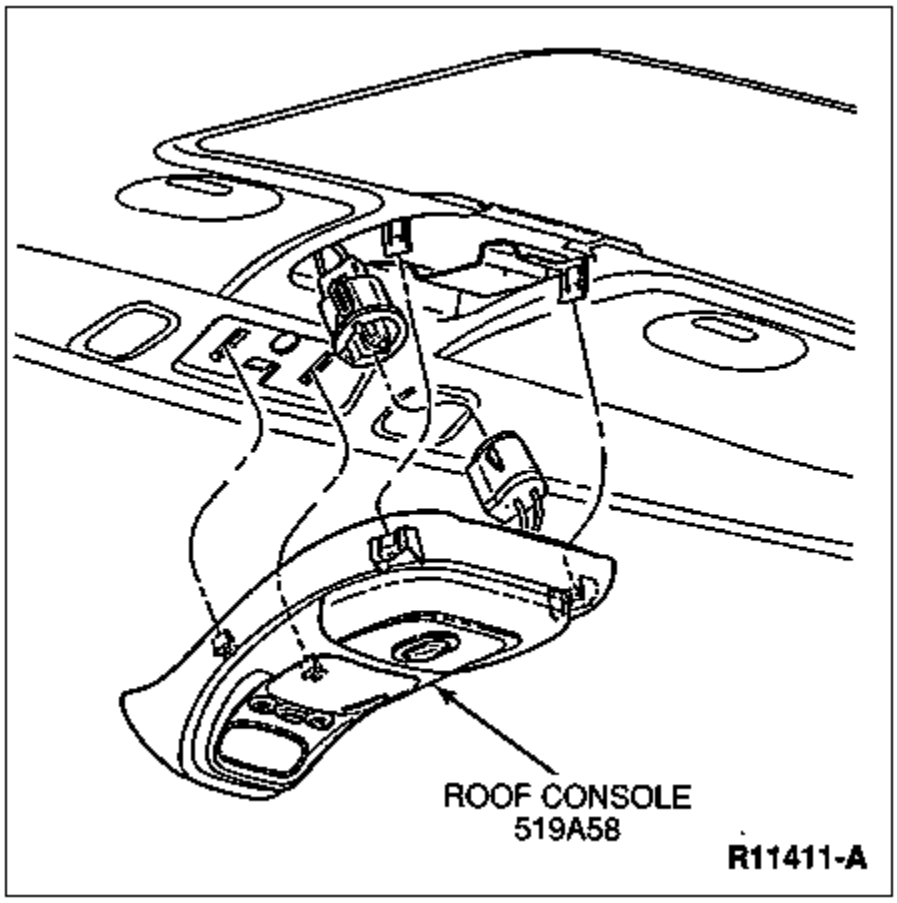
Console, Roof (with Power Moon Roof)

Removal and Installation

1. Push moon roof trim moulding back for clearance.
2. Using hand pressure, release snapping clips attaching console to mounting bracket.
3. Disconnect electrical connector.
4. Remove roof console (519A58).

For installation, follow removal procedures in reverse order.



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Console, Roof (Without Power Moon Roof)

Removal and Installation

1. Open door on roof console (519A58) and remove two (2) screws attaching console to mounting bracket.
2. Release two (2) tabs in front (closest to windshield) using hand pressure.
3. Disconnect electrical connector.
4. Remove roof console.

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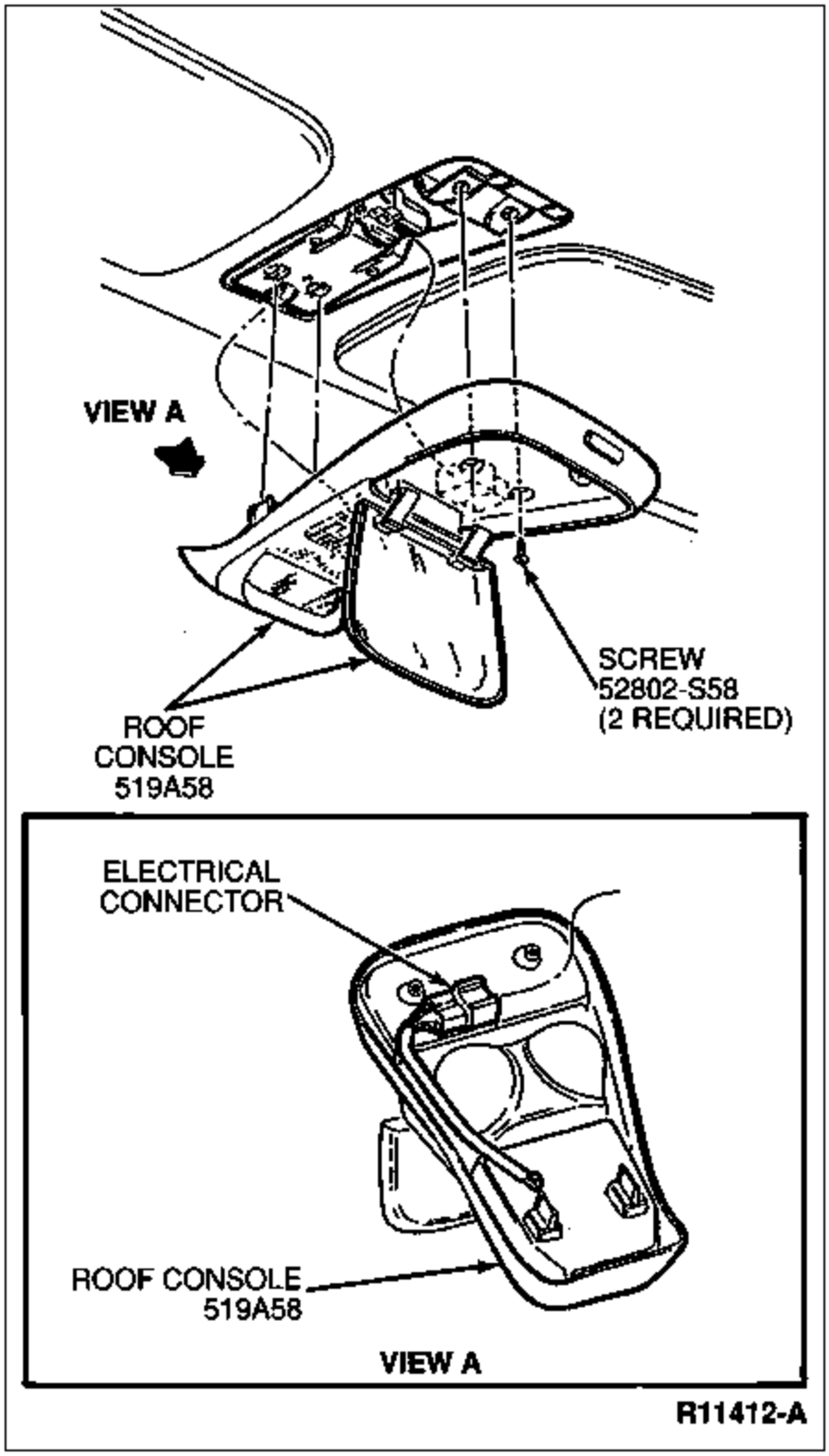

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Mounting Bracket, Floor Console, Aerostar

Removal and Installation

1. Remove floor console as described in Removal and Installation, Console, Floor, Aerostar in this section.
2. Remove two nut and washer assemblies retaining console panel rear mounting bracket to floor.
3. Remove the console panel rear mounting bracket.

To install, reverse the removal procedure.

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Mounting Bracket, Floor Console, Ranger

Removal and Installation

1. Remove console assembly as described in Removal and Installation, Base Console, Floor, Ranger in this section.
2. Remove two nuts retaining console panel front mounting bracket to floor.
3. Lift the console panel front mounting bracket from the weld studs.

To install, reverse the removal procedure. Tighten nuts to 7-11 Nm (62-97 lb-in).

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Mounting Bracket, Console Armrest, Ranger

Base Model

Removal and Installation

1. Remove the console armrest mounting access covers (047A62) from the right and left sides of the console panel (045A36).
2. Remove two bolts from each side of the console panel which are located behind the console armrest mounting access covers.
3. Remove the front seat center armrest.
4. To install, follow removal steps in reverse order. Tighten bolts to 9-14 Nm (80-124 lb-in).

Upper Series

Removal and Installation

1. Raise console armrest to full open position.
2. Remove four screws retaining the digital audio compartment (if equipped).
3. Remove one screw from the armrest bracket and remove armrest.
4. To install, follow removal steps in reverse order.

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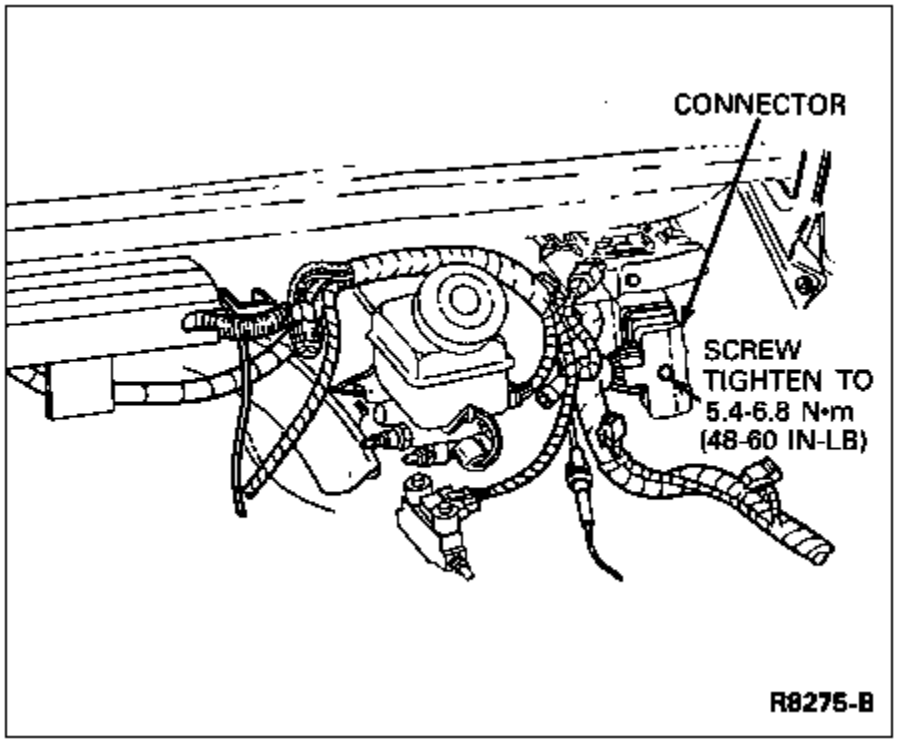
Instrument Panel, Aerostar

Removal and Installation

1. Disconnect battery positive cable.
2. Disconnect wiring connector on instrument panel located in the engine compartment, by loosening bolt and separating connectors.



3. Remove left and right windshield inside mouldings.
4. Remove defroster grille.
5. Remove glove compartment door finish panel (06036).
6. Remove instrument panel steering column cover (04459).
7. Remove four screws attaching the steering column lower reinforcement. Remove reinforcement.

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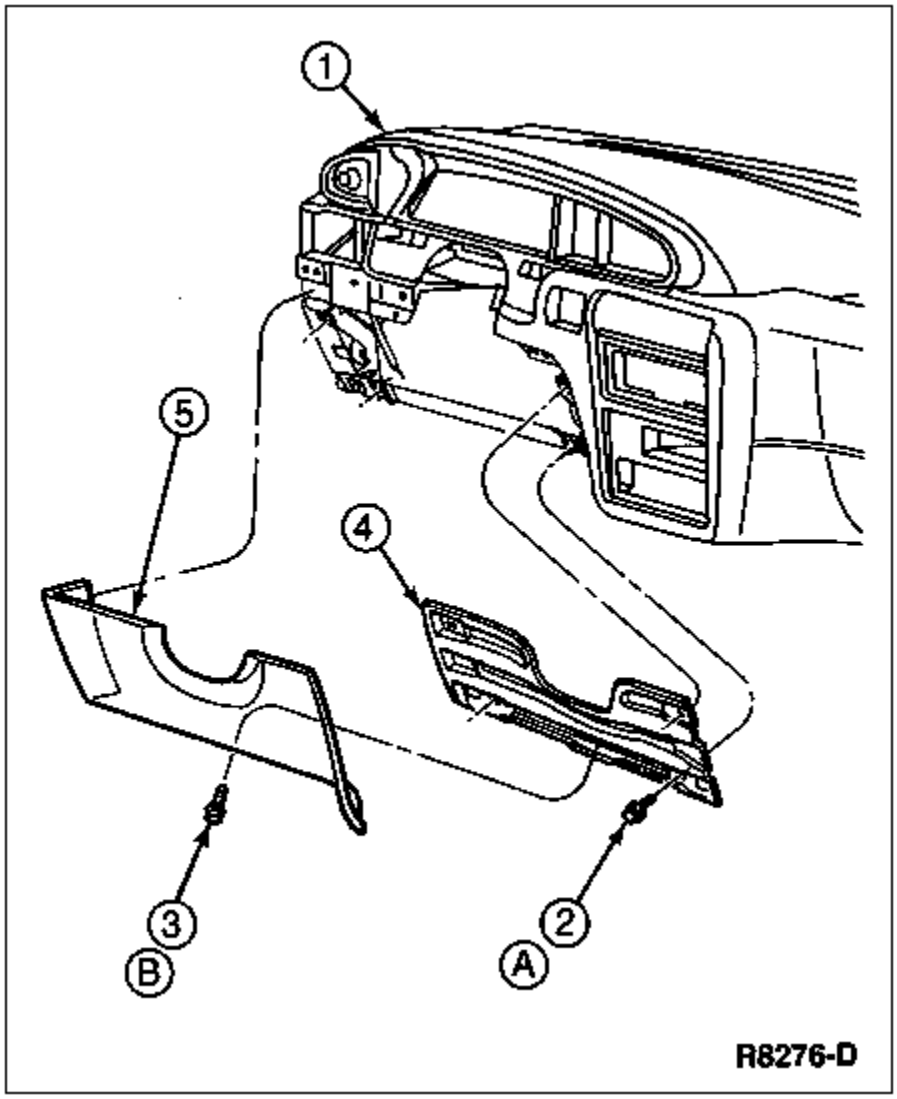

Item	Part Number	Description
1	04320	Instrument Panel
2	N803876-S36B	Screw (4 Req'd)
3	N803877-S36B	Screw (4 Req'd)
4	043C00	Steering Column Opening Reinforcement
5	04459	Instrument Panel Steering Column Cover
A	—	Tighten to 10-14 Nm (7-10 Lb-Ft)
B	—	Tighten to 2-3 Nm (18-26 Lb-In)

8. Remove right and left cowl side panels (02039).

9. Remove two nuts and hood latch control handle and cable (16916) assembly from left cowl side and reinstall the nuts to hold the bracket and relay (14A323).

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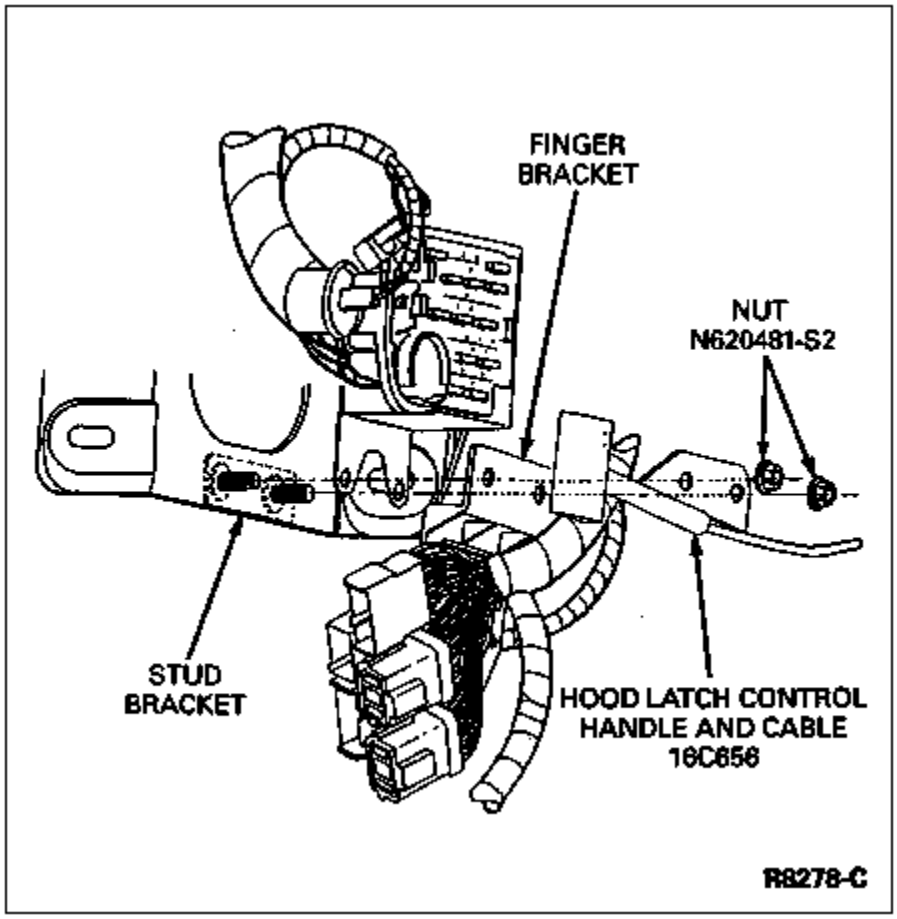

10. Disconnect the wiring on the left cowl side panel and, if equipped, the vacuum hose harness (19C827) connector. Number and location of connectors may vary depending on optional equipment.

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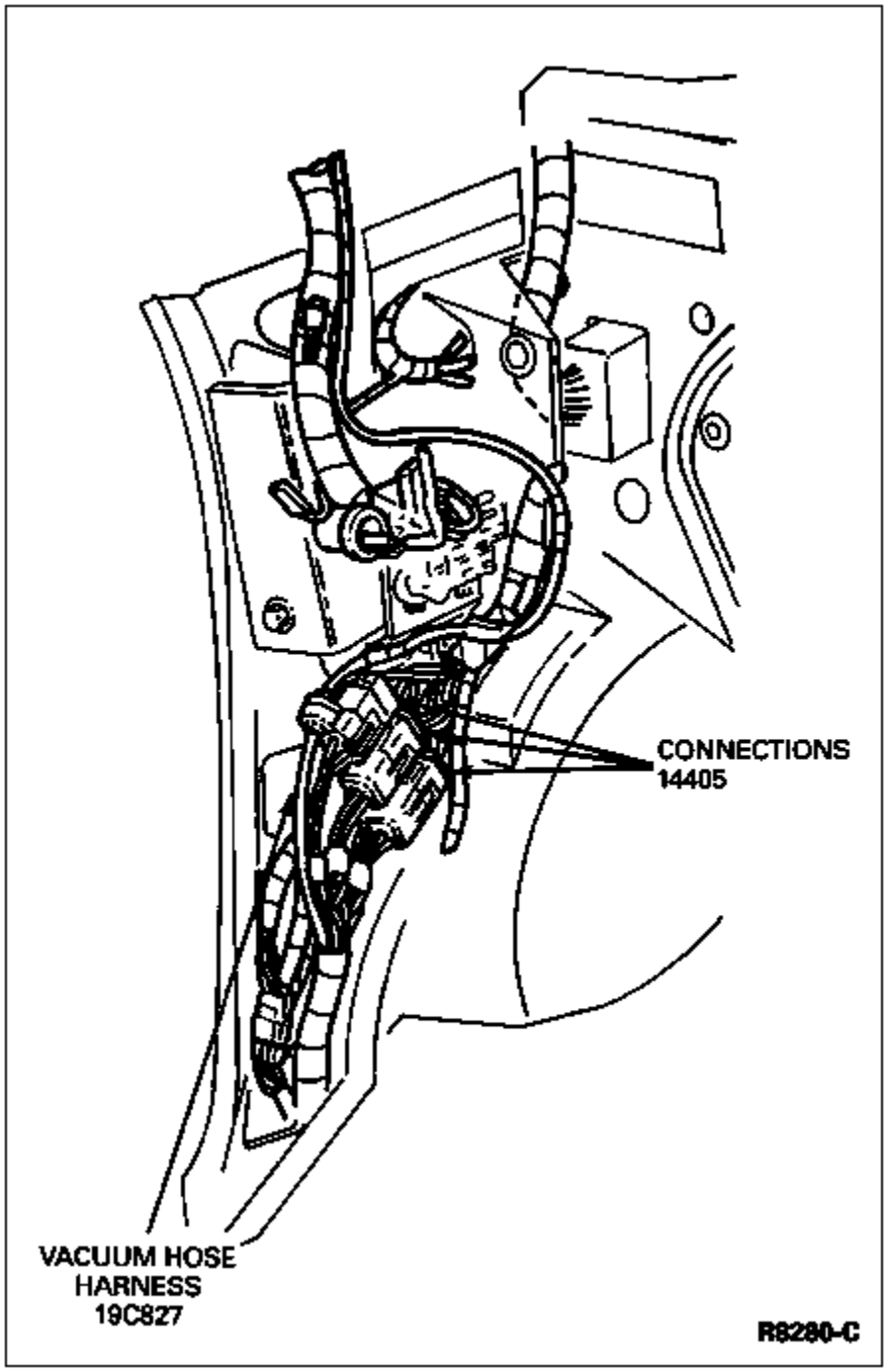

11. Disconnect the brake light switch wiring connector.

12. Remove steering column-to-extension shaft pinch bolt. Compress extension shaft toward engine and separate from the column U-joint.

13. Disconnect the transmission range indicator (7A110) from steering column.

14. Disconnect wiring to windshield wiper intermittent control module The module is located to the right of steering column.

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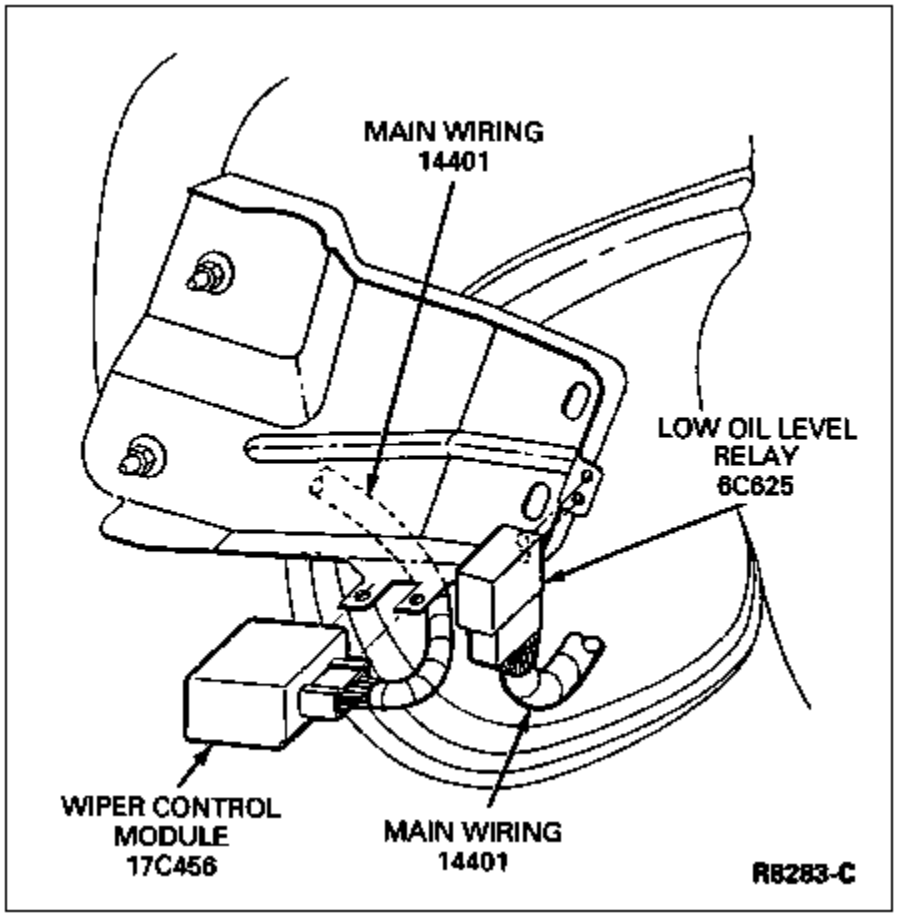

15. Disconnect radio antenna lead in cable (18812) at the right cowl side panel.

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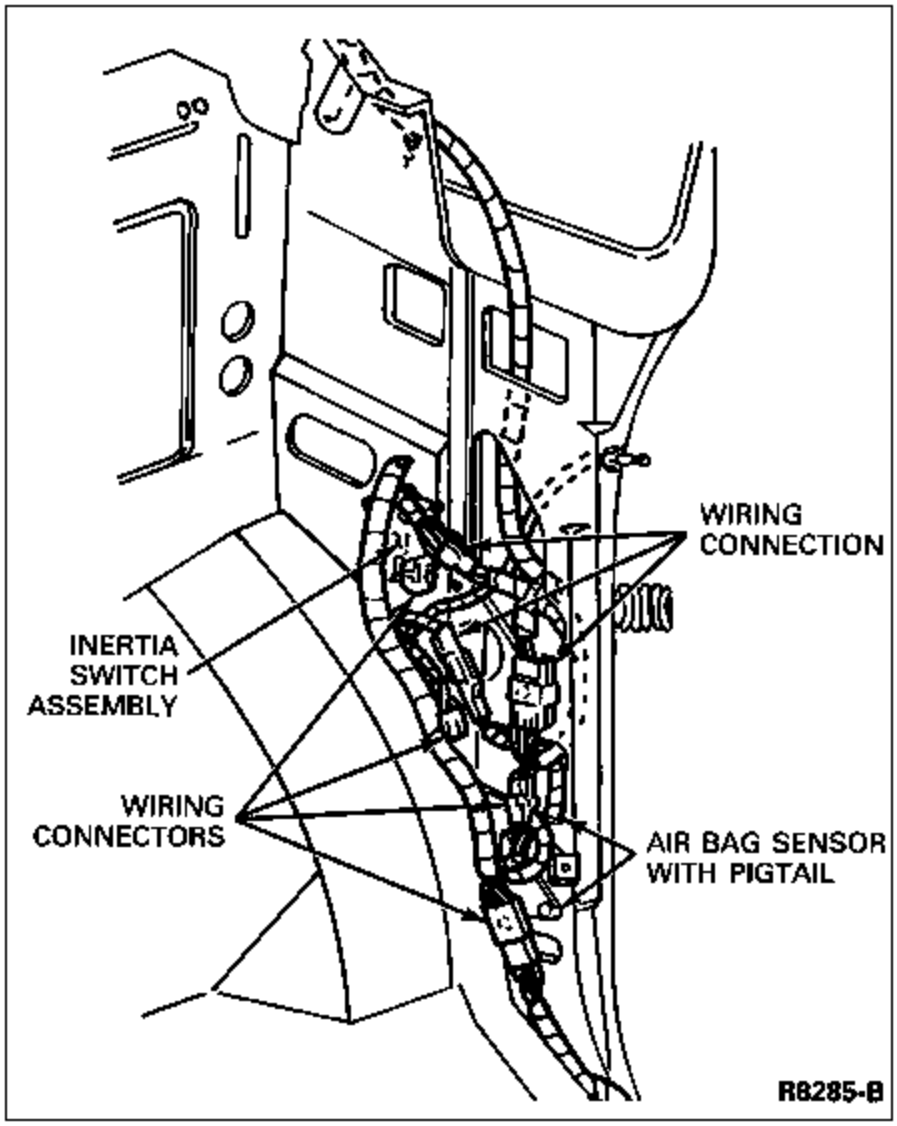

16. Disconnect heater temperature cable (18518). If equipped, disconnect vacuum hose harness connector.

17. Remove the five screws attaching the top of the instrument panel to the cowl side panel top.

18. Remove the one nut attaching the lower right side of the instrument panel to the cowl side panel.

19. Remove the two rearward nuts and loosen the two forward nuts located to the right of the steering column attaching the instrument panel to the center mounting bracket.

20. **NOTE: The following Steps (20, 21, 22) require two technicians.**

    Support the instrument panel. Remove three bolts and one nut attaching the instrument panel to left cowl side panel.

21. Carefully pull the instrument panel rearward and disconnect any remaining wires or other components.

22. Carefully remove instrument panel through the left front door (20124).

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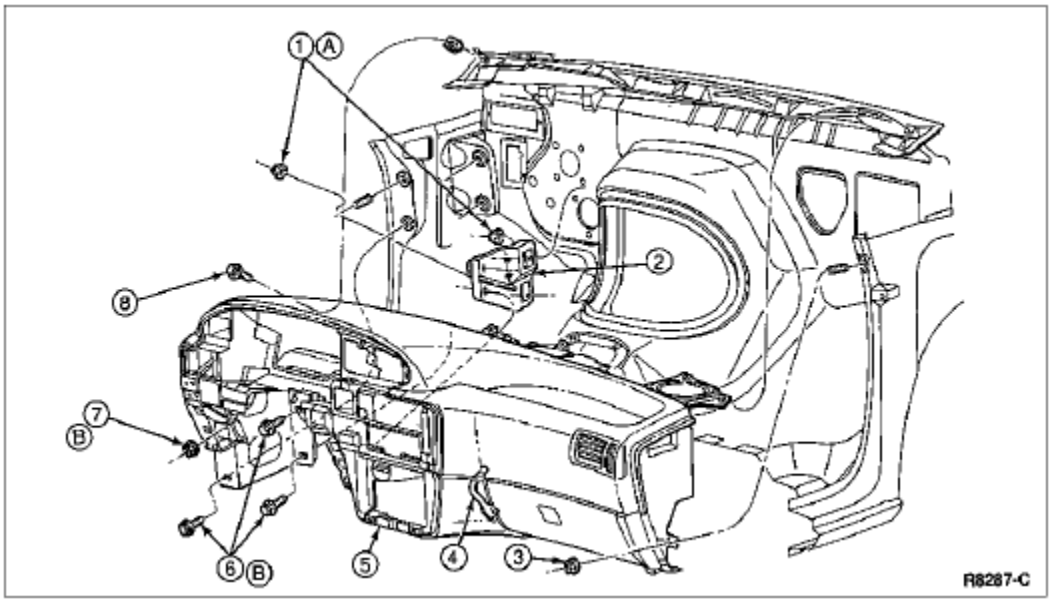
23. If replacing the instrument panel, transfer all the components to the replacement instrument panel.

For installation, follow removal procedures in reverse order.

When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.

Instrument Panel, Aerostar



Item	Part Number	Description
1	N620481-S2	Nut (2 Req'd)
2	043C76	Brace Assembly
3	N620480-S2	Nut (1 Req'd)
4	N045G90-A	Instrument Panel Brace
5	04320	Instrument Panel
6	N806965-S2	Screw and Washer (3 Req'd)
7	N621942-S2	Nut and Washer (1 Req'd)
8	N803876-S36B	Screw (1 Req'd)
A	—	Tighten to 10-14 Nm (7-10 Lb-Ft)
B	—	Tighten to 40-54 Nm (30-39 Lb-Ft)

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Instrument Panel, Ranger

Removal and Installation

1. Disconnect battery ground cable (14301).
2. Disconnect wiring connectors in engine compartment.
3. Remove two bolts retaining hood latch control handle and cable (16916) and lower cable and two bolts attaching parking brake release.
4. Move transfer case control to far forward position.
5. Remove instrument panel steering column cover (04459) by removing two (2) screws and pulling on cover to release grasshopper clips.
6. Remove bolt to bracket at right of accelerator pedal.
7. Remove instrument panel steering column reinforcement by removing six (6) screws.
8. Remove TK yoke by removing two (2) nuts from cross vehicle beam.
9. Open fuse panel door, and remove two (2) bolts attaching instrument panel to cowl (A pillar beam).
10. On right side of instrument panel lower, remove one (1) bolt.
11. Remove one (1) threadless fastener and two (2) pushpins attaching insulator to lower right-hand instrument panel .
12. Lift edge of defroster grille, using a flat wooden dowel, then pull up on defroster grille to release clips and tension tabs. Remove defroster grille.
13. Remove four (4) bolts at top of instrument panel.
14. Disconnect all electrical connections at rear of instrument panel.
15. Remove instrument panel.

Instrument Panel, Ranger

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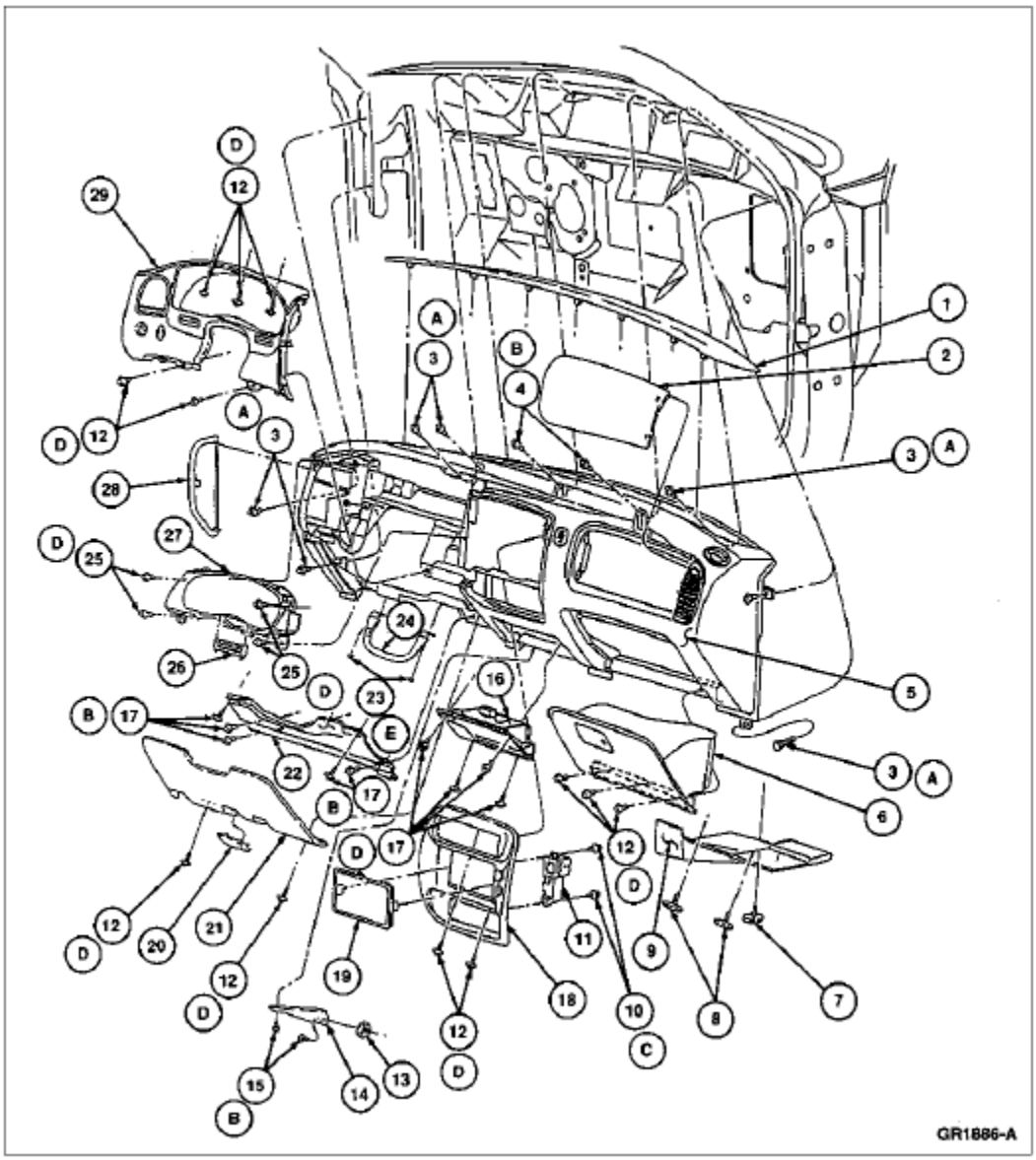

Item	Part Number	Description
1	046B62	Instrument Panel Defroster Opening Grille
2	043C18	Passenger Air Bag Opening Cover Assembly
3	N808849-S36	Screw (6 Req'd)
4	N805949-S36B	Screw (2 Req'd)
5	04304	Instrument Panel Assembly
6	1006024	Glove Box
7	N803613-S	Pushpin (1 Req'd)
8	N803362-S	Rivet (2 Req'd)
9	04398	Instrument Panel Sound Insulation
10	385754-S36B	Screw (2 Req'd)

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11	044C92	Instrument Panel Finish Center Bracket
12	N807122-S411	Screw (12 Req'd)
13	N806886-S36	Nut (1 Req'd)
14	043A50	Instrument Panel Brace
15	N606677-S36	Screw (2 Req'd)
16	04810	Instrument Panel Ash Receptacle
17	N803876-S36	Screw (10 Req'd)
18	044D70	Instrument Panel Finish Panel (Center)
19	04371	Instrument Panel Radio Opening Panel
20	044D82	Instrument Panel Cover Access Cover
21	04459	Instrument Panel Steering Column Cover
22	017A28	Instrument Panel Steering Column Opening Cover Reinforcement
23	—	Nut (2 Req'd)
24	044C86	Instrument Panel Steering Column Opening Center Reinforcement
25	N803877-S411	Screw (4 Req'd)
26	7A110	Transmission Range Indicator
27	10849	Instrument Cluster
28	045D62	Instrument Panel Fuse Panel Opening Door
29	044D70	Instrument Panel Finish Panel (Cluster)
A	—	Tighten to 26-34 Nm (20-25 Lb-Ft)
B	—	Tighten to 10-14 Nm (7-10 Lb-Ft)
C	—	Tighten to 1-2 Nm (9-18 Lb-In)
D	—	Tighten to 2-3 Nm (18-26 Lb-In)

16. If replacing instrument panel, transfer all components to new instrument panel.

For installation, follow removal procedures in reverse order.

When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.

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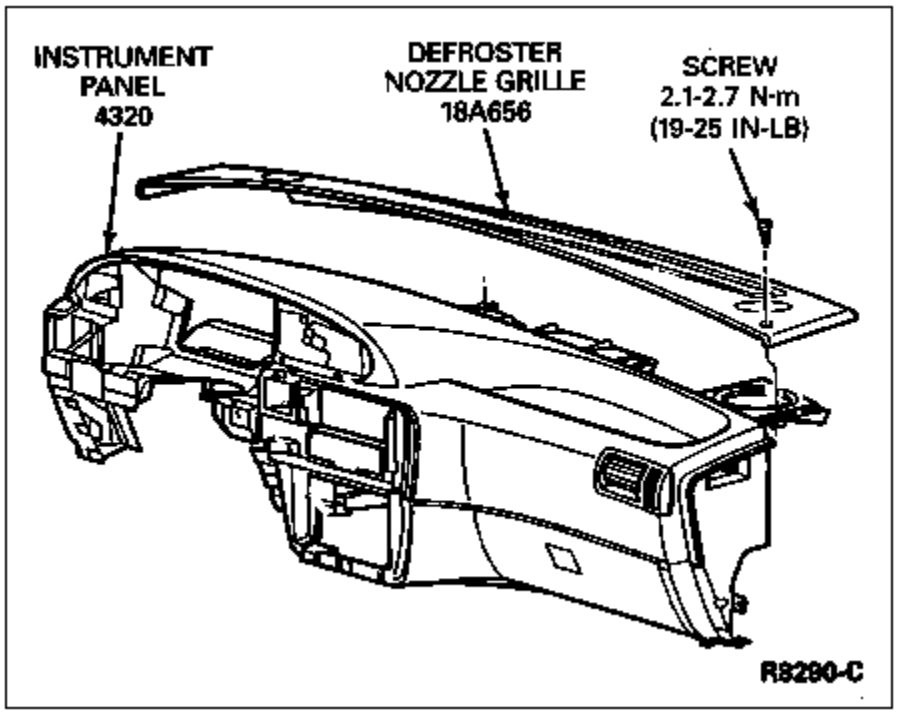
Defroster Grille, Aerostar

Removal and Installation

1. Remove the nine screws attaching the grille to the instrument panel.
2. Carefully lift up and pull the grille rearward. Remove from vehicle.

For installation, follow removal procedures in reverse order.



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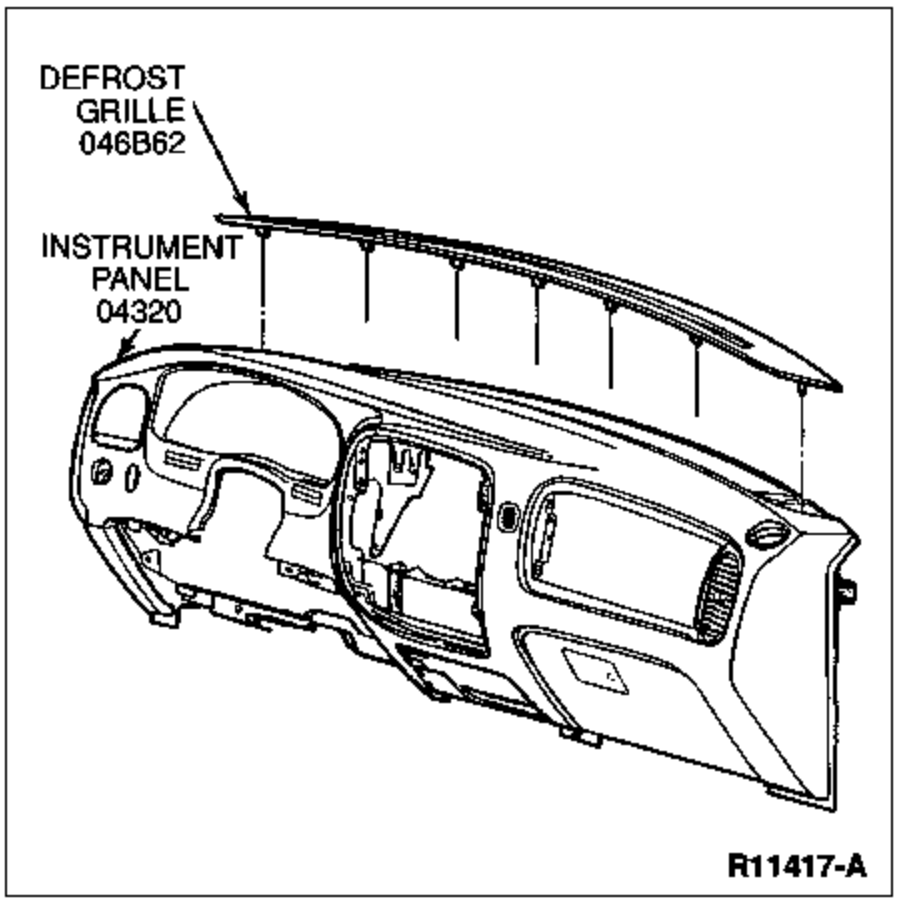
Defroster Grille, Ranger

Removal and Installation

1. Lift edge of defroster grille using a flat edge dowel.
2. Grab defroster grille edge and lift up to release clips and tension tabs.

For installation, follow removal procedure in reverse order.



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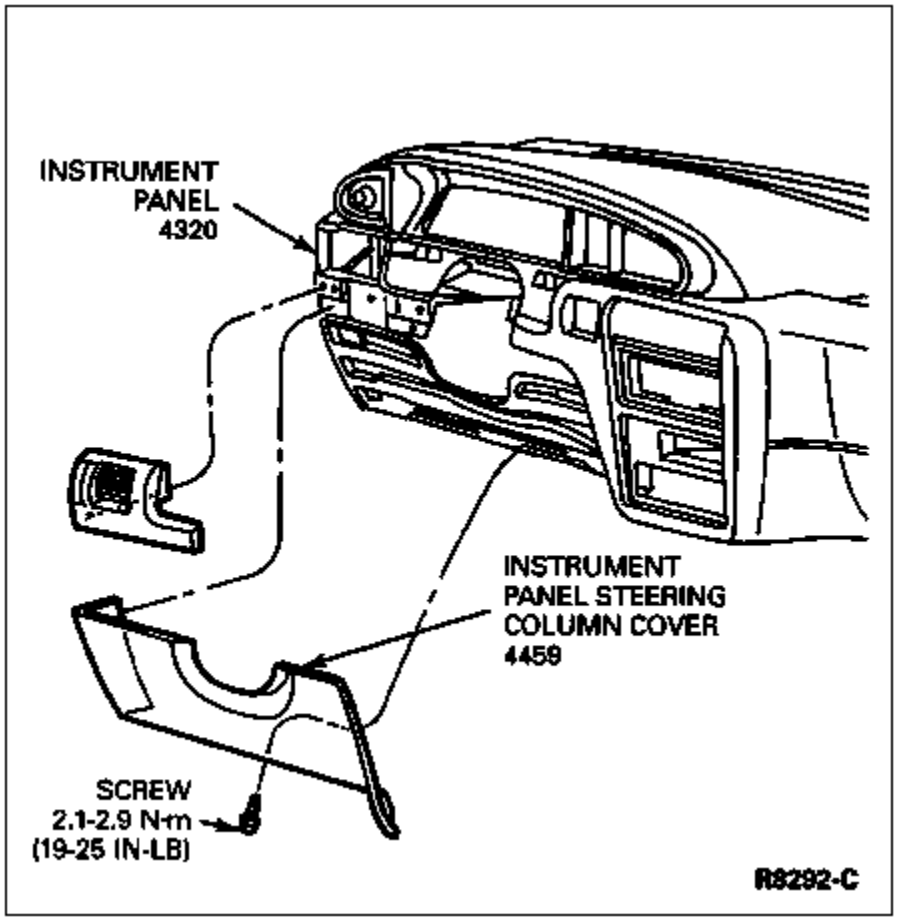
Instrument Cluster Finish Panel, Aerostar

Removal and Installation

1. Disconnect battery positive cable.
2. Remove three screws attaching the instrument panel steering column cover (04459).
3. Pull instrument panel steering column cover from instrument panel and unsnap the three upper and one right-hand side retainers.
4. Remove center instrument panel finish panel (044D70) as described in Removal and Installation, Center Finish Panel, Aerostar in this section.
5. Remove the left side instrument panel finish panel as described in Removal and Installation, Finish Panel, Left, Aerostar in this section.



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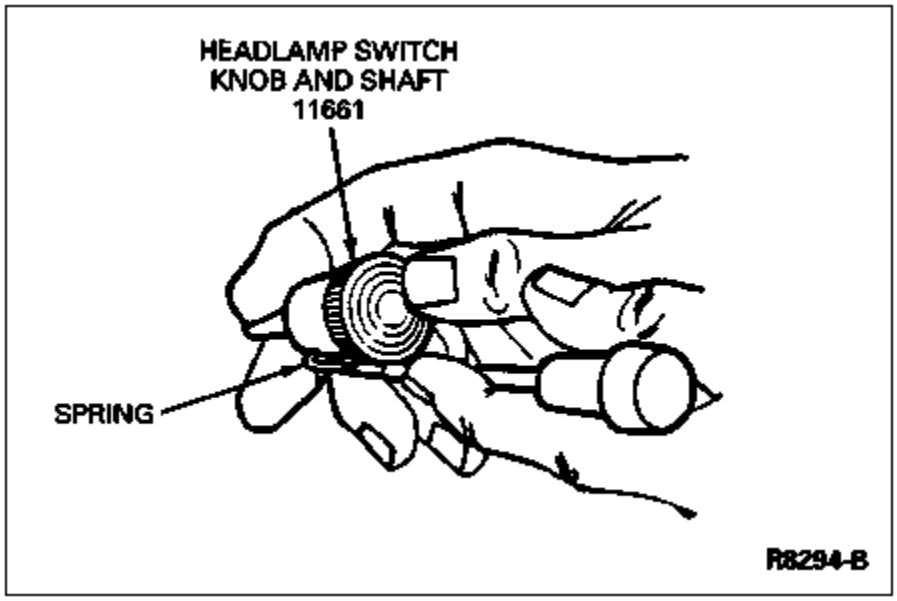
6. Remove headlamp switch knob and shaft (11661) by inserting hooked tool into knob slot to depress spring, then pull off shaft.



7. Remove three screws retaining bottom of the cluster finish panel.

8. Remove two screws retaining top of the cluster finish panel.

9. Pull the cluster finish panel rearward and unsnap the two retainers, one at each end.

For installation, follow the removal procedures in reverse order.

When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.

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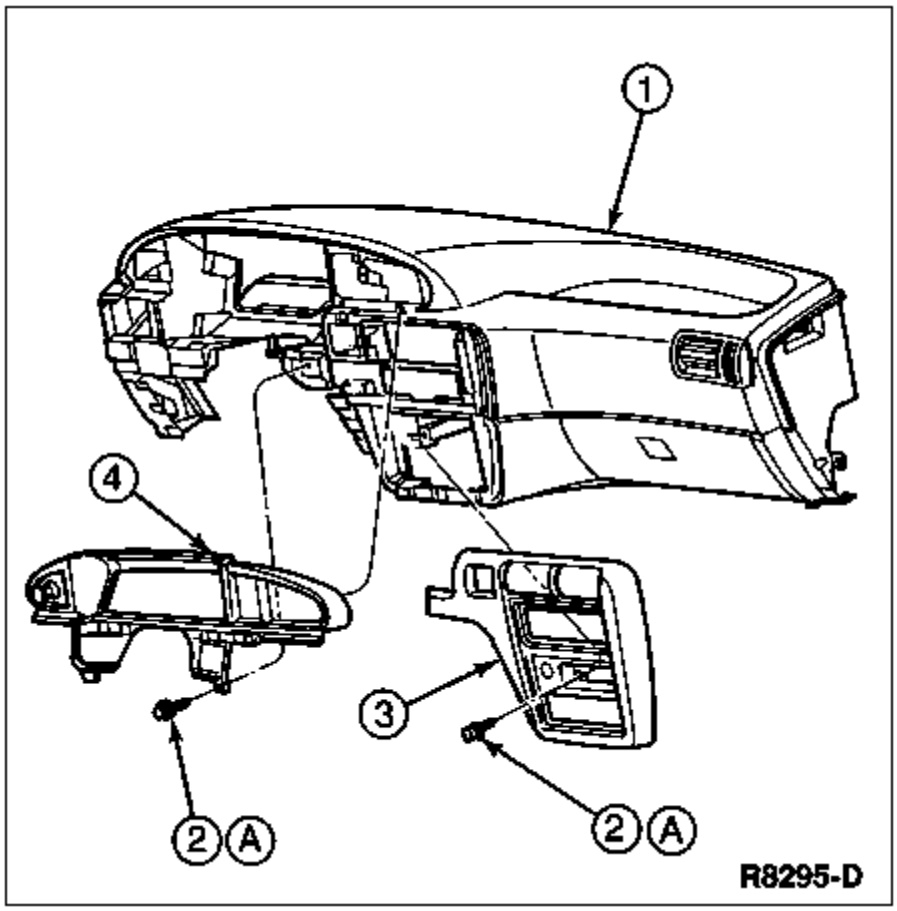

Item	Part Number	Description
1	04320	Instrument Panel
2	N803876-S36B	Screw
3	044D70	Instrument Panel Finish Panel
4	10K961	Instrument Panel Cluster Finish Panel
A	—	Tighten to 2-3 Nm (19-25 Lb-In)

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Instrument Cluster Finish Panel, Ranger

Removal and Installation

1. Remove center finish panel, refer to removal procedure in this section.
2. Remove two (2) screws attaching instrument panel steering column cover (04459) and pull cover to collapse grasshopper clips two (2).
3. Remove metal knee bolster retaining screws (7) and remove knee bolster.
4. Remove five (5) screws attaching instrument cluster finish panel.
5. Remove six (6) screws attaching instrument panel steering column opening cover reinforcement.
6. Disconnect electrical connector to headlamp switch and thumbwheel rotary dimmer switch.
7. Remove instrument cluster finish panel.

For installation, follow removal procedure in reverse order.

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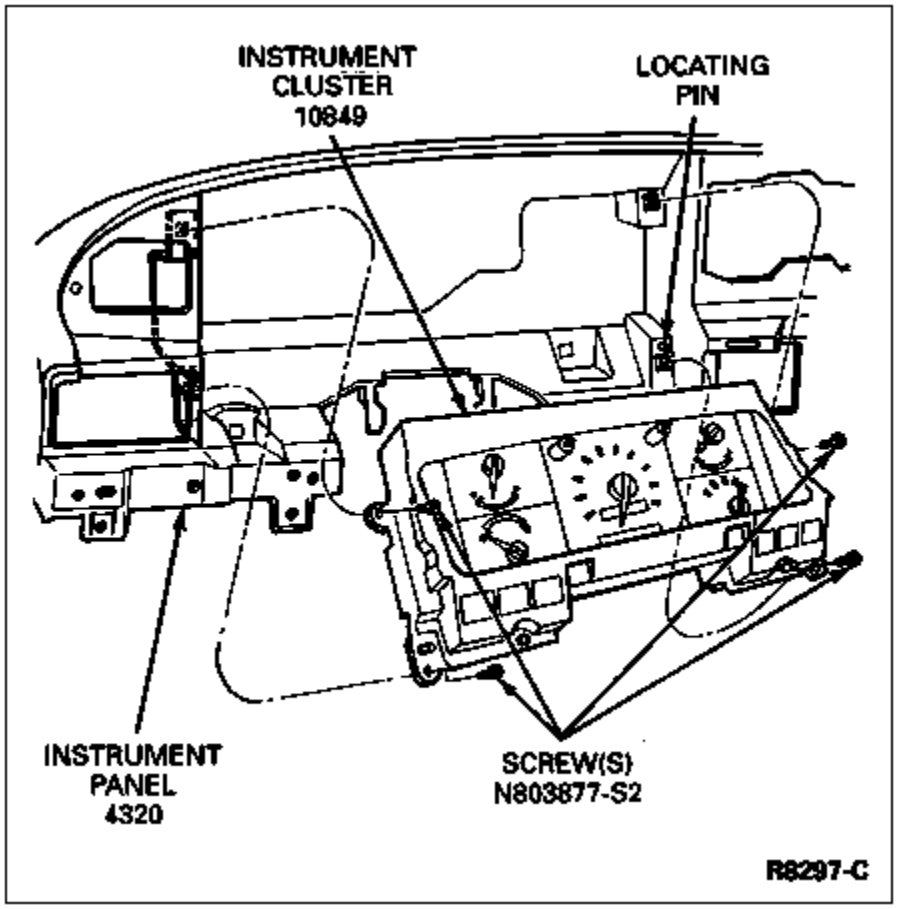
Instrument Cluster, Aerostar

Removal and Installation

1. Remove the instrument cluster finish panel as described in Removal and Installation, Instrument Cluster Finish Panel, Aerostar in this section.

2. Remove four screws attaching instrument cluster to instrument panel.



3. Disconnect PRND21 cable from instrument panel.

4. Pull instrument cluster (10849) rearward and disconnect wiring.

    - Mechanical instrument cluster — three connectors

5. Remove instrument cluster from instrument panel.

For installation, follow removal procedures in reverse order.

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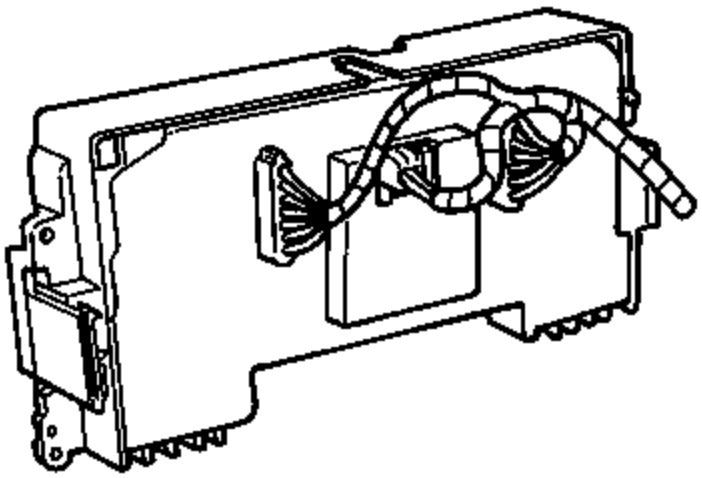

MECHANICAL CLUSTER — REAR VIEW

R8299-B

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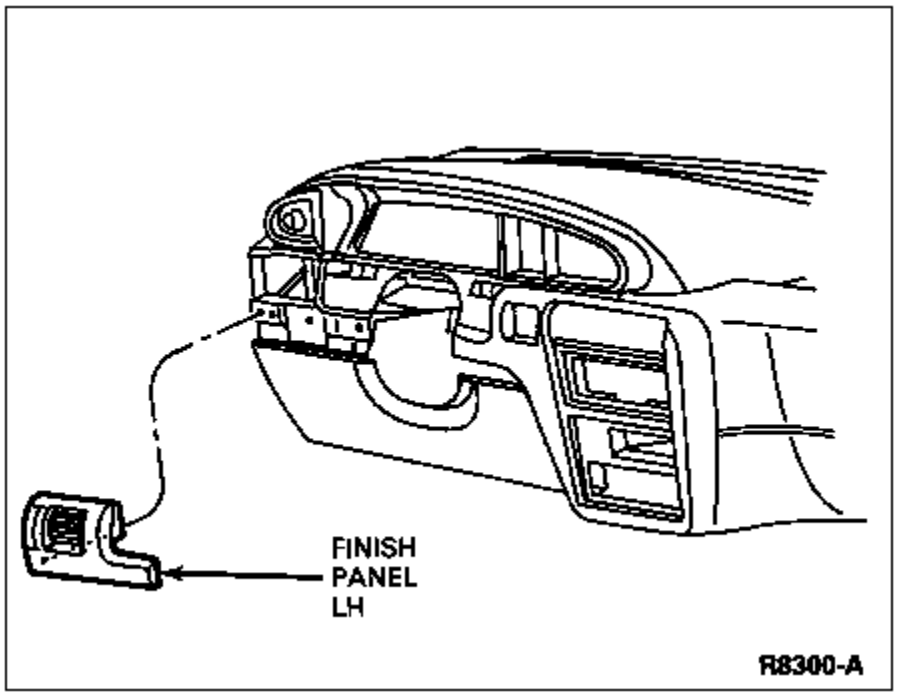
Finish Panel, Left, Aerostar

Removal and Installation

1. Pull instrument panel finish panel (044D70) rearward to disengage the five snap-in retainers (two on top, three on bottom).

2. To install, push finish panel into retainer holes.



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Finish Panel, Instrument Panel, Aerostar

Removal and Installation

1. Disconnect battery positive cable.
2. Remove three screws attaching instrument panel steering column cover (04459).
3. Pull lower cover from instrument panel. Unsnap one right side and three upper retainers.
4. Remove instrument panel ash receptacle (04810) and two exposed screws after instrument panel ash receptacle is removed.
5. Carefully pull instrument panel finish panel (044D70) rearward to unsnap the retainers and far enough to disconnect the wiring from the back.
6. Remove instrument panel finish panel from instrument panel.

For installation, follow removal procedures in reverse order.

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Center Finish Panel, Aerostar

Removal and Installation

1. Remove radio. Refer to Section 15-01 for radio removal and installation.
2. If equipped with radio opening cover, release tabs and remove.
3. Remove rear wipe/wash switch, rear defrost switches and fog lamp switch, if equipped.
4. Remove two (2) screws.
5. Remove four (4) grasshopper clips.
6. Remove center finish panel.
7. Disconnect electrical connector.

For installation, follow removal procedures in reverse order.

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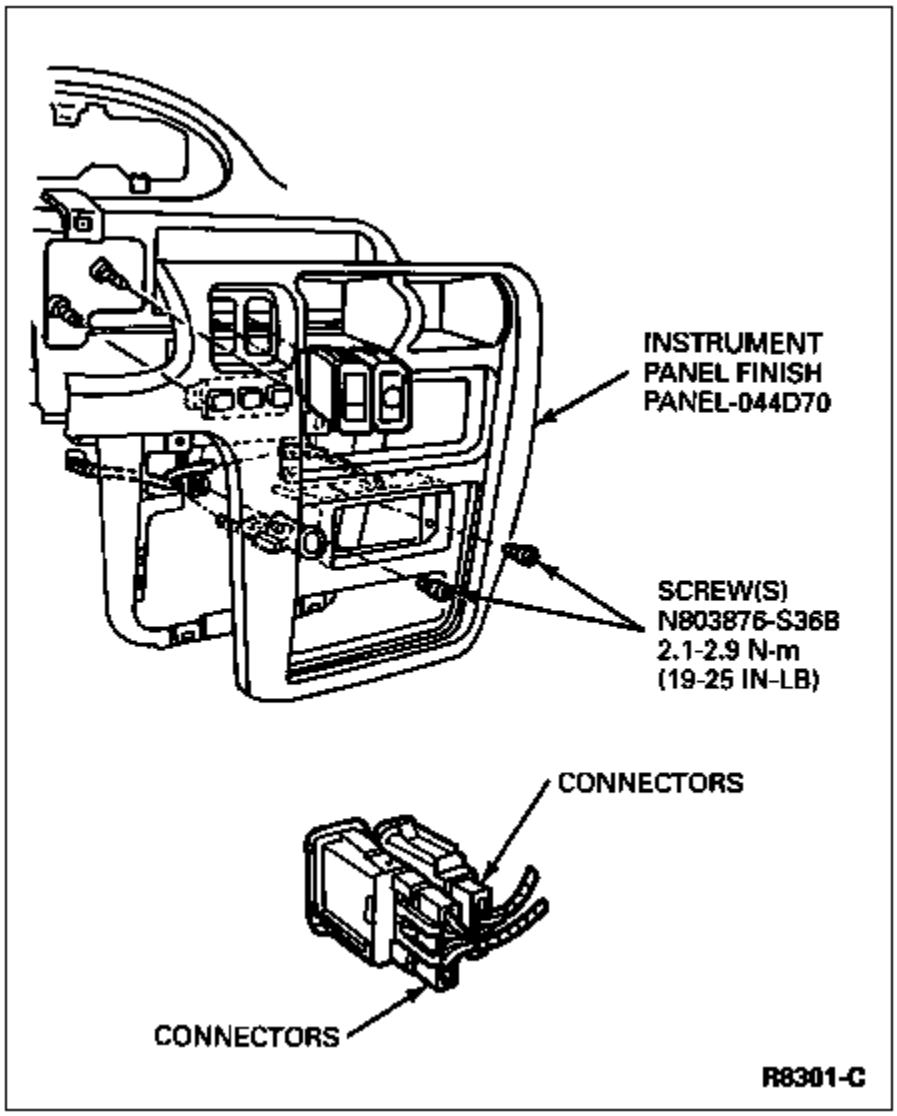

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Air Bag Delete Panel

Removal and Installation

1. Use blunt tool to release tabs attaching air bag delete cover to instrument panel. (Air bag delete has an electrical sensor that indicates to the air bag module that there is no passenger air bag.)

2. From back of air bag delete panel, disconnect electrical connection.

For installation, follow removal procedures in reverse order.

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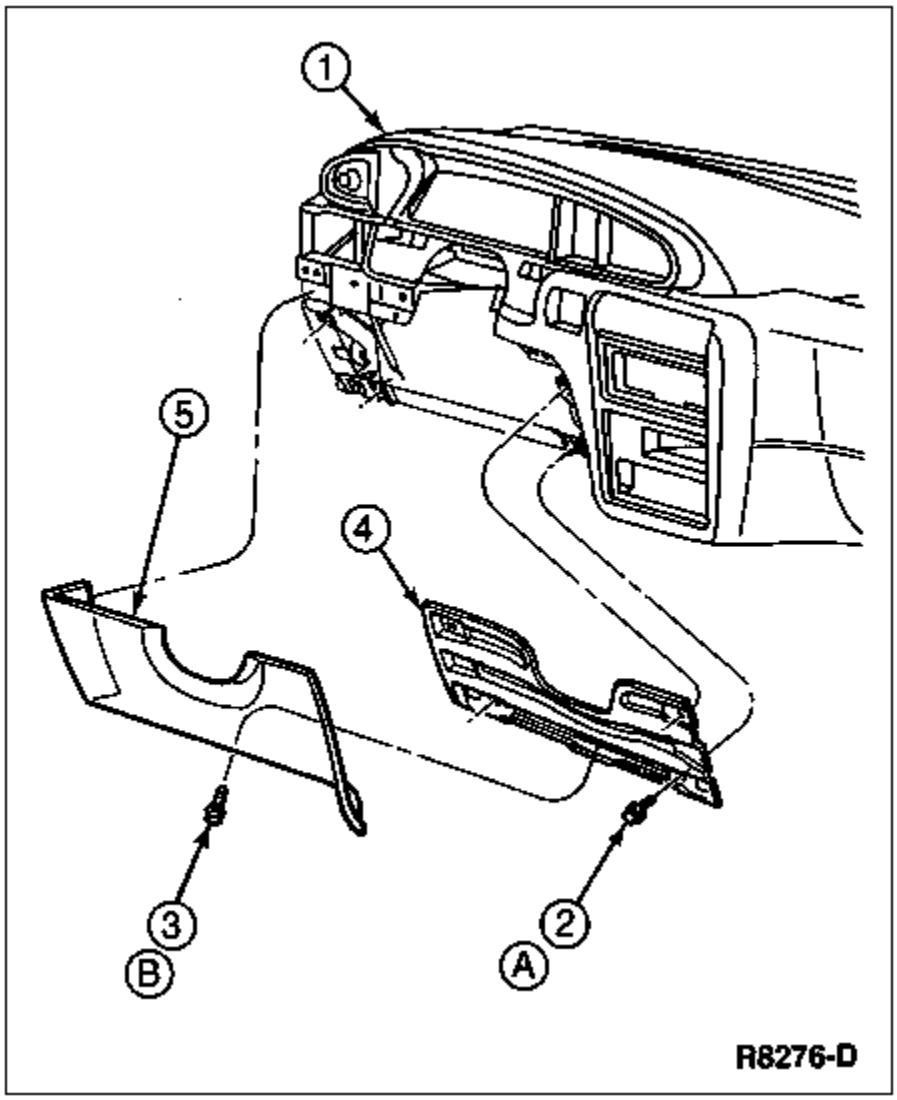
Steering Column Opening Cover Assembly and Reinforcement, Aerostar

Removal and Installation

1. Remove three screws attaching the instrument panel steering column cover (04459).
2. Pull instrument panel steering column cover from instrument panel and unsnap one right side and three upper retainers.
3. Remove four screws attaching the steering column lower reinforcement and remove reinforcement.

For installation, follow removal procedures in reverse order.



Item	Part Number	Description

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1	04320	Instrument Panel
2	N803876-S36B	Screw (4 Req'd)
3	N803877-S36B	Screw (4 Req'd)
4	043C00	Steering Column Opening Reinforcement
5	04459	Instrument Panel Steering Column Cover
A	—	Tighten to 10-14 Nm (7-10 Lb-Ft)
B	—	Tighten to 2-3 Nm (18-26 Lb-In)

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Instrument Panel Assembly, Lower, Aerostar

Removal and Installation

1. Remove instrument panel steering column cover (04459).
2. Remove instrument panel finish panel (044D70).
3. Remove glove box door assembly.
4. Disconnect glove box light wiring connector.
5. If equipped, disconnect the graphic equalizer wiring connectors.
6. Remove two bolts attaching the left end of the instrument panel steering column cover to the instrument panel.
7. Remove one screw attaching equalizer or reinforcement bracket to instrument panel steering column cover.
8. Remove five screws attaching the instrument panel steering column cover to the instrument panel.
9. If replacing the instrument panel steering column cover, transfer the components to the replacement instrument panel.

For installation, follow removal procedures in reverse order.

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Glove Compartment Door, Aerostar

Removal and Installation

1. Depress the two side stops inward, pull the glove compartment door finish panel (06036) open. Release the hinge pivots.
2. To install, line up the hinge pivots with the glove compartment door (06024). Position stop in instrument panel.
3. Close door to latched position.

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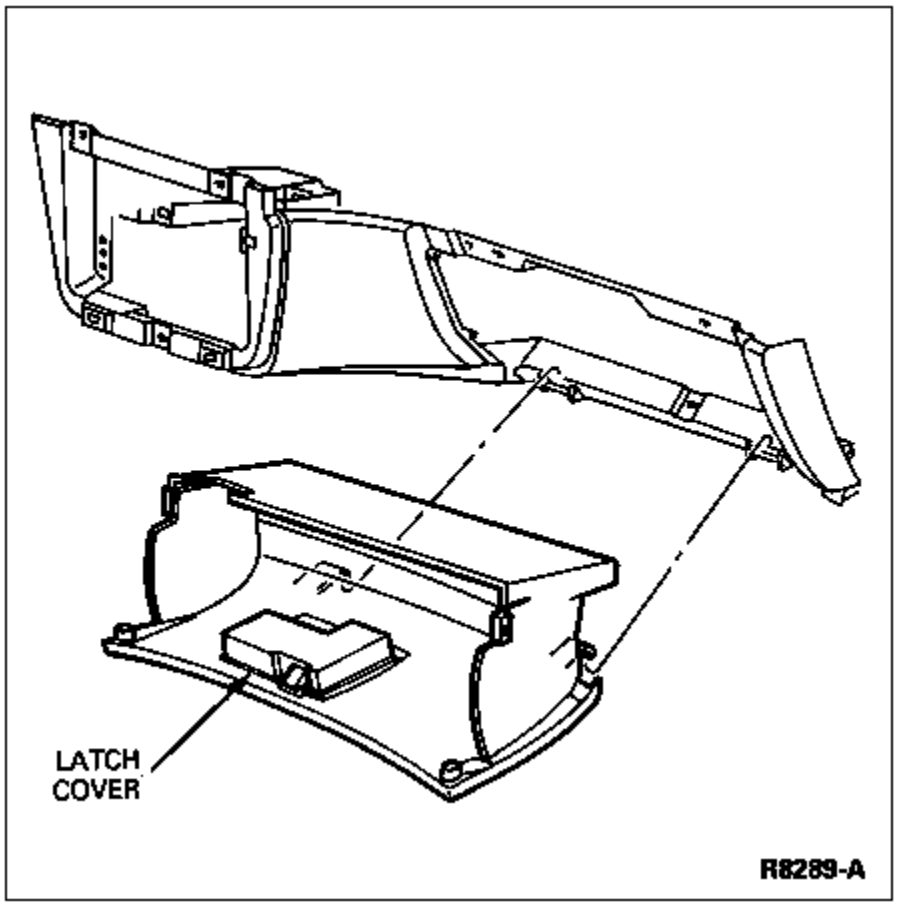
Latch Assembly, Glove Compartment, Aerostar

Removal and Installation

1. Remove latch cover from inside of glove compartment by unsnapping the four tabs.
2. Remove the two screws attaching the latch.

For installation, follow removal procedures in reverse order.



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SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Nut and Washer Assembly, Tape Cartridge, Aerostar	4-5	—	35-44
Screw(s) to Utility Tray Beverage Holder, Ranger	3-4	—	26-35
Bolt(s), Console, Ranger	9-14	—	80-124
Nut(s), Console, Ranger	7-11	—	62-97
Screw, Connector	5.4-6.8	—	48-62
Screw and Washer Assembly, Steering Column	10-14	7-10	—
Screw and Washer Assembly, Instrument Panel, Aerostar	40-54	30-39	—
Nut and Washer Assembly, Instrument Panel	10-14	7-10	—
Screw and Washer Assembly, Steering Column, Ranger	1-2	—	9-18
Defroster Grille, Aerostar	2-3	—	18-26
Screw, Center Finish Panel, Aerostar	2-3	—	18-26
Screw and Washer Assembly, Steering Lower Cover	2-3	—	18-26
Screw and Washer Assembly, Reinforcement	10-14	7-10	—
Screw, Ash Receptacle to Instrument Panel, Ranger	2-3	—	18-26
Screw, Defroster Grille, Aerostar	2.1-2.7	—	19-25

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SPECIAL SERVICE TOOLS/EQUIPMENT

ROTUNDA EQUIPMENT

Model	Description
014-00407	Digital Volt-Ohmmeter

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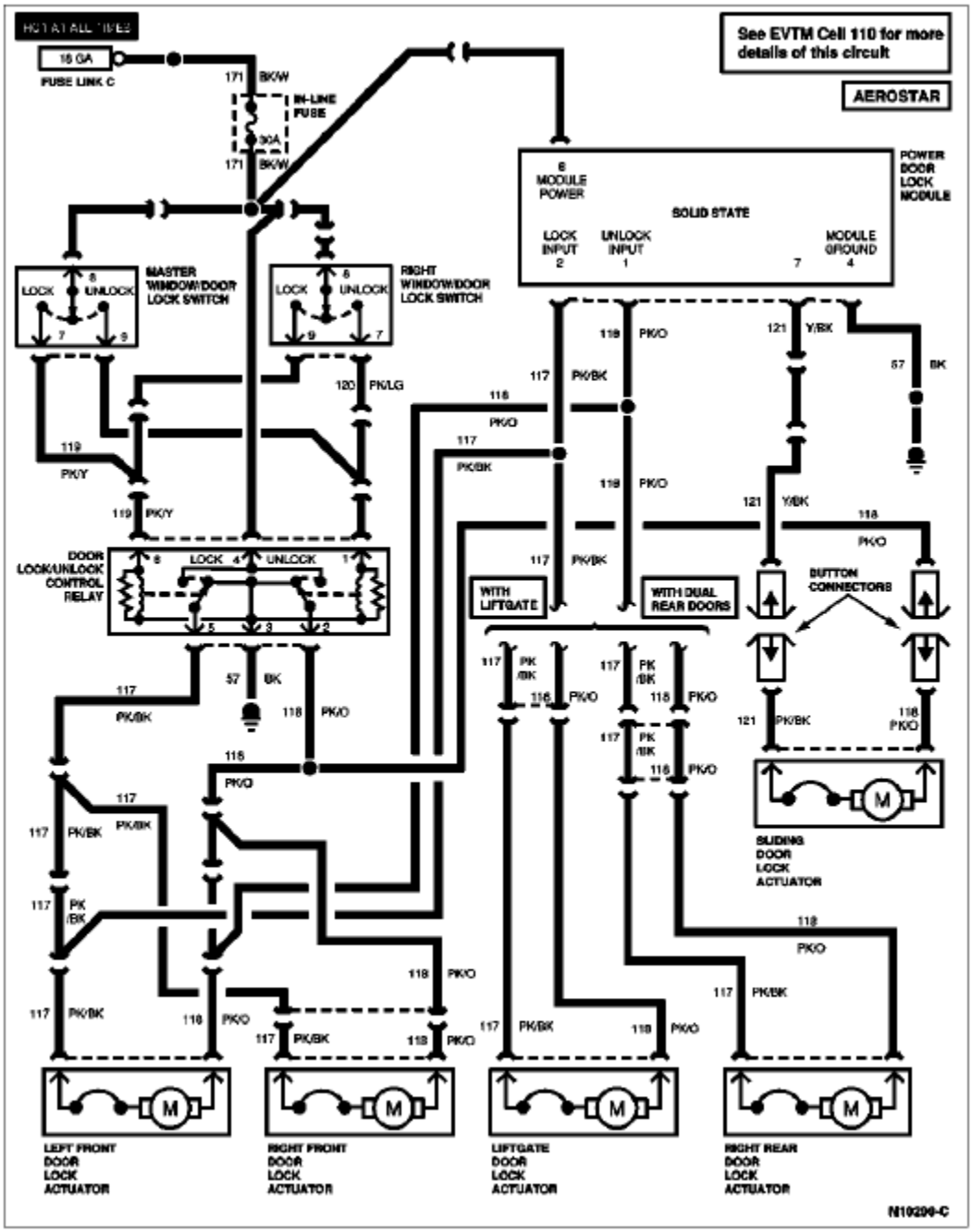
Electrical Schematics

Power Door Lock, Aerostar



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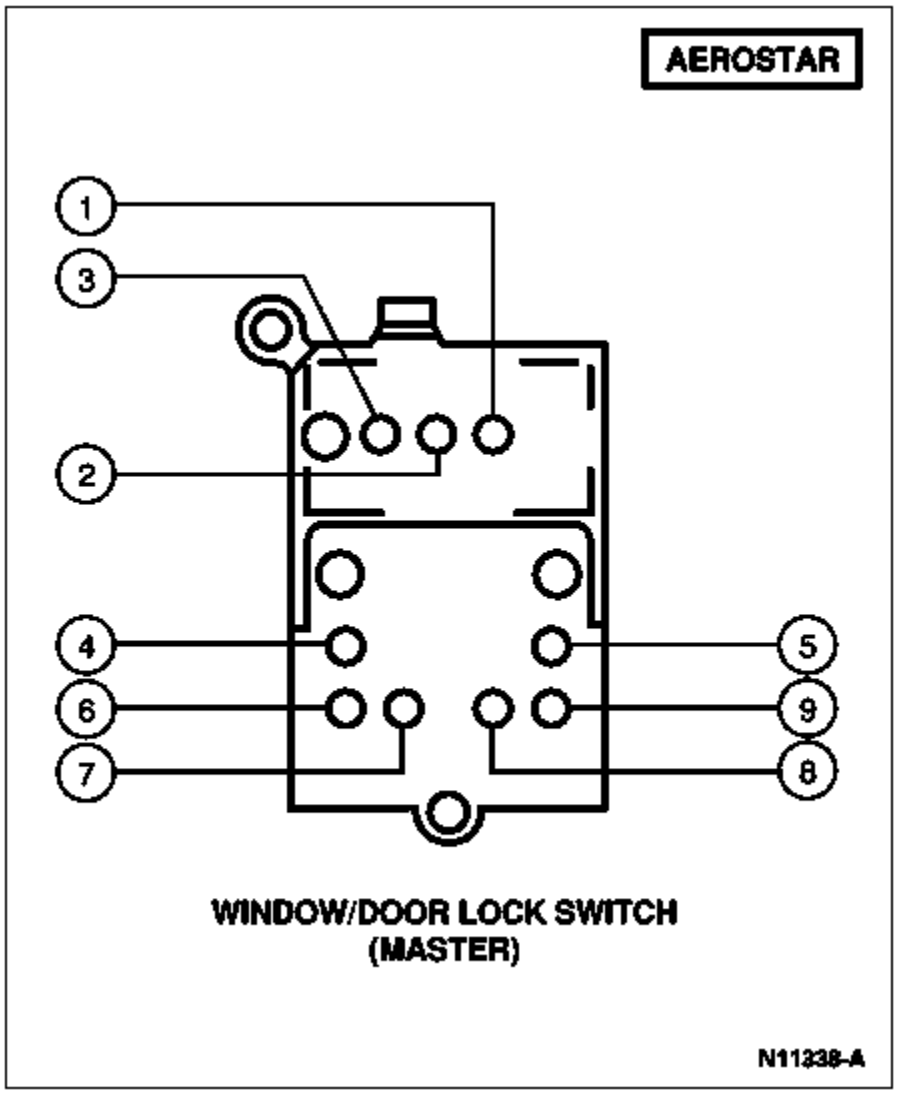

Pin Number	Circuit	Circuit Function
1	119 (PK/Y)	Door Lock Switch (Lock)
2	171 (BK/W)	Circuit Breaker to Seat Latch Relay
3	120 (PK/LG)	Door Lock Switch (Unlock)
4	400 (LB/BK)	Safety Relay Load Terminal to Window Regulator
5	57 (BK)	Ground Circuit
6	313 (W/Y)	LF Window Regulator Switch to LR Window Regulator Motor
7	314 (T/LB)	LF Window Regulator Switch to RF Window Regulator Motor
8	227 (Y)	LF Window Regulator Switch to LF Window Regulator Motor
9	226 (W/BK)	LF Window Regulator Switch to LF Window Regulator Motor

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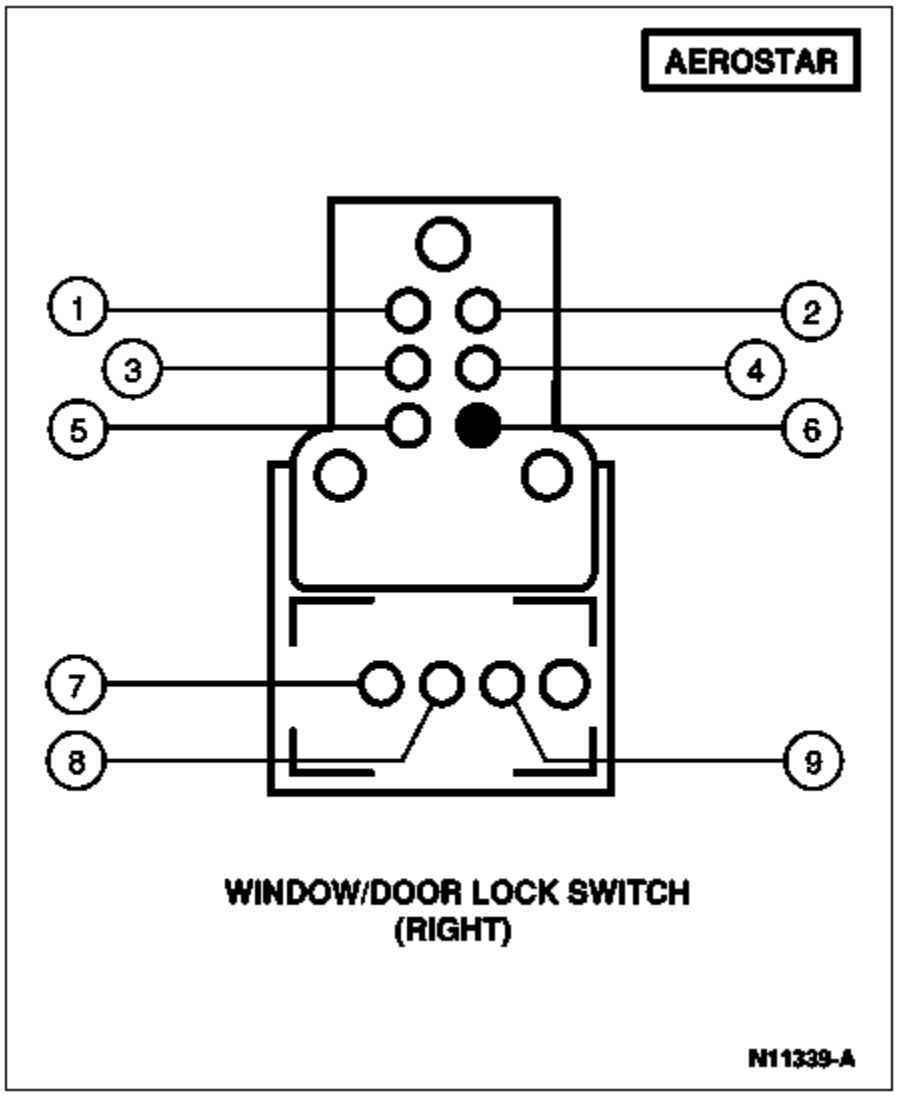

Pin Number	Circuit	Circuit Function
1	400 (LB/BK)	Safety Relay Load Terminal to Window Regulator Switch Feed
2	313 (W/Y)	LF Window Regulator Switch to LR Window Regulator Motor
3	334 (R/Y)	Window Regulator Switch to Window Regulator Motor
4	333 (Y/R)	Window Regulator Switch to Window Regulator Motor
5	314 (T/LB)	LF Window REgulator Switch to RF Window Regulator Motor
6	—	Not Used
7	120 (PK/LG)	Door Lock Switch (Unlock)
8	171 (BK/W)	Circuit Breaker to Seat Latch Relay
9	119 (PK/Y)	Door Lock Switch (Lock)

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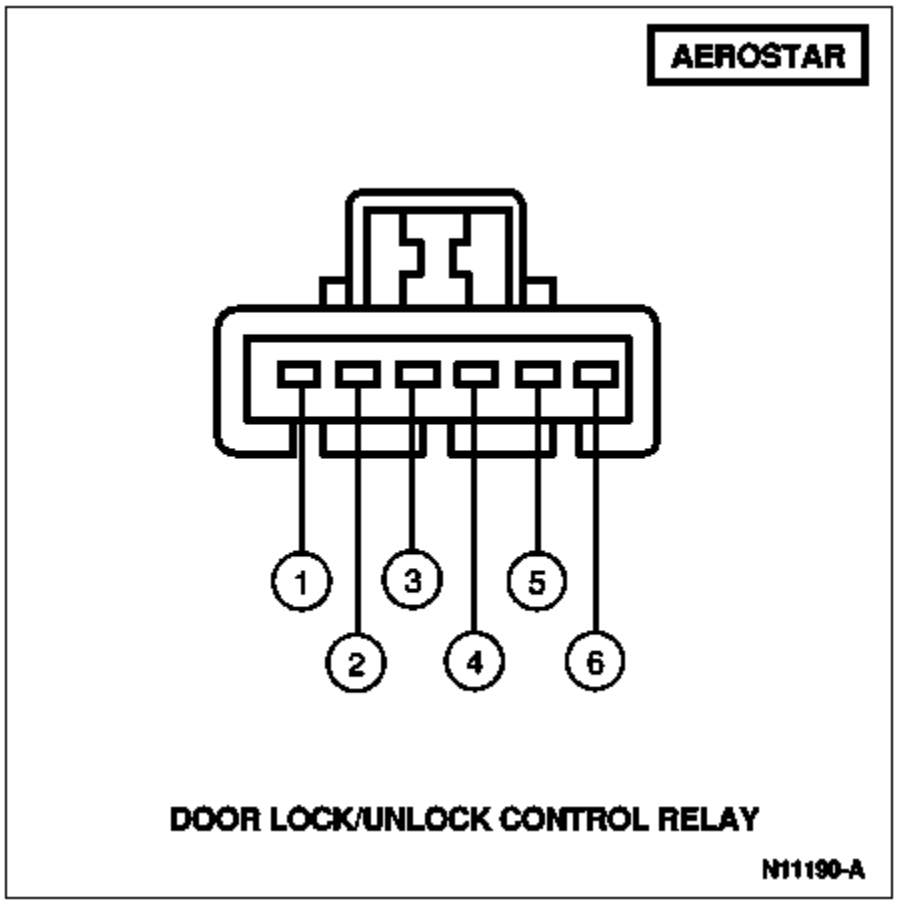

Pin Number	Circuit	Circuit Function
1	120 (PK/LG)	Door Lock Switch (Unlock)
2	118 (PK/O)	Door Lock Motor (Unlock)
3	57 (BK)	Ground Circuit
4	171 (BK/W)	Door Lock Feed to Lock/Unlock Control Relay
5	117 (PK/BK)	Door Lock Motor (Lock)
6	119 (PK/Y)	Door Lock Switch (Lock)

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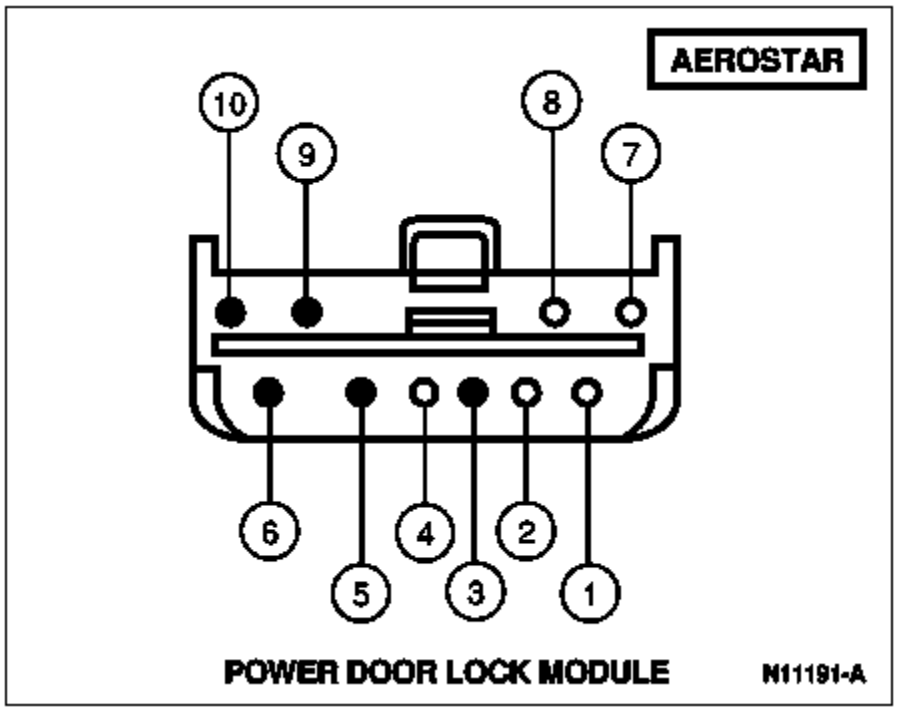

Pin Number	Circuit	Circuit Function
1	118 (PK/O)	Door Lock Motor (Unlock)
2	117 (PK/BK)	Door Lock Motor (Lock)
3	—	Not Used
4	57 (BK)	Ground Circuit
5	—	Not Used
6	—	Not Used
7	121 (Y/BK)	Sliding Door Lock Switch (Lock)
8	171 (BK/W)	Circuit Breaker to Seat Latch Relay
9	—	Not Used
10	—	Not Used

Power Locks, Ranger

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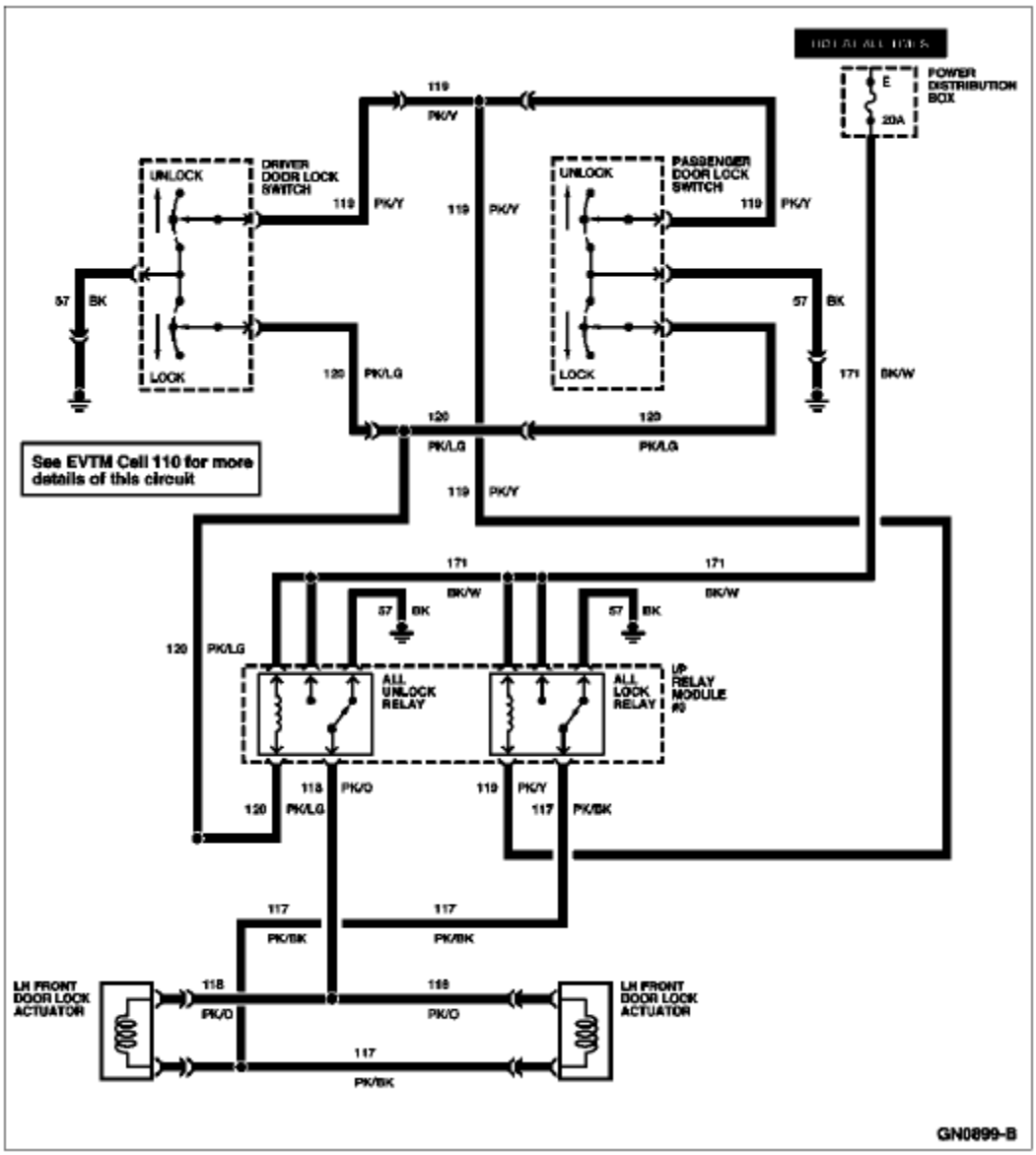

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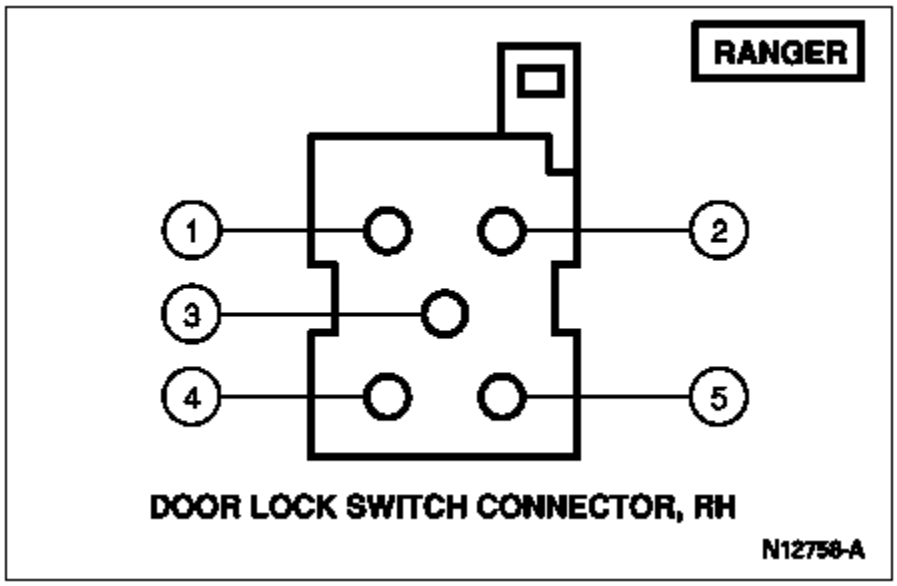
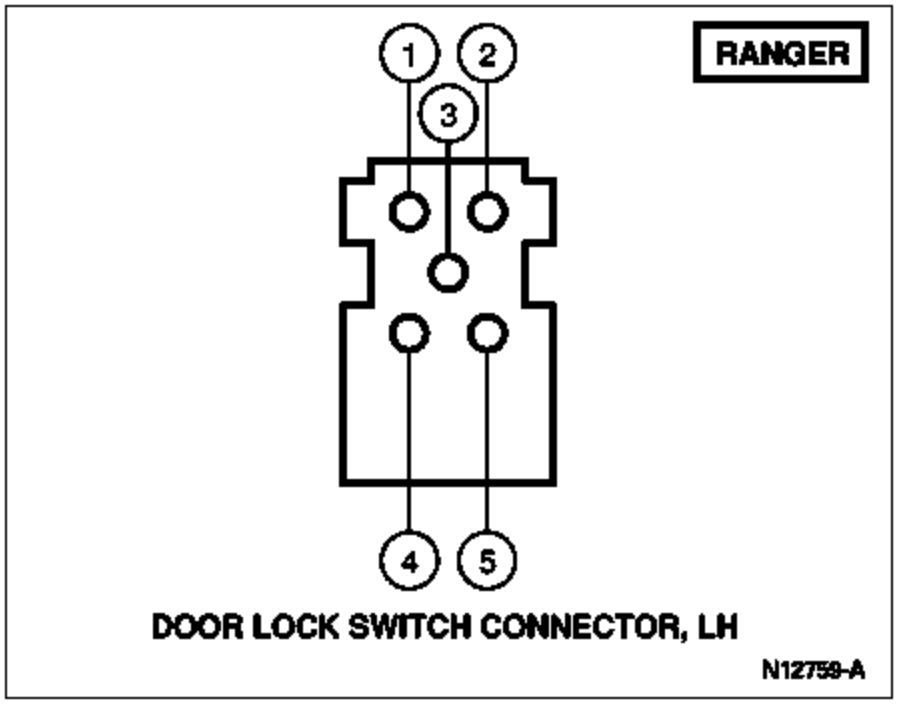


Pin Number	Circuit	Circuit Function
1	120 (PK/LG)	Door Lock Switch (Unlock)
2	—	Not Used
3	57 (BK)	Ground Circuit
4	—	Not Used
5	119 (PK/Y)	Door Lock Switch (Lock)



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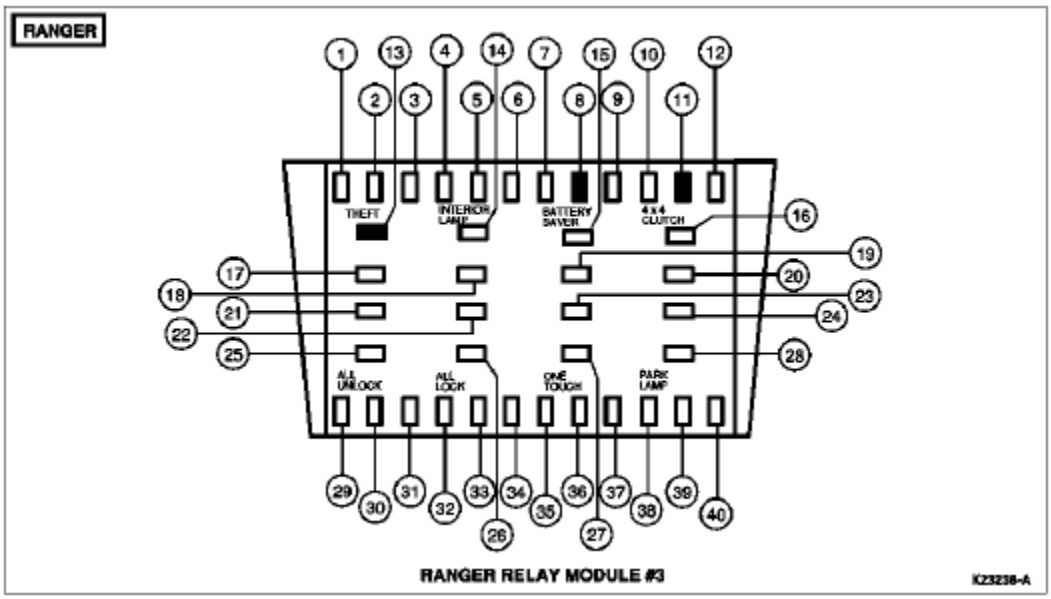
Pin Number	Circuit	Circuit Function
1	120 (PK/LG)	Door Lock Switch (Unlock)
2	—	Not Used
3	57 (BK)	Ground Circuit
4	—	Not Used
5	119 (PK/Y)	Door Lock Switch (Lock)

Ranger Relay Module Number Three



Pin Number	Circuit	Circuit Function
1	342 (LG/P)	Anti-Theft Relay Coil to Rap Module
2	33 (W/PK)	Anti-Theft Relay Start Contact Output
3	32 (R/LB)	Anti-Theft Relay Ignition Contact Output
4	1008 (LG/O)	Interior Lamp Relay Coil to GEM
5	55 (BK/PK)	Seat Belt Lamp to GEM Module
6	705 (LG/O)	Interior Lamp Relay Power — Coil
7	792 (T/Y)	Battery Saver Relay Coil to GEM
8	—	Not Used
9	88 (BK/W)	Battery Saver Relay Power — Coil

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10	705 (LG/O)	Clutch Relay Coil Power Feed
11	—	Not Used
12	275 Y	Clutch Relay Coil to GEM
13	—	Not Used
14	705 (LG/O)	Interior Lamp Relay Power — Contact
15	88 (BK/W)	Battery Saver Relay Power — Contact
16	704 (DG/LG)	Clutch Relay Contact Power Feed
17	32 (R/BK)	Anti-Theft Relay Ignition Start Feed
18	53 (BK/LB)	Interior Lamp Relay Output
19	401 (PK)	Battery Saver Relay Output
20	779 (BR)	Clutch Relay Contact Output to Clutch
21	118 (PK/O)	All Unlock Relay Common to Locks
22	117 (PK/BK)	All Lock Relay Common to Locks
23	903 (R)	One-Touch-Down Relay Common
24	14 (BR)	Parklamp Relay Output to Park Lamps
25	171 (BK/W)	All Unlock Relay N.O. Contact Power
26	171 (BK/W)	All Lock Relay N.O. Contact Power
27	400 (LB/BK)	One-Touch-Down Relay N.O. Contact
28	195 (T/W)	Parklamp Relay Contact Power
29	120 (PK/LG)	All Unlock Relay Coil to Switch Remote Control Alarm and Door Lock Module
30	57 (BK)	All Unlock Relay N.C. Contact Ground
31	171 (BK/W)	All Unlock Relay Coil Power Feed
32	119 (PK/Y)	All Lock Relay Coil to Switch Remote Control Alarm and Door Lock Module
33	57 (BK)	All Lock Relay N.C. Contact Ground
34	171 (BK/W)	All Lock Relay Coil Power Feed
35	400 (LB/BK)	One-Touch-Down Relay Coil Power
36	991 (T/LB)	One-Touch-Down Relay N.C. Contact
37	1007 (Y/R)	One-Touch-Down Relay Coil to GEM
38	195 (T/W)	Parklamp Relay Coil Power
39	1032 (W/BK)	Parklamp Relay Contact to Headlamp SW
40	218 (W/P)	Parklamp Relay Coil to Switch Remote Control Alarm and Door Lock Module

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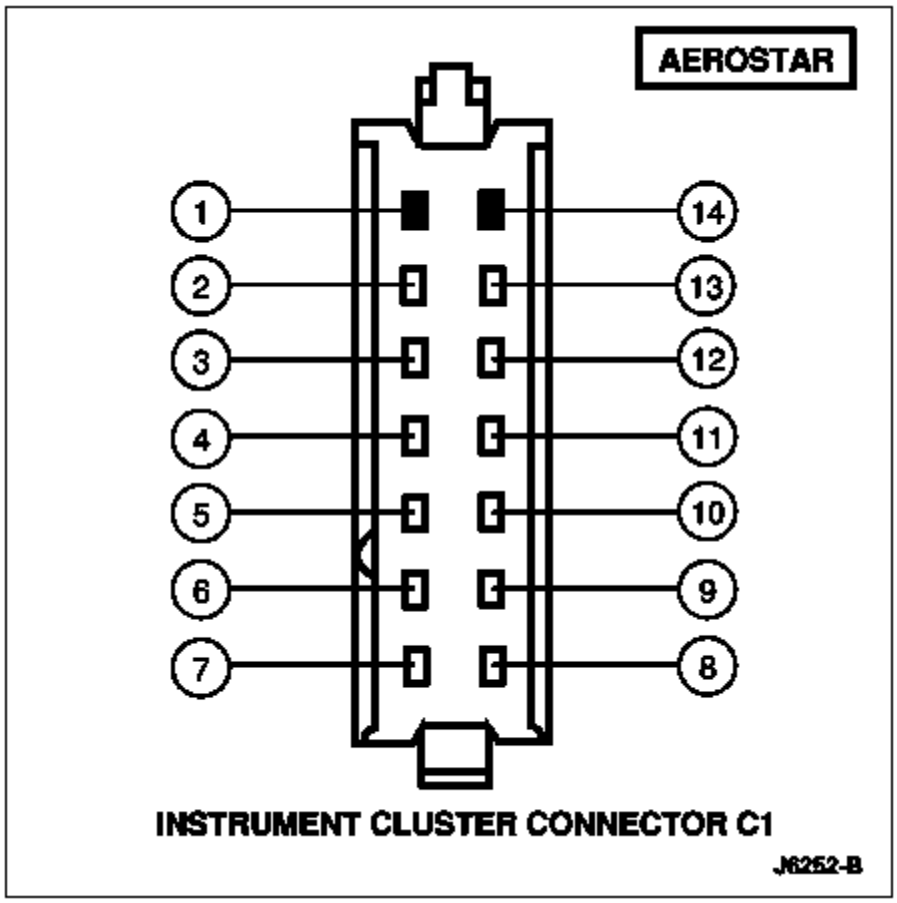

Pin Number	Circuit	Circuit Function
1	—	Not Used
2	627 (BK/O)	Open Door Warning Lamp to Open Door Warning Switch
3	977 (P/W)	Dual Brake Warning Switch to Indicator Lamp
4	603 (DG)	Failure Warning Light
5	658 (PK/LG)	PCM to Check Engine Indicator Lamp
6	29 (Y/W)	Fuel Gauge to Fuel Gauge Sender
7	3 (LG/W)	Front Turn Signal Lamp (LH)
8	31 (W/R)	Oil Pressure Indicator to Oil Pressure Sending Unit
9	570 (BK/W)	Dedicated Ground — Closed Loop
10	39 (R/W)	Temperature Gauge to Temperature Sending Unit
11	904 (LG/R)	Ignition Switch "COIL"/"ACCY" to Generator Regulator "IGN" Terminal
12	16 (R/LG)	Ignition Switch to Ignition Coil "Battery" Terminal
13	640 (R/Y)	Warning Lamps Feed
14	—	Not Used

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Inspection and Verification

1. Verify the vehicle owner's original concern by operating the power door locks to duplicate the concern.

2. Inspect to determine if one of the following mechanical or electrical concerns apply.

VISUAL INSPECTION CHART

Mechanical	Electrical
• Binding latch mechanism	• Open fuse:
• Binding linkage	■ Engine compartment
• Misaligned door	power distribution box
• Loose connectors	
• Corroded connectors	

3. If the concern(s) remains after the inspection, determine the symptom(s) and proceed to the following Symptom Chart.

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Symptom Chart — Handles, Locks, Latches And Mechanisms

NOTE: Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent to perform electrical pinpoint tests.

HANDLES, LOCKS, LATCHES AND MECHANISMS

Condition	Possible Source	Action
• One Door Lock Inoperative	• Circuitry. • Power door lock actuator.	• GO to Pinpoint Test A.
• All Door Locks Inoperative (Aerostar)	• Locks fuse open. • Battery/power circuit. • Poor ground. • Circuitry. • Door lock switch. • Door lock/unlock control relay.	• GO to Pinpoint Test B.
• All Door Locks Inoperative (Ranger)	• Locks fuse open in power distribution box. • Battery/power circuit. • Poor ground. • Circuitry. • Door lock switch. • All lock relay and all unlock relay.	• GO to Pinpoint Test C.
• All Locks Operate from One Switch Only	• Power to switch. • Door lock switch. • Circuitry.	• GO to Pinpoint Test D.
• Door Locks Operate One Way Only (Aerostar)	• Circuitry. • Poor ground. • Door lock/unlock control relay door lock switches.	• GO to Pinpoint Test E.
• Door Locks Operate One Way Only (Ranger)	• Circuitry. • Poor ground.	

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	• Door lock switches. • All lock relay or all unlock relay.	• GO to Pinpoint Test F.
• Sliding Door Lock Inoperative (Aerostar)	• Circuitry. • Sliding door lock actuator. • Power door lock module. • Sliding door contacts.	• GO to Pinpoint Test G.
• Liftgate Door Lock Inoperative	• Circuitry. • Power door lock actuator.	• GO to Pinpoint Test H.
• Door Locks Work with Engine Running Only	• Battery discharged.	• GO to Pinpoint Test J.
• Door Locks Work Intermittently	• Battery partially charged. • Connections loose, opening or shorting. • Intermittent door lock switch or power door lock actuator.	• GO to Pinpoint Test K.

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Pinpoint Tests

PINPOINT TEST A: ONE DOOR LOCK INOPERATIVE

A1 CHECK OPERATION OF SUSPECT DOOR LOCK

- Manually operate inoperative door lock.
- Check for binding or stuck condition.

Is lock stuck or binding?

Yes	No
REFER to Lubrication in this section. SERVICE as required. RETEST system.	GO to **A2**.

A2 CHECK SUSPECT POWER DOOR LOCK ACTUATOR LOCK OPERATION

- Gain access to suspect power door lock actuators as outlined.
- Disconnect power door lock actuator.
- Using a test lamp connected to a known good ground, check Circuit 117 (PK/BK) at harness connector while actuating door locks in the lock position.

Did test lamp illuminate?

Yes	No
GO to **A3**.	SERVICE Circuit 117 (PK/BK) for open circuit. RETEST system.

A3 CHECK POWER DOOR LOCK ACTUATOR FOR UNLOCK OPERATION

- Remove test lamp from Circuit 117 (PK/BK) and connect it to Circuit 118 (PK/O).
- Actuate switch in the unlock position.

Did test lamp illuminate?

Yes	No
GO to **A4**.	SERVICE Circuit 118 (PK/O) for open circuit. RETEST system.

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A4 CHECK POWER DOOR LOCK ACTUATOR

- Using two 10 gauge jumper wires connected to battery positive (+) and negative (-), attach jumpers to actuator connector; reverse polarity for opposite direction.

Did actuator operate correctly?

Yes	No
GO to **A5** .	REPLACE power door lock actuator. RETEST system.

A5 CHECK POWER DOOR LOCK ACTUATOR CURRENT DRAW

- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check actuator current draw.

Is current draw 6 amps or less?

Yes	No
RECONNECT power door lock actuator. REFER to Lubrication . RETEST system.	REPLACE power door lock actuator. RETEST system.

PINPOINT TEST B: ALL DOOR LOCKS INOPERATIVE (AEROSTAR)

B1 CHECK SUPPLY TO DOOR LOCK/UNLOCK CONTROL RELAY

- Disconnect door lock/unlock control relay.
- Connect voltmeter between Circuit 171 (BK/W) Pin 4 on relay connector and a known good ground.
- Measure voltage.

Is battery voltage present?

Yes	No
GO to **B4** .	GO to **B2** .

B2 CHECK CIRCUIT 171 (BK/W) FOR OPEN

- Disconnect Fuselink C, Circuit 171 (BK/W) from starter relay.
- Connect ohmmeter between Fuseline C eyelet and door lock/unlock control relay connector, Circuit 171, Pin 4.
- Measure resistance.

Is resistance 5 ohms or less?

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Yes	No
GO to **B3** .	SERVICE Circuit 171 (BK/W) for open. RETEST system.

B3 CHECK CIRCUIT 171 (BK/W) FOR SHORT TO GROUND

- Connect ohmmeter between door lock/unlock control relay connector Circuit 171 (BK/W) Pin 4 and a known good ground.
- Measure resistance.

Is resistance 5 ohms or less?

Yes	No
SERVICE Circuit 171 (BK/W) for short to ground. RETEST system.	GO to **B4** .

B4 CHECK GROUND CIRCUIT FOR DOOR LOCK/UNLOCK RELAY

- Connect ohmmeter between door lock/unlock relay connector Circuit 57 (BK) Pin 3 and a known good ground.
- Measure resistance.

Is resistance 5 ohms or less?

Yes	No
GO to **B5** .	SERVICE Circuit 57 (BK) for open. RETEST system.

B5 CHECK SUPPLY TO DOOR LOCK SWITCHES

- Remove door lock switches as outlined in this section.
- Connect a voltmeter between Circuit 171 (BK/W) Pin 2 on LH switch (Pin 8 on RH switch) and known good ground.
- Measure voltage.

Is battery voltage present?

Yes	No
GO to **B6** .	GO to **B2** .

B6 CHECK LOCK SIGNAL TO RELAY

- Connect voltmeter between door lock/unlock control relay connector Pin 6 Circuit 119 (PK/Y) and known good ground.

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- Actuate a switch to lock position.

Is battery voltage present?

Yes	No
GO to **B7** .	GO to **B8** .

B7 CHECK UNLOCK SIGNAL TO RELAY

- Connect voltmeter between door lock/unlock control relay connector Pin 1 Circuit 120 (PK/LG) and known good ground.
- Actuate a switch to unlock position.

Is battery voltage present?

Yes	No
GO to **B14** .	GO to **B9** .

B8 CHECK CIRCUIT 119 (PK/Y)

- Using a jumper, connect Circuit 171 (BK/W) Pin 2 and Circuit 119 (PK/Y) Pin 1 of the door lock switch connector.
- Connect voltmeter between door lock/unlock control relay connector Pin 6 Circuit 119 (PK/Y) and known good ground.
- Measure voltage.

Is battery voltage present?

Yes	No
REFER to Switch Test in Component Test. SERVICE as required. RETEST system.	GO to **B10** .

B9 CHECK CIRCUIT 120 (PK/LG)

- Using a jumper, connect Circuit 171 (BK/W) Pin 2 and Circuit 120 (PK/LG) Pin 3 of the door lock switch connector.
- Connect voltmeter between door lock/unlock control relay connector Circuit 120 (PK/LG) Pin 1 and known good ground.
- Measure voltage.

Is battery voltage present?

Yes	No
REFER to Switch Test in Component Test. SERVICE as required. RETEST system.	SERVICE Circuit 120 (PK/LG). RETEST system.

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B10 CHECK LOCK SIGNAL TO RELAY FOR OPEN

- Connect ohmmeter between LH door lock switch connector Circuit 119 (PK/Y) Pin 1 and the door lock/unlock control relay connector Circuit 119 (PK/Y) Pin 6.
- Measure resistance.

Is resistance 5 ohms or less?

Yes	No
GO to **B11** .	SERVICE Circuit 119 (PK/Y) for open. RETEST system.

B11 CHECK LOCK SIGNAL TO RELAY FOR SHORT TO GROUND

- Connect ohmmeter between LH door lock switch connector Circuit 119 (PK/Y) Pin 1 and known good ground.
- Measure resistance.

Is resistance 5 ohms or less?

Yes	No
SERVICE Circuit 119 (PK/Y) for short to ground. RETEST system.	GO to **B12** .

B12 CHECK UNLOCK SIGNAL TO RELAY FOR OPEN

- Connect ohmmeter between LH door lock switch connector Circuit 120 (PK/LG) Pin 3 and door lock/unlock control relay connector Circuit 120 (PK/LG) Pin 1.
- Measure resistance.

Is resistance 5 ohms or less?

Yes	No
GO to **B13** .	SERVICE Circuit 120 (PK/LG) for open. RETEST system.

B13 CHECK UNLOCK SIGNAL TO RELAY FOR SHORT TO GROUND

- Connect ohmmeter between LH door lock switch connector Circuit 120 (PK/LG) Pin 3 and known good ground.
- Measure resistance.

Is resistance 5 ohms or less?

Yes	No

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SERVICE circuit 120 (PK/LG) for short to ground. RETEST system.	RETEST system.

B14 CHECK CIRCUIT 118 (PK/O) FOR OPEN

- Connect ohmmeter between RF door lock actuator connector, Circuit 118 (PK/O) and the door lock/unlock control relay connector, Circuit 118 (PK/O), Pin 2.
- Measure resistance.

Is resistance 5 ohms or less?

Yes	No
GO to **B15** .	SERVICE Circuit 118 (PK/O) for open. RETEST system.

B15 CHECK CIRCUIT 118 (PK/O) FOR SHORT

- Connect ohmmeter between RF door lock actuator connector, Circuit 118 (PK/O) and known good ground.
- Measure resistance.

Is resistance 10,000 ohms or greater?

Yes	No
GO to **B16** .	SERVICE Circuit 118 (PK/O) for short to ground. RETEST system.

B16 CHECK CIRCUIT 117 (PK/BK) FOR OPEN

- Connect ohmmeter between RF door lock actuator connector, Circuit 117 (PK/BK), and the door lock/unlock control relay connector, Circuit 117 (PK/BK), Pin 5.
- Measure resistance.

Is resistance 5 ohms or less?

Yes	No
GO to **B17** .	SERVICE Circuit 117 (PK/BK) for open. RETEST system.

B17 CHECK CIRCUIT 117 (PK/BK) FOR SHORT

- Connect ohmmeter between RF door lock actuator connector, Circuit 117 (PK/BK), and known good ground.
- Measure resistance.

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Is resistance 10,000 ohms or greater?

Yes	No
REFER to Relay Test in Component Test. SERVICE as required. If relay is OK, REPLACE power door lock module. RETEST system.	SERVICE Circuit 117 (PK/BK) for short to ground. RETEST system.

PINPOINT TEST C: ALL DOOR LOCKS INOPERATIVE (RANGER)

C1 CHECK FUSE E (20A) IN POWER DISTRIBUTION BOX

Is the fuse open?

Yes	No
GO to **C5** .	GO to **C2** .

C2 CHECK SUPPLY TO ALL LOCK RELAY AND ALL UNLOCK RELAY

- Gain access to relay module No. 3.
- Remove all lock and all unlock relays located in instrument panel relay module No. 3. Refer to Section 18-01 for location illustrations.
- Connect voltmeter negative lead to known good ground, then test module Pins 25, 26, 31 and 34 individually with positive lead of voltmeter.
- Measure voltage on each pin.

Is battery voltage present on each pin?

Yes	No
GO to **C3** .	GO to **C4** .

C3 CHECK GROUND CIRCUIT FOR ALL LOCK AND ALL UNLOCK RELAYS

- Connect ohmmeter test lead to known good ground, then with other test lead, test module Pins 30 and 33 on instrument panel relay module No. 3.
- Measure resistance of each pin.

Is resistance 5 ohms or less on each pin?

Yes	No
GO to **C6** .	SERVICE Circuit 57 (BK) for open on any pin over 5 ohms. RETEST system.

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C4 CHECK CIRCUIT 171 (BK/W) FOR OPEN

- Connect ohmmeter between fuse E Circuit 171 (BK/W) of power distribution box and instrument panel relay module No. 3, Pins 25, 26, 31 and 34, test each individually.
- Measure resistance of each pin.

Is resistance 5 ohms or less on each pin?

Yes	No
GO to **C5** .	SERVICE Circuit 171 (BK/W) for open. RETEST system.

C5 CHECK CIRCUIT 171 (BK/W) FOR SHORT

- Connector ohmmeter between known good ground and instrument panel relay module No. 3 Pin 25.
- Measure resistance.

Is resistance 5 ohms or less on any pin?

Yes	No
SERVICE Circuit 171 (BK/W) for short to ground. RETEST system.	GO to **C6** .

C6 CHECK LOCK SIGNAL TO ALL LOCK RELAY FOR OPEN

- Connect ohmmeter between Circuit 119 (PK/Y) instrument panel relay module No. 3 and known good ground.
- Actuate any door lock switch to lock position.
- Measure resistance.

Is resistance 5 ohms or less?

Yes	No
REFER to Relay Test in component test. SERVICE as required. RETEST system.	GO to **C7** .

C7 CHECK CIRCUIT 119 (PK/Y) FOR OPEN

- Remove door lock switch as outlined in this section.
- Connect ohmmeter between Circuit 119 (PK/Y) of instrument panel module No. 3.
- Measure resistance.

Is resistance 5 ohms or less?

Yes	No

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GO to **C8** .	SERVICE Circuit 119 (PK/Y) for open. RETEST system.

C8 CHECK CIRCUIT 118 (PK/O) FOR OPEN

- Connect ohmmeter between RF door lock actuator connector, Circuit 118 (PK/O) and the instrument panel relay module No. 31, Circuit 118 (PK/O).
- Measure resistance.

Is resistance 5 ohms or less?

Yes	No
GO to **C9** .	SERVICE Circuit 118 (PK/O) for open. RETEST system.

C9 CHECK CIRCUIT 118 (PK/O) FOR SHORT

- Connect ohmmeter between RF door lock actuator connector, Circuit 118 (PK/O), and known good ground.
- Measure resistance.

Is resistance 10,000 ohms or greater?

Yes	No
GO to **C10** .	SERVICE Circuit 118 (PK/O) for short to ground. RETEST system.

C10 CHECK CIRCUIT 117 (PK/BK) FOR OPEN

- Connect ohmmeter between RF door lock actuator connector, Circuit 117 (PK/BK), and the instrument panel relay module No. 3, Circuit 117 (PK/BK), Pin 5.
- Measure resistance.

Is resistance 5 ohms or less?

Yes	No
GO to **C11** .	SERVICE Circuit 117 (PK/BK) for open. RETEST system.

C11 CHECK CIRCUIT 117 (PK/BK) FOR SHORT

- Connect ohmmeter between RF door lock actuator connector, Circuit 117 (PK/BK), and known good ground.
- Measure resistance.

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Is resistance 10,000 ohms or greater?

Yes	No
GO to **C12** .	SERVICE Circuit 117 (PK/BK) for short to ground. RETEST system.

C12 CHECK INSTRUMENT PANEL RELAY MODULE NO. 3

- Check the instrument panel relay module No. 3. Refer to Relay Test in component test.

Is the relay OK?

Yes	No
GO to **C13** .	REPLACE the instrument panel relay module No. 3. RETEST system.

C13 CHECK SWITCH GROUND CIRCUIT 57 (BK) FOR OPEN

- With switch removed, connect ohmmeter between Circuit 57 (BK) on switch connector and known good ground.
- Measure resistance.

Is resistance 5 ohms or less?

Yes	No
REFER to Switch Test in component test. SERVICE as required. RETEST system.	SERVICE Circuit 57 (BK) for open. RETEST system.

PINPOINT TEST D: ALL LOCKS WORK FROM ONE SWITCH ONLY

D1 CHECK SUSPECT SWITCH

- Remove suspect switch.
- Perform Switch Test . Refer to Component Tests in this section.

Did switch test OK?

Yes	No
GO to **D2** .	REPLACE door lock switch. RETEST system.

D2 CHECK CIRCUIT 57 (BK)

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- Check Circuit 57 (BK) for LH switch or for RH switch for continuity to ground.

Is there continuity?

Yes	No
GO to **D3** .	SERVICE Circuit 57 (BK) for open. RETEST system.

D3 CHECK CIRCUIT 119 (PK/Y)

- Remove opposite door lock switch.
- Using an ohmmeter, check Circuit 119 (PK/Y) from LH door lock switch connector to Circuit 119 (PK/Y) at RH door lock switch connector for continuity.

Is there continuity?

Yes	No
GO to **D4** .	SERVICE Circuit 119 (PK/Y) for open. RETEST system.

D4 CHECK CIRCUIT 120 (PK/LG)

- Using ohmmeter, check Circuit 120 (PK/LG) from LH door lock switch connector to Circuit 120 (PK/LG) at RH door lock switch connector for continuity.

Is there continuity?

Yes	No
REPLACE opposite door lock switch. RETEST system.	SERVICE Circuit 120 (PK/LG) for open. RETEST system.

PINPOINT TEST E: DOOR LOCKS OPERATE ONE WAY ONLY (AEROSTAR)

E1 CHECK LOCK OPERATION

- Actuate door lock switch to the lock position.

Did doors lock?

Yes	No
GO to **E6** .	GO to **E2** .

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E2 CHECK CIRCUIT 119 (PK/Y) TO DOOR LOCK/UNLOCK CONTROL RELAY FOR OPEN

- Remove door lock/unlock control relay.
- Using a test lamp, check for voltage at Circuit 119 (PK/Y) Pin 6 when door lock switch is actuated to the lock position.

Did test lamp illuminate?

Yes	No
REFER to Relay Test in component test. SERVICE as required. RETEST system.	GO to **E3** .

E3 CHECK CIRCUIT 119 (PK/Y) FOR OPEN

- Remove LH door lock switch as outlined in this section.
- Connect ohmmeter between Circuit 119 (PK/Y) Pin 1 on door lock switch connector and Circuit 119 (PK/Y) Pin 6 on door lock/unlock control relay connector.
- Measure resistance.

Is resistance 5 ohms or less?

Yes	No
GO to **E4** .	SERVICE Circuit 119 (PK/Y) for open. RETEST system.

E4 CHECK CIRCUIT 119 (PK/Y) FOR SHORT TO GROUND

- Connect ohmmeter between Circuit 119 (PK/Y) Pin 1 on door lock switch connector and known good ground.
- Measure resistance.

Is resistance 5 ohms or less?

Yes	No
SERVICE Circuit 119 (PK/Y) for short to ground. RETEST system.	GO to **E5** .

E5 CHECK DOOR LOCK/UNLOCK CONTROL RELAY OPERATION

- Reinstall door lock/unlock control relay.
- Using a jumper, connect Circuit 171 (BK/W) Pin 2 and Circuit 119 (PK/Y) Pin 1 on door lock switch connector.

Did door locks actuate?

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Yes	No
REFER to Switch Test in component test. SERVICE as required. RETEST system.	REFER to Relay Test in component test. SERVICE as required. RETESt system.

E6 CHECK CIRCUIT 120 (PK/LG) TO DOOR LOCK/UNLOCK CONTROL RELAY FOR OPEN

- Remove door lock/unlock control relay.
- Using a test lamp, check for voltage at Circuit 120 (PK/LG) Pin 1 when door lock switch is activated to the unlock position.

Did test lamp illuminate?

Yes	No
REFER to Relay Test in component test. SERVICE as required. RETEST system.	GO to **E7** .

E7 CHECK CIRCUIT 120 (PK/LG) FOR OPEN

- Remove LH door lock switch as outlined in this section.
- Connect ohmmeter between Circuit 120 (PK/LG) Pin 3 on door lock switch connector and Circuit 120 (PK/LG) Pin 1 on door lock/unlock control relay connector.
- Measure resistance.

Is resistance 5 ohms or less?

Yes	No
GO to **E8** .	SERVICE Circuit 120 (PK/LG) for open. RETEST system.

E8 CHECK CIRCUIT 120 (PK/LG) FOR SHORT TO GROUND

- Connect ohmmeter between Circuit 120 (PK/LG) Pin 3 on door lock switch connector and known good ground.
- Measure resistance.

Is resistance 5 ohms or less?

Yes	No
SERVICE Circuit 120 (PK/LG) for short to ground. RETEST system.	GO to **E9** .

E9 CHECK DOOR LOCK/UNLOCK CONTROL RELAY OPERATION

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- Reinstall door lock/unlock control relay.
- Using a jumper, connect Circuit 171 (BK/W) Pin 2 and Circuit 120 (PK/LG) Pin 3 on door lock switch connector.

Did door locks actuate?

Yes	No
REFER to Switch Test in component test. SERVICE as required. RETEST system.	REFER to Relay Test in component test. SERVICE as required. RETEST system.

PINPOINT TEST F: DOOR LOCKS OPERATE ONE WAY ONLY (RANGER)

F1 CHECK LOCK OPERATION

- Actuate door lock switch to the lock position.

Did doors lock?

Yes	No
GO to **F6** .	GO to **F2** .

F2 CHECK SUPPLY TO ALL LOCK RELAY

- Remove all lock relay from instrument panel relay module No. 3. Refer to Section 18-01 for location illustrations.
- Using a test lamp, check for voltage at Circuit 171 (BK/W) Pins 26 and 34.

Did test lamp illuminate at each pin?

Yes	No
GO to **F3** .	SERVICE Circuit 171 (BK/W) for open. RETEST system.

F3 CHECK GROUND TO ALL LOCK RELAY

- Connect ohmmeter between Circuit 57 (BK) of all lock relay connector and known good ground.
- Measure resistance.

Is resistance 5 ohms or less?

Yes	No
GO to **F4** .	SERVICE Circuit 57 (BK) for open. RETEST system.

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F4 CHECK LOCK SIGNAL TO ALL LOCK RELAY

- Connect ohmmeter between Circuit 119 (PK/Y) of all lock relay connector and known good ground.
- Actuate door lock switch to lock position.
- Measure resistance.

Is resistance 5 ohms or less?

Yes	No
REFER to Relay Test in component test. SERVICE as required. RETEST system.	GO to **F5** .

F5 CHECK RELAY COIL GROUND CIRCUIT

- Remove door lock switch as outlined in this section.
- Using a jumper, connect Circuit 119 (PK/Y) and Circuit 57 (BK) of door lock switch connector.
- Connect ohmmeter between Circuit 119 (PK/Y) of all lock relay connector and known good ground.
- Measure resistance.

Is resistance 5 ohms or less?

Yes	No
REFER to Switch Test in component test. SERVICE any door lock switch as required. RETEST system.	SERVICE Circuit 119 (PK/Y) or 57 (BK) of switch connector for open. RETEST system.

F6 CHECK SUPPLY TO ALL UNLOCK RELAY

- Remove all unlock relay from instrument panel relay module No. 3. Refer to Section 18-01 for location illustrations.
- Using a test lamp, check for voltage at Circuit 171 (BK/W) Pins 25 and 31.

Did test lamp illuminate at each pin?

Yes	No
GO to **F7** .	SERVICE Circuit 171 (BK/W) for open. RETEST system.

F7 CHECK GROUND TO ALL UNLOCK RELAY

- Connect ohmmeter between Circuit 57 (BK) of all unlock relay connector and known good ground.
- Measure resistance.

Is resistance 5 ohms or less?

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Yes	No
GO to **F8** .	SERVICE Circuit 57 (BK) for open. RETEST system.

F8 CHECK UNLOCK SIGNAL TO ALL UNLOCK RELAY

- Connect ohmmeter between Circuit 120 (PK/LG) of all unlock relay connector and known good ground.
- Actuate door lock switch to lock position.
- Measure resistance.

Is resistance 5 ohms or less?

Yes	No
REFER to Relay Test in component test. SERVICE as required. RETEST system.	GO to **F9** .

F9 CHECK RELAY COIL GROUND CIRCUIT

- Remove door lock switch as outlined in this section.
- Using a jumper, connect Circuit 120 (PK/LG) and Circuit 57 (BK) of door lock switch connector.
- Connect ohmmeter between Circuit 120 (PK/LG) of all unlock relay connector and known good ground.
- Measure resistance.

Is resistance 5 ohms or less?

Yes	No
REFER to Switch Test in component test. SERVICE any door lock switch as required. RETEST system.	SERVICE Circuit 120 (PK/LG) or 57 (BK) of switch connector for open. RETEST system.

PINPOINT TEST G: SLIDING DOOR LOCK INOPERATIVE (AEROSTAR)

G1 CHECK OPERATION OF SUSPECT DOOR LOCK

- Manually operate inoperative door lock.
- Check for binding or stuck condition.

Is lock stuck or binding?

Yes	No
REFER to Lubrication in this section. SERVICE	GO to **G2** .

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as required. RETEST system.	

G2 CHECK SUPPLY TO POWER DOOR LOCK MODULE

- Gain access to power door lock module as outlined in this section.
- Remove connector from power door lock module.
- Using a test lamp, check for voltage at Circuit 171 (BK/W) Pin 8 of power door lock module connector.

Did test lamp illuminate?

Yes	No
GO to **G3** .	SERVICE Circuit 171 (BK/W) for open. RETEST system.

G3 CHECK GROUND TO POWER DOOR LOCK MODULE

- Connect ohmmeter between Circuit 57 (BK) Pin 4 of power door lock module connector and known good ground.
- Measure resistance.

Is resistance 5 ohms or less?

Yes	No
GO to **G4** .	SERVICE Circuit 57 (BK) for open. RETEST system.

G4 CHECK LOCK SIGNAL TO POWER DOOR LOCK MODULE

- Using a test lamp, check for voltage at Circuit 117 (PK/BK) Pin 2 of power door lock module connector while door lock switch is actuated to the lock position.

Did test lamp illuminate?

Yes	No
GO to **G6** .	GO to **G5** .

G5 CHECK CIRCUIT 117 (PK/BK) FOR SHORT

- Remove door lock/unlock control relay as outlined in this section.
- Connect ohmmeter between Circuit 117 (PK/BK) Pin 2 of power door lock module connector and known good ground.
- Measure resistance.

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Is resistance 5 ohms or less?

Yes	No
SERVICE Circuit 117 (PK/BK) for short to ground. RETEST system.	SERVICE Circuit 117 (PK/BK) for open. RETEST system.

G6 CHECK UNLOCK SIGNAL TO POWER DOOR LOCK MODULE

- Using a test lamp, check for voltage at Circuit 118 (PK/O) Pin 1 of power door lock module connector while door lock switch is actuated to the unlock position.

Did test lamp illuminate?

Yes	No
GO to **G8** .	GO to **G7** .

G7 CHECK CIRCUIT 118 (PK/O) TO POWER DOOR LOCK MODULE FOR SHORT TO GROUND

- Remove door lock/unlock control relay as outlined in this section.
- Connect ohmmeter between Circuit 118 (PK/O) Pin 1 of power door lock module connector and known good ground.
- Measure resistance.

Is resistance 5 ohms or less?

Yes	No
SERVICE Circuit 118 (PK/O) for short to ground. RETEST system.	SERVICE Circuit 118 (PK/O) for open. RETEST system.

G8 CHECK CIRCUIT 121 (PK/BK) FOR OPEN

- Gain access to sliding door lock actuator as outlined in this section.
- Disconnect sliding door lock actuator.
- With sliding door closed, connect ohmmeter between Circuit 121 (PK/BK) on actuator connector and Circuit 121 (PK/BK) Pin 7 of power door lock module connector.
- Measure resistance.

Is resistance 5 ohms or less?

Yes	No
GO to **G9** .	SERVICE Circuit 121 (PK/BK) for open. RETEST system.

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G9 CHECK CIRCUIT 121 (PK/BK) FOR SHORT

- Connect ohmmeter between Circuit 121 (PK/BK) Pin 7 on power door lock module connector and known good ground.
- Measure resistance.

Is resistance 5 ohms or less?

Yes	No
SERVICE Circuit 121 (PK/BK) for short to ground. RETEST system.	GO to **G10** .

G10 CHECK CIRCUIT 118 (PK/O) TO DOOR LOCK/UNLOCK CONTROL RELAY FOR OPEN

- Connect ohmmeter between Circuit 118 (PK/O) at sliding door lock actuator connector and Circuit 118 (PK/O) at door lock/unlock control relay connector.
- Measure resistance.

Is resistance 5 ohms or less?

Yes	No
GO to **G11** .	SERVICE Circuit 118 (PK/O) for open. RETEST system.

G11 CHECK CIRCUIT 118 (PK/O) TO DOOR LOCK/UNLOCK CONTROL RELAY FOR SHORT TO GROUND

- Connect ohmmeter between sliding door lock actuator connector Circuit 118 (PK/O) and known good ground.
- Measure resistance.

Is resistance 5 ohms or less?

Yes	No
SERVICE Circuit 118 (PK/O) for short to ground. RETEST system.	GO to **G12** .

G12 CHECK THE POWER DOOR LOCK MODULE

- Perform the Component Test for the power door lock module. Refer to Power Door Lock Module Test in Component Test.

Is the power door lock module OK?

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Yes	No
REFER to Door Lock Actuator Test in Component Test. SERVICE as required. RETEST system.	REPLACE the power door lock module. RETEST the system.

PINPOINT TEST H: LIFTGATE DOOR LOCK INOPERATIVE

H1 CHECK OPERATION OF SUSPECT DOOR LOCK

- Manually operate liftgate door lock.
- Check for binding or stuck condition.

Is lock stuck or binding?

Yes	No
REFER to Lubrication in this section. SERVICE as required. RETEST system.	GO to **H2** .

H2 CHECK LIFTGATE POWER DOOR LOCK ACTUATOR LOCK OPERATION

- Gain access to liftgate power door lock actuator as outlined.
- Disconnect power door lock actuator.
- Using a test lamp connected to a known good ground, check Circuit 117 (PK/BK) at harness connector while actuating door locks in the lock position.

Did test lamp illuminate?

Yes	No
GO to **H3** .	SERVICE Circuit 117 (PK/BK) for open circuit. RETEST system.

H3 CHECK POWER DOOR LOCK ACTUATOR FOR UNLOCK POSITION

- Remove test lamp from Circuit 117 (PK/BK) and connect it to Circuit 118 (PK/O).
- Actuate switch in the unlock position.

Did test lamp illuminate?

Yes	No
GO to **H4** .	SERVICE Circuit 118 (PK/O) for open circuit. RETEST system.

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H4 CHECK POWER DOOR LOCK ACTUATOR

- Using two 10 gauge jumper wires connected to battery positive (+) and negative (-), attach jumpers to actuator connector; reverse polarity for opposite direction.

Did actuator operate properly?

Yes	No
GO to **H5** .	REPLACE power door lock actuator. RETEST system.

H5 CHECK POWER DOOR LOCK ACTUATOR CURRENT DRAW

- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check actuator current draw.

Is current draw 6 amps or less?

Yes	No
RECONNECT power door lock actuator. REFER to Lubrication . RETEST system.	REPLACE power door lock actuator. RETEST system.

PINPOINT TEST J: DOOR LOCKS WORK WITH ENGINE RUNNING ONLY

J1 CHECK SUPPLY CIRCUIT

- Using a voltmeter, check vehicle battery voltage.

Is voltage 10 volts or more?

Yes	No
GO to **J2** .	REFER to Section 14-00 for proper service. RETEST system.

J2 CHECK LATCH/LINKAGE

- Manually lock/unlock door.

Does latch operate easily?

Yes	No
GO to **J3** .	REFER to Lubrication and service as necessary.

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J3 CHECK DOOR LOCK SWITCH CONNECTOR

- Partially remove left door lock switch as outlined.
- Inspect connector for corrosion or damaged/loose connection.

Is connector OK?

Yes	No
REFER to Lubrication in this section and service as necessary. RETEST system.	SERVICE as required. RETEST system.

PINPOINT TEST K: DOOR LOCKS WORK INTERMITTENTLY

K1 CHECK CONNECTIONS

- Access all related components.
- Check connectors for corrosion and tightness.

Are connectors OK?

Yes	No
GO to **K2** .	SERVICE as required. RETEST system.

K2 CHECK GROUND CIRCUIT AT RH OR LH SWITCH

- Using an ohmmeter connected to a known good ground, connect second lead to Circuit 57 (BK) at Pin 3.
- Measure resistance of each circuit.

Is resistance 5 ohms or less?

Yes	No
REFER to Switch Test in Component test. SERVICE as required. RETEST systems.	SERVICE Circuit 57 (BK) for open circuit. RETEST system.

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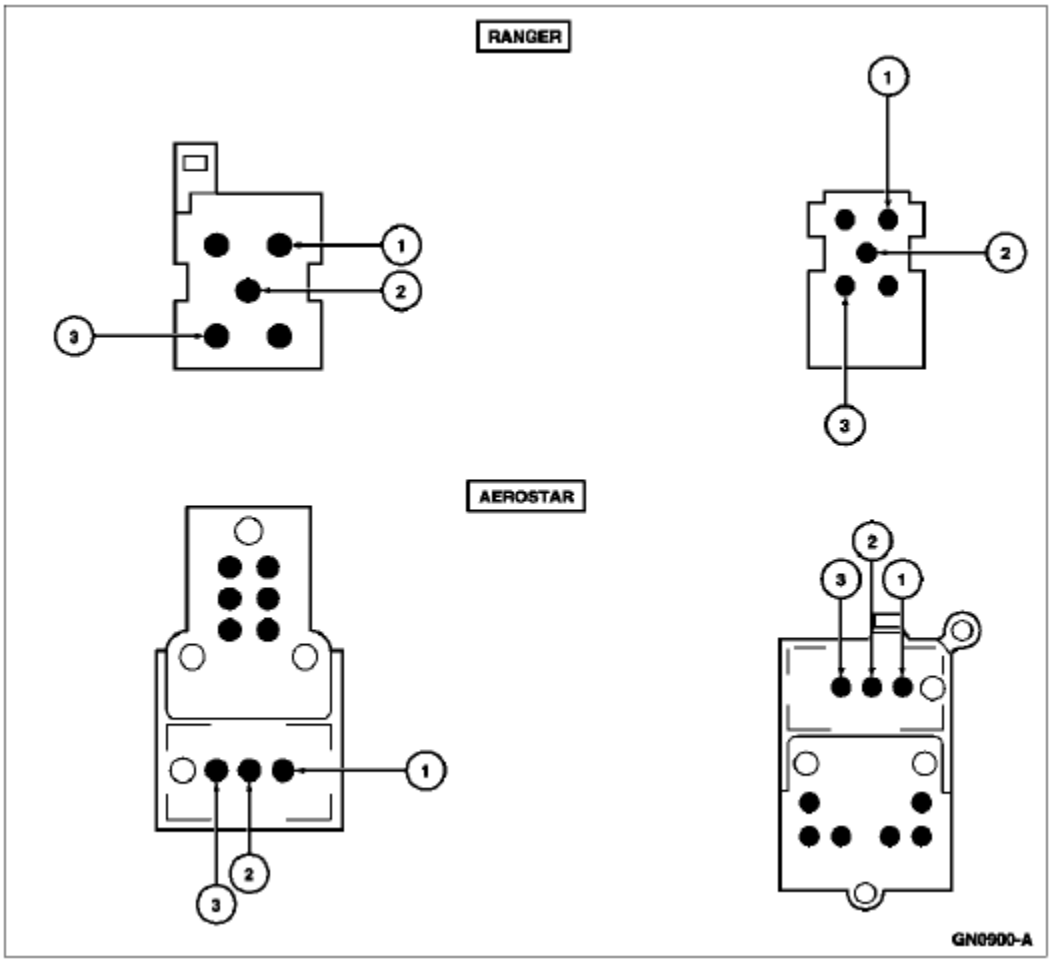
Component Tests

Door Lock Switch



1. Measure the resistance of the door lock switch in question, between terminals 1 and 2, while pressing the switch in the unlock position. The resistance should be less than 5 ohms; if not less than 5 ohms, REPLACE the door lock switch.

2. Measure the resistance of the door lock switch in question, between terminals 2 and 3, while pressing the switch in the lock position. The resistance should be less than 5 ohms; if not less than 5 ohms, REPLACE the door lock switch.

3. Measure the resistance of the door lock switch in question, between terminals 1 and 2. The resistance should be greater than 10,000 ohms; if not greater than 10,000 ohms, REPLACE the door lock switch.

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4. Measure the resistance of the door lock switch in question, between terminals 2 and 3. The resistance should be greater than 10,000 ohms; if not greater than 10,000 ohms, REPLACE the door lock switch.

Door Lock Actuator

NOTE: Do not hold power and ground to the power door lock actuator for more than five seconds at a time.

Apply 12 volts to one of the wire terminals and ground to the other wire terminal of the door lock actuator. Reverse the connections. The actuator should produce a clicking noise when power and ground is applied in both directions. If the actuator does not click, replace the power door lock actuator. Otherwise, return to the Pinpoint Test.

Power Door Lock Module, Aerostar

NOTE: Do not hold power and ground to the power door lock module for more than five seconds at a time.

Apply 12 volts to Pin 8 of the power door lock module and ground to Pin 4. Applying 12 volts to Pins 1 and 2 alternately will cycle Pin 7 to 12 volts, when Pin 1 is powered and ground, when Pin 2 is powered.

If it fails to respond in this manner, replace the power door lock module. Otherwise return to the Pinpoint Test.

Door Lock Relay

NOTE: Some relays are double relays and both sections of this type relay must prove good.

Remove the relay as outlined in this section. Connect an ohmmeter between the terminal that connects to Circuit 57 (B) and the terminal that connects to Circuit 118 (PK/O), for the unlock relay, or Circuit 117 (PK/BK), for the lock relay. The resistance should be 5 ohms or less.

Next, with the ohmmeter still connected to Circuit 118 (PK/O) terminal, for unlock relays, or Circuit 117 (PK/BK) terminal, for lock relays, connect the other test lead to the terminal that connects to Circuit 171 (BK/W). Energize the relay by applying 12 volts to the relay coil terminal, Circuit 120 (PK/LG) for runlock relays or Circuit 119 (PK/Y), for lock relays, and ground to the terminal that connects to Circuit 57 (BK) on the Aerostar or Circuit 171 (BK/W) on Ranger. The relay should click audibly and the ohmmeter should show resistance at 5 ohms or less.

If the resistance is over 5 ohms for either portion described above, replace the relay. Otherwise return to Pinpoint Test.

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Latch, Door

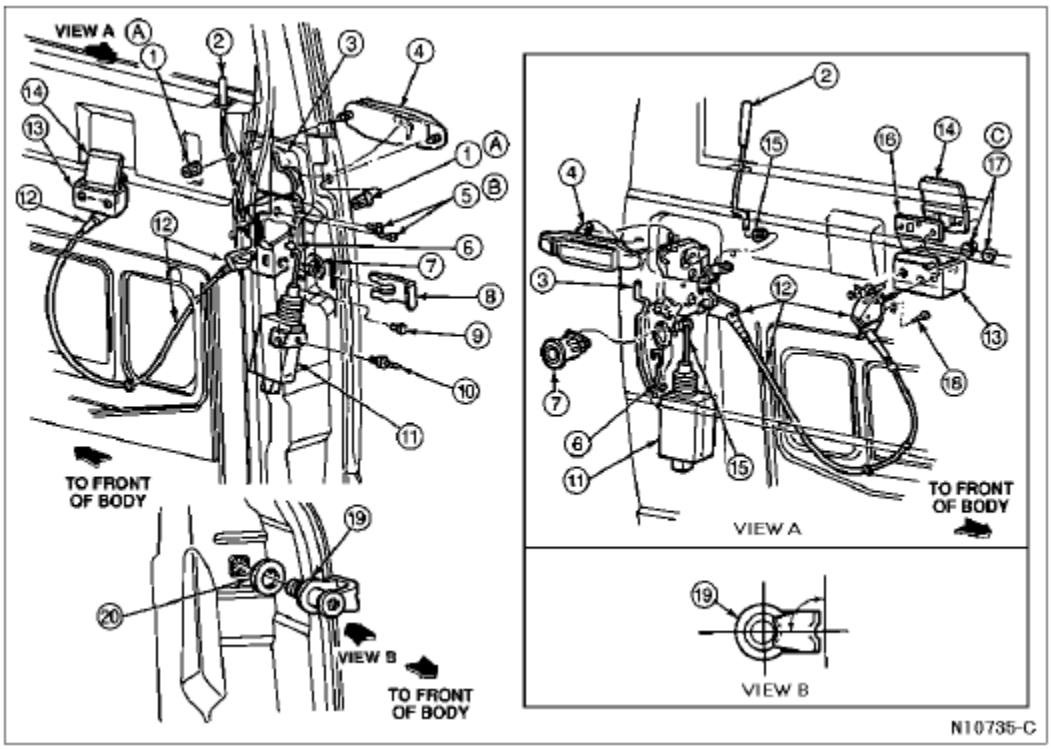
Front, Aerostar and Ranger

Removal and Installation

1. Remove the front door trim panel and watershield from the front door. Refer to Section 01-05A or Section 01-05B .
2. Disconnect front door latch actuating rod (22152) from lock cylinder.
3. Remove attaching screws from front door latch remote control and link (21818). Remove front door latch remote control and link from front door.
4. Disconnect front door latch control cylinder rod (22134) from front door latch remote control and link.
5. Disconnect front door latch remote control link.

For installation, follow removal procedures in reverse order.

Front Door Latch Installation, Aerostar



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Item	Part Number	Description
1	N804534-S39	Nut (2 Req'd Each Handle)
2	21852	Front Door Latch Push Button Rod
3	22152	Front Door Latch Actuating Rod
4	22404	Door Handle
5	N805653-S100	Screw (2 Req'd Each Side)
6	22134	Front Door Latch Control Cylinder Rod
7	22050	Door Lock Cylinder
8	22023	Door Lock Cylinder Retainer
9	N805654-S100	Screw and Washer
10	388047-S101	Rivet
11	218A42	Door Latch Actuator
12	21812	Front Door Latch
13	22634	Inside Door Handle Cup
14	22600	Inside Door Handle
15	386656-S	Bushing (2 Req'd Each Side)
16	22608	Spacer, Door Inside Handle
17	34653-36S	Nut and Washer (2 Req'd Each Side)
18	N611172-S2	Screw
19	22008	Door Latch Striker Plate
20	N801054-S100	Washer
A	—	Tighten to 7-11 Nm (62-97 Lb-In)
B	—	Tighten to 4-8 Nm (36-70 Lb-In)
C	—	Tighten to 1.7-2.3 Nm (11-20 Lb-In)

Latch, Front Door, Ranger

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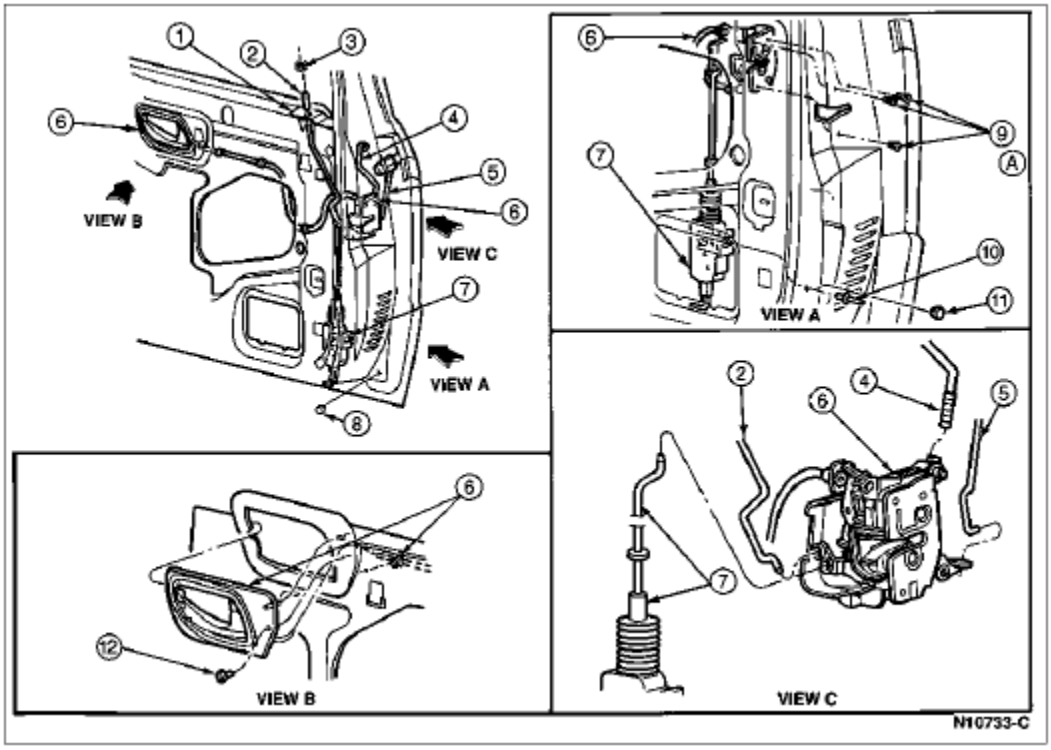

Item	Part Number	Description
1	20394	Front Door Inside Panel Sound Insulator
2	21852	Front Door Latch Push Button Rod
3	386656-S	Bushing
4	22152	Front Door Latch Actuating Rod
5	22134	Front Door Latch Control Cylinder Rod
6	21812	Front Door Latch
7	218A42	Door Latch Actuator
8	N807895-S	Bumper
9	N806679-S100	Screw (3 Req'd Each Side)
10	388047-S	Rivet
11	377934-S	Plug Button
12	N802034	Rivet
A	—	Tighten to 8-12 Nm (71-106 Lb-In)

Liftgate, Aerostar

Removal and Installation

1. Open liftgate and remove liftgate door trim panel and liftgate handle, if so equipped.
2. Disconnect liftgate latch release rod from control assembly.

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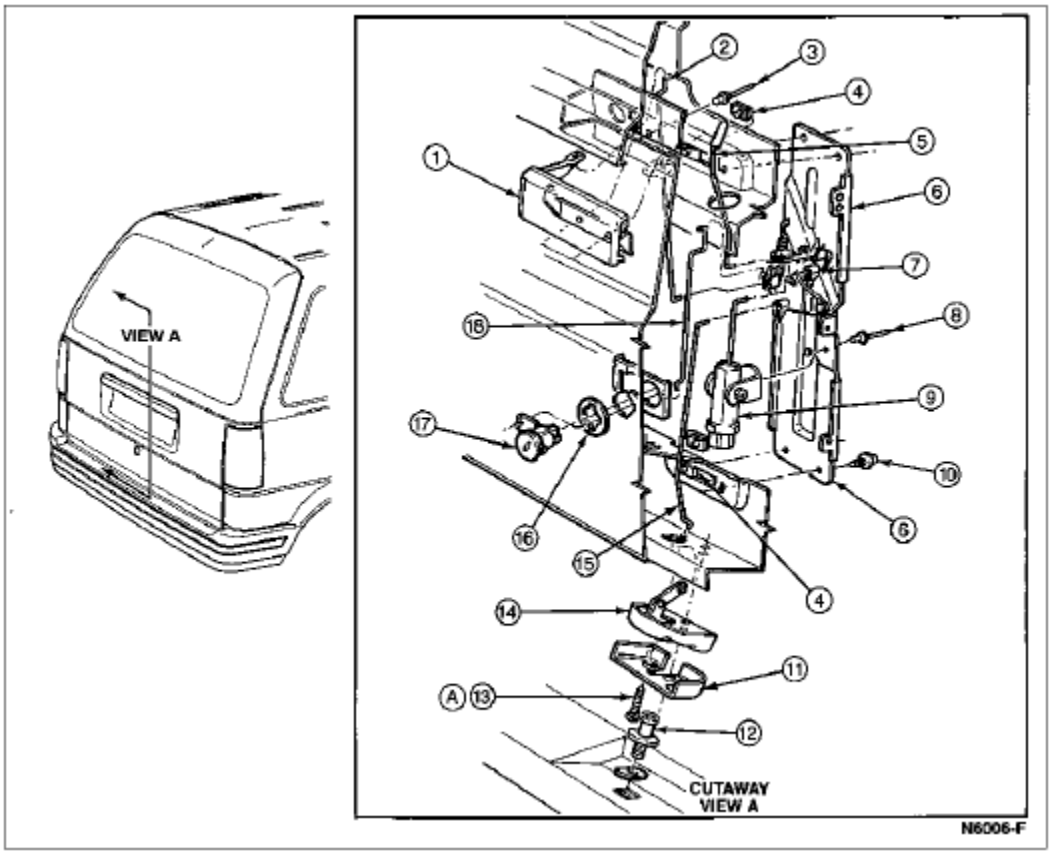
3. Remove three latch retaining screws and remove luggage compartment door lock mechanism cover (43243) and latch from liftgate.

4. On vehicles equipped with liftgate ajar warning switch, pull latch slightly away from liftgate and disconnect electrical wire harness from the latch.

To install, reverse Steps 1 through 4. Tighten liftgate handle retaining screws to 4-8 Nm (36-70 lb-in).

Liftgate Latch, Aerostar



Item	Part Number	Description
1	43400	Liftgate Handle
2	43329	Liftgate Latch Release Rod
3	390134-S100	Rivet (2 Req'd)
4	N802331-S100	U-Nut (4 Req'd)
5	431A32	Latch Push Button Rod
6	43170	Tailgate Latch Remote Control
7	390523-S	Clip
8	372820-S36	Rivet
9	431A38	Door Latch Actuator Assembly
10	N605891-S40	Bolt (4 Req'd)

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11	43243	Luggage Compartment Door Lock Mechanism Cover
12	404B12	Liftgate Latch Striker Assembly
13	N804353-S100	Screw (3 Req'd)
14	43150	Liftgate Latch Assembly
15	43298	Liftgate Latch Actuator Rod
16	43625	Pad
17	22050	Lock Cylinder
18	43876	Liftgate Lock Cylinder to Release Rod
A	—	Tighten to 9-14 Nm (7-10 Lb-Ft)

Body Side, Sliding, Aerostar

Removal and Installation

1. Remove sliding door trim panel, watershield and access hole cover plates.
2. Unlatch the sliding door.
3. Remove latch actuator rod retainer from center door retainer hole.
4. Disconnect the rear door latch actuator rod from the remote control assembly by opening the clip.
5. Open the door sufficiently to gain access to the three bolts attaching the rear latch to the sliding door. Remove bolts.
6. Remove the sliding door rear latch with the remote control actuator rod attached to the latch, from the sliding door.

For installation, follow removal procedures in reverse order. The three latch retainer bolts must not be tightened more than 9-14 Nm (6-10 lb-ft) when installed.

Latch, Sliding Door, Aerostar

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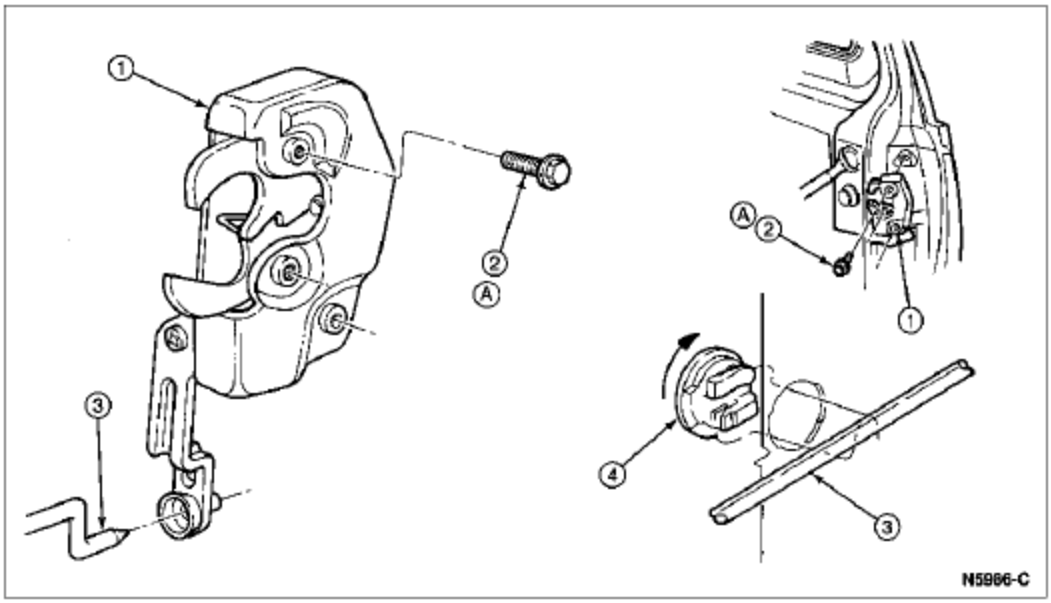

Item	Part Number	Description
1	264A32	Body Side Door Rear Latch Assembly
2	N804353-S100	Bolt (3 Req'd)
3	264A64	Body Side Door Rear Latch Actuator Rod
4	220A48	Actuator Rod Retainer
A	—	Tighten to 9-14 Nm (6-10 Lb-Ft)

Doors, Dual Rear, Aerostar

Removal and Installation

1. Remove trim panel and watershield. Refer to Section 01-05B .
2. Release threaded fitting of back door upper latch release cable assembly from door lock rod retainer on remote control assembly.
3. Disengage cable bushing from tab on remote control assembly.
4. Remove two back door upper latch attaching screws.
5. Remove latch assembly with cable assembly attached. Separate by removing cable bushing from retaining tab on latch. Replace either or both parts as required.
6. Reconnect latch and cable. Install retaining screws as shown in illustration following Lock Cylinder removal.
7. **NOTE: Cable must be routed down through door pillar.**

   Connect cable bushing and threaded fitting.

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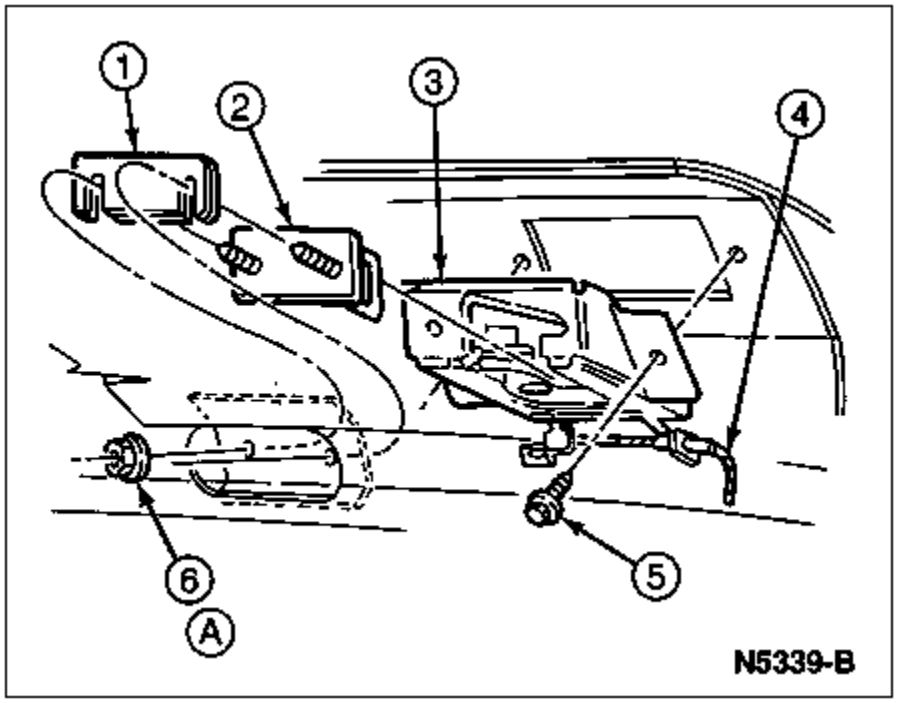
8. Install watershield and trim panel. Refer to Section 01-05B .



Item	Part Number	Description
1	44096	Door Striker Shim
2	43118	Rear Door Latch Upper Striker (Left Side)
3	43287	Back Door Upper Latch
4	431B42	Back Door Upper Latch Release Cable Assembly
5	N602728-S55	Screw (2 Req'd)
6	N621927-S36M	Nut and Washer
A	—	Tighten to 7-11 Nm (5-8 Lb-Ft)

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Latch and Rod, Lower

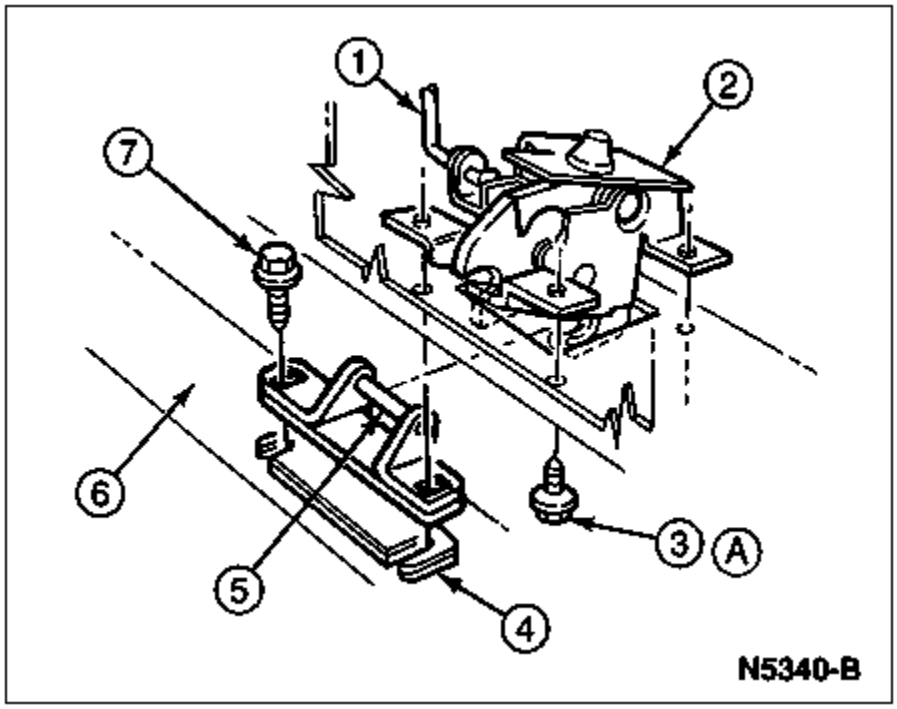
Aerostar

Removal and Installation

1. Remove trim panel and watershield. Refer to Section 01-05B .
2. Disconnect rod from remote control assembly.
3. **NOTE: If vehicle is equipped with courtesy lamp or door ajar lamp, the switch for these must be removed from right latch (one screw attachment) and installed with latch.**

   Remove four attaching screws, and remove latch.

For installation, follow removal procedures in reverse order.



Item	Part Number	Description
1	43298	Rear Door Latch Rod
2	43288	Back Door Lower Latch Assembly
3	N606676-S55	Bolt (4 Req'd)
4	44096	Door Striker Shim
5	43118	Back Door Lower Latch

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6	40010	Back Door (RH)
	40011	Back Door (LH)
7	N605892-S36	Bolt (2 Req'd)
A	—	Tighten to 7-11 Nm (5-8 Lb-Ft)

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Remote Control Assembly, Door Latch

Front Doors, All Vehicles

Refer to Door Latch Removal and Installation.

Removal

1. Remove the door trim and watershield.
2. Remove the screws attaching the remote control to the door inner panel, and remove the remote control.
3. Disconnect the latch remote control link or cable from the remote control.

Installation

1. Position the remote control to the door inner panel and connect the link or cable to the remote control.
2. Install the remote control attaching screw.
3. Check the remote control and latch operation.
4. Install the watershield and door trim panel.

Sliding Door, Aerostar

Removal and Installation

1. Remove the inside door handle screw.

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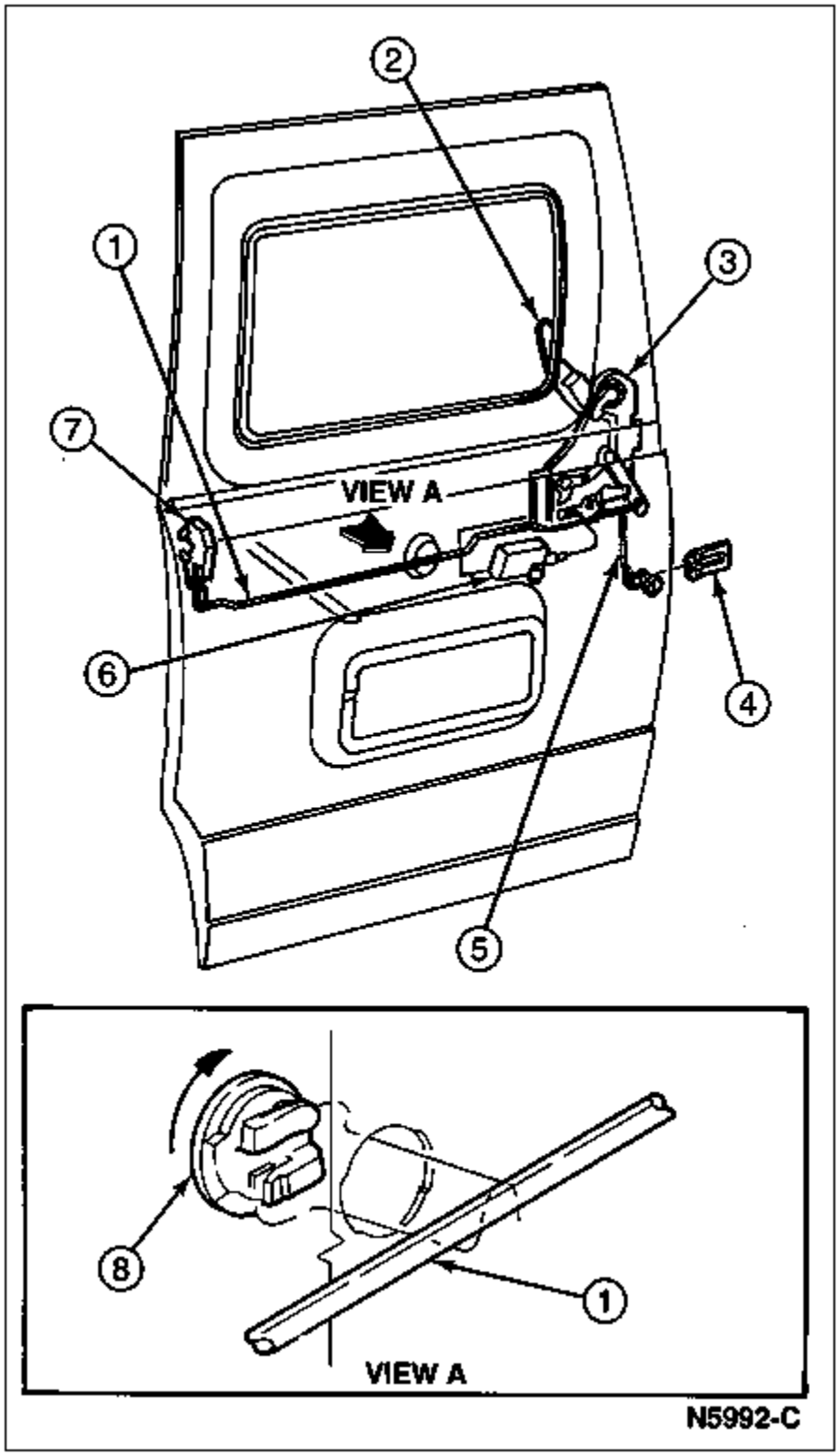

Item	Part Number	Description
1	264A64	Body Side Door Latch Actuator Rod
2	26680	Body Side Door Inside Handle

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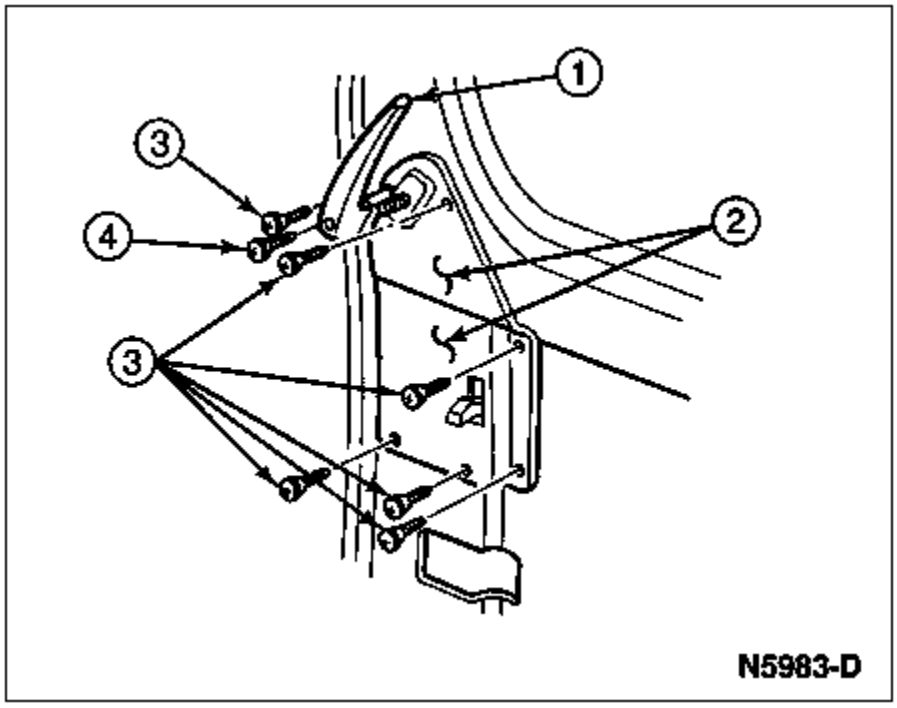
3	26404	Body Side Door Latch Remote Control Assembly
4	22023	Front Door Lock Cylinder Retainer
5	26642	Rear Door Latch Remote Control Rod
6	26594	Door Latch Actuator Assembly
7	264A32	Body Side Door Latch Assembly
8	265A99	Actuator Rod Retainer



Item	Part Number	Description
1	26680	Body Side Door Inside Handle
2	24766	Body Side Door Inner Panel Access Hole Cover Plate
3	56902-S55	Screw (6 Req'd)
4	390334-S2	Screw

2. On Hi Series-trimmed vehicles, remove the moulded upper body side door trim panels, and watershield. On Lo Series-trimmed vehicles, the remote control patch cover plate and access hole cover plates must be removed prior to proceeding to Step 3.

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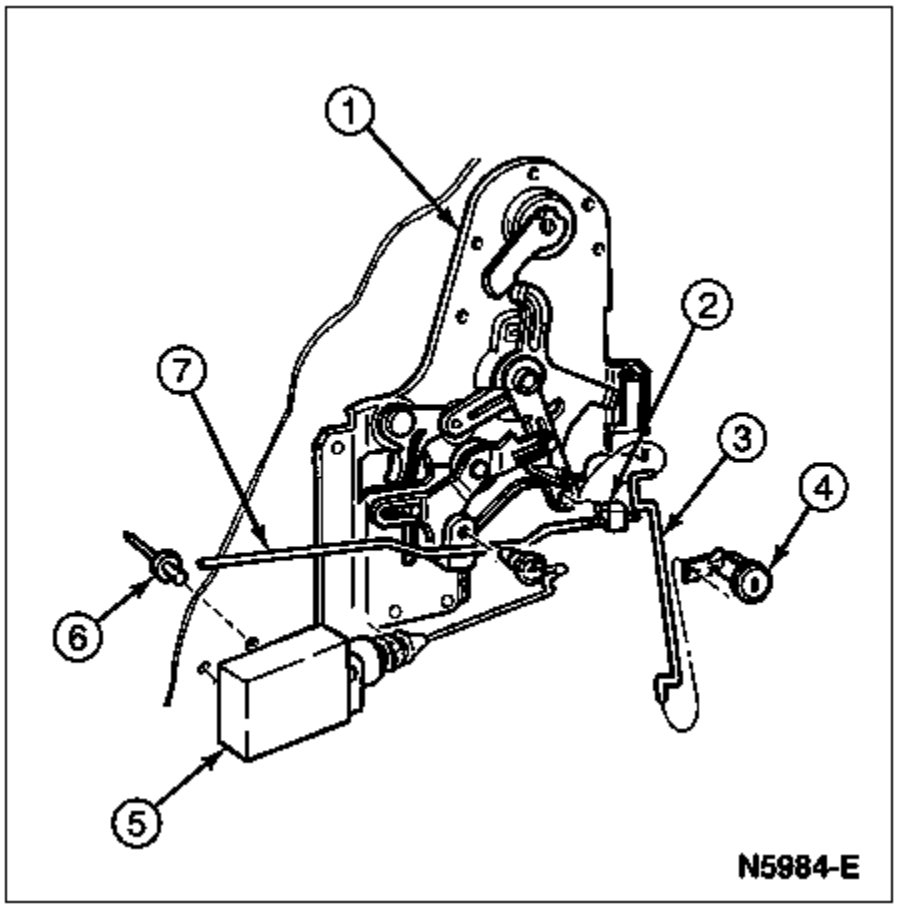

Item	Part Number	Description
1	26404	Rear Door Latch Remote Control Assembly
2	219A38	Retainer Assembly
3	26642	Rear Door Latch Remote Control Rod
4	22050	Door Lock Cylinder
5	26594	Door Latch Actuator Assembly
6	N806772-S100	Rivet (2 Req'd)
7	264A64	Rear Door Latch Actuator Rod

3. Using the lower access hole, disconnect the door lock cylinder rod and the remote actuator rod rear door latch from the remote control assembly latch levers.

   If the vehicle is equipped with power locks, drill out actuator bracket rivet, disconnect electrical connector to actuator, and remove remote control assembly with actuator.

4. **CAUTION: Use care not to enlarge inner panel retainer holes while drilling.**

   Using a 1/4-inch diameter drill, drill out the five rivets attaching the remote control assembly to the door inner panel. Remove the remote control assembly.

For installation, follow removal procedures in reverse order. Install new rivets with Heavy Duty Riveter.

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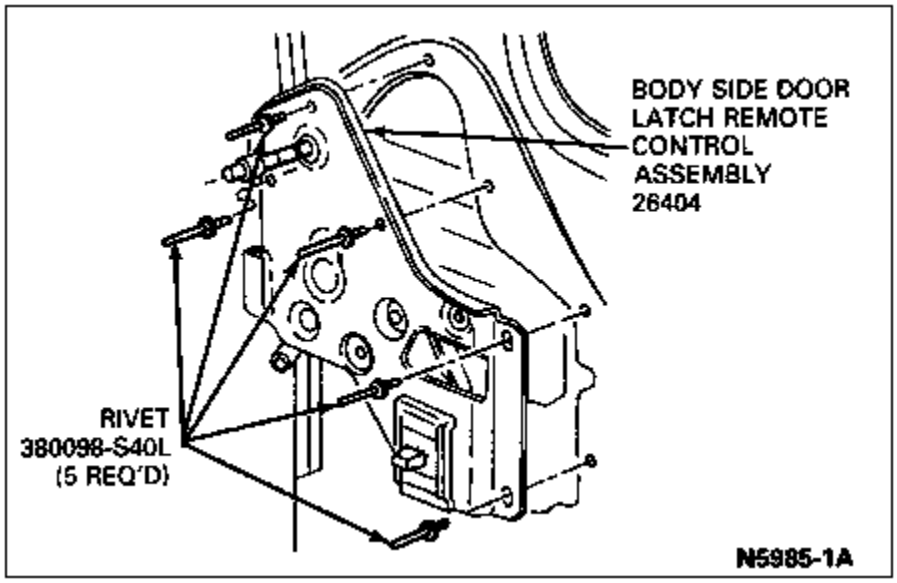

Dual Rear Door, Right Side, Aerostar

Removal

1. Remove rear door trim panel and watershield.
2. Disconnect cable and rod.
3. Disconnect bottom of rod from lock cylinder.
4. Disconnect outboard end of rod from inside handle remote. Remove by sliding through grommet in remote lever.
5. Disconnect power lock actuator rod if equipped with power locks.
6. Remove locating pin and attaching nuts. Remove outside handle.
7. Raise remote control enough to pull lock cylinder rod out of hole in inner panel. Remove rod from remote by sliding through grommet.
8. Remove push button rod from remote control by tipping remote control back and forth to thread rod out of grommet.

Installation

1. Install clips and grommets onto remote control assembly. Do not install power lock clip unless vehicle has power locks.
2. Slide push button rod through grommet in inner panel and thread end through lock lever grommet in remote control assembly. Maneuvering of remote control assembly is required.
3. With remote control still loose, thread lock cylinder rod through grommet on other end of lock lever and through hole in inner panel.

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4. Place remote control assembly to inner panel and install locating pin.

5. Install outside handle with two studs through door outer panel and remote control base. Secure with retaining nuts.

6. Slide rod through release lever grommet with end that has larger 90-degree bend portion toward inside handle assembly. Slide rod through hole in inner panel and connect to clip on remote control assembly.

7. Connect bottom of lock cylinder rod to lock cylinder lever. Connect power lock actuator rod, if so equipped.

8. Install cable grommet into slot in remote control frame. Lightly pull cable end fitting to remove free play (approximately 3mm [1/8 inch]). Insert fitting into retainer.

9. Lift up lightly on lower latch rod to remove free play (approximately 3mm [1/8 inch]). Insert threaded end into retainer.

10. Rotate upper and lower latch bolts into latched position. Check function of handles, lock rod, lock cylinder, etc.

11. **NOTE: If latches will not latch, cable or rod may have been pulled too far.**

    If all latches and switches operate properly, install watershield and trim panel.

Right Side Remote Control Assembly, Dual Rear Doors, Aerostar

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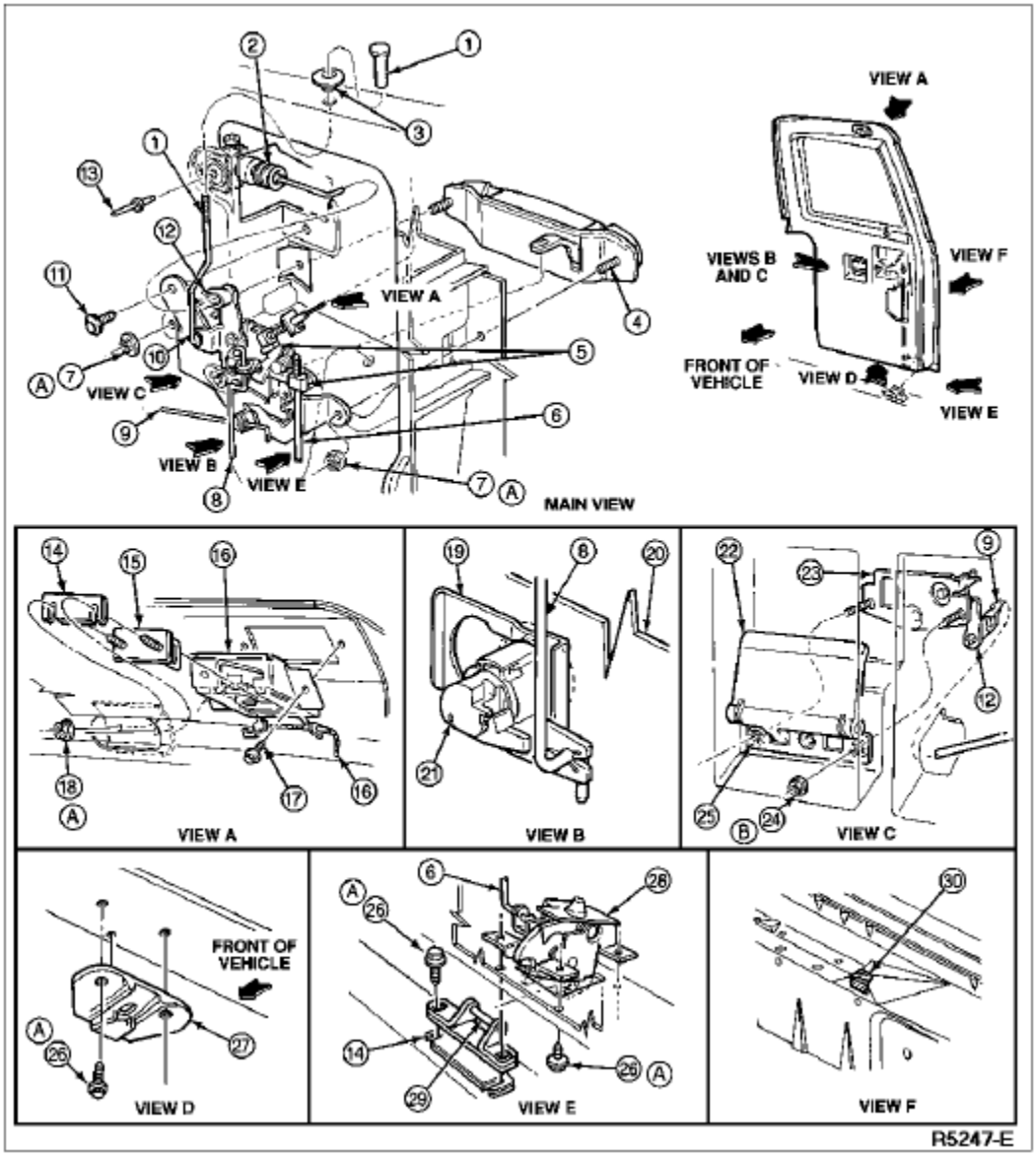

Item	Part Number	Description
1	431A46	Back Door Inside Rod
2	431A38	Lock Actuator Assembly
3	21999	Lock Rod Grommet
4	43400	Door Handle
5	219A36	Door Lock Rod Retainer Assembly
6	43298	Rear Door Lower Rod (RH)
7	N620480-S2	Nut (2 Req'd)
8	22134	Rear Door Latch Control to Cylinder
9	43136	Rear Door Latch Control Rod
10	431A42	Rear Door Latch Remote Control Assembly (RH)
11	388577-S	Pushpin

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12	389760-S	Clip (2 Req'd)
13	N802034-S	Rivet
14	44096	Door Striker Shim
15	43118	Rear Door Latch Upper Striker
16	43286	Back Door Upper Latch
17	N602728-S55	Screw (2 Req'd)
18	N621927-S36M	Nut and Washer (2 Req'd)
19	22023	Door Lock Cylinder Retainer
20	40010	Door Panel (RH)
	40011	Door Panel (LH)
21	22050	Door Lock Cylinder
22	22600	Inside Door Handle
23	21818	Front Door Latch Remote Control and Link
24	34653-S36	Nut and Washer (2 Req'd)
25	W623481-S2	Pushnut (2 Req'd)
26	N606676-S55	Bolt (8 Req'd)
27	40060	Rear Door Wedge and Plate Assembly
28	43288	Rear Door Lower Latch Assembly
29	43118	Rear Door Latch Lower Striker
30	11396	Shield
A	—	Tighten to 7-11 Nm (62-97 Lb-In)
B	—	Tighten to 1.7-2.3 Nm (11-20 Lb-In)

Dual Rear Door, Left Side, Aerostar

Removal

1. Remove trim panel and watershield. Refer to Section 01-05B .
2. Unclip lower latch rod and cable fitting from remote control assembly.
3. Remove three screws attaching remote control.
4. Partially remove remote control assembly from access hole to gain access to release rod assembly. Disengage and remove release rod.
5. Disengage cable grommet from forked flange in remote control assembly. Remove remote control assembly.

Installation

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1. Install retainer in remote control assembly.
2. Install cable grommet into slot in remote control base.
3. Position remote control assembly so release rod assembly can be installed into clip at end of lever.
4. Install three attaching screws.
5. Install lower latch rod into clip in remote control assembly.
6. Lightly pull slack out of cable (approximately 3mm [1/8 inch]) and install into retainer.
7. Check function of latches using release rod.
8. Install watershield and trim panel. Refer to Section 01-05B .

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Remote Control Assembly, Inside Handle

Dual Rear Doors, Aerostar

Removal and Installation

1. Remove two nuts and remove handle assembly.
2. Disengage rod from clip on inside remote control assembly by reaching through access hole below this area.
3. Remove pushnuts from studs to remote control, remove remote control.

For installation, follow removal procedures in reverse order.

Inside Handle and Remote Control Assembly, Dual Rear Doors, Aerostar

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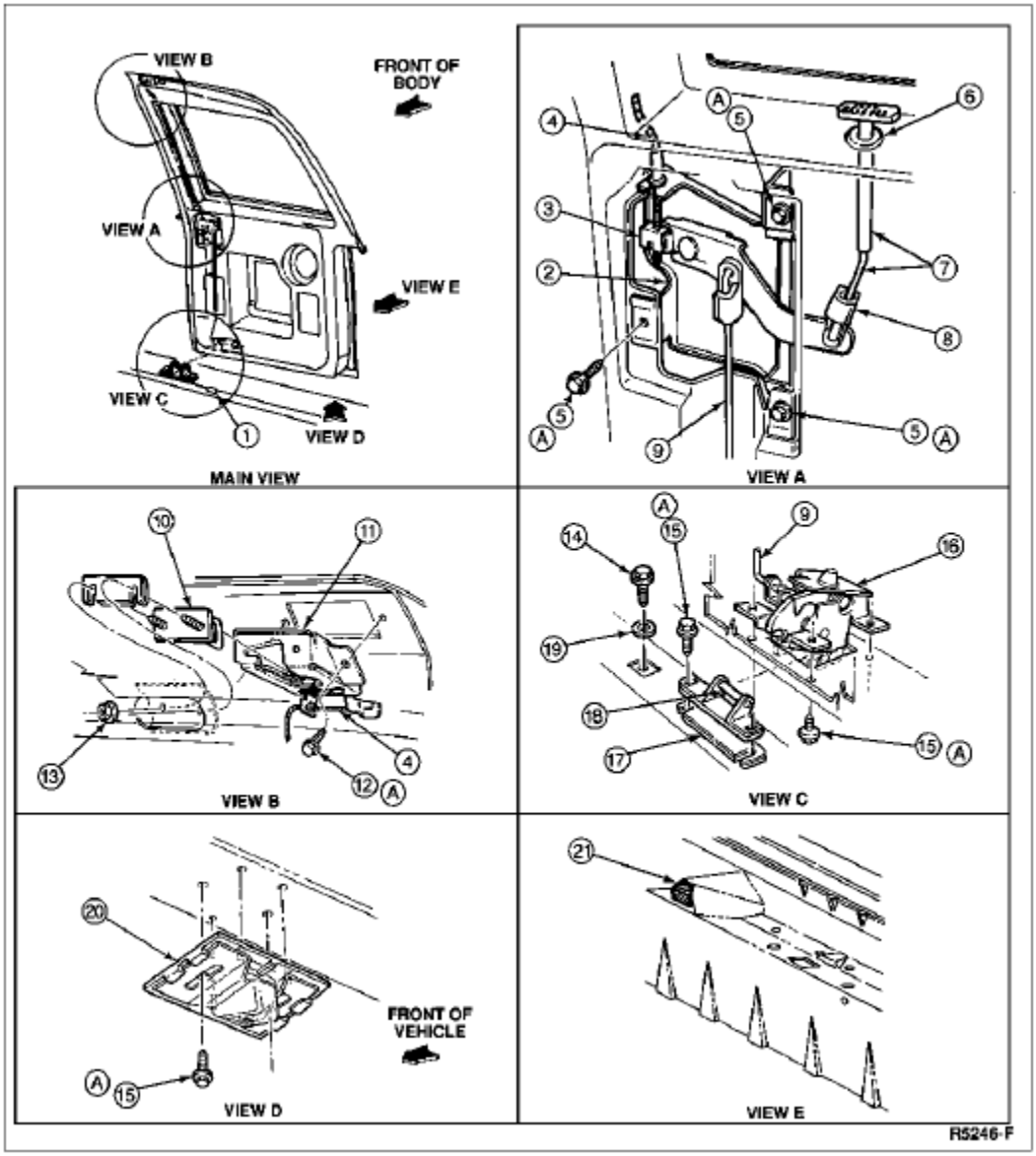

Item	Part Number	Description
1	11396	Shield
2	26404	Rear Door Latch Remote Control and Link
3	19A36	Door Latch Rod Retainer Assembly
4	31B43	Rear Door Upper Latch Release Cable Assembly
5	N605889-S36	Screw
6	21999	Door Latch Knob Grommet
7	431C02	Door Latch Control Rod Assembly
8	390522-S	Clip
9	43299	Rear Door Lower Latch Rod (Left Side)
10	4B147	Rear Door Latch Upper Striker (Left Side)
11	43287	Rear Door Upper Latch Assembly

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12	N602728-S55	Screw
13	N621927-S36M	Nut and Washer Assembly
14	N605918-S55	Bolt (to Fill Liftgate Striker Hole on Models with Dual Rear Doors)
15	N606676-S55	Bolt
16	43288	Rear Back Door Lower Latch Assembly
17	433A53	Back Door Latch Lower Striker Spacer
18	431L06	Back Door Latch Lower Striker
19	386659-S54B	Washer
20	40060	Rear Back Door Wedge and Plate Assembly
21	11396	Shield
A	—	Tighten to 7-11 Nm (62-97 Lb-In)

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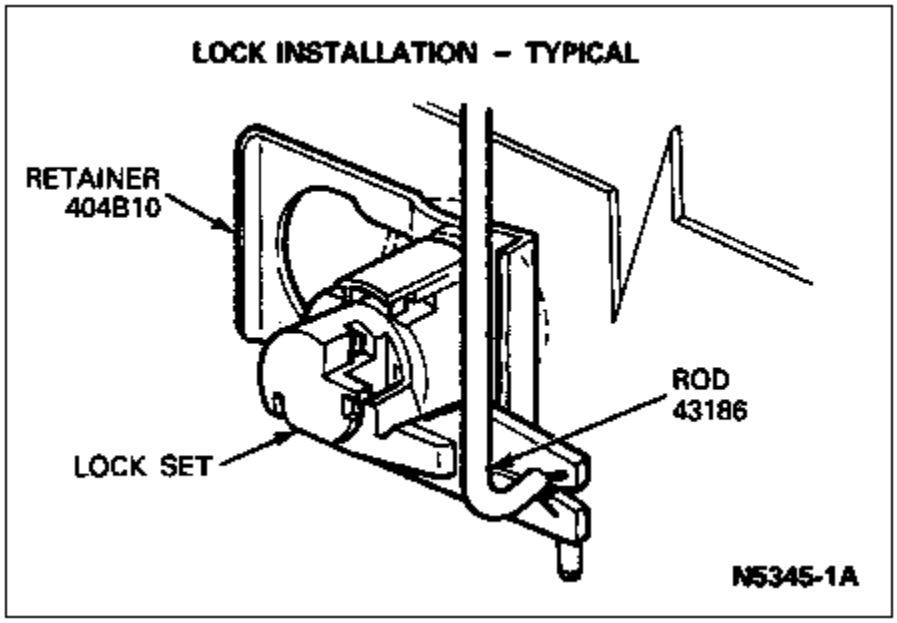
Lock Cylinder, Door

NOTE: When a lock cylinder is replaced, both door lock cylinders should be replaced in a set. This will eliminate carrying an extra key which will fit only one lock. If a key is to be replaced, the new key code number is stamped on a metal tag attached to the key.

NOTE: Individual lock cylinders are repaired by discarding the inoperative cylinder and building a new lock cylinder using the appropriate lock repair package. The lock repair package includes a detailed instruction sheet to build the new lock cylinder to the current key code to the vehicle.

Removal

1. Close window.
2. Remove the access hole cover and/or front door trim panel (23942) and pull away the watershield if so equipped. Refer to Section 01-05A or Section 01-05B .
3. Disconnect the front door latch control cylinder rod from the door lock cylinder retainer clip.



4. Slide the door lock cylinder retainer away from the lock cylinder.
5. If equipped with remote anti-theft personality (RAP) module, disconnect the RAP switch electrical connector.
6. Remove the lock cylinder.

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Installation

1. Insert the lock cylinder in the door and connect the lock cylinder retainer.
2. Connect the front door latch control cylinder rod to the door lock cylinder retainer.
3. Install the watershield. Using Gasket and Trim Adhesive D7AZ-19B508-B or equivalent adhesive meeting Ford specifications ESR-M11P17 or ESE-M2G52-A, cement the top and/or side edges of the watershield to the inner surface of the inner panel.
4. Install the access hole cover and/or front door trim panel.

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Lock Cylinder, Liftgate

Aerostar

Removal and Installation

NOTE: Individual lock cylinders are repaired by discarding the inoperative cylinder and building a new lock cylinder using the appropriate lock repair package. The lock repair package includes a detailed instruction sheet to build the new lock cylinder to the current key code to the vehicle.

Refer to the illustrations in this section following Liftgate, Aerostar in Removal and Installation.

1. Remove the liftgate latch as outlined.
2. Remove the liftgate lock cylinder retainer (with the lock-to-latch rod still attached) from the liftgate.

To install, reverse removal procedure.

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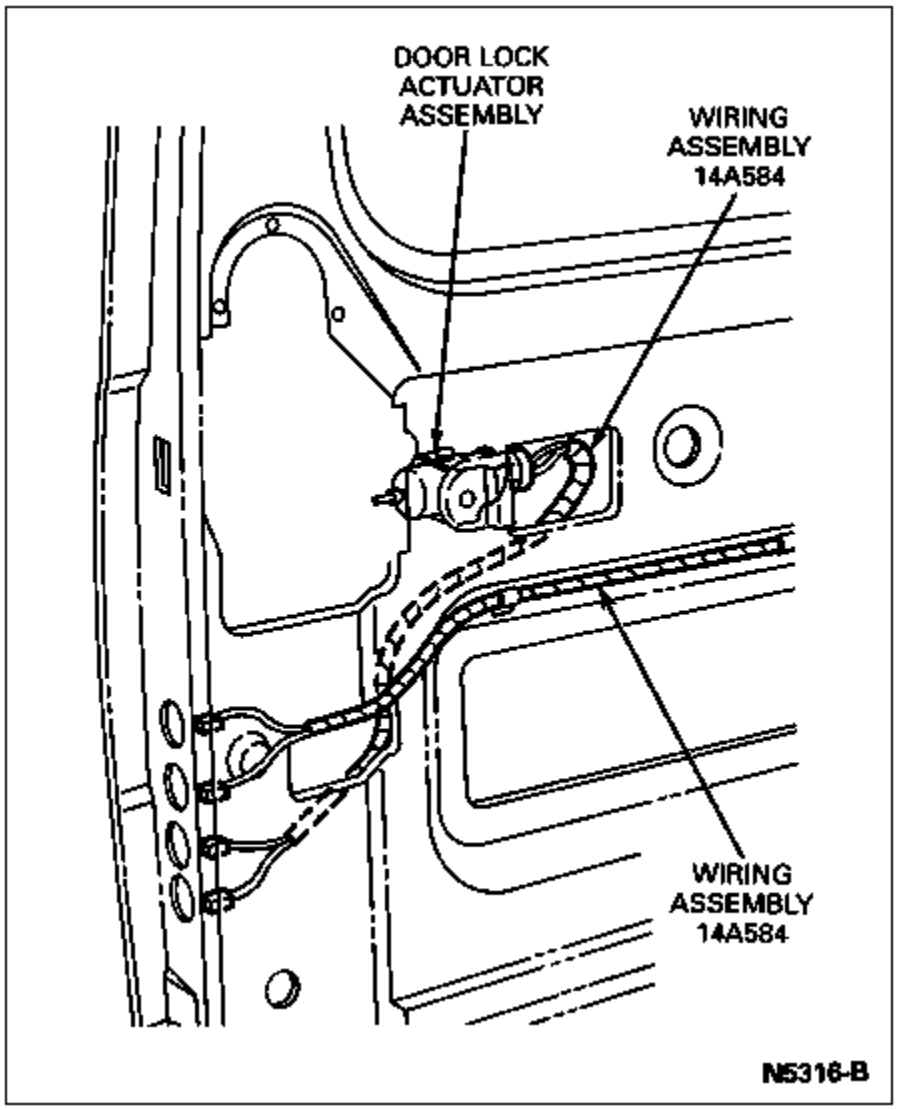
Actuator, Power Door Lock, Aerostar

Removal and Installation

1. Remove front door trim panel (23942). Refer to Section 01-05B .
2. Remove actuator motor and swivel bracket assembly from the door by drilling out the retaining pop rivet. Remove remote control.
3. Disconnect the door latch remote control link from the door latch.
4. Disconnect the wire harness plug at the motor connector.

For installation, follow removal procedures in reverse order. Old motor bracket must be replaced with new bracket which is supplied with replacement actuator motor assembly.



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Control Switch, Door Lock, Aerostar

Removal and Installation

1. Using a flat-bladed tool, carefully pry window regulator switch plate from switch housing.
2. Remove retaining nuts from front window regulator window at back of window regulator switch plate.
3. Using a thin-bladed screwdriver carefully pry door lock switch from front window regulator wiring.

For installation, follow the removal procedures in reverse order.

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Handle, Inside Door

Front and Rear

Removal

1. Remove front door trim panel and watershield. Refer to Section 01-05A or Section 01-05B .
2. Remove the inside door handle screws, nut and washer assemblies or rivet from the inside door handle and the front door frame.
3. Disconnect the door latch remote control link from the door latch assembly. Remove the inside door handle and the inside door latch remote control link.

For installation, follow removal procedures in reverse order. Install new rivets with Heavy Duty Riveter. Tighten Aerostar nut and washer assemblies to 1.7-2.3 Nm (1.2-1.7 lb-ft).

Body Side, Sliding, Aerostar

Removal and Installation

1. Remove screw from the sliding door handle.
2. Remove handle from latch assembly shaft.

For installation, follow removal procedures in reverse order. Tighten screw to 3.7-5.4 Nm (2.7-4 lb-ft).

Right Dual Rear, Aerostar

Removal and Installation

1. Remove rear door trim panel and watershield. Refer to Section 01-05B .
2. Disconnect the rear door latch remote control link from the inside door handle.
3. Remove two nut and washer assemblies from the handle and remote control assemblies. Remove the handle and remote control assemblies.

For installation, follow removal procedures in reverse order. Tighten nut and washer assemblies to 1.7-2.3 Nm (1.2-1.7 lb-ft).

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Handle, Outside Door

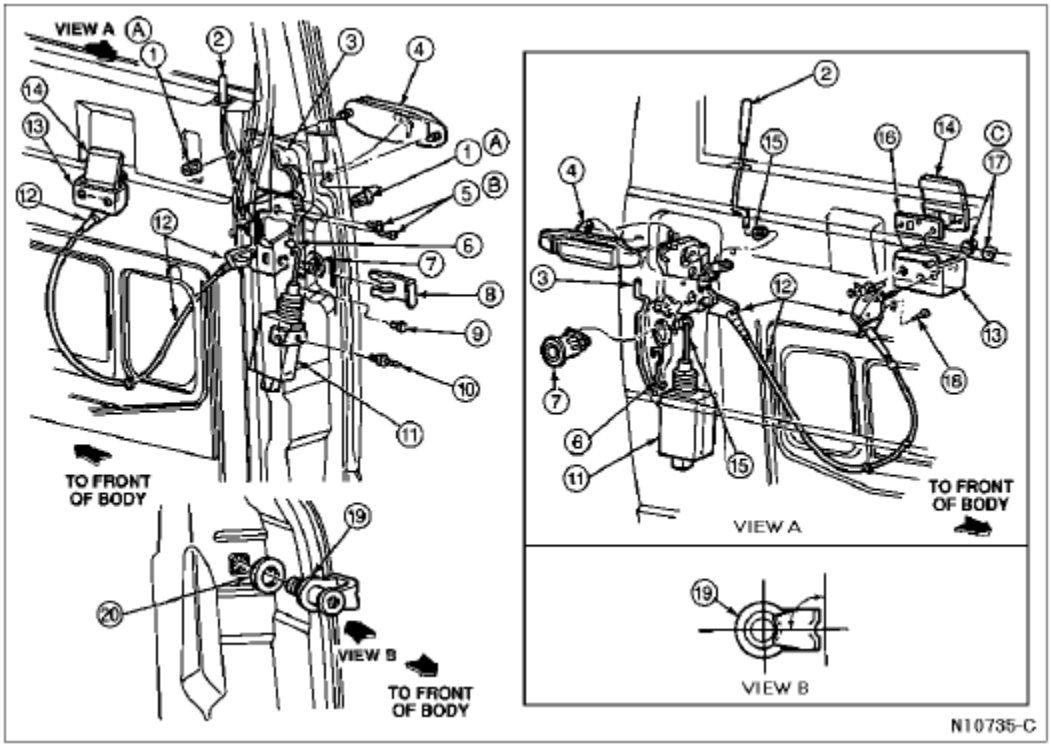
Front Doors, Aerostar

Removal and Installation

1. Remove the front door trim panel and watershield.
2. Disconnect the front door latch actuating rod from the front door latch.
3. Remove the two nuts retaining door handle.

For installation, follow removal procedures in reverse order.

Door Latch and Handle Installation, Aerostar



Item	Part Number	Description
1	N804534-S39	Nut (2 Req'd Each Handle)
2	21852	Front Door Latch Push Button Rod
3	22152	Front Door Latch Actuating Rod

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4	22404	Door Handle
5	N805653-S100	Screw (2 Req'd Each Side)
6	22134	Front Door Latch Control Cylinder Rod
7	22050	Door Lock Cylinder
8	22023	Door Lock Cylinder Retainer
9	N805654-S100	Screw and Washer
10	388047-S101	Rivet
11	218A42	Door Latch Actuator
12	21812	Front Door Latch
13	22634	Inside Door Handle Cup
14	22600	Inside Door Handle
15	386656-S	Bushing (2 Req'd Each Side)
16	22608	Spacer, Door Inside Handle
17	34653-36S	Nut and Washer (2 Req'd Each Side)
18	N611172-S2	Screw
19	22008	Door Latch Striker Plate
20	N801054-S100	Washer
A	—	Tighten to 7-11 Nm (62-97 Lb-In)
B	—	Tighten to 4-8 Nm (36-70 Lb-In)
C	—	Tighten to 1.7-2.3 Nm (11-20 Lb-In)

Front Doors, Ranger

Removal and Installation

1. Remove the access hole cover and/or trim panel and pull away the watershield, if equipped. Refer to Section 01-05A .
2. Disconnect door latch actuator rod from latch.
3. Block handle open.
4. Drill out the two rivets securing outside door handle to door.

For installation, follow removal procedures in reverse order.

Outside Handle

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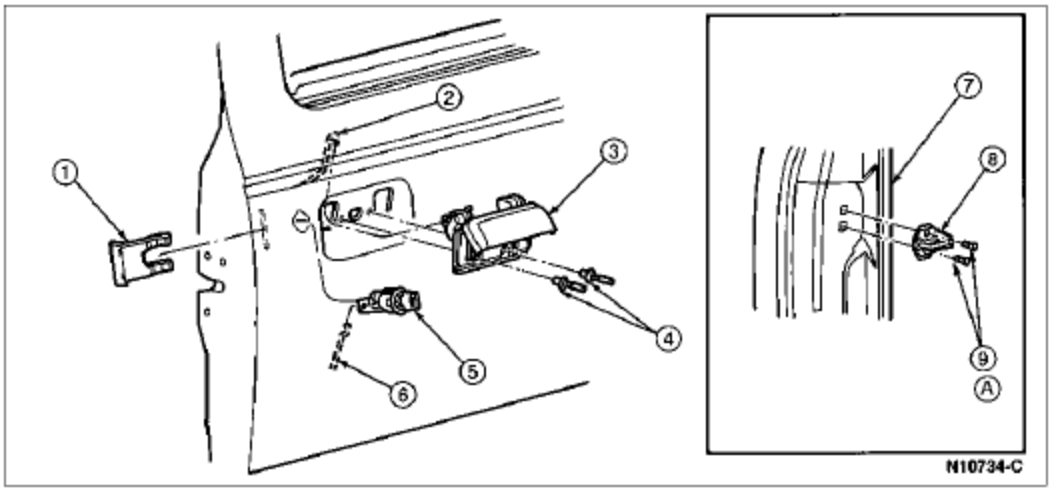

Item	Part Number	Description
1	22023	Door Lock Cylinder Retainer
2	22152	Door Latch Control Rod Knob
3	22404	Door Handle
4	388047-S	Rivet (2 Req'd Each Side)
5	22050	Door Lock Cylinder
6	22134	Front Door Latch Control Cylinder Rod
7	24300	Center Body Pillar
8	22008	Striker Assembly, Door Latch
9	N806680-S100	Screw (2 Req'd Each Side)
A	—	Tighten to 22-28 Nm (17-28 Lb-Ft)

Body Side, Sliding, Aerostar

Removal and Installation

1. Remove the access hole cover and/or trim panel and pull away the watershield, if so equipped. Refer to Section 01-05B .
2. Disconnect door latch actuator rod from latch.
3. Remove two nuts retaining handle.

For installation, follow removal procedures in reverse order.

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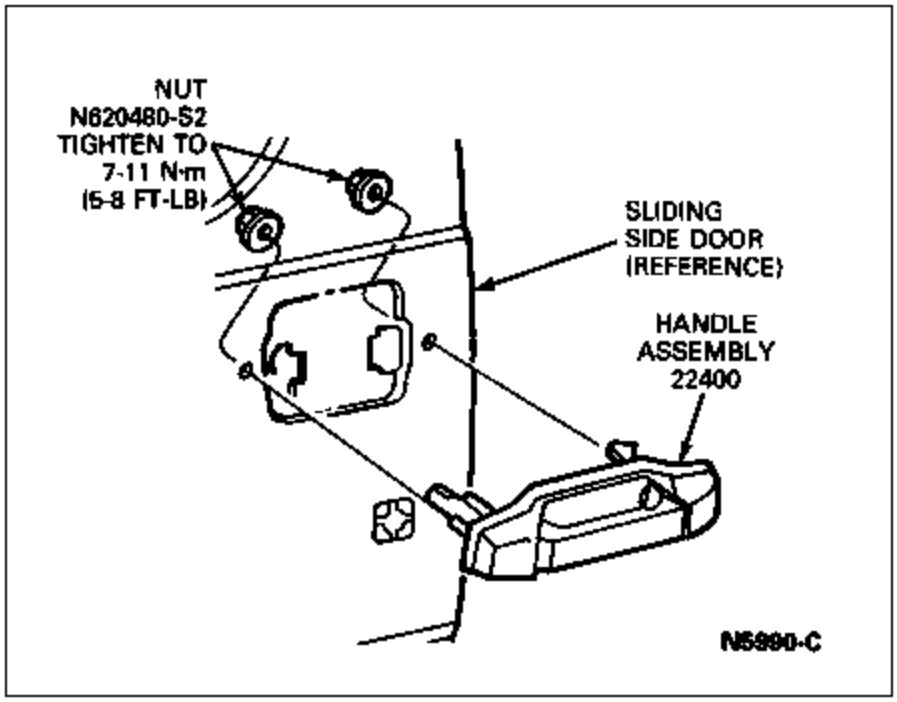

Dual Rear, Aerostar

Removal and Installation

1. Remove trim panel and watershield. Refer to Section 01-05B .
2. Remove retaining nuts.
3. Remove and replace outside handle.
4. Install retaining nuts.
5. Install watershield and trim panel. Refer to Section 01-05B .

Liftgate, Aerostar

Removal

1. Remove liftgate door trim panel and liftgate handle, if equipped.
2. Disconnect liftgate latch release rod from latch control assembly and remove from liftgate handle.
3. Tape or otherwise protect area of liftgate around liftgate handle to prevent paint damage.
4. Prop open liftgate handle (use wood props).
5. Remove two rivets attaching liftgate handle to liftgate. Use a drift punch to knock out center pin. Drill

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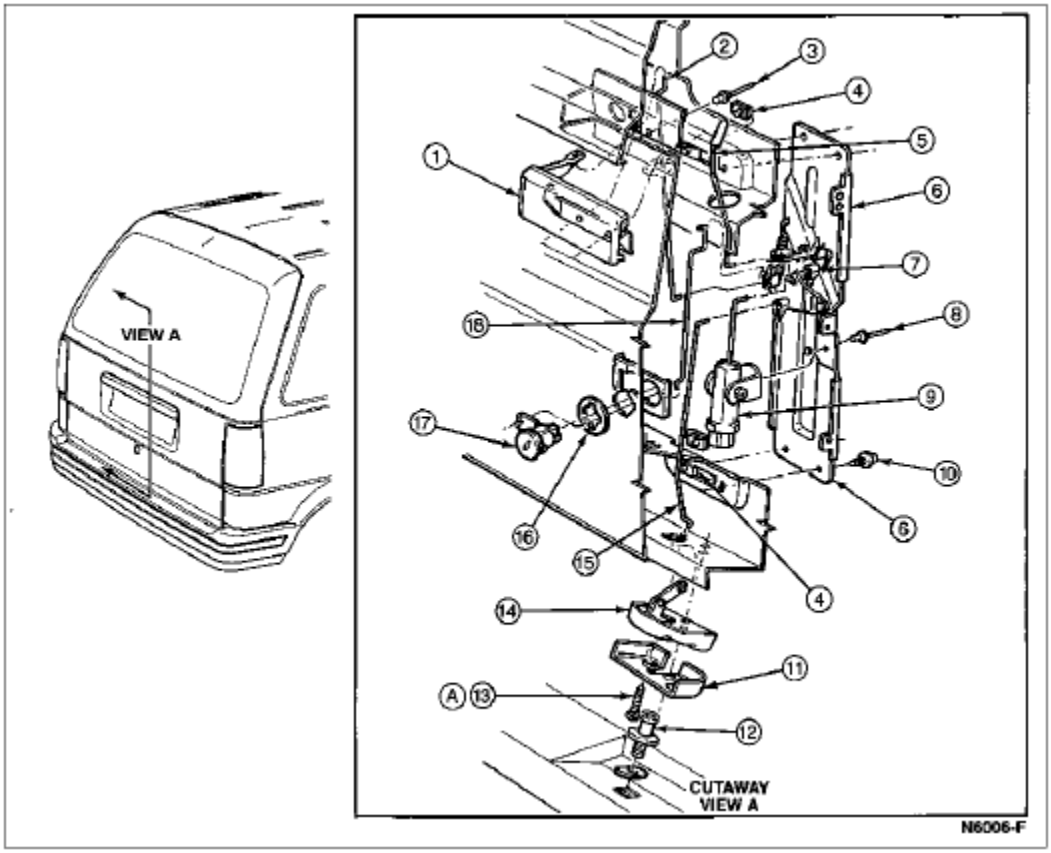
out remainder of rivet.

6. Remove prop and pull liftgate handle out of hole in liftgate.

Installation

1. Install liftgate handle, without control rod, into liftgate.
2. Prop open liftgate handle and install two rivets to attach liftgate handle.
3. Install control rod to liftgate handle, then install bottom of rod to latch control assembly.
4. Open and close liftgate to check operation.

Liftgate Outside Handle, Aerostar



Item	Part Number	Description
1	43400	Liftgate Handle
2	43329	Liftgate Latch Release Rod
3	390134-S100	Rivet (2 Req'd)
4	N802331-S100	U-Nut (4 Req'd)

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5	431A32	Latch Push Button Rod
6	43170	Tailgate Latch Remote Control
7	390523-S	Clip
8	372820-S36	Rivet
9	431A38	Door Latch Actuator Assembly
10	N605891-S40	Bolt (4 Req'd)
11	43243	Luggage Compartment Door Lock Mechanism Cover
12	404B12	Liftgate Latch Striker Assembly
13	N804353-S100	Screw (3 Req'd)
14	43150	Liftgate Latch Assembly
15	43298	Liftgate Latch Actuator Rod
16	43625	Pad
17	22050	Lock Cylinder
18	43876	Liftgate Lock Cylinder to Release Rod
A	—	Tighten to 9-14 Nm (7-10 Lb-Ft)

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Latch and Release Cable, Fuel Filler Door, Aerostar

Removal and Installation

1. **NOTE: In the event the remote release handle, fuel filler door latch handle, or latch assembly cable breaks, the fuel filler door can be released with the manual override fuel filler door latch handle located in the left rear floor stowage area on the floor for the extended model and in the left rear pillar area for the standard models.**

   To service the fuel filler door latch handle located on the lower B-pillar area adjacent to the driver side seat, remove the 4mm screw holding the handle in place. Refer to Section 01-05B .

2. Remove the screw holding the fuel filler door latch handle in place. After the fuel filler door latch handle is removed from the panel, remove the cable end fitting from the fuel filler door latch handle housing and disengage the wire strand ferrule from the fuel filler door latch handle.

3. If the latch assembly cable has to be serviced, remove the left interior trim panels as required, refer to Section 01-05B , the associated seat belt hardware (refer to Section 01-20A) and the rear seats (refer to Section 01-10).

4. Open the fuel filler door and disconnect the U-shaped fuel filler door assist spring by loosening the two nuts. Slide the spring out and disengage the ferrule ball from the keyway slot in the spring.

5. Remove the nut holding the fuel filler door latch to the housing.

6. From inside the vehicle pull the fuel filler door latch end away from the housing and remove the rest of the cable from the routed position.

7. Disconnect the clips holding the override fuel filler door latch handle in place and remove the latch assembly cable from the vehicle.

For installation, follow removal procedures in reverse order. Tighten all fasteners to specifications.

Latch and Release Cable Fuel Filler Door, Aerostar

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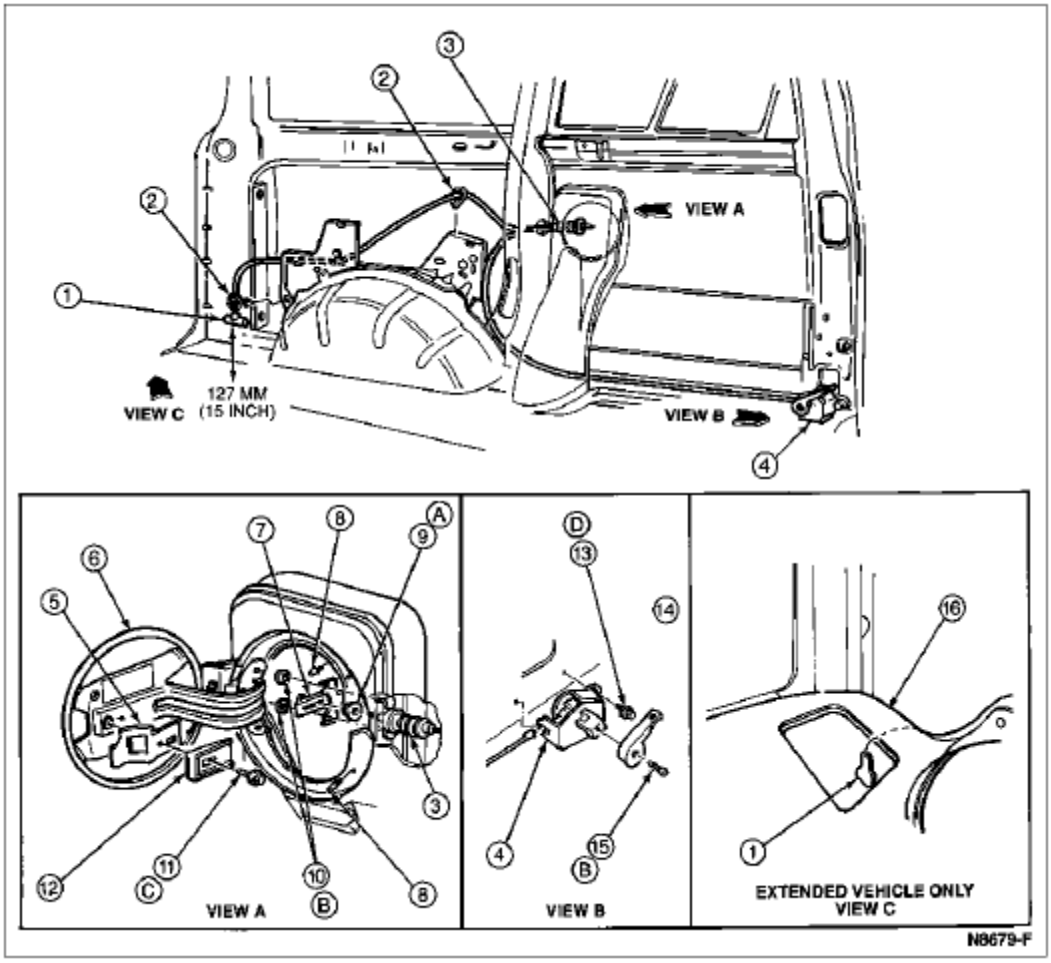

Item	Part Number	Description
1	—	Override Release Cable (Part of 28610)
2	382930-S	Clip (2 Req'd)
3	28610	Fuel Filler Door Latch
4	28616	Fuel Filler Door Latch Handle
5	282A42	Spring, Fuel Filler Door Assist
6	405A26	Fuel Door
7	405C18	Fuel Filler Door Assist Spring
8	N804462-S	Bumper (2 Req'd)
9	N620042-S36	Nut
10	N621900-S36M	Nut and Washer Assembly
11	N805062-S55	Screw and Washer Assembly
12	28608	Retainer, Fuel Filler Door
13	N610957-S2	Screw
14	40505	Handle, Fuel Filler Door
15	N604133-S2	Screw

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16	13000	Floor Carpet
A	—	Tighten to 4.0-5.6 Nm (36-49 Lb-In)
B	—	Tighten to 2.3-3.3 Nm (21-28 Lb-In)
C	—	Tighten to 1.8-2.6 Nm (16-23 Lb-In)
D	—	Tighten to 3.4-4.8 Nm (31-42 Lb-In)

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Actuator, Liftgate Lock, Power, Aerostar

Removal and Installation

1. Remove the liftgate door trim panel and watershield. Refer to Section 01-05A .
2. Disconnect the liftgate power lock actuator electrical connector.
3. Disconnect power actuator rod from the tailgate latch remote control (43170).
4. Drill out the rivet attaching the liftgate power lock actuator to the liftgate. Remove the liftgate power lock actuator.

For installation, follow removal procedures in reverse order. Install new rivets with Heavy Duty Riveter.

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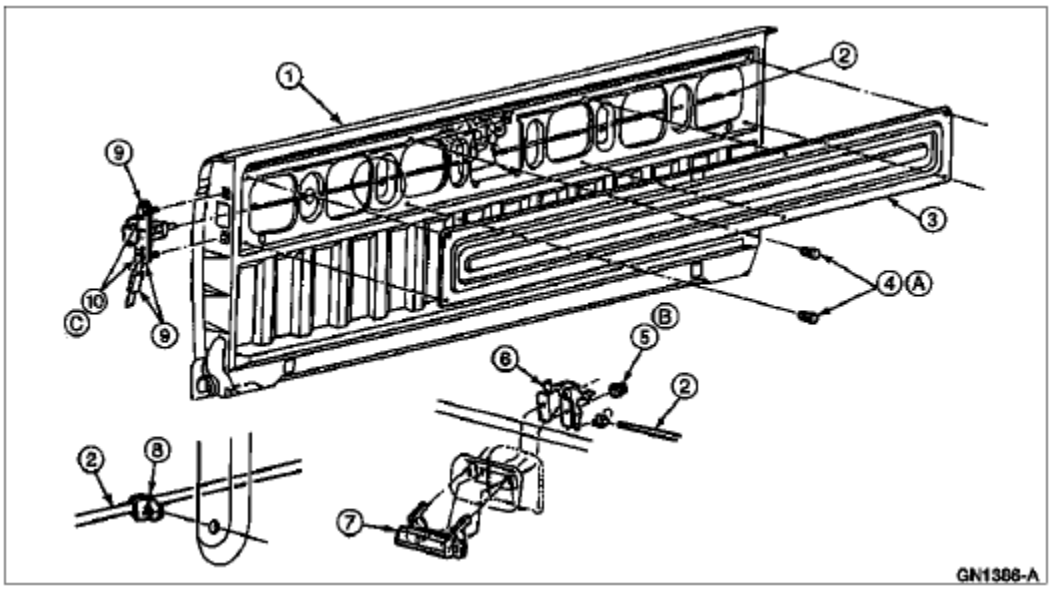
Handle and Control Assembly, Tailgate, Ranger

Removal and Installation

1. Open the tailgate and disconnect from upper support pin.
2. Remove screws from access cover. Remove cover.
3. Remove nuts and disconnect tailgate latch release links from tailgate latch remote control to remove tailgate latch release handle and tailgate latch remote control.
4. Remove clips from each side.
5. Remove two screws attaching tailgate latch. Remove tailgate latch from tailgate.

For installation, follow removal procedures in reverse order. Tighten nuts to remote control assembly and tailgate handle assembly to 10.2-13.8 Nm (91-122 lb-in). Tighten screws for access cover to 4.5-6.3 Nm (40-55 lb-in). Tighten screws for tailgate latch to 25.5-34.5 Nm (19-25 lb-ft). Adjust striker if necessary as described in this section.

Handle and Control Assembly, Tailgate, Ranger



Item	Part Number	Description
1	40700	Tailgate Assembly
2	431A78	Latch Release Link
3	43121	Cover

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4	N806149-S36	Screw (8 Req'd)
5	N620480-S36	Nut (2 Req'd)
6	43170	Tailgate Latch Remote Control
7	43400	Tailgate Latch Release Handle
8	382929-S	Clip
9	43150	Tailgate Latch
10	N806910-S100	Screw (2 Req'd Each Side)
A	—	Tighten to 4.5-6.3 Nm (40-55 Lb-In)
B	—	Tighten to 10.2-13.8 Nm (91-122 Lb-In)
C	—	Tighten to 25.5-34.5 Nm (19-25 Lb-Ft)

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Release Control Assembly, Tailgate

Removal

1. Remove tailgate inside panel cover retaining screws. Remove panel.
2. Disconnect two tailgate latch release links from tailgate latch remote control (43170).
3. If removing handle and tailgate latch remote control, remove two nut and washer assemblies from tailgate assembly.
4. Remove screws attaching tailgate latch.
5. Remove by sliding out link of tailgate.

Installation

1. **NOTE: Prior to installation, take out the slack in links and latches by pulling link to center of tailgate. Close plastic clip over closet thread of link.**

   Remove link from tailgate latch assembly.

   For installation, follow removal procedures in reverse order.

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Striker, Door Latch

Front Doors, All Vehicles

CAUTION: Do not cover up a poor door alignment with a latch striker adjustment.

NOTE: Use Torx® Drive Bit Set where required to loosen or tighten striker.

The striker pin can be adjusted laterally and vertically as well as fore and aft. The latch striker should be shimmed to obtain clearance between the latch striker and the latch. To check this clearance, perform the following steps:

1. Clean the latch jaws and the striker area.
2. Apply a thin layer of dark grease such as Premium Long-Life Grease XG-1-C or -K or equivalent meeting Ford specification ESA-M1C75-B to the latch striker.
3. As the door is closed and opened, a measurable, visual pattern will result.
4. **CAUTION: Do not use more than one shim per door.**

   Move the striker assembly laterally to provide a flush fit with the door and body.
5. Tighten the striker to 33-45 Nm (24-33 lb-ft).

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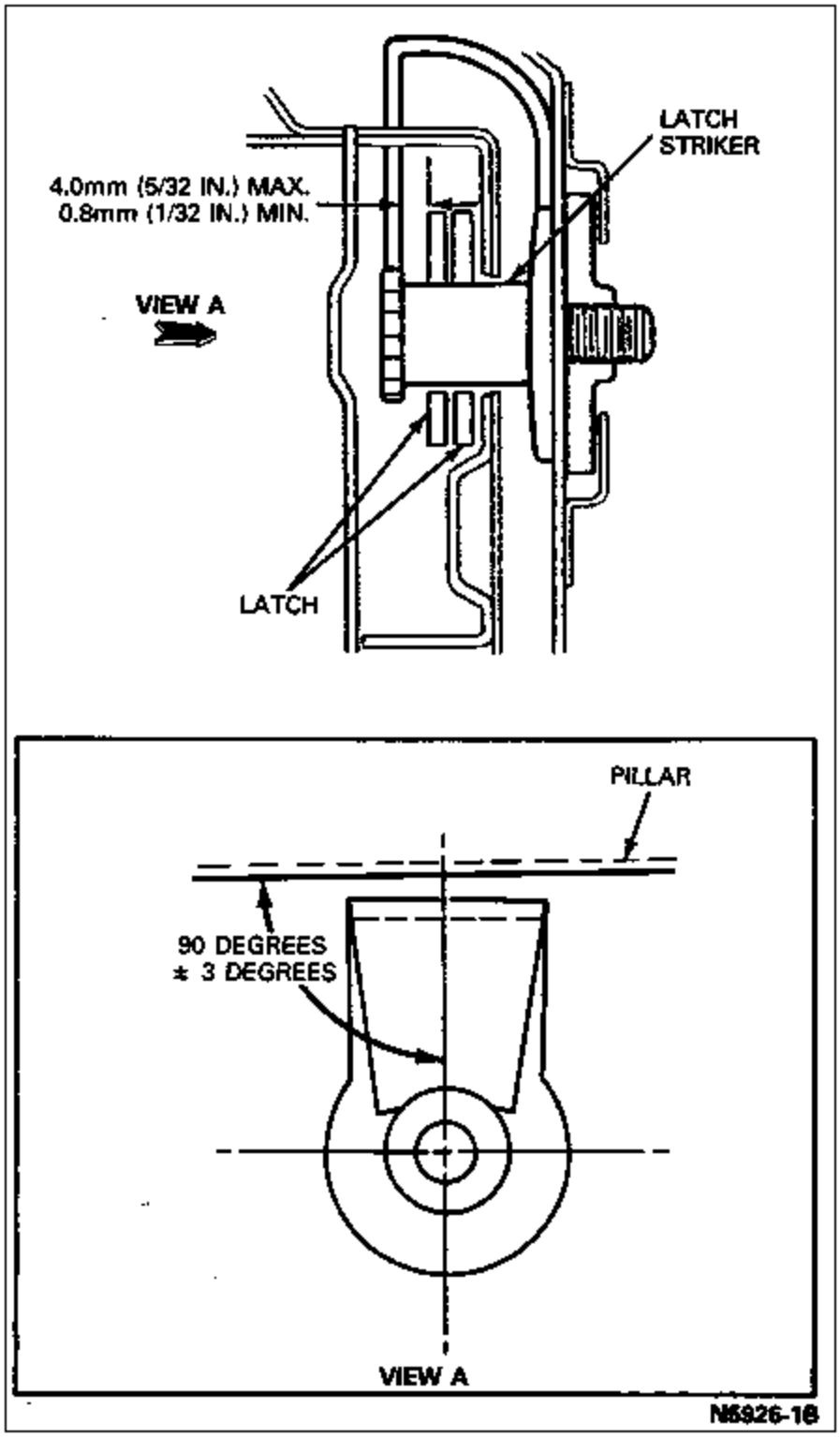

Body Side, Sliding, Aerostar

CAUTION: Striker adjusts in or out only. Up and down adjustment is obtained only with rear

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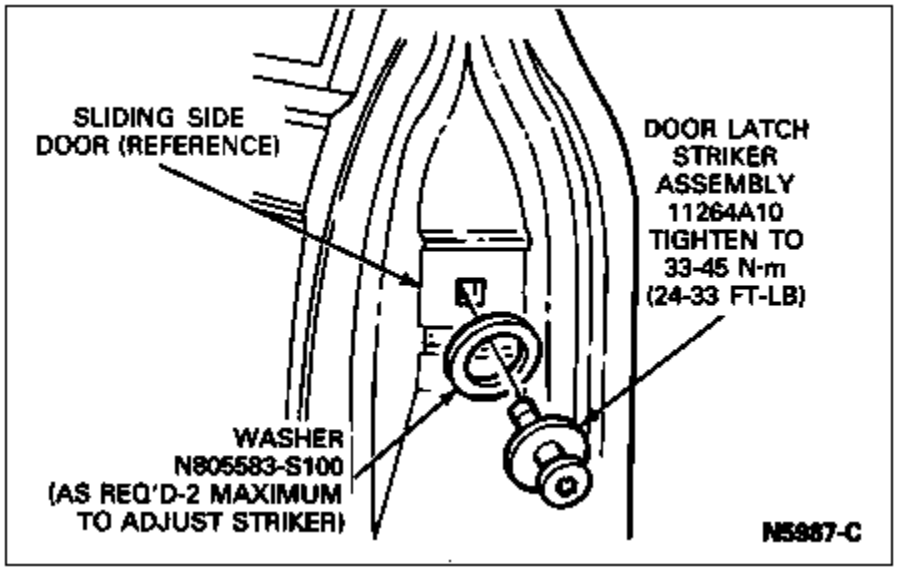
hinge, providing the rear hinge does not bind striker latch setting.

The sliding door latch is located at the rear of the door. When the door is closed, the latch engages the striker which positions the rear of the door to the body. Adjusting the striker in or out will position the rear edge of the sliding door as required to obtain the proper fit to the body.

Positioning the front edge of the door to the body, adjust the lower front guide and wedge striker.



Dual Rear Doors, Aerostar

Upper Striker

NOTE: Use an M-11 socket to loosen or tighten the nut and washer assemblies that attach the upper striker assemblies.

The strikers can be adjusted laterally and vertically, and shimmed fore and aft. Do not use more than four shims. To adjust striker, loosen attaching nuts so that striker can be moved around by hand. Close door firmly (thereby moving striker into proper position) and tighten retaining nuts.

NOTE: After adjusting either upper door striker, both the right and left wedge, and plate assemblies must be adjusted.

1. Open doors and remove both wedge assemblies.
2. Push wedge fully forward in plate.
3. Loosely assemble to door bottom.
4. Shut left door firmly to set wedge.
5. Open door and tighten retaining screws.

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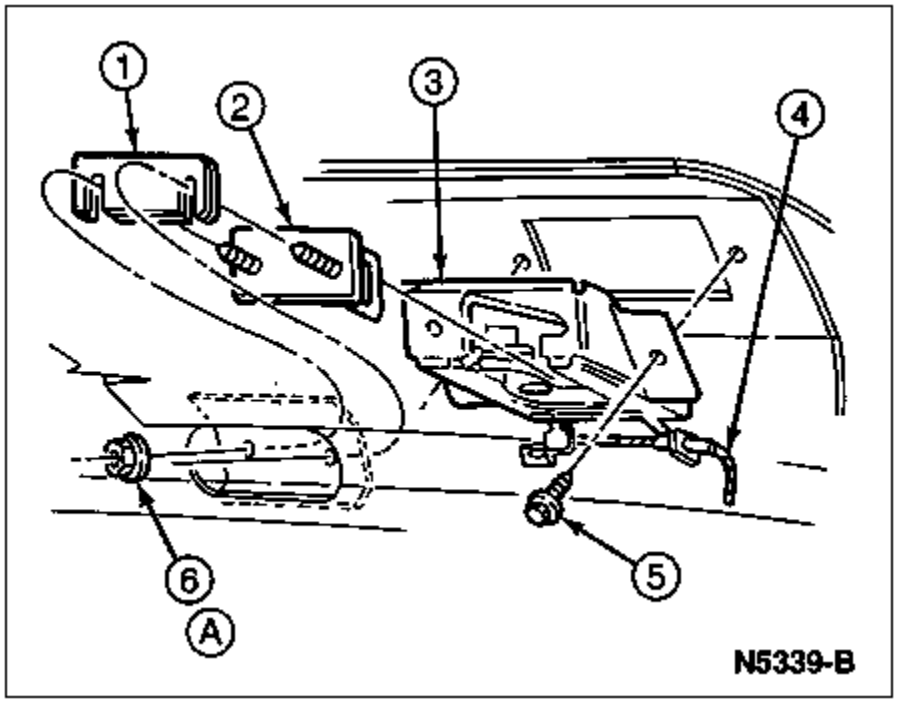
6. Repeat for right door.



Item	Part Number	Description
1	44096	Door Striker Shim
2	43118	Rear Door Latch Upper Striker (Left Side)
3	43287	Back Door Upper Latch
4	431B42	Back Door Upper Latch Release Cable Assembly
5	N602728-S55	Screw (2 Req'd)
6	N621927-S36M	Nut and Washer
A	—	Tighten to 7-11 Nm (5-8 Lb-Ft)

Lower Striker

NOTE: Use M-8 socket to loosen or tighten striker bolts.

NOTE: After adjusting either lower striker, both the right and left wedge and plate assemblies must be adjusted. Follow same procedure as above for upper door striker.

The strikers can be adjusted fore and aft, and shimmed vertically. The latch striker should not be adjusted to correct door sag. The latch striker should be shimmed to achieve correct clearance between latch striker and latch. To check this clearance, close one door at a time and observe the alignment as the latch engages the striker. Move the striker assembly fore and aft to provide a flush fit at the door and the body. **Do not use more than four shims.**

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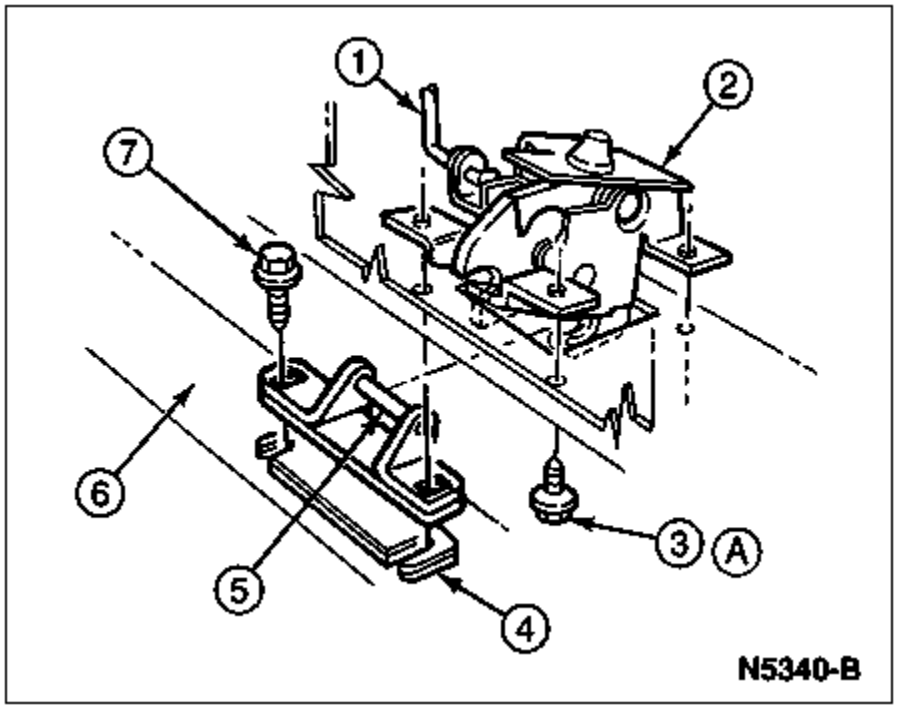

Item	Part Number	Description
1	43298	Rear Door Latch Rod
2	43288	Back Door Lower Latch Assembly
3	N606676-S55	Bolt (4 Req'd)
4	44096	Door Striker Shim
5	43118	Back Door Lower Latch
6	—	Body Panel
7	N605892-S36	Bolt (2 Req'd)
A	—	Tighten to 7-11 Nm (5-8 Lb-Ft)

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Striker, Liftgate, Aerostar

1. Loosen striker screws.
2. The liftgate striker assembly can be moved 4.0mm (1/6 inch). Adjust the striker radially, up, down, fore and aft so that the liftgate is flush.
3. Tighten the striker screws to 33-44 Nm (24-32 lb-ft).

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SPECIFICATIONS

Lock Repair/Replacement Specifications

Part Number	Lock Repair Package Name
F85Z-11582-AA	Ignition Lock Cylinder Kit
F87Z-151990-BA	Door Lock Cylinder Kit
F8DZ-5406082-AA	Glovebox Lock Cylinder Kit (Aerostar Only)
F87Z-7821990-BA	Sliding Door Lock Cylinder Kit (Aerostar Only)
F87Z-7821990-BA	Liftgate Lock Cylinder Kit (Aerostar Only)
F8DZ-5421970-AA	Lock Lever Kit

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Nut, Outside Front Door Handle, Aerostar	7-11	—	62-97
Screw, Front Door Latch Assembly, Aerostar	4-8	—	36-70
Nut and Washer, Inside Front Door Handle, Aerostar	1.7-2.3	—	11-20
Screw, Front Door Latch Assembly, Ranger	8-12	—	71-106
Screw, Liftgate Latch, Aerostar	9-14	7-10	—
Bolt, Sliding Door Latch Assembly, Aerostar	9-14	6-10	—
Nut and Washer, Back Door Upper Striker, Aerostar	7-11	5-8	—
Screw, Back Door Lower Latch, Aerostar	7-11	5-8	—
Nut and Washer, Dual Rear Doors, Aerostar	7-11	5-8	—
Screw, Dual Rear Doors, Aerostar	7-11	5-8	—
Nut and Washer, Dual Rear Doors Inside Handle, Aerostar	1.7-2.3	—	11-20
Nut, Outside Door Handle, Aerostar	7-11	—	62-97
Screw, Front Door Latch Assembly, Aerostar	4-8	—	36-70
Nut and Washer, Front Door Inside Handle, Aerostar	1.7-2.3	—	11-20
Screw, Liftgate Latch Assembly, Aerostar	9-14	7-10	—
Nut, Fuel Filler Door, Aerostar	4.0-5.6	—	36-49
Nut and Washer, Fuel Filler Door, Aerostar	2.3-3.3	—	21-28
Screw and Washer, Fuel Filler Door, Aerostar	1.8-2.6	—	16-23
Screw, Fuel Filler Door, Aerostar	3.4-4.8	—	31-32

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Screw, Tailgate Cover Plate, Ranger	4.5-6.3	—	40-55
Nut, Tailgate Remote Control Latch, Ranger	10.2-13.8	—	91-122
Screw, Tailgate Latch, Ranger	25.5-34.5	19-25	—
Screw, Tailgate Striker Assembly, Ranger	26-34	20-25	—
Screw, Liftgate Handle	4-8	—	36-70
Nut, Outside Door Handle, Aerostar	1.7-2.3	—	11-20
Screw, Striker Assembly, Ranger	22-28	—	17-28

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SPECIAL SERVICE TOOLS/EQUIPMENT

SPECIAL SERVICE TOOLS DESIRED

Tool Number	Description
D79P-2100-T	Torx® Drive Bit Set
D80L-23200-A	Heavy-Duty Riveter

ROTUNDA EQUIPMENT

Model	Description
014-00407	Digital Volt-Ohmmeter

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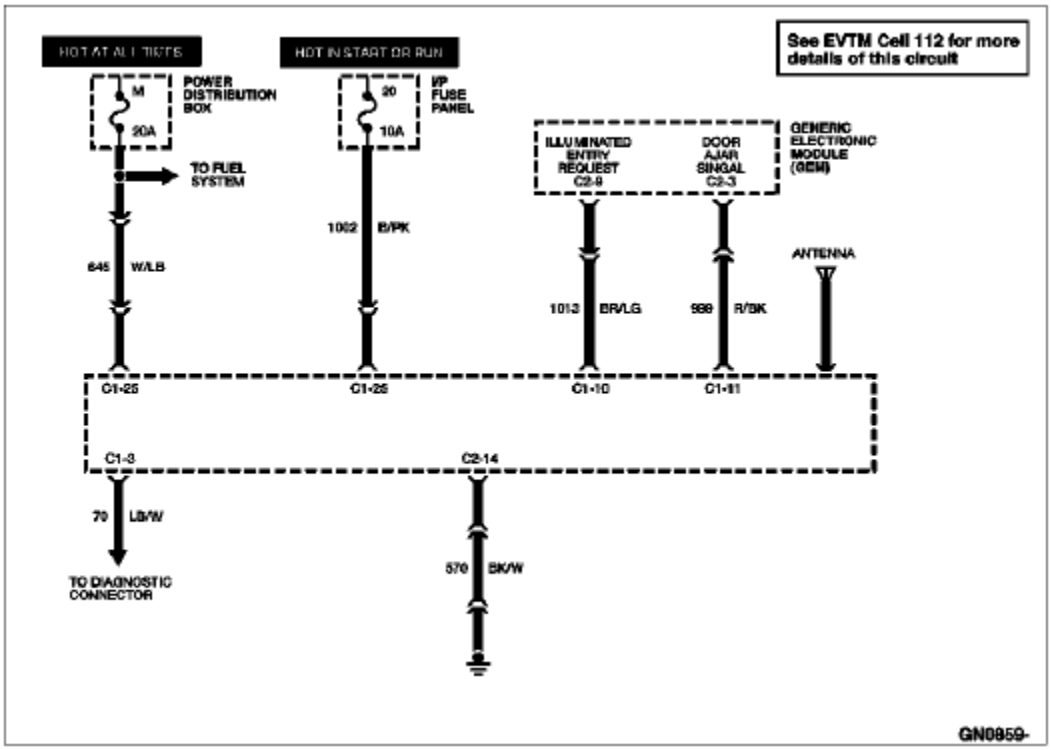
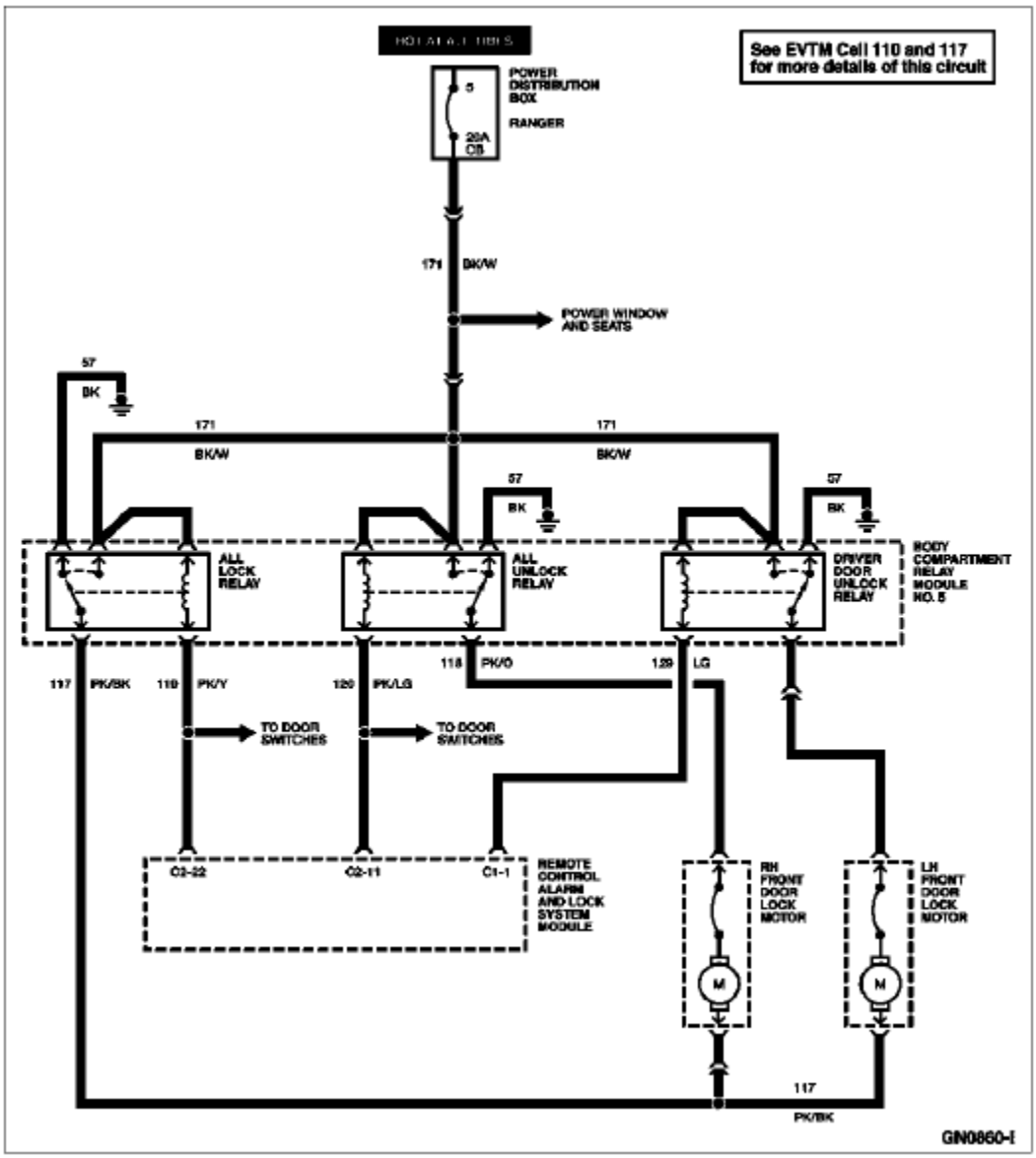
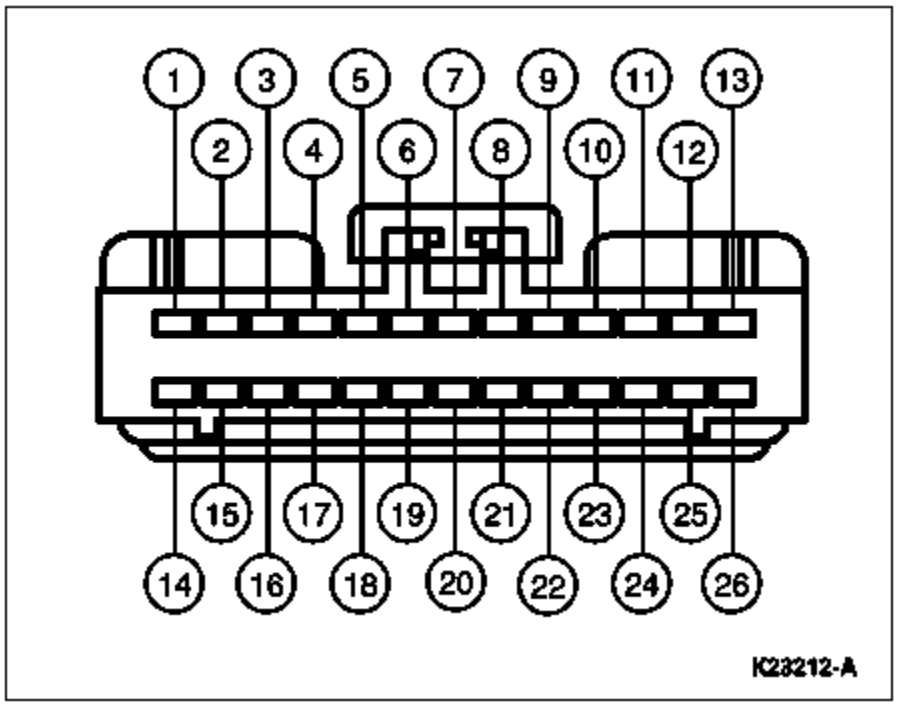
Electrical Schematics

Remote Control Alarm and Door Lock System Module — Door Lock CIrcuits





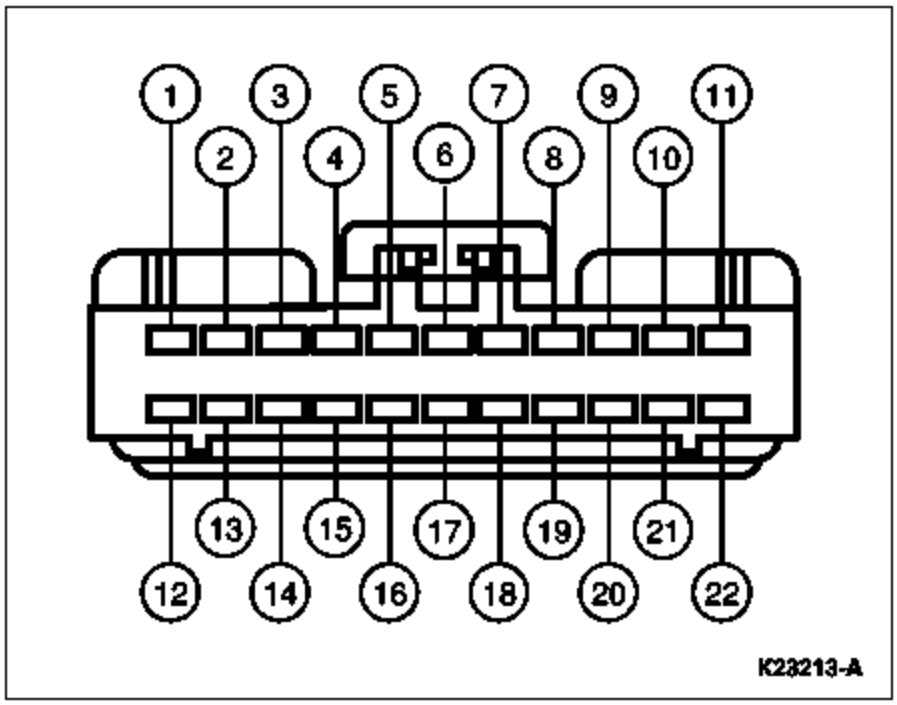
Receiver Assembly Connector 1



Pin Number	Circuit	Circuit Function
1	129 (LG)	Driver's Door Unlock Relay
2	—	Not Used
3	70 (LB/W)	Diagnostic Serial Link
4	—	Not Used
5	—	Not Used
6	—	Not Used
7	—	Not Used
8	—	Not Used
9	25 (DG/P)	Door Disarm Switches — from GEM
10	—	Not Used
11	999 (R/BK)	GEM Module Input to RAP Door Ajar
12	—	Not Used
13	—	Not Used
14	—	Not Used
15	—	Not Used
16	—	Not Used
17	936 (DG/W)	Ignition Key Lock Cylinder Tamper Sensor
18	—	Not Used
19	—	Not Used
20	—	Not Used

21	—	Not Used
22	—	Not Used
23	23 (T/LG)	Hood Switch
24	—	Not Used
25	1002 (BK/PK)	Ignition Switch Feed
26	—	Not Used

Receiver Assembly Connector 2

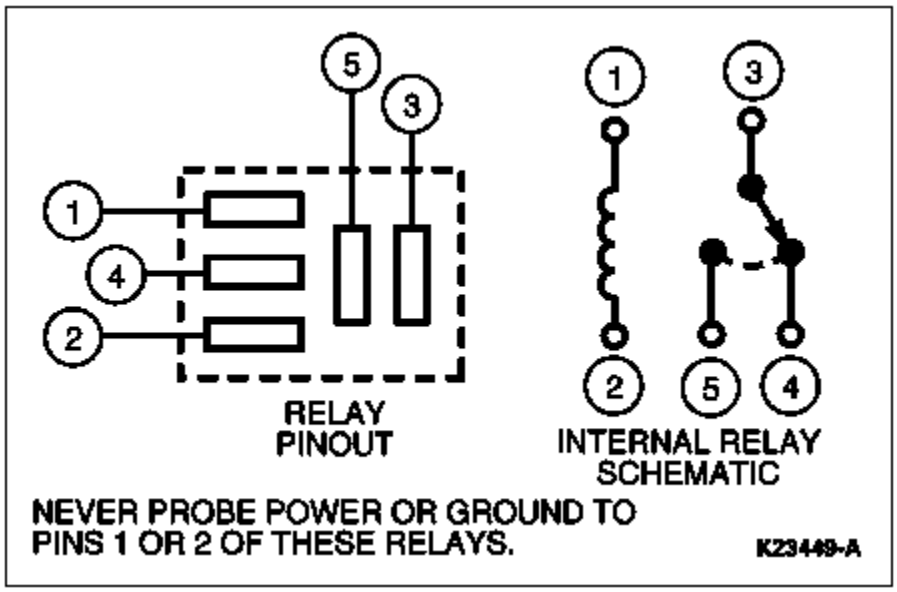


Pin Number	Circuit	Circuit Function
1	—	Not Used
2	—	Not Used
3	—	Not Used
4	—	Not Used
5	—	Not Used
6	—	Not Used
7	—	Not Used
8	218 (W/P)	Parklamp Relay
9	342 (LG/P)	Starter Interrupt Relay

10	1013 (BR/LG)	Illuminated Entry Request to GEM Module
11	120 (PK/LG)	All Unlock Relay
12	645 (W/LB)	Anti-Theft Module — Fused Feed
13	—	Not Used
14	570 (BK/W)	Ground
15	—	Not Used
16	343 (DB/LG)	Theft LED Indicator
17	—	Not Used
18	—	Not Used
19	—	Not Used
20	6 (Y/LG)	Horn Relay
21	—	Not Used
22	119 (PK/Y)	All Lock Relay

All Relay Connectors

The harness connectors to each system relay (horn, parklamp, starter interrupt) have the same pinout. Check the Electrical Schematics for circuit number, wire gauge and color.



Item	Part Number	Description
1	—	Battery Feed to Coil
2	—	Coil Ground
3	—	Battery Feed to Contacts
4	—	Normally Closed Connector
5	—	Coil Energized Contact

NOTE: NEVER probe power or ground to Pins 1 or 2 of these relays.

Inspection and Verification

NOTE: Doors may automatically unlock as a result of shorts in the door unlock circuits. Refer to Section 18-04A .

The electronic door lock control system is diagnosed as part of the overall remote control alarm and door lock system. Refer to Section 18-04B to initiate system self test, New Generation Star (NGS) Tester use and diagnostic test codes.

1. Verify the vehicle owner's original concern by duplicating the concern.

2. Inspect to determine if one of the following mechanical or electrical concerns apply:

VISUAL INSPECTION CHART

Mechanical	Electrical
• Damaged driver/passenger door lock cylinder	• Open fuses • Loose connections • Corroded connections

3. If the concern(s) remains after the inspection, determine the symptom(s) and proceed to the following Symptom Chart.

NOTE: For system inspection and verification using Rotunda New Generation Star (NGS) Tester 001-00500 or equivalent, refer to Section 18-04B .

To test and service door lock system:

- Check that battery is fully charged (if not, it may be causing the concern).

NOTE: When the battery has been disconnected and reconnected, some abnormal symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.

- Disconnect and reconnect battery to make sure system is reset.
- Perform the self test. If necessary, refer to Section 18-04B .
- Service only as specified in the tests.
- Repeat the self test to make sure the system is operational.

Symptom Chart — Electronic Door Lock Control System

NOTE: Use Rotunda New Generation Star (NGS) Tester 007-00500 or equivalent and Rotunda 73 Digital Multimeter 105-R0051 or equivalent to perform electrical pinpoint tests.

ELECTRONIC DOOR LOCK CONTROL SYSTEM

Condition	Possible Source	Action
• Door Lock Motors/Switches Inoperative or Door Locks Continuously Cycling	• Mechanical condition. • Switch. • Circuit. • GEM module.	• GO to Pinpoint Test A . **NOTE: Before proceeding with pinpoint test, go to Section 18-04B for system self test and diagnostic test codes.**
• Transmitter/Remote Entry Inoperative	• Transmitter. • Antenna. • Transmitter battery.	• GO to Pinpoint Test B . **NOTE: Before proceeding with pinpoint test, go to Section 18-04B for system self test and diagnostic test codes.**
• Illuminated Entry Request Inoperative	• GEM module. • Circuit.	• GO to Pinpoint Test C . **NOTE: Before proceeding with pinpoint test, go to Section 18-04B for system self test and diagnostic test codes.**

Pinpoint Tests

PINPOINT TEST A: DOOR LOCK MOTORS/SWITCHES INOPERATIVE

The door locks are wired so that the lock and unlock switches on the doors can operate the door locks with or without a receiver assembly installed in the system. The door lock switches are wired directly to the relays that control the door locks.

When the receiver assembly operates the door locks, it provides a ground just like the door lock switches.

If the receiver assembly is disconnected and the door locks still don't work, there is a switch, motor, lock mechanism, fuse or wiring issue.

The receiver assembly uses the LOCK ALL and UNLOCK ALL Circuits 119 and 120 as outputs, but also monitors these circuits as inputs to see when the door lock switches are pressed.

Pressing the UNLOCK switch on the door can unlock all doors. It unlocks the driver's door by supplying power to the driver's door lock motor through the normally closed contacts of the driver's door unlock relay.

NOTE: If state is SHORT, check and service Circuits 120 (PK/LG) and 119 (PK/Y) for short to ground or each other.

A1 CHECK MECHANICAL OPERATION OF LOCKS

- Manually (not electrically) cycle the lock by turning the key in the door.

Do the door lock mechanisms move freely?

Yes	No
GO to **A2** .	GO to Section 01-14A and SERVICE the door lock mechanisms (LUBRICATE linkage, CLEAR interferences, etc.).

A2 DOOR LOCKS DON'T WORK WITH LOCK SWITCHES ON THE DOORS

- Check the fuses for the door lock motors.

Are the fuses OK?

Yes	No

GO to **A3** .	LOCATE the wiring short in the door lock power circuits. REPLACE fuse.

A3 CHECK STATUS OF DOOR LOCK SWITCHES

- Enter in NGS: RAP, PID/DATA and select DD_LOCK to monitor the door lock and unlock switches.

  NOTE: Some vehicles may have power door locks, but may not have a receiver assembly system. If there is no receiver assembly, tests are limited to voltage and resistance measuring.

Is NGS DD_LOCK state OFF?

Yes	No
GO to **A4** .	If the display says UNLOCK, CHECK and SERVICE the all unlock Circuit 120 (PK/LG) or door unlock switches for a short to ground. If the display says LOCK, CHECK and SERVICE the all lock Circuit 119 (PK/Y) or door lock switches for a short to ground.

A4 CHECK OPERATION OF DOOR LOCK SWITCHES

- Press LOCK button on each door lock switch and confirm that NGS, RAP DD_ LOCK state changes to LOCK when switches are pressed.
- Press UNLOCK button on each door lock switch and confirm that NGS, RAP DD_ LOCK state changes to UNLOCK when switches are pressed.

Does LOCK and UNLOCK state for each door lock switch occur?

Yes	No
GO to **A5** .	If UNLOCK state doesn't occur, CHECK and SERVICE the all unlock Circuit 120 (PK/LG) or door unlock switches for an open, or SERVICE the grounding circuit for the door lock switch. If LOCK state doesn't occur, CHECK and SERVICE the all lock Circuit 119 (PK/Y) or door lock switches for an open. If always UNLOCK, CHECK and SERVICE the all unlock Circuit 120 (PK/LG) or door unlock switches for a short to ground. If always LOCK, CHECK and SERVICE the all lock Circuit 119 (PK/Y) or door lock switches for a short to ground.

A5 CHECK RECEIVER ASSEMBLY ALL LOCK OUTPUT

- Enter in NGS_RAP ACTIVE COMMANDS and select DOOR LOCK CONTROL.
- Toggle LOCK to ON.

Do all doors lock?

Yes	No
GO to **A6** .	CHECK and SERVICE Circuit 119 (PK/Y) from receiver assembly to relay.

A6 CHECK RECEIVER ASSEMBLY UNLOCK DRIVER'S DOOR OUTPUT

- Toggle DD LOCK to OFF.
- Toggle DD UNLOCK to ON.

Does the driver side door unlock?

Yes	No
GO to **A7** .	CHECK and SERVICE driver's door unlock Circuit 129 (LG) from receiver assembly to relay.

A7 CHECK RECEIVER ASSEMBLY ALL UNLOCK OUTPUT

- Toggle UNLOCK to ON.

Do all doors unlock?

Yes	No
GO to **A8** .	CHECK and SERVICE Circuit 120 (PK/LG) from receiver assembly to relay.

A8 CHECK DOOR LOCK SWITCH CIRCUIT

- Check Circuit 119 (PK/Y) for continuity between all lock relay and door lock switch.
- Check Circuit 119 (PK/Y) for continuity to ground.

Is there continuity and is resistance less than 100 ohms?

Yes	No
GO to **A9** .	SERVICE open or ground in Circuit 119.

A9 CHECK DOOR UNLOCK SWITCH CIRCUIT

- Check Circuit 120 (PK/LG) for continuity between unlock relay and door lock switch.

- Check Circuit 120 (PK/Y) for continuity to ground.

Is there continuity and is resistance less than 100 ohms?

Yes	No
GO to **A10** .	SERVICE open or ground in Circuit 120.

A10 CHECK DOOR UNLOCK POWER CIRCUITS

- Disconnect receiver assembly and GEM module.
- Remove all doors lock relay, all doors unlock relay and driver's door unlock relay.
- Jumper battery voltage to the common contact (Pin 3) of all doors unlock relay connector and jumper ground (Pin 4) to common contact (Pin 3) of all doors lock relay connector.

Do door lock motors unlock?

Yes	No
GO to **A11** .	SERVICE all circuits connecting to door lock relays for shorts or opens. REPLACE door lock relays only if required following wiring repairs. DISCONNECT door lock motors and power separately to confirm operation.

A11 CHECK DOOR LOCK POWER CIRCUITS

- Confirm receiver assembly and GEM module as well as the all doors lock relay, all doors unlock relay and driver's door unlock relay are disconnected.
- Jumper battery voltage to common contact (Pin 3) of all doors lock relay connector and jumper ground (Pin 4) to common contact (Pin 3) of the all doors unlock relay connector.

Do door lock motors lock?

Yes	No
CHECK and REPLACE relays by placing known good relays in place of door lock and unlock relays.	SERVICE all circuits jumpered in Pinpoint Test A10 for shorts or opens. REPLACE door lock relays only if required following wiring repairs. If substitute relays do not correct condition, GO to **A7** .

PINPOINT TEST B: TRANSMITTER/REMOTE ENTRY INOPERATIVE

Remote Entry range may be affected when operated within a quarter mile of some radio or TV towers. Although the range is reduced at these locations, the owner should still be able to enter their vehicle using the remote transmitter.

B1 CHECK TRANSMITTER/REMOTE ENTRY OPERATION

- Turn ignition OFF.
- Perform the self test as Described in Section 18-04B , Pinpoint Test A to insure that the receiver assembly has power.
- Press each button on remote entry transmitter fob while standing 10 meters/yards away from vehicle and confirm that operation is as described in Description and Operation, Transmitter, Remote Entry .

Was there an appropriate response for each button press?

Yes	No
System OK.	GO to **B2** if there was no response to the transmitter. GO to the correct pinpoint test for the specific output which did not function correctly, if there was only a partial response. Some outputs are covered in Section 13-11 .

B2 CHECK FOR ANY RESPONSE FROM TRANSMITTER NO. 1

Does system respond to any button press from transmitter in question when standing closer or inside of vehicle?

Yes	No
GO to **B4** .	GO to **B3** .

B3 CHECK FOR ANY RESPONSE FROM TRANSMITTER NO. 2

Does the system respond to any button press from the other transmitter when standing closer or inside of the vehicle?

Yes	No
GO to **B6** .	GO to **B4** .

B4 ANTENNA CHECK

- Confirm that while testing for 10 meters/yards range of remote entry system that the vehicle is more than .8 km (1/2 mile) away from radio or TV towers. If closer than .8 km (1/2 mile) away from a TV or radio tower, a 5 meter/yard range is acceptable.
- Check to see if the antenna connecting to the receiver assembly module is fully seated or is missing.
- Connect antenna or press it fully into receiver assembly.
- Test range with transmitter.

Has range improved?

Yes	No
REPEAT **B1** .	GO to **B5** .

B5 ANTENNA DAMAGE CHECK

- Disconnect antenna from RAP module.
- Check for less than 10 ohms of resistance from antenna signal pin to opposite end of antenna coax center conductor.
- Reconnect antenna to receiver assembly.

Is resistance less than 10 ohms?

Yes	No
Antenna is OK. GO to **B6** .	REPLACE the antenna and REPEAT **B1** .

B6 NGS TRANSMITTER TIC/DATA — STORED TICS

- Enter in NGS: RAP, FUNCTION TESTS, TRANSMITTER TIC/DATA in order to see which Transmitter Identification Codes (TICs) are stored in the RAP module.
- When TRANSMITTER TIC/DATA screen first comes up, different eight digit letter/number codes should appear next to the TIC 1: and TIC 2: symbols on right. TIC 1 is stored TIC for Transmitter 1, and TIC 2 is stored TIC for Transmitter 2.

  NOTE: Since receiver assembly can store up to 4 transmitter codes, there may be a second, third and/or fourth TIC programmed to system next to TIC 2, TIC 3 and TIC 4. These were extra transmitters programmed after vehicle was delivered.

Is there at least one transmitter stored and displayed next to TIC 1?

Yes	No
GO to **B7** .	TURN ignition OFF, PROGRAM all of the transmitters to be used with this system as described in Description and Operation, Transmitter, Remote Entry and REPEAT **B1** .

B7 NGS TRANSMITTER TIC/DATA — LAST TIC RECEIVED

- Turn ignition OFF.
- Press and release UNLOCK button many times for transmitter in question. Transmission received contains TIC for transmitter being operated and DATA for which button has been pressed.

  NOTE: Pressing CLEAR will clear last transmission received, but will not clear stored TICs in memory.

  NOTE: It is normal for LAST TIC RECEIVED and LAST DATA RECEIVED to flash different information momentarily when button is pressed. Information will lock in on correct values. Tester is catching computer updating its memory.

Does an eight digit letter/number code appear under LAST TIC RECEIVED: and word UNLOCK appear under LAST DATA RECEIVED:?

Yes	No
GO to **B10** . Transmitter and receiver assembly are OK.	GO to **B8** .

B8 NGS TRANSMITTER TIC/DATA — OTHER TRANSMITTER (IF EQUIPPED)

- Repeat Steps B6 and B7 , but press and release UNLOCK button many times for other transmitter after turning ignition OFF.

Does an eight digit letter/number code appear under LAST TIC RECEIVED: and word UNLOCK appear under LAST DATA RECEIVED:?

Yes	No
GO to **B9** .	GO to **B12** .

B9 TEST TRANSMITTER BATTERIES

- Switch batteries in good transmitter tested in Step B8 with poor transmitter tested in Step B7. (See Removal and Installation, Transmitter Battery .)
- Press and release the UNLOCK button many times for transmitter tested in B7.

Does an eight-digit letter/number code appear under LAST TIC RECEIVED: and word UNLOCK appear under LAST DATA RECEIVED:?

Yes	No
RETURN original batteries to both transmitters, REPLACE batteries in transmitter tested in **B7** , and REPEAT **B1** .	REPLACE transmitter. RETEST system.

B10 NGS TRANSMITTER TIC/DATA — TIC MATCH

NOTE: Ranger vehicles are factory equipped with one remote transmitter.

Does TIC under LAST TIC RECEIVED: match TIC 1 (or TIC 2 or TIC 3 or TIC 4)?

Yes	No
GO to **B11** .	TURN ignition OFF. PROGRAM all transmitters to be used with this system as described in Programming Transmitters , Description and Operation and REPEAT **B1** .

B11 NGS TRANSMITTER TIC/DATA — TIC MATCH

Do all buttons pressed for each transmitter create expected LAST DATA RECEIVED output?

Yes	No
System should be operating OK.	TURN ignition OFF. PROGRAM all transmitters to be used with this system as described in Description and Operation, Transmitter, Remote Entry and REPEAT **B1** .

B12 CHECK RECEIVER ASSEMBLY FOR EXPORT REMOTE SHORTING BAR

- Enter in NGS RAP PID/DATA and select NOREMOT.

Does NOREMOT PID display YES?

Yes	No
INSPECT wiring connector for no remote shorting Pin C1-22. If present, REMOVE and GO to **B1** . If not present, REPLACE receiver assembly. RETEST system.	REPLACE receiver assembly. RETEST system.

PINPOINT TEST C: ILLUMINATED ENTRY REQUEST INOPERATIVE

The GEM module (Section 18-04A) controls the interior lights with the illuminated entry function.

The receiver assembly sends pulses on the GEM illuminated entry circuit to request the illuminated entry begin or end. Circuit 1013 (BR/LG) is normally pulled up by the GEM module. The receiver assembly pulls the voltage low with pulses of different lengths.

- 200 mS pulse from receiver assembly requests illuminated entry on.
- 300 mS pulse from receiver assembly requests illuminated entry off.

C1 CHECK ILLUMINATED ENTRY OPERATION

- Press the UNLOCK button on a remote transmitter (for any keypad button) to unlock the doors and turn the illuminated entry on.
- Press the LOCK button on a remote transmitter (or lock with keypad) within 20 seconds of pressing the UNLOCK button to lock the doors and turn the illuminated entry off.

Does illuminated entry work as described?

Yes	No
Illuminated entry request function appears OK. CLARIFY with customer and REVIEW customer symptoms table.	If illuminated entry did not work as described, GO to **C2** . If driver's door either did not lock or did not unlock, REPEAT **C1** to make sure transmitter was pressed and GO to Pinpoint Test B .

C2 MEASURE GEM ILLUMINATED ENTRY VOLTAGES

- Measure the voltage on Circuit 1013 (BR/LG) at the receiver assembly (keep modules connected) using signal ground Circuit 570 (BK/W) as a voltage reference. Measure voltage with NGS, DIGITAL MEASUREMENT, VOLTMETER, setting RANGE at 40V.
- Continue to measure voltage and press the UNLOCK button on the transmitter (or any keypad button).

Was the MIN voltage captured when the pulse was transmitted less than 1.3V?

Yes	No
GO to **C3** .	CLEAR MIN voltage and REPEAT Test **C2** once to CONFIRM high voltage; if so, REPLACE receiver assembly. RETEST system.

C3 MEASURE GEM ILLUMINATED ENTRY PULSE WIDTHS

- Keep setup from C2.
- Select NGS, DIGITAL MEASUREMENT, PULSE WIDTH METER, and choose LEVEL setting LOW.
- Press the UNLOCK button on the transmitter (or any keypad button).

Was the PULSE WIDTH between 190 and 210 mS?

Yes	No
GO to **C4** .	REPLACE receiver assembly. RETEST system.

C4 CHECK GEM ILLUMINATED ENTRY REQUEST CIRCUIT

- Check Circuit 1013 (BR/LG) for shorts or an open between the RAP and GEM modules.

Is the wiring OK?

Yes	No
GO to Section 18-04A to diagnose the GEM module for illuminated entry operation.	SERVICE Circuit 1013 (BR/LG).

Antenna

Removal and Installation

NOTE: This vehicle uses an antenna that runs along the wiring harness. DO NOT REMOVE the damaged antenna from the wire harness.

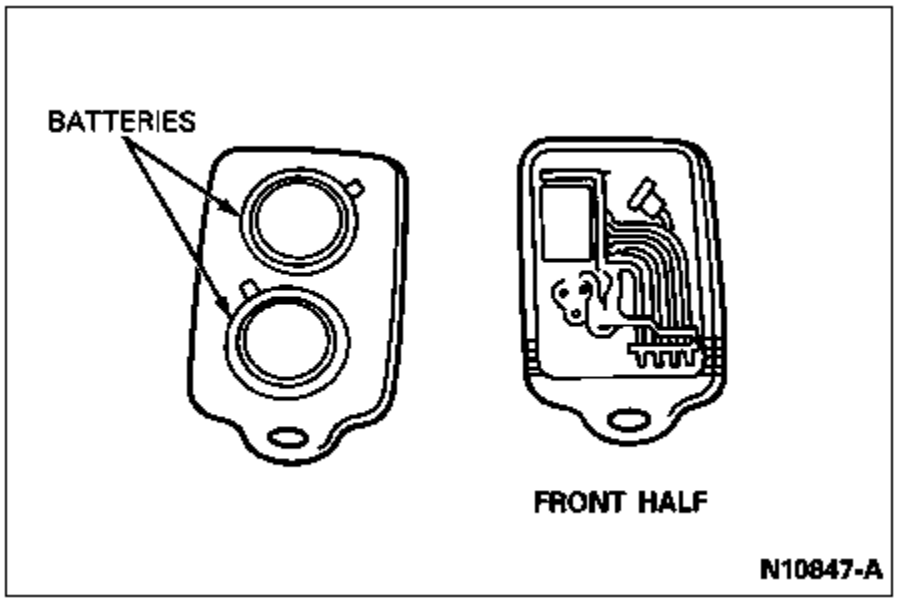
1. Locate the module by removing the proper trim.
2. Disconnect antenna from the module and tape securely out of the way.
3. Connect new antenna connector to the receiver assembly.
4. Install new antenna by securing along path followed by the unconnected damaged antenna. Secure using Ford-approved tie-wraps or tape.

Transmitter Battery

The door lock switch actuator transmitter is powered by two coin-type 3-volt lithium batteries. To replace the batteries, the transmitter comes apart by inserting a thin coin between the two halves of the transmitter, at the keyring end, and twist the halves apart.

CAUTION: Do not take the front half of the transmitter apart.

When installing the new batteries, be sure to place the positive side down as marked. Make sure batteries are fully seated to prevent dropping when transmitter halves are assembled. Snap the two halves back together.



SPECIAL SERVICE TOOLS/EQUIPMENT

ROTUNDA EQUIPMENT

Model	Description
007-00500	New Generation Star (NGS) Tester
105-R0051	Rotunda 73 Digital Multimeter

Wiper System, Windshield

The front windshield wiper system consists of a wiper control module, a windshield wiper motor (17508), a washer system, and multi-function switch (13K359).

The optional rear windshield wiper system consists of an electric motor mounted inside the liftgate, a washer system, a dash-mounted windshield wiper/washer switch, an in-line circuit breaker and a fuse block-mounted 15-amp fuse (14A094) in cavity 18.

Off/Low/High Speed

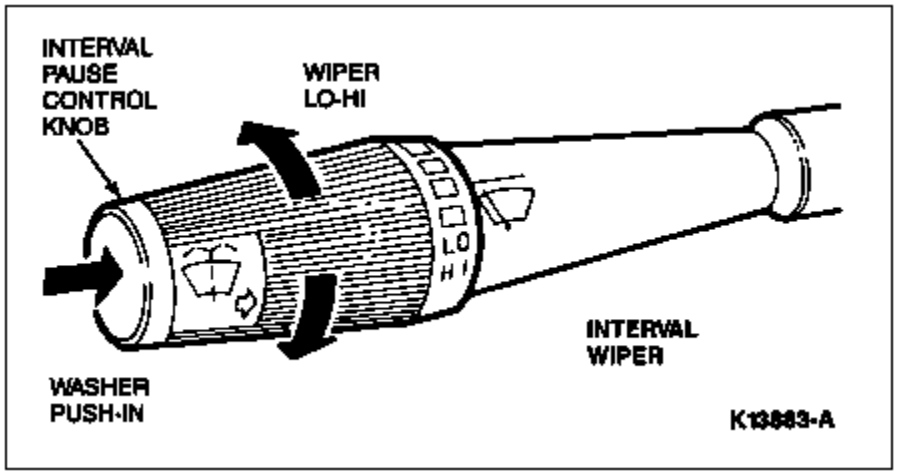
The permanent magnet three-brush electric wiper motor of the front wiper system allows selection of either low or high speed. When the multi-function switch is in the LOW position, the common brush Circuit 61 (Y/R) and low speed brush Circuit 58 (W) are used. When the switch is in the HIGH position, current bypasses part of the armature winding to the high speed brush Circuit 56 (DB/O), causing the motor to run faster. When the switch is moved to the OFF position, the motor will continue to run at low speed until the wipers park.

The rear wiper system motor runs at one speed only. When the dash-mounted switch is moved to OFF, the motor continues to run until the wiper parks.

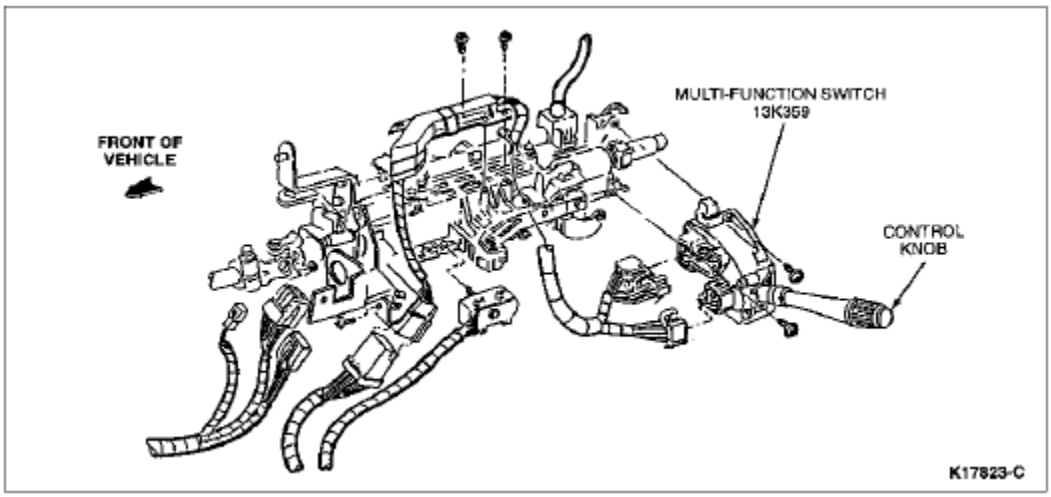
Interval (Front Wipers Only)

When the multi-function switch is in the interval (INT) position, the wipers will make single sweeps separated by a pause. The control knob on the end of the switch sets the length of the pause from approximately 1-12 seconds each.

When using interval wipe, the first wipe may not occur until after a pause of up to 12 seconds.



Interval Wipe/Wash System


FRONT OF VEHICLE
MULTI-FUNCTION SWITCH 13K359
CONTROL KNOB
K17823-C

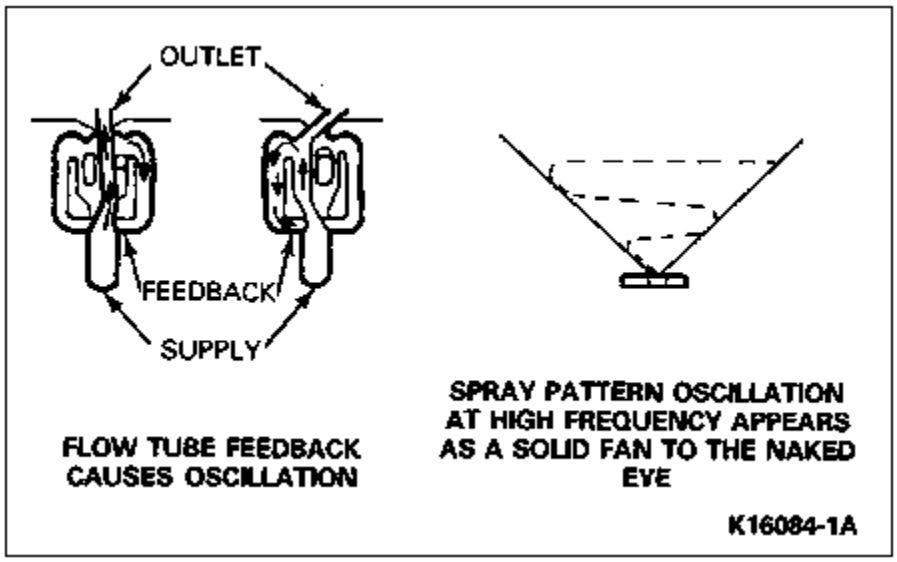
Washer System, Windshield

Front

The washer system for the front wipers consists of a control switch inside the multi-function switch (13K359), a windshield washer reservoir (17618), windshield washer pump, and necessary hoses/nozzle(s).

To engage the washer, push the knob of the multi-function switch toward the steering column. If the control switch is at the OFF or INT position, the wipers will run as long as the knob is depressed. When the knob is released, the washer will stop immediately, but the wipers will continue to run for one to four sweeps, then return to their previous set operation. Washer engagement does not affect wiper operation when the control switch is in the LO or HI position.

Each windshield washer nozzle jet and bracket (17603) expels what appears to be a wide fan-like spray pattern of large droplets of fluid on the windshield glass (03100). However, it is actually a single oscillating jet stream. This produces a more efficient cleansing action. Care should be taken to only actuate the system momentarily because of the greater volume of fluid used in this system. The windshield washer nozzle jet and brackets are not adjustable.

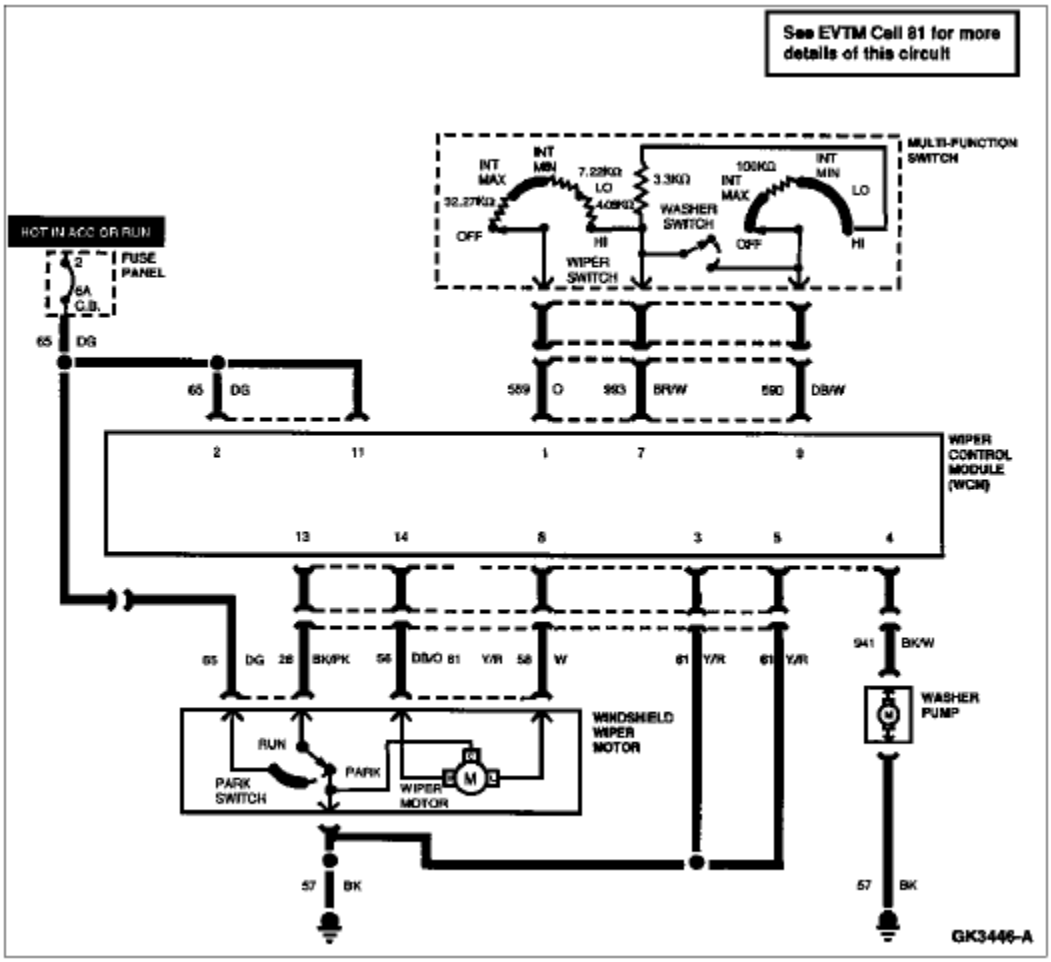


Rear Window

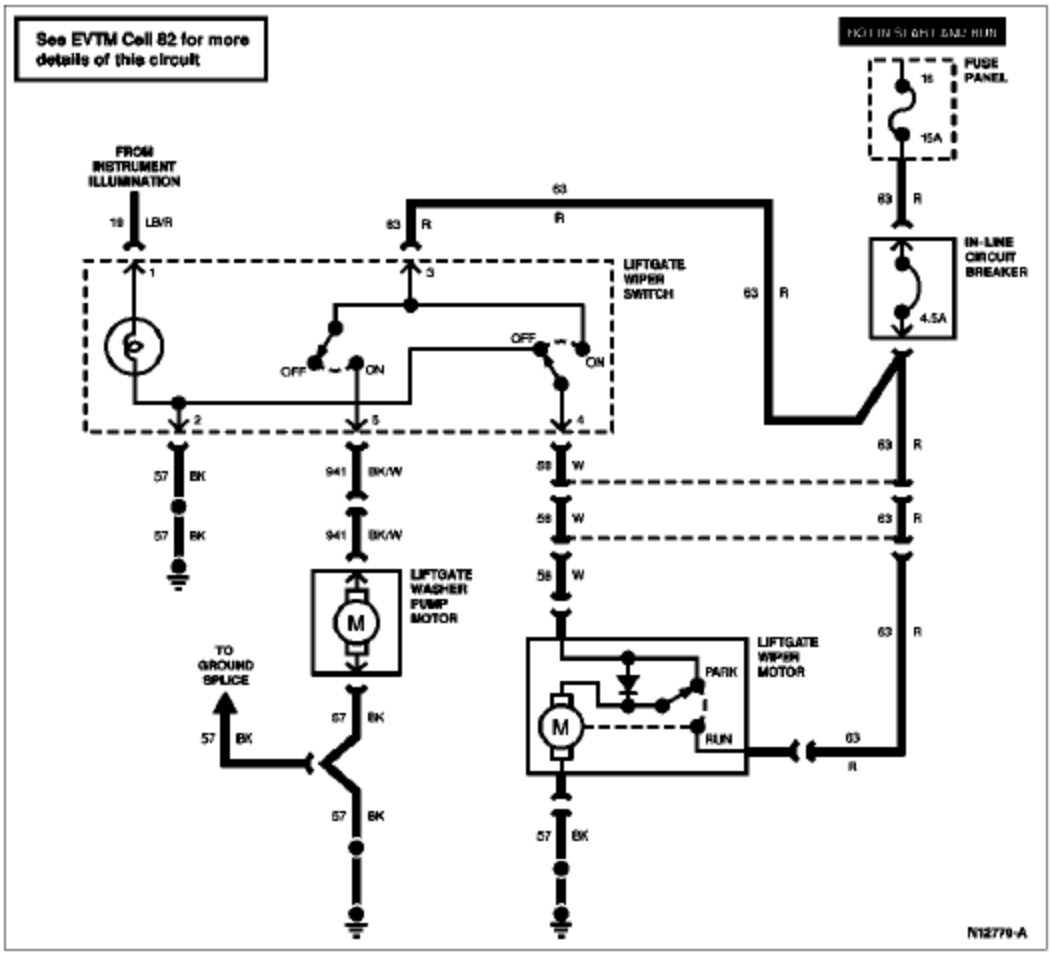
The washer system for the rear wipers consists of a dash-mounted switch, a windshield washer pump (17664), windshield washer reservoir, and a single hose/washer nozzle. The washer fluid reservoir is located behind the right quarter trim panel, and the fill cap is near the opening of the liftgate above the right rear lamp (13404). Fill the reservoir slowly to avoid spilling fluid. To engage the washer, push the dash-mounted switch. When the switch is released, the washer will stop immediately and the wipers will return to their previous set operation.

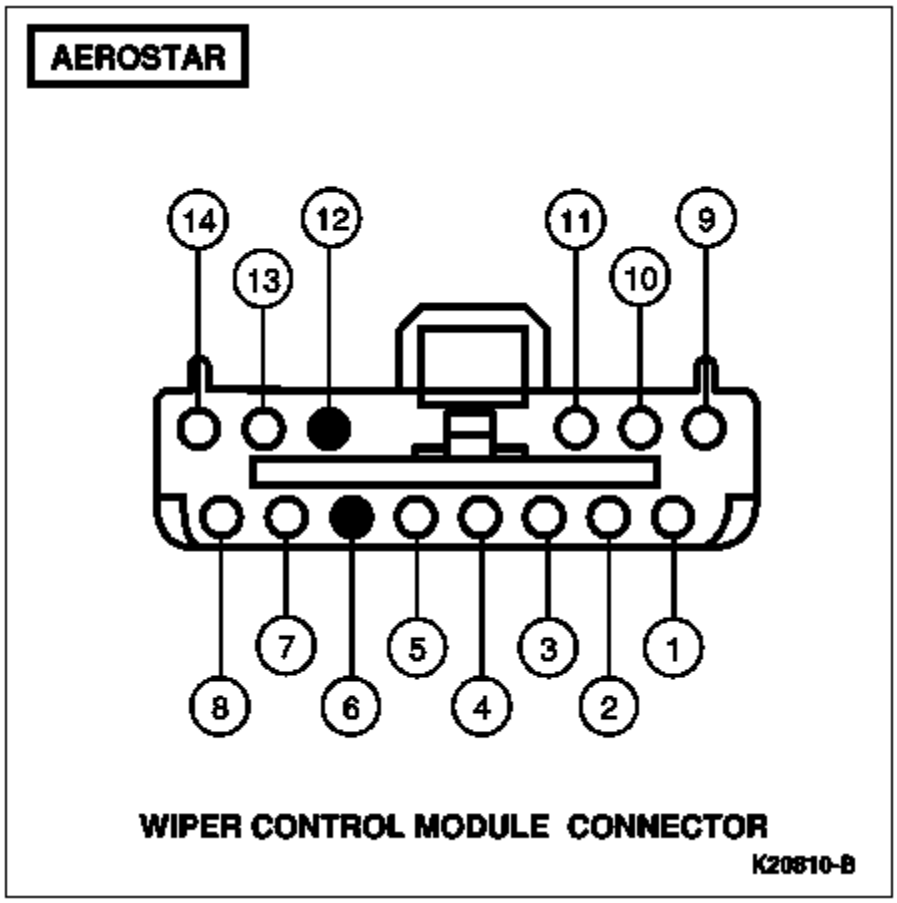
Electrical Schematics

Interval Wiper and Washer System

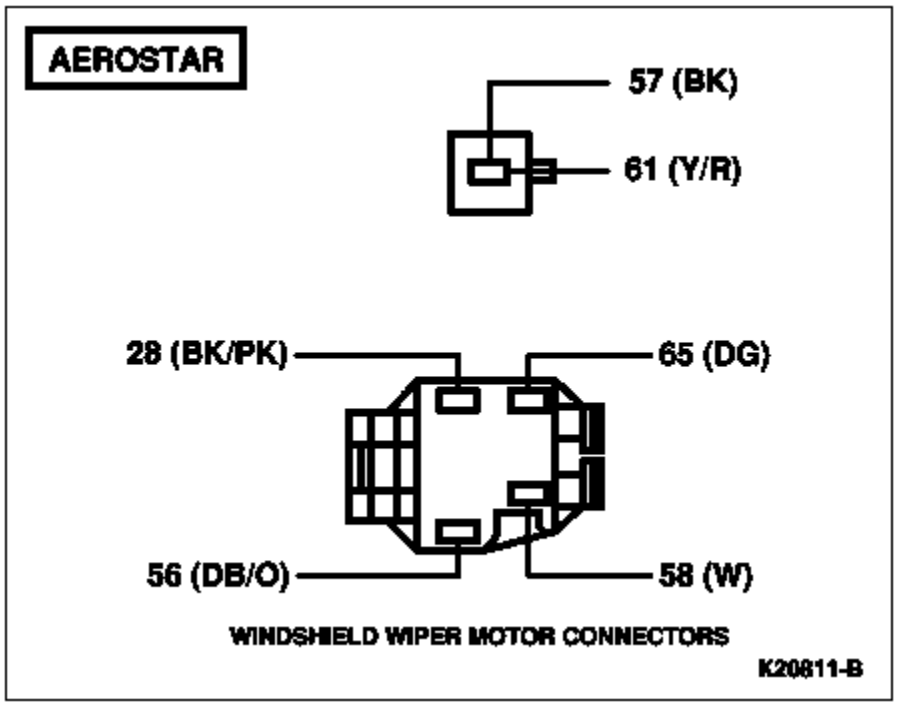


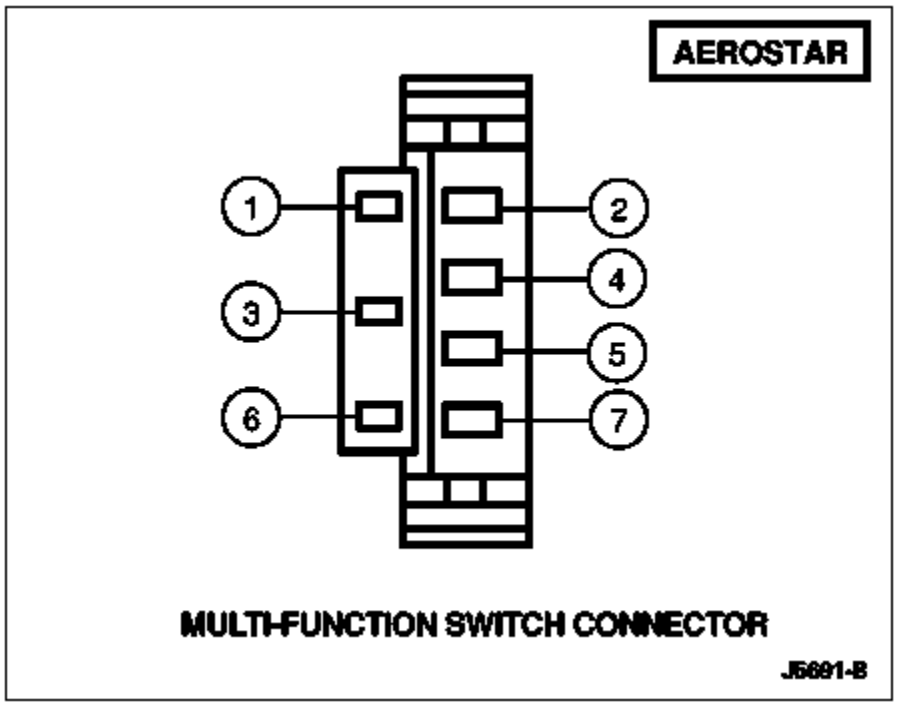
Liftgate Wiper and Washer System


See EVTM Cell 82 for more details of this circuit
NOT IN START AND RUN
FUSE PANEL
15
15A
FROM INSTRUMENT ILLUMINATION
19 LB/R
63 R
IN-LINE CIRCUIT BREAKER
4.5A
LIFTGATE WIPER SWITCH
OFF
ON
57 BK
941 BK/W
58 W
LIFTGATE WASHER PUMP MOTOR
LIFTGATE WIPER MOTOR
PARK
RUN
TO GROUND SPLICE
N12779-A



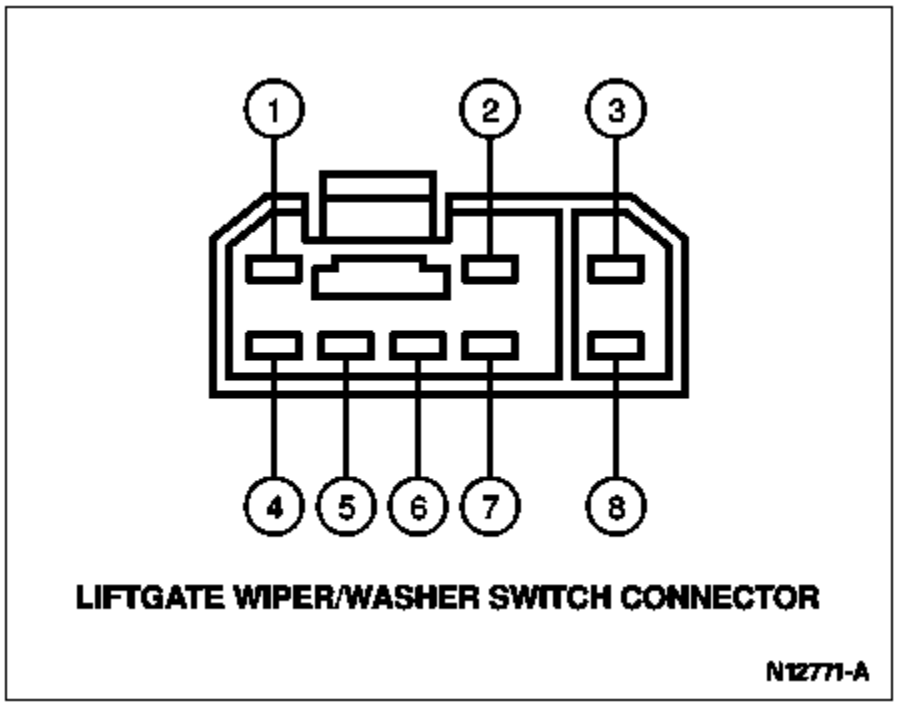
Pin Number	Circuit	Circuit Function
1	589 (O)	Multi-Function Switch (Mode)
2	65 (DG)	Ignition (Hot in Run or Accessory)
3	61 (Y/R)	Ground Circuit
4	941 (BK/W)	Washer Pump Motor Feed
5	61 (Y/R)	Ground Circuit
6	—	Not Used
7	993 (BR/W)	Multi-Function Switch (Common)
8	58 (W)	Windshield Wiper Motor — Lo
9	590 (DB/W)	Multi-Function Switch (INT Mode)
10	—	NOT USED
11	65 (DG)	Ignition (Hot in Run or Accessory)
12	—	Not Used
13	28 (BK/PK)	Windshield Wiper Motor — Park Switch
14	56 (DB/O)	Windshield Wiper Motor — Hi





Pin Number	Circuit	Circuit Function
1	589 (O)	Multi-Function Switch (Mode)

2	15 (R/Y)	Headlamp Dimmer Switch Feed
3	993 (BR/W)	Multi-Function Switch (Common)
4	13 (R/BK)	Headlamp Dimmer Switch to Low Beams
5	12 (LG/BK)	Headlamp Dimmer Switch to High Beams
6	590 (DB/W)	Multi-Function Switch (INT Mode)
7	196 (DB/O)	Headlamp Flash to Pass Switch Feed



Pin Number	Circuit	Circuit Function
1	—	Not Used
2	—	Not Used
3	—	Not Used
4	19 (LB/R)	Instrument Panel Lamps Feed
5	57 (BK)	Ground Circuit
6	63 (R)	Liftgate Wiper Switch to Liftgate Wiper Motor and Power Feed
7	58 (W)	Liftgate Wiper Switch to Liftgate Wiper Motor
8	941 (BK/W)	Liftgate Washer Pump Motor Feed

Inspection and Verification

1. Verify the vehicle owner's original concern by operating the wiper and washer system to duplicate the vehicle owner's concern.

2. Inspect to determine if one of the following mechanical or electrical concerns apply:

VISUAL INSPECTION CHART

Mechanical	Electrical
• Windshield wiper blade missing or damaged	• Open circuit breaker
• Binding windshield wiper pivot arm	• Damaged windshield wiper motor
• Binding windshield wiper mounting arm and pivot shaft	• Damaged windshield washer pump
• Empty windshield washer reservoir	• Open connectors
• Kinked or broken windshield washer hoses	• Corroded connectors • Inoperative windshield wiper switch

3. If the concern(s) remains after the inspection, determine the symptom(s) and proceed to the following symptom chart.

Symptom Chart — Windshield Wiper/Washer System Diagnosis

NOTE: Use 73 Digital Multimeter or equivalent, 105-R0051, Alternator, Regulator, Battery and Starter Tester (ARBST), 010-00725 or equivalent to perform electrical pinpoint tests.

WINDSHIELD WIPER/WASHER SYSTEM DIAGNOSIS

Condition	Possible Source	Action
• Windshield Washer Inoperative	• Low fluid level. • Plugged nozzles. • Bent or blocked hoses. • Blocked pump outlet. • Damaged circuit breaker. • Damaged multi-function switch. • Damaged wiper control module (WCM). • Damaged or worn washer pump. • Circuitry.	• GO to Pinpoint Test A.
• Windshield Wipers Inoperative at All Switch Positions	• Damaged circuit breaker. • Damaged multi-function switch. • Damaged wiper control module (WCM). • Damaged windshield wiper motor. • Circuitry.	• GO to Pinpoint Test B.
• Windshield Wipers Inoperative at Low Speed (High Speed OK)	• Damaged multi-function switch. • Damaged wiper control module (WCM). • Damaged windshield wiper motor. • Circuitry.	• GO to Pinpoint Test C.
• Windshield Wipers Inoperative at High Speed (Low Speed OK)	• Damaged multi-function switch. • Damaged wiper control module (WCM).	

	• Damaged windshield wiper motor. • Circuitry.	• GO to Pinpoint Test B.
• Windshield Wipers Inoperative at Interval (Low and High Only)	• Damaged multi-function switch. • Damaged wiper control module (WCM). • Circuitry.	• GO to Pinpoint Test D.
• No Wipe After Wash — Washer Pump Runs, Low Speed OK	• Damaged wiper control module (WCM).	• REPLACE Wiper Control Module (WCM).
• Windshield Wipers Will Not Park at Proper Position	• Damaged windshield wiper motor. • Damaged wiper control module (WCM). • Worn or damaged multi-function switch.	• GO to Pinpoint Test E.
• Windshield Wipers Continue to Run When Switch Is Turned Off	• Worn or damaged multi-function switch. • Damaged wiper control module (WCM). • Circuitry.	• GO to Pinpoint Test E.
• Rear Window Washer Inoperative	• Rear washer pump motor. • Liftgate wiper/washer switch. • Circuitry.	• GO to Pinpoint Test F.
• Rear Window Wiper Inoperative	• Fuses. • Circuit breaker. • Battery or charging system. • Liftgate wiper motor. • Liftgate wiper/washer switch. • Circuitry.	• GO to Pinpoint Test G.
• Rear Windshield Wiper Will Not Park	• Liftgate wiper motor. • Liftgate wiper/washer switch. • Circuitry.	• GO to Pinpoint Test H.
• Rear Windshield Wiper Will Not Turn Off	• Liftgate wiper motor. • Liftgate wiper/washer switch. • Circuitry.	• GO to Pinpoint Test J.

PINPOINT TEST A: WINDSHIELD WASHER INOPERATIVE

A1 WINDSHIELD WASHERS INOPERATIVE

- Check fluid level of windshield washer reservoir.

Is windshield washer reservoir empty?

Yes	No
FILL windshield washer reservoir. RETEST system.	GO to A2.

A2 TURN ON WASHER SWITCH

- Check operation of windshield washer pump.

Does windshield washer pump operate?

Yes	No
GO to A3.	GO to A6.

A3 INSPECT NOZZLE FOR BLOCKAGE

- Inspect windshield washer nozzle jet and bracket for blockage.

Is windshield washer nozzle jet and bracket blocked?

Yes	No
CLEAN or REPLACE windshield washer nozzle jet and bracket. RETEST system.	GO to A4.

A4 INSPECT HOSE, FILTER, CHECK VALVE, FOR BLOCKAGE OR KINKS

- Inspect hose, filter and check valve for blockage or kinks.

Are any blockages or kinks present?

Yes	No
CLEAN, REPAIR or REPLACE as necessary. RETEST system.	GO to A5.

A5 INSPECT PUMP OUTLET FOR BLOCKAGE

- Inspect washer pump outlet for blockage.

Is windshield washer pump outlet blocked or obstructed?

Yes	No
REMOVE windshield washer pump and CLEAN or REPLACE windshield washer pump. RETEST system.	CHECK washer pump feed in reservoir for blockage. SERVICE as required. RETEST system.

A6 CHECK FOR VOLTAGE AT WASHER PUMP

- Using a voltmeter, actuate the multi-function switch and check for voltage at windshield washer pump.

Is battery voltage present?

Yes	No
GO to **A7** .	GO to **A8** .

A7 CHECK PUMP GROUND

- Using a volt-ohmmeter, check resistance of ground Circuit 57 (BK) at pump connector to known good ground.

Is resistance five ohms or less?

Yes	No
REPLACE windshield washer pump. RETEST system.	REPAIR ground. RETEST system.

A8 TURN ON WINDSHIELD WIPERS

- Check operation of windshield wipers.

Do wipers operate?

Yes	No
GO to **A9** .	GO to Pinpoint Test B .

A9 CHECK MULTI-FUNCTION SWITCH RESISTANCE AT WIPER CONTROL MODULE

- Unplug connector from wiper control module.
- Depress windshield washer switch on end of multi-function switch.
- Check continuity between Circuits 993 (BR/W) and 590 (DB/W).

Is continuity present?

Yes	No
GO to **A11** .	GO to **A10** .

A10 CHECK MULTI-FUNCTION SWITCH

- Unplug wiper switch connector.
- Depress multi-function switch.
- Check for continuity between terminals 993 and 590.

Is continuity present?

Yes	No
SERVICE for open circuit between multi-function switch and wiper control module. RETEST system.	REPLACE multi-function switch. RETEST system.

A11 CHECK WASHER PUMP CIRCUIT

- Check continuity of Circuit 941 (BK/W) from wiper control module to windshield washer pump.

Is continuity present?

Yes	No
REPLACE wiper control module. RETEST system.	SERVICE for open circuit. RETEST system.

PINPOINT TEST B: WINDSHIELD WIPERS INOPERATIVE AT ALL SWITCH POSITIONS

B1 CHECK FOR SUPPLY VOLTAGE AT MOTOR

- Turn ignition switch on.
- Turn multi-function switch to high.
- Unplug windshield wiper motor.
- Check for battery voltage at Circuit 65 (DG).

Is battery voltage present?

Yes	No
GO to **B2** .	CHECK for : • Open circuit breaker in fuse panel.

	• Open wire Circuit 65 (DG). • SERVICE as required. RETEST system.

B2 CHECK FOR BATTERY VOLTAGE AT THE WIPER CONTROL MODULE (WCM)

- Disconnect wiper control module from wire harness.
- Check for battery voltage at Circuit 65 (DG) Pin 2 of connector.

Is battery voltage present?

Yes	No
GO to **B3** .	SERVICE open in power feed to module. RETEST system.

B3 CHECK FOR BATTERY VOLTAGE TO MOTOR WINDINGS

- Reconnect wiper control module.
- Turn ignition switch to run.
- Turn multi-function switch to high.
- Disconnect windshield wiper motor connector.
- Check for battery voltage between Circuits 61 (Y/R) and 56 (DB/O).

Is battery voltage present?

Yes	No
GO to **B7** .	GO to **B4** .

B4 CHECK FOR BATTERY VOLTAGE AT WIPER CONTROL MODULE CONNECTOR

- Check for battery voltage between Pins 10 and 14 (Circuits 61 (Y/R) and 56 (DB/O) of WCM connector at the wire harness side with multi-function switch in the HIGH position.

Is battery voltage present?

Yes	No
CHECK for: • Open wire Circuits 56 (DB/O) or 61 (Y/R). • Unseated terminal(s). • SERVICE as required. RETEST system.	GO to **B5** .

B5 CHECK WIRING BETWEEN WIPER CONTROL MODULE AND SWITCH

- Disconnect connector from wiper control module.

- Measure resistance between Circuits 993 (BR/W) and 589 (O) with wiper switch at high.

Is resistance less than five ohms?

Yes	No
REPLACE WCM. RETEST system.	GO to **B6** .

B6 CHECK MULTI-FUNCTION SWITCH CONTINUITY

- Disconnect harness from the multi-function switch.
- Check continuity between switch terminals for Circuits 993 (BR/W) and 589 (O) with SW in the HIGH position.

Is resistance less than one ohm?

Yes	No
CHECK for open wire between multi-function switch and Wiper Control Module. SERVICE as required. RETEST system.	CHECK for damaged multi-function switch. SERVICE as required. RETEST system.

B7 PREFORM WIPER MOTOR CURRENT DRAW TEST

Is current draw OK?

Yes	No
CHECK wiper linkage. SERVICE as required. RETEST system.	SERVICE windshield wiper motor as required. RETEST system.

PINPOINT TEST C: WINDSHIELD WIPERS INOPERATIVE AT LOW SPEED (HIGH SPEED OK)

C1 CHECK FOR BATTERY VOLTAGE TO MOTOR WINDINGS

- Turn ignition switch to run.
- Turn multi-function switch to low.
- Disconnect windshield wiper motor connector.
- Check for battery voltage between Circuits 61 (Y/R) and 58 (W).

Is voltage present?

Yes	No
GO to **C5** .	GO to **C2** .

C2 CHECK FOR BATTERY VOLTAGE AT WIPER CONTROL MODULE CONNECTOR

- Check for battery voltage between Pins 10 and 8 (Circuits 61 (Y/R) and 58 (W) of WCM connector at the wire harness side.

Is voltage present?

Yes	No
CHECK for: • Open wire Circuits 58 (W) or 61 (Y/R). • Unseated terminal(s). RETEST system.	GO to **C3** .

C3 CHECK WIRING BETWEEN WIPER CONTROL MODULE AND MULTI-FUNCTION SWITCH

- Disconnect connector from wiper control module.
- Measure resistance between Circuit 993 (BR/W) and 589 (O) with multi-function switch in the LOW position.

Is resistance between 3.5k and 4.5k Ohms?

Yes	No
REPLACE WCM. RETEST system.	GO to **C4** .

C4 CHECK CONTROL LINE SIGNAL AT MULTI-FUNCTION SWITCH

- Disconnect harness from the multi-function switch.
- Check continuity between switch terminals for Circuits 993 (BR/W) and 589 (O) with multi-function switch in the LOW position.

Is resistance between 3.5k and 4.5k Ohms?

Yes	No
SERVICE open wire between multi-function switch and wiper control module. RETEST system.	SERVICE damaged multi-function switch. RETEST system.

C5 PERFORM WIPER MOTOR CURRENT DRAW TEST

Is current draw OK?

Yes	No
CHECK wiper linkage. SERVICE windshield wiper motor as required. RETEST system.	SERVICE windshield wiper motor. RETEST system.

PINPOINT TEST D: WINDSHIELD WIPERS INOPERATIVE AT INTERVAL (LOW AND HIGH ONLY)

D1 CHECK MODE SELECT INPUT SIGNAL

- Disconnect wiper control module connector.
- Measure resistance between Circuits 993 (BR/W) and 589 (O) with multi-function switch in the INTERVAL position.

Is resistance between 10.5k and 12.0k Ohms?

Yes	No
GO to **D3** .	GO to **D2** .

D2 CHECK MODE SELECT SIGNAL AT WIPER SWITCH

- Disconnect harness from the multi-function switch.
- Measure resistance between terminals for Circuits 993 (BR/W) and 589 (O) with multi-function switch in the INTERVAL position.

Is resistance between 10.5k and 12.0k Ohms?

Yes	No
CHECK for open wire between multi-function switch and wiper control module. SERVICE as required. RETEST system.	CHECK for damaged multi-function switch. SERVICE as required. RETEST system.

D3 CHECK INTERVAL SELECT INPUT SIGNAL

- Rotate interval control on the multi-function switch from min. to max.
- Measure resistance between Circuits 590 (DB/W) and 993 (BR/W).

Is resistance 3.3k-103.3k Ohms?

Yes	No
REPLACE WCM. RETEST system.	GO to **D4** .

D4 CHECK INTERVAL SELECT INPUT SIGNAL AT WIPER SWITCH

- Disconnect harness from multi-function switch.
- Rotate interval control on the multi-function switch from min. to max.
- Measure resistance between terminals of wiper switch for Circuits 590 (DB/W) and 993 (BR/W).

Is resistance 3.3k-103.3k Ohms?

Yes	No
CHECk for open wires between the multi-function switch and the wiper control module. SERVICE as required. RETEST system.	CHECK for damaged multi-function switch. SERVICE as required. RETEST system.

PINPOINT TEST E: WINDSHIELD WIPERS WILL NOT PARK AT PROPER POSITION/CONTINUE TO RUN WHEN SWITCH IS TURNED OFF

E1 CHECK MOTOR GROUND

- Unplug wiper motor connector.
- Check for ground at Circuit 57 (BK).

Is ground present?

Yes	No
GO to **E2** .	SERVICE for open circuit. RETEST system.

E2 CHECK FOR BATTERY VOLTAGE AT WIPER MOTOR

- Key on.
- Multi-function switch off.
- Using a volt-ohmmeter, check for voltage between Circuit 65 (DG) and Circuit 57 (BK) at the windshield wiper motor connector.

Is battery voltage present?

Yes	No
GO to **E3** .	SERVICE open circuits. RETEST system.

E3 CHECK WIPER MOTOR CIRCUIT CONTINUITY THRU WIPER CONTROL MODULE

- With ignition in run and multi-function switch at off, check continuity between Circuits 28 (BK/PK) and 58 (W) and between 61 (Y/R) and known good ground at the windshield wiper motor connectors.

Is continuity present?

Yes	No
GO to **E5** .	GO to **E4** .

E4 CHECK CIRCUITS TO WIPER CONTROL MODULE

- Disconnect WCM connector.
- Check continuity of Circuits 28, 58, and 61 between windshield wiper motor and wiper control module.

Is continuity present?

Yes	No
GO to **E5** .	SERVICE for open circuit. RETEST system.

E5 CHECK WIPER LINKAGE

- Check linkage for being bent, cracked, or mispositioned from windshield wiper motor.

Is linkage OK?

Yes	No
REPLACE windshield wiper motor module. RETEST system.	SERVICE linkage as required. RETEST system.

PINPOINT TEST F: REAR WINDOW WASHER INOPERATIVE

F1 PRELIMINARY CHECK

- Check battery and charging system for proper operation.
- Check related fuses and circuit breaker.

Are they functioning properly?

Yes	No
GO to **F2** .	SERVICE circuit or component before processing. RETEST system.

F2 CHECK POWER SUPPLY TO WASHER PUMP MOTOR

- Gain access to liftgate washer pump motor.
- Disconnect washer pump motor connector.
- Key on.
- Using a test lamp volt-ohmmeter, check for voltage at connector Circuit 941 (BK/W) while depressing the rear washer switch.

Is voltage present?

Yes	No
GO to F3 .	GO to F4 .

F3 CHECK GROUND CIRCUIT TO WASHER PUMP MOTOR

- Key off.
- Using a self-powered test lamp or volt-ohmmeter, check for continuity between washer connector Circuit 57 (BK) and known good ground.

Is continuity present?

Yes	No
REPLACE liftgate washer pump motor. RETEST system.	SERVICE Circuit 57 (BK) for open. RETEST system.

F4 CHECK CIRCUIT 941 (BK/W) FOR OPEN

- Gain access to liftgate wiper/washer switch.
- Key on, leave switch connected to harness.
- Using a test lamp or volt-ohmmeter, check for voltage at switch connector Pin 5 Circuit 941 (BK/W) while depressing the washer switch.

Is voltage present?

Yes	No
SERVICE Circuit 941 (BK/W) for open. RETEST system.	REPLACE liftgate wiper/washer switch. RETEST system.

PINPOINT TEST G: REAR WINDOW WIPER INOPERATIVE

G1 PRELIMINARY CHECK

- Check battery and charging system for proper operation.
- Check related fuses and circuit breaker.

Are they functioning properly?

Yes	No
GO to G2 .	SERVICE circuit or component before proceeding. RETEST system.

G2 CHECK SWITCH SIGNAL TO WIPER MOTOR

- Gain access to liftgate wiper motor.
- Disconnect wiper motor connector.
- Key on, wiper switch to run.
- Using a test lamp or volt-ohmmeter, check for voltage at wiper motor connector Circuit 58 (W).

Is voltage present?

Yes	No
GO to **G3** .	GO to **G5** .

G3 CHECK RUN POWER SUPPLY TO WIPER MOTOR

- Key on.
- Using a test lamp or volt-ohmmeter, check for voltage at wiper motor connector Circuit 63 (R).

Is voltage present?

Yes	No
GO to **G4** .	SERVICE Circuit 63 (R) for open. RETEST system.

G4 CHECK GROUND TO WIPER MOTOR

- Using a self-powered test lamp or volt-ohmmeter, check for continuity between wiper motor connector Circuit 57 (BK) and known good ground.

Is continuity present?

Yes	No
REPLACE liftgate wiper motor. RETEST system.	SERVICE Circuit 57 (BK) for open. RETEST system.

G5 CHECK POWER SUPPLY TO WIPER SWITCH

- Gain access to liftgate wiper/washer switch.
- Key on, switch connected to harness and on.
- Using a test lamp or volt-ohmmeter, check for voltage at Pin 3 Circuit 63 (R) and Pin 4 Circuit 58 (W).

Is voltage present on both?

Yes	No
SERVICE Circuit 58 (W) for open. RETEST	If voltage is present on Pin 3 Circuit 63 (R) only, REPLACE liftgate wiper switch. If voltage is not

system.	present on either Pin, SERVICE Circuit 63 (R) for open. RETEST system.

PINPOINT TEST H: REAR WINDSHIELD WIPER WILL NOT PARK

H1 CHECK GROUND FOR PARK SWITCH

- Gain access to liftgate wiper motor.
- Disconnect wiper motor connector.
- Turn liftgate wiper switch off.
- Using a self-powered test lamp or volt-ohmmeter, check for continuity between wiper motor connector Circuit 58 (W) and known good ground.

Is continuity present?

Yes	No
REPLACE liftgate wiper motor. RETEST system.	GO to **H2** .

H2 CHECK CIRCUIT 58 (W) FOR OPEN

- Gain access to liftgate wiper/washer switch.
- Leave switch connected to harness.
- Using a self-powered test lamp or volt-ohmmeter, check for continuity between Pin 4, Circuit 58 (W) and known good ground.

Is continuity present?

Yes	No
SERVICE Circuit 58 (W) for open. RETEST system.	GO to **H3** .

H3 CHECK SWITCH GROUND FOR OPEN

- Using a self-powered test lamp or volt-ohmmeter, check for continuity between switch connector Pin 2 Circuit 57 (BK) and known good ground.

Is continuity present?

Yes	No
REPLACE liftgate wiper/washer switch. RETEST system.	SERVICE Circuit 57 (BK) for open. RETEST system.

PINPOINT TEST J: REAR WINDSHIELD WIPER WILL NOT TURN OFF

J1 CHECK LIFTGATE WIPER MOTOR OFF SIGNAL

- Gain access to liftgate wiper motor.
- Disconnect wiper motor connector.
- Turn wiper/washer switch to off.
- Using a self-powered test lamp or volt-ohmmeter, check for continuity between wiper motor connector Circuit 58 (W) and known good ground.

Is continuity present?

Yes	No
REPLACE liftgate wiper motor. RETEST system.	GO to **J2** .

J2 CHECK CIRCUIT 58 (W) FOR OPEN

- Gain access to liftgate wiper/washer switch.
- Disconnect switch connector.
- Using a self-powered test lamp or volt-ohmmeter, check for continuity between switch connector Pin 4 Circuit 58 (W) and liftgate wiper motor connector Circuit 58 (W).

Is continuity present?

Yes	No
GO to **J3** .	SERVICE Circuit 58 (W) for open. RETEST system.

J3 CHECK LIFTGATE WIPER/WASHER SWITCH GROUND

- Using a self-powered test lamp or volt-ohmmeter, check for continuity between wiper/washer switch Pin 2 Circuit 57 (BK) and known good ground.

Is continuity present?

Yes	No
REPLACE liftgate wiper/washer switch. RETEST system.	SERVICE Circuit 57 (BK) for open. RETEST system.

Component Tests

Circuit Breaker

NOTE: Front wiper motor and washer motor use the same circuit breaker.

The six-amp circuit breaker is located in the fuse panel.

Two separate tests are necessary to check for correct circuit breaker operation. Remove the circuit breaker from the fuse junction panel and connect the tester leads to the circuit breaker.

Test 1

1. Before connecting the circuit breaker to the Alternator, Regulator, Battery, and Starter Tester (ARBST) 010-00725 or equivalent, short the tester leads together and adjust the current draw until it equals the circuit breaker rating.

2. Connect the breaker to the tester. Leave the breaker connected to the tester for ten minutes. Hold the current reading on the ammeter at the rated current. If the circuit breaker opens during the ten minutes, replace the circuit breaker.

Test 2

1. Short the tester leads together and adjust the current draw until it is twice the rated current.

2. Connect the breaker. Hold the current reading on the ammeter at twice the rated current.

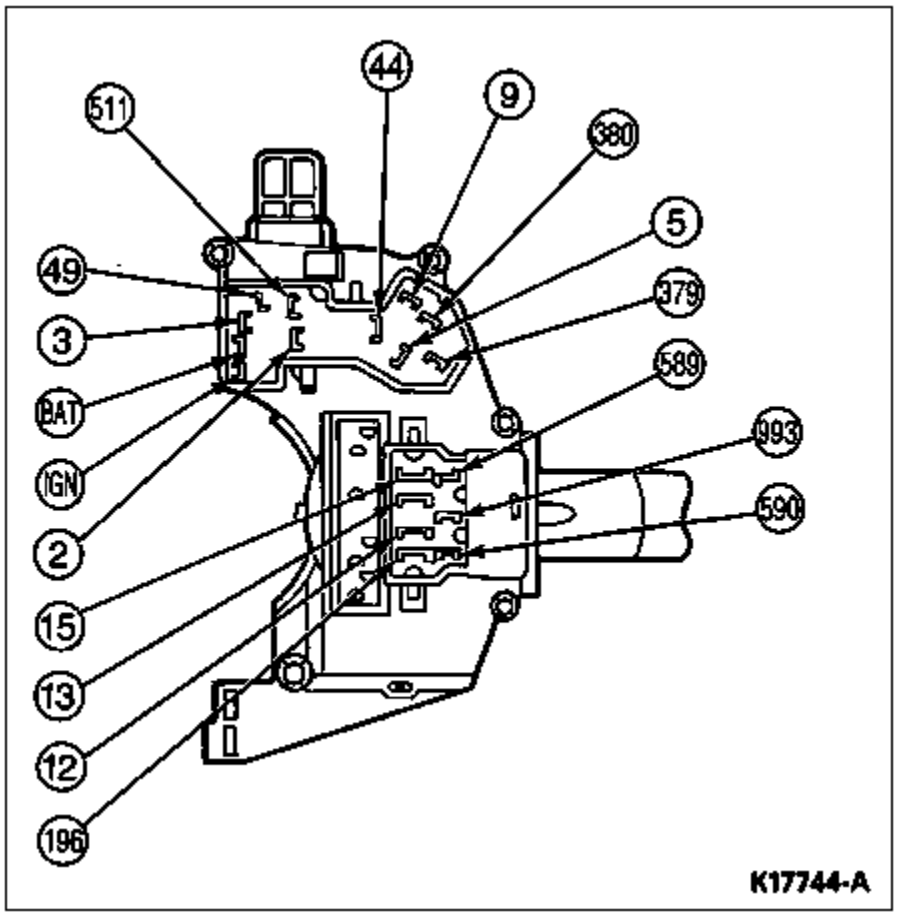
The current reading on the ammeter should drop to zero within 30 seconds. If it takes longer than 30 seconds for the circuit breaker to open (current reading drops to zero), replace the circuit breaker.

Multi-Function Switch Continuity Test

Check the continuity between the switch terminals. Either a self-powered test light or an ohmmeter can be used to test a standard two-speed switch. An ohmmeter must be used to test a switch used with the interval wiper system.

To detect marginal operation of the multi-function switch (13K359), move the lever while each reading is being taken.

If the multi-function switch does not exhibit continuity or if poor continuity exists in any switch position, replace the multi-function switch.



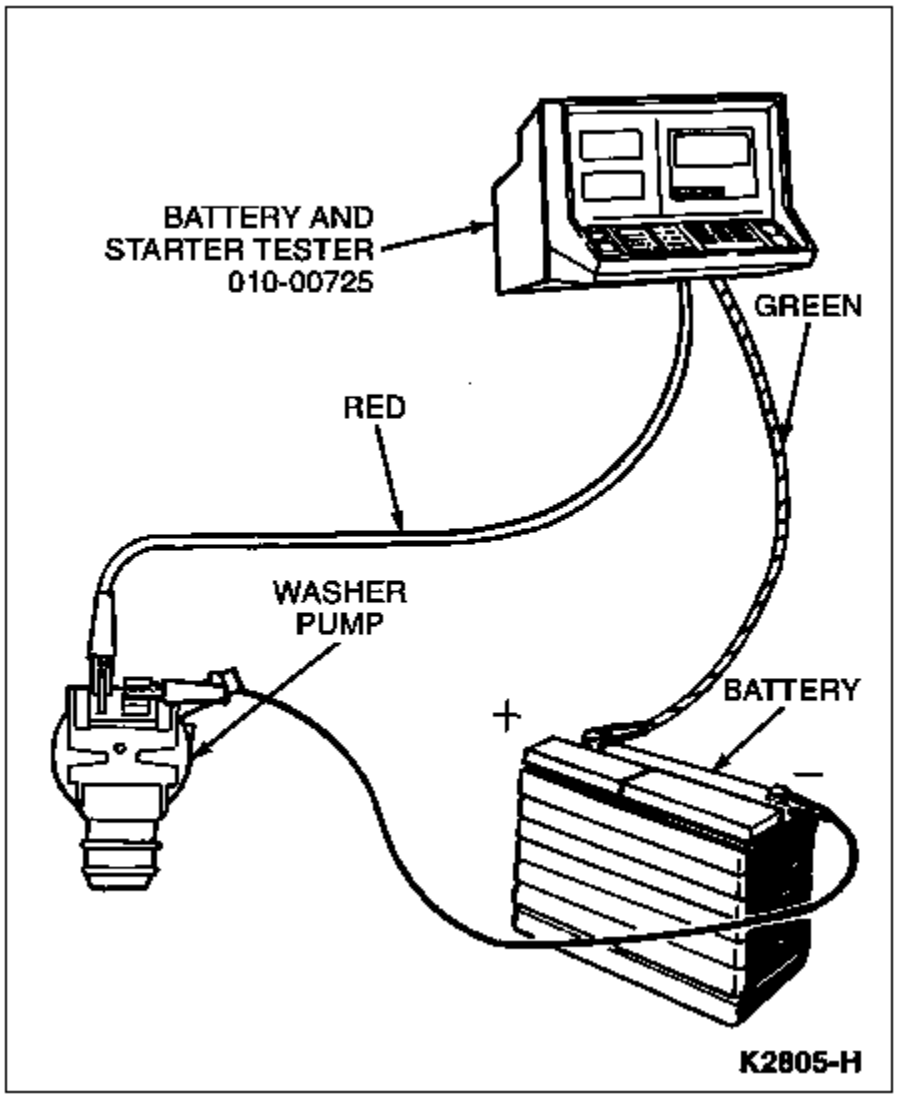
MULTI-FUNCTION SWITCH — BENCH CHECK CONTINUITY

Switch Actuator Position	Continuity by Circuit Number
Turn Signal Lever in Neutral — Hazard OFF	**Turn Signal:** Closed 511 to 5 and 9; 298 to 383. Open 511 to 2, 3, 44 and BAT: 44 to 2, 3, 5, 9; BAT to 383. **Cornering Lamp:** Open 15 to 379 and 380; 379 to 380.
Turn Signal Lever in Left Turn — Hazard OFF	**Turn Signal:** Closed 511 to 5; 44 to 3 and 9; IGN to 383. Open 511 to 3, 9, 44; 44 to 2, 5; BAT to 383. **Cornering Lamp:** Closed 15 to 380. Open 15 to 379; 379 to 380.
Turn Signal Lever in Right Turn — Hazard OFF	**Turn Signal:** Closed 511 to 9; 44 to 2 and 5; 298 to 383. Open 511 to 2, 5, 44; 44 to 3, 9 and BAT to 383. **Cornering Lamp:** Closed 15 to 380. Open 15 to 379; 379 to 380.
Hazard ON	Closed 44 to 2, 3, 5 and 9; BAT to 383. Open 511 to 5, 9, 44, 2 and 3; IGN to 383.
Hazard OFF Turn Signal Lever, Right	Closed 511 to 9; 44 to 2 and 5; 15 to 379. Open 511 to 2, 5, 44; 44 to 3 and 9.

Turn	
Headlamp Beam Switching:	
• Lever at **High Beam**	Closed 15 to 12. Open 15 to 13 and 196; 196 to 12.
• Lever at **Low Beam**	Closed 15 to 13. Open 15 to 12 and 196; 196 to 13.
• Lever at **FLASH-TO-PASS**	Closed 15 to 13; 196 to 12. Open 15 to 12; 196 to 13.
Wiper/Washer Switching:	
• Wash ON and Wiper OFF	Closed 993 to 590; Resistance 993 to 589, 47.6k Ohms ± 10%.
• Wiper OFF and Wash OFF	Resistance 993 to 590, 103.3k Ohms ± 10%. Resistance 993 to 589, 47.6k Ohms ± 10%.
• Wiper LO and Wash OFF	Resistance 993 to 590, 3.3k Ohms ± 10%. Resistance 993 to 589, 4.08k Ohms ± 10%.
• Wiper HI and Wash OFF	Resistance 993 to 590, 3.3k Ohms ± 10%. Closed 993 to 589.
• Wiper Interval and Wash OFF	Resistance 993 to 589, 11.33k Ohms ± 10%. Resistance 993 to 590. Gradually decreasing from 103.3k Ohms to 3.3k Ohms from Maximum Delay to Minimum Delay.

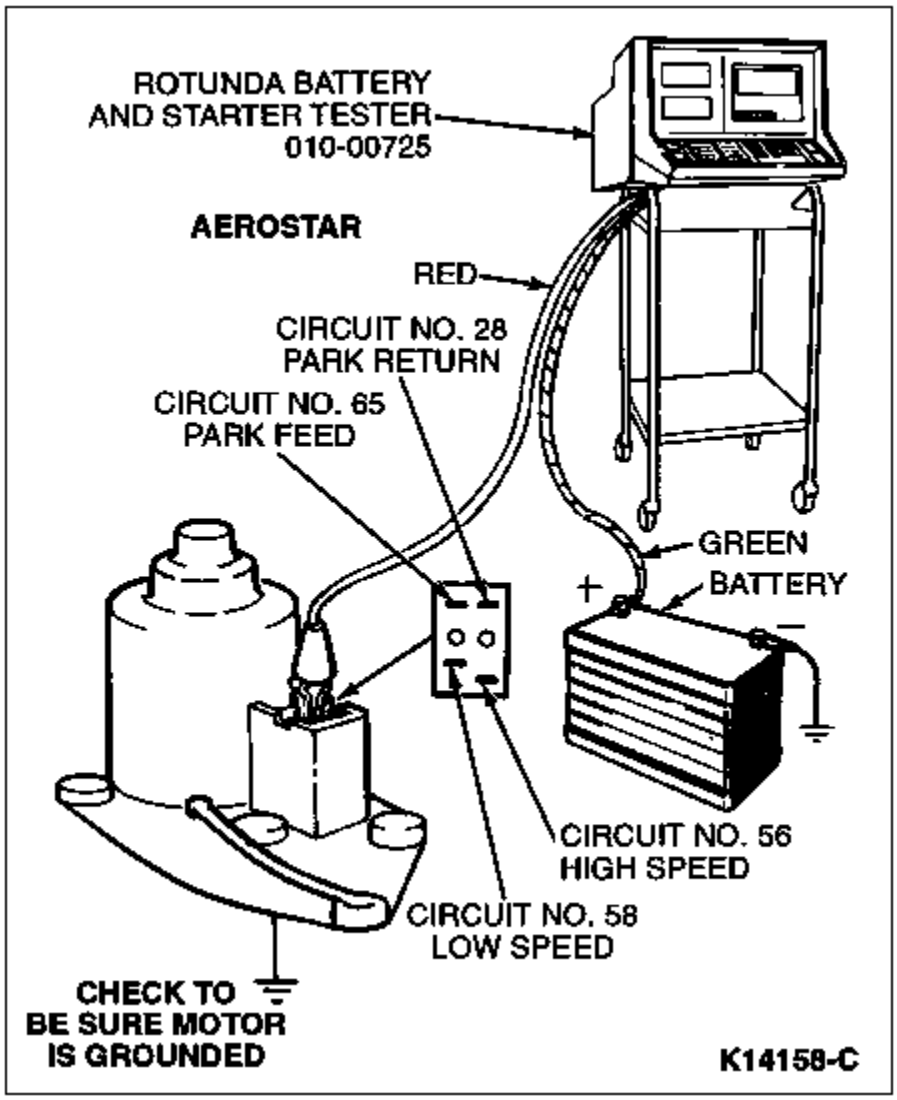
Current Draw, Windshield Washer Pump

Attach the leads of the 73 Digital Multimeter 105-R0051 or equivalent, or Alternator, Regulator, Battery and Starter Tester (ARBST) 010-00725 or equivalent as shown. The current draw should not exceed four amps nor be less than 1.7 amps while the windshield washer pump is pumping fluid.



Current Draw, Windshield Wiper Motor

1. Disconnect battery to starter relay cable (14300) from battery.
2. Disconnect windshield wiper pivot arm (17526) from windshield wiper motor (17504).
3. Disconnect the electrical plug to test the windshield wiper motor on the vehicle.
4. Connect the (green) lead from Rotunda Alternator, Regulator, Battery and Starter Tester 010-00725 (ARBST) or equivalent to the positive post of the battery.
5. Connect the positive (red) lead from the tester to low speed connection and high speed connection at connector plug as shown. In either case, the current draw should not exceed three amperes.


ROTUNDA BATTERY
AND STARTER TESTER
010-00725
AEROSTAR
RED
CIRCUIT NO. 28
PARK RETURN
CIRCUIT NO. 65
PARK FEED
GREEN
BATTERY
+
–
CIRCUIT NO. 56
HIGH SPEED
CIRCUIT NO. 58
LOW SPEED
CHECK TO
BE SURE MOTOR
IS GROUNDED
K14158-C

Windshield Wiper

Mounting Arm and Pivot Shaft

Removal and Installation

1. Turn multi-function switch (13K359) on. When windshield wiper pivot arms (17526) are in mid-position, turn ignition switch (11572) to OFF.
2. Disconnect windshield wiper motor (17504) electrical connector.
3. Remove both windshield wiper pivot arms. Refer to Windshield Wiper Pivot Arm Removal and Installation.
4. Remove cowl top vent panel (022A68).
5. Remove windshield wiper adapter and connecting arm clip (17531) retaining windshield wiper mounting arm and pivot shaft (17566) to wiper motor. Refer to the illustration under Wiper Motor Removal and Installation.
6. Remove four retaining screws.
7. Remove windshield wiper mounting arm and pivot shaft from vehicle.

For installation follow removal procedures in reverse order.

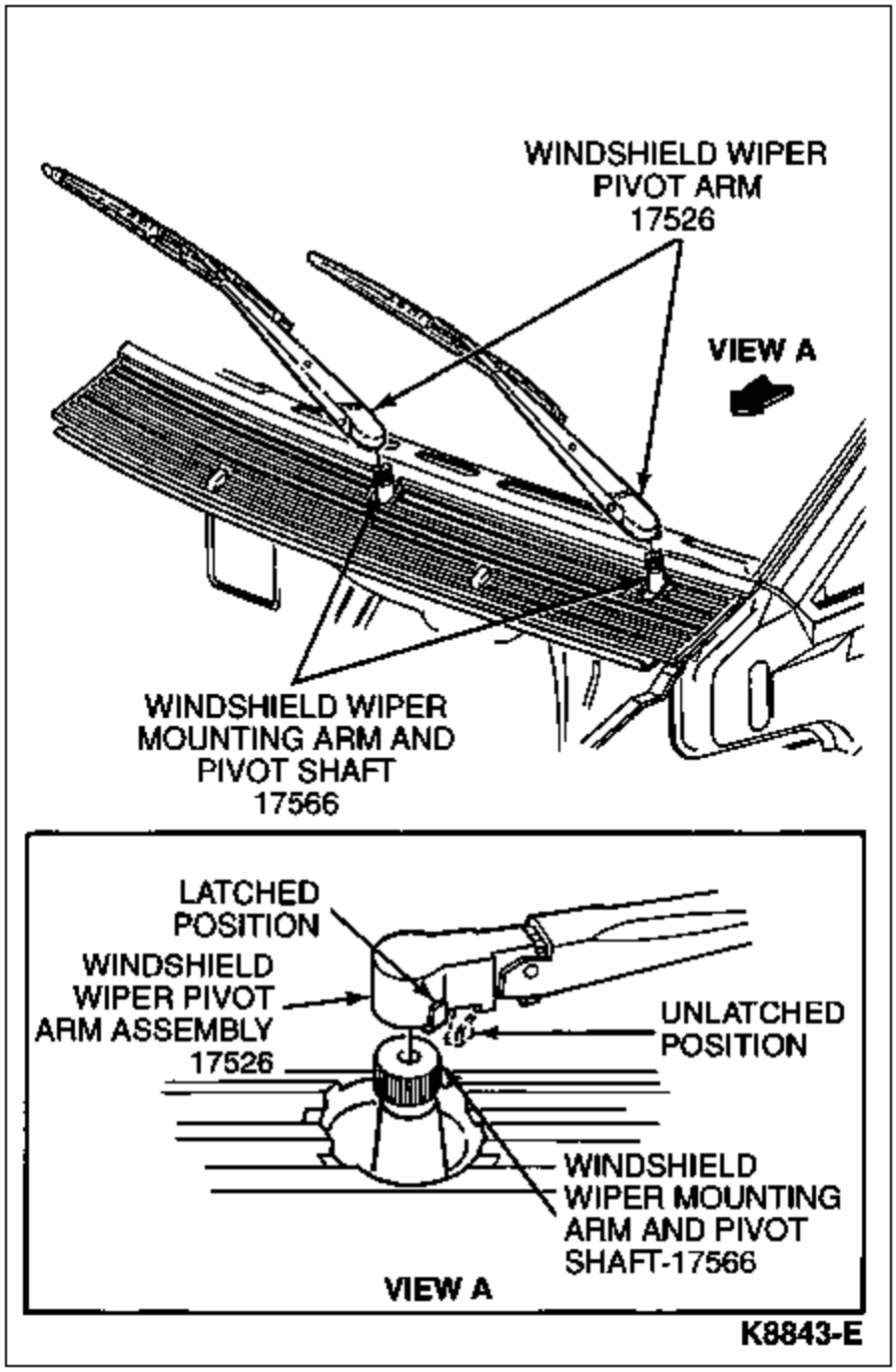
Pivot Arm

NOTE: No tools are required.

Removal and Installation

1. Raise windshield wiper pivot arm off windshield glass (03100) to specified dimension. Refer to Dimension X Chart in Specifications. Move slide latch away from windshield wiper mounting arm and pivot shaft.
2. Remove windshield wiper pivot arm assembly.

For installation, follow removal procedures in reverse order.



Wiper Blade

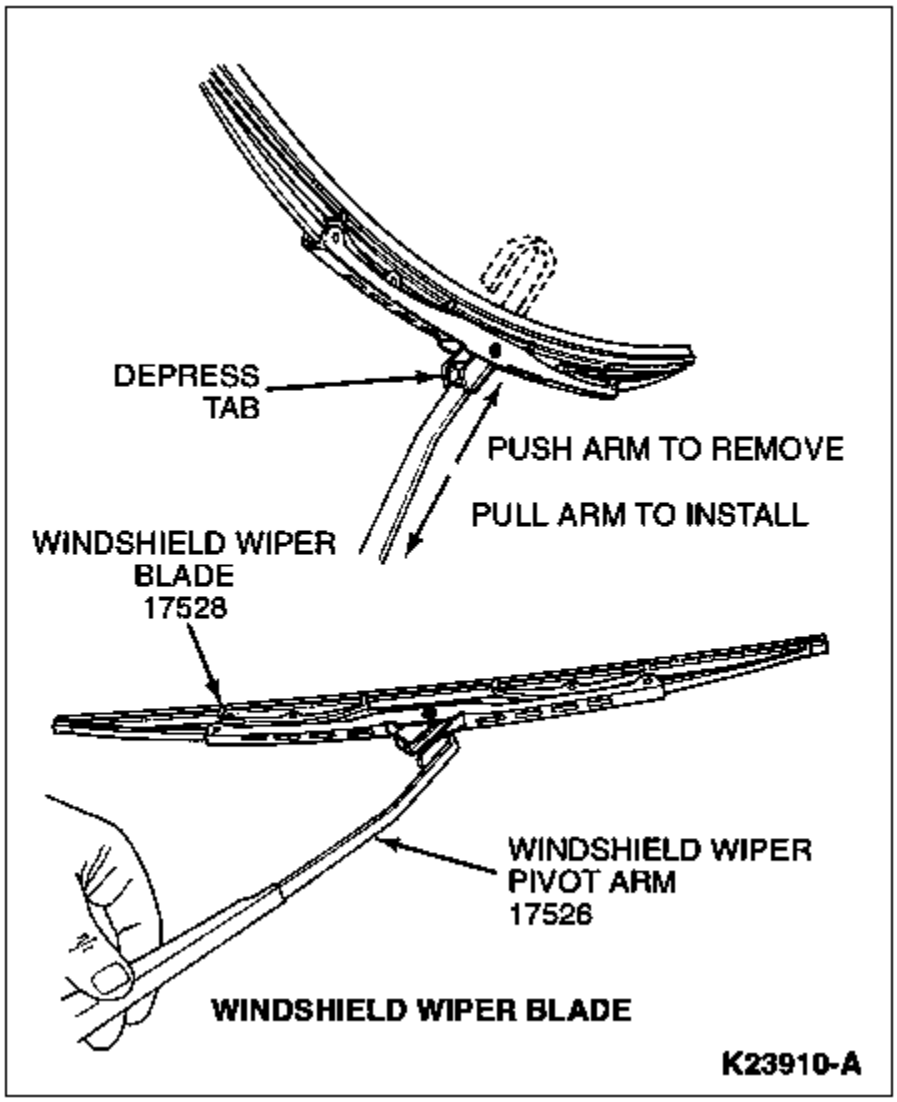
Removal and Installation

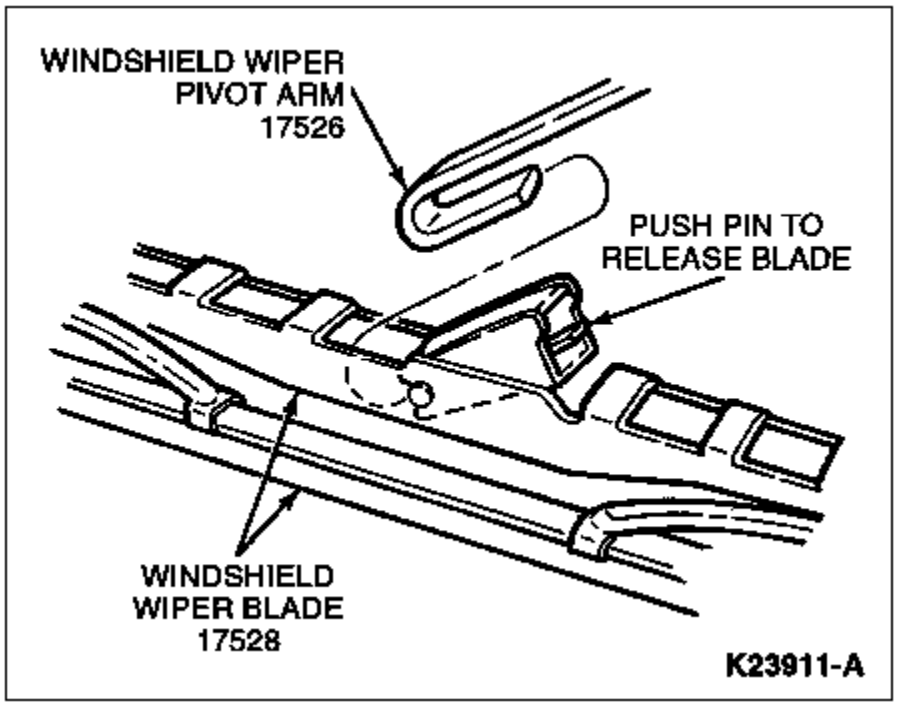
1. Cycle windshield wiper pivot arm assembly to where removal of windshield wiper blade (17528) can be performed without difficulty. Turn ignition switch off when wiper is in desired position.

2. To remove windshield wiper blade assembly from windshield wiper mounting arm and pivot shaft, depress lock tab and push windshield wiper mounting arm and pivot shaft away from windshield wiper

blade.

3. To install windshield wiper blade, pull windshield wiper mounting arm and pivot shaft down on windshield wiper blade until lock tab is engaged.

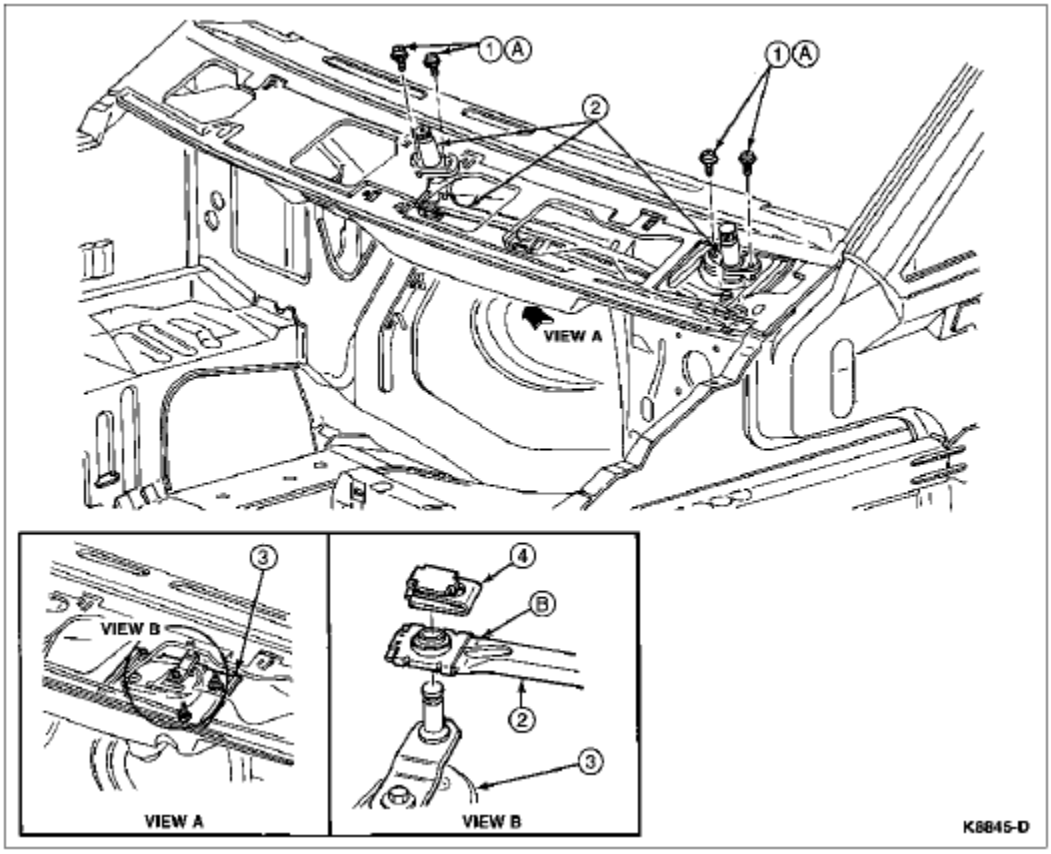




Motor

NOTE: The windshield wiper motor is not serviceable. It must be replaced as a complete assembly.

Front Windshield Wiper Motor

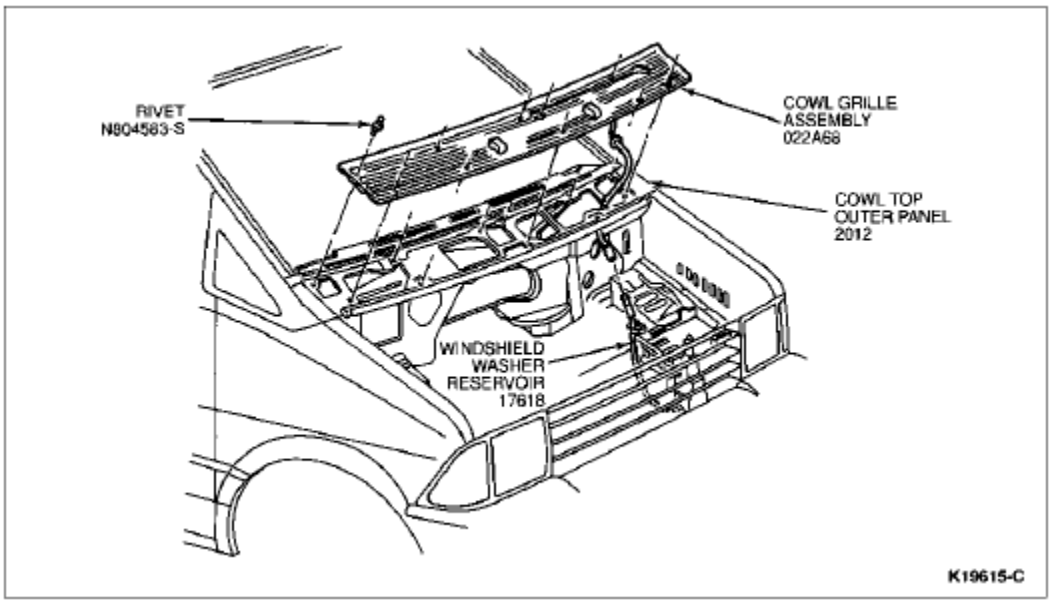


Item	Part Number	Description
1	N805837	Screw (2 Req'd Each Pivot)
2	17566	Windshield Wiper Mounting Arm and Pivot Shaft
3	17504	Windshield Wiper Motor
4	17531	Windshield Wiper Adapter and Connecting Arm Clip
A	—	Tighten to 7-10 Nm (62-89 Lb-In)
B	—	Press Here to Install

Removal and Installation

1. Turn the multi-function switch on. Turn ignition switch to RUN until the windshield wiper blades are in midpattern. Then turn ignition switch to OFF.
2. Disconnect battery.
3. Disconnect the wiring connector of windshield wiper motor.
4. Remove both windshield wiper mounting arm and pivot shafts.
5. Remove cowl top vent panel.

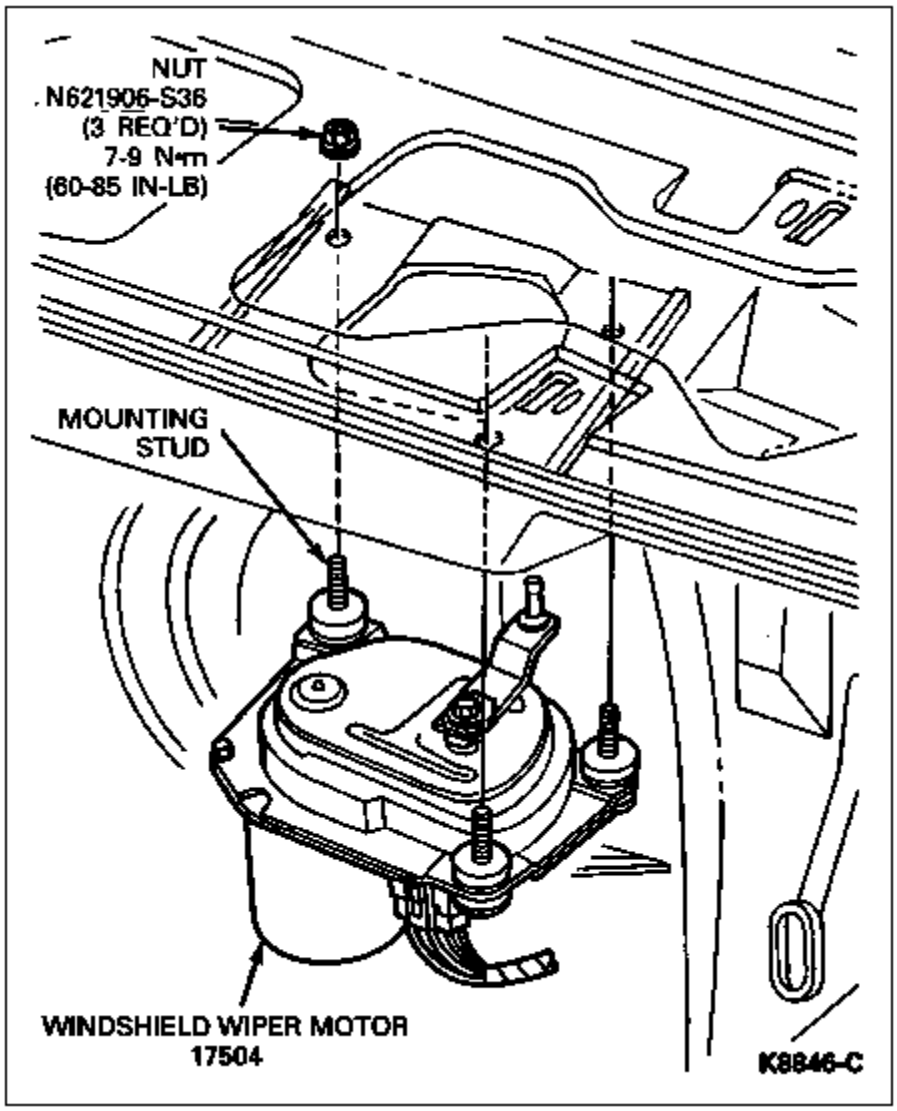
Cowl Top Vent Grille Removal



6. Remove windshield wiper adapter and connecting arm clip and disassemble linkage from crank arm.

7. **CAUTION: Support windshield wiper motor from underside to prevent it from falling and possible damage.**

   Remove retaining nuts.



NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650), relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 mi) or more to relearn the strategy.

For installation, follow removal procedures in reverse order.

Install the windshield wiper pivot arm and windshield wiper blade assemblies on the pivot shafts to dimension X. Dimension X is the distance between the centerline of the blade saddle and the top edge of the cowl top vent panel. The value of Dimension X for each vehicle is given in the Dimension X Chart in the Specifications portion of this section.

Windshield Wiper Control Module

Removal and Installation

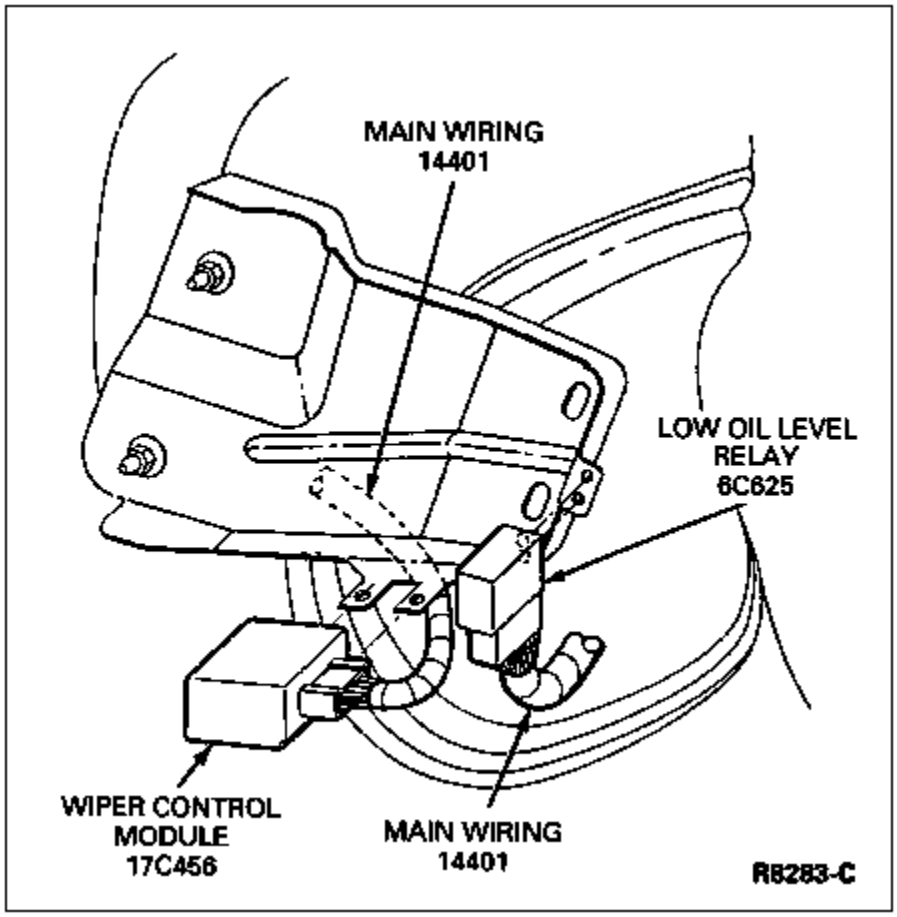
1. Disconnect battery.
2. Remove steering column lower trim panel. Refer to Section 11-04B .

3. Remove wiper control module from bracket.

4. Disconnect main wiring (14401) connector.

NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 mi) or more to relearn the strategy.

For installation, follow removal procedures in reverse order.



Washer Pump and Seal Assembly, Windshield

Removal

1. Remove windshield washer reservoir (17618) from vehicle. Disconnect main wiring (14401) and hose (17543).
2. Using a small-blade screwdriver, pry out windshield washer pump, being careful not to damage plastic housing.
3. Remove one-piece seal/filter and inspect for damage or debris.

Installation

1. Insert seal.
2. Lubricate inside diameter of seal with soapy solution.
3. Insert windshield washer pump into cavity until it is firmly seated in the seal.
4. Connect main wiring plugs and hose and replace windshield washer reservoir in vehicle.
5. Fill windshield washer reservoir slowly, otherwise air will be trapped in windshield washer reservoir causing it to overflow.
6. **CAUTION: Do not operate windshield washer pump until fluid is added to windshield washer reservoir.**

   Operate washer system.
7. Check for leaks.

Multi-Function Switch

NOTE: The handle is an integral part of the multi-function switch (13K359) and cannot be removed separately.

For removal and installation procedures refer to Section 11-05 .

Wiper System, Rear Window

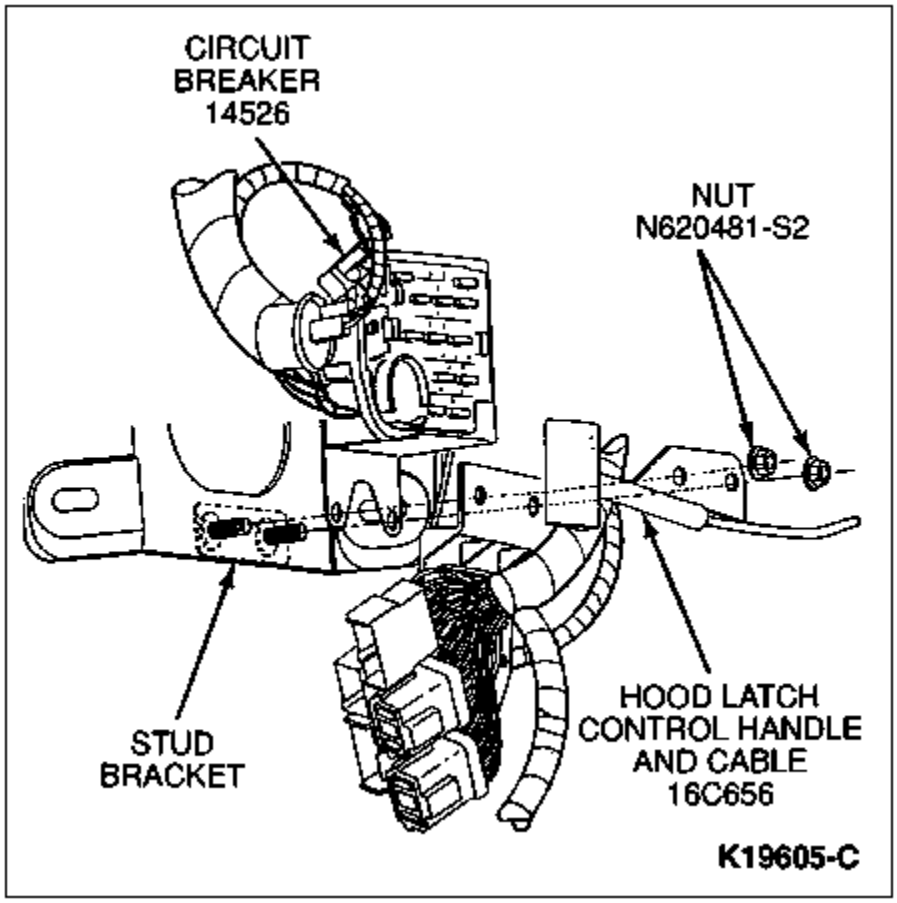
Circuit Breaker

Removal and Installation

1. Disconnect battery.
2. Remove screw from circuit breaker to instrument panel.
3. Remove wires from circuit breaker.

NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 mi) or more to relearn the strategy.

For installation, follow removal procedure in reverse order.



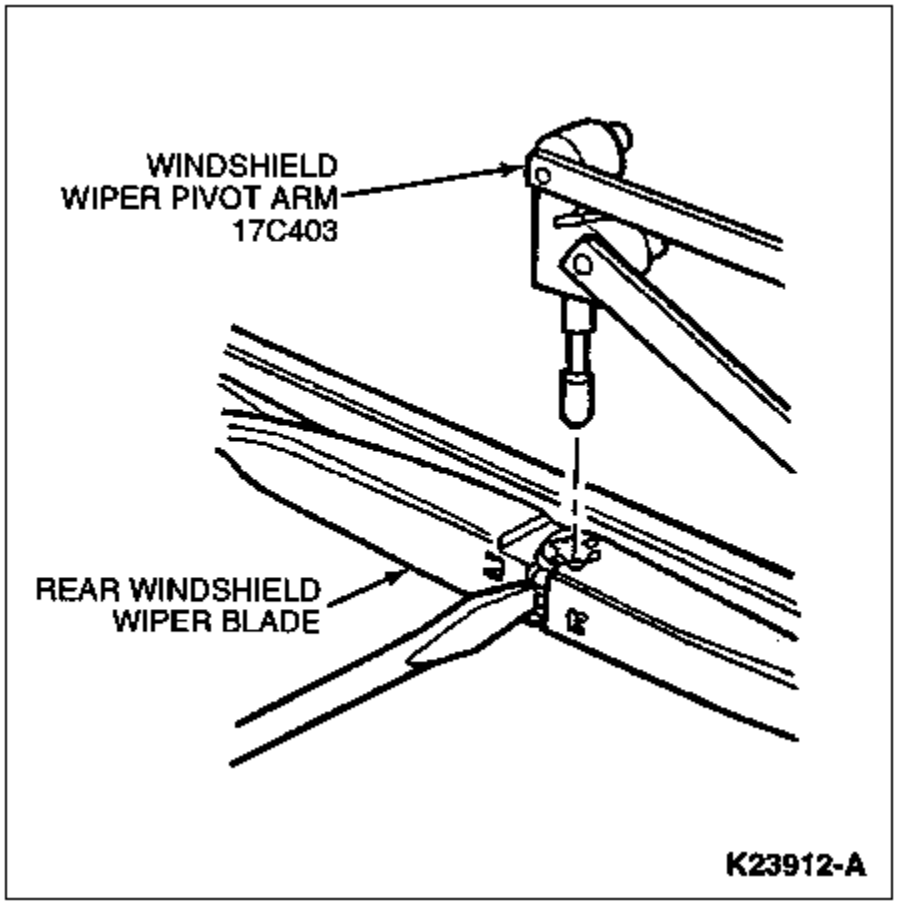
Wiper Blade, Rear

Removal and Installation

1. Cycle windshield wiper pivot arm (17526) and windshield wiper blade (17528) assembly to where removal of windshield wiper blade can be performed without difficulty. Turn ignition switch (11572) off at desired position.

2. To remove windshield wiper blade assembly, insert screwdriver in slot, push down on spring lock and pull windshield wiper blade assembly from pin.

3. To install, push the windshield wiper blade assembly on the pin so the spring lock engages the pin. Make sure the windshield wiper blade assembly is securely attached to pin.

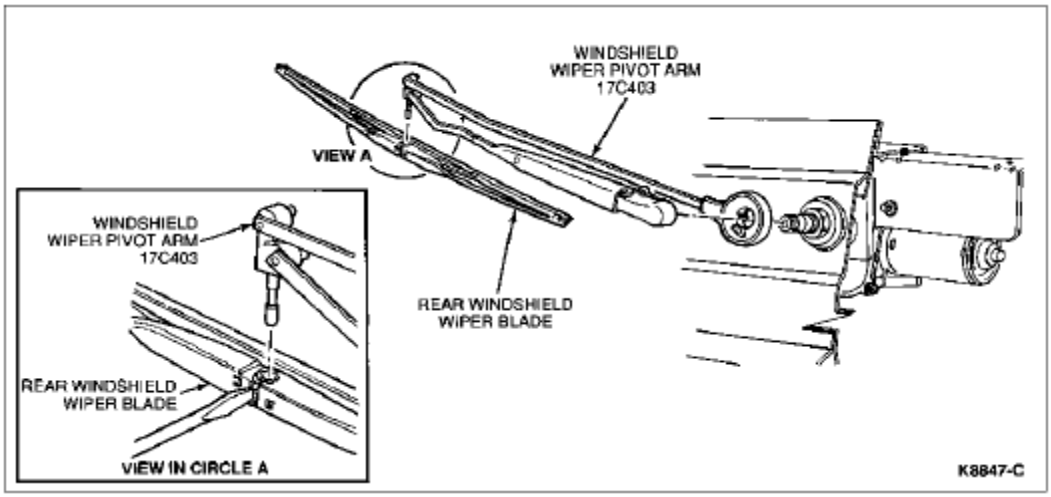


Arm, Wiper Pivot

NOTE: Windshield wiper pivot arm can be removed and installed without the aid of any tools.

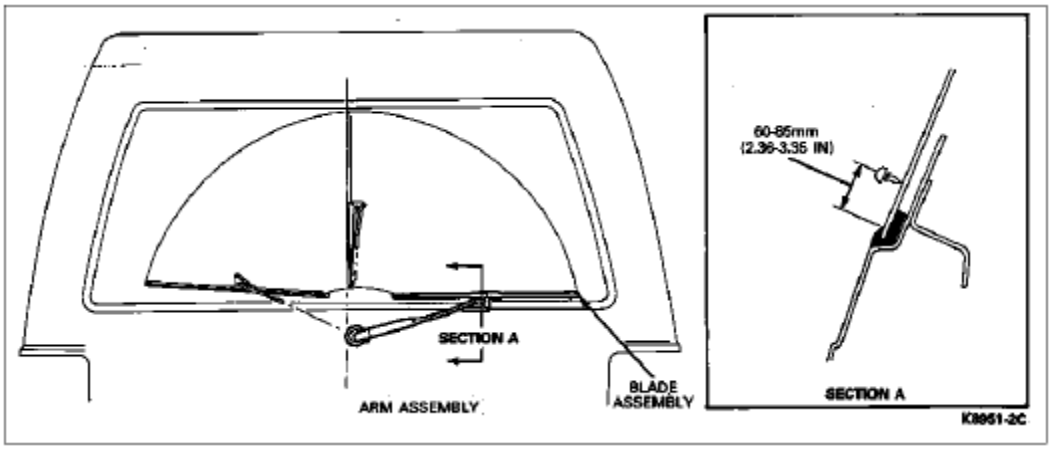
Removal and Installation

Arm and Blade Removal



1. Raise windshield wiper blade off back window glass, move latch from pivot shaft and release windshield wiper blade.

Rear Wiper Arm Assembly



2. **NOTE: Make sure pivot shaft is in park position and windshield wiper blade is positioned to the correct dimension.**

   Push main head over pivot shaft.

3. Hold the main arm head onto the pivot shaft, while raising the blade end of the windshield wiper pivot arm.

4. **NOTE: If windshield wiper pivot arm does not firmly contact back window glass, the latch is not fully seated.**

   Slide latch toward windshield wiper pivot arm until fully seated under pivot.

5. Lower windshield wiper pivot arm to back window glass.

Wiper/Washer Switch, Rear Window

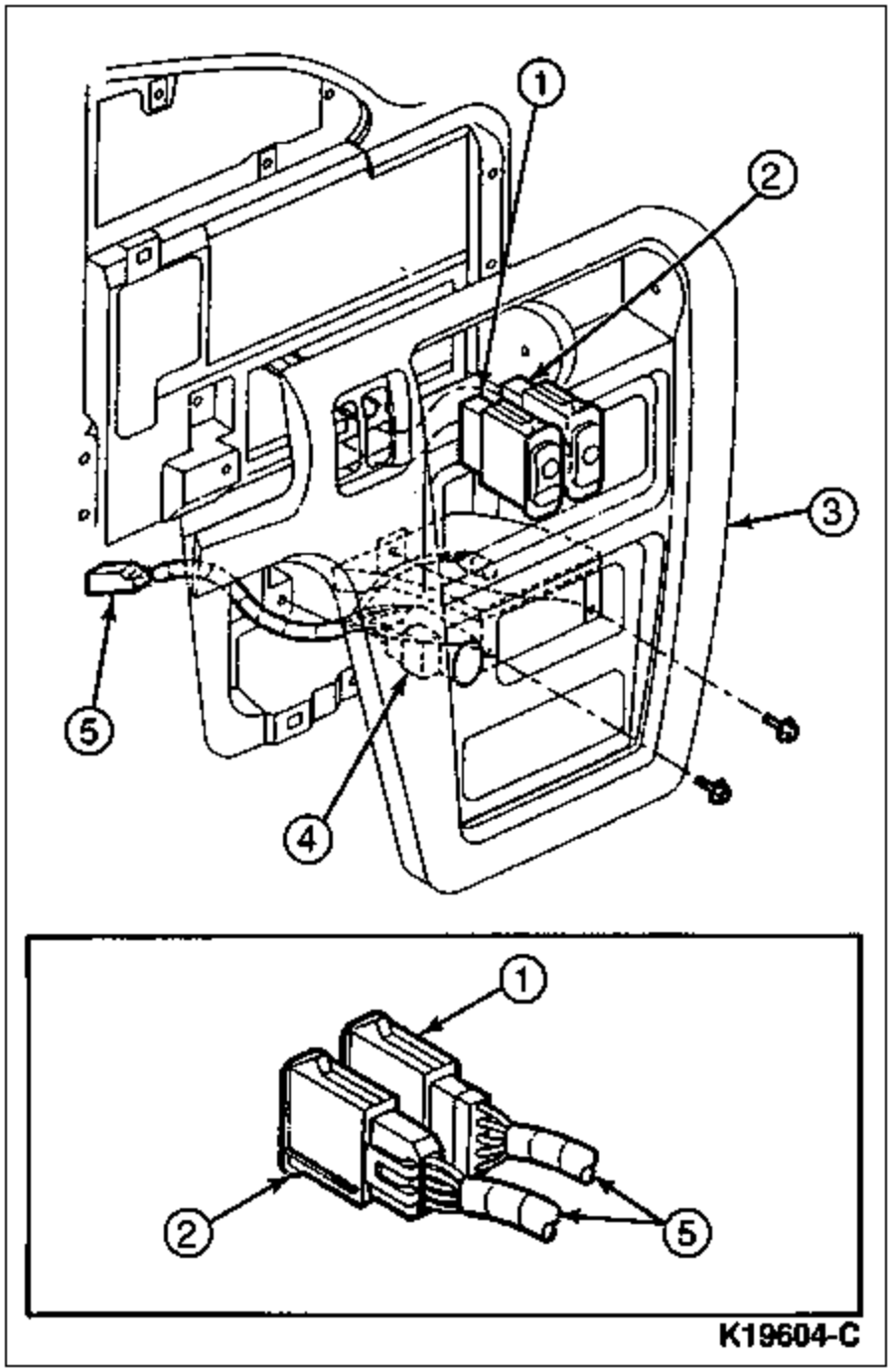
Removal

1. Disconnect the battery ground cable (14301).
2. Remove the center trim panel. Refer to Section 01-05A .
3. Remove the main wiring (14401) connector from rear windshield wiper/washer switch (17A553).
4. Remove windshield wiper/washer switch from the center trim panel by pushing on windshield wiper/washer switch from main wiring connector side until the snap-in mounting clips release.

Installation

1. Feed the main wiring connector through the windshield wiper/washer switch mounting hole on center trim panel.
2. Install main wiring connector to windshield wiper/washer switch.
3. Snap switch into center trim panel.
4. Install center trim panel.
5. **NOTE: When the battery ground cable has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 mi) or more to relearn the strategy.**

   Connect battery ground cable.
6. Check system operation.



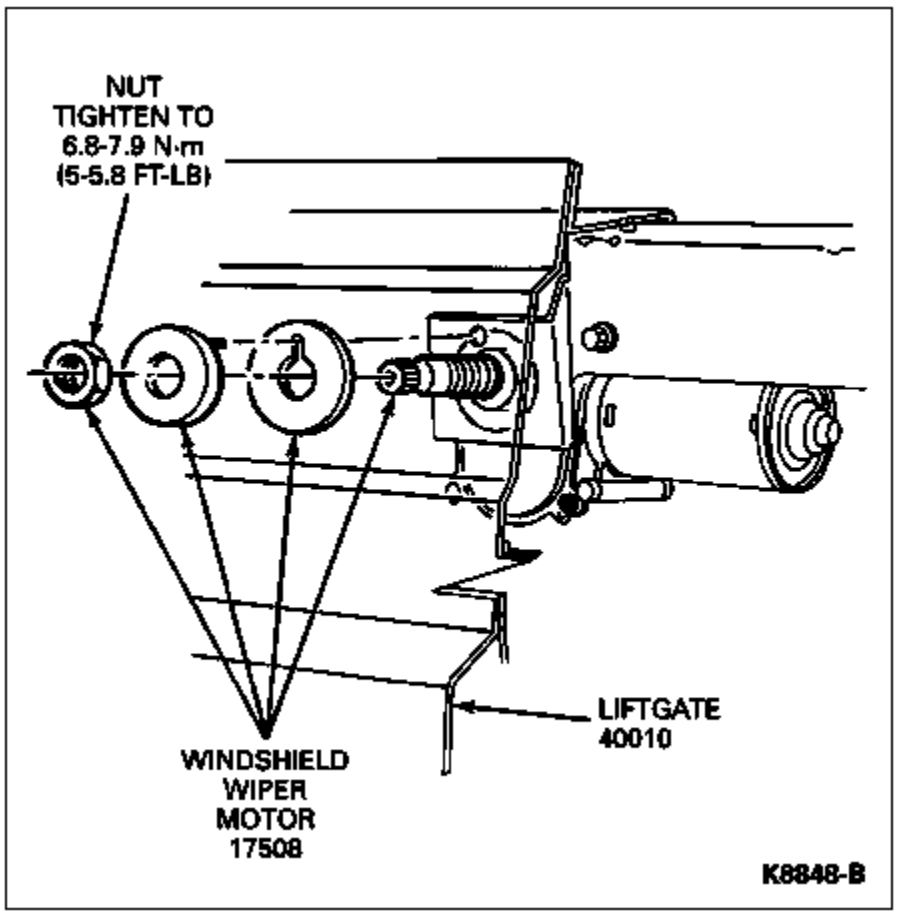
Item	Part Number	Description
1	17A406	Rear Window Wiper/Washer Switch
2	18C621	Heated Back Window Switch and Light
3	044D70	Instrument Panel Finish Panel
4	13776	Interior Lamp
5	14401	Main Wiring

Wiper Motor, Rear Window

Removal

NOTE: The windshield wiper motor is not serviceable. It must be replaced as a complete assembly.

1. Remove windshield wiper pivot arm (17526) and windshield wiper blade.
2. Remove motor shaft attaching nut and wedge block.
3. Remove liftgate door trim panel. Refer to Section 01-05B .
4. Disconnect electrical connector.
5. Remove motor wiring pins from inner panel.
6. Remove the windshield wiper motor.



Installation

1. Place windshield wiper motor into liftgate so windshield wiper motor output arm (17A436) protrudes through hole in outer panel.

2. Attach windshield wiper motor to liftgate door trim panel with bracket attaching screws. Do not tighten.

3. Install rubber seal and wedge block over windshield wiper motor output arm. Install pivot attaching nut. Tighten nut to 6.8-7.9 Nm (5-5.8 lb-ft).

4. Tighten motor bracket attaching screws. Tighten to 6.8-7.9 Nm (5-5.8 lb-ft).

5. Attach rear license lamp feed wiring (13B440) to liftgate door trim panel by installing wiring pushpins in holes provided.

6. **NOTE: Wiper system must be cycled and parked by operating the windshield wiper/washer switch (17A553). This will make sure system linkage is in PARK position before windshield wiper pivot arm and blade is installed.**

   Locate blade to specified installation position.

7. **NOTE: Use finger pressure only to slide latch, then release windshield wiper pivot arm and windshield wiper blade (17528) against back window glass.**

   While applying a downward pressure on windshield wiper pivot arm head, to obtain full seating, raise other end of windshield wiper pivot arm sufficiently to allow the latch to slide under windshield wiper pivot arm to locked position.

Washer Nozzle Jet and Bracket

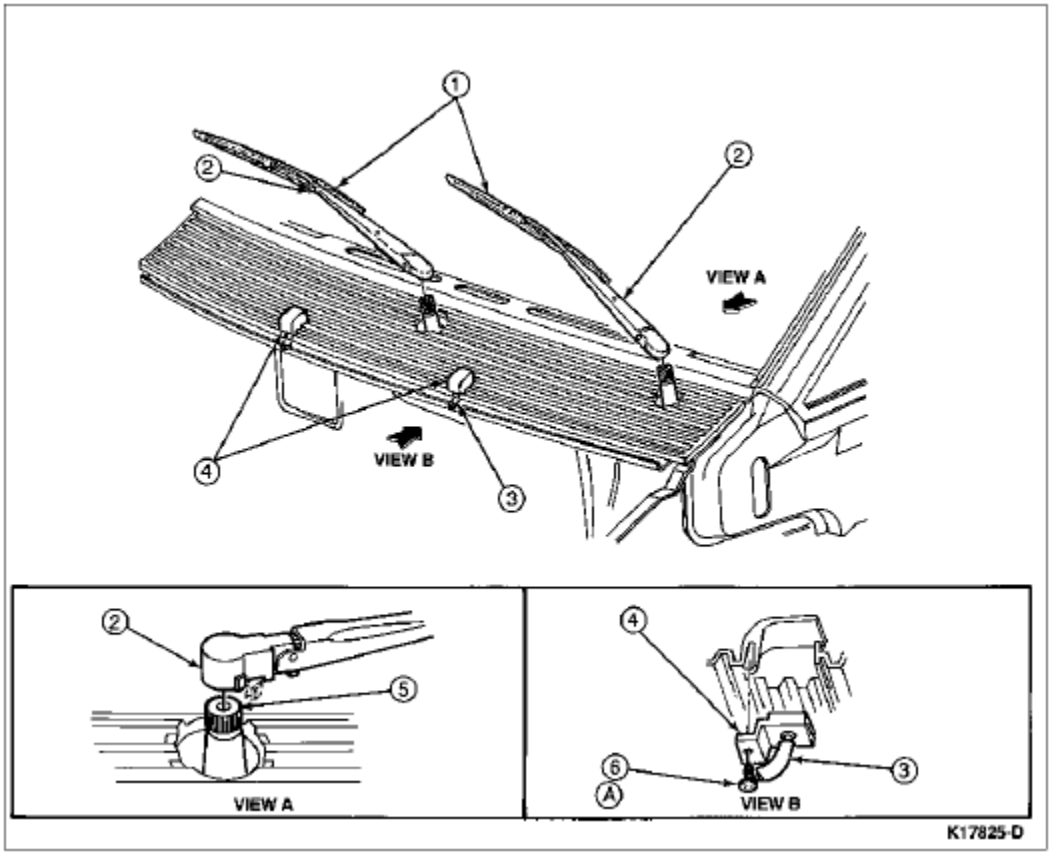
Removal

1. Remove right and left wiper windshield wiper pivot arms (17526).
2. Remove cowl top vent panel (022A68).
3. Disconnect hoses (17543).
4. Remove screw retaining windshield washer nozzle jet and bracket (17603) to cowl top vent panel.

Installation

1. Position windshield washer nozzle jet and bracket on cowl top vent panel.
2. Install screw. Tighten to 1-2 Nm (9-18 lb-in).
3. Connect hoses.
4. Install cowl top vent panel and windshield wiper pivot arm.
5. Operate front washer system to verify windshield washer nozzle jet and bracket aim and position.

Front Windshield Washer Nozzles



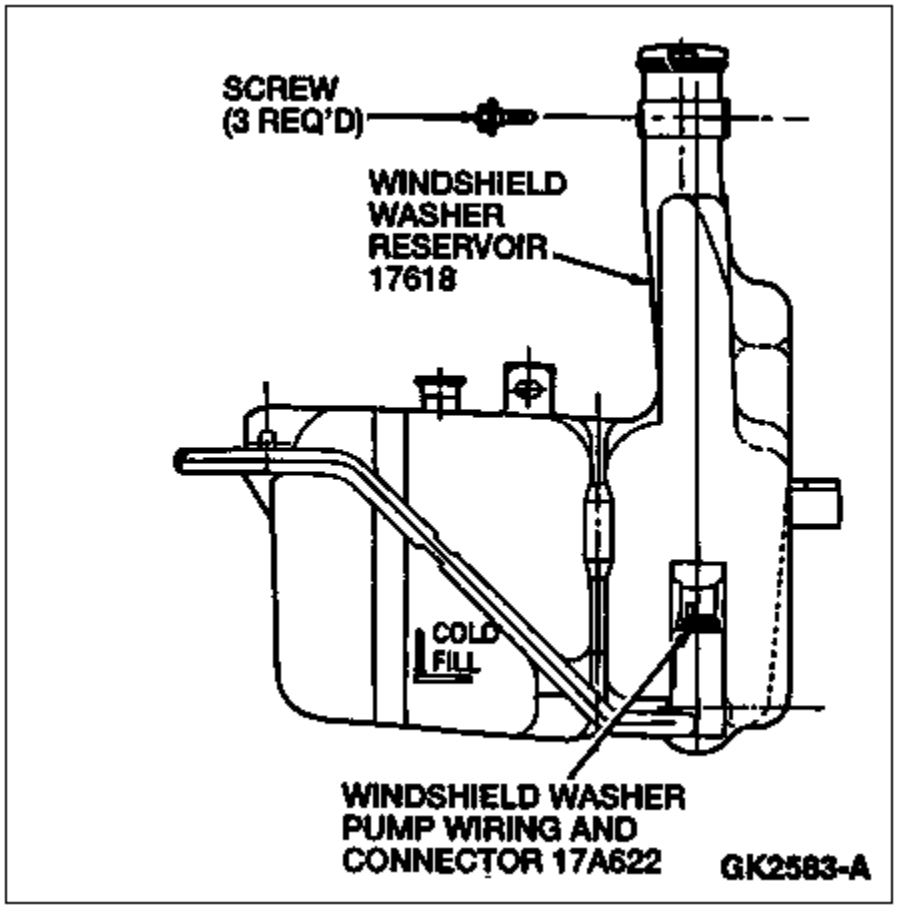
Item	Part Number	Description
1	17528	Windshield Wiper Blade
2	17526	Windshield Wiper Pivot Arm
3	17A605	Hose, Washer Nozzle Jet
4	17666	Windshield Washer Nozzle Jet and Bracket
5	17566	Windshield Wiper Mounting Arm and Pivot Shaft
6	56919	Screw
A	—	Tighten to 1-2 Nm (9-18 Lb-In)

Washer Pump and Reservoir

NOTE: The windshield washer reservoir (17618) assembly is serviced separately. The windshield washer pump and grommet are also serviced separately from the windshield washer reservoir.

Removal

1. Disconnect headlamp dash panel junction wire (14290) from windshield washer pump.
2. Remove retaining screws and lift assembly.
3. Disconnect hoses (17543).
4. Drain and discard contents of windshield washer reservoir.



Installation

CAUTION: Do not make electrical connection prior to filling reservoir. Do not operate

windshield washer pump prior to filling windshield washer reservoir.

1. Connect hoses.

2. Position assembly to front fender apron (16054) or front fender radiator support reinforcement (16B072). Install retaining screws.

3. Install hose and headlamp dash panel junction wire to windshield washer pump.

Washer System, Rear Window

Nozzle Jet and Bracket

Removal

1. Disconnect hose (17543) at windshield washer nozzle jet and bracket (17603).

2. Remove windshield washer nozzle jet and bracket attaching nut to liftgate. Remove windshield washer nozzle jet and bracket.

Installation

1. Position windshield washer nozzle jet and bracket to liftgate and install nut. Tighten nut to 1.0-1.5 Nm (8-13 lb-in).

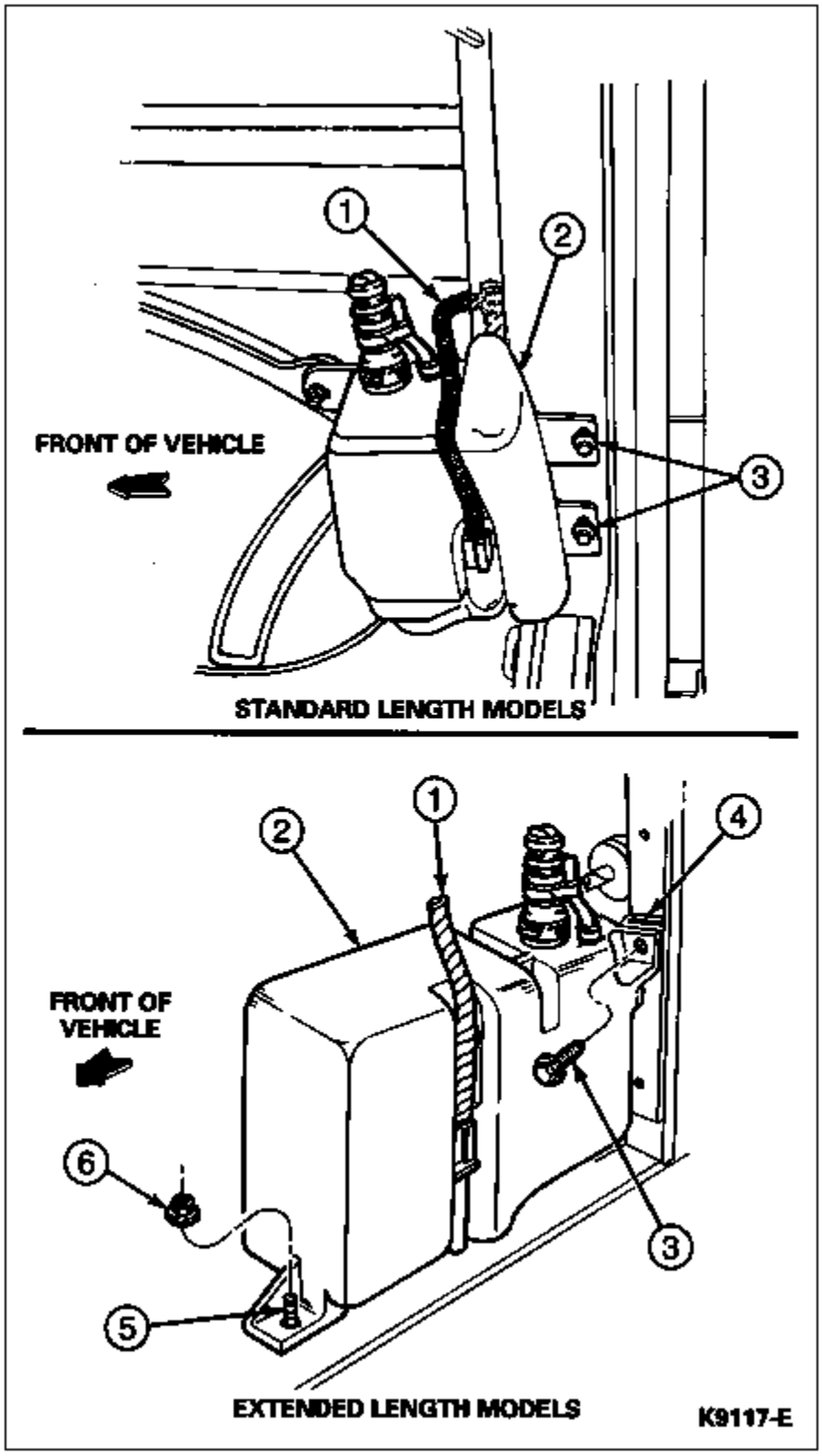
2. Connect hose to windshield washer nozzle jet and bracket and check washer operation.

Pump and Reservoir

Removal

1. Remove RH quarter trim panel. Refer to Section 01-05B .
2. **NOTE: Drain washer reservoir mounting bracket (17651) prior to removing windshield washer pump window washer hose (17408) to prevent spilling fluid on the floor of the van.**

   Disconnect windshield washer reservoir hose.
3. Disconnect windshield washer pump rear lamp wiring (14405).
4. Remove washer reservoir mounting bracket attaching screws to quarter trim panel and floor panel.
5. Remove washer reservoir mounting bracket.



Item	Part Number	Description
1	14401	Main Wiring
2	17618	Windshield Washer Reservoir

3	380924	Screw
4	N623342	J-Nut
5	N803448	Weld Stud
6	N621905	Nut

Installation

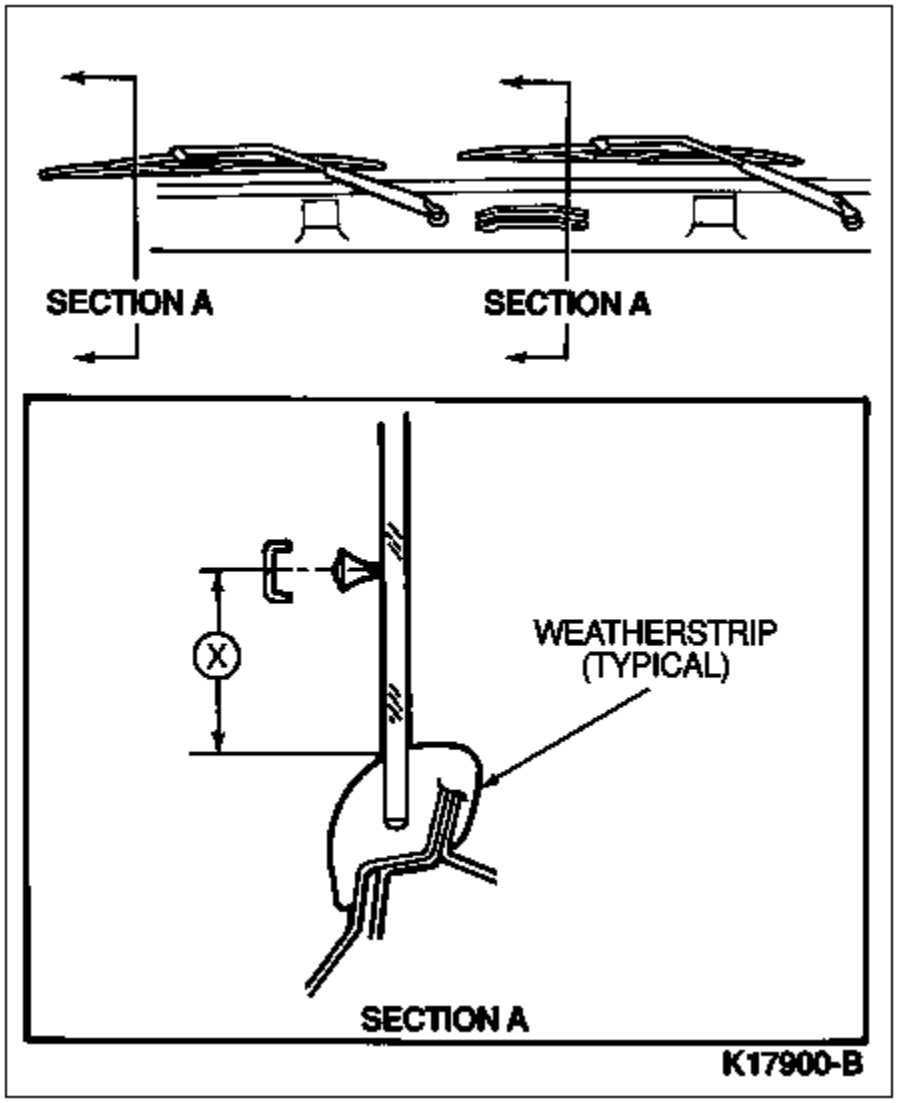
1. Install window washer hose to windshield washer pump discharge nipple.
2. Position washer reservoir mounting bracket on quarter trim panel and install attaching screws.
3. Connect rear lamp wiring to windshield washer pump.
4. Connect window washer hose.
5. Fill reservoir with washer fluid.
6. Check rear windshield washer operation.
7. Install quarter trim panel. Refer to Section 01-05B .

Park Position

Remove the arm and blade assemblies from the pivot shafts. Turn on the wiper switch, allow the motor to move the pivot shafts three or four cycles, and then turn off the wiper switch. This will place the pivot shafts in PARK position.

Install the arm and blade assemblies on the pivot shafts to Dimension X (69-96mm [2.7-3.8 inches] on driver's side; 77-104mm [3.0-4.1 inches] on passenger's side). Dimension X is the distance between the centerline of the blade saddle and the windshield lower moulding or weatherstrip. Dimension X distance must be maintained regardless of level of arm fastening.

Wiper Arm and Blade Adjustment



SPECIFICATIONS

WINDSHIELD WIPER MOTOR AND SWITCH TEST CURRENT LIMITS

Motor Type	Motor Current [a] Draw Test	Circuit Breaker/Switch Low Current Pass Test	Circuit Breaker/Switch High Current Pass Test
System "A"	2.5 Amperes	Must Hold One Hour at 6 Amperes	Must Trip Within 30 Seconds at 12 Amperes

[a] Motor maximum current when operated without linkage attached.

DIMENSION X

Driver's Side	Passenger's Side
69.0-96.0mm (2.7-3.8 Inches)	77.0-104.0mm (3.0-4.1 Inches)

TORQUE SPECIFICATIONS

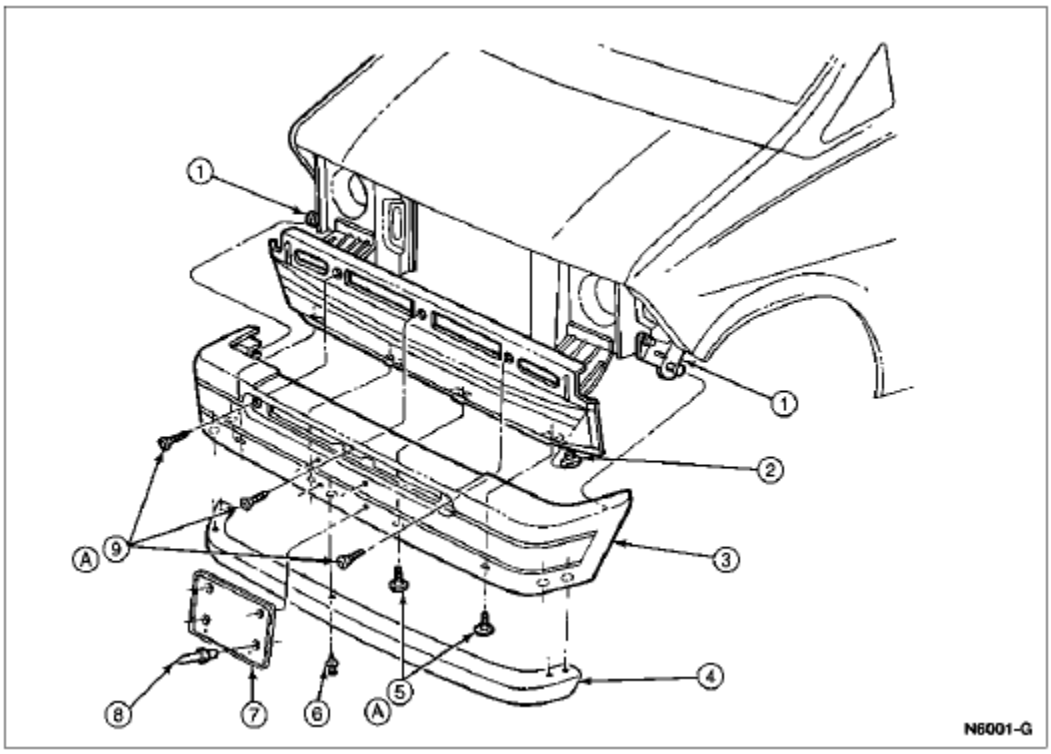
Description	Nm	Lb-Ft	Lb-In
Pivot Shaft Screws	7-10	—	62-89
Motor Bracket Attaching Screw	6.8-7.9	5-5.8	—
Pivot Attaching Nut	6.8-7.9	5-5.8	—
Reservoir Assembly Screw (2 Req'd Each Side)	4.0-6.0	—	35-53
Jet Assembly Locking Nut	1.0-1.5	—	9-13
Liftgate Nozzle Nut	1.0-2.0	—	8.8-17.7
Windshield Washer Nozzle Jet and Bracket Screw, Aerostar	1.0-2	—	9-18

Bumper, Front, Aerostar

Removal and Installation

The Aerostar front bumper is welded directly to the body shell and cannot be removed without drilling out spot welds.

Bumper, Front, Aerostar



Item	Part Number	Description
1	—	Bracket Assembly, Front Bumper Mounting End (Part of 16005)
2	N800852	Spring Nut
3	17D957	Front Bumper Cover
4	001A06	Deflector, Front Air
5	N803573-S100	Shoulder Bolt
6	N803362-S	Pushpin
7	17A385	Front License Plate Mounting Bracket
8	N803043-S	Plastic Rivet
9	N805070-S100	Screw, Shoulder

A	—	Tighten to 9-14 Nm (7-10 Lb-Ft)

Bumper Cover, Front, Aerostar

Removal and Installation

1. Remove five pushpins retaining air deflector to front bumper cover.
2. Remove air deflector.
3. Remove four bolts retaining bottom of front bumper cover to bumper.
4. Remove the three screws attaching front bumper cover to frame.
5. Pull front bumper cover away from vehicle to disengage retainers at both ends.
6. If required, remove front license plate mounting bracket (17A385) by drilling out four rivets.

For installation, follow removal procedures in reverse order. Tighten retaining screws and bolts to 9-14 Nm (7-10 lb-ft).

Bumper, Rear, Aerostar

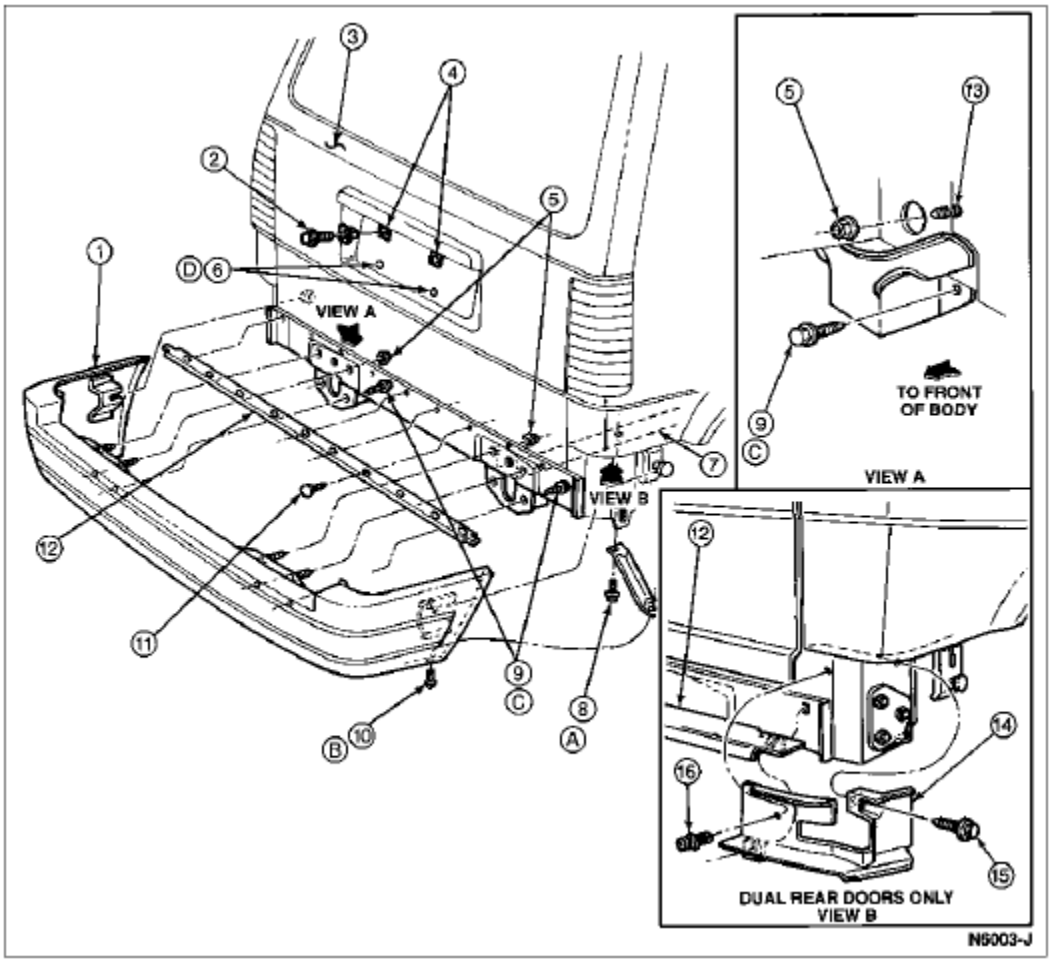
Removal and Installation

1. Support the rear bumper (17906) and remove all bolts and nuts.
2. Pull the rear bumper from the vehicle to disengage retainers at both ends of the rear bumper.

   For extended-length vehicles, remove bolts at both ends of bumper retaining reinforcement.

For installation, follow removal procedures in reverse order. Tighten upper reinforcement screw to 3.5-4.7 Nm (31-41 lb-in) and lower reinforcement bolt to 7-11 Nm (6-8 lb-ft). Tighten nuts attaching rear bumper to 17-27 Nm (13-19 lb-ft) and bolts to 22-34 Nm (17-25 lb-ft).

Bumper, Rear, Aerostar



Item	Part Number	Description

1	17906	Rear Bumper
2	N800369-S40	Screw
3	40010	Liftgate
4	380707-S	Nut, Plastic
5	N621940-S2	Nut
6	N804043-S	Pushpin, Bumper License Plate
7	5005	Frame
8	N800312-S36	Screw
9	N803417-S54	Bolt
10	N605892-S36	Bolt
11	383927-S	Pushpin
12	17808	Deflector, Rear Bumper Stone
13	17836	Deflector, Rear Bumper Stone End, with Dual Rear Doors Only
14	17788	Rear Bumper Isolator and Bracket
15	N800771-S55X	Screw, Drill Point
16	N803494-S	Pushpin
A	—	Tighten to 3.5-4.7 Nm (31-41 Lb-In)
B	—	Tighten to 7-11 Nm (6-8 Lb-Ft)
C	—	Tighten to 17-27 Nm (13-19 Lb-Ft)
D	—	Tighten to 22-34 Nm (17-25 Lb-Ft)

Isolator and Bracket, Rear Bumper

Removal and Installation

1. Support one rear bumper and remove six bolts attaching the rear bumper and isolator brackets to the frame.
2. Remove the rear bumper.
3. Remove four bolts and retainers attaching the rear bumper isolators and brackets from the bumper.

For installation, follow removal procedures in reverse order. Tighten the rear bumper isolator and bracket-to-bumper nuts to 113-153 Nm (84-112 lb-ft). Tighten rear bumper isolator and bracket-to-frame nuts to 113-153 Nm (84-112 lb-ft).

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Front Bumper Cover-to-Bumper Bolt, Aerostar	9-14	7-10	—
Front Bumper Cover-to-Bumper Screw, Aerostar	9-14	7-10	—
Rear Bumper Attaching Nuts, Aerostar	17-27	13-19	—
Rear Bumper Bracket-to-Frame Bolts, Aerostar	22-34	17-25	—
Rear Bumper Upper Reinforcement Screw, Aerostar	3.5-4.7	—	31-41
Rear Bumper Lower Reinforcement Bolt, Aerostar	7-11	6-8	—
Front Bumper Valence Panel Screw and Washer Assemblies	4.5-6.3	—	40-55
Front Bumper Bracket Nuts, Ranger	88-118	65-87	—
Front Fog Lamp Bracket Bolts, Ranger	77-103	57-75	—
Rear Bumper Inner Arm Bracket-to-Bumper Nuts, Ranger	113-153	84-112	—
Rear Bumper Outer Arm Bracket-to-Inner Arm Bracket Bolt, Ranger	113-153	84-112	—
Rear Bumper Outer Arm Bracket-to-Bumper Nut, Ranger	34-46	25-33	—
Rear Bumper Bracket-to-Frame Bolts, Ranger	113-153	84-112	—

Occupant Restraint System

WARNING: ALL OUTBOARD SAFETY BELT ASSEMBLIES INCLUDING RETRACTORS, BUCKLES, FRONT SEAT BELT BUCKLE SUPPORT ASSEMBLIES (SLIDE BAR), IF SO EQUIPPED, CHILD SAFETY SEAT TETHER ATTACHMENTS, AND ATTACHING HARDWARE SHOULD BE INSPECTED AFTER ANY COLLISION. ALL BELT ASSEMBLIES SHOULD BE REPLACED UNLESS A QUALIFIED TECHNICIAN FINDS THAT THE BELTS SHOW NO DAMAGE AND OPERATE PROPERLY. BELT ASSEMBLIES NOT IN USE DURING A COLLISION SHOULD ALSO BE INSPECTED AND REPLACED IF EITHER DAMAGE OR IMPROPER OPERATION IS NOTED.

The occupant restraint system consists of a dual locking mode retractor on the shoulder belt portion of the combination lap/shoulder safety belt for front seat passenger and rear seat outboard passengers.

The safety seat belts and shoulder belts are factory-installed in their proper locations. If the safety belts or shoulder belts are removed for any reason, they should be installed as described in this section.

When replacing safety belts and/or retractor assemblies, use only the replacement parts specified in the Ford Parts and Service Division Master Parts and Accessories Catalogs for the vehicle being serviced.

Continuous-Loop System

The front outboard safety belt, for Ranger vehicles and the front and rear outboard for Aerostar vehicles, is a continuous-loop system. The outboard combination lap and shoulder belts use a common sliding tongue. To secure the belts, the tongue is inserted into the inboard buckle.

The webbing for the lap belt is anchored inboard to the floor pan or seat frame.

The shoulder safety belt retractor is designed to let the webbing freely move in or out at all times, except during hard braking, hard cornering or impacts of approximately 8 km/h (5 mph) or more, when it is automatically locked by a mechanically actuated inertia sensor. The front outboard safety belt retractors for Ranger and Aerostar can be made to lock by pulling or jerking on the belt.

Lap/Shoulder Belt Retractor

WARNING: DO NOT INTRODUCE SLACK INTO THE SAFETY BELT SYSTEM BECAUSE THE BELT LOCKS UPON IMPACT WHERE IT IS POSITIONED. USE THE SHOULDER SAFETY BELT ON THE OUTSIDE SHOULDER ONLY. NEVER WEAR THE SHOULDER SAFETY BELT UNDER THE ARM. NEVER SWING IT AROUND THE NECK OVER THE INSIDE SHOULDER. NEVER USE A SINGLE BELT FOR MORE THAN ONE PERSON. ENSURE THE LAP PORTION OF THE BELT IS FITTED SNUGLY AND AS LOW AS POSSIBLE AROUND THE HIPS, NOT ON THE WAIST. FAILURE TO FOLLOW THESE PRECAUTIONS COULD INCREASE THE CHANCE AND/OR SEVERITY OF INJURY IN A COLLISION.

CAUTION: After unbuckling the safety belt, it is recommended that care be taken during retraction to prevent it from striking other passengers, or hitting trim panels or painted door surfaces.

Dual Locking Mode Seat Belt Retractor

Your vehicle is equipped with a dual locking mode retractor on the shoulder belt portion of the combination

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lap/shoulder safety belt for the front seat passenger and all rear outboard passengers. The retractor modes function in the following ways:

Vehicle Sensitive (Emergency) Locking Mode

In this operating mode, the lap/shoulder belt retractor will allow the occupant freedom of movement, locking tight only on hard braking, hard cornering or impacts of approximately 8 km/h (5 mph) or more. The front seat retractors, can be made to lock by pulling on the belt.

Automatic Locking Mode

In this operating mode, the lap/shoulder belt retractor will remain locked and does not allow the occupant freedom of movement. This mode provides the following:

- A tight lap/shoulder belt on the hips.
- Child seat restraint installation.

This mode must be used when installing a child seat or infant carrier on the front seat passenger side and rear outboard seats where dual locking retractors are provided. To switch the retractor from the emergency locking mode to the automatic locking mode, perform the following steps:

1. Buckle the lap/shoulder belt.

2. Grasp the shoulder portion of the belt and pull downward until all of the belt is extracted. When allowed to retract, a clicking sound will be heard. At that point, the belt retractor is in the automatic locking mode (child restraint mode).

3. A clicking sound will continue to be heard as the belt is allowed to retract. This indicates that the retractor is in the "automatic locking mode" (child restraint mode).

   NOTE: When the combination lap/shoulder belt is unbuckled and allowed to retract completely, the retractor will switch back to the vehicle sensitive (emergency) locking mode. See the detailed instructions under safety seats for children in this section.

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Safety Belt, Lap/Shoulder — Front and Rear Ranger

Energy Absorbing Sew Pattern

The short plastic boot on the front safety belt at the outboard anchor location on some vehicles covers an energy absorbing sew pattern on the safety belt.

WARNING: FAILURE TO REPLACE THE SAFETY BELT ASSEMBLY UNDER THE FOLLOWING CONDITIONS COULD RESULT IN SEVERE PERSONAL INJURIES IN THE EVENT OF A COLLISION.

In the event of an accident, sew pattern may release, and the colored REPLACE BELT label may become visible. If this occurs, **the safety belt, retractor and the safety belt buckle must be replaced** .

Safety Belt Energy Absorbing Sew Pattern Label

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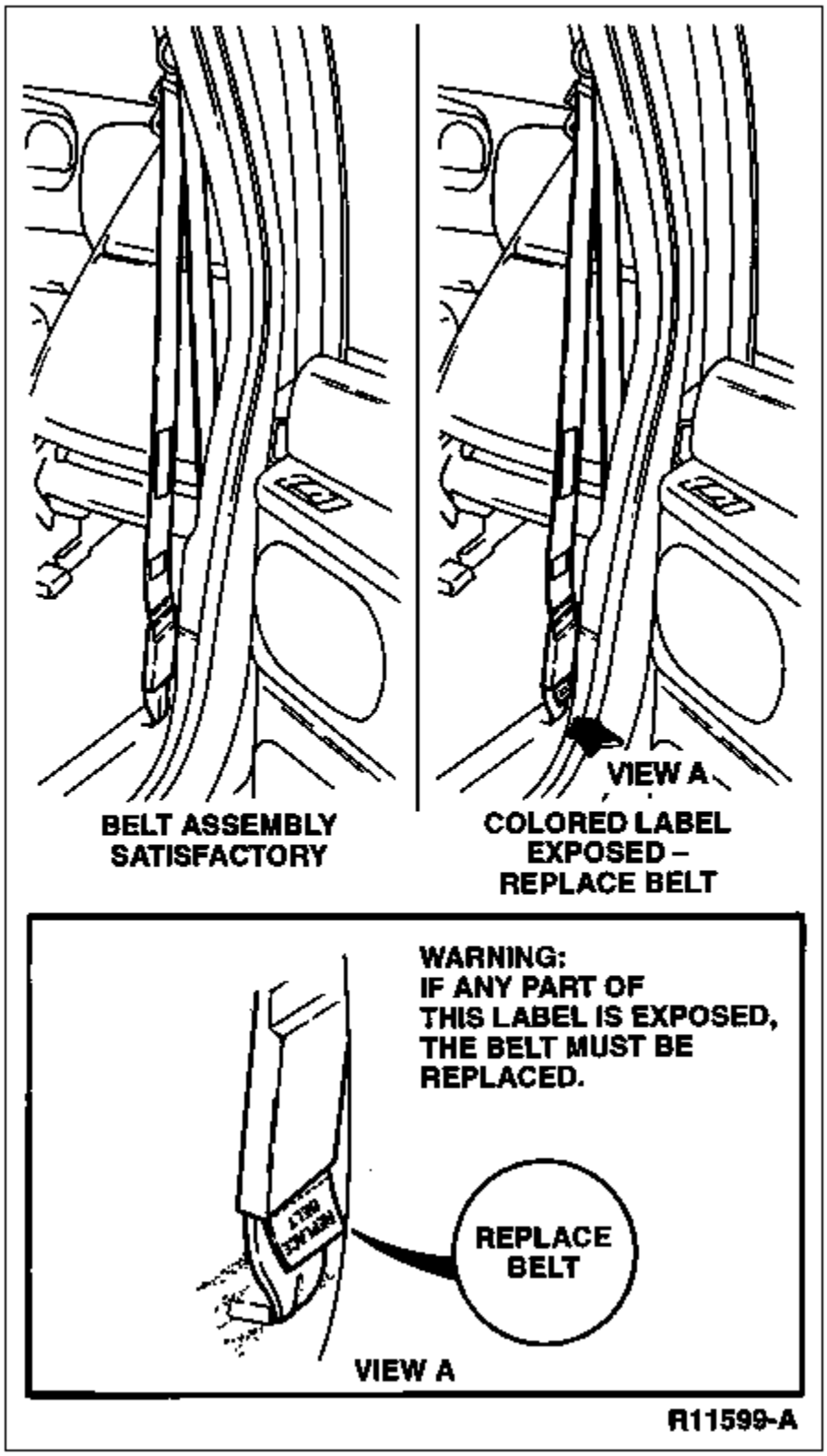

Fastening Safety Belts

After entering the vehicle, adjust the front seat (60012) to obtain the best position for driving comfort, access

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to controls and visibility. Then, use the following procedure for fastening safety belts.

1. **WARNING: USE THE SHOULDER BELT ON THE OUTSIDE SHOULDER ONLY. NEVER WEAR THE SHOULDER BELT UNDER THE ARM. NEVER SWING IT AROUND YOUR NECK OVER THE INSIDE SHOULDER. NEVER USE A SINGLE BELT FOR MORE THAN ONE PERSON. MAKE SURE THE LAP PORTION OF THE BELT IS FITTED SNUGLY AND AS LOW AS POSSIBLE AROUND THE HIPS, NOT ON THE WAIST. FAILURE TO FOLLOW THESE PRECAUTIONS COULD INCREASE THE CHANCE AND/OR SEVERITY OF INJURY IN A COLLISION.**

   To fasten the belt, pull the lap/shoulder belt from the safety belt retractor so the shoulder portion of the safety belt crosses the shoulder and chest. Be sure the belt is not twisted. If it is, remove the twist. Insert the belt tongue into the proper buckle until a snap is heard and the safety belt is latched.

   On Ranger SuperCab: Adjust the driver and/or passenger shoulder belt height adjuster up or down until the shoulder belt rests across the middle of your shoulder. To adjust, pinch the release button and adjust down to any of five (5) positions. You do not have to pinch the button for up adjustments.

   On Ranger Regular Cab: Adjust the shoulder belt up or down until the shoulder belt rests across the middle of your shoulder. To adjust, push the release button and slide the adjuster down. Then release the button. Make sure the adjuster is firmly in one of the four (4) positions. Pull up on the shoulder portion of the safety belt to tighten the lap portion to a snug fit. Make sure the safety belt is as low on the hips as possible.

2. To tighten the lap portion of the belt, pull up on the shoulder belt until it fits snugly. The belt should rest as low on the hips as possible.

3. **NOTE: The shoulder restraint portion of the safety belt adjusts automatically to a snug position.**

   NOTE: The rear retractors cannot be made to lock up when jerking on the shoulder belt.

   The safety belt system allows freedom of movement, locking only on hard braking or impacts of approximately 8 km/h (5 mph) or more. The front seat retractors can be made to lock by jerking on the safety belt.

Height Adjuster — Ranger SuperCab

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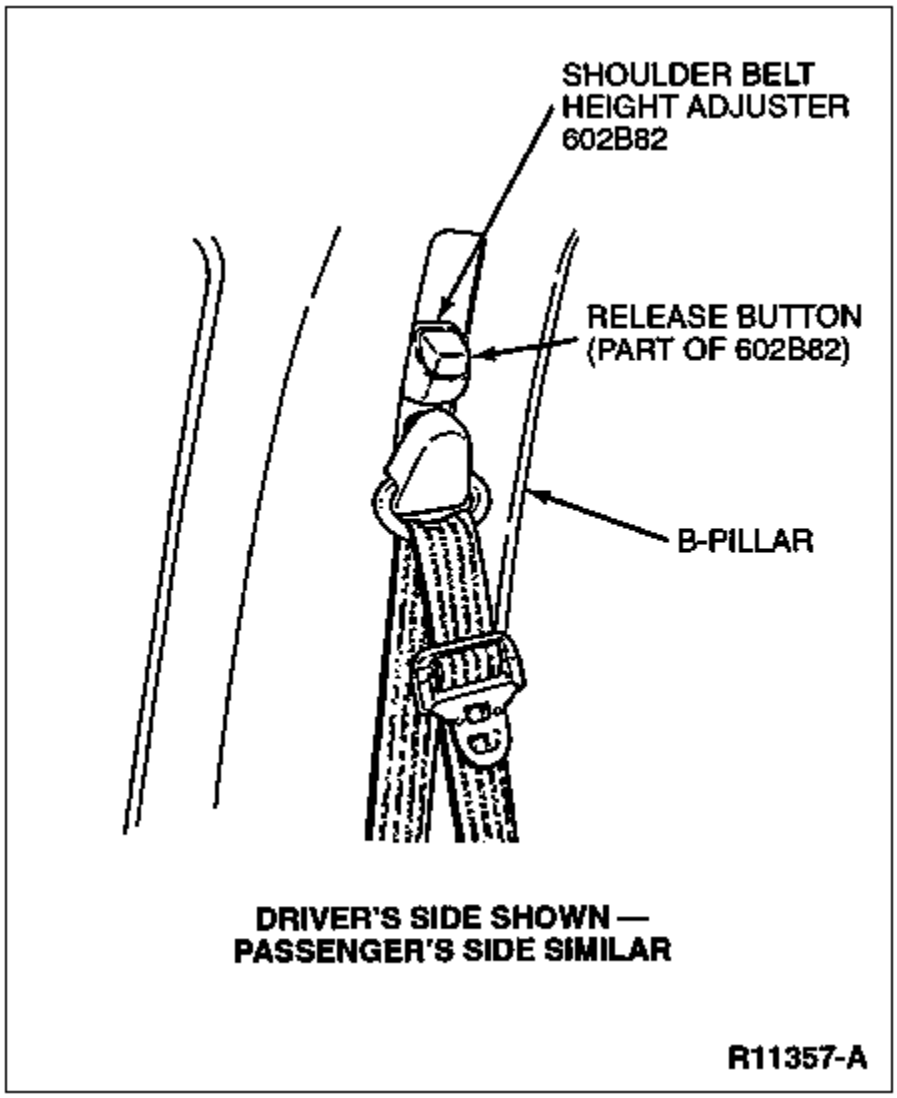

Height Adjuster — Ranger Regular Cab

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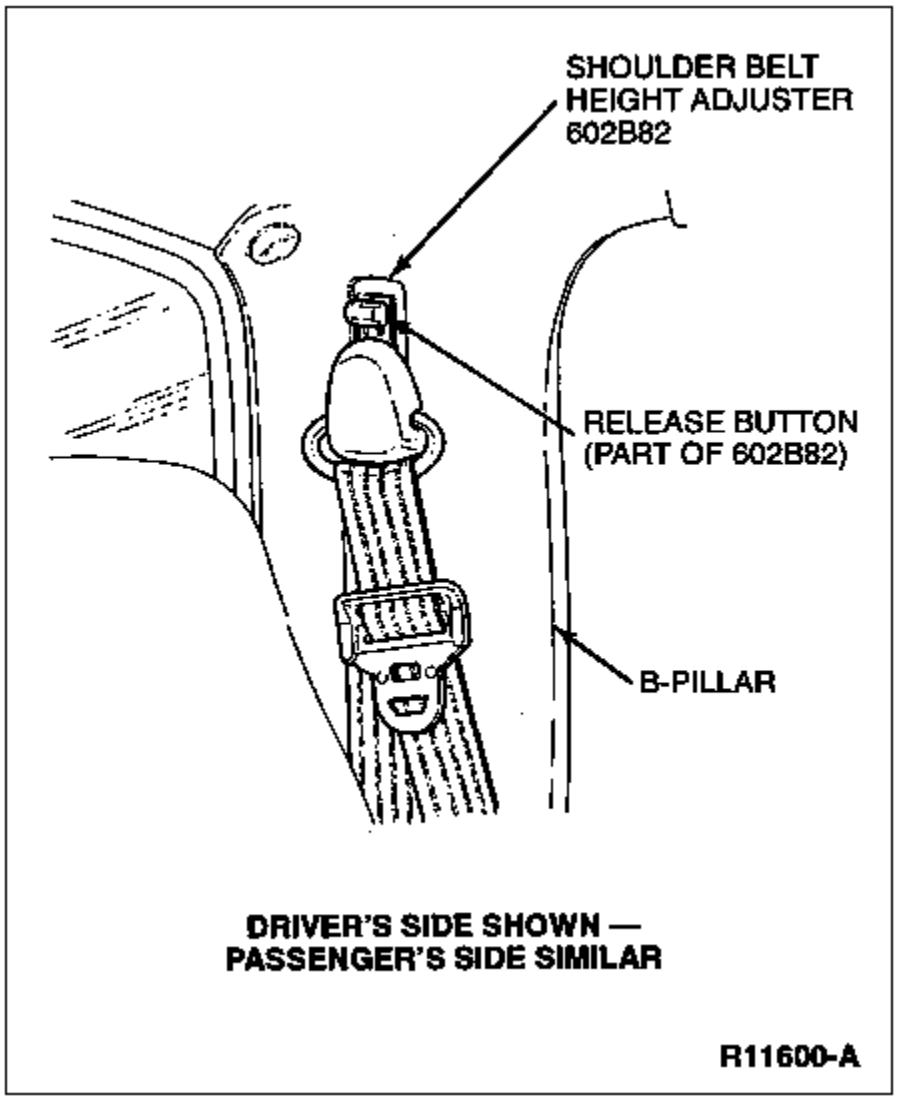

Fastening and Unfastening Safety Belts

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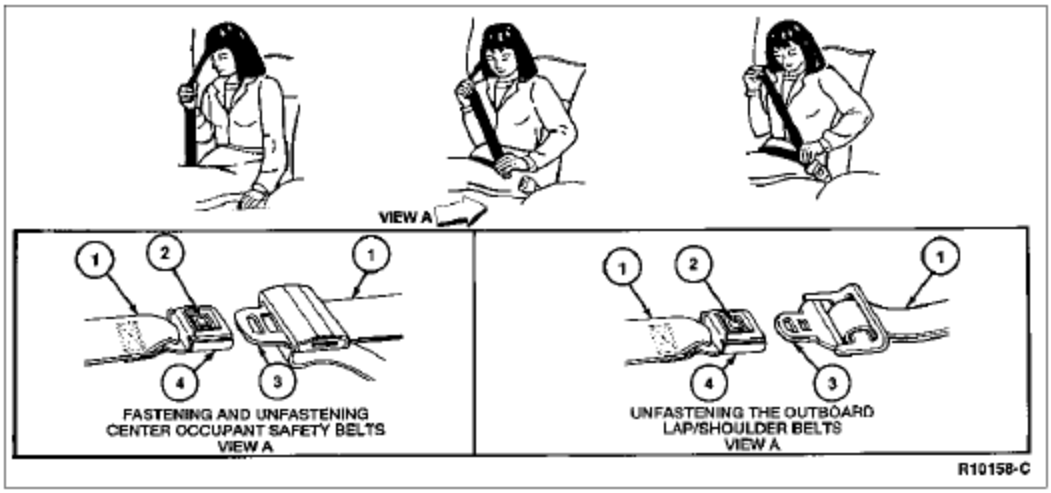

Item	Part Number	Description
1	—	Webbing
2	—	Release Button
3	—	Tongue
4	—	Buckle

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Safety Belt Extension Assembly

For some people, the safety belt may be too short even when it is fully extended. You can add about 20cm (8 inches) to the belt length with a safety belt extension assembly. Safety belt extensions Part number 611C22 are available at no cost from your dealer. The safety belt extension assembly is only available with black webbing and standard buckle and must be of the same manufacture as the belt system to which it is attached.

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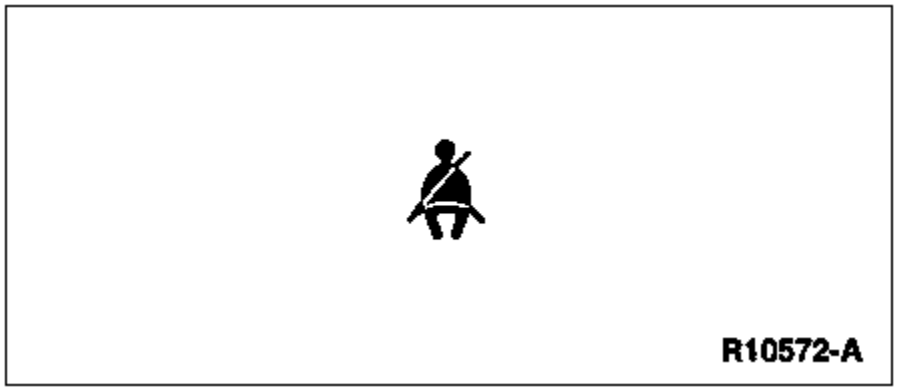
Warning System, Safety Belt

The continuous-loop system units incorporate a safety belt warning indicator switch (10B924), warning lamp and chime. The warning lamp and chime function as reminders to fasten the safety belt. The following events will take place:

- If safety belt is not buckled when the key is turned to the ON position, the lamp comes on for 1 to 2 minutes and the chime sounds for 4 to 8 seconds.
- If the safety belt is buckled while the lamp is on and the chime is sounding, both the lamp and chime turn off.
- If safety belt is buckled before the key is turned to the ON position, both the lamp and chime will not turn on.

Safety Belt Warning Lamp



On the Ranger the safety belt warning indicator switch and safety belt warning chime (10D840) are located below the instrument panel ash receptacle (04810) in the center of the instrument panel finish panel (044D70).

Safety Belt Warning Indicator Switch/Warning Chime, Aerostar

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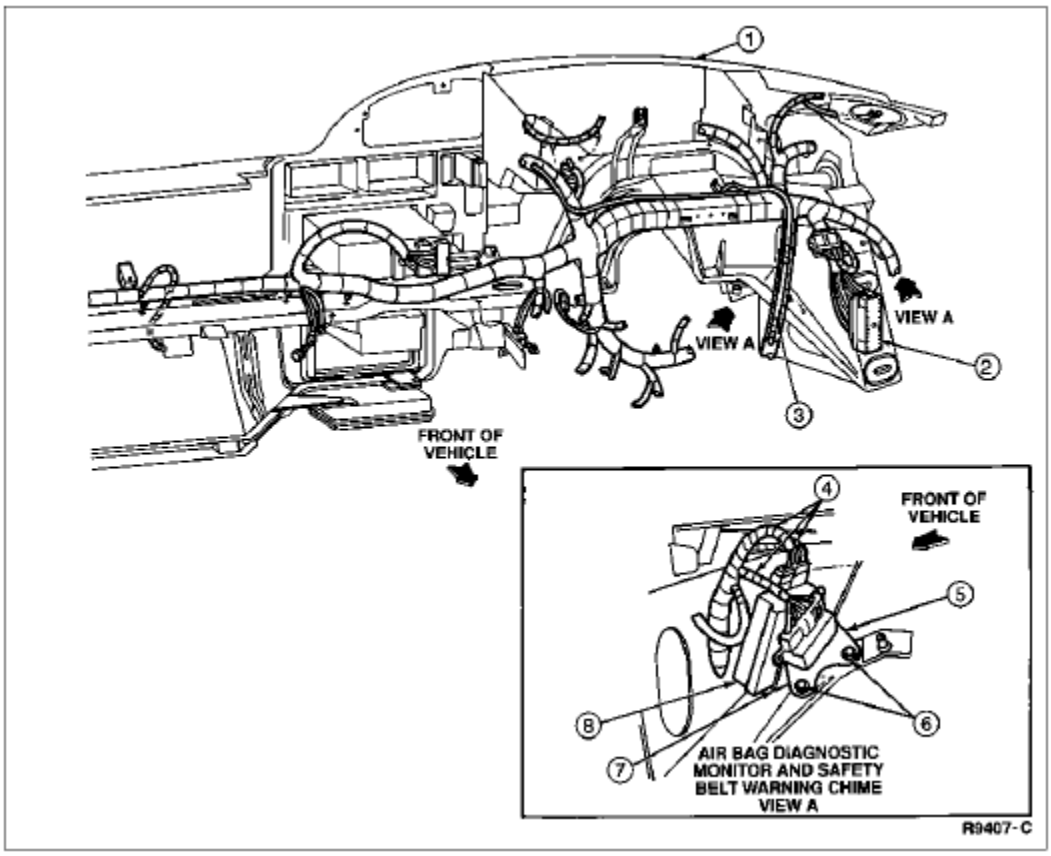

Item	Part Number	Description
1	04320	Instrument Panel
2	—	Connector (Part of 12A581)
3	19C827	Vacuum Hose Harness
4	14401	Wiring Assembly
5	14B058	Air Bag Monitor Bracket
6	N806339-S2	Screw
7	10D840	Safety Belt Warning Chime
8	14B056	Air Bag Diagnostic Monitor

Safety Belt Warning Indicator Switch/Warning Chime, Ranger

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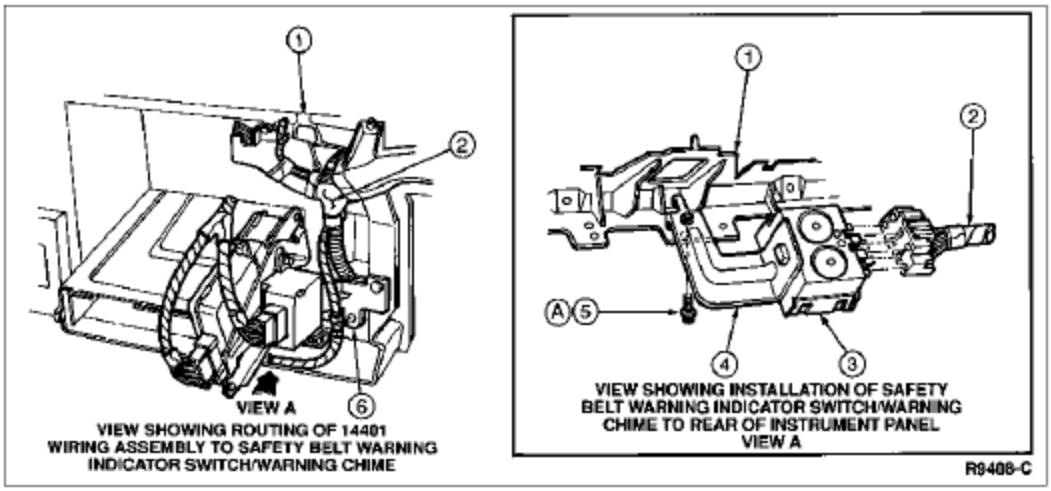

Item	Part Number	Description
1	04320	Instrument Panel
2	14401	Wiring Assembly
3	10B924	Safety Belt Warning Indicator Switch
4	10D876	Safety Belt Warning Chime Bracket
5	N804234	Screw
6	14B058	Air Bag Monitor Bracket
A	—	Tighten to 1.6-2.2 Nm (15-19 Lb-In)

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Child Safety Seat, Tether Attachment

Some manufacturers make safety seats with a tether strap that goes over the back of the vehicle seat and attaches to an anchoring point behind the vehicle seat.

Ford recommends the placement of tethered safety seats in a rear seating position with the tether strap attached to the tether anchoring point. The right front seating position may be used if it is the only seating position available.

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Child Restraint

For children who are too large for child safety seats, (see instructions with your child seat to determine maximum recommended size), the lap belts in the center rear or center front seats (60012) can be used. Lap/shoulder belts in other seats may be used if the lap belt portion fits snugly and low on the hips and the shoulder belt does not touch or rest in front of the face, chin, neck or throat. If you do not adjust the safety belt properly, the child's chances of being injured in a collision increase.

When installing a child safety seat be sure to use the correct safety belt buckle for that seating position, and make sure the tongue is securely fastened in the buckle.

Ford recommends placement of tethered safety seats in a rear seating position with the tether strap attached to the tether anchoring point as shown in this section.

If a tethered seat is installed in the front seat, it should be positioned in the center front seating position **only** and the tether strap should be secured to the center rear lap belt tongue or the webbing of the buckled center rear lap belt behind the child safety seat.

WARNING: FAILURE TO FOLLOW THESE PRECAUTIONS COULD INCREASE THE CHANCE AND/OR SEVERITY OF INJURY IN AN ACCIDENT.

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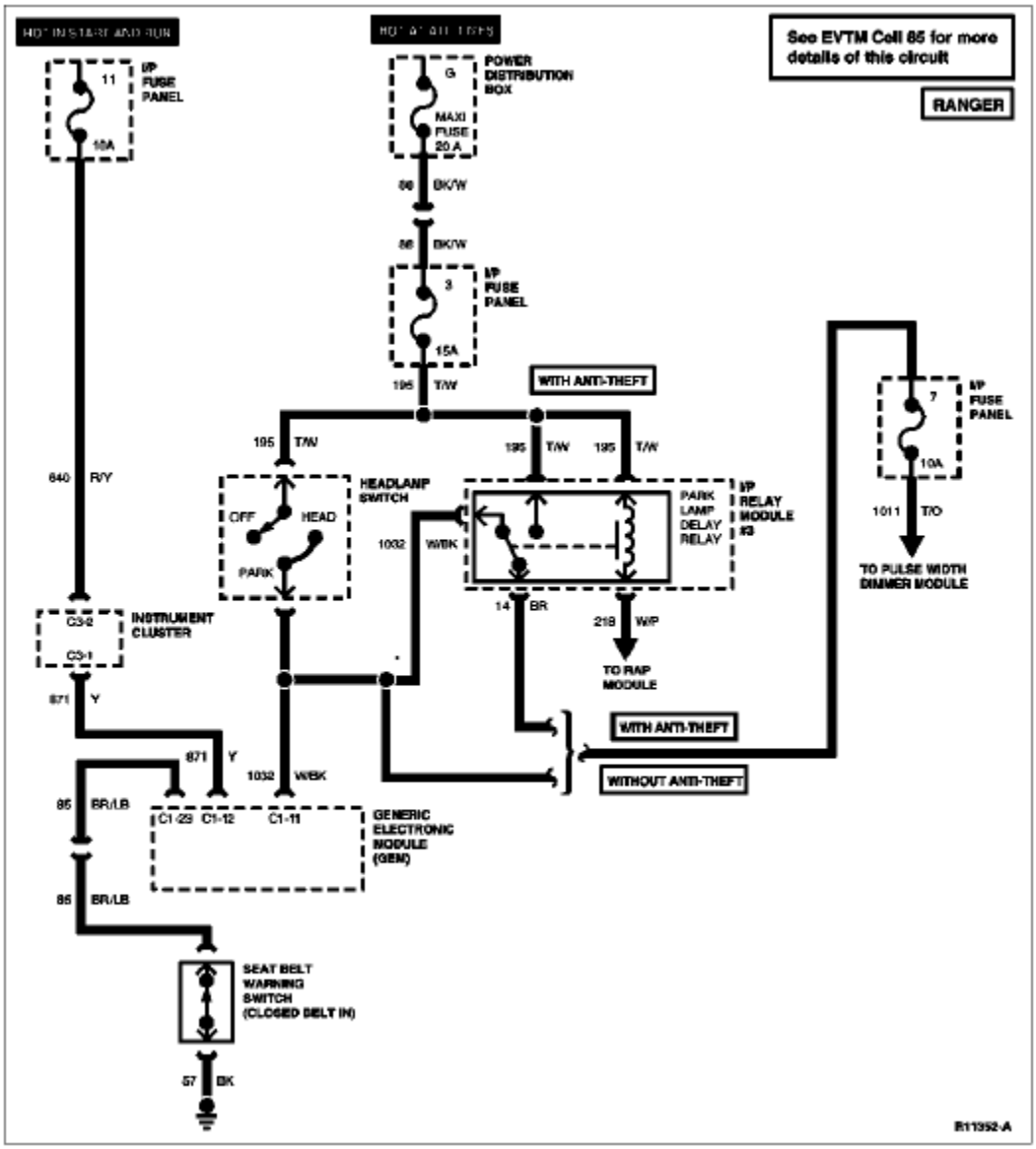
Electrical Schematics

Safety Belt Warning Chime, Ranger



Headlamp Switch

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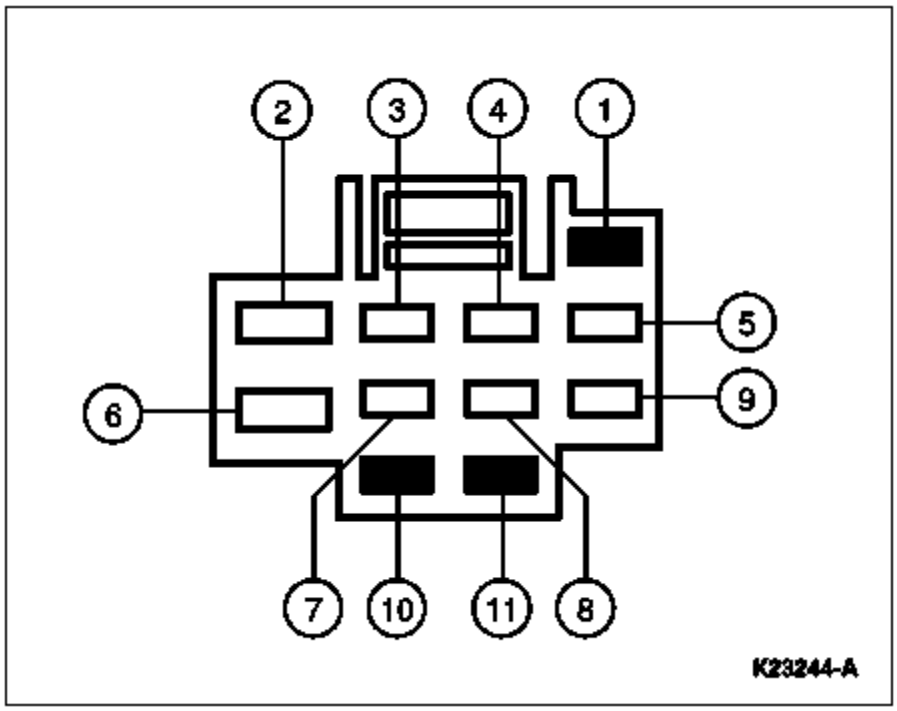

Pin Number	Circuit	Circuit Function
1	—	Not Used
2	15 (R/Y)	Headlamp Dimmer Switch Feed
3 [a]	14 (BR)	Headlamp Switch to Tail Lamps and Side Marker Lamps
4	640 (R/Y)	Warning Lamps Feed
5	195 (T/W)	Tail Lamp Switch Feed
6	196 (LB/O)	Headlamp Flash to Pass Switch Feed
7	57 (BK)	Ground Circuit
8	484 (O/BK)	Liquid Crystal Display
9	19 (LB/R)	Instrument Panel Lamps Feed
10	—	Not Used
11	—	Not Used

[a] Note: Pin 3 is Circuit 1032 (W/BK) for Anti-Theft Park Lamp Switch to Module.

Ranger GEM Connector

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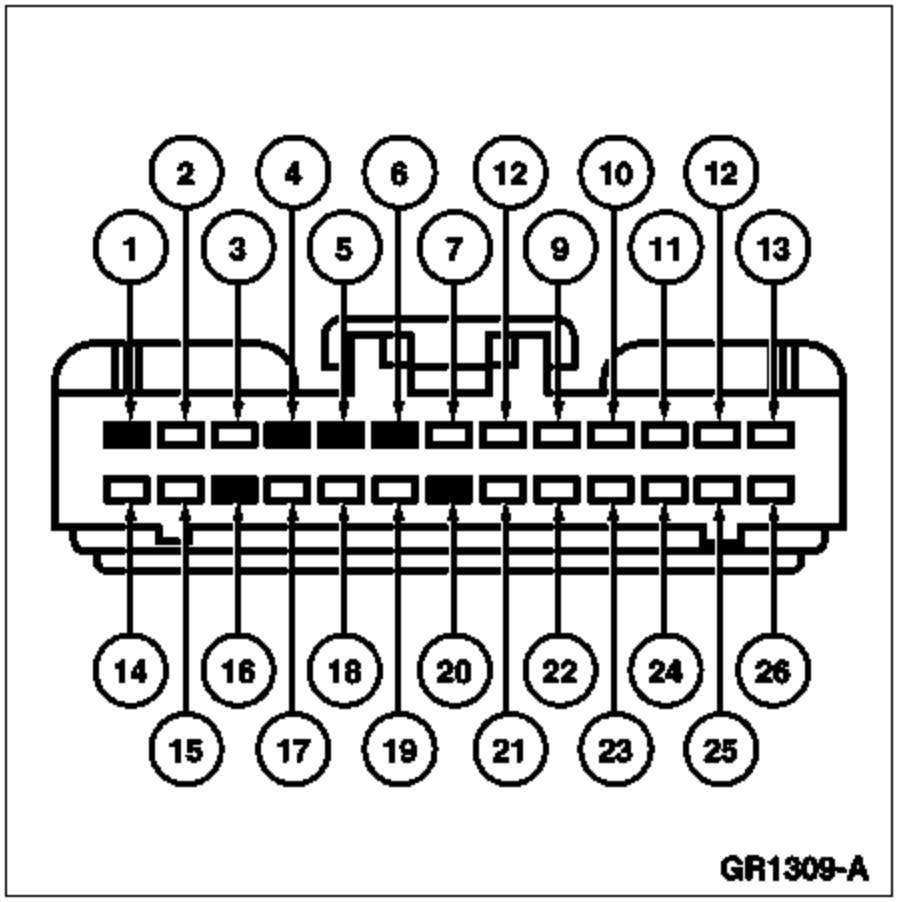

Pin Number	Circuit	Circuit Function
1	—	Not Used
2	209 (W/P)	Self Test Input to EC Module
3	930 (P/LG)	Door Handle Switches to GEM Module — Input
4	—	Not Used
5	—	Not Used
6	—	Not Used
7	761 (GY/R)	Passenger Door Ajar Lamp to GEM Module — Input
8	765 (Y/BK)	Drivers Door Ajar Lamp to GEM Module — Input
9	627 (BK/O)	Open Door Warning Lamp to Open Door Warning Switch
10	158 (BK/PK)	Key Warning Switch
11	1032 (W/BK)	Park Lamp Switch to Module
12	871 (Y)	Seat Belt Indicator Lamp to Module
13	680 (LB/O)	Front Wiper Switch Delay/Wash to GEM Module — Input
14	570 (BK/W)	Dedicated Ground — EC
15	671 (BK)	Front Wiper Motor Status to GEM Module — Input
16	—	Not Used

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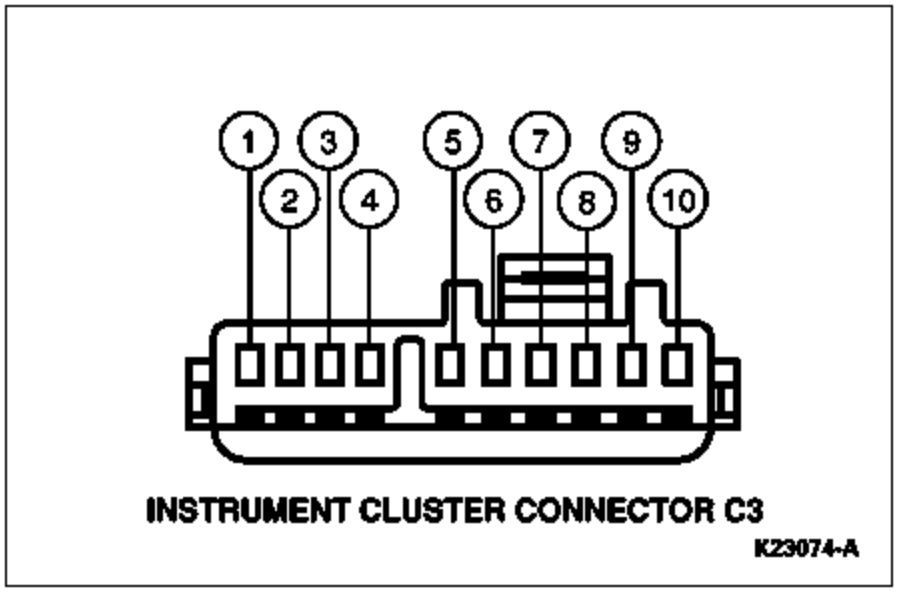
17	25 (DG/P)	Anti-Theft Switch Disarm
18	647 (GY/LB)	GEM Module to Front Wiper Speed Control Relay — Output
19	646 (Y/W)	GEM Module to Front Wiper Run/Dynamic Brake Relay — Output
20	—	Not Used
21	359 (GY/R)	Sensor Signal Return
22	684 (PK/Y)	Front Wiper Switch Mode Select to GEM Module — Input
23	85 (BR/LB)	Seat Belt Warning Timer to LH Front Retractor Switch
24	686 (T/R)	GEM Module to Front Washer Pump Relay — Input
25	70 (LB/W)	Generic Electronics Module (GEM) ISO Link
26	570 (BK/W)	Dedicated Ground — EC



Pin Number	Circuit	Circuit Function
1	871 (Y)	Seat Belt Indicator Lamp to Module
2	—	Not Used
3	398 (BK/Y)	EC Module to Check Engine Indicator Lamp
4	1001 (W/Y)	Fused Battery Feed to GEM Module Input
5	603 (DG)	Failure Warning Light
6	977 (P/W)	Dual Brake Warning Switch to Indicator Lamp
7	608 (BK/Y)	Air Bag Diagnostic Lamp Driver
8	904 (LG/R)	Ignition Switch "Coil/Accy" to Alternator Regulator "IGN" Terminal
9	584 (Y)	Alternator Lamp Feed
10	640 (R/Y)	Warning Lamps Feed

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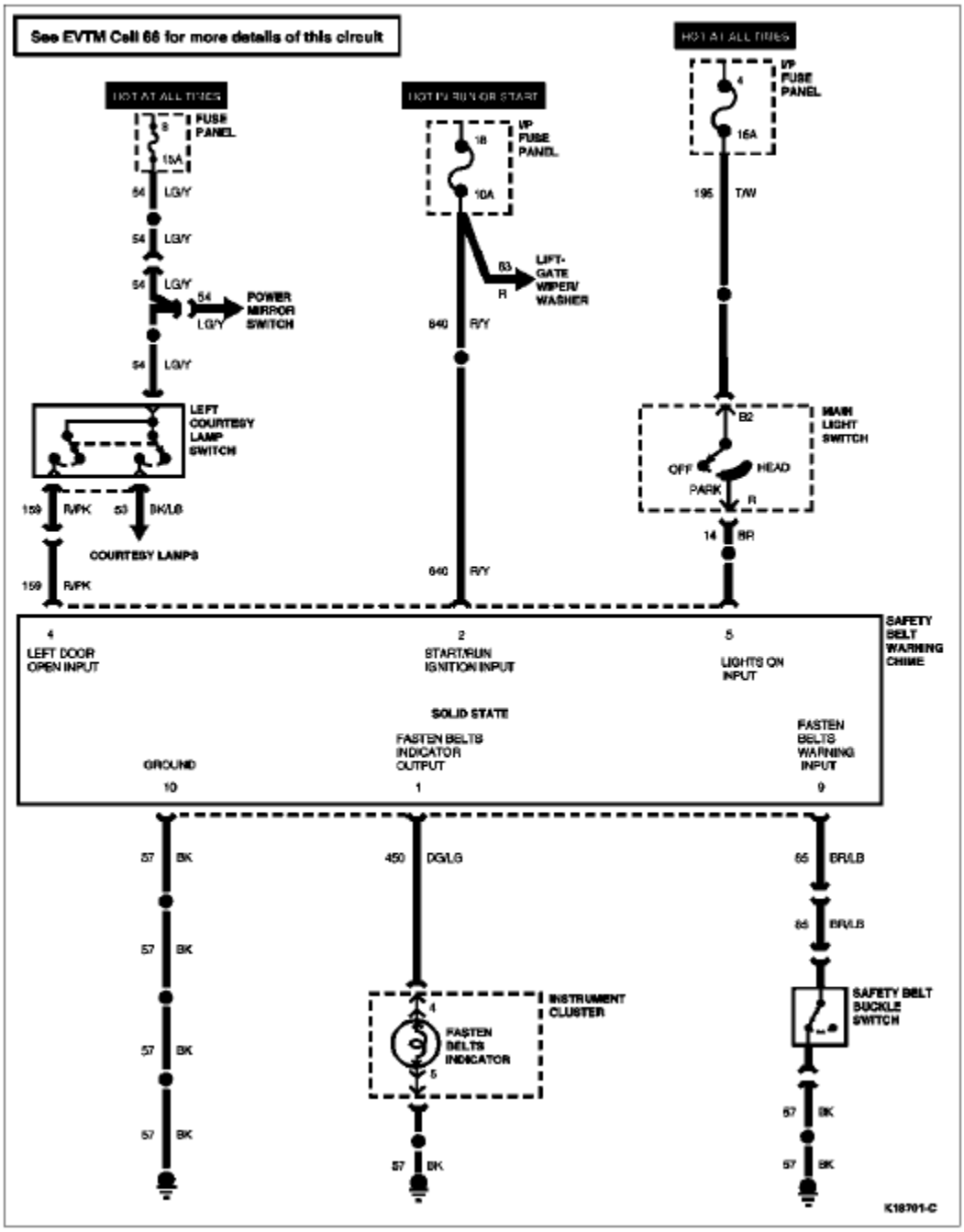
Safety Belt Warning Chime, Aerostar



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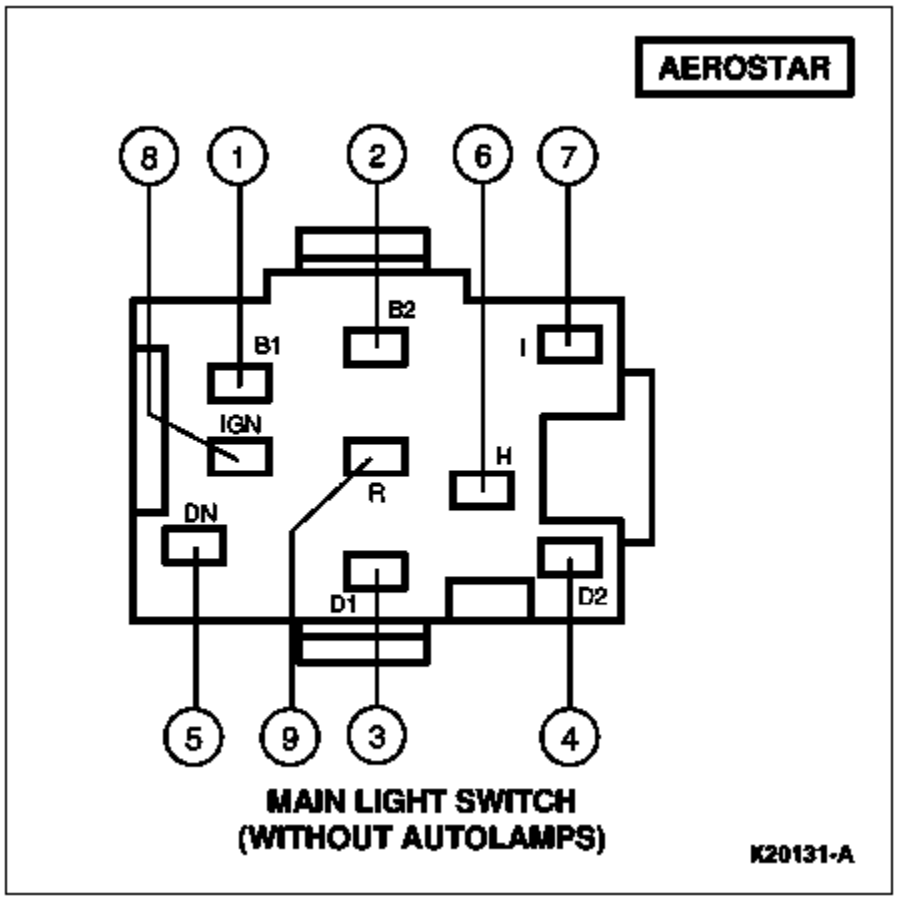

Pin Number	Circuit	Circuit Function
1	38 (BK/O)	Battery Input to Main Light Switch
2	195 (T/W)	Battery Input to Main Light Switch
3	54 (LG/Y)	Battery Input to Dome Switch
4	53 (BK/LB)	Dome Switch to Courtesy Lamps
5	484 (O/BK)	Main Light Switch to Radio LCD
6	15 (R/Y)	Main Light Switch to Dimmer
7	19 (LB/R)	Main Light Switch to Instrument Illumination
8	137 (Y/BK)	Battery Input, Hot in ACC or RUN
9	14 (BR)	Main Light Switch to Exterior Lamps

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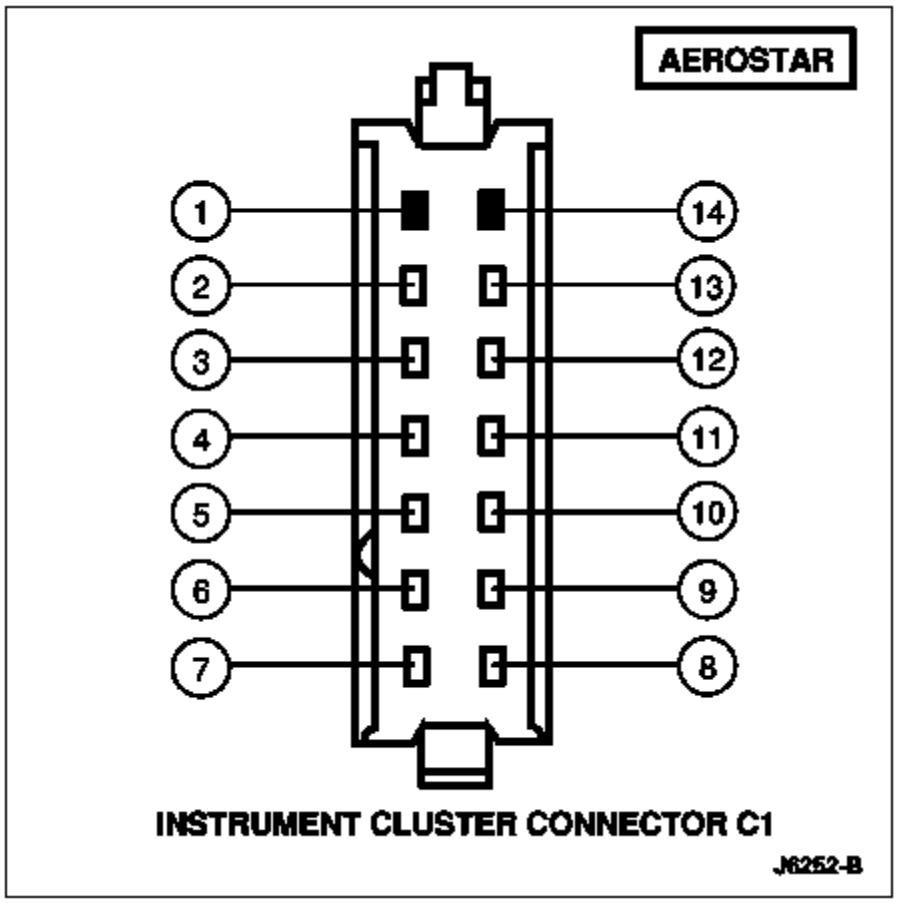

Pin Number	Circuit	Circuit Function
1	—	Not Used
2	627 (BK/O)	Open Door Warning Lamp to Open Door Warning Switch
3	977 (P/W)	Dual Brake Warning Switch to Indicator Lamp
4	603 (DG)	Failure Warning Lamp
5	658 (PK/LG)	PCM to Check Engine Indicator Lamp
6	29 (Y/W)	Fuel Gauge to Fuel Gauge Sending Unit
7	3 (LG/W)	Front Turn Signal Lamp (LH)
8	31 (W/R)	Oil Pressure Indicator to Oil Pressure Sensor
9	570 (BK/W)	Dedicated Ground Circuit
10	39 (R/W)	Temperature Gauge to Temperature Sending Unit
11	904 (LG/R)	Ignition Switch "Coil/Accy" to Alternator Regulator "IGN" Terminal
12	16 (R/LG)	Ignition Switch to Ignition Coil "BATT" Terminal
13	640 (R/Y)	Warning Lamps Feed
14	—	Not Used

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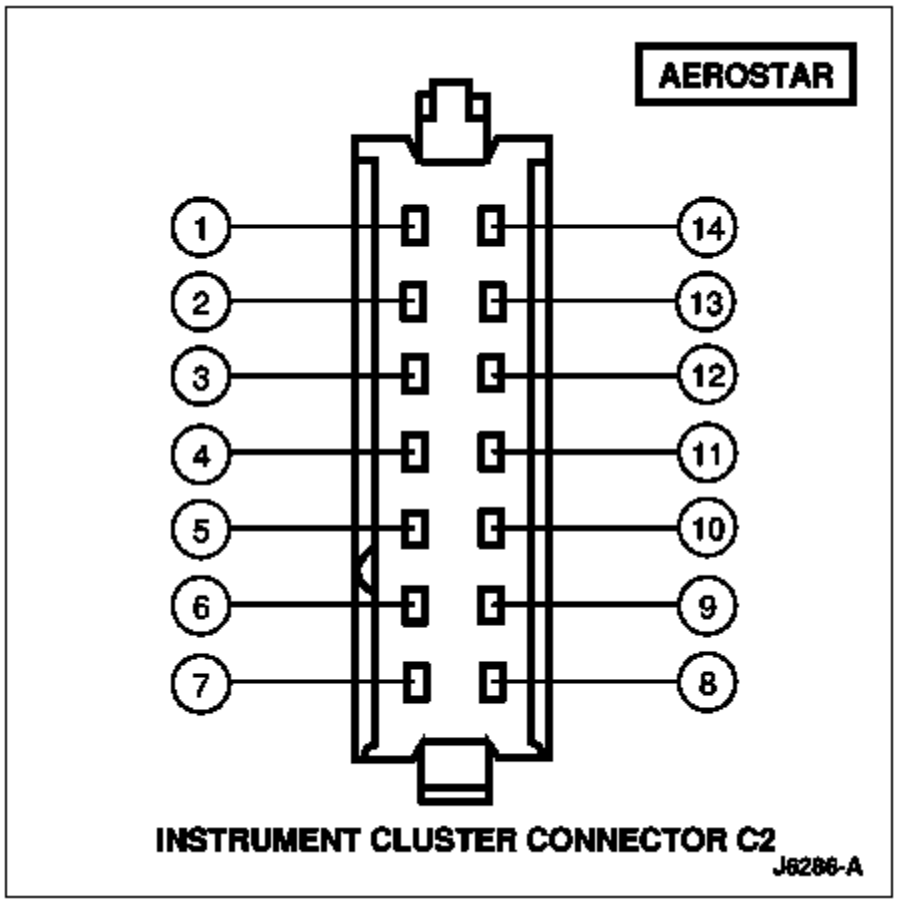

Pin Number	Circuit	Circuit Function
1	208 (GY)	Low Oil Level Relay to Warning Lamp
2	640 (R/Y)	Warning Lamps Feed
3	932 (GY/W)	Daytime Running Lamp
4	450 (DG/LG)	Seat Belt Warning Indicator Lamp Feed
5	57 (BK)	Ground Circuit
6	19 (LB/R)	Instrument Panel Lamps Feed
7	57 (BK)	Ground Circuit
8	2 (W/LB)	Front Turn Signal Lamp (RH)
9	57 (BK)	Ground Circuit
10	994 (W)	AWD Module to AWD Function Lamp
11	608 (BK/Y)	Air Bag Diagnostic Lamp Driver
12	640 (R/Y)	Warning Lamps Feed
13	570 (BK/W)	Dedicated Ground Circuit
14	397 (BK/W)	Signal Ground to Tachometer Gauge Module

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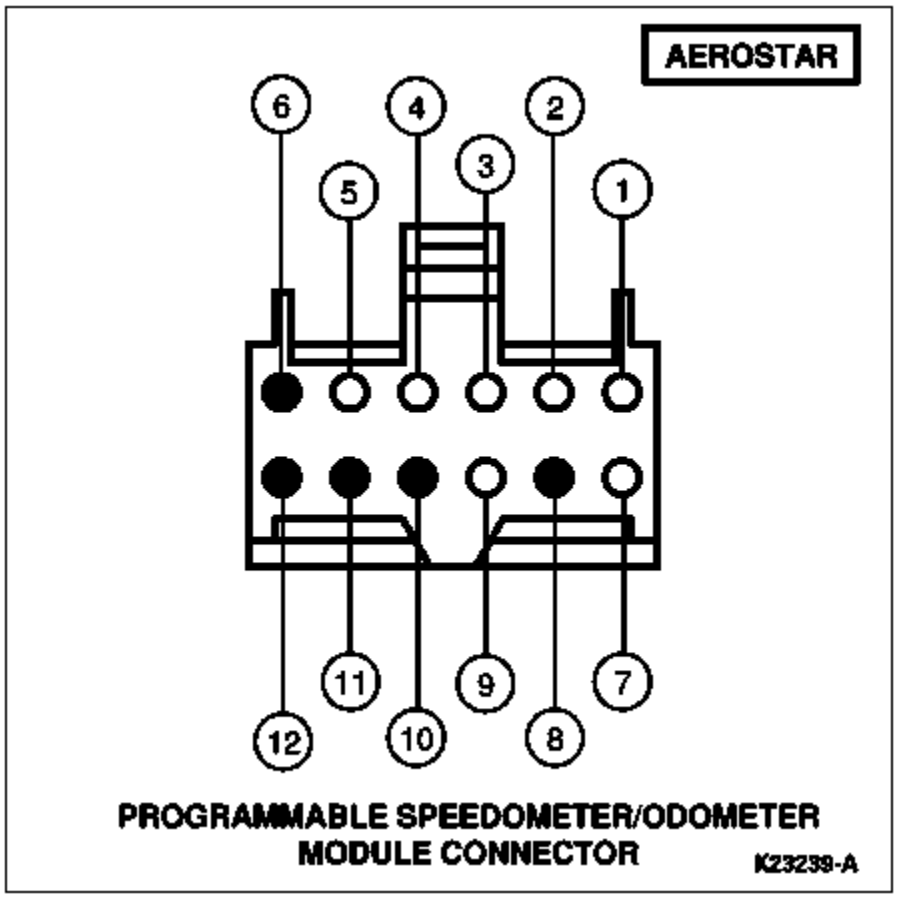

Pin Number	Circuit	Circuit Function
1	54 (LG/Y)	Interior Lamp Switch Feed
2	397 (BK/W)	Signal Ground to Tachometer Gauge Module
3	489 (PK/BK)	Instrument Cluster Ignition Run Feed
4	523 (R/PK)	Rear Sensor (High) to Module (RH)
5	519 (LG/BK)	Rear Sensor (Low) to Module (LH)
6	—	Not Used
7	679 (GY/BK)	Vehicle Speed Sensor (VSS) — Plus to PCM
8	—	Not Used
9	571 (BK/O)	ABS Module Diagnostic Ground
10	—	Not Used
11	—	Not Used
12	—	Not Used

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Inspection and Verification

Verify the vehicle owner's original concern by operating the restraint system to duplicate the vehicle owner's concern.

Check system fuses and operation of safety belt warning lamp. Check for bare, broken or misrouted wires. Make sure connectors are tightly engaged. Inspect the safety belt webbing for integrity.

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Symptom Chart — Active Restraints

ACTIVE RESTRAINTS

Condition	Possible Source	Action
• Safety Belt Warning Never/Always On	• Fuse. • Circuitry. • Warning indicator switch. • Connectors.	• REFER to Section 13-09 .
• Safety Belt Warning Chime Does Not Sound or Safety Belt Warning Indicator Lamp Does Not Function Properly	• Fuse. • Circuitry. • Connectors. • Safety belt warning chime. • Warning indicator switch.	• REFER to Section 13-09 .

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Safety Belts, Front Seats — Aerostar

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Seat Belt Bolt Bit (No. 50 Torx®)	T77L-2100-A

NOTE: Safety belt buckles, center adjust tongues and belt and retractors can be replaced separately. However, if a safety belt assembly was in use during a collision, the belt and retractor must be replaced as well as the center adjust tongue and belt and buckle assembly or the center adjust tongue and the cable and buckle assembly. When replacing safety belt and buckle, safety cable and buckle, center adjust tongues and belt and retractors, use only the replacement parts specified in the Ford Master Parts Catalogs for the make and model of the vehicle being serviced. Safety belt assemblies must not be interchanged between vehicle models.

Removal

1. Remove the quarter trim panel (31012).

2. **CAUTION: To prevent damage to the safety belt webbing when cutting through the slot in the belt loop, place a smooth, flat, hard object such as a metal ruler between the webbing and the back side of the belt loop.**

   NOTE: If the belt loop is damaged, the belt loop can be removed from the belt assembly by carefully cutting through the slot located on the back side of the belt loop.

   Remove the belt loop by carefully prying the belt loop away from the sheet metal.

3. Remove the bolt from front safety belt retractor and tongue to front floor pan (11135).

4. Lift floor carpet (13000) and remove bolt retaining floor anchor to front floor pan.

5. Remove front safety belt retractor cover (612C36) and remove bolt.

6. Remove front safety belt retractor.

Installation

1. Position the retractor and cover on the vehicle. Install the retractor bolt. Use Seat Belt Bolt Bit (No. 50 Torx®) T77L-2100-A, tighten to 40 Nm (30 lb-ft).

2. Position safety belt guide to vehicle and install the bolt. Using Seat Belt Bolt Bit (No. 50 Torx®) T77L-2100-A, tighten bolt to 40 Nm (30 lb-ft).

3. Install the front seat shoulder strap guide cover (60262).

4. Install the belt loop.

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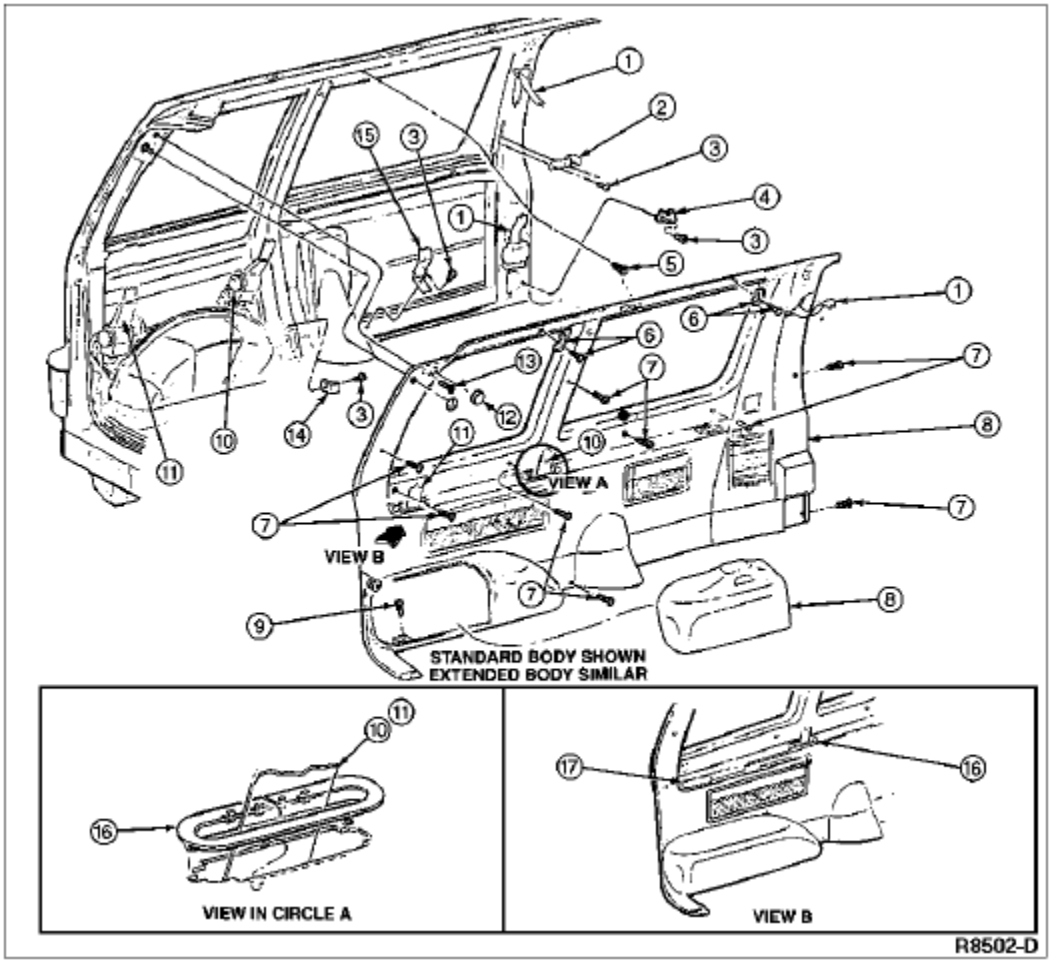
5. Feed the floor anchor end of the front safety belt through the quarter trim panel.
6. Install the quarter trim panel. Place bezel around front safety belt retractor and tongue (611B08) and snap onto quarter trim panel.
7. Position the floor anchor anti-rotation tab to the bead in the front floor pan. Install the bolt. Tighten the bolt to 40 Nm (30 lb-ft).
8. Check the restraint system for proper operation.

Quarter Trim Panel, Left Side Without Air Conditioning and Auxiliary Heater, Aerostar



Item	Part Number	Description
1	611B08	Front Safety Belt Retractor and Tongue
2	1124499	Retainer, Body Lock Pillar Inside Finish Panel Upper
3	55926-S2	Screw
4	1124377	Retainer, Body Lock Pillar Inside Finish Panel Lower

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5	N802900-S	Pushpin
6	29024	Coat Hook Cover
7	N800942-S2	Screw
8	31012	Quarter Trim Panel
9	382413-S36BX	Screw
10	611B68/611B68	Rear Safety Belt Retractor and Tongue, Second Row Seat
11	611B68/611B68	Rear Safety Belt Retractor and Tongue, Third Row Seat
12	1231378	Cover, Body Side Trim Panel
13	N801157-S2	Screw
14	1231495	Retainer, Body Side Wheelhouse Trim Panel
15	12311A99	Bracket, Body Side Trim Panel to Floor
16	601B30	Rear Seat Shoulder Strap Opening Bezel
17	601B26	Cover, Rear Seat Shoulder Belt Opening

Front Safety Belts, Outboard — Aerostar

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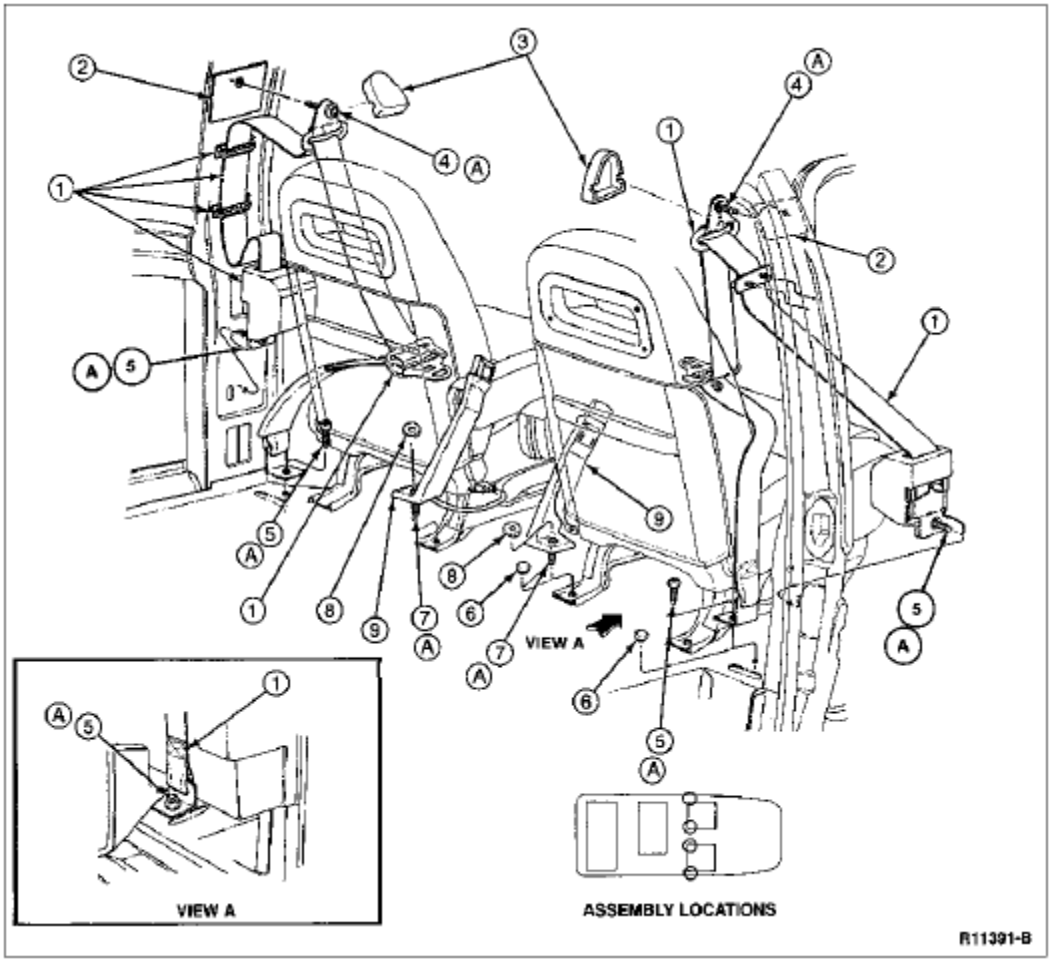

Item	Part Number	Description
1	611B08	Front Safety Belt Retractor and Tongue
2	11278D30	Tape, Body Lock Pillar Sight
3	602B60	Front Seat Shoulder Strap Guide Cover
4	386277-S100	Bolt
5	386273-S100	Bolt
6	388523-S	Plug Button, Used When Passenger Seat Not Required
7	386276-S100	Bolt
8	611B32	Safety Belt Retractor Cover Bolt Access Plug
9	61202	Front Seat Belt and Buckle
A	—	Tighten to 40 Nm (30 Lb-Ft)

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Safety Belts, Rear Seats, Outboard, Second Row Two-Passenger Bench — Aerostar

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Seat Belt Bolt Bit (No. 50 Torx®)	T77L-2100-A

NOTE: Safety belt buckles, center adjust tongues and belt and retractors can be replaced separately. However, if a safety belt assembly was in use during a collision, the belt and retractor must be replaced as well as the center adjust tongue and belt and buckle assembly or the center adjust tongue and the cable and buckle assembly. When replacing safety belt and buckle, safety cable and buckle, center adjust tongues and belt and retractors, use only the replacement parts specified in the Ford Master Parts Catalogs for the make and model of the vehicle being serviced. Safety belt assemblies must not be interchanged between vehicle models.

Removal

1. **NOTE: Bolt securing third row sling assembly must be removed.**

   Remove front seat shoulder belt guide cover and remove safety belt guide bolt.

2. Remove quarter trim panel screws.

3. Move the quarter trim panel (31012) toward the inside of the vehicle.

4. Remove front safety belt retractor and tongue bolt.

5. Remove front safety belt retractor and tongue (611B08) by passing belt and sling through opening in quarter trim panel.

Installation

To install, reverse removal procedures. Use Seat Belt Bolt Bit (No. 50 Torx®) T77L-2100-A to tighten front safety belt retractor and tongue bolt to 40 Nm (30 lb-ft).

- Make sure tab is secure in the quarter trim panel before securing with screw.

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Safety Belts, Rear Seats, Outboard, Third Row Bench or Bed Seat — Aerostar

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Seat Belt Bolt Bit (No. 50 Torx®)	T77L-2100-A

WARNING: WHEN REINSTALLING A REAR SEAT IN THE VEHICLE, INSTALL THE SEAT IN ITS ORIGINAL LOCATION. IMPROPER INSTALLATION OF THE SEAT WILL PREVENT CORRECT USE OF THE SHOULDER SAFETY BELT AND COULD INCREASE THE RISK AND/OR SEVERITY OF INJURY IN AN ACCIDENT.

NOTE: Safety belt buckles, center adjust tongues and belt and retractors can be replaced separately. However, if a safety belt assembly was in use during a collision, the belt and retractor must be replaced as well as the center adjust tongue and belt and buckle assembly or the center adjust tongue and the cable and buckle assembly. When replacing safety belt and buckle, safety cable and buckle, center adjust tongues and belt and retractors, use only the replacement parts specified in the Ford Master Parts Catalogs for the make and model of the vehicle being serviced. Safety belt assemblies must not be interchanged between vehicle models.

Removal

1. Detach safety belt anchor from rear seat back frame (613A38).
2. Remove seats from vehicle. Refer to Section 01-10 .
3. Fold down the sling cover and remove bolt.
4. Remove bezel from quarter trim panel (31012).
5. Remove screws securing quarter trim panel. The bolt securing the second row D-ring or sling must be removed.
6. Move quarter trim panel toward center of vehicle for access to rear safety belt retractor and tongue (611B68).
7. Remove bolt securing belt and rear safety belt retractor and tongue.
8. Remove rear safety belt retractor and tongue by passing through hole in quarter trim panel.

Installation

To install, reverse the removal procedures. Use Seat Belt Bolt Bit (No. 50 Torx®) T77L-2100-A and tighten all bolts to 40 Nm (30 lb-ft). Check safety belt for proper operation.

- Make sure the belt is not twisted before you insert it into the detachable anchor. A twisted safety belt may cause the safety belt retractor and tongue to not work properly. Insert the detachable anchor

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tongue into the detachable anchor until you hear a "snap" and feel the latch engage.

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Safety Belt, Rear Seats, Second Row, Aerostar

NOTE: Safety belt BUCKLES, center adjust tongues and belt and retractors can be replaced separately. However, if a safety belt assembly was in use during a collision, the belt and retractor must be replaced as well as the center adjust tongue and belt and buckle assembly or the center adjust tongue and the cable and BUCKLE assembly. When replacing safety belt and BUCKLE, safety cable and BUCKLE, center adjust tongues and belt and retractors, use only the replacement parts specified in the Ford Master Parts Catalogs for the make and model of the vehicle being serviced. Safety belt assemblies must not be interchanged between vehicle models.

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Seat Belt Bolt Bit (No. 50 Torx®)	T77L-2100-A

Removal

1. Detach safety belt from rear seat back frame (613A38).
2. Remove seats from vehicle. Refer to Section 01-10 for procedures.
3. Remove D-ring cover and remove bolt securing D-ring.
4. Remove bezel from quarter trim panel (31012).
5. Remove screws securing quarter trim panel. Bolt securing third row sling must be removed.
6. Move the quarter trim panel toward the center of vehicle for access to rear safety belt retractor and tongue (611B68).
7. Remove rear safety belt retractor and tongue assembly by passing through hole in quarter trim panel.
8. Remove bolt securing rear safety belt retractor and tongue. Remove rear safety belt retractor and tongue from vehicle.

Installation

WARNING: WHEN REINSTALLING A REAR SEAT IN THE VEHICLE, INSTALL THE SEAT IN ITS ORIGINAL LOCATION. IMPROPER INSTALLATION OF THE SEAT WILL PREVENT CORRECT USE OF THE SHOULDER SAFETY BELT AND COULD INCREASE THE RISK AND/OR SEVERITY OF INJURY IN AN ACCIDENT.

For installation, follow removal procedures in reverse order. Using Seat Belt Bolt Bit (No. 50 Torx®) T77L-2100-A, tighten bolts to 34-46 Nm (25-34 lb-ft). Check safety belt for proper operation.

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Make sure the belt is not twisted before you insert it into the detachable anchor. A twisted safety belt may cause the safety belt retractor and tongue to not work properly. Insert the detachable anchor tongue into the detachable anchor until you hear a "snap" and feel the latch engage.

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Safety Belt, Rear, Second Row Quad Bucket Seats and Three-Passenger Bench, Aerostar

NOTE: Safety belt BUCKLES, center adjust tongues and belt and retractors can be replaced separately. However, if a safety belt assembly was in use during a collision, the belt and retractor must be replaced as well as the center adjust tongue and belt and buckle assembly or the center adjust tongue and the cable and BUCKLE assembly. When replacing safety belt and BUCKLE, safety cable and BUCKLE, center adjust tongues and belt and retractors, use only the replacement parts specified in the Ford Master Parts Catalogs for the make and model of the vehicle being serviced. Safety belt assemblies must not be interchanged between vehicle models.

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Seat Belt Bolt Bit (No. 50 Torx®)	T77L-2100-A

Removal

1. Fold down sling cover and remove bolt securing sling.
2. Remove rear safety belt retractor cover (613C46).
3. Remove safety belt retractor cover bolt access plug (611B32).
4. Remove bolt securing anchor in step well.
5. Remove screws securing quarter trim panel (31012).
6. Move quarter trim panel toward the center of the vehicle.
7. Remove the bolt securing rear safety belt retractor and tongue (611B68) to vehicle.
8. Remove rear safety belt retractor and tongue by passing the rear safety belt retractor and tongue and sling through opening in the quarter trim panel.

Installation

1. Pass the rear safety belt retractor and tongue and sling through opening of quarter trim panel.
2. Position belt and retractor assembly to vehicle and secure with bolt. Using Seat Belt Bolt Bit (No. 50 Torx®) T77L-2100-A, tighten bolt to 34-46 Nm (25-34 lb-ft).
3. **NOTE: Make sure tab is secure in quarter trim panel before securing with screws.**

   Position quarter trim panel and secure with screws.
4. Position sling and secure with bolt. Using Seat Belt Bolt Bit (No. 50 Torx®) T77L-2100-A, tighten bolt

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to 34-46 Nm (25-34 lb-ft). Reposition sling cover.

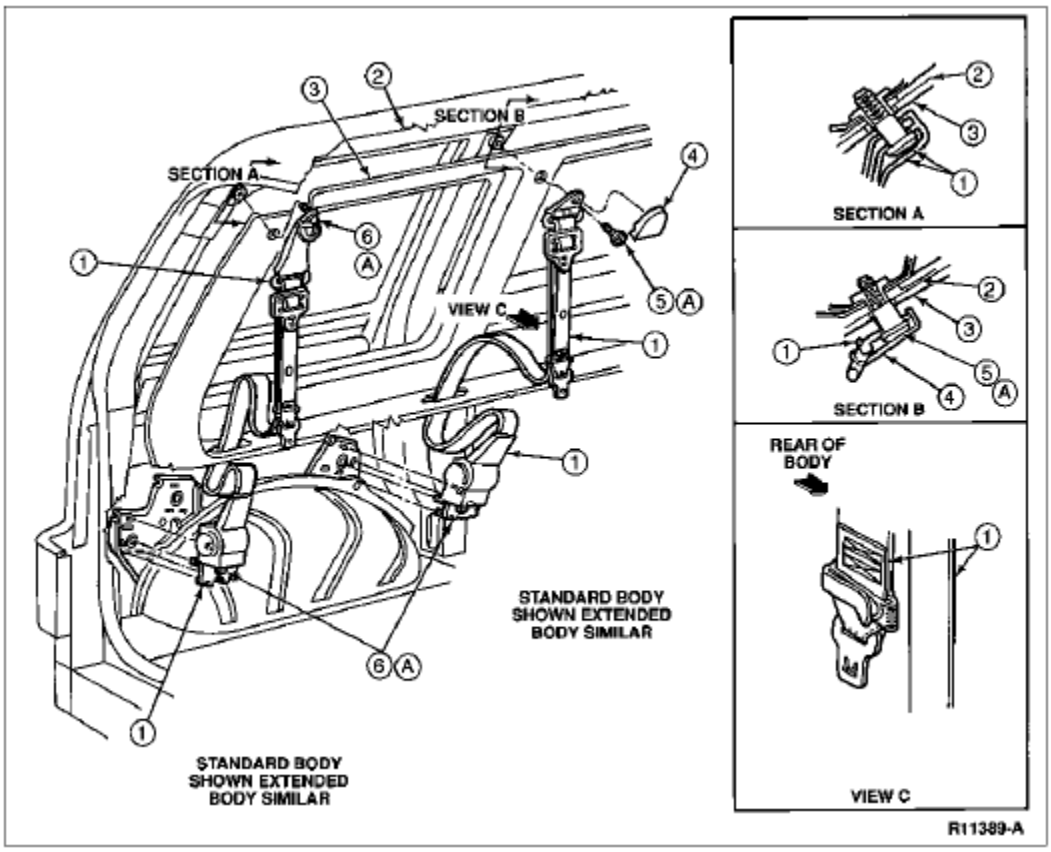
5. Position anchor to step well and secure with bolt. Using Seat Belt Bolt Bit (No. 50 Torx®) T77L-2100-A, tighten bolt to 34-46 Nm (25-34 lb-ft).

6. Install safety belt retractor cover bolt access plug.

7. Position rear safety belt retractor cover and secure with screws.

8. Check the restraint system for proper operation.

Quad Buckets, Second Row and Three-Passenger Bench, Left Side, Aerostar



Item	Part Number	Description
1	611B68	Rear Safety Belt Retractor and Tongue
2	51968	Roof Trim Panel
3	31012	Quarter Trim Panel
4	613C46	Cover, Rear Seat Shoulder Strap Guide
5	386276-S100	Bolt
6	386270-S100	Bolt
A	—	Tighten to 34-46 Nm

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		(25-34 Lb-Ft)

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Safety Belt, Rear, Detachable, Outboard, Aerostar

All rear outboard seating positions in Aerostar vehicles are equipped with rear seat shoulder safety belts. Rear seat shoulder safety belts with detachable anchors are provided on the second row RH bench seat, second row LH seat and third row RH and LH seat.

In addition to anchors in the rear floor and roof structure, some safety belts have a detachable anchor mounted to the outboard side of the rear seat cushion frames (63160).

NOTE: The following bilingual (English/French) WARNING statement is shown on the WARNING label attached to the lower portion of the safety belt.

WARNING: THIS SEAT BELT GIVES NO PROTECTION UNLESS THIS END IS BUCKLED TO SIDE OF REAR SEAT CUSHION FRAME.

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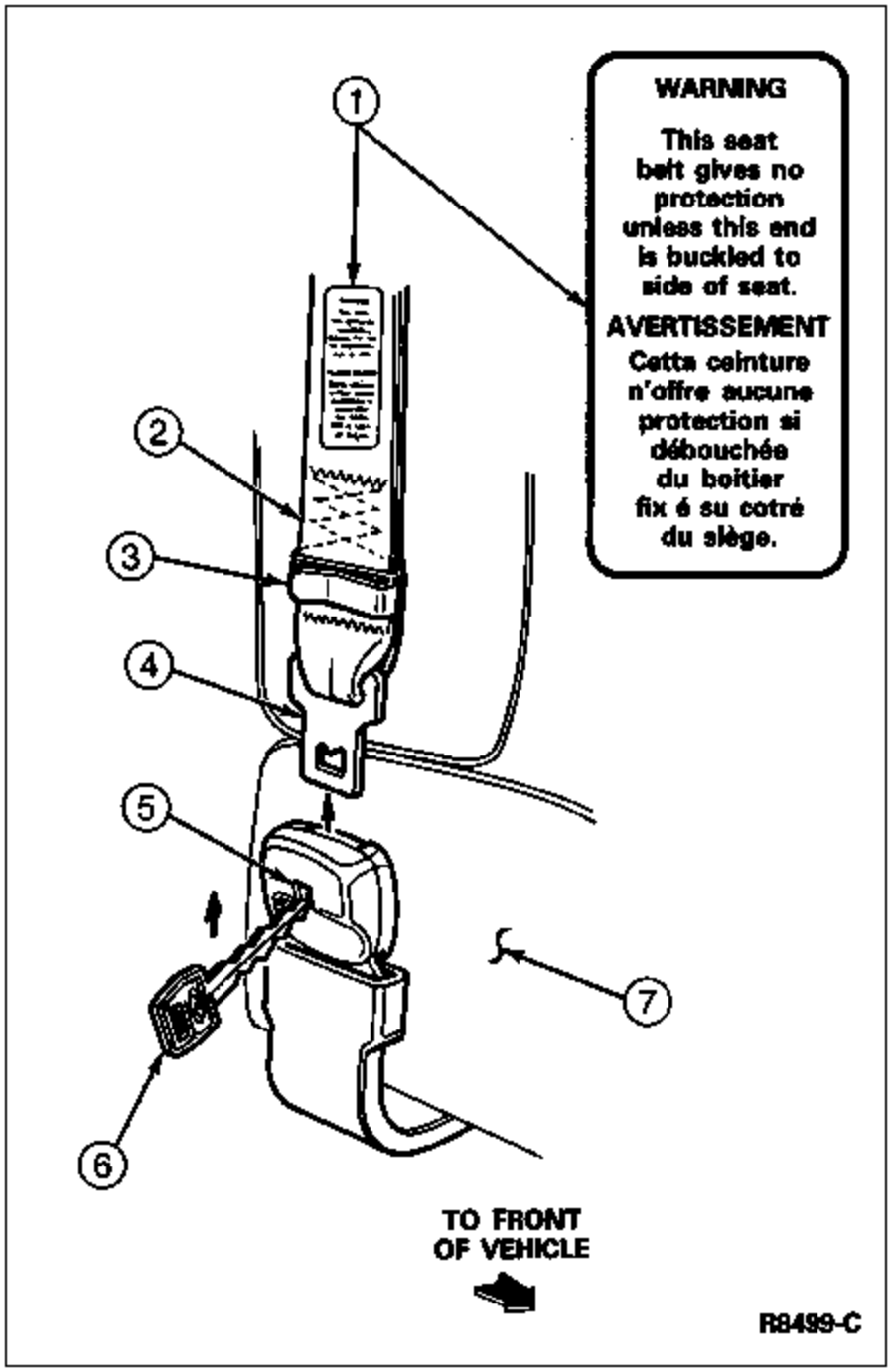

Item	Part Number	Description
1	—	Detachable Anchor Warning Label on Safety Belt (Part of 613C46)
2	611B68/611B69	Rear Safety Belt Assembly (Detached Position)
3	—	Shoulder Safety Belt Stowage Retainer (Part of 611B68/611B69)
4	—	Tongue End of Detachable Anchor (Part of 611B68/611B69)

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5	—	Slot in Detachable Anchor (PIA with Seat Kit)
6	—	Key or Small Screwdriver
7	63160	Rear Seat Cushion Frame

NOTE: The following bilingual (English/French) CAUTION statement is shown on the CAUTION labels attached to the upper portion of the safety belts.

Removal

NOTE: Prior to vehicle delivery, customers must be shown the locations of the detachable anchors and their proper use.

NOTE: Safety belt must be detached when removing rear seat. Refer to Section 01-10 for rear seat removal procedures.

Rear seat shoulder safety belts should remain engaged in detachable anchors, except when the rear seat assembly is removed.

WARNING: WHEN INSTALLING A REAR SEAT IN THE VEHICLE, INSTALL THE REAR SEAT IN ITS ORIGINAL LOCATION. IMPROPER INSTALLATION OF THE SEAT WILL PREVENT CORRECT USE OF THE SHOULDER SAFETY BELTS. IMPROPER USE OF THE SAFETY BELTS COULD INCREASE THE RISK AND/OR SEVERITY OF INJURY AND ACCIDENTS.

1. Disengage belt from seat by inserting key or small screwdriver into slot located in detachable anchor.
2. Lift screwdriver up and disengage belt.
3. Whenever a rear seat has been removed, the tongue end of the detachable anchor must be on the rear shoulder belt hook. Refer to illustration.

Installation

1. Install rear seat. Refer to Section 01-10 for rear seat installation procedures.

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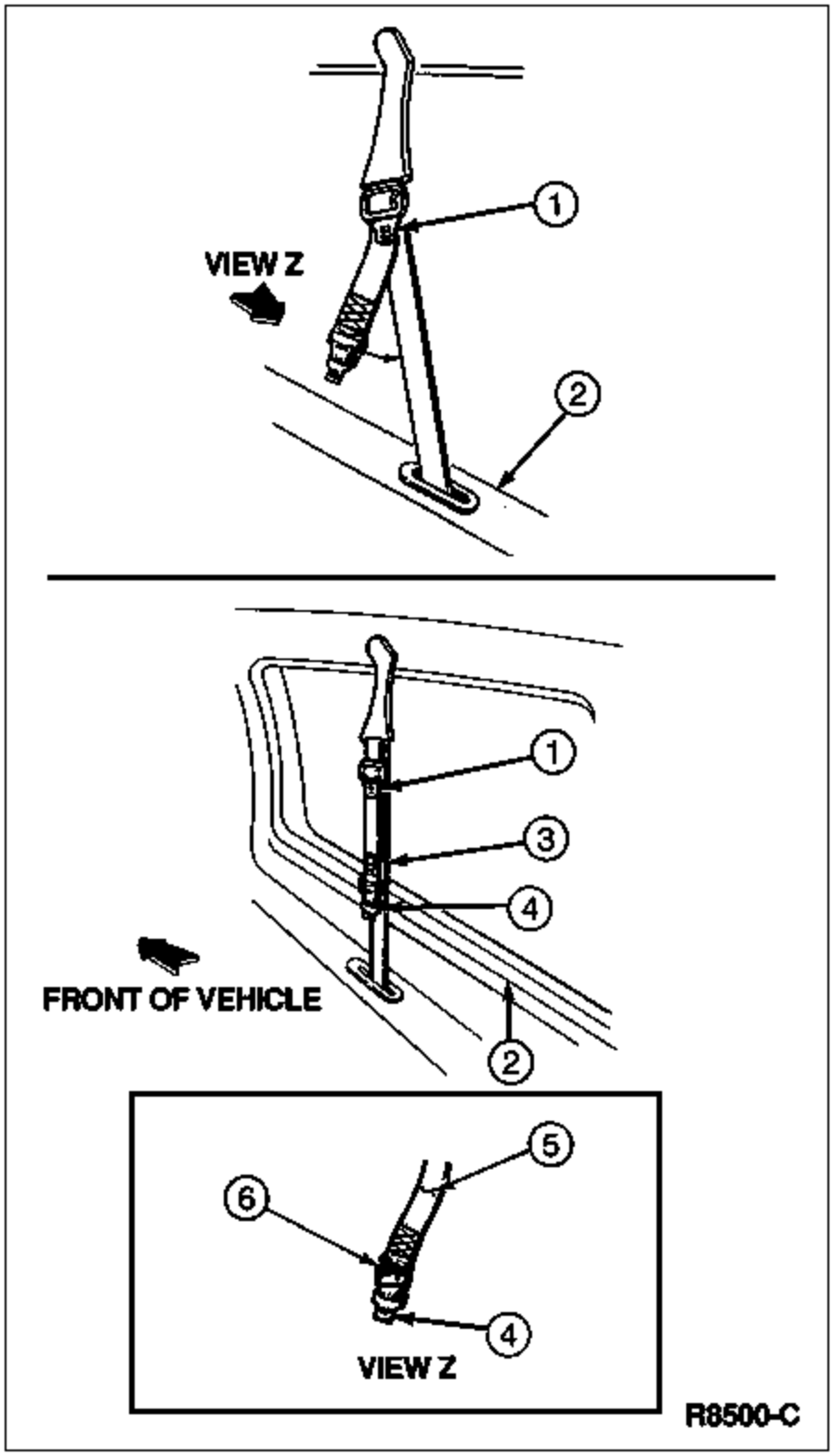

Item	Part Number	Description
1	60044	Rear Safety Belt Assembly
2	—	Shoulder Safety Belt Stowage Retainer

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		(Part of 60044)
3	—	Tongue End of Shoulder Safety Belt (Part of 60044)
4	—	Tongue End of Detachable Anchor (Part of 60044)
5	31012	Quarter Trim Panel
6	—	Shoulder Safety Belt in Stowed Position (Part of 60044)

2. Prior to inserting the detachable anchor tongue end into the detachable anchor, make sure the safety belt is not twisted. Insert the detachable anchor tongue end into the detachable anchor until you hear a "snap" and feel the latch engage. If the safety belt is twisted, disengage the tongue end from the detachable anchor, remove the twist and reinsert the tongue end until you hear a "snap" and feel the latch engage.

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Safety Belts, Rear, Center — Aerostar

NOTE: Safety belt BUCKLES, center adjust tongues and belt and retractors can be replaced separately. However, if a safety belt assembly was in use during a collision, the belt and retractor must be replaced as well as the center adjust tongue and belt and buckle assembly or the center adjust tongue and the cable and BUCKLE assembly. When replacing safety belt and BUCKLE, safety cable and BUCKLE, center adjust tongues and belt and retractors, use only the replacement parts specified in the Ford Master Parts Catalogs for the make and model of the vehicle being serviced. Safety belt assemblies must not be interchanged between vehicle models.

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Seat Belt Bolt Bit (No. 50 Torx®)	T77L-2100-A

The third row rear seat center belts (611B66) do not have rear safety belt retractor and tongues (611B68). To lengthen the rear seat center belt, tip the tongue at a right angle to the belt, and pull the tongue until the ends can be joined over the lap.

To fasten the third row rear seat center belt, insert the tongue into the open end of the rear safety belt and buckle (60044) until a "snap" is heard. To shorten the rear seat center belt, pull on the loose end of the webbing. The rear seat center belt should be snug across the hips, never across the waist.

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Safety Belts, Rear, Inboard, Second Row Bucket Seats — Aerostar

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Seat Belt Bolt Bit (No. 50 Torx®)	T77L-2100-A

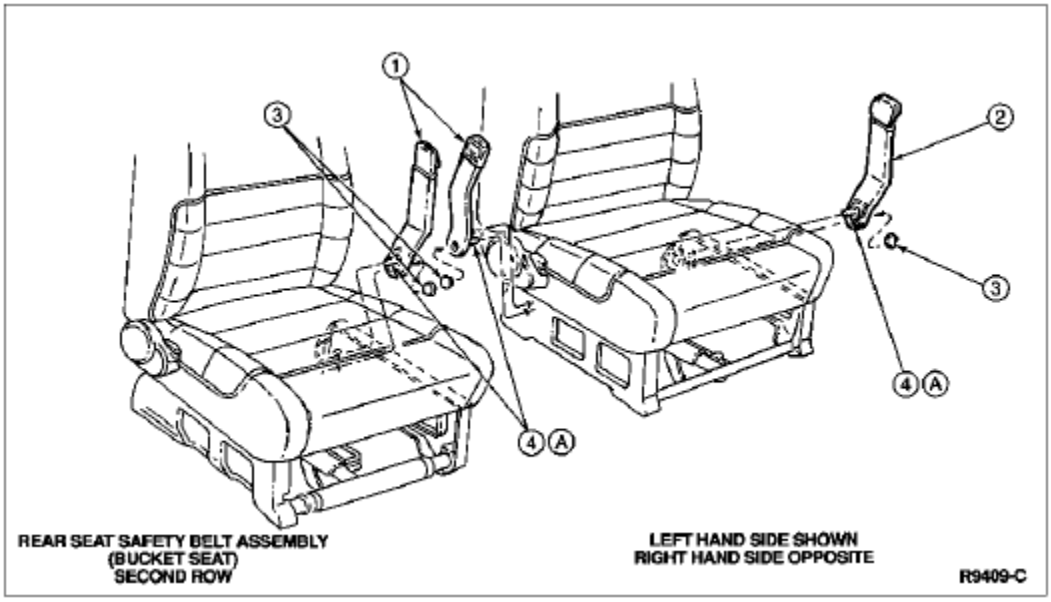
Removal

1. Remove plug button from buckle boot and remove buckle boot bolt.
2. Carefully pry open retractor cover and remove retractor bolt.

Installation

1. Position retractor to the pedestal and install retractor bolt. Tighten the bolt to 40 Nm (30 lb-ft).
2. Position buckle boot to the pedestal and install the buckle boot bolt. Tighten the bolt to 40 Nm (30 lb-ft). Install the plug button.

Inboard Safety Belts, Rear Seat, Second Row Bucket Seats — Aerostar



Item	Part Number	Description
1	160044	Rear Safety Belt and Buckle
2	—	Detachable Anchor (Left Rear Position Only)

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3	611B32	Plug
4	386273	Bolt
A	—	Tighten to 40 Nm (30 Lb-Ft)

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Safety Belts, Rear, Inboard, Three-Passenger Bench — Aerostar

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Seat Belt Bolt Bit (No. 50 Torx®)	T77L-2100-A

Removal

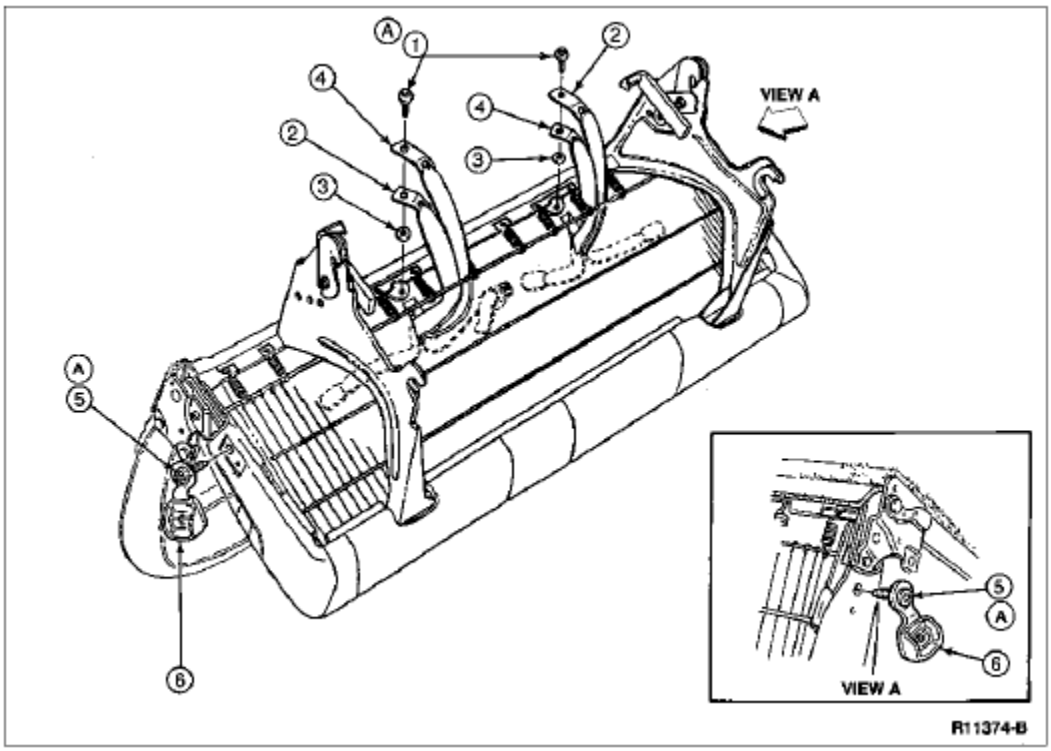
1. Remove seat side shields.
2. Remove the bolts from the rear safety belt and buckles to the rear seat cushion frame (63160).

Installation

To install, reverse the removal procedure.

Tighten bolt to 40 Nm (30 lb-ft).

Rear Safety Belts, Inboard, Three-Passenger Bench — Aerostar



Item	Part Number	Description

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1	386274-S100	Bolt
2	600A44	Rear Safety Belt and Buckle
3	388832	Washer
4	611B66	Rear Seat Center Belt
5	386276-S100	Bolt
6	601A90	Rear Safety Tongue Assembly (LH)
A	—	Tighten to 40 Nm (30 Lb-Ft)

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Safety Belts, Rear, Inboard, Two-Passenger Bench Seat — Aerostar

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Seat Belt Bolt Bit (No. 50 Torx®)	T77L-2100-A

Removal

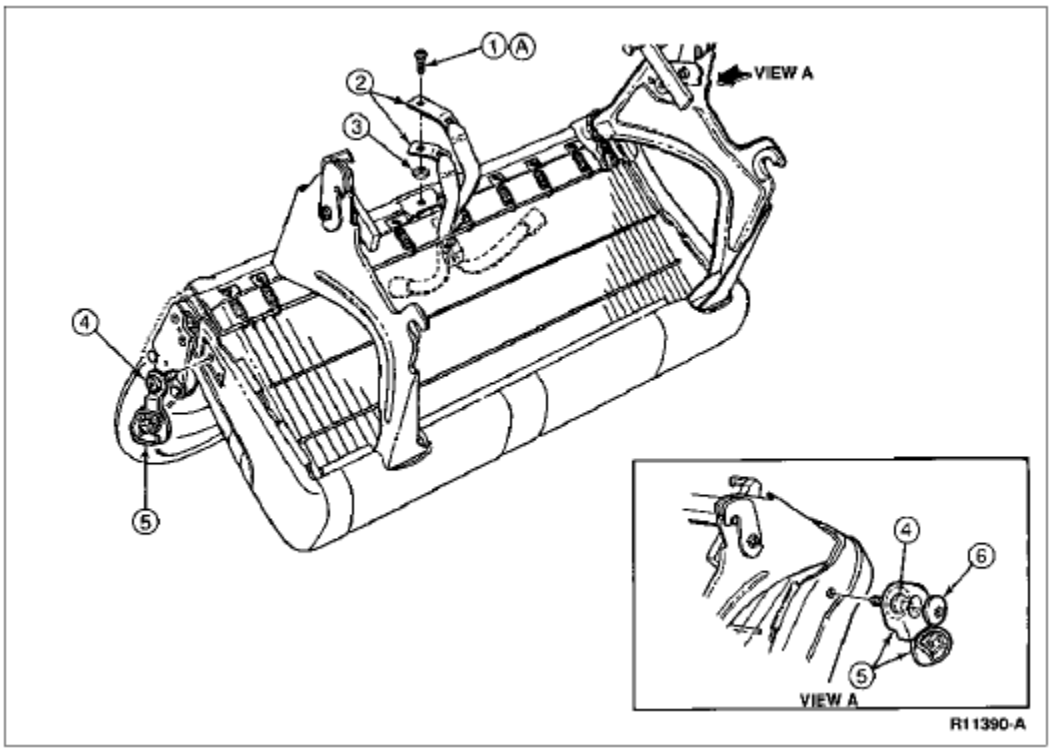
1. Remove safety belt retractor cover bolt access plug (611B32) from detachable anchor (right side only).
2. Remove bolt holding the detachable anchor assembly to the front floor pan (11135).

Installation

To install, reverse the removal procedure.

Tighten bolt to 40 Nm (30 lb-ft).

Rear Safety Belts, Inboard, Two-Passenger Bench Seat — Aerostar



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Item	Part Number	Description
1	386274-S100	Bolt
2	600A38	Rear Safety Belt and Buckle
3	388832	Washer
4	386276	Bolt
5	601A90	Detachable Anchor (Buckle and Stamp Assembly)
6	611B32	Safety Belt Retractor Cover Bolt Access Plug
A	—	Tighten to 40 Nm (30 Lb-Ft)

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Child Safety Seat, Tether Attachment

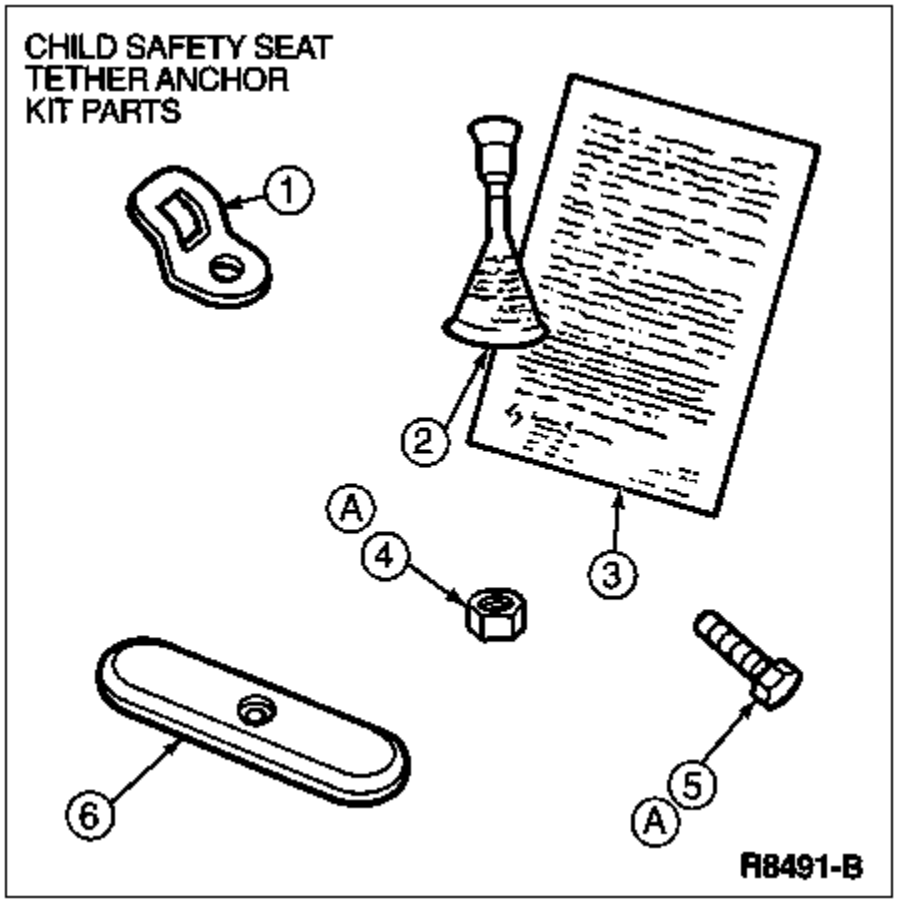
Some manufacturers make safety seats with a tether strap that goes over the back of the vehicle seat and attaches to the anchoring point behind the vehicle seat.

Ford recommends placement of tethered safety seats in a rear seating position with the tether strap attached to the tether anchoring point.

You can attach a tether strap anchor bracket to the rear floor by using a tether anchor kit available at no charge from any Ford dealership.

On four-door models, if a tethered seat is installed in the seat, it should be located only at the center front seating position, with the tether strap secured to the webbing of the buckled center rear lap belt behind the child safety seat. The rear lap/shoulder belts should not be used to secure the tether strap of a safety seat located in the front seat.

WARNING: FAILURE TO FOLLOW THESE PRECAUTIONS COULD INCREASE THE CHANCE AND/OR SEVERITY OF INJURY IN AN ACCIDENT.



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Item	Part Number	Description
1	—	Tether Bracket (Part of 613D74)
2	—	Thread Lock (Part of 613D74)
3	—	Instructions (Part of 613D74)
4	—	Nut, Tether Anchor (Part of 613D74)
5	N605533-S40	Bolt, Tether Anchor (Part of 613D74)
6	—	Tether Anchor Plate (Part of 613D74)
A	—	Tighten to 22-34 Nm (17-25 Lb-Ft)

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Instructions For Locating Tether Strap Anchor Drill Dimples For The Right Front Passenger Seat

General Instructions — Aerostar

Read these instructions carefully prior to installation of the child tether strap anchor kit. (See Kit Contents.)

Some manufacturers make safety seats with a tether strap that goes over the back of the vehicle seat and attaches to an anchoring point behind the vehicle seat.

Ford recommends placement of tethered safety seats in a rear seating position with the tether strap attached to the tether anchoring point as shown in this instruction sheet.

Four (4) tether strap anchor locations have been provided in the vehicle. If the child's safety seat located in the front, right-hand passenger seat, the tether strap anchor attachment location under the **second** row bench seat or right-hand bucket seat must be used. For second row seating positions, you must use one of the three (3) tether strap anchor locations under the third row bench seat. (Refer to following illustration.)

You can attach a tether strap anchor bracket to the rear floor by using a tether anchor kit, available at no charge from any Ford dealership.

The rear lap/shoulder safety belts should not be used to secure the tether strap of a safety seat located in the front seat.

WARNING: FAILURE TO FOLLOW THESE PRECAUTIONS COULD INCREASE THE CHANCE AND/OR SEVERITY OF INJURY IN AN ACCIDENT.

1. Remove the second row bench seat or both bucket seats.

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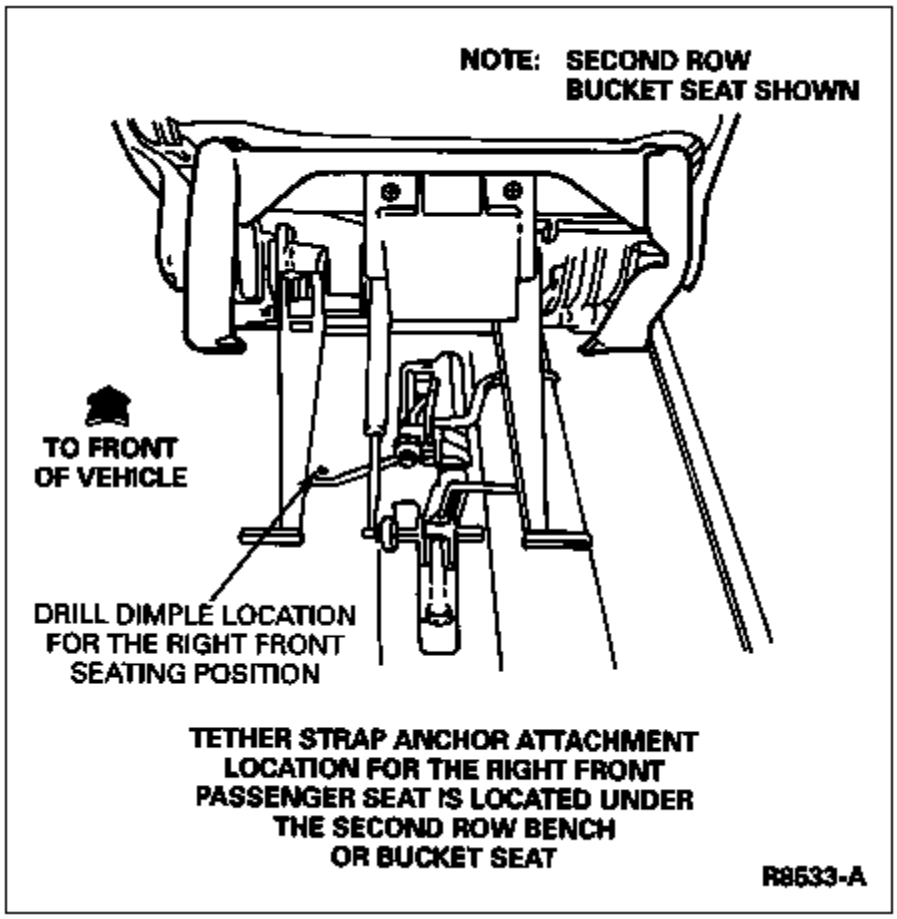

2. Locate the front and rear attaching screws **A** and **B** holding both the right and left floor well bezels to the floor.

3. From screw attachments **A** and **B** , working toward the center of the vehicle, apply a 15.2cm (six-inches) strip of 51mm (two inches) wide masking tape onto the floor carpet.

4. Lay a straightedge from the right-hand bezel attaching screw **A** to the left-hand bezel attaching screw **A** . Draw a line on the masking tape. Repeat this procedure for screw **B** .

5. From screw **A** , measure approximately 10.8cm (4-1/4 inches) toward the center of the vehicle and mark the tape **Point A** .

6. From screw **B** , measure the same distance and mark the tape **Point B** .

7. Apply a strip of tape connecting the two previously marked locations **(Points A and B)** .

8. Lay a straightedge from **Point A** to **Point B** and draw a line on the tape. Measure from **Point A** toward **Point B** , approximately 24.5cm (9-5/8 inches), and mark the tape.

9. Refer to "Instructions for Exposing Drill Dimples Underneath the Carpet" in this section.

Tether Attachment

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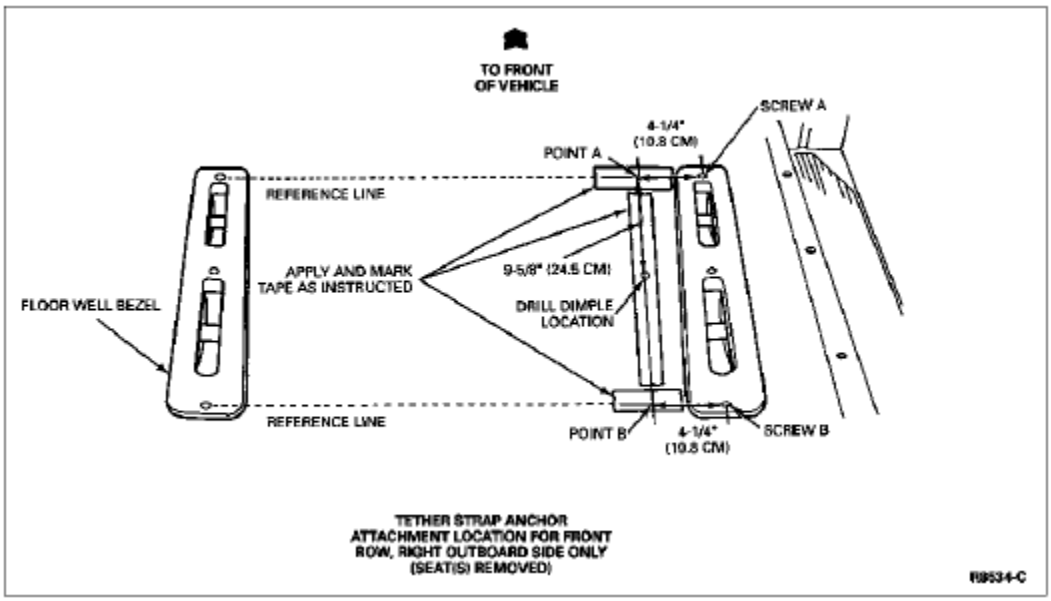

Instructions for Exposing Drill Dimples Underneath the Carpet — Aerostar

1. After the approximate location(s) have been determined, using the masking tape, press the carpeting where you marked the tape and feel the unsupported area beneath the carpeting. This will indicate the location of the floor drill dimple provided for the tether strap anchor.

2. Feel the unsupported edge of the 51mm x 51mm (2 inches by 2 inches) opening under the carpet. Cut the carpet as shown and fold it back to expose both the drill dimple and the embossed letter "T" near the drill dimple.

3. Refer to "Locations of the Drill Dimples for Mounting the Tether Strap Anchors" in this section.

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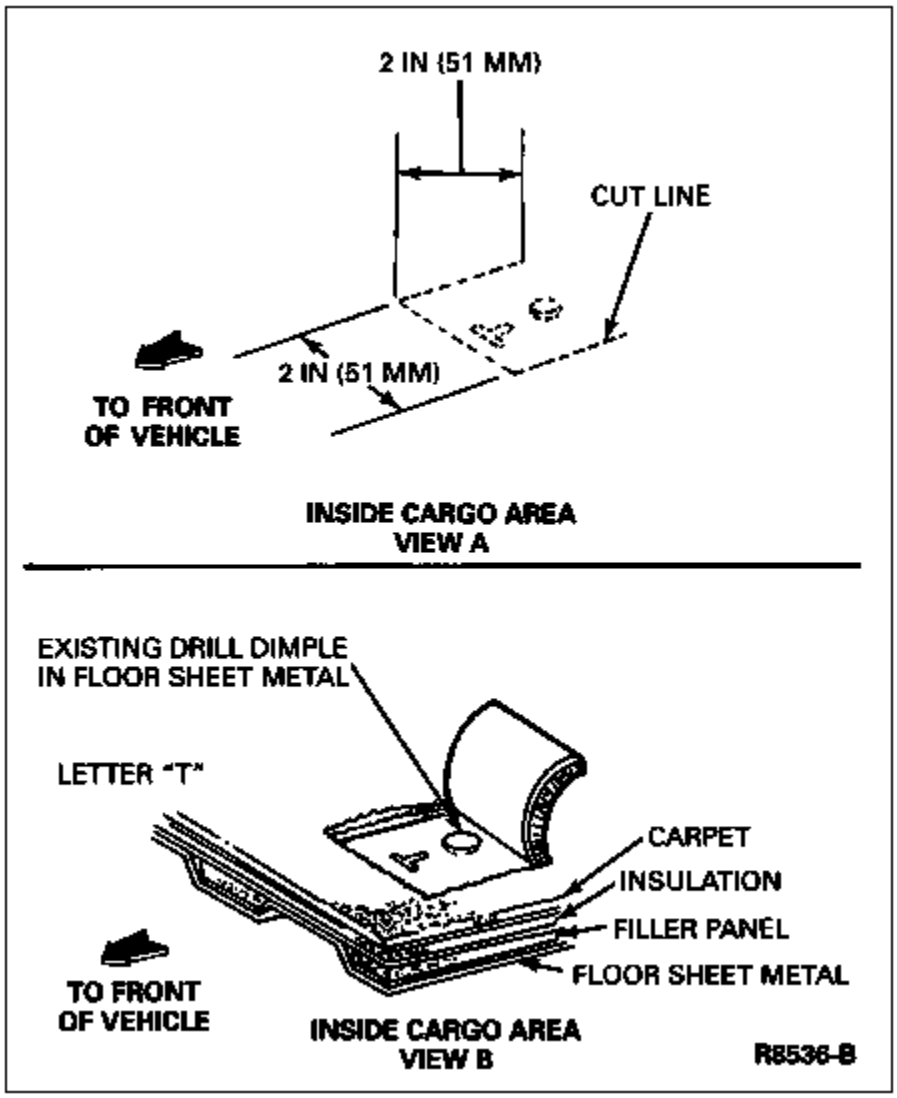

Tether Strap Anchor Locations for:

- Second Row Right-Hand:
  - 3-Passenger Bench.
  - Bucket Seat.

- Second Row Left-Hand:
  - 3-Passenger Bench.
  - 2-Passenger Bench.
  - Bucket Seat.

Tether Attachment Locations, 2nd Row RH and LH Bench and Bucket Seats

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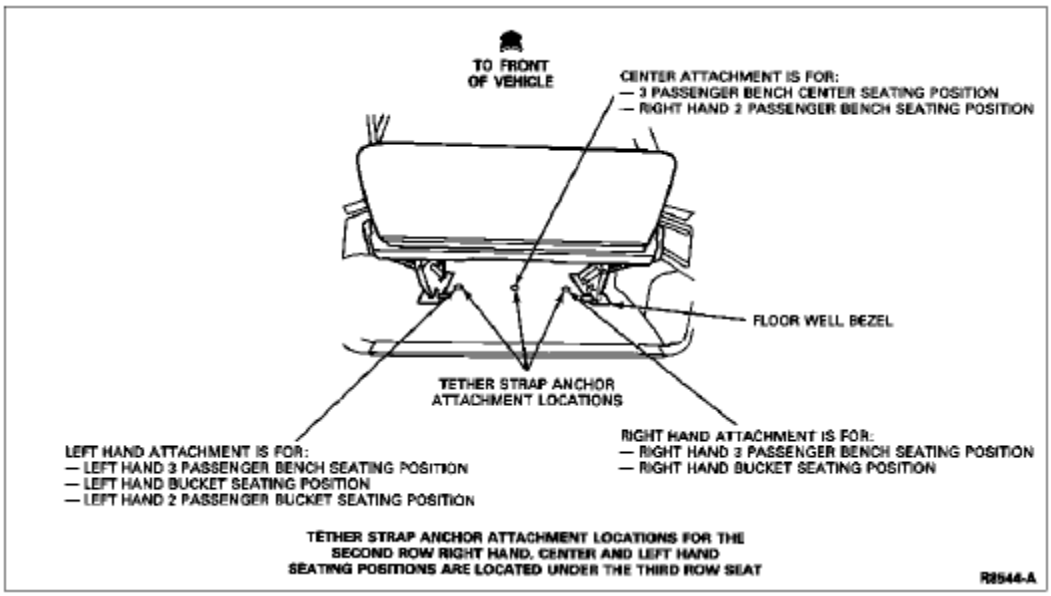

1. Remove the third row passenger bench seat.
2. Locate front and rear attaching screws **A** and **B** retaining the floor well bezels to the floor.
3. From screw attachments **A** and **B** , working toward the center of the vehicle, apply a 15.2cm (6-inches) strip of 51mm (2-inches) wide masking tape onto the floor carpet.
4. Lay a straightedge from the right-hand bezel attaching screw **A** to the left-hand bezel attaching screw **A** and draw a line on the masking tape. Repeat this procedure for screw **B** .
5. From screw **A** , measure approximately 10.8cm (4-1/4 inches) toward the center of the vehicle and mark the tape at **Point A** .
6. From screw **B** , measure the same distance and mark the tape at **Point B** .
7. Apply a strip of tape connecting the two previously marked locations (**Points A and B**).
8. Lay a straightedge from **Point A** to **Point B** and draw a line. Measure from **Point A** toward **Point B** , approximately 23.2cm (9-1/8 inches), and mark the tape.
9. Refer to "Instructions for Exposing Drill Dimples Underneath the Carpet" in this section.

Drill Dimple Location, 2nd Row RH and LH Bench and Bucket Seats

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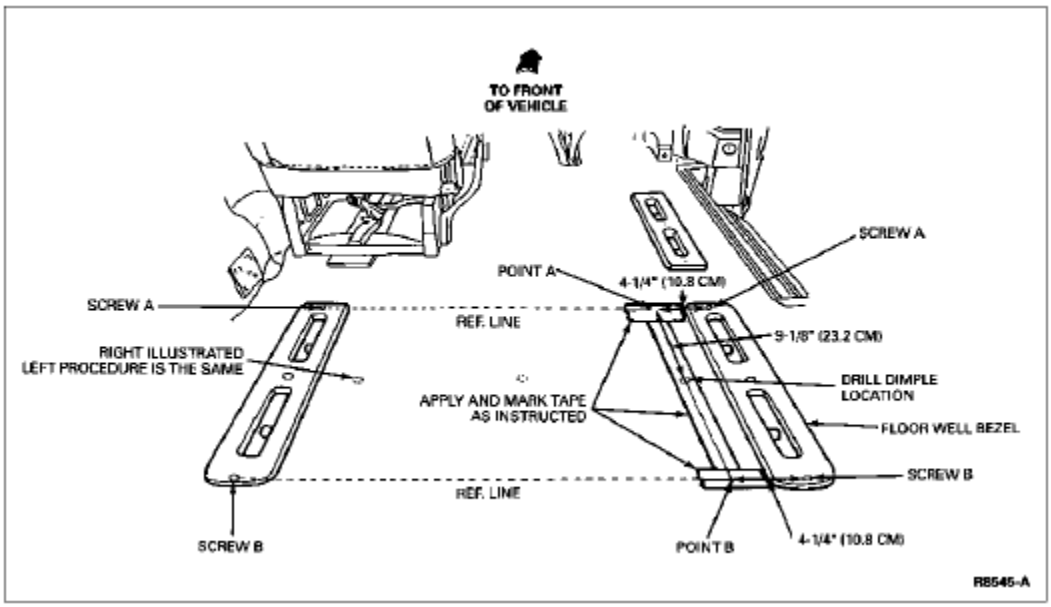


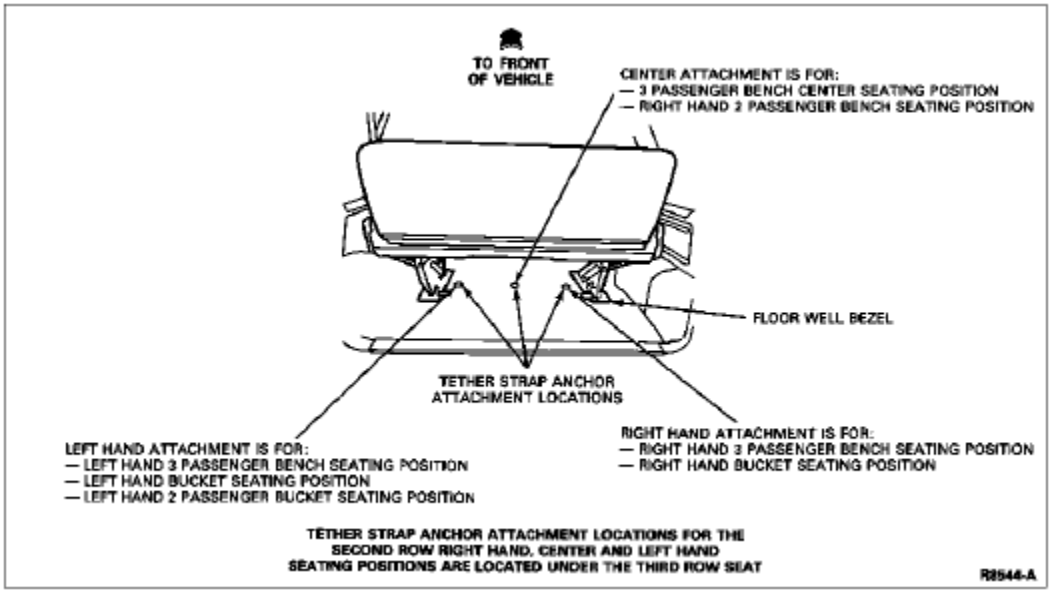
10. Refer to Steps 1-9 (finding the RH tether strap anchor location) and use the same procedure to find the left-hand tether strap anchor location.

Tether Strap Anchor Location for:

- Second Row:
  - Center 3-Passenger Bench.
  - Right-Hand 2-Passenger Bench.

1. Remove the third row passenger bench seat.

Tether Attachment Locations, 2nd Row Center and RH Bench Seats



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2. Locate front and rear attaching screws **A** and **B** retaining the floor well bezels to the floor. Refer to illustration in previous procedure.

3. From screw attachments **A** and **B** , working toward the center of the vehicle, apply a 45.7cm (1-1/2 feet) strip of 51mm (two inches) wide masking tape onto the floor carpet.

4. Lay a straightedge from right-hand bezel attaching screw **A** to the left-hand bezel attaching screw **A** . Draw a line on the masking tape. Repeat this procedure for attaching screw **B** .

5. From screw **A** , using a straightedge, measure approximately 32cm (12-5/8 inches) toward the center of the vehicle and mark the tape.

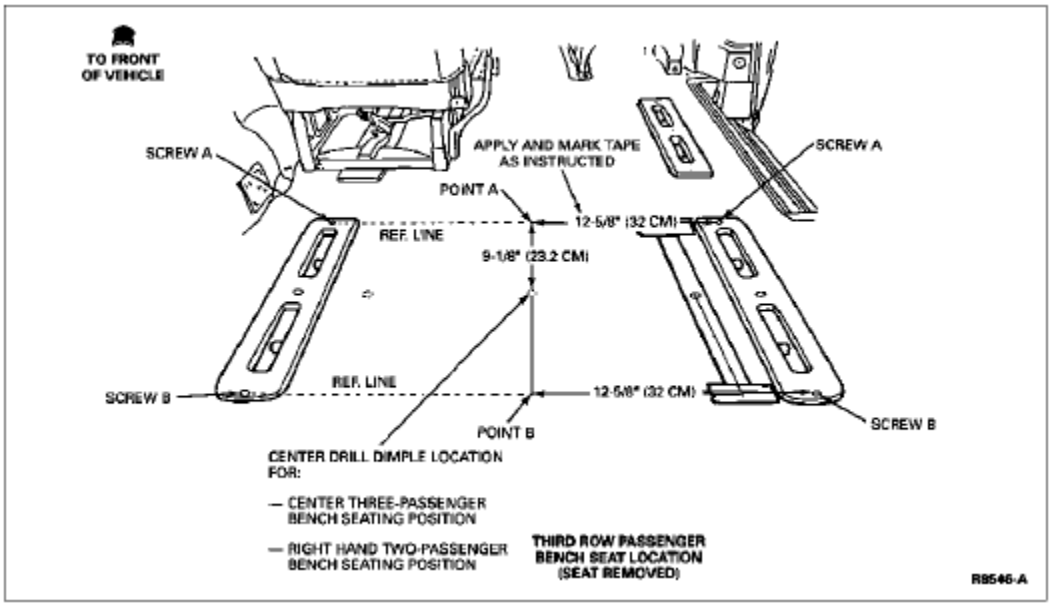
6. From screw **B** , measure the same distance and mark the tape.

7. Apply a 30cm (one-foot) strip of tape connecting the two previously marked locations (**Points A and B**).

8. Lay a straightedge from **Point A** to **Point B** and draw a line. Measure from **Point A** toward **Point B** , approximately 23.2cm (9-1/8 inches), and mark the tape.

9. Refer to "Instructions for Exposing Drill Dimples Underneath the Carpet" in this section.

Drill Dimple Locations, 2nd Row Center and RH Bench Seats



Locations of the Drill Dimples for Mounting the Tether Strap Anchors (View from Underneath the Vehicle) — Aerostar

1. Refer to the following illustration to find the drill dimple locations underneath the vehicle. Verify, before drilling hole through the floorpan, that the drill will not damage any underbody components.

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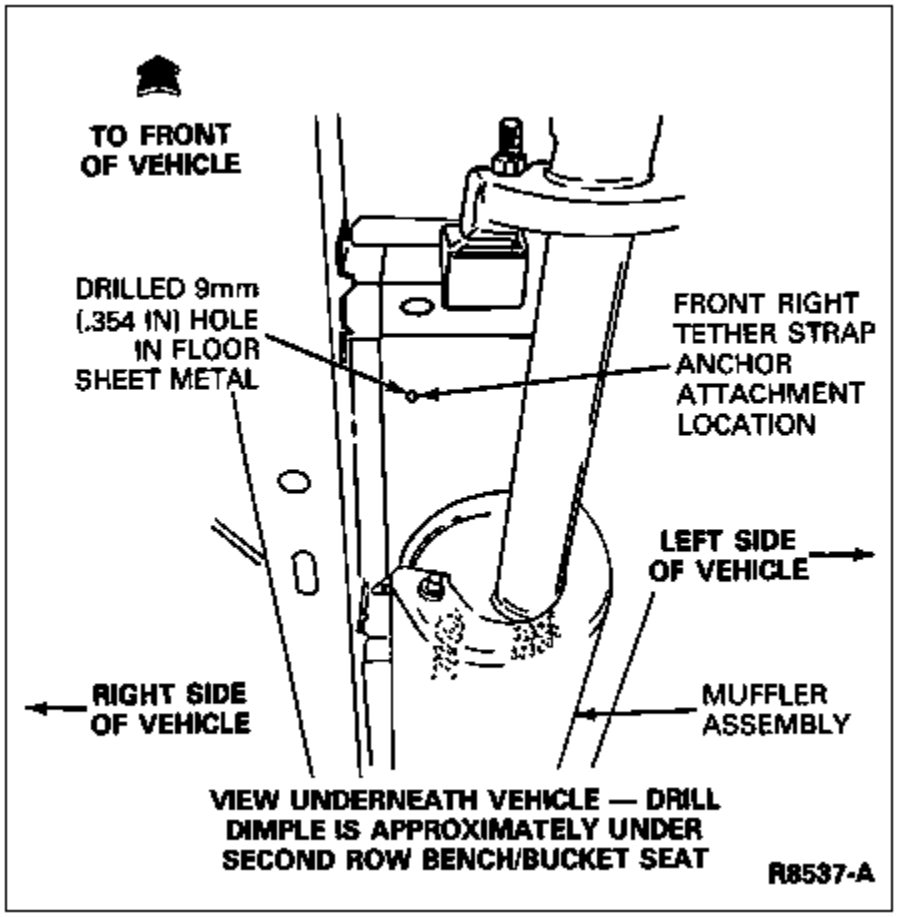
2. Refer to "Instructions for Installing Tether Strap Anchor Attachments" in this section.



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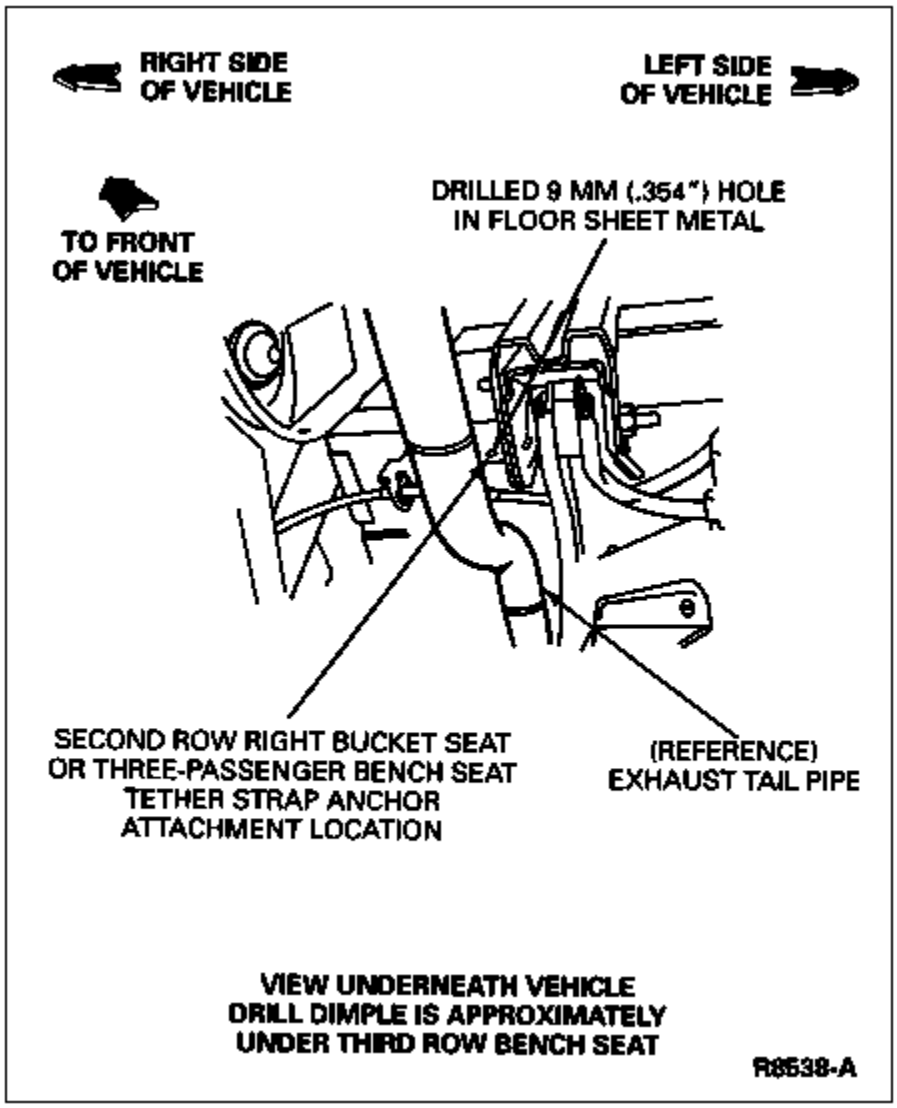

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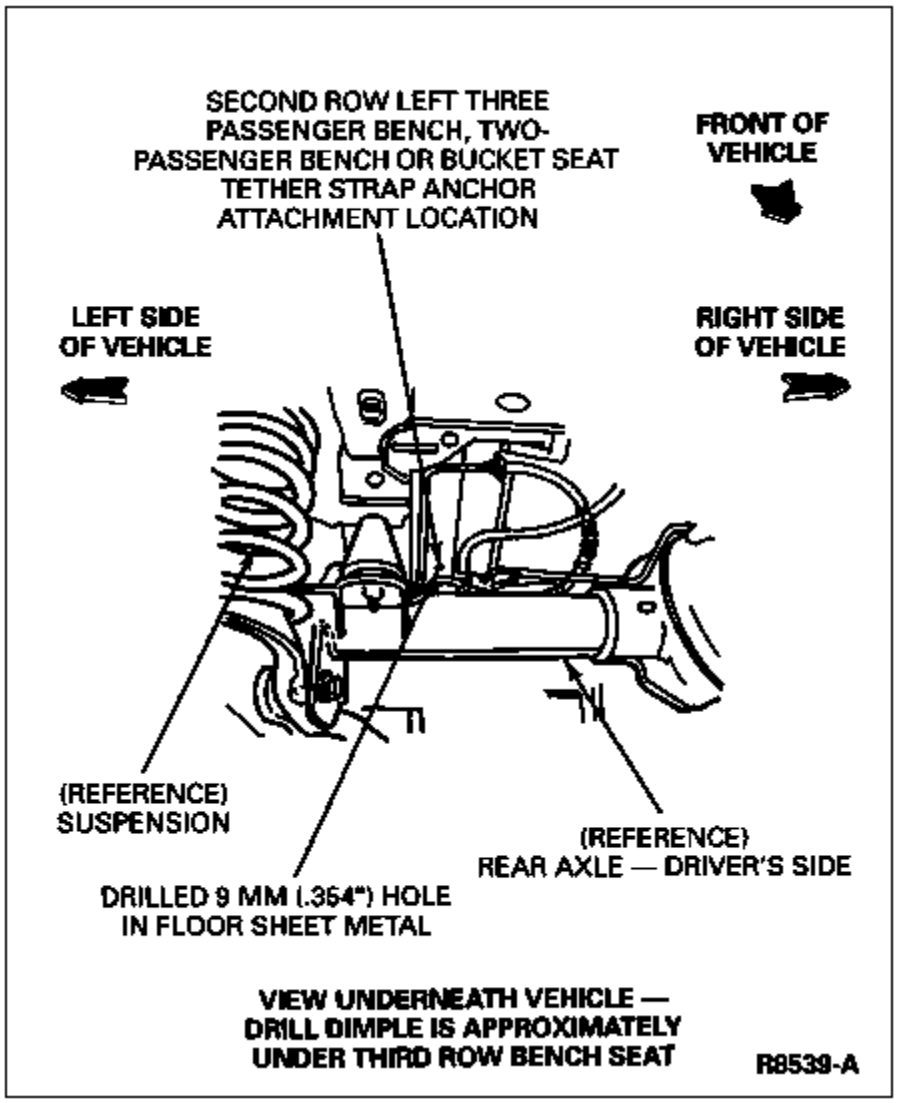

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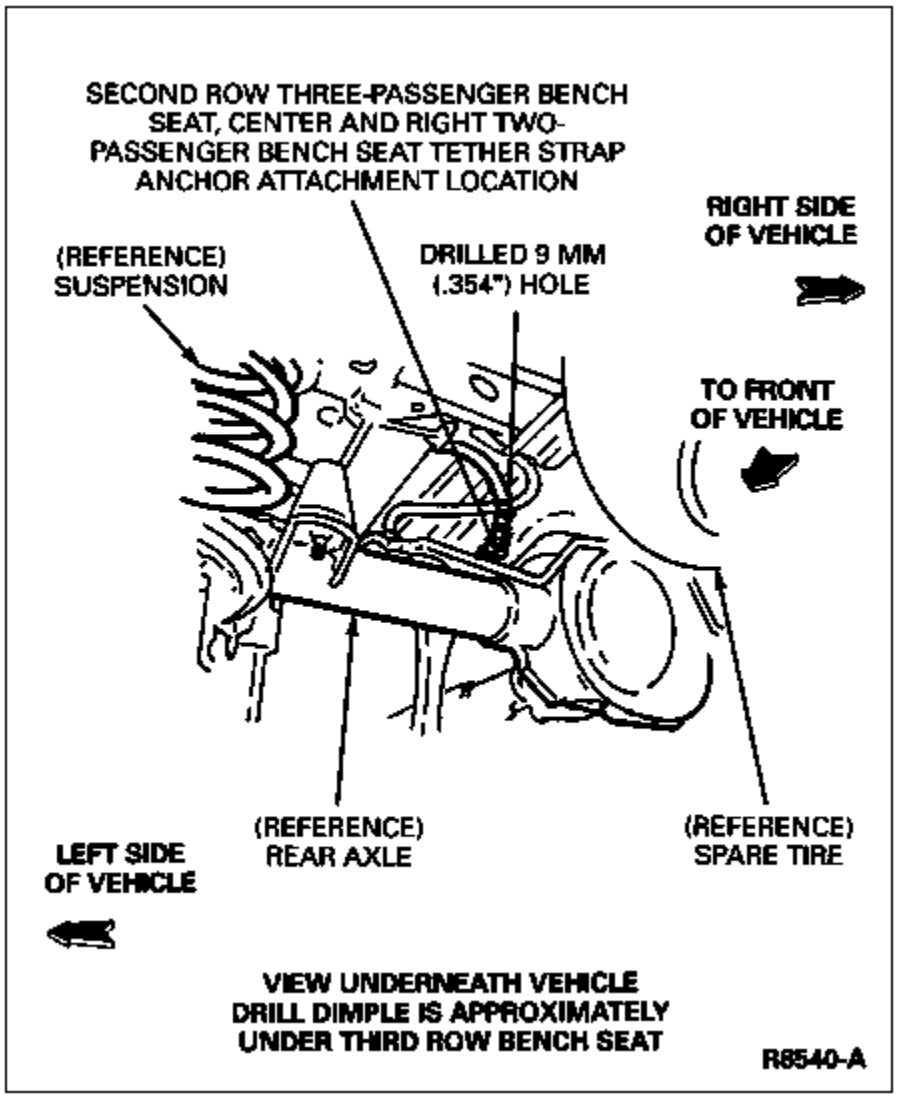

Instructions for Installing Tether Strap Anchor Attachments All Locations — Aerostar

1. From inside the cargo area, drill a 9mm (.354-inch) hole through the desired dimple(s).

2. **WARNING: THE TETHER BRACKET MUST BE BOLTED DIRECTLY TO THE FLOOR SHEET METAL. INTERIOR TRIM MUST NOT BE TRAPPED BETWEEN THE ANCHOR BRACKET AND THE SHEET METAL. FAILURE TO PROPERLY INSTALL THE ANCHOR BRACKET COULD RESULT IN IMPROPER PERFORMANCE IN THE EVENT OF AN ACCIDENT.**

   An assistant will be needed underneath the vehicle to attach the tether anchor. Before installing the tether hardware, read the instructions on the package containing thread locking material, then open the capsule and apply thread locking material to all threads on the tether attachment bolt. Install the child tether hardware as shown. It is important that the tether attachment bolt be tightened to 22-34 Nm (16-25 lb-ft).

3. **WARNING: THE THREADED HOLE IN THE TETHER ANCHOR HAS AN 8MM METRIC THREAD. A WRENCH WILL BE NEEDED TO TIGHTEN THE 8MM BOLT TO THE REQUIRED**

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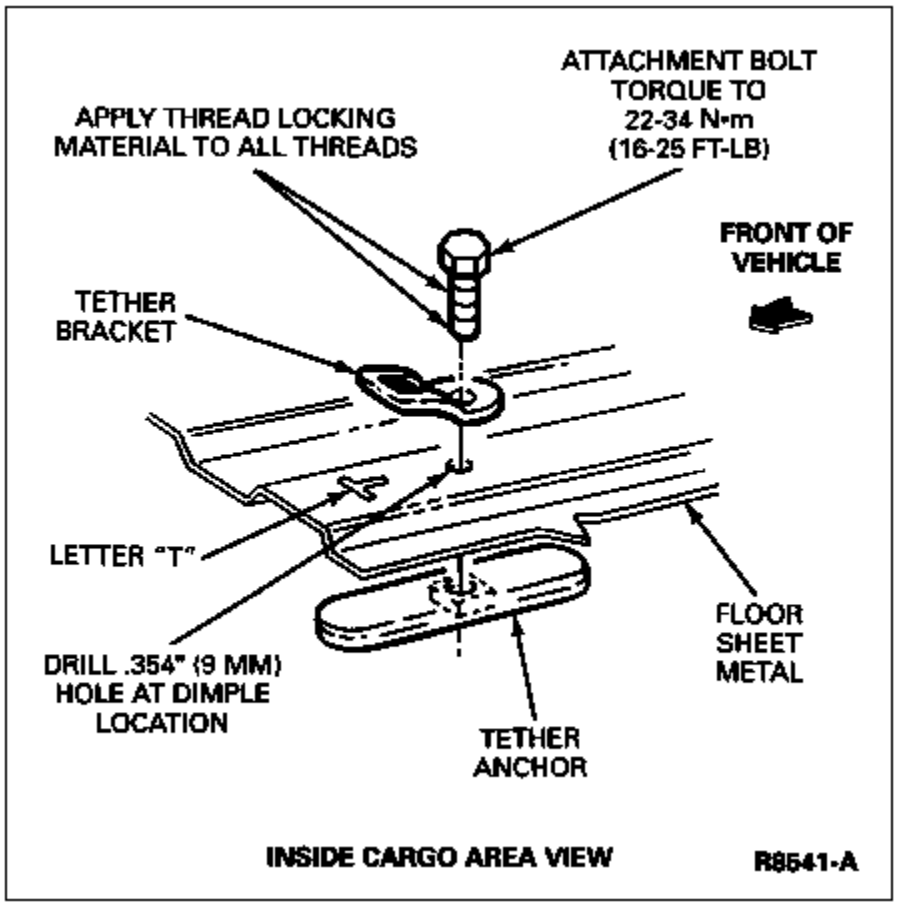
TORQUE. SOME CHILD RESTRAINTS COME WITH A NON-METRIC BOLT WITH A DIFFERENT THREAD. DO NOT USE A NON-METRIC BOLT AS IT MAY BE IMPOSSIBLE TO SCREW IT ALL THE WAY INTO THE HOLE, RESULTING IN INADEQUATE RETENTION OF THE CHILD RESTRAINT. USE ONLY THE METRIC ANCHOR BOLT SUPPLIED IN THE KIT. IF YOU NEED A REPLACEMENT METRIC BOLT OR ASSISTANCE, ANY FORD DEALER WILL BE HAPPY TO ASSIST YOU.

WARNING: IF THE ANCHOR BOLT(S) ARE EVER REMOVED, THE HOLE(S) IN THE FLOOR MUST BE SEALED TO PREVENT THE POSSIBILITY OF EXHAUST FUMES ENTERING THE PASSENGER COMPARTMENT.

Follow the child seat manufacturer's instructions to attach the tether strap to the tether bracket.



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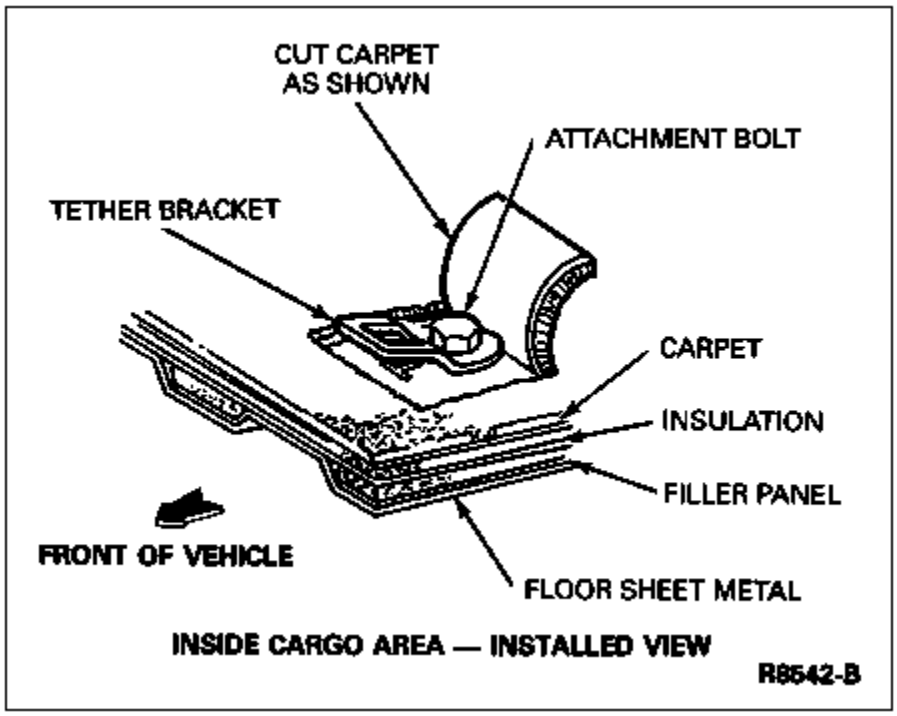

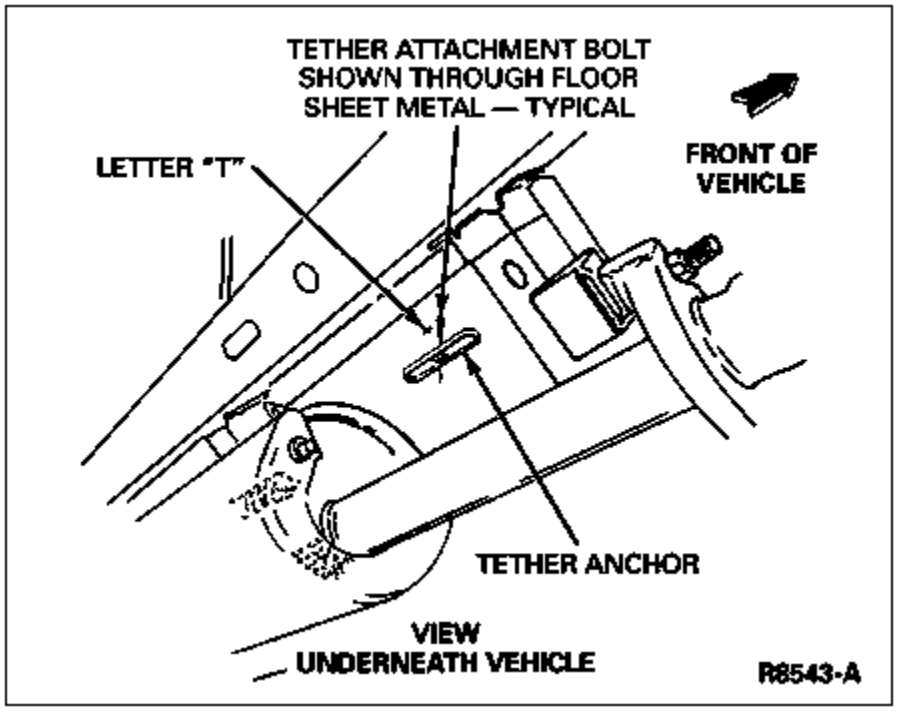

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SPECIFICATIONS

PARTS REPLACEMENT CHART

Original Parts			Replacement Parts		
Part No.	**Code Letter [1]**	**Part Name**	**Part No.**	**Code Letter [1]**	**Part Name**
389547-S190	IR	Bolt — 7/16-20 x 1.54 Panhead Shoulder Tapping — .75 Shldr.	389548-S190	S	Bolt — 1/2-13 x 1.54 Panhead Shoulder Locking — .75 Shldr.
386273-S100	IA	Bolt — 7/16-20 x 1.38 Panhead Tapping	383531-S36	X	Bolt — 1/2-13 x 1.38 Panhead Locking
386274-S100	IB	Bolt — 7/16-20 x 1.75 Panhead Tapping (.50 Shoulder)	383753-S36	Y	Bolt — 1/2-13 x 1.75 Panhead Locking (.50 Shoulder)
382580-S100	—	7/16 Flatwasher	382552-S100	—	1/2 Flatwasher
382629-S100	—	Washer — .463/.443 I.D. Plate (1.80 Dia. .190 Thick)	382552-S100	—	Washer — 1/2 Flat (1.30 Dia. .190 Thick)
382583-S100	—	Washer — 1/2 Serrated (.18 Thick)	382553-S100	—	Washer — 9/16 Flat (.25 Thick)
386272-S100	IF	Bolt — 7/16-20 x .88 Panhead Tapping	383437-S36	W	Bolt — 1/2-13 Panhead Locking
386276-S100	IL	Bolt — 7/16-20 x 1.75 Pan Shldr. Tapping — .75 Shldr.	383754-S36	Z	Bolt — 1/2-13 x 2.25 Panhead Locking (.88 Shoulder)
386277-S100	IK	Bolt — 7/16-20 x 1.38 Pan Shldr. Tapping — .50 Shldr.	385709-S36	T	Bolt — 1/2-13 x 1.38 Panhead Shoulder Locking
386392-S100	IG	Bolt — 7/16-20 x 2.15 Panhead Tapping	383754-S36	Z	Bolt — 1/2-13 x 2.25 Panhead Shoulder Locking
384966-S100	IV	Bolt — 7/16 20 x 1.75 Panhead Tapping	383531-S36	X	Bolt — 1/2-13 x 1.38 Panhead Locking
389370-S100	IM	Bolt — 7/16-20 x 1.15 Panhead Tapping	389478-S190	U	Bolt — 1/2-13 x 1.15 Panhead Locking

[1] Identification letter on top of bolt head or face of spacer.

Note: Bolt torque must be maintained at 40 Nm (30 lb-ft).

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft
Tether Attachment Bolt	22-34	16-25

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Safety Belt Bolts	40	30
Front Seat Shoulder Height Adjuster Bolts	40	30
Rear Seat Shoulder Height Adjuster Bolts	40	30
Retractor Bolts	40	30
Height Adjuster Nut	40	30
Safety Belt Buckle Nut/Washer	40	30
Front Seat Track Bolts	12-23	9-17
Rear Seat Track Bolts	19-26	14-19
Rear, Front Seat Back Inboard Pivot Bracket Nuts	39-55	29-41
Seat Back Nuts	40	30

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Supplemental Air Bag Restraint System (SRS)

The Supplemental Air Bag Restraint System is designed to provide increased accident protection for front seat occupants IN ADDITION TO that provided by the three point safety belt system. Safety belt use is necessary to obtain the best occupant protection and to receive the full advantages of the supplemental air bag restraint system. **FORD RECOMMENDS THE USE OF SAFETY BELT SYSTEMS FOR ALL VEHICLE OCCUPANTS.**

Refer to Section 01-20A for information on seat and shoulder belts.

The Supplemental Air Bag Restraint System (SRS) consists of:

- Electrical system
- Driver side air bag module (043B13)
- Sensors:
  - Cowl panel air bag sensors
  - Center air bag sensor
- Air bag diagnostic monitor (14B056)
- Air bag indicator
- Tone generator

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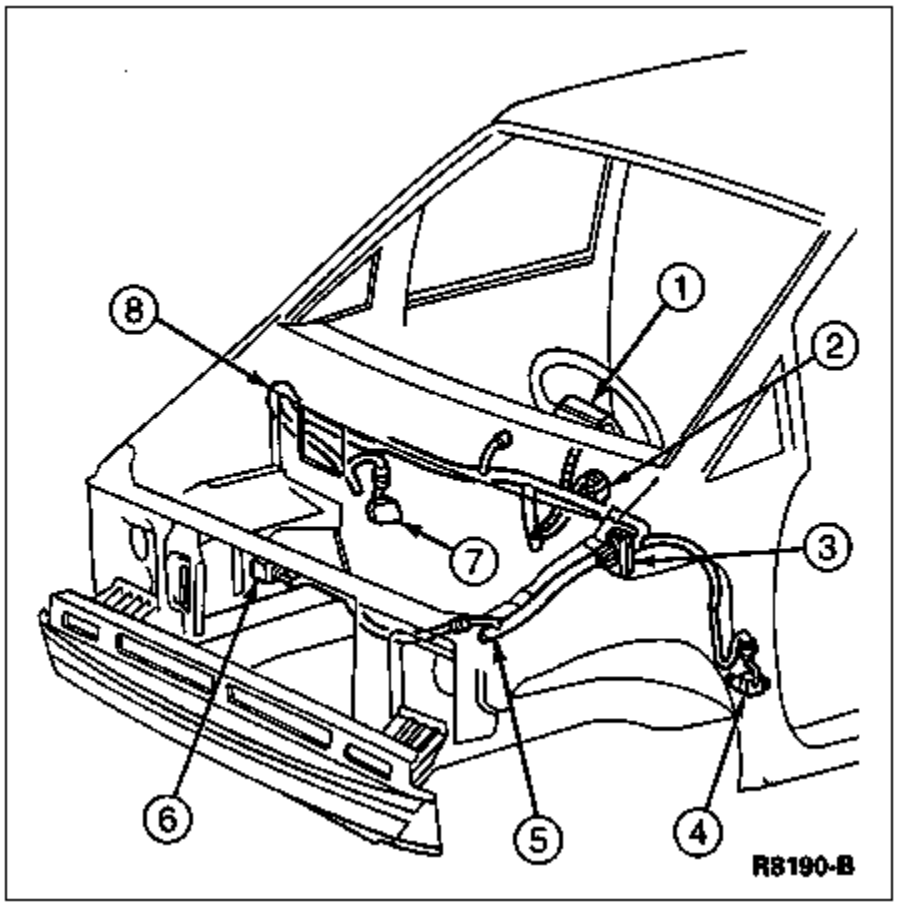

Item	Part Number	Description
1	043B13	Driver Side Air Bag Module
2	14B056	Air Bag Diagnostic Monitor
3	—	Connector at Safety Wall (Part of 12A580)
4	14B005	Cowl Side Air Bag Sensor and Bracket (LH)
5	12A581	Engine Control Sensor Wiring
6	14B006	Center Air Bag Sensor and Bracket
7	14B004	Cowl Side Air Bag Sensor and Bracket (RH)
8	14401	Main Wiring

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Air Bag Module, Driver Side

The driver side air bag module (043B13) is mounted in the center of the steering wheel (3600). The module consists of:

- Inflator
- Air bag
- Mounting plate and retainer ring
- Steering wheel trim cover

Inflator

NOTE: The inflator is a component of the driver side air bag module and is not a serviceable item. The driver side air bag module is serviced as a complete assembly.

When the LH cowl panel air bag safing and either the center air bag sensor or the RH cowl side panel air bag sensor close, signaling a crash, electric current flows to the air bag inflator. Inside the inflator, an igniter converts the electrical signal to thermal (heat) energy, causing the ignition of the inflator gas generant. This ignition reaction combusts the sodium azide/copper oxide gas generant in the inflator, producing nitrogen gas, which inflates the air bag.

Air Bag

NOTE: The air bag is a component of the driver side air bag module and is not a serviceable item. The driver side air bag module is serviced as a complete assembly.

The air bag:

- is constructed of neoprene coated nylon.
- is 711mm (28 inches) in diameter.
- fills to a volume of 0.065m ^{3} (2.3 ft ^{3}) in approximately 40 milliseconds.

Mounting Plate and Retaining Ring

NOTE: The mounting plate and retaining ring are components of the driver side air bag module and are not serviceable items. The driver side air bag module is serviced as a complete assembly.

The mounting plate and retainer ring attach and seal the air bag assembly to the inflator. The mounting plate is also used to attach the trim cover and to mount the entire driver side air bag module to the steering wheel.

Steering Wheel Trim Cover

NOTE: The steering wheel trim is a component of the driver side air bag module and is not a serviceable item. The driver side air bag module is serviced as a complete assembly.

The steering wheel trim cover is made of injection-moulded plastic and encases the air bag. When the supplemental air bag restraint system is activated, tear seams moulded into the steering wheel trim cover separate, allowing inflation of the air bag.

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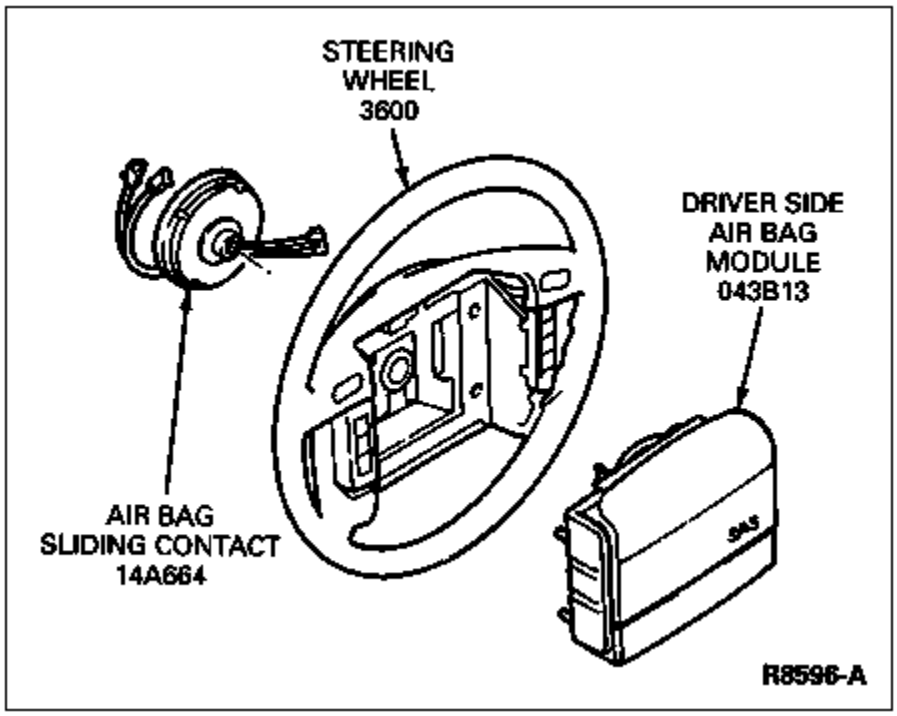

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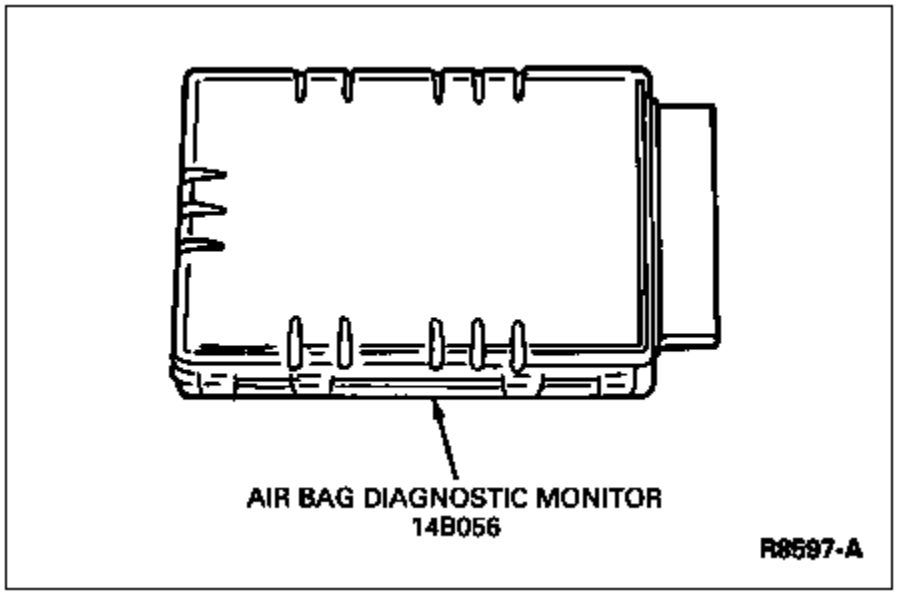
Air Bag Diagnostic Monitor

The air bag diagnostic monitor (14B056) continually monitors all supplemental air bag restraint system components and wiring connections for possible faults in the system. If the air bag diagnostic monitor detects a fault in the supplemental air bag restraint system when the ignition switch (11572) is in the RUN position, a diagnostic trouble code will be displayed on the air bag indicator, located in the instrument cluster. Performing system diagnostics is the main purpose of the air bag diagnostic monitor.

The air bag diagnostic monitor does not deploy the air bag in the event of a crash. The center air bag sensor and RH cowl side air bag sensor are "hard wired" to the air bag; therefore, the center and RH cowl side air bag sensors and LH cowl side air bag sensor determine when to deploy the air bag.



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Air Bag System Functions

Features and functions of the air bag diagnostic monitor (14B056) are described below.

- The air bag diagnostic monitor illuminates the air bag indicator for approximately six seconds when the ignition switch (11572) is in the RUN position and then turns the indicator off. This shows that the air bag indicator is operational. **If the air bag indicator does not illuminate or the indicator stays on or flashes at any time, a fault has been detected by the air bag diagnostic monitor.**
- Diagnostic trouble code 52 will display in approximately 30 seconds after the ignition switch is placed in the RUN position. All other codes will be displayed within 10 seconds of "Key On." This is the amount of time the air bag diagnostic monitor requires to perform all tests and verify system faults, if present.
- Each diagnostic trouble code (a series of flashes and pauses of the air bag indicator) represents a two digit number. Each diagnostic trouble code is always displayed at least twice. For example, a diagnostic trouble code 32 is displayed as three flashes, followed by a one second pause, then two flashes, followed by a three second pause.
- If a system fault is present and the air bag indicator is malfunctioning, an audible tone will be heard, indicating that system service is required. The tone is a series of five sets of beeps. **This does not indicate a diagnostic trouble code 55.** If the tone is heard, the air bag indicator is inoperative and a system fault that requires service is present.

CAUTION: The thermal fuse does not blow (open) because of excessive current flowing through it. DO NOT attempt to jumper out the thermal fuse with a circuit breaker or any other type of fuse.

- If a fault exists that makes unwanted air bag deployment possible, the air bag diagnostic monitor has an internal thermal fuse that will blow (open) automatically. This removes all power to the air bag deployment circuit.
- The air bag indicator will flash the appropriate diagnostic trouble code to indicate the suspect circuit. If the indicator is malfunctioning, the tone will be heard.
- Diagnostic trouble codes are prioritized numerically so if two or more different faults occur at the same time, the fault having the highest priority will be displayed first. After that fault has been corrected, the next highest priority fault will be displayed.
- The air bag diagnostic monitor includes an internal backup power supply. This feature provides sufficient backup power to deploy the air bag in the event that the battery or battery cables are damaged in an accident before the center air bag and front air bag sensors close. The backup power supply will deplete its stored energy approximately one minute after the **positive** battery cable is disconnected.

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Features and Functions

The following four steps show how the supplemental restraint system functions.

NOTE: Steps 1-3 take place in a fraction of a second.

1. The sensors in the vehicle detect a severe frontal impact. When a center air bag sensor or RH cowl side air bag sensor and the LH cowl side air bag sensor are closed at the same time, electrical current flows to the inflator and ignites the chemicals.

2. The chemicals then rapidly burn in the metal container. The rapid burning produces nitrogen gas and small amounts of dust. The nitrogen gas and dust are cooled and filtered during inflation of the air bag.

3. The inflating air bag splits open the trim cover. The air bag then rapidly unfolds and inflates in front of the driver.

4. After inflation, the gas empties through holes in the air bag. The air bag deflates very rapidly.

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Sensors

WARNING: VEHICLE SENSOR ORIENTATION IS CRITICAL FOR PROPER SYSTEM OPERATION. IF A VEHICLE EQUIPPED WITH A SUPPLEMENTAL AIR BAG RESTRAINT SYSTEM HAS BEEN INVOLVED IN A CRASH WHERE THE FRONT FENDERS OR RADIATOR GRILLE HAVE BEEN DAMAGED, INSPECT THE SENSOR MOUNTING BRACKETS FOR DEFORMATION. IF DAMAGED, THE SENSOR SHOULD BE REPLACED WHETHER OR NOT THE AIR BAG IS DEPLOYED. IN ADDITION, MAKE SURE THAT THE BODY STRUCTURE IN THE AREA OF THE SENSOR MOUNTING IS RESTORED TO ITS ORIGINAL CONDITION.

NOTE: Undamaged sensors will reset automatically after an accident and can be reused.

The center air bag sensor and bracket (14B006) and RH front air bag sensor and bracket (14B004) are electrical switches which react to impacts according to direction and force. Sensors discriminate between impacts that require air bag inflation and impacts that do not require air bag inflation. When an impact occurs that requires air bag inflation, the sensor contacts close, completing the electrical circuit necessary for system operation.

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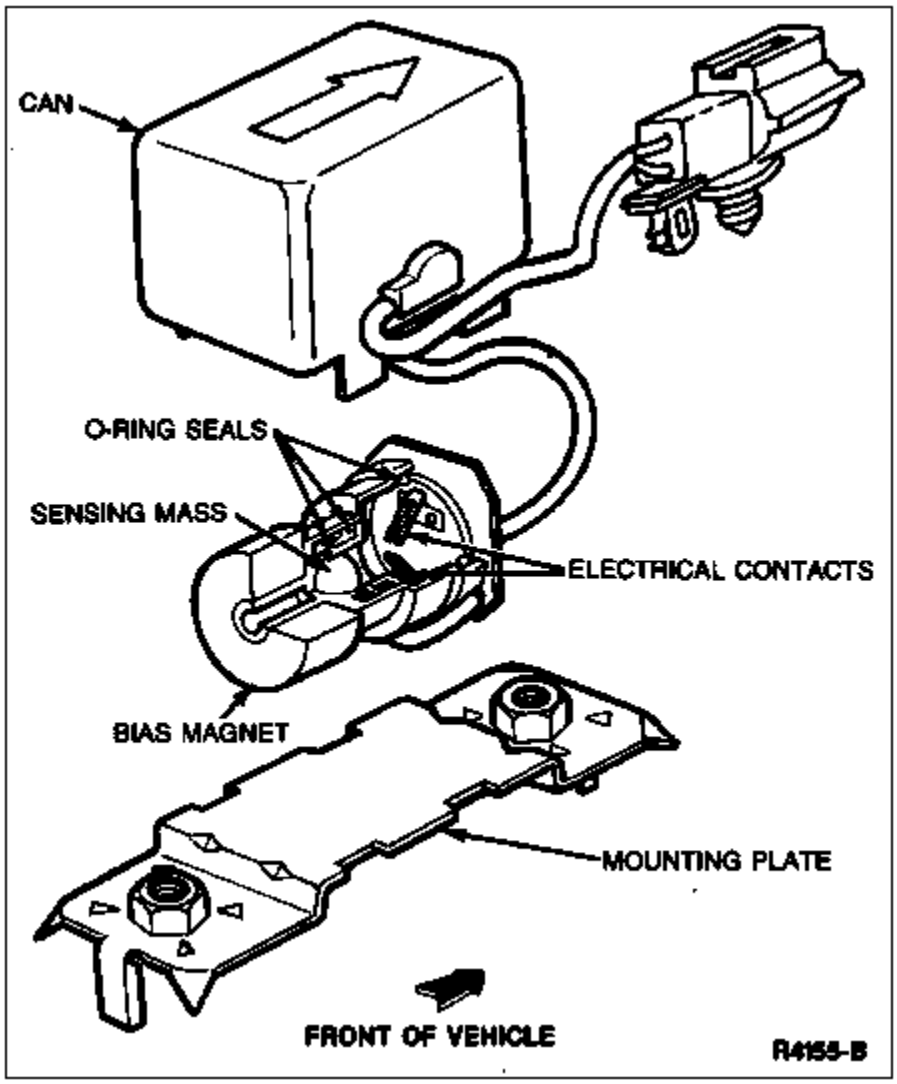

Three sensors are mounted in the vehicle. Their locations are as follows:

- A center air bag sensor and bracket at the center, upper radiator support.
- A RH front air bag sensor and bracket at the cowl side panel (02038) (RH).
- A LH front air bag sensor and bracket (14B005) at the cowl side panel (02039) in the passenger compartment.

At least two sensors (LH cowl side sensor and either the center air bag sensor or RH cowl side air bag sensor) must be activated to inflate the air bag.

Center air bag sensor and bracket and RH front air bag sensor and bracket and LH front air bag sensor and bracket automatically "reset" after a collision and do not require replacement unless physically damaged. Replace sensors only if proper alignment is not possible due to bent brackets, cut wires, etc.

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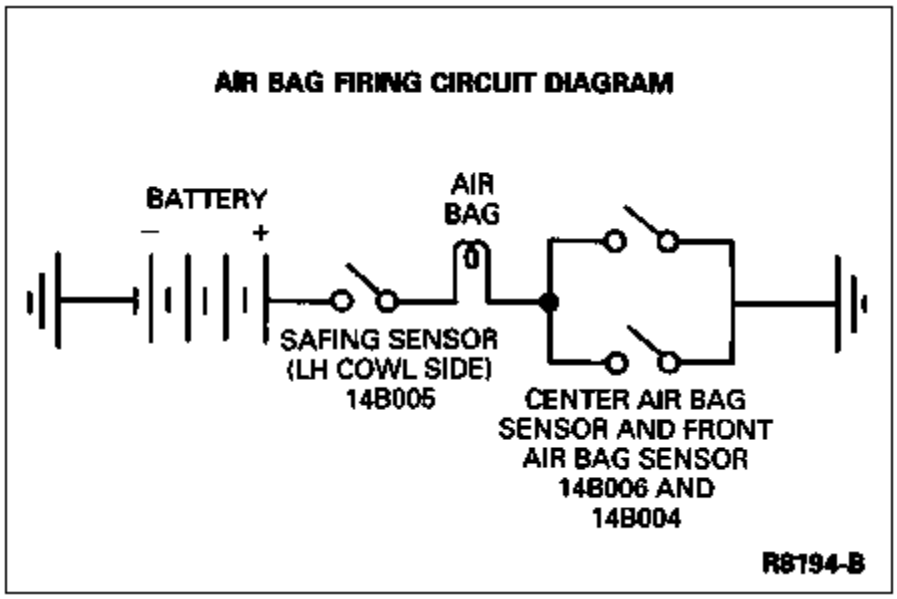

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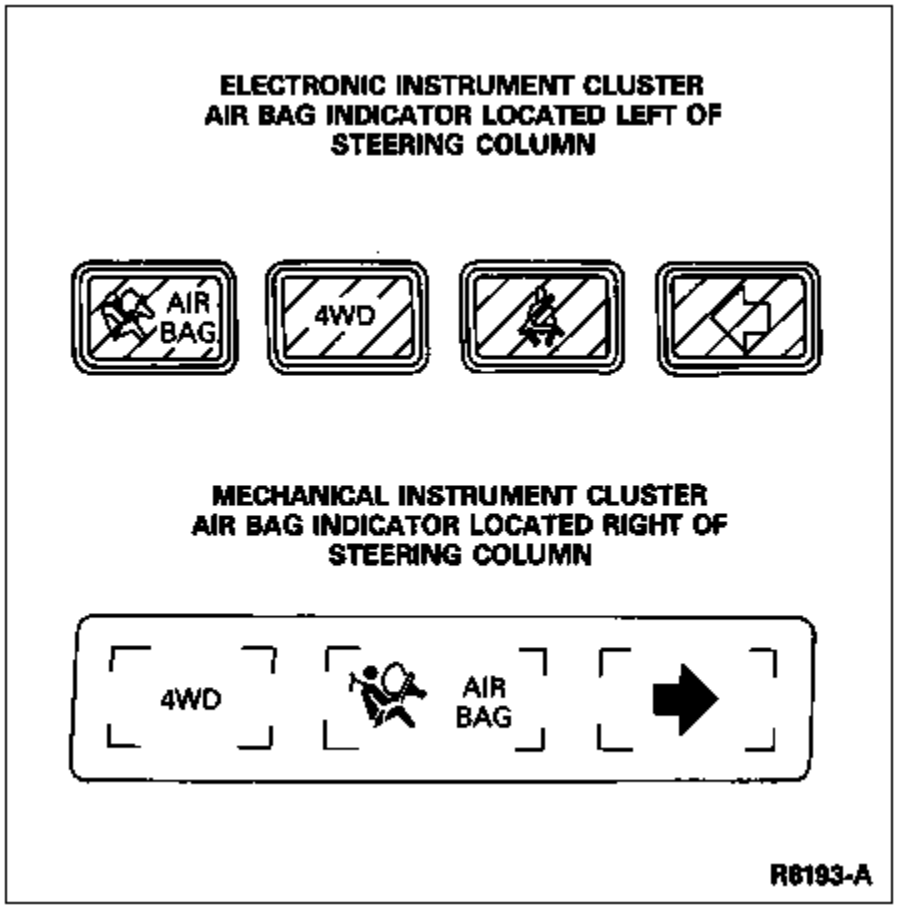
Air Bag Indicator

The air bag indicator will light continuously for approximately six seconds whenever the ignition switch (11572) is turned from OFF to RUN if the air bag is working properly. If system fault is present, the indicator will either fail to light, remain lit continuously or light in a flashing manner. The flashing manner may not occur until approximately 30 seconds after the ignition switch has been turned from OFF to RUN. This is the time required by the air bag diagnostic monitor (14B056) to test and verify any and all system faults. If the air bag indicator is inoperative and supplemental air bag restraint system fault exists, a tone will sound signaling the air bag indicator is inoperative and a system fault exists.

Tone Generator

The air bag indicator is the prime means of determining the supplemental air bag restraint system status. However, if the air bag indicator is inoperative and system fault exists, a tone will sound in a pattern of five sets of five beeps. If this occurs, the air bag indicator will need to be serviced before further diagnosing and testing can be completed. **Unless serviced, the supplemental air bag restraint system may not function properly in the event of an accident.**



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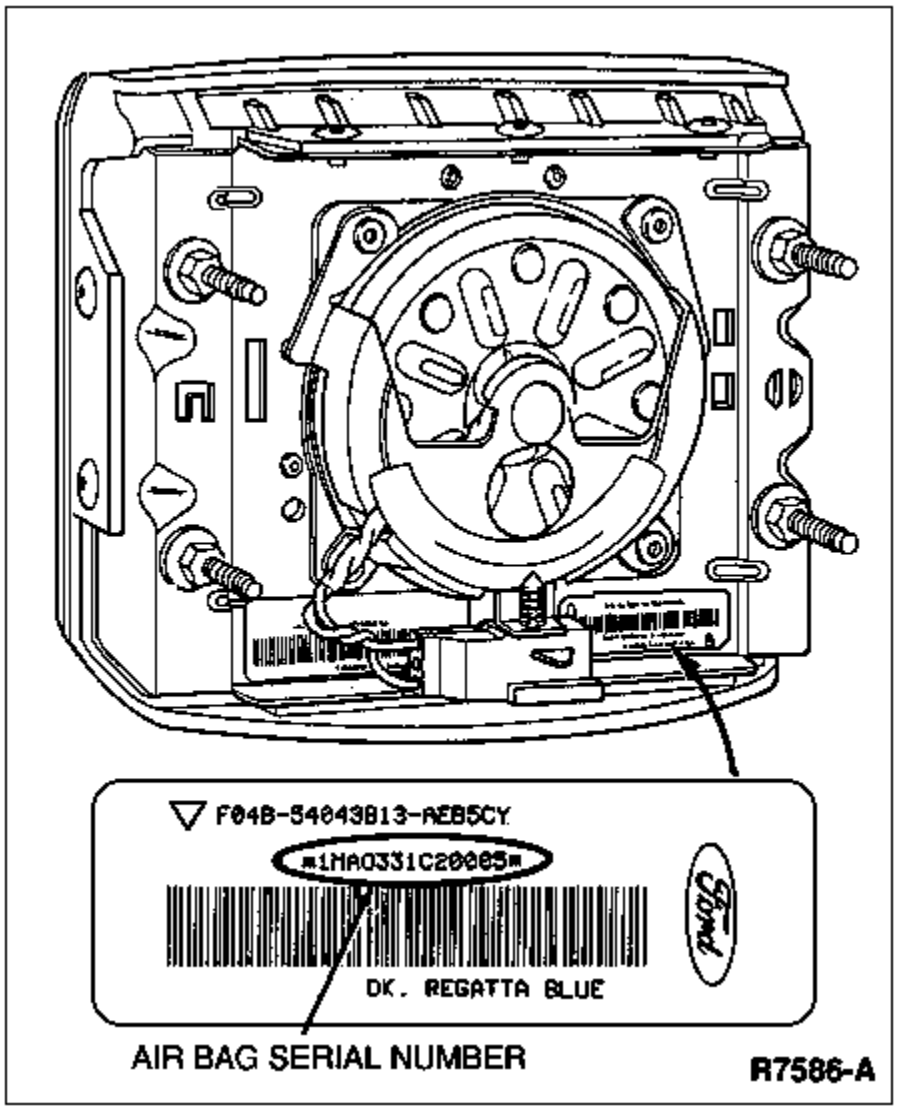
Warning Labels

Labels for the supplemental air bag restraint system are shown in the following illustrations.



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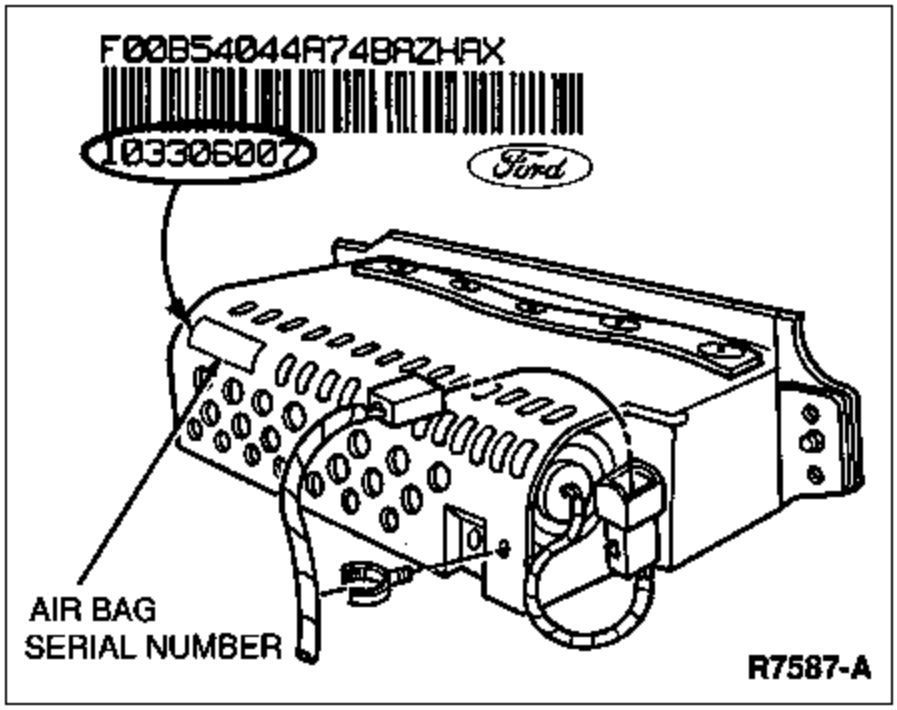
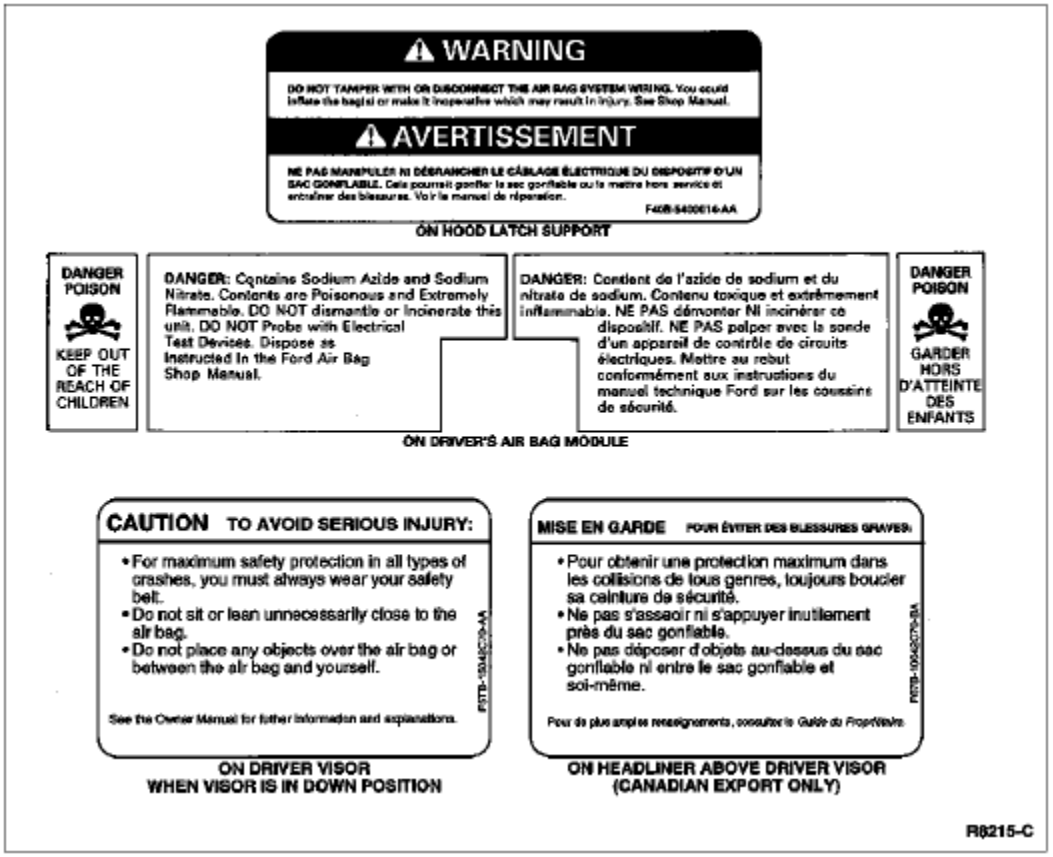


Air Bag Warning Labels



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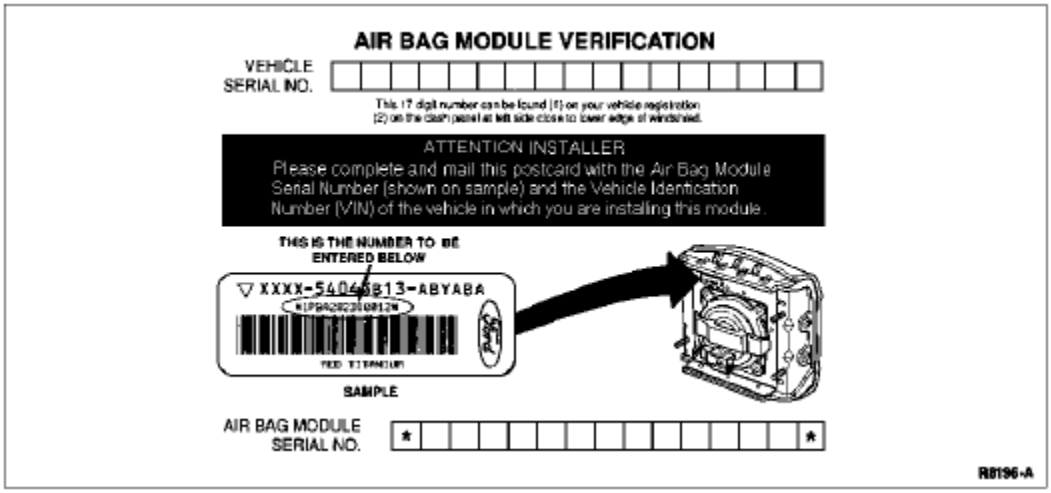
Air Bag Modules

Information on safe and effective replacement supplemental air bag restraint system components and handling are provided in this section. Refer to Diagnosis and Testing and Removal and Installation portions of this section for complete and effective service of the supplemental air bag restraint system.

When replacing a driver side air bag module (043B13), a prepaid return postcard is provided with the replacement driver side air bag module. The serial number for the new part and vehicle VIN number must be recorded and sent to Ford Motor Company.

For information on proper handling, storage, and disposal of the air bag inflator assemblies, refer to Removal and Installation in this section.

Vehicle Identification Number Location



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Service of Air Bag Equipped Vehicles Involved in a Collision

If the accident involved an air bag deployment, while servicing a vehicle equipped with a driver side air bag module (043B13), check the sensors and wiring for damage.

Sensors

WARNING: VEHICLE SENSOR ORIENTATION IS CRITICAL FOR PROPER SYSTEM OPERATION. IF A VEHICLE EQUIPPED WITH A SUPPLEMENTAL AIR BAG RESTRAINT SYSTEM HAS BEEN INVOLVED IN A CRASH WHERE THE UPPER RADIATOR SUPPORT OR COWL SIDE PANEL (RH) AND COWL SIDE PANEL (LH) HAVE BEEN DAMAGED, INSPECT THE SENSOR MOUNTING BRACKETS FOR DEFORMATION. IF DAMAGED, THE SENSOR SHOULD BE REPLACED WHETHER OR NOT THE AIR BAG IS DEPLOYED. IN ADDITION, MAKE SURE THE BODY STRUCTURE IN THE AREA OF THE SENSOR MOUNTING IS RESTORED TO ITS ORIGINAL CONDITION.

NOTE: Do not attempt to replace air bag cover with one from another driver side air bag module, for any reason.

NOTE: Undamaged sensors will reset automatically after an accident and can be reused.

Damaged Wiring

Inspect the sensor wiring and the wiring harness for any damage that may have occurred as a result of the accident. Replace as required any damaged:

- wiring
- terminals
- insulation
- connectors

If splices are required in adjacent wiring, the splices should be staggered 50mm (2 inches) apart from each other. Service splices as follows:

A durable splice is a 5-step process. Use for 16 gauge wire and smaller. For larger than 16 gauge wire, a jiffy splice must be used.

1. Correctly strip the wires.

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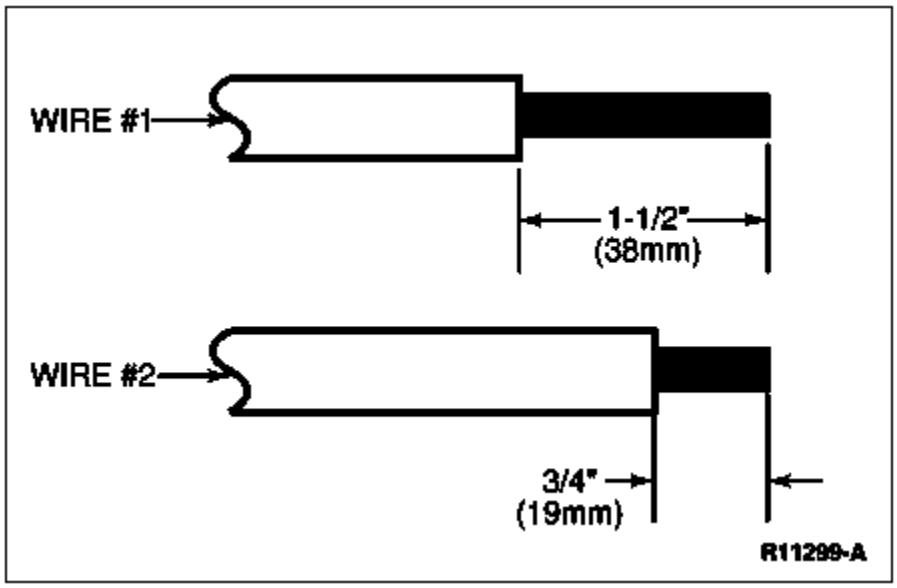

2. **NOTE: Durability of a splice is dependent on keeping the moisture out of the joint. The heat shrink tubing alone won't do the job. The tubing must contain a "hot melt sealant" which is squeezed from both ends of the tube during heating and forms an adhesive seal between the cable and the tube.**

   Durability of a wire splice is dependent on getting a joint that does not oxidize. Soldering is effective in keeping the air (oxide) out of the joint. Electronic circuits, and the very high current circuits, may fail because of oxidized joints. Oxidization cannot be seen with the naked eye.

   Twist and solder the wire (don't forget to install the shrink tubing first). Use rosin core, mildly activated (RMA) solder. (Do not use acid core.)

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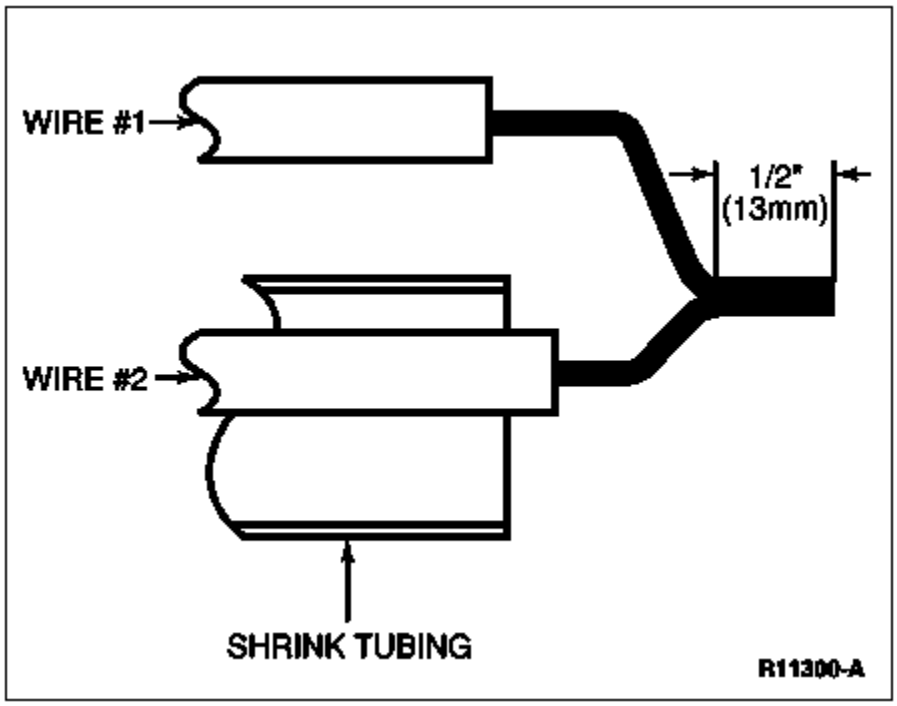
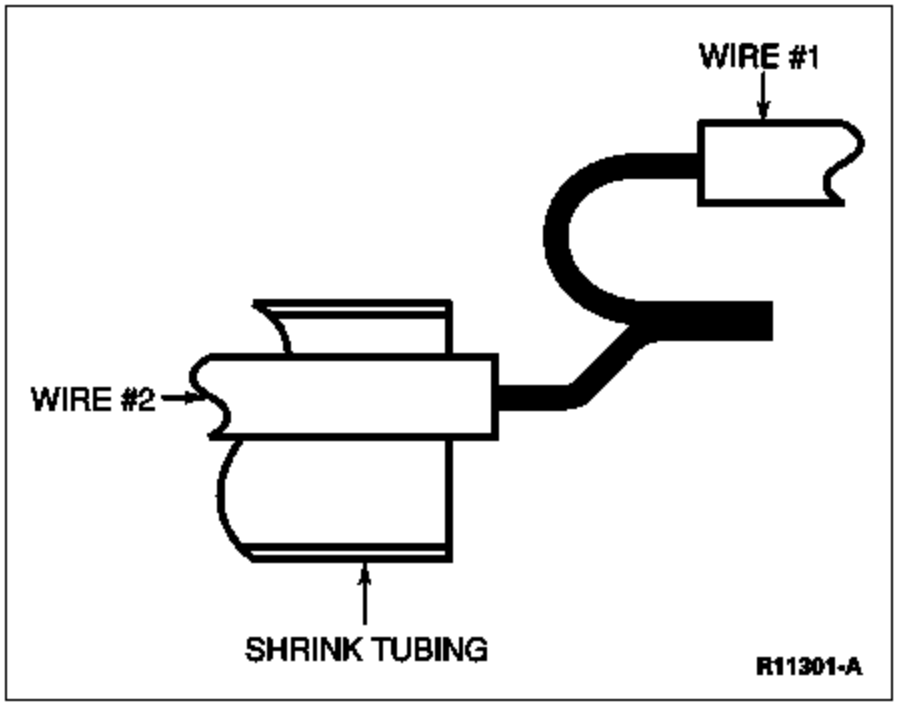


3. Form (bend) the circuit into a shape for sealing, as shown below.



4. Reposition the shrink tubing over the splice.

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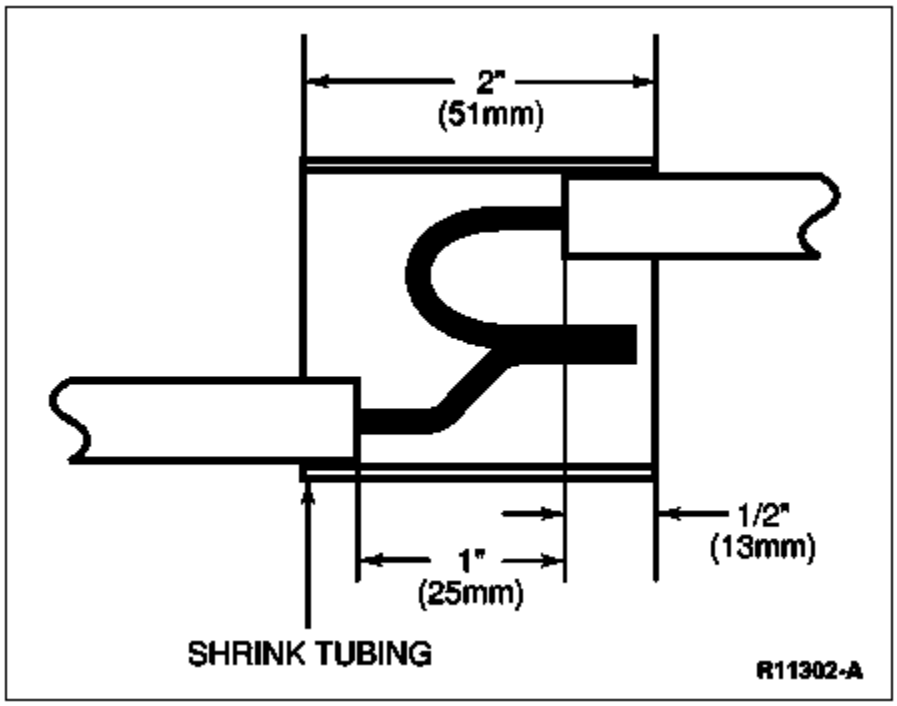
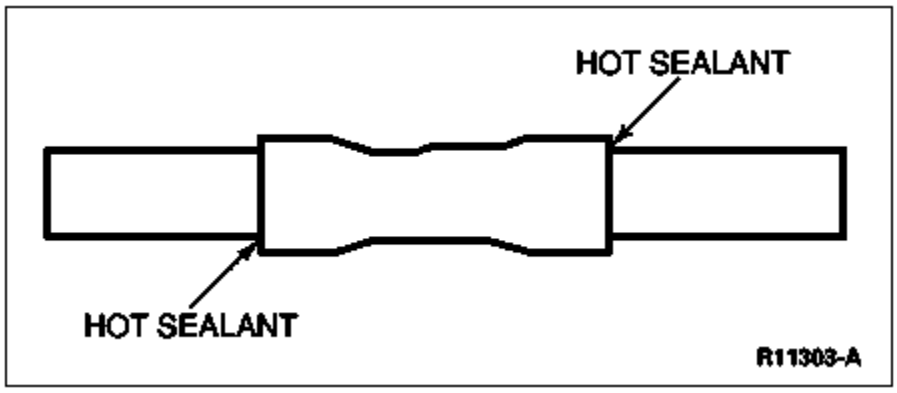


5. **NOTE: When the "hot sealant" flows out of both ends of the tube, it has been heated long enough.**

   CAUTION: Use a heat gun only. Do not use a hair dryer or any flame to heat the shrink tubing.

   Heat the entire length of the shrink tubing until the "hot sealant" comes out of both ends.



Steering Column and Air Bag Sliding Contact

If the collision involved air bag deployment, the steering column may have been loaded sufficiently to deform steering column instrument panel brackets (3676) or damage column wiring. An inspection should be made of the column structure and wiring to air bag sliding contact (14A664) to make sure that any damaged components are replaced. Refer to Section 11-04B .

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Air Bag System

CAUTION: Before attempting diagnostic prove out, check all sensors and wiring for damage or shorts that could cause the air bag diagnostic monitor thermal fuse to blow (open), causing unnecessary replacement.

After all service is completed, verify the air bag indicator operation as follows:

- Turn the ignition switch (11572) to the RUN position.
- If the indicator flashes, count the air bag indicator flashes only after the code (series of flashes) has cycled twice. Service as required.
- If the air bag indicator illuminates continuously for four to eight seconds and then goes out, the supplemental air bag restraint system is functioning properly and all faults have been serviced. If the air bag indicator does not illuminate, illuminates continuously for four to eight seconds then goes out, or remains continuously illuminated, there is a malfunction within the system. Refer to Diagnosis and Testing in this section.

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Diagnosing Customer Concerns Without Hard Diagnostic Trouble Codes

If a diagnostic trouble code is reported by the customer but is not present when the vehicle comes in for service, pinpoint diagnostics cannot be used. Following the pinpoint tests or fault tree diagnosis when the code is not flashing will result in needless replacement of the air bag diagnostic monitor (14B056) and repeat repairs.

The air bag diagnostic monitor does not contain any memory of the diagnostic trouble code after the ignition switch lock cylinder (11582) is turned off. If the code is unknown, instruct the customer on how to count a code.

- Demonstrate a diagnostic trouble code by disconnecting a center or front air bag sensor, turn the ignition switch lock cylinder to the ON position, and allow customer to count diagnostic trouble code.
- Reconnect the primary crash sensor and instruct customer to return when the code is known.

Once the diagnostic trouble code is known, read the "Normal Operation" section for the code involved.

- Study the circuit diagram and determine the location of components involved in creating that code.
- Do a thorough visual inspection of components, connectors, splices and wiring harnesses, looking for pinched wires, worn insulation on conductors, opens, shorts, or loosely mounted sensors.

The section "Possible Causes" lists the common concerns that relate to that particular code. Each concern is listed in the order in which it is most likely to occur.

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Diagnosing Customer Concerns With Hard Diagnostic Trouble Codes

Most supplemental air bag restraint system diagnostic procedures will require the use of the system deactivation and system reactivation procedures described below. These procedures allow the removal of the driver side air bag modules (043B13) from the vehicle, removing the risk of air bag deployment while diagnostics are performed.

The Rotunda Air Bag Simulator 105-R0010 or equivalent is required to perform diagnostics and testing of the supplemental air bag restraint system. The air bag simulator is a 2-ohm resistor that must be used to simulate an air bag connection in the system as specified in the deactivation procedure. It is not acceptable to jump the air bag connection with a zero ohm jumper wire. If a zero ohm jumper wire is used, a system fault may be displayed (Diagnostic Trouble Code 34 or 35) according to the priority scheme.

Deactivation Procedure

1. Disconnect battery positive cable.
2. Wait one minute. This is the time required for backup power supply in air bag diagnostic monitor (14B056) to deplete its stored energy.
3. Remove four nut and washer assemblies retaining driver side air bag module to steering wheel (3600).
4. Disconnect driver air bag connector.
5. Connect air bag simulator to vehicle harness at top of steering wheel.

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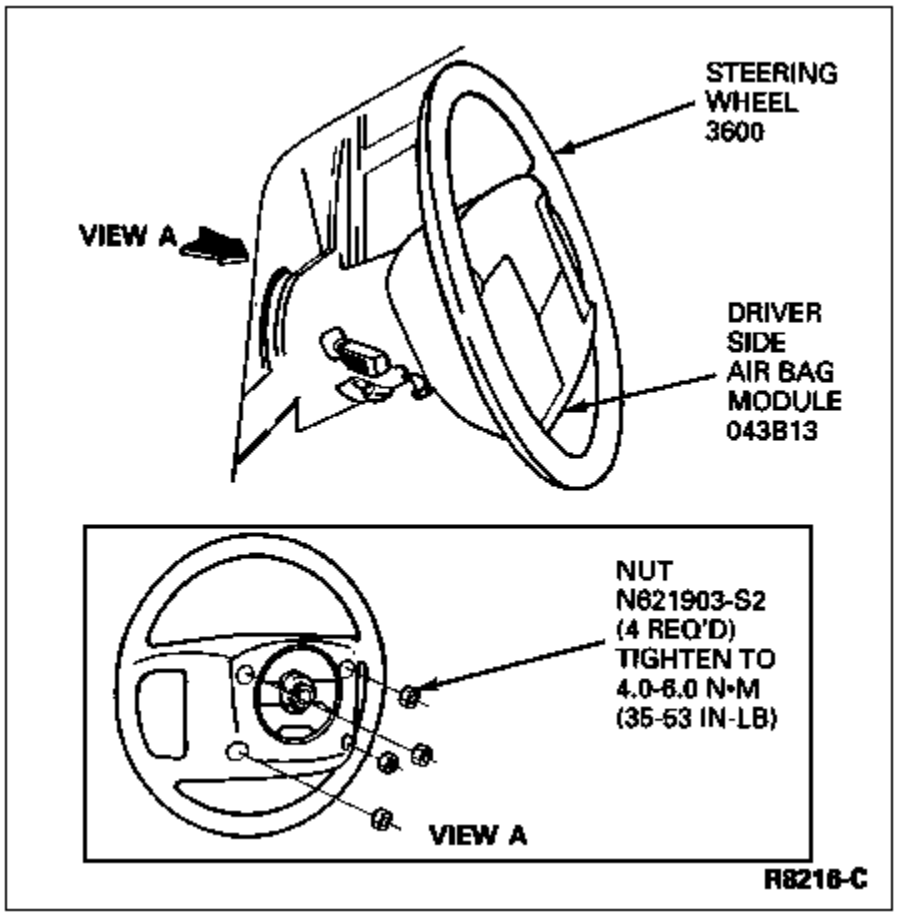

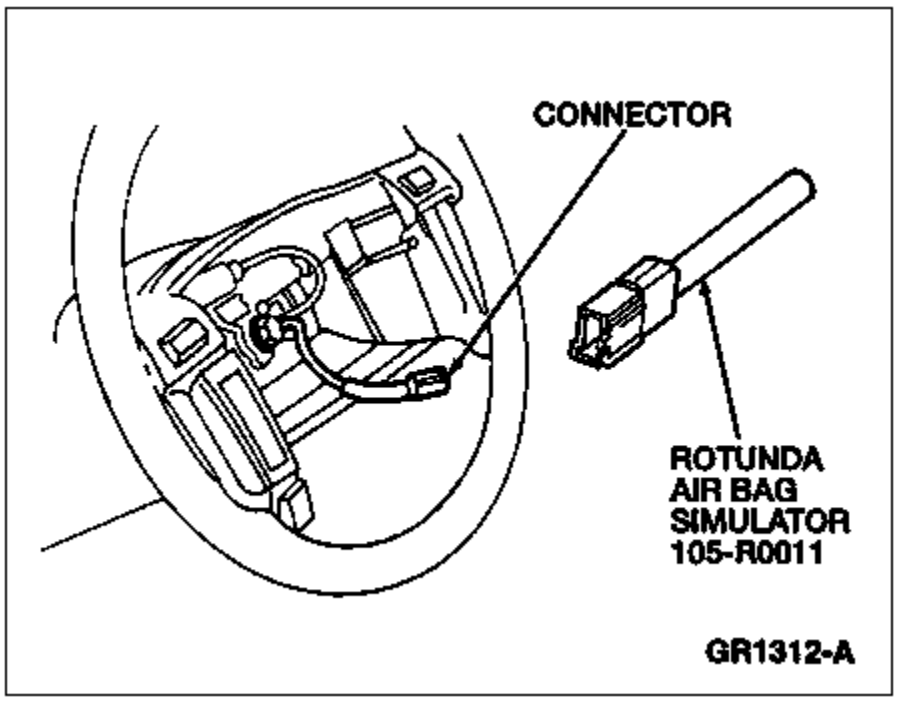

6. Connect battery positive cable.

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- When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 mi) or more to relearn the strategy.

Reactivation Procedure

1. Disconnect battery positive cable.
2. Wait one minute for backup power supply to deplete stored energy.
3. Remove air bag simulator from vehicle harness connector at top of steering column. Reconnect driver air bag module connector. Position driver side air bag module on steering wheel and secure with four nut and washer assemblies (10mm). Tighten nut and washer assemblies to 4-6 Nm (36-53 lb-in).
4. **WARNING: THE AIR BAG SIMULATOR MUST BE REMOVED AND THE AIR BAG RECONNECTED FOR THE SYSTEM TO BE REACTIVATED.**

   Connect battery positive cable.

   - When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 mi) or more to relearn the strategy.
5. Prove out system.

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Air Bag System Reconnect Check List

The check list below should be completed following diagnosis or repair of any air bag system concern.

1. Are center air bag sensor and bracket (14B006) and RH front air bag sensor and bracket (14B004) connected and mounted to vehicle?
2. Is LH front air bag sensor and bracket (14B005), in the cowl side panel (02039), connected and mounted to vehicle?
3. Is black three-way connector at base of steering column connected?
4. Is driver side air bag module (043B13) or air bag simulator connected?
5. Is air bag diagnostic monitor (14B056) connected?
6. Is vehicle battery connected?

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Air Bag System Component Location

1. Center air bag sensor and bracket (14B006) — center of radiator support upper bracket reinforcement
2. RH front air bag sensor and bracket (14B004) — cowl side panel (02038) (RH)
3. LH front air bag sensor and bracket (14B005) — cowl side panel (02039) (LH)
4. Driver side air bag module (043B13) — steering wheel (3600)
5. Air bag sliding contact (14A664) — behind steering wheel
6. Air bag diagnostic monitor (14B056) — under instrument panel (04320) left of steering column

    - A thermal fuse is built into the air bag diagnostic monitor. If a short to ground should occur in the air bag deployment circuit, the microcomputer in the air bag diagnostic monitor will send a signal to the fuse causing it to open. The open fuse removes all firing power (battery/backup power) from the deployment circuits. This prevents unwanted air bag deployments due to damaged vehicle wiring.
    - Code 51 is displayed whenever the diagnostic monitor thermal fuse is open and no other higher priority faults exist (consult Diagnostic Trouble Code Priority Table). Code 51 is normally seen after service of a Code 13 condition.
    - If a Code 51 exists and a Code 13 condition has not been serviced, this means an **intermittent** short-to-ground exists in the air bag deployment wiring. The intermittent short-to-ground must be located and serviced before servicing the Code 51 condition.
    - Since the thermal fuse is built into the air bag diagnostic monitor, the monitor must be replaced to service a Code 51 condition. NEVER replace the air bag diagnostic monitor without first determining the cause for the Code 51 condition. If the short-to-ground is not properly serviced, the short may reoccur, once again destroying the thermal fuse in the air bag diagnostic monitor.

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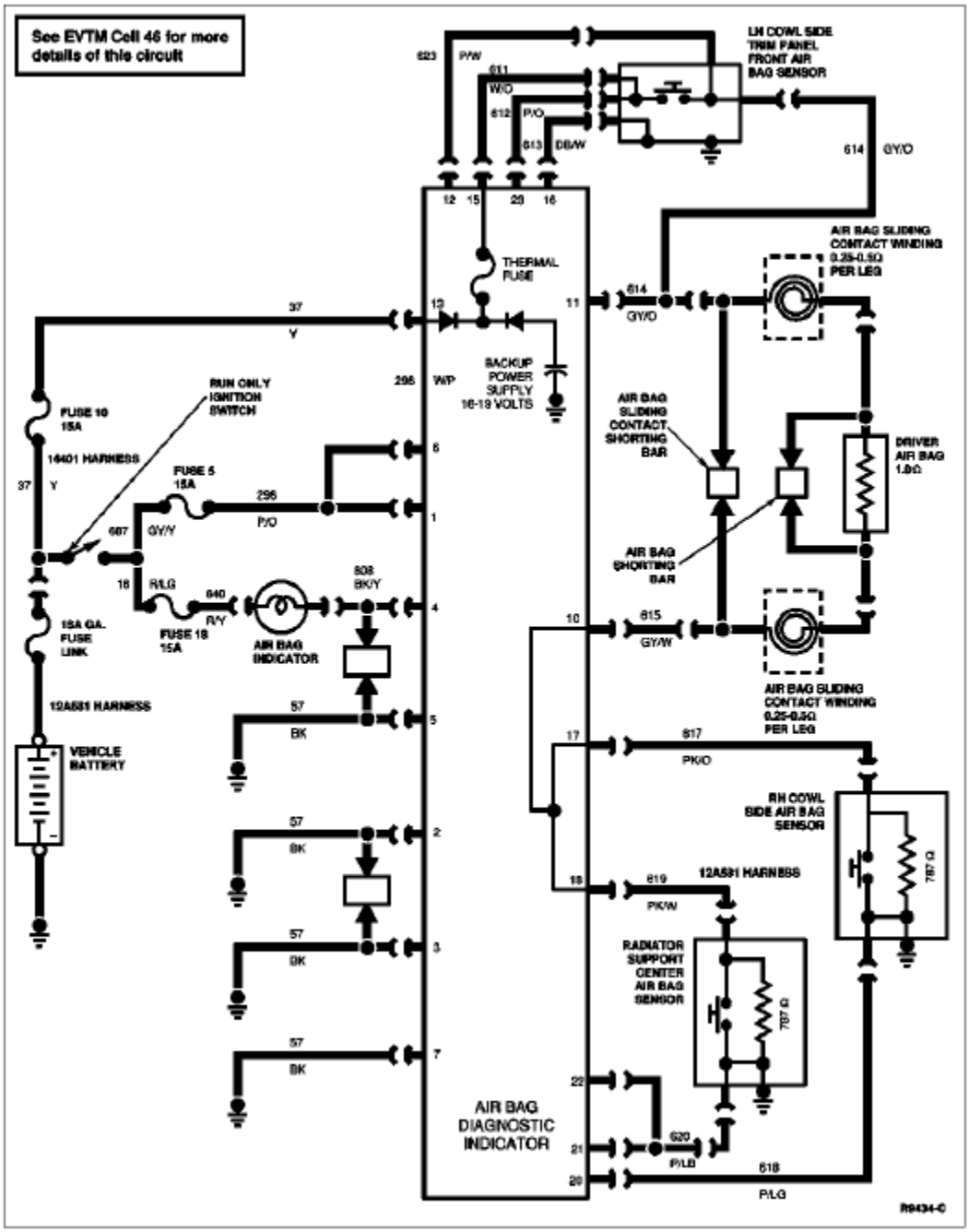
Electrical Schematic

Supplemental Air Bag Restraint System



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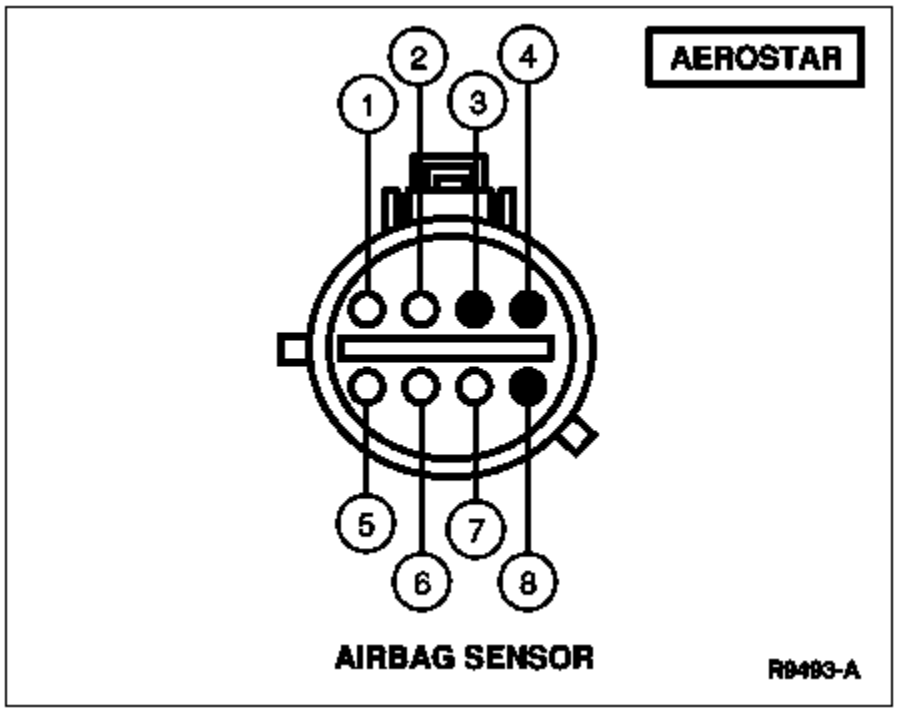
Air Bag Diagnostic Monitor Connectors



Pin Number	Circuit	Circuit Function
1	614 (GY/O)	Air Bag Feed Circuit Monitor
2	623 (P/W)	Safing Sensor Output Monitor
3	—	NOT USED
4	—	NOT USED
5	613 (DB/W)	Air Bag Safing Sensor (Ground) Monitor
6	612 (P/O)	Safing Sensor Diagnostic Input
7	611 (W/O)	Safing Sensor Feed
8	—	NOT USED

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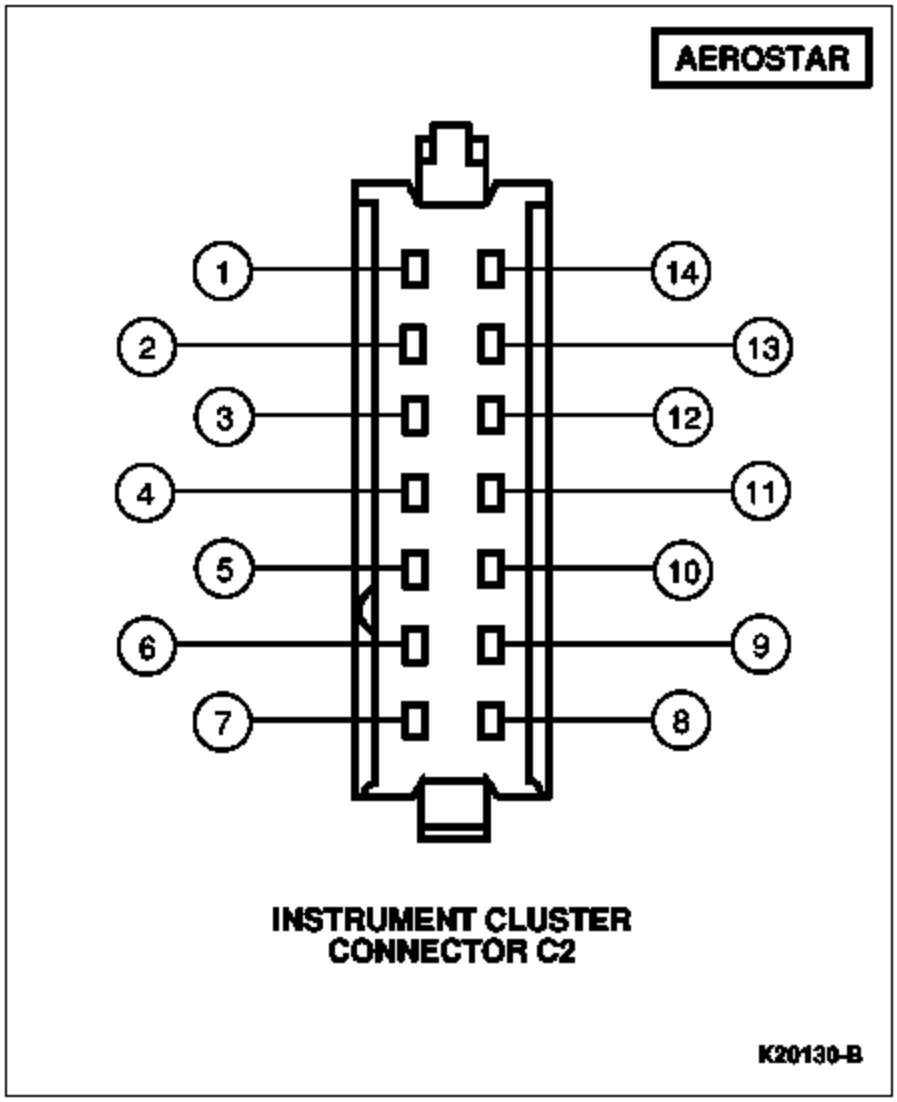

Pin Number	Circuit	Circuit Function
1	208 (GY)	"Check Oil" to Low Oil Level Relay
2	640 (R/Y), 640 (R/Y)	Power to "Check Oil" Indicator
3	932 (GY/W)	Power to High Beam Indicator
4	450 (DG/LG)	Power to Fasten Belts Indicator
5	57 (BK)	Illumination High Beam and Fasten Belts to Ground
6	19 (LB/R)	Power to Illumination
7	57 (BK), 57 (BK)	Turn Indicators to Ground
8	2 (W/LB)	Power to Right Turn Indicator
9	57 (BK)	Electronic 4WD to Ground
10	994 (W)	Power to Electronic 4WD Indicator

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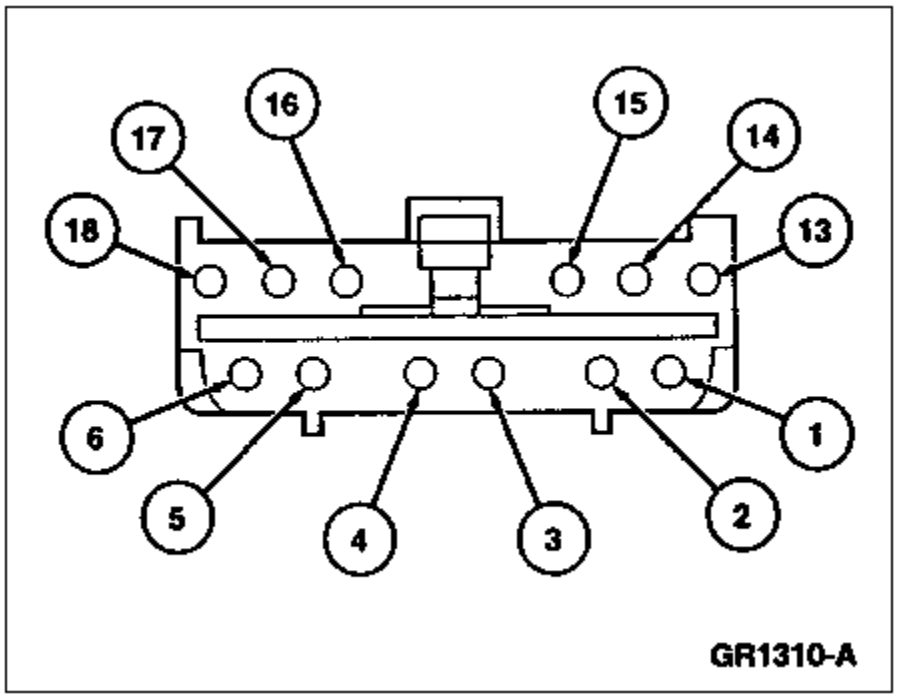
11	608 (BK/Y)	"Air Bag" to Air Bag Module
12	640 (R/Y)	Power to Gauges, Hot in START or RUN
13	570 (BK)	Fuel Gauge to Ground
14	397 (BK/W)	Voltmeter to Ground



Pin Number	Circuit	Circuit Function
1	298 (P/O)	Power (Hot In Run)
2	57 (BK)	Ground
3	57 (BK)	Ground
4	608 (BK/Y)	"Air Bag" Indicator Control
5	57 (BK)	Ground
6	298 (P/O)	Power (Hot In Run)
13	37 (Y)	Power (Hot At All Times)
14	—	NOT USED
15	611 (W/O)	Safing Sensor Feed
16	613 (DB/W)	Safing Sensor Ground Monitor
17	617 (PK/O)	RH Kick Panel Primary Crash Sensor Feed
18	619 (PK/W)	Center Radiator Primary Crash Sensor Feed

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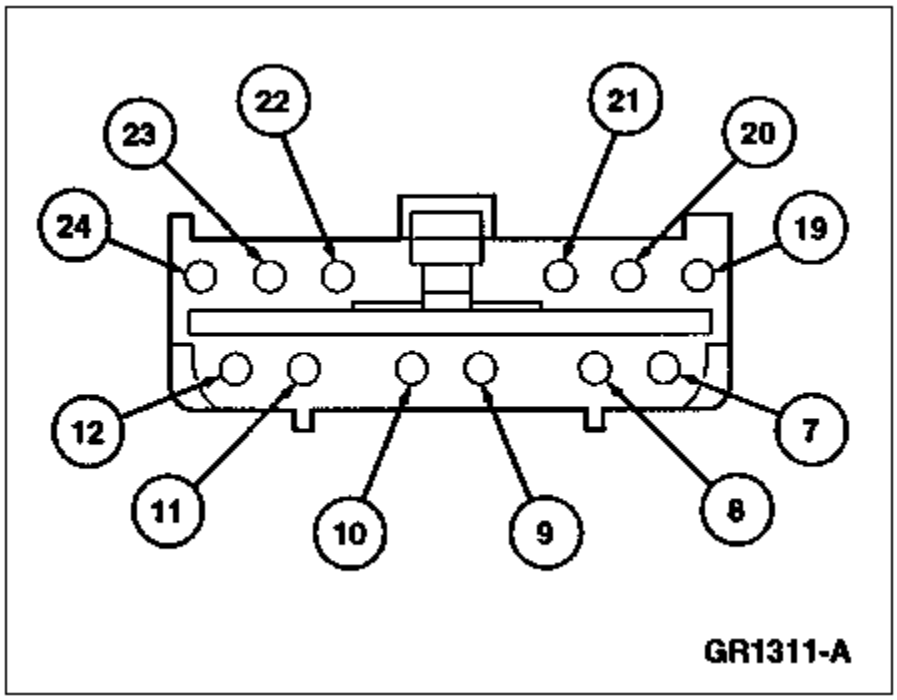

Pin Number	Circuit	Circuit Function
7	57 (BK)	Ground
8	—	NOT USED
9	—	NOT USED
10	615 (GY/W)	Driver's Air Bag Return
11	614 (GY/O)	Driver's Air Bag Feed Monitor
12	623 (P/W)	Safing Sensor Output Monitor
19	—	NOT USED
20	618 (P/LG)	RH Kick Panel Primary Crash Sensor Ground Monitor
21	620 (P/LB)	Center Radiator Primary Crash Sensor Ground Monitor
22	620 (P/LB)	Center Radiator Primary Crash Sensor Ground Monitor
23	612 (P/O)	Safing Sensor Feed Monitor
24	—	NOT USED

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Air Bag Diagnostic Monitor Diagnostic Trouble Code Priority Table

Diagnostic Trouble Code	Component/Fault Description
—	No Air Bag Indicator — Inoperative Lamp Circuit or No Ignition Voltage to Air Bag Diagnostic Monitor
—	Continuous Air Bag Indicator — Air Bag Diagnostic Monitor Disconnected or Inoperative
12	Low Battery Voltage
13	Air Bag or Primary Crash Sensor Shorted to Ground
21	Safing Sensor Not Mounted to Vehicle Properly
22	Safing Sensor Output Circuit Shorted to Battery Voltage
23	Safing Sensor Circuit Input Feed/Return Circuit Open
24	Safing Sensor Output Feed/Return Circuit Open or Low Resistance in a Primary Crash Sensor
32	Driver Side Air Bag Circuit High Resistance or Open
33	Passenger Side Air Bag Circuit High Resistance or Open
34	Driver Side Air Bag Circuit Low Resistance or Shorted
35	Passenger Side Air Bag Circuit Low Resistance or Shorted
41	Primary Crash Sensor Circuits High Resistance or Open
44	RH Primary Crash Sensor Not Mounted to Vehicle Properly
45	Center Radiator Primary Crash Sensor Not Mounted to Vehicle Properly
46	Open Splice Center Air Bag Sensor Ground Monitor
51	Air Bag Diagnostic Monitor Internal Thermal Fuse — Fuse Blown and Due to Intermittent Short to Ground
52	Backup Power Supply — Voltage Boost Fault
53	Primary Crash Sensor Circuits Resistance to Ground or Air Bag Diagnostic Monitor Fault
—	Rapid Continuous Flashing of Air Bag Indicator (No DTC) All Primary Crash Sensors Disconnected

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Pinpoint Test Directory

Condition	Test
No Air Bag Indicator — Inoperative Lamp Circuit or No Ignition Voltage to Air Bag Diagnostic Monitor	N
Continuous Air Bag Indicator — Air Bag Diagnostic Monitor Disconnected or Inoperative	C
Low Battery Voltage	12
Air Bag or Primary Crash Sensor Shorted to Ground	13
Safing Sensor Not Mounted to Vehicle Properly	21
Safing Sensor Output Circuit Shorted to Battery Voltage	22
Safing Sensor Circuit Input Feed/Return Circuit Open	23
Safing Sensor Output Feed/Return Circuit Open or Low Resistance in Primary Crash Sensor	24
Driver Side Air Bag Circuit High Resistance or Open	32
Passenger Side Air Bag Circuit High Resistance or Open	33
Driver Side Air Bag Circuit Low Resistance or Shorted	34
Passenger Side Air Bag Circuit Low Resistance or Shorted	35
Primary Crash Sensor Circuits High Resistance or Open	41
RH Primary Crash Sensor Not Mounted to Vehicle Properly	44
Center Primary Crash Sensor Not Mounted to Vehicle Properly	45
Open Splice Center Air Bag Sensor Ground Monitor	46
Air Bag Diagnostic Monitor Internal Thermal Fuse — Fuse Blown Due to Intermittent Short to Ground	51
Backup Power Supply — Voltage Boost Fault	52
Primary Crash Sensor Circuits Resistance to Ground or Air Bag Diagnostic Monitor Fault	53
Rapid Continuous Flashing of Air Bag Indicator (No DTC) All Primary Crash Sensors Disconnected	—

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Pinpoint Tests

PINPOINT TEST N: NO AIR BAG INDICATOR — INOPERATIVE LAMP CIRCUIT OR NO IGNITION VOLTAGE TO AIR BAG DIAGNOSTIC MONITOR

Normal Operation

The air bag indicator is designed to illuminate for 6 (± 2) seconds when the ignition switch lock cylinder (11582) is turned to the RUN position. This initial 6 seconds of air bag indicator illumination (continuous) is considered normal operation and is called prove out of the air bag indicator.

The air bag diagnostic monitor (14B056) requires power at Pins 1 and 6 in order to energize the air bag indicator circuit. If the air bag indicator circuit is open or the air bag diagnostic monitor does not have battery positive voltage at Pins 1 and 6, the air bag indicator will not illuminate.

Possible Causes

A No Air Bag Indicator condition can be caused by:

1. A burned out bulb or an open circuit in the wiring for air bag indicator circuit.
2. Loss of battery positive voltage at Pins 1 and 6 of the air bag diagnostic monitor.

No Air Bag Indicator — Inoperative Lamp Circuit or No Ignition Voltage to Air Bag Diagnostic Monitor

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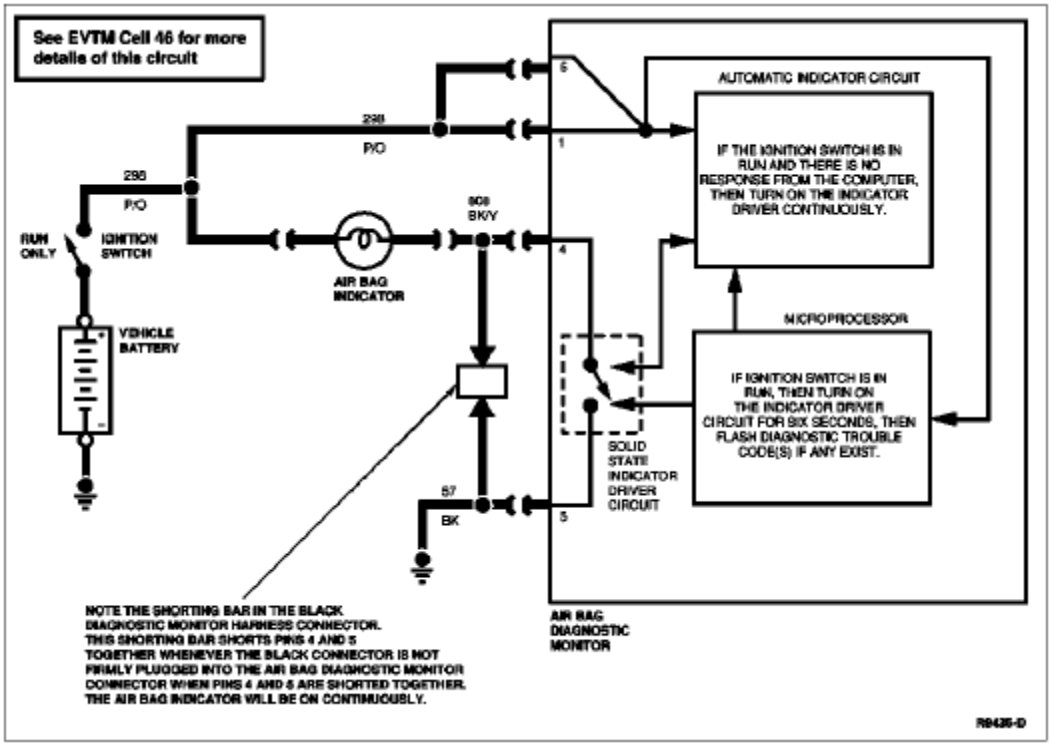

N1 CHECK BATTERY POSITIVE VOLTAGE

- Deactivate supplemental air bag restraint system.
- Disconnect air bag diagnostic monitor.
- Turn ignition switch lock cylinder to ON position.
- Measure voltage between Pins 1 (+) and 3 (-). Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent.

Is the voltage measured equal to battery voltage?

Yes	No
GO to **N2** .	LOCATE and SERVICE the open circuit in the "hot in run" feed from the fuse block. CHECK the fuse, connector, etc. CHECK for proper ground on Pin 3 of air bag diagnostic monitor connector. RECONNECT system. VERIFY system. REACTIVATE system.

N2 CHECK FOR OPEN INDICATOR CIRCUIT

- Leave air bag diagnostic monitor disconnected and ignition switch lock cylinder in ON position.

Is air bag indicator ON?

Yes	No

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REPLACE air bag diagnostic monitor. RECONNECT system. VERIFY system. REACTIVATE system.	GO to **N3** .

N3 CHECK INSTRUMENT CLUSTER

Is the air bag indicator operated by an electronic (digital) instrument cluster?

Yes	No
GO to **N4** .	LOCATE and SERVICE the open circuit in the air bag indicator circuitry. CHECK for a burned out bulb, open connectors, pushed out pins, blown fuse, etc. RECONNECT system. VERIFY system. REACTIVATE system.

N4 CHECK ELECTRONIC INSTRUMENT CLUSTER

- Remove the block locking wedge from the air bag diagnostic monitor harness connector.
- Measure the voltage between Pin 4 (+) and 3 (-). Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent.

Is the voltage equal to battery voltage?

Yes	No
REPLACE instrument cluster RECONNECT/ VERIFY/REACTIVATE system.	CHECK connectors on cluster. REPLACE instrument cluster if no poor connections are located. RECONNECT system. VERIFY system. REACTIVATE system.

PINPOINT TEST C: CONTINUOUS AIR BAG INDICATOR — AIR BAG DIAGNOSTIC MONITOR DISCONNECTED OR INOPERATIVE

Normal Operation

The air bag indicator is designed to illuminate for 6 (± 2) seconds when the ignition switch lock cylinder (11582) is turned to the ON position. This initial 6 seconds of air bag indicator illumination (continuous) is considered normal operation and is called prove out of the air bag indicator. If the air bag diagnostic monitor (14B056) detects any faults in the system following prove out, it will flash the air bag indicator a series of times to indicate the diagnostic trouble code that has been detected. If the air bag indicator comes on when the ignition switch lock cylinder is turned to the ON position and stays on for more than 8 seconds continuously, then a fault exists in the air bag indicator circuit.

The air bag diagnostic monitor incorporates a solid state circuit that shorts the air bag indicator line (Circuit 608 BK/Y) to ground to turn the air bag lamp on. When the gray diagnostic monitor harness connector is unplugged from the air bag diagnostic monitor, a shorting bar within the harness connector connects Pins 4 (air bag indicator) and 5 (ground) together. Therefore, the shorting bar will turn the air bag indicator ON whenever the gray diagnostic monitor harness connection is disconnected. Because the shorting bar makes

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a continuous connection between Pins 4 and 5 when the connector is disconnected, the air bag indicator will not flash; instead, it will be illuminated continuously.

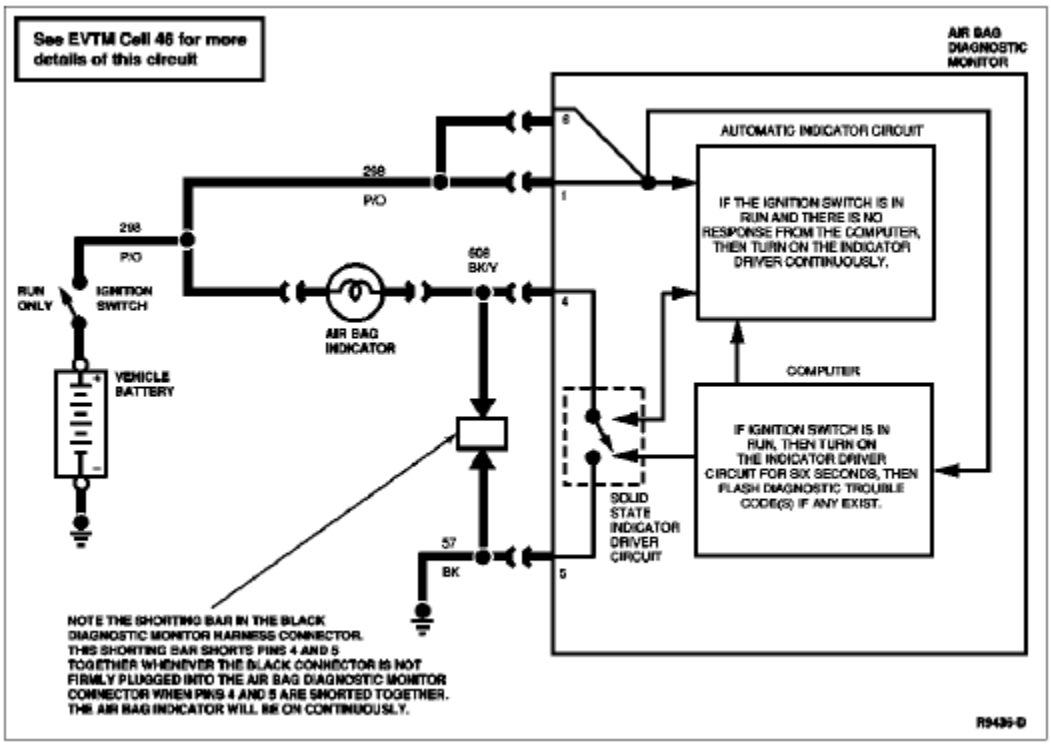
When the ignition switch lock cylinder is turned ON, the computer inside the air bag diagnostic monitor "wakes up" and after approximately 6 seconds turns the air bag indicator off. If the computer fails to wake up, the indicator driver circuit will automatically turn the air bag indicator on continuously indicating a problem in the air bag diagnostic monitor or at the black diagnostic monitor connector.

Possible Causes

Continuous illumination of the air bag indicator can be caused by:

1. A disconnected or poorly connected air bag diagnostic monitor may not push the shorting bar between Pins 4 and 5 into its fully retracted position. This shorts the air bag indicator line to ground and causes the air bag indicator to glow continuously.
2. Shorted air bag indicator wiring.
3. A faulty air bag diagnostic monitor.

Continuous Air Bag Indicator — Air Bag Diagnostic Monitor Disconnected or Inoperative



C1 CHECK IF AIR BAG DIAGNOSTIC MONITOR IS CONNECTED

- Deactivate the supplemental air bag restraint system.
- Inspect connectors on air bag diagnostic monitor.

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Are the connectors fully pushed together?

Yes	No
GO to **C2** .	Firmly MATE the connectors to the air bag diagnostic monitor. VERIFY system. REACTIVATE system.

C2 CHECK INDICATOR CIRCUITRY

- Disconnect air bag diagnostic monitor.
- Remove plastic locking wedge from the gray air bag diagnostic monitor harness connector.
- Turn ignition switch lock cylinder to ON position.

Is the air bag indicator on?

Yes	No
LOCATE and SERVICE the short to ground (in Circuit) RECONNECT system. VERIFY system. REACTIVATE system.	GO to **C3** .

C3 INSPECT SHORTING BAR

- Inspect the shorting bars on the plastic locking wedge for proper operation. Compare with another vehicle if necessary.

Is the shorting bar in good working condition?

Yes	No
REPLACE air bag diagnostic monitor. RECONNECT system. VERIFY system. REACTIVATE system.	REPLACE the plastic locking wedge with the correct replacement. Make sure air bag diagnostic monitor has shorting bars on the locking wedge. RECONNECT system. VERIFY system. REACTIVATE system.

PINPOINT TEST 12: LOW BATTERY VOLTAGE (CODE 12)

Normal Operation

The air bag diagnostic monitor measures the voltage at Pin 13 of the diagnostic monitor connector. Voltage at Pin 13 should be equal to battery voltage. If the voltage measured at Pin 13 drops to less than 9 volts, the air bag diagnostic monitor will flash out code 12.

Possible Causes

A drop in battery voltage at Pin 13 of the air bag diagnostic monitor can be caused by:

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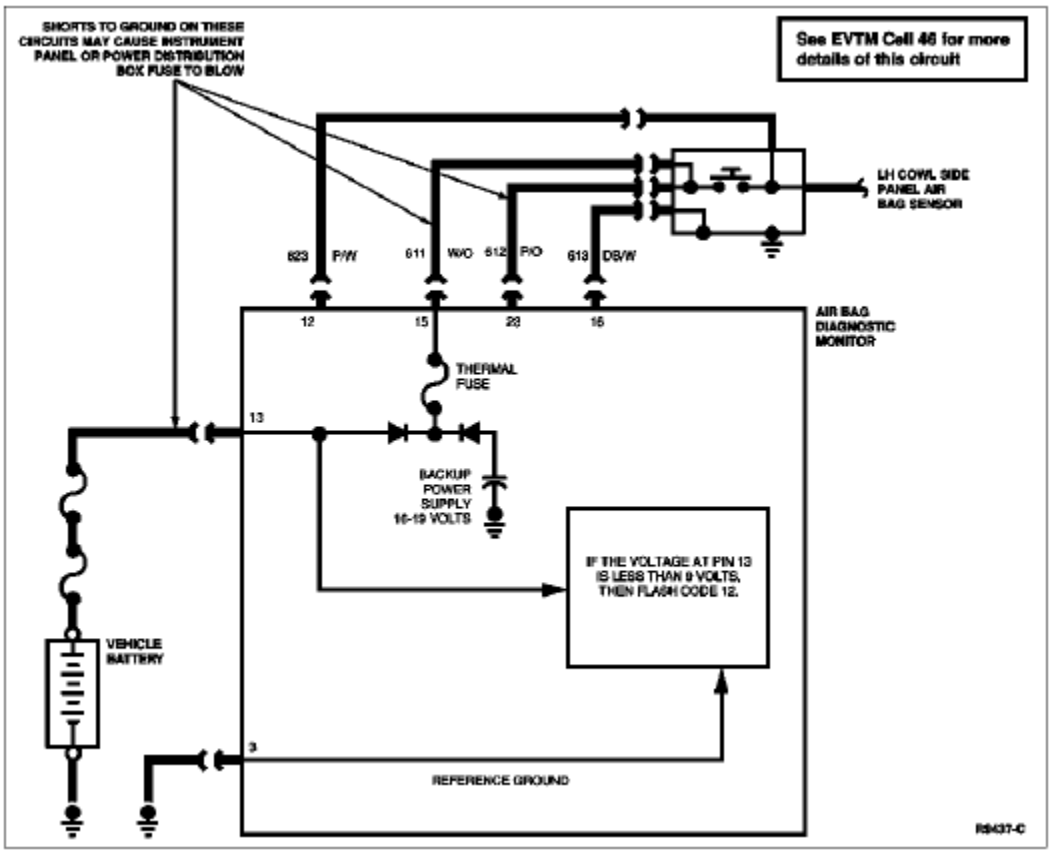
1. An open circuit that would prevent battery voltage from reaching Pin 13 of the air bag diagnostic monitor.

   NOTE: If the instrument panel fuse and/or the power distribution fuse are blown, make sure to diagnose the system for possible causes 2 and 3.

2. A short to ground in Circuit 611 (W/O) or 612 (P/O) may result in a blown instrument panel fuse and/or power distribution fuse.
3. An internal short to ground within the LH cowl side front air bag sensor and bracket (14B005) may result in a blown instrument panel fuse and/or power distribution fuse.
4. A problem in the charging system causing battery voltage to drop below 9 volts.

Low Battery Voltage



12-1 CHECK FOR DTC 12

- Turn ignition switch lock cylinder to ON.
- Count diagnostic trouble code (if any).

Is code 12 flashing?

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Yes	No
GO to 12-2 .	READ the normal operation description for this diagnostic trouble code. EXAMINE the trouble code schematic and look for areas where intermittent problems would occur (connectors, splices, crimps, etc.). Do not proceed with pinpoint tests until the code is flashing! Failure to do so will result in needless replacement of the air bag system components and repeat repairs.

12-2 VOLTAGE CHECK

- Deactivate system.
- Disconnect air bag diagnostic monitor.
- Turn ignition switch lock cylinder from OFF to ON.
- Measure voltage between air bag diagnostic monitor connector Pins 13 (+) and 3 (-). Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent.

Is voltage on Pin 13 equal to battery voltage?

Yes	No
REPLACE air bag diagnostic monitor. REPEAT 12-1 .	GO to 12-3 .

12-3 CHECK FUSE

- Check power feed fuse.

Is fuse blown?

Yes	No
REPLACE fuse. GO to 12-4 .	LOCATE and SERVICE the open circuit between fuse 10 and Pin 13 of the harness connection. GO to 12-6 .

12-4 CHECK FOR SHORT IN HARNESS

- Replace fuse.

Does fuse blow again?

Yes	No
LOCATE and SERVICE the short to ground between fuse and Pin 13 of the air bag diagnostic monitor harness connector. GO to 12-6 .	GO to 12-5 .

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12-5 CHECK FOR SHORT IN CIRCUIT 611 AND 612

- Reconnect air bag diagnostic monitor.
- Turn ignition switch lock cylinder from OFF to ON.

Did fuse blow again?

Yes	No
LOCATE and SERVICE short to ground in Circuit 611 (W/O) Pin 15 or Circuit 612 (P/O) Pin 13. GO to **12-6** .	The short to ground is intermittent. CHECK all circuits between the fuse air bag diagnostic monitor Pin 13 for pinched wires. Also CHECK Circuit 611 (W/O) and 612 (P/O) for intermittent shorts. LOCATE and SERVICE intermittent short. GO to **12-6** .

12-6 REACTIVATE SYSTEM

- Replace fuse if necessary.
- Reconnect system.
- Prove out system.

Does system prove out OK?

Yes	No
RETURN vehicle to customer.	RETURN to **12-1** .

PINPOINT TEST 13: AIR BAG MODULE OR FRONT AIR BAG PRIMARY CRASH SENSOR CIRCUIT SHORTED TO GROUND (CODE 13)

Normal Operation

The air bag diagnostic monitor measures the voltage at Pin 11 (Circuit 614 GY/O) of the air bag diagnostic monitor connector. The voltage at Pin 11 varies with charging system voltage (the expected voltage at Pin 11 is shown in the chart below).

Pin 11 Voltage	System Voltage
1.9	9.0
2.0	9.5
2.1	10.0
2.2	10.5
2.3	11.0
2.4	11.5

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2.5	12.0
2.6	12.5
2.7	13.0
2.8	13.5
2.9	14.0
3.0	14.5
3.1	15.0
3.2	15.5
3.3	16.0

Note that Circuit 614 is connected to Circuit 615 (GY/W) through the driver side air bag module (043B13). Also, note that Circuit 615 is connected to the center air bag sensor feed Circuits (617 [PK/O] and 619 [PK/W]) through a diode inside the air bag diagnostic monitor. If the air bag diagnostic monitor measures a voltage of 2.0 volts or less at Pin 11, the air bag diagnostic monitor will flash out code 13 to indicate a possible short to ground on this circuit (see possible causes below for additional circuits that may be shorted to ground). When flashing code 13, the air bag diagnostic monitor blows its internal thermal fuse. This disables the air bag deployment circuit. If the short to ground is corrected, the voltage at Pin 11 will return to normal and a diagnostic trouble code 51 will flash, indicating an open thermal fuse (see Diagnostic Trouble Code 51 for details).

- Diagnostic Trouble Code 13 will flash only while the short to ground is present.

Possible Causes

NOTE: Circuits 617 (PK/O) and 619 (PK/W) are connected together inside the air bag diagnostic monitor. Therefore, a short to ground on any of these circuits will short all of the circuits to ground.

Low voltage at Pin 11 of the air bag diagnostic monitor can be caused by:

1. A short to ground within the main wiring (14401) on Circuits 614 (GY/O), 615 (GY/W), 623 (P/W), 617 (PK/O) or 619 (PK/W) causing the diagnostic voltage to drop.
2. An internal short to ground within the air bag sliding contact (14A664) causing the driver side air bag circuit(s) to be shorted to ground.
3. An internal short to ground within the LH cowl side front air bag sensor and bracket causing Circuit 614 (GY/O) or 623 (P/W) to be shorted to ground.
4. An internal short to ground within one or both center air bag sensor and bracket (14B006) and RH cowl side front air bag sensor and bracket (14B004) causing Circuits 617 (PK/O) and 619 (PK/W) to be shorted to ground.
5. An internal short to case ground within the driver side air bag module.

Air Bag Module or Primary Crash Sensor Circuit Shorted to Ground

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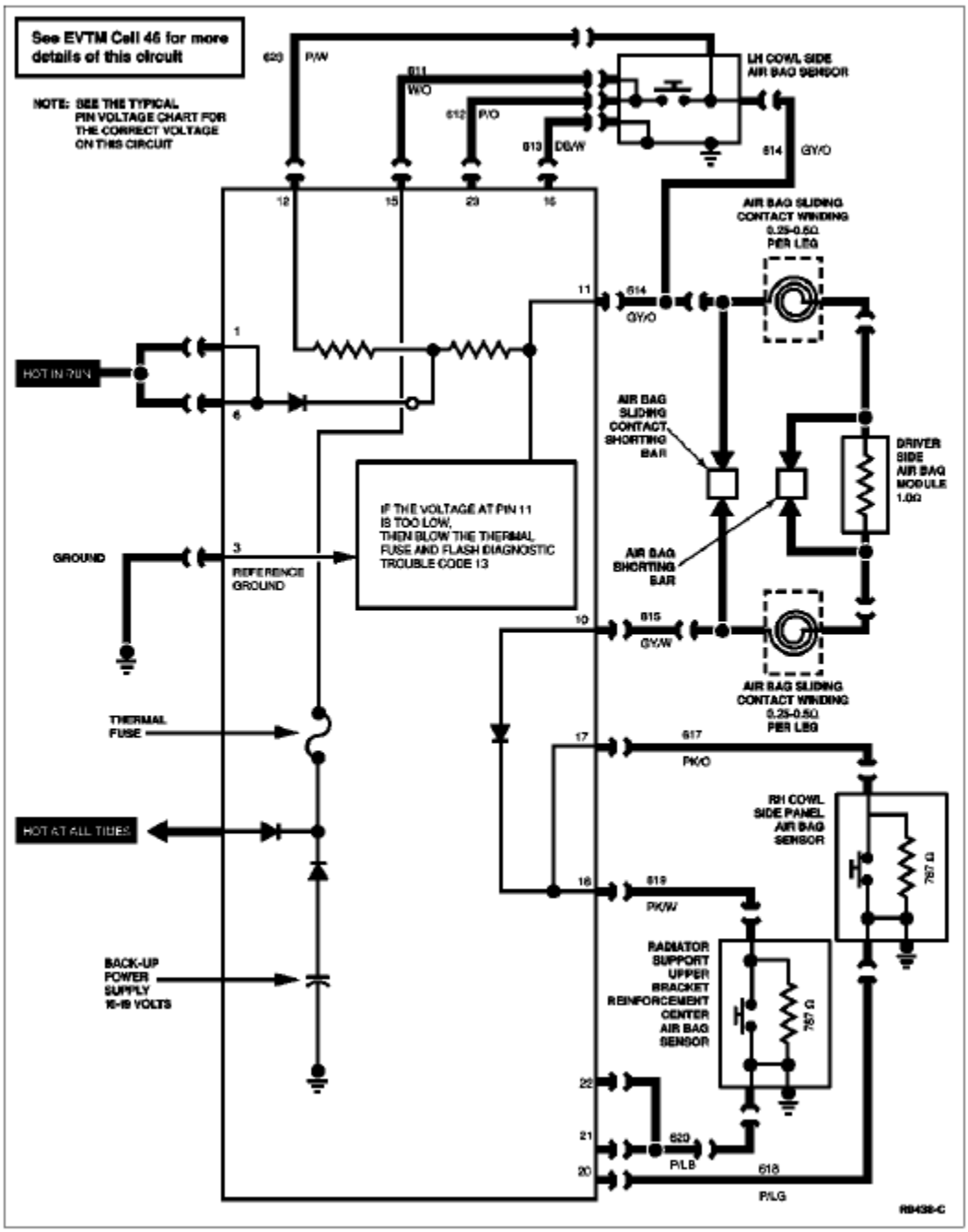

13-1 CHECK FOR DTC 13

- Turn ignition switch lock cylinder to ON.
- Count diagnostic trouble code (if any).

Is code 13 flashing?

Yes	No
	READ the normal operation description for this

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GO to **13-2** .	diagnostic trouble code. EXAMINE the fault code schematic and LOOK for areas where intermittent problems would occur (connectors, splices, crimps, etc.). Do not proceed with pinpoint tests until the code is flashing! Failure to do so will result in needless replacement of the air bag system components and repeat repairs.

13-2 CHECK FOR SHORTED AIR BAG MODULE

- Deactivate system. Carefully disconnect the air bag module. Do not disturb the wiring.
- Turn ignition switch lock cylinder to ON.

Is code 13 still flashing?

Yes	No
GO to **13-3** .	GO to **13-6** .

13-3 CHECK FOR SHORTED WIRING

- Set the Rotunda 73 Digital Multimeter 105-R0051 or equivalent to 2000 ohms scale or auto.
- Disconnect negative battery cable.
- Measure the resistance between Pin 3 (ground) and all of the following: Pin 11 (Circuit 614, GY/O) Pin 17 (Circuit 617, PK/O) Pin 18 (Circuit 619, PK/W) Normal resistance for these pins is as follows: Pin 11 open, infinite resistance, Pin 17 787 ± 10 ohms, Pin 18 787 ± 10 ohms.

Are any of these circuits shorted to ground?

Yes	No
If Pin 11 is shorted to ground, GO to **13-4** . If Pin 17 or 18 is shorted to ground, GO to **13-5** .	GO to **13-7** .

13-4 CHECK RESISTANCE IN AIR BAG SLIDING CONTACT

- Examine wiring connector where air bag sliding contact mates to the main vehicle harness underneath the steering column. Check for pinched and/or chafed wires. Service any damaged wiring. GO to **13-7** if damaged wiring is located.
- If no damaged wiring is located, disconnect air bag sliding contact from main harness, connect the air bag simulator to main vehicle harness in place of the air bag sliding contact.
- Measure the resistance of Pin 11 to ground.

Is Pin 11 still shorted to ground?

Yes	No
LOCATE and SERVICE the short to ground in either Circuit: 623 — (P/W) 614 — (GY/O) 615	

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— (GY/W) 616 — (PK/BK) Pass. BA. Vehicles Only. CHECK OASIS for potential locations where shorts may occur. When short has been serviced, GO to **13-7** .	REPLACE air bag sliding contact clockspring. GO to **13-7** .

13-5 LOCATE SHORTED SENSOR WIRING

NOTE: Make sure to measure across the PK/W and P/LB wires to the radiator support center air bag sensor.

- Locate and disconnect the center air bag or front air bag (RH) sensor that was shorted to ground.
- Measure resistance across the sensor contacts at the sensor connector. Normal resistance for a center air bag or front air bag (RH) sensor is 787 ± 10 ohms.

Is the sensor shorted?

Yes	No
REPLACE the sensor. GO to **13-7** .	LOCATE and SERVICE the short to ground in the wiring harness on the shorted circuit. GO to **13-7** .

13-6 CHECK AIR BAG SLIDING CONTACT

- Examine the air bag sliding contact in the steering wheel hub for pinched or chafed wires.

Do wires check OK?

Yes	No
REPLACE driver side air bag module. GO to **13-7** .	REPLACE air bag sliding contact. GO to **13-7** .

13-7 SHORT TO GROUND REPAIRED OR CORRECTED

- After a short to ground has been corrected, the air bag diagnostic monitor will flash out code 51. Code 51 indicates that the fuse inside the air bag diagnostic monitor is blown and the short to ground no longer exists. If a short to ground has not been located and serviced (short to ground corrected itself), consult OASIS for potential wiring shorts.

Has short to ground been correctly located and serviced?

Yes	No
REFER to Diagnostic Trouble Code 51 in this section.	RECONNECT system. VERIFY system. REACTIVATE system.

PINPOINT TEST 21: SAFING SENSOR NOT MOUNTED TO VEHICLE PROPERLY (CODE 21)

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Normal Operation

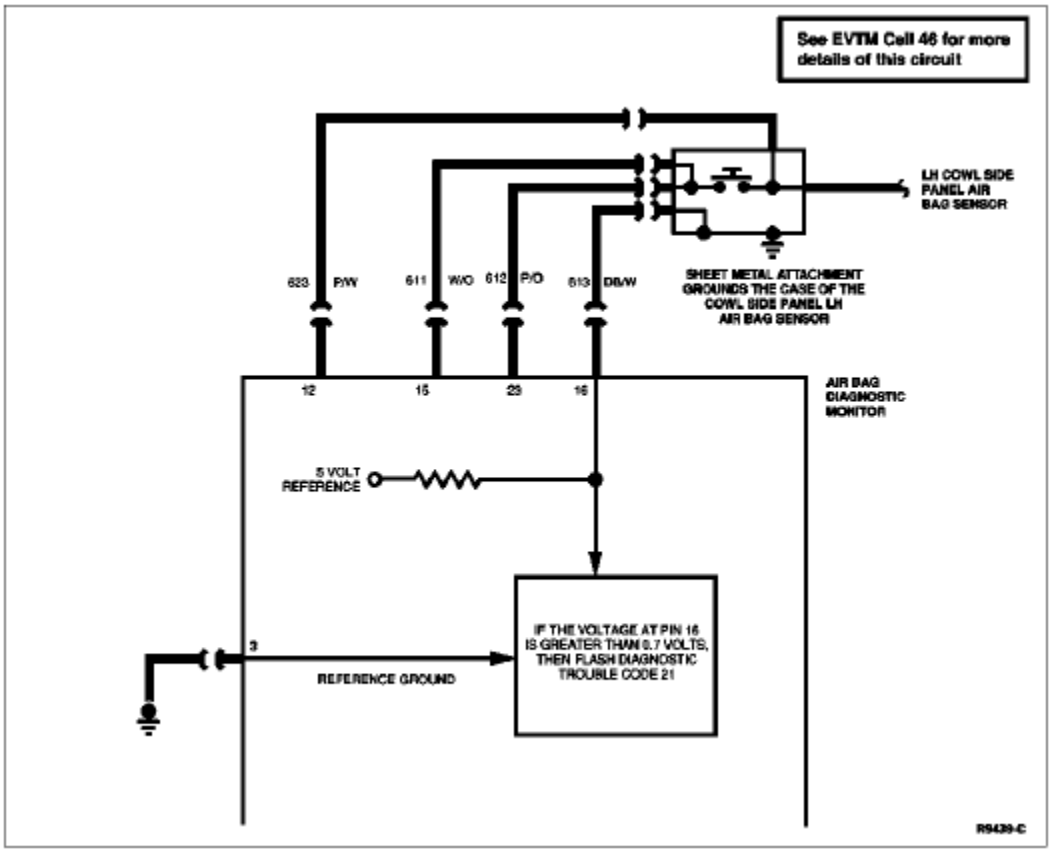
Circuit 613 (DB/W) is riveted to the side housing of LH cowl side front air bag sensor and bracket. The housing is grounded to the vehicle. A resistor inside the air bag diagnostic monitor is connected to Pin 16 (Circuit 613 DB/W) and a 5-volt reference voltage. If Circuit 613 is properly grounded, the voltage at Pin 16 will be 0 volts. If the voltage on Circuit 613 is greater than 0.7 volts, the air bag diagnostic monitor may flash diagnostic trouble Code 21, indicating that the LH cowl side front air bag sensor and bracket is not grounded properly to the vehicle.

Possible Causes

High voltage at Pin 16 can be caused by:

1. A poor connection due to loose mounting, dirt, or corrosion at the sensor mounting surface.
2. An open or damaged wire in Circuit 613 (DB/W) from Pin 16 of the diagnostic monitor connector to the LH cowl side front air bag sensor and bracket.
3. An open wire or loose rivet inside the LH cowl side front air bag sensor and bracket.

Safing Sensor Not Mounted to Vehicle Properly



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21-1 CHECK FOR DTC 21

- Turn ignition switch lock cylinder to ON.
- Count diagnostic trouble code (if any).

Is code 21 flashing?

Yes	No
GO to 21-2 .	READ the normal operation description for this diagnostic trouble code. EXAMINE the diagnostic trouble code schematic and look for areas where intermittent problems would occur (connectors, splices, crimps, etc.). Do not proceed with Pinpoint Test until the code is flashing! Failure to do so will result in needless replacement of the air bag system components and repeat repairs.

21-2 CHECK LEFT FRONT AIR BAG (LH) SENSOR

- Deactivate system.
- Disconnect battery ground cable.
- Measure resistance between Pin 3 (ground) and Pin 16 — Circuit 613 (DB/W) — front air bag (LH) sensor ground using Rotunda 73 Digital Multimeter 105-R0051 or equivalent.

Is the resistance greater than 2 ohms?

Yes	No
GO to 21-3 .	REPLACE air bag diagnostic monitor. RECONNECT system. VERIFY system. REACTIVATE system.

21-3 CHECK LH COWL SIDE SENSOR CIRCUIT

- Disconnect cowl side panel front air bag sensor.
- Measure resistance of Circuit 613 (DB/W) sensor wire to the sensor mounting sheet metal.

Is resistance greater than 2 ohms?

Yes	No
GO to 21-4 .	LOCATE and SERVICE the high resistance or open circuit in Circuit 613 (DB/W). RECONNECT system. VERIFY system. REACTIVATE system.

21-4 CHECK LH COWL SIDE AIR BAG SENSOR

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- Remove LH cowl side panel front air bag sensor and bracket from mounting to vehicle.
- Thoroughly clean sensor mounting surface.
- Install the LH cowl side panel front air bag sensor and bracket.
- Measure the Circuit 613 (DB/W) sensor wire to ground.

Is the resistance greater than 2 ohms?

Yes	No
REPLACE the LH cowl side front air bag sensor and bracket. RECONNECT system. VERIFY system. REACTIVATE system.	RECONNECT system, VERIFY system. REACTIVATE system.

PINPOINT TEST 22: SAFING SENSOR OUTPUT SHORTED TO BATTERY VOLTAGE (CODE 22)

Normal Operation

The air bag diagnostic monitor measures voltage at Pins 11 (Circuit 614, GY/O) and 12 (Circuit 623, P/W). The voltage at these pins is controlled by two resistors inside the air bag diagnostic monitor (along with the resistors inside the center air bag sensor and bracket and RH cowl side air bag sensor and bracket). Refer to normal operation for Code 24 for more information. This voltage varies with charging system voltage (the expected voltage at Pins 11 and 12 are shown in the chart below).

If the voltage at both of these pins exceeds 5 volts, the air bag diagnostic monitor will flash out code 22.

Pin 11 and Pin 12 Voltage	System Voltage
1.9	9.0
2.0	9.5
2.1	10.0
2.2	10.5
2.3	11.0
2.4	11.5
2.5	12.0
2.6	12.5
2.7	13.0
2.8	13.5
2.9	14.0
3.0	14.5
3.1	15.0
3.2	15.5
3.3	16.0

Possible Causes

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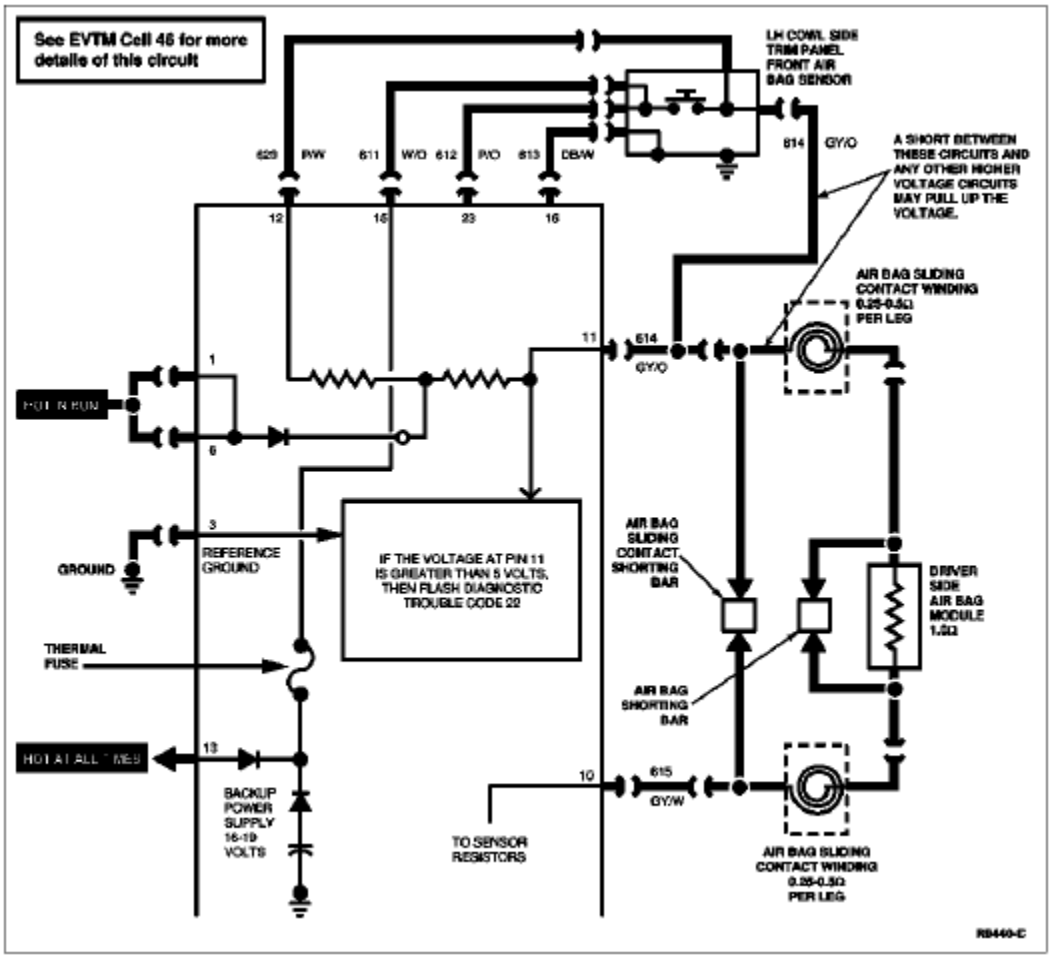
High voltage at Pins 11 and 12 can be caused by:

NOTE: The wiring harness leading to the LH cowl side front air bag sensor and bracket carries higher voltage circuits that may short to Circuits 614 and 623.

1. A short in the wiring harness between Circuits 614 (GY/O) or 623 (P/W) and another wire can cause high voltage on these circuits.
2. A short in the air bag sliding contact between Circuit 614 and some of the horn or speed control wiring.
3. A short across the normally open contacts of the LH cowl side front air bag sensor and bracket.
    - · The voltage at Circuit 611 and 612 inside the LH cowl side front air bag sensor and bracket is usually battery voltage or higher. There should be an open circuit across the contacts of the LH cowl side front air bag sensor and bracket, if the sensor is operating normally. If sensor contacts are closed, the voltage on Circuits 614 and 623 would be high (at least battery voltage).
4. Vehicle charging system voltage too high. If the generator output voltage is too high (greater than 17 volts) it may cause a code 22 to occur.

Safing Sensor Circuit Output Shorted to Battery Voltage



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22-1 PROVE OUT CONDITION

- Turn ignition switch lock cylinder to ON.
- Count diagnostic code (if any).

Is code 22 flashing?

Yes	No
GO to **22-2** .	READ the normal operation description for this diagnostic trouble code. EXAMINE the diagnostic trouble code schematic and look for areas where intermittent problems would occur (connectors, splices, crimps, etc.) Do not proceed with Pinpoint Test until the code is flashing! Failure to do so will result in needless replacement of the air bag system components and repeat repairs.

22-2 CHECK FOR SHORTED CIRCUIT

- Deactivate system.
- Measure voltage on Circuit 614 (GY/O) — Pin 11 to Pin 3 (ground).
- Use voltage table for the normal voltage specification.

Is the voltage measured high?

Yes	No
LOCATE and SERVICE the short to B+ on Circuit 614 (GY/O). GO to **22-3** .	REPLACE air bag diagnostic monitor. RECONNECT system. VERIFY system. REACTIVATE system.

22-3 CHECK FOR SHORTED WIRING

- Check for resistance across cowl side panel (LH) front air bag sensor and bracket contacts, circuit 611 (W/O) and circuit 614 (GY/O).

Is resistance infinite (open)?

Yes	No
CHECK for other wire to wire shorts. REPAIR shorts. RECONNECT system. VERIFY system. REACTIVATE system.	REPLACE LH cowl side front air bag sensor and bracket. RECONNECT system. VERIFY system. REACTIVATE system.

PINPOINT TEST 23: SAFING SENSOR INPUT FEED/RETURN CIRCUIT OPEN (CODE 23)

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Normal Operation

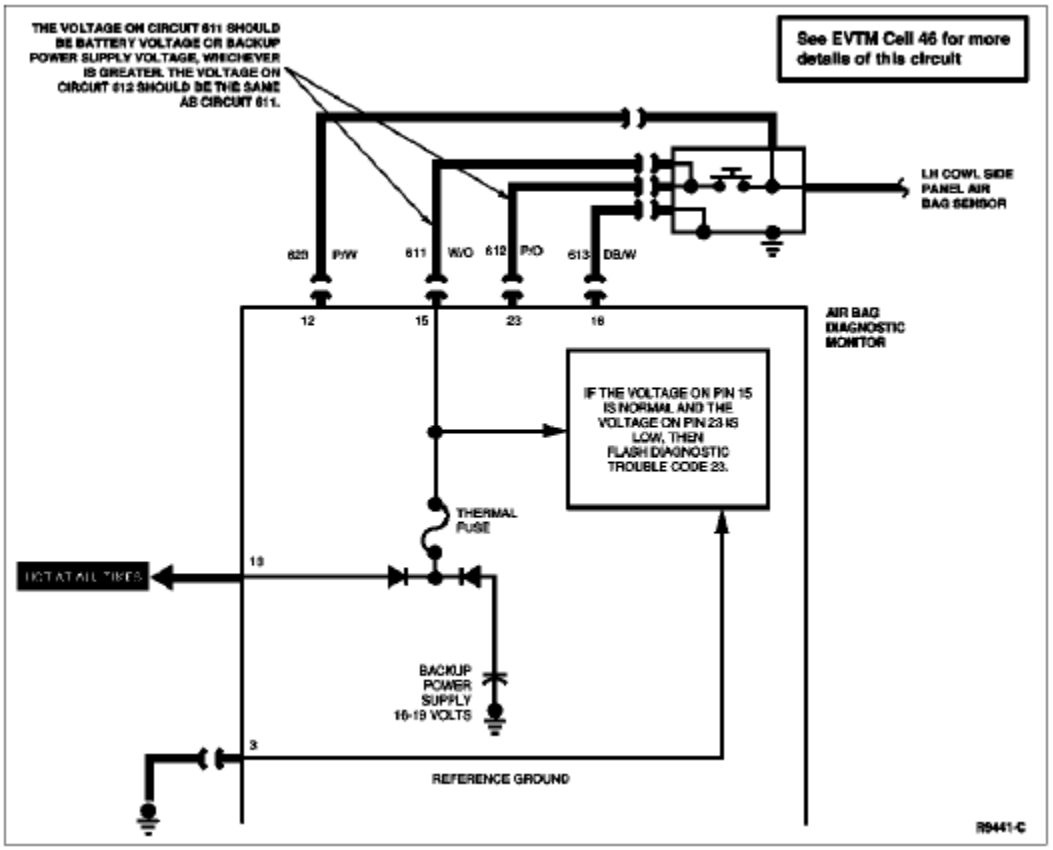
Battery voltage is provided at air bag diagnostic monitor Pin 15 (Circuit 611 W/O) at all times. However, voltage at Pin 15 can be as high as 19 volts (as provided by the backup power supply) when the ignition switch (11572) is in the RUN position and the backup power supply in the air bag diagnostic monitor is charged up. Circuit 612 (P/O) is connected to Circuit 611 (W/O) inside the LH cowl side air bag sensor and bracket. Therefore, the voltage at Pin 23 (Circuit 612 P/O) should be the same as the voltage at Pin 15 at all times. The air bag diagnostic monitor compares the voltage available at Pins 15 and 23. If the voltage at Pin 23 is low, the air bag diagnostic monitor will flash out Code 23 to indicate an open between these two circuits.

Possible Causes

Low voltage at Pin 23 can be caused by:

1. An open circuit in the wiring harness in either Circuit 611 (W/O) or 612 (P/O).
2. An open circuit inside the LH cowl side front air bag sensor and bracket across the Circuit 611 (W/O) and Circuit 612 (P/O) wires.

Safing Sensor Circuit Input Feed/Return Circuit Open



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23-1 CHECK FOR DTC 23

- Turn ignition switch lock cylinder to ON.
- Count diagnostic trouble code (if any).

Is code 23 flashing?

Yes	No
GO to 23-2 .	READ the normal operation description for this diagnostic trouble code. EXAMINE the diagnostic trouble code schematic and look for areas where intermittent problems would occur (connectors, splices, crimps, etc.). Do not proceed with Pinpoint Test until the code is flashing! Failure to do so will result in needless replacement of the air bag system components and repeat repairs.

23-2 DEACTIVATE SYSTEM

- Deactivate system.
- Turn ignition switch lock cylinder off then on.
- Wait 30 seconds.
- Measure voltage on the following pins using Pin 3 as a ground: Pin 15 — Circuit 611 (W/O). Pin 23 — Circuit 612 (P/O).
- Use the voltage table for the normal specification.

Is voltage on these pins normal?

Yes	No
REPLACE air bag diagnostic monitor. RECONNECT system. VERIFY system. REACTIVATE system.	GO to 23-3 .

23-3 CHECK CIRCUIT CONTINUITY

- Disconnect the cowl side panel (LH) front air bag sensor and bracket.
- Measure resistance across the Circuit 611 (W/O) and Circuit 612 (P/O) wires on the sensor connector.

Is there continuity across these circuits?

Yes	No
An open exists in the harness. LOCATE and SERVICE the open wire in either Circuit 611 or 612. RECONNECT the system. VERIFY The system. REACTIVATE the system.	REPLACE the LH cowl side panel front air bag sensor and bracket. RECONNECT the system. VERIFY the system. REACTIVATE the system.

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PINPOINT TEST 24: SAFING SENSOR OUTPUT FEED/RETURN CIRCUIT OPEN OR LOW RESISTANCE IN A PRIMARY CRASH SENSOR (CODE 24)

Normal Operation

The center air bag sensor and bracket and RH cowl side front air bag sensor and bracket have an internal resistor. The air bag diagnostic monitor uses the resistor in the center air bag sensor and bracket and RH cowl side front air bag sensor and bracket in combination with the two resistors inside the air bag diagnostic monitor to create a tightly controlled diagnostic voltage at Pin 11 (Circuit 614, GY/O). The sensors are tied together inside the air bag diagnostic monitor at Pins 17 (Circuit 617, PK/O) and 18 (Circuit 619, PK/W). Therefore, the resistors in the sensors are connected in parallel. The parallel combination of all the sensor resistors should be equal to 393 ohms.

The resistors inside the air bag diagnostic monitor are connected to Pins 11 (Circuit 614, GY/O) and 12 (Circuit 623, P/W) and are equal in value. Note that Circuits 614 and 623 are tied together inside the LH cowl side front air bag sensor and bracket. Therefore, the two resistors inside the air bag diagnostic monitor are connected in parallel and will function the same as one resistor of half the original value. Current flows from the battery positive voltage within the air bag diagnostic monitor, through the resistors, out to Circuits 614 (GY/O) and 623 (P/W) on Pins 11 and 12, through the LH cowl side panel front air bag sensor and bracket and out to the driver side air bag module. Current flows through the driver side air bag module and into Pin 10 (Circuit 615, GY/W).

Current then flows from Pin 10 through the diode inside the air bag diagnostic monitor and out to the center air bag sensor and bracket and RH cowl side air bag front air bag sensor and bracket through Pins 17 and 18. The current flows through each sensor resistor and terminates at the case ground of each sensor. Pin 11 is the midpoint of the resistor network and voltage at Pin 11 will change with vehicle charging system voltage. The expected voltage at Pin 11 is shown in the table below. The air bag diagnostic monitor measures the vehicle charging system voltage at Pin 13 (battery input). By measuring the voltage at Pin 13, the air bag diagnostic monitor can accurately predict what the voltage at Pin 11 should be in a normal functioning system.

If the connection between Circuits 614 (GY/O) and 623 (P/W) inside the air bag diagnostic monitor is broken, then the resistor on Pin 12 is no longer in the diagnostic circuit explained above. Both resistors are needed to pull up the diagnostic voltage to the correct value. In this situation, the resistor on Pin 11 is the only resistor inside the air bag diagnostic monitor pulling up the voltage. Therefore, the voltage on Pin 11 will be half of the normal expected voltage and the voltage on Pin 12 will be approximately equal to the vehicle charging system voltage.

The air bag diagnostic monitor does not measure the voltage on Pin 12, so the monitor bases its decision strictly on the voltage at Pin 11. If the voltage at Pin 11 is lower than it should be, the monitor will flash code 24.

Another situation that can cause low voltage at Pin 11 is a decrease in air bag sensor resistance (resistance is too low). If this occurs, the voltage at Pin 11 will be pulled down to a lower than normal value because the parallel combination resistance of center air bag sensor and bracket and RH cowl side front air bag sensor and bracket will be less than 390 ohms. In this situation, the voltage at Pins 11 and 12 will be identical, but the air bag diagnostic monitor does not measure the voltage at Pin 12. Therefore, a center air bag sensor and bracket or RH cowl side with low resistance may cause low voltage at Pin 11 and the air bag diagnostic monitor will flash code 24 on the air bag indicator.

Possible Causes

Low voltage at Pin 11 and high voltage at Pin 12 can be caused by:

1. An open circuit or high resistance in the wiring harness in Circuit 614 (GY/O) or 623 (P/W).

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2. An open circuit or high resistance inside the RH cowl side front air bag sensor and bracket across the GY/O and P/W wires.
    - Low voltage on both Pins 11 and 12 can be caused by:
3. Resistance to ground on Circuit 614 or 623. Circuits 614 and 623 should be open circuits to ground when the air bag diagnostic monitor is disconnected from main wiring. Resistance to ground on these circuits can cause a drop in the diagnostic voltage on both circuits.
4. Low resistance in one or more of center air bag sensor and bracket and RH cowl side front air bag sensor and bracket. If the resistance of one or more of the center air bag sensor and bracket and RH cowl side front air bag sensor and bracket is lower than normal, the voltage on Pin 11 will be pulled down too low.
5. A poor ground on Pin 3 of the air bag diagnostic monitor may cause voltage to appear on the diagnostic monitor ground reference. Any voltage on the ground reference will cause the air bag diagnostic monitor to measure the voltage at Pin 11 as low, even though the voltage on Pin 11 with respect to sheet metal is normal.
6. Intermittent battery voltage at Pin 13 can cause the reference voltage inside the air bag diagnostic monitor to fluctuate and can cause diagnostic trouble code 24 in some circumstances.

Pin 11 and Pin 12 Voltage	System Voltage
1.9	9.0
2.0	9.5
2.1	10.0
2.2	10.5
2.3	11.0
2.4	11.5
2.5	12.0
2.6	12.5
2.7	13.0
2.8	13.5
2.9	14.0
3.0	14.5
3.1	15.0
3.2	15.5
3.3	16.0

Safing Sensor Output Feed/Return Circuit Open or Low Resistance in a Primary Crash Sensor

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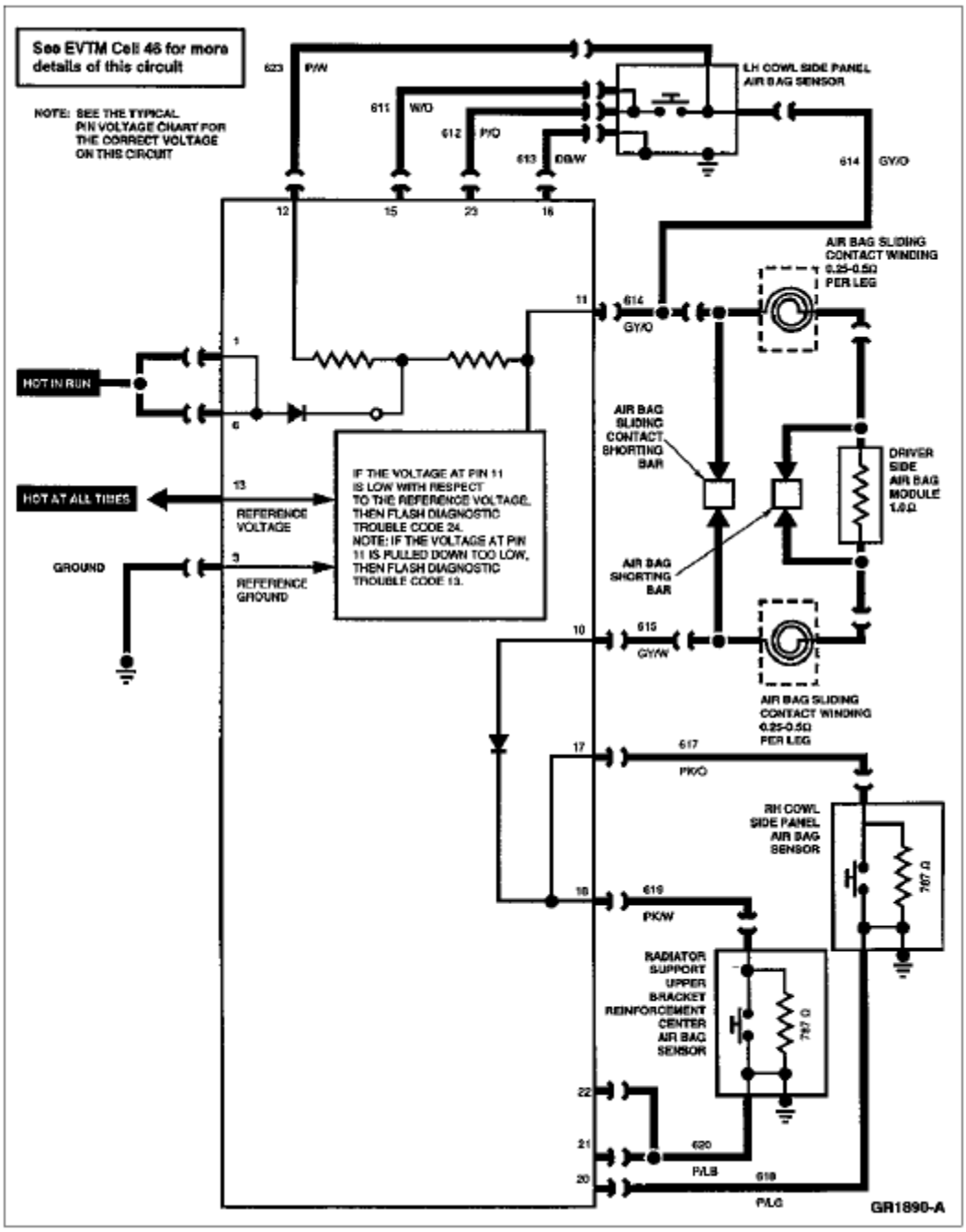

24-1 CHECK FOR DTC 24

- Turn ignition switch lock cylinder to ON.
- Count diagnostic code (if any).

Is code 24 flashing?

Yes	No
	READ the normal operation description for this

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GO to 24-2 .	diagnostic trouble code. EXAMINE the diagnostic trouble code schematic and LOOK for areas where intermittent problems would occur (connectors, splices, crimps, etc.) Do not proceed with Pinpoint Test until the code is flashing! Failure to do so will result in needless replacement of the air bag system components and repeat repairs.

24-2 DEACTIVATE SYSTEM

- Deactivate system.
- Turn the ignition switch lock cylinder off then on.
- Using Pin 3 as a ground, measure voltage on the following circuits: Pin 11 — Circuit 614 (GY/O) Pin 12 — Circuit 612 (P/W)
- Use the voltage table for normal specifications.

Are voltages at these terminals within specification?

Yes	No
CHECK the "Hot At All Times" voltage feed circuit, from the fuse block to Pin 13 of the air bag diagnostic monitor harness connector for intermittent open circuits. If none are found, REPLACE the air bag diagnostic monitor. RECONNECT the system. VERIFY the system. REACTIVATE the system.	If both Pin 11 and Pin 12 measure low voltage then GO to 24-3 . If Pin 11 measures high and Pin 12 measures low then GO to 24-4 .

24-3 CHECK CIRCUIT RESISTANCE

- Turn the ignition switch lock cylinder off.
- Disconnect the air bag diagnostic monitor.
- Disconnect the battery ground cable.
- Using Pin 3 as a ground, measure the resistance of the following pins in the air bag diagnostic monitor harness connector: Pin 17 — Circuit 617 (PK/O) Pin 18 — Circuit 619 (PK/W)

Are all resistance measurements 787 ohms (± 10) ohms?

Yes	No
GO to 24-6 .	GO to 24-5 .

24-4 CHECK FOR SHORTED CIRCUIT

- Turn ignition switch lock cylinder off then on.
- Disconnect the LH cowl side trim panel front air bag sensor and bracket.
- Measure the resistance across the Circuit 614 (GY/O) and Circuit 623 (P/W) wires in the sensor connector.

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Is there a short circuit across the Circuit 614 (GY/O) and Circuit 623 (P/W) wires?

Yes	No
LOCATE and SERVICE the open in Circuit 614 (GY/O) or Circuit 623 (P/W) of the wiring harness. RECONNECT system. VERIFY system. REACTIVATE system.	REPLACE the LH cowl side front air bag sensor and bracket. RECONNECT system. VERIFY system. REACTIVATE system.

24-5 CHECK SENSOR RESISTANCE

- Disconnect the abnormal front air bag sensor from the harness.
- Measure the resistance directly across the front air bag sensor contacts.

Is the resistance 787 ohms (±10 ohms)?

Yes	No
LOCATE and SERVICE the short to ground in the wiring harness. RECONNECT system. VERIFY system. REACTIVATE system.	REPLACE the LH cowl side front air bag sensor and bracket. RECONNECT system. VERIFY system. REACTIVATE system.

24-6 CHECK FOR SHORTED CIRCUIT ON PIN 11

- Using Pin 3 as a ground, measure the resistance of Pin 11 — Circuit 614 (GY/O) to ground (ohmmeter must be on its highest scale).

Is the circuit open?

Yes	No
REPLACE the air bag diagnostic monitor. RECONNECT system. VERIFY system. REACTIVATE system.	LOCATE and SERVICE short to ground in either Circuit 614 (GY/O), 615 (GY/W), 623 (P/O). Also check driver side air bag module, air bag sliding contact, LH cowl side front air bag sensor and bracket for internal shorts to ground. Once repaired, RECONNECT system. VERIFY system. REACTIVATE system.

PINPOINT TEST 32: DRIVER SIDE AIR BAD CIRCUIT HIGH RESISTANCE OR OPEN (DIAGNOSTIC TROUBLE CODE 32)

Normal Operation

NOTE: The connectors for the driver side air bag module and the air bag sliding contact have metal spring clips that act as shorting bars. These shorting bars are built into the plastic hardshell connectors. The shorting bars are designed to short Circuits 614 and 615 together when the connectors are not mated. Do not attempt to remove the air bag shorting bar and measure the resistance of the driver side air bag module.

The air bag diagnostic monitor measures the resistance across Pin 10 (Circuit 615, GY/W) and Pin 11 (Circuit 614, GY/O) every time the ignition switch is turned to the RUN position. Normal resistance across

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these circuits is between 1.5 and 2.0 ohms. This resistance comes from the driver side air bag module (approximately 1.0 ohms) and the windings of the air bag sliding contact (approximately 0.25 to 0.5 ohms per winding, two windings in all). If the resistance across these two circuits exceeds 4.0 ohms, this indicates a high resistance and the air bag diagnostic monitor will flash code 32.

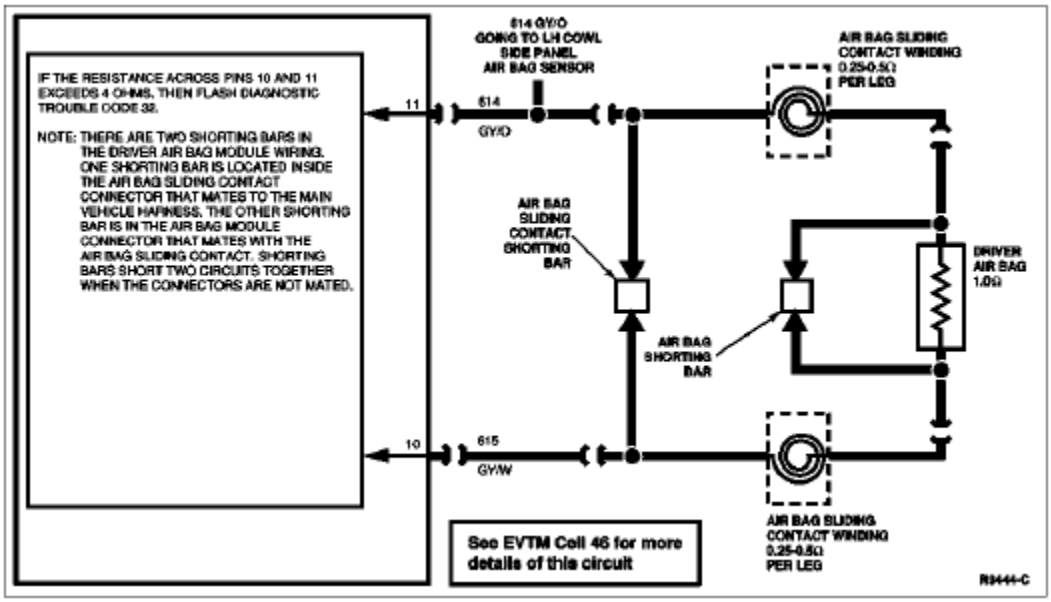
The shorting bar of the air bag sliding contact may be removed to measure the resistance of the air bag sliding contact. Use extreme care when reinstalling the shorting bar to make sure it is installed correctly.

Possible Causes

Excessive resistance across Pins 10 and 11 can be caused by:

1. A poor connection where the air bag sliding contact connects into the main wiring. The air bag sliding contact connector at the base of the steering column may have excessive resistance between the male and female terminals in the connector.
2. An open circuit or high resistance in the windings inside the air bag sliding contact.
3. An open circuit or high resistance in the wiring harness in either Circuit 614 (GY/O) or Circuit 615 (GY/W).
4. An open circuit or high resistance in the driver side air bag module. DO NOT attempt a direct resistance measurement of the driver side air bag module. Follow the diagnostic procedures to determine if the resistance is higher than normal.

Driver Side Air Bag Circuit High Resistance or Open



32-1 CHECK FOR DTC 32

- Turn ignition switch lock cylinder to ON.
- Count diagnostic trouble code (if any).

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Is code 32 flashing?

Yes	No
GO to 32-2 .	READ the normal operation description for this diagnostic trouble code. EXAMINE the diagnostic trouble code schematic and LOOK for areas where intermittent problems would occur (connectors, splices, crimps, etc.). Do not proceed with Pinpoint Test until the code is flashing! Failure to do so will result in needless replacement of the air bag system components and repeat repairs.

32-2 CHECK CIRCUIT RESISTANCE

- Deactivate system.
- Disconnect air bag diagnostic monitor.
- Set ohmmeter, Rotunda 73 Digital Multimeter 105-R0051 or equivalent on lowest scale possible (200 ohms for most meters).
- "Zero" the ohmmeter by touching the leads together and record the resistance reading.
- Remove the plastic locking wedge from the black harness connector.
- Measure the resistance across Pin 11 — Circuit 614 (GY/O) and Pin 10 — Circuit 615 (GY/W). Record the measurement. Subtract this reading from the reading made when zeroing the ohmmeter.

Is the result less than 2.5 ohms?

Yes	No
Make sure that the locking wedge has been removed from the block harness connector. Make sure to use the 2-ohm air bag simulator and not jumper wire. GO to 32-3 .	GO to 32-3 .

32-3 CIRCUIT RESISTANCE RESULTS

Is the result greater than 3.0 ohms?

Yes	No
GO to 32-5 .	GO to 32-4 .

32-4 CHECK CONNECTOR

- Reconnect the air bag diagnostic monitor.
- Turn the ignition switch lock cylinder OFF, then ON.

Is code 32 still flashing?

Yes	No

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REPLACE the air bag diagnostic monitor. RECONNECT system. VERIFY system. REACTIVATE system.	INSPECT air bag diagnostic monitor harness connector for improperly retained Pins 10 and 11. If OK, INSPECT sliding contact wiring in steering wheel for damaged wiring. If OK, RECONNECT driver side air bag module and VERIFY system. If Code 32 is still flashing, REPLACE driver side air bag module. RECONNECT system. VERIFY system. REACTIVATE system.

32-5 CHECK AIR BAG SLIDING CONTACT

- Disconnect the air bag sliding contact at the base of the steering column.
- Install the Rotunda Air Bag Simulator 105-R0011 or equivalent, on the main wiring harness at the base of the steering column.
- Measure the resistance across Pin 10 — Circuit 615 (GY/W) and Pin 11 Circuit 614 (GY/O) on the air bag diagnostic monitor harness connector. Subtract this reading from the reading made when zeroing the ohmmeter.

Is the result equal to 2.0 ohm ± 0.2-ohm?

Yes	No
REPLACE the air bag sliding contact. REFER to Section 11-04B for removal and installation procedures. RECONNECT system. VERIFY system. REACTIVATE systems.	LOCATE and SERVICE the open in Circuit 614 or 615. RECONNECT system. VERIFY system. REACTIVATE system.

PINPOINT TEST 33: PASSENGER SIDE AIR BAG CIRCUIT HIGH RESISTANCE OR OPEN (DIAGNOSTIC TROUBLE CODE 33)

Normal Operation

The air bag diagnostic monitor measures the resistance across Pin 8 and Pin 9 every time the ignition switch is turned to the RUN position. Normal resistance across these circuits is between 0.9 ohms and 1.1 ohms with a passenger air bag installed. Pin 7 of the air bag diagnostic monitor should be connected to ground. Connecting Pin 7 to ground programs the air bag diagnostic monitor to ignore high resistance on the passenger air bag circuits. If the resistance across these two circuits exceeds 4.0 ohms and Pin 7 is not grounded, the air bag diagnostic monitor will flash a code 33 on the air bag lamp.

Possible Causes

A high resistance or open in the air bag circuit can be caused by Pin 7 not connected to ground.

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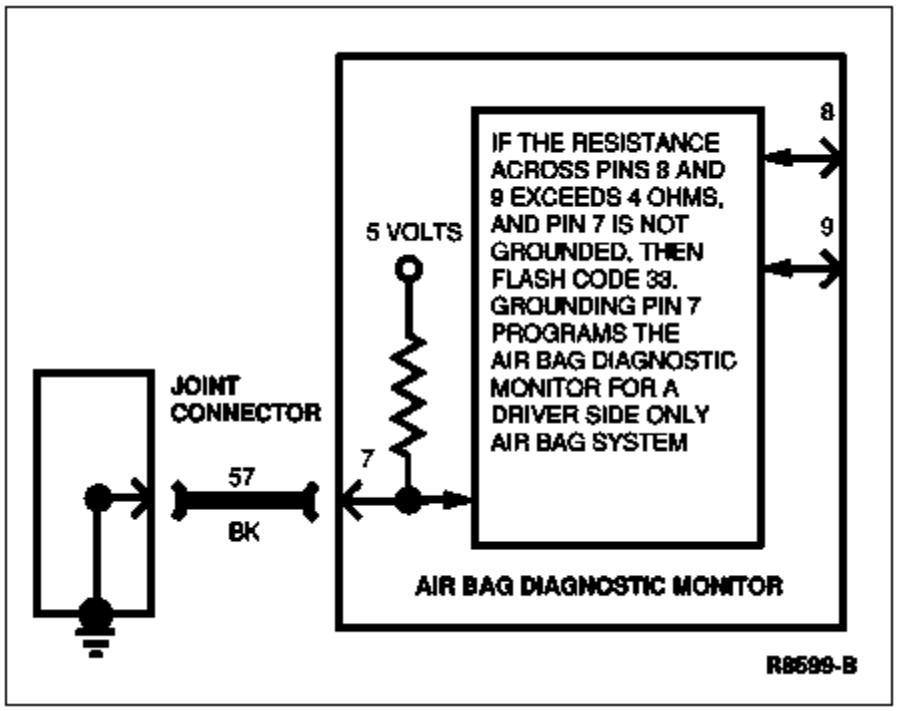

33-1 CHECK FOR GROUND

- Deactivate system.
- Disconnect air bag diagnostic monitor.
- Disconnect both battery cables.
- Measure resistance across air bag diagnostic monitor harness Pin 7 and Pin 3 (Ground).

Is the resistance less than 10 ohms?

Yes	No
REPLACE air bag diagnostic monitor. RECONNECT system. VERIFY air bag indicator.	LOCATE and CONNECT wire from Pin 7 to Ground. Make sure it is connected to proper area.

PINPOINT TEST 34: DRIVER SIDE AIR BAG CIRCUIT LOW RESISTANCE OR SHORTED (CODE 34)

Normal Operation

The air bag diagnostic monitor measures the resistance across Pin 10 (Circuit 615, GY/W) and Pin 11 (Circuit 614, GY/O) every time the ignition switch is turned to the RUN position. Normal resistance across these circuits is between 1.5 and 2.0 ohms. This resistance comes from the driver side air bag module (approximately 1.0 ohms) and the air bag sliding contact windings (0.25 to 0.5 ohms per winding, two windings in all). If the resistance across these two circuits is less than 0.7 ohms, the air bag diagnostic monitor will flash code 34 on the air bag indicator.

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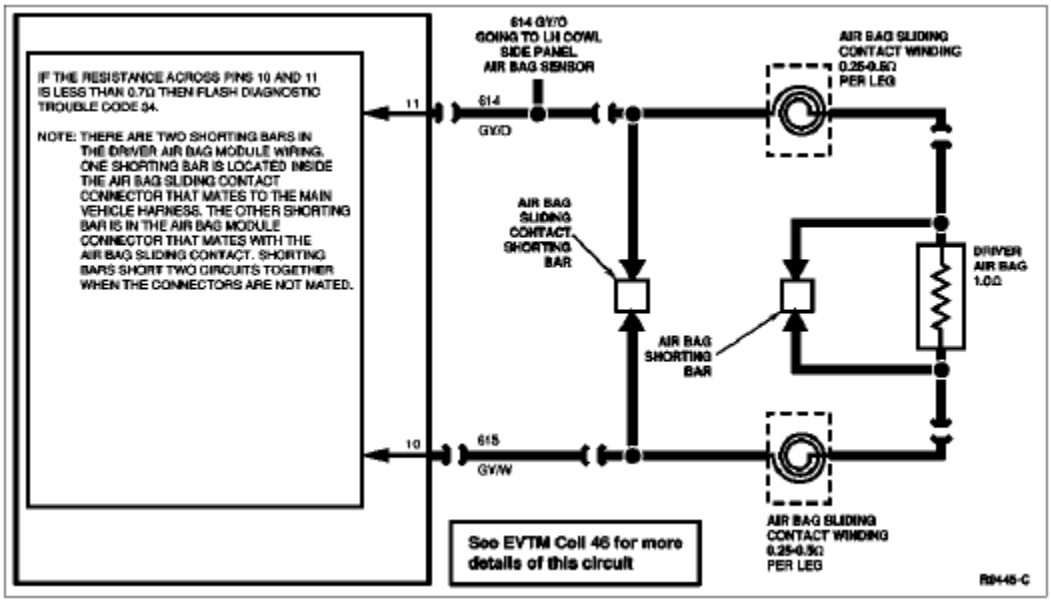
- The connectors for the driver side air bag module and the air bag sliding contact have metal spring clips that act as shorting bars. These shorting bars are built into the plastic hardshell connectors. The shorting bars are designed to short Circuits 614 and 615 together when the connectors are not mated. Do not attempt to remove the air bag shorting bar and measure the resistance of the driver side air bag module. The air bag sliding contact shorting bar may be removed to measure the resistance of air bag sliding contact. Use extreme care when reinstalling the shorting bar to make sure it is installed correctly.

Possible Causes

Low resistance across Pins 10 and 11 can be caused by:

1. A poorly mated air bag sliding contact connector may not push the shorting bars back into their fully retracted positions.
2. A faulty shorting bar may short Circuits 614 (GY/O) and 615 (GY/W) together.
3. A short in the air bag sliding contact windings between Circuits 614 and 615.
4. A short across the terminals within the driver side air bag module. DO NOT attempt a direct resistance measurement of the driver side air bag module. Follow the diagnostic procedures to determine if the resistance is lower than normal.

Driver Side Air Bag Circuit Low Resistance or Shorted



34-1 CHECK FOR DTC 34

- Turn ignition switch lock cylinder to ON.
- Count diagnostic trouble code (if any).

Is code 34 flashing?

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Yes	No
GO to **34-2** .	READ the normal operation description for this diagnostic trouble code. EXAMINE the diagnostic trouble code schematic and look for areas where intermittent problems would occur (connectors, splices, crimps, etc.). Do not proceed with pinpoint tests until the code is flashing! Failure to do so will result in needless replacement of the air bag system components and repeat repairs.

34-2 DEACTIVATE SYSTEM

- Deactivate system — leave driver side air bag harness connector empty (do not install the air bag simulator).
- Disconnect the air bag diagnostic monitor.
- Remove the plastic locking wedge from the block harness connector.
- Measure the resistance across Pin 11 — Circuit 614 (GY/O) and Pin 10 — Circuit 615 (GY/W).

Is the resistance across Pins 10 and 11 infinite (open)?

Yes	No
GO to **34-3** .	GO to **34-4** .

34-3 CHECK COMPONENT INSTALLATION

- Install Rotunda Air Bag Simulator 105-R0011 or equivalent, onto the air bag sliding contact connector at the steering wheel.
- Reconnect the air bag diagnostic monitor.
- Turn ignition switch lock cylinder from OFF to ON.
- Wait 30 seconds.

Is code 34 flashing?

Yes	No
REPLACE air bag diagnostic monitor. REACTIVATE system. VERIFY air bag indicator.	EXAMINE the shorting bar on the driver side air bag connector for proper function. **NOTE: EXAMINE the air bag sliding contact to main harness connector as an example of a normal shorting bar.** REPLACE the driver side air bag if the shorting bar is normal. REACTIVATE system. VERIFY air bag indicator.

34-4 CHECK AIR BAG SLIDING CONTACT

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- Disconnect the air bag sliding contact at the base of the steering column where it mates with the main vehicle harness.
- Measure the resistance across Pin 11 (Circuit 614, GY/O) and Pin 10 (Circuit 615, GY/W).

Is the resistance across Pins 10 and 11 infinite (open)?

Yes	No
EXAMINE the shorting bar on air bag sliding contact and main harness connector for proper function. **NOTE: EXAMINE the driver side air bag connector as an example of a normal shorting bar.** REPLACE the air bag sliding contact if the short bar is normal. REACTIVATE system. VERIFY air bag indicator.	LOCATE and SERVICE the short across Circuits 614 & 615 in the wiring harness. INSPECT the air bag diagnostic monitor harness connector and the air bag sliding contact harness connector for shorted terminals. REACTIVATE system. VERIFY air bag indicator.

PINPOINT TEST 35: PASSENGER SIDE AIR BAG CIRCUIT LOW RESISTANCE OR SHORTED (CODE 35)

Normal Operation

The air bag diagnostic monitor measures the resistance across Pin 8 and Pin 9 every time the ignition switch is turned to the RUN position. Normal resistance across these circuits is between 0.9 ohms and 1.1 ohms. If the resistance across Pins 8 and 9 is less than 0.7 ohms, the monitor will flash a code 35. Note that it does not matter if Pin 7 is grounded or not. If low resistance is measured across Pins 8 and 9 a diagnostic trouble code 35 will appear.

Possible Causes

Low resistance across Pins 8 and 9 can be caused by a short between Pins 8 and 9 at the air bag diagnostic monitor.

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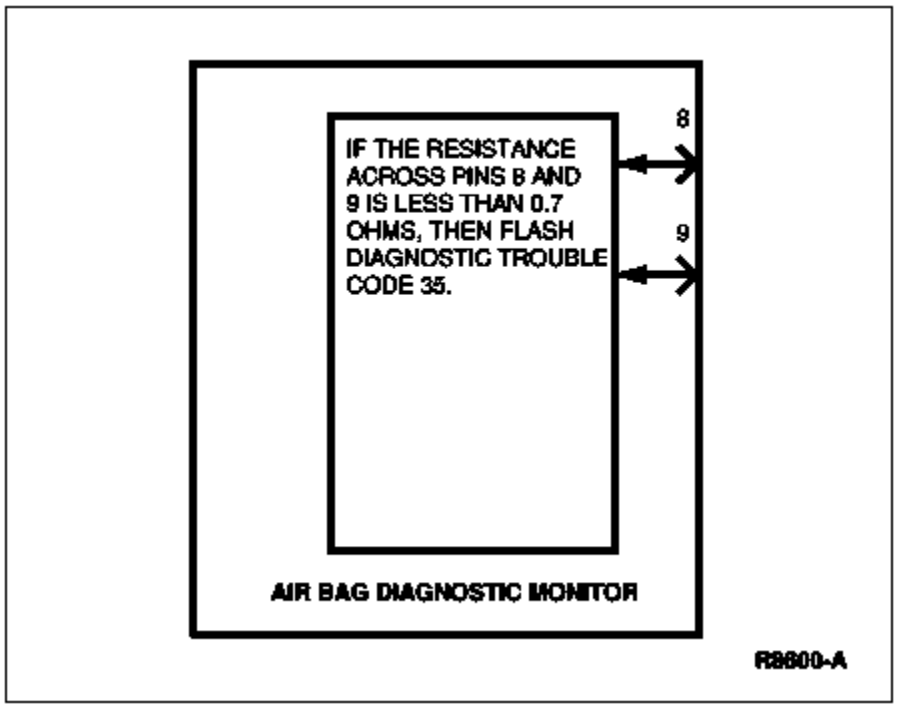

35-1 CHECK FOR DTC 35

- Turn ignition switch lock cylinder to ON.
- Count diagnostic trouble code.

Is code 35 flashing?

Yes	No
GO to 35-2 .	READ the normal operation description for this diagnostic trouble code. EXAMINE the diagnostic trouble code schematic and look for areas where intermittent problems would occur (connectors, splices, crimps, etc.). DO NOT proceed with Pinpoint Test until the code is flashing! Failure to do so will result in needless replacement of the air bag system components and repeat repairs.

35-2 CHECK FOR SHORT ACROSS PINS 8 AND 9 AT THE AIR BAG DIAGNOSTIC MONITOR

- Deactivate system.
- Disconnect the air bag diagnostic monitor.
- Remove the plastic locking wedge from the black harness connector.
- Measure the resistance across Pin 8 (Circuit 614, GY/O) and Pin 9 (Circuit 616, PK/BK).

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Is the resistance across these Pins infinite (open)?

Yes	No
REPLACE air bag diagnostic monitor. RECONNECT system. REACTIVATE system. VERIFY system.	LOCATE and SERVICE the short across Pins 8 and 9 of the wiring harness. INSPECT the diagnostic monitor harness connector and terminal for possible short circuits. RECONNECT system. REACTIVATE system. VERIFY air bag indicator.

PINPOINT TEST 41: PRIMARY CRASH SENSOR CIRCUITS HIGH RESISTANCE OR OPEN (CODE 41)

Normal Operation

The center air bag sensor and bracket and RH cowl side front air bag sensor and bracket each have an internal resistor. The air bag diagnostic monitor uses the resistor in center air bag sensor and bracket and RH cowl side air bag sensor and bracket in combination with the two resistors inside the air bag diagnostic monitor to create a tightly controlled diagnostic voltage at Pin 11 (Circuit 614, GY/O). The center air bag sensor and bracket and RH cowl side front air bag sensor and bracket are tied together inside the air bag diagnostic monitor at Pins 17 (Circuit 617, PK/O) and 18 (Circuit 619, PK/W). Therefore, the resistors in the sensors are connected in parallel. The parallel combination of all the sensor resistors should be equal to 393 ohms. The resistance of each sensor should be 787 ohms ± 10 ohms.

The resistors inside the air bag diagnostic monitor are connected to Pins 11 (Circuit 614, GY/O) and 12 (Circuit 623, P/W) and are equal in value. Note that Circuits 614 and 623 are tied together inside the LH cowl side panel front air bag sensor and bracket. Therefore, the two resistors inside the air bag diagnostic monitor are connected in parallel and will function the same as one resistor of half the original value. Current flows from the battery positive voltage within the air bag diagnostic monitor, through the resistors, out to Circuits 614 (GY/O) and 623 (P/W) on Pins 11 and 12, through the 5-wire LH cowl side front air bag sensor and bracket and out to the driver side air bag module. Current flows through the driver side air bag module and into Pin 10 (Circuit 615, GY/W). Current then flows from Pin 10 through the diode inside the air bag diagnostic monitor and out to the center air bag sensor and bracket and RH cowl side front air bag sensor and bracket through Pins 17, 18 and 19. The current flows through each sensor resistor and terminates at the case ground of each sensor. Pin 11 is the midpoint of the resistor network and voltage at Pin 11 will change with vehicle charging system voltage. The expected voltage at Pin 11 is shown in the table below. The air bag diagnostic monitor measures the vehicle charging system voltage at Pin 13 (battery input). By measuring the voltage at Pin 13, the air bag diagnostic monitor can accurately predict what the voltage at Pin 11 should be in a normal functioning system.

If the resistance of one or more of the sensors has increased in value, then the equivalent resistance of the sensors will be greater than 393 ohms. When sensor resistance increases, there is less overall resistance pulling the diagnostic voltage down. Therefore, the voltage at Pin 11 will increase and the air bag diagnostic monitor will flash code 41 to indicate high resistance (or an open circuit) in one of the sensor circuits. Another situation that may cause high voltage on Pin 11 is if resistance builds up across the normally open contacts of the LH cowl side front air bag sensor and bracket. Front air bag sensor and brackets do not normally have resistance across contacts. If resistance appears across the sensor contacts, then current will flow from Pin 15 (Circuit 611, W/O) through the abnormal resistance across the contacts of the LH cowl side front air bag sensor and bracket and into Circuit 614 (GY/O). Since the voltage at Pin 15 is battery voltage or higher, this will also cause an increase in voltage at Pin 11 and the air bag diagnostic monitor will flash code 41.

Possible Causes

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Higher than normal voltage on Pin 11 can be caused by:

1. An open in one or more of the circuits between the air bag diagnostic monitor and the center air bag sensor and bracket or front air bag sensor and bracket (RH). Circuit 617 (PK/O or 619 (PK/W) may have an open circuit in the wiring.
2. An abnormally high resistance value across one or more of the sensors. One or more of the sensor resistors may have too high resistance or may be a completely open circuit.
3. An intermittent open between the positive terminal of the battery and Pin 13 may cause the air bag diagnostic monitor to determine that voltage on Pins 17 and 18 is too high with respect to the voltage on Pin 13.
4. Resistance across the front air bag sensor and bracket (LH). The sensor is a normally open switch with infinite resistance across its contacts. If the sensor is faulty and some resistance builds up across the open contacts, the voltage on Circuit 611 (W/O) will pull up the voltage on Circuit 614 (GY/O).

Pin No. 10 and Pin No. 11 Voltage	Pin No. 17 and Pin No. 18 Voltage	System Voltage
1.9	1.4	9.0
2.0	1.5	9.5
2.1	1.6	10.0
2.2	1.7	10.5
2.3	1.8	11.0
2.4	1.9	11.5
2.5	2.0	12.0
2.6	2.1	12.5
2.7	2.2	13.0
2.8	2.3	13.5
2.9	2.4	14.0
3.0	2.5	14.5
3.1	2.6	15.0
3.2	2.7	15.5
3.3	2.8	16.0

Primary Crash Sensor Circuits High Resistance or Open

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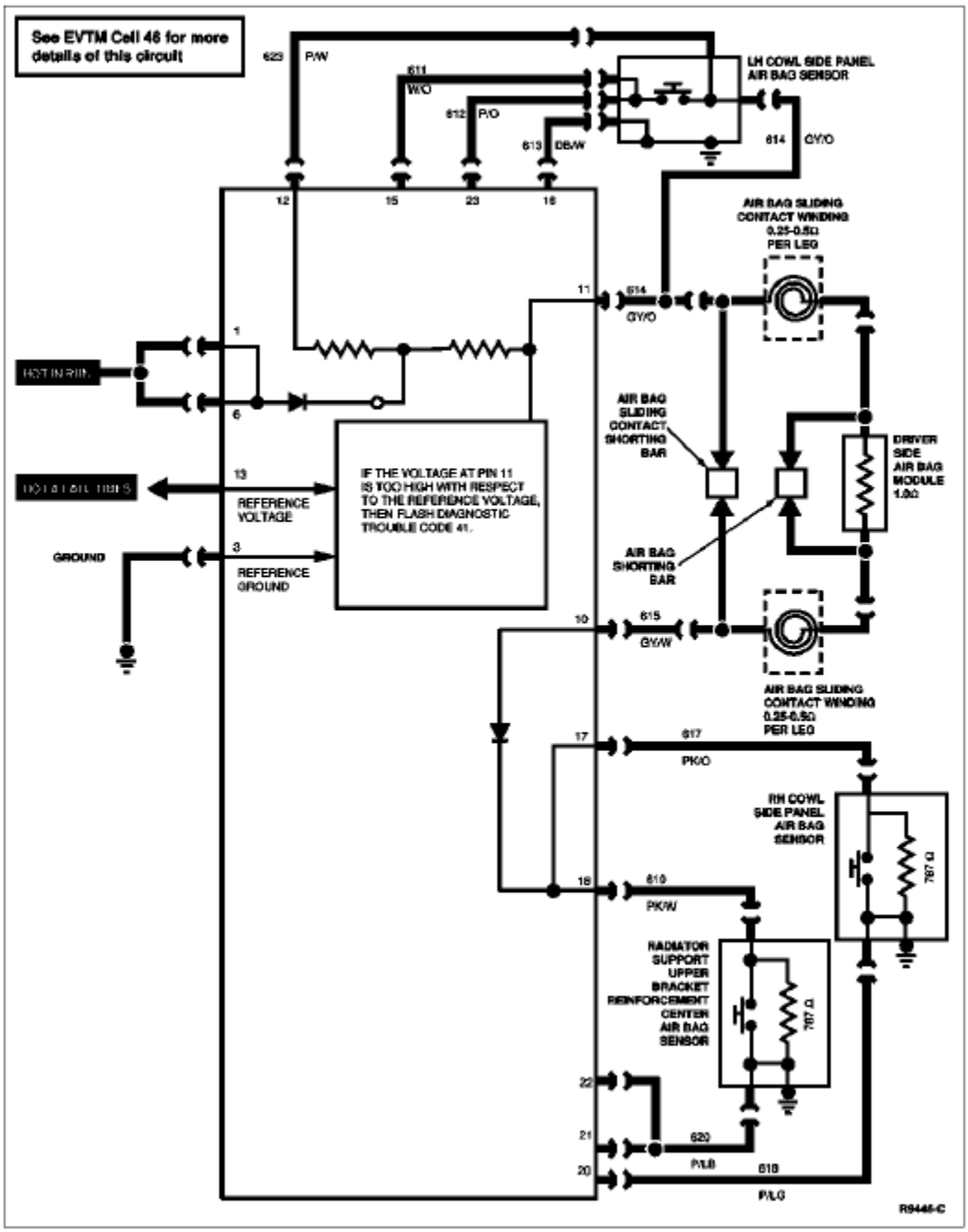

41-1 CHECK FOR DTC 41

- Turn ignition switch lock cylinder to ON.
- Count diagnostic trouble code (if any).

Is code 41 flashing?

Yes	No
	READ the normal operation description for this

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GO to 41-2 .	diagnostic trouble code. EXAMINE the diagnostic trouble code schematic and LOOK for areas where intermittent problems would occur (connectors, splices, crimps, etc.). Do not proceed with Pinpoint Test until the code is flashing! Failure to do so will result in needless replacement of the air bag system components and repeat repairs.

41-2 DEACTIVATE SYSTEM/MEASURE PIN 11

- Deactivate system.
- Turn ignition switch lock cylinder OFF then ON.
- Measure voltage between Pin 13 (+) and Pin 3 (-). Record the voltage as Charging System Voltage.
- Measure voltage between Pin 11 (Circuit 614, GY/O) and Pin 3 (ground).
- Use the Voltage Table to determine if the voltage at Pin 11 is within specification (± 1 volt).

Is the voltage measured within specification?

Yes	No
TURN ignition switch lock cylinder ON. INSPECT all terminations and connections between the positive terminal, the battery, and Pin 13 of the air bag diagnostic monitor. This includes the fuse terminal crimps, splices, etc. GO to 41-3 .	GO to 41-4 .

41-3 SERVICE POOR CONNECTIONS

During inspection of all connections, were any poor connections found?

Yes	No
SERVICE poor connections found. RECONNECT system. VERIFY system. REACTIVATE system.	REPLACE air bag diagnostic monitor. RECONNECT system. VERIFY system. REACTIVATE system.

41-4 MEASURE RESISTANCE ACROSS SENSOR CIRCUITS

- Turn ignition switch lock cylinder OFF.
- Disconnect air bag diagnostic monitor.
- Measure the resistance of both sensor circuits from Pins 17 and 18 of the air bag diagnostic monitor harness connector to Pin 3 (ground).

Does resistance measure 787 ± 10 ohms?

Yes	No
GO to 41-6 .	LOCATE and DISCONNECT the sensor with

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	abnormal reading. GO to **41-5** .

41-5 MEASURE RESISTANCE

- Measure the resistance across the abnormal sensor connector terminals.

Is the reading 787 ± 10 ohms?

Yes	No
LOCATE and SERVICE the open circuit in the wiring harness for the affected sensor. RECONNECT system. VERIFY system. REACTIVATE system.	REPLACE the abnormal sensor. RECONNECT system. VERIFY system. REACTIVATE system.

41-6 CHECK RESISTANCE ACROSS PINS 15 AND 11

- Place Rotunda 73 Digital Multimeter 105-R0051 or equivalent, on the highest ohm scale available (200,000 ohms or auto).
- Measure the resistance across Pin 15 — Circuit 611 (W/O) and Pin 11 of the air bag diagnostic monitor harness connector.

Is the reading infinite (open)?

Yes	No
LOCATE and SERVICE the short between the air bag circuits (614, 615 and 616) and B+, in the wire harness. RECONNECT system. VERIFY system. REACTIVATE system.	GO to **41-7** .

41-7 MEASURE RESISTANCE OF LH COWL SIDE AIR BAG SENSOR

- Disconnect the LH cowl side panel front air bag sensor and bracket.
- Measure the resistance across the GY/O and W/O wires in the LH cowl side front air bag sensor and bracket.

Is the reading infinite (open)?

Yes	No
LOCATE and SERVICE the short between Circuit 611 and 614 in the wiring harness. RECONNECT system. VERIFY system. REACTIVATE system.	REPLACE the sensor. RECONNECT system. VERIFY system. REACTIVATE system.

PINPOINT TEST 44: RH PRIMARY CRASH SENSOR NOT MOUNTED TO VEHICLE PROPERLY (CODE 44)

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Normal Operation

The air bag diagnostic monitor measures the resistance between Pin 20 Circuit 618 (P/LG) and Pin 3 (diagnostic monitor reference ground). If the air bag diagnostic monitor measures a difference of more than 2.0 ohms between Pin 20 and Pin 3, it will flash out code 44.

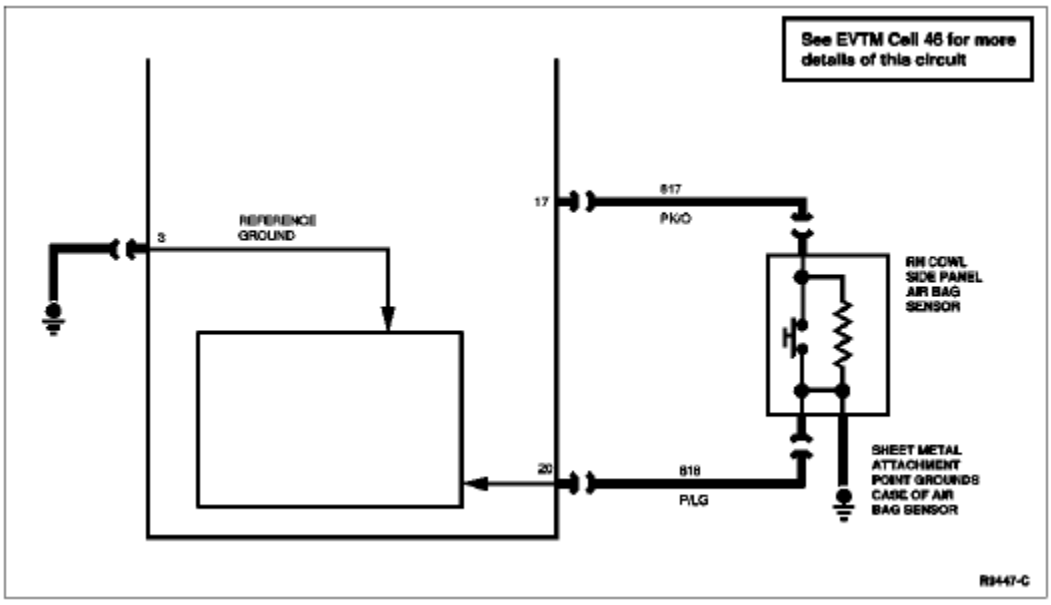
Note that Circuit 618 (P/LG) is attached to the side case of the RH cowl side trim panel front air bag sensor and bracket. In addition, the case is grounded to the vehicle.

Possible Causes

High Resistance on Pin 20 (Circuit 618, P/LG) to ground can be caused by:

1. A poor connection due to loose mounting, dirt, or corrosion at the mounting location in the RH cowl side trim panel front air bag sensor and bracket.
2. An open or damaged wire in Circuit 618 (P/LG) from Pin 20 of the diagnostic monitor harness connector to RH cowl side trim panel front air bag sensor and bracket.
3. An open wire or loose Circuit 618 (P/LG) wire attachment inside RH cowl side trim panel front air bag sensor and bracket.

RH Primary Crash Sensor Not Mounted to Vehicle Properly



44-1 CHECK FOR DTC 44

- Turn ignition switch lock cylinder to ON.
- Count diagnostic trouble code (if any).

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Is code 44 flashing?

Yes	No
GO to 44-2 .	READ the normal operation description for this diagnostic trouble code. EXAMINE the diagnostic trouble code schematic and look for areas where intermittent problems would occur (connectors, splices, crimps, etc.). Do not proceed with Pinpoint Test until the code is flashing! Failure to do so will result in needless replacement of the air bag system components and repeat repairs.

44-2 DEACTIVATE SYSTEM

- Deactivate system (leave battery positive cable disconnected).
- Disconnect air bag diagnostic monitor.
- Set Rotunda 73 Digital Multimeter 105-R0051 or equivalent, on the lowest ohm scale possible (200 ohms).
- Zero ohmmeter. RECORD resistance reading with the two leads together.
- Measure the resistance between Pin 20 and Pin 3 (ground).

Is the resistance greater than 2 ohms?

Yes	No
GO to 44-3 .	REPLACE air bag diagnostic monitor. RECONNECT system. VERIFY system. REACTIVATE system.

44-3 CHECK RH COWL SIDE PANEL AIR BAG SENSOR GROUND

- Disconnect the cowl side panel (RH) front air bag sensor and bracket from the harness.
- Measure the resistance between the P/LG "ground" wire in the sensor connector and a nearby, "good", chassis ground (make sure this ground is clean and bare).

Is the resistance less than 2 ohms?

Yes	No
INSPECT circuit between Pin 20 and the sensor. CHECK all terminal crimps, interconnections and splices for four connections. SERVICE any poor connections. RECONNECT system. VERIFY system. REACTIVATE system.	REMOVE screws retaining sensor. CLEAN mounting surface of sensor chassis. REMOUNT sensor. TIGHTEN screws to 10.0-14.0 Nm (7-10 lb-ft). GO to 44-4 .

44-4 MEASURE RESISTANCE OF SENSOR TO GROUND.

- Measure the resistance between the P/LG "ground" wire in the sensor connector and the chassis

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ground.

Is the resistance less than 2 ohms?

Yes	No
RECONNECT system. VERIFY system. REACTIVATE system.	REPLACE RH cowl side panel front air bag sensor and bracket. RECONNECT system. VERIFY system. REACTIVATE system.

PINPOINT TEST 45: CENTER PRIMARY CRASH SENSOR NOT MOUNTED TO VEHICLE PROPERLY (CODE 45)

Normal Operation

The air bag diagnostic monitor measures the resistance between Pin 21 (Circuit 620, P/LB) and Pin 3 (diagnostic monitor reference ground). If the air bag diagnostic monitor measures a difference of more than 2.0 ohms between Pin 21 and Pin 3, it will flash out code 45.

Note that Circuit 620 (P/LB) is attached to the side case of the center air bag sensor and bracket. In addition, the case is grounded to the vehicle.

Note that Circuit 620 (P/LB) is spliced into another wire going to Pin 22 of the air bag diagnostic monitor. Note also that Circuit 620 (P/LB) passes through an in-line connector between the main instrument panel harness and the engine compartment harness that connects to the center air bag sensor and bracket.

Possible Causes

High resistance on Pin 21 (Circuit 620, P/LB) to ground can be caused by:

1. A poor connection due to loose mounting, dirt, or corrosion at the mounting location of the center air bag sensor and bracket.
2. An open or damaged wire in Circuit 620 (P/LB) from Pin 21 of the diagnostic monitor harness connector to center air bag sensor and bracket. This includes splices and in-line connectors.
3. An open wire or loose Circuit 620 (P/LB) wire attachment inside center air bag sensor and bracket.

Center Radiator Primary Crash Sensor Not Mounted to Vehicle Properly

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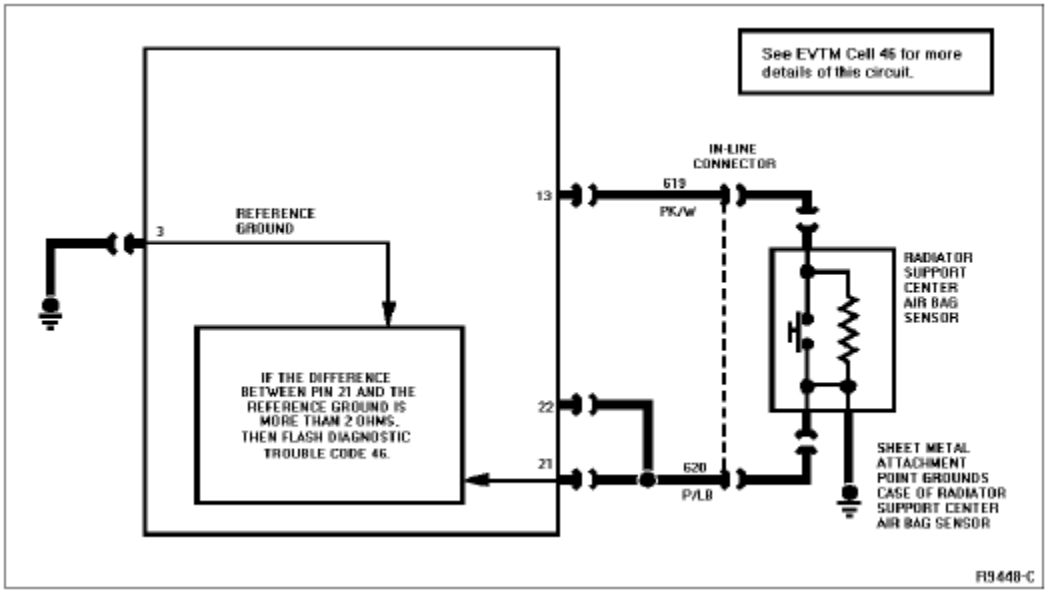

45-1 CHECK FOR DTC 45

- Turn ignition switch lock cylinder to ON.
- Count diagnostic trouble code (if any).

Is code 45 flashing?

Yes	No
GO to 45-2 .	READ the normal operation description for this diagnostic trouble code. EXAMINE the diagnostic trouble code schematic and look for areas where intermittent problems would occur (connectors, splices, crimps, etc.). Do not proceed with pinpoint tests until the code is flashing! Failure to do so will result in needless replacement of the air bag system components and repeat repairs.

45-2 DEACTIVATE SYSTEM

- Deactivate system (leave positive battery cable disconnected).
- Disconnect air bag diagnostic monitor.
- Set Rotunda 73 Digital Multimeter 105-R0051 or equivalent on the lowest ohm scale possible (200 ohms).
- Zero ohmmeter. Record resistance reading with the two leads together.
- Measure the resistance between Pin 21 and Pin 3 (ground).

Is the resistance greater than 2 ohms?

Yes	No

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GO to **45-3** .	REPLACE air bag diagnostic monitor.

45-3 CHECK CENTER AIR BAG SENSOR GROUND

- Disconnect the center air bag sensor and bracket from the harness.
- Measure the resistance between the P/LB "ground" wire in the sensor connector and a nearby, "good", chassis ground (make sure this ground is clean and bare.)

Is the resistance less than 2 ohms?

Yes	No
INSPECT circuit between Pin 21 and the sensor. CHECK all interconnects and splices for poor connections. SERVICE any poor connections. RECONNECT system. VERIFY system. REACTIVATE system.	REMOVE screws retaining sensor. CLEAN mounting surface of sensor and chassis. REMOUNT sensor. TIGHTEN screws to 10.0-14.0 Nm (7-10 lb-ft). GO to **45-4** .

45-4 MEASURE RESISTANCE OF SENSOR TO GROUND

- Measure the resistance between the P/LB "ground" wire in the sensor connector and the chassis ground.

Is the resistance less than 2 ohms?

Yes	No
RECONNECT system. VERIFY system. REACTIVATE system.	REPLACE center air bag sensor and bracket. RECONNECT system. VERIFY system. REACTIVATE system.

PINPOINT TEST 46: OPEN SPLICE CENTER AIR BAG SENSOR GROUND MONITOR (CODE 46)

Normal Operation

The air bag diagnostic monitor measures the resistance between Pin 22 (Circuit 620 P/LB) and Pin 3 (diagnostic monitor reference ground). If the air bag diagnostic monitor measures a difference of more than 2.0 ohms between Pin 22 and Pin 3, it will flash a code 46.

- Pin 22 is used in a three air bag sensor system as the third sensor ground monitor. In this case Pin 22 is spliced into the center radiator crash ground monitor of the center air bag sensor and bracket, because only two sensors are used.

Possible Causes

High resistance on Pin 22 (Circuit 934 "BR") to ground can be caused by:

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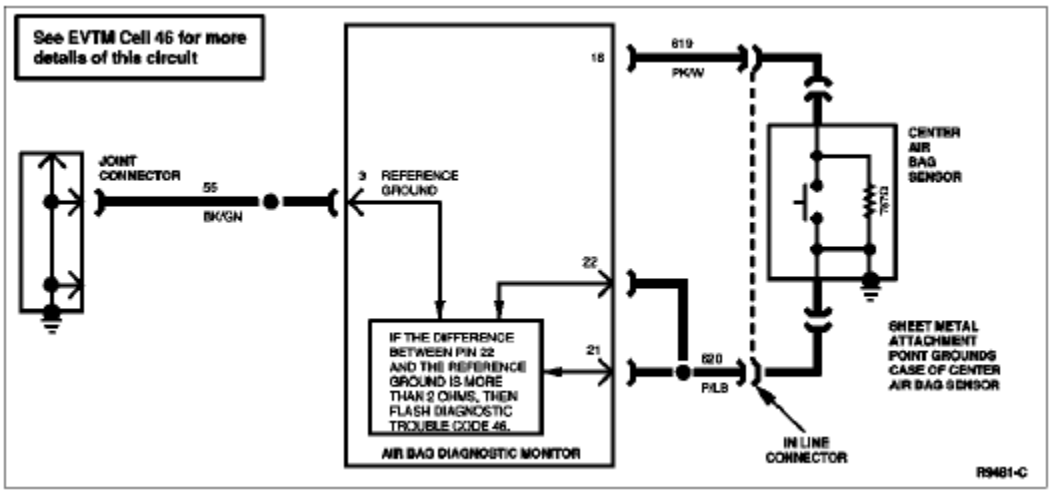
1. An open or damaged wire in Circuit 620 P/LB from Pin 22 of the diagnostic monitor harness connector to the splice which joins it to the P/LB wire coming from Pin 21.

Open Splice Center Air Bag Sensor Ground Monitor



46-1 CHECK FOR DTC 46

- Turn ignition switch lock cylinder to ON.
- Count diagnostic trouble code (if any).

Is code 46 flashing?

Yes	No
GO to **46-2** .	READ the normal operation description for this diagnostic trouble code. EXAMINE the diagnostic trouble code schematic and look for areas where intermittent problems would occur (connectors, splices, crimps, etc.). Do not proceed with pinpoint tests until the code is flashing! Failure to do so will result in needless replacement of the air bag system components and repeat repairs.

46-2 DEACTIVATE SYSTEM

- Deactivate system. Make sure positive battery cable is disconnected.
- Disconnect air bag diagnostic monitor.
- Set Rotunda 73 Digital Multimeter 105-R0051 or equivalent on lowest ohm scale (200 ohms).
- Zero ohmmeter, (record resistance value with the two leads together).
- Measure resistance across Pin 22, (Circuit 620, P/LB) and Pin 3, (Ground).

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Is resistance greater than 2 ohms?

Yes	No
SERVICE 620 P/LB splice where Pin 22 connects with Pin 21 of air bag diagnostic monitor. RECONNECT system. VERIFY system. REACTIVATE system.	REPLACE air bag diagnostic monitor. RECONNECT system. VERIFY system. REACTIVATE system.

Air Bag Diagnostic Monitor Internal Thermal Fuse — Fuse Blown Due to Intermittent Short to Ground

Normal Operation

NOTE: The air bag diagnostic monitor contains an internal thermal fuse that is not serviceable. The thermal fuse is controlled by a computer inside the air bag diagnostic monitor. The computer will blow the thermal fuse whenever a short on the deployment circuits occurs. The thermal fuse does not blow because of excessive current flowing through it. DO NOT attempt to jumper out the thermal fuse with a circuit breaker or any other type of fuse.

NOTE: DO NOT install a new air bag diagnostic monitor until the short has been located and corrected. If a short to ground has not been located and corrected, then the short to ground is intermittent and IS NOT PRESENT AT THIS TIME. Installing a new air bag diagnostic monitor with an intermittent short in the system will result in blown air bag diagnostic monitors and repeat repairs.

The air bag diagnostic monitor measures the voltages at the diagnostic monitor connector pins. When certain air bag deployment wires are shorted to ground (heavy lines illustrated in the schematic below), the supplemental air bag restraint system may become susceptible to unwanted deployment of the air bag(s). The air bag diagnostic monitor senses a short to ground on any of these circuits and helps prevent unwanted air bag deployant by blowing the diagnostic monitor thermal fuse. Blowing this fuse removes all power (battery and back-up power) from the air bag deployment circuits. While the short to ground exists, the monitor will flash code 13. If the short to ground is intermittent and temporarily corrects itself, the air bag diagnostic monitor will flash code 51.

NOTE: If the short to ground returns, the high priority code 13 will flash instead of 51.

If the air bag indicator is flashing code 51 and a short to ground has not been serviced, this means that an intermittent short to ground exists in the supplemental air bag restraint system. The air bag diagnostic monitor should be replaced only after repairs to the intermittent short have been completed.

Some service tips for finding an intermittent short to ground are:

1. Consult OASIS (Restraint Systems Service Code 104000) for up-to-date diagnostics and descriptions of wiring concern locations for the vehicle (VIN number) you are working on. OASIS is updated daily using concern descriptions from engineering and Dealership Service sources.

2. Inspect wiring and harness in areas where they pass through or are located next to metal components (i.e., engine compartment bulkhead, body sheet metal, component mounting brackets, etc.).

Code 51 After Air Bag Deployment

Occasionally, immediately after an air bag deploys, the internal wiring of the driver side air bag module may become shorted to the metal housing of the driver side air bag module. This internal driver side air bag module short in driver side air bag module is detected by the air bag diagnostic monitor as short to ground in

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the air bag deployment wiring. Since the air bag diagnostic monitor is still operating immediately after most deployments, the monitor will detect the shorted wiring and will flash code 13 and blow the internal thermal fuse. After the deployment, as the air bag cools off, the internal shorted wiring may correct itself, therefore the short to ground will no longer exist and the air bag diagnostic monitor will flash code 51. If a vehicle with a deployed air bag is flashing code 51, inspect and replace all the damaged areas of the vehicle with crushed wiring, sensors, etc. If no damage is found, assume that the deployed air bag was the cause for the intermittent short and replace the air bag diagnostic monitor when the new driver side air bag module is installed.

NOTE: Air bag diagnostic monitors can withstand several air bag deployments and do not need to be replaced after every deployment. Only replace the air bag diagnostic monitor if it is damaged.

Code 51 Sequence of Events

1. Short to ground occurs on one or more of the circuits shown in heavy lines in the schematic.

2. The air bag diagnostic monitor recognizes the shorted wiring and flashes out a diagnostic trouble code 13 and sends a signal to the internal thermal fuse, causing it to blow.

3. The air bag diagnostic monitor will continue to flash code 13 while the short to ground is present. If the short to ground goes away, a Diagnostic Trouble Code 51 appears.

4. The air bag diagnostic monitor only flashes a code 51 when the thermal fuse is blown and the short to ground is not present. Do not replace the air bag diagnostic monitor until the short to ground has been located and serviced. Consult OASIS for shorted wiring information.

Air Bag Diagnostic Monitor Internal Fuse Blown and Short to Ground No Longer Exists

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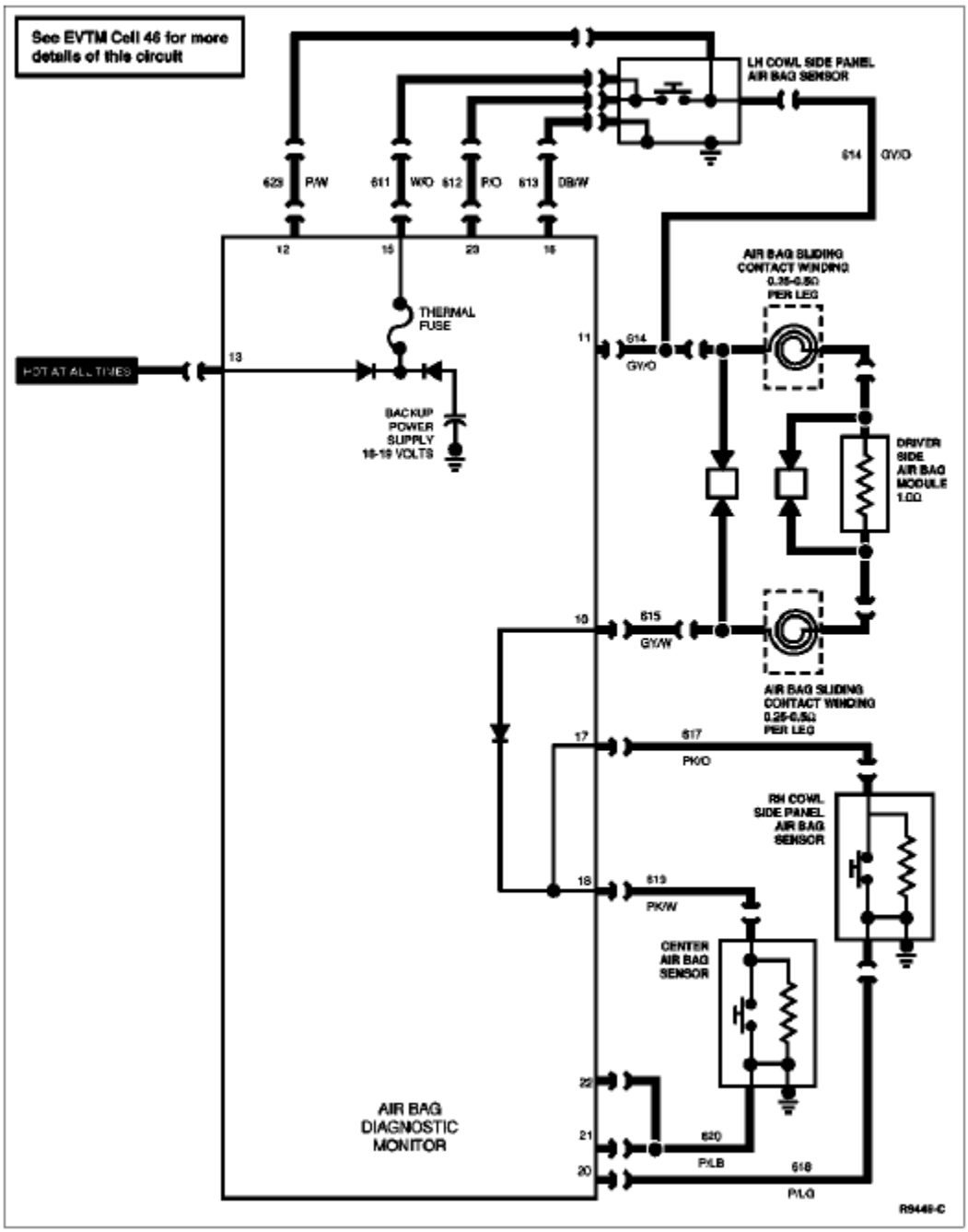

PINPOINT TEST 52: BACKUP POWER SUPPLY— VOLTAGE BOOST FAULT (CODE 52)

Normal Operation

A backup power supply is contained within the air bag diagnostic monitor that consists of four capacitors and a voltage boost circuit. The voltage boost circuit charges the capacitors to 16-19 volts when the ignition switch is turned to RUN. The backup power supply is connected through a diode to Pin 15 (Circuit 611,

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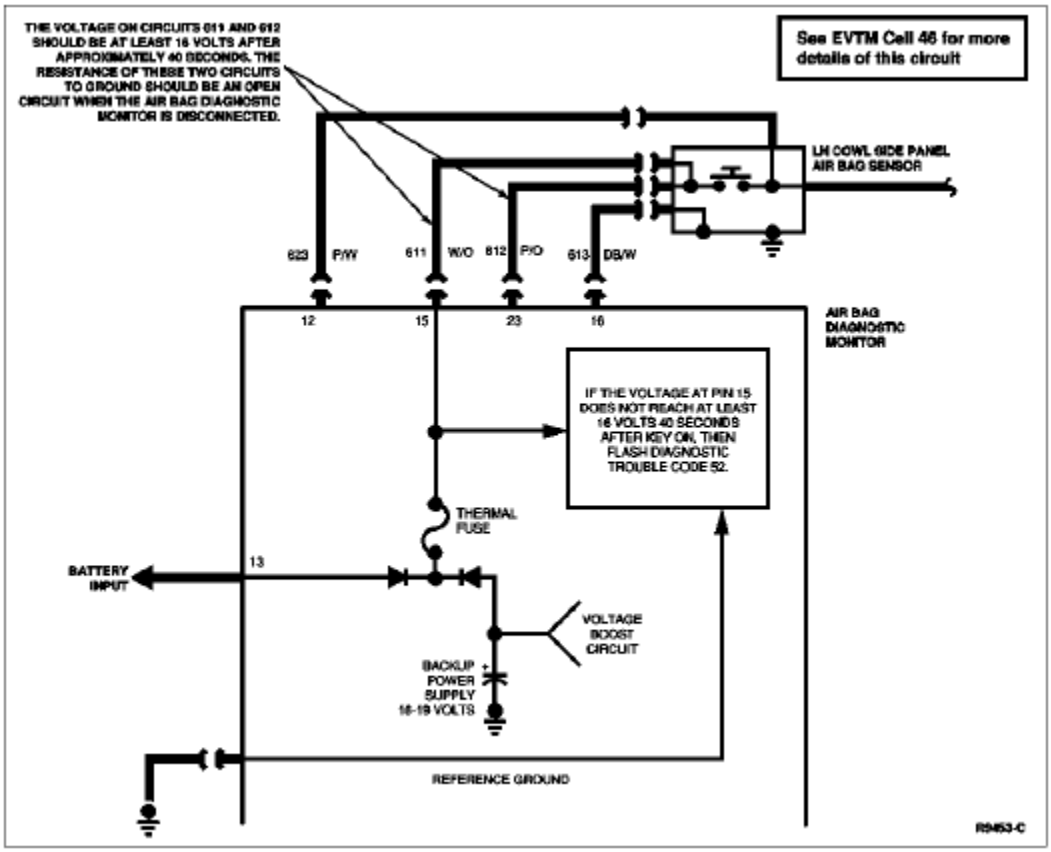
W/O) of the air bag diagnostic monitor. The resistance of Circuit 611 to ground is infinite since it is an open circuit. This open circuit allows the capacitor to maintain its higher voltage because there is no discharge path for the capacitor. The air bag diagnostic monitor measures the voltage on the backup power supply capacitors. If the voltage on the capacitors does not reach and maintain a minimum of 16 volts after approximately 30 seconds, the air bag diagnostic monitor will flash code 52 to indicate low voltage in the backup power supply voltage boost circuit.

Possible Causes

Low backup power supply voltage can be caused by:

1. Resistance on Circuit 611 (W/O) to ground. Resistance to ground on Circuit 611 or Circuit 612 (P/O) will cause the backup power supply capacitors to discharge and the boost circuit will not be able to boost the voltage.
2. Boost circuit failure within the air bag diagnostic monitor. If the voltage boost circuit in the air bag diagnostic monitor is faulty it is unable to raise backup power supply voltage on the capacitor.

Backup Power Supply Voltage Boost Fault



52-1 CHECK FOR DTC 52

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- Turn ignition switch lock cylinder to ON.
- Count diagnostic trouble code (if any).

Is code 52 flashing?

Yes	No
GO to 52-2 .	READ the normal operation description for this diagnostic trouble code. EXAMINE the diagnostic trouble code schematic and look for areas where intermittent problems would occur (connectors, splices, crimps, etc.). Do not proceed with Pinpoint Test until the code is flashing! Failure to do so will result in needless replacement of the air bag system components and repeat repairs.

52-2 DEACTIVATE SYSTEM

- Deactivate system.
- Turn ignition switch lock cylinder OFF then ON.
- Wait 30 seconds.
- Measure voltage between Pin 15 — Circuit 611 (W/O) and Pin 3 (ground).

Is the voltage measured within 16-19 volts?

Yes	No
REPLACE air bag diagnostic monitor. RECONNECT system. VERIFY system. REACTIVATE system.	GO to 52-3 .

52-3 CHECK FOR OPEN IN CIRCUIT 611

- Turn ignition switch lock cylinder off.
- Disconnect air bag diagnostic monitor.
- Set Rotunda 73 Digital Multimeter 105-R0051 or equivalent on 200,000 or auto scale.
- Measure resistance of Pin 15 — Circuit 611 (W/O) to Pin 3 (ground).

Is the resistance measured infinite (open)?

Yes	No
REPLACE air bag diagnostic monitor. RECONNECT system. VERIFY system. RECONNECT system.	GO to 52-4 .

52-4 MEASURE RESISTANCE OF CIRCUIT 611

- Disconnect the LH cowl side panel front air bag sensor and bracket.

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- Measure resistance between Pin 15 (Circuit 611, W/O) and Pin 3 (ground).

Is the resistance measured infinite (open)?

Yes	No
GO to **52-5** .	LOCATE and SERVICE the short to ground in Circuit 611, W/O. RECONNECT system. VERIFY system. REACTIVATE system.

52-5 CHECK FOR SHORT IN SENSOR

- Measure resistance of the Circuit 611 (W/O) wire in the LH cowl side panel front air bag sensor and bracket connector to sheet metal ground.

Is the resistance measured infinite (open)?

Yes	No
LOCATE and SERVICE the short to ground in Circuit 612 (P/O). RECONNECT system. VERIFY system. REACTIVATE system.	REPLACE LH cowl side panel front air bag sensor and bracket. RECONNECT system. VERIFY system. REACTIVATE system.

PINPOINT TEST 53: PRIMARY CRASH SENSOR CIRCUITS RESISTANCE TO GROUND OR AIR BAG DIAGNOSTIC MONITOR FAULT

Normal Operation

The air bag diagnostic monitor performs several self-tests every time the ignition switch is turned on. If any of these tests fail, the air bag diagnostic monitor will flash code 53.

Possible Causes

1. Internal self-test failure on air bag diagnostic monitor.

53-1 CHECK FOR DTC 53

- Turn ignition switch lock cylinder to ON.
- Count diagnostic trouble code (if any).

Is code 53 flashing?

Yes	No
REPLACE air bag diagnostic monitor.	READ the normal operation description for this diagnostic trouble code. EXAMINE the diagnostic trouble code schematic and LOOK for areas where intermittent problems would

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RECONNECT system. VERIFY system. REACTIVATE system.	occur (connectors, splices, crimps, etc.). Do not proceed with pinpoint tests until the code is flashing. Failure to do so will result in needless replacement of the air bag system components and repeat repairs.

Rapid Continuous Flashing of Air Bag Indicator (No Diagnostic Trouble Code), All Primary Crash Sensors Disconnected

Normal Operation

Each sensor has two wires. One wire is used for air bag deployment and monitoring the sensor's connection to the air bag diagnostic monitor (see Code 41 diagnosis for details). The other wire is used for monitoring the mounting (ground) of the sensor to sheet metal (see Code 44 and Code 45 diagnosis for details). If the code 41 diagnosis reveals the sensors are not connected **AND** if the code 44 and 45 diagnosis reveals that sensors are not properly grounded, then the air bag diagnostic monitor will flash the air bag indicator continuously at a fast rate.

Possible Causes

Rapid continuous flashing of the air bag indicator can be caused by:

1. Both the center air bag sensor and bracket and RH cowl side panel front air bag sensor and bracket are disconnected from the wiring harness or main wiring is not connected with engine control sensor wiring (12A581).

   A thermal fuse is built into the air bag diagnostic monitor. If a short to ground should occur in the air bag deployment circuit, the microcomputer in the air bag diagnostic monitor will send a signal to the fuse causing it to open. The open fuse removes all firing power (battery/backup power) from the deployment circuits. This prevents unwanted air bag deployments due to damaged vehicle wiring.

   Code 51 is displayed whenever the diagnostic monitor thermal fuse is open and no other higher priority faults exist (consult Diagnostic Trouble Code Priority Table). Code 51 is normally seen after service of a code 13 condition.

   If a code 51 exists and a code 13 condition has not been serviced, this means an **intermittent** short to ground exists in the air bag deployment wiring. The intermittent short to ground must be located and serviced before servicing the code 51 condition.

   Since the thermal fuse is built into the air bag diagnostic monitor, the monitor must be replaced to service a code 51 condition. NEVER replace the air bag diagnostic monitor without first determining the cause for the code 51 condition. If the short to ground is not properly serviced, the short may reoccur, once again destroying the thermal fuse in the air bag diagnostic monitor.

   Rapid Continuous Flashing

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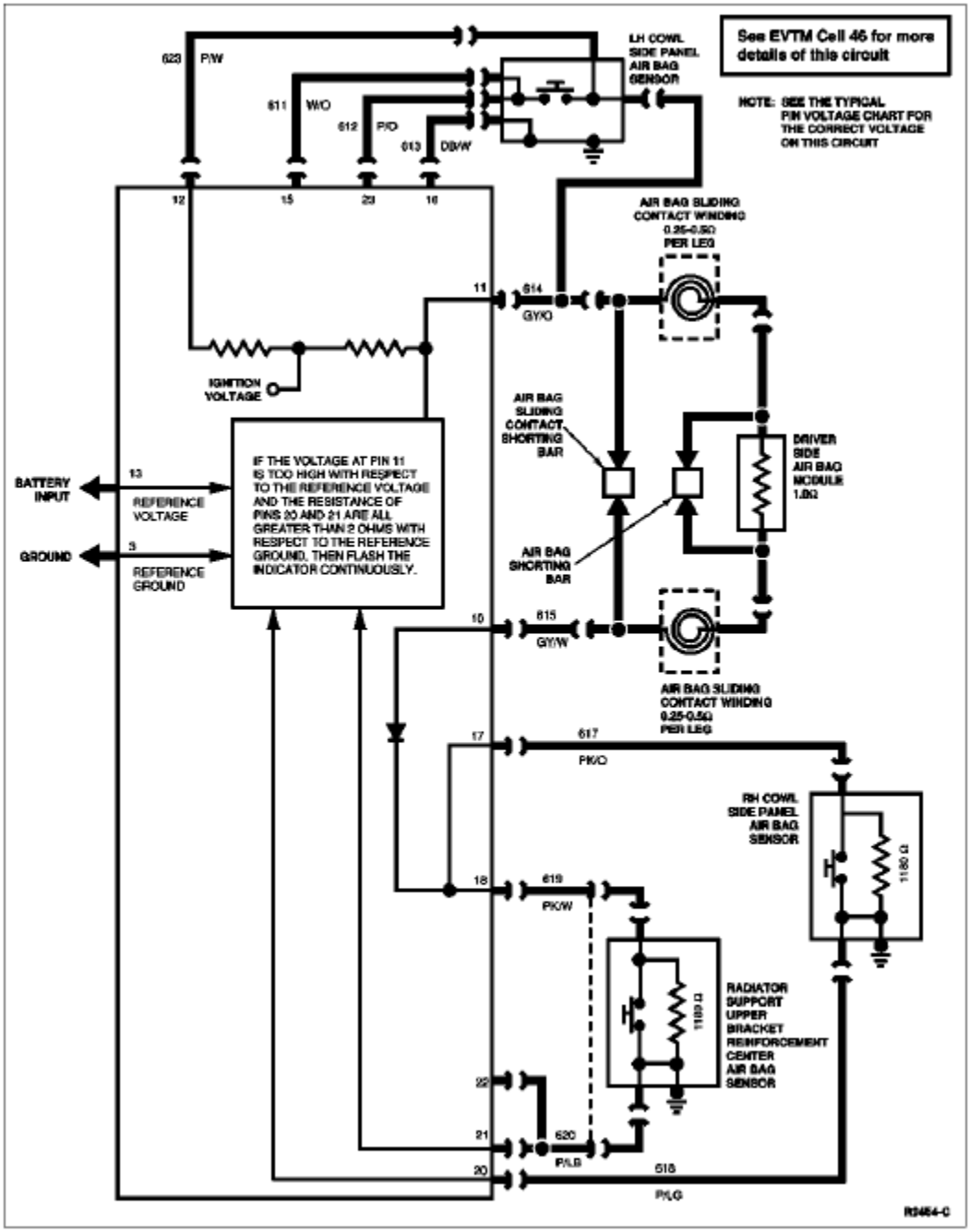

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Sensor, Right Cowl Side Panel

Removal and Installation

1. **WARNING: THE ELECTRICAL CIRCUIT NECESSARY FOR SYSTEM DEPLOYMENT IS POWERED DIRECTLY FROM THE BATTERY AND BACKUP POWER SUPPLY. TO AVOID ACCIDENTAL DEPLOYMENT AND POSSIBLE PERSONAL INJURY, THE BATTERY POSITIVE CABLE MUST BE DISCONNECTED PRIOR TO SERVICING OR REPLACING ANY SYSTEM COMPONENTS.**

   NOTE: To service stripped screws retaining front air bag sensor and bracket (14B004), replace screws with N802455-S190. Tighten to 13-17 Nm (10-13 lb-ft).

   Disconnect battery positive cable and wait one minute for backup power supply energy to be depleted.

   - When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.

2. Remove cowl side panel (02038) RH. Refer to Section 01-05B .
3. Disconnect wiring connector on RH cowl side panel front air bag sensor and bracket from connector on main wiring (14401).
4. Remove connector locator from cowl side panel.
5. Remove two screws retaining front air bag sensor and bracket to cowl side panel RH.
6. Remove front air bag sensor and bracket.

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Sensor and Bracket, Center

Removal and Installation

WARNING: THE ELECTRICAL CIRCUIT NECESSARY FOR SYSTEM DEPLOYMENT IS POWERED DIRECTLY FROM THE BATTERY AND BACKUP POWER SUPPLY. TO AVOID ACCIDENTAL DEPLOYMENT AND POSSIBLE PERSONAL INJURY, THE BATTERY POSITIVE CABLE MUST BE DISCONNECTED FOR ONE MINUTE PRIOR TO SERVICING OR REPLACING ANY SYSTEM COMPONENTS.

NOTE: To service stripped screws retaining center air bag sensor and bracket (14B006), replace screws with N802455-S190. Tighten to 13-17 Nm (10-13 lb-ft).

1. Disconnect battery positive cable and wait one minute for backup power supply energy to be depleted.

    - When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.

2. Disconnect electrical connectors on center air bag sensor and bracket from engine control sensor wiring (12A581).

3. Remove two wiring locators on the radiator upper support bracket reinforcement and one connector locator from LH headlamp opening panel.

4. Remove two screws retaining center air bag sensor and bracket to radiator support upper bracket reinforcement.

Center Air Bag Sensor and Bracket

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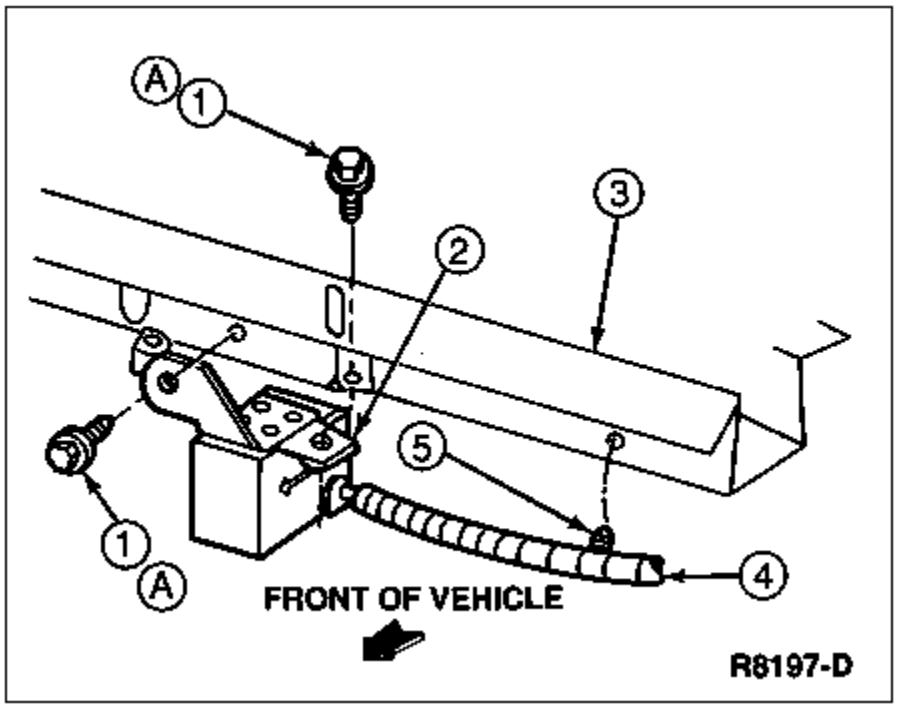

Item	Part Number	Description
1	N806327-S190	Screw
2	14B006	Center Air Bag Sensor and Bracket
3	8C241	Radiator Support Upper Bracket Reinforcement
4	12A581	Engine Control Sensor Wiring
5	—	Locator (Part of 12A581)
A	—	Tighten to 10-14 Nm (7-10 Lb-Ft)

5. Remove center air bag sensor and bracket.

   For installation, follow removal procedures in reverse order.

   - Tighten retaining screws on center air bag sensor and bracket to 10-14 Nm (89-124 lb-in).
   - Turn ignition switch lock cylinder (11582) ON and observe air bag indicator for system prove out.

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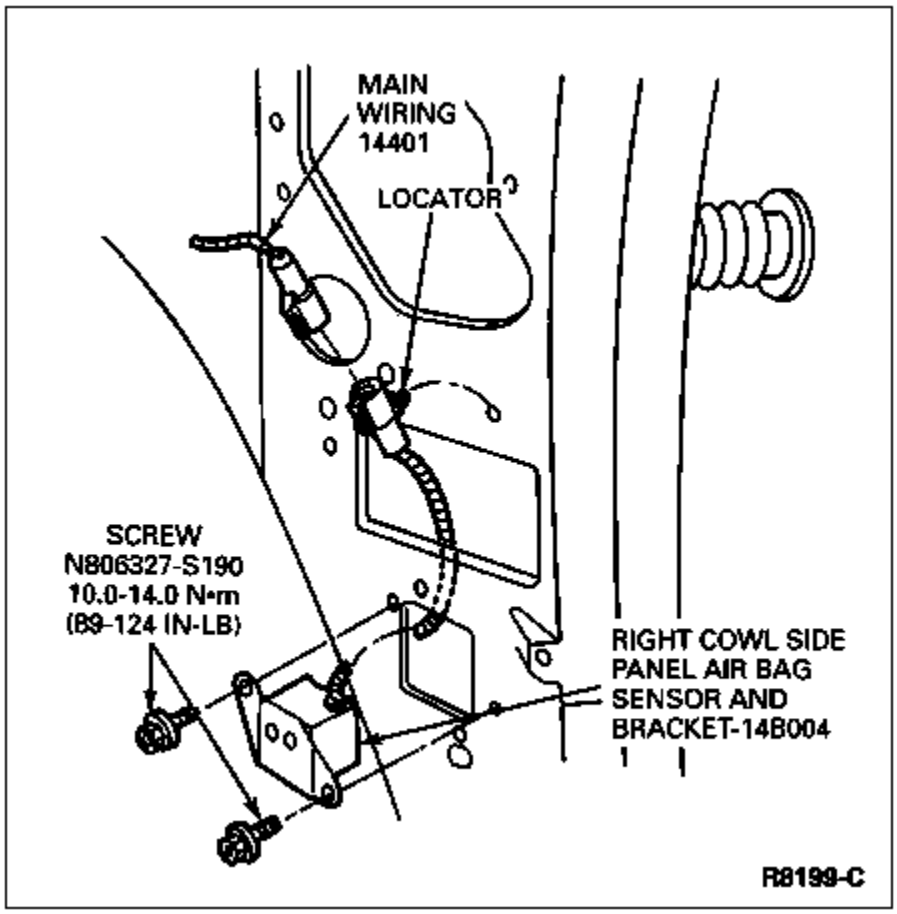

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Sensor, Left Cowl Side Panel (Safing Sensor)

Removal and Installation

1. **WARNING: THE ELECTRICAL CIRCUIT NECESSARY FOR SYSTEM DEPLOYMENT IS POWERED DIRECTLY FROM THE BATTERY AND BACKUP POWER SUPPLY. TO AVOID ACCIDENTAL DEPLOYMENT AND POSSIBLE PERSONAL INJURY, THE BATTERY POSITIVE CABLE MUST BE DISCONNECTED FOR ONE MINUTE PRIOR TO SERVICING OR REPLACING ANY SYSTEM COMPONENTS.**

   NOTE: To service stripped screws retaining LH cowl side front air bag sensor and bracket (14B005), replace old screws with N802455-S190. Tighten to 13-17 Nm (10-13 lb-ft).

   Disconnect battery positive cable and wait one minute for backup power supply to be depleted.

   - When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.

2. Remove cowl side panel (02039) LH. Refer to Section 01-05B .

3. Disconnect connector on front air bag sensor and bracket from wiring connector on main wiring (14401).

4. Remove connector locator from cowl side panel.

5. Remove two screws retaining front air bag sensor and bracket to cowl side panel LH.

6. Remove front air bag sensor and bracket.

For installation, follow removal procedures in reverse order.

- Tighten retaining screws to 10-14 Nm (89-124 lb-in).
- Run system prove out check.

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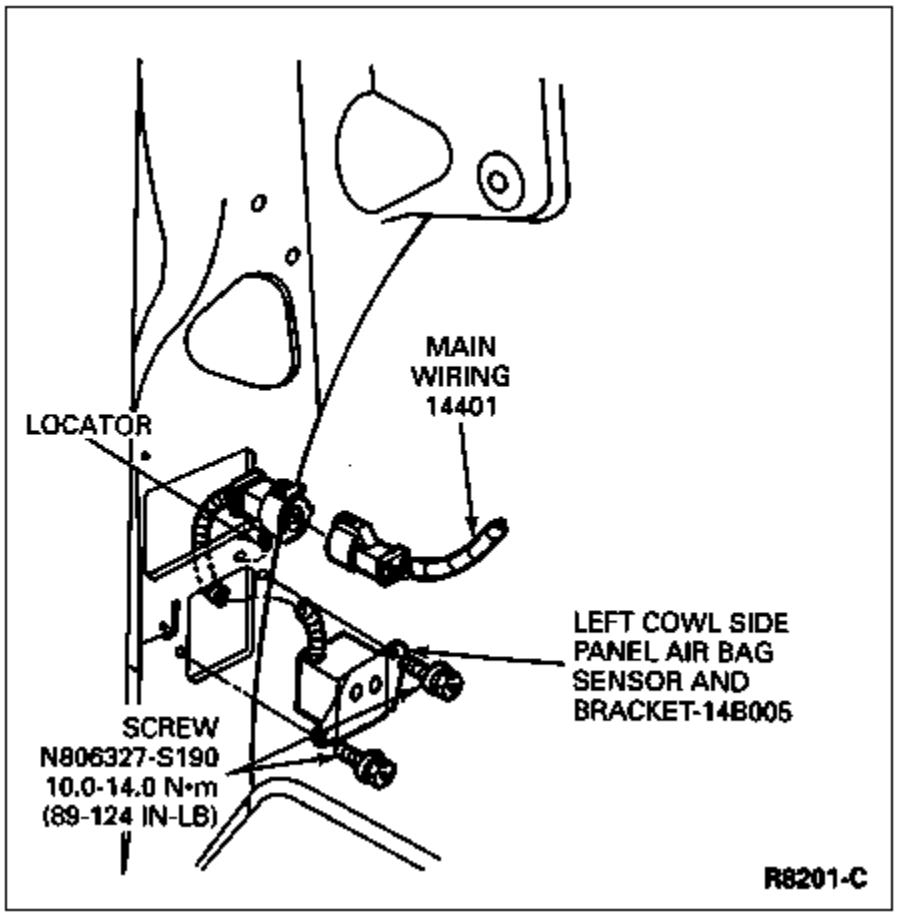

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Diagnostic Monitor, Air Bag

CAUTION: When servicing the air bag diagnostic monitor (14B056) with a blown internal fuse (diagnostic trouble code 51), find and repair all wire damage or shorts. A blown air bag diagnostic monitor can be used to find electrical faults without replacing components unnecessarily. The Diagnosis and Testing portion of this section is written to give safety first priority.

The following steps may be taken to find the cause that initiated a blown fuse:

1. Verify the system using the old air bag diagnostic monitor and verify the wiring repairs success before proceeding. Repeat as many times as required.
2. Replace the air bag diagnostic monitor when all wire repairs are complete.
3. If the diagnostic trouble code returns after making all wiring repairs, then replace the indicated component.

Removal and Installation

1. **WARNING: THE ELECTRICAL CIRCUIT NECESSARY FOR SYSTEM DEPLOYMENT IS POWERED DIRECTLY FROM THE BATTERY AND BACKUP POWER SUPPLY. TO AVOID ACCIDENTAL DEPLOYMENT AND POSSIBLE PERSONAL INJURY, THE BATTERY POSITIVE CABLE MUST BE DISCONNECTED FOR ONE MINUTE PRIOR TO SERVICING OR REPLACING ANY SYSTEM COMPONENTS.**

   Disconnect battery positive cable and wait one minute for backup power supply energy to be depleted.
2. Locate air bag diagnostic monitor beneath and to the left of the steering column and disconnect the two connectors.
3. Depress tabs retaining air bag diagnostic monitor to air bag monitor bracket (14B058). Slide air bag diagnostic monitor off air bag monitor bracket.
4. Disconnect wiring connectors on air bag diagnostic monitor. Remove air bag diagnostic monitor.

For installation, follow removal procedures in reverse order.

- Run system prove out check.

Air Bag Diagnostic Monitor

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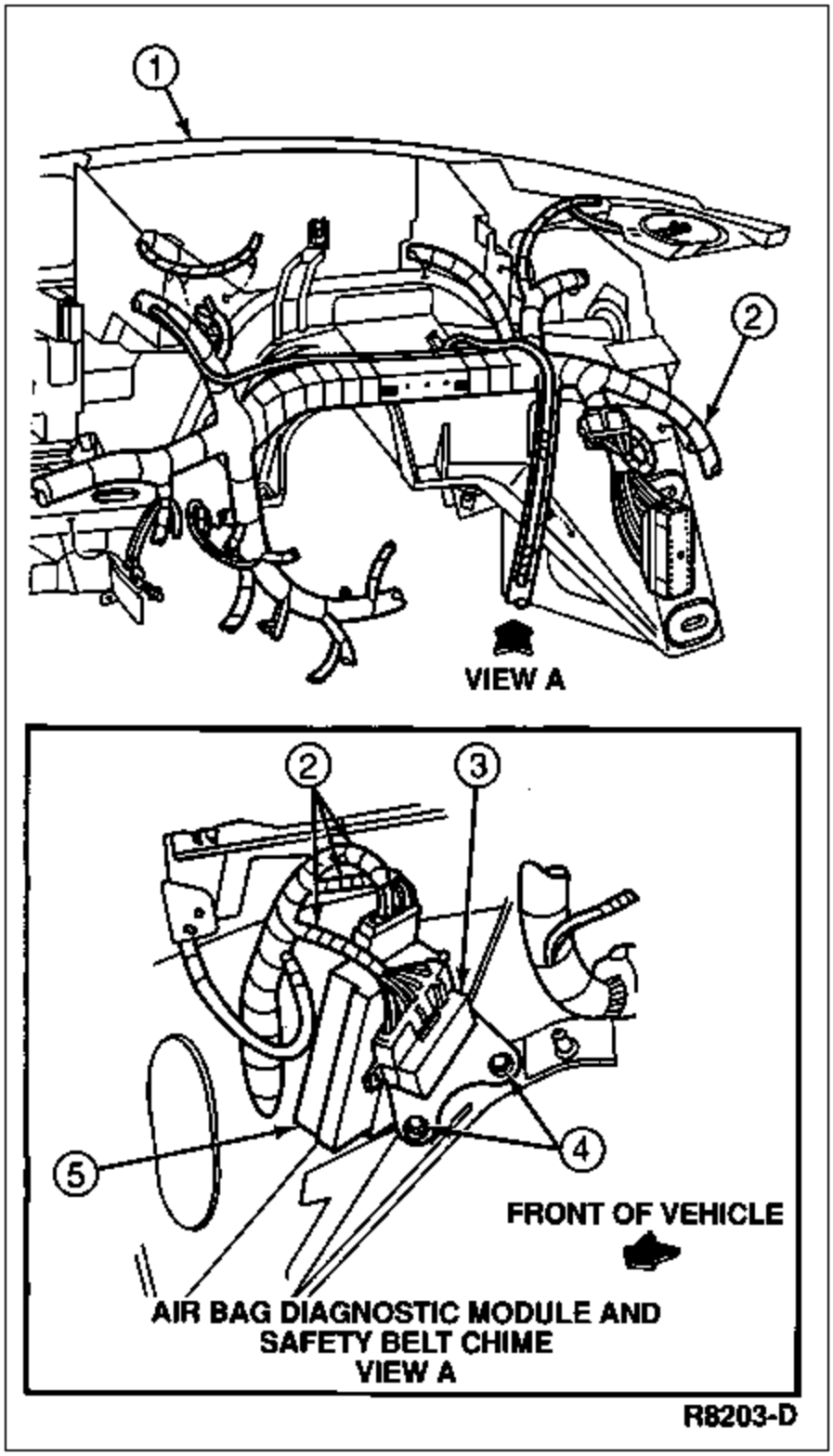

Item	Part Number	Description
1	04320	Instrument Panel (Rear View)
2	14401	Main Wiring

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3	10D840	Safety Belt Warning Chime
4	N806339-S2	Screws
5	14B056	Air Bag Diagnostic Monitor

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Module, Driver Side Air Bag

NOTE: In general, if the air bag did not deploy in an accident, it was not needed. Complete all diagnosis procedures before replacing any air bag system component.

Removal

WARNING: THE ELECTRICAL CIRCUIT NECESSARY FOR SYSTEM DEPLOYMENT IS POWERED DIRECTLY FROM THE BATTERY AND BACKUP POWER SUPPLY. TO AVOID ACCIDENTAL DEPLOYMENT AND POSSIBLE PERSONAL INJURY, THE BATTERY POSITIVE CABLE MUST BE DISCONNECTED FOR ONE MINUTE PRIOR TO SERVICING OR REPLACING ANY SYSTEM COMPONENTS.

1. Disconnect battery positive cable and wait one minute for backup power supply energy to be depleted.

2. Remove four nut and washer assemblies retaining driver side air bag module (043B13) to steering wheel (3600).

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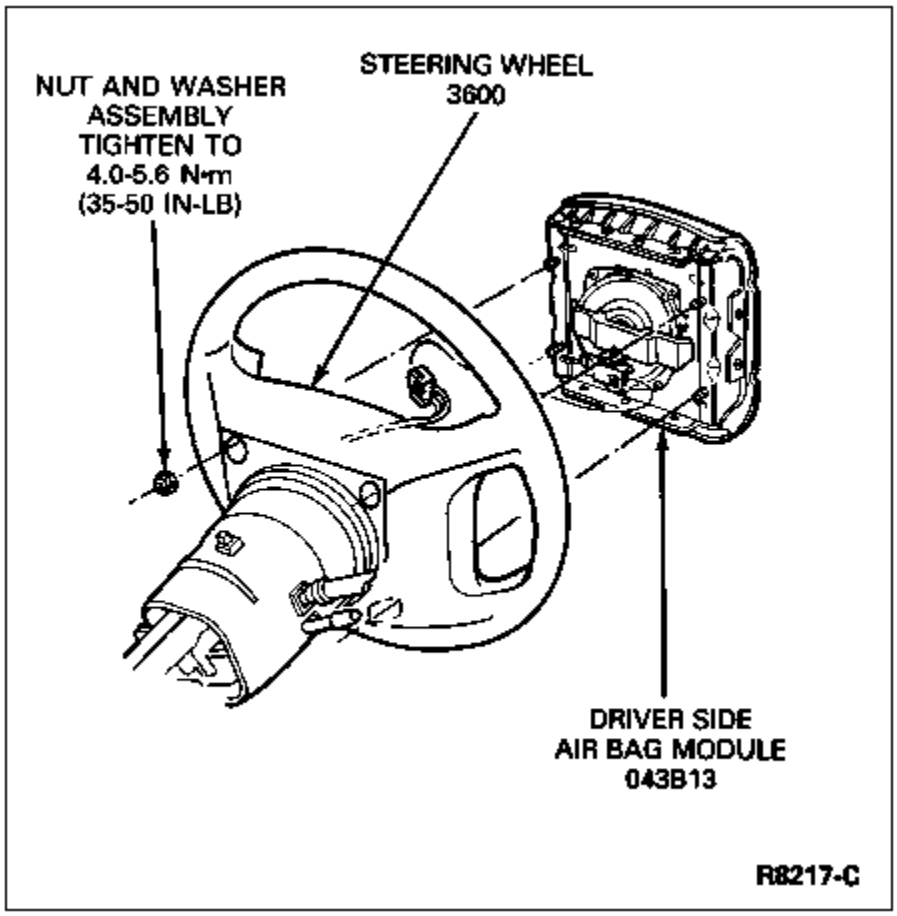

3. Disconnect the electrical connector on driver side air bag module from connector on air bag sliding contact (14A664).

4. **WARNING: AFTER REMOVING DRIVER SIDE AIR BAG MODULE , PLACE ON BENCH WITH TRIM COVER FACING UP.**

   Remove driver side air bag module.

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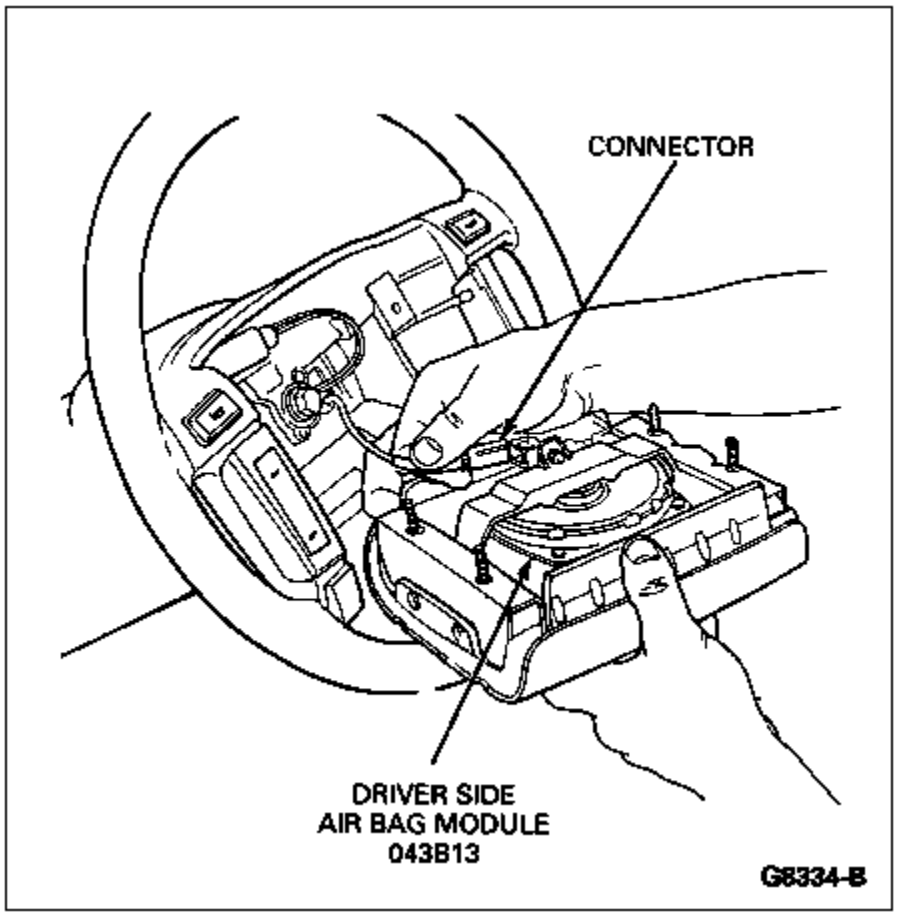

Installation

1. Fill out the traceability postcard supplied with the new driver side air bag module and return it to Ford Motor Company. Note the diagnostic trouble code.

2. Connect driver side air bag module wiring connector to connector on air bag sliding contact.

3. Position driver side air bag module to steering wheel and secure with four nut and washer assemblies. Tighten to 4-6 Nm (36-53 lb-in).

4. Connect battery positive cable.

    - When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650)

5. Turn ignition switch (11572) to ON position. Allow system to perform self-test.

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Sliding Contact, Air Bag

For the air bag sliding contact removal and installation procedures, refer to Section 11-04B .

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SPECIFICATIONS

MAJOR SYSTEM COMPONENT PART NUMBERS

Part Number	Component
043B13	Driver Air Bag Module
14B006	Sensor and Bracket Assembly, Front Center
14B005	Sensor and Bracket Assembly, Left Cowl Side Panel
14B004	Sensor and Bracket Assembly, Right Cowl Side Panel
14B056	Air Bag Diagnostic Monitor

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Driver Air Bag Module-to-Steering Wheel Nuts	4-6	—	36-53
Center Air Bag Sensor-to-Radiator Support Screws	10-14	7-10	—
Front Air Bag Sensor-to-Left Cowl Side Panel Screws	10-14	7-10	—
Front Air Bag Sensor-to-Right Cowl Side Panel	10-14	7-10	—
Replacement for Stripped Sensor Retaining Screws	13-17	10-13	—
Air Bag Slide Contact Screws	2-3	18-26	

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Frame and Crossmembers

WARNING: BEFORE REMOVAL OF ANY FRAME OR CROSSMEMBER COMPONENT BE SURE ANY ATTACHED OR SUPPORTED COMPONENT IS SECURELY HELD IN PLACE. OTHERWISE VEHICLE DAMAGE OR TECHNICIAN INJURY COULD RESULT FROM THESE COMPONENTS SHIFTING OR FALLING.

Removal

1. Raise vehicle and support on safety stands, Rotunda 077-00018 or equivalent.
2. Remove any attachment fasteners as required. If component to be removed is held in place by rivets, drill out rivet head using the appropriate size drill bit. Drive the remainder of the rivet out with a hammer and drift.
3. Remove component.

Installation

To install component, follow removal steps in reverse order. Make sure any replacement rivets are securely fastened.

Frame Inspection

Frame misalignment is the result of damaged or loose frame components.

Before checking frame alignment, inspect the frame (5005) for damage and loose parts. Inspect all frame members for cracks or bends. Check all welded connections for cracks. Inspect all rivets, bolts, and body support brackets for looseness. Make all necessary repairs or replacements.

Diagonal or X-Frame Checking Method

Alignment can be checked without removing the vehicle body from the frame (5005) by using the diagonal or X checking method.

This method should be used to identify misalignment prior to any attempt to straighten a frame.

1. Place the vehicle on a clean, level floor and set the parking brake.

2. Select at least four points along one frame side rail (5015) and very carefully transfer these points to the floor with a plumb bob. If desired, paper can be taped on the floor along both sides of the vehicle below the frame. Mark the point on the floor as accurately as possible.

3. Locate the corresponding points along the opposite frame side rail and very carefully transfer these points to the floor in the same manner.

4. Move the vehicle away from the marks on the floor, and measure between diagonal points. Both corresponding measurements should be equal within 6.35mm (1/4 inch). Measure diagonally between all points on the floor.

5. Measure between the corresponding points parallel to the frame side rail. These measurements should be within 6.36mm (1/4 inch) of each other.

   The squareness of the frame side rail web and the lower flanges at the spring hangers should be within 1.59mm (1/16 inch). The squareness of the side member web at the steering gear mounting location should be within 1.59mm (1/16). The web and the flange should be square at all other points within 3.18mm (1/8 inch).

   Any point on one sidemember should be within 3.18mm (1/8 inch) ahead, behind, above, or below the corresponding point on the opposite frame side rail. The frame side rail should not be bowed more than 3.18mm (1/8 inch) for each 2540mm (100 inches) of frame length. The overall width of frame should not vary more than 3.18mm (1/8 inch). The frame and frame side rail web and flanges should be square to each other and within 3.18mm (1/8 inch).

Misalignment Check, Unitized Body, Aerostar

To align or square up a body, take two opposite diagonal measurements between pillars. Use a measuring tram for these measurements. Take the measurements between reference points such as crease lines or weld joints which are diagonally opposite each other on the two pillars being measured. Since all measurements should be made from the bare metal, remove all interior trim from the checking points.

In some cases, it is difficult to obtain proper body alignment when repairing a body that is damaged on both sides. In these cases, horizontal and vertical measurements can be taken from a body of the same body style. Once these basic dimensions are taken and established on the damaged body, alignment can be made by diagonal measurements taken from points on two pillars.

Do not attempt to correct any serious misalignment with one jacking operation. This is particularly true if other sections of the body also require aligning. Align each section proportionately until the proper dimensions are obtained.

Door openings are checked in the same manner as the body. Horizontal, vertical, and diagonal checking points are established on all four sides of the door opening that is being measured.

Frame Service

Drilling Precautions

Do not drill holes in the flanges, since this tends to reduce the strength of frame (5005). Do not drill holes and/or attach any aftermarket components to the boxed, convoluted area of the frame side rails (5015) between thefront crossmember (5019) andfront bumper (17757) attachment.

NOTE: The following recommendations for straightening, reinforcement, and weld attachment DO NOT APPLY to the boxed, convoluted area of the frame side rails between the front crossmember and front bumper attachment (front frame horns). Repair of collision damage to this area of the frame will require installation of the appropriate frame repair kit.

Welding Precautions

CAUTION: Disconnect thebattery ground cable (14301) before using any electric welding equipment.

All frame welding should be done with a MIG welder, Rotunda 106-00052 or equivalent, and the heat should be kept in a small area to prevent change in metal hardness. **Do not apply heat to or weldframes without using a reinforcement on the repaired area. When a reinforcement is welded to a side member, run the welds lengthwise along the reinforcement.**

After any welding operation is complete, the welded area should be allowed to cool naturally.

Frame Straightening

Misalignment can be corrected by straightening the out-of-line parts or by replacing the crossmembers, braces, or brackets if they are badly damaged.

Straightening should be attempted onframes that fail to meet specification of the diagonal checking method or where damage is visually apparent.

CAUTION: If heat is to be used to assist in frame straightening, a protective welding blanket should be used to protect adjacent areas.

To prevent internal stresses in the metal, straightening should be limited to parts which are not severely bent. **If heat is needed to straighten a frame member, keep the temperature below 649°C (1200℉) (a dull red glow). Excessive heat may weaken the metal and cause permanent damage.** A temperature-sensitive thermal melt crayon should be used to monitor heat buildup. After any heat is applied to frame members, they should be allowed to cool naturally.

Frame Reinforcing

After a bent frame member has been straightened, inspect it closely for cracks. If any cracks show, the frame member should be reinforced or replaced.

Reinforcements can be made from channel, angle, or flat stock. The reinforcement stock should be of the same material and the same thickness as the frame member being reinforced and should extend a minimum

of 152mm (6 inches) to either side of the crack. SAE 1008/1010 (Low Carbon) Steel is recommended for reinforcements. Material specification for frame side rails is ESA-M1A35-C and for crossmembers and gussets is ESA-M1A33-C.

Weld Attachment

To make sure the repair is sound, the crack should be prepared before the reinforcement is welded to a cracked frame member. **The cracked area should be wire brushed to remove paint and expose the crack.** To prevent the crack from spreading, drill a 6.35mm (1/4-inch) hole at the root of the crack. Grind out the crack to form a V-shaped slot which will allow proper weld penetration.

The appropriate location of the reinforcement depends upon the location of the crack. If the crack is at the bottom of the channel, the reinforcement should be welded to the channel bottom. If the crack extends along the side of the channel, an additional reinforcement should be welded to the side. Drill clearance holes in the reinforcements to clear rivet and bolt heads when necessary.

Frame Member Replacement

If a damaged frame member is to be replaced, new bolts and Grade 8 fasteners required for replacement of parts should be of the same specification as the original bolts. In cases where it is necessary to substitute a bolt for a rivet, use the next larger size bolt.

The following chart lists recommended replacement specifications.

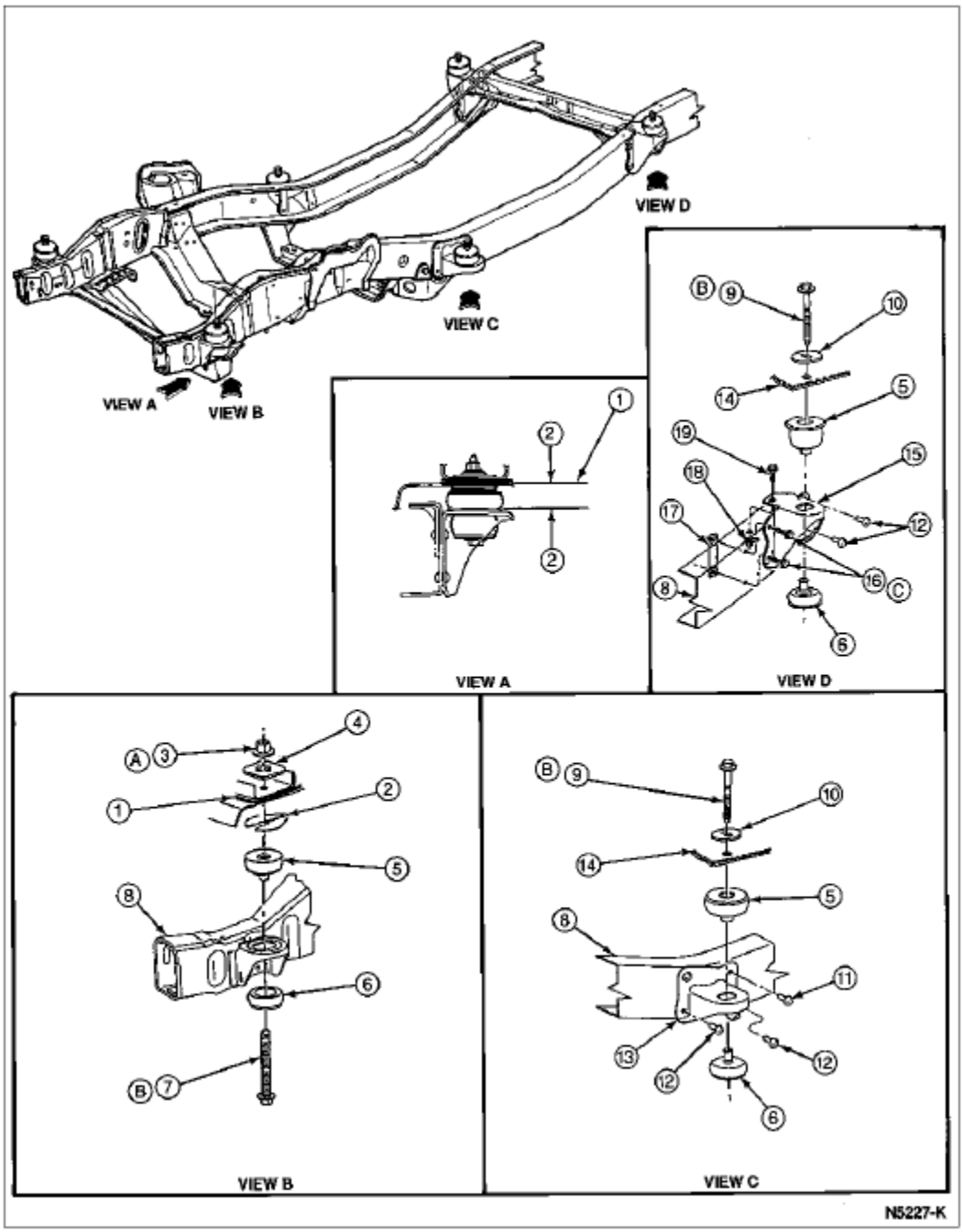
Frame Member Replacement Bolt Selection Chart

Rivet Diameter	Bolt Size	Bolt Part Number	Washer Part Number	Nut Part Number	Torque Specification
3/8 Inch and 10mm	7/16-14x1.25	56561-S2	Not Required	382400-S2	45-68 Nm (33-50 Lb-Ft)
3/8 Inch and 10mm	7/16-14x1.75	56563-S2	Not Required	382400-S2	45-68 Nm (33-50 Lb-Ft)
7/16 Inch	1/2-13x1.5 (Grade 5)	56783-S100	Not Required	33773-S2	72-102 Nm (53-75 Lb-Ft)
7/16 Inch	1/2-13x2.0 (Grade 8)	58677-S2	44879-S2	33773-S2	102-142 Nm (75-105 Lb-Ft)

Body Insulators

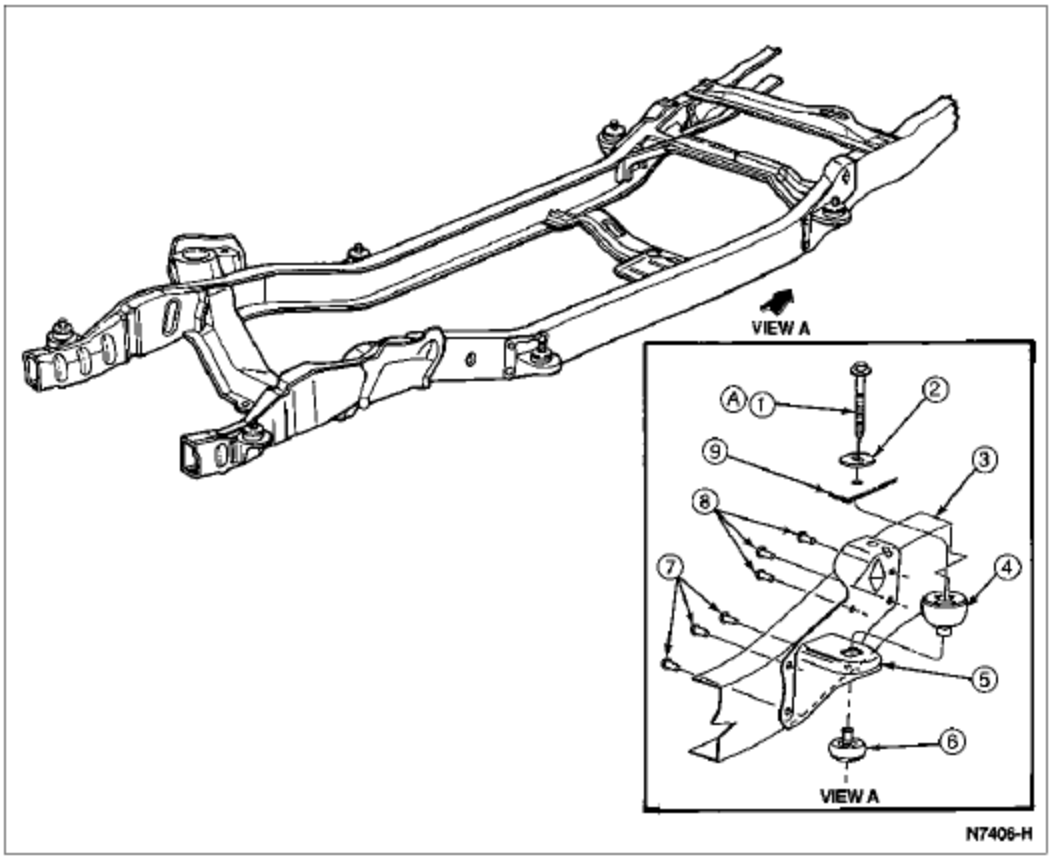
The body insulators are shown in the following illustrations.

Body to Frame Insulators, Ranger Regular Cab



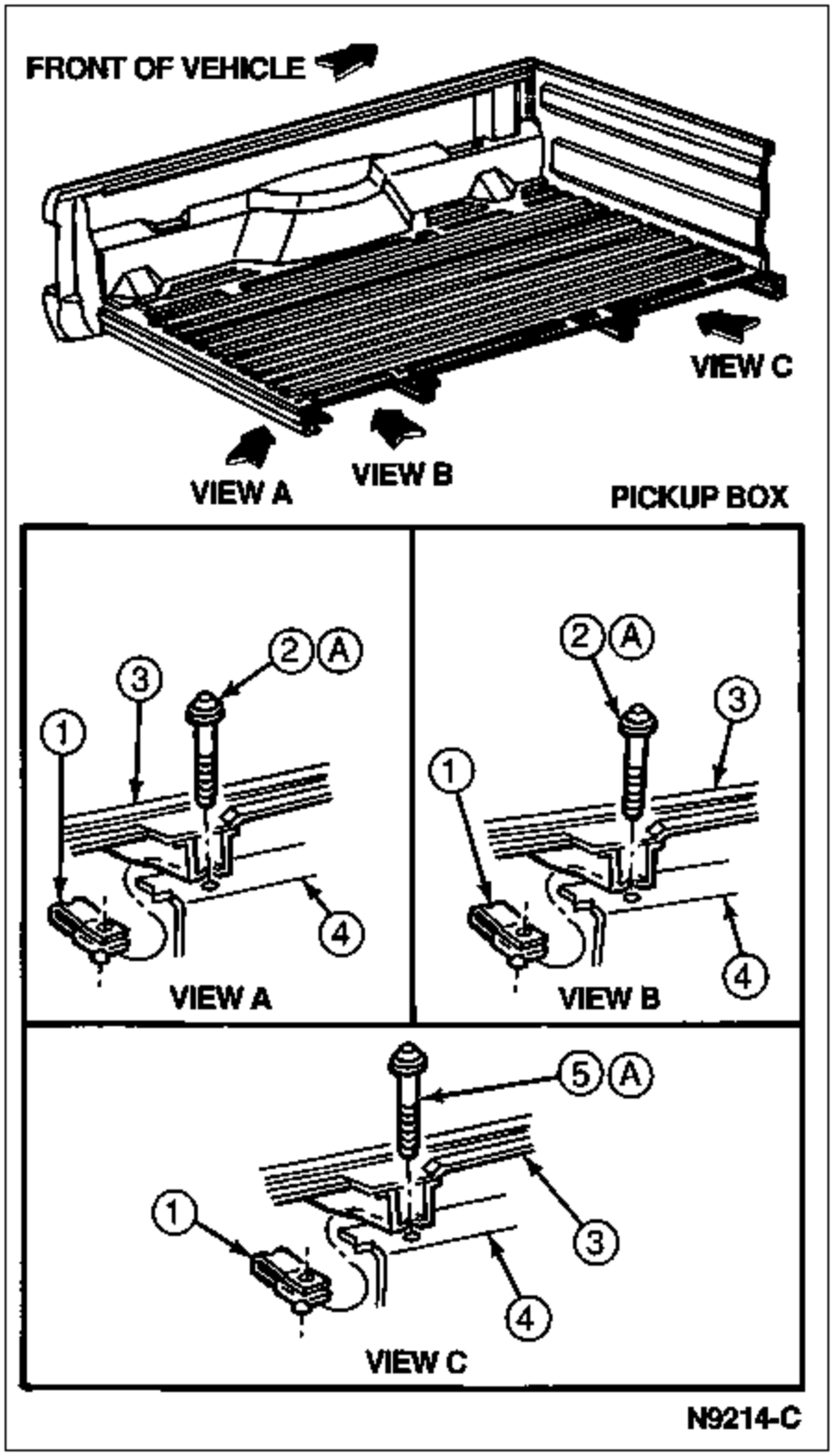
Item	Part Number	Description
1	8A297	Radiator Support
2	1000145	Split Shim
3	N621946-S2	Nut and Washer
4	N800788-S2	Spacer
5	1000192	Upper Insulator Assembly
6	1000193	Lower Insulator Assembly
7	N800442-S2	Bolt
8	—	Frame Rail (Part of 5005)
9	N807248-S100	Bolt and Washer
10	N802289-S2	Washer
11	N647098-S	Rivet
12	N647096-S	Rivet
13	5077	Front Bracket
14	11135	Front Floor Panel
15	5084	Rear Bracket
16	N802594-S56	Bolt
17	N803315-S2	Nut Retainer
18	N802641-S2	Nut Retainer
19	N802594-S56	Bolt
A	—	Tighten to 46-64 Nm (34-47 Lb-Ft)
B	—	Tighten to 68-92 Nm (50-68 Lb-Ft)
C	—	Tighten to 40-55 Nm (30-40 Lb-Ft)

Body to Frame Insulators, Ranger SuperCab



Item	Part Number	Description
1	N807248-S100	Bolt and Washer
2	N802289-S2	Washer
3	—	Frame Rail (Part of 5005)
4	1000192	Upper Insulator Assembly
5	5084	Rear Bracket
6	1000193	Lower Insulator Assembly
7	65093-S	Rivet
8	65090-S	Rivet
9	11135	Front Floor Panel
A	—	Tighten to 68-92 Nm (50-68 Lb-Ft)

Pickup Box to Frame Insulators, Ranger



Item	Part Number	Description
1	N803334-S426	Nut Retainer
2	N806251-S100	Bolt

3	11215	Pickup Box
4	—	Frame Rail (Part of 5005)
5	N806252-S100	Bolt
A	—	Tighten to 53-72 Nm (39-53 Lb-Ft)

Body Insulators (Except Under Radiator Support)

Disassembly

1. Remove interior trim as required.
2. Back out body mount bolt four or five turns and strike with a hammer to drive out the lower insulator. If the body mount bolt is not long enough to drive out the lower insulator, install a longer bolt or drift, and strike with a hammer to drive out the insulator.

Assembly

1. Position the upper insulator on top of the frame (5005) or frame bracket and install any shims that were removed during disassembly.
2. Position the body on the upper insulator and install the body mount bolts.
3. Position the lower absorber assembly to the bottom of the frame or frame bracket.
4. Tighten the body mount bolts. Refer to the appropriate illustration for the correct bolt torque specification.

Body Insulators at Radiator Support

Disassembly

1. Remove nut and washer from top of radiator support.
2. Back out bolt from under lower insulator.

Assembly

1. Place upper absorber assembly on frame bracket. Replace shims that were removed during disassembly.
2. Position lower insulator on bolt and thread bolt into shaft of upper insulator. Tighten bolt to 68-92 Nm (50-68 lb-ft). Make sure upper insulator is properly seated into frame bracket.
3. Replace nut and washer on top of radiator support (body mount surface). Tighten nut to 46-64 Nm (34-47 lb-ft).

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft
Insulator Assembly Bolts Attaching Body to Frame	68-92	50-68
Insulator Assembly Nuts and Washers Attaching Radiator Support to Frame	46-64	34-47
Rear Bracket Nut Retainers and Bolts Attaching Insulator Assemblies to Frame	40-55	30-40
Nut Retainers and Bolts Attaching Pickup Box to Frame	53-72	39-53

Support Insulators, Front Engine

Removal

1. Remove the rubber overflow tube from the radiator coolant recovery reservoir (8A080) and detach it from the fan shroud (8146) (where appropriate).
2. Remove the fan shroud attaching screws and lift the fan shroud back and drape it onto the fan blade (8600).
3. Support the engine (6007) using a wood block and a jack placed under the oil pan (6675).
4. Remove the nut and washer assemblies attaching front engine support insulators (6038) to front engine support brackets (6028). Lift the engine sufficiently to disengage the front engine support insulator upper stud from the front engine support brackets (6029).
5. Remove bolt attaching fuel pump shield (9A397) to left front engine support bracket, if required.
6. Remove front engine support insulator-to-front engine support mounting brackets (6031) attaching nut and washer assembly. Remove front engine support mounting brackets assembly.

Installation

1. **NOTE: For some applications it may be necessary to remove the front engine support brackets to gain access to the lower stud nuts of the front engine support insulator.**

   Install the front engine support insulator to the front engine support mounting bracket. If front engine support mounting bracket was removed, install it to the crossmember.
2. Install the bolt attaching fuel pump shield to left front engine support bracket, if required. Tighten to specification.
3. Lower the engine until the insulator stud engages in the slot/hole of front engine support brackets. Install attaching nuts and tighten to specification. Refer to the appropriate illustration for torque specifications.
4. Remove the jack and wood block from the engine oil pan.
5. Position the fan shroud to the radiator (8005) and install the attaching screws and tighten to specifications. Refer to Section 03-03 for fan shroud torque specifications.
6. Install the radiator overflow hose (8075) to the radiator coolant recovery reservoir and attach it to the shroud (where appropriate).

Support Insulator, Rear Engine

Removal

1. Place a block of wood and a jack under the transmission (7003).
2. Remove the two nuts attaching the transmission support crossmember (6A023) to the rear frame crossmember (5035). Raise the transmission sufficiently to lift the transmission support crossmember from the rear frame crossmember.
3. Remove the two bolts attaching the transmission support crossmember to the transmission and remove the transmission support crossmember.
4. On vehicles so equipped, remove the fasteners attaching theexhaust hanger insulator (5F262) to theengine and transmission support (6F065).
5. Remove the bolts and nuts attaching the rear frame crossmember to the frame side rails (5015) and remove the rear frame crossmember if necessary.

Installation

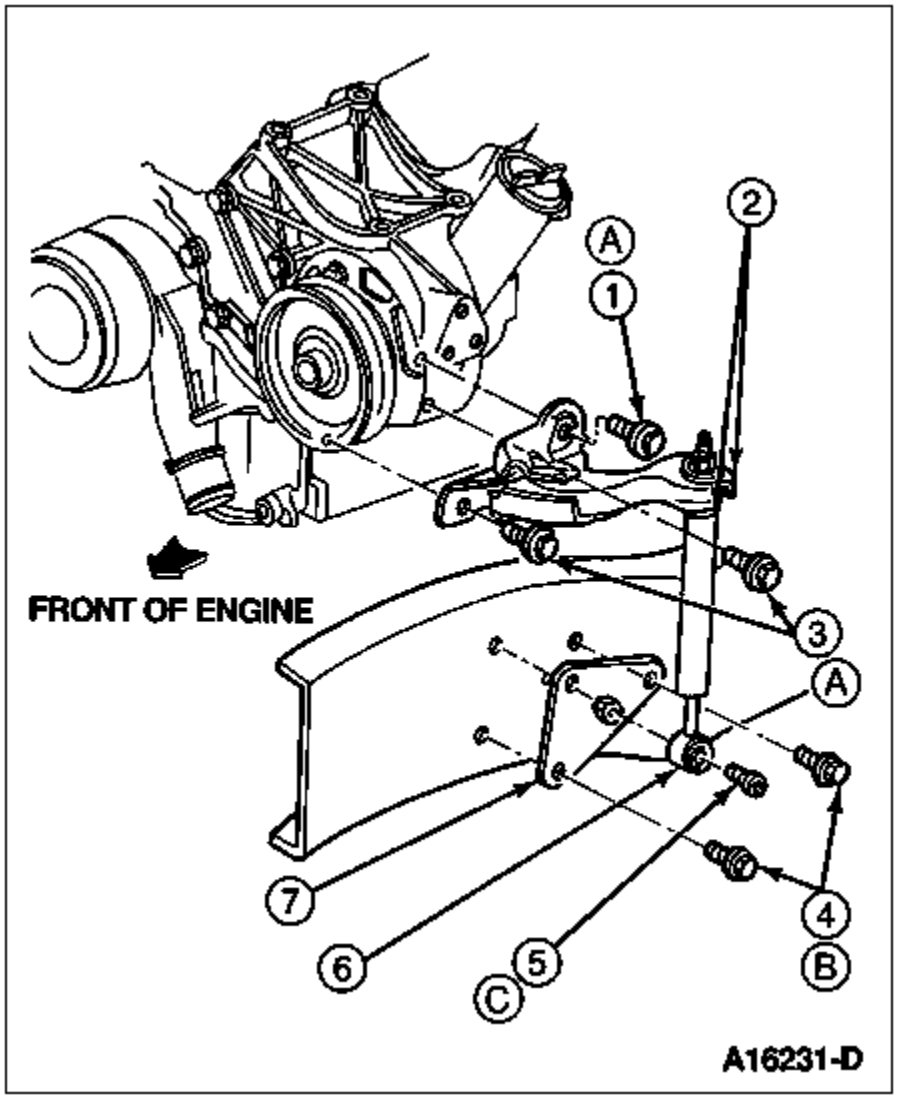
1. Position the fluid cooler inlet tube (7A030) to the transmission. Install the two attaching bolts and tighten to specification.
2. If so equipped, install the fasteners attaching the exhaust hanger insulator to the fluid cooler inlet tube. Tighten to specification listed in Section 09-00 .
3. Install the rear frame crossmember to the frame side rails. Refer to the appropriate illustration for torque specifications.
4. Lower the transmission and install the attaching nuts. Refer to the appropriate illustration for torque specifications.
5. Remove the jack and wood block from under the transmission.

Engine Damper, Ranger

Removal and Installation

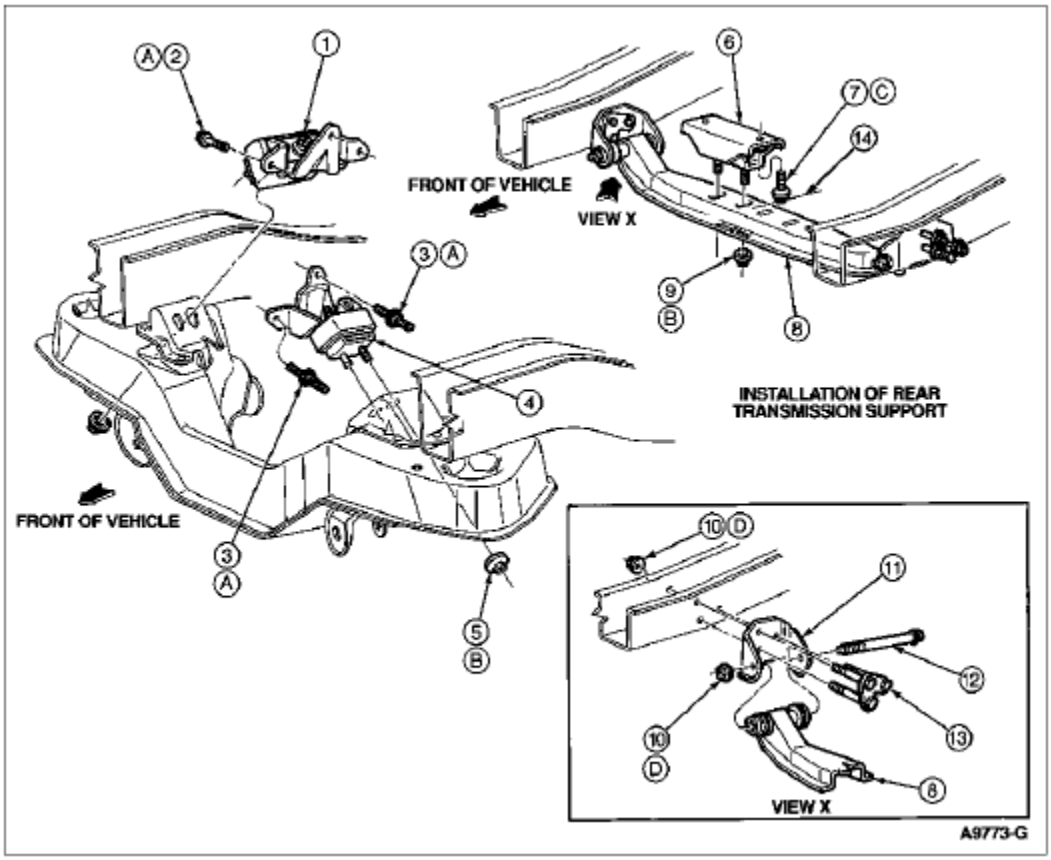
1. Remove the Torx® screw from the bottom of the engine mounting damper (6M046).
2. Remove the nut from the top damper stud and remove engine mounting damper from engine mount damper bracket reinforcement.
3. Remove attaching screws and remove engine mount damper bracket reinforcement (6F024), if required.

For installation follow removal procedures in reverse order. Refer to the following illustration for torque specifications.



Item	Part Number	Description
1	N808292	Stud
2	6M046	Engine Mounting Damper
3	N802653	Screw
4	W611645	Screw
5	N806479	Screw
6	—	White Mark at Outboard Side (Part of 6M046)
7	6F034	Engine Mount Damper Bracket Reinforcement
A	—	Tighten to 60-80 Nm (44-59 Lb-Ft)
B	—	Tighten to 47-63 Nm (35-46 Lb-Ft)
C	—	Tighten to 40-55 Nm (30-40 Lb-Ft)

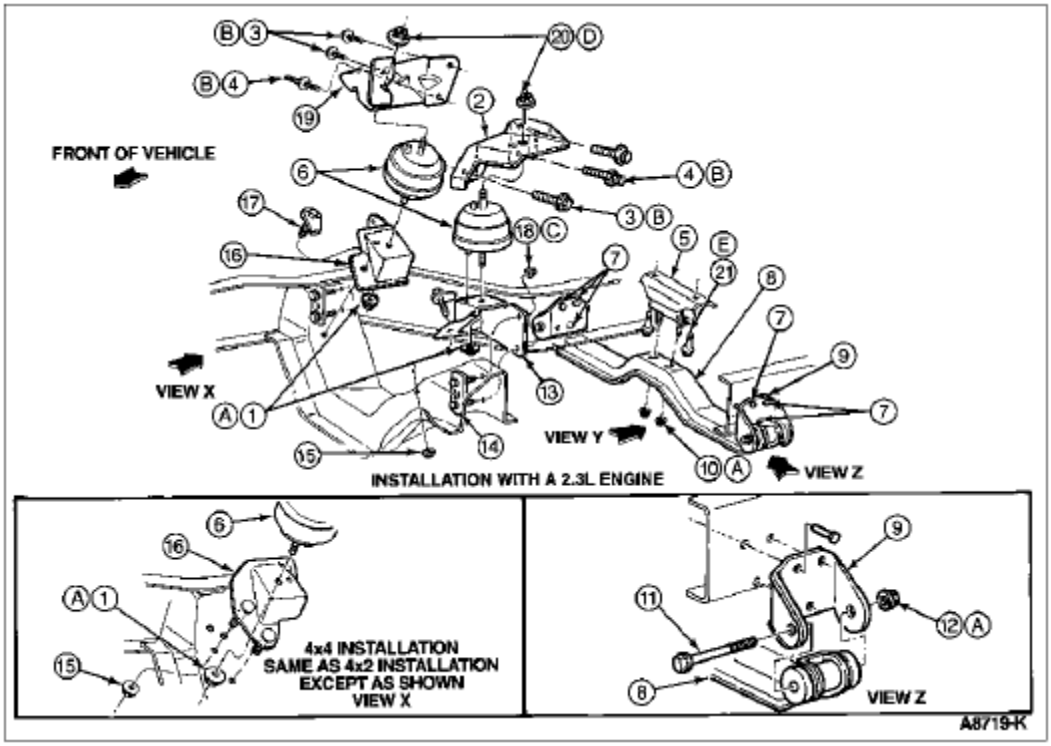
Front and Rear Engine Insulator Assemblies, Aerostar with 3.0L and 4.0L Engines



Item	Part Number	Description
1	6028	Front Engine Support Bracket and Insulator

		Assembly
2	N802653	Screw and Washer — 3 Req'd (3.0L), 4 Req'd (4.0L)
3	N804044	Stud — 3 Req'd (3.0L), 2 Req'd (4.0L)
4	6038	Front Engine Support Insulator and Bracket
5	N802330	Nut and Washer Assembly
6	6068	Transmission Support Insulator
7	390066-S2	Screw and Washer (2 Req'd)
8	6A023	Transmission Support Crossmember
9	N620483	Nut
10	N620482	Nut
11	6096	Rear Engine Support Bracket
12	N802044	Bolt
13	N803691	Bolt and Retainer
14	—	Centerline Crossmember (Part of 6A023)
A	—	Tighten to 60-81 Nm (44-60 Lb-Ft)
B	—	Tighten to 98-132 Nm (73-97 Lb-Ft)
C	—	Tighten to 77-104 Nm (57-76 Lb-Ft)
D	—	Tighten to 37-52 Nm (28-38 Lb-Ft)

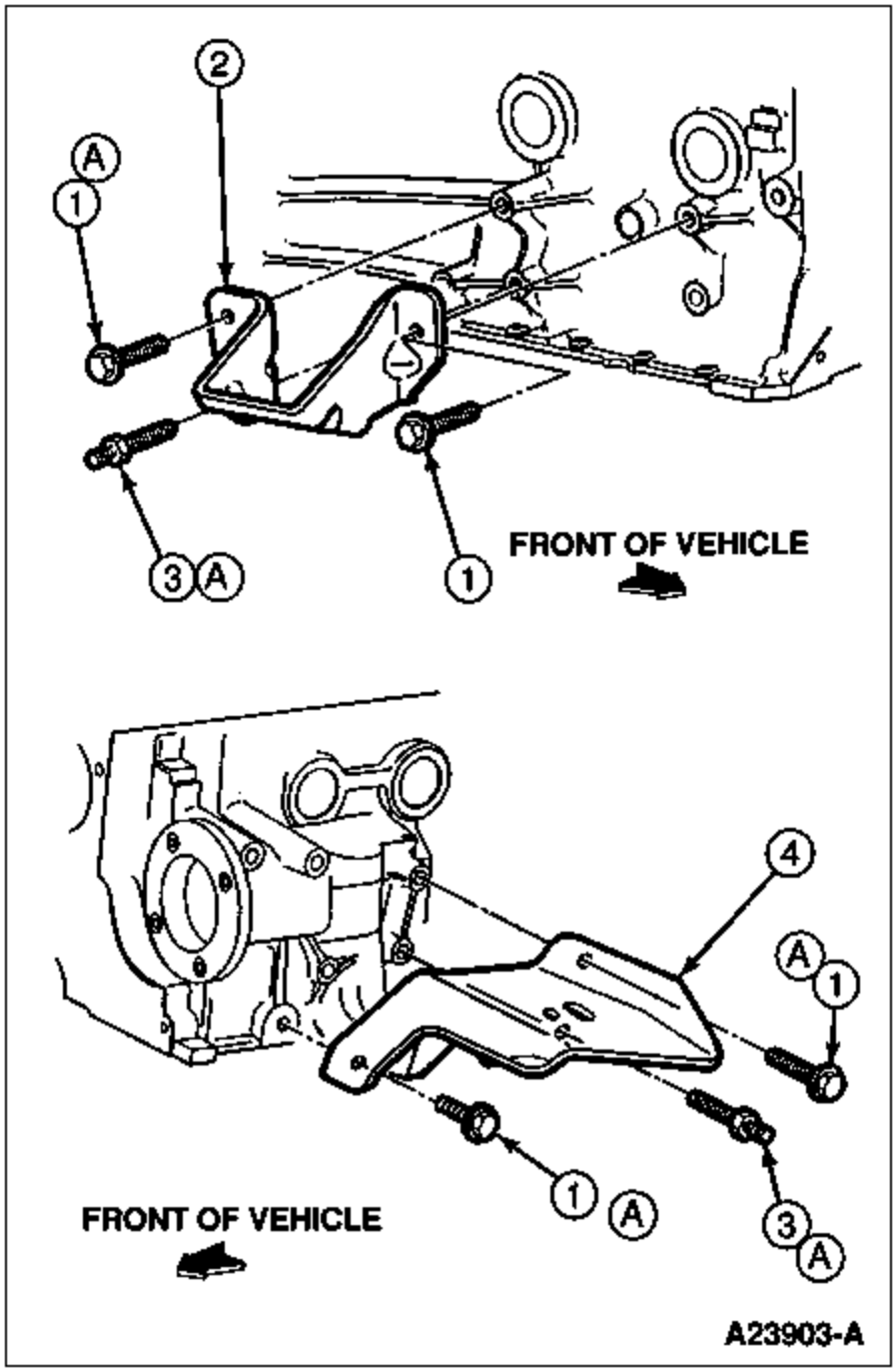
Front and Rear Engine Insulator Assemblies, Ranger with 2.3L Engine



Item	Part Number	Description
1	N801995	Nut and Washer
2	6031	Front Engine Support Mounting Bracket
3	N802653	Screw and Washer
4	N804044	Stud
5	6068	Transmission Support Insulator
6	6038	Front Engine Support Insulator
7	65092	Rivet
8	6A023	Transmission Support Crossmember
9	6096	Rear Engine Support Bracket
10	—	Nut (3 Req'd) (Part of 6068)
11	N803660	Bolt
12	N800937	Nut
13	6029	Front Engine Support Bracket (LH)
14	N807266	Bolt and Retainer
15	N802330	Nut and Washer
16	6028	Front Engine Support Bracket
17	N805420	Bolt and Retainer
18	N802073	Nut
19	6030	Front Engine Support Mounting Bracket
20	N807479-S100	Nut

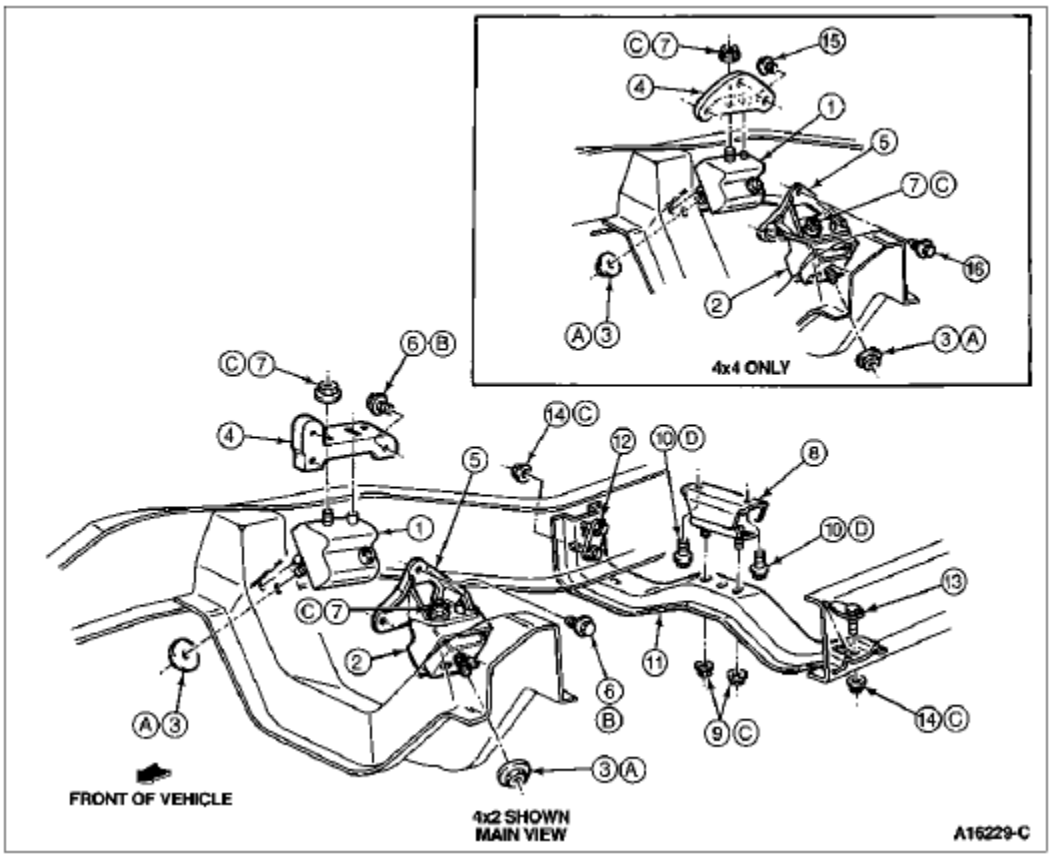
21	390066-S2	Screw and Washer (2 Req'd)
A	—	Tighten to 88-115 Nm (65-85 Lb-Ft)
B	—	Tighten to 60-81 Nm (45-59 Lb-Ft)
C	—	Tighten to 98-132 Nm (73-97 Lb-Ft)
D	—	Tighten to 88-118 Nm (65-87 Lb-Ft)
E	—	Tighten to 88-118 Nm (65-87 Lb-Ft)

Engine Support Brackets, Ranger with 2.3L Engine



Item	Part Number	Description
1	N802653-S100	Screw and Washer, M10-1.5x22
2	6030	Front Engine Support Mounting Bracket (RH)
3	N804044-S100	Stud, M10-1.5/M10-1.5x5.1
4	6031	Front Engine Support Mounting Bracket (LH)
A	—	Tighten to 60-81 Nm (44-60 Lb-Ft)

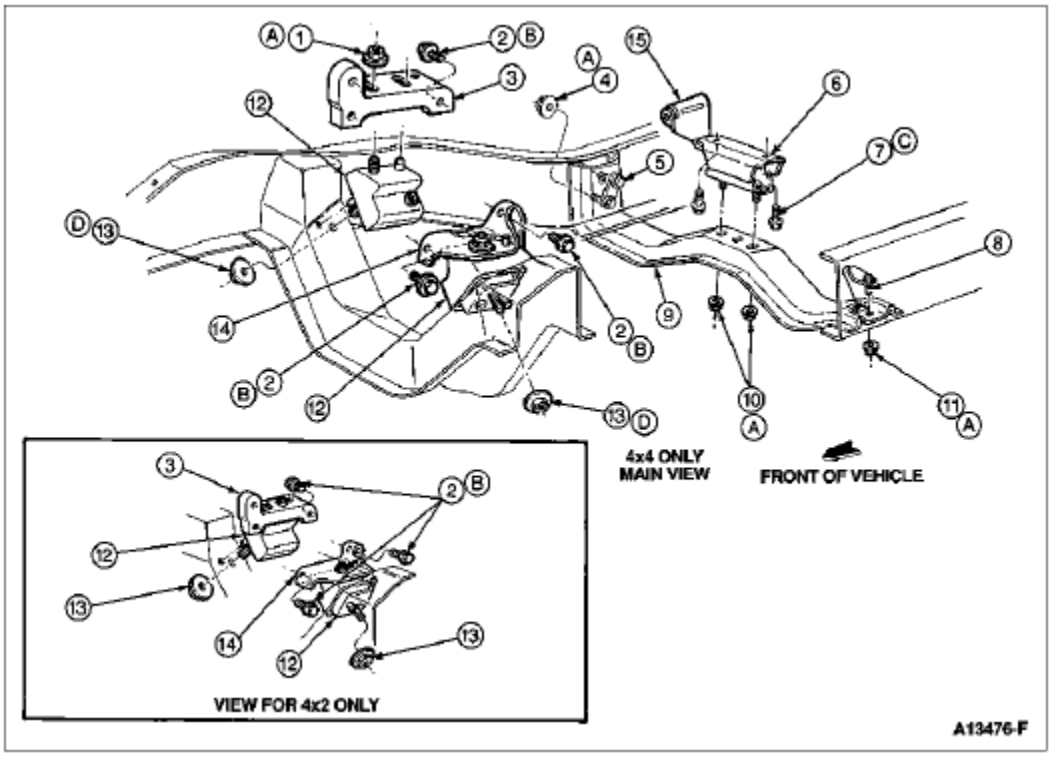
Front and Rear Engine Insulator Assemblies, Ranger with 3.0L Engine



Item	Part Number	Description
1	6038	Front Engine Support Insulator (RH)
2	6038	Front Engine Support Insulator (LH)
3	N802330-S2	Nut and Washer
4	6030	Front Engine Support Mounting Bracket (RH)
5	6031	Front Engine Support Mounting Bracket (LH)
6	N802653-S100	Screw and Washer
7	N801995-S102	Nut
8	6068	Transmission Support Insulator
9	N621945-S2	Nut and Washer
10	390066-S2	Screw and Washer (2 Req'd)
11	6A023	Transmission Support Crossmember
12	N807221-S2	Bolt and Retainer
13	N805420-S100	Bolt and Retainer
14	N800937-S2	Nut
15	N802653-S100	Screw and Washer

16	N807005-S100	Screw and Washer
A	—	Tighten to 98-132 Nm (73-97 Lb-Ft)
B	—	Tighten to 61-81 Nm (45-60 Lb-Ft)
C	—	Tighten to 88-115 Nm (65-85 Lb-Ft)
D	—	Tighten to 88-115 Nm (65-84 Lb-Ft)

Front and Rear Engine Insulator Assemblies, Ranger with 4.0L Engine



Item	Part Number	Description
1	N801995	Nut and Washer
2	N802653	Screw and Washer
3	6030	Front Engine Support Mounting Bracket
4	N800937	Nut
5	—	Bolt and Retainer
6	6068	Transmission Support Insulator
7	390066-S2	Screw and Washer (2 Req'd)
8	N805420	Bolt and Retainer
9	—	Rear Crossmember

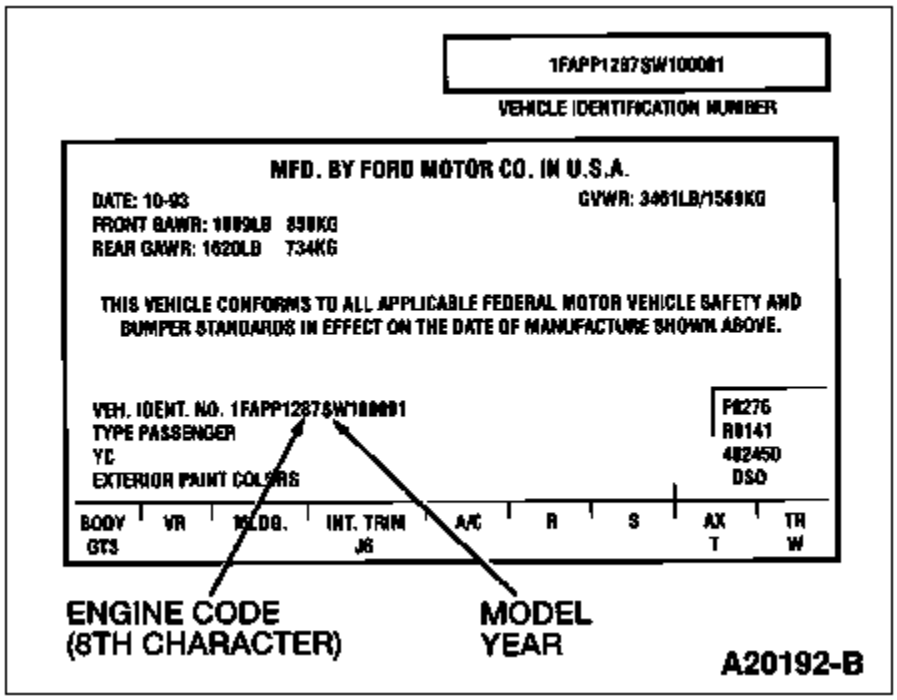
10	N621945	Nut
11	N800937	Nut (4 Req'd)
12	6038	Front Engine Support Insulator
13	N802330	Nut and Washer
14	6031	Front Engine Support Mounting Bracket (LH)
15	5E269	Exhaust Hanger
A	—	Tighten to 88-118 Nm (65-87 Lb-Ft)
B	—	Tighten to 60-80 Nm (44-59 Lb-Ft)
C	—	Tighten to 81-109 Nm (60-80 Lb-Ft)
D	—	Tighten to 98-132 Nm (72-97 Lb-Ft)

Engine Identification

For quick engine identification, refer to the Vehicle Emission Control Information (VECI) Decal mounted under the hood (16612). This decal lists engine information required for proper servicing of the engine (6007). Refer to Section 00-03 for further information. An engine identification label is also attached to the engine. The symbol code on the identification tag identifies each engine for determining parts usage, for instance, engine displacement and model year. Engine decal information is located in Section 03-01A , Section 03-01B , or Section 03-01C . The vehicle identification number (VIN) also gives engine information. The eighth digit identifies the engine. Refer to Section 00-01 for further information.

Vehicle Certification Label

Vehicle Certification Decal — Typical



The English certification label is attached to the door latch edge on the driver side door. The French certification label is attached to the door latch edge on the passenger side door.

The label contains the name of the manufacturer, the month and year of manufacture, the certification statement, and the vehicle identification number (VIN). The label also contains gross vehicle weight ratings, wheel and tire data, and information codes for additional vehicle data.

Safety Certification Decal

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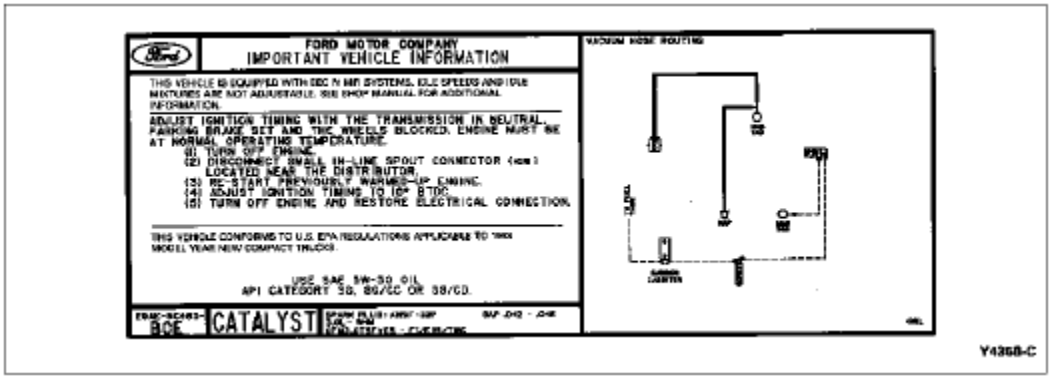
For quick engine identification, refer to the Safety Certification Decal. The decal is mounted on the LH front door lock face panel. Find the engine code (letter or number) on the decal, then refer to the engine identification chart to determine the engine type and size. An engine identification label is also attached to the engine. The symbol code on the identification tag identifies each engine for determining parts usage; for instance, engine displacement and model year. Engine decal information is located in Section 03-01A , Section 03-01B , and Section 03-01C .

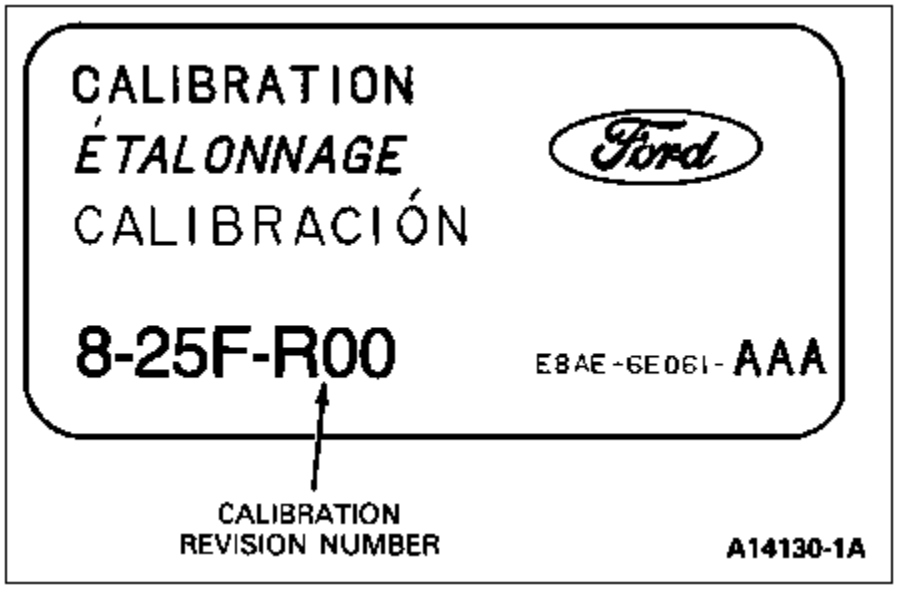
Safety Certification Decal



Emission Calibration Number Label

The emission calibration number label is located on the left side door or left door post pillar. It identifies the engine calibration number, the engine code number and revision level.

These numbers are used to determine if parts are unique to specific engines.



Always refer to these labels when replacement parts are required or when checking engine calibrations. Engine parts often differ within a displacement (liter or CID) family. Verification of identification codes will make sure that the proper parts are obtained. The codes contain all pertinent information relating to dates, optional equipment and revisions. The Ford Master Parts Catalog contains a complete listing of the codes and their application.

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Symptom Chart — Engine Diagnosis

ENGINE DIAGNOSIS

Condition	Possible Source	Action
• Difficult Starting	• Burnt intake valve or exhaust valve.	• REPLACE intake valve or exhaust valve.
	• Worn piston.	• REPLACE piston.
	• Worn piston ring(s).	• REPLACE piston ring(s).
	• Worn cylinder.	• SERVICE or REPLACE cylinder blocks.
	• Damaged cylinder head gasket.	• REPLACE cylinder head gasket.
	• Malfunctioning or damaged fuel system.	• REFER to Section 4A in the Powertrain Control/Emissions Diagnosis Manual for diagnosis and testing of the fuel system.
	• Malfunctioning or damaged ignition system.	• REFER to Section 4A in the Powertrain Control/Emissions Diagnosis Manual for diagnosis and testing of the ignition system.
• Poor Idling	• Damaged hydraulic valve tappet.	• REPLACE hydraulic valve tappet.
	• Damaged hydraulic valve tappet guide.	• REPLACE hydraulic valve tappet guide.
	• Improper valve-to-valve seat contact.	• REPLACE intake valve or exhaust valve and/or valve seat.
	• Damaged cylinder head gasket.	• REPLACE cylinder head gasket.
	• Malfunctioning or damaged fuel system.	• REFER to Section 4A in the Powertrain Control/Emissions Diagnosis Manual for diagnosis and testing of the fuel system.
	• Malfunctioning or damaged ignition system.	• REFER to Section 4A in the Powertrain Control/Emissions Diagnosis Manual for diagnosis and testing of the ignition system.
	• Worn or damaged valve stem seal/fouled spark plug.	• Replace valve stem seals.
• Abnormal Combustion	• Damaged hydraulic valve tappet.	• REPLACE hydraulic valve tappet.
	• Damaged hydraulic valve tappet bore.	• REPLACE cylinder head.
	• Burnt or sticking intake valve or exhaust valve.	• SERVICE or REPLACE intake valve or exhaust valve.

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	• Weak or broken valve spring.	• REPLACE valve spring.
	• Carbon accumulation in combustion chamber.	• ELIMINATE carbon buildup.
	• Malfunctioning or damaged fuel system.	• REFER to Section 4A in the Powertrain Control/Emissions Diagnosis Manual for diagnosis and testing of the fuel system.
	• Malfunctioning or damaged ignition system.	• REFER to Section 4A in the Powertrain Control/Emissions Diagnosis Manual for diagnosis and testing of the ignition system.
• Excessive Oil Consumption	• Worn piston ring groove.	• REPLACE piston.
	• Sticking piston ring(s).	• SERVICE or REPLACE piston ring(s).
	• Worn piston or cylinder.	• SERVICE and/or REPLACE piston or cylinder blocks.
	• Worn valve stem seal.	• REPLACE valve stem seal.
	• Worn valve stem or valve guide.	• REPLACE valve stem and guide.
	• Leaking oil.	• SERVICE oil leakage.
	• Worn piston rings.	• REPLACE piston rings.
	• Plugged PCV system.	• SERVICE PCV System.
• Engine Noise	• Excessive main bearing oil clearance.	• ADJUST clearance or REPLACE crankshaft main bearing.
	• Seized or heat damaged crankshaft main bearing.	• REPLACE crankshaft main bearing.
	• Excessive crankshaft end play.	• ADJUST end play or REPLACE crankshaft.
	• Excessive connecting rod bearing oil clearance.	• ADJUST clearance or REPLACE connecting rod.
	• Damaged connecting rod bearings.	• REPLACE connecting rod bearings.
	• Worn cylinder.	• SERVICE or REPLACE cylinder blocks.
	• Worn piston or piston pin.	• REPLACE piston or piston pin.
	• Damaged piston ring (s).	• REPLACE piston ring(s).
	• Bent connecting rod.	• REPLACE connecting rod.
	• Malfunctioning hydraulic valve tappet.	• REPLACE hydraulic valve tappet.
	• Excessive hydraulic valve tappet clearance.	• ADJUST clearance or REPLACE hydraulic valve tappet.

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	• Broken valve spring.	• REPLACE valve spring.
	• Excessive valve guide clearance.	• SERVICE clearance or REPLACE valve guide/stem.
	• Malfunctioning or damaged cooling system.	• REFER to Section 03-03 .
	• Malfunctioning or damaged fuel system.	• REFER to Section 4A in the Powertrain Control/Emissions Diagnosis Manual for diagnosis and testing of the fuel system.
	• Leaking exhaust system.	• SERVICE exhaust leakage.
	• Improper drive belt tension.	• REFER to Section 03-05 .
	• Malfunctioning generator bearing.	• REFER to Section 14-02 .
	• Loose timing chain/belt.	• ADJUST or REPLACE timing chain/belt.
	• Damaged timing chain/belt tensioner.	• REPLACE timing chain/belt tensioner.
	• Malfunctioning water pump bearing.	• REFER to Section 03-03 .
• Insufficient Power	• Malfunctioning hydraulic valve tappet.	• REPLACE hydraulic valve tappet.
	• Damaged hydraulic valve tappet bore.	• REPLACE cylinder head.
	• Compression leakage at valve seat.	• SERVICE or REPLACE valve, valve seat and/or cylinder head.
	• Seized valve stem.	• REPLACE valve stem.
	• Weak or broken valve spring.	• REPLACE valve spring.
	• Damaged cylinder head gasket.	• REPLACE cylinder head gasket.
	• Cracked or distorted cylinder head.	• REPLACE cylinder head.
	• Damaged, worn or sticking piston ring(s).	• SERVICE or REPLACE piston ring(s).
	• Worn or damaged piston.	• REPLACE piston.
	• Malfunctioning or damaged fuel system.	• REFER to Section 4A in the Powertrain Control/Emissions Diagnosis Manual for diagnosis and testing of the fuel system.
	• Malfunctioning or damaged ignition system.	• REFER to Section 4A in the Powertrain Control/Emissions Diagnosis Manual for diagnosis and testing of the ignition system.
	• Slipping transmission.	• REFER to Section 07-01A or Section 07-01B depending on transmission.

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	• Dragging brakes. • Incorrect tire size.	• REFER to Section 06-00 . • REFER to Section 04-04 .

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Positive Crankcase Ventilation (PCV) System Closed-Type

A malfunctioning closed crankcase ventilation system may be indicated by loping or rough engine idle. Do not attempt to compensate for this idle condition by disconnecting the crankcase ventilation system and making an air bypass or idle speed adjustment. **The removal of the crankcase ventilation system from the engine (6007) will adversely affect the fuel economy and engine ventilation with resultant shortening of engine life.** To determine whether the loping or rough idle condition is caused by a malfunctioning crankcase ventilation system, refer to the Powertrain Control/Emissions Diagnosis Manual.

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Engine Oil Leaks

When diagnosing engine oil leaks, the source and location of the leak must be identified prior to service.

Fluorescent Oil Additive Method

1. Add Rotunda Gas Engine Dye 164-R3705 or equivalent to the engine oil. Use 29.6 ml (1 ounce) of fluorescent additive in all engines.
2. Clean engine with a suitable solvent to remove all traces of oil.
3. Run engine for 15 minutes.
4. Stop engine and inspect all seal, gasket and galley plug areas for leaks using Rotunda Oil Leak Detector 164-R0756 or equivalent. A clear bright yellow or orange area will identify leak. For extremely small leaks, several hours may be required for the leak to appear.
5. **NOTE: For minor gasket leaks tightening the retaining bolts may resolve the problem.**

   Service all leaks as required.

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Leakage Points

Examine the following areas for oil leakage.

Underhood

- Valve cover sealant or gaskets
- Intake manifold gaskets/end seals
- Head gaskets (6051)
- Oil filter
- Oil level dipstick tube connection
- Oil pressure sensor (9278)

Under Engine — With Vehicle on Hoist

- Oil pan gasket (6710)
- Oil pan front and rear end seals
- Crankshaft front seal (6700)
- Crankshaft rear oil seal (6701)
- Oil pump (6600)

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Compression Test

Compression Gauge Check

1. Make sure oil in crankcase is of the correct viscosity and at proper level, and battery (10655) is properly charged. Operate vehicle until engine (6007) is at normal operating temperature. Turn off ignition, then remove all spark plugs (12405).

2. Set throttle plates in wide-open position.

3. Install Rotunda Compression Tester 014-00707 or equivalent in No. 1 cylinder.

4. Install an auxiliary starter switch in starting circuit. With ignition in the OFF position, and using auxiliary starter switch, crank engine at least five compression strokes and record highest reading. Note the approximate number of compression strokes required to obtain the highest reading.

5. Repeat test on each cylinder cranking the engine approximately the same number of compression strokes.

Test Results

The indicated compression pressures are considered within specification if the lowest reading cylinder is within 75 percent of the highest. Refer to the chart below.

Compression Pressure Limit Chart

Maximum		Minimum		Maximum		Minimum	
kPa	psi	kPa	psi	kPa	psi	kPa	psi
924	134	696	101	1131	164	848	123
938	136	703	102	1145	166	855	124
952	138	717	104	1158	168	869	126
965	140	724	105	1172	170	876	127
979	142	738	107	1186	172	889	129
993	144	745	108	1200	174	903	131
1007	146	758	110	1214	176	910	132
1020	148	765	111	1227	178	917	133
1034	150	779	113	1241	180	931	135
1048	152	786	114	1255	182	938	136
1062	154	793	115	1269	184	952	138
1076	156	807	117	1282	186	965	140
1089	158	814	118	1296	188	972	141
1103	160	827	120	1310	190	979	142
1117	162	834	121	1324	192	993	144

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Maximum		Minimum		Maximum		Minimum	
kPa	psi	kPa	psi	kPa	psi	kPa	psi
1338	194	1000	145	1544	224	1158	168
1351	196	1014	147	1558	226	1165	169
1365	198	1020	148	1572	228	1179	171
1379	200	1034	150	1586	230	1186	172
1393	202	1041	151	1600	232	1200	174
1407	204	1056	153	1613	234	1207	175
1420	206	1062	154	1627	236	1220	177
1434	208	1076	156	1641	238	1227	178
1448	210	1083	157	1655	240	1241	180
1462	212	1089	158	1669	242	1248	181
1476	214	1103	160	1682	244	1262	183
1489	216	1117	162	1696	246	1269	184
1503	218	1124	163	1710	248	1282	186
1517	220	1138	165	1724	250	1289	187
1531	222	1145	166				

Compression Readings — Interpreting

It is recommended the Compression Pressure Limit Chart be used when checking cylinder compression so that the lowest reading number is 75 percent of the highest reading.

If one or more cylinders reads low, squirt approximately one tablespoon of SAE 50 weight or equivalent engine oil on top of the pistons (6108) in the low reading cylinders. Repeat compression pressure check on these cylinders.

1. If compression improves considerably, piston rings (6149) are at fault.
2. If compression does not improve, valves are sticking or seating poorly.
3. If two adjacent cylinders indicate low compression pressures and squirting oil on pistons does not increase compression, cause may be a head gasket leak between cylinders. Engine oil and/or coolant in cylinders could result from this problem.

Example Readings

If, after checking the compression pressures in all cylinders, it was found that the highest reading obtained was 1351 kPa (196 psi) and the lowest pressure reading was 1069 kPa (155 psi), the engine (6007) is within specification and the compression is considered satisfactory.

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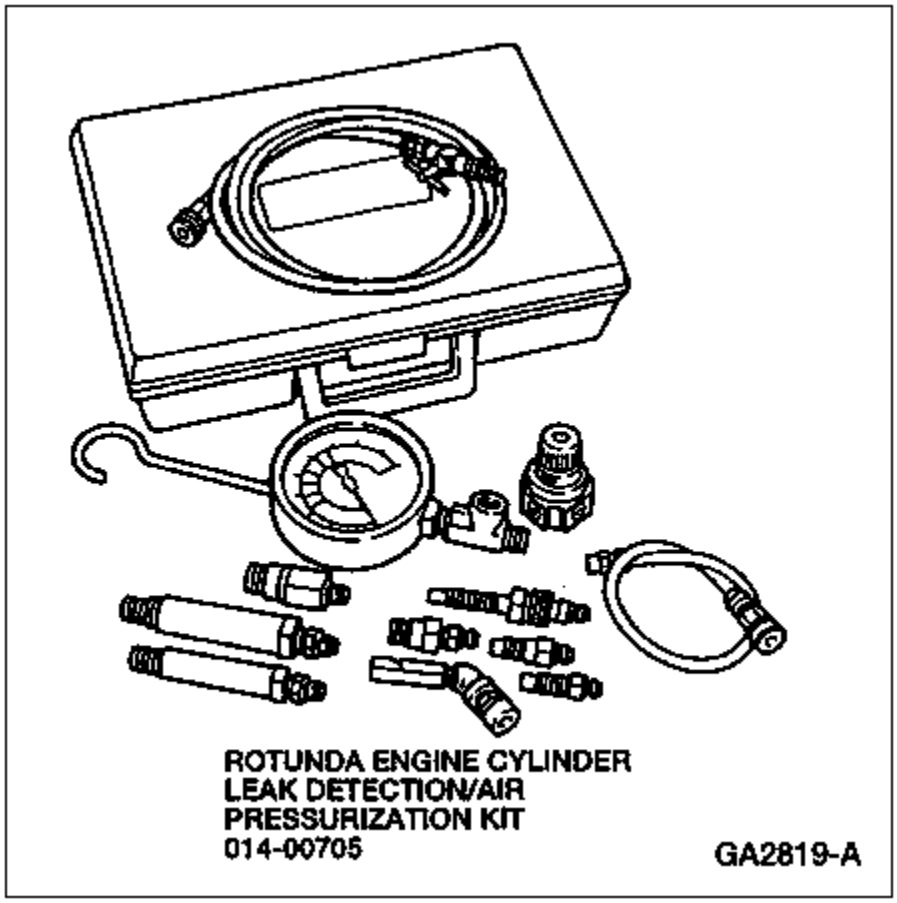
Cylinder Leakage Detector



When a cylinder produces a low reading, the use of Rotunda Engine Cylinder Leak Detection/Air Pressurization Kit 014-00708 or equivalent will be helpful in pinpointing the exact cause.

The leakage detector is inserted in the spark plug hole, the piston (6108) is brought up to top dead center (TDC) on the compression stroke, and compressed air is admitted.

Once the combustion chamber is pressurized, a special gauge will read the percentage of leakage. Leakage exceeding 20 percent is considered excessive.

While the air pressure is retained in the cylinder, listen for the hiss of escaping air. A leak by the intake valve (6507) will be audible in the throttle body (9E926). A leak by the exhaust valve (6505) can be heard at the tail pipe. Leakage past the piston rings (6149) will be audible at the positive crankcase ventilation (PCV) connection. (Oil filler neck in valve cover for 3.0L.) If air is passing through a blown head gasket (6051) to an adjacent cylinder, the noise will be evident at the spark plug hole of the cylinder into which the air is leaking. Cracks in the cylinder blocks (6010), or head gasket leakage into the cooling system may be detected by a stream of bubbles in the radiator (8005). To detect a cracked cylinder wall, it may be necessary to remove air supply at tool and move piston to BDC to expose full length of cylinder bore.

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Oil Leak and Valve Stem Seal Test

The cylinder leakage detector can be used to test for engine oil leaks and to check the valve stem seals (6571) for leakage.

1. Plug all crankcase openings except the one used for connecting the leakage detector.

2. **CAUTION: Use extreme caution when pressurizing crankcase. Applying air pressure above specified pressure risks damage to seals, gaskets and core plugs. Under no circumstances should pressure be allowed to exceed 21 kPa (3 psi).**

   Connect the leakage detector to a crankcase opening. The oil level indicator tube (6754) is convenient. Adjust the air pressure to approximately 21 kPa (3 psi).

3. Using a solution of liquid soap and water, brush the solution along the gasket sealing surfaces and bearing seals. Look for bubbles or foam.

4. Remove the spark plugs (12405) and rotate the crankshaft (6303) slowly with a wrench. Check for large amounts of air escaping into the cylinders as each intake valve (6507) and exhaust valve (6505) opens.

   The spark plugs on the leaking cylinders will probably show deposits of burned oil.

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Intake Manifold Vacuum Test

Bring the engine (6007) to normal operating temperature. Connect Rotunda Vacuum/Pressure Tester 164-R0253 or equivalent to the intake manifold (9424). Run the engine at the specified idle speed.

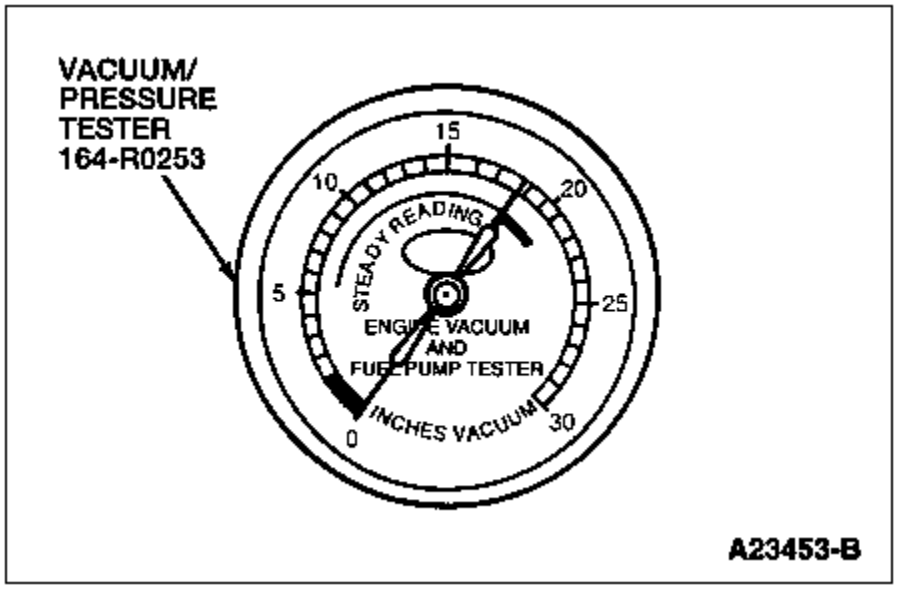
The vacuum gauge should read between -51 and -74 kPa (15 and 22 in-Hg) depending upon the engine condition and the altitude at which the test is performed. Subtract 5.5 kPa from the specified reading for every 500 meters (1 in-hg for every 1,000 feet) of elevation above sea level.

The reading should be quite steady. It may be necessary to adjust the gauge damper control (where used) if the needle is fluttering rapidly. Adjust damper until needle moves easily without excessive flutter.

Vacuum Gauge Readings — Interpretation

A careful study of the vacuum gauge reading while the engine is idling will help pinpoint trouble areas. Always conduct other appropriate tests before arriving at a final diagnostic decision. Remember that vacuum gauge readings, although helpful, must be interpreted with care.

Most vacuum gauges have a "normal" band indicated on the gauge face.



Following are potential gauge readings. Some should be considered as normal; others should be investigated further.

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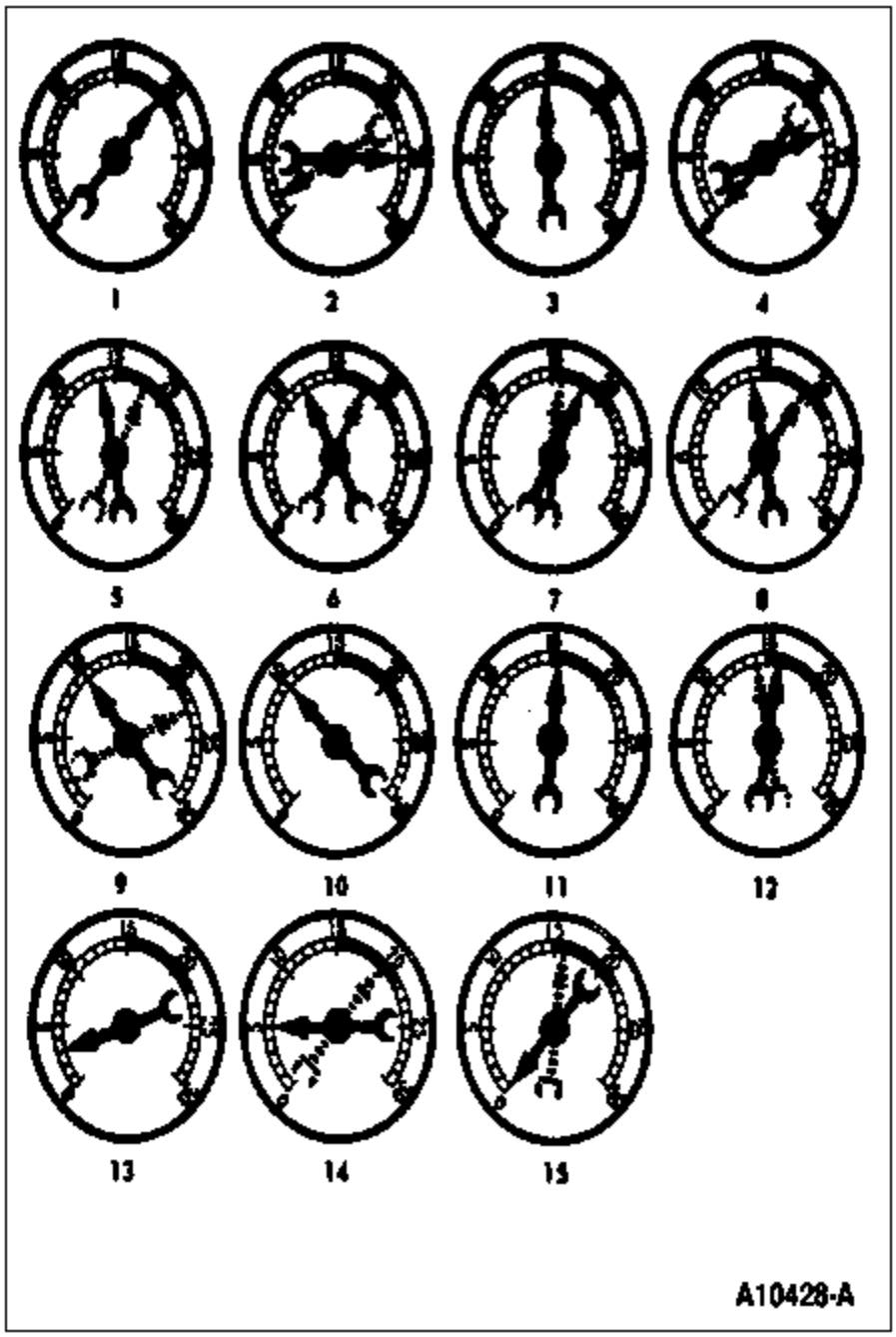

1. NORMAL READING: Needle between -51 and -74 kPa (15 and 20 in-Hg) and holding steady.

2. NORMAL READING DURING RAPID ACCELERATION AND DECELERATION: When engine is rapidly accelerated (dotted needle), needle will drop to a low (not to 0) reading. When throttle is suddenly released, the needle will snap back up to a higher than normal figure.

3. NORMAL FOR HIGH LIFT CAM WITH LARGE OVERLAP: Needle will register as low as -50 kPa (15 in-Hg) but will be relatively steady. Some oscillation is normal.

4. WORN RINGS OR DILUTED OIL: When engine is accelerated (dotted needle), needle drops to 0 kPa (0 in-Hg). Upon deceleration, needle runs slightly above 74 kPa (22 in-Hg).

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5. STICKING VALVE(S): When the needle (dotted) remains steady at a normal vacuum but occasionally flicks (sharp, fast movement) down and back about 13 kPa (4 in-Hg), one or more valves may be sticking.

6. BURNED OR WARPED VALVES: A regular, evenly spaced, downscale flicking of the needle indicates one or more burned or warped valves. Insufficient hydraulic valve tappet clearance will also cause this action.

7. POOR VALVE SEATING: A small but regular downscale flicking can mean one or more valves are not seating.

8. WORN VALVE GUIDES: When the needle oscillates (swings back and forth) over a 13 kPa (4 in-Hg) range at idle speed, the valve guides (6510) could be worn. As engine speed is increased, the needle will become steady if the valve guides are responsible.

9. WEAK VALVE SPRINGS: When the needle oscillation becomes more violent as engine rpm is increased, weak valve springs (6513) are indicated. The reading at idle could be relatively steady.

10. LATE VALVE TIMING: A steady but low reading could be caused by late valve timing.

11. IGNITION TIMING RETARDING: Retarded ignition timing will produce a steady but low reading.

12. INSUFFICIENT SPARK PLUG GAP: When spark plugs (12405) are gapped too close, a regular, small pulsation of the needle can occur.

13. INTAKE LEAK: A low, steady reading can be caused by an intake manifold or throttle body mounting flange gasket leak.

14. BLOWN HEAD GASKET: A regular drop of approximately 33-50 kPa (10-15 in-Hg) can be caused by a blown head gasket (6051) or warped head-to-block mounting surface.

15. RESTRICTED EXHAUST SYSTEM: When the engine is first started and is idled, the reading may be normal. But, as the engine rpm is increased, the back pressure caused by a clogged muffler, kinked tail pipe, etc., will cause the needle to slowly drop to 0. The needle then may slowly rise. Excessive exhaust clogging will cause the needle to drop to a low point even if the engine is only idled.

    When vacuum leaks are indicated, search out and correct the condition. Excess air leaking into the system will upset the fuel mixture and cause conditions such as rough idle, missing or acceleration, or burned valves. If the leak exists in an accessory unit such as the power brake, the unit will not function correctly. Always service vacuum leaks.

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Engine Oil Consumption, Excessive

The amount of oil an engine (6007) uses will vary with the way the vehicle is driven in addition to normal engine-to-engine variation.

Oil usage is normally greater during the first 16093 km (10,000 miles) of service. As mileage increases, oil usage generally improves. Cars and light trucks in normal service should get at least 1440 km (900 miles) to 0.95L (1 qt) after 16093 km (10,000 miles) of service.

Vehicles used in heavy-duty operation (severe service) may consume more oil. The following are examples of heavy-duty operation:

- High ambient temperatures
- Trailer towing applications
- Taxi cab applications
- Police service applications
- Severe loading applications
- Sustained high speed operation

Engines need oil to lubricate the following internal components:

- Engine block cylinder walls
- Pistons (6108) and piston rings (6149)
- Intake and exhaust valve stems
- Intake and exhaust valve guides (6510)
- All internal engine components

When the pistons move downward, a thin film of oil is left on the cylinder walls. The thin film of oil is burned away on the firing stroke during combustion. If an engine burned a drop of oil during each firing stroke, oil consumption would be about one quart for every mile traveled. Fortunately modern engines use much less oil than this example. However, even efficient engines will use some oil or they would quickly wear out. Additionally, as the vehicle is operated, some oil is drawn into the combustion chambers past the intake and exhaust valve stem seals (6571) and burned.

Many different conditions can affect oil consumption rates. A partial list of those conditions includes:

- Operator driving habits
- Ambient temperature
- Quality and viscosity of the oil
- Vehicle load and driving terrain

Operation under certain conditions can create a false impression of excessive oil consumption. Most commonly, this happens when the vehicle has been operated for repeated short trips at low ambient temperatures. Under these conditions, substantial amounts of condensed water and fuel can build up in the oil. If the vehicle is then run for a significant time at highway speeds and/or with heavy loads, much of the accumulated water and fuel can be removed by the engine ventilation system. Removing the water and fuel in a relatively short time will often create the appearance of an excessive consumption rate to the customer. In this situation, the customer could be assured that these events are normal for the conditions noted. The customer might also be advised to change oil and filter more frequently, especially prior to starting a long trip

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in cold weather if unduly concerned about this condition.

Make sure the selected engine oil meets the recommended API performance category "SH" and SAE viscosity grade as shown in the vehicle Owner Guide. It is also important that the engine oil is changed at the intervals specified for the typical operating conditions. Refer to Section 00-03 .

Oil Consumption Test

CAUTION: Care should be taken to direct the oil control nozzle away from the closure hose port in the oil fill tube during engine oil fill.

NOTE: To prevent oil from entering the PCV system during air powered oil fills, the closure hose should be disconnected from the oil fill tube and positioned aside. Cover the closure hose port with a shop towel to prevent oil from spilling onto the engine during engine oil fill. Connect closure hose after the oil has been filled to the proper level.

The following diagnostic procedure is intended to be used to determine the source of excessive internal oil consumption.

1. Determine what the customer considers excessive oil consumption to be. Note vehicle mileage and the following observations:
    a. How many kilometers (miles) are typically driven per 0.95L (1 qt) of oil used?
    b. How is the vehicle being used (e.g., sustained high speed operation, heavy loads, trailer towing, high ambient temperature, etc.)?
    c. What does the customer expect normal oil consumption to be?
2. Verify that the engine has no external oil leak as described under Engine Oil Leaks in this section.
3. Verify that the engine has the proper oil level dipstick (6750) by comparing the part number stamped on it against the Ford Master Parts Catalog. Verify that the oil level dipstick and oil level indicator tube (6754) are unmodified and in good condition. Verify that the oil level indicator tube is properly seated in the cylinder blocks (6010), and the oil level dipstick seats properly in the oil level indicator tube.
4. Verify that the engine is not being run in an overfilled condition. Check the oil level at least five minutes after a hot shutdown with the vehicle parked in a level area. Under no circumstances should the oil level be above the FULL line. If a significant overfill is indicated, perform Steps 5a through 5d to verify the oil level dipstick calibration. If the oil level dipstick calibration checks OK, instruct the customer to avoid overfilling the engine and return the vehicle to service. To verify the vehicle's actual oil consumption, perform Steps 5e and 5f only after the oil level dipstick has been calibrated.

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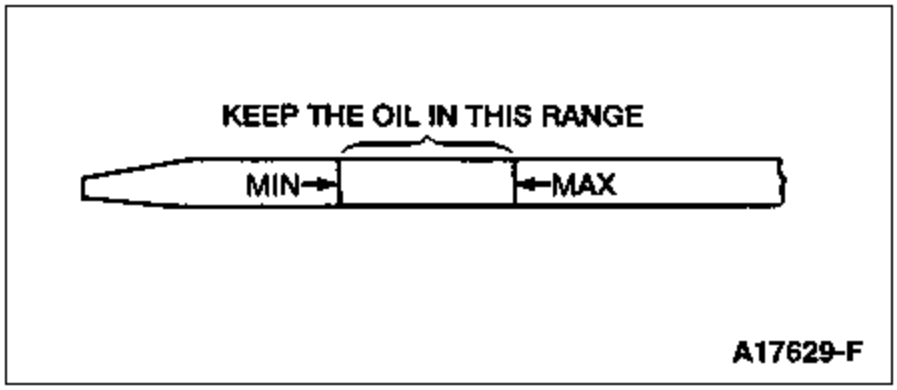

5. Perform engine oil consumption test as follows:

    a. Drain engine oil. Remove and replace oil bypass filter (6714). Use 0.95L (1 qt) less engine oil than recommended to refill crankcase with recommended quantity of oil.
    b. Run the engine for three minutes (ten minutes if cold), then turn engine off. Allow oil to drain into the oil pan (6675) for an additional five minutes (vehicle should be on level ground).
    c. Remove oil level dipstick and wipe clean. Do not wipe with anything contaminated with silicone compounds. Reinstall oil level dipstick being sure to seat it firmly in the oil level indicator tube. Remove the oil level dipstick and scribe a mark on the back (unmarked) surface at the indicated oil level. This should be about the same level as the MIN line on the face of the oil level dipstick.
    d. Add 0.95L (1 qt) of oil. Restart the engine and allow it to idle for at least two minutes. Shut down and allow oil to drain back for at least five minutes. Mark the oil level dipstick using the procedure above. This level may range from 5mm (0.20 inch) below the MAX line up to the MAX line.
    e. Instruct the customer to drive the vehicle as usual and do the following:
        - Check the oil level regularly at intervals of 160 to 240 km (100 to 150 miles).
        - Return to the service facility when the oil level drops below the MIN line scribed on the oil level dipstick by the technician.
        - In an emergency, add only 0.95L (1 qt) of the same oil and note the mileage at which the oil was added.
    f. Check the oil level under the same conditions as in Steps 5c and 5d, reading the back of the oil level dipstick where the scribe marks are located.
        - Measure the distance from the oil level to the upper scribe mark on the oil level dipstick and record.
        - Measure the distance between the two scribe marks and record.
        - Divide the first measurement by the second. Add one to this total for every 0.95L (1 qt) added by the customer as instructed in Step 5e.
        - Divide the distance driven during the oil test by the result. This quantity is the approximate oil consumption rate in miles per quart (mpq).
    g. If the calculated oil consumption rate is unacceptable, proceed to Step 6.

6. Check PCV system. Make sure system is not plugged.

7. Check for plugged oil drain-back holes in cylinder heads (6049) and cylinder blocks.

8. If condition still exists, perform a cylinder compression test as described in this section, and/or perform a cylinder leak detection test with Rotunda Engine Cylinder Leak Detection/Air Pressurization Kit 014-00705 or equivalent. This can be helpful in determining source of oil consumption, i.e., valves, piston rings, etc.

9. Check valve guides for excessive valve guide clearance. Replace all valve stem seals after correct valve guide clearance has been verified.

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10. **NOTE: After checking for worn parts, if it is determined parts should be replaced, make sure correct replacement parts are used.**

    Worn or damaged internal engine components can cause excessive oil consumption. Small deposits of oil on tip of spark plugs (12405) can be a clue to internal oil consumption. If internal oil consumption still persists, proceed as follows:

    a. Remove engine from vehicle and place it on an engine work stand. Remove intake manifold (9424)(s), cylinder heads, oil pan and oil pump (6600). Refer to procedure in Section 03-01A , Section 03-01B , Section 03-01C .
    b. Check piston ring clearance, ring gap and ring orientation. Refer to the procedure in this section. Service as required.
    c. Check for excessive bearing clearance as outlined in this section. Service as required.

11. Perform Step 5 again to confirm oil consumption concern has been resolved.

Oil Pressure Test

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Engine Oil Pressure Gauge	T73L-6600-A

1. Disconnect and remove the oil pressure sensor (9278) from the engine.

2. Connect Engine Oil Pressure Gauge T73L-6600-A and Transmission Test Adapter D87C-77000-A, or equivalent, to the oil pressure sender screw port.

3. Run the engine until normal operating temperature is reached.

4. Run the engine at 3,000 rpm and record the gauge reading.

5. The oil pressure should be:

    - 250-490 kPa (36-71 psi) at 3,000 rpm.

6. If the oil pressure is not within specification, check the following possible sources:

    a. Insufficient oil
    b. Oil leakage
    c. Worn or damaged oil pump
    d. Clogged oil pump screen cover and tube (6622)
    e. Excessive main bearing clearance
    f. Excessive connecting rod bearing clearance

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Valve Train Analysis — Static (Engine Off)

Valve Cover Removed

NOTE: Static Valve Train Analysis, with the engine (6007) off, is to be performed before Dynamic Valve Train Analysis, which is performed with engine running.

NOTE: Remove valve cover (6582). Refer to the procedure in Section 03-01A , Section 03-01B , Section 03-01C .

Check for damaged and/or severely worn parts, correct assembly, and use of correct parts by proceeding with the static engine analysis.

Rocker Arm

- Check for loose bolts, studs and nuts.
- Check for plugged oil feed in the rocker arm (6564), cylinder head (6049), or rocker arm shaft (6563) (if equipped).

Camshaft — Overhead Camshaft Engines

Inspect camshaft (6250), camshaft lobes and journals for excessive wear or scoring. Repair or replace camshaft, if necessary.

Push Rods

- Check for bent push rods (6565) and restriction in push rod oil passage.

Valve Springs

- Check for broken or damaged parts.

Valve Spring Retainer and Valve Spring Retainer Keys

- Check for proper seating of valve spring retainer keys (6518) on valve stem and in valve spring retainer (6514).

Positive Rotator and Valve Spring Retainer Keys

- Check for proper seating in the exhaust valve spring retainer — rotator type on valve stem.

Valves and Cylinder Head

- Check for signs of improper head gasket (6051) installation, such as the shape of the cylinder head and cylinder blocks (6010) and shape of the head gasket not matching.
- Check for signs of cylinder head gasket leakage such as coolant or oil leaking between the cylinder blocks and cylinder head.
- Check for plugged oil drain-back holes.

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- Check for worn or damaged valve tips.
- Check for missing or damaged intake and exhaust valve stem seals (6571)
- Check valve clearance as outlined in Section 03-01A , Section 03-01B , Section 03-01C .
- Check installed valve spring height.
- Check for missing or worn valve spring seats, if equipped.

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Valve Train Analysis — Dynamic (Except 2.3L)

NOTE: Static Valve Train Analysis, with engine (6007) off, is to be performed before Dynamic Valve Train Analysis which is performed with the engine running.

Start the engine. While engine is running at idle, check for proper operation of all parts. Check the following:

Rocker Arm

- Check for plugged oil feed in rocker arm (6564) or cylinder head (6049).
- Check for proper overhead valve train lubrication.

Push Rods

- Check for bent push rods (6565) and restriction in oil passage.
- Check for proper rotation of push rod.

Positive Rotator and Valve Spring Retainer Keys

- Check for proper operation of positive rotator.

Valves and Cylinder Head

- Check for plugged oil drain-back holes.
- Check for missing or damaged valve stem seals (6571).

If a condition of insufficient oiling is suspected, check oil passages for blockage, then accelerate the engine to 1200 rpm with the transmission (7003) in NEUTRAL (N) and the engine at normal operating temperature. Oil should spurt from the rocker arm oil holes such that valve tips and rocker arms are well oiled.

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Intake Valve Cleaning (Valves Installed) 2.3L OHC Engine

Cleaning and Inspection

NOTE: This procedure is to be used if there is a concern with hesitation on acceleration, rough idle, long crank times, and stall at idle and upon gear engagement after cold start.

NOTE: Many fluids are available to clean fuel injectors. Some injector cleaning fluids also claim to remove intake valve deposits (IVD). Engineering evaluation of these fluids indicates no ability to remove the intake valve deposits. If driveability concerns have been affected by injector cleaning fluids, it is most likely due to cleanup of fuel injector deposits. IVD is more difficult to remove than fuel injector deposits. IVD must be COMPLETELY removed to restore cold start driveability performance.

CAUTION: The overuse of fuel injector cleaning fluids may cause engine damage not covered under warranty.

CAUTION: Only walnut shell blasting using Rotunda 014-00975 Carbon Blaster and Automotive Borescope or equivalent is recommended for removing carbon from engine valves with the engine (6007) assembled. Other abrasives may cause engine damage on start-up if not completely removed.

1. Perform underhood inspection of vacuum lines and wiring.
2. Perform normal Engine Emission Diagnostics. Refer to the Powertrain Control/Emissions Diagnosis Manual.
3. If normal diagnostics have not resolved the driveability concerns, proceed with the following IVD inspection steps.
4. Remove any two spark plugs (12405).
5. **CAUTION: Do not bump the engine with the remote starter switch or ignition switch (11572) with the borescope in the spark plug hole or attempt to view the valve while rotating the engine. Damage to the borescope or engine may result.**

   Use a remote starter switch to bump the engine over until the intake valve (6507) is fully open in the cylinder to be inspected.
6. **CAUTION: Do not power the borescope light source from a vehicle battery (10655) while it is being charged, for example if the engine is running or the battery is connected to a charger, the lamp may fail.**

   Using the Rotunda Carbon Blaster and Automotive Borescope 014-00975 or equivalent automotive borescope, inspect the backside of the intake valves through the spark plug holes for the presence of carbon deposits. Compare the deposits with the deposit rating system chart. If any of the intake valves appear to have a carbon deposit level of 7 or less (lower number rating), intake valve cleaning

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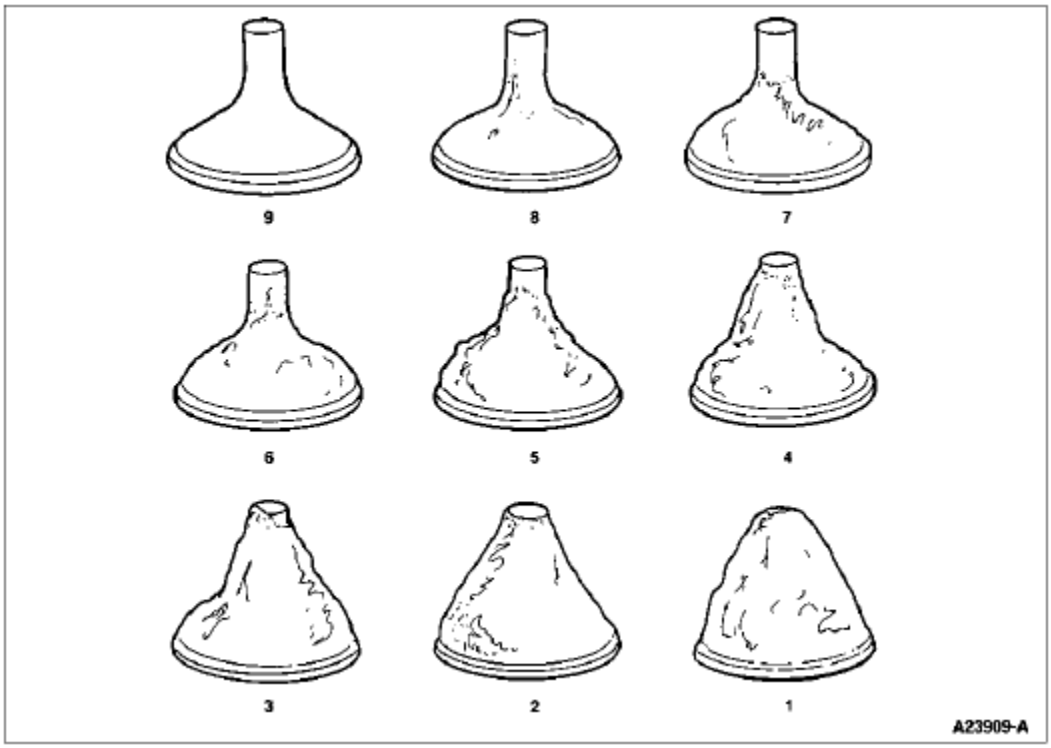
is required. If no carbon deposits are seen or the deposit level is 8 or cleaner, the drive concern may be the result of low volatility fuel. Refer to "Choosing the Right Fuel" in the vehicle owner guide.

Intake Valve Deposit Rating System



7. Remove the upper intake manifold assembly as outlined in Section 03-01A .
8. Remove the fuel injection supply manifold (9D280) and fuel injectors as outlined in Section 03-04A .
9. Remove flex hose and manifold adapter from the hand-held vacuum included with the Rotunda 014-00975 Carbon Blaster and Automotive Borescope. Insert tapered end of vacuum hose into intake port of lower intake manifold using a twisting motion to ensure a tight fit.
10. **NOTE: Detailed written instructions and a procedural video tape are included with the Rotunda 014-00975 Carbon Blaster and Automotive Borescope.**

    Perform the intake valve carbon cleaning procedure, using the Rotunda 014-00975 Carbon Blaster or equivalent on the intake valves that are in closed position. Cleaning takes approximately 1 to 1-1/2 minutes per valve.
11. Confirm the intake valve is clean using Rotunda 014-00975 or equivalent automotive borescope.
12. Using a remote starter switch bump the engine over until the remaining intake valves to be cleaned are in the closed position, and clean them as outlined above.
13. Install fuel injection supply manifold and fuel injectors as outlined in Section 03-04A .
14. Install the upper intake manifold as outlined in Section 03-01A .

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15. Refer vehicle owner to fuel recommendations under "Choosing the Right Fuel" in the Vehicle Owner Guide.

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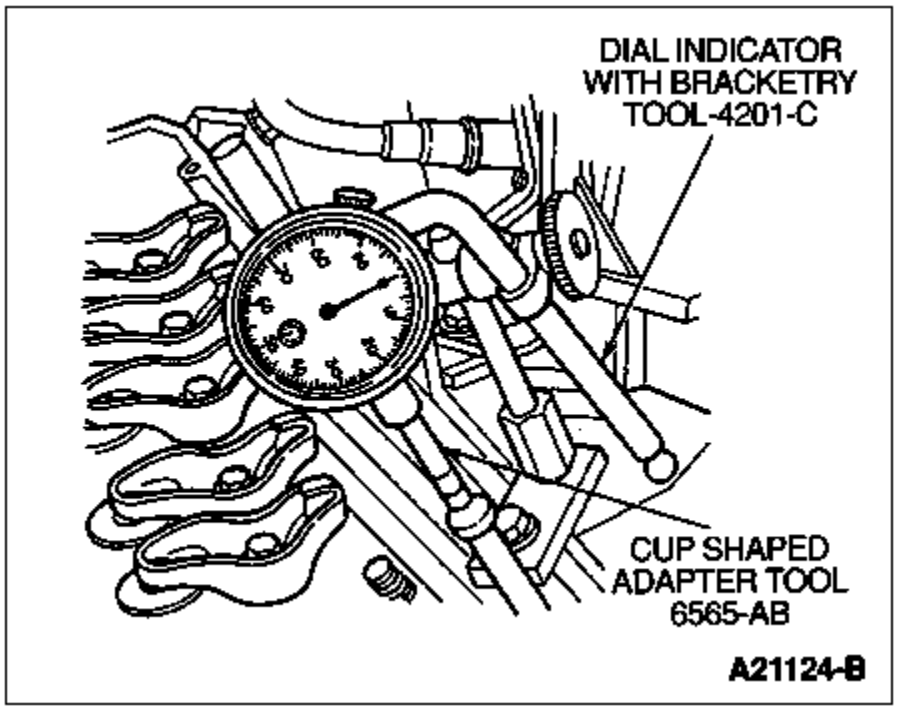
Camshaft Lobe Lift — 3.0L, 4.0L

This procedure is for checking lift with the camshaft (6250) installed. For checking with camshaft removed, refer to Service Procedures, Camshaft, Cam Lobe Lift in this section.

Check the lift of each lobe in consecutive order and make a note of the readings.

1. Remove valve covers (6582). Refer to the procedure in Section 03-01B or Section 03-01C .
2. Remove spark plugs (12405) wires and spark plugs.
3. On 3.0L engines, remove rocker arm bolts, rocker arm fulcrum and rocker arms (6564).
4. On 4.0L engines, remove rocker arm shaft (6563) and rocker arm assemblies. Refer to the procedure in Section 03-01C .
5. Make sure valve tappet (6500) is seated against camshaft lobe. Install Dial Indicator with Bracketry TOOL-4201-C or equivalent in such a manner as to have ball socket adapter of indicator on top of valve tappet or push rod (6565) and in same plane as valve tappet or push rod movement.

Typical Engine with Push Rods



6. Turn crankshaft (6303) using a socket and ratchet until valve tappet is on base circle of camshaft lobe. At this point, valve tappet will be in its lowest position.

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7. Zero dial indicator. Continue to rotate crankshaft slowly until valve tappet is in fully raised position (highest indicator reading).

8. Compare total camshaft lobe lift recorded on indicator with specifications.

9. **NOTE: If camshaft lobe lift on any lobe is below specified service limits, camshaft and valve tappets operating on worn lobe(s) must be replaced, as well as any valve tappet showing pitting or having contact face worn flat or concave. Refer to Hydraulic Valve Tappets in this section.**

   To check accuracy of original indicator reading, continue to rotate crankshaft until valve tappet is once again riding on base circle of camshaft lobe and read indicator. If indicator does not read zero, repeat Steps 6 and 7.

10. Remove dial indicator and auxiliary starter switch.

11. **CAUTION: After installing rocker arms, do not rotate crankshaft until valve tappets have had sufficient time to bleed down. To do otherwise may cause serious valve damage. Manually bleeding down will reduce waiting time.**

    On 4.0L engine, install rocker arm shaft and assembled rocker arms. Refer to the procedure in Section 03-01C . On 3.0L engine, install rocker arm, rocker arm fulcrum, and bolts. Refer to the procedure in Section 03-01B .

12. Install valve cover.

13. Install spark plugs and spark plug wires.

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Camshaft Lobe Lift, Overhead Camshaft Engines (2.3L) (Camshaft Installed)

This procedure is for checking lift with the camshaft (6250) installed. For checking with camshaft removed, refer to Service Procedures, Cam Lobe Lift (Camshaft Removed) in this section.

Check the lift of each lobe in consecutive order and make a note of the readings.

1. Remove valve cover (6582) as outlined in Section 03-01A .
2. Remove spark plugs (12405) as outlined in Section 03-01A .
3. Inspect the camshaft lobes for scoring and signs of abnormal wear.

   Lobe pitting, except in the general area of the lobe toe, is not detrimental to the operation of the camshaft. The camshaft should not be replaced unless lobe lift loss has exceeded the specifications or pitting has occurred in the lobe lift area.
4. Inspect for signs of camshaft bearing wear.
5. Using ratchet handle and socket on vibration damper bolt, rotate engine so cylinder number one exhaust valve is fully open — heel of cam at top.
6. Install TOOL-4201-C or equivalent Dial Indicator with Bracketry so tip of dial indicator is on heel of cam.
7. Zero dial indicator.
8. Slowly rotate engine until tip of dial indicator is on tip of cam and read. This is cam lift.
9. Write down cam lift and repeat for the rest of the cam lobes. If any lobe's lift is below the minimum lift specified in Section 03-01A , replace the camshaft.

Hydraulic Valve Tappet/Lash Adjuster

The hydraulic lash adjusters used in the overhead cam 2.3L I-4 engine are zero-lash hydraulic devices similar in construction and operation to the hydraulic valve tappets (6500) used on push rod engines. They are cleaned, inspected and checked in the same manner as hydraulic valve tappets. The instructions below apply equally to the lash adjuster and the valve tappet.

Hydraulic tappet noise may be caused by any of the following:

1. Excessive collapsed tappet gap
2. Sticking tappet plunger
3. Tappet check valve not functioning properly
4. Air in lubrication system

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5. Leak-down rate too rapid

6. Excessive valve guide wear

   Excessive collapsed tappet gap may be caused by loose rocker arm fulcrum bolts/nuts, incorrect initial adjustment, wear of tappet face, or worn roller tappets, push rod (6565), rocker arm (6564), rocker arm fulcrum or valve tip. With valve tappet collapsed, check gap between valve tip and rocker to determine if any other valve train parts are damaged, worn or out of adjustment. Replace any worn or damaged parts.

   A sticking tappet plunger may be caused by dirt, chips, or varnish inside the tappet. The sticking can be corrected by disassembling the valve tappet and removing the dirt, chips or varnish that are causing the condition.

   A tappet check valve that is not functional may be caused by an obstruction such as dirt or chips preventing it from closing when the cam lobe is lifting the valve tappet, or it may be caused by a broken check valve spring.

   Air bubbles in the lubrication system will prevent the valve tappet from supporting the valve spring load and may be caused by too high or too low an oil level in the oil pan (6675), or by air being drawn into the system through a hole, crack or leaking gasket on the oil pump screen cover and tube (6622).

   If the leakdown time is below the specified time for used valve tappets, noisy operation may result. If no other cause for noisy valve tappets can be found, the leakdown rate should be checked and any outside the specification, outlined in Section 03-01A , Section 03-01B , or Section 03-01C depending on engine, should be replaced.

Leakdown Testing

Assembled valve tappets can be tested with Hydraulic Tappet Leak-Down Tester or equivalent to check the leak-down rate. The leak-down rate specification is the time in seconds for the plunger to move a specified distance of its travel while under a 22.7 kg (50 lb.) load. Test the valve tappets as follows:

Remove valve tappets. Refer to the procedure in Section 03-01A , Section 03-01B or Section 03-01C .

1. **NOTE: Do not mix parts from different valve tappets. Parts are select-fitted and are not interchangeable.**

   NOTE: Valve tappets cannot be checked with engine oil in them. Only testing fluid can be used.

   Disassemble and clean valve tappet to remove all traces of engine oil.

2. Place valve tappet in tester, with plunger facing upward. Pour hydraulic tester fluid into cup to a level that will cover valve tappet assembly. The fluid can be purchased from manufacturer of tester. Using kerosene or any other fluid will not provide an accurate test.

3. Place a 7.94mm (0.31 inch) steel ball, provided with tester, in plunger cap.

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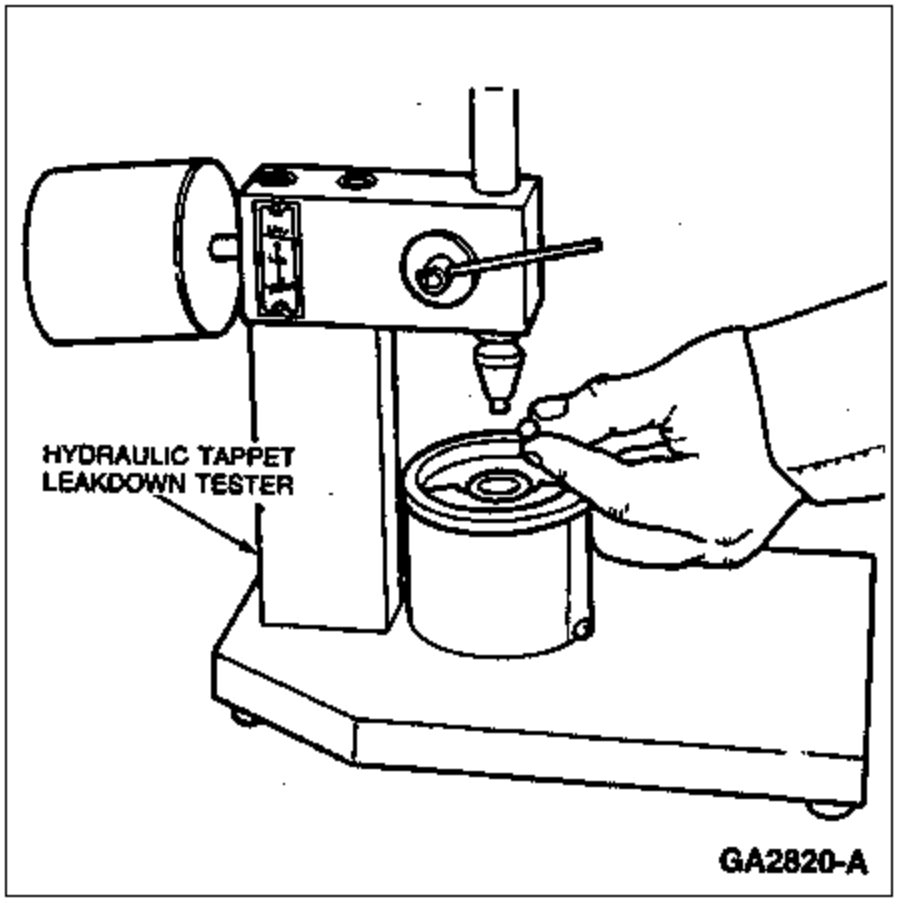
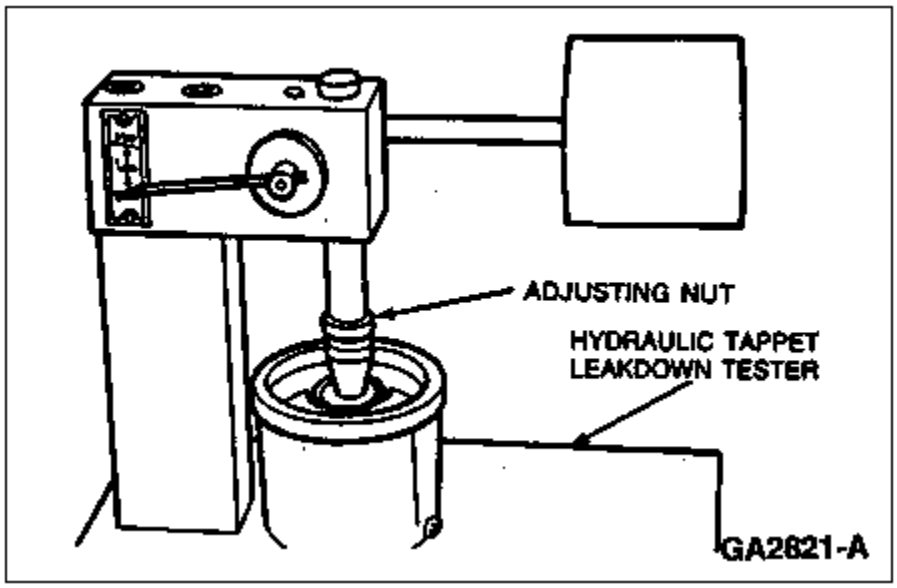


4. Work valve tappet plunger up and down until valve tappet fills with fluid and all traces of air bubbles have disappeared.

5. Adjust length of ram so that pointer is 1.59mm (0.06 inch) below starting mark when ram contracts valve tappet plunger, to facilitate timing as pointer passes Start Timing mark.



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Use center mark on pointer scale as Stop Timing point instead of original Stop Timing mark at top of scale.

6. Allow ram and weight to force valve tappet plunger downward. Measure exact time it takes for pointer to travel from Start Timing to Stop Timing marks of tester.

7. A valve tappet that is satisfactory must have a leakdown rate (time in seconds) within minimum and maximum limits specified in Section 03-01A , Section 03-01B , or Section 03-01C .

8. Remove fluid from cup and bleed fluid from valve tappet by working plunger up and down. This step will aid in depressing valve tappet plungers when checking valve clearance.

9. If a valve tappet is not within specifications:

    - Replace defective valve tappets. It is not necessary to disassemble and clean new valve tappets to test them since they are shipped with testing fluid.

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Camshaft End Play

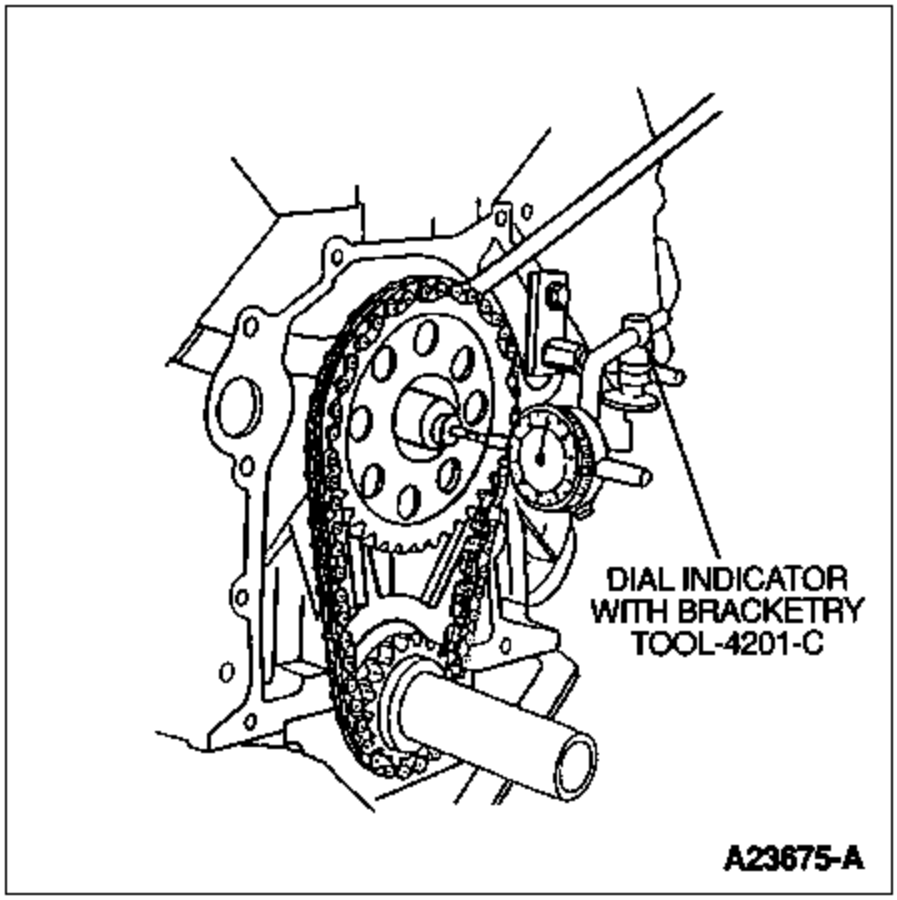
CAUTION: Prying against the camshaft sprocket (6256) with the valve train load on the camshaft (6250) can break or damage the camshaft sprocket. Therefore:

- **On 2.3L engine, remove the rocker arms. Refer to the procedure in Section 03-01A .**
- **On 3.0L engine, loosen rocker arm bolts and turn rocker arms (6564) off of push rods (6565). Refer to the procedure in Section 03-01B .**
- **On 4.0L engine, loosen rocker arm shaft bolts enough to free camshaft. Refer to the procedure in Section 03-01C .**

After checking camshaft end play, reinstall or retighten valve train components. Refer to Section 03-01A , Section 03-01B or Section 03-01C .

NOTE: For camshaft end play specifications, refer to Section 03-01A , Section 03-01B or Section 03-01C .

1. Install Dial Indicator with Bracketry TOOL-4201-C or equivalent so indicator point is on camshaft sprocket bolt.



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2. Push camshaft toward rear of engine (6007).

3. Zero dial indicator. Pull camshaft forward and release it. Compare dial indicator reading with specifications in Section 03-01A , Section 03-01B or Section 03-01C . If end play is excessive, replace camshaft thrust plate (6269).

4. Remove dial indicator.

5. After replacing camshaft thrust plate, check end play again. If it is still out of specified range, inspect camshaft and cylinder head (6049)/ cylinder blocks (6010) for excessive wear.

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Timing Chain Deflection — 3.0L and 4.0L

1. Remove engine front cover (6019). Refer to Section 03-01B or Section 03-01C .
2. Rotate the crankshaft (6303) so the camshaft sprocket (6256) and crankshaft sprocket timing marks line up.
3. Mark the top link(s) of the timing chain.
4. Have an assistant hold the crankshaft sprocket (6306) with a suitable tool so it cannot turn.
5. Place a machinist's scale above the timing chain (camshaft sprocket) so you can measure its movement.
6. Put a torque wrench and socket on the camshaft sprocket bolt.
7. Apply a maximum of 20 Nm (15 lb-ft) torque in a clockwise direction.
8. Note location of marked link on scale.
9. Apply a maximum of 20 Nm (15 lb-ft) torque in a counterclockwise direction while measuring the amount the marked link moves.
10. Movement should be less than 3.175mm (0.12 inch). If movement is excessive, replace timing chain. Refer to Section 03-01B or Section 03-01C .

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Timing Belt/Chain (2.3L)

NOTE: If the timing belt has greater than 193,000 km (120,000 miles) of use, the timing belt will need to be replaced. Refer to Section 03-01A for service procedures.

Camshaft Timing and Cylinder Identification (CID) Timing Check

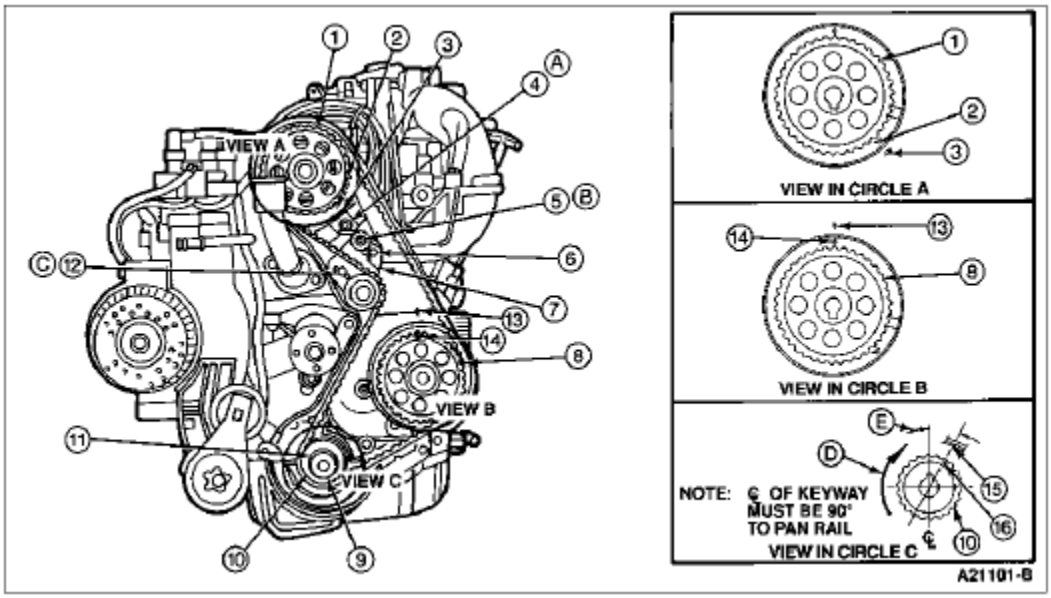
1. Remove both of the rubber access caps (camshaft sprocket and oil pump sprocket) from the outer timing cover.

2. Rotate crankshaft so that number one cylinder is at Top Dead Center (TDC) of the compression stroke. TDC will be indicated when the three timing marks are aligned:

    a. The timing mark on the crankshaft damper assembly will align with "TC" on the outer timing cover.
    b. The triangular timing mark on the camshaft sprocket will align with the timing mark on the inner timing cover.
    c. The diamond timing mark on the engine oil pump sprocket will align with the timing mark on the inner timing cover.

3. If the diamond or the triangle timing marks cannot be seen through the access holes of the outer timing cover, rotate crankshaft one revolution. TDC will be indicated when the three timing marks are aligned.

4. If the diamond or the triangle timing marks cannot be properly aligned, set the timing mark of the crankshaft damper assembly with "TC" on the outer timing cover. Remove the crankshaft damper assembly and outer timing cover as outlined in Section 03-01A .



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Item	Part Number	Description
1	6256	Camshaft Sprocket
2	—	Pointer Triangle (Part of Camshaft Sprocket)
3	—	Pointer Triangle (on Inner Timing Belt Cover)
4	N801658-S	Stud, M8 x 1.25
5	6K282	Spring Pivot Bolt
6	—	Stud (Part of 6K254)
7	6K254	Timing Belt Tensioner
8	6256	Oil Pump Sprocket
9	6303	Crankshaft
10	6306	Crankshaft Sprocket
11	N806700-S	Key
12	N800112-S2	Adjusting Bolt, M8-1.25 x 20
13	—	Pointer Diamond (on Inner Timing Belt Cover)
14	—	Pointer Diamond (on Oil Pump Sprocket)
15	—	Pointer Line (Part of 6019)
16	—	Pointer Circle (on 6306)
A	—	Tighten to 20-30 Nm (15-22 Lb-Ft) (See Text)
B	—	Tighten to 40-55 Nm (30-40 Lb-Ft) (See Text)
C	—	Tighten to 35-45 Nm (26-33 Lb-Ft) (See Text)
D	—	Direction of Rotation
E	—	29°

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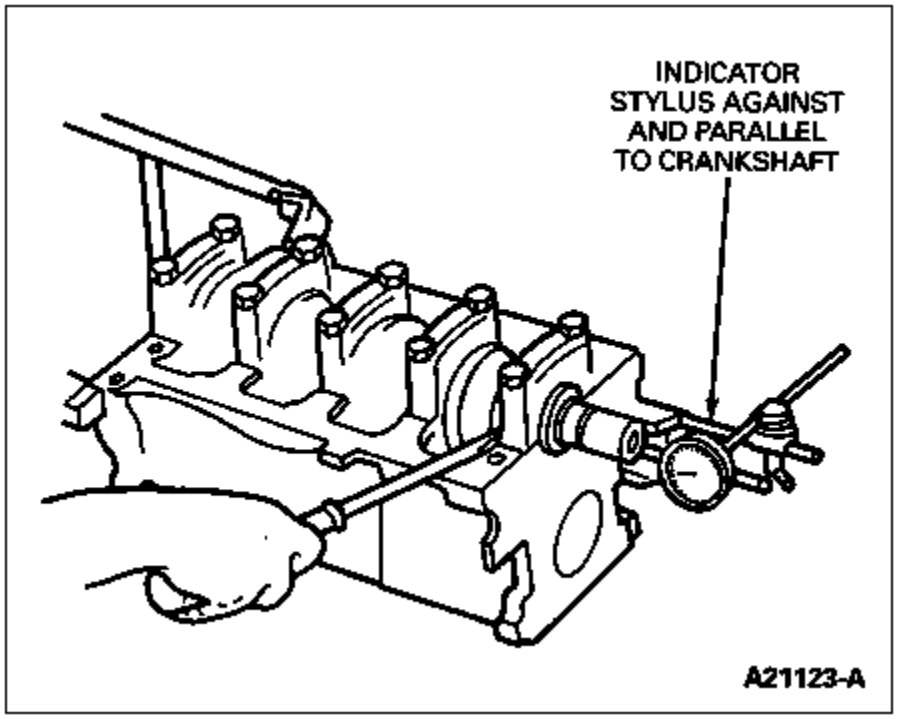
Crankshaft End Play

1. Install Dial Indicator with Bracketry TOOL-4201-C or equivalent so contact point rests against the end of the crankshaft post and indicator axis is parallel to crankshaft axis.

2. Force crankshaft (6303) toward rear of engine (6007).



3. Set indicator dial on zero mark. Push crankshaft forward and note reading on dial.

4. If the end play exceeds the wear limit listed in Section 03-01A , Section 03-01B or Section 03-01C . Replace the thrust bearing. Inspect the crankshaft for damage to the thrust face before installing the new bearing. If the end play is less than the minimum limit, inspect the thrust bearing faces for scratches, burrs, nicks, or dirt. If the thrust faces are not damaged or dirty, the main thrust bearing may not be aligned properly. Lubricate and install the thrust bearing and align the faces, following Main Bearing Replacement procedure in Section 03-01A , Section 03-01B or Section 03-01C . Check the crankshaft end play.

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Timing Chain Deflection — 3.0L and 4.0L

1. Remove engine front cover (6019). Refer to Section 03-01B or Section 03-01C .
2. Rotate the crankshaft (6303) so the camshaft sprocket (6256) and crankshaft sprocket timing marks line up.
3. Mark the top link(s) of the timing chain.
4. Have an assistant hold the crankshaft sprocket (6306) with a suitable tool so it cannot turn.
5. Place a machinist's scale above the timing chain (camshaft sprocket) so you can measure its movement.
6. Put a torque wrench and socket on the camshaft sprocket bolt.
7. Apply a maximum of 20 Nm (15 lb-ft) torque in a clockwise direction.
8. Note location of marked link on scale.
9. Apply a maximum of 20 Nm (15 lb-ft) torque in a counterclockwise direction while measuring the amount the marked link moves.
10. Movement should be less than 3.175mm (0.12 inch). If movement is excessive, replace timing chain. Refer to Section 03-01B or Section 03-01C .

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Timing Belt/Chain (2.3L)

NOTE: If the timing belt has greater than 193,000 km (120,000 miles) of use, the timing belt will need to be replaced. Refer to Section 03-01A for service procedures.

Camshaft Timing and Cylinder Identification (CID) Timing Check

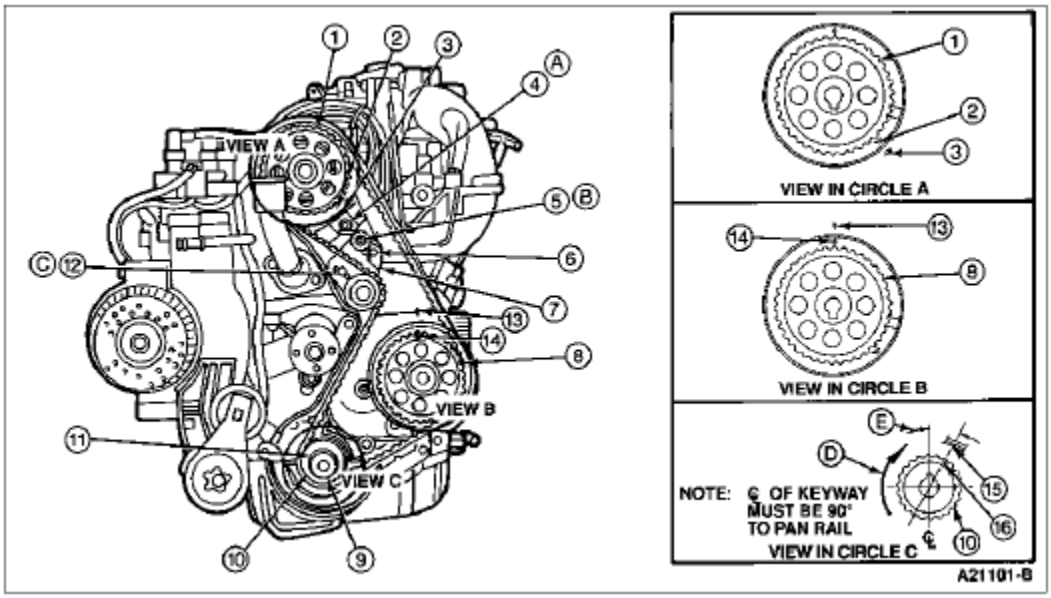
1. Remove both of the rubber access caps (camshaft sprocket and oil pump sprocket) from the outer timing cover.

2. Rotate crankshaft so that number one cylinder is at Top Dead Center (TDC) of the compression stroke. TDC will be indicated when the three timing marks are aligned:

    a. The timing mark on the crankshaft damper assembly will align with "TC" on the outer timing cover.
    b. The triangular timing mark on the camshaft sprocket will align with the timing mark on the inner timing cover.
    c. The diamond timing mark on the engine oil pump sprocket will align with the timing mark on the inner timing cover.

3. If the diamond or the triangle timing marks cannot be seen through the access holes of the outer timing cover, rotate crankshaft one revolution. TDC will be indicated when the three timing marks are aligned.

4. If the diamond or the triangle timing marks cannot be properly aligned, set the timing mark of the crankshaft damper assembly with "TC" on the outer timing cover. Remove the crankshaft damper assembly and outer timing cover as outlined in Section 03-01A .



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Item	Part Number	Description
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9	6303	Crankshaft
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D	—	Direction of Rotation
E	—	29°

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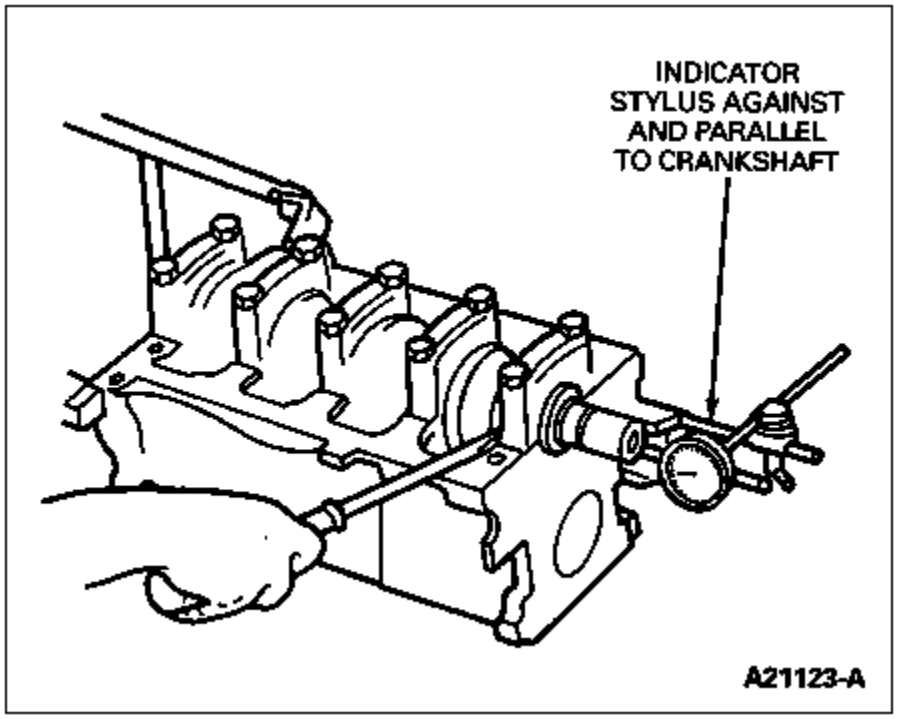
Crankshaft End Play

1. Install Dial Indicator with Bracketry TOOL-4201-C or equivalent so contact point rests against the end of the crankshaft post and indicator axis is parallel to crankshaft axis.

2. Force crankshaft (6303) toward rear of engine (6007).



3. Set indicator dial on zero mark. Push crankshaft forward and note reading on dial.

4. If the end play exceeds the wear limit listed in Section 03-01A , Section 03-01B or Section 03-01C . Replace the thrust bearing. Inspect the crankshaft for damage to the thrust face before installing the new bearing. If the end play is less than the minimum limit, inspect the thrust bearing faces for scratches, burrs, nicks, or dirt. If the thrust faces are not damaged or dirty, the main thrust bearing may not be aligned properly. Lubricate and install the thrust bearing and align the faces, following Main Bearing Replacement procedure in Section 03-01A , Section 03-01B or Section 03-01C . Check the crankshaft end play.

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Connecting Rod Side Clearance

1. Install Dial Indicator with Bracketry TOOL-4201-C or equivalent so that the contact point rests against the connecting rod cap.

2. Pull connecting rod cap toward front of engine (6007) and zero the dial indicator.

3. Push connecting rod cap toward rear of engine and observe amount of side clearance on dial indicator.

4. If side clearance exceeds specification in Section 03-01A , Section 03-01B or Section 03-01C . Replace connecting rod and cap.

   If side clearance is less than specification, remove connecting rod and cap and inspect for scratches, burrs, nicks or dirt between crankshaft (6303) and connecting rod (6200).

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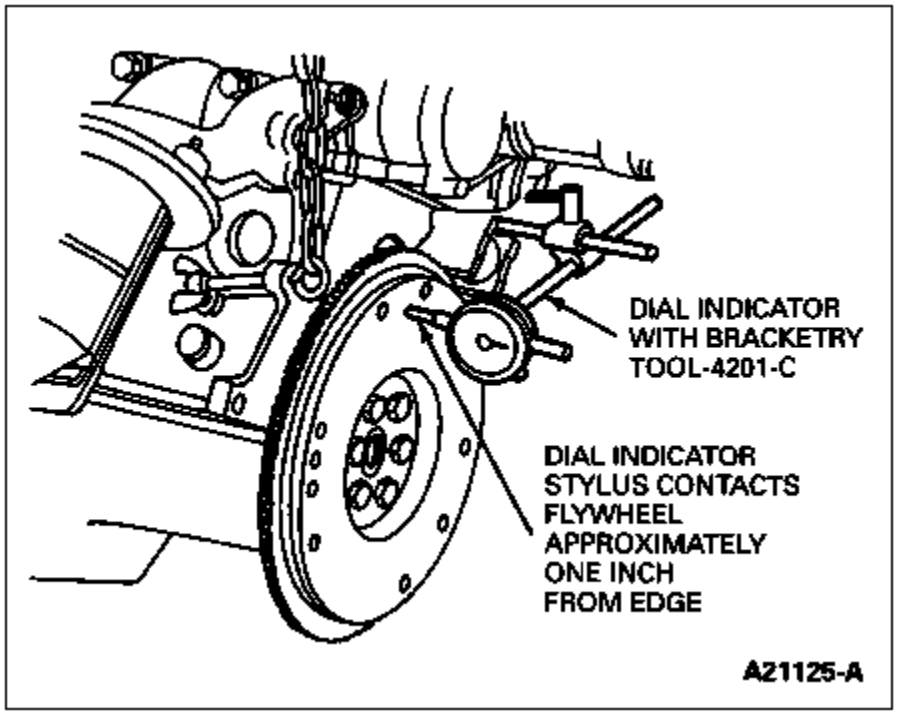
Flywheel Runout, Manual Transmission

1. Remove spark plugs (12405).

2. Install Dial Indicator with Bracketry TOOL-4201-C or equivalent so indicator points rest on face of the flywheel (6375).



3. Hold flywheel and crankshaft (6303) forward or backward as far as possible to prevent crankshaft end play from being indicated as flywheel runout.

4. Set indicator dial on zero mark. Turn flywheel one complete revolution while observing total indicator reading (TIR). If TIR exceeds specification, flywheel and ring gear assembly must be replaced.

5. If clutch face runout exceeds specification, remove flywheel and check for burrs between flywheel and face of crankshaft mounting flange. If no burrs exist, check runout of crankshaft mounting flange. Replace flywheel or machine crankshaft flywheel mounting face sufficiently to true-up the surface.

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Cylinder Block

Cleaning and Inspection

If the engine (6007) has been removed and disassembled, remove all core plugs and pipe plugs. Clean the cylinder blocks (6010) using solvent, preferably in a hot tank. Follow all safety and environmental precautions with regard to the solvent. Make sure all oil and dirt is cleaned from the cylinder blocks.

Make sure all oil passageways are clean. A rifle-cleaning brush is useful for this purpose.

Use a long-thin screwdriver to scrape the bottom of the water jackets through the openings in the top deck to make sure all scale and deposits are removed. Most engines have a "dead spot" at the back of the block where the coolant has to make a U-turn and drops any deposits. If the water jackets are not thoroughly cleaned, overheating will result.

Cylinder Block Distortion

Cylinder block distortion is rare because cylinder blocks are normalized after casting, and before machining, to relieve internal stresses from the casting process.

The most probable cause of cylinder block distortion would be extreme overheating which would probably be accompanied by other damage such as scored bearings or cylinder walls, warped cylinder heads (6049), and possible cylinder block cracks.

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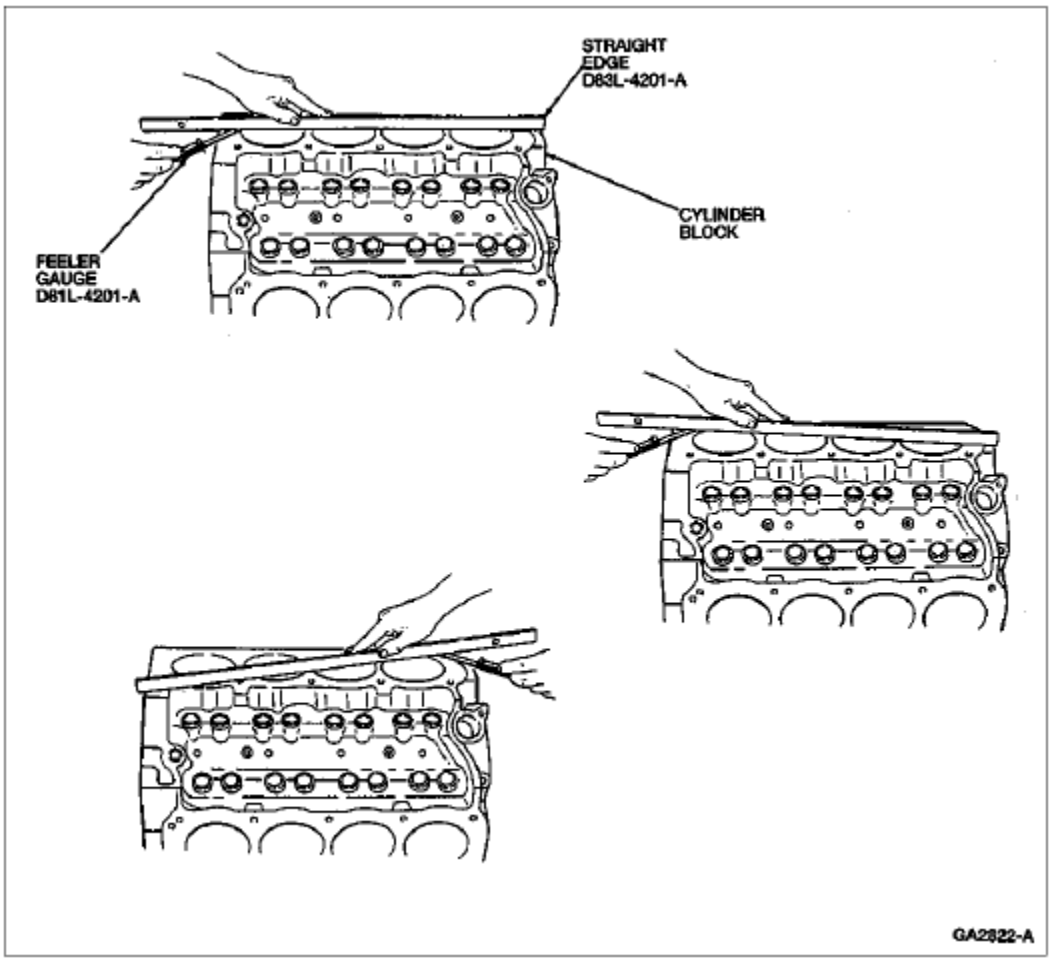
Cylinder Head Deck Flatness

1. Place a straightedge across the cylinder head deck in the three positions shown and measure any gaps between the straightedge and the deck with a feeler gauge. The deck should be flat within .076mm (0.003 in.) over 152mm (6 inches) and 0.152mm (0.006 in.) overall.

2. If necessary, resurface or replace cylinder blocks (6010).



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Main Bearing Bore Alignment

Main bearing bore misalignment may be suspected in cases of premature bearing wear if one bearing wears considerably more than the others or bearings wear cone-shaped.

NOTE: Bearings are not available with oversize outside diameters to allow line boring.

If bearing misalignment is suspected:

1. Acquire a gauge bar the same diameter as the crankshaft journals and which is straight within 0.076mm (0.003 in.).
2. Put a thin coating of Prussian Blue or similar die on gauge bar.
3. Insert good bearings in block.
4. Insert gauge bar in bearings and rotate one turn.
5. Remove gauge bar.
6. Inspect bearings. Blue die should be deposited evenly on all bearings. If die appears on only one side or bottom of bearing or not at all, block is distorted and should be replaced.

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Flywheel Housing Deck Flatness

A concern with the rear deck of the engine would be indicated by:

- Frequent replacement of pilot bearing and transmission input shaft bearing on manual transmission vehicles. Also hard shifting into high (not overdrive) gear or jumping out of gear.
- Frequent replacement of torque converter seals, input shaft seals or bearings, or transmission oil pump on an automatic transmission vehicle.

If cylinder block-to-transmission misalignment is suspected:

- With crankshaft (6303) installed and engine rear plate (7007) and flywheel (6375) removed, attach Dial Indicator with Bracketry TOOL-4201-C or equivalent to crankshaft. The dial indicator can be mounted by any method that holds the extension bar so it does not sag.
- Position the dial indicator on the machined flange slightly in from the left edge.
- Set the dial indicator on zero mark.
- Because the shape of the flange is irregular, lift the tip of the dial indicator off of the flange.
- Rotate the crankshaft to the 12 o'clock position and release the dial indicator tip.
- Take the reading.
- Lift the pointer off the flange and rotate the crankshaft so the dial indicator is just on the flange on the right side of the engine.
- Release the pointer and take the reading. The readings should vary less than 0.076mm (0.003 inch).
- Attach Dial Indicator with Bracketry TOOL-4201-C or equivalent to transmission input shaft (7017).
- Position dial indicator on transmission flange just above and inside of hole for left transmission bolt.
- Set dial indicator on zero mark.
- Slowly rotate transmission input shaft and take readings from dial indicator at 12 o'clock position and just above rightmost transmission-to-engine bolt hole.
- Reading should not vary more than 0.076mm (0.003 inch).

Sand Holes or Porous Engine Castings — Service

Porosity or sand hole(s), which will cause oil seepage or leakage, can occur with modern casting processes. A complete inspection of engine (6007) and transmission (7003) should be made. If the leak is attributed to the porous condition of the cylinder blocks (6010) or sand hole(s), service can be made with Devcon Aluminum Liquid F2 or equivalent meeting Ford manufacturing standard M3D35-A(E). Do not service cracks with this material. Service with this aluminum liquid F2 must be confined to those cast iron engine component surfaces where the inner wall surface is not exposed to engine coolant pressure or oil pressure, for example:

- Cylinder block surfaces extending along the length of the cylinder blocks, upward from the oil pan rail to the cylinder water jacket, but not including machined areas.
- Lower rear face of the cylinder blocks.

NOTE: Intake manifold casting. Service is not recommended to the intake manifold exhaust crossover section, since temperatures can exceed the recommended temperature limit of 260° C (500°F).

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- Cylinder front cover on engines using cast iron material.
- Cylinder head (6049), along the valve cover gasket surface.

The following procedure should be used to service porous areas or sand holes in cast iron.

1. Clean surface to be serviced by grinding or rotary filing to a clean bright metal surface. Chamfer or undercut hole or porosity to a greater depth than rest of cleaned surface. Solid metal must surround hole. Openings larger than 6.35mm (0.25 inch) should not be serviced using aluminum liquid F2. Openings in excess of 6.35mm (0.25 inch) can be drilled, tapped and plugged using common tools. Clean service area thoroughly. Aluminum liquid F2 will not stick to a dirty or oily surface.

2. Mix aluminum liquid F2 base and hardener as directed on container. Stir thoroughly until uniform.

3. Apply service mixture with a suitable clean tool (putty knife, wood spoon, etc.) forcing epoxy into hole or porosity.

4. Allow service mixture to harden. This can be accomplished by two methods. Heat-cure with a 250-watt lamp placed 254mm (10 inches) from serviced surface, or air-dry for 10-12 hours at temperatures above 10°C (50℉).

5. Sand or grind serviced area to blend with general contour of surrounding surface.

6. Paint the surface to match the rest of the cylinder blocks.

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Cylinder Walls, Refinishing

Cleaning

If the entire engine (6007) has not been disassembled, clean the individual cylinder bore(s) with a cloth soaked with solvent. Dry with a clean, lint-free cloth.

If the entire engine has been disassembled, refer to Cylinder Block Cleaning in this section.

After any cylinder bore service operation, such as honing or deglazing, clean the bore(s) with soap or detergent and water. Then thoroughly rinse the bore(s) with clean water to remove the soap or detergent, and wipe the bore(s) dry with a clean lint-free cloth. Finally wipe the bore(s) with a clean cloth dipped in XO-10W30-QSP or -DSP or equivalent motor oil meeting Ford specification ESE-M2C153-E.

Inspection

Before removing the piston (6108):

1. Check the amount of ridge at the top of the bore. A thick ridge is a sign of considerable wear.

2. Look for signs of coolant in the bore, especially rust on the bore surface indicating possible leaking head gasket (6051) or a crack in the cylinder bore.

3. Check the top of the piston for possible oversize. If oversize pistons have been installed, the oversize will be stamped in the top of the piston.

   After the piston is removed and the bore cleaned:

4. Look for scoring. These are parallel gouges usually on the piston thrust side, that is, at right angles to the piston pin (6135). If scored, the cylinder will have to be refinished.

5. Look for cracks. If unsure about a crack, tiny cracks may be detected by coating the bore with a mixture of 25 percent kerosene and 75 percent light engine oil. Wipe the bore dry and immediately apply a coating of zinc oxide dissolved in wood alcohol. Do not use rubbing alcohol as a substitute. If cracks are present, the coating will become discolored at the damaged area. Replace the cylinder blocks (6010) if it is cracked. Magnafluxing may also be used.

6. Check for cylinder wall glazing. When refinished, the cylinder bore is given a slightly rough finish with a cylinder hone to help seat the new piston rings (6149). This finish is worn away as the piston rings and cylinder bore "mate" and the bore becomes glassy smooth. If the engine has been run enough for this to have happened, the cylinder will at least have to be honed to seat the new piston rings. New piston rings should be installed when the piston is removed and reinstalled because piston rings are given a special finish by the factory to help them wear in and seat. In seating, the special finish is worn off. Reusing piston rings will result in high oil consumption.

Cylinder Bore

Make sure cylinder bore is clean and dry before measuring.

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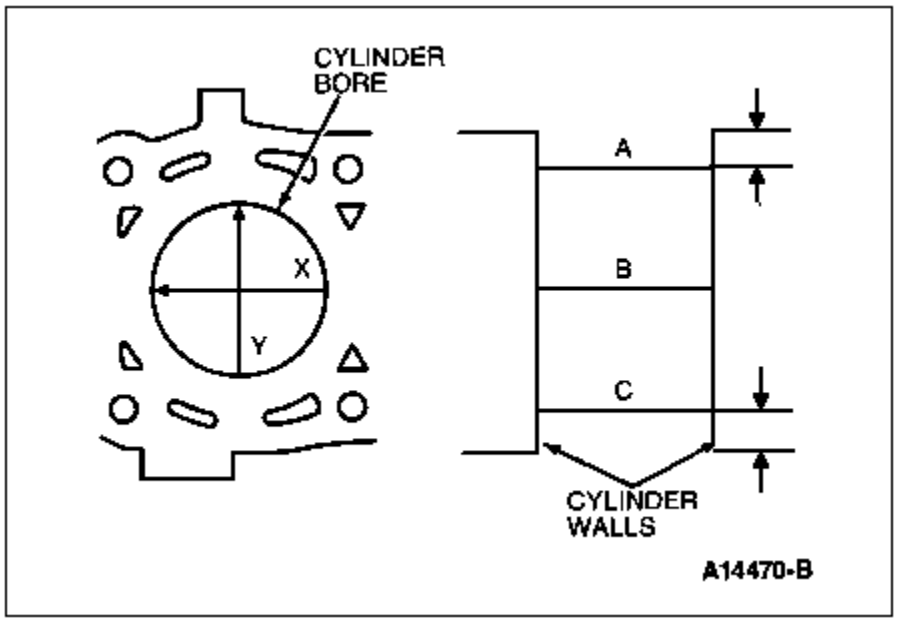
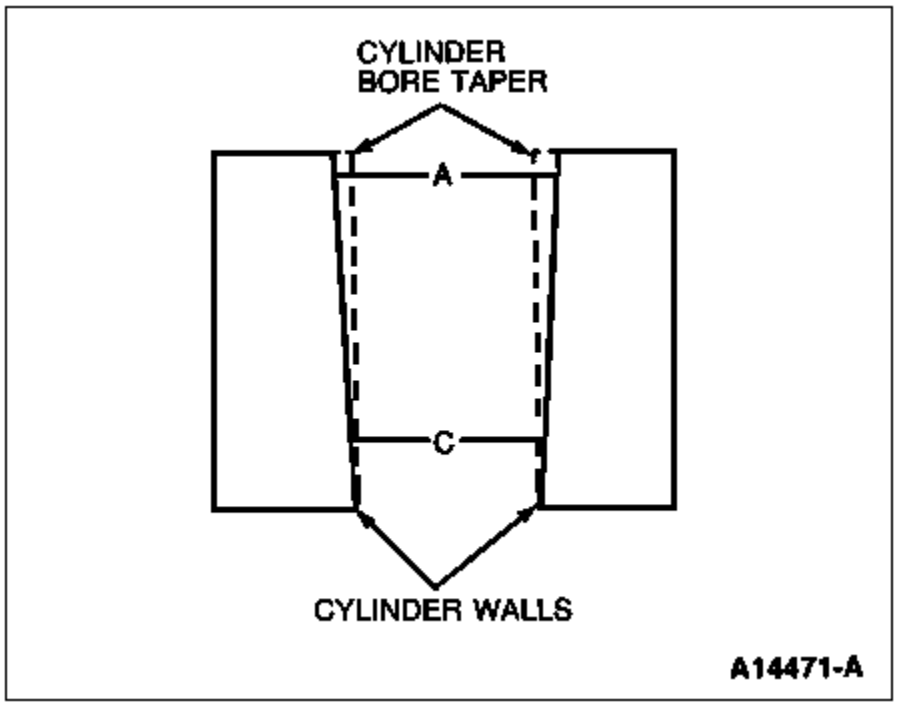
Using a suitable cylinder bore micrometer or gauge, measure the cylinder bore(s) in the X and Y directions (90 degrees apart) at points A, B, and C. The X direction is parallel to the piston pin. The Y direction is perpendicular to the piston pin and is the direction of piston thrust.



Cylinder Bore Taper

Subtract the micrometer or gauge reading from point C direction Y from point A direction Y. Also from point C direction X from point A direction X. Each difference should be less than 0.127mm (0.005 inch). If taper exceeds this specification, cylinder will have to be refinished.



Cylinder Out-of-Round

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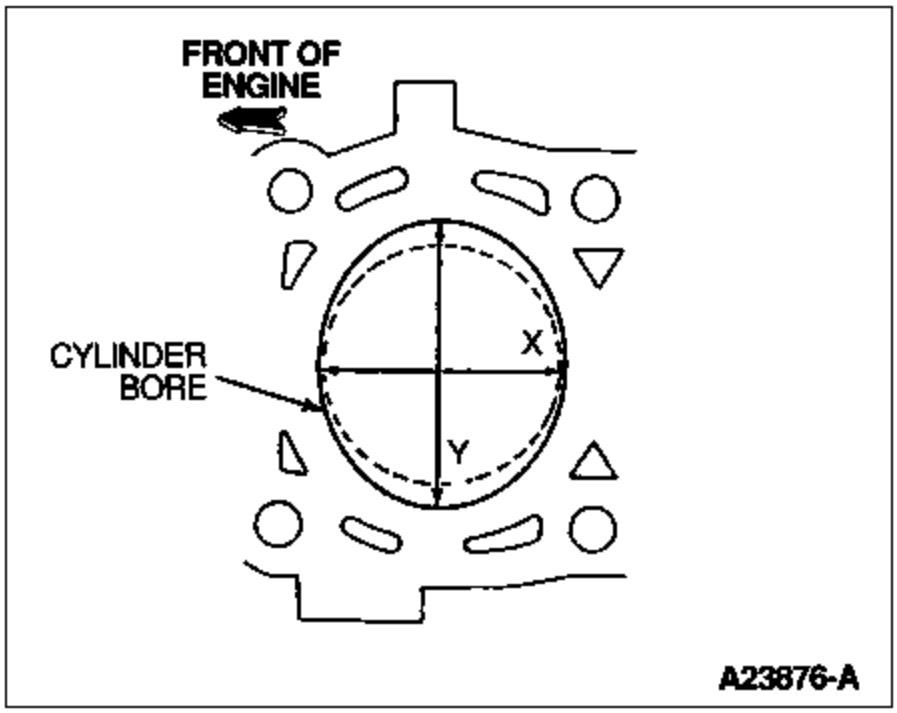
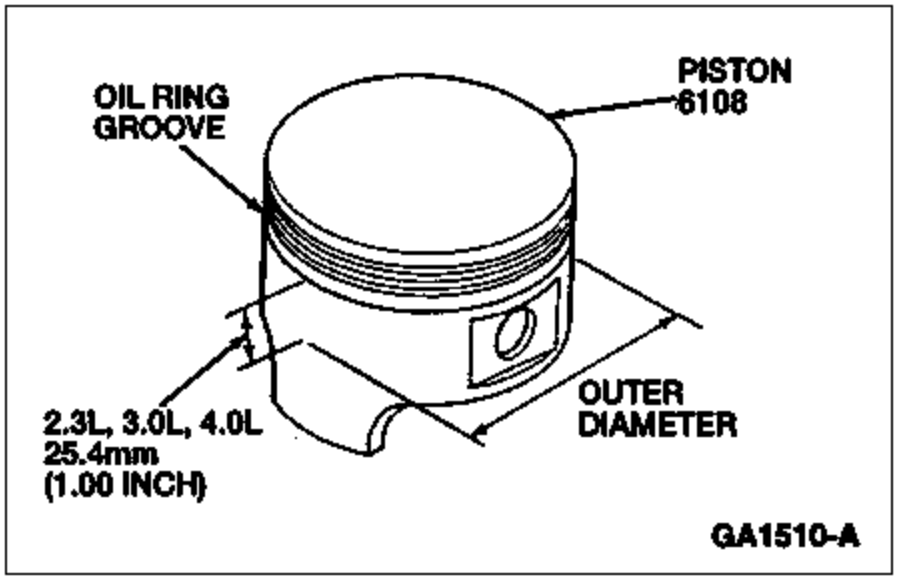
Subtract the reading of direction X (non-thrust) from direction Y (thrust side) at all points A, B, and C. All readings should be less than 0.127mm (0.005 inch). If out-of-round exceeds this specification, cylinder will have to be refinished.



Cylinder Bore Diameter

1. Measure the diameter of the piston on the thrust side — at right angles to the piston pin — 25.4mm (1.00 inch) below the oil ring groove on 2.3L, 3.0L, and 4.0L.



2. Measure the cylinder bore diameter at right angles to the piston pin at points A, B, and C as described under Cylinder Bore Taper.

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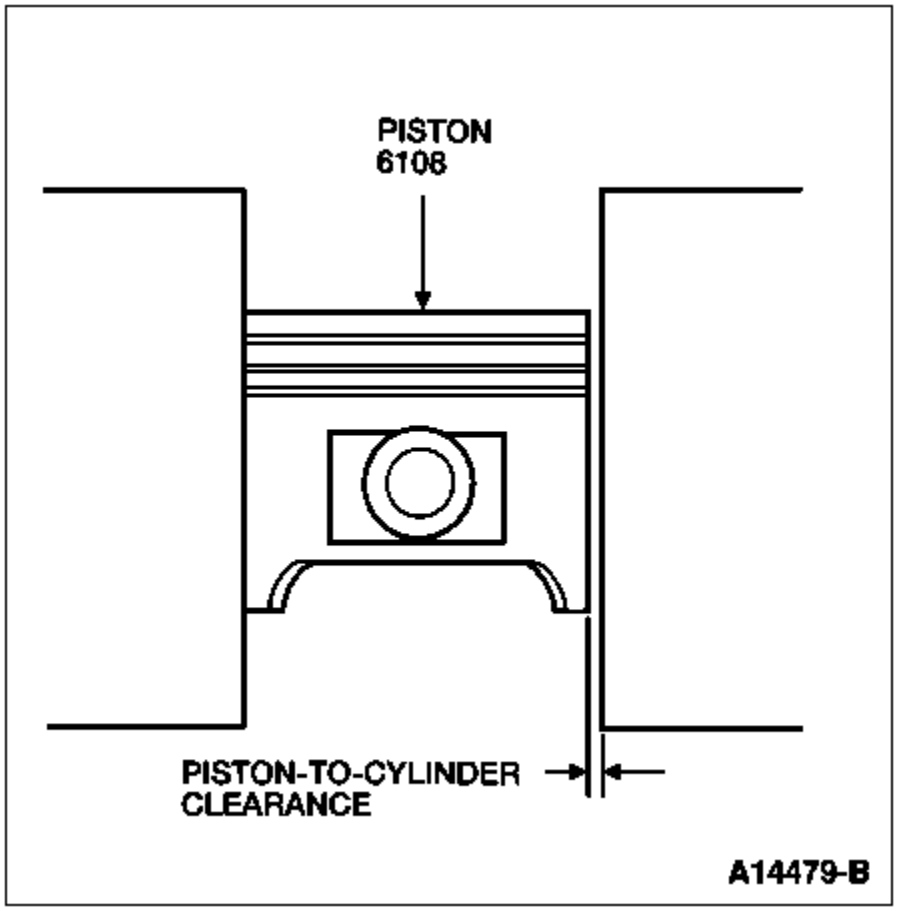
3. Subtract the piston diameter from the cylinder bore diameters. The difference should not exceed the maximum clearance allowed in the specifications in Section 03-01A , Section 03-01B or Section 03-01C .



Cylinder Wall Honing

Hone the cylinder bore either when reinstalling a piston with new piston rings, or to size a rebored cylinder to the piston and prepare the bore surface.

1. Measure the diameter of the piston on the thrust side — at right angles to the piston pin — 25.4mm (1.00 inch) below the oil ring groove on 2.3L, 3.0L, and 4.0L.

2. Measure the cylinder bore diameter at right angles to the piston pin at points A, B, and C as described under Cylinder Bore Taper.

3. Subtract the piston diameter from the maximum cylinder bore diameter to determine the maximum amount of material that can be removed.

4. Hone the cylinder according to the hone manufacturer's instructions to obtain the proper bore surface finish of 18-38 RMS.

    - Keep the hone moving up and down to achieve the proper crosshatch pattern.
    - Measure frequently to make sure not to remove too much of the cylinder wall creating excess clearance.

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Engine Block Plugs

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Impact Slide Hammer	T50T-100-A
Impact Slide Hammer	T59L-100-B

Removal and Installation

To remove a large core plug, drill a 12.70mm (0.50 inch) hole in the center of the plug and remove with an Impact Slide Hammer T59L-100-B or T50T-100-A or pry it out with a large drift punch. On a small core plug, drill a 6.35mm (0.25 inch) hole in the center of the plug and pry it out with a small pin punch. Clean and inspect the plug bore.

Prior to installing a core plug, the plug bore should be inspected for any damage that would interfere with the proper sealing of the plug. If the bore is damaged, it will be necessary to true the surface by boring for the next specified oversize plug.

Oversize plugs are identified by the OS stamped in the flat located on the cup side of the plug.

Coat the plug and/or bore lightly with an oil-resistant (oil galley) Stud and Bearing Mount E0AZ-19554-BA or equivalent meeting Ford specification WSK-M2G349-A1 or Threadlock 262 E2FZ-19554-B or equivalent meeting Ford specification WSK-M2G351-A6, and install it following the procedure for cup-type or expansion-type below:

Cup-Type

Cup-type core plugs are installed with the flanged edge outward. The maximum diameter of this plug is located at the outer edge of the flange. The flange on a cup-type plug flares outward with the largest diameter of the outer (sealing) edge.

CAUTION: It is imperative to push the plug into the machined bore by using a properly designed tool. Under no circumstances is the plug to be driven into the bore using a tool that contacts the flange. This method will damage the sealing edge and will result in leakage and/or plug blowout.

The flanged (trailing) edge must be below the chamfered edge of the bore to effectively seal the plugged bore.

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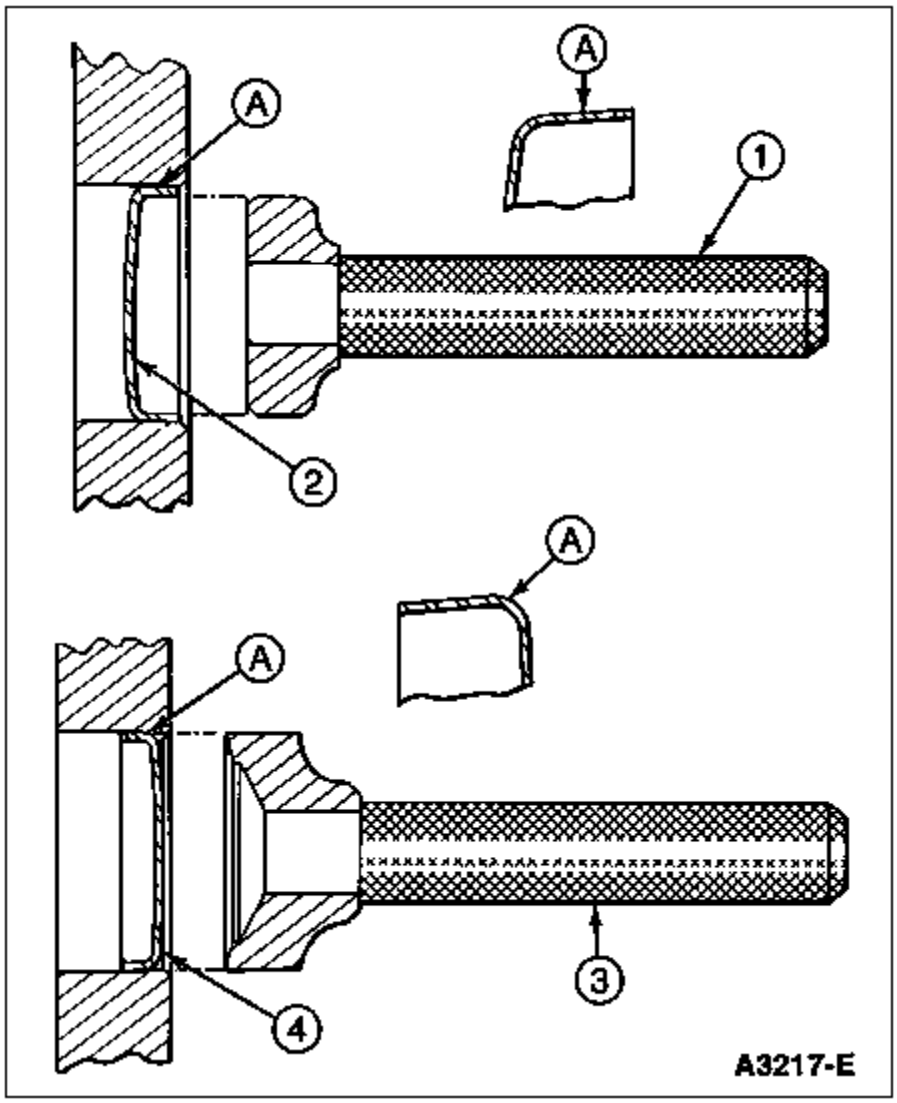

Item	Part Number	Description
1	—	Cup-Type Core Plug Replacer Tool — Typical
2	6026	Engine Block Plug — Cup-Type
3	—	Expansion-Type Core Plug Replacer Tool — Typical
4	6026	Engine Block Plug — Expansion-Type
A	—	Sealing Edge Before and After Installation

Expansion-Type

Expansion-type core plugs are installed with the flange edge inward. The maximum diameter of this plug is located at the base of the flange with the flange flaring inward.

CAUTION: It is imperative to push or drive the plug into the machined bore using a properly designed tool. Under no circumstances is the plug to be driven using a tool that contacts the crowned portion of the plug. This method will expand the plug prior to installation and may damage

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the plug and/or plug bore.

When installed, the trailing (maximum) diameter must be below the chamfered edge of the bore to effectively seal the plugged bore.

If the core plug replacing tool has a depth seating surface, do not seat the tool against a non-machined (casting) surface.

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Crankshaft Main and Connecting Rod Bearings

Cleaning

NOTE: Do not scrape gum or varnish deposits from the bearing shells.

Bearings that are to be reused should be identified so they can be installed in their original locations.

Clean the bearing inserts and caps thoroughly in solvent, and dry them with compressed air.

Inspection

Inspect each bearing carefully. Bearings that have a scored, chipped or worn surface should be replaced. Typical examples of unsatisfactory bearings and their causes are shown in the illustration. The copper lead bearing base may be visible through the bearing overlay. If the base showing is less than 20 percent of the total area, the bearing is not excessively worn. It is not necessary to replace the bearing if the bearing clearance is within recommended limits. Check the clearance of bearings that appear to be satisfactory with Plastigage® as described in this section.

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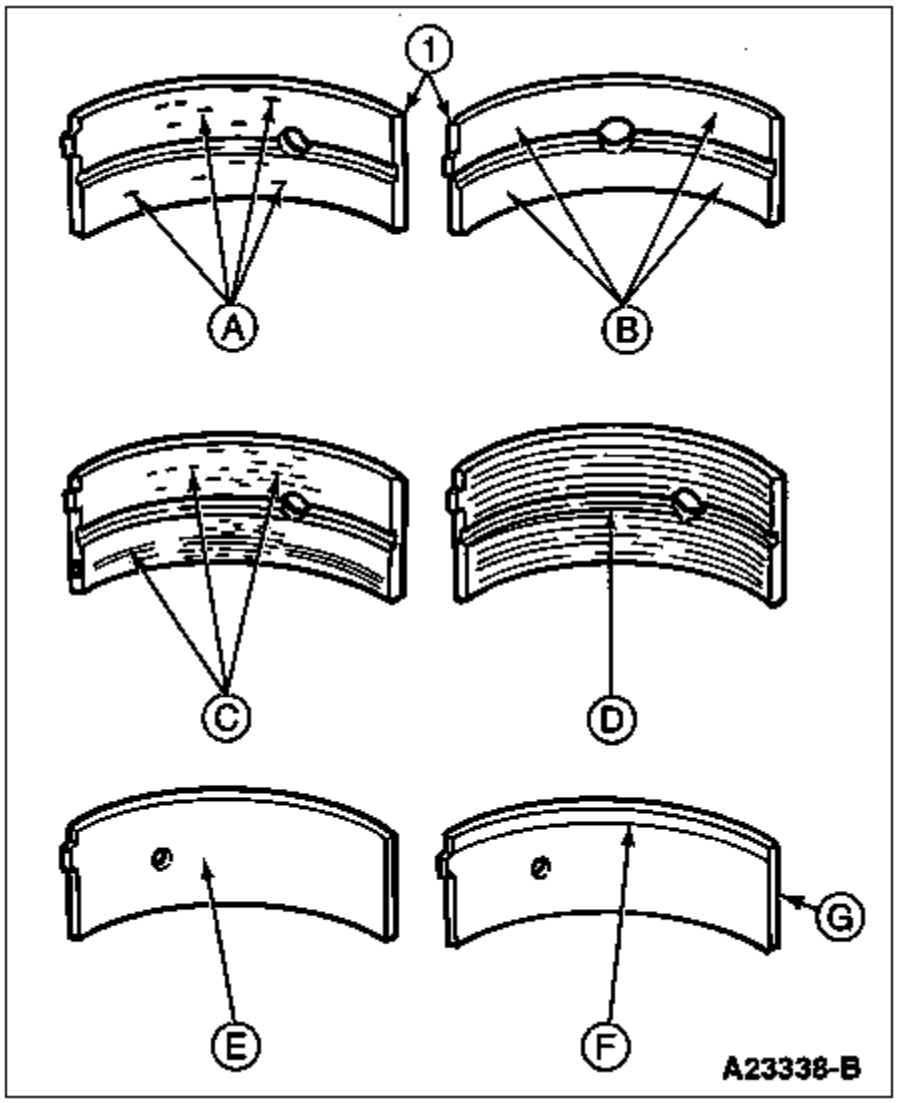

Item	Part Number	Description
1	6333	Connecting Rod Bearing
A	—	Fatigue Failure — Craters or Pockets
B	—	Improper Seating — Bright (Polished) Sections
C	—	Dirt Scratching, Imbedding
D	—	Overlay Wiped Out — Lack of Oil or Improper Clearance
E	—	Hourglass — Overlay Gone from Edges
F	—	Radius Ride
G	—	Overlay Gone from Mating Edge, One Side Only. Rod Cap Shift.

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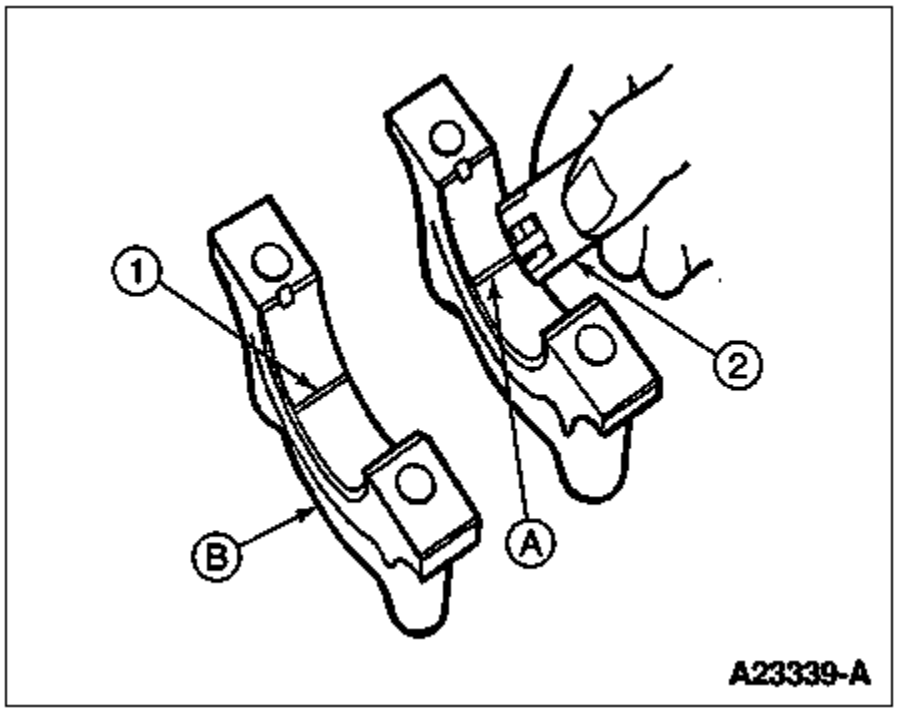
Crankshaft Main or Connecting Rod Bearings — Fitting Plastigage® Method

1. Clean crankshaft journals. Inspect journals and thrust faces for nicks, burrs or roughness that would cause premature bearing wear. **When replacing standard bearings with new bearings, it is good practice to fit bearing to minimum specified clearance.** If desired clearance cannot be obtained with a standard bearing, try a 0.050mm (0.002-inch) undersize bearing set to obtain proper clearance.

2. **CAUTION: Do not position jack under crankshaft pulley. Crankshaft post damage will result.**

   If fitting main bearing in-vehicle, position a jack under counterweight adjoining bearing which is being checked. Support crankshaft (6303) with jack so its weight will not compress Plastigage® and provide an erroneous reading.

3. Place a piece of Plastigage® D81L-6002-B or equivalent on bearing surface across full width of bearing cup and about 6.35mm (1/4 inch) off center.



Item	Part Number	Description
1	D81L-6002-B	Plastigage®
2	—	Plastigage® Scale (Part of D81L-6002-B)
A	—	Check Width of Plastigage®

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B	—	Location of Plastigage® Prior to Tightening

4. Install main bearing cap and tighten bolts to specification. Refer to Section 03-01A , Section 03-01B or Section 03-01C . Do not turn crankshaft while Plastigage® is in place.

5. Remove cap. Using Plastigage® scale, check width of Plastigage® at widest point to get minimum clearance. Check at narrowest point to get maximum clearance. Difference between reading is taper of journals.

6. If bearing clearance exceeds the specified limits, try using one of the various combinations of undersize bearings as directed by the accompanying table. Use of any other bearing combination is not recommended. Bearing clearance must be within specified limits. Refer to Specifications in Section 03-01A , Section 03-01B or Section 03-01C for main and connecting rod bearing clearance limits. If use of these bearing combinations does not bring clearance to the desired limits, refinish the crank journal to a standard undersize, and use the appropriate undersize bearing.

7. After bearing has been fitted and cleaned, apply a light coat of engine oil to journal and bearings. Install main bearing cap. Tighten main bearing cap bolts to specification. Refer to Section 03-01A , Section 03-01B or Section 03-01C .

For This Amount of Bearing Clearance Excess		Use This Bearing Size			
		(Upper Bearing)		(Lower Bearing)	
mm	Inch	mm	Inch	mm	Inch
0.0-0.013	0.0-0.0005	0.025	0.001 U.S.	Standard	Standard
0.013-0.026	0.0005-0.0010	0.025	0.001 U.S.	0.025	0.001 U.S.
0.026-0.039	0.0010-0.0015	0.050	0.002 U.S.	0.025	0.001 U.S.
0.039-0.052	0.0015-0.0020	0.050	0.002 U.S.	0.050	0.002 U.S.

Bore Gauge Method

1. Install bearings in the cylinder blocks (6010) and main bearing caps.

2. Install and tighten main bearing cap bolts to specification. Refer to Section 03-01A , Section 03-01B or Section 03-01C .

3. Use a micrometer to measure main bearing journals. Refer to the procedure in this section.

4. Use a bore gauge to measure the inside diameter of each bearing assembly. It may be necessary to measure the outer bearings first, then remove the main bearing caps and measure the inner bearings.

5. Subtract the maximum measurement for each journal from the minimum measurement of each bearing to determine the minimum oil clearance.

   Allowable clearances are:

   2.3L: Number one main bearing 0.010-0.054mm (0.0004-0.0021 inch) Numbers two to five main

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bearings 0.020-0.064mm (0.0008-0.0025 inch).

3.0L: 0.013-0.058mm (0.0005-0.0023 inch).

4.0L: 0.013-0.048mm (0.0005-0.0019 inch).

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Crankshaft

Cleaning

CAUTION: Handle the crankshaft (6303) with care to avoid possible damage to the finished surfaces.

Clean the crankshaft with solvent, then blow out all oil passages with compressed air.

Inspection

Measure the diameter of each journal in at least four places to determine an out-of-round, taper or undersize condition. For specifications, refer to Section 03-01A , Section 03-01B or Section 03-01C .

On vehicles equipped with a manual transmission, check the fit of the pilot bearing (7600) in the bore of the crankshaft. A needle roller bearing and adapter assembly is used as a pilot bearing. It is press fit directly into the crankshaft and should not be loose. Inspect the inner surface of the pilot bearing for wear or a bell-mouth condition. Check the inside diameter of the pilot bearing to see if it is worn or damaged. The bearing and adapter assembly cannot be serviced separately. The pilot bearing can only be installed with the seal end of the bearing facing the transmission. The bearing and seal are pregreased and do not require additional lubrication.

NOTE: A new pilot bearing must be installed whenever a pilot bearing is removed.

Inspect the pilot bearing, when used, for roughness, evidence of overheating or loss of lubricant. Replace if any of these conditions are found.

Crankshaft Runout

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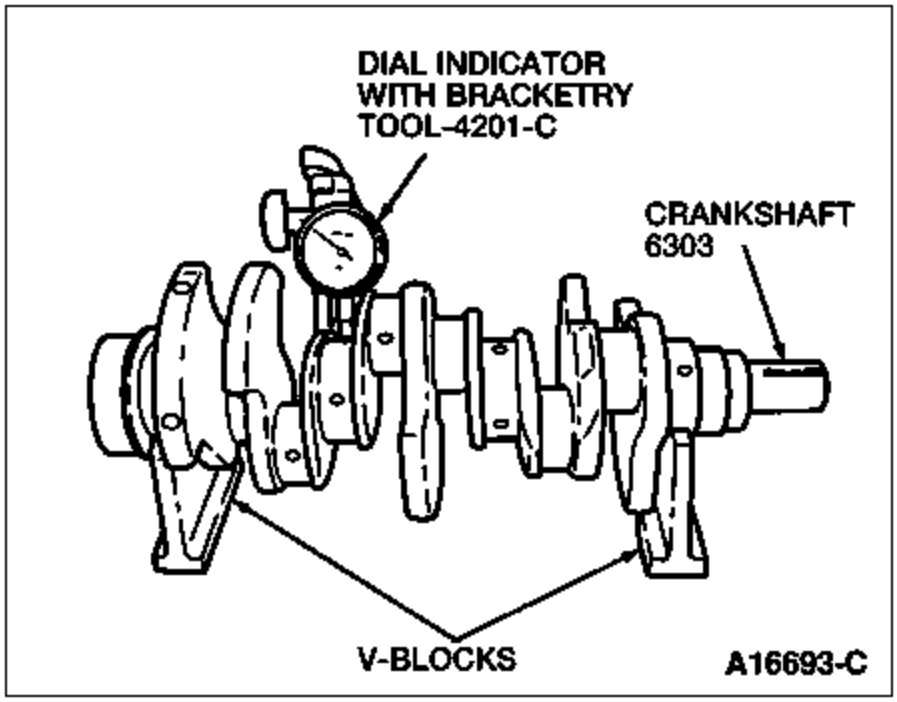

NOTE: Check crankshaft journals for out-of-round before checking for runout, or an out-of-round condition on the center journal could be confused for an excess runout condition.

1. Set V-blocks on surface plate and set crankshaft on V-blocks supported on the outer two main bearing journals.
2. Set up TOOL-4201-C or equivalent Dial Indicator with Bracketry to measure runout on center main bearing journal.
3. Zero dial indicator.
4. Slowly rotate crankshaft one revolution, recording highest and lowest readings.

Crankshaft End Play

Refer to crankshaft end play elsewhere in this section. Crankshaft must be installed in block with the bearings that will be used, but without connecting rods (6200), pistons (6108), or flywheel (6375) installed to check end play.

Crankshaft Main Journal and Connecting Rod Journals

Inspect the main journal and crankpin journal diameters. Measure the diameter of each journal at two different points in the directions as shown.

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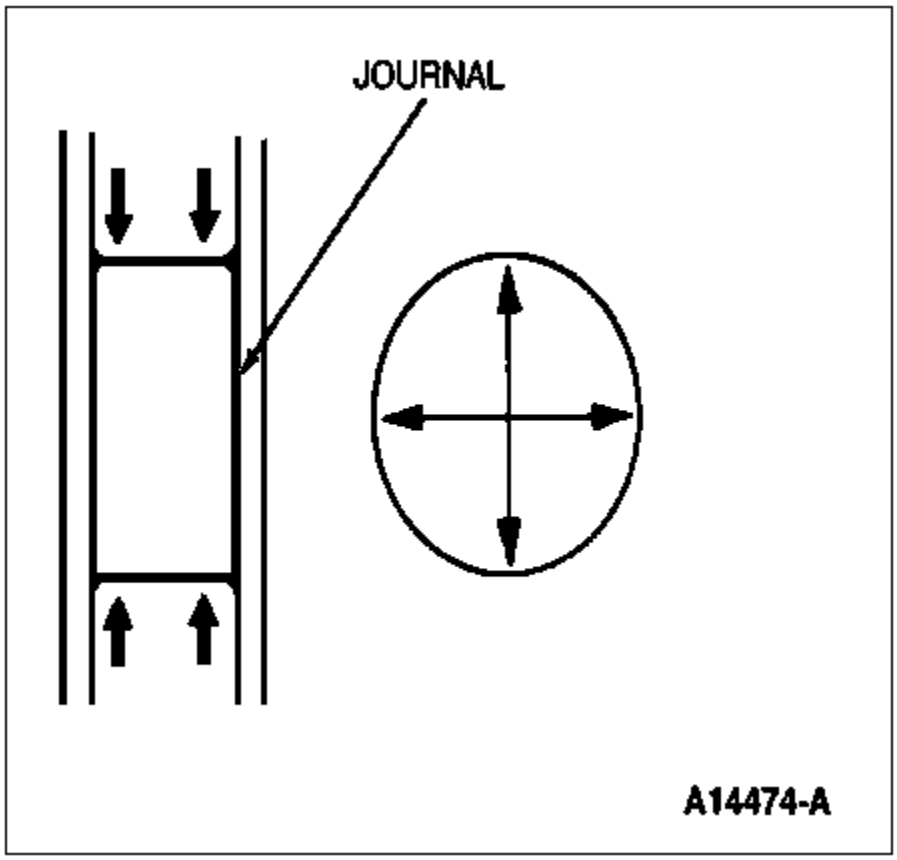

Refer to Section 03-01A , Section 03-01B or Section 03-01C for crankshaft journal specifications.

Journals, Refinishing

NOTE: Polish direction is clockwise as viewed from the front of the crankshaft.

Dress minor imperfections such as scores, nicks or burrs with an oil stone.

If journals are severely marred or exceed service limits for wear, taper, or out of round, they should be refinished to size for the next undersize crankshaft main bearing.

Follow crankshaft lathe manufacturer's instructions for refinishing crankshaft.

If the journals will not clean up to less than the maximum undersize bearing available, replace the crankshaft.

Always reproduce the same journal shoulder radius that existed originally. Too small a radius will result in fatigue failure of the crankshaft. Too large a radius will result in bearing failure due to radius ride of the crankshaft bearing.

After refinishing the journals, chamfer the oil holes. Polish the journals with a No. 500 grit polishing cloth and engine oil (crocus cloth may also be used as a polishing agent) to obtain a smooth finish.

Crankshaft Sprocket

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Inspect crankshaft sprocket (6306) for chipped, broken, or excessively worn teeth. Remove and replace as outlined in the appropriate Section 03-01A , Section 03-01B or Section 03-01C , depending on engine, if necessary.

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Pistons, Piston Pins and Piston Rings

Cleaning

1. Clean piston (6108) using suitable solvent.
2. Using a putty knife or scraper clean carbon off of the top of the piston.
3. Do not use a power wire brush to clean the piston skirt, crown, or piston ring grooves as it will remove metal.
4. If using a ring groove scraper, be careful not to remove metal from the piston ring lands.

Inspection

1. Inspect for a hole or crack in top of piston caused by pre-ignition or foreign object damage.
2. Excess wear in ring lands indicated by visible steps worn in ring lands.
3. Scoring or gouges on piston skirt or crown.
4. Looseness between piston and piston pin.

Pistons — Fitting

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Engine Cylinder Hone Set	T73L-6011-A

NOTE: There are two procedures for piston fitting. One is used when the original standard-size bore shows little wear and can be cleaned up. The second is used after the cylinder has been rebored.

Original Bore

1. Measure cylinder bore as outlined in this section under Cylinder Bore Measuring . If cylinder bore is not damaged and wear, taper, and out-of-round are within specifications listed in the appropriate Section 03-01A , Section 03-01B , or Section 03-01C . Depending on engine, then the cylinder bore may be cleaned up and reboring is unnecessary.
2. Hone cylinder, if necessary, to restore a proper crosshatch pattern so new rings can seat. Remove as little of the cylinder wall as possible.
    - If clearance exceeds specifications, the piston will have to be replaced.
    - If clearance is within specifications, proceed to assemble and install the piston as outlined in Section 03-01A , Section 03-01B or Section 03-01C depending on which engine.

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3. **NOTE: On 2.3L and 4.0L engines (6007) red select fit pistons are available for select fitting a standard size bore if only a slight cleanup was required. On 3.0L engines red and blue select fit pistons are available. On 3.0L engines a yellow 0.076mm (0.003 inch) oversize piston is available if greater cleanup was required. Refer to Master Parts Catalog.**

   Subtract from cylinder bore dimension determined earlier. If within specifications in Section 03-01A , Section 03-01B or Section 03-01C , install the piston as outlined in that section. If not, try the other color piston. If neither of the standard bore "color" pistons can be brought within the maximum clearance, fit the selected oversize piston.

After Reboring

NOTE: When reboring cylinder, leave bore 0.13mm (0.005 inch) undersize to allow for honing and fitting piston. Measure the diameter of the oversize piston on the thrust side at right angles to the piston pin (6135) 24.5mm (1.000 inch) below the oil ring groove for 2.3L, 3.0L, and 4.0L engines.

Oversize pistons are available in 0.51mm (0.020 inch), 0.76mm (0.030 inch) and 1.02mm (0.040 inch). Refer to Master Parts Catalog.

1. Remeasure the cylinder bore. Refer to the Cylinder Bore Measuring procedure in this section.

2. Subtract the piston diameter from the cylinder bore diameter to determine how much material must be removed during honing to establish correct piston-to-cylinder bore clearance. Refer to the specifications in Section 03-01A , Section 03-01B or Section 03-01C .

3. Use T73L-6011-A Engine Cylinder Hone Set to hone the cylinder bore to bring the piston-to-cylinder clearance within specifications.

   - Take frequent measurements to assure you do not remove too much metal from the cylinder bore.
   - Move hone up and down to attain proper crosshatch pattern and prevent tapering or bell-mouthing the cylinder bore.

4. Once proper fit and crosshatch pattern is achieved, assemble and install piston. Refer to the procedure in Section 03-01A , Section 03-01B or Section 03-01C . If the entire engine is being rebuilt, make sure piston and rod assemblies are marked so each piston is installed in the bore to which it was fitted.

Piston Rings — Fitting

NOTE: Do not reinstall used piston rings (6149). A special break-in finish, and sometimes an anti-scuff coating, is given to new piston rings by the factory. The purpose of the special finish is to help the new piston rings and cylinder bore mate properly. The special finish, like the crosshatching on the cylinder bore, wears off during break-in. The special finish will be already worn off used piston rings so they probably will not seat properly. For this reason attempting to reuse piston rings could lead to excess oil consumption and possible cylinder scoring.

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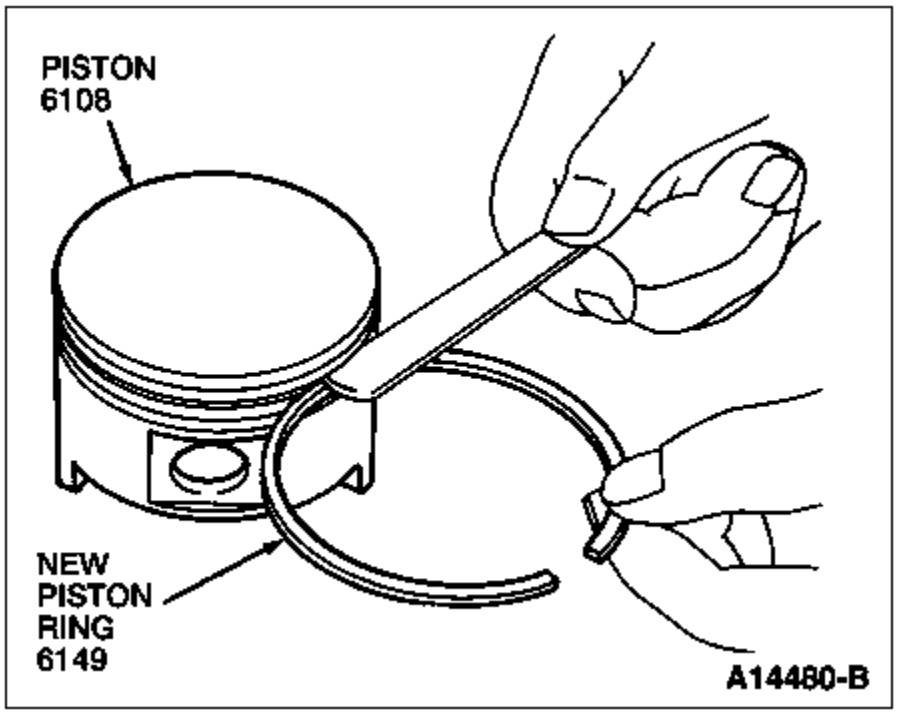
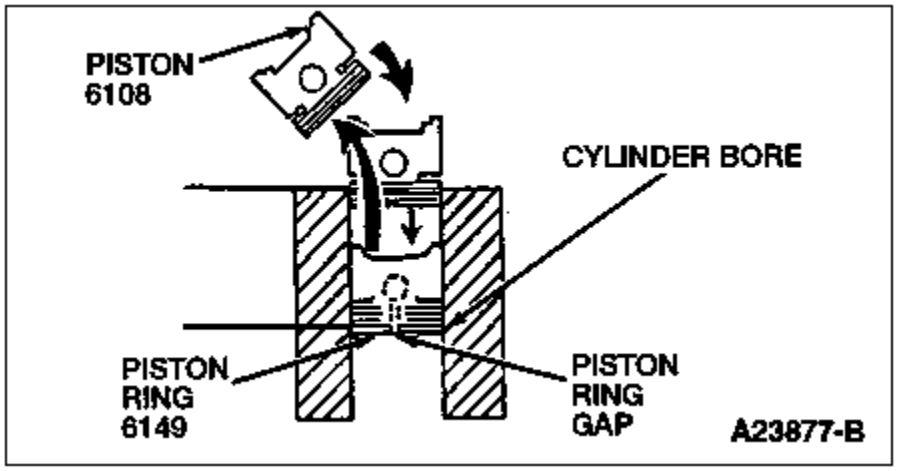


1. Insert each piston ring backwards in the appropriate piston ring groove.
2. Measure the clearance between the piston ring and groove (side clearance) with a feeler gauge and check against the side clearance specifications in Section 03-01A , Section 03-01B or Section 03-01C .
3. Insert the piston ring in the cylinder bore.
4. Using the piston, without piston rings, turned upside down, press the piston ring down to the center of the cylinder bore.



5. Make sure the piston ring is "square" in the cylinder bore.
6. Check the piston ring end gap specification in Section 03-01A , Section 03-01B or Section 03-01C .

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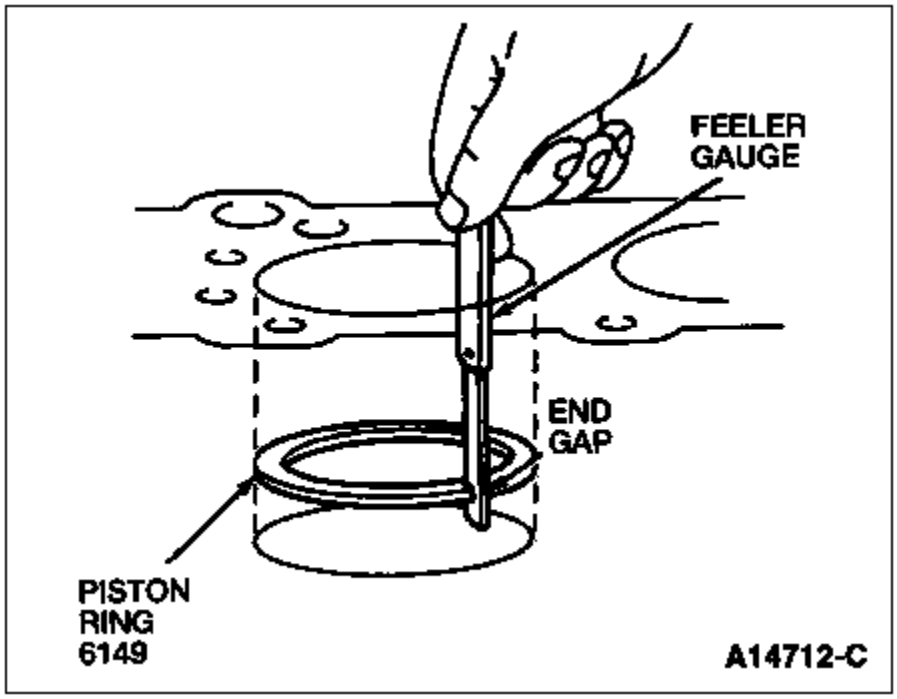
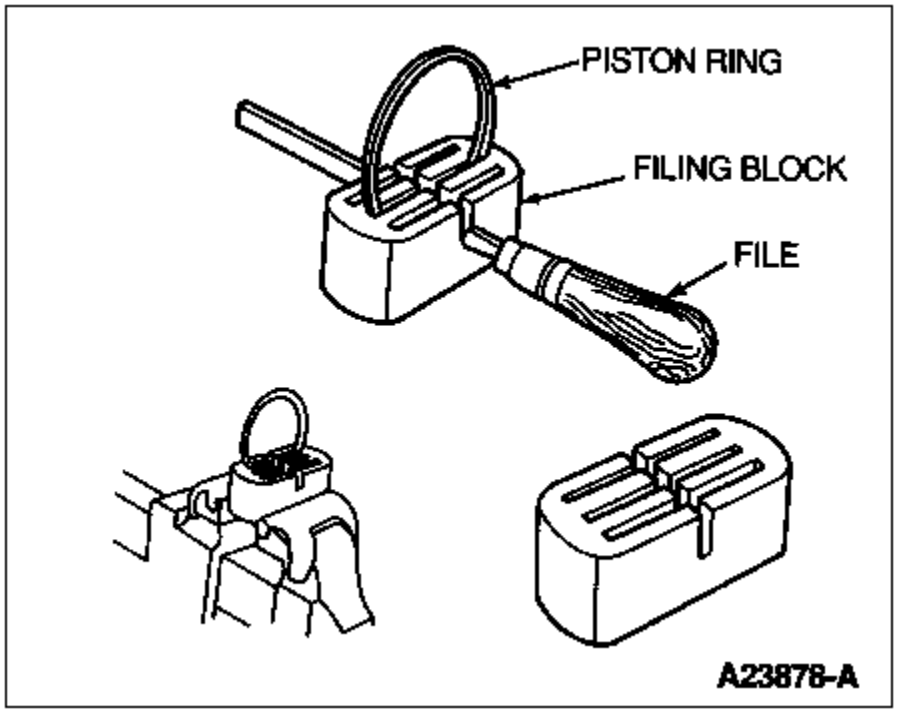
Use a feeler gauge to check the piston ring end gap.



7. If the piston ring end gap is too small, the piston ring will have to be filed until the piston ring end gap is within specifications. The use of a ring filing block helps ensure that the piston ring ends are filed square.



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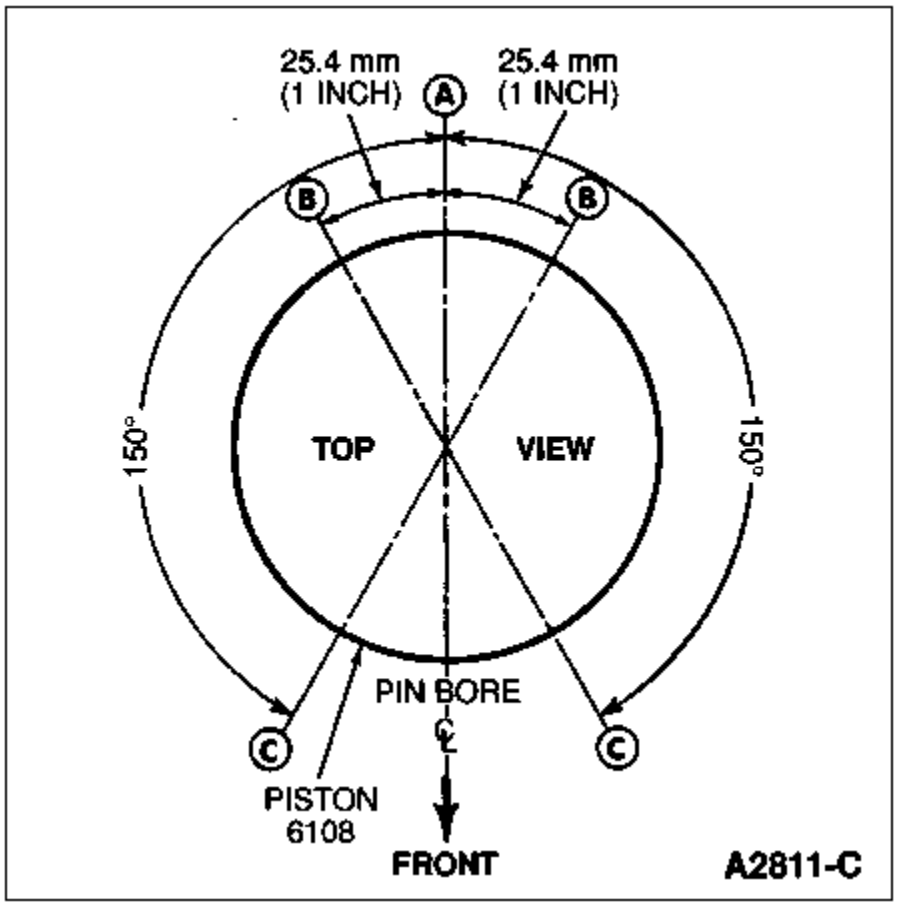
8. **CAUTION: Install the piston rings after the piston has been installed on the connecting rod. Since the piston may be supported by the crown during this operation, the piston rings could be damaged.**

   CAUTION: Use a piston ring expander to install the piston rings. Attempting to wind them on by hand may put a deep scratch in the piston or break the piston ring.

   Using a piston ring expander, install the piston rings starting with the oil control rings. Make sure piston rings are installed right side up. Refer to instructions with the piston ring set.

9. Rotate the piston rings so the piston ring end gaps are NOT lined up but are spaced properly as shown.



10. Use a feeler gauge to recheck piston ring side clearance.

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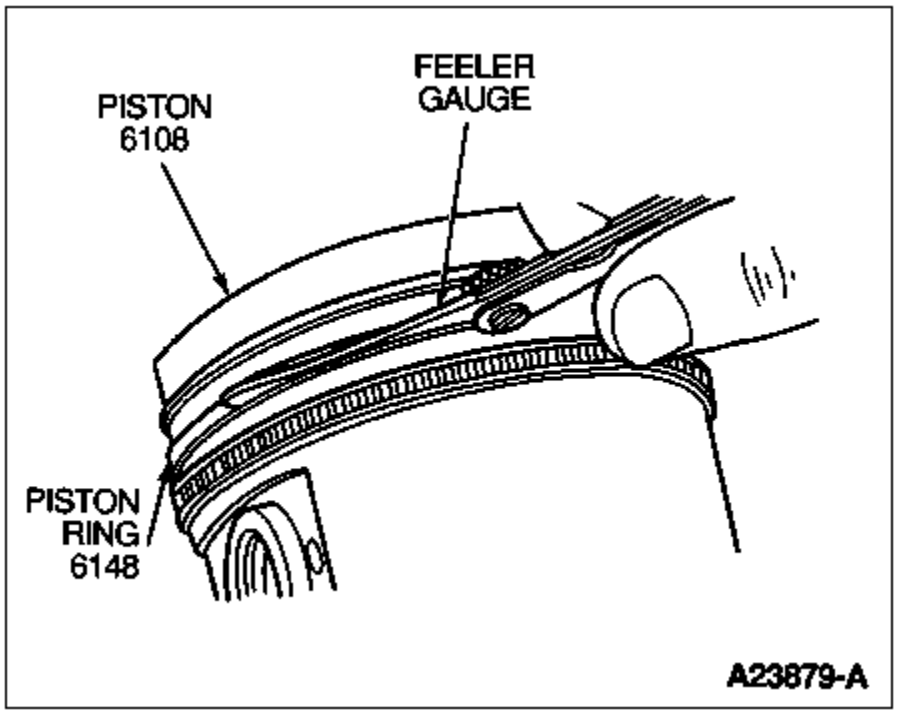

Piston and Piston Pin Fit

NOTE: New pistons come with fitted piston pins and should not require refitting unless the connecting rod bore is oversize.

All 2.3L, 3.0L, 4.0L engines use piston pins which press into the connecting rod (6200). The piston pivots on the piston pin. There is no connecting rod bushing but rather an interference fit between the piston pin and the connecting rod.

Refer to Section 03-01A , Section 03-01B or Section 03-01C for specifications and assembly instructions.

1. Clean and inspect the connecting rod. Refer to the procedure in this section.
2. Clean and inspect the piston and piston pin. Refer to the procedure in this section.
3. Use a suitable micrometer to measure the piston pin both places where the piston pivots and in the center where it is pressed into the connecting rod.
4. Use a suitable set of plug gauges or bore gauge to measure the upper bore of the connecting rod. An interference fit is required. If the bore is oversize it will be necessary to install an oversize piston pin. It is not necessary to rebore or ream the connecting rod.
5. If the pin-to-rod fit is within specifications, measure the piston pin bores in the piston.
6. Subtract the piston pin size from the piston pin bore sizes. Pin-to-piston clearance is listed in the Specifications in Section 03-01A , Section 03-01B or Section 03-01C .

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If clearance is excessive it will be necessary to fit an oversize piston pin.

7. To fit an oversize piston pin because either the pin-to-connecting rod or pin-to-piston clearance was excessive:

   - Obtain an appropriate oversize piston pin.
   - Hone or ream the piston pin bores in the piston to obtain the correct clearance.
   - It is not necessary to hone or ream the connecting rod piston pin bore oversize.

8. Once piston pin, connecting rod, and piston are correctly sized to each other, assemble as outlined in Section 03-01A , Section 03-01B or Section 03-01C .

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Connecting Rods

Piston Pin Clearance

Refer to Piston and Piston Pin Fit in this section.

Cleaning

Remove the bearings from the connecting rod (6200) and connecting rod cap. Identify each bearing location if they are to be used again. Clean the connecting rod in solvent, including the connecting rod bore and the back of the bearings. Do not use a caustic cleaning solution. Blow out all oil passages with compressed air.

Inspection

The connecting rods and related parts should be carefully inspected and checked for conformance to specifications. For specifications, refer to Section 03-01A , Section 03-01B or Section 03-01C . Various forms of engine wear caused by these parts can be readily identified.

A shiny surface on either pin boss inside of the piston (6108) usually indicates that a connecting rod is bent.

Abnormal connecting rod bearing wear can be caused by either a bent connecting rod, worn or damaged piston pin (6135), or a tapered connecting rod bore.

Twisted connecting rods can create an identifiable piston skirt wear pattern, but badly twisted connecting rods will disturb the action of the entire piston, piston rings, and connecting rod assembly and may be the cause of excessive oil consumption.

Check the connecting rods for bend or twist on a suitable alignment fixture. Follow the instructions of the fixture manufacturer. If the bend or twist exceeds specification, the connecting rod must be replaced.

Inspect the connecting rods for signs of fractures and the connecting rod bearing bores for out-of-round and taper. If the bore exceeds the recommended limits or if the connecting rod is fractured, it should be replaced.

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Camshaft/Cylinder Head Journals

Cleaning

1. Remove camshaft sprocket (6256) from camshaft (6250).
2. Clean the camshaft in an appropriate solvent and wipe it dry.
3. Remove light scuffs, scores, or nicks from the camshaft machined surfaces with an oil stone.

Inspection

Inspect the camshaft journals and lobes for scoring and signs of abnormal wear.

Lobe pitting, except in the general area of the lobe toe, is not detrimental to the operation of the camshaft. The camshaft should not be replaced unless cam lobe lift loss has exceeded the specifications or pitting has occurred in the cam lobe lift area.

Camshaft Bearings

1. If engine (6007) has not been disassembled and cleaned, wipe bearing bore clean with a clean rag and solvent. Dry with a clean rag.
2. Inspect for scoring and visible wear. Inspect if Babbitt has been worn away to base. If visibly worn or damaged, bearings will have to be replaced. If one of the center bearings is worn significantly more than the end bearings, check camshaft for excessive runout.
3. Using suitable bore gauge or inside micrometer, measure each bearing twice, 90 degrees apart, to determine bearing size and out-of-round.
4. Check results against specifications in appropriate Section 03-01A , Section 03-01B , or Section 03-01C , depending on which engine you are working on. If bearings are out of specifications, they will have to be replaced. Check camshaft journals before replacing bearings to determine if undersize bearings are required.
5. If necessary, replace bearings as outlined in Section 03-01A , Section 03-01B , or Section 03-01C , depending on which engine you are working on.

Camshaft Bearing Journals

1. Measure each journal twice, 90 degrees apart, to determine journal wear, size, and out-of-round.
2. Check measurements against specifications in Section 03-01A , Section 03-01B , or Section 03-01C , depending on which engine you are working on.
3. If journals are excessively out-of-round or worn, regrind to a standard undersize. Refer to Master

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Parts Catalogue. If journals are too worn to be refinished to an available undersize, camshaft will have to be replaced.

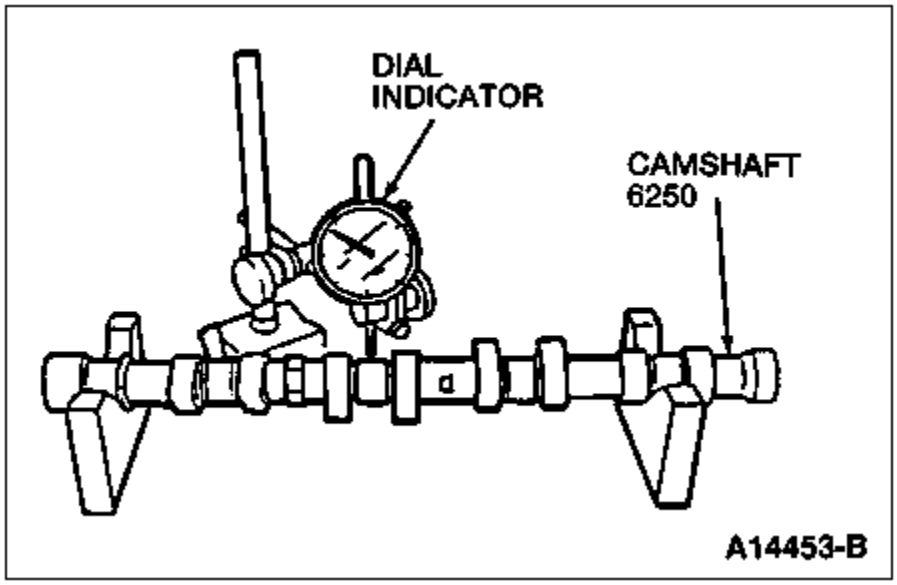
Camshaft Journals Oil Clearance

1. Measure camshaft bearings and camshaft bearing journals as outlined in this section.
2. Subtract size of journal from the size of its bearing.
3. Check clearance against specifications in Section 03-01A , Section 03-01B or Section 03-01C , depending on which engine you are working on.
4. If clearance is excessive, but camshaft journals are within specifications, simply install new bearings. If both bearings and journals are worn, turn camshaft journals to a standard undersize and install new undersize bearings.

Camshaft Runout

1. **NOTE: Check camshaft journals for out-of-round before checking for runout, or an out-of-round condition on the center journal could be confused for an excess runout condition.**

   Set suitable V-blocks on surface plate. Support outer camshaft journals on V-blocks.
2. Set up D78P-4201-B or equivalent Dial Indicator with Bracketry to check center bearing journal.
3. Zero dial indicator.
4. Slowly rotate camshaft to determine overall runout. If runout exceeds 0.03mm (0.0012 in.), replace camshaft.



Cam Lobe Lift (Camshaft Removed)

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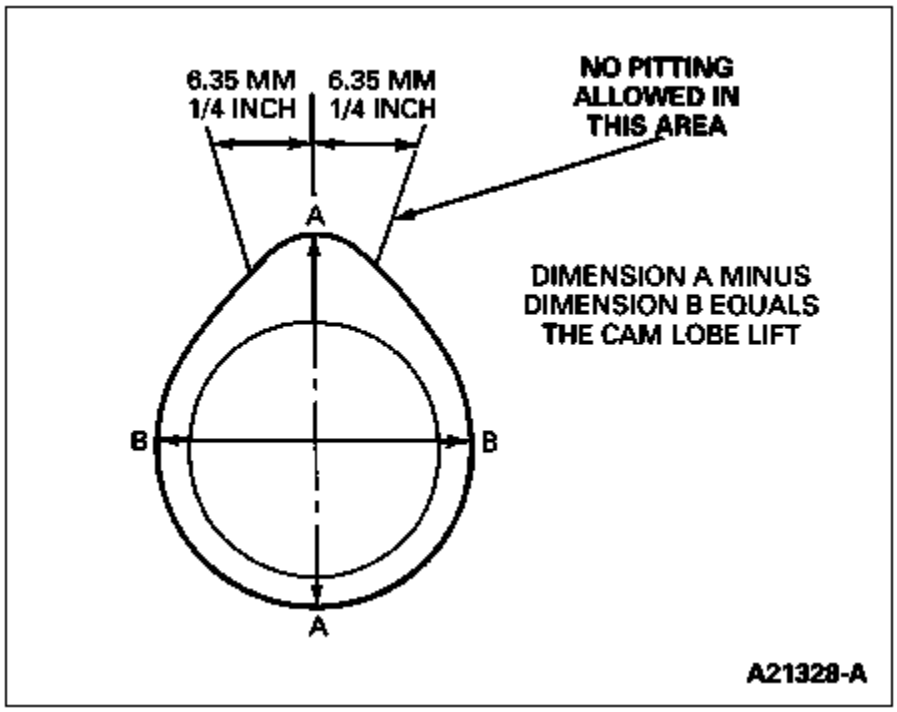
There are two ways of measuring cam lobe lift with the camshaft bearing (6261) removed, with a vernier caliper camshaft bearing or on a lathe or cam grinder with a dial indicator. The second method is more accurate.

With Calipers

1. Inspect camshaft bearing as outlined in this section.
2. Measure the distance of each cam lobe at the major diameter.
3. Measure the distance of each cam lobe at the minor diameter.
4. For each cam lobe, subtract the minor diameter from the major diameter. The result for each lobe is the lobe lift.
5. Check the lobe lift for each cam lobe against the specifications in Section 03-01A , Section 03-01B or Section 03-01C depending on which engine you are working on.
6. If any cam lobe is worn excessively, the camshaft and tappets will have to be replaced.



On a Camshaft Grinder or Lathe

1. Clean and inspect the camshaft as outlined in this section.
2. Install the camshaft on the lathe or camshaft grinder centers.
3. Position the dial indicator which comes with the machine at the heel of the cam lobe which you are

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going to check.

4. Zero the dial indicator.
5. Slowly turn the camshaft until the point of the dial indicator is on the tip of the cam lobe.
6. Read the dial indicator. This is your cam lobe lift.
7. Check the lobe lift against the specifications in Section 03-01A , Section 03-01B or Section 03-01C . If any cam is excessively worn, the camshaft and tappets will have to be replaced.

Camshaft Journal Oil Clearance

1. Use a suitable bore gauge or inside micrometer to measure camshaft bearings and camshaft bearing journals.
2. Subtract size of journal from the size of its bearing.
3. Check clearance against specifications in Section 03-01A , Section 03-01B or Section 03-01C .
4. If clearance is excessive, but camshaft journals are within specifications, install new bearings. If both bearings and journals are worn, turn camshaft journals to a standard undersize and install new oversize bearings.

Camshaft Sprocket

Inspect camshaft sprocket for worn or broken teeth. If necessary, remove as outlined in Section 03-01A , Section 03-01B or Section 03-01C .

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Hydraulic Valve Tappets

Valve tappets (6500) should be kept in proper sequence so that they can be installed in their original position. Inspect and test each valve tappet separately so as not to intermix. If any part of the valve tappet assembly needs replacing, replace the entire assembly.

Cleaning

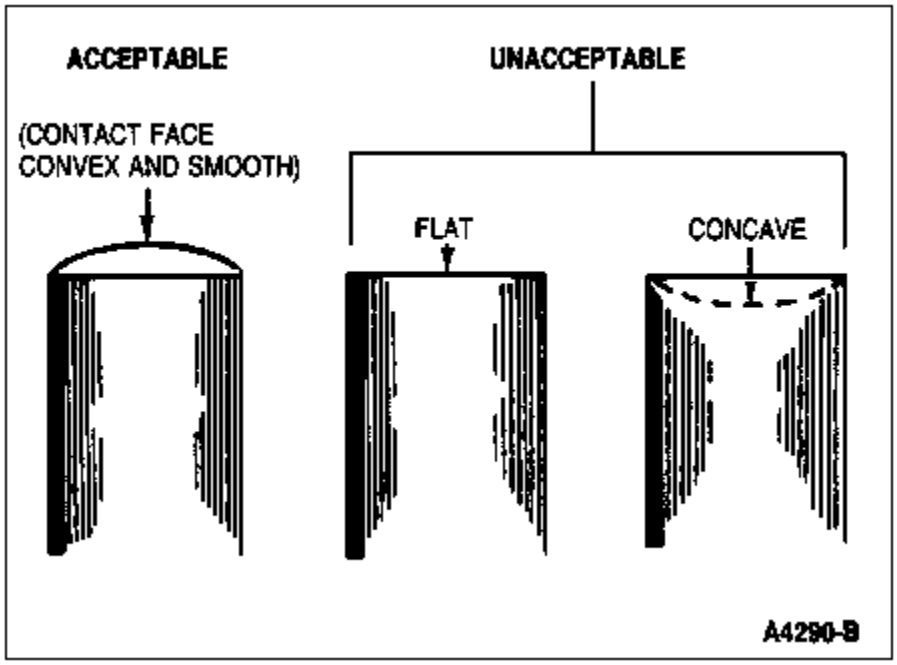
Thoroughly clean all the parts in clean solvent and wipe them with a clean, lint-free cloth.

Inspection

Inspect the parts and discard the entire valve tappet assembly if any part shows pitting, scoring or excessive wear. Replace the entire assembly if the plunger is not free in the body. The plunger should drop to the bottom of the body by its own weight when assembled dry and check ball assembly removed.

Assemble the valve tappet assembly and check for freedom of operation by pressing down on the plunger. The valve tappets can also be checked with a hydraulic tester to test the leak-down rate. Follow the instructions of the test unit manufacturer or refer to Valve Train Analysis — Dynamic in this section.

Valve, Flat — Tappet Wear



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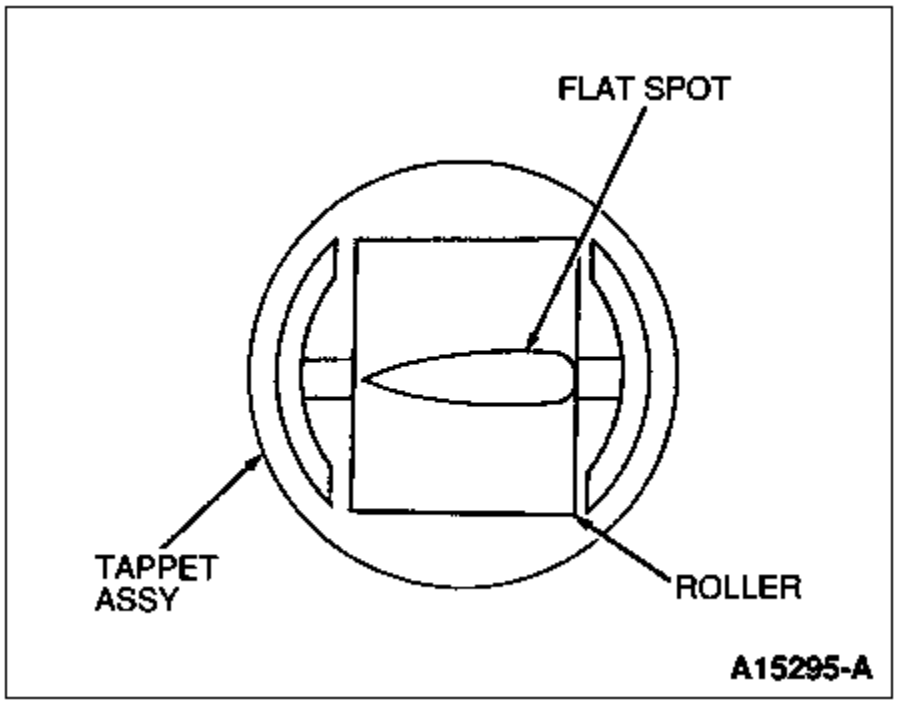
Valve Roller — Tappet Wear

Inspect roller tappet for flat spots or scoring. If flat spot is found, roller tappet must be replaced. Check camshaft lobes for proper height, or wear. Replace as required.



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Oil Pump

NOTE: On 2.3L engine, do not disassemble oil pump (6600) for inspection. If oil pump is questionable, replace it.

Cleaning

1. If not removed as part of engine disassembly, remove oil pump. Refer to Section 03-01B or Section 03-01C .
2. If not done already, lift out oil pump intermediate shaft (6A618).
3. Remove two oil pump screen cover and tube bolts and oil pump screen cover and tube (6622).
4. Remove the cover plate bolts and the cover plate.
5. Remove the inner rotor and shaft assembly, then remove the outer race.
6. Drill a small hole and insert a self-threading sheet metal screw of the proper diameter into the oil pressure relief valve chamber cap and pull the cap out of the chamber. Remove the spring and plunger.

Oil Pump — Typical (4.0L Shown)

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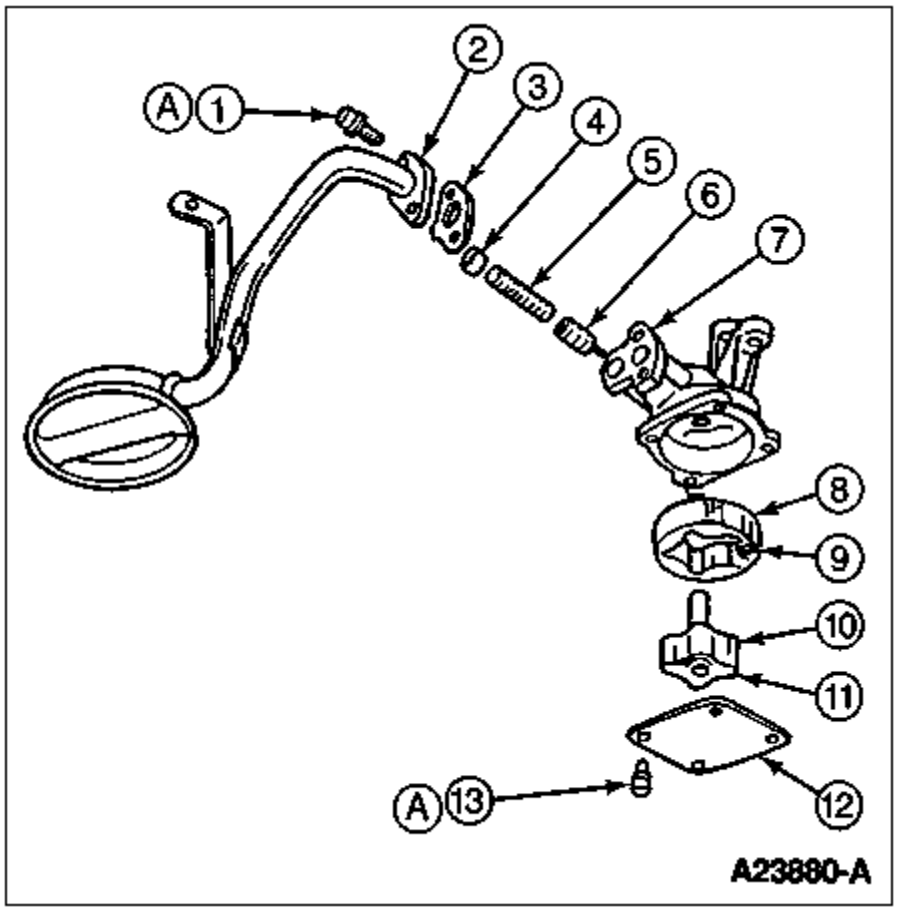

Item	Part Number	Description
1	—	Oil Pump Screen Cover and Tube Bolt
2	6622	Oil Pump Screen Cover and Tube
3	6626	Gasket
4	—	Plug (Part of 6600)
5	—	Oil Relief Valve Spring (Part of 6600)
6	—	Oil Relief Valve Plunger (Part of 6600)
7	—	Oil Pump Body (Part of 6600)
8	—	Outer Rotor (Part of 6600)
9	—	Identification Mark (Part of 6600)
10	—	Inner Rotor (Part of 6600)
11	—	Identification Mark (Part of 6600)
12	—	Cover Plate (Part of 6600)
13	—	Cover Plate Bolt (Part of 6600)
A	—	Tighten to 14-20 Nm (11-14 Lb-Ft)

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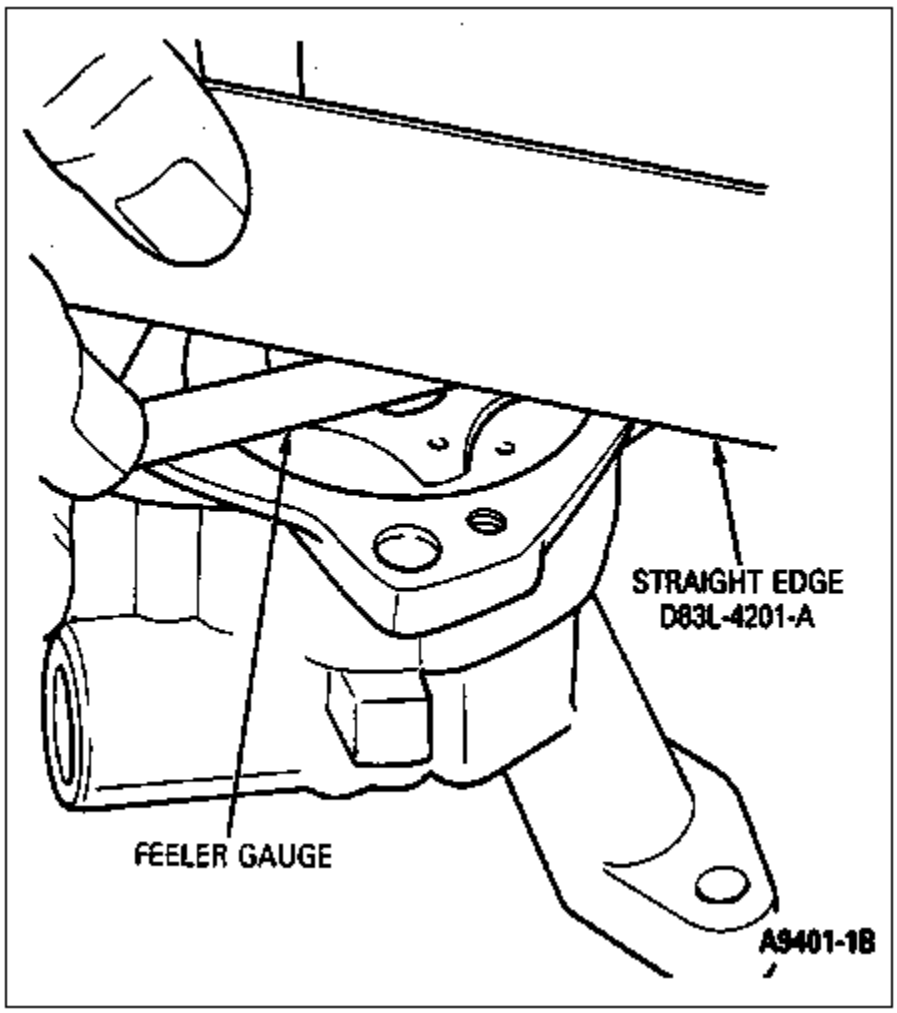
7. Clean all parts in solvent and dry them thoroughly with compressed air. Use a brush to clean the inside of the pump housing and pressure relief valve chamber. Make sure all dirt and metal particles are removed.

Inspection

1. Look for deep scoring in cover plate. Light concentric scratches only indicate that the pump has been used, and are acceptable. If cover plate is deeply scored, replace oil pump.
2. Look for scoring or wear on the shaft. If severely scored, replace shaft.
3. Inspect the rotor for burrs or score marks.
4. Remove minor imperfections from parts with an oil stone.

Rotor Clearance



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1. Use a straightedge and feeler gauge to make sure inside of cover plate is flat. If a 0.038mm (0.0013 inch) feeler gauge can go under straightedge, replace oil pump.

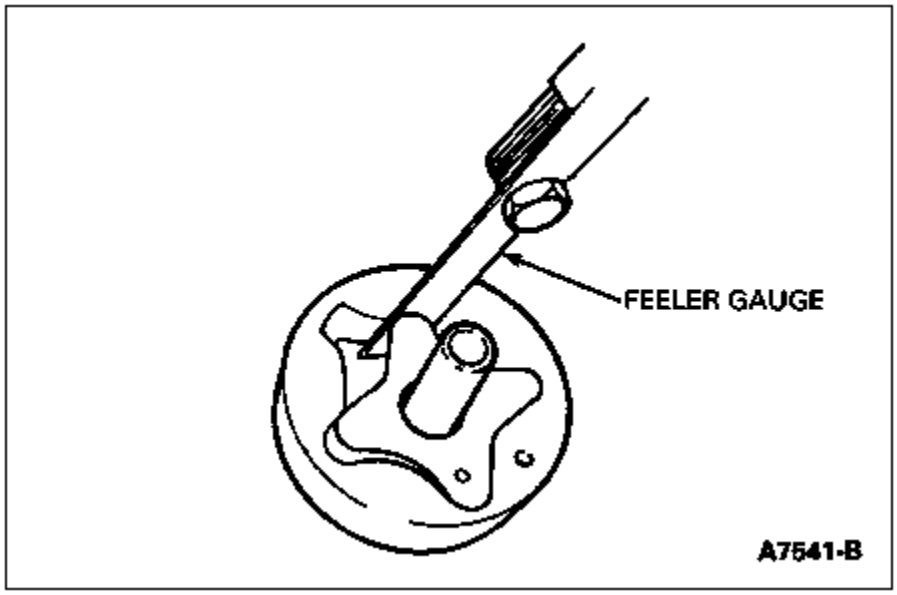
2. Insert the inner and outer rotor into the oil pump housing.

3. Place a straightedge over the rotor assembly and the oil pump housing.

4. Measure the clearance between the straightedge and the inner rotor, then the outer rotor. Clearance must not exceed 0.10mm (0.004 inch).

   If clearance is excessive, replace oil pump.

Tooth Tip Clearance



1. With inner and outer rotor installed, use feeler gauge to measure clearance between inner and outer rotor at tip of inner rotor furthest from outer rotor.

2. Check against specifications in Section 03-01B or Section 03-01C .

3. If clearance is excessive, replace oil pump.

Outer Rotor-to-Pump Body Clearance

1. Use feeler gauge to measure clearance between outer rotor (race) and housing.

2. Check against specifications in Section 03-01B or Section 03-01C .

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3. If clearance is excessive, replace oil pump.

Pressure Regulator Valve Inspection

Inspect valve plunger for scoring and free operation. Light scratches may be removed with a crocus cloth.

Pressure Regulator Valve Spring Inspection

1. Inspect for breaks, cracks, tilting, and collapsed coils.

2. Use Valve/Clutch Spring Tester TOOL-6513-DD or equivalent to check valve spring tension. Check against specifications in Section 03-01B or Section 03-01C . A weak spring must be replaced.

Pressure Regulator Valve to Housing Clearance

1. Use plug gauge to measure regulator valve bore.

2. Use micrometer to measure outside of plunger.

3. Subtract plunger diameter from bore size and check against specifications in Section 03-01B or Section 03-01C . If clearance is excessive, replace oil pump.

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Oil Pan

Cleaning

CAUTION: Do not damage the oil level sensor (if equipped) when cleaning the oil pan (6675).

Scrape any dirt or metal particles from the inside of the oil pan. Scrape all old gasket material from the gasket surface. Wash the pan in a solvent and dry it thoroughly. Make sure all foreign particles are removed.

Inspection

Check the oil pan for cracks, holes or damaged drain plug threads. Check the gasket surface for damage caused by overtightened bolts. Replace with a new oil pan if repairs cannot be made.

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Cylinder Heads

NOTE: Do not plane or grind more than 0.254mm (0.010 inch) from original cylinder head gasket surface.

Replace the cylinder head (6049) if it is cracked. Remove all burrs or scratches with an oil stone.

Cleaning

With the valves installed to protect the valve seats, remove deposits from the combustion chambers and valve heads with a scraper and a wire brush. Be careful not to damage the cylinder head gasket surface. After the valves are removed, clean the valve guide bores. Use cleaning solvent to remove dirt, grease and other deposits from the valves with a fine wire brush or buffing wheel.

Inspection

Inspect the cylinder heads for cracks or excessively burned areas in the exhaust outlet ports.

Check the cylinder head for cracks and inspect the gasket surface for burrs and nicks. Small imperfections of this type can be dressed down using an oil stone. Replace the cylinder head if it is cracked.

The following inspection procedures are for a cylinder head that is to be completely overhauled. For individual repair operations, use only the pertinent inspection procedure.

Spark Plug Thread Service

NOTE: The use of power or air driven tools is not approved for the installation of tapersets.

Damaged spark plug threads in the cylinder head can be serviced using Rotunda Sav-A-Thread Spark Plug Kit 107-R0921 or equivalent.

The procedure involves cutting new threads in the spark plug hole. After rethreading operation, a tapered sleeve will be installed in the cylinder head. The sleeve is threaded on the inside and outside. The outside threads into the cylinder head while the inside provides new threads for the spark plug (12405).

The service is permanent and will have no effect on cylinder head or spark plug life.

CAUTION: The cylinder head must be removed from engine (6007) before installing a taperset. The service procedure includes a thread cutting process which produces metal chips. Performing this procedure while the cylinder head is on the engine will cause metal chips to fall into the cylinder. Once in the cylinder, these chips can damage the cylinder wall when the engine is started.

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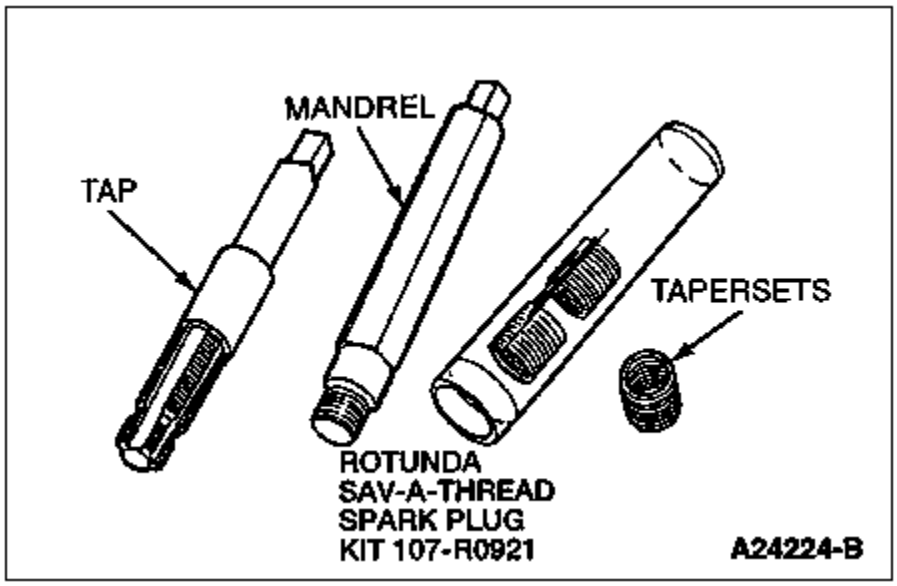
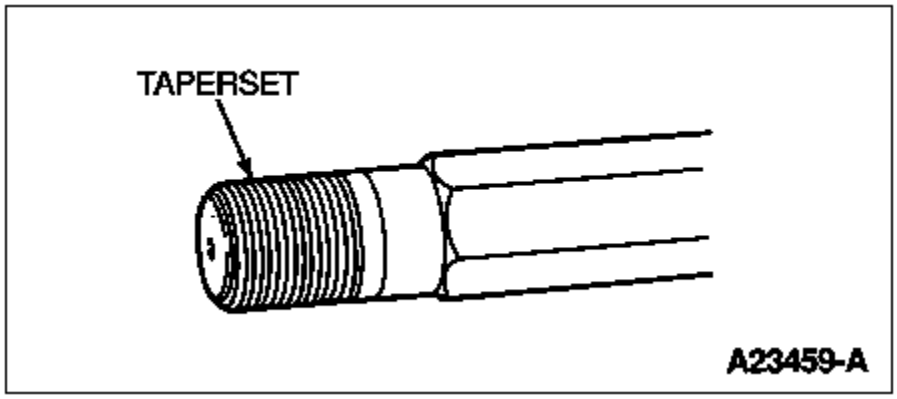


1. Thoroughly clean spark plug counter bore, seat and threads of all dirt or other foreign material.
2. Start tap into spark plug hole being careful to keep it properly aligned.

   As tap begins cutting new threads, apply aluminum cutting oil to tap, if aluminum.

   Continue cutting threads and applying oil until stop ring bottoms against spark plug seat.
3. Remove tap. Remove all metal chips using compressed air.
4. Coat threads of mandrel with cutting oil. Thread taperset onto mandrel until one thread of mandrel extends beyond taperset.



5. **NOTE: A properly installed taperset will be flush to one millimeter below spark plug gasket seat.**

   Thread taperset into tapped spark plug hole using a torque wrench. Continue tightening mandrel until torque wrench indicates 61 Nm (45 lb-ft).
6. To loosen mandrel for removal, hold mandrel stationary and turn mandrel body approximately one-

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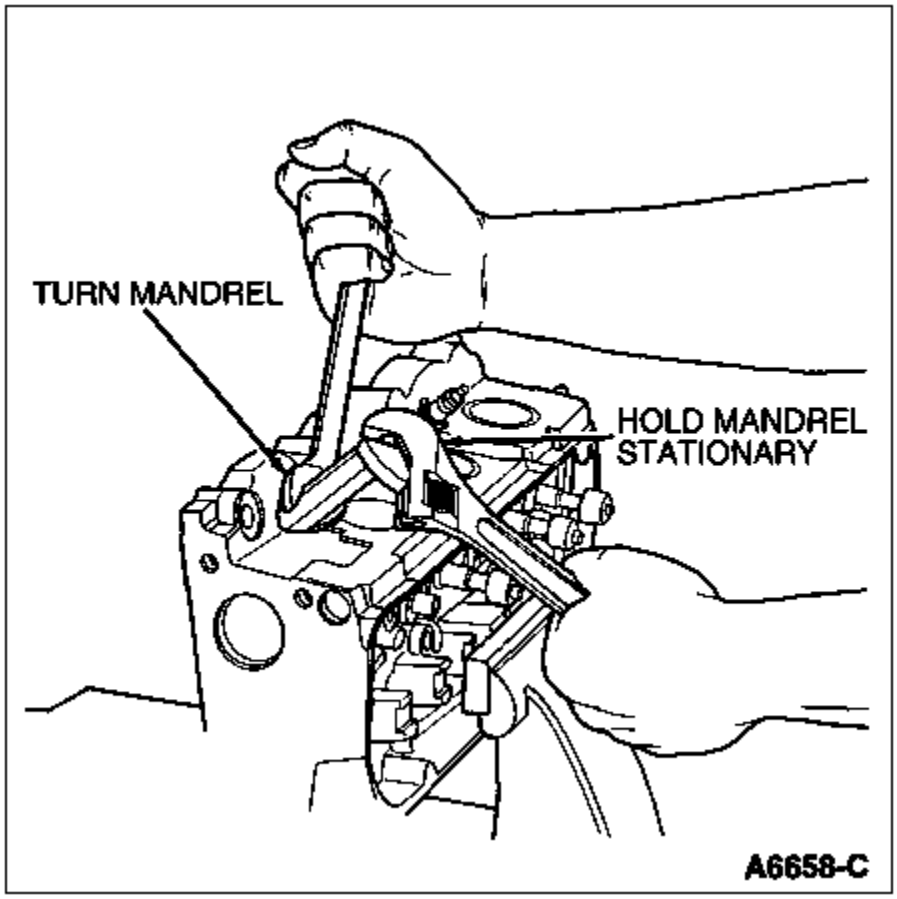
half turn. Remove mandrel.



Cylinder Head Flatness

NOTE: Do not plane or grind off more than 0.254mm (0.010 inch).

When a cylinder head is removed because of gasket leaks, check the flatness of the cylinder head gasket surface for conformance to specification. For specifications refer to General Specifications in this section. If necessary, refinish the cylinder head gasket surface.

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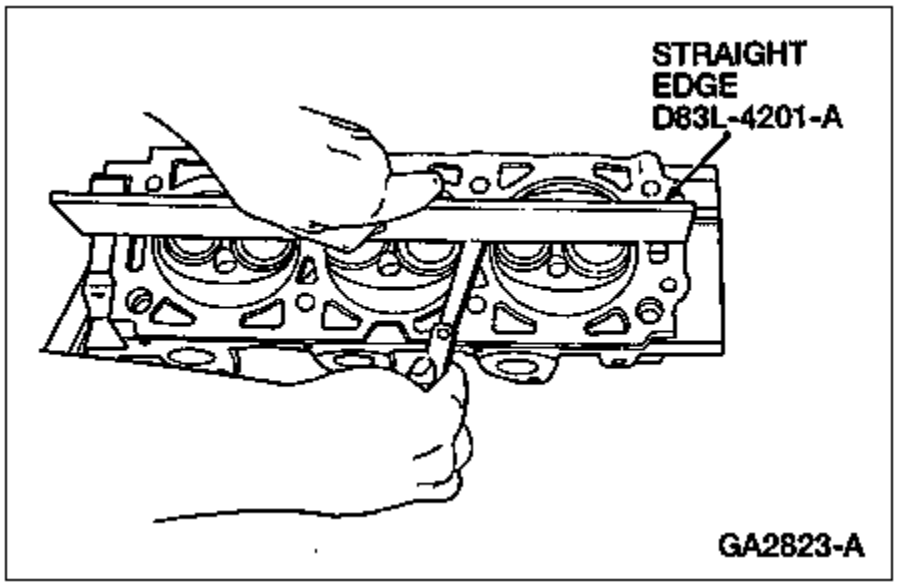
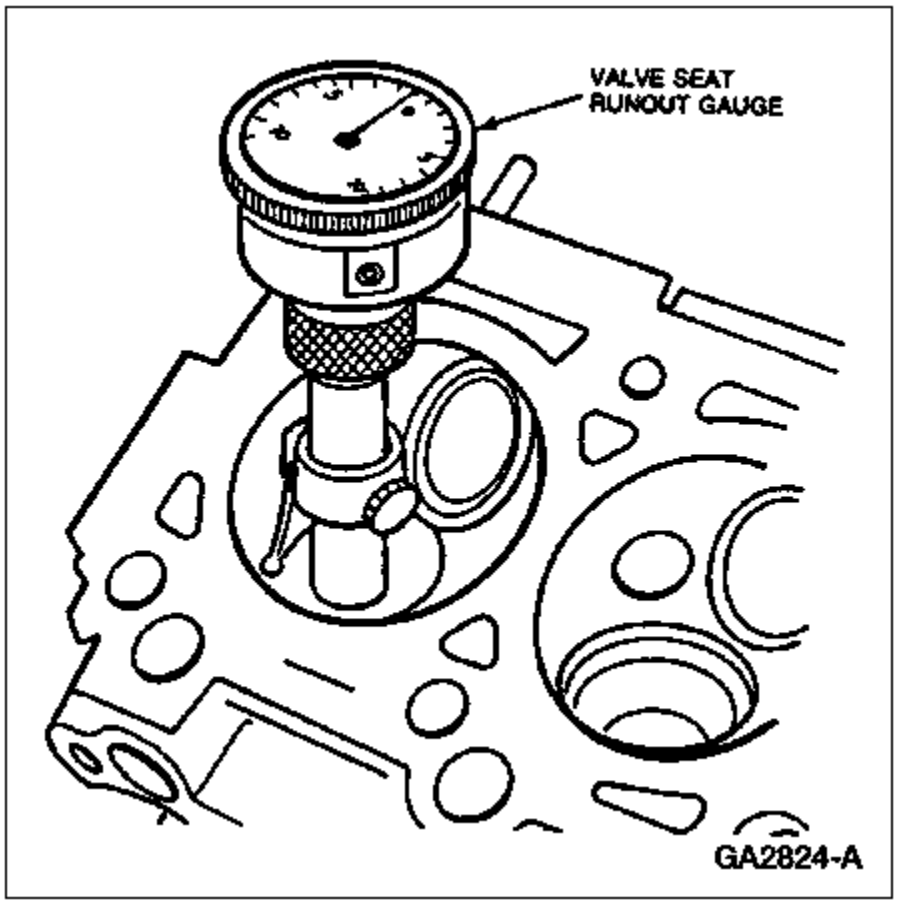


Valve Seat Runout

Check the valve seat runout with Valve Seat Runout Gauge as illustrated below. Follow the instructions of the gauge manufacturer. If the runout exceeds the wear limit, reface the valve and valve seat. For specifications, refer to engine Section 03-01A , Section 03-01B or Section 03-01C depending on engine.



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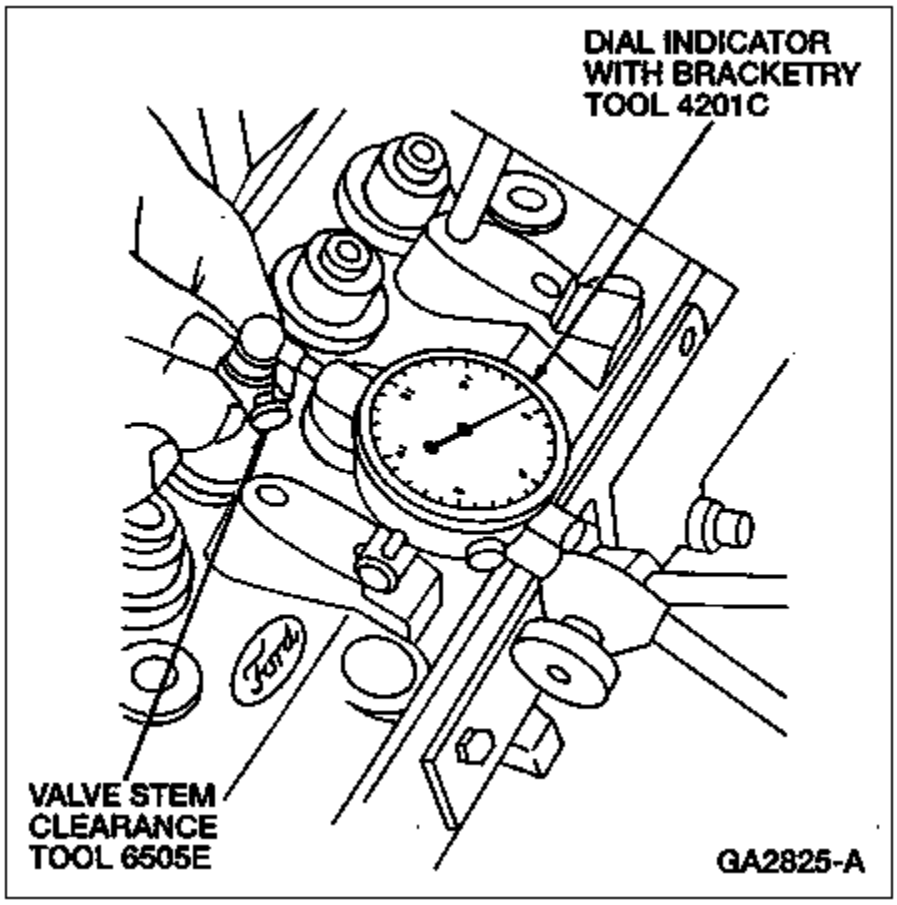
Valve Stem-to-Valve Guide Clearance

1. Check the valve stem-to-valve guide clearance of each valve in its respective valve guide (6510) with Valve Stem Clearance Tool TOOL-6505-E or equivalent and Dial Indicator With Bracketry TOOL-4201-C or equivalent. Use a flat-end indicator point.

2. Install Valve Stem Clearance Tool TOOL-6505-E or equivalent on the valve stem until it is fully seated, and tighten the knurled setscrew firmly. Permit the valve to drop away from its seat until the tool contacts the valve guide.



3. Install the Dial Indicator With Bracketry TOOL-4201-C, or equivalent, with its flat tip against the center portion of the spherical section of the Valve Stem Clearance Tool TOOL-6505-E, or equivalent, at approximately 90 degrees to the valve stem axis.

4. Move the valve stem back and forth in line with the dial indicator stem.

5. Take a reading on the dial indicator without removing the tool from the valve stem.

6. Divide the reading by two. This dimension is the valve stem-to-valve guide clearance.

7. If valve stem-to-valve guide clearance exceeds the wear limit, refer to Valve Guides, Reaming in this

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section.

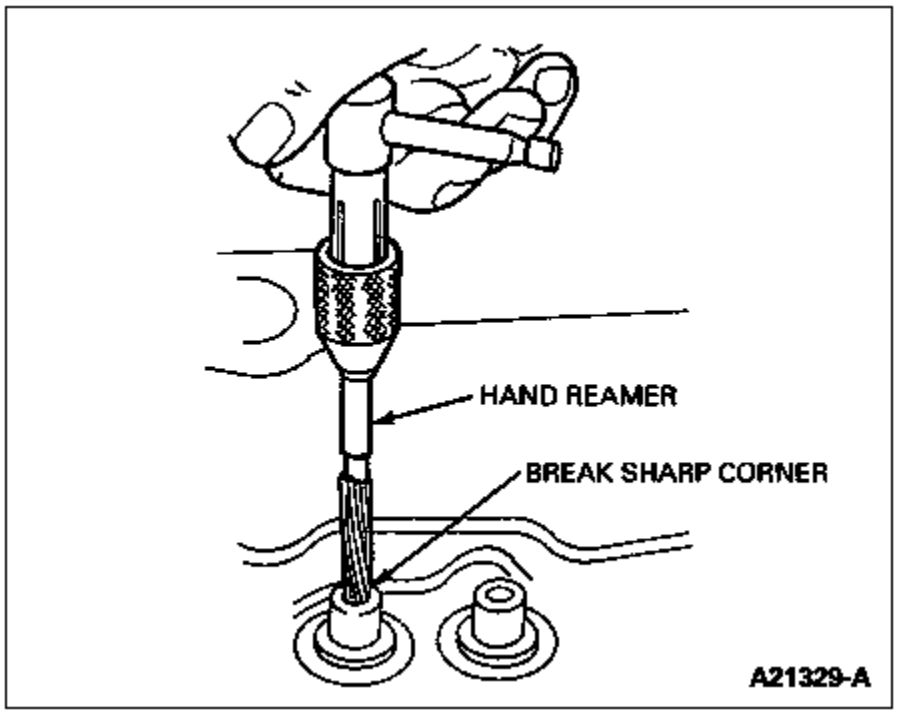
Valves, Select Fitting

If the valve stem-to-valve guide clearance exceeds the service clearance, ream the valve guide for the next oversize valve stem. Valves with oversize stem diameters are available for service. Refer to Master Parts Catalogue for available sizes. **Always reface the valve seat after the valve guide has been reamed.** Refer to Valve Guides, Reaming.

In the case of valve stem-to-valve guide clearance, the service clearance is intended as an aid to diagnosing engine noise only, and does not constitute a failure or indicate need for service. However, when overhauling or reconditioning a cylinder head, the service clearance should be regarded as a practical working value, and used as a determinant for installing the next oversize valve to make sure service life is extended.

Valve Guides, Reaming

If it becomes necessary to ream a valve guide to install a valve with an oversize stem, a hand reaming kit is available which contains the following reamer and pilot combinations: a 0.38mm (0.015-inch) OS reamer with a 0.076mm (0.003-inch) OS pilot, and a 0.76mm (0.030-inch) reamer with a 0.38mm (0.015-inch) OS pilot.



NOTE: If oversize valve stems and oversize stem seals are not available, bore out original valve guide and install service bushing. For 2.3L, push out original guide. Service bushing will be a regular production bushing. Ream inside diameter for specified clearance for standard size valve. Reface valve seat, as required. Install standard size valve stem oil seal.

When replacing a standard size valve with an oversize valve, always use the reamer in sequence (smallest oversize first, and then next smallest, etc.) so as not to overload the reamers. **Always reface the valve seat after the valve guide has been reamed, and use a suitable scraper to break the sharp corner (inside diameter) at the top of the valve guide.**

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NOTE: The interference angle of the valve and seat should not be lapped out. Remove all grooves or score marks from the end of the valve stem, and chamfer it as necessary. Do not remove more than 0.254mm (0.010 inch) from the end of the valve stem.

If the valve face runout is excessive and/or to remove pits and grooves, reface the valves to a true 45 degree angle. Remove only enough stock to correct the runout or to clean up the pits and grooves. If the edge of the valve head is less then 0.794mm (1/32 inch) thick after grinding, replace the valve as the valve will run too hot in the engine.

If the valve and/or valve seat has been refaced, it will be necessary to check the clearance between the rocker arm pad and the valve stem with the valve train assembly installed in the engine.

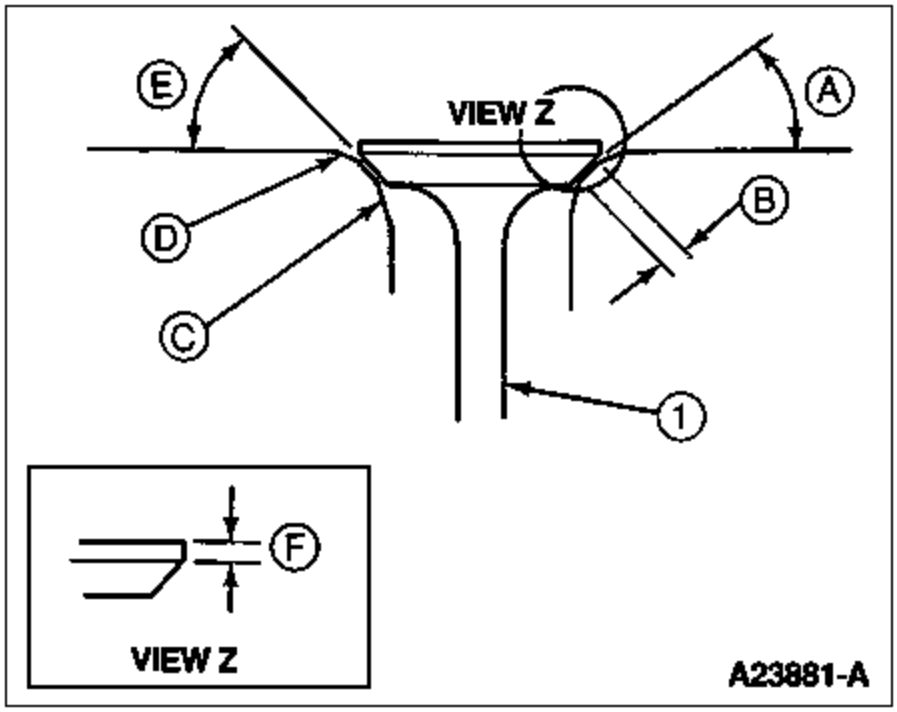
Valve Seats, Refacing

Measure the valve seat width. Reface the valve seat(s) if the width is not within specifications. Refer to Section 03-01A , Section 03-01B or Section 03-01C depending on engine.

Refer to Engine Service in the Rotunda Tool catalog for a description of the various types of valve seat grinders and cutters available.

Refacing the valve seat should be closely coordinated with the refacing of the valve face so that the finished seat and valve face will be concentric and the specified interference angle will be maintained. This is important so that the valve and seat will have a compression-tight fit. Make sure refacer grinding wheels are properly dressed.

Grind the valve seats of all engines to a true 45-degree angle. Remove only enough stock to clean up pits and grooves or to correct the valve seat runout. After the seat has been refaced, use a seat width scale or a machinist scale to measure the seat width. Narrow the seat, if necessary, to bring it within specification. Refer to Section 03-01A , Section 03-01B or Section 03-01C depending on engine, for specifications.



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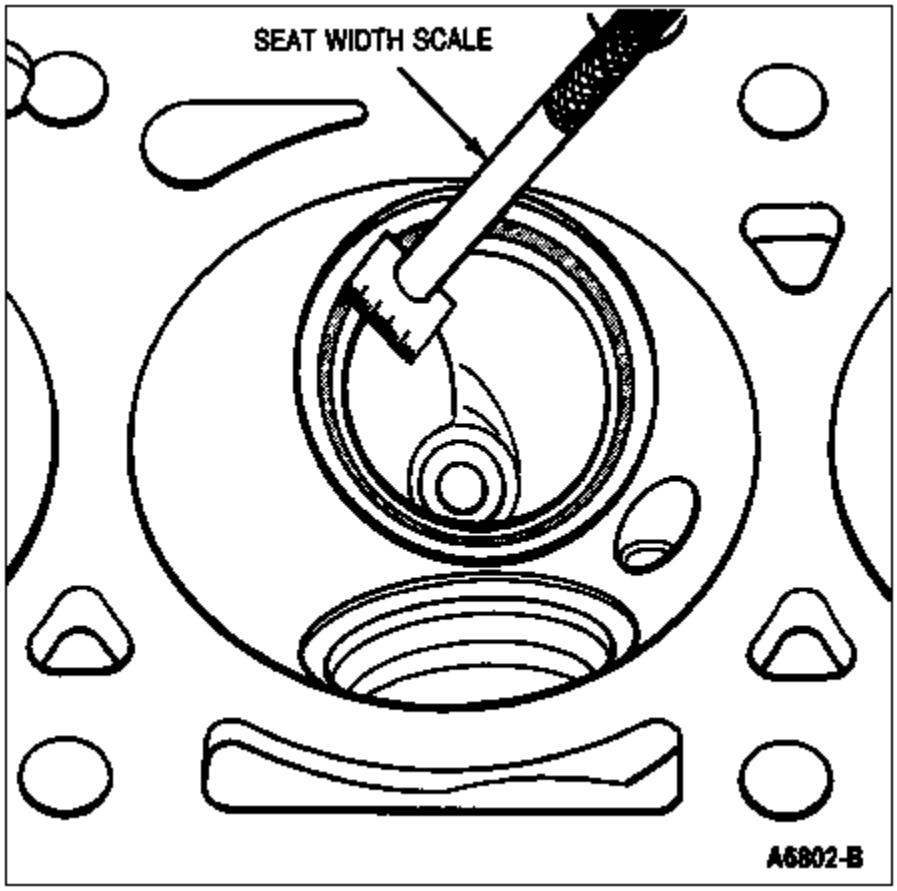
Item	Part Number	Description
1	—	Valve
A	—	Valve Seat Angle
B	—	Seat Width and Proper Location on Valve
C	—	Bottom Narrowing Angle 75 Degrees
D	—	Top Narrowing Angle 30 Degrees
E	—	Valve Face Angle
F	—	Valve Margin



If the valve seat width exceeds the maximum limit, remove enough stock from the top edge and/or bottom edge of the seat to reduce the width to specification.

On the intake and exhaust seats, use a 60-degree angle grinding wheel to remove stock from the bottom of the seat (raise the seats). A 30-degree angle wheel is used to remove stock from the top of the seats (lower the seats).

The finished valve seat should contact the approximate center of the valve face. It is good practice to determine where the valve seat contacts the face.

To do this, coat the seat with Prussian Blue and set the valve in place. Rotate the valve with light pressure. If

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the blue is transferred to the center of the valve face, the contact is satisfactory. If the blue is transferred to the top edge of the valve face, lower the valve seat. If the blue is transferred to the bottom edge of the valve face, raise the valve seat.

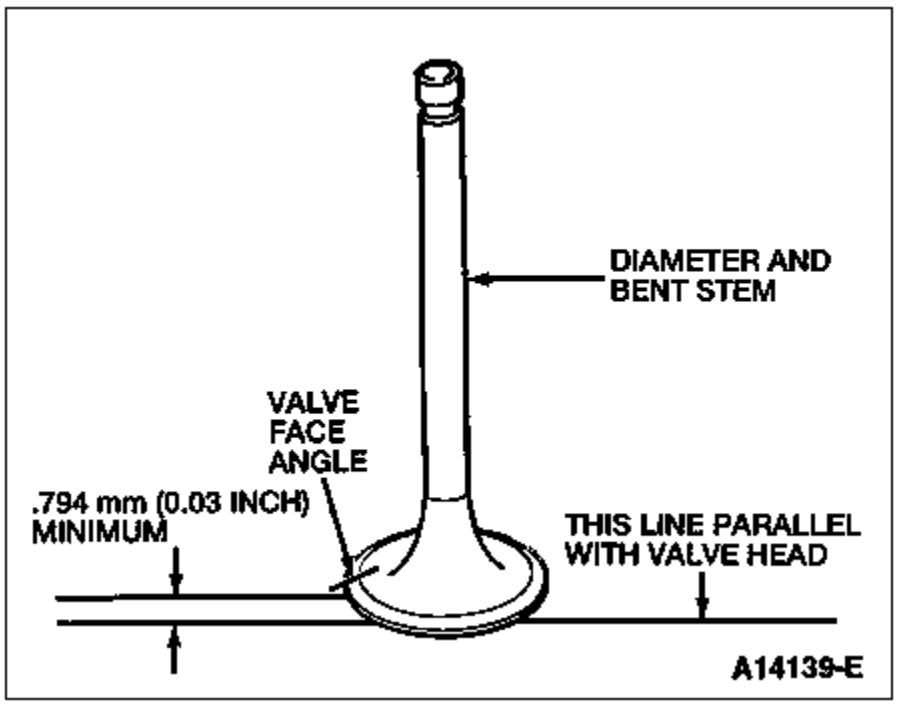
Valves, Inspection

The critical inspection points and tolerances of the valve are illustrated below. Refer to Specifications in Section 03-01A , Section 03-01B or Section 03-01C for service limits.

Inspect the valve stem for bends, and the end of the stem for grooves or scoring.

Inspect the valve face and the edge of the valve head for pits, grooves or scores. Inspect the stem for a bend condition and the end of the stem for grooves or scores. Check the valve head for signs of burning or erosion, warpage and cracking. Minor pits, grooves, etc., may be removed. Discard severely damaged valves.

Inspect the valve spring (6513), valve spring retainer (6514), valve spring retainer keys (6518) and discard any visually damaged parts.



Valves, Refacing

NOTE: Discard any excessively worn or damaged valve train parts.

Minor pits or grooves may be removed. Discard valves that are severely damaged if the face runout cannot be corrected by refinishing or if stem clearance exceeds specification. Refer to Section 03-01A , Section 03-01B or Section 03-01C for valve specifications.

Refer to Engine Service in the Rotunda Tool catalog for a description of the various types of valve resurfacing equipment.

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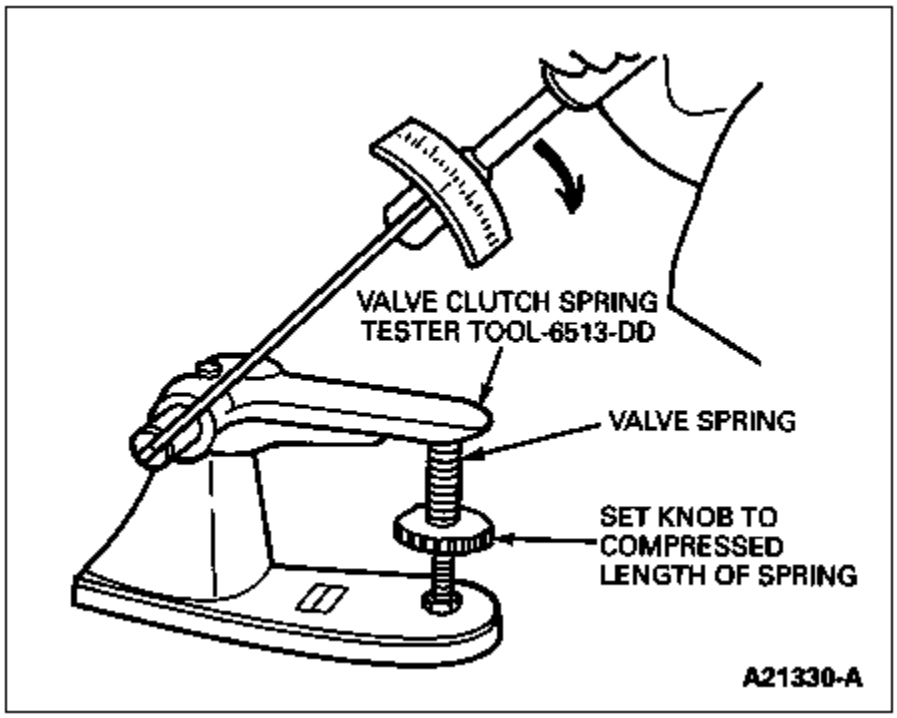
The valve refacing operation should be closely coordinated with the valve seat refacing operations so that the finished angles of the valve face and valve seat will be to specifications and provide a compression-tight fit.

Make sure refacer grinding wheels are properly dressed.

Valve Spring Tension



Inspect the valve springs, valve spring retainers, and valve spring retainer keys for wear or damage. Discard any damaged parts.

Check the valve springs for proper pressure at the specified spring lengths using Valve/Clutch Spring Tester TOOL-6513-DD or equivalent. Apply torque until click is heard; read torque wrench and multiply reading by two. Weak valve springs cause poor engine performance. Replace any valve spring not within specification. For specifications, refer to Section 03-01A , Section 03-01B or Section 03-01C . Manually rotating the valve spring assemblies while installed in the engine will not determine condition of valve springs.

CAUTION: Make sure the valve springs are reassembled to their own original dampers by pushing damper on the spring. Do not open damper with any kind of tool in order to reassemble.

Valve Spring Squareness

Check each valve spring for squareness using a steel square and a flat surface. Stand the valve spring and square on end. Slide the valve spring up to the square. Revolve the valve spring slowly and observe the space between the top coil of the valve spring and the square.

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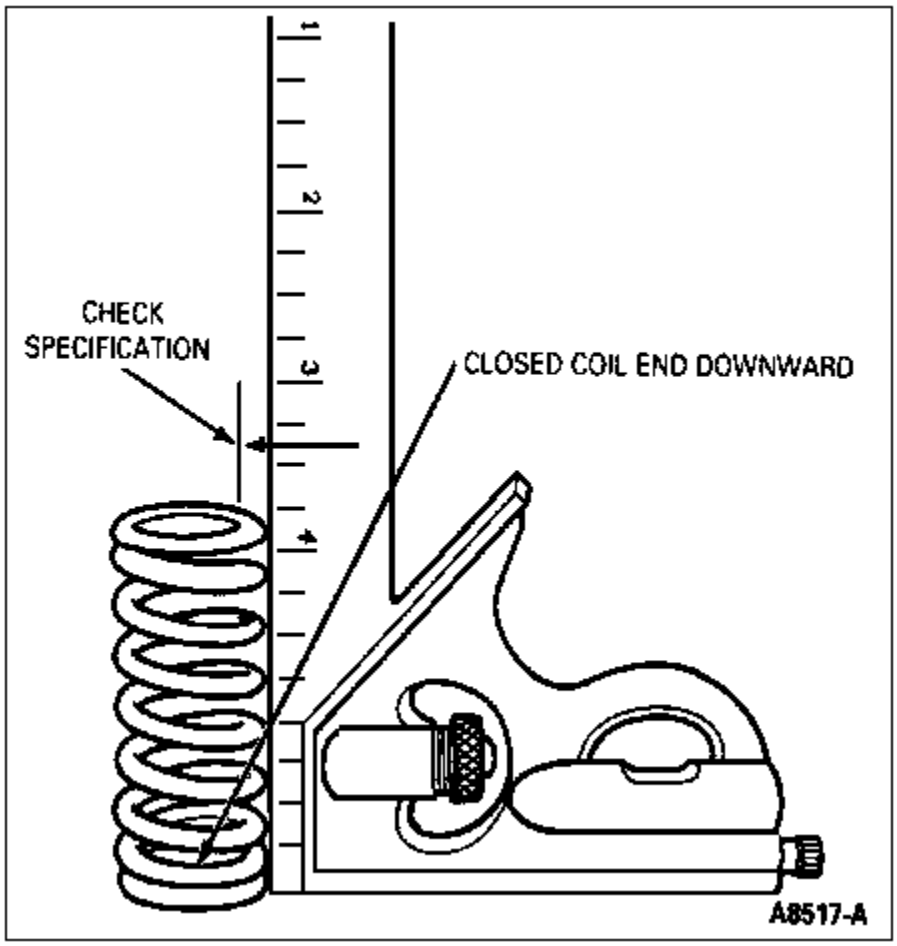

Refer to Specifications in Section 03-01A , Section 03-01B or Section 03-01C for out-of-square limits. Follow the same procedure for new valve springs before installation.

Make sure the proper valve spring (color-coded) is installed.

CAUTION: Make sure the valve springs are reassembled to their own original dampers by pushing damper on the valve spring. Do not open damper with any kind of tool in order to reassemble.

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Rocker Arm

Cleaning

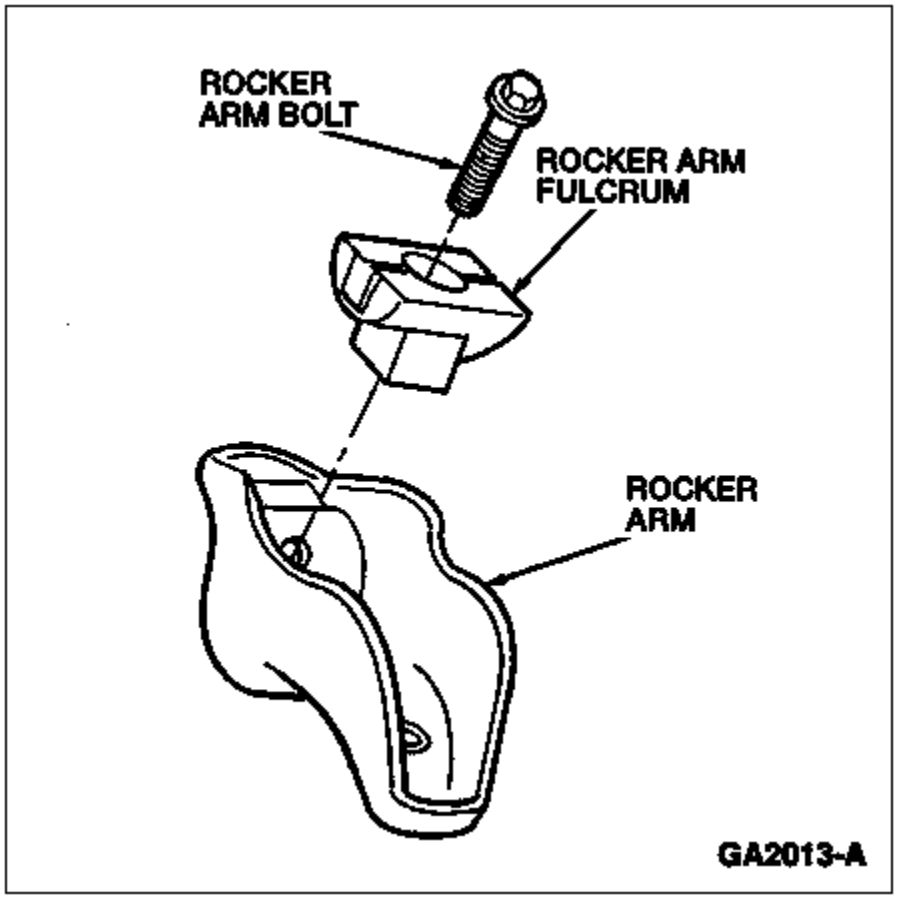
Clean all parts thoroughly. Make sure all oil passages are open.

Make sure oil passage in the push rod end of the rocker arm (6564) is open.

Inspection

Inspect the rocker arm for nicks, scratches, scores or scuffs. Replace any damaged parts.

Rocker Arm, 3.0L Shown



Inspect the pad at the valve end of the rocker arm for indications of scuffing or abnormal wear. If the pad is grooved, replace the rocker arm. Do not attempt to true this surface by grinding. On pedestal-mounted rocker arms, check the rocker arm pad, side rails, rocker arm fulcrum, and fulcrum seat for excessive wear, cracks, nicks or burrs. Check the rocker arm bolt for stripped or broken threads.

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Rocker Arm (3.0L and 4.0L)/Camshaft Follower (2.3L)

Cleaning

Clean all parts thoroughly. Make sure all oil passages are open.

Make sure oil passage in the push rod end of the rocker arm (6564) is open.

Inspection

Inspect the shaft and the rocker arm bore for nicks, scratches, scores or scuffs. Replace any damaged parts.

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Push Rods 3.0L and 4.0L

Cleaning

Clean the push rods in a suitable solvent. Blow out the oil passage in the push rod (6565) with compressed air.

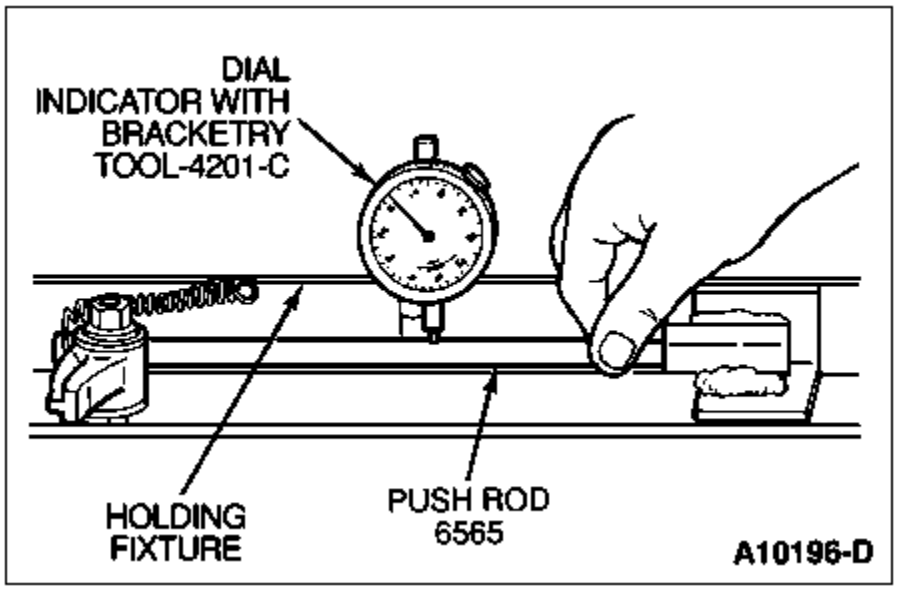
Inspection

NOTE: Do not attempt to straighten push rod.

Check the ends of the push rods for nicks, grooves, roughness or excessive wear. Replace damaged push rods.

The push rods can be visually checked for straightness while they are installed in the engine by rotating them with the valve closed. They also can be checked with a dial indicator.

If the push rod is bent beyond specifications, it should be replaced.



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Intake Manifold

Cleaning

Remove all gasket material from the machined surfaces of the upper and lower intake manifolds. Clean the manifold in a suitable solvent and dry it with compressed air.

Inspection

NOTE: Remove all filings and foreign matter that may have entered the manifold as a result of service.

Inspect the manifold for cracks, damaged gasket surfaces, or other problems that would make it unfit for further service. Replace all studs that are stripped or otherwise damaged. Clean the EGR exhaust passages.

Check the baffle plate(s) on the underside of the manifold if so equipped. The baffle(s) should be securely fastened.

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Exhaust Manifold

Cleaning

Remove all gasket or foreign material from all inlet and outlet sealing surfaces of the exhaust manifolds.

Inspection

Inspect the cylinder head joining flanges of the exhaust manifold (9430) for evidence of exhaust gas leaks.

Inspect the exhaust manifold for cracks, damaged gasket surfaces, or other damage that would make them unfit for further service. Warped or cracked exhaust manifolds must be replaced.

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Flexplate Inspection — Automatic Transmission

NOTE: A visual inspection for damage is the only check required for flexplates. Do not use any specifications in flywheel inspections (i.e. run-out, flatness).

Inspect the flexplate and ring gear assembly for visual signs of damage (i.e. cracks, chipped or worn teeth). If damaged replace the flexplate and ring gear assembly.

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Flywheel Inspection — Manual Transmission

With the flywheel installed on the crankshaft check the gear face run-out. Refer to flywheel specifications located in Section 08-00.

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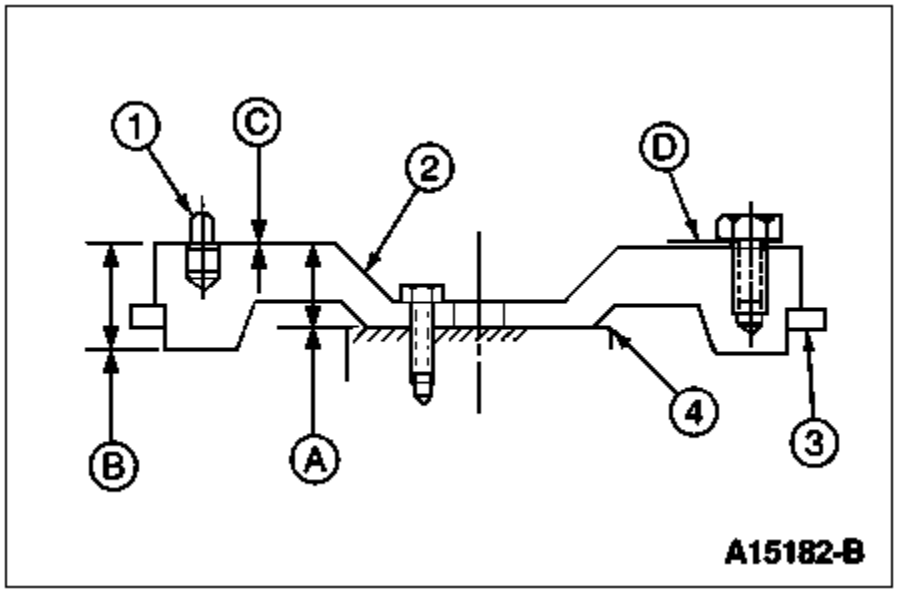
Flywheel Clutch Surface Machining

Inspect the flywheel (6375) for cracks, heat check, or other damage that would make it unfit for further use. Acceptable flywheels may be repaired by polishing with fine grade (400 grit) sandpaper. Flywheels may be resurfaced to remove scratches or grooves. After resurfacing, the flywheel thicknesses must not be less than the dimensions noted in the chart in Specifications portion of this section.

- Mount flywheel rigidly on crankshaft mounting flange.
- After machining:
  - Surface runout must not exceed 0.13mm (0.005 inch) TIR; surface finish must be in the range of 4.0/1.3 micrometer (160/52 microinch).
  - Major diameter of dowel pin (press-fit diameter) must not extend above the new surface.
  - The clutch pressure plate retaining bolts must screw into the flywheel under hand torque to within 1.50mm (0.06 inch) of new surface.
  - Flywheels with dimensions less than the charted dimensions must not be used; install new service flywheel.

Charts

Dimension "A" is the minimum acceptable dimension from the crankshaft mounting surface to the new resurfaced clutch face surface. Dimension "B" is a referenced minimum acceptable dimension for the overall width of the outer flange.



Item	Part Number	Description
1	—	Dowel Pin (Part of 6375)
2	6375	Flywheel
3	—	Ring Gear (Part of 6375)
4	6303	Crankshaft

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A	—	Dimension A
B	—	Dimension B
C	—	Dowel Pin Height
D	—	Pressure Plate Bolt Height

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SPECIFICATIONS

NOTE: For specific engine specifications, refer to Section 03-01A , Section 03-01B or Section 03-01C depending on which engine you are working on.

General Engine Specifications

Item	Dimension
Normal Engine Vacuum at Idle	-51 to -74 kPa (15-22 In-Hg)
Maximum Allowable Timing Chain Deflection (3.0L and 4.0L)	3.175mm (0.12 In.)
Cylinder Block Cylinder Head Deck Flatness — Maximum Variation	0.076mm (0.003 In.) over 152mm (6 In.) 0.152mm (0.006 In.) Overall
Cylinder Block Bearing Bore Alignment — Maximum Variation	0.076mm (0.003 In.) 0.051mm (0.002in) (5.0L)
Cylinder Block Flywheel Housing Flange Flatness Maximum Variation	0.076mm (0.003 In.)
Maximum Allowable Cylinder Bore Taper	0.127mm (0.005 In.)
Maximum Allowable Cylinder Bore Out-of-Round	0.127mm (0.005 In.)
Measuring Point for Piston Diameter — Below Oil Ring Groove	25.4mm (1.00 In.)
Required Oil Clearance — Crankshaft Journal to Main Bearing	Refer to Section 03-01A , Section 03-01B or Section 03-01C Depending on Engine.
Maximum Allowable Crankshaft Runout	0.05mm (0.002 In.)
Maximum Piston Clearance	0.076mm (0.003 In.) 0.0559mm (0.0022 In) (5.0L) 0.051mm (0.002 In) (2.3L)
Maximum Oil Pump Cover Flatness Variation	0.038mm (0.0015 In.)
Oil Pump Rotor Clearance	0.10mm (0.004 In.)
Minimum Engine Valve Margin	0.794mm (0.03 In)
Maximum Allowable Camshaft Runout	0.03mm (0.0012 In.)

Flywheel Dimensions

Flywheel Part Number	Dimension "A" mm (Inch)	Dimension "B" mm (Inch)
E3TZ-6375-A	25.95 (1.02)	28.45 (1.12)
E69Z-6375-B	28.18 (1.10)	28.85 (1.14)

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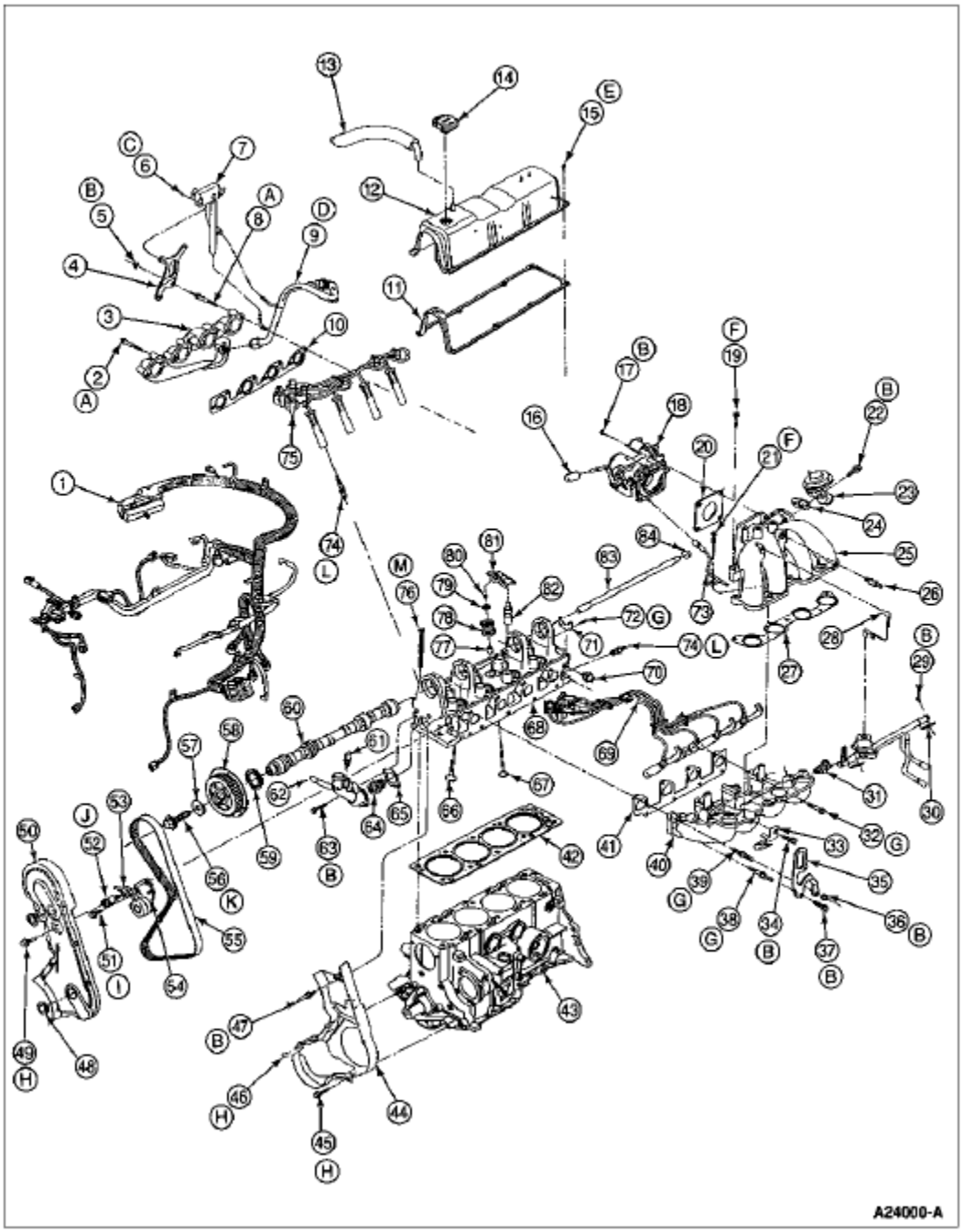
Engine Components

The views shown are typical and provide a reference for procedures. The numbers and part descriptions shown in the legends are basic part numbers corresponding with the Ford Master Parts Catalog.

2.3L OHC (Dual Plug) Engine Components, Top



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Item	Part Number	Description
1	12A581	Engine Control Sensor Wiring
2	N806949-S100	Bolt, M10-1.5 x 59.1
3	9430	Exhaust Manifold
4	17A084	Engine Lifting Eye (Rear)
5	N620481-S2	Nut, M8-1.25
6	N807202-S36	Bolt, M5-0.8 x 16
7	9J433	EGR Transducer
8	N806948-S100	Stud, M10-1.5 x M8-1.25 x 89.6
9	9D477	EGR Valve to Exhaust Manifold Tube
10	9448	Exhaust Manifold Gasket
11	6584	Valve Cover Gasket
12	6582	Valve Cover
13	6853	Crankcase Ventilation Hose
14	6766	Oil Filler Cap
15	N805087-S2	Screw, M6-1 x 15
16	386800-S	Cap
17	N605788-S36	Bolt, M8-30
18	9E926	Throttle Body
19	N807462-S101	Bolt, M8-1.25 x 67.2
20	9E936	Throttle Body Gasket
21	N807461-S2	Bolt, M8-1.25 x 45 (5 Places)
22	N806781-S2	Bolt (Part of 9D475)
23	9D475	EGR Valve
24	9D476	EGR Valve Gasket
25	9425	Intake Manifold, Upper
26	9A474	Intake Manifold Vacuum Outlet Fitting and Cap
27	9H486	Intake Manifold Upper Gasket
28	9E498	Fuel Pressure Regulator Vacuum Tube
29	N807897-S100	Bolt, M8-1.25 x 31
30	9S441	Fuel Injection Supply Manifold

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31	9F593	Fuel Injector
32	N807462-S101	Bolt, M8-1.25 x 67.2 (4 Places)
33	14A004	42-Pin Connector Bracket
34	N605904-S36	Bolt, M8-1.25 x 16.6
35	17A084	Engine Lifting Eye (Front)
36	N620481-S2	Nut, M8-1.25
37	N808162-S2	Bolt, M8-1.25 x 33
38	N807458-S101	Stud, M8-1.25 x 1.25 x 96.2
39	N808163-S100	Stud, M8-1.25 x 1.25 x 63.7
40	9424	Intake Manifold, Lower
41	9439	Intake Manifold Gasket
42	6051	Head Gasket
43	6010	Cylinder Blocks
44	6E005	Inner Timing Belt Cover
45	N804958-S8	Screw, M6-1 x 22.5
46	N621906-S2	Nut, M6-1
47	N808049-S102	Stud, M8-1.25 x 51
48	352284-S	Plug, Rubber 1-1/4 x 7/16 Inch
49	N808534-S2	Bolt, M6-1 x 17
50	6E011	Outer Timing Belt Cover
51	N800112-S100	Bolt, M8-1.25 x 20
52	6K282	Timing Belt Spring Bolt
53	6L273	Timing Belt Tension Spring
54	6K254	Belt Tensioner Assembly
55	6268	Timing Belt
56	N600414-S	Bolt, M12-1.75 x 45
57	6278	Camshaft Sprocket Washer
58	6256	Camshaft Sprocket
59	6700	Crankshaft Front Seal
60	6250	Camshaft
61	12A648	Engine Coolant Temperature Sensor

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62	8594	Water Outlet Connection
63	N800025-S100	M8-1.25 x 18
64	8575	Water Thermostat
65	8255	Thermostat Gasket
66	6507	Intake Valve
67	6505	Exhaust Valve
68	6049	Cylinder Head
69	12281	Spark Plug Wire and Bracket Assembly (LH)
70	9278	Engine Oil Pressure Sender
71	6A222	Camshaft Retaining Plate
72	N604465-S	Screw, M6-1 x 16
73	9G271	Evaporative Emission Return Tube Assembly
74	12405	Spark Plug
75	12280	Spark Plug Wire and Bracket Assembly (RH)
76	N807013-S	Bolt, M12-1.75 x 100.7
77	6571	Valve Stem Seal
78	6513	Valve Spring
79	6514	Valve Spring Retainer
80	6518	Valve Spring Retainer Key
81	6529	Roller Finger Follower
82	6C501	Hydraulic Lash Adjuster
83	6B273	Camshaft Oil Flow Control Rod
84	376049-S36	Expansion Plug
A	—	Refer to Exhaust Manifold Installation in This Section for Tightening Instructions
B	—	Tighten to 20-30 Nm (15-22 Lb-Ft)
C	—	Tighten to 2.7-3.7 Nm (24-32 Lb-In)
D	—	Tighten Nut Both Ends to 34-47 Nm (25-35 Lb-Ft)
E	—	Tighten to 9-13 Nm (80-115 Lb-In)
F	—	Refer to Upper Intake Manifold Installation in This Section for Tightening Instructions
G	—	Refer to Lower Intake Manifold Installation in This Section for Tightening Instructions
H	—	Tighten to 8-12 Nm (70-106 Lb-In)
I	—	Tighten to 35-45 Nm (26-33 Lb-Ft)

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		Refer to Timing Belt Installation in This Section
J	—	Tighten to 40-55 Nm (30-40 Lb-Ft) Refer to Timing Belt Installation in This Section
K	—	Tighten to 70-95 Nm (52-70 Lb-Ft)
L	—	Tighten to 9-20 Nm (79-177 Lb-In) Color Code: No. 1 and No. 2 Right-Hand and Left-Hand Green, No. 3 and No. 4 Right-Hand and Left-Hand White
M	—	Refer to Cylinder Head Installation in This Section for Tightening Instructions

2.3L OHC (Dual Plug) Engine Components, Bottom

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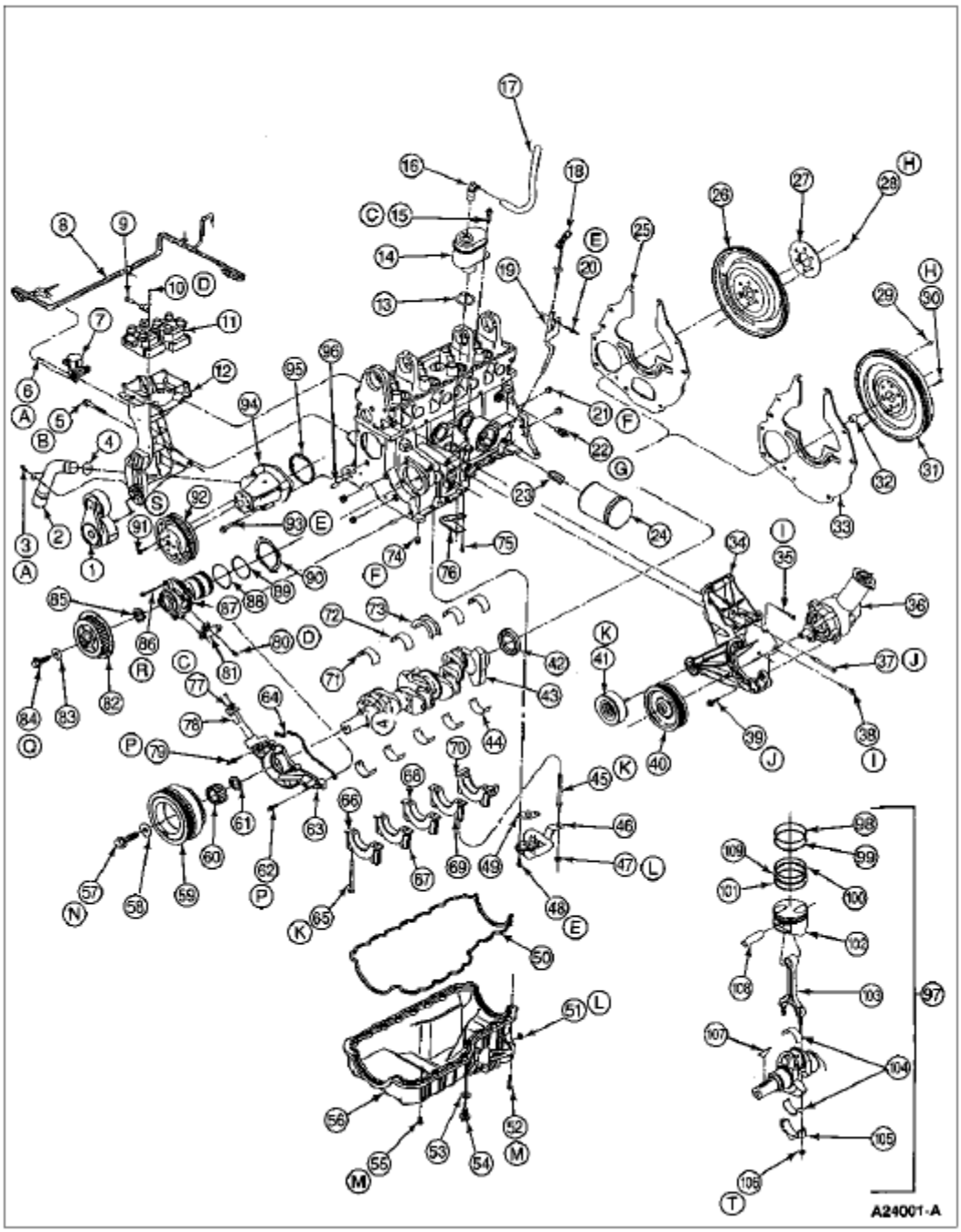

Item	Part Number	Description
1	6B209	Drive Belt Tensioner
2	8290	Water Pump Inlet Tube
3	N606676-S2	Screw, M6-1 x 22.5
4	87056-S100	O-Ring
5	N606064-S309	Bolt, M10-1.5 x 60
6	N606676-S2	Screw, M6-1 x 20

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7	9J459	EGR Vacuum Regulator Solenoid
8	9E498	Main Emission Vacuum Control Connector
9	18801	Radio Ignition Interference Capacitor
10	N606502-S36	Bolt, M5-0.8 x 37
11	12029	Ignition Coil
12	10153	Generator Mounting Bracket
13	87057-S94	O-Ring
14	6A785	Crankcase Vent Oil Separator
15	N805087-S2	Screw, M6-1 x 15
16	6A666	Positive Crankcase Ventilation Valve and Hose Assembly
17	6853	Crankcase Ventilation Hose
18	6750	Oil Level Dipstick
19	6754	Oil Level Indicator Tube
20	N807689-S2	Stud, M8-1.25 x M5-0.80 x 42.3
21	87838-S105	Pipe Plug, 3/8-18 x 3/8
22	10884	Water Temperature Indicator Sender Unit
23	6890	Oil Filter Mounting Insert
24	6714	Oil Filter
25	7007	Engine Rear Plate
26	6375	Flywheel
27	6A366	Flywheel Reinforcing Plate (Automatic Transmission)
28	N802741-S	Bolt, M10-1 x 20
29	7K578	Flywheel-to-Pressure Plate Dowel
30	N800028-S	Bolt, M10-1 x 30
31	6375	Flywheel (Manual Transmission)
32	7120	Pilot Bearing
33	7007	Engine Rear Plate (Manual Transmission)
34	2882	A/C Compressor Mounting Bracket
35	N606572-S309	Bolt, M10-1.5 x 123
36	3A674	Power Steering Pump
37	N606051-S309	Bolt, M8-1.25 x 100
38	N606068-S309	Bolt, M10-1.5 x 80
39	N800199-S309	Bolt, M10-1.5 x 33
40	3A733	Power Steering Pump Pulley
41	3F671	Power Steering Belt Idler Support

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42	6701	Crankshaft Rear Oil Seal
43	6303	Crankshaft
44	6333	Crankshaft Main Bearing (Lower)
45	N803729-S	Stud, M10-1.5 x M12-1.75 x 108.5
46	6622	Oil Pump Cover Screen and Tube
47	N620482-S	Nut, M10-1.5
48	N605786-S2	Bolt, M8-1.25 x 20
49	6626	Oil Pump Inlet Tube Gasket
50	6710	Oil Pan Gasket
51	6C629	Oil Pan Spacer
52	N806379-S36	Bolt, M6-1 x 57.5
53	6734	Oil Pan Drain Plug Gasket
54	6730	Oil Pan Drain Plug
55	N806378-S36	M6-1 x 27.5
56	6675	Oil Pan
57	N805044-S2	Bolt, M14-1.5 x 55
58	6378	Crankshaft Pulley Retaining Washer
59	6312	Crankshaft Pulley
60	6306	Crankshaft Sprocket
61	6700	Crankshaft Front Seal
62	N807497-S2	Bolt, M6-1 x 37.5
63	6019	Engine Front Cover
64	6020	Engine Front Cover Gasket
65	N806835-S	M12-1.75 x 80
66	—	Front Main Bearing Cap (Part of 6010)
67	—	Front Intermediate Main Bearing Cap (Part of 6010)
68	—	Center Main Bearing Cap (Part of 6010)
69	—	Rear Intermediate Main Bearing Cup (Part of 6010)
70	—	Rear Main Bearing Cap (Part of 6010)
71	6333	Crankshaft Main Bearing (Upper No. 1, Color Code Blue)
72	6333	Crankshaft Main Bearing (Upper, 3 Places)
73	6337	Crankshaft Thrust Main Bearing
74	87338-S8	Pipe Plug, 3/8-18
75	N605890-S2	Bolt, M6-1 x 14
76	6A630	Cylinder Block Ventilation Baffle
77	N605892-S2	Bolt, M6-1 x 20
78	6C315	Crankshaft Position Sensor

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79	N807288-S2	Stud, M6-1 x 1 x 61.9
80	N605880-S309B	Bolt, M5-0.8 x 20
81	6B288	Camshaft Position Sensor
82	6256	Oil Pump Sprocket
83	6278	Oil Pump Sprocket Washer
84	N600313-S2	Bolt, M10-1.5-40
85	6700	Oil Pump Front Seal
86	N606523-S2	Bolt, M6-1 x 47.5
87	6621	Oil Pump Assembly
88	87072-S100	O-Ring, Oil Pump Outlet/Vent
89	87071-S100	O-Ring, Oil Pump Inlet/Outlet
90	6659	Oil Pump to Cylinder Block Gasket
91	N806863-S2	Screw, M8-1.25 x 25
92	8509	Water Pump Pulley
93	N808517-S100	Bolt, M8-1.25 x 53
94	8501	Water Pump
95	8507	Water Pump Housing Gasket
96	N807419-S	Dowel
97	6100	Piston and Connecting Rod Assembly
98	6150	Upper Compression Ring
99	6152	Second Compression Piston Ring
100	6159	Oil Control Piston Ring
101	6159	Oil Control Piston Ring
102	6110	Piston and Rod Assembly
103	6205	Connecting Rod
104	6211	Connecting Rod Bearings
105	6210	Connecting Rod Cap
106	N800113-S	Nut, M9-1
107	N806700-S	Woodruff Key
108	6135	Piston Pin
109	6161	Oil Control Ring Segment
A	—	Tighten to 8-12 Nm (70-106 Lb-In)
B	—	Refer to Generator Bracket Installation in Section 03-05
C	—	Tighten to 8-12 Nm (70-106 Lb-In)
D	—	Tighten to 5-7 Nm (45-61 Lb-In)

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E	—	Tighten to 20-30 Nm (14-22 Lb-Ft)
F	—	Tighten to 31-38 Nm (23-28 Lb-Ft)
G	—	Tighten to 11-24 Nm (8-18 Lb-Ft)
H	—	Tighten to 73-87 Nm (54-64 Lb-Ft)
I	—	Tighten to 41-54 Nm (29-40 Lb-Ft)
J	—	Tighten to 22-28 Nm (16-20 Lb-Ft)
K	—	Refer to Crankshaft Installation in This Section
L	—	Select to Fit As Outlined Under Oil Pan Installation in This Section
M	—	Tighten to 13.5-18.5 Nm (120-163 Lb-In)
N	—	Tighten to 125-165 Nm (93-121 Lb-Ft)
P	—	Tighten to 13-16 Nm (115-144 Lb-In)
Q	—	Tighten to 40-55 Nm (29-40 Lb-Ft)
R	—	Tighten to 10-14 Nm (89-123 Lb-In)
S	—	Tighten to 20-55 Nm (15-18 Lb-Ft)
T	—	Tighten to 41-49 Nm (30-36 Lb-Ft)

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Valve Cover and Gasket

Removal

1. Disconnect intake air temperature sensor (IAT sensor) (12A697) and remove air cleaner outlet tube (9B659).
2. Remove accelerator control splash shield (9E766).
3. Remove throttle body. Refer to Section 03-04A for procedure.
4. Snap ignition cables out of ignition coil and place to the side.
5. Snap main emission vacuum control connector (9E498) and engine control sensor wiring (12A581) out of valve cover brackets.
6. Remove bolts and valve cover (6582).
7. Remove valve cover gasket (6584) from valve cover. If necessary, remove oil filler cap (6766).

Installation

1. Clean valve cover. Clean valve cover gasket surface on cylinder head (6049).
2. Put valve cover gasket in place on cylinder head.
3. Install valve cover. Alternately tighten bolts to 9-13 Nm (80-115 lb-in).
4. Snap engine wiring harness, vacuum harness and ignition cables back into place in brackets attached to valve cover.
5. Install throttle body as outlined in Section 03-04A .
6. Install accelerator control splash shield.
7. If removed, install oil filler cap.
8. Install air cleaner outlet tube and connect intake air temperature sensor.
9. Start engine (6007) and check for leaks.

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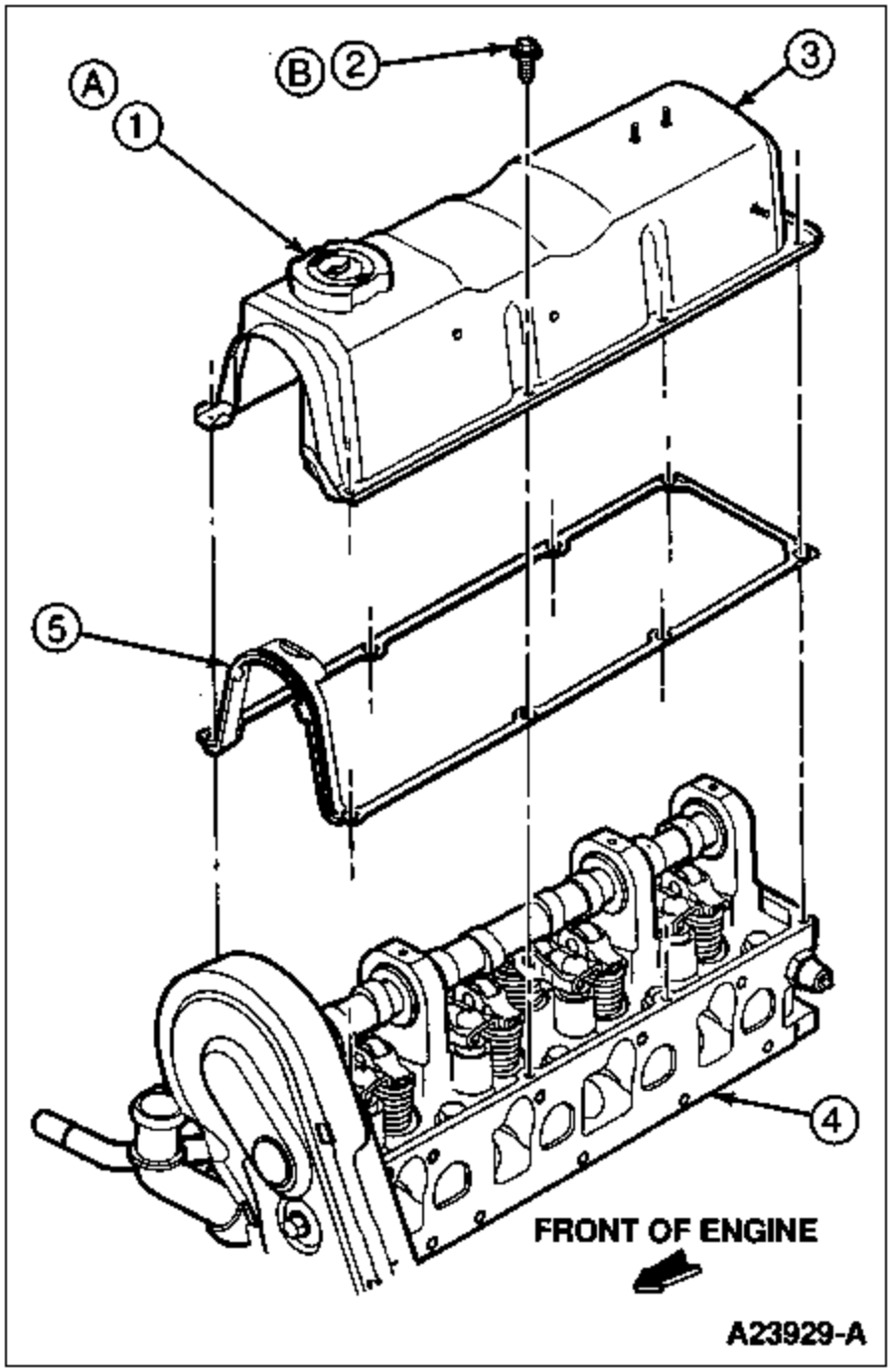

Item	Part Number	Description
1	6766	Oil Filler Cap
2	N805087-S2	Screw, M6-1x15
3	6582	Valve Cover
4	6049	Cylinder Head
5	6584	Valve Cover Gasket
A	—	Tighten Until Ratchet Click Is Heard or Felt

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B	—	Tighten to 9-13 Nm (80-115 Lb-In)

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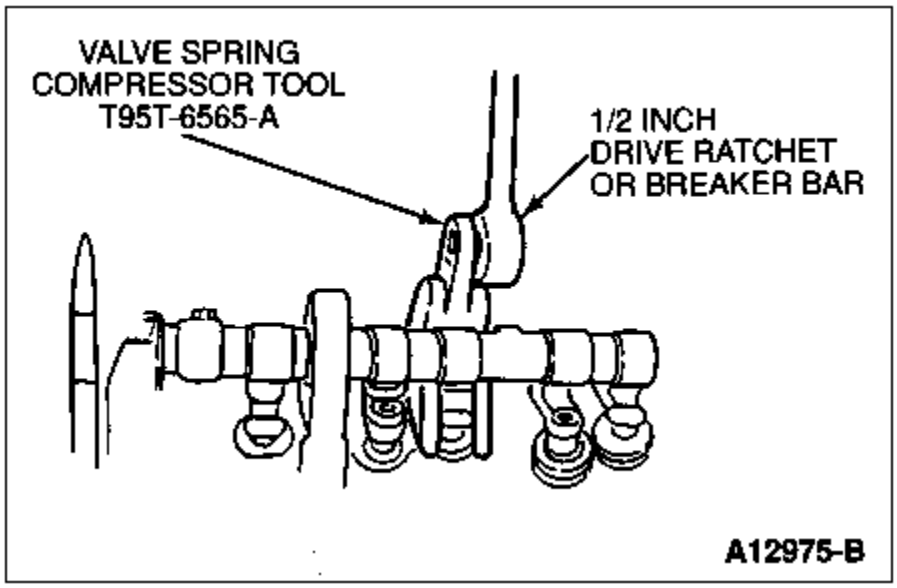
Camshaft Follower and Hydraulic Lash Adjuster

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Valve Spring Compressor	T95T-6565-A

Removal

1. Remove the valve cover as outlined in this section.
2. Rotate the camshaft (6250) so the rocker arm (6564) to be removed is on the heel of its cam.
3. Using Valve Spring Compressor T95T-6565-A, compress and hold down the valve and valve spring (6513). Slide out the roller finger follower over the lash adjuster.



4. Lift out the hydraulic lash adjuster.

Installation

1. Rotate camshaft so roller finger follower can be slid under heel of cam.
2. Lubricate contact points of roller finger follower with Ford Multi-Purpose Grease D0AZ-19584-AA or equivalent meeting Ford specification ESR-M1C159-AA.
3. If removed, place the lash adjuster in position in the bore.
4. Compress the valve spring using Valve Spring Compressor T95T-6565-A. Position the roller finger

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follower over the hydraulic lash adjuster and the valve stem. Release valve spring.

5. **CAUTION: Make sure the hydraulic lash adjuster has been collapsed and released before rotating camshaft.**

   Using Valve Spring Compressor T88T-6565-BH, compress and release hydraulic lash adjuster.

6. Install valve cover (6582) as outlined in this section.

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Valve Spring, Retainer and Valve Stem Seal

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Valve Spring Compressor	T95T-6565-A
Valve Stem Seal Replacer	T95T-6510-B

If the valve or valve seat has not been damaged, the valve spring (6513), valve stem seal (6571), valve spring retainer (6514) or valve spring retainer keys (6518) may be replaced by holding the affected valve against its seat using compressed air. Use an appropriate air line tool installed in the spark plug hole. A minimum of 965 kPa (140 psi) line pressure is required. If air pressure does not hold the valve shut, the valve is damaged or burned and the cylinder head (6049) must be removed and serviced. Refer to Section 03-00 .

Removal

1. Remove the valve cover (6582) as outlined in this section.
2. Rotate the camshaft (6250) so the roller finger follower for the valve to be serviced is on the heel of the cam.
3. Using Valve Spring Compressor T95T-6565-A, compress and hold down the valve spring. Slide out the roller finger follower over the lash adjuster.
4. Replace spark plug (12405) for cylinder being serviced with an air line adapter. Mark location so spark plug is returned to the same cylinder.
5. **CAUTION: The crankshaft may rotate when air pressure is applied. Remove all objects from fan area (lights, extension cords, etc).**

   Turn on air supply and pressurize cylinder. Air pressure may rotate the crankshaft until the piston (6108) reaches the bottom of the stroke.
6. Using Valve Spring Compressor T95T-6565-A compress the valve spring and remove the valve spring retainer keys, valve spring retainer. Remove and discard the stem seal.
7. If air pressure has forced the piston to the bottom of the cylinder, any removal of air pressure will allow the valve(s) to drop into the cylinder. Wrap a rubber band, tape or string around the end of the valve stem to prevent valve falling in and still allow enough travel to check the valve for binds.
8. Inspect the valve stem for damage. Rotate the valve and check the stem tip for eccentric movement. Move the valve up and down through normal travel in the valve guide (6510) and check the stem for any binding. If the valve has been damaged, it will be necessary to remove the cylinder head as outlined in this section and service. Refer to Section 03-00 .

Installation

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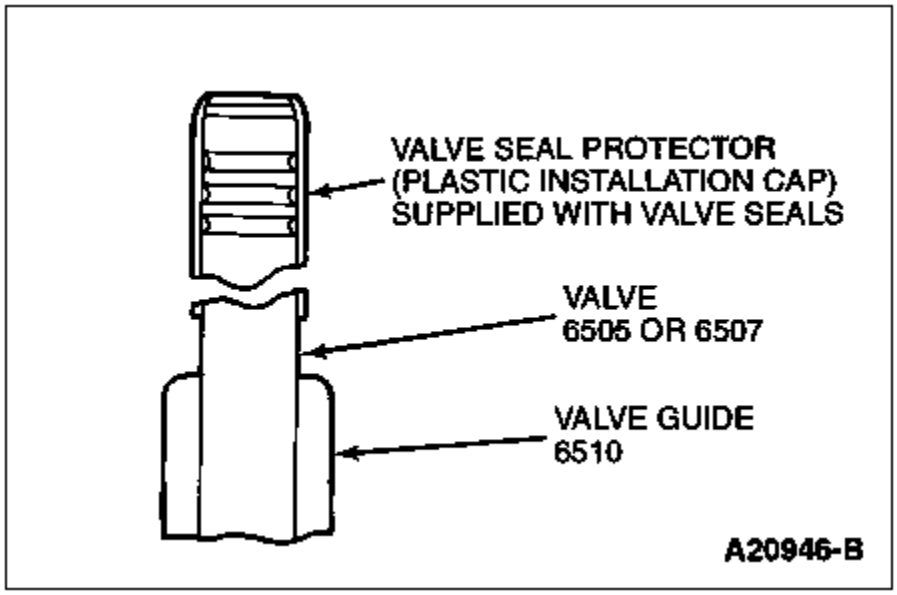
1. **CAUTION: Install valve seal protector (plastic installation cap) included with valve seal kit over end of valve before installing valve stem seal or valve stem seal will be cut by valve retainer key grooves in valve. If valve stem seal is cut it will leak causing oil burning and valve fouling.**

   Put valve seal protector (plastic installation cap) over end of valve as illustrated.



2. Start valve stem seal carefully over cap. Push valve stem seal down until jacket touches top of valve guide.

3. Remove seal protector (plastic cap). Use Valve Stem Seal Replacer T95T-6510-B to install valve stem seal on valve guide.

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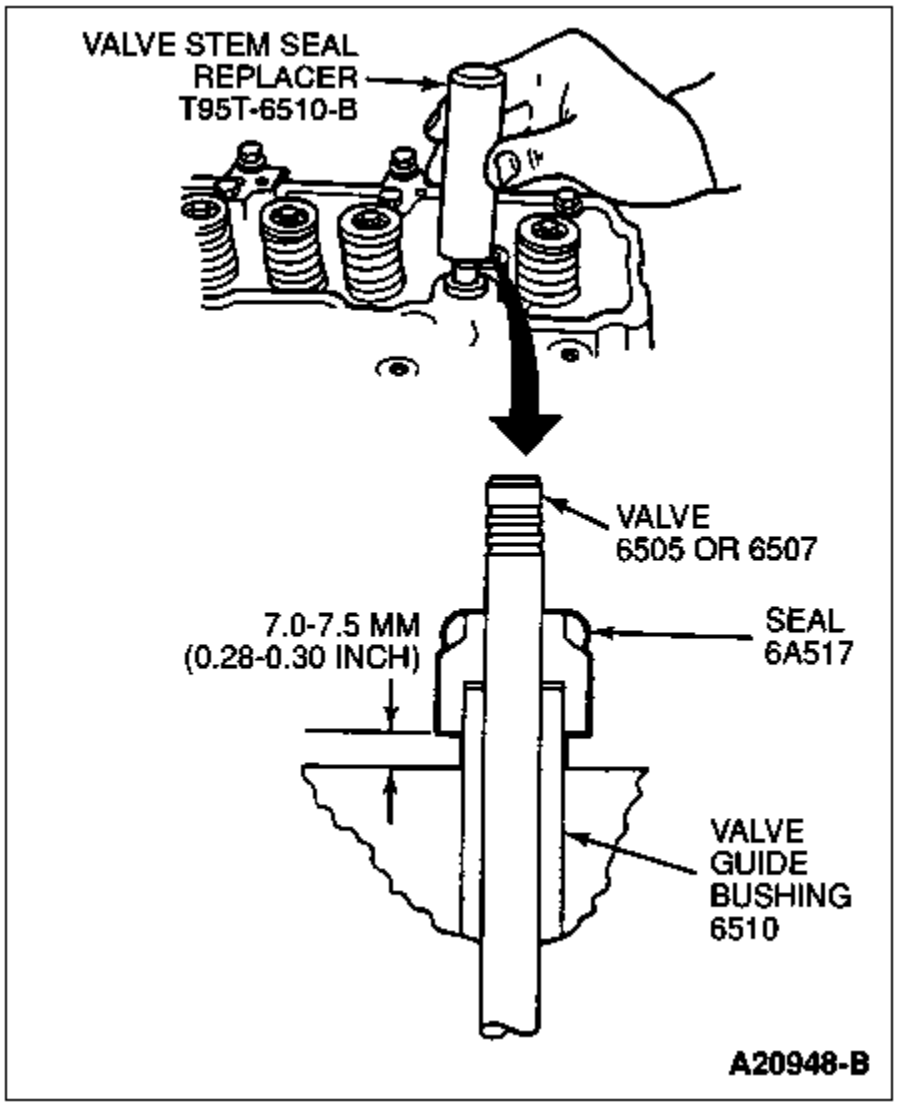

4. Apply a small amount of Ford Multi-Purpose Grease D0A2-19584-AA or equivalent meeting Ford specification ESR-M1C159-A to valve spring retainer key to hold in place during installation.

5. With cylinder pressurized, place valve spring and valve spring retainer into position.

6. Compress valve spring with Valve Spring Compressor T95T-6565-A and install valve spring retainer keys. Release spring to seat valve spring retainer keys in proper cylinder.

7. Release air pressure and remove air adapter. Install spark plug in proper cylinder.

8. Grease contact surfaces of roller finger follower with Ford Multi-Purpose Grease D0AZ-19584-AA or equivalent meeting Ford specification ESR-M1C159-A.

9. Using Valve Spring Compressor T95T-6565-A, compress and hold down the valve and spring. Slide the roller finger follower into place over valve and lash adjuster. Release spring.

10. Using Valve Spring Compressor T95T-6565-A, compress and release lash adjuster.

11. Install valve cover as outlined in this section.

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Crankshaft Pulley and Damper

Removal

1. With vehicle in park if it has an automatic transmission, or reverse if it has a manual transmission, loosen crankshaft damper bolt.
2. Using flex handle, rotate drive belt tensioner (6B209) and remove drive belt (8620).
3. Remove crankshaft damper from crankshaft (6303).

Installation

1. Align keyway with key, install crankshaft damper on crankshaft, and snug crankshaft damper bolt.
2. Position drive belt and rotate drive belt tensioner away from drive belt.
3. Position drive belt under drive belt tensioner and release drive belt tensioner, tensioning drive belt.
4. Tighten crankshaft damper retaining bolt to 125-165 Nm (93-121 lb-in).

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Camshaft Timing Belt Outer Cover

Removal

1. Remove two screws and fan guard (8A611). Remove two screws and fan shroud (8146) and set on fan blade (8600).
2. Remove four screws and fan. Take out fan shroud at the same time.
3. Loosen four fan clutch (8A616) and water pump pulley (8509)-to-water pump bolts.
4. Rotate drive belt tensioner (6B209) and remove drive belt (8620).
5. Remove four bolts, fan clutch, and water pump pulley.
6. Recover refrigerant from air conditioning system. Refer to Section 12-00 .
7. Remove four bolts and A/C compressor (19703) from A/C compressor mounting bracket (2882) and set aside with hoses attached.
8. Remove bolts and A/C compressor mounting bracket with attached power steering pump (3A674) and set aside with hoses attached.
9. Remove timing belt outer cover retaining screw.
10. Release seven cover interlocking tabs and remove outer timing belt cover.

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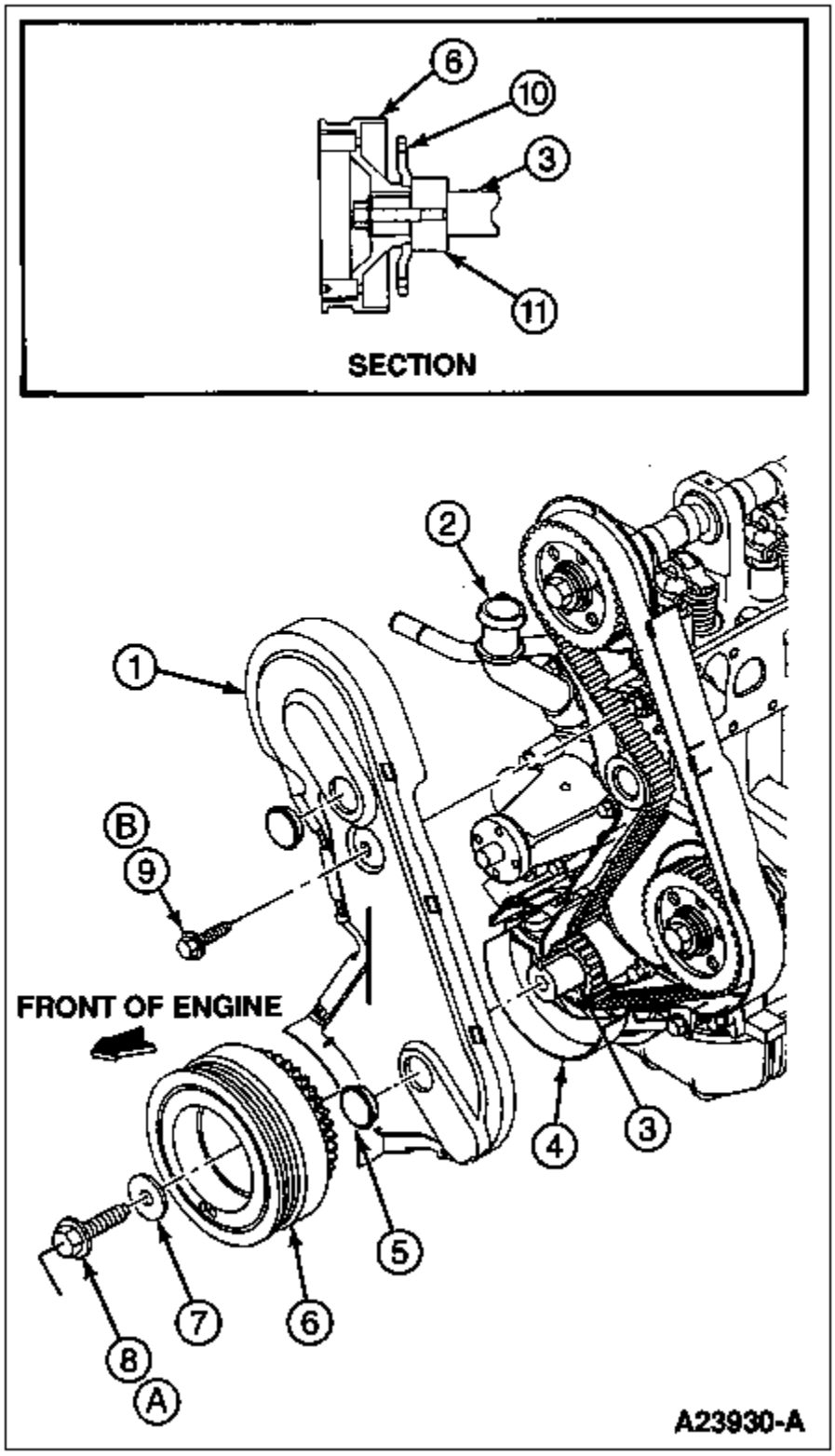

Item	Part Number	Description
1	6E011	Outer Timing Belt Cover Assembly
2	8594	Water Outlet Connection

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3	6303	Crankshaft
4	6E005	Inner Timing Belt Cover
5	N807419-S	Plug (Part of 6E011)
6	6312	Crankshaft Pulley
7	6378	Crankshaft Pulley Retaining Washer
8	N805044-S2	Bolt, M14-1.5 x 55
9	N808534-S2	Bolt, M6-1 x 17
10	—	Pulse Wheel (Part of 6312)
11	6306	Crankshaft Sprocket
A	—	Tighten to 125-165 Nm (93-121 Lb-Ft)
B	—	Tighten to 8-12 Nm (70-106 Lb-In)

Installation

1. Position outer timing belt cover and secure by snapping the seven interlocking tabs into place.
2. Install timing belt cover retaining screw and tighten to 8-12 Nm (70-106 lb-in).
3. Install A/C compressor mounting bracket with attached power steering pump. Tighten bolts to 21-28 Nm (16-20 lb-ft).
4. Install A/C compressor and tighten bolts to 21-28 Nm (16-20 lb-ft).
5. Install water pump pulley and fan clutch and tighten snug but not tight.
6. Install drive belt.
7. Using flex handle, rotate drive belt tensioner, position drive belt, and rest tensioner pulley on belt.
8. Tighten four fan clutch and pulley-to-water pump bolts to 17-23 Nm (13-16 lb-ft).
9. Position fan shroud over fan clutch shaft.
10. Install fan shroud and fan guard.

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Camshaft Timing Belt Inner Cover

Removal

1. Remove timing belt as outlined in this section.
2. Remove timing belt tensioner as outlined in this section.
3. Remove oil pump sprocket as outlined in this section.
4. Remove screw and nut securing inner timing belt cover to cylinder block.
5. Loosen stud two or three turns.
6. Remove inner timing belt cover.

Installation

1. Position inner timing belt cover on front of engine (6007) and stud.
2. Install nut and bolt and tighten to 8-12 Nm (70-106 lb-in).
3. Tighten stud to 20-30 Nm (14-22 lb-ft).
4. Install oil pump sprocket as outlined in this section.
5. Install timing belt tensioner as outlined in this section. Tighten M8 bolt to 21-28 Nm (16-20 lb-ft) and M10 bolts (3) to 40-55 Nm (30-40 lb-ft).
6. Install timing belt as outlined in this section.

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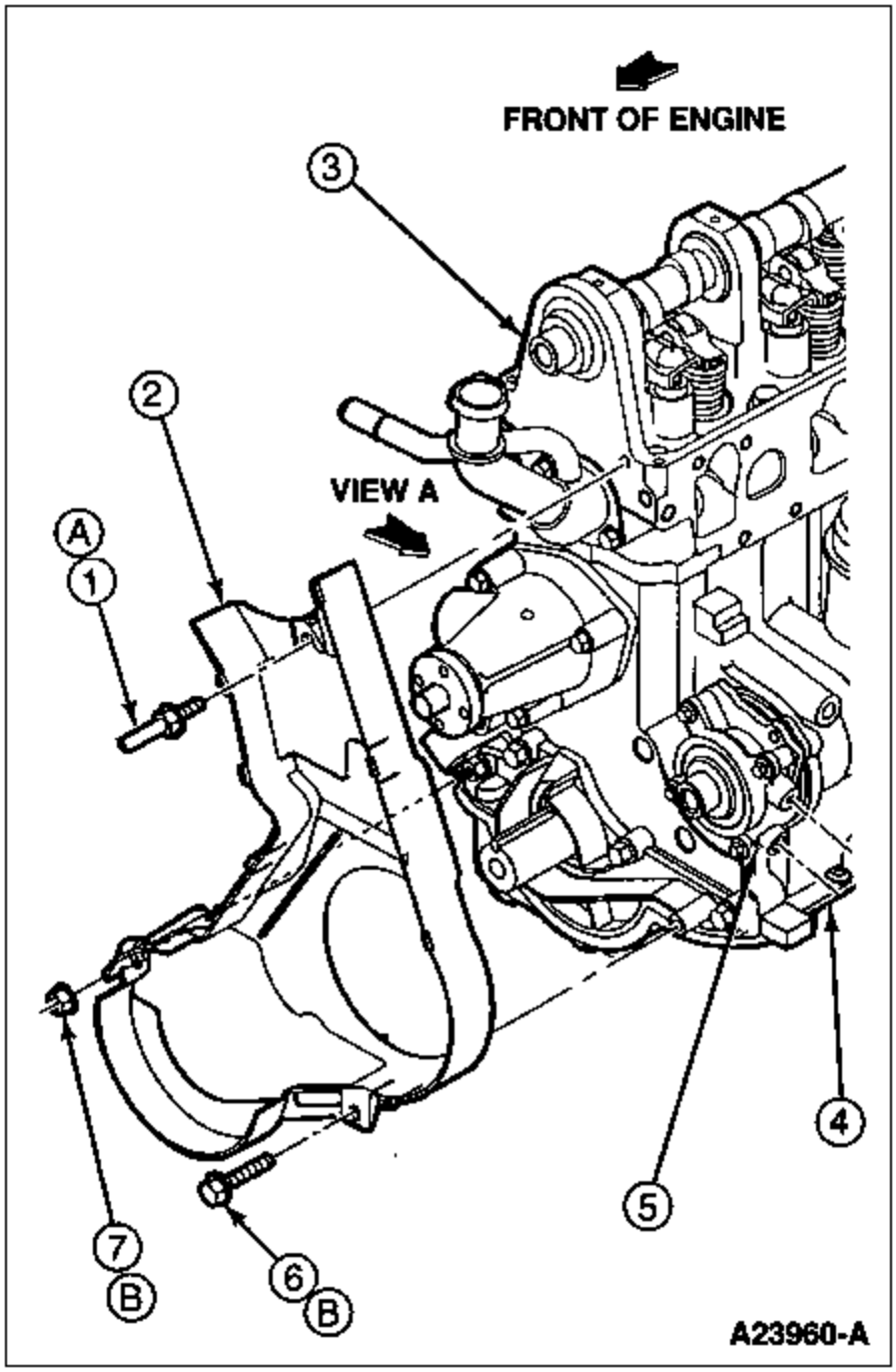

Item	Part Number	Description
1	N808049-S102	Stud, M8-1.25 x 51
2	6E005	Inner Timing Belt Cover
3	6049	Cylinder Head
4	6010	Cylinder Blocks
5	6600	Oil Pump
6	N804958-S8	Bolt, M6-1 x 22.5

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7	N621506-S2	Nut, M6-1
A	—	Tighten to 20-30 Nm (15-22 Lb-Ft)
B	—	Tighten to 8-12 Nm (71-106 Lb-In)

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Camshaft Timing Belt

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Camshaft Belt Tension Adjusting Tool	T74P-6254-A

Removal

1. Remove spark plugs (12405).
2. Align crankshaft (6303) so number one piston is at TDC (top dead center) as indicated by timing marks. Refer to illustration.
3. Remove outer timing belt cover as outlined in this section.
4. **CAUTION: If you attempt to remove timing belt or adjust tension without loosening both timing belt tensioner adjusting bolt and spring pivot bolt, you will break Camshaft Belt Tension Adjusting Tool T74P-6254-A when you attempt to relieve tension on belt.**

   Loosen timing belt spring pivot bolt. Do not remove.
5. Hold tensioner with Camshaft Belt Tension Adjusting Tool T74P-6254-A.

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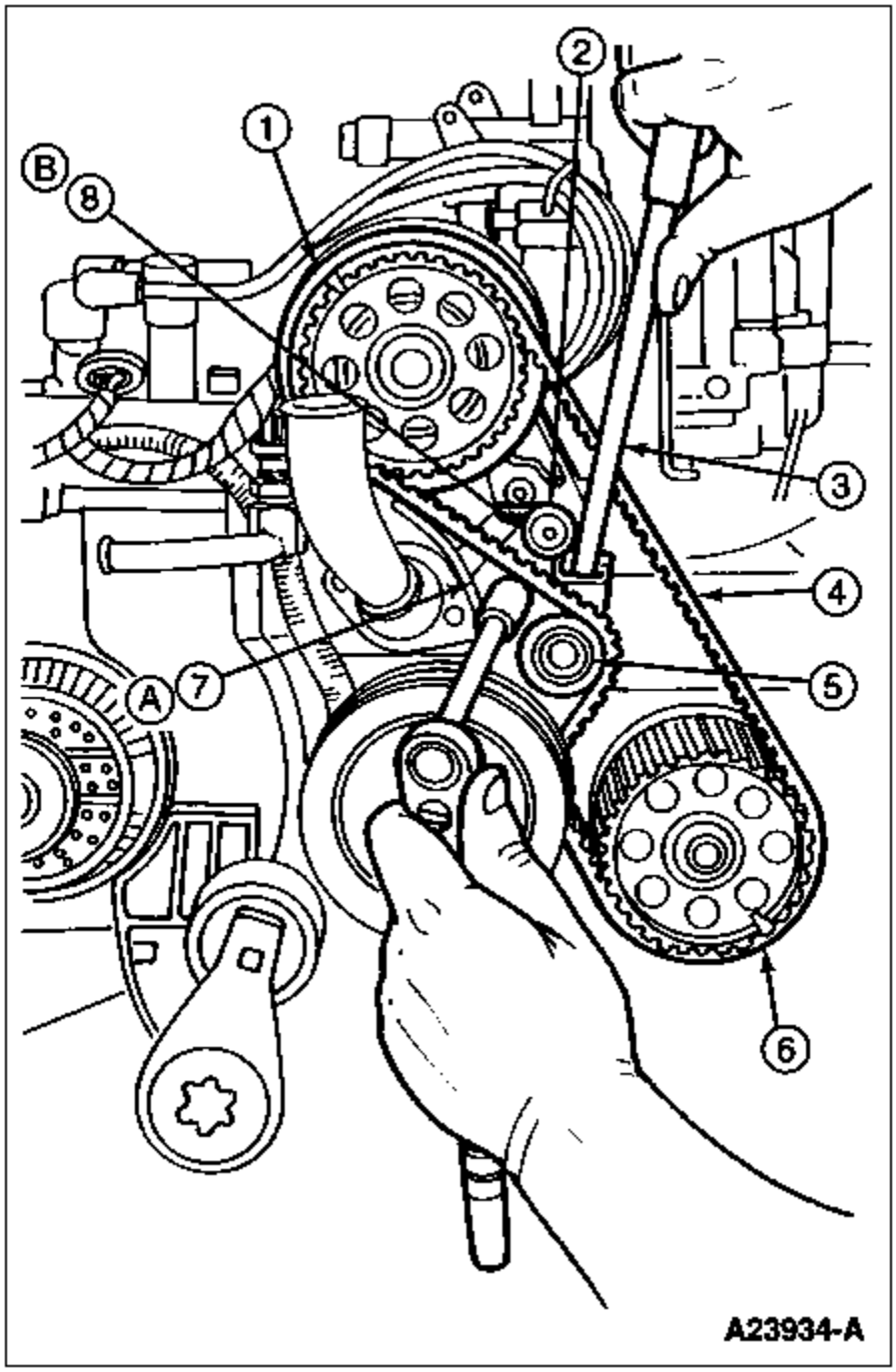

Item	Part Number	Description
1	6256	Camshaft Sprocket (Timing Mark)
2	6L273	Timing Belt Tensioner Spring
3	T74P-6254-A	Camshaft Belt Tension Adjusting Tool
4	6268	Timing Belt
5	6K254	Timing Belt Tensioner
6	6256	Oil Pump Sprocket

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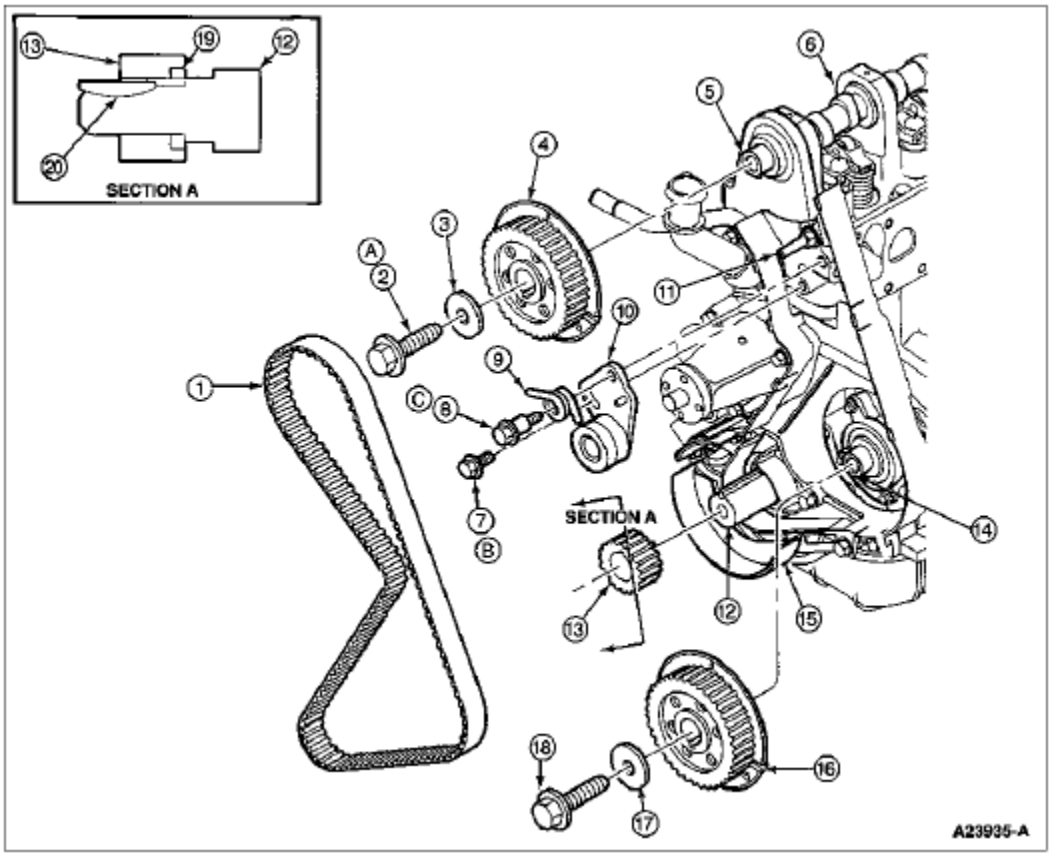
		(Timing Mark)
7	N800112-S100	Tensioner Adjusting Bolt, M8-1.25 x 20 (Under Wrench)
8	6K282	Timing Belt Tensioner (Spring Pivot) Bolt
A	—	Tighten to 35-45 Nm (26-33 Lb-Ft)
B	—	Tighten to 40-55 Nm (30-40 Lb-Ft)

6. While holding tensioner, loosen adjusting bolt and gradually release spring tension.
7. Using adjusting tool, rotate tensioner, against spring pressure, as far clockwise as possible. While holding, tighten adjusting bolt to hold tensioner away from belt.
8. Remove timing belt.

Camshaft Timing Belt, 2.3L I-4



Item	Part Number	Description
1	6268	Timing Belt

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2	N600414-S	Bolt, M12-1.75 x 45
3	6278	Washer
4	6256	Camshaft Sprocket
5	6250	Camshaft
6	6049	Cylinder Head
7	N80012-S100	Bolt, M8-1.25 x 20
8	6K282	Timing Belt Tensioner Bolt
9	61273	Timing Belt Tensioner Spring
10	6K254	Belt Tensioner Assembly
11	—	Stud (Part of 6049)
12	6303	Crankshaft
13	6306	Crankshaft Sprocket
14	6600	Oil Pump
15	6E005	Inner Timing Belt Cover
16	6256	Oil Pump Sprocket
17	—	Washer (Part of N600313-S2)
18	N600313-S2	Bolt, M10-1.5 x 40
19	—	Recess (Part of 6306)
20	—	Crankshaft Keyway
A	—	Tighten to 70-95 Nm (51-70 Lb-Ft) (See Text)
B	—	Tighten to 35-45 Nm (25-33 Lb-Ft) (See Text)
C	—	Tighten to 40-55 Nm (30-40 Lb-Ft) (See Text)

Installation

NOTE: Care must be taken during timing belt installation to prevent damage to the inner timing cover.

1. If not done:
    a. Loosen tensioner adjusting bolt.
    b. Using Camshaft Belt Tension Adjusting Tool T74P-6254-A, pry tensioner clockwise against spring tension as far as possible.
    c. Tighten adjusting bolt to hold tensioner in released position.
2. Align crankshaft so number one piston is at TDC (top dead center) with crankshaft key pointing straight up and circle on crankshaft sprocket (6306) aligned with notch in engine front cover (6019).
3. Align triangle on camshaft sprocket with triangle on inner timing belt cover.

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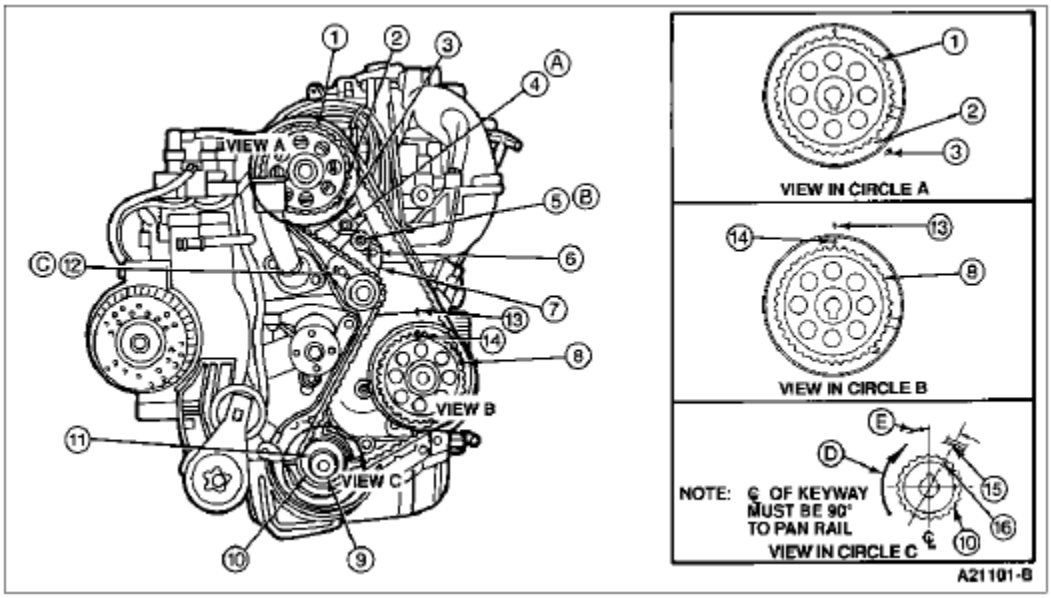
4. Align diamond on oil pump sprocket with diamond on inner timing belt cover.

Timing Mark Alignment



Item	Part Number	Description
1	6256	Camshaft Sprocket
2	—	Pointer Triangle (Part of Camshaft Sprocket)
3	—	Pointer Triangle (on Inner Timing Belt Cover)
4	N801658-S	Stud, M8 x 1.25
5	6K282	Spring Pivot Bolt
6	—	Stud (Part of 6K254)
7	6K254	Timing Belt Tensioner
8	6256	Oil Pump Sprocket
9	6303	Crankshaft
10	6306	Crankshaft Sprocket
11	N806700-S	Key
12	N800112-S2	Adjusting Bolt, M8-1.25 x 20
13	—	Pointer Diamond (on Inner Timing Belt Cover)
14	—	Pointer Diamond (on Oil Pump Sprocket)
15	—	Pointer Line (Part of 6019)

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16	—	Pointer Circle (on 6306)
A	—	Tighten to 20-30 Nm (15-22 Lb-Ft) (See Text)
B	—	Tighten to 40-55 Nm (30-40 Lb-Ft) (See Text)
C	—	Tighten to 35-45 Nm (26-33 Lb-Ft) (See Text)
D	—	Direction of Rotation
E	—	29°

5. Install timing belt over crankshaft sprocket. Then, proceeding counterclockwise, over oil pump sprocket and camshaft sprocket.

6. Loosen tensioner adjusting bolt allowing tensioner pulley to press against timing belt.

7. **NOTE: When performing the following step, do not rotate crankshaft counterclockwise as timing belt may jump a cog, putting camshaft or camshaft position sensor on oil pump out of time.**

   Rotate crankshaft two revolutions clockwise.

8. Bring crankshaft slowly, without stopping, to number one cylinder firing position (keyway directly up).

9. Recheck timing mark alignment. Repeat steps if timing marks are not properly aligned.

10. Rotate tensioner assembly against belt with torque wrench up to 41-45 Nm (30-33 lb-ft) and tighten adjusting bolt.

11. Tighten adjusting bolt to 35-45 Nm (26-33 lb-ft).

12. Tighten spring pivot bolt to 40-55 Nm (30-40 lb-ft).

13. Install outer timing belt cover as outlined in this section.

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Camshaft and Oil Pump Sprocket

NOTE: Removal and installation steps are the same for both camshaft and oil pump (6600) sprockets.

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Cam Sprocket Holding/Removing Tool	T74P-6256-B

Removal

1. Remove outer timing belt cover as outlined in this section.
2. Remove timing belt as outlined in this section.
3. Install Cam Sprocket Holding/Removing Tool T74P-6256-B on sprocket. Use tool to hold sprocket and remove bolt and washer.

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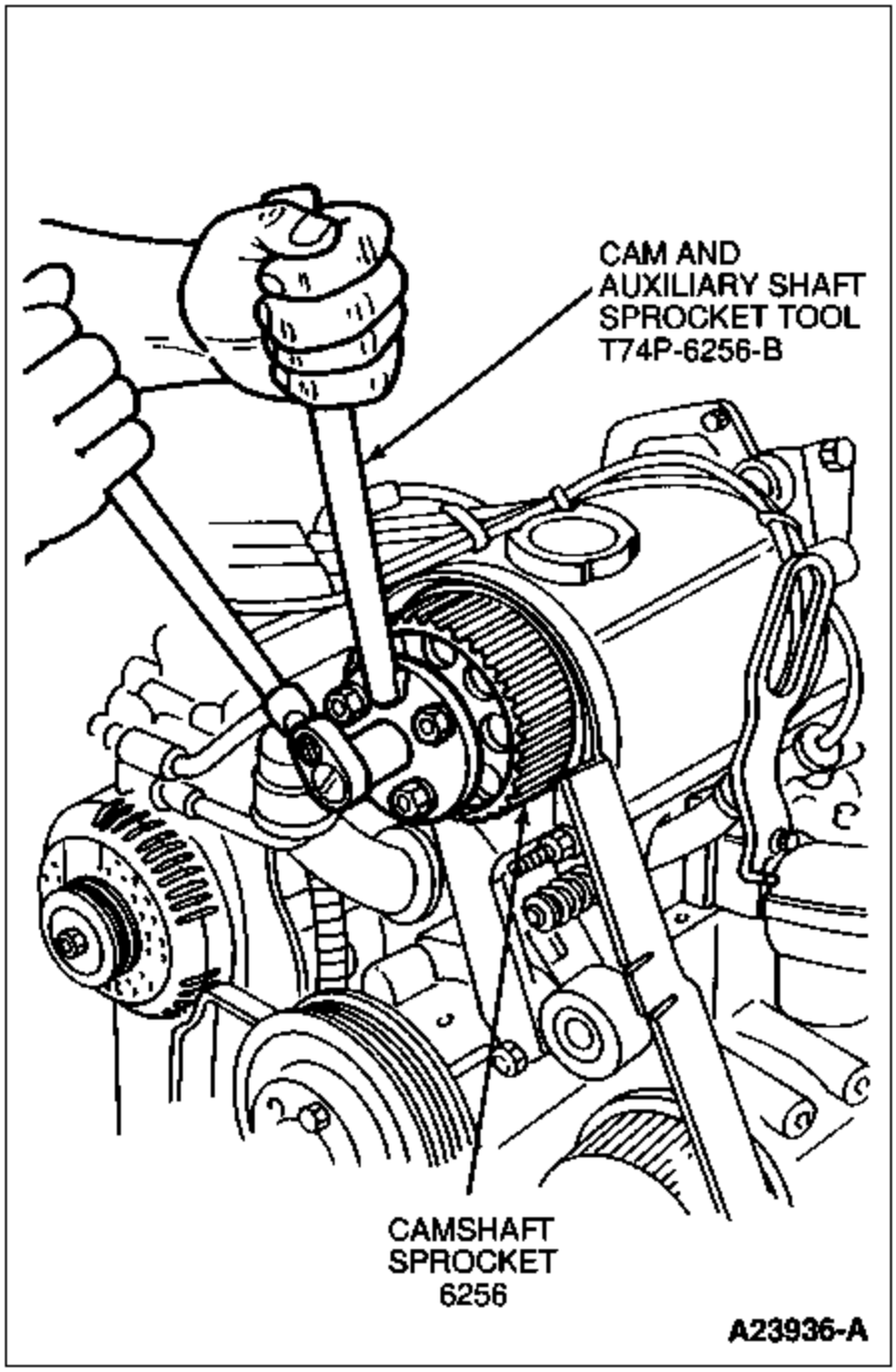

4. Install threaded puller insert in Cam Sprocket Holding/Removing Tool T74P-6256-B and remove sprocket.

5. Remove tool from sprocket.

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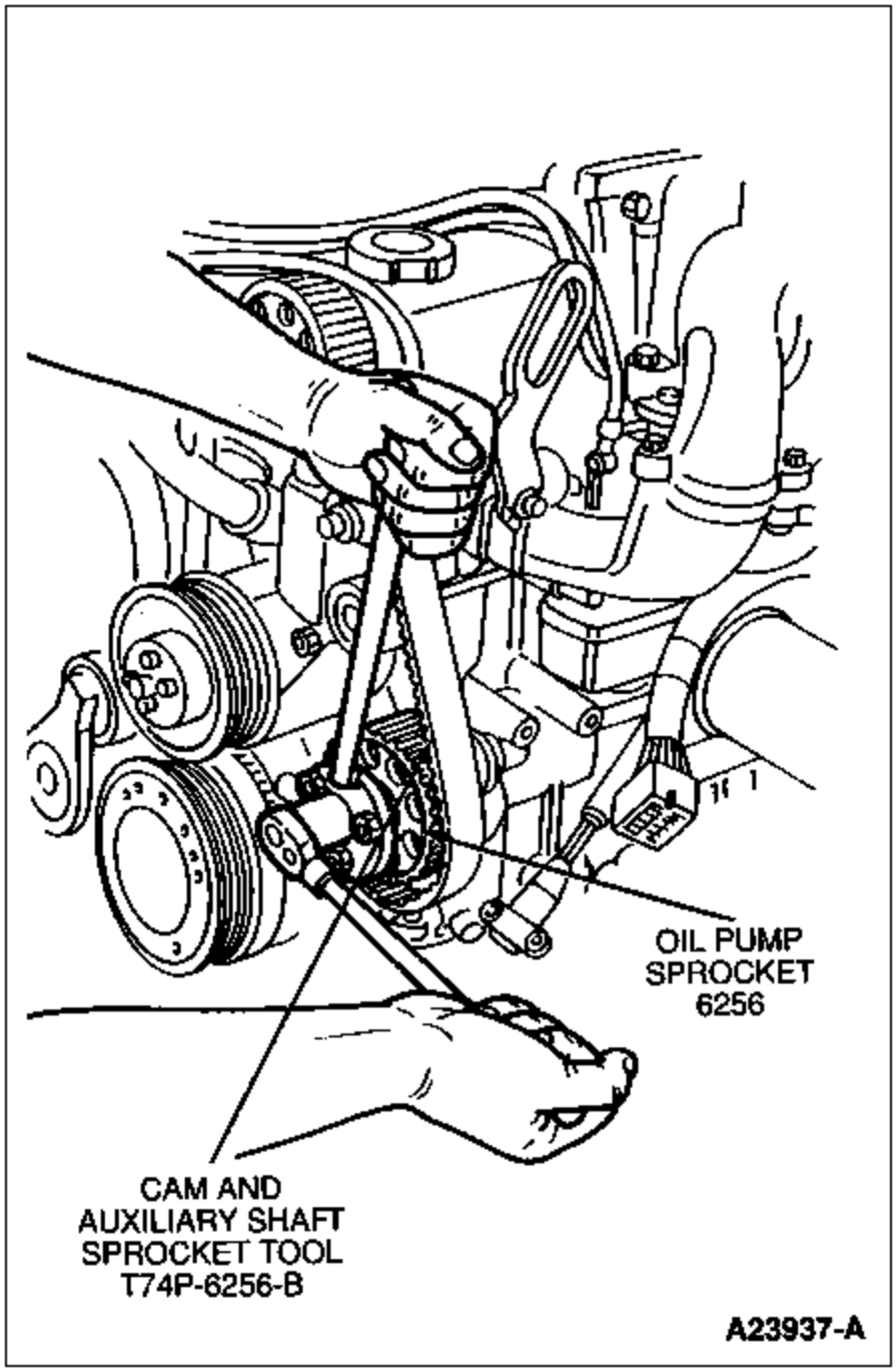

Installation

1. Position key and sprocket on shaft.
2. Install Cam Sprocket Holding/Removing Tool T74P-6256-B, without threaded puller insert, on sprocket.
3. Install sprocket bolt and washer and tighten to 70-95 Nm (52-70 lb-ft).
4. Remove tool.

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5. Install timing belt as outlined in this section.
6. Install outer timing belt cover as outlined in this section.

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Crankshaft Sprocket

Removal

1. Remove outer timing belt cover as outlined in this section.
2. Remove crankshaft damper and crankshaft pulley retaining washer (6378).
3. Remove crankshaft damper.
4. Remove timing belt as outlined in this section.
5. Remove crankshaft sprocket (6306).

Installation

1. Install crankshaft sprocket.
2. Install timing belt as outlined in this section.
3. Install outer timing belt cover as outlined in this section.
4. Install crankshaft pulley (6312), washer, and bolt. Tighten bolt to 125-165 Nm (92-121 lb-ft).

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Timing Belt Tensioner

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Belt Tension Adjusting Tool	T74P-6254-A
Camshaft Belt Tensioner Tool	T74P-6256-B

Removal

1. Remove outer timing belt cover as outlined in this section.
2. Remove timing belt as outlined in this section.
3. **NOTE: Belt tensioner assembly is under spring tension.**

   Hold tensioner by prying against spring pressure with Belt Tensioner Adjusting Tool T74P-6254-A. Remove adjustment bolt (which goes through slot in base of tensioner).
4. Release pressure.
5. Remove spring pivot bolt, spring, and tensioner assembly.

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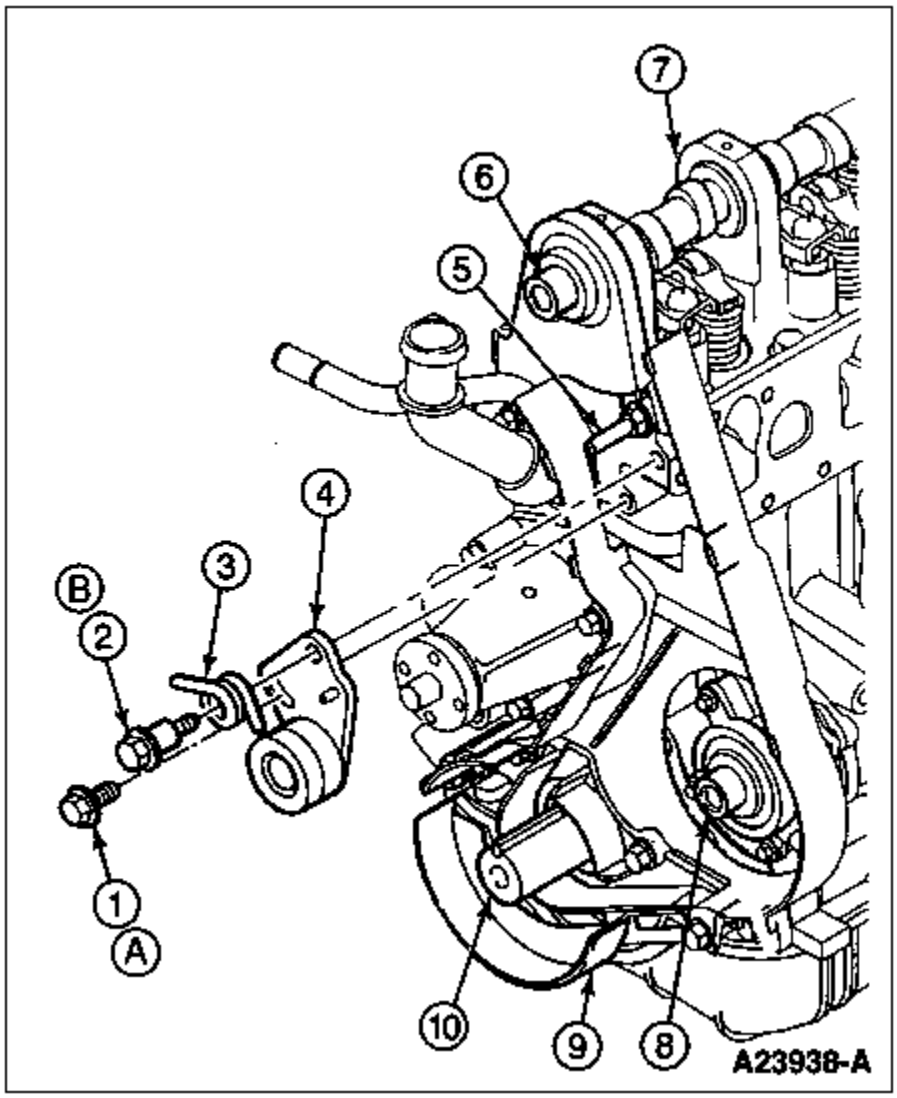

Item	Part Number	Description
1	N80012-S100	Bolt, M8-1.25 x 20
2	6K282	Timing Belt Tensioner Bolt
3	6L273	Timing Belt Tensioner Spring
4	6K254	Belt Tensioner Assembly
5	—	Stud (Part of 6049)
6	6250	Camshaft
7	6049	Cylinder Head
8	6600	Oil Pump
9	6E005	Inner Timing Belt Cover
10	6303	Crankshaft
A	—	Tighten to 35-45 Nm (26-33 Lb-Ft) (See Text)
B	—	Tighten to 40-55 Nm

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		(30-40 Lb-Ft) (See Text)

Installation

1. Install belt tensioner and timing belt tensioner spring on cylinder head placing one leg of spring under stud on cylinder head (6049) and other leg against pin on tensioner and install spring pivot bolt loosely.

2. Using Camshaft Belt Tensioner Tool T74P-6256-B, rotate tensioner clockwise against spring tension as far as possible and install adjustment bolt and tighten to restrain tensioner.

3. **NOTE: Spring pivot bolt is to be tightened after timing belt is installed. Adjusting bolt is tightened as part of timing belt installation.**

   Install timing belt as outlined in this section.

4. After installing timing belt, tighten spring pivot bolt to 40-55 Nm (30-40 lb-ft).

5. Install outer timing belt cover as outlined in this section.

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Camshaft

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Valve Spring Compressor	T95T-6565-A
Cam Sprocket Holding/Removing Tool	T74P-6256-B
Front Seals Replacer	T74P-6150-A
Front Cover Seal Remover	T74P-6700-B

NOTE: Front of engine must be raised for this operation.

Removal

1. Remove outer timing belt cover as outlined in this section.
2. Remove valve cover (6582) as outlined in this section.
3. Rotate the camshaft (6250) so the rocker arm (6564) is on the heel of its cam.
4. Using Valve Spring Compressor T95T-6565-A compress valve springs (6513) and remove all roller finger followers.
5. Remove camshaft sprocket using Cam Sprocket Holding/Removing Tool T74P-6256-B.
6. Remove camshaft seal using Front Cover Seal Remover T74P-6700-B.
7. Remove camshaft retainer plate (two screws).
8. **CAUTION: Be careful to avoid damaging journals and lobes.**

   Remove camshaft.

Camshaft Installation, 2.3L

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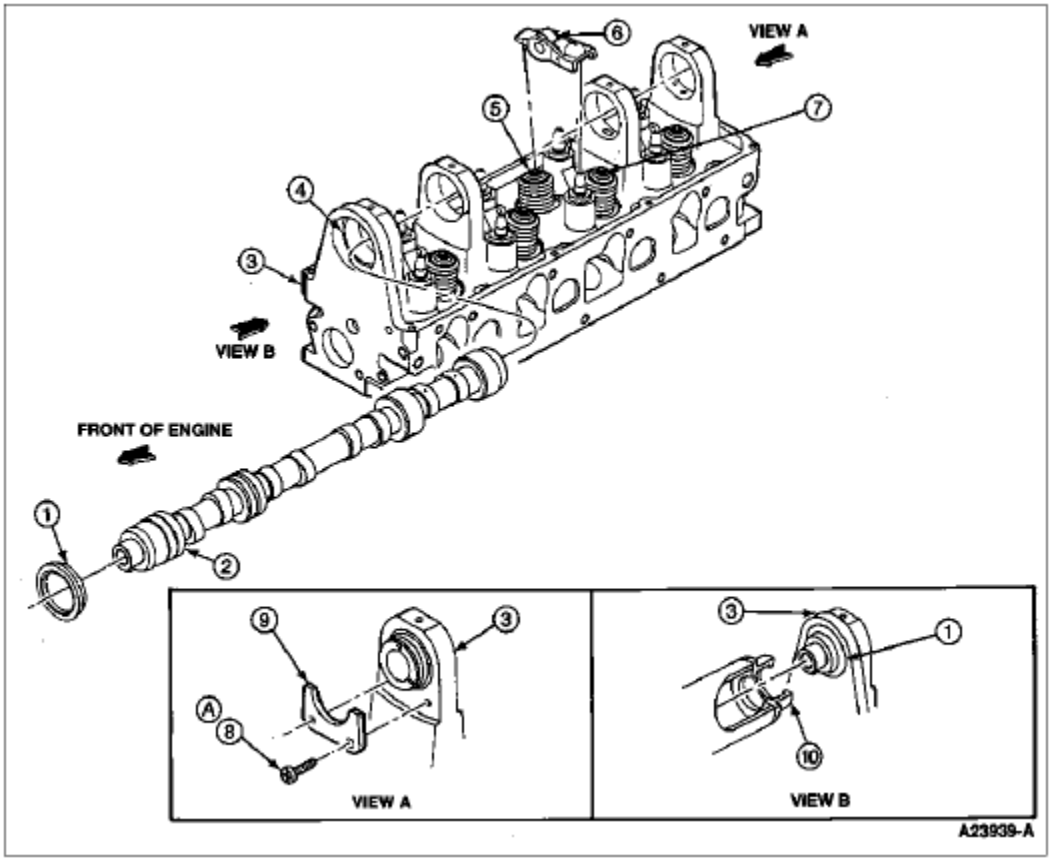

Item	Part Number	Description
1	6700	Camshaft Front Seal
2	6250	Camshaft
3	6049	Cylinder Head
4	6261	Camshaft Bearing
5	6505	Exhaust Valve
6	6564	Rocker Arm
7	6507	Intake Valve
8	N604465-S	Pan Head Screw, M6-1 x 16
9	6A222	Camshaft Retaining Plate
10	T74P-6150-A	Cam and Auxiliary Shaft Seal Replacer
A	—	Tighten to 8-12 Nm (71-106 Lb-In)

Installation

1. Coat the camshaft lobes with Ford Multi-Purpose Grease D0AZ-19584-AA or equivalent meeting Ford specification ESR-M1C159-A and lubricate the journals with heavy oil SF before installation. Carefully slide the camshaft through the camshaft bearings (6261).

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2. Install camshaft retaining plate. Tighten screws to 8-12 Nm (6-9 lb-ft).
3. Install camshaft front seal using Front Seals Replacer T74P-6150-A.
4. Install camshaft sprocket to camshaft.
5. Install retaining bolt using Cam Sprocket Holding/Removing Tool T74P-6256-B to hold sprocket. Tighten to 70-95 Nm (52-70 lb-ft).
6. Install timing belt as outlined in this section.
7. Install outer timing belt cover as outlined in this section.
8. Using Valve Spring Compressor T95T-6565-A compress valve spring and install followers.
9. Using Valve Spring Compressor T95T-6565-A, compress and release valve tappet.
10. Install valve cover as outlined in this section.
11. Start engine (6007) and check for leaks.

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Camshaft and Oil Pump Oil Seal

NOTE: The camshaft and oil pump shaft seals are each replaced in the same manner with the same tools after the respective sprocket has been removed.

NOTE: Always use a new attaching bolt when replacing the camshaft sprocket or use Teflon® or equivalent sealing tape on the threads of the old bolt.

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Cam Sprocket Holding/Removing Tool	T74P-6256-B
Front Cover Seal Remover	T74P-6700-B
Front Seals Replacer	T74P-6850-A

Removal

1. Remove outer timing belt cover as outlined in this section.
2. Remove timing belt as outlined in this section.
3. Install Cam Sprocket Holding/Removing Tool T74P-6256-B on sprocket and use tool to hold sprocket and remove bolt and washer.

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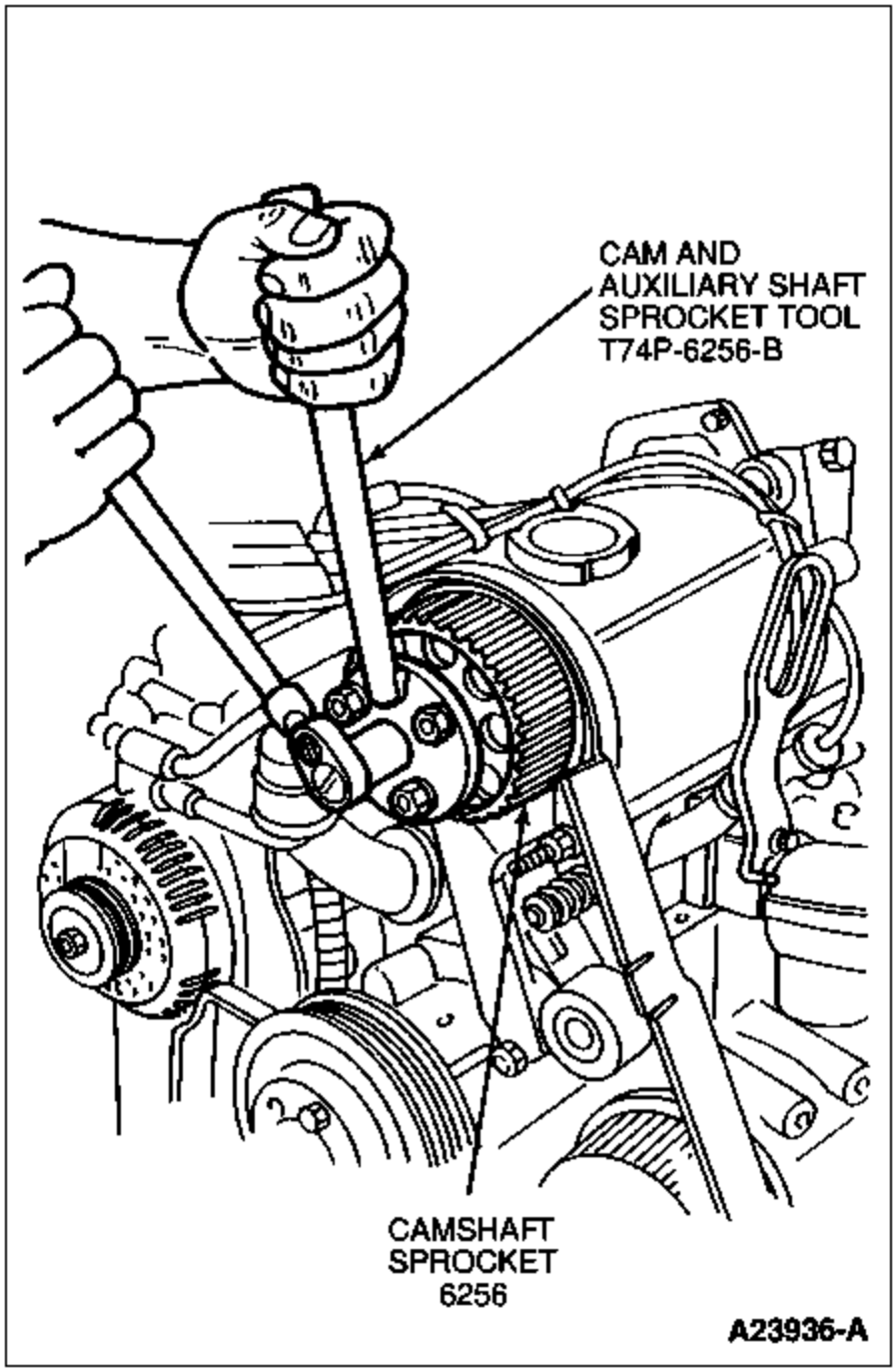

4. Install threaded puller insert in Cam Sprocket Holding/Removing Tool T74P-6256-B and pull sprocket.

5. **NOTE: When positioning Front Cover Seal Remover T74P-6700-B, make sure the jaws are gripping the thin edge of the seal very tightly before operating the jack screw portion of the tool.**

   Install Front Cover Seal Remover T74P-6700-B, making sure jaws are tightly gripping the thin edge of the seal. Clean journal of debris.

6. Remove seal.

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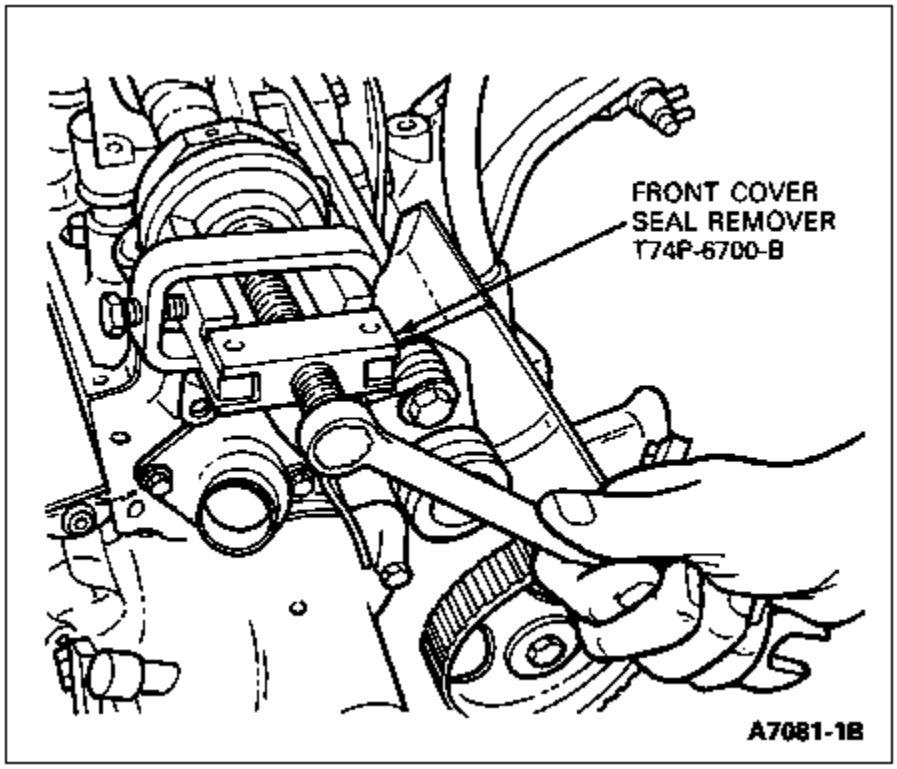

Installation

1. Position camshaft or oil pump shaft seal on Front Seals Replacer T74P-6850-A and press into place.

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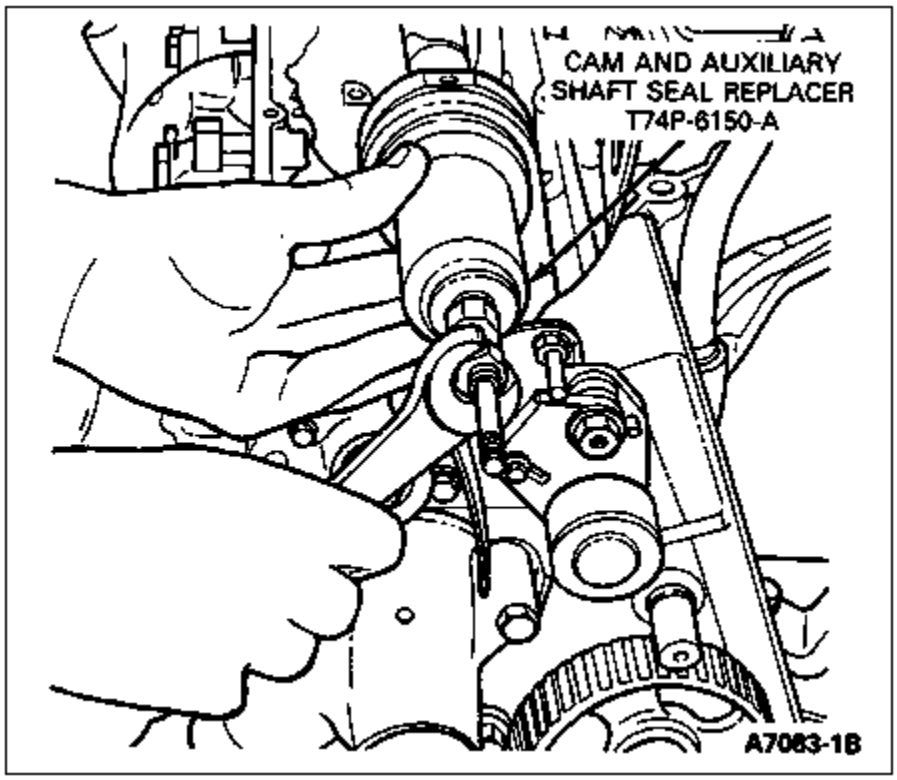

2. Remove tool.
3. Position sprocket on shaft.
4. Install Cam Sprocket Holding/Removing Tool T74P-6256-B, without threaded puller insert, on sprocket.
5. Install sprocket bolt and washer and tighten to 70-95 Nm (52-70 lb-ft).
6. Remove tool.
7. Install timing belt as outlined in this section.
8. Install outer timing belt cover as outlined in this section.

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Cylinder Block Front Cover Seal

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Front Cover Seal Remover	T74P-6700-B
Cam Bearing Adapter Tube	T72C-6250

Removal

1. Remove outer timing belt cover as outlined in this section.
2. Remove timing belt as outlined in this section.
3. Remove crankshaft pulley hub bolt.
4. Slide crankshaft pulley (6312) off crankshaft (6303).
5. Slide crankshaft sprocket off of crankshaft.
6. Remove key from crankshaft.
7. **NOTE: When positioning Front Cover Seal Remover T74P-6700-B, make sure jaws are gripping the thin edge of the seal tightly before operating the jack screw portion of the tool.**

   Install Front Cover Seal Remover T74P-6700-B, making sure jaws are gripping the thin edge of the seal.
8. Remove seal.
9. Clean journal of debris.

Installation

1. Using Cam Bearing Adapter Tube T72C-6250 and crankshaft pulley hub bolt, press engine front cover seal into engine front cover (6019).
2. Remove tool.
3. Install key.
4. Install crankshaft sprocket (6306), crankshaft pulley, washer, and bolt. Tighten bolt to 125-165 Nm (92-121 lb-ft).
5. Install timing belt as outlined in this section.
6. Install outer timing belt cover as outlined in this section.

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Cylinder Head

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Camshaft Belt Tensioner Tool	T74P-6254-A

Removal

WARNING: RESIDUAL PRESSURE REMAINS IN FUEL SYSTEM AFTER ENGINE IS SHUT OFF. THIS COULD RESULT IN INJURY OR FIRE WHEN FUEL LINES ARE DISCONNECTED. DISCONNECT INERTIA FUEL SHUTOFF SWITCH AND CRANK ENGINE A MINIMUM OF 15 SECONDS TO DEPRESSURIZE SYSTEM. REFER TO SECTION 10-01.

1. Disconnect battery ground cable (14301).
2. Drain cooling system.
3. Disconnect intake air temperature sensor (IAT sensor) (12A697) and mass air flow sensor (MAF sensor) (12B579).
4. Remove air cleaner outlet tube (9B659).
5. Remove upper intake manifold and assembled throttle body as outlined in this section.
6. Remove engine control sensor wiring (12A581).
7. Remove ignition wire and brackets (12280)/spark plug wire sets (12281) from spark plugs (12405) and valve cover attachments.
8. **NOTE: Unique platinum spark plugs are used. If all eight spark plugs are not "PP" series, they will need to be marked for replacement in the same cylinder. Refer to Section 03-07B .**

   Remove spark plugs.
9. Disconnect required vacuum hoses.
10. Remove engine oil level indicator tube (6754).
11. Apply penetrating lubricant E8AZ-19A501-B to EGR tube nuts. Unscrew nuts and remove EGR valve to exhaust manifold tube (9D477).
12. Remove valve cover (6582) retaining bolts and remove cover.
13. Using flex handle, rotate drive belt tensioner (6B209) counterclockwise and remove drive belt (8620).
14. Recover refrigerant from air conditioning system. Refer to Section 12-00 .

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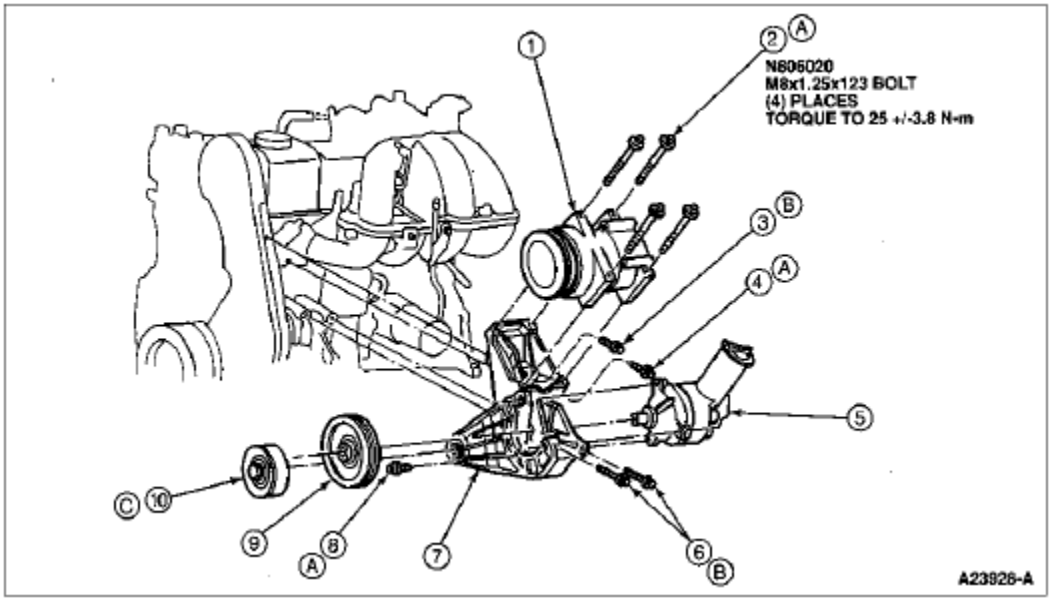
15. Disconnect air conditioning compressor electrical connections.

16. Remove four bolts and A/C compressor (19703) and set to one side without disconnecting hoses. Do not let compressor hang by hoses.

17. Remove bolts and A/C compressor mounting bracket (2882) with assembled power steering pump (3A674), and set to one side without disconnecting hoses.

A/C Compressor Mounting Bracket, 2.3L



Item	Part Number	Description
1	19703	A/C Compressor
2	N806020	Bolt, M8-1.25 x 123
3	N606572	Bolt, M10-1.5 x 123
4	N606051	Bolt, M8-1.25 x 100
5	3A674	Power Steering Pump
6	N606068	Bolt, M10-1.5 x 80
7	10153	A/C Compressor Mounting Bracket
8	N800199	Bolt, M10-1.5 x 33
9	3A733	Power Steering Pump Pulley
10	3F671	Power Steering Belt Idler Support
A	—	Tighten to 22-28 Nm (16-21 Lb-Ft)
B	—	Tighten to 41-54 Nm (29-40 Lb-Ft)
C	—	Tighten to 53-71 Nm

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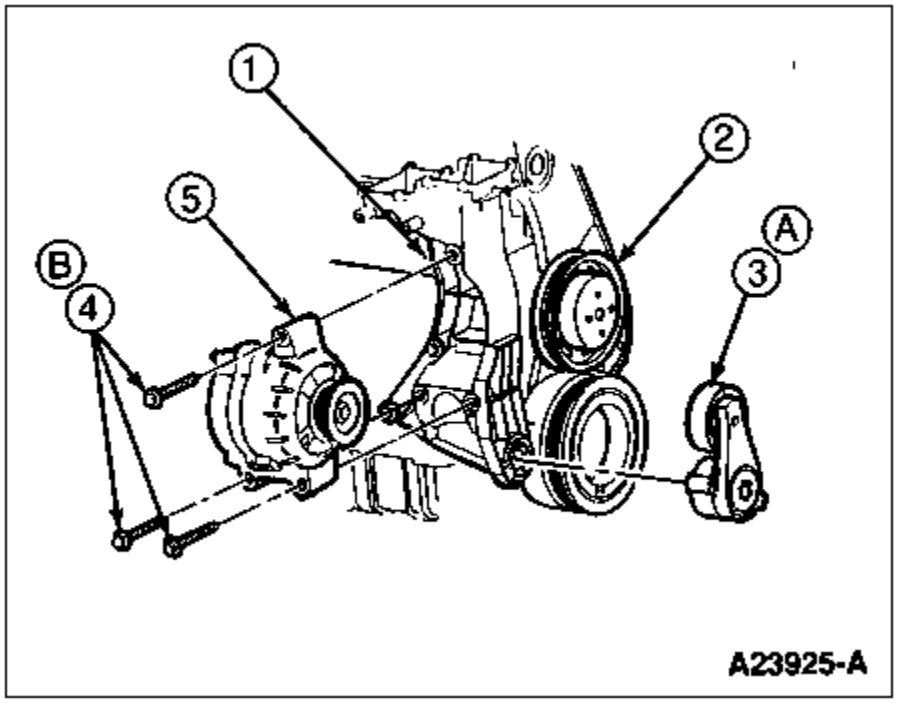
		(39-53 Lb-Ft)

18. Disconnect generator (GEN) (10346) electrical connections.

19. Remove lower radiator hose (8286) and heater water hose (18472) from water pump inlet tube (8290) and thermostat housing.

20. Remove bolts securing water pump inlet tube to generator mounting bracket (10153) and remove water pump inlet tube.

21. Remove three bolts from generator. Remove generator. Remove 3 bolts from generator mounting bracket. Remove bracket with ignition coils (12029) and ignition wire and brackets attached.



Item	Part Number	Description
1	10153	Generator Mounting Bracket
2	8509	Water Pump Pulley
3	6B209	Drive Belt Tensioner
4	N606068	Bolt, M10-1.5 x 80
5	10300	Generator
A	—	Tighten to 40-55 Nm (30-40 Lb-Ft)
B	—	Tighten to 41-54 Nm (30-40 Lb-Ft)

22. Disconnect upper radiator hose (8260) at both ends and remove from vehicle.

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23. Remove fan clutch (8A616) and water pump pulley (8509).
24. Remove timing belt outer cover as outlined in this section.
25. Remove timing belt as outlined in this section.
26. Remove timing belt tensioner adjuster bolt, spring pivot bolt, timing belt tensioner spring, and tensioner.
27. Remove front engine lifting eye (17A084).
28. Remove retaining bolts and lower intake manifold.
29. Remove rear engine lifting eye.
30. Remove the eight exhaust manifold (9430) retaining bolts and studs (6 bolts, 2 studs).
31. Remove cylinder head retaining bolts (10).
32. Remove the cylinder head (6049).
33. Clean cylinder head gasket surface at the block.
34. Clean lower and upper intake manifold gasket surfaces.
35. Clean exhaust manifold gasket surface.
36. Clean exhaust manifold gasket surface at the cylinder head.
37. Clean cylinder head gasket surface at the cylinder head.
38. Clean intake manifold gasket surface at the cylinder head.
39. Blow oil out of the cylinder block bolt holes.
40. Clean valve cover gasket surface on the cylinder head.
41. Check cylinder head for flatness as outlined in Section 03-00 . Cylinder head and cylinder blocks (6010) cylinder head gasket surface should be flat to 0.08mm (0.003 inch) over any 152mm (6 inches) and flat within 0.16mm (0.006 inch) overall.

Installation

1. Position head gasket (6051) on the block.
2. Position cylinder head to cylinder blocks.
3. Install 10 cylinder head bolts in numerical sequence. Tighten to 70 Nm (51 lb-ft) in illustrated sequence. Retighten to 70 Nm (51 lb-ft) in sequence. Then turn all head bolts an additional 90-100 degrees in sequence.

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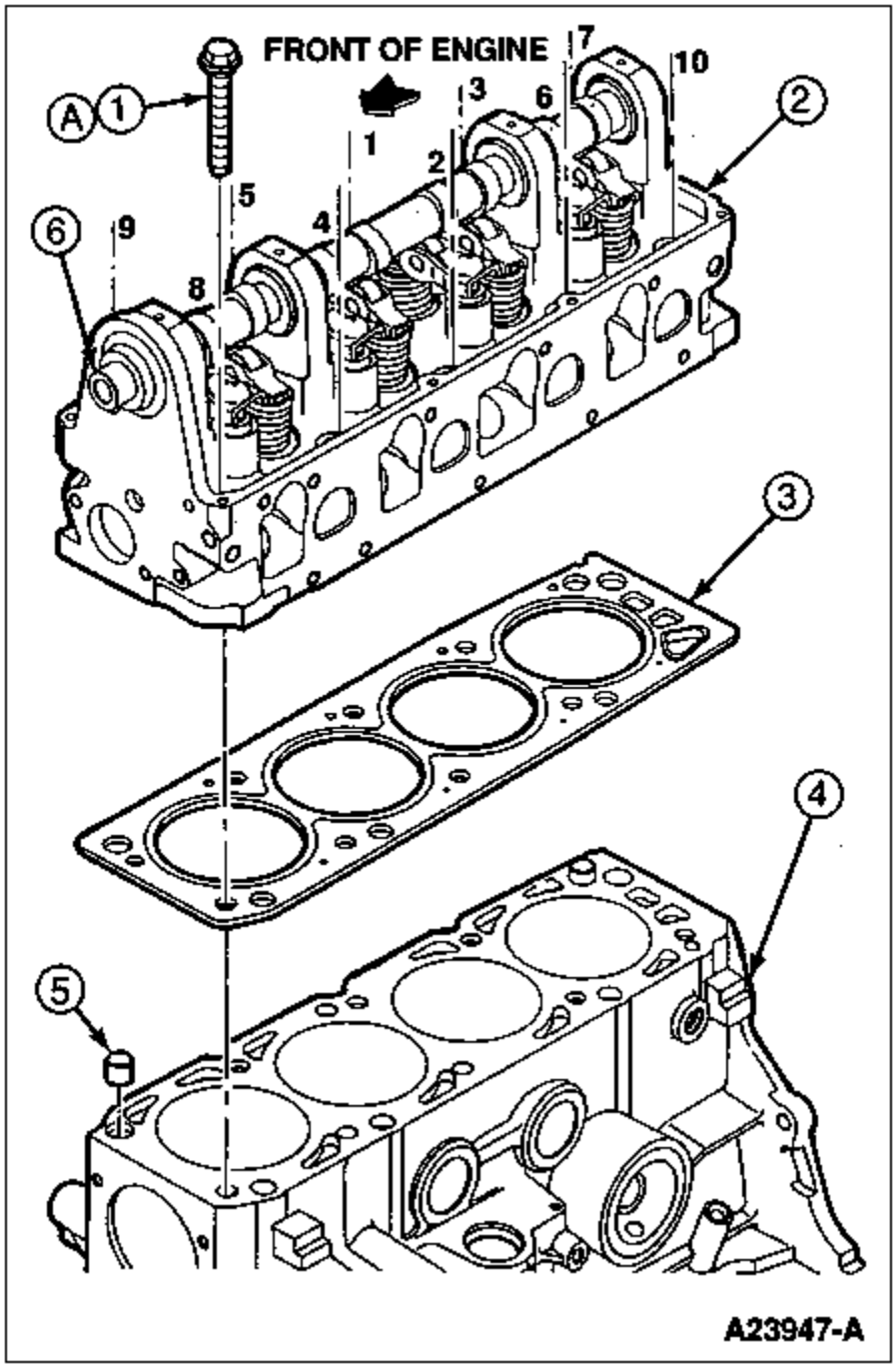

Item	Part Number	Description
1	N807013-S	Bolt, M12-1.75 x 100.7
2	6049	Cylinder Head
3	6051	Head Gasket
4	6010	Cylinder Blocks
5	—	Dowel (Part of 6010)

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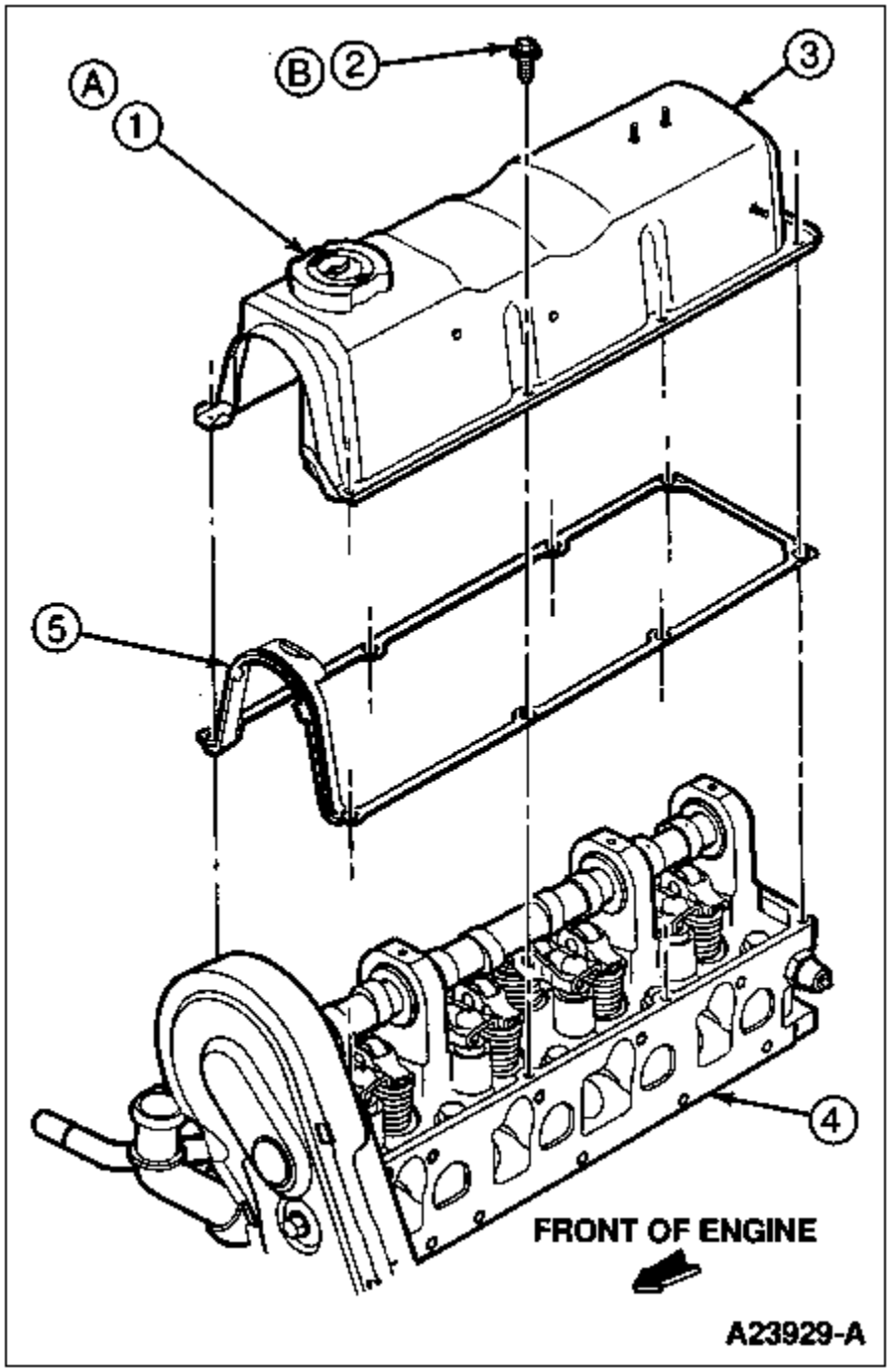
6	6251	Camshaft
A	—	Tighten in Illustrated Sequence According to Procedure in Text

4. Install valve cover and valve cover gasket (6584). Tighten retaining bolts to 9-13 Nm (80-115 lb-in).



Item	Part Number	Description

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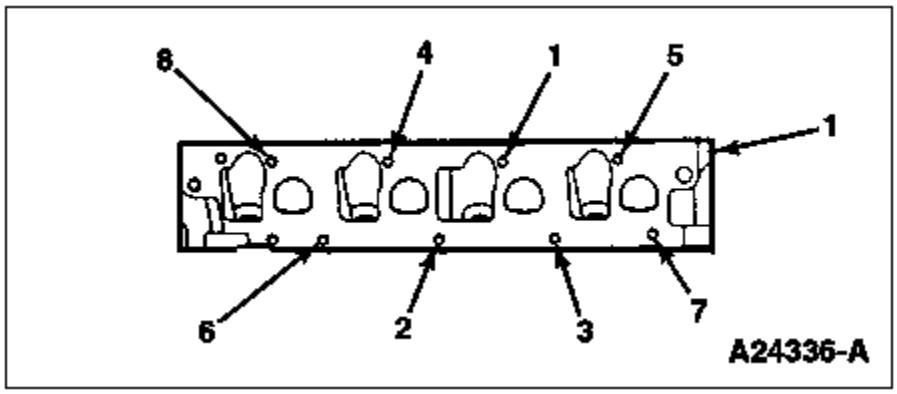
1	6766	Oil Filler Cap
2	—	Screw, M6-1 x 15
3	6582	Valve Cover
4	6049	Cylinder Head
5	6584	Valve Cover Gasket
A	—	Tighten Until Ratchet Click Is Heard or Felt
B	—	Tighten to 9-13 Nm (80-115 Lb-In)

5. Install lower intake manifold and gasket. Tighten retaining nuts/bolts in sequence to 26-38 Nm (19-28 lb-ft).

Lower Intake Torque Sequence



6. Install front lifting eye and tighten nut and bolt to 20-30 Nm (15-22 lb-ft).

7. Install exhaust manifold, gasket, and eight exhaust manifold retaining bolts and/or stud bolts. Tighten the bolts in sequence in two steps: 20-30 Nm (178-204 lb-in), then 60-80 Nm (20-30 lb-ft).

Exhaust Manifold

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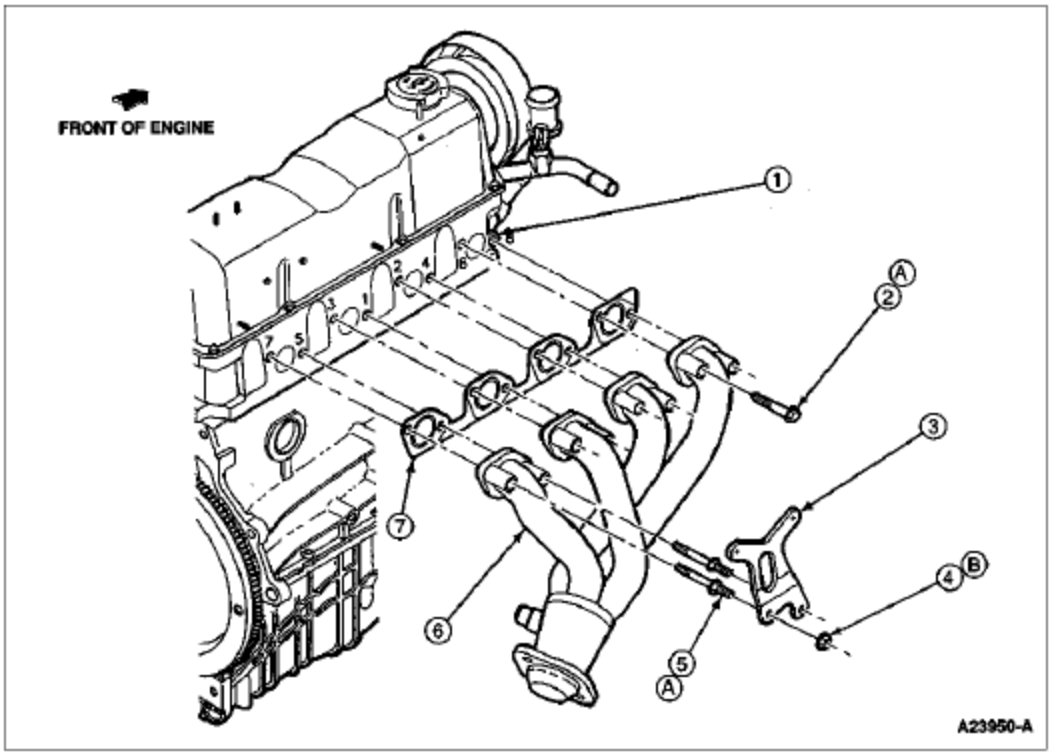

Item	Part Number	Description
1	6049	Cylinder Head
2	N806949-S100	Bolt, M10-1.5 x 59.1 (6 Places)
3	17A084	Engine Lifting Eye
4	N620481-S2	Nut, M8-1.25 (2 Places)
5	N806948-S100	Stud, M10-1.5 x M8-1.25 x 89.6 (2 Places)
6	9430	Exhaust Manifold
7	9448	Exhaust Manifold Gasket
A	—	Tighten in Two Stages According to Instructions in Text
B	—	Tighten to 20-30 Nm (15-22 Lb-Ft)

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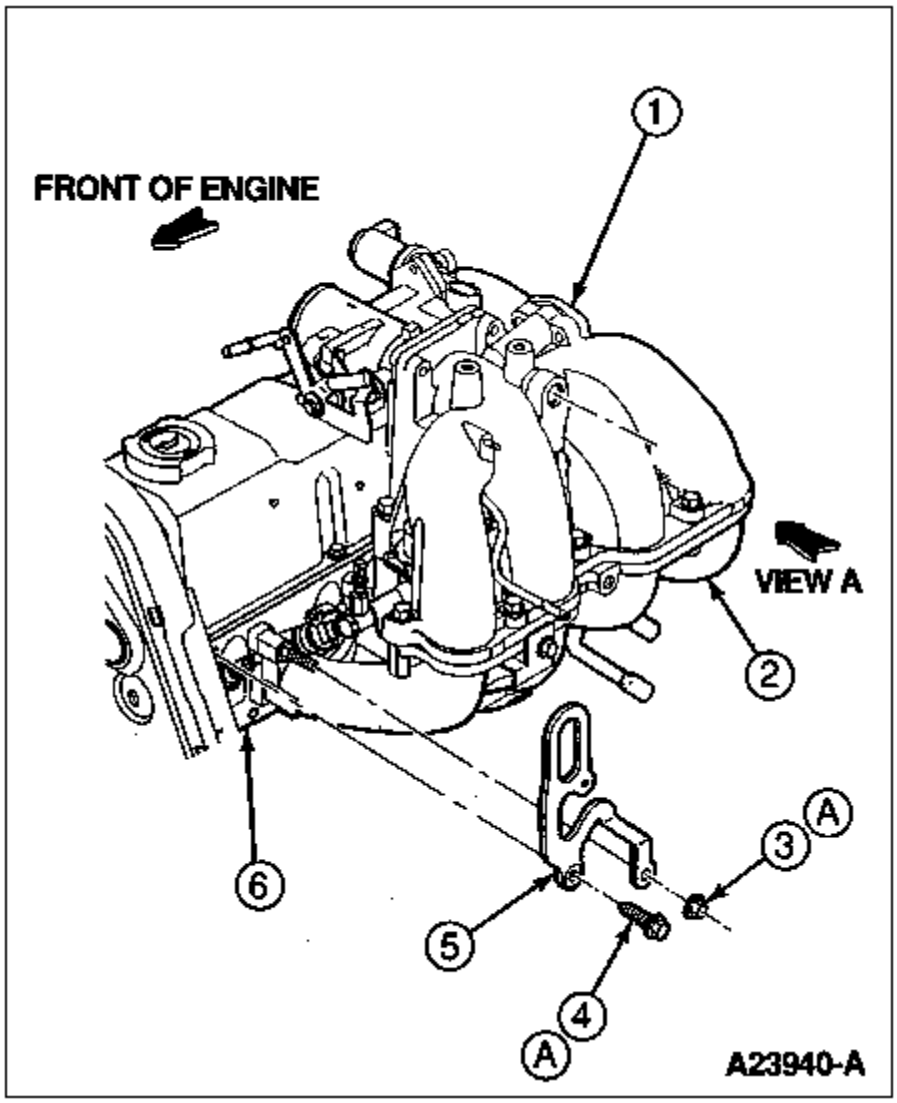

Item	Part Number	Description
1	9425	Upper Intake Manifold
2	9K461	Lower Intake Manifold
3	N620481-S2	Nut, M8-1.25
4	N808162-S2	Bolt, M8-1.25 x 33
5	17A084	Engine Lifting Eye (Front)
6	6049	Cylinder Head
A	—	Tighten to 20-30 Nm (14-22 Lb-Ft)

8. Install timing belt tensioner and timing belt tensioner spring on cylinder head placing one leg of timing belt tensioner spring under stud on cylinder head and other leg against pin on timing belt tensioner and install spring pivot bolt.

9. Install timing belt as outlined in this section.

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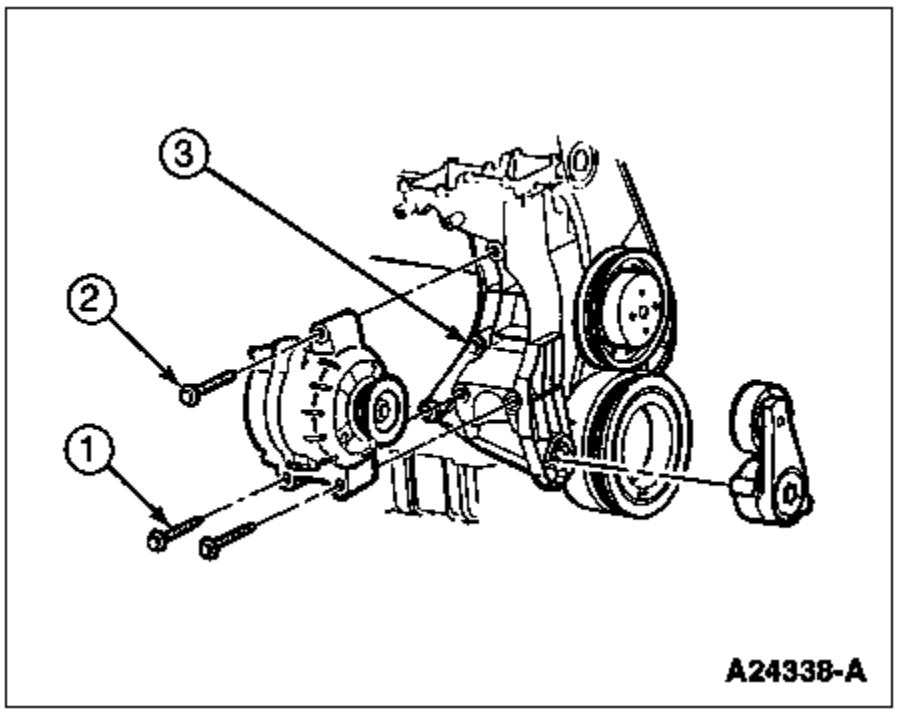
10. Install outer timing belt cover as outlined in this section.

11. Install generator mounting bracket with assembled ignition coils and ignition wire and brackets. Refer to the following installation drawing for correct torque sequence. Tighten in order illustrated.

Generator and Bracket Torque Sequence



Item	Part Number	Description
1	—	Tighten to 40-55 Nm (30-41 Lb-Ft)
2	—	Tighten to 40-55 Nm (30-41 Lb-Ft)
3	—	Tighten to 40-55 Nm (30-41 Lb-Ft)

12. Replace O-ring lubricated with silicone grease on water pump inlet tube.

13. Install water pump inlet tube into water pump (8501). Tighten inlet tube-to-generator bracket bolts to 9-12 Nm (80-106 lb-in).

14. Install lower radiator hose.

15. Install generator. Tighten generator-to-bracket bolts to 40-54 Nm (30-40 lb-ft).

16. Connect upper radiator hose hose and heater water hose and tighten hose clamps (8287).

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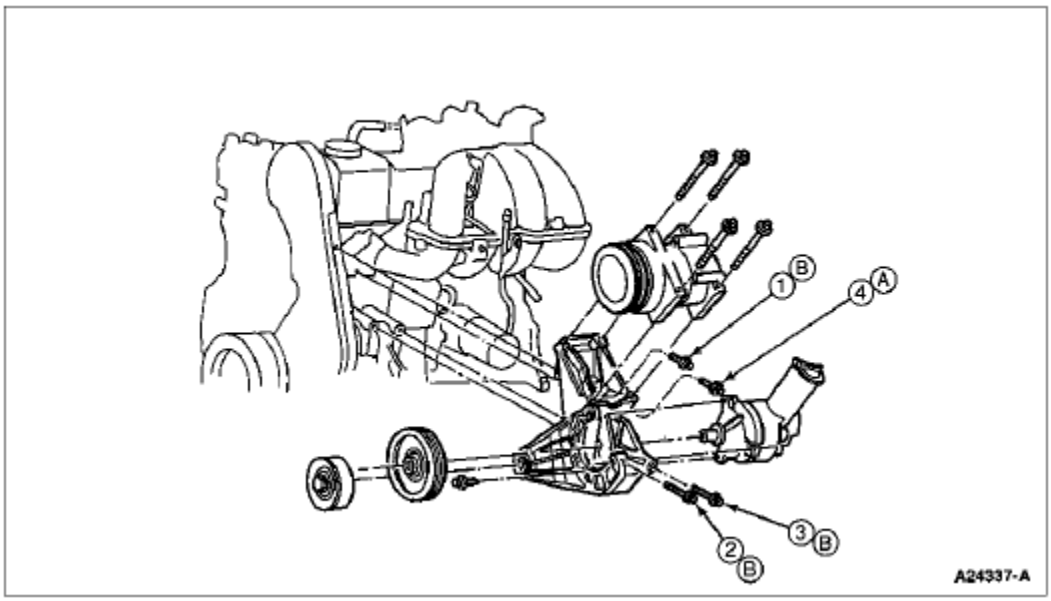
17. Install A/C compressor mounting bracket with attached power steering pump. Refer to the following installation drawing for correct bolt torque sequence. Tighten in order illustrated. Torque bolts 1 and 2 to 40-55 Nm (30-41 lb-ft), bolt 3 to 21-28 Nm (15-21 lb-ft).

A/C Compressor Bracket Torque Sequence



Item	Part Number	Description
1	N606572	Bolt, M10-1.5 x 123
2	N606068	Bolt, M10-1.5 x 80
3	N606068	Bolt, M10-1.5 x 80
4	N606051	Bolt, M8-1.25 x 100
A	—	Tighten to 22-28 Nm (15-21 Lb-Ft)
B	—	Tighten to 41-54 Nm (29-40 Lb-Ft)

18. Install A/C compressor with attached hoses and tighten bolts to 21-28 Nm (16-20 lb-ft).

19. Install water pump pulley and fan clutch. Tighten bolts snug.

20. Position drive belt.

21. Using flex handle, rotate drive belt tensioner, position drive belt, and rest tensioner pulley on drive belt.

22. Tighten four fan clutch and pulley-to-water pump bolts to 17-23 Nm (13-16 lb-ft).

23. Position fan shroud (8146) over fan clutch shaft.

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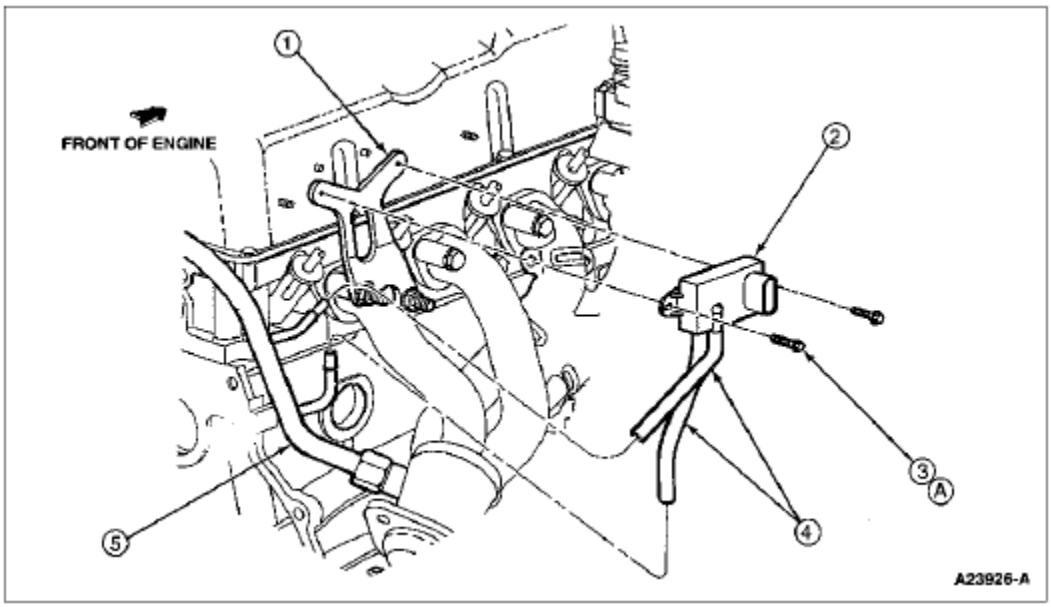
24. Install fan shroud and fan guard (8A611).
25. **NOTE: Spark plug gap is 1.07-1.17mm (0.042-0.046 inch).**

    Install spark plugs in proper locations.
26. Install engine oil level indicator tube.
27. Position and connect engine control sensor wiring. Install ignition wires.
28. Install upper intake manifold as outlined in this section.
29. Install EGR valve to exhaust manifold tube and tighten nuts to 34-47 Nm (25-34 lb-ft).
30. Install EGR transducer (9J433) to rear engine lifting eye. Tighten bolts to 2.7-3.7 Nm (24-32 lb-ft).

EGR Transducer



Item	Part Number	Description
1	17A084	Engine Lifting Eye
2	9J433	EGR Transducer
3	N807202-S36	Bolt, M5-0.8 x 16
4	—	Hoses (Part of 9J433)
5	9D477	EGR Valve to Exhaust Manifold Tube
A	—	Tighten to 2.7-3.7 Nm (24-32 Lb-Ft)

31. Fill cooling system. Refer to Section 03-03 .

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32. Install air cleaner outlet tube to throttle body (9E926) and engine air cleaner (ACL) (9600).

33. Connect intake air temperature sensor and mass air flow sensor.

34. **NOTE: When the battery (10655) has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven to relearn the strategy.**

    Connect battery ground cable.

35. Recharge air conditioner system. Refer to appropriate section in Group 12.

36. Start engine (6007) and check for leaks.

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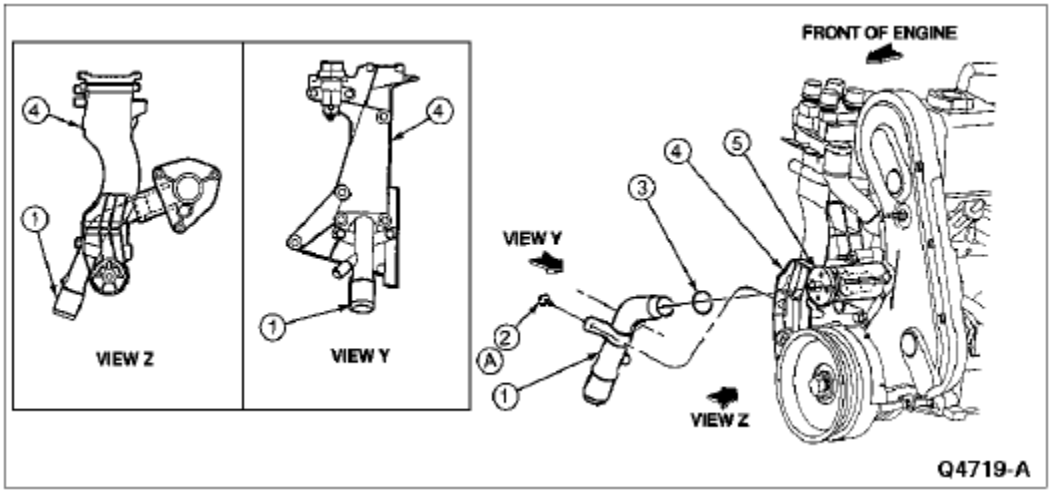
Water Pump

Removal

1. Drain cooling system.
2. Using 1/2-inch drive handle, rotate drive belt tensioner (6B209) and remove drive belt (8620).
3. Remove fan clutch and shroud.
4. Remove water pump pulley (8509).
5. Remove heater water hose (18472) to water pump inlet tube (8290).
6. Remove lower radiator hose (8286) from the water pump inlet tube.
7. Remove water inlet tube-to-generator bracket bolts and water pump inlet tube.

Water Pump Inlet Tube



Item	Part Number	Description
1	8274	Water Pump Inlet Tube
2	N606676-S2	Screw and Washer Assembly, M6-1 x 22.5
3	87056-S100	O-Ring
4	10153	Generator Mounting Bracket
5	8501	Water Pump

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A	—	Tighten to 9-12 Nm (78-107 Lb-In)

8. Remove water pump (8501) retaining bolts and remove water pump.

9. Clean water pump gasket surface of cylinder block.

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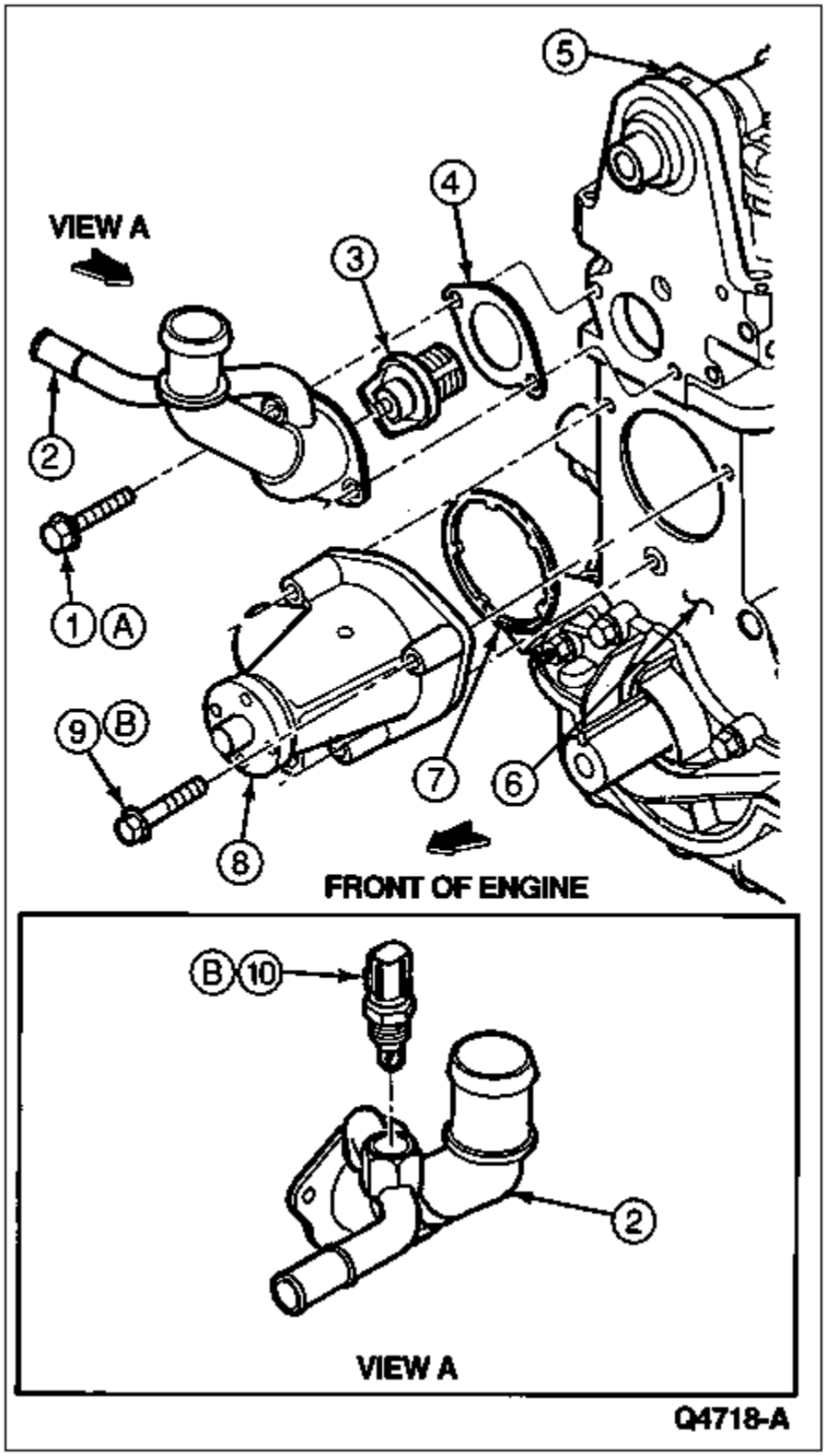

Item	Part Number	Description
1	800025-S100	Screw, M8-1.25 x 18
2	8594	Water Outlet Connection

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3	8575	Water Thermostat
4	8255	Gasket
5	6049	Cylinder Head
6	6010	Cylinder Blocks
7	8507	Water Pump Housing Gasket
8	8501	Water Pump
9	N808517-S100	Bolt, M8-1.25 x 53
10	12A648	Engine Coolant Temperature Sensor
A	—	Tighten to 20-30 Nm (14-21 Lb-Ft)
B	—	Tighten to 16-24 Nm (12-17 Lb-Ft)

Installation

1. Apply Pipe Sealant with Teflon® D8AZ-19554-A or equivalent meeting Ford specification ESG-M4G194-A to water pump bolts prior to installation.
2. Position gasket and water pump on cylinder blocks (6010) and install screws. Alternately tighten to 20-30 Nm (15-20 lb-ft).
3. Replace water inlet tube O-ring (lubricated with silicone grease).
4. Install water pump inlet tube in water pump. Tighten water inlet tube-to-generator bracket bolts to 9-12 Nm (80-106 lb-in).
5. Install lower radiator hose to water pump.
6. Install heater water hose to the water pump inlet tube.
7. Install water pump pulley and fan clutch (8A616) and tighten bolts finger-tight.
8. Using half-inch drive handle, rotate drive belt tensioner and install drive belt.
9. Tighten fan clutch and water pump pulley bolts to 20-25 Nm (14-19 lb-ft).
10. Install fan blade (8600) and tighten screws to 6-8 Nm (52-71 lb-in).
11. Install fan and shroud.
12. Fill cooling system. Refer to Section 03-03 .
13. Start engine (6007) and check for leaks.

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Upper Intake Manifold

Removal

NOTE: If removing upper intake manifold for access to other components only, throttle body may remain attached.

1. Disconnect intake air temperature sensor (IAT sensor) (12A697).
2. Remove air cleaner outlet tube (9B659).
3. Remove accelerator control splash shield (9E766).
4. Disconnect electrical connections to:
    a. Throttle position sensor (TP sensor) (9B989)
    b. Idle air control valve (IAC valve) (9F715)
5. Disconnect accelerator cable (9A758).
6. Remove accelerator cable bracket bolts and tie bracket and cables out of the way.
7. Disconnect PCV valve from oil separator.
8. Tag and disconnect vacuum hoses from manifold vacuum tee:
    a. Power brakes
    b. EGR
    c. Speed control
9. Disconnect fuel pressure regulator vacuum line at fitting located on underside of intake manifold.
10. Remove two bolts and EGR valve (EGR valve) (9D475) and EGR valve gasket (9D476).

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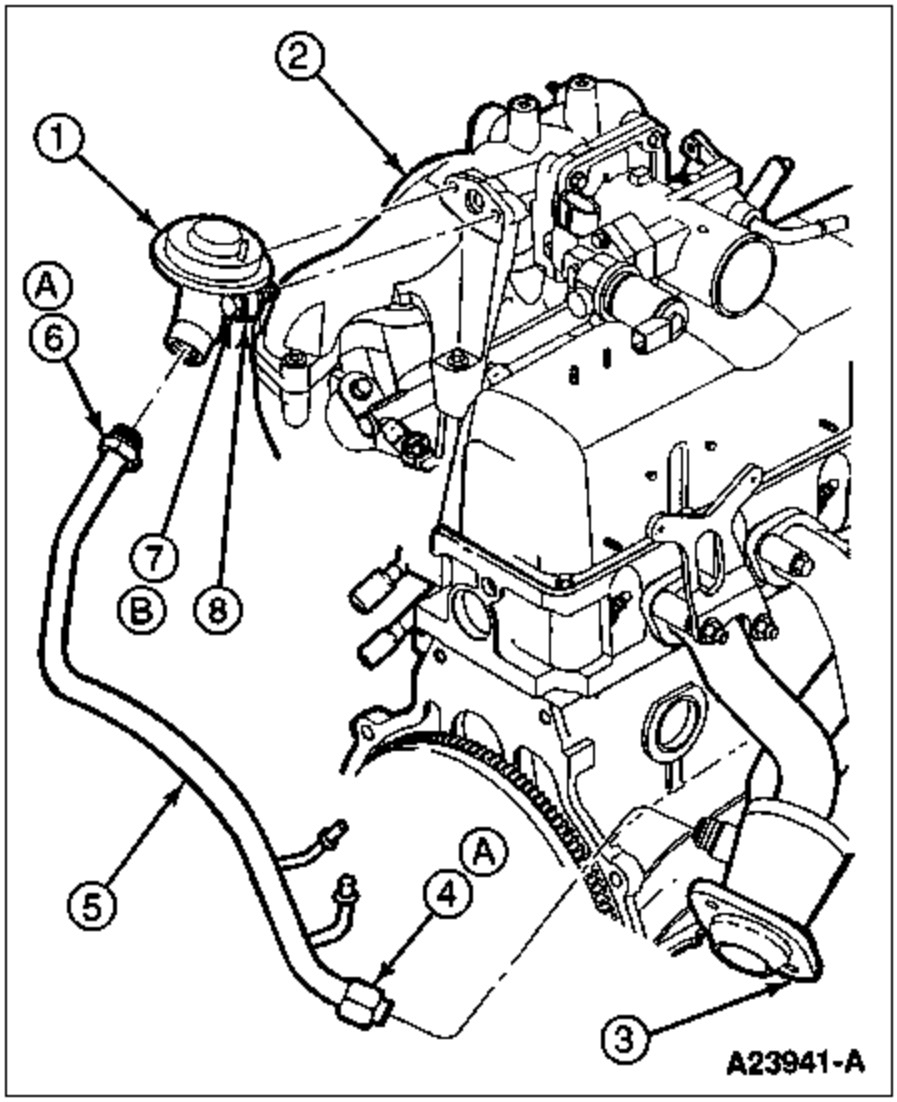

Item	Part Number	Description
1	9D460	EGR Valve
2	9424	Upper Intake Manifold
3	9430	Exhaust Manifold
4	—	Nut (Part of 9D477)
5	9D477	EGR Valve to Exhaust Manifold Tube
6	—	Nut (Part of 9D477)
7	N806781-S2	Screw, M8-1.25 x 35
8	9D476	EGR Valve Gasket
A	—	Tighten to 34-47 Nm (25-35 Lb-Ft)
B	—	Tighten to 20-30 Nm (15-22 Lb-Ft)

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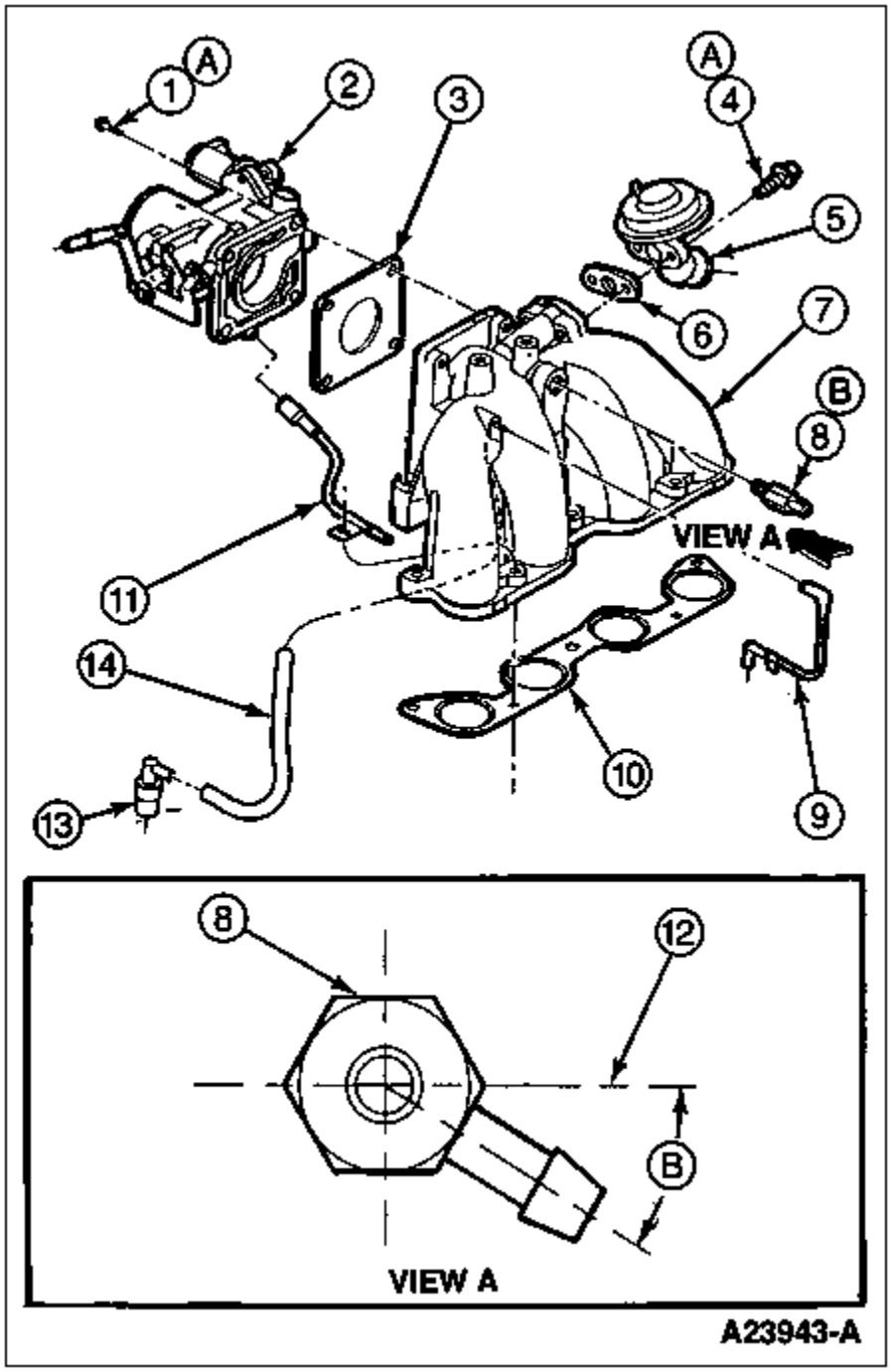
11. Remove seven bolts and upper intake manifold and intake manifold upper gasket (9H486) from lower intake manifold.

12. Remove evaporative emission return tube (9G271) from throttle body (9E926) and upper intake manifold.

13. Remove four bolts, throttle body and throttle body gasket (TB gasket) (9E936) from upper intake manifold.



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Item	Part Number	Description
1	N605788-S36	Bolt, M8x30
2	9E926	Throttle Body
3	9E936	Throttle Body Gasket
4	N806781-S2	Bolt
5	9D475	EGR Valve
6	9D476	EGR Valve Gasket
7	9425	Upper Intake Manifold
8	9A474	Intake Manifold Vacuum Outlet Fitting and Cap
9	9E498	Fuel Pressure Regulator Vacuum Tube
10	9H486	Intake Manifold Upper Gasket
11	9G271	Evaporative Emission Return Tube
12	—	Centerline of Fitting 9A474 Parallel to Engine Crankshaft
13	6B690	PCV Valve
14	6K817	PCV Hose
A	—	Tighten to 20-30 Nm (15-22 Lb-Ft)
B	—	Tighten to 16-24 Nm (12-17 Lb-Ft) Then Rotate So Side Nipple Is 30 Degrees Below Centerline of Nipple Parallel with Engine Crankshaft

14. If necessary, remove intake manifold vacuum outlet fitting from upper intake manifold.

Installation

1. If removed, install intake manifold vacuum outlet fitting. Tighten to 16-24 Nm (12-17 lb-ft). Rotate clockwise so side nipple is 30 degrees below centerline of nipple parallel with engine crankshaft (6303) (bottom of upper intake manifold).

2. Install throttle body gasket, throttle body, and four bolts to upper intake manifold. Alternately tighten to 20-30 Nm (15-22 lb-ft).

3. Install evaporative emission return tube on throttle body tube and position on upper intake manifold.

4. Position intake manifold upper gasket and upper intake manifold.

5. Start bolts. Tighten in sequence to 7-10 Nm (61-88 lb-in). Tighten in sequence to 26-38 Nm (19-28 lb-ft).

6. Install PCV valve into crankcase vent oil separator (6A785).

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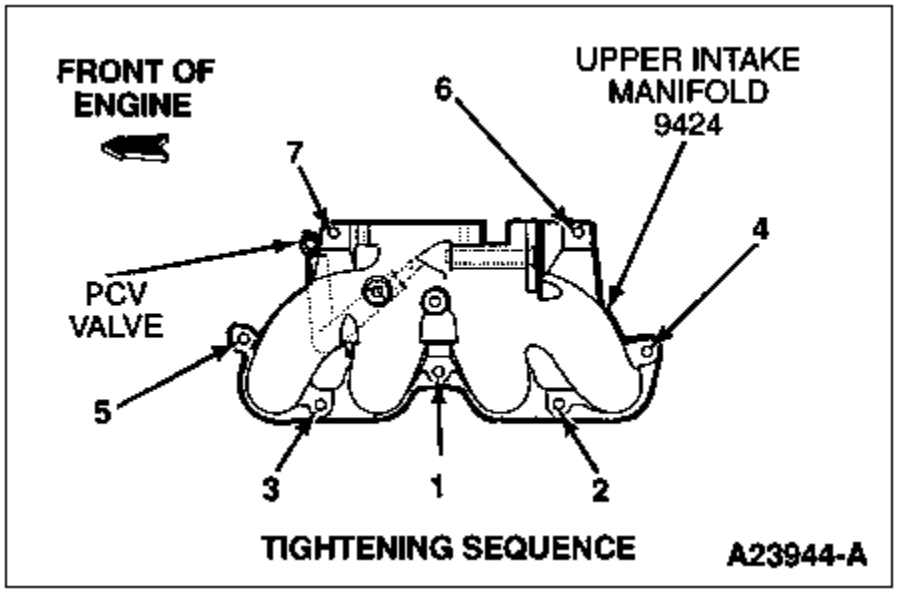

7. Install EGR valve and EGR valve gasket and tighten bolts to 20-30 Nm (15-22 lb-ft).
8. Install EGR valve to exhaust manifold tube (9D477) and tighten nuts to 34-47 Nm (25-34 lb-ft).
9. Connect vacuum hoses to intake manifold vacuum tee:
    a. Fuel pressure regulator
    b. Speed control
    c. EGR
    d. Power brakes
10. Connect fuel pressure regulator vacuum line to fitting on upper intake manifold.
11. Connect crankcase ventilation hose (6853) to PCV valve to oil separator.
12. Install accelerator cable bracket (9723) to throttle body and tighten bolts to 21-28 Nm (16-20 lb-ft).
13. Connect accelerator cable.
14. Connect throttle body and upper intake manifold electrical connections:
    a. Idle air control valve
    b. Throttle position sensor
15. Install air cleaner outlet tube.
16. Connect intake air temperature sensor and mass air flow sensor (MAF sensor) (12B579).
17. Install accelerator control splash shield.
18. Connect EVAP hose to metal tube.
19. Start engine (6007) and check for leaks.

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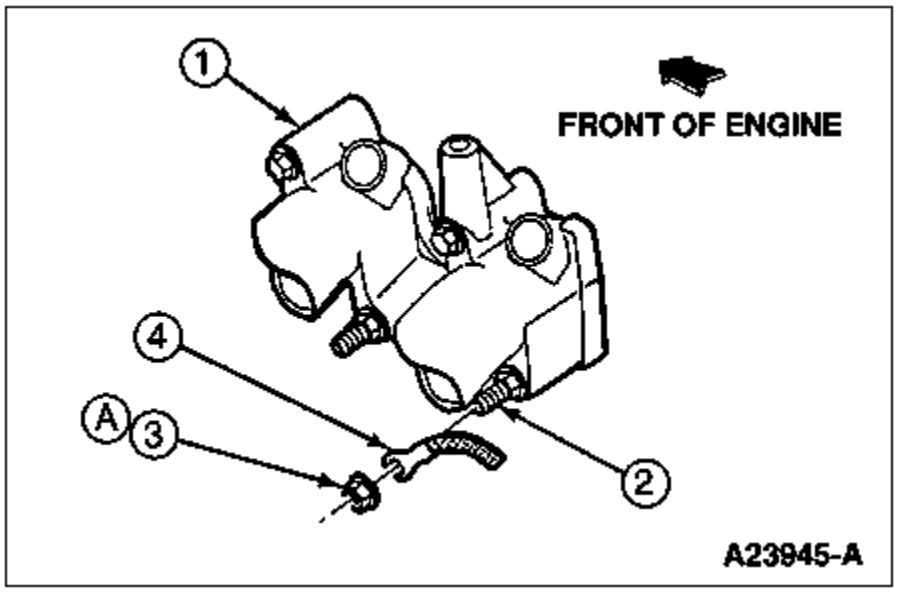
Lower Intake Manifold

Removal

WARNING: RESIDUE FUEL PRESSURE REMAINS IN FUEL SYSTEM AFTER ENGINE IS SHUT OFF. THIS COULD RESULT IN INJURY OR FIRE WHEN FUEL LINES ARE DISCONNECTED. DISCONNECT INERTIA FUEL SHUTOFF SWITCH AND CRANK ENGINE A MINIMUM OF 15 SECONDS TO DEPRESSURIZE SYSTEM. REFER TO SECTION 10-01.

1. Disconnect battery ground cable (14301).
2. Remove engine oil dipstick bracket retaining bolt.
3. Remove upper intake manifold as outlined in this section.
4. Remove nut and dash panel ground cable (14303) from No. 7 stud.



Item	Part Number	Description
1	9424	Intake Manifold, Lower
2	N807458-S101	Stud, M8-1.25 x 1.25 x 96.2
3	N620481-S2	Nut, M8 x 1
4	14303	Dash Panel Ground Cable
A	—	Tighten to 9-12 Nm

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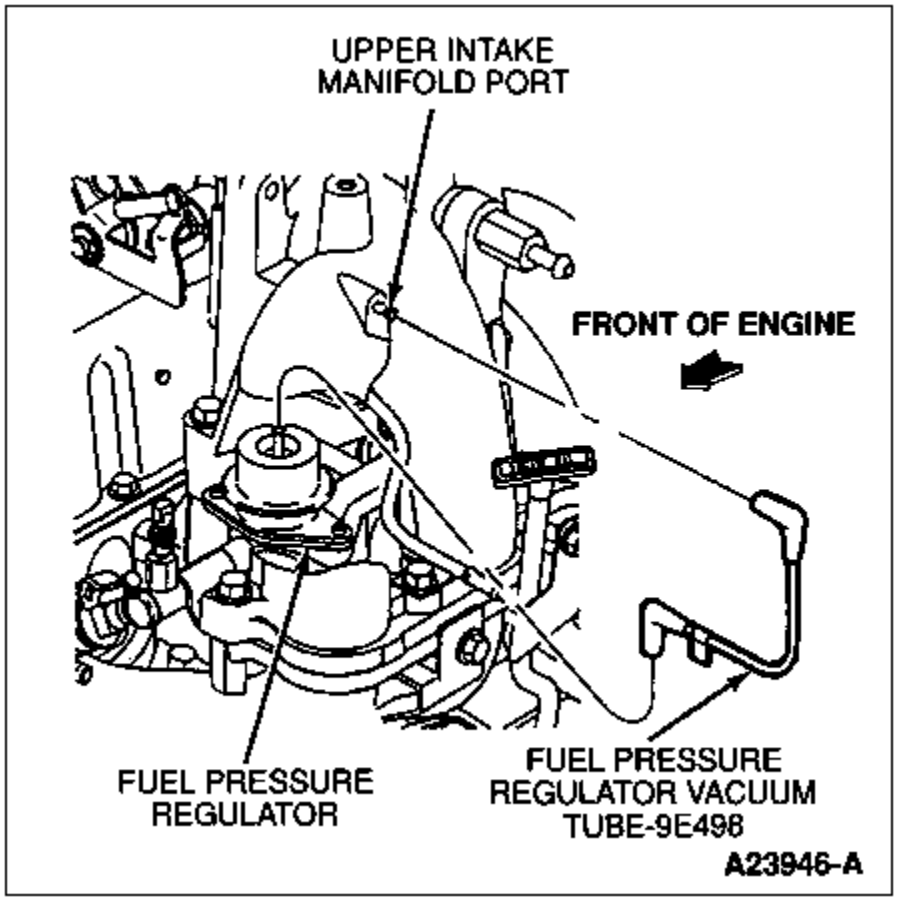
		(80-106 Lb-In)

5. Remove wiring harness clip from No. 3 and 6 studs.



6. Remove fuel tube clip (9A317) from fuel inlet and return fittings.

7. Using Spring Lock Coupling Disconnect Tool, disconnect fuel hoses at the fuel rail supply tube and fuel rail return tube.

   a. Fit tool to coupling so tool can enter cage to release garter spring.
   b. Push the tool into the cage opening to release female fitting from garter spring.
   c. Pull the coupling male and female fittings apart.
   d. Remove the tool from the disconnected coupling.

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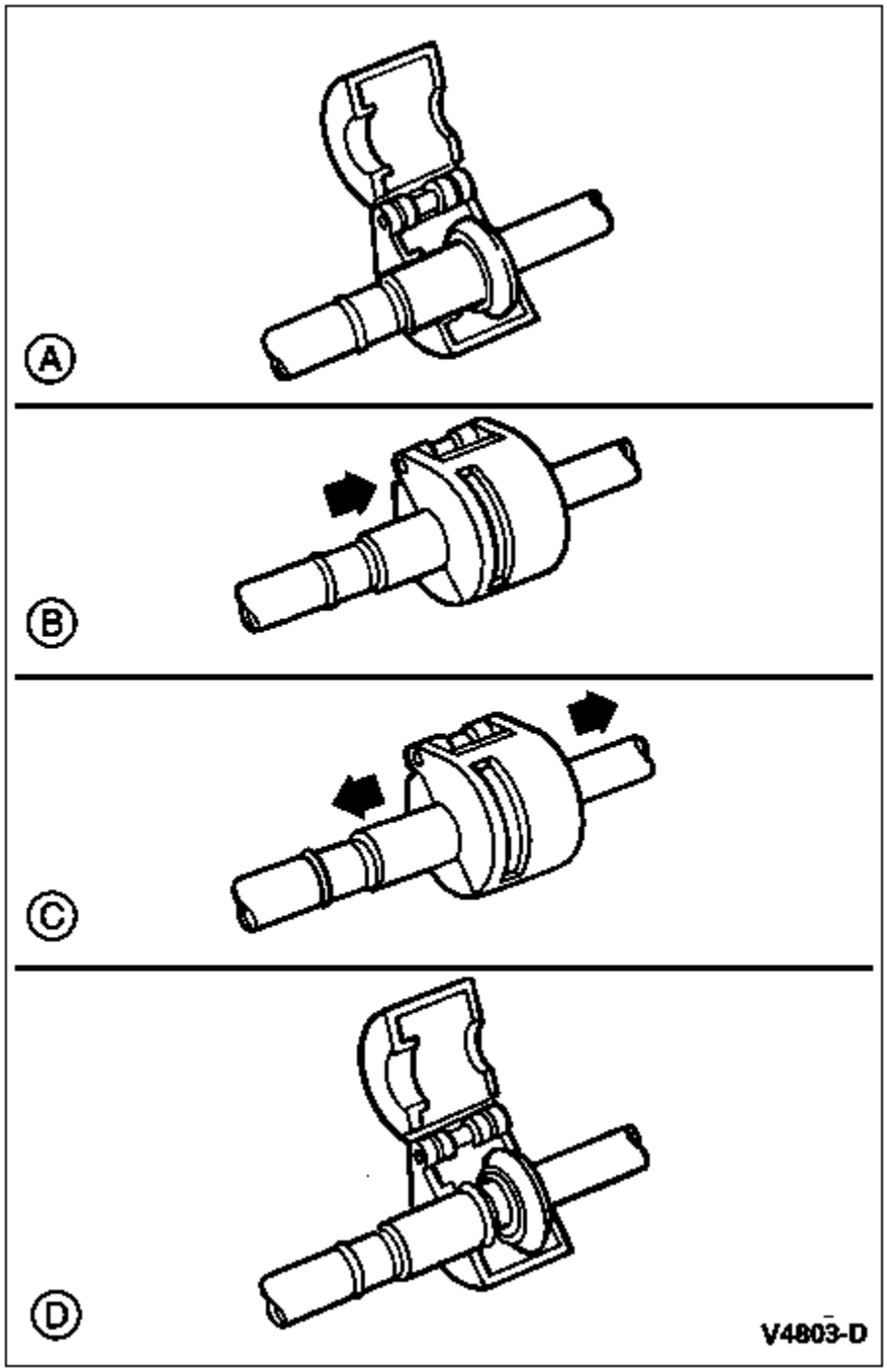

8. Disconnect the electrical connectors from all four fuel injector nozzle tips (9E527) and move fuel charging wiring (9D930) aside.

9. Remove engine lifting eye.

10. Remove four bottom retaining bolts from lower manifold.

11. Remove four upper retaining bolts/studs from lower manifold. Remove lower intake manifold assembly.

12. Remove two screws and fuel injection supply manifold (9D280) from lower intake manifold, if

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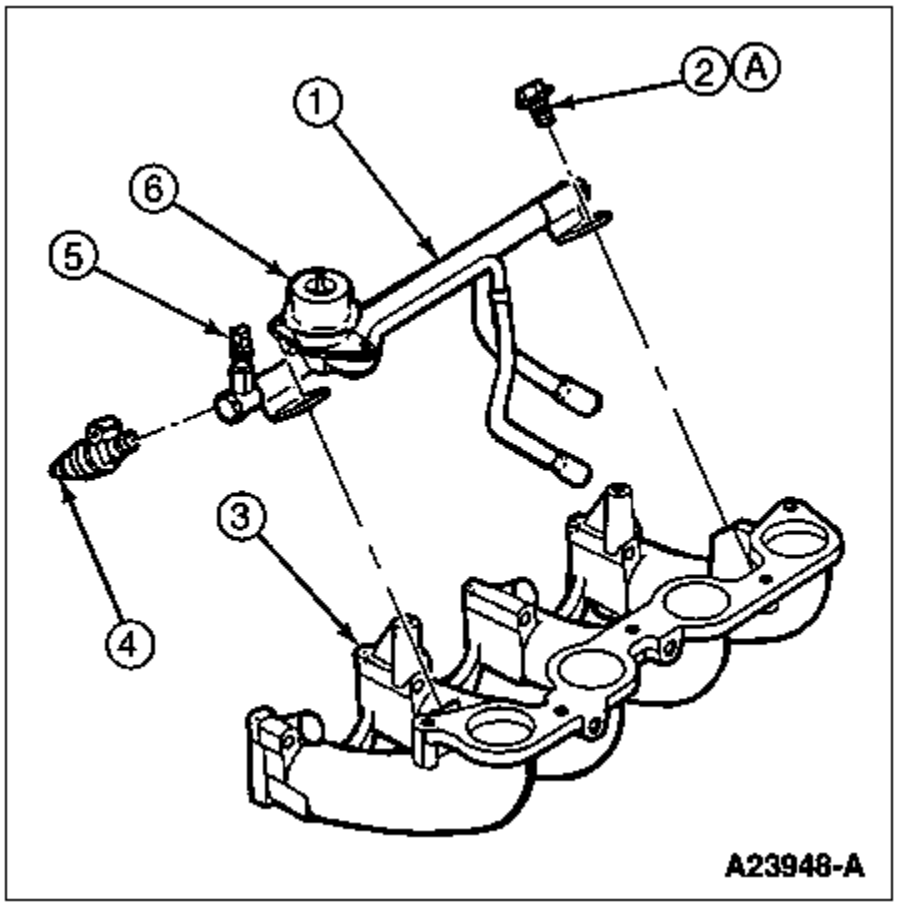
necessary.

13. Remove fuel injector nozzle tips from lower intake manifold, if necessary. Grasping injector body, pull up while gently rocking injector from side to side.

14. If necessary, remove bolt and 42-pin connector bracket.



Item	Part Number	Description
1	9D280	Fuel Injection Supply Manifold
2	N807897-S100	Bolt, M8-1.25 x 31
3	9424	Intake Manifold, Lower
4	9F593	Fuel Injector
5	9H321	Fuel Pressure Relief Valve
6	9C968	Fuel Pressure Regulator
A	—	Tighten to 20-30 Nm (15-22 Lb-Ft)

Installation

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1. Clean and inspect the mounting faces of the intake manifold assembly and the cylinder head (6049). Both surfaces must be clean and flat.

2. If fuel injector nozzle tips were removed:

    a. Inspect injector O-rings (two per injector) for signs of deterioration.
    b. If replacing, lubricate new O-rings with 10W-30 motor oil such as XO-10W30-ASP or equivalent meeting Ford specification ESE-M2C153-E and install two on each injector.
    c. Install fuel injectors into lower intake manifold.

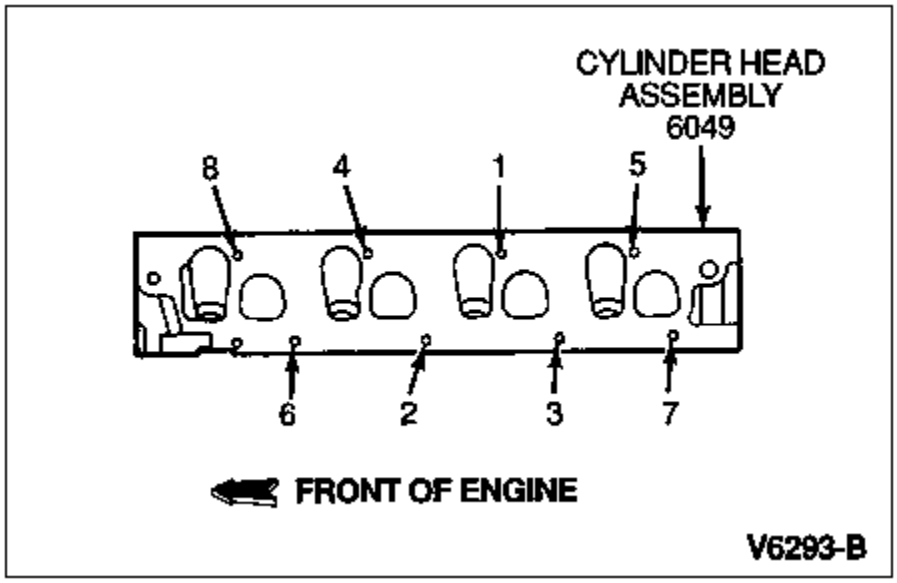
3. If removed, install fuel injection supply manifold. Tighten bolts to 20-30 Nm (15-22 lb-ft).

4. Clean and lightly oil manifold bolt threads.

5. Install a new intake manifold gasket (9439).

6. Position the lower manifold assembly to cylinder head. Install four upper manifold retaining bolts/studs finger-tight.

7. Install four remaining manifold bolts/studs. Tighten all bolts to 26-38 Nm (19-28 lb-ft) following the tightening sequence.



8. Connect electrical connectors to fuel injector nozzle tips.

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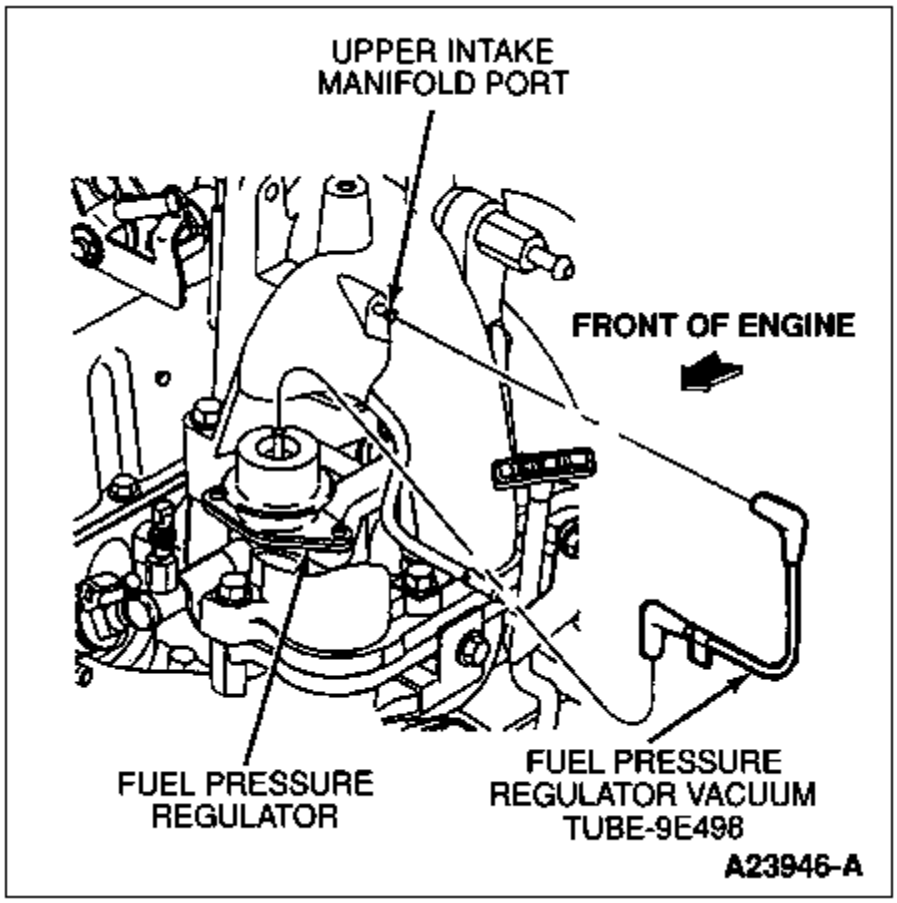

9. Push wiring harness clip onto front bottom intake manifold stud.

10. Install dash panel ground cable on rear bottom intake manifold stud and tighten nut to 9-12 Nm (80-106 lb-in).

11. Install upper intake manifold as outlined in this section.

12. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module relearns its adaptive strategy. The vehicle may need to be driven to relearn the strategy.**

    Connect battery ground cable.

13. Start engine (6007) and check for leaks.

Lower Intake Manifold Installation, 2.3L

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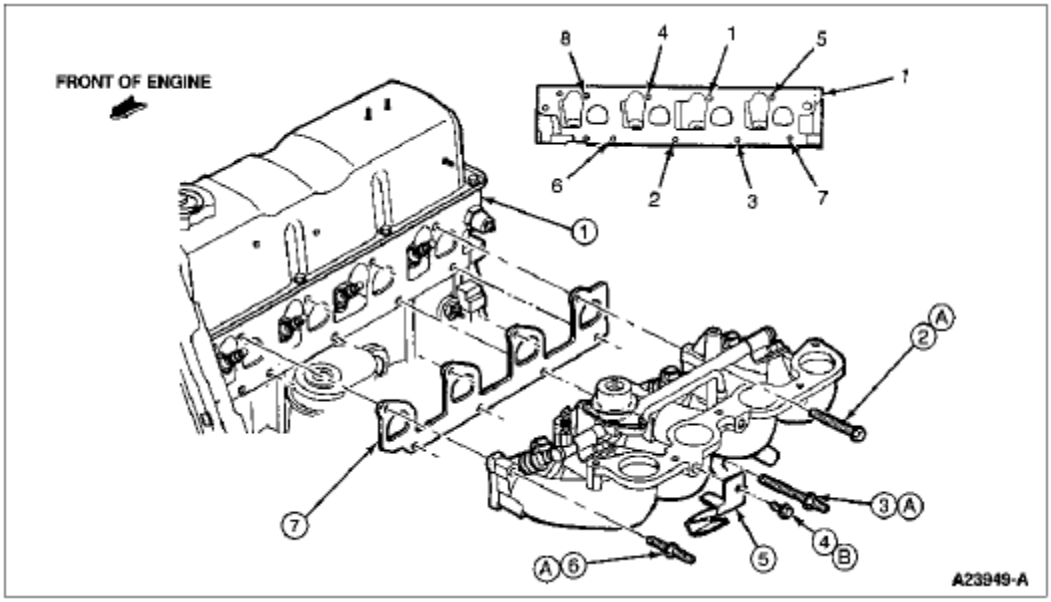

Item	Part Number	Description
1	6049	Cylinder Head
2	N807462-S101	Bolt, M8-1.25 x 67.2 (Holes 1, 2, 4 and 5)
3	N807458-S101	Stud, M8-1.25 x 1.25 x 96.2 (Holes 3, 6 and 7)
4	N605904-S36	Bolt, M8-1.25 x 16.6
5	14A004	42 Pin Connector Bracket
6	N808163-S100	Stud, M8-1.25 x 1.25 x 63.7 (Hole 8)
7	9439	Intake Manifold Gasket
A	—	Refer to Procedure in Text
B	—	Tighten to 20-30 Nm (15-22 Lb-In)

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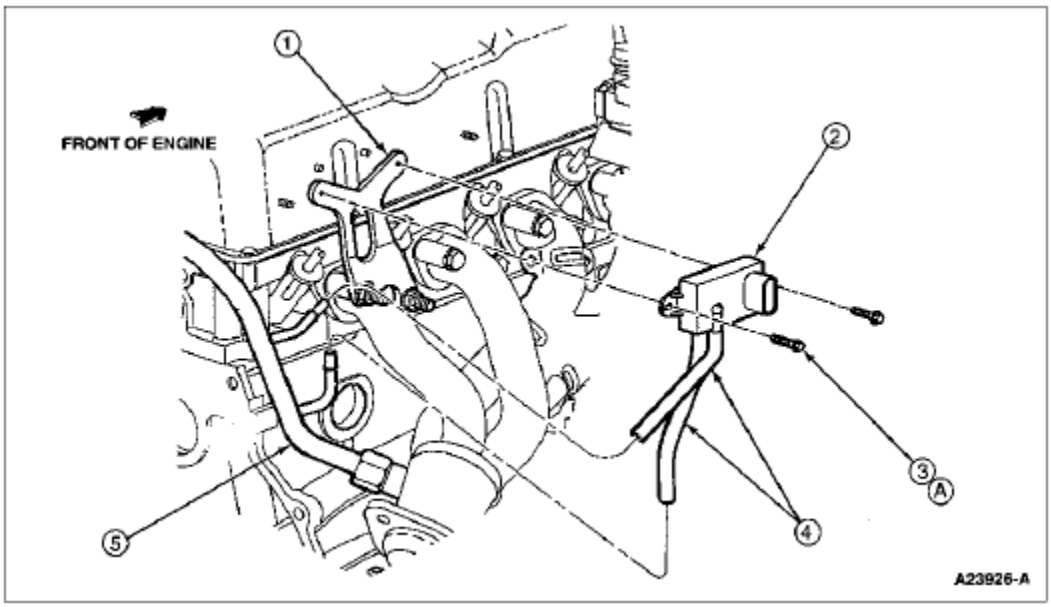
Exhaust Manifold

Removal

1. Install protective covers.
2. Disconnect intake air temperature sensor (IAT sensor) (12A697).
3. Remove air cleaner outlet tube (9B659).
4. Disconnect EGR transducer (9J433) tubes from EGR valve to exhaust manifold tube (9D477).

EGR Transducer



Item	Part Number	Description
1	17A084	Engine Lifting Eye
2	9J433	EGR Transducer
3	N807202-S36	Bolt, M5-0.8 x 16
4	—	Hoses (Part of 9J433)
5	9D477	EGR Valve to Exhaust Manifold Tube
A	—	Tighten to 2.7-3.7 Nm (24-32 Lb-In)

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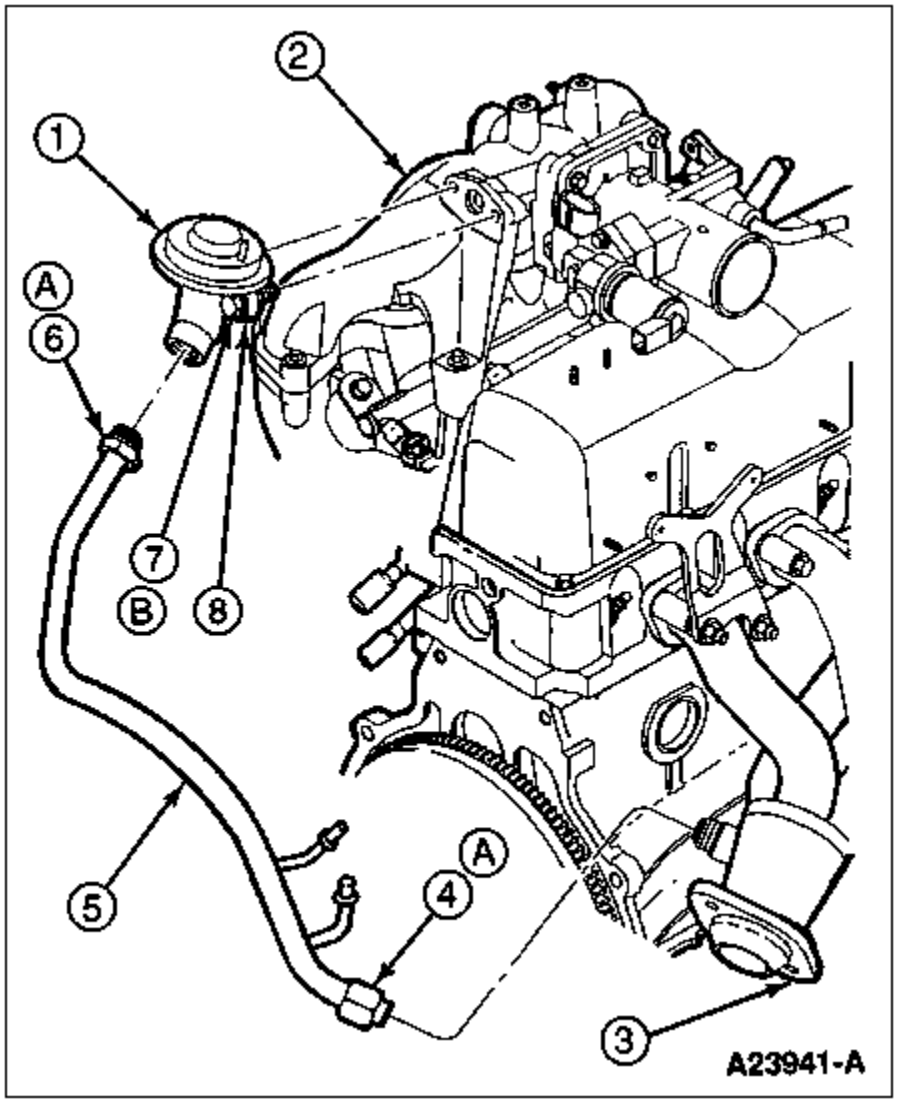
5. Remove EGR valve to exhaust manifold tube at the exhaust manifold (9430) and at the EGR external pressure valve (9F483).



Item	Part Number	Description
1	9D475	EGR Valve
2	9424	Upper Intake Manifold
3	9430	Exhaust Manifold
4	—	Nut (Part of 9D477)
5	9D477	EGR Valve to Exhaust Manifold Tube
6	—	Nut (Part of 9D477)
7	N806781-S2	Screw, M8-1.25 x 35
8	9D476	EGR Valve Gasket
A	—	Tighten to 34-47 Nm

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		(25-35 Lb-Ft)
B	—	Tighten to 20-30 Nm (15-22 Lb-Ft)

6. Disconnect three way catalytic converter (TWC) (5E212) from exhaust manifold.
7. Remove two nuts and remove rear engine lifting eye from exhaust manifold studs with DPFE sensor and hoses attached.
8. Remove two studs and six bolts and remove exhaust manifold and exhaust manifold gasket (9448) from engine (6007).

Installation

1. If necessary, clean gasket surfaces on exhaust manifold and cylinder head.
2. Install exhaust manifold and exhaust manifold gasket.
3. Install fasteners.
4. **NOTE: Exhaust manifold fasteners must be tightened in two stages.**

   Tighten fasteners to 20-30 Nm (15-22 lb-ft) in the sequence shown in the illustration.
5. Retighten fasteners to 60-80 Nm (45-59 lb-ft) in the sequence shown in the illustration.
6. Position engine rear lifting eye on studs as shown in the illustration. Install retaining nuts and tighten to 20-30 Nm (15-25 lb-ft).
7. Install EGR valve to exhaust manifold tube. Tighten nuts to 34-47 Nm (25-35 lb-ft).
8. Connect EGR transducer hoses to EGR valve to exhaust manifold tube in correct order.
9. Connect three way catalytic converter to exhaust manifold. Refer to Section 09-00 .
10. Install the air cleaner outlet tube.
11. Connect intake air temperature sensor and mass air flow sensor (MAF sensor) (12B579).

Exhaust Manifold

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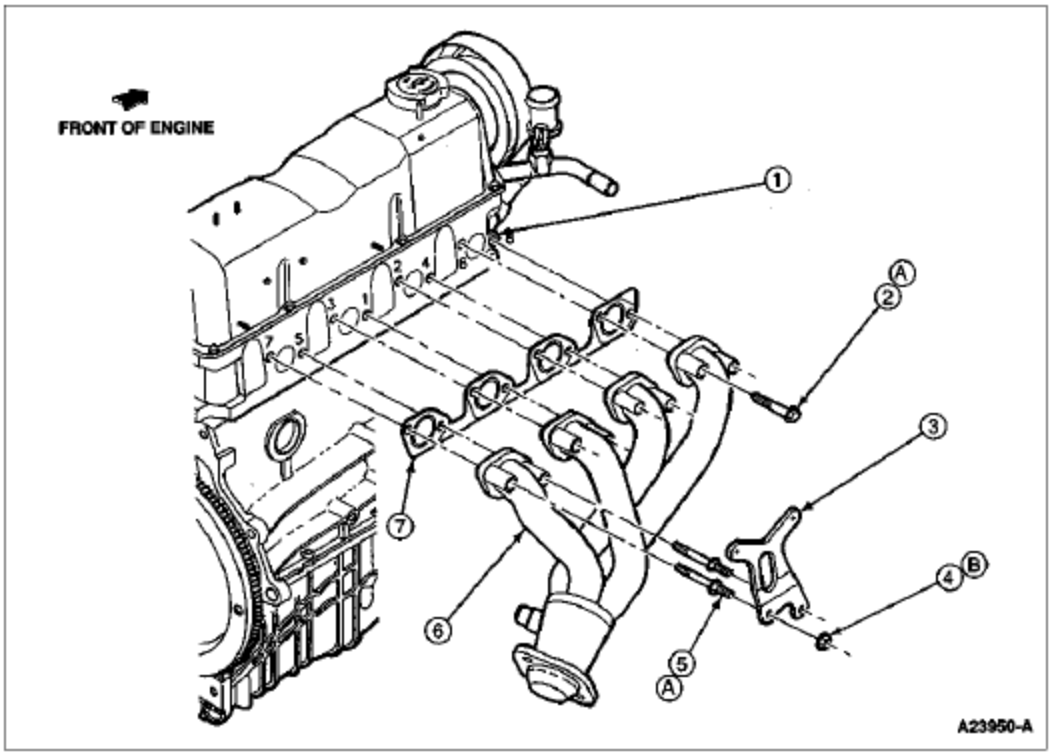

Item	Part Number	Description
1	6049	Cylinder Head
2	N806949-S100	Bolt, M10-1.5 x 59.1 (6 Places)
3	17A084	Engine Lifting Eye
4	N620481-S2	Nut, M8-1.25 (2 Places)
5	N806948-S100	Stud, M10-1.5 x M8-1.25 x 89.6 (2 Places)
6	9430	Exhaust Manifold
7	9448	Exhaust Manifold Gasket
A	—	Tighten in Two Steps According to Instructions in Text
B	—	Tighten to 20-30 Nm (15-22 Lb-Ft)

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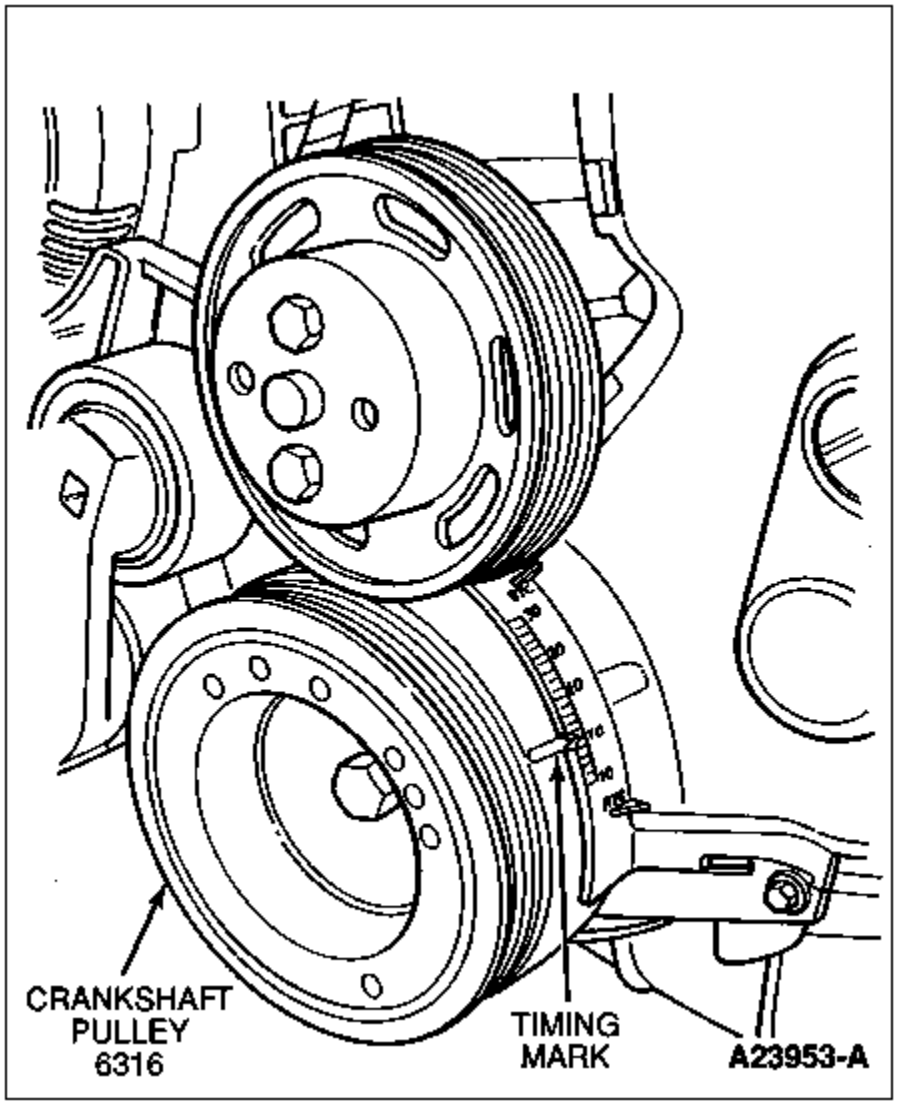
Oil Pump

Removal

1. Rotate crankshaft (6303) so number one piston (6108) is at TDC (Top Dead Center) of its compression stroke.



2. Remove outer timing belt cover as outlined in this section.

3. Remove timing belt as outlined in this section.

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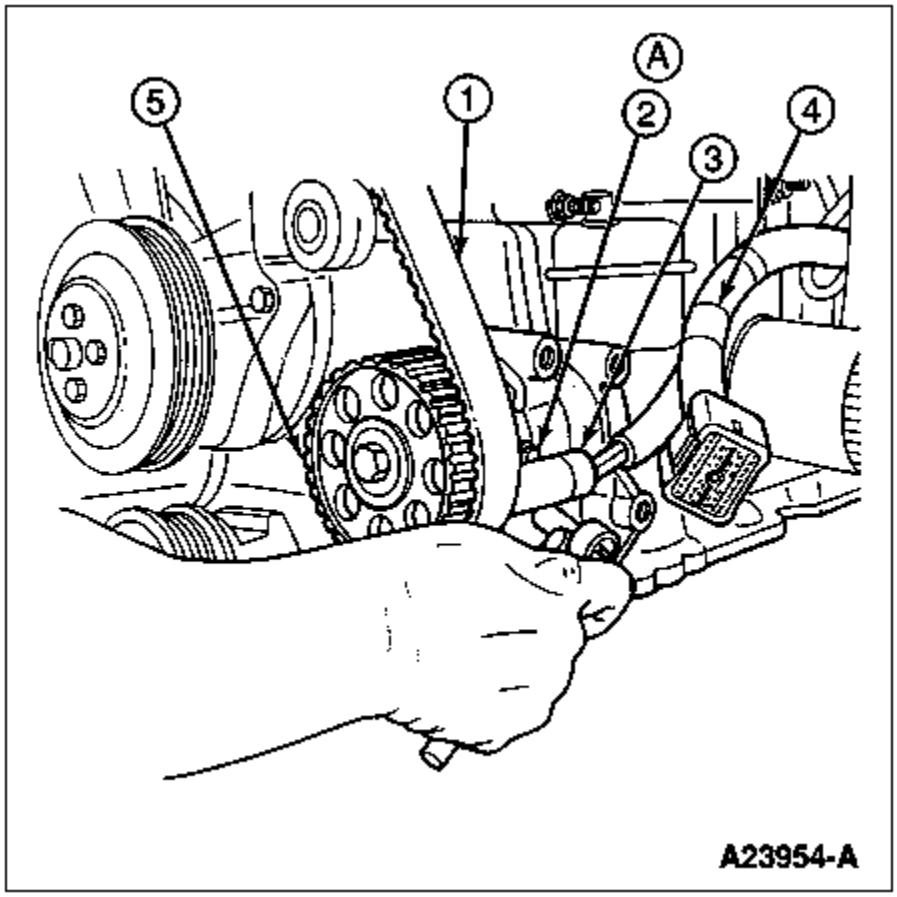
4. Remove oil pump timing belt sprocket as outlined in this section.
5. Disconnect the camshaft position (CMP) sensor wiring connector.
6. Remove two screws and camshaft position sensor (CMP sensor) (6B288).



Item	Part Number	Description
1	6E005	Inner Timing Belt Cover
2	N605880-S3098	Bolt, M5-0.8 x 20 (Part of 6007)
3	6B288	Camshaft Position Sensor
4	12A581	Engine Control Sensor Wiring
5	6256	Camshaft Sprocket
A	—	Tighten to 5-7 Nm (45-61 Lb-In)

7. Remove four oil pump screws.
8. **CAUTION: Do not pry on sealing surfaces.**

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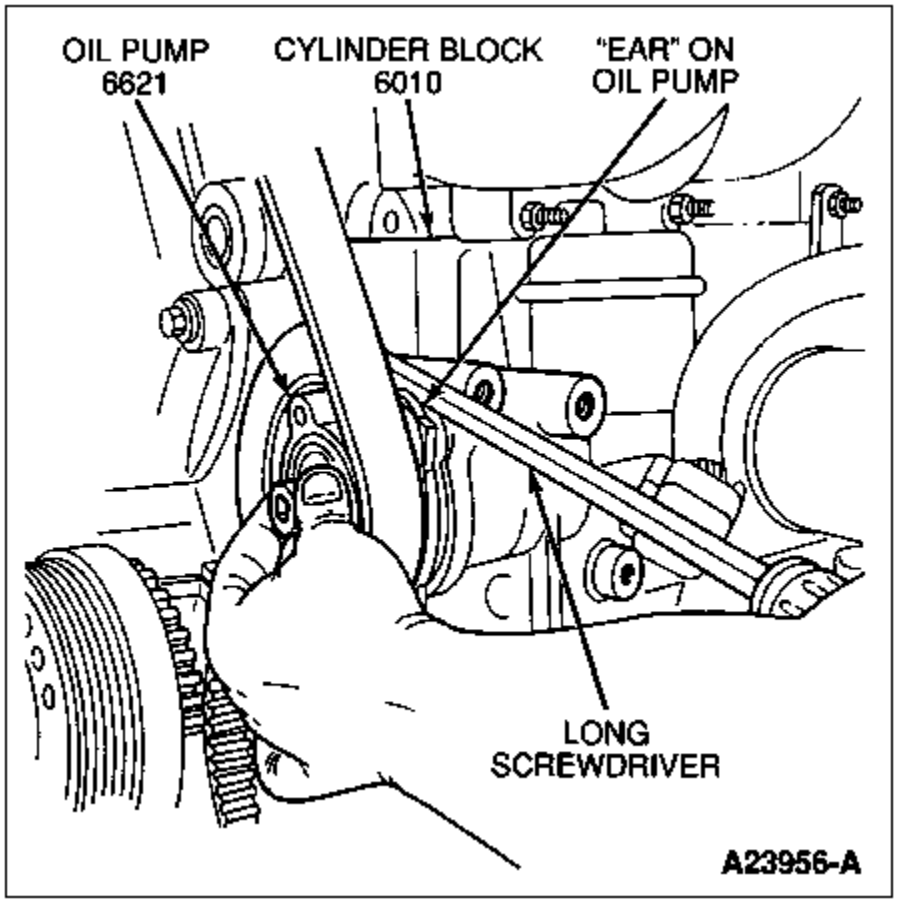
Pry between cylinder blocks (6010) and ear on oil pump (6600) as shown to loosen oil pump.



9. Remove oil pump and oil pump to cylinder block gasket (6659).
10. Clean surfaces of oil pump and cylinder blocks.

Installation

NOTE: Inspect and clean oil pump hole in the cylinder block before installing the oil pump.

1. If original oil pump is to be reused, install new oil pump O-ring seals on oil pump.
2. Prime back of oil pump and O-rings with 236 ml (eight ounces) of fresh motor oil.
3. Add oil to cylinder block hole.

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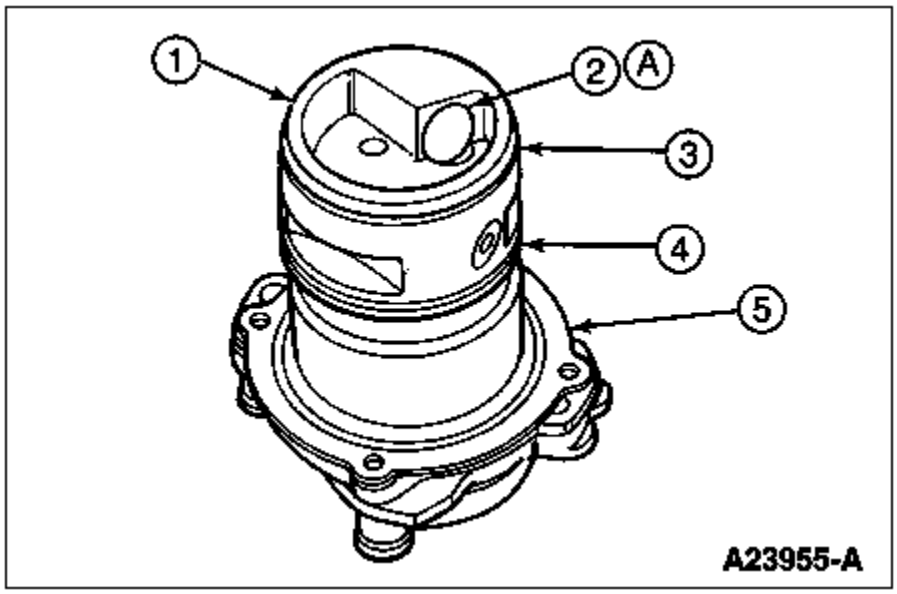

Item	Part Number	Description
1	6600	Oil Pump
2	—	Inlet Passage (Part of 6621)
3	87071-S100	O-Ring
4	87072-S100	O-Ring
5	6659	Oil Pump to Cylinder Block Gasket
A	—	Tilt Oil Pump and Pour In 236 ml (8 Oz.) of Motor Oil to Prime Pump

4. Install oil pump and oil pump to cylinder block gasket being careful to retain the oil in the back of the pump.
5. Install four oil pump screws and tighten to 10-14 Nm (89-123 lb-in).
6. Install oil pump sprocket as outlined in this section.
7. Check to make sure crankcase is filled to proper level with motor oil.
8. Prime oil pump with a drill motor, by rotating oil pump sprocket approximately 10 revolutions or until resistance is felt.
9. Install camshaft position sensor and screws. Tighten screws to 5-7 Nm (45-70 lb-in).
10. Connect the camshaft position sensor electrical connector.
11. Align timing marks and install timing belt as outlined in this section.
12. Install outer timing belt cover as outlined in this section.

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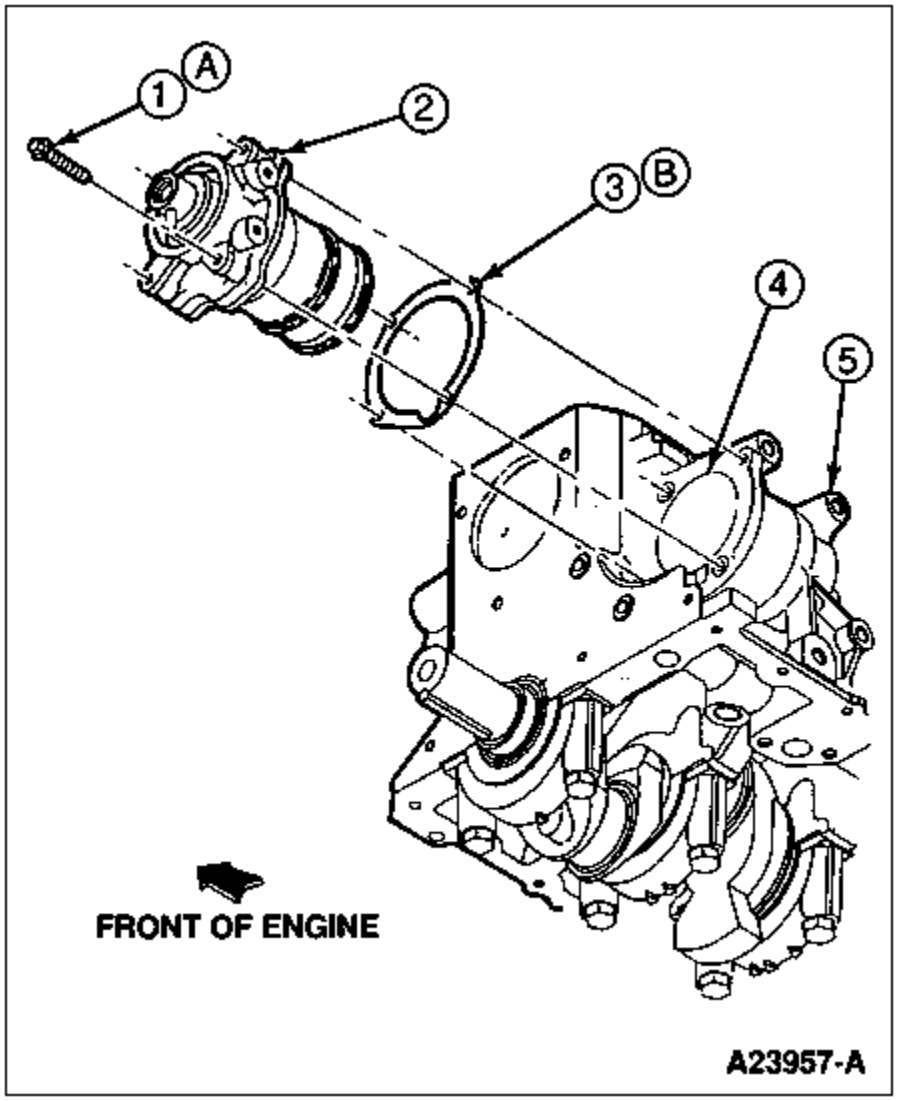
13. Install oil filler cap (6766) and tighten until it ratchets.



Item	Part Number	Description
1	N606523-S2	Bolt, M6-1 x 47.5
2	6600	Oil Pump
3	6659	Oil Pump to Cylinder Block Gasket
4	—	Oil Pump Cavity (Part of 6010)
5	6010	Cylinder Blocks
A	—	Tighten to 10-14 Nm (88-123 Lb-In)
B	—	Side Marked "Block" Goes Toward Cylinder Block

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Flywheel

Removal

1. Remove transmission (7003). Refer to Section 07-01A , Section 07-01B or Section 07-03 depending on transmission type.
2. Remove clutch, if equipped, as outlined in Section 08-01 .
3. Remove attaching bolts and flywheel, or flexplate and flywheel reinforcing plate (6A366).

Installation

NOTE: All major rotating components including flex plate/flywheel are individually balanced to zero. Engine assembly balancing is not required. Balance weights should NOT be installed on new flywheels.

NOTE: Special bolts are used for flywheel/flexplate installation. Do not use standard bolts.

1. If vehicle has manual transmission, inspect pilot bearing. If necessary, replace as outlined in Section 08-01 .
2. Install engine rear plate (7007), if removed.
3. Position flywheel or flexplate and flywheel reinforcing plate on the crankshaft and install attaching bolts. Tighten in standard cross-tightening sequence to 73-87 Nm (54-64 lb-ft).
4. If equipped, install clutch as outlined in Section 08-01 .
5. Install transmission as outlined in Section 07-01A , Section 07-01B or Section 07-03 , depending on transmission type.

Flywheel Installation, Automatic and Manual Transmission

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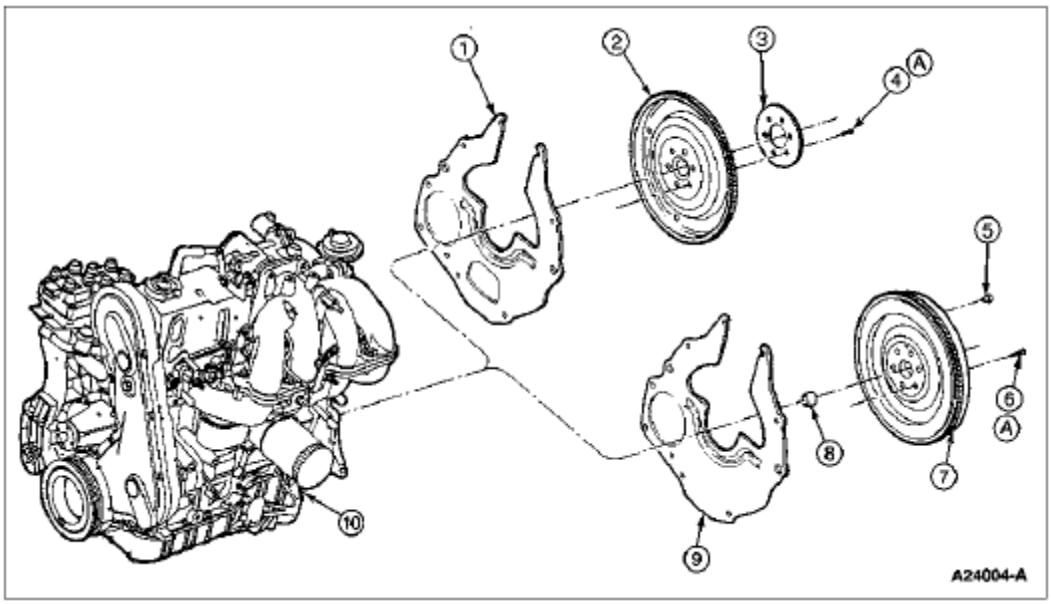

Item	Part Number	Description
1	7007	Engine Rear Plate (Automatic Transmission)
2	6375	Flywheel (Automatic Transmission — Also Called Flexplate)
3	6A366	Flywheel Reinforcing Plate (Automatic Transmission)
4	N802741-S	Bolt, M10-1 x 20
5	6397	Flywheel Dowel — Manual Transmission Only (3 Places)
6	N800028-S	Bolt, M10-1 x 30
7	6375	Flywheel (Manual Transmission)
8	7120	Pilot Bearing
9	7007	Engine Rear Plate (Manual Transmission)
10	6007	Engine (2.3L)
A	—	Tighten to 73-87 Nm (54-64 Lb-Ft)

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Crankshaft Rear Oil Seal

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Jet Plug Remover	T77L-9533-B
Rear Main Seal Replacer	T82L-6701-A

Removal

1. Remove transmission (7003) as outlined in Section 07-01A , Section 07-01B , or Section 07-03 , depending on transmission type.

2. Remove flywheel or flex plate as outlined in this section.

3. **NOTE: Clean exterior surface of crankshaft rear oil seal (6701) and cylinder blocks (6010) before removing crankshaft rear oil seal.**

   Using a sharp awl, punch one hole into the seal metal surface between the seal lip and the cylinder blocks. Screw in the end of Jet Plug Remover T77L-9533-B. Remove crankshaft rear oil seal. Use caution to avoid scratching or damaging block or crankshaft oil seal surface.

Installation

1. Apply clean Motorcraft Super Premium Motor Oil XO-5W30-QSP or equivalent meeting Ford specification ESE-M2G153-E to seal lips and inner seal edge.

2. Place crankshaft rear oil seal on Rear Main Seal Replacer T82L-6701-A. Position to ol and crankshaft rear oil seal to rear of engine (6007). Alternate bolt tightening to seat the crankshaft rear oil seal properly.

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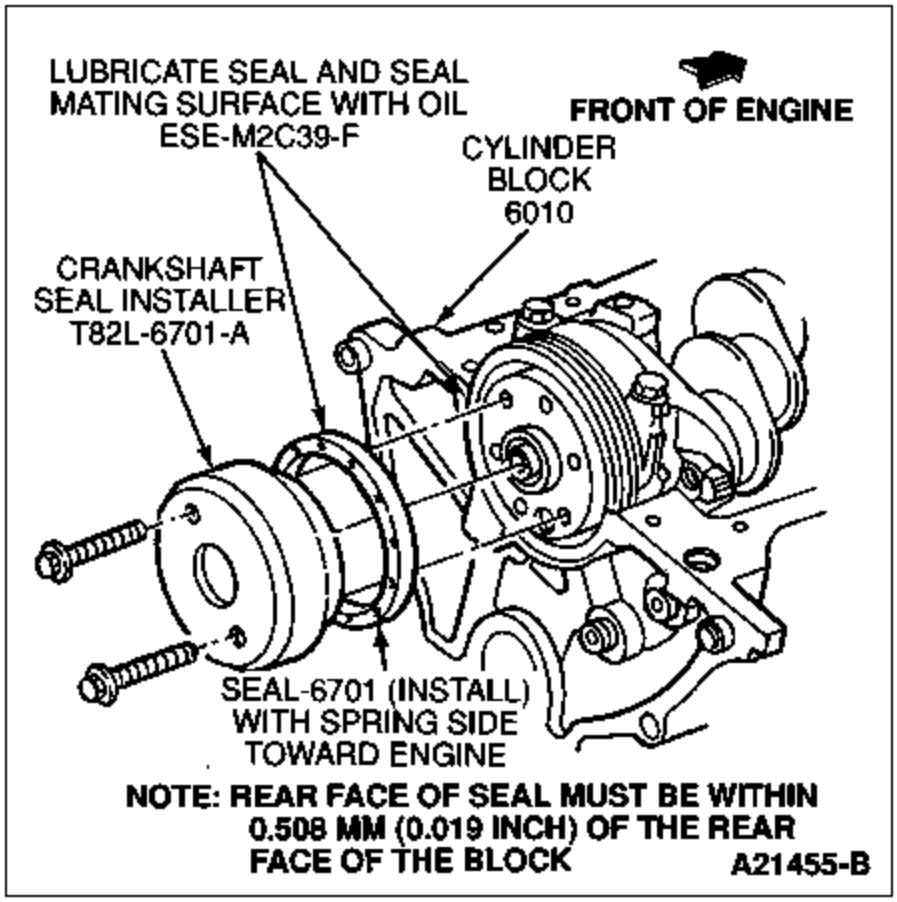

3. Install flywheel or flex plate as outlined in this section.

4. Install transmission as outlined in Section 07-01A , Section 07-01B , or Section 07-03 , depending on transmission type.

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Oil Filter and Adapter

Removal

1. Position oil drain pan under oil filter.
2. Using suitable oil filter wrench, loosen oil filter.
3. Unscrew oil filter by hand and remove. Properly recycle or dispose of oil in filter.

Installation

1. Apply clean motor oil of the same type as is being used in the engine to the oil filter gasket.
2. **NOTE: Do not tighten filter with oil filter wrench.**

   Install oil filter and tighten by hand.

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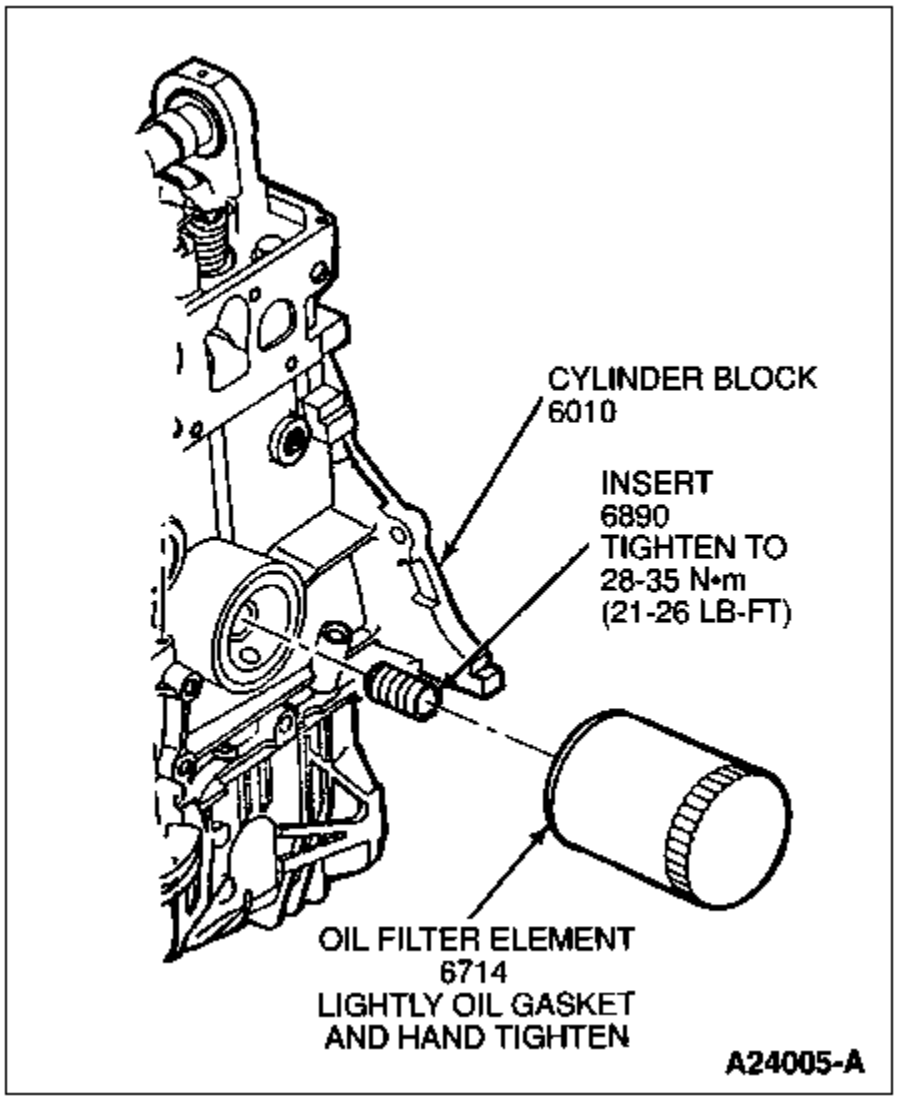

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Oil Level Indicator Tube

Removal

1. Remove oil level dipstick (6750).
2. Remove bolt securing oil level indicator tube (6754) to lower intake manifold.
3. Pull out oil level indicator tube from cylinder blocks (6010).

Installation

1. Clean all old sealer from the oil level indicator tube.
2. Apply Gasket Maker E2AZ-19562-B or equivalent meeting Ford specification WSK-M2G349-A10 to end of oil level indicator tube that pushes into cylinder block.
3. Install oil level indicator tube. Tighten stud to 20-30 Nm (15-22 lb-ft).
4. Install oil level dipstick.

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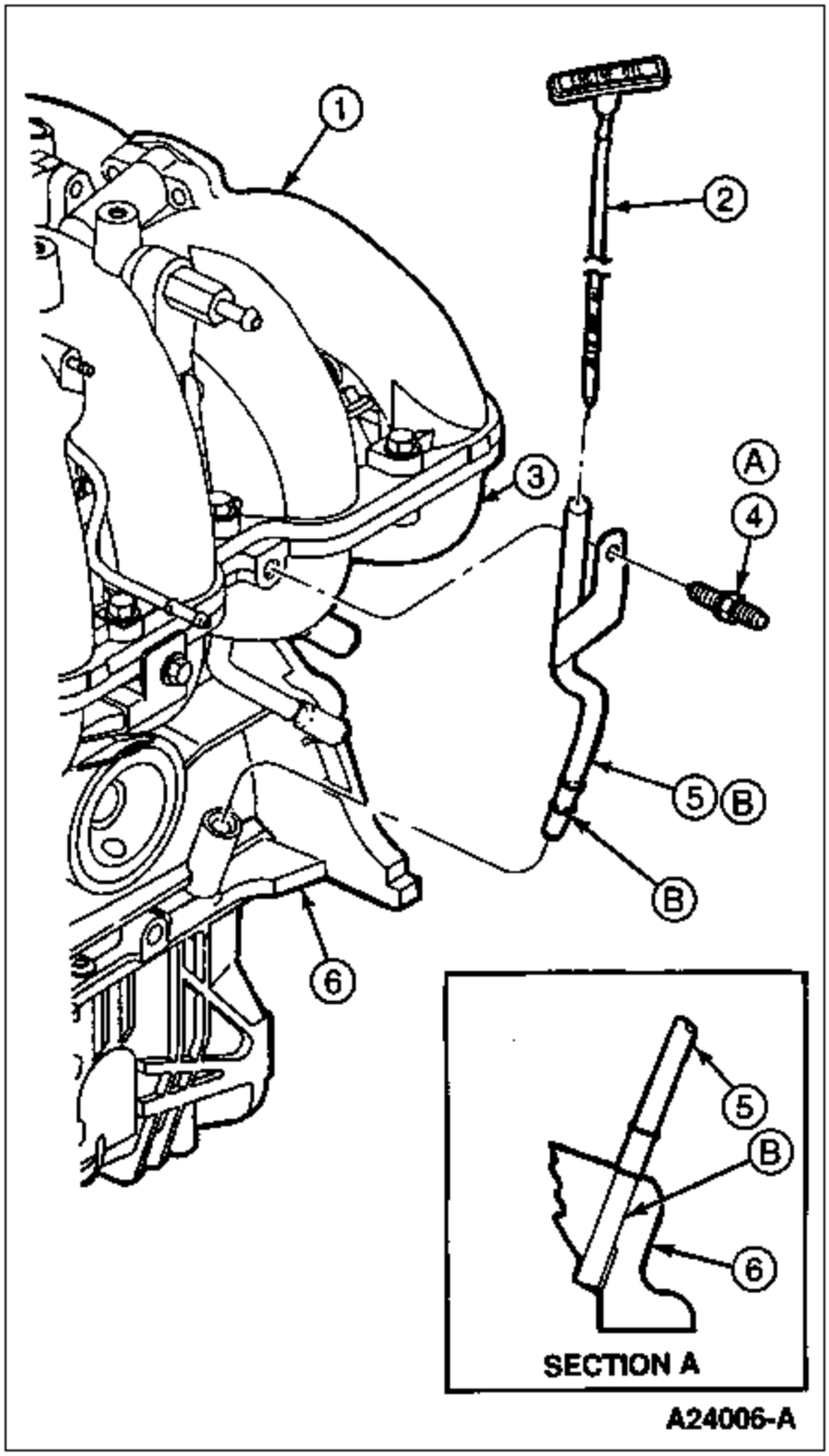

Item	Part Number	Description
1	9424	Upper Intake Manifold

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2	6750	Oil Level Dipstick
3	9424	Intake Manifold, Lower
4	N807689-S2	Stud, M8-1.25 x M5-0.80 x 42.3
5	6754	Oil Level Indicator Tube
6	6010	Cylinder Blocks
A	—	Tighten to 20-30 Nm (15-22 Lb-Ft)
B	—	Apply Gasket Maker E2AZ-19562-B (WSK-M2G349-A10) or Equivalent

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Sensors

Oil Pressure Sender/Sensor

Removal and Installation

NOTE: The pressure switch-type sender used with the indicator lamp system is not interchangeable with the variable resistance-type unit which is used with the gauge system. Refer to the Master Parts Catalog for proper parts usage. Installation of the wrong part will result in an inoperative oil pressure indicating system and a damaged sender unit or gauge.

1. Make sure the ignition switch (11572) is turned off.
2. Disconnect the wire at the sender terminal.
3. Remove the oil pressure sensor (9278) from the cylinder head (6049).
4. Apply Pipe Sealant with Teflon® D8AZ-19554-A or equivalent meeting Ford specification WSK-M2G350-A2 to new sender threads.

   For installation follow removal procedures in reverse order. Tighten switch to 11-24 Nm (8-18 lb-ft).

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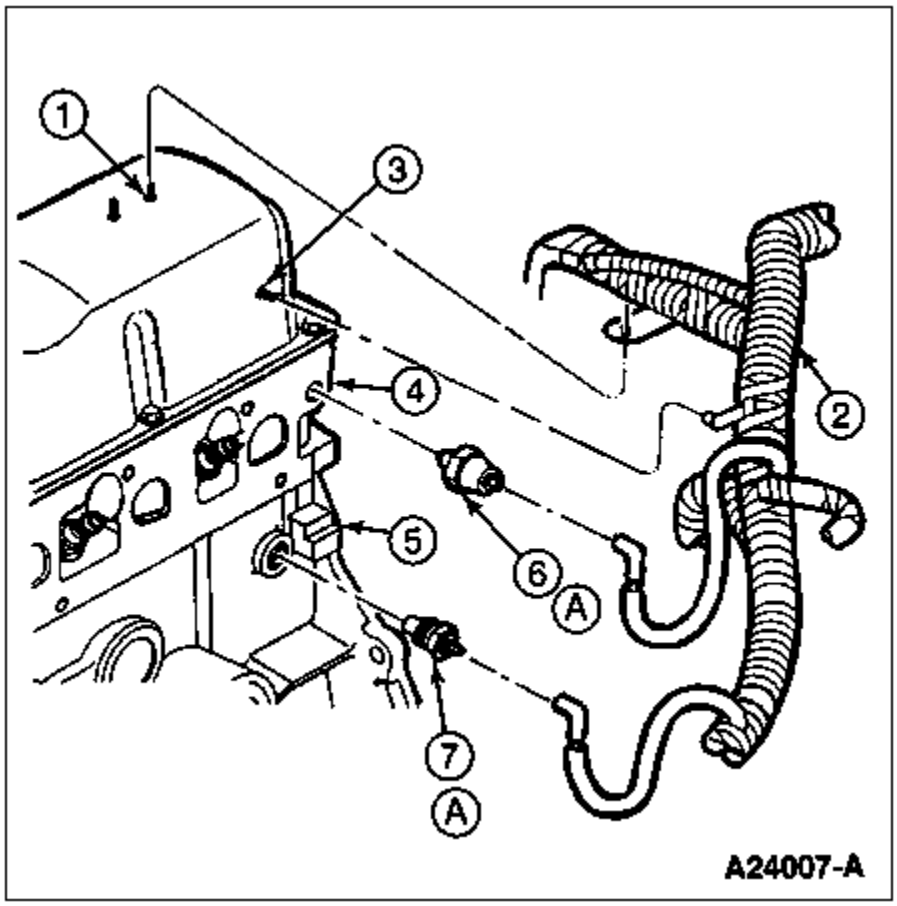

Item	Part Number	Description
1	—	Stud (Part of 6582)
2	12A581	Engine Control Sensor Wiring
3	—	Stud (Part of 6582)
4	6049	Cylinder Head
5	6010	Cylinder Blocks
6	9278	Oil Pressure Sensor
7	10884	Water Temperature Indicator Sender Unit
A	—	Tighten to 11-24 Nm (97-212 Lb-In)

Engine Coolant Temperature Sensor

Refer to Section 03-14 for engine coolant temperature sensor (ECT sensor) (12A648) removal and installation.

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Engine

Removal

WARNING: RESIDUAL PRESSURE REMAINS IN FUEL SYSTEM AFTER ENGINE IS SHUT OFF. THIS COULD RESULT IN INJURY OR FIRE WHEN FUEL LINES ARE DISCONNECTED.

1. Disconnect inertia fuel shutoff switch (IFS switch) (9341) which is located in passenger compartment on the dash next to the transmission tunnel.
2. Crank engine (6007) with starter 15 seconds to depressurize fuel system.
3. Disconnect battery ground cable (14301) and battery to starter relay cable (14300).
4. Drain cooling system.
5. Mark hinge location and remove hood (16612).
6. Disconnect intake air temperature sensor (IAT sensor) (12A697).
7. Remove air cleaner outlet tube (9B659).

Air Filter and Inlet Tube

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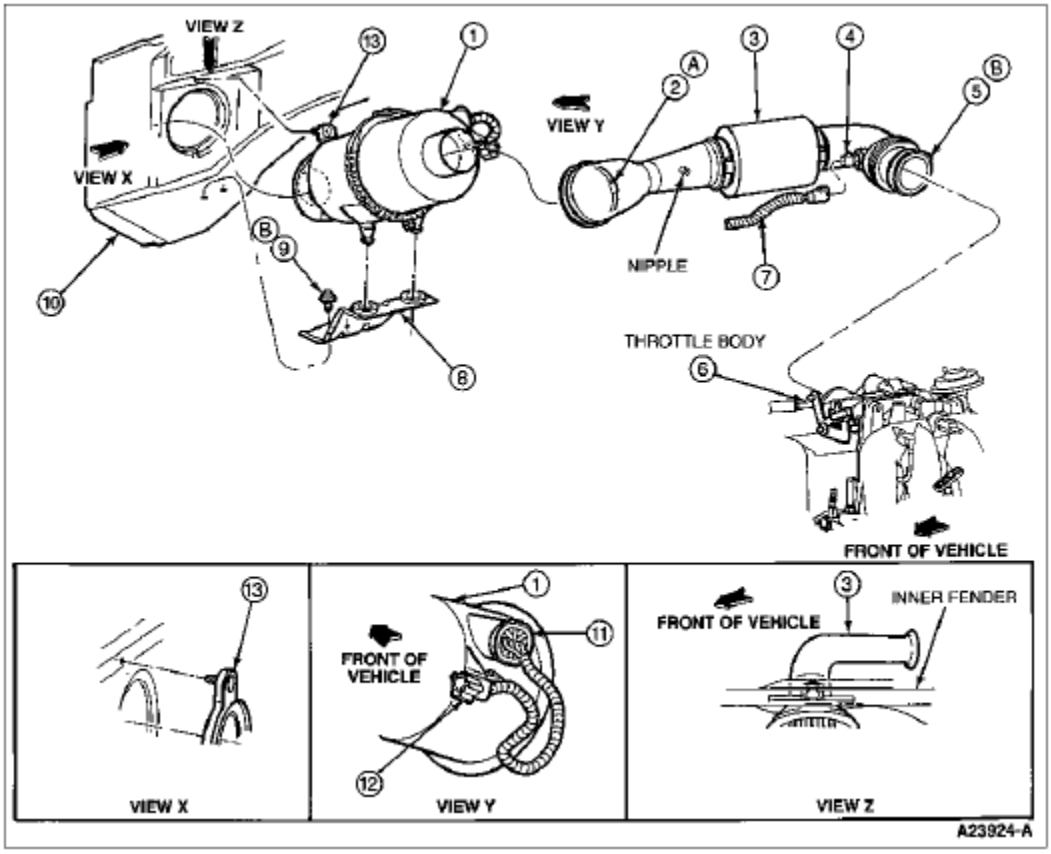

Item	Part Number	Description
1	9600	Engine Air Cleaner
2	—	Clamp (Part of 9F805)
3	9B659	Air Cleaner Outlet Tube
4	12A697	Intake Air Temperature Sensor
5	—	Clamp (Part of 9F805)
6	9E926	Throttle Body
7	12A581	Engine Control Sensor Wiring
8	9626	Engine Air Cleaner Mounting Bracket
9	N606074-S36	Screw, M6-1 x 16.5
10	16B145	Inner Fender
11	12B579	Mass Air Flow Sensor
12	—	Connector (Part of 12B579)
13	9C631	Air Cleaner Retainer
A	—	Tighten to 2.3-3.3 Nm (21-29 Lb-In)
B	—	Tighten to 9-12 Nm (79-107 Lb-In)

8. Remove accelerator control splash shield (9E766).

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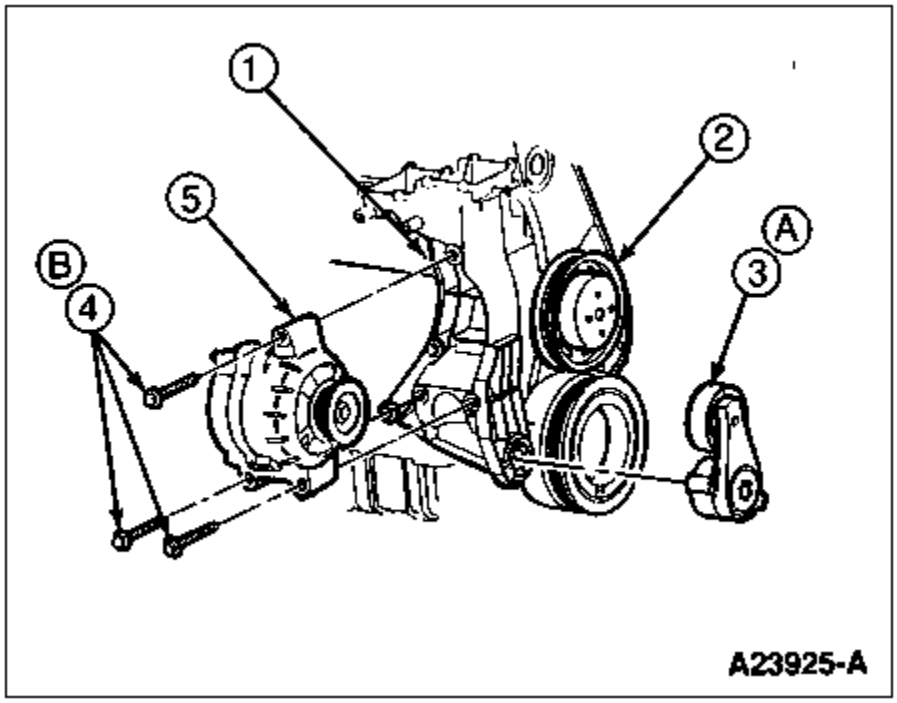
9. Remove upper radiator hose (8260) and lower radiator hose (8286).
10. If equipped remove fan guard (8A611) or, if equipped, remove four screws and fan shroud (8146) and hang on fan blade (8600).
11. Disconnect radiator overflow hose (8075).
12. Remove two radiator bolts and remove radiator (8005).
13. Remove nut and wire from generator (GEN) (10346).
14. Unplug generator connector.
15. Using suitable door trim tool, unfasten two wire clips and relocate generator cable out of the way.
16. Unplug engine coolant temperature sensor (ECT sensor) (12A648).
17. Remove three bolts and generator.



Item	Part Number	Description
1	10153	Generator Mounting Bracket
2	8509	Water Pump Pulley
3	6B209	Drive Belt Tensioner
4	N606068	Bolt, M10-1.5 x 80
5	10300	Generator
A	—	Tighten to 40-55 Nm

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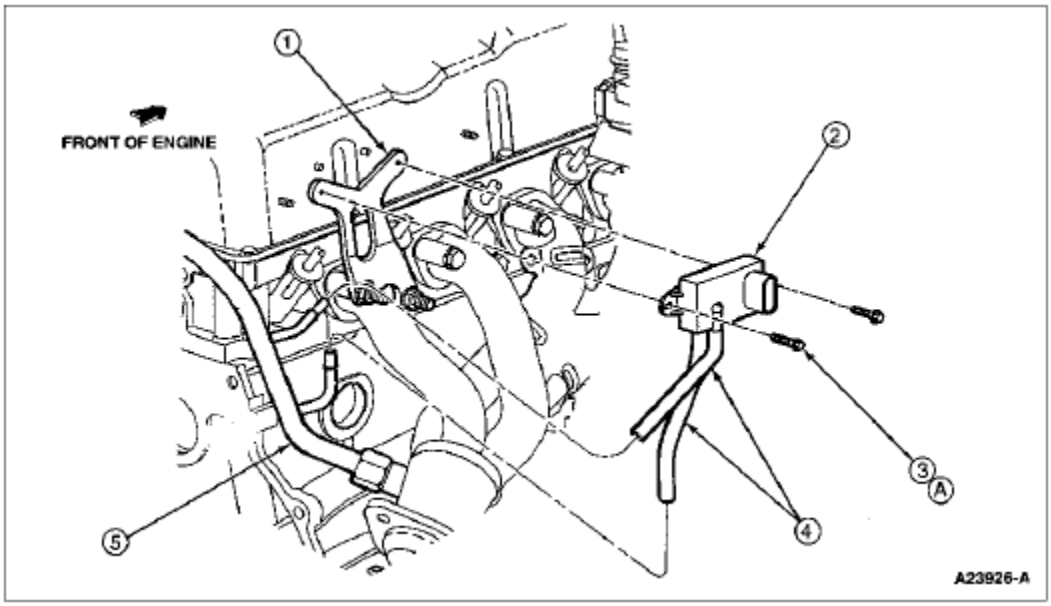
		(30-40 Lb-Ft)
B	—	Tighten to 41-54 Nm (30-40 Lb-Ft)

18. Disconnect upper heater water hose (18472) from water outlet connection, and tie out of the way.
19. Disconnect lower heater water hose from water pump inlet tubes.
20. Disconnect ignition wires from ignition coils (12029).
21. Disconnect engine control sensor wiring (12A581) from both ignition coils, EVR solenoid, and radio ignition interference capacitor (18801).
22. Remove two bolts and water pump inlet tube (8290) from generator mounting bracket (10153) and water pump (8501).
23. Remove three bolts and generator mounting bracket.
24. Disconnect accelerator cable (9A758) from lever on throttle body (9E926). Leave attached to bracket.
25. Remove two screws and assembled accelerator cable and bracket from throttle body and tie to the side.
26. Disconnect 42 pin and 104 pin connectors to engine compartment harness.
27. Disconnect and remove EGR pressure sensor from engine lifting eye.

EGR Transducer



Item	Part Number	Description

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1	17A084	Engine Lifting Eye
2	9J433	EGR Transducer
3	N807202-S36	Bolt, M5-0.8 x 16
4	—	Hoses (Part of 9J433)
5	9D477	EGR Valve to Exhaust Manifold Tube
A	—	Tighten to 2.7-3.7 Nm (24-32 Lb-In)

28. Disconnect Evaporative Emissions System purge hose located at left front corner of engine.

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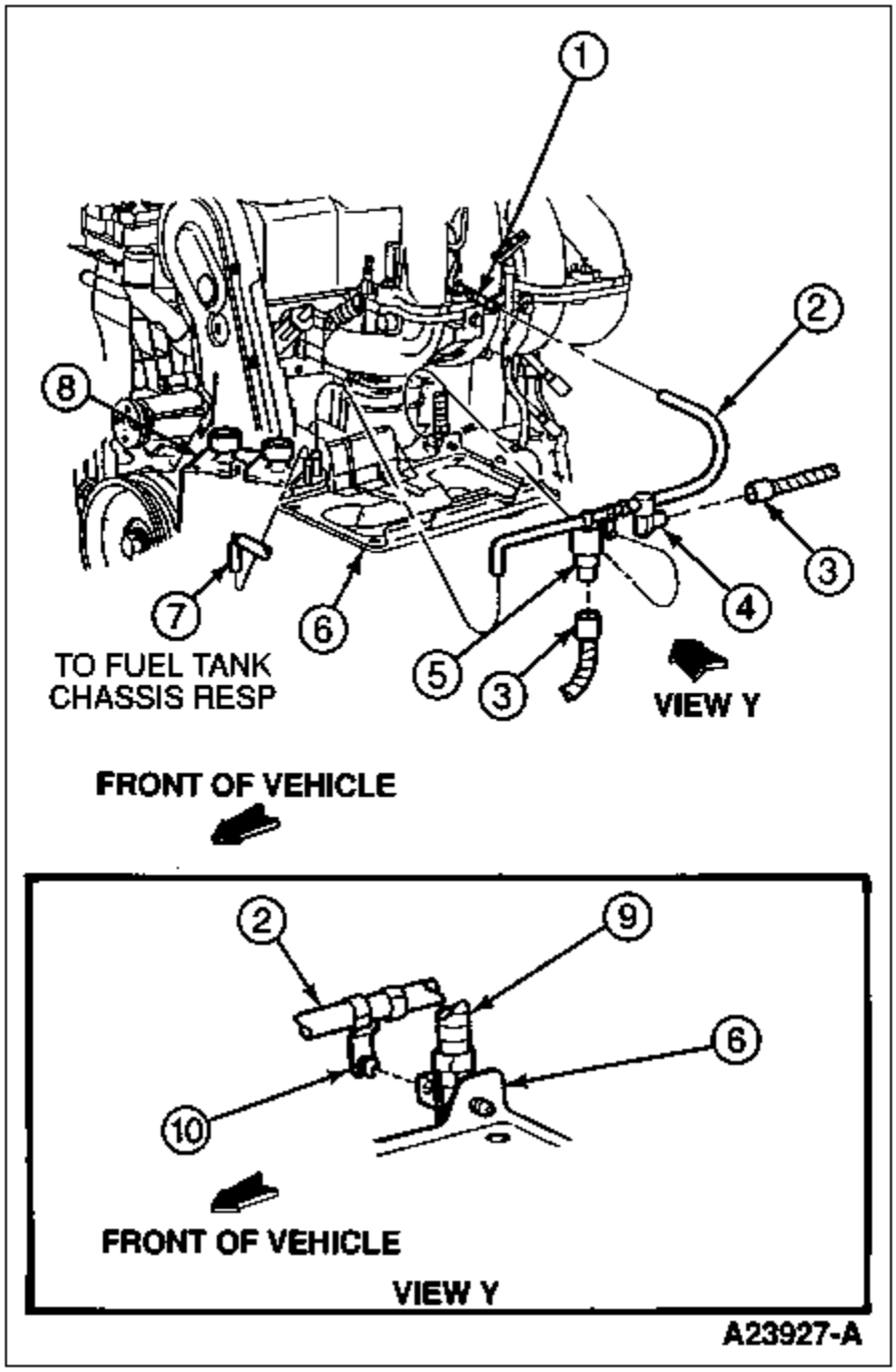

Item	Part Number	Description
1	9G271	Evaporative Emission Return Tube
2	9C987	Fuel Vapor Hose and Valve Assembly
3	14290	Engine Compartment Wiring Assembly
4	14A606	Thermistor Sensor (Part of 9C987)
5	9C915	Evaporative Emission (EVAP) Canister Purge

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		Solenoid
6	10732	Battery Tray
7	9B248	Vapor Line to Fuel Tank
8	9D653	Evaporative Emissions Canister
9	14300	Battery to Starter Relay Cable
10	—	Hose Clip (Part of 9C987)

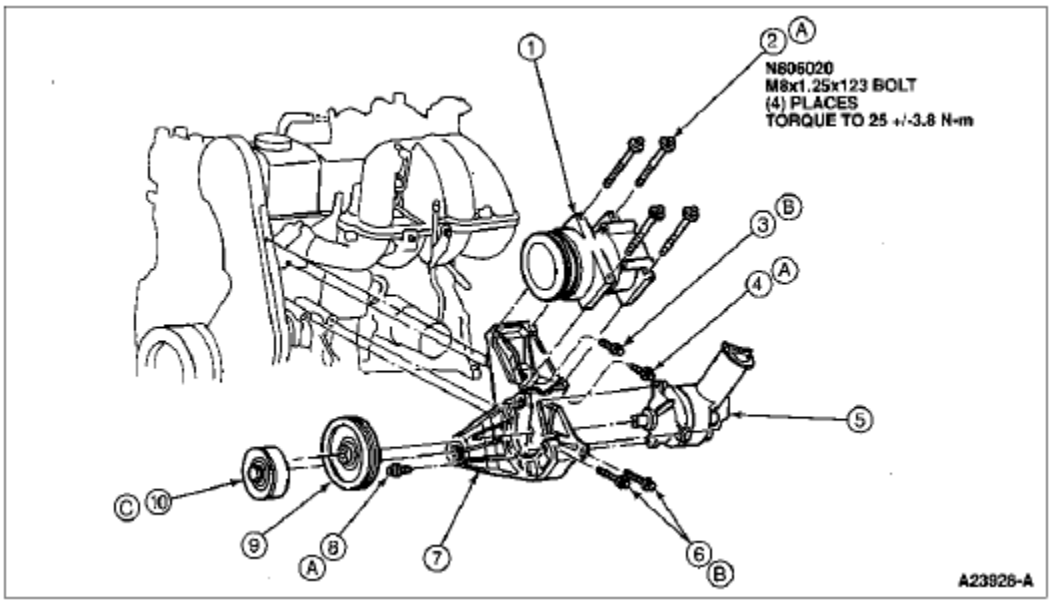
29. If equipped, using Rotunda R134a Recovery Unit, discharge Air Conditioning System.

30. Using quick disconnect tools as outlined in Section 12-00 , disconnect air conditioning hoses from suction accumulator and condenser.

31. Remove four bolts and A/C compressor (19703) and the A/C manifold and tube (19D734).

32. Remove power steering pump bracket bolts. Set off as far as possible. Bracket will catch on steering gear and intake manifold, but can be moved enough to remove engine.

EGR Transducer



Item	Part Number	Description
1	19703	A/C Compressor
2	N806020	Bolt, M8-1.25 x 123
3	N606572	Bolt, M10-1.5 x 123
4	N606051	Bolt, M8-1.25 x 100
5	3A674	Power Steering Pump

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6	N606068-S309	Bolt, M10-1.5 x 80
7	2882	A/C Compressor Mounting Bracket
8	N800199	Bolt, M10-1.5 x 33
9	3A733	Power Steering Pump Pulley
10	3F671	Power Steering Belt Idler Support
A	—	Tighten to 22-28 Nm (15-21 Lb-Ft)
B	—	Tighten to 41-54 Nm (29-40 Lb-Ft)
C	—	Tighten to 53-71 Nm (39-53 Lb-Ft)

33. Raise vehicle.
34. Remove starter motor solenoid terminal cover (11N087).
35. Disconnect starter electrical connections.
36. Disconnect heated oxygen sensors (HO2S) (9F472) lead connectors.
37. Remove two bolts and disconnect three way catalytic converter (TWC) (5E212) from exhaust manifold (9430).
38. Remove both fuel tube clips.
39. Using fuel system quick disconnect tool as outlined in Section 03-04A disconnect fuel return hose from fuel injection supply manifold (9D280).
40. Using fuel system quick disconnect tool as outlined in Section 03-04A , disconnect fuel supply hose from fuel injection supply manifold.
41. Disconnect three connectors from transmission lead.
42. Remove bolt and disconnect ground cable from left side of engine.
43. Remove three bolts and starter motor (11002).
44. If vehicle has automatic transmission, remove torque converter-to-flywheel nuts.
45. Remove two engine-to-transmission bolts at right rear engine support bracket (6096) and left rear engine support bracket.
46. Remove four lower engine-to-transmission bolts and spacers, if equipped.
47. Lower vehicle.
48. Support transmission (7003) with a suitable transmission jack.
49. Connect lifting equipment to engine lifting eyes and support engine.
50. Remove top two engine-to-transmission bolts.

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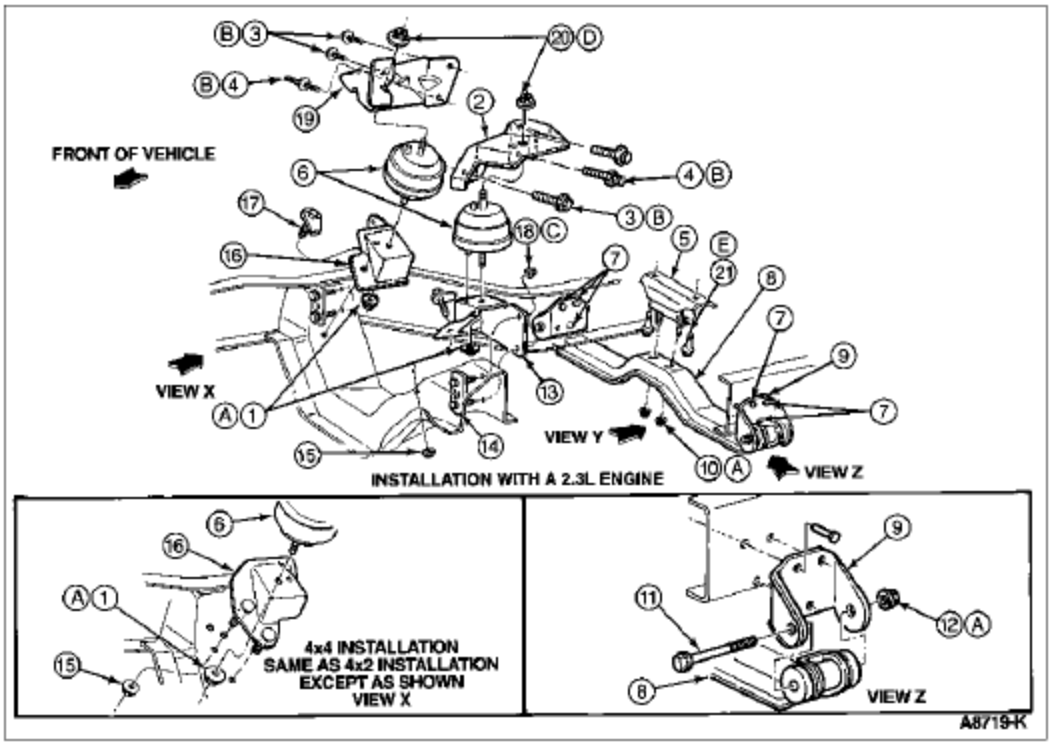
51. Remove two bottom engine-to-transmission bolts and spacers, if equipped.

52. Remove engine mount nuts.

Front and Rear Engine Insulator Assemblies, Ranger with 2.3L Engine



Item	Part Number	Description
1	N801995	Nut and Washer
2	6031	Front Engine Support Mounting Bracket
3	N802653	Screw and Washer
4	N804044	Stud
5	6068	Transmission Support Insulator
6	6038	Front Engine Support Insulator
7	65092	Rivet
8	6A023	Transmission Support Crossmember
9	6096	Rear Engine Support Bracket
10	—	Nut (3 Req'd) (Part of 6068)
11	N803660	Bolt
12	N800937	Nut
13	6029	Front Engine Support Bracket (LH)
14	N802453	Bolt and Retainer

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15	N802330	Nut and Washer
16	6028	Front Engine Support Bracket
17	N805420	Bolt and Retainer
18	N802073	Nut
19	6030	Front Engine Support Mounting Bracket
20	N807479-S100	Nut
21	390066-S2	Screw and Washer (2 Req'd)
A	—	Tighten to 88-115 Nm (65-85 Lb-Ft)
B	—	Tighten to 61-88 Nm (45-65 Lb-Ft)
C	—	Tighten to 97-127 Nm (71-94 Lb-Ft)
D	—	Tighten to 88-118 Nm (65-87 Lb-Ft)
E	—	Tighten to 81-109 Nm (60-80 Lb-Ft)

53. With help of assistant, remove engine.

54. Mount engine on suitable engine stand.

Installation

CAUTION: If oil pan (6675) was not changed, make sure any spacers on the oil pan-to-transmission holes are in place before installing transmission. If oil pan was replaced, make sure any spacers determined necessary in oil pan installation or engine assembly procedure are in place. If clearance between the engine oil pan and transmission is insufficient or excessive, oil pan damage or oil leakage can occur when pan-to-transmission bolts are tightened.

1. Position lifting equipment and remove engine from engine stand.

2. **NOTE: To facilitate engine installation, make two guide pins from M10 x 22mm bolts by cutting off the hex-heads and grinding a screwdriver slot in the head end. Install guide pins on opposite sides in engine-to-transmission bolt holes, before attempting to install engine-to-transmission.**

   Install guide pins in transmission.

3. Install engine with help of assistant.

4. Install engine mount nuts. Tighten to 88-118 Nm (65-87 lb-ft).

5. Position A/C compressor mounting bracket (2882) with assembled power steering pump (3A674) and install bolts. Tighten power steering pump bracket-to-engine bolts to 1 at 21-28 Nm (16-20 lb-ft) and 3 at 40-55 Nm (30-41 lb-ft).

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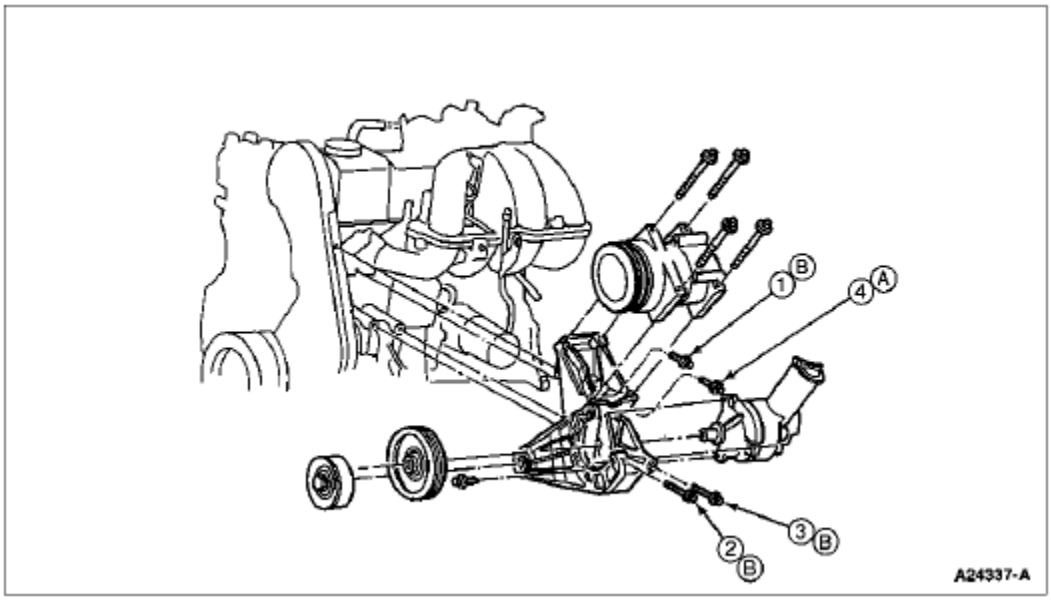
6. Remove transmission jack from under transmission and raise vehicle on hoist.

7. Install engine-to-transmission bolts, except those where guide pins are located and the two top bolts, and tighten snug but not tight.

Compressor Mounting Bracket Torque Sequence



Item	Part Number	Description
1	N606572	Bolt, M10-1.5 x 123
2	N606068	Bolt, M10-1.5 x 80
3	N606068	Bolt, M10-1.5 x 80
4	N606051	Bolt, M8-1.25 x 100
A	—	Tighten to 22-28 Nm (15-21 Lb-Ft)
B	—	Tighten to 41-54 Nm (29-40 Lb-Ft)

8. Remove two guide pins and replace with bolts.

9. Tighten engine-to-transmission bolts to 38-51 Nm (28-38 lb-ft).

10. On vehicles with automatic transmission, install torque converter-to-flywheel nuts. Tighten to 31-39 Nm (23-39 lb-ft).

11. Install starter motor. Tighten starter-to-engine bolts to 20-27 Nm (15-20 lb-ft).

12. Install ground cable and bolt to left side of engine.

13. Connect transmission lead to engine fuel charging wiring.

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14. Connect fuel line and return line to fuel injection supply manifold.
15. Install fuel tube clip.
16. Connect three way catalytic converter to exhaust manifold. Tighten bolts to 34-46 Nm (25-33 lb-ft).
17. Install cable brackets with assembled battery to starter relay cable.
18. Connect both Heated Oxygen Sensor (HO2S) leads to sensor extension harness.
19. Connect starter electrical connections. Tighten starter cable nut to 9-14 Nm (80-124 lb-in).
20. Lower vehicle.
21. Install two top engine-to-transmission bolts. Tighten to 38-51 Nm (28-38 lb-ft).
22. Connect two engine control sensor extension wiring (12A690) connectors (104 pin and 42 pin).
23. Connect evaporative emissions purge hose located behind engine.

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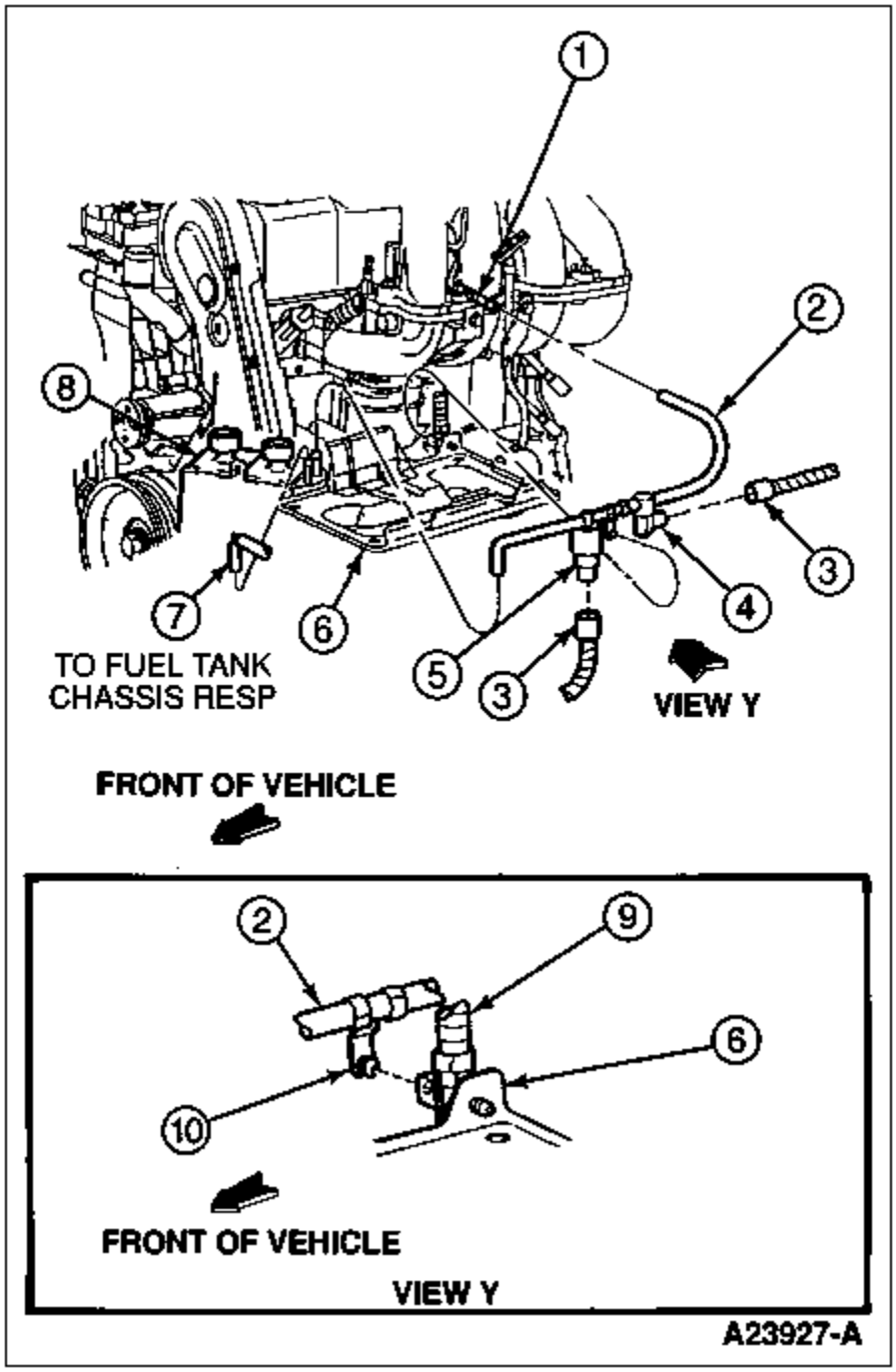

Item	Part Number	Description
1	9G271	Evaporative Emission Return Tube
2	9C987	Fuel Vapor Hose and Valve Assembly
3	14290	Vehicle Compartment Wiring Assembly
4	—	Thermistor Sensor (Part of 9C987)
5	9C915	Evaporative Emission Solenoid
6	10732	Battery Tray

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7	9B248	90° Elbow and Hose
8	9D653	Evaporative Emissions Canister
9	14300	Battery to Starter Relay Cable
10	—	Hose Clip (Part of 9C987)

24. Install EGR transducer (9J433) to rear engine lifting eye (17A084). Connect vacuum hoses electrical connections to EGR transducer. Connect Delta PFE Sensor hoses to EGR valve to exhaust manifold tube (9D477).

25. Connect dash panel ground cable (14303).

26. Connect vacuum hose to power brake booster (2005).

27. Install accelerator cable bracket (9723) to upper intake manifold. Tighten bolts to 21-28 Nm (16-21 lb-ft).

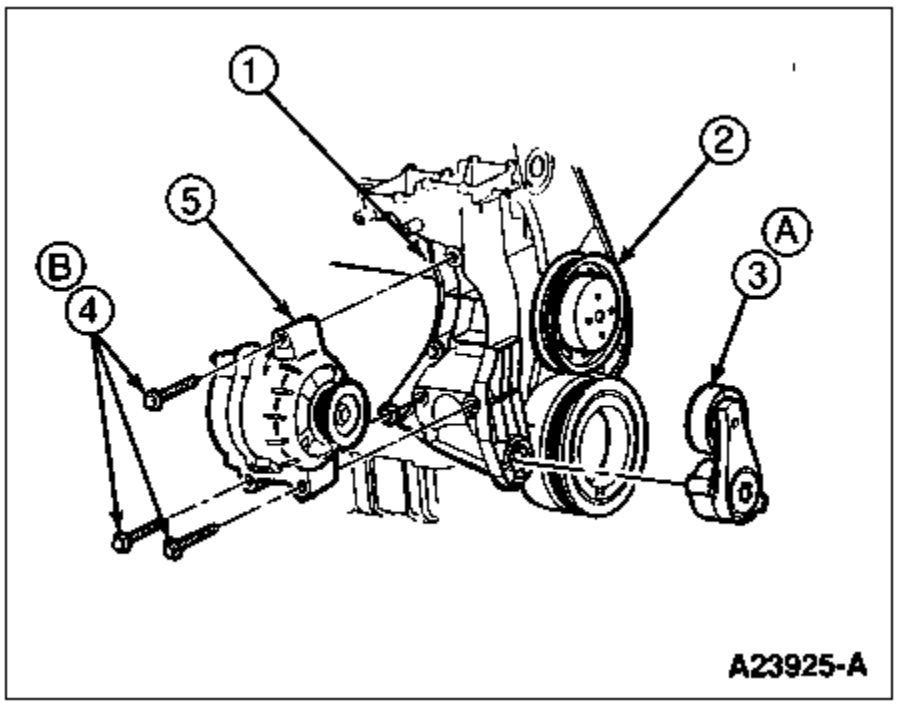
28. Connect accelerator cable to throttle body.

29. Connect lower heater water hose.

30. Connect upper heater water hose.

31. Install generator mounting bracket and tighten bolts to 44-54 Nm (30-40 lb-ft).

32. Install generator (GEN) (10300) to bracket and tighten bolts to 41-54 Nm (30-40 lb-ft).



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Item	Part Number	Description
1	10153	Generator Mounting Bracket
2	8509	Water Pump Pulley
3	6B209	Drive Belt Tensioner
4	N606068	Bolt, M10-1.5 x 80
5	10300	Generator
A	—	Tighten to 40-55 Nm (30-40 Lb-Ft)
B	—	Tighten to 41-54 Nm (30-40 Lb-Ft)

33. Connect electrical connectors to ignition coils. Connect spark plug wires to ignition coils.
34. Position drive belt (8620).
35. Using socket handle (3/8 inch), rotate drive belt tensioner (6B209) against spring tension, push drive belt into position, and gradually release belt tension so tensioner pulley rests on back of belt.
36. Tighten fan clutch bolts to 17-23 Nm (13-16 lb-ft).
37. Connect engine coolant temperature sensor.
38. Position generator voltage regulator wiring (14305) over front of engine.
39. Connect generator plug-in connector.
40. Connect generator terminal and tighten nut to 7-9 Nm (60-81 lb-in).
41. If equipped with air conditioning, position fan shroud on fan blade.
42. Install radiator.
43. On air-conditioned vehicles, install fan shroud to radiator and tighten screws to 5-8 Nm (48-71 lb-in).
44. On non-air-conditioned vehicles, install fan guard and tighten screws to 5-8 Nm (48-71 lb-in).
45. Snap electrical harness guides into holders.
46. Connect radiator overflow hose to radiator.
47. Install lower radiator hose.
48. Install upper radiator hose.
49. If equipped with air conditioning, recharge system. Refer to appropriate section in Group 12.
50. Fill crankcase to proper level with oil specified in Section 03-03 .
51. Install air cleaner outlet tube.

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52. Connect intake air temperature sensor and mass air flow sensor (MAF sensor) (12B579).

53. Fill cooling system with coolant specified in Section 03-03 .

54. Install accelerator control splash shield.

55. Connect inertia fuel shutoff switch.

56. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven to relearn the strategy.**

    Connect battery to starter relay cable and battery ground cable.

57. With help of assistant install hood and adjust.

58. Start engine and check for leaks.

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Engine Front Cover

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Cam Sprocket Holding/Removing Tool	T74P-6256-B
Front Cover Seal Remover	T74P-6700-B
Front Cover Alignment Tool	T74P-6019-B
Front Seal Replacer	T74P-6150-A

NOTE: This procedure will require the following replacement parts: oil pan gasket (6710), crankshaft front seal (6700), engine front cover gasket (6020) and a water pump inlet tube O-ring (87056-5100).

Removal

1. Remove engine (6007) as outlined in this section.
2. Remove outer timing belt cover and timing belt as outlined in this section.
3. Remove engine oil pan (6675) as outlined in this section.
4. Remove crankshaft damper bolt.
5. Remove crankshaft damper.
6. Remove crankshaft sprocket (6306).
7. Remove oil pump sprocket bolt. Using Cam Sprocket Holding/Removing Tool, T74P-6256-B, remove oil pump sprocket.
8. Remove stud, screw, nut, and timing belt tensioner.
9. Remove two screws and water pump inlet tube (8290).
10. Remove one screw and crankshaft position sensor (CKP sensor) (6C351).
11. Remove one bolt and one nut from inner timing belt cover.
12. Remove inner timing belt cover.
13. **NOTE: Remove the crankshaft front seal while the front cover is still mounted on the engine.**

    Using Front Cover Seal Remover, T74P-6700-B, remove crankshaft front seal.

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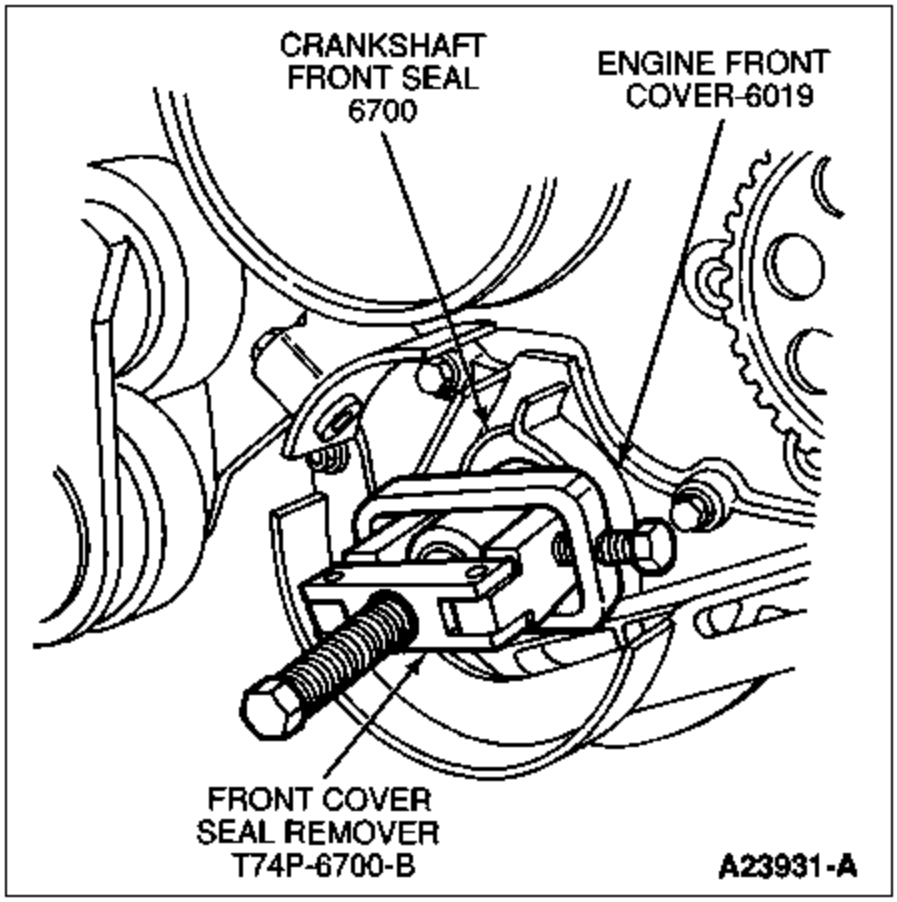
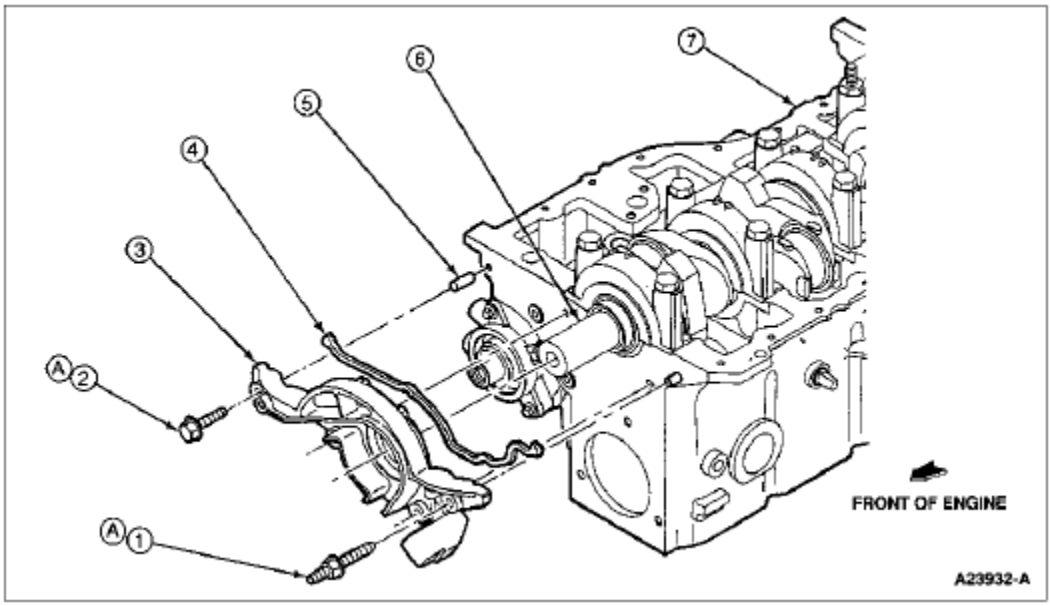


14. Remove four bolts, engine front cover and gasket.

Engine Front Cover Installation



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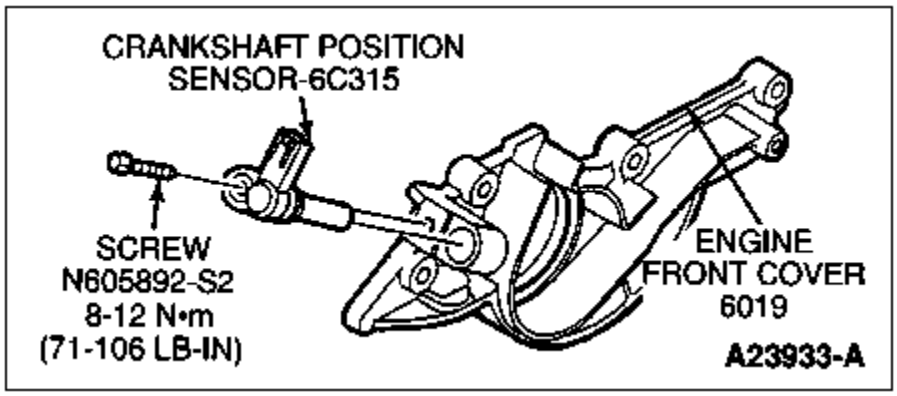
Item	Part Number	Description
1	807288-S2	Stud, M6 1-1 x 61.9
2	N807497-S2	Bolt, M6 1-1 x 37.5
3	6019	Engine Front Cover
4	6020	Engine Front Cover Gasket
5	—	Dowel Bushing (Part of 6010)
6	6303	Crankshaft
7	6010	Cylinder Blocks
A	—	Tighten to 13-16 Nm (115-141 Lb-In)

Installation

1. Install a new engine front cover gasket in engine front cover.
2. Install front cover assembly onto cylinder blocks (6010).
3. Tighten three bolts and one stud to 13-16 Nm (10-11 lb-ft).
4. Position a new crankshaft front seal on Front Seals Replacer T74P-6150-A and press into place using vibration damper bolt. Remove bolt and tool.
5. Install a new oil pan gasket and the oil pan as outlined in this section.
6. Install inner timing belt cover.
7. Tighten inner timing belt cover bolts to 8-12 Nm (70-106 lb-in).
8. Install crankshaft position sensor (CKP sensor) (6C315) and tighten bolt to 8-12 Nm (70-106 lb-in).



9. Lubricate and install new O-ring on water pump inlet tube.

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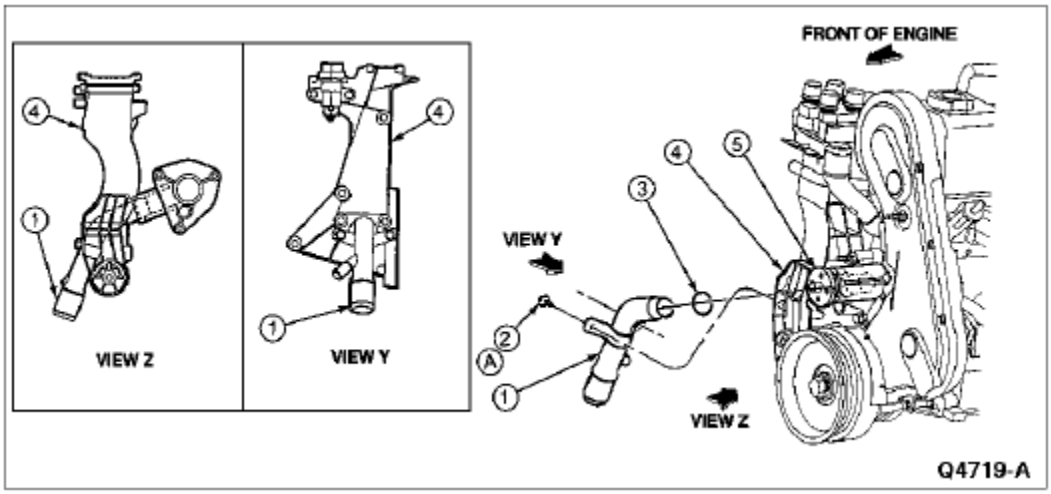
10. Install water pump inlet tube into water pump (8501).

11. Install water inlet tube-to-generator bracket bolts and tighten to 9-12 Nm (80-106 lb-in).

Water Pump Inlet Tube



Item	Part Number	Description
1	8290	Water Pump Inlet Tube
2	N606676-S2	Screw and Washer Assembly, M6-1 x 22.5
3	87056-S100	O-Ring
4	10153	Generator Mounting Bracket
5	8501	Water Pump
A	—	Tighten to 9-12 Nm (78-107 Lb-In)

12. Install crankshaft sprocket, crankshaft damper, washer, and bolt. Tighten bolt to 125-165 Nm (92-121 lb-ft).

13. Install oil pump sprocket and tighten bolt to 40-55 Nm (30-40 lb-ft).

14. Align sprockets and install timing belt as outlined in this section.

15. Install outer timing belt cover as outlined in this section.

16. Install engine as outlined in this section.

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Oil Pan—All Except Ranger 4x2 Vehicles with Manual Transmission

Removal

1. Remove the engine (6007) as detailed in this section.

2. **CAUTION: Do not turn engine upside down with oil pan attached. Sludge and debris in oil pan will fall into cylinders, pistons, and connecting rods, possibly causing rapid wear. Sludge may also plug engine oil pickup screen.**

   Mount engine on a suitable engine stand right side up.

3. Remove the oil pan retaining bolts and remove the oil pan (6675).

4. Remove the oil pan gasket (6710) and throughly clean the engine and oil pan gasket surfaces.

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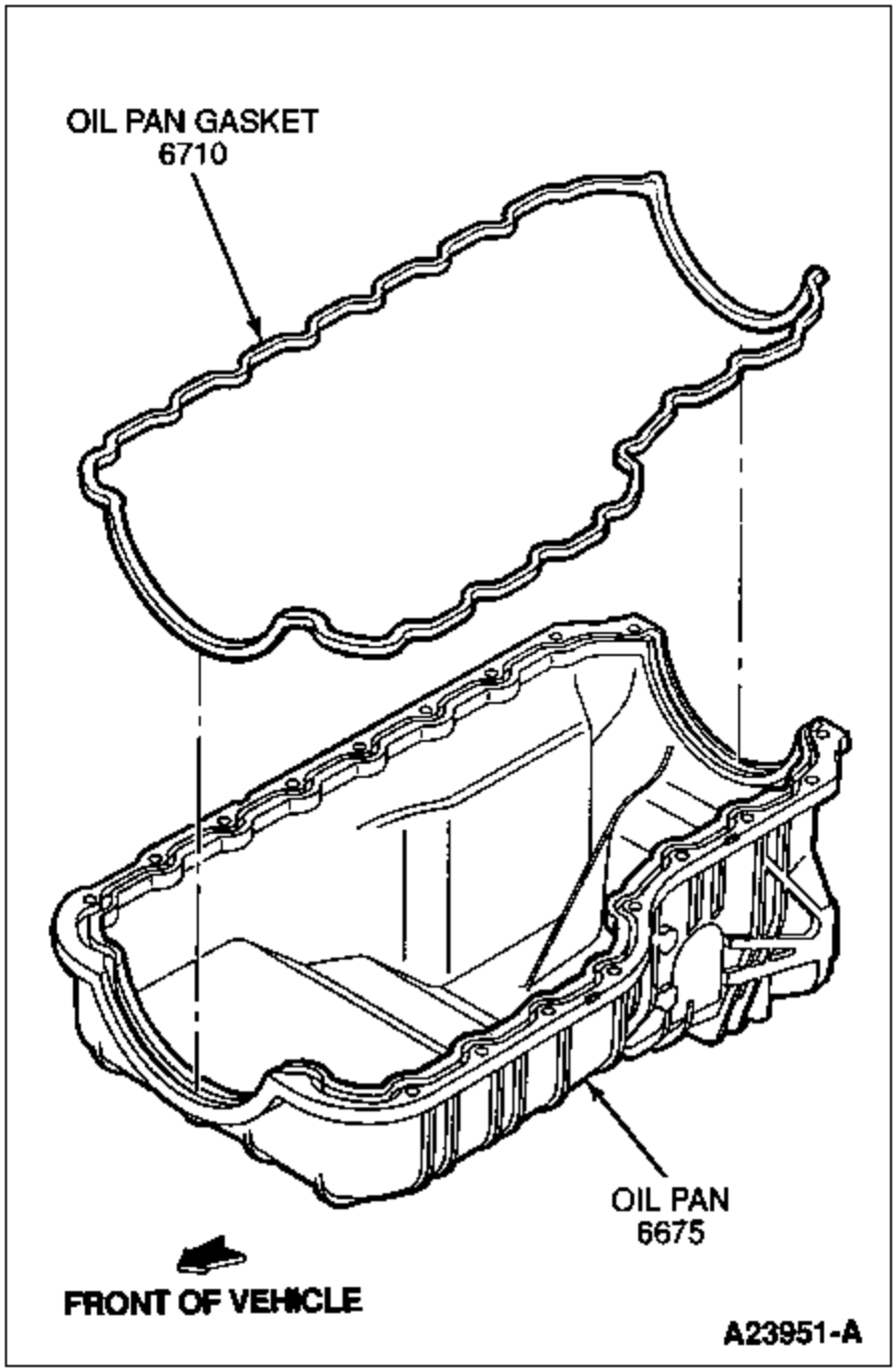

Installation

1. **NOTE: The transmission (7003) bolts to the engine and oil pan when installed. It is necessary to measure the gap between the surface of the rear face of the oil pan (at the spacer locations) and the rear face of the cylinder blocks (6010).**

   Apply Silicone Gasket and Sealant F1AZ-19562-A or equivalent meeting Ford specification WSE-M4G320-A2, in six places at joints between engine front cover (6019) and the cylinder block and rear main bearing cap and engine block as shown.

2. Install a new oil pan gasket to the oil pan and position the oil pan to the engine.

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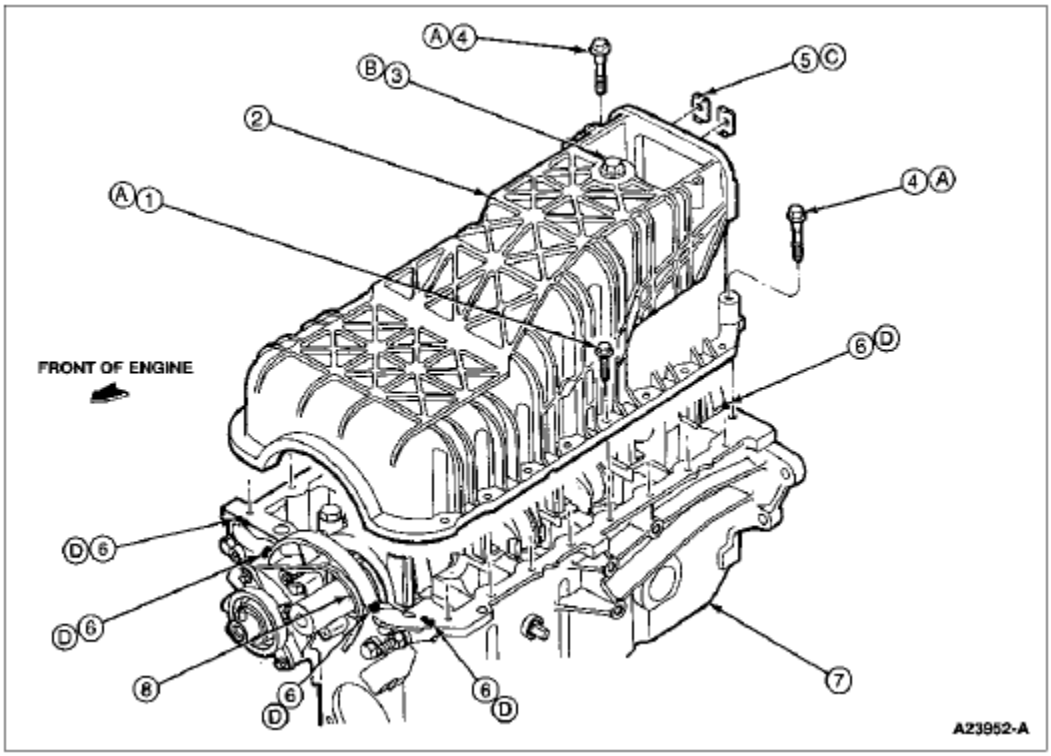
Oil Pan



Item	Part Number	Description
1	N806378-S36	Bolt, M6-1 x 27.5 (16 Places)
2	6675	Oil Pan
3	6730	Oil Pan Drain Plug, M8
4	N806379-S36	Bolt, M6-1 x 57.5
5	6C629	Oil Pan Spacer
6	19562	Silicone Gasket and Sealant
7	6010	Cylinder Blocks
8	6019	Engine Front Cover
A	—	Tighten to 14-16 Nm (123-141 Lb-In)
B	—	Tighten to 20-34 Nm (15-25 Lb-Ft)
C	—	If Replacing Oil Pan or Transmission, Select According to Text
D	—	Apply in Six Places Shown (Left Side of Rear Main Cap Is Hidden)

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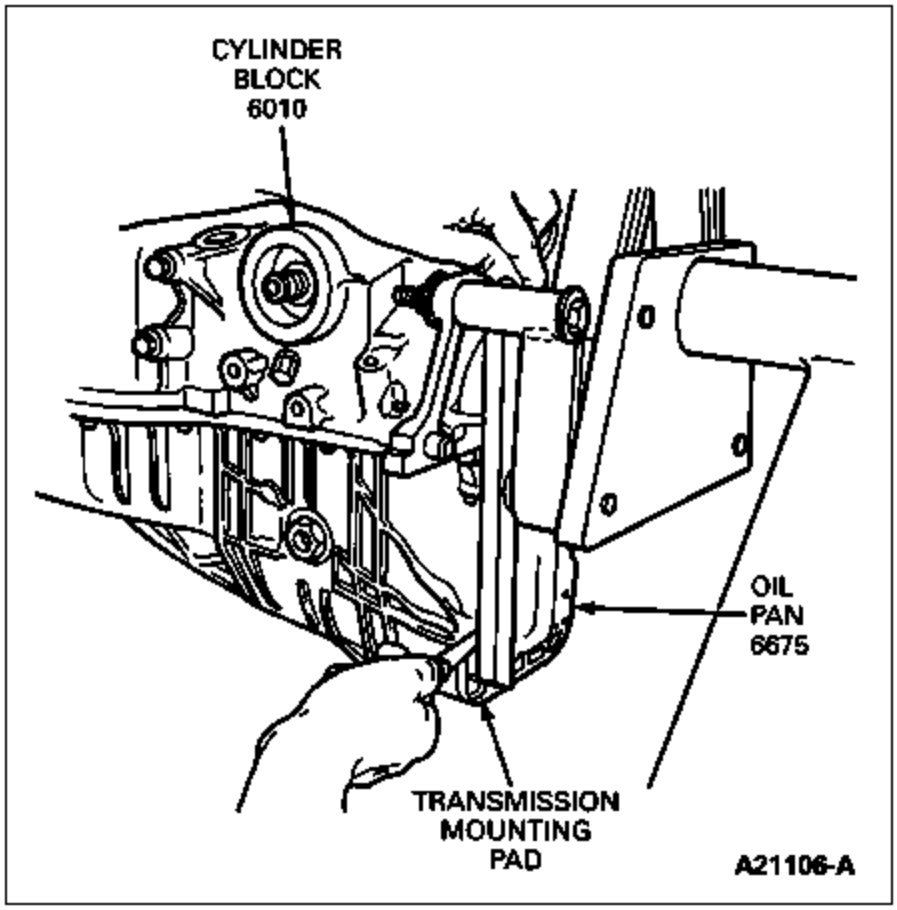
3. Install and tighten the oil pan retaining bolts to 14-16 Nm (123-141 lb-in).

4. **CAUTION: Failure to measure the required spacer thickness can result in insufficient, or excessive, clearance between the engine oil pan and the transmission when installed in the vehicle. This can result in oil pan damage and an oil leak.**

   With the oil pan installed on the engine, position a straight edge flat on the rear of the cylinder blocks so that it extends over one of the oil pan/transmission bolt mounting pads.



5. Measure the gap between the mounting pad and the straight edge using a feeler gauge. Repeat the procedure for the other mounting pad. Select spacers of the required thickness from the chart.

SPACER SELECTION CHART

Measured Gap		Spacer Required		
mm	Inch	mm	Inch	Shim Color Code
0.0-0.254	0.0-0.010	None	None	—
0.27-0.51	0.011-0.020	0.254	0.010	Yellow
0.52-0.76	0.021-	0.508	0.020	Blue

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	0.030			
0.78-1.01	0.041-0.040	0.762	0.030	Pink

6. Install the selected oil pan spacers (6C629) to the mounting pads on the rear of the oil pan before bolting the engine and transmission together.

7. Install engine as outlined in this section.

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Oil Pan — Ranger Manual Transmission 4x2 Vehicles

Removal

1. Disconnect negative battery cable. Refer to Section 14-01 .
2. Shift transmission into NEUTRAL. Remove gearshift lever boot and lever.
3. Remove oil level indicator and fan shroud. Position shroud over fan blade.
4. Raise vehicle on hoist. Refer to Section 00-02 .
5. **NOTE: Make a reference mark on driveshaft for installation.**

   Remove driveshaft midship bearing retainers. Disconnect driveshaft from rear axle.
6. Remove driveshaft. Install a suitable plug in the extension housing to prevent leakage, if transmission was not drained.
7. Disconnect hydraulic clutch hose from case using Clutch Coupling Tool T88T-70522-A. Install protective caps.
8. Remove starter cable bracket hold-down.
9. Remove starter motor and secure it aside.
10. Disconnect exhaust bracket-to-transmission support insulator.
11. Disconnect electrical connectors from wiring harness at top of transmission and rear HO2S connector.
12. Secure transmission to transmission jack.
13. Remove transmission support insulator nuts from crossmember and remove crossmember-to-frame rail bolts. Lower crossmember from vehicle.
14. Remove transmission-to-engine retainers and slide transmission rearward. Lower transmission from vehicle.
15. Remove pressure plate, clutch disc, flywheel, and separator plate. Refer to Section 08-01 .
16. Drain engine oil.
17. Remove oil pan bolts and lower pan.
18. Remove oil pump screen and oil pan assembly.
19. Remove oil pan gasket and clean mating surfaces.

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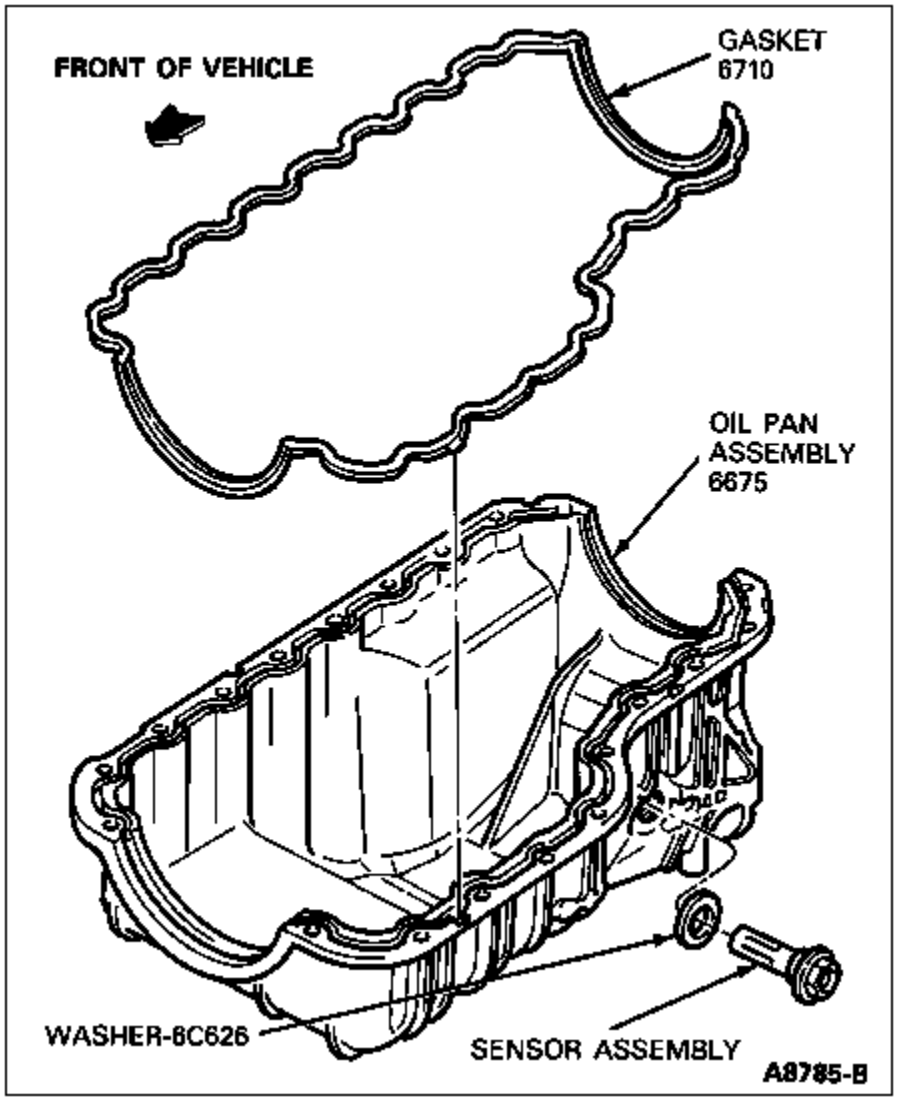

Installation

1. **NOTE: Transmission bolts to engine and oil pan.**

   Position a new oil pan gasket onto oil pan. Lay oil pump screen into oil pan and position oil pan under engine. Install screen and gasket to block. Tighten nut to 40-55 Nm (29-40 lb-ft) and bolts to 20-30 Nm (15-22 lb-ft).

2. Apply Silicone Gasket and Sealant F1AZ-19562-A or equivalent meeting Ford specification WSE-M4G320-A2 in six places, at joints between engine front cover and cylinder block and between rear main bearing cap and engine block.

3. Install oil pan to engine. Tighten bolts to 14-16 Nm (123-141 lb-in).

4. Install separator plate and flywheel. Tighten bolts in standard cross-tightening sequence to 73-87 Nm (54-64 lb-ft).

5. Using Clutch Aligner T74P-7137-K, install clutch disc and pressure plate. Uniformly torque the bolts to

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21-32 Nm (15-24 lb-ft) in sequence. Remove clutch aligner tool.

6. Position transmission under vehicle and raise it into place. Install transmission-to-engine bolts. Tighten to 38-51 Nm (28-38 lb-ft).

7. Raise transmission. Install rear crossmember and transmission support insulator retainers. Tighten nuts to 88-115 Nm (65-85 lb-ft). Remove transmission jack.

8. Connect exhaust bracket to transmission support insulator. Tighten retainers to 88-118 Nm (65-87 lb-ft).

9. Install starter motor and harness bracket retainer. Tighten bolts to 22-28 Nm (16-21 lb-ft).

10. Connect hydraulic clutch hose, transmission harness connectors, and rear HO2S connector.

11. **NOTE: Make sure midship bearing is reinstalled, square to driveshaft. If spacers were removed from under midship bearing bracket, make sure they are reinstalled.**

    Install driveshaft slip yoke into the transmission. Install center support bearing retainers. Tighten them to 37-50 Nm (27-37 lb-ft).

12. Position driveshaft so index mark on rear yoke is in line with index mark on rear axle companion flange. Install and tighten bolts to 88-119 Nm (65-87 lb-ft).

13. Lower vehicle.

14. Position fan shroud, install bolts, and insert oil level indicator. Tighten bolts to 6-8 Nm (52-71 lb-in).

15. Install gearshift lever and tighten nut to 16-24 Nm (12-18 lb-ft). Install gearshift lever boot.

16. If needed, fill clutch reservoir to reservoir step with Ford High Performance DOT 3 Brake Fluid C6AZ-19542-A or DOT 3 equivalent fluid meeting Ford specification ESA-M6C25-A.

17. Raise vehicle.

18. Loosen bleed screw. Have an assistant slowly depress the clutch pedal to floor and hold it there. While pedal is held down, tighten bleed screw.

19. Loosen bleed screw. Have an assistant slowly depress the clutch pedal to floor and hold it there. While pedal is held down, tighten bleed screw. Tighten to 3-5 Nm (27-44 lb-in).

20. Lower vehicle.

21. **NOTE: Hydraulic system should now be fully bled and should properly release clutch. Reservoir must be kept full at all times to make sure there will be no additional introduction of air into system.**

    Refill the clutch reservoir.

22. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms can occur while the powertrain control module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

    Connect the negative battery cable.

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23. Fill crankcase with Super Premium SAE 5W30 Engine Oil XO-5W30-QSP or equivalent meeting Ford specification WSS-M2C153-G.

24. Start engine and check for oil leaks.

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Oil Pan—4 Cylinder 4x4 Ranger, Manual Transmission Only

Description	Tool Number
Clutch Coupling Tool	T88T-70522-A
Three Bar Engine Support	014-00750
Clutch Aligner	T74P-7137-K

Removal

1. Disconnect the battery ground cable.

2. **CAUTION: Be careful not to separate the gearshift lever and transfer case lever boots from the molding.**

   Shift the transmission into neutral and the transfer case into 4L position. Remove the screw retaining the gearshift lever boot (with its molding) from the floor. Slide the boot up and remove the nut from the studded bolt retaining the transmission gearshift lever. Install the nut on the opposite end of the studded bolt to release the bolt from the shifter. Remove the gearshift lever from the transmission and position it out of the way.

3. Remove the two bolts that retain the fan shroud to the radiator. Remove the fan shroud and the engine oil indicator.

4. Disconnect the IAT and MAF sensors from the air inlet tube and PCV clean air tube from the air cleaner. Loosen the air tube hose clamp at the throttle body and disconnect the clamp at the air cleaner. Remove air cleaner and inlet tube assembly.

5. Disconnect the DPFE sensor connector and remove the sensor retaining bolts and remove the sensor from the vehicle.

6. Raise the vehicle on hoist. Refer to Section 00-02 .

7. Remove the bolt retaining the starter harness bracket located at the lower right side of the engine block. Remove the starter motor retaining bolts and position the starter out of the way.

8. Disconnect the hydraulic clutch line from the transmission using Clutch Coupling Tool T88T-70522-A.

9. **NOTE: Make a reference mark on the driveshaft to aid during installation.**

   Remove the front driveshaft retaining bolts from the transfer case yoke. Using mechanics wire or a suitable strap, secure the driveshaft out of the way.

10. **NOTE: Make a reference mark on the driveshaft to aid during installation.**

    Remove the rear driveshaft retaining bolts from the center support and from the transfer case yoke. Using mechanics wire or a suitable strap, secure the driveshaft out of the way.

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11. Remove the large and small bolts that retain the shifter linkage bracket to the transmission extension housing. Position the linkage out of the way.

12. Position a jack stand under the rear of the transfer case.

13. Remove the transmission support insulator nuts and the crossmember retaining bolts. Remove the crossmember from the vehicle.

14. Remove the right transmission insulator retaining bolt and position the exhaust hanger away from the transmission.

15. Loosen the catalytic converter-to-exhaust manifold retaining bolts to allow the engine to tilt rearward when the transmission is lowered. Using a mechanics wire or a suitable strap, position the exhaust as far to the right of the vehicle as possible.

16. Position a transmission jack under the transmission. Secure the transmission with a chain or strap.

17. Remove the jack stand from under the vehicle.

18. Slightly lower the transmission. Disconnect the transfer case motor, backup lamp switch, VSS, and rear HO2S connectors. Disconnect the three harness locator pins, located at the top of the transmission. Position the harness out of the way.

19. Remove the transmission-to-engine retainers, work the transmission off of the locating dowels and slide the transmission rearward. Lower the transmission and transfer case as an assembly from the vehicle.

20. **CAUTION: If the clutch cover and plate are to be reinstalled, the bolts must be removed evenly or permanent damage to the diaphragm spring will occur.**

    NOTE: Check for clutch cover finger height variation before removing the cover. Replace the clutch cover and disk if necessary.

    Mark the assembly position of the clutch pressure plate and cover to the flywheel if installing the original components. Evenly loosen the clutch pressure plate and cover attaching bolts in a star pattern until the clutch pressure plate diaphragm spring is expanded. Remove the bolts, clutch pressure plate and clutch disc from the flywheel.

21. Remove the flywheel retaining bolts and the flywheel. Remove the engine-to-transmission separator plate.

22. Partially lower the vehicle.

23. Remove the left and right engine mount retaining nuts.

24. **NOTE: Two small sections of chain may be required for the engine support hooks to reach the lifting eyes.**

    Position and adjust Rotunda Three Bar Engine Support 014-00750 or equivalent to the vehicle engine compartment and to the engine lifting eyes.

25. **CAUTION: Lift the engine approximately two inches to remove the engine oil pan. Lifting more could cause the engine to contact the body or possibly damage surrounding components.**

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NOTE: To gain access to adjust the three bar engine support, lift and suppport the hood to the full upward position.

Raise the engine with a floor jack using a block of wood to protect the oil pan. Adjust the lift hooks on the three bar engine support while raising the engine, to hold the engine in place. Remove the floor jack from the oil pan.

26. Raise the vehicle. Refer to Section 00-02 .

27. Drain the oil from the engine.

28. Remove the engine oil pan retainers and remove the oil pan from the vehicle. Discard the oil pan gasket.

29. **CAUTION: Prevent engine contamination by using necessary precautions to keep the old sealer or gasket materials from getting into the engine.**

    NOTE: It is extremely important that all old sealer is removed from all joining faces and grooves.

    Thoroughly clean all exposed areas with Metal Surface Cleaner F4AZ-19A536-RA or equivalent meeting Ford specification WSE-M5B392-A.

30. **NOTE: It is extremely important that all parts are wiped down with Extra Strength Spot and Stain Remover B7A-19521-AA after the parts have been cleaned and washed.**

    Thoroughly clean the transmission bell housing area and the rear of the cylinder block. Clean and inspect the oil inlet tube.

Installation

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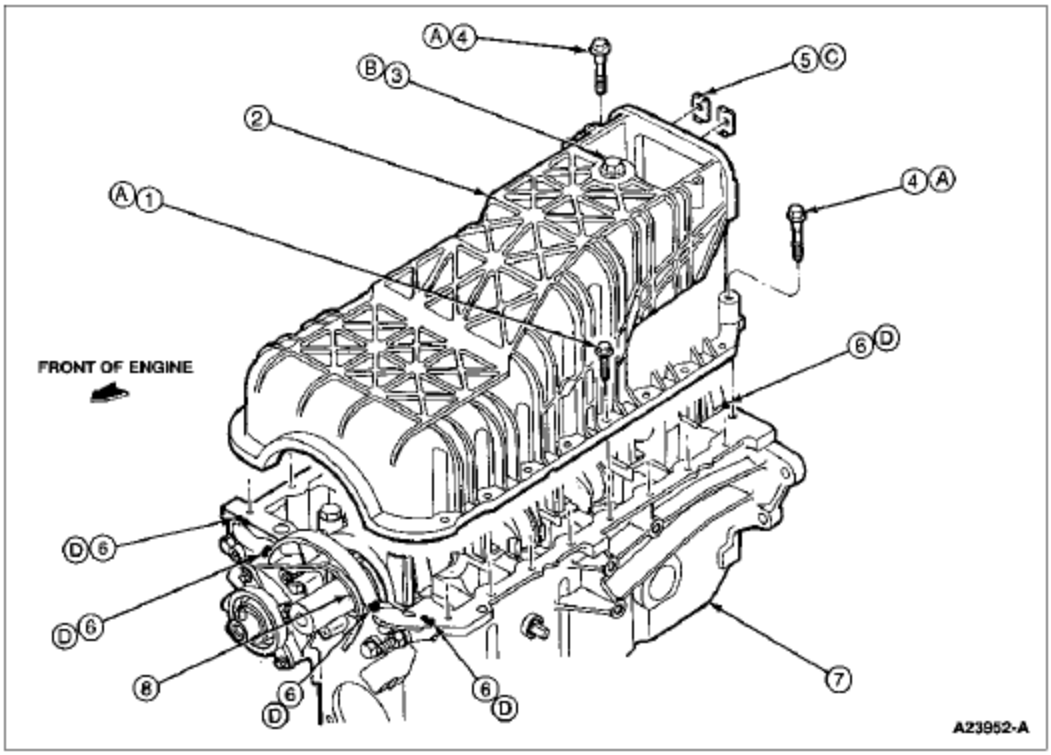

Item	Part Number	Description
1	N806378-S36	Bolt, M6-1 x 27.5 (16 Places)
2	6675	Oil Pan
3	6730	Oil Pan Drain Plug, M8
4	N806379-S36	Bolt, M6-1 x 57.5
5	6C629	Oil Pan Spacer
6	19562	Silicone Gasket and Sealant
7	6010	Cylinder Block
8	6019	Engine Front Cover
A	—	Tighten to 14-16 Nm (123-141 Lb-In)
B	—	Tighten to 20-34 Nm (15-25 Lb-Ft)
C	—	If replacing oil pan or transmission, select according to text.
D	—	Apply in six places shown (left side of rear main cap is hidden)

1. Apply Silicone Gasket and Sealant F1AZ-19562-A or equivalent meeting Ford specification WSE-M4G320-A2 in six places at the joints between the engine front cover and the cylinder block and between the rear main bearing cap and the engine block. Install a new oil pan gasket to the oil pan and position the oil pan to the engine.

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2. **CAUTION: Failure to align the rear face of the oil pan mounting pads to the rear face of the cylinder block can result in oil pan damage and oil leaks.**

   NOTE: If the rear face of the oil pan cannot be aligned within 0.010 inch of rear face of the cylinder block, oil pan spacers must be used.

   Position oil pan to cylinder block. Install the four oil pan retainers tight enough to align bolt holes, but loose enough that oil pan can be pushed rearward. Align rear face of oil pan with rear face of the cylinder block. Install remaining oil pan bolts. Evenly tighten oil pan retainers to 7-10 Nm (62-89 lb-in).

3. Position a straightedge on the rear of cylinder block so it extends over the transmission mounting pads on oil pan. Using a feeler gauge, measure the gap between mounting pads and straightedge. Select and install the required spacer thickness if distance is greater than 0.010 inch.

Measured Gap		Spacer Required		
mm	**inch**	**mm**	**inch**	**Shim Color Code**
0.0 - 0.254	0.0 - 0.010	—	—	—
0.27-0.51	0.011-0.020	0.254	0.010	Yellow
0.52-0.76	0.021-0.030	0.508	0.020	Blue
0.78-1.01	0.031-040	0.762	0.030	Pink

4. Position starter to right side of engine. Install the starter harness bracket and retaining nut. Tighten nut to 20-27 Nm (15-20 lb-in).

5. Partially lower vehicle.

6. Position a floor jack under engine oil pan, using a block of wood to protect the pan. Use floor jack to support engine weight while lowering three bar engine support. Lower and position engine to frame mount studs and remove floor jack. Remove the hood support.

7. Remove three bar engine support.

8. Install left and right engine mount retaining nuts. Tighten nuts 94-125 Nm (69-92 lb-ft).

9. Raise vehicle.

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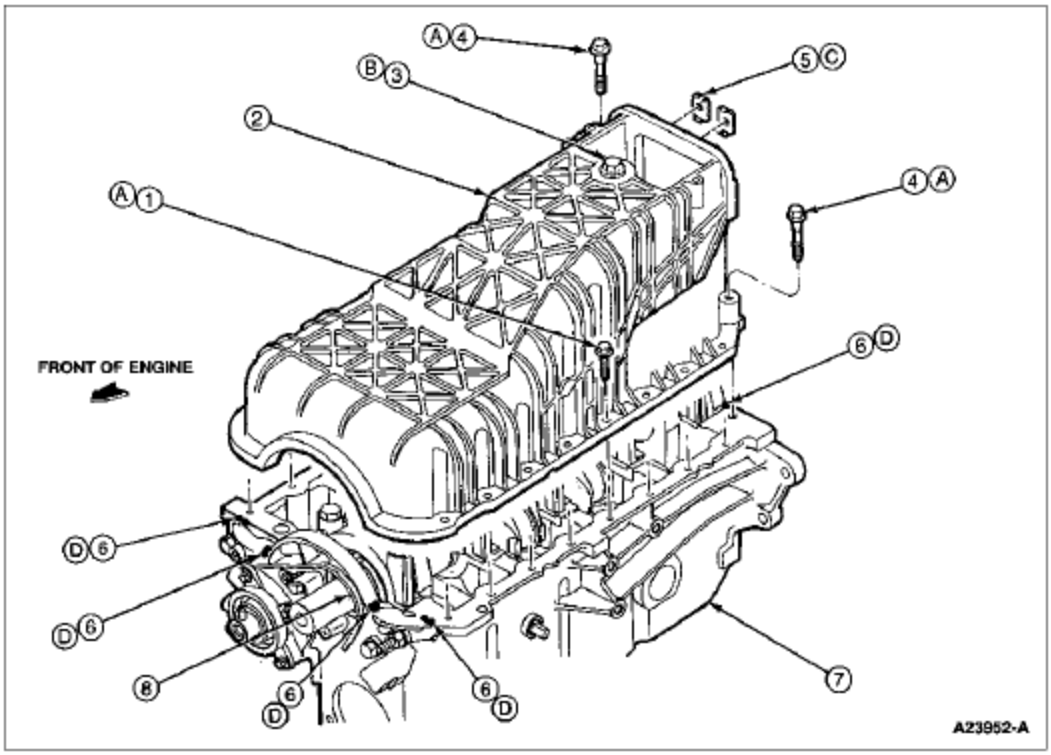

Item	Part Number	Description
1	N806378-S36	Bolt, M6-1 x 27.5 (16 Places)
2	6675	Oil Pan
3	6730	Oil Pan Drain Plug, M8
4	N806379-S36	Bolt, M6-1 x 57.5
5	6C629	Oil Pan Spacer
6	19562	Silicone Gasket and Sealant
7	6010	Cylinder Block
8	6019	Engine Front Cover
A	—	Tighten to 14-16 Nm (123-141 Lb-In)
B	—	Tighten to 20-34 Nm (15-25 Lb-Ft)
C	—	If Replacing Oil Pan or Transmission, Select According to Text
D	—	Apply in Six Places Shown (Left Side of Rear Main Cap Is Hidden)

10. **NOTE: If necessary, pin-punch separator plate at guide pins to retain plate to engine block.**

    Install the separator plate and flywheel. Tighten flywheel retaining bolts in a standard cross-tightening sequence to 73-87 Nm (54-64 lb-ft).

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11. Using Clutch Aligner T74P-7137-K, install clutch disc and pressure plate. Uniformly tighten bolts to 21-32 Nm (15-24 lb-ft) in a standard cross-tightening sequence. Remove clutch aligner tool.

12. Position transmission and transfer case assembly under vehicle and raise them into place. Install transmission-to-engine retaining bolts and tighten to 38-51 Nm (28-38 lb-ft).

13. Connect backup lamp switch, VSS and rear HO2S connectors. Connect three harness locator pins to top of transmission.

14. Position a jack stand under rear of transfer case.

15. Remove transmission jack.

16. Remove mechanics wire or retaining strap from exhaust and position exhaust hanger to right transmission insulator. Install retaining bolt and tighten to 97-118 Nm (72-87 lb-ft).

17. Slightly raise transmission and transfer case assembly. Install rear crossmember, crossmember support retaining bolts and transmission support insulator retaining nuts. Tighten retainers to 88-115 Nm (65-85 lb-ft).

18. Remove jack stand from under transfer case.

19. Install exhaust manifold bolts and tighten to 34-46 Nm (25-34 lb-ft).

20. Install starter bolt and retaining bolts. Tighten bolts to 22-28 Nm (16-21 lb-ft).

21. Connect hydraulic clutch line and transfer case shift motor connector.

22. **NOTE: On extended cab models, make sure the center bearing bracket is installed square to driveshaft. If spacers were removed from under center bearing bracket, make sure they are reinstalled.**

    Install driveshaft. Install center support bearing attaching bolts. Tighten bolts to 37-50 Nm (27-37 lb-ft).

23. **NOTE: Make sure transfer case is in 4L position before installing the shifter linkage.**

    Position shifter linkage bracket to transmission extension housing. Install large and small retaining bolts. Tighten large bolt to 94-122 Nm (69-90 lb-ft) and small bolt to 43-56 Nm (32-41 lb-ft).

24. Position rear of driveshaft to transfer case yoke and install retaining bolts. Tighten bolts to 27-38 Nm (20-28 lb-ft).

25. Lower vehicle.

26. Position fan shroud and install retaining bolts. Tighten bolts to 6-8 Nm (53-71 lb-in). Install the engine oil indicator.

27. Install the DPFE sensor and retaining bolts. Tighten bolts to 2.7-3.7 Nm (24-32 lb-in). Connect harness connector.

28. Install air inlet tube and pushpin to right fender. Connect IAT and MAF sensor connectors and PCV fresh air tube to air cleaner.

29. Install gearshift lever and retaining nut. Tighten nut to 16-24 Nm (12-18 lb-ft). Install gearshift lever

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boot.

30. Fill and bleed hydraulic clutch system.
31. Connect battery ground cable.
32. Fill engine with engine oil.
33. Start engine and check for leaks.

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Oil Pan — Ranger, Automatic Transmission, 4x2

Removal

1. Disconnect battery ground cable. For additional information, refer to Section 14-01 .
2. Remove engine and transmission fluid level indicators.
3. Raise vehicle on hoist. For additional information, refer to Section 00-02 .
4. **NOTE: Make a reference mark on the driveshaft for installation.**

   Remove driveshaft on Ranger SuperCab. Remove driveshaft center bearing bracket.
5. Remove the shift cable from ball stud on transmission and remove cable mount from transmission housing. Disconnect the transmission harness locator from the bracket.
6. Remove the starter cable bracket hold-down and the transmission cooling line bracket from the engine.
7. Remove starter motor and secure aside.
8. Remove torque converter nuts.
9. Disconnect muffler from converter.
10. Raise transmission jack up to transmission to slightly relieve weight from mount and secure. Remove nuts from number three crossmember.
11. Remove crossmember retainers, remove crossmember.
12. Lower transmission jack to gain access to transmission bolts and harness.
13. Disconnect Heated Oxygen Sensors from transmission harness. Remove bolts from converter to manifold.
14. Remove bolt from converter bracket to transmission tail-shaft then remove the converter.
15. Remove both lines from transmission.
16. Disconnect electrical connectors from wiring harness at top of transmission.
17. Remove transmission-to-engine retainers, work the transmission off locating dowels, slide transmission rearward and remove upper filler tube. Lower the transmission from vehicle.
18. Remove flywheel and separator plate.
19. Drain oil from engine.

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20. Remove oil pan bolts and lower pan.

21. Remove oil pump screen and let lay in pan. Slide oil pan back over top of radius arm crossmember and remove.

22. Remove gaskets (06710 and 07E062) and clean oil pan (06675) mating surfaces.

Installation

1. **NOTE: Transmission bolts are bolted to the engine and oil pan when installed. It is necessary to measure the gap between the surface of the rear face of the oil pan (at the spacer locations) and the rear face of the cylinder block.**

   Install new pan gasket, position oil pump screen into oil pan and position assembly in vehicle. Install screen with a new gasket. Tighten nut to 47 Nm (33 lb-ft) and the bolts to 25 Nm (18 lb-ft).

2. Apply Silicone Gasket Sealant F1AZ-19562-A or equivalent meeting Ford specification WSE-M4G320-A2 in six places at joints between engine front cover, cylinder block, rear main bearing cap, and engine block.

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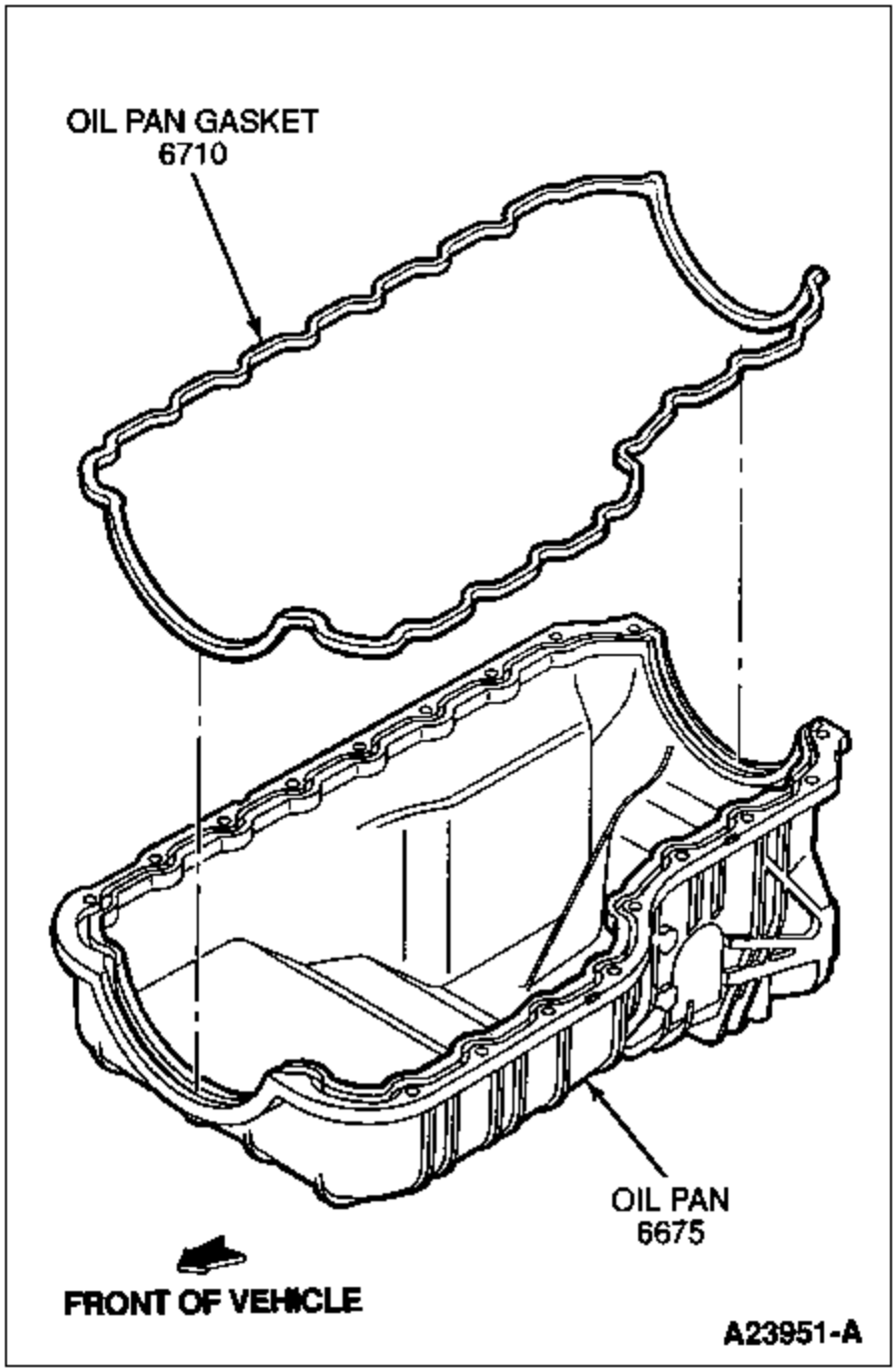

3. Install oil pan to engine. Tighten bolts to 15 Nm (132 lb-in).

4. **CAUTION: Failure to measure the required 1 spacer thickness can result in insufficient, or excessive, clearance between the engine oil pan and the transmission when installed in the vehicle. This can result in oil pan damage and an oil leak.**

   NOTE: If the rear face of the oil pan cannot be aligned within 0.010 inch of the rear face of the cylinder block, the oil pan spacer should be used.

   With the oil pan installed on engine, position a straight edge flat on rear of cylinder block so that it extends over one of oil pan/transmission bolt mounting pads.

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5. Install separator plate and flexplate. Tighten in standard cross-tightening sequence to 78 Nm (58 lb-ft).

6. **CAUTION: Do not allow torque converter to disengage from transmission oil pump gear.**

   NOTE: The torque converter must rest squarely against flexplate. This indicates that the torque converter pilot is not binding against engine crankshaft.

   Position transmission under vehicle and raise into place. Install six lower bolts that attach transmission to engine. Lower transmission down to install filler tube, upper two bolts, and bracket for transmission harness connectors and filler tube. Tighten bolts to 43 Nm (32 lb-ft).

7. Connect two 16 pin connectors from transmission harness to main harness at top of transmission.

8. **NOTE: Case connector fittings should be held with a wrench to prevent them from moving when tightening the tube nuts.**

   Install the transmission cooler lines. Tighten fittings to 39 Nm (28 lb-ft). Install transmission cooler line bracket bolt at lower right side of engine block and tighten securely.

9. Snap shifter cable onto ball stud of transmission lever, install shifter cable bracket. Tighten bolts to 25 Nm (18 lb-ft).

10. Install catalytic converter to manifold bolts. Install rear converter mount to transmission tailshaft. Tighten manifold bolts to 39 Nm (29 lb-ft) and rear mount bolt to 42 Nm (31 lb-ft). Connect Heated Oxygen Sensor connectors front and rear.

11. Raise transmission, install rear crossmember, transmission support insulator attaching nuts. Tighten nuts to 88 Nm (65 lb-ft). Remove transmission jack.

12. Connect muffler to converter. Tighten bolts to 28 Nm (21 lb-ft).

13. Rotate engine clockwise using crankshaft pulley-retaining bolt to install new torque converter nuts. Tighten nuts to 34 Nm (27 lb-ft).

14. Install starter motor and starter harness bracket. Tighten bolts to 22 Nm (16 lb-ft).

15. Position the driveshaft so that the index mark on rear yoke is in line with index mark on rear axle companion flange and install retaining bolts. Tighten bolts to 88-119 Nm (65-88 lb-ft).

16. Lower vehicle.

17. Insert engine and transmission fluid indicators.

18. Connect the battery ground cable.

19. Fill crankcase with correct viscosity and amount of engine oil.

20. Start engine and check for engine oil leaks.

21. Top off transmission fluid.

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Oil Pump Screen, Cover, and Tube

Removal

1. Remove engine (6007) as outlined in this section.
2. Remove oil pan (6675) as outlined in this section.
3. Remove nut, two screws, oil pump screen cover and tube (6622) and oil pump inlet tube gasket (6626).

Installation

1. Throughly clean oil pump screen cover and tube.
2. Clean all mounting surfaces.
3. Install oil pump screen cover and tube and oil pump inlet tube gasket.
4. Install two screws, and nut.
5. Tighten screws to 20-30 Nm (14-22 lb-ft).
6. Tighten nut to 40-55 Nm (30-41 lb-ft).
7. Install oil pan as outlined in this section.
8. Install engine as outlined in this section.

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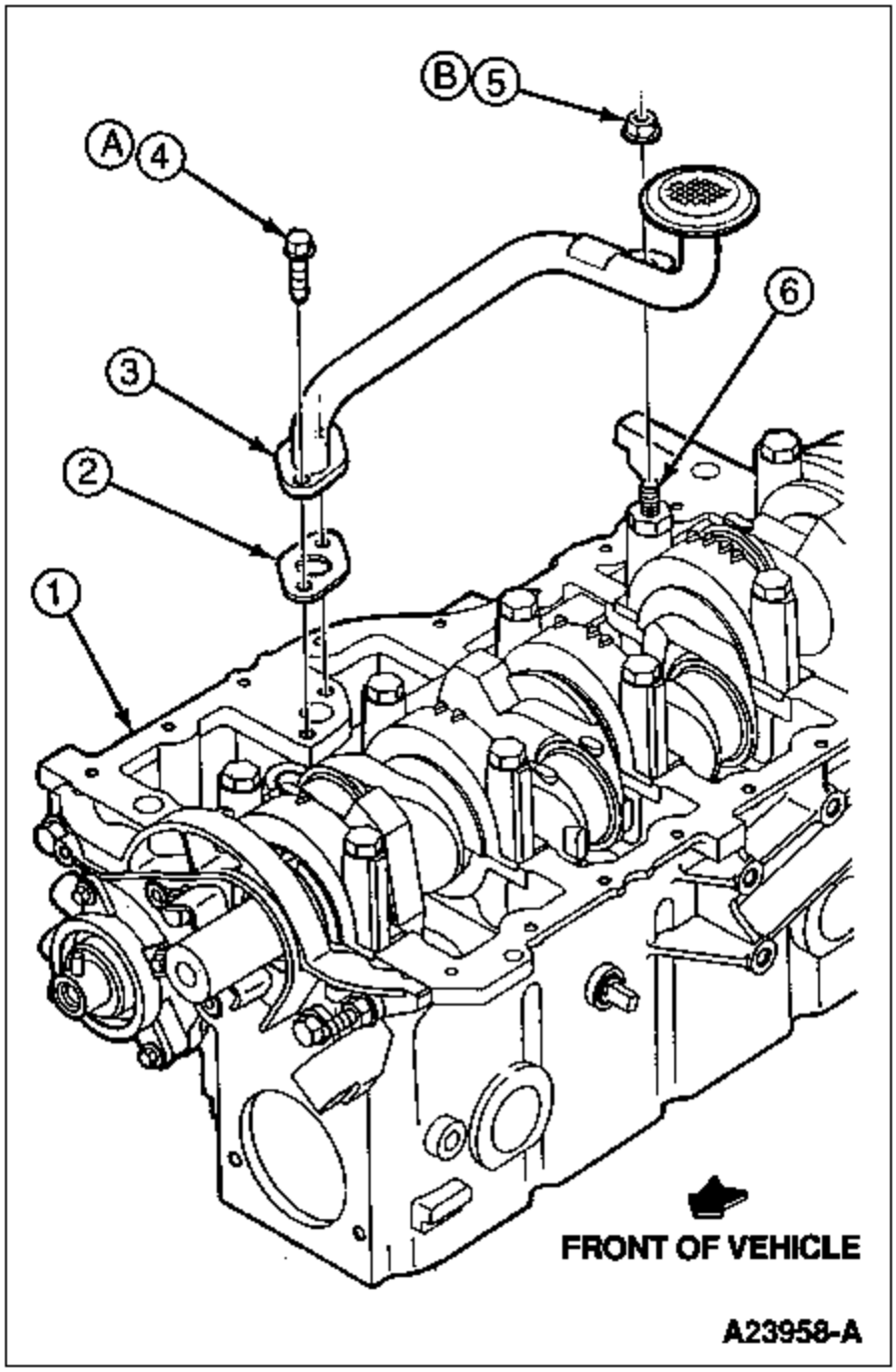

Item	Part Number	Description
1	6010	Cylinder Blocks
2	6626	Oil Pump Inlet Tube Gasket
3	6622	Oil Pump Screen Cover and Tube
4	N605786-S2	Bolt, M8-1.25 x 20
5	N620482-S	Nut, M10-5
6	N803729-S	Bearing Cap Stud

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A	—	Tighten to 20-30 Nm (15-22 Lb-Ft)
B	—	Tighten to 40-55 Nm (29-40 Lb-Ft)

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Crankshaft

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Cam Sprocket Holding/Removing Tool	T74P-6256-B
Front Cover Seal Remover	T74P-6700-B
Cam Bearing Adapter Tube	T72C-6250
Clutch Aligner	T71P-7137-H

Removal

1. Remove engine (6007) as outlined in this section and install on suitable engine stand.
2. If manual transmission, loosen bolts one turn at a time in sequence and remove clutch pressure plate (7563) and clutch disc (7550).
3. **NOTE: Special bolts are used for attaching flywheel to crankshaft. Keep flywheel bolts separate for installation.**

   Remove flywheel-to-crankshaft bolts (6379) and flywheel or flexplate and flywheel reinforcing plate (6A366).
4. Remove engine rear plate (7007).
5. Drain oil from engine.
6. Remove engine oil level dipstick (6750) and oil level indicator tube (6754).
7. Remove crankshaft bolt and washer.
8. Remove crankshaft damper.
9. Remove outer timing belt cover screw, depress tabs, and remove outer timing belt cover.
10. Remove screw retaining crankshaft position sensor (CKP sensor) (6C315). Remove crankshaft position sensor from engine front cover (6019).
11. Loosen timing belt pivot bolt one-half turn.
12. Hold timing belt tensioner with T74P-6254-A Camshaft Belt Tensioner Tool and remove adjusting bolt. Relax tensioner spring.
13. Remove timing belt.
14. Install T74P-6256-B Cam Sprocket Holding/Removing Tool on oil pump sprocket.

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15. Remove oil pump sprocket bolt and washer.
16. Install puller part of T74P-6256-B Cam Sprocket Holding/Removing Tool. Remove oil pump sprocket.
17. Slide crankshaft sprocket (6306) off crankshaft (6303).
18. Remove inner timing belt cover.
19. Remove oil pan screws and oil pan (6675).
20. Remove oil pan gasket (6710).
21. Rotate engine on stand so crankshaft is up.
22. Remove two bolts and nut and remove oil pump screen cover and tube (6622).
23. Using T74P-6700-B Front Cover Seal Remover, remove front cover oil seal as outlined in this section.
24. Remove bolts and front engine cover.
25. Make sure connecting rod caps are marked so each cap can be kept with each rod.
26. Remove connecting rod nuts and four caps.
27. **NOTE: Each main bearing cap, except rear cap, is marked with arrows pointing to the front of the engine. The number of arrows corresponds to the number of the main bearing cap. For example, one arrow for the front cap, two arrows for the number two cap.**

    Remove bolts and main bearing caps.
28. Lift out crankshaft. Crankshaft rear oil seal (6701) will come out with crankshaft. Remove seal from crankshaft.
29. Inspect bearings and replace as necessary. Inspect crankshaft as outlined in Section 03-00 and recondition or replace as necessary.

Installation

CAUTION: Lubricate parts with Motorcraft Super Premium Motor Oil XO-5W30-QSP or equivalent meeting Ford specification ESE-M2C153-E during assembly to prevent a dry start and engine damage.

1. If removed, install upper crankshaft bearings. If reusing bearings, reinstall each bearing in the same place from which it was removed.
2. Install crankshaft.
3. If removed, install bearings in main bearing caps. If reusing bearings, install bearing in same place from which it was removed.
4. Apply Plastigage® to crankshaft bearing journals.

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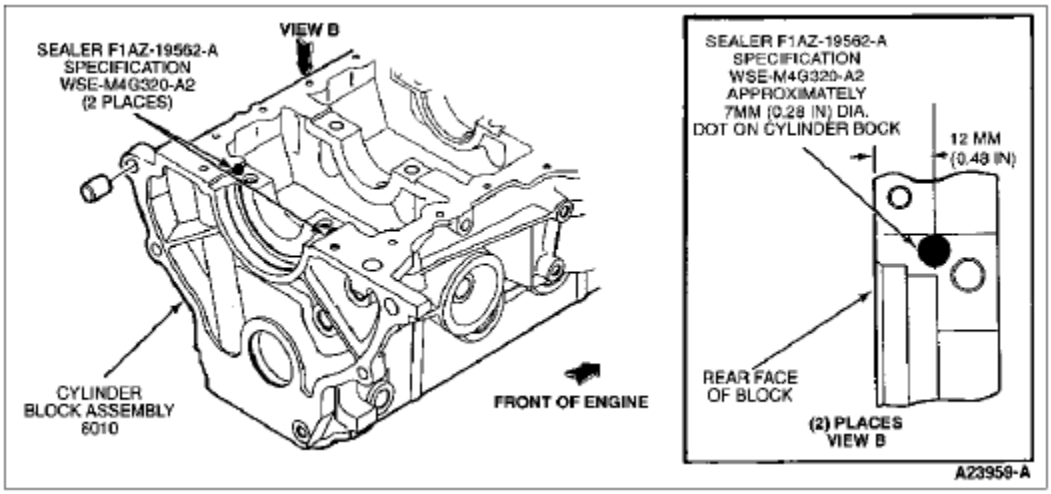
5. Install main bearing caps and bolts. Alternately tighten bolts to 68-81 Nm (50-60 lb-ft). Retighten to 108-122 Nm (80-90 lb-ft).

6. Remove caps. Check Plastigage® for bearing clearance using chart on package. If OK, go on to next step. If not, correct clearance.

7. Apply a 7mm (0.47-inch) dot of Silicone Gasket and Sealant F1AZ-19562-A, or equivalent meeting Ford specification WSE-M4G320-A2 on each side of cylinder blocks (6010) as shown in illustration. No sealer allowed on inside diameter of seal lip.

Rear Main Bearing Cap Sending



8. Lubricate bearings and reinstall main bearing caps and bolts.

9. Alternately tighten main bearing bolts to 68-81 Nm (50-60 lb-ft). Retighten to 102-115 Nm (75-85 lb-ft).

10. Check crankshaft end play as outlined in Section 03-00 .

11. Install piston and rod assemblies to crankshaft. For each assembly:

    a. Put piece of hose or other protector over connecting rod bolts (6214) to protect crankshaft journal.
    b. Rotate crankshaft so journal for piston to be installed is at bottom of stroke.
    c. Push piston and rod assembly into place guiding rod bolts around crankshaft journal.
    d. Insert connecting rod bearings (6211) in connecting rod end cap.
    e. Finish pushing piston and rod assembly into place.
    f. Apply Plastigage® to bearing journal.
    g. Install connecting rod cap and alternately tighten connecting rod nuts to 34-41 Nm (25-30 lb-ft). Then retighten to final torque of 41-49 Nm (30-36 lb-ft).
    h. Remove cap and check bearing clearance with chart on Plastigage® package.
    i. If all right, lubricate connecting rod bearings and reinstall cap.
    j. Alternately tighten connecting rod nuts to 34-41 Nm (25-30 lb-ft). Then retighten to final torque of 41-49 Nm (30-36 lb-ft).
    k. Repeat for remaining piston and connecting rod assemblies.

12. Using Cam Bearing Adapter Tube T72C-6250 and crankshaft damper bolt, press crankshaft front seal

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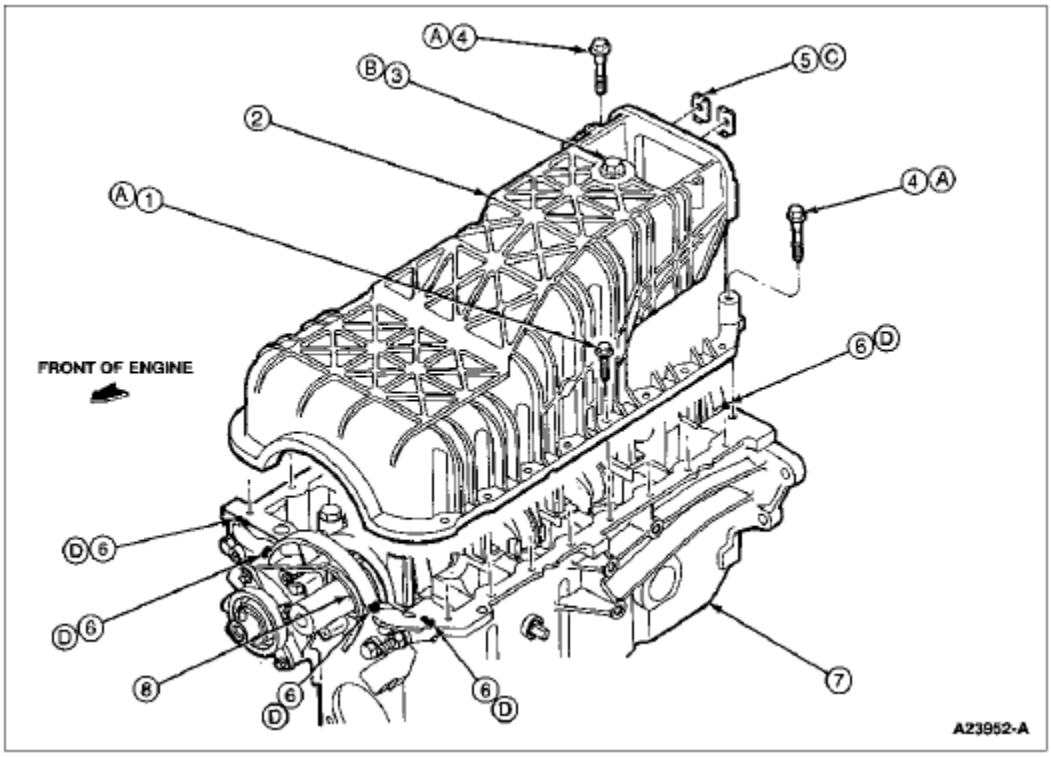
(6700) into place in engine front cover.

13. Install oil pump screen cover and tube. Tighten bolts to 20-30 Nm (15-22 lb-ft). Tighten pickup tube-to-main bearing cap nuts to 40-55 Nm (30-40 lb-ft).

14. Apply a small amount of Silicone Gasket and Sealant F1AZ-19562-A, or equivalent meeting Ford specification WSE-M4G320-A2 at joints between front engine cover and cylinder blocks and rear main cap and cylinder blocks as shown.

Oil Pan



Item	Part Number	Description
1	N806378-S36	Bolt, M6-1 x 27.5 (16 Places)
2	6675	Oil Pan
3	6730	Oil Pan Drain Plug, M8
4	N806379-S36	Bolt, M6-1 x 57.5
5	6C629	Oil Pan Spacer
6	19562	Silicone Gasket and Sealant
7	6010	Cylinder Blocks
8	6019	Engine Front Cover

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A	—	Tighten to 14-16 Nm (123-141 Lb-In)
B	—	Tighten to 20-34 Nm (15-25 Lb-Ft)
C	—	If Replacing Oil Pan or Transmission, Select According to Text
D	—	Apply in Six Places Shown (Left Side of Rear Main Cap Is Hidden)

15. Press new oil pan gasket into groove in oil pan and install oil pan. Tighten screws to 13-16 Nm (10-12 lb-ft).

16. **CAUTION: If oil pan was not replaced make sure any spacers on the oil pan-to-transmission holes are in place. If replaced, make sure any spacers necessary in installation or engine assembly procedure are in place. If clearance between the engine oil pan and transmission is insufficient, or excessive, oil pan damage or oil leakage can occur when pan-to-transmission bolts are tightened.**

    If oil pan was replaced:

    a. Position a straightedge flat on the rear of the engine block so that it extends over the oil pan-to-transmission mounting bolt pads.
    b. Measure the gap between the mounting pad and the straightedge using a feeler gauge. Select spacers of the required thickness from chart. If pan cannot be brought into specifications of 0-0.254mm (0-0.009 in.) with spacers, replace oil pan.

SPACER SELECTION CHART

Measured Gap		Spacer Required		
mm	**Inch**	**mm**	**Inch**	**Shim Color Code**
0.0-0.254	0.0-0.010	None	None	—
0.27-0.51	0.011-0.020	0.254	0.010	Yellow
0.52-0.76	0.021-0.030	0.508	0.020	Blue
0.78-1.01	0.031-0.040	0.762	0.030	Pink

17. Install inner timing belt cover.

18. Install inner timing belt cover screw and nut and tighten to 8-11 Nm (71-97 lb-in). Install stud nut to inner timing belt cover and cylinder head and tighten to 20-30 Nm (15-22 lb-ft).

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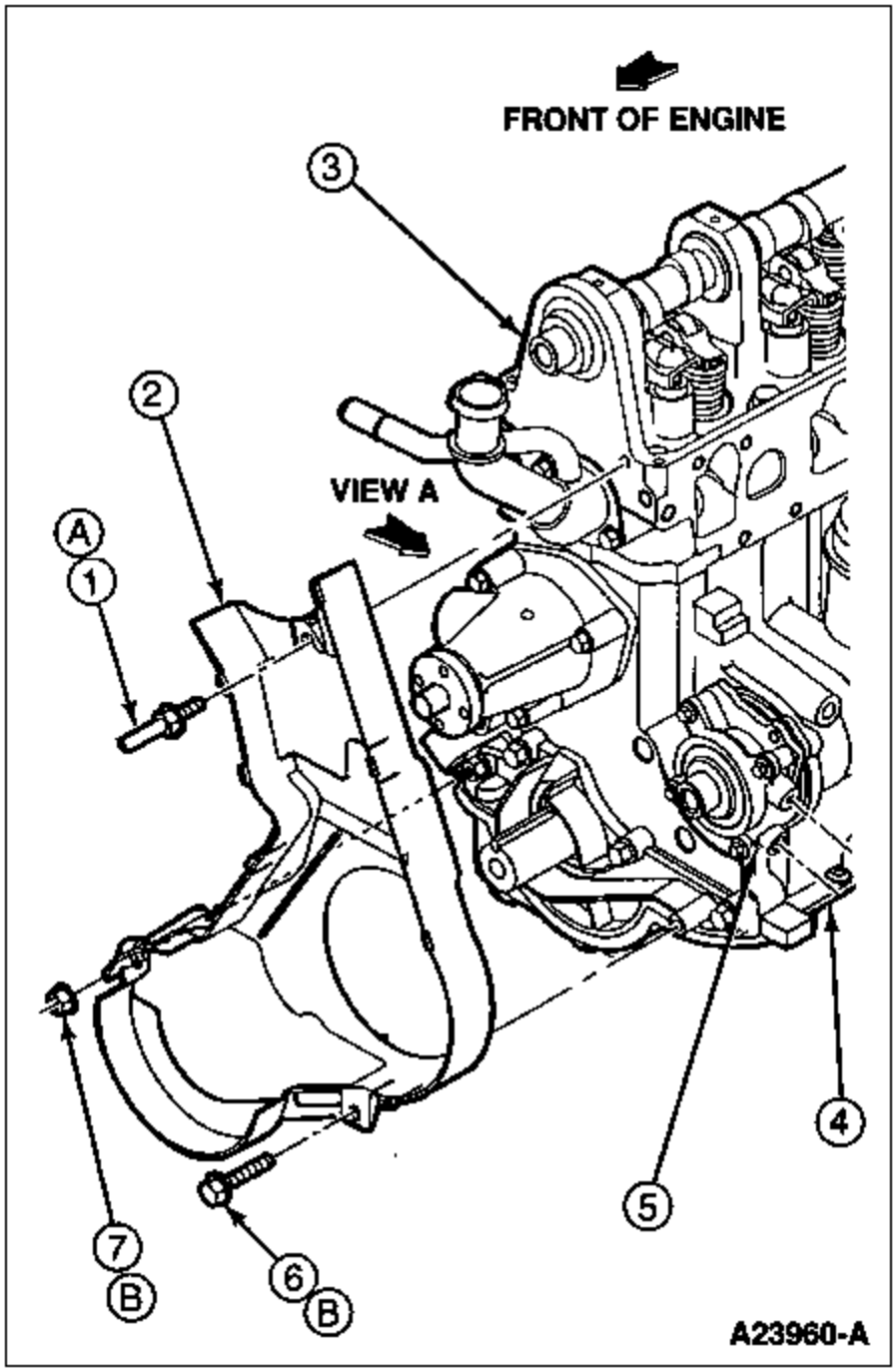

Item	Part Number	Description
1	N808049-S102	Stud, M8-1.25 x 51
2	6E005	Inner Timing Belt Cover
3	6049	Cylinder Head
4	6010	Cylinder Blocks
5	6600	Oil Pump
6	N804958-S8	Bolt, M6-1 x 22.5

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7	N621906-S2	Nut, M6-1
A	—	Tighten to 20-30 Nm (15-22 Lb-Ft)
B	—	Tighten to 8-12 Nm (71-106 Lb-In)

19. Slide crankshaft sprocket onto crankshaft. Recess goes toward cylinder blocks.

20. Apply Threadlock 262 E2FZ-19554-B or equivalent meeting Ford specification WSK-M2G351-A6 to camshaft bolt threads. Install bolt and washer finger-tight.

21. Install Cam Sprocket Holding/Removing Tool T79P-6256-B on sprocket. Tighten camshaft bolt to 70-95 Nm (52-70 lb-ft). Remove tool.

22. Install oil pump sprocket.

23. Install oil pump sprocket bolt and washer finger-tight.

24. Prime oil pump.

25. Install Cam Sprocket Holding/Removing Tool T74P-6256-B on sprocket. Tighten bolt to 40-55 Nm (30-40 lb-ft). Remove tool.

26. Install and adjust timing belt as outlined in this section.

27. Install crankshaft position sensor (CKP sensor) (6C351) and tighten bolt to 8-12 Nm (71-106 lb-in).

28. Install outer timing belt cover. Snap tabs into slot. Install screw and tighten to 8-12 Nm (70-106 lb-in).

29. Install crankshaft pulley (6312), and washer. Tighten bolt to 125-165 Nm (93-121 lb-ft).

30. Connect retaining clip for crankshaft position sensor lead.

31. Remove engine from engine stand.

32. Install crankshaft rear oil seal using T82L-6701-A Crankshaft Seal Installer.

33. Position engine rear plate.

34. Install flywheel or flexplate and flywheel reinforcing plate. Tighten special flywheel-to-crankshaft bolts to 73-87 Nm (54-64 lb-ft).

35. If equipped, install clutch disc and clutch pressure plate and tighten bolts finger-tight.

36. Install Clutch Aligner T71P-7137-H aligning clutch disc to transmission input shaft pilot bearing (7118).

37. **CAUTION: Clutch pressure plate bolts must be tightened one or two turns at a time in sequence or pressure plate will be bent causing faulty clutch operation.**

    Tighten clutch pressure plate bolts in a criss-cross pattern one or two turns at a time. Tighten pressure plate bolts 21-32 Nm (15-24 lb-ft).

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38. Remove clutch alignment tool.

39. Install engine as outlined in this section.

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Crankshaft Main Bearings

Removal

NOTE: The main bearing inserts are a precision selective fit. To check bearing clearances or to select fit a new bearing, refer to Section 03-00 .

1. Remove engine (6007) as outlined in this section.
2. Remove oil pan (6675) as outlined in this section.
3. Remove oil pump screen cover and tube (6622) as outlined in this section.
4. **NOTE: Replace one bearing at a time, leaving the other bearings securely fastened.**

   Remove main bearing cap to which new bearings are to be installed.
5. Remove bearing from cap.
6. Press on end of upper bearing without tang to start it out.
7. Rotate bearing out from between crankshaft (6303) and cylinder blocks (6010).

Installation

1. Place lubricated, upper bearing on crankshaft and rotate into place.
2. Place lower bearing into cap.
3. Apply Plastigage® to crankshaft bearing journal.
4. Install bearing cap.
5. Lightly oil main bearing bolt or stud. Alternately tighten to 68-81 Nm (50-60 lb-ft). Retighten to 108-122 Nm (80-89 lb-ft).
6. Remove main bearing cap.
7. Check Plastigage® for bearing clearance using chart on package. Clearance should be 0.010-0.056mm (0.0004-0.0022 inch) for front main bearing or 0.020-0.066mm (0.0008-0.0026 inch) for bearings 2-5.
8. If clearance is OK, lubricate bearings with Super Premium Motor Oil X0-5W30-QSP or equivalent meeting Ford specification ESE-M2C153-E and reinstall cap.
9. Apply a 7mm (0.27-inch) dot of Silicone Gasket and Sealant F1AZ-19562-A, or equivalent meeting Ford specification WSE-M4G320-A2 on each side of cylinder blocks as shown in illustration before installing the No. 5 cap.

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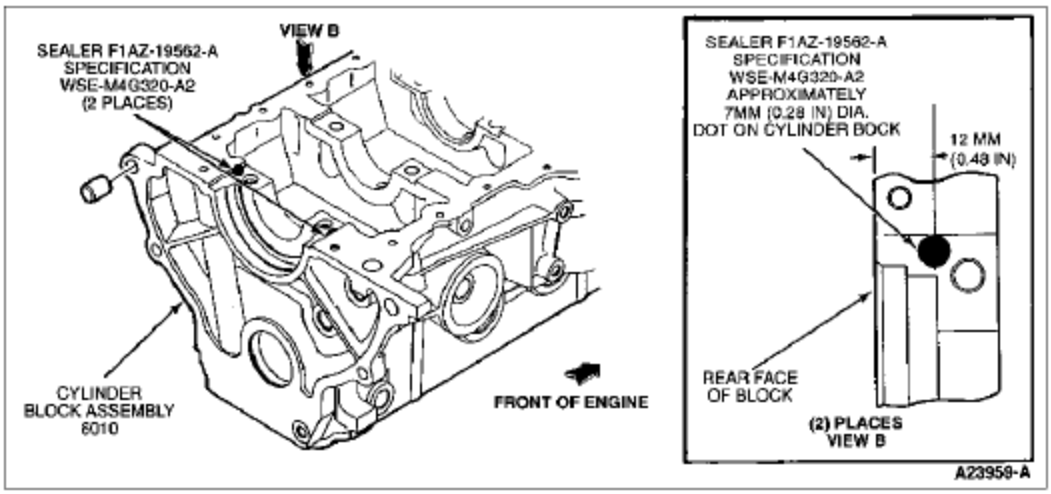
Rear Main Bearing Cap Area Sealing



10. Alternately tighten bolts or stud to 68-81 Nm (50-60 lb-ft). Retighten to 102-115 Nm (75-84 lb-ft).
11. Check crankshaft end play as outlined in Section 03-00 .
12. Install oil pump screen cover and tube as outlined in this section.
13. Install oil pan as outlined in this section.
14. Install engine as outlined in this section.

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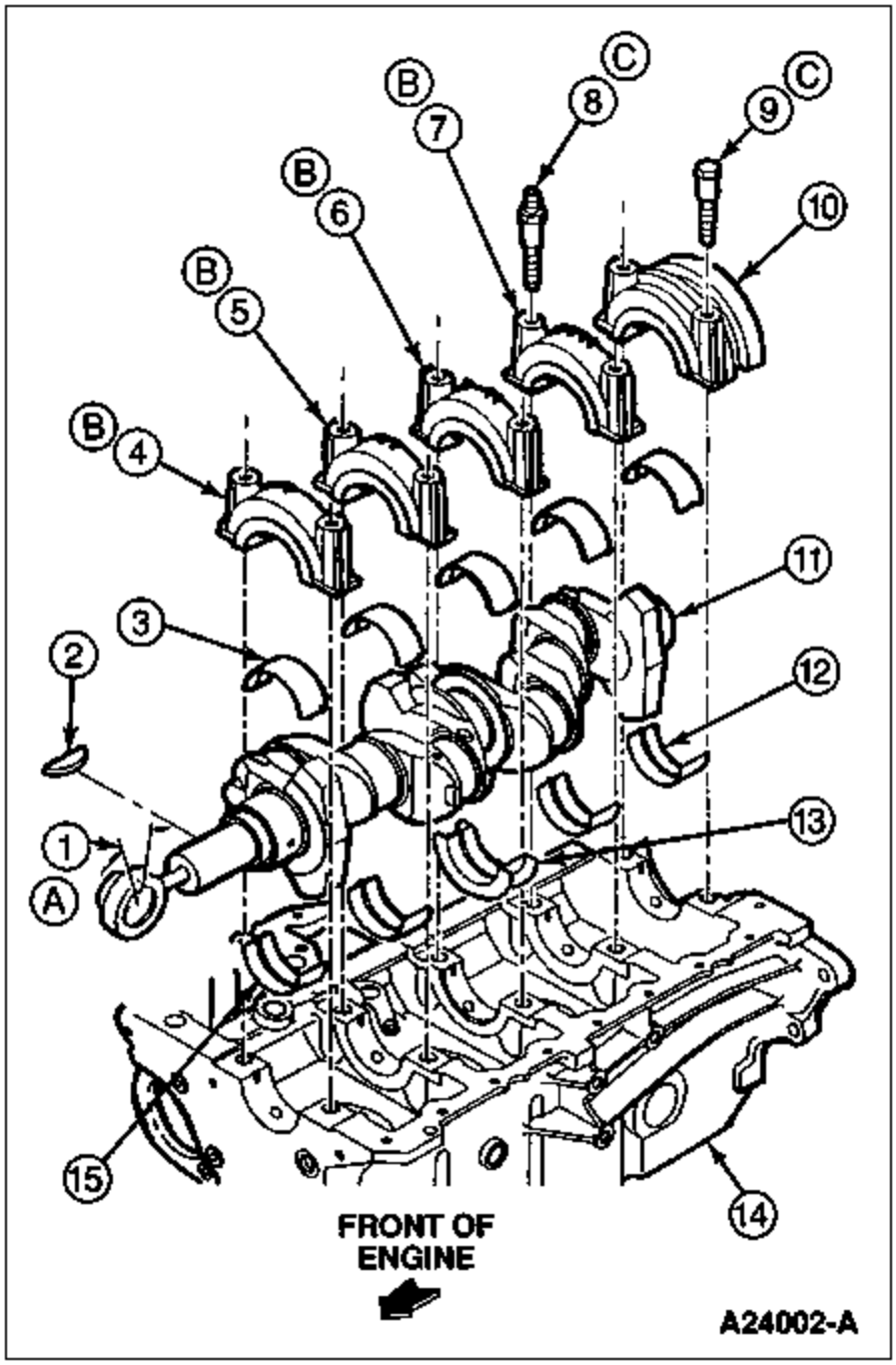

Item	Part Number	Description
1	D78P-4201-G	Dial Indicator
2	6B316	Crankshaft Key
3	6A338	Lower Main Bearing (5 Places)
4	—	Front Main Bearing Cap (Part of 6010)

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5	—	Front Intermediate Main Bearing Cap (Part of 6010)
6	—	Center Main Bearing Cap (Part of 6010)
7	—	Rear Intermediate Main Bearing Cap (Part of 6010)
8	N803729-S	Stud, M10-1.5 x M12-1.75 x 108.5 (1 Place)
9	N807497-S2	Bolt, M12-1.75 x 80
10	—	Rear Main Bearing Cap (Part of 6010)
11	6303	Crankshaft
12	6333	Crankshaft Main Bearing, Upper (3 Places)
13	6337	Crankshaft Thrust Main Bearing
14	6010	Cylinder Blocks
15	6333	Crankshaft Main Bearing, Upper (Color Code Blue — Number One Journal Only)
A	—	Crankshaft End Play 0.07-0.20mm (0.002-0.007 Inch)
B	—	Assemble with Arrow Pointing Forward. Marked with 1 to 4 Arrows Front-to-Rear
C	—	Tighten According to Procedure in Text

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Pistons and Connecting Rods

Removal

1. Remove engine (6007) as outlined in this section, and install on engine stand.
2. Remove oil pan (6675) as outlined in this section.
3. Remove oil pump screen cover and tube (6622) as outlined in this section.
4. Remove cylinder head (6049) as outlined in this section.
5. **CAUTION: Never cut into the ring travel area in excess of 0.8mm (1/32 inch) when removing ridges.**

   Remove any ridges and/or deposits from the upper end of the cylinder bores as follows.

   Turn the crankshaft until the piston to be removed is at the bottom of its travel and place a cloth on the piston head to collect the cuttings. Remove any ridge and/or deposits from the upper end of the cylinder bores. Remove the cylinder ridge with a ridge cutter. Follow the instructions furnished by the tool manufacturers.
6. Make sure all connecting rod caps are marked so that they can be installed in their original positions.
7. Turn the crankshaft until the connecting rod being removed is down.
8. Remove the connecting rod nuts and caps.
9. **CAUTION: Avoid damage to the crankshaft journal or the cylinder wall when removing the piston and rod.**

   Push the connecting rod and piston assembly out the top of the cylinder with the handle end of a hammer.
10. Remove the bearing inserts from the connecting rod (6200) and cap.
11. Select the proper bore gauge and micrometer. Measure the cylinder bore for out of round and taper as outlined in Section 03-00 . Deglaze cylinder bore as outlined in Section 03-00 .
12. Remove rings and clean ring grooves. Clean carbon from piston, pin and ring (6102).
13. Check ring gaps using the procedure given in Section 03-00 .
14. **NOTE: Never install compression rings on pistons by hand. Always use a ring expander tool.**

    Install rings using a ring expander tool. Check ring side clearance.
15. Clean crankshaft journals.

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16. If necessary, disassemble piston and rod assemblies as outlined in this section.

17. Clean gasket surfaces and fasteners.

Installation

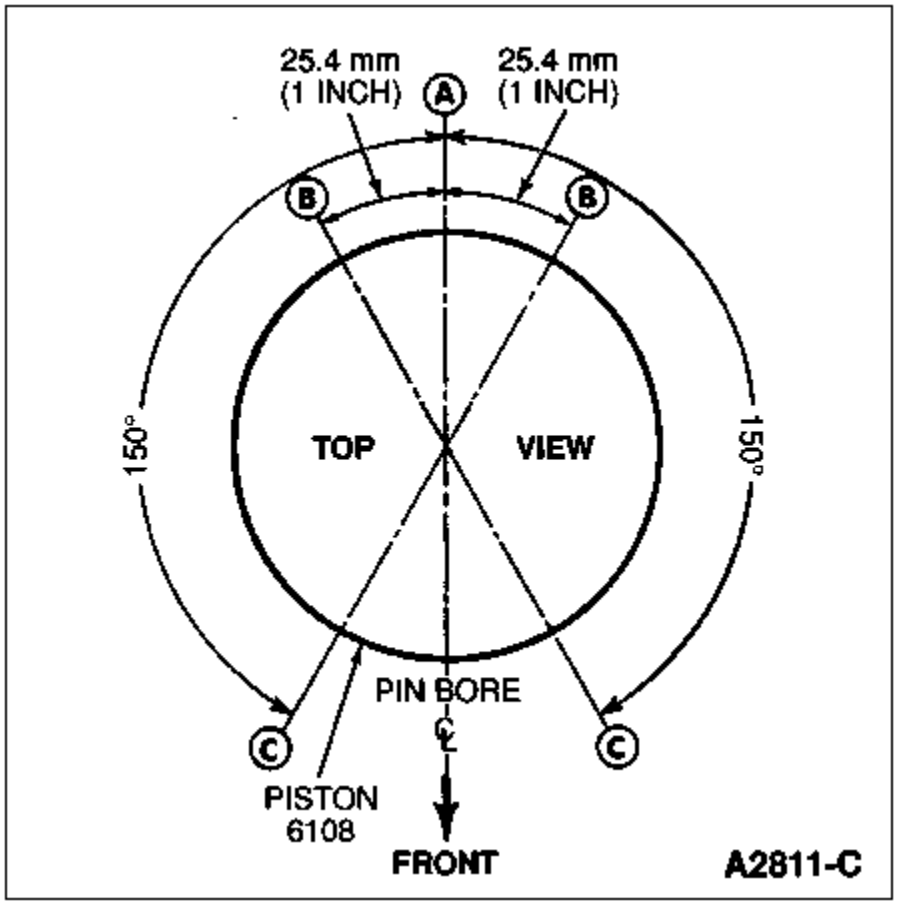
1. If disassembled, assemble piston and connecting rod assembly as outlined in this section.

2. Refer to Pistons, Piston Pins, and Piston Rings in Section 03-00 for Cleaning, Inspection, Pistons — Fitting, and Piston Rings — Fitting.

3. If necessary install piston and pin on connecting rod as outlined in this section.

4. Using a piston ring expander, install the piston rings, starting with the oil control rings. Make sure rings are installed right side up. Refer to instructions with piston ring set.

5. Rotate the rings so the end gaps are NOT lined up but are spaced properly as shown.



6. Check the ring side clearance as outlined in Section 03-00 . Side clearance for both compression rings should be 0.041-0.084mm (0.016-0.0033 inch) and snug fit for the oil control ring.

7. Put a piece of hose or other protector over connecting rod bolt (6214) to protect crankshaft journal.

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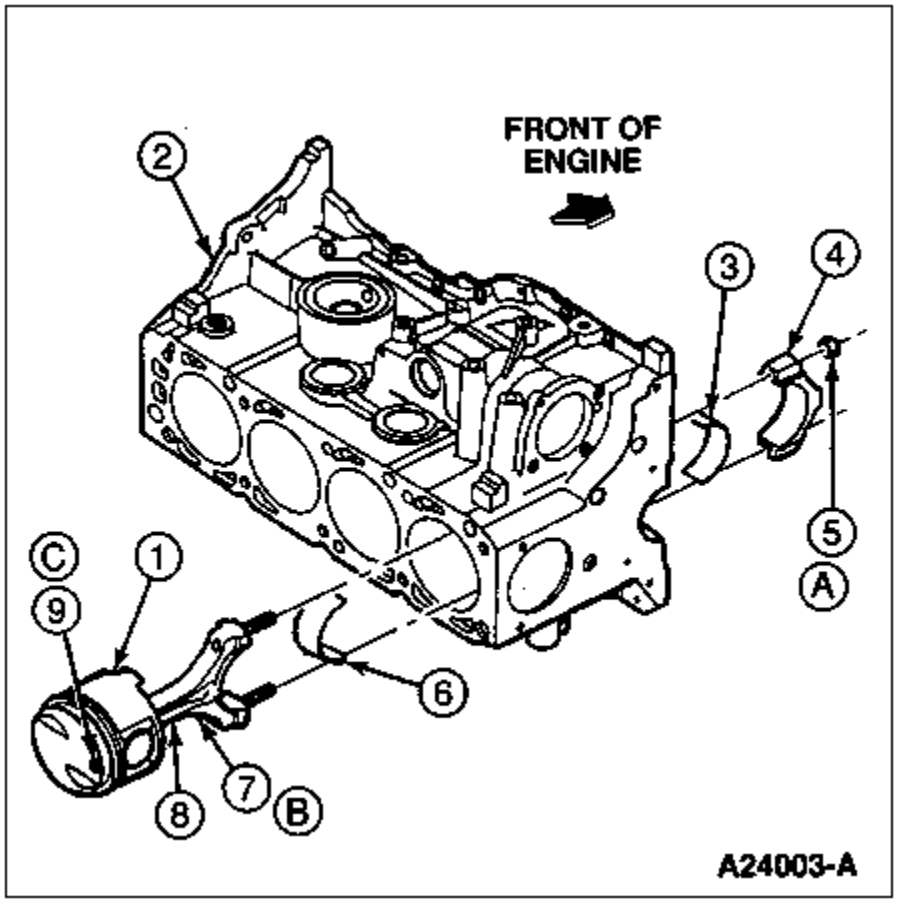
8. Rotate crankshaft (6303) so journal for piston (6108) to be installed is at the bottom of its stroke.

9. **CAUTION: Install the piston, pin and ring with the indentation notch in the piston head toward the front of the engine.**

   Apply motor oil to piston and cylinder bore and start piston and rod assembly into cylinder guiding bolts around crankshaft journal.



Item	Part Number	Description
1	6100	Piston
2	6010	Cylinder Blocks
3	6211	Connecting Rod Bearing, Lower
4	—	Connecting Rod Cap (Part of 6205)
5	N800113-S	Nut, M9-1
6	6211	Connecting Rod Bearing, Upper
7	—	Squirt Hole (Part of 6205)
8	6205	Connecting Rod

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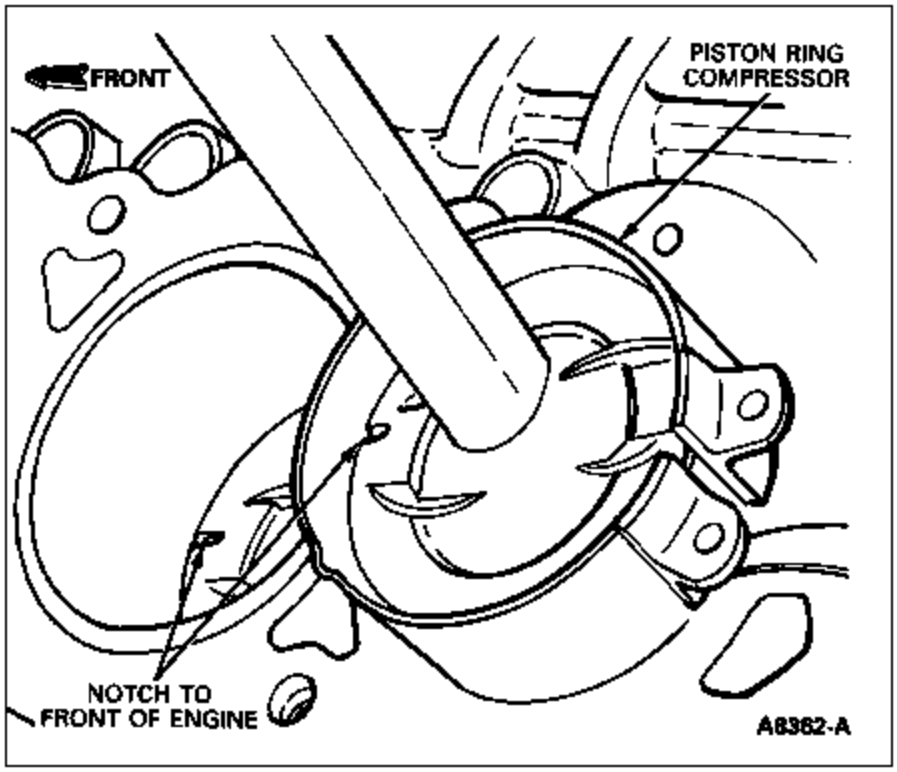
9	—	Notch (Part of 6100)
A	—	Tighten According to Procedure in Text
B	—	Squirt Hole Faces Away from Oil Pump
C	—	Notch Goes Toward Front of Engine

10. Compress piston rings using suitable piston ring compressor.

11. Tap piston assembly into place using bottom of hammer handle.



12. Insert bearings in connecting rod and cap.

13. Apply Plastigage® to bearing journal. Refer to Section 03-00 .

14. Install connecting rod cap. Hand-start each connecting rod nut until flush with end of rod bolt. Alternately tighten connecting rod nuts to 34-41 Nm (25-30 lb-ft). Then retighten to final torque of 41-49 Nm (30-36 lb-ft).

15. Remove cap and check bearing clearance with chart on Plastigage® package.

16. Lubricate connecting rod bearings (6211) with Super Premium Motor Oil XO-5W30-05P or equivalent meeting Ford specification ESE-M2C153-E.

17. Reinstall connecting rod cap.

18. Alternately tighten connecting rod nuts to 34-41 Nm (25-30 lb-ft). Then retighten to final torque of 41-49 Nm (30-36 lb-ft).

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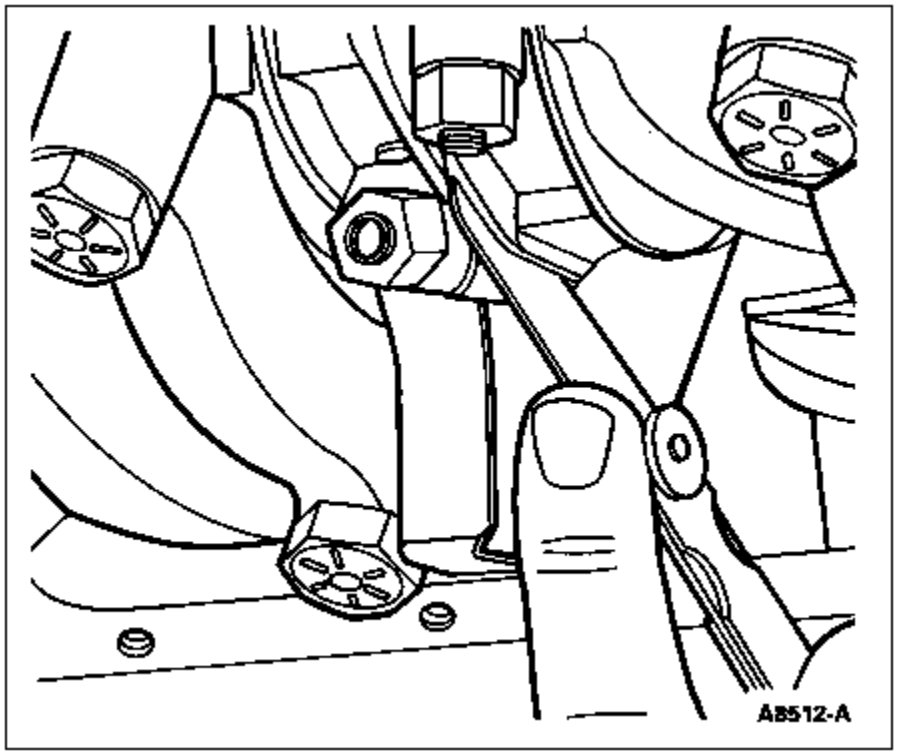
19. Check side clearance. Side clearance should be 0.09-0.29mm (0.0035-0.0115 inch).



20. Repeat for other piston and rod assemblies as needed.
21. Install cylinder head as outlined in this section.
22. Install oil pump screen cover and tube as outlined in this section.
23. Install oil pan as outlined in this section.
24. Install engine as outlined in this section.

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Connecting Rod Bearings

Removal

1. Remove engine (6007) as outlined in this section, and install on engine stand.
2. Remove spark plug (12405) of cylinder where bearing is to be replaced.
3. Remove oil pan (6675) as outlined in this section.
4. Rotate engine so it is upside down and remove oil pump screen cover and tube (6622) as outlined in this section.
5. Rotate crankshaft (6303) until connecting rod in which bearing is to be replaced is at the bottom of its stroke.
6. Remove two connecting rod nuts.
7. Remove connecting rod cap.
8. Push piston and connecting rod assembly up into bore.
9. Remove bearing insert from connecting rod.
10. Remove bearing insert from connecting rod cap.
11. Inspect connecting rod bearings (6211) as outlined in Section 03-00 .
12. Inspect journal and measure for taper and out-of-round as outlined in Section 03-00 .

    Out-of-round should be less than 0.01524mm (0.0006 inch). Taper should be less than 0.06mm per centimeter of length (0.006 inch per inch of length).
13. Inspect connecting rod bearing bore, measure for out-of-round and taper. Maximum out-of-round is 0.0120mm (0.0004 inch). Maximum taper is 0.0102mm (0.0004 inch).
14. Thoroughly clean bearing bore of connecting rod and cap.

Installation

1. Make sure bearing bore of connecting rod and cap and bearing journal are clean.
2. Insert upper bearing insert into connecting rod.
3. Insert lower bearing insert into connecting rod cap.
4. Apply Plastigage® to bearing journal. Refer to Section 03-00 .
5. **NOTE: Do not scratch journal with connecting rod bolts.**

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Carefully pull up piston and connecting rod assembly into place on crankshaft.

6. Install connecting rod cap. Hand-start each connecting rod nut until flush with end of rod bolt. Alternately tighten connecting rod nuts (6212) to 34-41 Nm (25-30 lb-ft). Then retighten to final torque of 41-49 Nm (30-36 lb-ft).
7. Remove cap and check bearing clearance.
8. Lubricate connecting rod bearings with Motorcraft Super Premium Motor Oil XO-5W30-QSP or equivalent 5W30 motor oil meeting Ford specification ESG-M2C153-E.
9. Install connecting rod cap.
10. Hand start connecting rod nuts until nuts are flush with ends of connecting rod bolts.
11. Alternately tighten connecting rod nuts to 34-41 Nm (25-30 lb-ft). Then alternately tighten again to final torque of 41-49 Nm (30-36 lb-ft).
12. Install oil pump screen cover and tube as outlined in this section.
13. Install oil pan as outlined in this section.
14. Install spark plugs.
15. Install engine as outlined in this section.

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Engine

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Cam Sprocket Holding/Removing Tool	T74P-6256-B
Front Cover Seal Remover	T74P-6700-B
Cam Bearing Adapter Tube	T72C-6250
Front Seal Replacer	T74P-6150-A
Crankshaft Seal Installer	T82L-6701-A
Clutch Aligner	T71P-7137-H

Disassembly

1. Remove engine (6007) as outlined in this section and install on suitable stand.
2. If manual transmission, loosen bolts one turn at a time and remove clutch pressure plate (7563) and clutch disc (7550).
3. **CAUTION: Special bolts are used for attaching flywheel to crankshaft (6303). Keep flywheel-to-crankshaft bolts (6379) separate for installation.**

   Remove bolts and flywheel or flexplate and reinforcement.
4. Remove engine rear plate (7007).
5. Drain oil from engine.
6. Remove oil filter.
7. Disconnect EGR transducer electrical connector.
8. Apply Penetrating Lubricant E8AZ-19A501-B or equivalent to EGR valve to exhaust manifold tube (9D477) nuts. Loosen nuts and remove EGR valve to exhaust manifold tube.
9. Remove two nuts and rear engine lifting eye.
10. Remove exhaust manifold bolts and studs and exhaust manifold (9430).
11. Remove right engine mount bracket.

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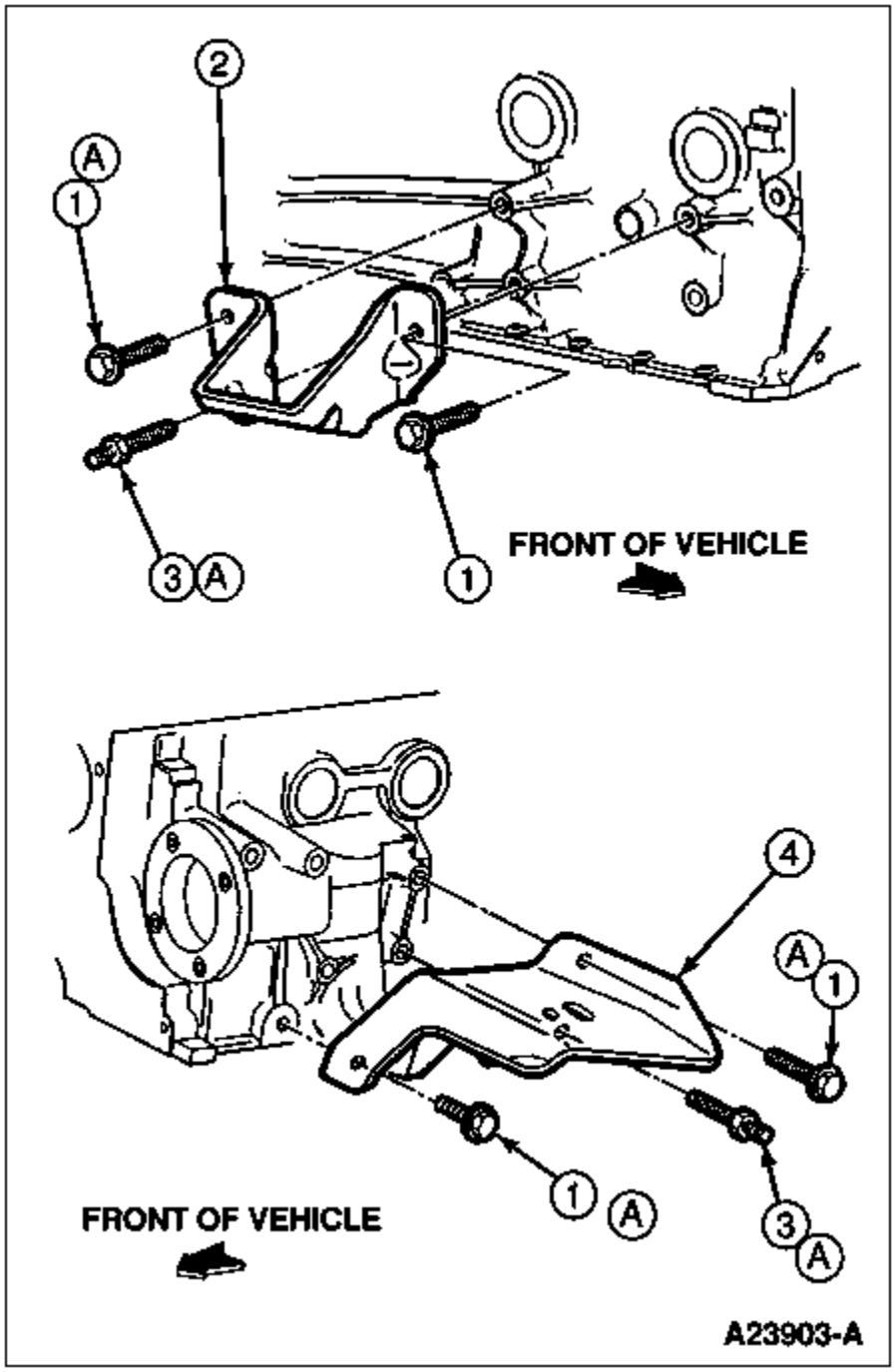
Engine Support Brackets, Ranger with 2.3L Engine



Item	Part Number	Description
1	N802653-S100	Screw and Washer, M10-1.5x22
2	6030	Front Engine Support Mounting Bracket (RH)
3	N804044-S100	Stud, M10-1.5/M10-1.5x5.1
4	6031	Front Engine Support Mounting Bracket (LH)

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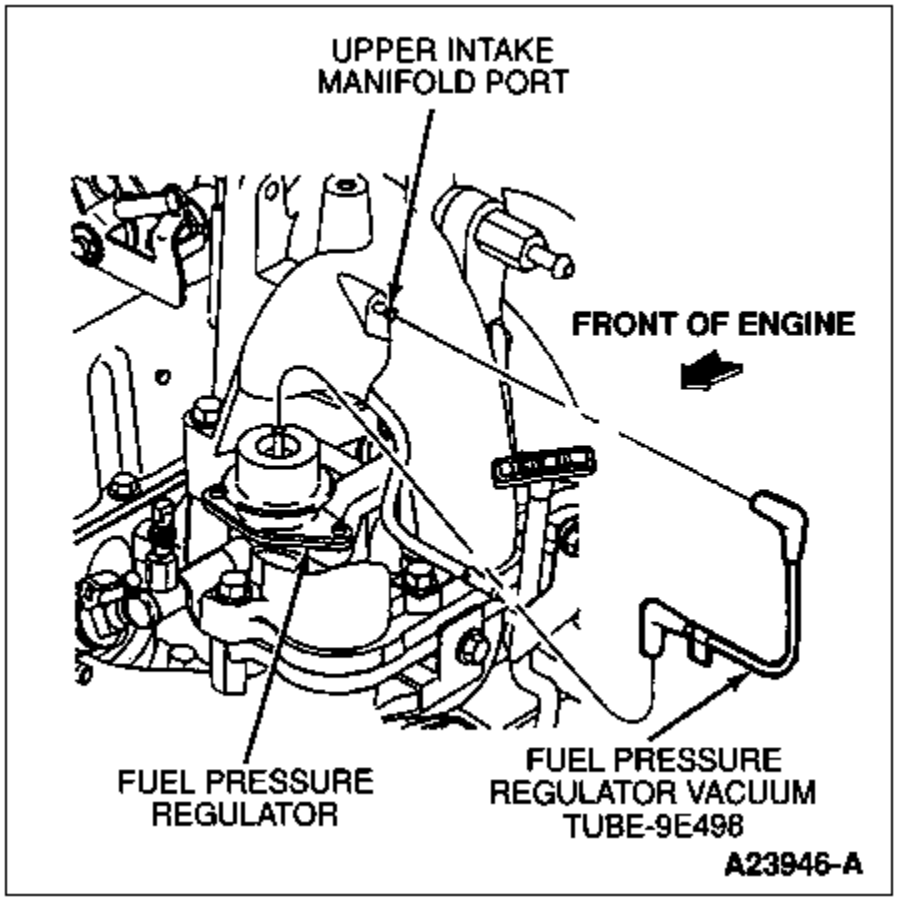
A	—	Tighten to 60-81 Nm (44-60 Lb-Ft)

12. Disconnect fuel pressure regulator vacuum line from fuel pressure regulator (9C968).



13. Remove vacuum connections from EGR valve (EGR valve) (9D475).

14. Remove engine control sensor wiring (12A581) and vacuum tab from top of valve cover.

15. Disconnect electrical connector at EGR vacuum regulator solenoid (9J459) valve.

16. Remove two bolts and assembled EGR vacuum regulator solenoid and EGR vacuum regulator bracket (9J472).

17. Disconnect EGR valve vacuum connector.

18. Disconnect throttle position (TP) sensor connector and idle air control (IAC) valve connector.

19. Disconnect positive crankcase ventilation valve (PCV valve) (6A666) and crankcase ventilation hose (6853) from crankcase vent oil separator (6A785).

20. Remove seven bolts, two studs and upper intake manifold with assembled throttle body (9E926). Remove intake manifold upper gasket (9H486).

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21. Disconnect vacuum connection from vacuum fitting in upper intake manifold.

22. Remove crankcase ventilation hose from valve cover.

23. Remove left side spark plug wire set from coils and spark plugs, and snap clips off of valve cover.

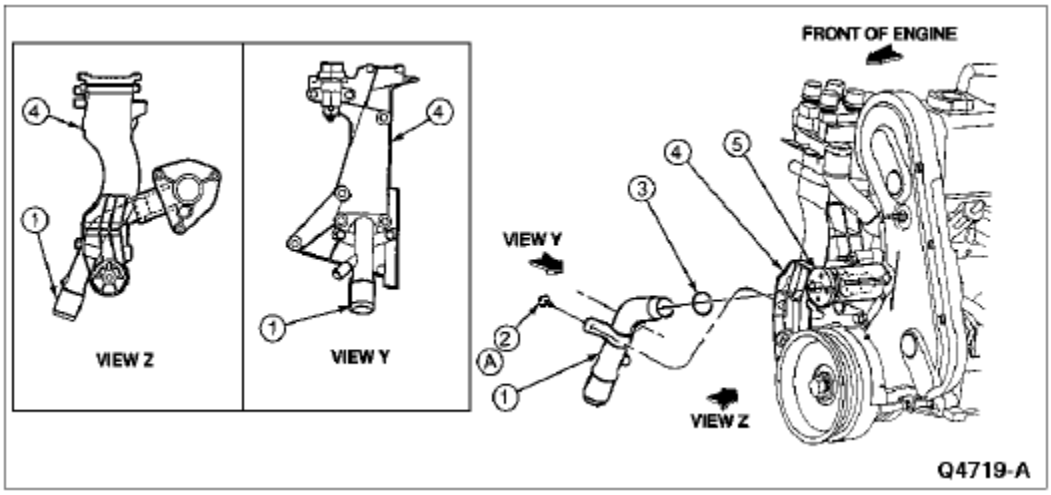
24. Disconnect engine wiring harness clip from rear left side of valve cover.

25. Remove right side spark plug wire set from ignition coils and spark plugs.

26. Disconnect vacuum harness and engine wiring from right side of valve cover and remove vacuum harness.

27. Remove two water inlet tube-to-generator bracket bolts and water pump inlet tube (8290).

Water Pump Inlet Tube



Item	Part Number	Description
1	8290	Water Pump Inlet Tube
2	N606676-S2	Screw and Washer Assembly, M6-1x22.5
3	87056-S100	O-Ring
4	10153	Generator Mounting Bracket
5	8501	Water Pump
A	—	Tighten to 9-12 Nm (78-107 Lb-In)

28. Disconnect engine control sensor wiring from ignition coils (12029) and radio voltage regulator capacitor (18832).

29. Remove three bolts and generator mounting bracket from engine with ignition coils assembled.

30. Disconnect oil pressure sensor (9278) and engine coolant sensor electrical connections from the

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cylinder block.

31. Disconnect engine wiring from four fuel injector nozzles and two clips to fuel rail.

32. Remove clip on fuel charging wiring (9D930) from stud on lower intake manifold.

33. Disconnect fuel charging wiring from crankshaft position sensor (CKP sensor) (6C315).

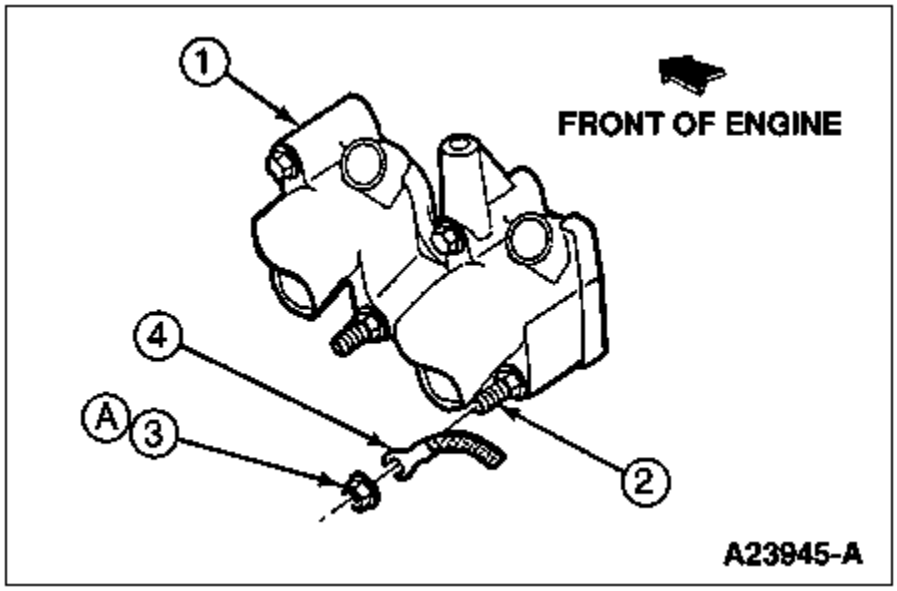
34. Disconnect fuel charging wiring from camshaft position sensor (CMP sensor) (6B288) and clip from stud on lower intake manifold.

35. Disconnect engine control sensor wiring from the 42 pin connector bracket mounted on the lower intake manifold.

36. Remove engine control sensor wiring.

37. Remove stud and engine oil level indicator tube (6754).

38. Remove bolt and audio ground cable from engine.



Item	Part Number	Description
1	9424	Intake Manifold, Lower
2	N807458-S101	Stud, M8-1.25 x 1.25 x 96.2
3	N620481-S2	Nut, M8 x 1
4	14303	Audio Ground Cable
A	—	Tighten to 9-12 Nm (80-106 Lb-In)

39. Remove lifting eye and lower intake manifold with assembled fuel injectors and fuel injection supply manifold (9D280).

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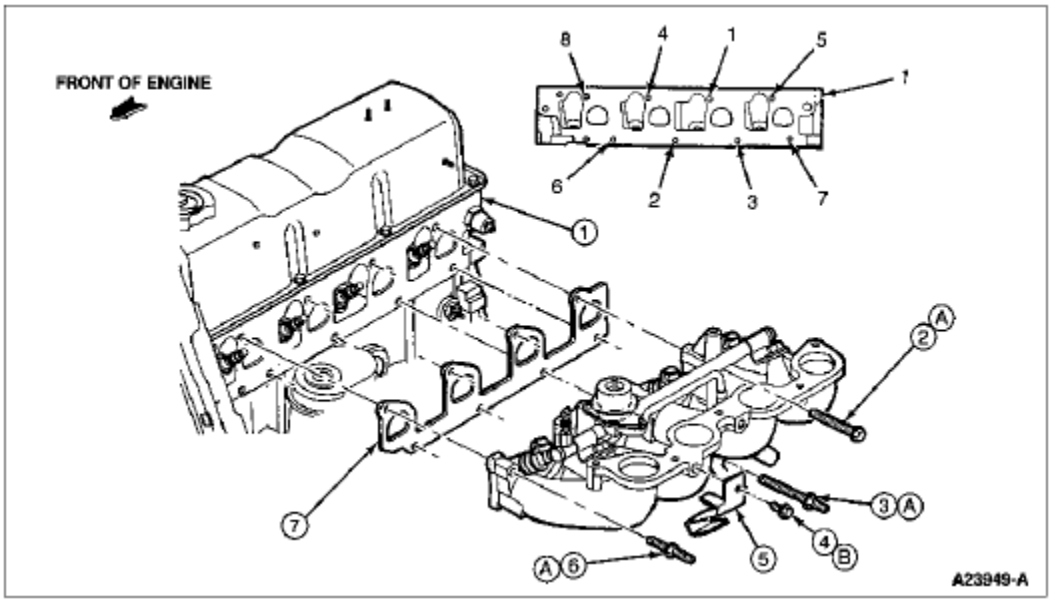
40. Remove studs and bolts and remove lower intake manifold with assembled fuel injectors and fuel injection supply manifold.

Lower Intake Manifold



Item	Part Number	Description
1	6049	Cylinder Head
2	N807462-S101	Bolt, M8-1.25 x 67.2 (Holes 1, 2, 4 and 5)
3	N807458-S101	Stud, M8-1.25 x 1.25 x 96.2 (Holes 3, 6 and 7)
4	N605904-S36	Bolt, M8-1.25 x 16.6
5	14A004	42 Pin Connector Bracket
6	N808163-S100	Stud, M8-1.25 x 1.25 x 63.7 (Hole 8)
7	9439	Intake Manifold Gasket
A	—	Refer to Procedure in Text
B	—	Tighten to 20-30 Nm (15-22 Lb-In)

41. Remove left engine mount bracket.

42. Remove bolt and crankcase vent oil separator.

43. Remove engine coolant temperature sensor from cylinder blocks (6010).

44. Using suitable oil pressure sender socket, remove oil pressure sensor from cylinder head (6049).

45. **NOTE: Unique platinum spark plugs (12405) are used. If all eight spark plugs are not "PP" series, they will need to be marked for replacement in the same cylinder. Refer to Section 03-**

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07B .

Remove eight spark plugs and use tape to label the reinstallation locations.

46. Remove crankshaft damper bolt and washer.

47. Remove crankshaft damper.

48. Remove outer timing belt cover bolt. Depress tabs and remove outer timing belt cover.

49. Remove bolt and crankshaft position sensor (CKP sensor) (6C351).

50. Loosen timing belt tensioner spring pivot bolt one-half turn.

51. Hold timing belt tensioner with T74P-6254-A Camshaft Belt Tensioner Tool and remove adjusting bolt. Relax timing belt tensioner spring.

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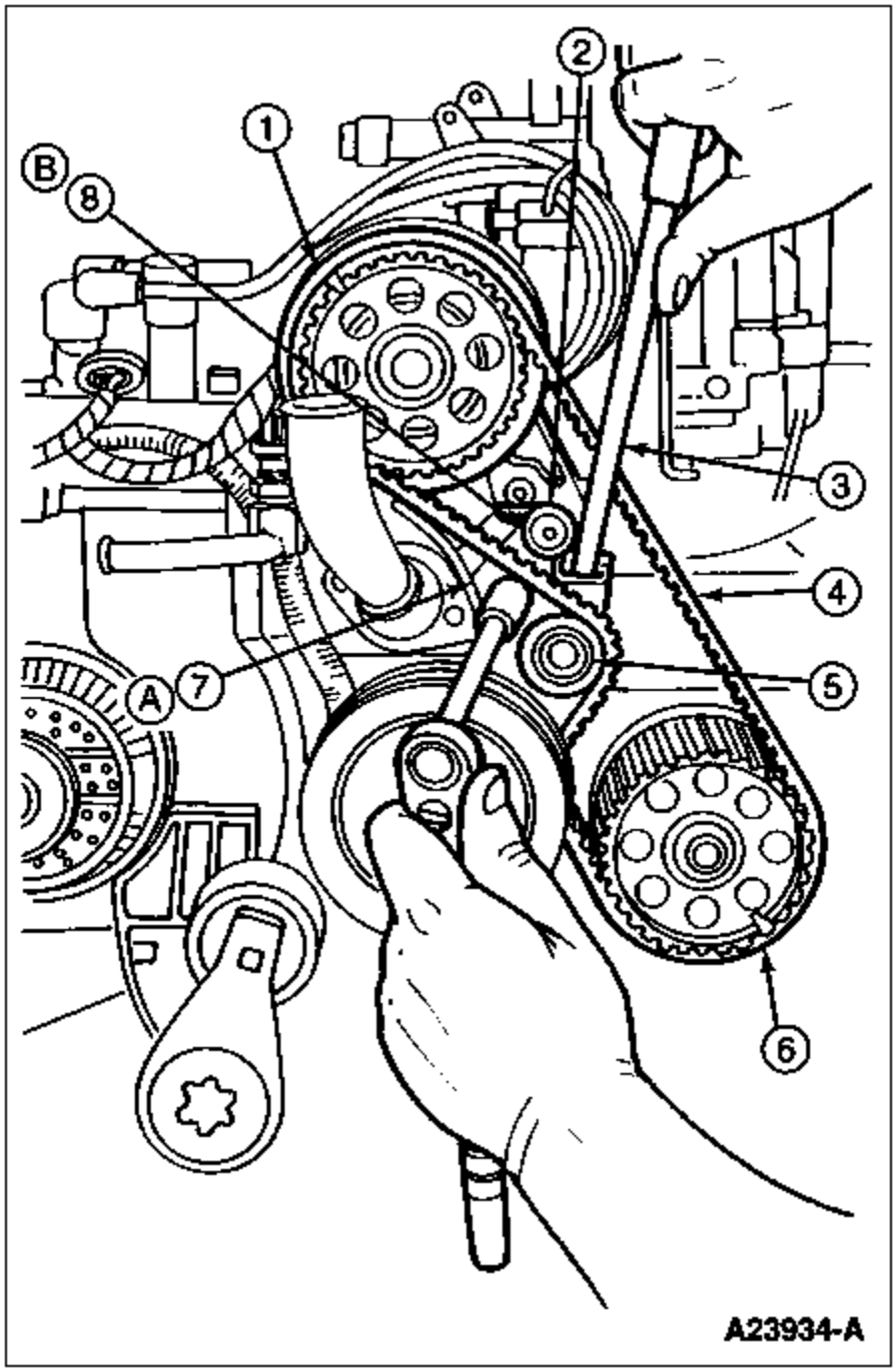

Item	Part Number	Description
1	6256	Camshaft Sprockets
2	6L273	Timing Belt Tensioner Spring
3	T74P-6254-A	Camshaft Belt Tension Adjusting Tool
4	6268	Timing Belt
5	6K254	Timing Belt Tensioner
6	6256	Oil Pump Sprocket

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7	N800112-S100	Tensioner Adjusting Bolts, M8-1.25 x 20 (Under Wrench)
8	6K282	Timing Belt Tensioner (Spring Pivot) Bolt
A	—	Tighten to 35-45 Nm (26-33 Lb-Ft) (Refer to Text)
B	—	Tighten to 40-55 Nm (30-40 Lb-Ft) (Refer to Text)

52. Remove timing belt.

53. Hold timing belt timing belt tensioner spring with T74P-6254-A Camshaft Belt Tensioner Tool and remove spring pivot bolt. Relax spring and remove spring and tensioner.

54. Install T74P-6256-B Cam Sprocket Holding/Removing Tool on camshaft sprocket.

55. Remove camshaft sprocket bolt and washer.

56. Install puller part of T74P-6256-B Cam Sprocket Holding/Removing Tool. Pull off camshaft sprocket.

57. Install T74P-6256-B Cam Sprocket Holding/Removing Tool on oil pump sprocket.

58. Remove oil pump shaft bolt and washer.

59. Install puller part of T74P-6256-B Cam Sprocket Holding/Removing Tool. Remove oil pump sprocket.

60. Remove crankshaft sprocket (6306).

61. Remove inner timing belt cover.

62. Remove two screws, clutch pressure plate, water thermostat (8575), and oil cooler return tube gasket (6N789).

63. **NOTE: Steps 1 through 63 take the engine down to a "long block." For further disassembly, continue.**

    Remove three bolts, water pump (8501), and O-ring.

64. Remove valve cover (6582) and valve cover gasket (6584).

65. Remove cylinder head bolts.

66. **NOTE: Steps 1 through 65 take the engine down to a "short block." For further disassembly, continue.**

    Remove cylinder head, and head gasket (6051).

67. Remove four bolts from oil pump (6600).

68. Remove oil pump and oil pump to cylinder block gasket (6659).

69. Remove oil pan bolts and oil pan (6675).

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70. Remove oil pan gasket (6710).

71. Using ridge reamer, remove ridge from top of cylinder bores. Put a rag in cylinder to keep shavings from between piston (6108) and bore. Follow instructions of tool manufacturer.

72. Rotate engine on stand so crankshaft is up.

73. Remove two bolts and nut and remove oil pump screen cover and tube (6622) as an assembly.

74. Using T74P-6700-B Front Cover Seal Remover, remove engine front cover seal as outlined in this section.

75. Remove bolts and engine front cover (6019).

76. Make sure connecting rod caps are marked so each cap can be kept with its rod.

77. Remove connecting rod nuts and four caps.

78. **NOTE: Each main bearing cap, except the rear cap, is marked with arrows pointing to the front of the engine. The number of arrows corresponds to the number of the main bearing cap. For example, one arrow for the front cap, two arrows for the number two cap.**

    Remove main bearing bolts and main bearing caps.

79. Lift out crankshaft. Crankshaft rear oil seal (6701) will come out with crankshaft. Remove seal from crankshaft.

80. Remove upper main bearings from block. Store them so they can be put back in the same places if they are to be reused.

81. Remove lower crankshaft bearings from main bearing caps. Store them so they can be put back in the same caps if they are to be reused.

82. Replace connecting rod caps on connecting rods and install nuts finger-tight.

83. Remove piston and rod assemblies from engine. It may be necessary to tap the bottom of each piston with the end of a hammer handle to remove.

84. Use suitable Allen wrench to remove oil filter mounting insert (6890), if necessary.

85. Remove front and rear oil gallery plugs, if necessary.

86. Disassemble piston and rod assemblies as outlined in this section, if necessary.

87. Disassemble cylinder head as outlined in this section, if necessary.

88. Clean and inspect parts as outlined in Section 03-00 . Repair or replace as outlined in Section 03-00 .

89. Clean old sealer from cylinder blocks and attaching parts.

Assembly

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CAUTION: Lubricate parts with Motorcraft Super Premium Motor Oil XO-5W30-QSP or equivalent meeting Ford specification ESE-M2C153-E during assembly to prevent a dry start and engine damage.

1. If disassembled or repaired, reassemble cylinder head as outlined in this section.
2. If necessary, assemble piston and connecting rod assemblies as outlined in this section.
3. If necessary, replace core plugs as outlined in Section 03-00 .
4. If removed, install oil filter mounting insert and tighten to 28-35 Nm (20-25 lb-ft).
5. Install any oil gallery plugs removed and tighten to 38-45 Nm (28-33 lb-ft).
6. Install upper crankshaft main bearings. If reusing bearings, reinstall each bearing in the same place from which it was removed.
7. Install crankshaft.
8. Install bearings in main bearing caps. If reusing bearings, install bearing in same place from which it was removed.
9. Apply Plastigage® to crankshaft bearing journals.
10. Install main bearing caps and bolts. Alternately tighten bolts to 68-81 Nm (50-60 lb-ft). Retighten to 102-115 Nm (75-85 lb-ft).
11. Remove caps. Check Plastigage® for bearing clearance using chart on package. If OK, go on to next step. If not, correct clearance.
12. Apply a 7mm (0.27-inch) dot of Silicone Gasket and Sealant F1AZ-19562-A, or equivalent meeting Ford specification WSE-M4G320-A2 on each side of cylinder blocks as shown in illustration.

Rear Main Bearing Cap Area Sealing

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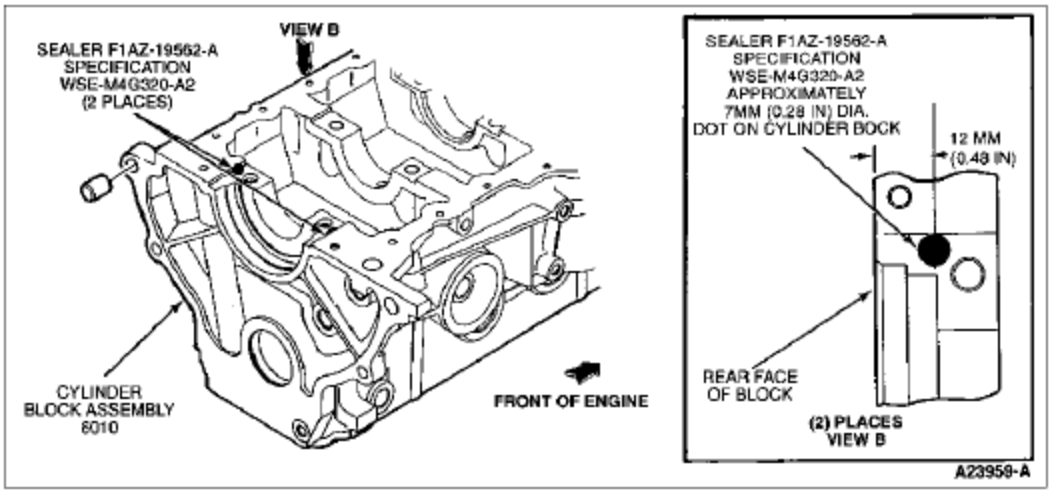

13. Lubricate crankshaft and bearings using oil meeting Ford specification ESE-M2C153-E and reinstall main bearing caps, bolts, and stud.

14. Alternately tighten main bearing bolts and stud to 68-81 Nm (50-60 lb-ft). Retighten to 102-115 Nm (80-90 lb-ft).

Crankshaft and Bearings, Installation, 2.3L Engine

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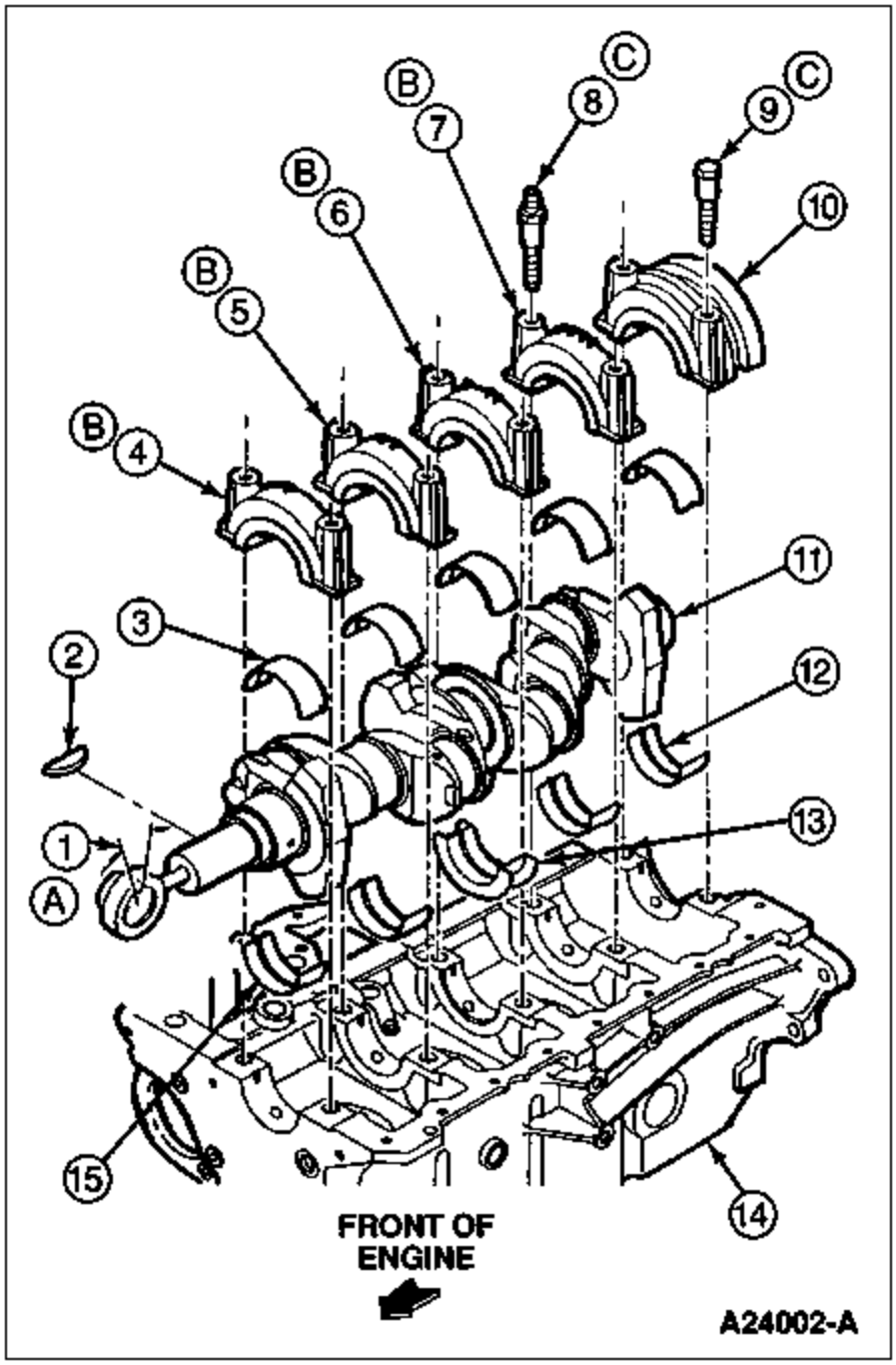

Item	Part Number	Description
1	D78P-4201-G	Dial Indicator
2	N806700	Crankshaft Key
3	6A338	Lower Main Bearing (5 Places)
4	—	Front Main Bearing Cap (Part of 6010)

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5	—	Front Intermediate Main Bearing Cap (Part of 6010)
6	—	Center Main Bearing Cap (Part of 6010)
7	—	Rear Intermediate Main Bearing Cap (Part of 6010)
8	N803729-S	M10-1.5 x M12-1.75 x 108.5 (1 Place)
9	N807497-S2	M12-1.75 x 80
10	—	Rear Main Bearing Cap (Part of 6010)
11	6303	Crankshaft
12	6333	Crankshaft Main Bearing, Upper (3 Places)
13	6337	Crankshaft Thrust Main Bearing
14	6010	Cylinder Blocks
15	6333	Crankshaft Main Bearing, Upper (Color Code Blue — Number One Journal Only)
A	—	Crankshaft End Play 0.07-0.20mm (0.002-0.007 Inch)
B	—	Assemble with Arrows Pointing Forward. Marked with 1 to 64 Arrows Front-to-Rear
C	—	Tighten According to Procedure in Text

15. Check crankshaft end play as outlined in Section 03-00 .

16. Install piston and rod assemblies. For each assembly:

    a. Put piece of hose or other protector over rod bolts to protect crankshaft journal.
    b. Rotate crankshaft so journal for piston to be installed is at the bottom of its stroke.
    c. Start piston and connecting rod assembly into cylinder, guiding bolts around crankshaft journal.
    d. Compress piston rings using suitable piston ring compressor.
    e. Tap piston assembly into place using bottom of hammer handle.
    f. Insert bearings in connecting rod and cap.
    g. Apply Plastigage® to bearing journal.
    h. Install connecting rod cap. Alternately tighten connecting rod nuts to 34-41 Nm (25-30 lb-ft). Retighten to final torque of 41-49 Nm (30-36 lb-ft).
    i. Remove connecting rod cap and check bearing clearance with chart on Plastigage® package.
    j. Lubricate bearings crankshaft journal using oil meeting Ford specification ESE-M2C153-E and reinstall connecting rod cap.
    k. Alternately tighten connecting rod nuts to 34-41 Nm (25-30 lb-ft). Retighten to final torque of 41-49 Nm (30-36 lb-ft).
    l. Check side clearance. Side clearance should be between 0.09-0.29mm (0.0035-0.0115 inch).
    m. Repeat for remaining piston and connecting rod assemblies.

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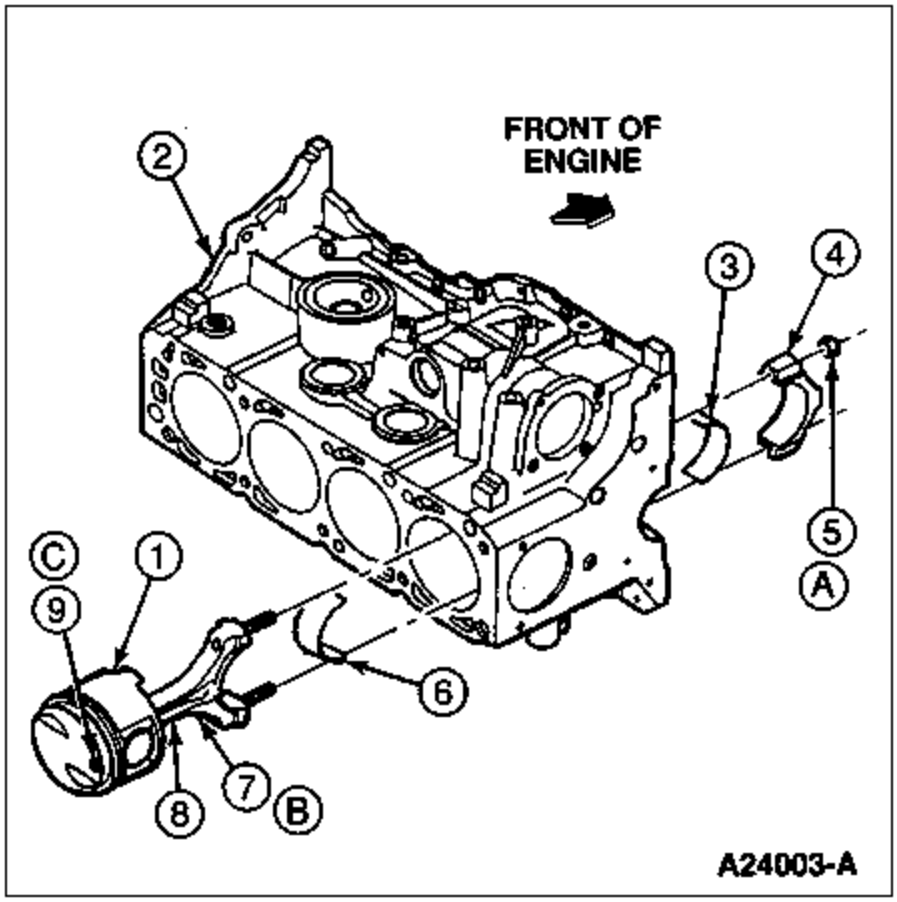

Item	Part Number	Description
1	6100	Piston
2	6010	Cylinder Blocks
3	6211	Connecting Rod Bearing, Lower
4	—	Connecting Rod Cap (Part of 6205)
5	N800113-S	Nut, M9-1
6	6211	Connecting Rod Bearing, Upper
7	—	Squirt Hole (Part of 6205)
8	6205	Connecting Rod
9	—	Notch (Part of 6100)
A	—	Tighten According to Procedure in Text
B	—	Squirt Hole Faces Away from Oil Pump
C	—	Notch Goes Toward Front of Engine

17. Install engine front cover onto cylinder block and tool.

Engine Front Cover

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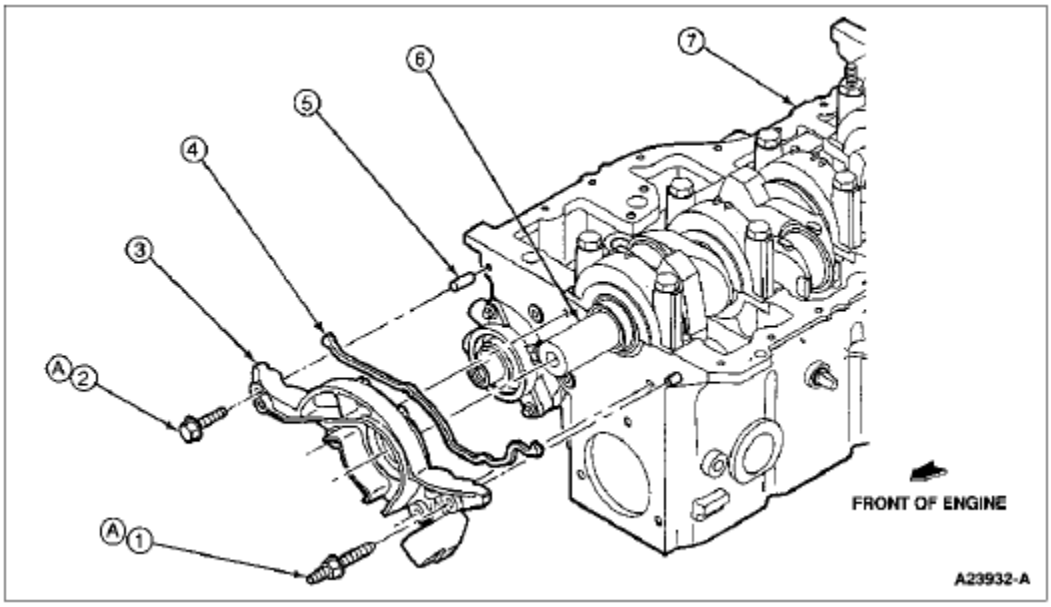

Item	Part Number	Description
1	N805892-S2	Stud, M6 1-1 x 61.9
2	N807497-S2	Bolt, M6 1-1 x 37.5
3	6019	Engine Front Cover
4	6020	Engine Front Cover Gasket
5	—	Dowel Bushing (Part of 6010)
6	6303	Crankshaft
7	6010	Cylinder Blocks
A	—	Tighten to 13-16 Nm (115-141 Lb-In)

18. Tighten three bolts and one stud to 13-16 Nm (10-11 lb-ft).

19. Using Cam Bearing Adapter Tube T72C-6250 and crankshaft damper bolt, press engine front cover seal into engine front cover.

20. Install oil pump screen cover and tube. Tighten bolts to 20-30 Nm (15-22 lb-ft). Tighten pickup tube-to-main bearing cap to 40-55 Nm (30-40 lb-ft).

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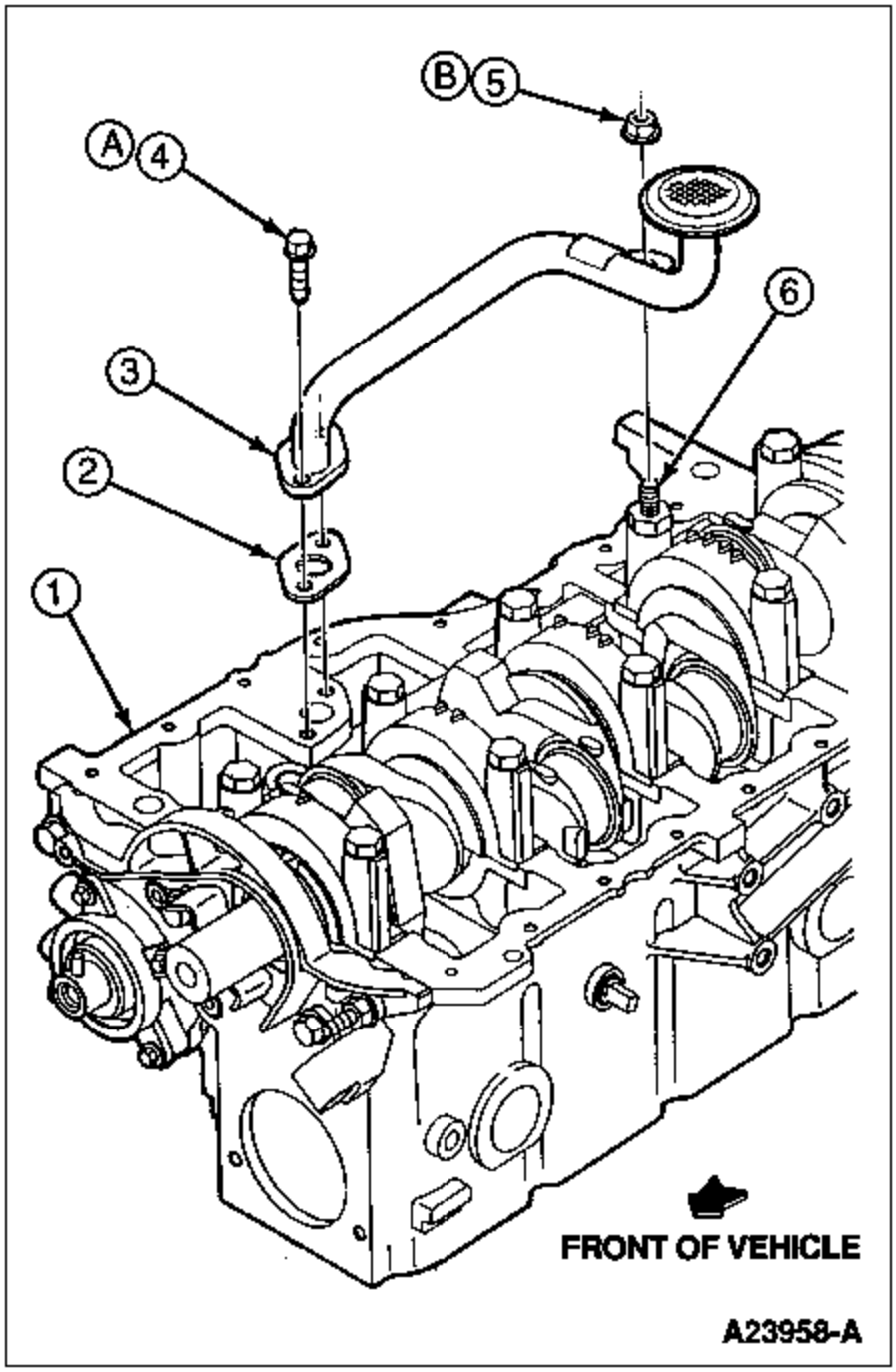

Item	Part Number	Description
1	6010	Cylinder Blocks
2	6626	Oil Pump Inlet Tube Gasket
3	6622	Oil Pump Screen Cover and Tube
4	N605786-S2	Bolt, M8-1.25 x 20
5	N620482-S	Nut, M10-5
6	N803729-S	Bearing Cap Stud

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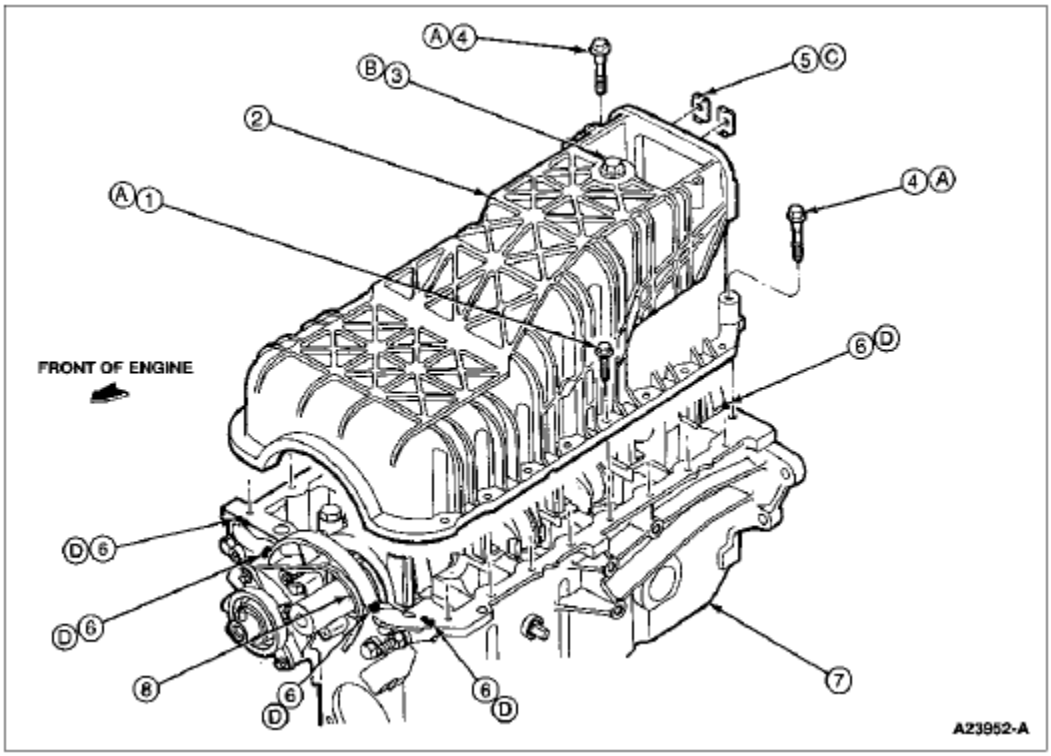
A	—	Tighten to 20-30 Nm (15-22 Lb-Ft)
B	—	Tighten to 40-55 Nm (29-40 Lb-Ft)

21. Apply a small amount of Silicone Gasket Sealant F1AZ-19562-A, or equivalent meeting Ford specification WSE-M4G320-A2 at joints between engine front cover and cylinder blocks and rear main cap and cylinder blocks as shown.

Oil Pan



Item	Part Number	Description
1	N806378-S36	Bolt, M6-1 x 27.5 (16 Places)
2	6675	Oil Pan
3	6730	Oil Pan Drain Plug, M8
4	N806379-S36	Bolt, M6-1 x 57.5
5	6C629	Oil Pan Spacer
6	19562	Sealer F1AZ-19562-A, Loctite® 598 Ultra Black, Specification WSE-M4G323-A3
7	6010	Cylinder Blocks

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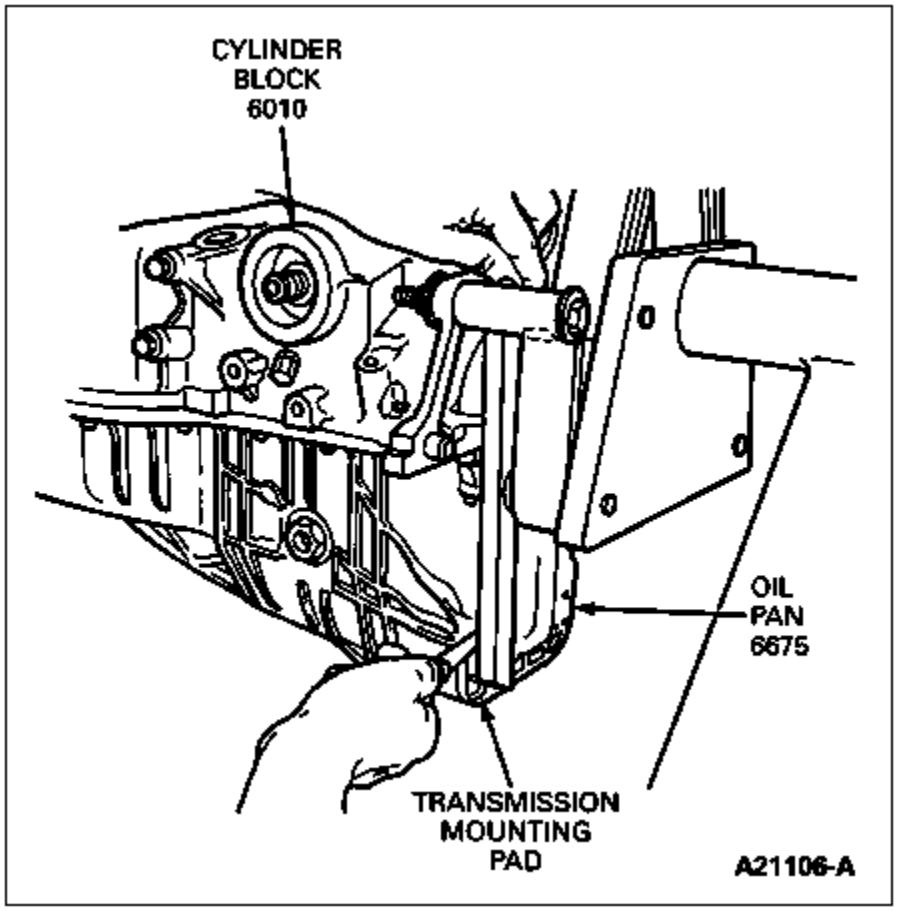
8	6019	Engine Front Cover
A	—	Tighten to 14-16 Nm (123-141 Lb-Ft)
B	—	Tighten to 20-34 Nm (15-25 Lb-Ft)
C	—	If Replacing Oil Pan or Transmission, Select According to Text
D	—	Apply in Six Places Shown (Left Side of Rear Main Cap Is Hidden)

22. Press oil pan gasket into groove in oil pan and install oil pan. Tighten bolts to 13-16 Nm (10-12 lb-ft).

23. **CAUTION: Failure to measure the required spacer thickness can result in insufficient or excessive clearance between the engine oil pan and the transmission (7003) when installed in vehicle. This can result in oil pan damage and an oil leak.**

    Position a straightedge flat on the rear of the cylinder blocks so that it extends over the oil pan-to-transmission mounting bolt pads.



24. Measure the gap between the mounting pad and the straightedge using a feeler gauge. Select spacers of the required thickness from chart. If oil pan cannot be brought into specifications of 0-0.254mm (0-0.009 inch) with spacers, replace oil pan.

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SPACER SELECTION CHART (6C629)

Measured Gap		Spacer Required		
mm	**Inch**	**mm**	**Inch**	**Shim Color Code**
0.0-0.254	0.0-0.010	None	None	—
0.27-0.51	0.011-0.020	0.254	0.010	Yellow
0.52-0.76	0.021-0.030	0.508	0.020	Blue
0.78-1.01	0.031-0.040	0.762	0.030	Pink

25. Install oil pan drain plug (6730) and new oil pan drain plug gasket (6734). Tighten to 20-34 Nm (15-25 lb-ft).

26. Rotate engine right side up on stand.

27. Position new head gasket.

28. Position cylinder head.

29. Install 10 cylinder head bolts in illustrated sequence. Tighten to 70 Nm (51 lb-ft) in illustrated sequence. Re-tighten to 70 Nm (51 lb-ft) in sequence. Then turn all head bolts an additional 80-100 degrees in sequence.

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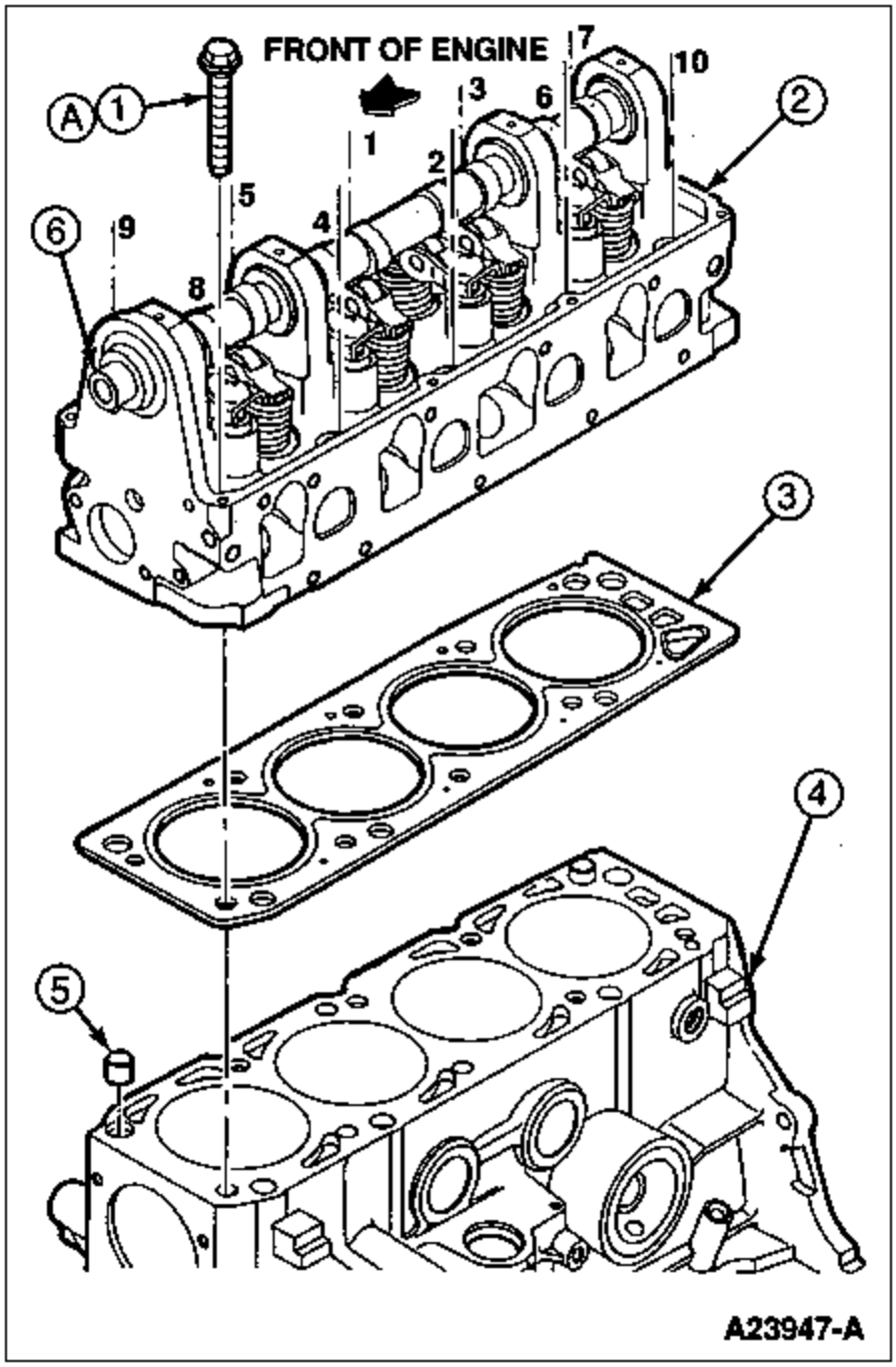

Item	Part Number	Description
1	N807013-S	Bolt, M12-1.75 x 100.7
2	6049	Cylinder Head
3	6051	Head Gasket
4	6010	Cylinder Blocks
5	—	Dowel (Part of 6010)
6	6250	Camshaft

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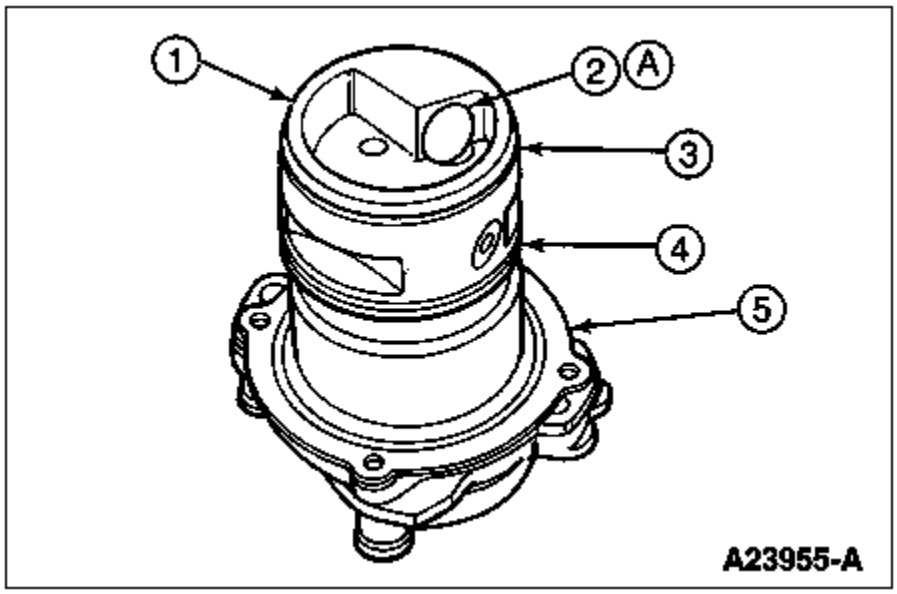
A	—	Tighten in Illustrated Sequence According to Procedure in Text

30. **NOTE: Inspect and clean oil pump hole in the cylinder block before installing the oil pump.**

    If original oil pump is to be reused, install new oil pump O-ring seals on oil pump.

31. Prime back of oil pump with 236ml (eight ounces) of fresh motor oil.



Item	Part Number	Description
1	6600	Oil Pump
2	—	Inlet Passage (Part of 6621)
3	87071-S100	O-Ring
4	87072-S100	O-Ring
5	6659	Oil Pump to Cylinder Block Gasket
A	—	Tilt Oil Pump and Pour In 236ml (8 Oz.) of Motor Oil to Prime Pump

32. Install oil pump and oil pump to cylinder block gasket being careful to retain the oil in the pump.

33. Install four oil pump bolts and tighten to 10-14 Nm (89-123 lb-in).

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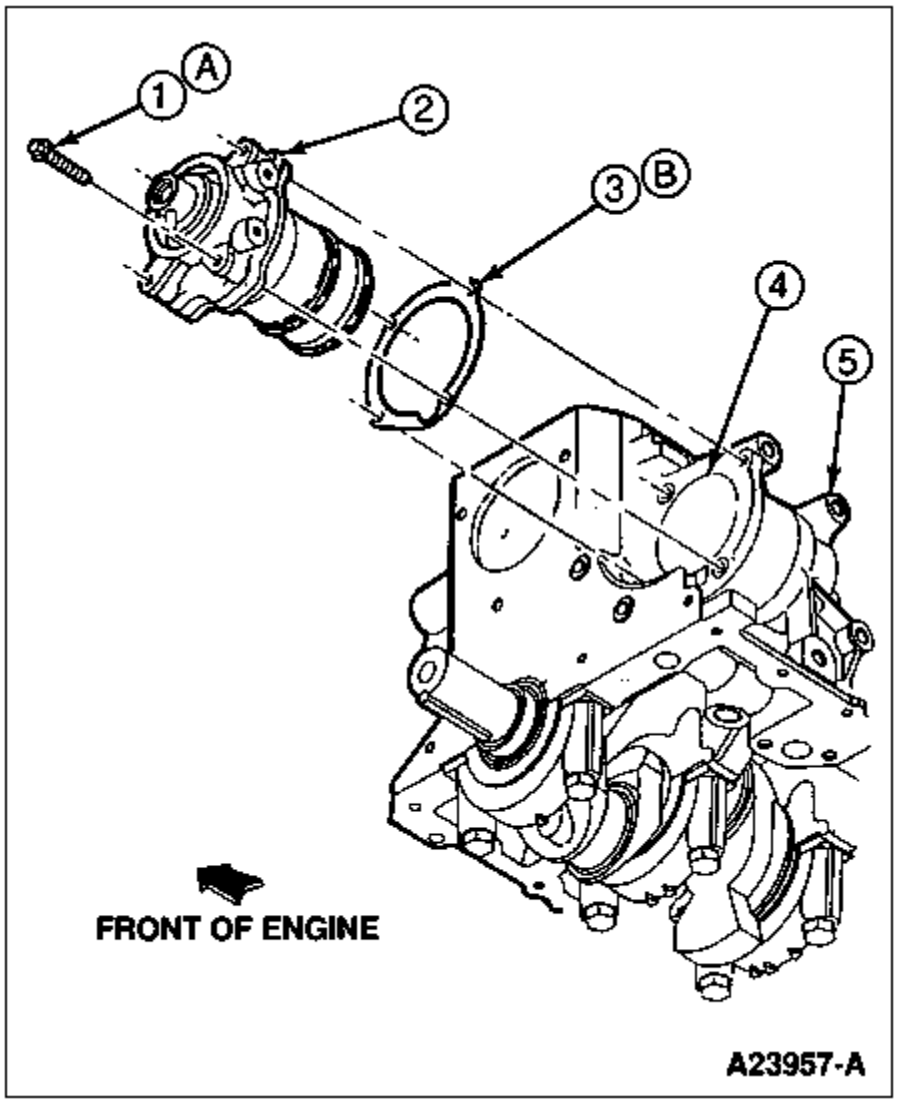

Item	Part Number	Description
1	N606523-S2	Bolt, M6-1 x 4.75
2	6600	Oil Pump
3	6659	Oil Pump to Cylinder Block Gasket
4	—	Oil Pump Cavity (Part of 6010)
5	6010	Cylinder Blocks
A	—	Tighten to 10-14 Nm (88-123 Lb-In)
B	—	Side Marked "Block" Goes Toward Cylinder Block

34. Position valve cover gasket on cylinder head. No sealer is required.

35. Install valve cover and screws. Tighten screws to 9-13 Nm (80-115 lb-in).

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36. Install the water pump housing gasket (8507) into a groove on the rear of the water pump.

37. Apply pipe sealant with Teflon® D8AZ-19554-A or equivalent meeting Ford specification WSK-M2G350-A2 to threads of water pump bolts.

38. Install water pump. Tighten bolts to 20-30 Nm (15-22 lb-ft).

39. Make sure inner thermostat gasket is not grooved, torn, or excessively soft. Snap water thermostat into water hose outlet connection and twist.

40. Apply a small amount of sealer and position water hose connection gasket on water hose connection (8592).

41. Install water outlet connection. Tighten bolts to 20-30 Nm (15-22 lb-ft).

42. Install inner timing belt cover.

43. Install inner timing belt cover screw and nut and tighten to 8-12 Nm (71-108 lb-in). Install stud to inner timing belt cover and cylinder head and tighten to 20-30 Nm (15-22 lb-ft).

44. Slide crankshaft sprocket onto crankshaft. Recess goes toward cylinder blocks and timing mark faces out.

45. Install camshaft sprocket on camshaft (6250).

46. Apply Threadlock 262 E2FZ-19554-B or equivalent meeting Ford specification WSK-M2G351-A6 to camshaft bolt threads. Install bolt and washer finger-tight.

47. Install Cam Sprocket Holding/Removing Tool T74P-6256-B on sprocket. Tighten camshaft bolt to 70-95 Nm (52-70 lb-ft). Remove tool.

48. Install oil pump sprocket.

49. Install oil pump bolt and washer finger-tight.

50. Install Cam Sprocket Holding/Removing Tool T74P-6256-B on sprocket. Tighten bolt to 40-55 Nm (30-41 lb-ft). Remove tool.

51. Check to make sure crankcase is filled to proper level with motor oil.

52. Install oil pressure sensor into cylinder head and tighten to 11-24 Nm (8-17 lb-ft) with appropriate oil pressure gauge socket.

53. Prime oil pump by rotating oil pump sprocket with a drill motor until resistance is felt.

54. Install timing belt tensioner, spring, and pivot bolt with legs of timing belt tensioner spring against stud on tensioner and stud nut in cylinder head.

55. Using T74P-6254-A Camshaft Belt Tensioner Tool, rotate tensioner against spring tension and install adjusting bolt and tighten until snug enough to hold tensioner against spring tension.

56. Install and adjust timing belt as outlined in this section.

57. Install camshaft position sensor and screws. Tighten screws to 5-7 Nm (45-70 lb-in).

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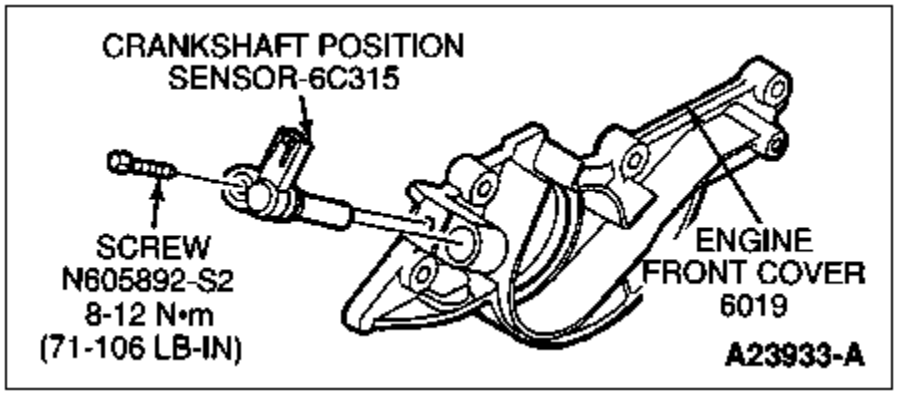

58. Install timing belt cover. Snap tabs into slot. Install bolt and tighten to 8-12 Nm (70-106 lb-in).

59. Install crankshaft damper, bolt and washer. Tighten bolt to 125-165 Nm (93-121 lb-ft).

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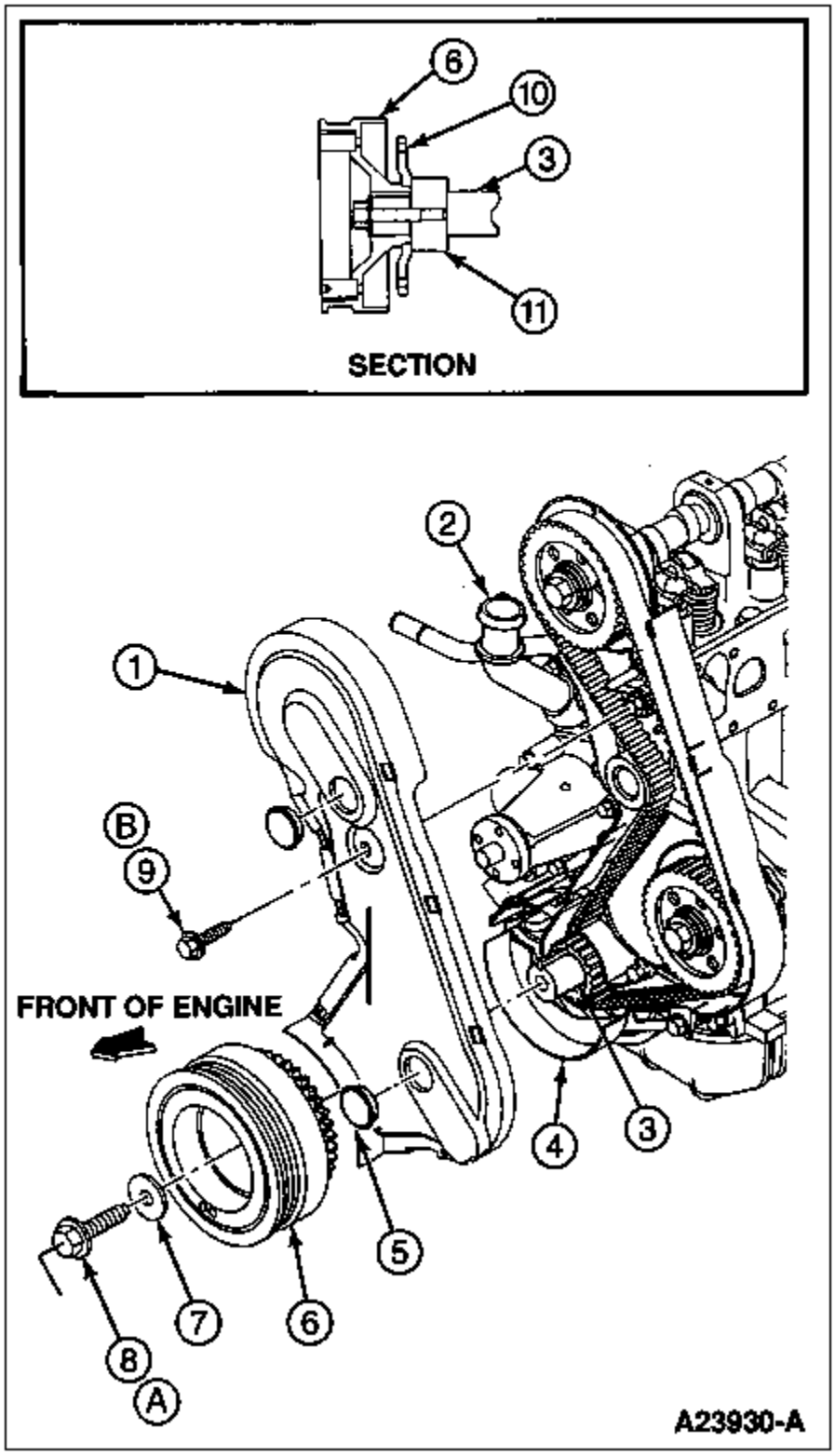

Item	Part Number	Description
1	6019	Engine Front Cover
2	8594	Water Outlet Connection

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3	6303	Crankshaft
4	6019	Inner Timing Belt Cover
5	—	Plug (Part of 6019)
6	6312	Crankshaft Pulley
7	6378	Crankshaft Pulley Retaining Washer
8	N600414-S	Bolt, M14-1.5 x 55
9	N808534-S2	Bolt, M6-1 x 17
10	—	Pulse Wheel (Part of 6312)
11	6306	Crankshaft Sprocket
A	—	Tighten to 125-165 Nm (93-121 Lb-Ft)
B	—	Tighten to 8-12 Nm (70-106 Lb-In)

60. Install spark plugs in proper locations and tighten to 9-20 Nm (7-15 lb-ft).
61. Install engine coolant temperature sensor into cylinder block and tighten to 11-24 Nm (8-17 lb-ft).
62. Lubricate O-ring and install crankcase vent oil separator and tighten to 8-12 Nm (6-9 lb-ft).
63. Install left front engine support mounting bracket (6031) and tighten bolts to 60-80 Nm (44-59 lb-ft).
64. Install right front engine support mounting bracket and tighten bolts to 60-80 Nm (44-59 lb-ft).

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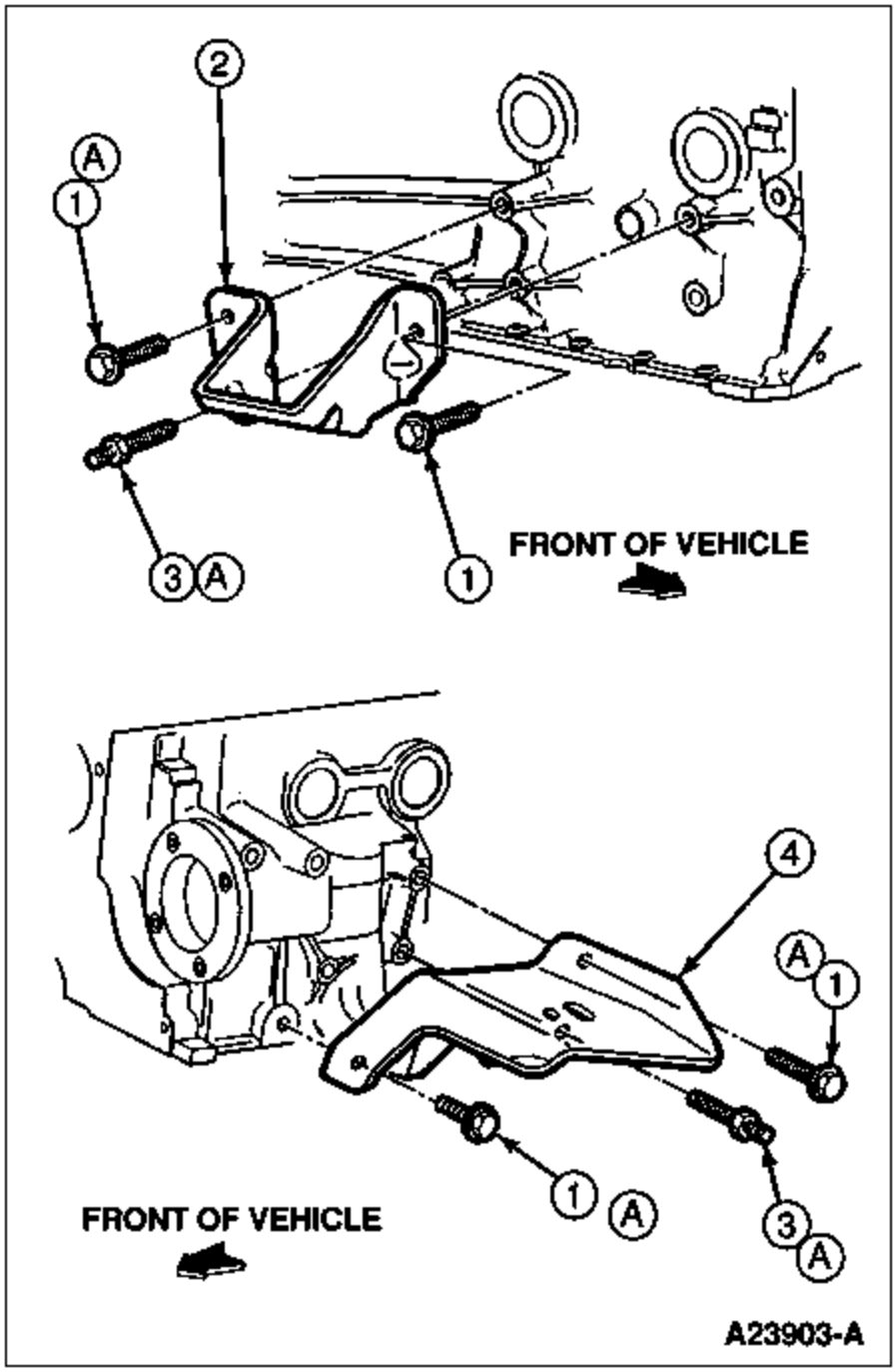

Item	Part Number	Description
1	N802653-S100	Screw and Washer, M10-1.5 x 22
2	6030	Front Engine Support Mounting Bracket
3	N804044-S100	Stud, M10-1.5/M10-1.5 x 5.1
4	6031	Front Engine Support Mounting Bracket (LH)
A	—	Tighten to 60-81 Nm (44-60 Lb-Ft)

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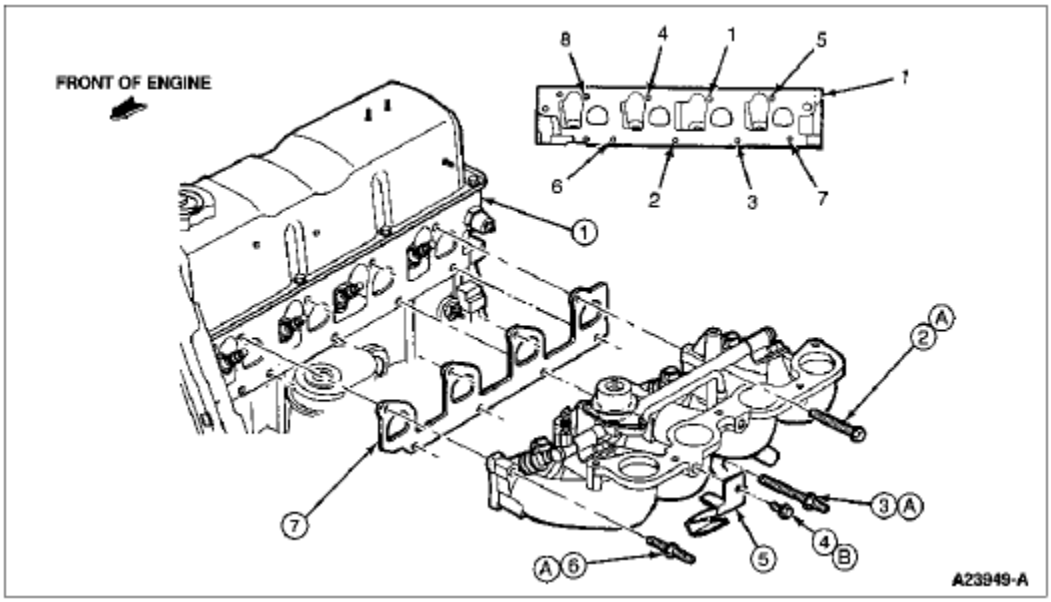
65. Install lower intake manifold, lifting eye, and new intake manifold gasket (9439). Stud bolts go in front lower and rear lower holes. Tighten according to illustrated sequence to 26-38 Nm (19-28 lb-ft).

66. Install engine lifting eye (17A084) using bolt and nut on lower intake manifold stud. Tighten bolt and nut to 20-30 Nm (15-22 lb-ft).

Lower Intake Manifold



Item	Part Number	Description
1	6049	Cylinder Head
2	N807462-S101	Bolt, M8-1.25 x 67.2 (Holes 1, 2, 4 and 5)
3	N807458-S101	Stud, M8-1.25 x 1.25 x 96.2 (Holes 3, 6 and 7)
4	N605904-S36	Bolt, M8-1.25 x 16.6
5	14A004	42 Pin Connector Bracket
6	N808163-S100	Stud, M8-1.25 x 1.25 x 63.7 (Hole 8)
7	9439	Intake Manifold Gasket
A	—	Refer to Procedure in Text
B	—	Tighten to 20-30 Nm (15-22 Lb-In)

67. Install audio ground cable and tighten nut to 9-12 Nm (80-106 lb-ft).

68. Apply gasket maker E2AZ-19562-B or equivalent meeting Ford specification WSK-M2G349-A10 to end of engine oil level indicator tube that pushes into cylinder blocks.

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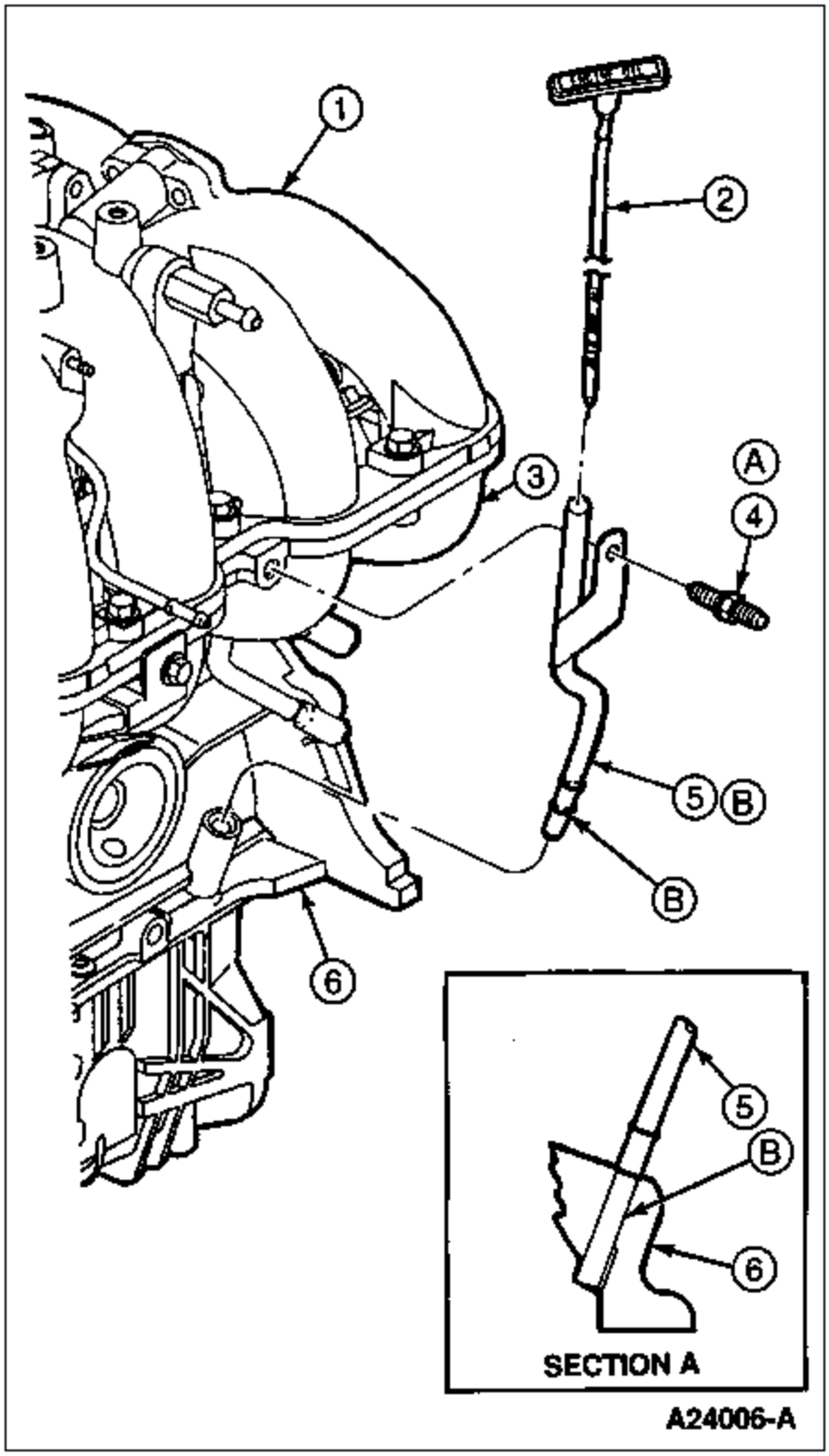

Item	Part Number	Description
1	9424	Upper Intake Manifold

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2	6750	Oil Level Dipstick
3	9424	Intake Manifold, Lower
4	N807689-S2	Stud, M8-1.25 x M5-0.80 x 42.3
5	6754	Oil Level Indicator Tube
6	6010	Cylinder Blocks
A	—	Tighten to 20-30 Nm (15-22 Lb-Ft)
B	—	Apply Gasket Maker E2AZ-19562-B (WSK-M2G349-A10) or Equivalent

69. Install engine oil level indicator tube. Tighten stud to 20-30 Nm (15-22 lb-ft). Install engine oil level dipstick (6750).

70. Connect retaining clip for crankshaft position sensor lead.

71. Install engine control sensor wiring to valve cover by pushing retaining clips into place on weld studs at the top of the valve cover. Two places on the right side and one place on the left of the cover. Connect engine control sensor wiring to:

    - Fuel injector (9F593) and clips.
    - Coolant temperature sender.
    - Oil pressure sender.

72. Install left side spark plug wires and secure to retaining clips to the side of the valve cover.

73. Position intake manifold upper gasket.

74. Install positive crankcase ventilation valve onto oil separator.

75. Install upper intake manifold with assembled throttle body, EGR external pressure valve (9F483), and tee. Tighten upper-to-lower intake manifold bolts to 7-10 Nm (26-38 lb-in) in sequence shown.

Upper Intake Manifold

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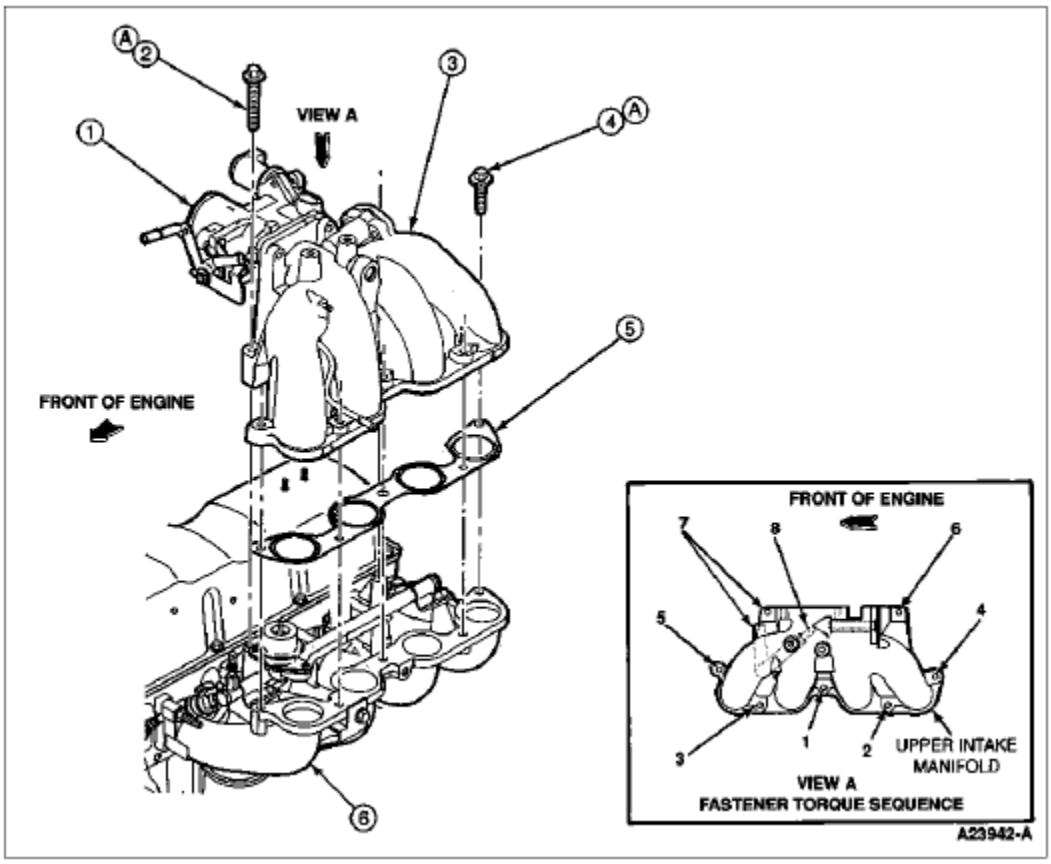

Item	Part Number	Description
1	9E926	Throttle Body
2	N807462-S2	Bolt, M8-1.25 x 67.2
3	9424	Intake Manifold, Upper
4	N807461-S2	Bolt, M8-1.25 x 45
5	9H486	Intake Manifold Upper Gasket
6	9424	Intake Manifold, Lower
A	—	Tighten According to Procedure in Text

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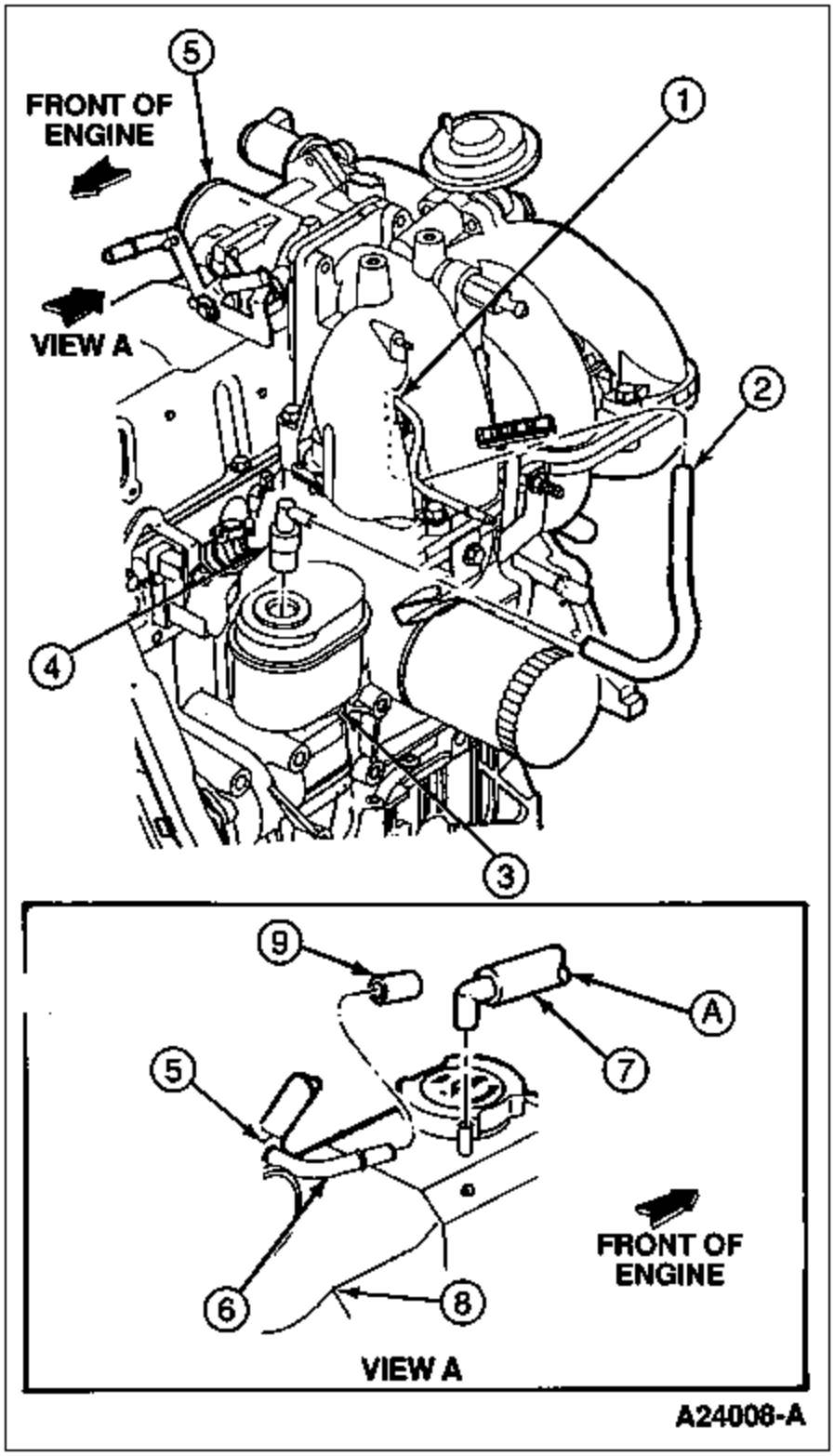

Item	Part Number	Description
1	—	PCV Tube (Part of 9424)

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2	6K817	Crankcase Hose
3	6A785	Oil Separator Assembly
4	6A666	Positive Crankcase Ventilation Valve
5	9E926	Throttle Body
6	—	Hose (Part of 9E926)
7	6853	Crankcase Ventilation Hose
8	6582	Valve Cover
9	N386800-S	Vacuum Cap
A	—	To Air Cleaner Outlet

76. Connect engine wiring connectors to:

    - Idle air control valve (IAC valve) (9F715)
    - Throttle position sensor (TP sensor) (9B989)
    - Camshaft position sensor

    Press the wiring harness on the studs of the lower intake manifold (2 places).

77. Install the 42 pin connector bracket to the lower intake manifold and tighten to 20-30 Nm (15-22 lb-ft). Clip the 42 pin connector from the engine wiring harness to the bracket.

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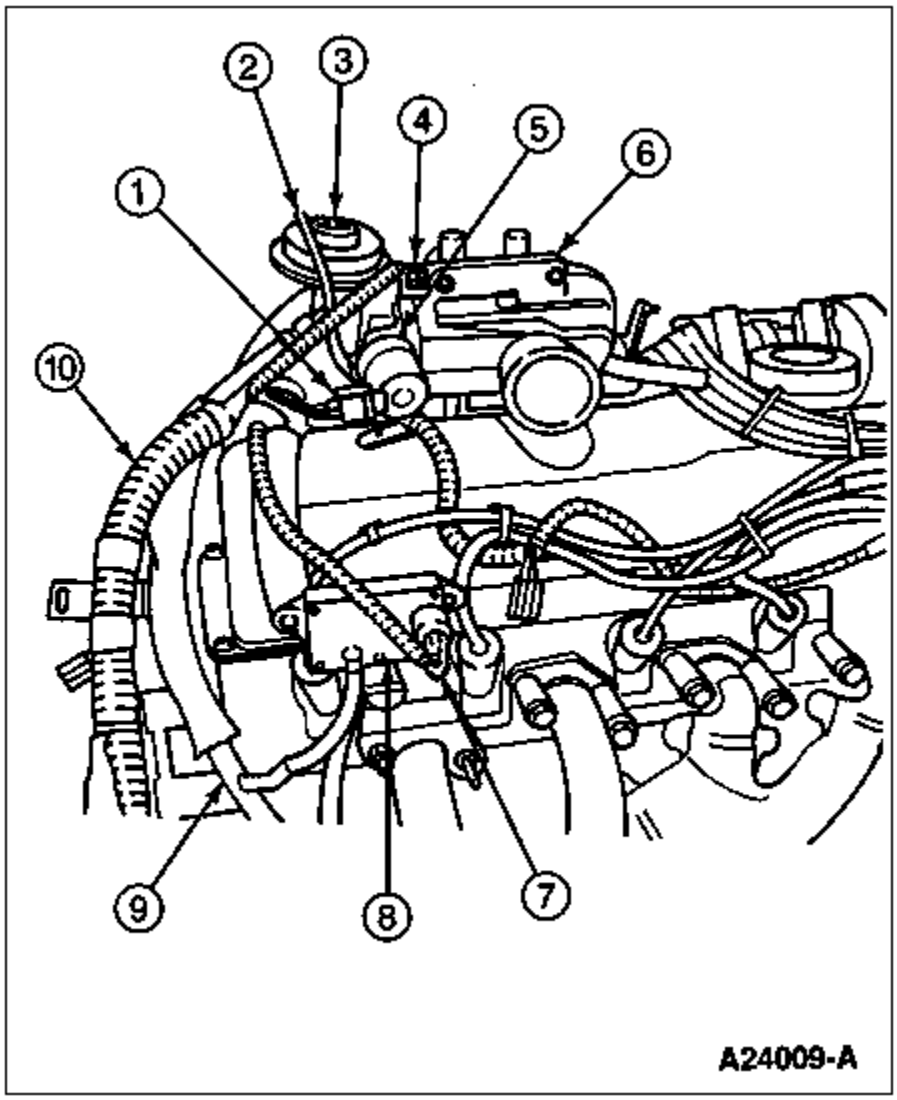

Item	Part Number	Description
1	—	Idle Air Control Valve Connector (Part of 12A581)
2	—	EGR Valve Vacuum Connection (Part of 12A581)
3	9D475	EGR Valve
4	—	Throttle Position Sensor Connector (Part of 12A581)
5	9F715	Idle Air Control Valve
6	9E926	Throttle Body
7	—	EGR Transducer Connector (Part of 12A581)
8	9J433	EGR Transducer
9	9D477	EGR Valve to Exhaust Manifold Tube
10	12A581	Engine Control Sensor Wiring

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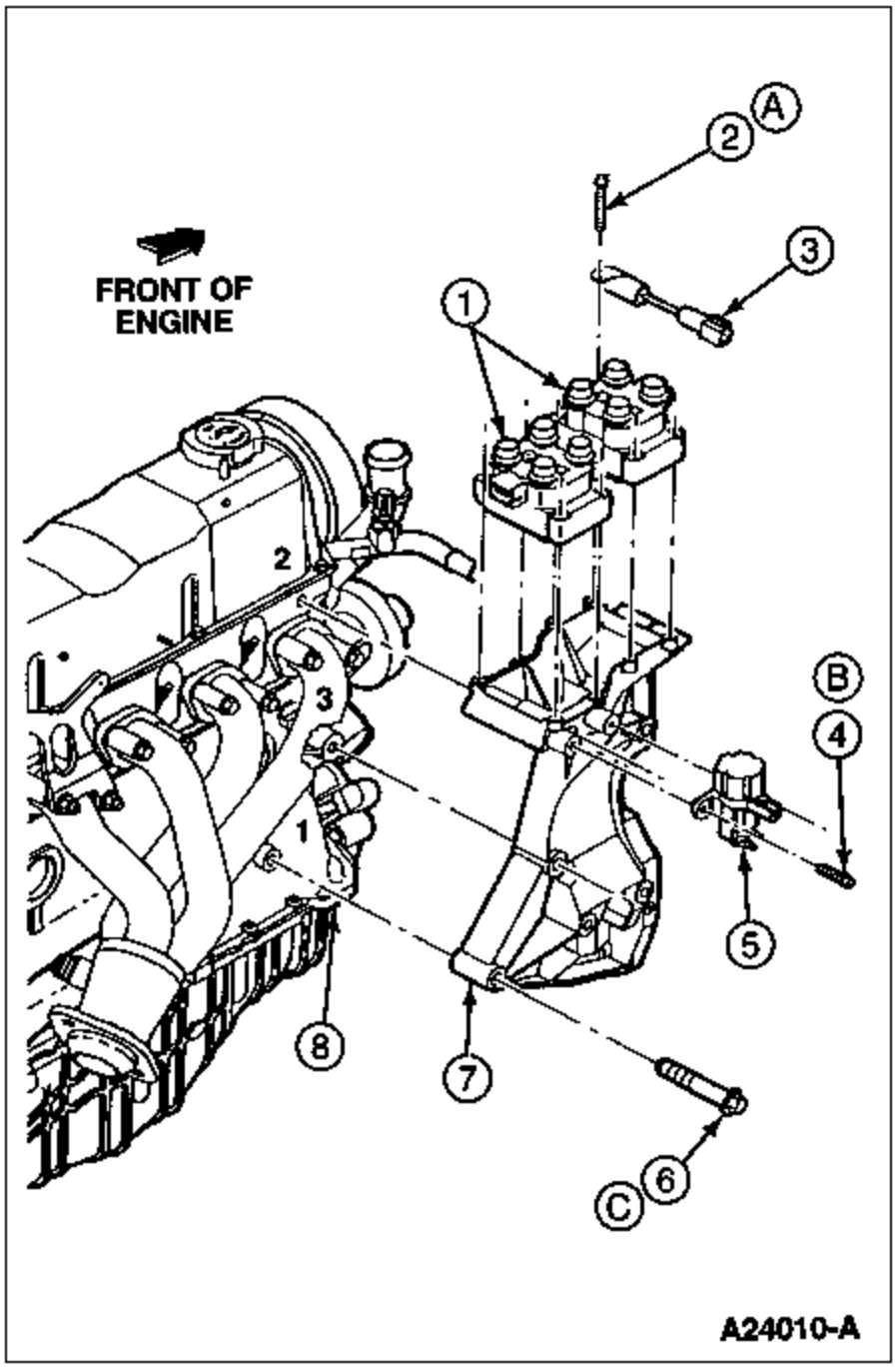
78. Install assembled ignition coils and generator mounting bracket (10153).

    a. Hand start bolt in hole No. 1 until snug.
    b. Hand start bolt in hole No. 2 until snug.
    c. Install bolt in hole No. 3 and tighten to 40-55 Nm (30-40 lb-ft).
    d. Tighten bolts No. 1 and 2 in order, to 40-55 Nm (30-40 lb-ft).



Item	Part Number	Description
1	12029	Ignition Coils
2	N606502-S36	Bolt, M5-0.8 x 37

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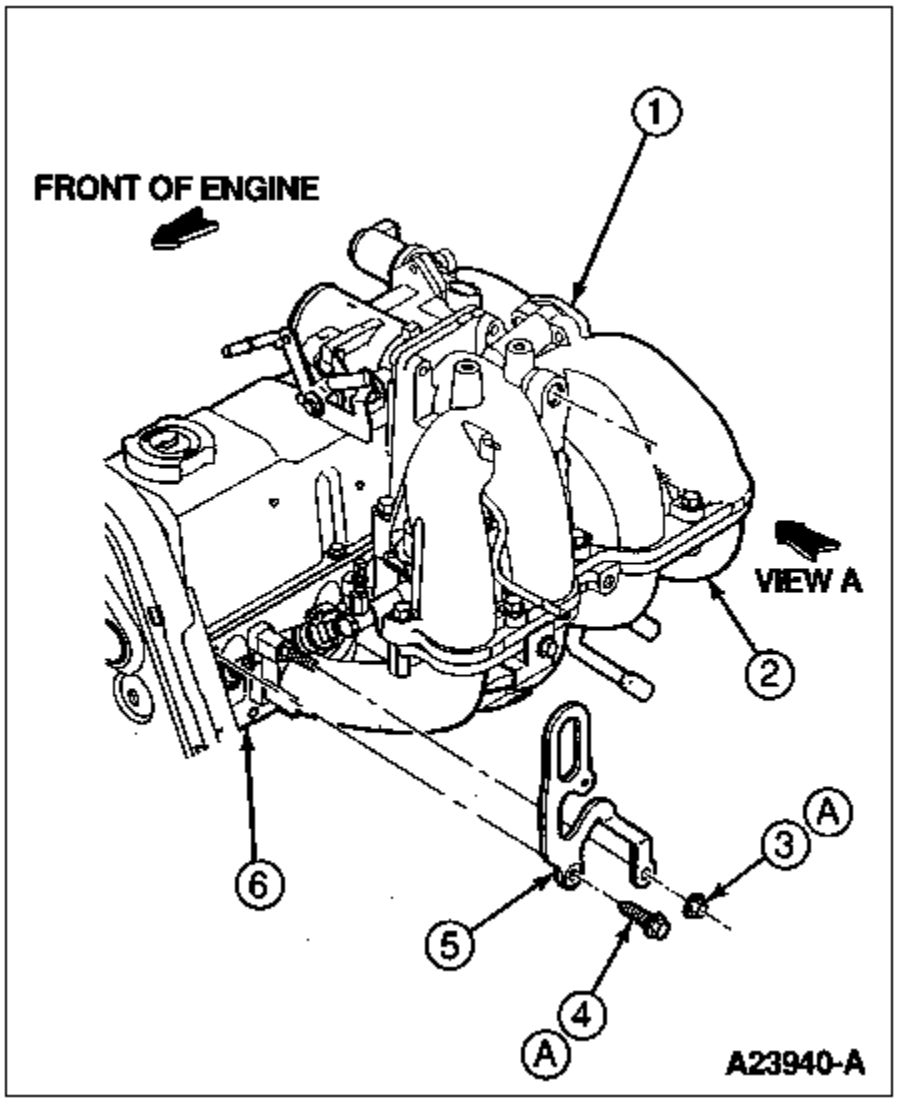
3	18801	Radio Ignition Interference Capacitor
4	N606676-S2	Screw, M6-1 x 20
5	9J459	EGR Vacuum Regulator Solenoid
6	N606064-S309	Bolt, M10-1.5 x 60
7	10153	Generator Mounting Bracket
8	6010	Cylinder Blocks
A	—	Tighten to 5-7 Nm (45-61 Lb-In)
B	—	Tighten to 8-12 Nm (70-106 Lb-In)
C	—	Tighten According to Instructions in Text

79. Install EGR vacuum regulator (EVR) control. Tighten bolts to 8-12 Nm (70-106 lb-in).



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Item	Part Number	Description
1	9424	Upper Intake Manifold
2	9424	Lower Intake Manifold
3	N620481-S2	Nut, M8-1.25
4	N808162-S2	Bolt, M8-1.25 x 33
5	17A084	Engine Lifting Eye, Front
6	6049	Cylinder Head
A	—	Tighten to 20-30 Nm (14-22 Lb-Ft)

80. Install vacuum line harness to top of engine and right side of valve cover.

81. Connect EVR electrical connector and the two double vacuum hose connections.

82. Make the following engine wiring harness connections:

    - Crankshaft position sensor and mounting clip to generator mounting bracket.
    - Both ignition coils.
    - Radio capacitor.
    - Engine coolant temperature sensor (ECT sensor) (12A648) located in the water outlet connector.

83. Connect triple connector at intake manifold vacuum outlet fitting.

84. Connect EGR vacuum line.

85. Connect vacuum line to fuel pressure regulator vacuum line to upper intake manifold.

86. Install spark plug wire set (12259) to ignition coils.

87. Connect right side spark plug wires and clip spark plug wire separator to valve cover.

Ignition Wiring

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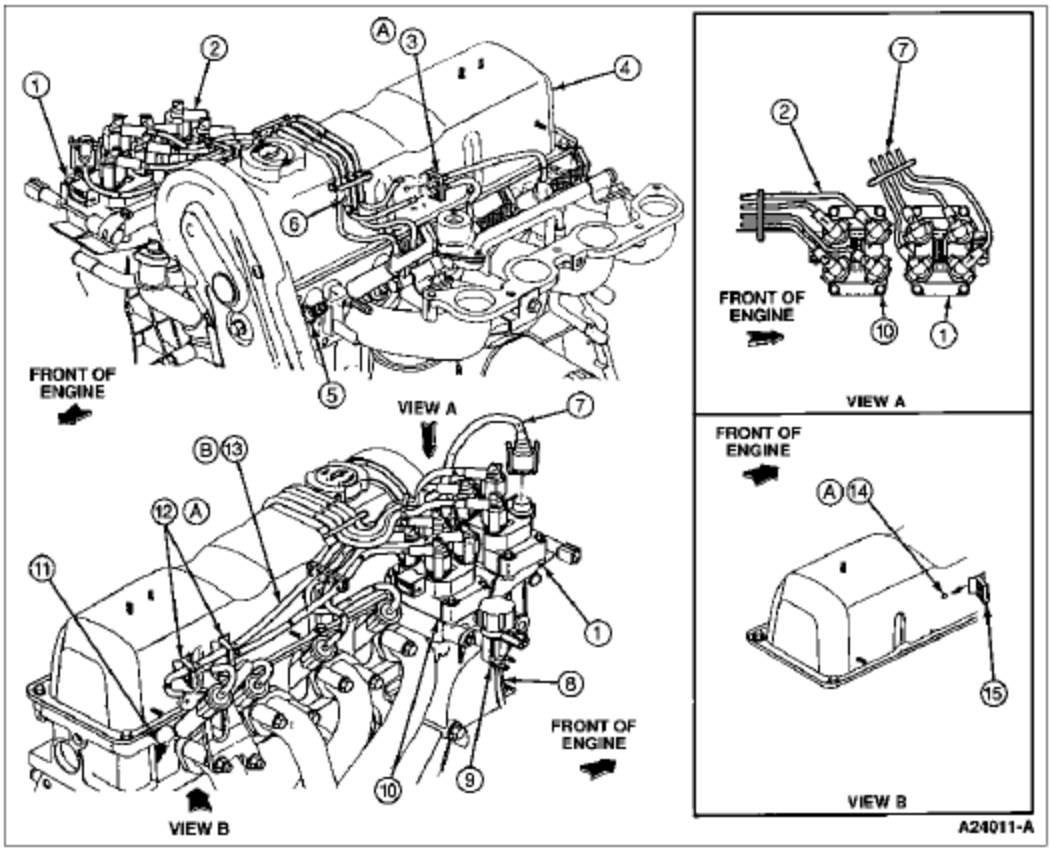

Item	Part Number	Description
1	12029	Ignition Coil — Secondary
2	12280	Ignition Wire and Bracket (Right)
3	—	Retainer (Part of 12281)
4	6582	Valve Cover
5	12405	Spark Plug (LH)
6	—	T-Stud (Part of 6582)
7	12281	Ignition Wire and Bracket (Left)
8	10153	Generator Mounting Bracket
9	9J459	EGR Vacuum Regulator Solenoid
10	12029	Ignition Coil — Primary
11	12405	Spark Plug (RH)
12	—	Retainer (Part of 12280)
13	—	"R" (Part of 12280)
14	—	T-Stud (Part of 6582)
15	—	Retainer (Part of 12280)
A	—	Retainers Push Onto T-Studs (Part of 6582)

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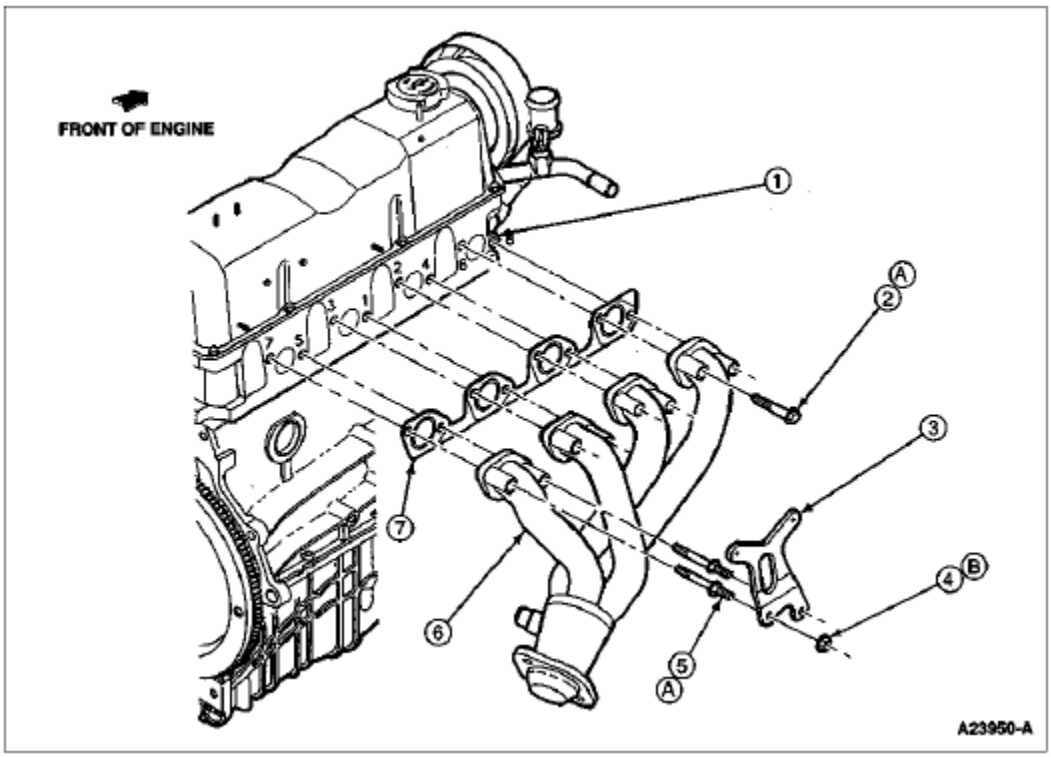
B	—	"R" Indicates Right Side

88. Install exhaust manifold and gasket. Tighten bolts in sequence to 20-30 Nm (15-22 lb-ft). Retighten in sequence to 60-80 Nm (45-59 lb-ft). Stud bolts go in holes No. 5 and No. 7.

Exhaust Manifold



Item	Part Number	Description
1	6049	Cylinder Head
2	N806949-S100	Bolt, M10-1.5 x 59.1 (6 Places)
3	17A084	Engine Lifting Eye
4	N620481-S2	Nut, M8-1.25 (2 Places)
5	N806948-S100	Stud, M10-1.5 x M8-1.25 x 89.6 (2 Places)
6	9430	Exhaust Manifold
7	9448	Exhaust Manifold Gasket
A	—	Tighten in Two Stages According to Instructions in Text
B	—	Tighten to 20-30 Nm (15-22 Lb-Ft)

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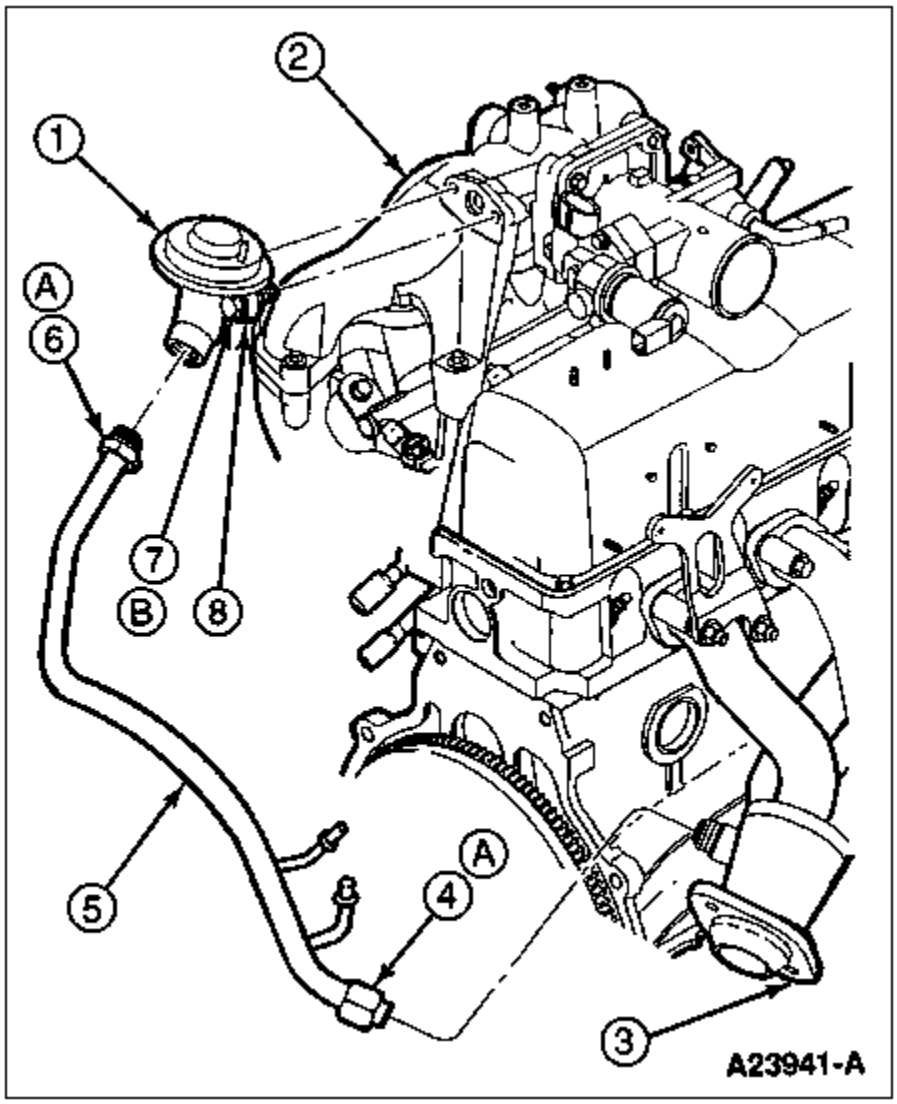
89. Install right engine lifting eye. Tighten nuts to 20-30 Nm (15-22 lb-ft).

90. Install EGR valve to exhaust manifold tube to exhaust manifold and EGR valve. Tighten nuts to 34-47 Nm (25-34 lb-ft).



Item	Part Number	Description
1	9D475	EGR Valve
2	9424	Intake Manifold, Upper
3	9430	Exhaust Manifold
4	—	Nut (Part of 9D477)
5	9D477	EGR Valve to Exhaust Manifold Tube
6	—	Nut (Part of 9D477)
7	N806781-S2	Screw, M8-1.25 x 35

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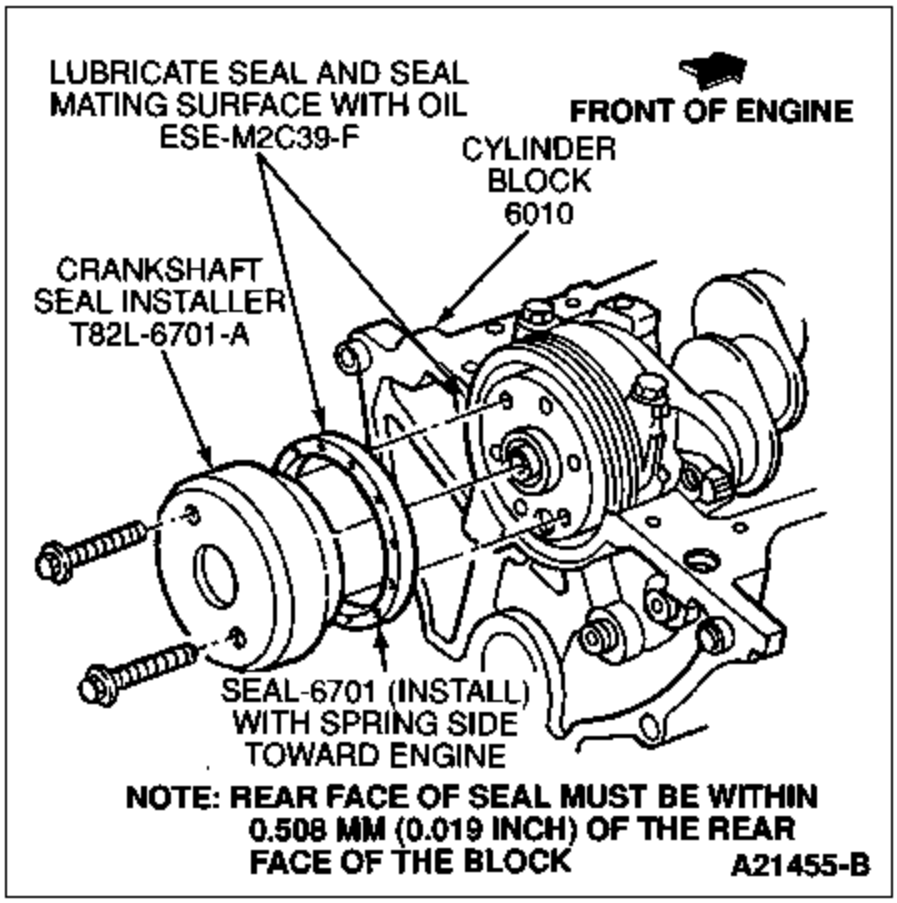
8	9D476	EGR Valve Gasket
A	—	Tighten to 34-47 Nm (25-35 Lb-Ft)
B	—	Tighten to 20-30 Nm (15-22 Lb-Ft)

91. Remove engine from engine stand.

92. Install crankshaft rear oil seal using T82L-6701-A Crankshaft Seal Installer.



93. Position engine rear plate.

94. Install flywheel or flexplate and reinforcement. Tighten special flywheel-to-crankshaft bolt to 73-87 Nm (54-64 lb-ft).

95. If equipped, install clutch disc and clutch pressure plate and tighten bolts finger-tight.

96. Install Clutch Aligner T71P-7137-H aligning clutch disc to transmission input shaft pilot bearing (7118).

97. **CAUTION: Clutch pressure plate bolts must be tightened one turn at a time in sequence or faulty clutch operation can occur.**

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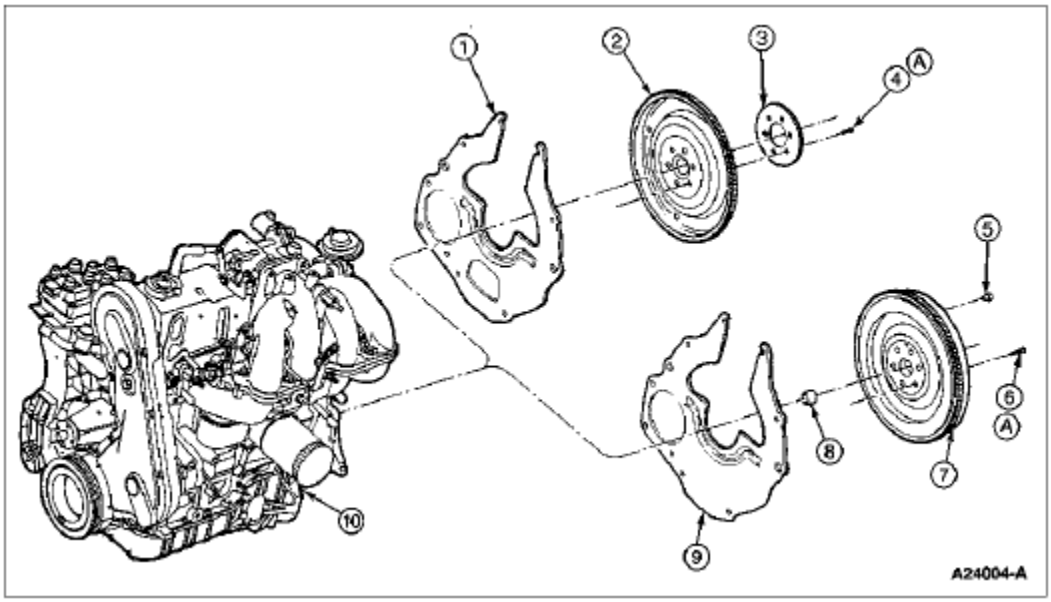
Tighten clutch pressure plate bolts in a criss-cross sequence one turn at a time until clutch pressure plate is contacting flywheel. Tighten pressure plate bolts to 21-32 Nm (15-24 lb-ft).

98. Remove clutch alignment tool.

Flywheel Installation, 2.3L Engine



Item	Part Number	Description
1	7007	Engine Rear Plate (Automatic Transmission)
2	6375	Flywheel (Automatic Transmission — Also Called Flexplate)
3	6A366	Flywheel Reinforcing Plate (Automatic Transmission)
4	N802741-S	Bolt, M10-1 x 20
5	6397	Flywheel Dowel (3 Places)
6	N800028-S	Bolt, M10-1 x 30
7	6375	Flywheel (Manual Transmission)
8	7120	PIlot Bearing
9	7007	Engine Rear Plate (Manual Transmission)
10	6007	Engine (2.3L)
A	—	Tighten to 73-87 Nm (54-64 Lb-Ft)

99. Install engine as outlined in this section.

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Cylinder Head

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Valve Spring Compressor	T95T-6565-A
Cam Sprocket Holding/Removing Tool	T74P-6256-B
Front Cover Seal Remover	T74P-6700-B
Cam Bearing Replacer	T71P-6250-A
Camshaft Bearing Set	T65L-6250-A
Front Seals Replacer	T74P-6150-A
Valve Stem Seal Replacer	T95L-6510-A
Valve Guide Replacer	T95T-6510-B

Disassembly

NOTE: When disassembling cylinder head (6049), mark the cam followers, lash adjusters, and valves so that they can be installed in the original positions.

1. Remove cylinder head as outlined in this section.
2. Remove the deposits from the combustion chambers with scraper and wire brush.
3. Mount cylinder head on bench fixture.
4. Rotate the camshaft (6250) so the cam follower to be removed is on the heel of its cam.
5. Using Valve Spring Compressor T95T-6565-A, compress and hold down the valve spring (6513). Slide out the cam follower over the lash adjuster.
6. Repeat steps 4 and 5 until all the cam followers are removed.
7. Store lash adjusters in order.
8. Using Valve Spring Compressor T95T-6565-A, compress valve spring and remove valve spring retainer key (6518), valve spring retainer (6514), and valve spring.
9. Remove valve and store in order.
10. Remove valve stem seal (6571).
11. Repeat above three steps until all the valves are removed.

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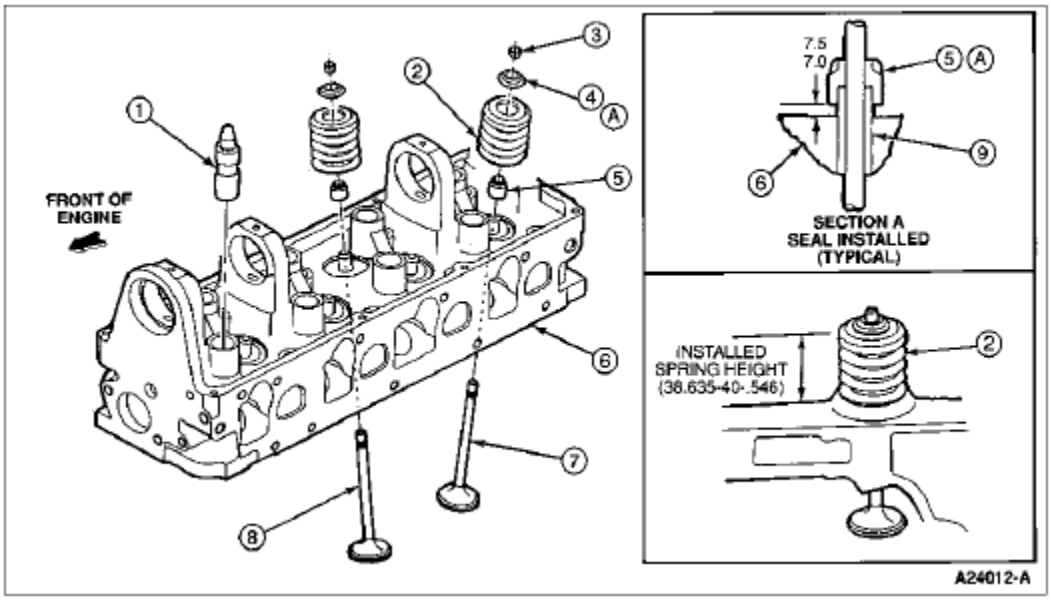
Cylinder Head Assembly



Item	Part Number	Description
1	6500	Valve Tappet
2	6513	Valve Spring
3	6518	Valve Spring Retainer Key
4	6514	Valve Spring Retainer
5	6571	Valve Stem Seal
6	6049	Cylinder Head
7	6507	Intake Valve
8	6505	Exhaust Valve
9	6510	Valve Guide
A	—	Press Seal into Place So Distance from Bottom of Seal to Surface of Cylinder Head Is 7.5-7.0mm (0.30-0.28 Inch)
B	—	Valve Spring Installed Height 38.635-40.546mm (1.52-1.59 Inch)

12. **NOTE: It is not necessary to remove sprocket from camshaft unless camshaft or sprocket is to be serviced.**

    Install Cam Sprocket Holding/Removing Tool T74P-6256-B on sprocket. Using tool to hold sprocket remove bolt and washer.

13. Install threaded puller insert in Cam Sprocket Holding/Removing Tool T74P-6256-B and remove sprocket.

14. Remove tool from sprocket.

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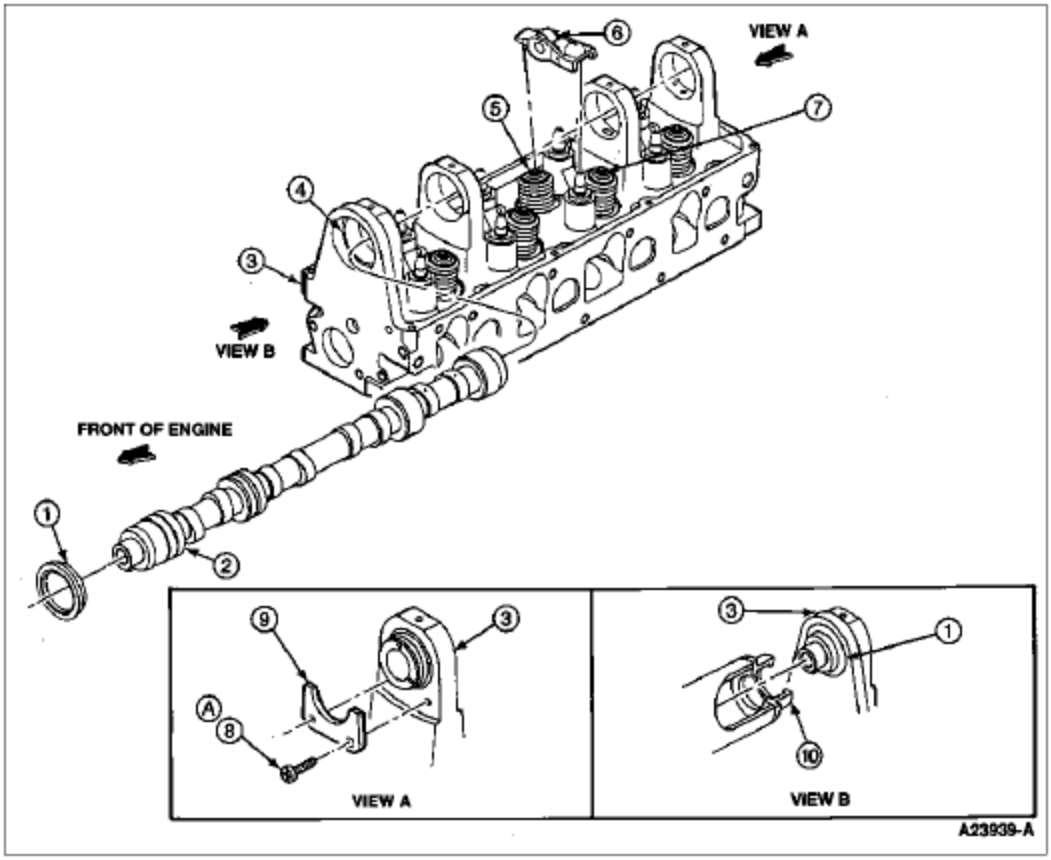
15. **NOTE: When positioning Front Cover Seal Remover T74P-6700-B, make sure the jaws are gripping the thin edge of the seal tightly before operating the jack screw portion of the tool.**

    Install Front Cover Seal Remover T74P-6700-B. Pull camshaft front seal.

16. Remove two screws and camshaft retaining plate.

17. Remove camshaft.

Camshaft



Item	Part Number	Description
1	6700	Camshaft Front Seal
2	6250	Camshaft
3	6049	Cylinder Head
4	6261	Camshaft Bearing
5	6505	Exhaust Valve
6	6564	Rocker Arm
7	6507	Intake Valve
8	N604465-S	Pan Head Screw, M6-1 x 16

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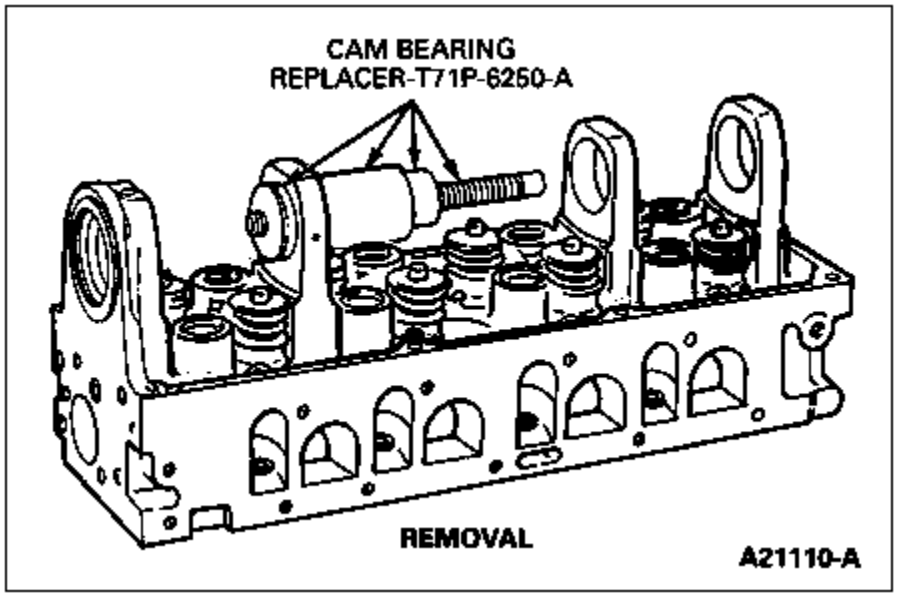
9	6613	Auxiliary Shaft Retaining Plate
10	T74P-6150-A	Cam and Auxiliary Shaft Seal Replacer
A	—	Tighten to 8-12 Nm (71-106 Lb-In)

18. To remove camshaft bearing (6261):

    a. Use tool sets Cam Bearing Replacer T71P-6250-A and Camshaft Bearing Set T65L-6250-A.
    b. Select proper size expanding collet and backup nut, and assemble on expanding mandrel.
    c. With expanding collet collapsed, install coiled assembly in the camshaft bearing, and tighten backup nut on the expanding mandrel until the collet fits the camshaft bearing.
    d. Assemble puller screw, cup, and nut on expanding mandrel.
    e. Tighten the puller nut against the thrust bearing to remove the camshaft bearing. Be sure to hold the end of the puller screw to prevent it from turning.
    f. Repeat steps to remove the other three bearings.



Assembly

1. Clean and inspect cylinder head, cam followers, valve springs, and valves as outlined in Section 03-00 .

2. **CAUTION: Failure to use the correct expanding collet can cause severe bearing damage.**

   NOTE: The camshaft bearings are available pre-finished to size and require no reaming for standard and 0.08mm (0.15-inch) undersize journal diameters.

   NOTE: Make sure to align oil hole in camshaft bearing with the oil hole in the cylinder head before pressing camshaft bearing into place.

   Position new camshaft bearing at the bearing bore and press into place using Camshaft Bearing Set T65L-6250-A and Cam Bearing Replacer T71P-6250-A.

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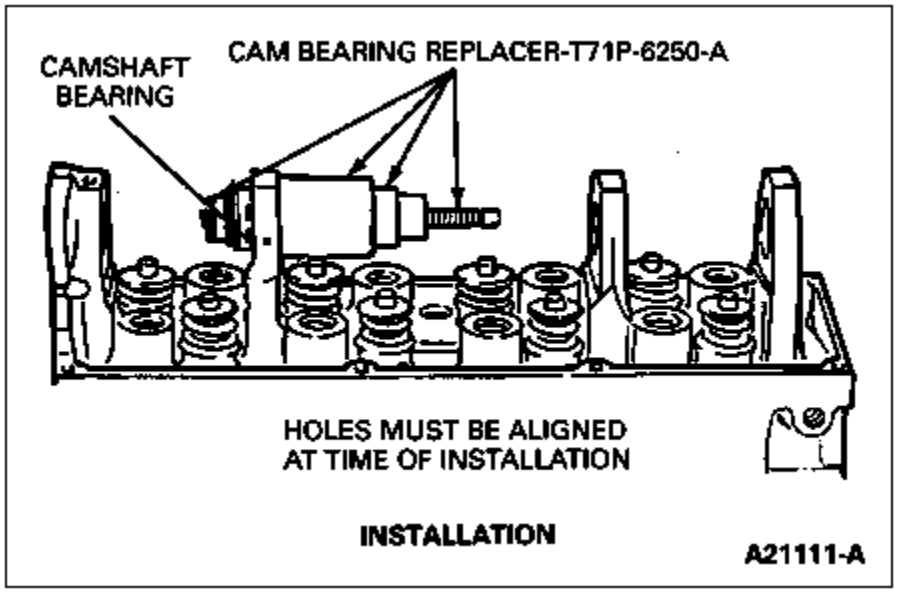

3. Make sure the cup plug is in the rear of the camshaft.
4. Lubricate the camshaft lobes and journals with Motorcraft Super Premium Motor Oil XO-5W30-ASP or equivalent meeting Ford specification ESE-M2C153-E.
5. Carefully slide the camshaft into place through the camshaft bearings. Be careful not to scratch camshaft bearings.
6. Install the camshaft rear retainer. Tighten the two screws to 8-12 Nm (70-106 lb-in).
7. Position camshaft front seal on Front Seals Replacer T74P-6150-A and press into place.
8. Remove tool.

Camshaft

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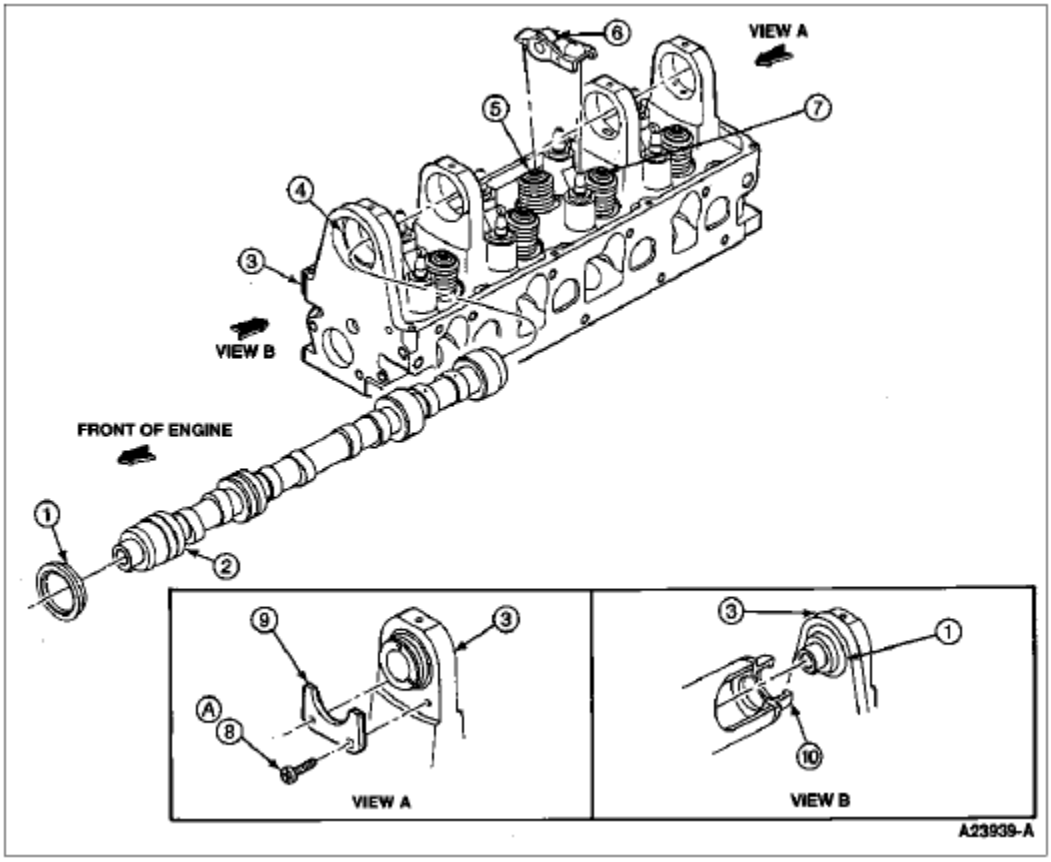

Item	Part Number	Description
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2	6250	Camshaft
3	6049	Cylinder Head
4	6261	Camshaft Bearing
5	6505	Exhaust Valve
6	6564	Rocker Arm
7	6507	Intake Valve
8	N604465-S	Pan Head Screw, M6-1 x 16
9	6613	Auxiliary Shaft Retaining Plate
10	T74P-6150-A	Cam and Auxiliary Shaft Seal Replacer
A	—	Tighten to 8-12 Nm (71-106 Lb-In)

9. Check camshaft end play as outlined in Section 03-00 .
10. Position camshaft sprocket on camshaft.
11. Install Cam Sprocket Holding/Removing Tool T74P-6256-B, without threaded puller insert, on sprocket.

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12. Install sprocket bolt and washer. Tighten to 70-95 Nm (52-70 lb-ft).

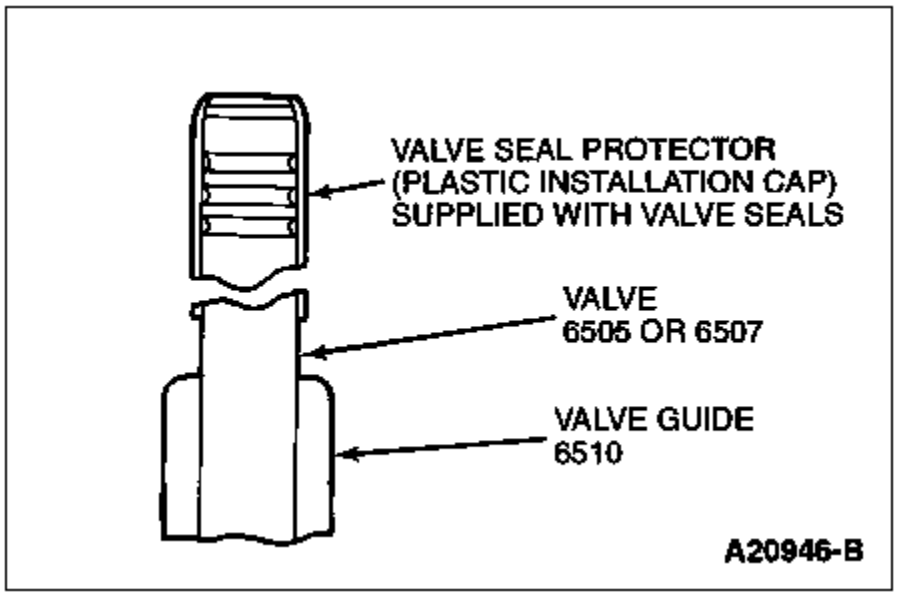
13. Remove tool.

14. Install valve lash adjusters.

15. Install one valve and check valve runout, looseness in guide, and seating as outlined in Section 03-00 .

16. **CAUTION: Install valve seal protector (plastic installation cap) included with valve seal kit over end of valve before installing valve stem seal or valve stem seal will be cut by valve keeper grooves in valve. If valve stem seal is cut it will leak, causing oil burning and valve fouling.**

    Put valve seal protector (plastic installation cap) over end of valve as illustrated.



17. Start valve stem seal carefully over cap. Push valve stem seal down until jacket touches top of guide.

18. Remove seal protector (plastic cap). Use Valve Stem Seal Replacer T95T-6510-B to seat valve stem seal on valve guide.

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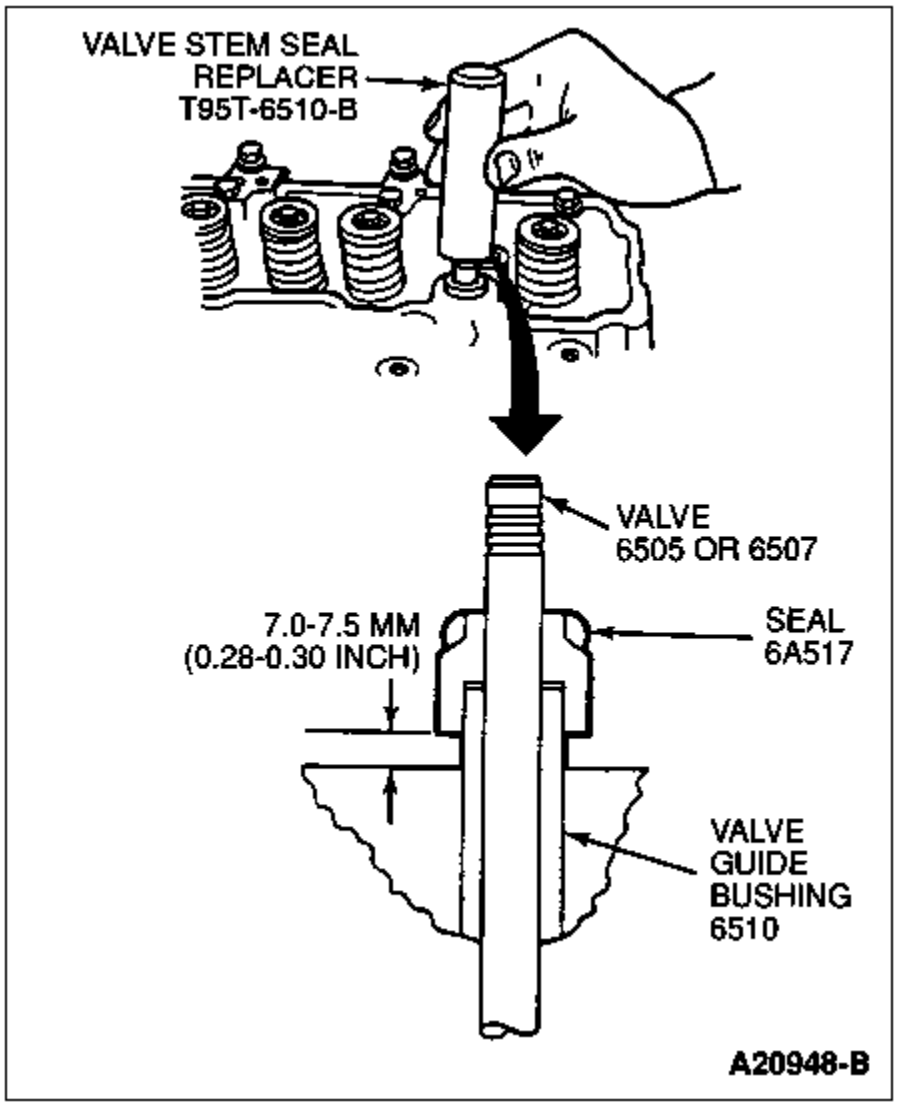

19. Apply a small amount of Ford Multi-Purpose Grease D0AZ-19584-AA or equivalent to valve spring retainer keys to hold them in place during installation.

20. Put valve spring and valve spring retainer into place.

21. **NOTE: Spring must not be compressed beyond a height of 27.5mm (1.08 inch) during assembly.**

    Compress valve spring with Valve Spring Compressor T95T-6565-A and install valve spring retainer keys. Release spring to seat valve spring retainer keys.

22. Check installed height of valve spring assembly:

    a. Measure from cylinder head machined spring pad to top of valve spring. Dimension should be 38.635-40.546mm (1.507-1.581 inch).

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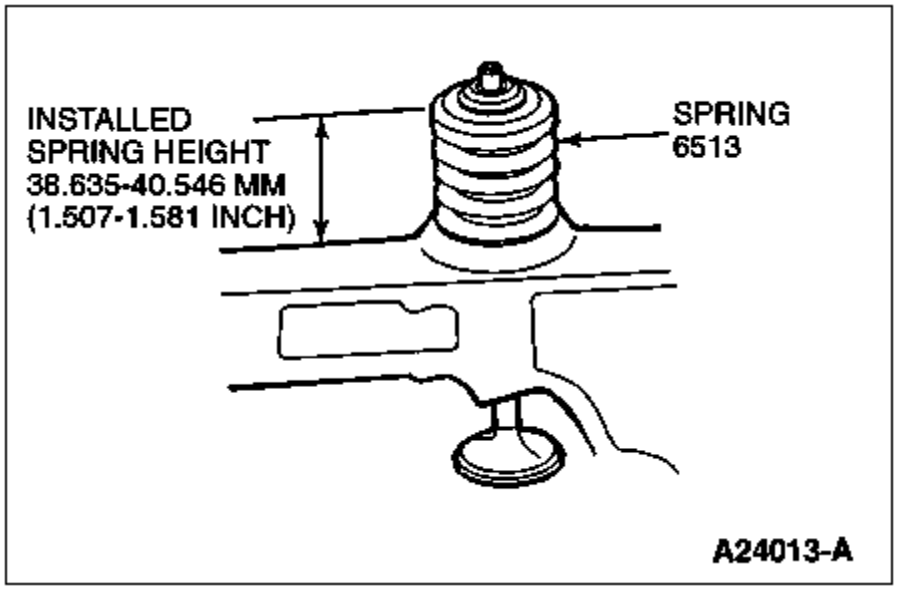

23. Repeat steps 15 through 22 until all valves are installed.

24. Oil contact surfaces of cam followers with clean engine oil.

25. With heel of cam facing down, use Valve Spring Compressor T95T-6565-A to compress and hold down the valve spring. Slide the cam follower into place.

26. **CAUTION: Make sure the affected lash adjuster has been collapsed and released before rotating camshaft.**

    Using Valve Spring Compressor T95T-6565-A, compress and release lash adjuster.

27. Repeat the above steps until all cam followers are installed.

28. Install cylinder head as outlined in this section.

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Piston and Piston Pins

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Piston Pin Removing and Installing Set	T68P-6135-A

Disassembly

1. Remove the connecting rod bearing (6211) from the connecting rod and cap.

   Install the cap on the connecting rod from which it was removed.

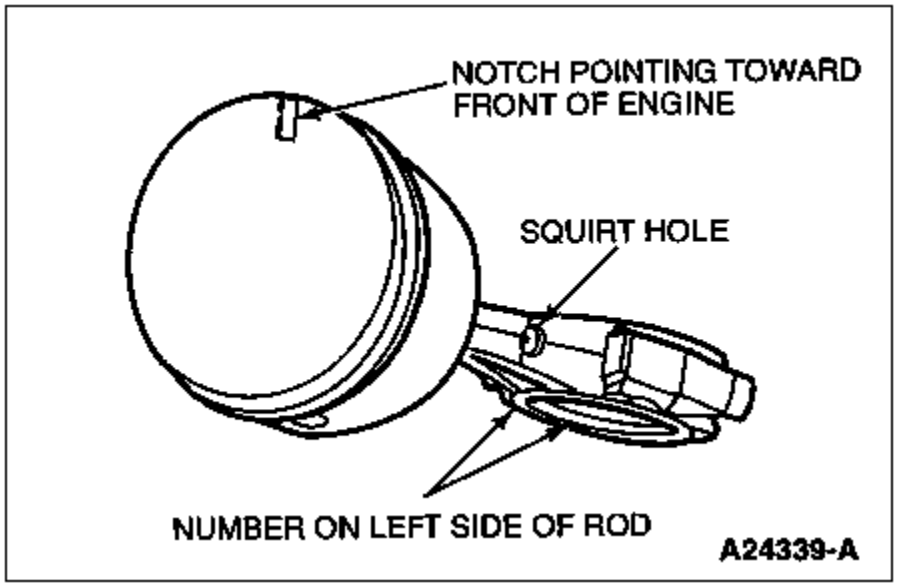
2. Remove the piston rings using a suitable piston ring expander.

3. Store the piston, pin and connecting rod to ensure assembly with the same rod and installation in the same cylinders from which they were removed.

4. Using an arbor press and Piston Pin Removing and Installing Set T68P-6135-A press the piston pin (6135) from the piston and connecting rod (6200).

Assembly

1. Apply a light coat of Motorcraft Super Premium Motor Oil XO-5W30-QSP or equivalent to all parts. Assemble the piston to the connecting rod with the oil squirt holes on the side of the connecting rod and the notch in the piston positioned as shown. Use arbor press and Piston Pin Removing and Installing Set T68P-6135-A.



2. Install the piston rings using a suitable piston ring expander. Check the end gap of all piston rings.

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They must be within specifications of 0.20-0.41mm (0.008-0.016 inch) for top ring, 0.33-0.50mm (0.013-0.019 inch) for second ring, and 0.25-0.76mm (0.010-0.030 inch) for oil control ring.

3. Check the ring side clearance. Refer to Section 03-00 . Side clearance for both compression rings should be 0.041-0.084mm (0.0016-.0033 inch) and a snug fit for the oil control ring.

4. Make sure the connecting rod bearings and the bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause a failure. Install the connecting rod bearings in the connecting rod and cap with the tangs fitting the slots provided.

   Make certain lock slots in cap are on the same side of bore as the lock slot in rod. Avoid nicking crank pin journals during rod installation.

5. Install assembled piston and connecting rod assembly as outlined in this section.

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Cylinder Block Assembly

Disassembly

1. Mount the engine (6007) on a work stand and remove all parts not furnished with the new cylinder blocks (6010), following Engine Disassembly and Assembly in this section.

2. Remove the old cylinder blocks from the work stand.

Assembly

1. Clean the gasket and seal surfaces of all serviceable parts and assemblies.

2. Position the new cylinder blocks on a work stand and transfer all serviceable parts removed from the old cylinder blocks, following Engine Disassembly and Assembly as outlined in this section.

3. Check all assembly clearances and correct as necessary.

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Hydraulic Lash Adjuster

Disassembly and Assembly

NOTE: Do not mix parts from different lash adjusters. Parts are select fit and not interchangeable.

1. Remove snap ring.
2. Remove fulcrum, plunger, and spring.
3. Clean to remove all traces of motor oil and varnish. Make sure check ball is free.
4. To assemble, lubricate parts with clean Super Premium Motor Oil XO-5W30-QSP or equivalent meeting Ford specification ESE-M2C153-E and reverse disassembly steps. If it is necessary to store lash adjusters for some time before installation, protect them from dust and dirt. If not kept clean, they may stick in operation.
5. Perform leak-down test as outlined in Section 03-00 .

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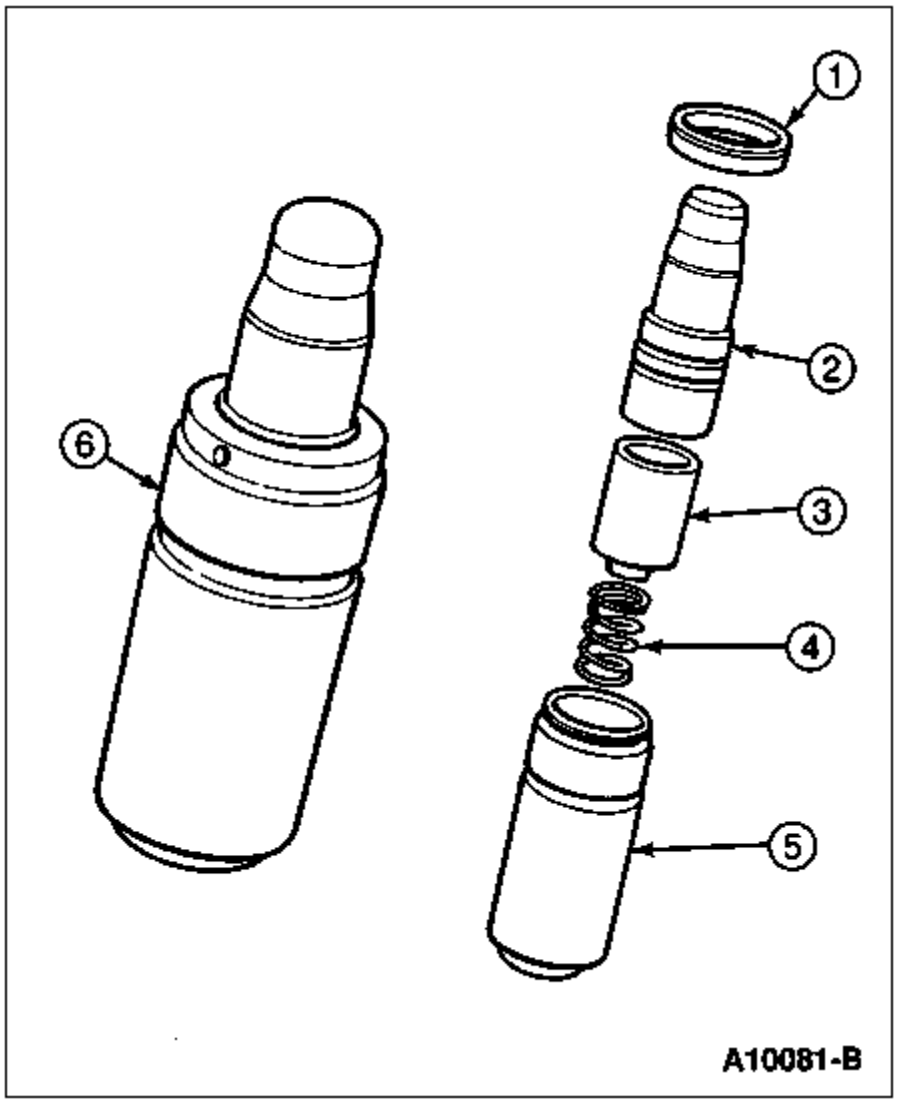

Item	Part Number	Description
1	—	Retaining Ring (Part of 6500)
2	—	Arm Fulcrum (Part of 6500)
3	—	Plunger (Part of 6500)
4	—	Plunger Return Spring (Part of 6500)
5	—	Body (Part of 6500)
6	6500	Valve Tappet (Assembled)

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Cylinder Block, Bare

Before replacing a cylinder blocks (6010) determine if it is repairable. If so, make the necessary repairs following the procedures given in Section 03-00 .

Disassembly

1. Completely disassemble the old engine, following engine Disassembly procedure in this section.
2. Remove core plugs as outlined in Section 03-00 .
3. Remove oil gallery pipe plugs.
4. **NOTE: A rifle-cleaning brush is helpful for cleaning engine oil galleries.**

   Clean cylinder blocks and inspect as outlined in Section 03-00 .

Assembly

1. If using new or reconditioned cylinder blocks, uncrate and clean preservative materials according to suppliers' instructions.
2. Position the new cylinder block in a work stand and install all serviceable parts removed from the old cylinder block, following engine Assembly procedure in this section.
3. Check all assembly clearances and correct as necessary.

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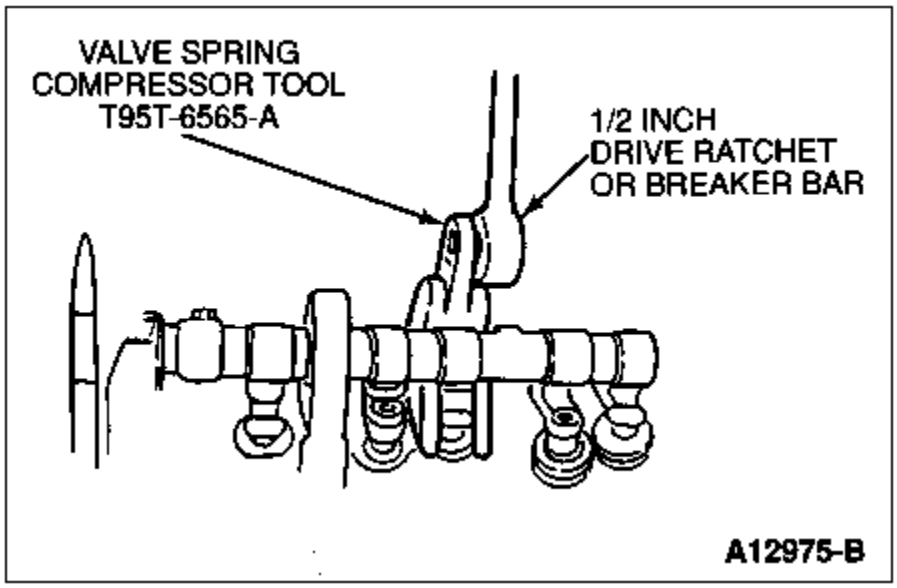
Valve Clearance, Hydraulic Valve Lash Adjuster

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Valve Spring Compressor	T95T-6565-A

1. Position the camshaft (6250) so that the base circle of the lobe is facing the cam follower of the valve to be checked.

2. Using Valve Spring Compressor T95T-6565-A slowly apply pressure to the cam follower until the lash adjuster is completely collapsed. Hold the follower in this position and insert the proper size feeler gauge between the base circle of the cam and the follower.



3. Remove the cam follower and inspect for damage if the clearance is excessive.

4. Measure the valve spring assembled height to make sure the valve is not sticking if the cam follower appears to be intact and not excessively worn.

5. If the valve spring assembled height is correct, check the dimensions of the camshaft. Refer to Camshaft Lobe Lift, Section 03-00 .

6. If the camshaft dimensions are to specifications, remove, clean and test the lash adjuster. Refer to Hydraulic Tappets, Section 03-00 .

7. Install the lash adjuster and check the clearance. Replace damaged or worn parts as necessary.

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Camshaft Timing

Checking Timing

An access plug is provided in the cam drive belt cover so that camshaft timing can be checked without removal of the cover or any other parts.

NOTE: Camshaft and timing belt sprockets turn one revolution for every two revolutions of the crankshaft.

NOTE: If the timing belt has greater than 193,000 km (120,000 miles) of use, the timing belt will need to be replaced. Refer to service procedures in this section.

1. Remove both of the rubber access caps (camshaft sprocket and oil pump sprocket) from the outer timing cover.

2. Rotate crankshaft so that number one cylinder is at the compression stroke of Top Dead Center (TDC). TDC will be indicated when the three timing marks are aligned:

    a. The timing mark on the crankshaft damper assembly will align with "TC" on the outer timing cover.
    b. The triangular timing mark on the camshaft sprocket will align with the timing mark on the inner timing cover.
    c. The diamond timing mark on the engine oil pump socket will align with the timing mark on the inner timing cover.

3. If the diamond or the triangle timing marks cannot be seen through the access holes of the outer timing cover, rotate crankshaft one revolution. TDC will be indicated when the three timing marks are aligned.

4. If the diamond or the triangle timing marks cannot be properly aligned, set the timing mark of the crankshaft damper assembly with "TC" on the outer timing cover. Remove the crankshaft damper assembly and outer timing cover as outlined in this section.

Inspecting Camshaft and Oil Pump Sprocket Timing, 2.3L Engine

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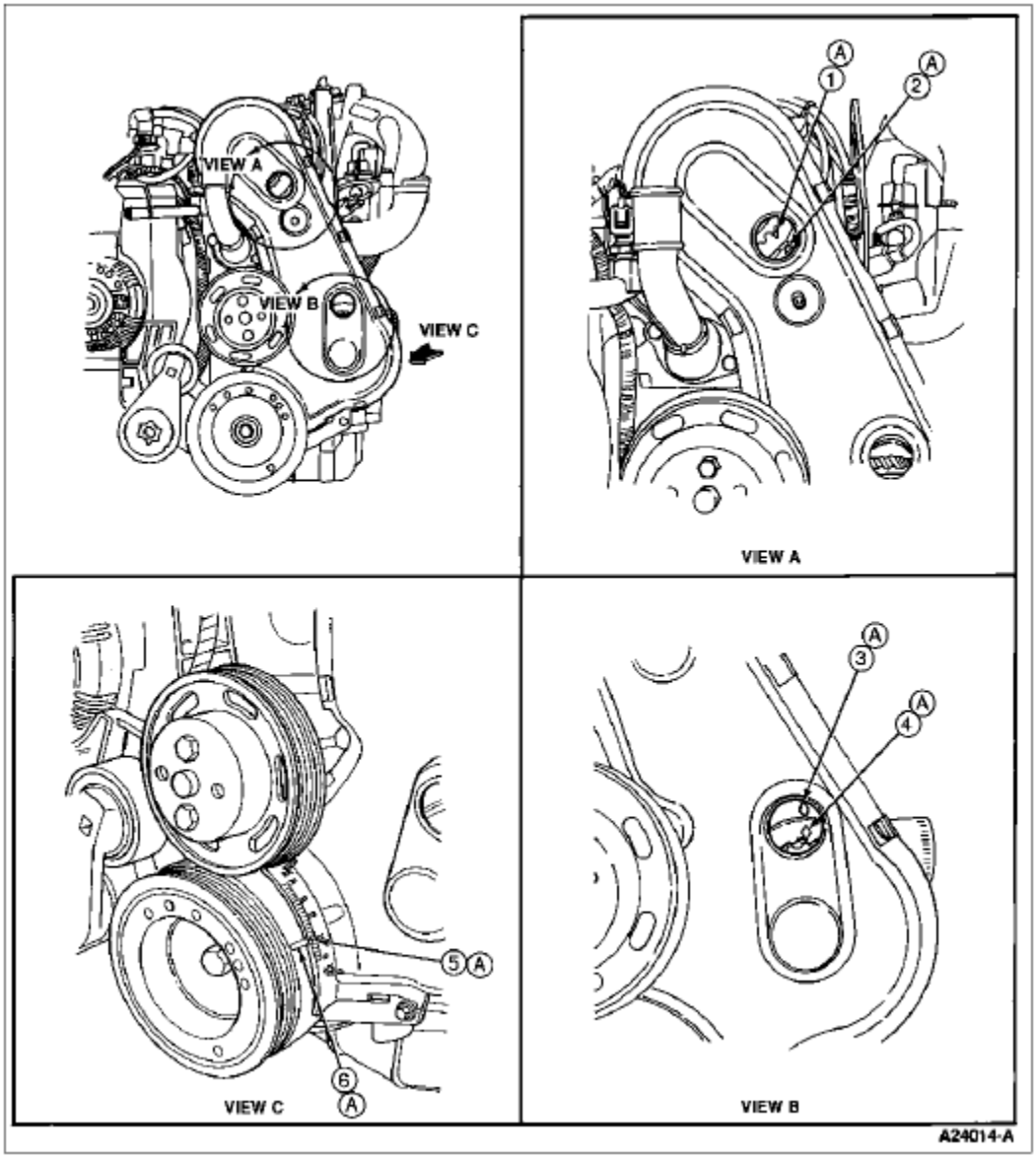

Item	Part Number	Description
1	—	Triangle Mark on Camshaft Sprocket (Part of 6256)
2	—	Triangle Mark on Inner Timing Belt Cover (Part of 6019)
3	—	Diamond Mark on Inner Timing Belt Cover (Part of 6019)
4	—	Diamond Mark on Oil Pump Sprocket (Part of 6526)
5	—	TDC Mark on Outer Timing Belt Cover (Part of 6019)
6	—	Mark (Line) on Crankshaft Pulley (Part of 6316)
A	—	Check Timing According to Text

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Adjusting Timing Belt

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Crankshaft Belt Tension Adjusting Tool	T74P-6254-A

1. Remove the outer timing belt cover as outlined in this section.

2. **NOTE: Timing belt should be replaced at 193,000 km (120,000-mile) intervals. If belt has more than 193,000 km (120,000 miles), replace timing belt as outlined in this section.**

   Inspect belt for cracked or damaged teeth, fraying, cracking, or oil. If belt is worn or damaged, replace. If there is oil on the belt, determine which seal is leaking and replace seal before replacing belt.

3. **CAUTION: Attempting to adjust timing belt tension without loosening spring pivot bolt will break Crankshaft Belt Tension Adjusting Tool T74P-6254-A when relieving tension on the belt.**

   If belt timing or tension is incorrect, loosen timing belt spring pivot bolt.

4. Hold tensioner with Camshaft Belt Tension Adjusting Tool T74P-6254-A.

5. While holding tensioner, loosen adjusting bolt and gradually release spring tension.

Loosening Timing Belt Tensioner, 2.3L

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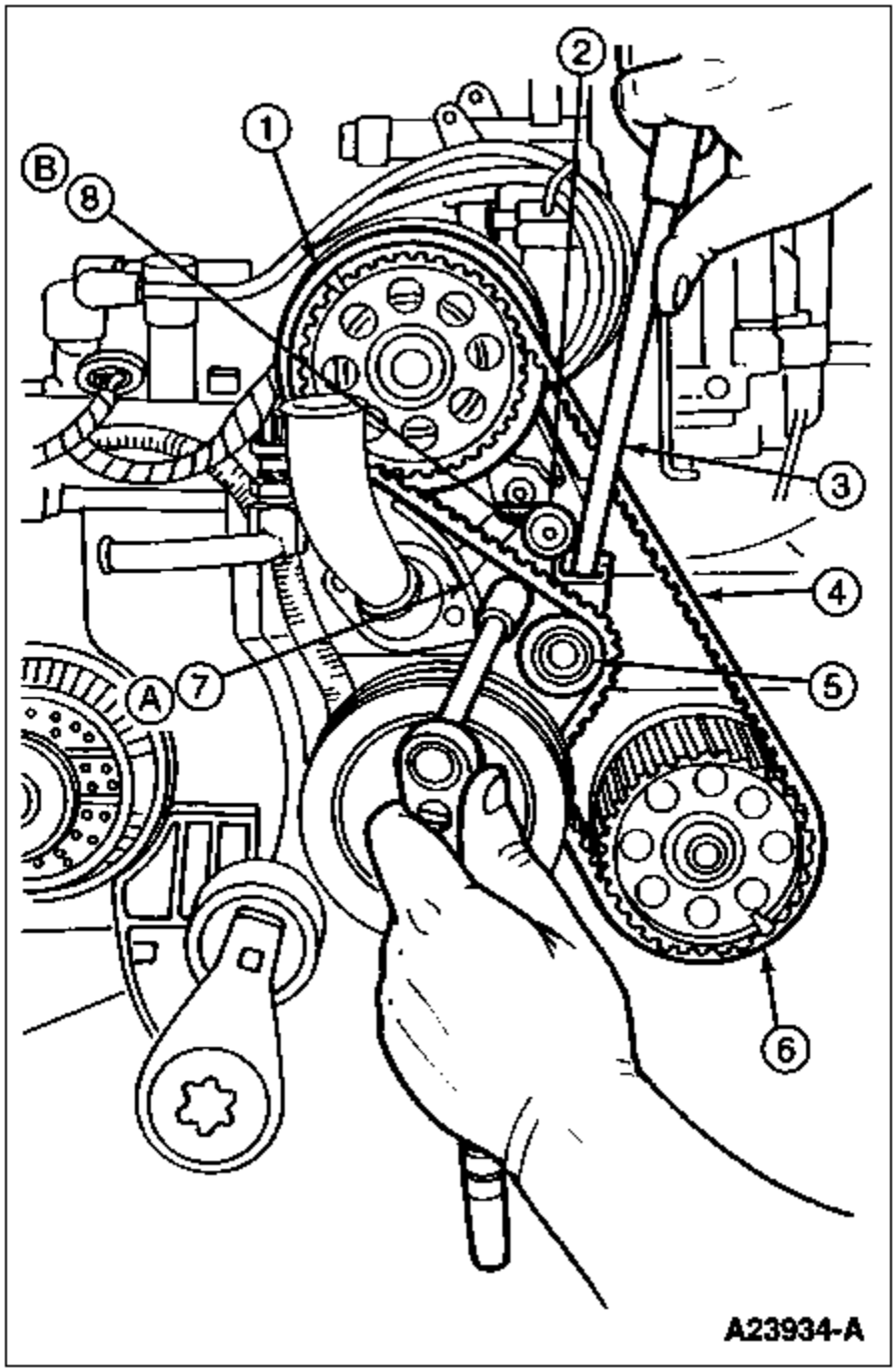

Item	Part Number	Description
1	6256	Camshaft Sprocket
2	6L273	Timing Belt Tensioner Spring
3	T74P-6254-A	Camshaft Belt Tension Adjusting Tool
4	6268	Timing Belt
5	6K254	Timing Belt Tensioner
6	6256	Oil Pump Sprocket

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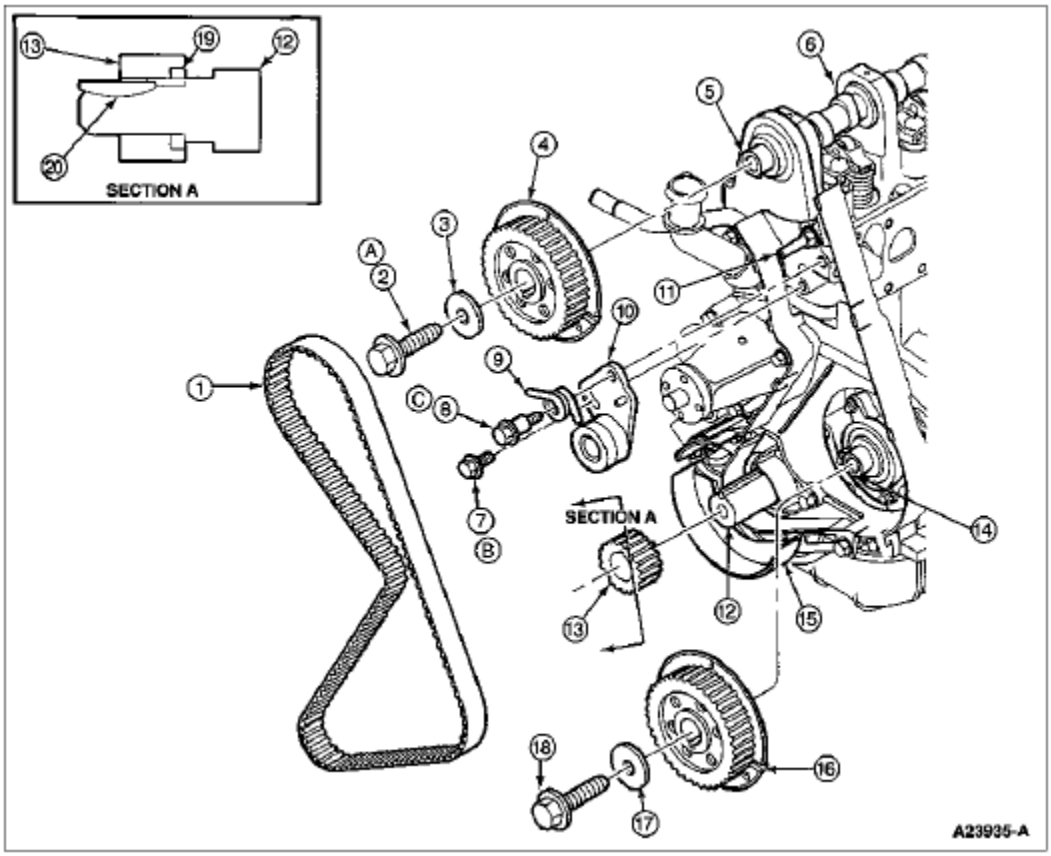
7	N800112-S100	Tensioner Adjusting Bolt, M8-1.25 x 20 (Under Wrench)
8	6K282	Timing Belt Tensioner (Spring Pivot) Bolt
A	—	Tighten to 35-45 Nm (26-33 Lb-Ft) (Refer to Text)
B	—	Tighten to 40-55 Nm (30-40 Lb-Ft) (Refer to Text)

6. Using adjusting tool, pry tensioner away from belt. While holding, tighten adjusting bolt. There should be no tension on belt.

Camshaft Timing Belt, 2.3L I-4



Item	Part Number	Description
1	6268	Timing Belt
2	N600414-S	Bolt, M12-1.75 x 45
3	6278	Washer
4	6256	Camshaft Sprocket
5	6250	Camshaft

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6	6049	Cylinder Head
7	N80012-S100	Bolt, M8-1.25 x 20
8	6K282	Timing Belt Tensioner Bolt
9	6L273	Timing Belt Tensioner Spring
10	6K254	Belt Tensioner Assembly
11	N808049-S102	Stud (Part of 6049)
12	6303	Crankshaft
13	6306	Crankshaft Sprocket
14	6600	Oil Pump
15	6019	Inner Timing Belt Cover
16	6256	Oil Pump Sprocket
17	6278	Camshaft Sprocket Washer
18	N600313-S2	Bolt, M10-1.5 x 40
19	—	Recess (Part of 6306)
A	—	Tighten to 70-95 Nm (51-70 Lb-Ft See Text)
B	—	Tighten to 35-45 Nm (25-33 Lb-Ft) (Refer to Text)
C	—	Tighten to 40-55 Nm (30-40 Lb-Ft) (Refer to Text)

7. Remove bolt, washer, and crankshaft damper.
8. Remove the drive belt and inspect it for wear or damage. If the belt is damaged, replace it.
9. Remove one spark plug (12405) from each cylinder and mark locations on a piece of tape for reinstallation.
10. If not done:
    a. Loosen tensioner adjusting bolt.
    b. Using Camshaft Belt Tension Adjusting Tool T74P-6254-A, pry tensioner clockwise against spring tension as far as possible.
    c. Tighten adjusting bolt to hold tensioner in released position.
11. Align crankshaft (6303) so number one piston (6108) is at TDC (top dead center) as indicated by timing mark.
12. Align circle on crankshaft sprocket with line on engine front cover.
13. Align triangle on camshaft sprocket with triangle on inner timing belt cover.
14. Align diamond on oil pump sprocket with diamond on inner timing belt cover.

Timing Mark Alignment

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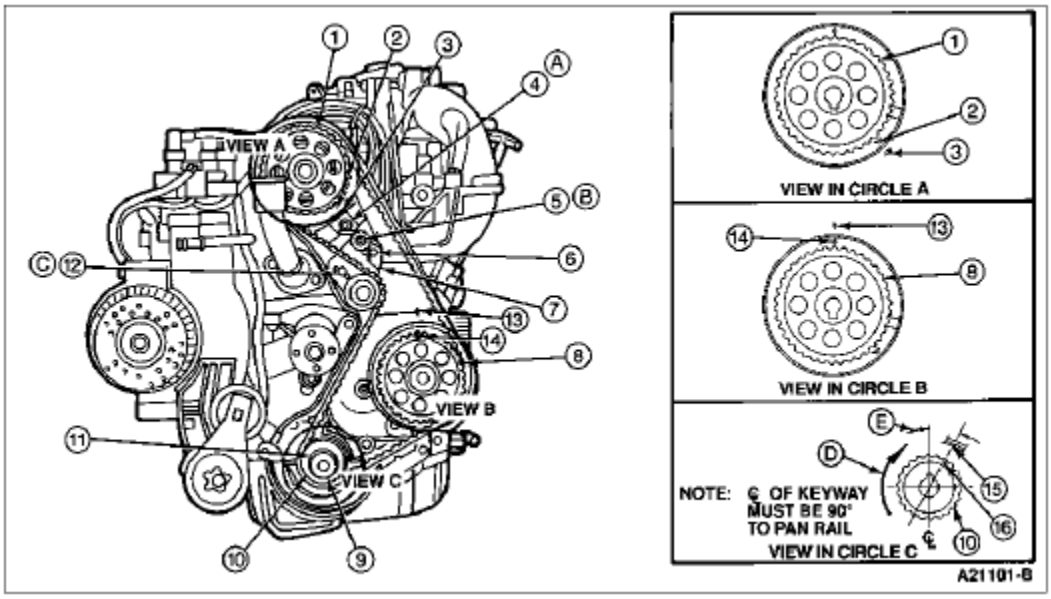

Item	Part Number	Description
1	6256	Camshaft Sprocket
2	—	Pointer Triangle (Part of Camshaft Sprocket)
3	—	Pointer Triangle (on Inner Timing Belt Cover)
4	N808049-S102	Stud, M8 x 1.25
5	6K282	Spring Pivot Bolt
6	—	Stud (Part of 6K254)
7	6K254	Timing Belt Tensioner
8	6256	Oil Pump Sprocket
9	6303	Crankshaft
10	6306	Crankshaft Sprocket
11	N806700-S	Key
12	N800112-S2	Adjusting Bolt, M8-1.25 x 20
13	—	Pointer Diamond (on Inner Timing Belt Cover)
14	—	Pointer Diamond (on Oil Pump Sprocket)
15	—	Pointer Line (Part of 6019)
16	—	Pointer Circle (on 6306)
A	—	Tighten to 20-30 Nm (15-22 Lb-Ft) (Refer to Text)
B	—	Tighten to 40-55 Nm

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		(30-40 Lb-Ft) (Refer to Text)
C	—	Tighten to 35-45 Nm (26-33 Lb-Ft) (Refer to Text)
D	—	Direction of Rotation
E	—	29°

15. Install timing belt over crankshaft sprocket (6306). Then, proceeding counterclockwise, over oil pump sprocket and camshaft sprocket, verify all three timing marks are aligned.

16. Loosen tensioner adjusting bolt allowing tensioner pulley to press against timing belt.

17. **NOTE: When performing the following step, do not rotate crankshaft counterclockwise as timing belt may jump a cog, putting camshaft or oil pump (6600) out of time.**

    Rotate crankshaft two revolutions clockwise.

18. Bring crankshaft slowly, without stopping, to number one cylinder firing position (keyway directly up).

19. Recheck timing mark alignment. Repeat steps if timing marks are no longer properly aligned.

20. Rotate tensioner assembly against bolt with torque wrench up to 41-45 Nm (30-33 lb-ft) and tighten adjusting bolt.

21. Tighten adjusting bolt to 35-45 Nm (26-33 lb-ft).

22. Tighten spring pivot bolt to 40-55 Nm (30-40 lb-ft).

23. Install outer timing belt cover as outlined in this section.

24. Install spark plugs in proper locations.

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SPECIFICATIONS

General Specifications

Item	Specification
Displacement	2.3L (140 Cubic Inches)
Number of Cylinders	4
Bore and Stroke	3.780 x 3.126
Firing Order	1-3-4-2
Oil Pressure (Hot @ 2000 rpm)	40-60
Drive Belt Tension	Refer to Section 03-05 , Accessory Drive
Combustion Chamber Volume (cc)	55.5-58.5
Valve Guide Bore Diameter	0.3433-0.3443
Valve Seats	
Width — Intake	0.068-0.088
Width — Exhaust	.070-.090
Angle	45°
Runout Limit (T.I.R. Max)	0.0020
Valve Arrangement (Front to Rear)	E-I-E-I-E-I-E-I
Valve Lash Adjuster Bore Diameter	0.8430-0.9449
Valve Stem to Guide Clearance	
Intake	0.0010-0.0027
Exhaust	0.0015-0.0032
Service Clearance Limit	0.0055 Max.
Valve Head Diameter	
Intake	1.723-1.747
Exhaust	1.49-1.51
Valve Face Runout Limit	0.002 Max.
Valve Face Angle Limit	44°
Valve Stem Diameter (Std.)	
Intake	.2746-.2754
Exhaust	.2736-.2744
(0.015 Oversize)	
Intake	.2896-.2904
Exhaust	.2886-.2894
(0.030 Oversize)	
Intake	.3046-.3054

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Exhaust	.3036-.3044
Valve Springs	
Compression Pressure (Lb. @ Spec. Length)	
Intake and Exhaust (Installed)	57-63 @ 1.56
Intake and Exhaust (Valve Open)	118-132 @ 1.16
(Valve Closed)	57-63 @ 1.56
Free Length (Approximate)	2.02
Assembled Height	1.54-1.58
Service Limit	5% Pressure Loss @ Specified Length
Out of Square Service Limit	5/64 (0.078)
Rocker Arm (Cam Follower)	
Ratio	1.86:1
Valve Tappet, Lifter or Adjuster	
Diameter (Standard)	0.8422-0.8427
Clearance-to-Bore	0.0007-0.0027
Service Limit	0.005 Max.
Hydraulic Leak-Down Rate (1)	2-8 Seconds
Collapsed Tappet Gap	
Allowable	0.035-0.055 @ Cam
Desired	0.040-0.050 @ Cam

Camshaft Specifications

Item	Specification
Lobe Lift	
Intake	0.2163
Exhaust	0.2163
Theoretical Valve Lift @ Zero Lash	
Intake	0.402
Exhaust	0.402
End Play	0.001-0.007
Service Limit	0.009
Journal-to-Bearing Clearance	0.001-0.003
Service Limit	0.006
Journal Diameter	
No. 1	1.7713-1.7720
No. 2	1.7713-1.7720

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No. 3	1.7713-1.7720
No. 4	1.7713-1.7720
Runout Limit	0.005 Max. T.I.R.
Out-of-Round Limit	0.005 T.I.R. Max.
Front Bearing Location	(2) 0.000-0.010

Cylinder Block Specifications

Item	Specification
Head Gasket Surface Flatness	0.003 in any 6 In. — 0.006 overall
Head Gasket Surface Finish (RMS)	60-150
Cylinder Bore Diameter Surface Finish (CLA) Out-of-Round Limit Out-of-Round Service Limit Taper Service Limit	3.7795-3.7801 18-38 0.0015 0.005 0.010
Main Bearing Bore Diameter	2.3971-2.3979

Crankshaft, Flywheel And Connecting Rod Specifications

Item	Specification
Main Bearing Journal Diameter	2.2059/2.2051 In.
Out-of-Round Limit	0.0006 Max.
Taper Limit	0.0006 per In.
Journal Runout Limit	0.002 Max.
Surface Finish (RMS)	10 Max.
Runout Service Limit	0.005 In.
Thrust Bearing Journal Length	1.201-1.199
Connecting Rod Journal	
Diameter	2.0464-2.0472 In.
Out-of-Round Limit	0.0006 Max.
Taper Limit	0.0006 per Inch Max.
Surface Limit (RMS)	10 Max.
Main Bearing Thrust Face	
Surface Finish (RMS)	35 Front/25 Rear (Max.)

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Runout Limit	0.001 Max.
Flywheel Clutch Face Runout Limit	 0.005 In.
Flywheel Ring Gear Lateral Runout (T.I.R.)	
Standard Transmission	0.025 In.
Automatic Transmission	0.060 In.
Crankshaft Free End Play Limit	0.004-0.008 In.
Service Limit	0.012 In.
Connecting Rod Bearings	
Clearance to Crankshaft	
Desired	0.0008-0.0015 In.
Allowable	0.0008-0.0026 In.
Bearing Wall Thickness (Std.) (3)	0.0619-0.0624 In.
Main Bearings	
Clearance to Crankshaft	
Desired	0.0008-0.0015 In.
Allowable	0.0008-0.0026 In.
Bearing Wall Thickness (Std.) (3)	0.0956-0.0951 In.
Connecting Rod Piston Pin Bore Diameter	23.124-23.144mm (0.9104-0.9112 In.)
Crankshaft Bearing Bore Diameter	55.170-55.190mm (2.1720-2.1728 In.)
Out-of-Round Limit	0.0004 In.
Taper Limit	0.0004 In.
Length (Center-to-Center)	5.4558-5.4591
Alignment (Bore-to-Bore Max. Difference (4)	
Twist	0.003
Bend	0.0015
Side Clearance (Assembled to Crank)	
Standard	0.0035-0.0115
Service Limit	0.014

Piston And Rings Specifications

Item	Specification
Piston	
Diameter (5)	

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Coded Red	95.9688-95.994mm (3.7883-3.7793 In.)
Piston-to-Bore Clearance (Select Fit)	0.254-0.508mm (0.010-0.020 In.)
Service Piston Selection (17)	
Piston Bore Diameter (Cylinder)	Service Piston Required
95.994-96.045mm (3.7793-3.7813 In.)	
Pin Bore Diameter	23.179-23.175mm (0.9124-0.9126 In.)
Ring Groove Width	
Compression (Top)	1.5182-1.5392mm (0.0598-0.0606 In.)
Compression (Bottom)	1.5182-1.5392mm (0.0598-0.0606 In.)
Oil	3.030-3.056mm (0.1193-0.1203 In.)
Piston Pin	
Length	62.29-70.10mm (2.728-2.760 In.)
Diameter	
Standard	23.167-23.170mm (0.9121-0.9122 In.)
0.001 Oversize	23.193-23.195mm (0.9131-0.9132 In.)
0.002 Oversize	23.218-23.221mm (0.9141-0.9142 In.)
Piston-to-Pin Clearance	0.0055-0.0116mm (0.00022-0.00046 In.)
Pin-to-Rod Clearance	Interference Fit
Piston Rings Ring Width Compression (Top)	1.46-1.490mm (0.058-0.059 In.)
Compression (Bottom)	1.46-1.490mm (0.058-0.059 In.)
Side Clearance	
Compression (Top)	0.041-0.084mm (.0016-.0033 In.)
Compression (Bottom)	0.041-0.084mm (.0016-.0033 In.)
Oil Ring	Snug Fit
Service Limit	0.15mm (0.006 In.) Max.
Ring Gap	

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Compression (Top)	0.20-0.41mm (0.008-0.016 In.)
Compression (Bottom)	0.33-0.48mm (0.013-0.019 In.)
Oil (Steel Rail)	0.33-0.76mm (0.010-0.030 In.)

Lubrication System Specifications

Item	Specification
Oil Pump	
Relief Valve Spring Tension (Lbs. Spec. Length)	8.4-10.6 @ 1.32 In.
Driveshaft-to-Housing Bearing Clearance	0.0014-0.0033
Relief Valve-to-Bore Clearance	0.0015-0.0030
Rotor Assembly End Clearance (Assembled)	0.004 Max.
Outer Race-to-Housing Clearance	0.0055-0.0125
Oil Capacity (Quarts U.S.)	6

Torque Specifications — Special Applications

Item	Torque		
	Size	Nm	Lb-Ft
Oil Pump Shaft Sprocket Bolt	M-10	40-55	28-40
Belt Tensioner (Timing Pivot Bolt)	M-10	40-55	28-40
Belt Tensioner (Timing) Adjusting Bolt	M-8	35-45	14-21
Camshaft Sprocket Bolt	M-12	70-95	50-71
Camshaft Thrust Plate Bolt	M-6	8-12	6-9
Connecting Rod Nut (10)	M-9	41-49	30-36
Crankshaft Pulley Bolt	M-14	125-165	103-133
Cylinder Head Bolt (11)	M-12	—	—
Exhaust Manifold to Cylinder Heat Bolt, Stud or Nut (12)	M-10	20-30, then 60-80	15-22, then 45-59

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Flywheel to Crankshaft Bolt	M-10	73-87	56-64
Intake Manifold to Cylinder Head Bolt/Nut (13)	M-8	26-38	19-28
Main Bearing Cap Bolt (14)	M-12	102-115	75-85
Oil Pressure Sending Wire to Block	—	11-24	8-18
Oil Pump Screen Tube and Cover to Block	M-8	20-30	15-22
Oil Pan Drain Plug to Pan	M-14	20-34	15-25
Oil Pan to Block	M-6	13-16	10-12
Oil Filter Insert to Cylinder Block	—	28-35	20-25
Oil Filter to Engine	(15)	13-15	115-133 (Lb-In)
Rocker Arm Cover to Cylinder Head	M-6	9-13	80-115 (Lb-In)
Spark Plug to Cylinder Head	M-14	9-20	7-15
Engine Coolant Temperature Sending Unit to Block	—	11-24	8-18
Crankshaft Position Sensor Bolt	M6	8-12	6-9
Camshaft Position Sensor Bolt	M5	5-7	45-62 (Lb-In)
Water Jacket Drain Plug to Block	—	16-24	12-18
Water Pump to Block Bolt	M-8	20-30	15-22
EGR Valve to Spacer Bolt	M-8	20-30	15-22
EGR Tube to Exhaust Manifold Conn.	—	34-47	25-35
Oil Pump Bolt	M-6	10-14	88-123 (Lb-In)
Water Outlet Connection Bolt	M-8	20-30	15-22
Cylinder Front Cover Bolt	M-6	13-16	116-141 (Lb-In)
Inner Timing Belt Cover Stud	M-8	20-30	15-22
Outer Timing Belt Cover Bolt	M-6	8-12	6-9
Transmission-to-Engine Bolts	M-10	38-51	28-38
Crankcase Vent Baffle to Cylinder Block	M6	8-12	6-9
Oil Separator Bolt	M6	8-12	6-9
Engine Coolant Temperature Sensor to Water Outlet Connector	—	16-24	12-18
Rear Lifting Eye Nuts	M8	20-30	15-22
42 Pin Connector Bracket to Lower Intake Manifold	M8	20-30	15-22
Generator Bracket to Cylinder Head and Block (Sequence Required)	M10	40-55	30-40
Ignition Coils to Generator Bracket	M5	5-7	44-62 (Lb-In)
EVR Solenoid to Generator Bracket	M8	8-12	6-9
Upper to Lower Intake Manifold	M8	7-10, then 26-	5-8, then 20-

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		38	28
Vacuum Fitting to Upper Intake Manifold	—	16-24	12-18
Front Lifting Eye (Bolt/Nut)	M8	20-30	15-22
Converter-to-Exhaust Manifold Bolts	—	34-36	25-34
Power Steering Pump-to-Engine Bolts	—	21-28	16-20

(1) Time required for plunger to leak down 3.18mm (1/8 in.) of travel with 22.68 kg (50 lb.) load leak-down fluid in lash adjuster.

(2) Distance in inches that front bearing is installed below front face of bearing tower.

(3) 0.002 undersize = add 0.001 to standard thickness.

(4) Pin bore and crank bearing bore must be parallel and in the same vertical plane, within the specified total difference when measured at the ends of an 8 in. bar — 4 in. on each side of rod centerline.

(5) Measured at 14.58mm from bottom of skirt, centerline — 90°to the pin.

(6) Add one quart with filter change.

(7) On engine, temperature normal, curb idle, in neutral, brakes set.

(8) Pump to tank return line pinched off, new fuel filter in line.

(9) Smallest orifice = no less than 0.220 in. I.D.

(10) Torque in sequence in two steps:

- Step 1 — 34-41 Nm (25-30 lb-ft).
- Step 2 — 39-41 Nm (28-30 lb-ft).

(11) Install cylinder head bolts in sequence. Tighten in sequence to 70 Nm (51 lb-ft). Retighten in sequence to 70 Nm (51 lb-ft). Turn all cylinder item bolts an additional 90-100 degrees in sequence.

(12) Torque in sequence in two steps:

- Step 1 — 20-30 Nm (15-22 lb-ft).
- Step 2 — 60-80 Nm (44-59 lb-ft).

(13) Torque in sequence in two steps:

- Step 1 — 7-10 Nm (62-88 lb-in).
- Step 2 — 26-38 Nm (19-28 lb-ft).

(14) Torque in sequence in two steps:

- Step 1 — 68-81 Nm (50-60 lb-ft).
- Step 2 — 102-115 Nm (75-85 lb-ft).

(15) 1/2 turn after gasket contacts surface — oil gasket.

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Valve Cover and Gasket

NOTE: The rocker covers installed on the 3.0L engine incorporate integral (built-in) gaskets which should last the life of the vehicle. Be sure to adhere to the following steps when removing and replacing rocker covers. Replacement gaskets are available if required.

Removal

1. Disconnect battery ground cable (14301) and set aside.

2. Disconnect the crankcase ventilation hose from the air cleaner outlet tube. Disconnect the wiring connectors from the mass air flow (MAF) sensor, intake air temperature (IAT) sensor, and the harness locator from the outlet tube. Loosen the clamps at the throttle body and air cleaner and remove the outlet tube.

3. Remove air cleaner outlet tube.

4. Disconnect the canister purge hose from the canister purge valve at the LH frame rail and the locator from the accelerator control bracket. Remove the accelerator control splash shield.

5. Disconnect the throttle cable (09A758A) and speed control cable (9A825) from the throttle body and the locator at the top of the intake manifold. Remove the cable bracket retaining bolts and remove bracket with cables attached. Position the bracket and cables out of the way.

6. Disconnect the wiring connectors from the coil connector, radio noise suppressor, the EVR and left side spark plug wires from coil. Disconnect right side spark plug wires from the locators and wires from the spark plugs. Disconnect the vacuum hose from the EVR and heater control tee. Remove the brace from the coil bracket and the exhaust manifold. Remove the coil assembly.

7. Disconnect the right side valve cover harness locators. Disconnect the IAT harness locator from the generator bracket. Remove the right side valve cover and gasket.

8. Disconnect the DPFE vacuum hoses and the wiring connector. Remove the EGR valve tube from the valve and exhaust manifold.

9. Disconnect the vacuum hoses from the brake booster, EGR, and the engine vacuum harness from upper intake and position the harness out of the way.

10. Disconnec the wiring connectors from the throttle position sensor (TPS) and idle air control (IAC). Disconnect the 42-pin connector from the bracket at the rear of intake manifold. Remove the positive crankcase ventilation (PCV) valve from the valve cover.

11. Remove the upper intake manifold and gasket. Tape the lower intake openings closed.

12. Disconnect the left side spark plug wire locators and wires from the spark plugs. Remove the left side valve cover and gasket.

13. **NOTE: Do not clean the valve cover gasket with solvent. Damage to the valve cover gasket may occur.**

    Clean the valve covers and mating surfaces.

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14. Clean upper intake manifold and mating surfaces.

Installation

1. **NOTE: Use Silicone Gasket and Sealant F6AZ-19562-AA or equivalent meeting Ford specification WSE-M4G323-A6.**

   Apply sealant and install the left valve cover and a new gasket. Tighten the bolts to 14 Nm (10 lb-ft).

2. **NOTE: Use Silicone Gasket and Sealant F6AZ-19562-AA or equivalent meeting Ford specification WSE-M4G323-A6.**

   Apply sealant and install the right valve cover and a new gasket. Tighten the bolts to 14 Nm (10 lb-ft).

3. Route the left side spark plug wires and connect the wires to the locators on the valve cover and to the spark plugs.

4. **NOTE: Tighten the bolts in sequence in two steps.**

   Remove the tape from the lower intake manifold and install a new gasket. Install upper intake manifold, and the three bolts and the three stud bolts. Tighten the bolts in two steps. Tighten to 20 Nm (14 (lb-ft) then tighten to 25 Nm (18 lb-ft). Route and connect the PCV valve and hose.

5. Connect the brake booster vacuum, EGR valve and the engine vacuum harness to the upper intake manifold.

6. Install the coil and bracket assembly to the upper intake manifold. Install the coil bracket brace to the bracket and exhaust manifold. Tighten the retainers to 18 Nm (13 lb-ft).

7. Connect the wiring connectors to the coil connector, radio noise suppressor, EVR vacuum and electrical connectors, left side spark plug wires to the coil and right side spark plug wires to the spark plugs.

8. Connect the right side valve cover harness locators. Connect the heater control vacuum hose source to the engine vacuum harness. Connect the IAT harness locator to the generator bracket.

9. Install the EGR valve tube. Tighten the tube nut to 20 Nm (15 lb-ft). Tighten the bolt to 16 Nm (11 lb-ft). Connect the DPFE vacuum hoses and electrical connector.

10. Connect the throttle cable (09A758A) and speed control cable (9A825) to the throttle body and locator. Install the bracket with cables attached to the throttle body. Tighten the bolts to 10 Nm (89 lb-in).

11. Connect the canister purge hose to the valve and the locator to the accelerator control bracket. Install the accelerator control splash shield.

12. Connect the wiring connectors to the TPS and IAC and the 42-pin connector to the bracket at the rear of the intake manifold.

13. Install the outlet tube and tighten the clamps securely. Connect the crankcase ventilation hose to the air cleaner outlet tube. Connect the wiring connectors to the MAF sensor, IAT sensor, and the harness locator to the outlet tube.

14. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its**

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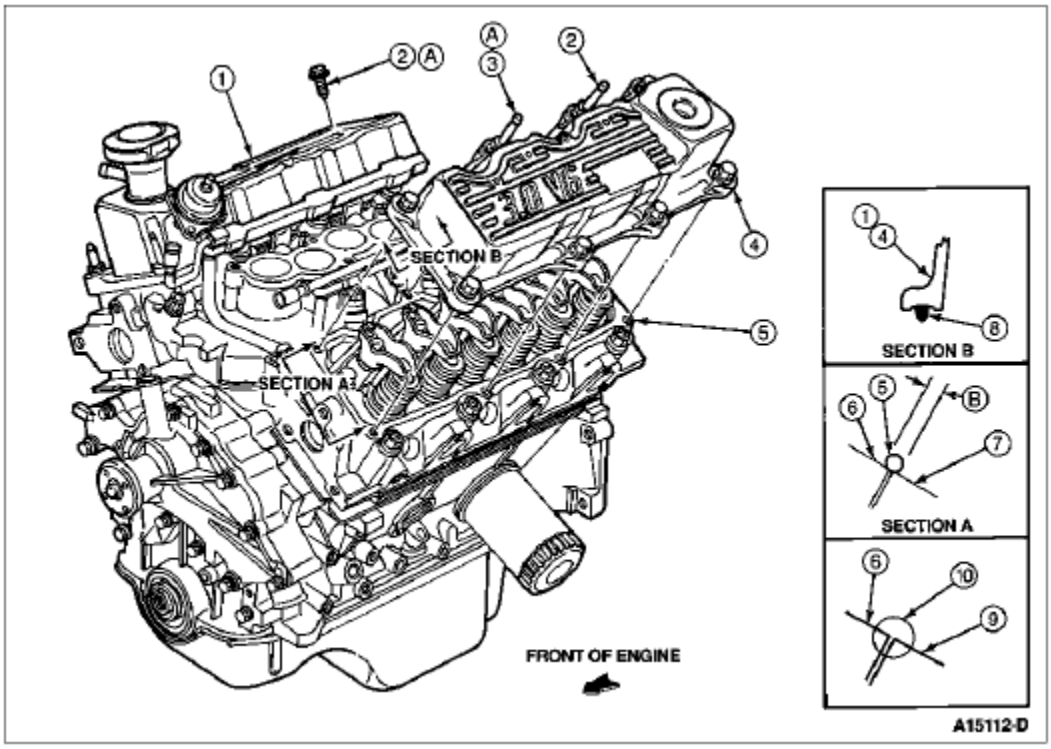
adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.

Connect battery ground cable .

Valve Cover Installation, Ranger



Item	Part Number	Description
1	6582	Valve Cover (RH)
2	N803298-S	Screw and Washer
3	N803262-S	Stud
4	6582	Valve Cover (LH)
5	ESE-M4G195-B	Sealer
6	9424	Intake Manifold
7	6049	Cylinder Head
8	6584	Valve Cover Gasket
9	6049	Cylinder Head
10	—	Intersection of Head and Intake Manifold Must Be Flush to Within ± 1mm (0.04 In.). Gasket Must Not Protrude Above Highest Surface.
A	—	Tighten to 10-14 Nm

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		(7-10 Lb-Ft)
B	—	4-6mm (.15-.23 In.)

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Rocker Arm

Refer to Valve Tappet, Hydraulic In-Vehicle Service for removal and installation of the rocker arms. Perform only the steps necessary to remove the rocker arms.

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Valve Tappet, Hydraulic

NOTE: Before replacing a tappet for noisy operation, make sure the noise is not caused by improper valve-to-rocker arm clearance or by worn rocker arms or push rods. Refer to Section 03-00 .

Removal

1. **NOTE: On 3.0L Aerostar it is necessary to remove the engine (6007) from the vehicle to perform this procedure. Refer to Engine Assembly, Aerostar , Removal and Installation, in this section.**

   Disconnect ground cable at battery and set aside.

2. Drain engine cooling system.

3. Remove PCV closure hose from valve cover (6582) and air cleaner outlet tube.

4. Remove air cleaner outlet tube from throttle body (9E926) and engine air cleaner (ACL) (9600).

5. **WARNING: COVER THE VALVE WITH A SHOP RAG TO PREVENT ACCIDENTAL FUEL SPRAY INTO THE EYES.**

   Carefully relieve fuel pressure at fuel supply manifold fuel pressure relief valve as outlined in Section 03-04B .

6. Remove fuel tube clips. Disconnect fuel lines as outlined in Section 03-04B .

7. Mark location of vacuum lines and remove.

8. Disconnect electrical connectors of:

   - Intake air temperature sensor (IAT sensor) (12A697)
   - Idle air control valve (IAC valve) (9F715)
   - Engine coolant temperature sensor (ECT sensor) (12A648)
   - Camshaft position sensor (12A112)
   - Ignition coil
   - Radio ignition interference capacitor (18801)
   - Water temperature indicator sender unit (10884)
   - EGR pressure sensor, if equipped
   - EGR vacuum regulator control, if equipped

9. Disconnect upper radiator hose from thermostat housing. After loosening hose clamp, use a twisting motion on hose to loosen from housing.

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10. Remove ignition coil and bracket assembly (two nuts) from top of throttle body and pencil brace at exhaust manifold.

11. Remove throttle body, refer to Section 03-04B .

12. Disconnect fuel injector harness retaining standoffs from inboard rocker arm cover studs. Carefully disconnect electrical connections to each fuel injector and remove fuel charging wiring (9D930) from engine.

13. Disconnect heater water hoses at engine.

14. Remove spark plug wire set (12281) from spark plugs (12405) by using a twisting motion on the rubber boot. Remove harness retaining standoffs from rocker arm cover studs.

15. Remove valve covers as outlined in this section.

16. **NOTE: Intake manifold (9424) may be removed with fuel injection supply manifold (9F792) and fuel injectors in place.**

    Remove intake manifold retaining bolts using a Torx® head socket. Before attempting to remove intake manifold, break the seal between the manifold and cylinder blocks (6010). Wedge a large screwdriver or similar heavy-duty tool between the intake manifold and the cylinder blocks. Pry upward on the tool using the lug on top of the engine front cover (6019) as a leverage point. Removal of generator (GEN) (10300) may be required for this step. Use care to prevent damage to machined surfaces.

17. Loosen rocker arm bolt of the valve tappet (6500) to be replaced enough to allow the rocker arm (6564) to be lifted off the push rod (6565) and rotated to one side.

18. Remove push rods. If more than one is removed, identify each push rod's location. The push rods should be installed in their original location and position during reassembly.

19. Loosen roller tappet guide plate retainer bolts (2). Remove tappet guide plate retainer from tappet valley.

20. Remove valve tappet guide plate (6K512) from valve tappets by lifting straight up.

21. **NOTE: If the valve tappets are stuck in the bore(s) due to excessive varnish or gum deposits, it may be necessary to use a claw-type tool to aid removal. Work the valve tappet in and out of the lifter bore to loosen it from the deposits.**

    To remove, grasp valve tappet and pull in line with bore.

Installation

NOTE: Lightly oil all bolt and stud threads before installation.

1. **CAUTION: Aluminum components gouge easily, which may result in gasket leaks. Always use care when scraping aluminum gasket surfaces.**

   Clean mating gasket surfaces of intake manifold and cylinder head (6049). Lay a clean cloth or shop rag in the tappet valley to catch any gasket material. After scraping, carefully lift cloth from tappet

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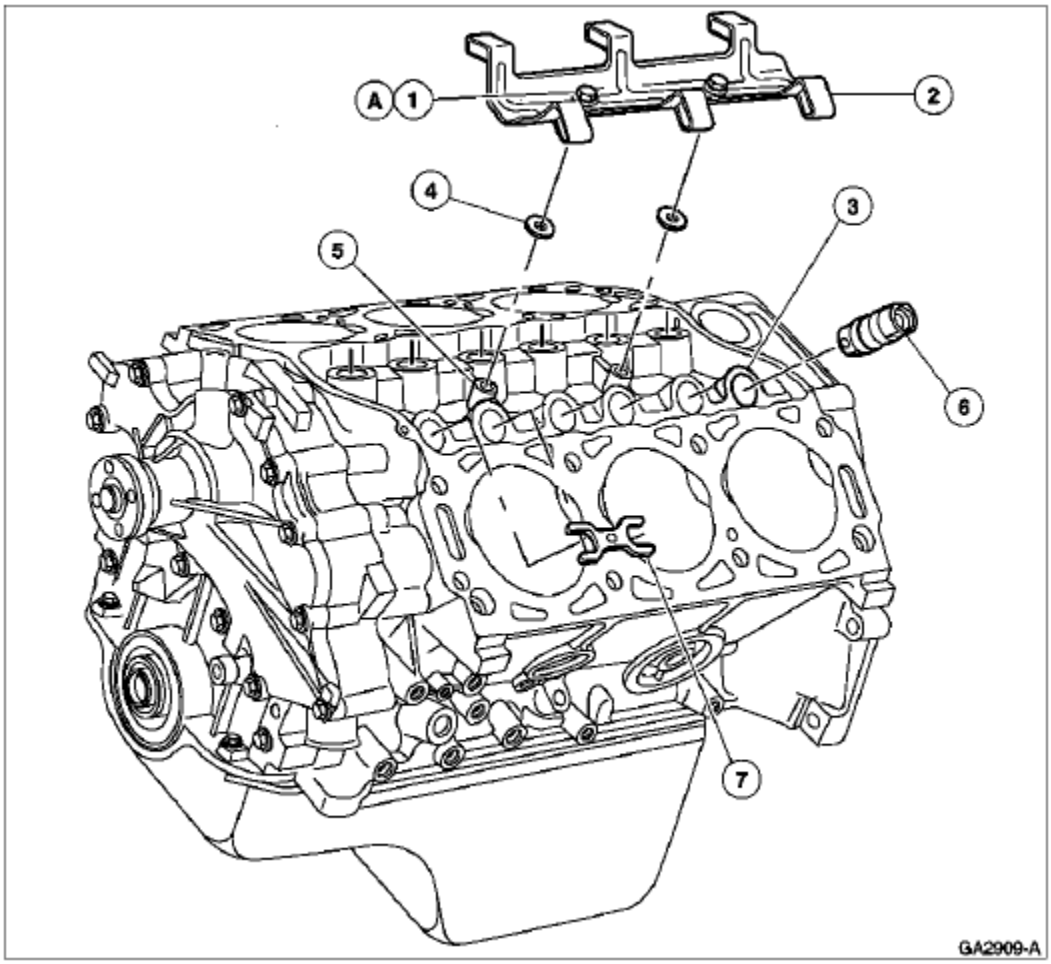
valley preventing any particles to enter oil drain holes or cylinder head. Use a suitable solvent to remove old rubber sealant.

2. Lubricate valve tappets and bore with Engine Assembly Lubricant D9AZ-19579-D or equivalent meeting Ford specification ESR-M99C80-A.



Item	Part Number	Description
1	—	Bolt (Part of 6K564)
2	6K564	Tappet Guide Plate and Retainer
3	—	Cylinder Block Assembly Tappet Bore (Part of 6010)
4	—	Washer (Part of 6K564)
5	—	Cylinder Block Assembly Guide Plate Retainer (Part of 6010)
6	6500	Valve Tappet
7	6K512	Valve Tappet Guide Plate
A	—	Tighten to 10-14 Nm (7-10 Lb-Ft)

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3. Install valve tappet into bore.

4. **NOTE: Install plate with the word "UP" and button visible.**

   Align valve tappet flats. Install valve tappet guide plate.

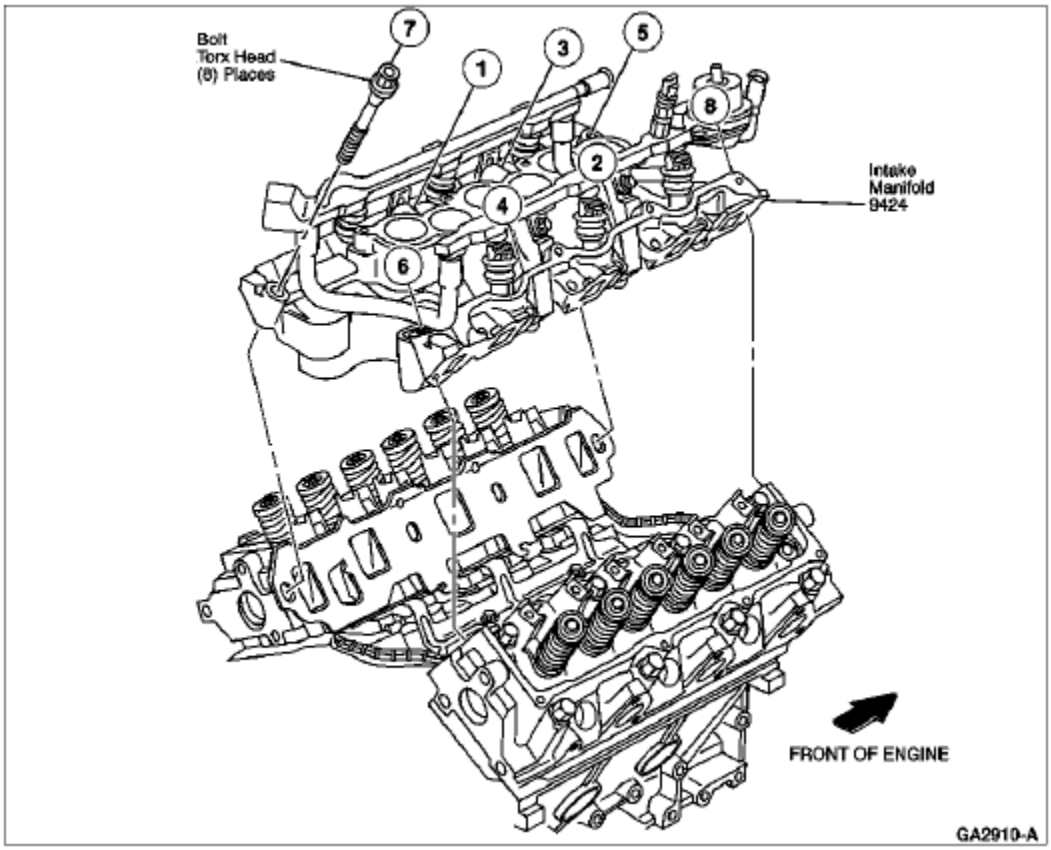
5. Install tappet guide plate retainer over valve tappet guide plates. Retainer orientation is not important. Hand-start two retaining bolts. Tighten bolts to 10-14 Nm (7-10 lb-ft).

6. Apply a 5-6mm drop of Silicone Rubber D6AZ-19562-AA or -BA or equivalent meeting Ford specification ESB-M4G92-A or ESE-M4G195-A to intersection of cylinder block and cylinder head assembly at four corners as shown in the illustration under Intake Manifold in this section.

7. Position intake manifold gaskets (9439) onto cylinder heads. Align the intake gasket locking tabs to the provisions on the cylinder head gaskets as shown in the illustration.

8. Install front and rear intake manifold seals as shown in the illustration under Intake Manifold in this section. Secure with retaining features.

9. Lower intake manifold into position aligning manifold bolt holes to those in the cylinder head. Use care to prevent disturbing the rubber sealer which can cause sealing voids. Install bolts 1, 2, 3 and 4 and hand-snug. Install remaining bolts and tighten in a two-step process. Tighten in numerical sequence to 15 Nm (11 lb-ft), then again to 26-32 Nm (19-24 lb-ft).



10. **NOTE: Rocker arm must be fully seated into cylinder head and push rod must be fully seated in rocker arm and lifter sockets prior to final-tightening.**

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Apply ESE-M2C39-F oil to removed push rods and rocker arms. Install push rods. Move rocker arms into position with push rod and snug rocker arm bolts. Rotate crankshaft (6303) to position camshaft lobe(s) straight down and away from push rods. Tighten rocker arm bolt to 11 Nm (8 lb-ft) to seat rocker arm into cylinder head. Final-tighten bolt to 26-38 Nm (19-28 lb-ft).

11. Install valve covers as outlined in this section.

12. Install fuel charging wiring to each fuel injector. Secure with standoffs to inboard rocker arm cover studs.

13. Install throttle body assembly and new intake manifold upper gasket (9H486) as outlined in Section 03-04B . Install ignition coil and bracket assembly (Ranger only). Tighten retaining nuts to 16-20 Nm (12-15 lb-ft).

14. Install spark plug wire set and bracket RH and/or spark plug wire set LH. Install wire harness standoffs to rocker arm cover studs and connect wires to spark plugs and ignition coil.

15. Install fuel lines to fuel injection supply manifold as outlined in Section 03-04B .

16. Install fuel tube clips.

17. Install upper radiator hose and heater water hoses. Tighten hose clamps securely.

18. Connect vacuum lines to premarked locations.

19. Connect electrical connections of:

    - Intake air temperature sensor
    - Idle air control valve (IAC valve)
    - Engine coolant temperature sensor
    - Distributor
    - Ignition coil
    - Radio ignition interference capacitor
    - Water temperature indicator sender unit
    - EGR pressure sensor, if equipped
    - EGR vacuum regulator control, if equipped

    Refer to Section 18-01 for further information.

20. **NOTE: Engine coolant is corrosive to all engine bearing material. Replacing oil after removal of a coolant carrying component prevents failure later.**

    Fill and bleed cooling system with specified coolant and proper mixture.

21. Replace crankcase oil and filter.

22. Install air cleaner outlet tube to throttle body and engine air cleaner. Tighten retaining clamps to 1.9 Nm (17 lb-in).

23. Install PCV closure hose to valve cover and air cleaner outlet tube.

24. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the**

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strategy.

Connect ground cable at battery.

25. Start engine and check for coolant, oil fuel and vacuum leaks.

26. Verify and correct default base initial engine timing to 10 degrees BTDC. Refer to the Powertrain Control/Emissions Diagnosis Manual.

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Intake Manifold

Upper

Refer to Section 03-04B for throttle body removal and installation procedures.

Lower

Removal

1. Disconnect ground cable at battery and set aside.
2. Drain engine cooling system.
3. Remove PCV closure hose from valve cover (6582) and air cleaner outlet tube.
4. Remove air cleaner outlet tube from throttle body (9E926) and engine air cleaner (ACL) (9600).
5. **CAUTION: Cover the fuel pressure relief valve with a shop rag to prevent accidental fuel spray into the eyes.**

   Carefully relieve fuel pressure at fuel pressure relief valve as outlined in Section 03-04B .
6. Remove fuel tube clips. Disconnect fuel supply and return lines as outlined in Section 03-04B .
7. Mark location of vacuum lines and remove.
8. Disconnect electrical connectors of:

   - Intake air temperature sensor (IAT sensor) (12A697)
   - Idle air control valve (IAC valve) (9F715)
   - Engine coolant temperature sensor (ECT sensor) (12A648)
   - Camshaft position sensor (12A112)
   - Ignition coil
   - Radio ignition interference capacitor (18801)
   - Water temperature indicator sender unit (10884)
   - EGR pressure sensor, if equipped
   - EGR vacuum regulator control, if equipped

   Refer to Section 18-01 for further information.

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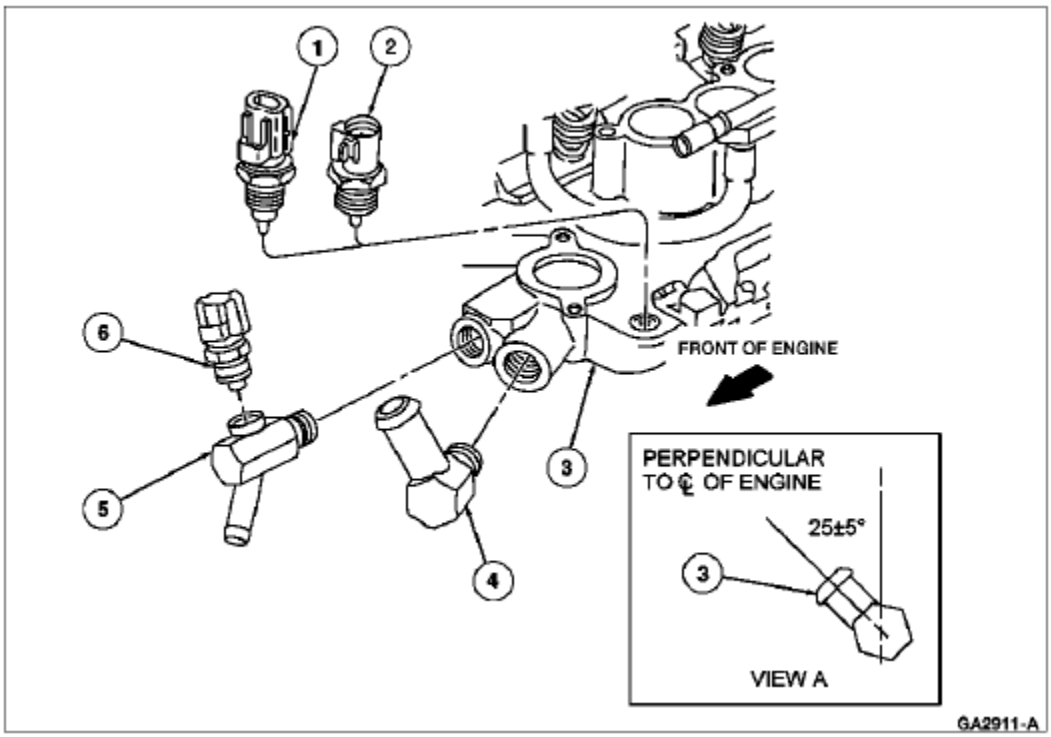

Item	Part Number	Description
1	12A648	Engine Coolant Temperature Sensor(Ranger)
2	124648	Engine Coolant Temperature Sensor (Aerostar)
3	9424	Intake Manifold
4	806344	Heater Elbow
5	18599	Hot Water Heater Elbow Connection
6	10884	Water Temperature Indicator Sender Unit
A	—	Tighten to 16-24 Nm (12-17 Lb-Ft)

9. Disconnect upper radiator hose from thermostat housing connection. After loosening hose clamp, use a twisting motion on hose to loosen from housing.

10. Remove ignition coil and bracket assembly (two nuts) from top of throttle body and pencil brace at exhaust manifold.

11. Remove throttle body as outlined in Section 03-04B .

12. Disconnect fuel charging wiring retaining standoffs from inboard rocker arm cover studs. Carefully disconnect electrical connections to each fuel injector and remove harness from engine.

13. Disconnect heater water hoses.

14. Remove spark plug wire set (12281) from spark plugs (12405) by using a twisting motion on the rubber boot. Remove harness retaining standoffs from rocker arm cover studs.

15. Remove valve covers as outlined in this section.

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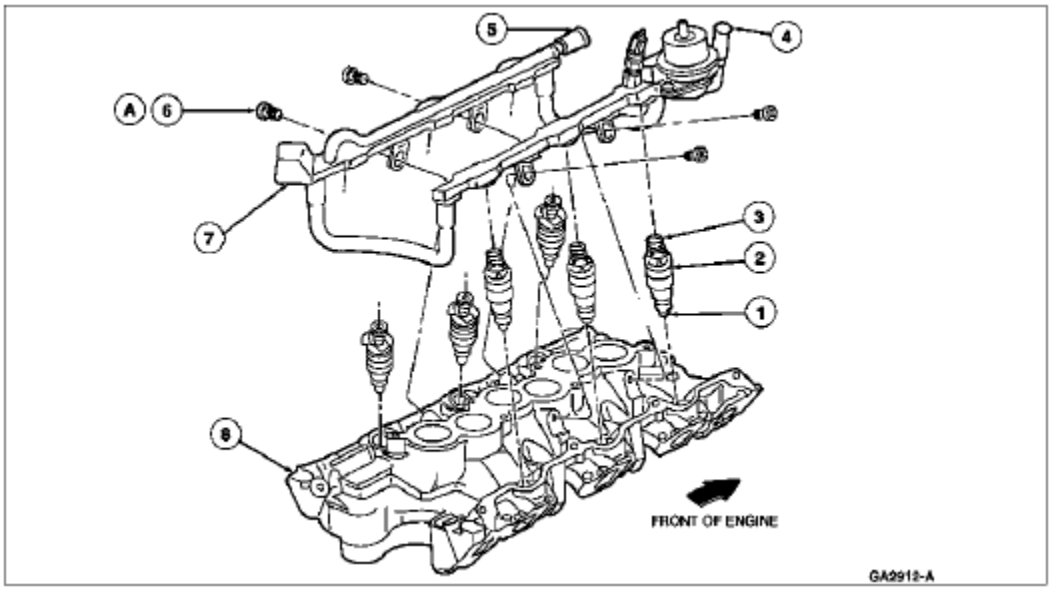
16. Loosen cylinder No. 3 intake valve rocker arm bolt and rotate rocker arm (6564) off push rod (6565) and away from top of valve stem. Remove push rod.

NOTE: Intake manifold (9424) may be removed with fuel injector and fuel injection supply manifolds (9F792) in place.

17. Remove intake manifold retaining bolts using a Torx® head socket. Before attempting to remove intake manifold, break the seal between the intake manifold and cylinder blocks (6010). Wedge a large screwdriver or similar heavy-duty tool between the manifold and the block. Pry upward on the tool using the lug on top of the front cover as a leverage point. Removal of generator (GEN) (10300) may be required for this step. Use care to prevent damage to machined surfaces.

Fuel Rail and Injectors to Intake Manifold, Installation



Item	Part Number	Description
1	—	Outlet End (Part of 9F593)
2	9F593	Fuel Injector
3	—	Inlet End (Part of 9F593)
4	—	Black Shipping Cap (Part of 9F593)
5	—	Green Shipping Cap (Part of 9F593)
6	N802353-S100	Bolt
7	9F792	Fuel Injection Supply Manifold
8	9424	Intake Manifold
A	—	Tighten to 8-12 Nm (71-106 Lb-In)

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Installation

NOTE: Lightly oil all retaining bolt and stud threads before installation.

CAUTION: Aluminum components gouge easily which may cause gasket to leak. Always use care when scraping aluminum gasket surfaces.

1. Clean mating gasket surfaces of intake manifold and cylinder blocks. Lay a clean cloth or shop rag in the tappet valley to catch any gasket material. After scraping, carefully lift cloth from tappet valley preventing any particles from entering oil drain holes or cylinder head. Use a suitable solvent to remove old rubber sealant.

2. If installing new intake manifold, transfer:

    - Fuel injectors
    - Fuel injection supply manifold
    - Engine coolant temperature sensor
    - Water thermostat (8575)
    - Water thermostat housing
    - Hot water heater elbow connection (18599) by-pass fitting (18599).
    - Coolant temperature sending unit

3. Apply a 5-6mm drop of Silicone Rubber D6AZ-19562-AA or -BA or equivalent meeting Ford specification ESB-M4G92-A or ESE-M4G195-A to intersection of cylinder blocks and cylinder head (6049) at four corners as shown in the illustration.

4. Position intake manifold gaskets (9439) onto cylinder heads. Align the intake gasket locking tabs to the provisions on the cylinder head gaskets as shown in the illustration.

Intake Manifold Gasket, Installation

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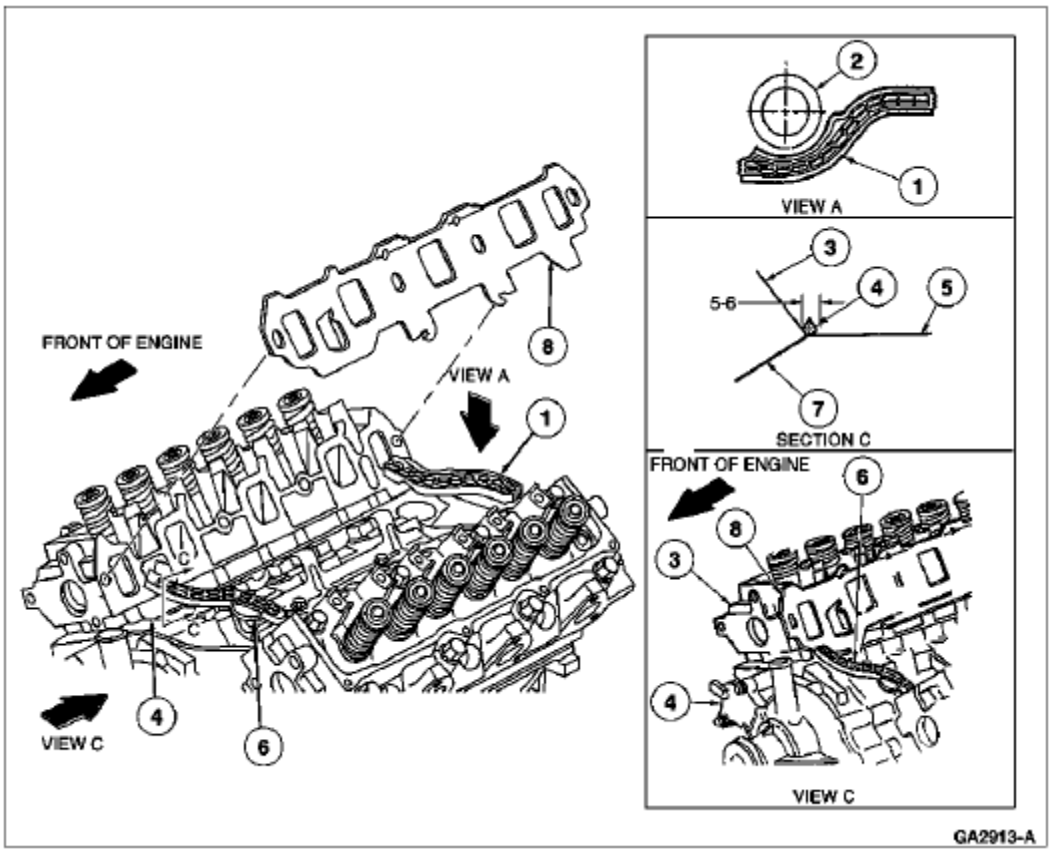

Item	Part Number	Description
1	9A424	Seal, Intake Manifold, Rear
2	—	Distributor Hole (Part of Cylinder Block)
3	6049	Cylinder Head
4	ESE-M4G195-B	Sealer (4 places)
5	6010	Cylinder Blocks
6	9A424	Seal, Intake Manifold, Front
7	6051	Head Gasket
8	9439	Intake Manifold Gasket

5. Install front and rear intake manifold seals as shown in the illustration. Secure with retaining features.

6. Lower intake manifold into position aligning manifold bolt holes to those in the cylinder head. Use care to prevent disturbing the rubber sealer which can cause sealing voids. Install bolts 1, 2, 3 and 4 and hand-snug. Install remaining bolts and tighten in a two-step process. Tighten in numerical sequence to 15 Nm (11 lb-ft), then again to 26-32 Nm (19-24 lb-ft).

Intake Manifold Bolt Torquing Sequence

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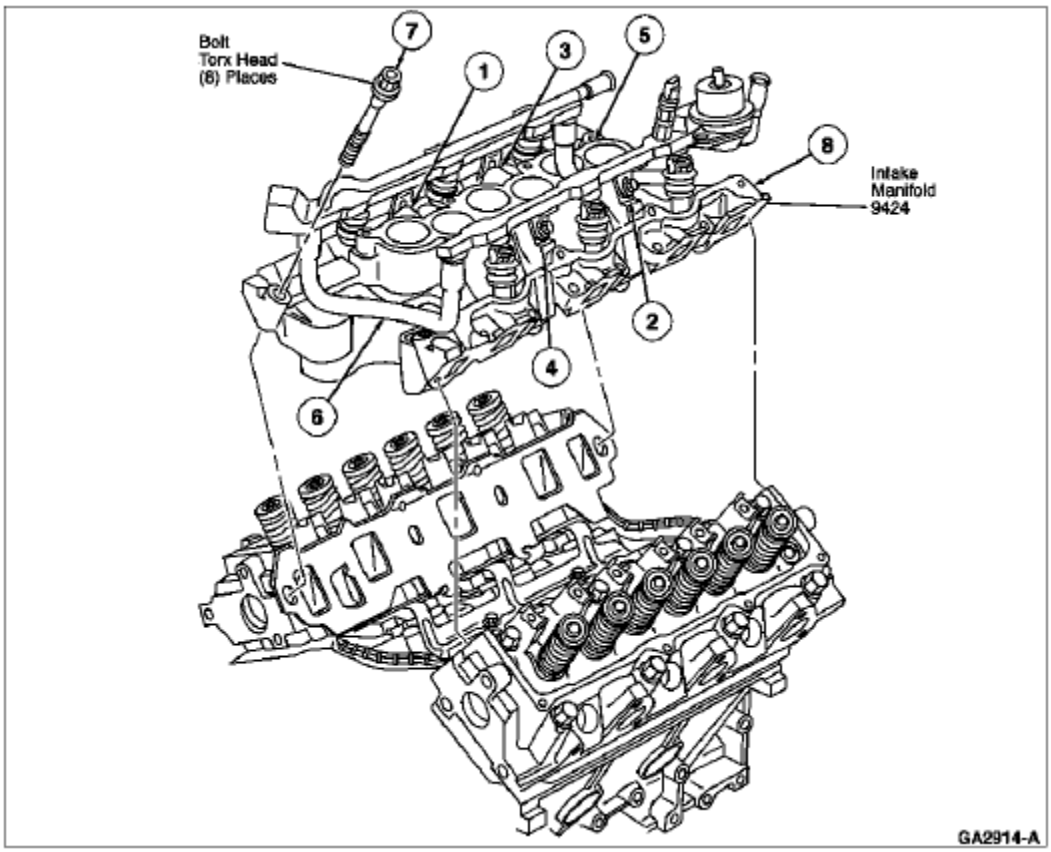

7. **CAUTION: If a new distributor or camshaft position sensor is installed, be sure to add the rest of the pint of Engine Assembly Lubricant D9AZ-19579-D or equivalent meeting Ford specification ESR-M99C80-A to the engine oil by pouring it through the distributor hole onto the cam drive gear. Run engine at idle for five minutes before driving vehicle.**

   Dip entire distributor or camshaft position sensor drive gear in Engine Assembly Lubricant D9AZ-19579-D or equivalent meeting Ford specification ESR-M99C80-A.

8. **NOTE: Rocker arm fulcrum must be fully seated into cylinder head and push rod must be fully seated in rocker arm and lifter sockets prior to final tightening.**

   Apply Engine Assembly Lubricant D9AZ-19579-D or equivalent meeting Ford specification ESR-M99C80-A to cylinder No. 3 intake valve push rod and rocker arm. Install push rod. Move rocker arm into position with push rod and snug rocker arm bolt. Rotate crankshaft (6303) to position camshaft lobe straight down and away from valve tappet (6500). Tighten retaining bolt to 11 Nm (8 lb-ft) to seat rocker arm fulcrum into cylinder head. Final-tighten bolt to 26-38 Nm (19-28 lb-ft) in any position.

9. Install valve covers as outlined in this section.

10. Install fuel charging wiring (9D930) to each fuel injector. Secure with standoffs to inboard rocker arm cover studs.

Ignition Coil Installation

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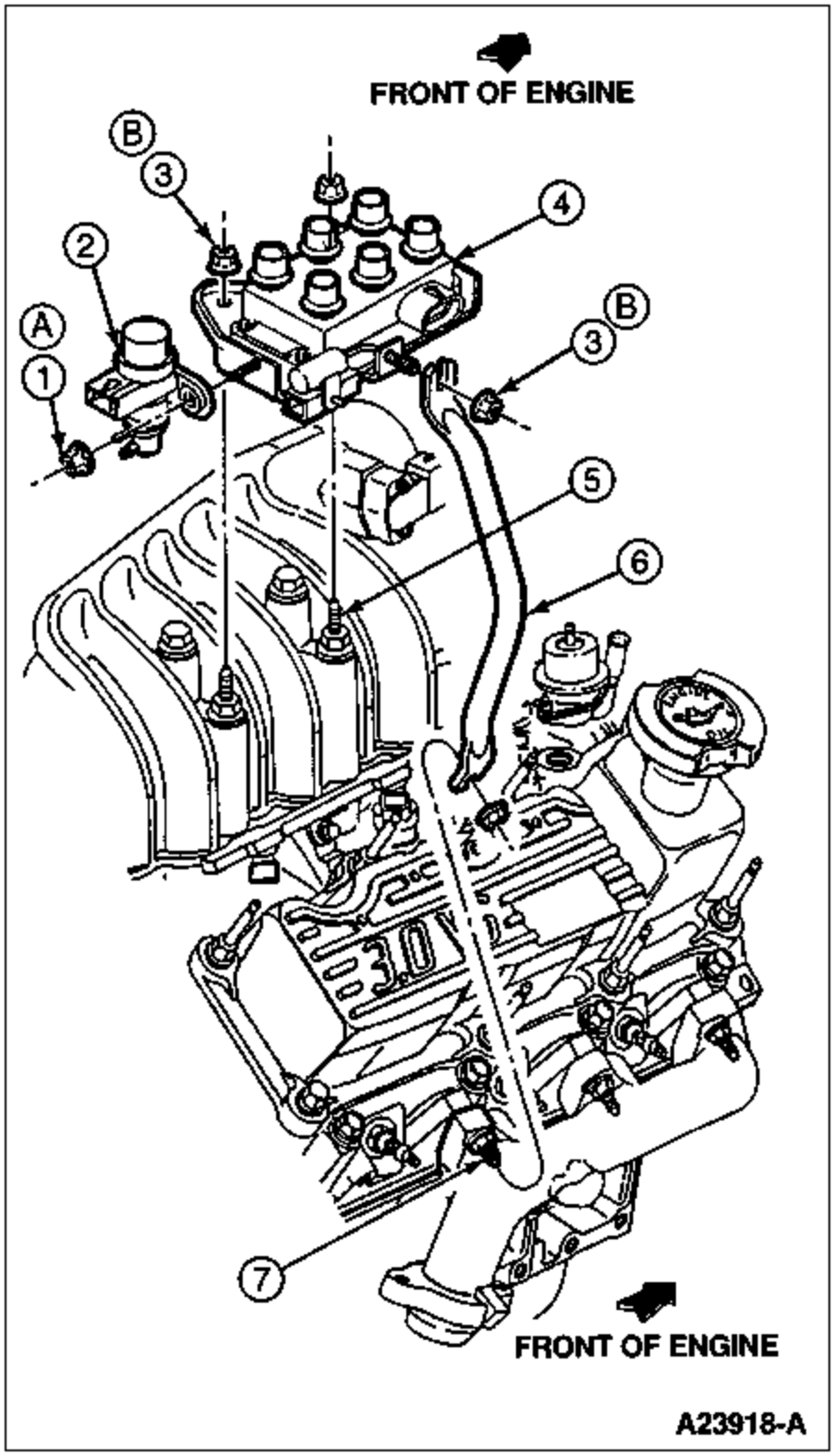

Item	Part Number	Description
1	—	Nut (Part of 12A310)
2	9J472	EGR Vacuum Regulator Bracket

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3	—	Nut (Part of 12A310)
4	12A310	Ignition Coil and Bracket Assembly
5	—	Stud (Part of 9E926)
6	12N004	Ignition Coil Mounting Bracket
7	—	Exhaust Manifold Stud (Part of 9430)
A	—	Tighten to 8-12 Nm (6-9 Lb-Ft)
B	—	Tighten to 16-20 Nm (12-15 Lb-Ft)

11. Installthrottle body and newintake manifold gasketas outlined in Section 03-04B . Install coil and bracket assembly (Ranger only). Tighten retaining nuts to 16-20 Nm (12-15 lb-ft).

12. Install wire harness standoffs to rocker arm cover studs and connect wires to spark plug and ignition coil.

13. Install fuel supply and return lines to fuel injection supply manifold as outlined in Section 03-04B .

14. Install fuel tube clips.

15. Install upper radiator hose and heater water hoses. Tighten hose clamps securely.

16. Connect vacuum lines to premarked locations.

17. Connect electrical connections of:

    - Radio ignition interference capacitor
    - Idle air control valve
    - Engine coolant temperature sensor
    - Distributor
    - Ignition coil
    - Radio ignition interference capacitor
    - Water temperature indicator sender unit
    - EGR pressure sensor, if equipped
    - EGR vacuum regulator control, if equipped

    Refer to Section 18-01 for further information.

18. **NOTE: Engine coolant is corrosive to all engine bearing material. Replacing oil after removal of a coolant carrying component prevents failure later.**

    Fill and bleed cooling system with specified coolant and proper mixture.

19. Replace crankcase oil and oil filter.

20. Install air cleaner outlet tube to throttle body and MAF sensor (12B579). Tighten retaining clamps to 1.9 Nm (17 lb-in).

21. Install closure hose to valve cover and air cleaner outlet tube.

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22. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

    Connect ground cable at battery.

23. Start engine (6007) and check for coolant, oil, fuel and vacuum leaks.

24. Verify and correct default base initial engine timing to 10 degrees BTDC. Refer to the Powertrain Control/Emissions Diagnosis Manual. Tighten retaining bolt to 19-30 Nm (14-22 lb-ft).

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Cylinder Head(s)

Removal

1. **NOTE: On 3.0L Aerostar it is necessary to remove the engine (6007) from the vehicle to perform this procedure. Refer to Engine Assembly, Aerostar , Removal and Installation, in this section.**

   Disconnect ground cable at battery and set aside.

2. Drain cooling system. Refer to Section 03-03 .

3. Remove:

   - Engine air cleaner outlet tube
   - Engine air cleaner
   - PCV closure hose

4. Remove throttle body (9E926) as outlined in Section 03-04B .

5. Remove engine oil filler adapter (Aerostar only).

6. Disconnect fuel lines as outlined in Section 03-04B .

7. Mark vacuum line location and remove lines.

8. Disconnect upper radiator hose and heater water hoses and move out of the way.

9. Disconnect spark plug wires from spark plugs with a turning motion and remove spark plug wire separators from valve cover retaining pins.

10. Remove ignition coil and bracket from top of throttle body and pencil at exhaust manifold.

11. Remove spark plugs (12405) and bring number one piston to top dead center of the compression stroke.

12. Remove intake manifold (9424) as outlined.

13. Remove engine accessory drive belt (8620).

14. On Ranger only:

    a. Recover refrigerant from A/C system. Refer to Section 12-00 .
    b. Disconnect liquid line at condenser and suction hose from accumulator.
    c. Plug or cap all openings in the air conditioning system to keep dirt, foreign material and excess moisture out of the system.
    d. Remove 4 bolts securing A/C compressor to power steering pump support bracket and remove A/C compressor and hoses assembly from vehicle.

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15. If left cylinder head is being removed, perform the following:

    a. Remove fuel line retaining bracket from stud bolt on left side of power steering pump support bracket and remove stud bolt.
    b. Loosen lower bolt on left side of power steering pump support bracket two or three turns, but DO NOT REMOVE.
    c. Remove three bolts securing power steering pump support bracket to front of left cylinder head and carefully allow power steering pump and bracket to tilt forward.
    d. Remove engine oil level indicator tube attaching nut from exhaust manifold stud. Remove oil level indicator tube from exhaust manifold.

16. If right cylinder head (6049) is being removed, perform the following:

    a. Disconnect wiring from generator.
    b. Remove three generator bracket and adjusting arm retaining bolts. Remove generator/bracket assembly from vehicle.

17. Remove exhaust inlet pipe or pipes and exhaust manifolds (9430) and exhaust manifold.

18. Loosen rocker arm bolts and remove rocker arm assemblies. Identify the location of each assembly. The rocker arm assemblies must be installed in their original location during reassembly.

19. Remove push rods (6565). Identify the position of each rod. The push rods should be installed in their original position during reassembly.

20. Remove cylinder head retaining bolts.

21. Remove cylinder heads.

22. Remove head gaskets (6051) and discard.

Installation

NOTE: Lightly oil all bolt and threads before installation. Always use new bolts when installing a cylinder head.

1. **CAUTION: Aluminum components gouge easily. Gouges in aluminum components will cause gaskets to leak.**

   Lay a clean shop rag in lifter valley to catch any gasket particles. Clean cylinder head, intake manifold and cylinder head to block gasket surfaces. After scraping, lift cloth so no gasket material falls into lifter valley. If the cylinder head was removed for a head gasket replacement, check the flatness of the cylinder head and block gasket surfaces. Refer to Section 03-00 .

2. **NOTE: Replace alignment dowels if damaged.**

   Position head gaskets on cylinder blocks (6010) using the dowels for alignment. Make sure gasket is aligned as shown in the illustration.

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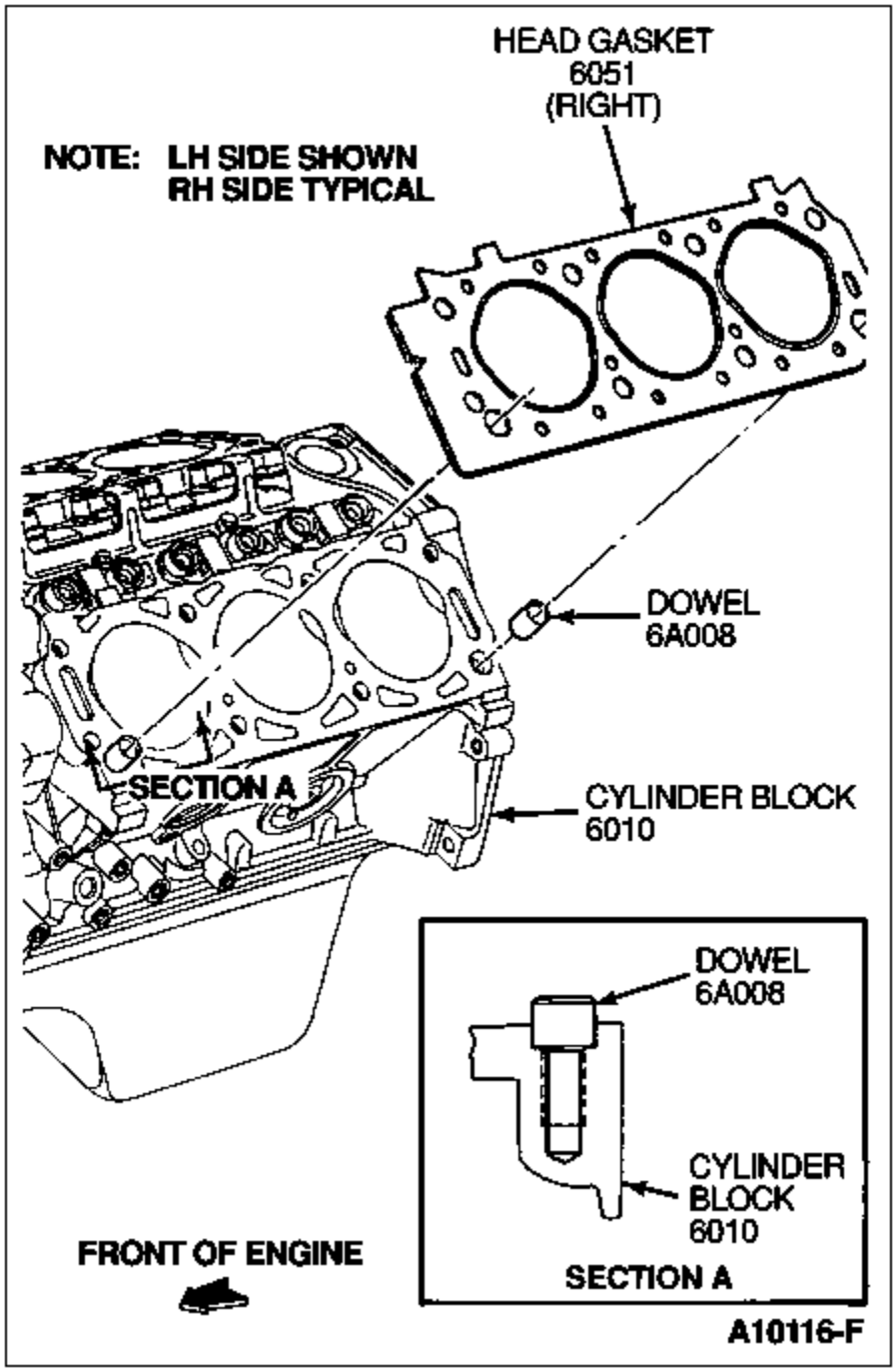

3. Carefully position cylinder heads on cylinder blocks.
4. Install new cylinder head retaining bolts and hand tighten.
5. Tighten retaining bolts in sequence as illustrated to 80 Nm (59 lb-ft).
6. Back off all bolts a minimum of one full turn (360 degrees).
7. **NOTE: When the cylinder head retaining bolts have been tightened using this procedure, it is not necessary to retighten the bolts after extended engine operation. However, the bolts can be checked for tightness if desired.**

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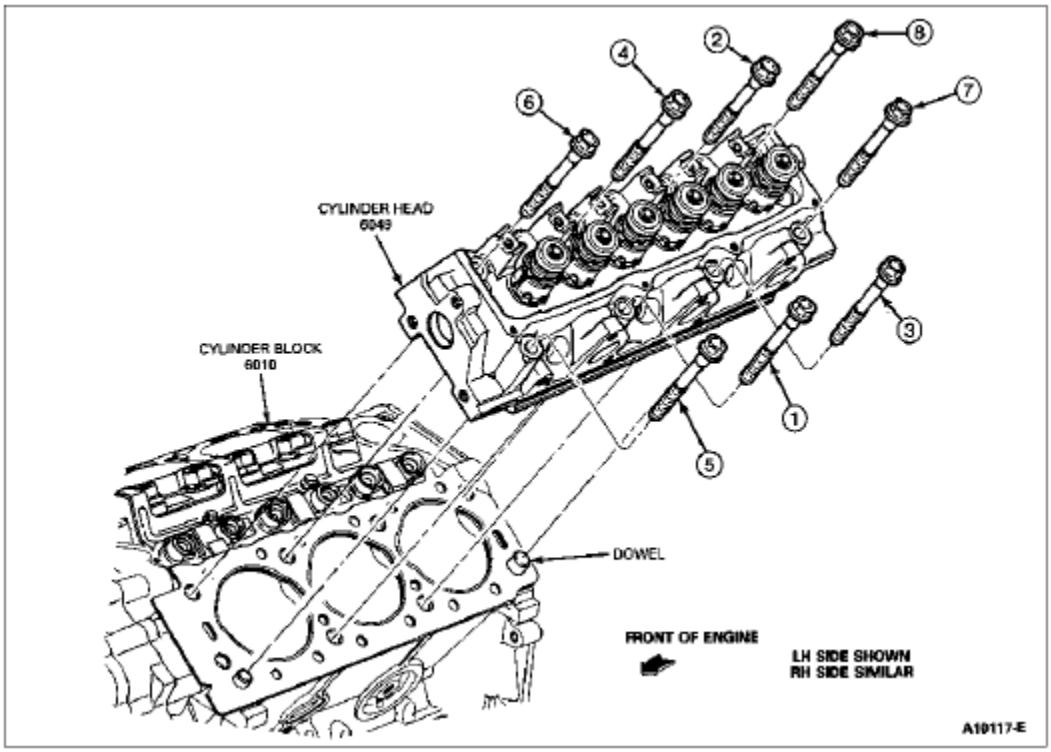
Retighten the cylinder head retaining bolts in sequence in two tightening steps as follows:

- 45-55 Nm (33-41 lb-ft)
- 85-99 Nm (63-73 lb-ft)

Cylinder Head Assembly, Installation



8. Install intake manifold as outlined in this section.

9. Dip each push rod Engine Assembly Lubricant D9AZ-19579-D or equivalent meeting Ford specification ESR-M99C80-A heavy engine oil. Install push rods in their original positions and orientation.

10. Loosely install rocker arm assemblies in original locations. Apply Engine Assembly Lubricant D9AZ-19579-D or equivalent meeting Ford specification ESR-M99C80-A heavy engine oil. Tighten rocker arm fulcrum bolts to 10-12 Nm (8-10 lb/ft) while lifter is on base circle of corresponding cam lobe. Final tighten rocker arm fulcrum bolts to 26-38 Nm (20-28 lb/ft).

11. **CAUTION: Rocker arm fulcrum must be fully seated into cylinder head and push rods must be fully seated in lifter and rocker arm sockets during final tightening.**

    NOTE: With number one piston at top dead center (TDC) of the exhaust stroke, you can tighten intake rockers of cylinder numbers 1 and 4, and exhaust rockers of cylinder 2 and 5. With the crankshaft rotated so number one piston is 135 degs. after top dead center (ATDC) of the exhaust stroke, you can tighten intake rockers of cylinder numbers 2, 3, 5 and 6, and exhaust rockers of cylinder numbers 1, 3, 4 and 6.

    NOTE: If the original valve train components are being reused, a valve clearance check is not required.

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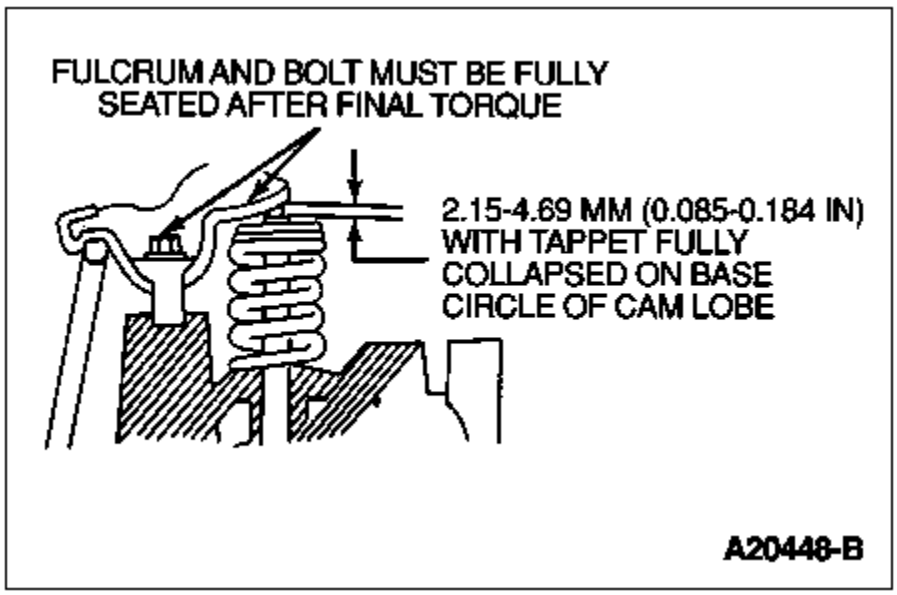
You must check rocker arm to valve tip clearance if a cam, lifters, push rods, rocker arms, rocker arm fulcrums or valves are replaced, or valves are ground.



12. Install valve covers as outlined in this section.

13. Install exhaust manifolds as outlined in this section. Tighten retaining bolts to 20-30 Nm (15-22 lb/ft). Install inlet pipe retaining nuts, tighten to 39-42 Nm (30-32 lb/ft).

14. Apply Cup Plug Sealer meeting Ford specification ESE-M4621-A or equivalent to cylinder block. Install oil level indicator tube into cylinder block. Oil level indicator tube must bottom out as illustrated. Tighten oil level indicator tube retaining nut at exhaust manifold stud bolt to 16-20 Nm (12-14 lb/ft).

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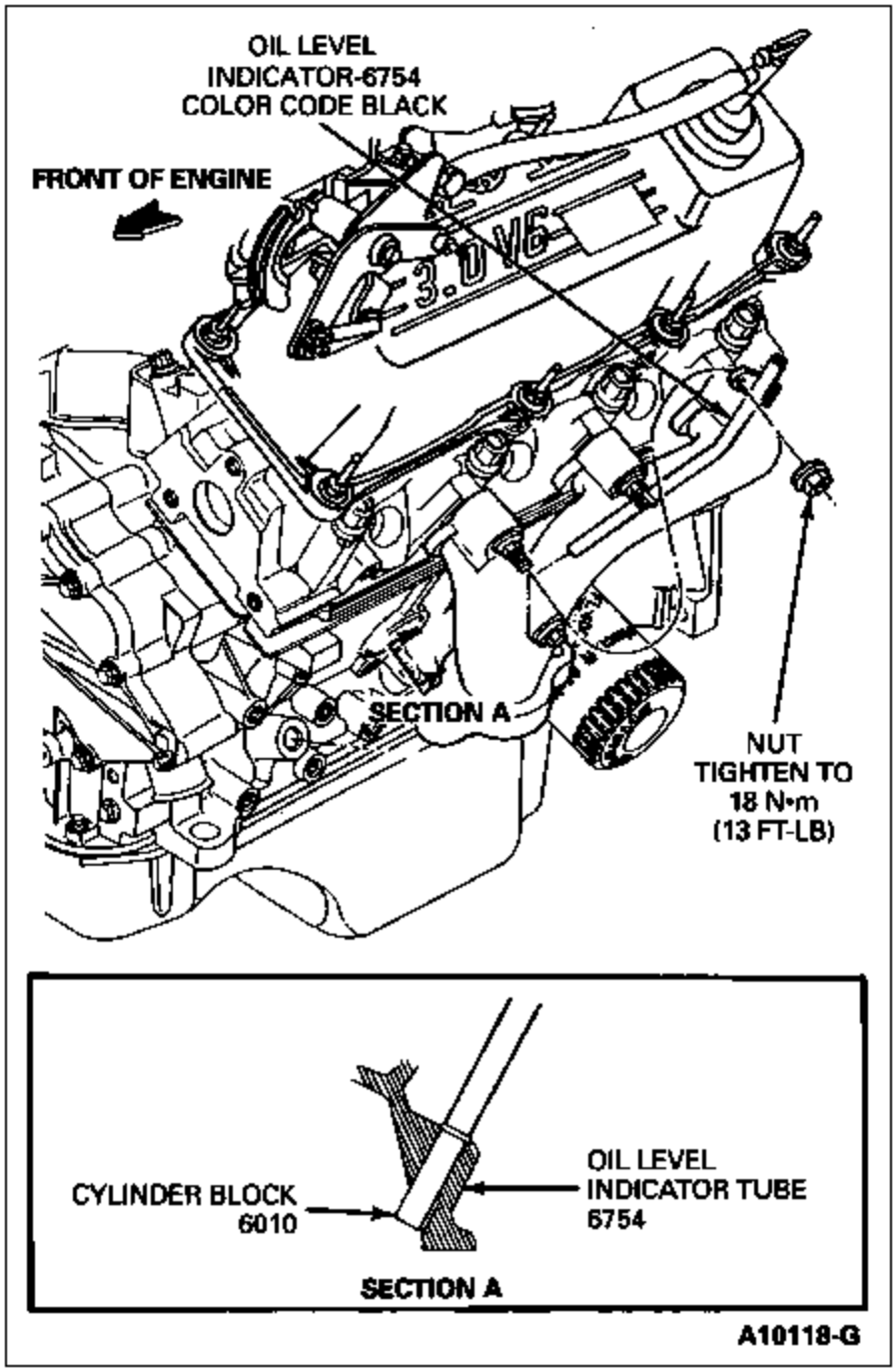

15. Install fuel charging wiring (9D930) to fuel injectors and inboard rocker arm cover studs. Connect fuel charging wiring to engine control sensor wiring (12A581) and secure with retaining features.

16. Install throttle body and new intake manifold gasket (9439) as outlined. Refer to Section 03-04B .

17. If left cylinder head was removed, perform the following:

    a. Install three bolts securing power steering pump support bracket to front of left cylinder head, finger tight only.
    b. Install stud bolt at left side of power steering pump support bracket. Tighten all five bolts securing power steering pump support bracket to engine block and cylinder head to 40-62 Nm

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(30-46 lb/ft).
c. Install fuel line retaining bracket to stud bolt on left side of power steering pump support bracket and secure with nut. Tighten nut to 16-20 Nm (12-15 lb/ft).

18. If right cylinder head was removed, perform the following:

    a. Install generator (GEN) (10300) and generator bracket assembly. Tighten three retaining bolts to 48 Nm (35 lb-ft).
    b. Install generator brace and tighten nuts to 26-35 Nm (20-25 lb-ft).
    c. Connect generator voltage regulator wiring.

19. On Ranger only:

    a. Position A/C compressor and hose assembly on power steering pump support bracket. Install 4 bolts securing A/C compressor to power steering pump support bracket and tighten four fasteners to 21-29 Nm (15-21 lb/ft).
    b. Remove plugs and caps from all openings in the air conditioning system.
    c. Connect liquid line at condenser and suction hose to accumulator.
    d. Evacuate and recharge A/C system. Refer to Section 12-00 .

20. Install engine accessory drive belt.

21. Install ignition coil and bracket assembly to throttle body stud bolts and pencil brace at exhaust manifold. Tighten three nuts to 16-20 Nm (12-14 lb/ft).

22. Connect fuel lines to fuel injection supply manifold (9F792) as outlined in Section 03-04A . Install fuel tube clips.

23. Connect upper radiator hose and heater water hoses. Tighten hose clamps securely. Refer to Section 03-03 .

24. Connect vacuum lines to premarked locations.

25. Install engine oil filler adapter (Aerostar only).

26. **NOTE: Engine coolant is corrosive to all engine bearing material. Replacing engine oil after removal of a coolant-carrying component prevents failure later.**

    Drain and change engine oil.

27. Install air cleaner outlet tube to throttle body and engine air cleaner (ACL) (9600). Tighten clamps securely. Refer to Section 03-12 .

28. Install closure hose at air cleaner outlet tube and valve cover (6582).

29. **CAUTION: This engine has aluminum components and requires a special corrosion-inhibiting coolant formulation to avoid radiator damage. Refer to Section 03-03 for coolant specifications.**

    Fill and bleed cooling system.

30. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

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Connect ground cable at battery.

31. Start engine and check for coolant, fuel, oil, vacuum and exhaust leaks.
32. Verify base ignition timing as outlined.
33. Check and, if necessary, adjust speed control linkage.

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Crankshaft Pulley/Vibration Damper/Crankshaft Front Seal

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Front Cover Seal Replacer	T70P-6B070-A
Crankshaft Damper Remover	T58P-6316-D
Vibration Damper Remover Adapter	T82L-6316-B
Vibration Damper and Seal Replacer	T82L-6316-A

Removal

1. Disconnect ground cable at battery and set aside.
2. Remove air cleaner outlet tube assembly.
3. Remove drive belts.
4. Remove four pulley-to-damper retaining bolts.
5. Remove crankshaft pulley (6312).
6. Remove crankshaft vibration damper bolt and crankshaft vibration damper washer.
7. Remove crankshaft vibration damper from crankshaft (6303) using Crankshaft Damper Remover T58P-6316-D and Vibration Damper Remover Adapter T82L-6316-B.
8. Pry crankshaft front seal (6700) from engine front cover (6019) with a flat-bladed screwdriver or other similar tool. Use care to prevent damage to engine front cover and crankshaft.

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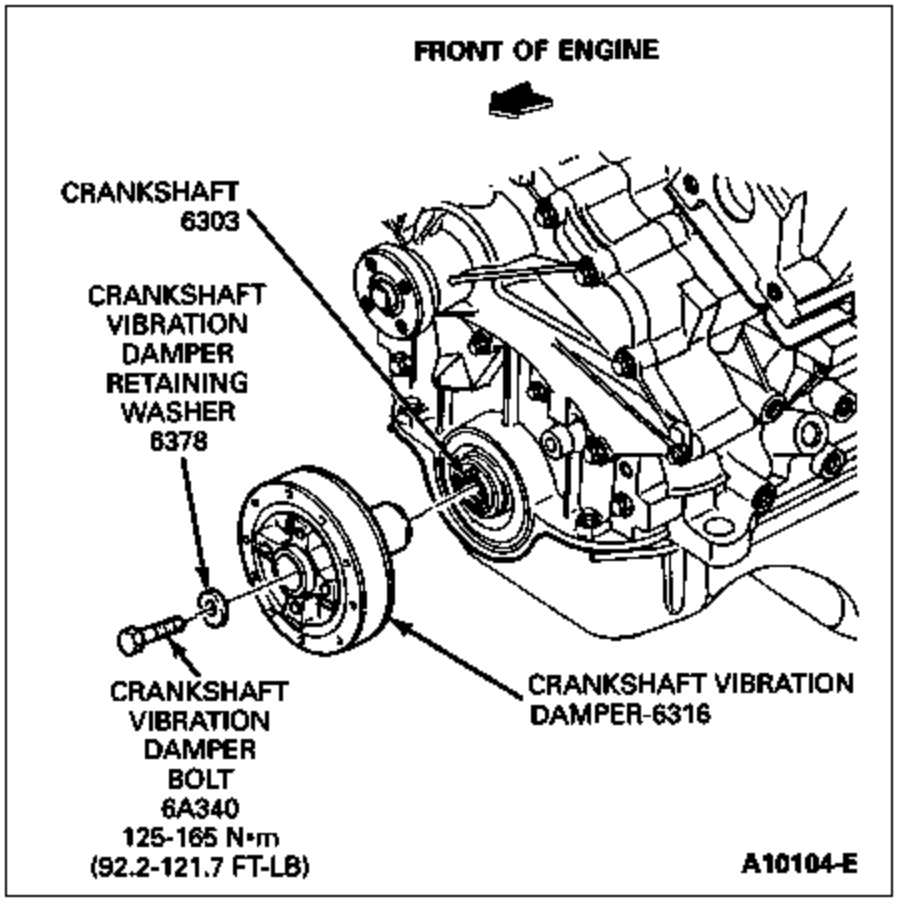

Installation

1. Inspect front cover and shaft seal surface of the crankshaft damper for damage, nicks, burrs or other roughness which may cause the new seal to fail. Service or replace components as necessary.

2. Lubricate seal lip with clean engine oil and install crankshaft front seal using Vibration Damper and Seal Replacer T82L-6316-A and Front Cover Seal Replacer T70P-6B070-A.

3. Coat crankshaft damper sealing surface with clean engine oil. Apply RTV F4AZ-19562-B or equivalent meeting Ford specification WSE-M4G323-A1 using Rotunda Gasket Gun with Regulator 071-R0001 or equivalent to keyway of damper prior to installation. Install crankshaft vibration damper using Vibration Damper and Seal Replacer T82L-6316-A. Install crankshaft vibration damper bolt and crankshaft vibration damper washer and tighten to 125-165 Nm (92-122 lb-ft).

4. Position crankshaft pulley and install attaching bolts. Tighten attaching bolts to 32 Nm (24 lb-ft).

5. Install engine (6007) accessory drive belt (8620) and route as illustrated. Check to ensure drive belt is riding in ribbed pulley correctly or early failure will result.

6. Install air cleaner outlet tube.

7. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

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Connect ground cable at battery.

8. Start engine and check for oil leaks.

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Water Pump

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Fan Clutch Holding Tool	T84T-6312-C
Fan Clutch Nut Wrench	T84T-6312-D

Removal

1. Disconnect ground cable at battery and set aside.
2. Remove engine air cleaner outlet tube.
3. **CAUTION: Fan clutch has left-hand threads so nut must be turned clockwise to remove.**

   Loosen nut on fan clutch using Fan Clutch Holding Tool T84T-6312-C and Fan Clutch Nut Wrench T84T-6312-D and remove fan blade and clutch assembly from water pump (8501).
4. Remove 2 screws holding fan shroud to radiator (8005). Remove fan blade and clutch assembly and fan shroud together.
5. Drain cooling system.
6. Loosen, do not remove, 4 water pump pulley (8509) retaining screws.
7. Rotate engine drive belt tensioner clockwise and remove engine drive belt (8620).
8. Remove 4 water pump pulley retaining screws and water pump pulley.
9. Remove 3 electrical connectors at generator (GEN) (10300).
10. On Aerostar only, remove oil fill tube retaining nut at generator stud and lift tube from stud.
11. Remove 3 bolts retaining generator bracket to cylinder head (6049) and remove generator and bracket as an assembly.

Engine Accessory Installation, 3.0L, Ranger

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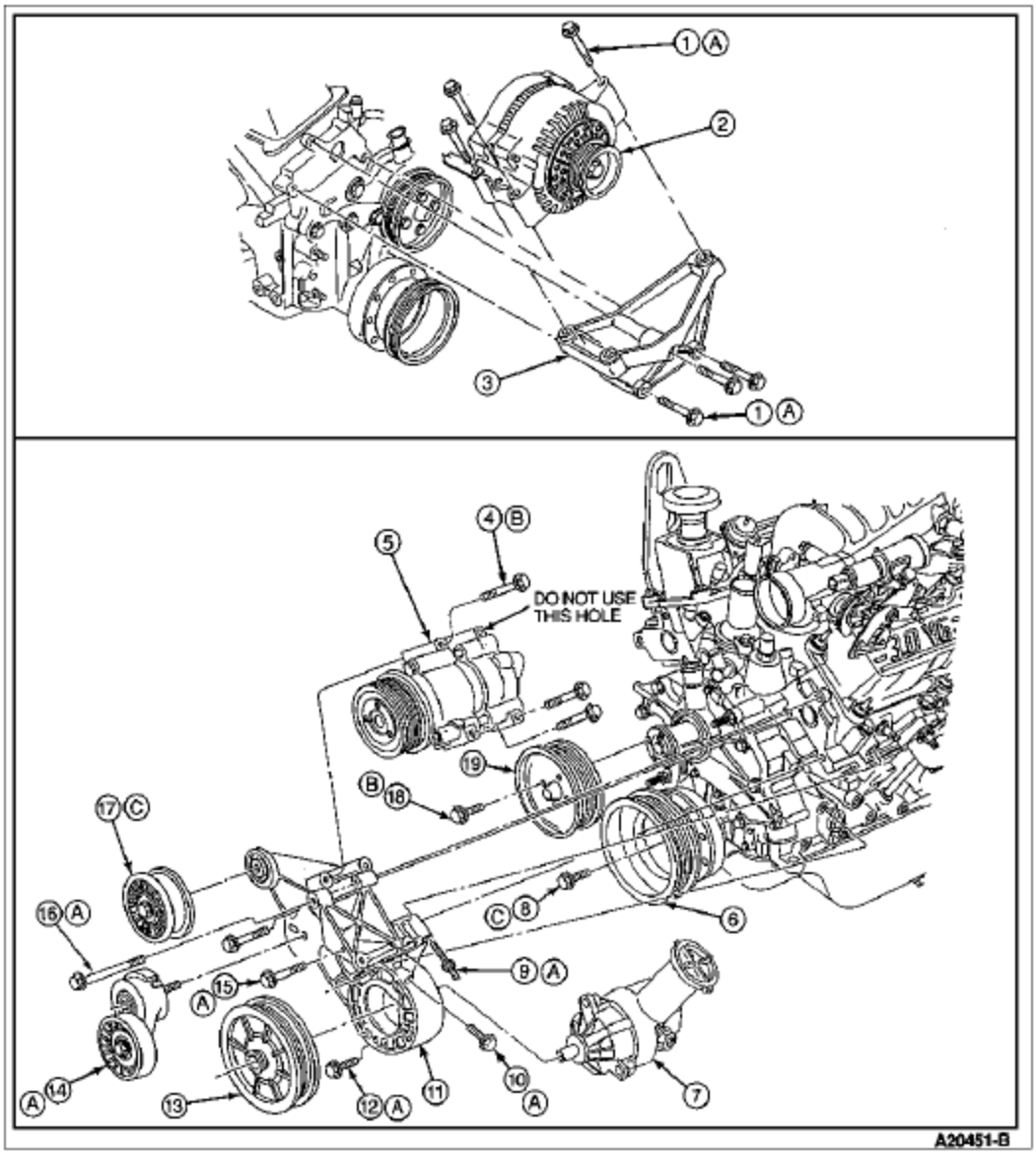

Item	Part Number	Description
1	N606068-S2	Bolt
2	10300	Generator
3	10153	Generator Mounting Bracket
4	N806020-S2	Bolt
5	19703	A/C Compressor
6	6312	Crankshaft Pulley
7	3A674	Power Steering Pump
8	N807551-S100	Bolt
9	N807123-S2	Stud
10	N605805-S2	Bolt
11	2882	A/C Compressor Mounting Bracket

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12	N800199-S8M	Bolt
13	3A733	Power Steering Pump Pulley
14	6B209	Drive Belt Tensioner
15	N60608-S2	Bolt
16	N807124-S2	Bolt
17	3F671	Belt Adjuster
18	N802096-S2	Bolt
19	8509	Water Pump Pulley
A	—	Tighten to 40-55 Nm (30-41 Lb-Ft)
B	—	Tighten to 21-29 Nm (15-21 Lb-Ft)
C	—	Tighten to 53-72 Nm (39-53 Lb-Ft)

12. Disconnect crank position sensor (CKP) wiring.

13. Remove heater water return hose at water pump.

14. Remove bypass hose from fitting at intake manifold (9424).

15. **CAUTION: Use care not to damage the throttle linkage or fuel lines.**

    On Ranger only, remove 3 screws securing A/C compressor to power steering pump support bracket. Using a piece of wood bridged from the top of the battery to the throttle body (9E926), suspend the A/C compressor with a wire tie or other suitable material.

16. Using a Torx® 50 driver, remove enginedrive belt tensioner (6B209) assembly.

17. On Aerostar only, if equipped with auxiliary heater, remove screw retaining auxiliary heater tube bracket at power steering pump support bracket.

18. Remove lower radiator hose at radiator and water pump.

19. Remove 5 screws retaining power steering pump support bracket to the engine (6007) and secure power steering pump and bracket assembly toward battery tray.

20. Remove 12 water pump retaining bolts and note bolt location.

21. Remove water pump and discard old water pump gasket.

Installation

NOTE: Lightly oil all bolts and stud threads before installation except those requiring special sealant.

1. Clean gasket surfaces on engine front cover (6019) and water pump carefully. (Use care as

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aluminum gouges easily.)

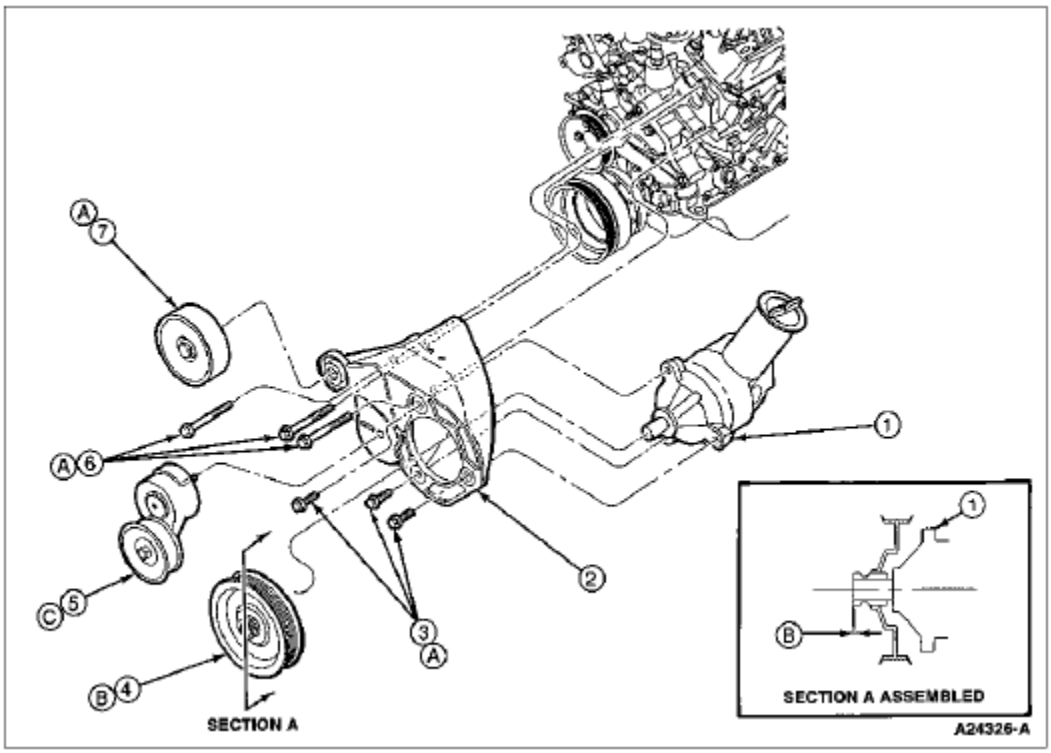
2. Position a new gasket on water pump sealing surface using Gasket and Trim Adhesive D7AZ-19B508-B or equivalent meeting Ford specification ESE-M2G52-A to hold gasket in position.

3. Install water pump on engine front cover and hand-tighten 12 attaching bolts. Refer to Engine Front Cover in this section for tightening specifications.

4. Reinstall lower radiator hose at water pump and radiator and tighten clamps.

5. Reinstall power steering pump support bracket to engine and torque to (5 fasteners) (Ranger) 48-61 Nm (35-45 lb-ft) or (3 fasteners) (Aerostar) 40-54 Nm (30-40 lb-ft).

Power Steering Support Bracket — Aerostar



Item	Part Number	Description
1	3A674	Power Steering Pump
2	3C511	Power Steering Pump Support
3	N800199-S309	Bolt
4	3A733	Power Steering Pump Pulley
5	6B209	Drive Belt Tensioner
6	N606068-	Bolt

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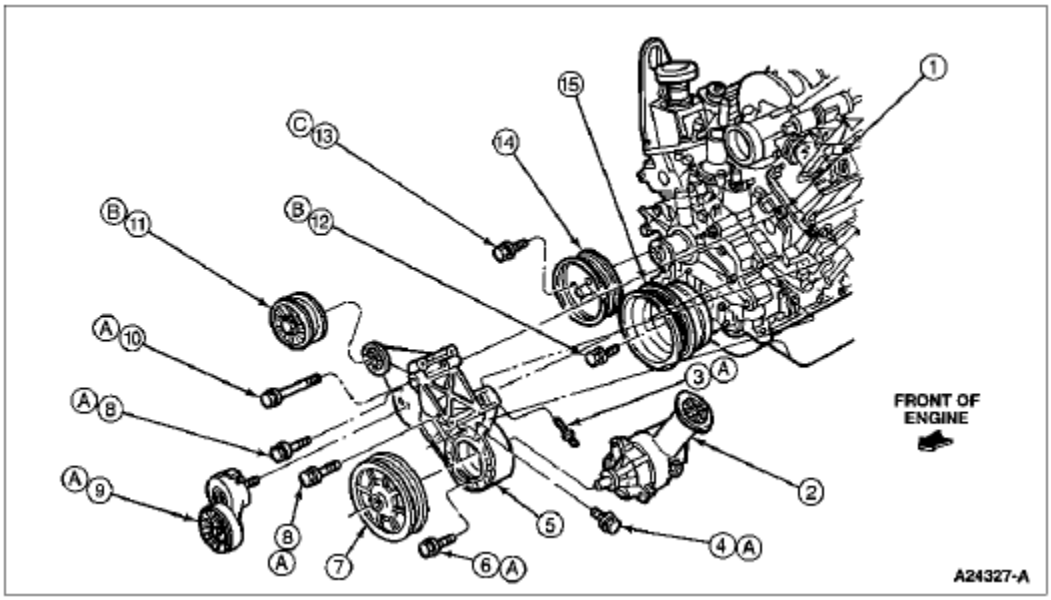
	S309	
7	3F671	Power Steering Belt Idler Support
A	—	Tighten to 40-55 Nm (30-41 Lb-Ft)
B	—	Pulley with Pull-Off Groove Facing Front, Flush with End of Shaft + /- .25mm (0.018 Inch)
C	—	Tighten to 30-50 Nm (22-37 Lb-Ft)

Power Steering Support Bracket — Ranger



Item	Part Number	Description
1	6049	Cylinder Head
2	3A674	Power Steering Pump
3	N807123-S2	Stud
4	N605805-S2	Bolt
5	—	Power Steering Bracket (Part of 3A674)
6	N800199	Bolt
7	3A733	Power Steering Pump Pulley
8	N606068-S2	Bolt
9	6B209	Drive Belt Tensioner
10	N807124-S2	Bolt
11	3F671	Power Steering Belt Idler Support
12	N807551-S100	Bolt (4 Places)

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13	N602098-S2	Screw and Washer
14	8509	Water Pump Pulley
15	6312	Crankshaft Pulley
A	—	Tighten to 40-55 Nm (30-41 Lb-Ft)
B	—	Tighten to 53-72 Nm (39-53 Lb-Ft)
C	—	Tighten to 21-29 Nm (16-21 Lb-Ft)

6. Reinstall engine accessory drive belt tensioner and torque to 35-45 Nm (27-33 lb-ft).
7. On Ranger only, install A/C compressor to steering pump support bracket with 3 bolts and torque to 22-28 Nm (17-21 lb-ft).
8. Reconnect bypass hose to fitting on intake manifold and tighten clamp.
9. Install heater water return hose at water pump fitting and tighten clamp.
10. On Aerostar only, if equipped with auxiliary heater, reinstall auxiliary heater tube bracket at power steering pump support bracket and torque to 8-12 Nm (6-8 lb-ft).
11. Connect crank position sensor (CKP) wiring at sensor.
12. Reinstall generator and bracket assembly to right cylinder head with 3 bolts and torque to 40-54 Nm (30-40 lb-ft).

Front End Accessory Drive, Upper — Aerostar

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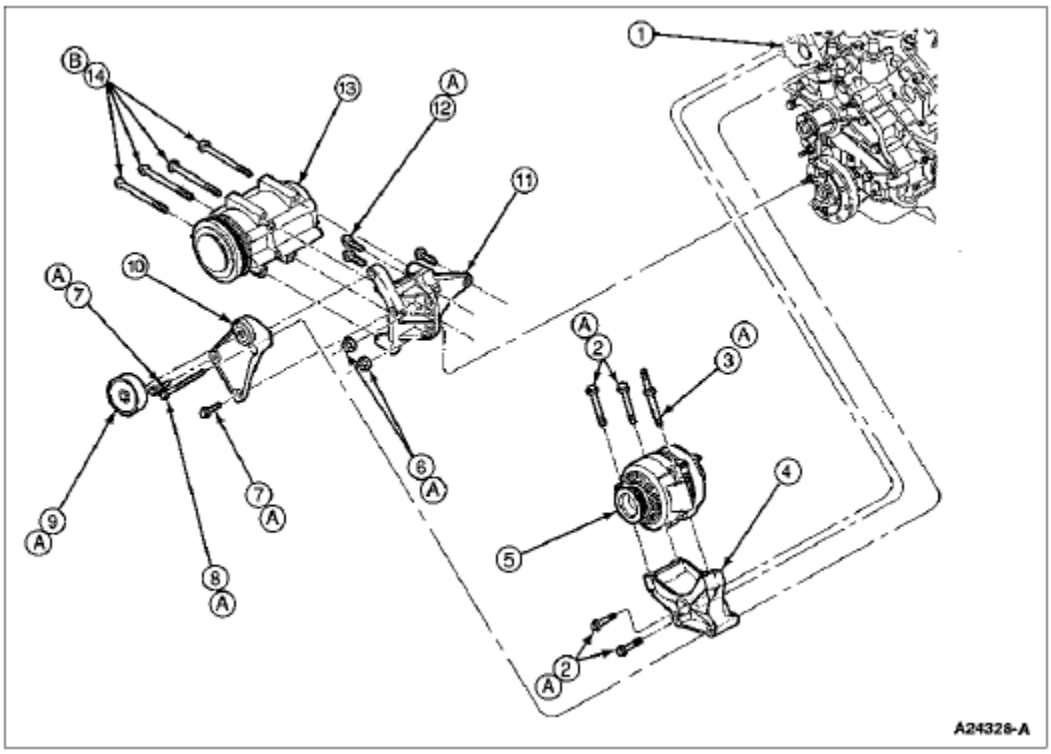

Item	Part Number	Description
1	6049	Cylinder Head (RH)
2	N606068-S309	Bolt
3	N806209-S309	Stud
4	10A313	Generator Bracket
5	10300	Generator
6	N802827-S309	Nut
7	N606706-S309	Bolt
8	N606070-S309	Bolt
9	3F671	Power Steering Belt Idler Support
10	8680	Belt Idler Bracket
11	—	A/C Compressor Bracket (Part of 19703)
12	N605801-S309	Bolt
13	19703	A/C Compressor
14	N806020-S309	Bolt
A	—	Tighten to 40-55 Nm (30-41 Lb-Ft)
B	—	Tighten to 21-29 Nm (16-21 Lb-Ft)

Front End Accessory Drive, Upper — Ranger

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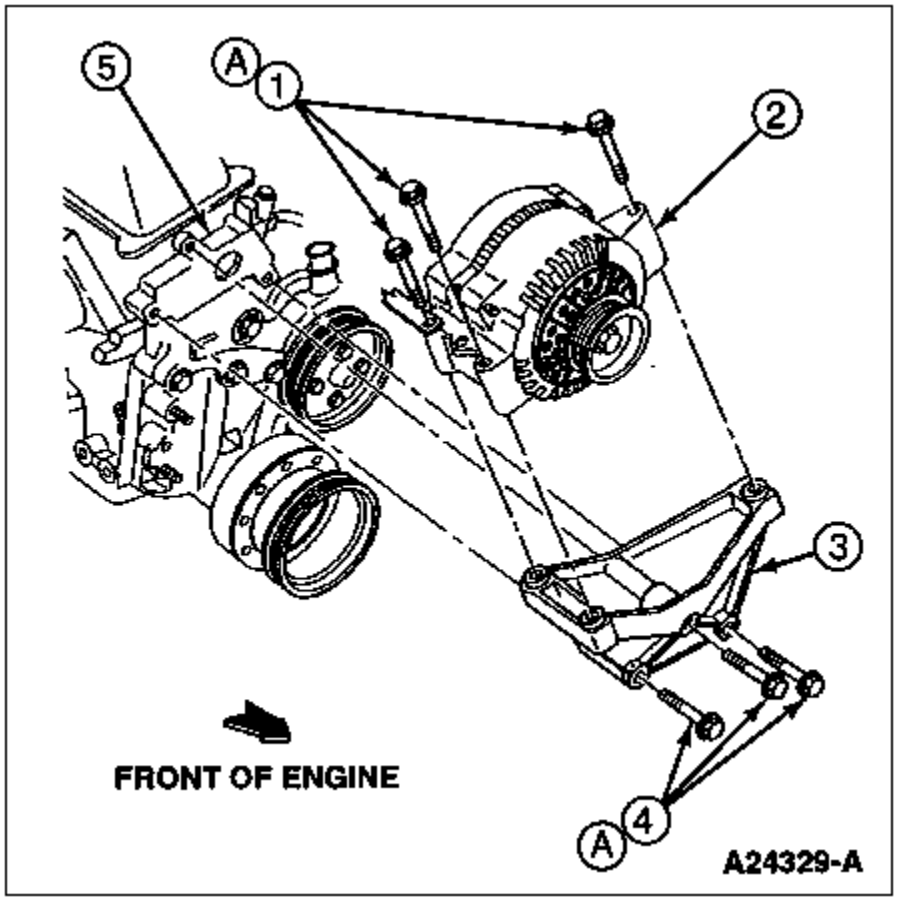

Item	Part Number	Description
1	N606068-S2	Bolt
2	10300	Generator
3	10A313	Generator Bracket
4	N606065-S2	Bolt
5	6049	Cylinder Head (RH)
A	—	Tighten to 40-55 Nm (30-41 Lb-Ft)

13. Reconnect 3 wiring connectors in generator.
14. Install oil fill tube bracket over stud at generator and torque retaining nut to 42-50 Nm (32-37 lb-ft).
15. Install water pump pulley on water pump hub and tighten bolts finger-tight.
16. Wrap engine accessory drive belt around all pulleys except generator. Rotate belt tensioner clockwise and when belt clears, slip over alternator pulley.

Front End Accessory Drive, Drive Belt Routing — Aerostar

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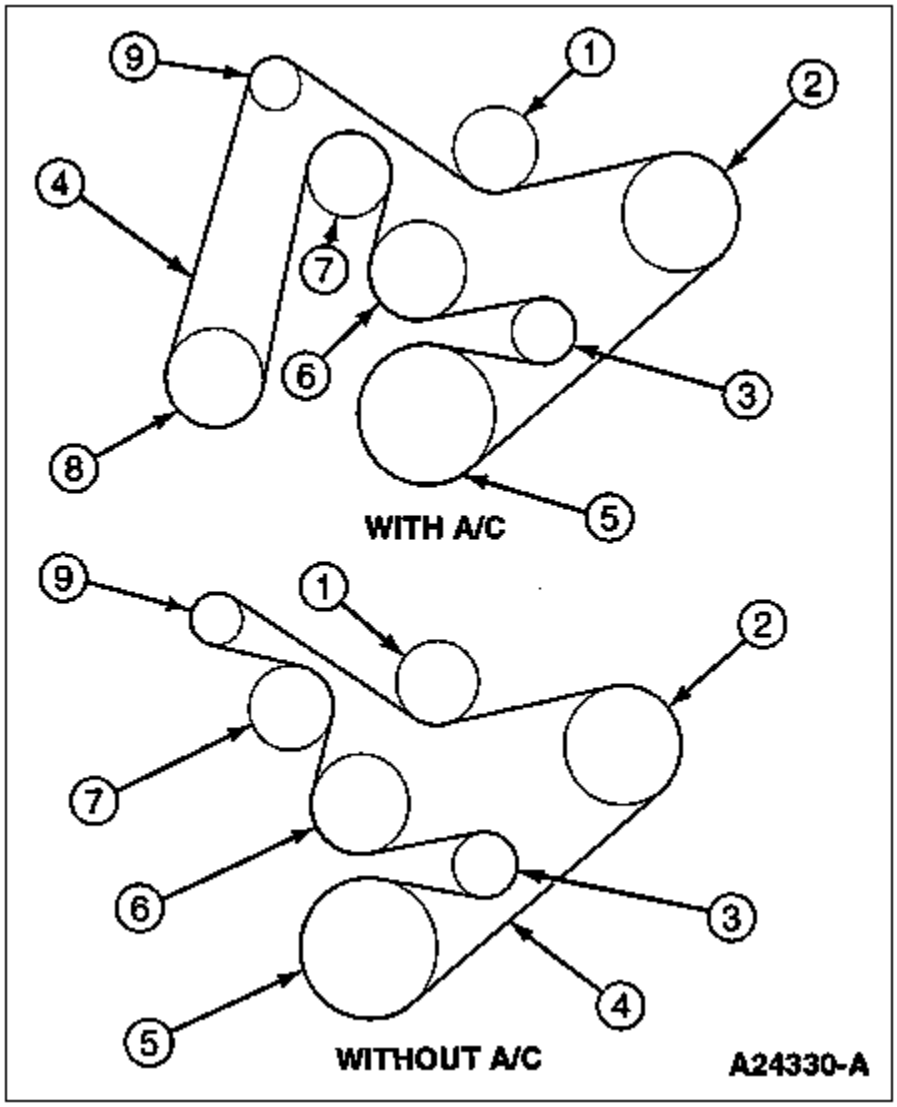

Item	Part Number	Description
1	3F671	Power Steering Belt Idler Support
2	3A733	Power Steering Pump Pulley
3	6B209	Drive Belt Tensioner
4	8620	Drive Belt
5	6312	Crankshaft Pulley
6	8509	Water Pump Pulley
7	—	Idler (Part of 8A620)
8	19703	A/C Compressor
9	10300	Generator

Front End Accessory Drive, Drive Belt Routing — Ranger

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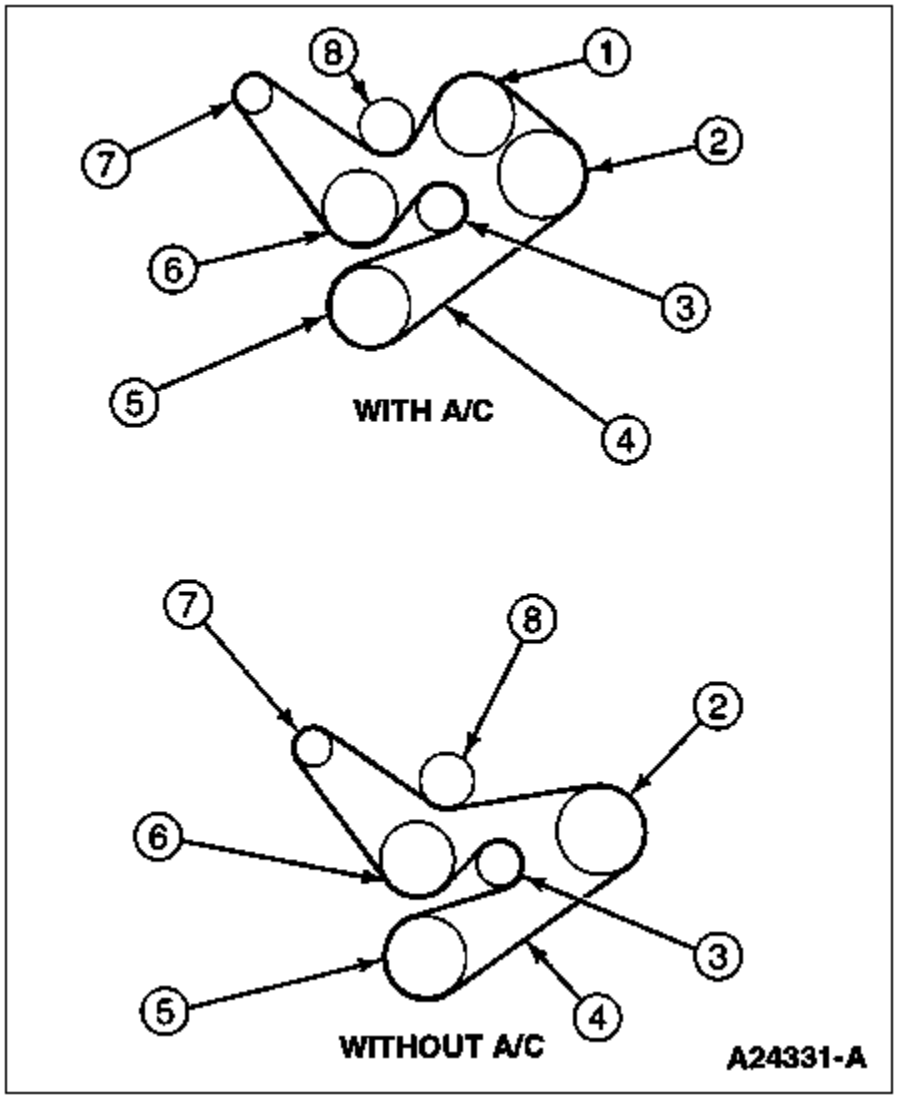

Item	Part Number	Description
1	19703	A/C Compressor
2	3A733	Power Steering Pump Pulley
3	6B209	Drive Belt Tensioner
4	8620	Drive Belt
5	6312	Crankshaft Pulley
6	8509	Water Pump Pulley
7	10300	Generator
8	3F671	Power Steering Belt Idler Support

17. Torque water pump pulley bolts to 23-32 Nm (18-24 lb-ft).

18. Place radiator fan and clutch assembly in fan shroud and slide fan shroud into position. Lower edge

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of fan shroud should locate in clips at bottom of radiator. Secure top of fan shroud with 2 screws and torque to 6-8 Nm (53-71 lb-in).

19. **CAUTION: Fan clutch has left-hand threads so nut must be turned clockwise to remove.**

    Install fan clutch on water pump hub and torque to 41-135 Nm (30-100 lb-ft) using Tool T84T-6312-C and Fan Clutch Nut Wrench T84T-6312-D.

20. Reinstall engine air cleaner outlet tube and tighten clamps.

21. Fill engine cooling system to specified level. Refer to Section 03-03 .

22. Reconnect ground cable at battery.

23. Start vehicle and check for leaks. Allow engine to reach operating temperature and verify no fluid leaks. Shut off engine, check and correct all fluid levels.

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Engine Front Cover

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Fan Clutch Holding Tool	T84T-6312-C
Fan Clutch Nut Wrench	T84T-6312-D
Vibration Damper and Seal Replacer	T82L-6316-A
Vibration Damper Remover Adapter	T82L-6316-B
Crankshaft Damper Remover	T58P-6316-D

Removal

1. Disconnect ground cable at battery and set aside.
2. **NOTE: Engine front cover (6019) can be removed with water pump (8501) installed. To perform this operation, do not remove bolts 11 through 15 in the Fastener Location, Water Pump Front Cover illustration.**

   Remove water pump as outlined in this section (if required).
3. Raise vehicle on hoist.
4. On Aerostar only, remove 4 screws holding A/C compressor (19703) to engine bracket and support compressor to sidemember of engine compartment.
5. On Aerostar only, remove 3 screws securing A/C compressor bracket to cylinder blocks (6010) and 2 nuts in front at timing cover studs.

Engine Accessory Installation, 3.0L — Ranger

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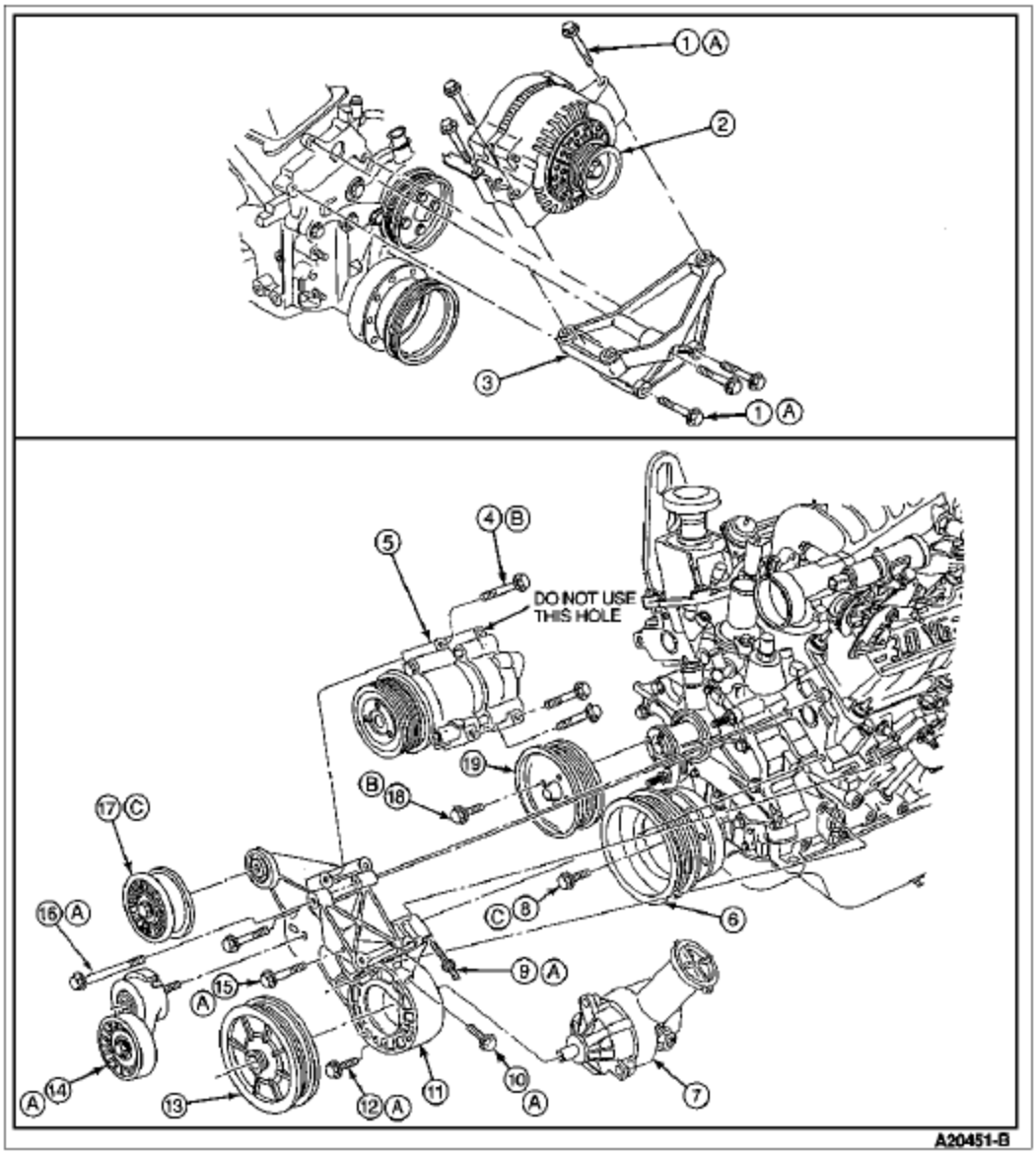

Item	Part Number	Description
1	N606068-S2	Bolt
2	10300	Generator
3	10153	Generator Mounting Bracket
4	N806020-S2	Bolt
5	19703	A/C Compressor
6	6312	Crankshaft Pulley
7	3A674	Power Steering Pump
8	N807551-S100	Bolt
9	N807123-S2	Stud
10	N605805-S2	Bolt
11	2882	A/C Compressor Mounting Bracket

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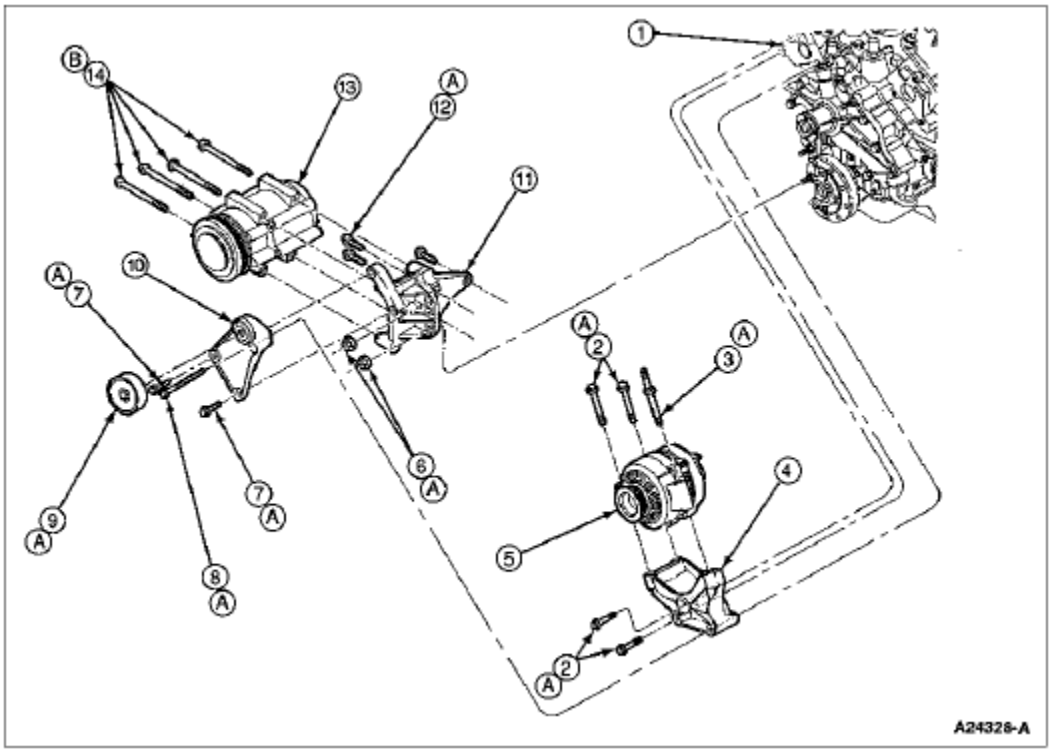
12	N800199-S8M	Bolt
13	3A733	Power Steering Pump Pulley
14	6B209	Drive Belt Tensioner
15	N60608-S2	Bolt
16	N807124-S2	Bolt
17	3F671	Belt Adjuster
18	N802096-S2	Bolt
19	8509	Water Pump Pulley
A	—	Tighten to 40-55 Nm (30-41 Lb-Ft)
B	—	Tighten to 21-29 Nm (15-21 Lb-Ft)
C	—	Tighten to 53-72 Nm (39-53 Lb-Ft)

Engine Accessory Installation, Upper— Aerostar



Item	Part Number	Description
1	6049	Cylinder Head (RH)
2	N606068-S309	Bolt
3	N806209-S309	Stud
4	10A313	Generator Bracket

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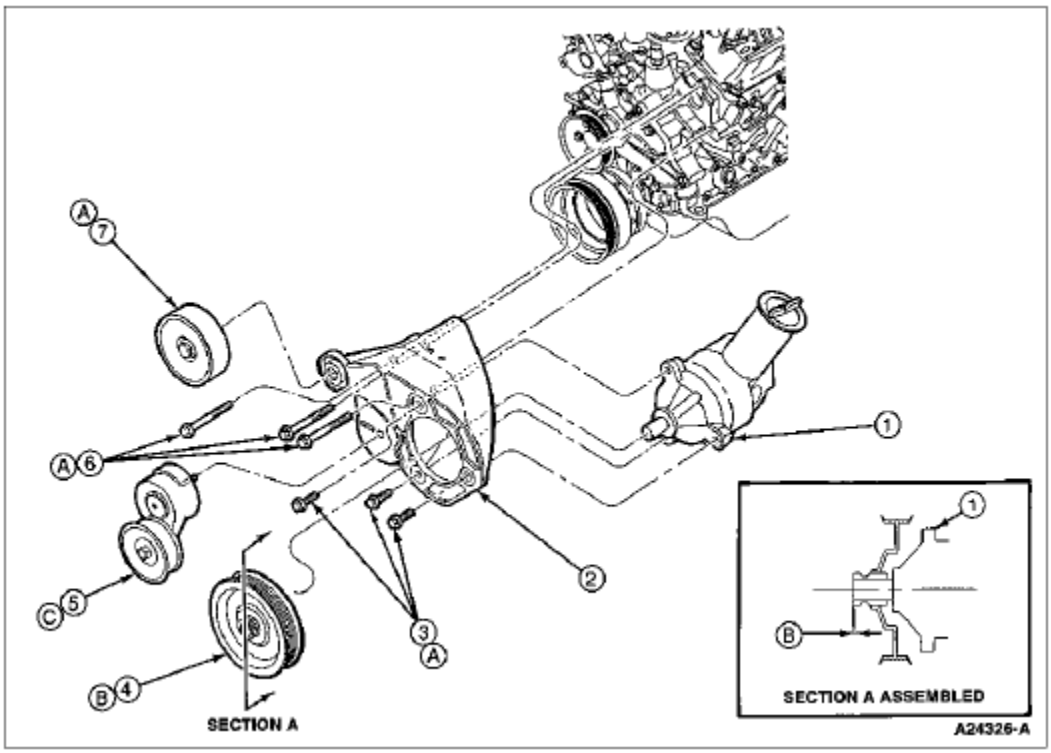
5	10300	Generator
6	N802827-S309	Nut
7	N606706-S309	Bolt
8	N606070-S309	Bolt
9	3F671	Power Steering Belt Idler Support
10	8680	Belt Idler Bracket
11	—	A/C Compressor Bracket (Part of 19703)
12	N605801-S309	Bolt
13	19703	A/C Compressor
14	N806020-S309	Bolt
A	—	Tighten to 40-55 Nm (30-41 Lb-Ft)
B	—	Tighten to 21-29 Nm (16-21 Lb-Ft)

Engine Accessory Installation, Lower — Aerostar



Item	Part Number	Description
1	3A674	Power Steering Pump
2	3C511	Power Steering Pump Support
3	N800199-	Bolt

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	S309	
4	3A733	Power Steering Pump Pulley
5	6B209	Drive Belt Tensioner
6	N606068-S309	Bolt
7	3F671	Power Steering Belt Idler Support
A	—	Tighten to 40-55 Nm (30-41 Lb-Ft)
B	—	Pulley with Pull-Off Groove Facing Front, Flush with End of Shaft + /- .25mm (0.018 Inch)
C	—	Tighten to 30-50 Nm (22-37 Lb-Ft)

6. Remove 4 screws retaining crankshaft pulley (6312) and remove pulley.
7. Remove bolt and washer retaining crankshaft damper to crankshaft.
8. Remove crankshaft vibration damper from crankshaft (6303) using Crankshaft Damper Remover T58P-6316-D and Damper Remover Adapter T82L-6316-B.
9. Drain engine oil from crankcase.
10. Remove oil pan (6675) as outlined in this section and discard oil pan gasket (6710).
11. Lower vehicle.

Fastener Location, Water Pump Front Cover

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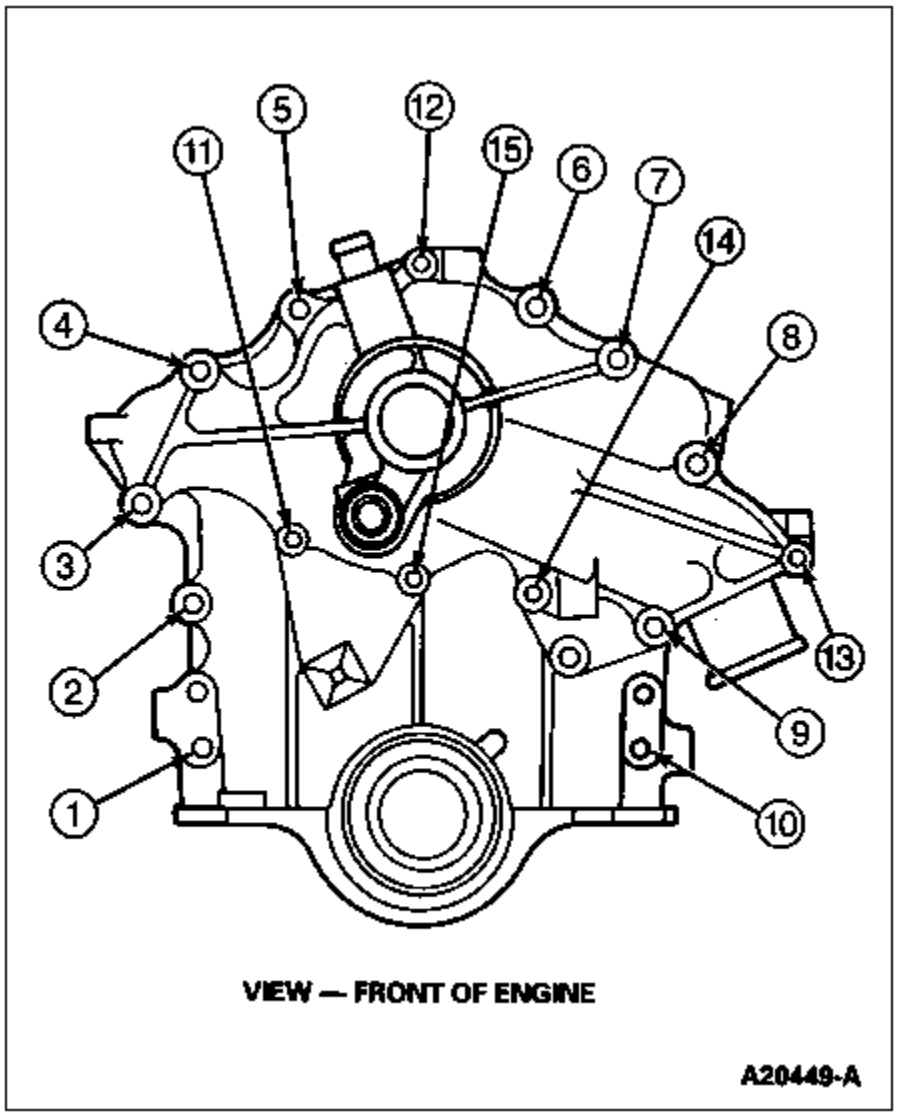

Fastener and Hole No.	Fasteners			
	Part No.	Size	Nm	Lb-Ft
1 [a]	N804215	M8 x 1.25 x 72.25	20-30	15-22
2 [a]	N804215	M8 x 1.25 x 72.25	20-30	15-22
3 [a]	N804811-S8	M8 x 1.25 x 73.0	20-30	15-22
4	N804811-S8	M8 x 1.25 x 73.0	20-30	15-22
5	N804811	M8 x 1.25 x 73.0	20-30	15-22
6	N807515	M8 x 1.25 x 104.3	20-30	15-22
7	N804811-S8	M8 x 1.25 x 73.0	20-30	15-22
8	N804811-S8	M8 x 1.25 x 73.0	20-30	15-22
9	N804811-S8	M8 x 1.25 x 70.0	20-30	15-22
10	N606543-S2	M8 x 1.25 x 52.0	20-30	15-22

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11	N804576-S8	M6 x 1.0 x 28.5	8-12	6-8
12	N804576-S8	M6 x 1.0 x 28.5	8-12	6-8
13	N804576-S8	M6 x 1.0 x 28.5	8-12	6-8
14	N804576-S8	M6 x 1.0 x 28.5	8-12	6-8
15	N804576-S8	M6 x 1.0 x 28.5	8-12	6-8

[a] Apply Pipe Sealant with Teflon D8AZ-19554-A or equivalent meeting Ford specifications WSK-M2G350-AZ and ESR-M18P7-A to fastener threads.

12. Remove remaining bolts in engine front cover and remove cover. Discard old engine front cover gasket (6020).

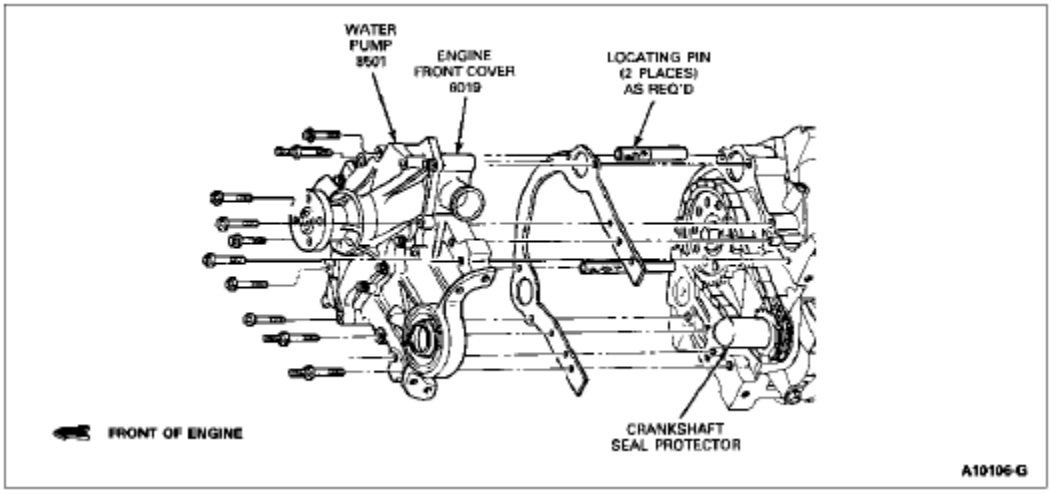
13. Pry crankshaft front seal (6700) from engine front cover with a flat-blade screwdriver or similar tool. Use care to prevent damage to engine front cover.

14. While timing cover is off, inspect timing chain and sprockets to ensure continued service as outlined in Section 03-00 .

Installation

CAUTION: Aluminum components gouge easily, which may result in gasket leaks. Always use care when servicing aluminum gasket surfaces.

Engine Front Cover



NOTE: Lightly oil all bolt threads except those requiring special sealants.

1. If crankshaft front seal is to be replaced, follow instructions outlined in this section.

2. Clean gasket surfaces on cylinder blocks and engine front cover.

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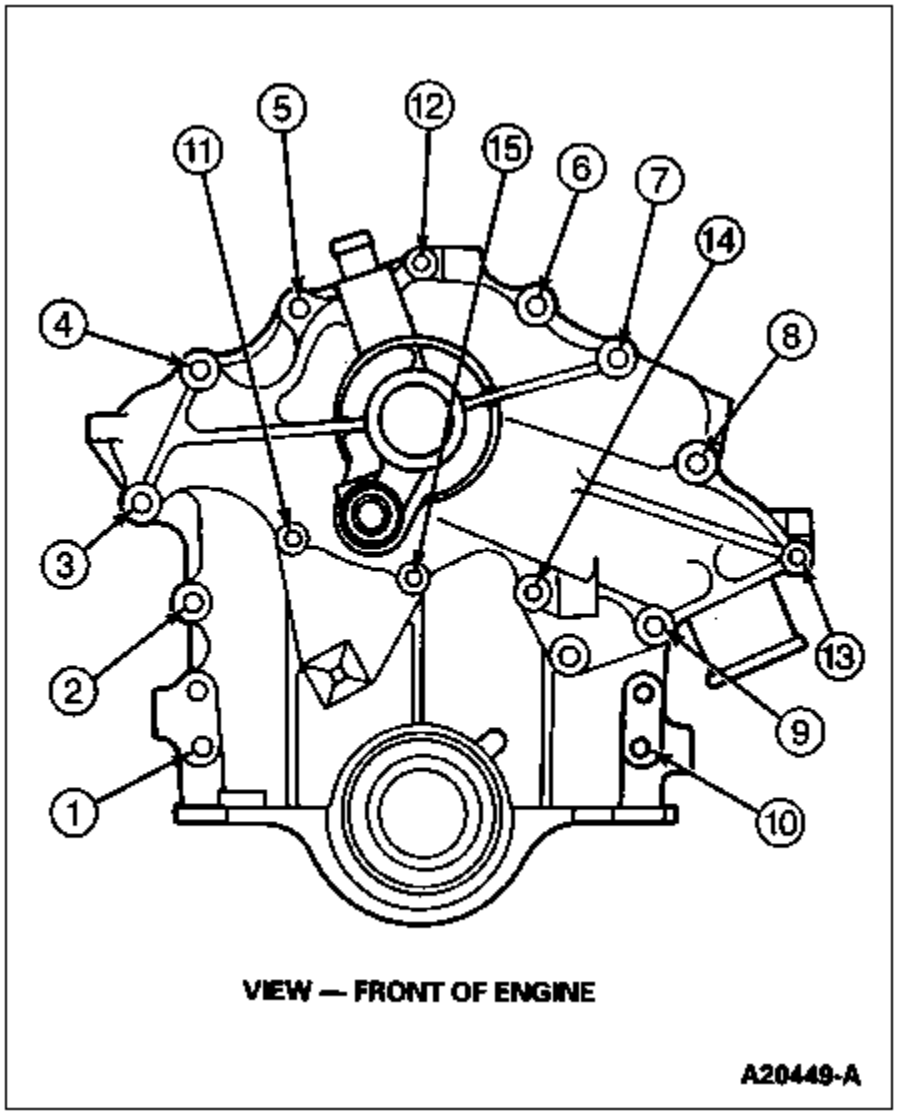
3. Align new engine front cover gasket on cylinder blocks dowel pins. Note bolts that require pipe sealant on accompanying chart.



Fastener and Hole No.	Fasteners			
	Part No.	Size	Nm	Lb-Ft
1 [a]	N804215	M8 x 1.25 x 72.25	20-30	15-22
2 [a]	N804215	M8 x 1.25 x 72.25	20-30	15-22
3 [a]	N804811-S8	M8 x 1.25 x 73.0	20-30	15-22
4	N804811-S8	M8 x 1.25 x 73.0	20-30	15-22
5	N605909-S8	M8 x 1.25 x 73.0	20-30	15-22
6	N807515	M8 x 1.25 x 104.3	20-30	15-22
7	N804811-S8	M8 x 1.25 x 73.0	20-30	15-22

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8	N804811-S8	M8 x 1.25 x 73.0	20-30	15-22
9	N804811-S8	M8 x 1.25 x 70.0	20-30	15-22
10	N606543-S2	M8 x 1.25 x 52.0	20-30	15-22
11	N804576-S8	M6 x 1.0 x 28.5	8-12	6-8
12	N804576-S8	M6 x 1.0 x 28.5	8-12	6-8
13	N804576-S8	M6 x 1.0 x 28.5	8-12	6-8
14	N804576-S8	M6 x 1.0 x 28.5	8-12	6-8
15	N804576-S8	M6 x 1.0 x 28.5	8-12	6-8

[a] Apply Pipe Sealant with Teflon D8AZ-19554-A or equivalent meeting Ford specifications WSK-M2G350-AZ and ESR-M18P7-A to fastener threads.

4. Install engine front cover and attaching bolts. Refer to the previous illustration. Tighten bolts 1 through 10 to 20-30 Nm (15-22 lb-ft) and bolts 11 through 15 to 8-12 Nm (6-8 lb-ft).

5. Raise vehicle.

6. Install oil pan as outlined in this section.

7. Coat crankshaft vibration damper sealing surface with clean engine oil. Apply RTV or equivalent meeting Ford specification ESE-M4G195-B, using Rotunda RTV Dispenser 021-00031, to keyway of damper prior to installation. Install damper using Damper/Front Cover Seal Installer T82L-6316-A. Install crankshaft pulley bolt (6A340) and crankshaft pulley retaining washer (6378) and torque to 125-165 Nm (94-123 lb-ft).

8. Install crankshaft pulley and torque 4 screws to 53-70 Nm (40-52 lb-ft).

9. On Aerostar only, position A/C compressor bracket over 2 engine front cover studs and install 2 nuts on engine front cover studs and 3 screws into engine block bosses. Torque all A/C compressor bracket retainers to 41-54 Nm (31-40 lb-ft).

10. Detach A/C compressor from sidemember of engine compartment and secure to A/C compressor bracket with 4 screws. Torque fasteners to 22-28 Nm (17-21 lb-ft).

11. Lower vehicle.

12. Install water pump as outlined in this section (if removed).

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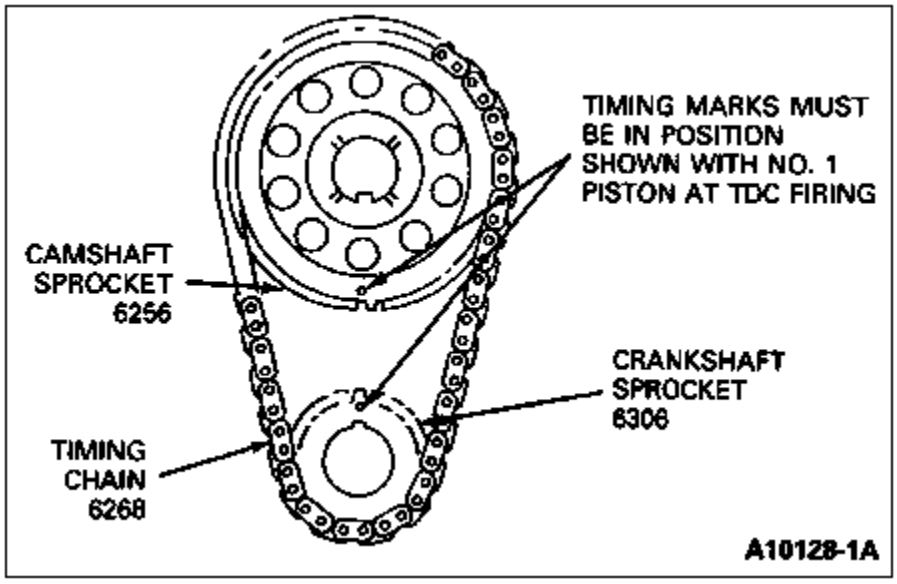
Timing Chain, Sprockets, Tensioners and Guides

Removal

1. Disconnect ground cable at battery and set aside.
2. Remove engine front cover (6019) as outlined in this section.
3. Rotate crankshaft (6303) until No. 1 piston (6108) is at top dead center (TDC) and the timing marks are aligned as illustrated.
4. Check timing chain deflection for excessive wear as outlined in Section 03-00 .
5. Slide camshaft sprocket (6256), crankshaft sprocket (6306) and timing chain forward and remove as an assembly.
6. Clean timing cover and oil pan sealing surfaces of all gasket material and silicone sealer.



Installation

1. Clean and inspect all parts before installation.
2. Slide camshaft sprocket, crankshaft sprocket and timing chain on as an assembly with timing marks aligned as illustrated.
3. **NOTE: The timing chain sprocket bolt has a drilled oil passage for timing chain lubrication. If damaged, do not replace with standard bolt. Clean oil passage with solvent.**

   Install timing chain sprocket bolt and crankshaft pulley retaining washer (6378). Tighten bolt to 55-70

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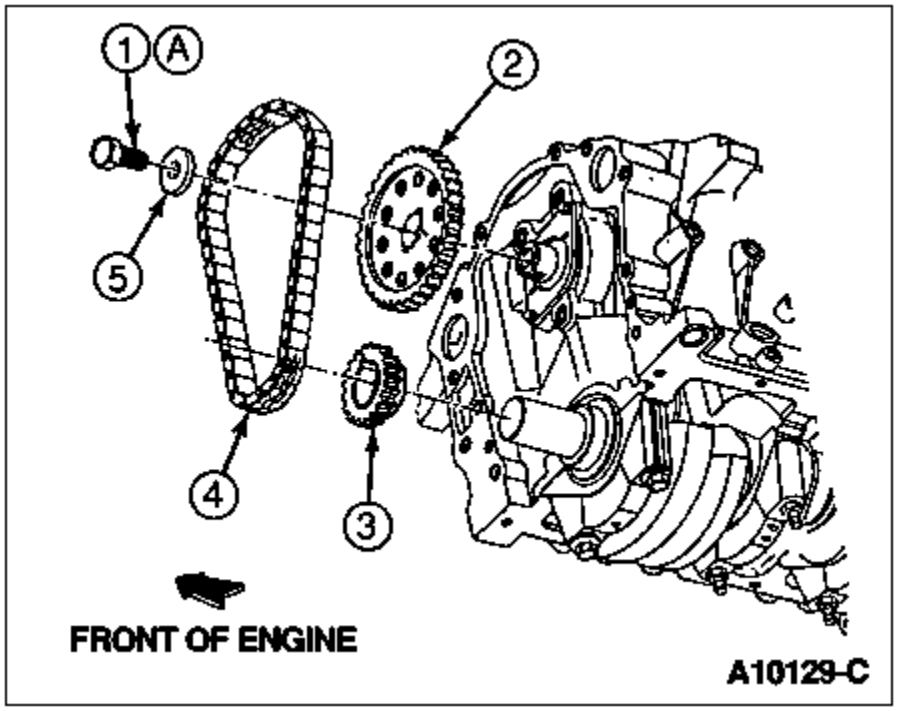
Nm (41-52 lb-ft). Lubricate chain and sprockets with engine oil.



Item	Part Number	Description
1	6279	Camshaft Sprocket Bolt
2	6256	Camshaft Sprocket
3	6306	Crankshaft Sprocket
4	6268	Timing Chain/Belt
5	6278	Camshaft Sprocket Washer
A	—	Tighten to 55-70 Nm (41-52 Lb-Ft)

4. Inspect crankshaft front seal (6700) for burrs or cuts. If required, replace seal using Front Cover Seal Installer T70P-6B070-A.
5. Position engine front cover gasket (6020) onto cylinder block alignment dowels.
6. Install engine front cover onto cylinder blocks (6010) using caution to not damage crankshaft front seal.
7. Install retaining bolts and tighten as outlined in this section.
8. Install oil pan (6675) and new oil pan gasket (6710) as outlined in this section.
9. Install water pump (8501) if removed.
10. Install crankshaft vibration damper and crankshaft pulley as outlined in this section.

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11. Install front end accessory drive components as outlined. Refer to Section 03-05 for routing and tension of drive belt.

12. Fill crankcase with the correct viscosity and weight engine oil.

13. **CAUTION: This engine has aluminum components and requires a special corrosion-inhibiting coolant formulation to avoid radiator damage. Refer to Section 03-03 for coolant specifications.**

    Fill and bleed cooling system.

14. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

    Connect battery ground cable (14301).

15. Start engine (6007) and check for coolant, oil and exhaust leaks.

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Camshaft

Removal

1. **NOTE: On 3.0L Aerostar it is necessary to remove the engine (6007) from the vehicle to perform this procedure. Refer to Engine Assembly, Aerostar , Removal and Installation, in this section.**

   Disconnect ground cable at battery and set aside.

2. Rotate crankshaft (6303) so No. 1 piston is at 0 degrees at Top Dead Center (TDC) on the compression stroke.

3. Remove radiator as outlined in Section 03-03 .

4. Recover A/C refrigerant and remove A/C condenser core as outlined in Section 12-00 .

5. Remove engine front cover (6019) and timing chain and sprockets as outlined in this section.

6. Remove intake manifold (9424) and valve covers (6582) as outlined in this section.

7. Loosen rocker arm bolts enough to allow the rocker arms (6564) to be lifted off the push rod (6565) and rotated to one side.

8. Remove push rods. Identify each push rod's location. The push rods should be installed in their original location and position during reassembly.

9. Loosen roller tappet guide plate retainer bolts (2). Remove tappet guide plate retainer from tappet valley.

10. Remove valve tappet guide plates (6K512) from valve tappets (6500) by lifting straight up.

11. **NOTE: If the valve tappets are stuck in the bores due to excessive varnish or gum deposits, it may be necessary to use a claw-type tool to aid removal. Work the valve tappet up and down in the bore to loosen it from the deposits.**

    Remove valve tappets by grasping each valve tappet and pulling in line with bore.

12. Remove the two camshaft thrust plate retaining bolts and camshaft thrust plate (6269).

13. **CAUTION: Damage to camshaft bearings and/or camshaft can occur if camshaft is allowed to drop on bearing surface or cylinder block.**

    Remove camshaft (6250) by pulling slowly toward front of engine keeping camshaft perfectly in line with camshaft bores.

Installation

NOTE: Lightly oil all retaining bolt and stud threads before installation except those specified for

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special sealant.

1. **CAUTION: Aluminum components gouge easily which can cause gasket leaks. Always use care when scraping aluminum gasket surfaces.**

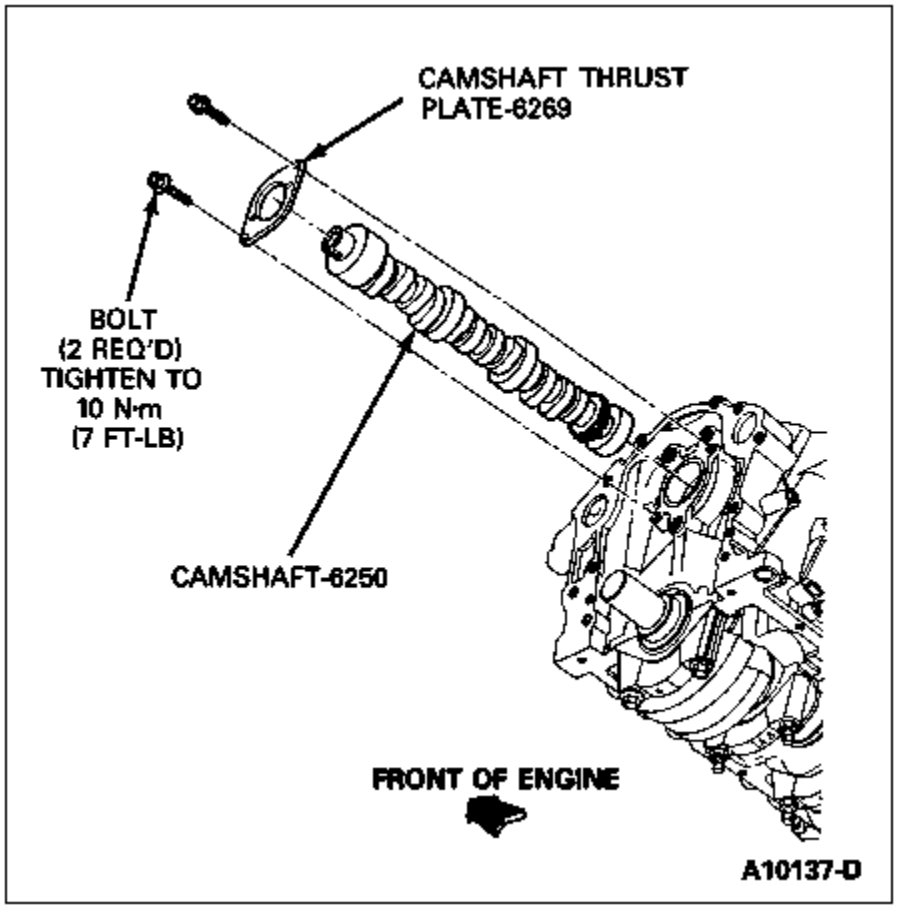
   Clean mating gasket surfaces of intake manifold and cylinder head (6049). Lay a clean cloth or shop rag in the tappet valley to catch any gasket material. After scraping, carefully lift cloth from tappet valley preventing any particles from entering oil drain holes or cylinder head. Use a suitable solvent to remove old rubber sealant. Clean gasket mating surfaces of engine front cover to cylinder block.

2. Inspect camshaft bearings for wear. Replace as outlined in this section.

3. Clean and inspect all components before installation.

4. Lubricate camshaft lobes, bearing surfaces, and distributor drive gear liberally with Engine Assembly Lubricant D9AZ-19579-D or equivalent meeting Ford specification ESR-M99C80-A.

5. Slide camshaft through bearings into cylinder blocks (6010) remembering to keep camshaft perfectly in line with front bearing.



6. Lubricate camshaft thrust plate with Engine Assembly Lubricant D9AZ-19579-D or equivalent meeting Ford specification ESR-M99C80-A and install with two retaining bolts. Tighten bolts to 8-12 Nm (6-8 lb-ft).

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7. If installing a new camshaft, check end play as specified in Section 03-00 . If clearance is excessive, replace camshaft.

8. **CAUTION: Do not replace camshaft sprocket bolt (6279) with a standard bolt or severe engine damage will occur. This bolt is an oil carrying, precision component.**

   Lubricate timing chain and sprockets with Engine Assembly Lubricant D9AZ-19579-D or equivalent meeting Ford specification ESR-M99C80-A and install as an assembly. Align marks as illustrated. Inspect camshaft sprocket (6256) for blockage of drilled oil passages and clean as required. Install camshaft sprocket bolt and washer and tighten to 50-70 Nm (37-52 lb-ft).

9. Lubricate valve tappets and bore with Engine Assembly Lubricant D9AZ-19579-D or equivalent meeting Ford specification ESR-M99C80-A.

10. Install valve tappets into original bores.

11. **NOTE: Install valve tappet guide plates with the word "UP" or button visible.**

    Aligning tappet flats, install valve tappet guide plates.

12. Install tappet guide plate and retainer (6K564) over valve tappet guide plates. (NOTE: Retainer orientation is not important.) Hand-start two retaining bolts. Tighten bolts to 10-14 Nm (7-10 lb-ft).

13. Apply a 5-6mm drop of Silicone Rubber D6AZ-19562-AA or equivalent meeting Ford specification ESB-M4G92-A or ESE-M4G195-A to intersection of cylinder block and cylinder head assembly at four corners.

14. Position intake manifold gaskets (9439) on tocylinder heads. Align the intake gasket locking tabs to the provisions on the head gaskets (6051).

15. Install front and rear intake manifold seals. Secure with retaining features.

16. Lower intake manifold into position aligning manifold bolt holes to those in the cylinder head. Use care to prevent disturbing the rubber sealer which can cause sealing voids. Install bolts 1, 2, 3 and 4 and hand-snug. Install remaining bolts. Tighten in numerical sequence to 15 Nm (11 lb-ft), then again to 26-32 Nm (19-24 lb-ft).

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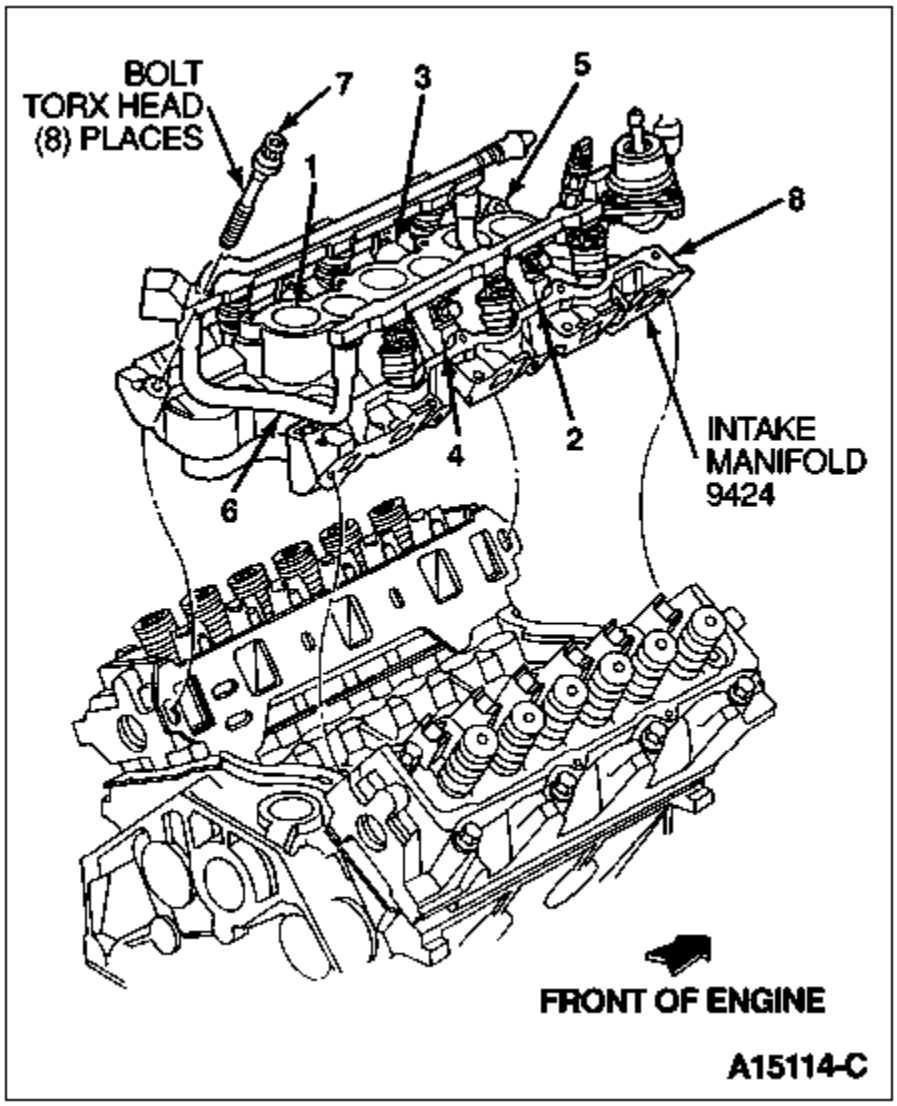

17. Completely coat camshaft position sensor gear teeth with Engine Assembly Lubricant D9AZ-19579-D or equivalent meeting Ford specification ESR-M99C80-A.

18. **CAUTION: If a new camshaft is installed, always add the rest of the pint of Engine Assembly Lubricant D9AZ-19579-D or equivalent meeting Ford specification ESR-M99C80-A to the engine oil by pouring it through the distributor hole onto the camshaft drive gear. Run engine at idle for five minutes before driving vehicle.**

    Install camshaft position sensor. Refer to Section 03-14 .

19. Rotate engine socamshaft is in Position A, as shown, with camshaft sprocket timing mark and crankshaft sprocket timing mark at top center.

20. **NOTE: Lubricate each push rod, rocker arm, and rocker arm fulcrum with Engine Assembly Lubricant D9AZ-19579-D or equivalent meeting Ford specification ESR-M99C80-A before installing.**

    Install push rod, rocker arm, rocker arm fulcrum, and rocker arm bolt for valves:

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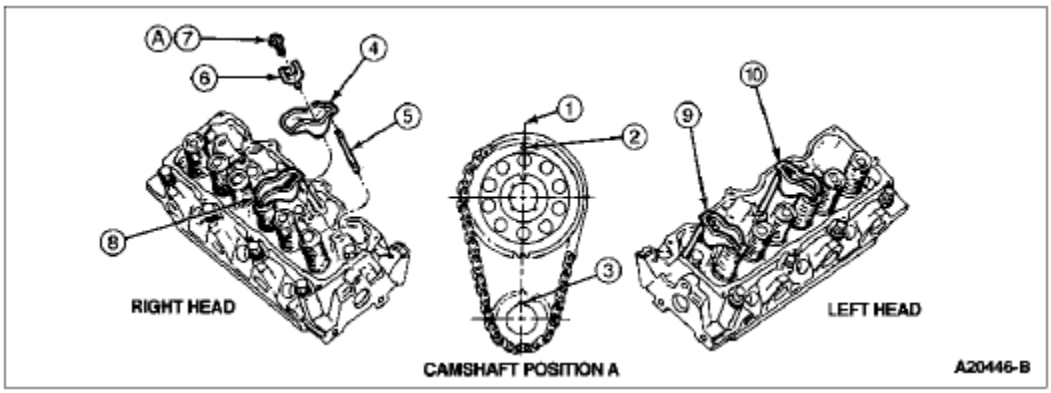
- Cylinder No. 1 Intake
- Cylinder No. 2 Exhaust
- Cylinder No. 4 Intake
- Cylinder No. 5 Exhaust

Tighten rocker arm bolts to 11 Nm (8 lb-ft).

21. For valves in above step, check rocker arm-to-valve clearance. Clearance should be 2.15-4.69mm (0.084-0.184 in.).

Camshaft Position A — Rocker Arm, Push Rod, and Fulcrum Installation



Item	Part Number	Description
1	—	Centerline of Keyway Vertical Within Five Degrees
2	—	Camshaft Sprocket Timing Mark at Top Center
3	—	Crankshaft Sprocket Timing Mark at Top Center
4	6564	Rocker Arm, No. 1 Intake
5	6565	Push Rod
6	6A528	Rocker Arm Fulcrum
7	6A527	Rocker Arm Bolt
8	6564	Rocker Arm and Parts
9	6564	Rocker Arm and Parts
10	6564	Rocker Arm and Parts
A	—	Tighten to 11 Nm (8 Lb-Ft)

22. Rotate engine so camshaft is in Position B, as shown, with camshaft sprocket timing mark at two o'clock position and crankshaft sprocket timing mark at 4:30 position.

23. **NOTE: Lubricate each push rod, rocker arm, and rocker arm fulcrum with Engine Assembly Lubricant D9AZ-19579-D or equivalent meeting Ford specification ESR-M99C80-A before installing.**

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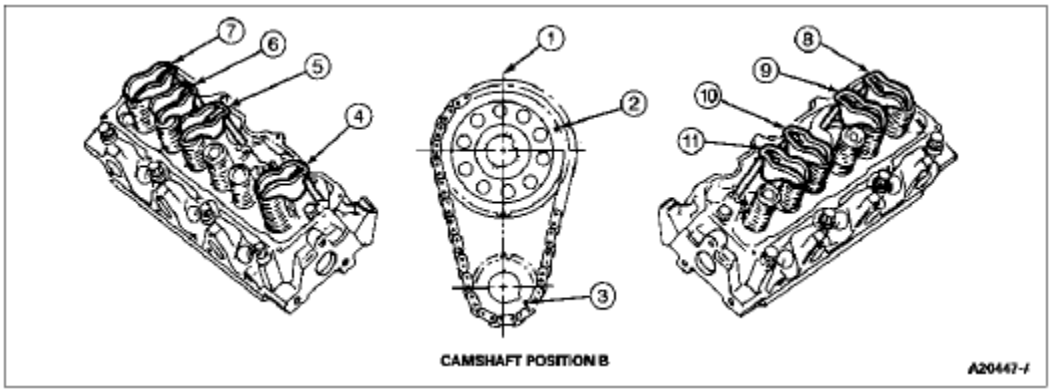
Install push rod, rocker arm, rocker arm seat (6A528), and rocker arm bolt for valves:

- Cylinder No. 1 Exhaust
- Cylinder No. 2 Intake
- Cylinder No. 3 Exhaust
- Cylinder No. 3 Intake
- Cylinder No. 4 Exhaust
- Cylinder No. 5 Intake
- Cylinder No. 6 Exhaust
- Cylinder No. 6 Intake

Tighten rocker arm bolts to 11 Nm (8lb-ft).

24. For valves in above step, check rocker arm-to-valve clearance. Clearance should be 2.15-4.69mm (0.084-0.184 in.).

Camshaft Position B — Rocker Arm, Push Rod, and Fulcrum Installation



Item	Part Number	Description
1	—	Centerline
2	—	Camshaft Sprocket Timing Mark at Two o'Clock Position
3	—	Crankshaft Sprocket Timing Mark at 4:30 Position
4	6564	Rocker Arm (No. 1 Exhaust Rocker Arm and Parts)
5	6564	Rocker Arm (No. 2 Intake Rocker Arm and Parts)
6	6564	Rocker Arm (No. 3 Exhaust Rocker Arm and Parts)
7	6564	Rocker Arm (No. 3 Intake Rocker Arm and Parts)
8	6564	Rocker Arm (No. 6 Exhaust Rocker Arm and Parts)
9	6564	Rocker Arm (No. 6 Intake Rocker Arm and Parts)
10	6564	Rocker Arm (No. 5 Intake Rocker Arm and Parts)
11	6564	Rocker Arm (No. 4 Exhaust Rocker Arm and Parts)

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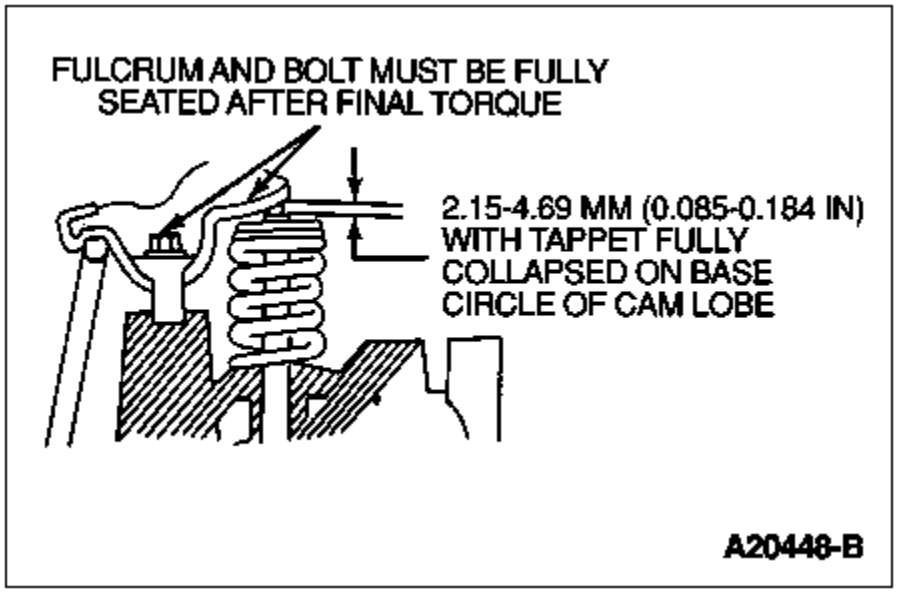
25. **CAUTION: Rocker arm fulcrum must be fully seated into cylinder head and push rod must be fully seated into lifter sockets before final tightening.**

    Final-tighten allrocker arm bolts (6A527) to 26-38 Nm (19-28 lb-ft) with camshaft in any position.



26. Installengine front cover including oil pan (6675), crankshaft vibration damper and front accessory components as outlined in this section for Aerostar or Ranger.

27. On Ranger vehicles, position the air conditioning hose and manifold assembly in engine compartment with hoses as originally routed with no kinks or binds.

28. Remove all caps and plugs. Push suction hose into coupling on accumulator and liquid line into coupling on condenser.

29. Position hose assembly manifold to A/C compressor and install retaining bolt. Tighten to 25-30 Nm (18-22 lb-ft).

30. Evacuate and recharge air conditioning system as outlined in Section 12-00 .

31. Install valve covers as outlined in this section.

32. Install fuel injector electrical harness to each injector. Secure with standoffs to inboard rocker arm cover studs.

33. Install throttle body (9E926) as outlined in Section 03-04B .

34. Install ignition coil and bracket assembly (Ranger only). Tighten retaining nuts to 16-20 Nm (12-15 lb-ft).

35. Position the EGR tube in the EGR valve and start the first few threads of the flare nut. Install the bolt at the exhaust manifold end and tighten to 20-30 Nm (15-22 lb-ft). Tighten the flare nut to 35-65 Nm (26-48 lb-ft).

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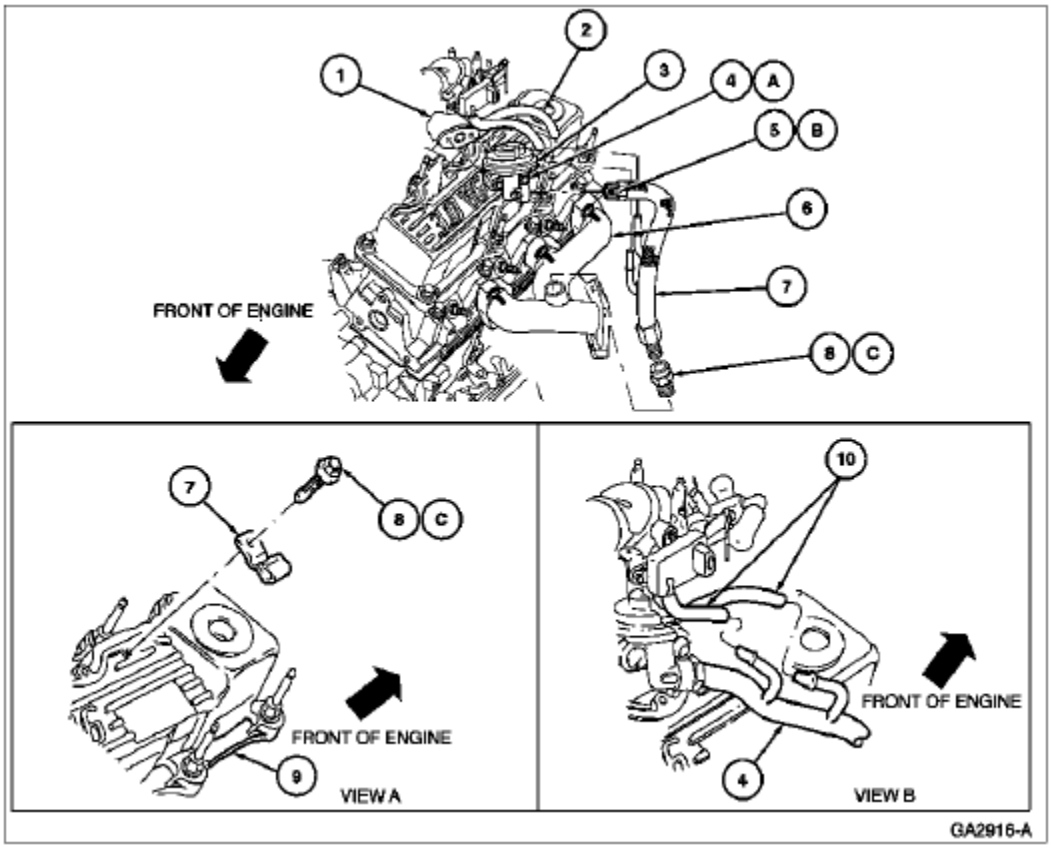
36. Connect two pressure differential hoses from the EGR pressure sensor to the EGR tube.

EGR Tube — Ranger



Item	Part Number	Description
1	—	Throttle Body
2	—	Transducer Hose
3	—	EGR Valve
4	—	Bolt & Washer
5	—	EGR Tube Upper Fitting
6	—	Exhaust Manifold (L.H.)
7	—	EGR Valve to Exhaust Manifold Tube
8	—	EGR Tube Lower Fitting
A	—	Tighten to 20-30 Nm (15-22 lb/ft)
B	—	Tighten to 35-65 Nm 26-48 lb/ft)
C	—	Tighten to 35-65 Nm (26-48 Lb-Ft)

37. Connect fuel lines tofuel injection supply manifold (9F792) as outlined in Section 03-04B .

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38. Install fuel line safety clips.

39. Connect vacuum lines to premarked locations.

40. Connect electrical connections of:

    - Intake air temperature sensor (IAT sensor) (12A697)
    - Idle air control valve (IAC valve) (9F715)
    - Engine coolant temperature sensor (ECT sensor) (12A648)
    - Camshaft position sensor
    - Ignition coil
    - Radio ignition interference capacitor (18801)
    - Water temperature indicator sender unit (10884)
    - EGR pressure sensor, if equipped
    - EGR vacuum regulator control, if equipped

Refer to Section 18-01 for further information.

41. Fill and bleed cooling system with specified coolant and proper mixture.

42. Fill crankcase with specified amount and viscosity of oil.

43. Install air cleaner outlet tube to throttle body and MAF sensor (12B579) . Tighten retaining clamps to 1.9 Nm (16 lb-in).

44. Install closure hose to valve cover and air cleaner outlet tube provisions.

45. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while thepowertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

    Connect ground cable at battery.

46. Start engine and check for coolant, oil, fuel and vacuum leaks.

47. Verify and correct default base initial engine timing to 10 degrees BTDC. Refer to the Powertrain Control/Emissions Diagnosis Manual. Tighten retaining bolt to 24 Nm (18 lb-ft).

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Exhaust Manifolds

Removal

WARNING: ALLOW ENGINE (6007) TO COOL SUFFICIENTLY BEFORE REMOVING MANIFOLDS. SERIOUS INJURY WILL RESULT FROM CONTACT WITH HOT EXHAUST MANIFOLDS.

1. Disconnect ground cable at battery and set aside.
2. **NOTE: Spray retaining nuts with rust penetrant prior to loosening to prevent removal of stud with nut.**

   Raise vehicle. Loosen and remove muffler inlet pipe retaining nuts from exhaust manifolds (9430).
3. Lower vehicle.

Right-Hand Side

1. Remove spark plugs (12405).
2. Remove exhaust manifold retaining bolts and studs.
3. Remove exhaust manifold from vehicle.

Left-Hand Side

1. Disconnect two Delta PFE sensor hoses from EGR valve to exhaust manifold tube (9D477).
2. Loosen EGR tube flare nut at EGR valve (EGR valve) (9D475).
3. On Ranger, remove EGR tube bolt at exhaust manifold. On Aerostar, loosen and remove flare nut at exhaust manifold connector (9F485).
4. Remove engine oil level indicator dipstick tube retaining nut. Rotate or remove tube out of way.
5. Remove exhaust manifold and exhaust manifold gasket (9448) from vehicle.

Exhaust Manifold Installation

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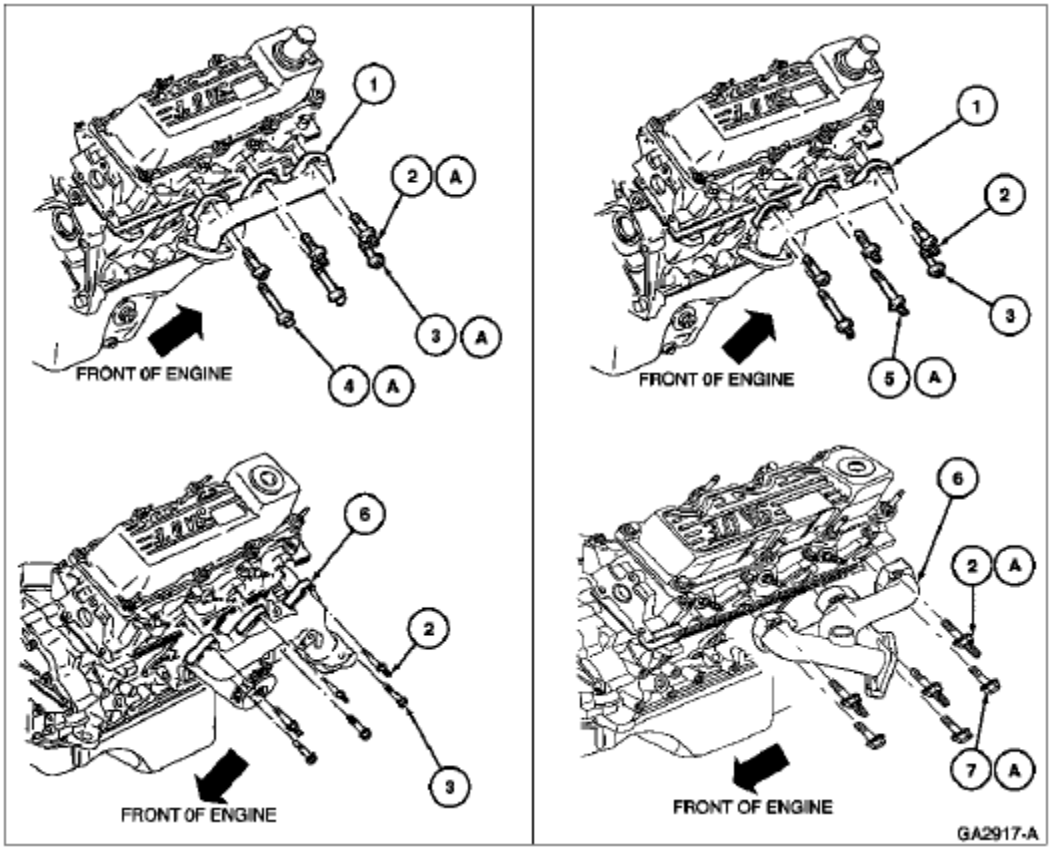

Item	Part Number	Description
1	9430	Exhaust Manifold, Right
2	N804468-S	Stud
3	N804465-S2	Screw and Washer
4	—	Bolt
5	N805702-S2	Hex Flange Stud, M8 x 1.25 x 90
6	9430	Exhaust Manifold, Left
7	—	Screw and Washer
A	—	Tighten to 20-30 Nm (15-22 Lb-Ft)

Installation

1. Clean mating surfaces of exhaust manifolds and cylinder heads (6049) of carbon deposits.
2. Position right or left exhaust manifold and exhaust manifold gasket in place to cylinder head and hand-tighten retaining bolts and studs. Tighten to 20-30 Nm (15-22 lb-ft).
3. Rotate or install oil level indicator tube (6754) to appropriate exhaust stud and install retaining nut if exhaust manifold was removed. Tighten to 16-20 Nm (12-15 lb-ft). Apply ESE-M4G217-A sealer to tube prior to installation if tube was removed.

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4. Install spark plugs. Tighten to 11 Nm (8 lb-ft).

5. Install EGR tube flare nut into exhaust manifold connector (9F485) (Aerostar) finger tight.

6. Install EGR tube flare nut into EGR valve finger-tight.

7. Install bolt in EGR valve to exhaust manifold tube at exhaust manifold and tighten to 20-30 Nm (15-22 lb-ft).

8. Tighten flare nuts to 35-65 Nm (26-48 lb-ft).

9. Connect two Delta PFE sensor hoses onto ports in EGR tube.

10. Connect exhaust inlet pipe to left exhaust manifold and right exhaust manifold. Tighten retaining nuts to 41 Nm (30 lb-ft). Tighten both nuts in equal amounts to correctly seat inlet pipe flange.

11. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

    Connect ground cable at battery.

12. Start engine and check for oil and exhaust leaks.

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Oil Pan, Ranger

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Engine Lifting Sling	014-00036

Removal

1. Disconnect battery ground cable. For additional information, refer to Section 14-01 .
2. Remove air cleaner outlet tube assembly by unclipping air cleaner clamp, loosening hose clamp at outlet tube, disconnecting intake air temperature (IAT) sensor and mass air flow (MAF) sensor connectors, and crankcase ventilation hose.
3. Remove oil level indicator fan shroud retaining bolts. Position shroud over fan blade.
4. Remove radiator support bolts. Raise and secure radiator to front core support.
5. Remove engine mount nuts from studs.
6. Unclip 42-pin connector from bracket and position it aside.
7. Install suitable lifting brackets to left and right exhaust manifolds. Attach Rotunda Engine Lifting Sling 014-00036 (or equivalent) to lifting brackets. With a suitable lifting device raise engine approximately 50.8 mm (2 in). Install wood blocks between engine mounts and support brackets. Remove lifting device.
8. Raise vehicle on hoist. For additional information, refer to Section 00-02 .
9. Drain the oil.
10. Remove transmission insulator retaining nuts and install a jack stand to extension housing. Raise transmission about 25.4-101.6mm (1-4 in) to gain access for removal of oil pan.
11. Remove transmission inspection cover.
12. Remove starter motor splash shield.
13. Remove starter motor retaining bolts and secure starter aside.
14. If equipped, disconnect and remove low oil level sensor.
15. **NOTE: Oil pan fits tightly between transmission spacer plate and oil pump pickup tube. Use care when removing pan to avoid damaging either part.**

    Remove oil pan bolts and lower pan.
16. Remove oil pump retaining bolts. Lower and twist pump to allow the oil pan to lower completely.

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Remove the pump and pan assembly from vehicle.

17. Remove and discard oil pan gasket.

18. Clean the oil pan mating surface.

Installation

1. **NOTE: When using silicone rubber sealer, assembly should occur within 15 minutes after sealer application. After this time, the sealer may start to set up, and its sealing effectiveness could be reduced.**

   Apply a 4.0-6.0 mm (1/5 inch) bead of Silicone Rubber D6AZ-19562-AA or -BA (or equivalent meeting Ford specifications ESB-M4G92-A and ESE-M4G195-A) to junction of rear main bearing cap and cylinder block and to junction of front cover assembly and cylinder block. Position oil pan gasket to cylinder block and secure it with Gasket and Trim Adhesive D7AZ-19B508-B (or equivalent meeting Ford specifications ESR-M11P17-A and ESE-M2G52-A).

2. Install oil pump assembly and bolt. Tighten bolt to 40-55 Nm (30-40 lb-ft).

3. **NOTE: If oil pan is replaced with a new pan you must tighten new pan to spec then loosen and retighten.**

   Position oil pan to cylinder block and install oil pan to engine bolts. Tighten bolts to 10-14 Nm (7-10 lb-ft).

4. Remove jack stand and install transmission insulator retaining nuts. Tighten nuts to 85-118 Nm (63-87 lb-ft).

5. **NOTE: When replacing low oil level sensor, use a new metal gasket with a rubber O-ring.**

   Install low oil level sensor. Tighten sensor to 20-34 Nm (15-25 lb-ft).

6. Install transmission inspection cover and retaining bolts. Tighten bolts to 10-14 Nm (7-10 lb-ft).

7. Install starter motor and bolts. Tighten bolts to 22-28 Nm (17-20 lb-ft).

8. Securely install starter motor splash shield.

9. Lower vehicle.

10. Install lifting device and support engine. Remove wood blocks and lower engine back into original position. Remove lifting device and Rotunda Engine Lifting Sling 014-00036 (or equivalent). Remove lifting brackets from right and left exhaust manifolds.

11. Remove support straps, lower radiator into position, and install radiator bolts to core support. Position fan shroud and install the retaining bolts. Tighten bolts to 6-8 Nm (52-71 lb-in).

12. Install engine mount nuts and tighten to 98-132 Nm (72-97 lb-ft).

13. Connect 42-pin connector to the bracket and install oil level indicator.

14. Install engine air cleaner outlet tube assembly. Connect IAT sensor, MAF sensor, and crankcase ventilation hose. Securely tighten the hose clamp.

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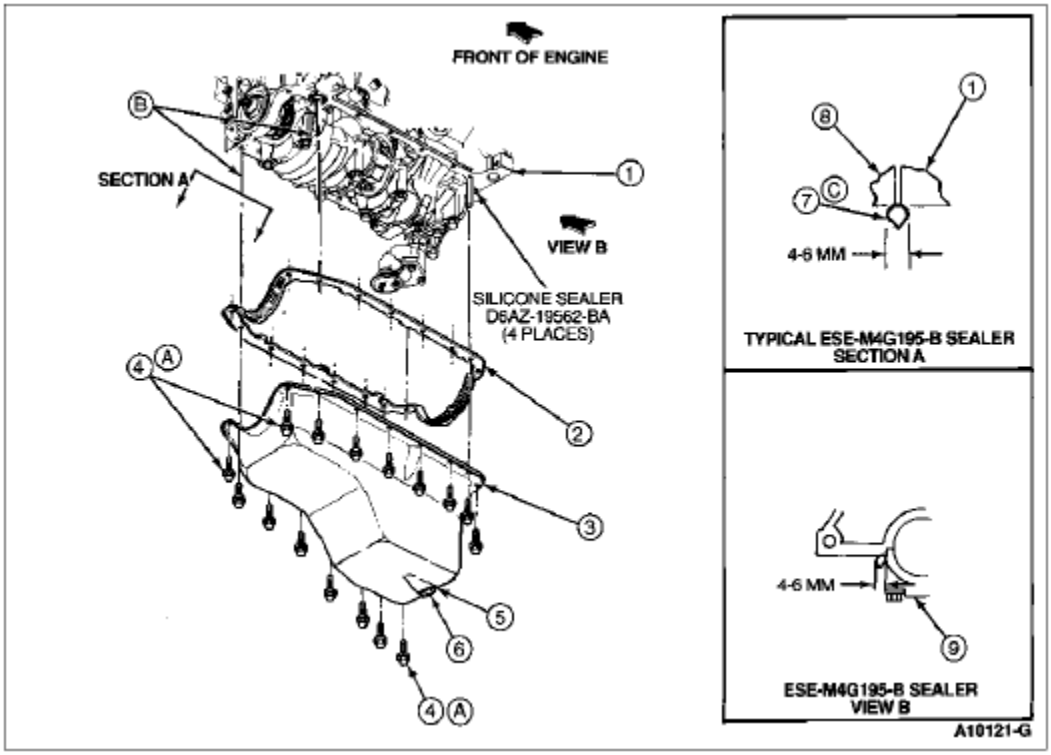
15. **NOTE: When battery has been disconnected and reconnected, some abnormal drive symptoms can occur while powertrain control module (PCM) (12A650) relearns its adaptive strategy. Vehicle may need to be driven 16 km (10 miles) or more to relearn strategy.**

    Connect battery ground cable.

16. Fill crankcase with correct viscosity and amount of engine oil.

17. Start engine and check for oil leaks.

Oil Pan Installation — Ranger



Item	Part Number	Description
1	6010	Cylinder Block
2	6710	Oil Pan Gasket
3	6675	Oil Pan
4	N803159-S	Screw and Washer
5	6734	Oil Pan Drain Plug Gasket
6	6730	Oil Pan Drain Plug
7	ESE-M4G195-B	Sealer
8	6059	Front Cover
9	—	Rear Main Bearing Cap (Part of 6010)

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A	—	Tighten to 10-14 Nm (7-10 Lb-Ft)
B	D6AZ-19562-BA	Silicone Sealer — 4 Places
C	—	Stop Bead 3mm from Timing Chain Cavity

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Oil Pan, Aerostar

Removal

1. Disconnect ground cable at battery and set aside.
2. Remove oil level dipstick (6750).
3. Raise vehicle.
4. Remove retainer clip at sensor, if equipped with a low oil level sensor (6C624). Remove electrical connector from sensor.
5. Drain crankcase.
6. Remove starter motor.
7. Remove transmission as outlined in Section 07-01A .
8. Remove oil pan retaining bolts. Remove oil pan (6675).
9. Remove old oil pan gasket (6710) and discard.

Installation

NOTE: Lightly oil all bolt threads before installation.

1. Clean the gasket surfaces on the cylinder blocks (6010) and oil pan.
2. **NOTE: When using silicone rubber sealer, assembly should occur within 15 minutes after sealer application. After this time, the sealer may start to set up, and its sealing effectiveness may be reduced.**

   Apply a 4.0-6.0mm (1/5-inch) bead of Silicone Sealer D6AZ-19562-AA or -BA or equivalent meeting Ford specification ESB-M4G9Z-A to the junction of the rear main bearing cap and cylinder block and junction of the front cover assembly and cylinder block. See following illustration.
3. Position oil pan gasket to cylinder blocks and secure with Gasket and Trim Adhesive D7AZ-19B508-B or equivalent meeting Ford specification ESE-M2G52-A.
4. Position oil pan to cylinder block.
5. Install oil pan attaching bolts and tighten to 10-14 Nm (7-10 lb-ft).
6. Install transmission as outlined in Section 07-01A .
7. Install starter motor and transmission inspection cover.
8. Install low oil level sensor connector to sensor and install retainer clip.

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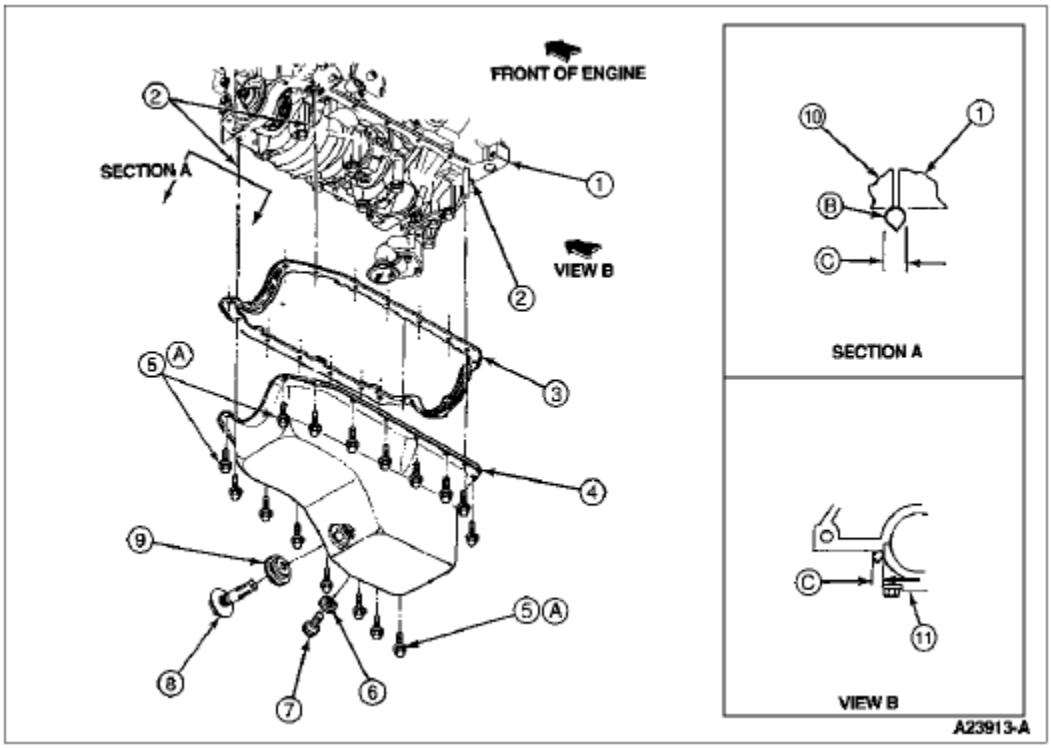
9. Lower vehicle.
10. Replace oil level dipstick.
11. Fill crankcase with correct viscosity and amount of engine oil.
12. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

    Connect ground cable at battery.
13. Start engine (6007) and check for engine oil leaks.

Oil Pan Installation — Aerostar



Item	Part Number	Description
1	6010	Cylinder Blocks
2	F1AZ-19562-A	RTV Sealer (4 Places)
3	6710	Oil Pan Gasket
4	6675	Oil Pan
5	N803159-S	Screw and Washer

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6	6734	Oil Pan Drain Plug Gasket
7	6730	Oil Pan Drain Plug
8	6C624	Low Oil Level Sensor
9	6C626	Low Oil Level Sensor Washer
10	6019	Engine Front Cover
11	—	Rear Main Bearing Cap (Part of 6010)
A	—	Tighten to 27-41 Nm (20-30 Lb-Ft)
B	—	Stop Bead 3mm (0.117 In.) from Timing Chain Cavity
C	—	4-6mm (0.156-0.234 In.)

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Oil Pump

Removal

1. Remove oil pan (6675) as outlined.
2. Remove retaining bolt and remove oil pump and intermediate shaft.

Installation

1. **NOTE: If replacing oil pump make sure to remove oil pump intermediate shaft (6A618) from oil pump.**

   If replacing oil pump (6600), insert oil pump intermediate shaft assembly into hex drive hole in oil pump until oil pump intermediate shaft retaining ring (6629) "clicks" into place.
2. Install oil pump with oil pump intermediate shaft through intermediate shaft hole in rear main bearing cap. Position oil pump over locating pins.
3. Install retaining bolt and tighten to 40-55 Nm (30-40 lb-ft).
4. Install oil pan as outlined.

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Crankshaft

Removal

1. Remove engine (6007) from vehicle as outlined in this section, remove flywheel and engine rear plate, and install on a work stand.
2. Drain crankcase oil.
3. Remove spark plugs (12405).
4. Remove oil pan (6675) as outlined in In-Vehicle procedures in this section.
5. Remove engine front cover (6019) as outlined in In-Vehicle procedures in this section.
6. Check timing chain deflection as outlined in Section 03-00 .
7. Remove camshaft sprocket bolt (6279) and camshaft sprocket washer (6278).
8. Remove timing chain/belt (6268), camshaft sprocket (6256) and crankshaft sprocket (6306) as an assembly. Using one hand on the camshaft sprocket and the other on the crankshaft sprocket, pull assembly forward and off of camshaft (6250) and crankshaft (6303).
9. Rotate engine 180 degrees on engine stand. Remove oil pump retaining bolt and lift oil pump (6600) off of bearing cap.
10. **NOTE: All main bearing caps are marked with arrows. One arrow identifies No. 1 main bearing cap, two arrows identify No. 2 cap, etc. All connecting rods (6200) and caps are identified by matching correlation letters. Connecting rods are not identified to a cylinder number.**

    Remove connecting rod caps. Rotate crankshaft to position cap to be removed to bottom of stroke. Loosen and remove two retaining nuts per cap. Place retaining nuts so that they may be reinstalled on the same rod bolt.
11. Tap cap with a plastic mallet to separate from connecting rod bolt (6214). Remove cap from crankshaft. If lower bearing remained on crankshaft, carefully grasp both sides of bearing and pull straight up away from journal (oil acts as an adhesive between two precision fitted components). Place bearing back into cap and tag for cylinder position number.
12. Install protective rubber caps such as fuel hose onto connecting rod bolts. Using a wooden hammer handle or similar device, tap piston (6108) into cylinder bore while guiding connecting rod bolt away from crankshaft. Push assembly in far enough to prevent crankshaft rotation from hitting connecting rod bolt. Make sure upper connecting rod bearing is still seated in rod.
13. Perform above three steps for remaining connecting rod bolts.
14. Loosen and remove crankshaft main bearing cap bolts. Place retaining bolts so that they may be reinstalled in the original position.

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15. Lift crankshaft straight up from cylinder blocks (6010). Make sure crankshaft bearing surfaces are not scratched or damaged by contact with cylinder block.

16. **NOTE: If crankshaft main bearings (6333) are to be reused, they should be identified to make sure that they are installed in their original positions.**

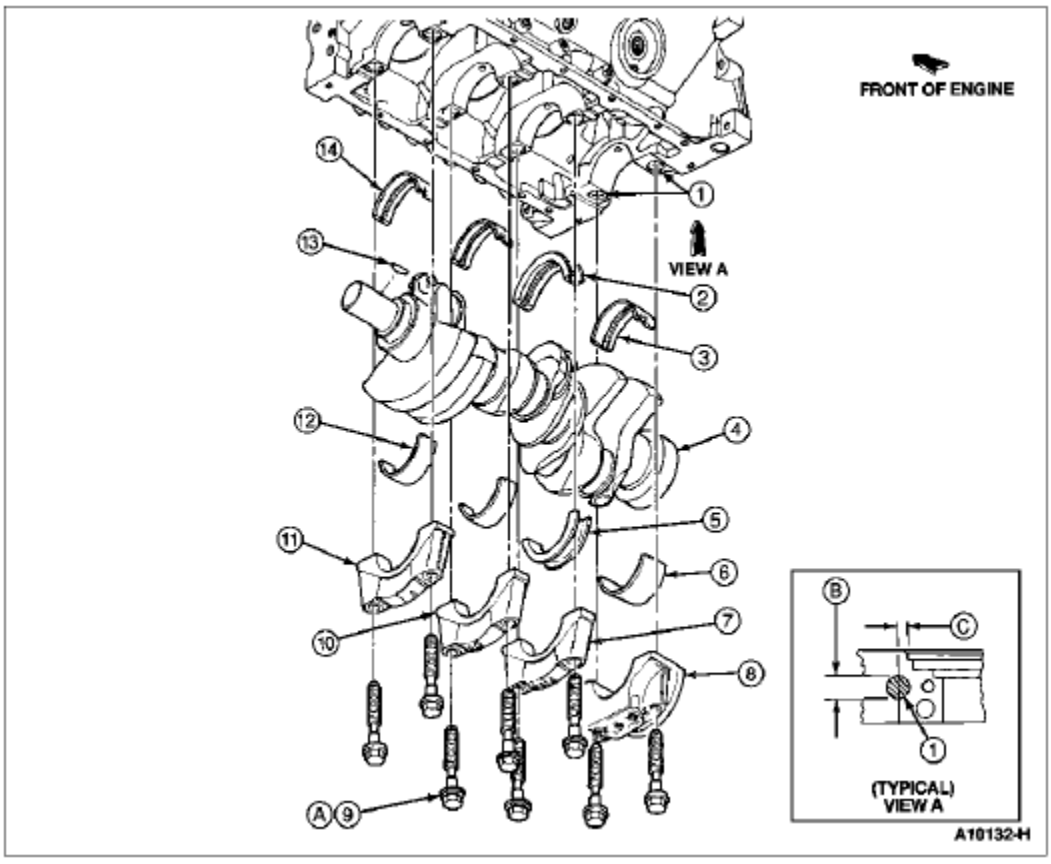
    Remove crankshaft main bearings from cylinder blocks and bearing caps.

17. Remove connecting rod bearing (6211) from the connecting rods and caps.

18. **CAUTION: Make sure bearing inserts and bearing bores are clean. Foreign material under the inserts will distort the bearing and cause a failure.**

    Inspect all machined surfaces on the crankshaft for nicks, scratches, scores, etc., which could cause premature bearing wear. Lightly stone all such surfaces.

Crankshaft and Bearing Installation



Item	Part Number	Description
1	E1FZ-19562-A	Sealer

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2	6337	Crankshaft Thrust Main Bearing, Upper
3	6333	Crankshaft Main Bearing, Rear Upper
4	6303	Crankshaft
5	6337	Crankshaft Thrust Main Bearing, Lower
6	6333	Crankshaft Main Bearing, Rear Lower
7	—	Rear Intermediate Cap (Part of 6010)
8	—	Rear Cap (Part of 6010)
9	6345	Crankshaft Main Bearing Cap Stud
10	—	Front Intermediate Cap (Part of 6010)
11	—	Front Cap. Assemble Caps with Arrows on Caps Pointing Forward. Caps Are Identified 1 Through 4 Front to Rear. (Part of 6010)
12	6333	Crankshaft Main Bearing, Lower
13	6B316	Crankshaft Key
14	6333	Crankshaft Main Bearing, Upper
A	—	Tighten to 75-85 Nm (55-63 Lb-Ft)
B	—	5-6mm (.20-.24 In.)
C	—	2mm (0.08 In.)

Installation

1. If the crankshaft main bearing journals have been refinished to a definite undersize, install the correct undersize crankshaft main bearings.

2. Place upper main bearing inserts in position in the bores with the tang fitted in the slot provided.

3. Install lower main bearing inserts in bearing caps.

4. Lower crankshaft into place carefully.

5. Check the clearance of each main bearing. Select fit the bearings for proper clearance. Refer to Section 03-00 .

6. **NOTE: Make sure that the main bearing caps are installed in their original positions and orientation.**

   After bearings have been fitted, apply a light coat of heavy engine oil, SAE 50, to the journal's bearings and rear seal surface. Install all bearing caps. Apply a 6mm (1/4-inch) dot of Gasket Eliminator E1FZ-19562-A or equivalent meeting Ford specification WSK-M2G348-A4 between rear cap and cylinder block (two places). Refer to the procedure in this section.

7. Lubricate the journal with engine oil and install the thrust bearing cap with the bolts finger-tight. Pry

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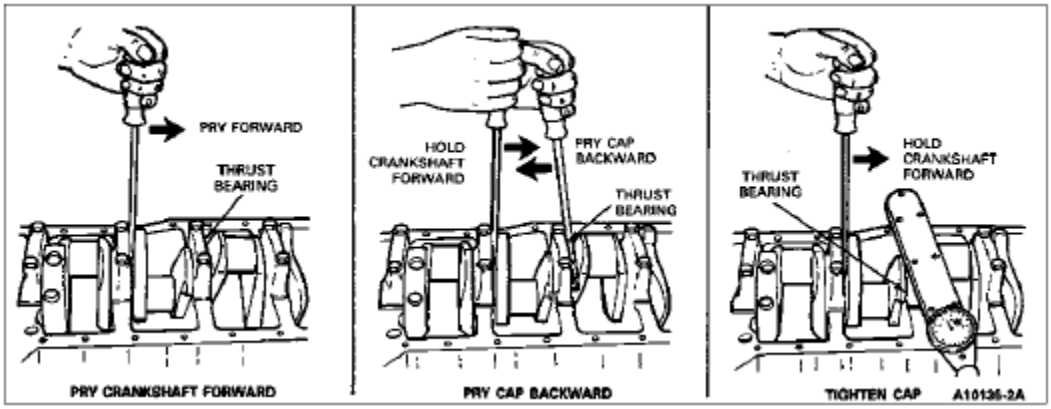
the crankshaft forward against the thrust surface of the upper half of the bearing. Hold the crankshaft cap to the rear. This will align the thrust surfaces of both halves of the bearing. Retain the forward pressure on the crankshaft. Tighten the crankshaft main bearing cap stud (6345) to 75-85 Nm (55-63 lb-ft).

Thrust Bearings, Alignment



8. Check crankshaft end play. Refer to Section 03-00 .

9. If end play exceeds specification, replace upper and lower crankshaft thrust main bearing (6337). If the end play is less than specification, inspect the bearing and crankshaft thrust faces for damage, dirt or improper alignment. Install thrust bearing and align the faces. Recheck end play.

10. Install new connecting rod bearings in the connecting rods and caps. Check the clearance of each bearing. Refer to Section 03-00 .

11. If bearing clearances are to specification, apply a light coat of heavy engine oil, SAE 50, to the journals and bearings.

12. Turn the crankshaft throw to the bottom of the stroke. Push the piston, pin and ring (6102) all the way down until the rod bearings seat on the crankshaft journal.

13. Make sure connecting rod is seated on crankshaft journal and install connecting rod cap. Tighten attaching nuts to 31-39 Nm (23-28 lb-ft).

14. After piston, pin and ring and connecting rod assemblies have been installed, check connecting rod crankshaft journal.

15. Turn engine on the work stand so that the front end is up. Install timing chain/belt, crankshaft, crankshaft sprockets, engine front cover, new oil seal and crankshaft vibration damper as outlined in the In-Vehicle part of this section.

16. Turn engine on the work stand so that the rear end is up. Install crankshaft rear oil seal (6701).

17. Clean oil pan, oil pump and oil pump screen assembly.

18. Prime oil pump by filling the inlet opening with oil and rotating the pump shaft until oil emerges from the outlet opening. Install oil pump and oil pan as outlined.

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19. Position flywheel (6375) on the crankshaft. Tighten to specification.
20. Install crankshaft pulley. Install and adjust drive belt to specification. Refer to Section 03-05 .
21. Remove engine from the work stand and install in vehicle.

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Crankshaft Main Bearings

The main bearing inserts are a precision selective fit. To check the bearing clearances or to select fit a new bearing, refer to Section 03-00 .

Removal

1. Disconnect ground cable at battery and set aside.
2. Remove engine accessory drive belt (8620).
3. Remove oil pan (6675) as outlined in this section.
4. Remove oil pump (6600).
5. Replace one bearing at a time, leaving the other bearings securely fastened. Remove main bearing cap to which new bearings are to be installed.
6. **NOTE: Rotate remover against end of crankshaft main bearing (6333) opposite locating tang.**

   Insert Main Bearing Insert Tool TOOL-6331-E or equivalent in the oil hole in the crankshaft (6303).
7. Rotate crankshaft in the direction of the engine rotation to force the bearing out of the cylinder blocks (6010).
8. Clean crankshaft journals. Inspect journals and thrust faces (thrust bearings) for nicks, burrs, or bearing pickup that would cause premature bearing wear.
9. Refer to Crankshaft Rear Oil Seal in this section if the crankshaft rear oil seal (6701) is to be replaced.

Installation

NOTE: Lightly oil all bolt and stud threads before installation.

1. Lubricate and position the upper crankshaft main bearing on the crankshaft journal with the plain end started into the side of the cylinder block with the locking tang slot. Line up the bearing tang with the slot in the block.
2. Install Main Bearing Insert Tool TOOL-6331-E or equivalent in the crankshaft journal oil hole.
3. With the bearing and tool in position, rotate the crankshaft so that the tool catches the edge of the bearing, pushes into position, and seats in the cylinder block. Remove tool.
4. Install bearing insert in the main cap.
5. If bearing insert clearance is to be checked, refer to Section 03-00 .
6. If No. 1 or No. 2 crankshaft main bearing was removed, lubricate the bearing surface with Engine Assembly Lubricant D9AZ-19579-D or equivalent meeting Ford specification ESR-M99C80-A. Install

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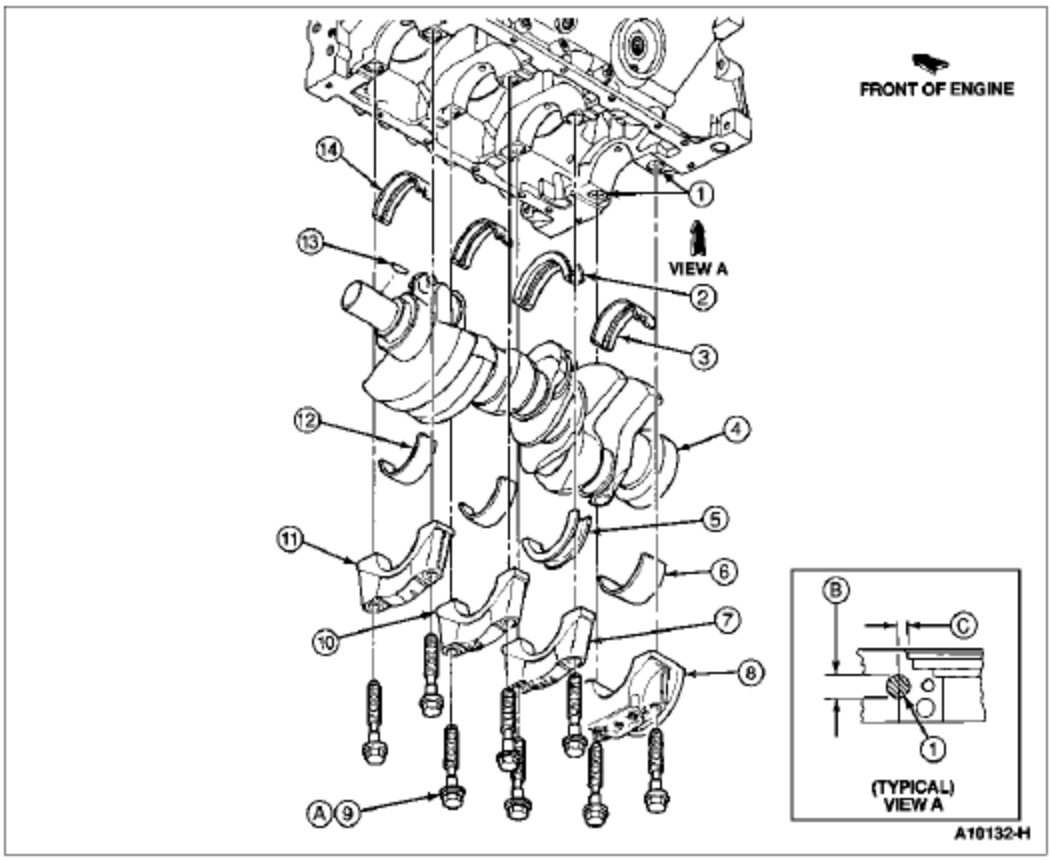
main cap. Tighten attaching bolts to 80 Nm (60 lb-ft).

Crankshaft and Bearings



Item	Part Number	Description
1	E1FZ-19562-A	Sealer
2	6337	Crankshaft Thrust Main Bearing
3	6333	Crankshaft Main Bearing, Rear Upper
4	6303	Crankshaft
5	6337	Crankshaft Thrust Main Bearing, Lower
6	6333	Crankshaft Main Bearing, Rear Lower
7	6327	Rear Intermediate Cap (Part of 6010)
8	—	Rear Cap (Part of 6010)
9	6345	Crankshaft Main Bearing Cap Stud
10	—	Front Intermediate Cap (Part of 6010)

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11	—	Front Cap. Assemble Caps with Arrows on Caps Pointing Forward. Caps Are Identified 1 Through 4 Front to Rear. (Part of 6010)
12	6333	Crankshaft Main Bearing, Lower
13	6B316	Crankshaft Key
14	6333	Crankshaft Main Bearing
A	—	Tighten to 80 Nm (60 Lb-Ft)
B	—	5-6mm (.20-.24 In.)
C	—	2mm (0.08 In.)

7. Perform the following if the rear main bearing cap was removed:

    a. Remove all traces of sealant from the main bearing cap to cylinder block parting line.
    b. Apply a 6mm (1/4-inch) dot of Gasket Eliminator E1FZ-19562-A or equivalent meeting Ford specification WSKM2G348-A4 between rear cap and cylinder blocks (two places). (See illustration.)
    c. Lubricate bearing surfaces with Engine Assembly Lubricant D9AZ-19579-B or equivalent meeting Ford specification ESR-M99C80-A. Install main bearing cap. Tighten attaching bolts to 75-85 Nm (55-63 lb-ft).

8. If the thrust bearing inserts were removed, perform the following:

    a. Lubricate bearing surface with Engine Assembly Lubricant D9AZ-19579-B or equivalent meeting Ford specification ESR-M99C80-A, and install the main bearing cap with bolts finger-tight.
    b. Pry crankshaft forward against the thrust surface on the upper bearing insert while holding the bearing cap to the rear. This aligns thrust rear surfaces on both halves of the bearing.
    c. While holding the crankshaft forward, tighten cap attaching bolts to 75-88 Nm (55-63 lb-ft).

9. Install oil pump.

10. Install oil pan and new oil pump as outlined.

11. Install engine accessory drive belt.

12. Connect ground cable to battery.

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Pistons and Connecting Rods

Removal

NOTE: If more than one piston (6108) is being removed, identify the piston and connecting rod cap to the cylinder number. Caps are matched to connecting rods (6200) and are identified with matching correlation letters as illustrated. Each component should be installed in its original position during assembly.

1. **NOTE: On 3.0L Aerostar it is necessary to remove the engine (6007) from the vehicle to perform this procedure. Refer to Engine Assembly, Aerostar , Removal and Installation in this section.**

   Disconnect ground cable at battery and set aside.

2. Remove spark plugs and bring number 1 cylinder to top dead center of compression stroke.

3. Drain cooling system.

4. Perform all intake manifold removal steps as outlined in this section.

5. Remove cylinder heads (6049) as outlined in this section. If only one cylinder head is to be removed, remove spark plugs (12405) from remaining cylinder head.

6. Remove oil pan (6675) as outlined in this section.

7. Loosen and remove retaining bolt and remove oil pump (6600) and oil pump intermediate shaft (6A618).

8. Inspect the top of the cylinder bore(s) before removing the piston, pin and ring (6102) assembly. If a ridge has formed at the top of the cylinder, it must be removed before piston extraction. Remove ridge as follows:

   a. Turn crankshaft (6303) until the piston and connecting rod to be removed is at the bottom of the cylinder bore.
   b. Place a clean shop cloth over the piston head to collect cuttings.
   c. Remove ridge using a suitable ridge reamer following the manufacturer's instructions. Never cut into the piston ring travel more than 0.794mm (1/32 inch) when removing the ridge.

9. Loosen connecting rod cap retaining nuts.

10. Rotate crankshaft to place piston and connecting rod assembly at bottom of its travel in bore.

11. Remove connecting rod nuts (6212) from cap. Place connecting rod nut so that they may be reinstalled on the same rod bolt.

12. **CAUTION: Use extreme care to prevent scratching or nicking crankshaft journal.**

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Tap cap with a plastic mallet to separate from connecting rod. Carefully remove cap from crankshaft. If lower bearing remained on crankshaft, carefully grasp both sides of connecting rod bearing (6211) and pull straight down away from crankshaft (oil acts as an adhesive between two precision fitted components).

13. **NOTE: If crankshaft journal inhibits safe removal of piston assembly, rotate crankshaft out of the way once protective caps are clear of journal.**

    NOTE: Protective caps may be made from rubber fuel hose.

    Install protective rubber caps onto connecting rod bolts to protect crankshaft journal contact from bolt threads.

14. **NOTE: If connecting rod bearing remained on crankshaft journal, carefully rotate bearing around journal and remove as lower bearing.**

    Push piston and connecting rod assembly up slightly using wooden end of hammer or similar device while guiding connecting rod from crankshaft journal. Remove upper connecting rod bearing from connecting rod.

15. **CAUTION: Do not push piston assembly out of bore too fast as damage to piston, pin and ring, cylinder bore, or crankshaft journal can result from contact to connecting rod.**

    Push connecting rod bearing and connecting rod up out of bore by tapping with wooden end of hammer or similar device while guiding connecting rod from crankshaft journal.

16. Install cap to connecting rod in original position and secure with retaining nuts.

17. Refer to Piston Disassembly in this section if piston, pin and ring is to be disassembled.

Installation

NOTE: Lightly oil all retaining bolts and stud threads before installation.

1. **CAUTION: When honing or cleaning cylinder wall(s), make sure crankshaft journals are protected by wrapping a clean shop cloth around the machined surfaces.**

   Inspect cylinder bore for excessive scratches. If new piston rings are to be installed, the cylinder wall should be honed to exhibit a visible cross-hatch pattern for proper ring seating. If honing is required, follow manufacturer's instructions. After honing, thoroughly clean cylinder bore using a detergent and water solution.

2. Install protective rubber caps on the connecting rod bolts.

3. Lubricate piston, pin and ring and cylinder walls with Engine Assembly Lubricant D9AZ-19579-D or equivalent meeting Ford specification ESR-M99C80-A.

4. Rotate crankshaft journal to bottom of its travel (if moved).

5. Arrange piston rings alternately around piston to prevent ring end gaps from aligning to each other.

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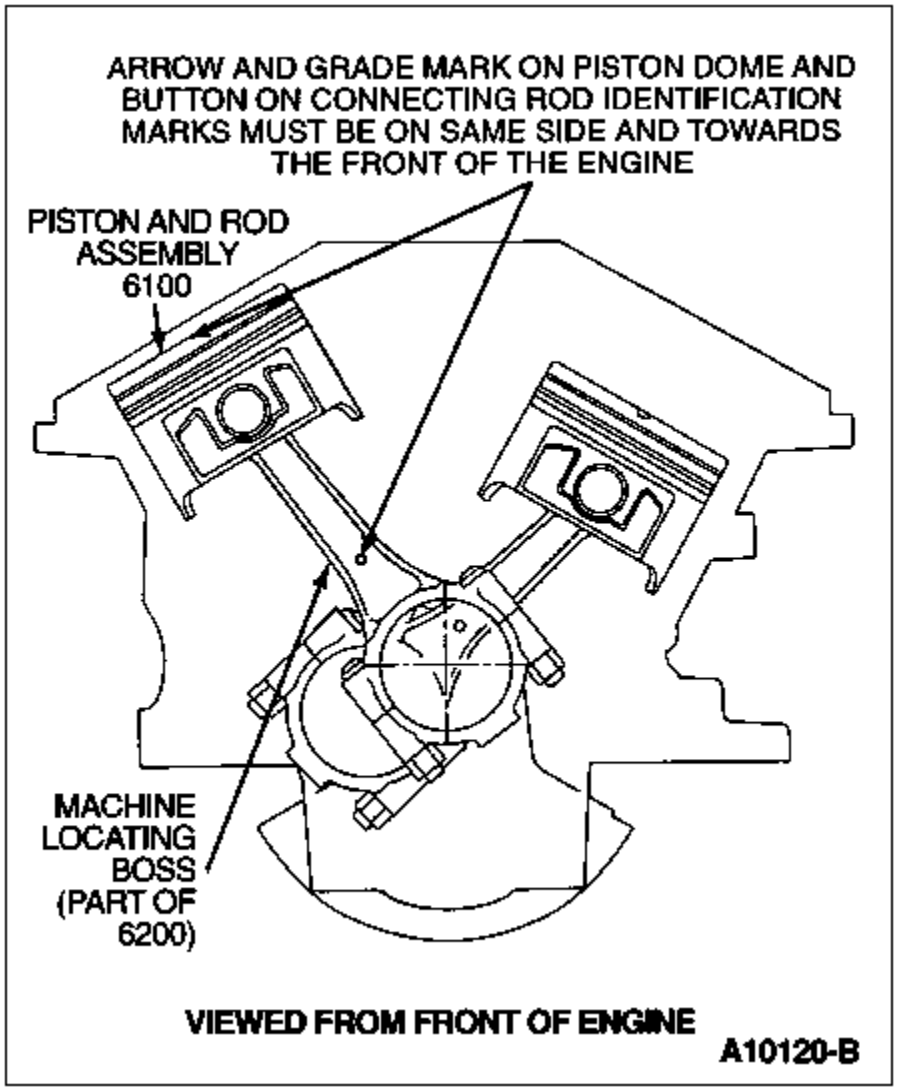

6. Install piston ring compressor D81L-6002-C or equivalent to piston.

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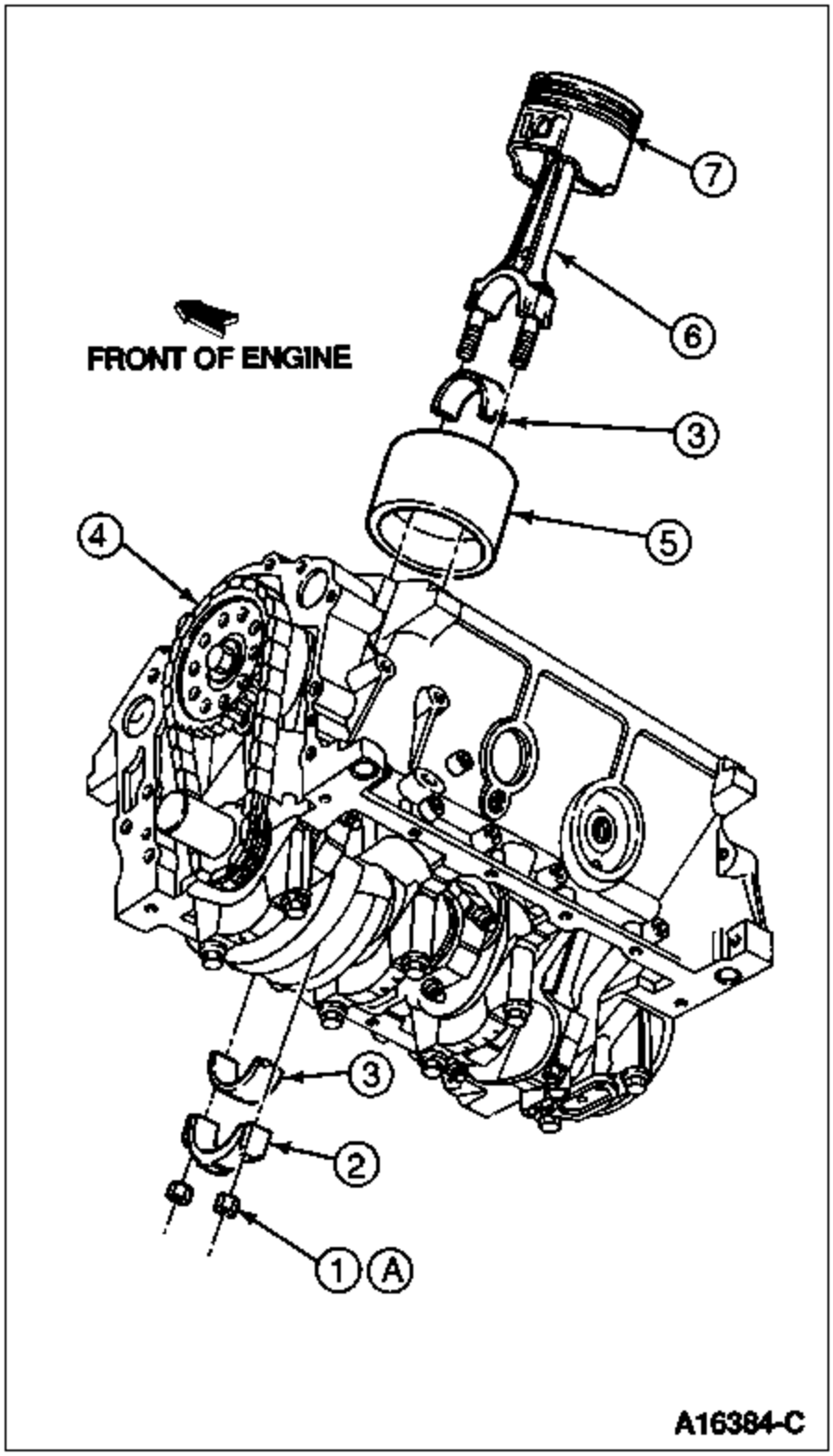

Item	Part Number	Description
1	6212	Connecting Rod Nut
2	6210	Rod Cap

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3	6211	Connecting Rod Bearing
4	6010	Cylinder Blocks
5	D81L-6002-C	Piston Ring Compression Tool
6	6200	Connecting Rod
7	6108	Piston
A	—	Tighten to 31-39 Nm (23-29 Lb-Ft)

7. Install clean, dry upper connecting rod bearing.

8. Lubricate bearing surfaces and crankshaft journal with Engine Assembly Lubricant D9AZ-19579-D or equivalent meeting Ford specification ESR-M99C80-A engine oil, if clearances are within specification.

9. Carefully align piston to cylinder bore making sure piston dome notch and button on connecting rod face the front of engine. Install piston by tapping with wooden hammer handle or similar device while aligning connecting rod to crankshaft journal. Remove protective rubber caps and install cap with a clean, dry bearing.

10. Check connecting rod bearing and side clearances. Refer to Section 03-00 .

11. Make sure connecting rod is seated correctly on crankshaft journal. Install cap and lubricated bearing assembly. Tighten retaining nuts to 31-39 Nm (23-29 lb-ft).

12. Install oil pump and oil pump intermediate shaft. Tighten retaining bolt to 40-55 Nm (30-41 lb-ft).

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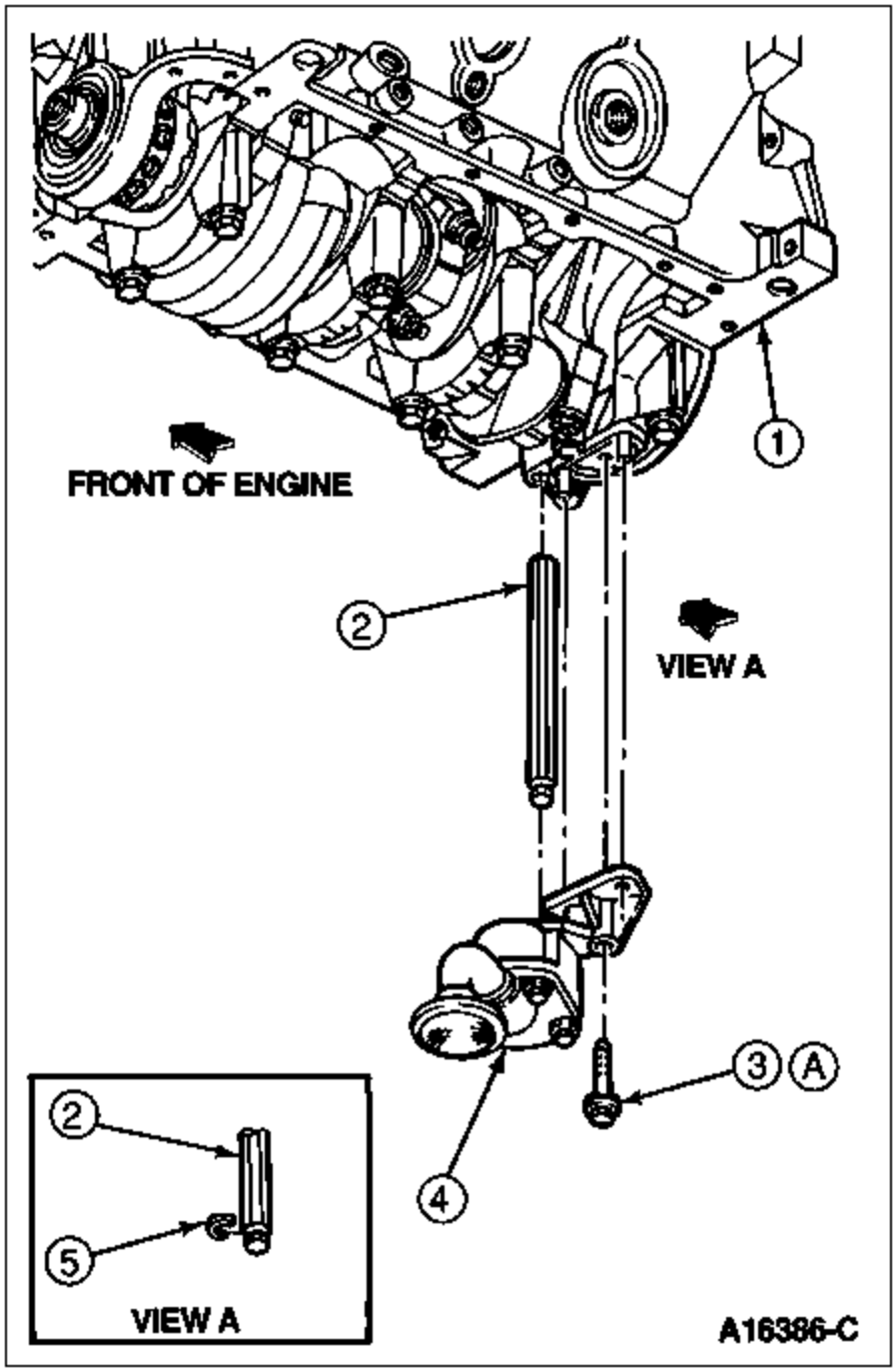

Item	Part Number	Description
1	—	Bolt (Part of 6600)
2	6600	Oil Pump
3	6629	Oil Pump Intermediate Shaft Retaining Ring
4	6A618	Oil Pump Intermediate Shaft
5	6010	Cylinder Blocks
A	—	Tighten to 40-55 Nm (30-41 Lb-Ft)

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13. Install oil pan as outlined in this section.

14. **CAUTION: If a new distributor or camshaft position sensor is installed, run engine at idle for five minutes before driving vehicle.**

    Dip entire distributor or camshaft position sensor drive gear in Engine Assembly Lubricant D9AZ-19579-D or equivalent meeting Ford specification ESR-M99C80-A.

15. Pour the rest of the pint of Engine Assembly Lubricant D9AZ-19579-D or equivalent meeting Ford specification ESR-M99C80-A through distributor hole onto cam drive gear.

16. For Ranger, install camshaft position sensor. Refer to Section 03-14 , Engine Controls, Electronic, for fuel injection timing.

17. Install cylinder heads as outlined in this section.

18. Install and perform intake manifold installation procedures as outlined in this section.

19. Fill crankcase with specified amount and viscosity of engine oil.

20. Fill and bleed cooling system.

21. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

    Connect ground cable at battery.

22. Start engine and check for oil, exhaust, coolant and vacuum leaks.

23. Check and set initial ignition timing.

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Connecting Rod Bearings

The connecting rod bearings are a selective fit to provide for necessary operational clearances and oil pressure. Refer to Section 03-00 to measure bearing clearances and selection of the proper bearing insert.

NOTE: This operation is performed easiest with engine out of the vehicle. However, it can be performed with the engine in the vehicle.

Removal

1. Disconnect ground cable at battery and set aside.
2. Remove all six spark plugs (12405) to allow for uninhibited crankshaft rotation.
3. Raise vehicle.
4. Remove oil pan (6675) as outlined in this section.
5. Remove oil pump (6600) if required as outlined in this section.
6. Turn connecting rod (6200) until crankshaft (6303) from which the bearings are to be removed is at the lowest point of travel.
7. Loosen retaining nuts and remove from cap. Place retaining nuts so that they may be reinstalled on the same rod bolt.
8. **CAUTION: Use extreme care to not scratch crankshaft journal.**

   Tap cap with a plastic mallet to separate from connecting rod. Carefully remove cap from crankshaft. If lower bearing remained on crankshaft, carefully grasp both sides and remove (oil acts as an adhesive between two precision fitted components).
9. **NOTE: Protective caps may be made from rubber fuel line.**

   Install protective rubber caps onto connecting rod bolts to protect crankshaft journal from bolt threads.
10. Push piston (6108) up into cylinder bore to provide clearance for removal. Remove upper connecting rod bearing (6211).
11. Inspect connecting rod bearings, crankshaft journal and connecting rod bearing surfaces for damage or wear.

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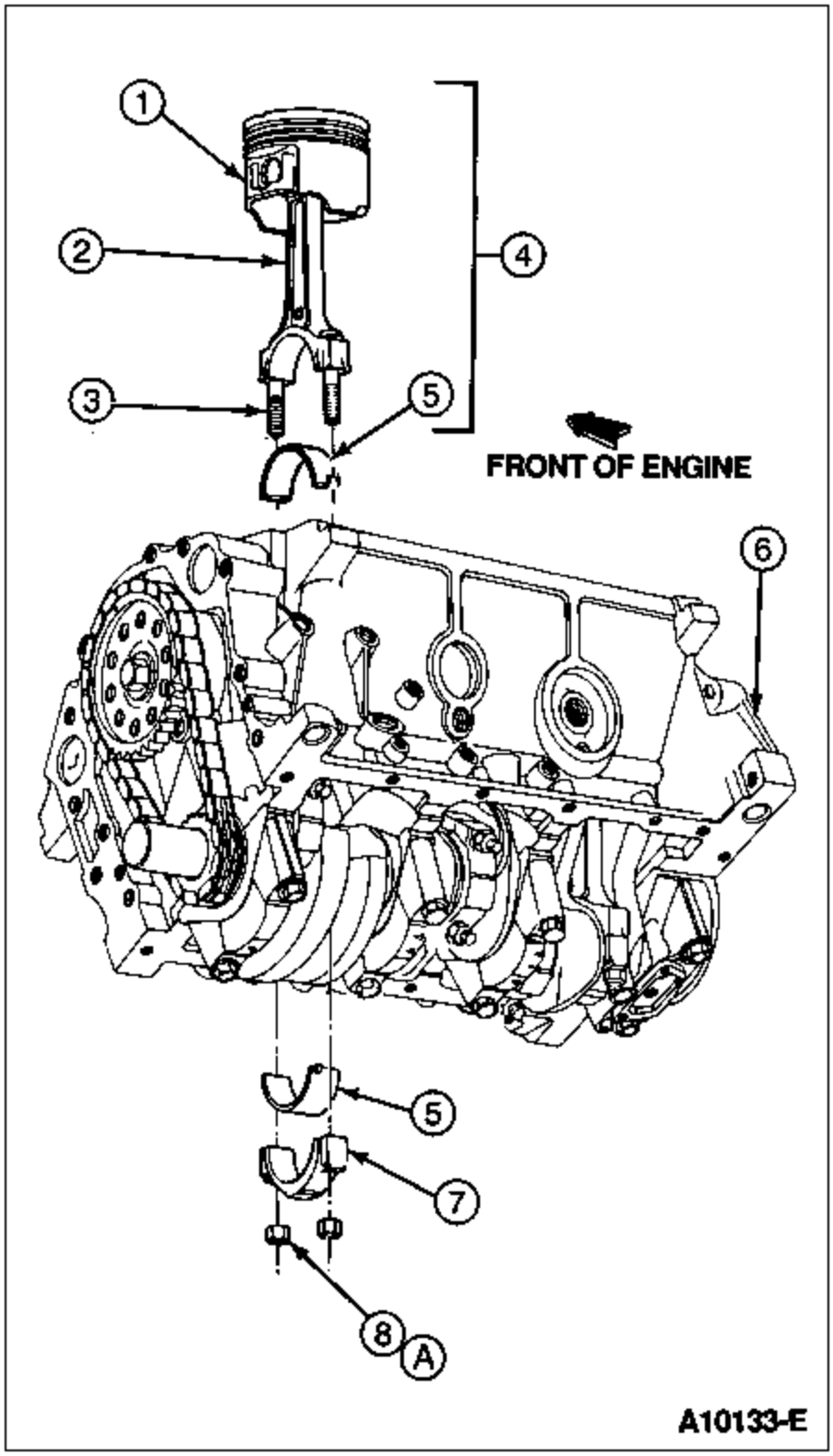

Item	Part Number	Description
1	6102	Piston, Pin and Ring
2	6200	Connecting Rod

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3	6214	Connecting Rod Bolt
4	6102	Piston, Pin, Ring and Connecting Rod Assembly
5	6211	Connecting Rod Bearing
6	6010	Cylinder Blocks
7	—	Connecting Rod Cap (Part of 6010)
8	6212	Connecting Rod Nut
A	—	Tighten to 31-39 Nm (23-29 Lb-Ft)

Installation

NOTE: Lightly oil all bolt and stud threads before installation.

1. **CAUTION: Contaminants allowed to remain on the cap or connecting rod bearing can distort the bearing or damage the crankshaft journals.**

   Thoroughly clean connecting rod bearings (including new bearings), connecting rod cap and connecting rod with solvent.

2. Clean crankshaft journal and lubricate with Engine Assembly Lubricant D9AZ-19579-B or equivalent meeting Ford specification ESR-M99C80-A. Make sure the entire journal is well lubricated.

3. Install upper connecting rod bearing in the connecting rod. Align locating tab with relief in connecting rod and seat fully into the rod. Lubricate bearing surface with Engine Assembly Lubricant D9AZ-19579-B or equivalent meeting Ford specification ESR-M99C80-A.

4. Pull connecting rod down until it seats onto the crankshaft journal.

5. Install connecting rod bearing into rod cap. Align locating tab to relief cap. Lubricate bearing surface with Engine Assembly Lubricant D9AZ-19579-B or equivalent meeting Ford specification ESR-M99C80-A.

6. Remove protective rubber caps from rod bolts.

7. **NOTE: Connecting rods and caps are matched to each other. Never mix connecting rod caps between other connecting rods. Match code letters stamped on the side of cap and connecting rod so that they are both on the same side.**

   Install connecting rod cap and the retaining nuts. Tighten retaining nuts to 31-39 Nm (23-29 lb-ft).

8. Install oil pump if removed. Align oil pump intermediate shaft (6A618) with camshaft position sensor, align pump with dowels and install retaining bolt. Tighten to 40-55 Nm (30-41 lb-ft).

9. Inspect and clean oil pump intake screen.

10. Install oil pan and new oil pan gasket (6710) as outlined.

11. Lower vehicle.

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12. Install spark plugs. Tighten to 9-20 Nm (7-15 lb-ft).

13. Add correct amount and viscosity engine oil.

14. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

    Connect ground cable at battery.

15. Disconnect electrical connector at EDIS coil pack. Crank engine for 15 seconds to re-establish oil to oil pump and bearing surfaces then reconnect coil pack.

16. Start engine and check for oil leaks.

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Flywheel

Removal

1. Remove transmission as outlined in the appropriate section in Group 07.
2. **NOTE: The engine rear plate can be removed.**

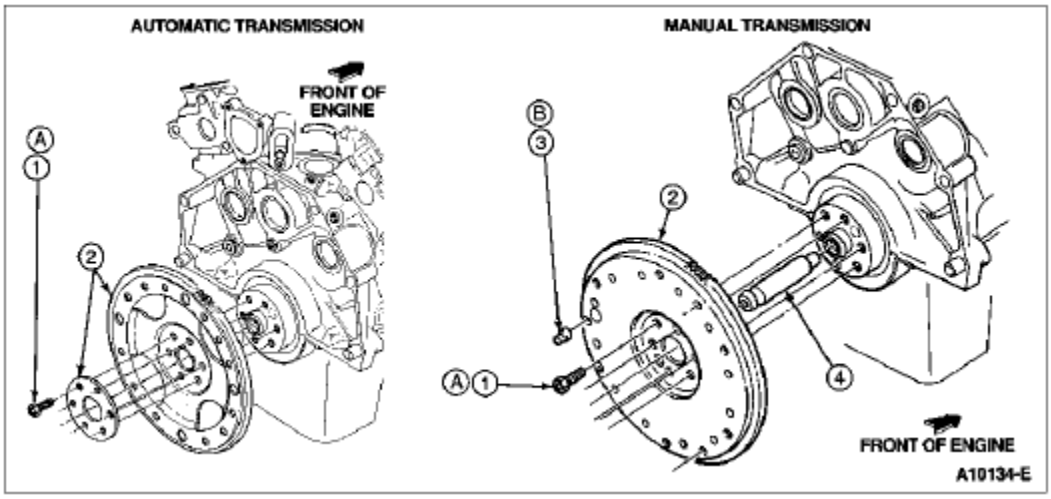
   Remove flywheel-to-crankshaft bolts (6379), flywheel reinforcing plate (6A366) (if equipped) and flywheel (6375).

Installation

All major rotating components including flex plate/flywheel are individually balanced to zero. Engine assembly balancing is not required. Balance weights should **NOT** be installed on new flywheels.

1. Install engine rear plate, if removed.
2. Position flywheel on the crankshaft, flywheel reinforcing plate (if equipped), and install attaching bolts. Tighten attaching bolts to 73-87 Nm (54-64 lb-ft) using the standard cross-tightening sequence.
3. Install transmission. See applicable section in Group 07.

Flywheel Installation



Item	Part Number	Description
1	6379	Flywheel-To-Crankshaft Bolt

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2	6375	Flywheel
3	—	Dowel (3 Req'd) (Part of 6375)
4	—	Alignment Tool
A	—	Tighten to 73-87 Nm (54-64 Lb-Ft)
B	—	Dowel Must Be Bottomed in Flywheel

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Crankshaft Rear Oil Seal

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Jet Plug Remover	T77L-9533-B
Crankshaft Rear Seal Replacer	T88L-6701-A

Removal

1. Remove the flywheel. For additional information, refer to Flywheel in this section.
2. **CAUTION: Use care to avoid scratching or damaging the oil seal surface or leakage may occur.**

   Using a sharp awl, punch one hole into the crankshaft rear oil seal metal surface between the seal lip and the cylinder block.
3. Screw the threaded end of the special tool into the oil seal. Use the special tool to remove the crankshaft rear oil seal.

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Installation

1. Lubricate the outer lips and the inner seal on the crankshaft rear oil seal with Super Premium SAE 5W-30 Motor Oil XO-5W-30-QSP or equivalent meeting Ford specification WSS-M2C153-G.
2. Using the special tool, install the crankshaft rear oil seal. Alternate bolt tightening to correctly seat the crankshaft rear oil seal.

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3. Install the flywheel. For additional inforamtion, refer to Flywheel in this section.

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Camshaft Rear Bearing Cover

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Impact Slide Hammer	T59L-100-B
Impact Slide Hammer	T50T-100-A

Removal

1. Remove transmission. Refer to the applicable section in Group 07.
2. Remove flywheel (6375). Refer to the Flywheel procedure in this section.
3. Using a sharp chisel or punch and hammer, cut a hole in the center of the camshaft rear bearing cover.
4. Remove the camshaft rear bearing cover using Impact Slide Hammer T59L-100-B or T50T-100-A. The plug can also be pried from the bore using a large punch. Use care to prevent damage to the plug bore.

Installation

Prior to installing camshaft rear bearing cover, the plug bore should be inspected for any damage that would interfere with the proper sealing of the plug. If the bore is damaged it will be necessary to true the surface by boring for the next specified oversize plug. Oversize plugs are identified by the "OS" stamped in the flat located on the cup side of the plug.

NOTE: Apply a light coating of Gasket Eliminator E1FZ-19562-A or equivalent meeting Ford specification WSK-M2G348-A4 to the sealing edge of the plug before installation.

1. Install camshaft rear bearing cover using a suitable driver.
2. Install flywheel. Refer to the Flywheel/Flex Plate procedure in this section. Tighten flywheel attaching to 73-87 Nm (54-64 lb-ft).
3. Install transmission. Refer to the applicable section in Group 07.

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Oil Filter and/or Adapter

Removal

1. Raise vehicle on hoist. Refer to Section 00-02 .
2. Position drain pan beneath engine oil pan (6675).
3. Remove oil pan drain plug and drain.
4. Remove oil filter.

Installation

1. Install oil pan drain plug. Tighten to 20-34 Nm (15-25 lb-ft).
2. Lubricate oil filter gasket with fresh engine oil.
3. Thread oil filter onto adapter until gasket contacts cylinder blocks (6010) and then advance oil filter an additional one-half turn.
4. Lower vehicle.
5. Refill crankcase to proper level with specified engine oil.
6. Start engine and check for leaks.

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Oil Level Indicator Tube

Removal

1. Remove oil level dipstick (6750) from oil level indicator tube (6754).
2. Remove oil level indicator tube retaining nut from exhaust manifold stud.
3. Remove oil level indicator tube from cylinder blocks (6010).

Installation

1. **NOTE: Using solvent, clean oil level indicator tube and cylinder block sealing surfaces before applying silicone sealer.**

   Apply a 3mm (1/8-inch) bead of Silicone Rubber D6AZ-19562-AA or equivalent meeting Ford specification ESB-M4G92-A or ESE-M4G-195-A to oil level indicator tube where oil level indicator tube mates with cylinder blocks.
2. Install oil level indicator tube into cylinder blocks.
3. Install oil level indicator tube bracket onto exhaust manifold stud. Install and tighten oil level indicator tube retaining nut to 16-20 Nm (12-15 lb-ft).
4. Install oil level dipstick into oil level indicator tube.

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Oil Pressure Switch

Removal and Installation

1. **NOTE: The pressure switch-type unit used with the indicator lamp system is not interchangeable with the variable resistance-type unit called a sender, which is used with the gauge system. Refer to the Master Parts Catalog for proper parts usage. Installation of the wrong part will result in an inoperative oil pressure indicating system and a damaged switch unit or gauge.**

   Make sure the engine (6007) is turned off.

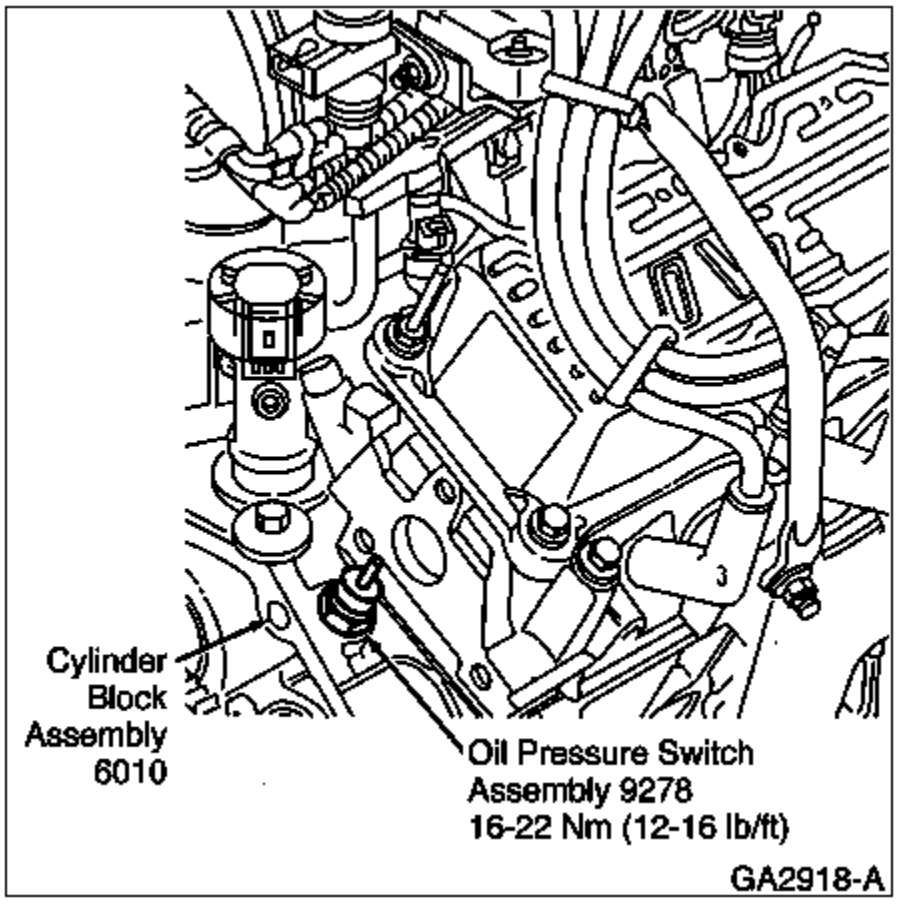
2. On Aerostar, remove inside engine cover.

3. Disconnect the wire at the switch unit terminal

4. Remove the oil pressure sensor (9278) from its mounting.

5. Apply Pipe Sealant with Teflon® D8AZ-19554-A or equivalent meeting Ford specification WSK-M2G350-A2 to new switch unit threads.

For installation follow removal procedures in reverse order. Tighten switch to 11-24 Nm (8-18 lb-ft).



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Engine Assembly, Aerostar

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Fan Clutch Holding Tool	T84T-6312-C
Fan Clutch Nut Wrench	T84T-6312-D
Clutch Coupling Tool	T88T-70522-A

Removal

1. Disconnect positive and negative battery cables from battery terminals. Remove the retaining bolt from battery cable support-to-frame bracket at left front of engine. Secure cables to engine (6007).

2. Loosen radiator drain cock and drain coolant from radiator. Refer to Section 03-03 .

3. Disconnect PCV closure hose at engine air cleaner outlet tube. Release clips retaining air cleaner top. Loosen air cleaner outlet duct clamp at throttle body (9E926) and remove air cleaner top and air cleaner outlet tube together.

4. Remove vacuum supply hoses from:

    a. Power brake booster.
    b. Cruise control at check valve near throttle linkage (if equipped).
    c. Manifold absolute pressure sensor (MAP sensor).
    d. Heater and air conditioner supply hose at A/C vacuum check valve near A/C vacuum reservoir tank and bracket.

5. Secure vacuum hoses to engine.

6. Remove upper radiator hose and lower radiator hose.

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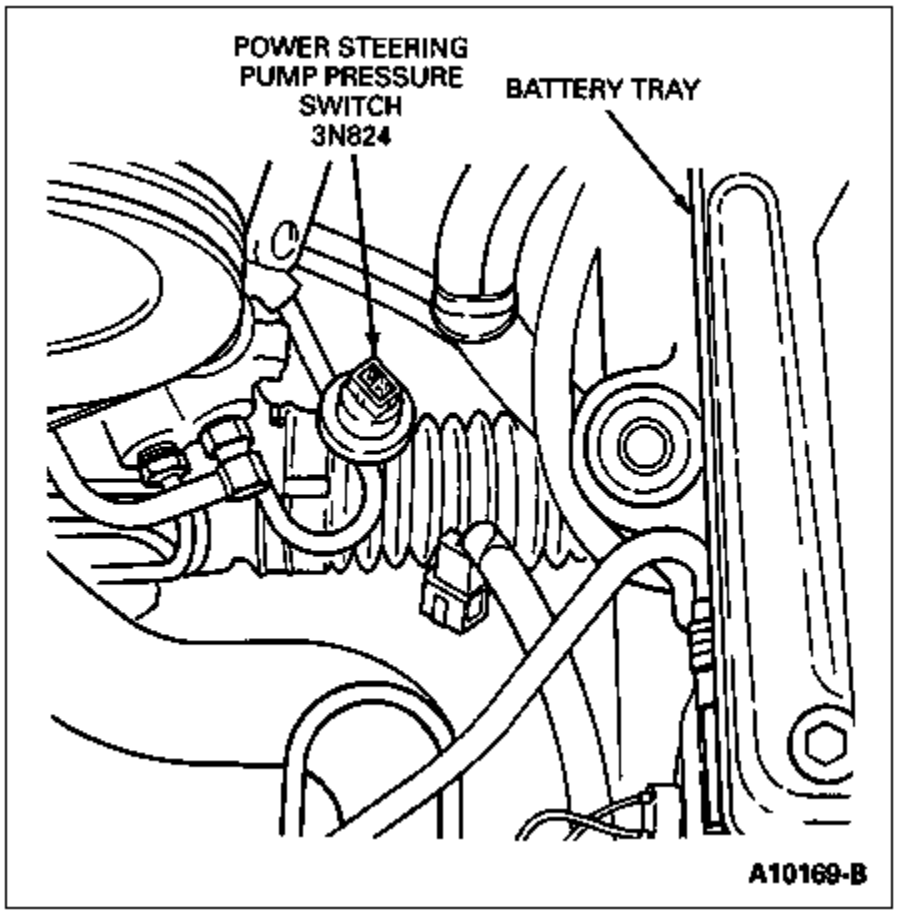

7. Disconnect power steering pressure switch (PSP switch).
8. Remove power steering pressure hose from clips in fan shroud.
9. Remove two screws holding fan shroud to radiator and pull fan shroud out of lower clips. Rest fan shroud on radiator fan.
10. Disconnect automatic transmission cooler lines from radiator.
11. Remove two radiator upper retaining bolts and lift radiator from core support.
12. Remove fan shroud from engine compartment.
13. Disconnect fuel charge wiring connectors at top center of dash panel.
14. Loosen clamps and disconnect heater water hoses at water pump (8501) and intake manifold fittings.

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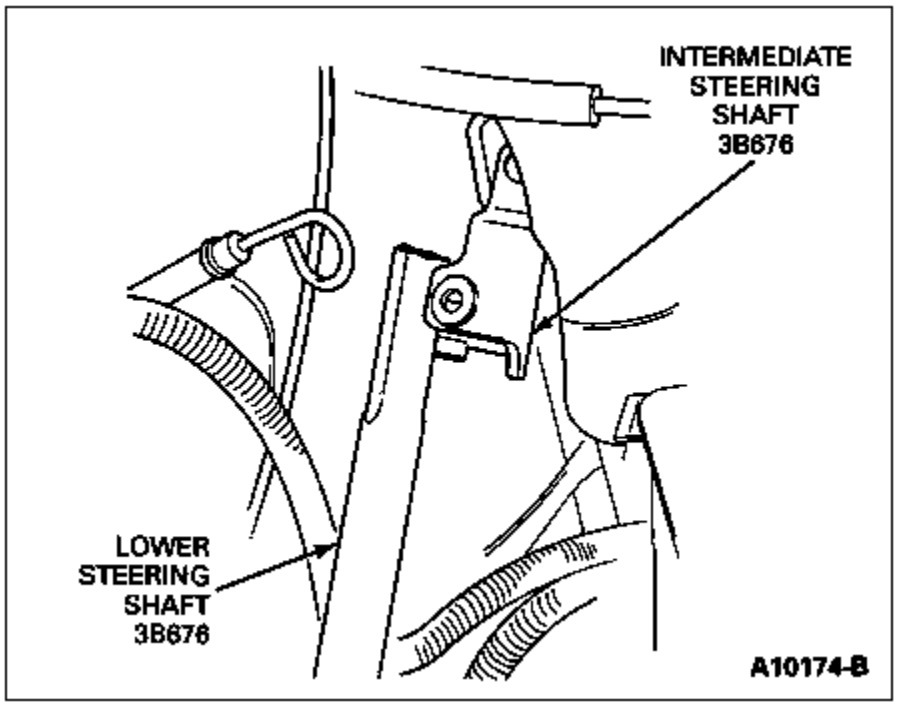

15. Loosen pinch bolt and disconnect steering column at intermediate shaft.

16. Follow the procedure as outlined in Section 12-00 to recover air conditioning system and recycle refrigerant.

17. **NOTE: All openings in the air conditioning system must be capped to keep dirt, foreign material, and excess moisture out of the system.**

    Disconnect air conditioner liquid line at condenser and suction line from accumulator.

18. Disconnect canister purge hose at evaporative emissions canister (EVAP canister purge solenoid under engine air cleaner base and secure to engine.

19. Release fuel system pressure as outlined in Section 03-04B .

20. Remove oil level dipstick (6750).

21. Raise vehicle.

22. Remove wheel hub bolt nuts and remove both front wheel and tire assemblies.

23. **NOTE: Place a piece of 4x4 wooden block or other suitable material between the rear of the engine cradle and the forward surface of the oil pan sump to keep the engine from tilting rearward and damaging components when removing the transmission.**

    Remove transmission as outlined in Section 07-01B .

24. Loosen and remove exhaust manifold stud nuts. Remove bolts retaining three-way catalytic converter to muffler. Disconnect and remove muffler and three-way catalytic converter (TWC). Refer to Section 09-00 for specific removal and installation procedures.

25. Remove dash panel ground cables. One is located on cylinder head (6049) just behind power

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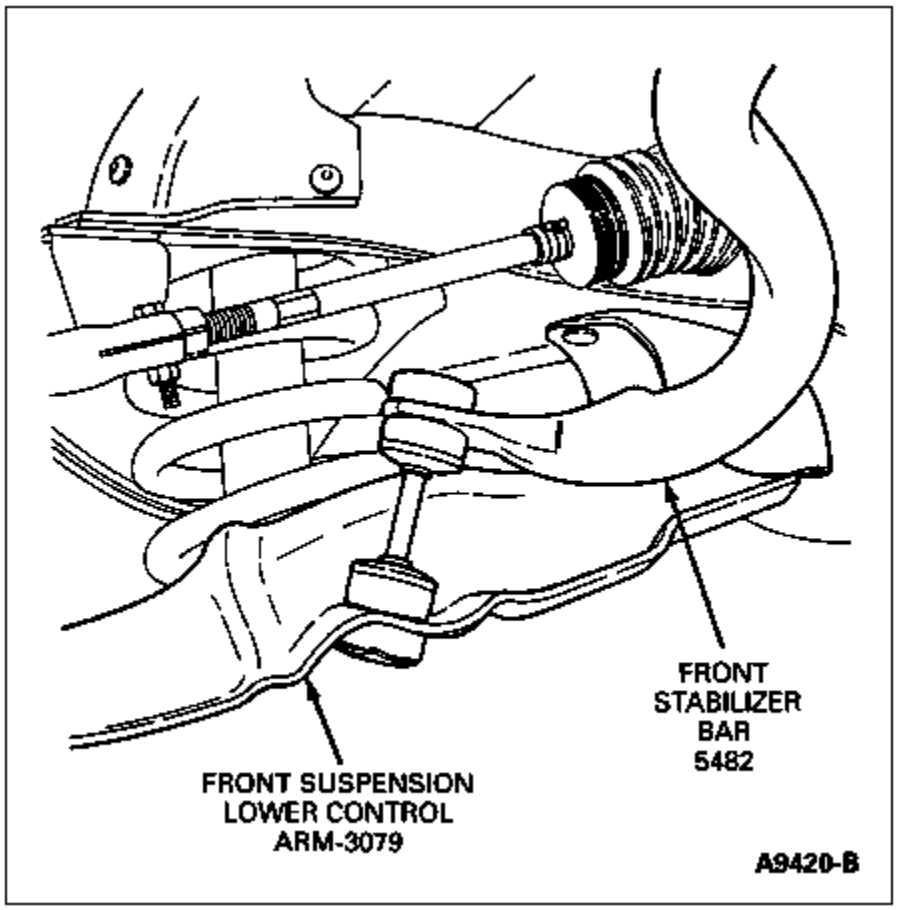
steering pump. The other is located just above where exhaust manifold (9430) and three-way catalytic converter (TWC) connect.

26. Remove nuts and disconnect front stabilizer bar from front suspension lower arms. Discard nuts.



27. Remove disc brake calipers as outlined in Section 06-03 and secure to suspension upper arms.

28. Disconnect fuel lines along left frame rail near engine mounts as outlined in Section 03-04B .

29. Position a jack under front suspension lower arm and raise arm until tension is applied to front coil spring. Remove pinch bolt and nut retaining spindle to upper control arm ball joint. Slowly lower jack under front suspension lower arm to disconnect spindle from ball joint.

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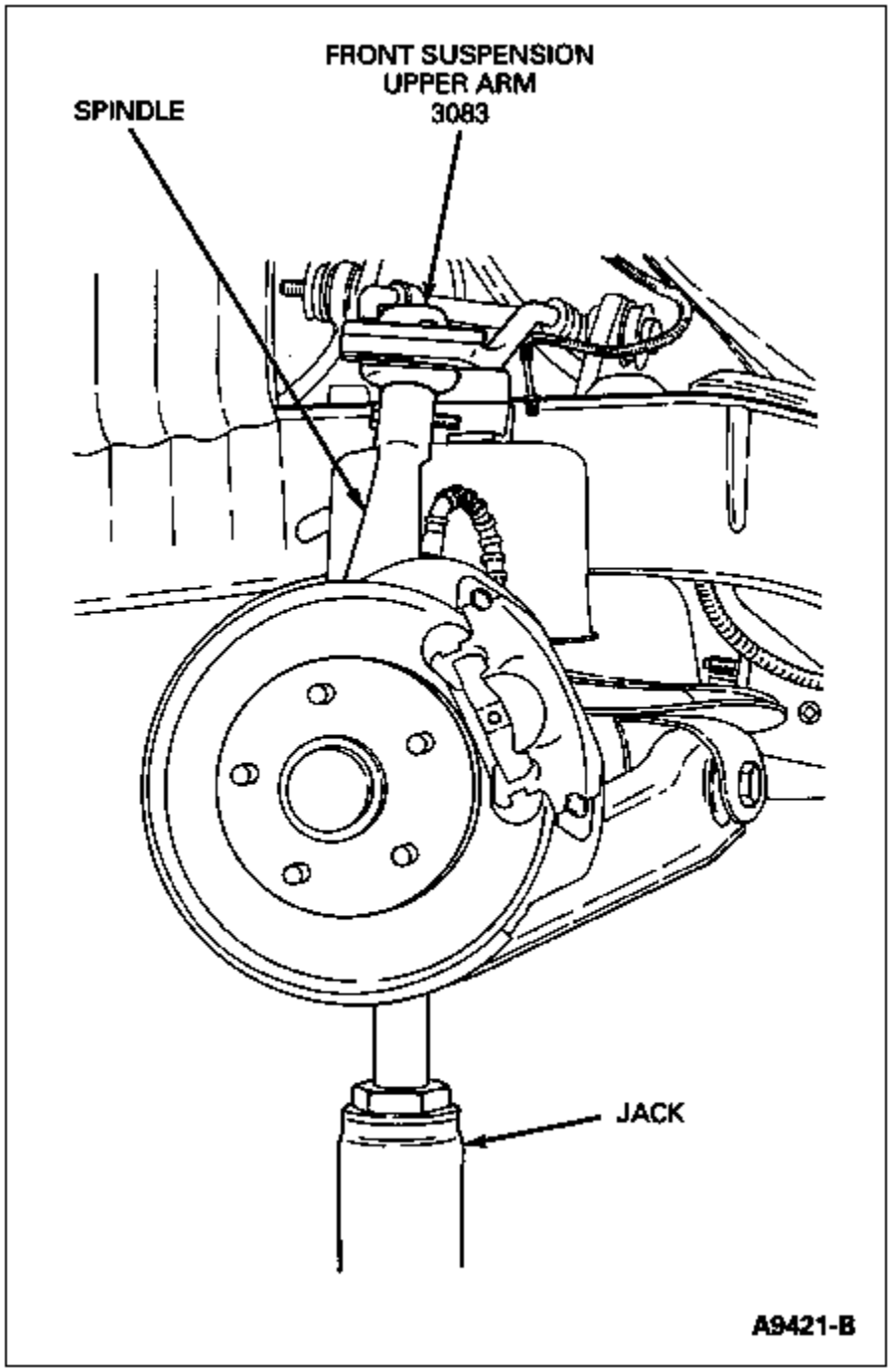

30. Position Powertrain Removal Lift 014-00765 or equivalent under crossmember and engine.

31. Lower vehicle until crossmember rests on removal lift. Place wood blocks under front crossmember and rear of cylinder blocks (6010) to keep engine and crossmember assembly level. Install safety chains around crossmember.

32. Remove three nuts from bolts that retain engine crossmember assembly to frame on each side of vehicle.

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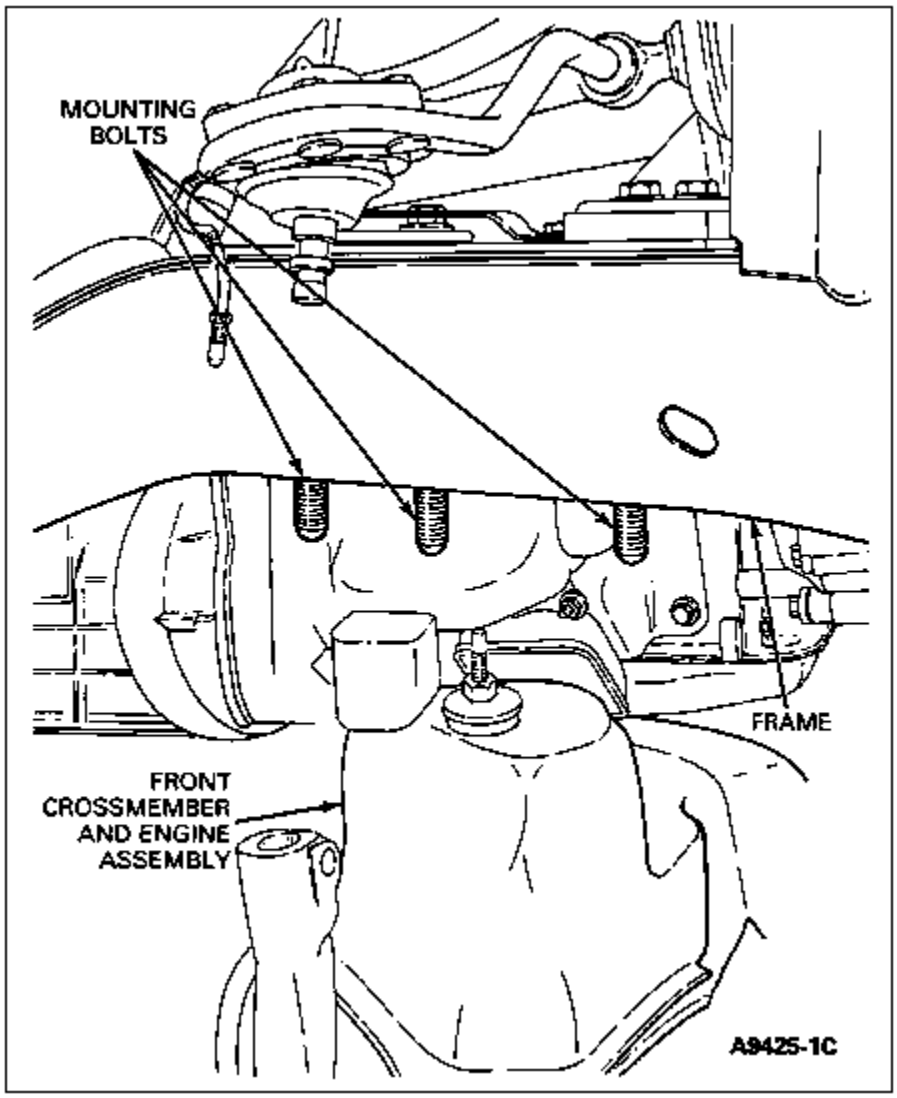

33. Lower engine and raise vehicle, making sure A/C compressor and wiring harnesses and hoses do not interfere with the process.

34. When engine and crossmember assembly are clear, roll lift out from under vehicle.

35. Attach Engine Lifting Eyes D81L-6001-D or equivalent to left rear cylinder head with a bolt.

36. The engine lifting eye should still be on the right cylinder head. If not, install a second lifting bracket.

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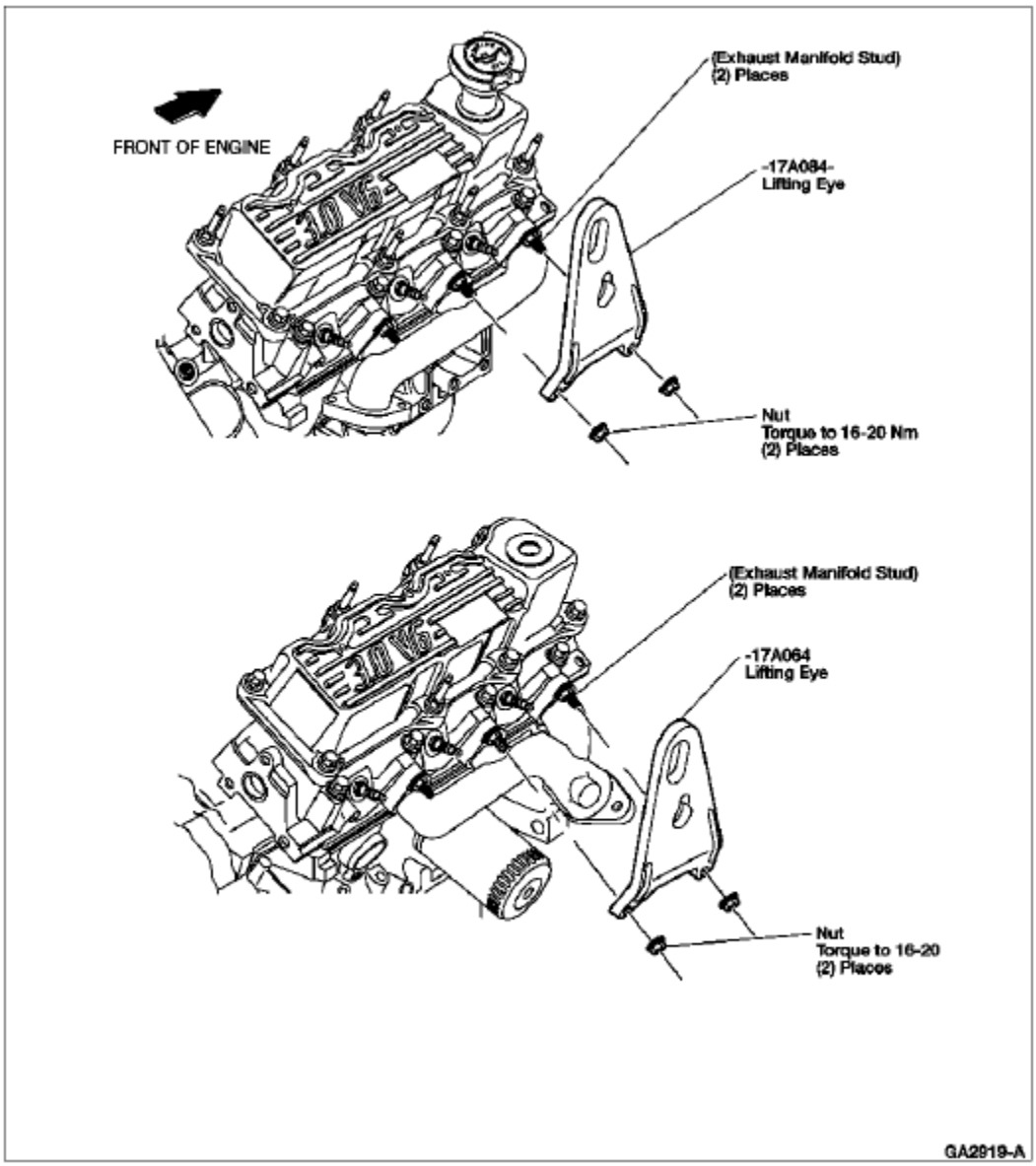

37. **CAUTION: The support hook or chain must angle rearward to the rear attaching point. Damage will result if chain runs across throttle cable or throttle valve mechanism.**

    NOTE: When only two support points are used, the engine assembly will hang slightly down at the rear with the transmission attached. With the transmission removed, the engine assembly will hang slightly down at the front because of the weight of the accessories.

    To eliminate tilt:

    a. For forward tilt, attach a chain from the left (front) support bar to the stud on the No. 4 exhaust runner.
    b. For rearward tilt, attach a chain from the right (rear) support bar to the exhaust manifold between the No. 2 and No. 3 exhaust runner.

Installation

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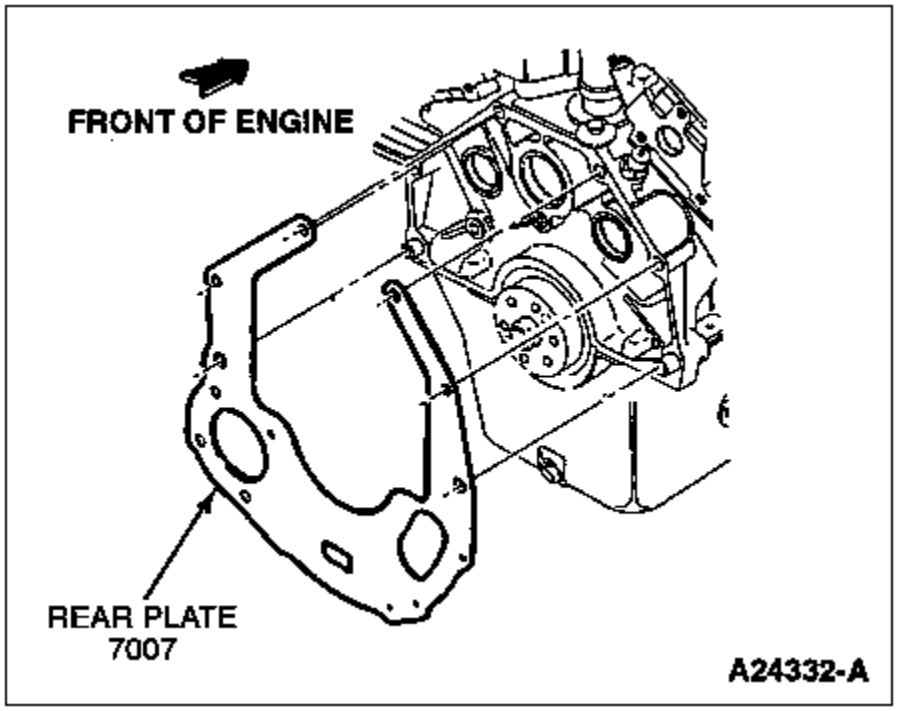
1. Install engine lifting eyes on engine, connect with a chain and attach to a floor crane.

2. Remove attaching bolts and remove engine from work stand.

3. **NOTE: Place a block of wood between the crossmember and the forward edge of the oil pan sump to keep engine level.**

   With front crossmember securely positioned on Powertrain Removal Lift 014-00265 or equivalent, slowly lower engine until engine mount studs are piloted in crossmember holes. Install retaining nuts and tighten to 96-127 Nm (71-94 lb-ft). Install safety chains.

4. Position engine rear plate on rear of engine.



5. Make sure vehicle is secured on hoist and maneuver Powertrain Removal Lift under vehicle. Align lift and engine/crossmember assembly so three mounting bolts on each side of frame are in alignment with holes in crossmember.

6. Lower vehicle slowly so bolts are piloted in crossmember holes. Raise engine lift or lower hoist so crossmember is against frame. Install nuts retaining crossmember to frame and tighten to 196-264 Nm (145-195 lb-ft).

7. Remove safety chain, raise vehicle and remove Powertrain Removal Lift.

8. Install three-way catalytic converter (TWC) to exhaust manifolds (do not tighten bolts at this time). Install a new gasket between three-way catalytic converter and muffler inlet pipe, install nuts and bolts and tighten to 25-35 Nm (18-26 lb-ft).

9. **NOTE: Make sure torque converter rotates freely and is not bound up.**

   When the torque converter is fully installed, check dimension A: minimum 10.23mm (7/16 inch);

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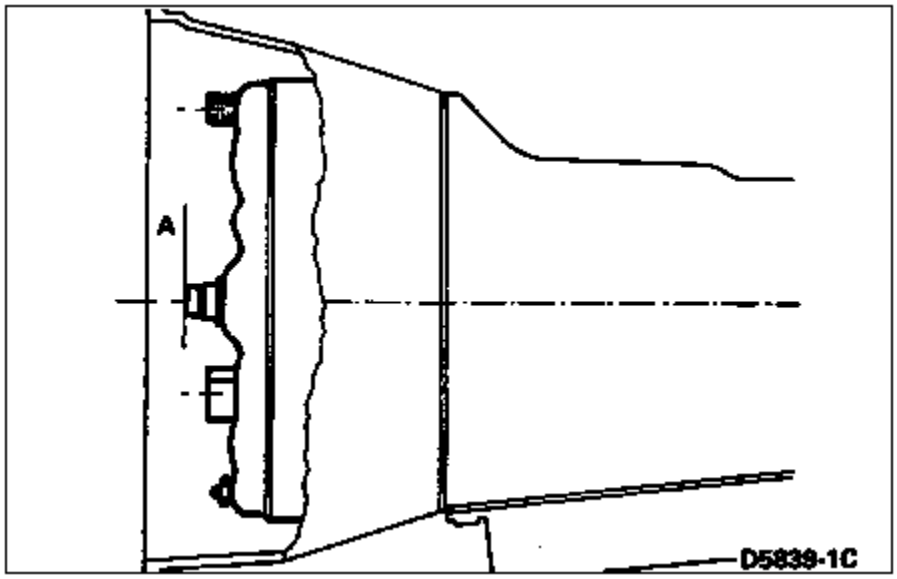
maximum: 14.43mm (9/16 inch).



If removed, position torque converter to transmission, making sure converter hub is fully engaged in front pump support and gear.

10. **CAUTION: Use care while moving transmission with torque converter installed. If transmission is tipped forward, the converter can slide out of the converter housing. It is best to secure the torque converter in the transmission case until the transmission is on a transmission jack and is ready to get bolted to the engine.**

    Once the converter is properly installed, place transmission on transmission jack and secure with a safety chain.

11. Rotate torque converter so drive studs are in alignment with holes in flywheel.

12. Move transmission forward into position, being careful not to damage flywheel or converter pilot. The converter house is piloted to the engine block with 2 dowel pins in the rear of the engine block.

13. Route transmission oil level dipstick tube up through engine compartment and insert in transmission.

14. Install converter housing to engine attaching fasteners. Ensure transmission oil level dipstick tube is secured by the torque converter bolt. Tighten to 44-60 Nm (33-44 lb-ft).

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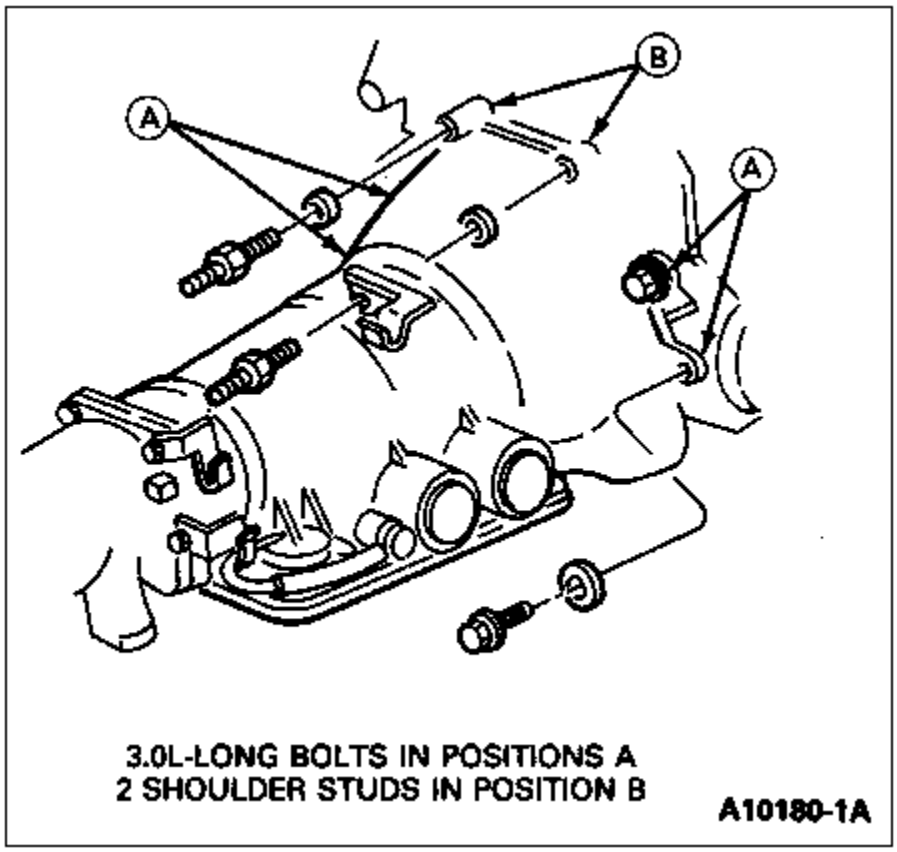

15. Connect transmission oil cooler lines to fittings on case and install oil cooler lines. Tighten cooler line flair nuts to 22-30 Nm (16-22 lb-ft).

16. If removed, install rear engine support insulator to transmission. Tighten bolts to 81-108 Nm (60-80 lb-ft).

17. Position rear engine crossmember in 2 rear engine support brackets. Markings on rear engine support indicate direction of installation. Install nuts and bolts and tighten to 37-52 Nm (28-38 lb-ft). Refer to Section 02-03 for specific procedures.

18. Lower transmission slowly so studs are installed in proper slots in rear engine support. Install nuts and tighten to 97-127 Nm (74-94 lb-ft). Remove safety chain and remove transmission jack.

19. Tighten three-way catalytic converter to exhaust manifolds bolts to 34-46 Nm (25-34 lb-ft).

20. Connect driveshaft to transmission and rear axle, observing alignment marks made during removal. Install bolts securing rear cross-shaft to pinion flange. Tighten bolts to 95-129 Nm (70-95 lb-ft).

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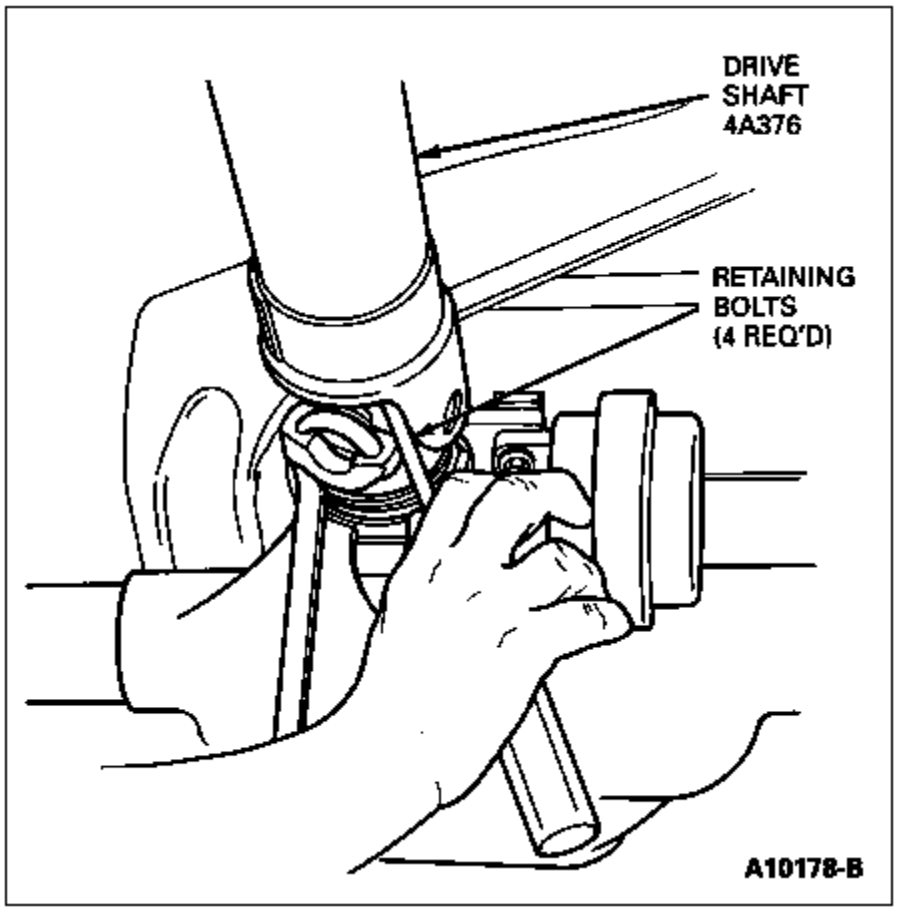

21. Position a 22mm socket and breaker bar on crankshaft damper bolt. Rotate crankshaft (6303) clockwise (as viewed from front) to gain access to each of the torque converter studs. Install a nut on each stud and tighten to 27-46 Nm (20-34 lb-ft).

22. Install converter housing lower cover to converter housing and tighten to 16-22 Nm (12-16 lb-ft).

23. Install starter to transmission. Install dash panel ground cable and starter ground strap. Tighten starter bolts to 21-27 Nm (15-20 lb-ft). Connect starter relay cable and tighten nut and washer.

24. Position shifter cable in shifter cable bracket on transmission case. Press end of cable on ball stud on lower portion of manual valve detent lever. Refer to Section 07-05 to adjust shifter cable.

25. Install kickdown control cable in bracket and press end of cable on ball stud.

26. Connect neutral/start switch and converter clutch solenoid wiring connectors.

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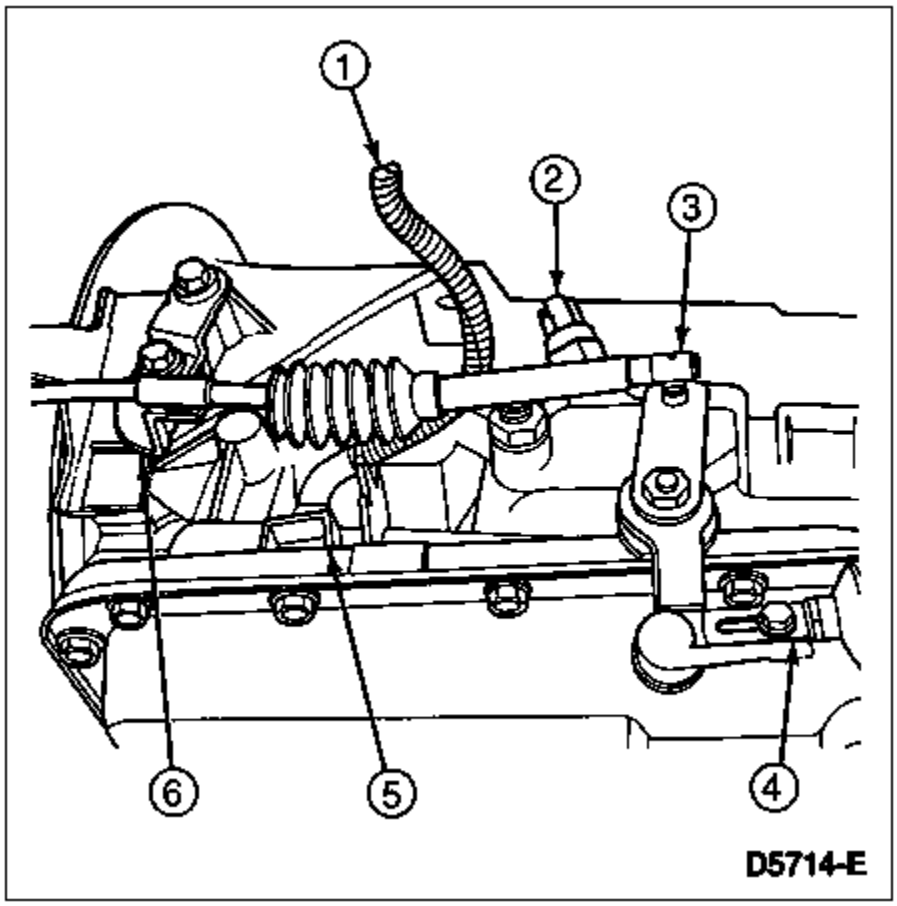

Item	Part Number	Description
1	—	Converter Clutch Solenoid Connect Wires
2	7A247	Park/Neutral Position Switch
3	7A187	Kickdown Control Shaft Rod
4	7E395	Shift Cable and Bracket
5	—	Converter Clutch Solenoid and 3-4 Shift Solenoid
6	7B229	Transmission Shift Cable Bracket

27. Insert speedometer gear and cable into transmission. Insert bolt through clamp and tighten to 2.25-2.82 Nm (20-25 lb-in).

28. Install a jack under the lower control arm. Slowly raise lower control arm until front coil spring is under tension. Continue to raise lower control arm until steering knuckle can be connected to the upper ball joint. Install pinch bolt and nut and tighten to 37-50 Nm (27-37 lb-ft).

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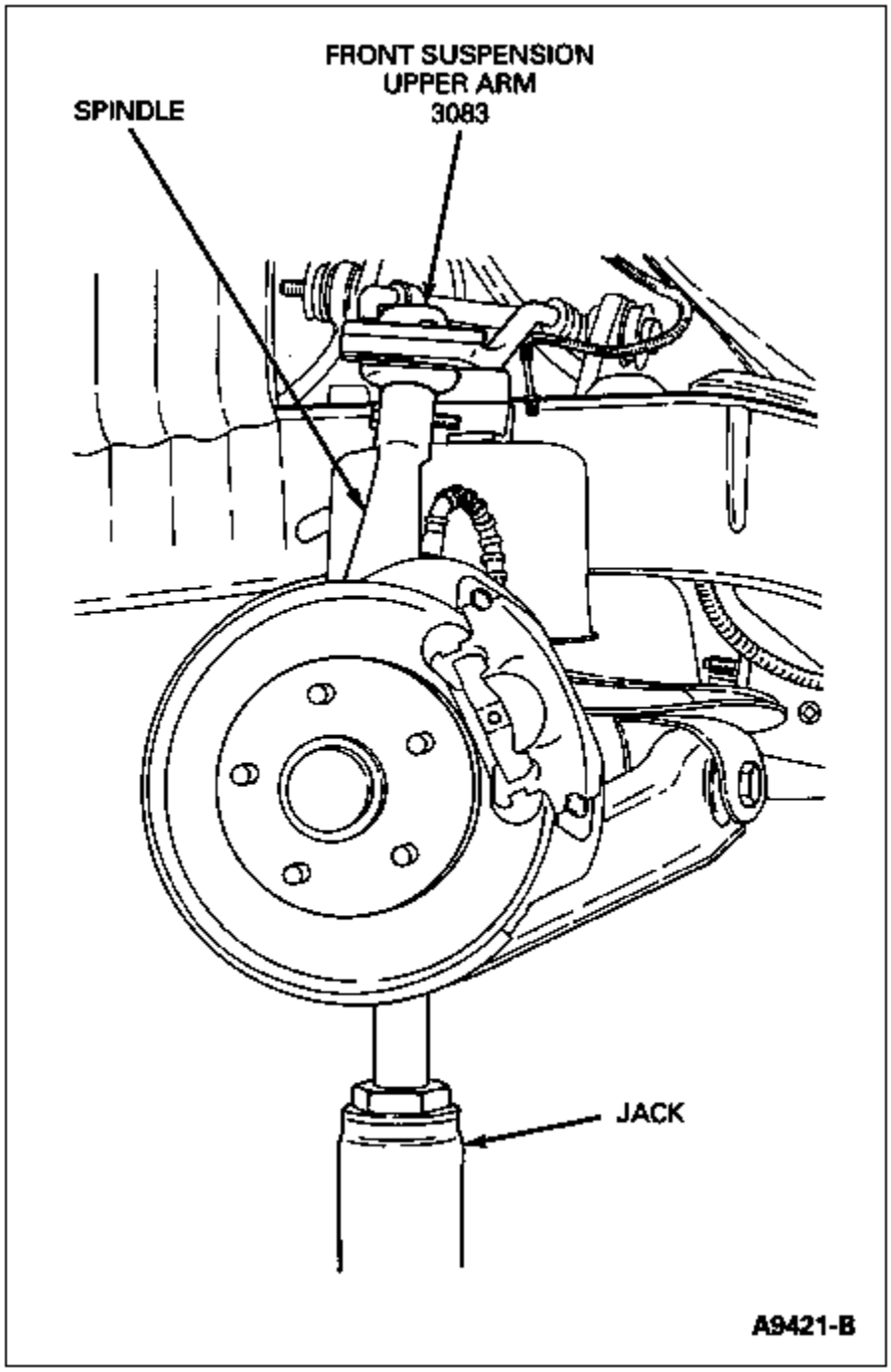

29. Connect front stabilizer bar to lower control arms. Install new stabilizer bar link nuts and tighten to 16-24 Nm (12-18 lb-ft).

30. Reinstall front brake calipers to steering knuckle as outlined in Section 06-03 .

31. Reconnect fuel lines along left frame rail near engine mount as outlined in Section 03-04B .

32. Install front wheel and tire assemblies on rotors. Install and tighten wheel lug nuts to 115-155 Nm (85-114 lb-ft).

33. Connect electrical connector for heated oxygen sensor (HO2S).

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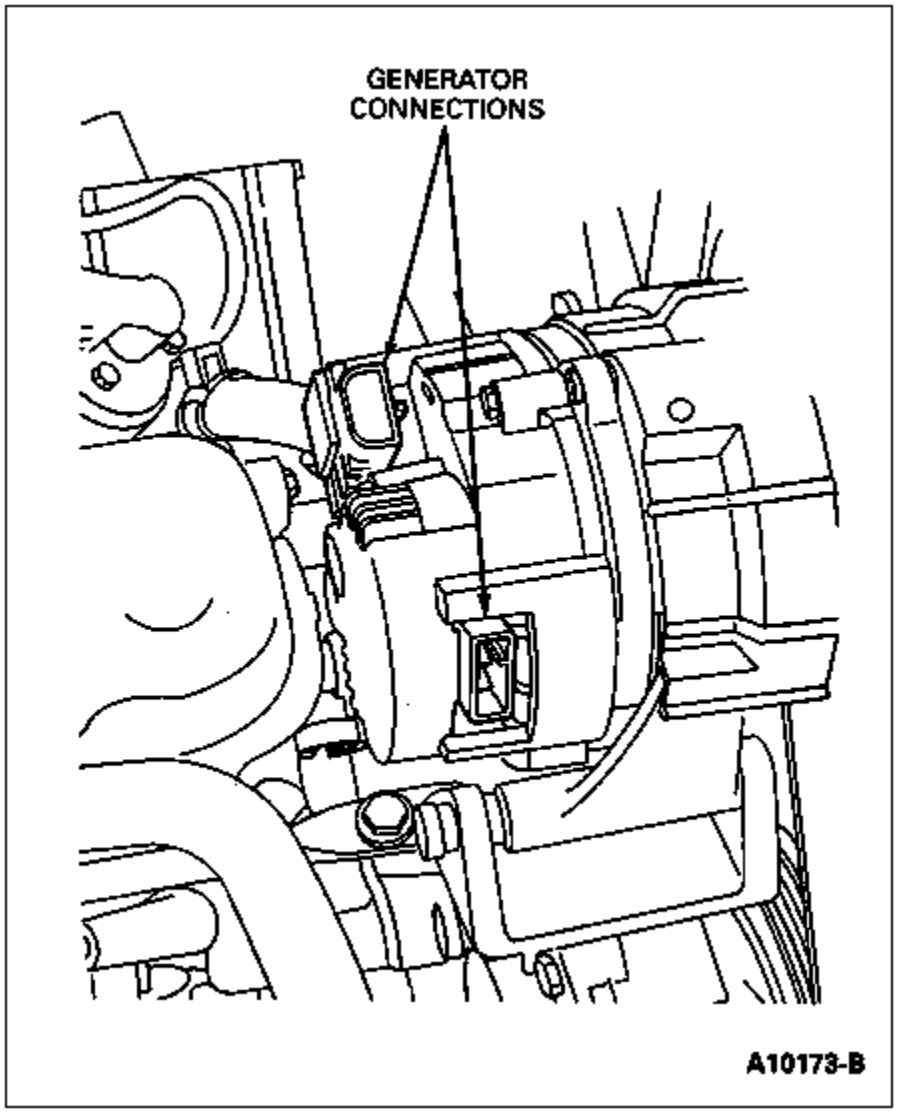
34. Position 2 dash panel ground straps on engine and tighten 2 ground strap bolts.
35. Lower vehicle.
36. Connect oil pressure sensor electrical connector through cab area.
37. Install rear engine compartment cover inside vehicle.
38. From inside engine compartment, in front of vehicle connect 2 electrical connectors to generator.



39. Connect vacuum supply hose to power brake booster.
40. Reconnect cruise control vacuum at check valve and linkage to throttle shaft.
41. Connect barometric manifold absolute pressure sensor vacuum line located on dash panel.
42. Connect steering column at intermediate shaft. Install pinch bolt and tighten to 41-57 Nm (30-42 lb-ft).

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43. Connect electrical connector to power steering pressure switch (PSP switch).

44. Reconnect heater water supply and return hoses.

45. **CAUTION: Fan clutch nut has left hand thread. Turn counterclockwise to tighten.**

    Install assembled fan blade and clutch and tighten to 41-135 Nm (30-100 lb-ft) using Fan Clutch Holding Tool T84T-6312-C and Fan Clutch Nut Wrench T84T-6312-D.

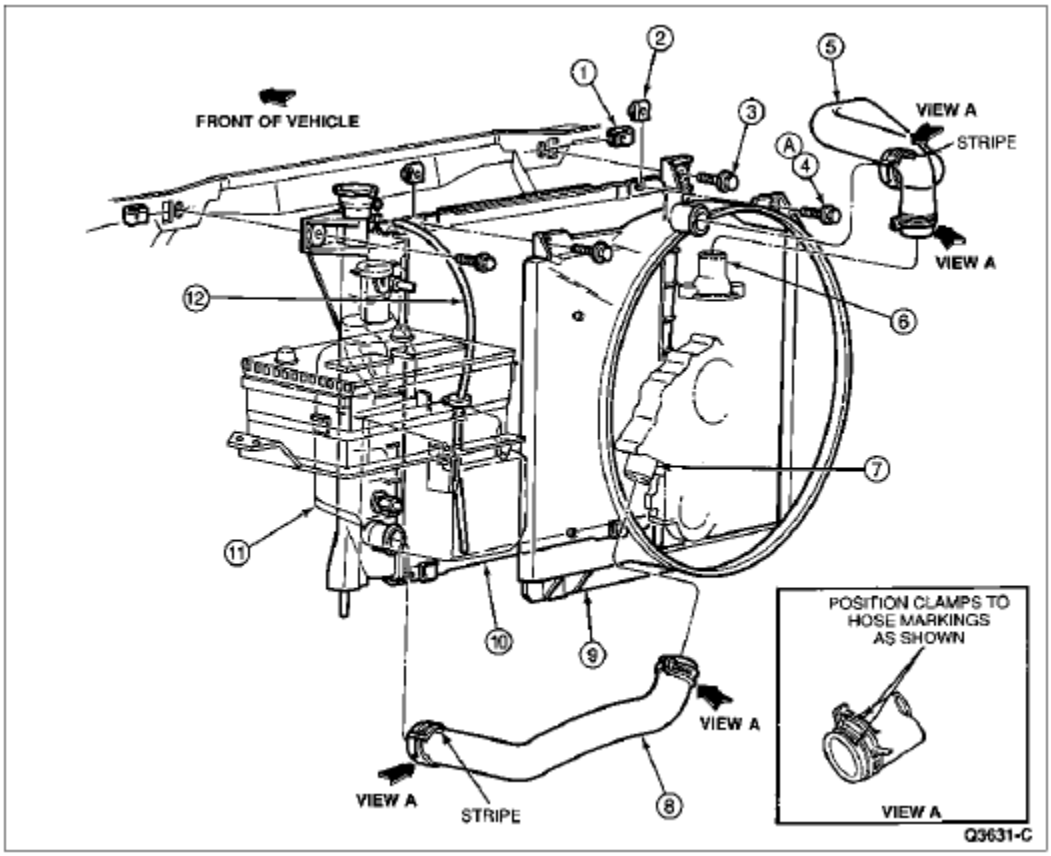
46. Install fan shroud over fan blade.

47. Install radiator (8005) by positioning 2 lower guide pins in grommets and securing at top with 2 retaining bolts. Tighten bolts to 17-27 Nm (13-20 lb-ft).

48. Reconnect transmission oil cooler lines to fittings in left radiator tank. Tighten cooling line flair nuts to 22-30 Nm (16-22 lb-ft).

49. Position fan shroud in retaining clips at bottom and secure with 2 bolts at top. Tighten screws to 6-8 Nm (53-71 lb-in).

Radiator Installation, Aerostar 3.0L



	Part	

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Item	Number	Description
1	N801731-S2	U-Nut
2	N804639-S2	U-Nut
3	N606692-S2	Screw and Washer Assembly
4	N606677-S2	Screw and Washer Assembly
5	8260	Upper Radiator Hose Install with Stripe at 12:00 O'Clock Position
6	8592	Water Hose Connection
7	8501	Water Pump
8	8286	Lower Radiator Hose Install with Stripe at 12:00 O'Clock Position
9	8146	Fan Shroud
10	8005	Radiator
11	17B613	Reservoir
12	8075	Radiator Overflow Hose
A	—	Tighten to 6-8 Nm (53-71 Lb-In)

50. Connect hose to evaporative emission canister purge valve (EVAP canister purge valve) (9C915).

51. Reconnect A/C suction hose to accumulator and discharge line to condenser. Evacuate and refill with refrigerant as outlined in Section 12-00 .

52. Route belt as illustrated but do not wrap over alternator pulley. With wrench, rotate engine drive belt tensioner clockwise and slide belt over alternator pulley.

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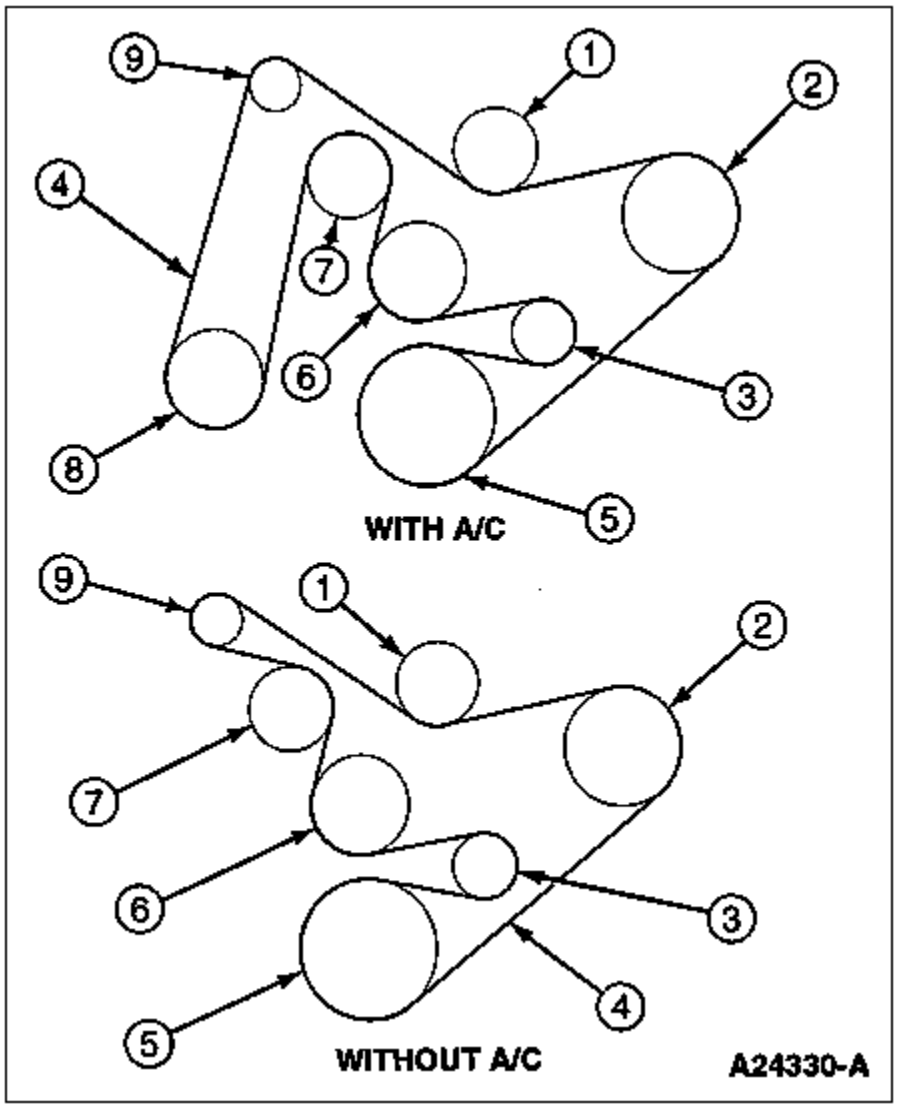

Item	Part Number	Description
1	3F671	Power Steering Belt Idler Support
2	3A733	Power Steering Pump Pulley
3	6B209	Drive Belt Tensioner
4	8620	Drive Belt
5	6312	Crankshaft Pulley
6	8509	Water Pump Pulley
7	—	Idler (Part of 8A620)
8	19703	A/C Compressor
9	10300	Generator

53. Connect accelerator cable to ball stud located on throttle body. Connect cruise control cable if equipped. Install accelerator control splash shield.

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54. Connect upper and lower radiator hoses at radiator.

55. Install engine air cleaner outlet tube at throttle body and engine air cleaner.

56. Install PCV closure hose at air cleaner outlet tube and valve cover.

57. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

    Connect ground cable at battery.

58. Fill cooling system to specified level. Refer to Section 03-03 .

59. Check and adjust all fluid levels. Refer to appropriate sections.

60. Start and run engine to check for proper operation and leaks. Service as required.

61. Check and, if required, align front suspension. Refer to Section 04-00 .

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3.0L Engine, Ranger

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Fan Clutch Holding Tool	T84T-6312-C
Fan Clutch Nut Wrench	T84T-6312-C
Clutch Coupling Tool	T88T-70522-A
Strap Wrench	D85L-6000-A
Fuel Pressure Gauge	T80L-9974-B
Spring Lock Coupling Disconnect Tool (3/8 inch)	T81P-19623-G1
Spring Lock Coupling Disconnect Tool (1/2 inch)	T81P-19623-G2
Spring Lock Coupling Disconnect Tool (5/8 inch)	T83P-19623-C
Spring Lock Coupling Disconnect Tool (3/4 inch)	T85L-19623-A
Spreader Bar	D93P-6001-A3
Teflon® Seal Replacer Set	D90P-3517-A

Removal

1. Disconnect the negative battery cable. Refer to Section 14-01 .
2. Drain the cooling system. Refer to Section 03-03 .
3. Discharge and recover the refrigerant from the A/C system. Refer to Section 12-03A .
4. Drain the power steering fluid.
5. Disconnect the hood light connector and locator from the hood. Unclip the ground strap from the right side of the hood. Mark the location of the hood hinges, remove the four bolts, and remove the hood.
6. Disconnect the crankcase ventilation hose from the air cleaner outlet tube. Disconnect the electrical connectors from the mass air flow (MAF) sensor and the intake air temperature (IAT) sensor. Disconnect the harness locator from the air cleaner outlet tube. Loosen the clamp at the throttle body, unsnap the air cleaner cover from the air cleaner housing. Remove the air cleaner cover and air cleaner outlet tube as an assembly.

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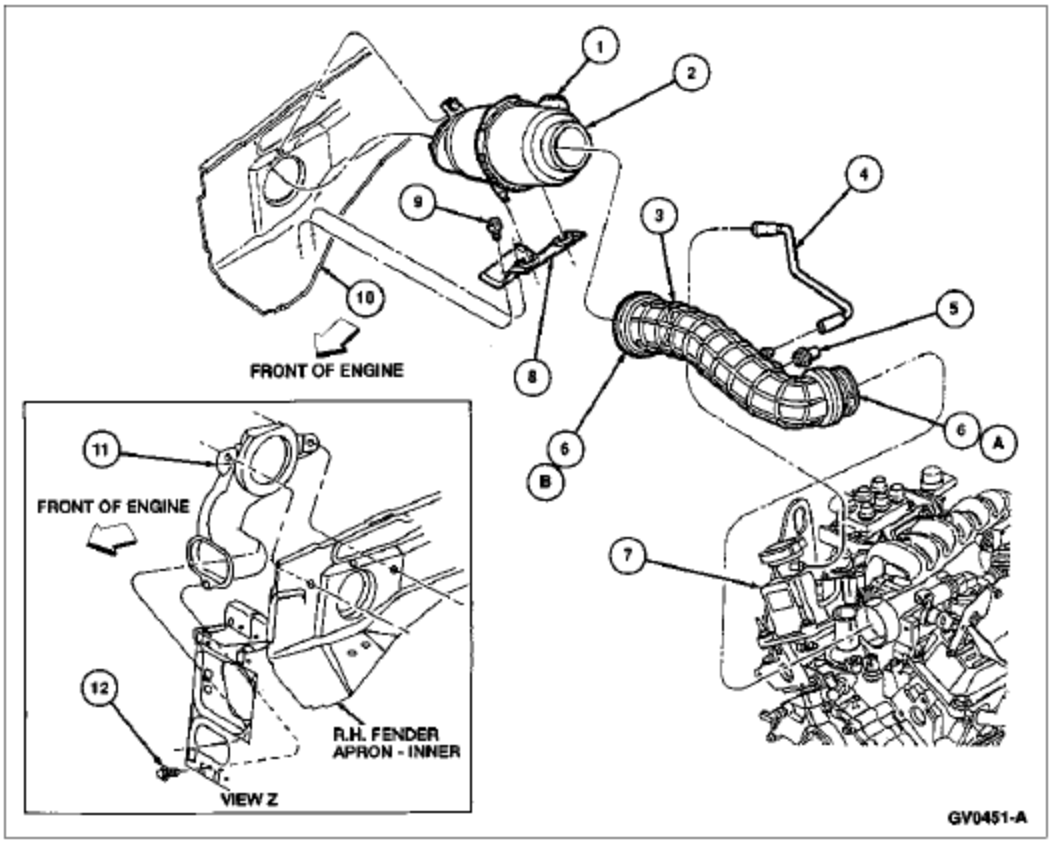

Item	Part Number	Description
1	12B579	Mass Airflow Sensor
2	9600	Engine Air Cleaner
3	9B659	Air Cleaner Outlet Tube
4	6853	Crankcase Ventilation Hose
5	12A697	Intake Air Temperature Sensor
6	—	Clamp (Part of 9B659)
7	6582	Valve Cover
8	9626	Engine Air Cleaner Mounting Bracket
9	N606675-S310	Screw, 1 x 16.5 (2 Req'd)
10	16006	Front Fender, Inner (RH)
11	9B660	Air Inlet Tube
12	N605894	Bolt (3 Req'd)
A	—	Tighten to 2-3 Nm (18-27 Lb-In)
B	—	Tighten to 1-2 Nm (9-18 Lb-In)

7. Compress and position the clamps on the upper radiator hose and remove the hose.
8. Lift the drive belt tensioner by rotating it and remove the accessory drive belt. Position the accessory

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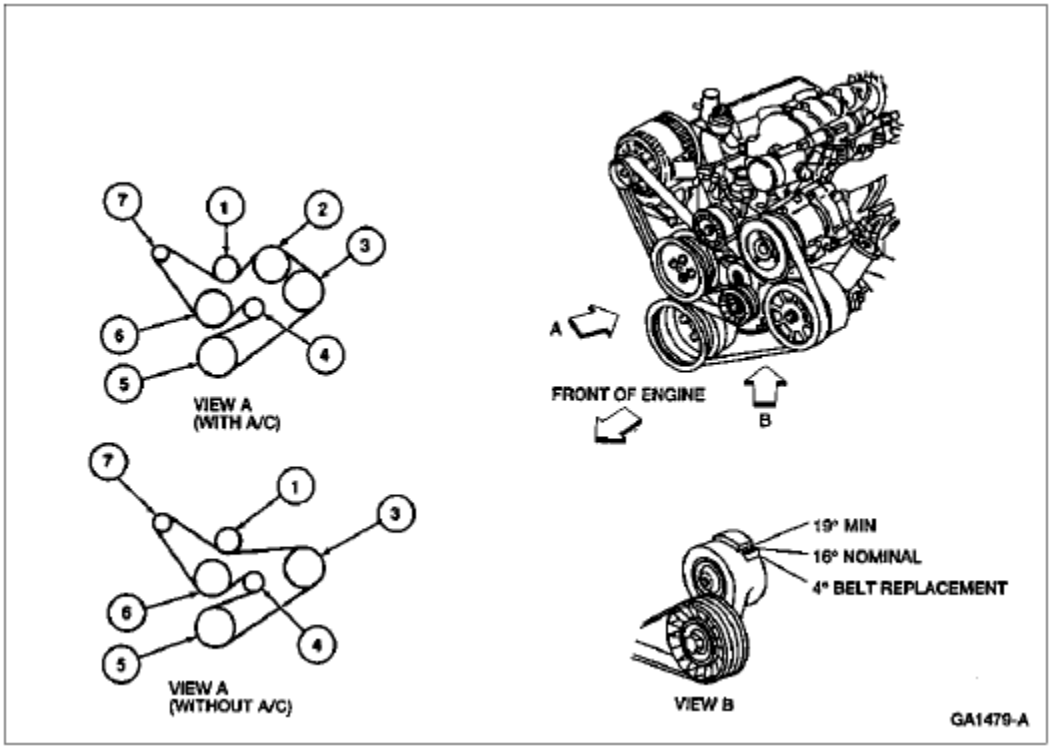
drive belt over the radiator.



Item	Part Number	Description
1	3F671	Belt Idler Pulley
2	19D629	A/C Compressor
3	3D673	Power Steering Pump Pulley
4	6B209	Drive Belt Tensioner
5	6312	Crankshaft Pulley
6	8A528	Water Pump Pulley
7	10300	Generator

9. Remove the fan shroud retaining bolts. Using Strap Wrench D85L-6000-A or equivalent to hold the water pump pulley, remove the fan blade and fan clutch assembly. Remove the fan blade and fan shroud as an assembly.

10. Remove the radiator overflow hose from the radiator and position it out of the way. Remove the accessory drive belt.

11. Compress the clamp on the lower radiator hose and disconnect the hose from the radiator.

12. Disconnect the automatic transmission oil cooling lines from the radiator fittings. Install protective caps over the lines.

13. Remove the radiator bolts. Tilt the radiator back and lift it directly upward, clear of the radiator support bracket.

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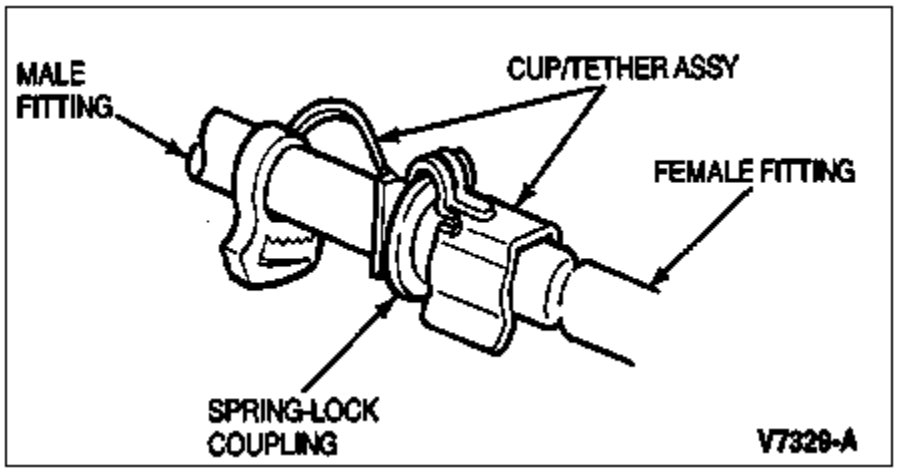
14. **CAUTION: When disconnecting the speed control cable from the ball stud, use a screwdriver (or similar tool) close to the stud and pry slowly. Pulling by hand can damage the cable.**

    Remove the accelerator control splash shield pushpins and the shield. Disconnect the accelerator and speed control cables from the ball stud at the throttle body. Remove the speed control cable from the locator at the exhaust gas recirculation (EGR) transducer bracket. Remove the bolts retaining the accelerator cable bracket to the intake manifold. Remove the speed control cable from the locator. Position the bracket and cables out of the way.

15. **WARNING: FUEL SUPPLY LINES ON VEHICLES EQUIPPED WITH FUEL INJECTED ENGINES REMAIN PRESSURIZED FOR LONG PERIODS OF TIME AFTER ENGINE SHUTDOWN. FUEL SYSTEM PRESSURE MUST BE RELIEVED PRIOR TO FUEL SYSTEM SERVICE, TO PREVENT POSSIBLE INJURY.**

    Remove the protective cap from the fuel pressure relief valve. Connect Multiport Fuel Injection (MFI) Fuel Pressure Gauge (EFI/CFI) T80L-9974-B to the fuel pressure relief valve on the fuel injection supply manifold. Place the end of the adapter in a suitable container. Open the manual valve of the tool to relieve the pressure. Close the manual valve and disconnect the tool from the relief valve. Remove the container and install the protective cap on the relief valve.

16. Remove the safety clips from the pressure and return fuel line spring lock couplings at the chassis-to-engine connections (lower left side of the engine).



17. **NOTE: Inspect the couplings for missing or damaged O-rings. If either O-ring is damaged, both O-rings must be replaced. Replace the O-rings or garter springs only with the appropriate replacement parts.**

    Position a Spring Lock Coupling Disconnect Tool D87L-9280-A (3/8-inch), D87L-9280-B (1/2-inch) on the couplings. Push the tool into the cage opening to release the fitting from the garter spring. Remove the tool and pull the coupling apart. Install protective caps over the fuel lines.

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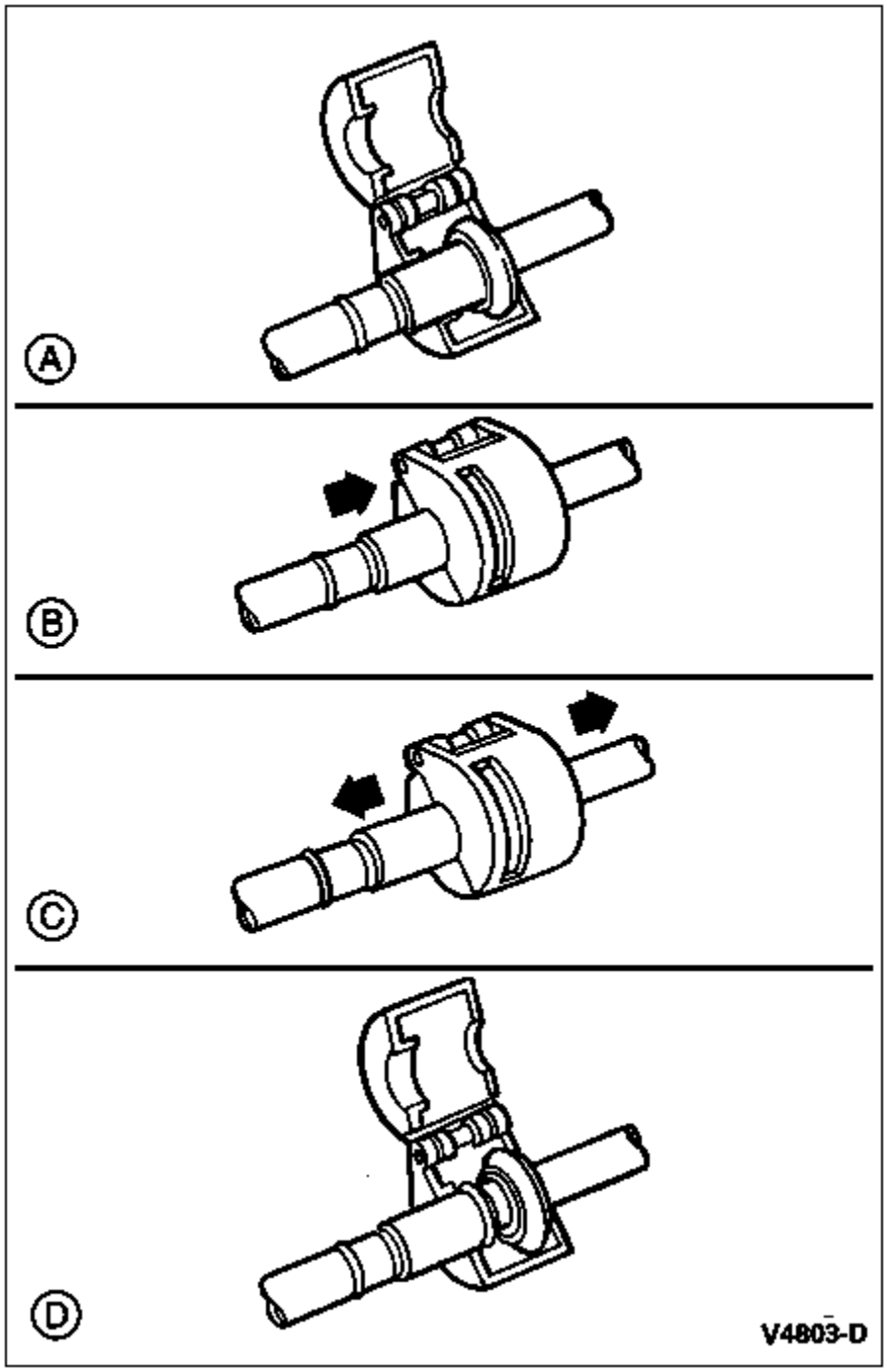

18. Remove the fuel line bracket nut from the A/C compressor/power steering bracket stud. Remove the lines and bracket. Position them out of the way.

19. Disconnect the electrical connector from the A/C pressure cutoff switch. Remove the nut retaining the A/C line to the water pump studded bolt.

20. Remove the A/C safety clips at the condenser tube and at the suction accumulator/drier. Install Spring Lock Coupling Disconnect Tool T81P-19623-G1, T81P-19623-G2, T83P-19623-C, or T85L-19623-A to the couplings. Close the tool and push it into the open side of the cage, to expand the garter spring. Release the fitting, remove the tool, and disconnect the fittings. Install protective caps.

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21. Disconnect the electrical connector from the A/C compressor clutch and two wire locators from the rear of the compressor. Remove the bolt retaining the A/C manifold and tube to the compressor.

22. Remove the bolts retaining the compressor to the bracket. Separate the A/C manifold and tube from the compressor and remove the compressor. Install protective caps into the compressor. Remove the A/C manifold and tube and install caps.

23. Compress and position the clamps on the heater hoses at the water pump and intake manifold. Remove the hoses and position them out of the way.

24. Disconnect the electrical connections from the generator (GEN) and the wire locator from the generator (GEN) bracket. Position the harness out of the way.

25. Remove the Torx® bolt retaining the accessory drive belt tensioner and remove the tensioner.

26. Disconnect the power steering pressure line from the power steering pump. Install a protective cap over the fitting.

27. Remove the bolts retaining the A/C compressor/power steering pump bracket. Position the bracket and pump forward. Compress and position the clamp on the power steering return hose and disconnect from the power steering pump. Remove the bracket and pump assembly.

28. Disconnect the vacuum hose from the purge valve at the left wheel well. Disconnect the vacuum reservoir vacuum hose from the vacuum connector, located at the right valve cover.

29. Compress the clamp and disconnect the power brake booster vacuum hose from the vacuum tree. Position the hose out of the way.

30. Loosen the bolt of the 42-pin connector at the rear of the left valve cover and separate the connector. Position the connector out of the way.

31. Remove the nut retaining the ground strap to the windshield wiper motor retaining stud and position the ground strap out of the way.

32. Loosen the bolt and disconnect the powertrain control module (PCM) connector. Remove the nut retaining the PCM wiring harness bracket to the bulkhead. Remove the studded bolt retaining the ground wire to the bulkhead. Position the harness over the engine.

33. Disconnect the two 16-pin transmission connectors from the rear of the right cylinder head. Disconnect the right hand heated oxygen sensor (HO2S) connector.

34. **NOTE: The right hand bolt retains the upper filler tube.**

    Remove the two upper converter housing-to-engine retaining bolts and remove the upper filler tube.

35. **NOTE: If the engine is not going to be reinstalled, the replacement engine must now be mounted to an engine stand.**

    Install Engine Lifting Eyes D81L-6001-D or equivalent to the right hand and left hand exhaust manifolds.

36. Raise the vehicle. Refer to Section 00-02 .

37. Drain the engine oil.

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38. Remove the bolt and nut retaining the oil filter drain funnel. Remove the starter motor bolts and secure the starter out of the way. Remove the drain funnel.

39. Remove the torque converter dust cover retaining bolts and remove the cover.

40. **NOTE: Use the crankshaft pulley bolt to rotate the converter. Mark the converter stud and flexplate to aid during assembly.**

    Remove and discard the converter-to-flexplate nuts.

41. Remove the exhaust manifold-to-exhaust pipe nuts.

42. Remove the studded bolt retaining the ground cable to the left side of the engine block and position the cable aside.

43. Remove the bolt retaining the transmission oil cooler line bracket to the right rear of the cylinder block.

44. Remove the remaining converter housing-to-engine retaining bolts.

45. Lower the vehicle.

46. Remove the engine mount retaining nuts.

47. **NOTE: Position a block of wood on a floor jack, to protect the transmission.**

    Position the floor jack under the front of the transmission and slightly raise it.

48. Position and connect Floor Crane 077-00043 or equivalent and Modular Engine Lifting Bar 014-00073 or equivalent to the lifting brackets. Slightly raise the engine. Carefully separate the engine from the transmission. Carefully lift the engine out of the engine compartment.

Installation

1. Position the paint marks at the 12 o'clock position on both the torque converter and flexplate.

2. **NOTE: Make sure the studs on the torque converter align with the holes in the flexplate. Make sure the dowels in the cylinder block engage the transmission housing.**

   Carefully lower the engine into the engine compartment. Align the torque converter studs with the holes in the flexplate. Fully engage the engine to the transmission. Lower the engine and position the engine mounts. Disconnect the floor crane and balance bar from the lifting brackets and position them out of the way.

3. Install the upper LH converter housing-to-engine retaining bolt. Lower and remove the floor jack.

4. Install both engine mount retaining nuts. Tighten to 95 Nm (70 lb-ft).

5. Raise the vehicle.

6. Install the remaining converter housing-to-engine retaining bolts. Tighten to 40 Nm (30 lb-ft).

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7. **NOTE: Use the crankshaft pulley bolt to rotate the converter.**

   Install new torque converter-to-flexplate nuts. Tighten to 40 Nm (30 lb-ft).

8. Install the torque converter dust cover and retaining bolts. Tighten to 14 Nm (10 lb-ft).

9. Position the transmission oil cooler line bracket to the right rear of the engine block and install the retaining bolt. Tighten to 23 Nm (17 lb-ft).

10. Position the exhaust system and install the manifold-to-exhaust pipe retaining nuts. Tighten to 40 Nm (30 lb-ft).

11. Install the ground cable to the left rear area of the engine block. Tighten to 23 Nm (17 lb-ft).

12. Position the oil filter drain funnel. Install the starter motor and retaining bolts. Tighten to 25 Nm (18 lb-ft). Install and securely tighten the drain funnel retaining bolt and nut.

13. Lower the vehicle.

14. Remove the engine lifting eyes from the exhaust manifolds.

15. Connect the two 16-pin transmission connectors to the rear of the right hand cylinder head. Connect the right hand HO2S connector.

16. **NOTE: The RH bolt retains the upper filler tube. Inspect the O-ring on the filler tube and replace as necessary.**

    Install the upper filler tube into the lower filler tube. Install the RH upper converter housing-to-engine retaining bolt. Tighten both upper bolts to 45 Nm (33 lb-ft).

17. Install the ground strap to the wiper motor studded bolt. Tighten to 10 Nm (89 lb-in).

18. Connect the 42-pin connector to the rear of the left valve cover. Tighten to 6 Nm (53 lb-in).

19. Connect the power brake booster vacuum hose to the vacuum tree and position the clamp. Connect the vacuum hose to the purge flow (PF) sensor at the left wheel well. Connect the vacuum reservoir vacuum hose at the vacuum connector above the right hand valve cover.

20. Position and install the harness to the PCM and tighten the bolt to 6 Nm (53 lb-in). Install the ground wire to the bulkhead and tighten to 10 Nm (89 lb-in). Install the harness locator onto the studded bolt and securely tighten the nut.

21. Position the generator and A/C compressor wiring harness in place and connect the generator connections. Tighten to 10 Nm (89 lb-in).

22. Install the heater hoses to the intake manifold and the water pump. Compress and position the hose clamps.

23. Position the A/C compressor/power steering pump bracket with the pump attached to the steering gear box. Remove the protective cap, install the power steering return hose, and position the hose clamp. Install the bracket and power steering pump assembly. Tighten to 45 Nm (33 lb-ft).

24. Remove the protective cap from the power steering pressure line, using Teflon® Seal Replacer Set D90P-3517-A or equivalent. Install a new Teflon® seal onto the line and install the line to the power steering pump. Tighten to 45 Nm (33 lb-ft).

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25. Install the accessory drive belt tensioner and the Torx® retaining bolt. Tighten to 45 Nm (33 lb-ft).

26. **NOTE: Inspect the O-ring seals, replace as necessary. Make sure the fuel lines and bracket are positioned between the compressor and A/C line.**

    Remove the protective caps from the A/C manifold and tube. Position the manifold and tube and install the retaining nut at the water pump studded bolt. Tighten to 12 Nm (9 lb-ft).

27. Remove the protective caps from the A/C compressor. Position the compressor and align the manifold lines to the compressor. Install the compressor retaining bolts and tighten to 45 Nm (33 lb-ft).

28. Install the A/C manifold and tube retaining bolt. Tighten to 27 Nm (20 lb-ft).

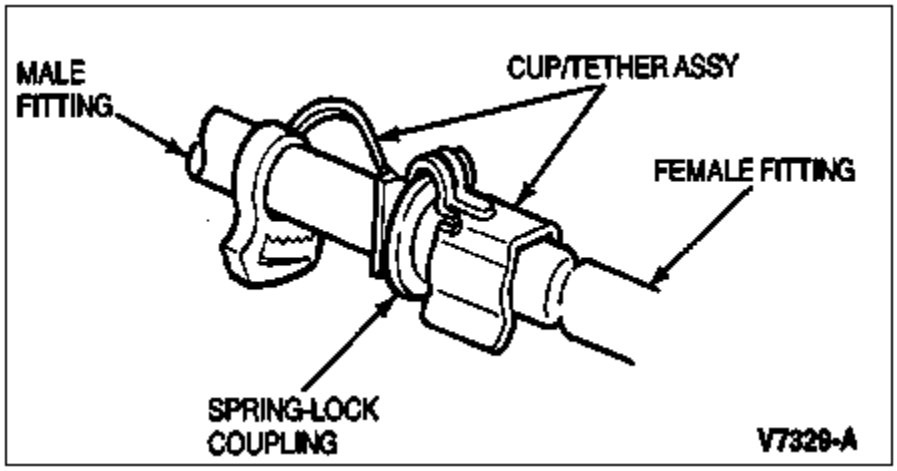
29. Connect the A/C manifold and tube to the condenser tube and the suction accumulator/drier. Install the safety clips.

30. Connect the electrical connector to the A/C pressure cutoff switch and the A/C compressor clutch. Connect the wire locators to the rear of the compressor.

31. Install the accelerator and speed control cables, with the bracket, to the intake manifold. Tighten to 10 Nm (89 lb-in). Connect the cables to the ball stud and the speed control cable to the locator at the EGR transducer bracket.

32. Install the fuel line bracket onto the studded bolt on the A/C compressor/power steering bracket. Tighten to 50 Nm (37 lb-ft).

33. Remove the protective caps and connect the fuel lines to the chassis (lower left side of the engine). Install the safety clips.



34. Install the accelerator control splash shield and the pushpin retainers.

35. Carefully lower the radiator into the vehicle, guiding the locators into the grommets. Install the retaining bolts and tighten to 12 Nm (9 lb-ft).

36. Install the lower radiator hose. Position the clamp.

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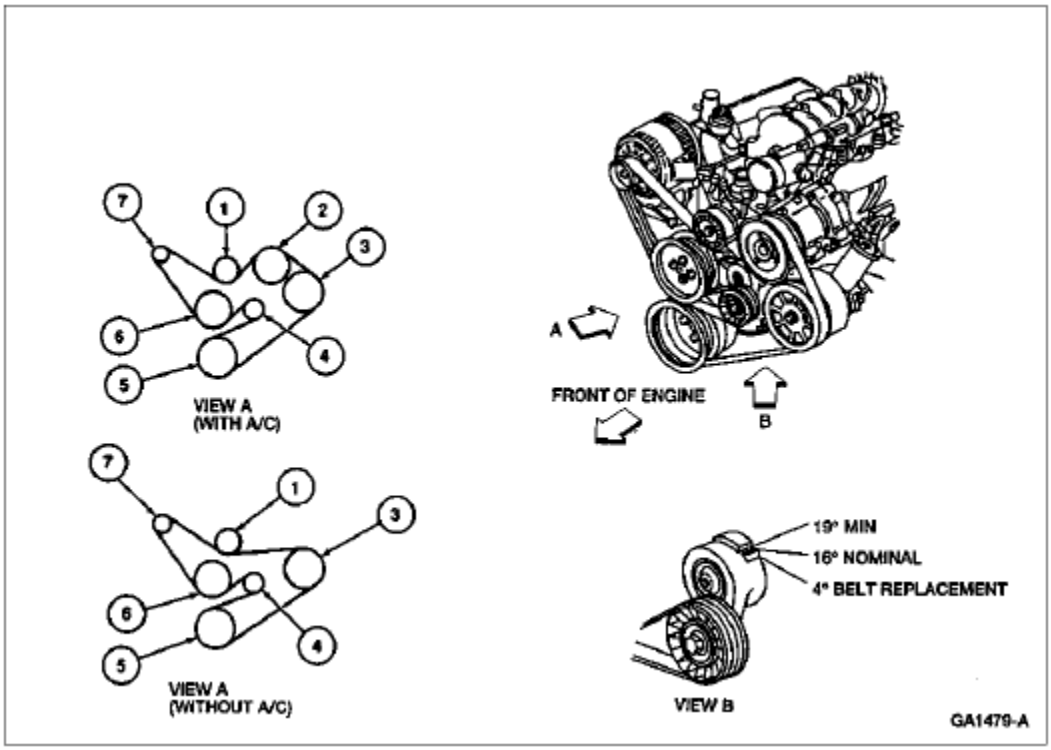
37. Remove the protective caps and connect the automatic transmission oil cooling lines to the radiator connectors. Tighten to 20 Nm (15 lb-ft).

38. **NOTE: The fan clutch has left-hand threads, so it must be turned counterclockwise for installation and tightening.**

    Position the accessory drive belt over the front of the engine. Carefully lower the fan shroud and the fan and clutch assembly into the vehicle. Using Strap Wrench D85L-6000A or equivalent, install the fan clutch assembly. Tighten the fan to 53 Nm (39 lb-ft).

39. Position the fan shroud into the lower retainers and install the upper retaining bolts. Tighten to 7 Nm (62 lb-in).

40. Install the accessory drive belt.



Item	Part Number	Description
1	3F671	Belt Idler Pulley
2	19D629	A/C Compressor
3	3D673	Power Steering Pump Pulley
4	6B209	Drive Belt Tensioner
5	6312	Crankshaft Pulley
6	8A528	Water Pump Pulley
7	10300	Generator

41. Install the radiator overflow hose to the radiator. Install the upper radiator hose and position the

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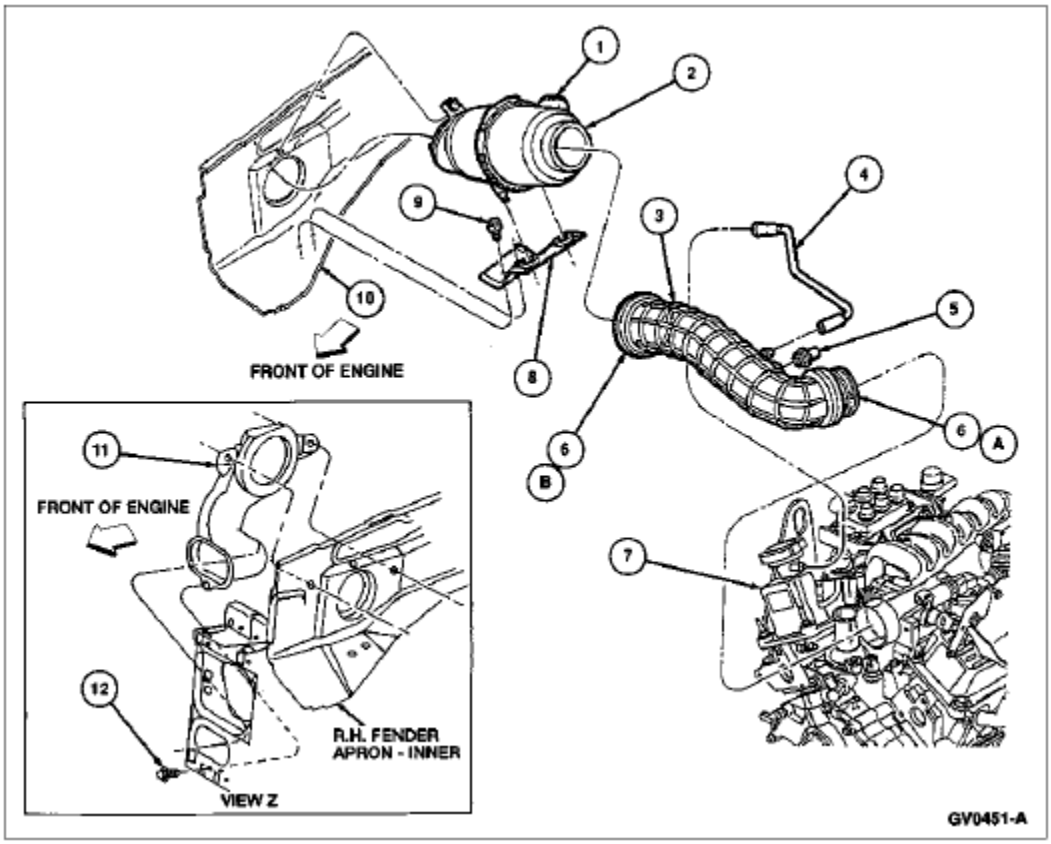
clamps.

42. Position the air cleaner cover assembly. Connect the air cleaner outlet tube to the throttle body and securely tighten the clamp. Snap the air cleaner cover to the air cleaner housing. Connect the electrical connections to the MAF sensor and the IAT sensor. Connect the wire locators to the air cleaner and outlet tube. Connect the crankcase ventilation hose to the air cleaner outlet tube.



Item	Part Number	Description
1	12B579	Mass Airflow Sensor
2	9600	Engine Air Cleaner
3	9B659	Air Cleaner Outlet Tube
4	6853	Crankcase Ventilation Hose
5	12A697	Intake Air Temperature Sensor
6	—	Clamp (Part of 9B659)
7	6582	Valve Cover
8	9626	Engine Air Cleaner Mounting Bracket
9	N606675-S310	Screw, 1 x 16.5 (2 Req'd)
10	16006	Front Fender, Inner (RH)
11	9B660	Air Inlet Tube
12	N605894	Bolt (3 Req'd)

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A	—	Tighten to 2-3 Nm (18-27 Lb-In)
B	—	Tighten to 1-2 Nm (9-18 Lb-In)

43. Install and align the hood. Tighten to 9 Nm (80 lb-in). Connect the hood light connector and locator pin to the hood. Clip the ground strap to the hood on the right hand side.
44. Install the negative battery cable.
45. Fill the cooling system.
46. Fill the engine with oil.
47. Fill the power steering system.
48. Evacuate, pressurize, leak test, and recharge the A/C system.
49. Check the operation of the engine.

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Camshaft Bearings

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Camshaft Bearing Set	T65L-6250-A

Removal

1. Remove engine (6007) from vehicle as outlined in this section.
2. Place engine on work stand and remove camshaft (6250), crankshaft (6303) and camshaft rear bearing cover.
3. Remove camshaft bearing with Camshaft Bearing Set T65L-6250-A.
4. Select proper size expanding collet and backup nut, and assemble on the expanding mandrel. With the expanding collet collapsed, install collet assembly in the camshaft bearing, and tighten backup nut on the expanding mandrel until the collet fits the camshaft bearing.
5. Assemble puller screw and extension, if necessary, and install on the expanding mandrel. Wrap a cloth around the threads of the puller screw to protect the bearing or journal. Tighten the puller nut against the thrust bearing and pulling plate to remove camshaft bearing. Be sure to hold the end of the puller screw to prevent it from turning.
6. Repeat above step for each bearing. To remove the camshaft bearing, install the puller from the rear of the cylinder blocks (6010).

Installation

The camshaft bearings are available pre-finished to size and require no reaming for standard and 0.38mm (0.015 inch) undersize journal diameters.

CAUTION: Failure to use the correct expanding collet can cause severe bearing damage.

1. **NOTE: Align the oil holes in the bearings with the oil holes in the cylinder block before pressing bearings into place. Make sure the front bearing is installed 0.51-0.89mm (0.020-0.035 inches) below the front face of the cylinder block.**

   Position new bearings at the bearing bores and press them in place with Camshaft Bearing Set T65L-6520-A. Be sure to center the pulling plate and puller screw to avoid damage to the bearing.
2. Install camshaft rear bearing bore plug as outlined in this section.
3. Install camshaft, crankshaft, flywheel (6375) and related parts. It is not necessary to check connecting rod and main bearing clearances as part of camshaft bearing replacement.
4. Install engine in vehicle as outlined in this section.

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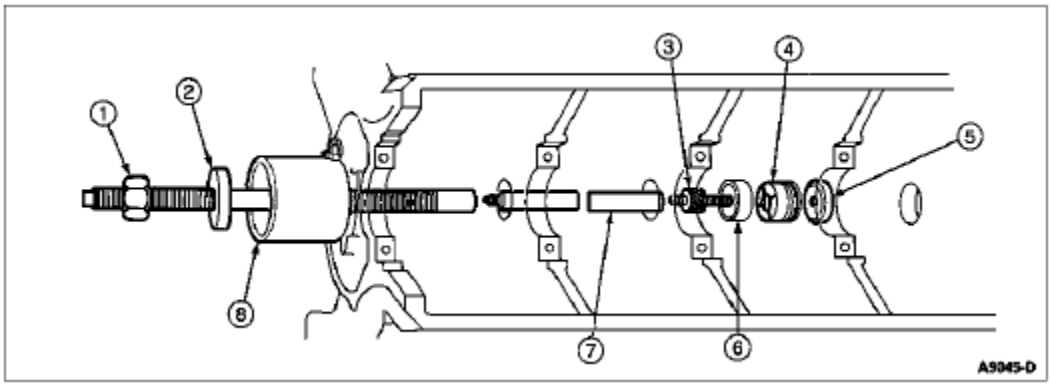
Camshaft Bearings, Removal/Installation



Item	Part Number	Description
1	—	Pulling Screw (Part of T65L-6250-A)
2	—	Pulling Plate (Part of T65L-6250-A)
3	—	Expanding Mandrel (Part of T65L-6250-A)
4	—	Expanding Collet (Part of T65L-6250-A)
5	—	Backup Nut (Part of T65L-6250-A)
6	6262	Bearing, Camshaft (Part Number Given Is for Reference Only)
7	—	Puller Screw Extension (Part of T65L-6250-A)
8	—	Front Spacer (Part of T65L-6250-A)

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Oil Pan, Ranger 4x4

Removal

1. Remove the engine (6007) from the vehicle as outlined in this section.
2. Remove the oil pan bolts.
3. Remove the oil pan (6675) from the engine.
4. Remove oil pan gasket (6710) and discard.

Installation

1. Lightly oil all bolt threads before installation.
2. **NOTE: When using silicone rubber sealer, assembly should occur within 15 minutes after sealer application. After this time, the sealer may start to set up, and its sealing effectiveness may be reduced.**

   Apply a 4.0-6.0mm (1/5-inch) bead of Silicone Rubber D6AZ-19562-AA or equivalent meeting Ford specification ESB-M4G92-A or ESE-M4G195-A to the junction of the rear main bearing cap and cylinder blocks (6010) and junction of the front cover assembly and cylinder blocks.
3. Position oil pan gasket to cylinder blocks and secure with Gasket and Trim Adhesive D7AZ-19B508-B or equivalent meeting Ford specification ESE-M2G52-A.
4. Position oil pan to cylinder blocks.
5. Install oil pan attaching bolts and tighten to 12 Nm (9 lb-ft).
6. Install engine in vehicle as described in this section.

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Engine

Disassembly

1. Remove throttle body (9E926) as outlined in Section 03-04B .
2. Remove spark plugs (12405).
3. Remove right exhaust manifold (9430) and left exhaust manifold as outlined in this section.
4. Remove intake manifold (9424) as outlined in this section.
5. Before attempting to remove the intake manifold, break the seal between the intake manifold and the cylinder blocks (6010). Wedge a large screwdriver between the manifold and the block. Pry downward on the screwdriver using the lug on the water pump (8501) as a leverage point. Use care to prevent damage to machined surfaces.
6. Loosen rocker arm fulcrum attaching bolts enough to allow the rocker arm (6564) to be lifted off the push rod (6565) and rotated to one side.
7. Remove push rods. Identify the position of each rod. The push rods should be installed in their original position during reassembly.
8. Loosen roller tappet guide plate retainer bolts (2). Remove water pump from tappet valley.
9. Remove tappet guide plate retainers from valve tappets (6500) by lifting straight up.
10. **NOTE: If a valve tappet is stuck in its bore due to excessive varnish or gum deposits, it may be necessary to use a claw-type tool to aid removal. Work the valve tappet up and down in the bore to loosen it from the deposits.**

    To remove, grasp each valve tappet and pull in line with bore.
11. Remove cylinder heads (6049) as outlined in this section.
12. Remove crankshaft pulley and crankshaft vibration damper as outlined. Use Crankshaft Damper Remover T58P-6316-D and Vibration Damper Remover Adapter T82L-6316-B to remove vibration damper.
13. Remove flywheel (6375) and engine rear plate.
14. Remove engine front cover (6019) and water pump as outlined. Water pump may be removed with timing cover as an assembly if desired. Refer to Engine Front Cover Removal and Installation in this section.
15. Remove camshaft sprocket bolt (6279) and camshaft sprocket washer (6278).
16. **NOTE: If the crankshaft sprocket (6306) is difficult to remove, it can be pried off using two**

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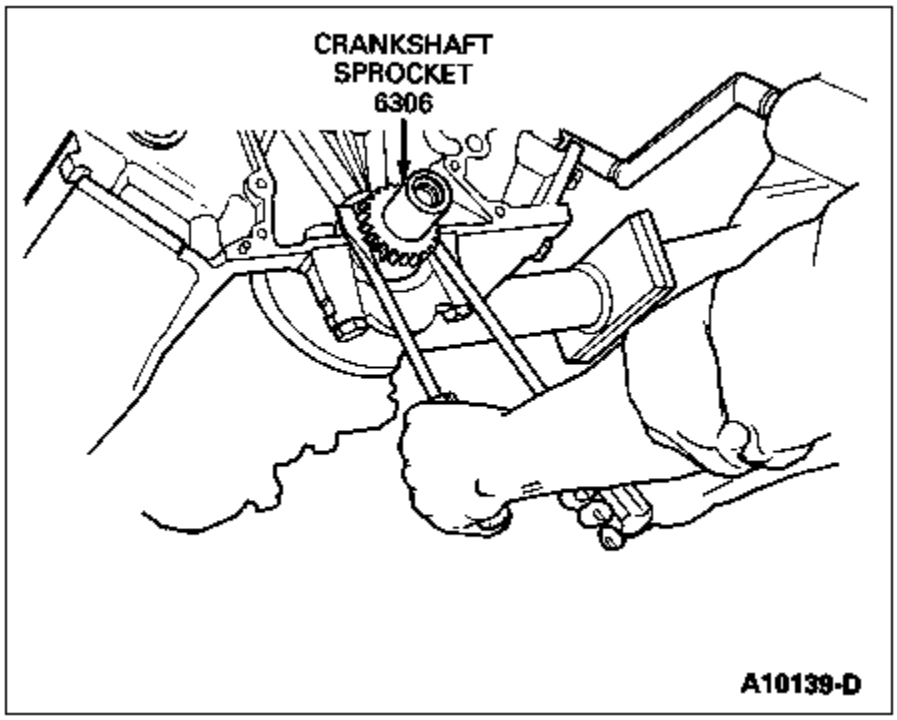
large screwdrivers. Use care to prevent damage to finished areas on the crankshaft (6303).

Remove timing chain/belt (6268), camshaft sprocket (6256) and camshaft (6250) as an assembly.



17. Remove camshaft thrust plate bolts and camshaft thrust plate (6269).

18. Remove camshaft. Use care to prevent damage to camshaft bearing surfaces and lobes.

19. Rotate engine (6007) 180 degrees.

20. Remove oil pump (6600).

21. **NOTE: The cylinder number is stamped on the top of each piston (6108). Matched letters are stamped on the sides of corresponding rod and cap.**

    NOTE: Before removing the pistons, inspect the top of the cylinder bores. If necessary, remove the ridge and/or carbon deposits from each cylinder using a suitable ridge remover. Before the ridge or deposits are removed turn the crankshaft until the piston, pin and ring (6102) is at the bottom of the bore. Cover the piston with a clean shop towel to collect the cuttings. After the cutting operation, turn thecrankshaft until the piston is at the top of bore and remove the shop towel and the cuttings. Never cut into the ring travel area in excess of 0.794mm (0.03125 inch).

    Remove connecting rod nuts and tap out piston, pin and ring and connecting rod (6200) with a wooden hammer handle. Nuts should go on the same stud they were removed from. Make sure caps are reinstalled on same rod and orientated correctly.

22. The location of each piston, connecting rod bearing (6211), and rod cap should be noted. When the engine is assembled, each component should be installed in its original position.

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23. Remove crankshaft rear oil seal (6701).

24. **NOTE: The location of the main bearings and caps should be noted. When the engine is reassembled, each bearing and cap should be installed in its original position.**

    Remove main bearing caps and crankshaft as outlined in this section.

25. For cleaning purposes, oil gallery and cooling jacket plugs can be removed.

Assembly

Lightly oil attaching bolt and stud threads before installation except those specifying special sealant.

1. Install oil gallery and cooling jacket plugs. Tighten plugs to 16-24 Nm (12-17 lb-ft). Before installation, coat plug threads with Pipe Sealant with Teflon® D8AZ-19554-A or equivalent meeting Ford specification WSK-M2G350-A2.

2. **NOTE: Scratching of the crankshaft journal can be prevented by covering the connecting rod bolts with spark plug boots.**

   Install crankshaft as follows:

   a. Install main bearing inserts in the cylinder block. Note that third bearing from front is the thrust bearing.
   b. Lubricate bearing inserts with Engine Assembly Lubricant D9AZ-19579-D or equivalent meeting Ford specification ESR-M99C80-A heavy engine oil, and carefully lower the crankshaft into place. Use care to prevent damage to bearing surfaces.
   c. Apply a 6mm (1/4-inch) dot of Gasket Eliminator E1FZ-19562-A or equivalent meeting Ford specification WSK-M2G348-A4 between rear cap and cylinder block (two places).
   d. Install crankshaft main bearing (6333) and crankshaft thrust main bearing (6337) in the main caps and install caps. Note that caps are numbered with arrow heads. No. 1 is located at front of engine with arrow heads facing front of engine.
   e. Install crankshaft main bearing cap studs (6345).
   f. Wedge a large screwdriver between cylinder block web and crankshaft cheek located in front of the No. 3 main bearing before tightening bearing cap attaching bolts. Do not jam the screwdriver into place. Tap into position only enough to hold the crankshaft forward while the cap bolts are tightened.
   g. Tighten crankshaft main bearing cap studs to 75-85 Nm (55-63 lb-ft) and remove screwdriver.

3. Install crankshaft rear oil seal as outlined and check for crankshaft end play. Refer to Section 03-00 .

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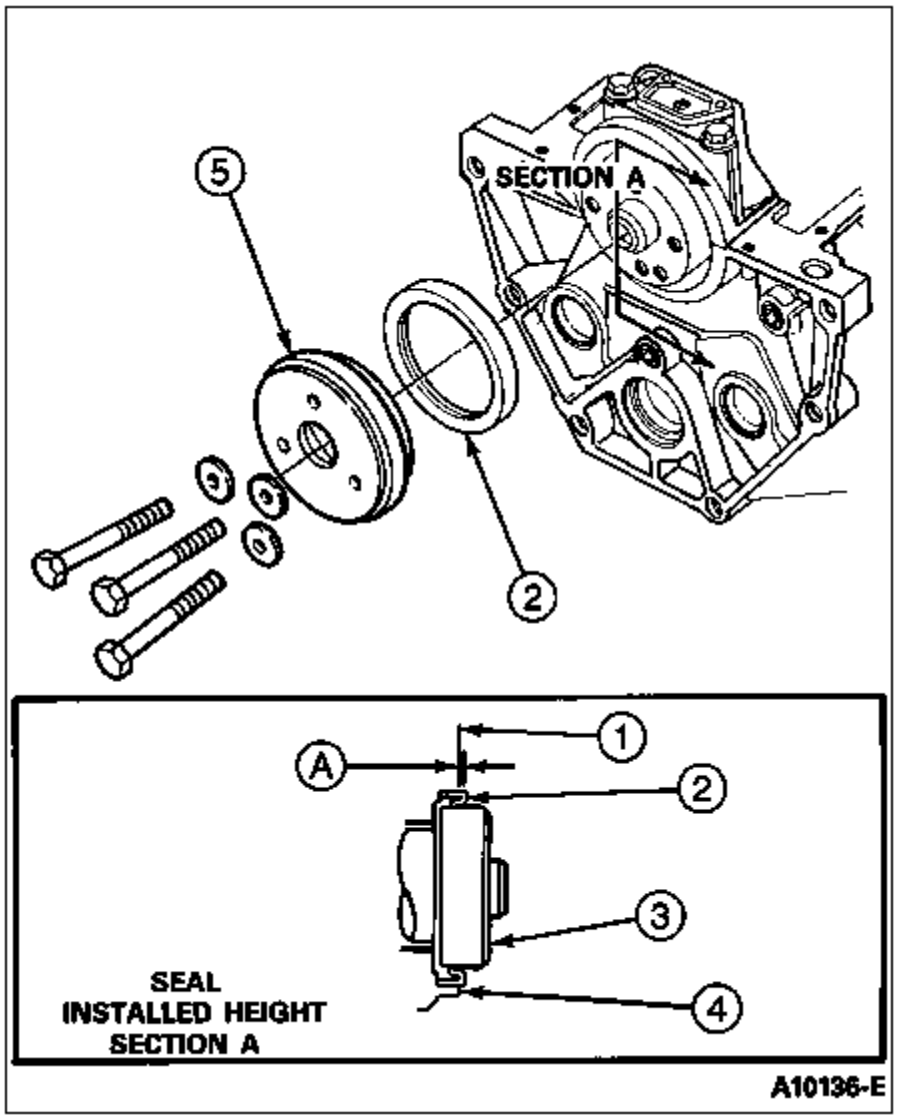

Item	Part Number	Description
1	6010	Cylinder Blocks
2	6701	Crankshaft Rear Oil Seal
3	6303	Crankshaft
4	—	Rear Main Bearing Cap (Part of 6010)
5	T88L-6701-A	Rear Main Seal Installer
A	—	.5mm (.019 Inch) (Do Not Bottom)

4. Install the piston, pin and ring as follows:

    a. Install connecting rod bearings in the connecting rods and the connecting rod caps.

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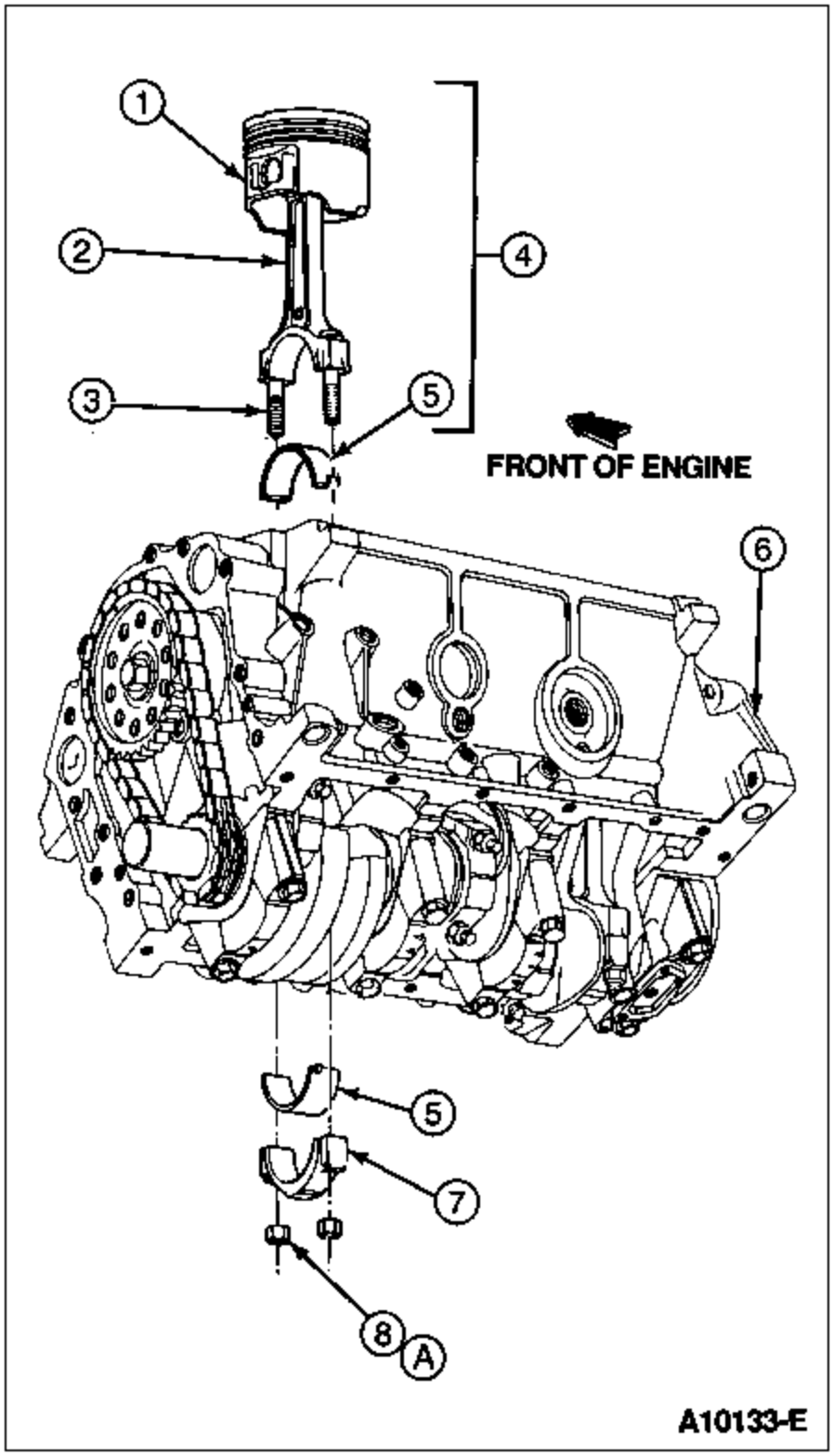

Item	Part Number	Description
1	6102	Piston, Pin and Ring
2	6200	Connecting Rod

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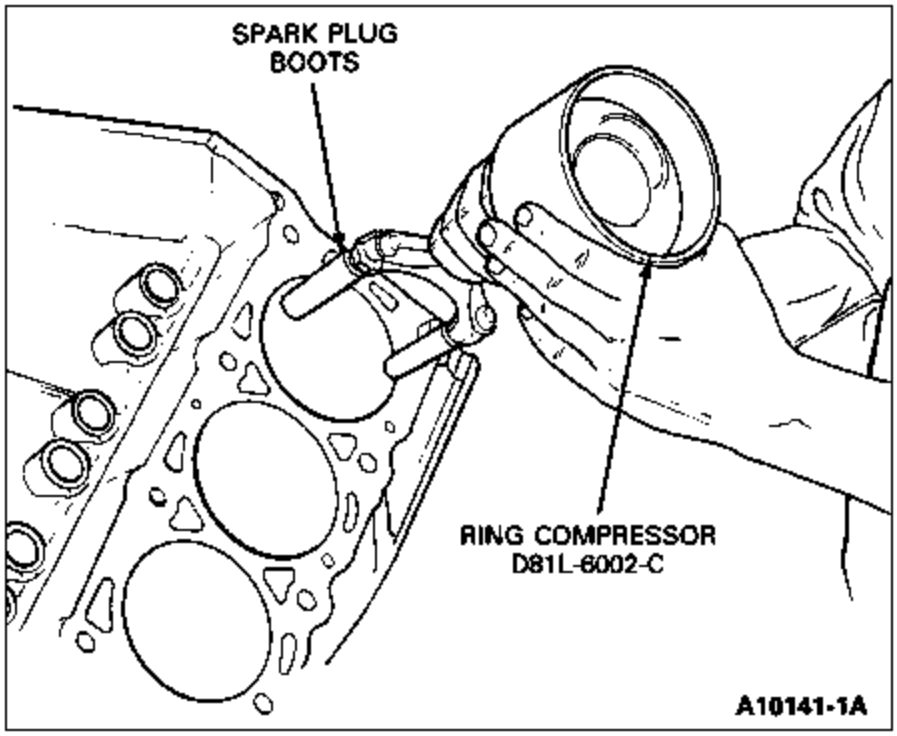
3	6214	Connecting Rod Bolt
4	6102	Piston, Pin, Ring and Connecting Rod Assembly
5	6211	Connecting Rod Bearing
6	6010	Cylinder Blocks
8	—	Connecting Rod Cap (Part of 6200)
9	6212	Connecting Rod Cap
A	—	Tighten to 31-39 Nm (23-29 Lb-Ft)

b. Arrange piston ring gaps around the piston, pin and rings.
c. Install piston, pin and rings using a Piston Ring Compressor D81L-6002-C (ESR-M99C80-A) or equivalent. The notch in the piston dome has to face the front of the engine.



Lubricate the piston, pin and ring and cylinder walls with Engine Assembly Lubricant D9AZ-19579-D or equivalent meeting Ford specification ESR-M99C80-A before installation.
d. Install connecting rod caps and connecting rod nuts (6212). Tighten attaching nuts to 31-39 Nm (23-28 lb-ft).

5. Check connecting rod side clearance as outlined.

6. Install camshaft rear bearing cover using a suitable driver. Coat the sealing edge of the plug with Gasket Eliminator E1FZ-19562-A or equivalent meeting Ford specification WSK-M2G348-A4 before installation.

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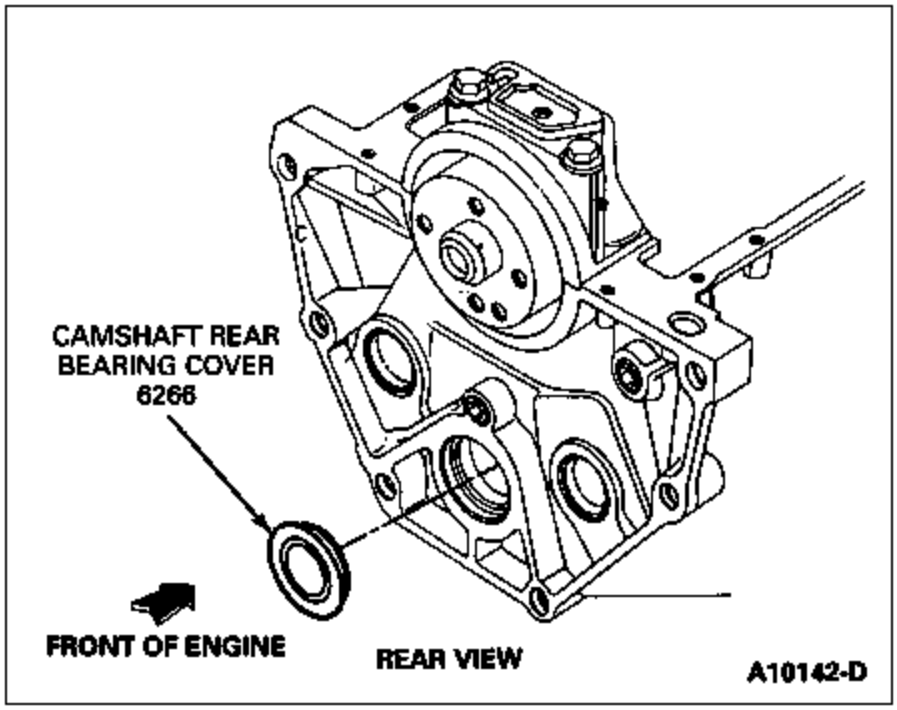

7. Coat camshaft lobes with Engine Assembly Lubricant D9AZ-19579-D or equivalent meeting Ford specification ESR-M99C80-A, and lubricate the camshaft bearings with heavy oil SG. Install camshaft. Use care to prevent damage to bearing surface.

8. Lubricate camshaft thrust plate with Engine Assembly Lubricant D9AZ-19575-D or equivalent meeting Ford specification ESR-M99C80-A and install with two retaining bolts. Tighten bolts to 8-12 Nm (6-8 lb-ft).

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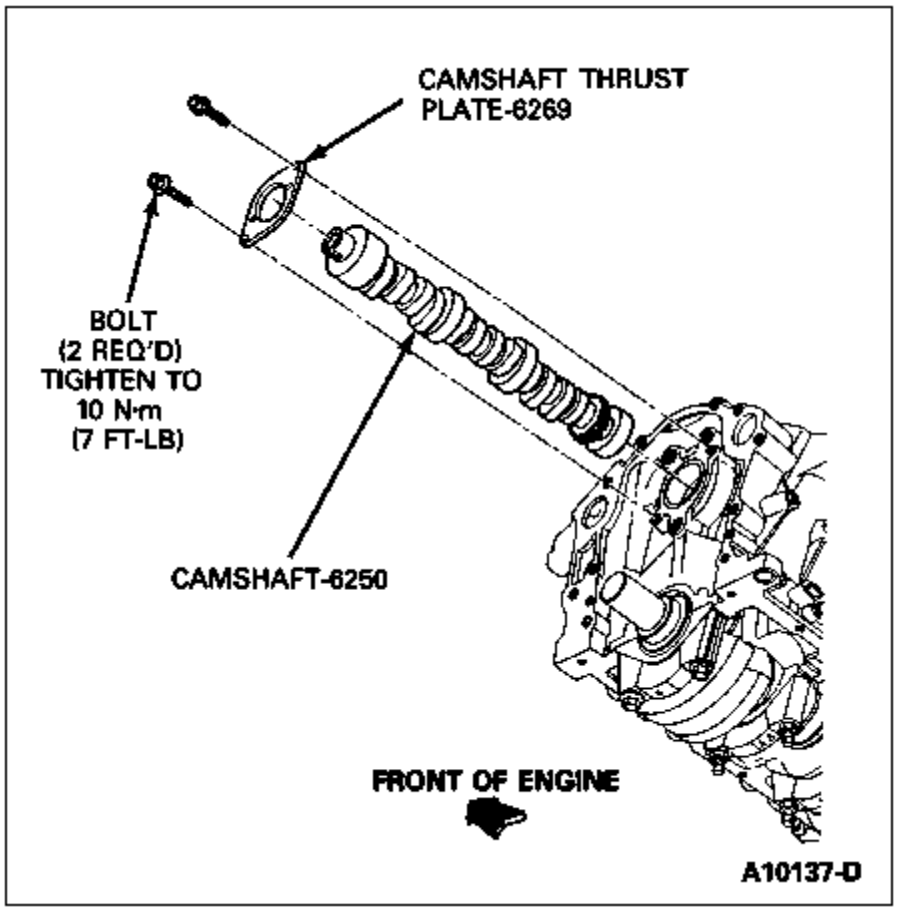

9. Lubricate timing chain with clean engine oil.

    - Rotate crankshaft, as necessary, to position the crankshaft sprocket timing mark in the 6 o'clock position with No. 1 piston at top dead center firing.
    - Install camshaft sprocket (with timing mark in the 12 o'clock position), crankshaft sprocket and timing chain.
    - Make sure the crankshaft keyway, cam sprocket timing mark, and crank sprocket timing mark are properly aligned after installation.

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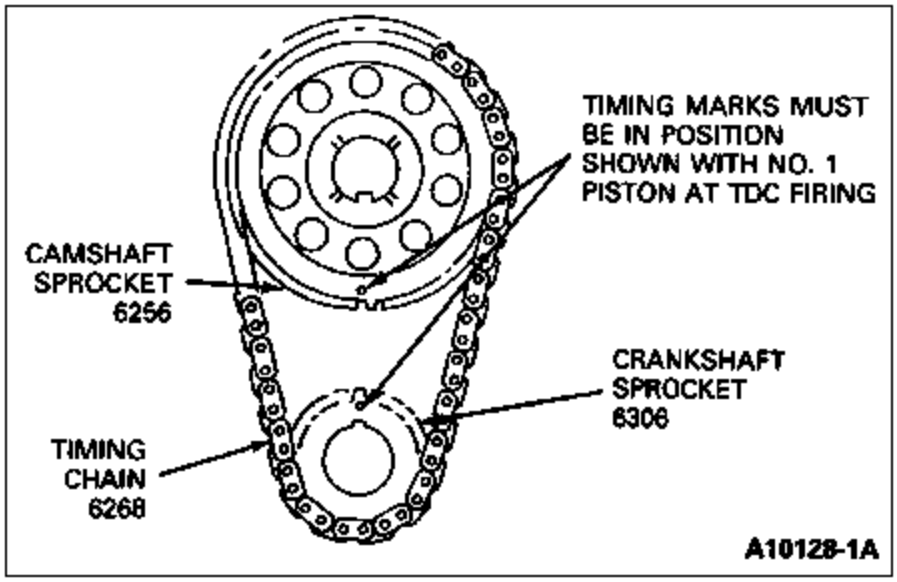

10. Install camshaft sprocket bolt and tighten to 55-70 Nm (41-52 lb-ft). Check the drilled oil passages of the attaching bolt to make sure they are not plugged.

Fastener and Hole No.	Fasteners			
	Part No.	Size	Nm	Lb-Ft
1 [a]	N804215	M8 x 1.25 x 72.25	20-30	15-22
2 [a]	N804215	M8 x 1.25 x 72.25	20-30	15-22
3 [a]	N804811-S8	M8 x 1.25 x 73.0	20-30	15-22
4	N804811-S8	M8 x 1.25 x 73.0	20-30	15-22
5	N605909-S8	M8 x 1.25 x 73.0	20-30	15-22
6	N807515	M8 x 1.25 x 104.3	20-30	15-22
7	N804811-S8	M8 x 1.25 x 73.0	20-30	15-22
8	N804811-S8	M8 x 1.25 x 73.0	20-30	15-22
9	N804811-S8	M8 x 1.25 x 70.0	20-30	15-22
10	N606543-S2	M8 x 1.25 x 52.0	20-30	15-22
11	N804576-S8	M6 x 1.0 x 28.5	8-12	6-8
12	N804576-S8	M6 x 1.0 x 28.5	8-12	6-8
13	N804576-S8	M6 x 1.0 x 28.5	8-12	6-8
14	N804576-S8	M6 x 1.0 x 28.5	8-12	6-8
15	N804576-S8	M6 x 1.0 x 28.5	8-12	6-8

[a] Apply Pipe Sealant with Teflon D8AZ-19554-A or equivalent meeting Ford specifications WSK-M2G350-AZ and ESR-M18P7-A to fastener threads.

11. Assemble oil pump intermediate shaft retaining ring (6629) on end of oil pump intermediate shaft (6A618) and insert shaft into hole in oil pump until retainer clicks into place.

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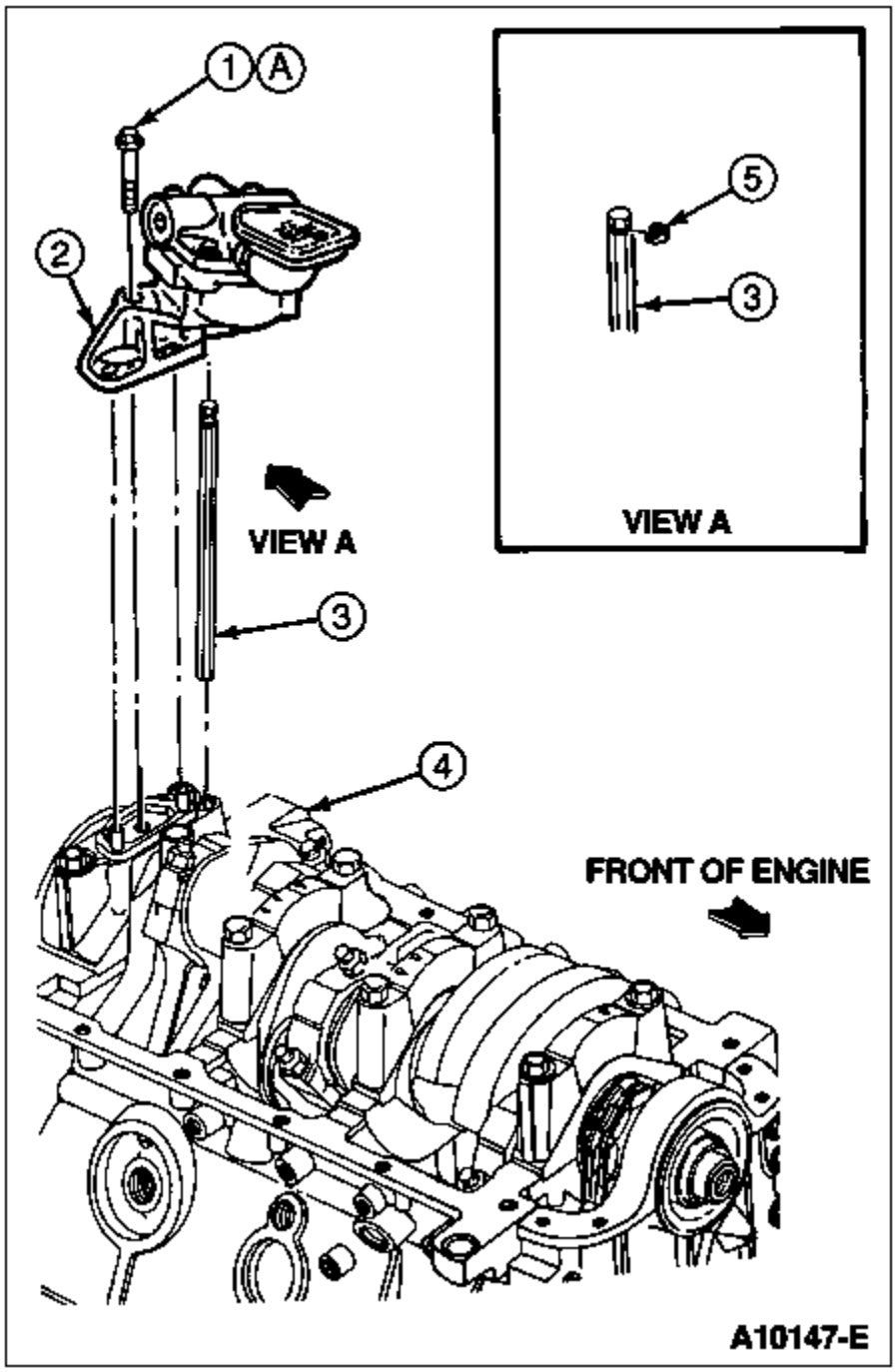
12. Pilot oil pump withoil pump intermediate shaft through hole in rear main bearing cap, position pump over pins.

13. Install oil pump attaching bolts and tighten to 40-55 Nm (30-40 lb-ft).



Item	Part Number	Description
1	—	Bolt (Part of 6600)

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2	6600	Oil Pump
3	6A618	Oil Pump Intermediate Shaft
4	6010	Cylinder Blocks
5	6629	Oil Pump Intermediate Shaft Retaining Ring
A	—	Tighten to 40-55 Nm (30-40 Lb-Ft)

14. Install the oil pan gasket (6710) as follows:

    a. Using a small-bladed screwdriver, remove any sealer which may have been squeezed into the oil pan sealing area when the rear main bearing cap was installed. Place a 6.35mm (1/4-inch) drop of sealer into seal groove where the bearing cap meets the block.
    b. Apply a 3.0-4.0mm (1/8-inch) bead of Silicone Rubber D6AZ-19562-BA or equivalent meeting Ford specifications ESB-M4G92-A and ESE-M4G195-A to the seams where the engine front cover meets with the cylinder blocks and to each end of the pan end seal.
    c. Locate oil pan gasket-to-cylinder block pan rail and secure retaining features.
    d. Install oil pan (6675) and tighten attaching bolts to 10-14 Nm (7-10 lb-ft).

15. Lubricate oil filter gasket with engine oil and install oil filter.

16. Lubricate valve tappets with Engine Assembly Lubricant D9AZ-19579-D or equivalent meeting Ford specification ESR-M99C80-A or equivalent and install.

17. **NOTE: Install valve tappet guide plate (6K512) with the word "UP" and button visible.**

    Align tappet flats and install valve tappet guide plates.

18. Install retainer over valve tappet guide plates. Retainer orientation is not important. Hand-start two retaining bolts then tighten to 10-14 Nm (7-10 lb-ft).

19. Install new head gasket (6051) using the dowels to align the gasket.

20. Tighten the cylinder head attaching bolts in two tightening steps in the sequence as shown to 50 Nm (37 lb-ft), then 85-99 Nm (63-73 lb-ft).

Cylinder Head Attaching Bolts, Installation

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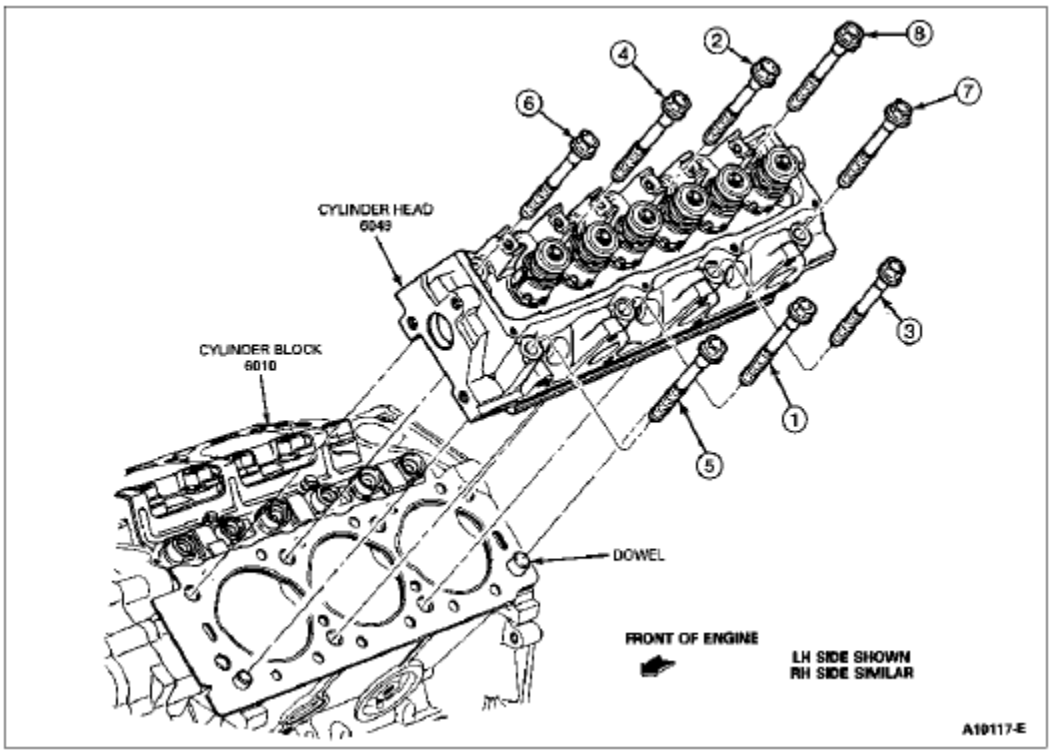

21. Rotate engine so camshaft is in Position A, as shown, with camshaft sprocket timing mark and crankshaft sprocket timing mark at top center.

22. **NOTE: Lubricate eachpush rod,rocker arm, and rocker arm fulcrum with Engine Assembly Lubricant D9AZ-19579-D or equivalent meeting Ford specification ESR-M99C80-A before installing.**

    Install push rod, rocker arm, rocker arm fulcrum, and rocker arm bolt for valves:

    - Cylinder No. 1 Intake
    - Cylinder No. 2 Exhaust
    - Cylinder No. 4 Intake
    - Cylinder No. 5 Exhaust

    Tighten rocker arm bolts (6A527) to 11 Nm (8 lb-ft).

23. For valves in above step, check rocker arm-to-valve clearance. Clearance should be 2.15-4.69mm (0.084-0.184 in.).

Camshaft Position A — Rocker Arm, Push Rod, and Fulcrum Installation

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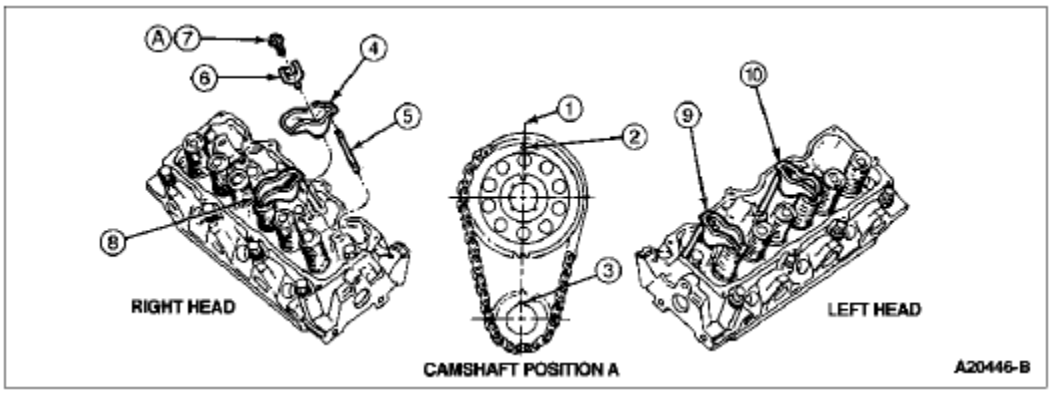

Item	Part Number	Description
1	—	Centerline of Keyway Vertical Within Five Degrees
2	—	Camshaft Sprocket Timing Mark at Top Center
3	—	Crankshaft Sprocket Timing Mark at Top Center
4	6564	Rocker Arm, No. 1 Intake
5	6565	Push Rod
6	6A528	Rocker Arm Seat
7	6A527	Rocker Arm Bolt
8	6564	Rocker Arm, No. 2 Exhaust
9	6564	Rocker Arm, No. 4 Intake
10	6564	Rocker Arm, No. 5 Exhaust

24. Rotate engine so camshaft is in Position B, as shown, with camshaft sprocket timing mark at two o'clock position and crankshaft sprocket timing mark at 4:30 position.

25. **NOTE: Lubricate each push rod, rocker arm, and rocker arm fulcrum with Engine Assembly Lubricant D9AZ-19579-D or equivalent meeting Ford specification ESR-M99C80-A before installing.**

    Install push rod, rocker arm, rocker arm fulcrum and rocker arm bolt for valves:

    - Cylinder No. 1 Exhaust
    - Cylinder No. 2 Intake
    - Cylinder No. 3 Exhaust
    - Cylinder No. 3 Intake
    - Cylinder No. 4 Exhaust
    - Cylinder No. 5 Intake
    - Cylinder No. 6 Exhaust
    - Cylinder No. 6 Intake

26. For valves in above step, check rocker arm-to-valve clearance. Clearance should be 2.15-4.69mm (0.084-0.184 in.).

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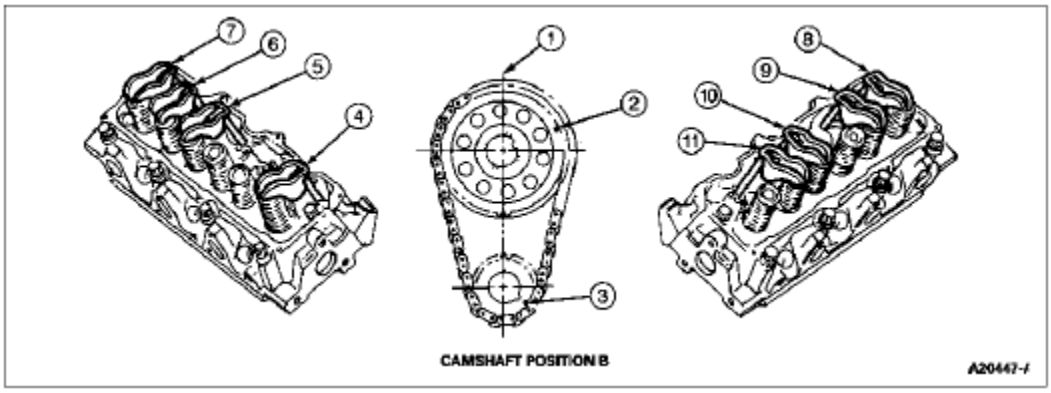
Camshaft Position B — Rocker Arm, Push Rod, and Fulcrum Installation



Item	Part Number	Description
1	—	Centerline
2	—	Camshaft Timing Mark at Two o'Clock Position
3	—	Crankshaft Sprocket Timing Mark at 4:30 Position
4	—	No. 1 Exhaust Rocker Arm and Parts
5	—	No. 2 Intake Rocker Arm and Parts
6	—	No. 3 Exhaust Rocker Arm and Parts
7	—	No. 3 Intake Rocker Arm and Parts
8	—	No. 6 Exhaust Rocker Arm and Parts
9	—	No. 6 Intake Rocker Arm and Parts
10	—	No. 5 Intake Rocker Arm and Parts
11	—	No. 4 Exhaust Rocker Arm and Parts

27. **CAUTION: Rocker arm fulcrum must be fully seated into cylinder head and push rod must be fully seated into lifter sockets before final tightening.**

Final-tighten bolts to 26-38 Nm (19-28 lb-ft). Camshaft may be in any position.

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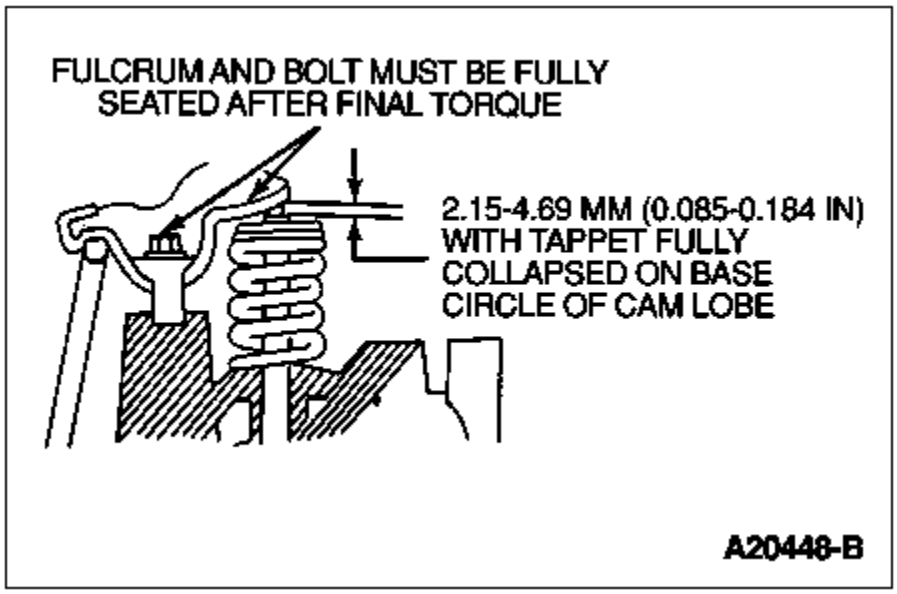

28. Position a new water pump housing gasket (8507) on the engine front cover and install water pump if the water pump was removed from the engine front cover during the engine disassembly.

29. **NOTE: The threads of cover attaching bolts must be covered with Pipe Sealant with Teflon® D8AZ-19554-A or equivalent meeting Ford specification WSK-M2G350-A2 before installation.**

    Tighten water pump attaching bolts according to accompanying chart.

30. Position an engine front cover gasket (6020) on engine. Install engine front cover. Tighten attaching bolts according to accompanying chart.

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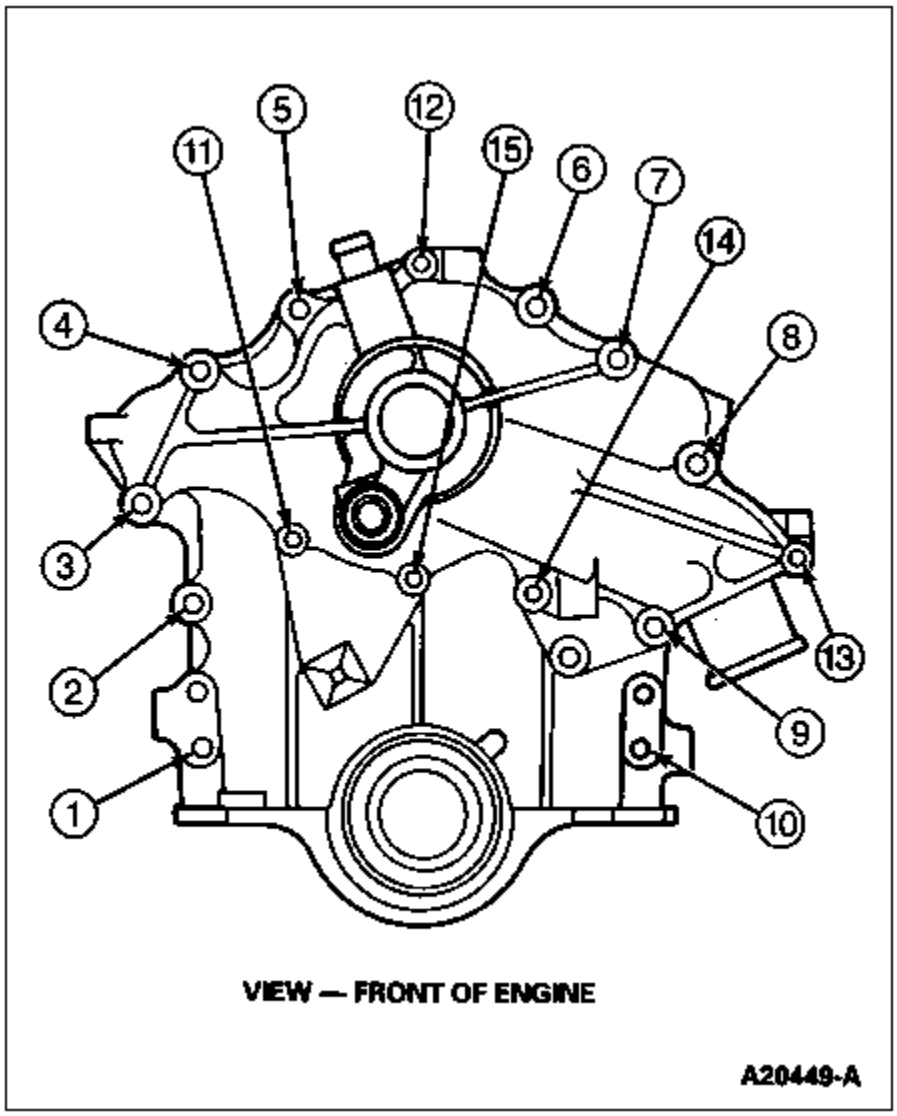

31. Install intake manifold as follows: Use a suitable solvent to clean the intake manifold, cylinder head and cylinder block mating surfaces, as these should be clean and free of old silicone rubber sealer.

32. Apply Silicone Rubber Sealer D6AZ-19562-AA or equivalent meeting Ford specification ESB-M4G92-A or ESE-M4G195-A to intersection of cylinder blocks and cylinder head at four corners, as shown.

Intake Manifold Gasket, Installation

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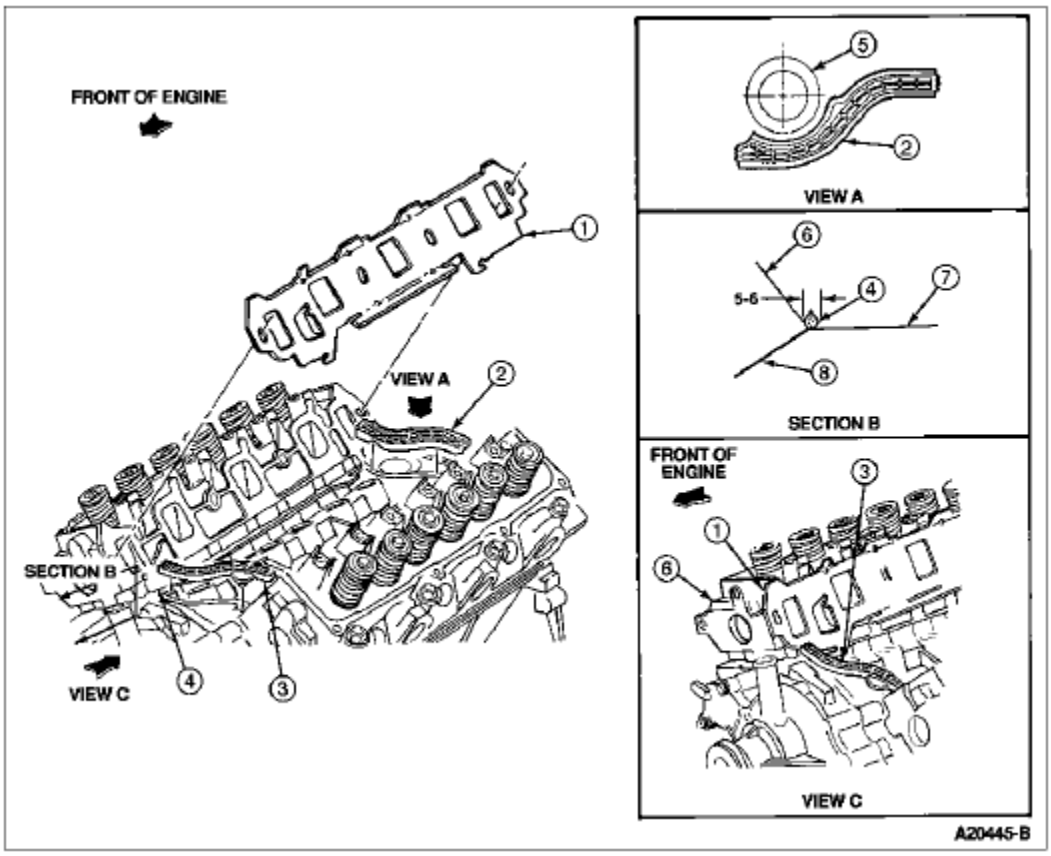

Item	Part Number	Description
1	9439	Intake Manifold Gasket
2	—	Seal, Intake Manifold, Rear Distributor Hole (Part of 9439)
3	—	Seal, Intake Manifold, Front (Part of 9439)
4	WSE-M4G323-A3	Sealer (4 Places)
5	—	Distributor Hole (Part of 6010)
6	6049	Cylinder Head
7	6010	Cylinder Blocks
8	6051	Head Gasket

33. Install front and rear intake manifold seal. Secure with retaining features.

34. Position intake manifold gaskets (9439) in place and insert locking tabs over tabs on head gaskets as shown.

35. Apply Silicone Rubber D6AZ-19562-AA or equivalent meeting Ford specifications ESB-M4G92-A or ESE-M4G195-A over intake manifold gaskets.

36. Carefully lower intake manifold into position on cylinder blocks and cylinder heads to prevent disturbing the silicone sealer and causing gasketing voids.

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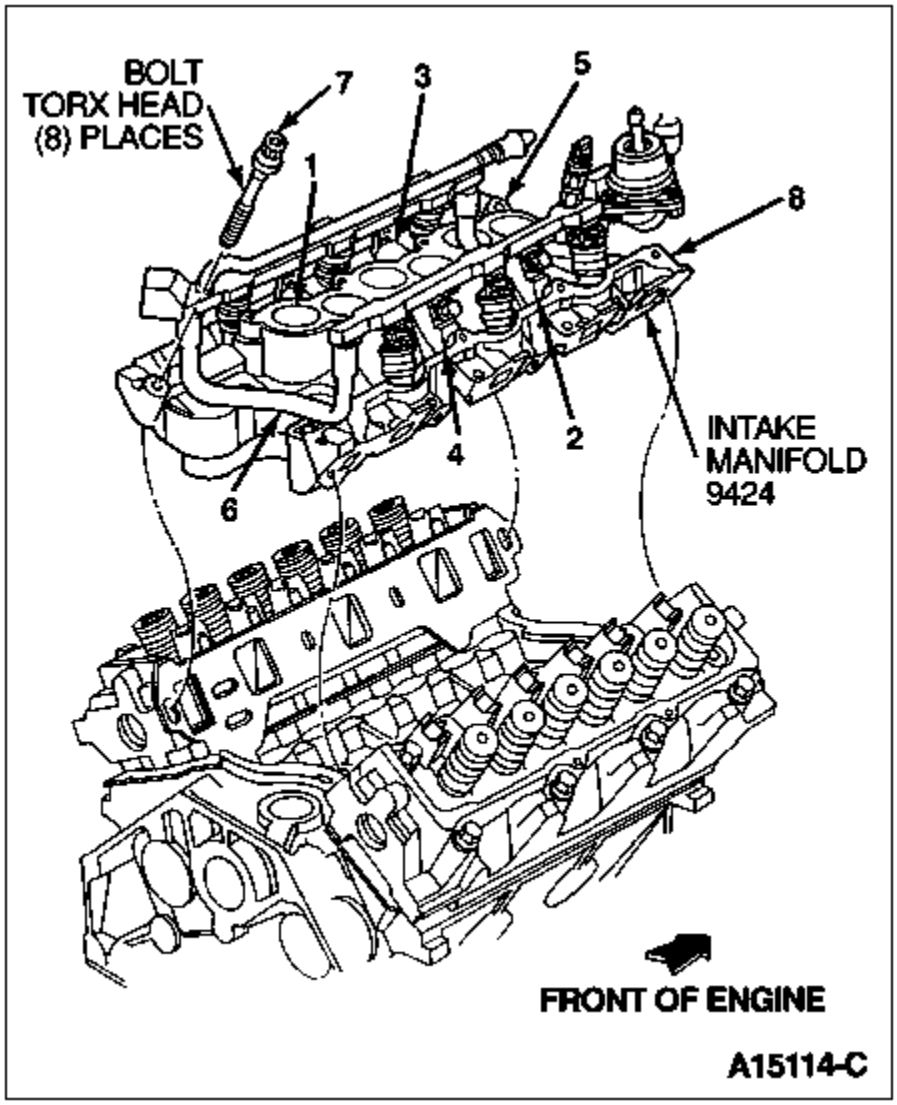
37. Install bolts and tighten, in the numerical sequence shown, to the following specifications in two steps:

    - 15 Nm (11 lb-ft)
    - 26-32 Nm (19-24 lb-ft)

Intake Manifold Assembly Bolts, Installation



38. Install water thermostat (8575) into water hose connection. Rotate water thermostat into water outlet in a clockwise direction to secure thermostat to connector. Install water hose connection and water outlet connection gasket. Tighten attaching bolts to 20-30 Nm (15-22 lb-ft).

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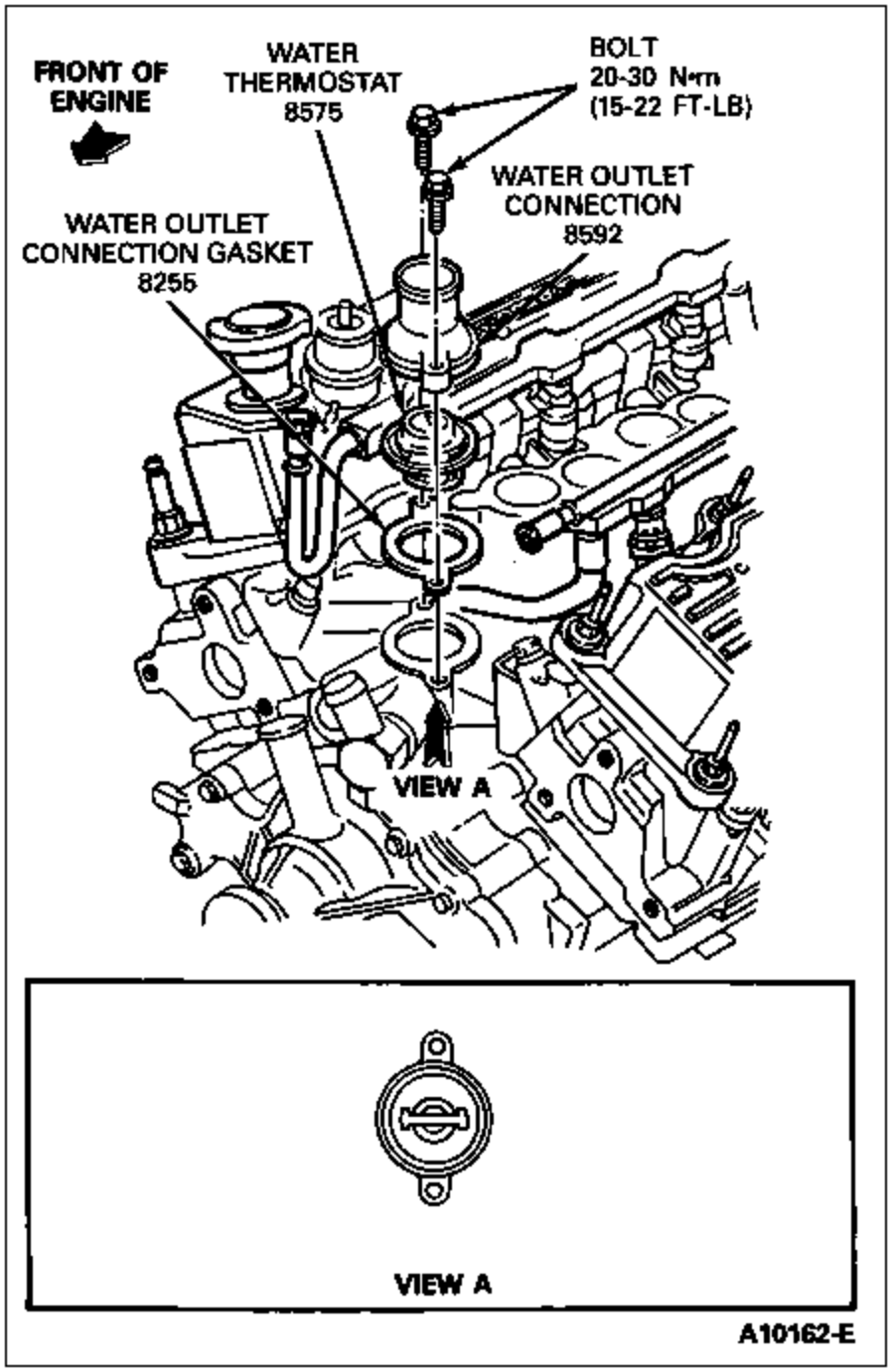

39. Install spark plugs. Tighten to 27 Nm (20 lb-ft).

40. Clean valve cover and cylinder head sealing surfaces with solvent to remove all gasket material and dirt.

41. Apply Silicone Rubber D6AZ-19562-AA or equivalent meeting Ford specification ESB-M4G92-A or ESE-M4G195-A to intersection of cylinder head and intake manifold.

42. Install valve cover gasket and secure with retaining features.

43. Install valve cover. Install screw and washer assemblies and stud assemblies. Tighten to 10-14 Nm

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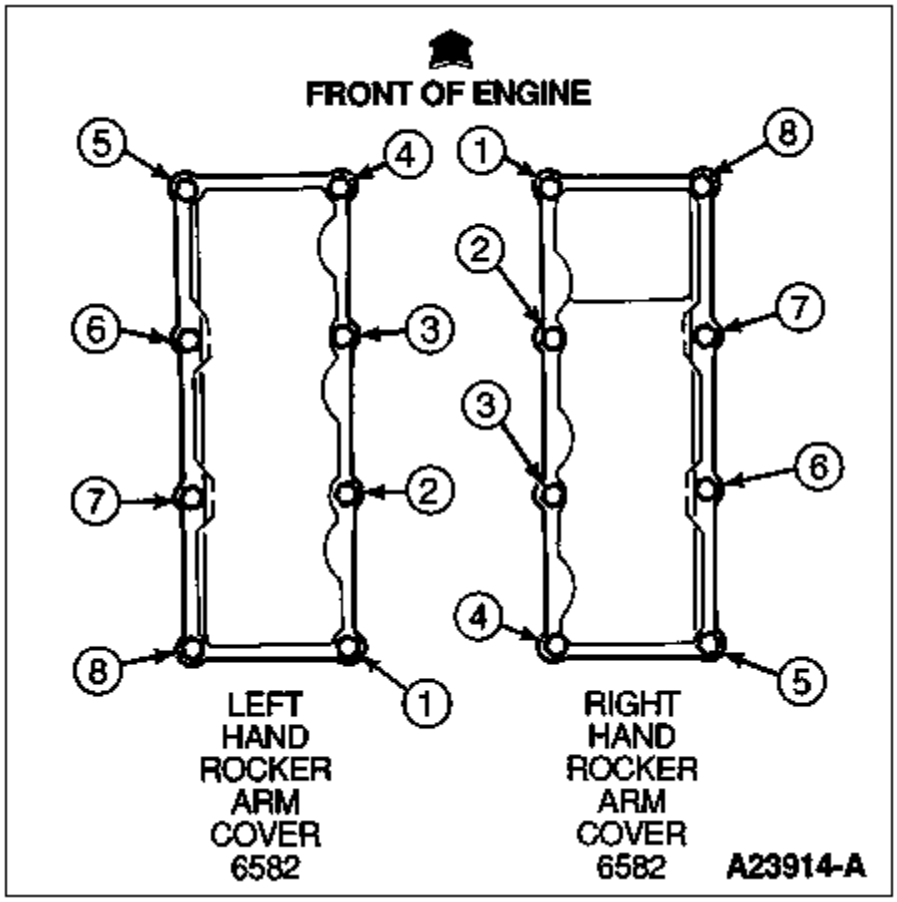
(7-10 lb-ft).

Rocker Arm Cover Stud and Bolt Usage



Valve Cover Installation

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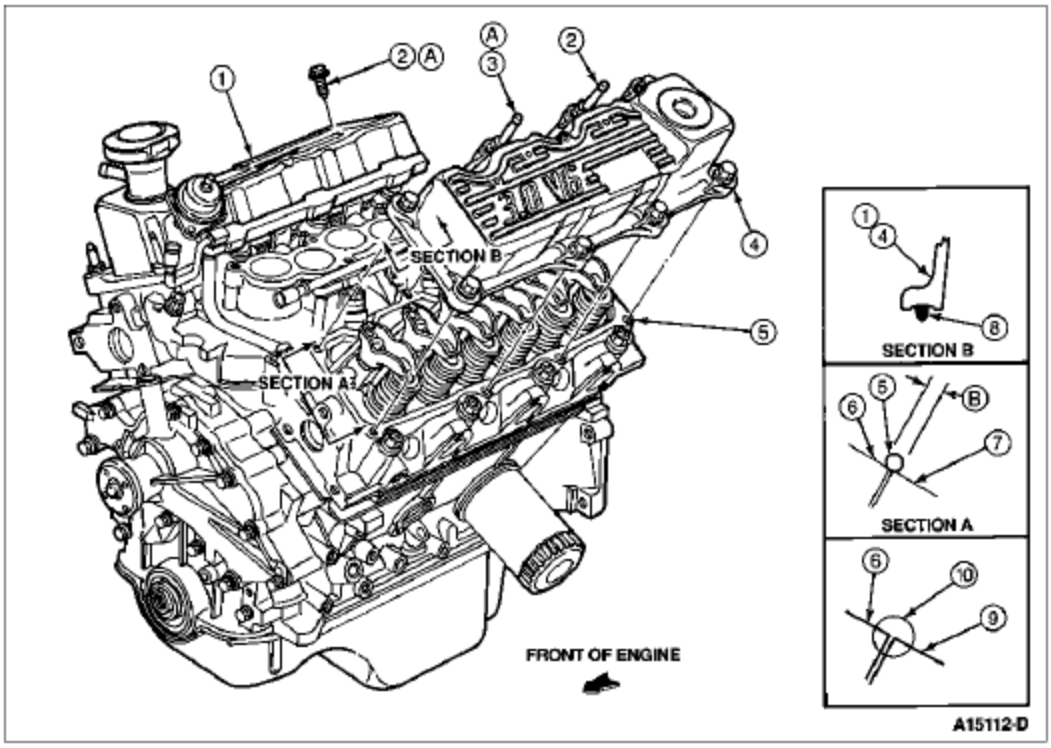

Item	Part Number	Description
1	6582	Valve Cover, Right
2	N803298-S	Screw and Washer
3	N803262-S	Stud
4	6582	Valve Cover, Left
5	ESE-M4G195-B	Sealer
6	9424	Intake Manifold
7	6049	Cylinder Head
8	—	Gasket (Part of 6582)
9	6049	Cylinder Head
10	—	Intersection of Head and Intake Manifold Must Be Flush to Within ± 1mm (0.04 In.). Gasket Must Not Protrude Above Highest Surface
A	—	Tighten to 10-14 Nm (7-10 Lb-Ft)
B	—	4-6mm (.15-.23 In.)

44. **CAUTION: If a new distributor or camshaft position sensor is installed, run engine at idle for five minutes before driving vehicle.**

Dip entire camshaft position sensor drive gear in Engine Assembly Lubricant D9AZ-19579-D or equivalent meeting Ford specification ESR-M99C80-A.

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45. If a new camshaft position sensor, pour the rest of the pint of Engine Assembly Lubricant D9AZ-19579-D or equivalent meeting Ford specification ESR-M99C80-A through distributor hole onto cam drive gear.

46. Install camshaft position sensor. Refer to Section 03-14 , Engine Controls, Electronic, for fuel injection timing.

47. Install crankshaft vibration damper using Vibration Damper and Seal Replacer T82L-6316-A and Front Cover Seal Installer T70P-6B070-A. Tighten crankshaft pulley bolt (6A340) to 125-165 Nm (92-122 lb-ft).

48. Connect spark plug wire set (12281) to the spark plugs.

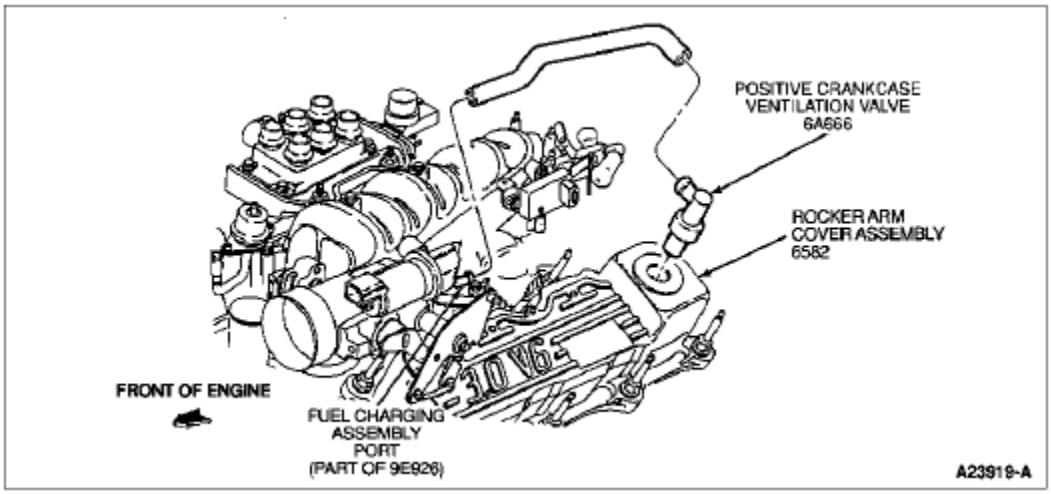
49. Install the following PCV system components:

    - Positive crankcase ventilation valve (PCV valve) (6A666) and crankcase ventilation grommet.
    - PCV closure hose.
    - Oil filler cap (Ranger).

50. Install oil filler cap. Note the location of the oil dipstick tube support bracket. Tighten exhaust manifold attaching bolts to 20-30 Nm (15-22 lb-ft).

51. Install flywheel. Tighten the attaching bolts to 73-87 Nm (54-64 lb-ft) in the standard cross-tightening sequence.

PCV System Components, Installation, Ranger



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Cylinder Head

Disassembly

1. Remove rocker arm bolt (6A527), rocker arm seat (6A528) and rocker arms (6564).
2. Clean carbon out of the cylinder head combustion chambers before removing the valves.
3. **NOTE: Keep valves and springs together and store so each valve may be returned to its respective guide.**

   Compress valve spring (6513) using Valve Spring Compressor T81P-6513-A. Remove valve spring retainer key (6518) and release valve spring.
4. Remove valve spring retainer (6514), valve spring, valve stem seal (6571) and exhaust valve (6505) or intake valve (6507). Discard valve stem seal. Identify all valve parts as to which cylinder they were removed from and whether intake or exhaust. Repeat Steps 3 and 4 for the rest of the valves.
5. Clean, inspect and service the cylinder head (6049), as required, or prepare to transfer all usable parts to a new cylinder head.

Assembly

All valves, valve stems and valve guides are to be lubricated with heavy oil SF. Apply Ford Multi-Purpose Grease D0AZ-19584-AA or equivalent meeting Ford specification ESR-M1C159-A to the valve tips before installation.

1. Install each exhaust valve or intake valve in the port from which it was removed or to which it was fitted.
2. Install valve stem seal. Use a 5/8-inch deep-well socket and a light mallet or hammer to seat seal on valve stem. Make sure intake seals and exhaust seals are on proper stem.
3. Install valve spring over exhaust valve or intake valve and then install valve spring retainer. Compress valve spring and install valve spring retainer key.
4. **CAUTION: Do not install valve spring spacers unless necessary. Use of spacers in excess of recommendations will result in overstressing the valve springs and overloading the camshaft lobes which could lead to spring breakage and/or worn camshaft lobes.**

   Measure the assembled height of the valve spring from the top of the spring seat to the underside of the valve spring retainer with dividers. Check the dividers against a scale. If the assembled height is greater than specification, install the necessary 0.030-inch thick spacer(s) between the cylinder head spring pad and the valve spring to bring the assembled height to the recommended height.
5. Position rocker arms and rocker arm fulcrums on cylinder head and install rocker arm bolts. **Do not tighten bolts.** The bolts must be loose enough to allow the rocker arm to be rotated to the side.

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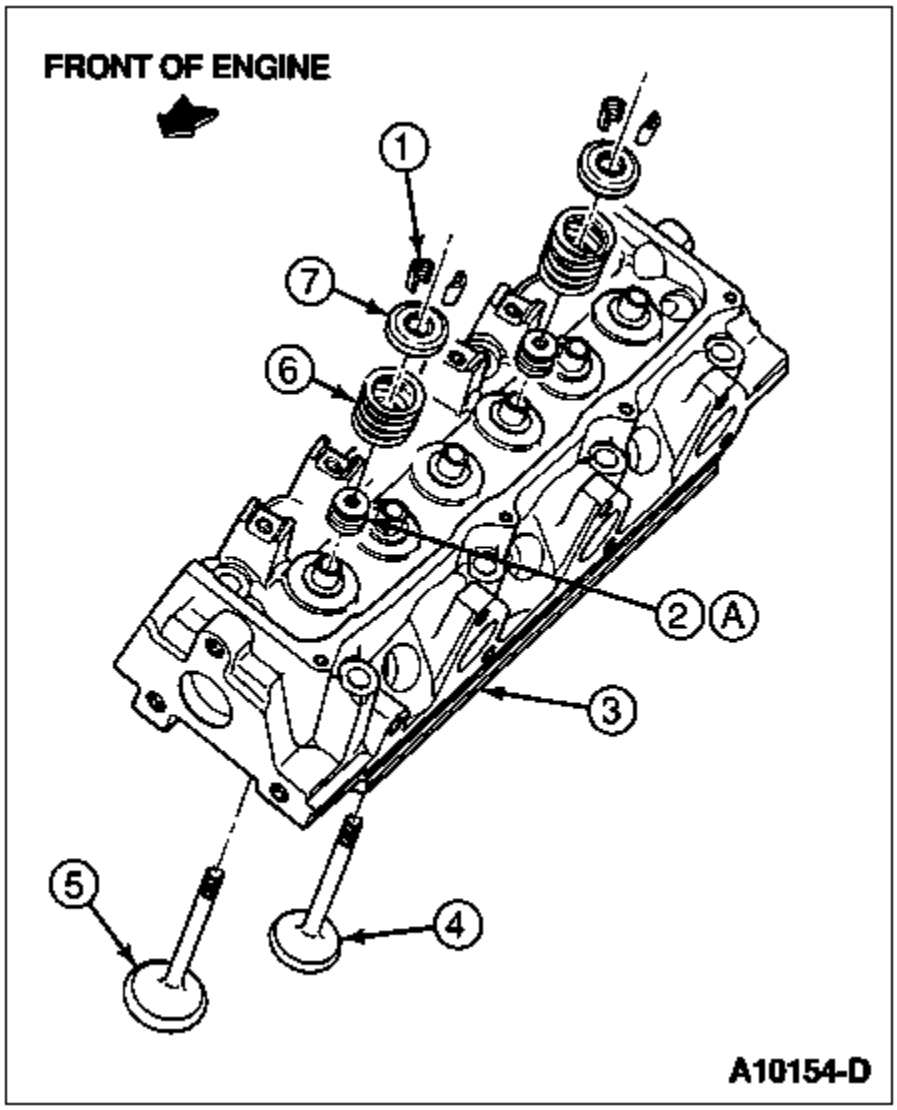

Item	Part Number	Description
1	6518	Valve Spring Retainer Key
2	6571	Valve Stem Seal
3	6049	Cylinder Head
4	6505	Exhaust Valve
5	6507	Intake Valve
6	6513	Valve Spring
7	6514	Valve Spring Retainer
A	—	Exhaust Valve Stem Seal Red Band and Intake Valve Seal Silver Band

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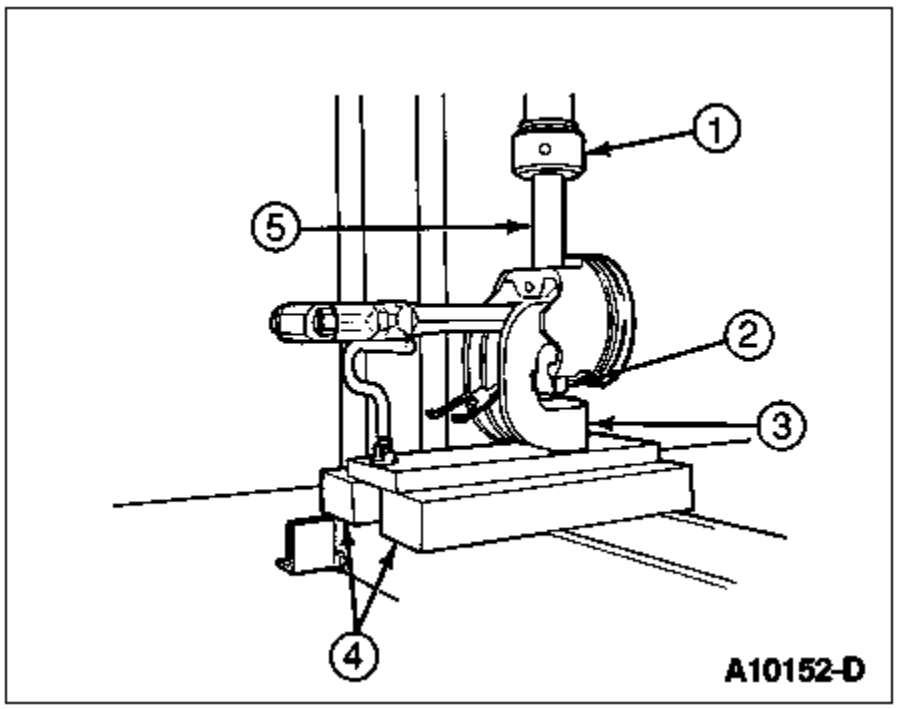
Pistons and Connecting Rods

Disassembly

1. Remove connecting rod bearing (6211) from connecting rod (6200) and cap.
2. Remove partial piston ring set using a suitable piston ring expander.
3. Mark connecting rod and cap to ensure assembly with the same piston (6108) and installation in the same cylinders from which they were removed.
4. Using an arbor press and Piston Pin Removal and Replacer T68P-6135-A, press the piston pin from the piston and connecting rod.



Item	Part Number	Description
1	—	Press Ram (Part of T68P-6135-A)
2	6135	Piston Pin
3	—	Receiving Tube

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		(Part of T68P-6135-A)
4	—	Press Plates (Part of T68P-6135-A)
5	—	Pin Pusher (Part of T68P-6135-A)

Assembly

Check the fit of a new piston, pin and ring (6102) in the cylinder bore before assembling the piston pin (6135) and piston, pin and ring to the connecting rod as outlined in Section 03-00 .

The piston pin bore of a connecting rod and the diameter of the piston pin must be within specification.

1. Check the ring side clearance of the compression rings with Feeler Gauge D81L-4201-A or equivalent by inserting it between the ring and its lower land. The gauge should slide freely around the entire ring circumference without binding. Any wear that occurs will form a step at the inner portion of the lower land. If the lower lands have high steps, the piston should be replaced.

2. Apply a light coat of engine oil to all parts.

3. Assemble the piston, pin and ring to the connecting rod, putting the notch in the piston dome and the connecting rod on the same side.

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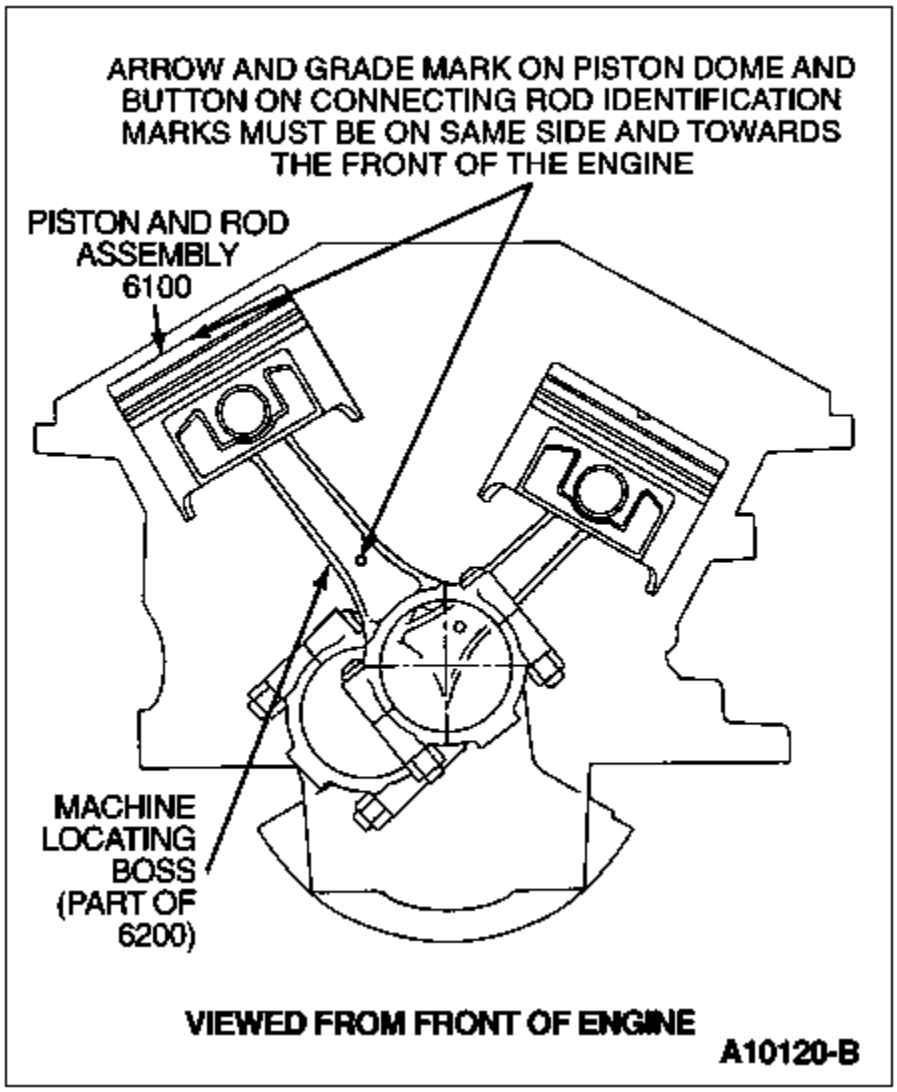

- On V-6 engines with one rod per pin, both sides of rod have larger chamfers.

4. **NOTE: Make certain piston floats during installation operation.**

   Start the piston pin in the piston and connecting rod (this may require a very light tap with a mallet). Using an arbor press and Piston Pin Remover/Replacer T68P-6135-A, press the piston pin through the piston until the piston pin is centered in the piston.

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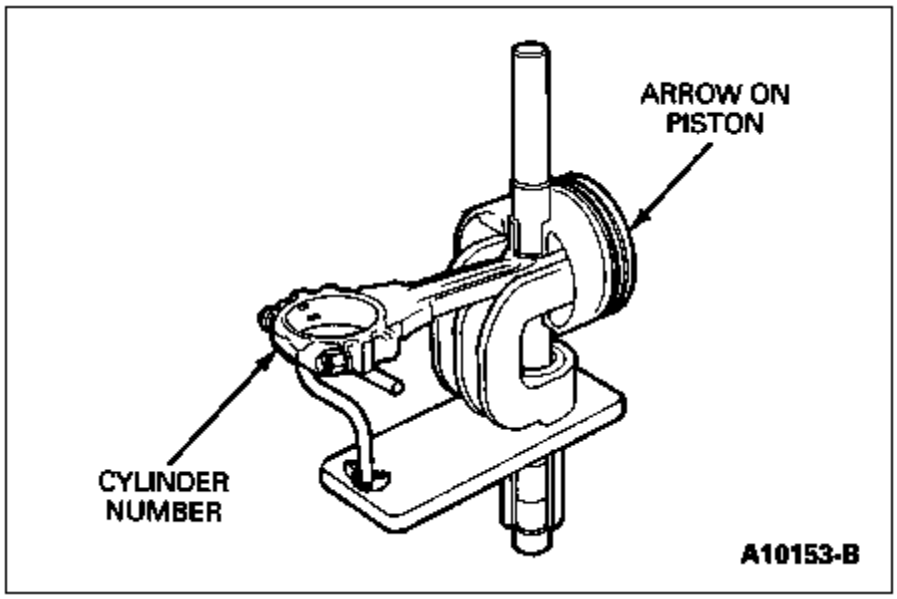

5. Check the end gap of all piston rings. It must be within specification. Follow the instructions contained on the piston ring package and install the partial piston ring sets.

6. Make sure connecting rod bearings and the bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause a failure. Install the connecting rod bearings in the connecting rod and cap with the tangs fitting in the slots provided.

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Valve Tappet, Hydraulic

The internal parts of each hydraulic valve tappet (6500) are matched sets. Do not intermix the parts. Keep the valve tappets intact until they are to be cleaned. Valve tappets should always be tested after assembly. Refer to the cleaning, inspection and test procedures in Section 03-00 .

Disassembly

Disassemble and assemble each valve tappet separately. Identify the valve tappets so they can be installed in their original bores.

1. Grasp the lock ring with needlenose pliers to release it from the groove. It may be necessary to depress the plunger to fully release lock ring.
2. Remove the push rod cup, metering valve (disc), plunger and spring.
3. Remove the plunger, the check valve and the check valve retainer and plunger spring. Carefully remove the plunger spring, the check valve retainer and the check valve disc from the plunger.

Assembly

1. Place the plunger upside down on a clean work bench.
2. Place the check valve (disc or ball check) in position over the oil hole on the bottom of the plunger. Set the check valve spring on top of the check valve (disc or ball check).
3. Position the check valve retainer over the check valve and spring and push the retainer down into place on the plunger.
4. Place the plunger spring, and then the plunger (open end up) into the valve tappet body.
5. Position the metering valve (disc) in the plunger, and then place the push rod cup in the plunger.
6. Depress the plunger, and position the closed end of the lock ring in the groove of the valve tappet body. With the plunger still depressed, position the open ends of the lock ring in the groove. Release the plunger, and then depress it again to fully seat the lock ring.
7. Use the Hydraulic Tappet Leak-Down Tester TOOL-6500-E or equivalent to fill the valve tappets with test fluid.

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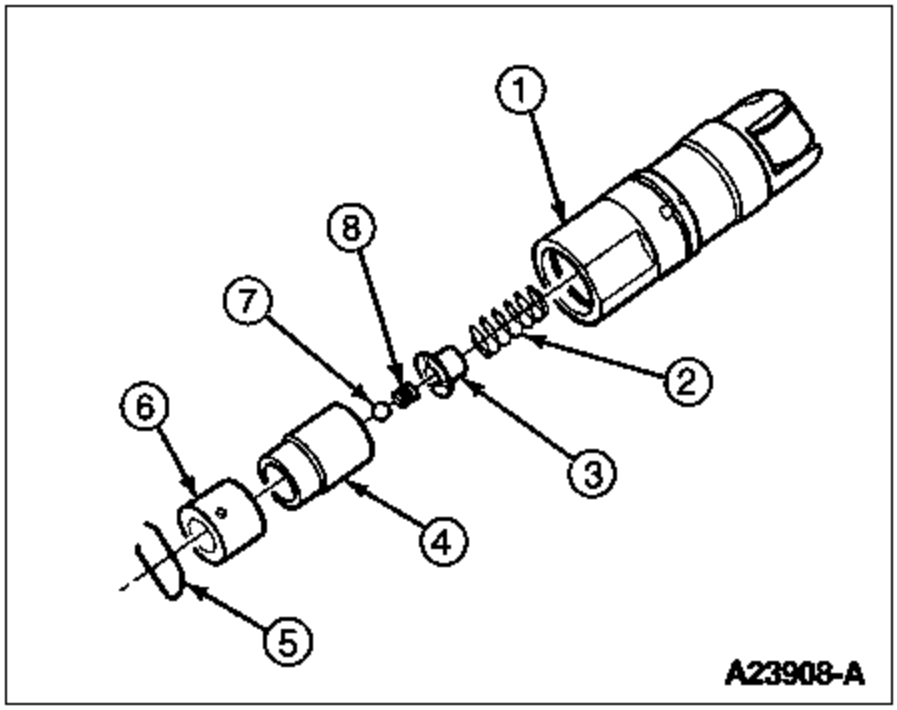

Item	Part Number	Description
1	—	Body (Part of 6500)
2	—	Plunger Spring (Part of 6500)
3	—	Check Ball Retainer (Part of 6500)
4	—	Plunger (Part of 6500)
5	—	Lock Ring (Part of 6500)
6	—	Push Rod Cup (Part of 6500)
7	—	Check Ball (Part of 6500)
8	—	Check Ball Spring (Part of 6500)

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Cylinder Block Assembly

Disassembly

1. Mount the engine (6007) in a work stand and remove all parts not furnished with the new cylinder blocks (6010), following the procedures in Removal and Installation .
2. Remove the four cylinder head to block dowels (6A008) and the cylinder block drain plugs.
3. Remove the used cylinder blocks from the work stand.

Assembly

1. Clean the gasket and seal surfaces of all serviceable parts and assemblies.
2. Position the new cylinder blocks in a work stand and install the cylinder head to block dowels and block cylinder drain plugs.
3. Transfer all serviceable parts removed from the used cylinder blocks, following the procedures in Removal and Installation .
4. Check all assembly clearances and correct as necessary.

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Cylinder Block, Bare

Before replacing a cylinder blocks (6010), determine if it is serviceable. If so, make the necessary service. Refer to Section 03-00 .

Disassembly

1. Completely disassemble the used engine, following the procedures in Removal and Installation .
2. Remember to ridge ream the cylinder bores before removing pistons (6108).
3. Remove the cylinder head to block dowels (6A008) and the cylinder block drain plugs.

Assembly

1. Clean the gasket and seal surfaces of all serviceable parts and assemblies.
2. Position the new cylinder blocks in a work stand and install the cylinder head to block dowels and the cylinder block drain plugs.
3. Transfer all serviceable parts removed from the used cylinder blocks, following the procedures in Removal and Installation .
4. Check all assembly clearances and correct as necessary.

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Valve Clearance

1. With No. 1 piston on TDC at the end of compression stroke (Position No. 1 in the illustration) check the following valves:

   Position 1

   No. 1 exhaust valve (6505) No. 1 intake valve (6507)

   No. 3 exhaust valve No. 2 intake valve

   No. 6 exhaust valve No. 4 intake valve

2. Rotate crankshaft 360 degrees to position No. 2 and check the following valves:

   Position 2

   No. 2 exhaust valve No. 3 intake valve

   No. 4 exhaust valve No. 5 intake valve

   No. 5 exhaust valve No. 6 intake valve

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SPECIFICATIONS

Torque Specifications

Torque Specifications — Except When Another Value Is Specified for That Particular Part				
Thread Size — Plug	**Cast Iron**	**Aluminum**	**Thread Size — Bolt**	**Cast Iron and Aluminum**
1/4-18 Pipe	16-24 Nm (12-18 Lb-Ft)	11-16 Nm (8-12 Lb-Ft)	M6	8-12Nm (71-106 Lb-In)
3/8-18 Pipe	30-44 Nm (22-32 Lb-Ft)	16-24 Nm (12-18 Lb-Ft)	M8	20-30 Nm (15-22 Lb-Ft)
			M10	40-55 Nm (30-41 Lb-Ft)
			M12	70-95 Nm (52-70 Lb-Ft)
			M14	110-155 Nm (81-114 Lb-Ft)

General Specifications

Item	Specification
Displacement	3.0L
Number of Cylinders	6
Bore and Stroke	
Bore	89.00mm (3.50 In.)
Stroke	80.00mm (3.14 In.)
Firing Order	1-4-2-5-3-6
Oil Pressure (Hot 2500 RPM)	40-60 PSI
Drive Belt Tension	See Chart

Cylinder Head And Valve Train

Item	Specification
Combustion Chamber Volume (cc)	50.1-47.1
Valve Guide Bore Diameter Intake and Exhaust	8.745-8.720mm (0.3443-0.3433 In.)
Valve Seats	
Width— Intake and Exhaust	1.5-2.0mm (.06-.08 In.)
Angle	45°
Runout (T.I.R.)	0.076mm (0.003 In.)
Bore Diameter (Insert Counterbore Diameter)	47.097mm (1.8542 In.) Max.

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Intake Exhaust	47.072mm (1.8532 In.) Min. 39.730mm (1.5645 In.) Max.
Gasket Surface Flatness	0.08mm (0.003 In.) over 152.0mm (6.00 In.)
Valve Stem to Guide Clearance	
Intake	0.026-0.068mm (.001-0.0027 In.)
Exhaust	0.038-0.081mm (0.0015-0.0032 In.)
Valve Head Diameter	
Intake	40.0mm (1.57 In.)
Exhaust	33.0mm (1.30 In.)
Valve Face Runout Limit	0.05mm (0.002 In.)
Valve Face Angle	44°
Valve Stem Diameter (Std.)	
Intake	7.960-7.940mm (0.3134-0.3126 In.)
Exhaust	7.948-7.928mm (0.3129-0.3121 In.)
Oversize	
Intake	8.340-8.320mm (0.3283-0.3276 In.)
Exhaust	8.328-8.308mm (0.3279-0.3271 In.)
Oversize	
Intake	8.720-8.700mm (0.3433-0.3425 In.)
Exhaust	8.708-8.688mm (0.3428-0.3420 In.)
Valve Springs	
Compression Pressure (N [Lbf.] @ Spec. Length)	
Valve open to maximum lift	800.6N (180 Lbs.) 29.5mm (1.16 In.)
Valve closed	288.1N (65 Lbs.) 40.1mm (1.58 In.)
Free Length (Approximate)	46.7mm (1.84 In.)
Installed Spring Height	44.17-41.98mm (1.736-1.650 In.)
Service Limit	10% Force Loss @ Specified Height
Rocker Arm	
Ratio	1.61
Valve Tappet, Hydraulic	
Diameter (Std.)	22.206mm (0.874 In.)
Clearance to Bore	0.018-0.069mm (0.0007-0.0027 In.)
Service Limit	0.127mm (0.005 In.)
Hydraulic Leak-Down Rate	(a)

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Collapsed Tappet Gap (Nominal)	
Intake	2.23-4.77mm (0.088-0.189 In.)
Exhaust	2.23-4.77mm (0.088-0.189 In.)
Distributor Shaft Bearing Bore Diameter Tappet Bore Diameter	22.268-22.230mm (0.08767-0.8752 In.)
Camshaft Bore Inside Diameter	
No. 1	54.688-54.713mm (2.1531-2.1541 In.)
No. 2	54.188-54.213mm (2.1334-2.1344 In.)
No. 3	54.188-54.213mm (2.1334-2.1344 In.)
No. 4	54.688-54.713mm (2.1531-2.1541 In.)

Camshaft Specifications

Item	Specification
Lobe Lift	
Intake	6.604mm (0.260 In.)
Exhaust	6.604mm (0.260 In.)
Allowable Lobe Lift Loss	0.127mm (0.005 In.)
Theoretical Valve Lift @ Zero Lash	
Intake	10.65mm (0.419 In.)
Exhaust	10.65mm (0.419 In.)
End Play	
Service Limit	0.003mm (.007 In.)
Journal to Bearing Clearance	0.025-0.076mm (0.001-0.003 In.)
Journal Diameter	
All	50.987-51.013mm (2.0074-2.0084 In.)
Cam Bearing I.D.	51.038-51.063mm (2.0094-2.0104 In.)
Runout Limit	0.05mm (0.002 In.) Runout of No. 2 or No. 3 relative to No. 1 and No. 4
Out-of-Round Limit	0.025mm (0.001 In.)

Cylinder Block Specifications

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Item	Specification
Head Gasket Surface Flatness	0.08mm (0.003 In.) in 152.0mm (6.00 In.)
Head Gasket Surface Finish (RMS)	1.0-3.3 Micrometers
Cylinder Bore	
Diameter	89.00mm (3.504 In.)
Surface Finish (RMS)	0.45-0.96
Out-of-Round Limit	0.025mm (0.001 In.)
Out-of-Round Service Limit	0.050mm (0.002 In.)
Taper Service Limit	0.050mm (0.002 In.)
Main Bearing Bore Diameter	68.905mm (2.713 In.) 68.885mm (2.712 In.)

Crankshaft And Flywheel Specifications

Item	Specification
Main Bearing Journal Diameter	63.983-64.003mm (2.5190-2.5198 In.)
Out-of-Round Limit	0.008mm (0.0003 In.)
Taper Limit	0.06mm (0.0006 In.) Total 0.013mm (0.0003 In.) per 25mm (1 In.)
Journal Runout Limit	0.05mm (0.002 In.) (1), 0.05mm (0.002 In.) (2)
Surface Finish (RMS)	0.25 Micrometers (10.0 Micro In.)
Thrust Bearing Journal Length	25.775-25.825mm (1.0148-1.067 In.)
Connecting Rod Journal	
Diameter	53.983-54.003mm (2.1253-2.1261 In.)
Out-of-Round Limit	0.006mm (0.0003 In.) Max. 0.015mm (0.0006 In.) Total
Taper Limit	0.008mm per 25mm (0.0003 In. per In.)
Surface Limit (RMS)	0.25 Micrometers (10.0 Micro In.)
Main Bearing Thrust Face	
Surface Finish (RMS)	0.4 Micrometers (0.157 Micro In.) Front; 0.4 Micrometers (0.157 Micro In.) Rear

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Runout Limit	0.025mm (0.001 In.)
Flywheel Ring Gear Lateral Runout (T.I.R.)	
Automatic Transmission	1.778mm (0.07 In.)
Crankshaft End Play	0.10-0.20mm (0.004-0.008 In.)
Connecting Rod Bearings	
Clearance to Crankshaft	
Desired	0.025-0.035mm (0.001-0.0014 In.)
Allowable	0.020-0.066mm (0.00086-0.0027 In.)
Bearing Wall Thickness (Std.)	1.557-1.570mm (0.0612-0.0618 In.)
Main Bearings	
Clearance to Crankshaft	
Desired	0.25-0.035mm (0.001-0.0014 In.)
Allowable	.020-.066mm (0.0005-0.0023 In.)
Bearing Wall Thickness (Std.)	2.444-2.481mm 1st and 2nd 2.491-2.427 3rd and Rear

Connecting Rod, Piston And Rings Specifications

Item	Specification
Connecting Rod	
Piston Pin Bore Diameter	23.105-23.145mm (0.9096-0.9112 In.)
Crankshaft Bearing Bore Diameter	57.15-57.17mm (2.250-2.251 In.)
Length (Center-to-Center)	140.46-140.54mm (5.530-5.533 In.)
Alignment (Bore-to-Bore Max. Diff.)	
Twist	0.075 per 25mm (0.003 per In.)
Bend	0.04 per 25mm (0.0016 per In.)
Side Clearance (Assembled to Crank)	
Standard	0.15-0.35mm (0.006-0.014 In.)

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Service Limit	0.36mm Max. (0.014 In. Max.)

Piston Specifications

Item	Specification
Diameter	
Coded Red	88.962-88.978mm (3.5024-3.5031 In.)
Coded Blue	88.988-89.004mm (3.5035-3.5041 In.)
Coded Yellow	89.014-89.030mm (3.5045-3.5051 In.)
Piston-to-Bore Clearance	0.030-0.056mm (0.0012-0.0022 In.)
Service Limit	0.081mm Max.
Service Piston Selection (b)	
Piston Bore Diameter	Service Piston Grade Required
89.009-89.035mm (3.5043-3.5053 In.)	RED
89.035-89.060mm (3.5053-3.5063 In.)	BLUE
89.060-89.086mm (3.5063-3.5073 In.)	YELLOW
Ring Groove Width	
Compression (Top)	1.530-1.555mm (0.0602-0.0612 In.)
Compression (Bottom)	1.530-1.555mm (0.0602-0.0612 In.)
Oil	4.030-4.055mm (0.1587-0.1596 In.)
Piston Pin	
Length	76.5-77.2mm (3.012-3.039 In.)
Diameter	23.162-23.175mm (0.9119-0.9124 In.)
Pin to Piston Clearance	0.005-0.012mm (0.002-0.0005 In.)
Pin to Rod Clearance	Press Fit 4 KiloNewtons (900 Lbs.)
Piston Rings	
Ring Width	
Compression (Top)	1.460-1.490mm (0.0575-0.0587 In.)
Compression (Bottom)	1.460-1.490mm

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	(0.0575-0.0587 In.)
Oil Ring	Side Seal — Snug Fit
Service Limit	Side Clearance 0.15mm Max. (0.0006 In. Max.)
Ring Gap	
Compression (Top) (in Gauge)	0.25-0.50mm (0.01-0.02 In.)
Compression (Bottom) (in Gauge)	0.25-0.50mm (0.01-0.02 In.)
Oil Ring (Steel Rail) (in Gauge)	0.25-1.25mm (0.010-0.049 In.)
Side Clearance	
1st Ring	0.040-0.095mm (0.0016-0.0037 In.)
2nd Ring	0.040-0.095mm (0.0016-0.0037 In.)

Lubrication System Specifications

Item	Specification
Oil Pump	
Relief Valve Spring Tension (Force @ Length)	44.9-40.5 N (10.1-9.1 Lb.) @ 28.2mm (1.11 In.)
Relief Valve to Bore Clearance	0.073-0.043mm (0.0029-0.0017 In.)
Oil Pump Gear Backlash	0.02-0.03mm (0.008-0.012 In.)
Oil Pump Gear Radial Clearance	
(Idler and Driver)	0.125-0.050mm (0.0055-0.002 In.)
Oil Pump Gear Height Clearance	0.0825-0.010mm (0.0032-0.0003 In.)
Idler Shaft to Idler Gear Clearance Driver Shaft to Housing Clearance	0.069-0.039mm (0.0027-0.0015 In.) 0.073-0.038mm (0.0019-0.0005 In.)
Oil Capacity	4.25 Liters (4.5 quarts) with filter change

(a) 20-200 seconds to leak-down 3.18 (0.125 in.) with 225 Newtons (50 pounds) load and tappet filled with leak-down fluid.

(b) When placing pistons, measure the cylinder bore as described in Section 03-00 , General Engine

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Service, and install the indicated service piston.

(1) Runout of journals II and III to journals I and IV.

(2) Runout of adjacent journals to each other.

* Engine packages equipped with Tripminder: Return line must be closed when checking pressure.

Drive Belt Tension

"V" Ribbed Belts	Specifications		Allowable Minimum
	New Belt [a] Installation Tension	Used Belt [b] Reset Tension	Cold Belt [b c] Audit Check
6 Rib (Non-Serpentine)	150-190	140-160	90

[a] New belt installed and tensioned; engine not rotated.
[b] Used belt is any belt that has rotated on an engine.
[c] Cold belt (i.e., 3-hour soak; 0 warm-up).

Torque Specifications

Description	Nm	Lb-Ft	Lb-In
1/4-18 Cylinder Block Plug	20-28	14-20	—
3/8-18 Cylinder Block/Intake Manifold Plug	31-45	23-30	—
Main Bearing Cap Studs and Bolts	75-85	55-62	—
Connecting Rod Cap — Nuts	31-39	23-28	—
Oil Pump to Rear Main Bearing Cap — Bolt	40-55	30-40	—
Camshaft Thrust Plate — Bolts	8-12	6-8	—
Camshaft Sprocket — Bolt	55-70	41-51	—
Front Cover to Cylinder Block — Bolts/Studs	20-30	15-22	—
Oil Pan to Cylinder Block Bolts	10-14	7-10	—
Low Oil Level Sensor	27-41	20-30	—
Oil Pan Drain Plug	14	10	—
Crankshaft Damper — Bolt	125-165	92-122	—
Flexplate/Flywheel to Crankshaft — Bolts	73-87	54-64	—
Water Pump to Front Cover — Bolts/Stud	8-12	6-8	—
Oil Filter Insert to Cylinder Block	27-40	20-29	—
Oil Filter to Adapter — Tighten Half Turn After Gasket Contacts Sealing Surface	—	—	—
Cylinder Head Bolt — Tighten in Two Steps, Step 1 45-55 Nm (33-41 Lb-Ft) and Step 2 85-99 Nm (63-73 Lb-Ft)	—	—	—

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Rocker Arm Fulcrum to Cylinder Head	26-38	19-28	—
Intake Manifold — Bolts — Tighten in Two Steps, 15 Nm (11 Lb-Ft) Then to 26-32 Nm (19-24 Lb-Ft)	—	—	—
Exhaust Manifold to Cylinder Head — Bolts/Studs	20-30	15-22	—
Engine Oil Dipstick Tube to Exhaust Manifold — Nut	16-20	12-14	—
Spark Plug to Cylinder Head	9-20	7-14	—
Rocker Arm Cover to Cylinder Head/Intake — Bolts/Studs	10-14	7-10	—
Fuel Rail to Intake Manifold — Bolts	8-12	6-9	—
Fuel Pressure Regulator to Fuel Rail — Bolts	4	3	—
Fuel Pressure Relief Valve to Fuel Rail	8	6	—
ECT Sensor to Intake Manifold	20	15	—
Heater Elbow to Intake Manifold	16-24	12-18	—
Thermostat Housing to Intake Manifold — Bolts, Ranger	20-30	15-22	—
Coolant Temperature Sender to Intake Manifold	16-24	12-18	—
Distributor Hold Down — Bolt	19-30	14-22	—
Distributor Cap to Housing — Screws	2-4	—	18-35
Throttle Body to Intake Manifold — Bolts/Studs	20-30	15-22	—
ACT Sensor to Throttle Body	20	15	—
Vacuum Fitting to Throttle Body	11	8	—
BPA Solenoid to Throttle Body — Screws	10	7	—
Throttle Position Sensor to Throttle Body — Screws	3	—	27
EGR Cover to Throttle Body — Bolts	20-30	15-22	—
Coil Bracket to Cylinder Head — Bolts, Aerostar	48	35	—
Coil Bracket to Cylinder Head — Bolts, Ranger	16-20	12-15	—
Tappet Guide Plate Retainer Assembly	10-14	7-10	—
Heat Stove to Exhaust Manifold (Ranger Only)	6	—	53
Idler Bracket to Alternator Top Attaching Flange Bolt	33-46	24-34	—
Alternator Pivot Bolt	61-75	45-57	—
EGR Tube Flare Nut to EGR Valve	35-65	26-47	—
EGR Tube Bolt to Exhaust Manifold	20-30	15-22	—
EGR Valve to Throttle Body-Screws	25	19	—
EGR Pressure Valve Sensor to Throttle Body	10-15	7-11	—
Idler Pulley Adv. Bolts (2 Places)	40-55	30-40	—
Bracket, Idler Top Bolt	40-55	30-40	—
Bracket, Idler Front Attach Bolt Lower	40-55	30-40	—
Bracket, Idler Front Attach Bolt Upper	70-95	52-70	—
A/C Lower Mounting Bracket to Engine Nuts	41-61	30-45	—
Nut Brace to Engine, A/C	20-30	15-22	—

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Bolt Front Brace to Engine Brace A/C	41-61	30-45	—
Support A/C Comp. Mounting Bolt to Bracket Assembly (2 Places)	41-61	30-45	—
Bolt A/C Comp. Mounting (5 Places)	41-61	30-45	—
Front A/C Comp. Plate to Lower A/C Mounting Bracket Bolt	41-61	30-45	—
Front A/C Comp. Plate Nut to Engine Stud (2 Places)	41-61	30-45	—
Front Brace, A/C to Engine Stud — Nut	20-30	15-22	—
Engine Bracket Reinforcement Brace to Engine Bracket — Nut (Damper)	80-107	60-79	—
Engine Bracket Reinforcement Brace to Engine Bracket — Bolt (Damper)	47-67	35-49	—
POWER STEERING W/O A/C			
Power Steering Brace Bolt (2 Places)	40-62	30-46	—
Power Steering Front Bracket Bolt (2 Places)	40-62	30-46	—
Power Steering Front Bracket Bolt (3 Places)	40-62	30-46	—
POWER STEERING WITH A/C			
Power Steering Brace Bolt (Upper)	40-62	30-46	—
Power Steering Brace Bolt (Lower)	24-32	18-24	—
Power Steering Front Bracket Nut (2 Places)	40-62	30-46	—
Power Steering Front Bracket to A/C Bracket — Bolt	40-62	30-46	—
Front Bracket to Power Steering Pump — Bolt (3 Places)	40-62	30-46	—

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Valve Cover and Gasket, Ranger

Removal

1. Disconnect negative battery cable.
2. Drain cooling system.
3. Disconnect the wiring connectors and locator from the intake air temperature (IAT) and mass air flow (MAF) sensors. Remove the breather hose from the RH valve cover and remove the air cleaner tube.
4. Remove the accelerator control splash shield. Disconnect the accelerator and speed control cables from the throttle body. Remove the accelerator control bracket with cables attached and position aside.
5. Disconnect the idle air control (IAC), differential pressure feedback EGR (DPFE) transducer, throttle position sensor (TPS), EGR vacuum regulator (EVR) solenoid electrical connectors and vacuum hoses.
6. Disconnect the brake booster vacuum hose, vacuum connectors from the upper intake manifold and the positive crankcase ventilation (PCV) valve from the LH valve cover.
7. Disconnect the 42-pin connector and the powertrain control module (PCM) harness locator from the bracket mounted to the under side of intake manifold.
8. Disconnect the ignition coil electrical connector, locator, and the noise suppressor electrical connector. Disconnect the ignition wires from the spark plugs.
9. Disconnect the vent line from under the throttle body.
10. Disconnect the spark plug wires from the seven retaining clips. Remove the two ignition coil bolts from the upper intake manifold and one bolt from RH exhaust manifold. Remove the coil pack with ignition wires as an assembly.
11. Disconnect the vacuum hose from the EGR valve. Disconnect the EGR tube flange nut from the EGR valve. Remove the EGR valve and gasket. Discard the gasket.
12. Remove the oil level indicator tube bracket nut and remove the oil level indicator tube and indicator.
13. Remove the stud retaining the EGR outlet tube bracket to the exhaust manifold. Remove the upper intake manifold and gasket. Discard the gasket. Tape the lower intake manifold openings.
14. Disconnect the wiring connector from the oil pressure-sending unit and locators. Position harness aside.
15. Disconnect the upper radiator hose from the thermostat housing. Disconnect the heater hose from the intake manifold. Position the hoses aside.
16. Remove the LH valve cover (with gasket). Discard the gasket.

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17. Remove the RH valve cover (with gasket). Discard the gasket.

18. Clean both valve covers.

Installation

1. **NOTE: Apply Silicone Gasket and Sealant F6AZ-19562-AA or equivalent meeting Ford specifications WSE-M4G323-A6 to the intake manifold-to-cylinder head parting seams.**

   Install the LH and RH valve cover gaskets.

2. Install the LH valve cover. Tighten the bolts to 10 Nm (89 lb-in).

3. Install the RH valve cover. Tighten the bolts to 10 Nm (89 lb-in).

4. Position harness, and connect the oil pressure-sending unit and locators.

5. Remove the tape from the lower intake manifold. Install new upper intake manifold seals. Install the upper intake manifold with the EGR outlet tube attached. Tighten the nuts to 20 Nm (15 lb-ft).

6. Install the EGR outlet tube to exhaust manifold. Tighten stud to 40 Nm (30 lb-ft).

7. Install the oil level indicator tube bracket to EGR bracket stud. Tighten the nut to 20 Nm (15 lb-ft). Install the oil indicator.

8. Connect the upper radiator hose to the thermostat housing. Connect the heater hose to the intake manifold.

9. Install the EGR valve with a new gasket to outlet tube bracket. Connect the EGR vacuum line and the inlet tube from the exhaust manifold. Tighten the EGR valve bolts to 20 Nm (15 lb-ft). Tighten the tube nut to 34 Nm (25 lb-ft).

10. Install the coil pack with ignition wires as an assembly. Tighten the two ignition coil bolts to the upper intake manifold and one bolt on right exhaust manifold to 20 Nm (15 lb-ft). Connect the ignition wires to the seven retaining clips and spark plugs.

11. Connect the ignition coil electrical connector, locator, and the noise suppressor electrical connector.

12. Connect the vent line under the throttle body.

13. Connect the 42-pin connector and the PCM harness locator to the bracket mounted to the under side of intake manifold.

14. Connect the TPS electrical connector and hoses to the DPFE transducer.

15. Connect the vacuum hoses to the brake booster, upper intake manifold and the PCV valve to the LH valve cover.

16. Connect the IAC valve, EVR solenoid wiring connectors and vacuum hoses.

17. Install the accelerator control bracket to throttle body. Tighten the bolts to 13 Nm (10 lb-ft). Connect the accelerator and speed control cables to the throttle body. Install the accelerator splash shield.

18. Install the breather hose to the RH valve cover and to the inlet tube and install the assembly. Connect

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the electrical connectors to the IAT and MAF sensors.

19. Connect the negative battery cable.
20. Fill the cooling system.
21. Start the engine and check for leaks.

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Valve Cover and Gasket, Aerostar

Removal

1. Disconnect battery ground cable (14301) and remove intake shield and air cleaner outlet tube (9B659).
2. Remove inside engine cover.
3. For right valve cover, remove oil fill pipe (6A868), oil level indicator tube (6754), and transmission oil filler tube (7A228).
4. Remove generator (GEN) (10346) and ignition coil (12029) and assembled bracket. Refer to Section 03-07C .
5. Remove spark plug wires from clips on valve cover (6582).
6. For left valve cover, remove upper intake manifold as outlined in this section.
7. Remove left valve cover bolts, rocker arm cover flange plate (6A523) and valve cover.
8. Remove A/C compressor (19703) from A/C compressor mounting bracket (2882) and set out of the way. Do not disconnect hoses from A/C compressor.
9. Remove right valve cover bolts, rocker arm cover flange plates, and valve cover.

Installation

1. Clean valve cover, cylinder head (6049), and intake manifold gasket surfaces.
2. Locate valve cover gaskets (6584) on valve covers.
3. **NOTE: Since silicone rubber will set up within 15 minutes, if you are installing both covers, apply only to one side at a time.**

   Apply Silicone Rubber D6AZ-19562-BA or equivalent meeting Ford specifications ESB-M4G92-A and ESE-M4G195-A, to left intake manifold-to-cylinder head parting seam.
4. Install right valve cover, rocker arm cover flange plates, and bolts. Snug bolts starting from center bolts and working in crisscross pattern to end bolts. Tighten in same pattern to 6-8 Nm (4.5-5.9 lb-ft).

Rocker Arm Cover and Gasket, Installation

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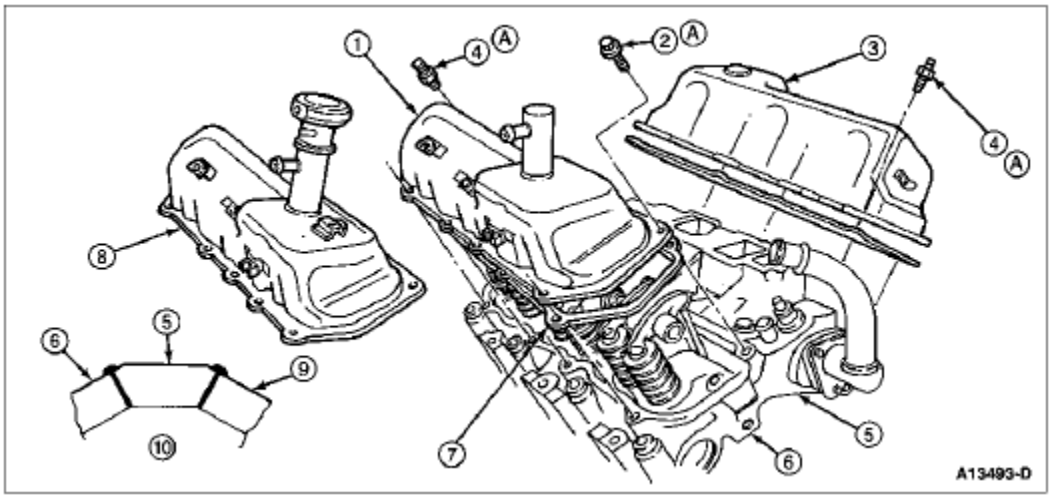

Item	Part Number	Description
1	6582	Valve Cover — Aerostar (RH)
2	E800390-S72	Screw, M 6 x 22 Flange Head
3	6582	Valve Cover (LH)
4	W701041	Stud
5	9424	Intake Manifold
6	6049	Cylinder Head (RH)
7	6584	Valve Cover Gasket
8	6582	Valve Cover — Ranger (RH)
9	6049	Cylinder Head (LH)
10	6010	Cylinder Blocks
A	—	Tighten to 8-10 Nm (71-89 Lb-In)

5. Install A/C air register impingement screen on A/C compressor mounting bracket and tighten compressor bolts to 24-30 Nm (18-23 lb-ft).
6. Snap spark plug wires into clips on valve cover.
7. Install upper intake manifold as described in this section.
8. Apply Silicone Rubber D6AZ-19562-BA or equivalent meeting Ford specifications ESB-M4G92-A and ESE-M4G195-A to right intake manifold-to-cylinder head parting seam.
9. Install left valve cover, bolts, and rocker arm cover flange plates and snug bolts starting from center bolts and working in crisscross pattern to end bolts. Tighten in same pattern to 6-8 Nm (4.5-5.9 lb-ft).
10. Install ignition coil and assembled bracket and generator. Refer to Section 03-07C .
11. Snap spark plug wires into clips on valve cover.
12. Install oil fill pipe, oil level indicator tube, and transmission oil filler tube.

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13. Install air cleaner outlet tube and shield.

14. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

    Connect battery ground cable, start engine and check for leaks.

15. Install engine cover and close hood.

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Rocker Arm

Removal

1. Remove valve covers (6582) as outlined in this section.

2. **CAUTION: If the rocker arm shafts (6563) are not loosened gradually, the shaft may become bent or damaged during removal.**

   Remove the rocker arm shafts by loosening the rocker arm shaft support bolts two turns at a time until the shaft can be removed.

Installation

1. Lubricate all rocker arm assemblies with Engine Assembly Lubricant D9AZ-19579-D or equivalent meeting Ford specification ESR-M99C80-A.

2. Install the rocker arm shaft assemblies and draw the shaft support bolts down evenly, two turns at a time, until the rocker shaft assemblies are fully down. Tighten shaft support bolts to 32 Nm (24 lb-ft). Then torque again an additional 90°.

3. Install valve covers as outlined in this section.

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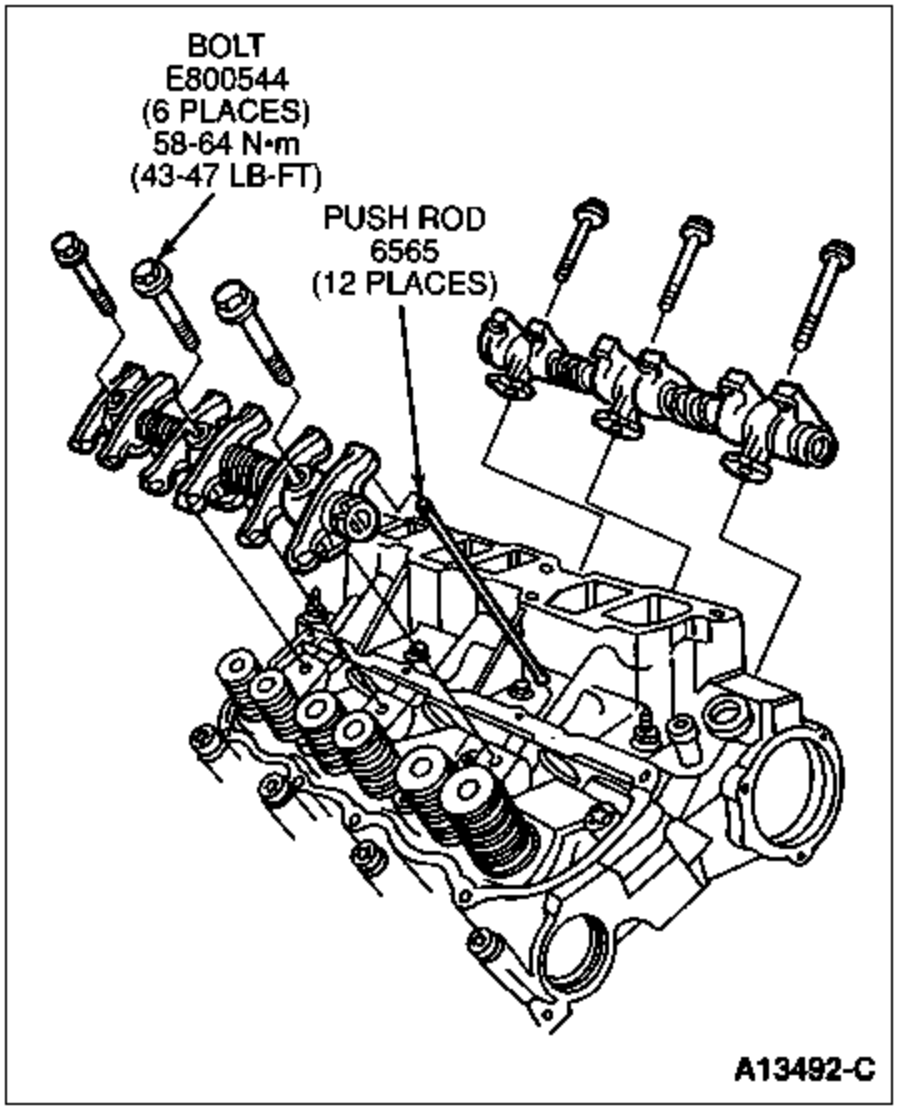

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Valve Spring, Retainer and Valve Stem Seal

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Valve Spring Compressor	T86L-6565-A
Valve Spring Compressor Bar	T74P-6565-B
Valve Stem Seal Replacer	T90T-6571-A

NOTE: Broken valve springs (6513) or leaking valve stem seals (6571) and retainer may be replaced without removing the cylinder head (6049), provided damage to the intake valve (6507) or valve seat has not occurred.

Removal

1. Remove the valve cover (6582) and valve rocker arm shaft (6563) as described under Valve Cover, Aerostar or Valve Cover, Ranger and Rocker Arm . Remove the applicable spark plug (12405).

2. Remove both push rods (6565) and valve tappets (6500) of the cylinder to be serviced.

3. **CAUTION: Engine may turn over when air pressure is applied. Remove all objects from fan area (lights, extension cords, etc.).**

   Install an air line with an adapter in the spark plug hole.

4. **NOTE: If air pressure fails to hold the valve in the closed position when removing retainers, it can be presumed that the intake valve is not seating or is damaged. If this condition occurs, remove the cylinder head for further inspection.**

   Turn on the air supply. **Air pressure may turn the crankshaft until the piston reaches the bottom of the stroke.**

5. Using the Valve Spring Compressor T86L-6565-A and Valve Spring Compressor Bar T74P-6565-B compress the valve spring and remove the valve spring retainer keys (6518), valve spring retainer (6514) and the valve spring.

6. Remove the valve stem seal. If air pressure has forced the piston to the bottom of the cylinder, any removal of air pressure will allow the intake valves or exhaust valves (6505) to fall into the cylinder. A rubber band, tape or string wrapped around the end of the valve stem will prevent this condition and will still allow enough travel to check the intake valve or exhaust valve for binds.

Installation

1. Lubricate a new valve stem seal with engine oil XO-5W30-QSP or equivalent meeting Ford specification WSE-M2903-A1 or SAE 5W-30 Service SG and install on valve stem using Valve Stem Seal Replacer T90T-6571-A.

2. Position the rocker arm shaft spring (6587) over the intake valve or exhaust valve. Install the valve spring retainer. Using Valve Spring Compressor Bar T74P-6565-B and Valve Spring Compressor

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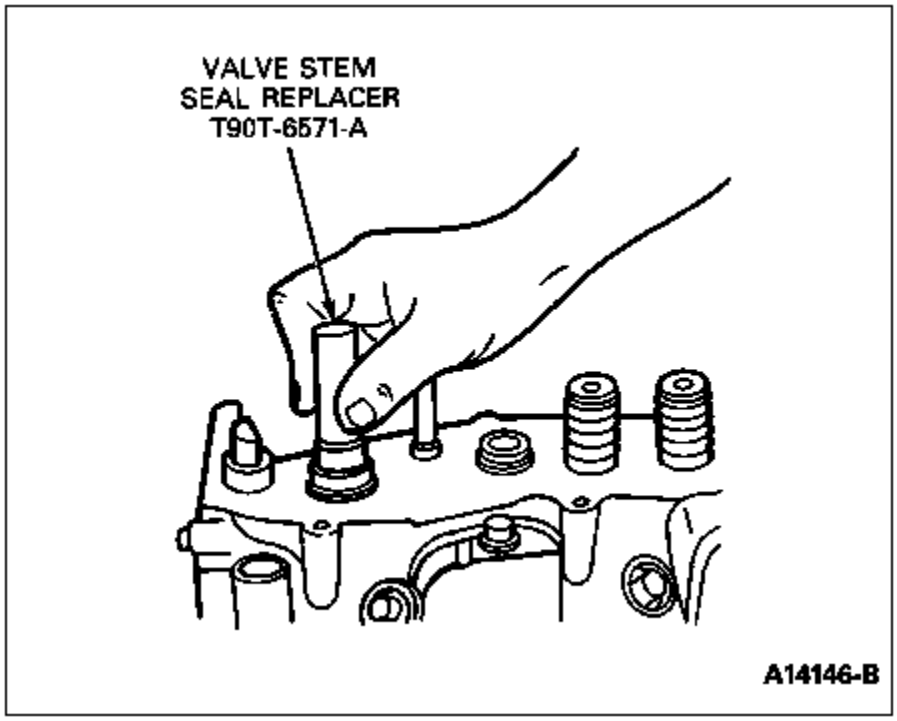
T86L-6565-A, compress the valve spring and install the valve spring retainer keys.



3. Apply SAE 50 Service SG oil or equivalent meeting Ford specification ESE-M2C39-F to both ends of the push rods, the valve tips and both ends of the rocker arms (6564). Install the valve tappets, making sure the lower end of the rod is positioned in the tappet push rod cup.

4. Turn off the air and remove the air line and adapter. Install the spark plug.

5. Clean the valve cover and cylinder head gasket surfaces. Install the valve cover as outlined in this section.

6. Run the engine (6007) at fast idle and check for oil and fuel leaks.

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Valve Tappet, Hydraulic

NOTE: Before removing a valve tappet (6500) for noisy operation, make sure the noise is not caused by improper valve-to-rocker arm clearance or by worn rocker arms (6564) or push rods (6565). Refer to Section 03-00 for diagnosis and testing procedures.

Removal

1. Remove cylinder head (6049) assembly as outlined in this section.

2. Remove the valve tappets. Note the location of each valve tappet so each one can be installed in the original position.

Installation

1. **NOTE: Lightly oil all bolt and stud threads before installation, except those specifying special sealant. Using solvent, clean the intake manifold, cylinder head and valve rocker arm cover sealing surfaces.**

   Lubricate each tappet and bore with Engine Assembly Lubricant D9AZ-19579-D or equivalent meeting Ford specification ESR-M99C80-A or engine oil SAE 50 Service SG ESE-M2C39-F.

2. Install each valve tappet in the bore from which it was removed with the alignment tab in the locating groove of the bore. If new valve tappets are being installed, check for free fit in the bore.

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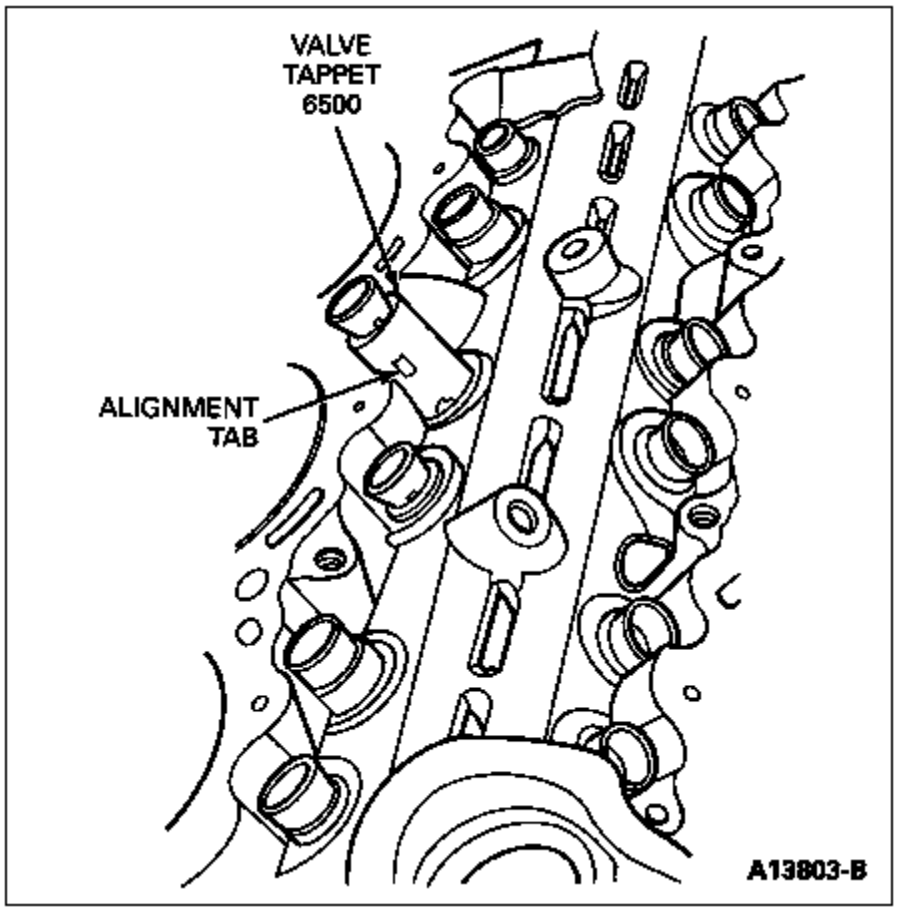

3. Install cylinder head assembly as outlined in this section.

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Intake Manifold, Upper

Removal

NOTE: The procedure for removal and installation of the upper intake manifold (9424) has been changed. After removing the ignition coil and bracket assembly, the EGR valve (EGR valve) (9D475), the intake manifold to EGR valve tube, and the EGR transducer vacuum lines must be removed. Refer to Section 03-08 .

NOTE: The intake manifold is a four-piece assembly consisting of the upper intake manifold, the throttle body (9E926), the fuel injection supply manifold (9D280) and the lower intake manifold. For servicing of the throttle body and fuel injection supply manifold, refer to Section 03-04C .

WARNING: RESIDUAL PRESSURE REMAINS IN FUEL SYSTEM AFTER ENGINE IS SHUT OFF. THIS COULD RESULT IN INJURY OR FIRE WHEN FUEL LINES ARE DISCONNECTED. DISCONNECT INERTIA FUEL SHUTOFF SWITCH AND CRANK ENGINE UNTIL FUEL IN LINES IS USED UP. REFER TO SECTION 03-04C.

1. Disconnect the battery ground cable (14301) at the battery.
2. Disconnect the intake air temperature (IAT) electrical connector and crankcase ventilation hose from air cleaner outlet tube.
3. Loosen clamps and remove air cleaner outlet tube from vehicle.
4. Remove the accelerator control splash shield and disconnect the throttle cable, and if equipped, speed control cable from the upper intake.
5. Disconnect vacuum hoses from the brake booster and upper intake.
6. Disconnect the exhaust feed hoses from the differential pressure feedback EGR (DPFE) sensor.
7. Disconnect the PCV ventilation hose from the upper intake manifold.
8. Disconnect the electrical connectors from the DPFE, idle air control (IAC), throttle position (TP) sensor and EGR transducer.
9. Remove the anti-lock electronic control module. Refer to procedure in Section 06-09A .
10. Remove floor mount cup holder and remove the interior engine access cover.
11. Disconnect heater hose locating bracket and unbolt transmission filler tube and position aside.
12. Disconnect spark plug wires from the ignition coil pack and disconnect fuel charging wiring from ignition coil pack.
13. Remove the retaining nut on the engine oil level indicator dipstick tube and remove tube.

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14. Remove the EGR tube retaining bolts and release EGR tube from upper intake.
15. Disconnect the mass air flow (MAF) sensor electrical connector.
16. Disconnect the bulkhead wiring harness, remove pushpin locators and position wiring harness aside.
17. Remove the three bulk head bracket bolts and remove bracket.
18. Remove the two EGR transducer retaining bolts and remove transducer from the upper intake manifold.
19. Remove the six nuts securing the upper intake manifold and remove the upper intake manifold.
20. Remove and discard upper intake manifold gaskets.

Installation

1. Replace intake manifold gaskets and install the upper intake manifold.
2. Tighten the upper manifold nuts to 20-25 Nm (15-18 lb-ft) using intake the center-out sequence.
3. Install EGR transducer on upper intake manifold with the retaining two bolts.
4. Fit bulkhead wiring harness bracket and install the three retaining bolts.
5. Connect the bulkhead wiring harness, install pushpin locators and position wiring.
6. Connect the MAF sensor electrical connector.
7. Install the EGR tube into upper intake manifold and tighten retaining bolts.
8. Install the engine oil level indicator dipstick tube and tighten the retaining nut.
9. Connect spark plug wires on ignition coil pack and connect fuel charging wiring to ignition coil pack.
10. Install transmission filler tube and connect heater hose locating bracket.
11. Install interior engine access cover and floor mount cup holder.
12. Install the anti-lock electronic control module; refer to procedure in Section 06-09A .
13. Connect electrical connections at the DPFE, IAC, TP sensor and EGR transducer.
14. Connect vacuum hose at the brake booster and the PCV ventilation hose at the upper intake manifold.
15. Connect the exhaust feed hoses to the DPFE.
16. Install the throttle cable, and if equipped, the speed control cable on to the upper intake.
17. Install the accelerator control splash shield to the throttle body.

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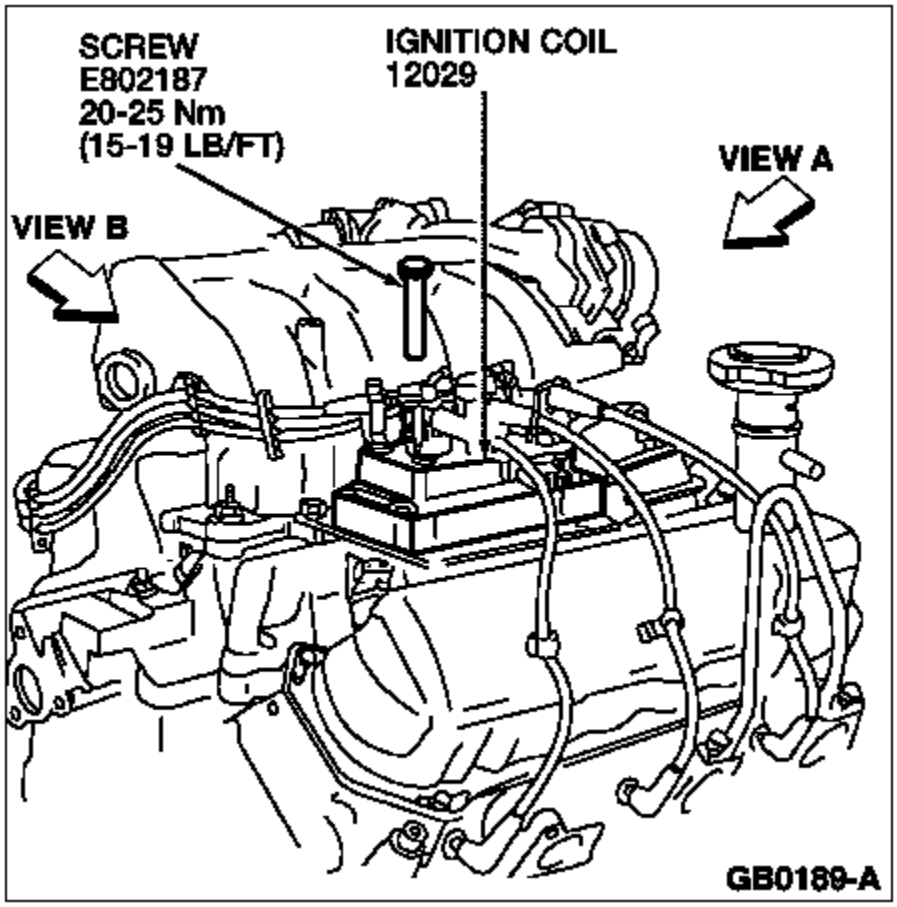
18. Install air cleaner outlet and tighten the two clamps.
19. Connect the IAT electrical connector and crankcase ventilation hose to the air cleaner outlet tube.
20. Connect the ground cable at the battery.



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Intake Manifold, Lower

Removal

1. Remove the upper intake manifold as outlined in this section.
2. Remove the valve covers as outlined in this section.
3. Disconnect the fuel supply and return lines at the fuel supply manifold as outlined in Section 03-04C .
4. Drain the coolant from the cooling system.
5. Remove the lower intake manifold retaining bolts. Tap the intake manifold lightly with a plastic mallet to break the gasket seal and lift off the lower intake manifold.
6. Remove all old gasket material and sealing compound; make certain that no material is left in the intake ports or lifter valley.

Installation

1. **NOTE: Once applied, the silicone sealer will set up in approximately 15 minutes. The intake manifold must be installed immediately after the sealer is applied.**

   Apply Silicone Rubber D6AZ-19562-BA or equivalent meeting Ford specifications ESB-M4G92-A and ESE-M4G195-A to the block and cylinder head mating surfaces at the four corners shown. Install the intake manifold gasket (9439) and again apply sealer to the four corner locations.

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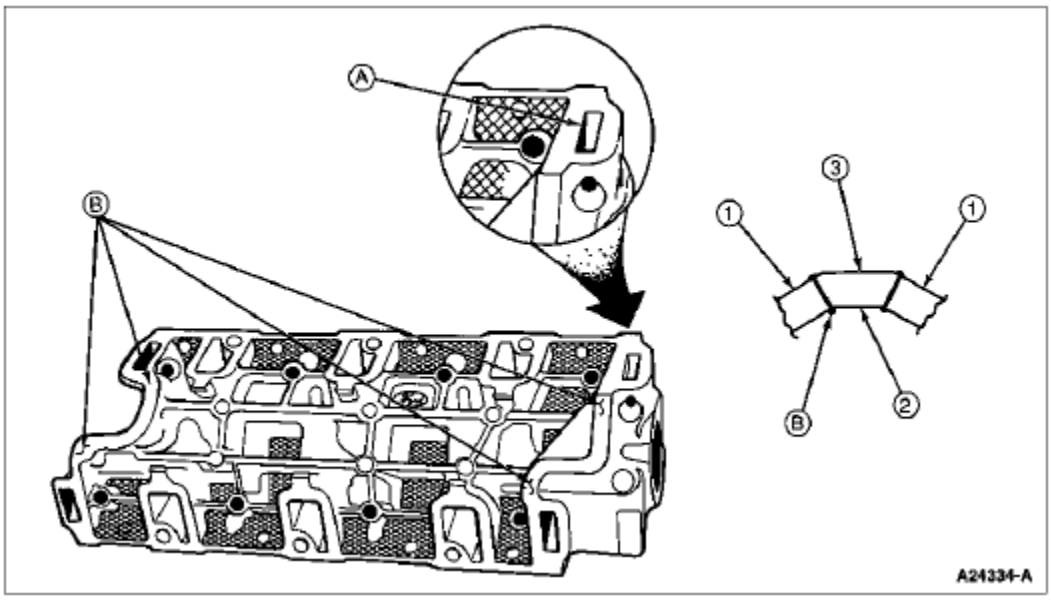

Item	Part Number	Description
1	6049	Cylinder Head
2	9439	Intake Manifold Gasket
3	9424	Intake Manifold
A	—	Examine Closely for Erosion, Corrosion, or Pitting on This Surface
B	—	Silicone Sealer — 4 Places

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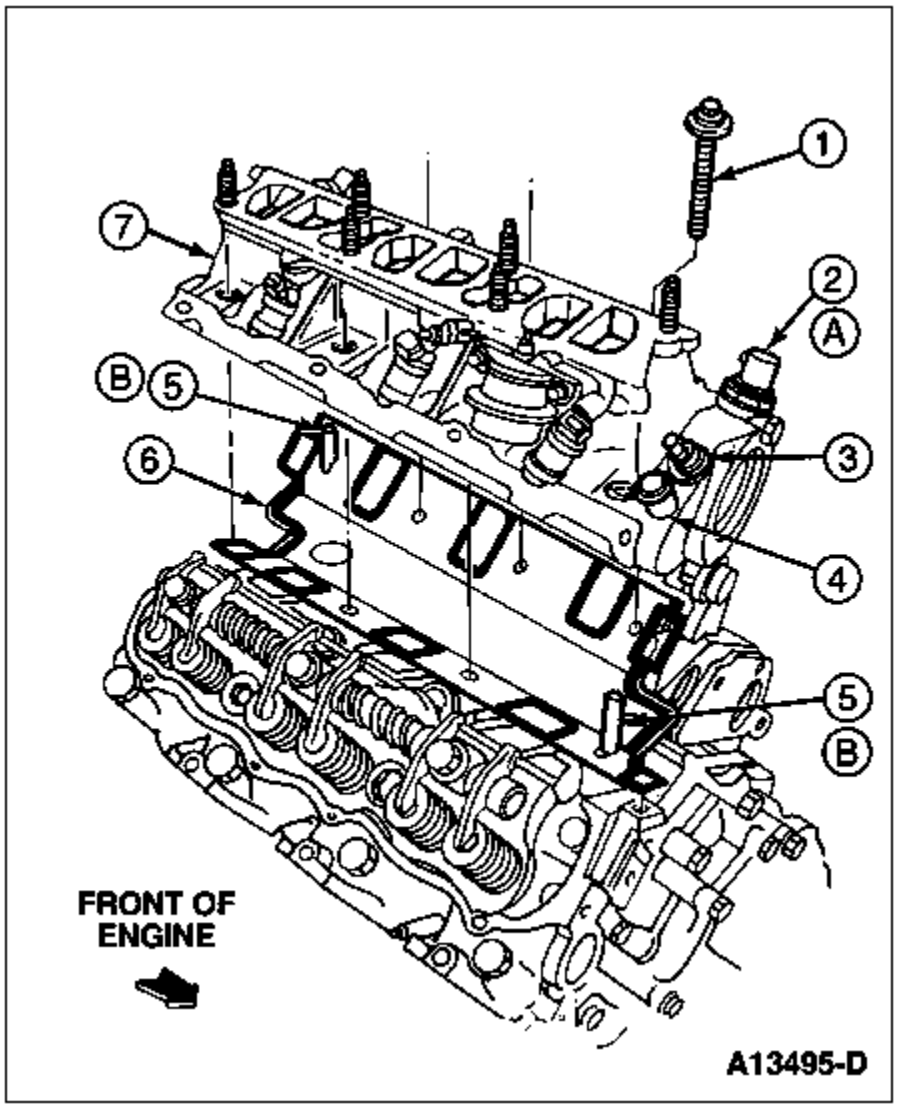

Item	Part Number	Description
1	W702301S309M	Bolt with Captive Washer (8)
2	12A648	Engine Coolant Temperature Sensor
3	10884	Water Temperature Indicator Sender Unit
4	8501	Water Pump
5	—	Stud (2) (Part of 9424)
6	9439	Intake Manifold Gasket
7	9424	Intake Manifold
A	—	Tighten to 16 Nm (12 Lb-Ft)
B	—	Used to Locate Lower Intake Manifold Only

2. Position the intake manifold with the aid of two guide studs located in position 3 and 4 below, and install the bolts hand-tight. Then remove the two guide studs and replace with bolts. Tighten the intake manifold bolts in three stages following the sequence shown.

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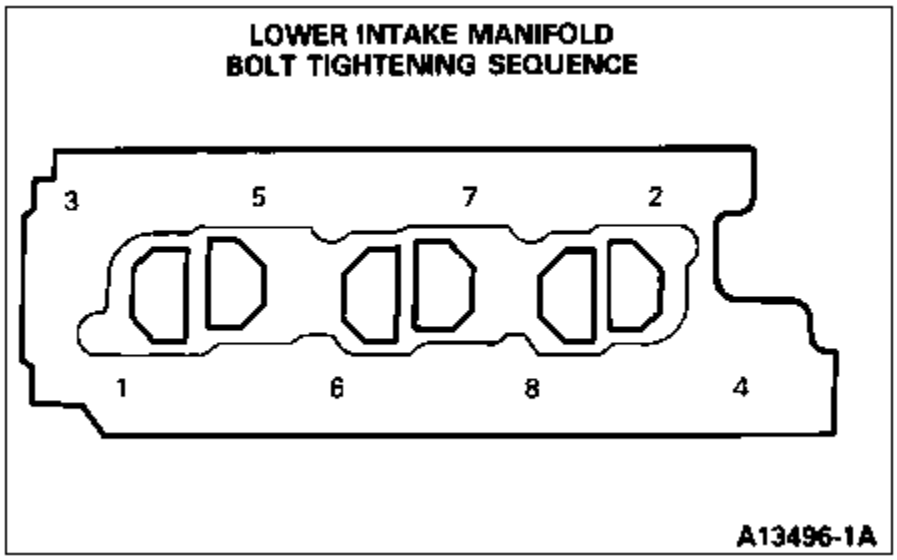
a. 8 Nm (6 lb-ft)
b. 15 Nm (11 lb-ft)
c. 22 Nm (16 lb-ft)



3. Apply Silicone Rubber D6AZ-19562-BA or equivalent meeting Ford specifications ESB-M4G92-A and ESE-M4G195-A to the four locations at the joint where the intake manifold and the cylinder heads (6049) meet (as shown).

4. Install valve covers (6582) as outlined in this section.

5. Connect the fuel supply and return lines at the fuel supply manifold as outlined in Section 03-04C .

6. Install upper intake manifold as outlined in this section.

7. **NOTE: It is important to follow the coolant filling procedure described in Section 03-03 .**

   Fill and bleed the cooling system as detailed in Section 03-03 .

8. Check the fuel system for leaks as outlined.

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Cylinder Head(s)

Removal

WARNING: RESIDUAL PRESSURE REMAINS IN FUEL SYSTEM AFTER ENGINE IS SHUT OFF. THIS COULD RESULT IN INJURY OR FIRE WHEN FUEL LINES ARE DISCONNECTED. DISCONNECT INERTIA FUEL SHUTOFF SWITCH AND CRANK ENGINE A MINIMUM OF 15 SECONDS TO DEPRESSURIZE SYSTEM. REFER TO SECTION 03-04C.

NOTE: In 1996, the cylinder heads (6049) removal and installation procedure changed. Before removal of the LH exhaust manifold (9430), the EGR valve to exhaust manifold tube must be removed. Refer to Section 03-08 .

1. Disconnect the battery ground cable (14301) and secure out of the way.
2. Drain the cooling system.
3. Remove the upper and lower intake manifolds and valve covers (6582) as outlined in this section.
4. If left cylinder head is being remove, perform the following steps:
    a. Lift drive belt tensioner (6B209) by rotating it counterclockwise and remove drive belt (8620).
    b. Remove four bolts securing air conditioning compressor to bracket and one screw securing air conditioner manifold tube to upper intake manifold and set compressor to one side.
    c. Remove A/C compressor mounting bracket (2882) with assembled power steering pump (3A674) and position to one side.
    d. Remove the spark plugs (12405).
5. If the right cylinder head is being removed, perform the following steps:
    a. Lift drive belt tensioner by rotating it counterclockwise and remove drive belt.
    b. Remove the generator (GEN) (10346) and generator mounting bracket (10153).
    c. Remove the ignition coil (12029) and assembled bracket.
    d. Remove the spark plugs.
6. Remove the exhaust inlet pipe, exhaust manifold, RH and exhaust manifold, LH.
7. Remove the rocker arm shaft assembly as outlined in this section. Remove the valve tappets (6500), and place them in a rack for installation in the same position.
8. Remove the cylinder head attaching bolts and discard.
9. Remove the cylinder heads.
10. Remove and discard the head gasket (6051).

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Installation

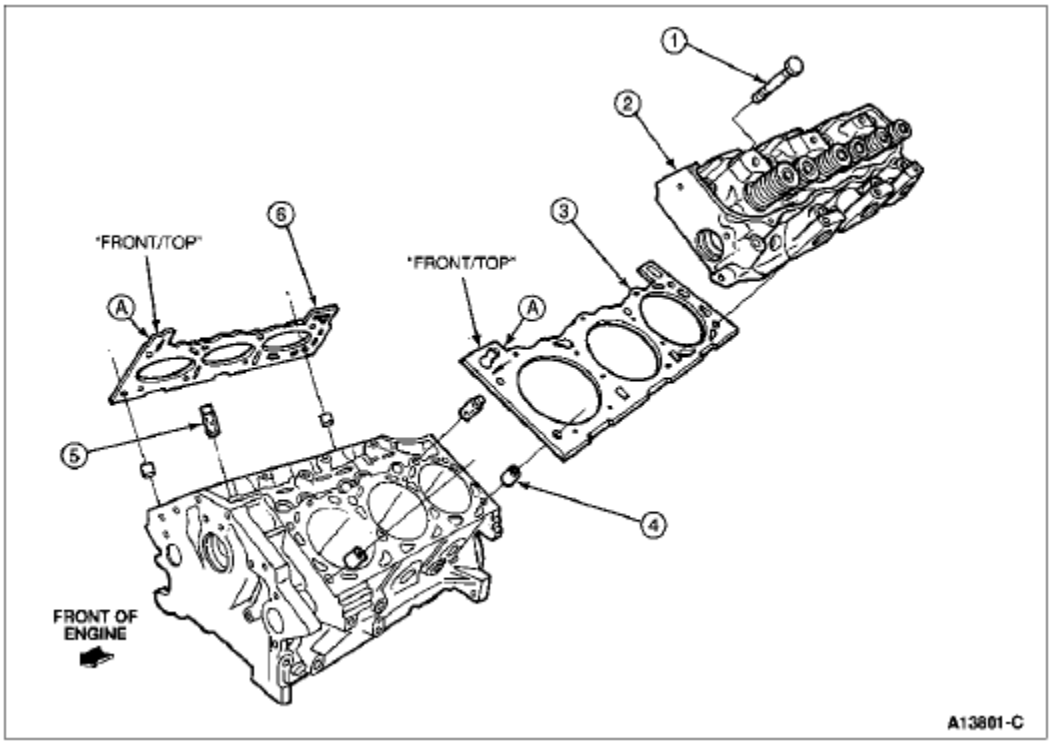
CAUTION: The 4.0L engine should always be assembled using new cylinder head bolts.

NOTE: If cylinder heads were completely disassembled, refer to Cylinder Head Disassembly and Assembly in this section.

NOTE: Head gaskets are not interchangeable, they are either right- or left-hand side.

NOTE: The cylinder heads and intake manifold installation procedure has changed. The cylinder head bolts and intake manifold bolts are tightened alternately and in sequence to ensure correct fit and gasket crush. Failure to follow complete sequence will cause follow-up repair. The following steps provide the new tightening procedure for cylinder head and intake manifold bolts.

Cylinder Head, Installation



Item	Part Number	Description
1	6065	Cylinder Head Bolt
2	6049	Cylinder Head
3	6051	Head Gasket (LH)

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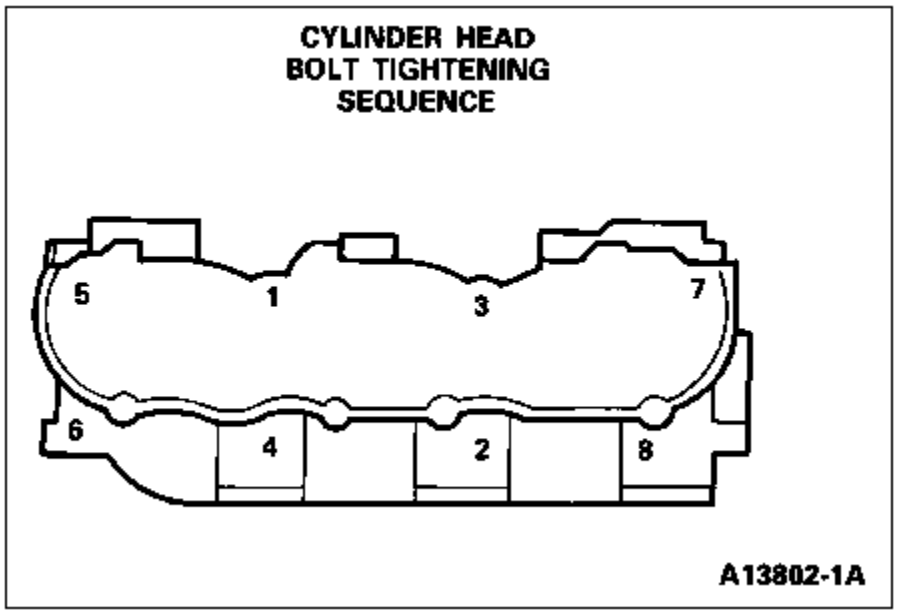
4	6A008	Cylinder Head to Block Dowel
5	6500	Valve Tappet
6	6051	Head Gasket (RH)
A	—	Installation Arrows (on Top) Must Point to Front of Engine

1. Clean mating surfaces to ensure they are free of oil and dirt. Install cylinder head locating dowels.

2. Position cylinder head gaskets on cylinder blocks (6010). The installation arrows on the head gaskets must be pointing to the front of the engine (6007).

3. Install and tighten cylinder head bolts in the sequence shown, in the following steps.

   - Step 1 — 30-35 Nm (22-26 lb-ft)
   - Step 2 — 70-75 Nm (52-56 lb-ft)
   - Step 3 — rotate bolts 90 degrees



4. **NOTE: Once applied, the silicone sealer will set up in approximately 15 minutes. The intake manifold must be installed immediately after the sealer is applied.**

   Apply Silicone Rubber D6AZ-19562-BA or equivalent meeting Ford specifications ESB-M4G92-A and ESE-M4G195-A to the block and cylinder head mating surfaces at the four corners shown. Install the intake manifold gasket (9439) and again apply sealer to the four corner locations.

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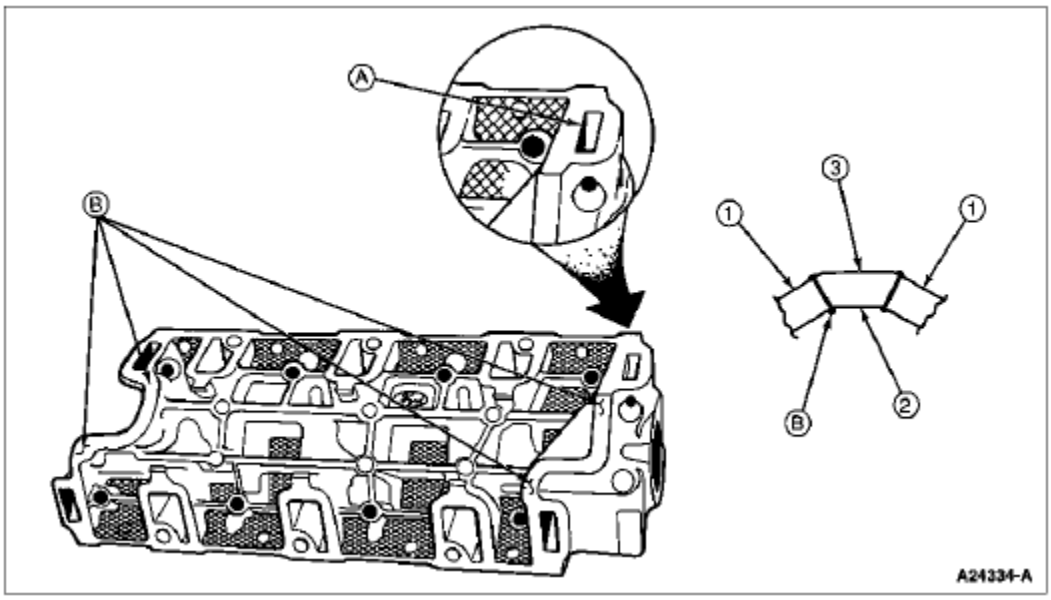

Item	Part Number	Description
1	6049	Cylinder Head
2	9439	Intake Manifold Gasket
3	9424	Intake Manifold
A	—	Examine Closely for Erosion, Corrosion, or Pitting on This Surface
B	—	Silicone Sealer — 4 Places

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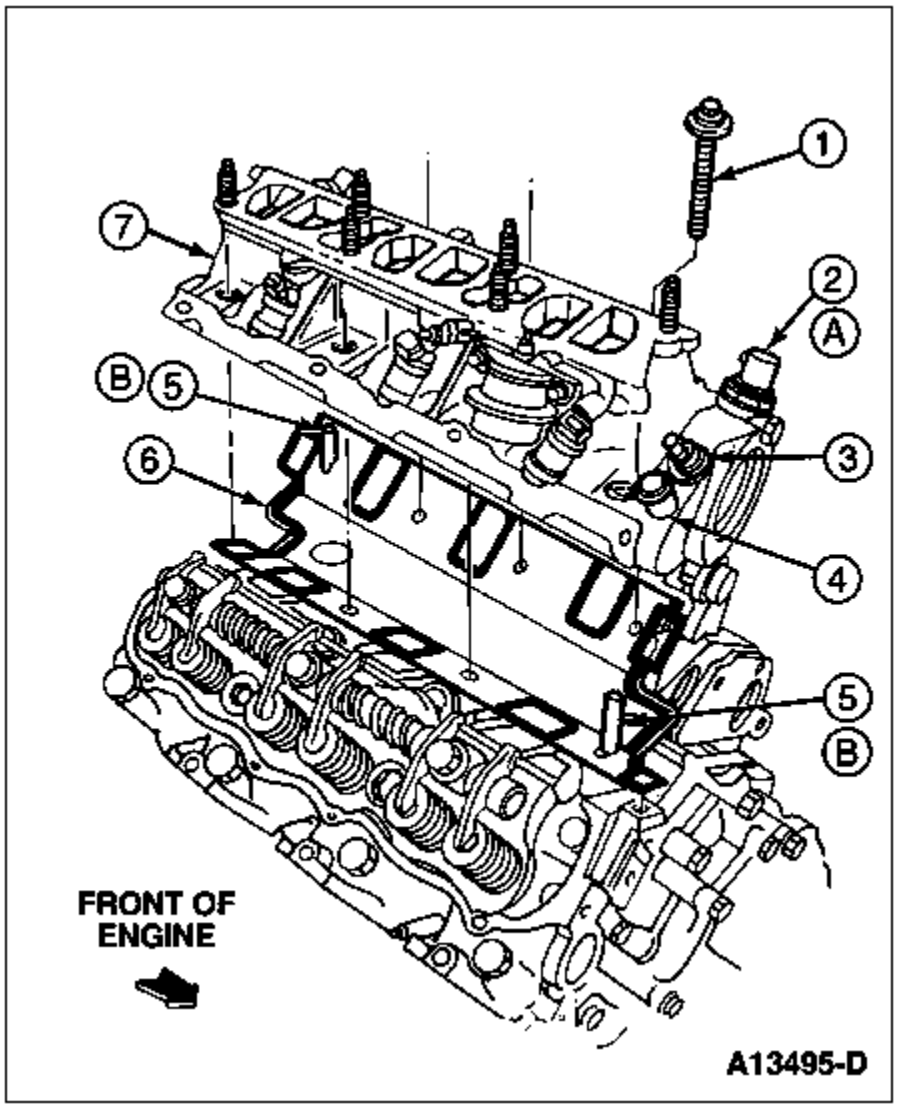

Item	Part Number	Description
1	W702301S309M	Bolt with Captive Washer (8)
2	12A648	Engine Coolant Temperature Sensor
3	10884	Water Temperature Indicator Sender Unit
4	8501	Water Pump
5	—	Stud (2) (Part of 9424)
6	9439	Intake Manifold Gasket
7	9424	Intake Manifold
A	—	Tighten to 16 Nm (12 Lb-Ft)
B	—	Used to Locate Lower Intake Manifold Only

5. Position the intake manifold with the aid of two guide studs located in position 3 and 4 below, and install the bolts hand-tight. Then remove the two guide studs and replace with bolts. Tighten the intake manifold bolts in three stages following the sequence shown.

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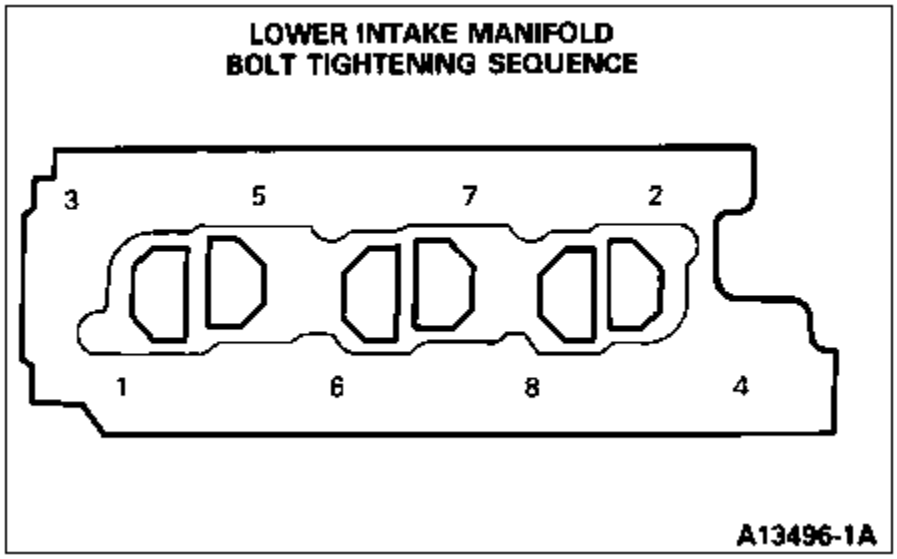
a. 8 Nm (6 lb-ft)
b. 15 Nm (11 lb-ft)
c. 22 Nm (16 lb-ft)



6. Install valve tappets. Install rocker arms (6564) as outlined in this section.
7. Apply Silicone Rubber D6AZ-19562-BA or equivalent meeting Ford specifications ESB-M4G92-A and ESE-M4G195-A to the four locations at the joint where the intake manifold and the cylinder heads meet (as shown).
8. Install valve covers as outlined in this section.
9. Connect the fuel supply and return lines at the fuel supply manifold as outlined in Section 03-04C .
10. Install upper intake manifold as outlined in this section.
11. Install air conditioner compressor on bracket and screw retaining air conditioner manifold tube to upper intake manifold. Tighten compressor bolts to 21-29 Nm (15-21 lb-ft).
12. Install the exhaust inlet pipe, RH exhaust manifold and LH exhaust manifold.
13. Install the spark plugs.
14. Install the generator.
15. Install drive belt over pulleys. Make sure that all V-grooves make proper contact with pulleys.
16. Lift tensioner and slide drive belt under drive belt tensioner. Release tensioner to rest pulley on drive belt.
17. Install the A/C compressor mounting bracket with assembled power steering pump to the cylinder heads.
18. Install the A/C compressor (19703) (if equipped).

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19. Fill and bleed the cooling system as detailed in Section 03-03 .

20. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

    Connect the battery ground cable at the battery.

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Crankshaft Pulley/Damper/Front Oil Seal

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Crankshaft Damper Remover	T74P-6316-A
Front Cover Aligner	T74P-6019-A

Removal

1. Lift drive belt tensioner (6B209) by rotating it clockwise. Remove drive belt (8620).
2. Remove crankshaft pulley bolt.
3. Remove crankshaft vibration damper and pulley from crankshaft (6303) using Crankshaft Damper Remover T74P-6316-A.
4. Pry crankshaft front seal (6700) from engine front cover (6019) with a flat-bladed screwdriver or other similar tool. Use care to prevent damage to engine front cover and crankshaft.

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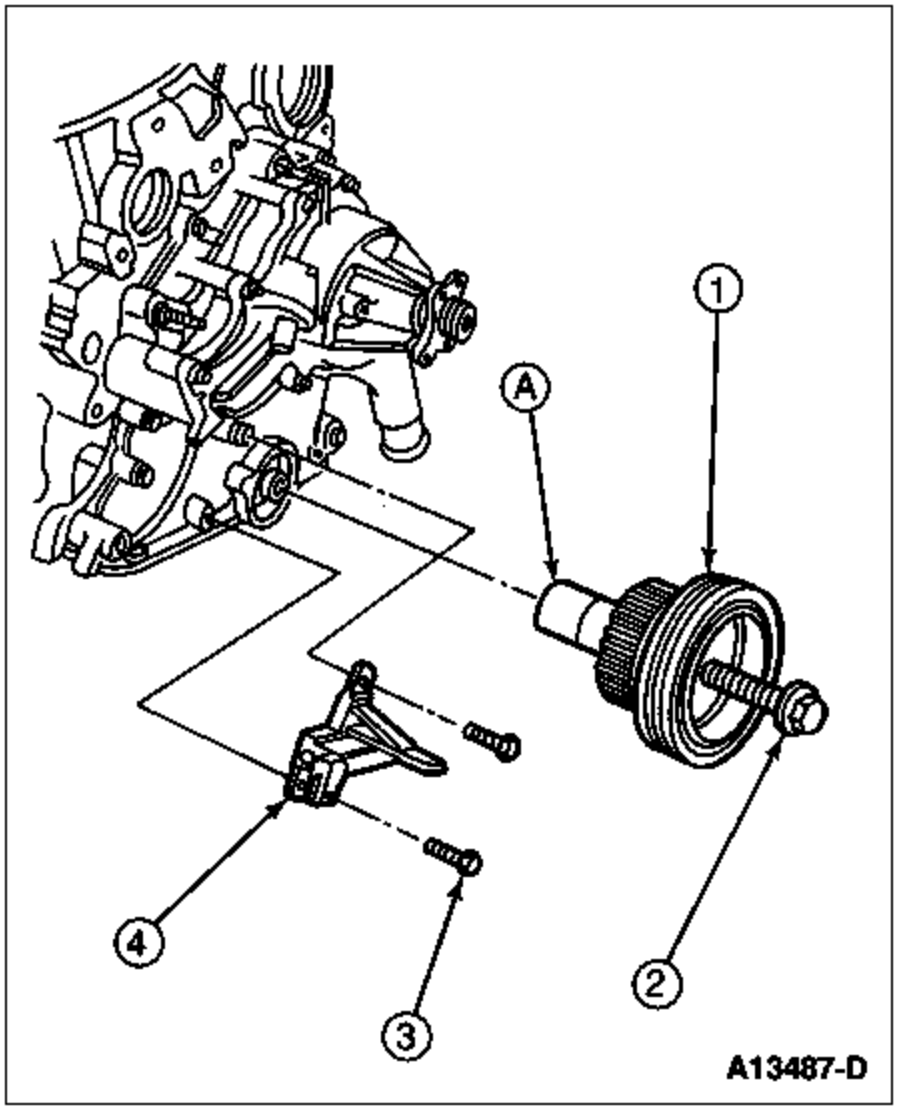

Item	Part Number	Description
1	6312	Crankshaft Pulley
2	E800611	Crankshaft Pulley Bolt
3	E602164	Screw
4	6C315	Crankshaft Position Sensor
A	—	Lubricate with Engine Oil

Installation

1. Inspect engine front cover and shaft seal surface of the crankshaft damper for damage, nicks, burrs or other roughness which may cause the new seal to fail. Service or replace components as necessary.

2. **CAUTION: Do not drive damper on with a hammer.**

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Lubricate seal lip with clean engine oil XO-5W30-QSP or equivalent meeting Ford specification ESE-M2C153-E or SAE 5W-30 Service SG engine oil and install crankshaft front seal using Front Cover Aligner T74P-6019-A and Crankshaft Front Seal Installer T90T-6701-A.

3. Coat crankshaft damper sealing surface with clean engine oil XO-5W30-QSP or equivalent meeting Ford specification ESE-M2C153-E or SAE 5W-30 Service SG engine oil. Apply RTV using Rotunda RTV Dispenser or equivalent to keyway of damper prior to installation. Install damper using Crankshaft Damper Replacer T74P-6316-B. Install damper attaching bolt and tighten to 40-50 Nm (30-37 lb-ft), then turn bolt an additional 80-90 degrees tighter.

4. Install accessory drive belt over pulleys. Make sure that all V-grooves make proper contact with pulley.

5. Lift tensioner and slide belt under tensioner pulley. Release tensioner to rest pulley on belt.

6. Start engine and check for oil leaks.

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Front Cover Oil Seal

SPECIAL SERVICE TOOL(S) REQUIRED

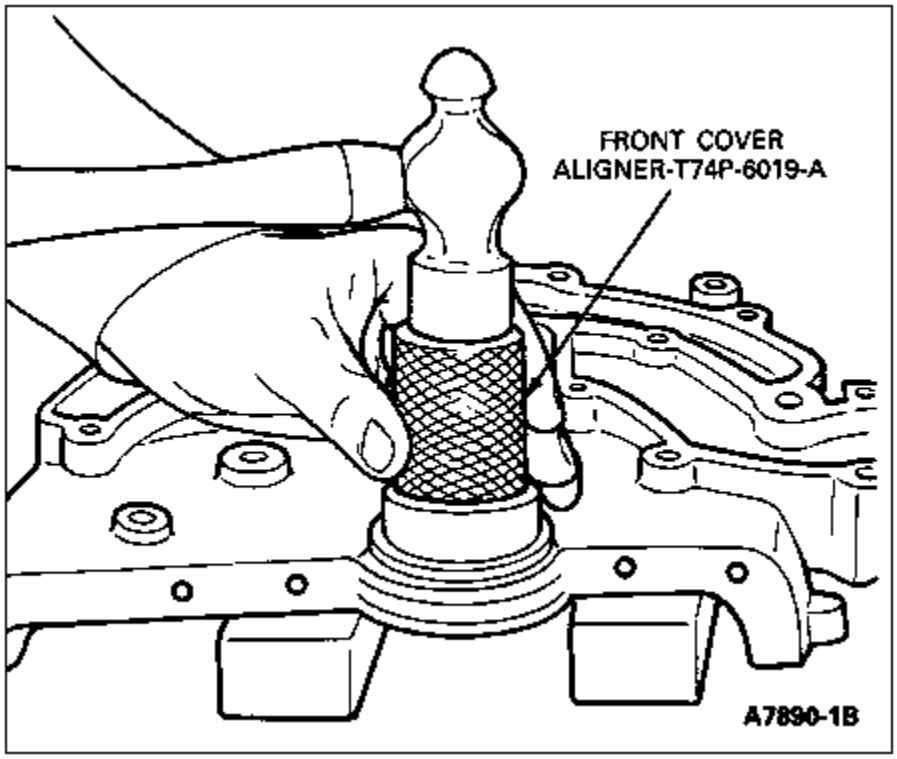
Description	Tool Number
Front Cover Aligner	T74P-6019-A
Front Crank Seal Replacer	T90T-6701-A

Removal

1. Support the front cover to prevent damage while driving out seal.
2. Drive out seal from front cover with Front Cover Aligner T74P-6019-A or with Front Crank Seal Replacer T90T-6701-A.

Installation

1. Support the front cover to prevent damage while installing seal.
2. Coat the new front cover oil seal with SAE 50 Service SG engine oil. Install the new seal in the front cover as shown with Front Cover Aligner T74P-6019-A.



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Water Pump

Removal

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Fan Clutch Holding Tool	T84T-6312-C
Fan Clutch Nut Wrench	T84T-6312-D

NOTE: The drive belt routing, drive belt tensioner (6B209), and idler pulley have changed. The following illustration shows current accessory drive configuration.

Engine Accessory Drive

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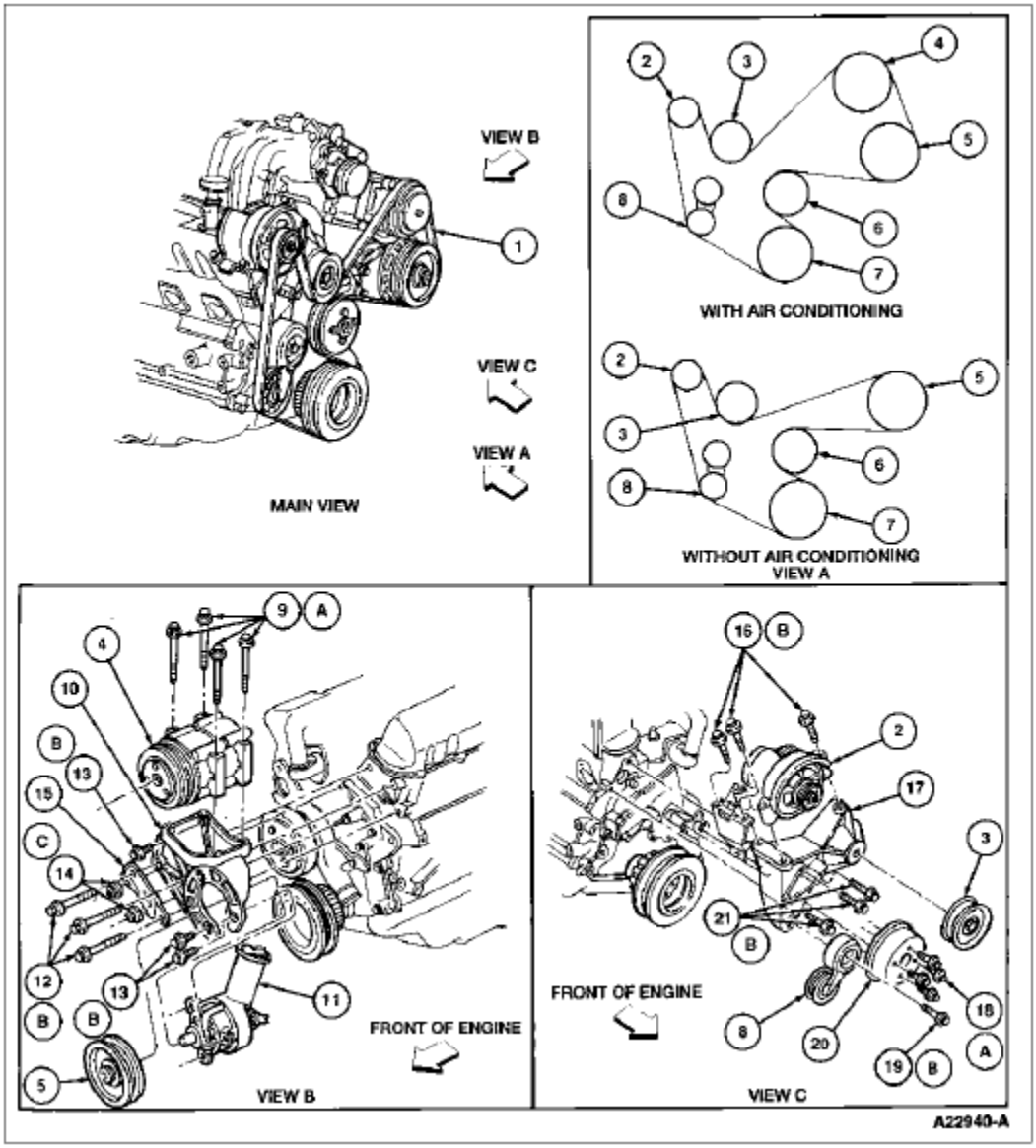

Item	Part Number	Description
1	8620	Drive Belt
2	10300	Generator
3	8678	Belt Idler Pulley
4	19703	A/C Compressor
5	3A733	Power Steering Pump Pulley
6	8501	Water Pump
7	6312	Crankshaft Pulley
8	6B209	Drive Belt Tensioner
9	N806020-S309	A/C Compressor Bolts (4 Req'd)
10	2882	A/C Compressor Mounting Bracket

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11	3A674	Power Steering Pump
12	N606572-S2	A/C Compressor Mounting Bracket Bolts (3 Req'd)
13	N800199-S309	Power Steering Pump Bolts (3 Req'd)
14	N620481-S2	A/C Compressor Mounting Bracket Brace Nuts (2 Req'd)
15	3C718	A/C Compressor Mounting Bracket Brace
16	N606068-S2	Generator Bolts (3 Req'd)
17	10153	Generator Mounting Bracket
18	N802096-S2	Water Pump Pulley Bolts (4 Req'd)
19	N605805-S2	Drive Belt Tensioner Bolt
20	8509	Water Pump Pulley
21	N606068-S2	Generator Mounting Bracket Bolts (3 Req'd)
A	—	Tighten to 22-28 Nm (17-20 Lb-Ft)
B	—	Tighten to 40-55 Nm (30-40 Lb-Ft)

1. Drain the coolant. Detach the lower radiator hose (8286) and the heater return hose from the water pump (8501). Refer to Section 03-03 .

2. Remove fan blade (8600) and fan clutch (8A616) assembly using Fan Clutch Holding Tool T84T-6312-C and Fan Clutch Nut Wrench T84T-6312-D.

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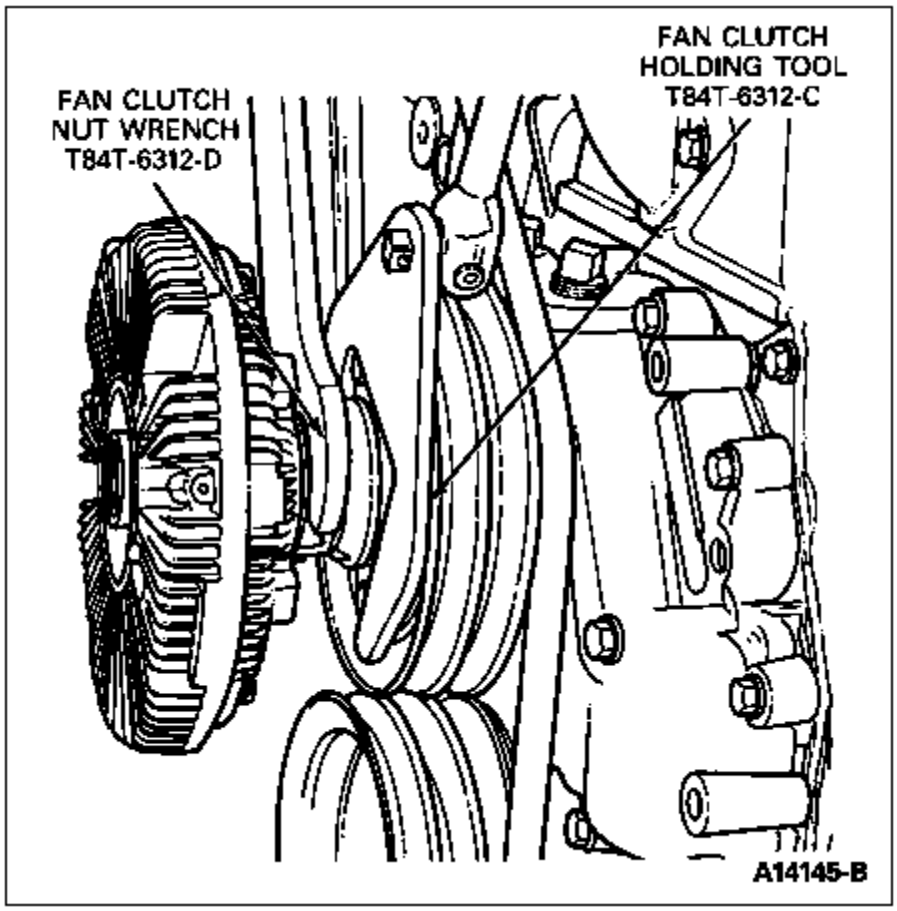

3. Lift drive belt tensioner by rotating it counterclockwise and remove drive belt (8620).
4. Without disconnecting lines, remove A/C compressor mounting bracket (2882) and brace with assembled A/C compressor (19703) and power steering pump (3A674) and set to one side.
5. Remove two bolts and drive belt tensioner.
6. Remove three bolts and generator mounting bracket (10153) with assembled generator (GEN) (10346) and set to one side.
7. Remove the water pump pulley (8509).
8. Remove the water pump assembly attaching bolts and remove water pump.

Installation

1. Remove all gasket material from the sealing surfaces on engine front cover (6019) and water pump assembly. Apply sealer to both sides of the new water pump housing gasket (8507) and place the water pump housing gasket on the water pump.
2. Position the water pump to the front cover with two bolts finger-tight. Tighten all water pump assembly attaching bolts to 8.5-12 Nm (6-9 lb-ft).

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3. Install water pump pulley. Tighten bolts to 22-28 Nm (16-20 lb-ft).

4. Install generator mounting bracket with assembled generator. Tighten bracket-to-cylinder head bolts to 40-55 Nm (30-40 lb-ft).

5. Install drive belt tensioner. Tighten bolts to 40-55 Nm (30-40 lb-ft).

6. Install A/C compressor mounting bracket and brace with assembled power steering pump and A/C compressor. Tighten three bracket-to-cylinder head bolts and two bracket-to-front cover nuts to 40-55 Nm (30-40 lb-ft).

7. Install fan blade and fan clutch assembly using Fan Clutch Holding Tool T84T-6312-C and Fan Clutch Nut Wrench T84T-6312-D. Tighten to 40-135 Nm (30-100 lb-ft).

8. Start the engine (6007) and check for leaks.

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Engine Front Cover

Removal

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Fan Clutch Holding Tool	T84T-6312-C
Fan Clutch Nut Wrench	T84T-6312-D
Crankshaft Damper Remover	T74P-6316-A
Crankshaft Front Seal Replacer	T90T-6701-A

1. **NOTE: It is necessary to remove oil pan to properly reseal front cover to oil pan. For Ranger it is necessary to remove engine to remove oil pan. For Aerostar it is necessary to remove transmission to reseal oil pan.**

   On Ranger, remove engine (6007) as outlined in this section.

2. On Aerostar:

   a. Open hood and remove air cleaner outlet tube (9B659).
   b. Drain coolant. Lift drive belt tensioner (6B209) by rotating it counterclockwise and remove drive belt (8620).
   c. Remove fan clutch (8A616) and fan blade (8600) using Fan Clutch Holding Tool T84T-6312-C and Fan Clutch Nut Wrench T84T-6312-D.
   d. Remove four screws and fan shroud (8146).
   e. Without disconnecting lines, remove A/C compressor mounting bracket (2882) and brace with assembled A/C compressor (19703) and power steering pump (3A674) and set to one side.
   f. Remove two bolts and drive belt tensioner.
   g. Remove three bolts and generator mounting bracket (10153) with assembled generator (GEN) (10346) and set to one side.
   h. Raise vehicle and remove transmission as outlined in Group 07.

3. Remove water pump pulley (8509).

4. Remove lower radiator hose (8286).

5. **NOTE: Engine front cover (6019) may be removed with water pump (8501) attached.**

   Remove water pump if necessary.

6. Remove bolt and, using Crankshaft Damper Remover T74P-6316-A, remove crankshaft vibration damper and pulley (6B321).

7. Remove crankshaft position sensor (CKP sensor) (6C315).

8. Remove engine front cover. Note location of different length bolts as you remove cover.

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9. Remove oil pan (6675) as outlined in this section.

Installation

1. Remove gasket material and sealer from gasket surfaces. Inspect engine front cover and damper seal surface for nicks, burns, or other roughness which could cause a gasket or seal to fail.
2. Apply sealing compound to cylinder block sealing surfaces.
3. Apply sealing compound to front cover gasket surface and position engine front cover gasket (6020) on front cover.
4. If necessary, replace crankshaft front seal (6700) using Crankshaft Front Seal Replacer T90T-6701-A.
5. Place outer timing belt cover on engine and start all retaining bolts two or three turns. Make sure to get different length bolts back in their proper holes.
6. Position engine front cover to the center of the crankshaft (6303) and to oil pan sealing face of the cylinder blocks (6010).
7. Tighten front cover bolts to 17-21 Nm (13-15 lb-ft).
8. Install crankshaft position sensor.
9. Install oil pan as outlined in this section.
10. Lubricate seal lip with clean engine oil X0-5W30-QSP or equivalent meeting Ford specification ESE-M2C153-E or SAE 5W-30 Service SG engine oil and install crankshaft front seal using Crankshaft Front Seal Installer T90T-6701-A.
11. Coat crankshaft damper sealing surface with clean engine oil X0-5W30-QSP or equivalent meeting Ford specification ESE-M2C153-E or SAE-5W-30 Service SG engine oil.
12. Apply Silicone Rubber D6AZ-19562-BA or equivalent meeting Ford specifications ESB-M4G92-A and ESE-M4G195-A to keyway of crankshaft vibration damper and pulley prior to installation.
13. **CAUTION: Do not drive damper on with a hammer.**

    Install crankshaft vibration damper and pulley using Crankshaft Damper Replacer T74P-6316-B. Install crankshaft pulley bolt and tighten to 40-50 Nm (30-37 lb-ft), then turn bolt an additional 80-90 degrees tighter.
14. If water pump was removed from engine front cover:
    a. Install water pump housing gasket (8507) on the water pump.
    b. Position water pump on engine front cover with two bolts finger-tight. Tighten all water pump bolts to 8.5-12 Nm (6-9 lb-ft).
15. On Ranger, install engine as outlined in this section.

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16. On Aerostar:

    a. Install transmission as outlined in Group 07.
    b. Install lower radiator hose.
    c. Install water pump pulley. Tighten bolts to 22-28 Nm (17-21 lb-ft).
    d. Install generator mounting bracket with assembled generator. Tighten bracket-to-cylinder head bolts to 40-50 Nm (30-37 lb-ft).
    e. Install drive belt tensioner. Tighten bolts to 40-50 Nm (30-40 lb-ft).
    f. Install A/C compressor mounting bracket and brace with attached power steering pump and A/C compressor. Tighten three bracket-to-cylinder head bolts and two bracket-to-front cover nuts to 40-55 Nm (30-40 lb-ft).
    g. Install fan shroud.
    h. Install fan blade and fan clutch assembly using Fan Clutch Holding Tool T84T-6312-C and Fan Clutch Nut Wrench T84T-6312-D. Tighten to 40-135 Nm (30-100 lb-ft).

17. Install drive belt over pulleys. Make sure that all V-grooves make proper contact with the pulleys.

18. Lift tensioner and slide drive belt under tensioner pulley. Release drive belt tensioner to rest pulley on belt.

19. Install air cleaner outlet tube.

20. Refill cooling system. Start engine and check for leaks.

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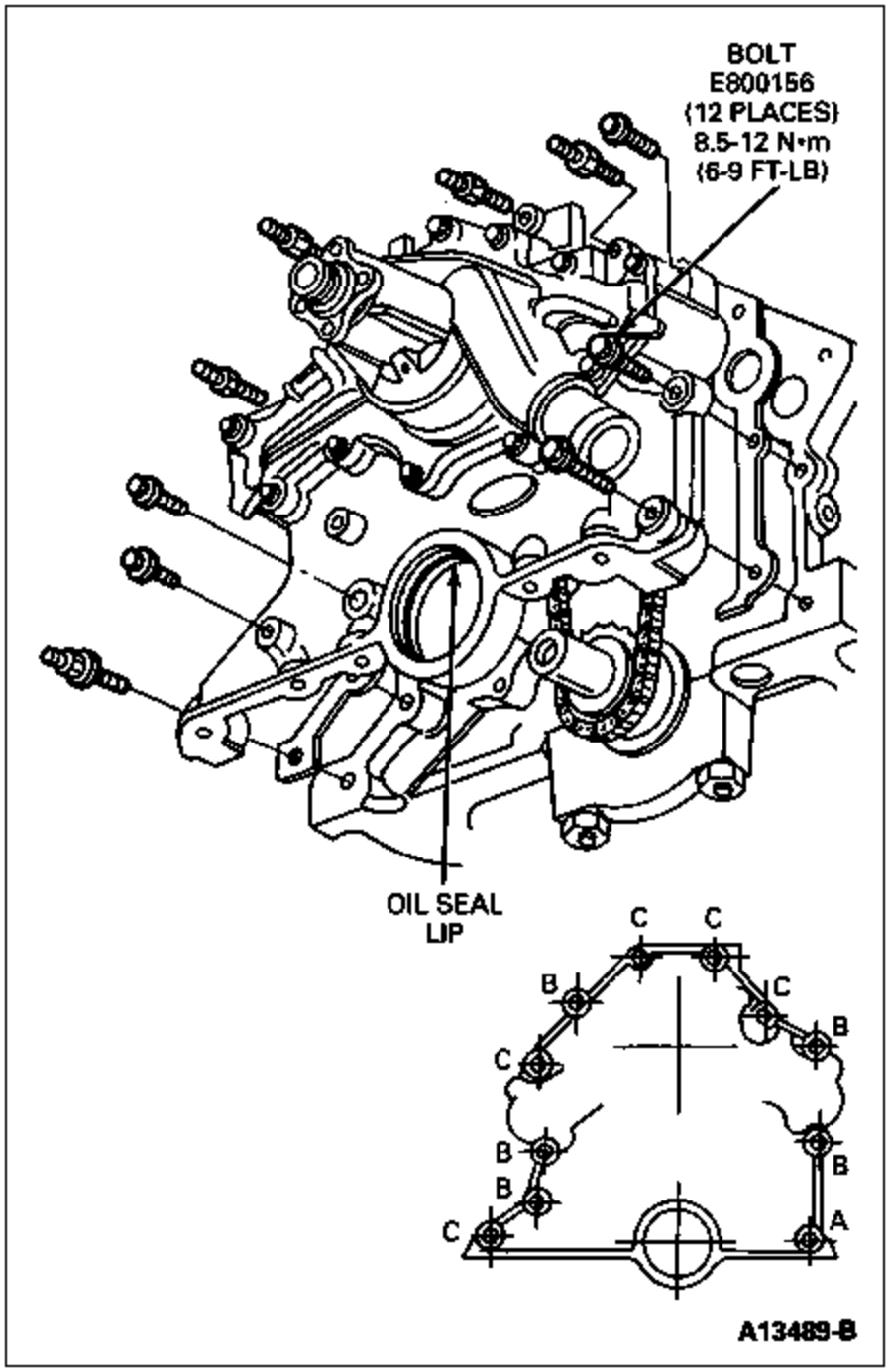

FRONT COVER BOLTS

Fastener	Location	Size	Quan.	Torque Nm (Lb-Ft)
Bolt	A	M8x47	(1)	17-21 (13-15)
Bolt	B	M8x25	(5)	17-21 (13-15)
Stud	C	M8-47-19	(5)	17-21 (13-15)

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Timing Chain, Sprockets, Tensioners and Guides

Removal

NOTE: It is necessary to replace oil pan gasket (6710) when removing and installing engine front cover (6019). On Ranger, it is necessary to remove engine (6007) to remove oil pan (6675). On Aerostar, it is necessary to remove transmission to properly seal oil pan

1. On Aerostar vehicles remove radiator (8005) as outlined in Section 03-03 .
2. Remove engine front cover as outlined in this section.
3. **NOTE: A packaging clip from a new automatic tensioner can be used to hold tensioner in a retracted position. If a packaging clip is not available, fabricate a clip to hold the tensioner in a retracted position using shop materials.**

   Push timing chain/belt tensioner (6K254) into the retracted position and install retaining clip.
4. Remove the camshaft sprocket retaining bolt and the crankshaft sprocket key.
5. Remove the crankshaft sprocket (6306) and camshaft sprocket (6256) with the timing chain/belt (6268).
6. Remove the timing chain/belt and timing chain guide (6K297) as required.

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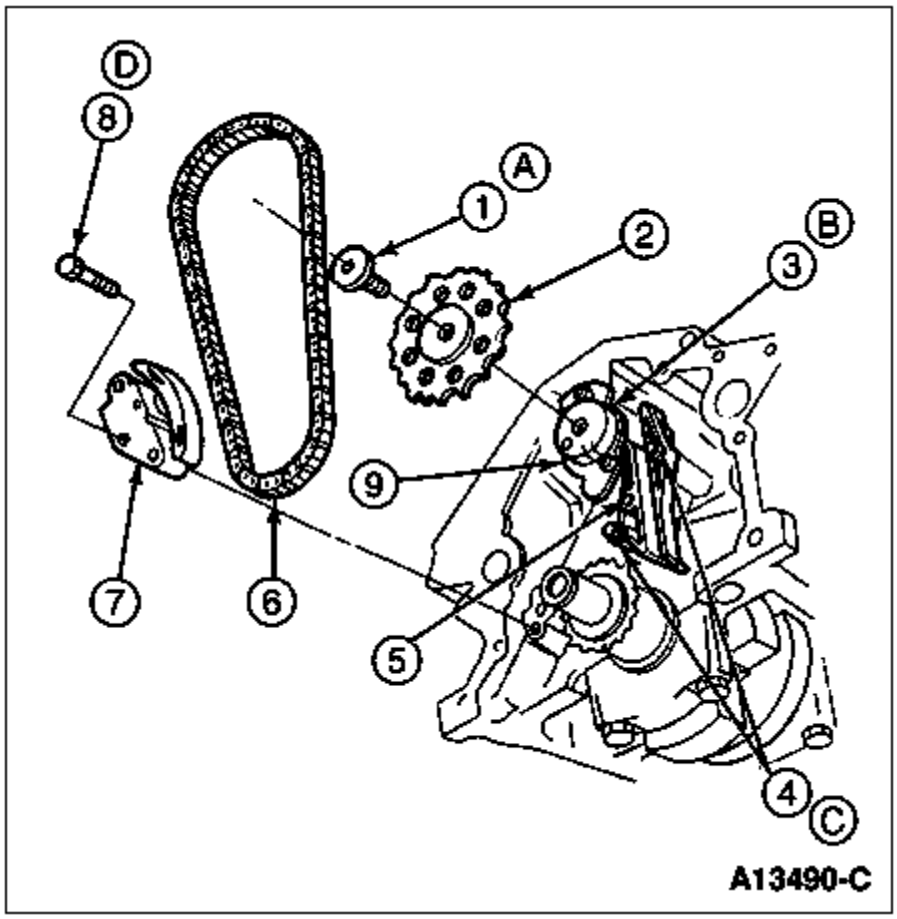

Item	Part Number	Description
1	E804389-S200	Torx® Screw
2	6256	Camshaft Sprocket
3	6250	Camshaft
4	E804358-S75	Torx® Bolt
5	6K297	Timing Chain Guide
6	6268	Timing Chain/Belt
7	6K254	Timing Chain/Belt Tensioner
8	E600112-S	Bolt
9	6269	Camshaft Thrust Plate
A	—	Tighten to 60-68 Nm (40-50 Lb-Ft)
B	—	Camshaft End Play to Be Within 0.065-0.165mm (0.025-0.064 Inch)
C	—	Tighten to 10-12 Nm (7-9 Lb-Ft)
D	—	Tighten to 9-11 Nm

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		(7-8 Lb-Ft)

Installation

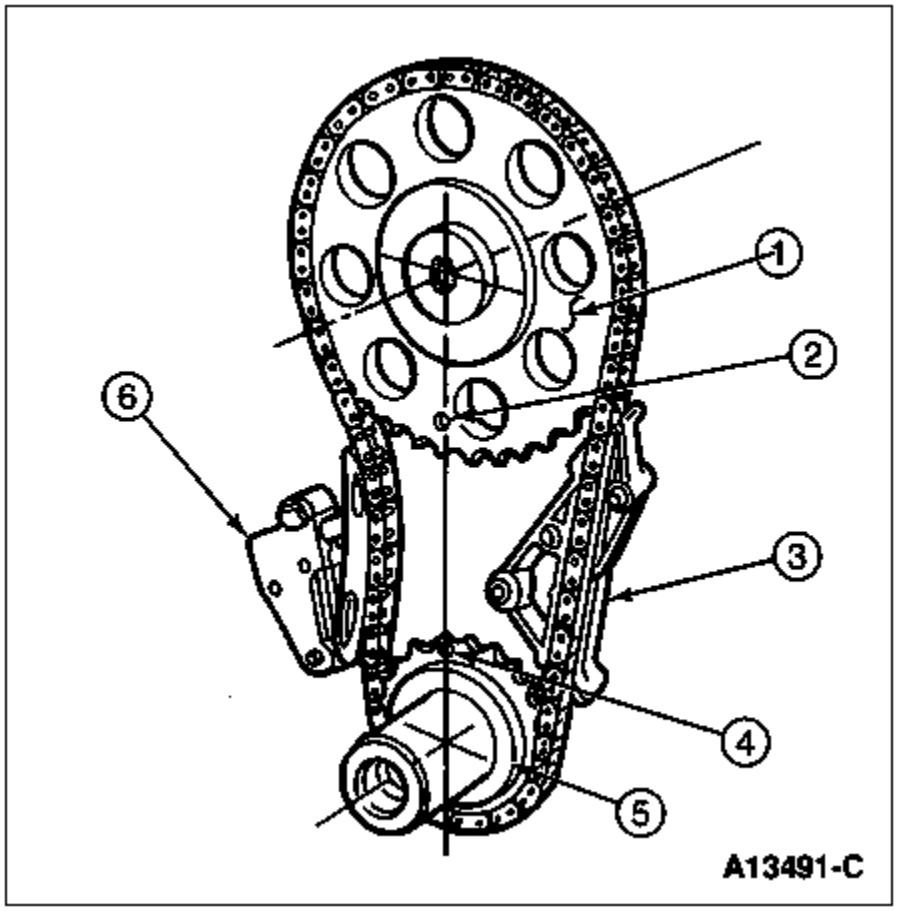
1. Install the timing chain guide to the cylinder blocks (6010) with the pin of the guide inserted into the oil hole in the block. Install the two retaining bolts, and tighten to 10-12 Nm (7-9 lb-ft).

2. Position the camshaft (6250) so the timing mark will align with the crankshaft (6303). Position the crankshaft so the timing mark will align with the camshaft.

3. Install the crankshaft sprocket, camshaft and timing chain/belt together.

4. **NOTE: Make sure that the tensioner side of the timing chain is held inward, and that the guide side of the chain is straight and tight.**

   Install the crankshaft key and check the timing marks on the crankshaft sprocket and camshaft sprocket for correct alignment (as shown).



Item	Part Number	Description

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1	6256	Camshaft Sprocket
2	—	Camshaft Timing Mark (Part of 6256)
3	6K297	Timing Chain Guide
4	—	Crankshaft Timing Mark (Part of 6306)
5	6306	Crankshaft Sprocket
6	6K254	Timing Chain/Belt Tensioner

5. Install the camshaft sprocket retaining bolt, and tighten to 60-68 Nm (44-50 lb-ft).
6. Remove the clip from the timing chain/belt tensioner.
7. Check the camshaft end play as outlined in Section 03-00 .
8. Install the engine front cover as outlined in this section. On Aerostar, install the radiator.
9. Fill and bleed the cooling system. Refer to Section 03-03 .
10. Fill the crankcase with clean engine oil of the recommended grade and viscosity.
11. Start the engine and operate at fast idle. Check for coolant and oil leaks.

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Camshaft

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Sensor Adjusting Wrench	T94T-12270-A

NOTE: 4.0L OHV engines are equipped with a camshaft position sensor (CMP sensor) (12A112) mounted on the camshaft synchronizer (12A362). The camshaft synchronizer replaces the oil pump drive assembly. To perform the removal and installation procedure for the camshaft (6250), the camshaft synchronizer must be removed after oil pan (6675) removal. Refer to Section 03-14 for camshaft synchronizer removal and installation.

Removal

NOTE: It is necessary to replace oil pan gasket (6710) when removing and installing engine front cover (6019). On the Ranger, it is necessary to remove the engine (6007) to remove the oil pan. On Aerostar, it is necessary to remove the transmission to properly reseal oil pan.

1. On the Ranger, remove engine as outlined in this section.
2. On Aerostar vehicles, remove radiator (8005) as outlined in Section 03-03 and remove transmission as outlined in Group 07.
3. Remove the upper and lower intake manifolds as outlined in this section.
4. Remove the engine front cover as outlined in this section.
5. Remove the oil pan as outlined in this section.
6. Remove the hold-down clamp (12270), screw and oil pump drive shaft from the rear of the cylinder blocks (6010).
7. **NOTE: Ranger has a CID sensor mounted on top of the oil pump drive assembly. Sensor Adjusting Wrench T94T-12270-A is designed for easy access to the hold-down clamp screw.**

   On the Ranger, disconnect the engine wiring harness connector at the CID sensor.
8. Remove the valve covers (6582) and rocker arm shaft (6563) assemblies as outlined in this section. Lift out the push rods (6565) and place in a marked rack so they can be installed in the same location.
9. Remove the valve tappets (6500). Refer to Tappet removal and installation procedure in this section.
10. Push the timing chain/belt tensioner (6K254) into the retracted position, and install the retaining clip.

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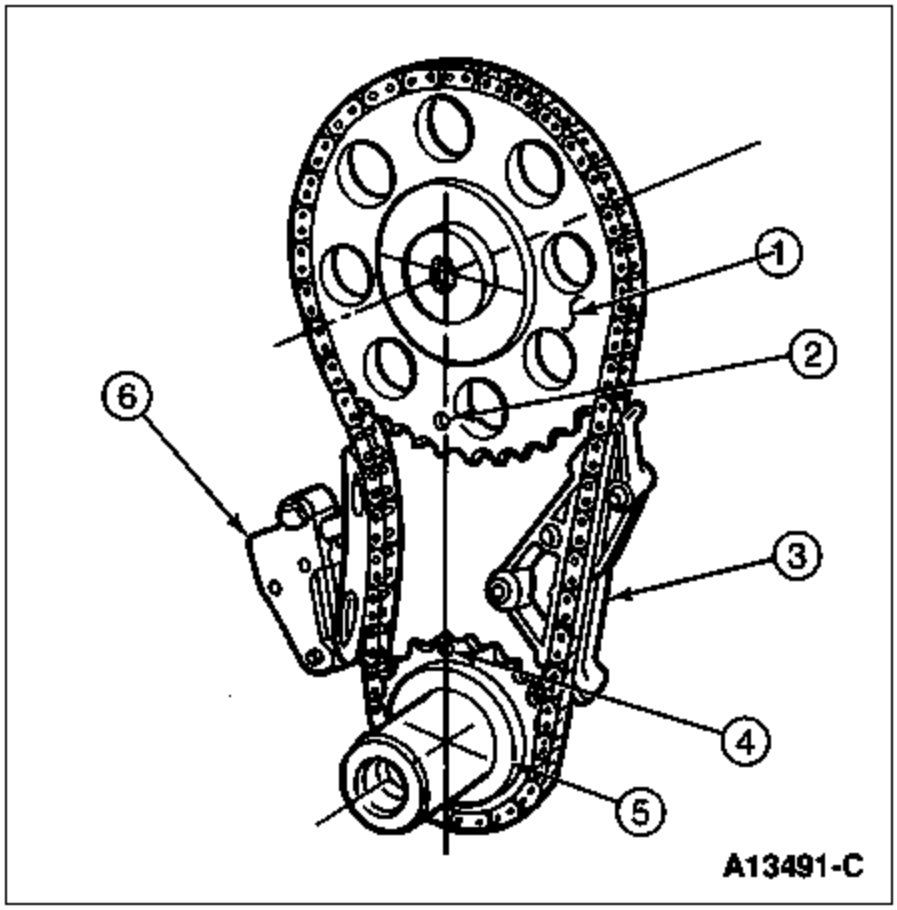

Item	Part Number	Description
1	6256	Camshaft Sprocket
2	—	Camshaft Timing Mark (Part of 6256)
3	6K297	Timing Chain Guide
4	—	Crankshaft Timing Mark (Part of 6306)
5	6306	Crankshaft Sprocket
6	6K254	Timing Chain/Belt Tensioner

11. Remove the camshaft sprocket attaching bolt and remove the camshaft sprocket (6256) from the camshaft.

12. Remove the camshaft thrust plate (6269).

13. Remove the camshaft carefully from the cylinder blocks, avoiding any damage to the camshaft bearings.

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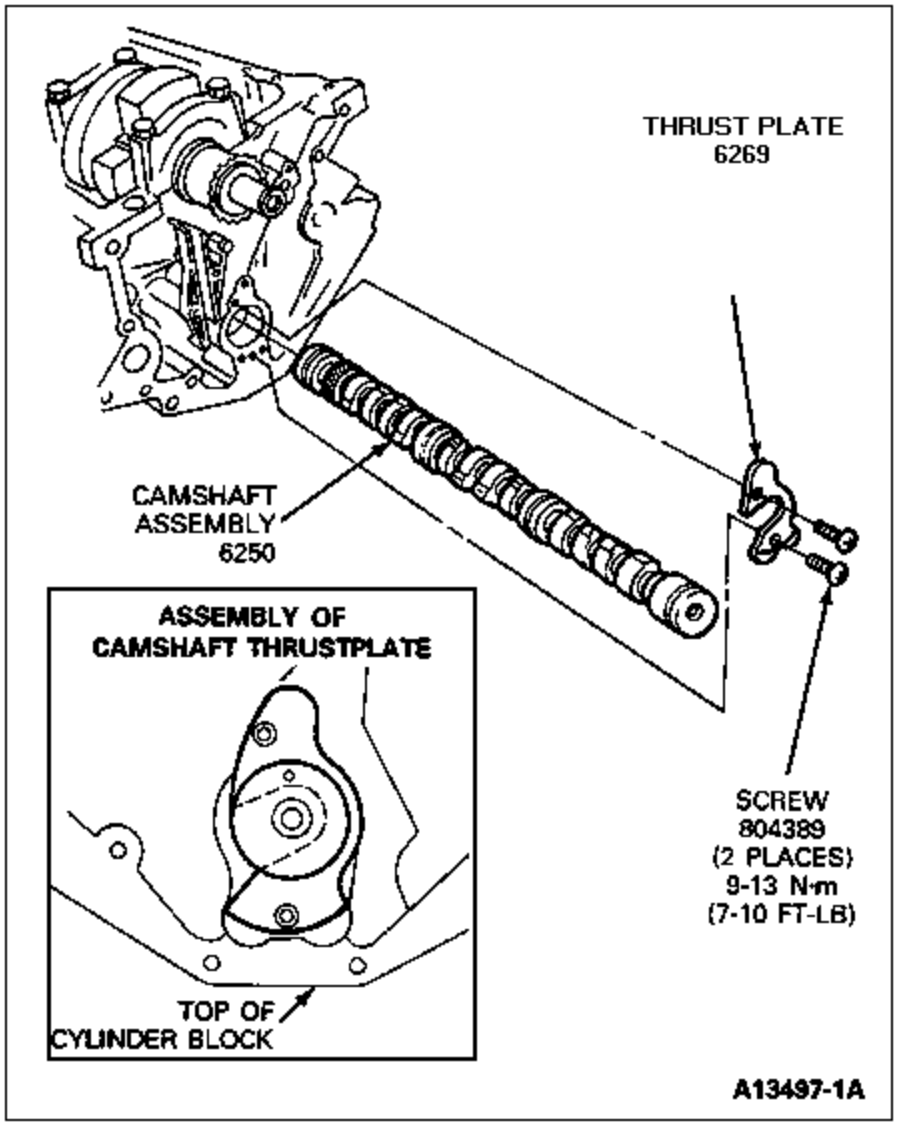

Installation

1. Oil the camshaft journals and cam lobes with SAE 50 Service SG engine oil or equivalent meeting Ford specification ESE-M2C39-F. Insert the camshaft key.

2. Install the camshaft in the cylinder blocks, being careful to avoid damaging the bearing surfaces.

3. Install the thrust plate as shown so that it covers the main oil gallery. Tighten the attaching screws to 9-13 Nm (7-10 lb-ft).

4. Turn the camshaft and crankshaft (6303) as necessary to align the timing marks. Install the camshaft sprocket, install the attaching bolt and tighten to 60-68 Nm (44-50 lb-ft).

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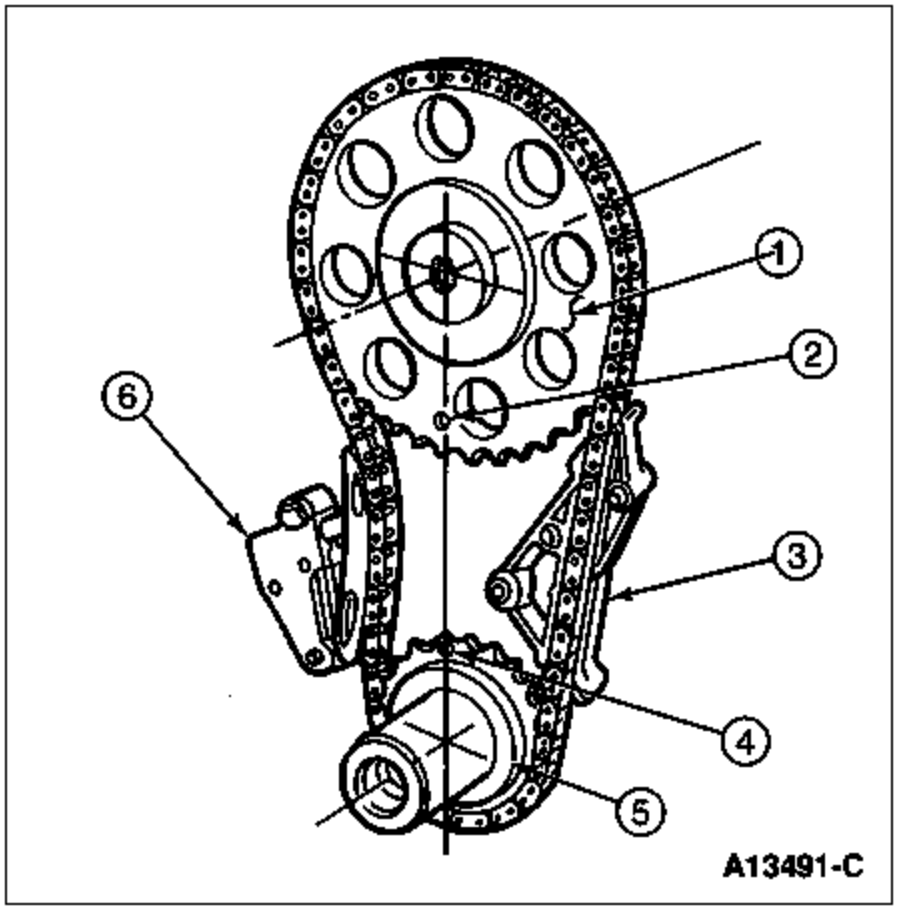

Item	Part Number	Description
1	6256	Camshaft Sprocket
2	—	Camshaft Timing Mark (Part of 6256)
3	6K297	Timing Chain Guide
4	—	Crankshaft Timing Mark (Part of 6306)
5	6306	Crankshaft Sprocket
6	6K254	Timing Chain/Belt Tensioner

5. Check the camshaft for correct end play. Refer to Section 03-00 . End play should be 0.065-0.165mm (0.0025-0.0064 inch). Remove the clip from the timing chain tensioner.

6. Position the valve tappets in their original locations as outlined. Apply SAE 50 Service SG or equivalent oil meeting Ford specification ESE-M2C39-F to both ends of the push rods. Install the push rods in the same locations as removed.

7. Install the intake manifolds as outlined in this section.

8. Install the rocker arm shaft assemblies. Tighten the rocker arm stand bolts evenly and in sequence to 6-8 Nm (53-71 lb-in). Refer to Rocker Arm , Installation in this section.

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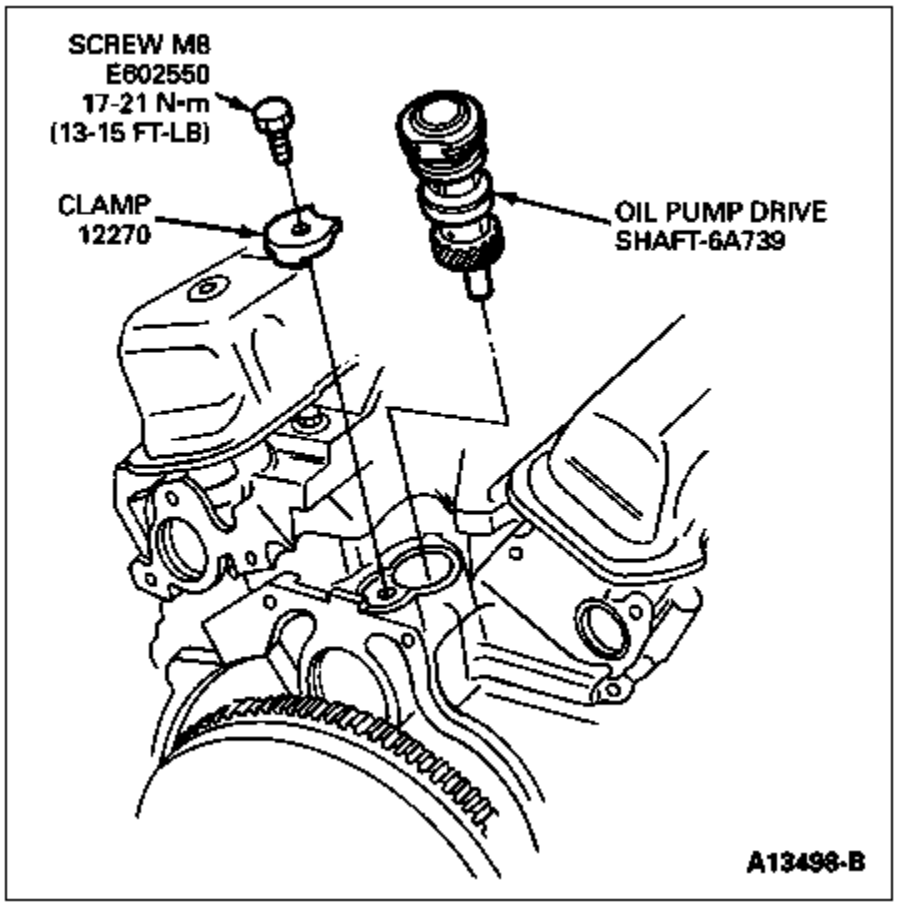
9. Install the valve covers as outlined.

10. Install the engine front cover as an assembly. Refer to Engine Front Cover , Installation, in this section.

11. Install the oil pump drive, hold-down clamp and screw.



12. Install oil pan as outlined in this section.

13. Install engine front cover as outlined in this section.

14. On the Ranger, install engine as outlined in this section.

15. On Aerostar vehicles, install transmission as outlined in this section.

16. On Aerostar, install the radiator.

17. Fill the cooling system to the proper level with the specified coolant and bleed the cooling system as outlined in Section 03-03 .

18. Fill the crankcase with the specified quantity and grade of oil.

19. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive**

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symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.

Connect the battery ground cable (14301) to the battery.

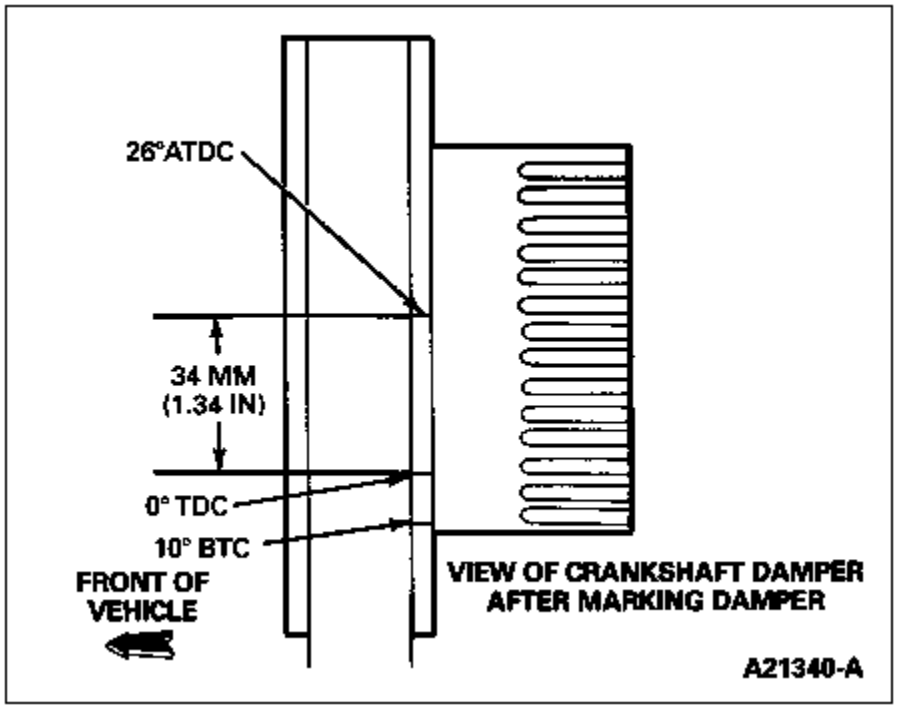
20. Run the engine at fast idle speed and check for coolant, fuel, vacuum and oil leaks.

Installation, Ranger

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
CID Testing Wiring Harness	T94T-50-B

1. After performing Steps 1-11 above, rotate crankshaft until TDC mark on the damper is accessible. If not present, place an additional mark on the damper at 26 degrees After Top Dead Center (ATDC). This position is 34mm (1.34 inches) counterclockwise from the Top Dead Center (TDC) mark.



2. Position No. 1 cylinder to TDC between compression and ignition stroke. (Both intake and exhaust valves must be closed with TDC mark on vibration damper at pointer.)

3. Lubricate oil pump drive pinion and O-ring on assembled oil pump drive gear and CID sensor with SM-2C 1013-A oil. Do not get oil above mounting flange.

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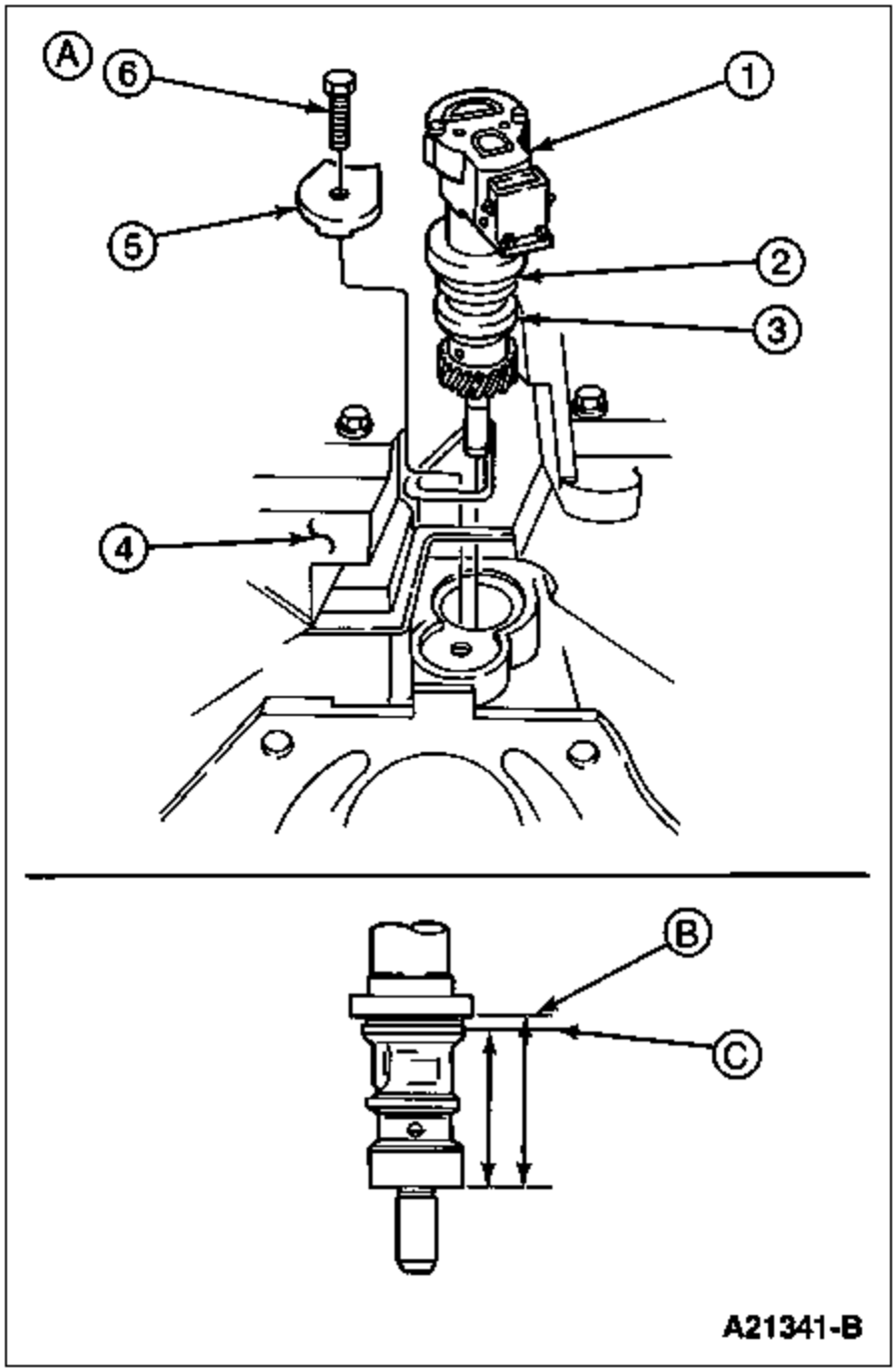

Item	Part Number	Description
1	12K073	CID Sensor
2	E853103-S	O-Ring
3	6846	Oil Pump Drive Assembly
4	6007	Engine
5	12270	Hold-Down Clamp
6	E602550	Screw

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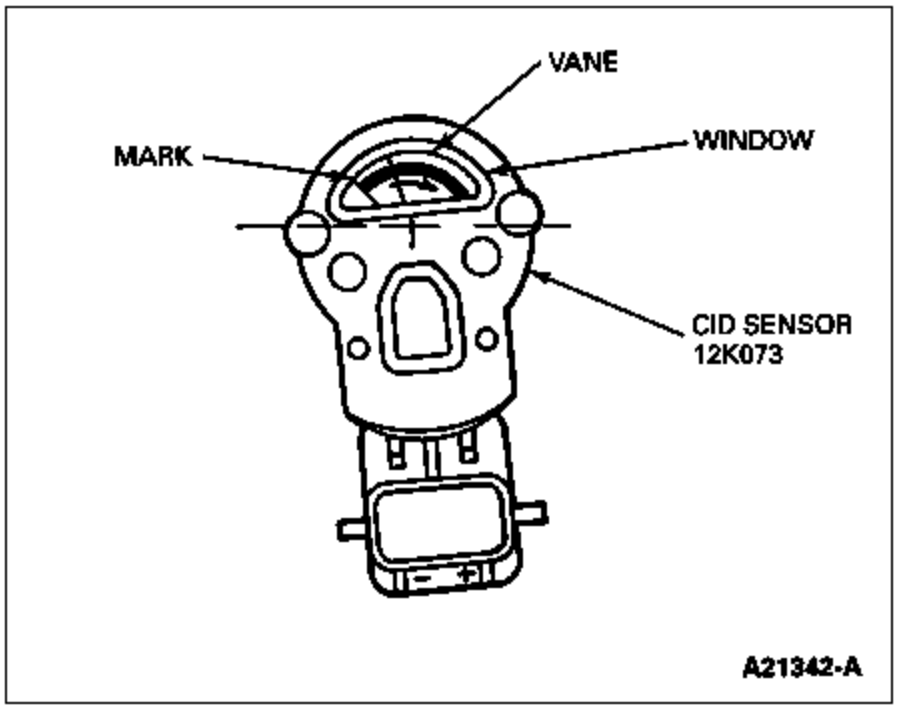
A	—	Tighten to 17-21 Nm (13-15 Lb-Ft)
B	—	Maximum Level for Pre-Oiling Drive Gear
C	—	Minimum Level for Pre-Oiling Drive Gear

4. **NOTE: Normal CID sensor rotation is clockwise viewed from top of CID sensor.**

   Align the CID sensor rotor as shown with the trailing edge of the vane lined up with the short mark at the left-hand side of the plastic window.



5. Position the sensor above its hole at right angles to the block rear face.

6. Install the assembled CID sensor and oil pump drive gear into the engine. As the assembly is pushed into place, the camshaft gear will rotate the sensor vane clockwise toward the center of the window.

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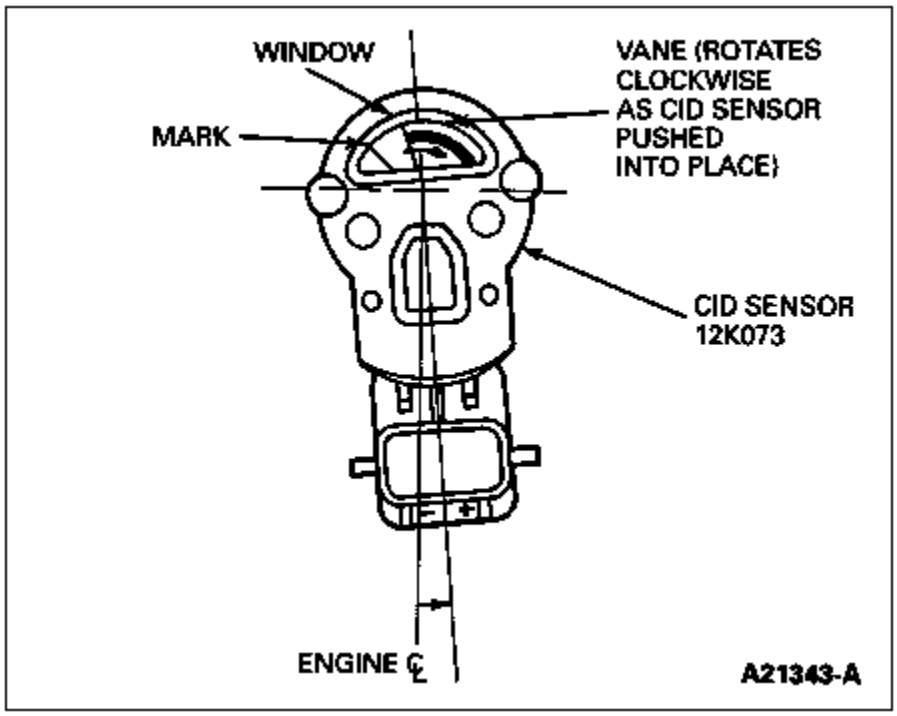
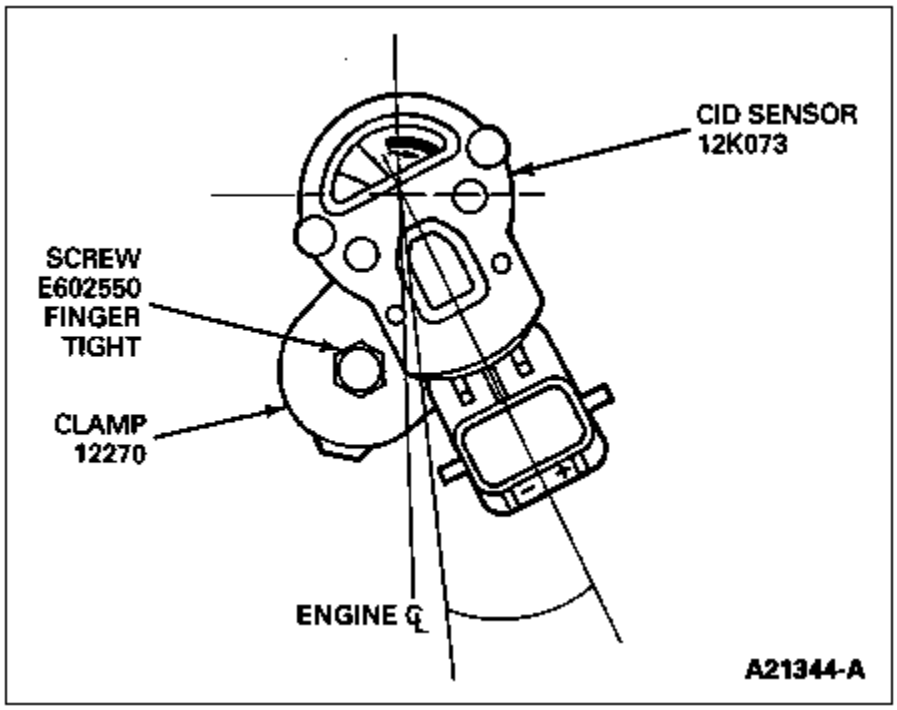


7. Rotate the CID sensor counterclockwise. Install clamp and screw finger-tight. Rotate the sensor back to its position at right angles to the back of the block.



8. Connect the CID Testing Wiring Harness T94T-50-B to the CID Sensor.

9. Connect the CID Testing Wiring Harness leads:

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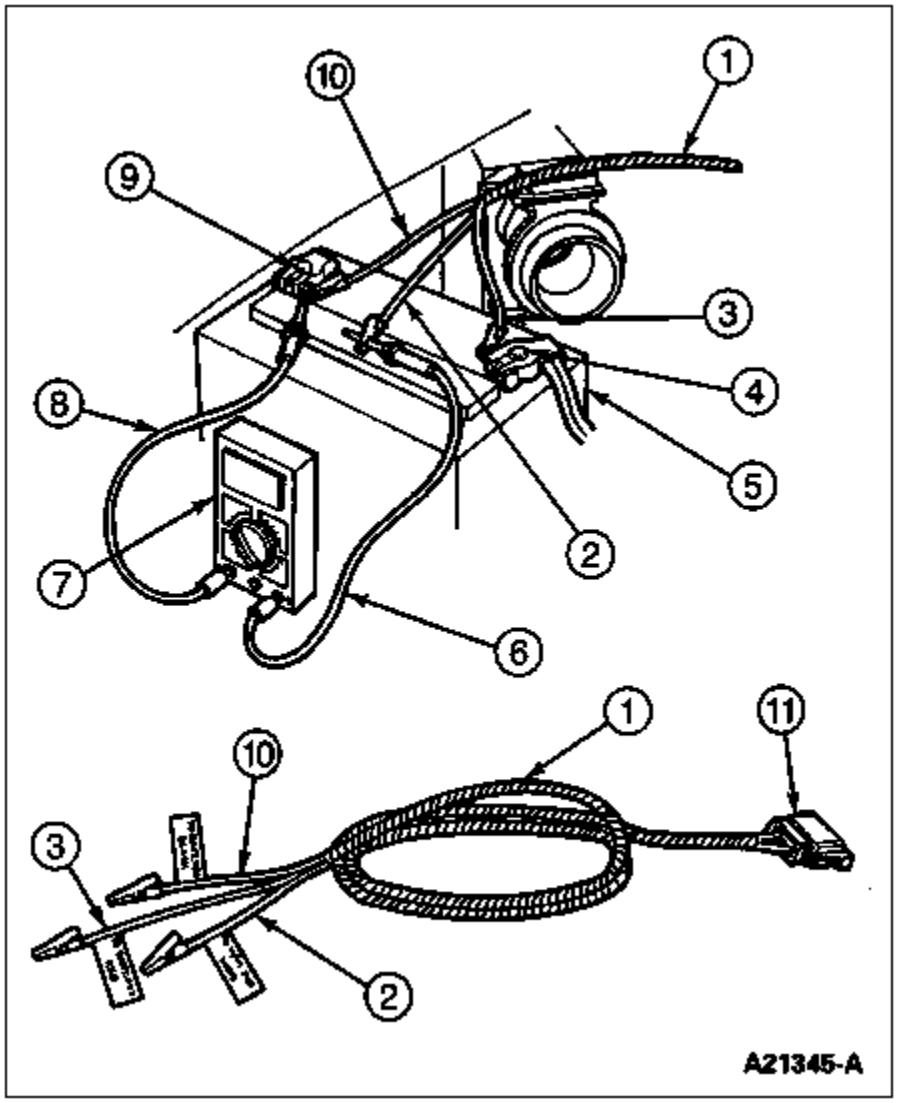
a. Red harness wire to battery positive terminal.
b. Black harness wire to battery negative terminal.
c. Voltmeter positive lead to harnesses white lead.
d. Voltmeter negative lead to battery negative terminal.



Item	Part Number	Description
1	T94T-50-B	CID Testing Wiring Harness
2	—	White Lead (Part of T94T-50-B)
3	—	Red Lead (Part of T94T-50-B)
4	—	Positive Terminal (Part of 10655)
5	10655	Battery
6	—	Red Lead (Part of 007-00407)

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7	007-00407	Rotunda Digital Volt-Ohmmeter or Equivalent
8	—	Black Lead (Part of 007-00407)
9	—	Negative Terminal (Part of 10655)
10	—	Black Lead (Part of T94T-50-B)
11	—	Connector (Part of T94T-50-B) (Attaches to CID Sensor)

10. Rotate engine two revolutions to take up slack in timing chain and return No. 1 cylinder to its compression stroke.

11. **NOTE: No. 1 cylinder must be at 26 degrees After Top Dead Center (ATDC) to set CID sensor.**

    Verify that No. 1 cylinder is on its compression stroke (both valves closed).

12. Continue to rotate the crankshaft until the new 26 degrees ATDC mark lines up with the timing pointer.

13. **NOTE: The voltmeter will register battery voltage whenever the CID sensor closes and makes a complete circuit.**

    While rotating the CID sensor, note the exact point where the sensor switches from 0 to 12 volts on the voltmeter.

14. **NOTE: The final movement to set the CID sensor must be in a COUNTERCLOCKWISE direction.**

    Rotate the CID sensor clockwise past the CID switching point (from 12 to 0 volts).

15. Rotate the CID sensor counterclockwise and stop at the exact point the voltmeter switches from 0 to 12 volts.

16. Tighten the CID sensor hold-down bolt to 17-21 Nm (13-15 lb-ft) using Sensor Adjusting Wrench T94T-12270-A.

17. Disconnect the testing wiring harness and the voltmeter and proceed with Step 12 of Installation above.

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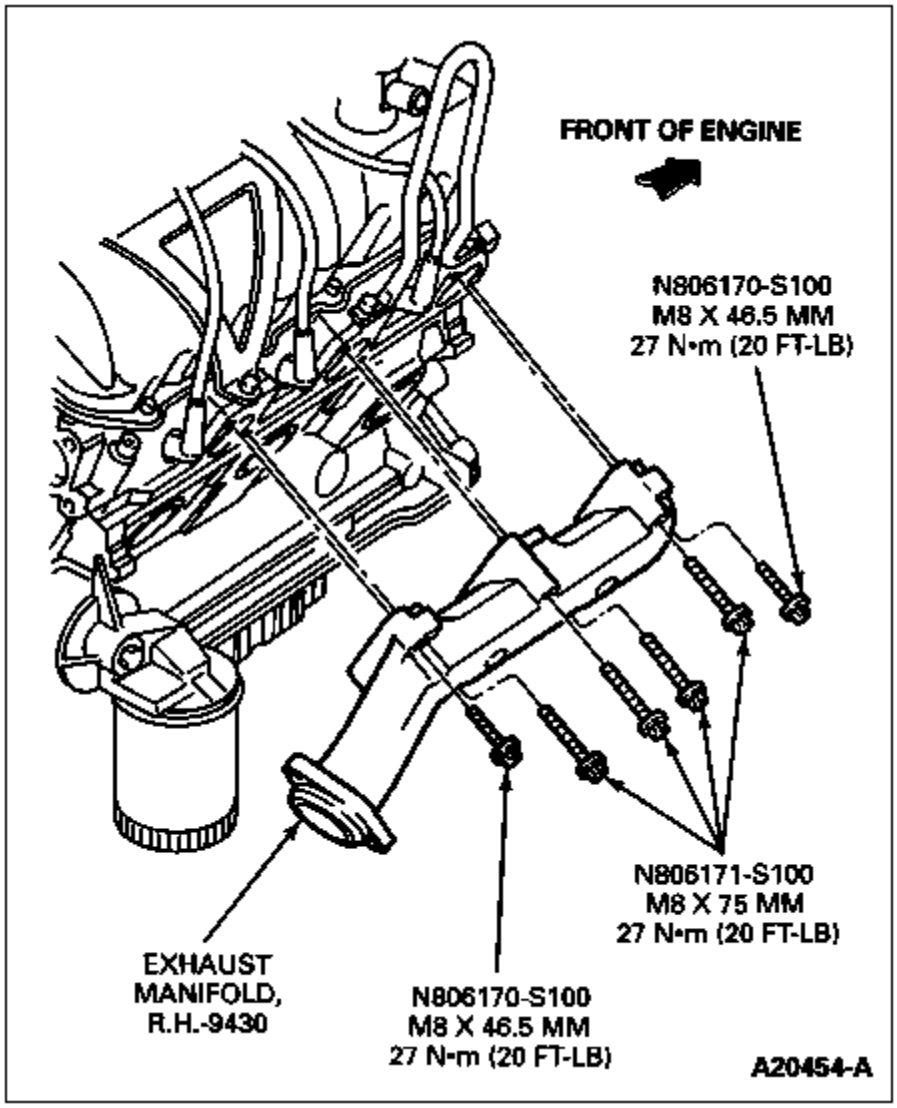
Exhaust Manifold, RH

Removal

1. Remove heater hose support bracket.
2. Disconnect heater water hoses (18472).
3. Remove manifold-to-exhaust inlet pipe attaching nuts.
4. Remove exhaust manifold attaching bolts. Remove exhaust manifold (9430).



Installation

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1. **NOTE: Lightly oil all bolt and stud threads before installation.**

   Clean mating surfaces on the exhaust manifold, cylinder head (6049) and exhaust inlet pipe (5246).

2. Position exhaust manifold on the cylinder head and install manifold attaching bolts. Tighten to 25 Nm (18 lb-ft).

3. Connect exhaust inlet pipe to the exhaust manifold. Tighten the attaching nuts to 27 Nm (20 lb-ft).

4. Install heater hose support bracket.

5. Connect heater water hose.

6. Fill and bleed cooling system. Refer to Section 03-03 .

7. Start engine (6007) and check for exhaust and coolant leaks.

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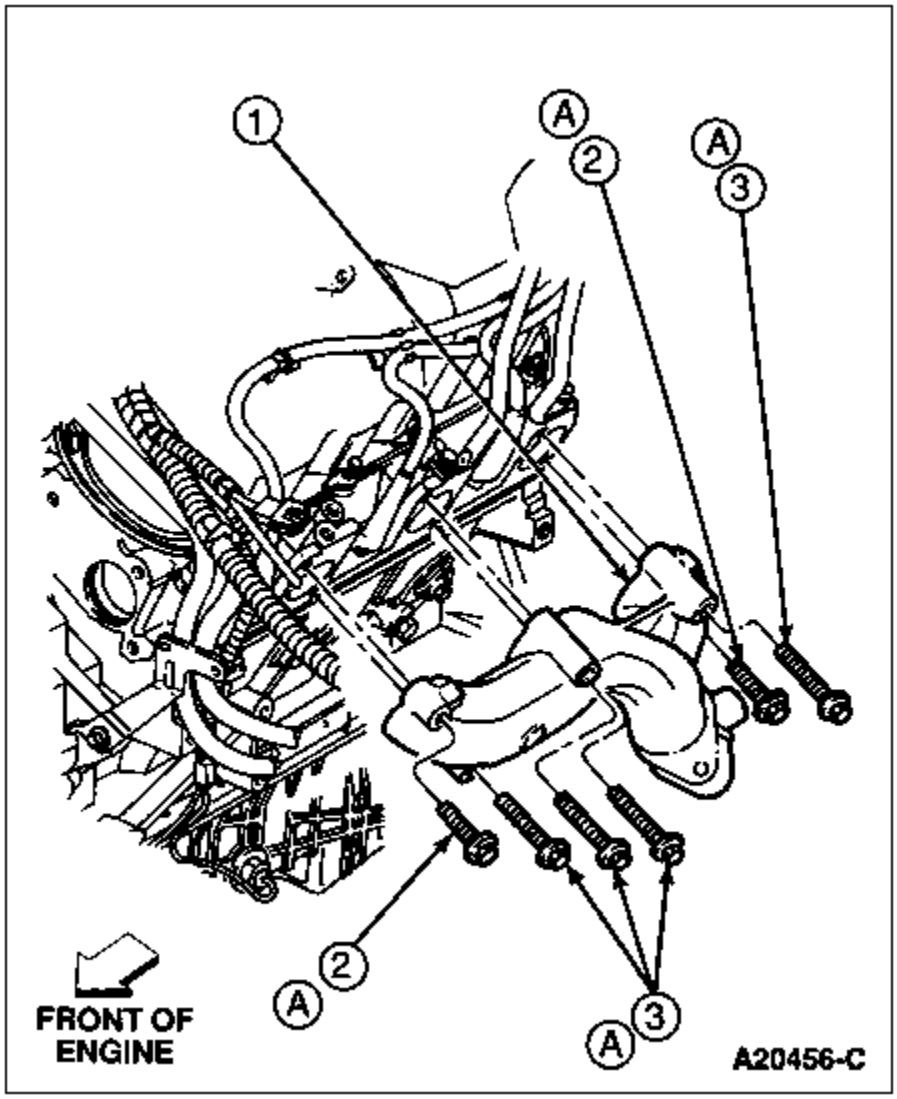
Exhaust Manifold, LH

LH Exhaust Manifold — Ranger



Item	Part Number	Description
1	9430	Exhaust Manifold (LH)
2	N806170-S100	Exhaust Manifold Bolts (2 Req'd)
3	N806171-S100	Exhaust Manifold Bolts (4 Req'd)
A	—	Tighten to 27 Nm (20 Lb-Ft)

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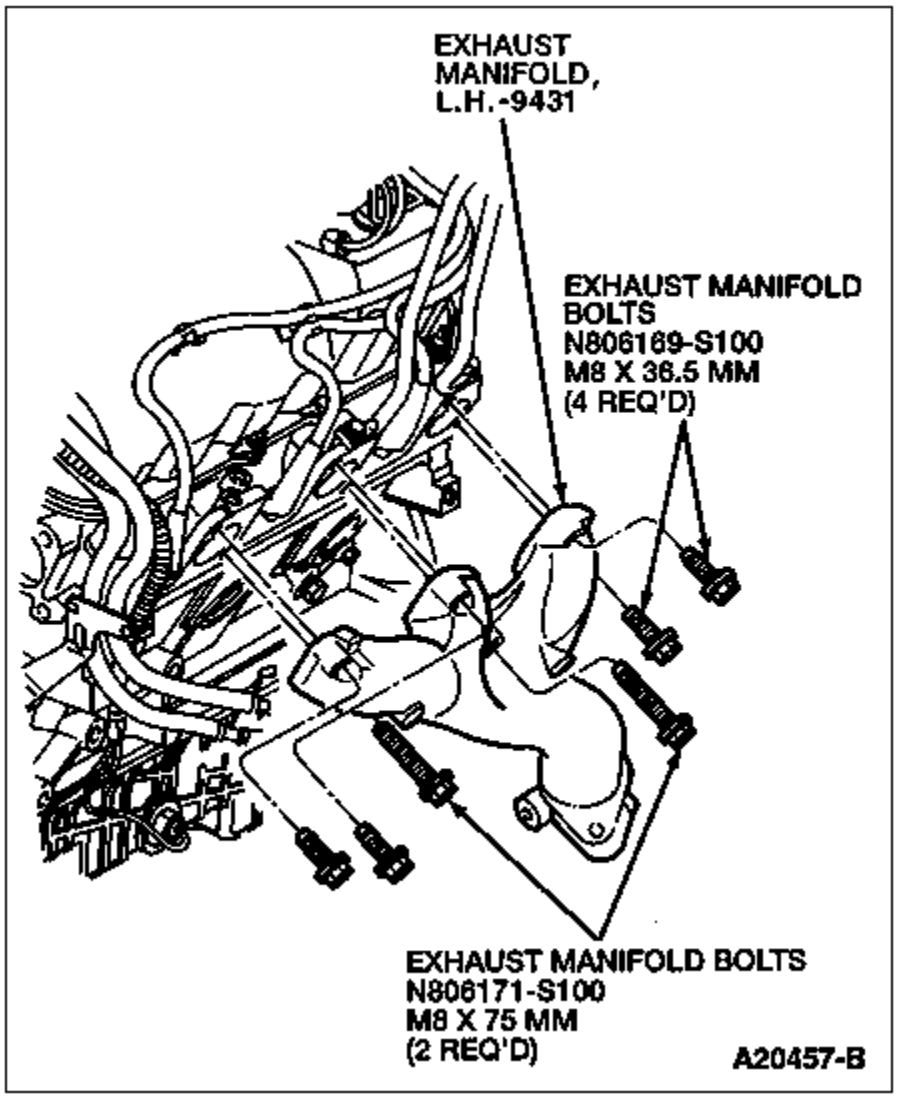
LH Exhaust Manifold — Aerostar



Removal

1. Remove oil level indicator tube support bracket.
2. Disconnect the EGR transducer vacuum hoses.
3. Loosen and remove the EGR valve to exhaust manifold tube.
4. Remove EGR valve bolts and EGR valve.
5. Remove the intake manifold to EGR valve tube stud and the intake manifold to EGR valve tube.

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6. Remove power steering pressure hose (3A719) and power steering return hose (3A713) if necessary.
7. Remove exhaust pipe to manifold nuts.
8. Remove exhaust manifold bolts and exhaust manifold (9430).

Installation

1. **NOTE: Lightly oil all bolt and stud threads before installation.**

   Clean mating surfaces on the exhaust manifold, cylinder head (6049) and exhaust pipe.
2. Position exhaust manifold on the cylinder head and install exhaust manifold bolts. Tighten to 27 Nm (20 lb-ft).
3. Connect exhaust pipe to the exhaust manifold. Tighten the exhaust pipe to manifold nuts to 27 Nm (20 lb-ft).
4. Connect power steering pressure hose and power steering return hose, if removed.
5. Position the intake manifold to EGR valve tube to the intake manifold and install the intake manifold to EGR valve tube stud. Tighten to 40-55 Nm (30-40 lb-ft).
6. Position the EGR valve to the intake manifold to EGR valve tube and install the EGR valve bolts. Tighten to 20-30 Nm (15-22 lb-ft).
7. Install the EGR valve to exhaust manifold tube. Tighten the EGR valve to exhaust manifold tube nuts to 34-48 Nm (26-35 lb-ft).
8. Connect the EGR transducer vacuum hoses.
9. Install oil level indicator tube support bracket. Apply sealant to end of oil indicator tube to prevent oil leak at block.

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Oil Pan, Aerostar and Aerostar E-4WD

Removal

1. Position the vehicle on a suitable hoist.
2. Disconnect the battery ground cable (14301).
3. Remove engine cover.
4. Remove rear engine support and transmission (7003). Refer to Section 07-01A .
5. Remove starter motor.
6. Remove flywheel (6375). Refer to Section 03-01C .
7. On E-4WD vehicles:
    a. Support front suspension lower arm (3078) with transmission jack.
    b. Note bolt arm position and remove both left lower control arm pivot bolts.
    c. Remove transmission jack and allow control arm to hang. It is retained by shock absorber and ball joint.
    d. Support front suspension lower arm (3079) with transmission jack.
    e. Note bolt arm position and remove both right lower control arm pivot bolts.
    f. Remove transmission jack and allow control arm to hang. It is retained by shock absorber and ball joint.
    g. Support front carrier assembly with transmission jack.
    h. Remove bolts and rear pivot crossmember.
    i. Remove bolts and nuts servicing front carrier assembly to front drive axle crossmember.
    j. Lower front carrier assembly enough to access oil pan (6675).
8. Drain the engine oil and remove the oil bypass filter (6714).
9. Remove the engine oil pan bolts and nuts.
10. Remove the oil pan.
11. Remove the crankshaft oil windage baffle (6L680) and oil pump (6600) assembly.
12. **NOTE: Leave the wedge seal tabs sealed in position in the cavities between the rear main cap and cylinder blocks (6010) to help ensure a good seal in these areas.**

    Carefully lift the rear outside corners of the oil pan gasket and use a suitable sharp instrument to cut off the soft rubber wedge seal tabs.
13. Thoroughly clean all sealing surfaces with Ford Metal Surface Cleaner F4AZ-19A536-RA or equivalent meeting Ford specification WSE-M5B392-A.

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Installation

1. **CAUTION: Prevent engine contamination. Always use necessary precautions to prevent old sealer or gasket material from falling into engine.**

   Thoroughly clean all the oil and the old sealer from the oil pan taking special care to remove all the old sealer from the oil pan gasket in the oil pan. Thoroughly wash the oil pan.

2. Thoroughly clean all exposed areas with Metal Surface Cleaner F4AZ-19A536-RA or equivalent meeting Ford specification WSE-M5B392-A.

3. Thoroughly clean all oil and old sealer from the cylinder block oil pan sealing area and the rear main bearing cap.

4. After all parts have been thoroughly cleaned and washed, it is necessary and extremely important that they be wiped down with Extra Strength Spot and Stain Remover B7A-19521-AA meeting Ford specification ESR-M5B197-A or denatured alcohol.

5. Thoroughly clean the transmission bell-housing area and the rear of the cylinder blocks. Oil removal should be verified with an ultraviolet lamp ("black light").

Oil Pan Installation

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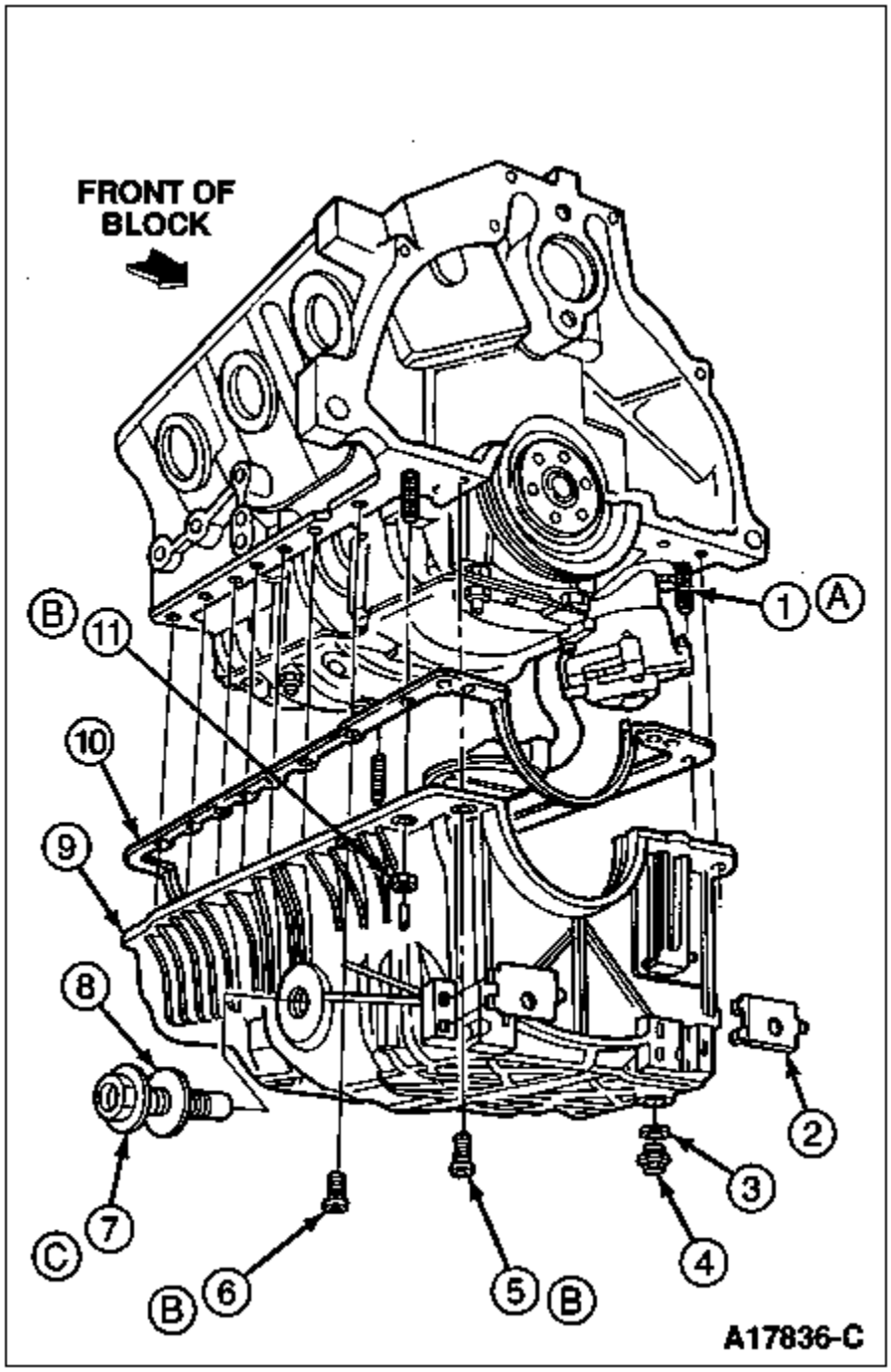

Item	Part Number	Description
1	E804579-S72	Stud
2	6C629	Oil Pan Spacer
3	6734	Oil Pan Drain Plug Gasket
4	6730	Oil Pan Drain Plug
5	E804587-S72	Torx® Bolt
6	E802185-S72	Bolt

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7	6C624	Low Oil Level Sensor
8	6C626	Low Oil Level Sensor Washer
9	6675	Oil Pan
10	6710	Oil Pan Gasket
11	E60012-S72	Nut
A	—	Tighten to 4 Nm (35 Lb-In)
B	—	Tighten to 7-10 Nm (5-7 Lb-Ft)
C	—	Tighten to 17-27 Nm (13-20 Lb-Ft)

6. Clean and inspect the oil inlet tube. Prime the oil pump by filling the inlet opening with oil while rotating the shaft until oil emerges from the outlet opening. Install the pump and screen and tighten the oil pump bolts to 17-21 Nm (13-15 lb-ft).

7. Install the crankshaft oil windage baffle and tighten the crankshaft oil baffle nuts to 17-21 Nm (13-15 lb-ft).

8. Use a suitable sharp instrument to cleanly cut the rubber wedge seal tabs off of new oil pan gasket (6710).

9. Apply a bead of Silicone Gasket and Sealant F6AZ-19562-AA or equivalent meeting Ford specification WSE-M4G323-A6 on each of the gasket tabs remaining between the rear main cap and cylinder blocks, on the sealing rail at the front cover to block joint, and on the corners of the radius of the front cover.

   Refer to the Ford Powertrain Service Engineering Video 1995 Powertrain Update POV503 — 4.0L Engine Oil Leaks.

10. Position the oil pan gasket on the flange of the cylinder blocks.

11. Apply a bead of Silicone Gasket and Sealant F6AZ-19562-AA or equivalent meeting Ford specification WSE-M4G323-A6 on the oil pan flange at the radius areas at the front and rear.

12. Position theoil pan to the cylinder blocks. Install and snug four oil pan nuts tight enough to align the bolt holes, but loose enough for the oil pan to move backward.

13. **CAUTION: Failure to align the rear face of the oil pan mounting pads to the rear face of the cylinder block can result in oil pan damage and oil leaks.**

    NOTE: The transmission is mounted to the engine (6007) and oil pan when installed.

    Use a straightedge to align the rear face of the oil pan mounting pads to the rear face of the cylinder blocks.

14. Install the remaining oil pan bolts and finger-tighten.

15. Tighten the oil pan nuts and bolts evenly to 7-10 Nm (5-7 lb-ft).

16. Install the oil pan drain plug (6730) and the oil filter (6731).

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17. On E-4WD vehicles, perform the following steps:

    a. Raise front carrier assembly into place.
    b. Install front carrier assembly to front drive axle crossmember bolts and tighten to 95-108 Nm (70-80 lb-ft).
    c. Install rear pivot cross member and tighten bolts.
    d. Remove transmission jack and use it to raise front suspension lower arm into place.
    e. Install right lower control arm pivot bolts with bolt arm in original position. Install nuts and tighten to 136-190 Nm (100-140 lb-ft).
    f. Remove transmission jack and use to raise front suspension lower arm into place.
    g. Install left lower control arm pivot bolts with bolt arm in original position. Install nuts and tighten to 136-190 Nm (100-140 lb-ft).
    h. Remove transmission jack.

18. Install the flywheel. Refer to Section 03-01C .

19. Install the transmission and rear engine support. Refer to Section 07-01A .

20. Install the starter motor (11001).

21. Lower the vehicle.

22. Install the engine cover.

23. After letting vehicle sit overnight, fill the crankcase with the quantity and quality of engine oil. Refer to Section 00-03 .

24. **NOTE: When battery voltage is removed from the powertrain control module (PCM) (12A650), all learned values will be cleared and reset to predetermined values. When battery voltage is restored to the PCM, the vehicle may exhibit certain driveability concerns. It will be necessary to drive the vehicle to allow the PCM to relearn values for optimum driveability and performance.**

    Connect the battery ground cable.

25. Start the engine and check for leaks.

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Oil Pump

NOTE: The oil pump (6600) is only serviced as an assembly. Refer to Section 03-00 for disassembly and cleaning instructions.

Removal

1. **NOTE: On Ranger vehicles it is necessary to remove the engine to remove the oil pan. On Aerostar vehicles, it is necessary to remove the transmission as outlined in Group 07 to properly reseal the oil pan.**

   Remove oil pan (6675) as detailed in this section.

2. Remove oil pump attaching bolts. Lift off oil pump and withdraw oil pump intermediate shaft (6A618).

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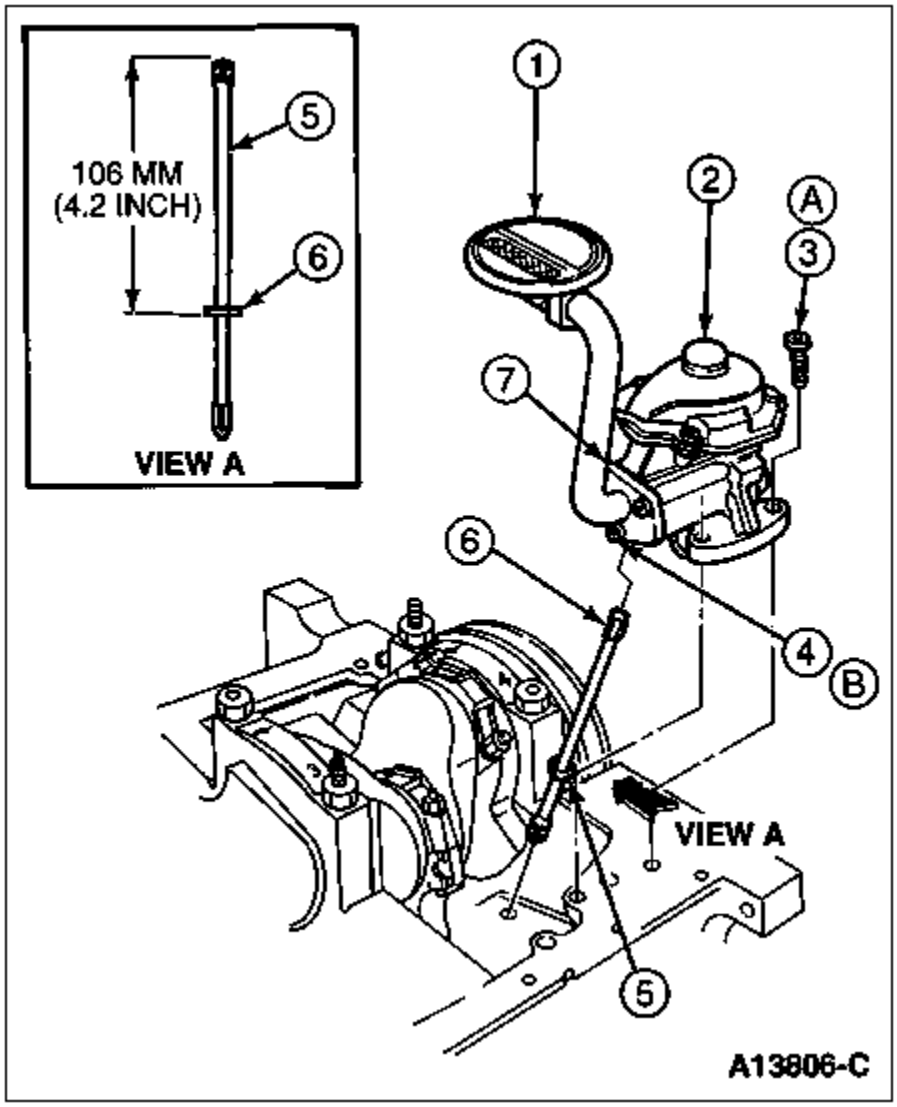

Item	Part Number	Description
1	6622	Oil Pump Screen Cover and Tube
2	6600	Oil Pump
3	E804387	Screw
4	E804553	Screw
5	6A618	Oil Pump Intermediate Shaft
6	6629	Oil Pump Intermediate Shaft Retaining Ring
7	6626	Oil Pump Inlet Tube Gasket
A	—	Tighten to 17-21 Nm (13-15 Lb-Ft)
B	—	Tighten to 9-13 Nm (7-10 Lb-Ft)

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Installation

1. Prime the oil pump by filling either the inlet or outlet port with engine oil XO-5W30-QSP or equivalent meeting Ford specification WSE-M2903-A1 or SAE 5W-30 Service SG engine oil. Rotate the pump shaft to distribute the oil within the pump body.

2. Insert oil pump intermediate shaft into block with the pointed end facing inward. The pointed end is closest to the pressed-on flange. Place oil pump in position to install attaching screws. Tighten screws 17-21 Nm (13-15 lb-ft). Clean and install the oil pump screen cover and tube (6622) with an oil pump inlet tube gasket (6626). Tighten the bolts to 9-13 Nm (7-10 lb-ft).

3. Install oil pan as outlined under Oil Pan, Installation, Aerostar or Ranger .

4. Operate the engine (6007) at fast idle speed and check for oil leaks.

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Crankshaft Main Bearings

The main and connecting rod bearing inserts are selective fit. **Do not file or lap bearing caps or use shims to obtain the proper bearing clearance. Selective fit main bearings are available for service in standard and undersizes. Refer to the parts catalog for the available sizes. Undersize bearings which are not selective fit are available for use on journals that have been refinished. Refer to Specifications at the end of this section.**

Removal

1. **NOTE: Oil pan removal on Ranger requires engine removal. Rear main bearing replacement on Aerostar vehicles requires engine removal.**

   Drain the crankcase. Remove the oil pan (6675) and oil pump (6600) as outlined in this section.

2. **Replace one crankshaft main bearing (6333) at a time, leaving the other crankshaft main bearings securely fastened.** Remove the main bearing cap to which new crankshaft main bearings are to be installed.

3. Insert Main Bearing Insert TOOL-6331-E or equivalent in the crankshaft journal oil hole.

4. Rotate the crankshaft (6303) slowly in the direction of engine rotation to force the bearing insert out of the block.

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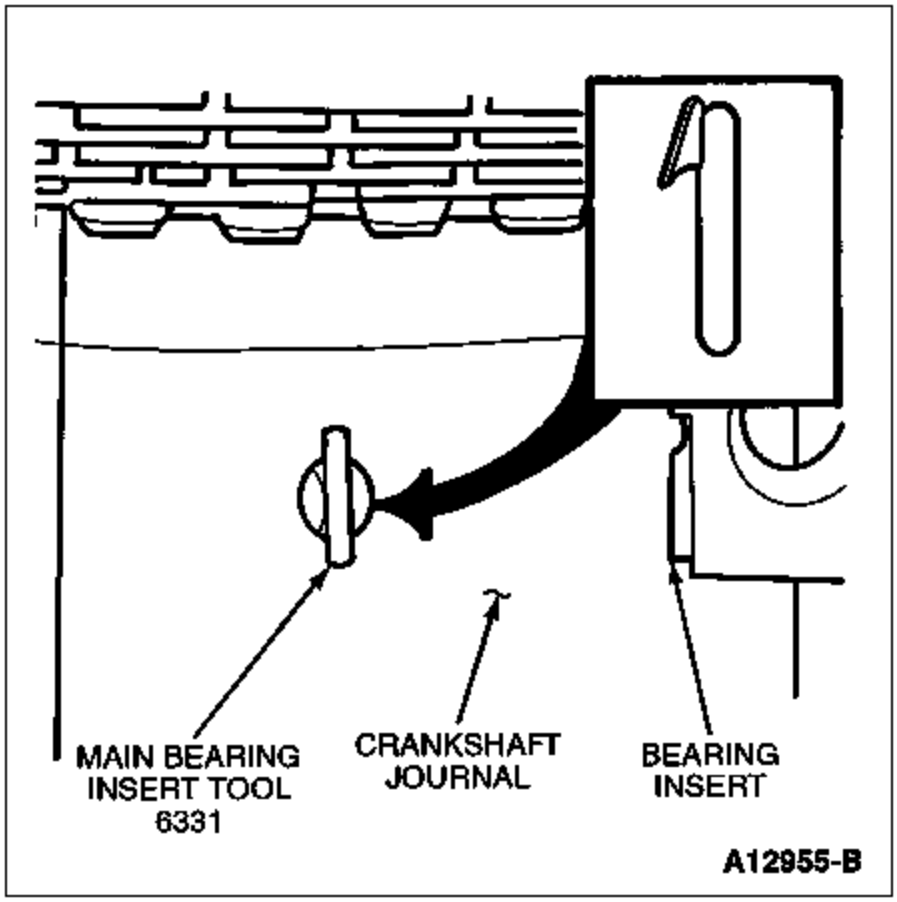

Installation

1. Clean each crankshaft journal before installing the main bearing insert. Inspect the journals for nicks, burrs, or bearing pickup that would cause premature bearing wear.

2. Select fit the bearing for proper clearance following procedures under Fitting Main and Connecting Rod Bearings in Section 03-00 .

3. **NOTE: New bolts must be used for assembling main bearing caps.**

   NOTE: Make sure that the main bearing caps are installed in their original positions and orientation.

   To install the upper main bearing, lubricate the bearing with heavy engine oil SF. Then place the end of the bearing over the shaft on the locking tang side of the cylinder blocks (6010) and partially install the bearing so that Main Bearing Insert TOOL-6331-E or equivalent can be inserted in the journal oil hole. With tool installed, rotate the crankshaft slowly in the opposite direction of engine rotation until the bearing tang is seated. Remove the bearing tool.

4. For bearings number one, two, and three, coat the bearing insert and journal with SAE 50 Service SG meeting Ford specification ESE-M2C39-F and install the bearing cap. Tighten the cap to 90-104 Nm (66-77 lb-ft).

5. Install the remaining bearings in the same manner. If servicing the rear main bearing, apply sealer to the cap as shown.

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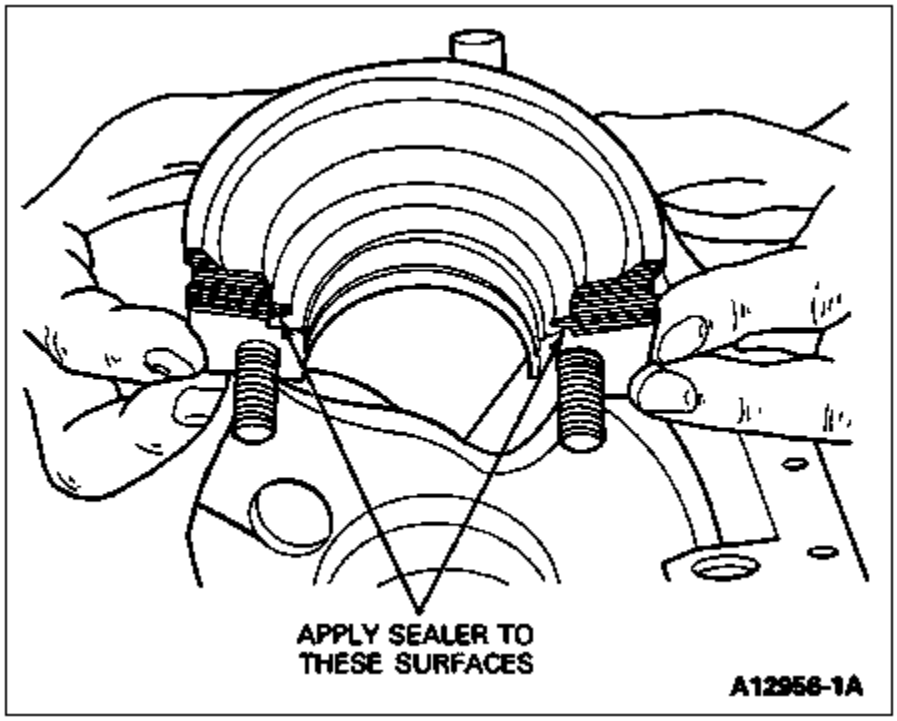
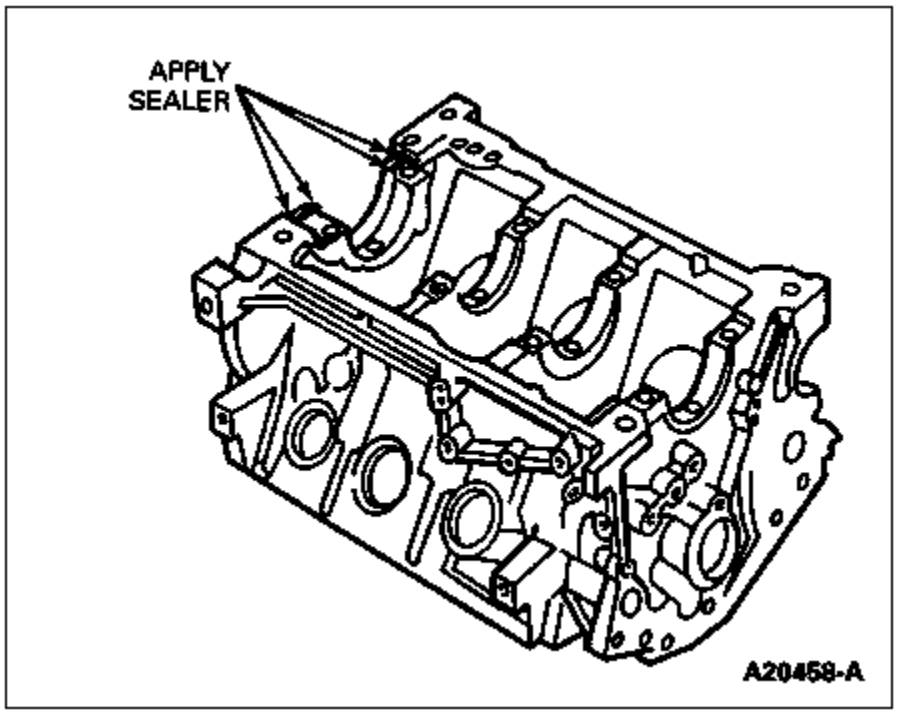


Cylinder Block Sealer Application



6. For rear main bearing:

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a. Clean all oil off rear main bearing cap and block mating surface using Ford Extra Strength Spot and Stain Remover B7A-19521-AA meeting Ford specification ESR-M5B197-A.
b. Place a bead of Ford Gasket Eliminator E1FZ-19562-A meeting Ford specification WSK-M2G348-A4 or Loctite 515® sealer to the block along the corners of the rear main bearing cap joint area and on the joint face, approximately 1/2 inch from the rear of the cylinder blocks as illustrated.
c. **NOTE: New bolts must be used during assembly.**

   Verify that the lower rear main bearing insert is in place. Install the rear main bearing cap and snug the bolts.
d. Align the rear main bearing cap to block by moving the bearing cap fore or aft (approximately 13mm [1/2 inch] inward in the rear oil seal bore) so that the rear seal stop of the block and cap line up. This will ensure that the rear main oil seal will seat squarely when installed in the bore.
e. Tighten the rear main cap bolts to 90-104 Nm (66-77 lb-ft).
f. Fill the cavities on both sides of the rear main cap with Ford Gasket Eliminator E1FZ-19562-A meeting Ford specification WSK-M2G348-A4 or Loctite 515® . Refer to Figure 2.
g. Reinstall the oil pump and crankshaft oil windage baffle (6L680) tray. Torque to 17-21 Nm (13-15 lb-ft).

7. Install crankshaft rear oil seal as outlined in this section.

8. On Ranger vehicles, reinstall engine (6007) in vehicle.

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Pistons and Connecting Rods

Removal

1. **NOTE: On the Ranger, it is necessary to remove the engine to remove the oil pan and perform this procedure.**

   Drain engine cooling system.

2. Remove intake manifold as outlined in this section.

3. Remove cylinder head (6049) as outlined in this section.

4. Remove oil pan (6675) and crankshaft oil windage baffle (6L680).

5. Remove oil pump (6600) and oil pump intermediate shaft (6A618).

6. Inspect the top of each cylinder bore before removing the piston (6108). If a ridge has formed at the top of the cylinder it must be removed before piston removal. Remove ridge as follows:

   a. Turn crankshaft (6303) until the piston to be removed is at the bottom of the cylinder bore.
   b. Place a clean shop cloth over the piston head to collect cuttings.
   c. Remove ridge using a suitable ridge reamer following the instructions of manufacturer. Never cut into the ring travel area more than 0.794mm (1/32 inch) when removing the ridge.

7. **NOTE: The cylinder number is stamped on the top of the piston. Matched letters are stamped on the sides of corresponding rod and cap.**

   Turn crankshaft until the piston to be removed is at the high point of its travel. If more than one piston is being removed, identify the pistons and connecting rod ca ps. Each component should be installed in its original position during assembly.

8. Remove connecting rod cap attaching nuts and cap.

9. Install spark plug boots over connecting rod cap studs and push piston out through top of the cylinder bore. Use care to prevent damage to bearing surfaces.

10. Install connecting rod cap and hold in position with cap attaching nuts.

11. If piston is to be disassembled, refer to Piston Disassembly in this section.

12. Inspect cylinder bore. If new piston rings are to be installed on the piston, a visible cross-hatch pattern should be obvious on cylinder bore wall.

    - If honing is required, remove glaze from cylinder wall using spring-loaded hone. Follow manufacturer's instructions when using this type of equipment.

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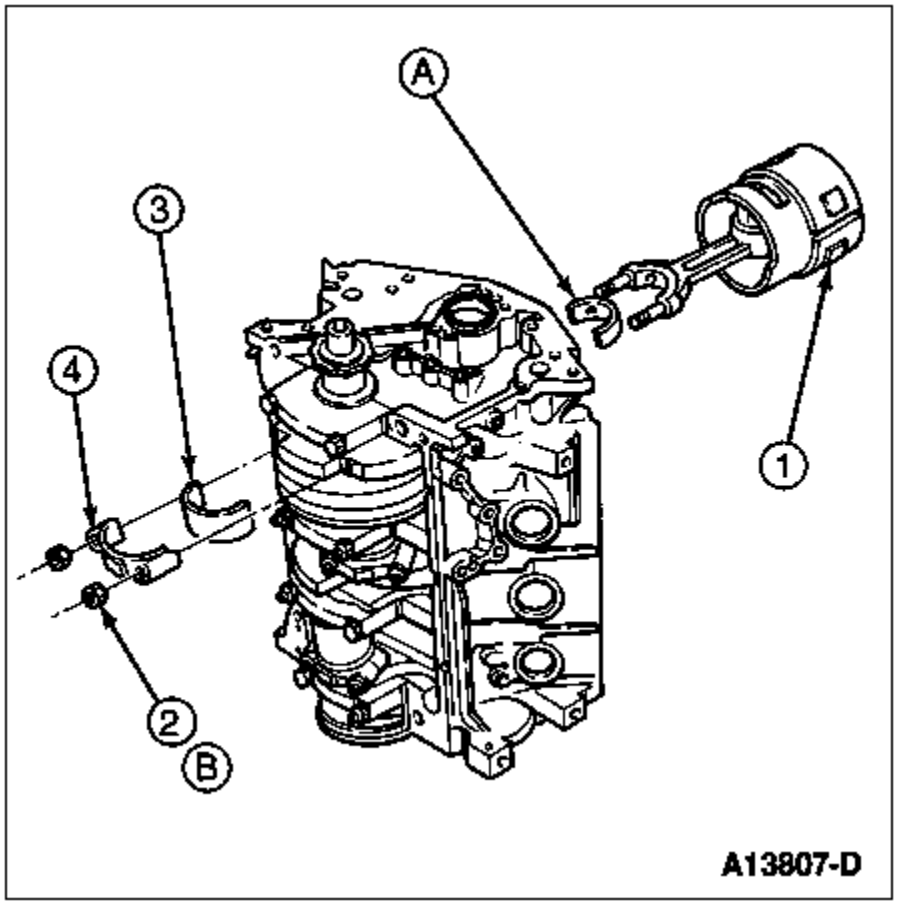
13. After honing, thoroughly clean cylinder bore using a detergent and water solution.



Item	Part Number	Description
1	D81L-6002-C	Piston Ring Compressor
2	6212	Connecting Rod Nut
3	6211	Connecting Rod Bearing
4	—	Connecting Rod Bearing Cap (Part of 6200_
A	—	Oil Hole to Be Assembled As Shown Toward Right Bank Cylinders
B	—	Tighten to 25-32 Nm (18-24 Lb-Ft)

Installation

CAUTION: When installing pistons, make sure arrows in the piston domes face the front of

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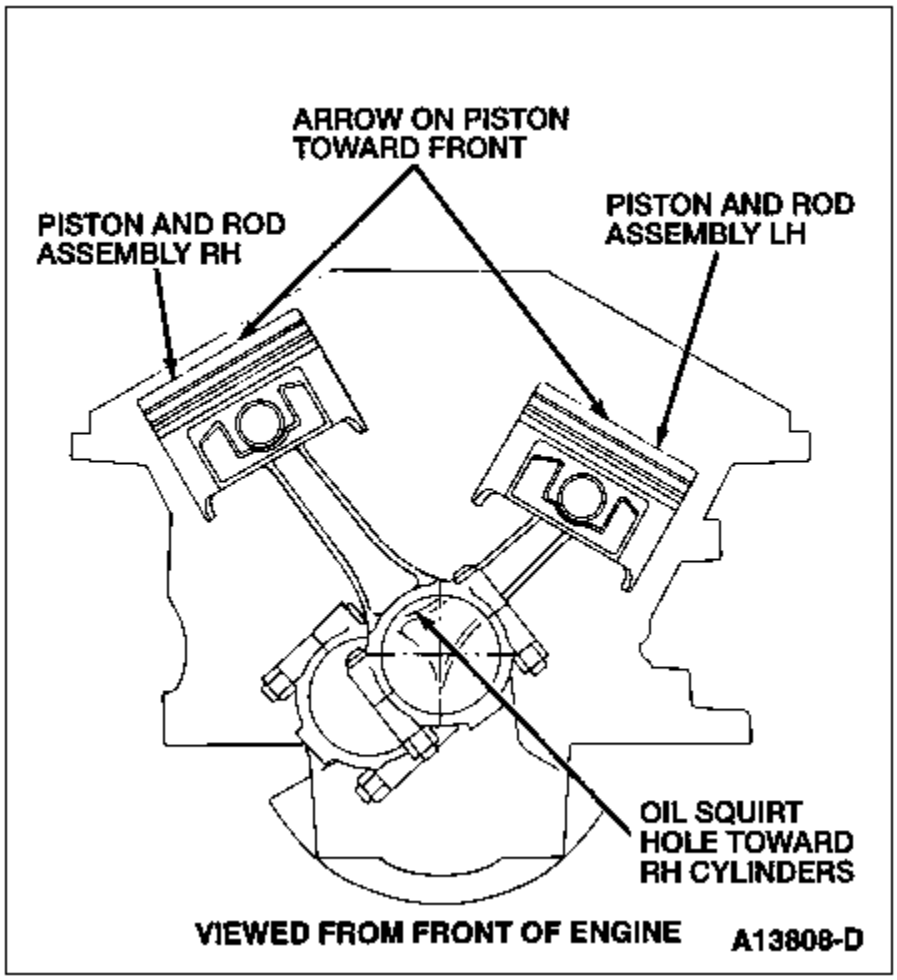
engine (6007) and the oil squirt holes are oriented toward the RH side of the engine (toward the RH cylinders).



NOTE: Connecting rod and cap are not identified from the factory as to cylinder position.

Lightly oil all attaching bolt and stud threads before installation except those specifying special sealant.

Make sure piston ring gaps are spaced as shown.

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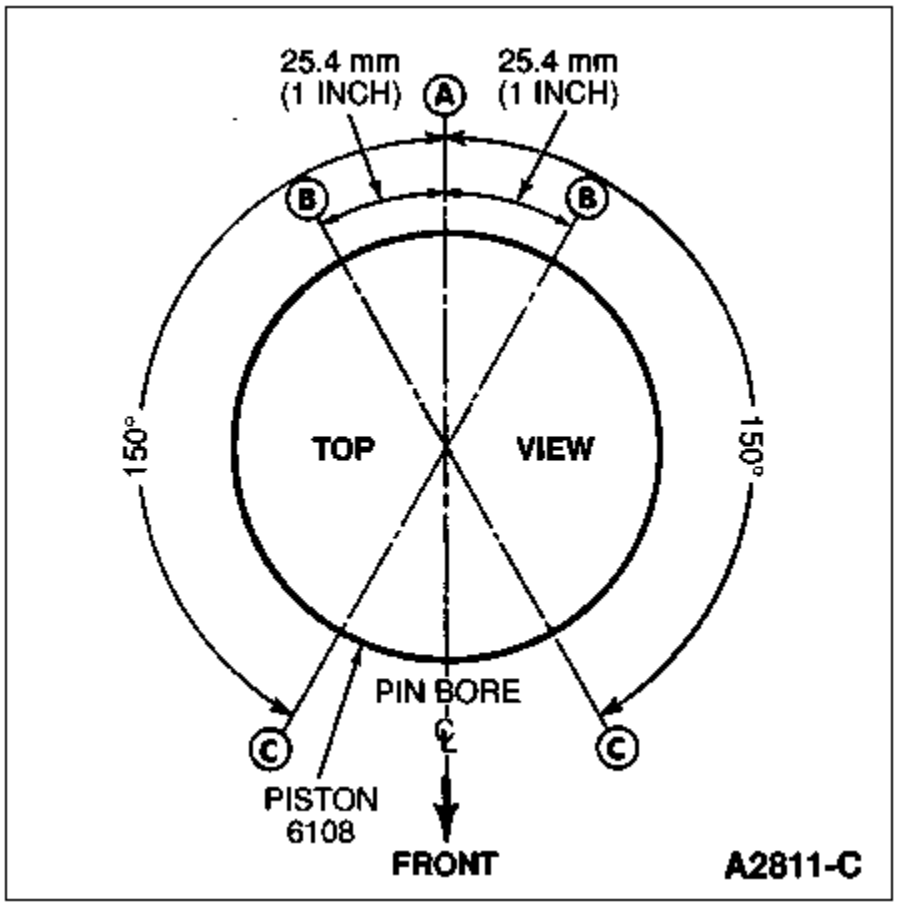

1. Lubricate cylinder wall and piston with Engine Assembly Lubricant D9AZ-19579-D or equivalent meeting Ford specification ESR-M99C80-A or SAE 50 Service SG or equivalent oil meeting Ford specification ESE-M2C39-F.

2. Remove connecting rod cap and install spark plug boots on the connecting rod studs.

3. **NOTE: Be sure to install the pistons in the same cylinders from which they were removed or to which they were fitted. The connecting rod and bearing caps are identified with matching correlation letters. Letters on the connecting rod and bearing cap must be on the same side when installed in the cylinder bore. If a connecting rod (6200) is transposed from one block or cylinder to another, new bearings should be fitted.**

   Install piston using Piston Ring Compressor D81L-6002-C or equivalent.

4. As piston is tapped into bore with a hammer handle, guide connecting rod onto crankshaft journal to avoid damage to bearing surfaces.

5. Check connecting rod bearing clearance. Refer to Section 03-00 .

6. Lubricate bearing surfaces with Engine Assembly Lubricant D9Z-19579-D or equivalent meeting Ford specification ESR-M99C80-A or SAE 50 Service SG or equivalent oil meeting Ford specification ESE-M2C39-F oil.

7. Make sure connecting rod is seated on crankshaft journal and install connecting rod cap. Tighten the attaching nuts to 25-32 Nm (18-24 lb-ft).

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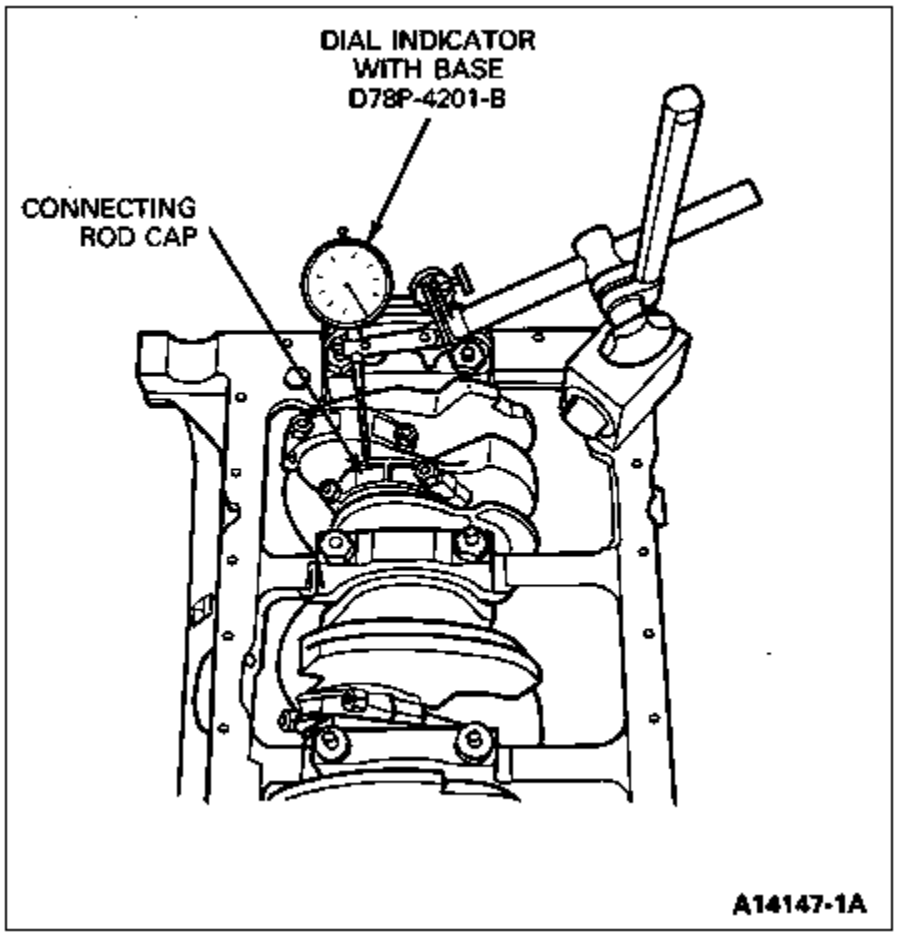
8. If necessary, check connecting rod side clearance as outlined. Refer to Section 03-00 .



9. Check the piston installed height if any of the following repair procedures have been performed:

- New pistons were installed.
- New connecting rods were installed.
- New cylinder blocks (6010) was installed.
- Cylinder block machine work (that could affect cylinder block deck height).
- Cylinder block crankshaft align boring.

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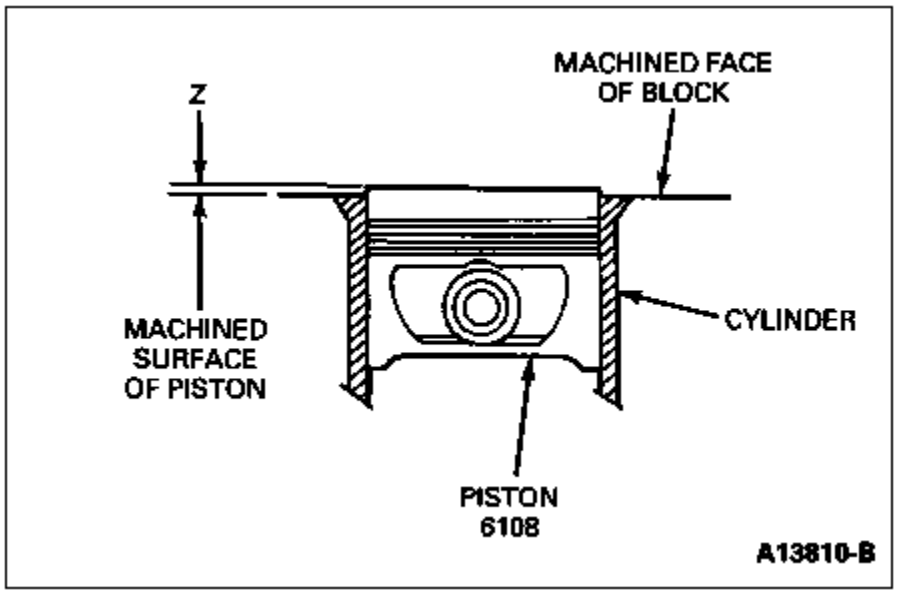

10. **NOTE: Each piston to be positioned at TDC. Dimension "Z" is the average of two readings measured from top of cylinder block to piston dome face.**

    NOTE: Both measurements must be taken parallel to crankshaft and a straight line through the measuring points must pass through the true center of the cylinder.

    Check the piston installed height as follows:

    a. Install Dial Indicator with Base D78P-4201-B or equivalent on the cylinder deck, next to the piston to be checked.
    b. Zero the indicator with the tip on the engine block deck.
    c. Carefully move the indicator over to the piston and take a reading on the piston's machined crown.

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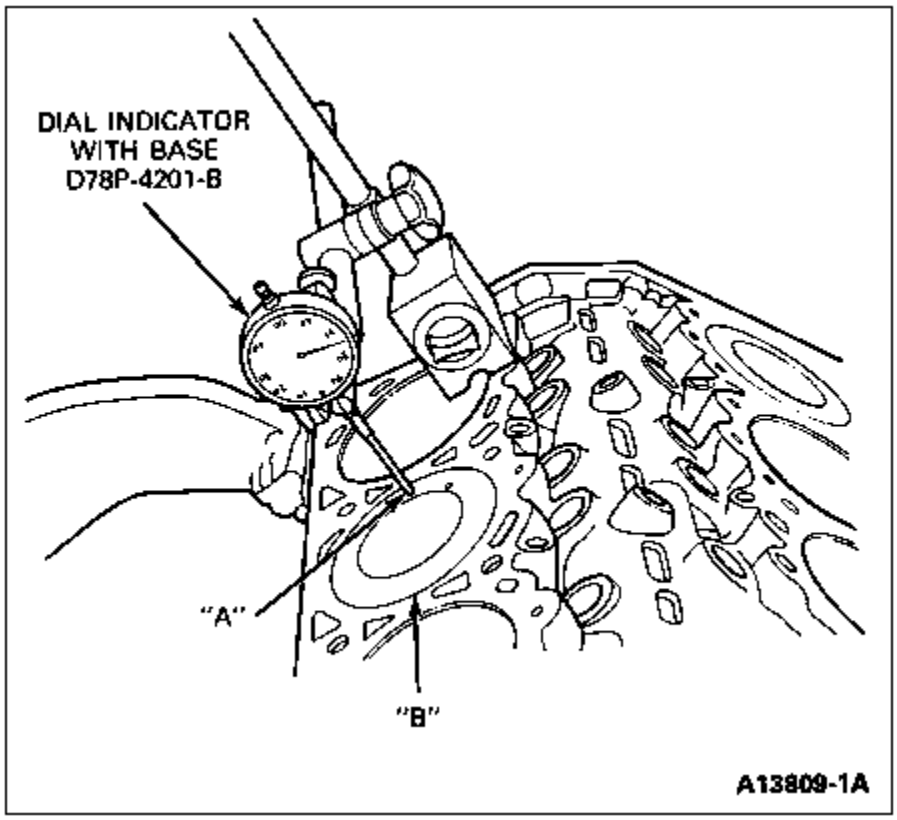

d. Take a reading at the front "A" and rear "B" of the piston, in line with the piston pin (6135).
e. Compare readings with specifications.
f. If the difference between the two readings ("A" and "B") is excessive, the piston or connecting rod is damaged or out of specification.

	Minimum	Maximum
Piston Height	mm (Inch)	mm (Inch)
"Z"	0.04 (0.0016)	0.52 (0.020)

11. Install oil pump and oil pump intermediate shaft. Tighten attaching bolts to 17-21 Nm (13-15 lb-ft).
12. Install crankshaft oil windage baffle. Tighten nuts to 17-21 Nm (13-15 lb-ft).
13. Install oil pan as outlined in this section.
14. Install cylinder heads as outlined in this section.
15. Install intake manifolds as outlined in this section.
16. Install valve covers (6582) as outlined in this section.
17. If removed from vehicle, install engine as outlined in this section.
18. Fill crankcase with specified oil.
19. Fill cooling system with specified coolant.

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20. Start engine and check for oil, exhaust and coolant leaks.

21. Check and, if necessary, adjust transmission throttle linkage and speed control.

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Connecting Rod Bearings

NOTE: The connecting rod bearings are selective fit. Refer to procedures under Fitting Main and Connecting Rod Bearings, Section 03-00 .

Removal

1. **NOTE: On Ranger, it is necessary to remove the engine (6007) to remove the oil pan (6675). On Aerostar it is necessary to remove the transmission to properly reseal the oil pan.**

   Drain the crankcase. Remove the oil pan and related parts as outlined in this section.

2. Remove the crankshaft oil windage baffle (6L680) and oil pump (6600).

3. Rotate the crankshaft (6303) until the connecting rod (6200) in which the bearings are to be fitted is at the bottom.

4. Remove the bearing cap from the connecting rod, then remove the connecting rod bearing (6211).

5. Cover connecting rod bolts with protective covers (old spark plug boots) to avoid damage to crankshaft journals.

Installation

1. Make sure connecting rod bearing and bearing bore in connecting rod and cap are clean. Foreign material under inserts or between rod and cap will distort the bearing and cause premature failure.

2. Clean the crankshaft journal.

3. Check connecting rod oil squirt holes for restrictions.

4. Install the bearing inserts in the connecting rod and cap with the tangs fitted in the slots provided.

5. Pull the connecting rod assembly down firmly on the crankshaft journal.

6. Select fit the bearing following procedures in Section 03-00 .

7. Clean and apply a light coat of engine oil XO-5W30-QSP meeting Ford specification ESE-M2C153-E or equivalent SAE 5W-30 Service SG to the journal and bearings. Install the connecting rod cap. Tighten the nuts to 25-32 Nm (18-24 lb-ft).

8. Clean the oil pump inlet tube screen. Prime the pump by filling the inlet opening with XO-5W30-QSP or equivalent meeting Ford specification ESE-M2C153-E or SAE 5W-30 Service SG engine oil while rotating the shaft until oil emerges from the outlet opening. Install the oil pump with a new gasket and tighten the attaching bolts to 17-21 Nm (13-15 lb-ft).

9. Install the oil pan as outlined in this section.

10. If removed from vehicle, install engine as outlined in this section.

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11. Fill the crankcase to the correct level with the specified oil. Start the engine and check for leaks.

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Flywheel

Removal

1. Remove transmission as outlined in Group 07.
2. If equipped with manual transmission, remove clutch assembly as outlined in Section 08-01 .
3. Remove flywheel-to-crankshaft bolts (6379) and remove flexplate and flywheel crankshaft spacer (6434) or flywheel.

Installation

All major rotating components including flexplate/flywheel are individually balanced to zero. Engine assembly balancing is not required. Balance weights should **NOT** be installed in new flywheels.

1. **NOTE: Special bolts are used for flywheel/flexplate installation. Do not use standard bolts.**

   If vehicle has manual transmission, inspect Pilot Bearing. If necessary, replace as outlined in Section 08-01 .
2. Position flywheel or flywheel crankshaft spacer and flexplate on crankshaft (6303) and hand-start flywheel-to-crankshaft bolts.
3. Using standard cross-tightening sequence, tighten flywheel-to-crankshaft bolts as follows:

   a. First stage — 12-15 Nm (9-11 lb-ft).
   b. Second stage — 68-74 Nm (50-55 lb-ft).
4. If vehicle has manual transmission, install clutch as outlined in Section 08-01 .
5. Install transmission as outlined in Group 07.

Flywheel/Flexplate Installation, Ranger, and Aerostar

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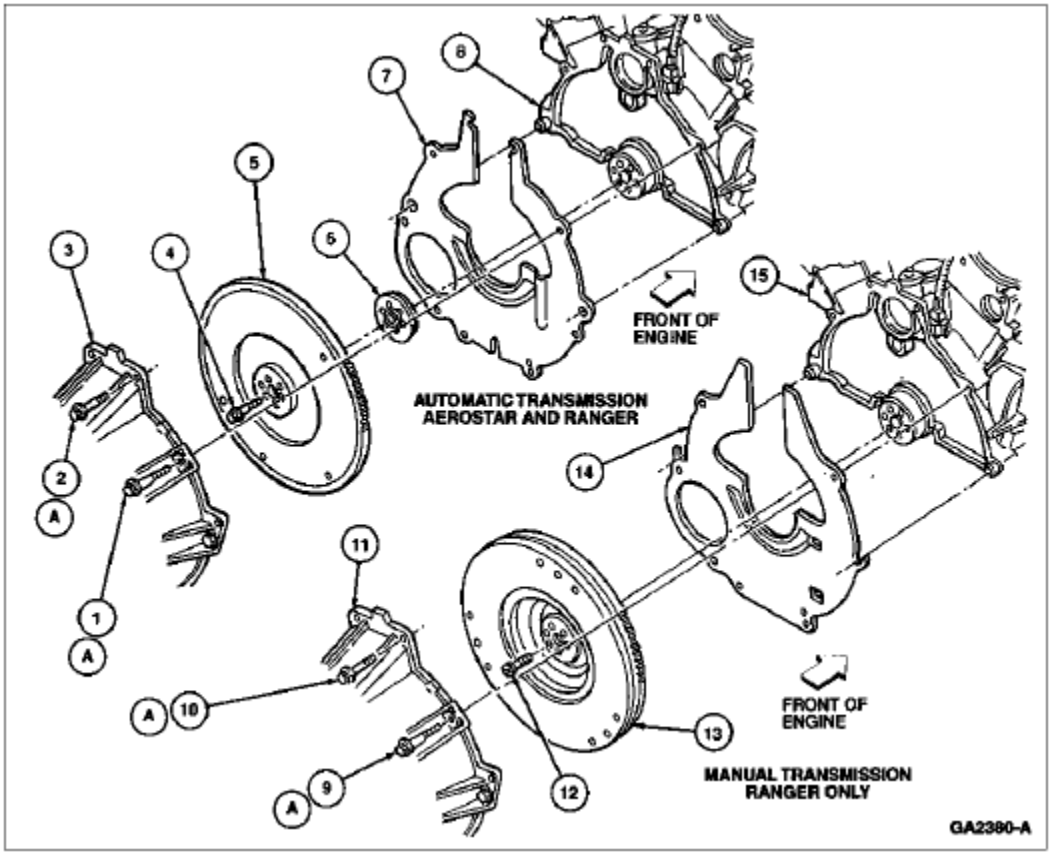

Item	Part Number	Description
1	N606062-S2	Bolt, M10 x 50mm
2	N802662-S2	Bolt, M10 x 40mm
3	7003	Transmission (Automatic)
4	6379	Flywheel-To-Crankshaft Bolt
5	6375	Flexplate (Automatic Transmission)
6	6434	Flywheel Crankshaft Spacer
7	7007	Engine Rear Plate
8	6007	Engine
9	N606062-S2	Bolt, M10 x 50mm
10	N802662-S2	Bolt, M10 x 40mm
11	7003	Transmission (Manual)
12	6379	Flywheel-To-Crankshaft Bolt
13	6379	Flywheel (Manual Transmission)
14	7007	Engine Rear Plate
15	6007	Engine
A	—	Tighten to 38-51 Nm (28-38 Lb-Ft)

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Crankshaft Rear Oil Seal

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Rear Crankshaft Seal Replacer	T95T-6701-A
Rear Crankshaft Seal Replacer	T97T-6701-A

NOTE: Use dye and black light as outlined in Section 03-00 to determine if oil leak is from oil pan gasket (6710) or crankshaft rear oil seal.

Removal

1. Remove the transmission as outlined in Group 07.
2. If equipped with manual transmission, remove clutch as outlined in Section 08-01 .
3. Remove flywheel-to-crankshaft bolts (6379) and remove flex plate and flywheel crankshaft spacer (6434) or flywheel.
4. Use an awl to punch two holes in the crankshaft rear oil seal (6701). Punch the holes on opposite sides of the crankshaft (6303) and just above the bearing cap-to-cylinder block split line. Install a sheet metal screw in each hole. Use two large screwdrivers or small pry bars and pry against both screws at the same time to remove the crankshaft rear oil seal. It may be necessary to place small blocks of wood against the cylinder blocks (6010) to provide a fulcrum point for the pry bars. **Use caution throughout this procedure to avoid scratching or otherwise damaging the crankshaft oil seal surface.**
5. Clean the oil seal recess in the cylinder blocks and main bearing cap. **Inspect and clean the oil seal contact surface on the crankshaft. Refer to Section 03-00 .**

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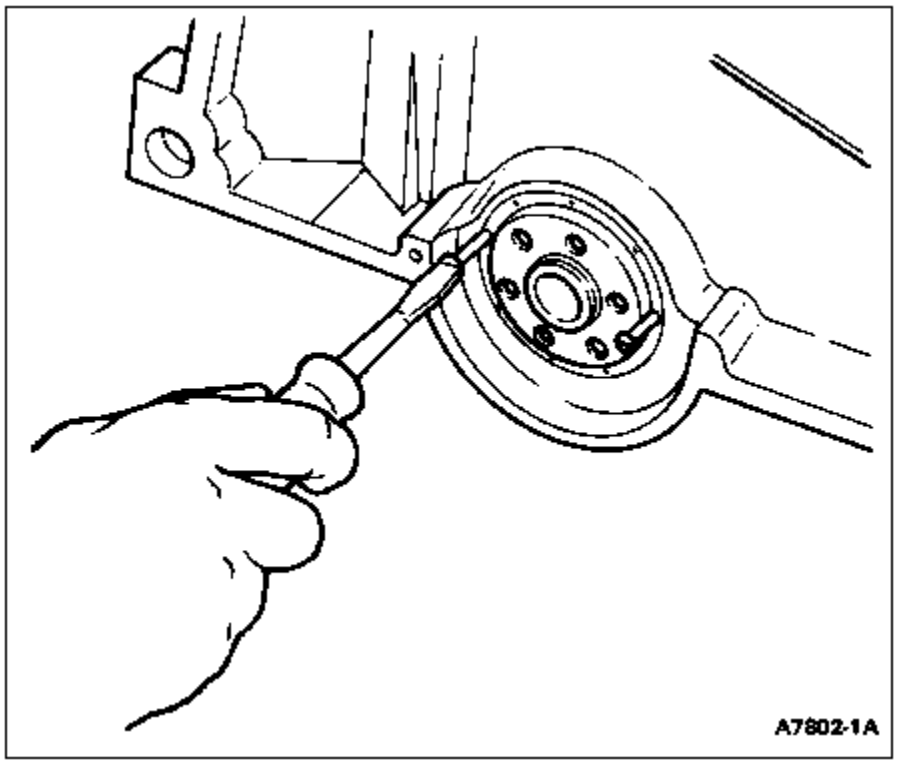

Installation

Crankshaft rear oil seals used for service applications can come either with or without a metallic crankshaft sleeve. Special Service Tool T95T-6701-A and T97T-6701-A Rear Crankshaft Seal Replacer, is used for both applications.

The rear crankshaft seal adapter and two mounting screws attach to the crankshaft. The threaded hole in the center of the crankshaft seal adapter is used by the rear crankshaft seal replacer to draw down and locate the crankshaft rear oil seal.

The rear crankshaft seal protector is used for installing seals without a metallic sleeve. It is not used when installing a rear main oil seal with a sleeve.

CAUTION: Do not remove the metal sleeve from the seal.

CAUTION: This installation procedure requires the use of hand tools only. The use of power tools or hammering on the installer can damage the sleeve and seal.

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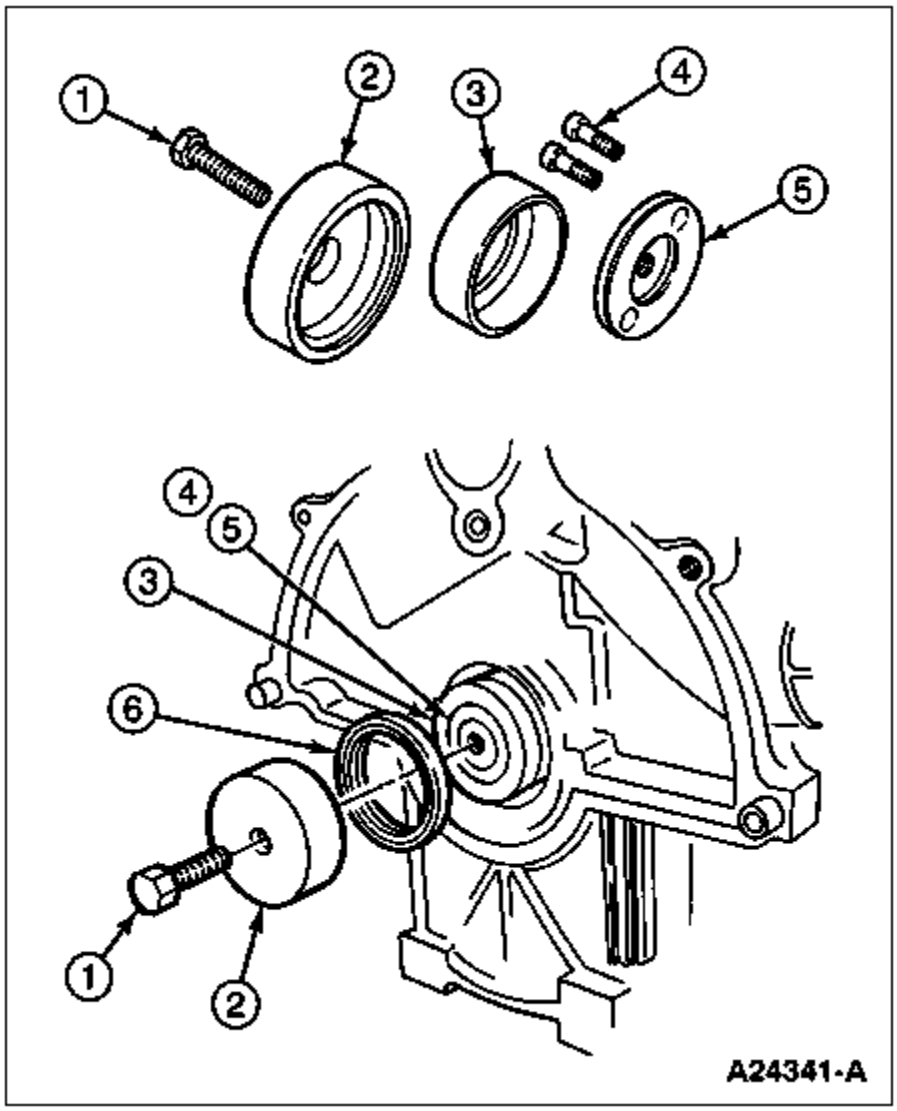

Item	Part Number	Description
1	—	Bolt (Part of T95T-6701-A)
2	T95T-6701-A2	Rear Crankshaft Seal Replacer
3	T95T-6701-A1	Rear Crankshaft Seal Protector
4	T95T-6701-A4	Bolts
5	T95T-6701-A3	Rear Crankshaft Adapter
6	6701	Crankshaft Rear Oil Seal

Seal Installation With Metal Sleeve

1. Attach the rear crankshaft adapter to the rear of the crankshaft using the supplied mounting screws.
2. Apply a few drops of clean engine oil to the inboard side of the seal/sleeve at the area where the seal contacts the sleeve.

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3. Apply a very light film of clean engine oil on the inner diameter of the sleeve and outer diameter of seal.

4. Slide the seal/sleeve over the rear crankshaft seal adapter with flange to the rear of the engine.

5. **NOTE: It is normal for the seal to sit approximately 0.76mm (0.030 inch) deeper than the sleeve flange. DO NOT ADJUST.**

   Use the rear crankshaft seal replacer and supplied bolt to push the rear seal into the cylinder blocks.

   Remove rear crankshaft seal adapter.

Seal Installation Without Metal Sleeve

1. Attach the rear crankshaft adapter to the rear of the crankshaft using supplied mounting screws.

2. Slide rear crankshaft seal protector over the rear crankshaft seal adapter and over the end of the crankshaft.

3. Start the crankshaft rear oil seal over the rear crankshaft seal protector.

4. Use the rear crankshaft seal replacer and supplied bolt to push the seal into the cylinder blocks.

5. Remove rear crankshaft seal protector and rear crankshaft seal adapter.

6. Install flywheel (6375). Tighten flywheel-to-crankshaft bolts as follows:

   a. First stage — 12-15 Nm (9-11 lb-ft).
   b. Second stage — 68-74 Nm (50-55 lb-ft).

7. If equipped, install clutch as outlined in Section 08-01 .

8. Install transmission as outlined in Group 07.

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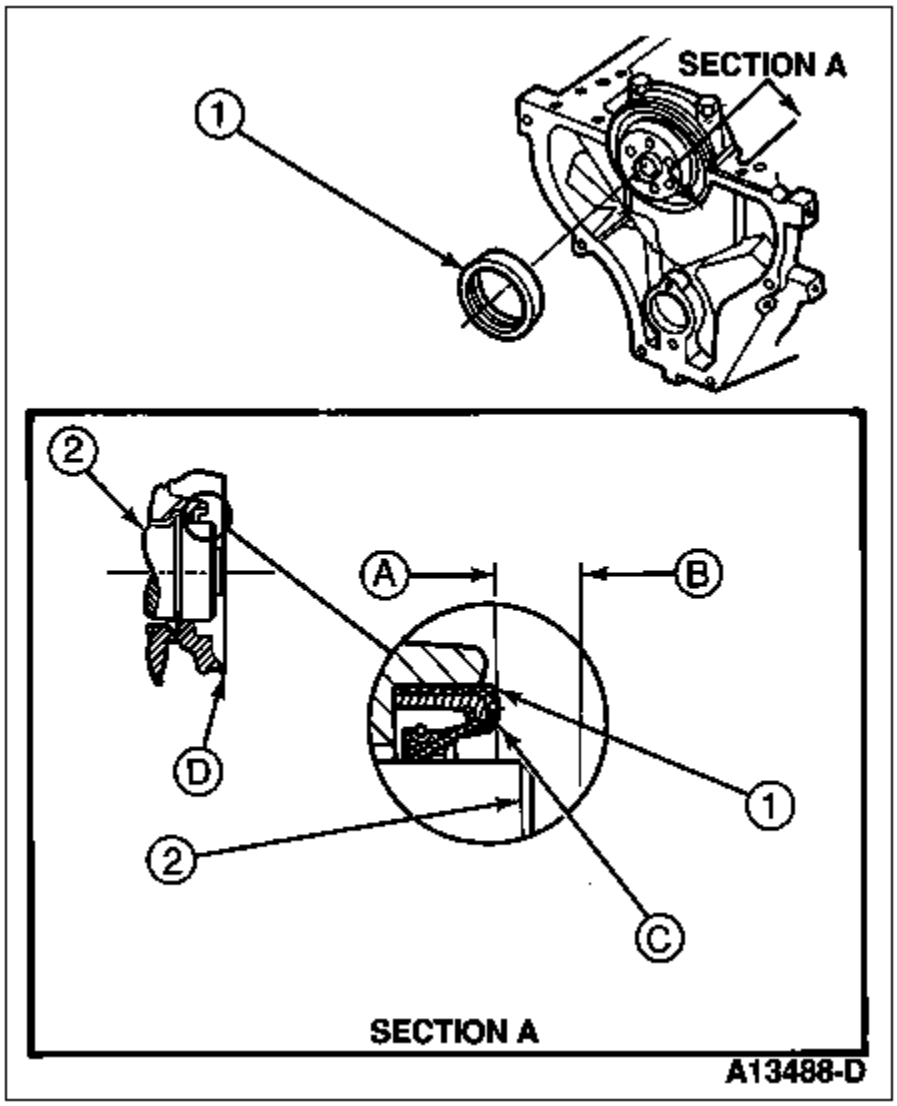

Item	Part Number	Description
1	6701	Crankshaft Rear Oil Seal
2	6303	Crankshaft
A	—	10.5 + 0.2-0.3mm (0.413 + 0.008-0.012 Inch)
B	—	Installation Dimension from Rear Face of Cylinder Block to Oil Seal
C	—	After Installation This Surface Must Be Square with Centerline of Crankshaft Within 0.38mm (0.015 Inch)
D	—	Rear Face of Cylinder Block

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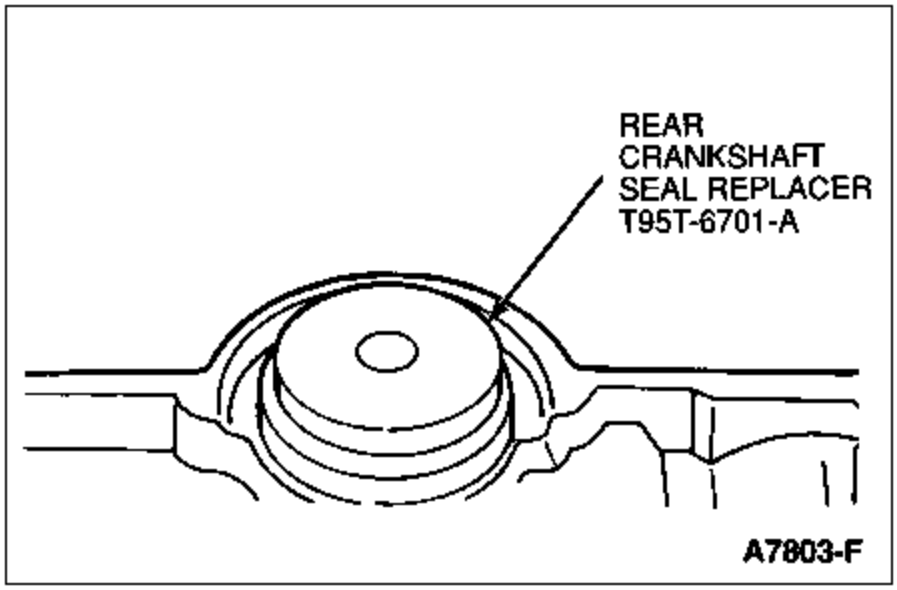

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Camshaft Rear Bearing Cover

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Slide Impact Hammer	T59L-100-B
Slide Impact Hammer	T50T-100-A

Removal

1. Remove transmission. Refer to the applicable section in Group 07.
2. If equipped with manual transmission, remove clutch as outlined in Section 08-01 .
3. Remove flywheel-to-crankshaft bolts (6379) and remove flexplate and flywheel reinforcing plate (6A366) or flywheel.
4. Using a sharp chisel or punch and hammer, cut a hole in the center of the camshaft rear bearing cover (6266).
5. Remove the camshaft rear bearing cover using Impact Slide Hammer T59L-100-B or T50T-100-A. The camshaft rear bearing cover can also be pried from the bore using a large punch. Use care to prevent damage to the plug bore.

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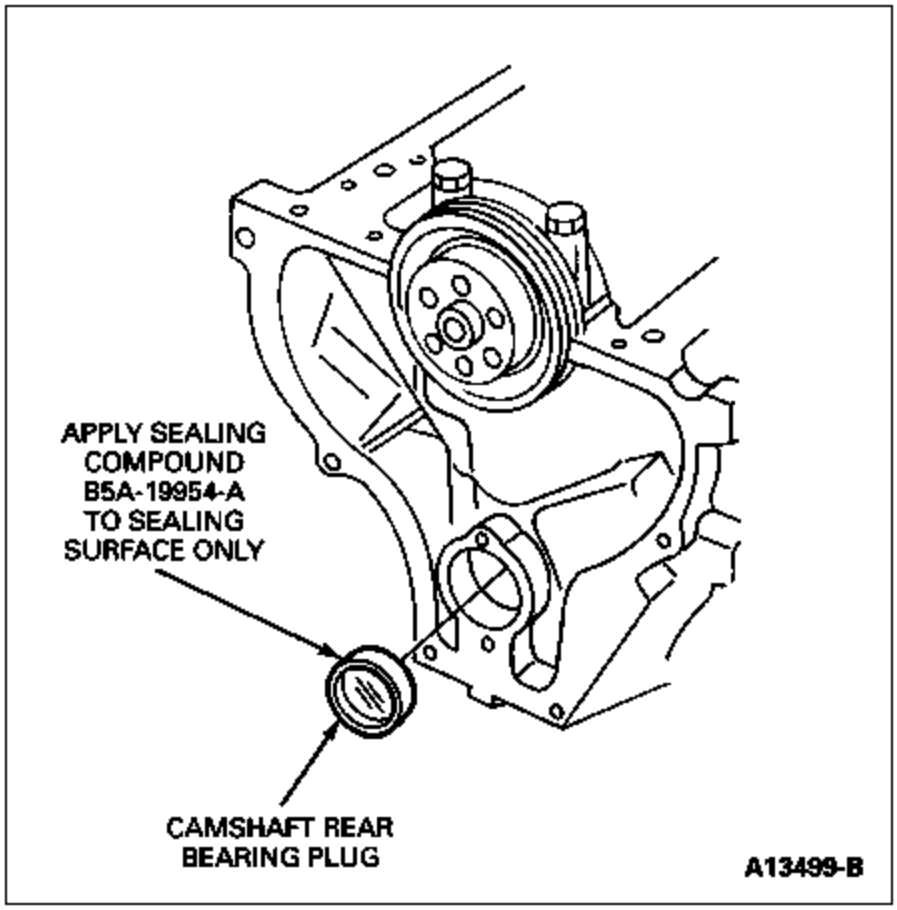

Installation

Prior to installing camshaft rear bearing cover, the plug bore should be inspected for any damage that would interfere with the proper sealing of the plug. If the bore is damaged it will be necessary to true the surface by boring for the next specified oversize plug. Oversize (OS) plugs are identified by the OS stamped in the flat located on the cup side of the plug.

1. Apply a light coating of Perfect-Seal Sealing Compound B5A-19554-A meeting Ford specifications ESR-M18P2-A and ESE-M4G115-A or equivalent to the sealing edge of the camshaft rear bearing cover before installation. Install bore camshaft rear bearing cover using a suitable driver.

2. Install flywheel or flexplate and flywheel reinforcing plate. Tighten flywheel-to-crankshaft bolts as follows:

    a. First stage — 12-15 Nm (9-11 lb-ft).
    b. Second stage — 68-74 Nm (50-55 lb-ft).

3. If equipped, install clutch as outlined in Section 08-01 .

4. Install transmission. Refer to the applicable section in Group 07.

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Oil Filter

Removal

1. **NOTE: It may be necessary to pull the battery cables forward and out of the way in order to access the oil filter.**

   Place a drip pan under the filter.

2. Use suitable oil filter wrench to loosen filter.

3. Unscrew and remove the oil bypass filter (6714) from the oil filter mounting insert (6890). Empty oil remaining in filter into appropriate container so it may be properly recycled or discarded. Clean the filter adapter recess.

Oil Filter and Adapter — Ranger

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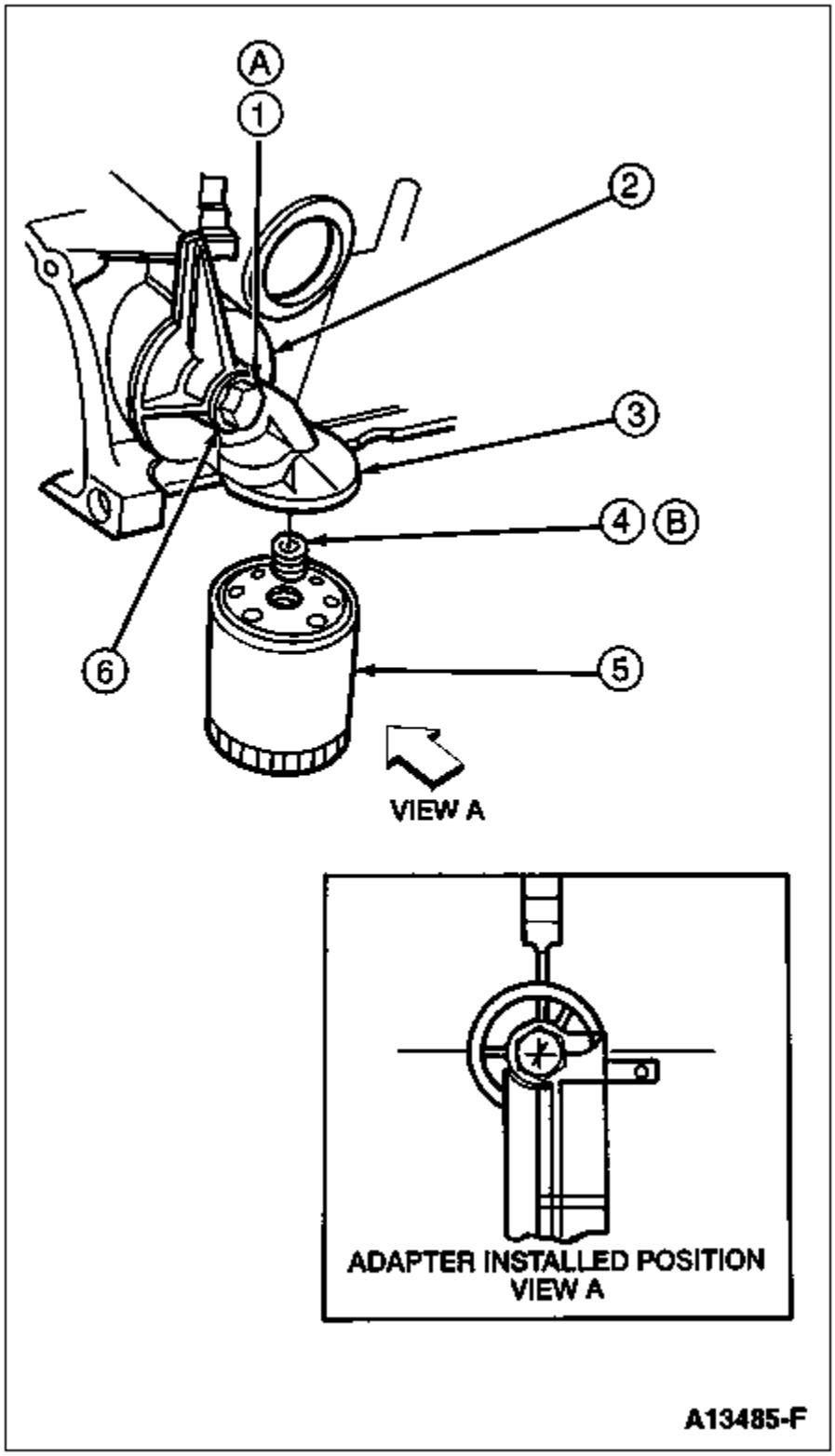

Item	Part Number	Description
1	6894	Oil Filter Adapter Mounting Bolt
2	6L621	O-Ring

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3	6881	Oil Filter Adapter
4	6890	Oil Filter Mounting Insert
5	6714	Oil Bypass Filter
6	E843188-S	O-Ring
A	—	Tighten to 35-40 Nm (26-30 Lb-Ft)
B	—	Tighten to 35-48 Nm (26-35 Lb-Ft)

Installation

1. Coat the gasket on the replacement oil bypass filter with clean oil. Position the oil bypass filter on the oil filter mounting insert. Hand-tighten the oil bypass filter until the gasket contacts the adapter face, then advance it one-half turn.

2. Fill the crankcase to the correct level with the specified viscosity and grade of oil.

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Oil Filter Adapter

Removal

1. Place a drip pan under the oil bypass filter (6714) and remove oil bypass filter.
2. On Aerostar, remove the small locating bolt securing the oil filter adapter (6881) to the cylinder blocks (6010).
3. Remove the oil filter adapter mounting bolt (6894) from the adapter, and remove the oil filter adapter from the engine (6007).

Oil Filter and Adapter — Aerostar

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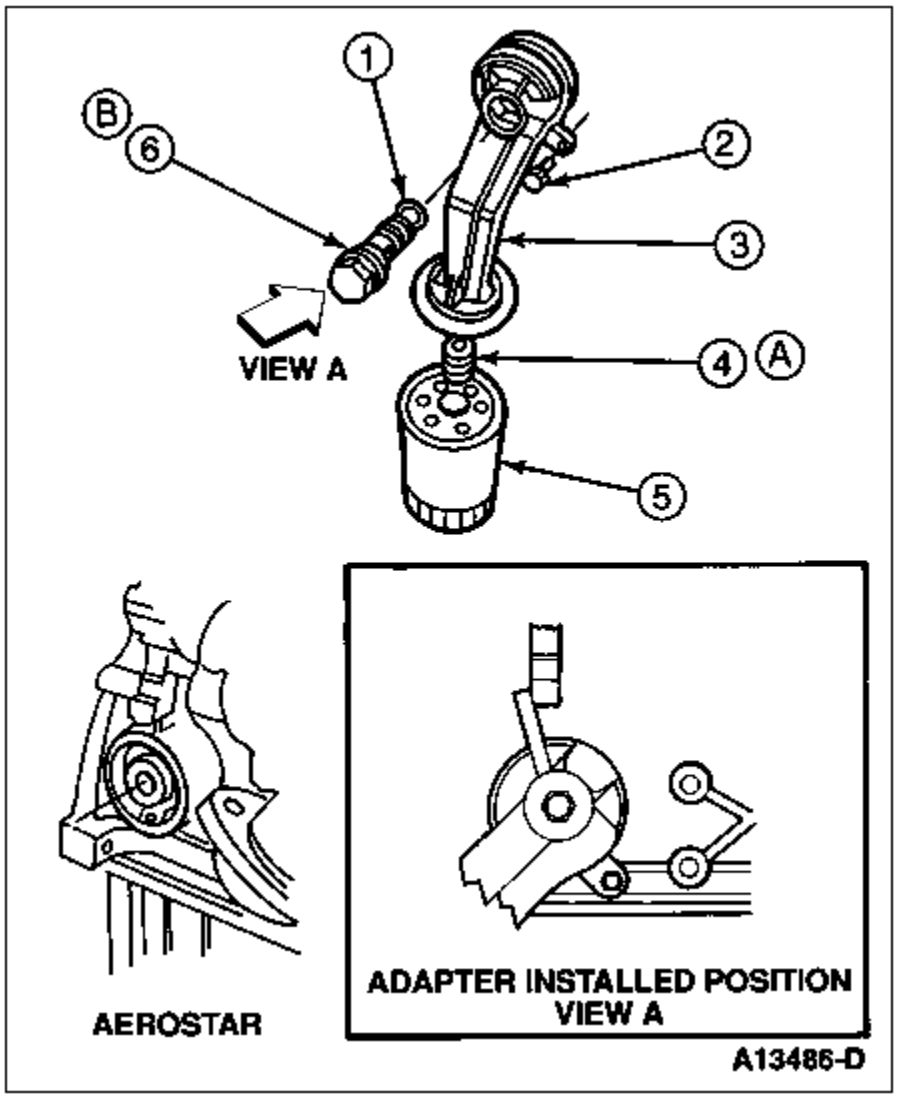

Item	Part Number	Description
1	E853188-S	O-Ring
2	E602189	Bolt
3	6881	Oil Filter Adapter
4	6890	Oil Filter Mounting Insert
5	6714	Oil Bypass Filter
6	6894	Oil Filter Adapter Mounting Bolt
A	—	Tighten to 14-21 Nm (10-15 Lb-Ft)
B	—	Tighten to 35-40 Nm (26-30 Lb-Ft)

Installation

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1. Position the oil filter adapter to the cylinder blocks with a new gasket between the oil filter adapter and the cylinder blocks.

Oil Filter and Adapter — Ranger

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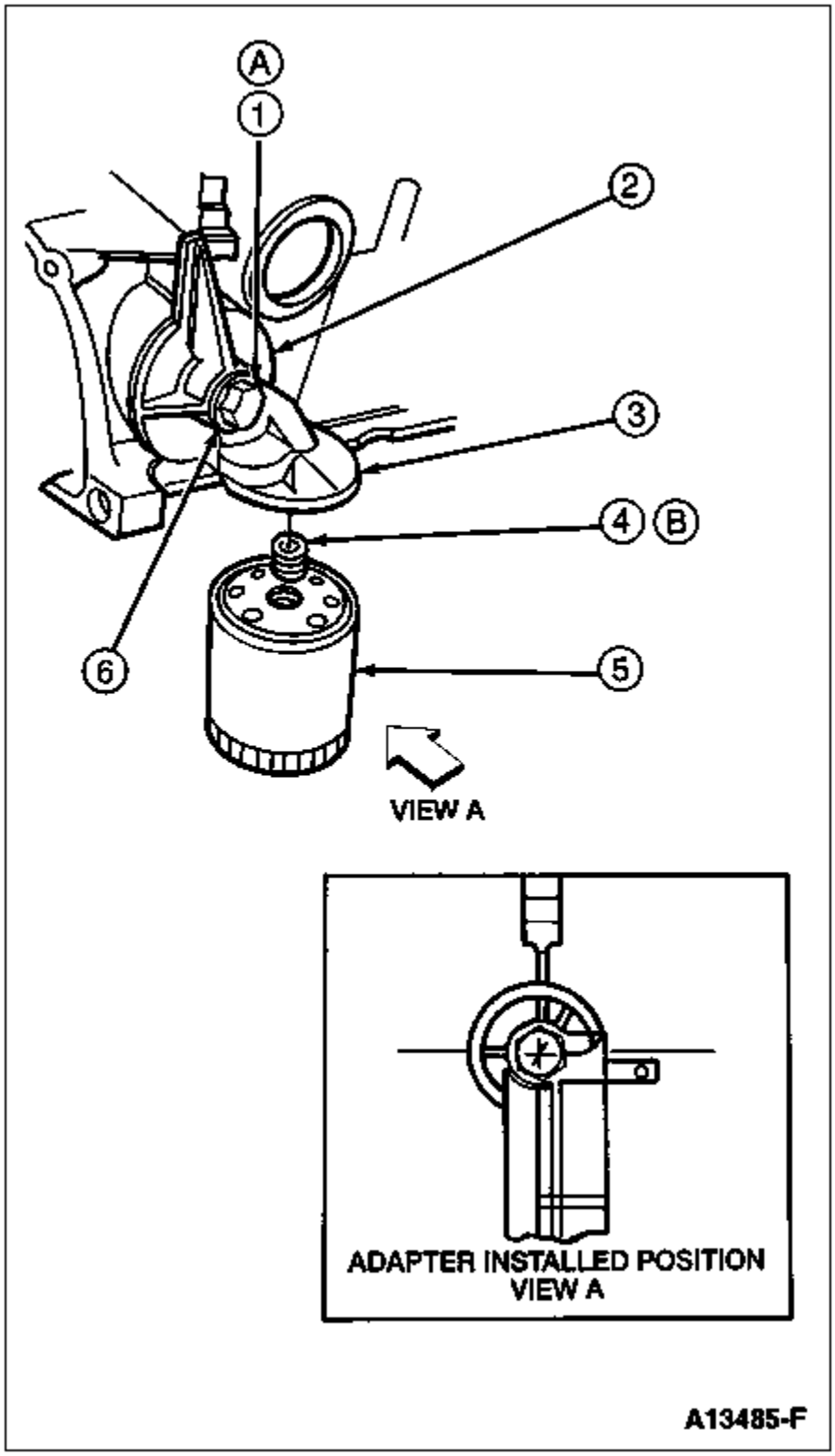

Item	Part Number	Description
1	6894	Oil Filter Adapter Mounting Bolt
2	6L621	O-Ring

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3	6881	Oil Filter Adapter
4	6890	Oil Filter Mounting Insert
5	6714	Oil Bypass Filter
6	E843188-S	O-Ring
A	—	Tighten to 35-40 Nm (26-30 Lb-Ft)
B	—	Tighten to 35-48 Nm (26-35 Lb-Ft)

2. Install a new oil filter mounting bolt seal (6749) on the oil filter adapter mounting bolt and install the bolt into the engine block, hand-tight.
3. Position the oil filter adapter as shown, aligning the locating bolt (Aerostar).
4. Tighten the oil filter adapter mounting bolt to 35-40 Nm (26-30 lb-ft). On Aerostar vehicles, install the locating bolt.

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Sensors

Low Oil Level Sensor

Removal

1. With engine off, drain at least 1.9 liters (2 quarts) of oil from engine (6007).
2. Disconnect electrical connection.
3. Remove low oil level sensor (6C624) with a 26mm (1-inch) socket or end wrench. Discard old gasket.

Installation

1. **NOTE: Always replace gasket when removing low oil level sensor.**

   Install new gasket onto low oil level sensor, noting flange faces sensor and the words "pan side" are facing the oil pan (6675).

2. **NOTE: When replacing low oil level sensor using a metal gasket with a rubber O-ring, tighten sensor to 17-27 Nm (13-20 lb-ft).**

   Install low oil level sensor and gasket assembly. Tighten to 20-34 Nm (15-25 lb-ft).

3. Connect electrical connection.
4. Refill crankcase to correct level.
5. Start engine and check for oil leaks.

Typical Oil Level Sensor Installation

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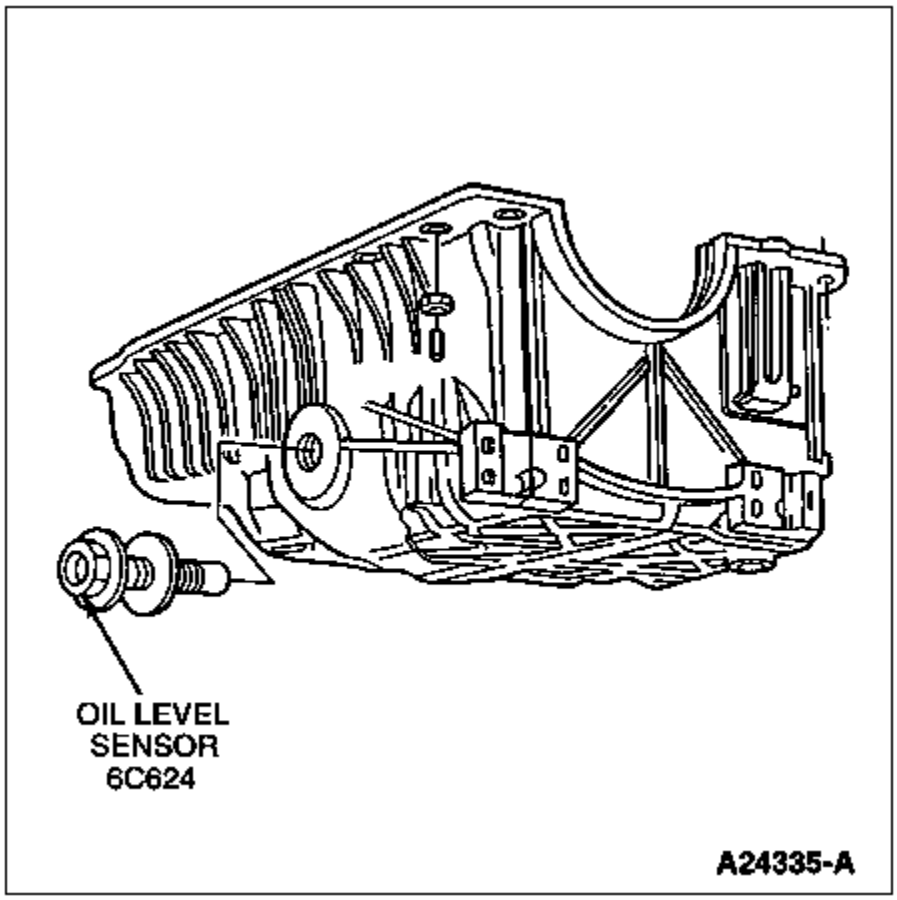

Oil Pressure Sender/Switch

Removal and Installation (4.0L Engine)

1. Make sure engine is turned off.
2. Remove electrical connection to oil pressure sensor (9278) at the front left of the engine block.
3. Remove switch from cylinder blocks (6010).
4. Apply Pipe Sealant with Teflon®, D8AZ-19554-A meeting Ford specifications ESG-M4G-194-A and ESR-M18P7-A or equivalent to new switch unit threads.

   For installation follow removal procedures in reverse order. Tighten oil pressure sensor to 11-16 Nm (8-12 lb-ft). If the oil pressure switch fitting was removed, tighten to 11-16 Nm (8-12 lb-ft) and then one additional turn for correct orientation (fitting should be vertical to 30 degrees toward front of vehicle). Start engine and check switch for oil leaks.

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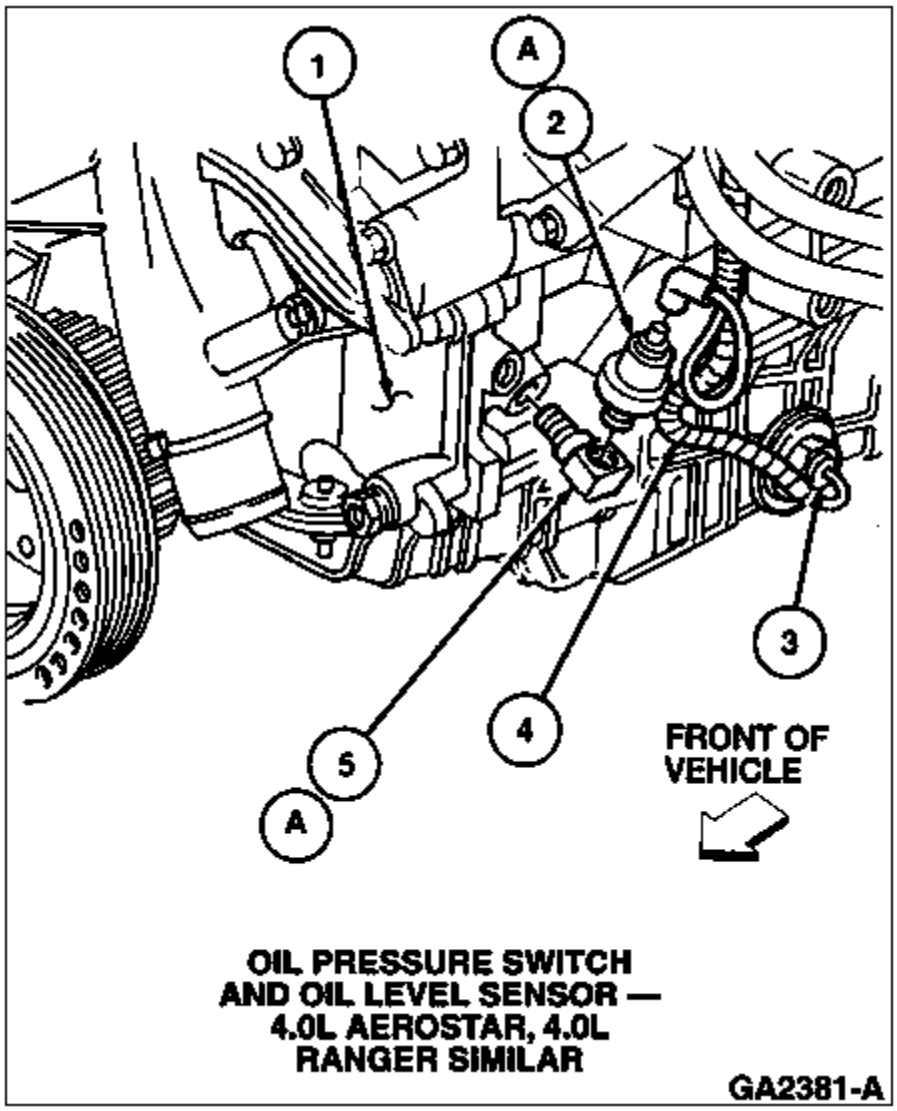

Item	Part Number	Description
1	6010	Cylinder Blocks (LH)
2	9278	Oil Pressure Sensor
3	6C624	Low Oil Level Sensor
4	9D930	Fuel Charging Wiring
5	9B339	Oil Pressure Sender Fitting
A	—	Tighten to 11-16 Nm (8-12 Lb-Ft)

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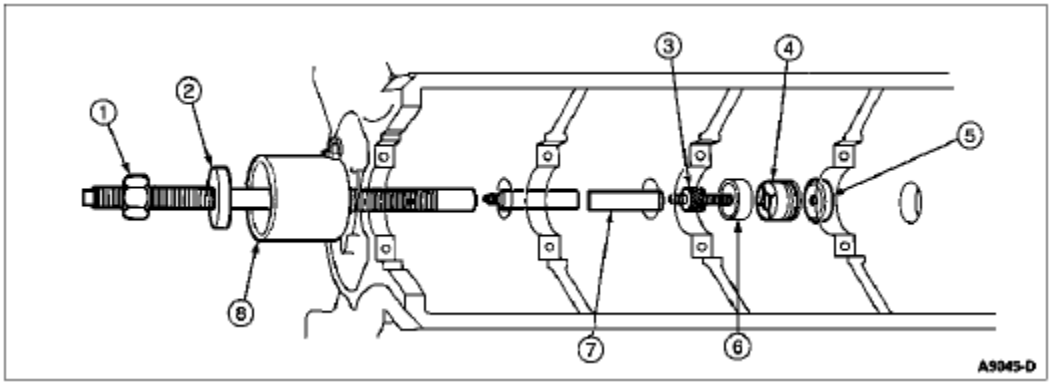
Camshaft Bearings

Removal

1. Remove engine (6007). Place engine on work stand and remove camshaft (6250), crankshaft (6303) and camshaft rear bearing cover (6266).
2. Remove camshaft bearing (6261) with Camshaft Bearing Set T65L-6250-A.
3. Select proper size expanding collet and backup nut, and assemble on the expanding mandrel. With the expanding collet collapsed, install collet assembly in the camshaft bearing, and tighten backup nut on the expanding mandrel until the collet fits the camshaft bearing.
4. Assemble pulling screw and extension, if necessary, and install on the expanding mandrel. Wrap a cloth around the threads of the pulling screw to protect the bearing or journal. Tighten the pulling nut against the thrust bearing and pulling plate to remove camshaft bearing. Be sure to hold the end of the pulling screw to prevent it from turning.
5. Repeat the above step for each bearing. To remove the front bearing, install the puller from the rear of the block.

Camshaft Bearings, Removal and Installation



Item	Part Number	Description
1	—	Pulling Screw (Part of T65L-6250-A)
2	—	Pulling Plate (Part of T65L-6250-A)
3	—	Expanding Mandrel (Part of T65L-6250-A)

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4	—	Expanding Collet (Part of T65L-6250-A)
5	—	Backup Nut (Part of T65L-6250-A)
6	6262	Bearing, Camshaft (Part Number Given Is for Reference Only)
7	—	Puller Screw Extension (Part of T65L-6250-A)
8	—	Front Spacer (Part of T65L-6250-A) NOTE: All items except No. 6 (Bearing) are included in Camshaft Bearing Set T65L-6250-A.

Installation

The camshaft bearings are available pre-finished to size and require no reaming for standard and 0.081mm (0.015 inch) undersize journal diameters.

1. **NOTE: Align the oil holes in the camshaft bearings with the oil holes in the cylinder blocks (6010) before pressing bearings into place.**

   Make sure the front bearing is installed 0.51-0.89mm (0.020-0.035 inches) below the front face of the cylinder block.

   Position camshaft bearings at the bearing bores and press them in place with Camshaft Bearing Set T65L-6250-A. Be sure to center the pulling plate and puller screw to avoid damage to the bearing.

   Failure to use the correct expanding collet can cause severe bearing damage.

2. Install camshaft rear bearing cover as outlined.

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Oil Pan, Ranger

Removal

1. Remove the engine (6007) as detailed in this section.

2. **CAUTION: Mounting the engine upside down on the engine stand before removing the oil pan (6675) may cause sludge to drop into the cylinders and onto the camshaft (6250) and valve tappets (6500) causing rapid wear when the engine is restarted.**

   Mount the engine on an engine stand **with the engine upright** . Remove the oil pan and crankshaft oil windage baffle (6L680).

3. Rotate the engine upside down and remove the oil pump (6600) and rear main bearing cap.

4. Remove and discard the crankshaft rear main seal.

Installation

1. **CAUTION: Prevent engine assembly contamination. Always use necessary precautions to prevent old sealer or gasket material from falling into the engine.**

   Thoroughly clean **ALL** the oil and the old sealer from the oil pan taking special care to remove **ALL** the old sealer from the oil pan gasket groove in the oil pan. Thoroughly clean the oil pan.

2. **NOTE: Thoroughly clean all exposed areas with metal surface cleaner F4AZ-19A536-RA or denatured alcohol. Place special attention on removing the remains of the integral rubber wedge seal. The tabs on the wedge seal tear away from the oil pan gasket when the oil pan is removed and remain lodged between the block and the rear main bearing cap.**

   Thoroughly clean **ALL** the old sealer from the rear main bearing cap using a scraper and wire wheel. The original sealer used during production assembly becomes extremely hard after it has cured. It is extremely important that **ALL** old sealer is removed from all joining faces and grooves.

3. Thoroughly clean **ALL** oil and old sealer from the cylinder block oil pan sealing area and the rear main bearing cap joint area.

4. Thoroughly clean **ALL** oil and old sealer from the area at the rear main bearing cap.

5. After all parts have been thoroughly cleaned and washed, it is necessary and extremely important that they be wiped down with Extra Strength Spot and Stain Remover B7A-19521-AA meeting Ford specification ESR-M5B197-A or denatured alcohol.

6. Thoroughly clean the transmission bell-housing area and the rear of the cylinder blocks (6010). Oil removal should be verified with an ultraviolet lamp ("black light").

7. Apply a bead of Ford Gasket Eliminator E1FZ-19562-A or Loctite® 515, or equivalent sealer meeting

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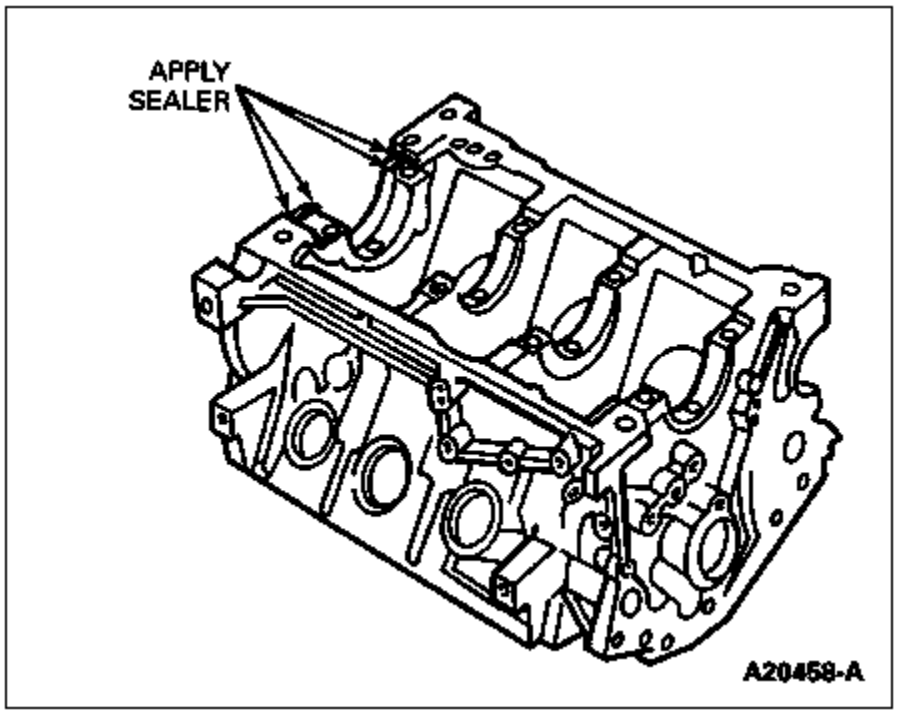
Ford specification ESE-M4G234-A1, to the cylinder blocks along the corners of the rear main bearing cap joint area, and on the joint face approximately 13mm (1/2 inch) from the rear of the cylinder blocks.

Cylinder Block Sealer Application



8. **NOTE: New main bearing cap bolts must be used during assembly.**

   Verify that the lower rear main bearing insert is in place and install the rear main bearing cap and snug the bolts.

9. **NOTE: The rear main bearing cap MUST be aligned and installed properly to seal. Misalignment will cause an oil leak.**

   Align the rear main bearing cap to block by moving the bearing cap fore or aft so the rear seal stop (located approximately 1/2 inch inward in the rear oil seal bore) of the block and cap line up. This will ensure the crankshaft rear oil seal (6701) will seat properly when installed in the bore.

10. Tighten the bolts evenly to 90-104 Nm (66-77 lb-ft).

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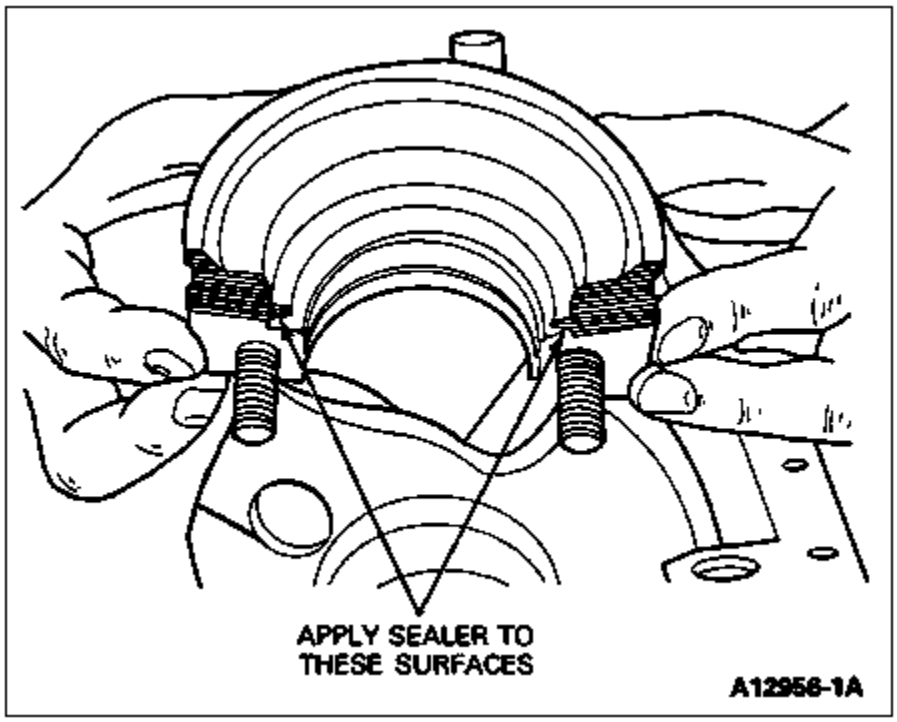

11. **CAUTION: Use a NEW oil seal. Failure to install a new seal, or incorrect installation will result in an oil leak after the vehicle is returned to service.**

    Fill the cavities on both sides of the rear main cap with Gasket Eliminator E1FZ-19562-A or Loctite 515® or equivalent sealer meeting Ford specification ESE-M4G234-A1. See illustration.

Oil Pan Installation

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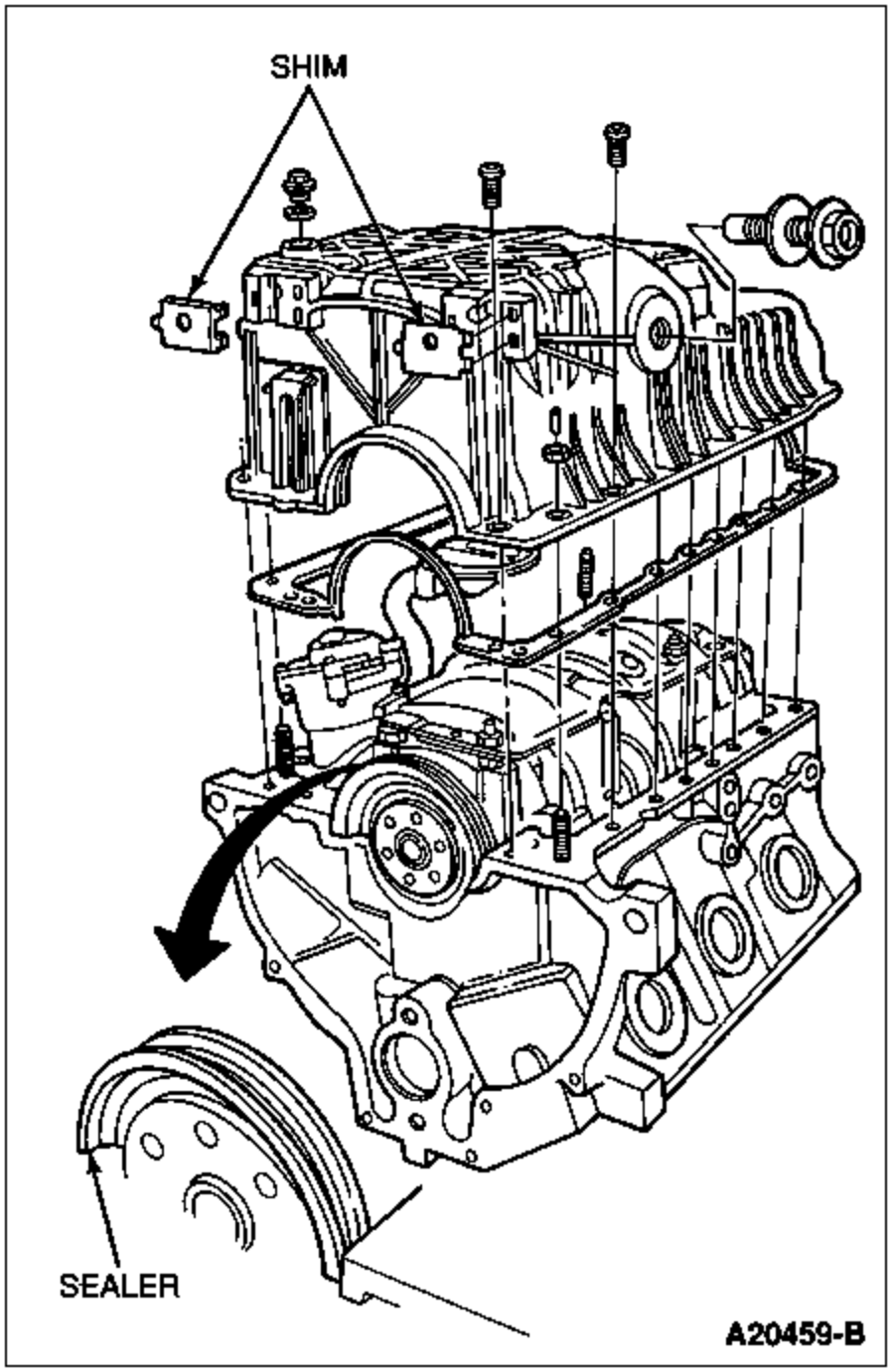

12. Clean and inspect the oil inlet tube. Prime the oil pump by filling the inlet opening with oil while rotating the shaft until oil emerges from the outlet opening. Install the pump and screen and tighten the bolts to 17-21 Nm (13-15 lb-ft).

13. Install the windage tray and tighten to 17-21 Nm (13-15 lb-ft).

14. Place a bead of Ford Silicone Sealer F1AZ-19562-A, Loctite® 598 or equivalent sealer in the oil pan gasket flange at the radius areas at the front and rear of the oil pan.

15. Place the oil pan gasket (6710) in place on the flange of cylinder block while setting integral wedge seal in place.

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16. Place a bead of Ford Silicone Sealer F1AZ-19562-A, or Loctite® 598 or equivalent sealer meeting Ford specification WSE-M4G279, on top of the oil pan gasket at the radius areas at the front and rear of the oil pan.

17. Place a bead of Ford Silicone Sealer F1AZ-19562-A or Loctite® 598 sealer or equivalent meeting Ford specification WSE-M4G277, on the cylinder blocks at the cylinder block-to-front cover joint area.

18. Set the oil pan in place as the wedge seal is placed in position. Install and snug four oil pan nuts tight enough to align the bolt holes, but loose enough that the oil pan may be pushed backwards.

19. **NOTE: If the rear face of the oil pan cannot be aligned within .010 inch of the rear face of the cylinder blocks, the oil pan spacer (6C629) should be used.**

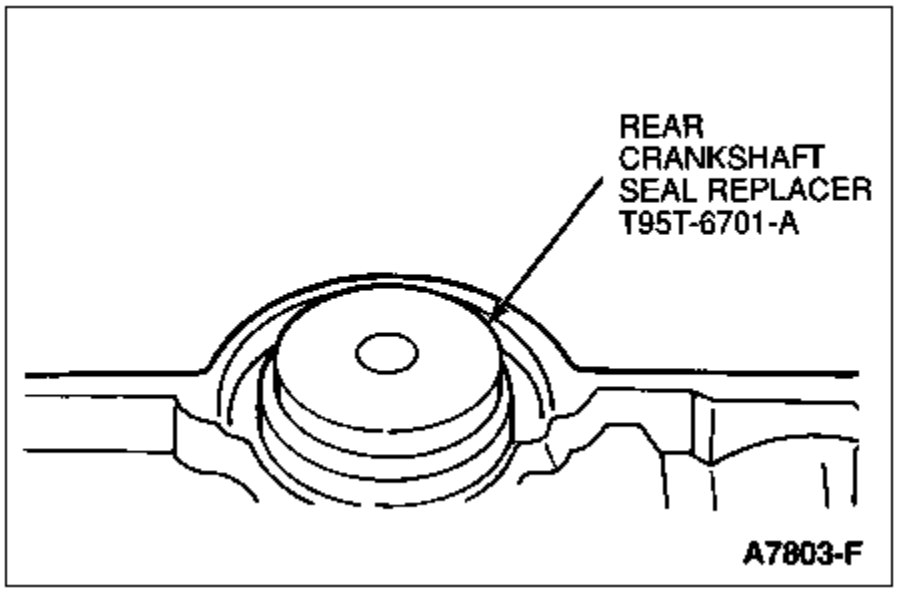
    Align the rear face of the oil pan with the rear face of the cylinder blocks.

20. Install the remaining oil pan bolts and finger-tighten.

21. Tighten the oil pan nuts and bolts evenly to 7-10 Nm (62-89 lb-in).

22. **NOTE: Do not put oil in the engine or run the engine until the next day to allow the sealers to set up properly. If time is not allowed for sealers to cure, engine will leak.**

    Always use a new crankshaft rear oil seal. Coat the rear main seal-to-cylinder block surface of the oil seal with oil XO-5W30-QSP or equivalent meeting Ford specification WSE-M2903-A1 or equivalent SAE 5W-30 Service SG engine oil. Refer to Crankshaft Rear Oil Seal Installation in this section.



23. **CAUTION: Failure to measure the required spacer thickness will result in insufficient or excessive clearance between the oil pan and the transmission (7003) when installed in the vehicle. This can result in oil pan damage and an oil leak.**

    NOTE: The transmission bolts to the engine and oil pan when installed, so it is important to measure the gap between the surface of the rear face of the oil pan (at the spacer locations) and the rear face of the cylinder blocks. Refer to the following procedure for checking this

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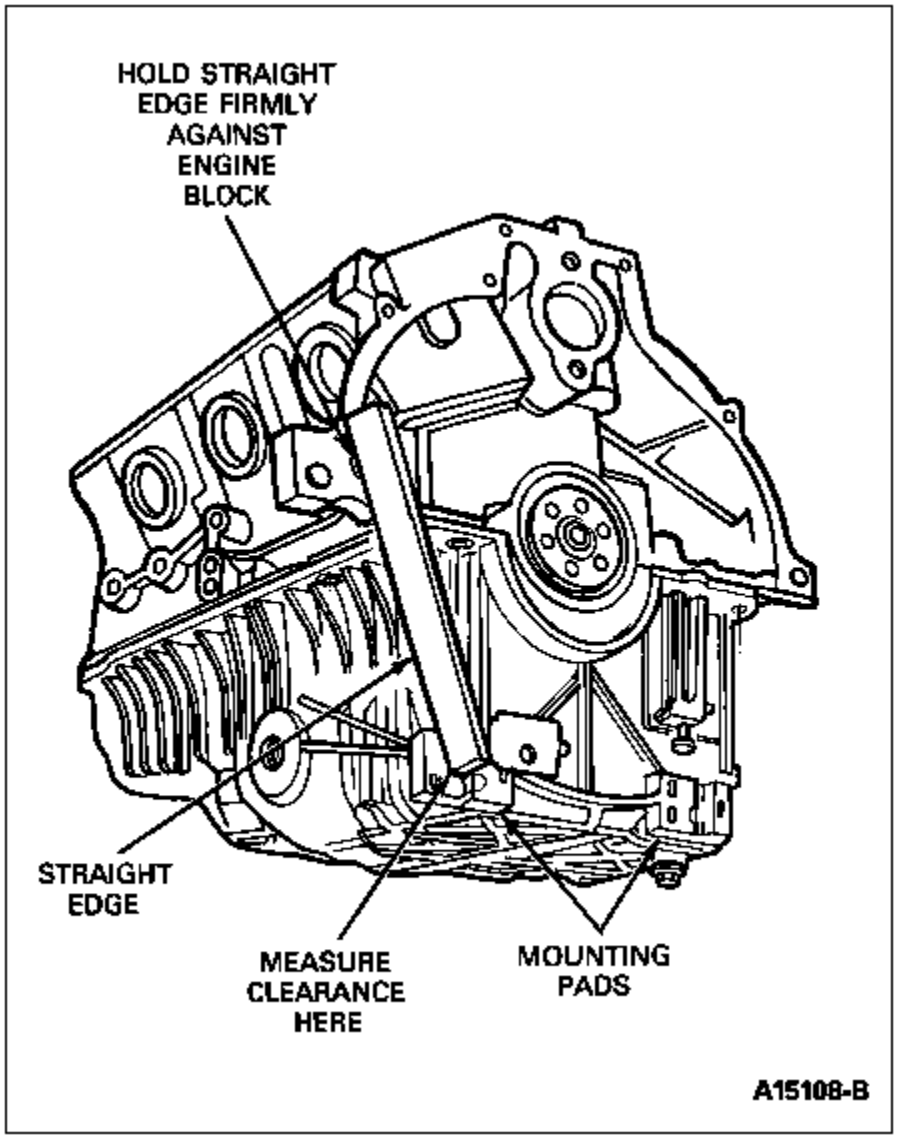
dimension.

Determine if oil pan spacers will be required at installation.

a. With the oil pan installed on the engine, position straightedge D83L-4201-A or equivalent flat on the rear of the cylinder blocks (as shown) so that it extends over one of the oil pan/transmission bolt mounting pads.



b. Using Feeler Gauge D81L-4201-A or equivalent, measure the gap between the mounting pad and the straightedge. Repeat the procedure for the other mounting pad. Select oil pan spacer of the required thickness from the chart.
c. Install the selected oil pan spacer to the mounting pads on the rear of the oil pan before bolting the engine and transmission together.

24. Remove engine from stand and install as outlined in this section.

SPACER SELECTION CHART

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Measured Gap		Spacer Required		
mm	Inch	mm	Inch	Shim Color Code
0.0-0.254	0.0-0.010	None	None	—
0.27-0.51	0.011-0.020	0.254	0.010	Yellow
0.52-0.76	0.021-0.029	0.508	0.020	Blue
0.77-1.00	0.030-0.039	0.762	0.030	Pink

Oil Pan, Installation

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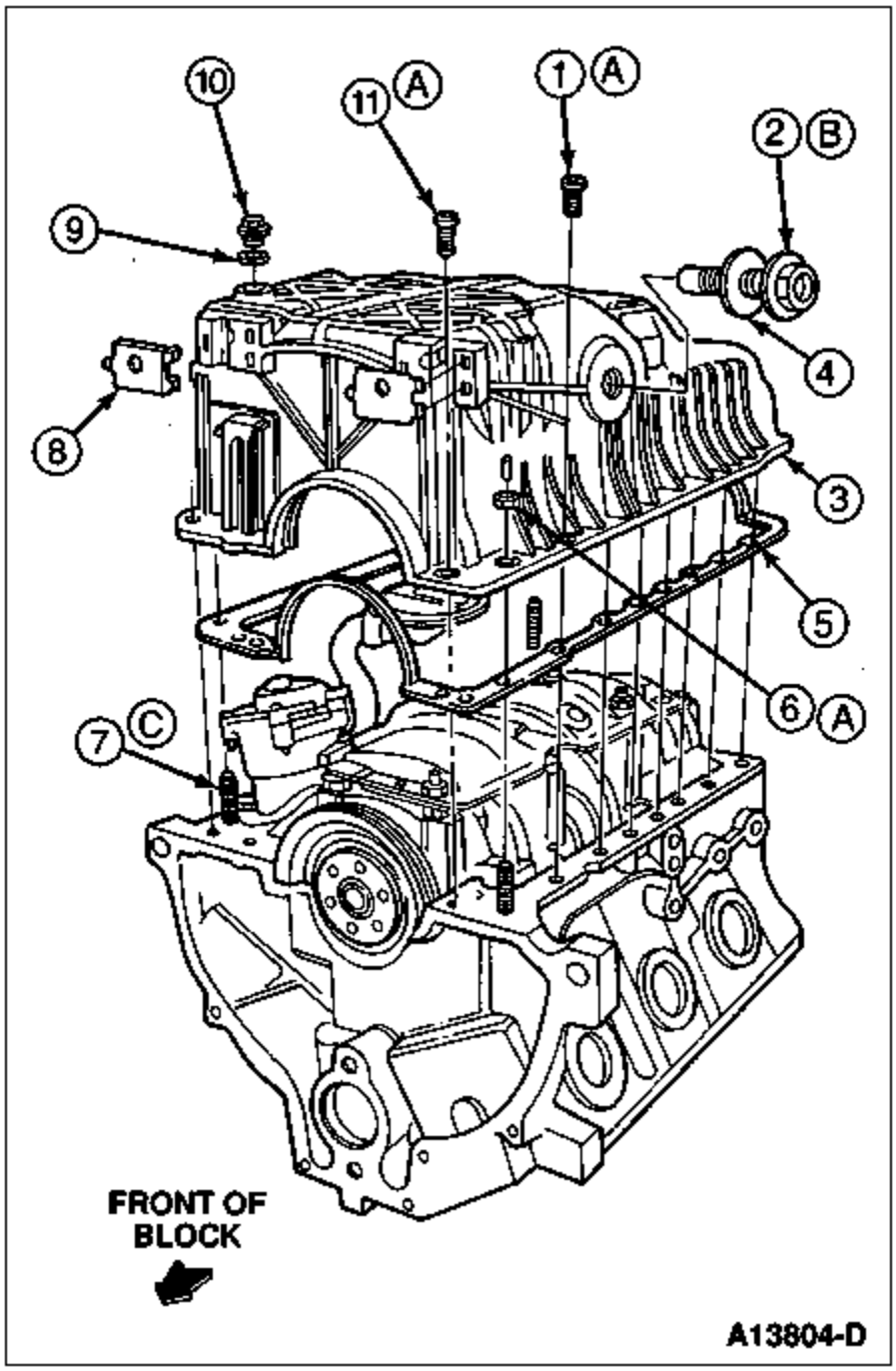

Item	Part Number	Description
1	E804588-S72	Bolt
2	6C624	Low Oil Level Sensor
3	6C626	Low Oil Level Sensor Washer
4	6675	Oil Pan
5	6710	Oil Pan Gasket
6	E60012-S72	Nut

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7	E804579-S72	Stud
8	6C629	Oil Pan Spacer
9	6734	Oil Pan Drain Plug Gasket
10	6730	Oil Pan Drain Plug
11	E804587-S72	Torx® Bolt
A	—	Tighten to 7-10 Nm (5-7 Lb-Ft)
B	—	Tighten to 17-21 Nm (13-20 Lb-Ft)
C	—	Tighten to 4 Nm (35 Lb-In)

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Engine Assembly, Ranger

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Fan Clutch Nut Wrench	T84T-6312-D
Fan Clutch Holding Tool	T84T-6312-C

WARNING: RESIDUAL PRESSURE REMAINS IN FUEL SYSTEM AFTER ENGINE IS SHUT OFF. THIS COULD RESULT IN INJURY WHEN FUEL LINES ARE DISCONNECTED. DISCONNECT INERTIA FUEL SHUTOFF SWITCH AND CRANK ENGINE UNTIL FUEL IN LINES IS USED UP. REFER TO SECTION 03-04C.

NOTE: It is not necessary to remove upper intake manifold for engine removal.

Removal

1. Disconnect the battery ground cable (14301) and drain the cooling system.
2. Using Rotunda 023-0100 Refrigerant Reclaim System or equivalent, drain air conditioning system, if equipped.
3. Remove the hood (16612).
4. Remove the accelerator control splash shield (9E766) and air cleaner outlet tube (9B659).
5. Remove the upper radiator hose (8260) and lower radiator hose (8286).
6. Remove the fan shroud attaching bolts and position the shroud over the fan blade (8600). Disconnect radiator overflow hose (8075). Remove radiator bolts and remove radiator (8005). Lift fan shroud (8146) off of fan blade.
7. Using Fan Clutch Nut Wrench T84T-6312-D and Fan Clutch Holding Tool T84T-6312-C, remove fan blade. Using wrench, lift drive belt tensioner pulley (6B217) and remove drive belt (8620).
8. Recover refrigerant from air conditioning system. Refer to Section 12-00 .
9. Disconnect air conditioning manifold tube assembly from A/C compressor (19703). Disconnect compressor electrical connector.
10. Remove A/C compressor mounting bracket (2882) and brace and set aside. It is not necessary to disconnect power steering return hose (3A713) and power steering pressure hose (3A719).
11. Using door trim tool, remove connector from generator mounting bracket (10153). Remove clip from engine control sensor wiring (12A581) and generator mounting bracket.

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12. Disconnect generator (GEN) (10300). Remove bolts and generator mounting bracket with attached generator and set aside.

13. Disconnect the manifold tube assembly at the intake manifold (9424) and water pump (8501).

14. Remove the ground wires from the cylinder block and wire from air conditioning pressure switch.

15. Disconnect accelerator cable (9A758) and kickdown control shaft rod (7A187) and remove throttle cable bracket.

16. Tag and disconnect vacuum lines from rear of engine, throttle body (9E926), and intake manifold.

17. Remove air conditioning manifold tube assembly bolt from upper intake manifold, disconnect lines from suction accumulator/drier (19C836) and A/C condenser core (19712), and remove.

18. Disconnect the fuel tank-to-fuel rail fuel lines at the fuel rail. Refer to Section 03-04C .

19. For California Ranger, disconnect the engine wiring harness connector at the CID sensor.

20. Tag and disconnect remaining vacuum line and electrical connectors.

21. Disconnect heated oxygen sensor (HO2S) (9F472).

22. Remove two top transmission-to-engine bolts and oil filler tube (7A228).

23. Raise the vehicle and secure with safety stands.

24. Disconnect the exhaust inlet pipes (5246) at the exhaust manifolds.

25. Disconnect the battery to starter relay cable (14300) and remove the starter motor (11001).

26. If vehicle has an automatic transmission (7003), remove flex plate-to-torque converter nuts through starter opening.

27. **NOTE: It is not necessary to disconnect the clutch hydraulic line for engine removal on manual transmission vehicles.**

    Remove the converter housing-to-cylinder block bolts and the adapter plate-to-converter housing bolt.

28. Partially lower the vehicle.

29. Remove battery cable bracket bolt and wire harness-to-engine clip.

30. On automatic transmission vehicles, remove transmission line bracket-to-engine bolts.

31. Install lifting brackets on the exhaust manifolds. Attach Rotunda Engine Lifting Sling 014-00036 or equivalent.

32. Position a jack under the transmission.

33. Raise the engine (6007) slightly and carefully pull it from the transmission. Carefully lift the engine out of the engine compartment so that the rear cover plate is not bent, or components damaged. Install the engine on a work stand.

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Installation

1. **NOTE: To facilitate engine-to-transmission installation and prevent clutch hub damage on manual transmission vehicles, make two guide studs by cutting the heads off two M10 x 70mm bolts and grinding a screwdriver slot in each bolt on the unthreaded end.**

   Install two studs into opposite engine-to-transmission bolt holes in engine to simplify installation.

2. Attach Rotunda Engine Lifting Sling 014-00036 or equivalent and hoist to lifting brackets at exhaust manifolds. Remove engine from work stand.

3. Lower the engine carefully into the engine compartment. Make sure exhaust manifolds are properly aligned with the exhaust inlet pipes.

4. Remove transmission jack and lifting equipment from engine.

5. Install transmission-to-engine bolts finger-tight and remove guide studs and install those two bolts finger-tight.

6. Position transmission-to-engine bracket and finish installing transmission-to-engine bolts and tighten to 38-51 Nm (28-38 lb-ft).

7. Install flexplate-to-torque converter nuts and tighten to 45-61 Nm (33-45 lb-ft).

8. Install starter motor and tighten bolts to 20-27 Nm (15-20 lb-ft). Install starter bracket and tighten to specifications.

9. Route and connect battery cable.

10. Connect the muffler inlet pipes at the exhaust manifolds. Tighten bolts to 37-50 Nm (27-37 lb-ft).

11. Install transmission line bracket bolts and tighten to 16-24 Nm (12-18 lb-ft).

12. Install battery cable bracket bolt and tighten.

13. Install the engine front support nuts and washer to the crossmember or through-bolts.

14. Lower the vehicle.

15. Install ground wires to cylinder block.

16. Route wiring harness through intake manifold.

17. For Ranger, connect the engine wiring harness connector to the CID sensor.

18. Connect air conditioner manifold tube assembly to condenser A/C condenser core and suction accumulator/drier and install bolt attaching it to upper intake manifold.

19. Install vacuum hoses, PCV hose, and tie strap.

20. Uncap and connect fuel lines as outlined in Section 03-04C .

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21. Install accelerator cable bracket (9723) and tighten bolts to 21-27 Nm (15-20 lb-ft).

22. Install A/C compressor mounting bracket and brace with assembled power steering pump (3A674) and A/C compressor. Tighten screws to 40-55 Nm (30-40 lb-ft).

23. Plug in compressor electrical connections.

24. Install warm air duct.

25. Connect heater water hose (18472) to water pump and other electrical and vacuum connections.

26. Install generator mounting bracket with assembled generator. Tighten bolts to 40-55 Nm (30-40 lb-ft).

27. Connect heater water hose to engine. Clip engine control sensor wiring to side of generator mounting bracket.

28. Install drive belt over pulleys. Make sure that all V-grooves make proper contact with pulleys.

29. Lift tensioner and slide belt under tensioner pulley. Release drive belt tensioner (6B209) to rest on belt.

30. Install air cleaner outlet tube, accelerator control splash shield, and radiator overflow hose.

31. Fill and bleed the cooling system. Refer to Section 03-03 . Fill the crankcase with the proper grade and quantity of oil.

32. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

    Connect battery ground cable.

33. Charge air conditioning system, if so equipped as outlined in Section 12-00 .

34. Operate the engine at fast idle until it reaches normal operating temperature and check all gaskets and hose connections for leaks.

35. Install and adjust the hood.

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Engine Assembly, Aerostar

Removal

1. **NOTE: The engine assembly on Aerostar E4WD vehicles can be removed through the front of the engine compartment without the transmission (7003) attached.**

   WARNING: RESIDUAL PRESSURE REMAINS IN FUEL SYSTEM AFTER ENGINE IS SHUT OFF. THIS COULD RESULT IN INJURY OR FIRE WHEN FUEL LINES ARE DISCONNECTED. DISCONNECT INERTIA FUEL SHUTOFF SWITCH AND CRANK ENGINE UNTIL FUEL IN LINES IS USED UP. REFER TO SECTION 03-04C.

   Open the hood (16612) and disconnect the battery negative cable.

2. Recover refrigerant from air conditioning system. Refer to Section 12-00 .
3. Remove the radiator grille (8200) and inside engine cover.
4. Remove the air cleaner outlet tube (9B659) and the engine air cleaner (ACL) (9600).
5. Disconnect and remove the A/C condenser core (19712) (if so equipped) as detailed in Section 12-03A .
6. Position a drain pan under the oil pan (6675) and drain the engine oil.
7. Position a drain pan, disconnect and remove the power steering return hose (3A713).
8. Remove the front bumper (17757).
9. Position a drain pan, disconnect and remove the transmission fluid cooler (7A095).
10. Drain the radiator (8005) and remove the upper radiator hose (8260) and lower radiator hose (8286).
11. Disconnect the fluid cooler inlet tube (7A030) and fluid cooler tube (7A031) from the radiator.
12. Disconnect the fan shroud (8146) and position it over the fan blade (8600).
13. Remove the radiator.
14. Using a wrench, lift drive belt tensioner pulley (6B217) and remove the drive belt (8620).
15. Remove the radiator air deflector (8327).
16. Remove the hood and the center hood latch support.
17. Disconnect and remove the generator (GEN) (10346).

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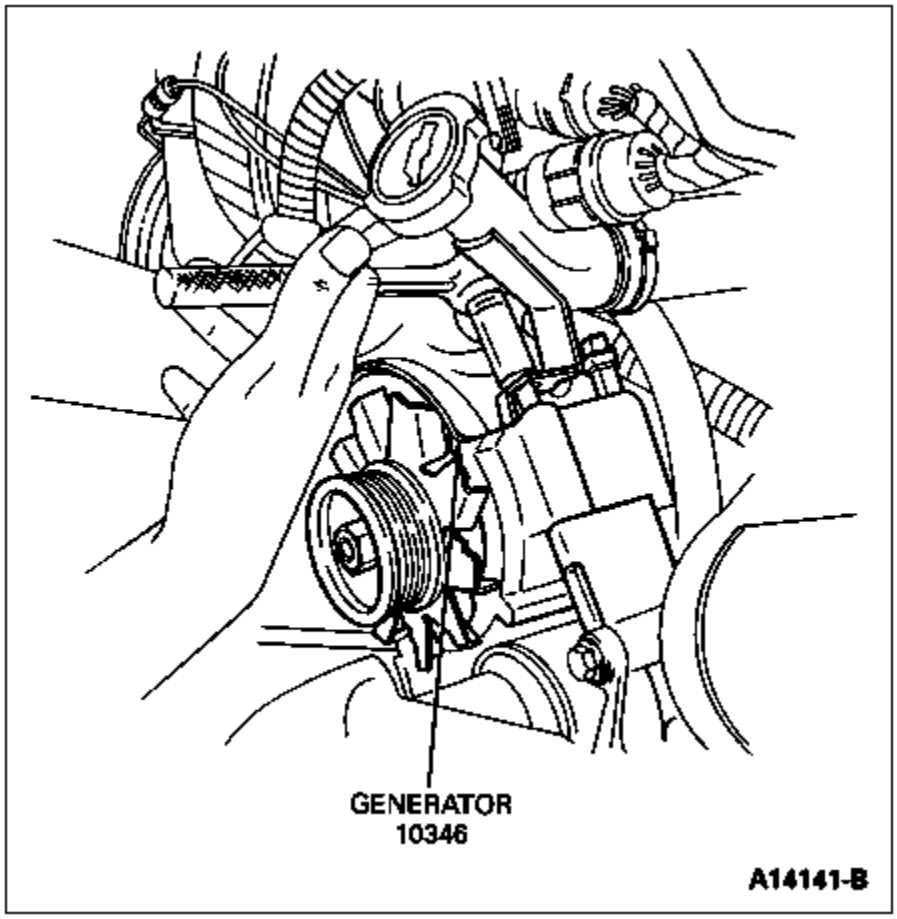

18. Disconnect and remove the A/C compressor (if so equipped) as detailed in Section 12-03A .
19. Remove the oil fill pipe (6A868).
20. From inside the vehicle, remove the engine cover.
21. Remove the accelerator control splash shield (9E766).
22. At the power steering pump (3A674), remove the power steering pressure hose (3A719) and power steering return hoses.
23. Remove the power steering pump and A/C compressor mounting bracket (2882).

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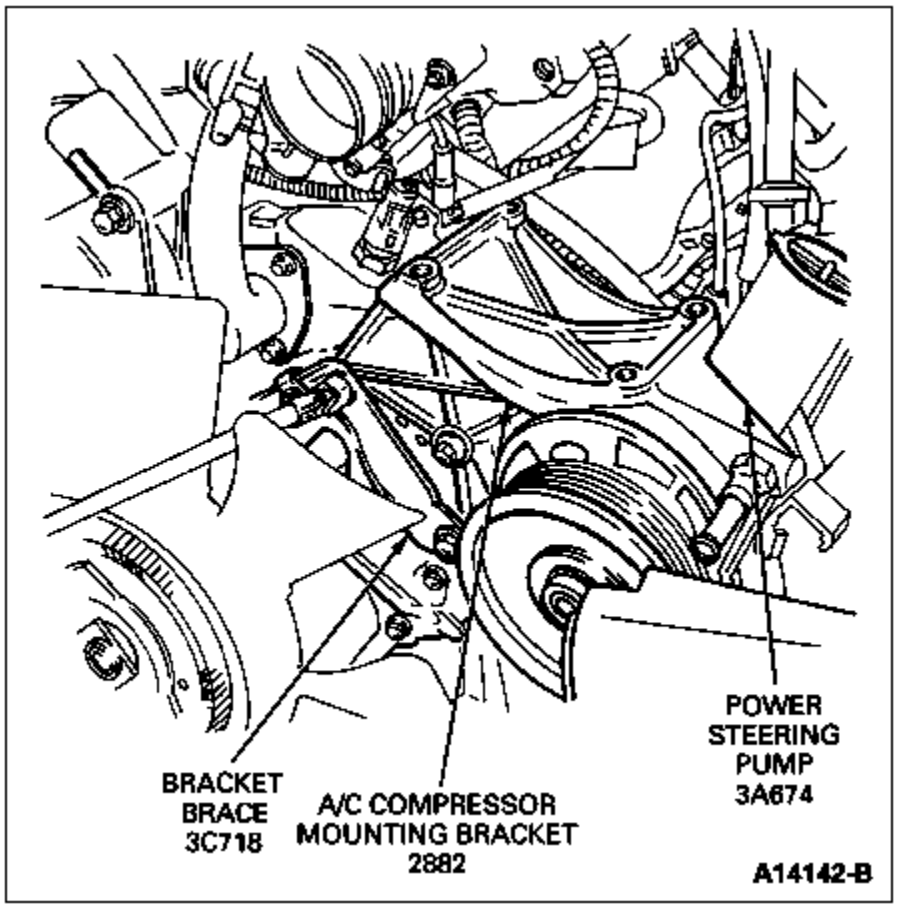

24. Remove the transmission oil filler tube (7A228) and fluid level indicator (7A020).
25. Remove the engine oil level dipstick (6750) and oil level indicator tube (6754).
26. Disconnect the dual converter Y pipe (5F250) from the exhaust manifolds (9430).
27. Disconnect and remove the starter motor (11001).
28. Remove the converter-to-flywheel bolts through the starter motor opening in the converter housing.
29. Remove the transmission oil cooler line bracket retaining bolt.

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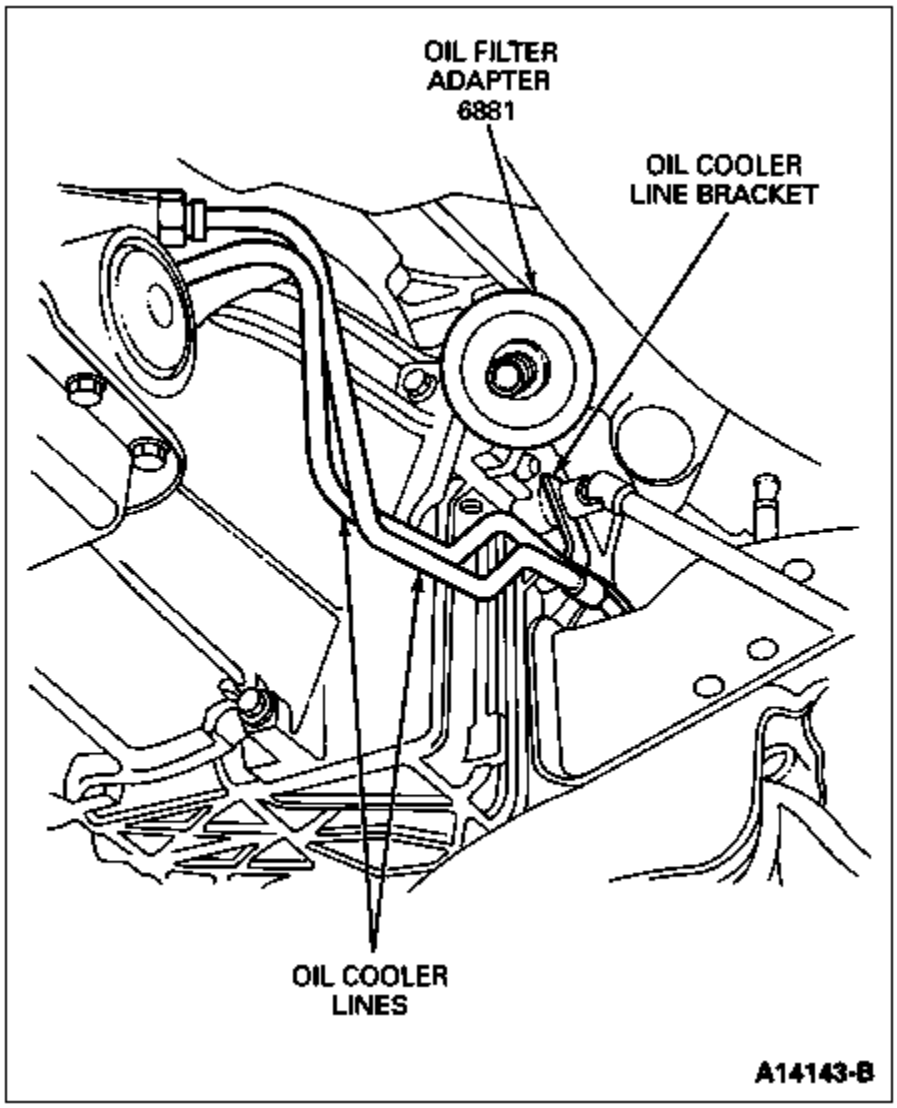

30. Remove the engine mount to frame bolts (left and right sides).
31. Remove the torque converter housing to engine bolts, except the upper bolts.
32. Remove the left front engine support insulator (6038) from the engine.
33. Remove the upper torque converter housing bolts.

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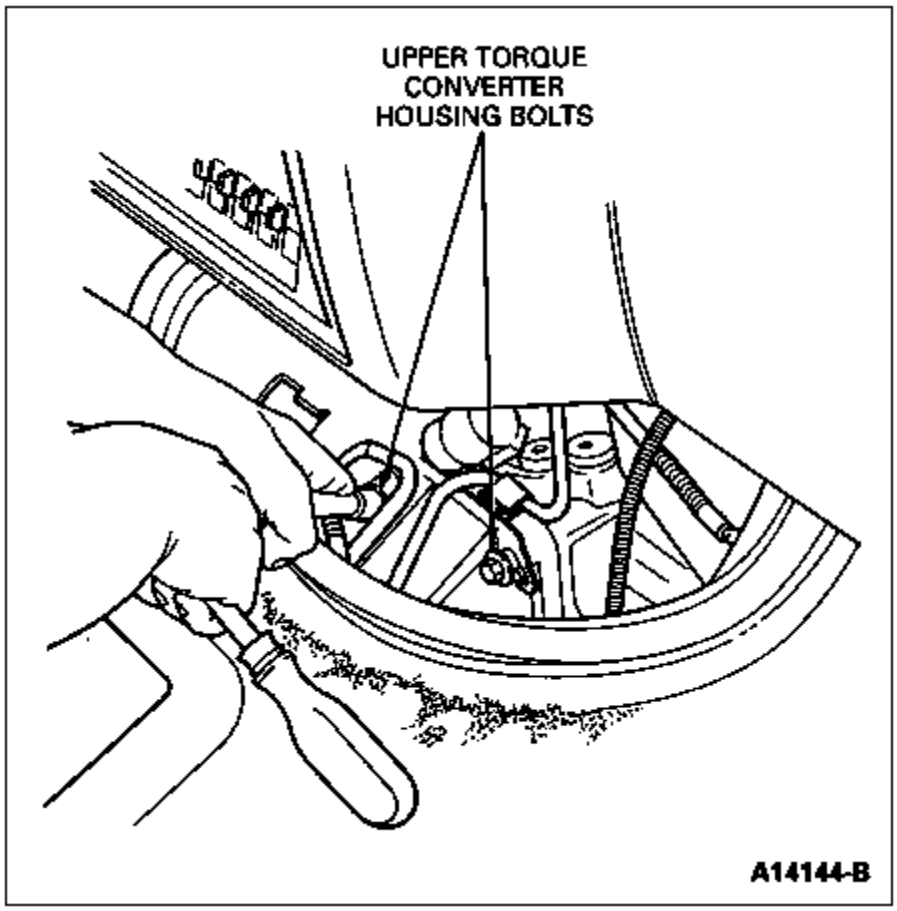

34. Disconnect the transmission and transfer case electrical connectors.

35. Using Disconnect Tools D87L-9280-A and D87L-9280-B, disconnect the fuel supply and return lines where the engine supply and return tubes connect to the chassis fuel lines to the left of the engine near the frame. Refer to Section 03-04C .

36. Disconnect the accelerator cable (9A758) and accelerator cable bracket (9723) and position aside.

37. Disconnect the upper and lower heater water hoses (18472).

38. Disconnect the engine vacuum lines from the evaporative emissions canister (EVAP canister) (9D653), lower intake manifold and the upper intake manifold vacuum outlet fitting and cap.

39. Remove the spark plug wires from the ignition coil (12029) assembly and disconnect and remove the ignition coil assembly, with ignition coil mounting strap (12043).

40. Disconnect the electrical connector from the throttle body throttle position sensor (TP sensor) (9B989).

41. Remove the throttle body (9E926) and upper intake manifold as an assembly.

42. Disconnect the fuel charging wiring connectors at both left front and right rear of engine.

43. Install engine lifting brackets on the right front and left rear of the engine (6007) and remove from the vehicle.

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Installation

NOTE: To facilitate engine-to-transmission installation and prevent clutch hub damage on manual transmission vehicles, make two guide studs by cutting the heads off two M10 x 70mm bolts and grinding a screwdriver slot in the end of each bolt on the unthreaded end.

1. **WARNING: DO NOT OPERATE ENGINE WITH HOOD OPEN UNTIL FAN HAS BEEN FIRST CHECKED FOR POSSIBLE CRACKS AND SEPARATION.**

   Position the engine in the vehicle and remove the engine lifting brackets.

2. Connect the fuel charging wiring main connectors.

3. Install the throttle body and upper intake manifold.

4. Install the ignition coil and ignition coil mounting strap, and connect the spark plug wires and the coil assembly wiring connector.

5. Connect the electrical connector for the throttle position sensor.

6. Connect the upper and lower heater water hoses.

7. Connect the engine vacuum lines to the evaporative emissions canister, lower intake manifold and the upper intake manifold vacuum outlet fitting and cap.

8. Connect the accelerator cable and accelerator cable bracket.

9. Connect the fuel supply and return lines where engine supply and return tubes connect to the chassis fuel lines to the left of the engine near the frame.

10. Install the left front engine support insulator.

11. Install the converter housing to engine bolts. Connect the transmission electrical connectors.

12. Install the engine mount to frame bolts (left and right sides).

13. Install the transmission oil cooler line bracket retaining bolt.

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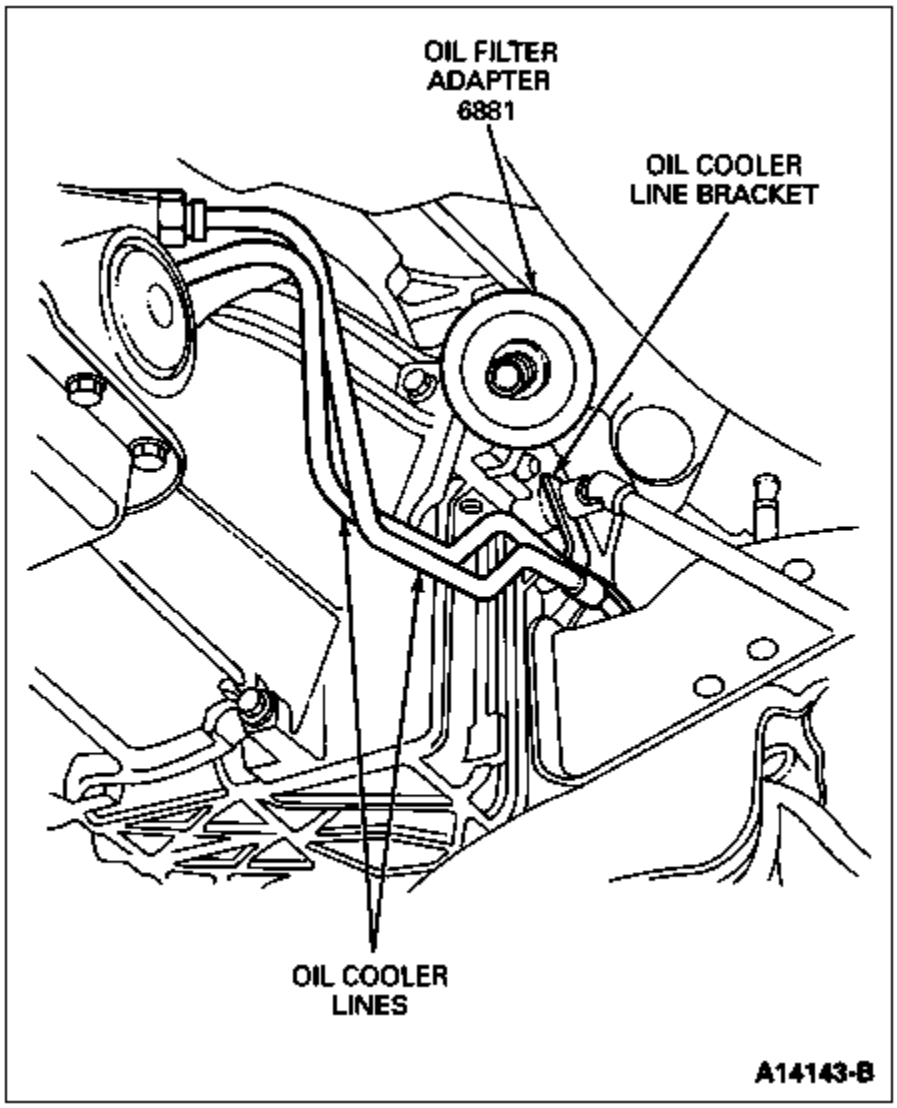

14. Through the starter motor opening in the converter housing, install the converter-to-flywheel bolts.

15. Install the starter motor and connect the starter motor wires. Connect the exhaust system to the manifolds.

16. Install the transmission oil filler tube and fluid level indicator.

17. Install the engine oil level dipstick and oil level indicator tube.

18. Install the power steering pump and A/C compressor mounting bracket.

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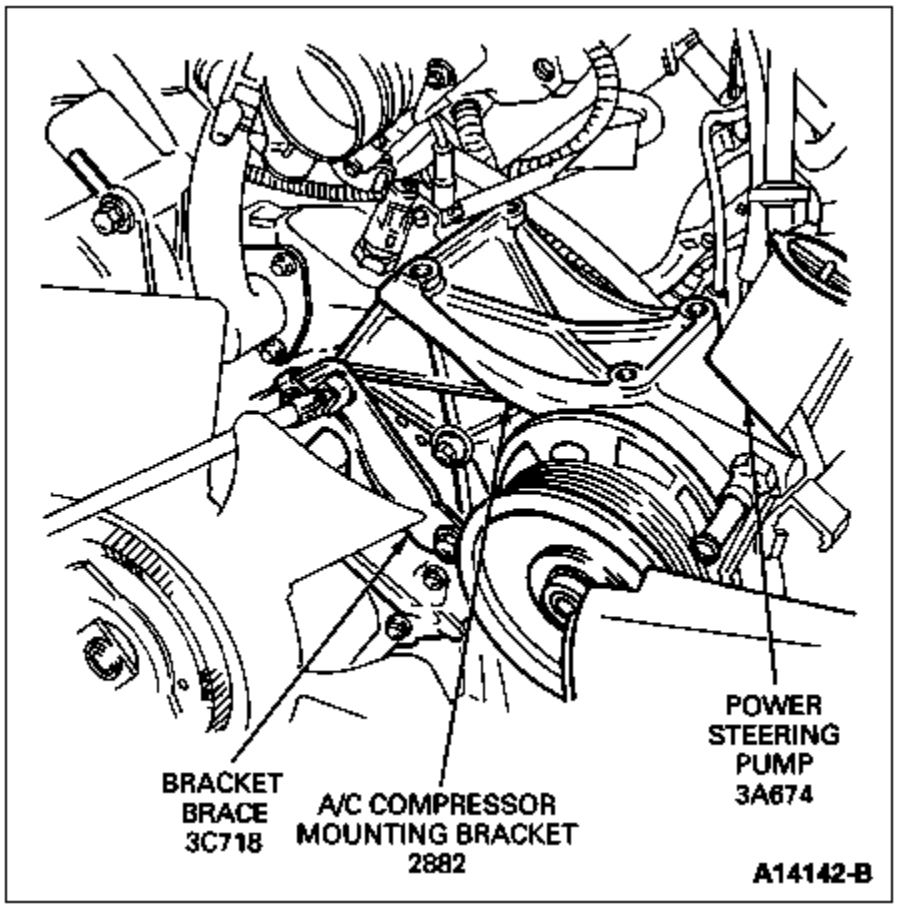

19. Install the power steering pressure hose and power steering return hose at the power steering pump.
20. Install the accelerator control splash shield.
21. Install the engine oil fill pipe (6763).
22. From inside the vehicle, install the engine cover.
23. Install and connect the A/C compressor (19703) (if so equipped) as detailed in Section 12-03A .
24. Install and connect the generator.

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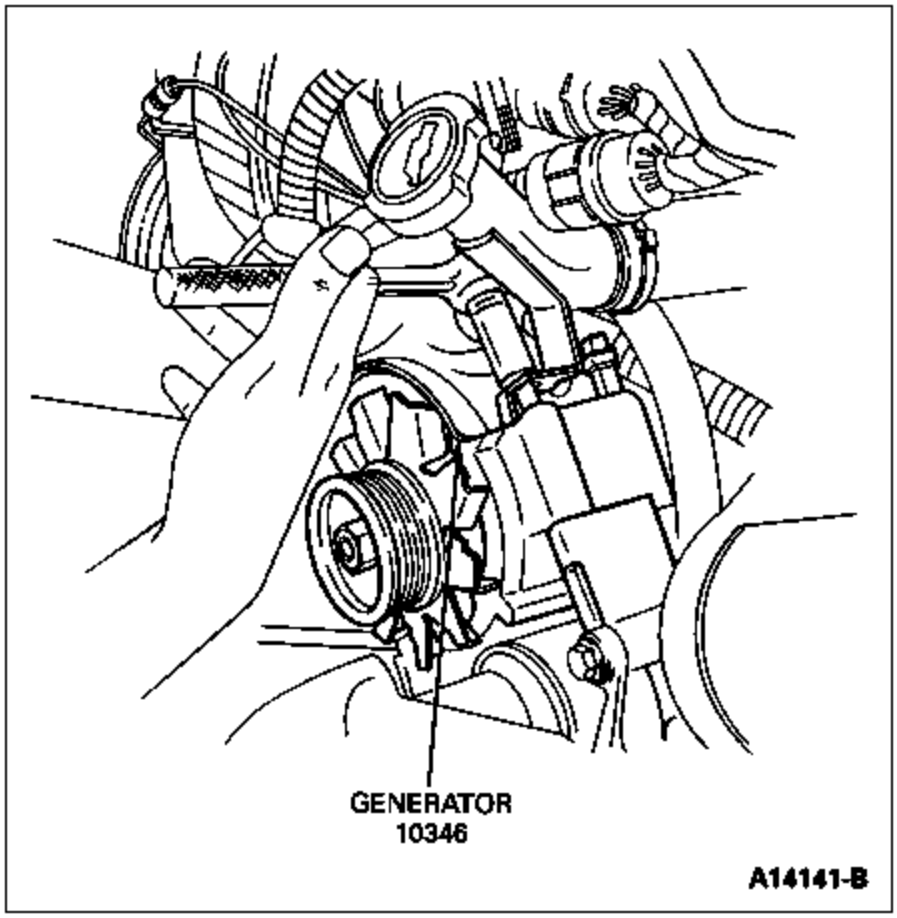

25. Install the hood and center hood latch support.
26. Install the right front radiator air deflector.
27. Install drive belt.
28. Install the radiator.
29. Install the radiator fan shroud.
30. Connect the fluid cooler inlet tube and oil cooler outlet tube at the radiator.
31. Install the upper radiator hose and lower radiator hose, fill and bleed the cooling system.
32. Install the transmission fluid cooler.
33. Install the front bumper.
34. Install and connect the power steering return hose.
35. Refill the engine with the recommended quantity and quality of engine oil.
36. Install and connect the A/C condenser core (if so equipped) as detailed in Section 12-03A .

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37. Install the engine air cleaner and air tube.

38. Install the radiator grille and inside engine cover.

39. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

    Connect the battery ground cable (14301).

40. Recharge air conditioning as outlined in Section 12-00 .

41. Start engine and check for leaks.

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Crankshaft

Removal

1. Remove engine (6007) from vehicle and place on a work stand.
2. Remove oil pan (6675) and oil pan gasket (6710) as outlined in this section.
3. Remove engine front cover (6019) assembly as outlined in this section.
4. Remove timing chain/belt (6268), camshaft sprocket (6256) and crankshaft sprocket (6306).
5. Invert engine on the work stand. Remove flywheel (6375). Remove oil pump screen cover and tube (6622) and oil pump (6600).
6. Make sure all bearing caps (main and connecting rod) are marked so they can be installed in their original positions. Turn crankshaft (6303) until connecting rod (6200) from which the cap is being removed is up. Remove connecting rod cap. Push connecting rod and piston assembly up in the cylinder. Repeat procedure for the remaining connecting rod assemblies.
7. Remove main bearing caps.
8. **CAUTION: Handle the crankshaft with care to avoid possible fracture or damage to the finished surfaces.**

   Lift the crankshaft carefully out of the block so that the upper thrust bearing surfaces are not damaged.

Installation

NOTE: If bearings are to be reused, they should be identified to make sure that they are installed in their original positions.

Crankshaft Assembly, Installation

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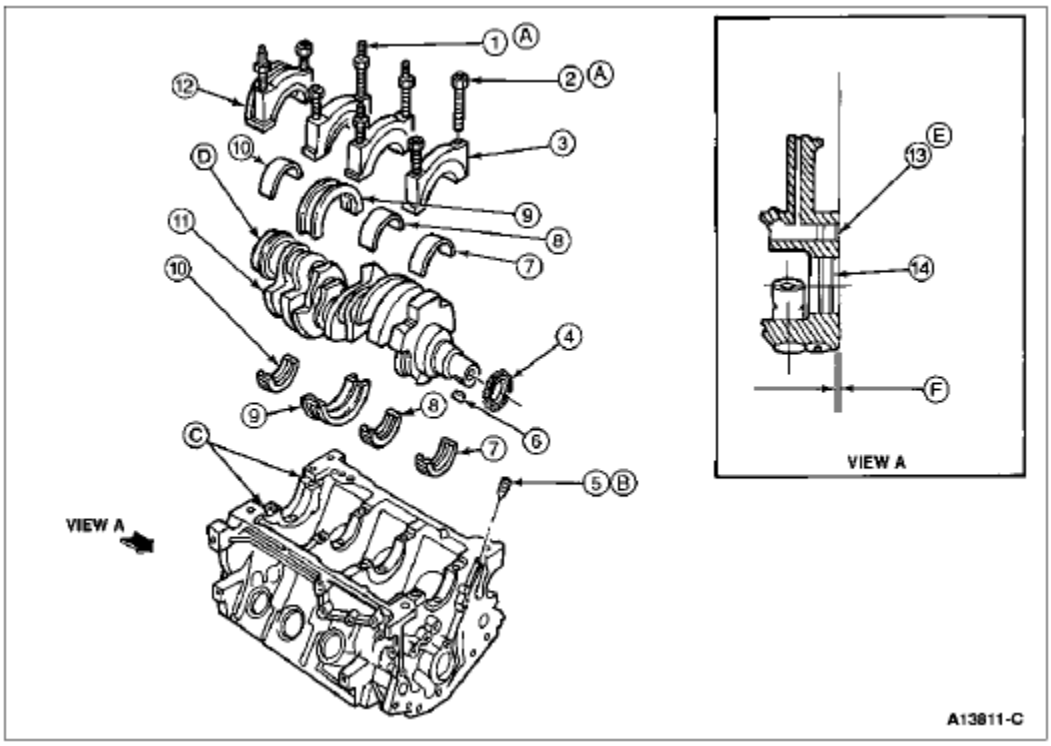

Item	Part Number	Description
1	6345	Stud, Main Bearing Cap (4 Places)
2	6345	Bolt, Main Bearing Cap (4 Places)
3	—	Main Bearing Cap (Part of 6010)
4	6306	Crankshaft Sprocket
5	6026	Oil Gallery Plug
6	375055-GS	Key
7	6333	Crankshaft Main Bearing (No. 1)
8	6333	Crankshaft Main Bearing (No. 2)
9	6337	Crankshaft Thrust Main Bearing (No. 3 Main Bearing)
10	6333	Crankshaft Main Bearing (No. 4)
11	6303	Crankshaft
12	—	Rear Main Bearing Cap (Part of 6010)
13	87837-5	Oil Gallery Plug
14	6266	Camshaft Rear Bearing Cover
A	—	Tighten to 90-104 Nm (66-77 Lb-Ft)

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B	—	Tighten to 6-12 Nm (4-9 Lb-Ft)
C	—	Seal Here with Silicone Rubber D6AZ-19562-BA or Equivalent Meeting Ford Specifications ESB-M4G92-A and ESE-M4G195-A
D	—	Apply Engine Fill Oil
E	—	Tighten to 27-37 Nm (20-27 Lb-Ft)
F	—	Flush or Maximum to Chamfer

1. Remove crankshaft main bearings (6333) from cylinder blocks (6010) and bearing caps.
2. Remove connecting rod bearing (6211) from the connecting rod and caps.
3. Inspect all machined surfaces on the crankshaft for nicks, scratches, scores, etc., which could cause premature bearing wear. Lightly stone all such surfaces.
4. **CAUTION: Make sure crankshaft main bearings and bearing bores are clean. Foreign material under the inserts will distort the crankshaft main bearing and cause a failure.**

   If the crankshaft main bearing journals have been refinished to a definite undersize, install the correct undersize crankshaft main bearings.
5. Place upper main bearing inserts in position in the bores with the tang fitted in the slot provided.
6. Install lower main bearing inserts in bearing caps.
7. Carefully lower crankshaft into place.
8. Check the clearance of each crankshaft main bearing. Select fit the crankshaft main bearings for proper clearance. Refer to Section 03-00 .
9. **NOTE: Make sure that the main bearing caps are installed in their original positions and orientation.**

   Apply a light coat of SAE 50 Service SG meeting Ford specification ESE-M2C39-F oil, to the journals and bearings, and rear seal surface. Install all bearing caps.
10. Lubricate the journal with engine oil and install the thrust bearing cap with the bolts finger-tight. Pry the crankshaft forward against the thrust surface of the upper half of the bearing. Hold the crankshaft cap to the rear. This will align the thrust surfaces of both halves of the bearing. Retain the forward pressure on the crankshaft. Tighten the cap bolts to 90-104 Nm (66-77 lb-ft).

Thrust Bearing Cap, Installation

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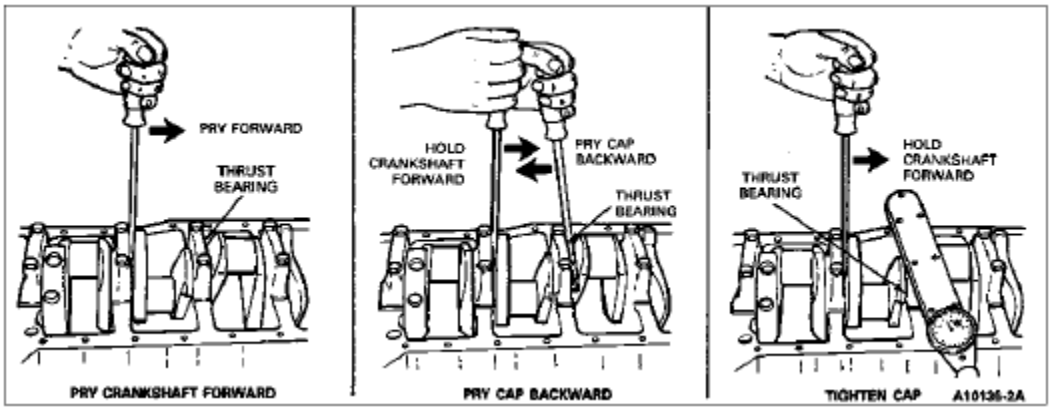

11. Check crankshaft end play as outlined in Section 03-00 . End play should be 0.05-0.32mm (0.002-0.0125 inch).

12. If end play exceeds specification, replace upper and lower thrust bearings. If the end play is less than specification, inspect thrust bearing faces for damage, dirt or improper alignment. Install thrust bearing and align the faces. Recheck end play.

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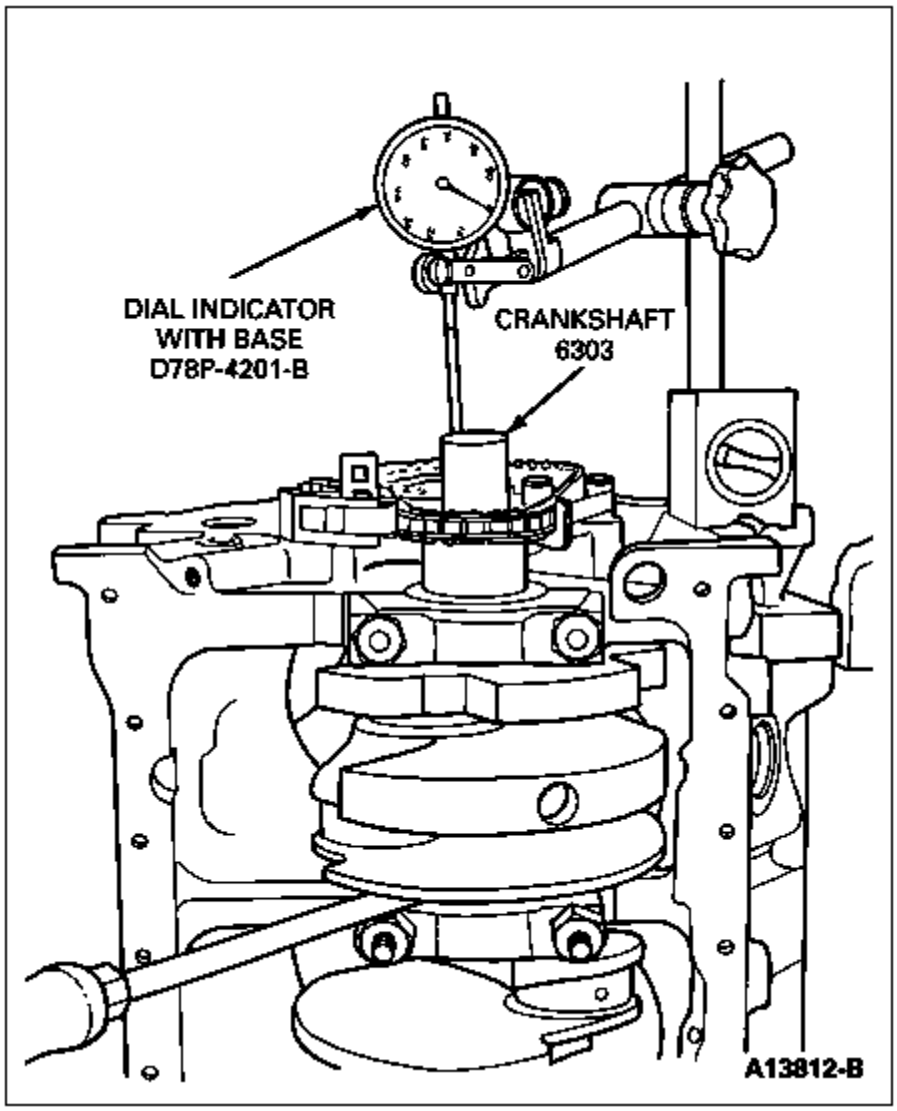

Cylinder Block Sealer Application

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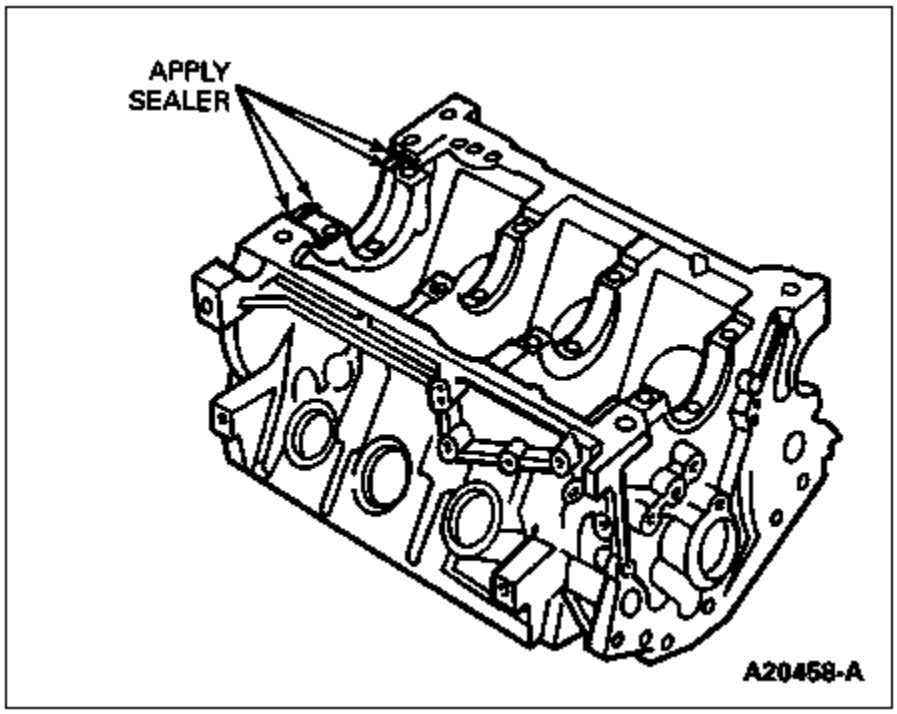

13. Seal and assemble the rear main cap to the cylinder block.

    a. Clean all oil off of rear main bearing cap and block mating surface using Extra Strength Spot and Stain Remover, B7A-19521-AA or equivalent meeting Ford specification ESR-M5B197-A.
    b. Place a bead of Gasket Eliminator E1FZ-19562-A or Loctite® 515 sealer or equivalent meeting Ford specification WSK-M2G348-A4 to the block along the corners of the rear main bearing cap joint area and on the joint face, approximately 13mm (1/2 inch) from the rear of the cylinder blocks as illustrated.
    c. **NOTE: New bolts must be used during assembly.**

       Verify that the lower rear main bearing insert is in place. Install the rear main bearing cap and snug the bolts.
    d. Align the rear main bearing cap to block by moving the bearing fore or aft (approximately 13mm [1/2 inch] inward in the rear oil seal bore) so that the rear seal stop of the block and cap line up. This will ensure that the rear main oil seal will seat squarely when installed in the bore.
    e. Torque the rear main cap bolts to 90-104 Nm (66-77 lb-ft).
    f. Fill the cavities on both sides of the rear main cap with Gasket Eliminator E1FZ-19562-A or Loctite® 515 sealer or equivalent meeting Ford specification WSK-M2G348-A4.

14. Install crankshaft rear oil seal as outlined in this section.

15. Install new connecting rod bearings in the connecting rods and caps. Check the clearance of each bearing. Refer to Section 03-00 .

16. Check clearances for each connecting rod bearing as outlined in Section 03-00 .

17. If bearing clearances are to specification, apply a light coat of SAE 50 Service SG oil to the connecting rod journals and bearings.

18. Turn the crankshaft throw to the bottom of the stroke. Push the piston (6108) all the way down until the connecting rod bearings seat on the crankshaft journal.

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19. Install connecting rod cap.

20. After piston and connecting rod assemblies have been installed, check connecting rod side clearance.

21. Turn engine on the work stand so that the front end is up. Install timing chain/belt, camshaft sprockets, crankshaft sprocket, engine front cover, crankshaft front seal (6700) and crankshaft vibration damper and pulley (6B321) as outlined in this section.

    Turn engine on the work stand so that the rear end is up. Install rear oil seal as outlined in this section.

22. Clean oil pan, oil pump and oil pump screen cover and tube assembly.

23. Prime oil pump by filling the inlet opening with XO-5W30-QSP meeting Ford specification ESE-M2C153-E or SAE 5W-30 Service SG oil and rotating the pump shaft until oil emerges from the outlet opening. Install oil pump, crankshaft oil windage baffle (6L680) and oil pan.

24. Position flywheel on the crankshaft. Tighten according to procedure in this section.

25. Turn engine on the work stand so that the engine is in the normal upright position.

26. Install engine in vehicle.

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Engine

Removal and Installation

NOTE: 4.0L OHV engines are equipped with a camshaft position sensor (CMP sensor) (12A112) mounted on the camshaft synchronizer (12A362). The camshaft synchronizer replaces the oil pump drive assembly.

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Engine

NOTE: The cylinder head (6049)(s) and intake manifold installation procedure has changed. The cylinder head bolts and intake manifold bolts are tightened alternately and in sequence to ensure correct fit and gasket crush. Failure to follow complete sequence will cause follow up repair. Refer to Cylinder Head installation procedure in this section.

NOTE: 4.0L OHV engines are equipped with a camshaft position sensor (CMP sensor) (12A112) mounted on the camshaft synchronizer (12A362). The camshaft synchronizer replaces the oil pump drive assembly. Refer to Section 03-14 for camshaft synchronizer removal and installation.

NOTE: When installing the oil pump (6600) during engine assembly refer to the following illustration.

Disassembly

1. **NOTE: Before starting disassembly, remove all wiring harnesses, emission control system, ignition system, flywheel or flexplate and front end accessory drive components. For more detailed information on any particular system, refer to the specific section in the appropriate repair group.**

   NOTE: All valve train components should be identified to make sure they are installed in their original positions during assembly.

   With the engine (6007) mounted on a work stand: Remove the left and right hand valve covers (6582) as outlined in this section and discard the gaskets.

2. Remove the right exhaust manifold (9430) and left exhaust manifold.

3. Remove the upper intake manifold, the fuel injection supply manifold (9D280), fuel injectors and lower intake manifold as outlined in Section 03-04C and in this section.

4. Remove the bolt and clamp retaining the oil pump drive shaft and remove the oil pump drive shaft.

5. Remove the oil level dipstick (6750) and oil level indicator tube (6754) and remove the oil filter, adapter and oil cooler (if equipped).

6. Remove the rocker arm (6564), rocker arm shaft (6563), rocker arm shaft support (6531), and push rod (6565) as outlined in this section.

7. Remove the cylinder heads as outlined in this section.

8. Remove the crankshaft position sensor (CKP sensor) (6C315), crankshaft vibration damper and pulley (6B321) from the front of the engine as outlined in this section.

9. Remove the oil pan (6675) as outlined in this section and discard the oil pan gasket (6710).

10. Remove the water pump housing gasket (8507) and front cover as an assembly. Discard the gasket and seal.

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11. Remove the oil pump, oil pump screen cover and tube (6622), oil pump intermediate shaft (6A618) and crankshaft oil windage baffle (6L680).

12. Remove the crankshaft rear oil seal.

13. Remove the timing chain vibration damper (6284)

14. Remove the camshaft sprocket capscrew and slide the timing chain vibration damper, crankshaft sprocket (6306) and camshaft sprocket (6256) off as an assembly. Remove the timing chain guide (6K297).

15. Remove the camshaft thrust plate (6269) and remove the camshaft (6250).

16. **NOTE: Pistons (6108), connecting rods (6200) and connecting rod bearings (6211) should be numbered to make sure they are assembled in their original positions.**

    NOTE: Before removing pistons, inspect the top of the cylinder bores. If necessary, remove the ridge and/or carbon deposits from each cylinder using Cylinder Ridge Reamer T64L-6011-EA.

    Remove the connecting rod caps and remove the pistons.

17. **CAUTION: When removing the crankshaft (6303), take care not to damage any of the bearing surfaces on the crankshaft.**

    NOTE: The location of the main bearing caps and the crankshaft main bearings (6333) should be identified. When the engine is assembled, crankshaft main bearings which are to be reused should be installed in their original positions.

    Remove the crankshaft main bearing caps, crankshaft main bearings and crankshaft.

18. For cleaning purposes, the oil gallery and coolant drain plugs can be removed.

Assembly

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Rear Crankshaft Seal Replacer	T97T-6701-A
Valve Stem Seal Replacer	T90T-6571-A

Before assembling cylinder blocks (6010), all sealing surfaces must be clean and free of chips, dirt, paint, and foreign material. Also, make sure coolant and oil passages are clear.

If new piston rings are to be installed and no visible cross hatch marks remain on the cylinder wall, remove cylinder wall glaze using a spring type tool. Follow instructions of tool manufacturer.

Crankshaft Assembly, Installation

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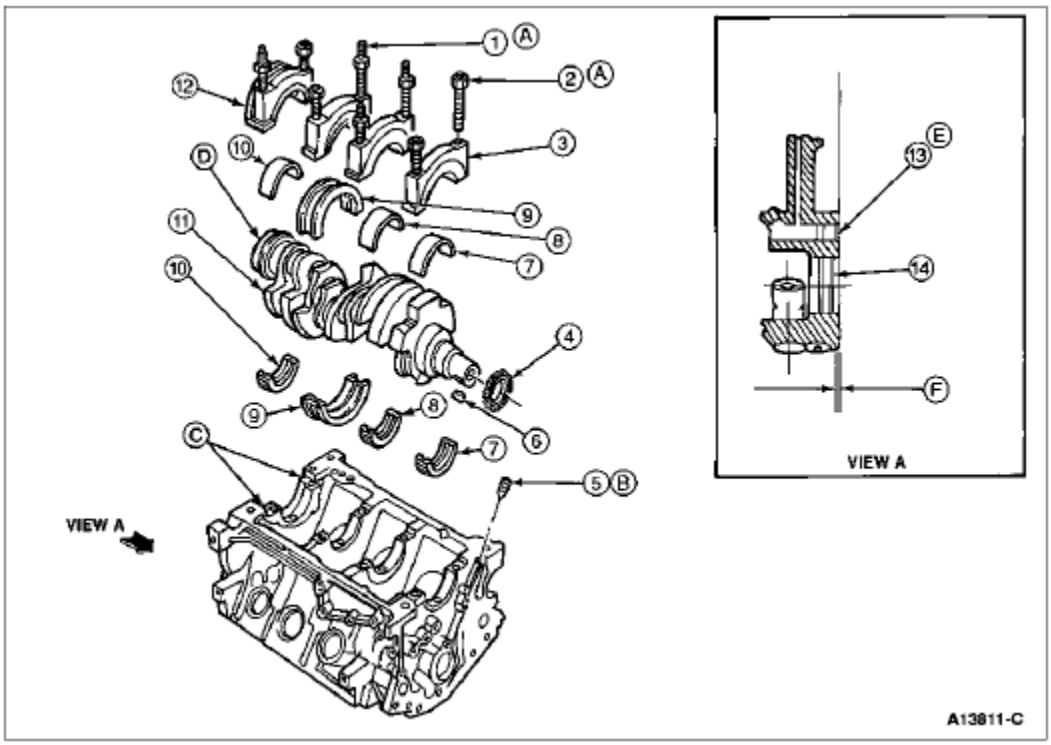

Item	Part Number	Description
1	6345	Stud, Main Bearing Cap (4 Places)
2	6345	Bolt, Main Bearing Cap (4 Places)
3	—	Main Bearing Cap (Part of 6010)
4	6337	Crankshaft Thrust Main Bearing (No. 3 Main Bearing)
5	6333	Crankshaft Main Bearing (No. 2)
6	6306	Crankshaft Sprocket
7	375055-G5	Key
8	6333	Crankshaft Main Bearing (No. 1)
9	6026	Oil Gallery Plug
10	6333	Crankshaft Main Bearing (No. 4)
11	6303	Crankshaft
12	—	Rear Main Bearing Cap (Part of 6010)
13	87837-5	Oil Gallery Plug
14	6266	Camshaft Rear Bearing Cover
A	—	Tighten to 90-104 Nm (66-77 Lb-Ft)
B	—	Tighten to 6-12 Nm

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		(4-9 Lb-Ft)
C	—	Seal Here with Silicone Rubber D6AZ-19562-BA or Equivalent Meeting Ford Specifications ESB-M4G92-A and ESE-M4G195-A
D	—	Apply Engine Fill Oil
E	—	Tighten to 27-37 Nm (20-27 Lb-Ft)

1. **CAUTION: Prevent engine contamination. Always use necessary precautions to prevent old sealer or gasket material from falling into the engine.**

   NOTE: Lightly oil all attaching bolt and stud threads before installation, except those specifying special sealant.

   Before beginning to assemble engine:

   a. Clean ALL the oil and the old sealer from the oil pan, taking special care to remove ALL the old sealer from the oil pan gasket groove in the oil pan. Thoroughly wash the oil pan.
   b. Clean ALL the old sealer from the rear main bearing cap USING A SCRAPER AND WIRE WHEEL. The original sealer used during production assembly becomes extremely hard after it has cured. It is extremely important that ALL the old sealer be removed from joint faces and grooves.
   c. Clean ALL the oil and old sealer from the cylinder block oil pan sealing area and the rear main bearing cap joint area.
   d. After all the parts have been cleaned they must be wiped down with a cleaner that leaves no residue or film such as Ford Extra Strength Spot Remover B7A-19521-AA meeting Ford specification ESR-M5B197-A or denatured alcohol.
   e. Clean the transmission bell-housing area and the rear of the cylinder block of ALL oil residue. Verify with a black light that all oil residues have been cleaned from this area.

2. Place crankshaft upper main bearings in position in the bores with the tang fitting in the slot provided. Lubricate bearings with SAE 50 Service SG oil.

3. Install the lower main bearings in the bearing caps.

4. Lower crankshaft into place. Use care to prevent damage to bearing surfaces.

5. Check clearance of each main bearing, following the procedure under Fitting Main and Connecting Rod Bearings in Section 03-00 .

6. After crankshaft main bearings have been fitted, apply SAE 50 Service SG oil to the journals and bearings.

7. **NOTE: Apply Silicone Rubber D6AZ-19562-BA meeting Ford specifications ESB-M4G92 and ESE-M4G195-A or equivalent in a 1.59mm (1/16-inch) bead in each corner of rear main bearing cap saddle, the full length of the saddle.**

   Install all bearings and caps except thrust bearing cap (No. 3 bearing). **MAKE SURE MAIN BEARING CAPS ARE INSTALLED IN THEIR ORIGINAL POSITION.** Tighten bearing caps to 90-104 Nm (66-77 lb-ft).

8. Install thrust bearing cap (No. 3) with bolts finger-tight.

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9. Pry crankshaft forward against thrust surface of upper half of bearing.

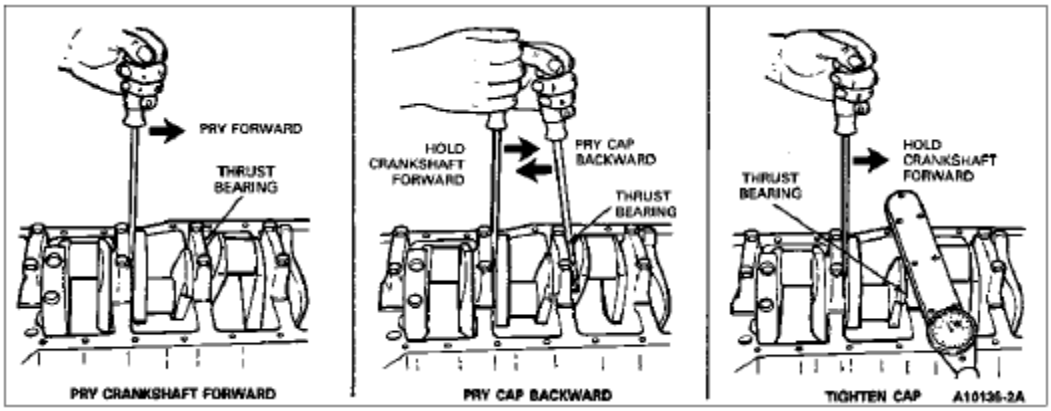
10. Hold crankshaft forward and pry thrust bearing cap to the rear. This will align thrust surfaces of both halves of the bearing.

11. Retain forward pressure on crankshaft. Tighten No. 3 cap bolts to specification.

12. Force crankshaft toward the rear of the engine.

13. Check crankshaft end play. End play should be 0.05-0.32mm (0.002-0.0125 inch). Refer to Section 03-00 .

Thrust Bearing Cap, Installation



14. Coat all camshaft bearings, camshaft lobes and oil pump drive shaft with SAE 50 Service SG oil.

15. Slide camshaft carefully through camshaft bearings. Install camshaft thrust plate with groove toward cylinder blocks. Tighten thrust plate retaining bolts.

16. Check camshaft end play. Refer to Section 03-00 . If not within specification, replace camshaft thrust plate.

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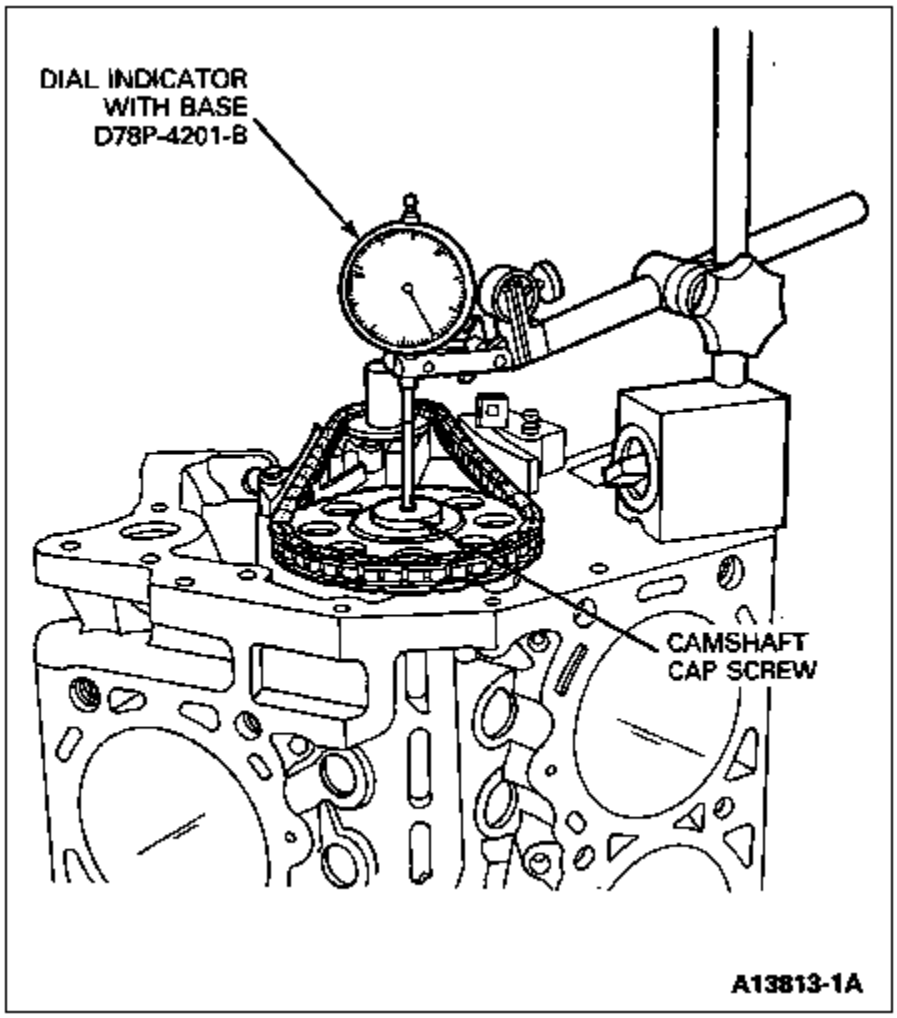

17. Install the timing chain guide with the guide pin in to the oil supply hole. Tighten guide bolts to 10-12 Nm (7-9 lb-ft).

18. Install camshaft sprocket, timing chain/belt (6268) and crankshaft sprocket. Position sprockets and timing chain/belt on camshaft and crankshaft simultaneously.

19. **NOTE: A packaging clip from a new automatic tensioner can be used to hold tensioner in a retracted position. If a packaging clip is not available, fabricate a clip using shop materials.**

    With the timing chain vibration damper held in the retracted position with clip, install the tensioner and tighten the bolts to 9-11 Nm (7-8 lb-ft).

20. Install the camshaft capscrew. Tighten camshaft capscrew to 60-68 Nm (44-50 lb-ft).

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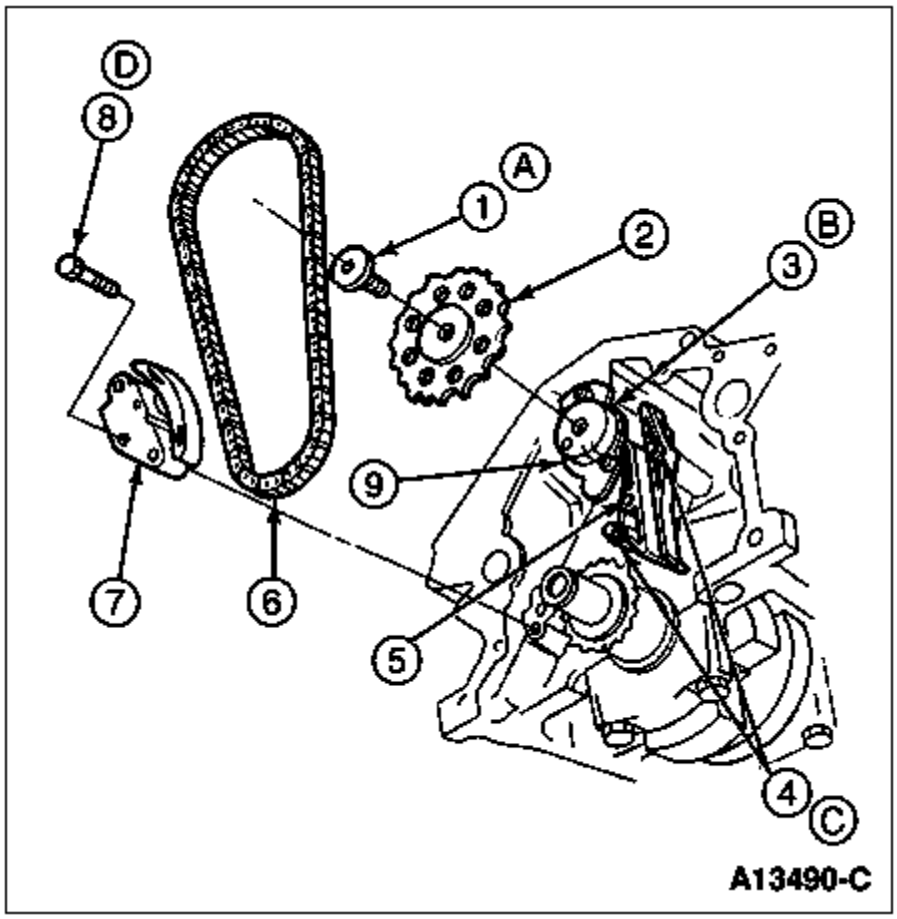

Item	Part Number	Description
1	E804389-S200	Torx® Screw
2	6256	Camshaft Sprocket
3	6250	Camshaft
4	E804358-S75	Torx® Bolt
5	6K297	Timing Chain Guide
6	6268	Timing Chain/Belt
7	6K254	Timing Chain/Belt Tensioner
8	E600112-5	Bolt
9	6269	Camshaft Thrust Plate
A	—	Tighten to 60-68 Nm (44-50 Lb-Ft)
B	—	Camshaft End Play to Be Within 0.065-0.165mm (0.025-0.064 Inch)
C	—	Tighten to 10-12 Nm (7-9 Lb-Ft)
D	—	Tighten to 9-11 Nm

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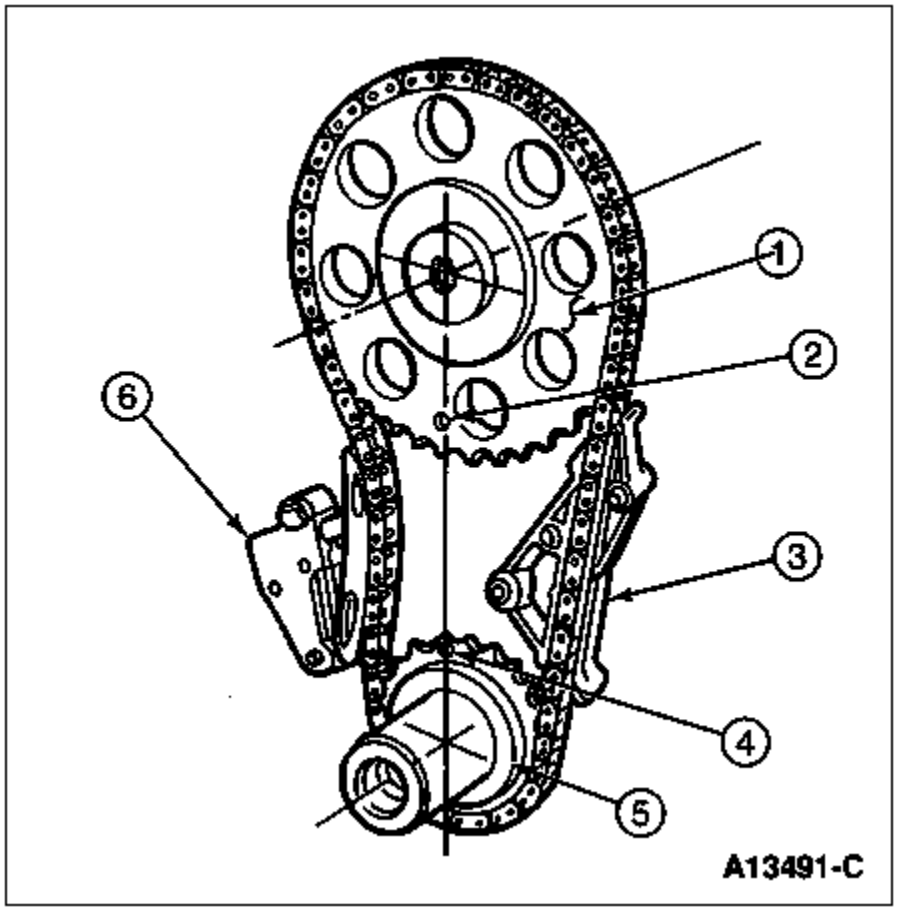
		(7-8 Lb-Ft)

21. After the sprockets have been installed, insert the crankshaft sprocket key. Make sure timing marks on the sprockets are aligned as shown.



Item	Part Number	Description
1	6256	Camshaft Sprocket
2	—	Camshaft Timing Mark (Part of 6256)
3	6K297	Timing Chain Guide
4	—	Crankshaft Timing Mark (Part of 6306)
5	6306	Crankshaft Sprocket
6	6K254	Timing Chain/Belt Tensioner

22. Remove the clip that holds the timing chain vibration damper in a released position.

23. Oil the piston rings, pistons and cylinder walls. Be sure to install the pistons in the same cylinders from which they were removed.

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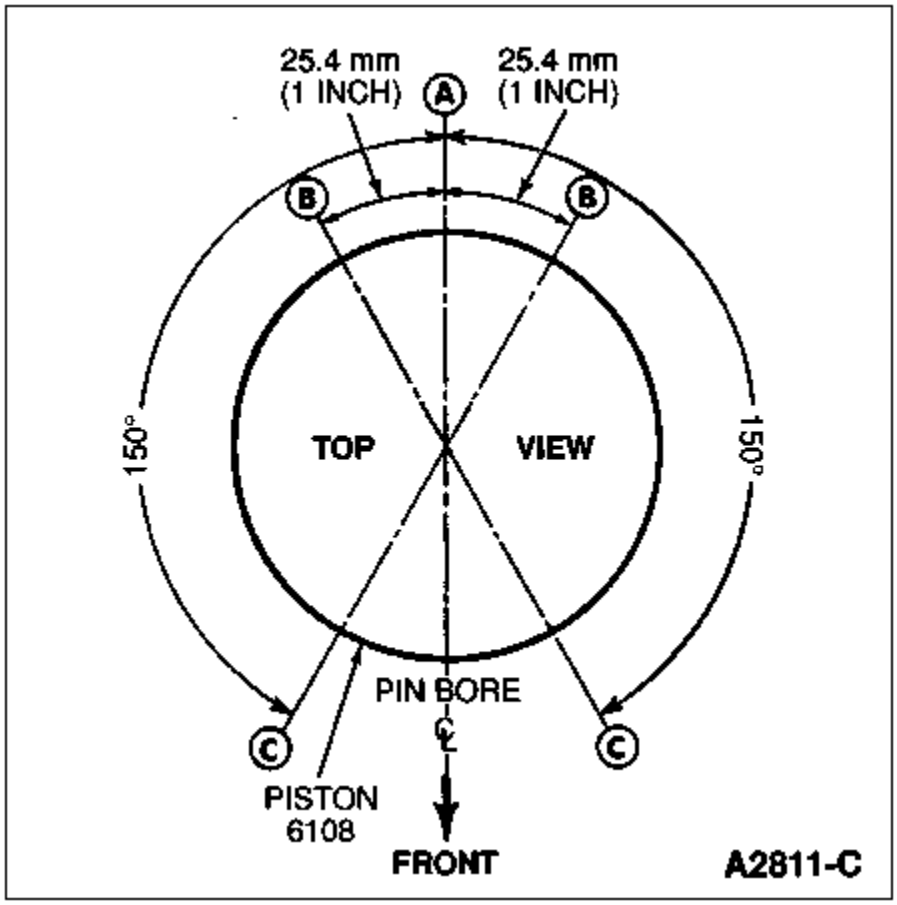
24. Make sure the ring gaps are properly spaced around the circumference of the piston. Refer to Piston and Connecting Rod Installation in this section.



25. **NOTE: Install piston with indentation notch in the piston head toward front of engine.**

    Install a piston ring compressor on the piston and push piston in with a hammer handle until it is slightly below the top of the cylinder. Be sure to guide connecting rods to avoid damaging crankshaft journals (cover studs).

26. Check clearance of each connecting rod bearing. Refer to procedure in Section 03-00 .

27. After bearings have been fitted, apply a light coat of SAE 50 Service SG oil to the journals and bearings.

28. Turn the crankshaft throw to the bottom of its stroke. Push piston all the way down until connecting rod bearing seats on the crankshaft journal.

29. Install connecting rod cap. Tighten nuts to 25-32 Nm (18-24 lb-ft).

30. Check side clearance between connecting rods on each crankshaft journal.

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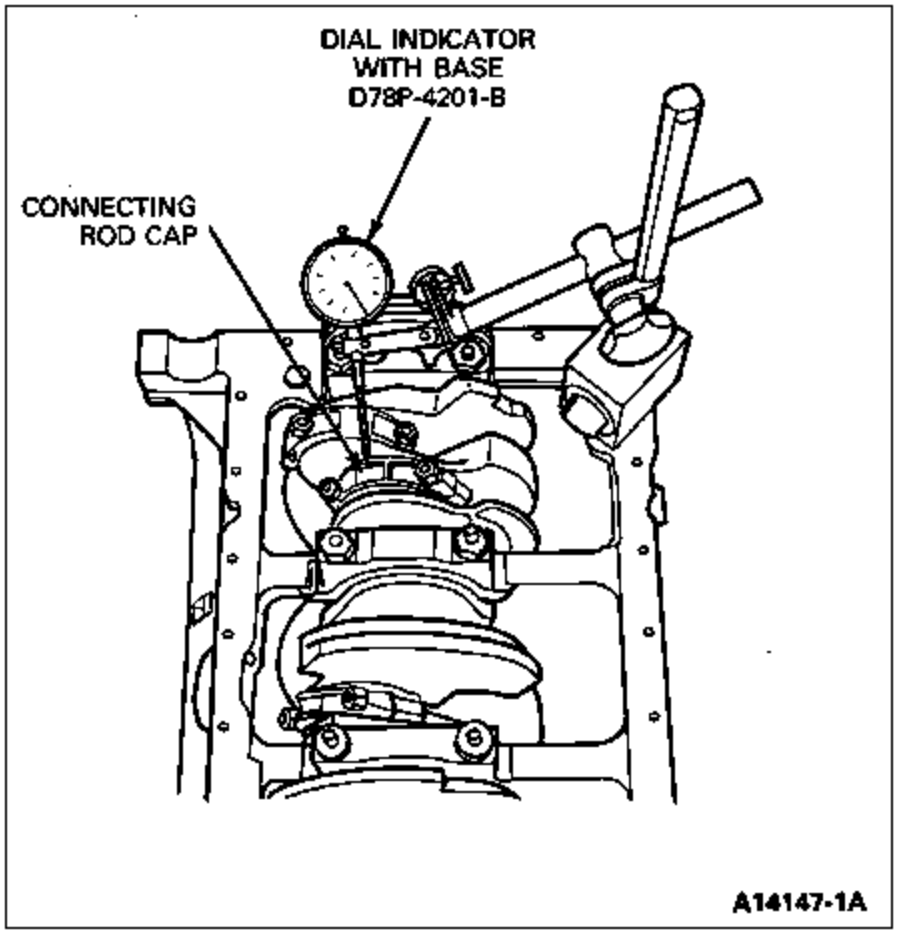

31. Check the crankshaft and connecting rod bearings for assembled rotational torque. Torque required to rotate the crankshaft assembly with pistons installed is not to exceed 45 Nm (33 lb-ft).

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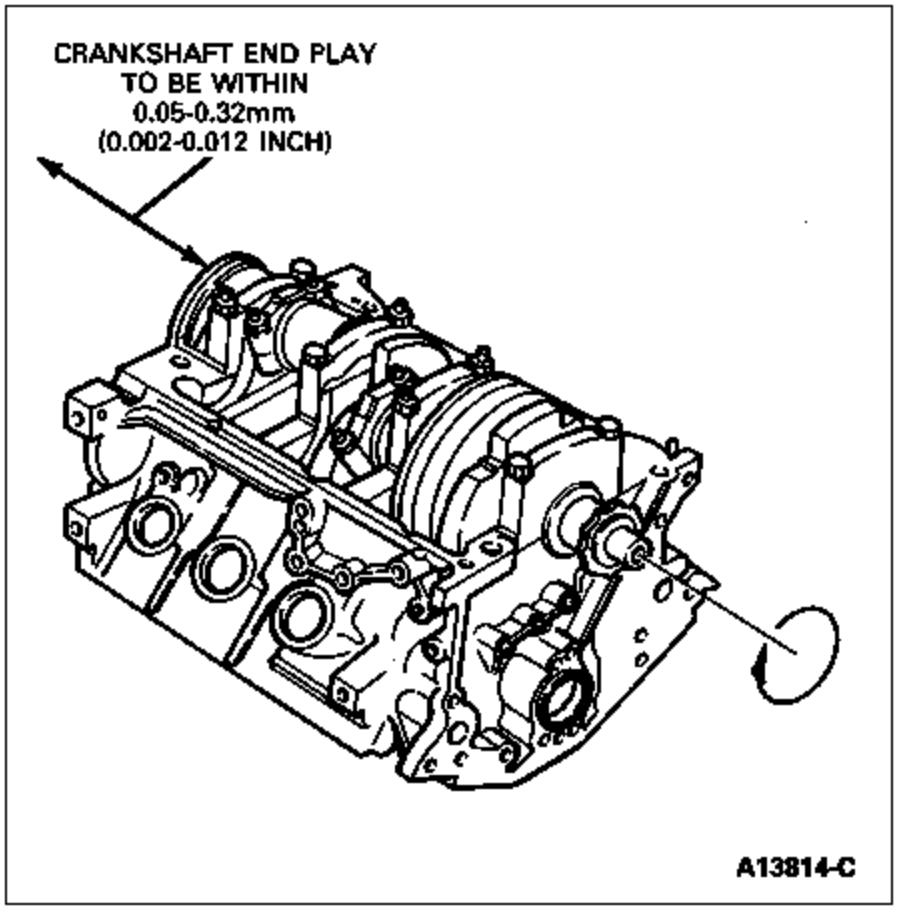

32. Check the piston installed height if any of the following repair procedures have been performed:

    - New pistons were installed.
    - New connecting rods were installed.
    - New cylinder blocks was installed.
    - Cylinder block machine work (that could affect cylinder block deck height).
    - Cylinder block crankshaft align boring.

    Refer to Piston and Connecting Rod Removal and Installation procedures in this section for piston height checking procedure.

33. **NOTE: New rear main bearing bolts must be used during assembly.**

    Seal and assemble the rear main cap to the cylinder blocks.

    a. Place a bead of Ford Gasket Eliminator E1FZ-19562-A meeting Ford specification WSK-M2G348-AA or Loctite® 515 sealer to the block along the corners of the rear main bearing cap joint area and on the joint face, approximately 13mm (1/2 inch) from the rear of the block as shown in illustration.

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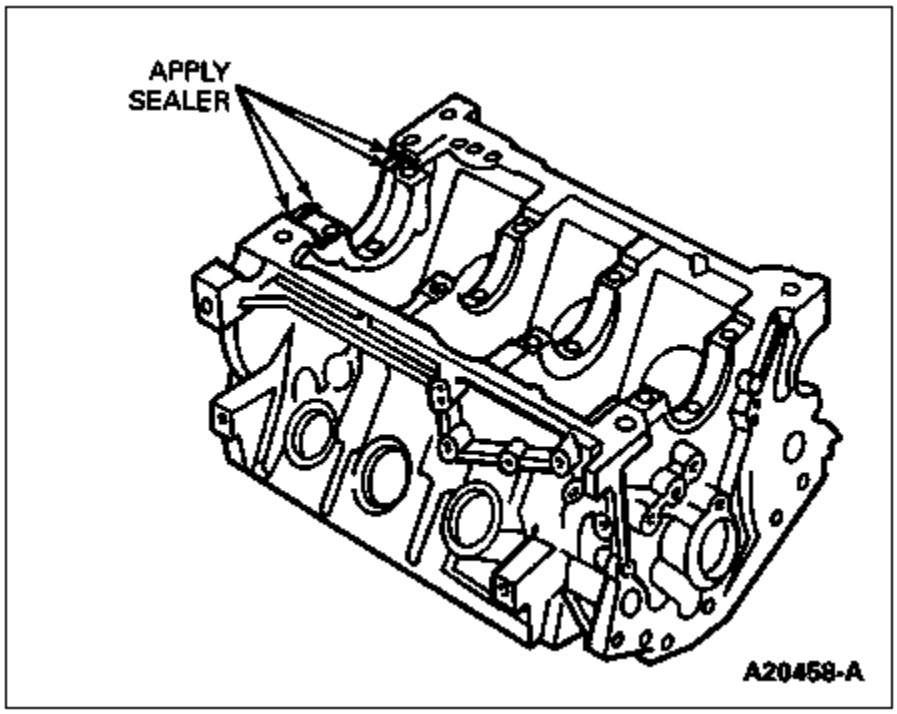

b. Verify that the lower rear main bearing insert is in place. Install the rear main bearing cap and snug the bolts.
c. Align the rear main bearing cap to cylinder blocks by moving the bearing fore or aft approximately 13mm (1/2 inch) inward in the rear oil seal bore so that the rear seal stop of the block and cap line up. This will ensure that the crankshaft rear oil seal (6701) will seat squarely when installed in the bore.
d. Torque the rear main cap bolts to 90-104 Nm (66-77 lb-ft).
e. Fill the cavities on both sides of the rear main cap with Ford Gasket Eliminator E1FZ-19562-A meeting Ford specification WSK-M2G348-A4 or Loctite® 515.
f. Wipe the excessive sealer from the cylinder block/rear main cap area.

34. Install the crankshaft oil windage baffle. Tighten nuts to 17-21 Nm (13-15 lb-ft).

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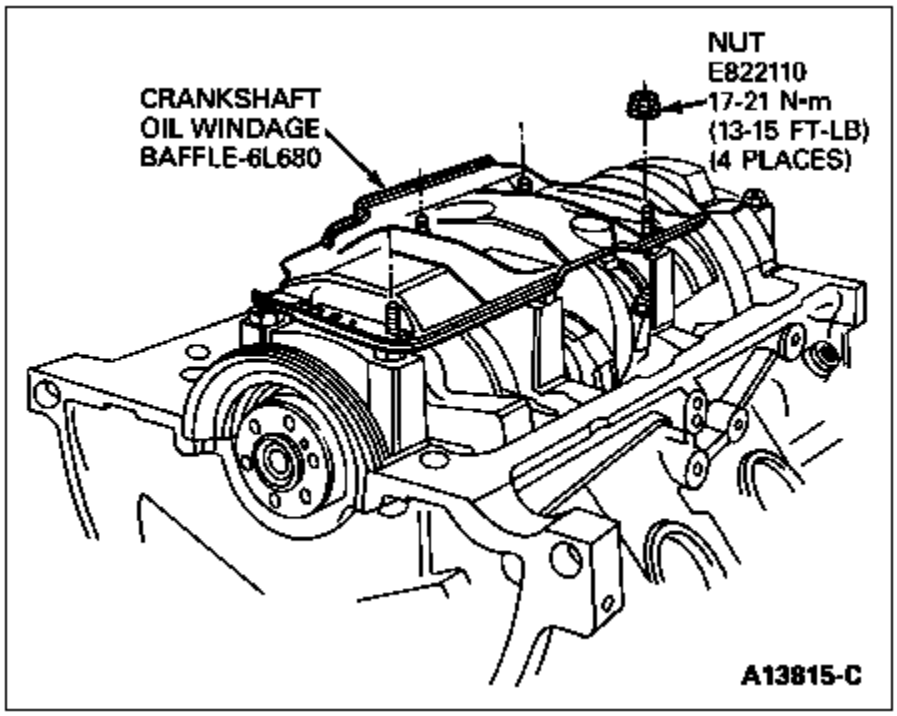

35. Prime the oil pump with XO-5W30-QSP meeting Ford specification ESE-M2C153-E or equivalent SAE 5W-30 Service SG oil and install oil pump, oil pump intermediate shaft, and oil pump screen cover and tube. Tighten oil pump bolts to 17-21 Nm (13-15 lb-ft).

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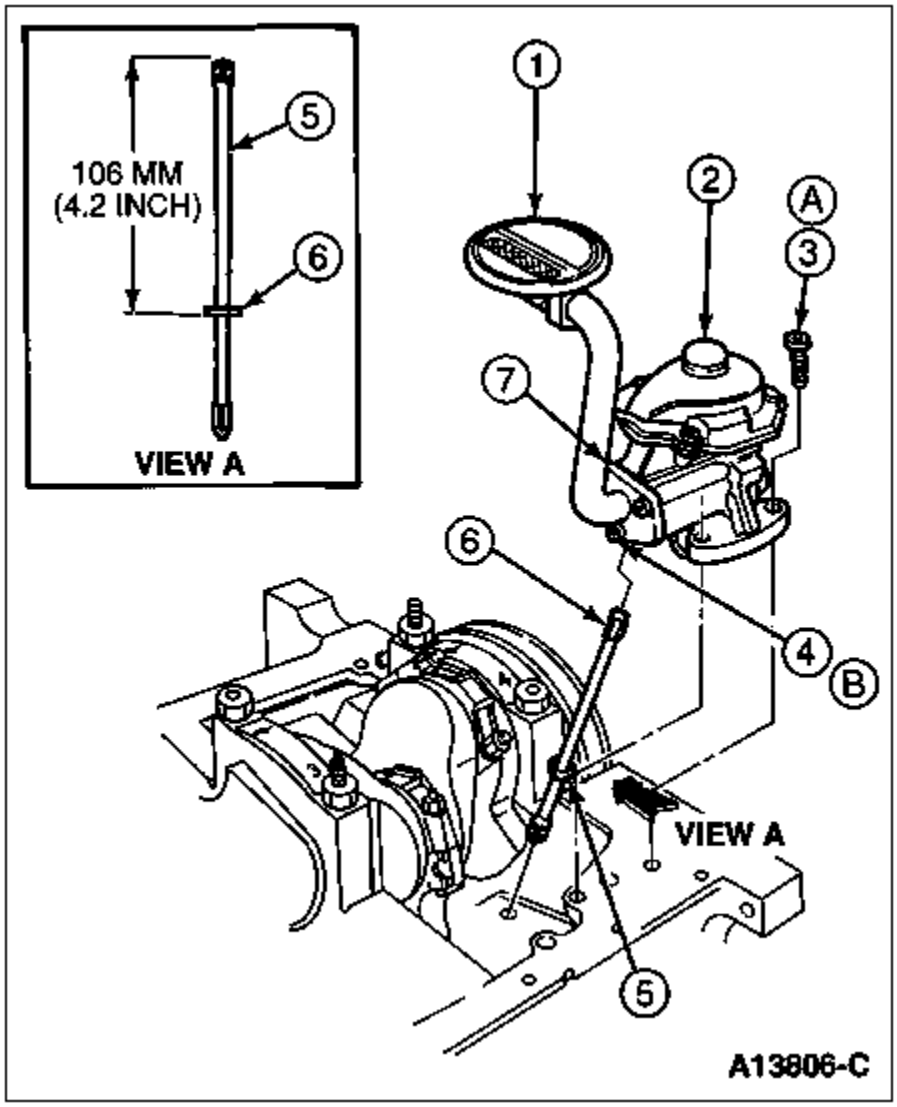

Item	Part Number	Description
1	6A618	Oil Pump Intermediate Shaft
2	6629	Oil Pump Intermediate Shaft Retaining Ring
3	6622	Oil Pump Screen Cover and Tube
4	6600	Oil Pump
5	E804387	Screw
6	E804553	Screw
7	6626	Oil Pump Inlet Tube Gasket
A	—	Tighten to 17-21 Nm (13-15 Lb-Ft)
B	—	Tighten to 9-13 Nm (7-10 Lb-Ft)

36. Install crankshaft rear oil seal. (Refer to the procedure in this section.)

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37. Install crankshaft front seal (6700), gasket, and front cover. Tighten cover bolts to 17-21 Nm (13-15 lb-ft).

38. Install crankshaft vibration damper and pulley as detailed in this section. Tighten bolt to 40-50 Nm (30-37 lb-ft). Then tighten bolt another 85 degrees.

39. Install crankshaft position sensor and tighten bolts to 9-12 Nm (80-106 lb-in).

40. Install the oil filter adapter (6881), oil cooler (if equipped) and a new oil bypass filter (6714).

Oil Pan, Installation

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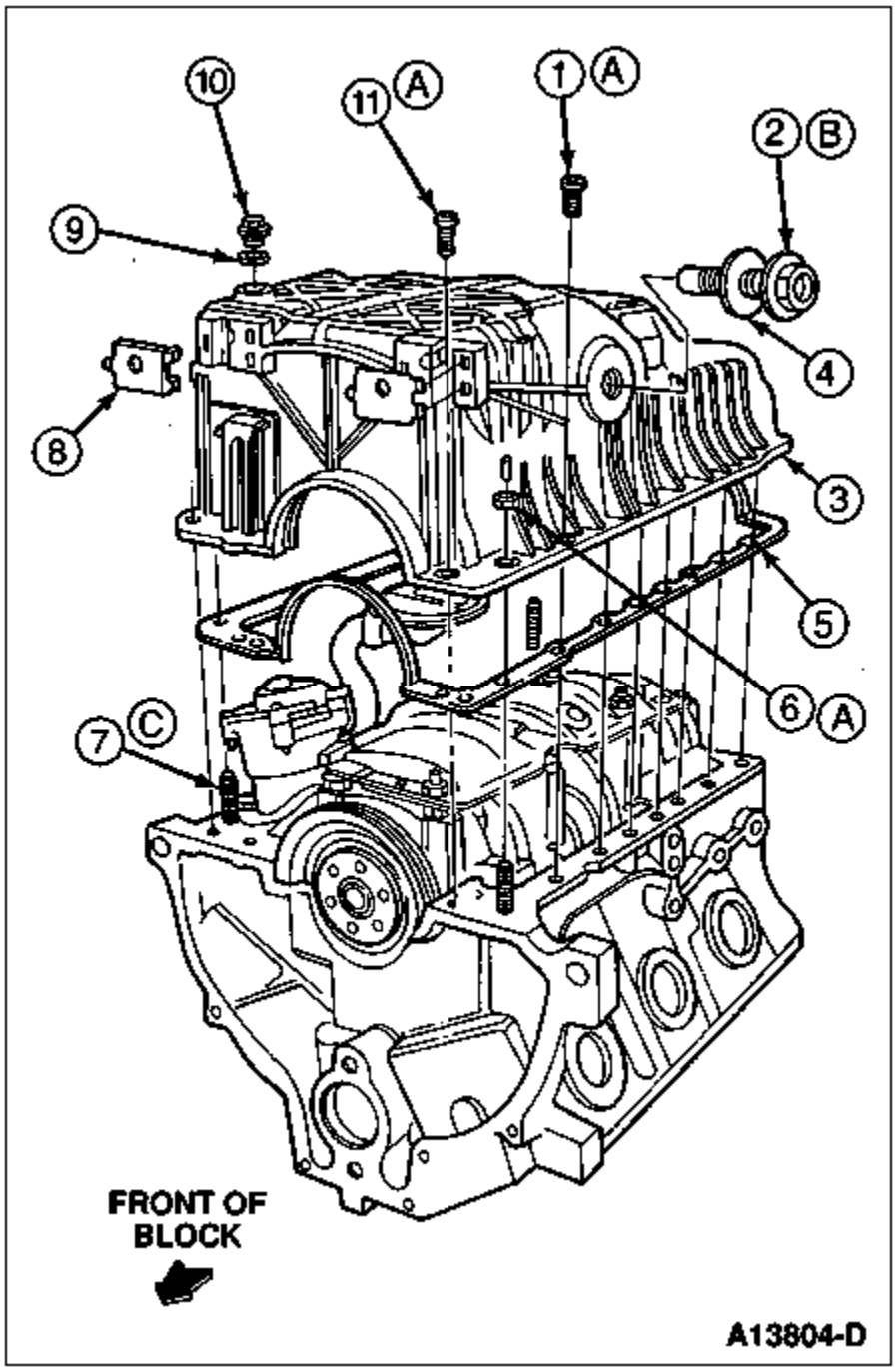

Item	Part Number	Description
1	E804588-S72	Bolt, M6
2	6C624	Low Oil Level Sensor
3	6C626	Low Oil Level Sensor Washer
4	6675	Oil Pan
5	6710	Oil Pan Gasket
6	E60012-S72	Nut

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7	—	Stud (Part of 6010)
8	6A674	Clip
9	6734	Oil Pan Drain Plug Gasket
10	6730	Oil Pan Drain Plug
11	6C629	Torx® Bolt
A	—	Tighten to 7-10 Nm (5-7 Lb-Ft)
B	—	Tighten to 17-21 Nm (13-20 Lb-Ft)
C	—	Tighten to 4 Nm (35 Lb-In)

41. Install and seal the oil pan:

    a. Place a bead of Ford Silicone Sealer F1AZ-19562-A meeting Ford specification WSE-M4G320-A2 or Loctite® 598 sealer in the oil pan gasket groove at the radius areas at the front and rear of the oil pan.
    b. Place a bead of Ford Silicone Sealer F1AZ-19562-A meeting Ford specification WSE-M4G320-A2 or Loctite® 598 on top of the oil pan gasket at the radius areas at the front and rear of the oil pan.
    c. Place a bead of Ford Silicone Sealer F1AZ-19562-A meeting Ford specification WSE-M4G320-A2 or Loctite® 598 on the cylinder blocks at the cylinder block to front cover joint area.
    d. Set the oil pan in place and snug the 4 pan nuts. Ensure integral wedge seal is properly located.
    e. Align the rear face of the oil pan with the rear face of the cylinder blocks.

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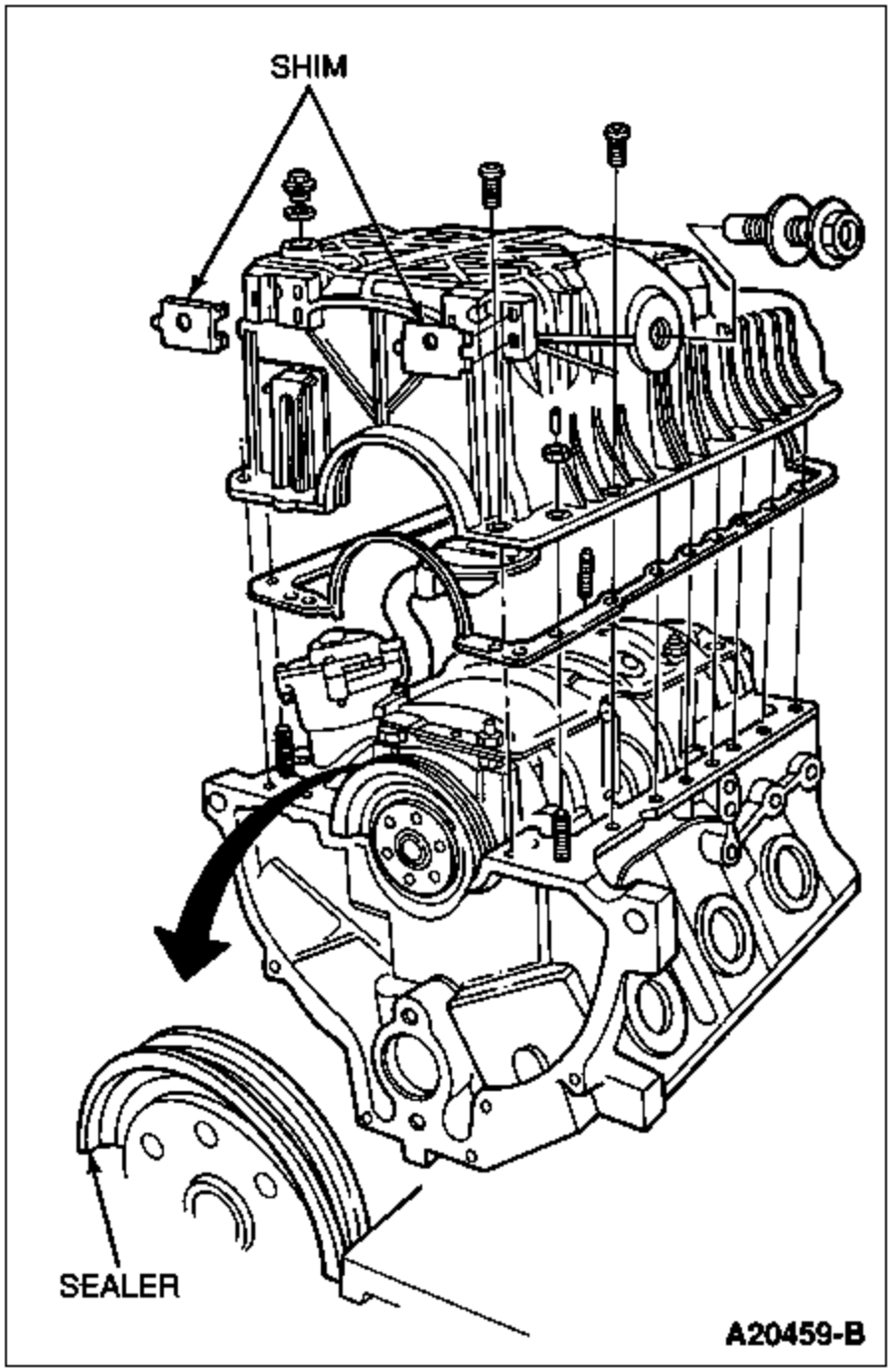

f. Install the remaining oil pan bolts and torque to 7-10 Nm (62-89 lb-ft).

42. **NOTE: Always use a new rear main seal.**

Refer to Crankshaft Rear Oil Seal Installation in this section.

43. **NOTE: The transmission bolts to the engine and oil pan when installed, so it is important to measure the difference between the surface of the rear face of the oil pan (at the spacer locations) and the rear face of the cylinder blocks. If the rear face of the oil pan cannot be aligned within .0100 in. of the rear face of the cylinder block, the appropriate shims must be used. Refer to the following procedure for checking this dimension.**

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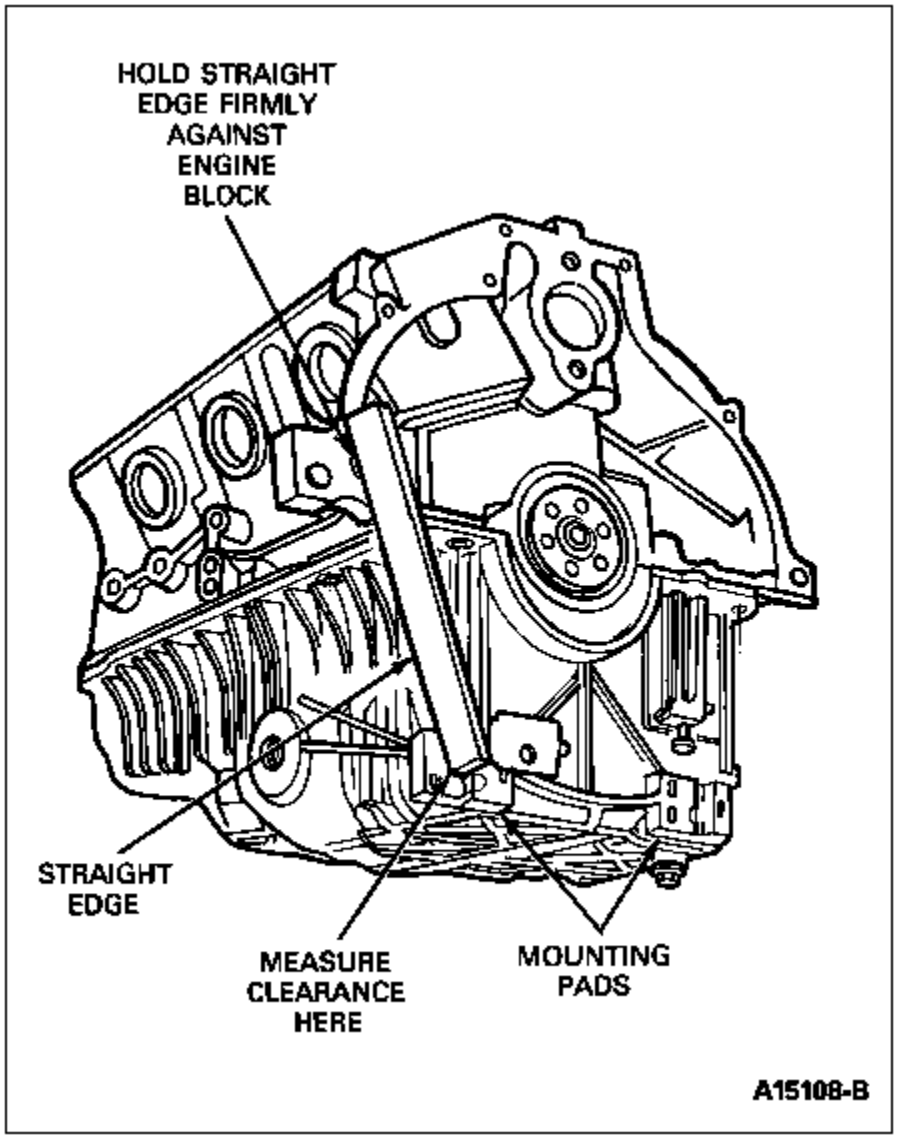
CAUTION: Failure to measure the required spacer thickness can result in insufficient, or excessive clearance between the oil pan and transmission when installed in the vehicle. This can lead to oil pan damage, and/or oil leakage.

Determine if spacers are needed and if so, what thickness:

a. With the oil pan installed on the engine, position a straightedge on the rear of the cylinder blocks so that it is in contact with the transmission mounting machined face of the cylinder blocks and extends over one of the oil pan/transmission bolt mounting pads.



b. Using a feeler gauge, measure the gap between the mounting pad and the straightedge. Repeat the procedure on the other mounting pad. Select spacers of the required thickness from the chart.
c. Install the selected spacers to the mounting pads on the rear of the oil pan before bolting the engine and transmission together.

SPACER SELECTION CHART

Measured Gap	Spacer Required

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mm	Inch	mm	Inch	Shim Color Code
0.0-0.254	0.0-0.010	None	None	—
0.27-0.51	0.011-0.020	0.254	0.010	Yellow
0.52-0.76	0.021-0.029	0.508	0.020	Blue
0.77-1.00	0.030-0.039	0.762	0.030	Pink

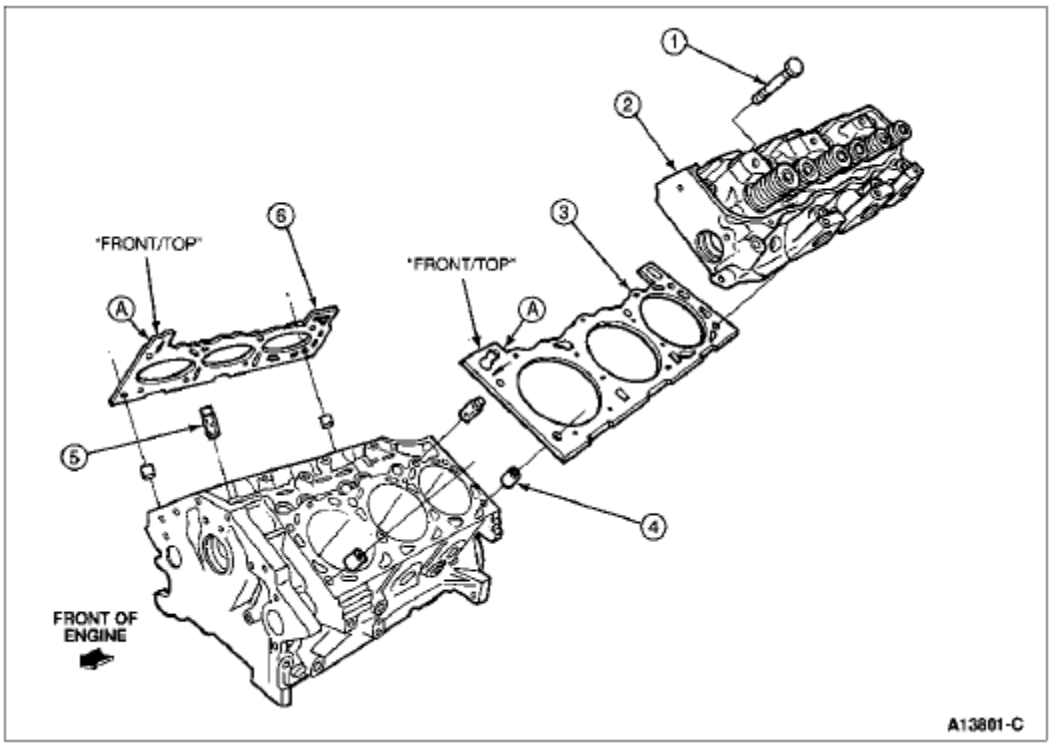
44. Install valve tappets (6500) in their original bores.

45. **NOTE: If cylinder head was completely disassembled, refer to Cylinder Head Disassembly and Assembly in this section.**

    NOTE: Head gaskets are not interchangeable.

    Install cylinder head locating dowels. Position cylinder head gaskets (6051) on cylinder blocks ensuring the installation arrows on the head gaskets are pointing to the front of the engine.

Cylinder Head, Installation



Item	Part Number	Description
1	6065	Cylinder Head Bolt

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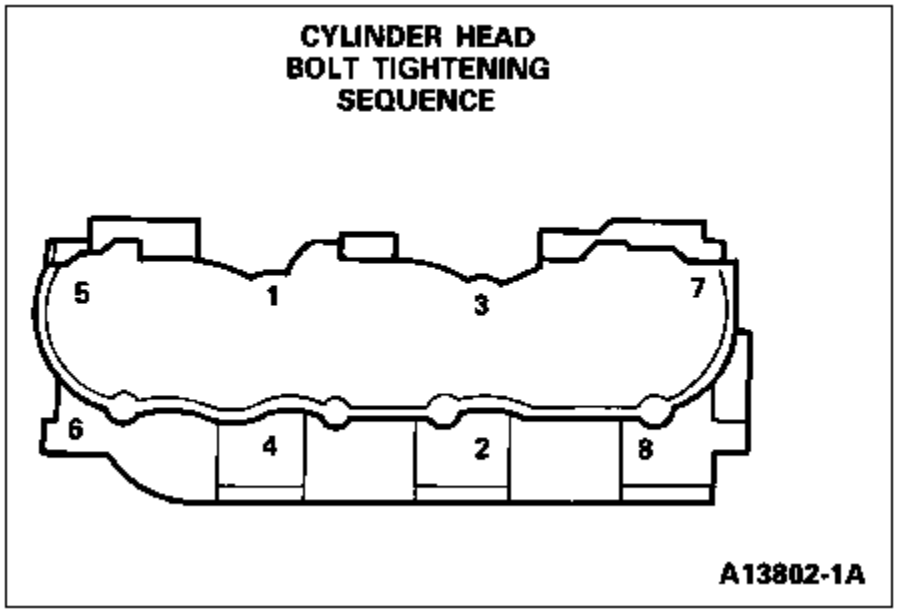
2	6049	Cylinder Head
3	6051	Head Gasket (LH)
4	6A008	Cylinder Head to Block Dowel
5	6500	Valve Tappet
6	6051	Head Gasket (RH)
A	—	Installation Arrows (on Top) Must Point to Front of Engine

46. Install and tighten the cylinder head bolts, in the sequence shown, in the following steps.

- Step 1 — 30-35 Nm (22-26 lb-ft)
- Step 2 — 70-75 Nm (52-56 lb-ft)
- Step 3 — rotate bolts 90 degrees



47. **NOTE: Once applied, the silicone sealer will set up in approximately 15 minutes. The intake manifold must be installed immediately after the sealer is applied.**

Apply Silicone Rubber D6AZ-19562-BA or equivalent meeting Ford specifications ESB-M4G92-A and ESE-M4G195-A to the block and cylinder head mating surfaces at the four corners. Install the intake manifold gasket (9439) and again apply sealer to the four corner locations.

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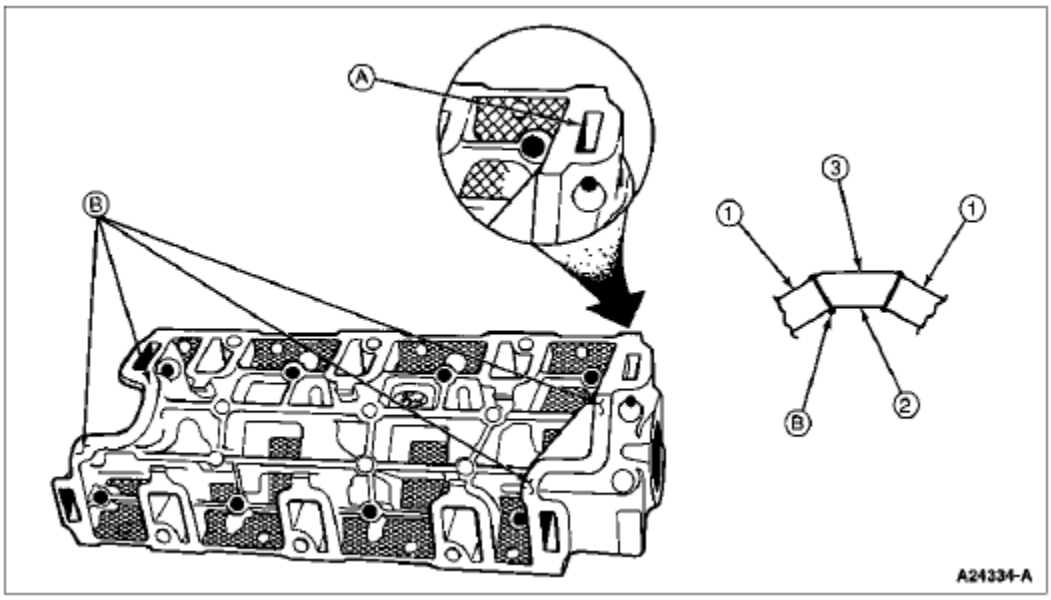

Item	Part Number	Description
1	6049	Cylinder Head
2	9439	Intake Manifold Gasket
3	9424	Intake Manifold
A	—	Examine Closely for Erosion, Corrosion, or Pitting on This Surface
B	—	Silicone Sealer — 4 Places

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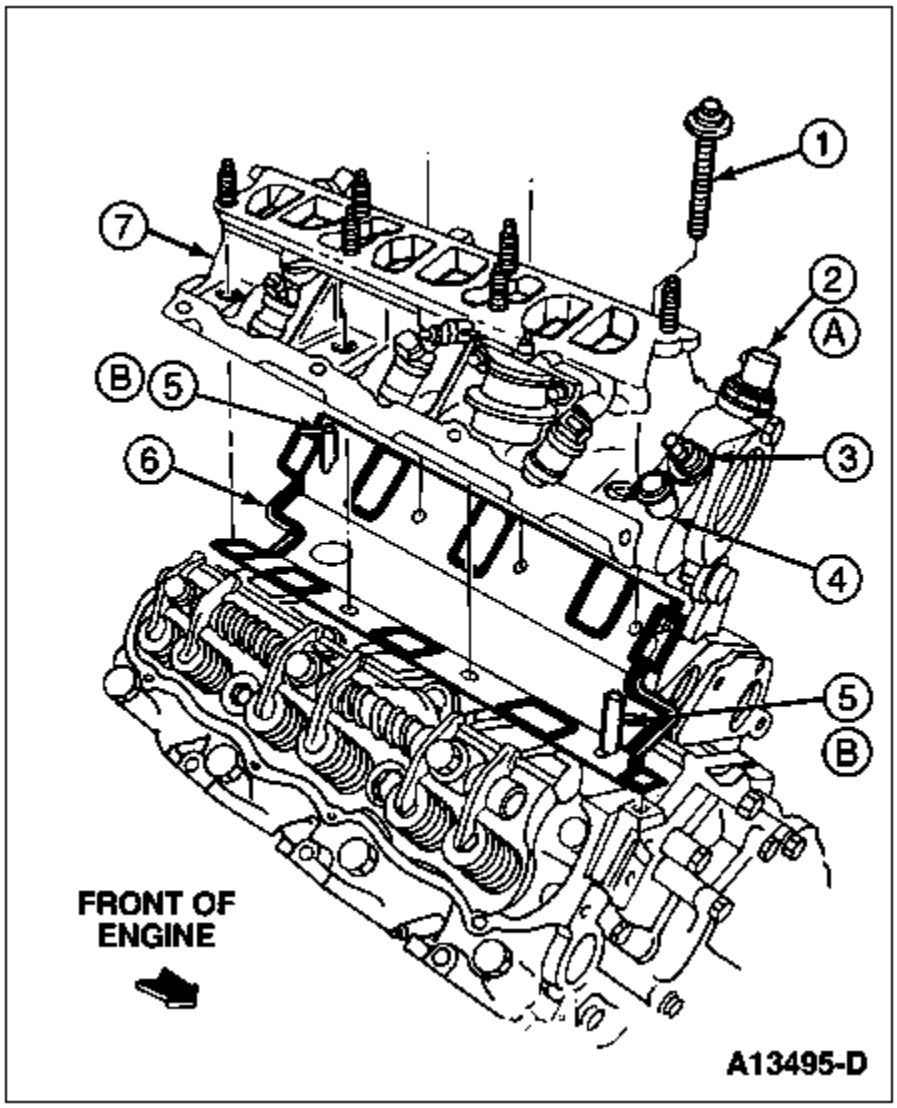

Item	Part Number	Description
1	W702301S309M	Bolt with Captive Washer (8)
2	12A648	Engine Coolant Temperature Sensor
3	10884	Water Temperature Indicator Sender Unit
4	8501	Water Pump
5	—	Stud (Part of 9424)
6	9439	Intake Manifold Gasket
7	9424	Intake Manifold
A	—	Tighten to 16 Nm (12 Lb-Ft)
B	—	Used to Locate Lower Intake Manifold Only

48. Position the intake manifold (9424) with the aid of two guide studs in position 3 and 4 below, and then install the intake manifold bolts. Remove the two guide studs and replace with bolts. Tighten the intake manifold bolts in three stages following the sequence shown.

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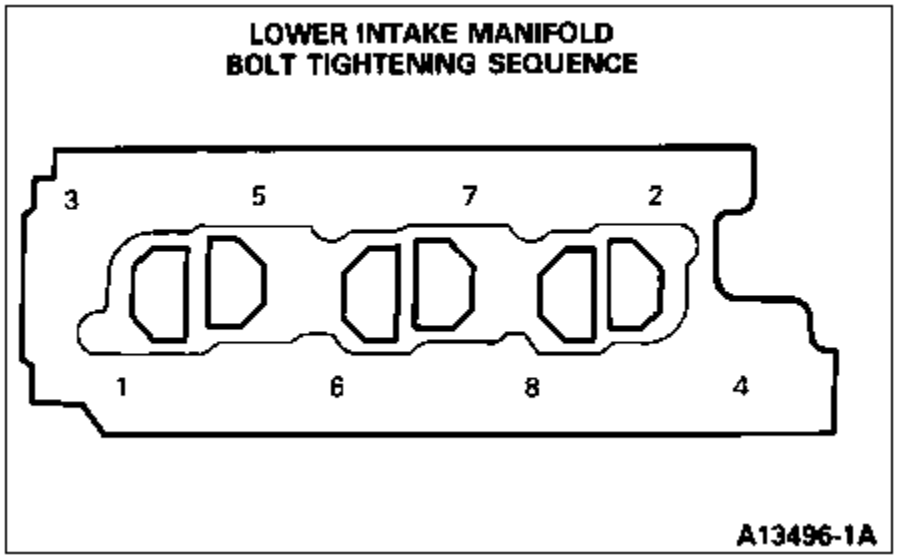
a. 8 Nm (6 lb-ft)
b. 15 Nm (11 lb-ft)
c. 22 Nm (16 lb-ft)



49. **NOTE: Lightly oil bolts with engine oil prior to installation. Do not place any oil in the threads on the cylinder head.**

Install valve tappets, rocker arm and shaft assemblies as outlined in this section.

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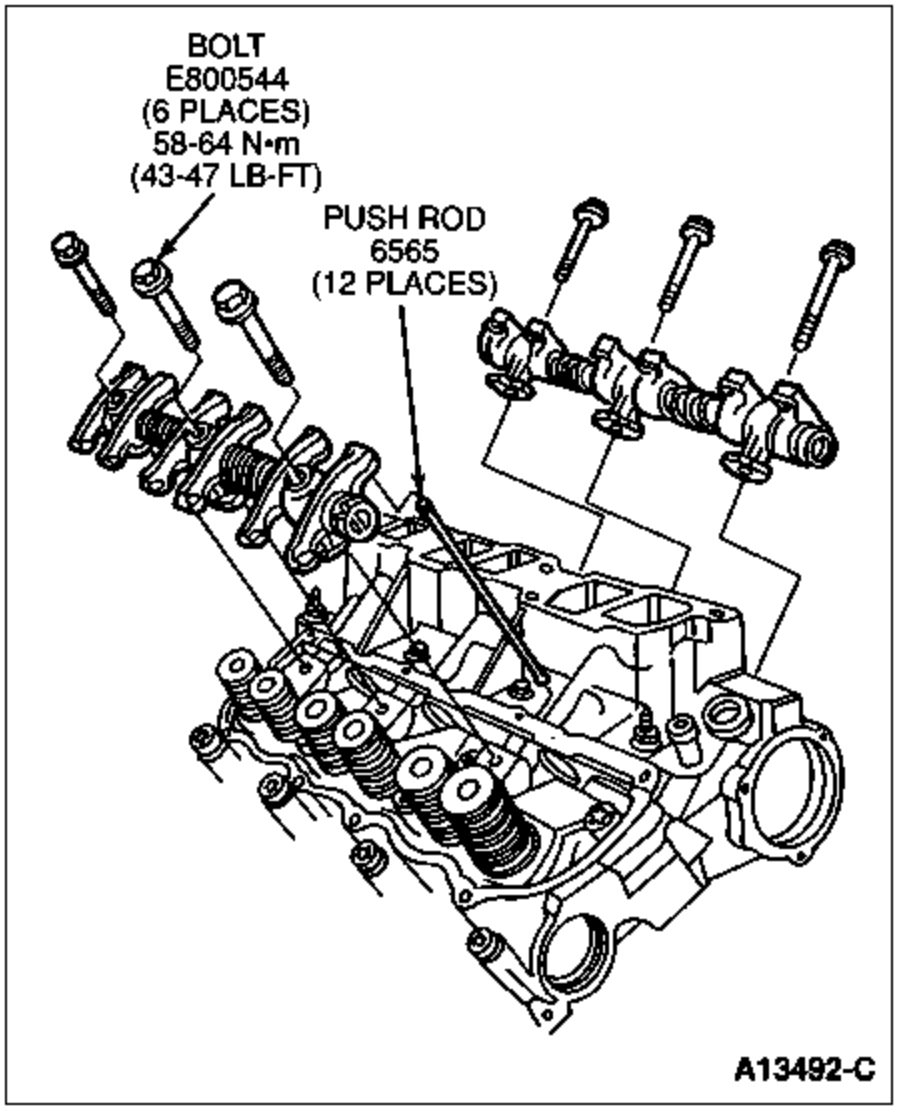

50. Install oil level indicator tube, oil level dipstick assembly.

51. **NOTE: Since silicone rubber will set up within 15 minutes, if you are installing both covers, apply only to one side at a time.**

    Apply Silicone Rubber D6AZ-19562-BA or equivalent meeting Ford specifications ESB-M4G92-A and ESE-M4G195-A to intake manifold-to-cylinder head parting seam.

Rocker Arm Cover and Gasket, Installation

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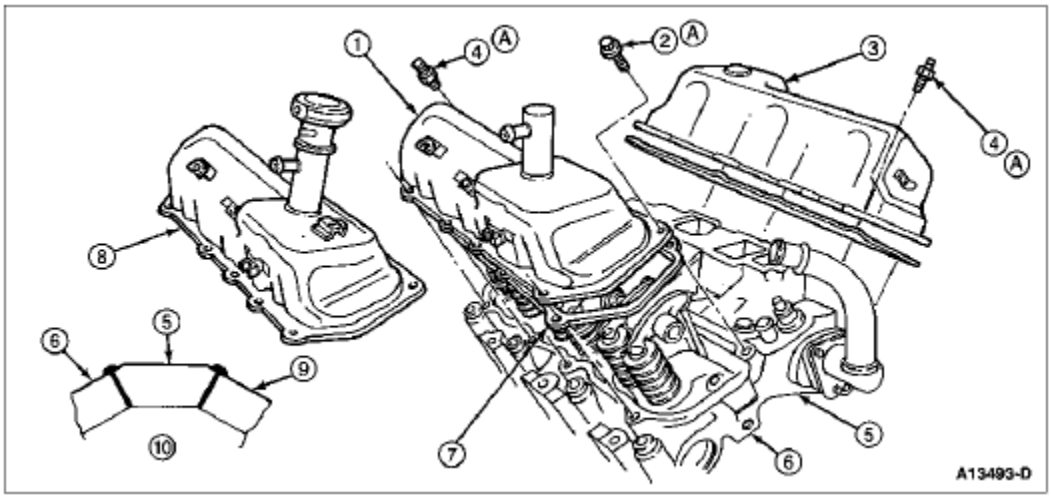

Item	Part Number	Description
1	6582	Valve Cover — Aerostar (RH)
2	E800390-S72	Screw, M6x22 Flange Head
3	6582	Valve Cover (LH)
4	W701041	Stud
5	9424	Intake Manifold
6	6049	Cylinder Head (RH)
7	6584	Valve Cover Gasket
8	6582	Valve Cover — Ranger (RH)
9	6049	Cylinder Head (LH)
10	6010	Cylinder Blocks
A	—	Tighten to 8-10 Nm (71-89 Lb-In)

52. Install left valve cover, rocker arm cover flange plates (6A523), and bolts and snug bolts starting from center bolts and working in crisscross pattern to end bolts. Tighten in same pattern to 6-8 Nm (53-70 lb-in).

53. Install the upper intake manifold and tighten the nuts to 20-25 Nm (15-18 lb-ft).

54. Install the oil pump drive and secure with the clamp and bolt. Tighten the bolt to 17-21 Nm (13-15 lb-ft).

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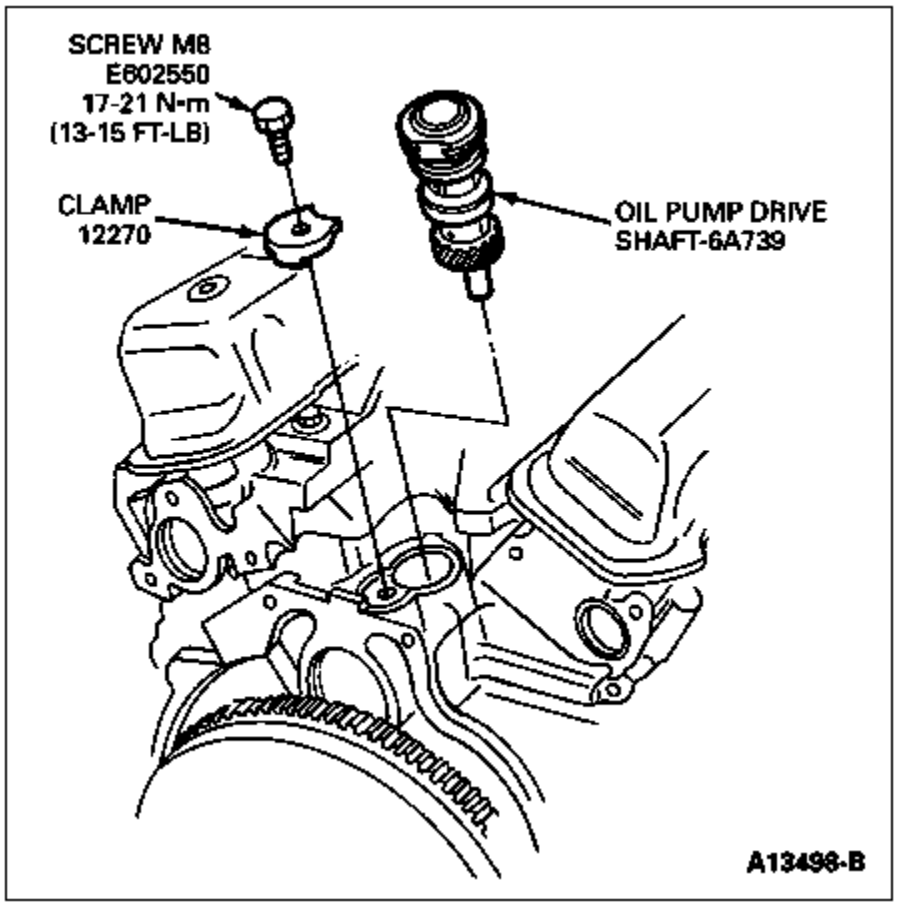

55. Install wiring harnesses, emission control system, fuel system, ignition system and front end accessory drive components, by referring to procedures in the specific sections.

Assembly, Ranger

1. After performing Steps 1-55 above, rotate crankshaft until TDC mark on the damper is accessible. If not present, place an additional mark on the damper at 26 degrees After Top Dead Center (ATDC). This position is 34mm (1.34 inches) counterclockwise from the Top Dead Center (TDC) mark.

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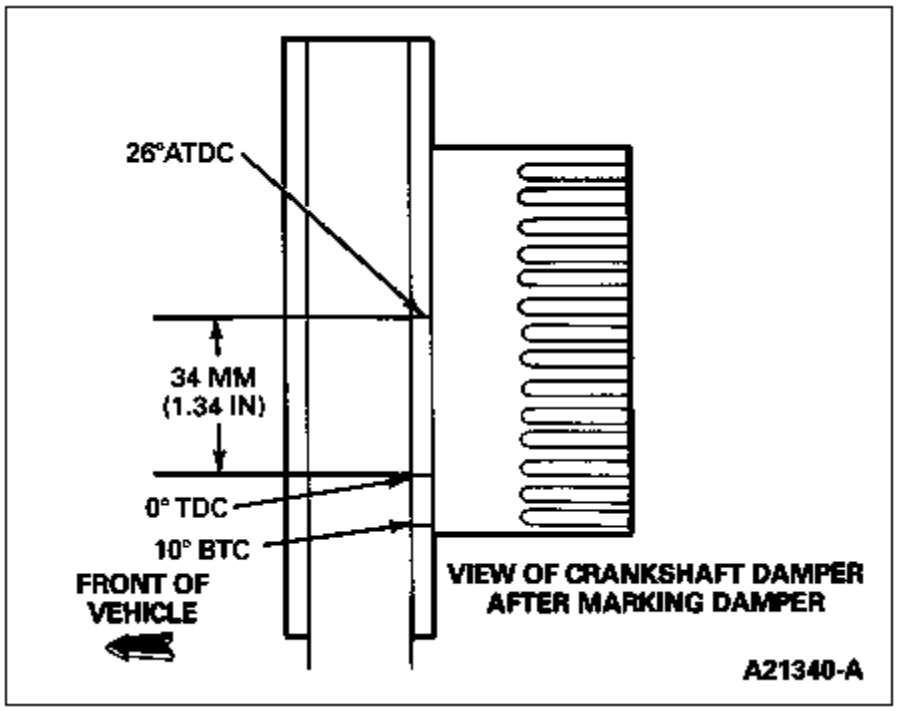

2. Position No. 1 cylinder to TDC between compression and ignition stroke. (Both intake and exhaust valves must be closed with TDC mark on vibration damper at pointer.)

3. Lubricate oil pump drive pinion and O-ring on assembled oil pump drive gear and CID sensor with SM-2C 1013-A oil. Do not get oil above mounting flange.

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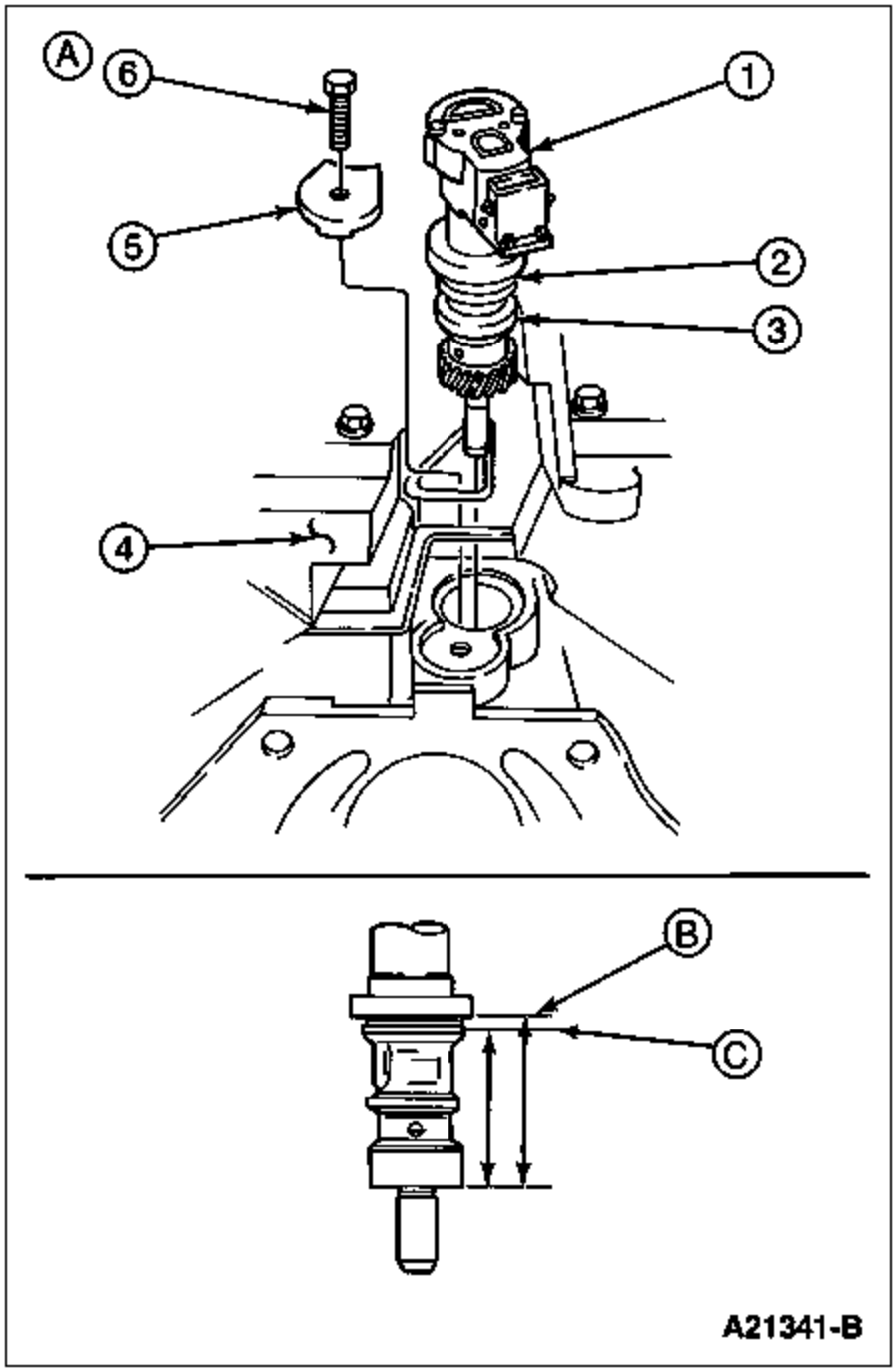

Item	Part Number	Description
1	12K073	CID Sensor (California Only)
2	E853103-S	O-Ring
3	6846	Oil Pump Drive Assembly
4	6007	Engine
5	12270	Distributor Hold-Down Clamp
6	E602550	Screw

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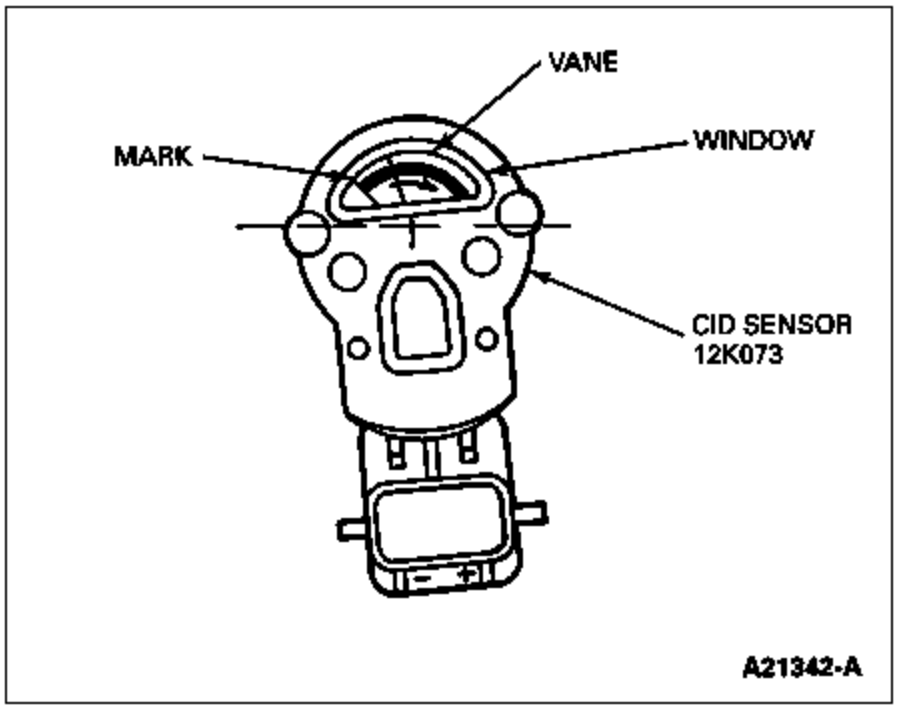
A	—	Tighten to 17-21 Nm (13-15 Lb-Ft)
B	—	Maximum Level for Pre-Oiling Drive Gear
C	—	Minimum Level for Pre-Oiling Drive Gear

4. **NOTE: Normal CID sensor rotation is clockwise viewed from top of CID sensor.**

   Align the CID sensor rotor as shown with the trailing edge of the vane lined up with the short mark at the left hand side of the plastic window.



5. Position the sensor above its hole at right angles to the block rear face.

6. Install the assembled CID sensor and oil pump drive gear into the engine. As the assembly is pushed into place, the camshaft gear will rotate the sensor vane clockwise toward the center of the window.

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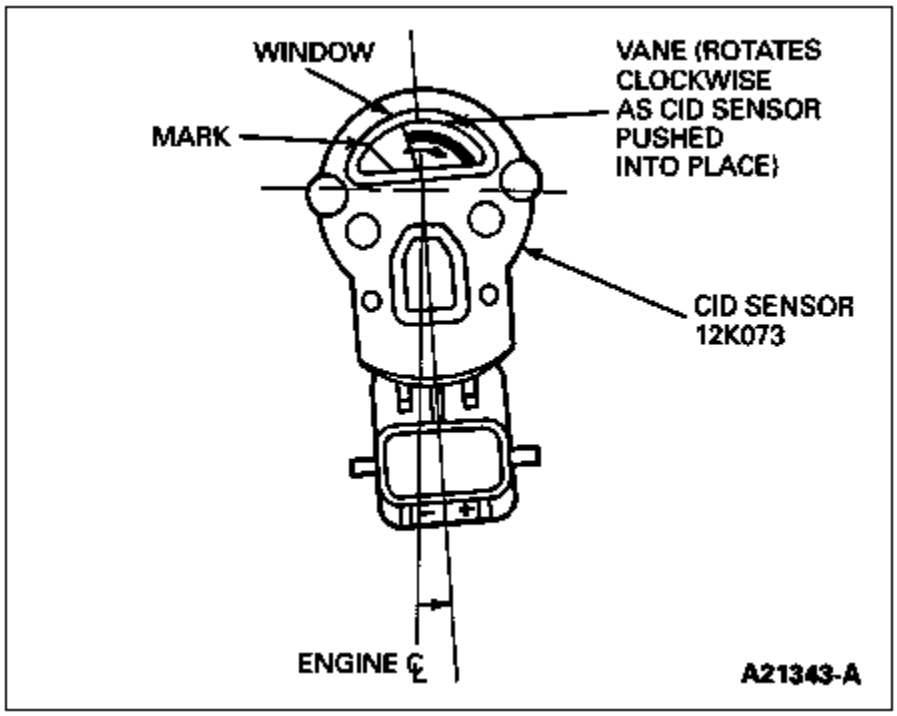
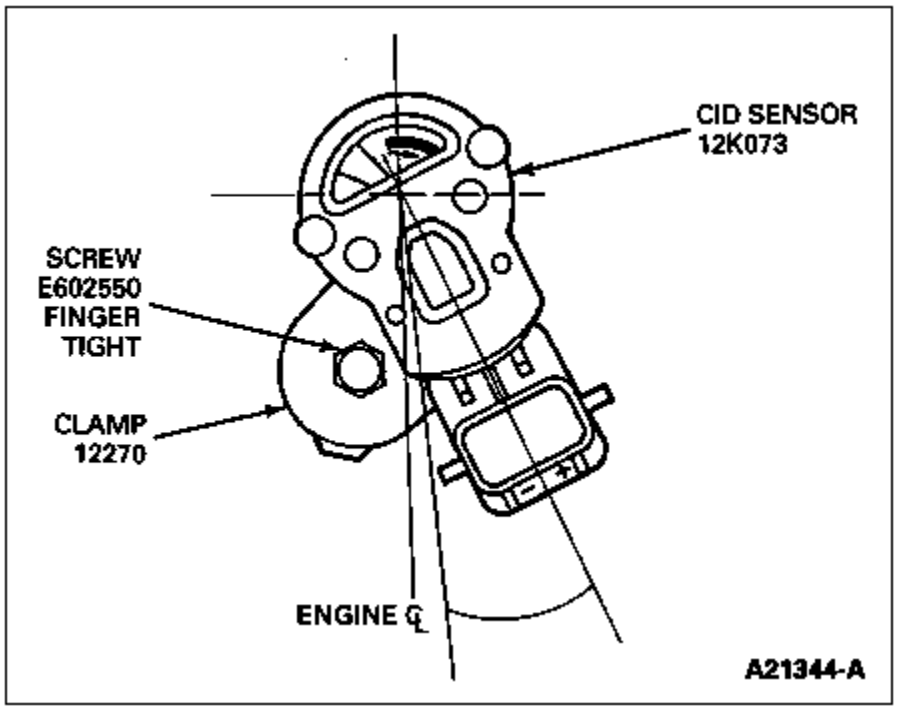


7. Rotate the CID sensor counterclockwise. Install clamp and screw finger-tight. Rotate the sensor back to its position at right angles to the back of the block.



8. **NOTE: For out of vehicle assembly, use loose 12 volt battery or battery in a conveniently located vehicle.**

   Connect the CID Testing Wiring Harness T94T-50-B to the CID Sensor.

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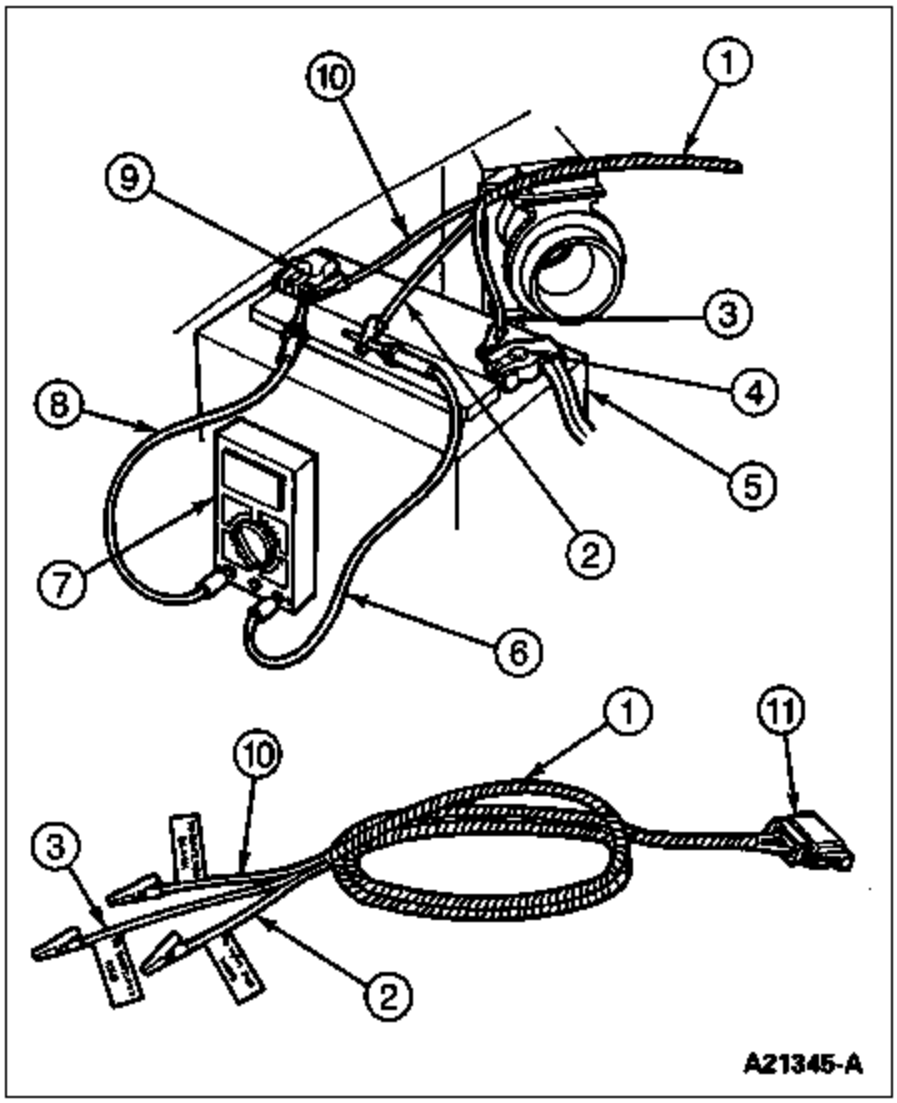
9. Connect the CID Testing Wiring Harness leads:

    a. Red harness wire to battery positive terminal.
    b. Black harness wire to battery negative terminal.
    c. Voltmeter positive lead to harnesses white lead.
    d. Voltmeter negative lead to battery negative terminal.



Item	Part Number	Description
1	T94T-50-B	CID Testing Wiring Harness
2	—	White Lead (Part of T94T-50-B)
3	—	Red Lead (Part of T94T-50-B)
4	—	Positive Terminal (Part of 10655)
5	10655	Battery

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6	—	Red Lead (Part of 007-00407)
7	007-00407	Rotunda Digital Volt-Ohmmeter or Equivalent
8	—	Black Lead (Part of 007-00407)
9	—	Negative Terminal (Part of 10655)
10	—	Black Lead (Part of T94T-50-B)
11	—	Connector (Part of T94T-50-B) (Attaches to CID Sensor)

10. Rotate engine two revolutions to take up slack in timing chain and return No. 1 cylinder to its compression stroke.

11. **NOTE: No. 1 cylinder must be at 26 degrees After Top Dead Center (ATDC) to set CID sensor.**

    Verify that No. 1 cylinder is on its compression stroke (both valves closed).

12. Continue to rotate the crankshaft until the new 26 degrees ATDC mark lines up with the timing pointer.

13. **NOTE: The voltmeter will register battery voltage whenever the CID sensor closes and makes a complete circuit.**

    While rotating the CID sensor, note the exact point where the sensor switches from 0 to 12 volts on the voltmeter.

14. **NOTE: The final movement to set the CID sensor must be in a COUNTERCLOCKWISE direction.**

    Rotate the CID sensor clockwise past the CID switching point (from 12 to 0 volts).

15. Rotate the CID sensor counterclockwise and stop at the exact point the voltmeter switches from 0 to 12 volts.

16. Tighten the CID sensor hold-down bolt to 17-21 Nm (13-15 lb-ft) using Sensor Adjusting Wrench T94T-12270-A.

17. Disconnect the testing wiring harness and the voltmeter and install wiring harnesses, emission control system, fuel system, ignition system and front end accessory drive components, by referring to procedures in the specific sections.

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Cylinder Head

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Valve Stem Seal Replacer	T90T-6571-A

Disassembly

1. Remove deposits from the combustion chambers and valve heads with a scraper and a wire brush. **Be careful not to scratch the cylinder head gasket surfaces.**

2. Compress the valve springs (6513). Remove the valve spring retainer keys (6518) and release the valve springs.

3. Remove the valve spring retainer (6514), valve stem seal (6571), and intake valve (6507) or exhaust valve (6505). Discard the valve stem seals. Identify all valve parts for assembly. Remove the left exhaust manifold (9430) or right exhaust manifold assembly and spark plugs (12405).

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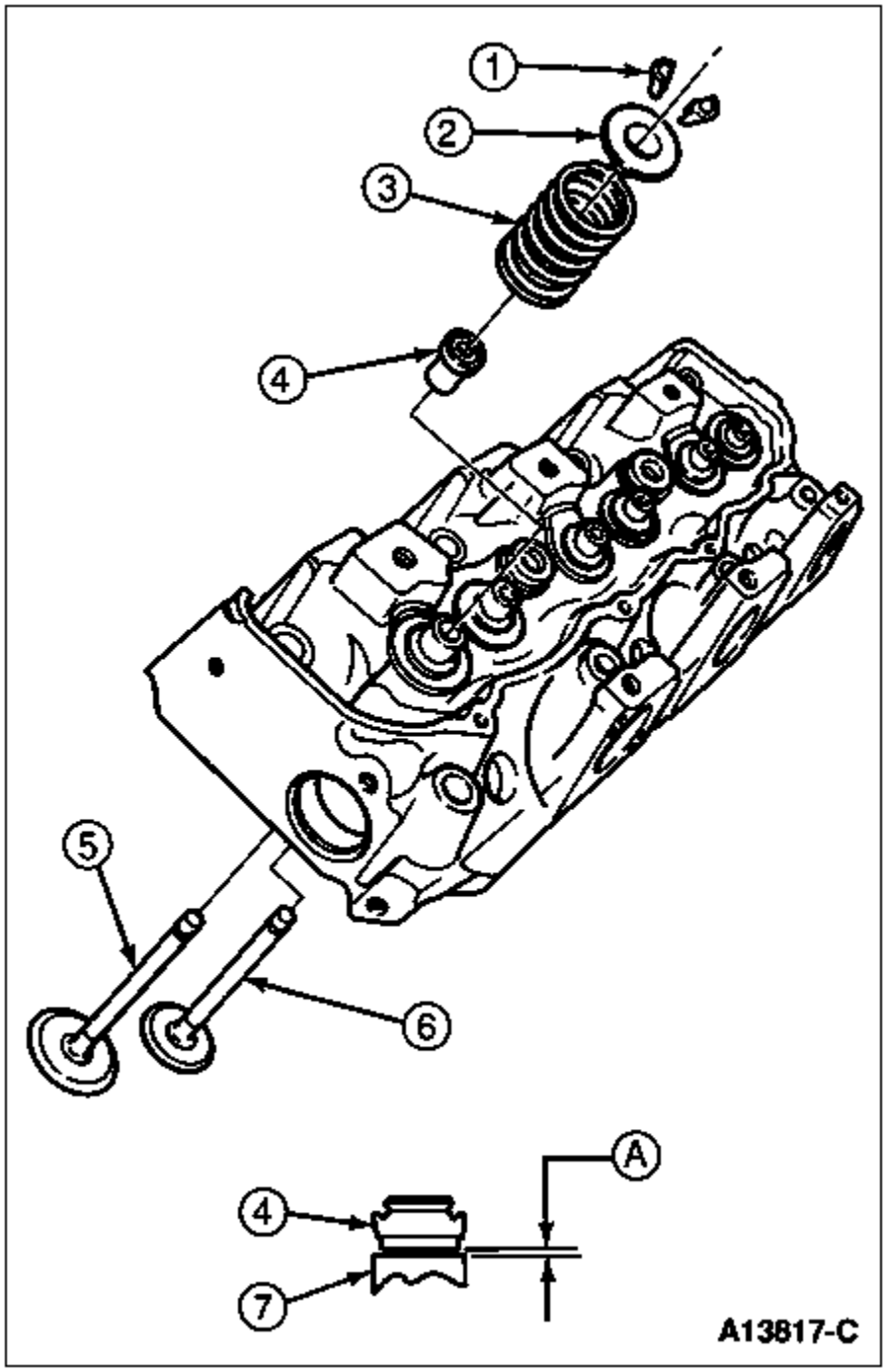

Item	Part Number	Description
1	6518	Valve Spring Retainer Key
2	6514	Valve Spring Retainer
3	6513	Valve Spring
4	6571	Valve Stem Seal
5	6507	Intake Valve
6	6505	Exhaust Valve

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7	—	Valve Guide Boss (Part of 6507)
A	—	0.5mm (0.019 Inch) Maximum Gap

Assembly

1. Clean, inspect and repair all parts before assembly.
2. Install the left exhaust manifold or right exhaust manifold and spark plugs. Tighten the spark plugs and manifold attaching parts to specifications.
3. Lubricate the valve guides and valve stems with engine oil. Apply SAE 50 Service SG or equivalent oil to the tips of the valve stems.
4. Install each valve in the valve guide from which it was removed or to which it was fitted. Install a new oil-coated valve stem seal on the valve using Valve Stem Seal Replacer T90T-6571-A.
5. Install the valve spring over the valve, with close coils toward the cylinder head. Install the spring valve spring retainer.
6. Compress the valve spring and install the valve spring retainer keys.
7. Measure the assembled height of the valve spring from the surface of the cylinder head spring pad to the underside of the valve spring retainer with dividers.
8. **CAUTION: Do not install spacers unless necessary. Use of excess spacers will result in overstressing the valve springs and overloading the camshaft lobes, which would lead to spring breakage and worn camshaft lobes.**

   Check the dividers against a scale. If the assembled height is greater than specifications, install the necessary spacer(s) between the cylinder head spring pad and the valve spring to bring the assembled height to the recommended dimension.

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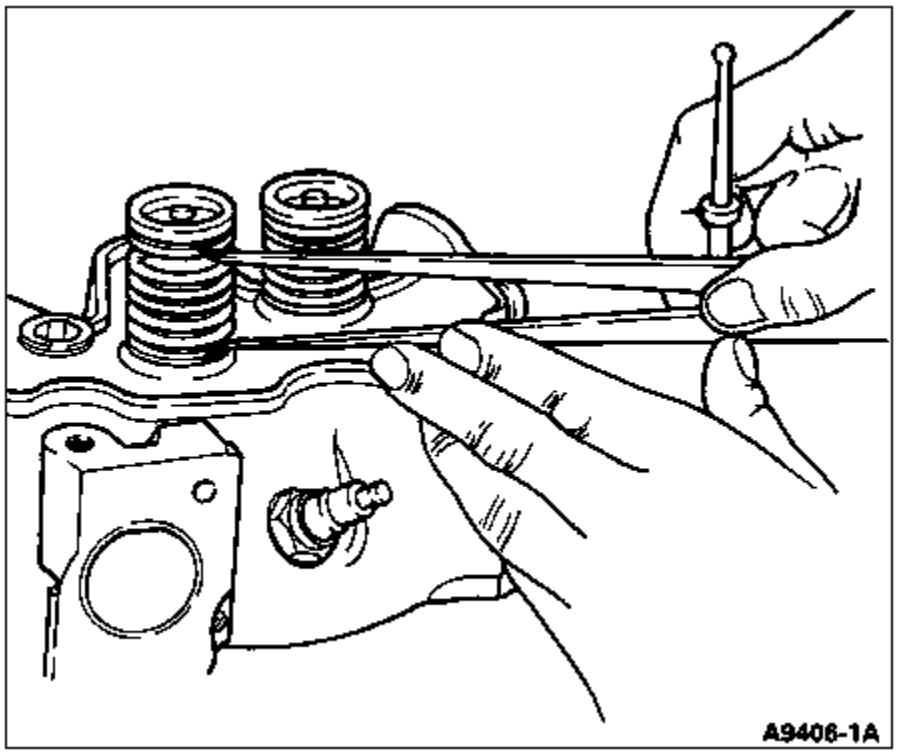

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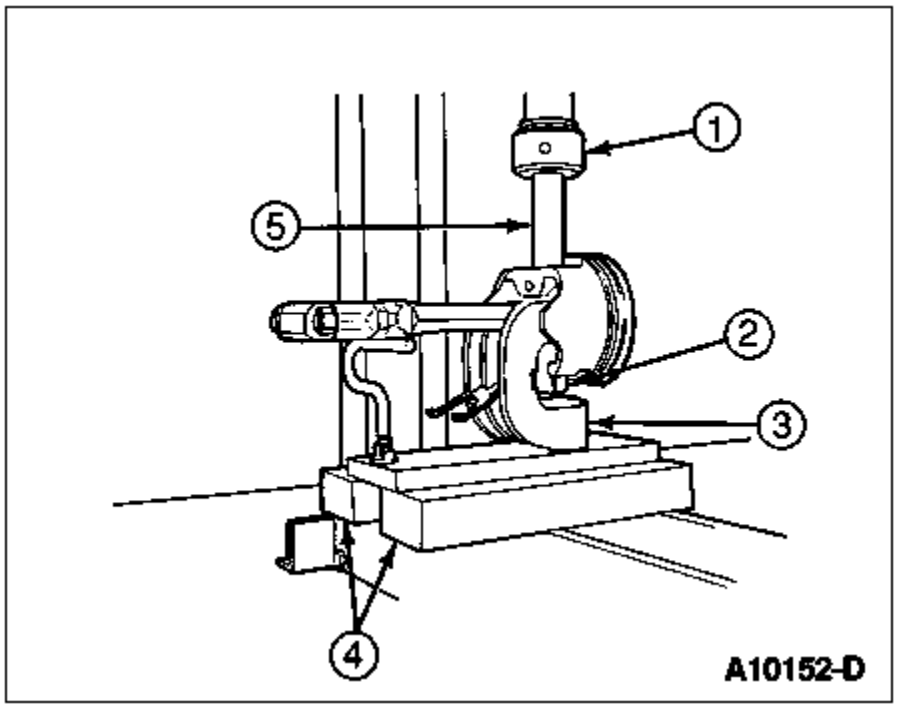
Pistons, Piston Pins and Rings

Disassembly

1. Remove connecting rod bearings (6211) from connecting rod and cap.
2. Remove piston rings using a suitable piston ring expander.
3. Mark connecting rod cap to make sure of assembly with the same piston (6108) and installation in the same cylinders from which they were removed.
4. Using an arbor press and Piston Pin Removal and Replacer D81L-6135-A or equivalent, press the piston pin (6135) from the piston and connecting rod (6200).



Item	Part Number	Description
1	—	Press Ram (Part of D81L-6135-A)
2	6135	Piston Pin
3	—	Receiving Tube (Part of D81L-6135-A)

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4	—	Press Plates (Part of D81L-6135-A)
5	—	Pin Pusher (Part of D81L-6135-A)

Assembly

Check the fit of a new piston in the cylinder bore as outlined in Section 03-00 before assembling the piston and piston pin to the connecting rod.

The piston pin bore of a connecting rod and the diameter of the piston pin must be within specification.

1. Apply a light coat of engine oil XO-5W30-QSP or equivalent meeting Ford specification ESE-M2C153-E or SAE 5W-30 Service SG or SAE 50 Service SG to all parts.

2. **NOTE: Squirt hole faces right bank cylinders.**

   Assemble the piston to the connecting rod, putting the notch in the piston dome and the connecting rod on the same side.

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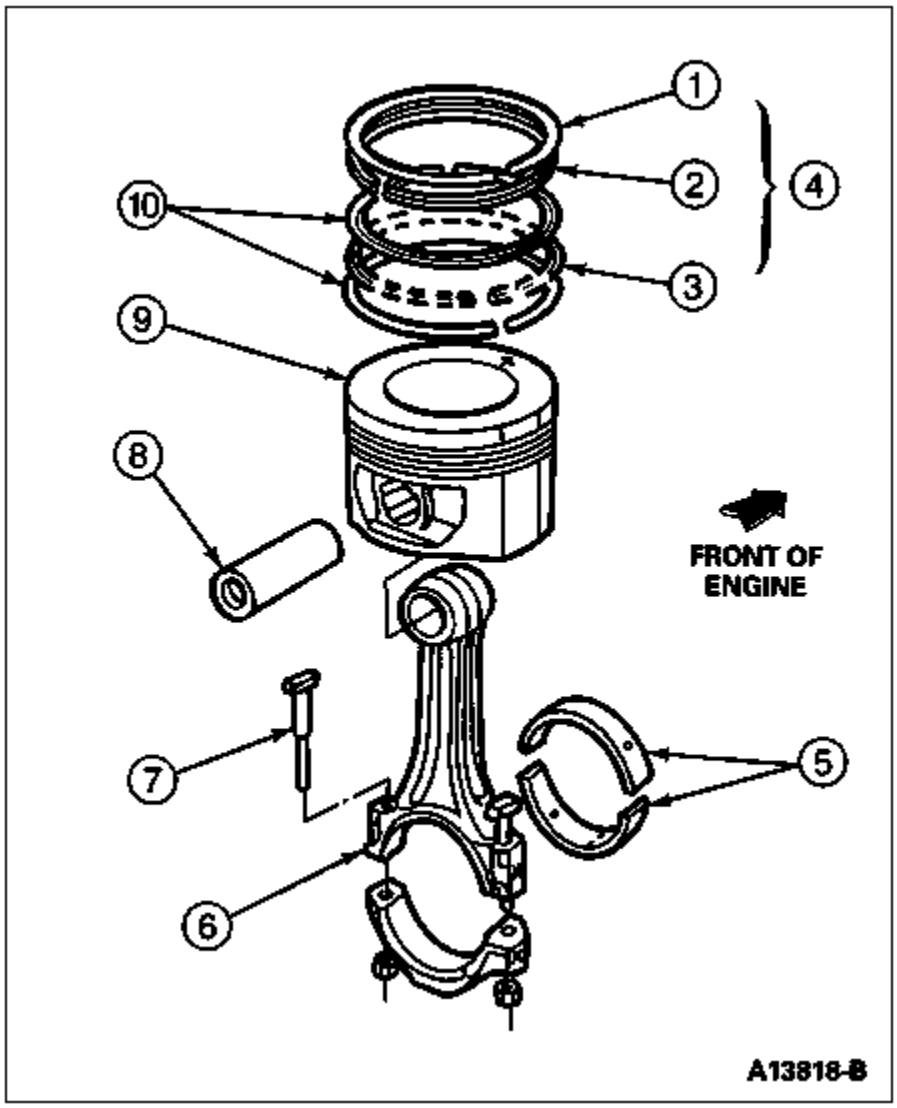

Item	Part Number	Description
1	—	Piston Ring Compression, Upper (Part of 6148)
2	—	Piston Ring Compression, Second (Part of 6148)
3	—	Piston Ring, Oil Control (Part of 6148)
4	6148	Partial Piston Ring Set
5	6211	Connecting Rod Bearing
6	6200	Connecting Rod
7	6214	Connecting Rod Bolt
8	6135	Piston Pin
9	6108	Piston
10	—	Piston Ring Expander, Oil Control Ring (Part of 6148)

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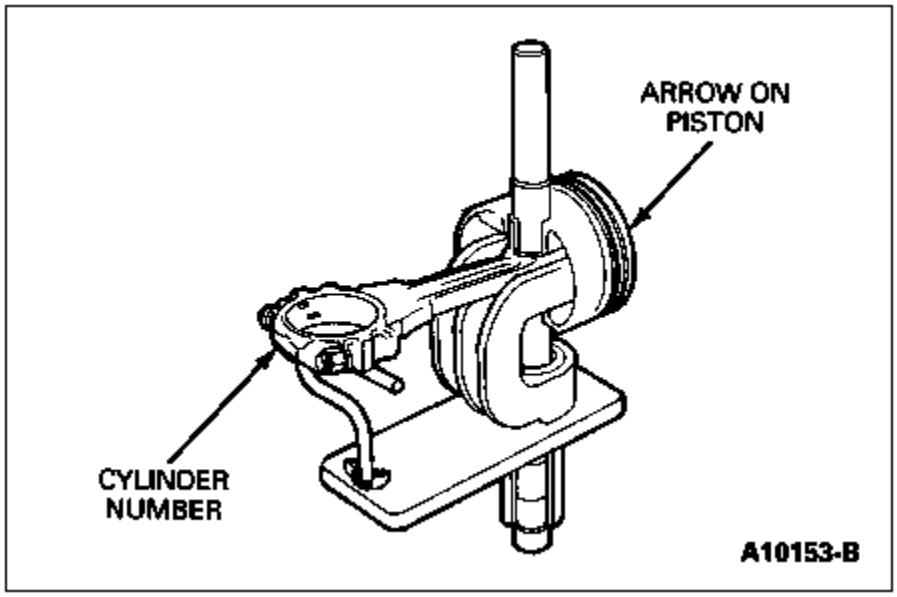
3. Start the piston pin in the piston and connecting rod (this may require a very light tap with a mallet). Using an arbor press and Piston Pin Tool D81L-6135-A or equivalent, press the piston pin through the piston until the piston pin is centered in the piston.



4. Check the end gap of all piston rings. It must be within specification:

   - Compression (Top) 0.38-0.58mm (0.015-0.023 in.)
   - Compression (Bottom) 0.38-0.58mm (0.015-0.023 in.)
   - Oil Ring (Steel Rail) 0.38-1.39mm (0.015-0.055 in.)

5. Follow the instructions contained on the piston ring package and install the piston rings.

6. Check the ring side clearance of the compression rings with Feeler Gauge D81L-4201-A or equivalent by inserting it between the ring and its lower land. The gauge should slide freely around the entire ring circumference without binding. Any wear that occurs will form a step at the inner portion of the lower land. If the lower lands have high steps, the piston should be replaced.

7. Make sure bearing inserts and the bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause a failure. Install the connecting rod bearings in the connecting rod and cap with the tangs fitting in the slots provided.

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Cylinder Block Assembly

Disassembly

1. Mount the engine (6007) on a work stand and remove all parts not furnished with the new cylinder assembly.
2. Remove the old cylinder assembly from the work stand.

Assembly

1. Clean the gasket and seal surfaces of all serviceable parts and assemblies.
2. Position the new cylinder assembly in a work stand and transfer all serviceable parts removed from the old cylinder assembly.
3. Check all assembly clearances and correct as necessary.

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Cylinder Block, Bare

Before replacing a cylinder blocks (6010), determine if it is repairable. If so, make the necessary repairs following the procedures given in Section 03-00 .

Disassembly

1. Completely disassemble the old engine.
2. Remove core plugs as outlined in Section 03-00 .
3. Remove oil gallery pipe plugs.
4. **NOTE: A rifle-cleaning brush is helpful for cleaning engine oil galleries.**

   Clean cylinder blocks and inspect as outlined in Section 03-00 .

Assembly

1. If using new or reconditioned cylinder block uncrate and clean preservative materials according to supplier's instructions.
2. Position the new cylinder blocks in a work stand and install all serviceable parts removed from the old cylinder blocks.
3. Check all assembly clearances and correct as necessary.

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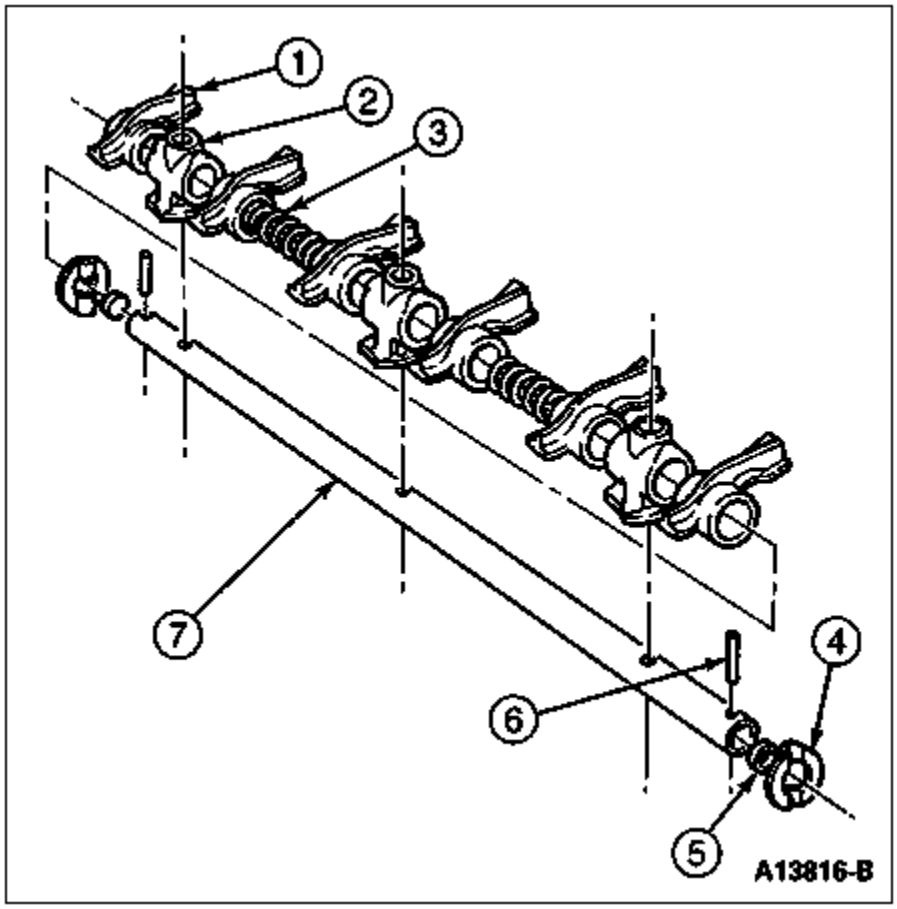
Rocker Arm Shaft Assembly

Disassembly

1. Remove the spring washer and pin from each end of the rocker arm shaft (6563).
2. Slide the rocker arms (6564), springs and rocker arm shaft supports (6531) off the rocker arm shaft. Be sure to mark the parts for assembly in the same locations.
3. If it is necessary to remove the plugs from each end of the rocker arm shaft, drill or pierce the plug on one end large enough for steel rod to pass through. Use a steel rod to knock out the plug on the opposite end. Working from the open end, knock out the remnants of the first plug.



Item	Part Number	Description
1	6564	Rocker Arm
2	6531	Rocker Arm Shaft Support
3	6587	Rocker Arm Shaft Spring

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4	6598	Rocker Arm Shaft Washer
5	6572	Rocker Arm Shaft Plug
6	6A533	Rocker Arm Shaft Retaining Pin
7	6563	Rocker Arm Shaft

Assembly

1. Use a blunt tool and install a plug, cup side out, in each end of the rocker arm shaft if the plugs were removed from the shaft. Make sure plugs are in deep enough that they do not block pin holes.

2. Install a spring washer and pin on one end of the rocker arm shaft, coat the rocker arm shaft with heavy SF engine oil and install the parts in the same sequence in which they were removed.

3. Install the remaining spring washer and pin.

4. Coat the rocker arm pads with SAE 50 Service SG (ESE-M2C39-F) oil before installation on the engine.

5. Install the rocker arm shaft with the oil holes pointing down. This position of the shaft can be recognized by a notch on the front face of the shaft.

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Valve Clearance

The 4.0L engine uses hydraulic roller tappets and non-adjustable rocker arms (6564). The valve tappets (6500) are not adjustable, and if found to be excessively worn or noisy, should be tested and repaired or replaced as described in Section 03-00 .

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SPECIFICATIONS

Engine Specifications

Item	Specification
Displacement	4.0L (4000 cc)
Number of Cylinders	6
Bore and Stroke	100 x 84mm (3.94 x 3.31 inch)
Firing Order	1-4-2-5-3-6
Oil Pressure (Hot @ 2000 RPM)	40-60
Drive Belt Tension	a
Compression Pressure	b

[a] Refer to Section 03-05 .
[b] PSI of lowest cylinder must be within 75% of highest (see section 03-00).

General Specifications

Cylinder Head And Valve Train

Item	Specification
Combustion Chamber Volume (cc)	46.34-48.34
Valve Guide Bore Diameter	0.3174-0.3184
Valve Seats	
Width — Intake	0.060-0.079
Width — Exhaust	0.060-0.079
Angle	45°
Runout Limit (T.I.R. Max)	0.0015
Valve Arrangement (Front to Rear)	LH = I-E-I-E-I-E RH = E-I-E-I-E-I
Gasket Surface Flatness	a
Gasket Surface Finish (RMS)	60-150
Valve Stem-to-Guide Clearance	
Intake	0.0008-0.0025
Exhaust	0.0018-0.0035
Service Clearance	0.0055
Valve Head Diameter	
Intake	43.5mm (1.71 Inch.)
Exhaust	34.5mm (1.36 Inch.)

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Valve Face Runout Limit	0.002 Max.
Valve Face Angle	44°
Valve Stem Diameter (Std.)	
Intake	0.3159-0.3167
Exhaust	0.3149-0.3156
Valve Stem Diameter (0.008 Oversize)	
Intake	0.3239-0.3245
Exhaust	0.3228-0.3235
Valve Stem Diameter (0.016 Oversize)	
Intake	0.3318-0.3324
Exhaust	0.3307-0.3314
Valve Springs	
Compression Pressure (Lb. @ Spec. Length)	60.0-68.0 @ 1.585 138.0-149.0 @ 1.222
Free Length (Approximate)	1.91
Assembled Height	1-37/64-1-39/64
Service Limit	[b]
Out-Of-Square	5/64 (0.078)
Rocker Arm	
Shaft Diameter	0.7799-0.7811
Bore Diameter	0.7830-0.7842
Ratio	1.46:1
Push Rod Runout (T.I.R. Max.)	0.020
Valve Roller Tappet	
Diameter (Std.)	0.8742-0.8755
Clearance to Bore	0.0005-0.0022
Service Limit	0.005

[a] 0.003 in any 6 inches — 0.006 overall.
[b] 10% pressure loss @ specified length.

Camshaft

Item	Specification
Lobe Lift	
Allowable Lobe Lift Loss	0.005
Theoretical Valve Lift @ Zero Lash	
Intake	0.4024
Exhaust	0.4024
End Play	0.065-0.165mm (0.0025-0.0064 inch)
Thrust Plate Thickness	0.158-0.159

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Journal-to-Bearing Clearance	0.001-0.0026
Service Limit	0.006
Bearing Outside Diameter	0.158-0.159
No. 1	49.57-49.59 (1.951-1.952)
No. 2	49.21-49.23 (1.937-1.938)
No. 3	48.83-48.85 (1.922-1.923)
No. 4	48.44-48.46 (1.907-1.908)
Runout	0.127 (0.05) Max. T.I.R.
Out-of-Round	0.0076 (0.0003) Max. T.I.R.
Bearing Inside Diameter	
No. 1	49.635-49.655 (1.954-1.955)
No. 2	49.255-49.275 (1.939-1.940)
No. 3	48.750-48.768 (1.919-1.920)
No. 4	48.875-48.895 (1.924-1.925)
Front Bearing Location	[a] 0.040-0.060

[a] Distance in inches that front edge of bearing is installed below front face of cylinder block.

Cylinder Block

Item	Specification
Head Gasket Surface Flatness	[a]
Finish (RMS)	60-150
Crankshaft to Rear Face of Block Runout (T.I.R. Max.)	0.005

[a] 0.003 in any 6 inches — 0.006 overall.

Cylinder Bore And Piston

Item	Specification
Taper Bore Diameter	0.8750-0.8760
Main Bearing Bore Diameter	2.3866-2.3874
Cylinder Bore Diameter	
Diameter	3.9527-3.9543
Surface Finish (RMS)	18.38
Out-of-Round	0.0015
Out-of-Round Service Limit	0.005
Taper Service Limit	0.010
Piston	
Height [a]	0.0015-00205
Diameter [b]	
Standard	3.9524-3.9531
Piston-to-Bore Clearance	0.0008-0.0019

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Pin Bore Diameter	0.9450-0.9452
Ring Groove Width	
Compression (Top)	0.083-0.0811
Compression (Bottom)	0.1197-0.1205
Oil	0.1579-0.1587
Piston Pin	
Length	2.835-2.866
Diameter	
Red	0.9446-0.9448
Blue	0.9448-0.9449
Pin-to-Piston Clearance	0.0003-0.0006
Pin-to-Rod Clearance	Interference Fit
Piston Rings	
Ring Width	
Compression (Top)	0.0778-0.0783
Compression (Bottom)	0.1172-0.1177
Side Clearance	
Compression (Top)	0.0020-0.0033
Compression (Bottom)	0.0020-0.0033
Oil Ring	Snug Fit
Service Limit	0.006
Ring Gap	
Compression (Top)	0.015-0.023
Compression (Bottom)	0.015-0.023
Oil Ring (Steel Rail)	0.015-0.055

[a] Height of piston above cylinder block surface to TDC position.
[b] Measured 56mm (2.205 in.) from piston dome at 90 degrees to the pin.

Crankshaft And Flywheel

Item	Specification
Main Bearing Journal Diameter	2.2433-2.2441
Out-of-Round	0.0006
Taper Limit	0.0006 per Inch
Journal Runout	0.002 Max.
Surface Finish (RMS)	12
Runout Service Limit	0.005
Thrust Bearing Journal	
Length	1.039-1.041
Connecting Rod Journal	
Diameter	2.1252-2.1260

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Out-of-Round	0.0003
Taper Limit	0.0003 per Inch
Surface Finish (RMS)	8.8 Max.
Main Bearing Thrust Face	
Surface Finish	20 Max.
Runout (T.I.R.)	0.001 Max.
Flywheel Clutch Face Runout	0.0015
Flywheel Ring Gear Lateral Runout (T.I.R.)	
Standard Transmission	0.015
Automatic Transmission	0.060
Crankshaft Free End Play	0.05-0.32mm (0.002-0.0125 inch)
Connecting Rod Bearings	
Clearance to Crankshaft —	
Desired	0.0003-0.0024
Allowable	0.0005-0.0022
Bearing Wall Thickness (Std.) [1]	Std. — 0.0551-0.0554 Yellow — 0.0555-0.0558
Main Bearing	
Clearance to Crankshaft —	
Desired	0.0008-0.0015
Allowable	0.0005-0.0019
Bearing Wall Thickness (Std.) [1]	Std. — 0.0708-0.0711 Yellow — 0.0712-0.0715

[1] 0.002 Undersize = add 0.001 to standard thickness.

Connecting Rod

Item	Specification
Piston Pin Bore Diameter	23.41-23.46mm (0.9217-0.9236 inch)
Crankshaft Bearing Bore	2.2370-2.2378
Diameter	
Out-of-Round	0.0004
Taper	0.0004
Length (Center-to-Center)	145.965-146.035mm (5.7467-5.7494 Inch)
Alignment (Bore-to-Bore Max. Diff.) [a]	
Twist	0.038mm (0.0015 Inch)
Bend	0.0125mm (0.00049 Inch)
Slide Clearance (Assembled to Crank)	

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Standard	0.092-0.268mm (0.0036-0.0106 Inch)
Service Limit	0.014

[a] Pin and crank bearing bore must be parallel and in same vertical plane within the specified total difference when measured at end of an 8 inch bar, 4 inches on each side of rod centerline.

Lubricating System

Item	Specification
Oil Pump	
Relief Valve Spring Tension (Lbs. at Spec. Length)	13.6-14.7 @ 1.39
Drive Shaft-to-Housing Bearing Clearance	0.0015-0.0030
Relief Valve-to-Bore Clearance	0.0015-0.0030
Rotor Assembly End Clearance (Assembled)	0.0014-0.0044
Outer Race-to-Housing Clearance	0.006-0.02
Minimum Oil Pressure At 2,000 RPM (Engine At Normal Operating Temperature) KPA (PSI)	103 (15)
Oil Capacity (Quarts U.S.)	4 + 1

Torque Specifications

Description	Nm	Lb-Ft	Lb-In
Oil Filter Adapter — Through Bolt	35-40	26-30	—
Water Pump to Front Cover — Bolts	8.5-12	6-9	—
Cylinder Front Cover — Bolts	17-21	13-15	—
Timing Chain Guide — Bolts	10-12	7-9	—
Timing Chain Tensioner — Bolts	9-11	7-8	—
Camshaft Sprocket — Bolt	60-68	44-50	—
Rocker Arm Stand — Bolts	62-70	46-52	—
Rocker Arm Cover — Bolts	6-8	4.5-5.9	—
EI Coil Bracket to Engine — Bolts	26-32	19-24	—
Upper Intake Manifold — Nuts	20-25	15-18	—
Camshaft Thrust Plate — Screws	9-13	7-10	—
Oil Pump Drive Assembly Hold-Down — Bolt	17-21	13-15	—
Thermostat Housing — Bolts	9-13	7-10	—
Oil Pressure Switch	18-22	13-16	—
Coolant Temperature Sensor	16	12	—

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Coolant Temperature Sender	4.5-7	3-5	—
Oil Pan — Bolts and Nuts	7-10	5-7	—
Oil Pump Pick-Up to Pump Screws	9-13	7-10	—
Oil Pump to Engine Block — Screws	17-21	13-15	—
Connecting Rod Bearing Cap — Nuts	25-32	18-24	—
Crankshaft Main Bearing Cap — Bolts	90-104	66-77	—
Crankshaft Oil Baffle — Nuts	17-21	13-15	—
Cylinder Head Bolts	a	a	—
Lower Intake Manifold — Nuts and Bolts	a	a	—
Flywheel Bolts	a	a	—
Crankshaft Pulley/ Vibration Damper Bolt	40-50	30-37	—
Crankshaft Position Sensor	9-12	—	80-106
Control Arm Pivot Bolts and Nuts	136-190	100-140	—
Transmission to Oil Pan Bolts	38-51	28-38	—
Exhaust Manifold Bolts	27	20	—
Exhaust Pipe to Manifold Nuts	27	20	—
Intake Manifold to EGR Valve Tube Stud	40-55	30-40	—
EGR Valve Bolts	20-30	15-22	—
EGR Valve to Exhaust Manifold Tube Nuts	34-48	26-35	—
Oil Pan Stud	4	—	35
Crossmember Bolts	95-108	70-80	—
Oil Filter Mounting Insert	14-21	10-15	—
Water Pump Pulley Bolts	22-28	17-20	—
Generator Mounting Bracket Bolts	40-55	30-40	—
Drive Belt Tensioner Bolt	40-55	30-40	—
Generator Bolts	40-55	30-40	—
A/C Compressor Mounting Bracket Brace Nuts	40-55	30-40	—
Power Steering Pump Bolts	40-55	30-40	—
A/C Compressor Bolts	22-28	17-20	—
A/C Compressor Mounting Bracket Bolts	40-55	30-40	—
Spark Plugs	9-20	7-15	—

[a] Tightened in stages and in sequence. Refer to text for procedure.

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Inspection and Verification

1. Verify the vehicle owner's original concern by operating the system.
2. Inspect to determine if one of the following mechanical concerns apply:

Mechanical
• Damaged hoses • Loose/damaged hose clamps • Damaged water thermostat • Damaged head gaskets • Damaged intake manifold gasket • Damaged water pump • Damaged radiator • Damaged radiator coolant recovery reservoir • Damaged heater core

3. If the concern(s) remains after the inspection, determine the symptom(s) and proceed to the following symptom chart.

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Symptom Chart — Engine Cooling

NOTE: Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent to perform electrical pinpoint tests.

ENGINE COOLING

Condition	Possible Source	Action
• Loss of Coolant	• Damaged radiator. • Damaged water pump. • Loose/damaged radiator hoses/clamps/heater water control valve. • Loose/damaged heater water hoses. • Damaged heater core. • Cracked cylinder block or head. • Damaged engine gaskets. • Damaged radiator coolant recovery reservoir. • Damaged engine block plug.	• GO to Pinpoint Test A.
• Engine Overheats	• Damaged water thermostat. • Damaged water pump. • Internal engine coolant leak. • Inoperative cooling fan clutch. • Plugged radiator. • Plugged heater core. • Loose/damaged drive belt. • Defective radiator cap. • Low coolant level.	• GO to Pinpoint Test B.
• Engine Does Not Reach Normal Operating Temperature	• Damaged water thermostat.	• GO to Pinpoint Test C.
• Block Heater Does Not Operate Properly	• Block heater wiring. • Block heater.	• GO to Pinpoint Test D.

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Pinpoint Tests

PINPOINT TEST A: LOSS OF COOLANT

A1 CHECK COOLANT LEVEL

NOTE: If engine is hot, allow engine to cool before proceeding.

- Check coolant level at radiator coolant recovery reservoir.

Is coolant level OK?

Yes	No
GO to **A2** .	REFILL as outlined. GO to **A7** .

A2 CHECK FOR VISIBLE LEAKAGE

- Engine coolant has an added dye that makes the coolant an excellent leak detector.
- Check entire cooling system for visible leakage, clamps, hoses, water valve.

Is there visible leakage?

Yes	No
SERVICE leaking component. RETEST system.	GO **A3** .

A3 CHECK RADIATOR CAP

- Test pressure relief radiator cap. Refer to Radiator Cap/Pressure Relief Cap Pressure Test component test in this section.
- Allow engine to cool. Remove radiator cap, inspect radiator cap for foreign material between sealing gasket and diaphragm.

Did pressure relief radiator cap test OK?

Yes	No
GO to **A4** . Go to **A8** .	REPLACE damaged radiator cap. RETEST system. REFER to Cleaning and Inspection . Service as

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	required.

A4 CHECK COOLANT FOR INTERNAL LEAKAGE

- Visually inspect coolant in radiator coolant recovery reservoir for signs of transmission fluid or engine oil.

Are contaminants evident in coolant?

Yes	No
If engine oil is evident, REMOVE cylinder head. Refer to Section 03-01A , Section 03-01B , or Section 03-01C , depending on engine. INSPECT for leaking head gasket and head or block cracks. If transmission fluid is evident, REPLACE the radiator as outlined in this section and CHECK condition of transmission fluid as outlined in this section.	GO to **A5** .

A5 CHECK ENGINE AND TRANSMISSION FOR COOLANT

- Remove fluid level indicator for engine and transmission.
- Carefully inspect fluid level indicator for evidence of coolant.

Is coolant evident?

Yes	No
If coolant is evident in engine oil, REMOVE cylinder head. Refer to Section 03-01A , Section 03-01B , or Section 03-01C , depending on engine. INSPECT for leaking head gasket and head or block cracks. If coolant is evident in transmission fluid, REFER to Fluid Condition. Check in Section 07-01A or Section 07-01B . REPLACE radiator.	GO to **A6** .

A6 PRESSURE TEST COOLING SYSTEM

- Pressurize cooling system. Refer to the procedure in this section.

  NOTE: Check inside vehicle for possible heater core leakage.

Is there leakage?

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Yes	No
SERVICE leaking component. RETEST system.	GO to **A7** .

A7 CHECK RADIATOR OVERFLOW HOSE

- Remove radiator overflow hose.
- Inspect radiator overflow hose for obstruction, cracks or cuts.

Is radiator overflow hose condition OK?

Yes	No
GO to A9.	SERVICE hose as required.

A8 CHECK RESERVOIR

- Replenish coolant to "Cold" level.
- Inspect radiator coolant recovery reservoir for leaks.

Is there leakage at radiator coolant recovery reservoir?

Yes	No
REPLACE radiator coolant recovery reservoir. RESTORE vehicle.	REFER to Pressure Test in this section. SERVICE as required.

PINPOINT TEST B: ENGINE OVERHEATS

B1 CHECK COOLANT LEVEL

NOTE: If engine is hot, allow engine to cool before proceeding.

- Remove radiator cap and check coolant level at radiator coolant recovery reservoir.

Is coolant level OK?

Yes	No
GO to **B2** .	REFILL as outlined. GO to Pinpoint Test A .

B2 CHECK DRIVE BELT

- Inspect drive belt for proper adjustment and signs of damage.

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Is drive belt properly adjusted and showing no sign of damage?

Yes	No
GO to **B3** .	ADJUST or REPLACE drive belt. REFER to Section 03-05 . RETEST system.

B3 CHECK FOR AIRFLOW OBSTRUCTION

- Visually inspect A/C condenser core and radiator for obstructions, such as leaves or bugs.

Is there any obstruction?

Yes	No
REMOVE obstruction and CLEAN A/C condenser core and radiator. RETEST system.	GO to **B4** .

B4 CHECK WATER THERMOSTAT OPERATION

- Run engine for 10 minutes.
- Feel the inlet and outlet heater water hose and the underside of the upper radiator hose.

Are the upper radiator hose and heater water hoses cold?

Yes	No
REPLACE water thermostat. REFER to the procedure in this section. RETEST system.	GO to **B5** .

B5 CHECK COOLING FAN

- Engine running.
- Check for proper cooling fan clutch operation as outlined in Component Tests.

Did cooling fan clutch operate OK?

Yes	No
GO to **B6** .	REPLACE fan clutch. REFER to the procedure in this section. RETEST system.

B6 CHECK FOR RUST OR CORROSION ON RADIATOR TUBES

- Remove radiator cap and inspect header ends of radiator tubes for signs of blockage by rust that migrated from engine or from corroding tubes.

Is there evidence of rust or corrosion blocking tubes?

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Yes	No
REPLACE radiator.	GO to **B7** .

B7 CHECK WATER PUMP CONDITION AND OPERATION

- Inspect water pump for leaking or signs of bearing or seal concerns such as grease on the water pump shaft.
- Remove drive belt and check for water pump shaft looseness.
- Rotate water pump manually; feel for bearing problems and the possibility the impeller came loose from the shaft.

Does water pump appear OK?

Yes	No
GO to **B8** .	REMOVE and INSPECT water pump. REPLACE water pump as required. REFER to the procedure in this section.

B8 CHECK ENGINE COOLANT PASSAGES FOR OBSTRUCTION

- Remove cylinder heads. Refer to Section 03-01A , Section 03-01B , or Section 03-01C , depending on engine.
- Probe coolant passageways with a long thin screwdriver to see if there is obstruction from rust, scale, or core sand.

Are rust, scale, or sand obstructing coolant passageways?

Yes	No
SCRAPE coolant passageways clean with long, thin screwdriver, then FLUSH.	RESTORE vehicle. PERFORM road test.

PINPOINT TEST C: ENGINE DOES NOT REACH NORMAL OPERATING TEMPERATURE

C1 CHECK THERMOSTAT OPERATION

- Perform either the Electrical Thermostat Test component tests or Mechanical Thermostat Test component test as described in this section.

Does water thermostat pass either of these tests?

Yes	No
REINSTALL water thermostat and CHECK temperature gauge for proper operation.	REPLACE thermostat.

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REFER to the procedure in this section.	

PINPOINT TEST D: ENGINE BLOCK HEATER DOES NOT OPERATE PROPERLY

D1 CHECK PLUG AND WIRE

- Check for corroded or broken spades on plug.
- Check for broken, cracked or cut wires.

Are plug and wires OK?

Yes	No
GO to **D2** .	REPAIR or REPLACE as necessary. GO to **D2** .

D2 CHECK CONTINUITY OF PLUG AND WIRES

- Disconnect plug and block heater. Check continuity of wires from plug to element connectors.

Are plug and wires OK?

Yes	No
GO to **D3** .	REPAIR or REPLACE plugs and wires as necessary. GO to **D4** .

D3 CHECK RESISTANCE OF BLOCK HEATER

- Plug disconnected.
- Check for continuity across block heater pins.

Is there continuity?

Yes	No
GO to **D4** .	REPLACE engine block heater. GO to **D4** .

D4 CHECK OPERATION

- Reconnect block heater.
- Key ON. Make sure engine is cold (ambient temperature). Key OFF.
- Plug in block heater to known good 120V A/C source and wait 10 minutes.
- Key ON. Coolant should be up to 5 to 10℃ (40-50°F) (bottom of NORMAL range on gauge).

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Has system performed as specified?

Yes	No
ADVISE customer of proper operation.	REPLACE engine block heater.

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Component Test

Pressure Test

WARNING: NEVER REMOVE THE RADIATOR CAP UNDER ANY CONDITIONS WHILE THE ENGINE IS OPERATING OR WHEN THE COOLING SYSTEM IS HOT. FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN DAMAGE TO THE COOLING SYSTEM OR ENGINE OR PERSONAL INJURY. TO AVOID HAVING SCALDING HOT COOLANT OR STEAM BLOW OUT OF THE RADIATOR, USE EXTREME CARE WHEN REMOVING THE RADIATOR CAP. WAIT UNTIL THE ENGINE HAS COOLED, THEN WRAP A THICK CLOTH AROUND THE RADIATOR CAP AND TURN IT SLOWLY TO THE FIRST STOP, STEP BACK WHILE THE PRESSURE IS RELEASED FROM THE COOLING SYSTEM. WHEN THE PRESSURE HAS BEEN RELEASED, PRESS DOWN ON THE RADIATOR CAP (STILL WITH A CLOTH), TURN AND REMOVE IT.

1. Shut off the engine (6007).
2. Open hood and install protective fender covers.
3. When engine is cool, carefully remove radiator cap (8100).
4. Disconnect battery ground cable (14301).
5. Adjust radiator coolant level to 25mm (1 inch) below filler neck before testing.
6. Disconnect the electrical connector from the water temperature indicator sender unit (10884) and remove the water temperature indicator sender unit from the engine.
7. Install the adapter fitting from the Rotunda Radiator/Heater Core Pressure Tester or equivalent (the adapter has a male thread on one end, and a hose connector on the other end to accommodate the tester hose).
8. Remove the radiator overflow hose (8075) from the overflow nipple. Install a separate hose firmly on the overflow nipple. Insert free end of hose into a container of water. Wipe sealing surfaces of filler neck and inspect for scratches, cracks, gouges, etc., that may prevent proper sealing. If seal surfaces are damaged in any way the radiator (8005) must be replaced.

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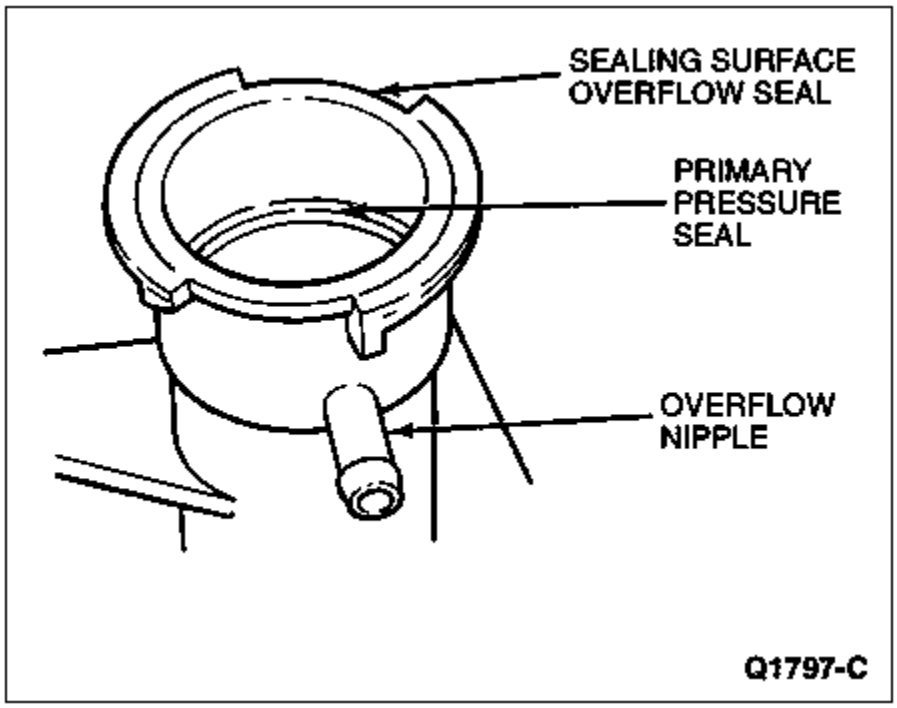

9. Attach the pressure pump and gauge to the adapter fitting and pressurize the cooling system to 97 kPa (14 psi) (minimum test pressure).

   No bubbles should appear in the water container when the system is pressurized to the minimum test pressure. Gradually increase the system pressure until a slight stream of bubbles appear in the water container. Do not exceed the maximum operating pressure specification of 124 kPa (18 psi).

   Replace any radiator cap that exceeds the specified maximum operating pressure without discharging bubbles.

10. Remove and wash the radiator cap in clean water to dislodge all foreign particles from the gaskets if the radiator cap does not hold pressure. Check the sealing surface in the radiator filler neck.

    Inspect the cam lock flanges on both sides of the filler neck for maximum cap engagement.

11. Pressurize the cooling system as described in Steps 7-9 (using a radiator cap that operates within the specified minimum and maximum pressure limits) and observe the gauge reading for approximately two minutes. Pressure should be held between 97 and 124 kPa (14 and 18 psi) and should not drop during this time.

    Results: If the system holds pressure, proceed to Step 12.

    If the pressure drops, check for leaks at the engine-to-heater core hoses, engine-to-radiator hoses, bypass hose, water valve hose (if applicable), thermostat housing gasket, radiator and heater core (18476), etc. Also refer to engine system checks if a leak cannot be located in the cooling system. Correct any leaks found and recheck the system.

12. Release the system pressure by loosening the radiator cap, then remove the adapter. Install the water temperature indicator sender unit and check coolant level. Replenish as necessary with the correct coolant solution.

13. Check the radiator overflow hose for any obstructions which may block the flow of coolant either to or

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from the radiator coolant recovery reservoir.

14. **NOTE: When the battery voltage is removed from the powertrain control module (PCM) (12A650), all learned values will be cleared and reset to predetermined values. When battery voltage is restored to the PCM, the vehicle may exhibit certain driveability concerns. It will be necessary to drive the vehicle to allow the PCM to relearn values for optimum driveability and performance.**

    Connect battery ground cable.

Radiator Cap/Pressure Relief Cap Pressure Test

WARNING: NEVER REMOVE THE RADIATOR CAP UNDER ANY CONDITIONS WHILE THE ENGINE IS OPERATING. FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN DAMAGE TO THE COOLING SYSTEM OR ENGINE AND/OR PERSONAL INJURY. TO AVOID HAVING SCALDING HOT COOLANT OR STEAM BLOW OUT OF THE RADIATOR, USE EXTREME CARE WHEN REMOVING THE RADIATOR CAP FROM A HOT RADIATOR. WAIT UNTIL THE ENGINE HAS COOLED, THEN WRAP A THICK CLOTH AROUND THE RADIATOR CAP AND TURN IT SLOWLY TO THE FIRST STOP. STEP BACK WHILE THE PRESSURE IS RELEASED FROM THE COOLING SYSTEM. WHEN IT IS CERTAIN ALL THE PRESSURE HAS BEEN RELEASED, PRESS DOWN ON THE RADIATOR CAP (STILL WITH A CLOTH), TURN AND REMOVE.

1. Remove radiator cap from radiator filler neck.
2. Use water to clean in area of rubber seal and vacuum relief valve. Immerse radiator cap in water and install radiator cap pressure test adapter from Rotunda Radiator/Heater Core Pressure Tester or equivalent on the radiator cap.

    The filler neck seal is reversible so it may be used on either end of radiator cap pressure test adapter.
3. Immerse filler neck seal in water and install in filler neck adapter. Then, install filler neck adapter with seal on open end of radiator cap pressure test adapter.
4. Connect female quick disconnect fitting of pressure test pump to male quick disconnect fitting of filler neck adapter.
5. **NOTE: If plunger of pump is depressed too quickly, an erroneous pressure reading will result.**

    Slowly depress plunger of pressure test pump until pressure gauge reading stops increasing, and note highest pressure reading obtained.
6. Release pressure by turning pressure relief screw counterclockwise. Then tighten pressure relief screw and repeat Step 5 at least twice to ensure pressure test reading is repeatable within acceptable gauge reading limits of radiator cap and is not erratic.
7. If pressure test gauge readings are not within acceptable gauge reading limits, replace radiator cap.

Thermostat, Water

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The water thermostat (8575) should be replaced only after the following tests have been performed.

Thermostat Test, Electrical

CAUTION: Always vent the exhaust to the outside when performing this test.

NOTE: When the battery voltage is removed from the powertrain control module, all learned values will be cleared and reset to predetermined values. When battery voltage is restored to the PCM, the vehicle may exhibit certain driveability concerns. It will be necessary to drive the vehicle to allow the PCM to relearn values for optimum driveability and performance.

NOTE: Procedure is most accurate if performed indoors at less than 37.8°C (100°F) ambient air. This test may be performed with or without the hood open and with the engine warm or cold.

1. Check coolant level in radiator and engine coolant recovery reservoir. Fill as needed.

2. With the key OFF, remove the engine coolant temperature (ECT) sensor harness connector and attach the Rotunda Service Coolant Temperature Monitor Harness 007-00064 or equivalent as a jumper between the powertrain control module and the ECT. Attach a Rotunda 73 Digital Multimeter 105-R0051 or equivalent to the thermostat monitor harness. Voltage values (0 to 5 V) may now be monitored while the sensor retains its connection to the wiring harness.

   Rotunda New Generation STAR (NGS) Tester 007-00500 or the Service Bay Diagnostic System (SBDS) may be used to monitor the ECT on vehicles equipped with Data Link Connector (DLC). The SBDS sequence to use for the screen is: Toolbox-Electronic Engine Control and DCL-Item.

3. **NOTE: Running this test with the vehicle in gear or with the A/C compressor clutch engaged (running) will cause improper diagnosis.**

   Place transmission in PARK (P) or NEUTRAL (N).

4. Start the engine and allow to idle throughout this test. Allow engine to run for 2 minutes, then record the ECT voltage. Record ECT voltage every 60 seconds. When ECT voltage trend changes direction or only changes slightly (0.03 voltage or less) from the previous reading, record this as the thermostat opening voltage. Use the voltage and corresponding coolant temperature chart listed below.

Coolant Temperature °C (°F)	ECT (Volts)
22 (71)	3.00
43 (109)	2.01
71 (159)	1.01
82 (180)	0.75
91 (195)	.59
97 (206)	.50
105 (221)	.40

5. If the thermostat opening voltage is greater than 0.75 volts and less than 82°C (180°F), replace the water thermostat.

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6. If the thermostat opening voltage is less than 0.75 volts and greater than 82°C (180°F), water thermostat is good and should not be replaced. Refer to the cooling Symptom Chart for further instructions.

7. If the voltage is less than 0.45 volts before the thermostat opens, the thermostat should be replaced.

Thermostat Test, Mechanical

Remove the water thermostat and immerse in a boiling solution of antifreeze and water mixture. An 92°C (197°F) water thermostat open to 0.08mm (0.003 inch), when heated in the boiling solution to 100°C (21 2° F), should open 3.2mm (0.125 inch).

If heat is not available, check the water thermostat for leakage. Hold the water thermostat up to a lighted background. Leakage of light around the thermostat valve at room temperature indicates that the water thermostat should be replaced. Some water thermostats have a small leakage notch at one location on the perimeter of the thermostat valve, which is considered normal.

Radiator Leak Test, Removed from Vehicle

CAUTION: Do not leak test an aluminum radiator in the same water that is used to leak test copper/brass radiators. Flux and caustic cleaners may be present in the test water which will corrode aluminum.

Clean the radiator before leak testing to prevent contaminating the test tank. Then leak test the radiator in clean water with 144 kPa (21 psi) air pressure.

A separate clean test tank is recommended for aluminum radiators. If a separate tank is not available for aluminum radiator testing, rinse the test tank each time before testing an aluminum radiator.

Fan Clutch Test

Spin the fan. A light resistance should be felt. If there is no resistance or very high resistance, replace the fan clutch.

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Thermostat, Water, All Except 3.0L

Removal

CAUTION: Do not pry on water thermostat (8575) to remove.

1. Drain the cooling system so that the coolant level is below the water thermostat as described in Cleaning and Inspection, Cooling System Draining and Filling in this section.
2. Disconnect the heater return hose at thermostat housing located on the left front lower side of the engine (6007) (2.3L only). Disconnect engine coolant temperature sensor (ECT sensor) (12A648) connector (2.3L only).
3. Remove upper radiator hose (8260).
4. Remove the coolant outlet housing retaining bolts. Pull the elbow away from the cylinder head (6049) or manifold sufficiently to provide access to the water thermostat. Remove the water thermostat and gasket.

2.3L Engine

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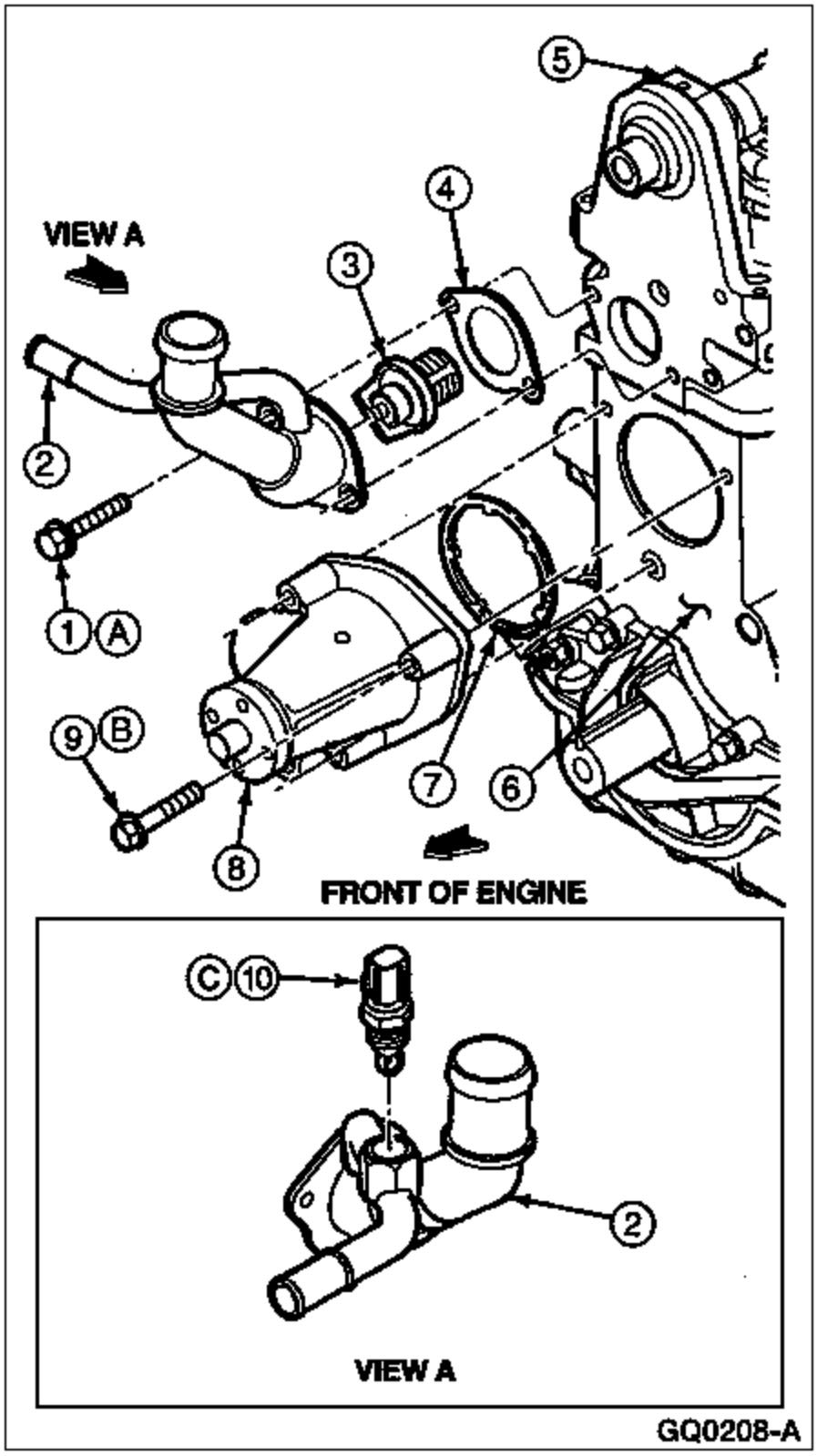

Item	Part Number	Description
1	N80025-S	Screw, M8-1.25 x 18

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2	8594	Water Outlet Connection
3	8575	Water Thermostat
4	8255	Gasket
5	6049	Cylinder Head
6	6010	Cylinder Blocks
7	8507	Water Pump Housing Gasket
8	8501	Water Pump
9	N605663-S100	Bolt, M8-1.25 x 53
10	12A648	Engine Coolant Temperature Sensor
A	—	Tighten to 20-30 Nm (14-21 Lb-Ft)
B	—	Tighten to 16-24 Nm (12-17 Lb-Ft)
C	—	Tighten to 13-20 Nm (10-15 Lb-Ft)

4.0L Engine

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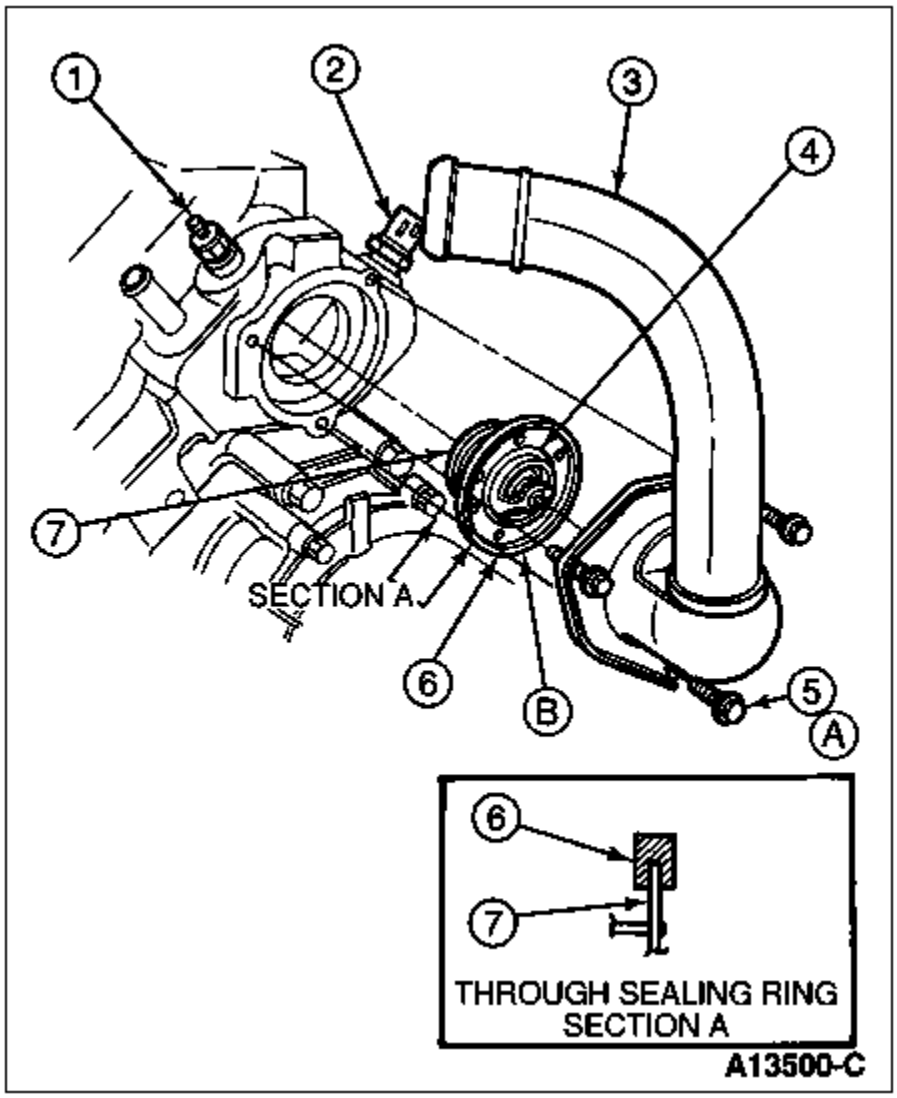

Item	Part Number	Description
1	10884	Water Temperature Sender
2	12A648	Engine Coolant Temperature Sensor
3	8592	Water Outlet Connection
4	—	Air Release Valve (Part of 8575)
5	E800156	Bolt
6	E854214	Sealing Ring (See B)
7	8575	Water Thermostat
A	—	Tighten to 9-12 Nm (77-110 Lb-In)
B	—	Sealing Ring Must Be Preassembled onto Thermostat Prior to Thermostat Installation. Air Release Valve Must Be Positioned Once Thermostat Is Installed.

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Installation

WARNING: DO NOT STAND IN LINE WITH OR NEAR RADIATOR FAN BLADE (8600) WHEN ENGINE IS RUNNING.

CAUTION: The thermostat seal (8590) must be positioned on the water outlet connection before the water thermostat is installed.

To prevent incorrect installation of the water thermostat, the water outlet connection casting contains a locking recess into which the water thermostat is turned and locked. Install the water thermostat with the bridge section in the outlet casting. Turn the water thermostat clockwise to lock it in position on the flats cast into the water outlet connection.

1. Clean the upper radiator hose connection, cylinder head and water outlet connection surfaces. Coat a new thermostat housing gasket with Perfect Seal Sealing Compound B5A-19554-A or equivalent meeting Ford specification ESE-M4G115-A. Position the thermostat housing gasket on the cylinder head opening.

   It is critical that the correct water thermostat installation alignment be made to provide coolant flow to heater. Insert and rotate water thermostat to the left or right until it stops in the water outlet connection housing, then visually check for full width of heater outlet tube opening to be visible within the thermostat port in assembly.

   This port alignment at assembly is required to provide maximum coolant flow to the heater.

2. Position the coolant water outlet connection against the cylinder head, intake manifold (9424) or water pump (8501). Install and tighten the retaining bolts to 20-30 Nm (14-21 lb-ft).

3. Connect the upper radiator hose to water outlet connection.

4. Fill the cooling system with the recommended Premium Cooling System Fluid E2FZ-19549-AA or equivalent meeting Ford specification ESE-M97B44-A and water mixture as described in this section. Check for leaks and proper coolant level after the engine has reached operating temperature.

   A coolant mixture of 50 percent ethylene glycol and 50 percent water is recommended to maintain best overall performance. To avoid damaging the radiator (8005), the ethylene glycol should not exceed 60 percent.

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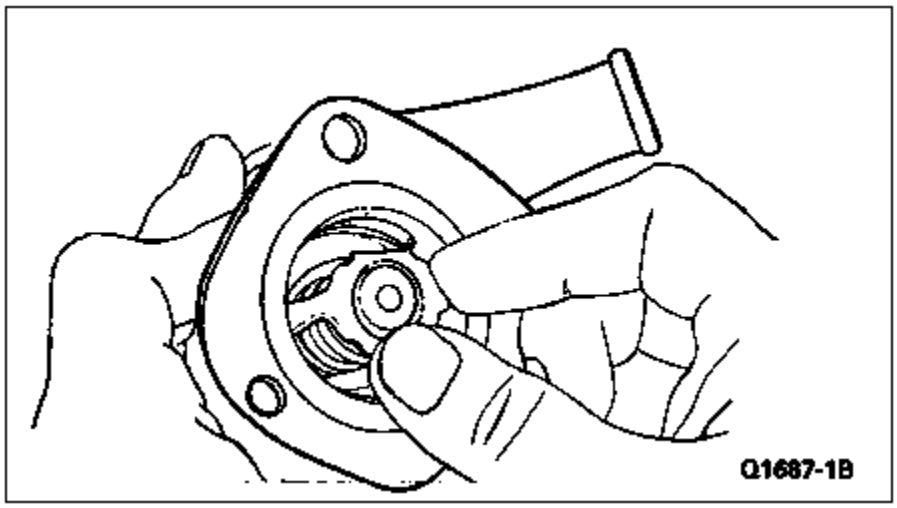

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Thermostat, Water, 3.0L Aerostar and Ranger

Removal

1. Drain cooling system.
2. Remove upper radiator hose (8260) from water outlet connection.
3. Remove two retaining bolts.
4. Remove water outlet connection and water thermostat (8575) as an assembly.
5. Discard gasket. Clean sealing surfaces with gasket scraper. Gouges in aluminum could form leak paths. Use care when scraping thermostat housing-to-gasket mating surfaces.

Installation

1. Make sure sealing surfaces are totally free of gasket material.
2. Install water thermostat into thermostat housing as illustrated.
3. Position gasket onto thermostat housing using bolts as holding devices. Install water thermostat and tighten bolts to 20-30 Nm (14-21 lb-ft).
4. Install upper radiator hose. Tighten clamp securely.
5. Fill and bleed cooling system with proper amount and mixture.
6. Start engine (6007) and check for coolant leaks.

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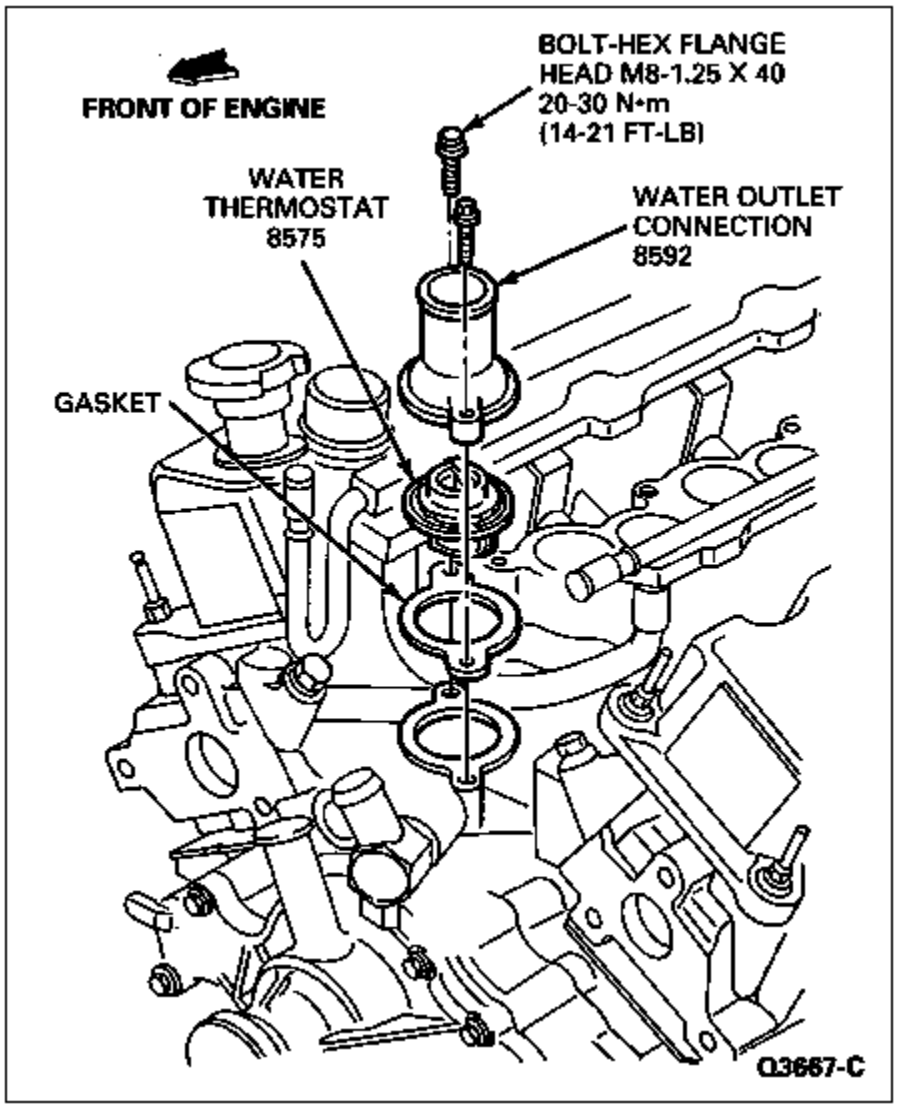

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Thermostat, Water, 3.0L Aerostar and Ranger

Removal

1. Drain cooling system.
2. Remove upper radiator hose (8260) from water outlet connection.
3. Remove two retaining bolts.
4. Remove water outlet connection and water thermostat (8575) as an assembly.
5. Discard gasket. Clean sealing surfaces with gasket scraper. Gouges in aluminum could form leak paths. Use care when scraping thermostat housing-to-gasket mating surfaces.

Installation

1. Make sure sealing surfaces are totally free of gasket material.
2. Install water thermostat into thermostat housing as illustrated.
3. Position gasket onto thermostat housing using bolts as holding devices. Install water thermostat and tighten bolts to 20-30 Nm (14-21 lb-ft).
4. Install upper radiator hose. Tighten clamp securely.
5. Fill and bleed cooling system with proper amount and mixture.
6. Start engine (6007) and check for coolant leaks.

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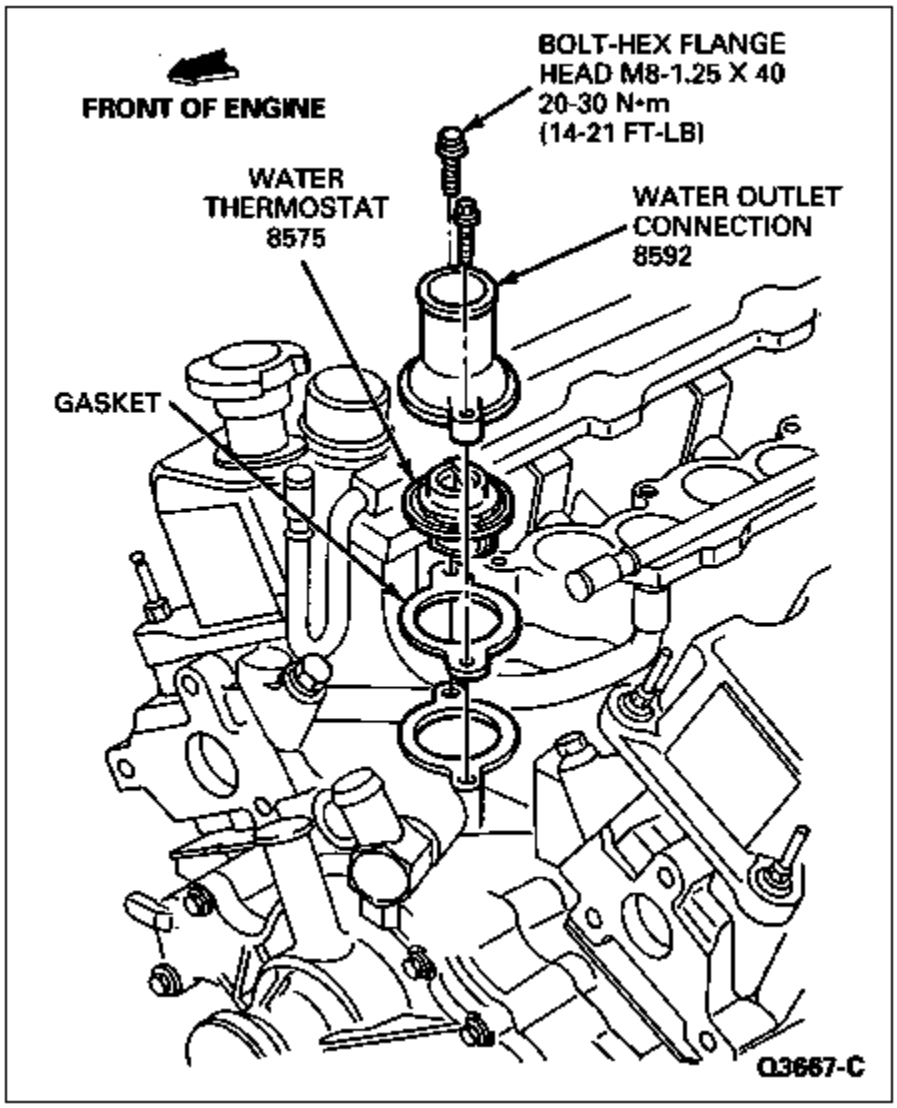

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Radiator Hoses

Collapsing radiator hoses (especially upper radiator hose (8260)) may be an indication of a malfunctioning vacuum relief valve in the radiator cap (8100). Inspect and clean radiator cap. (Refer to Cleaning and Inspection, Radiator Pressure Cap in this section). Also make sure that overflow hose is open between radiator coolant recovery reservoir and radiator (8005).

Removal

Replace the cooling system hoses whenever they become cracked, swelled, deteriorated, or have a tendency to collapse.

Partially drain the cooling system to replace the cooling system upper radiator hose. Drain the cooling system completely to replace the lower radiator hose (8286).

NOTE: In some cases, constant tension spring clamps are used to attach the upper radiator hose and lower radiator hose to the radiator.

1. Drain or partially drain the cooling system by removing the radiator cap and attaching a 9.5mm (3/8-inch) inside diameter hose to the draincock nipple, located at the lower rear corner of the radiator. Then open the radiator draincock (8115) and allow the coolant to flow through the hose into a suitable container.

2. Expand the clamps on each end of the hose(s) to be removed. Slide the hose(s) off the connections.

Installation

WARNING: DO NOT STAND IN LINE WITH OR NEAR THE ENGINE COOLING FAN BLADE WHEN THE ENGINE IS RUNNING.

1. Position the clamps on each end of the new hose. Slide the hose onto the connectors.

2. Slide the clamps toward the ends of the hose until each clamp is completely beyond the beads and is fully seated.

3. Fill the cooling system with a 50/50 mixture of ethylene glycol and water and bleed the system.

4. Operate the engine (6007) for several minutes, then check the hose(s) and connections for leaks.

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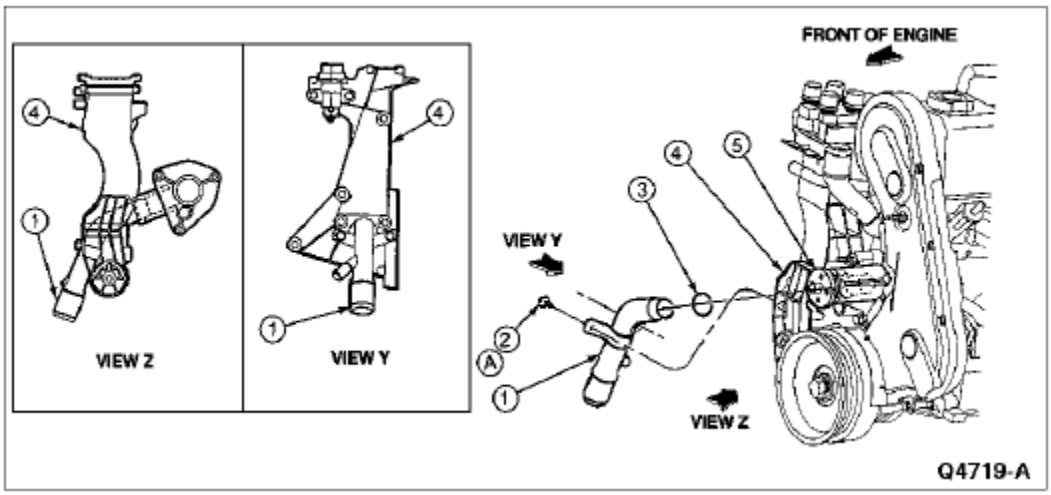
Radiator Lower Hose Tube, 2.3L Engine

Removal and Installation

1. Drain cooling system.
2. Raise vehicle.
3. Remove the lower radiator hose clamp and disconnect the lower radiator hose (8286) from the water pump inlet tube (8290).
4. Disconnect lower heater water hose (18472) from lower radiator hose if necessary.
5. Remove the two screws retaining the lower radiator hose to the generator mounting bracket (10153).
6. Remove lower radiator hose from the radiator (8005).
7. To install, reverse removal procedure. Always use a new O-ring. Apply Ford Multi-Purpose Grease D0AZ-19584-AA or equivalent meeting Ford specification ESE-M99B176-A grease to small diameter of O-ring prior to installation. Tighten screws to 9-12 Nm (78-107 lb-in). Refill and bleed the cooling system as outlined in Cleaning and Inspection, Draining and Filling in this section.

Water Inlet Tube, 2.3L



Item	Part Number	Description
1	8290	Water Pump Inlet Tube
2	N606676-S2	Screw and Washer Assembly, M6-1 x 22.5
3	87056-S100	O-Ring

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4	10153	Generator Mounting Bracket
5	8501	Water Pump
A	—	Tighten to 9-12 Nm (78-107 Lb-In)

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Bypass Hose

There is no bypass hose on 2.3L, and 4.0L engines. On 2.3L engines coolant bypass with a closed thermostat is achieved through internal passageways in the cylinder blocks (6010) and cylinder head (6049). On 4.0L engines, bypass is achieved through passageways in the lower intake manifold and cylinder blocks.

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Engine Oil Cooler

Removal

1. Drain the cooling system. Refer to procedure in this section.
2. Remove the lower radiator hose (8286). Refer to the procedure in this section.
3. Remove the oil bypass filter (6714).
4. Remove the cooler hose clamps (reposition on hose).
5. Remove the oil cooler bolt.
6. Remove the oil cooler (6A642).
7. Remove the engine oil cooler-to-water pump hose.

Installation

CAUTION: Be sure to check and adjust engine oil level to proper levels.

To install, reverse the removal procedure.

Tighten the oil bypass filter one-half turn after gasket contact.

Tighten oil cooler bolt 54-88 Nm (40-65 lb-ft).

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EGR Valve Spacer Coolant Hoses

Removal

1. Disconnect the battery ground cable (14301).
2. Partially drain the cooling system.
3. Remove the air cleaner outlet tube (9B659).
4. Disconnect the electrical connector for the EGR external pressure valve (9F483).
5. Disconnect the vacuum hose for the EGR external pressure valve.
6. Remove the two EGR external pressure valve-to-spacer nuts and the EGR external pressure valve.
7. Loosen the hose clamps and remove the coolant supply and return hoses.

Installation

To install, reverse the removal procedure.

Tighten the two EGR external pressure valve nuts 16-24 Nm (12-18 lb-ft).

NOTE: When the battery voltage is removed from the powertrain control module (PCM) (12A650), all learned values will be cleared and reset to predetermined values. When battery voltage is restored to the PCM, the vehicle may exhibit certain driveability concerns. It will be necessary to drive the vehicle to allow the PCM to relearn values for optimum driveability and performance.

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Bypass Hose — Aerostar 3.0L

Removal

1. Drain the cooling system by removing the radiator cap (8100) and attaching a 9.5mm (3/8-inch) inside diameter hose to the draincock nipple, located at the lower rear corner of the radiator. Then open the radiator draincock (8115) and allow the coolant to flow through the hose into a suitable container.
2. Loosen the hose clamps on the water bypass tube (8548).
3. Remove the water bypass tube.

Installation

To install, reverse the removal procedure.

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Radiator

Aluminum Core, Crossflow

Removal

1. **NOTE: Refer to following illustrations.**

   Drain the cooling system by removing the radiator cap (8100) and attaching a 9.5mm (3/8-inch) inside diameter hose to the draincock nipple, located at the lower rear corner of the radiator tank. Then, open the radiator draincock (8115) and allow the coolant to flow through the hose into a suitable container.

2. Remove the air cleaner outlet tube (9B659).

3. Remove the rubber radiator overflow hose (8075) from the radiator (8005) and store it out of the way.

4. Use Fan Clutch Wrench T96T-6312-A and Fan Hub Wrench T96T-6312-B to remove the fan clutch (8A616) from the water pump pulley (8509).

5. Remove the two upper attaching screws of the fan shroud (8146) or finger guard. Lift the fan shroud out of the lower retaining clips and drape it on the fan blade (8600).

6. Loosen upper and lower hose clamps at the radiator and remove upper radiator hose (8260) and lower radiator hose (8286) from the radiator connectors.

7. For vehicles with automatic transmission (7003):

   a. Disconnect the two transmission cooling lines from the oil cooler fittings on the radiator.
   b. Disconnect the transmission cooler tube support bracket from the bottom flange of the radiator by removing the screw.

8. Remove the two radiator upper attaching screws.

9. Tilt the radiator back (rearward) approximately 25mm (one inch) and lift directly upward, clear of the radiator support bracket (8052) and the fan blade.

10. If either upper radiator hose or lower radiator hose is to be replaced, loosen clamp at the engine end and slip the hose off the connections with a twisting motion.

11. Lift the fan shroud off the fan and remove from the vehicle.

12. Remove the radiator lower support rubber insulators.

Installation

WARNING: DO NOT STAND IN LINE WITH OR NEAR ENGINE COOLING FAN BLADE WHEN

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REVVING ENGINE (6007).

1. Position the radiator lower support rubber insulators to radiator support bracket.

2. Position fan shroud on fan assembly before radiator is installed.

3. If either upper radiator hose or lower radiator hose has been replaced, position hose on engine with index arrow in line with mark on fitting at engine.

4. Position radiator into engine compartment to radiator support bracket, being careful to clear fan blade. Make sure that mountings on both tanks are inserted into holes in rubber insulators of radiator support bracket and that the radiator is firmly seated on insulators. Be sure to attach overflow hose to the nipple on filler neck.

5. Install upper attaching bolts to attach the radiator to the radiator support bracket. Tighten to 6-8 Nm (52-71 lb-in).

6. For vehicles with automatic transmission:

    a. Loosely connect the two transmission cooling lines to radiator oil cooler fittings.
    b. Connect the transmission cooler tube support bracket to the bottom flange of the radiator with the attaching screw.
    c. Attach cooler tubes onto plastic clip on tube radiator support bracket.
    d. Tighten cooler tube nuts attaching the cooler tube to radiator connectors. Tighten tube nuts to 16-24 Nm (12-18 lb-ft).

7. Attach upper radiator hose to radiator. Position upper radiator hose on radiator connector so that stripe on hose is at the 12 o'clock position. Slide the hose clamp (8287) into its installed position.

8. Position lower radiator hose to radiator with stripe on lower radiator hose at 6 o'clock position. Slide the hose clamp into its installed position.

9. Position fan shroud in lower retainer clips and attach the top of the fan shroud to radiator with two screw and washer assemblies. Tighten to 6-8 Nm (53-71 lb-in).

10. Attach rubber radiator overflow hose to radiator and radiator coolant recovery reservoir (8A080). Make sure radiator overflow hose is attached to uppermost nipple on filler neck.

11. Fill the cooling system with a 50/50 mixture of ethylene glycol and water, and bleed the system.

12. Operate the engine for several minutes and check hoses and connections for leaks.

Radiator Installation, Aerostar 3.0L

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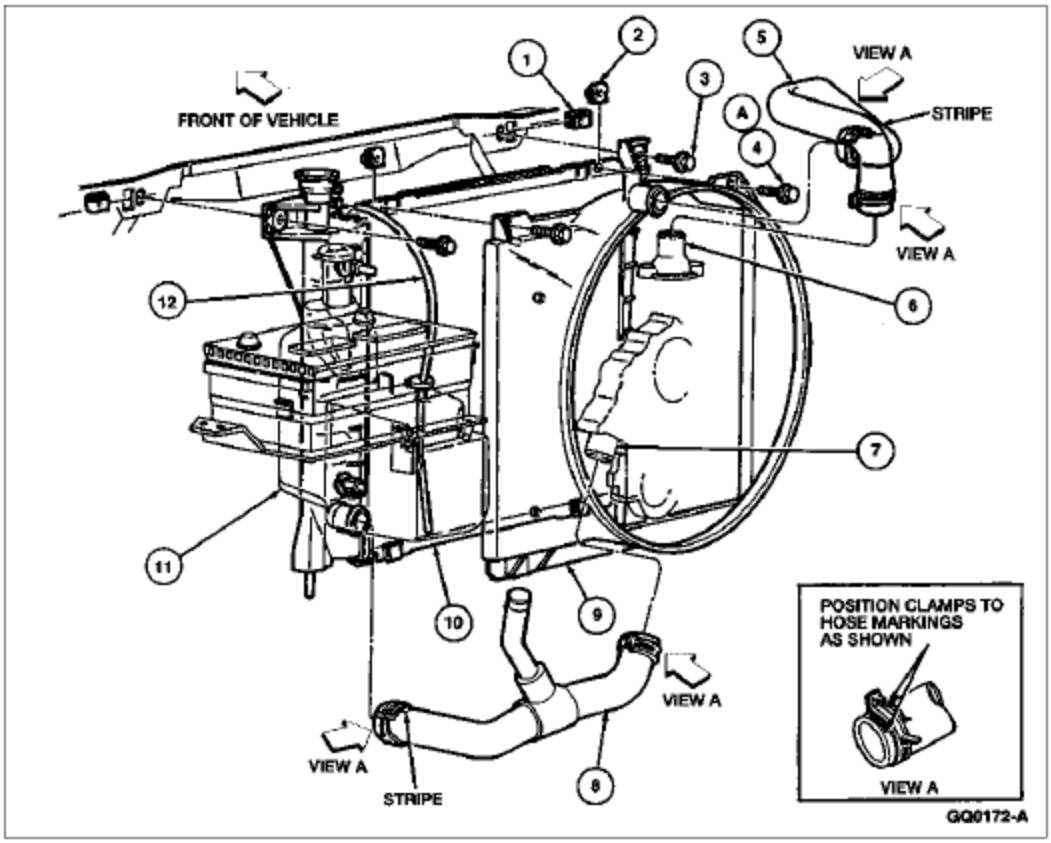

Item	Part Number	Description
1	N801731-S2	U-Nut
2	N804639-S2	U-Nut
3	N606692-S2	Screw and Washer Assembly
4	N606677-S2	Screw and Washer Assembly
5	8260	Upper Radiator Hose Install with Stripe at 12 O'Clock Position
6	8592	Water Outlet Connection
7	8501	Water Pump
8	8286	Lower Radiator Hose Install with Stripe at 12 O'Clock Position
9	8146	Fan Shroud
10	8005	Radiator
11	17B613	Reservoir
12	8075	Radiator Overflow Hose
A	—	Tighten to 6-8 Nm (53-71 Lb-In)

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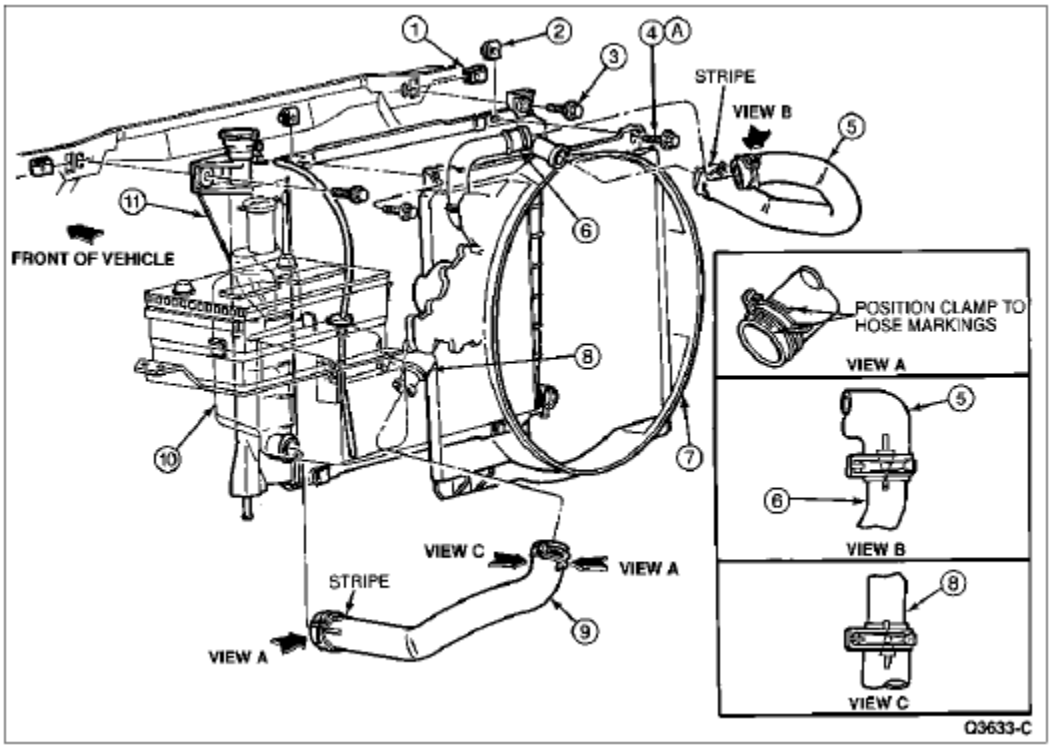
Radiator Installation, Aerostar 4.0L SFI



Item	Part Number	Description
1	N801732-S2	U-Nut
2	N804639-S2	U-Nut
3	N606692-S2	Screw and Washer Assembly
4	N606677-S2	Screw and Washer Assembly
5	8260	Upper Radiator Hose Install with Stripe at 12 O'Clock Position
6	8592	Water Outlet Connection
7	8146	Fan Shroud
8	8501	Water Pump
9	8286	Lower Radiator Hose Install with Stripe at 12 O'Clock Position
10	17B613	Reservoir
11	8005	Radiator
A	—	Tighten to 6-8 Nm (53-71 Lb-Ft)

Radiator Installation, Ranger 2.3L Engine

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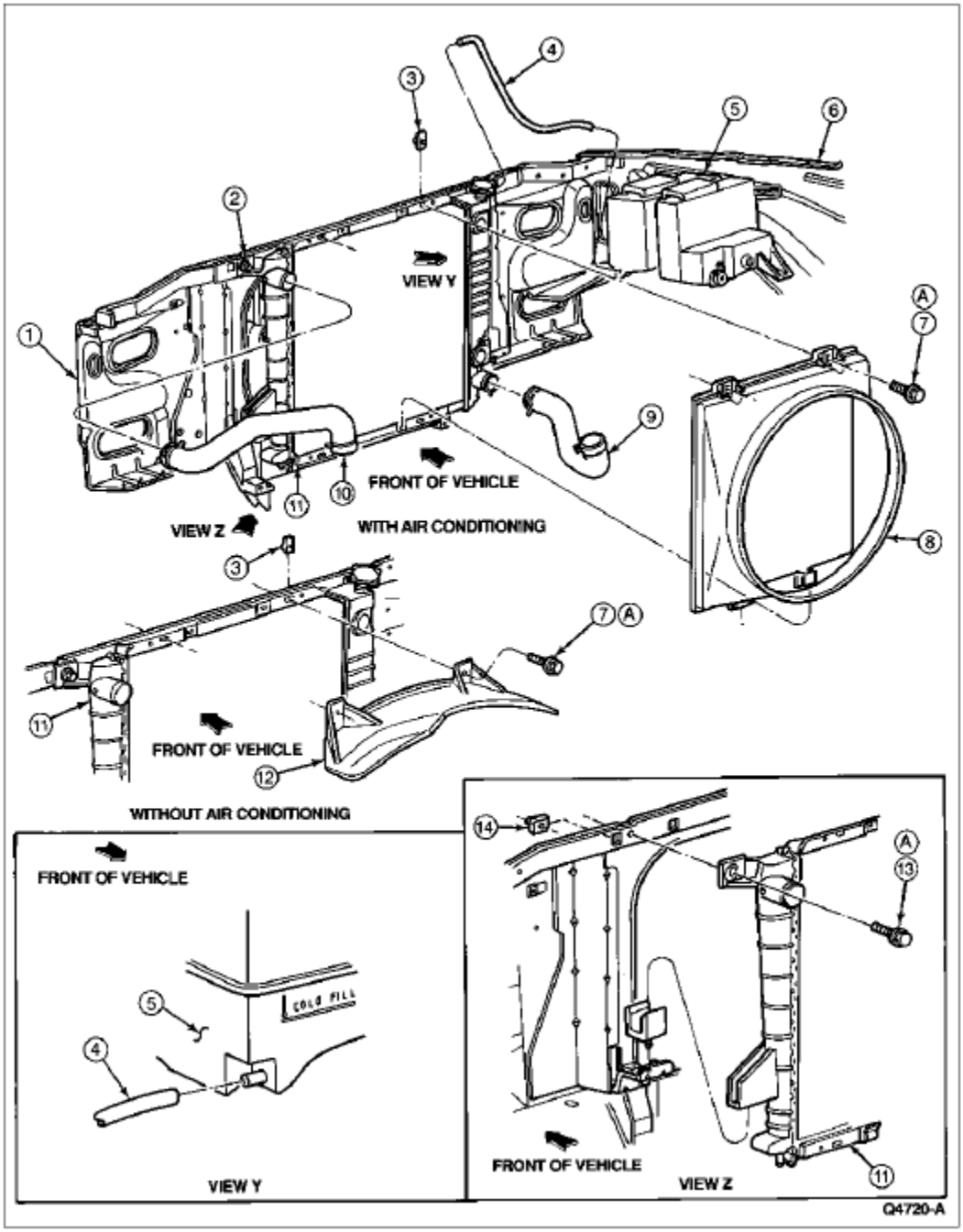

Item	Part Number	Description
1	16138	Radiator Support
2	8A340	Radiator Upper Reinforcement
3	N623332-S301	U-Nut, M6
4	8N029	Radiator Overflow Hose
5	17618	Windshield Washer Reservoir

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6	16K006	Inner Fender
7	N802408-S301	Screw, M6-1 x 22.6
8	8146	Fan Shroud
9	8286	Lower Radiator Hose
10	8260	Upper Radiator Hose
11	8005	Radiator
12	8A611	Fan Guard
13	N606691-S301	Screw, M8-1.25 x 35
14	N623343-S301	U-Nut, M8
A	—	Tighten to 6-8 Nm (53-71 Lb-In)

Radiator Installation, Ranger 3.0L Engine

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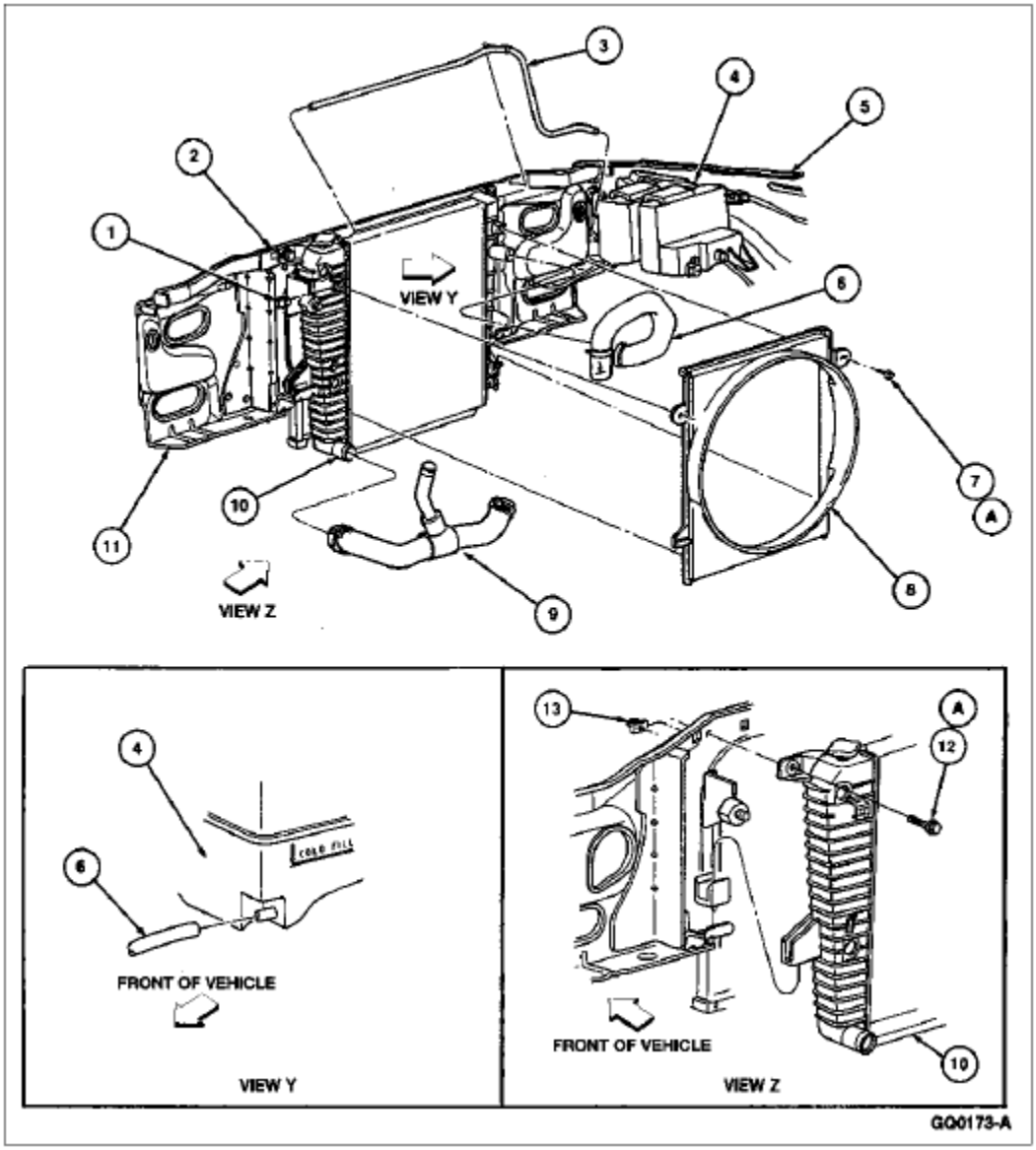

Item	Part Number	Description
1	N623332-S301	U-Nut, M6
2	8A340	Radiator Upper Reinforcement
3	8075	Radiator Overflow Hose
4	17618	Windshield Washer Reservoir (with Radiator Overflow Reservoir)
5	16K006	Inner Fender
6	8260	Upper Radiator Hose
7	N802408-S301	Screw, M6-1.0 x 16
8	8146	Fan Shroud
9	8286	Lower Radiator Hose

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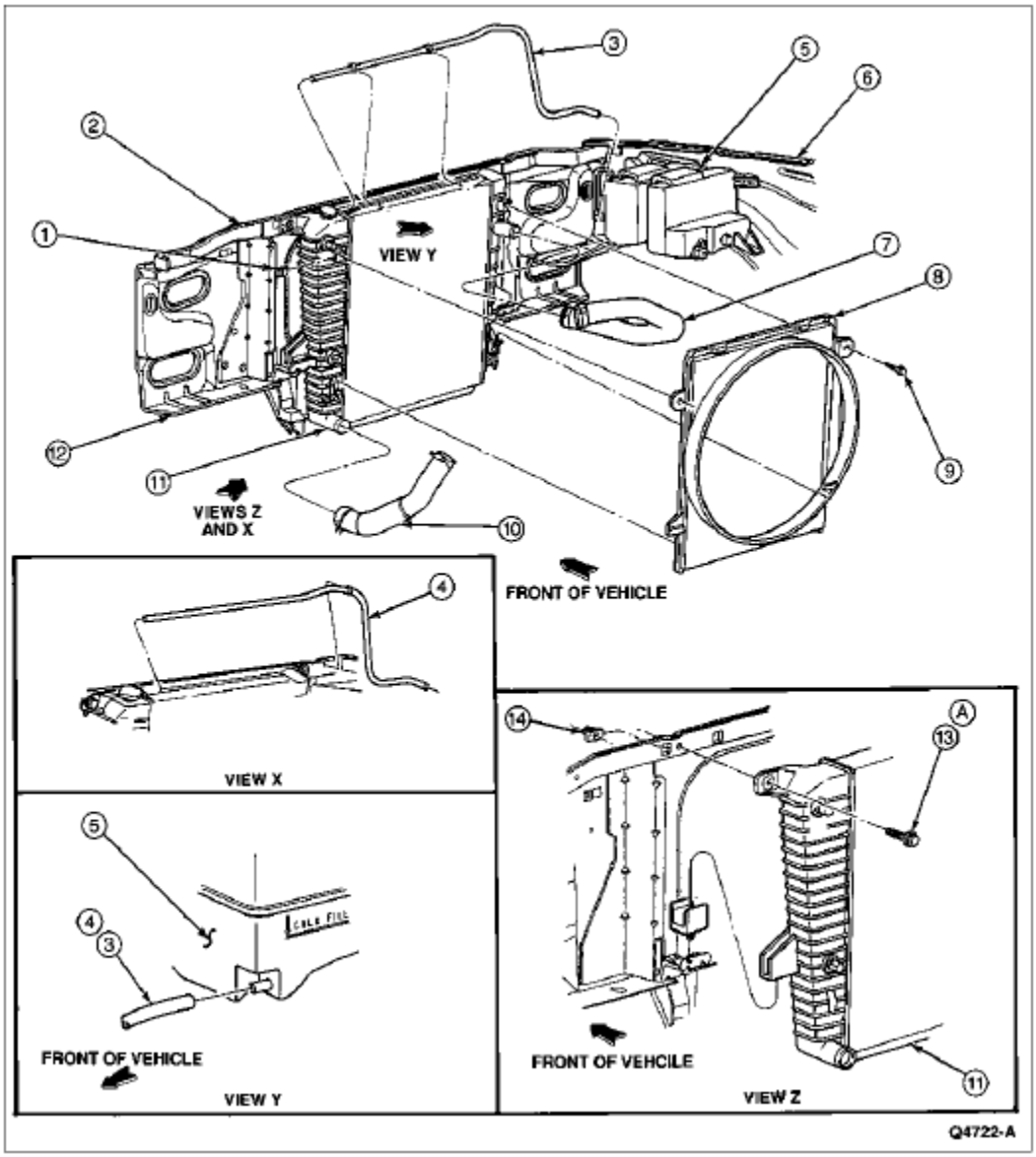
10	8005	Radiator
11	16138	Radiator Support
12	N606991-S301	Screw, M6-1.25 x 37.5
13	N623343-S301	U-Nut, M8
A	—	Tighten to 6-8 Nm (53-71 Lb-In)

Ranger 4.0L Radiator Installation



Item	Part Number	Description

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1	N623332-S301	U-Nut, M6
2	8A340	Radiator Upper Reinforcement
3	8075	Radiator Overflow Hose (Automatic Transmission)
4	8075	Radiator Overflow Hose (Manual Transmission)
5	17618	Windshield Washer Reservoir (with Radiator Overflow Reservoir)
6	16K006	Inner Fender
7	8260	Upper Radiator Hose
8	8146	Fan Shroud
9	N802408-S301	Screw, M6-1.0 x 16
10	8286	Lower Radiator Hose
11	8005	Radiator
12	16138	Radiator Support
13	N606691-S301	Screw, M8-1.25 x 37.5
14	N623343-S301	U-Nut, M8
A	—	Tighten to 6-8 Nm (53-71 Lb-In)

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Radiator Coolant Recovery Reservoir

Removal

1. Drain the coolant from the radiator coolant recovery reservoir (8A080) by disconnecting the overflow line at the radiator filler neck overflow nipple and allowing it to siphon into a suitable container.

2. Remove the radiator coolant recovery reservoir attachments and remove the combination radiator coolant recovery reservoir.

Installation

WARNING: DO NOT STAND IN LINE WITH OR NEAR THE ENGINE COOLING FAN BLADE (8600) WHEN THE ENGINE (6007) IS RUNNING.

1. Position the radiator coolant recovery reservoir in the vehicle and install attaching screws. Tighten to 6-8 Nm (52-71 lb-in).

2. Connect the overflow tube to the radiator (8005).

3. Fill and bleed the cooling system. Check for coolant leaks and proper coolant level after the engine reaches normal operating temperature.

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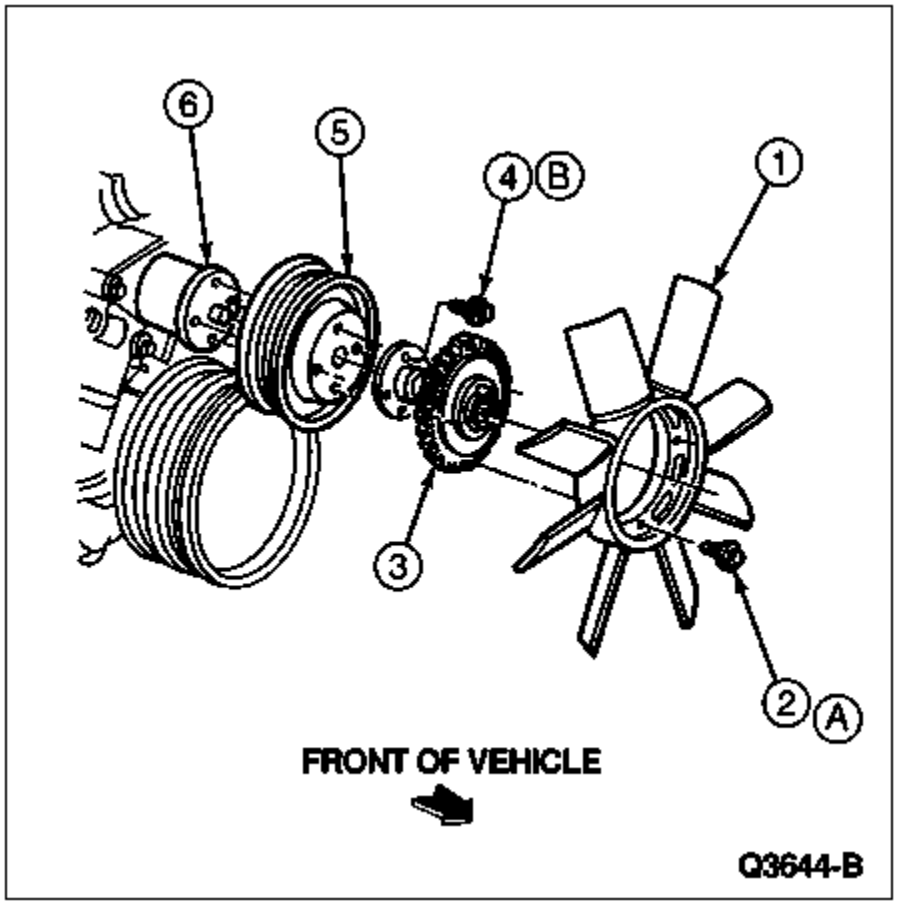
Cooling Fan Blade and Fan Clutch, Mechanical

2.3L

Removal

1. Loosen four screws holding fan clutch (8A616) to water pump pulley (8509).
2. Loosen belt tension. Remove four screws retaining fan clutch and fan blade (8600) to water pump pulley. Remove assembly from vehicle.
3. If equipped with fan shroud (8146), remove two screws, disconnect overflow tube and remove from vehicle. Lift fan shroud off lower retaining clips. Place fan shroud behind fan in order to access fan bolts.
4. Remove four screws retaining fan to fan clutch and separate.



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Item	Part Number	Description
1	8600	Fan Blade
2	N602527-S2	Screw and Washer Assembly, M6-1.0 x 14
3	8A616	Fan Clutch
4	N806863-S2	Screw and Washer Assembly, M8-1.25 x 25
5	8509	Water Pump Pulley
6	8501	Water Pump
A	—	Tighten to 6-8 Nm (53-71 Lb-In)
B	—	Tighten to 16-24 Nm (12-17 Lb-Ft)

Installation

1. Position fan to fan clutch and secure with four screws. Tighten to 6-8 Nm (53-70 lb-in).
2. Install fan shroud to radiator (8005). Tighten screws to 6-8 Nm (53-71 lb-in). Connect the overflow tube.
3. Position fan and fan clutch to water pump pulley and secure with four screws. Tighten to 16-24 Nm (12-17 lb-ft).

3.0L and 4.0L

SPECIAL SERVICE TOOLS DESIRED

Tool Number	Description
T84T-6312-C	Fan Clutch Holding Tool
T84T-6312-D	Fan Clutch Nut Wrench

Removal

1. Remove the fan shroud as outlined in Removal and Installation, Radiator in this section.
2. **CAUTION: On 3.0L engines only, the large nut which attaches fan clutch to the hub of the water pump shaft has a left-hand thread and must be rotated clockwise for removal.**

   Remove the nut using Fan Clutch Holding Tool T84T-6312-C and Fan Clutch Nut Wrench T84T-6312-D.
3. Remove the fan and fan clutch as an assembly.
4. Remove the bolts attaching the fan to the fan clutch, if necessary.

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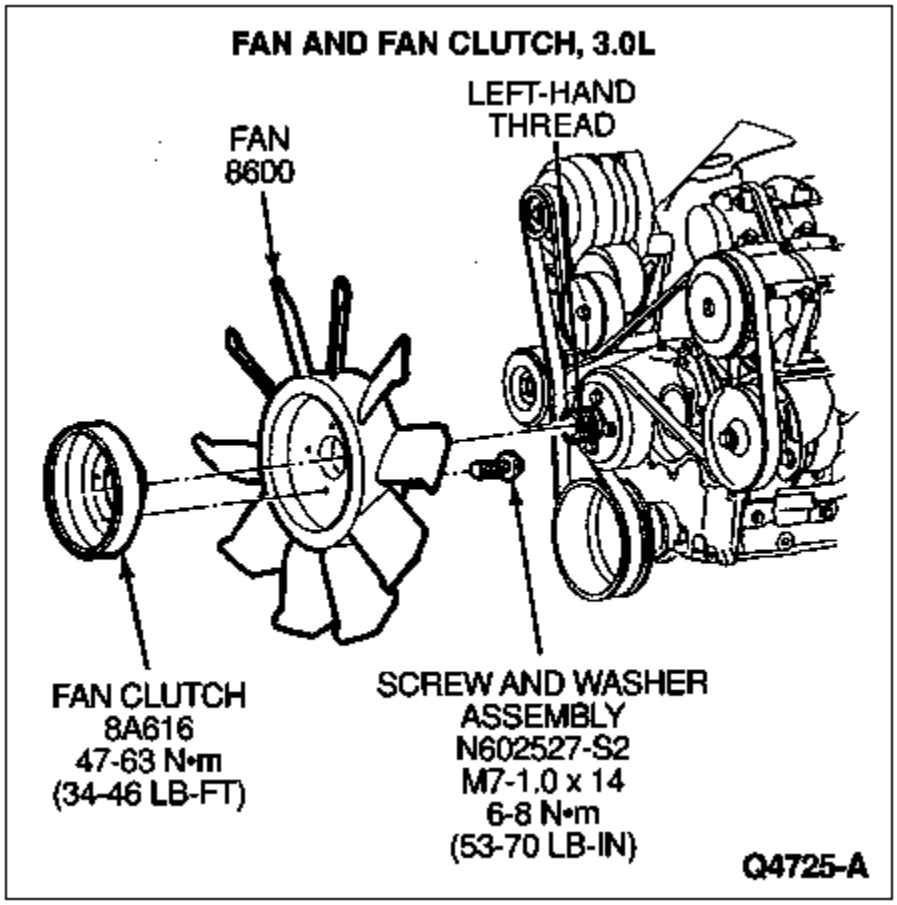

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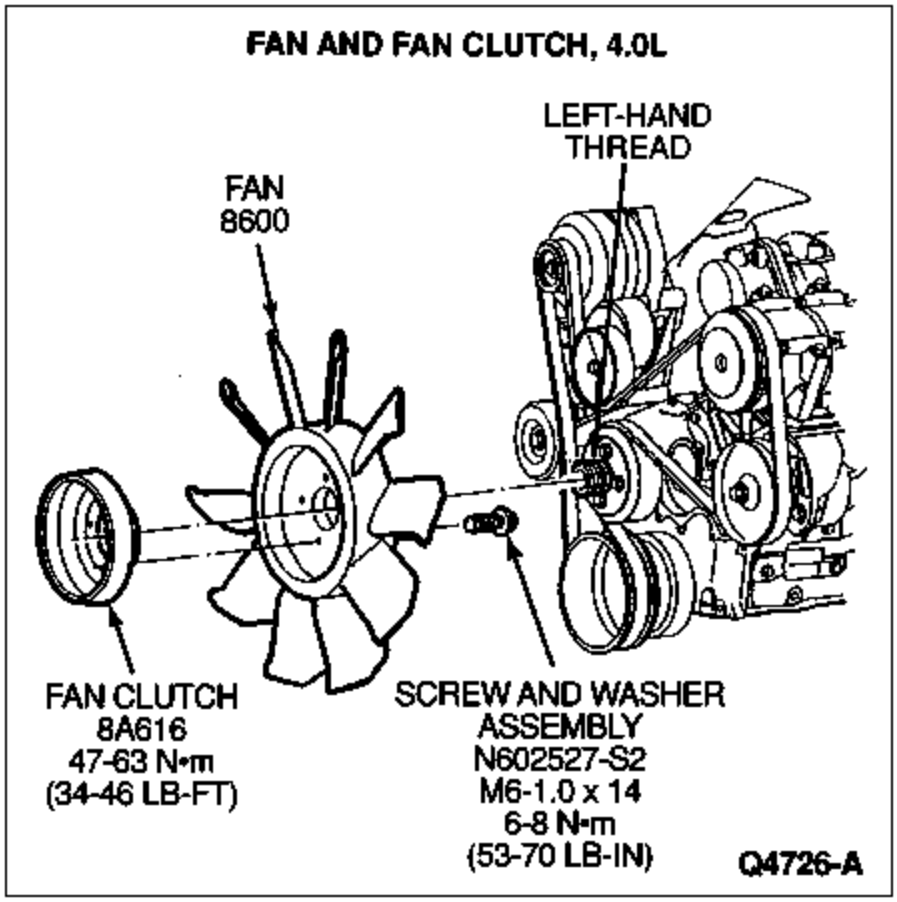

Installation

CAUTION: On 3.0L engines only, the fan clutch nut has a left-hand thread and must be rotated counterclockwise for tightening.

For installation, follow removal steps in reverse order. Tighten the fan-to-clutch bolts to 6-8 Nm (53-71 lb-in). Tighten the fan clutch assembly nut to 47-63 Nm (34-46 lb-ft).

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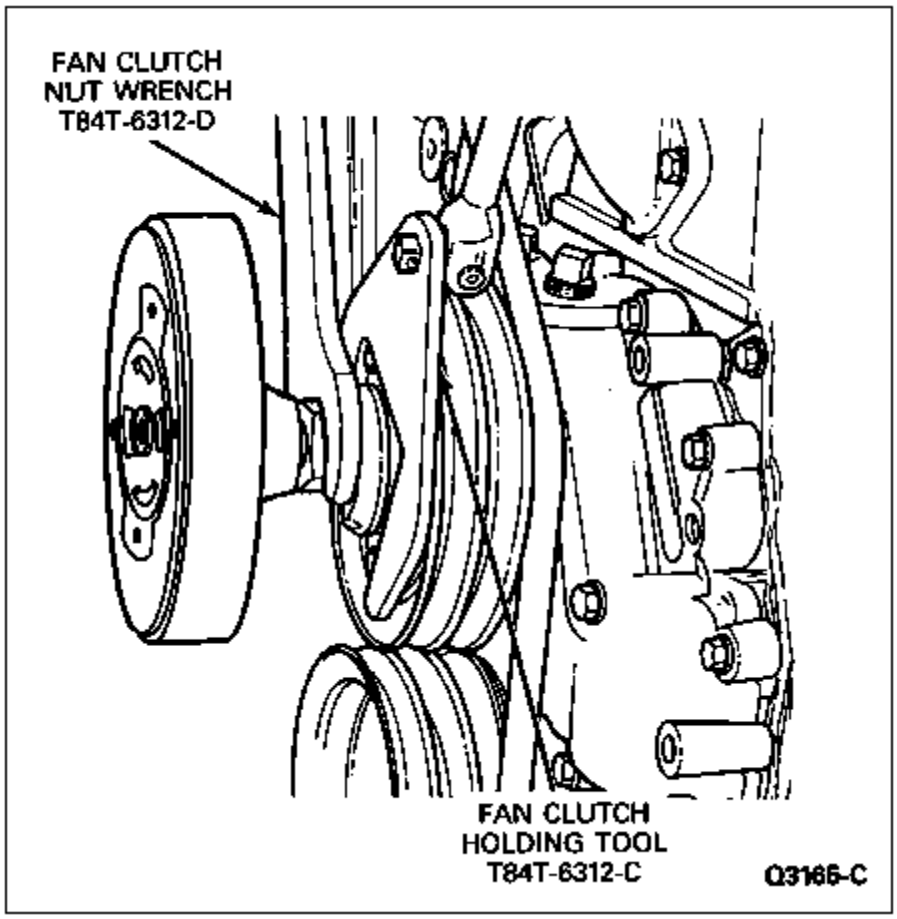

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Radiator Draincock

Aluminum Core Radiator

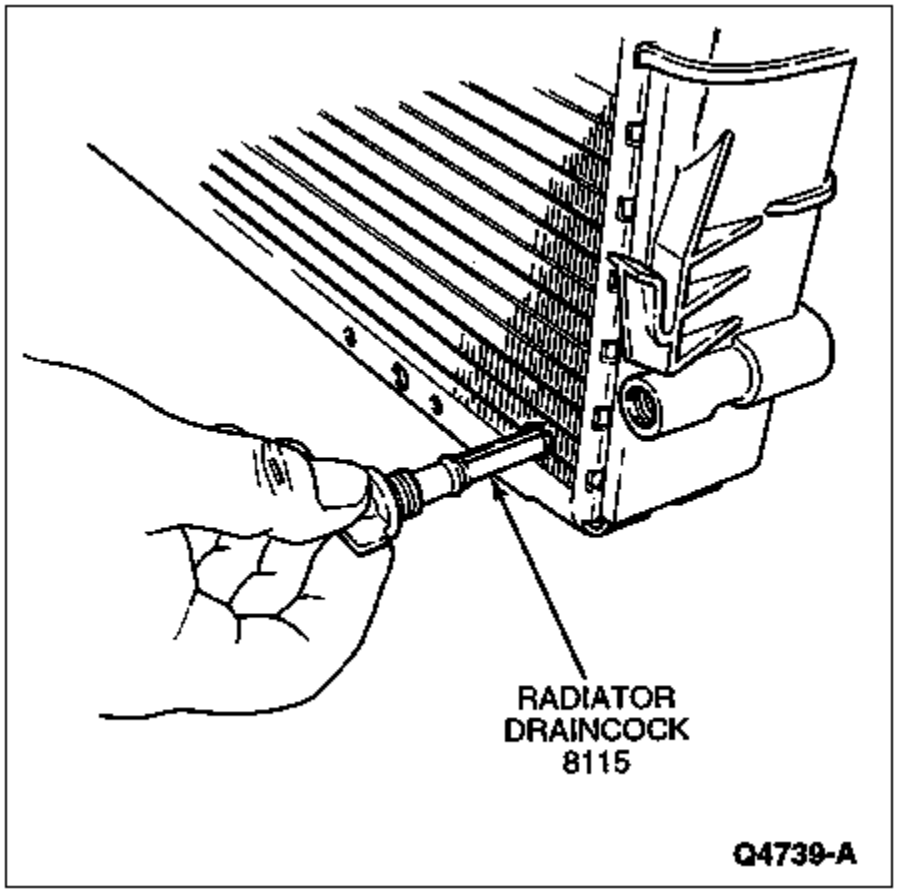
The radiator draincock (8115) is located near the bottom of the inlet tank.

Removal

1. Drain the cooling system by removing the radiator cap (8100) and attaching a 9.5mm (3/8 inch) inside diameter hose to the draincock nipple, located at the lower rear corner of the radiator tank. Then, open the radiator draincock and allow the coolant to flow through the hose into a suitable container.

   Remove the rubber hose from the radiator (8005) and store it out of the way.

2. Unscrew the stem to the ends of the threads. Gently pull the stem from the radiator tank.



Installation

1. Push the radiator draincock into the tank opening until it snaps into place. Continue to push the radiator draincock into the tank until the threads on the draincock engage the threads on the tank.

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2. Tighten the draincock stem by turning clockwise to 2.0-2.7 Nm (18-25 lb-in).

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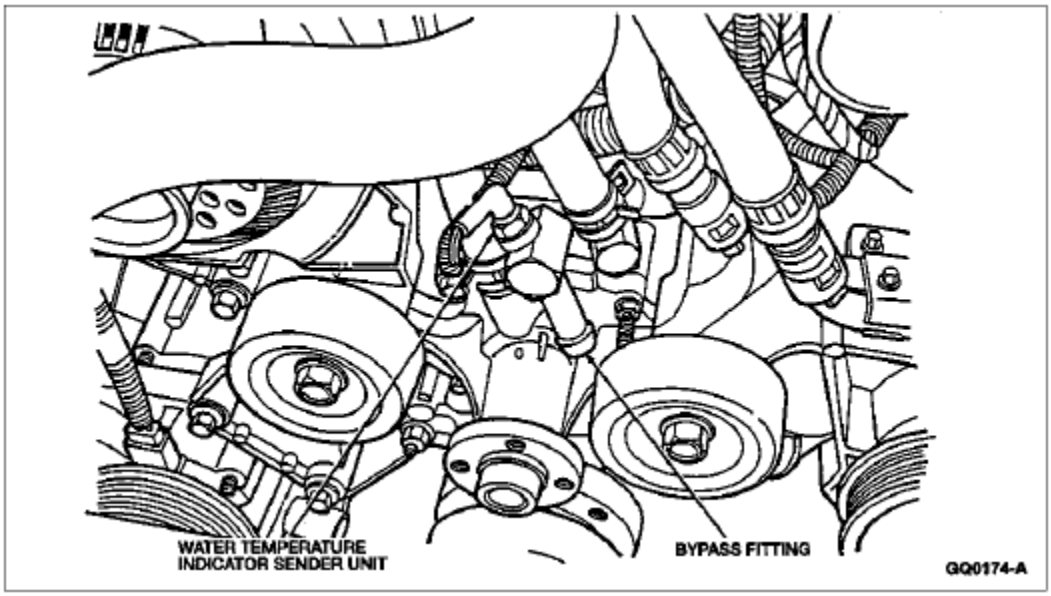
Water Temperature Indicator Sender Unit



Removal and Installation

WARNING: NEVER REMOVE THE RADIATOR CAP UNDER ANY CONDITIONS WHILE THE ENGINE IS OPERATING. FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN DAMAGE TO THE COOLING SYSTEM OR ENGINE AND/OR PERSONAL INJURY. TO AVOID HAVING SCALDING HOT COOLANT OR STEAM BLOW OUT OF THE RADIATOR, USE EXTREME CARE WHEN REMOVING THE CAP FROM A HOT RADIATOR. IF POSSIBLE, WAIT UNTIL THE ENGINE HAS COOLED, THEN WRAP A THICK CLOTH AROUND THE RADIATOR CAP AND TURN IT SLOWLY TO THE FIRST STOP. STEP BACK WHILE THE PRESSURE IS RELEASED FROM THE COOLING SYSTEM. WHEN YOU ARE SURE ALL THE PRESSURE HAS BEEN RELEASED, PRESS DOWN ON THE CAP (STILL WITH A CLOTH), TURN AND REMOVE IT.

1. Remove radiator cap (8100) to relieve any pressure and then replace cap. This reduces coolant loss during sender replacement.
2. Disconnect the temperature sending unit wire at the water temperature indicator sender unit (10884).
3. Prepare the new water temperature indicator sender unit for installation by applying Ford Pipe Sealant with Teflon® D8AZ-19554-A or equivalent meeting Ford specification WSK-M2G350-A2 or a small amount of electrically conductive sealer to the threads.
4. Remove the water temperature indicator sender unit and immediately install the new water temperature indicator sender unit. Tighten to 11-24 Nm (8-18 lb-ft).
5. Connect the temperature sending wire to the water temperature indicator sender unit.
6. Refill cooling system to replace lost coolant. Refer to the procedure in this section.

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7. Start the engine (6007). Check the water temperature indicator sender unit operation.

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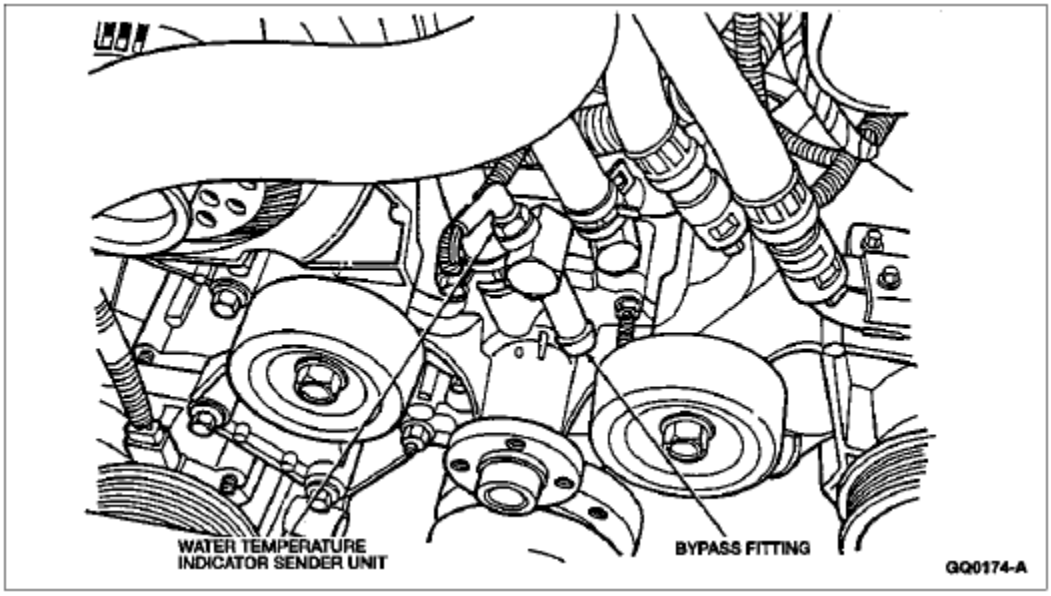
Engine Coolant Temperature (ECT) Sensor

Removal



1. Disconnect the battery ground cable (14301).
2. Disconnect the spark plug wires at the ignition coils (12029).
3. Disconnect the electrical connectors to the ignition coils.
4. Remove the two ignition coil bracket-to-intake manifold nuts.
5. Disconnect the EGR vacuum regulator solenoid (9J459).
6. Remove the ignition coils.
7. Disconnect the engine coolant temperature (ECT) sensor connector.
8. Remove the engine coolant temperature sensor (ECT sensor) (12A648).

Installation

To install, reverse the removal procedure.

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Tighten the engine coolant temperature sensor 13-20 Nm (10-15 lb-ft).

Tighten the ignition coil bracket-to-intake manifold nuts 16-24 Nm (12-18 lb-ft).

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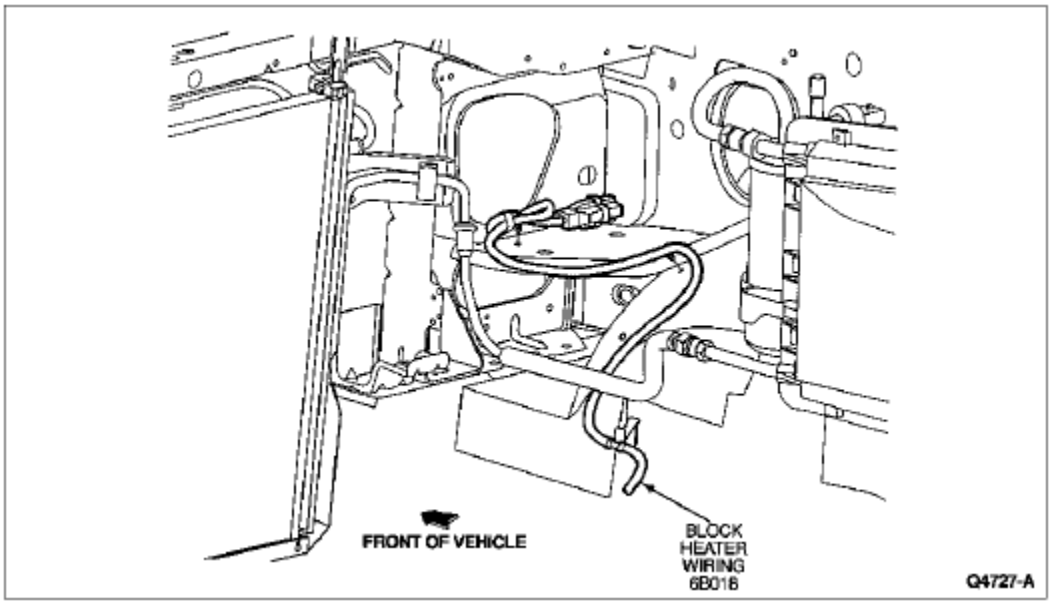
Block Heater Wiring

Block Heater Wiring Routing



1. Unplug cable from block heater (6A051).
2. Use door trim panel removing tool to remove block heater wiring (6B018) from battery tray (10732), inner fender, engine mount brackets, and cylinder blocks (6010) (if applicable).
3. Remove block heater wiring from vehicle.
4. To install, reverse the removal procedure.

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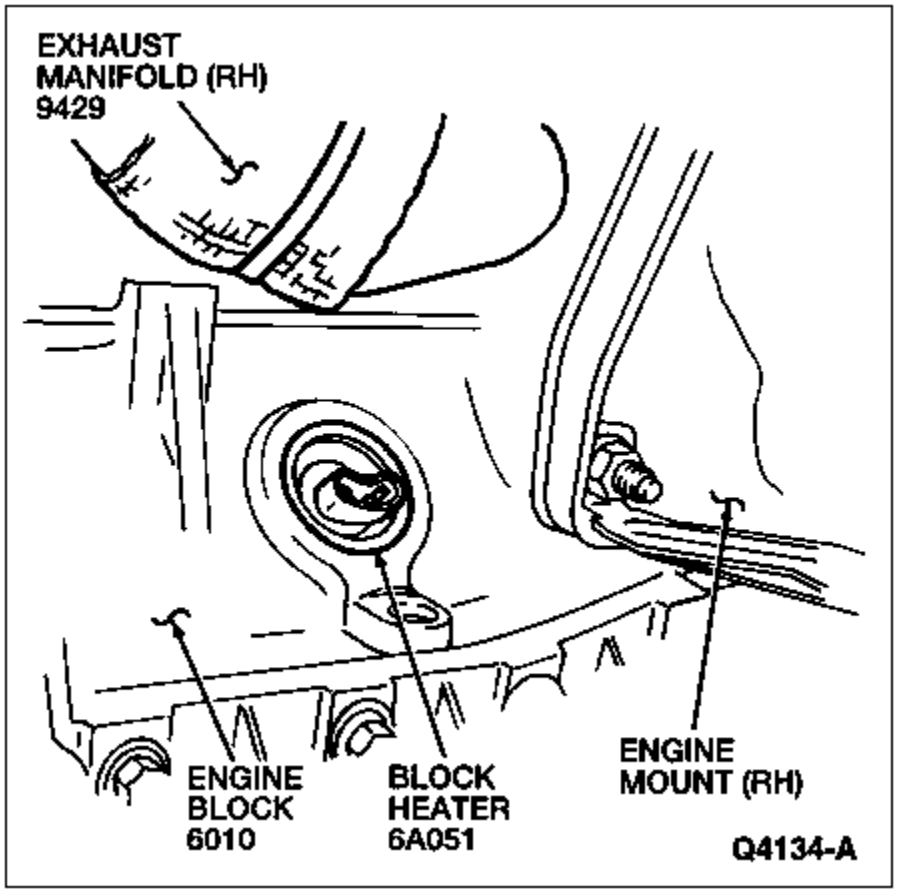
Block Heater



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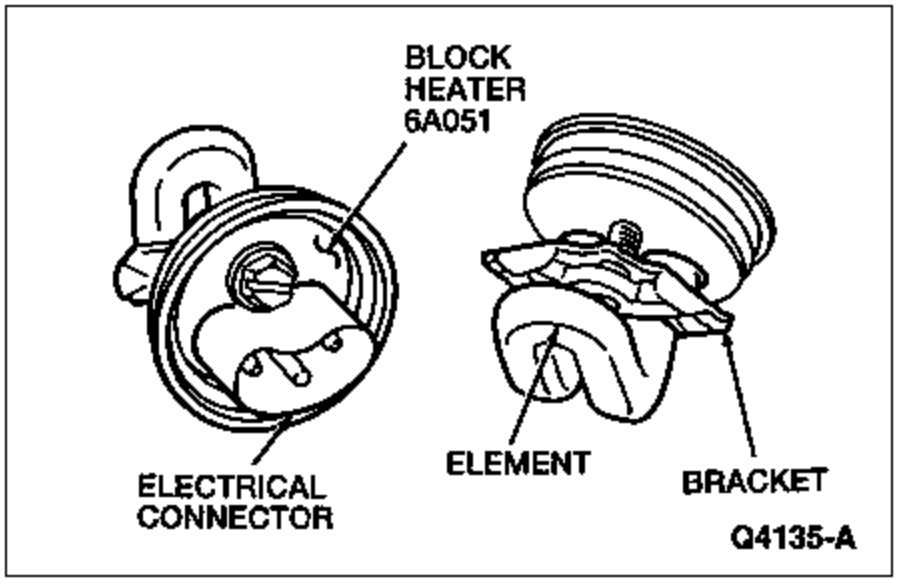

Removal and Installation

CAUTION: Exceeding the block heater (6A051) installation torque specification may damage new part and reduce sealing ability.

CAUTION: During removal threaded parts may fall into engine block cooling passages if excessively loosened.

NOTE: Service block heater by replacement only.

1. Open radiator draincock (8115) and remove coolant from radiator (8005) and engine (6007).
2. Unscrew the block heater screw only the minimum number of turns to gain "pry" access to the outer cup edge. Carefully remove the block heater. Note the position that the element is pointed. (e.g., 12 o'clock, 6 o'clock, etc.)
3. Clean the inside diameter of the core plug hole machined surface and hole entrance. Remove any burrs at the hole entrance to avoid damage to the O-ring.
4. Cover rubber O-ring and core opening with a liberal coating of Ford Premium Long-Life Grease XG-1-C or -K or equivalent meeting Ford specification ESA-M1C75-B.
5. Insert block heater in core plug hole in the same position as it was removed.
6. Tighten screw in normal clockwise direction. Torque to 1.6-1.8 Nm (14-16 lb-in).
7. Close radiator draincock and refill radiator with a mixture of 50/50 ethylene glycol and water.

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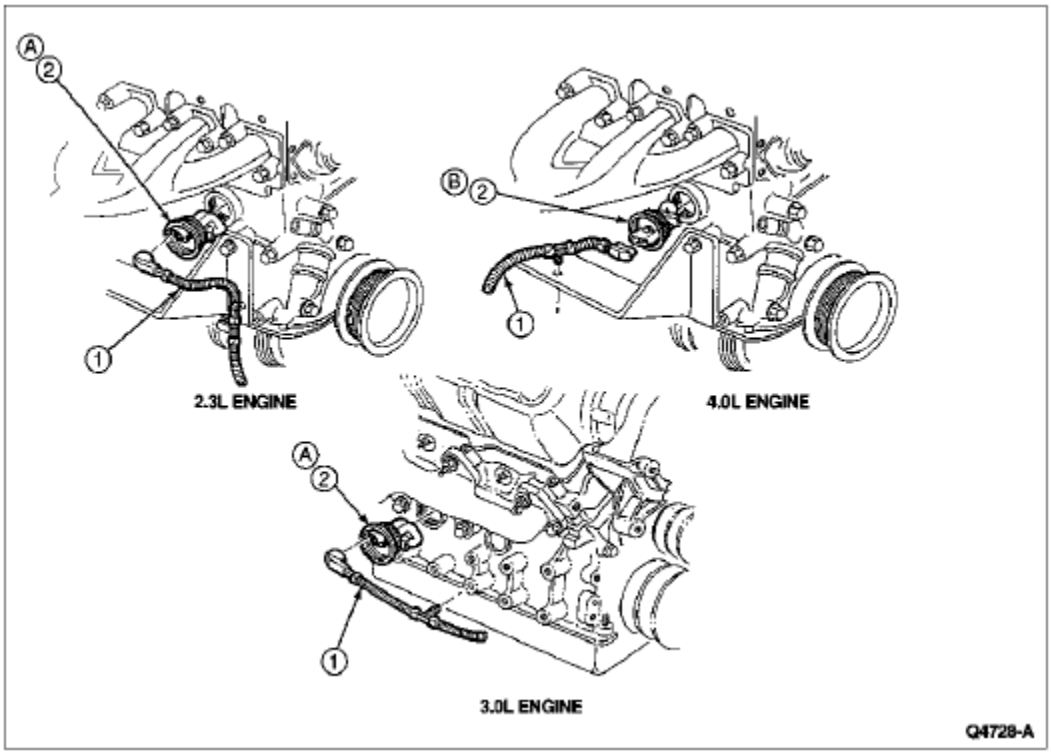
Block Heater Installation, Ranger and Aerostar



Item	Part Number	Description
1	6B018	Block Heater Wiring
2	6A051	Block Heater
A	—	Orient Block Heater in 6 O'Clock Position
B	—	Orient Block Heater in 12 O'Clock Position

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SPECIFICATIONS

Engine Cooling System Refill Capacities

Engine	Equipment	Approximate Capacity		
		U.S. Quarts	Imperial Quarts	Liters
3.0L V-6	All Transmissions	11.8	9.8	11.2
2.3L I-4	All Transmissions	7.2	6.0	6.8
4.0L V-6	Base Cool — All Transmission and A/C Manual	8.1	6.5	7.6
4.0L V-6	Automatic Transmission — A/C, Super Cool	8.5	7.0	8.0

Cooling System Refill Capacities

Engine	Equipment	Approximate Capacity		
		U.S. Quarts	Imperial Quarts	Liters
3.0L V-6	All Transmissions	11.8	9.8	11.2
5.0L V-8	All Transmissions	13.5	11.2	12.8

Cooling System Pressure Specifications

Operating Pressure	Min. Test Pressure	Max. Operating Pressure
110 kPa (16 psi)	-97 kPa (-14 psi)	124 kPa (18 psi)

Cooling System Part Numbers/Application Chart

Refer to Master Parts List for service part numbers and applications.

Coolant Mixture

Refill recommendations are 50/50 mixture of water and permanent coolant/antifreeze such as Ford Premium Cooling System Fluid E2FZ-19549-AA or -B or equivalent meeting Ford specification ESE-M97B44-A.

Minimum acceptable coolant/water concentration is 45% antifreeze to 55% water. Maximum acceptable is 60% coolant to 40% water. Use only a hand held refractometer such as Rotunda Battery and Antifreeze Tester 014-R1060 or equivalent to check concentration.

In an emergency, ordinary tap water with a low alkali content may be used, provided the system is drained and flushed and filled with the specified coolant/water mixture as soon as possible.

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Thermostat Housing Bolts	20-30	14-21	—

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EGR External Pressure Valve Nuts	16-24	12-18	—
Oil Cooler Bolt	54-88	40-65	—
Fan Shroud Bolts	6-8	—	53-71
Fan Clutch-to-Water Pump Pulley	46-63	34-46	—
Radiator-to-Radiator Support	17-27	12.5-20	
Radiator Coolant Recovery Reservoir-to-Body	6-8	—	53-71
Speed Control Servo to Body	8.9-12.1	—	79-107
Fan Blade Bolts	19-26	14-19	—
Draincock Stem	2.0-2.7	—	18-25
Water Temperature Indicator Sender Unit	11-24	8-18	—
Engine Coolant Temperature Sensor	13-20	10-15	—
Coil, Bracket and Capacitor Assembly-to-Intake Manifold	16-24	12-18	—
Transmission Oil Line Fitting to Radiator	31-35	23-25	—
Transmission Oil Line Nut to Fitting on Radiator	22-30	17-22	—
Transmission Cooler Tube Support Bracket Screw	17-23	13-16	—
Radiator to A/C Condenser Bolt	6-8	—	53-71
Air Deflector to Frame	12-17	—	106-150
Block Heater	1.6-1.8	—	14-16
Radiator Hose Clamp (Double Wire Clamp Used on Some Vehicles)	2.3-3.4	—	20-30
Thermostat Housing	20-30	14-21	—
Thermostat Housing 4.0L	9-12	—	77-110
Radiator to Radiator Support	17-27	12.5-20	—
Fan to Clutch	6-8	—	53-71
Clutch to Water Pump 3.0L, 2.9L and 4.0L	47-63	34-46	—
Coolant Recovery Bottle to Body	6-8	—	53-71
Shroud/Finger Guard to Radiator	6-8	—	53-71
Transmission Oil Line Fitting to Radiator	31-35	23-25	—
Transmission Oil Line Nut to Fitting on Radiator	22-30	17-22	—
Hose Clamp	2	18	—
Temperature Sending Unit	11-24	8-18	—
Water Pump to Cylinder Block — 2.3L	16-24	12-17	—
Oil Cooler Retaining Nuts	12-15	9-11	—
Cooler Tube to Radiator Connector Nuts	16-24	12-18	—
Water Pump Inlet Tube Attaching Screws	9-12	—	78-107
Draincock	2.0-2.7	—	18-25

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Tips to Avoid Lean Air-Fuel Conditions

Rough idle, hesitation, poor throttle response, induction backfire and stalls during cold start/warm up may be caused by the poor volatility of some high octane premium grade unleaded fuels (91 octane or higher ([R+M]/2). When compared to regular grade unleaded fuel (87 octane ([R+M]/2), high octane premium grade unleaded fuel may cause long crank time.

Use a regular grade unleaded fuel in all vehicles, except where a premium unleaded fuel is recommended in the owner guide. If lean air-fuel type symptoms are experienced, determine the grade and brand of fuel used and offer the following service tips.

- Advise those using a higher octane grade fuel to switch to a regular grade unleaded fuel. For those using a regular grade fuel, advise them to try another brand.
- Do not advise using a higher octane unleaded fuel than is recommended for that specific engine. Ford engines are designed to perform best using a high quality regular grade unleaded fuel.
- Only advise using a higher octane unleaded fuel to avoid potentially damaging spark knock or ping, but do so only after mechanical repairs are ineffective.
- All unleaded gasolines used should contain detergent additives that are advertised as having KEEP CLEAN or CLEAN UP performance for both intake valves (6507) and fuel injectors (9F593).

Pressure Check

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Multiport Fuel Injection (MFI) Fuel Pressure Gauge (EFI/CFI)	T80L-9974-B

1. Disconnect electrical connection to inertia fuel shutoff switch (IFS switch) (9341).
2. Crank engine for 15 seconds to reduce system pressure.
3. Remove cap from fuel pressure relief valve (9H321) (Schrader valve).
4. **CAUTION: Use care to prevent combustion from fuel spillage.**

   Install Multiport Fuel Injection (MFI) Fuel Pressure Gauge (EFI/CFI) T80L-9974-B on fuel pressure relief valve.
5. Connect inertia fuel shutoff switch.
6. Start engine (6007) and check fuel pressure.
7. Accelerate engine. Pressure should remain stable throughout acceleration.

Refer to Powertrain Control/Emissions Diagnosis Manual for further diagnosis and testing procedures.

Fuel Charging System

Pre-Service Procedures

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Multiport Fuel Injection (MFI) Fuel Pressure Gauge (EFI/CFI)	T80L-9974-B

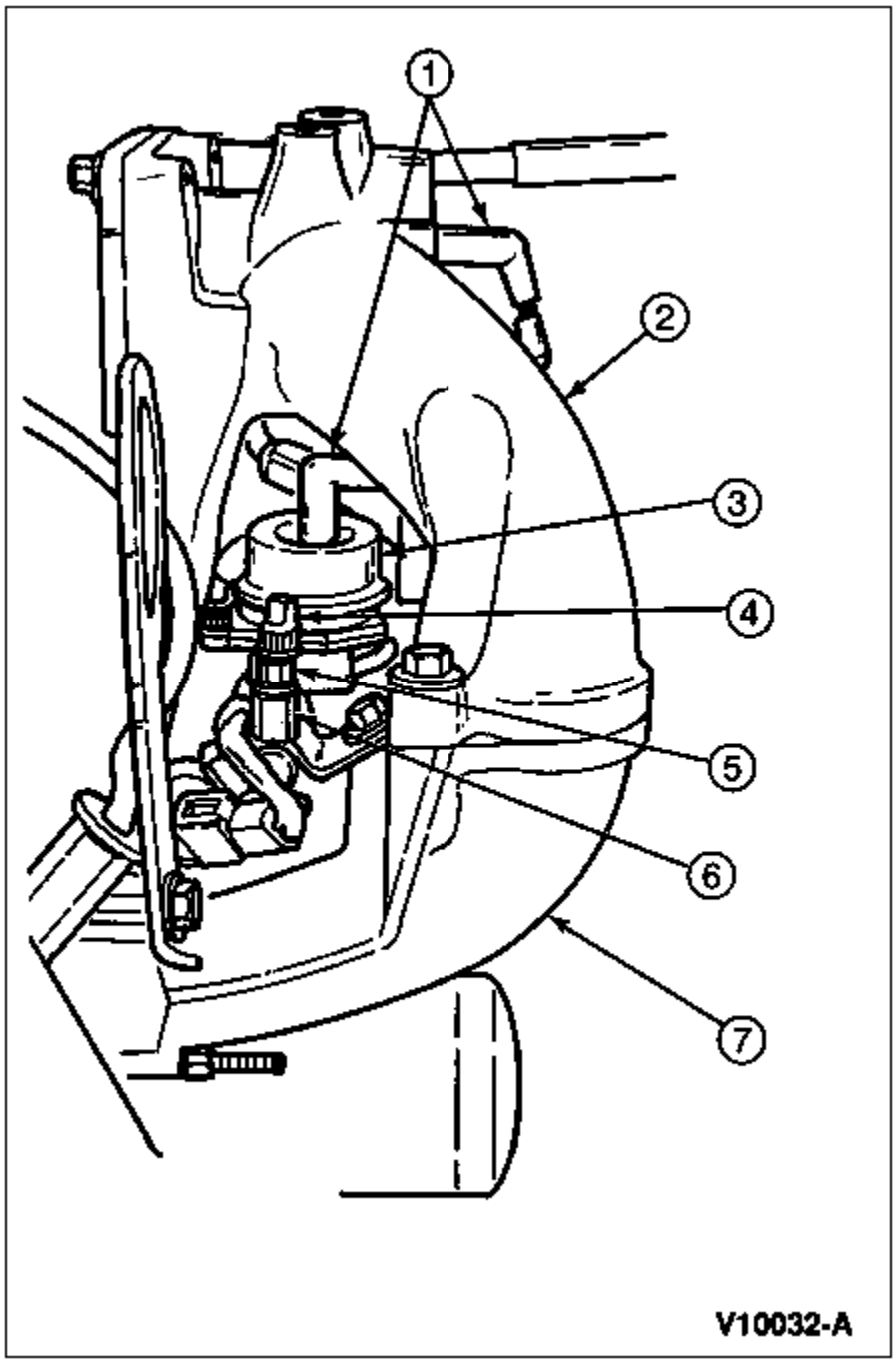
CAUTION: Fuel supply lines on SFI engines will remain pressurized for some period of time after the engine is shut off. This residual pressure must be relieved before servicing of the fuel system is begun.

WARNING: DISCONNECT BATTERY GROUND CABLE (14301) BEFORE PERFORMING ANY MAINTENANCE PROCEDURE WHICH MAY RESULT IN FUEL SPILLAGE OR LEAKING, EVEN IF FUEL IS DIRECTED INTO A SUITABLE CONTAINER. AS LONG AS THE BATTERY (10655) IS CONNECTED, THERE IS THE POSSIBILITY OF SHORTING AND SPARKING ELECTRICAL COMPONENTS AND RESULTING FIRE OR EXPLOSION HAZARD.

NOTE: There are two ways to release residual pressure in the system and prepare the vehicle for fuel system service.

First Method

1. Disconnect battery ground cable.
2. Remove fuel tank filler cap (9030) to relieve tank pressure.
3. Remove fuel pressure relief valve cap (9H323) and connect Multiport Fuel Injection (MFI) Fuel Pressure Gauge (EFI/CFI) T80L-9974-B to the fuel pressure relief valve (9H321) on the fuel injection supply manifold (9D280).



Item	Part Number	Description
1	9E498	Fuel Pressure Regulator Vacuum Tube
2	9424	Upper Intake Manifold
3	9C968	Fuel Pressure Regulator
4	9H323	Fuel Pressure Relief Valve Cap
5	9H321	Fuel Pressure Relief Valve
6	9D280	Fuel Injection Supply Manifold

7	9424	Lower Intake Manifold

4. Direct the drain hose to a suitable container and depress the pressure relief button.

Second Method

1. Disconnect inertia fuel shutoff switch (IFS switch) (9341). Inertia fuel shutoff switch location may be determined from owner's guide.
2. Operate ignition switch to crank the engine (6007) for 15-20 seconds to relieve pressure.
3. Disconnect battery ground cable.
4. Remove fuel tank filler cap to relieve tank pressure.

Post-Service Procedures

After the service is complete and the fuel charging assembly is installed onto engine, the following steps must be taken:

1. Install the fuel tank filler cap.
2. Connect battery ground cable.
3. **NOTE: Check all connections at fuel rails, push-connect fittings, fuel injectors, etc.**

   CAUTION: The fuel system is normally pressurized to 276 kPa (40 psi).

   Turn ignition switch (11572) on and off several times without starting engine to pressurize the fuel system. Check for fuel leaks at fuel pressure regulator (9C968), fuel injectors and fuel connect fittings.
4. Start engine and warm to operating temperature. Check for coolant leak if coolant was removed.
5. **NOTE: When the battery (10653) has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

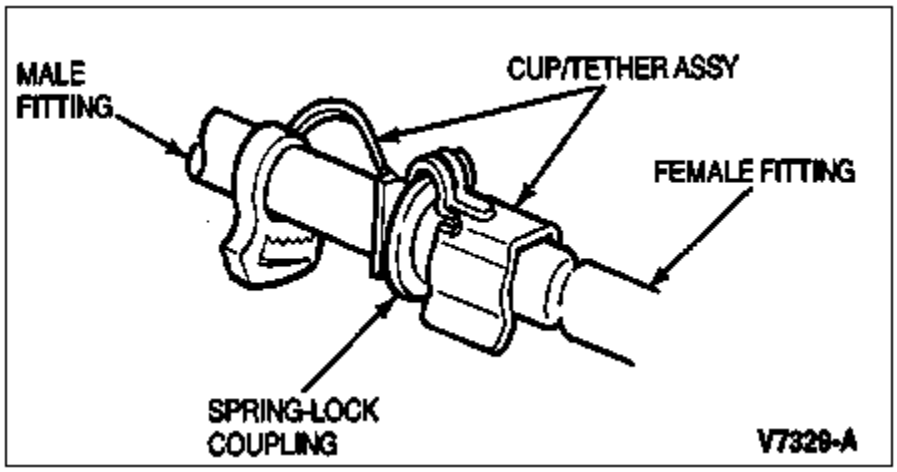
   Perform EEC self-test to check system's function. Refer to Powertrain Control/Emissions Diagnosis Manual. Recheck for fuel leaks.

Spring Lock Coupling

SPECIAL SERVICE TOOL(S) REQUIRED

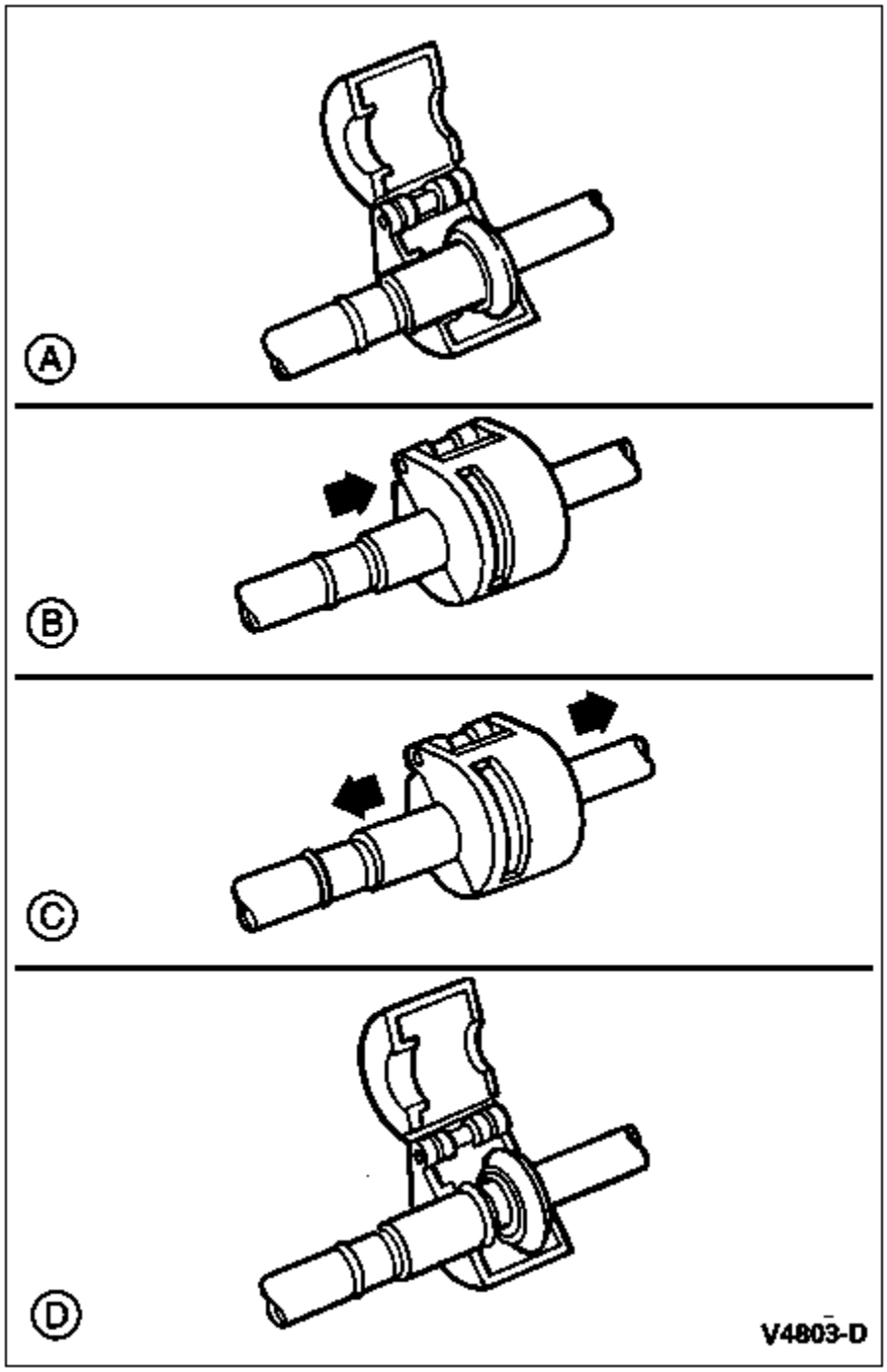
Description	Tool Number
Spring Lock Coupling Disconnect Tool (3/8 Inch)	T81P-19623-G1
Spring Lock Coupling Disconnect Tool (1/2 Inch)	T81P-19623-G2

The spring lock coupling is a fuel line coupling held together by a garter spring inside a circular cage. When the coupling is connected, the flared end of the female fitting slips behind the garter spring inside the cage of the male fitting. The garter spring and cage then prevent the flared end of the female fitting from pulling out of the cage. As a redundant locking feature, a horseshoe shaped retaining clip is incorporated to improve the retaining reliability of the spring lock coupling.



Removal

1. Perform pre-service procedures as outlined in Removal and Installation, Fuel Charging System in this section.
2. Remove retaining clip from spring lock coupling by hand only. Do not use any sharp tool or screwdriver as it may damage the spring lock coupling.
3. Twist fitting to free it from any adhesion at the O-ring seals.
4. Using Spring Lock Coupling Disconnect Tool T81P-19623-G1 (3/8 inch) or T81P-19623-G2 (1/2 inch), disconnect fuel hoses at the fuel rail supply tube and fuel rail return tube.
    a. Fit tool to coupling so tool can enter cage to release garter spring.
    b. Push the tool into the cage opening to release female fitting from garter spring.
    c. Pull the coupling male and female fittings apart.
    d. Remove the tool from the disconnected coupling.



Installation

1. Make sure the garter spring is in cage of male fitting. If garter spring is missing, install a new spring by pushing it into cage opening. If garter spring is damaged, remove it from cage with a small wire hook (do not use a screwdriver) and install a new spring.

2. Clean all dirt or foreign material from both pieces of coupling.

3. **WARNING: USE ONLY THE SPECIFIED O-RINGS AS THEY ARE MADE OF A SPECIAL MATERIAL. THE USE OF ANY O-RING OTHER THAN THE SPECIFIED O-RING MAY ALLOW**

THE CONNECTION TO LEAK INTERMITTENTLY DURING VEHICLE OPERATION.

Replace missing or damaged O-rings. Use only O-rings listed for spring lock couplings.

4. Lubricate male fitting and O-rings and inside of female fitting with clean engine oil XO-10W30-QSP or equivalent meeting Ford specification ESE-M2C153-E.

5. Fit female fitting to male fitting and push until garter spring snaps over flared end of female fitting.

6. Ensure coupling engagement by pulling on fitting and visually checking to make sure garter spring is over flared end of female fitting.

7. **NOTE: All vehicles require the large black clip to be installed on the supply side fuel line and the small gray clip to be installed on the return side fuel line.**

   Position retaining clip over metal portion of spring lock coupling. Firmly push retaining clip onto spring lock coupling. Make sure horseshoe portion of clip is over the coupling. Do not install retaining clip over rubber fuel line.

Fuel Charging Assembly

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Spring Lock Coupling Disconnect Tool (3/8 Inch)	T81P-19623-G1
Spring Lock Coupling Disconnect Tool (1/2 Inch)	T81P-19623-G2

Removal

1. **NOTE: Not all assemblies may be serviceable while on the engine. In some cases, removal of the fuel charging assembly may facilitate service of the various subassemblies. To remove the entire fuel charging assembly, the following procedure should be performed.**

   NOTE: If removing upper intake manifold for access to other components only, throttle body may remain attached.

   Perform pre-service procedures as outlined in Removal and Installation, Fuel Charging System in this section.

2. Disconnect intake air temperature sensor (IAT sensor) (12A697) and mass air flow sensor (MAF sensor) (12B579).

3. Remove air cleaner outlet tube (9B659).

4. Remove accelerator control splash shield (9E766).

5. Disconnect electrical connections to:

   a. Throttle position sensor (TP sensor) (9B989)
   b. Idle air control valve (IAC valve) (9F715)
   c. EGR vacuum regulator solenoid (9J459)

6. Disconnect accelerator cable (9A758).

7. Remove accelerator cable bracket bolts and tie bracket and cables out of the way.

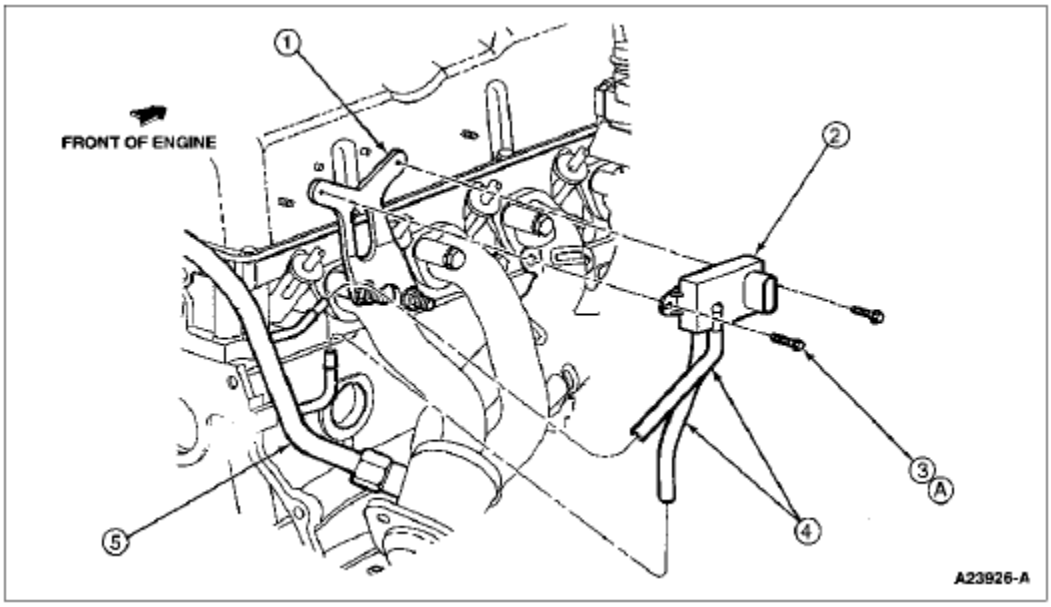
8. Disconnect crankcase ventilation hose (6853) from upper intake manifold.

9. Tag and disconnect vacuum hoses from manifold vacuum tee:

   a. Power brakes
   b. EGR
   c. Speed control
   d. Fuel pressure regulator

10. Disconnect EGR transducer hoses from EGR valve to exhaust manifold tube (9D477).

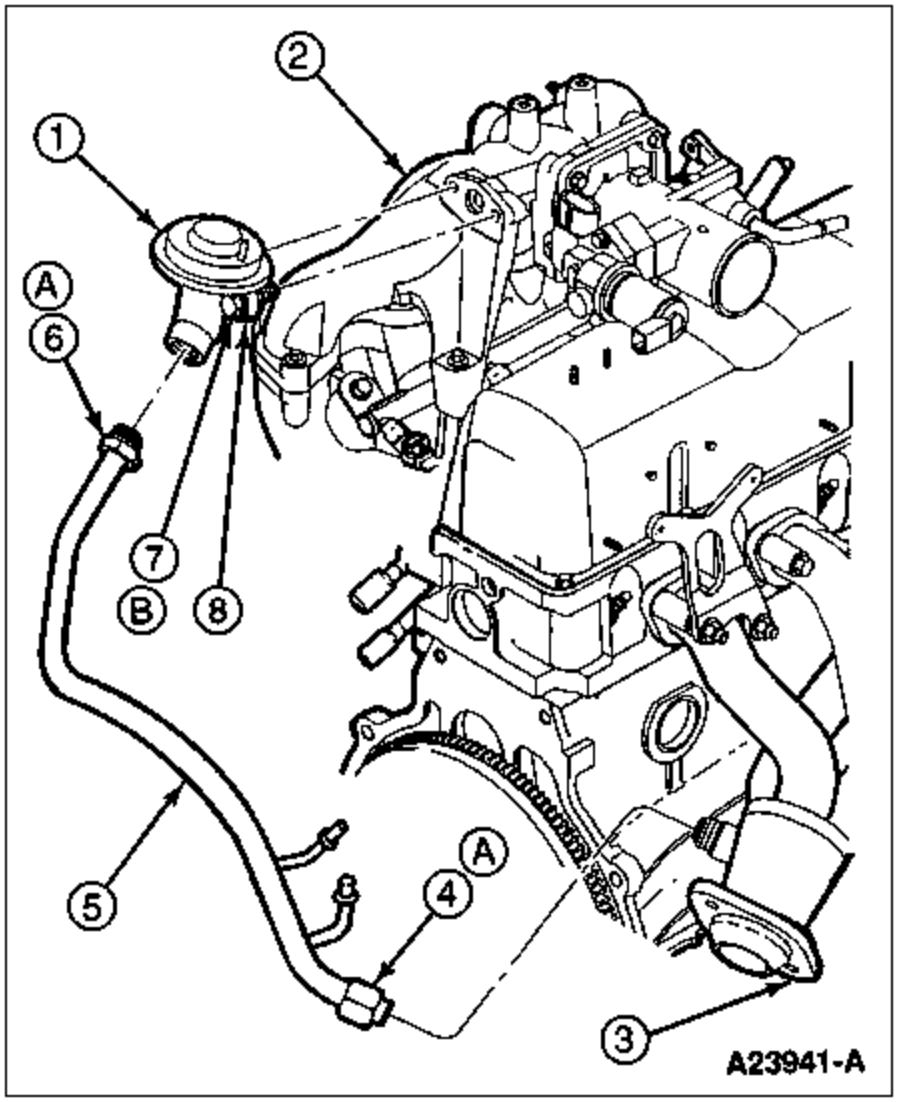
EGR Transducer



Item	Part Number	Description
1	17A084	Engine Lifting Eye
2	9J433	EGR Transducer
3	N807202-S36	Bolt, M5-0.8x16
4	—	Hoses (Part of 9J433)
5	9D477	EGR Valve to Exhaust Manifold Tube
A	—	Tighten to 2.7-3.7 Nm (24-32 Lb-Ft)

11. Apply Professional Choke and Linkage Cleaner E8AZ-19A501-AA, or equivalent penetrating lubricant meeting Ford specification ESR-M14P10-A to EGR tube nuts. Unscrew nuts and remove EGR valve to exhaust manifold tube.

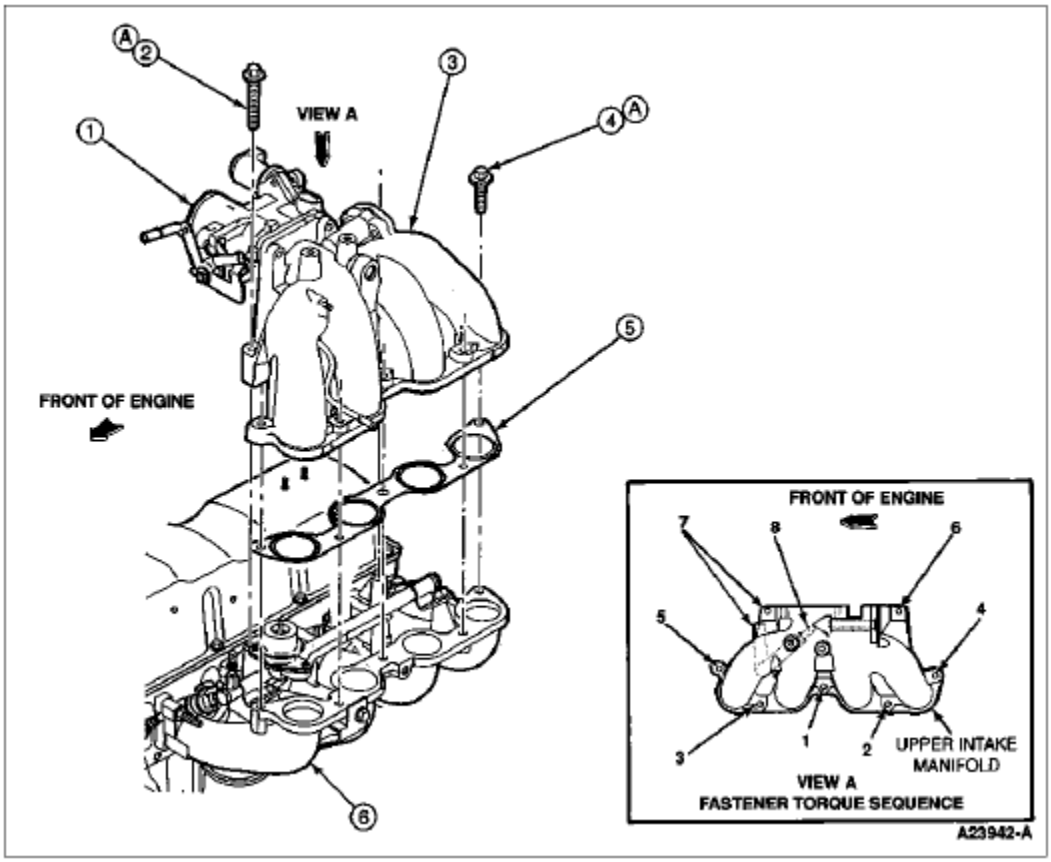
12. Remove two bolts and EGR valve (EGR valve) (9D475) and EGR valve gasket (9D476).



Item	Part Number	Description
1	9D475	EGR Valve
2	9424	Upper Intake Manifold
3	9430	Exhaust Manifold
4	—	Nut (Part of 9D477)
5	9D477	EGR Valve to Exhaust Manifold Tube
6	—	Nut (Part of 9D477)
7	N806781-S2	Screw, M8-1.25 x 35
8	9D476	EGR Valve Gasket
A	—	Tighten to 34-47 Nm (25-35 Lb-Ft)
B	—	Tighten to 20-30 Nm (15-22 Lb-Ft)

13. Remove six bolts and upper intake manifold and intake manifold upper gasket (9H486) from intake manifold (9424).

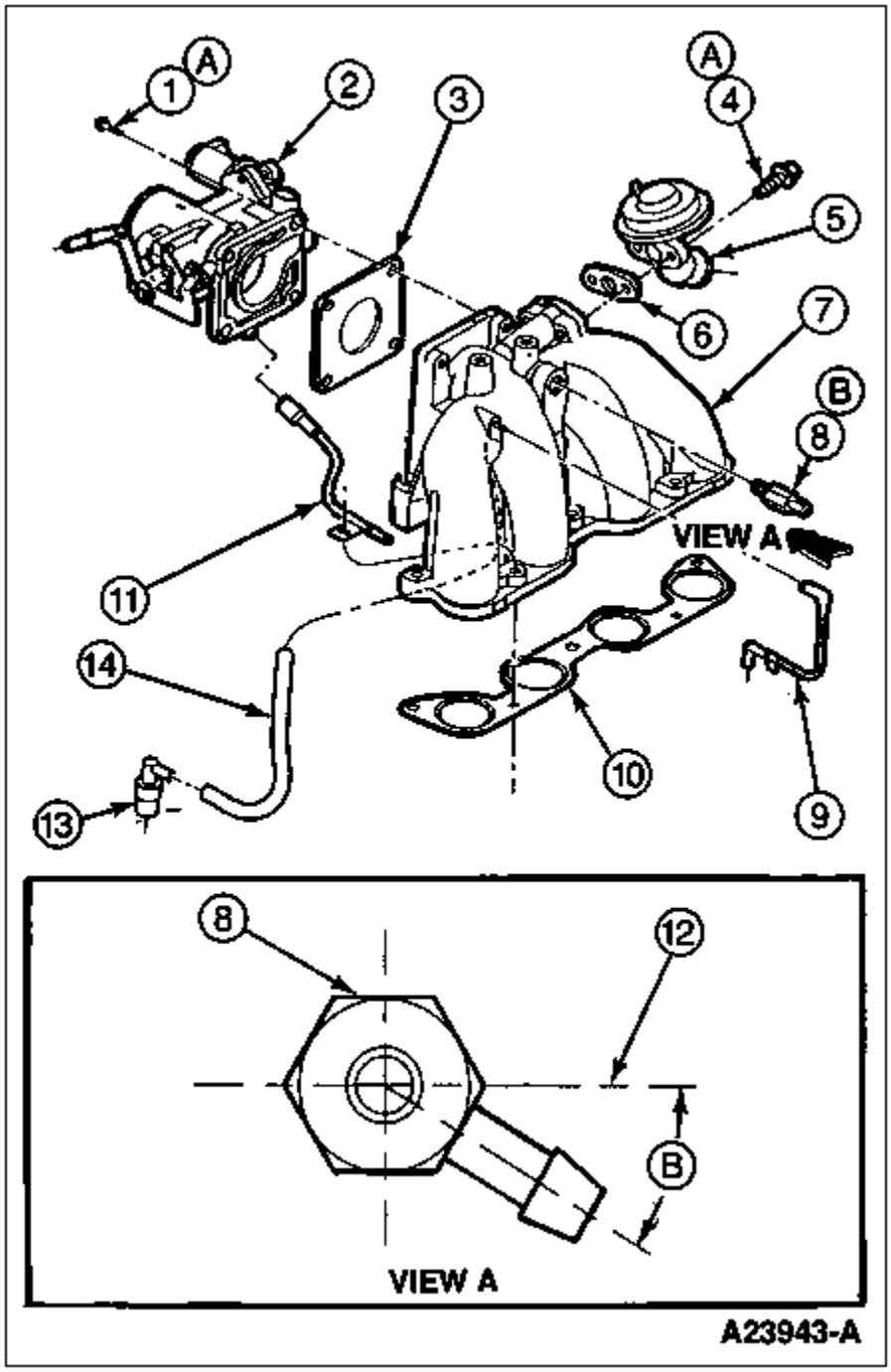
Upper Intake Manifold



Item	Part Number	Description
1	9E926	Throttle Body
2	N807462-S2	Bolt, M8-1.25 x 67.2
3	9424	Upper Intake Manifold
4	N807461-S2	Bolt, M8-1.25 x 45
5	9H486	Intake Manifold Upper Gasket
6	9424	Intake Manifold, Lower
A	—	Tighten According to Procedure in Text

14. If necessary, remove evaporative emission return tube (9G271) from throttle body (9E926) and upper intake manifold.

15. If necessary, remove four bolts, throttle body, and throttle body gasket (TB gasket) (9E936) from upper intake manifold.

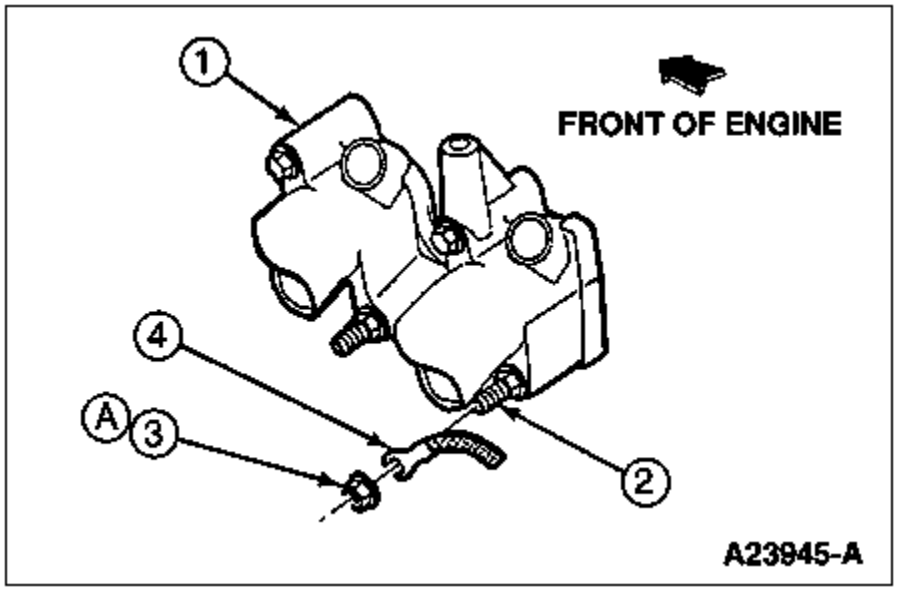


Item	Part Number	Description
1	N605788-S36	Bolt, M8-30
2	9E926	Throttle Body
3	9E936	Throttle Body Gasket

4	N806781-S2	Bolt
5	9D475	EGR Valve
6	9D476	EGR Valve Gasket
7	9425	Upper Intake Manifold
8	9A474	Intake Manifold Vacuum Outlet Fitting and Cap
9	9E498	Fuel Pressure Regulator Vacuum Tube
10	9H486	Intake Manifold Upper Gasket
11	9G271	Evaporative Emission Return Tube
12	—	Horizontal Reference
A	—	Tighten to 20-30 Nm (15-22 Lb-Ft)
B	—	Tighten to 6-12 Nm (54-106 Lb-In) then rotate so side nipple is 30 degrees below centerline of nipple parallel with engine crankshaft.

16. If necessary, remove intake manifold vacuum outlet fitting and cap (9A474) from upper intake manifold.

17. Remove nut and dash panel ground cable (14303) from No. 7 stud.

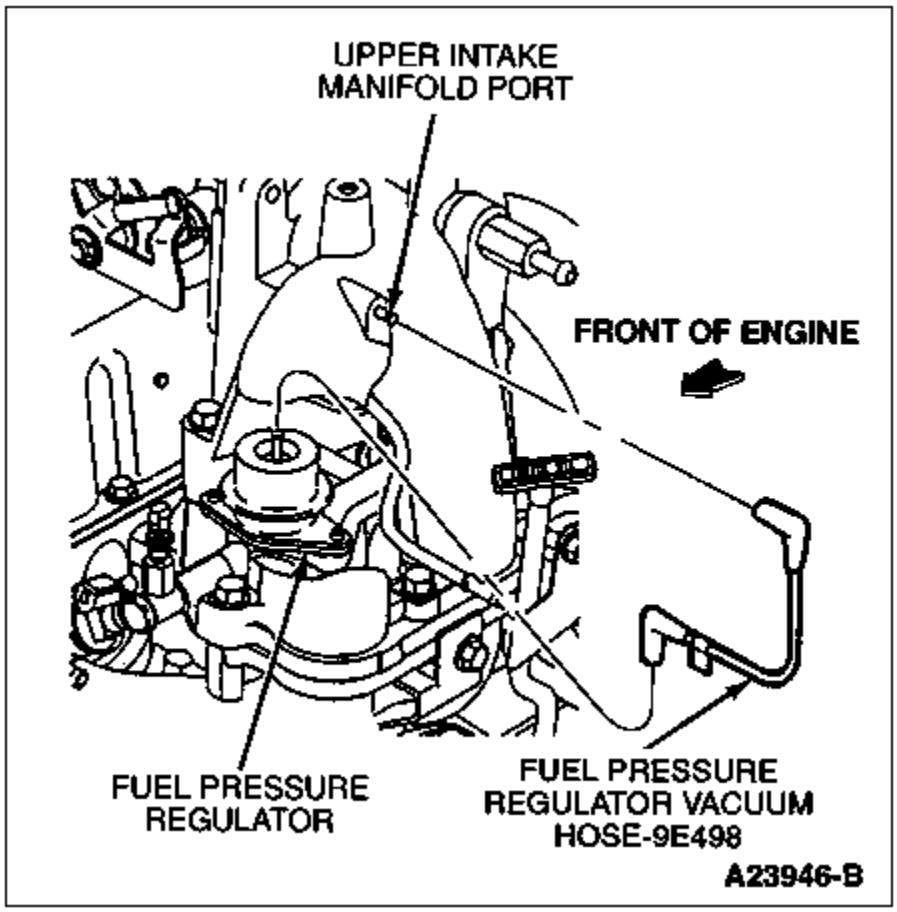


Item	Part Number	Description
1	9424	Intake Manifold
2	N807458-S101	Stud, M8-1.25 x 1.25 x 96.2
3	N620481-S2	Nut, M8 x 1

4	14303	Dash Panel Ground Cable
A	—	Tighten to 8-12 Nm (79-106 Lb-In)

18. Remove wiring harness clip from No. 6 stud.

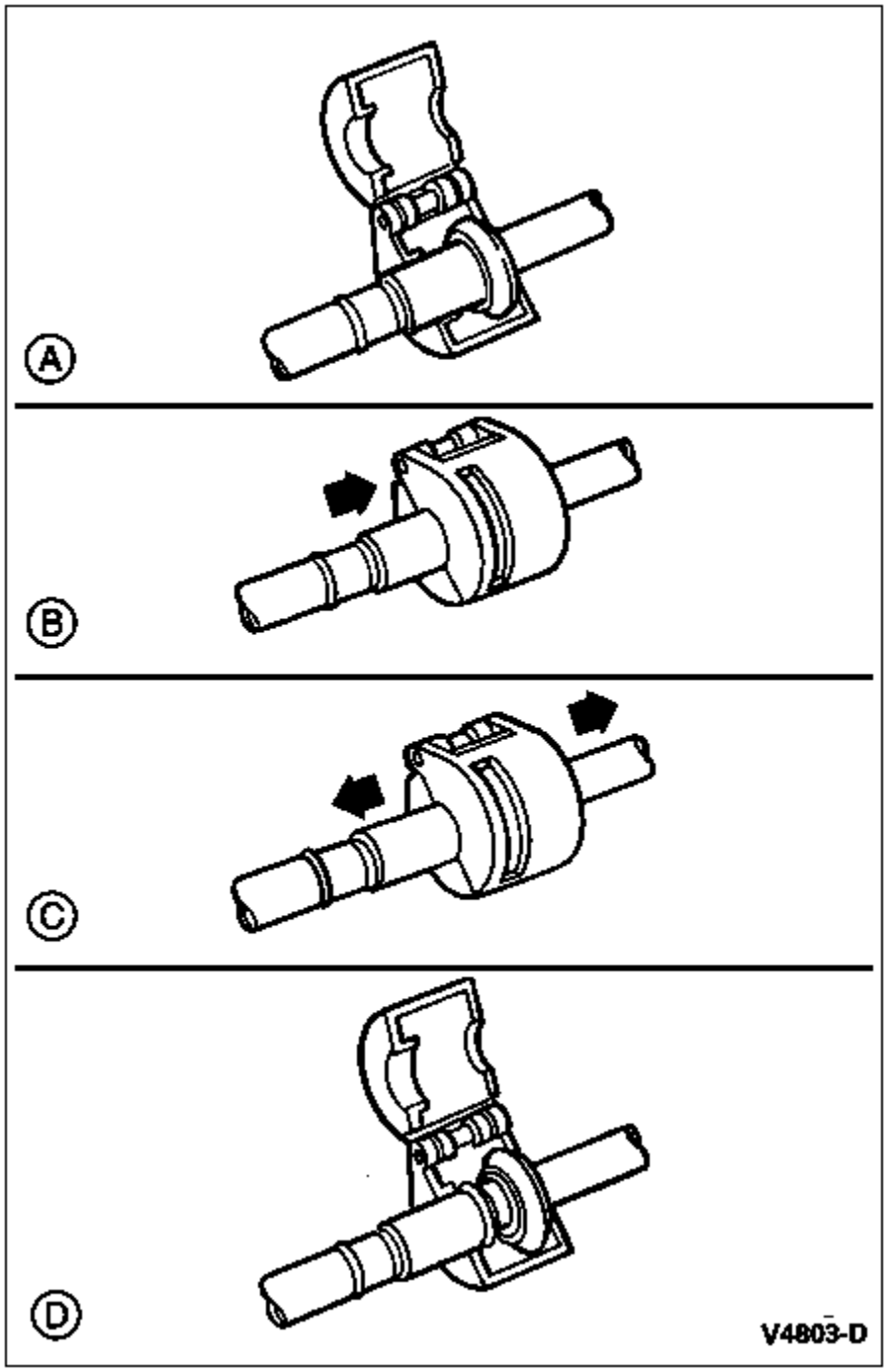
19. Disconnect vacuum hose from fuel pressure regulator (9C968).



20. Remove fuel tube clip (9A317) from fuel inlet and return fittings.

21. Using Spring Lock Coupling Disconnect Tool T81P-19623-G1 (3/8 Inch) or T81P-19623-G2 (1/2 inch), disconnect fuel hoses at the fuel rail supply tube and fuel rail return tube.

    a. Fit tool to coupling so tool can enter cage to release garter spring.
    b. Push the tool into the cage opening to release female fitting from garter spring.
    c. Pull the coupling male and female fittings apart.
    d. Remove the tool from the disconnected coupling.



22. Disconnect the electrical connectors from all four fuel injectors and move fuel charging wiring (9D930) aside.

23. Remove four bottom retaining bolts from lower manifold.

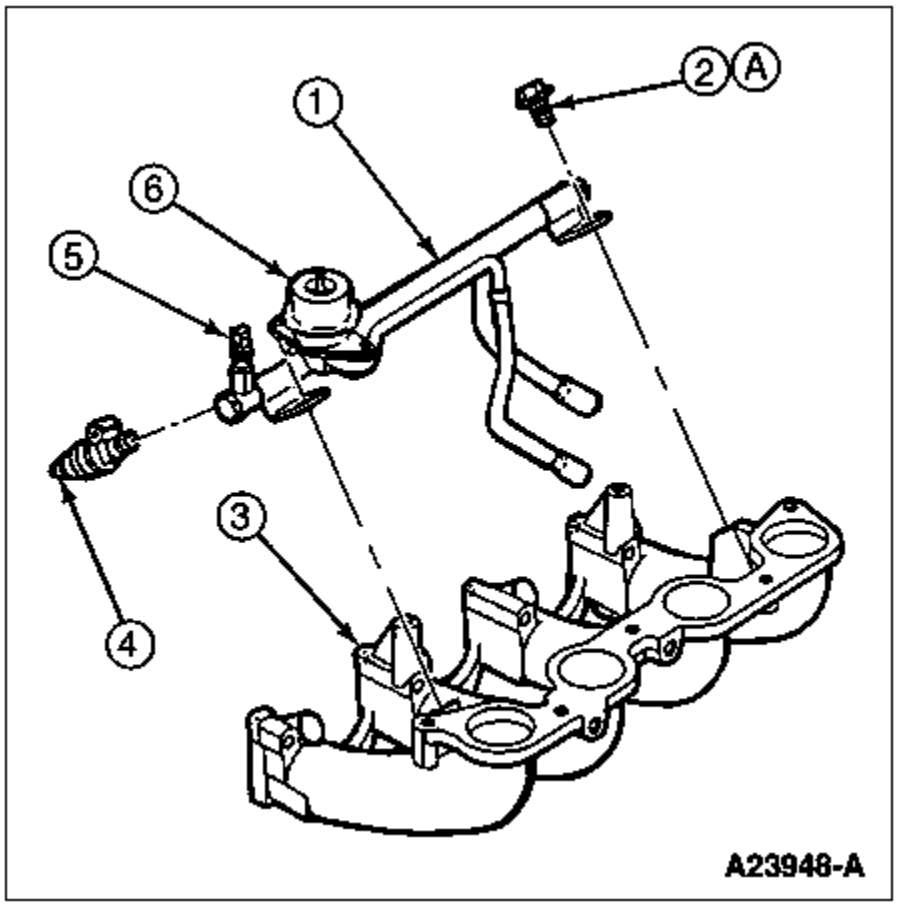
24. Remove four upper retaining bolts from lower manifold. Remove lower intake manifold assembly.

25. Remove two screws and fuel injection supply manifold (9D280) from lower intake manifold, if necessary.

26. Remove fuel injectors (9F593) from lower intake manifold, if necessary. Grasping injector body, pull

up while gently rocking injector from side to side.

27. If necessary, remove screw and 42-pin connector bracket.



Item	Part Number	Description
1	9D280	Fuel Injection Supply Manifold
2	N807897-S100	Bolt, M8-1.25 x 31
3	9424	Intake Manifold, Lower
4	9F593	Fuel Injector
5	9H321	Fuel Pressure Relief Valve
6	9C968	Fuel Pressure Regulator
A	—	Tighten to 20-30 Nm (15-22 Lb-Ft)

Installation

1. Clean and inspect the mounting faces of the intake manifold assembly and the cylinder heads (6049). Both surfaces must be clean and flat.

2. If fuel injectors were removed:

    a. Inspect injector O-rings (two per injector) for signs of deterioration.
    b. If replacing, lubricate new O-rings with 10W-30 motor oil such as XO-10W30-QSP or equivalent meeting Ford specification ESE-M2C153-E and install two on each injector.
    c. Install fuel injectors into lower intake manifold.

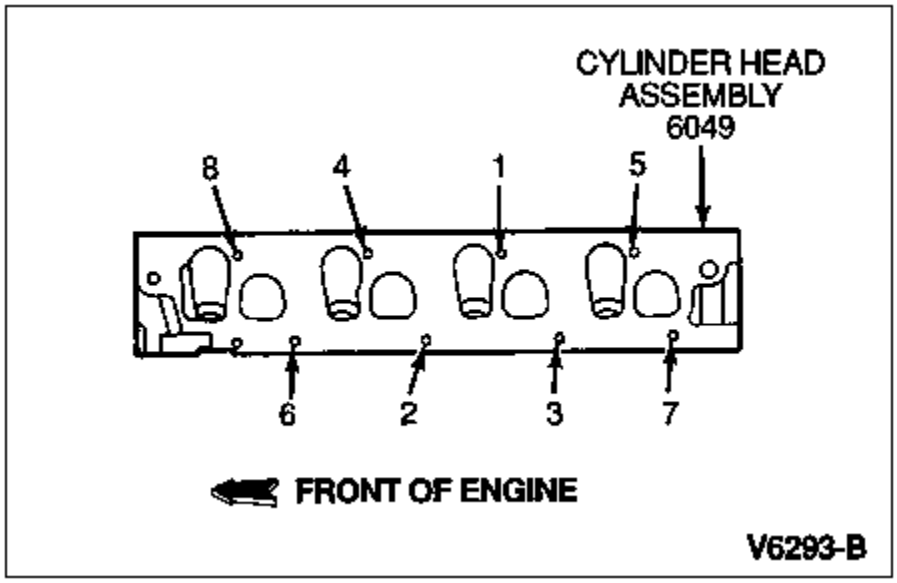
3. If removed, install fuel injection supply manifold. Tighten bolts to 20-30 Nm (15-22 lb-ft).

4. Clean and lightly oil manifold bolt threads.

5. Install a new intake manifold gasket (9439).

6. Position the lower manifold assembly to cylinder head. Install four upper manifold retaining bolts finger-tight.

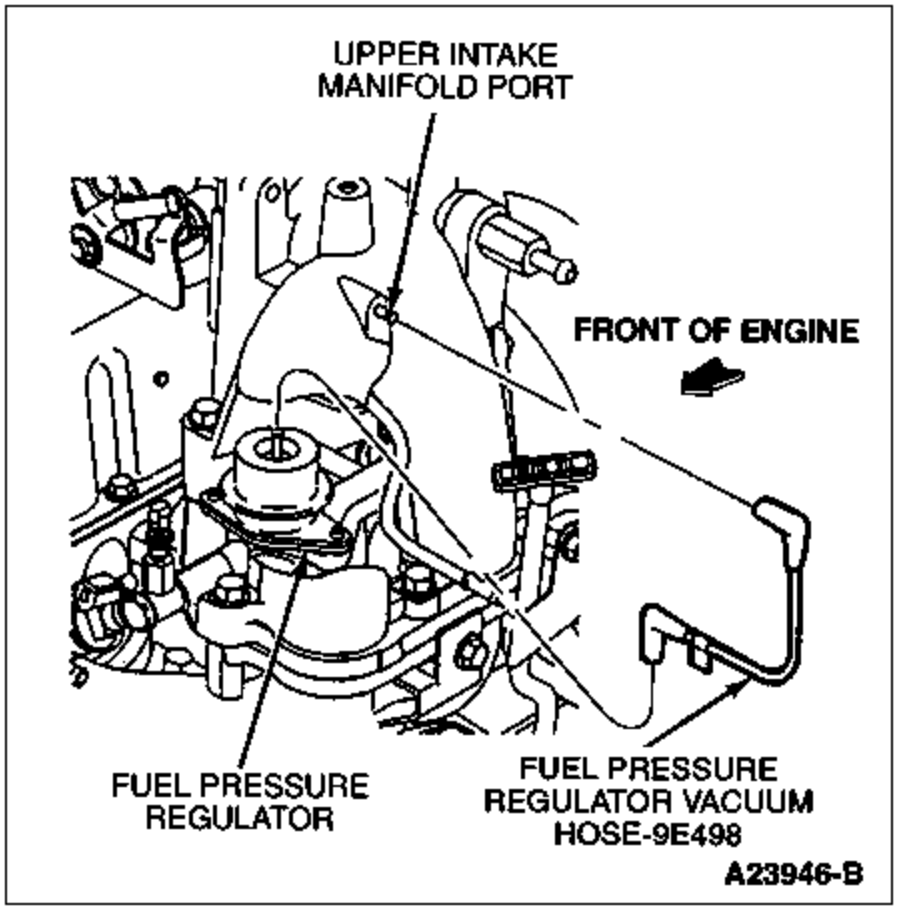
7. Install four remaining manifold bolts. Tighten all bolts to 26-38 Nm (19-28 lb-ft) following the tightening sequence.



8. Install the fuel injection supply manifold and fuel injectors with two retaining bolts. Tighten bolts to 20-30 Nm (15-22 lb-ft).

9. Connect electrical connectors to fuel injectors.

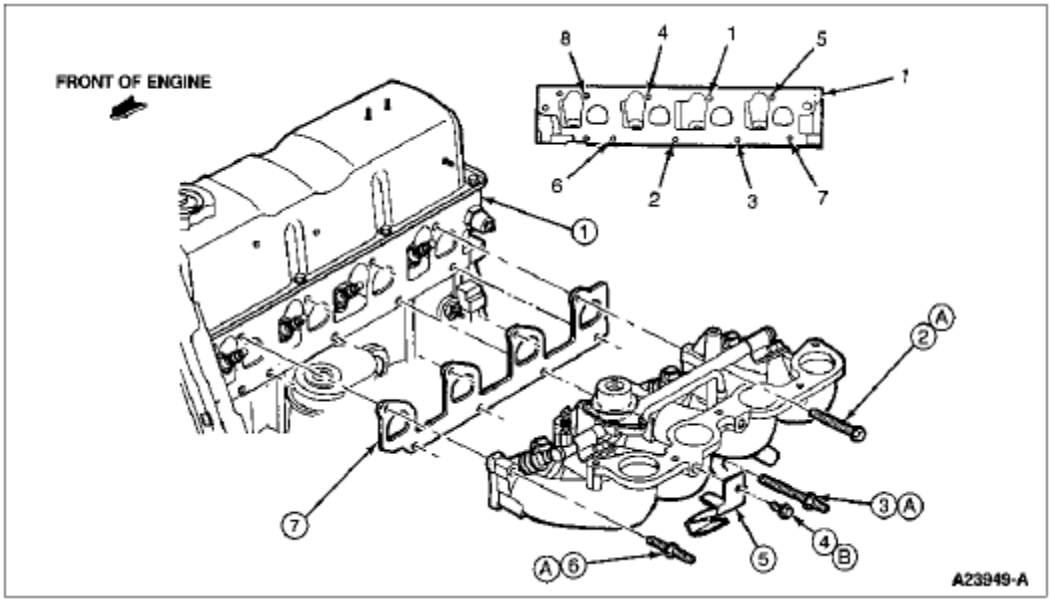
10. Connect vacuum hose to fuel pressure regulator.



11. Push wiring harness clip onto front bottom intake manifold stud.

12. Install dash panel ground cable on rear bottom intake manifold stud and tighten nut to 8-12 Nm (79-106 lb-in).

Lower Intake Manifold



Item	Part Number	Description
1	6049	Cylinder Head
2	N807462-S101	Bolt, M8-1.25 x 67.2 (Holes 1, 2, 4, and 5)
3	N807458-S101	Stud, M8-1.25 x 1.25 x 96.2 (Holes 3, 6, and 7)
4	N605904-S36	Bolt, M8-1.25 x 16.6
5	14A004	42-Pin Connector Bracket
6	N808163-S100	Stud, M8-1.25 x 1.25 x 63.7 (Hole 8)
7	9439	Intake Manifold Gasket
A	—	Refer to Procedure in Text
B	—	Tighten to 20-30 Nm (15-22 Lb-In)

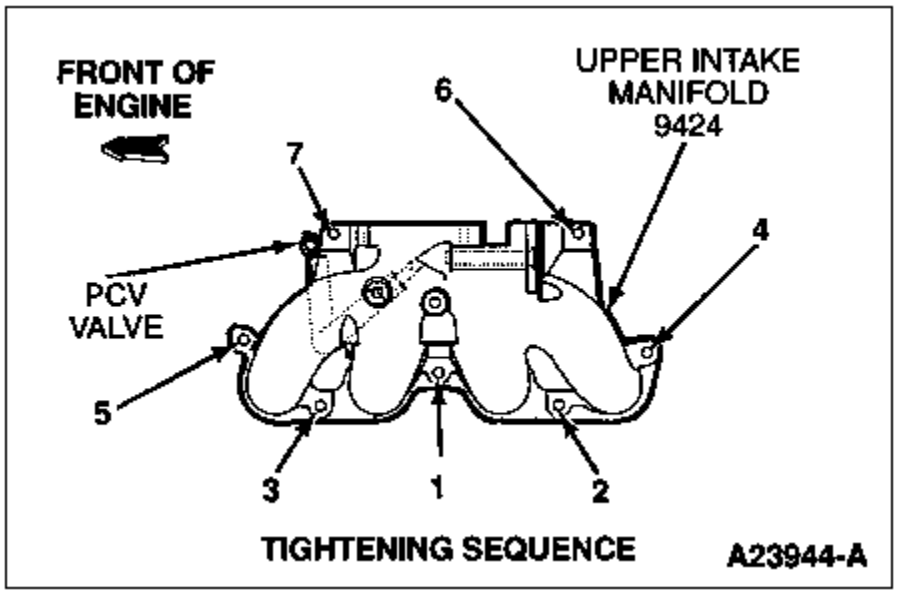
13. If removed, install intake manifold vacuum outlet fitting and cap. Tighten to 6-12 Nm (54-106 lb-in). Rotate clockwise so side nipple is 30 degrees below centerline of nipple parallel with engine crankshaft (6303) (bottom of upper intake manifold).

14. If removed, install throttle body gasket, throttle body and four bolts to upper intake manifold. Alternately tighten to 20-30 Nm (15-22 lb-ft).

15. If removed, install evaporative emission return tube on throttle body tube and position on upper intake manifold.

16. Position intake manifold upper gasket and upper intake manifold.

17. Start bolts. Tighten in sequence to 7-10 Nm (61-88 lb-in) then tighten in sequence to 26-38 Nm (19-28 lb-ft).



18. Install EGR valve and EGR valve gasket and tighten bolts to 20-30 Nm (15-22 lb-ft).

19. Install EGR valve to exhaust manifold tube and tighten nuts to 34-47 Nm (25-34 lb-ft).

20. Connect vacuum hoses to intake manifold vacuum tee:

    a. Fuel pressure regulator
    b. Speed control
    c. EGR valve
    d. Power brakes

21. Connect EGR transducer (9J433) hoses to correct nipples on EGR valve to exhaust manifold tube.

22. Connect crankcase ventilation hose to throttle body.

23. Install accelerator cable bracket (9723) to throttle body and tighten bolts to 21-28 Nm (16-20 lb-ft).

24. Connect accelerator cable.

25. Connect throttle body and upper intake manifold electrical connections:

    a. EGR vacuum regulator solenoid
    b. Ignition control module (ICM) (12A199)
    c. Idle air control valve
    d. Throttle position sensor

26. Connect intake air temperature sensor and mass air flow sensor.

27. Install accelerator control splash shield.

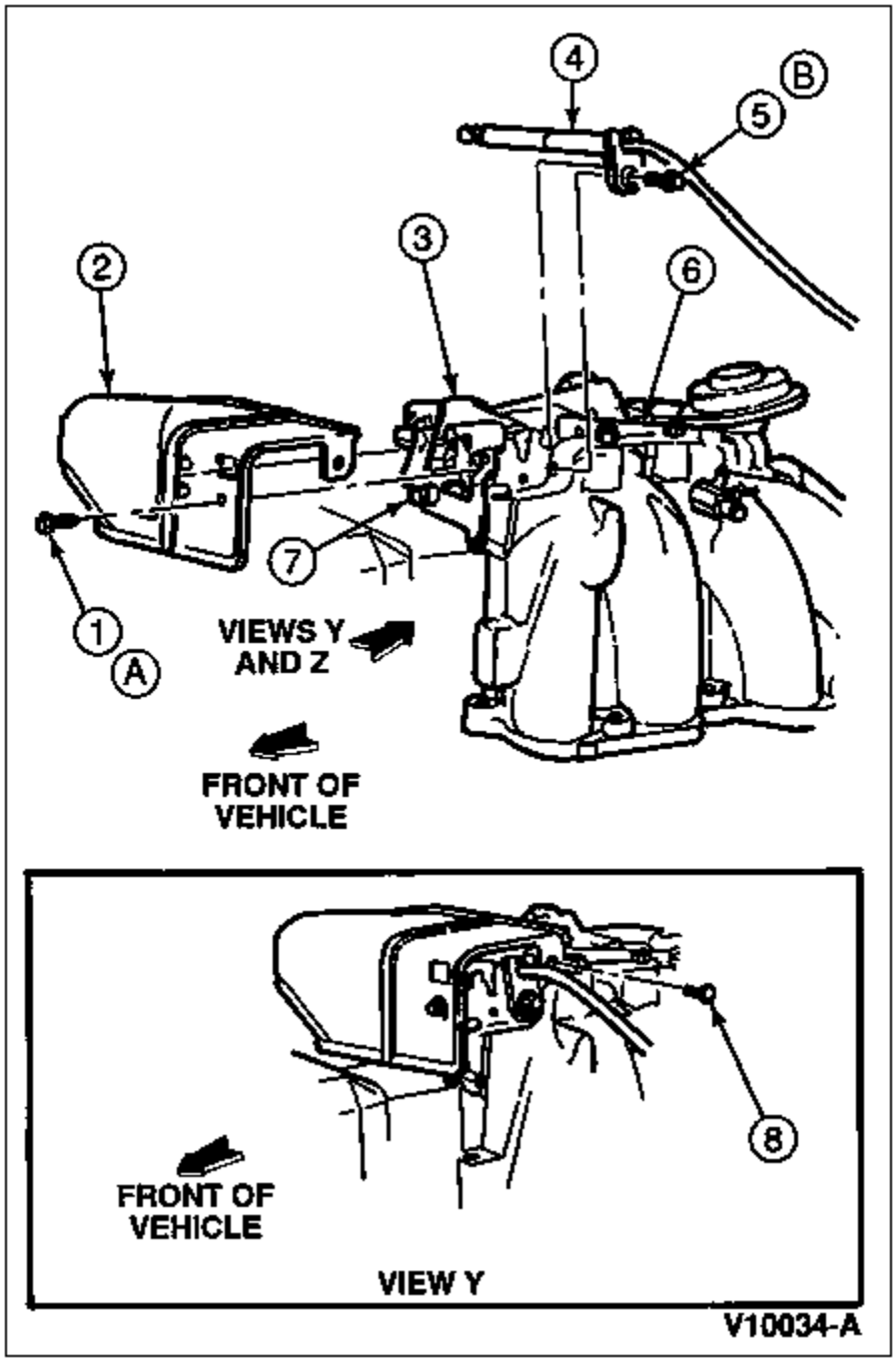
28. Install air cleaner outlet tube.

29. Start engine (6007) and check for leaks.

Throttle Body

Removal

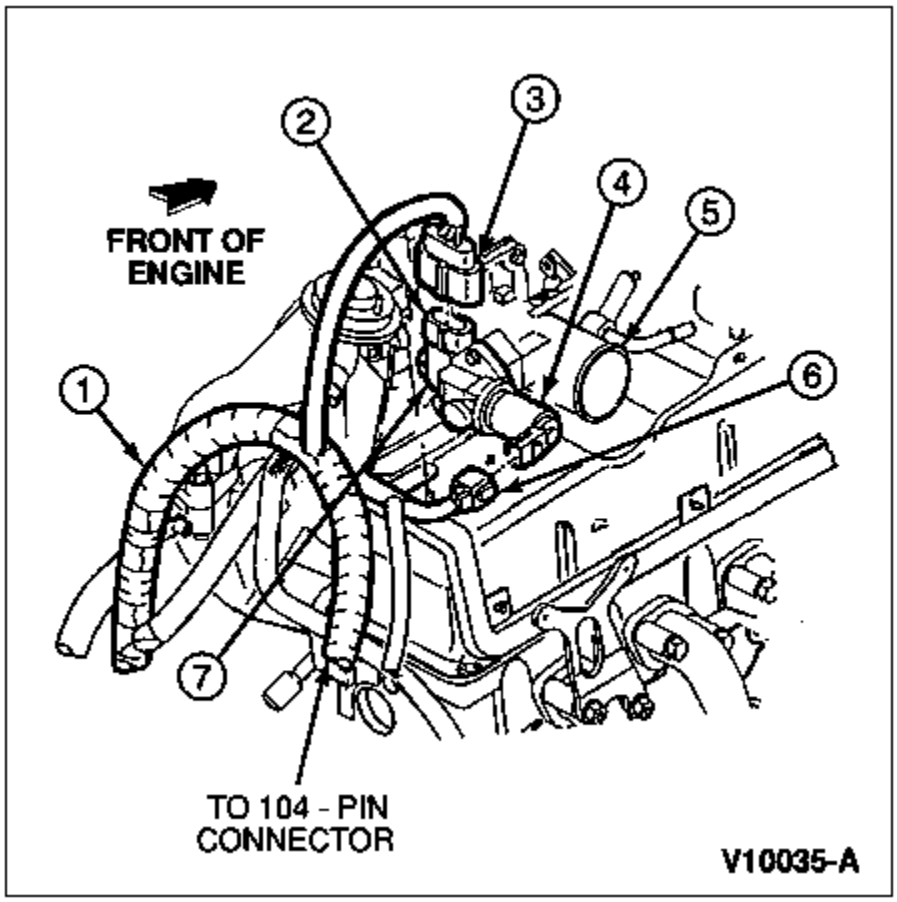
1. Remove the accelerator control splash shield (9E766). Using a screwdriver pry the accelerator cable (9A758) and cruise control cable off throttle lever ball stud. Unbolt the accelerator cable and bracket from the throttle body (9E926) and position out of the way.



Item	Part Number	Description
1	N610959-S2	Screw, M6.3-19
2	9E766	Accelerator Control Splash Shield
3	9E926	Throttle Body
4	9A758	Accelerator Cable
5	N610959-S2	Screw, M6.3-19
6	9723	Accelerator Cable Bracket

7	—	Ball Stud (Part of 9E926)
8	N804527-S100	Pushpin
A	—	Tighten to 6-8 Nm (52-71 Lb-In)
B	—	Tighten to 7-9 Nm (60-81 Lb-In)

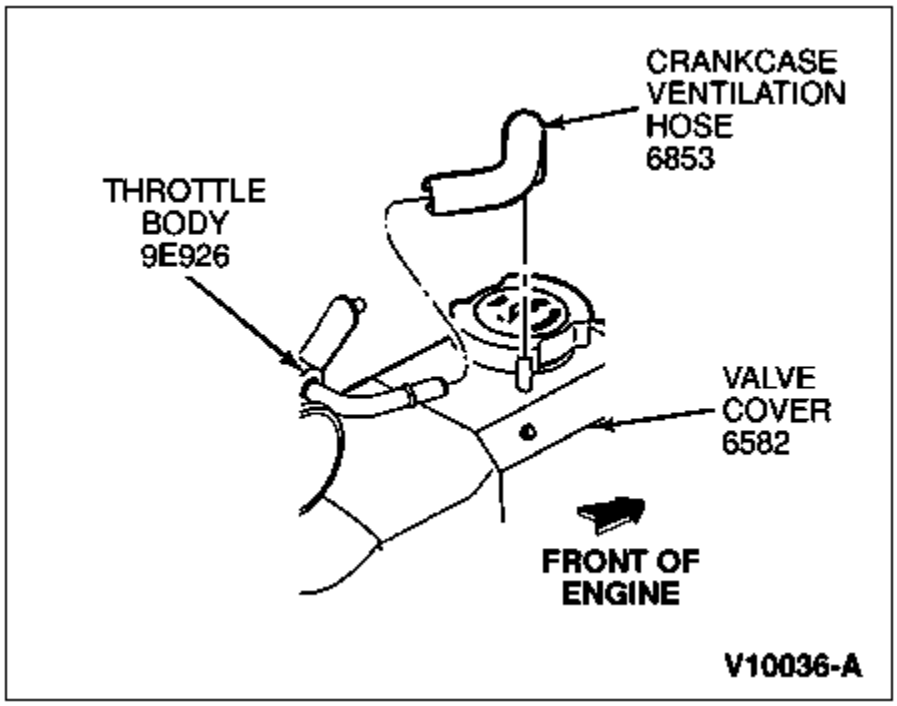
2. Disconnect the wire connectors at the throttle position sensor (TP sensor) (9B989) and the idle air control valve (IAC valve) (9F715).



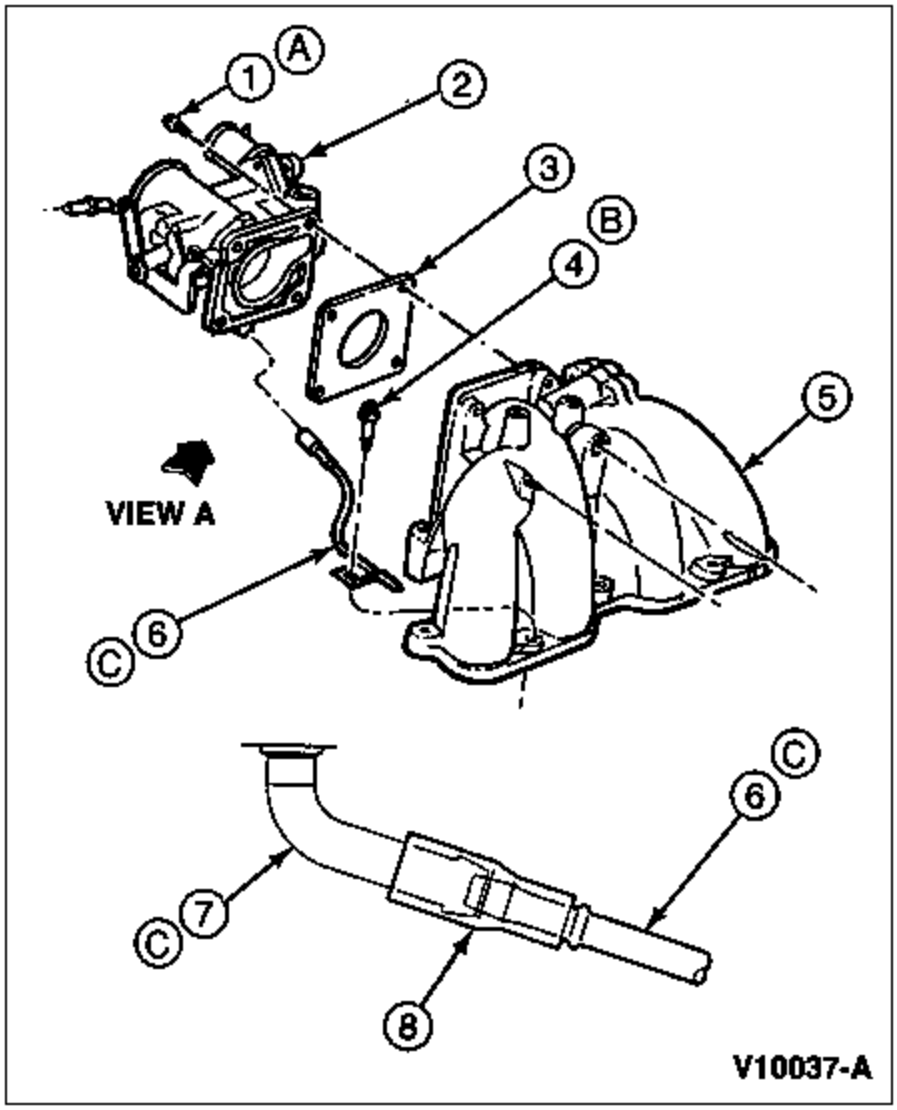
Item	Part Number	Description
1	12A581	Engine Control Sensor Wiring
2	9B989	Throttle Position Sensor
3	—	Throttle Position Sensor Connector (Part of 12A581)
4	9F715	Idle Air Control Valve
5	9E926	Throttle Body
6	—	Idle Air Control Valve Connector (Part of 12A581)
7	9B989	Throttle Position Sensor

3. Loosen the clamp and disconnect the engine air cleaner intake tube and duct (9A673) from the throttle body.

4. Disconnect the crankcase ventilation hose.



5. Remove the four bolts securing the throttle body to the upper intake manifold (9424), and remove the throttle body and disconnect throttle body from evaporative emission return tube (9G271).



Item	Part Number	Description
1	N605788-S36	Bolt, M8-30
2	9E926	Throttle Body
3	9E936	Throttle Body Gasket
4	N807461-S2	Bolt, M8-1.25 x 45
5	9425	Upper Intake Manifold
6	9G271	Evaporative Emission Return Tube
7	—	Fuel Vapor Port (Part of 9E926)
8	—	Connector Hose (Part of 9G271)
A	—	Tighten to 20-30 Nm

		(15-22 Lb-Ft)
B	—	If removed by itself, tighten to 26-38 Nm (19-28 lb-ft). If part of installing entire upper intake manifold, refer to Upper Intake Manifold Installation text, Section 03-01A .
C	—	Fully press together so connecting hose is firmly seated on both tube and port.

Installation

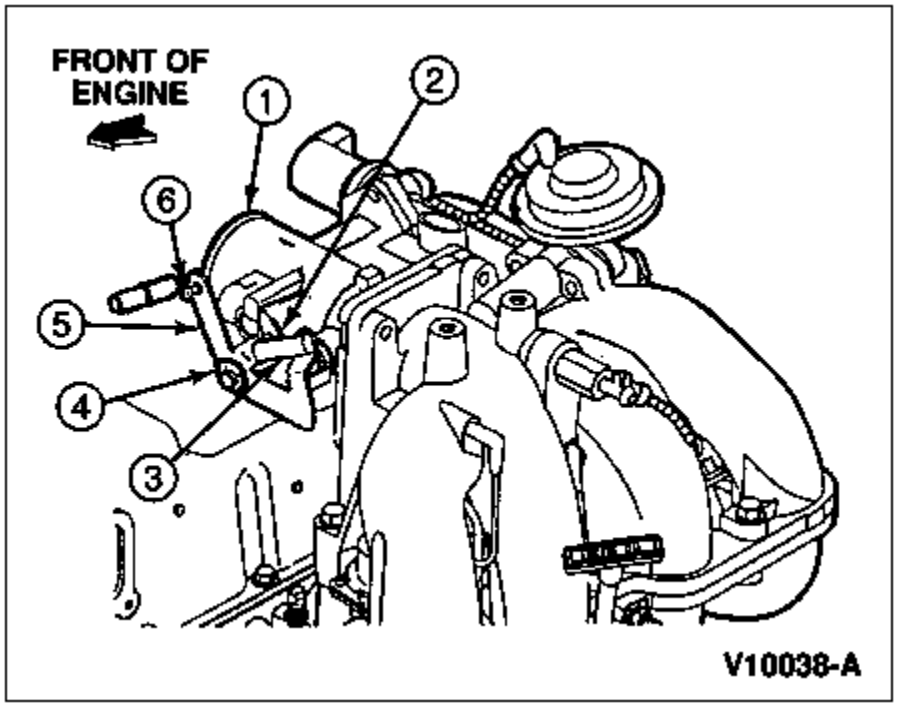
1. Push throttle body fuel vapor port into fuel vapor return tube connector hose.
2. Position the throttle body and new gasket to the upper intake manifold, and hand-start all four bolts. Tighten the bolts evenly to 20-30 Nm (15-25 lb-ft).
3. Connect the crankcase ventilation hose.
4. Connect the engine air cleaner intake tube and duct to the throttle body and tighten the clamp to 2-3 Nm (18-27 lb-in).
5. Connect the wire connectors at the throttle position sensor and the idle air control valve.
6. Connect the throttle linkage and cruise control. Bolt accelerator cable and bracket and oil pressure sensor to throttle body. Install the accelerator control splash shield and tighten screw to 6-8 Nm (52-71 lb-in).
7. Make sure that nothing interferes with the operation of the accelerator linkage and that the accelerator cable does not bind. With engine (6007) running and vehicle in park (automatic transmission) or neutral (manual transmission) and parking brake set, quickly step on and release accelerator pedal. Engine should return to idle without hesitation or accelerator cable binding. Relocate components or replace accelerator cable as needed.

Secondary Throttle Lever

Removal and Installation

1. Remove accelerator control splash shield (9E766).
2. Remove retaining bolt and move accelerator cable out of the way.
3. Disconnect and remove rod connecting primary and secondary lever assemblies.
4. Remove E-ring and steel and plastic washers, noting the location of each for reassembly.
5. Remove secondary lever assembly.

For installation, follow removal procedures in reverse order. Tighten accelerator cable retaining bolt to 7-9 Nm (60-81 lb-in). Tighten accelerator splash shield retaining screw to 6-8 Nm (52-71 lb-in).



Item	Part Number	Description
1	9E926	Throttle Body
2	—	Primary Throttle Lever (Part of 9E926)
3	—	Connecting Rod (Part of 9E926)
4	—	E-Clip (Part of 9E926)

5	—	Secondary Throttle Lever (Part of 9E926)
6	—	Ball Stud (Part of 9E926)

Idle Air Control Valve

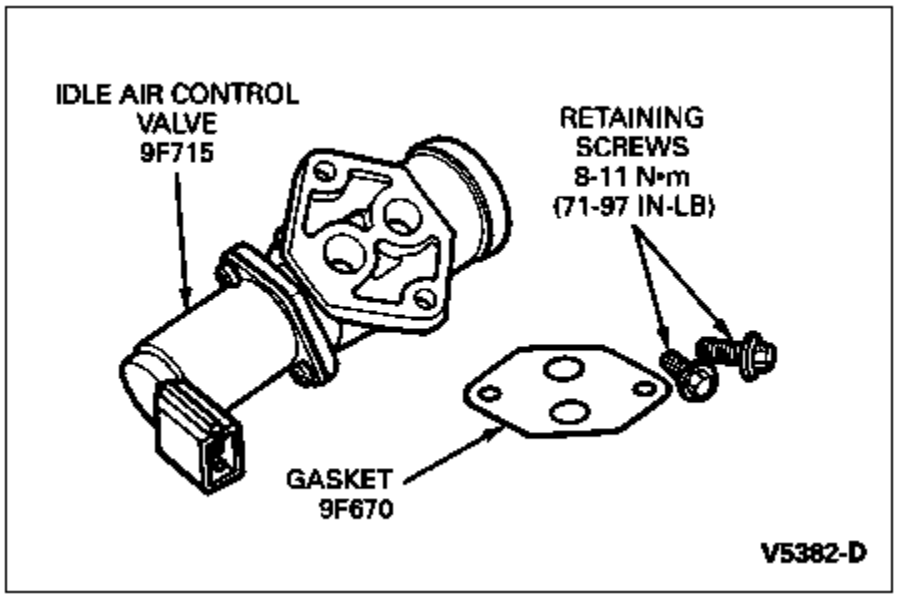
Removal

1. Remove accelerator control splash shield (9E766).
2. Disconnect idle air control valve connector from idle air control valve (IAC valve) (9F715).
3. Remove two idle air control valve retaining screws.
4. **NOTE: If scraping is necessary, be careful not to damage idle air control valve or throttle body gasket surfaces, or drop material into throttle body (9E926).**

   Remove idle air control valve and gasket.

Installation

1. Make sure that both throttle body and idle air control valve gasket surfaces are clean.



2. Install gasket on throttle body surface and mount idle air control valve, securing it with two retaining screws. Tighten to 8-11 Nm (71-97 lb-in).
3. Connect electrical connector for idle air control valve.
4. Install accelerator control splash shield and tighten screw to 6-8 Nm (52-71 lb-in).

Throttle Position Sensor

Removal

1. **NOTE: The throttle position sensor (TP sensor) (9B989) can only be removed after the idle air control valve (IAC valve) (9F715) has been removed from the throttle body (9E926).**

   Remove the idle air control valve as described in Removal and Installation, Idle Air Control Valve in this section.

2. Disconnect throttle position sensor from the wiring harness.

3. Remove the two throttle position sensor retaining screws.

4. Remove the throttle position sensor and gasket.

Installation

1. Make sure that both throttle body and idle air control valve gasket surfaces are clean.

2. **CAUTION: Slide rotary tangs into position over throttle shaft blade, then rotate throttle position sensor CLOCKWISE ONLY to installed position. Failure to install the throttle position sensor in this manner may result in excessive idle speeds.**

   Position the throttle position sensor and gasket on the throttle body. Make sure that rotary tangs on sensor are in proper alignment with the throttle shaft blade.

3. **NOTE: This throttle position sensor is non-adjustable.**

   Secure throttle position sensor to throttle body with two retaining screws. Tighten to 3-4 Nm (27-35 lb-in).

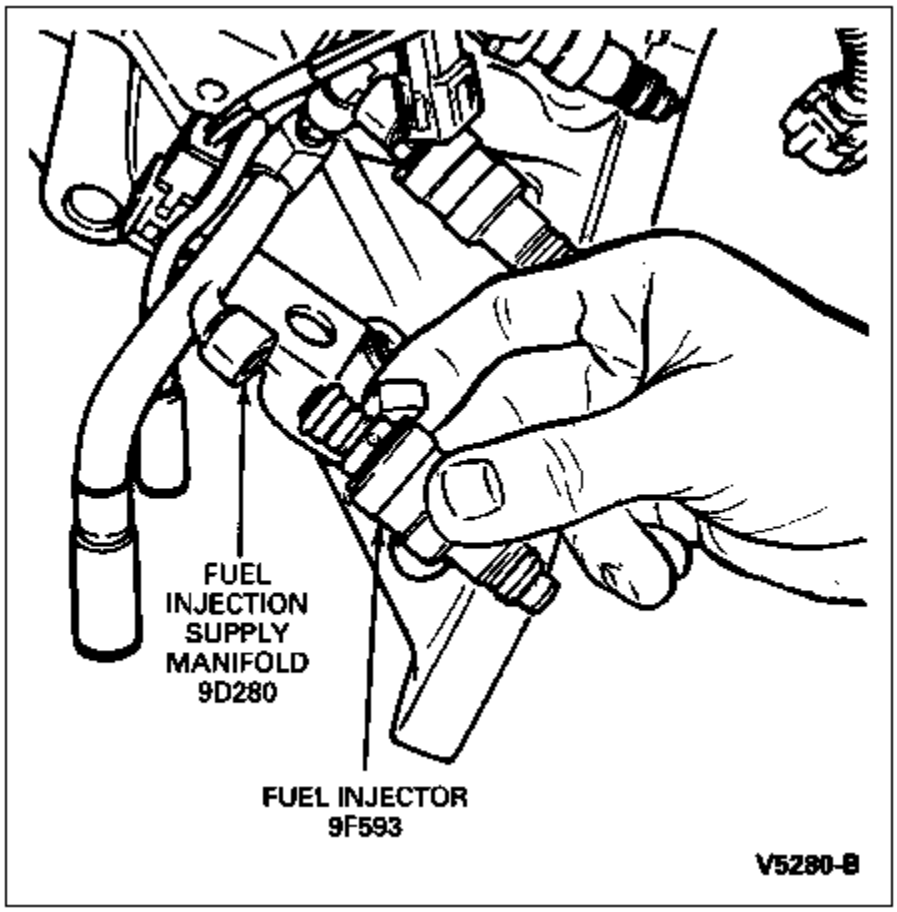
4. Connect electrical connector from the harness to the sensor.

Fuel Injector

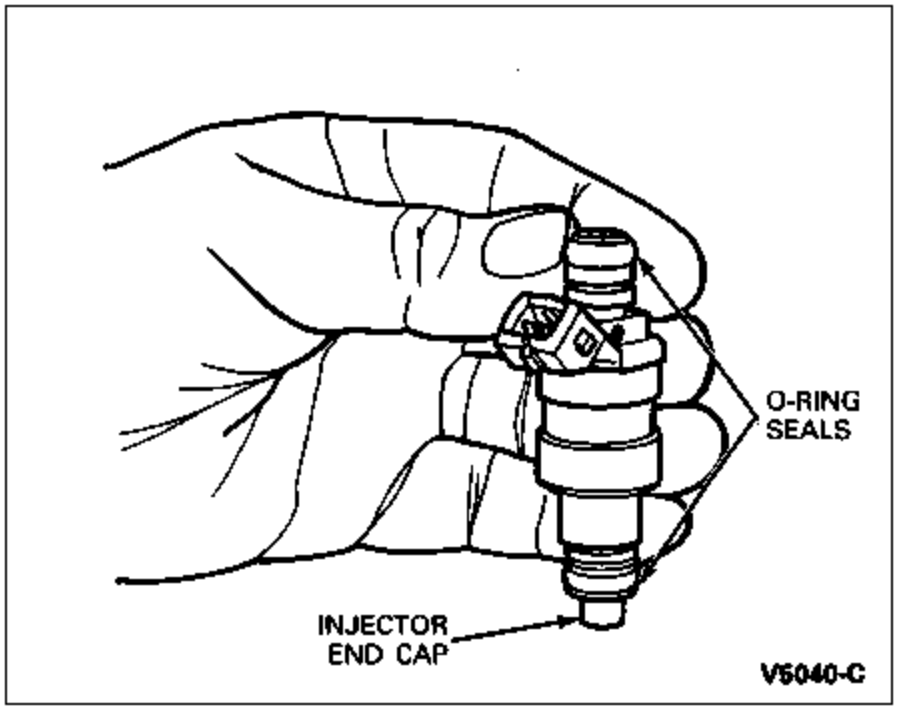
Removal and Installation

1. Remove fuel injection supply manifold (9D280) as outlined in Removal and Installation, Fuel Injection Supply Manifold in this section.

2. Grasping injector body, pull up while gently rocking fuel injector from side to side.



3. Inspect fuel injector O-rings (two per injector) for signs of deterioration. Replace as required.



For installation, follow removal procedures in reverse order. Refer to Removal and Installation, Fuel Injection Supply Manifold in this section.

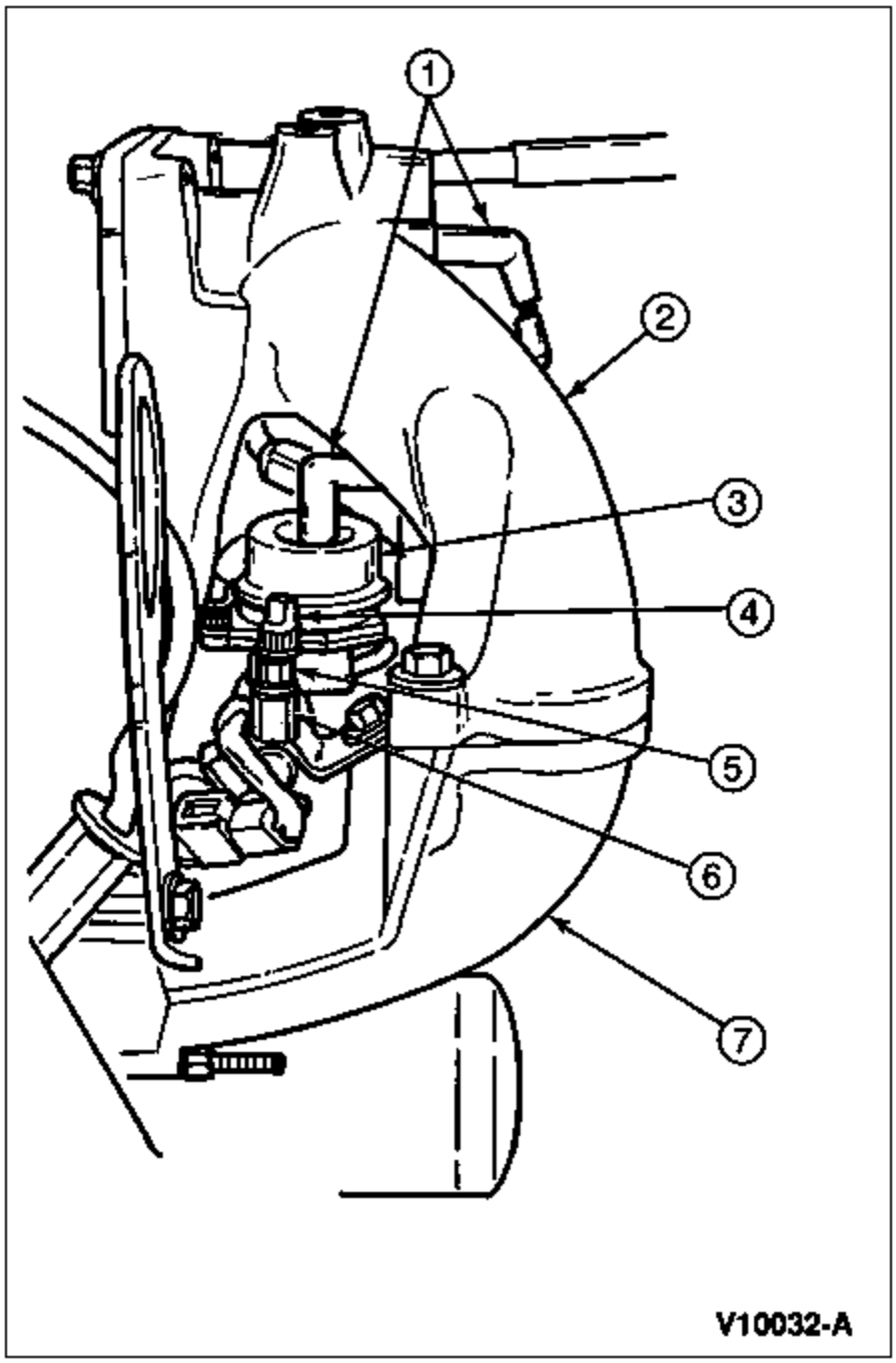
Fuel Pressure Relief Valve

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Multiport Fuel Injection (MFI) Fuel Pressure Gauge (EFI/CFI)	T80L-9974-B

Removal and Installation

1. Perform pre-service procedures as outlined in Removal and Installation, Fuel Charging System in this section.
2. If not removed, remove fuel pressure relief valve cap (9H323).
3. Using an open-end wrench, remove fuel pressure relief valve (9H321).
4. Install fuel pressure relief valve and cap. Tighten valve to 6-10 Nm (53-89 lb-in). Install cap onto fuel pressure relief valve.



Item	Part Number	Description
1	9E498	Fuel Pressure Regulator Vacuum Tube
2	9424	Upper Intake Manifold
3	9C968	Fuel Pressure Regulator
4	9H323	Fuel Pressure Relief Valve Cap
5	9H321	Fuel Pressure Relief Valve
6	9D280	Fuel Injection Supply Manifold

7	9424	Lower Intake Manifold

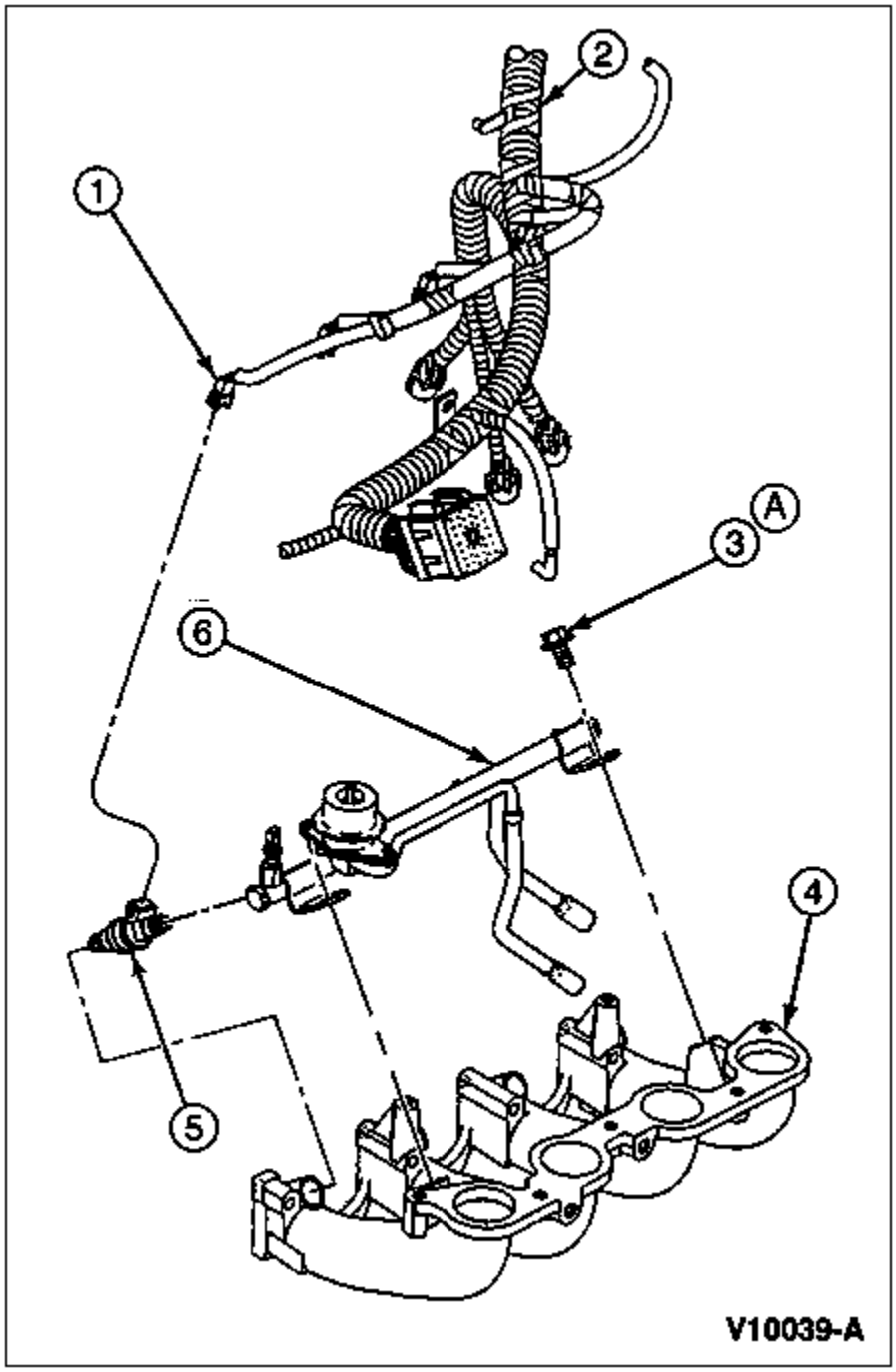
Fuel Injection Supply Manifold

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Spring Lock Coupling Disconnect Tool (3/8 Inch)	T81P-19623-G1
Spring Lock Coupling Disconnect Tool (1/2 Inch)	T81P-19623-G2

Removal

1. Perform pre-service procedures as outlined in Removal and Installation, Fuel Charging System in this section.



Item	Part Number	Description
1	—	Fuel Injector Connector (Part of 12A581)
2	12A581	Engine Control Sensor Wiring
3	N807897-S100	Bolt, M8-1.25 x 31
4	9424	Lower Intake Manifold
5	9F593	Fuel Injector
6	9D280	Fuel Injection Supply Manifold

A	—	Tighten to 20-30 Nm (15-22 Lb-Ft)

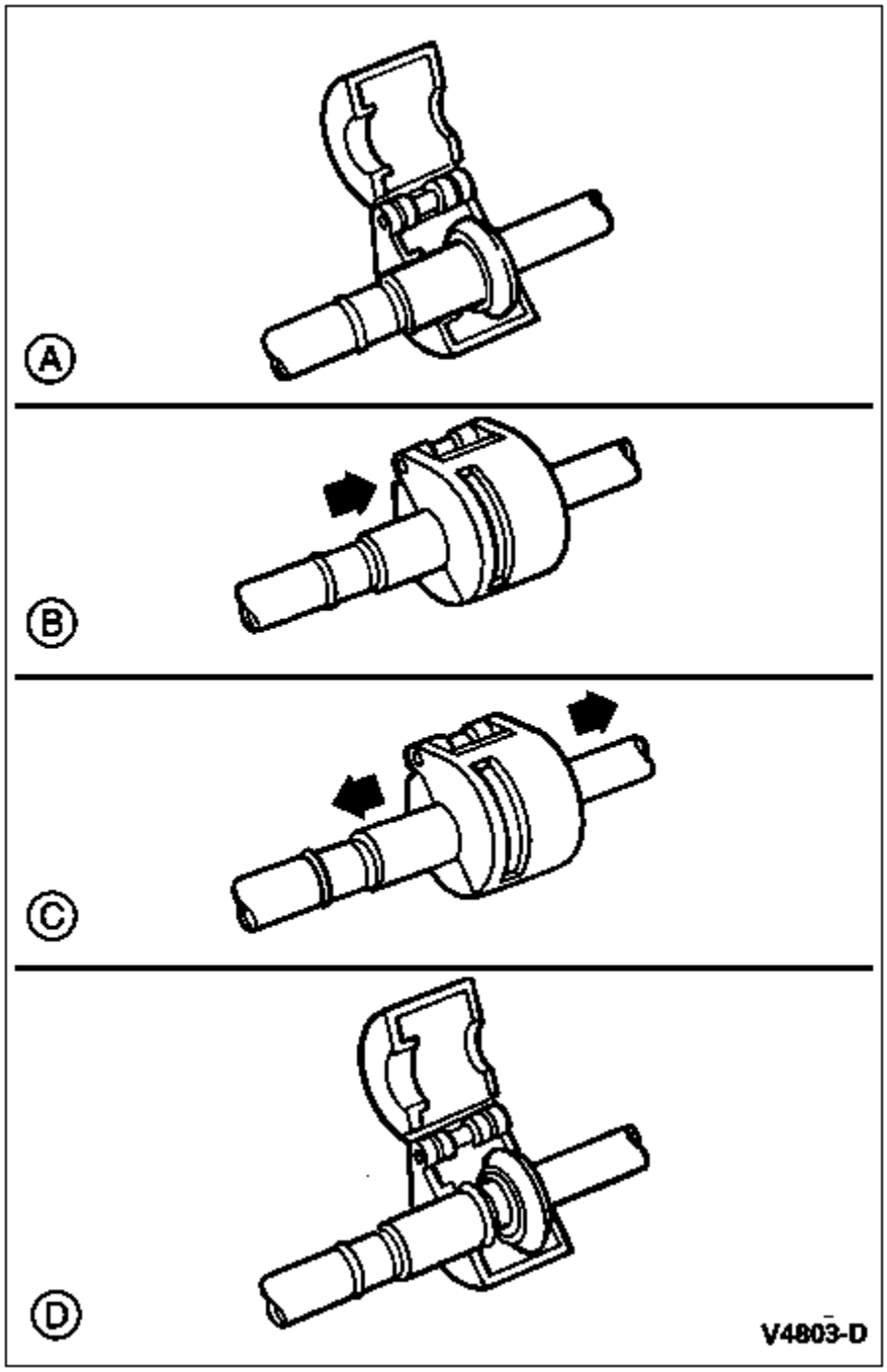
2. Remove the upper intake manifold (9424) as described in Section 03-01A .

3. Disconnect fuel injector electrical connectors.

4. Remove spring lock coupling retainer clips from fuel inlet and return fittings.

5. Using Spring Lock Coupling Disconnect Tool, T81P-19623-G1 (3/8 inch) or T81P-19623-G2 (1/2 inch), disconnect fuel hoses at the fuel rail supply tube and fuel rail return tube.

    a. Fit tool to coupling so tool can enter cage to release garter spring.
    b. Push the tool into the cage opening to release female fitting from garter spring.
    c. Pull the coupling male and female fittings apart.
    d. Remove the tool from the disconnected coupling.



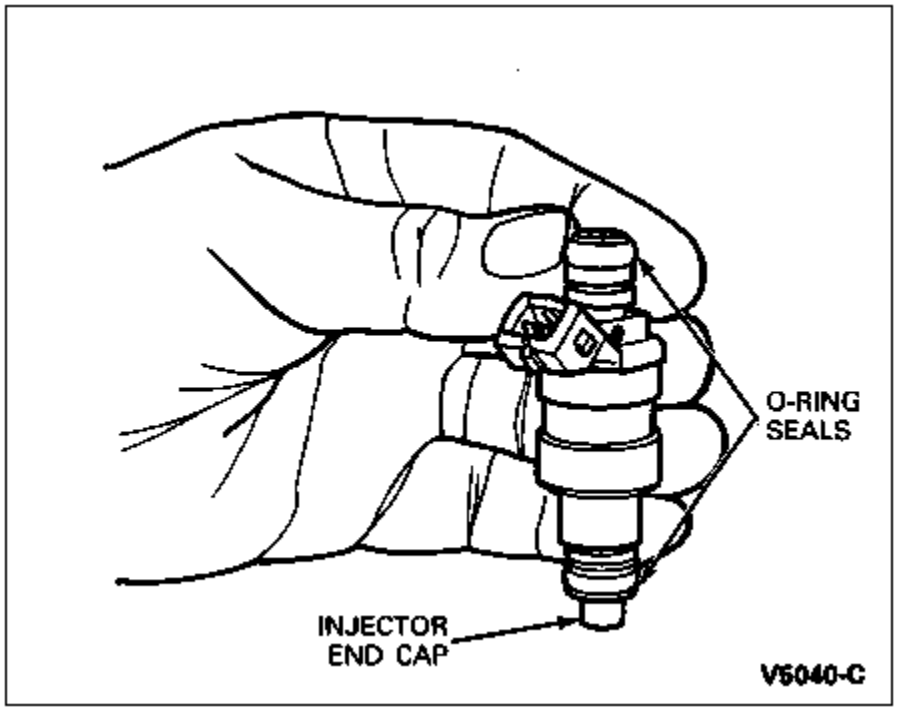
6. Remove two fuel supply manifold retaining bolts.
7. Carefully disengage fuel injection supply manifold (9D280) and fuel injectors from engine and remove fuel injection supply manifold and fuel injectors.

Installation

1. **CAUTION: Never use silicone grease. It will clog the fuel injectors. Make sure the injector**

end caps are clean and free of contamination.

Lubricate new O-rings with 10W-30 oil such as XO-10W30-QSP or equivalent meeting Ford specification ESE-M2C153E and install two on each injector (one per injector if injectors were not removed from fuel injection supply manifold).



2. Install the fuel injection supply manifold and fuel injectors into the intake manifold.
3. Push the fuel injection supply manifold down to make sure that all the fuel injector O-rings are fully seated in the fuel rail cups and intake manifold.
4. Secure the fuel injection supply manifold using two retaining bolts, while holding the fuel injection supply manifold down. Tighten to 20-30 Nm (15-22 lb-ft).
5. Connect fuel supply and return lines to fuel injection supply manifold.
6. Reinstall spring lock coupling retainer clips on fuel inlet and return fittings.
7. After the fuel injection supply manifold has been installed and before the fuel injector wire connectors have been connected, turn the ignition switch lock cylinder (11582) to the ON position. This will cause the fuel pump to run for two to three seconds and pressurize the fuel system.
8. Using a clean paper towel, check for leaks where the fuel injector is installed into the fuel injection supply manifold.
9. Install the upper intake manifold as described under Removal and Installation, Fuel Charging Assembly .
10. Install the cap on the fuel pressure relief valve (9H321).

11. Connect the fuel injector wire connectors. Start the engine and let it idle for two minutes.

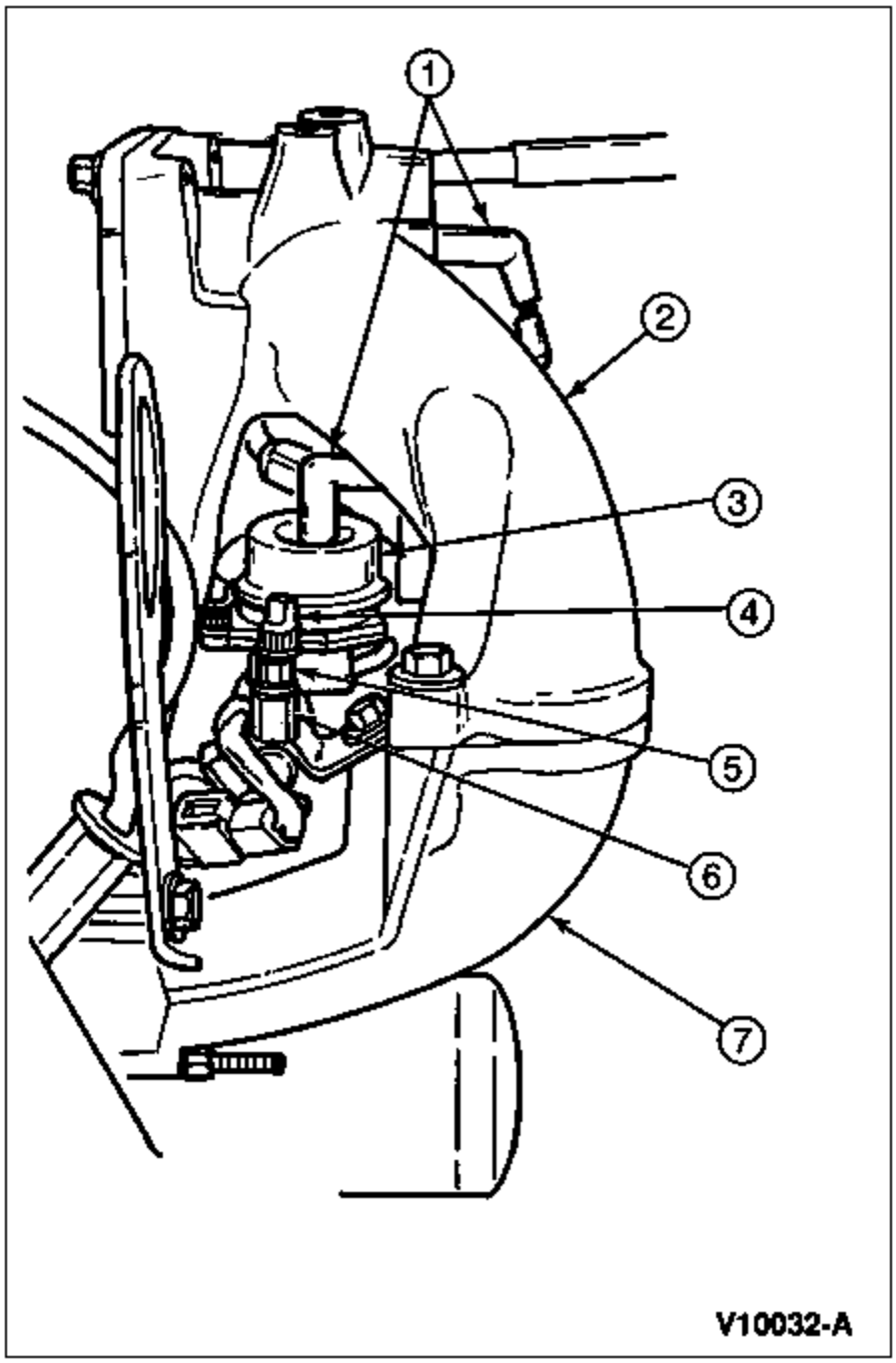
12. Turn the engine off and check for fuel leaks where the fuel injector (9F593) is installed in the fuel injection supply manifold. Also check for any leakage at the intake manifold and cylinder head.

Fuel Pressure Regulator

Removal

1. Perform pre-service procedures as outlined in this section.
2. Remove vacuum line at fuel pressure regulator (9C968).
3. Remove two Allen retaining screws from fuel pressure regulator housing and discard.
4. **NOTE: If scraping is necessary, be careful not to damage fuel pressure regulator or fuel supply line return seal surfaces.**

   Remove fuel pressure regulator, return seal and O-rings. Discard return seal and O-rings.



Item	Part Number	Description
1	9E498	Fuel Pressure Regulator Vacuum Tube
2	9424	Upper Intake Manifold
3	9C968	Fuel Pressure Regulator
4	9H323	Fuel Pressure Relief Valve Cap
5	9H321	Fuel Pressure Relief Valve
6	9D280	Fuel Injection Supply Manifold

7	9424	Lower Intake Manifold

Installation

1. **NOTE: Never use silicone grease. It will clog the injectors.**

   Lubricate new fuel pressure regulator O-rings with light oil SAE 30 XO-30-QSD or equivalent meeting Ford specification ESE-M2C153-E.

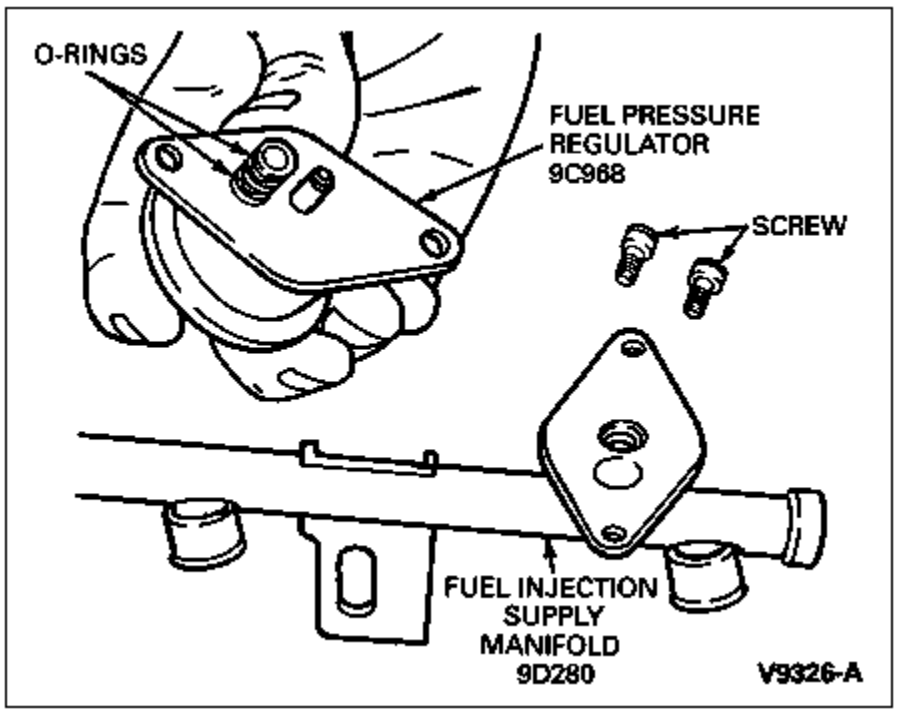
2. Make sure return seal surfaces of fuel pressure regulator and fuel injection supply manifold (9D280) are clean.

3. Install new O-rings and new return seal on fuel pressure regulator.

4. Place return seal in the recess of the regulator mounting plate. Make sure regulator return tube does not cut or damage return seal when installing fuel pressure to fuel injector supply manifold.

5. Using new Allen head retaining screws, install fuel pressure regulator on fuel injection supply manifold. Tighten three retaining screws to 3-5 Nm (27-44 lb-in).

6. Install fuel pressure regulator vacuum tube at fuel pressure regulator.

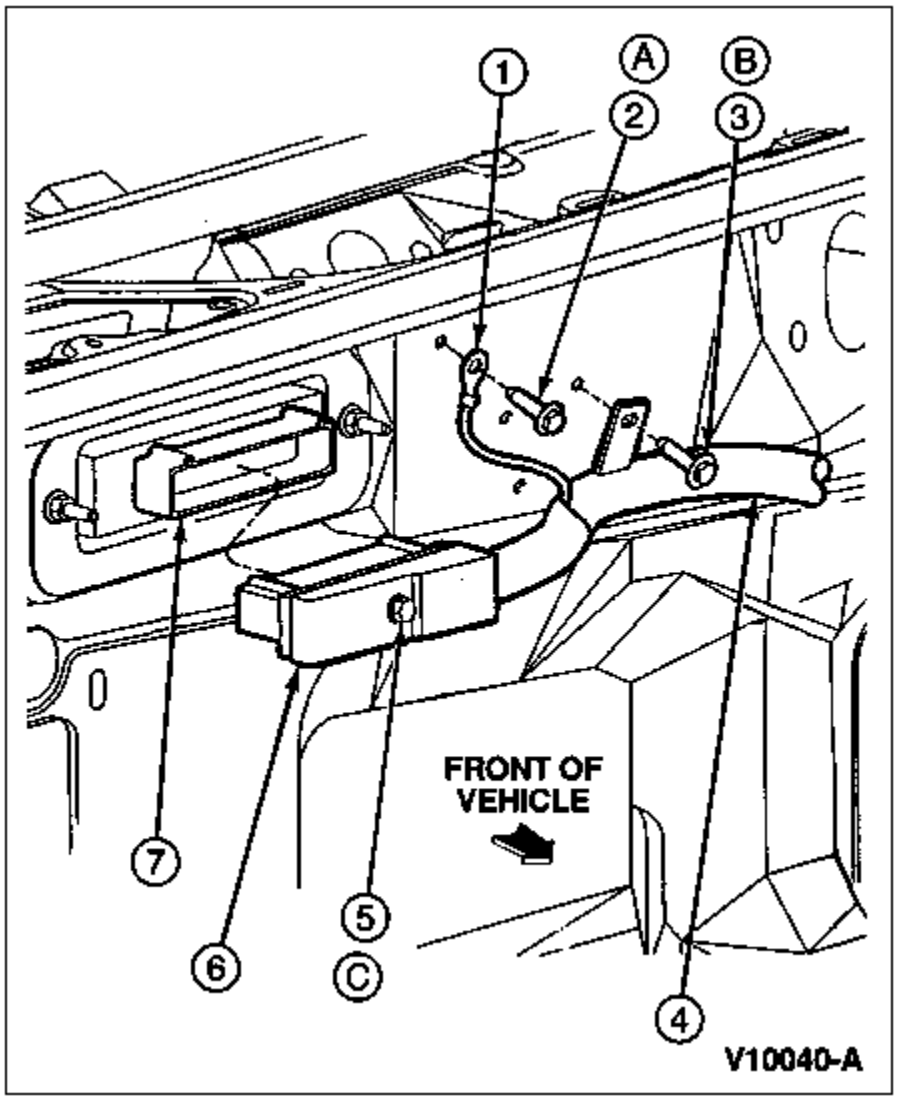


Engine Control Sensor Wiring

NOTE: A single engine control sensor wiring harness connects all engine sensors and engine mounted fuel system components including the fuel injectors.

Removal

1. Perform pre-service procedures as outlined in Removal and Installation, Fuel Charging System in this section.
2. Disconnect mass airflow sensor connector and intake air temperature sensor connector.
3. Loosen clamps and remove air cleaner outlet tube (9B659).
4. Remove upper intake manifold as outlined in Section 03-01A .
5. Remove screw attaching PCM ground cable to dash.
6. Unscrew center bolt and disconnect PCM connector.
7. Remove screw attaching engine control sensor wiring (12A581) to dash assembly.

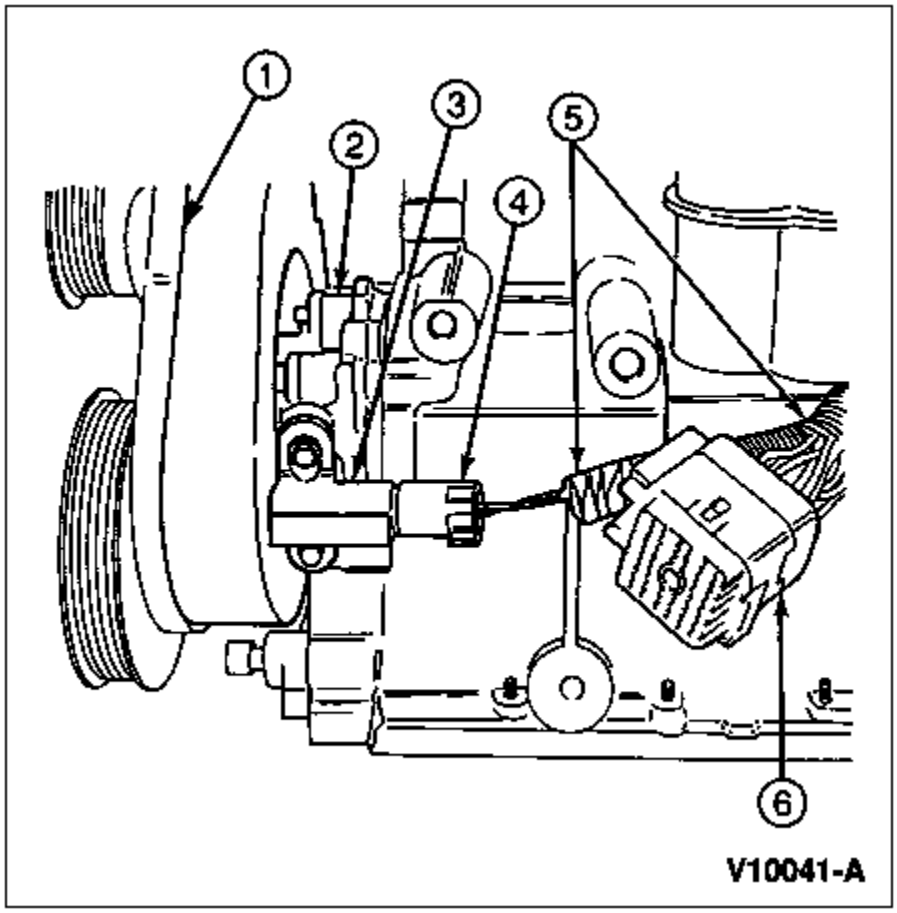


Item	Part Number	Description
1	—	PCM Ground Cable (Part of 12A581)
2	N805375-S36MG	Screw
3	N805375-S36MG	Screw
4	12A581	Engine Control Sensor Wiring
5	—	Bolt (Part of 12A581)
6	—	PCM Connector (Part of 12A581)
7	12A650	Powertrain Control Module
A	—	Tighten to 8-12 Nm (79-107 Lb-In)
B	—	Tighten to 4 Nm (36 Lb-In)
C	—	Tighten to 6-7 Nm

		(46-63 Lb-In)

8. Disconnect connector to camshaft position sensor (CMP sensor) (6B288). Remove retainer from intake manifold stud.

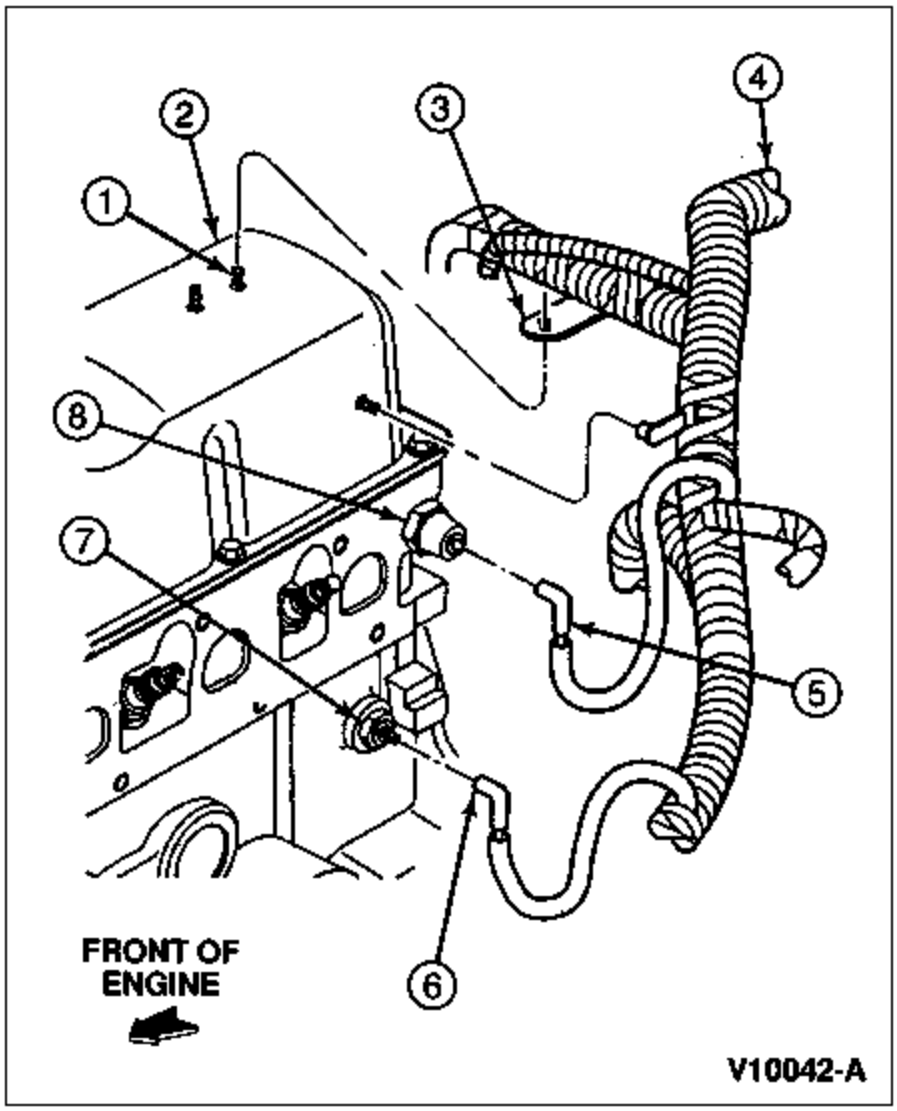
9. Unscrew bolt and disconnect 42-pin connector from engine compartment wiring.



Item	Part Number	Description
1	6019	Timing Belt Inner Cover
2	6600	Oil Pump
3	6B288	Camshaft Position Sensor
4	—	Camshaft Position Sensor Connector (Part of 12A581)
5	12A581	Engine Control Sensor Wiring
6	—	42-Pin Connector (Part of 12A581)

10. Disconnect water temperature indicator sender unit (10884).

11. Disconnect heated oxygen sensor leads.
12. Disconnect transmission lead connector.
13. Disconnect four fuel injectors.
14. Disconnect oil pressure sensor (9278).

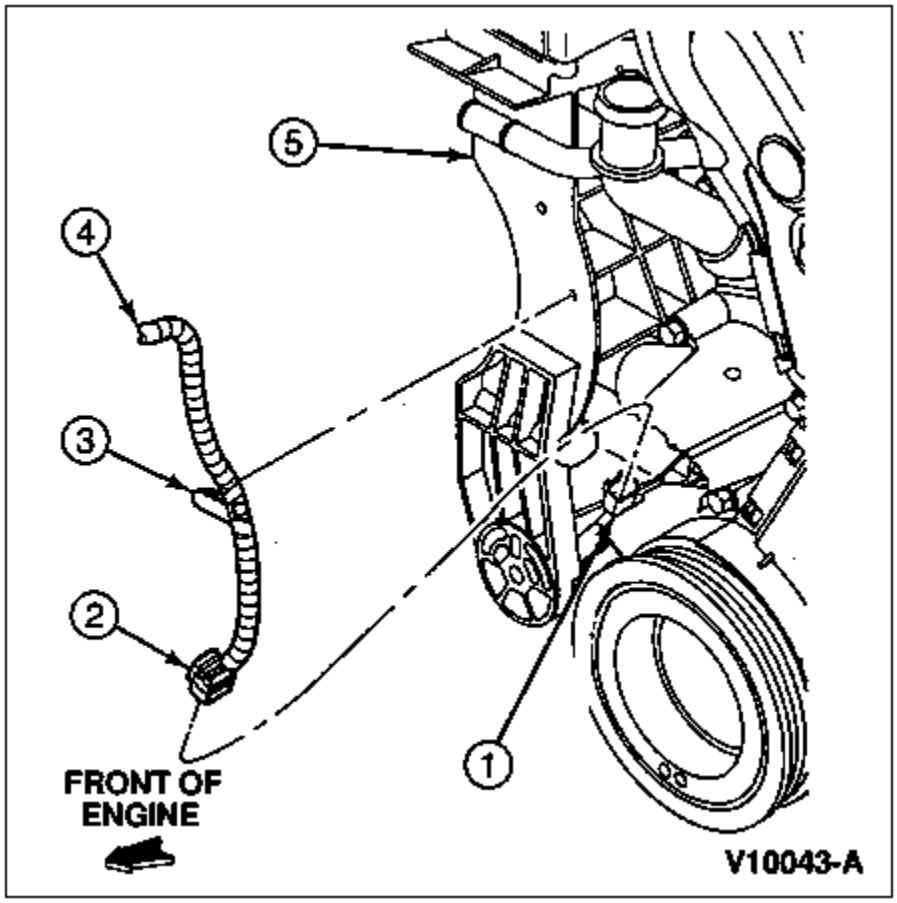


Item	Part Number	Description
1	—	Stud (Part of 6582)
2	6582	Valve Cover
3	—	Retainer — 3 Places (Part of 12A581)
4	12A581	Engine Control Sensor Wiring

5	—	Oil Pressure Sender Connector (Part of 12A581)
6	—	Water Temperature Sender Connector (Part of 12A581)
7	10884	Water Temperature Indicator Sender Unit
8	9278	Oil Pressure Sensor

15. Unsnap clips retaining harness to fuel injection supply manifold (9D280) and remove retainers from studs on valve cover (6582) and lay left branch of engine control sensor wiring on top of valve cover.

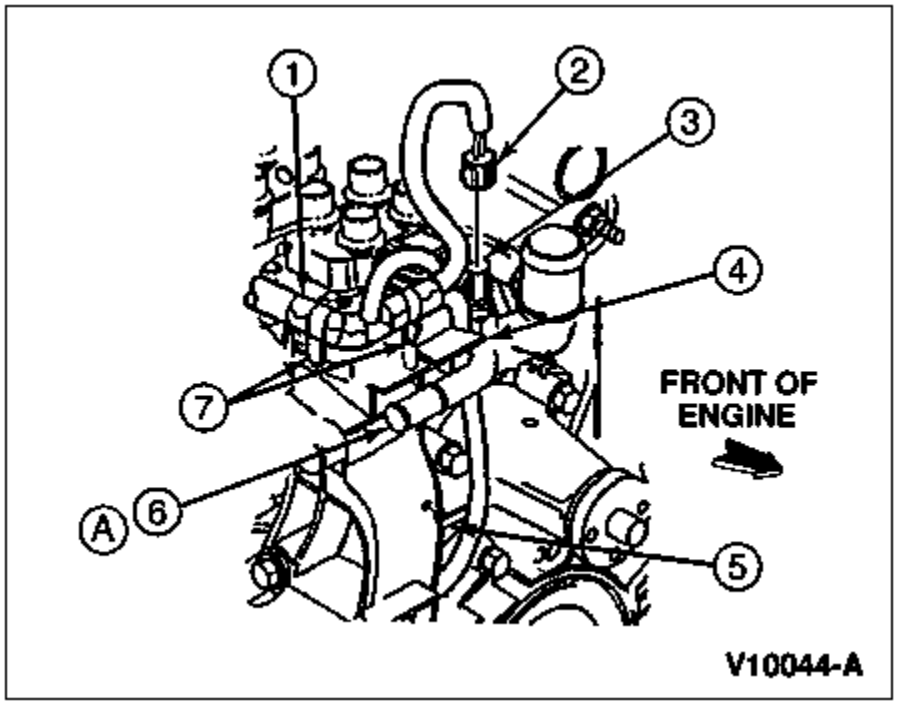
16. Disconnect crankshaft position sensor connector and pull retainer loose from generator mounting bracket (10153).



Item	Part Number	Description
1	6C315	Crankshaft Position Sensor
2	—	Crankshaft Position Sensor Connector (Part of 12A581)
3	—	Retainer (Part of 12A581)
4	12A581	Engine Control Sensor Wiring

5	10153	Generator Mounting Bracket

17. Disconnect engine coolant temperature sensor connector.

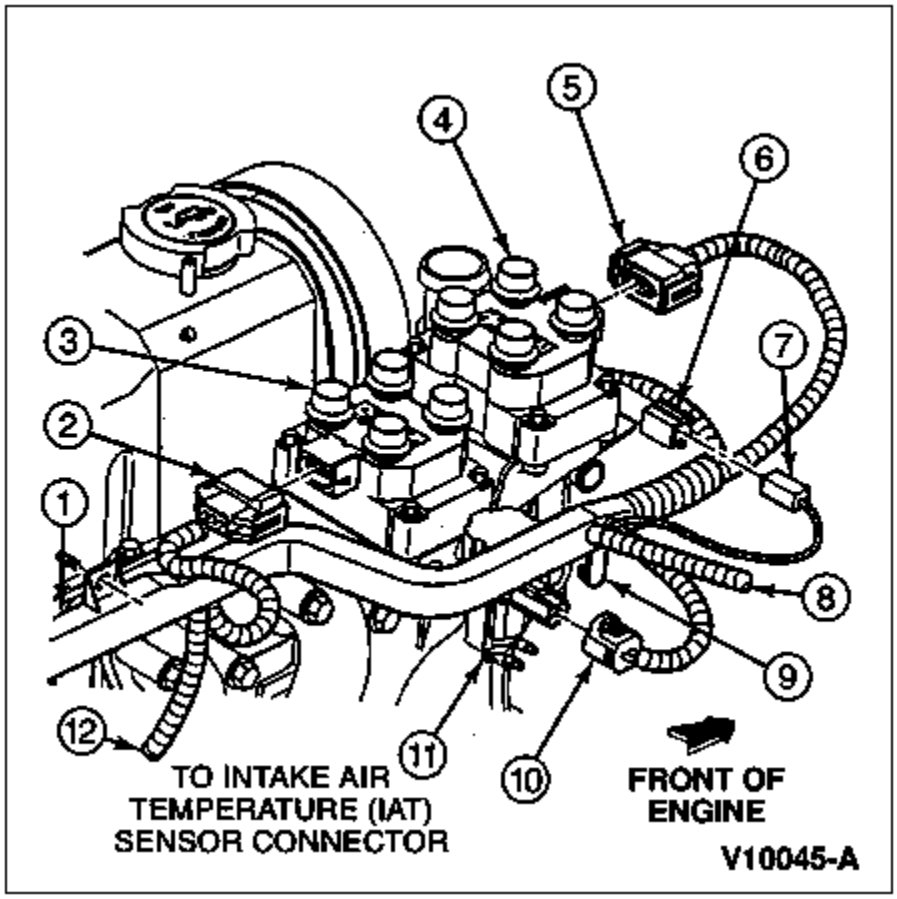


Item	Part Number	Description
1	12A581	Engine Control Sensor Wiring
2	—	Engine Coolant Temperature Sensor Connector (Part of 12A581)
3	12A648	Engine Coolant Temperature Sensor
4	10153	Generator Mounting Bracket
5	—	Retainer (Part of 12A581)
6	8594	Water Outlet Connection
7	—	Retainer (Part of 12A581)
A	—	Route engine control sensor wiring branch to crankshaft position sensor behind water outlet connection.

18. Route crankshaft position sensor branch of engine control sensor wiring out from behind generator mounting bracket.

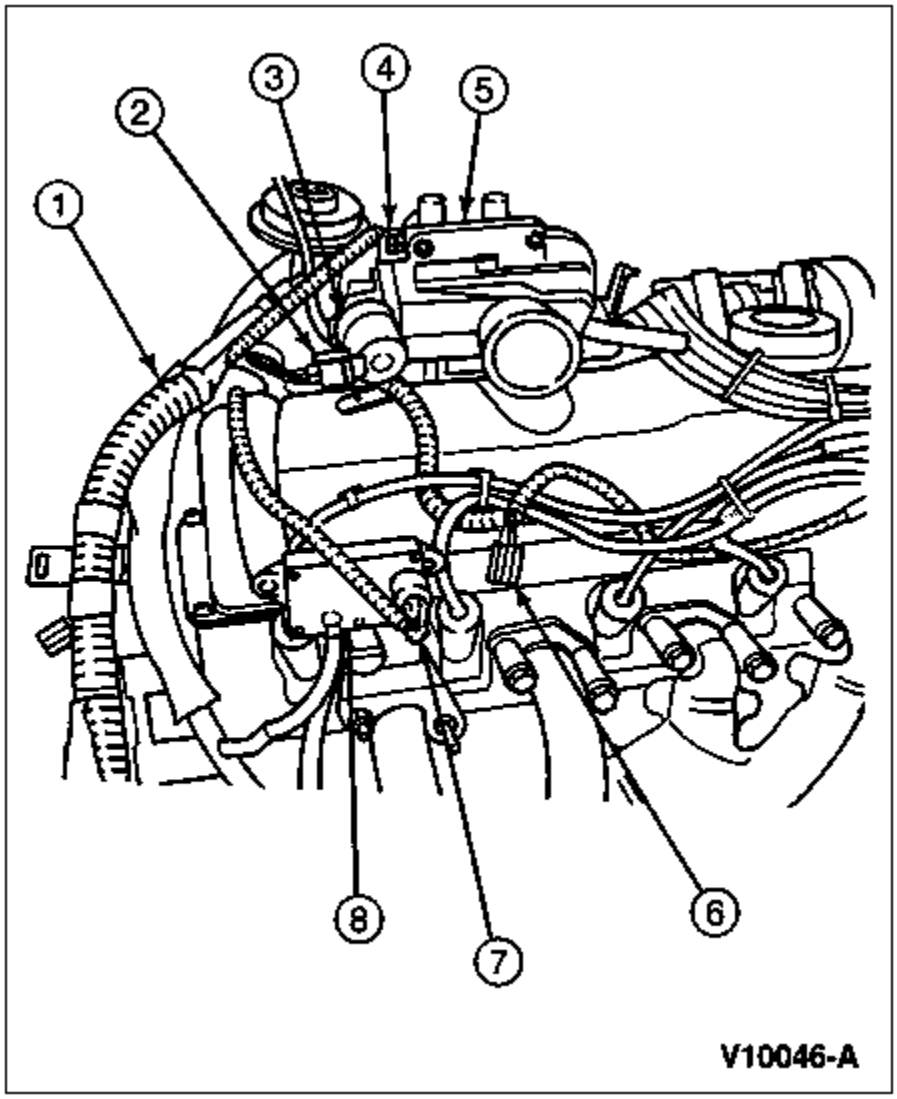
19. Disconnect radio interference capacitor and front ignition coil connector.

20. Disconnect EGR regulator control connector and rear coil connector.



Item	Part Number	Description
1	12A581	Engine Control Sensor Wiring
2	—	Rear Ignition Coil Connector (Part of 12A581)
3	12029	Ignition Coil (Rear)
4	12029	Ignition Coil (Front)
5	—	Front Ignition Coil Connector (Part of 12A581)
6	18801	Radio Ignition Interference Capacitor
7	—	Radio Capacitor Connector (Part of 12A581)
8	—	Branch to Mass Airflow Sensor (Part of 12A581)
9	—	Retainer (Part of 12A581)
10	—	EGR Vacuum Regulator Control Connector (Part of 12A581)
11	9J459	EGR Vacuum Regulator Control
12	—	Branch to Intake Air Temperature Sensor (Part of 12A581)

21. Disconnect throttle position sensor and idle air control connectors at the throttle body (9E926).



Item	Part Number	Description
1	12A581	Engine Control Sensor Wiring
2	—	Idle Air Control Valve Connector (Part of 12A581)
3	9F715	Idle Air Control Valve
4	—	Throttle Position Sensor Connector (Part of 12A581)
5	9E926	Throttle Body
6	—	Intake Air Temperature Sensor Connector (Part of 12A581)
7	—	EGR Transducer Connector (Part of 12A581)
8	9J459	EGR Vacuum Regulator Solenoid

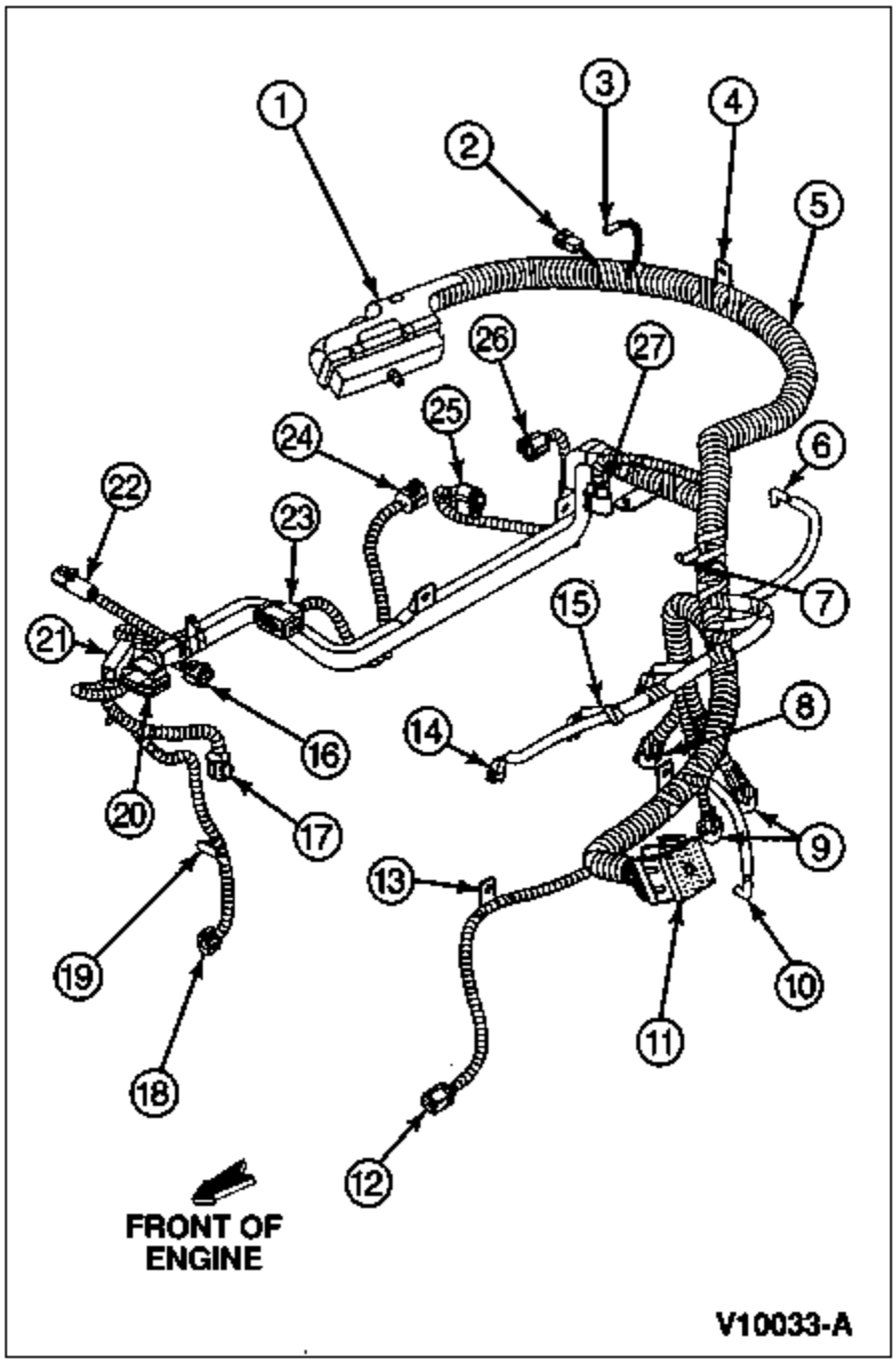
22. Disconnect EGR transducer connector.

23. Remove retainers from studs on valve cover.

24. Remove engine control sensor wiring from vehicle.

Installation

1. Position engine control sensor wiring.
2. Snap retainers onto studs on valve cover.
3. Connect EGR transducer connector.
4. Connect throttle position sensor (TP sensor) (9B989) and idle air control sensor connectors on throttle body.
5. Connect EGR regulator control connector and rear coil connector.
6. Route crankshaft position sensor branch behind generator mounting bracket.
7. Connect radio interference capacitor and front ignition coil connectors.
8. Plug in crankshaft position sensor connector. Push retainer into hole in generator mounting bracket.
9. Route left branch of engine control sensor wiring into place and snap retainers onto fuel injection supply manifold. Snap retainers onto studs on valve cover.
10. Connect oil pressure sensor.
11. Connect four fuel injectors.
12. Connect transmission lead connector.
13. Connect two heated oxygen sensor leads to engine control sensor wiring.
14. Connect water temperature sensor leads.
15. Connect 42-pin connector to engine compartment wiring harness and tighten bolts to 4-5 Nm (36-49 lb-in).
16. Route branch to camshaft position sensor and connect. Push retainers onto intake manifold studs.
17. Connect PCM connector. Tighten bolt to 6-7 Nm (46-63 lb-in).
18. Install screw attaching engine control sensor wiring to dash assembly. Tighten to 4 Nm (36 lb-in).
19. Clean surface of dash to ensure good connection where PCM ground cable attaches. Connect PCM ground cable to dash and tighten screw to 8-12 Nm (79-107 lb-in).



Item	Part Number	Description
1	—	104-Pin Connector to PCM (Part of 12A581)
2	—	Octane Adjust Switch (Part of 12A581)
3	—	PCM Ground Cable (Part of 12A581)
4	—	Retainer (Part of 12A581)
5	12A581	Engine Control Sensor Wiring

6	—	Oil Pressure Sensor Connector (Part of 12A581)
7	—	Retainer, Attaches to Valve Cover Stud (Part of 12A581)
8	—	Connector to Transmission Harness (Part of 12A581)
9	—	Connectors to Heated Oxygen Sensor Wiring (Part of 12A581)
10	—	Water Temperature Sensor Connector (Part of 12A581)
11	—	42-Pin Connector to Engine Compartment Wiring (Part of 12A581) (Attaches to Bracket on Lower Intake Manifold)
12	—	Camshaft Position Sensor Connector (Part of 12A581)
13	—	Retainer, Attaches to Intake Manifold Stud
14	—	Fuel Injector Connector, 4 Places (Part of 12A581)
15	—	Clip, 2 Places, Attaches to Fuel Injection Supply Manifold (Part of 12A581)
16	—	Connector to EGR Vacuum Regulator Control (Part of 12A581)
17	—	Connector to Engine Coolant Temperature Sensor (Part of 12A581)
18	—	Connector to Crankshaft Position Sensor
19	—	Retainer, 3 Places, Attaches to Generator Bracket (Part of 12A581)
20	—	Ignition Coil Connector (Part of 12A581)
21	—	Connector to Radio Ignition Interference Capacitor (Part of 12A581)
22	—	Connector to Mass Airflow Sensor (Part of 12A581)
23	—	Ignition Coil Connector (Part of 12A581)
24	—	Connector to Intake Air Temperature Sensor (Part of 12A581)
25	—	Connector to EGR Transducer (Part of 12A581)
26	—	Connector to Idle Air Control Valve (Part of 12A581)
27	—	Connector to Throttle Position Sensor (Part of 12A581)

20. Install upper intake manifold as outlined in Section 03-01A .
21. Install air cleaner outlet tube are tighten clamps to 1.4-2 Nm (13-17 lb-in).
22. Connect intake air temperature sensor (IAT sensor) (12A697) and mass air flow sensor (MAF sensor) (12B579).
23. Perform fuel system post-service procedures as outlined in Removal and Installation, Fuel Charging System in this section.

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Throttle Body to Upper Intake Manifold	20-30	15-22	—
EGR Valve to Upper Intake Manifold	20-30	15-22	—
Upper to Lower Intake Manifold	a	a	—
Intake Manifold Outlet Fitting and Cap	b	b	—
Lower Intake Manifold to Cylinder Head	c	c	—
Fuel Injection Supply Manifold Bolts	20-30	15-22	—
EGR Transducer to Lifting Eye	2.7-3.7	—	24-32
EGR Tube Nuts	34-47	25-35	—
Dash Panel Ground Cable to Intake Manifold Nut	9-12	—	80-106
42-Pin Connector Bracket	20-30	15-22	—
Accelerator Control Splash Shield Bolt	6-8	—	52-71
Accelerator Cable to Bracket Bolt	7-9	—	60-81
Idle Air Control Valve to Throttle Body Screw	8-11	—	71-97
Fuel Pressure Regulator Screws	3-5	—	27-44
PCM Ground Screw to Dash Assembly	8-12	—	79-107
Engine Control Sensor Wiring to Dash Screw	4	—	35
Engine Control Sensor Wiring to PCM Connector	6-7	—	53-62
Fuel Pressure Relief Valve	6-10	—	53-89
Air Filter Outlet Tube	1.4-2	—	13-17
TP Sensor to Throttle Body	3-4	—	27-35
Accelerator Cable Bracket-to-Throttle Body	21-28	16-20	—

[a] Refer to Upper Intake Manifold Installation, Section 03-01A .
[b] Tighten to 6-12 Nm (54-106 lb-in) then rotate so side outlet is 30 degrees below centerline.
[c] Refer to Lower Intake Manifold Installation, Section 03-01A .

Tips to Avoid Lean Air-Fuel Conditions

Rough idle, hesitation, poor throttle response, induction backfire and stalls during cold start/warm-up may be caused by the poor volatility of some high octane premium grade unleaded fuels (91 octane or higher [R+M]/2). When compared to regular grade unleaded fuel (87 octane [R+M]/2), high octane premium grade unleaded fuel may cause long crank time.

Use a regular grade unleaded fuel in all vehicles, except where a premium unleaded fuel is recommended in the owner guide. If lean air-fuel type symptoms are experienced, determine the grade and brand of fuel used and offer the following service tips.

- Advise those using a higher octane grade fuel to switch to a regular grade unleaded fuel. For those using a regular grade fuel, advise them to try another brand.
- Do not advise using a higher octane unleaded fuel than is recommended for that specific engine. Ford engines are designed to perform best using a high quality, regular grade unleaded fuel.
- Only advise using a higher octane unleaded fuel to avoid potentially damaging spark knock or ping, but do so only after mechanical fixes are ineffective.
- All unleaded gasolines used should contain detergent additives that are advertised as having KEEP CLEAN or CLEANUP performance for intake valves (6507).

Refer to Powertrain Control/Emissions Diagnosis Manual for further diagnosis and testing procedures.

Pressure Check

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Fuel Pressure Gauge	T80L-9974-B

1. Disconnect electrical connection to inertia fuel shutoff switch (IFS switch) (9341).
2. Crank engine for 15 seconds to reduce system pressure.
3. Remove cap from fuel pressure relief valve (9H321) (Schrader valve).
4. **CAUTION: Use care to prevent combustion from fuel spillage.**

   Install Fuel Pressure Gauge T80L-9974-B on fuel pressure relief valve.
5. Connect inertia fuel shutoff switch.
6. Start engine (6007) and check fuel pressure.
7. Accelerate engine. Pressure should remain stable throughout acceleration.

Refer to Powertrain Control/Emissions Diagnosis Manual for further diagnosis and testing procedures.

Fuel Charging System

Pre-Service Procedures

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Fuel Pressure Gauge	T80L-9974-B

WARNING: DISCONNECT BATTERY GROUND CABLE (14301) BEFORE PERFORMING ANY MAINTENANCE PROCEDURE WHICH MAY RESULT IN FUEL SPILLAGE OR LEAKING, EVEN IF FUEL IS DIRECTED INTO A SUITABLE CONTAINER. AS LONG AS THE BATTERY IS CONNECTED, THERE IS THE POSSIBILITY OF SHORTING AND SPARKING ELECTRICAL COMPONENTS AND RESULTING FIRE OR EXPLOSION HAZARD.

CAUTION: Fuel supply lines on SFI and MFI engines will remain pressurized for some period of time after the engine is shut off. This residual pressure must be relieved before servicing of the fuel system is begun.

There are two ways to release residual pressure in the system and prepare the vehicle for fuel system service.

First Method

1. Disconnect battery ground cable.
2. Remove fuel tank filler cap (9030) to relieve tank pressure.
3. Remove fuel pressure relief valve cap (9H323) and connect tool T80L-9974-B to the fuel pressure relief valve (9H321) on the fuel injection supply manifold (9F792).
4. Direct the drain hose to a suitable container and depress the pressure relief button.

Second Method

1. Disconnect inertia fuel shutoff switch (IFS switch) (9341). Inertia fuel shutoff switch location may be determined from owner guide.
2. Operate ignition switch (11572) to crank the engine for 15-20 seconds to relieve pressure.
3. Disconnect battery ground cable.
4. Remove fuel tank filler cap to relieve tank pressure.

Post-Service Procedures

CAUTION: The fuel system is normally pressurized to 276 kPa (40 psi).

After the service is compete and the fuel charging assembly is installed onto engine (6007), the following steps must be taken:

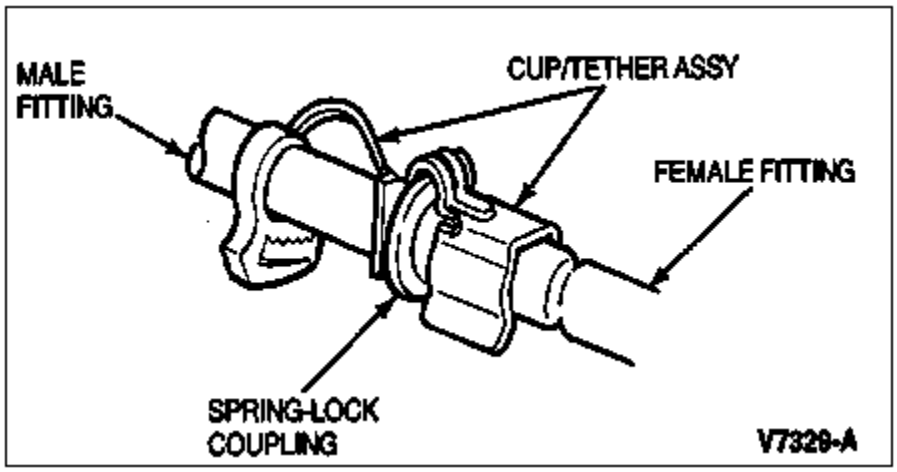
1. Install the fuel tank filler cap.
2. Connect battery ground cable.
3. Check all connections at fuel rails, push-connect fittings, fuel injectors, etc.
4. Turn ignition switch on and off several times without starting engine to pressurize the fuel system. Check for fuel leaks at fuel pressure regulator (9C968), fuel injector and fuel connect fittings.
5. Start engine and warm up to operating temperature. Check for coolant leak if coolant was removed.
6. Perform EEC self test to check system's function. Refer to Powertrain Control/Emissions Diagnosis Manual. Recheck for fuel leaks.

Spring Lock Coupling

SPECIAL SERVICE TOOL(S) REQUIRED

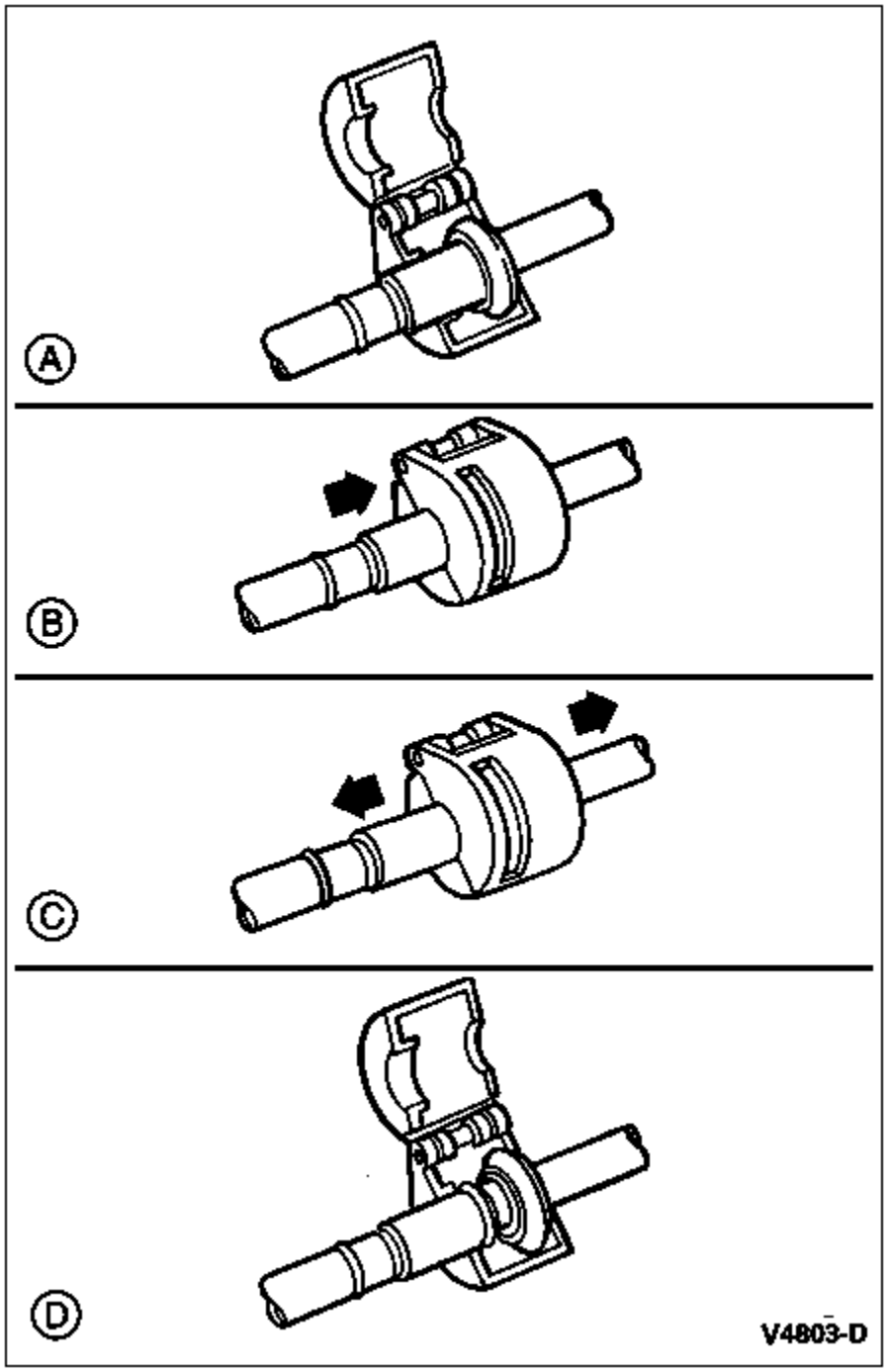
Description	Tool Number
Spring Lock Coupling Disconnect Tool (3/8-Inch)	T81P-19623-G1
Spring Lock Coupling Disconnect Tool (1/2-Inch)	T81P-19623-G2

The spring lock coupling is a fuel line coupling held together by a garter spring inside a circular cage. When the coupling is connected, the flared end of the female fitting slips behind the garter spring inside the cage of the male fitting. The garter spring and cage then prevent the flared end of the female fitting from pulling out of the cage. As a redundant locking feature, a horseshoe shaped retaining clip is incorporated to improve the retaining reliability of the spring lock coupling.



Removal

1. Perform Pre-Service procedures as described in this section.
2. Remove retaining clip from spring lock coupling by hand. Do not use any sharp tool or screwdriver as it may damage the spring lock coupling.
3. Twist fitting to free it from any adhesion at the O-ring seals.
4. Using Spring Lock Coupling Disconnect Tool, disconnect fuel hoses at the fuel rail supply tube and fuel rail return tube.
    a. Fit tool to coupling so tool can enter cage to release garter spring.
    b. Push the tool into the cage opening to release female fitting from garter spring.
    c. Pull the coupling male and female fittings apart.
    d. Remove the tool from the disconnected coupling.



Installation

1. Make sure the garter spring is in cage of male fittings. If garter spring is missing, install a new spring by pushing it into cage opening. If garter spring is damaged, remove it from cage with a small wire hook (do not use a screwdriver) and install a new spring.

2. Clean all dirt or foreign material from both pieces of coupling.

3. **WARNING: USE ONLY THE SPECIFIED O-RINGS, AS THEY ARE MADE OF A SPECIAL MATERIAL. THE USE OF AN O-RING OF THE IMPROPER MATERIAL MAY ALLOW THE CONNECTION TO LEAK INTERMITTENTLY DURING VEHICLE OPERATION.**

   Replace missing or damaged O-rings. Use only O-rings listed in spring lock coupling illustration.

4. Lubricate male fitting and O-rings and inside of female fitting with clean engine oil.

5. Fit female fitting to male fitting and push until garter spring snaps over flared end of female fitting.

6. Ensure coupling engagement by pulling on fitting and visually checking to make sure garter spring is over flared end of female fitting.

7. **NOTE: All vehicles require the large black clip to be installed on the supply side fuel line and the small gray clip to be installed on the return side fuel line.**

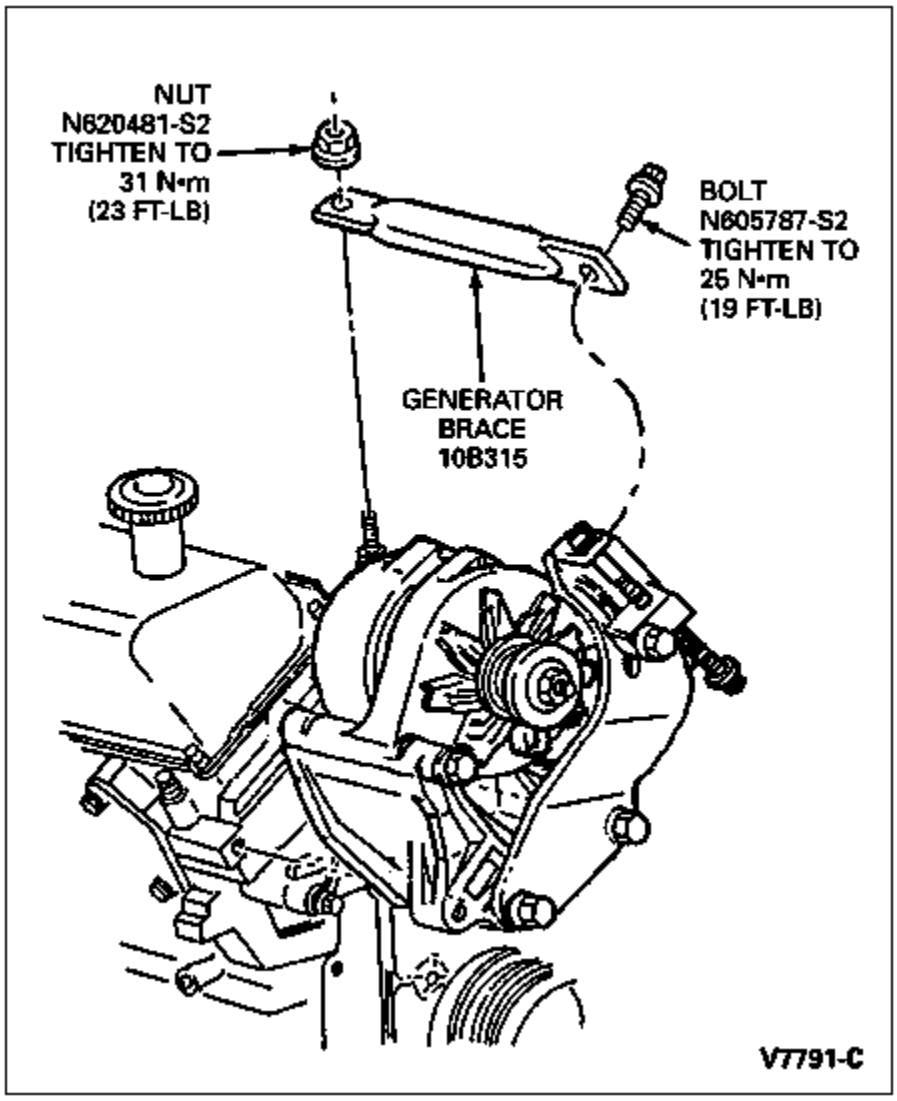
   Position retaining clip over metal portion of spring lock coupling. Firmly push retaining clip onto spring lock coupling. Make sure horseshoe portion of clip is over the coupling. Do not install retaining clip over rubber fuel line.

Throttle Body and Upper Intake Manifold — Aerostar

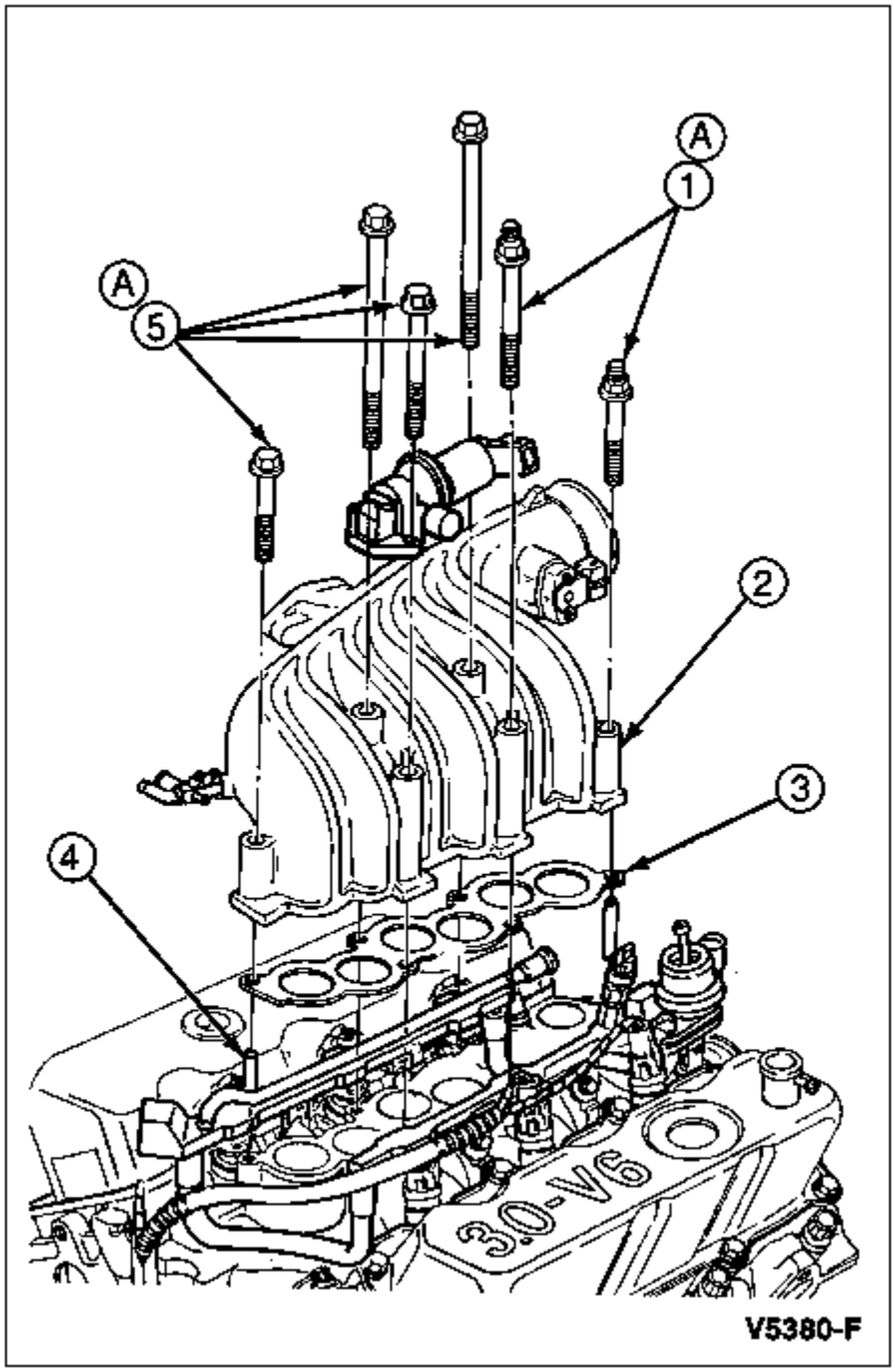
Removal

NOTE: The 3.0L throttle body (9E926) and upper intake manifold are combined in one piece.

1. Disconnect the battery negative lead.
2. Disconnect intake air temperature sensor (IAT sensor) connector.
3. Remove engine air cleaner intake tube and duct (9A673) between air cleaner and throttle body by loosening two clamps.
4. Remove fuel supply manifold shield (9J314) by removing three plastic push retainers which attach the fuel supply manifold shield to the power steering pump bracket and accelerator cable bracket.
5. Mark and disconnect PCV hose and vacuum hoses at vacuum fittings on intake manifold.
6. Disconnect and remove accelerator and speed control cables from accelerator mounting bracket and throttle lever.
7. Remove generator brace (10B315).



8. Remove wiring harness connector carefully at throttle position sensor (TP sensor) (9B989) and idle air control valve (IAC valve) (9F715).
9. Remove retainer and position aside coil assembly and bracket.
10. Remove EGR tube.
11. Remove retainer for transmission fluid level indicator tube and position aside.
12. Disconnect vacuum hoses for EGR valve, brake booster and EGR vacuum regulator solenoid.
13. Disconnect EGR differential pressure feedback transducer electrical connector.
14. Disconnect EGR vacuum regulator solenoid electrical connector.
15. Remove four bolts and two stud bolts retaining throttle body to intake manifold (9424). Lift throttle body from intake manifold.



Item	Part Number	Description
1	—	Stud Bolts (Part of 9E926)
2	9E926	Throttle Body
3	9H486	Intake Manifold Upper Gasket
4	—	Guide Pin (2 Req'd) (Part of 9E926)
5	—	Bolts (Part of 9E926)

A	—	Tighten to 25 Nm (19 Lb-Ft)

16. Remove and discard gasket from intake manifold.

Installation

1. **NOTE: If scraping is necessary, be careful not to damage throttle body, intake manifold, or allow material to fall into intake manifold.**

   Clean and inspect mounting faces of throttle body and intake manifold. Both surfaces must be clean and flat.

2. Clean and lightly oil bolt and stud threads.

3. Install a new gasket.

4. Install throttle body to intake manifold using guide pins as locators.

5. Install stud bolts and four retaining bolts in sequence positions shown in illustration. Hand-tighten.

6. Tighten bolts to 25 Nm (19 lb-ft) in sequence as numbered.

7. Connect EGR vacuum regulator solenoid electrical connector.

8. Connect EGR differential pressure feedback transducer electrical connector.

9. Connect vacuum hoses for EGR, brake booster, and EGR vacuum regulator solenoid.

10. Install retainers for transmission fluid level indicator tube.

11. Install EGR tube.

12. Install coil bracket and coil assembly.

13. Reinstall spring lock coupling retaining clips on fuel inlet and return fittings.

14. Connect wiring harness to throttle position sensor, intake air temperature sensor and idle air control valve.

15. Install accelerator cable and speed control cable, if so equipped.

16. Install vacuum hoses to vacuum fittings.

17. Connect the battery negative lead.

18. Use EEC self test to check for proper sensor function. Refer to the Powertrain Control/Emissions Diagnosis Manual .

19. Install engine air cleaner intake tube and duct.

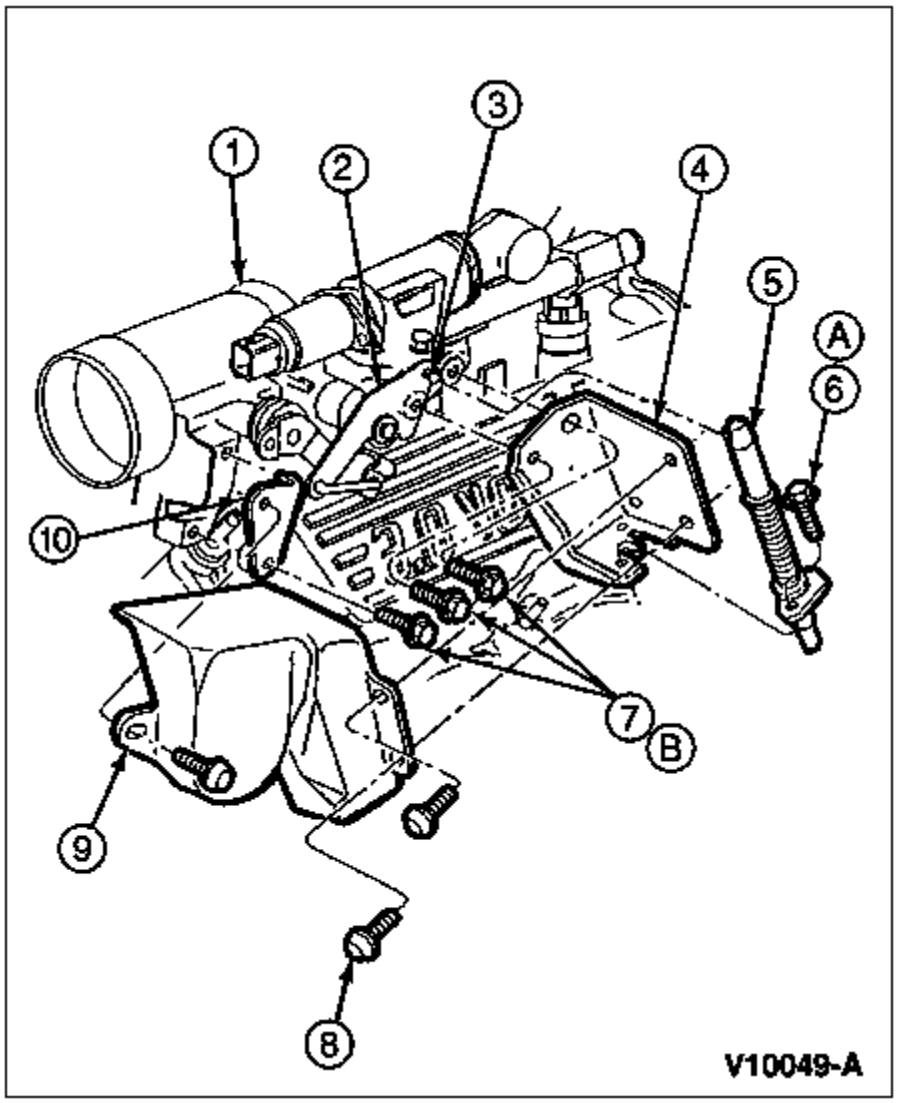
20. Run engine and check idle. Refer to the Powertrain Control/Emissions Diagnosis Manual. Install fuel supply manifold shield.

Throttle Body and Upper Intake Manifold — Ranger

Removal

NOTE: The 3.0L throttle body (9E926) and upper intake manifold are combined in one piece.

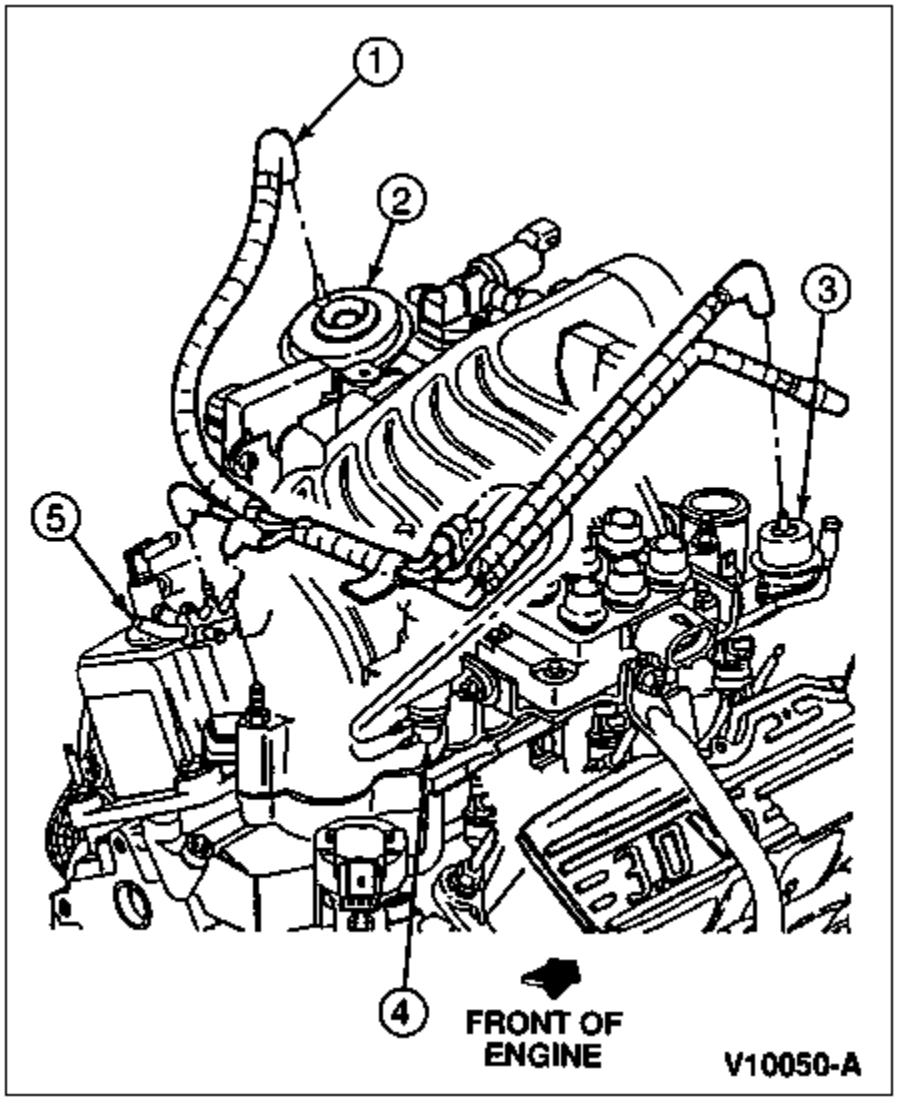
1. Perform Pre-Service procedures as described in this section.
2. Disconnect electrical connectors to the intake air temperature sensor (IAT sensor) (12A697) and mass air flow sensor (MAF sensor) (12B579).
3. Disconnect air crankcase ventilation hose (6853) from nipple on valve cover (6582).
4. Loosen clamps and remove air cleaner outlet tube (9B659).
5. Using trim removing tool, remove pushpins and accelerator control splash shield (9E766).
6. Disconnect accelerator cable (9A758) from throttle body. Remove three screws and accelerator cable bracket (9723) and position assembled accelerator cable and accelerator cable bracket out of the way.



Item	Part Number	Description
1	9E926	Throttle Body
2	—	Secondary Throttle Lever (Part of 9E926)
3	—	Ball Stud (Part of 9E926)
4	9728	Accelerator Cable Bracket
5	9A758	Accelerator Cable
6	N610959-S2	Screw, M6.3 x 13
7	N605786-S2	Bolt, M8-1.25 x 20
8	N804527-S100	Pushpin
9	9E766	Accelerator Control Splash Shield
10	9N818	Accelerator Shield Bracket
A	—	Tighten to 7-9 Nm (60-81 Lb-In)
B	—	Tighten to 8-10 Nm

		(67-92 Lb-In)

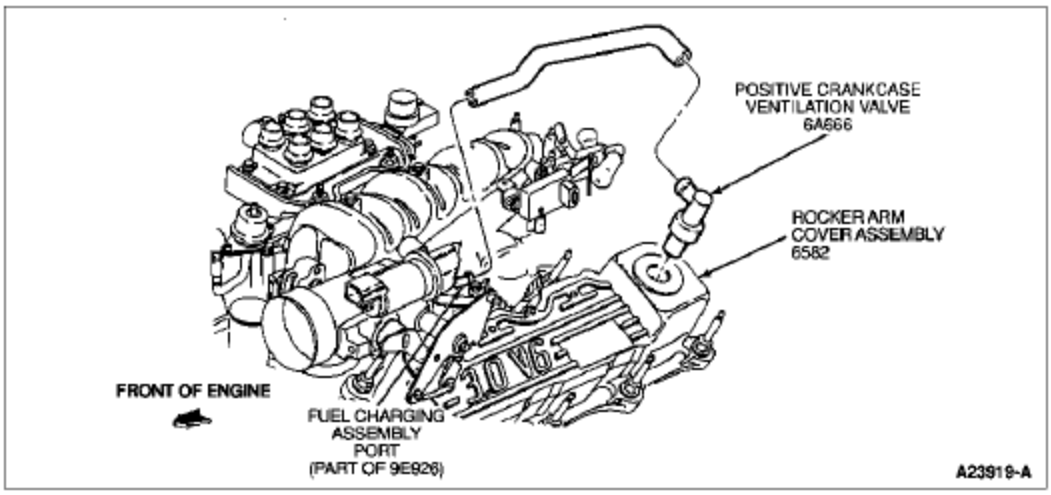
7. Tag and disconnect connectors of emission control vacuum harness and remove.



Item	Part Number	Description
1	9E498	Emission Control Vacuum Harness
2	9D475	EGR Valve
3	9C968	Fuel Pressure Regulator
4	9J459	EGR Vacuum Regulator Solenoid
5	9A474	Intake Manifold Vacuum Outlet Fitting and Cap

8. Disconnect PCV hose from throttle body.

PCV Hose

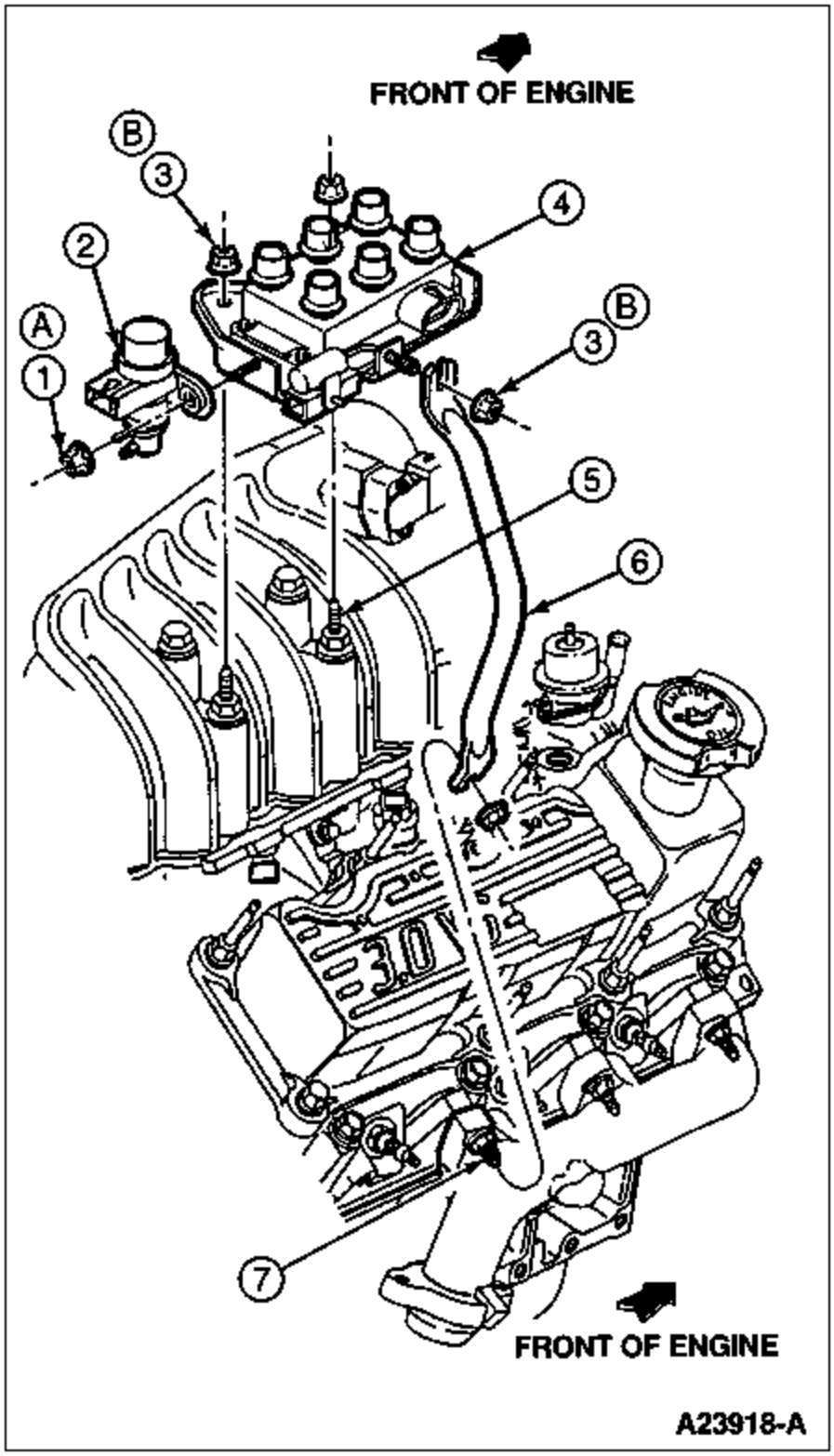


9. Disconnect spark plug wires from ignition coil (12029) and position out of the way.

10. Disconnect electrical connections from ignition coil, EGR vacuum regulator solenoid (9J459), EGR transducer (9J433), idle air control valve (IAC valve) (9F715), and throttle position sensor (TP sensor) (9B989).

11. Remove two nuts and ignition coil mounting bracket (12N004).

12. Remove two nuts and ignition coil with assembled bracket, EGR vacuum regulator solenoid and radio ignition interference capacitor (18801).



Item	Part Number	Description
1	—	Nut, M8 x 1.25 (Part of 12A310)

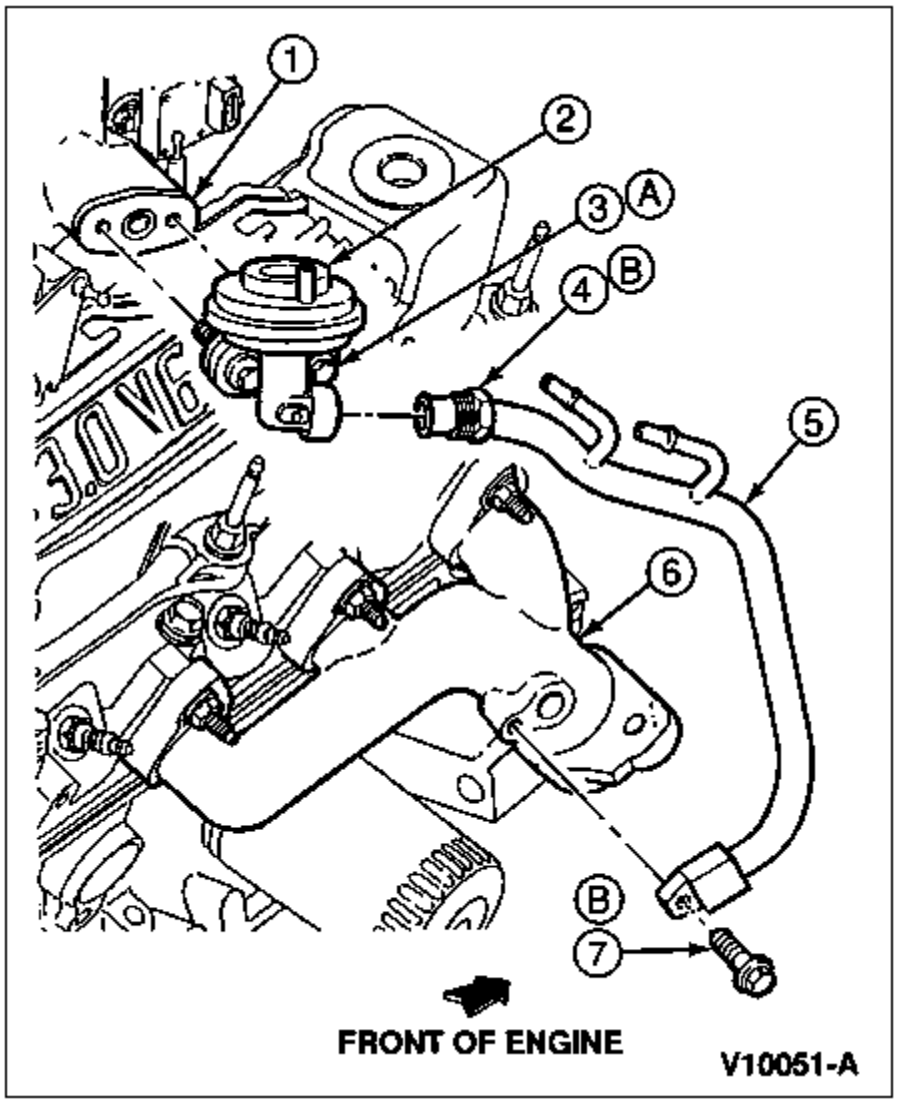
2	9J459	EGR Vacuum Regulator Solenoid
3	—	Nut, M8 x 1.25 (Part of 12A310)
4	12A310	Ignition Coil and Bracket Assembly (Includes 12029 Ignition Coil)
5	—	Stud (Part of 9430)
6	12N004	Ignition Coil Support Bracket
7	—	Exhaust Manifold Stud
A	—	Tighten to 8-12 Nm (71-106 Lb-In)
B	—	Tighten to 16-20 Nm (12-15 Lb-Ft)

13. Disconnect two hoses from EGR valve to exhaust manifold tube (9D477) which go to the EGR transducer.

14. Remove bolt securing EGR valve (EGR valve) (9D475) to EGR valve to exhaust manifold tube.

15. Loosen EGR valve to exhaust manifold tube to EGR valve nut and remove EGR valve to exhaust manifold tube.

Ranger Only

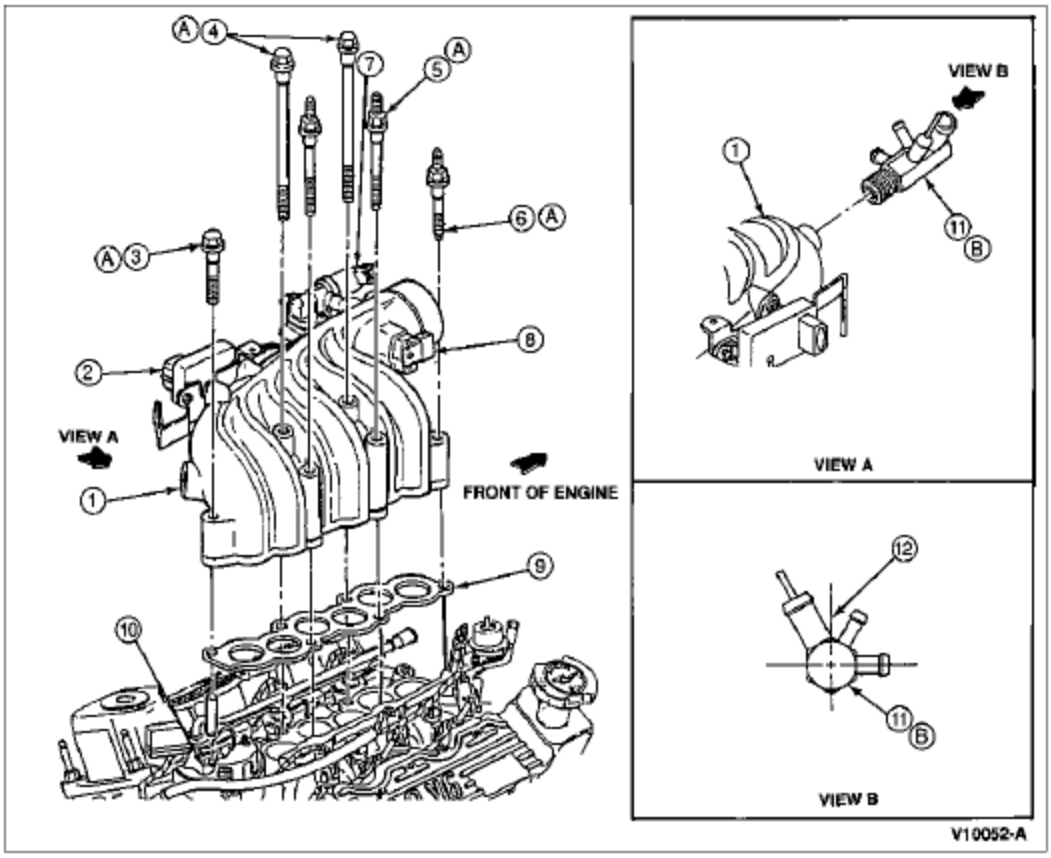


Item	Part Number	Description
1	9E926	Throttle Body
2	9D475	EGR Valve
3	—	Bolt, M8-1.25 x 39 (Part of 9D475)
4	—	Nut (Part of 9D477)
5	9D477	EGR Valve to Exhaust Manifold Tube
6	9430	Exhaust Manifold (LH)
7	—	Bolt, M8-1.25 x 25 (Part of 9D477)
A	—	Tighten to 20-30 Nm (15-22 Lb-Ft)
B	—	Tighten to 35-65 Nm (26-47 Lb-Ft)

16. Disconnect remaining hoses from EGR vacuum regulator solenoid.

17. Remove bolts and studs, upper intake manifold, and intake manifold upper gasket (9H486).

Upper Intake Manifold — Ranger



Item	Part Number	Description
1	9E926	Throttle Body
2	9J433	EGR Transducer
3	—	Bolt, M8-1.25 x 68 (Part of 9E926)
4	—	Bolt, M8-1.25 x 130 (Part of 9E926)
5	—	Stud, M8-1.25 x 129.3 (Part of 9E926)
6	—	Stud, M8-1.25 x 99.3
7	9F715	Idle Air Control Valve
8	9B989	Throttle Position Sensor
9	9H486	Intake Manifold Upper Gasket

10	9424	Lower Intake Manifold
11	9A474	Intake Manifold Vacuum Outlet Fitting and Cap
12	—	Parallel to Vertical Centerline of Manifold Hose (Part of 9A474)
A	—	Refer to Text for Tightening Instructions
B	—	Tighten to 8-13 Nm (71-115 Lb-In). Then Advance to Position Shown (Less Than One Full Turn, No Backup Allowed).

18. If necessary, remove EGR transducer, throttle position sensor, idle air control valve, EGR valve and intake manifold vacuum outlet fitting and cap (9A474) from upper intake manifold.

Installation

1. If removed, install intake manifold vacuum outlet fitting and cap and tighten to 8-13 Nm (71-115 lb-in), then advance to position shown. No backup allowed.

2. If removed, install new EGR valve gasket and EGR valve onto upper intake manifold. Tighten EGR valve screws to 20-30 Nm (15-22 lb-ft).

3. **CAUTION: Slide throttle position sensor rotary tangs into position over throttle shaft blade, then rotate throttle position sensor clockwise to installed position only. Failure to install the throttle position sensor in this manner may result in excessive idle speeds.**

   If removed, install throttle position sensor. Make sure rotary tangs on throttle position sensor are in proper alignment and that the red seal is inside the connector housing.

4. Secure throttle position sensor to throttle body with two retaining screws and tighten to 2.8-3.8 Nm (25-33 lb-in).

5. If removed, install idle air control valve, idle air control gasket (IAC gasket) (9F670), and two retaining screws. Tighten screws to 10 Nm (89 lb-in).

6. If removed, install EGR transducer on upper intake manifold and tighten screws.

7. Install intake manifold upper gasket on lower intake manifold.

8. Position upper intake manifold on lower intake manifold.

9. Install two central bolts and two studs, and hand-tighten.

10. Install remaining bolt and remaining stud bolt, and hand-tighten.

11. Tighten all fasteners in sequence shown to 25 Nm (18 lb-ft).

12. Connect hoses to intake manifold vacuum outlet fitting and cap.

13. Install EGR valve to exhaust manifold tube to EGR valve and tighten nut finger-tight.

14. Install EGR valve to exhaust manifold tube to exhaust manifold bolt and tighten to 20-30 Nm (15-22 lb-ft).

15. Tighten EGR tube nut to 35-65 Nm (26-47 lb-ft).

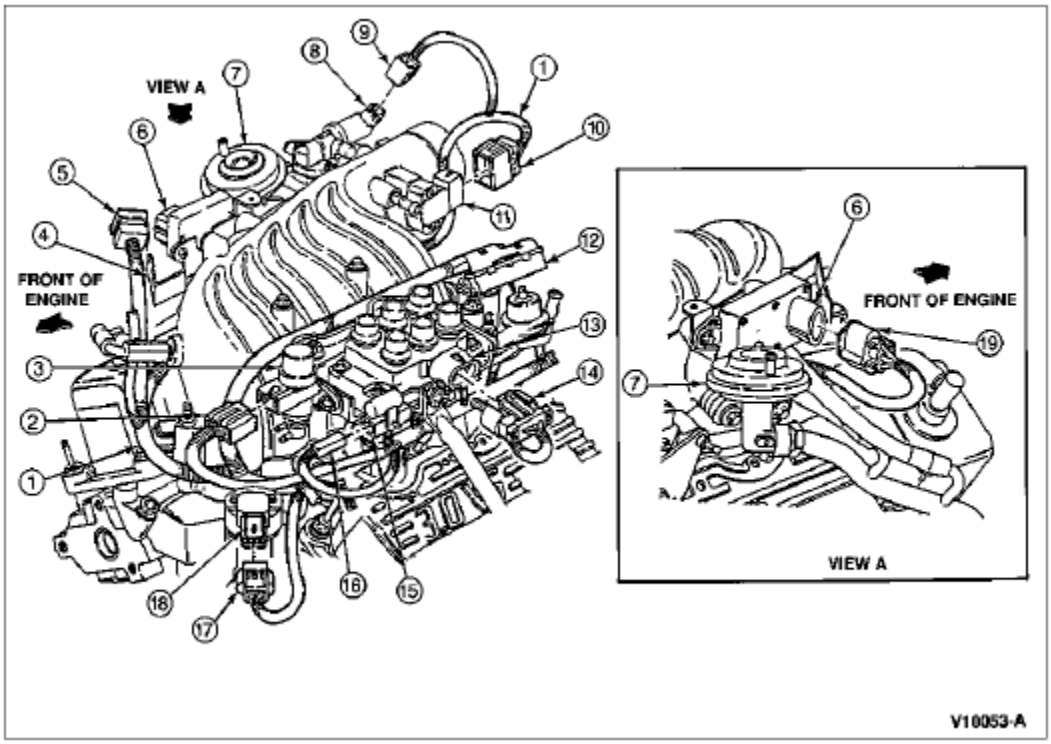
16. Connect two hoses from EGR transducer to EGR valve to exhaust manifold tube.

17. Install ignition coil with assembled bracket to upper intake manifold and tighten nuts finger-tight.

18. Install ignition coil support bracket and nuts and tighten to 16-20 Nm (11-14 lb-ft). Tighten ignition coil bracket-to-throttle body nuts to 16-20 Nm (11-14 lb-ft).

19. Attach electrical connections to ignition coil, EGR vacuum regulator solenoid, EGR transducer, idle air control valve and throttle position sensor.

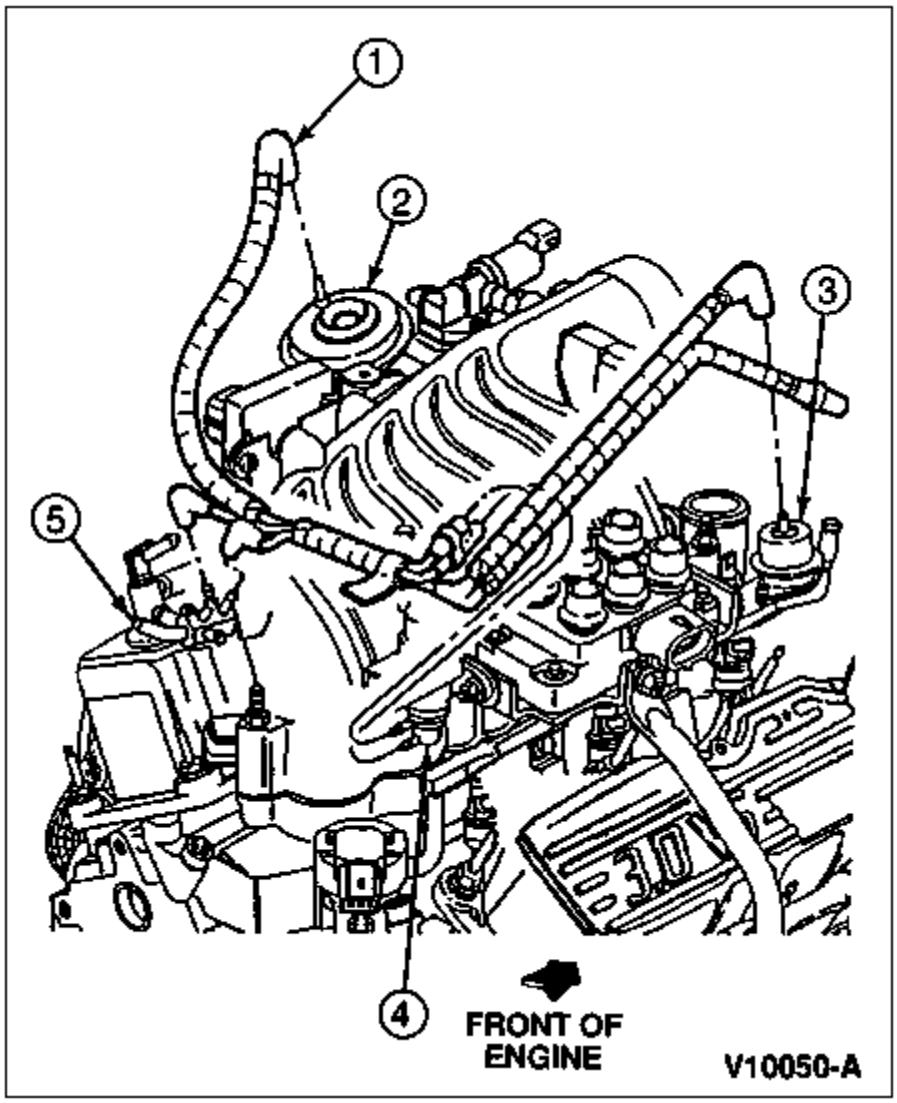
Sensor Electrical Connections — Ranger



Item	Part Number	Description
1	12A581	Engine Control Sensor Wiring
2	—	Connector to EGR Vacuum Regulator Control (Part of 12A581)
3	9J459	EGR Vacuum Regulator Solenoid
4	—	EGR Transducer Bracket (Part of 9J433)
5	—	42-Pin Connector to Engine Compartment Wiring

		Assembly (Part of 12A581)
6	9J433	EGR Transducer
7	9D475	EGR Valve
8	9F715	Idle Air Control Valve
9	—	Connector to Idle Air Control Valve (Part of 12A581)
10	—	Connector to Throttle Position Sensor (Part of 12A581)
11	9B989	Throttle Position Sensor
12	—	PCM Connector (Part of 12A581)
13	12029	Ignition Coil
14	—	Connector to Ignition Coil (Part of 12A581)
15	18801	Radio Ignition Interference Capacitor
16	—	Connector to Radio Interference Capacitor (Part of 12A581)
17	—	Connector to Camshaft Position Sensor (Synchronizer) (Part of 12A581)
18	12A112	Camshaft Position Sensor
19	—	Connector to EGR Transducer (Part of 12A581)

20. Connect spark plug wires to ignition coil.
21. Connect PCV hose to throttle body.
22. Position emission control vacuum harness and connect vacuum connections.



Item	Part Number	Description
1	9F498	Emission Control Vacuum Harness
2	9D475	EGR Valve
3	9C968	Fuel Pressure Regulator
4	9J459	EGR Vacuum Regulator Solenoid
5	9A474	Intake Manifold Vacuum Outlet Fitting and Cap

23. Install assembled accelerator cable and bracket. Tighten bracket-to-upper intake manifold bolts to 8-10 Nm (67-92 lb-in).

24. Install accelerator control splash shield and pushpins.

25. Install air air cleaner outlet tube to air filter and throttle body and tighten clamps.

26. Connect crankcase ventilation hose to valve cover.

27. Attach electrical connectors to the intake air temperature sensor and mass air flow sensor.

28. Make sure that nothing interferes with the operation of the accelerator linkage and that the accelerator cable does not bind. With engine running and vehicle in park (automatic transmission) or neutral (manual transmission) and parking brake set, quickly step on and release accelerator pedal. Engine (6007) should return to idle without hesitation or cable binding. Relocate components or replace accelerator cable as needed.

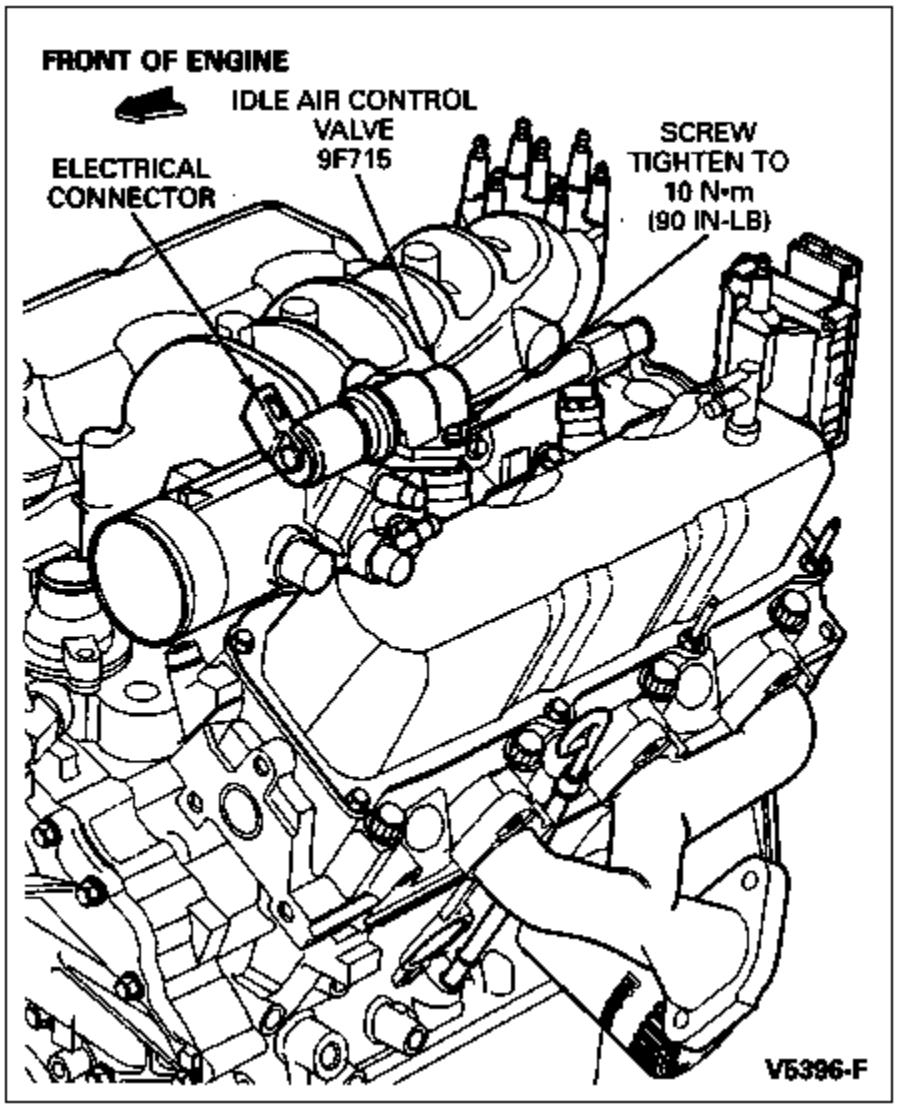
29. Perform Fuel System Post-Service procedures as described in this section.

Idle Air Control Valve

Removal

1. Disconnect idle air control valve connector from wiring harness.
2. Remove two idle air control valve retaining screws.

Idle Air Control Valve — Aerostar Shown, Ranger Similar

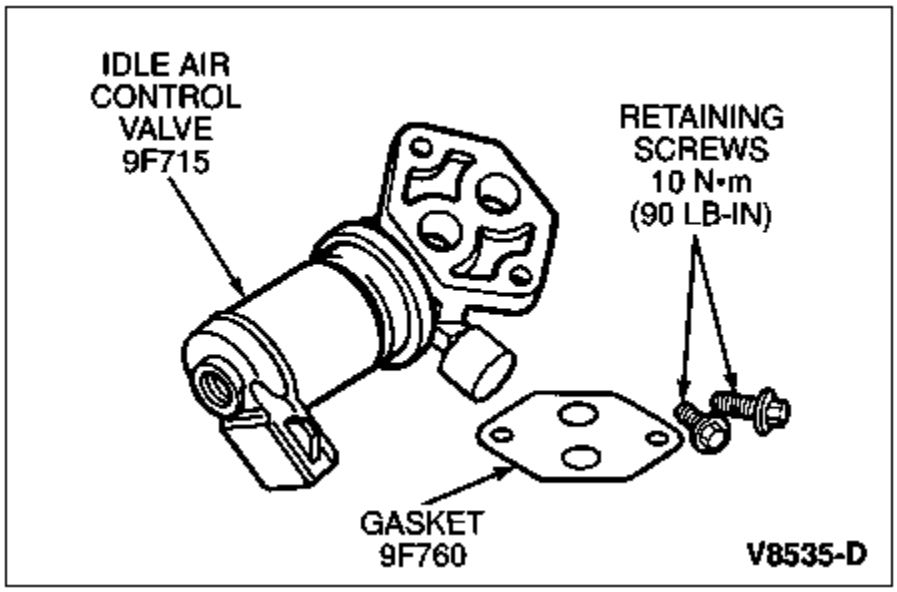


3. Remove idle air control valve (IAC valve) (9F715) and fuel charging gasket kit (9F760).

Installation

1. **NOTE: If scraping is necessary, be careful not to damage throttle body (9E926), throttle body gasket surfaces or drop material into throttle body.**

   Make sure both throttle body and idle air control valve gasket surfaces are clean.



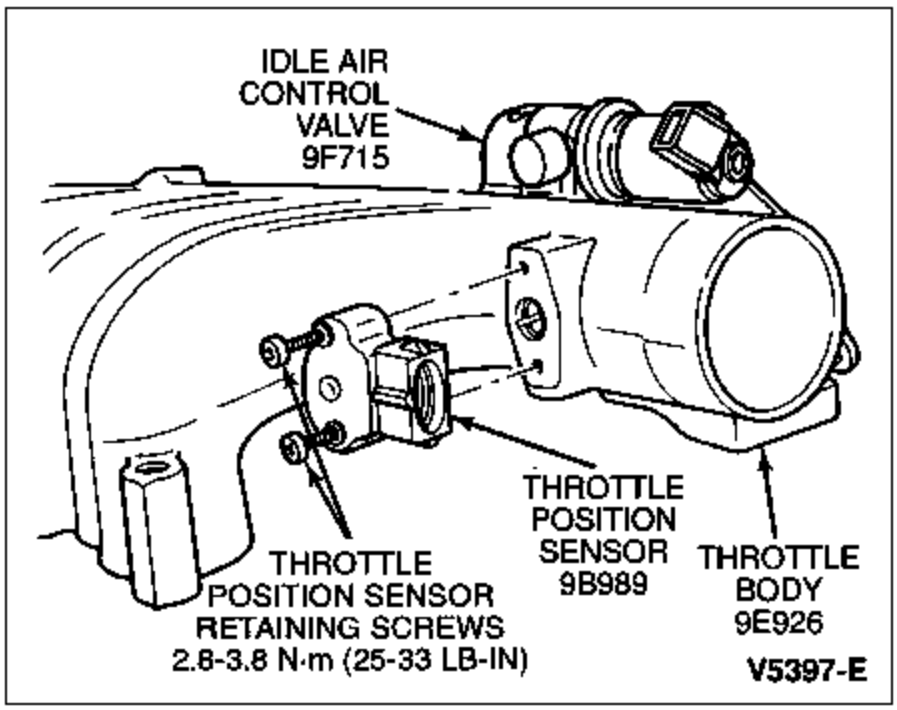
2. Install gasket on surface of throttle body and mount idle air control valve, securing it with two retaining screws. Tighten to 10 Nm (90 lb-in).

3. Install electrical connector to idle air control valve.

Throttle Position (TP) Sensor

Removal

1. Disconnect throttle position sensor (TP sensor) (9B989) from wiring harness.
2. Remove two throttle position sensor retaining screws.
3. Remove throttle position sensor.



Installation

1. **CAUTION: Slide rotary tangs into position over throttle shaft blade, then rotate throttle position sensor clockwise to installed position only. Failure to install the throttle position sensor in this manner may result in excessive idle speeds.**

   Install throttle position sensor. Make sure rotary tangs on throttle position sensor are in proper alignment and that the red seal is inside the connector housing.

2. **NOTE: This throttle position sensor is not adjustable.**

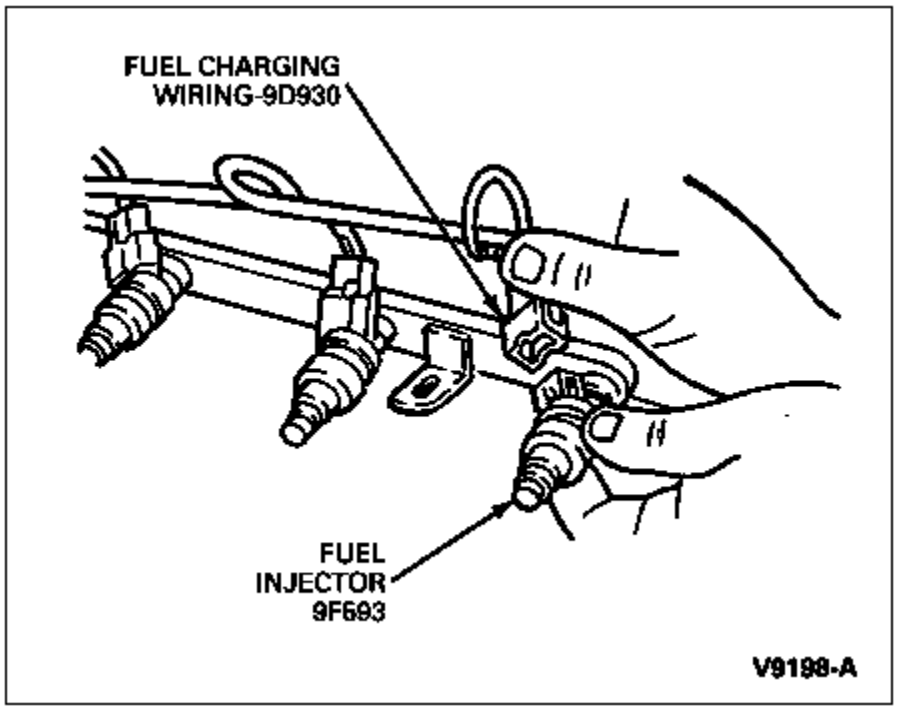
   Secure throttle position sensor to throttle body (9E926) assembly with two retaining screws. Tighten to 2.8-3.8 Nm (25-33 lb-in).

3. Install electrical connector to throttle position sensor.

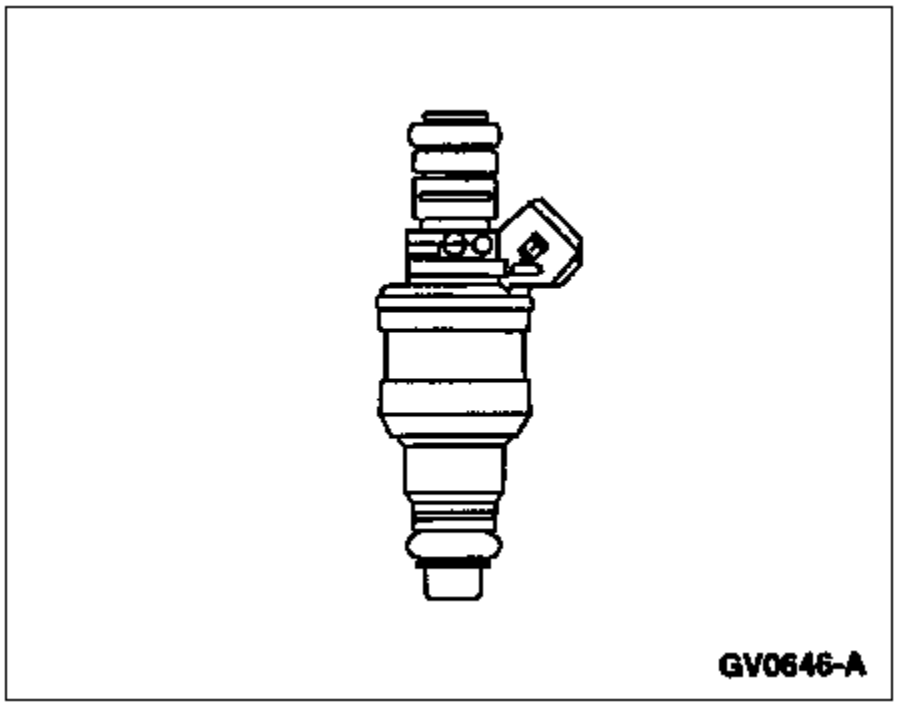
Fuel Injector

Removal

1. Perform Pre-Service procedures as described in this section.
2. Remove throttle body (9E926) as described in this section.
3. Remove fuel injection supply manifold (9F792) as described in this section.
4. Remove fuel injector retaining clips as required.
5. Carefully remove electrical harness connectors from individual fuel injectors as required.



6. Grasping fuel injector body, pull up while gently rocking fuel injection from side to side.
7. Inspect fuel injector O-rings (two per injector) for signs of deterioration. Replace as required.
8. Inspect fuel injector body, end cap and washer for signs of dirt and deterioration.



Installation

1. **NOTE: Never use silicone grease. Silicone grease will clog the fuel injectors.**

   Lubricate fuel injector top O-rings with clean engine oil XO-10W30-WSP or equivalent meeting Ford specification ESE-M2C153-E.

2. Install fuel injectors. Use a light, twisting, pushing motion to install them.

3. Reconnect fuel injector retaining clips as required.

4. Install fuel injection supply manifold as described in this section.

5. Install fuel charging wiring connectors to fuel injectors.

6. Install throttle body as described in this section.

7. Perform Post-Service procedures as described in this section.

Fuel Pressure Relief Valve (Schrader Valve)

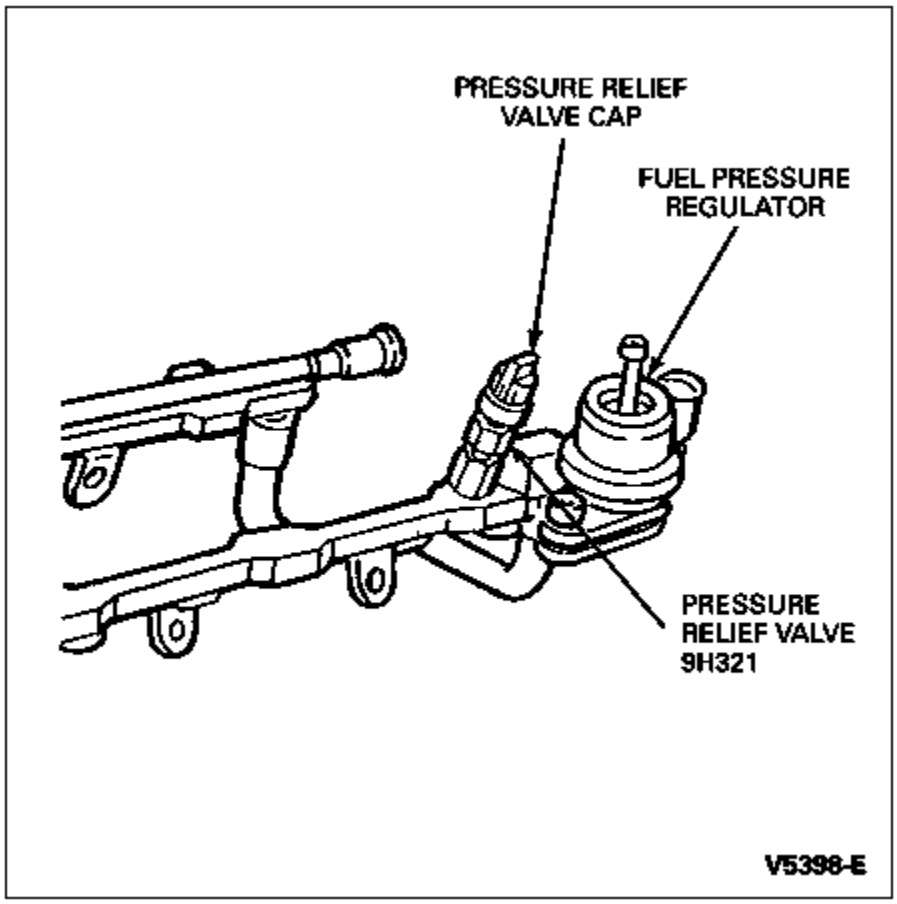
Removal

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Fuel Pressure Gauge	T80L-9974-B

CAUTION: Fuel supply lines on MFI and SFI engines will remain pressurized for some period of time after the engine is shut off. This residual pressure must be relieved before servicing of the fuel system is begun.

1. Perform Pre-Service procedures as described in this section.



2. Using a socket wrench, remove fuel pressure relief valve (9H321) from fuel injection supply manifold (9D280).

Installation

1. Install fuel pressure relief valve and cap. Tighten fuel pressure relief valve to 8 Nm (71 lb-in) and the cap to 1 Nm (9 lb-in).

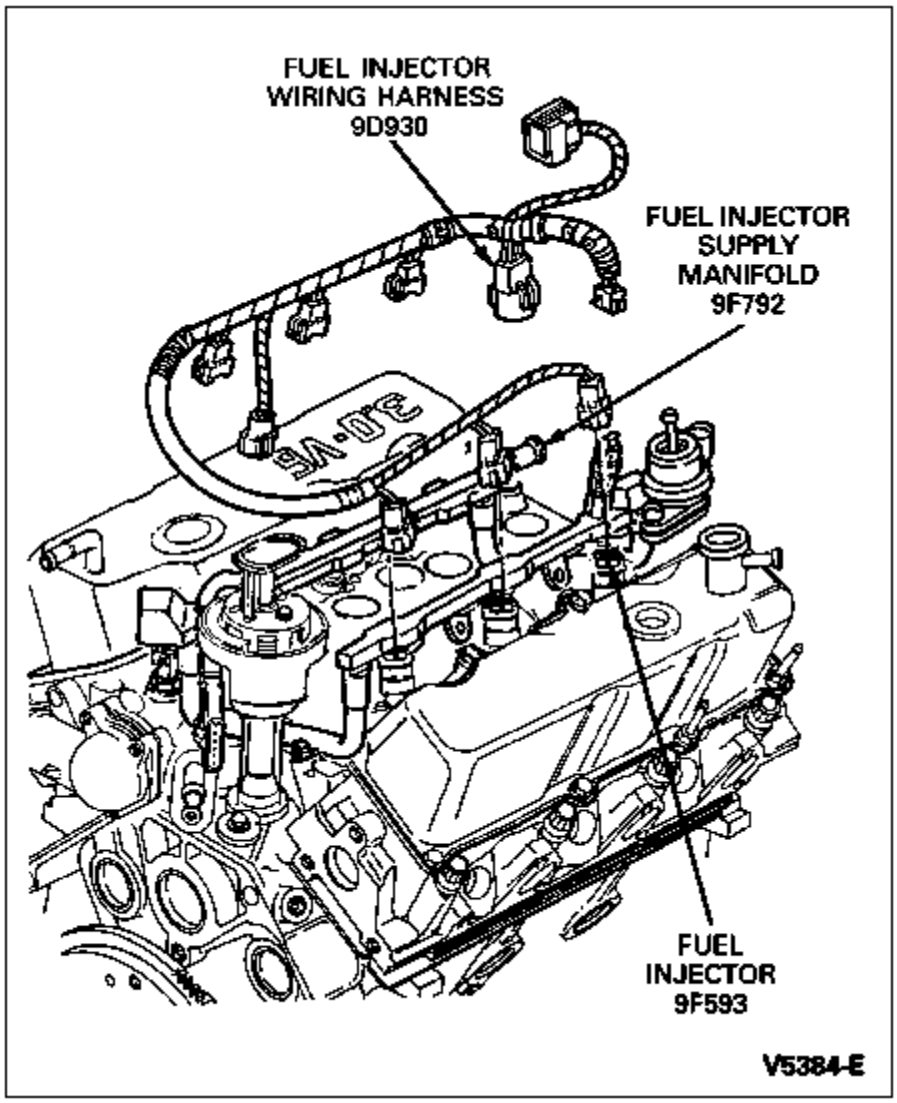
2. Perform Post-Service fuel system procedures as described in this section.

Fuel Injection Supply Manifold

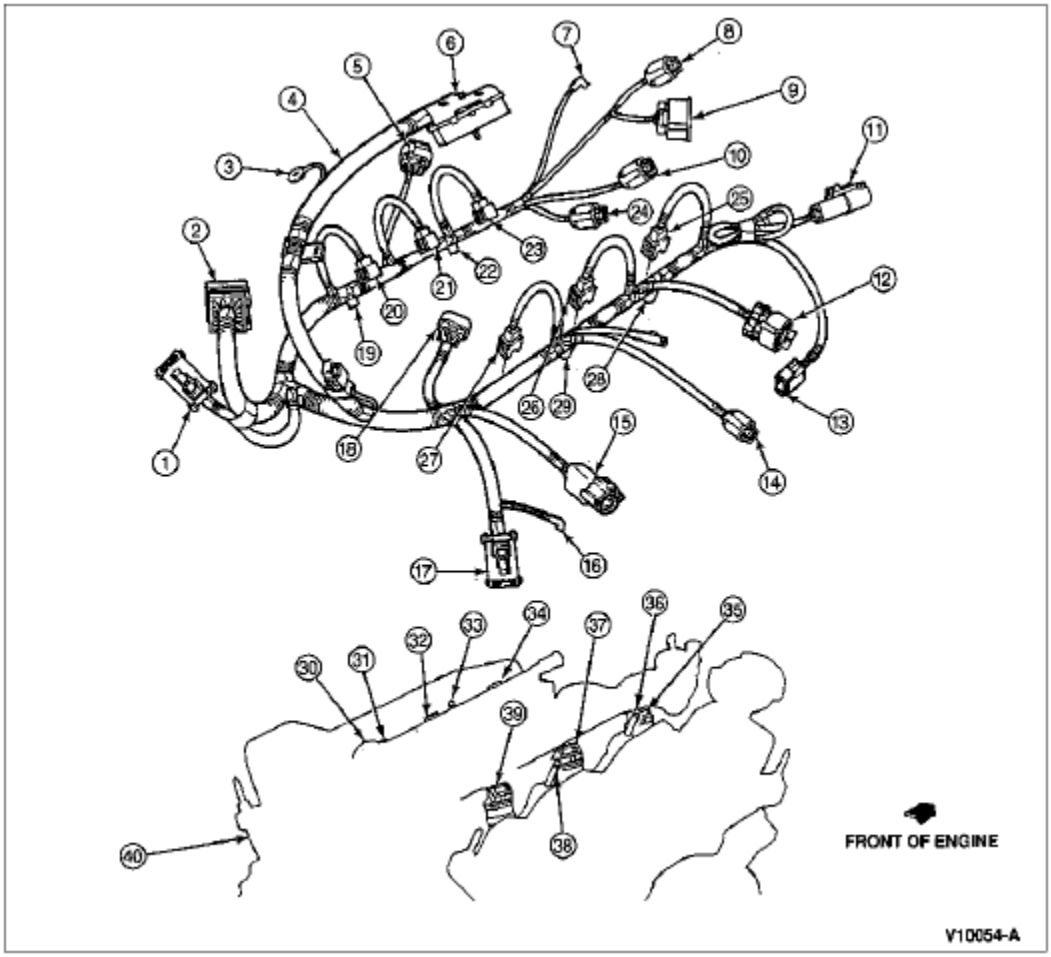
Removal

1. Remove throttle body (9E926) as described in this section.
2. Remove fuel line safety clips. Disconnect fuel supply and fuel return lines using appropriate spring lock coupling disconnect tool as described in this section.
3. Carefully disconnect fuel charging wiring (9D930) (Aerostar) or engine control sensor wiring (12A581) (Ranger) from fuel injectors.

Fuel Charging Wiring — Aerostar



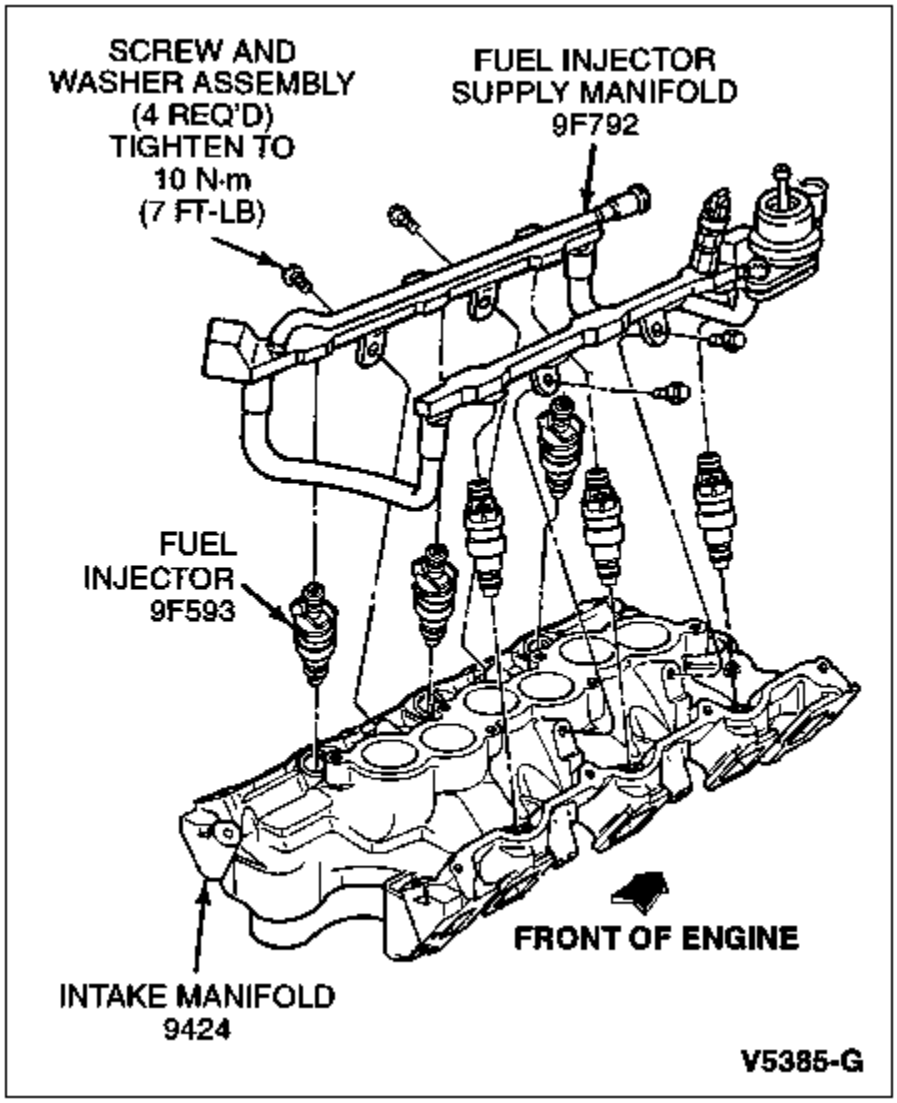
Fuel Charging Wiring — Ranger



Item	Part Number	Description
1	—	Connector to Engine Control Sensor Extension Harness (Part of 12A581)
2	—	42-Pin Connector to Engine Compartment Wiring Assembly (Part of 12A581)
3	—	Ground Cable (Part of 12A581)
4	12A581	Engine Control Sensor Wiring
5	—	Connector to EGR Transducer (Part of 12A581)
6	—	Connector to PCM (Part of 12A581)
7	—	Connector to Water Temperature Sensor (Part of 12A581)
8	—	Connector to Idle Air Control Valve (Part of 12A581)
9	—	Connector to Throttle Position Sensor (Part of 12A581)
10	—	Connector to Intake Air Temperature Sensor (Part of 12A581)

11	—	Connector to Mass Airflow Sensor (Part of 12A581)
12	—	Connector to Ignition Coil (Part of 12A581)
13	—	Connector to Crankshaft Position Sensor (Part of 12A581)
14	—	Connector to EGR Vacuum Regulator Control (Part of 12A581)
15	—	Connector to Oxygen Sensors (Part of 12A581)
16	—	Connector to Oil Pressure Sender (Part of 12A581)
17	—	Connector to Engine Control Sensor Extension Harness (Part of 12A581)
18	—	Connector to Camshaft Position Sensor (Synchronizer) (Part of 12A581)
19	—	Retainer to Valve Cover Stud (Part of 12A581)
20	—	Connector to Fuel Injector Number 6 (Part of 12A581)
21	—	Connector to Fuel Injector Number 5 (Part of 12A581)
22	—	Retainer to Valve Cover Stud (Part of 12A581)
23	—	Connector to Fuel Injector Number 4 (Part of 12A581)
24	—	Connector to Engine Coolant Temperature Sensor (Part of 12A581)
25	—	Connector to Fuel Injector Number 1 (Part of 12A581)
26	—	Connector to Fuel Injector Number 2 (Part of 12A581)
27	—	Connector to Fuel Injector Number 3 (Part of 12A581)
28	—	Retainer to Valve Cover Stud (Part of 12A581)
29	—	Retainer to Valve Cover Stud (Part of 12A581)
30	—	Valve Cover Stud (Part of 6007)
31	—	Fuel Injector Number 6
32	—	Fuel Injector Number 5
33	—	Valve Cover Stud (Part of 6007)
34	—	Fuel Injector Number 4
35	—	Fuel Injector Number 1
36	—	Valve Cover Stud (Part of 6007)
37	—	Fuel Injector Number 2
38	—	Valve Cover Stud (Part of 6007)
39	—	Fuel Injector Number 3
40	6007	Engine

4. Remove four fuel injection supply manifold retaining bolts (two on each side).



5. Carefully disengage fuel injection supply manifold (9F792) by lifting and gently rocking the fuel injection supply manifold.

6. **CAUTION: Fuel injectors and fuel injection supply manifold must be handled with extreme care to prevent damage to sealing areas and sensitive fuel metering orifices.**

   Remove fuel injectors by lifting while gently rocking side to side.

7. Place removed components in a clean container to avoid contamination.

Installation

1. **WARNING: USE ONLY THE SPECIFIED O-RINGS AS THEY ARE MADE OF A SPECIAL MATERIAL. THE USE OF ANY O-RING OTHER THAN THE SPECIFIED O-RING MAY ALLOW**

THE CONNECTION TO LEAK INTERMITTENTLY DURING VEHICLE OPERATION.

NOTE: When reinstalling fuel injection supply manifold with new or used fuel injectors, particular attention should be paid to proper O-ring seating to make sure that no fuel leaks exist.

Examine O-ring for deterioration. Install new O-ring if required (two per injector).

2. Make sure fuel injector end caps are clean and free of contamination or damage.

3. Lubricate all top O-rings with clean XO-10W 30-WSP oil or equivalent meeting Ford specification ESE-M2C153-E.

4. Install fuel injectors in fuel injection supply manifold using a light, twisting, pushing motion.

5. **CAUTION: Do not use silicone grease to lubricate O-rings. Silicone grease can plug fuel injectors.**

   Lubricate all lower O-rings with clean engine oil.

6. Carefully install fuel injection supply manifold and fuel injectors into lower intake manifold, one side at a time. Push the fuel injection supply manifold down to make sure that all injector O-rings are fully seated in the fuel injection supply manifold cups and lower intake manifold.

7. While holding fuel injection supply manifold in place, install two retaining bolts hand-tight and then tighten to 8-12 Nm (6-8 lb-ft).

8. Repeat Steps 6 and 7 for other side of fuel injection supply manifold.

9. Connect fuel supply and return line couplings as described in this section.

10. Connect fuel charging wiring on Aerostar or engine control sensor wiring on Ranger to fuel injectors.

11. Install throttle body as described in this section.

12. Turn the ignition switch (11572) to the ON position. This will cause the fuel pump (9350) to run for 2-3 seconds and pressurize the fuel system.

13. Use a clean paper towel to check for leaks where the fuel injector is installed into the fuel injection supply manifold.

14. Connect the fuel injector wiring connector, start the engine and let it idle for two minutes.

15. Turn the ignition switch off and check for fuel leaks where the fuel injector is installed in the fuel injection supply manifold and lower intake manifold.

16. Connect vacuum line to fuel pressure regulator (9C968).

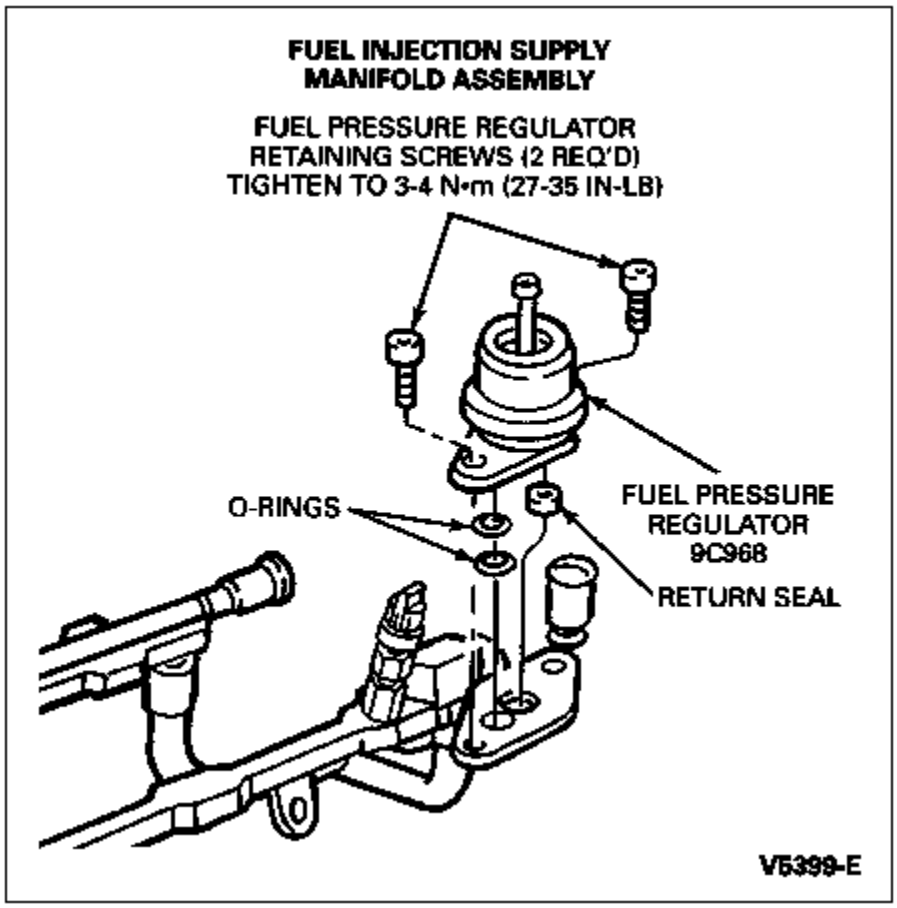
Fuel Pressure Regulator

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Fuel Pressure Gauge	T80L-9974-B

Removal

1. Perform Pre-Service procedures as described in this section.
2. Remove vacuum line from fuel pressure regulator (9C968).
3. In order to gain access to fuel pressure regulator screws, loosen or remove fuel injection supply manifold to intake manifold mounting bolt(s) as required and carefully lift fuel pressure regulator side of fuel injection supply manifold (9F792).
4. Remove two socket head retaining screws from regulator housing, and discard.
5. Remove fuel pressure regulator, return seal and O-rings. Discard return seal and O-rings.
    - If scraping is necessary, be careful not to damage fuel pressure regulator or fuel supply line sealing surfaces.



Installation

1. Lubricate new fuel pressure regulator O-rings with clean engine oil.
2. Make sure return seal surfaces of fuel pressure regulator and fuel injection supply manifold are clean.
3. Install new O-rings and new return seal on fuel pressure regulator.
4. Using new Allen head retaining screws, install fuel pressure regulator on fuel injection supply manifold. Tighten two retaining screws to 3-4 Nm (27-35 lb-in).
5. Install fuel pressure regulator side of fuel injection supply manifold to fuel injectors and lower intake manifold. Make sure fuel injection supply manifold is fully seated on all three fuel injectors and that the injector O-rings are seated at the top and bottom of each fuel injectors. While pushing down on fuel injection supply manifold, tighten fuel injection supply manifold to intake manifold bolt(s) to 8-12 Nm (6-8 lb-ft).
6. Connect vacuum line to fuel pressure regulator.
7. Perform Fuel System Post-Service procedures as described in this section.

Fuel Charging Wiring — Aerostar

Removal

1. Perform Pre-Service procedures as described in this section.
2. Disconnect electrical connectors from fuel injectors.
3. Disconnect connectors from fuel charging wiring (9D930) and throttle position sensor (TP sensor) (9B989), intake air temperature sensor (IAT sensor) (12A697) and idle air control valve (IAC valve) (9F715).
4. Remove fuel charging wiring.

Installation

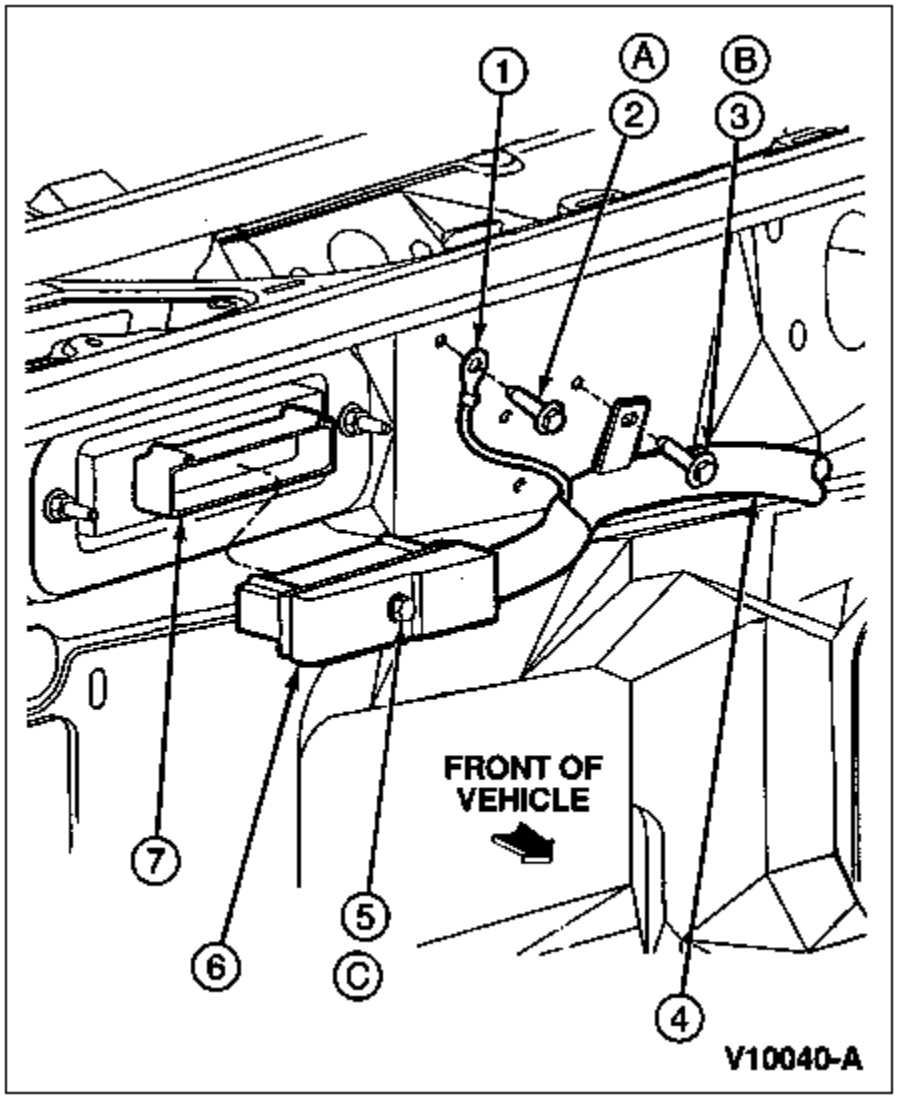
1. Position fuel charging wiring alongside fuel injectors.
2. Snap electrical connectors into position on fuel injectors.
3. Connect throttle position sensor, intake air temperature sensor, idle air control valve and fuel injector harness connectors.
4. Verify that all electrical connectors are firmly seated.
5. Perform Fuel System Post-Service procedures as described in this section.
6. Use EEC self test connector and procedure to check for sensor function. Refer to Powertrain Control/Emissions Diagnosis Manual.

Engine Control Sensor Wiring — Ranger

NOTE: A single engine control sensor wiring harness connects all engine sensors and engine mounted fuel system components including the fuel injectors.

Removal

1. Perform Pre-Sirvice procedures as described in this section.
2. Disconnect mass airflow sensor connector and intake air temperature sensor connector.
3. Loosen clamps and remove air cleaner outlet tube (9B659).
4. Remove throttle body (9E926) as described in this section.
5. Unscrew center bolts and disconnect PCM connector.
6. Remove screw attaching engine control sensor wiring (12A581) to dash assembly.

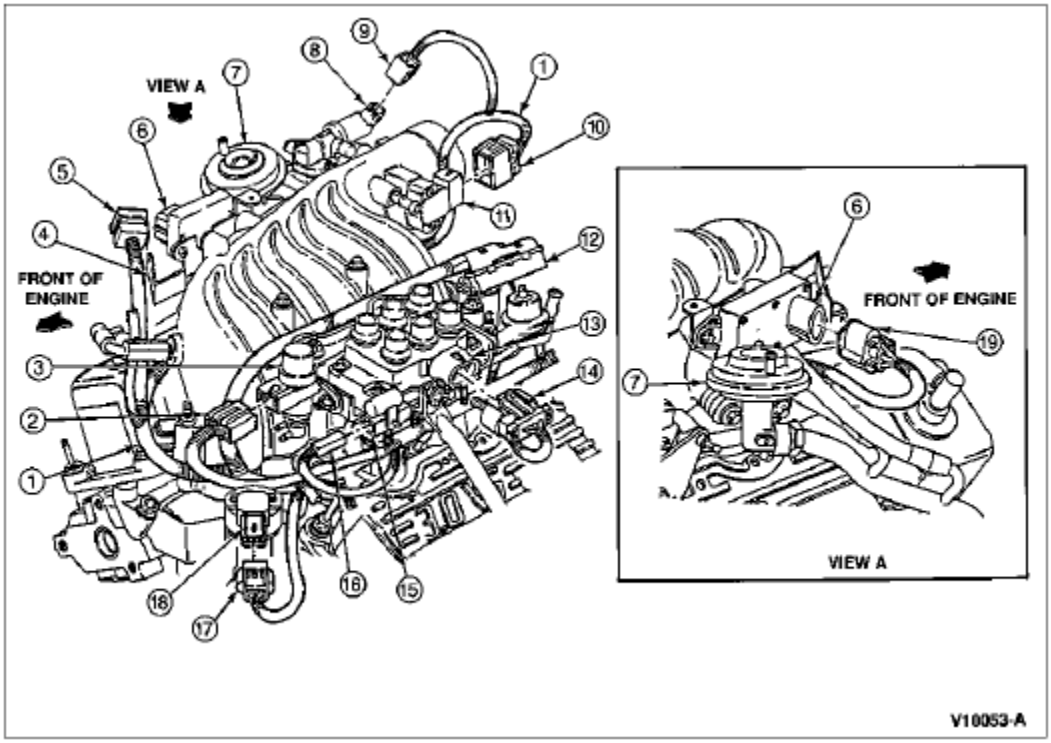


Item	Part Number	Description
1	—	PCM Ground Cable (Part of 12A581)
2	N805375-S36MG	Screw
3	N805375-S36MG	Screw
4	12A581	Engine Control Sensor Wiring
5	—	Bolt (Part of 12A581)
6	—	PCM Connector (Part of 12A581)
7	12A650	Powertrain Control Module
A	—	Tighten to 8-12 Nm (79-107 Lb-In)
B	—	Tighten to 4 Nm (36 Lb-In)
C	—	Tighten to 6-7 Nm

		(46-63 Lb-In)

7. Unscrew bolt and disconnect 42-pin connector from engine compartment wiring.
8. Disconnect two connectors to engine control sensor extension wiring (12A690).
9. Disconnect connectors to camshaft position sensor (synchronizer), water temperature indicator sender unit (10884), engine coolant temperature sensor (ECT sensor) (12A648), crankshaft position sensor (CKP sensor) (6C315), and fuel injectors.
10. Remove engine control sensor wiring from vehicle.

Engine Sensor Electrical Connections — Ranger



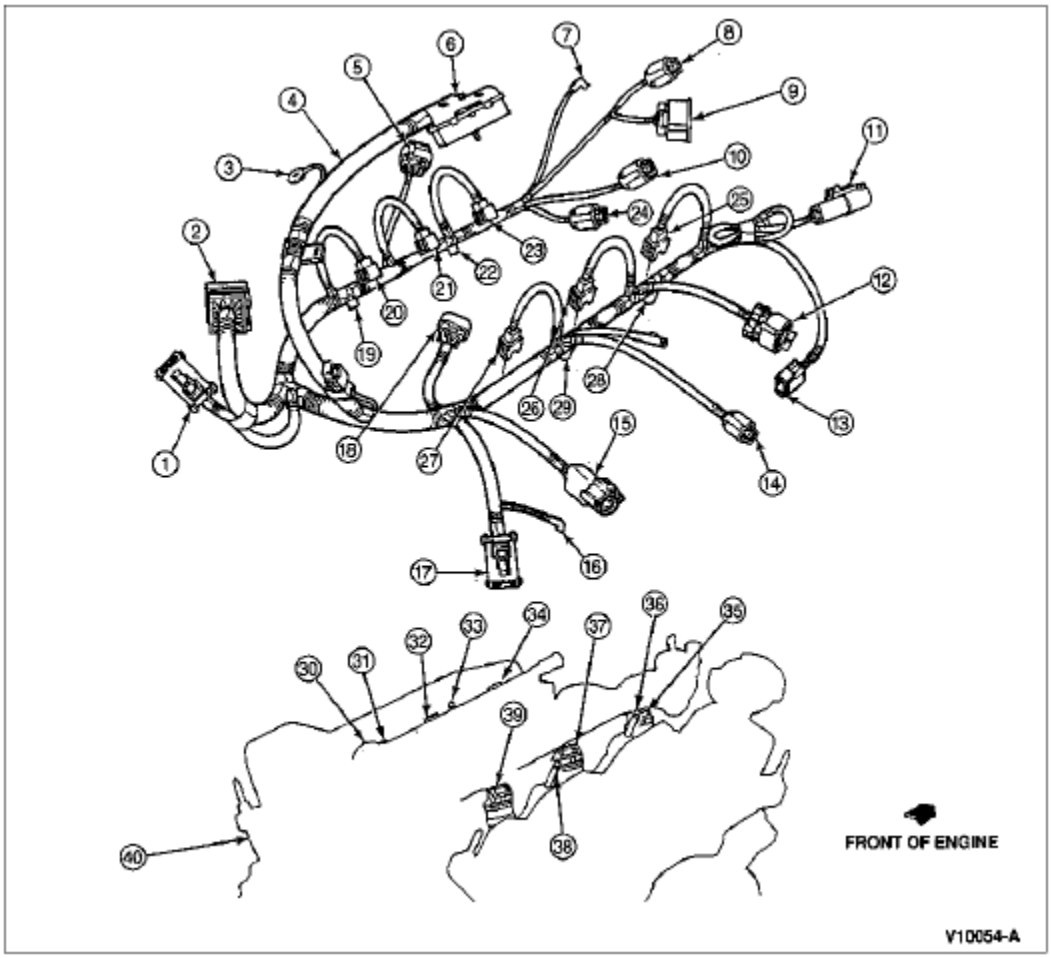
Item	Part Number	Description
1	12A581	Engine Control Sensor Wiring
2	—	Connector to EGR Vacuum Regulator Control (Part of 12A581)
3	9J459	EGR Vacuum Regulator Solenoid
4	—	EGR Transducer Bracket (Part of 9J433)
5	—	42-Pin Connector to Engine Compartment Wiring Assembly (Part of 12A581)
6	9J433	EGR Transducer

7	9D475	EGR Valve
8	9F715	Idle Air Control Valve
9	—	Connector to Idle Air Control Valve (Part of 12A581)
10	—	Connector to Throttle Position Sensor (Part of 12A581)
11	9B989	Throttle Position Sensor
12	—	PCM Connector (Part of 12A581)
13	12029	Ignition Coil
14	—	Connector to Ignition Coil (Part of 12A581)
15	18801	Radio Ignition Interference Capacitor
16	—	Connector to Radio Interference Capacitor (Part of 12A581)
17	—	Connector to Camshaft Position Sensor (Synchronizer) (Part of 12A581)
18	12A112	Camshaft Position Sensor
19	—	Connector to EGR Transducer (Part of 12A581)

Installation

1. Position engine control sensor wiring.
2. Attach connectors to fuel injectors, crankshaft position sensor, engine coolant temperature sensor, water temperature indicator sender unit and camshaft position sensor (synchronizer).
3. Attach two connectors to engine control sensor extension wiring.
4. Attach 42-pin connector to engine compartment wiring harness and tighten bolt to 4-5 Nm (36-49 lb-in).
5. Attach PCM connector. Tighten bolt to 6-7 Nm (46-63 lb-in).
6. Install screw attaching engine control sensor wiring to dash assembly. Tighten to 4 Nm (36 lb-in).
7. Clean surface of dash to ensure good connection where PCM ground cable attaches. Connect PCM ground cable to dash and tighten screw to 8-12 Nm (79-107 lb-in).
8. Install throttle body as described in this section.
9. Install air cleaner outlet tube and tighten clamps to 1.4-2 Nm (13-17 lb-in).
10. Connect intake air temperature sensor (IAT sensor) (12A697) and mass air flow sensor (MAF sensor) (12B579).
11. Perform Fuel System Post-Service procedures as described in this section.

Engine Control Sensor Wiring — Ranger



Item	Part Number	Description
1	—	Connector to Engine Control Sensor Extension Harness (Part of 12A581)
2	—	42-Pin Connector to Engine Compartment Wiring Assembly (Part of 12A581)
3	—	Ground Cable (Part of 12A581)
4	12A581	Engine Control Sensor Wiring
5	—	Connector to EGR Transducer (Part of 12A581)
6	—	Connector to PCM (Part of 12A581)
7	—	Connector to Water Temperature Sensor (Part of 12A581)
8	—	Connector to Idle Air Control Valve (Part of 12A581)

9	—	Connector to Throttle Position Sensor (Part of 12A581)
10	—	Connector to Intake Air Temperature Sensor (Part of 12A581)
11	—	Connector to Mass Airflow Sensor (Part of 12A581)
12	—	Connector to Ignition Coil (Part of 12A581)
13	—	Connector to Crankshaft Position Sensor (Part of 12A581)
14	—	Connector to EGR Vacuum Regulator Control (Part of 12A581)
15	—	Connector to Oxygen Sensors (Part of 12A581)
16	—	Connector to Oil Pressure Sender (Part of 12A581)
17	—	Connector to Engine Control Sensor Extension Harness (Part of 12A581)
18	—	Connector to Camshaft Position Sensor (Synchronizer) (Part of 12A581)
19	—	Retainer to Retainer to Valve Cover Stud (Part of 12A581)
20	—	Connector to Fuel Injector Number 6 (Part of 12A581)
21	—	Connector to Fuel Injector Number 5 (Part of 12A581)
22	—	Retainer to Valve Cover Stud (Part of 12A581)
23	—	Connector to Fuel Injector Number 4 (Part of 12A581)
24	—	Connector to Engine Coolant Temperature Sensor (Part of 12A581)
25	—	Connector to Fuel Injector Number 1 (Part of 12A581)
26	—	Connector to Fuel Injector Number 2 (Part of 12A581)
27	—	Connector to Fuel Injector Number 3 (Part of 12A581)
28	—	Retainer to Valve Cover Stud (Part of 12A581)
29	—	Retainer to Valve Cover Stud (Part of 12A581)
30	—	Valve Cover Stud (Part of 6007)
31	—	Fuel Injector Number 6
32	—	Fuel Injector Number 5
33	—	Valve Cover Stud (Part of 6007)
34	—	Fuel Injector Number 4
35	—	Fuel Injector Number 1
36	—	Valve Cover Stud (Part of 6007)
37	—	Fuel Injector Number 2
38	—	Valve Cover Stud (Part of 6007)

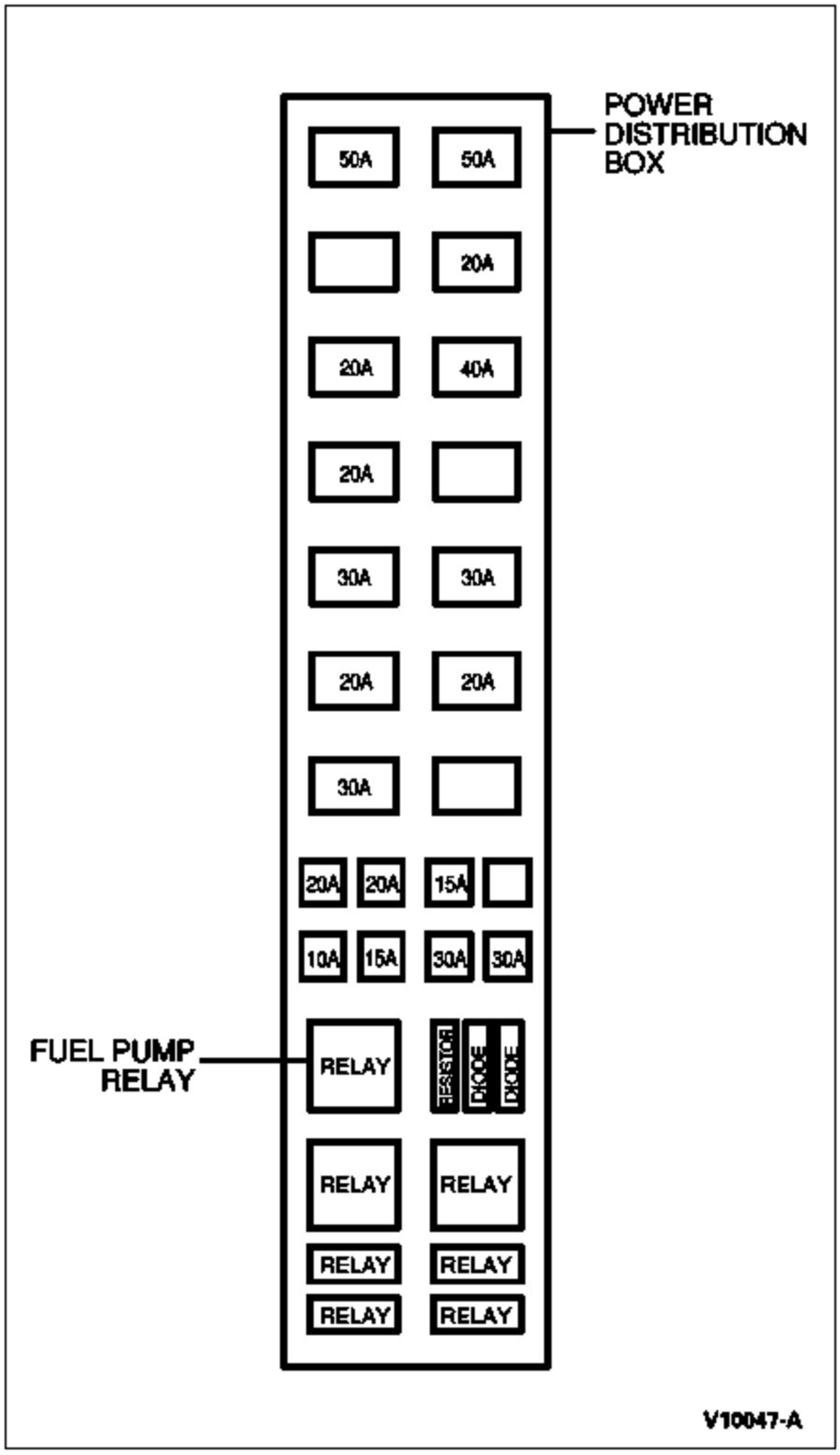
39	—	Fuel Injector Number 3
40	6007	Engine

Fuel Pump Relay

Removal and Installation

1. Disconnect battery ground cable (14301).
2. Open power distribution box.
3. Unplug and remove fuel pump relay from socket 7.
4. Plug in new fuel pump relay.
5. Close power distribution box cover.
6. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns it adaptive strategy. The vehicle may need to be driven 16 km (10 miles) to relearn the strategy.**

   Reconnect battery ground cable.
7. Turn on ignition switch (11572) without starting engine and listen for fuel pump operation.


POWER DISTRIBUTION BOX
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50A
20A
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40A
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15A
10A
15A
30A
30A
FUEL PUMP RELAY
RELAY
RESISTOR
DIODE
DIODE
RELAY
RELAY
RELAY
RELAY
RELAY
RELAY
V10047-A

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Intake Manifold to Head	32	24	—
Air Supply Tube Clamps	3.0	—	27
Throttle Body to Intake Manifold Bolts	25	19	—
Idle Air Control Valve to Throttle Body	10	—	90
Throttle Position Sensor to Throttle Body	2.8-3.8	—	27
Fuel Pressure Relief (Schrader) Valve	8.0	—	71
Fuel Pressure Relief Valve Cap	1	—	9
Fuel Injection Supply Manifold to Intake Assembly	8-12	6-8	—
Fuel Pressure Regulator to Fuel Injection Supply Manifold	3-4	—	27-35
Accelerator Cable Bracket	8-10	—	67-92
EGR Valve to Ignition Coil Bracket	8-12	—	71-106
Ignition Coil Bracket to Intake Manifold	16-20	12-15	—
EGR Valve to Air Intake Throttle Body	20-30	15-22	—
EGR Tube to Manifold	35-65	26-47	—
PCM Connector Bolt — Ranger	6-7	—	46-63
PCM Ground Cable to Dash — Ranger	8-12	—	79-107

Fuel Charging System

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Fuel Pressure Gauge	T80L-9974-B

Pre-Service Procedures

The fuel charging assembly consists of the throttle body (9E926), and the upper and lower intake manifolds (9424). Prior to service or removal of the fuel charging assembly, the following steps must be taken:

1. Disconnect battery ground cable battery lead and secure it out of the way. Remove the fuel supply manifold shield (9J314).
2. Remove engine air cleaner intake tube and duct (9A673) from air cleaner to throttle body.
3. Remove fuel tank filler cap (9030) to relieve tank pressure.
4. Release pressure from fuel system at fuel pressure relief valve (9H321) (Schrader) on fuel injection supply manifold (9D280). Use Fuel Pressure Gauge T80L-9974-B. To gain access to fuel pressure relief valve, valve cap must first be removed.

Post-Service Procedures

After the service is complete and the fuel charging assembly is installed onto engine, the following steps must be taken:

1. Install engine air cleaner intake tube and duct to throttle body.
2. Install the fuel tank filler cap.
3. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

   Connect battery ground cable.
4. **NOTE: Check all connections at fuel rails, push-connect fittings, fuel injectors, etc.**

   CAUTION: The fuel system is normally pressurized to 276 kPa (40 psi).

   Turn ignition switch (11572) on and off several times without starting engine to pressurize the fuel system. Check for fuel leaks at fuel pressure regulator (9C968), fuel injectors and fuel connect fittings.

5. Start engine and warm to operating temperature. Check for coolant leak if coolant was removed.

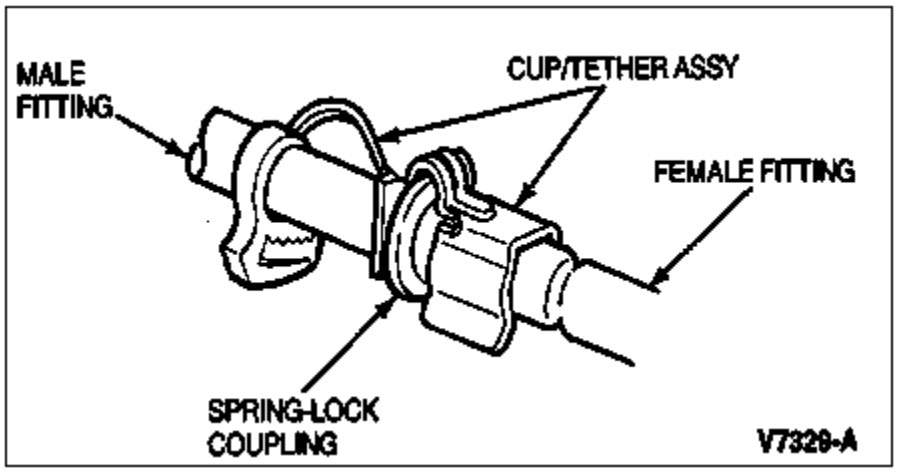
6. Perform EEC Self Test to check system's function. Refer to Powertrain Control/Emissions Diagnosis Manual. Recheck for fuel leaks.

Spring Lock Coupling

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Spring Lock Coupling Disconnect Tool Set	T84L-19623-B

The spring lock coupling is a fuel line coupling held together by a garter spring inside a circular cage. When the coupling is connected, the flared end of the female fitting slips behind the garter spring inside the cage of the male fitting. The garter spring and cage then prevent the flared end of the female fitting from pulling out of the cage. As a redundant locking feature, a horseshoe shaped retaining clip is incorporated to improve the retaining reliability of the spring lock coupling.



Removal

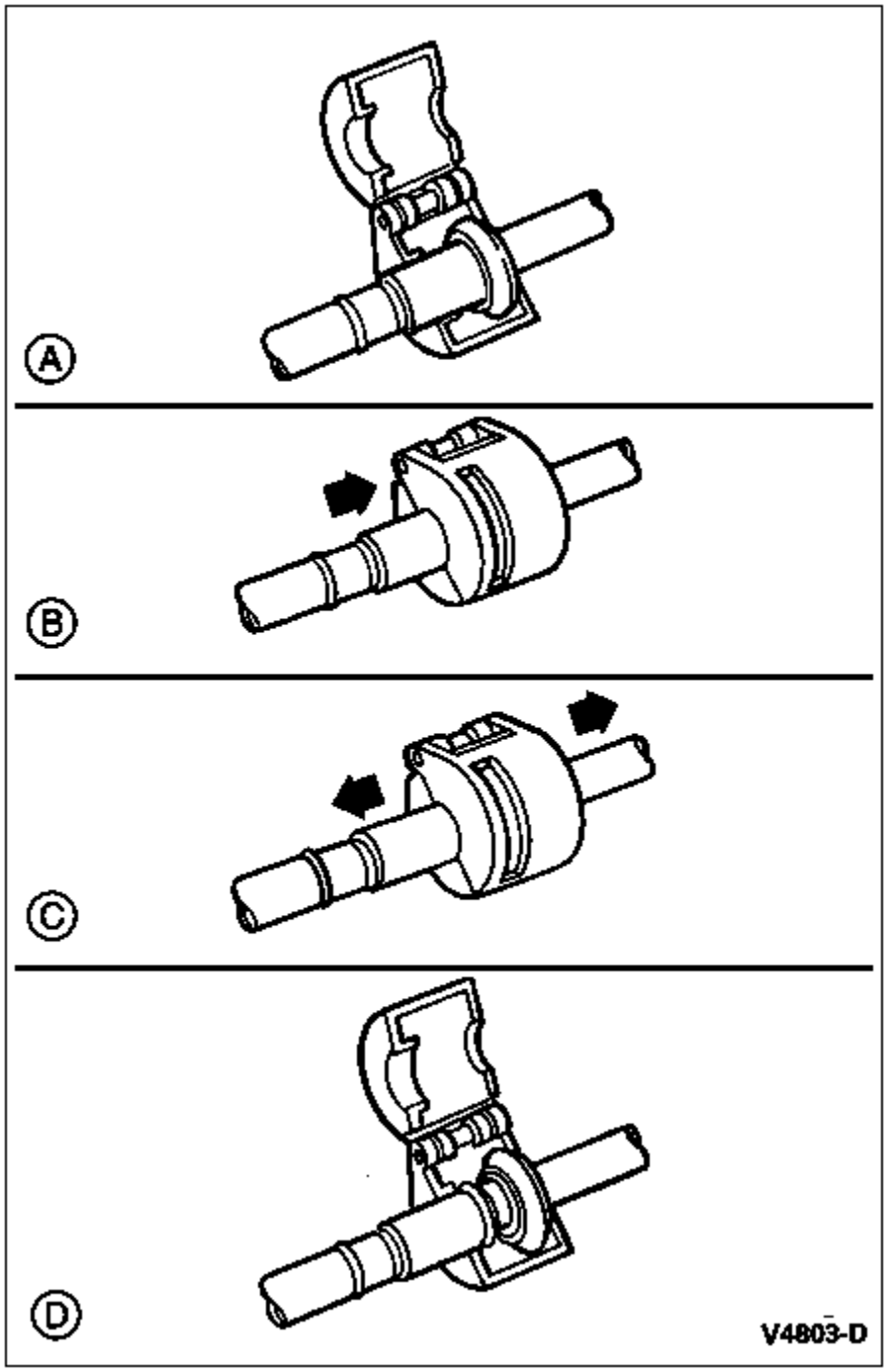
1. Release fuel system pressure. Refer to Section 10-00 for fuel system pressure relief procedures. A fuel pressure relief valve (9H321) on the fuel injection supply manifold (9D280) is provided for this procedure.

2. Remove retaining clip from spring lock coupling by hand only. Do not use any sharp tool or screwdriver as it may damage the spring lock coupling.

3. Twist fitting to free it from any adhesion at the O-ring seal.

4. Using Spring Lock Coupling Disconnect Tool T81P-19623-G1 (3/8 Inch) or T81P-19623-G2 (1/2 Inch) (part of Spring Lock Disconnect Tool Set T84L-19623-B), disconnect fuel hoses at the fuel rail supply tube and fuel rail return tube.

    a. Fit tool to coupling so tool can enter cage to release garter spring.
    b. Push the tool into the cage opening to release female fitting from garter spring.
    c. Pull the coupling male and female fittings apart.
    d. Remove the tool from the disconnected coupling.



Installation

1. Make sure the garter spring is in cage of male fitting. If garter spring is missing, install a new spring by pushing it into cage opening. If garter spring is damaged, remove it from cage with a small wire hook (do not use a screwdriver) and install a new spring.

2. Clean all dirt or foreign material from both pieces of coupling.

3. **WARNING: USE ONLY THE SPECIFIED O-RINGS AS THEY ARE MADE OF A SPECIAL MATERIAL. THE USE OF ANY O-RING OTHER THAN THE SPECIFIED O-RING MAY ALLOW**

THE CONNECTION TO LEAK INTERMITTENTLY DURING VEHICLE OPERATION.

Replace missing or damaged O-rings. Use only O-rings specified for spring lock couplings.

4. Lubricate male fitting and O-rings and inside of female fitting with clean engine oil XO-10W30-QSP or equivalent meeting Ford specification ESE-M2C153-E.

5. Fit female fitting to male fitting and push until garter spring snaps over flared end of female fitting.

6. Check coupling engagement by pulling on fitting and visually checking to make sure garter spring is over flared end of female fitting.

7. **NOTE: All vehicles require the large black clip to be installed on the supply side fuel line and the small gray clip to be installed on the return side fuel line.**

   Position retaining clip over metal portion of spring lock coupling. Firmly push retaining clip onto spring lock coupling. Make sure horseshoe portion of clip is over the coupling. Do not install retaining clip over rubber fuel line.

Fuel Injection Supply Manifold, Upper

Ranger

Removal

1. Disconnect the negative battery cable.
2. Disconnect the intake air temperature (IAT) sensor electrical connector.
3. Remove the crankcase ventilation hose from the right valve cover. Loosen the induction tube clamps and remove the tube.
4. Remove the accelerator control splash shield.
5. Remove the throttle cable from the retaining clip, located on top of the upper manifold. Unclip the throttle/speed control cables from the throttle body. Separate the cables and remove them from the mounting bracket. Position the cables out of the way.
6. Remove the 42-pin engine connector from the mounting bracket.
7. Disconnect the ignition coil and the coil capacitor electrical connectors. Disconnect the engine harness locator from the coil bracket and position the harness out of the way.
8. Disconnect the ignition wires from the ignition coil pack.
9. Disconnect the throttle position (TP) sensor electrical connector.
10. Disconnect the differential pressure feedback EGR system, intake air control (IAC) valve and EGR vacuum regulator solenoid electrical connectors.
11. Disconnect the vacuum harness from the upper intake manifold and EGR vacuum regulator solenoid.
12. Remove the positive crankcase ventilation (PCV) and the brake booster hose from the upper intake manifold.
13. Remove the engine harness locator from the rear of the intake manifold.
14. Disconnect the differential pressure feedback EGR system hoses from the sensor.
15. Disconnect the canister purge hose from the throttle body.
16. Remove the upper intake manifold retaining nuts.
17. Position the alternator wiring harness bracket out of the way.
18. Lift up and forward to disengage the EGR inlet tube from the upper intake manifold. Route the left

ignition wires through the manifold opening while removing the manifold from the engine.

19. **WARNING: THE FUEL SUPPLY LINES ON VEHICLES EQUIPPED WITH FUEL INJECTED ENGINES REMAIN PRESSURIZED FOR LONG PERIODS OF TIME, AFTER ENGINE SHUT DOWN. FUEL SYSTEM PRESSURE MUST BE RELIEVED PRIOR TO FUEL SYSTEM SERVICE, TO PREVENT POSSIBLE INJURY.**

    Connect the Multiport Fuel Injection Fuel Pressure Gauge T80L-9974-B to the fuel pressure relief valve, located on the fuel supply manifold. Open the manual valve on the gauge to release the fuel system pressure. Once the pressure is released, close the valve and remove the gauge from the supply manifold.

20. Disconnect the fuel injector electrical connectors.

21. Disconnect the fuel pressure regulator vacuum hose.

22. Remove the fuel supply manifold and the fuel injectors as an assembly. Install protective tape and caps to the engine openings.

23. Disconnect the fuel supply line from the fuel supply manifold and install a protective cap.

24. **CAUTION: Do not use metal scrapers, wire brushes, power abrasive discs, or other abrasive means to clean the sealing surfaces.**

    NOTE: It is important that the gasket surfaces are free from all dirt, oil and debris. Remove and discard the gaskets. Clean the gasket surfaces. Clean the gasket sealing surfaces with Metal Surface Cleaner F4AZ-19A536-RA or equivalent meeting Ford specification WSE-M5B392-A. Allow the surfaces to dry until there is no sign of wetness.

    Remove the gaskets and clean the gasket surfaces.

Installation

1. **WARNING: DO NOT CARRY AN OPEN FLAME OF ANY TYPE WHEN WORKING ON OR NEAR AN OPEN FUEL SYSTEM. OVER A PERIOD OF TIME THE FUEL SYSTEM MAY BUILD PRESSURE, USE CAUTION WHEN REMOVING THE PROTECTIVE CAPS. INSPECT THE FUEL LINE O-RING SEALS FOR DAMAGE PRIOR TO ASSEMBLY. REPLACE THE O-RINGS ONLY WITH APPROPRIATE REPLACEMENT PARTS. LUBRICATE THE O-RINGS WITH CLEAN ENGINE OIL PRIOR TO ASSEMBLY. FAILURE TO FOLLOW THESE INSTRUCTIONS MAY RESULT IN PERSONAL INJURY.**

    NOTE: Install a new gasket.

    To install, reverse the removal procedure.

Aerostar

Removal

1. Disconnect the negative battery cable. For additional information, refer to Section 14-01 .

2. Loosen the induction tube hose clamps and disconnect the intake air temperature (IAT) electrical connector. Disconnect the crank case-ventilation hose from the induction tube and remove the induction tube.
3. Remove the accelerator control splash shield.
4. Disconnect the throttle and speed control cables from the throttle body. Remove the throttle cable-mounting bracket and the cable-retaining clip from the upper manifold. Position the cables out of the way.
5. Disconnect the canister purge hose, located below the throttle body, and position it aside.
6. Disconnect the throttle position (TP) sensor, differential pressure feedback EGR system, idle air control (IAC) valve and EGR vacuum regulator solenoid electrical connectors.
7. Disconnect the vacuum harness from the upper intake manifold and the EGR vacuum regulator solenoid sensor.
8. Disconnect the differential pressure feedback EGR system hoses from the sensor.
9. Partially raise the vehicle and remove the ignition coil bracket-retaining bolt from the exhaust manifold through the right side wheel-well. For additional information, refer to Section 00-02 .
10. Raise the vehicle. For additional information, refer to Section 00-02 .
11. Remove the EGR tube-nut from the exhaust manifold.
12. Lower the vehicle. For additional information, refer to Section 00-02 .
13. Remove the retaining screw from the floor mount cup holder and pull upward to release the retaining clips.
14. Remove the anti-lock electronic control module and disconnect the electrical connector.
15. Unclip the three retaining clips and remove the interior engine access cover.
16. Disconnect the heater hose retaining bracket and position the heater hoses out of the way.
17. Remove the transmission fluid level indicator. Remove the transmission filler tube from the support bracket and position aside.
18. Disconnect the ignition wires four, five and six from the ignition coil pack. Remove the ignition wires from the locator on the upper intake manifold and position the wires out of the way.
19. Remove the ignition coil bracket and position out of the way.
20. Remove the positive crankcase ventilation (PCV) and brake booster hoses from the upper intake manifold.
21. Remove the oil level indicator. Remove the oil indicator tube retaining nuts and position the tube aside.
22. Remove the exhaust gas recirculation (EGR) inlet tube bracket retaining bolt from the exhaust manifold. Remove the EGR inlet tube from the upper intake manifold.

23. Remove the upper intake manifold retaining nuts. Remove the transmission filler tube support bracket and the upper intake manifold from the vehicle.

24. **WARNING: FUEL SUPPLY LINES ON VEHICLES EQUIPPED WITH FUEL INJECTED ENGINES REMAIN PRESSURIZED FOR LONG PERIODS OF TIME AFTER ENGINE SHUT DOWN. FUEL SYSTEM PRESSURE MUST BE RELIEVED PRIOR TO FUEL SYSTEM SERVICE TO PREVENT POSSIBLE INJURY.**

    Connect the Multiport Fuel Injection Fuel Pressure Gauge T80L-9974-B to the fuel pressure relief valve, located on the fuel supply manifold. Open the manual valve on the gauge to relieve the fuel system pressure. Once the pressure is relieved, close the valve and remove the gauge from the supply manifold.

25. Disconnect the fuel pressure regulator vacuum hose.

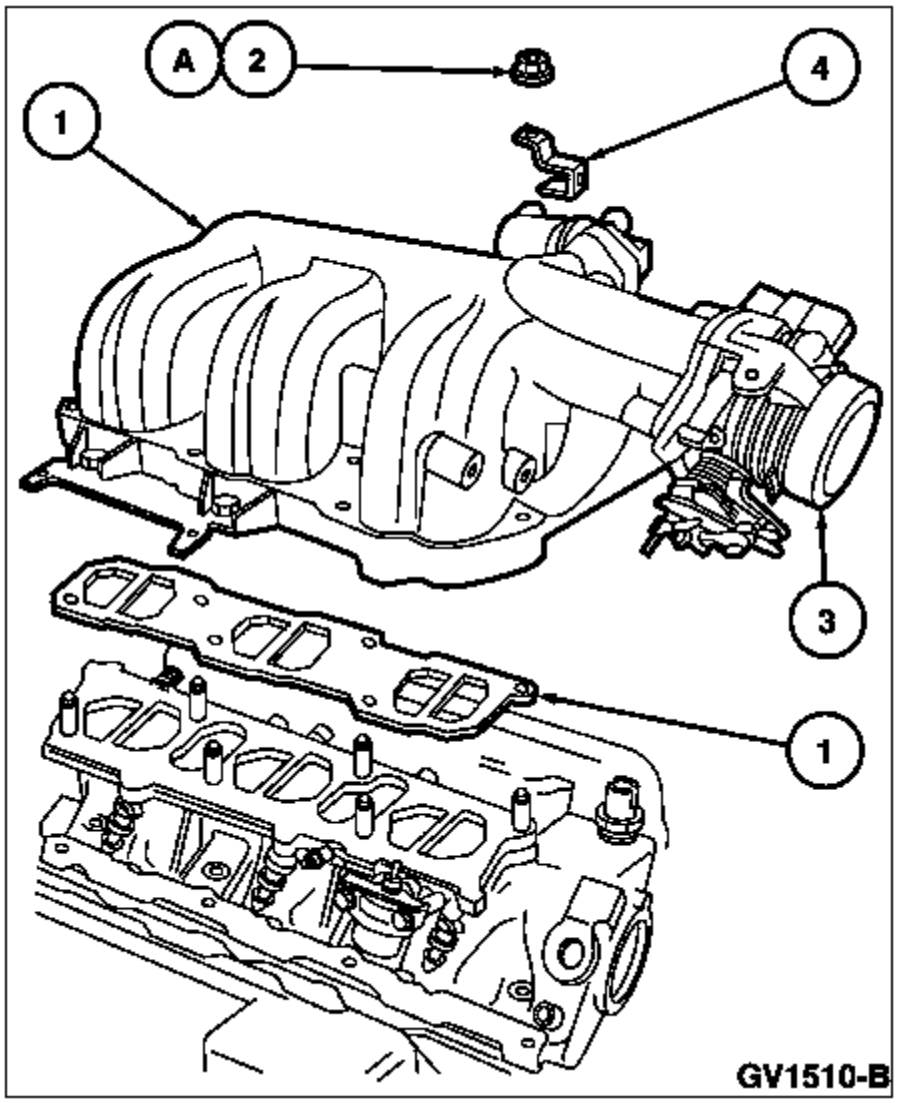
26. Disconnect the fuel line fittings from the fuel supply manifold. Positon the fuel lines out of the way.

27. Remove the fuel supply manifold.

28. **CAUTION: Do not use metal scrapers, wire brushes, power abrasive discs, or other abrasive means to clean the sealing surfaces.**

    NOTE: It is important that the gasket surfaces are free from all dirt, oil and debris.

    Remove and discard the gaskets and clean the gasket surfaces. Clean the gasket sealing surfaces with Metal Surface Cleaner F4AZ-19A536-RA, or equivalent, meeting Ford specification WSE-M5B392-A. Allow to dry until there is no sign of wetness. Remove the gaskets and clean the gasket surfaces.



Item	Part Number	Description
1	9424	Intake Manifold (Upper)
2	E822110-S72	Nut (6 Req'd)
3	9E926	Throttle Body
4	14N063	Bracket
5	9E463	Gasket
A	—	Tighten to 20-25 Nm (15-18 Lb-Ft)

Installation

1. **CAUTION: Do not use silicone grease to lubricate O-rings. Silicone grease can plug fuel injectors.**

   NOTE: Inspect the fuel injectors O-ring seals for damage, prior to assembly. Replace the O-

rings with the appropriate replacement parts only. Lubricate the O-rings with clean engine oil, prior to assembly.

Install the fuel supply manifold spacer plate and the new gaskets. Install the supply manifold and tighten the retaining studs to 12 Nm (9 lb-ft).

2. **WARNING: DO NOT CARRY AN OPEN FLAME OF ANY TYPE WHEN WORKING ON OR NEAR AN OPEN FUEL SYSTEM. OVER A PERIOD OF TIME, THE FUEL SYSTEM MAY BUILD PRESSURE. USE CAUTION WHEN REMOVING THE PROTECTIVE CAPS.**

   Connect the supply and return fuel line fittings to the fuel rail. Tighten the fittings to 22 Nm (17 lb-ft).

3. Connect the fuel pressure regulator vacuum hose.

4. Replace the upper intake manifold gasket. Install the upper intake manifold and the transmission filler tube support bracket. Tighten the upper intake manifold retaining nuts to 23 Nm (17 lb-ft).

5. Connect the canister purge hose to the bottom side of the throttle body.

6. Connect the TP sensor, differential pressure feedback EGR system, IAC valve and EGR vacuum regulator solenoid electrical connectors.

7. **NOTE: Lubricate the EGR O-ring, prior to assembly. Inspect the EGR inlet tube O-ring for damage and replace if necessary.**

   Position the EGR inlet tube to the upper intake manifold and to the exhaust manifold. Install the EGR inlet tube bracket retaining bolt and tighten to 22 Nm (18 lb-ft).

8. Position the oil indicator tube and install the retaining nuts. Tighten the lower retaining nut to 22 Nm (18 lb-ft). Tighten the upper retaining nut to 5 Nm (44 lb-in). Install the oil level indicator.

9. Connect the differential pressure feedback EGR system hoses to the sensor.

10. Connect the vacuum harness to the upper intake manifold and the EGR vacuum regulator solenoid.

11. Install the PCV and brake booster hoses to the upper intake manifold.

12. Install the coil pack bracket and tighten the upper retaining bolts to 23 Nm (17 lb-ft).

13. Raise the vehicle.

14. Install the EGR tube-nut to the exhaust manifold and tighten the nut to 40 Nm (30 lb-ft).

15. Partially lower the vehicle.

16. Through the right side wheel-well, install the ignition coil bracket-retaining bolt to the exhaust manifold. Tighten the retaining bolt to 23 Nm (17 lb-ft).

17. Lower the vehicle.

18. Connect the ignition wires to the ignition coil pack. Install the ignition wires to the ignition wire locator.

19. Install the transmission filler tube to the support bracket and securely tighten the retaining bolt. Install

the transmission fluid level indicator.

20. Position the heater hoses to the heater hose-retaining bracket. Connect the retaining bracket.

21. Install the interior engine access cover.

22. Connect the anti-lock electronic control module electrical connector and install the control module. Securely tighten the retaining nuts.

23. Install the floor mount cup holder. Securely tighten the retaining screw.

24. Install the throttle cable-mounting bracket. Tighten the mounting bracket to 11 Nm (9 lb-ft).

25. Connect the throttle and speed control cables to the throttle body. Install the throttle cable-retaining clip.

26. Install the accelerator control splash shield and securely tighten the retaining bolts.

27. Install the air induction tube and securely tighten the retaining clamps. Connect the crank case-ventilation hose and the IAT sensors.

28. **NOTE: When the battery is disconnected and reconnected, some abnormal drive symptoms may occur while the vehicle relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 mi) or more to relearn the strategy.**

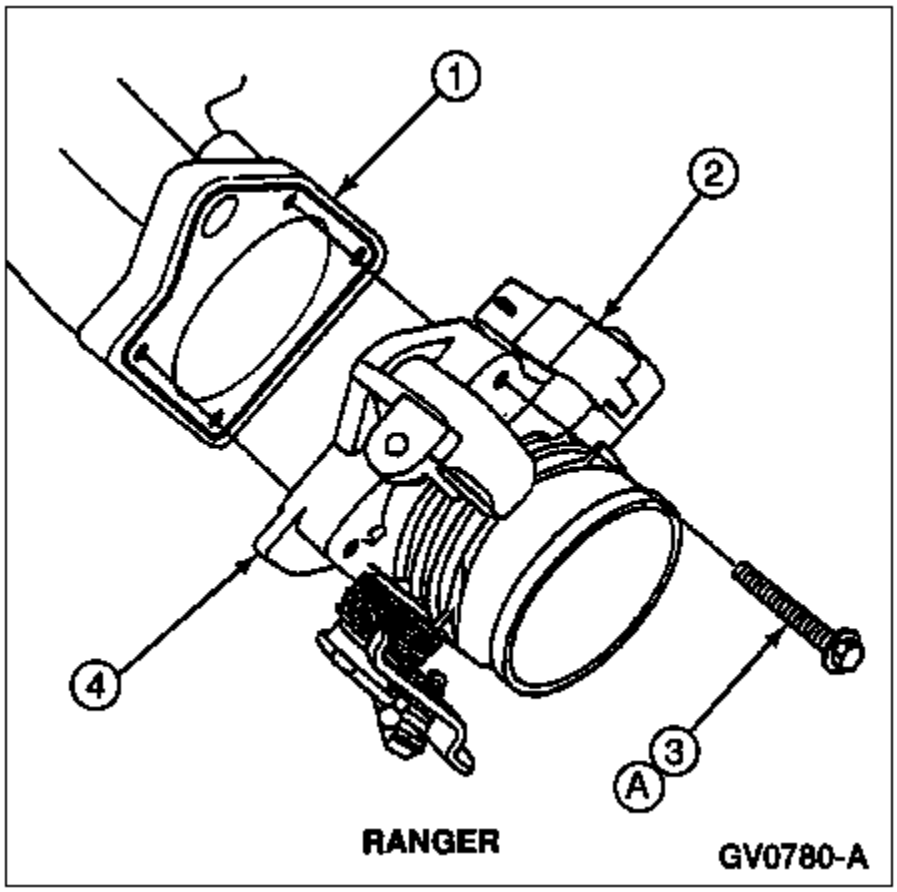
    Connect negative battery cable.

29. Turn the ignition switch on and off several times without starting engine to pressurize the fuel system. Check for fuel leaks at fuel injectors and fuel connections. Start the engine and check for leaks.

Throttle Body

Removal

1. Remove fuel supply manifold shield (9J314) and disconnect throttle cable from ball stud.
2. Disconnect throttle position sensor electrical connector.
3. Remove engine air cleaner intake tube and duct (9A673) at throttle body (9E926).
4. Disconnect canister purge hose from the fitting beneath throttle body.
5. Remove four screws retaining throttle body to upper intake manifold (9424).
6. Carefully separate throttle body from upper intake manifold.
7. Remove and discard gasket between throttle body and upper intake manifold.



Item	Part Number	Description
1	9424	Intake Manifold (Upper)
2	9B989	Throttle Position Sensor
3	N801610-S72	Bolt
4	9E926	Throttle Body
A	—	Tighten to 8-12 Nm (70-106 Lb-In)

Installation

1. **NOTE: If scraping is necessary, be careful not to damage gasket surfaces of throttle body and upper intake manifolds, or allow material to drop into intake manifold.**

   Make sure that both throttle body and upper intake manifold gasket surfaces are clean.

2. Install throttle body gasket on two screws installed in the throttle body.

3. Install throttle body to upper intake manifold.

4. Secure throttle body to upper intake manifold with two remaining screws. Tighten all to 8-12 Nm (70-106 lb-in).

5. Connect throttle position sensor electrical connector.

6. Connect canister purge hose to fitting beneath throttle body.

7. Install the fuel supply manifold shield.

Throttle Position Sensor

Removal

1. Disconnect throttle position sensor (TP sensor) (9B989) from wiring harness.
2. Remove two throttle position sensor retaining screws.
3. Remove throttle position sensor and discard gasket.

Installation

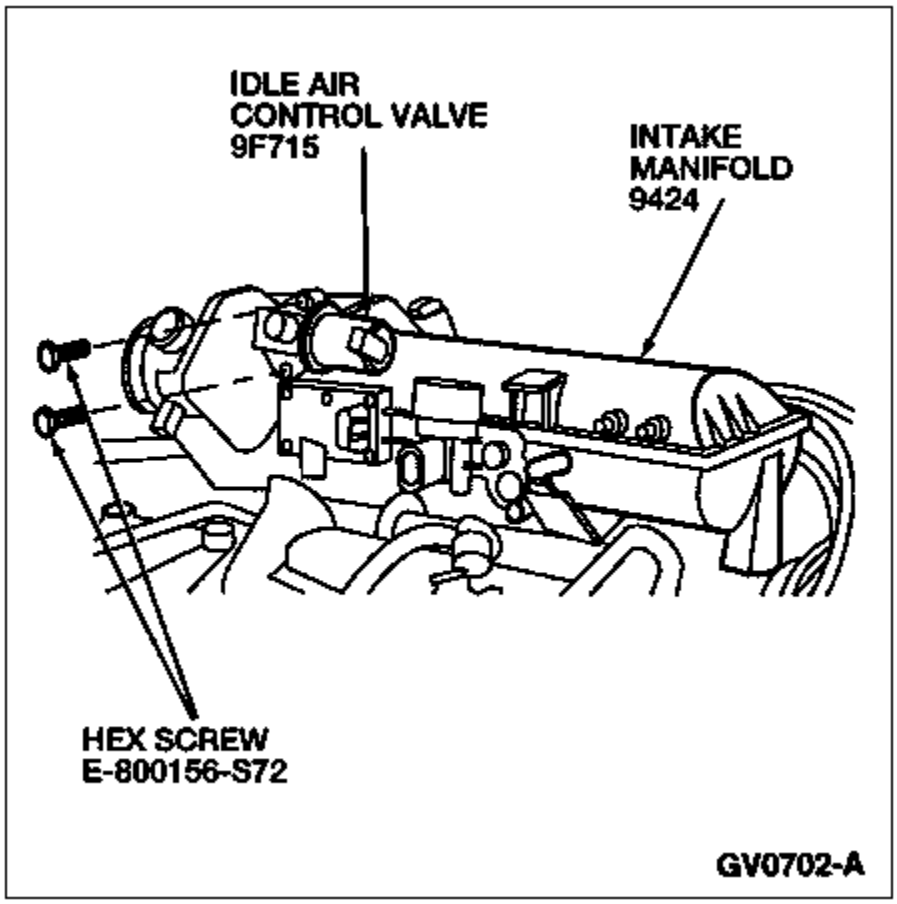
1. Using a new gasket, position throttle position sensor with connector facing rearward.
2. Secure throttle position sensor to throttle body (9E926) with two retaining screws. Tighten to 2.8-3.8 Nm (24-33 lb-in).
3. Connect electrical connector to harness.

Idle Air Control Valve

Removal and Installation

1. Disconnect the idle air control valve connector from the wiring harness.
2. Remove the two idle air control valve retaining bolts.
3. Remove the idle air control valve (IAC valve) (9F715) and gasket.

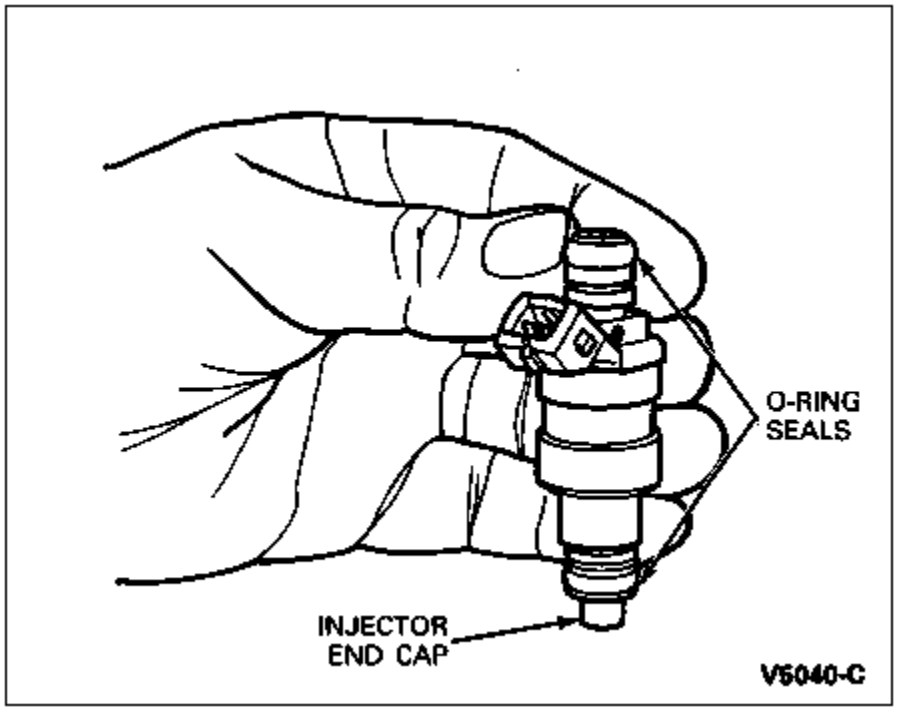
   For installation, follow removal steps in reverse order. Make sure gasket surfaces are clean. If scraping is necessary, be careful not to damage gasket surfaces. Tighten retaining screws to 9-11 Nm (80-97 lb-in).



Fuel Injector

Removal

1. Release pressure from fuel system as described in Section 10-00 .
2. Remove upper intake manifold (9424) as described in Removal and Installation, Fuel Injection Supply Manifold, Upper in this section.
3. Remove fuel injection supply manifold (9D280) as described in Removal and Installation, Fuel Injection Supply Manifold, Lower in this section.
4. Carefully remove electrical harness connectors from individual fuel injectors as required.
5. Remove injector retaining clips as required.
6. Grasping fuel injector body, pull up while gently rocking fuel injector from side to side.
7. Inspect fuel injector O-rings (two per fuel injector) for signs of deterioration. Replace as required.



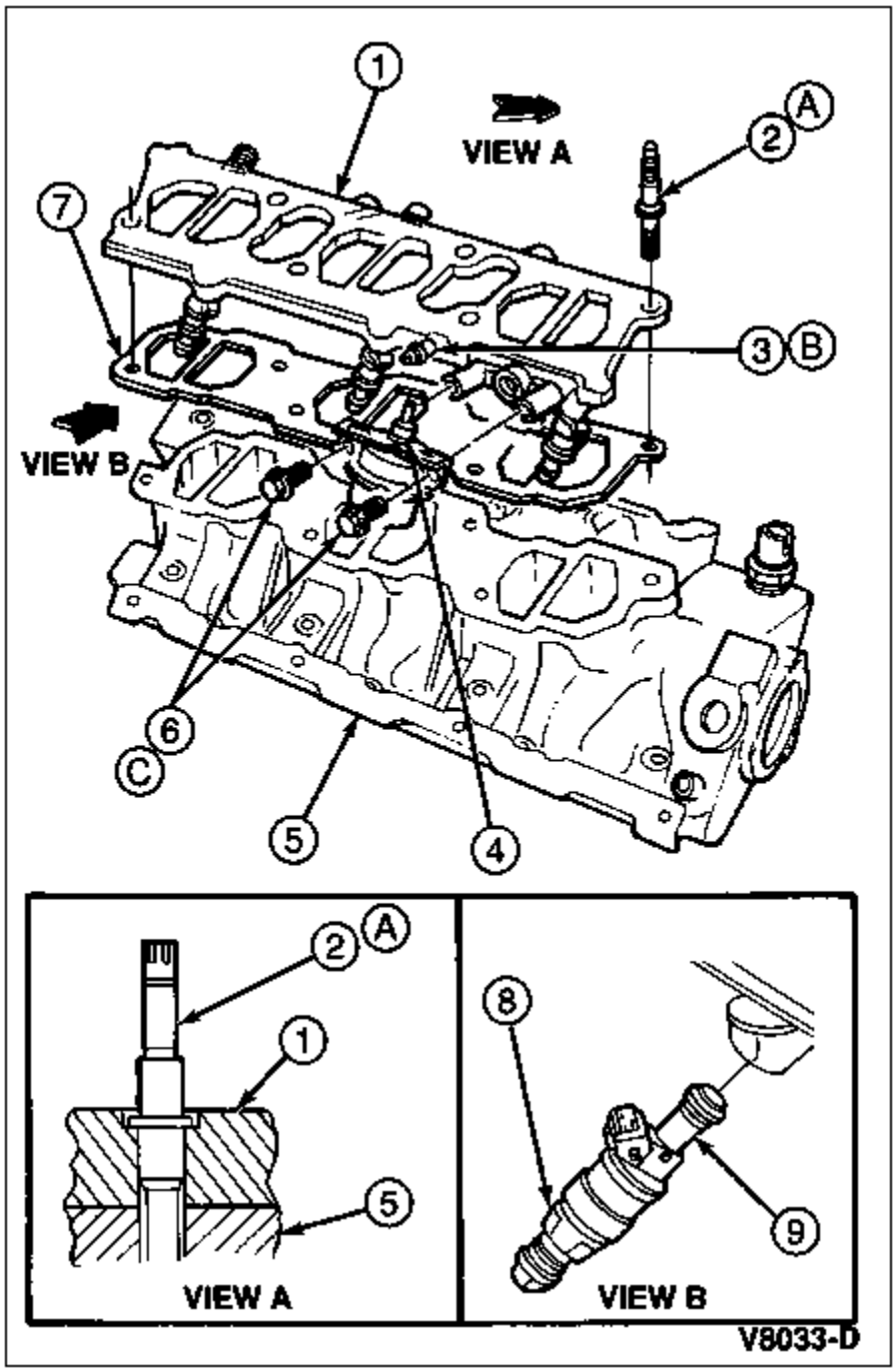
Installation

1. **CAUTION: Never use silicone grease. It will clog the fuel injectors.**

Lubricate new O-rings with a light grade oil such as X0-10W-30-QSP or equivalent meeting Ford specification ESE-M2C153-E and install two on each fuel injector.

2. Install fuel injectors, using a light, twisting, pushing motion.

3. Install fuel injection supply manifold as described in Removal and Installation, Fuel Injection Supply Manifold, Lower in this section. Replace retainer clips if distorted.



Item	Part Number	Description
1	9D280	Fuel Injection Supply Manifold
2	E805674	Stud (6 Req'd)
3	9H321	Fuel Pressure Relief Valve
4	9C968	Fuel Pressure Regulator
5	9424	Intake Manifold
6	E801274	Bolt (2 Req'd)
7	9E436	Gasket
8	9V550	Noise Isolator
9	—	Fuel Injector
A	—	Tighten to 10-14 Nm (89-124 Lb-In)
B	—	Tighten to 3-6 Nm (27-53 Lb-In)
C	—	Tighten to 8-11 Nm (70-97 Lb-In)

4. Install electrical harness connectors to fuel injectors (9F593).

5. Install upper intake manifold as described in Removal and Installation, Fuel Injection Supply Manifold, Upper in this section. Perform fuel charging assembly Post-Service .

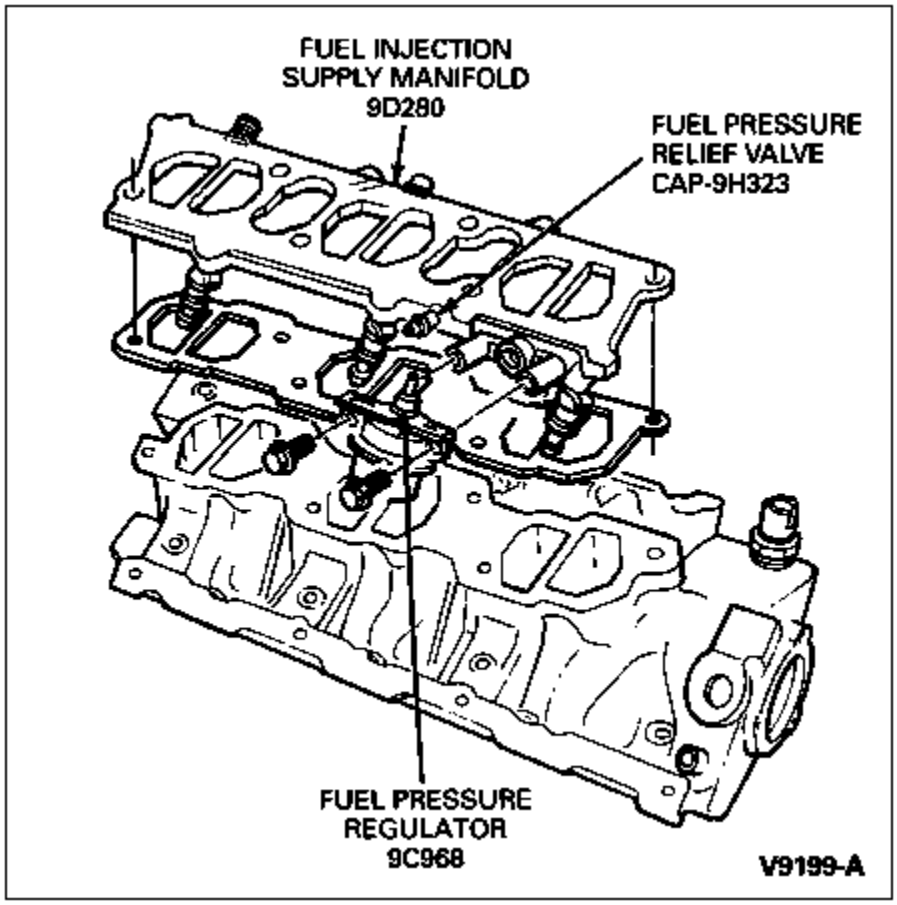
Fuel Pressure Relief Valve (Schrader Valve)

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Fuel Pressure Gauge	T80L-9974-B

Removal

1. If fuel injection supply manifold (9D280) is mounted to engine, remove fuel tank filler cap (9030), then release pressure from system at fuel pressure relief valve (9H321) on fuel injection supply manifold using Fuel Pressure Gauge T80L-9974-B. Cap on fuel pressure relief valve must be removed.



2. Using a socket wrench, remove fuel pressure relief valve from fuel injection supply manifold.

Installation

1. Install fuel pressure relief valve and cap. Tighten fuel pressure relief valve to 3-6 Nm (27-53 lb-in) and the cap to 1 Nm (9 lb-in).

Fuel Injection Supply Manifold, Lower

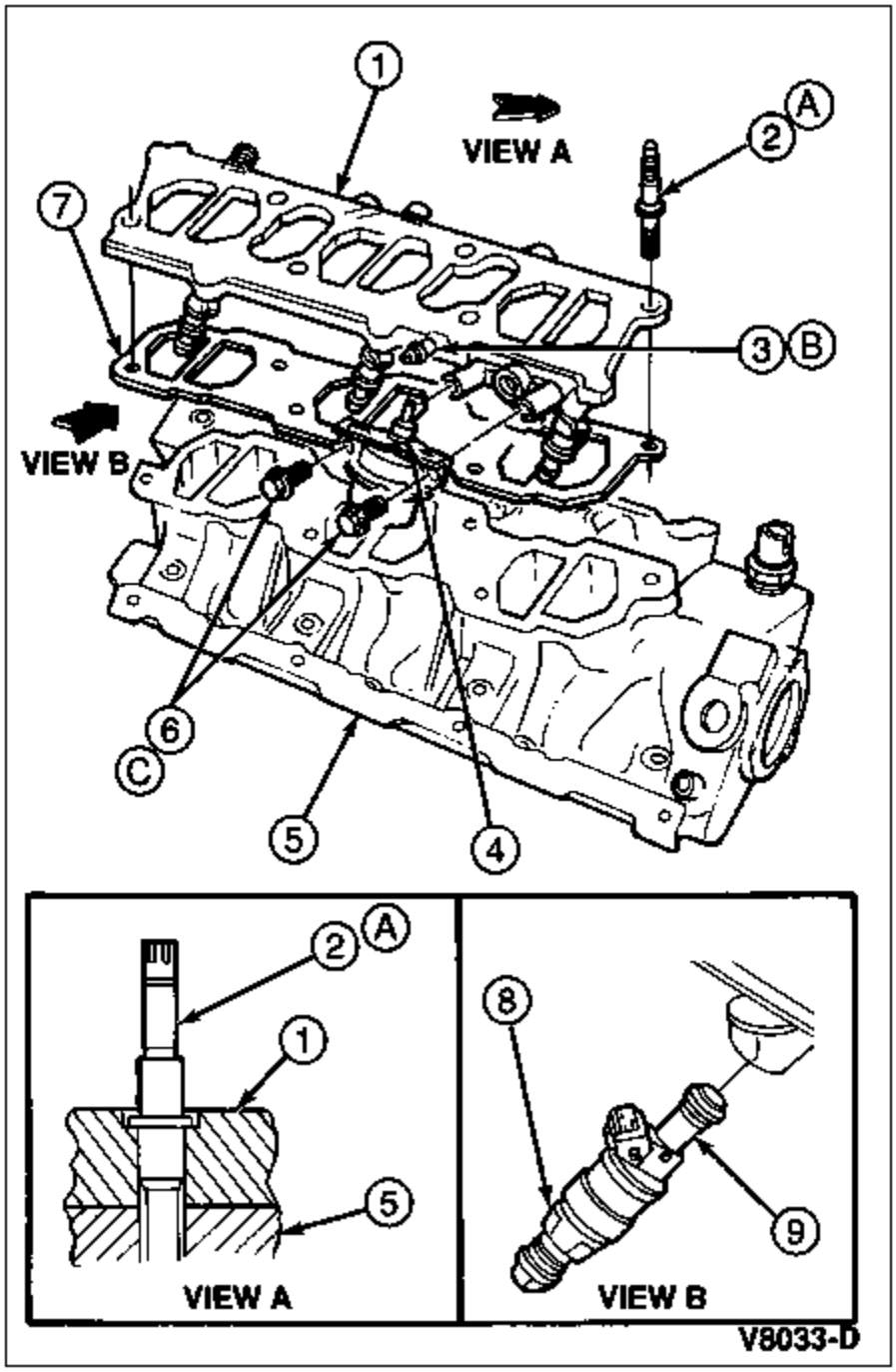
Removal

1. Thoroughly clean the engine.
2. Release pressure from fuel system as described in Section 10-00 .
3. Remove the upper intake manifold assembly as described in Removal and Installation, Fuel Injection Supply Manifold, Upper in this section.
4. Disconnect the fuel supply line fitting at the fuel injection supply manifold (9D280)
5. Disconnect the fuel return line at the fuel pressure regulator.
6. Remove the six Torx® head stud bolts retaining the lower fuel injection supply manifold and remove the manifold. Be sure to clean off the gasket material from the upper and lower fuel injection supply manifolds.
7. Remove the fuel injectors from the fuel injection supply manifold (9F792) and wipe cup clean with a clean, dry cloth.

Installation

1. Check that all holes in the lower fuel injection supply manifold are clean and clear of debris.
2. Position new gaskets on the lower fuel injection supply manifold mounting surface.
3. Make sure the fuel injector end caps are clean and free of contamination. Inspect fuel injector O-rings. Replace if required.
4. **CAUTION: Do not use silicone grease to lubricate O-rings. Silicone grease can plug fuel injectors.**

   Carefully wipe the fuel injector recesses in the intake manifold and make sure they are free of contamination. Lubricate the recesses with light grade oil XO-10W30-QSP or equivalent meeting Ford specification ESE-M2C153-E.
5. Locate the three fuel injectors on the right side recesses of the intake manifold (9424) . Then locate the three on the left.
6. Position the fuel injection supply manifold and press down firmly until the fuel injectors are fully seated in the fuel injection supply manifold and lower intake manifold. The fuel injection supply manifold should be fully seated on the lower intake manifold.
7. Install the six Torx® head stud bolts and tighten to 12-16 Nm (107-125 lb-in).



Item	Part Number	Description
1	9D280	Fuel Injection Supply Manifold
2	E805674	Stud (6 Req'd)
3	9H321	Fuel Pressure Relief Valve
4	9C968	Fuel Pressure Regulator
5	9424	Intake Manifold

6	E801274	Bolt (2 Req'd)
7	9E436	Gasket
8	9V550	Noise Isolator
9	—	Fuel Injector
A	—	Tighten to 10-14 Nm (89-124 Lb-In)
B	—	Tighten to 3-6 Nm (27-53 Lb-In)
C	—	Tighten to 8-11 Nm (71-97 Lb-In)

8. Install the fuel supply line and tighten the fitting to 25-30 Nm (19-22 lb-ft).
9. Install the fuel return line and tighten to 18-22 Nm (14-16 lb-ft).
10. Install the upper intake manifold as described in Removal and Installation, Fuel Injection Supply Manifold, Upper in this section.
11. Refer to Removal and Installation, Fuel Charging System, Post-Service procedure in this section.

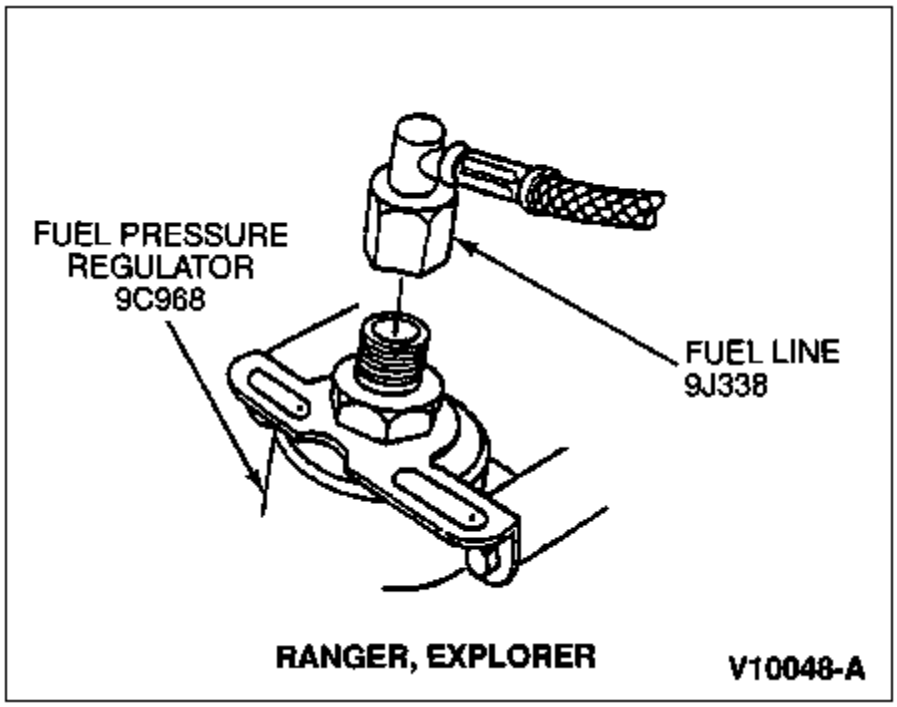
Fuel Pressure Regulator

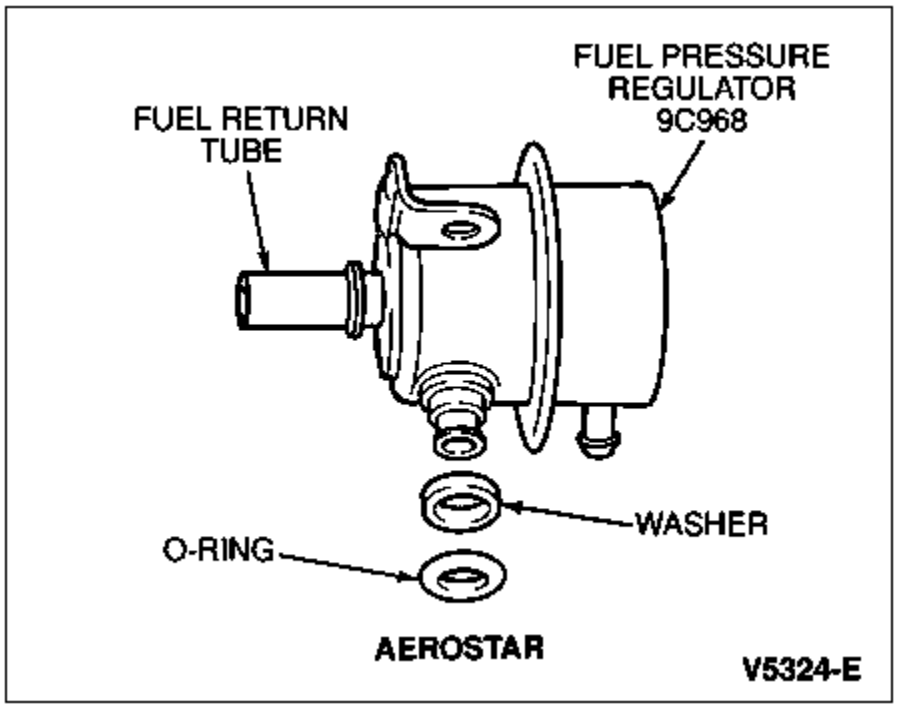
SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Fuel Line Coupling Tool	T90T-9550-A

Removal

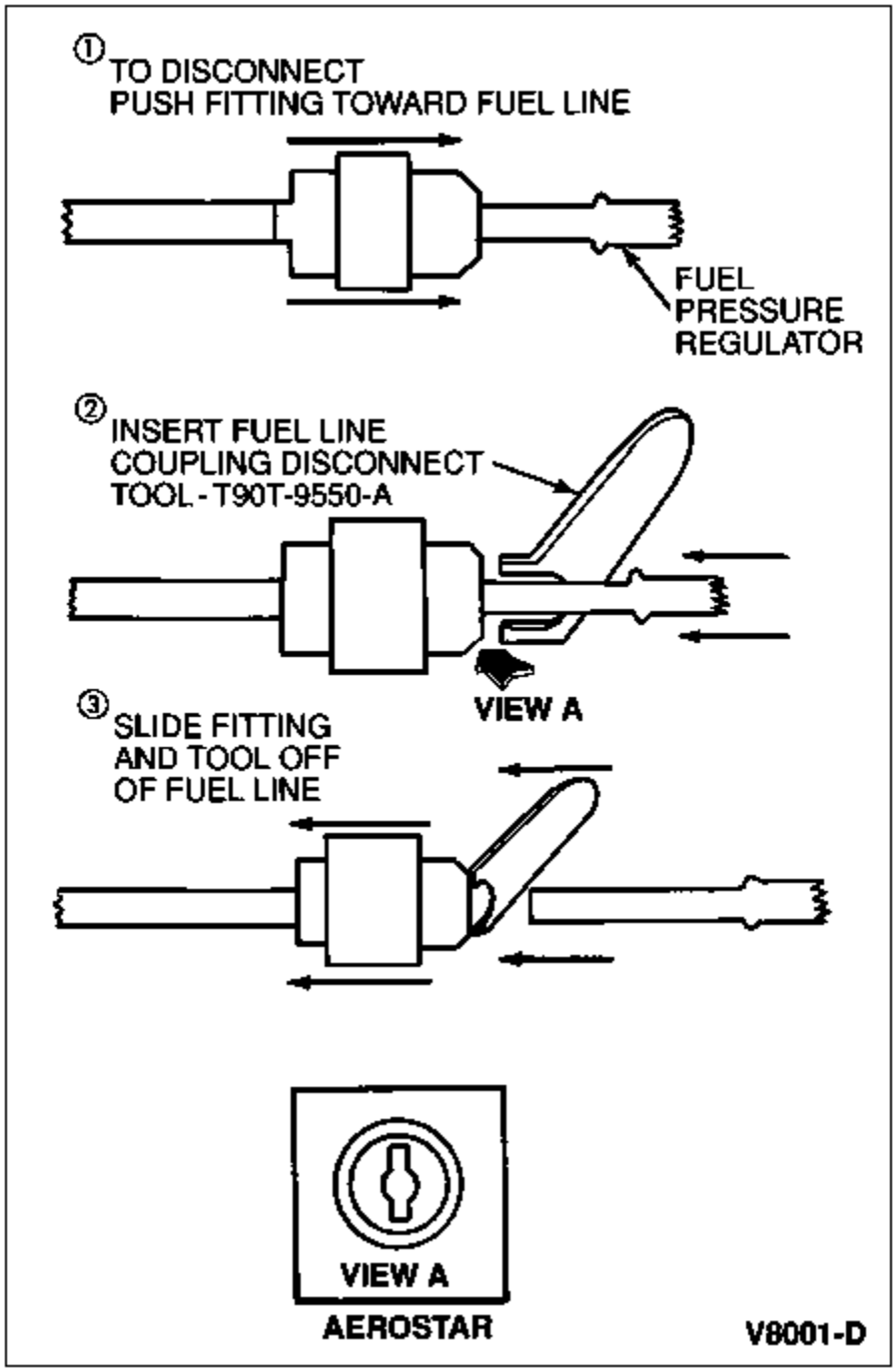
1. If removing fuel pressure regulator (9C968) while fuel injection supply manifold (9D280) is installed on engine, release pressure from fuel system as described in Section 10-00 .
2. Remove vacuum line at fuel pressure regulator.





3. On Aerostar, disconnect the fuel return line from the fuel pressure regulator as follows:

    a. Disengage the locking tabs on the connector retainer and separate the retainer halves.
    b. Inspect the visible internal portion of the fitting for dirt accumulation. Clean the fitting before disassembly.
    c. To disengage the fitting from the fuel pressure regulator, insert the fingers on Fuel Line Coupling Tool T90T-9550-A into the slots in the coupling.
    d. Using the tool, pull the fitting from the fuel pressure regulator.
        - If the fitting has been properly disengaged, the fitting should slide off the regulator with minimum effort.



4. On Ranger remove nut securing fuel line to regulator.
5. Remove two retaining screws from fuel pressure regulator housing.
6. Remove fuel pressure regulator O-ring and washer. Discard washer and inspect O-ring for signs of cracks or deterioration.
7. Inspect fuel return tube for kinks and abrasions.

Installation

1. Install new washer and O-ring on fuel pressure regulator.
2. **NOTE: Never use silicone grease. It will clog the fuel injectors.**

   Lubricate fuel pressure regulator O-ring with light oil ESF-M6C2-A or equivalent.
3. Make sure surfaces of fuel pressure regulator and fuel injection supply manifold are clean.
4. Install fuel pressure regulator on fuel injection supply manifold. Tighten two retaining screws to 8-11 Nm (70-97 lb-in).
5. Install vacuum line to fuel pressure regulator.
6. Install the fuel return line as described in Removal and Installation, Fuel Injection Supply Manifold, Lower in this section.

Fuel Charging Wiring

Removal

1. **NOTE: Make sure ignition switch (11572) is in OFF position and fuel system is depressurized.**

   Disconnect electrical connectors from fuel injectors.

2. Disconnect connectors from main wiring harness and throttle position sensor (TP sensor) (9B989), intake air temperature sensor (IAT sensor) (12A697) and idle air control valve (IAC valve) (9F715).

3. Remove wiring assembly.

Installation

1. Position wiring harness alongside fuel injectors.

2. Snap electrical connectors into position on fuel injectors.

3. Connect throttle position sensor, intake air temperature sensor, idle air control valve and main harness connectors.

4. Verify that all electrical connectors are firmly seated.

5. Use EEC Self Test connector and procedure to check for sensor function.

SPECIFICATIONS

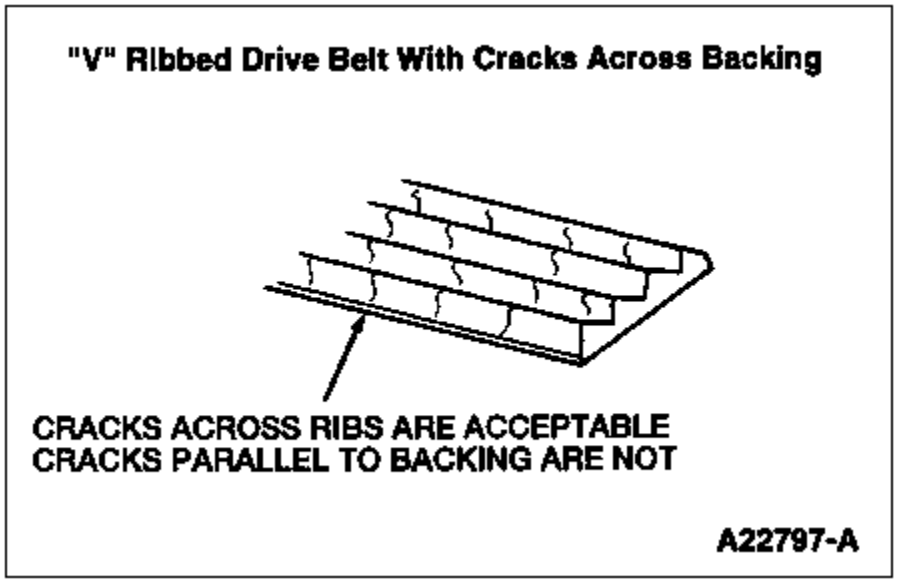
TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Fuel Injection Supply Manifold to Intake Manifold — Stud Bolts	12-16	—	107-125
Upper Intake Manifold to Lower Intake Manifold Nuts	20-25	15-18	—
Throttle Body to Intake Manifold	8-12	—	70-106
Idle Air Control Valve to Intake Manifold	9-11	—	80-97
Throttle Position Sensor to Throttle Body	2.8-3.8	—	24-33
Fuel Pressure Regulator to Injector Manifold	8-11	—	70-97
Fuel Injection Supply Line to Fuel Supply Manifold	25-30	19-22	—
Fuel Pressure Relief Valve	3-6	—	27-53
Fuel Return Line	18-22	14-16	—

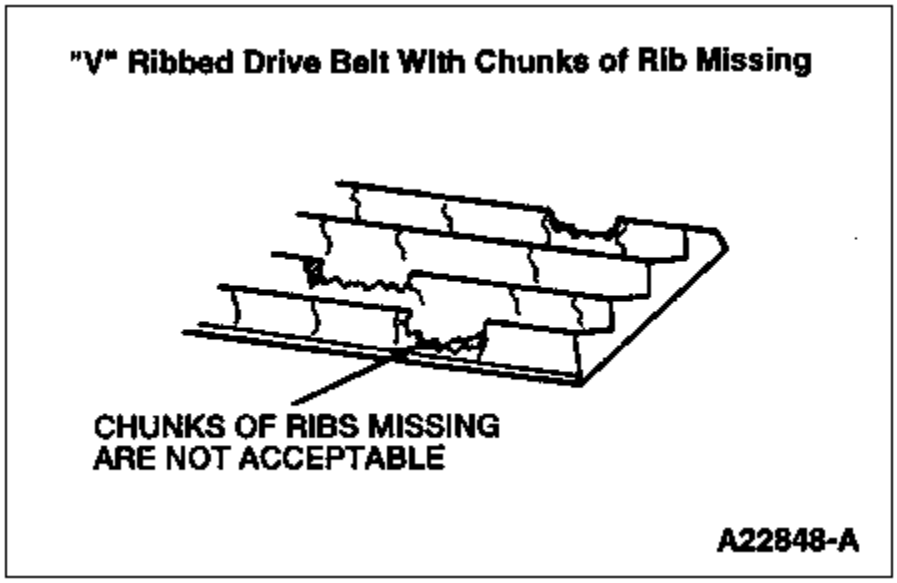
Inspection and Verification

Drive Belt Cracking/Chunking/Wear

Under severe operating conditions (high temperatures, low humidity), drive belt rib cracking can occur at less than 96,000 km (60,000 miles). Drive belt rib cracking across backing is not a reason for concern and has no detrimental effect on belt performance. Cracks parallel to backing are not acceptable.



Drive belt "chunking" occurs when the rubber material actually chunks out between the cracks. Replace the drive belt (8620) if chunking occurs.



Drive Belt Noise/Flutter

Drive belt "chirp" is a regularly occurring chirping noise that occurs due to pulley misalignment or excessive pulley runout. It can be a result of a damaged pulley or an improperly replaced pulley that was not properly aligned.

To correct, determine the area where the noise comes from. Then check each of the pulleys in that area with a straightedge to the crankshaft pulley and look for the accessory pulleys to be out of position in the fore/aft direction or at an angle to the straightedge.

Belt squeal is an intermittent noise that occurs when the drive belt slips on a pulley during certain conditions such as engine start up, rapid engine acceleration, or A/C clutch engagement.

Drive belt squeal can occur under the following conditions:

1. If the A/C discharge pressure goes above 2895 kPa (420 psi). This can occur if:

    a. The A/C system is overcharged.
    b. The A/C condenser core airflow is blocked.
    c. The engine fan blade (8600) is not engaging fully at idle.

2. If A/C OFF equalized pressure (the common discharge and suction pressure that occurs after several minutes) exceeds 965 kPa (140 psi), which is a rare occurrence at high ambient temperatures with a hot engine, turn A/C OFF for a few seconds and then back ON after fan blade begins to cool A/C condenser core.

3. If any of the accessories are damaged, or have a worn or damaged bearing or internal torsional resistance above normal for any reason. All of the accessories should be rotatable by hand in the unloaded condition. If any are not, the accessory should be inspected.

4. If fluid gets on the drive belt. These would include power steering fluid, engine coolant, engine oil or air conditioning system lubricant.

    If fluid does get on the drive belt during service, the best policy is to clean the drive belt with soap and water and thoroughly rinse with clean water. The drive belt does not have to be replaced if no apparent damage has occurred.

5. If drive belt is too long. A drive belt that is too long will allow the drive belt tensioner arm to go all the way to drive belt tensioner arm travel stop under certain load conditions, which will untension the drive belt. If the drive belt tensioner (6B209) is resting on the stop, replace the drive belt.

6. If the drive belt tensioner is worn or damaged. The drive belt tensioner arm should rotate freely without binding.

Symptom Chart — Noise Diagnosis Guide

NOISE DIAGNOSIS GUIDE

Condition	Possible Source	Action
• Excessive Noise/Belt Squeal	• Seized accessory.	• CHECK all accessories for free rotation and REPLACE accessory if necessary. REPLACE drive belt.
	• Loose drive belt.	• CHECK condition of drive belt. REPLACE drive belt. • CHECK that automatic drive belt tensioner is within the indicator marks. CHECK for correct drive belt length if drive belt tensioner is out of operating range.
• Rattle	• Loose accessory pulley or accessory.	• CHECK for looseness and TIGHTEN.
• Noisy Tensioner Pulley Bearing	• Worn tensioner pulley bearing.	• REPLACE drive belt tensioner.
• Belt Chirp	• Misaligned accessory or accessory pulley.	• ALIGN or REPLACE accessory or accessory pulley.

Component Tests

Drive Belt Tensioner, Automatic

The drive belt tensioner (6B209) can be checked as follows:

1. With the engine running, observe drive belt tensioner movement. The drive belt tensioner should move (respond) when the A/C compressor cycles or when the engine (6007) is accelerated rapidly. If the drive belt tensioner movement is constant and excessive, a pulley or shaft is probably bent or a pulley is out of round. In rare cases, excessive belt rideout (uneven depth of grooves in belt) can cause excessive drive belt tensioner movement. This condition can be checked by replacing the suspect drive belt (8620) with a known good original equipment drive belt and repeating the observation.

2. With engine off, check for proper drive belt routing. Refer to the illustrations under Removal and Installation . Service as required.

3. Visually inspect the wear indicator on the drive belt tensioner to ensure the drive belt is within operating range. Replace the drive belt as required.

4. Rotate the drive belt tensioner and check for a binding or frozen condition. Replace components as required.

Drive Belt Misalignment

CAUTION: Incorrect drive belt installation will cause excessive drive belt wear and may cause the drive belt to come off the drive pulleys.

NOTE: Original equipment drive belts are made of a special cord construction and are subjected to special testing before they are approved for use.

Replacement drive belts, other than O.E.M., may track differently/improperly. If a replacement drive belt tracks improperly, the drive belt should be replaced with an O.E.M. drive belt to avoid performance failure or loss of drive belt during cold operation.

NOTE: 4.0L does not have flat idler on tensioner.

With the engine running, check drive belt tracking (the position of the drive belt on one of the grooveless pulleys, idlers or drive belt tensioner. If the edge of the drive belt rides beyond the edge of the pulley, noise and premature wear may result). If a drive belt tracking condition exists, visually check the drive belt tensioner for damage, especially the mounting pad surface. If the drive belt tensioner is not installed correctly with the locating pins in the locating holes, the mounting surface pad will be out of position. This will result in abnormal drive belt tension and chirp and squeal noises.

If the above procedures do not correct the drive belt noise, try replacing the drive belt with a known good original equipment drive belt. However, the drive belt noise may return (with mileage) if one of the above

conditions still exists uncorrected.

- With engine running, visually observe the grooves in the pulleys (not the pulley flanges) for excessive wobble. Replace components as required.
- Check all accessories, mounting brackets and drive belt tensioner, for any interference that would prevent the component from mounting properly. Correct any interference condition and recheck belt tracking.
- Tighten all accessories, mounting brackets and drive belt tensioner retaining hardware to specification. Recheck drive belt tracking.

Drive Belt Replacement

Drive Belt, Serpentine

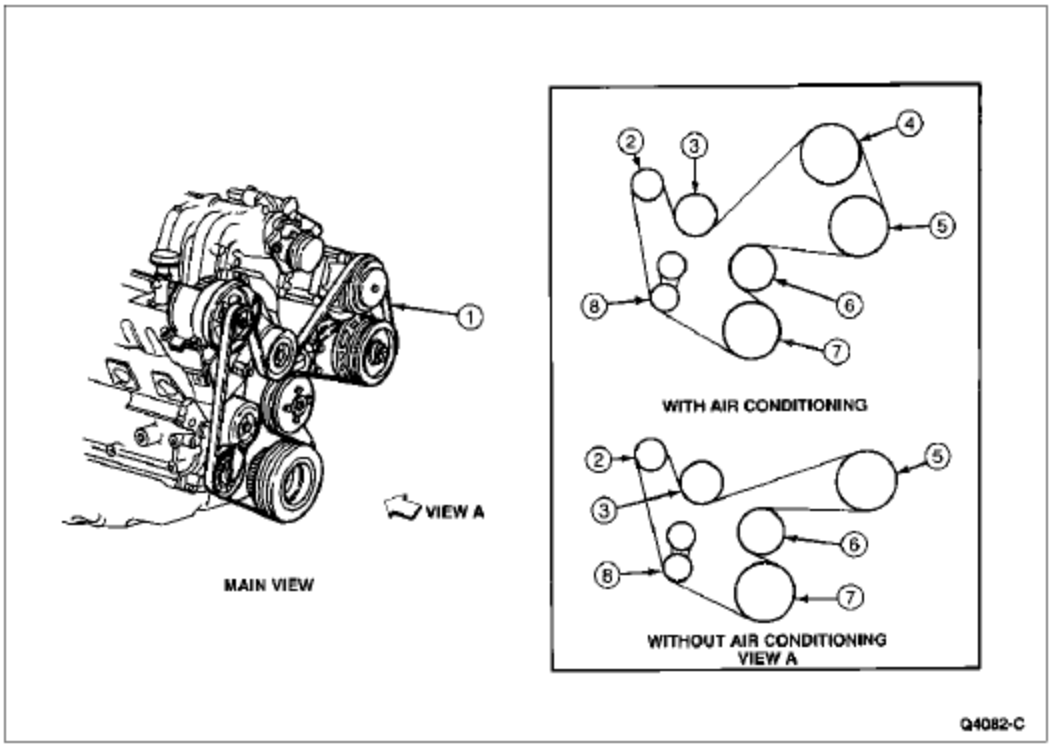
NOTE: Conditions requiring replacement of drive belt (8620) are excessive cracking or wear, severe glazing or frayed cords. Replace drive belts exhibiting any of these conditions. Minor cracks in the back of the drive belt are considered acceptable.

NOTE: The 2.3L, 3.0L, and 4.0L engines (6007) are equipped with drive belt tensioners (6B209) that indicate when the drive belt is worn (stretched). A pointer and gauge are built into the drive belt tensioner. When the pointer no longer registers within the range limits of the gauge, the drive belt must be replaced.

Removal

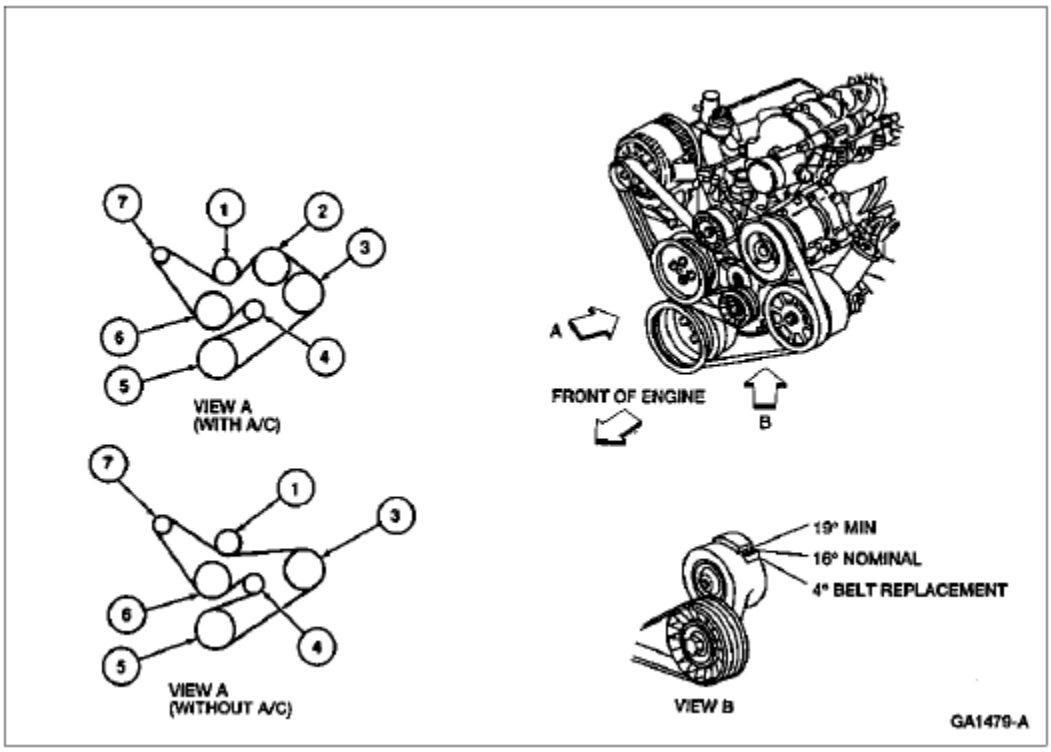
1. Disconnect the intake air temperature (IAT) sensor electrical connector.
2. On Aerostar, disconnect the mass air flow (MAF) sensor electrical connector.
3. Disconnect crankcase ventilation hose.
4. Loosen air cleaner outlet tube clamps and remove tube.
5. Lift drive belt tensioner by rotating it counterclockwise and remove the drive belt. (For 3.0L Aerostar and Ranger, rotate clockwise.)

Belt Installation — Aerostar, Ranger 4.0L



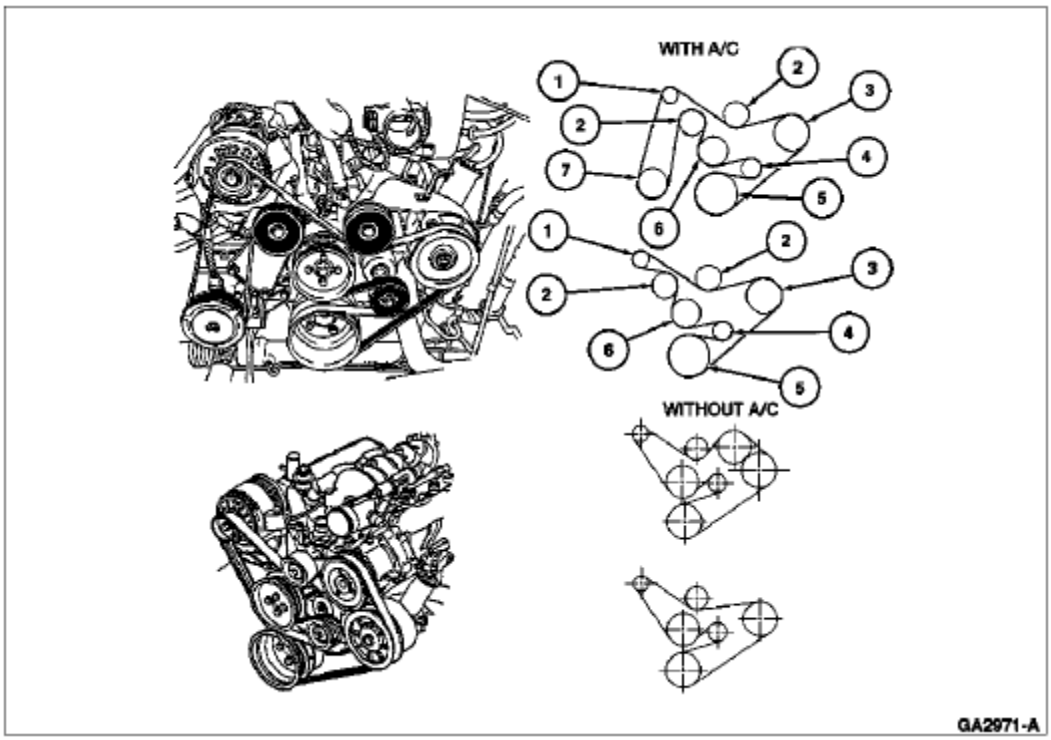
Item	Part Number	Description
1	8620	Drive Belt
2	10300	Generator
3	8678	Belt Idler Pulley
4	19703	A/C Compressor
5	3A733	Power Steering Pump Pulley
6	8501	Water Pump
7	6312	Crankshaft Pulley
8	6B209	Drive Belt Tensioner

Belt Installation — Ranger 3.0L



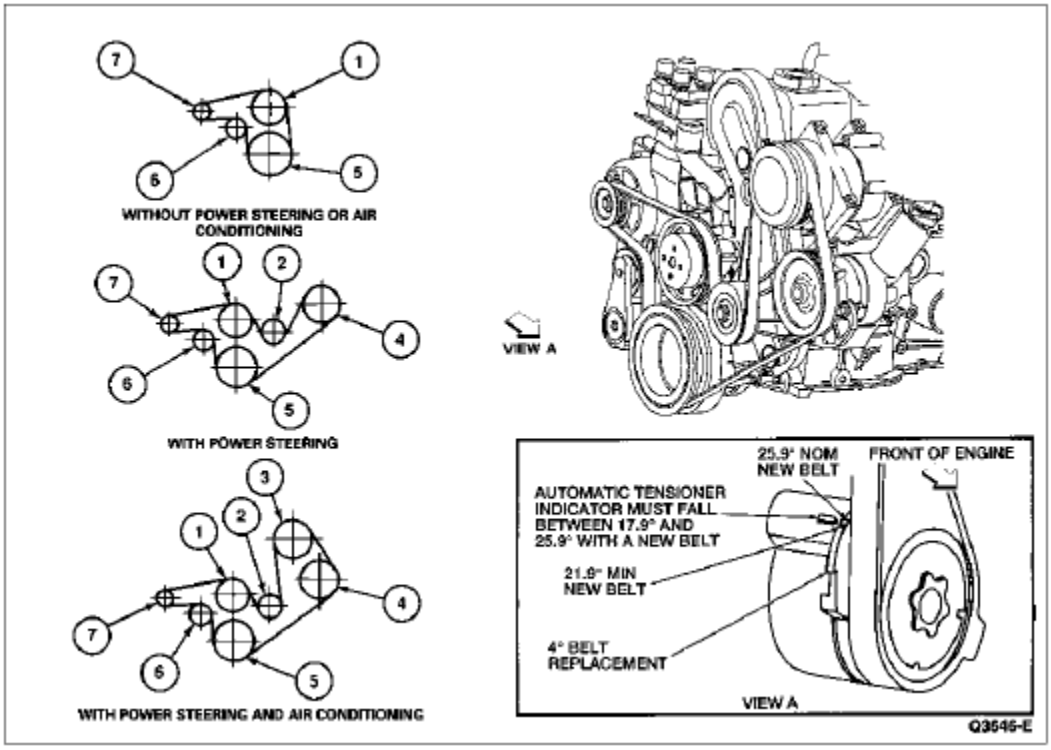
Item	Part Number	Description
1	3F671	Belt Idler Pulley
2	19D629	A/C Compressor
3	3D673	Power Steering Pump Pulley
4	6B209	Drive Belt Tensioner
5	6312	Crankshaft Pulley
6	8A528	Water Pump Pulley
7	10300	Generator

Belt Installation — Aerostar 3.0L



Item	Part Number	Description
1	10300	Generator
2	3F671	Belt Idler Pulley
3	3D673	Power Steering Pump Pulley
4	6B209	Drive Belt Tensioner
5	6312	Crankshaft Pulley
6	8A528	Water Pump Pulley
7	19D629	A/C Compressor

Belt Installation — Ranger 2.3L



Item	Part Number	Description
1	8509	Water Pump Pulley
2	3F671	Belt Idler Pulley
3	2E884	A/C Clutch Pulley
4	3D673	Power Steering Pump Pulley
5	6312	Crankshaft Pulley
6	6B209	Drive Belt Tensioner
7	10300	Generator

Installation

1. Position new drive belt over pulleys.
   - Make sure that all V-grooves make proper contact with the pulley.
   - Make sure that drive belts are properly seated on the pulleys. One revolution of the engine with an incorrectly seated drive belt may snap the drive belt cords.
2. On all engines, lift drive belt tensioner and route drive belt under drive belt tensioner pulley. Release drive belt tensioner to rest on drive belt.
3. Install air cleaner outlet tube (9B659) and tighten clamps to 2-3 Nm (18-26 lb-in).
4. Connect crankcase ventilation hose.

5. On Aerostar, connect the mass air flow (MAF) sensor electrical connector.
6. Connect the intake air temperature (IAT) sensor electrical connector.

Drive Belt Tensioner, Automatic

Removal

1. Remove drive belt (8620). Refer to the procedure in this section.
2. On 2.3L and 4.0L engines (6007), remove drive belt tensioner bolt and drive belt tensioner (6B209).

Installation

To install, reverse removal procedure.

On Ranger 2.3L, 3.0L and all 4.0L engines tighten the drive belt tensioner bolt to 40-55 Nm (30-40 lb-ft). On Aerostar 3.0L and Ranger 3.0L engines tighten to 23-32 Nm (17-23 lb-ft).

Drive Belt Tensioner, Automatic

The drive belt tensioner (6B209) has no provision for adjustment and will be damaged if forced to travel beyond its operating range.

Automatic tensioners are calibrated at the factory to provide the correct amount of tension to the belt for a given FEAD system. Unless a spring within the tensioner assembly breaks or some other mechanical part of the tensioner fails, there is no need to check tensioner for proper tension.

The only mechanical check that needs to be made, if you have any doubt to the tensioner function, would be to remove the belt in the area of the tensioner, then using the proper tool, rotate the tensioner from its relaxed position thru its full stroke and back to the relaxed position to assure there is no "stick, grab, bind," and to assure that there is tension on the tensioner spring. If the tensioner meets these criteria, it should be assumed to be a good tensioner.

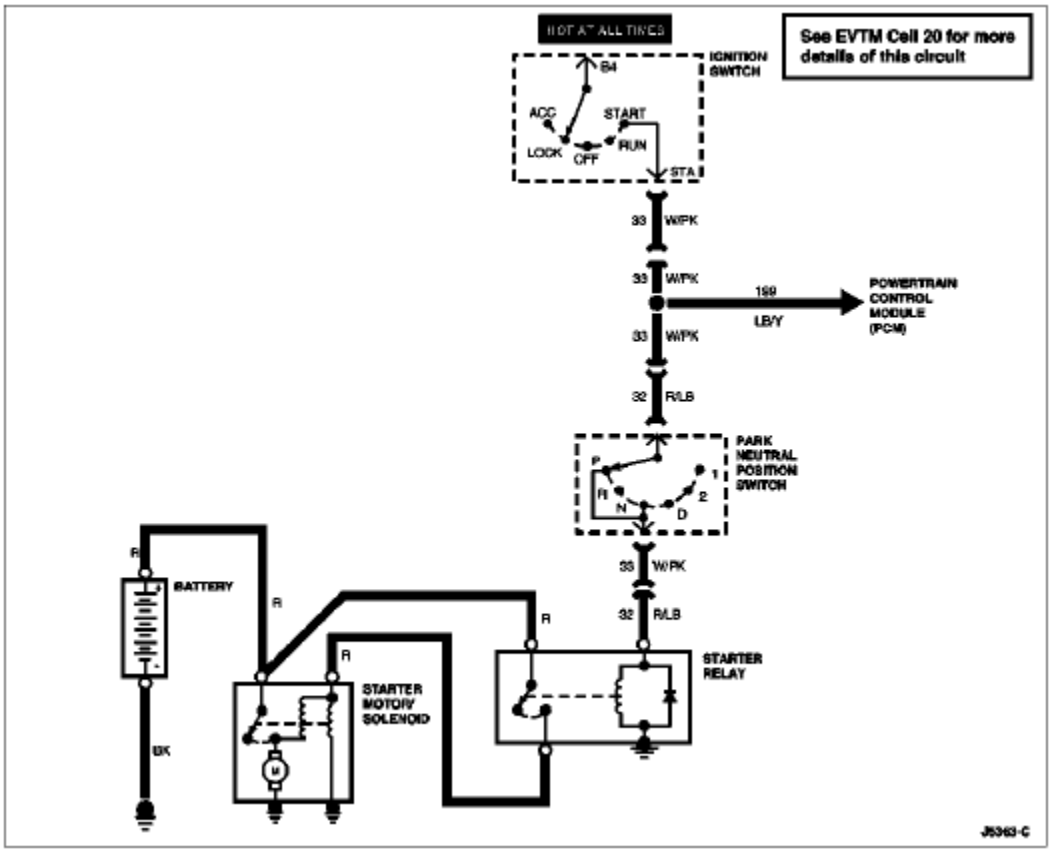
SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Fan-to-Clutch Bolts, All Engines	6-8	—	53-70
Clutch-to-Pulley Screws, 2.3L	17-23	13-17	—
Clutch-to-Pulley Nut, 3.0L and 4.0L	40-135	30-100	—
Crankshaft Pulley Bolts, Aerostar 3.0L, Air Conditioning	40-54	30-40	—
Air Conditioning Brace Nuts, All 4.0L	40-54	30-40	
Water Pump Pulley Bolts, Aerostar 3.0L	23-32	17-23	
Air Conditioning Compressor Bolts, All 4.0L	21-29	15-21	—
Air Conditioning Mounting Bracket Bolts, All 4.0L	40-50	30-37	—
Drive Belt Tensioner Bolt (Aerostar 3.0L, Ranger 3.0L)	23-32	17-23	—
Drive Belt Tensioner Bolt (Aerostar 4.0L, 2.3L/4.0L Ranger)	40-55	30-40	—
Air Cleaner Outlet Tube Bolts	2-3	—	18-26

Electrical Schematics

Starter Motor Circuit, Aerostar



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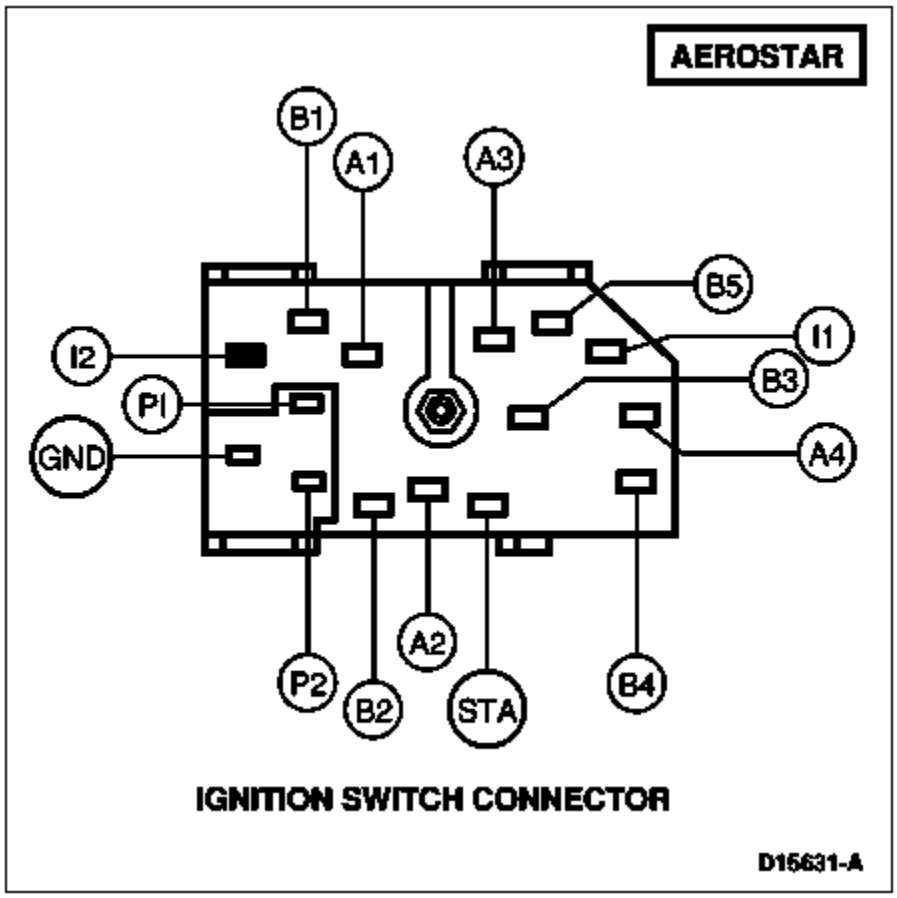

Pin Number	Circuit	Circuit Function
A1	297 (BK/LG)	Fused Run/Accessory Feed
A2	687 (GY/Y)	Accessory Feed (Hot in Run)
A3	687 (GY/Y)	Accessory Feed (Hot in Run)
A4	687 (GY/Y)	Accessory Feed (Hot in Run)
B1	37 (Y)	Battery Input
B2	37 (Y)	Battery Input
B3	37 (Y)	Battery Input
B4	37 (Y)	Battery Input
B5	37 (Y)	Battery Input
I1	16 (R/LG)	Ignition Switch to Ignition Coil "BATT" Terminal
I2	—	Not Used
P1	512 (T/LG)	Brake Indicator Prove Out
P2	41 (BK/LB)	Warning Lamp Prove Out
STA	33 (W/PK)	Starter Control (Hot in Start)
GND	57 (BK)	Ground Circuit

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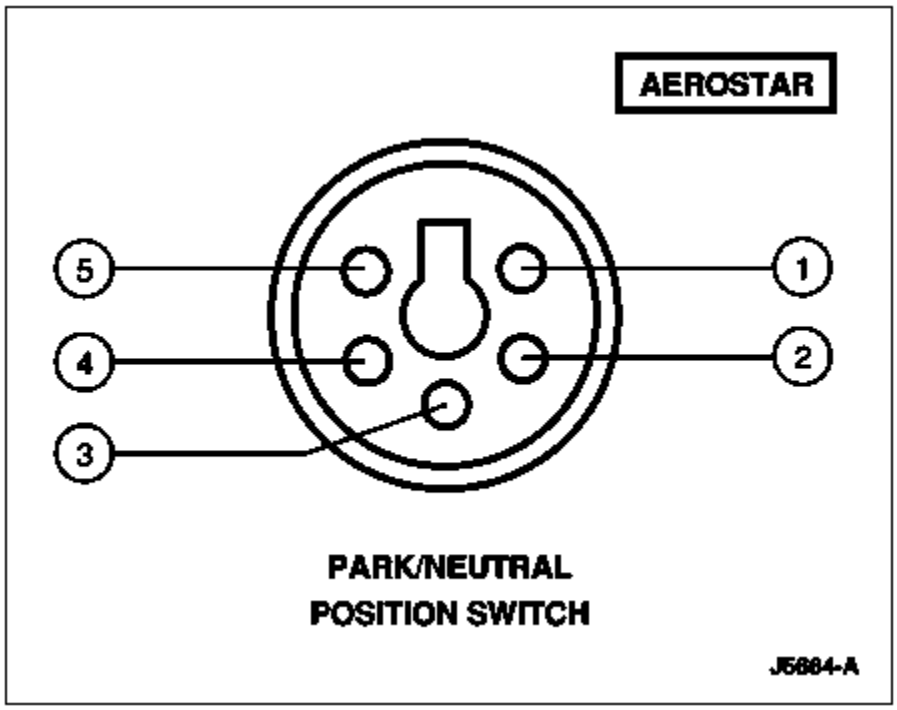

Pin Number	Circuit	Circuit Function
1	140 (BK/PK)	Backup Lamp
2	298 (P/O)	Fused Run Only Feed
3	32 (R/LB)	Starter Control
4	33 (W/PK)	Starter Control (Hot in Start)
5	463 (R/W)	Electric Transfer Case Module to Park Neutral Position (PNP) Switch

Starter Motor Circuit, Ranger with Manual Transmission

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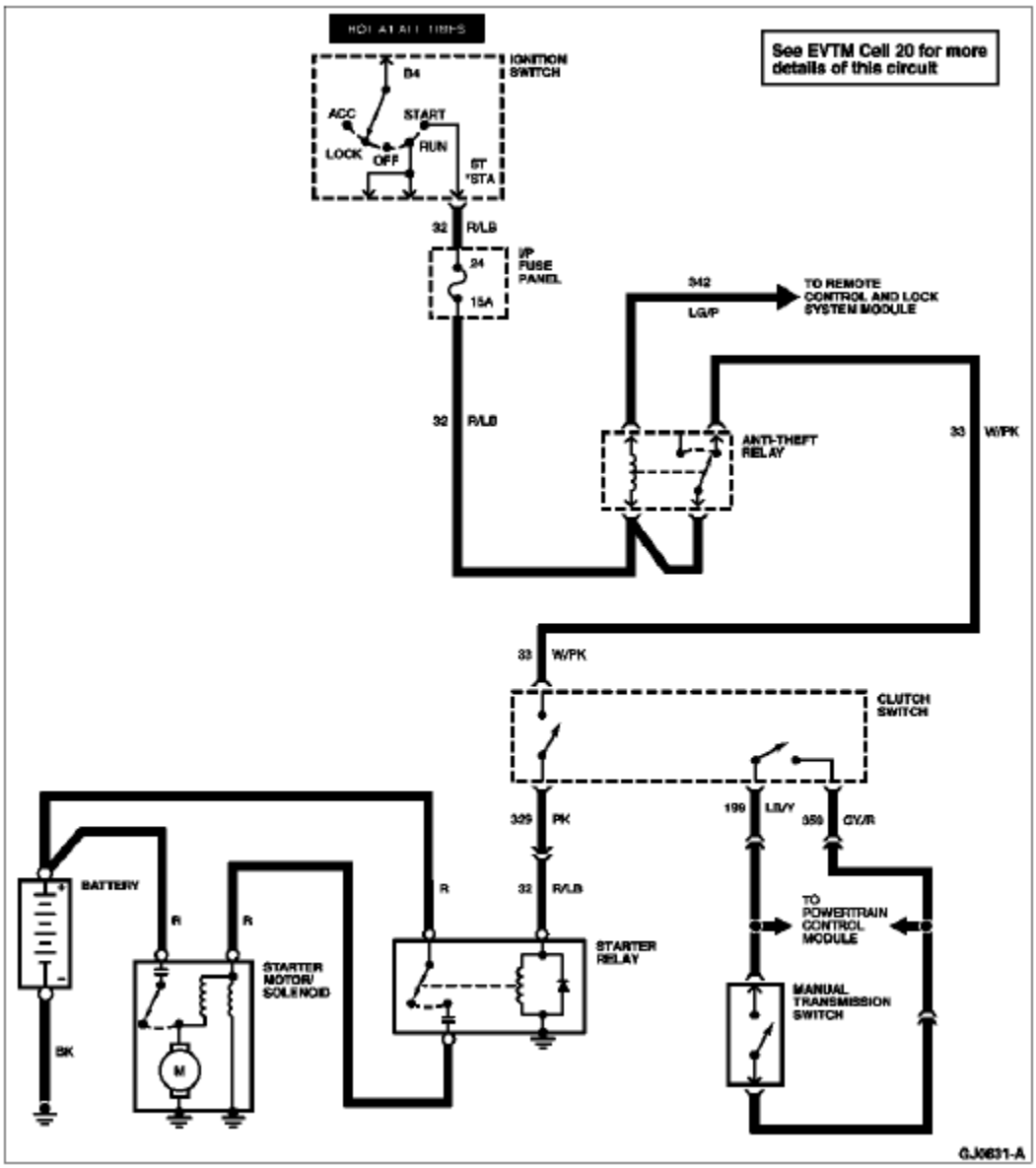

Ranger with Automatic Transmission

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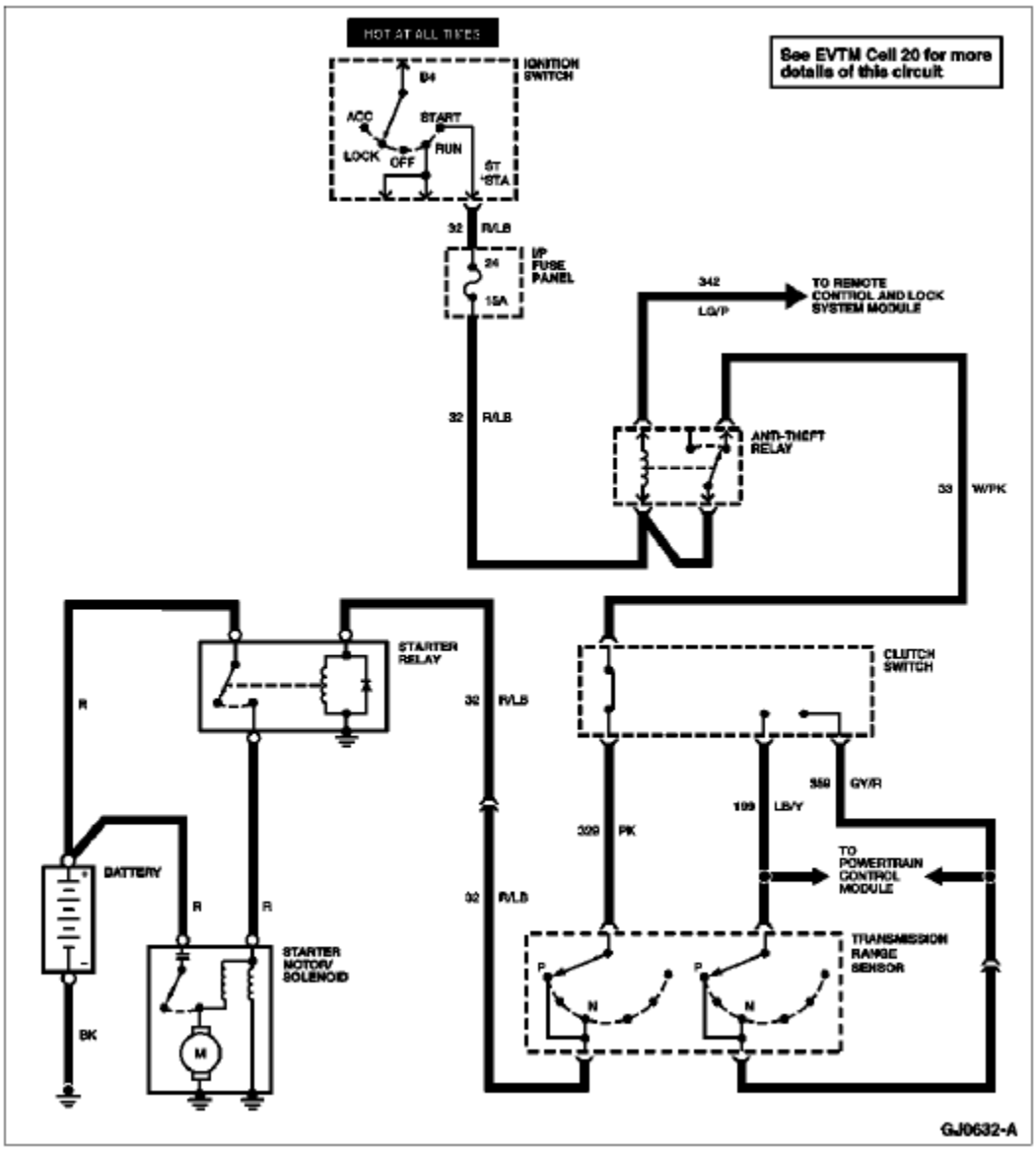

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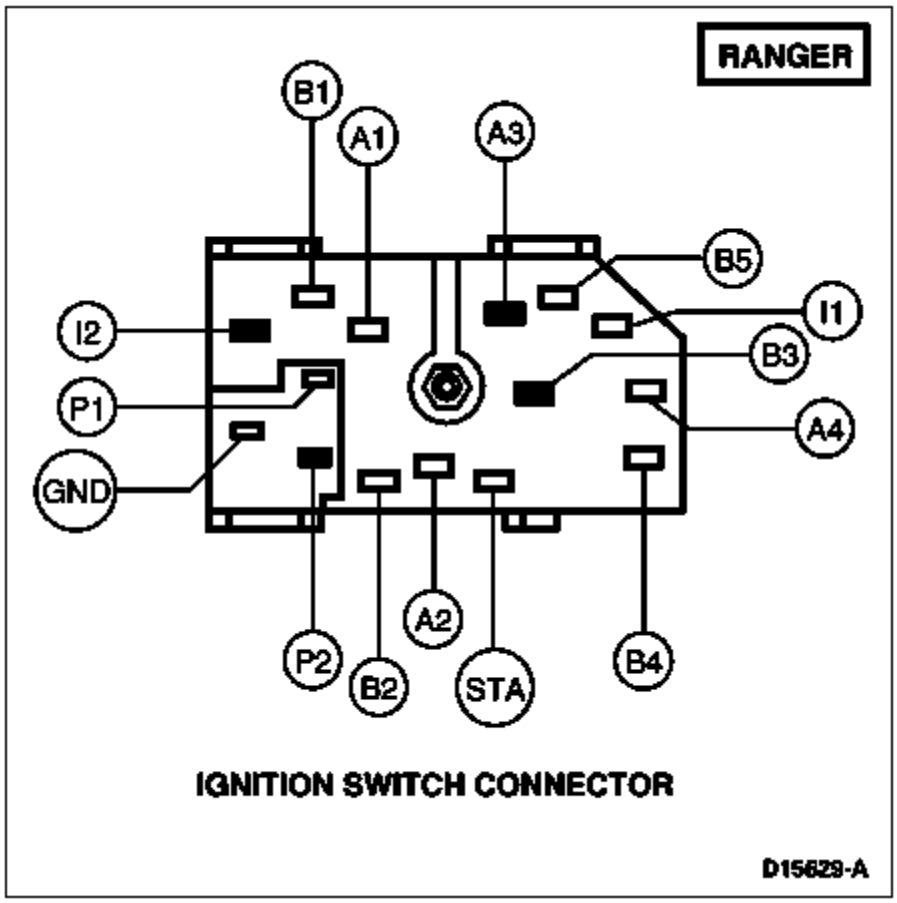

Pin Number	Circuit	Circuit Function
A1	297 (BK/LG)	Fused Run/Accessory Feed
A2	687 (GY/Y)	Accessory Feed (Hot in Run)
A3	—	Not Used
A4	687 (GY/Y)	Accessory Feed (Hot in Run)
B1	37 (Y)	Battery Input
B2	37 (Y)	Battery Input
B3	—	Not Used
B4	37 (Y)	Battery Input
B5	37 (Y)	Battery Input
I1	1050 (LG/P)	Fused Ignition Switch Feed to Run/Run Start
I2	—	Not Used
P1	512 (T/LG)	Brake Indicator Prove Out
P2	—	Not Used
STA	32 (R/LB)	Starter Control (Hot in Start)
GND	57 (BK)	Ground Circuit

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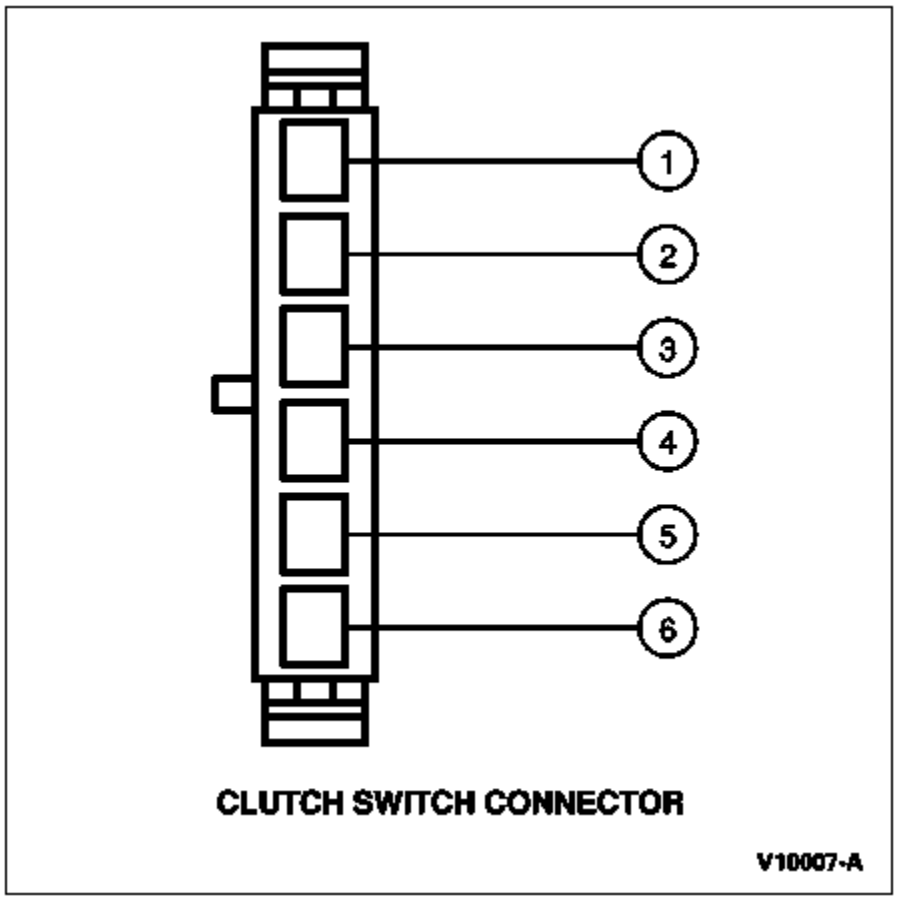
Ranger



Pin Number	Circuit	Circuit Function
1	199 (LB/Y)	Transmission Range Sensor to PC
2	359 (GY/R)	Sensor Signal Return
3	306 (T/LB)	Clutch Switch to Speed Control Module
4	511 (LG)	Brake On/Off (BOO) Switch to Stoplamps
5	329 (PK)	Crank Enable Relay
6	33 (W/PK)	Starter Control to Interlock Module

Ranger

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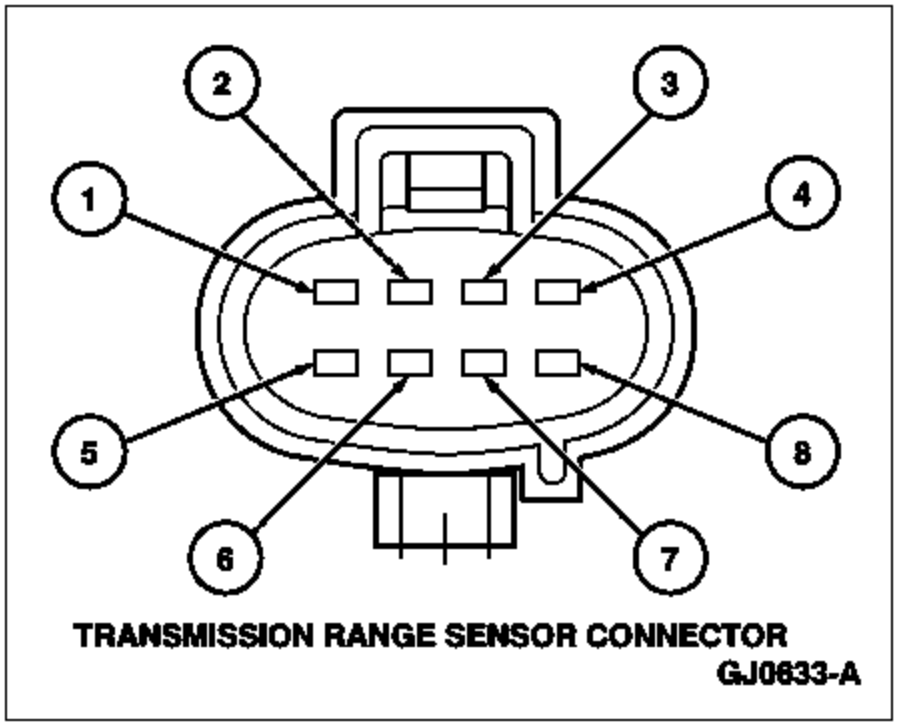

Pin Number	Circuit	Circuit Function
1	32 (R/LB)	Starter Control (Hot in Start)
2	298 (P/O)	Fused Run Only Feed
3	140 (BK/PK)	Backup Lamp Power Feed
4	329 (PK)	Wiring Connector Plug (Hot in Start)
5	57 (BK)	Ground
6	199 (LB/Y)	Transmission Range (TR) Sensor to Powertrain Control Module (PCM)
7	359 (GY/R)	Sensor Signal Return
8	463 (R/W)	Electric Transfer Case Module to Transmission Range (TR) Sensor

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Inspection and Verification

WARNING: WHEN SERVICING STARTER MOTOR (11001) OR PERFORMING OTHER UNDERHOOD WORK IN THE VICINITY OF THE STARTER MOTOR, BE AWARE THAT THE HEAVY GAUGE BATTERY INPUT LEAD AT THE STARTER SOLENOID (11390) IS "ELECTRICALLY HOT" AT ALL TIMES. A PROTECTIVE CAP OR BOOT IS PROVIDED OVER THE TERMINAL OF THIS LEAD AND MUST BE REPLACED AFTER SERVICING. BE SURE TO DISCONNECT BATTERY NEGATIVE CABLE BEFORE SERVICING STARTER.

WARNING: WHEN WORKING IN AREA OF THE STARTER MOTOR, BE CAREFUL TO AVOID TOUCHING HOT EXHAUST COMPONENTS.

CAUTION: When disconnecting the plastic hardshell connector at the solenoid S terminal, grasp the plastic connector and pull lead off. DO NOT pull separately on lead wire.

1. Inspect starting system for loose connections.
2. If system does not operate properly, note condition and continue diagnosis using the symptom chart.

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Symptom Chart — Starting System

NOTE: Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent to perform electrical pinpoint tests.

STARTING SYSTEM

Condition	Possible Source	Action
• Engine Cranks Slowly	• Loose connections in starter solenoid battery feed or ground circuit. • Undercharged battery. • Malfunctioning starter motor.	• GO to Pinpoint Test A .
• Engine Does Not Crank	• Loose or corroded battery cable connections. • Undercharged battery. • Starter motor. • Starter motor solenoid relay switch. • Transmission range (TR) sensor. • Anti-theft relay. • RAP module. • Ignition switch.	• GO to Pinpoint Test B .
• Unusual Starter Noise	• Starter motor improperly mounted. • Malfunctioning starter motor. • Improper starter drive engagement.	• GO to Pinpoint Test C .

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Pinpoint Tests — Starting System

CAUTION: Remove plastic safety cap on starter solenoid and disconnect hardshell connector at solenoid S-terminal as described under Removal and Installation in this section.

NOTE: Hoist vehicle (if necessary) to access terminals of starter solenoid (11390).

PINPOINT TEST A: ENGINE CRANKS SLOWLY

A1 CHECK CONNECTIONS AT BATTERIES

- Inspect all battery cable connections for looseness and corrosion.

Are battery connections clean and tight?

Yes	No
GO to **A2**.	CLEAN and TIGHTEN connections at battery.

A2 STARTER LOAD TEST

- Perform starter load test. Refer to Component Tests in this section.

Did starter pass load test?

Yes	No
GO to **A3**.	TEST battery. REFER to Section 14-00. If battery is OK, GO to **A4**.

A3 CHECK FOR EXCESSIVE RESISTANCE

- Perform voltage drop tests. Refer to Component Tests in this section.

Did starter circuit pass voltage drop test?

Yes	No
GO to **A4**.	CLEAN circuit connection as necessary.

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A4 STARTER NO-LOAD TEST

- Perform starter no-load test. Refer to Component Tests in this section.

Did starter pass no-load test?

Yes	No
Slow cranking is caused by excessive engine drag.	REPAIR or REPLACE starter.

PINPOINT TEST B: ENGINE DOES NOT CRANK

B1 CHECK BATTERY CONNECTIONS

- Inspect battery terminals for loose or corroded connections.

Are the battery terminals clean and tight?

Yes	No
GO to **B2** .	CLEAN and TIGHTEN battery terminals.

B2 CHECK BATTERY

- Check battery. Refer to Section 14-00 .

Is the battery OK?

Yes	No
GO to **B3** .	CHARGE or REPLACE the battery.

B3 CHECK STARTER MOTOR

- Turn ignition key to START position.

Does the starter motor spin?

Yes	No
GO to **B20** .	GO to **B4** .

B4 CHECK CIRCUIT PROTECTION

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- Check fuse 1 (60A) in the Power Distribution Box.

Is fuse OK?

Yes	No
GO to **B5** .	REPLACE fuse.

B5 CHECK BATTERY FEED TO FUSE

- Remove fuse 1 (60A) from the Power Distribution Box.
- Measure voltage between the fuse battery feed terminal and battery ground terminal.

Is battery voltage present?

Yes	No
GO to **B6** .	REPAIR (BK) wire from starter motor solenoid relay switch to Power Distribution Box.

B6 CHECK GROUND AT THE ENGINE BLOCK

- Measure voltage between battery positive terminal and engine block.

Is there battery voltage?

Yes	No
GO to **B8** .	CLEAN and TIGHTEN battery ground cable at the engine block. GO to **B7** .

B7 VERIFY GROUND AT THE ENGINE BLOCK

- Measure voltage between battery positive terminal and engine block.

Is there battery voltage?

Yes	No
GO to **B8** .	REPLACE battery ground cable.

B8 CHECK POWER SUPPLY TO STARTER MOTOR B TERMINAL

- Key in OFF position.
- Measure voltage at the starter B terminal.

Is battery voltage present?

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Yes	No
GO to **B9** .	REPLACE battery positive cable.

B9 CHECK POWER SUPPLY TO STARTER MOTOR S TERMINAL

- Vehicle in PARK.
- With key in START position, check for battery voltage at the starter S-terminal.

Is battery voltage present?

Yes	No
REPLACE starter motor.	GO to **B10** .

B10 CHECK POWER FOR BATTERY VOLTAGE AT THE STARTER MOTOR SOLENOID RELAY SWITCH

- With the key in START position, check for battery voltage at the starter motor solenoid relay switch terminal.

Is battery voltage present?

Yes	No
REPLACE R wire between the starter motor solenoid relay switch and starter motor.	GO to **B11** .

B11 CHECK GROUND AT THE STARTER MOTOR SOLENOID RELAY SWITCH

- Measure voltage between the battery positive terminal and the starter motor solenoid relay switch case ground.

Is battery voltage present?

Yes	No
GO to **B12** .	REPAIR poor ground to the vehicle body, or CLEAN surface between the starter motor solenoid relay switch and vehicle body.

B12 CHECK FOR BATTERY VOLTAGE AT THE STARTER MOTOR SOLENOID RELAY SWITCH

- Measure voltage between the battery negative terminal and battery positive cable at the starter motor solenoid relay switch.

Is battery voltage present?

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Yes	No
GO to **B13** .	REPLACE battery positive cable.

B13 CHECK FOR BATTERY VOLTAGE ON CIRCUIT 32 (R/LB)

- With ignition key in START position, measure voltage on Circuit 32 (R/LB) at the starter motor solenoid relay switch.

Is battery voltage present?

Yes	No
REPLACE starter motor solenoid relay switch.	GO to **B14** .

B14 CHECK BATTERY FEED TO STARTER MOTOR SOLENOID RELAY SWITCH AT THE TRANSMISSION RANGE SENSOR

- With ignition key in START position, measure voltage on Circuit 32 (R/LB) at the transmission range (TR) sensor.

Is battery voltage present?

Yes	No
REPAIR open in Circuit 32 (R/LB).	GO to **B15** .

B15 CHECK FOR BATTERY FEED TO THE TRANSMISSION RANGE SENSOR

- With ignition key in START position, measure voltage on Circuit 329 (PK) at the transmission range (TR) sensor.

Is battery voltage present?

Yes	No
REPLACE transmission range (TR) sensor.	GO to **B16** .

B16 CHECK FOR BATTERY VOLTAGE AT THE ANTI-THEFT RELAY

- With ignition key in START position, measure voltage on Circuit 329 (PK) at the anti-theft relay.

Is battery voltage present?

Yes	No
REPAIR open in Circuit 329 (PK). Vehicles equipped with the wiring connector plug, check	GO to **B17** .

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wiring connector plug for continuity. REPLACE as necessary.	

B17 CHECK BATTERY FEED TO ANTI-THEFT RELAY

- With ignition key in START position, measure voltage on Circuit 32 (R/LB), at anti-theft relay.

Is battery voltage present?

Yes	No
GO to **B18** .	GO to **B19** .

B18 CHECK FOR GROUND IN CIRCUIT 342 (LG/P)

- With one multimeter lead connected to a known good B+, connect second lead to Circuit 342 (LG/P) at the anti-theft relay.

Is there ground present?

Yes	No
REFER to Section 18-04B .	REPLACE anti-theft relay.

B19 CHECK FUSE

- Check fuse 24 (10A) in the instrument panel.

Is fuse OK?

Yes	No
REFER to Section 18-04B .	REPLACE fuse.

B20 CHECK FLYWHEEL

- Remover the starter motor.
- Inspect flywheel and drive pinion for damage or excessive wear.

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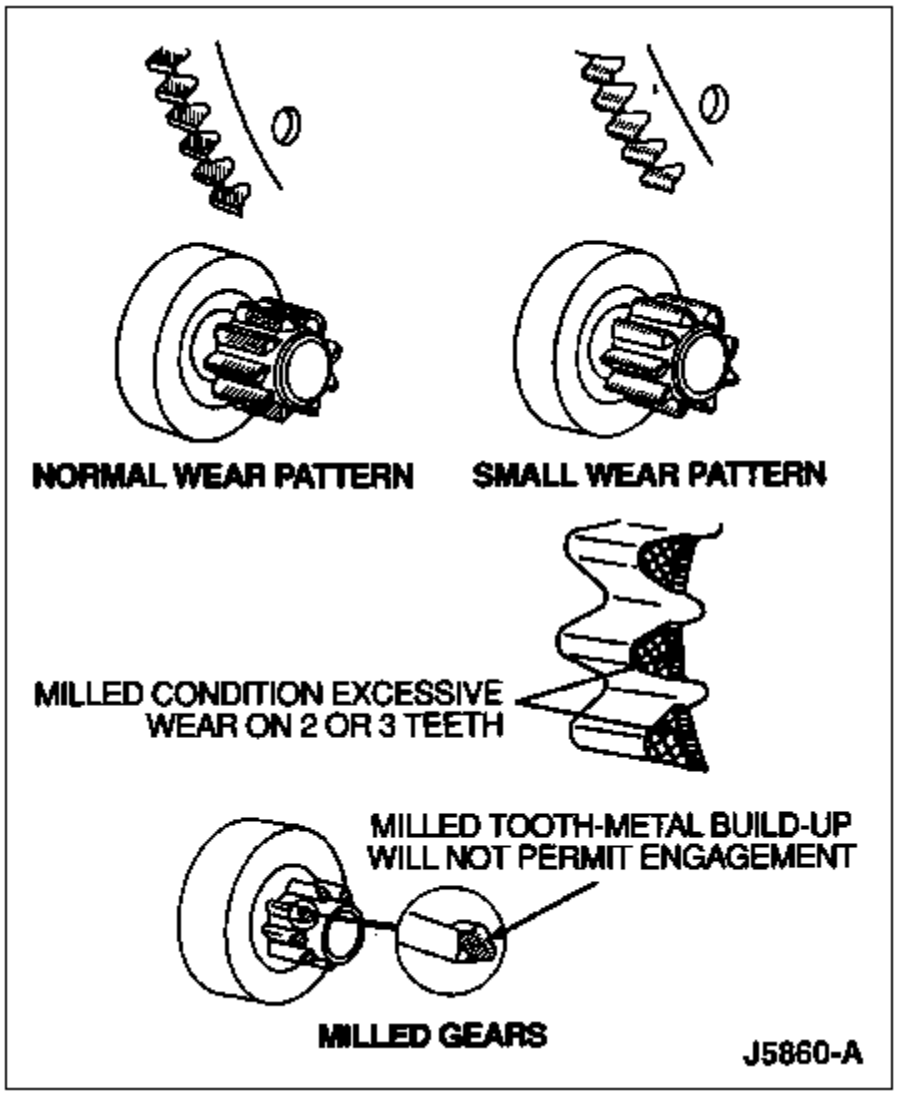

Is flywheel or drive pinion worn or damaged?

Yes	No
REPLACE the flywheel and drive pinion. REFER to appropriate engine section in Group 03.	GO to **B21** .

B21 OVERRUNNING CLUTCH

- Check operation of overrunning clutch. Refer to Drive Pinion Test in Component Tests in this section.

Does overrunning clutch operate properly?

Yes	No
DISASSEMBLE starter and INSPECT starter.	REPLACE overrunning clutch.

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PINPOINT TEST C: UNUSUAL STARTER NOISE

C1 CHECK STARTER MOTOR MOUNTING

- Inspect the starter motor mounting.
- Check the starter motor mounting bolts for looseness.

Is the starter motor mounted properly?

Yes	No
GO to **C2** .	REMOUNT or REPLACE the starter motor.

C2 CHECK STARTER DRIVE ENGAGEMENT

- Remove the starter motor.
- Inspect the starter drive and flywheel for damage. Refer to Pinpoint Test Step B20 in this section.

Are the starter drive and flywheel OK?

Yes	No
CHECK drive pinion overrunning clutch. REFER to Component Tests procedures in this section.	REPLACE as necessary.

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Component Tests

Starter

Load Test

Batteries (10655) must be fully charged and serviceable before performing a starter load test. Refer to Section 14-00 for battery inspection and test procedures.

1. Set parking brake and shift transmission (7003) into neutral.
2. Prevent engine (6007) from starting by disconnecting wiring at ignition coil.
3. Connect Rotunda Alternator, Regulator, Battery and Starter Tester (ARBST) 010-00725 or equivalent. Make sure that current is not flowing through ammeter and heavy-duty carbon pile rheostat portion of circuit (rheostat at maximum counterclockwise position).
4. Connect remote starter switch across starter relay S and battery terminal.
5. Key to run.
6. Crank engine and determine exact reading on voltmeter.
7. Stop cranking engine and reduce resistance of carbon pile until voltmeter indicates same reading as that obtained while starter motor (11001) cranked the engine. The ammeter will indicate starter current draw under load. Check this with value listed in Specifications .

Starter Motor Load Test

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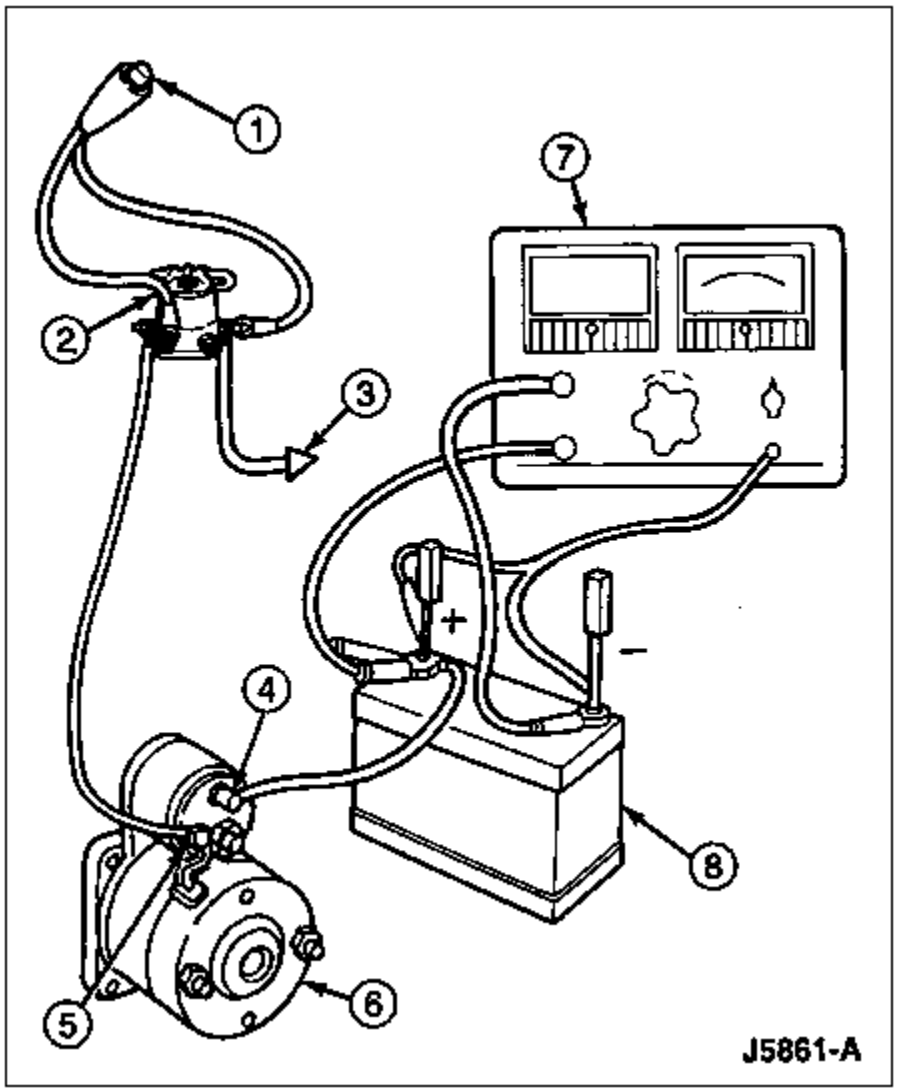

Item	Part Number	Description
1	—	Remote Starter Switch
2	—	Starter Relay
3	—	To Ignition Switch
4	—	Starter Solenoid B-Terminal
5	—	Starter Solenoid S-Terminal
6	11001	Starter Motor
7	010-00725	Alternator, Regulator, Battery and Starter Tester
8	10655	Battery

Drive Pinion Test

If the overrunning clutch in the starter drive (11350) does not operate, the starter motor will engage but will

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not crank the engine.

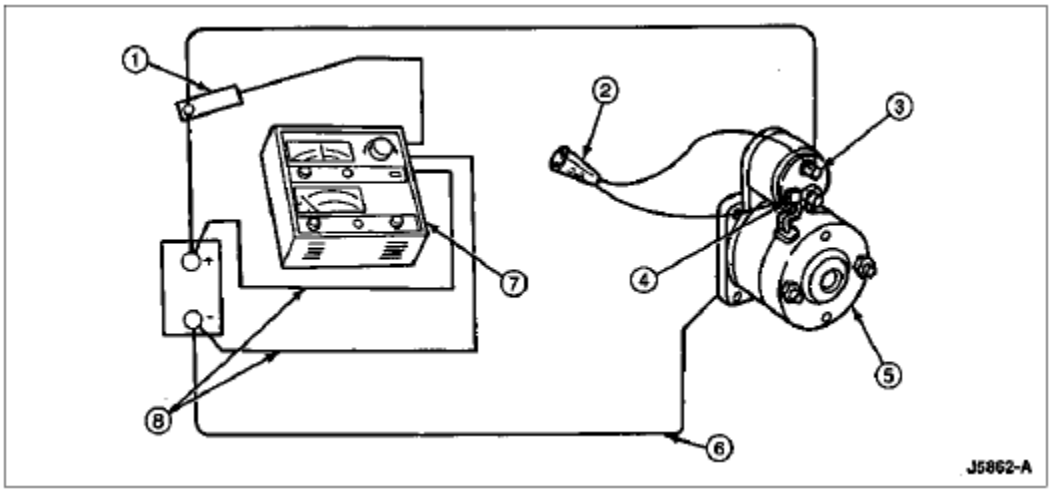
The starter motor must be removed to check the overrunning clutch. Using a small pry bar, turn the drive pinion clockwise and counterclockwise. In one direction, the pinion should freewheel. In the other direction, the overrunning clutch should lock the pinion to the armature shaft. If the pinion freewheels in both directions, replace the starter drive.

NOTE: The above check can be misleading. An overrunning clutch may lock when manually rotated, but will not hold under engine cranking torque. Replace the starter drive if indicated by reasonable diagnostic procedures.

No-Load Test

1. Remove starter motor.
2. Connect a fully charged battery, a Rotunda Alternator, Regulator, Battery and Starter Tester 010-00725 or equivalent and a remote starter switch to starter motor as shown in following electrical schematic.
3. Close remote starter switch. Pinion should shift to crank position and motor should run smoothly.
4. While the starter motor is running, check voltmeter and ammeter readings.
5. Voltage should be greater than 11.0 volts and the amperage should be no more than 70 amps.
6. If voltage is lower than specified voltage, or amperage is higher than specified amperage, refer to following chart to determine cause and corrective action.

Starter Motor No-Load Test Electrical Schematic



Item	Part Number	Description
1	—	Inductive Pickup

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2	—	Remote Starter Switch
3	—	B-Terminal
4	—	S-Terminal
5	11001	Starter Motor
6	—	Ground Connection to Starter
7	010-00725	Alternator, Regulator, Battery and Starter Tester
8	—	Voltmeter Leads

STARTER MOTOR NO-LOAD TEST RESULTS

TEST RESULT	POSSIBLE SOURCE	ACTION TO TAKE
• Normal Current and Speed	• Cranking motor OK.	• RECHECK battery, switches and wiring, including voltage drop tests, if cranking motor operation on engine is slow or sluggish.
• Current Flow With Test Circuit Switch Open	• Solenoid contacts stuck closed.	• TEST and, if necessary, REPLACE solenoid assembly.
• Failure to Operate With Very Low or No Current	• Open solenoid winding. • Open field circuit.	• INSPECT and TEST solenoid assembly. • INSPECT and TEST frame and field assembly.
	• Open armature coil(s) or high insulation between commutator bars. • Broken brush spring(s) or worn brushes.	• INSPECT armature. • INSPECT brushes and brush springs.
• Failure to Operate With High Current	• Frozen bearing, or other damage to drivetrain. • Direct ground in terminals or fields.	• INSPECT bearings, armature, driveshaft and related drive parts. • INSPECT and TEST frame and field assembly, solenoid assembly, armature and brush installations for shorts.
• Low Speed With High Current	• Excessive friction in bushings or gear reduction unit, bent armature shaft or loose pole shoe, bent driveshaft.	• INSPECT bearings, armature, driveshaft, and gear reduction gears.
	• Shorted armature. • Grounded armature or fields.	• INSPECT and TEST armature. • INSPECT and TEST frame and field coil assembly and armature.
• Low Speed With Normal (or Low) Current	• High internal electrical resistance caused by poor connections, defective leads or dirty commutator.	• INSPECT internal wiring, electrical connections and armature commutator.

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	• Open solenoid winding.	• INSPECT and TEST solenoid assembly.
	• Open field circuit.	• INSPECT and TEST frame and field assembly.
	• Open armature coil(s) or high insulation between commutator bars.	• INSPECT armature.
	• Broken brush spring(s) or worn brushes.	• INSPECT brushes and brush springs.
• High Speed With High Current	• Shorted fields.	• INSPECT and TEST field and frame assembly.

Voltage Drop Tests

If the starter motor cranks slowly and the battery is satisfactory, there may be a malfunction of the starter or in the cranking circuit wiring. To determine if the problem is in the wiring, a voltage drop test must be performed on the following:

- motor feed circuit.
- motor ground circuit.
- individual cables.

These tests are performed to determine if there is excessive resistance in the starter motor circuit. Always make the multimeter connections at the component terminal rather than at the cable wiring end connector. Making a connection at the wiring end connector could result in false readings because the meter will not pick up a high resistance between the wiring connector and the component.

Motor Feed Circuit

A motor feed circuit test checks all wiring and connections between battery positive terminal and starter motor for excessive resistance.

1. Prevent engine from starting by disconnecting wiring at ignition coil.
2. Connect a remote starter switch between starter solenoid S-terminal and battery terminal.
3. Connect Rotunda 73 Digital Multimeter 105-R0051 or equivalent positive lead to battery positive (+) post. Connect Rotunda 73 Digital Multimeter 105-R0051 or equivalent negative lead to solenoid M-terminal.
4. Engage remote starter switch. Read and record voltage. Voltage reading should be 0.5 volt or less.
5. If voltage reading is higher than this, indicating excessive resistance, move the Rotunda 73 Digital Multimeter 105-R0051 or equivalent negative lead to starter solenoid B-terminal and repeat test. If voltage reading at B-terminal is lower than 0.5 volt, concern is either in connections at the starter solenoid (11390) or in solenoid contacts.
6. Remove cables from solenoid B-, S-, and M-terminals. Clean cables and connections and reinstall cables to proper terminals. Repeat Steps 1 through 5 above. If voltage drop reading is still higher than

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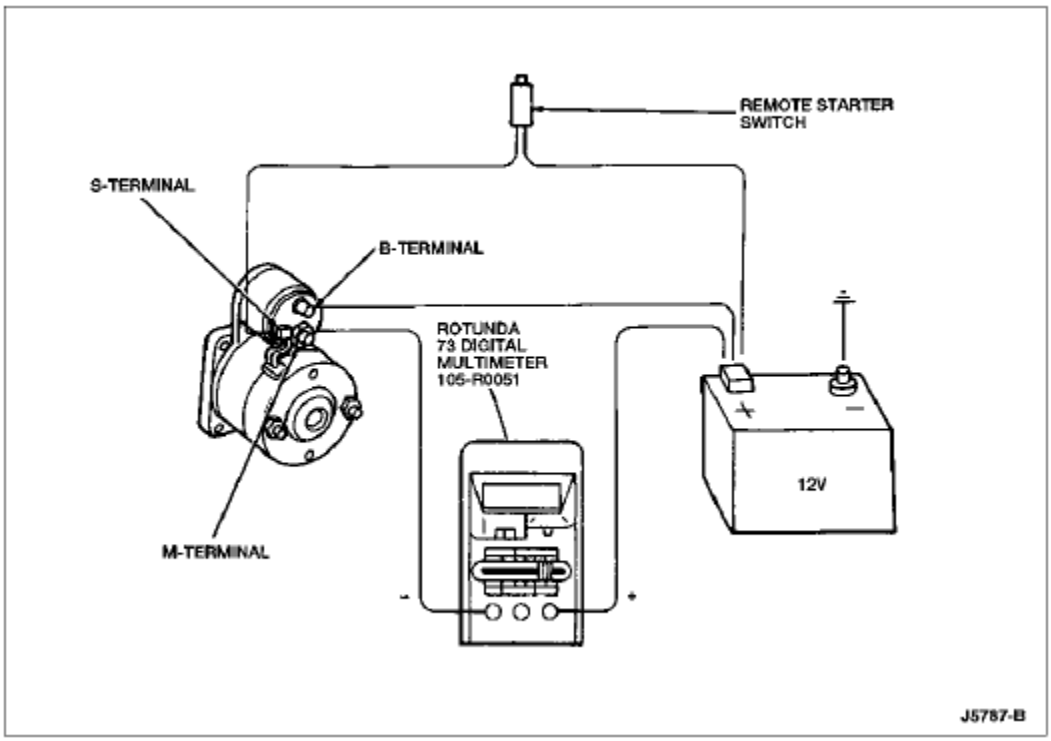
0.5 volt when checked at M-terminal or lower when checked at B-terminal, concern is in solenoid contacts. Remove and replace starter motor or starter solenoid, if available.

7. If the voltage reading taken at the starter solenoid B-terminal is still higher than 0.5 volt after cleaning cables and connections at starter solenoid, concern is either in positive (+) battery cable connection, or in positive battery cable itself.

8. By moving the Rotunda 73 Digital Multimeter 105-R0051 or equivalent negative lead toward battery and checking each mechanical connection point, excessive voltage drop can be located. When high reading disappears, last mechanical point that was checked is concern.

Motor Feed Circuit Voltage Drop Test



Motor Ground Circuit

A slow cranking condition can be caused by resistance in the ground or return portion of the cranking circuit. A starter motor ground circuit test checks the circuit between the starting motor ground and the battery negative terminal. Check the voltage drop in the ground circuit as follows.

1. Prevent engine from starting by disconnecting wiring at ignition coil.

2. Connect a remote starter switch between starter solenoid S-terminal and the battery terminal.

3. Connect a Rotunda 73 Digital Multimeter 105-R0051 or equivalent positive lead to starter motor housing (connection must be clean and free of rust or grease). Connect Rotunda 73 Digital Multimeter 105-R0051 or equivalent negative lead to negative (-) battery terminal.

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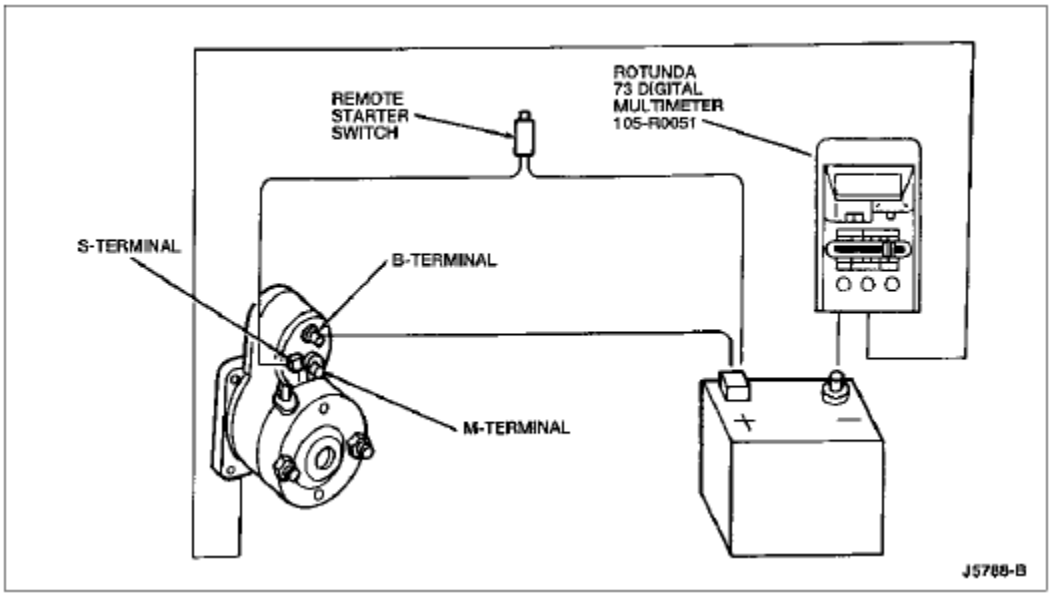
4. Engage remote starter switch and crank engine. Read and record the multimeter reading. Reading should be 0.2 volt or less.

5. If voltage drop is more than 0.2 volt, clean negative cable connections at battery and body connections, and retest. If voltage drop is still too high, test individual cables.

Motor Ground Circuit Voltage Drop Test



Individual Cable

A battery cable problem can produce symptoms similar to a dead battery, bad solenoid, or weak starting motor. If the cables do not allow enough current flow, the starter will turn slowly or not at all.

1. Connect positive (+) lead of Rotunda 73 Digital Multimeter 105-R0051 or equivalent to battery positive (+) post. Connect negative (-) lead to starter solenoid B-terminal.

2. To locate excessive voltage drop in cable, move multimeter negative (-) lead toward battery and check each mechanical connection point. When high reading disappears, last mechanical connection point that was checked is the problem.

Starter Solenoid

1. Disconnect battery ground cable (14301).

2. Using a Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check windings of starter solenoid assembly for continuity as follows:

    - Check resistance of solenoid pull-in and hold-in windings in series by measuring resistance between motor terminal and solenoid case. Resistance should be approximately 0.95 ohms.

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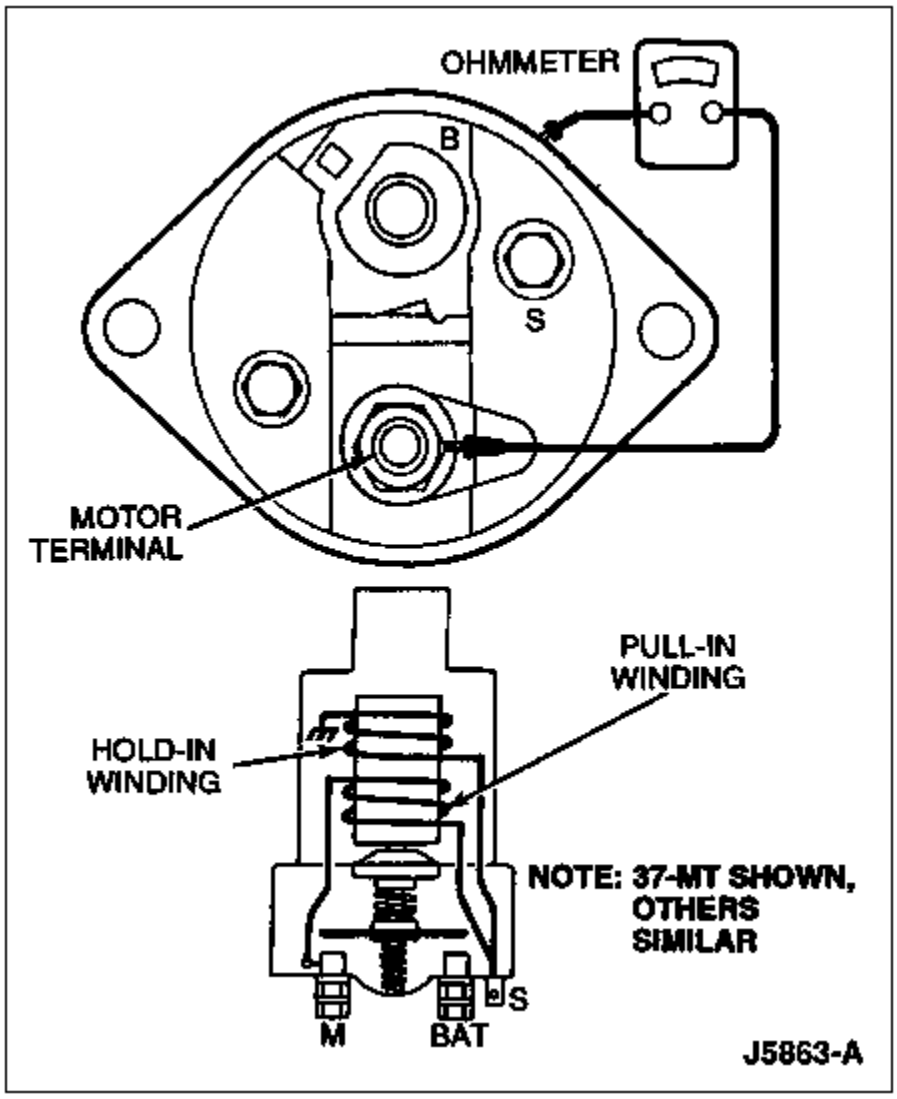
- An extremely high resistance reading indicates a break or fault in winding continuity. A very low resistance reading indicates a short or ground in the winding circuit. Either condition is cause for replacement of the starter solenoid assembly.

Starter Motor Solenoid Windings Test



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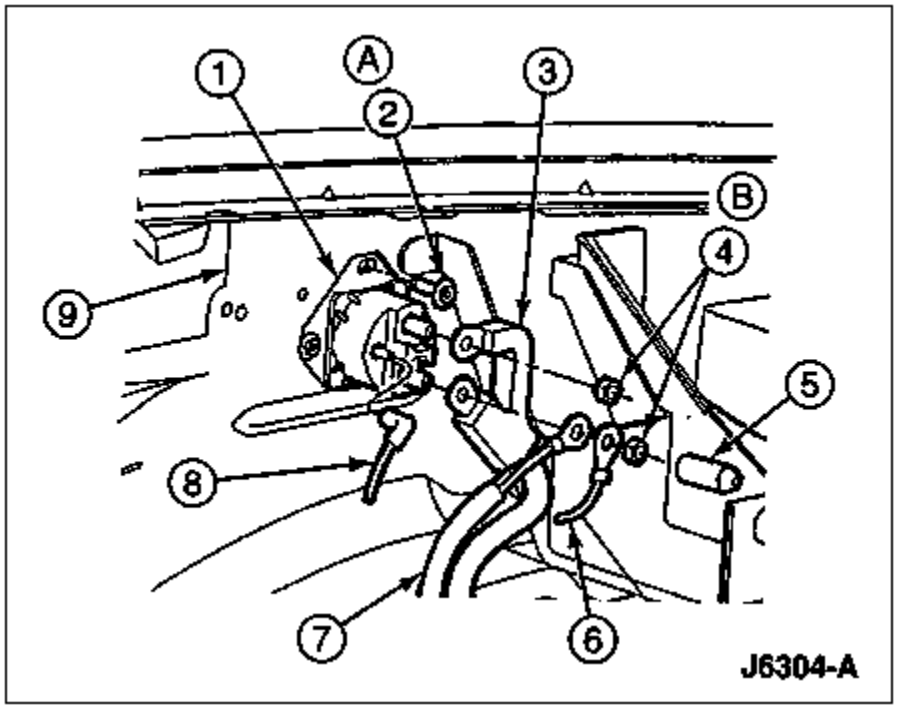
Starter Relay

Removal



Item	Part Number	Description
1	11450	Starter Motor Solenoid Relay Switch
2	N610959-S36	Screw, Starter Motor Solenoid Relay Switch-to-Inner Fender
3	14300	Battery to Starter Relay Cable
4	381561-S36	Nut, Starter Motor Solenoid Relay Switch Terminal
5	14A396	Cover, Starter Relay Terminal
6	14290	Wiring Assembly
7	14305	Wiring Assembly
8	14290	Push-on Connector
9	16015	Inner Fender (LH)
A	—	Tighten to 11-13 Nm

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		(98-115 Lb-In)
B	—	Tighten to 7-9 Nm (62-79 Lb-In)

1. Disconnect the battery ground cable (14301).
2. Remove the starter relay terminal cover.
3. Remove the two terminal starter motor solenoid relay switch nuts.
4. Pull off the push-on connector.
5. **NOTE: To aid installation, note wire assembly orientation.**

   Remove the wiring assemblies from the starter motor solenoid relay switch terminals.
6. Remove the two starter motor solenoid relay switch-to-inner fender screws and the starter motor solenoid relay switch (11450).

Installation

To install, reverse the removal procedures.

Tighten the starter motor solenoid relay switch-to-inner fender screws to 11-13 Nm (98-115 lb-in).

Tighten the starter motor solenoid relay switch terminal nuts to 7-9 Nm (62-79 lb-in).

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Starter Motor

WARNING: WHEN SERVICING STARTER MOTOR (11001) OR PERFORMING ANY MAINTENANCE IN THE AREA OF THE STARTER MOTOR, NOTE THE HEAVY GAUGE INPUT LEAD CONNECTED TO THE STARTER SOLENOID (11390) IS HOT AT ALL TIMES. MAKE SURE THE PROTECTIVE CAP IS INSTALLED OVER THE TERMINAL AND IS REPLACED AFTER SERVICE.

Removal

1. Disconnect the battery ground cable (14301).
2. Raise and support the vehicle.
3. **CAUTION: When disconnecting hardshell connector at S terminal, grasp the plastic shell and pull off. Do not pull on wire. Be careful to pull straight off to prevent damage to the connector and S terminal. If any part of the connection is damaged, replace the damaged components.**

   Disconnect starter cable and push-on connector from starter solenoid.
4. Remove upper bolt.
5. Remove lower bolt.
6. Remove the starter motor from the vehicle.

Installation

1. Position starter motor to engine and install upper and lower bolt finger-tight.
2. Tighten the upper bolt to 22-28 Nm (16-21 lb-ft).
3. Tighten the lower bolt to 22-28 Nm (16-21 lb-ft).
4. Connect connector on starter solenoid. Be careful to push straight on and make sure connector locks in position with a notable click or detent.
5. Install starter cable nut to terminal. Tighten to 11-13 Nm (91-122 lb-in).
6. Replace red safety cap.
7. Lower vehicle to floor.
8. **NOTE: When the powertrain control module (PCM) (12A650) is disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

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Connect battery ground cable.

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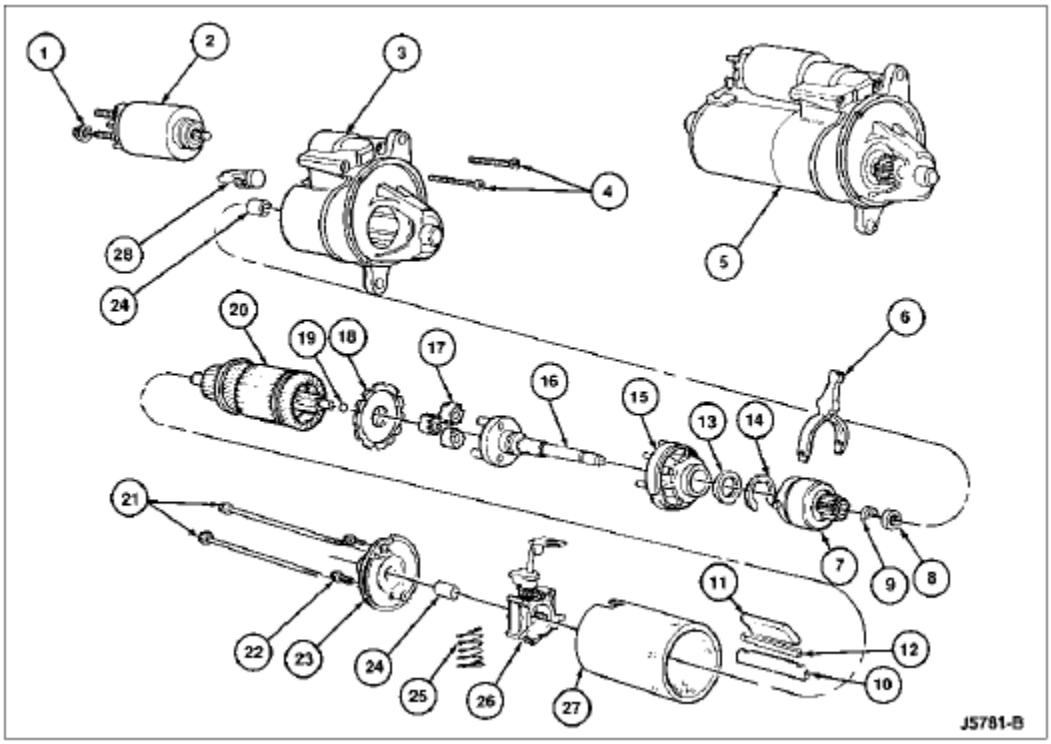
Starter Motor

NOTE: Although disassembly and service procedures are shown for the starter motor (11001) in this section, the starter motor should be returned to Ford Return Parts Center for analysis and review.

Starter Motor



Item	Part Number	Description
1	N805403	Terminal Nut
2	11390	Starter Solenoid
3	11130	Drive End Housing
4	N805405 (2 Req'd)	Starter Solenoid Screws
5	11001	Starter Motor
6	11067	Drive Lever and Pin
7	11350	Starter Drive
8	11223	Stop Ring Retainer
9	11222	Starter Drive Stop Ring

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10	11A169 (6 Required)	Magnet Retainer
11	11A168 (6 Required)	Magnet Pole Piece
12	11A161 (6 Required)	Pole Shunt
13	11036	Pinion Thrust Washer
14	N805404	E-Ring
15	11A165	Stationary Gear
16	11355	Output Shaft
17	11K190	Planet Gear
18	11A167	Planet Gear Retainer
19	11A172	Armature Thrust Ball
20	11005	Starter Motor Armature
21	N805428 (2 Req'd)	Through-Bolt
22	N805406 (2 Req'd)	Brush End Plate Screw
23	11049	Brush End Plate and Bushing
24	11135	Bushing Bearing
25	11059	Brush Spring
26	11434	Brush Holder
27	11076	Starter Frame
28	11A171	Housing Seal

Disassembly

1. Remove the M-terminal nut, then slide positive brush connector from M-terminal.
2. Remove the two starter solenoid screws and the starter solenoid (11390).
3. Remove the through-bolts and separate drive end housing from starter frame and magnet (11075).
4. Remove seal (11A171) from drive end housing. Remove drive assembly from drive end housing.
5. Remove drive lever and pin (11067) from starter drive (11350).
6. Remove starter drive stop ring (11222), stop ring retainer (11223) and starter drive from output shaft (11355).
7. Pry E-Ring off output shaft, then remove pinion thrust washer (11036) and stationary gear (11A165).
8. **NOTE: Armature thrust ball (11A172) may become dislodged when planet gear retainer (11A167), planet gears (11K190) and bushing are removed from output shaft.**

   Remove output shaft from starter frame and magnet. Remove planet gear retainer, planet gears, bushing and armature thrust ball from output shaft.
9. Remove brush end plate screws. Remove brush end plate and bushing (11049) and brush holder (11061).

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10. Push starter motor armature (11005) out of starter frame and magnet.

Assembly

1. **NOTE: Before inserting starter motor armature into starter frame and magnet apply a thin coat of Syncolon SCC-4-030 or equivalent meeting Ford specification WSF-M1C218-B on both ends of starter motor armature shaft and spline.**

   Insert starter motor armature into starter frame and magnet.

2. Install brush holder, making sure brushes fit over commutator. Apply Syncolon SCC-4-030 or equivalent meeting Ford specification WSF-M1C218-B to brush end plate and bushing.

3. Push seal tightly into slot on starter frame and magnet and attach brush end plate and bushing. Insert brush end plate screws and tighten to 2-3 Nm (18-26 lb-in).

4. Apply Syncolon SCC-4-030 or equivalent meeting Ford specification WSF-M1C218-B to output shaft spline. Install stationary gear, pinion thrust washer and attach output shaft E-ring.

5. Install starter drive, starter drive stop ring and stop ring retainer onto output shaft. Attach drive lever and pin to starter drive.

6. Apply Syncolon SCC-4-030 or equivalent meeting Ford specification WSF-M1C218-B to planet gear and install. Install bushing and armature thrust ball onto output shaft.

7. Apply Syncolon SCC-4-030 or equivalent meeting Ford specification WSF-M1C218-B into drive end housing bearing bore until approximately one-quarter full. Install output shaft into drive end housing, making sure to line up output shaft with hole in drive end housing.

8. Install seal into drive end housing and install planet gear retainer.

9. Position starter frame and magnet to drive end housing and install through-bolts. Tighten through-bolts to 5-10 Nm (45-88 lb-in).

10. Position starter solenoid to drive end housing, making sure plunger is attached to drive lever and pin. Insert starter solenoid screws and tighten to 5-10 Nm (45-88 lb-in).

11. Attach positive brush connector to starter solenoid M-terminal. Tighten M-terminal nut to 9-14 Nm (80-123 lb-in).

12. Check that no-load current draw is within specification. Refer to Component Tests in this section.

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Starter Drive Replacement

Disassembly

1. Remove positive brush connector from M-terminal. Remove starter solenoid screws and remove starter solenoid (11390).
2. Remove through-bolts and separate drive end housing from the starter frame and magnet (11075).
3. Remove the seal (11A171).
4. Remove the output shaft (11355) and detach drive lever and pin (11067).
5. Remove starter drive stop ring (11222) and stop ring retainer (11223) from output shaft and then remove starter drive (11350).

Assembly

1. Apply a thin coating of Syncolon SCC-4-030 or equivalent meeting Ford specification WSF-M1C218-B on output shaft spline. Install starter drive assembly on output shaft. Install starter drive stop ring and stop ring retainer. Attach drive lever and pin.
2. Partially fill drive end housing bearing bore with Syncolon SCC-4-030 or equivalent meeting Ford specification WSF-M1C218-B (approximately one-quarter full). Install output shaft in drive end housing.
3. Install lever support and seal in drive end housing.
4. Position starter frame and magnet to drive end housing and install through-bolts. Tighten to 5-10 Nm (45-88 lb-in).
5. Install starter solenoid and tighten starter solenoid screws to 5-10 Nm (45-88 lb-in).

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Armature Replacement, Starter Motor

Disassembly

1. Remove positive brush connector from M-terminal.
2. Remove through-bolts and separate starter motor (11001) from drive end housing.
3. Remove brush end plate and bushing screws, brush end plate and bushing (11049) and brush holder (11061) from starter frame and magnet (11075). Remove starter motor armature (11005) from frame.

Assembly

1. Install starter motor armature in frame. Apply a thin coating of Syncolon SCC-4-030 or equivalent meeting Ford specification WSF-M1C218-B on both ends of shaft and pinion.
2. Install brush holder. Push seal (11A171) onto frame. Apply Syncolon SCC-4-030 or equivalent meeting Ford specification WSF-M1C218-B to bearing bore in brush end plate and bushing and attach to starter frame and magnet.
3. Position starter frame and magnet to drive end housing and install through-bolts. Tighten to 5-10 Nm (45-88 lb-in).
4. Attach positive brush connector to starter solenoid M-terminal. Tighten M-terminal nut to 9-14 Nm (80-123 lb-in).
5. Check that no-load current draw is within specification. Refer to Component Tests in this section.

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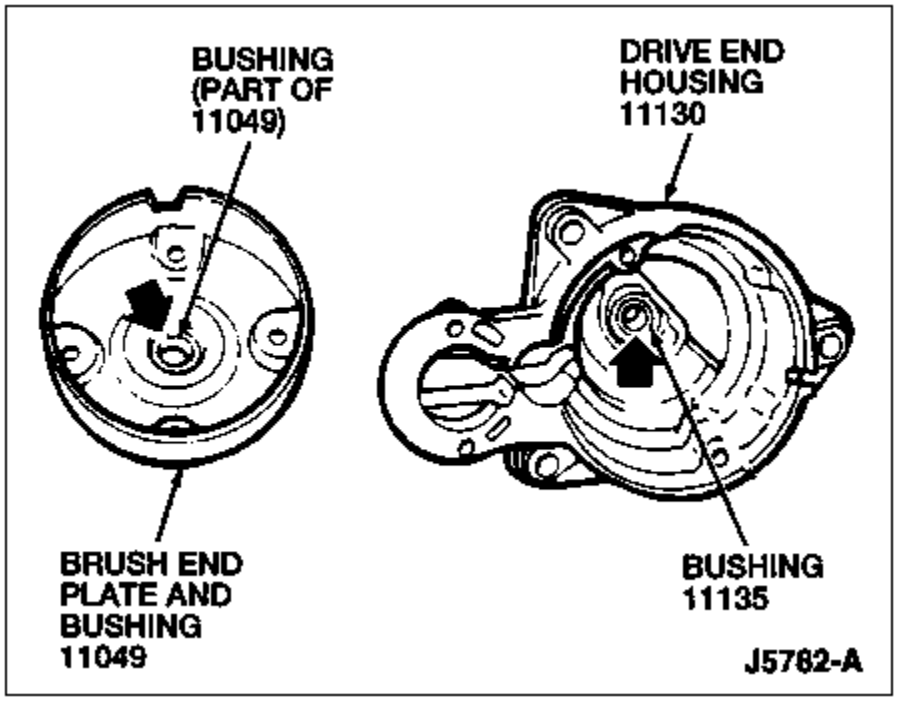
Bushings



Disassembly

Use a suitable bushing driver to press or tap the bushings out of the housing. Be sure the housing is well supported.

Assembly

1. Immerse new bushings in engine oil (SAE 20) for at least 20 minutes before installation.
2. **NOTE: Do not ream the bushings after installation since the self-lubricating qualities of the bushing may be damaged.**

   Use a suitable bushing driver to press or tap the new bushing into position.

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Drive End Housing

Disassembly

1. Remove positive brush connector from M-terminal.
2. Remove starter solenoid screws and starter solenoid (11390).
3. Remove through-bolts and separate drive end housing from starter frame.

Assembly

1. Apply a thin coating of Syncolon SCC-4-030 or equivalent meeting Ford specification WSF-M1C218-B to end of armature shaft and bushing bore in drive end housing.
2. Position drive end housing on starter frame and install through-bolts. Tighten through-bolts to 5-10 Nm (45-88 lb-in).
3. Position starter solenoid on drive end housing and install starter solenoid screws. Tighten starter solenoid screws to 5-10 Nm (45-88 lb-in).
4. Install positive brush connector on M-terminal.

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Brush End Plate

Disassembly

1. Remove through-bolts and brush end plate and bushing screws.
2. Remove brush end plate and bushing (11049).

Assembly

1. Apply a thin coating of Syncolon SCC-4-030 or equivalent meeting Ford specification WSF-M1C218-B to end of armature shaft and bushing bore in brush end plate and bushing.
2. Install brush end plate and bushing.
3. Install through-bolts and brush end plate and bushing screws. Tighten through-bolts to 5-10 Nm (45-88 lb-in). Tighten brush end plate and bushing screws to 2-3 Nm (18-26 lb-in).

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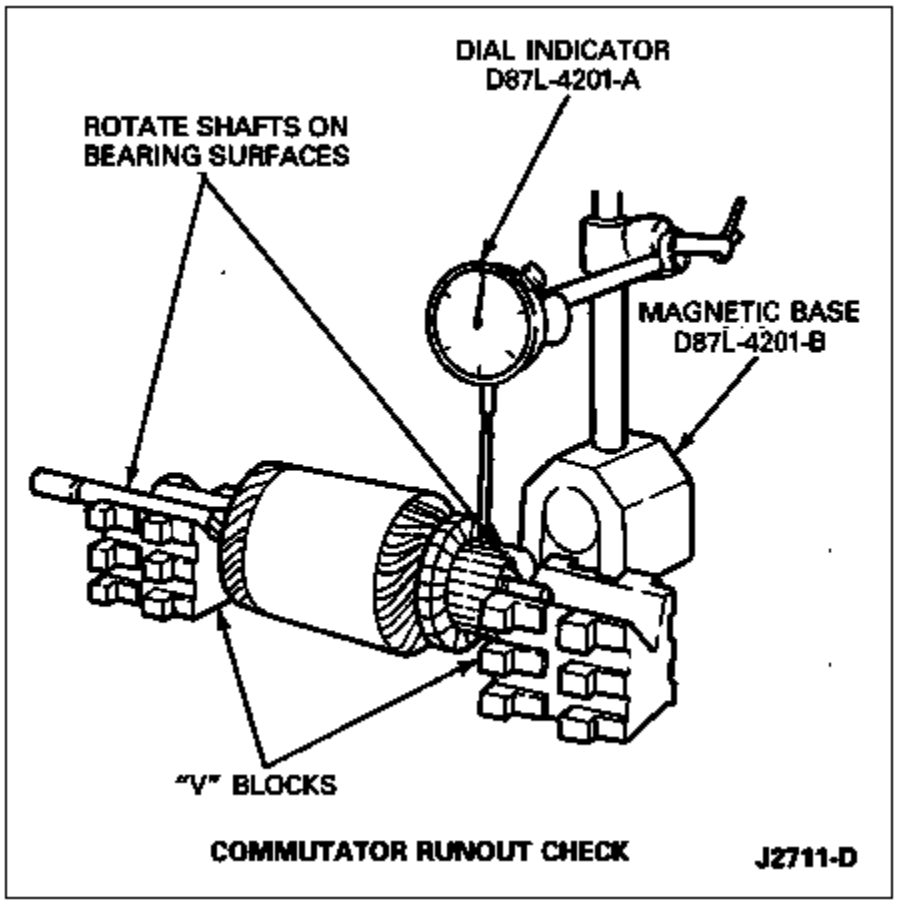
Armature Coil, Starter Motor

CAUTION: Do not wash the starter drive because the solvent will wash out the lubricant causing starter drive to slip. Use a brush or compressed air to clean the starter drive, starter motor armature, brush, and gear assemblies, drive end housing, pole pieces and planet gears. Wash all other parts in solvent and dry.

1. Inspect windings for broken or burned insulation and unwelded or open connections.

2. Check starter motor armature (11005) for open circuits, shorts and grounds. Check for pole rub or rub on magnetic shunts.

3. Check commutator for runout. Inspect starter motor armature shaft and two bearings for scoring and excessive wear with Dial Indicator D87L-4201-A and Magnetic Base D87L-4201-B or equivalents. If commutator is rough, or more than 0.12mm (.005 inch) out of round, it must be replaced.



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Bushings

The armature shaft is supported on three sintered bronze bushings installed in the drive end housing, lever housing and brush end plate.

These bushings have a dull finish, as compared to the early-type machined, cast bronze bushings which had a shiny finish.

1. The bushings can be pressed or tapped out of their housing using a suitable puller or driver of the appropriate size. Be sure the housing is well supported.

2. Before pressing the bushing into place, dip it in SAE 20 oil. Also, tangent wicks should be soaked with SAE 20 oil. Insert the wick into place first, and then press in the bushing.

3. DO NOT DRILL, REAM OR MACHINE sintered bushings in any way. These bushings are supplied to size. If drilled or reamed, the ID (inside diameter) will be too large; also, the bushing pores will be sealed over.

It is not necessary to cross-drill a sintered bushing when used with a tangent wick. Because the bushing is so highly porous, oil from the wick touching the outside bushing surface will bleed through and lubricate the shaft.

4. The lever housing bushing prevents starter motor armature deflection during cranking. As compared to end frame bushings, the clearance between the lever housing bushing and shaft is large and the clearance provides a loose fit when assembled.

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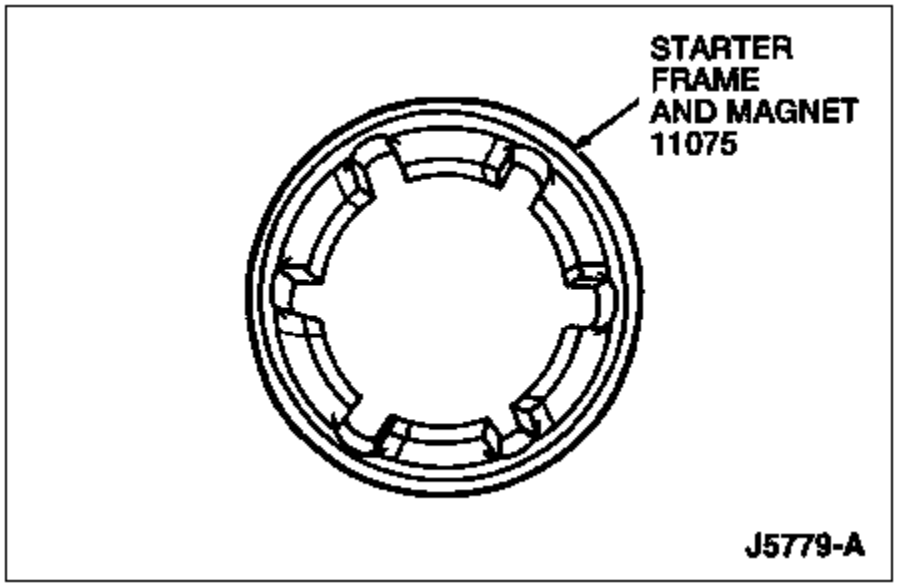
Starter Frame and Magnet



Check the starter frame and magnet (11075) for visible damage and replace as necessary.

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Brush and Brush Holder

1. Check brushes for free movement in brush holders. Inspect brushes for excessive wear. Where brush leads are insulated, make sure insulation is not burned or worn.

2. The brushes should be well seated to commutator; that is, contacting commutator over at least 60 percent of brush contact area. If not, fit brushes to commutator with fine sandpaper until desired seating area is obtained. Do only one brush at a time. Clean brushes and commutator with compressed air. Make sure no abrasive particles from sandpaper are embedded in the contact area of brushes.

3. New brushes are not ground to fit the commutator; therefore, they must be seated as described.

4. Mark each brush and brush holder with which it was seated to permit assembly in the same position.

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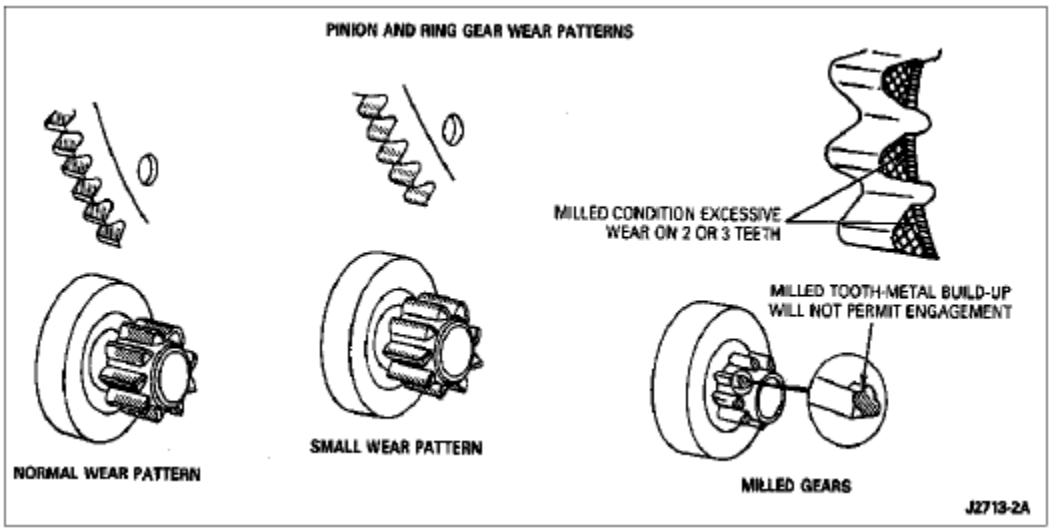
Starter Drive/Flywheel Ring Gear Inspection

Inspect the wear pattern on the starter drive (11350) and the flywheel ring gear (6384).



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SPECIFICATIONS

STARTER SPECIFICATIONS

Starter Motor				Load		Starter Brushes	
Motor Diameter	**Current Draw Under Normal Load**	**Normal Engine Cranking Speed**	**Min. Stall Torque @ 5 Volts**	**Max. Load**	**No Load**	**Mfg. Length**	**Spring Tension**
101.6mm (4 Inches)	130-220 Amps	140-220 RPM	14.7 Nm (11.0 Lb-Ft)	800 Amps	70 ± 10 Amps	16.8mm (0.66 Inch)	18 N (64 oz.)

Maximum commutator runout is 0.12mm (0.005 inch). Maximum starting circuit voltage drop (battery positive terminal to starter terminal) at normal engine temperature is 0.5 volt.

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Starter Solenoid Screws	5-10	—	45-88
M-Terminal Nut	9-14	—	80-123
B-Terminal Nut	9-14	—	80-123
Through-Bolt	5-10	—	45-88
Upper Starter Motor Bolt	22-28	17-20	—
Lower Starter Motor Bolt	22-28	17-20	—
Brush End Plate Screw	2-3	—	18-26
Starter Motor Solenoid Relay Switch Terminal Nuts	7-9	—	62-79
Starter Motor Solenoid Relay Switch-to-Inner Fender Screws	11-13	—	98-115
Starter Relay Cable Nut	11-13	—	98-115

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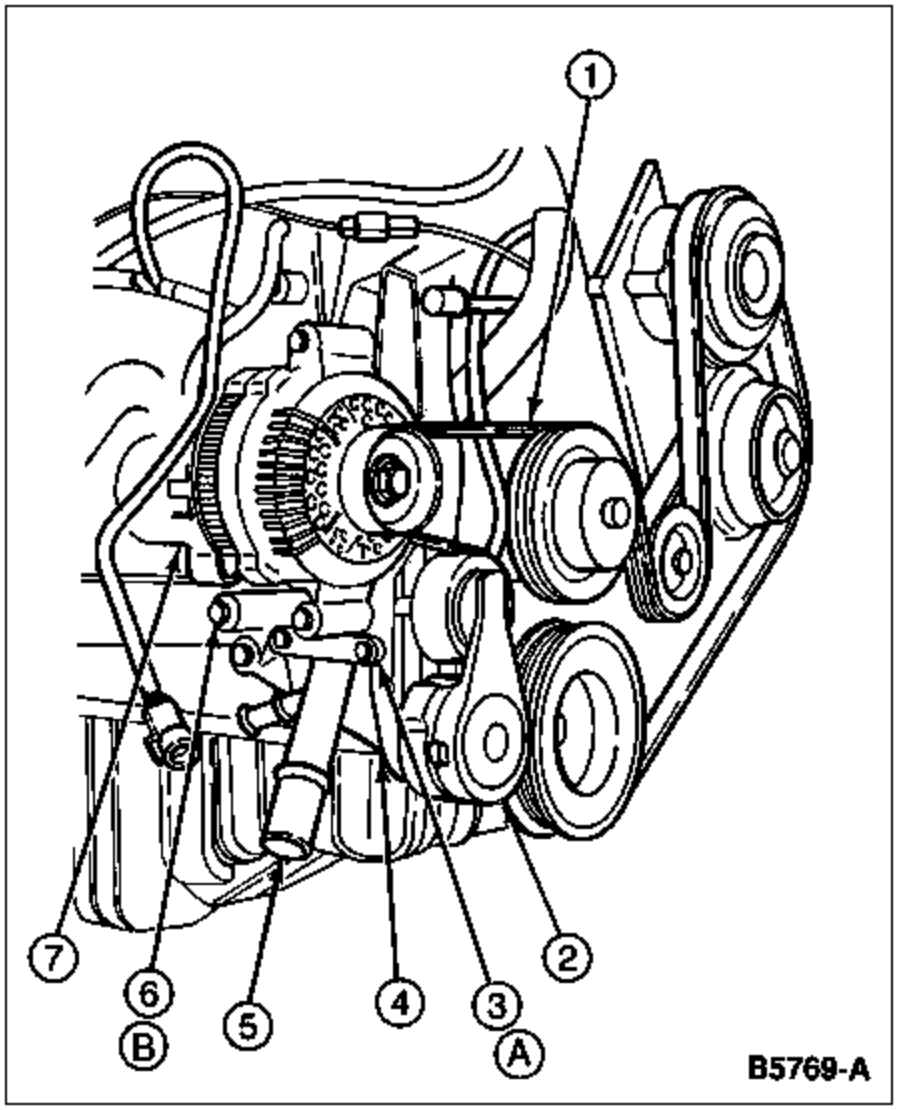
Crankshaft Position Sensor

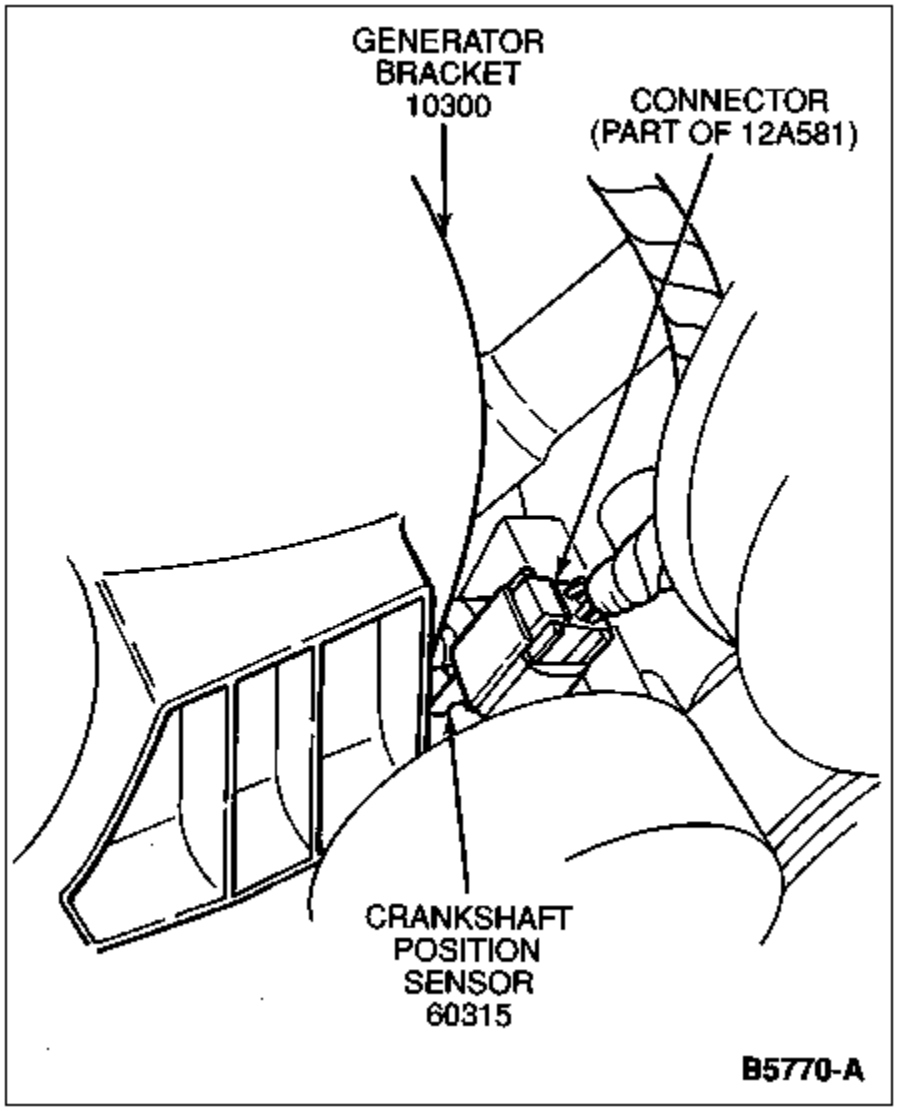
Removal

1. Disconnect battery ground cable (14301).
2. Drain cooling system.
3. Using flex handle, rotate drive belt tensioner (6B209) and remove drive belt (8620).
4. Disconnect generator connectors. Remove three bolts and generator (GEN) (10300).
5. Remove lower radiator hose (8286) and heater water hose (18472) from water pump inlet tube (8290).
6. Remove two bolts and water pump inlet tube. Remove O-ring from water pump inlet tube.

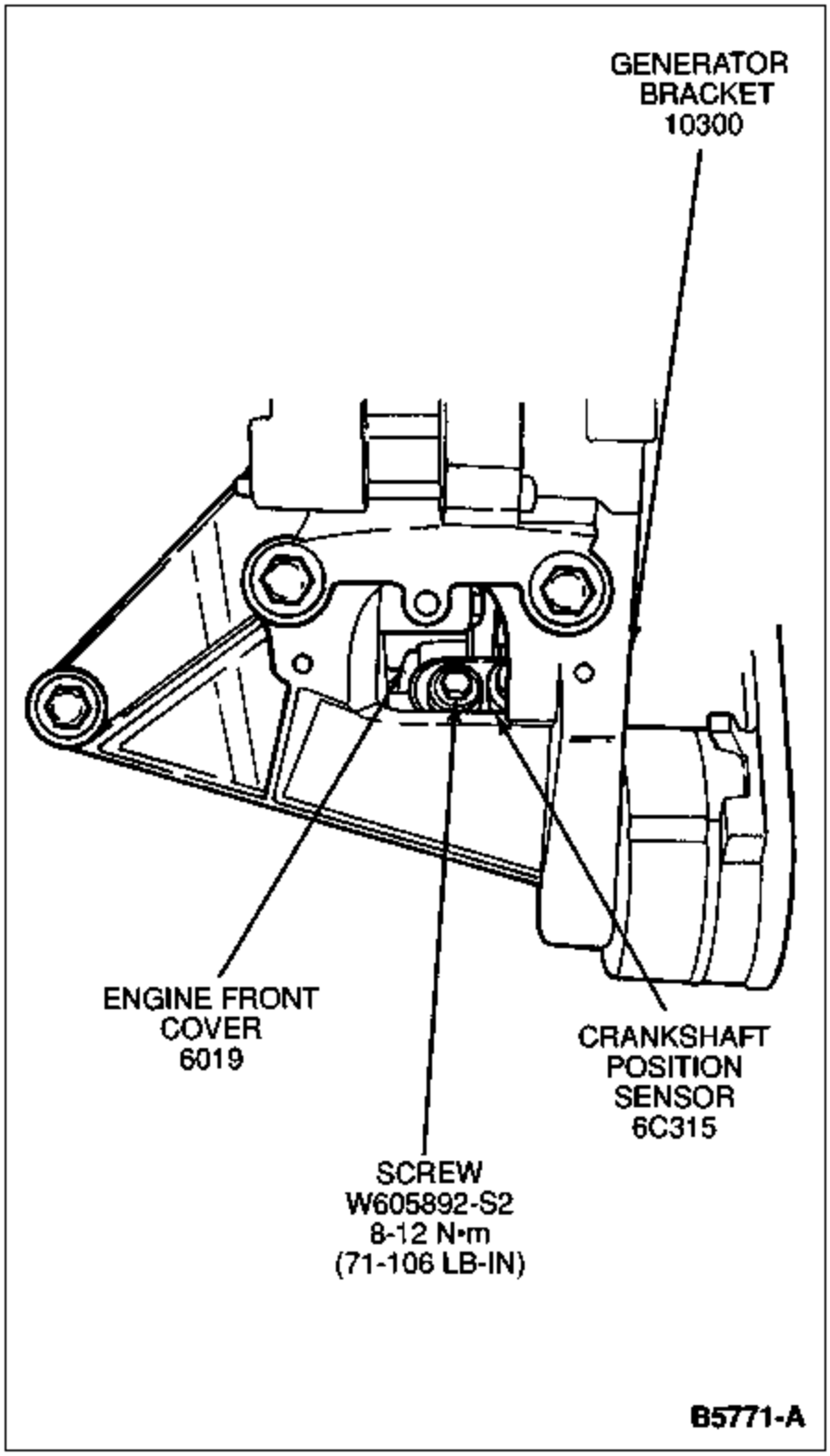


Item	Part Number	Description
1	8620	Drive Belt
2	6B209	Drive Belt Tensioner
3	N60676-S2	Screw, M6-1 x 22.5
4	10153	Generator Mounting Bracket
5	8290	Water Pump Inlet Tube
6	N606068-S	Bolt, M10-1.5 x 80
7	10300	Generator
A	—	Tighten to 9-12 Nm (78-107 Lb-In)
B	—	Tighten to 41-54 Nm (30-40 Lb-Ft)

7. Disconnect crankshaft position sensor connector.



8. Remove crankshaft position sensor retaining screw.
9. Carefully pry crankshaft position sensor (CKP sensor) (6C315) from engine front cover (6019).



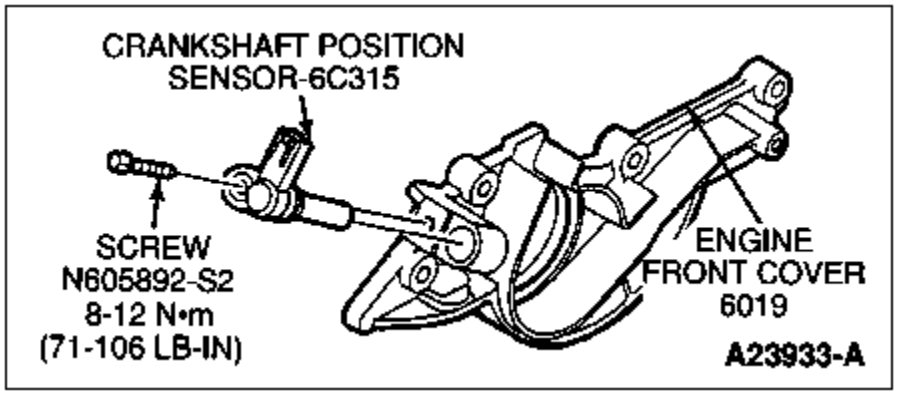
Installation

1. **NOTE: Engine front cover design precisely locates crankshaft position sensor so no**

adjustment is required.

Install crankshaft position sensor.

2. Install screw and tighten to 8-12 Nm (71-106 lb-in).



3. Connect crankshaft position sensor.
4. Install new O-ring on water pump inlet tube.
5. Install water pump inlet tube into water pump (8501).
6. Install water pump inlet tube-to-generator bracket bolts and tighten to 9-12 Nm (79-107 lb-in).
7. Install lower radiator hose and heater water hose on water pump inlet tube.
8. Install generator to generator mounting bracket (10153) and hand-start generator-to-bracket bolts. Alternately tighten bolts to 41-54 Nm (30-40 lb-ft).
9. Connect generator connectors.
10. Position drive belt. Rotate drive belt tensioner, position drive belt and rest tensioner pulley on belt.
11. **NOTE: When the battery (10653) has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

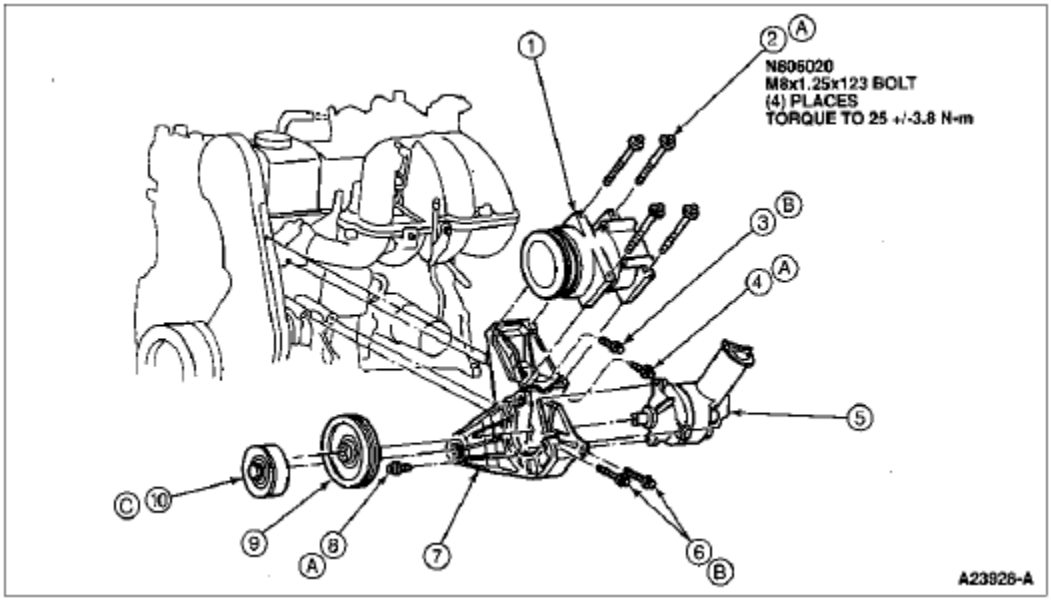
    Connect battery ground cable.
12. Fill cooling system as outlined in Section 03-03 .

Camshaft Position Sensor

Removal

1. Discharge air conditioner and recover refrigerant as outlined in Section 12-00 .
2. Disconnect battery ground cable (14301).
3. Using 3/8-inch drive flex-head handle, rotate drive belt tensioner (6B209) and remove drive belt (8620).
4. Remove four bolts securing A/C compressor (19703) to A/C compressor mounting bracket (2882) and set aside.
5. Remove three bolts and A/C compressor mounting bracket with attached power steering pump (3A674) and set aside.

Power Steering Pump Bracket

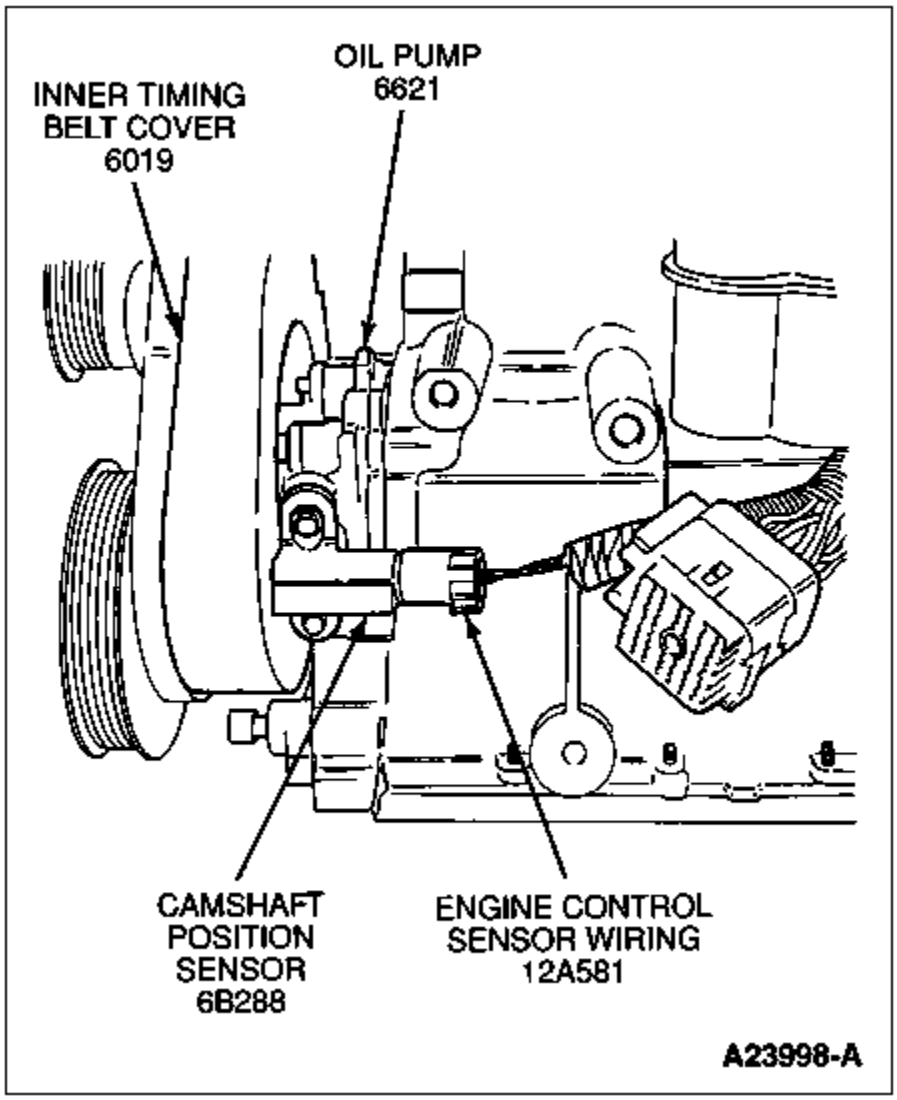


Item	Part Number	Description
1	19703	A/C Compressor
2	N806020	Bolt, M8-1.25 x 123
3	N606572	Bolt, M10-1.5 x 123
4	N606051	Bolt, M8-1.25 x 100
5	3A674	Power Steering Pump

6	N606068-S309	Bolt, M10-1.5 x 80
7	2882	A/C Compressor Mounting Bracket
8	N800199	Bolt, M10-1.5 x 33
9	3A733	Power Steering Pump Pulley
10	3F671	Power Steering Belt Idler Support
A	—	Tighten to 22-28 Nm (15-21 Lb-Ft)
B	—	Tighten to 41-59 Nm (29-40 Lb-Ft)
C	—	Tighten to 53-71 Nm (39-53 Lb-Ft)

6. Disconnect engine control sensor wiring (12A581) from camshaft position sensor (CMP sensor) (6B288).

7. Remove two bolts and camshaft position sensor from oil pump (6600).



Installation

1. Install camshaft position sensor on oil pump. Tighten two screws to 5-7 Nm (45-61 lb-in).
2. Connect engine control sensor wiring to camshaft position sensor.
3. Install A/C compressor mounting bracket with assembled power steering pump and hand start upper front bolt (tight hole) then upper rear bolt (slot hole).
4. Tighten upper front bolt to 40-54 Nm (30-40 lb-ft).
5. Install and tighten lower front bolt to 40-54 Nm (30-40 lb-ft).
6. Tighten upper rear bolt to 22-28 Nm (16-21 lb-ft).
7. Install and tighten lower rear bolt to 40-54 Nm (30-40 lb-ft).
8. Install A/C compressor and hand-start upper front bolt.

9. Install and tighten lower front compressor-to-bracket bolt to 22-28 Nm (16-21 lb-ft).

10. Install and tighten upper rear bolt to 22-28 Nm (16-21 lb-ft).

11. Install and tighten lower rear compressor-to-bracket bolt to 22-28 Nm (16-21 lb-ft).

12. Position drive belt. Using flex-head handle, rotate drive belt tensioner and put drive belt in place. Rest tensioner pulley on drive belt to tension.

13. **NOTE: When the battery (10653) has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

    Connect battery ground cable.

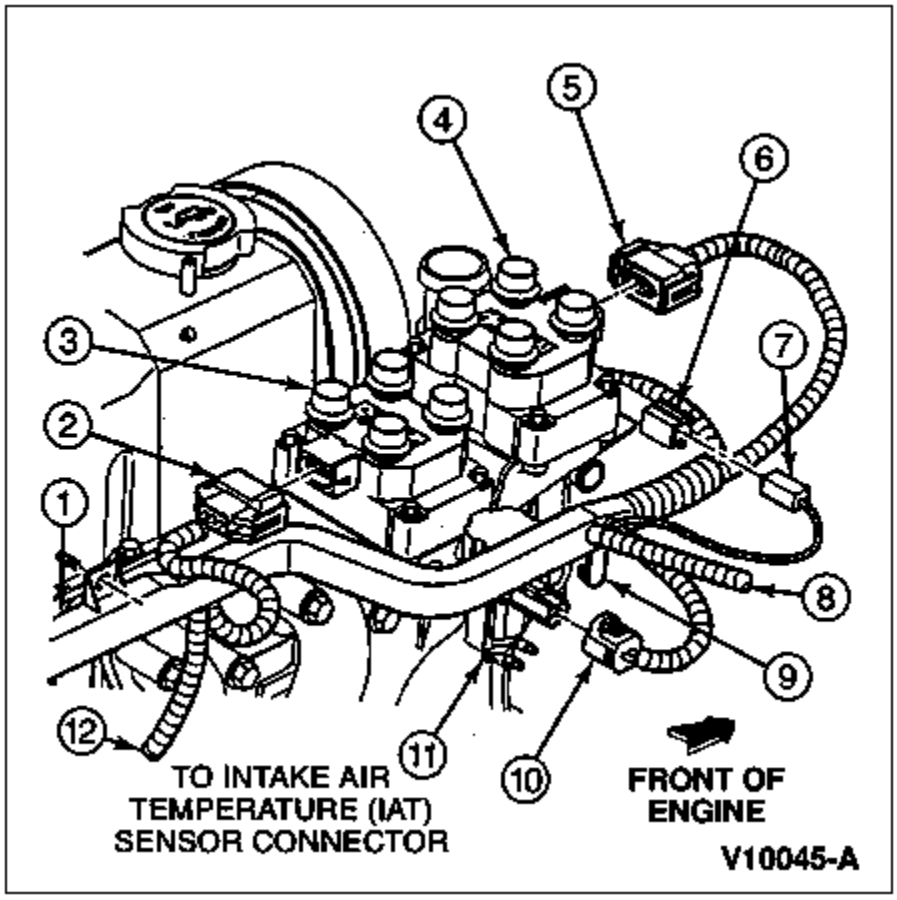
14. Recharge air conditioning system as outlined in Section 12-00 .

Ignition Coil Pack

Removal

1. To disconnect the spark plug wire set (12259) from the ignition coils, squeeze the locking tabs on the coil retainer and pull upward on the boot with a slight side-to-side twist. Do not pull on the spark plug wire set.

2. Disconnect the engine control sensor wiring (12A581) electrical connector from the ignition coil (12029).



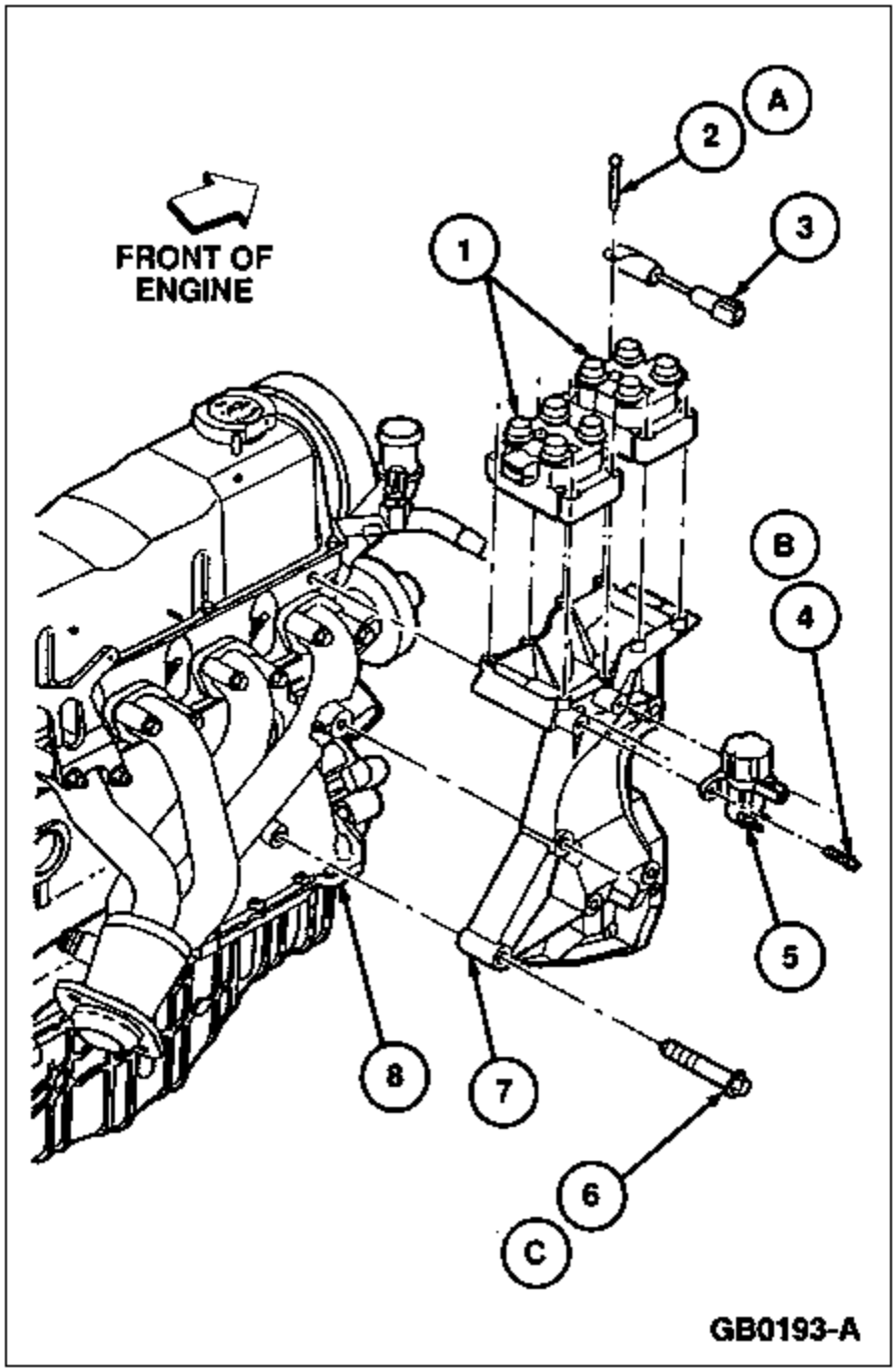
Item	Part Number	Description
1	12A581	Engine Control Sensor Wiring
2	—	Rear Ignition Coil Connector (Part of 12A581)
3	12029	Ignition Coil (Rear)

4	12029	Ignition Coil (Front)
5	—	Front Ignition Coil Connector (Part of 12A581)
6	18801	Radio Ignition Interference Capacitor
7	—	Radio Capacitor Connector (Part of 12A581)
8	—	Branch to Mass Airflow Sensor (Part of 12A581)
9	—	Retainer (Part of 12A581)
10	—	EGR Vacuum Regulator Control Connector (Part of 12A581)
11	9J549	EGR Vacuum Regulator Control
12	—	Branch to Intake Air Temperature Sensor (Part of 12A581)

3. Remove the four ignition coil retaining screws.
4. Remove the ignition coil.

Installation

1. Install the ignition coil and the four ignition coil pack retaining screws on generator mounting bracket (10153).
2. Tighten the four ignition coil retaining screws to 4.5-7.0 Nm (40-62 lb-in).
3. Connect the engine control sensor wiring electrical connector to the ignition coil.
4. To connect the spark plug wire set on the ignition coils in their proper locations, squeeze the locking tabs on the coil retainer and push downward on the boot with a slight side-to-side twist. Each of the terminals is identified on the ignition coil. The firing order of each coil is 1-3-4-2. Check that each of the spark plug wires is fully seated and both locking tabs are engaged.



Item	Part Number	Description
1	12029	Ignition Coils
2	N606502-S36	Bolt, M5-0.8 x 37
3	18801	Radio Ignition Interference Capacitor
4	N606676-S309	Screw, M6-1 x 20
5	9J459	EGR Vacuum Regulator Solenoid
6	N606064-S309	Bolt, M10-1.5 x 60

7	10153	Generator Mounting Bracket
8	6010	Cylinder Blocks
A	—	Tighten to 5-7 Nm (44-62 Lb-In)
B	—	Tighten to 8-12 Nm (71-106 Lb-In)
C	—	Tighten According to Instruction in Text

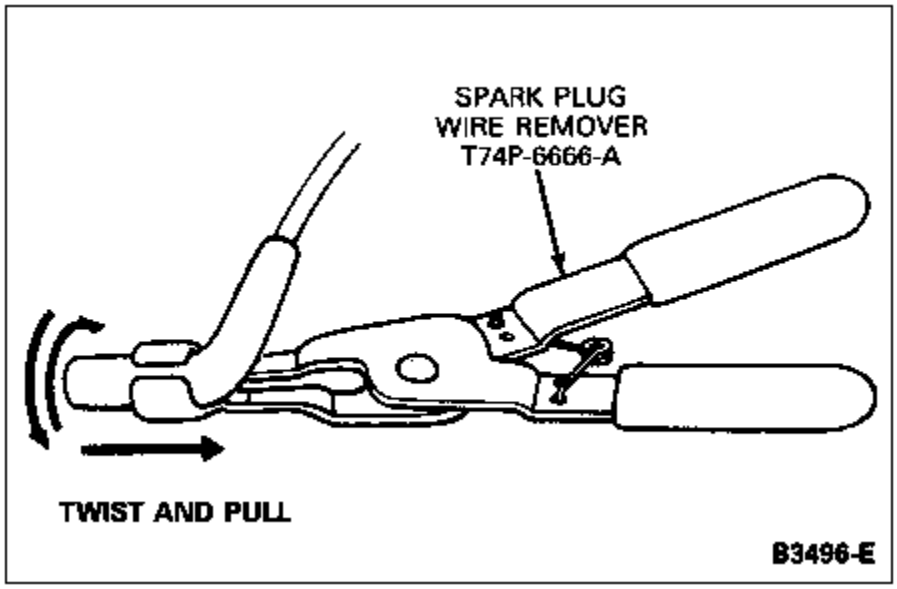
Ignition Wires

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Spark Plug Wire Remover	T74P-6666-A

Removal

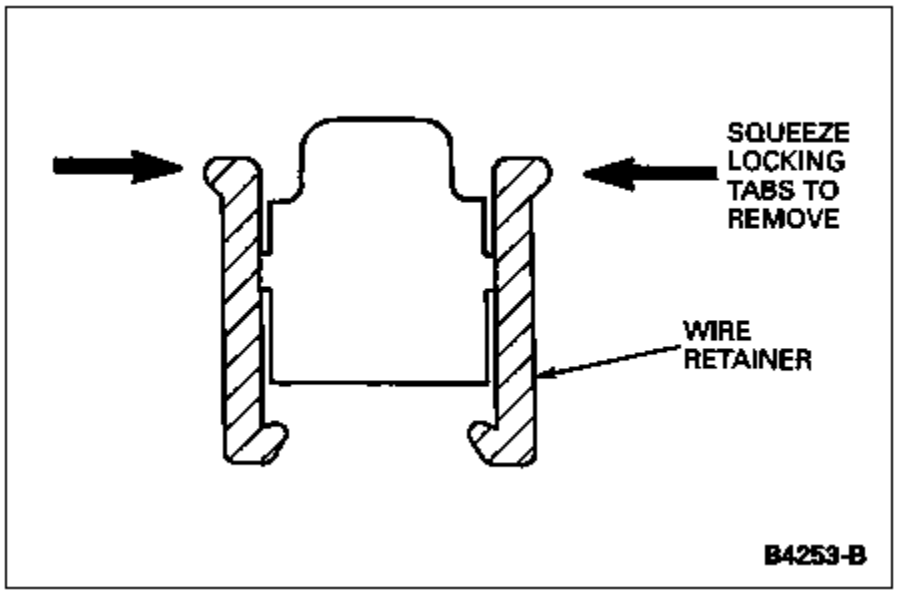
1. Remove spark plug wires from spark plugs with Spark Plug Wire Remover T74P-6666-A, pulling outward on the boot with a slight side-to-side twist. Do not pull on the spark plug wire set (12259).



2. Squeeze the locking tabs on the coil retainer and pull upward on the boot with a slight side-to-side twist to disconnect the spark plug wire set from the ignition coils. Do not pull on the spark plug wire set.

Installation

1. Apply an even coating of Silicone Dielectric Compound WA-10, D7AZ-19A331-A or equivalent meeting Ford specification ESE-M1C171-A to the entire interior surface of the spark plug boot.



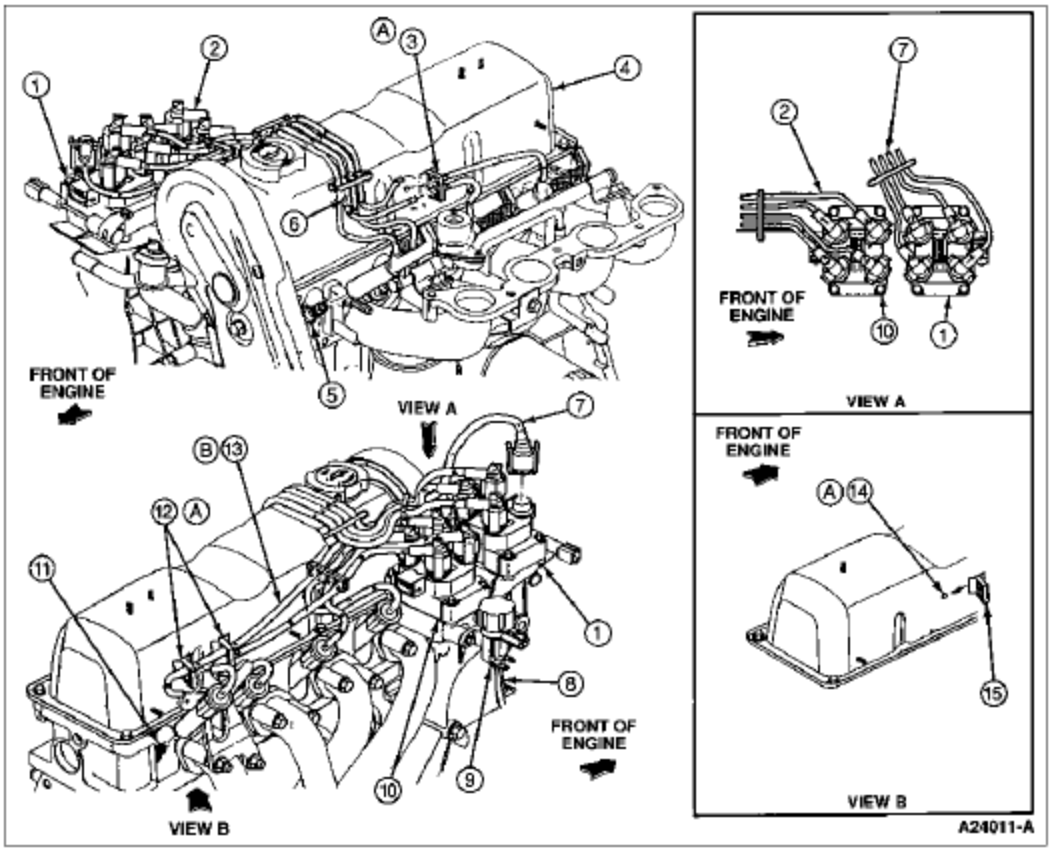
2. Squeeze locking tabs on coil retainer and push down on boot with a slight side-to-side twist to connect spark plug wire set on the ignition coils. Each of the terminals is identified on the ignition coils (12029). The firing order of each coil is 1-3-4-2. Check that each of the spark plug wires is fully seated and both locking tabs are engaged.

3. Remove the ignition wire separator (12297) from the spark plug wire set and reinstall it in the same relative position on the new set.

4. Route the spark plug wire set toward the spark plugs.

5. Connect each spark plug wire set on the proper spark plug.

Spark Plug Wires and Firing Order, 2.3L Engine



Item	Part Number	Description
1	12029	Ignition Coil
2	12280	Ignition Wire and Bracket (Left)
3	—	Retainer (Part of 12281)
4	6582	Valve Cover
5	12405	Spark Plug (LH)
6	—	T-Stud (Part of 6582)
7	12281	Ignition Wire and Bracket (Right)
8	10153	Generator Mounting Bracket
9	9J459	EGR Vacuum Regulator Solenoid
10	12029	Ignition Coil
11	12405	Spark Plug (RH)
12	—	Retainer (Part of 12280)
13	—	"R" (Part of 12280)
14	—	T-Stud (Part of 6582)
15	—	Retainer (Part of 12280)
A	—	Retainer Push onto T-Studs (Part of 6582)
B	—	"R" Indicates Right Side

Radio Ignition Interference Capacitor

Removal

1. Make sure ignition switch (11572) is turned off.
2. Disconnect radio ignition interference capacitor (18801) from engine control sensor wiring (12A581).
3. Remove left front coil screw and radio ignition interference capacitor.

Installation

To install, reverse removal procedures.

Tighten coil to generator bracket screw to 5-7 Nm (44-61 lb-in).

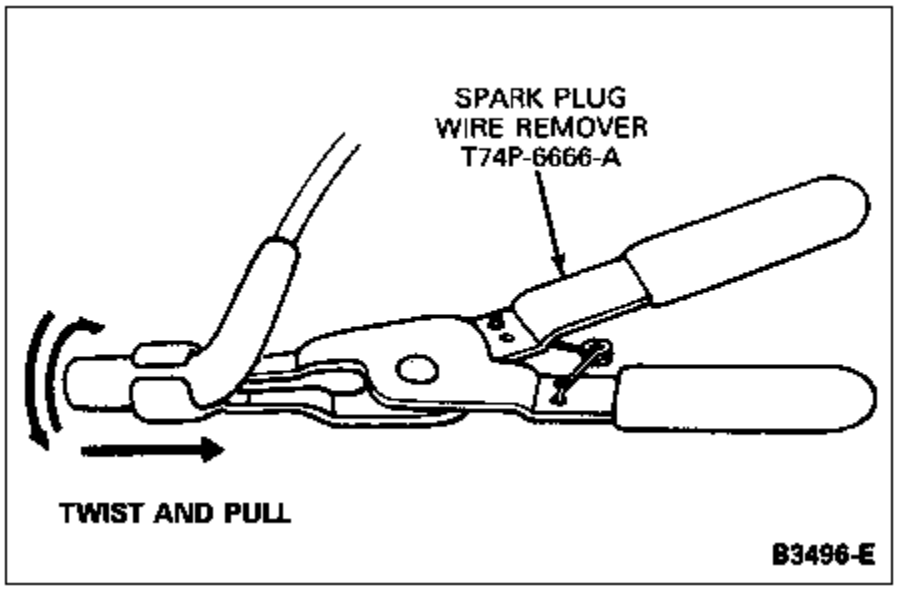
Spark Plugs

NOTE: Refer to the Spark Plug Inspection Chart to determine the condition of the spark plugs.

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Spark Plug Wire Remover	T74P-6666-A

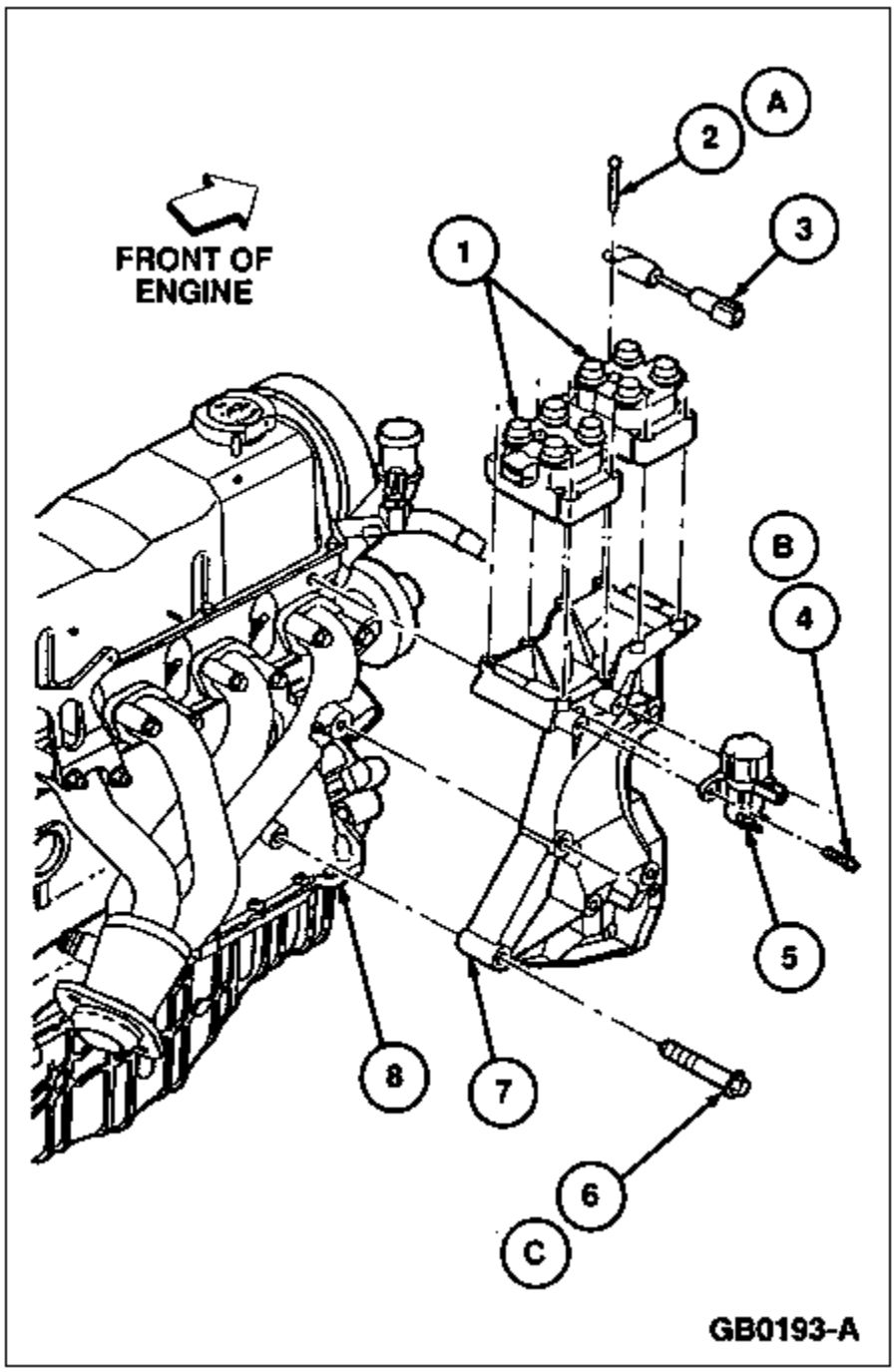
Removal



1. Remove spark plug wires from spark plugs with Spark Plug Wire Remover T74P-6666-A, pulling outward on the boot with a slight side-to-side twist. Do not pull on the spark plug wire set (12259).
2. Loosen spark plugs (12405) and remove any dirt or foreign material from spark plug areas of cylinder head (6049) with compressed air.
3. Remove spark plugs.

Installation

1. Inspect and adjust spark plugs. Refer to Adjustments in this section.
2. Install spark plugs.
3. Tighten spark plugs to 9-20 Nm (7-15 lb-ft).
4. Connect spark plug wires to spark plugs.



Item	Part Number	Description
1	12029	Ignition Coils
2	N606502-S36	Bolt, M5-0.8 x 37
3	18801	Radio Ignition Interference Capacitor
4	N606676-S309	Screw, M6-1 x 20
5	9J459	EGR Vacuum Regulator Solenoid
6	N606064-S309	Bolt, M10-1.5 x 60
7	10153	Generator Mounting Bracket
8	6010	Cylinder Blocks
A	—	Tighten to 5-7 Nm (45-61 Lb-In)
B	—	Tighten to 8-12 Nm (70-106 Lb-In)
C	—	Tighten According to Instruction in Text

Spark Plugs

Using a suitable spark plug gap tool, adjust spark plug gap to 1.07-1.17mm (0.042-0.046 in.).

Ignition Timing

Base ignition timing is preset at 10 degrees ± 2 degrees BTDC, and is **not adjustable** .

SPECIFICATIONS

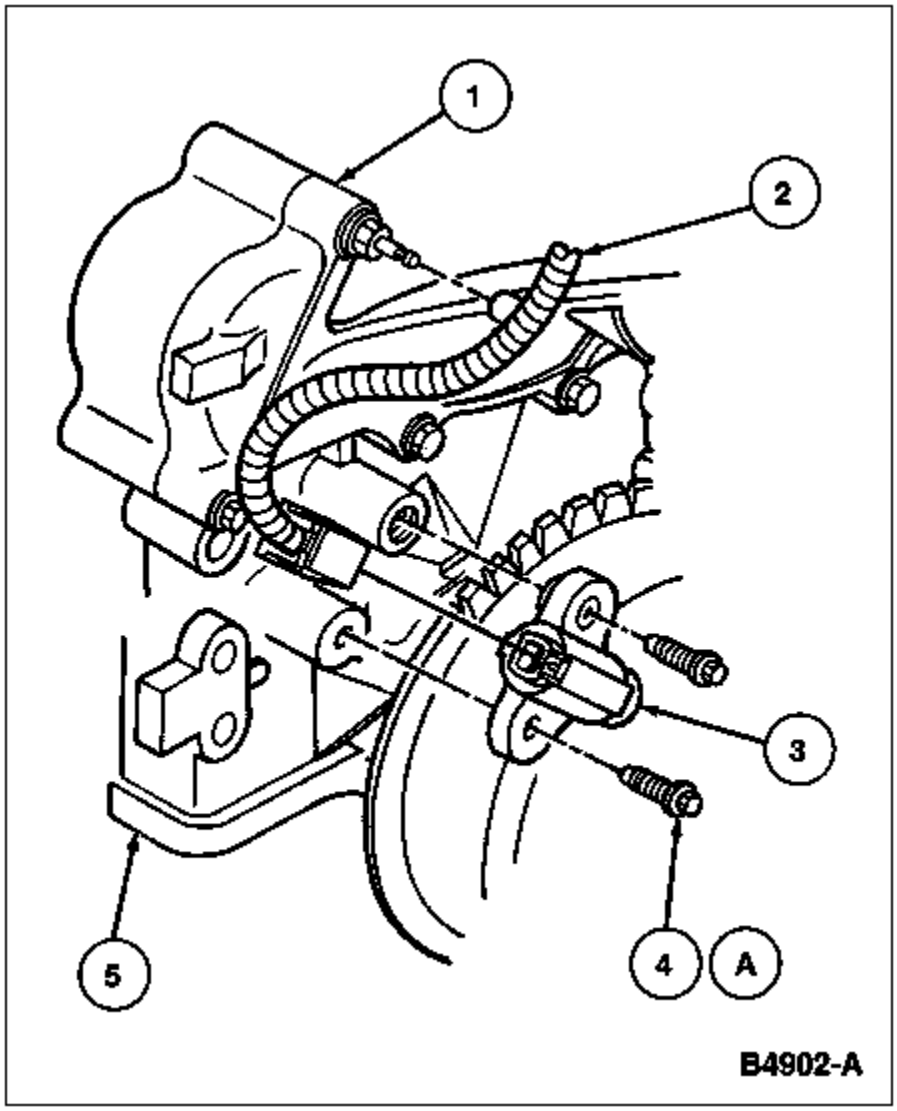
IGNITION SYSTEM SPECIFICATIONS

Firing Order	Ignition Timing	Plug Type	Plug Gap
1-3-4-2	10° ± 2° Non- Adjustable BTDC	AWSF-32F	1.07-1.17mm (.042-.046 In.)

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Spark Plugs	9-20	7-15	—
Coil Mounting Screws	5-7	—	44-62
Crankshaft Hub Bolt	125-165	93-121	—
Crankshaft Position Sensor	8-12	—	71-106

Crankshaft Position Sensor



Item	Part Number	Description
1	8501	Water Pump
2	9D930	Fuel Charging Wiring
3	6C315	Crankshaft Position Sensor
4	N606500-S8 (2 Req'd)	Crankshaft Position Sensor Bolt
5	6019	Engine Front Cover
A	—	Tighten to 5-7 Nm

		(45-61 Lb-In)

Removal

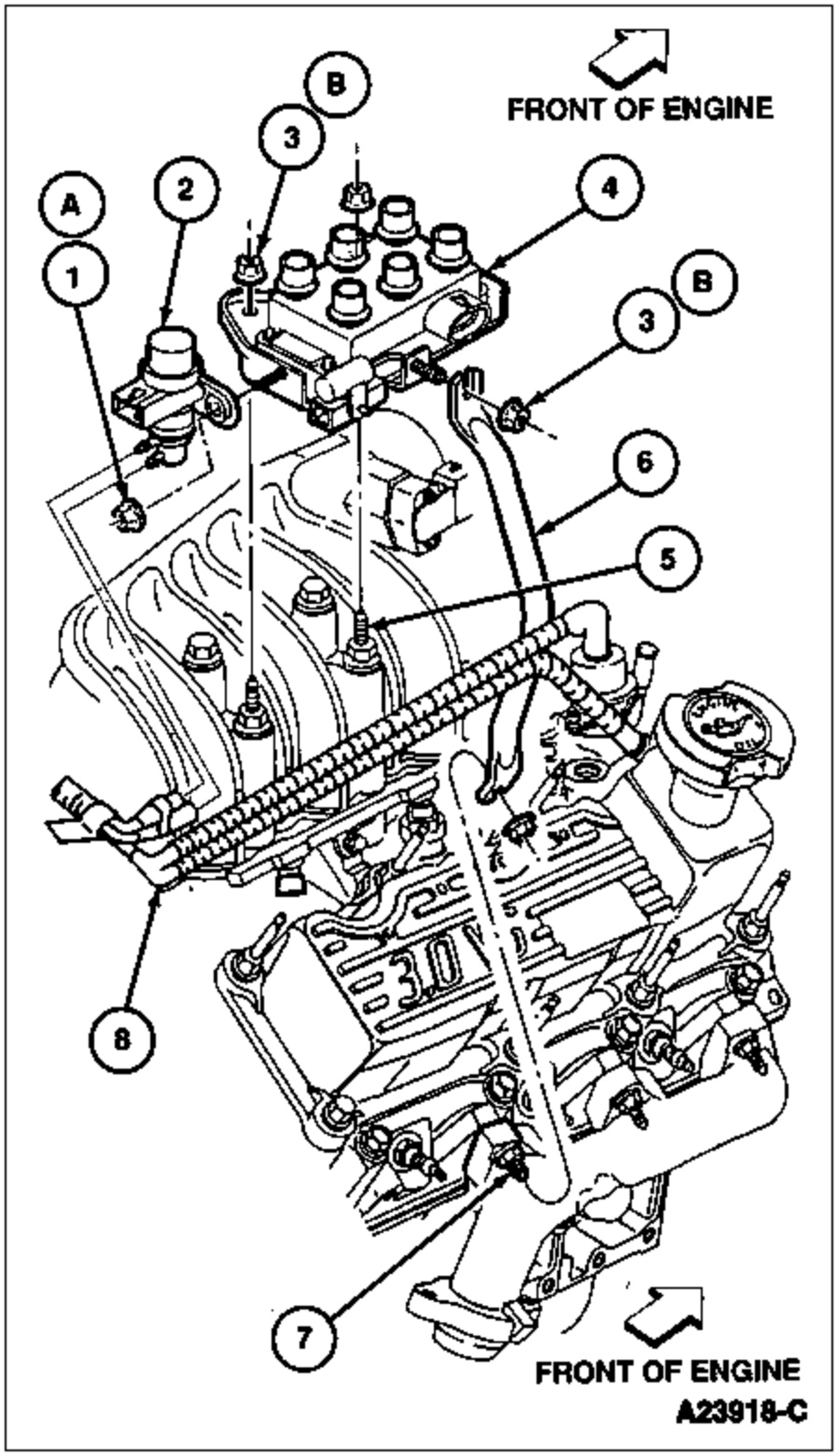
1. Disconnect battery ground cable (14301).
2. Raise and support the vehicle.
3. Disconnect crankshaft position sensor electrical connector from the crankshaft position sensor (CKP sensor) (6C315).
4. Remove CKP sensor bolts and remove crankshaft position sensor.

Installation

1. Position crankshaft position sensor and install CKP sensor bolts. Tighten to 5-7 Nm (45-61 lb-in).
2. Properly route engine fuel charging wiring (9D930) and connect CKP sensor electrical connector to crankshaft position sensor.
3. Lower the vehicle.
4. **NOTE: When battery voltage is removed from the powertrain control module (PCM) (12A650), all learned values will be cleared and reset to predetermined values. When battery voltage is restored to the PCM, the vehicle may exhibit certain driveability concerns. It will be necessary to drive the vehicle to allow the PCM to relearn values for optimum driveability and performance.**

   Connect battery ground cable.

Ignition Coil



Item	Part Number	Description
1	—	EGR Vacuum Regulator Solenoid Nuts
2	9J459	EGR Vacuum Regulator Solenoid

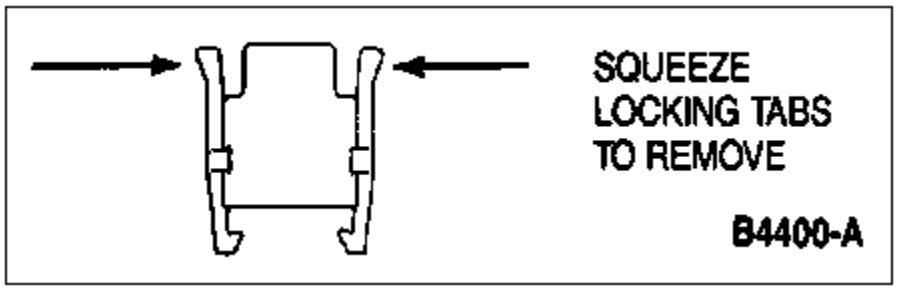
3	—	Ignition Coil and Bracket Assembly Nut
4	12A310	Ignition Coil and Bracket Assembly
5	—	Throttle Body Stud
6	12N004	Ignition Coil Mounting Bracket
7	—	Exhaust Manifold Stud
8	—	Emission Vacuum Control Connector Assembly
A	—	Tighten to 8-12 Nm (71-106 Lb-In)
B	—	Tighten to 16-20 Nm (12-14 Lb-Ft)

Removal

1. Disconnect fuel charging wiring electrical connectors from ignition coil (12029) and radio ignition interference capacitor (18801).

2. **CAUTION: Do not pull on the spark plug wire as it may separate from the spark plug wire connector inside the spark plug wire boot.**

   Disconnect spark plug wires by squeezing locking tabs and twisting while pulling upward.



3. Remove two ignition coil nuts and top ignition coil mounting bracket nut. Remove ignition coil and radio ignition interference capacitor. Save radio ignition interference capacitor for installation with new ignition coil.

4. Remove EGR vacuum regulator solenoid nuts EGR vacuum regulator solenoid (9J459).

Installation

1. Position the EGR vacuum regulator solenoid and install the nuts. Install EGR vacuum regulator bracket (9J472) nut. Tighten EGR vacuum regulator solenoid nuts to 8-12 Nm (6-8 lb-ft).

2. Position ignition coil and radio ignition interference capacitor to ignition coil mounting bracket.

3. Install two ignition coil nuts and top ignition coil mounting bracket nut. Tighten to 16-20 Nm (12-14 lb-ft).

4. Apply Silicone and Dielectric Compound D7AZ-19331-A (Motorcraft WA-10), or equivalent meeting Ford specification ESA-M1C171-A to all spark plug wire boots.

5. Install each spark plug wire connector to the proper terminal on the ignition coil. Make sure spark plug wire boots are fully seated.

6. Connect ignition coil and radio ignition interference capacitor electrical connectors.

Bracket, Ignition Coil

Removal

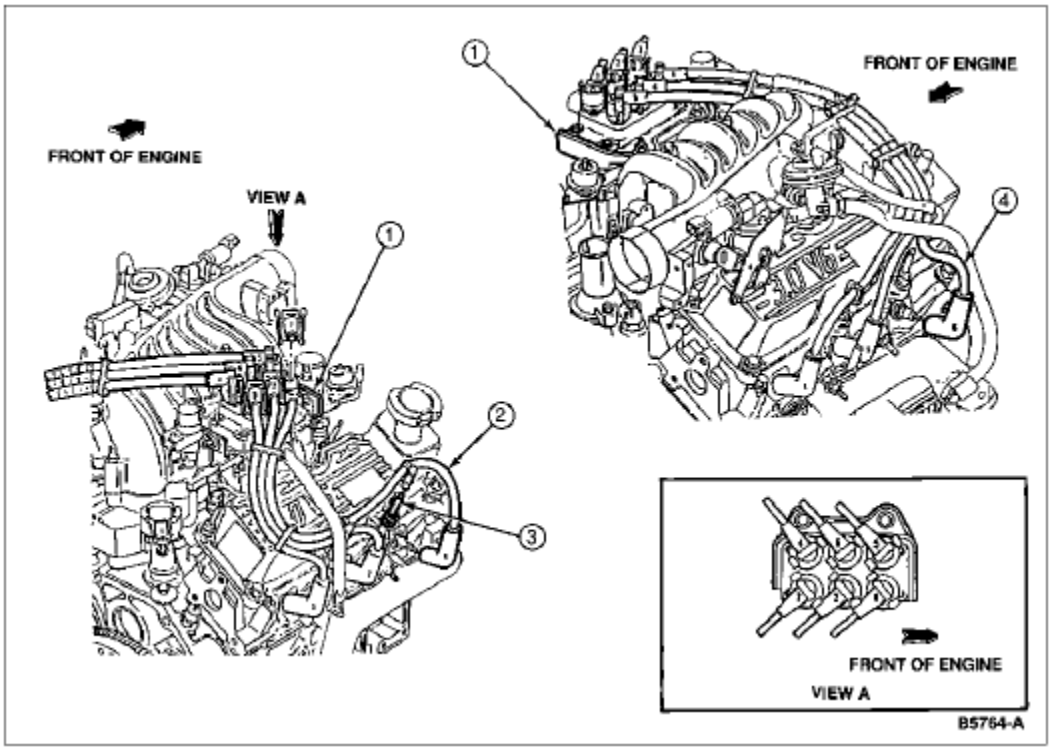
Remove two ignition coil mounting bracket nuts and ignition coil mounting bracket.

Installation

Position the ignition coil mounting bracket on the ignition coil (12029) and the exhaust manifold stud. Install two ignition coil mounting bracket nuts. Tighten to 16-20 Nm (12-14 lb-ft).

Spark Plug Wires

Spark Plug Wires



Item	Part Number	Description
1	12029	Ignition Coil
2	12280	Spark Plug Wire (RH)
3	—	Valve Cover Bolt or Stud
4	12281	Spark Plug Wire (LH)

SPECIAL SERVICE TOOL(S) REQUIRED

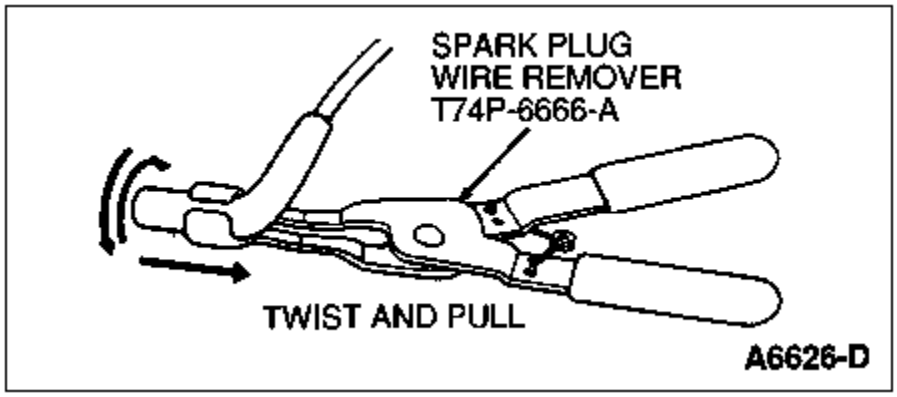
Description	Tool Number
Spark Plug Wire Remover	T74P-6666-A

Removal

1. Remove the inside engine cover.

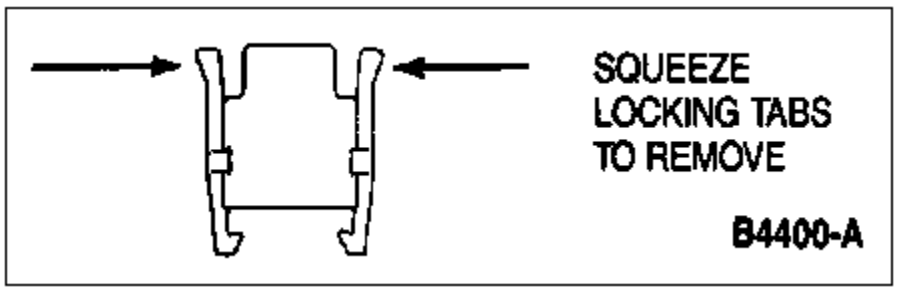
2. **CAUTION: Do not pull on the spark plug wire as it may separate from the spark plug wire connector inside the spark plug wire boot.**

   When removing spark plug wires from spark plugs (12405), use Spark Plug Wire Remover T74P-6666-A. Grasp and twist the spark plug wire boot back and forth on the spark plug insulator to release the connector.



3. **CAUTION: Do not pull on the spark plug wire as it may separate from the spark plug wire connector inside the spark plug wire boot.**

   Disconnect the spark plug wire from the ignition coil (12029) by squeezing the locking tabs and twisting while pulling upward.



4. Open spark plug wire separators and remove spark plug wire.

Installation

CAUTION: Proper installation of spark plug wires is critical to vehicle operation. If one spark plug wire is not properly installed on spark plug or ignition coil, both spark plugs connected to that

segment of the ignition coil may not fire under load.

1. **NOTE: When a spark plug wire is removed for any reason from a spark plug or ignition coil, or a new spark plug wire is installed, Silicone and Dielectric Compound D7AZ-19331-A (Motorcraft WA-10), or equivalent meeting Ford specification ESA-M1C171-A must be applied to the spark plug wire boot prior to installation.**

   Use a small, clean tool to coat the entire interior surface of the boot with Silicone Dielectric Compound D7AZ-19331-A (Motorcraft WA-10), or equivalent meeting Ford specification ESA-M1C171-A.

2. Install each spark plug wire to the proper terminal on the ignition coil. The terminals on the ignition coil and the spark plug wire are numbered. Make sure the spark plug wire boots are fully seated and that both spark plug wire boot locking tabs are engaged.

3. Route the spark plug wires.

4. Connect the spark plug wires to the spark plugs.

5. Install the inside engine cover.

Radio Ignition Interference Capacitor

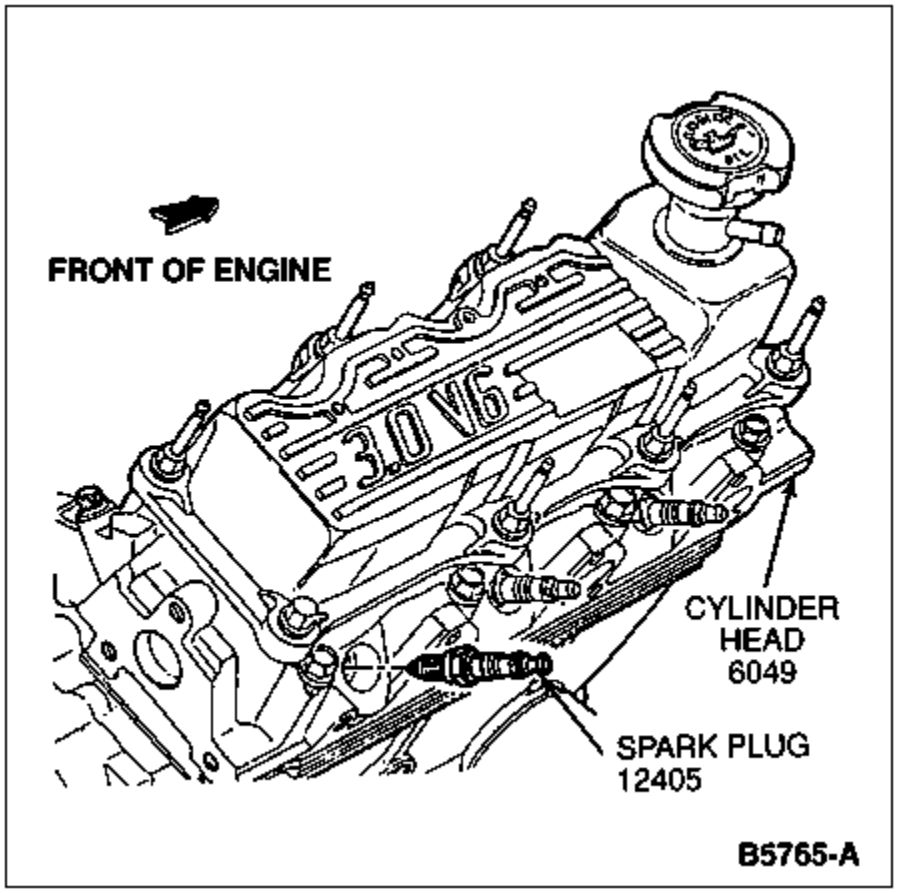
Removal

1. Disconnect engine control sensor wiring connector from radio ignition interference capacitor (18801).
2. Remove radio ignition interference capacitor screw.
3. Remove radio ignition interference capacitor screw.
4. Remove radio ignition interference capacitor.

Installation

To install, reverse the removal procedure. Tighten radio ignition interference capacitor screw to 4.5-7 Nm (40-61 lb-in).

Spark Plugs



Removal

1. Remove the inside engine cover.
2. Disconnect spark plug wires from spark plugs (12405).
3. Loosen spark plugs and, before removing the spark plugs, use compressed air to remove any dirt or foreign material from spark plug areas of cylinder head (6049).
4. **NOTE: If a spark plug is removed for examination, it must be installed in the same cylinder.**

   - **Cylinders No. 1, No. 2, No. 3 have a PG suffix.**
   - **Cylinders No. 4, No. 5, No. 6 have a P suffix.**

   NOTE: If a spark plug needs to be replaced, use only spark plugs with the service number

suffix letters "PP" as shown on the engine decal.

Remove spark plugs.

Installation

1. **NOTE: Refer to the Spark Plug Inspection Chart under Spark Plugs, Cleaning and Inspection, in this section to determine the condition of the spark plugs.**

   Check and adjust spark plugs.

2. Use a suitable spark plug gap tool to adjust spark plug gap to 1.07-1.17mm (0.042-0.046 in).

3. Install spark plugs and tighten to 9-20 Nm (7-15 lb-ft).

4. Connect spark plug wires to spark plugs.

5. Install the inside engine cover.

Spark Plugs

Use a suitable spark plug gap tool to adjust spark plug gap to 1.07-1.17mm (0.042-0.046 inch) following tool manufacturer's instructions.

Ignition Timing

Initial engine ignition timing (base timing) is 10 ± 2 degrees BTDC and is not adjustable.

SPECIFICATIONS

IGNITION SYSTEM SPECIFICATIONS

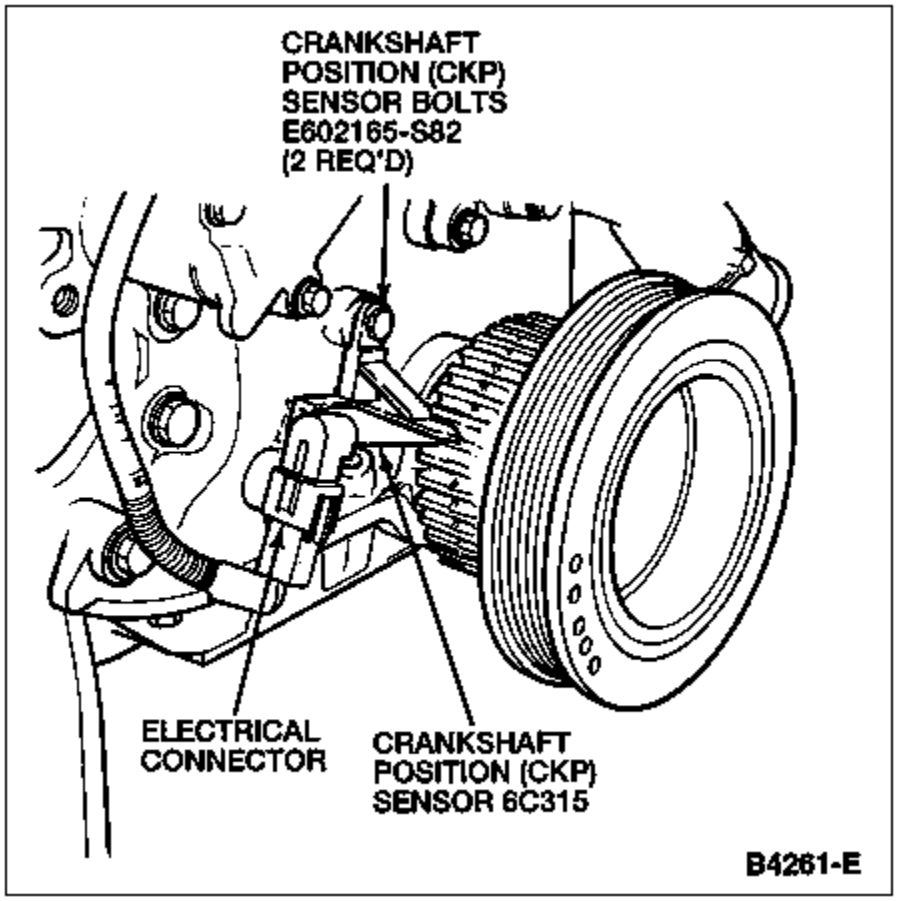
Description	Specification
Spark Plug Type	AWSF32P and AWSF32PG
Spark Plug Gap	1.07-1.17mm (0.042-0.046 Inch)
Firing Order	1-4-2-5-3-6

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Crankshaft Position Sensor Bolts	5-7	—	45-61
Ignition Coil Screws	4.5-7	—	40-61
Ignition Coil Mounting Bracket Nuts	16-20	12-14	—
Spark Plugs	9-20	7-15	—
EGR Vacuum Regulator Solenoid Nut	8-12	6-8	—
Ignition Coil Nuts	16-20	12-14	—
Radio Ignition Interference Capacitor Screw	4.5-7	—	40-61

Crankshaft Position Sensor

Removal



1. Disconnectbattery ground cable (14301).
2. Disconnect crankshaft position sensor (CKP sensor) electrical connector from wiring harness.
3. Remove CKP sensor bolts and remove crankshaft position sensor (CKP sensor) (6C315).

Installation

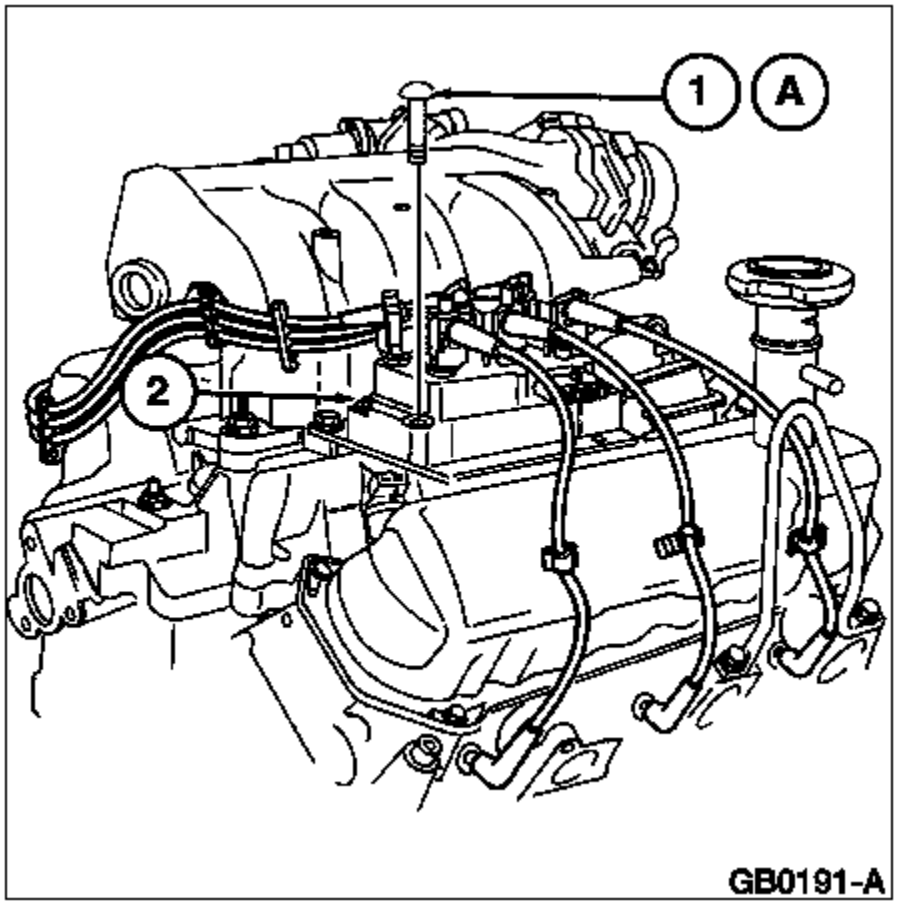
1. Position crankshaft position sensor on engine (6007).
2. Install two CKP sensor bolts and tighten to 9-12 Nm (80-106 lb-in).
3. Route CKP sensor wiring harness and connect electrical connector.
4. **NOTE: When battery voltage is removed from the powertrain control module (PCM) (12A650),**

all learned values will be cleared and reset to predetermined values. When battery voltage is restored to the PCM, the vehicle may exhibit certain driveability concerns. It will be necessary to drive the vehicle to allow the PCM to relearn values for optimum driveability and performance.

Connect battery ground cable.

Ignition Coil

Removal



Item	Part Number	Description
1	E802669	Ignition Coil Bolt (4 Req'd)
2	—	Ignition Coil Pack
A	—	Tighten to 5-7Nm (45-61 Lb-In)

1. Disconnect battery ground cable (14301).
2. Disconnect fuel charging wiring (9D930) from ignition coil (12029).
3. Remove spark plug wires by squeezing locking tabs to release ignition coil boot retainers.
4. On Ranger vehicles equipped with air conditioning, remove air conditioning tube-to-plenum bolt and

move tube enough to gain access to ignition coil bolts.

5. Remove ignition coil bolts and remove ignition coil.

Installation

1. Install ignition coil. Tighten ignition coil bolts to 5-7 Nm (45-61 lb-in).

2. On Ranger vehicles equipped with air conditioning, reposition air conditioning tube and secure. Tighten air conditioning tube-to-plenum bolt to 26-32 Nm (20-23 lb-ft).

3. Connect spark plug wires and connect fuel charging wiring to ignition coil.

4. **NOTE: When the battery voltage is removed from the powertrain control module (PCM) (12A650), all learned values will be cleared and reset to predetermined values. When battery voltage is restored to the PCM, the vehicle may exhibit certain driveability concerns. It will be necessary to drive the vehicle to allow the PCM to relearn values for optimum driveability and performance.**

   Connect battery ground cable.

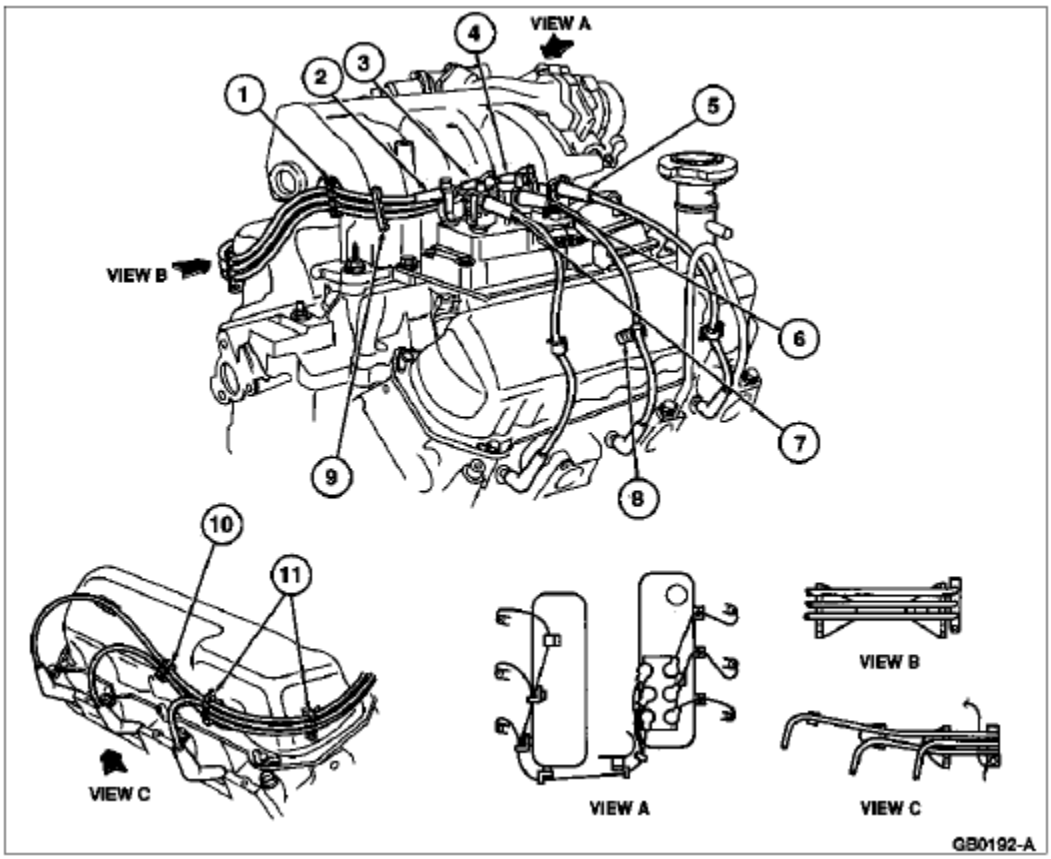
Ignition Wires

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Spark Plug Wire Remover	T74P-6666-A

Removal

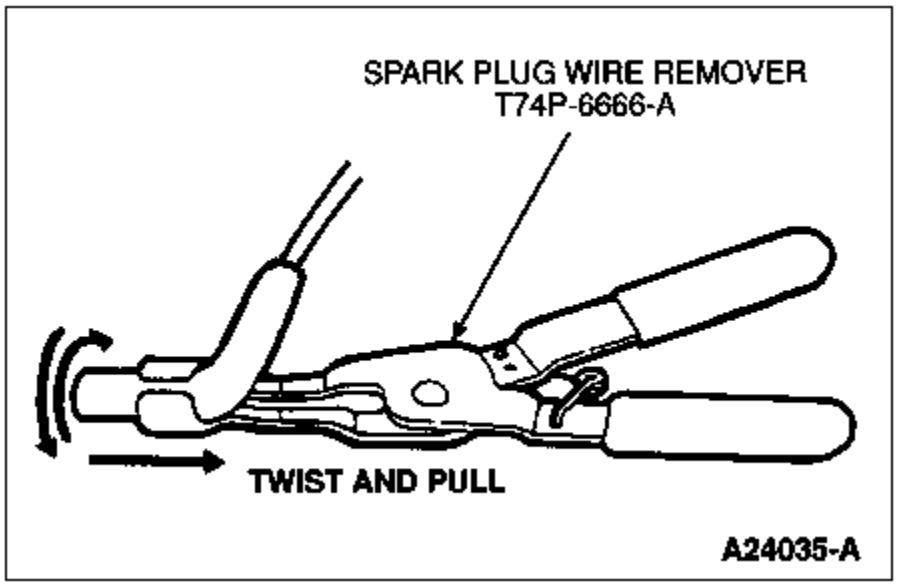
Spark Plug Wire Routing



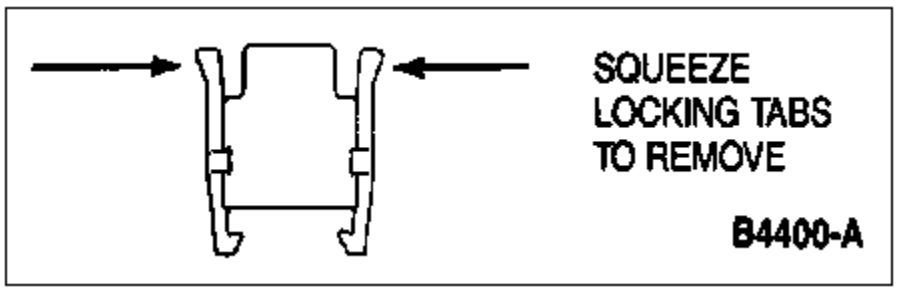
Item	Part Number	Description
1	W703402-S	Clip, Quad

2	12287	Spark Plug Wire No. 4
3	12285	Spark Plug Wire No. 6
4	12282	Spark Plug Wire No. 5
5	12286	Spark Plug Wire No. 1
6	12283	Spark Plug Wire No. 2
7	12284	Spark Plug Wire No. 3
8	W700891-S	Clip (4 Req'd)
9	E4AE-12297-CA	Separator, 4-Way
10	W700891-S	Clip
11	E865603-S	Clip, Quad (2 Req'd)

When removing spark plug wires from spark plugs (12405), use the Spark Plug Wire Remover T74P-6666-A. Grasp and twist the boot back and forth on the spark plug insulator to free the boot. Use the special tool to pull the boot from the spark plug. Do not pull on the spark plug wire directly, as it may separate from the connector inside the boot.



When removing spark plug wires from the ignition coil (12029), squeeze the locking tabs of the coil wire retainer and remove using a twisting and pulling motion. Do not pull on the spark plug wires.



Installation

CAUTION: Proper installation of spark plug wires is critical to vehicle operation. If one spark plug wire is not properly installed on spark plug or ignition coil, both spark plugs connected to that ignition coil may not fire under load.

1. Whenever a high tension wire is removed for any reason from a spark plug or ignition coil, or a new spark plug wire is installed, apply Silicone Brake Caliper Grease and Dielectric Compound D7AZ-19331-AA Motorcraft WAIO, or equivalent meeting Ford specification ESA-M1C171-1C171-A to the boot prior to installation. Using a small, clean tool, coat the entire interior surface of the boot with the compound.

2. Install each spark plug wire on the proper ignition coil. Refer to the previous illustration which shows spark plug wire routing. The terminal cylinder numbers are identified on the ignition coil. Make sure that the coil wire boots are fully seated and that both coil boot retainer locking tabs have engaged. The 4.0L firing order is 1-4-2-5-3-6.

3. Remove the wire retaining brackets from the old spark plug wires and install brackets in same relative position on the new wires. Install spark plug wires and retaining brackets on the engine (6007).

4. Connect spark plug wires to proper spark plugs.

Spark Plugs

Removal

1. Disconnect the intake air temperature (IAT) and mass airflow (MAF) electrical connectors. Remove the crankcase ventilation tube (6C342) from the right valve cover and remove the air cleaner outlet tube assembly (9R504).

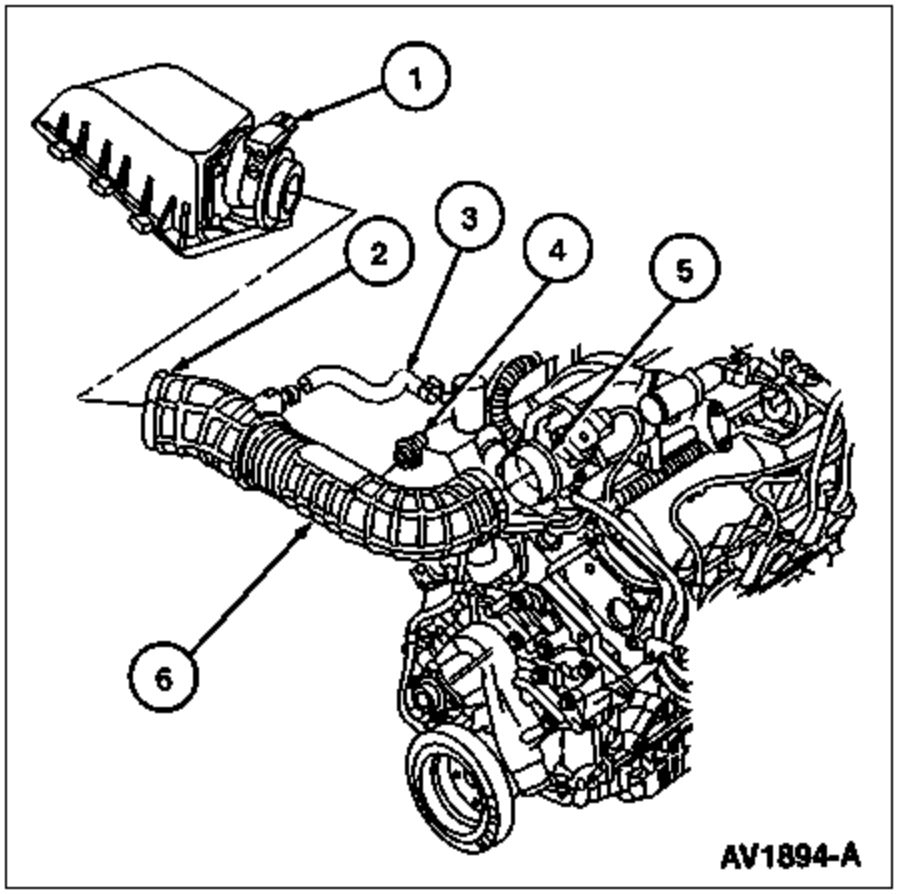
2. Remove the ignition wires from the spark plugs.

3. **NOTE: Use compressed air to remove any foreign material in the spark plug well before removing the spark plugs. If an original spark plug is reused, make sure it is installed in the same cylinder it was taken from. Replacement spark plugs can be used in any cylinder.**

   Remove the spark plugs.

4. Inspect the spark plugs for the following:

   - deposits bridging spark plug gap
   - wet black deposits (oil fouling)
   - dry black deposits (carbon fouling)
   - overheating
   - deposits fused on spark plug
   - pre-ignition damage



Installation

1. Set the spark plugs air gap as necessary. The correct spark plug gap is 1.3-1.4 mm (0.052-0.056 in).
2. Install the spark plugs. Tighten the plugs to 15 Nm (11 lb-ft).
3. Install the spark plug wires to the spark plugs.
4. Install the air cleaner outlet tube assembly. Install the crankscase ventilation tube to the right valve cover. Connect the IAT and MAF sensors.

Spark Plugs

NOTE: Platinum enhanced spark plugs should not require adjustment throughout service life.

Use a suitable spark plug gap tool to check spark plug gap. The correct spark plug gap is 1.3-1.4mm (0.052-0.056 inch).

Ignition Timing

Ignition timing is preset at 10° BTDC and is not ad justable.

SPECIFICATIONS

IGNITION SYSTEM SPECIFICATIONS

Firing Order	Ignition Timing	Plug Type	Plug Gap
1-4-2-5-3-6	10° ± 2° BTDC Non-Adjustable	AWSF-42PG AWSF-42P	1.3-1.4mm (0.052-0.056 In.)

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Crankshaft Position (CKP) Sensor Bolts	9-12	—	80-106
Ignition Coil Bolts	5-7	—	45-61
Ignition Coil Mounting Bracket Bolts	26-32	20-23	—
Spark Plugs	9-20	7-15	—
Air Conditioning Tube-to-Plenum Bolt	26-32	20-23	—

PCV Valve

Removal

1. Disconnect crankcase ventilation hose (6853) from positive crankcase ventilation valve (PCV valve) (6A666).
2. Remove positive crankcase ventilation valve (PCV valve) from crankcase ventilation grommet (6A892).
3. Inspect crankcase ventilation grommet for deterioration and replace if necessary.

Installation

To install, reverse the removal procedure.

PCV Hoses

Crankcase Ventilation Hose

Removal

1. Disconnect crankcase ventilation hose (6853) from positive crankcase ventilation valve (PCV valve) (6A666).

2. Disconnect crankcase ventilation hose from fitting on intake manifold (9424).

Installation

To install, reverse the removal procedure.

EGR Valve — 2.3L, 3.0L, 4.0L

Removal

1. Disconnect the vacuum hose from the EGR valve (EGR valve) (9D475).
2. Disconnect the EGR valve to exhaust manifold tube (9D477) from the EGR valve.
3. Remove the EGR valve bolts and the EGR valve.
4. Remove the EGR valve gasket (9D476) and clean gasket sealing surface. If the old EGR valve is to be installed, clean the gasket sealing surface.

Installation

1. Position EGR valve with a new EGR valve gasket and install EGR valve bolts. Tighten to 20-30 Nm (15-22 lb-ft).
2. Connect the EGR valve to exhaust manifold tube to the EGR valve. Tighten EGR valve to exhaust manifold tube nut to 34-48 Nm (26-35 lb-ft). On 3.0L engines (6007), tighten EGR valve to exhaust manifold tube bolt to 20-30 Nm (15-22 lb-ft).
3. Connect the vacuum hose to the EGR valve.

EGR Valve to Exhaust Manifold Tube — 2.3L, 3.0L, 4.0L

Removal

1. Disconnect the EGR valve to exhaust manifold tube (9D477) at the EGR valve (EGR valve) (9D475) and exhaust manifold.
2. Disconnect hoses and remove EGR valve to exhaust manifold tube.
3. Remove EGR valve tube to manifold connector (9F485) from exhaust manifold, if necessary.

Installation

To install, reverse the removal procedure.

Tighten EGR valve tube to manifold connector and EGR valve to exhaust manifold tube nuts to 34-48 Nm (26-35 lb-ft). On 3.0L engines (6007), tighten EGR valve to exhaust manifold tube bolt to 20-30 Nm (15-22 lb-ft).

EGR (DPFE) Differential Pressure Feedback Transducer — 2.3L, 3.0L, 4.0L

Removal

1. Disconnect battery ground cable (14301).
2. Disconnect electrical connector from EGR backpressure transducer (9J460).
3. Disconnect hoses from EGR valve to exhaust manifold tube (9D477).
4. Remove EGR transducer bolts and EGR transducer (9J433).

Installation

NOTE: When battery voltage is removed from the powertrain control module (PCM) (12A650), all learned values will be cleared and reset to predetermined values. When battery voltage is restored to the PCM, the vehicle may exhibit certain driveability concerns. It will be necessary to drive the vehicle to allow the PCM to relearn values for optimum driveability and performance.

To install, reverse the removal procedure.

Tighten EGR transducer bolts to 3.5-4.5 Nm (31-39 lb-in).

EGR Vacuum Regulator Solenoid

Removal

1. Disconnect battery ground cable (14301).
2. Disconnect electrical connector from EGR vacuum regulator solenoid (9J459).
3. Disconnect vacuum hoses from EGR vacuum regulator solenoid.
4. Remove EGR vacuum regulator solenoid nut(s) and EGR vacuum regulator solenoid.

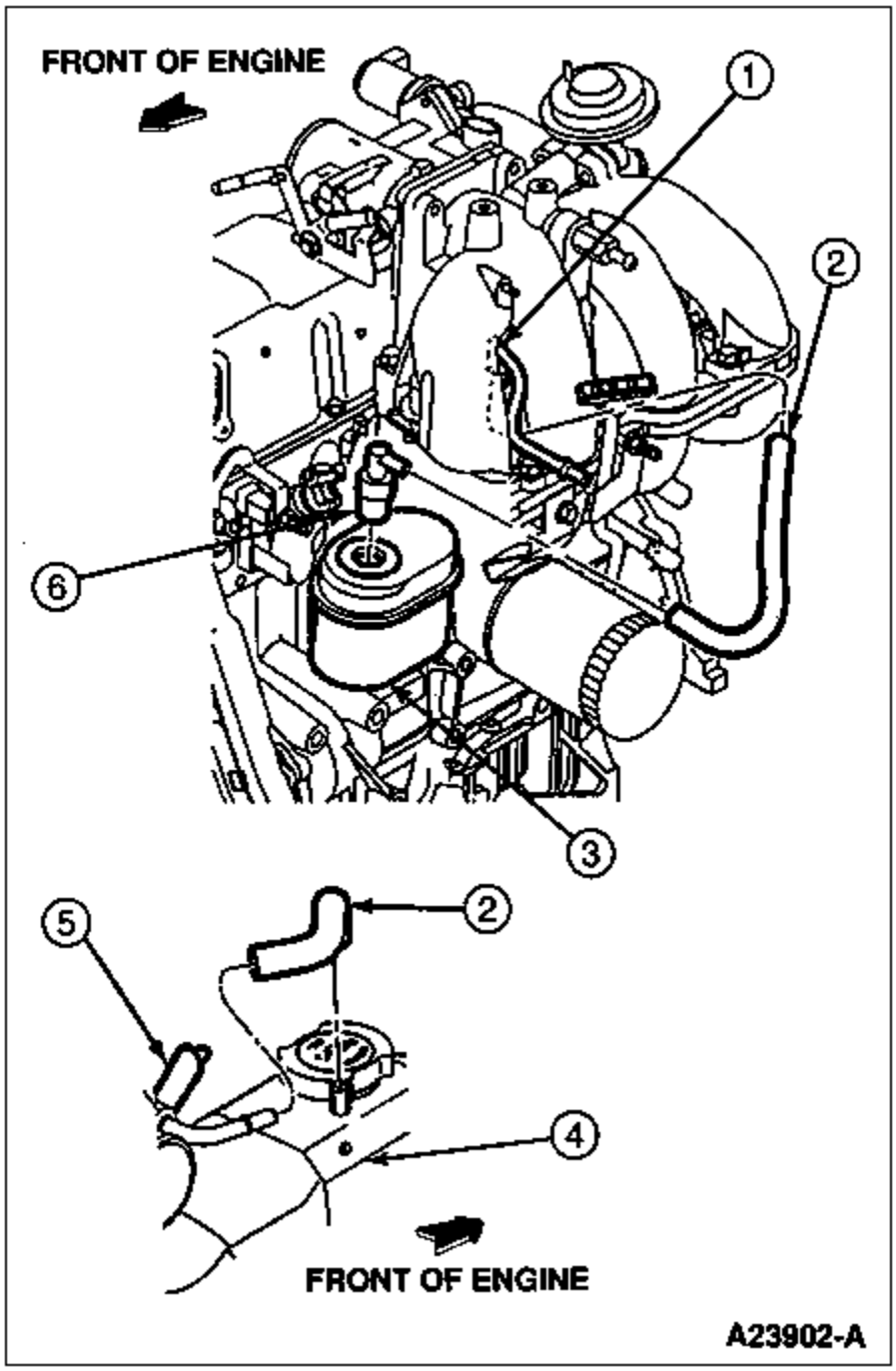
Installation

NOTE: When battery voltage is removed from the powertrain control module (PCM) (12A650), all learned values will be cleared and reset to predetermined values. When battery voltage is restored to the PCM, the vehicle may exhibit certain driveability concerns. It will be necessary to drive the vehicle to allow the PCM to relearn values for optimum driveability and performance.

To install, reverse the removal procedure.

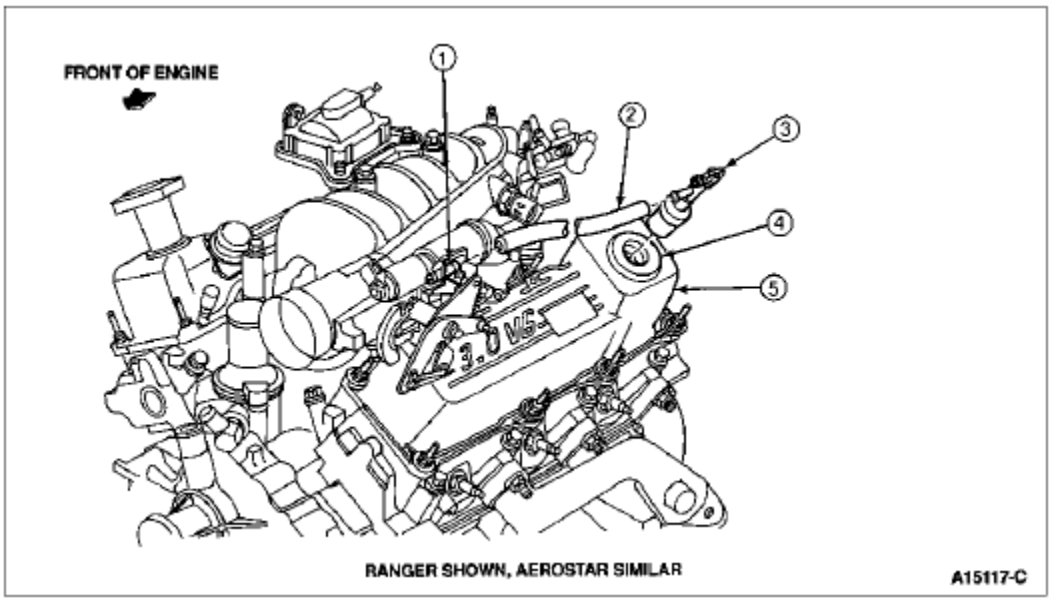
Tighten the EGR vacuum regulator solenoid nut(s) to 8-12 Nm (71-106 lb-in).

Positive Crankcase Ventilation System, 2.3L Engine



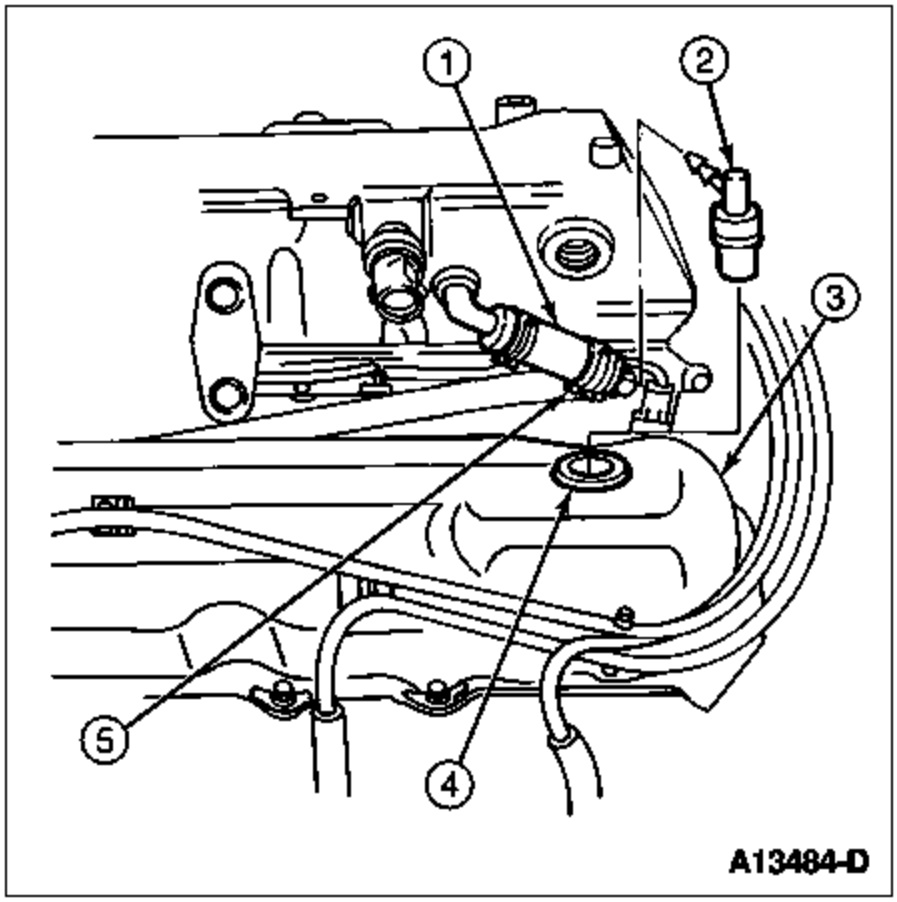
Item	Part Number	Description
1	—	PVC Tube (Part of 9F697)
2	6853	Crankcase Ventilation Hose
3	6A785	Crankcase Vent Oil Separator
4	6582	Valve Cover
5	9F697	Upper Intake Manifold Assembly Tube
6	6A666	Positive Crankcase Ventilation Valve

Positive Crankcase Ventilation System, 3.0L Engine



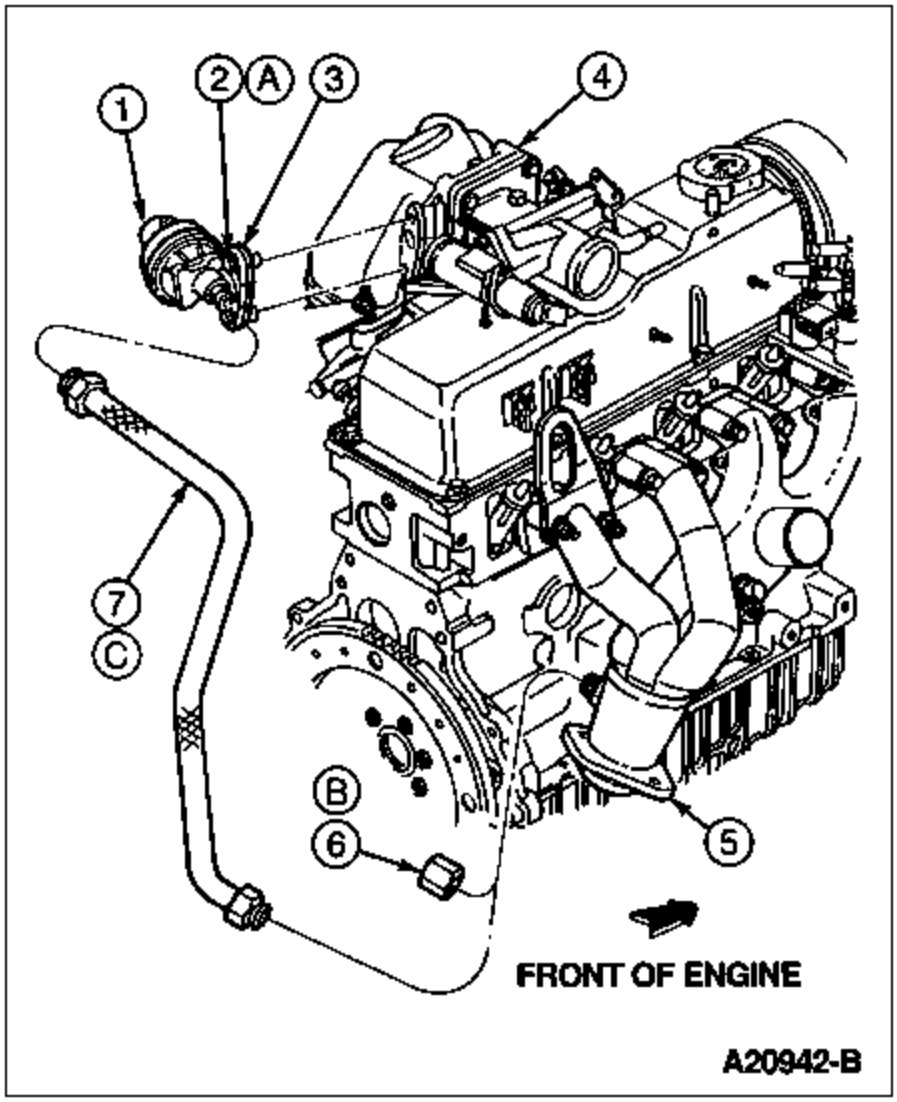
Item	Part Number	Description
1	—	Fuel Charging Assembly Nipple (Part of 9E926)
2	6853	Crankcase Ventilation Hose
3	6A666	Positive Crankcase Ventilation Valve
4	6A892	Crankcase Ventilation Grommet
5	6582	Valve Cover

Positive Crankcase Ventilation System, 4.0L Engine



Item	Part Number	Description
1	6853	Crankcase Ventilation Hose
2	6A666	Positive Crankcase Ventilation Valve
3	6582	Valve Cover
4	E890091	Crankcase Ventilation Grommet
5	E863084-S101	Hose Clip (2 Places)

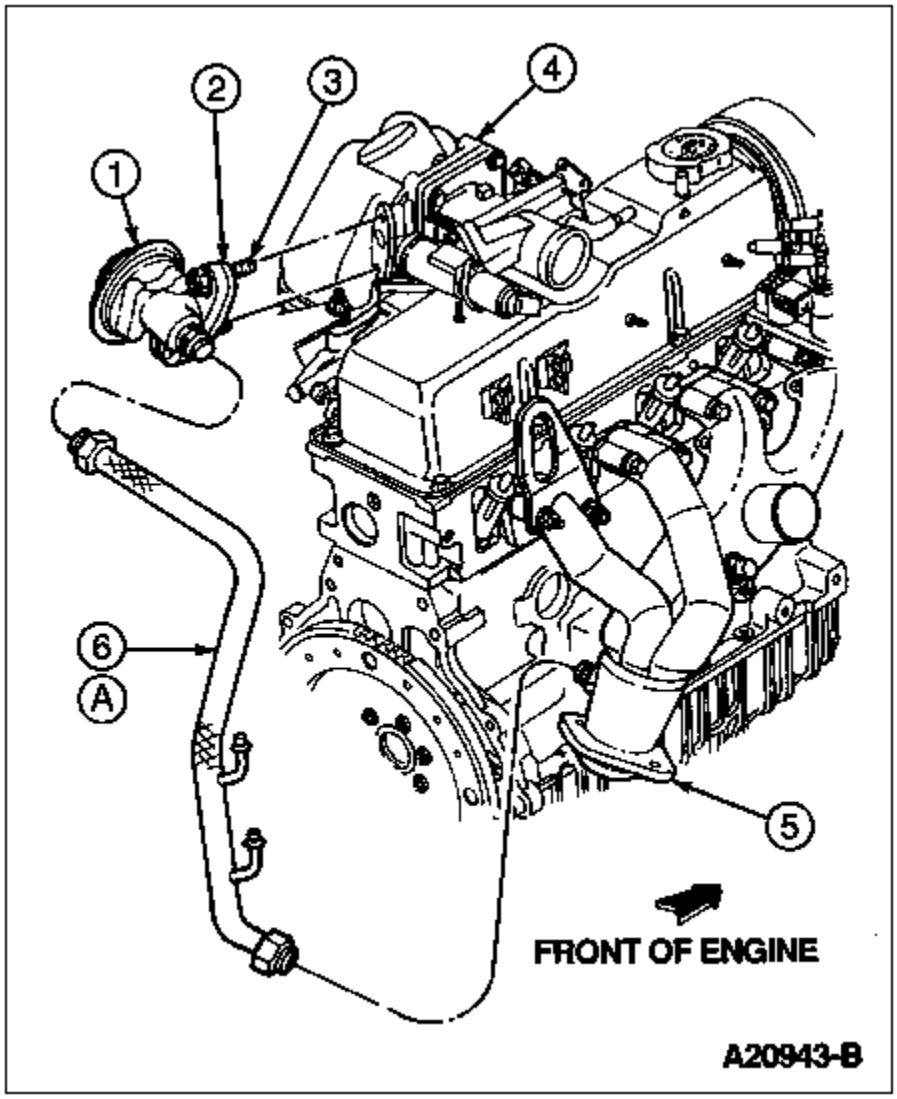
2.3L Engine EGR Valve and Components (49 States)



Item	Part Number	Description
1	9F483	EGR External Pressure Valve (Manual Transmission Only)
2	—	Screw and Washer Assembly (Part of 9D475)
3	9D476	EGR Valve Gasket
4	9424	Intake Manifold
5	9430	Exhaust Manifold
6	N807040	Cap (Automatic Transmission Only)
7	9D477	EGR Valve to Exhaust Manifold Tube (Manual Transmission Only)
A	—	Tighten to 20-30 Nm (15-22 Lb-Ft)
B	—	Tighten to 35-45 Nm (26-33 Lb-Ft)

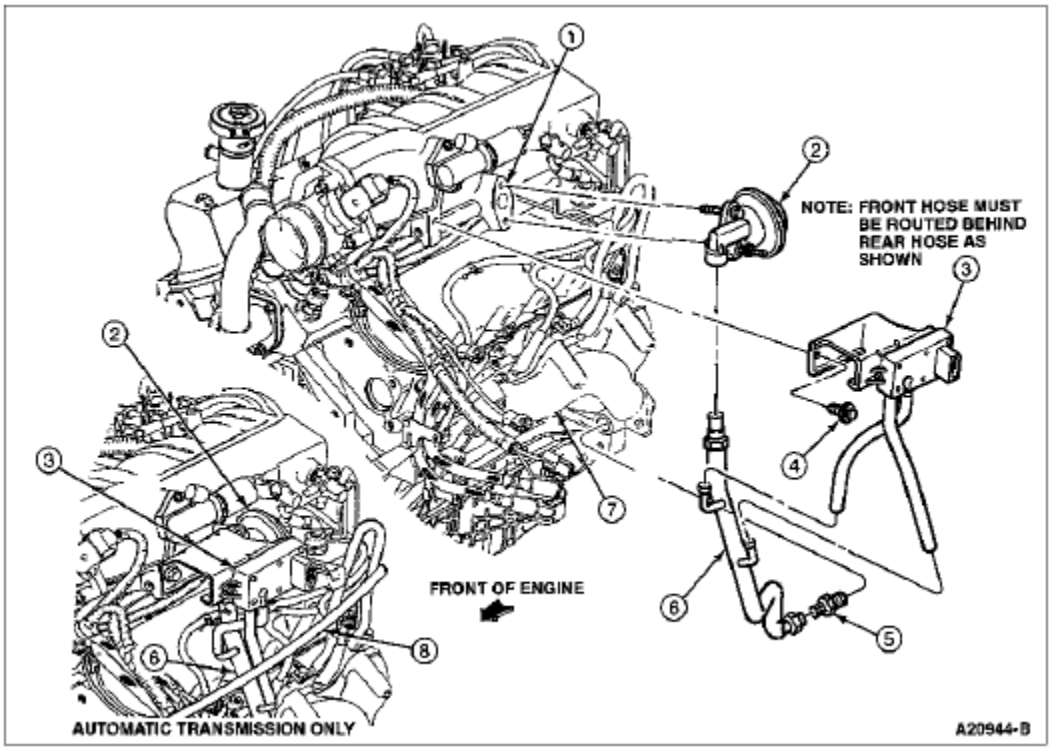
C	—	Tighten to 34-48 Nm (25-35 Lb-Ft) (Both Ends)

2.3L Engine EGR Valve and Components (California)



Item	Part Number	Description
1	9D475	EGR Valve
2	9D476	EGR Valve Gasket
3	—	Screw and Washer Assembly (Part of 9D475)
4	9424	Intake Manifold
5	9430	Exhaust Manifold
6	9D477	EGR Valve to Exhaust Manifold Tube
A	—	Tighten to 34-48 Nm (25-35 Lb-Ft) (Both Ends)

4.0L Engine EGR Valve and Components



Item	Part Number	Description
1	9424	Intake Manifold
2	9D475	EGR Valve (Must Be Installed Prior to EGR Transducer)
3	9J433	EGR Transducer
4	N801571	Bolt
5	9F485	EGR Valve Tube to Manifold Connector
6	9D477	EGR Valve to Exhaust Manifold Tube
7	9430	Exhaust Manifold
8	7A187	Transmission Kickdown Cable

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
EGR Valve Bolts	20-30	15-22	—
EGR Valve to Exhaust Manifold Tube Nuts	34-48	26-35	—
EGR Transducer Bolts	3.5-4.5	—	31-39
EGR Valve to Exhaust Manifold Tube Bolt (3.0L)	20-30	15-22	—
EGR Vacuum Regulator Solenoid Nuts	8-12	—	71-106
EGR Valve Sensor Nuts	1.9-2.5	—	17-22
Ignition Coil and Bracket Assembly Nut	16-20	12-14	—
Intake Manifold to EGR Valve Tube Stud	40-55	30-40	—
EGR Valve Nuts	20-30	15-22	—

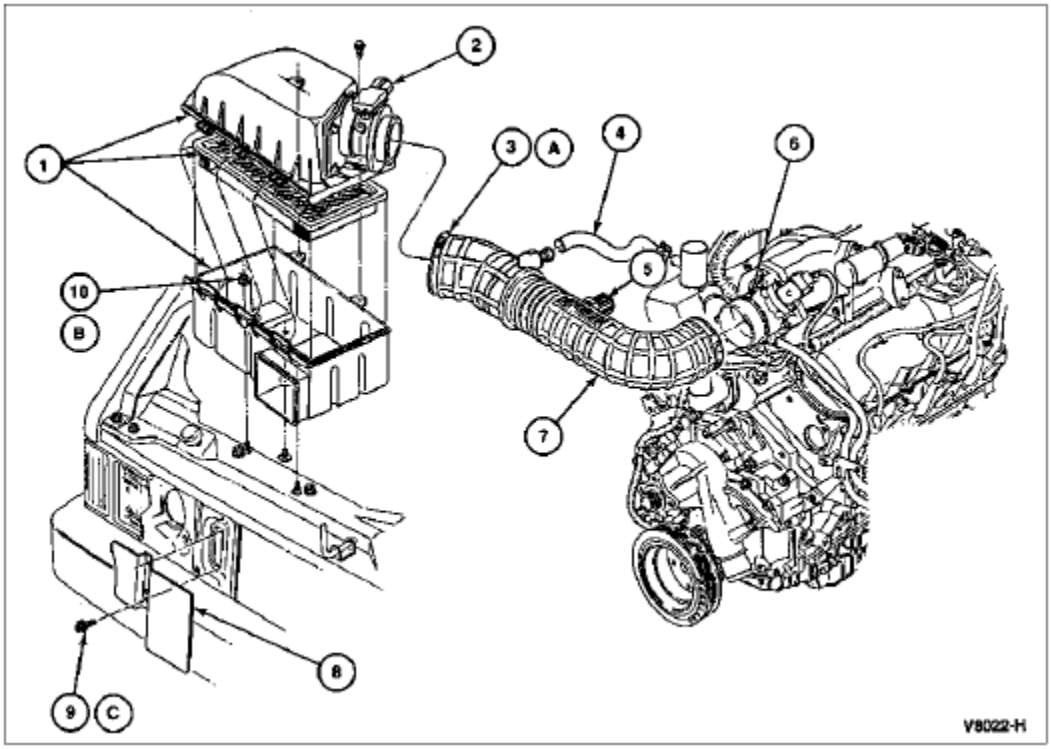
Air Cleaner Element, Aerostar

Refer to Section 00-03 for the Emissions Systems Maintenance Schedule for frequency of air cleaner element (ACL element) inspection/replacement.

Removal

1. Loosen air cleaner outlet tube clamp and remove air cleaner outlet tube (9B659) from mass air flow sensor (MAF sensor) (12B579).

Intake Air System — Aerostar 4.0L Shown, 3.0L Similar



Item	Part Number	Description
1	9600	Engine Air Cleaner
2	12B579	Mass Air Flow Sensor
3	—	Air Cleaner Outlet Tube Clamp
4	6C342	Crankcase Ventilation Hose
5	12A697	Intake Air Temperature Sensor
6	9E926	Throttle Body

7	9B659	Air Cleaner Outlet Tube
8	8N081	Air Intake Baffle
9	56901-S2	Air Intake Baffle Screw (2 Req'd)
10	N621906-S2	Engine Air Cleaner Nut
A	—	Tighten to 4-6 Nm (36-54 Lb-In)
B	—	Tighten to 8-12 Nm (71-106 Lb-In)
C	—	Tighten to 3-7 Nm (27-61 Lb-In)

2. Disconnect engine control sensor wiring (12A581) from mass air flow sensor. Disconnect intake air temperature sensor electrical connector.

3. **NOTE: Do not remove air cleaner cover screws.**

   Loosen air cleaner cover screws until air cleaner cover is free from engine air cleaner (ACL) (9600). Release air cleaner cover clips if equipped.

4. Position air cleaner cover aside.

5. **CAUTION: Do not tamper with sensing elements located in the airflow bypass of the MAF sensor.**

   Remove air cleaner element (ACL element) (9601).

Installation

1. Clean all inside surfaces of the engine air cleaner. Refer to Cleaning and Inspection in this section.

2. Install the air cleaner element.

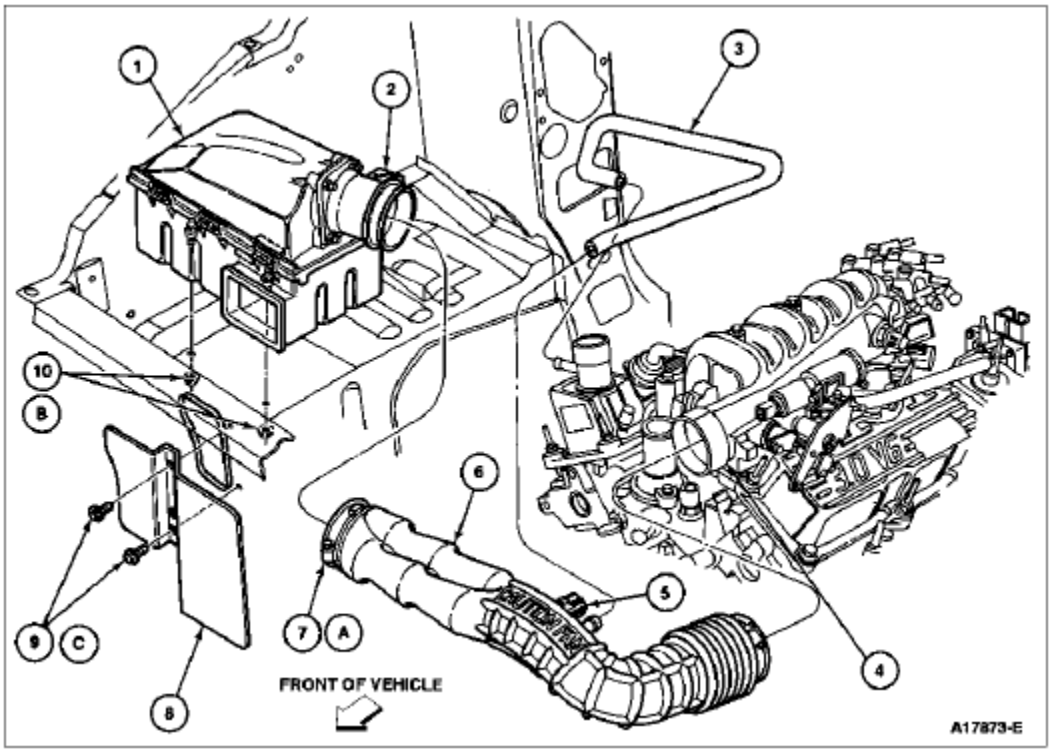
3. Position air cleaner cover. Fasten air cleaner cover clips if equipped. Tighten air cleaner cover screws to 3-4 Nm (27-35 lb-in).

4. Connect engine control sensor wiring to mass air flow sensor. Connect intake air temperature sensor electrical connector.

5. Install the air cleaner outlet tube. Tighten the air cleaner outlet tube clamp to 4-6 Nm (36-54 lb-in).

Engine Air Cleaner — Aerostar

Intake Air System — Aerostar



Item	Part Number	Description
1	9600	Engine Air Cleaner
2	12B579	Mass Air Flow Sensor (MAF)
3	6C342	Crankcase Ventilation Hose
4	9E926	Throttle Body
5	12A697	Intake Air Temperature Sensor
6	9B659	Air Cleaner Outlet Tube
7	—	Air Cleaner Outlet Tube Clamp
8	8N081	Air Intake Baffle
9	56902-S2	Air Intake Baffle Screws (2 Req'd)
10	N621906-S2	Engine Air Cleaner Nut
A	—	Tighten to 4-6 Nm (36-54 Lb-In)

B	—	Tighten to 8-12 Nm (71-106 Lb-In)
C	—	Tighten to 3-7 Nm (27-61 Lb-In)

Removal

1. **CAUTION: Do not tamper with sensing elements located in the airflow bypass of the mass air flow sensor (MAF sensor) (12B579).**

   Loosen air cleaner outlet tube clamp and remove air cleaner outlet tube (9B659) from mass air flow sensor.

2. Disconnect the mass air flow sensor.

3. Remove two engine air cleaner nuts and engine air cleaner (ACL) (9600).

Installation

1. Clean all inside surfaces of the engine air cleaner. Refer to Cleaning and Inspection in this section.

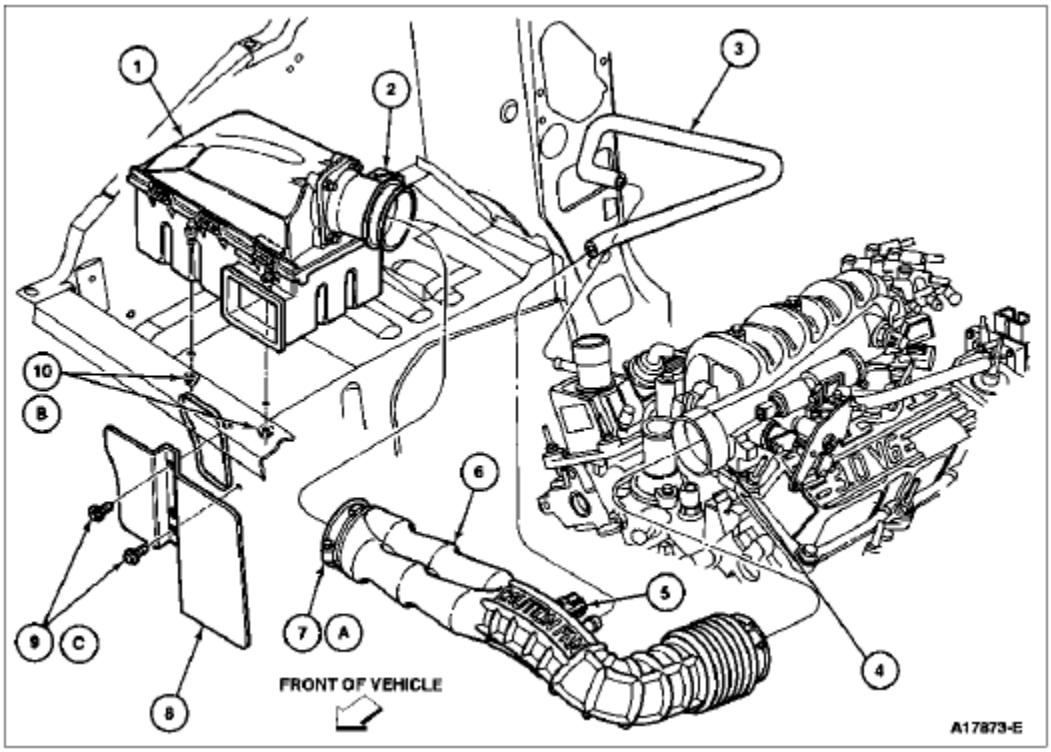
2. Install engine air cleaner and tighten two engine air cleaner nuts to 8-12 Nm (71-106 lb-in).

3. Connect engine control sensor wiring (12A581) to mass air flow sensor.

4. Install air cleaner outlet tube. Tighten air cleaner outlet tube clamp to 4-6 Nm (36-54 lb-in).

Air Cleaner Outlet Tube

Intake Air System — Aerostar



Item	Part Number	Description
1	9600	Engine Air Cleaner
2	12B579	Mass Air Flow Sensor (MAF)
3	6C342	Crankcase Ventilation Hose
4	9E926	Throttle Body
5	12A697	Intake Air Temperature Sensor
6	9B659	Air Cleaner Outlet Tube
7	—	Air Cleaner Outlet Tube Clamp
8	8N081	Air Intake Baffle
9	56902-S2	Air Intake Baffle Screws (2 Req'd)
10	N621906-S2	Engine Air Cleaner Nut
A	—	Tighten to 4-6 Nm (36-54 Lb-In)

B	—	Tighten to 8-12 Nm (71-106 Lb-In)
C	—	Tighten to 3-7 Nm (27-61 Lb-In)

Removal

1. Disconnect crankcase ventilation hose (6853) from air cleaner outlet tube (9B659) on 3.0L and 4.0L .0L equipped vehicles.
2. Disconnect intake air temperature (IAT) sensor electrical connector.
3. Loosen air cleaner outlet tube-to-throttle body clamp and the air cleaner outlet tube-to-air cleaner clamp (Ranger) or the air cleaner outlet tube clamp at the mass air flow sensor (MAF sensor) (12B579) (Aerostar).
4. Remove the air cleaner outlet tube from the vehicle.

Installation

To install, reverse the removal procedure.

Tighten the air cleaner outlet tube-to-air cleaner clamp to 1-2 Nm (9-18 lb-in).

Tighten the air cleaner outlet tube-to-throttle body clamp to 2-3 Nm (18-27 lb-in).

Air Cleaner Element, Ranger

NOTE: Refer to Section 00-03 for the Emissions Systems Maintenance Schedule for air cleaner element inspection or replacement.

Removal

1. Remove engine air cleaner (ACL) (9600). Refer to Engine Air Cleaner removal in this section.
2. Pull snap ring on engine air cleaner to separate air cleaner body.
3. **CAUTION: Do not tamper with the sensing elements located in the mass air bypass of the mass airflow sensor.**

   Remove air cleaner element (ACL element) (9601).

Installation

1. Clean all inside surfaces of engine air cleaner. Refer to Engine Air Cleaner cleaning in this section.
2. Install air cleaner element.
3. Position engine air cleaner body parts and close snap ring.
4. Install engine air cleaner. Refer to Engine Air Cleaner installation in this section.

Engine Air Cleaner, Ranger

Removal

1. **NOTE: Removal and installation steps are the same for all Ranger vehicles even though parts may differ in appearance.**

   On 3.0L and 4.0L engines (6007), disconnect crankcase ventilation hose (6853) from air cleaner outlet tube (9B659).

2. Disconnect mass airflow (MAF) sensor connector.

3. Disconnect intake air temperature (IAT) sensor electrical connector.

4. Loosen engine air cleaner (ACL) (9600) clamp.

5. Carefully separate engine air cleaner and remove air cleaner element.

Installation

For installation, follow removal procedures in reverse order.

A mild detergent solution may be used to facilitate assembly of engine air cleaner to engine air cleaner mounting bracket (9626) and inner front fender.

Air Cleaner Outlet Tube, Ranger

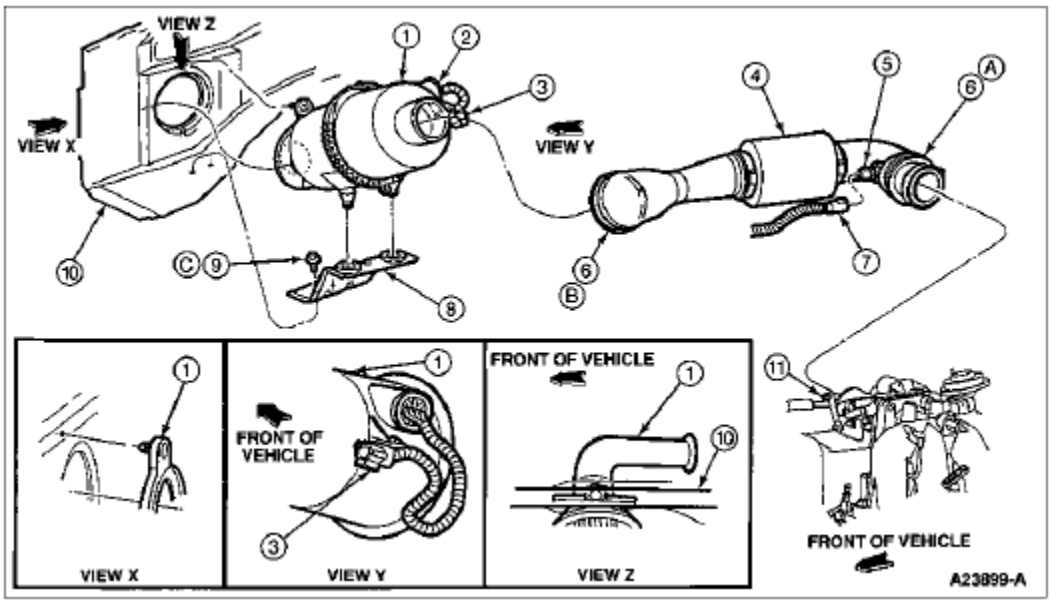
Removal

1. Disconnect crankcase ventilation hose (6853) from air cleaner outlet tube (9B659) on 3.0L and 4.0L engines (6007).
2. Disconnect mass airflow (MAF) sensor connector.
3. Disconnect intake air temperature (IAT) sensor electrical connector.
4. Loosen air cleaner outlet tube clamps at engine air cleaner (ACL) (9600) and throttle body (9E926) and remove tube.

Installation

For installation, follow removal procedures in reverse order.

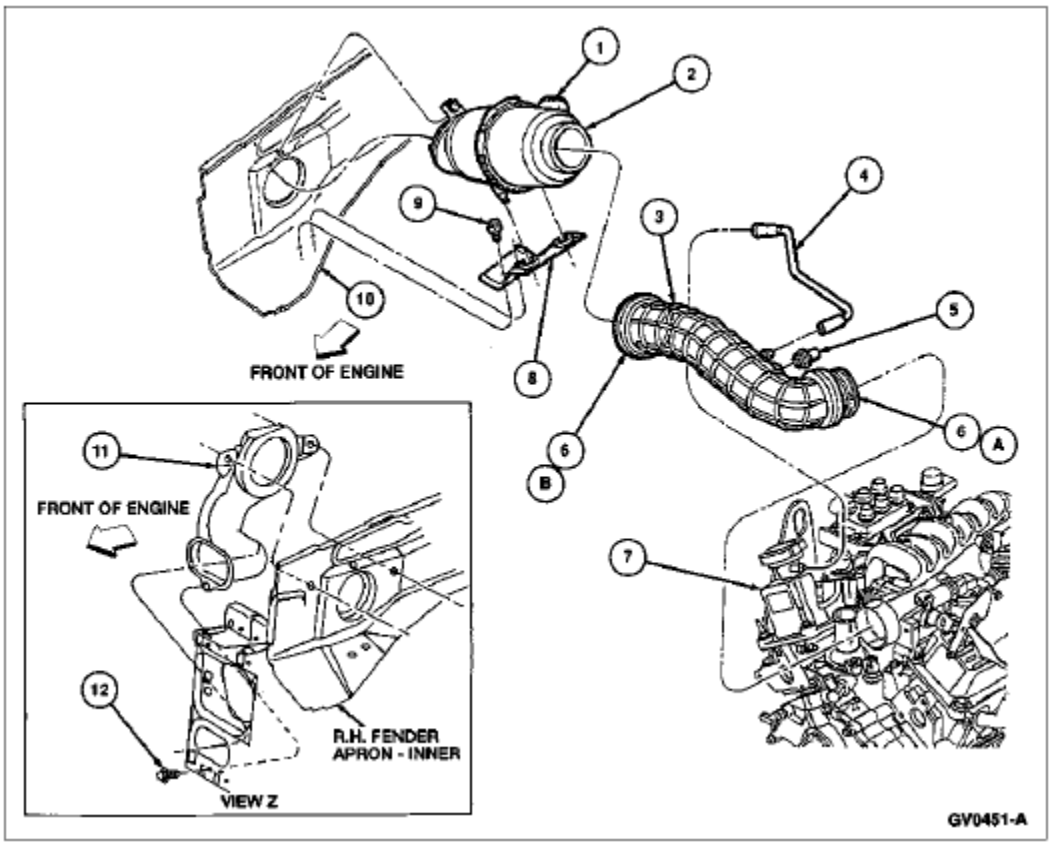
Air Intake System, Ranger 2.3L



Item	Part Number	Description
1	9600	Engine Air Cleaner
2	12B579	Mass Airflow Sensor

3	—	Mass Airflow Sensor Connector (Part of 9600)
4	9B659	Air Cleaner Outlet Tube
5	12A697	Intake Air Temperature Sensor
6	—	Clamp (Part of 9B659)
7	12A581	Wiring Harness
8	9626	Engine Air Cleaner Mounting Bracket
9	N606074-S36	Screw and Washer, 1 x 16.5 (2 Req'd)
10	16006	Front Fender, Inner (RH)
11	9E926	Throttle Body
A	—	Tighten to 2-3 Nm (18-27 Lb-In)
B	—	Tighten to 1-2 Nm (9-18 Lb-In)
C	—	Tighten to 9-12 Nm (80-106 Lb-In)

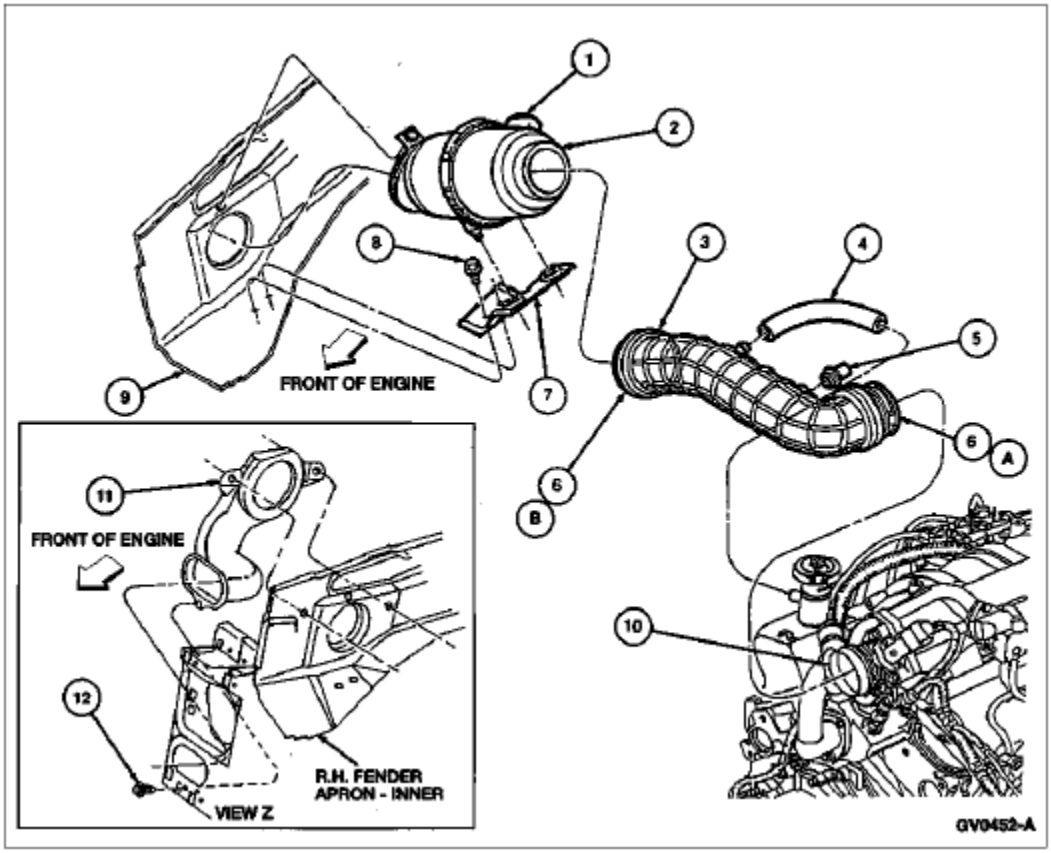
Air Intake System, Ranger 3.0L



Item	Part Number	Description
1	12B579	Mass Airflow Sensor

2	9600	Engine Air Cleaner
3	9B659	Air Cleaner Outlet Tube
4	6853	Crankcase Ventilation Hose
5	12A697	Intake Air Temperature Sensor
6	—	Clamp (Part of 9B659)
7	6582	Valve Cover
8	9626	Engine Air Cleaner Mounting Bracket
9	N606675-S310	Screw, 1 x 16.5 (2 Req'd)
10	16006	Front Fender, Inner (RH)
11	9B660	Air Inlet Tube
12	N605894	Bolt (3 Req'd)
A	—	Tighten to 2-3 Nm (18-27 Lb-In)
B	—	Tighten to 1-2 Nm (9-18 Lb-In)
C	—	Tighten to 9-12 Nm (80-106 Lb-In)
D	—	Tighten to .8-1.2 Nm

Air Intake System, Ranger 4.0L



Item	Part Number	Description
1	12B579	Mass Airflow Sensor
2	9600	Engine Air Cleaner
3	9B659	Air Cleaner Outlet Tube
4	381186-S125A	Crankcase Ventilation Hose
5	12A697	Intake Air Temperature Sensor (Explorer)
6	—	Clamp (Part of 9B659)
7	9626	Engine Air Cleaner Mounting Bracket
8	N606674-S36	Screw and Washer, 1 x 16.5 (2 Req'd)
9	16006	Front Fender, Inner (RH)
10	9E926	Throttle Body
11	9B660	Air Inlet Tube
12	N605894	Bolt (3 Req'd)
A	—	Tighten to 2-3 Nm (18-27 Lb-In)
B	—	Tighten to 1-2 Nm (9-18 Lb-In)
C	—	Tighten to 9-12 Nm (80-106 Lb-In)
D	—	Tighten to .8-1.2 Nm

SPECIFICATIONS

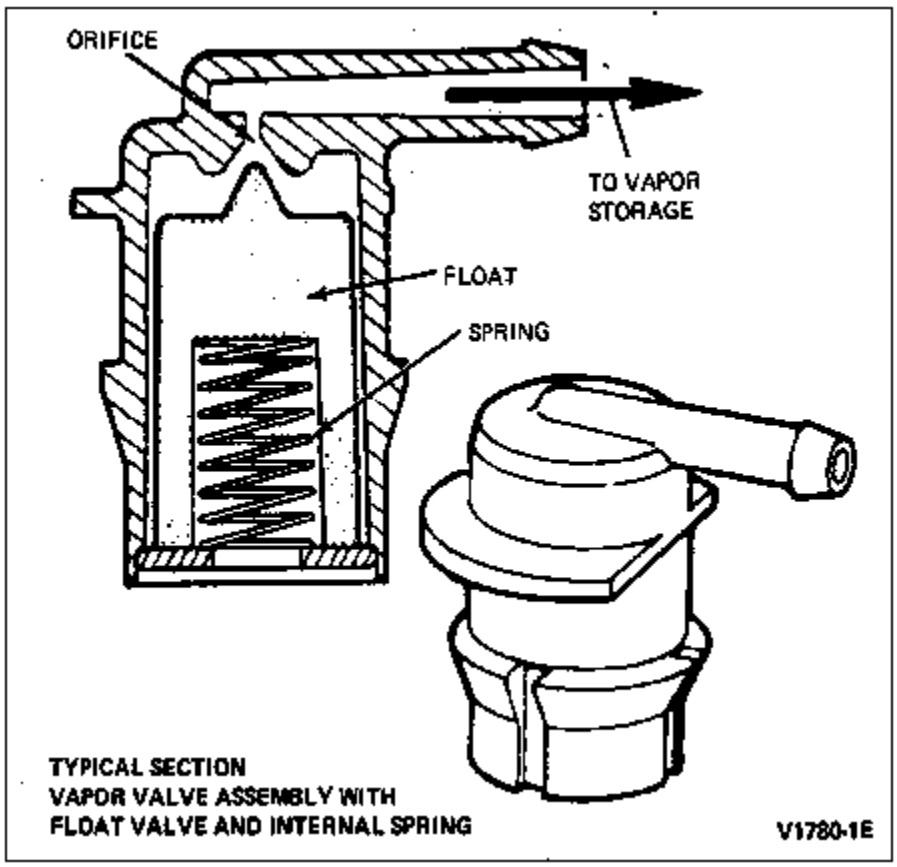
TORQUE SPECIFICATIONS

Description	Nm	Lb-In
Aerostar		
Engine Air Cleaner Nut	8-12	71-106
Air Cleaner Outlet Tube Clamp	3-5	27-44
Air Cleaner Cover Screw	3-4	27-35
Air Intake Baffle Screws	3-7	27-61
Ranger		
Air Cleaner Outlet Tube-to-Air Cleaner Clamp	1-2	9-18
Air Cleaner Outlet Tube-to-Throttle Body Clamp	2-3	18-27
Engine Air Cleaner Mounting Bracket Screw	9-12	80-106
Air Inlet Tube to Fender and Radiator Support. (3.0L and 4.0L)	.8-1.2	7-10

Fuel Vapor Valve (Aerostar 3.0L Engine)

Fuel tank vapor valve assemblies make use of a small orifice, 1.27mm (0.050 inch), that allows only vapor and not fuel to pass into the line running forward to the evaporative emissions canister (EVAP canister) (9D653). This assembly mounts directly to the fuel tank (9002) using a fuel vapor separator seal.

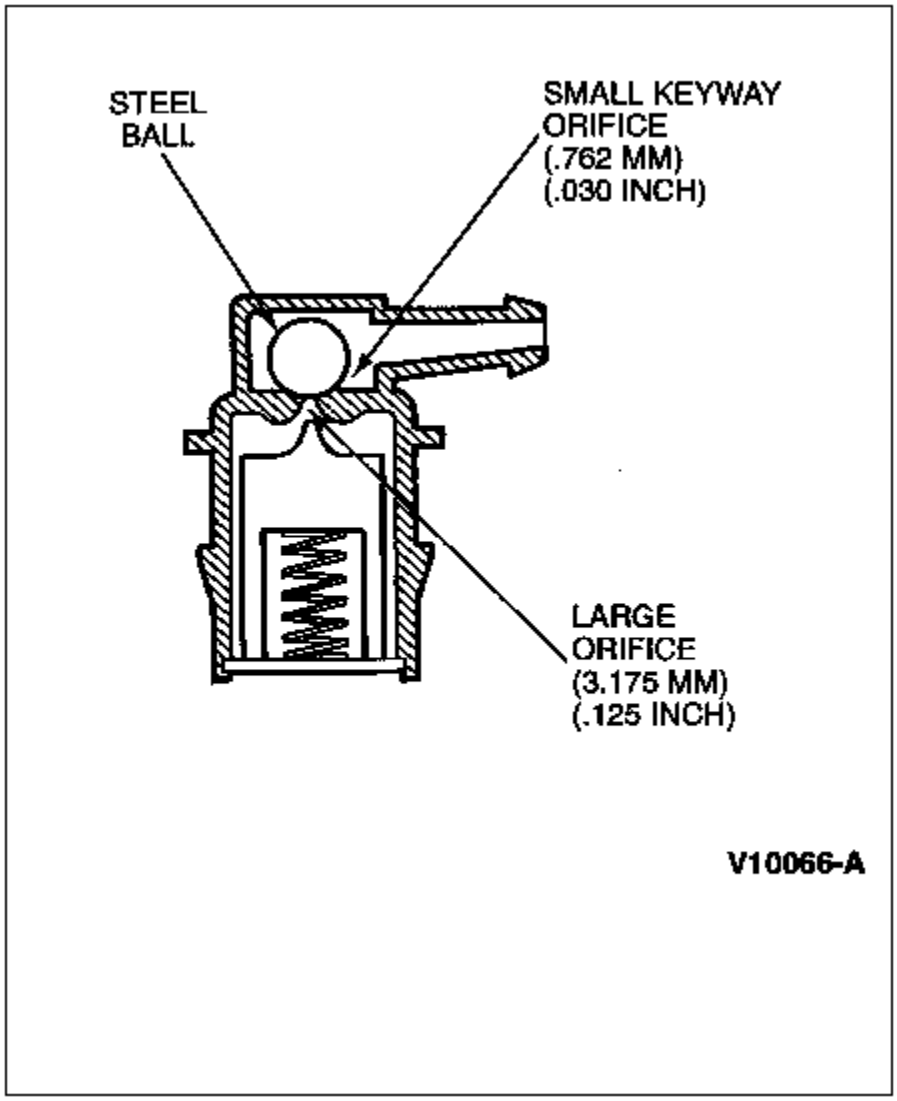
Fuel vapors trapped in the sealed fuel tank are vented through the orificed evaporative emission valve (9B593) in the top of the fuel tank. The vapors leave the evaporative emission valve through a single vapor line and continue to the evaporative emissions canister in the engine compartment for storage, until such time as they are purged to the engine (6007).



Fuel Vapor Valve (Ranger)

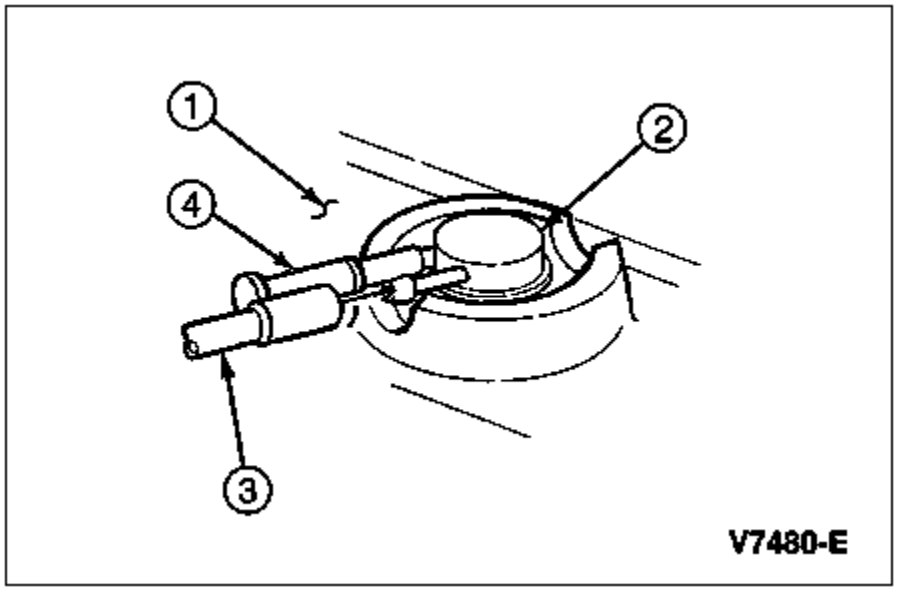
The Ranger 2.3L, 3.0L and 4.0L engines use a new valve design with a "head valve" which does not allow vapor flow until a predetermined pressure is reached (8 inches H_2O).

The new head valve allows flow through the .762mm (.030-inch) keyway orifice until there is sufficient pressure to lift the ball (head valve) about 8 inches H_2O or 2.0685 kPa (0.3 psi). When the head valve is open, vapor can flow through the larger 3.175mm (.125-inch) orifice.



Fuel Vapor Valve, Aerostar (4.0L Engine)

The evaporative emission valve (9B593) uses a small orifice, 1.83mm (0.072 inch), that allows vapors to pass into the vapor line running forward to the evaporative emissions canister (EVAP canister) (9D653). This evaporative emission valve mounts directly into the fuel tank (9002) using a fuel vapor separator seal. Fuel vapors trapped in the sealed fuel tank are vented through the orificed evaporative emission valve. The vapors from the fuel tank leave the evaporative emission valve through a single vapor line and continue to the evaporative emissions canister in the engine compartment for storage.



Item	Part Number	Description
1	9002	Fuel Tank
2	9B227	Valve and Hose Assembly
3	9G271	Evaporative Emission Return Tube
4	—	Purge Port (Part of 9B227)

Inspection and Verification

1. Verify the vehicle owner's original concern by removing fuel tank filler cap (9030) to duplicate the condition.

2. Inspect to determine if any of the following mechanical concerns apply:

Mechanical
• Hissing sound or release of pressure as the fuel tank filler cap is removed from the fuel tank filler pipe.

3. If the concern(s) remain after the inspection, determine the symptoms and proceed to the following Symptom Chart.

Symptom Chart — Evaporative Emissions

EVAPORATIVE EMISSIONS

Condition	Possible Source	Action
• Fuel Tank Pressure Abnormal	• Evaporative emission hoses or inlets blocked. • Tubes or hoses kinked or pinched.	• GO to Pinpoint Test A .

Pinpoint Tests

PINPOINT TEST A: FUEL TANK PRESSURE ABNORMAL

A1 CANISTER HOSE AND INLET TUBE BLOCKAGE TEST

- Test canister fuel vapor hose and inlet nipple for blockage.

Are fuel vapor hoses or inlets blocked?

Yes	No
GO to **A2**.	GO to **A6**.

A2 FUEL EVAPORATIVE EMISSION SYSTEM BLOCKAGE TEST

- Test fuel tank evaporative emission system for blockage.

Are all system passages open?

Yes	No
GO to **A7**.	REMOVE blockage or REPLACE component.

A3 VAPOR TUBE INSPECTION

- Inspect vapor tube and fuel vapor hoses for kinks or pinched areas.

Are tube or fuel vapor hoses kinked or pinched?

Yes	No
SERVICE or REPLACE tube or fuel vapor hoses. VERIFY service.	GO to **A4**.

A4 VAPOR HOSE INSPECTION

- Inspect vapor hose routing between fuel tank and body for pinches.

Is vapor hose pinched?

Yes	No
LOOSEN fuel tank and reroute hose. VERIFY service.	GO to **A5** .

A5 FUEL VAPOR VALVE INSPECTION

- Remove fuel tank.
- Remove evaporative emission valve.
- Inspect evaporative emission valve for open air passage through orifice.

Is air passage open?

Yes	No
INSTALL evaporative emission valve in fuel tank. INSTALL fuel tank. System test complete. RESTORE vehicle.	REPLACE evaporative emission valve. VERIFY service.

A6 FLOW TEST (FUEL TANK FILLER CAP INSTALLED)

CAUTION: Do not use other high pressure air supplies. Damage to evaporative emissions canister will result.

- Install hand pump and pressure gauge Rotunda Vacuum Tester 014-R1054 or equivalent in fuel vapor hose at test point B1 (refer to the following illustration).
- Hand pump to a maximum of 17.2 kPa (2.5 psi).

Does pressure drop to zero immediately?

Yes	No
System flow OK. No service required.	GO to **A3** .

A7 FLOW TEST (FUEL TANK FILLER CAP REMOVED)

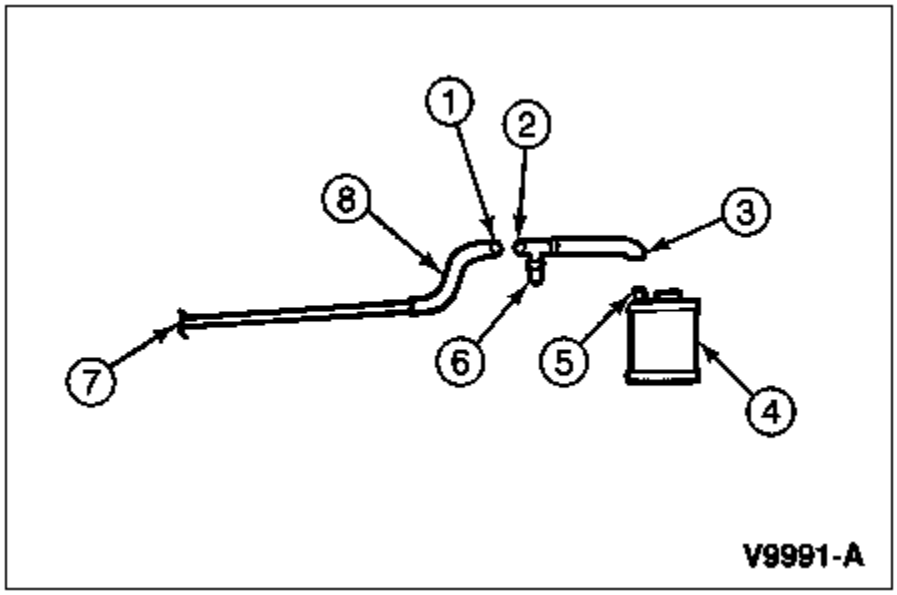
CAUTION: Failure to remove fuel tank filler cap may result in damage to fuel tank.

- Remove fuel tank filler cap from fuel tank filler pipe.

CAUTION: Do not use other high-pressure air supplies. Damage to fuel tank may result.

- Install hand pump and pressure gauge onto tee or evaporative emission canister nipple at test point B2.
- Hand pump to a maximum of 17.2 kPa (2.5 psi).

Does pressure drop to zero immediately?



Item	Part Number	Description
1	—	Test Point B2 with Tee
2	—	Test Point B1 with Tee
3	—	Test Point B2 without Tee
4	—	Evaporative Emissions Canister (EVAP canister)
5	—	Test Point B1 without Tee
6	—	Close Off Line
7	—	To Fuel Tank
8	—	Evaporative Emission Return Tube

Yes	No
System OK. No service required.	GO to **A4** .

Evaporative Emissions

WARNING: THE EVAPORATIVE EMISSION SYSTEM CONTAINS FUEL VAPOR AND CONDENSED FUEL VAPOR. ALTHOUGH NOT PRESENT IN LARGE QUANTITIES, IT STILL PRESENTS THE DANGER OF EXPLOSION OR FIRE. DISCONNECT THE BATTERY GROUND CABLE FROM THE BATTERY TO MINIMIZE THE POSSIBILITY OF AN ELECTRICAL SPARK OCCURRING, POSSIBLY CAUSING A FIRE OR EXPLOSION IF FUEL VAPOR OR LIQUID FUEL ARE PRESENT IN THE AREA.

CAUTION: Fuel supply lines on vehicles with fuel injected engines (6007) will remain pressurized for long periods of time after engine shutdown. The pressure must be relieved before servicing the fuel system. Refer to fuel system pressure relief. Refer to Section 10-01 . For servicing information on fuel lines refer to Section 10-01 .

Evaporative emission components have been designed and tested to exceed 193,116 km (120,000 miles) or 11 years of vehicle use. No maintenance or servicing should be required. However, if components have been damaged and are to be replaced, or if disconnection or removal is required for diagnosis, the following techniques should be used to aid in servicing the system.

Evaporative emission systems are shown in the illustrations that follow. Refer to these illustrations for component location and installation instructions.

Use Ford-approved parts for replacement of fuel and vapor hoses and tubes. Original equipment components are designed to resist most environmental conditions encountered in the evaporative emission system.

Fuel Vapor Canister, Aerostar, Ranger

Removal and Installation

Refer to the appropriate illustration for component location.

1. Disconnect vapor hoses from evaporative emissions canister (EVAP canister) (9D653) to be removed.

2. Remove screw retaining evaporative emissions canister.

3. Lift evaporative emissions canister to disengage tab on back side of evaporative emissions canister, and remove evaporative emissions canister.

For installation, follow removal steps in reverse order. Refer to Specifications for retaining screw torque specifications.

Evaporative Emission Valve

Removal

1. Lower fuel tank (9002).
2. Remove evaporative emission hose from evaporative emission valve.
3. Turn evaporative emission valve counterclockwise and remove from fuel tank.

Installation

To install, reverse the removal procedure.

Fuel Vapor Canister Purge Regulator Valve, Aerostar, Ranger

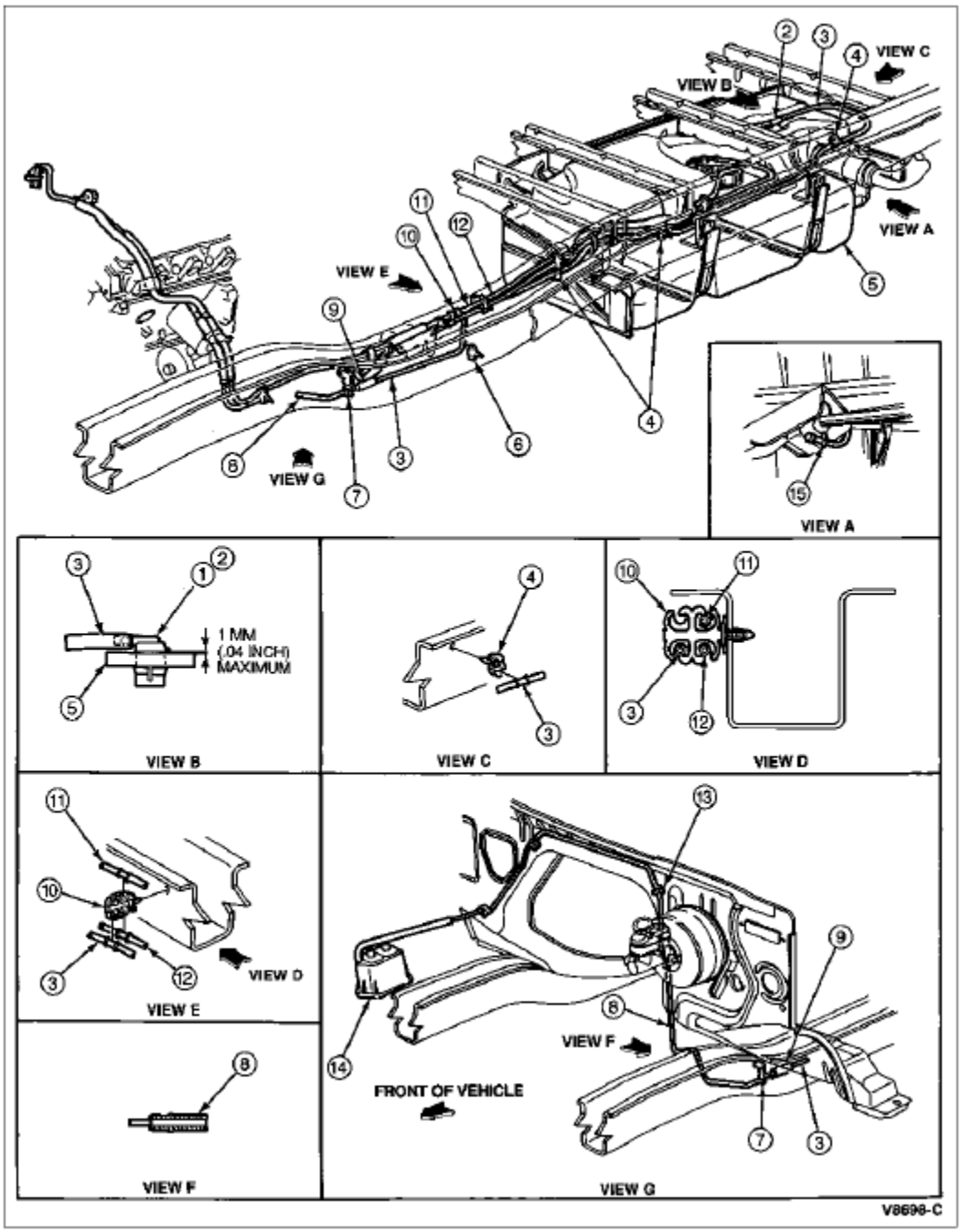
Removal and Installation

1. Disconnect wire harness from evaporative emission canister purge valve (EVAP canister purge valve) (9C915).
2. Disconnect wire harness from thermistor.
3. Disconnect evaporative emission canister purge valve assembly from fuel vapor canister and throttle body.
4. To install, reverse removal procedure.

Fuel Vapor Valve

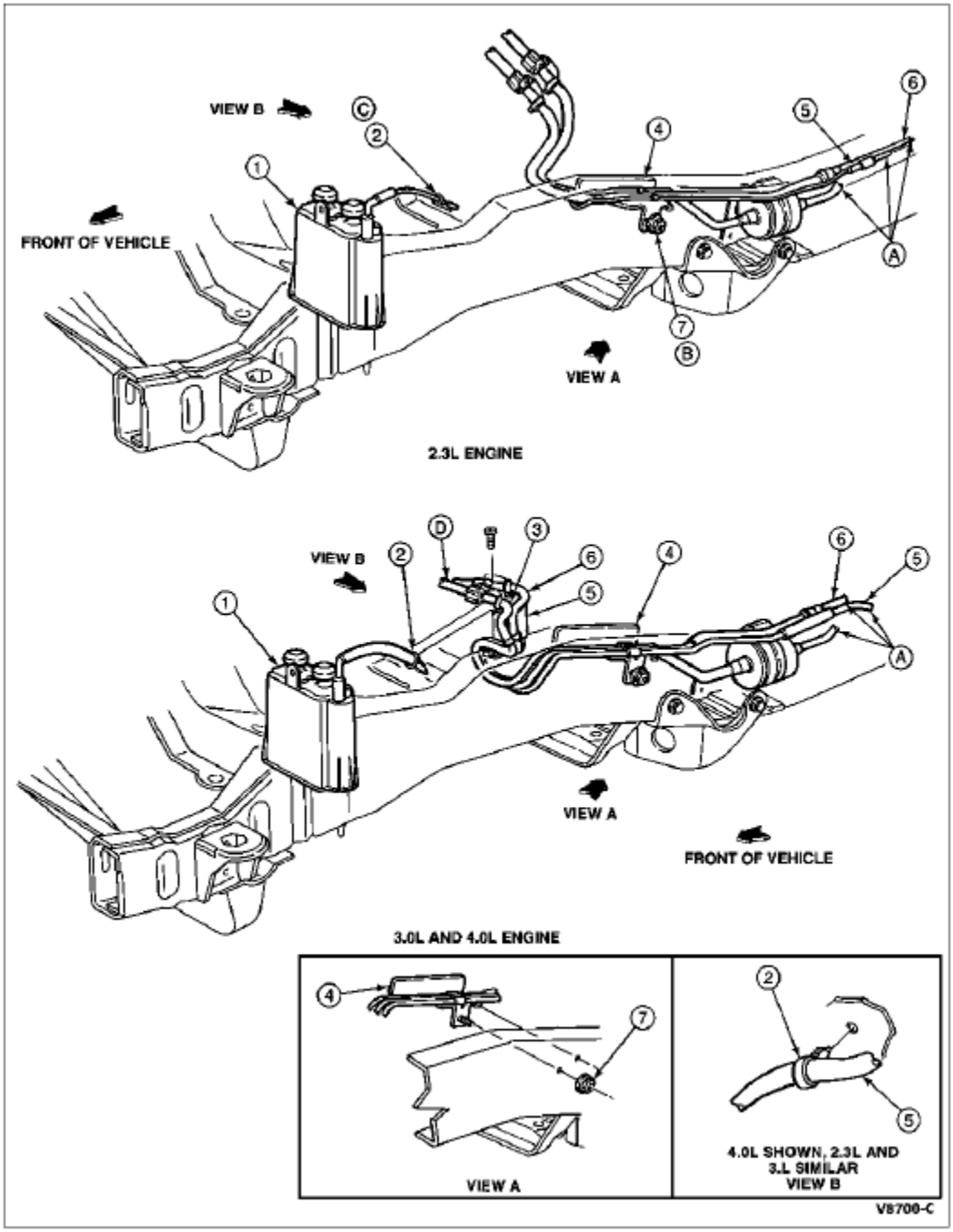
Refer to Section 10-01 .

Vapor Lines, Aerostar



Item	Part Number	Description
1	9B593	Evaporative Emission Valve (3.0L)
2	9B227	Fuel Vapor Valve and Hose (4.0L)
3	9B033	Tube Assembly — Fuel Tank Vapor Outlet
4	14A163	Wiring Harness Retainer
5	9002	Fuel Tank
6	N802768	Clip (Do Not Install Vapor Line in Brake Line Clip)
7	N803994-S	Clip — Triple
8	9E616	Evaporative Emission Canister Inlet Tube
9	—	Hose (Part of 9B033)
10	9A317	Fuel Tube Clip
11	9B324	Fuel Return Line
12	9323	Fuel Supply Line
13	N803854	Clip
14	9D653	Evaporative Emissions Canister
15	370443-S2	Clip

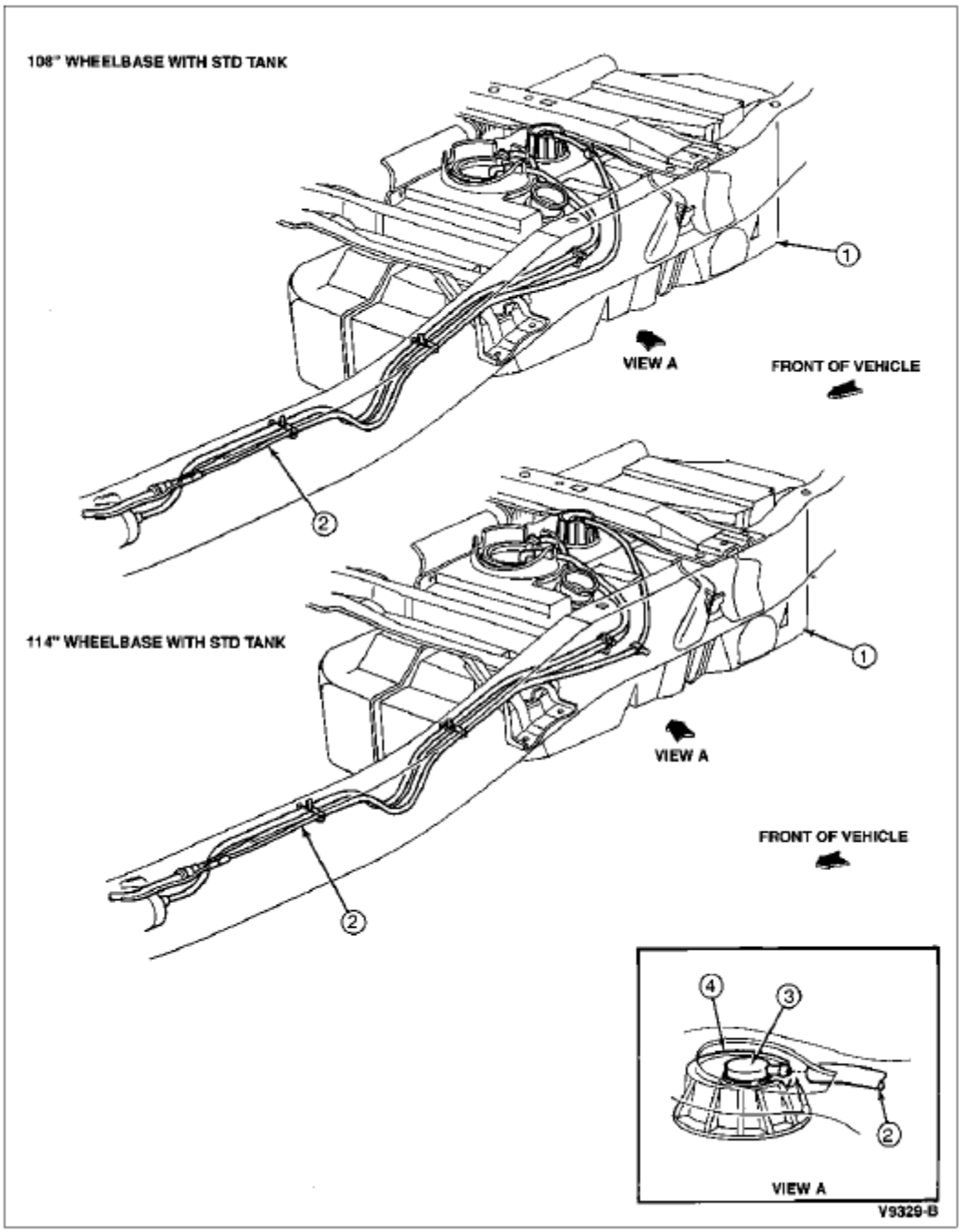
Vapor Lines, 2.3L, 3.0L and 4.0L, Ranger



Item	Part Number	Description
1	9D653	Evaporative Emissions Canister
2	N803640-S	Clip
3	9323	Fuel Supply Line (Part of 9S286 Tube — Fuel Front)
4	—	Support (Part of 9S286 Tube — Fuel Front)
5	9B033	Vapor Tube (Part of 9S286 Tube — Fuel Front)
6	9B324	Rear Fuel Tube (Part of 9S286 Tube — Fuel Front)

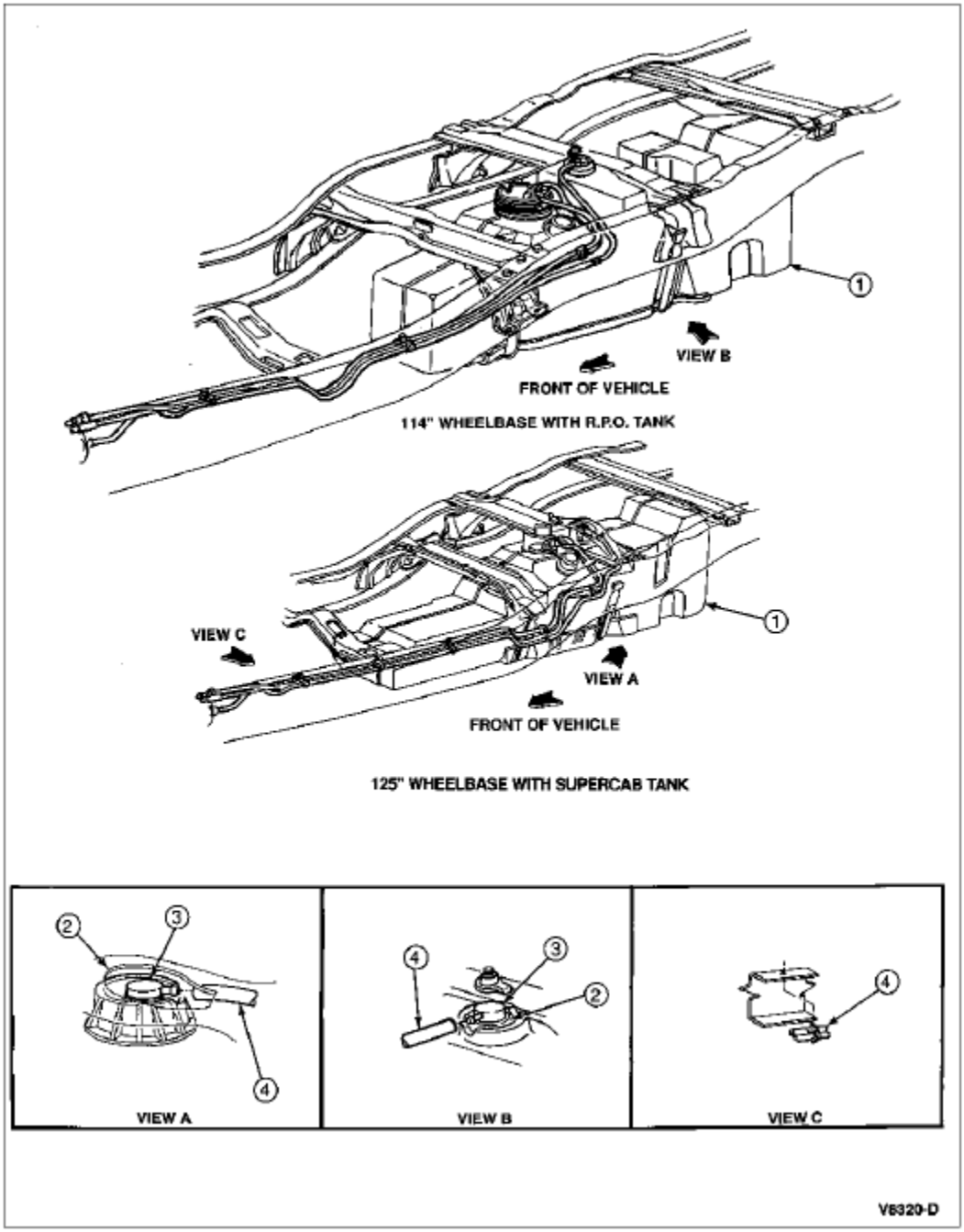
7	N620481-S2	Nut, M8-1.25
A	—	For Continuation, See Illustrations, "Fuel Tank Vapor Lines, Ranger"
B	—	Tighten to 19-26 Nm (14-20 Lb-Ft)
C	—	For Continuation, See Illustration, "Engine Vapor Lines, Ranger, 2.3L"
D	—	For Continuation, See Illustration, "Engine Vapor Lines, Ranger and Explorer, 4.0L"

Fuel Tank Vapor Lines, Ranger



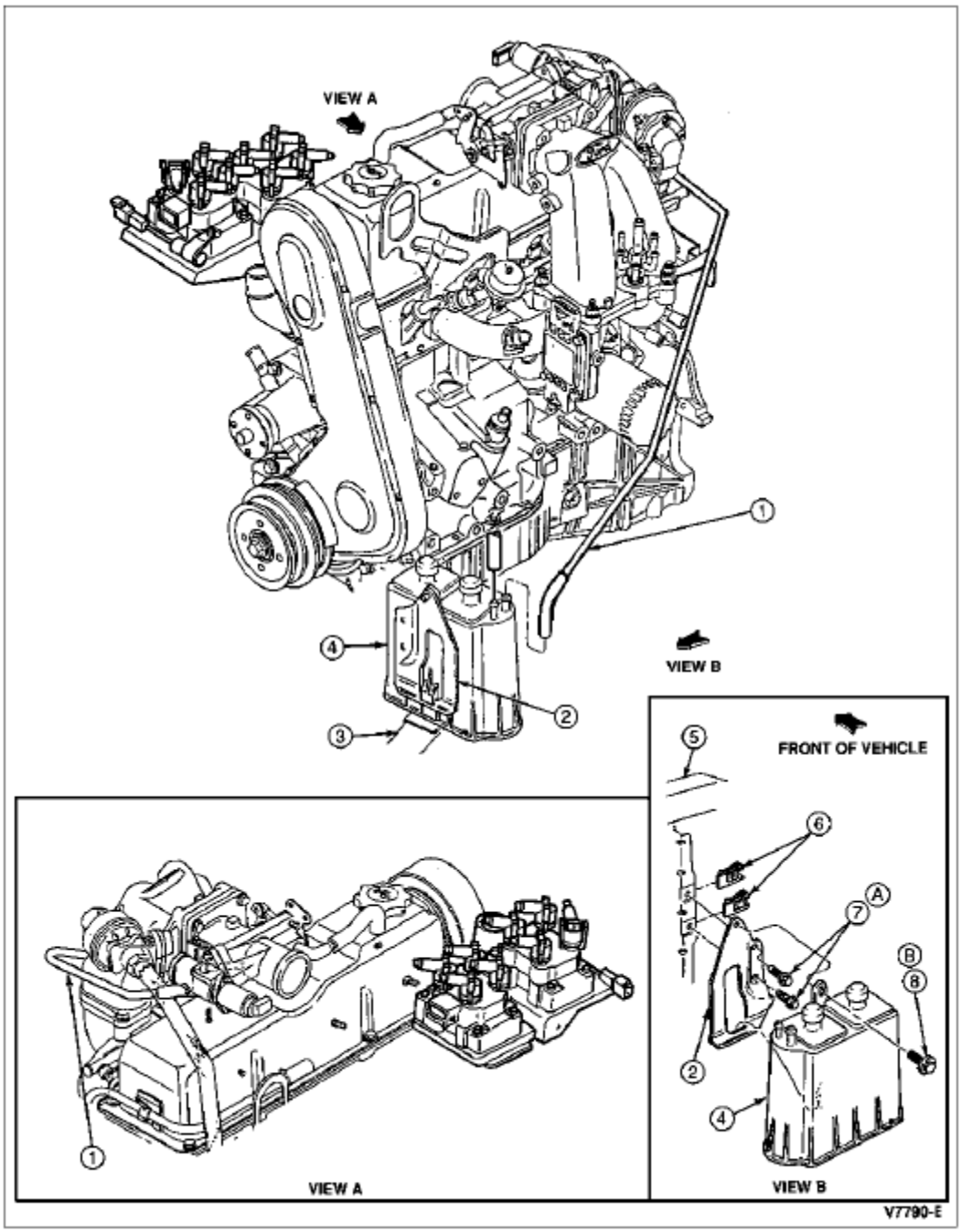
Item	Part Number	Description
1	9002	Fuel Tank
2	9J279	Rear Fuel Tube
3	9B593	Evaporative Emission Valve
4	9B076	Fuel Vapor Valve Grommet

Fuel Tank Vapor Lines, Ranger (Continued)



Item	Part Number	Description
1	9002	Fuel Tank
2	9B076	Fuel Vapor Valve Grommet
3	9B227	Evaporative Valve
4	9J279	Fuel and Vapor Return Tube

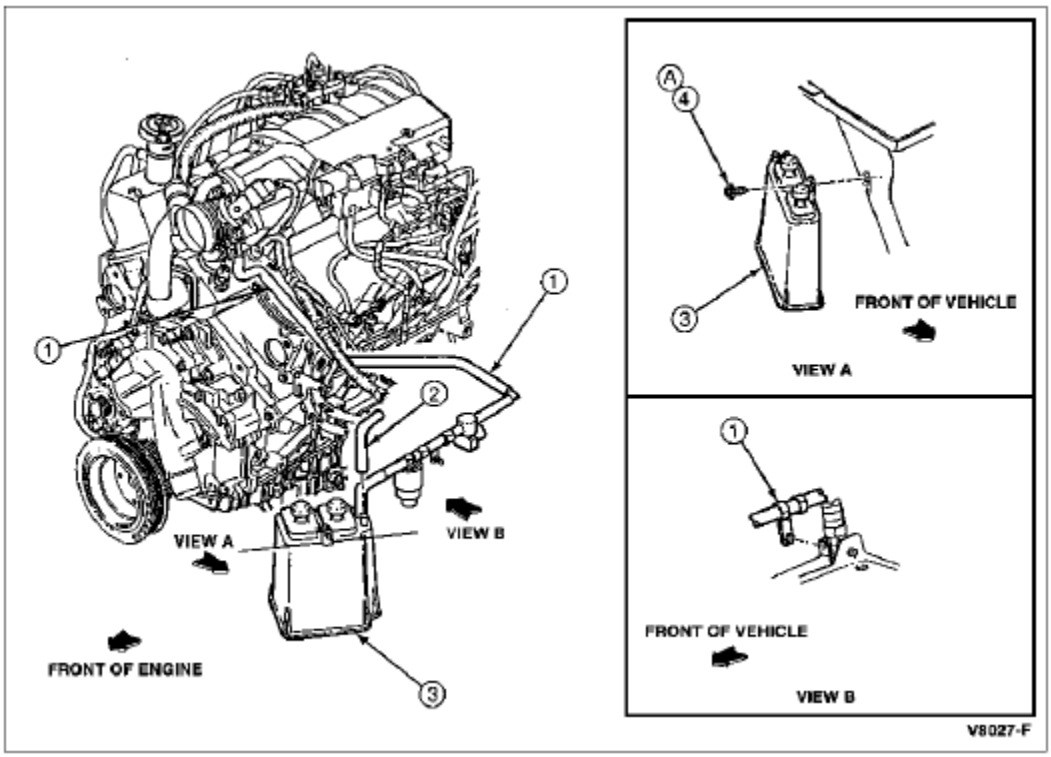
Engine Vapor Lines, 2.3L, Ranger



Item	Part Number	Description
1	9G271	Evaporative Emission Return Tube
2	9D664	Fuel Bracket
3	5005	Frame
4	9D653	Evaporative Emissions Canister
5	8A058	Radiator Support (Reference)
6	45261-S2	U-Nut
7	N610959-S2	Screw

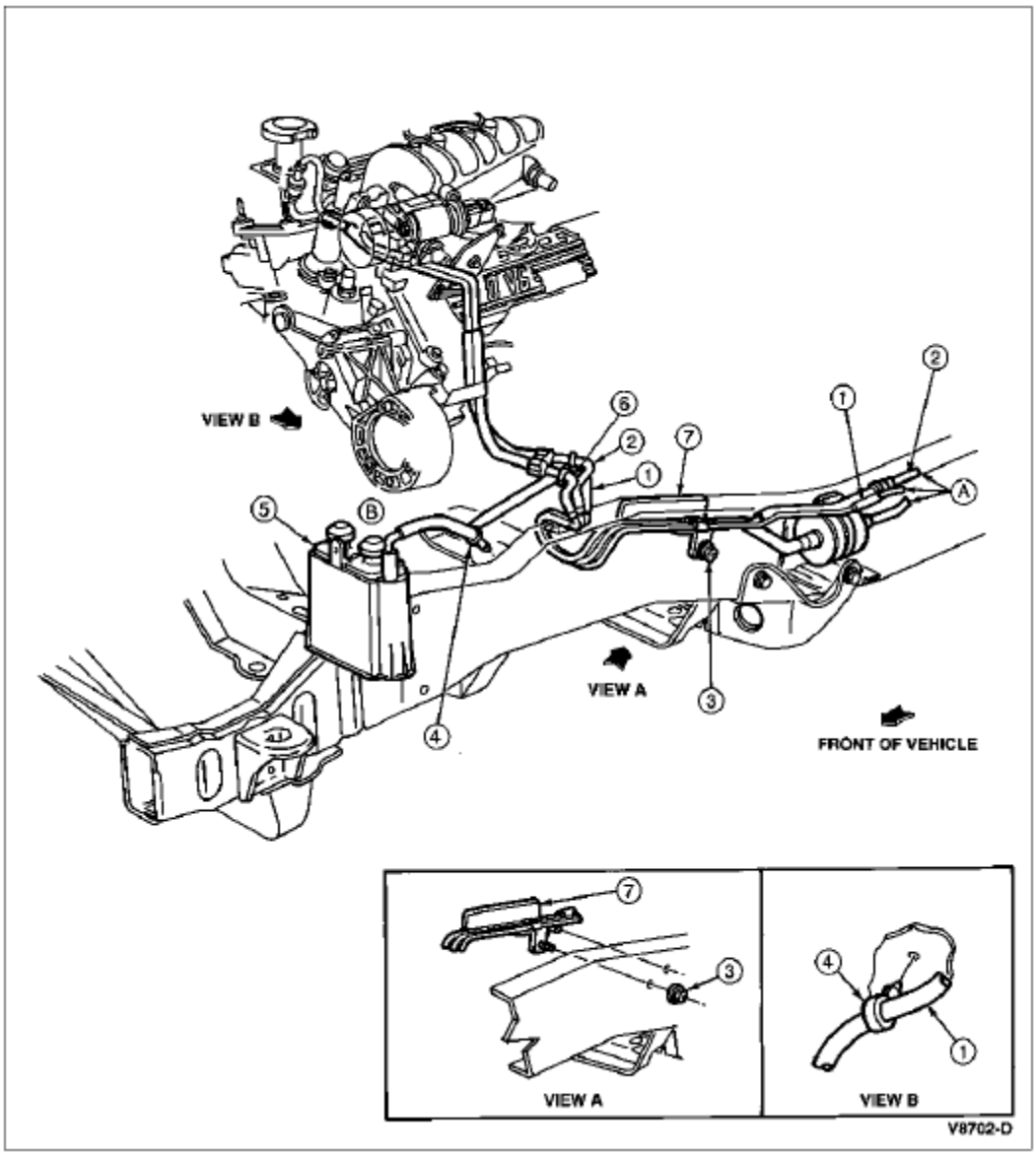
8	N800369-S2	Screw
A	—	Tighten to 8-12 Nm (71-106 Lb-In)
B	—	Tighten to 5-9 Nm (44-80 Lb-In)

Engine Vapor Lines, 4.0L, Ranger



Item	Part Number	Description
1	9C987	Hose and Valve Assembly
2	9S286	Front Fuel Supply Return and Vapor Tube
3	9D653	Evaporative Emissions Canister
4	N800369-S2	Screw
A	—	Tighten to 5-7 Nm (44-62 Lb-In)

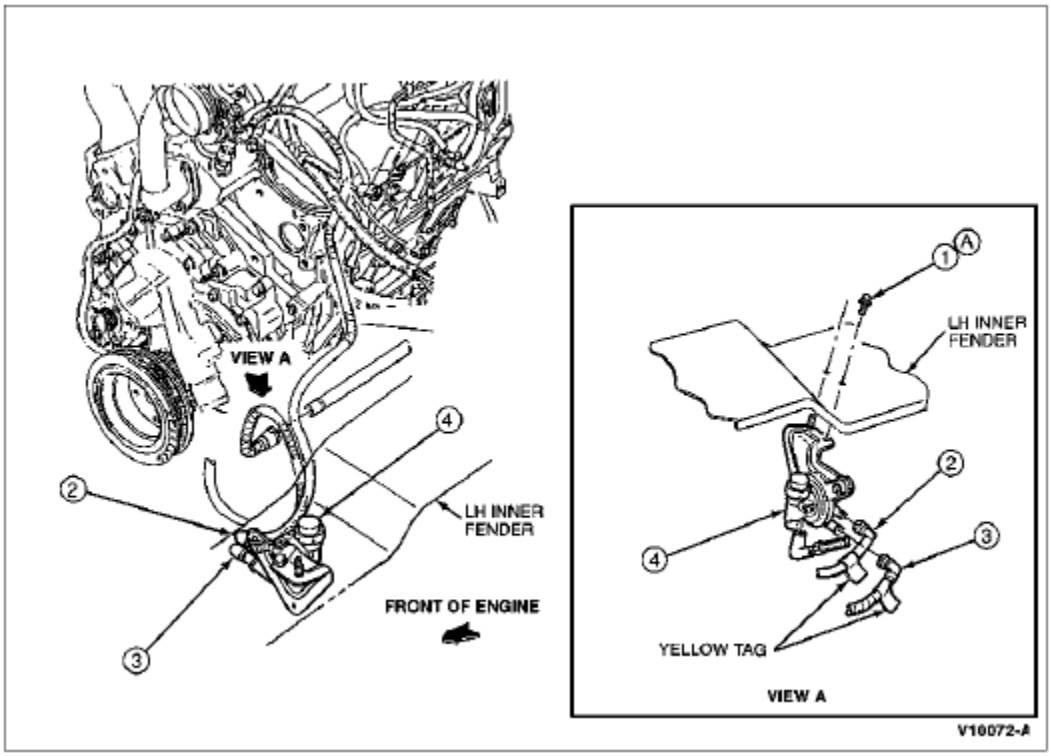
Chassis Vapor Lines, 3.0L, Ranger



Item	Part Number	Description
1	9B033	Vapor Tube (Part of 9S286 Tube — Fuel Front)
2	9B324	Rear Fuel Tube (Part of 9S286 Tube — Fuel Front)
3	N620481-S2	Nut
4	N803640-S	Clip
5	9D653	Evaporative Emissions Canister
6	9323	Fuel Supply Line (Part of 9S286 Tube — Fuel Front)
7	—	Support (Part of 9S286 Tube — Fuel Front)
A	—	For Continuation See Illustrations "Fuel Tank Vapor Lines, Ranger"
B	—	For Continuation See Illustration "Engine Vapor Lines,

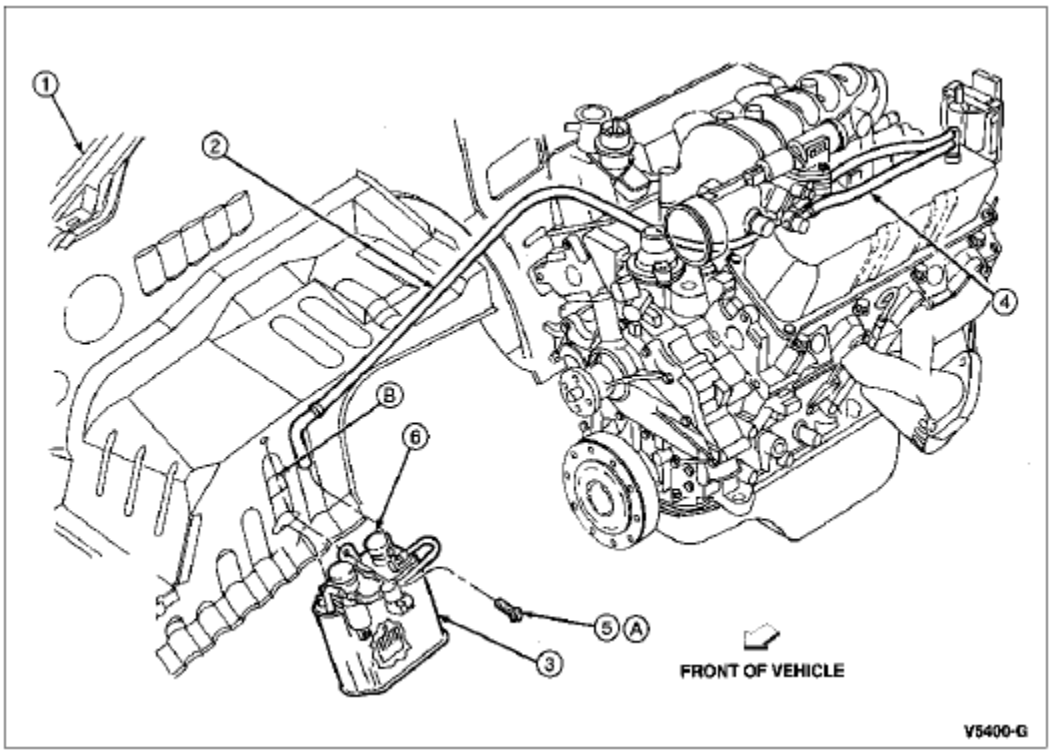
		Ranger, 3.0L"

Fuel Vapor Management Valve



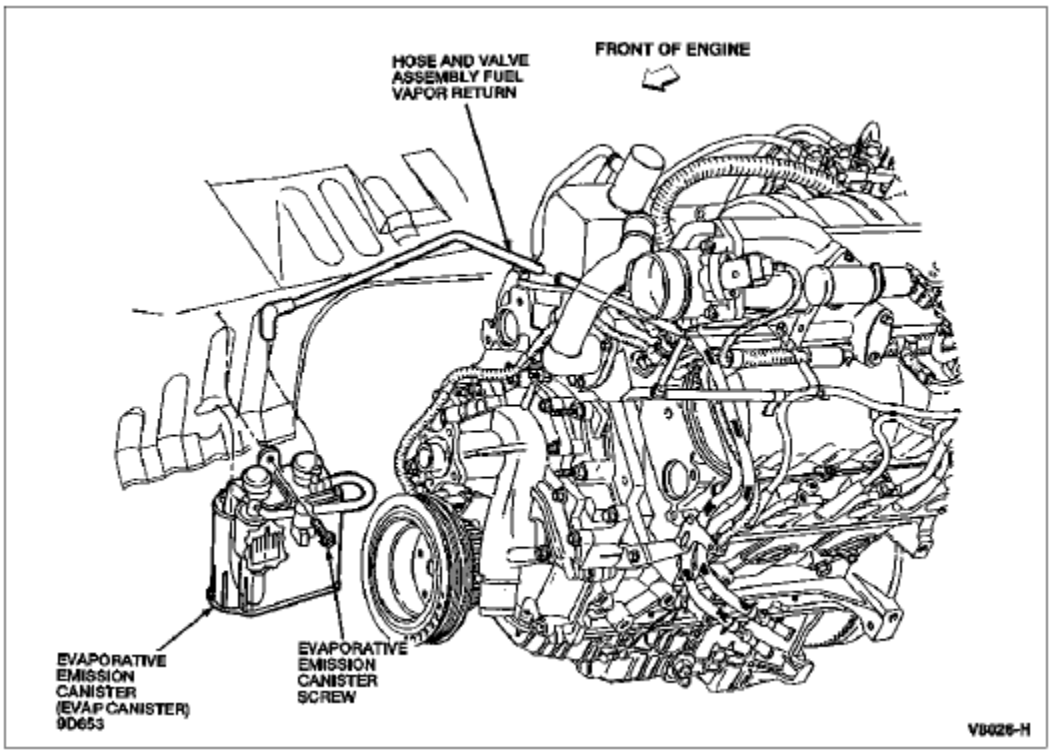
Item	Part Number	Description
1	N605902-S2	Bolt
2	9G271	Fuel Vapor Hose
3	9G271	Fuel Vapor Hose
4	9F933	Fuel Vapor Management Valve
A	—	Tighten to 21-29 Nm (15-21 Lb-Ft)

Engine Vapor Lines — Aerostar 3.0L

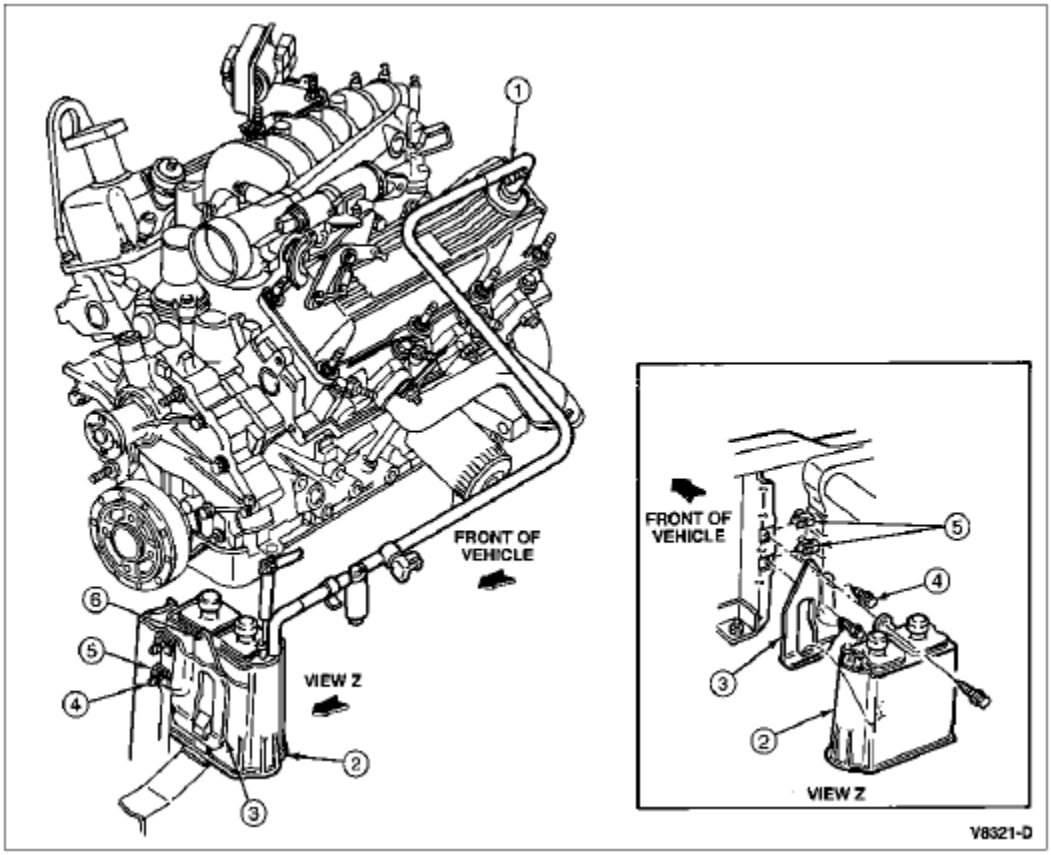


Item	Part Number	Description
1	16054	Right Fender Apron (Reference)
2	—	Fuel Vapor Return Hose and Valve
3	9C915	Evaporative Emission Purge Valve
4	6853	PCV Hose
5	N800369-S2	Screw
6	9D653	Evaporative Emissions Canister
A	—	Tighten to 6-8 Nm (53-71 Lb-In)
B	—	Insert Tab at Back of Canister into Slot in Fender Apron. Align Hole and Install Screw.

Engine Vapor Lines — Aerostar 4.0L



Engine Vapor Lines — Ranger 3.0L



Item	Part Number	Description
1	—	Fuel Vapor Return Hose and Valve
2	9D653	Evaporative Emissions Canister
3	9D664	EVAP Canister Bracket
4	N610959	Screw
5	45261	U-Nut
6	N800369	Screw

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Nut, Support Retainer, Ranger, All Engines	15-20	11-15	—
Screw, Fuel Vapor Canister Bracket-to-Radiator Support, Ranger 2.3L and 3.0L	8-12	—	71-106
Screw, Fuel Vapor Canister-to-Bracket, Ranger 2.3L and 3.0L	5-9	—	44-80
Screw, Fuel Vapor Canister-to-Bracket, Ranger	5-7	—	44-62
Screw, Evaporative Emission Canister-to-Fender Apron, Aerostar 3.0L and 4.0L	6-8	—	53-71
Evaporative Emissions Canister Bracket Bolts-Explorer	21-29	16-21	—
Fuel Vapor Management Valve Bolt	21-29	15-21	—
Battery Hold-Down Clamp Bolt	10-14	7-10	—
Battery Cable Bolts	7-10	5-7	—
Battery Tray Bolts and Nut	11-14	8-10	—

Safeguards

1. Always disconnect the battery ground cable (14301) prior to service.
2. Follow diagnostic procedures outlined in the Powertrain Control/Emissions Diagnosis Manual.
3. Disconnect the powertrain control module (PCM) (12A650) from the wire harness before measuring for continuity, resistance or energizing with any voltage source.
4. Never measure voltage or resistance directly at the powertrain control module.

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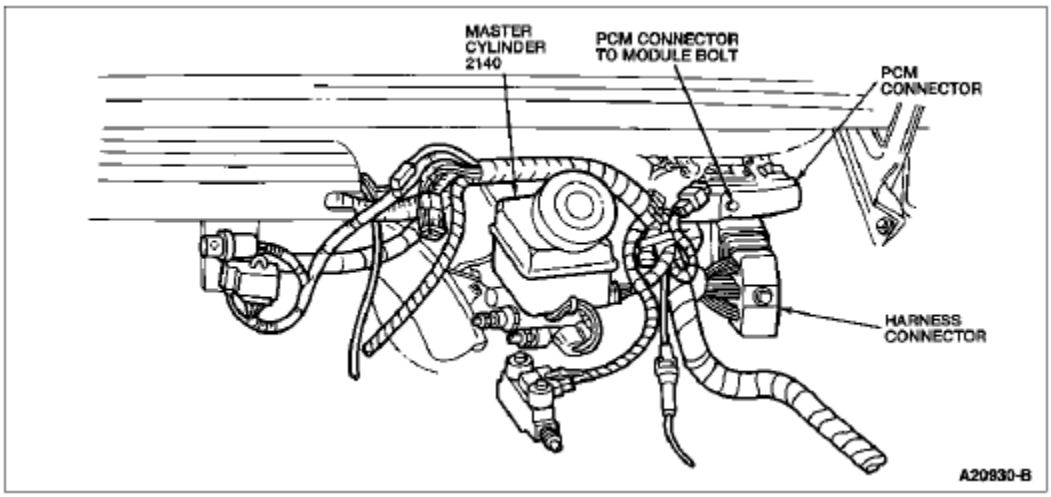
Powertrain Control Module (PCM) — Aerostar

Removal

1. Disconnect the battery ground cable (14301).
2. Loosen PCM connector to module bolt and unplug PCM connector.

Powertrain Control Module — Aerostar



3. Remove two PCM cover bolts and PCM cover. Remove powertrain control module (PCM) (12A650) from PCM bracket.

Installation

NOTE: When battery voltage is removed from the powertrain control module, all learned values will be cleared and reset to predetermined values. When battery voltage is restored to the PCM, the vehicle may exhibit certain driveability concerns. It will be necessary to drive the vehicle to allow the PCM to relearn values for optimum driveability and performance.

To install powertrain control module, reverse the removal procedure.

Tighten PCM connector to module bolt to 5 to 7 Nm (45 to 61 lb-in). Tighten PCM cover bolts to 8-10 Nm (71-88 lb-in).

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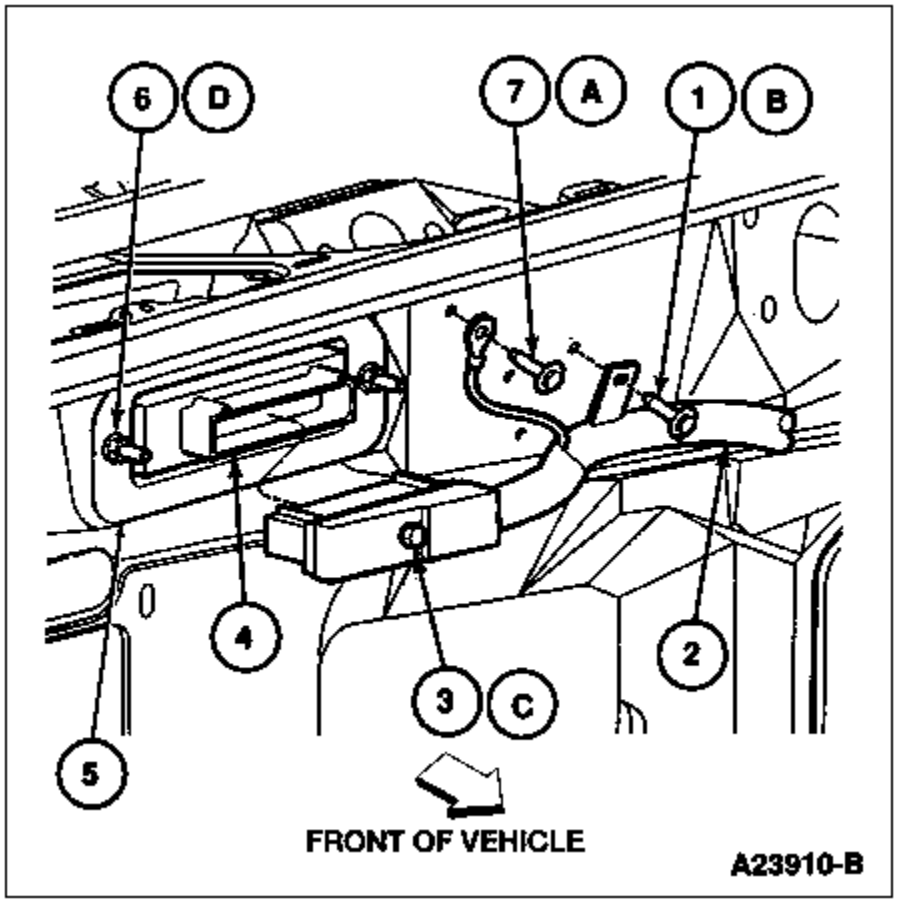
Powertrain Control Module (PCM) — Ranger

Powertrain Control Module — Ranger



Item	Part Number	Description
1	N805375-S36	Engine Control Sensor Wiring Bracket Bolt
2	12A581	Engine Control Sensor Wiring
3	—	PCM Connector to Module Bolt
4	12A650	Powertrain Control Module
5	12B523	PCM Cover
6	N806385-S2	PCM Cover Nuts (2 Req'd)
7	—	Ground Strap Bolt
A	—	Tighten to 9-12 Nm

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		(80-106 Lb-In)
B	—	Tighten to 4.8 Nm (42 Lb-In)
C	—	Tighten to 5-7 Nm (45-61 Lb-In)
D	—	Tighten to 4-5.6 Nm (36-49 Lb-In)

Removal

1. Disconnect battery ground cable (14301).
2. Loosen PCM connector to module bolt and unplug PCM connector.
3. Remove two PCM cover nuts and PCM cover.
4. Remove powertrain control module (PCM) (12A650).

Installation

NOTE: When battery voltage is removed from the powertrain control module, all learned values will be cleared and reset to predetermined values. When battery voltage is restored to the PCM, the vehicle may exhibit certain driveability concerns. It will be necessary to drive the vehicle to allow the PCM to relearn values for optimum driveability and performance.

To install, reverse the removal procedure.

Tighten PCM connector to module bolt to 5-7 Nm (45-61 lb-in). Tighten PCM cover nuts to 4-5.6 Nm (36-49 lb-in).

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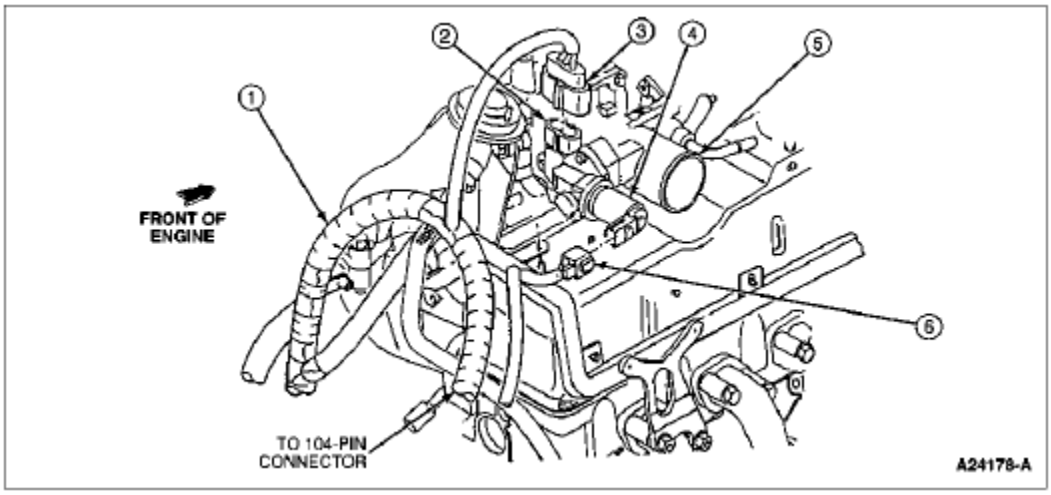
Throttle Position (TP) Sensor, 2.3L Engine

Removal

1. Disconnect battery ground cable (14301).
2. Disconnect throttle position sensor (TP sensor) (9B989) electrical connector engine control sensor wiring (12A581).
3. Remove the two throttle position sensor retaining screws.
4. Remove the throttle position sensor and throttle position sensor gasket (9F782).

Throttle Position Sensor, 2.3L



Item	Part Number	Description
1	12A581	Engine Control Sensor Wiring
2	9B989	Throttle Position Sensor
3	—	Throttle Position Sensor Connector (Part of 12A581)
4	9F715	Idle Air Control Valve
5	9E926	Throttle Body
6	—	Idle Air Control Valve Connector (Part of 12A581)

Installation

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1. **CAUTION: Slide rotary tangs into position over throttle shaft blade, then rotate throttle position sensor CLOCKWISE ONLY to installed position. Failure to install the throttle position sensor in this manner may result in excessive idle speeds.**

   Position the throttle position sensor on the throttle body. Make sure that rotary tangs on sensor are in proper alignment with the throttle shaft blade.

2. **NOTE: This throttle position sensor is non-adjustable.**

   Secure throttle position sensor to throttle body (9E926) with two retaining screws. Tighten to 3-4 Nm (28-35 lb-in).

3. Make sure that both the idle air control valve gasket and surfaces are clean.

4. Install idle air control gasket (IAC gasket) (9F670) on throttle body surface and mount idle air control valve (IAC valve) (9F715), securing it with two retaining screws. Tighten to 8-11 Nm (71-97 lb-in).

5. Connect electrical connectors to both the throttle position sensor and the idle air control valve.

6. **NOTE: When battery voltage is removed from the powertrain control module (PCM) (12A650), all learned values will be cleared and reset to predetermined values. When battery voltage is restored to the PCM, the vehicle may exhibit certain driveability concerns. It will be necessary to drive the vehicle to allow the PCM to relearn values for optimum driveability and performance.**

   Connect battery ground cable.

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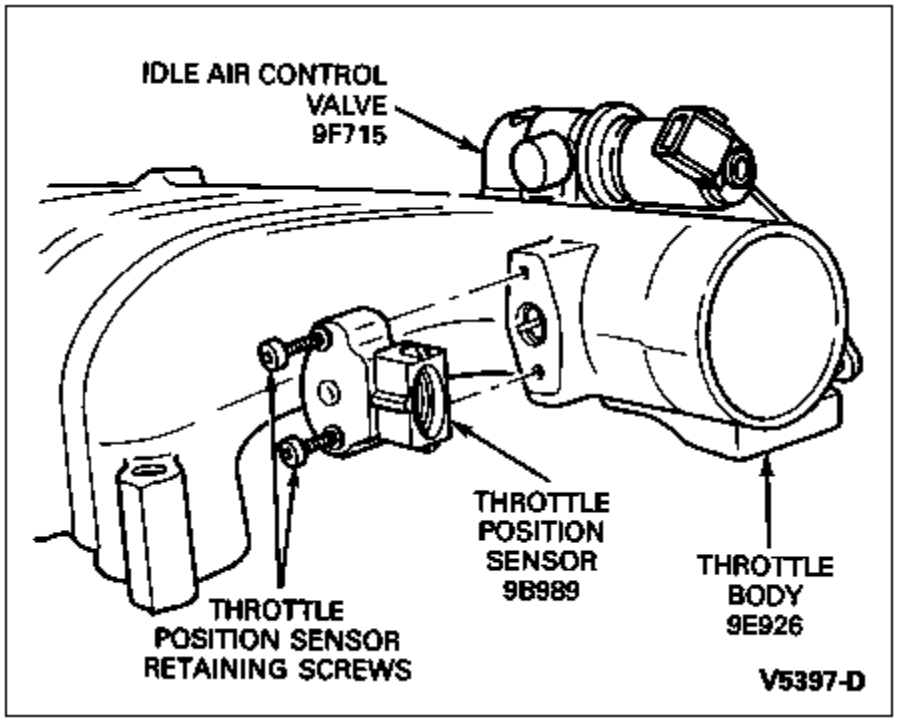
Throttle Position (TP) Sensor, 3.0L Engine

Removal

1. Disconnect battery ground cable (14301).
2. Disconnect the fuel charge wiring connector at the throttle position sensor (TP sensor) (9B989).
3. Remove two throttle position sensor retaining screws.
4. Remove throttle position sensor.



Installation

1. **CAUTION: Slide rotary tangs into position over throttle shaft blade, then rotate throttle position sensor clockwise to installed position only. Failure to install the throttle position sensor in this manner may result in excessive idle speeds.**

   Install throttle position sensor. Make sure that rotary tangs on sensor are in proper alignment and that the red seal is inside the connector housing.

2. **NOTE: This throttle position sensor is non-adjustable.**

   Secure sensor to throttle body (9E926) with two retaining screws. Tighten to 3-4 Nm (27-35 lb-in).

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3. Install electrical connector to sensor.

4. **NOTE: When battery voltage is removed from the powertrain control module (PCM) (12A650), all learned values will be cleared and reset to predetermined values. When battery voltage is restored to the PCM, the vehicle may exhibit certain driveability concerns. It will be necessary to drive the vehicle to allow the PCM to relearn values for optimum driveability and performance.**

   Connect battery ground cable.

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Throttle Position (TP) Sensor, 4.0L Engine

Removal

1. Disconnect battery ground cable (14301).
2. Disconnect throttle position sensor (TP sensor) (9B989) from fuel charging wiring (9D930).
3. Remove two throttle position sensor retaining screws.
4. Remove throttle position sensor and discard throttle position sensor gasket (9F782).

Installation

1. Position new throttle position sensor gasket and throttle position sensor with connector facing rearward.
2. Secure throttle position sensor to throttle body (9E926) with two retaining screws. Tighten to 3-4 Nm (27-35 lb-in).
3. Connect electrical connector to throttle position sensor.
4. **NOTE: When battery voltage is removed from the powertrain control module (PCM) (12A650), all learned values will be cleared and reset to predetermined values. When battery voltage is restored to the PCM, the vehicle may exhibit certain driveability concerns. It will be necessary to drive the vehicle to allow the PCM to relearn values for optimum driveability and performance.**

   Connect battery ground cable (14301).

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Mass Airflow (MAF) Sensor, Ranger

Removal

CAUTION: Sensing elements located in the airflow bypass are not to be tampered with.

1. Disconnect battery ground cable (14301).
2. Disconnect mass airflow extension wiring.
3. Release air cleaner band clamp.
4. Separate the inlet and outlet sides of the engine air cleaner.
5. Peel back the convolute from the MAF extension wiring. Cut tape if necessary.
6. Pull grommet out of outlet side of engine air cleaner and slide it down the extension wiring.
7. Remove the MAF sensor plate and the MAF sensor from the outlet side of the engine air cleaner.
8. Disconnect MAF sensor connector.
9. Remove MAF from sensor plate. The MAF sensor electronics module and body are calibrated as a unit and must be serviced as a complete unit.

Installation

1. Install mass air flow sensor (MAF sensor) (12B579) to sensor plate. Torque MAF sensor to 8-11 Nm.
2. Connect MAF sensor connector.
3. Clean the screeen on the 4.0L Ranger and ensure it is properly aligned.
4. Install the MAF sensor plate and MAF sensor into outlet side of engine air cleaner.
5. **CAUTION: The grommet used to seal the opening for the MAF extension wiring must be fully seated, otherwise, unmetered air will enter the engine.**

   Slide grommet up the extension wiring and install into outlet side of engine air cleaner.
6. Replace the convolute around the extension wiring and tape if necessary.
7. Align the notch and position the inlet and outlet sides of the engine air cleaner.
8. Secure the engine air cleaner band clamp.
9. Connect the MAF extension wiring.

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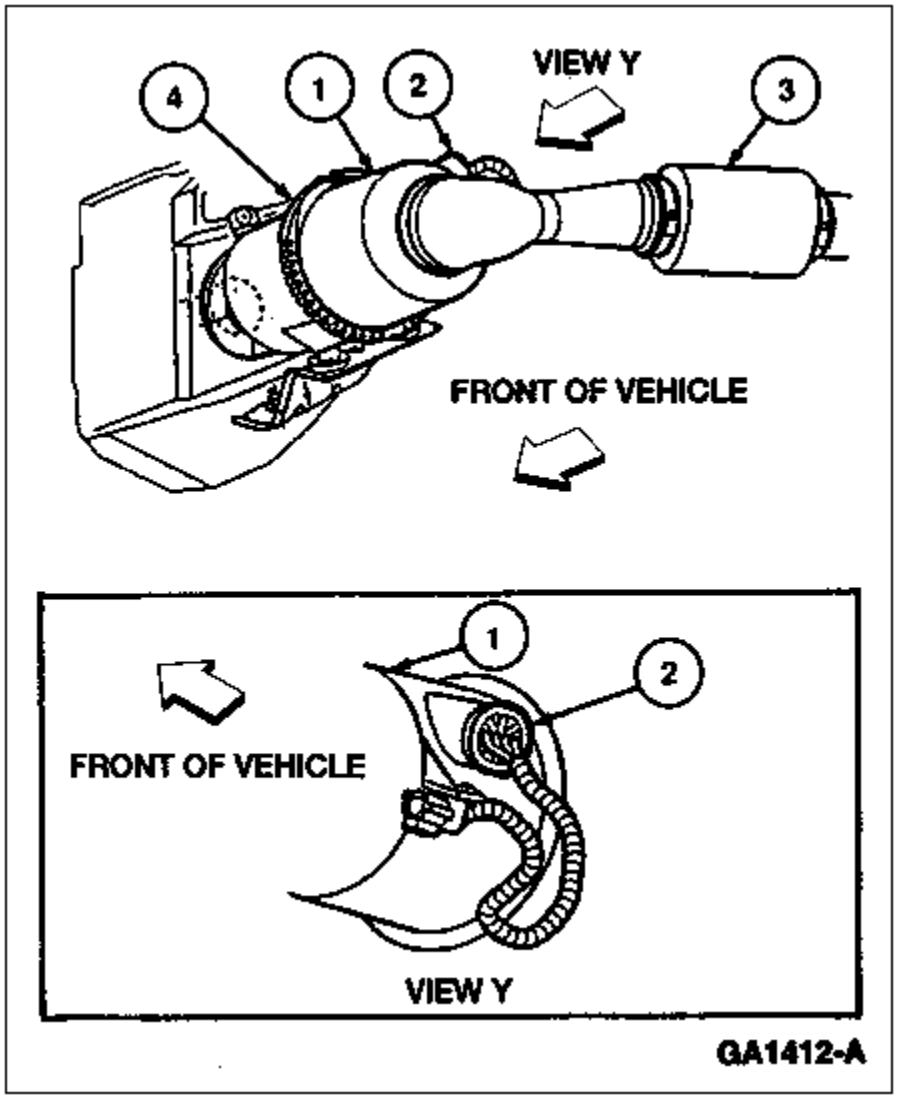
10. **NOTE: When battery voltage is removed from the powertrain control module (PCM) (12A650), all learned values will be cleared and reset to predetermined values. When battery voltage is restored to the PCM, the vehicle may exhibit certain driveability concerns. It will be necessary to drive the vehicle to allow the PCM to relearn values for optimum driveability and performance.**

    To install, reverse the removal procedure.

11. Connect ground cable at battery.



Item	Part Number	Description
1	9600	Engine Air Cleaner
2	—	Grommet and MAF Sensor Extension Wiring.
3	9B659	Air Cleaner Outlet Tube

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4	—	Air Cleaner Band Clamp

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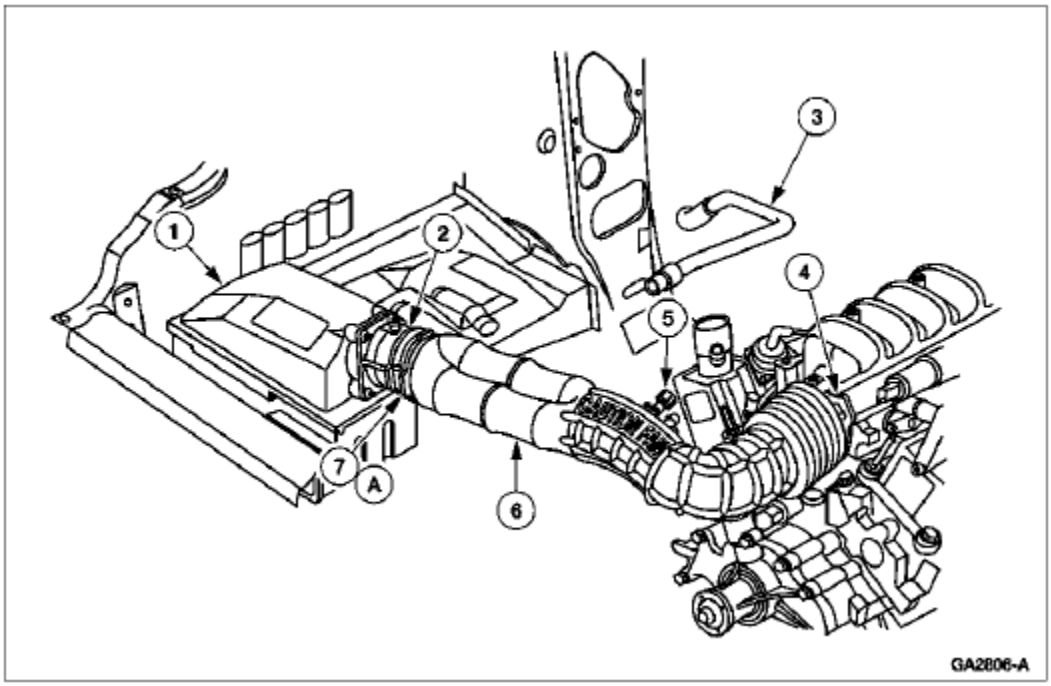
Mass Airflow (MAF) Sensor — Aerostar



Item	Part Number	Description
1	9600	Engine Air Cleaner
2	12B579	Mass Air Flow Sensor (MAF Sensor)
3	6C342	Crankcase Ventilation Hose
4	9E926	Throttle Body
5	12A697	Intake Air Temperature Sensor (IAT Sensor)
6	9B659	Air Cleaner Outlet Tube
7	—	Air Cleaner Outlet Tube Clamps (2 Req'd)

Removal

1. Disconnect battery ground cable (14301).
2. Loosen the air cleaner outlet tube clamp at the mass air flow sensor (MAF sensor) (12B579) and remove the air cleaner outlet tube (9B659)air cleaner outlet tube from the MAF sensor.
3. Disconnect MAF sensor electrical connector.

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4. Remove four MAF sensor nuts.
5. Remove the MAF sensor and discard the gasket.

Installation

1. Clean the sealing surfaces of the engine air cleaner and MAF sensor.
2. Position MAF sensor and new gasket to the engine air cleaner (ACL) (9600) engine air cleaner.
3. Install four MAF sensor nuts and tighten to 10 Nm 88 lb-in).
4. Connect MAF sensor electrical connector.
5. Install the air cleaner outlet tube and tighten the air cleaner outlet tube clamps to 2-3 Nm (18-27 lb-in).
6. **NOTE: When battery voltage is removed from the powertrain control module (PCM) (12A650), all learned values will be cleared and reset to predetermined values. When battery voltage is restored to the PCM, the vehicle may exhibit certain driveability concerns. it will be necessary to drive the vehicle to allow the PCM to relearn values for optimum driveability and performance.**

   Connect negative battery cable.
7. Start the engine and check for air leaks and proper MAF sensor operation.

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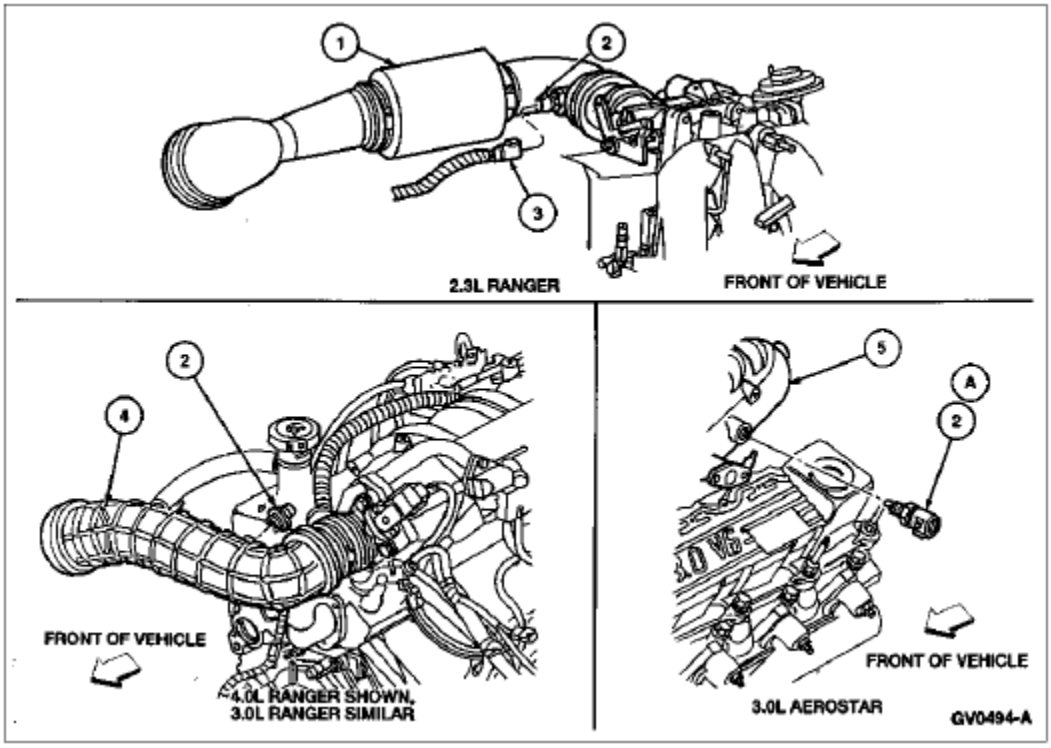
Intake Air Temperature (IAT) Sensor

Removal and Installation

1. Disconnect negative battery cable.
2. Disconnect electrical connector from intake air temperature sensor (IAT sensor) (12A697).
3. Remove intake air temperature sensor.
4. To install, reverse removal procedure. Aerostar only, tighten intake air temperature sensor to 12-17 Nm (9-13 lb-ft).
5. **NOTE: When battery voltage is removed from the powertrain control module (PCM) (12A650), all learned values will be cleared and reset to predetermined values. When battery voltage is restored to the PCM, the vehicle may exhibit certain driveability concerns. It will be necessary to drive the vehicle to allow the PCM to relearn values for optimum driveability and performance.**

   Connect negative battery cable.

Intake Air Temperature (IAT) Sensor Location, 2.3L, 3.0L and 4.0L Engines



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Item	Part Number	Description
1	9B659	Air Cleaner Outlet Tube
2	12A697	Intake Air Temperature Sensor
3	12A581	Engine Wiring Harness
4	9B659	Air Cleaner Outlet Tube
5	9E926	Throttle Body
A	—	Tighten to 12-17 Nm (9-13 Lb-Ft)

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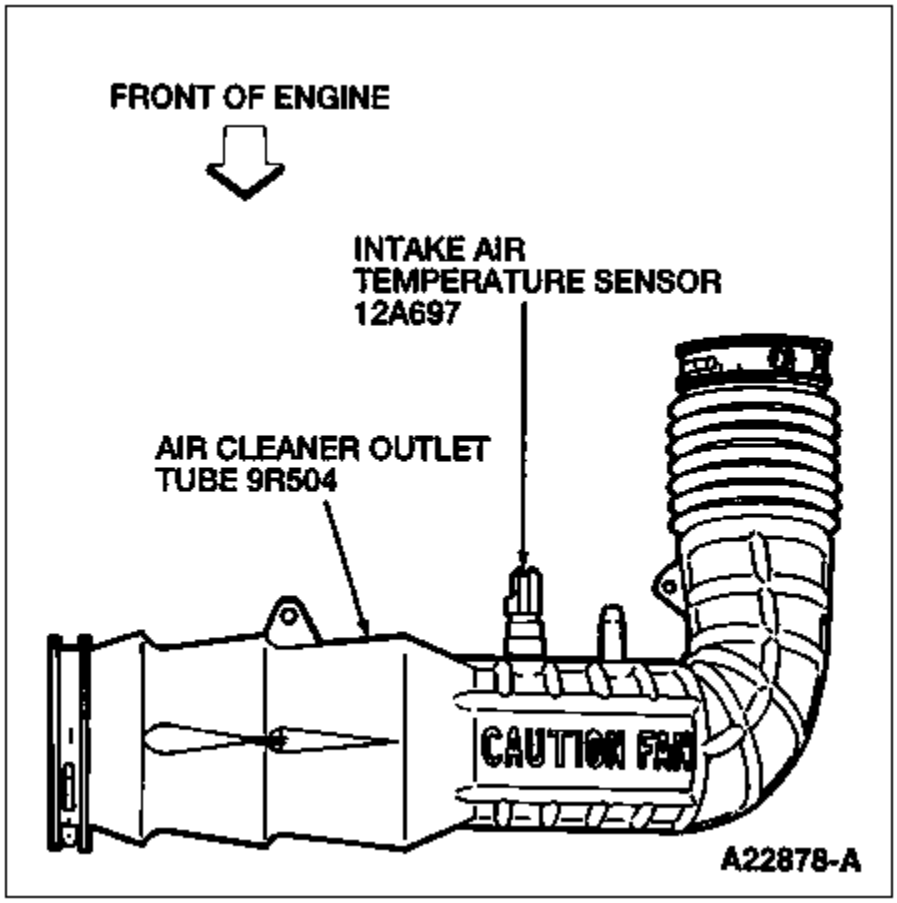
Intake Air Temperature (IAT) Sensor Location 4.0 Aerostar



Removal

1. Disconnect battery ground cable (14301).
2. Disconnect electrical connector from intake air temperature sensor (IAT sensor) (12A697).
3. Loosen screw clamp securing IAT tube to engine air cleaner outlet tube and remove intake air temperature sensor.

Installation

1. Install IAT and torque to 3-5 Nm (27-44 lb-in).
2. Position engine air cleaner outlet tube and tighten screw clamp.

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3. **NOTE: When battery voltage is removed from the powertrain control module (PCM) (12A650), all learned values will be cleared and reset to predetermined values. When battery voltage is restored to the PCM, the vehicle may exhibit certain driveability concerns. It will be necessary to drive the vehicle to allow the PCM to relearn values for optimum driveability and performance.**

   Connect battery ground cable.

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Idle Air Control Valve (IAC), 2.3L Engine

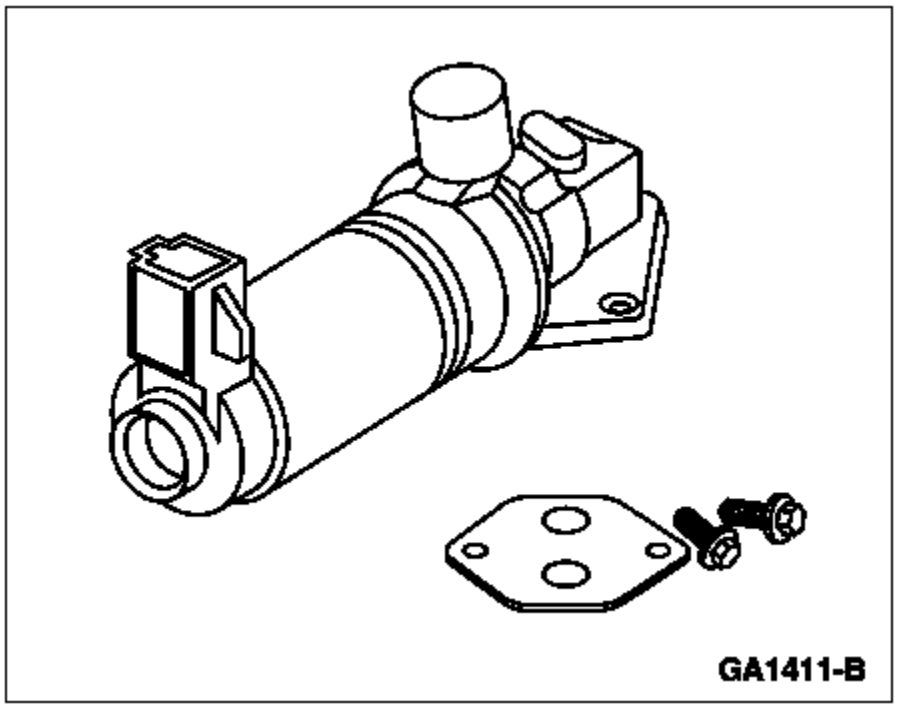
Removal

1. Disconnect battery ground cable (14301).
2. Disconnect idle air control valve electrical connector.
3. Remove two idle air control valve retaining screws.
4. Remove idle air control valve (IAC valve) (9F715) and idle air control gasket (IAC gasket) (9F670).
5. **NOTE: If scraping is necessary, be careful not to damage idle air control valve or throttle body gasket surfaces, or drop material into throttle body.**

   Clean gasket surfaces.

Installation

1. Make sure that both throttle body (9E926) and idle air control valve gasket surfaces are clean.



2. Install idle air control gasket on throttle body surface and mount idle air control valve, securing it with two retaining screws. Tighten to 8-11 Nm (71-97 lb-in).
3. Connect electrical connector to idle air control valve.

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4. **NOTE: When battery voltage is removed from the powertrain control module (PCM) (12A650), all learned values wil be cleared and reset to predetermined values. When battery voltage is restored to the PCM, the vehicle may exhibit certain driveability concerns. It will be necessary to drive the vehicle to allow the PCM to relearn values for optimum driveability and performance.**

   Connect battery ground cable.

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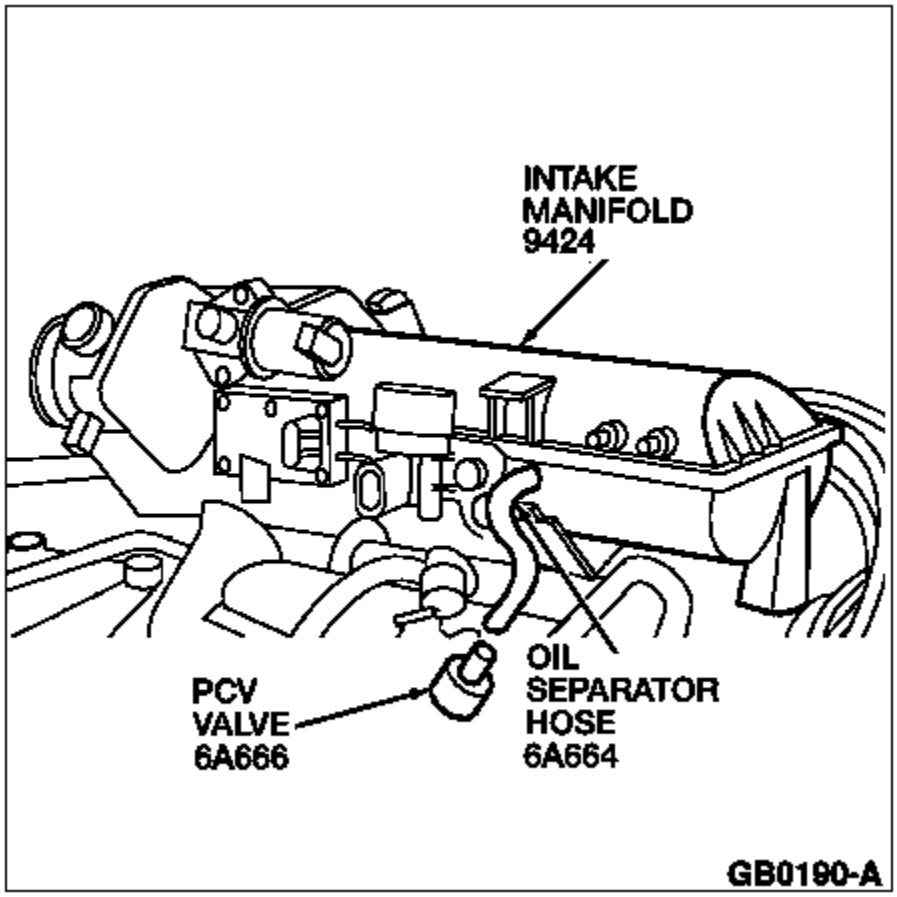
Idle Air Control (IAC) Valve — 3.0L, 4.0L

Idle Air Control Valve — 4.0L



Idle Air Control Valve — 3.0L

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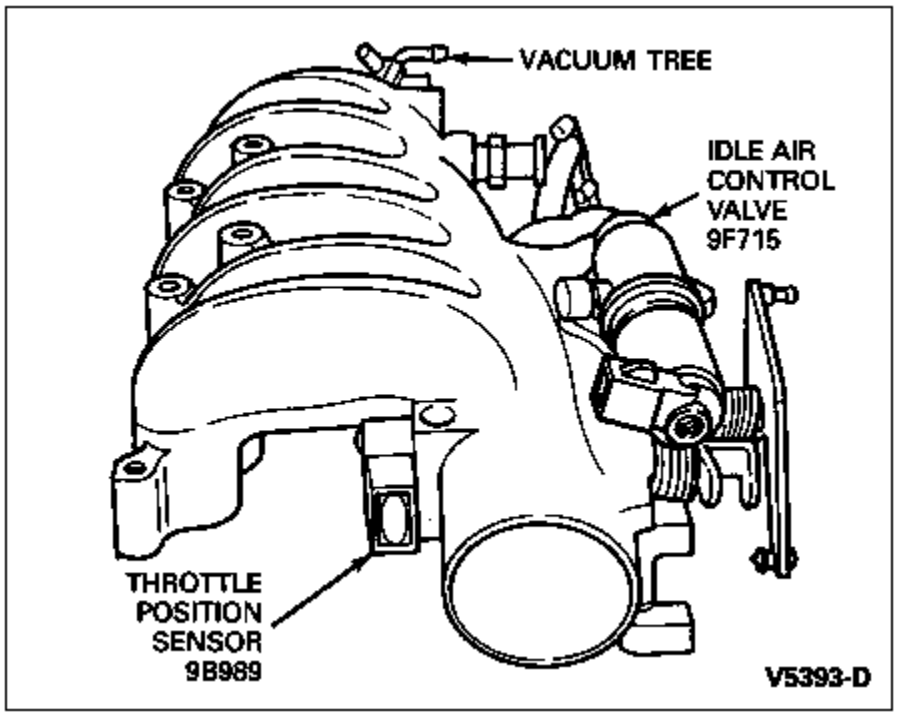

Removal

1. Disconnect the battery ground cable (14301).
2. Remove the screws and the accelerator cable splash shield.
3. Disconnect the fuel charging wiring (9D930) connector at the idle air control valve.
4. Remove the two idle air control valve bolts.
5. Remove the idle air control valve (IAC valve) (9F715) and the idle air control gasket (IAC gasket) (9F670).

Installation

1. Position the IAC gasket and the IAC.
2. Install the two IAC bolts and torque to 9-11 Nm (80-97 lb-in).
3. Connect the fuel charging wiring connector to the idle air control valve.
4. Position the accelerator cable splash shield and install the screw.
5. **NOTE: When the battery voltage is removed from the powertrain control module (PCM) (12A650), all learned values will be cleared and reset to predetermined values. When battery voltage is restored to the PCM, the vehicle may exhibit certain driveability concerns. It will be necessary to drive the vehicle to allow the PCM to relearn values for optimum driveability and performance.**

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Connect the battery ground cable.

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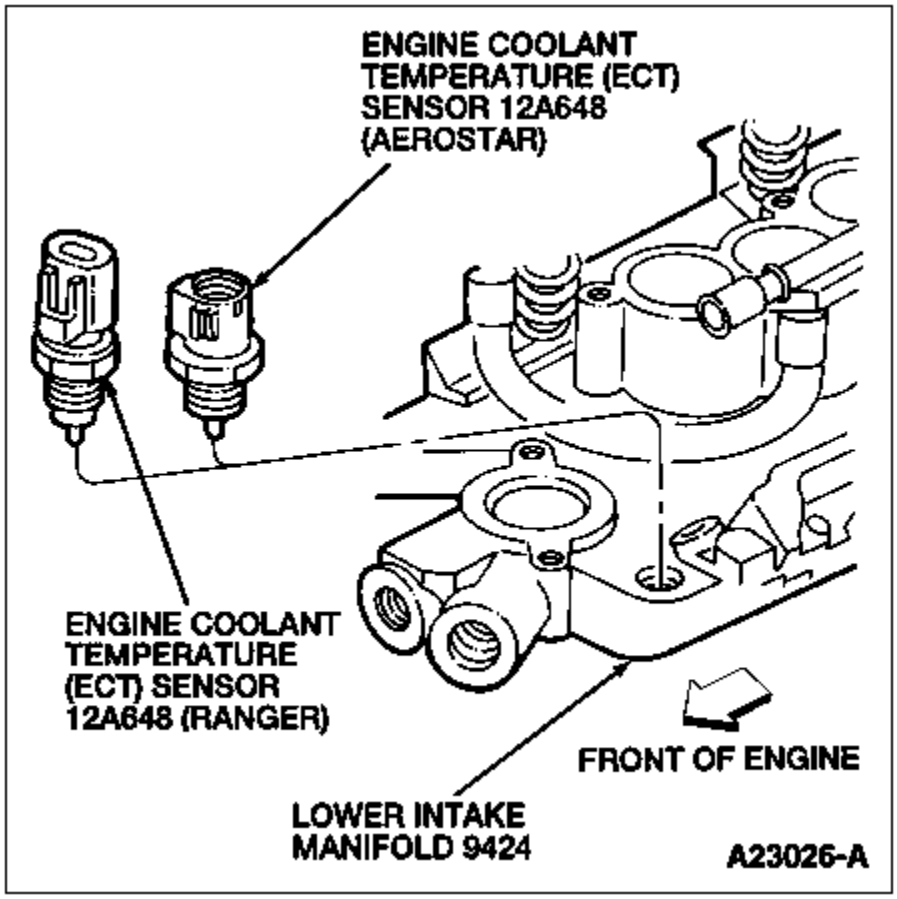
Engine Coolant Temperature (ECT) Sensor

Engine Coolant Temperature (ECT) Sensor — 3.0L



Removal

1. Disconnect battery ground cable (14301).

Engine Coolant Temperature (ECT) Sensor — 2.3L

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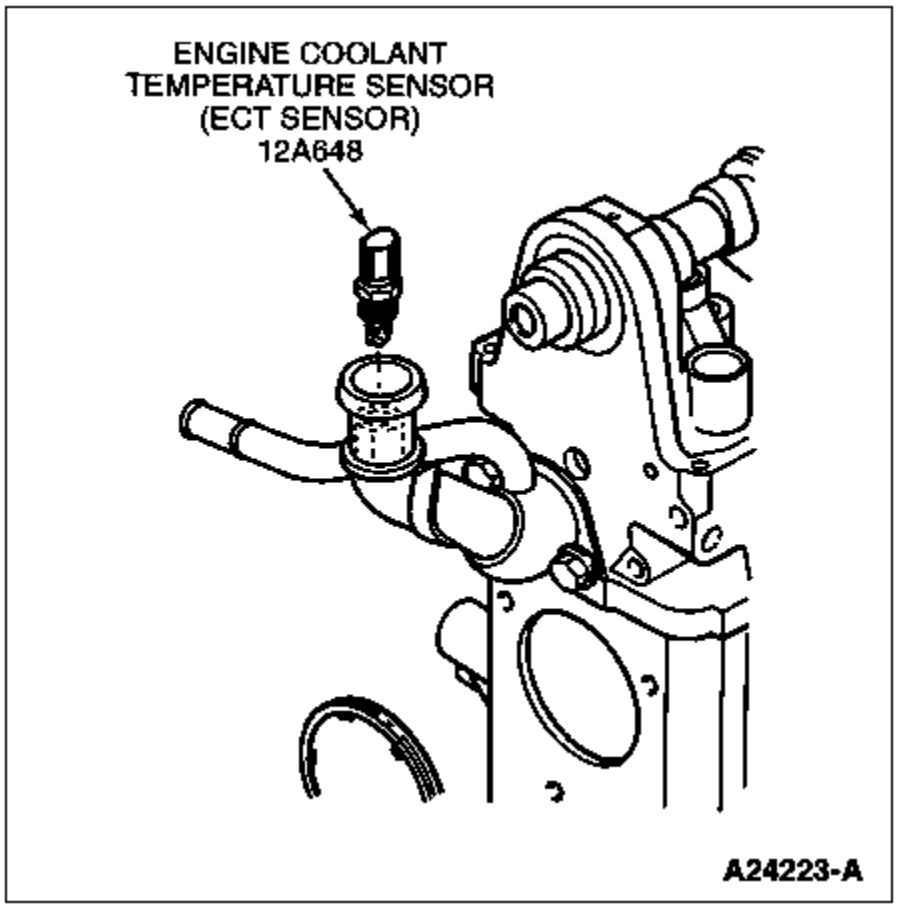

2. Partially drain cooling system. Refer to Section 03-03 for cooling system service procedures.
3. Disconnect engine coolant temperature sensor (ECT sensor) (12A648) electrical connector.
4. On 3.0L and 4.0L engines, remove engine coolant temperature sensor from lower intake manifold.
5. On 2.3L engines, remove engine coolant temperature sensor from heater hot water supply tube.

Installation

1. Install ECT and torque to 16-24 Nm (12-17 lb-ft).
2. Connect ECT electrical connection.
3. Refill cooling system; refer to Section 03-03 for cooling system service procedure.
4. **NOTE: When battery voltage is removed from the powertrain control module (PCM) (12A650), all learned values will be cleared and reset to predetermined values. When battery voltage is restored to the PCM, the vehicle may exhibit certain driveability concerns. It will be necessary to drive the vehicle to allow the PCM to relearn values for optimum driveability and performance.**

   Connect battery ground cable.

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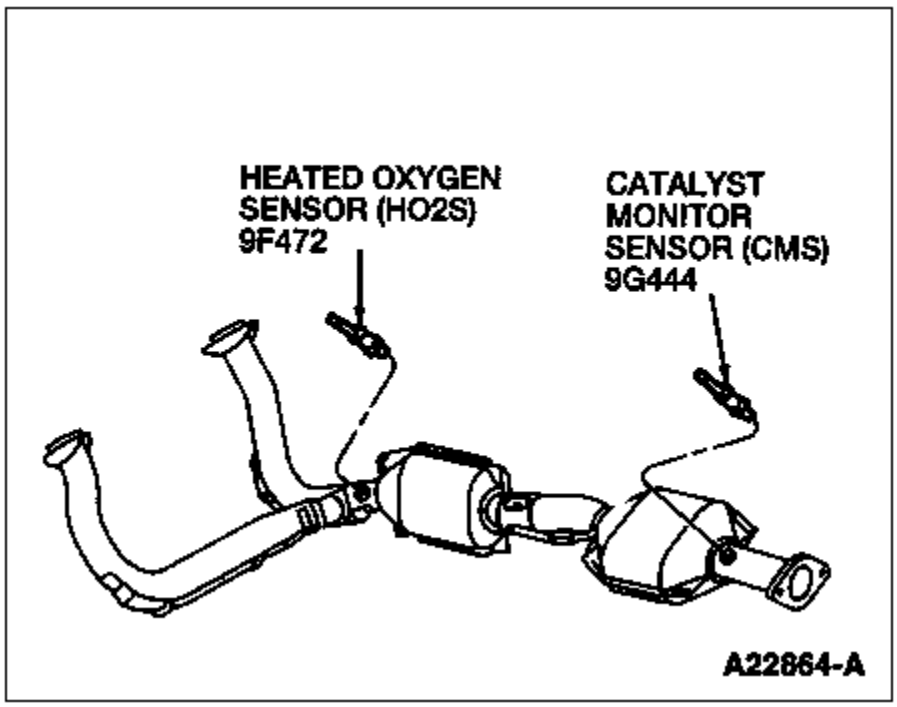
Heated Oxygen Sensor (HO2S)

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Oxygen Sensor Wrench	T94P-9472-A

Removal

Heated Oxygen Sensor (HO2S) Location — Aerostar 3.0L, 4.0L



Heated Oxygen Sensor (HO2S) Location, 2.3L, 3.0L, and 4.0L Engines

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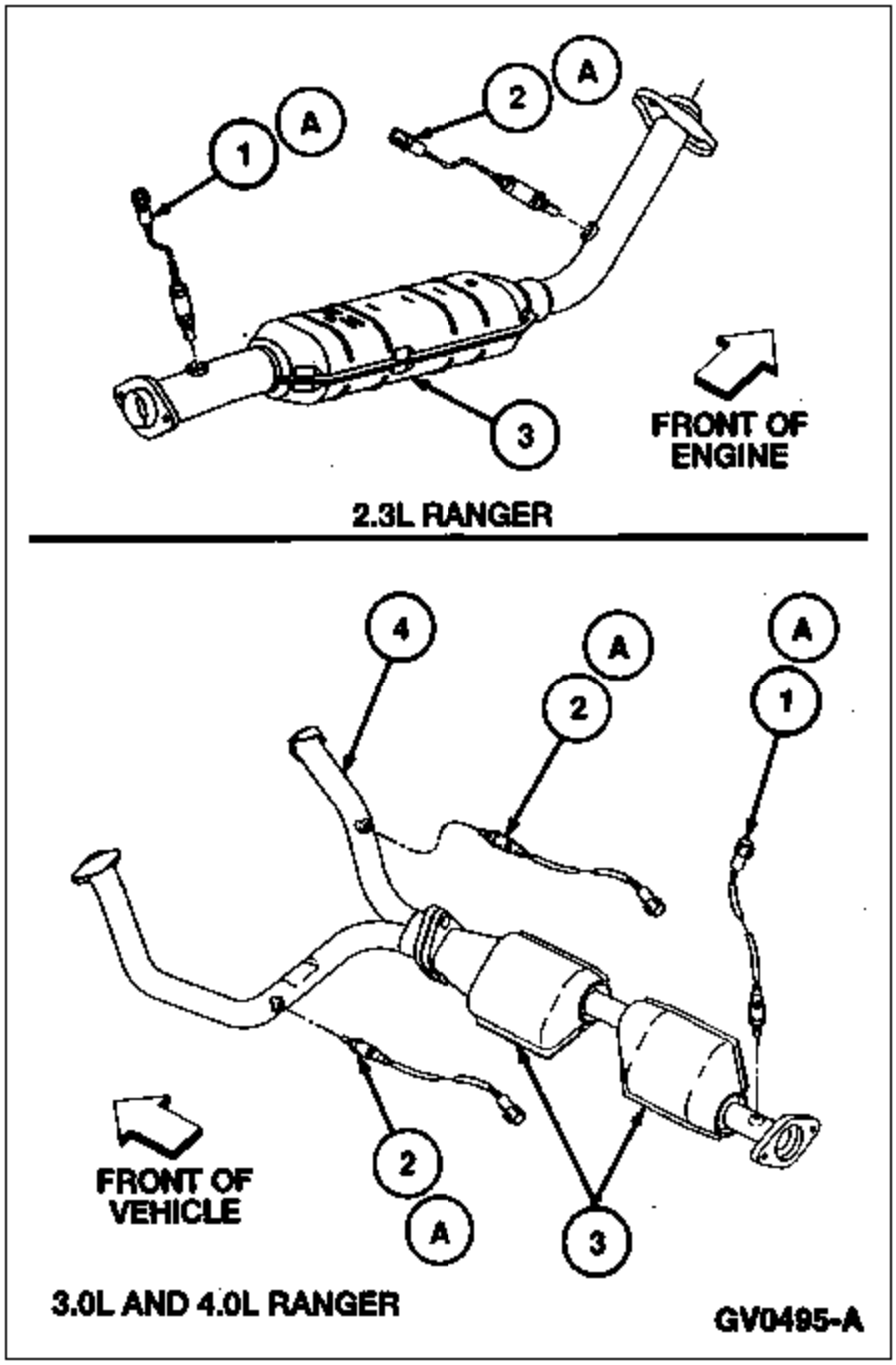

Item	Part Number	Description
1	9G444	HO2S (Catalyst Monitor)
2	9F472	HO2S (Engine Control)
3	5E212	Catalytic Converter
4	5246	Exhaust Inlet
A	—	Tighten to 34-46 Nm (25-34 Lb-Ft)

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1. **NOTE: If excessive force is needed to remove heated oxygen sensor (HO2S) (9F472), lubricate heated oxygen sensor with Ford Penetrating Lubricant E8AZ-19A501-B or equivalent prior to removal.**

   Disconnect battery ground cable (14301).

2. Disconnect heated oxygen sensor from engine control sensor extension wiring (12A690).

3. On 3.0L and 4.0L raise and support vehicle.

4. Remove heated oxygen sensors from exhaust manifold, inlet pipe, or dual converter Y pipe (5F250), using Oxygen Sensor Wrench T94P-9472-A.

Installation

1. Apply a light coat of anti-seize compound F6AZ-9L494-AA install and tighten heated oxygen sensors to 36-46 Nm (27-33 lb-ft).

2. **NOTE: When battery voltage is removed from the powertrain control module (PCM) (12A650), all learned values will be cleared and reset to predetermined values. When battery voltage is restored to the PCM, the vehicle may exhibit certain driveability concerns. It will be necessary to drive the vehicle to allow the PCM to relearn values for optimum driveability and performance.**

   Connect battery ground cable.

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Camshaft Position (CMP) Sensor — 3.0L and 4.0L

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Syncro Positioning Tool — 3.0L, 4.0L	T95T-12200-A

CAUTION: Syncro Positioning Tool T95T-12200-A (3.0L, 4.0L) must be obtained prior to installation of the replacement synchronizer assembly. Failure to follow this procedure will result in the fuel system being out of time with the engine (6007), possibly causing engine damage.

CAUTION: Prior to the removal of the camshaft position sensor (CMP sensor) (12A112), set No. 1 cylinder to 0 degrees top dead center (TDC) of compression stroke. Then note the position of the camshaft position sensor electrical connector. The installation procedure requires that the electrical connector be located in the same position.

Removal

1. Disconnect battery ground cable (14301).
2. Disconnect fuel charging wiring electrical connector from camshaft position sensor.
3. Remove the CMP sensor screws and camshaft position sensor from camshaft synchronizer.

CAUTION: Do not move crankshaft (6303) until entire installation procedure is complete. Doing so will result in the fuel system being out of time with the engine resulting in possible emissions fault.

NOTE: If camshaft synchronizer is to be removed from the cylinder blocks (6010), proceed with Step 4. If the camshaft synchronizer is not being removed, proceed to installation Step 8.

4. Remove hold-down clamp (12270).
5. Remove camshaft synchronizer from cylinder blocks.

Installation

1. Attach Syncro Positioning Tool T95T-12200-A (3.0L, 4.0L).

Camshaft Synchronizer — 3.0L, 4.0L

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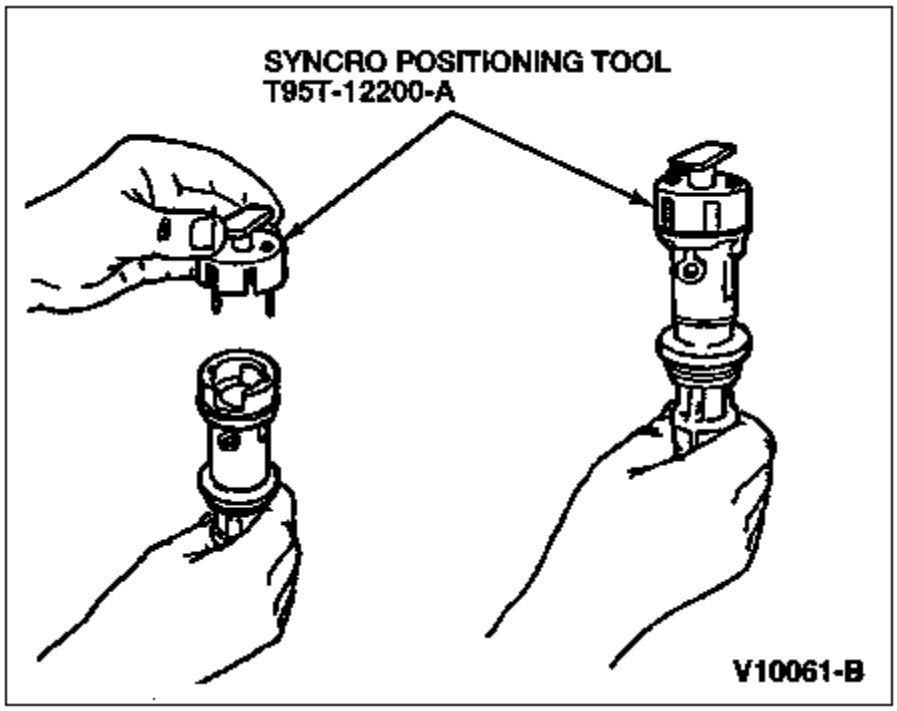

2. Align the synchronizer vane with the radial slot of the Syncro Positioning Tool T95T-12200-A (3.0L).
3. Rotate the tool on the synchronizer base until the tool's boss engages the base notch.
4. Dip gear end into ESE-M2C123-A oil or equivalent to coat gear, thrust washer and lower bearing.

Syncro Positioning Tool — 3.0L, 4.0L

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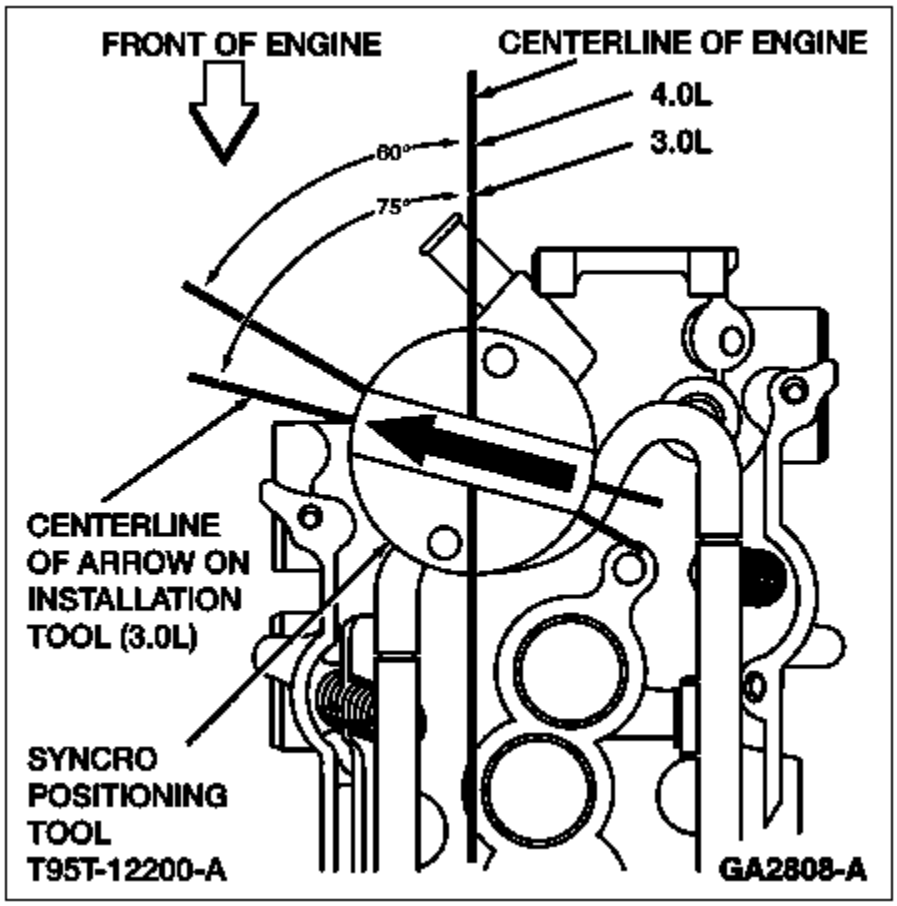

5. **CAUTION: Do not rotate crankshaft when syncro positioning tool is on the camshaft synchronizer. Armature tab will be damaged and synchronizer timing may be shifted.**

   Install camshaft synchronizer so that drive gear engagement occurs when arrow on Syncro Positioning Tool T95T-12200-A is pointed approximately 75 degrees (3.0L), 60 degrees (4.0L) counterclockwise off the centerline of the engine. This step will locate camshaft position sensor electrical connector to the original position.

6. **CAUTION: If camshaft position sensor electrical connector is not positioned properly, DO NOT reposition the connector by rotating the synchronizer assembly. This will result in the fuel system being out of time with the engine, possibly causing engine damage. Remove the synchronizer assembly and repeat Step 5.**

   Install hold-down clamp and tighten to 19-30 Nm (14-22 lb-ft) on 3.0L and 4.0L.

7. Remove Syncro Positioning Tool.

8. Install CMP sensor and CMP sensor screws. Tighten to 2.5-3.5 Nm (23-30 lb-in).

9. Connect fuel charging wiring electrical connector to camshaft position sensor (CMP sensor).

10. **NOTE: When battery voltage is removed from the powertrain control module (PCM) (12A650), all learned values will be cleared and reset to predetermined values. When battery voltage is restored to the PCM, the vehicle may exhibit certain driveability concerns. It will be necessary**

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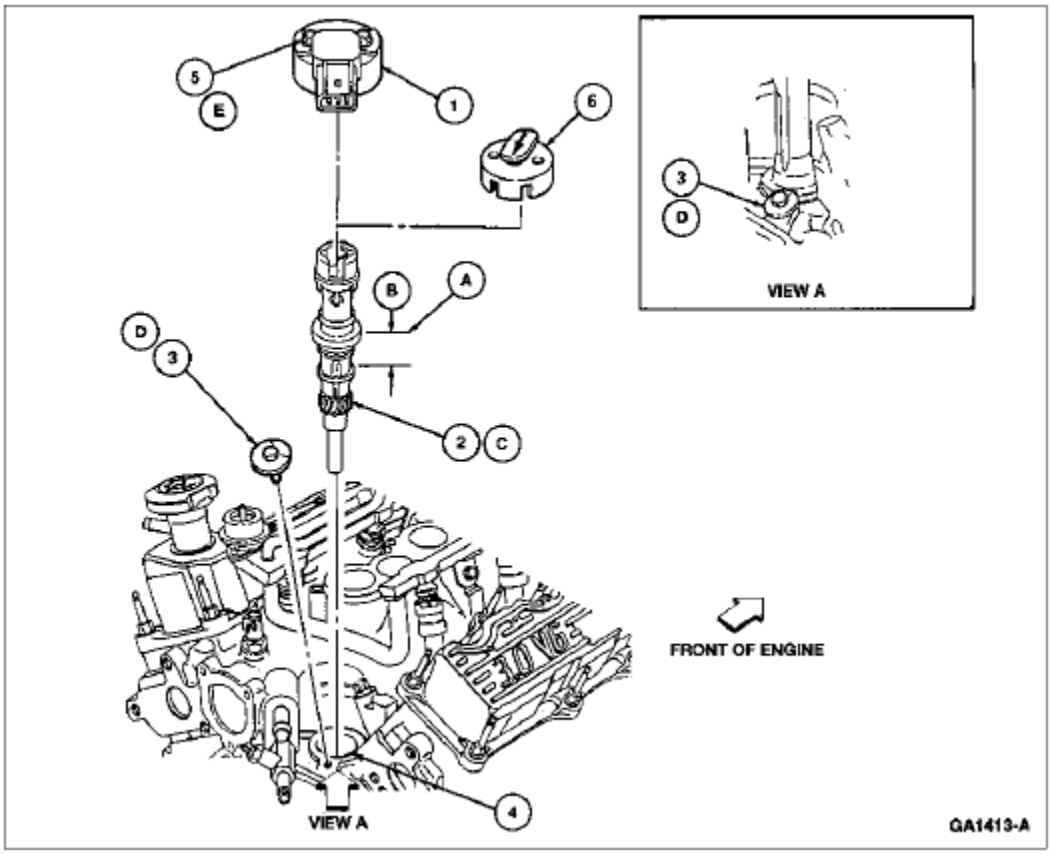
to drive the vehicle to allow the PCM to relearn values for optimum driveability and performance.

Connect battery ground cable.

Camshaft Position (CMP) Sensor — 3.0L Shown, 4.0L



Item	Part Number	Description
1	12A112	Camshaft Position Sensor
2	12A362	Camshaft Synchronizer
3	12270	Hold-Down Clamp
4	6010	Cylinder Blocks
5	N602704-S	CMP Sensor Screws (2 Req'd)
6	T95T-12200-A	Syncro Positioning Tool (3.0L) (4.0L)
A	—	Bottom of Flange
B	—	22mm (.88 In.) Maximum
C	—	Pre-Lube Synchronizer Gear with ESE-M2C123-A Oil
D	—	Tighten to 19-30 Nm (14-22 Lb-Ft) (3.0L and 4.0L)

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E	—	Tighten to 2.5-3.5 Nm (23-30 Lb-In)

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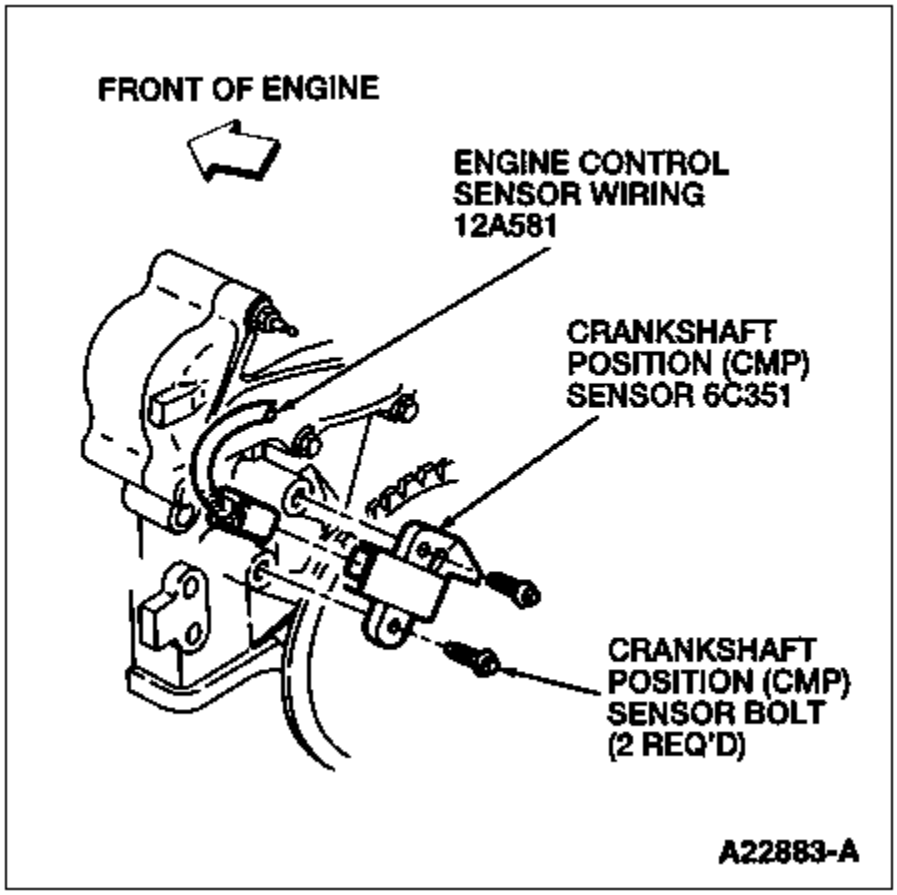
Crankshaft Position (CKP) Sensor — 3.0L, 4.0L



Removal

1. Disconnect battery ground cable (14301).
2. Disconnect CKP sensor electrical connector.
3. Remove two CKP sensor screws and remove crankshaft position sensor (CKP sensor) (6C351).

Installation

1. Position crankshaft position sensor on engine (6007).
2. Install two CKP sensor screws and tighten to 9-12 Nm (80-106 lb-in) 4.0L, or to 4-7 Nm (35-62 Lb-In) for 3.0L.
3. Route CKP sensor wiring harness and connect electrical connector.

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4. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the adaptive strategy.**

   Connect battery ground cable.

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Crankshaft Position (CKP) Sensor, 2.3L Engine

For service refer to Section 03-07A .

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SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Throttle Position Sensor Screws — 2.3L	3-4	—	28-35
Air Cleaner Outlet Tube Clamp	2-3	—	18-27
Engine Coolant Temperature (ECT) Sensor — 2.3L, 3.0L, 4.0L	16-24	12-17	—
Heated Oxygen Sensor (HO2S)	34-46	25-33	—
CKP Sensor Screws — 4.0L	9-12	—	80-106
CMP Sensor Screws 3.0L, 4.0L	2.5-3.5	—	23-30
CKP Sensor Screws 3.0L	4-7	—	35-62
PCM Connector to Module Bolt	5-7	—	45-61
PCM Cover Nut	4-5.6	—	36-49
PCM Cover Bolts	8-10	—	71-88
Ground Strap Screw	3-5	—	27-44
PCM Seal Screws	3-5	—	27-44
PCM Bracket Studs	6-8	—	54-70
Ground Strap Bolt	9-12	—	80-106
Engine Control Sensor Wiring Bracket Bolt	4.8	—	42
Throttle Position Sensor Screws	3-4	—	27-35
Hold Down Clamps — 3.0L, 4.0L	19-30	14-22	—
Idle Air Control Valve Bolts	9-11	—	80-97
Mass Air Flow (MAF) Sensor Nuts	8-11	—	72-98
Air Intake Baffle Screws	3-7	—	27-61
CMP Sensor Bolts 2.3L	5-7	—	45-61
CKP Sensor Screws 2.3L	8-12	—	71-106
IAT Sensor 3.0L	12-17	9-13	—
IAT Sensor 2.3L	8-11	—	71-97
IAT Sensor 4.0L	3-5	—	27-44

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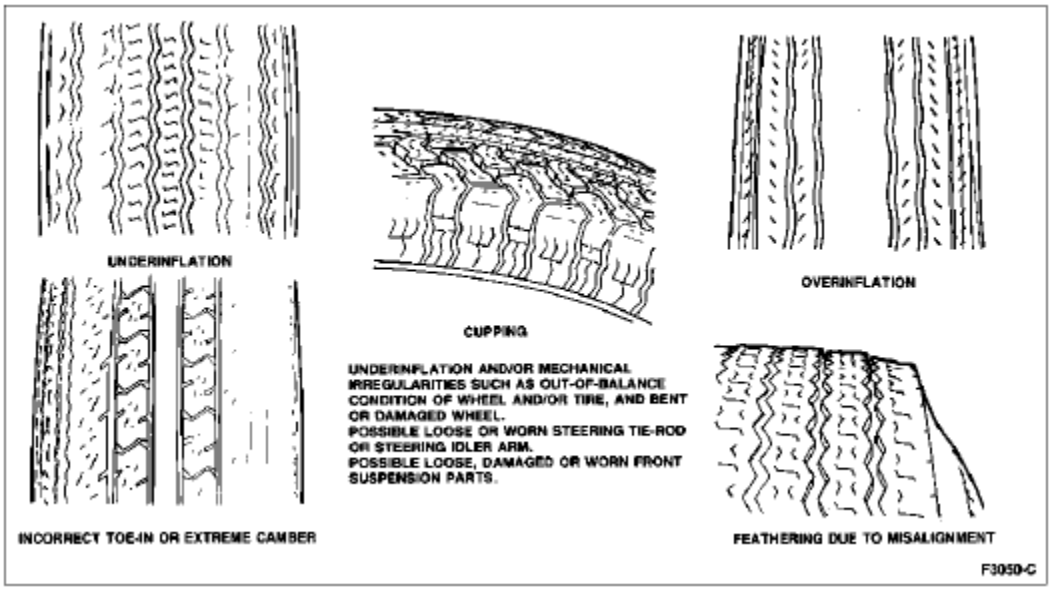
Inspection and Verification

Tire Wear

Inspect tires for wear. The original equipment tires have built-in tread wear indicators to show when tires need replacement. Abnormal or excessive wear may be caused by incorrect wheel alignment, wheel/tire imbalance or improper tire pressure.

Tire Wear Indications



Vibration and Roughness

Vibration, roughness, tramp, shimmy and thump may be caused by excessive tire or wheel runout, worn or cupped tires, or wheel and tire unbalance.

These conditions may also be caused by rough or undulating road surfaces. Driving the vehicle on different types of road surfaces will indicate if the road surfaces are actually causing the condition.

Do not immediately suspect the tires when attempting to diagnose a vibration concern. Other sources of vibration include the following:

- loose or worn wheel bearings
- loose or worn suspension or steering components
- brake hub and rotor runout
- loose engine or transmission supports
- engine-driven accessories

This section covers those vibrations related to the tires and wheels.

For diagnostic procedures and service for non-tire related vibrations, refer to Section 00-04 .

Road Test

A tire vibration diagnostic procedure always begins with a road test. The road test and customer interview (if available) will provide much of the information needed to find the source of a vibration.

During the road test, drive the vehicle on a road that is smooth and free of undulations. If vibration is apparent, note and record the following:

- The speed at which the vibration occurs.
- What type of vibration occurs in each speed range — mechanical or audible.
- How the vibration is affected by changes in vehicle speed, engine speed, and engine torque.
- Type of vibration sensitivity — torque sensitive, vehicle speed sensitive, or engine speed sensitive.

Use the following explanation of terms to help isolate the source of the vibration.

Torque Sensitive

This means that the condition can be improved or worsened by accelerating, decelerating, coasting, maintaining a steady vehicle speed and application of engine torque.

Vehicle Speed Sensitive

This means that the vibration always occurs at the same vehicle speed and is not affected by engine torque, engine speed, or transmission gear selection.

Engine Speed Sensitive

This means that the vibration occurs at varying vehicle speeds when a different transmission gear is selected. It can sometimes be isolated by increasing or decreasing engine speed with the transmission in NEUTRAL, or by stall testing with the transmission in gear. If the condition is engine-speed sensitive, the condition is not related to tires.

If the road test indicates the vibration is related to the tires or wheels, refer to Diagnosis and Testing, Tire Wear in this section. Refer to the Symptom Chart to help pinpoint the cause of the concern. For more wheel and tire diagnosis, refer to Section 04-04 . If the road test indicates that there is tire whine, but no shake or vibration, the noise originates with the contact between the tire and the road surface.

- A thumping noise usually means that the tire has flat or soft spots making a noise as they slap the roadway. Tire whine can be distinguished from axle noise because axle noise diminishes or changes according to load or speed. Tire noise remains the same over a range of speeds.
- To verify that tire noise is not associated with shake or vibration, inflate the tires one at a time and check for a change in the sound. The pitch or whine will change as the increased pressure changes the tire frequency.
- Be sure to deflate tires to their proper pressures after this check is completed.
- A complete road test procedure is provided in Section 00-04 .

Front End

CAUTION: Do not attempt to adjust front wheel alignment without first making a preliminary inspection of the front end parts and correcting where necessary.

Prior to inspection:

- Fill all fluids to specification.
- Make sure spare tire or wheel and related equipment are properly stored.
- Remove all payloads and any excessive accumulation of mud, dirt or road deposits from the chassis and underbody.
- Inflate all tires to the pressure specified on the Safety Compliance Certification Label (usually located on the inside driver's door pillar).
- Check both front tires for the same size, ply rating, and load range.

Inspection

1. Check for excessive wheel bearing end play. Refer to the procedure in Diagnosis and Testing, Wheel Bearing End Play, Front in this section. Adjust and/or replace the wheel bearings as described in Section 04-01A (4x2) or Section 05-03A (4x4 Ranger). For Aerostar E-4WD, replace the wheel hub and bearing as an assembly. Refer to Section 05-03C (Aerostar E-4WD).

2. Check for worn or damaged spindle ball joints (Ranger) or upper and lower suspension arm ball joints (Aerostar). Replace the ball joints as described in Section 04-01A (4x2), Section 04-01C (Aerostar E-4WD), or Section 05-03B (4x4 Ranger).

3. Check for bent steering linkage or excessively worn joints. Inspect inner and outer tie rods. Refer to Section 11-03 (Ranger), or Section 11-02C (Aerostar).

4. For Ranger, check the steering gear mounting bolts and tighten to the specified torque.

5. For Ranger only, inspect the radius arm if bent or damaged. Inspect the bushings at the radius arm-to-frame attachment for wear or looseness. Repair or replace parts as required.

6. For Aerostar, inspect the upper and lower suspension arm-to-frame bushings and attachments for wear and looseness. Repair or replace parts as necessary.

7. Check other suspension components for damage.

8. **NOTE: Specifications in this manual do not apply to vehicles with aftermarket changes.**

   Check for aftermarket changes to steering, suspension, wheel and tire components (i.e., competition, heavy duty, etc.).

Ball Joint, Upper — Inspection

Refer to Component Tests in this section. To service ball joints, refer to Section 04-01A for Aerostar (4x2) and Ranger (4x2). Refer to Section 04-01C for Aerostar (E-4WD). Refer to Section 05-03B for Ranger (4x4).

Ball Joint, Lower — Inspection

Refer to Component Tests in this section. To service ball joints, refer to Section 04-01A for Aerostar (4x2) and Ranger (4x2). Refer to Section 04-01C for Aerostar (E-4WD). Refer to Section 05-03B for Ranger (4x4).

Shock Absorber Checks

CAUTION: The low-pressure gas shock absorbers are charged with nitrogen gas to 931 kPa (135 psi) for 1 inch and 1-3/16 inch bore, and 1034 kPa (150 psi) for 1-3/8 inch bore. Do not attempt to open puncture or apply heat to the shock absorbers.

All vehicles are equipped with low-pressure gas-filled hydraulic shock absorbers of the direct acting type. They are nonadjustable and nonrefillable. They cannot be serviced as cartridges and must be serviced as shock assemblies.

Before replacing a shock absorber, check the action of the shock absorbers as follows.

Vehicle Inspection

1. Check all tires for proper inflation pressure.
2. Check tire condition to confirm proper front end alignment, tire balance and overall tire condition such as separation or bulges.
3. Check the vehicle for optional suspension equipment such as heavy duty handling or trailer tow suspensions. These suspensions will have a firmer ride feeling than standard suspensions.
4. Check the vehicle attitude for evidence of possible overload or sagging.

   Many times front spring or torsion bar and front shock absorbers are replaced in an effort to solve a vehicle sag concern. Shock absorbers by design are hydraulic damping units only, and unlike suspension springs, do not support any suspension loads. Therefore, replacing a shock absorber will not correct a vehicle sag concern.
5. Road test vehicle to confirm customer concern.
6. Make sure the shock absorber is securely and properly installed.
7. Check the shock absorber insulators for damage and wear.
8. Replace any worn or damaged insulators and tighten attachments to the specified torque (on a shock absorber which incorporates internal insulators, replace the shock absorbers).
9. Tighten shock absorber attachments to specified torque. Refer to Section 04-01A (4x2), Section 04-01B (4x4), or Section 04-01C (Aerostar E-4WD).
10. Inspect the shock absorber for evidence of fluid leakage.

    A light film of oil (weepage) on the upper portion of the shock absorber is permissible and is a result of proper shock lubrication. Weepage is a condition in which a thin film of oil may be deposited on the shock outer tube (body) and is normally noticed due to the collection of dust in this area. Shock absorbers which exhibit this weepage condition are functional units and should not be replaced. Leakage is a condition in which the entire shock body is covered with oil and the oil will drip from the shock onto the pavement.

If this condition exists, perform the following steps:

- Make sure that fluid observed is not from sources other than the front shock absorber.
- Replace the worn or damaged front shock absorber.

11. Disconnect the lower end of the front shock absorber.

12. With shock absorber in normal upright position, extend and compress the shock absorber as fast as possible, using as much travel as possible. Action should become smooth and uniform throughout each stroke.

    - Higher resistance on extension than on compression is a normal condition.
    - Faint swish noises are also normal.

Hoist Check

1. **Noise:** Noise can be caused by loose suspension or shock attachments. Verify that all shock attachments and the suspension components are tight. Replace any worn or damaged upper stud insulators. Check front spring and front shock absorbers for external damage.

2. **Bottoming Out/Hopping:** Check condition of the rubber suspension travel stops (front suspension bumpers (3020)). Replace if worn or missing. Examine for evidence of previous overload or damaged components.

3. **Force-Check:** Support front suspension lower arm (3078) or axle, and remove lower front shock attachment. Stroke front shock body using as much travel as possible. The action should be smooth and uniform throughout each stroke. Damping forces should be equivalent on both sides of the vehicle.

4. Replace only the worn or damaged front shock absorber.

   In the past it was recommended that front shock absorbers be replaced in pairs if one unit became unrepairable. Improved sealing, new materials, design, and improved rod machining and hardening techniques have added to the reliability of shock absorbers. **Therefore, front shock absorbers no longer need to be replaced in pairs when only one unit is not repairable.**

Bench Test

The front shock absorbers are gas-pressurized, which results in their being fully extended when not restrained. If a front shock absorber does not fully extend, it is damaged and should be replaced. Check length overall. If the front shock absorber does not meet the length overall requirement, it is a good indication something internal is not to specification and the front shock absorber should be replaced.

With the front shock absorber in the normal upright position, compress it and allow it to extend three times to purge the pressure chamber of any gas that may have been introduced during handling.

Place the front shock absorber right side up in a vise. Hand-stroke the front shock absorber as fast as possible using as much travel as possible. Action should be smooth and uniform throughout each stroke. Higher resistance on extension than on compression is normal.

The following conditions are abnormal:

- A lag or skip at reversal of travel near mid-stroke when front shock absorber is properly primed and in the installed position
- Seizing
- Noise, other than a faint swish, such as a clicking upon fast stroke reversal
- Excessive fluid leakage
- With rod fully extended, any lateral motion of rod in relation to outer cylinder

If front shock absorber action remains erratic after purging air, install a front shock absorber, replacing only the damaged front shock absorber. Front shock absorbers do not need to be replaced as sets.

Suspension, Rear

1. Check for leaks on rear shock absorbers (18125).

2. Check shock absorber operation (whether operation is stiff, rough or spongy).

3. Check condition of rear suspension bushings and rear suspension springs.

If the above check reveals evidence of excessive wear, deterioration, or improper operation, replace damaged components.

Vehicle Lean

Side-to-side vehicle lean should be verified by measuring the fender lip-to-ground dimension before beginning diagnosis and service actions. Normal acceptable limits are:

- Maximum of 16mm (5/8 inch) variance between left and right front wheel lips to ground.
- Maximum of 20mm (3/4 inch) variance between left and right rear wheel lips to ground.

NOTE: Codes identifying the front and rear springs are printed on the Safety Standard Certification Label. If a spring should require replacement because it is damaged, worn or due to a leaning condition, replace only with the same part as specified on the label. In rare instances, the spring codes will not reflect the springs as installed due to a district special order (DSO) option or assembly plant substitution. If a DSO option number is shown on the certification label, the District Office can establish whether springs are affected. If the factory-installed springs do not agree with the code printed on the Safety Standard Certification Label (right and left spring part number should match), replace the damaged or worn spring with a new spring of the same part number as the damaged or worn spring. It will not be necessary to replace the matching, non-worn or undamaged spring.

Once a lean condition has been verified, the following procedure should be followed to resolve the condition:

1. Place the vehicle on a flat, smooth surface.

2. Inspect vehicle for any heavy add-ons that may cause excessive weight on any corner of the vehicle.

    - In cases where the excess weight is a snow plow, a rear tailgate lift, etc., the vehicle must be diagnosed with the equipment in place.
    - Measure corner weights if necessary.
    - Vehicle should be empty, fuel tanks full, no cargo such as tools, equipment or debris in the pickup box or rear body section.
    - Vehicle must be sitting on the wheels and tires and not a hoist, jack or jackstands.

3. Check all wheels (1007) and tires:

    - Wheels must be same size and design, right and left side on each axle.
    - Wheels size and design, tire size and tire design should be as indicated on the Vehicle Certification Label.
    - Check air pressure of all tires; inflate to specifications indicated on the Vehicle Certification Label.

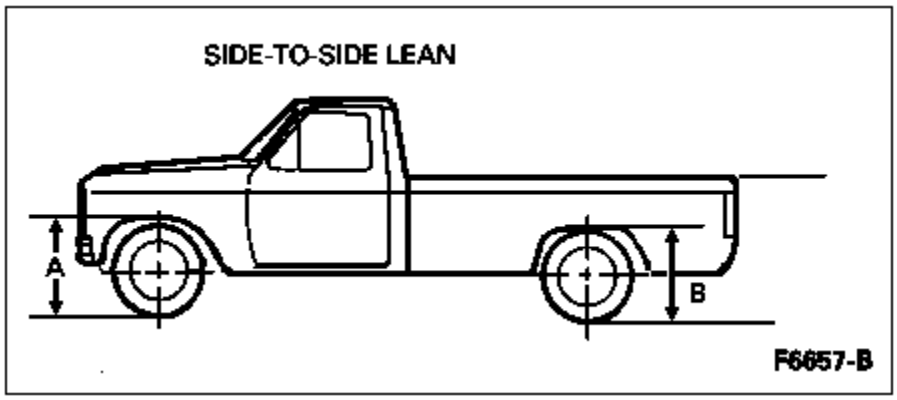
4. Check front and rear suspension. Make sure the same spring is on the left/right front and left/right rear. The front coil springs (5310) have I.D. tags indicating the part number. The rear springs (5560) have the part number stamped on the bottom just behind the U-bolt attachment.

5. Jounce the vehicle's front and rear suspension to normalize the vehicle static ride height.

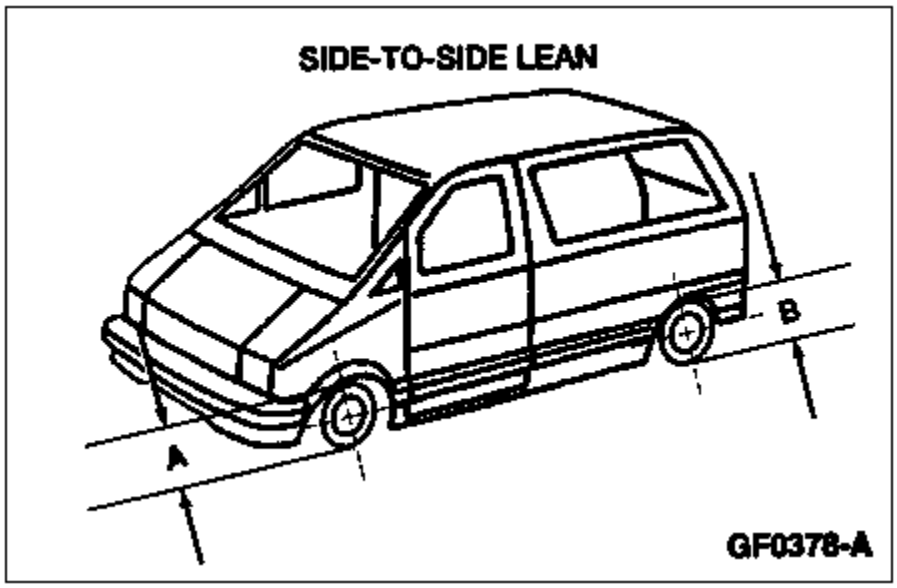
6. Measure the height of the right and left fender lip openings for both front (dimension A) and rear (dimension B).

7. Calculate the side-to-side differences for each dimension. If these differences are greater than 16mm (5/8 inch) between left or right front and/or 20mm (3/4 inch) between left and right rear, adjustment can be performed following the procedure under Adjustments, Vehicle Lean in this section.

Ranger



Aerostar


SIDE-TO-SIDE LEAN
A
B
GF0378-A

Symptom Chart — Suspension, Service

Refer to the following chart for front suspension problems. For driveline noise, refer to Section 00-04 . For additional diagnostics related to alignments, refer to Section 05-00 .

SUSPENSION, SERVICE

Condition	Possible Source	Action
• Vehicle Leans to One Side	• Incorrect tire pressure.	• ENSURE specified tire pressure for all four tires.
	• Improper tire/wheel usage.	• INSTALL correct tire/wheel combination.
	• Vehicle overloaded or unevenly loaded.	• CORRECT as required.
	• Loose, worn or damaged front or rear suspension components.	• Visually INSPECT suspension systems. REPAIR or REPLACE as required.
	• Improper spring usage or improperly installed and seated springs.	• Correct as required.
	• Incorrect front axle ride height.	• ADJUST or REPLACE as required.
	• Twin I-Beam to frame dimension out of specifications (over 16mm [5/8 inch] difference side to side) for Ranger.	• For Ranger, REFER to Adjustments, Front Lean for instructions on shimming to ADJUST ride height.
	• Incorrect rear axle ride height.	• ADJUST or REPLACE as required.
	• Rear axle to frame dimension out of specification (Ranger).	• For Ranger , LOOSEN spring shackle and hanger bolts, both sides. JOUNCE vehicle. TIGHTEN U-bolts to specification. RECHECK height.
		• If side-to-side ride height is less than 20mm (3/4 inch), REFER to Adjustments, Rear Lean in this section.
		• If ride height is greater than 20mm (3/4 inch), SWITCH rear springs from side to side.
		• If rear spring switch is not effective, REPLACE both rear springs.
		• TIGHTEN all bolts to specification.
• Front Bottoming or Riding Low	• Incorrect tire pressure.	• CORRECT as required.

	• Improper tire/wheel usage.	• INSTALL correct tire/wheel combination.
	• Vehicle overloaded or unevenly loaded.	• REMOVE or REDISTRIBUTE load as required.
	• Broken or incorrectly installed front coil springs.	• REPAIR or REPLACE as necessary.
	• Loose or broken front shock absorbers.	• TIGHTEN or REPLACE as necessary.
	• Distorted or split front suspension bumper.	• CORRECT as required.
	• Improper ride height.	• For Ranger and Aerostar, MEASURE vertical distance between axle and spring tower flange/frame rail. If height is below ride heights, INSTALL shims (part number 389117 shims — 2 max.) under lower spring seats.
	• Incorrect front coil springs.	• REPLACE front coil springs.
• Dogtracking of Rear Wheels	• Loose or damaged front or rear suspension components.	• INSPECT, REPAIR or REPLACE as required.
	• Loose rear spring U-bolts.	• CHECK for damaged components. REPAIR as required.
	• Rear springs improperly installed on axle.	• REPAIR as required.
	• Rear spring center bolt bent.	• REPLACE center bolt.
	• Non-OEM size/style tires and/or wheels.	• INSTALL OEM equipment.
• Shimmy or Wheel Tramp	• Loose front axle pivot bracket attaching parts (Ranger).	• TIGHTEN to specification.
	• Loose upper or lower control arm attaching parts (Aerostar).	• INSPECT and TIGHTEN to specification.
	• Tire pressure.	• ADJUST air pressure in tires.
	• Excessive tire sidewall deflection.	• INSPECT, ADJUST air pressure and REPLACE as necessary.
	• Irregular tire wear or tire sizes not uniform.	• CHECK front wheel alignment, ADJUST and REPLACE with same size tires.
	• Loose wheel lugnuts.	• REPLACE damaged parts. TIGHTEN to specifications.
	• Front wheel bearing adjustment.	• ADJUST to specifications.
	• Radial runout of wheels.	• FOLLOW tire and wheel runout

		check in this section.
	• Radial runout of tires.	• FOLLOW tire and wheel runout check in Section 04-04 .
	• Wheel and tire lateral runout not to specifications.	• FOLLOW tire and wheel runout check in Section 04-04 .
	• Wheel and tire balance.	• BALANCE wheels and tires.
	• Front wheel alignment (toe-in, camber and caster).	• SET toe to specifications. SET caster to specifications.
	• Deteriorated radius arm bushing (Ranger).	• REPLACE.
	• Loose or damaged front shock absorbers.	• TIGHTEN and REPLACE as necessary.
	• Loose, worn or damaged steering linkage and idler arm connections (Ranger).	• TIGHTEN or REPLACE as necessary.
	• Loose, worn or damaged steering tie rods (Aerostar).	• TIGHTEN or REPLACE as necessary.
	• Broken or sagging springs.	• REPLACE as required.
	• Loose steering gear mounting.	• INSPECT and REPAIR as required. TIGHTEN to specifications.
	• Incorrect steering gear adjustment (Ranger).	• ADJUST to specifications.
	• Worn ball joints.	• REPLACE ball joints.
• Sway or Roll	• Tire pressure.	• ADJUST air pressure in tires.
	• Worn or loose stabilizer assembly.	• TIGHTEN or REPLACE as required.
	• Loose or defective front shock absorbers.	• TIGHTEN or REPLACE as required.
	• Excessive load or body height.	• CORRECT as necessary.
	• Unequal load distribution (side to side or excessively rearward).	• CORRECT as necessary.
	• Loose wheel lugnuts.	• TIGHTEN to specifications.
	• Broken or sagging spring (Ranger, Aerostar).	• REPLACE as required.
	• Steering gear adjustment (Ranger).	• ADJUST to specifications.
	• Loose steering gear mounting.	• CHECK for damaged components. REPAIR as required.
	• Excessive front or rear	• CORRECT as necessary.

	overhang.	
	• Broken tie bolts on rear spring.	• REPLACE as required.
	• Non-OEM size/style tires and/or wheels.	• INSTALL OEM equipment.
• Wander	• Improper loading.	• WEIGH vehicle/balance load.
	• Improper tire/wheel size.	• REPLACE as necessary.
	• Improper tire pressure.	• INFLATE to specification.
	• Steering gear not centered (Ranger).	• CENTER steering wheel by ADJUSTING tie rod.
	• Steering gear preload/meshload adjustment off (Ranger).	• MEASURE/ADJUST preload/meshload.
	• Incorrect wheel alignment.	• ALIGN front end.
	• Excessive spindle rotating torques.	• INSPECT ball joints. REPLACE as necessary.
	• Steering linkage ball studs sloppy (Ranger).	• INSPECT and REPLACE as necessary.
	• Steering inner or outer tie rods sloppy (Aerostar).	• INSPECT and REPLACE as necessary.
• Sticky, Steering, Pointing or Poor Small Angle Returnability	• High spindle rotating torque.	• INSPECT and REPAIR.
	• Fluid level low.	• CHECK fluid level.
	• Incorrect front wheel toe set (poor groove feel mainly).	• MEASURE and RESET toe-in
	• Excessive steering gear preload/meshload (Ranger).	• MEASURE and ADJUST meshload/preload.
• Drift/Pull	• Improper loading creating caster split.	• MEASURE alignment and service as required. WEIGH vehicle.
	• Mismatched tires/wheels.	• REPAIR as required.
	• Tire pressure.	• INFLATE to specification.
	• Uneven tire wear (conicity).	• REPAIR through tire rotation.
	• Unequal tire circumferences.	• MEASURE and REPAIR.
	• Excessive caster split.	• CHECK caster split — SET to optimum caster split per alignment chart in this section.
	• Improper toe set.	• MEASURE and RESET toe-in.
	• Front/rear wheel brake	• CHECK during alignment inspection.

	drag. • Power steering rotary control valve centering (Ranger).	• CHECK steering gear centering. REFER to Section 11-02B .
• Drift Left or Right	• Tires. • Steering linkage. • Alignment.	• PERFORM Pinpoint Test A .
• Steering Wheel Off-Center	• Clear vision. • Steering linkage.	• PERFORM Pinpoint Test B .
• Tracks Improperly	• Caster. • Rear suspension.	• PERFORM Pinpoint Test C .
• Rough Ride	• Front shock absorbers. • Rear shock absorbers.	• PERFORM Pinpoint Test D .
• Excessive Noise	• Shock absorbers • Springs. • Suspension components.	• PERFORM Pinpoint Test E .
• Improper Tire Wear	• Tires (alignment). • Tires (balance).	• PERFORM Pinpoint Test F .
• Vibration	• Tires and wheels. • Wheel bearings. • Wheel hubs. • Rotors. • Drums.	• PERFORM Pinpoint Test G .

Pinpoint Tests

PINPOINT TEST A: DRIFT LEFT OR RIGHT

A1 CHECK TIRES

- Inspect tires for excessive wear or damage.

Are tires excessively worn or damaged?

Yes	No
REPLACE tires.	GO to **A2** .

A2 CHECK STEERING LINKAGE

- Raise vehicle on hoist.
- Check steering linkage for indications of excessive wear or damage.

Is there indication of excessive wear or damage?

Yes	No
REPAIR or REPLACE worn or damaged components as necessary.	GO to **A3** .

A3 CHECK VEHICLE ALIGNMENT

- Place vehicle on an alignment rack.
- Check vehicle alignment.

Is alignment within specification?

Yes	No
GO to **B1** .	ADJUST alignment as necessary.

PINPOINT TEST B: STEERING WHEEL OFF-CENTER

B1 CHECK CLEAR VISION

- Place vehicle on alignment rack.

Is clear vision within specifications?

Yes	No
GO to **B2** .	ADJUST clear vision to specification. REFER to Adjustments, Alignment For Clear Vision .

B2 INSPECT STEERING COMPONENTS

- Raise vehicle on hoist.
- Inspect steering and suspension components for excessive wear or damage.

Are steering and suspension components excessively worn or damaged?

Yes	No
REPLACE or REPAIR worn components. REFER to Section 04-01A , Section 04-01B , Section 04-01C or Section 11-00 .	GO to **C1** .

PINPOINT TEST C: TRACKS IMPROPERLY

C1 CHECK CASTER

- Place vehicle on alignment rack.

Is caster within specification?

Yes	No
GO to **C2** .	ALIGN vehicle.

C2 CHECK REAR SUSPENSION

- Measure vehicle wheel base for LH and RH.
- Compare measurements.

Are measurements the same?

Yes	No
	INSPECT rear suspension components for wear or damage. REPAIR or REPLACE worn or

GO to **D1** .	damaged components as required. REFER to Section 04-02 .

PINPOINT TEST D: ROUGH RIDE

D1 CHECK FRONT SHOCK ABSORBERS

- Raise vehicle on hoist.
- Inspect front shock absorbers for oil leaks or damage.

Are front shock absorbers leaking?

Yes	No
REPLACE front shock absorbers. REFER to Section 04-01A , Section 04-01B or Section 04-01C .	GO to **D2** .

D2 CHECK REAR SHOCK ABSORBERS

- With vehicle on hoist, inspect rear shock absorbers for oil leak or damage.

Are rear shock absorbers leaking?

Yes	No
REPLACE rear shock absorbers. REFER to Section 04-02 .	Vehicle OK.

PINPOINT TEST E: EXCESSIVE NOISE

E1 INSPECT SUSPENSION

- Raise vehicle on hoist.
- Inspect shock absorber mount bolts.

Are mounting bolts loose or broken?

Yes	No
TIGHTEN/REPLACE shock absorber mount bolts. REFER to Section 04-01A , Section 04-01B or Section 04-02 .	GO to **E2** .

E2 INSPECT SPRINGS

- With vehicle on hoist, inspect springs for damage.

Are springs damaged?

Yes	No
REPLACE springs. REFER to Section 04-01A , Section 04-01B , Section 04-01C or Section 04-02 .	GO to **E3** .

E3 INSPECT FRONT SUSPENSION

- Inspect front suspension components for excessive wear or damage.

Are front suspension components worn or damaged?

Yes	No
REPLACE worn or damaged front suspension components. REFER to Section 04-01A , Section 04-01B or Section 04-01C .	Vehicle OK.

PINPOINT TEST F: IMPROPER TIRE WEAR

F1 INSPECT TIRES

- Raise vehicle on hoist.
- Inspect tires for uneven wear on inner or outer shoulder.

Is there uneven tire wear?

Yes	No
ALIGN vehicle. REPLACE tires if badly worn.	GO to **F2** .

F2 UNEVEN TIRE WEAR

- With vehicle on hoist, inspect tires for sawtooth pattern.

Do tires have sawtooth pattern?

Yes	No
ALIGN vehicle. REPLACE tires if badly worn.	GO to **F3** .

F3 CHECK FOR CUPPED TIRE

- With vehicle on hoist, inspect tires for cupping or dishing.

Are tires cupped or dished?

Yes	No
BALANCE and ROTATE tires.	Vehicle OK.

PINPOINT TEST G: VIBRATION

G1 ROAD TEST

- Accelerate vehicle to the speed which the customer indicated the vibration occurred.

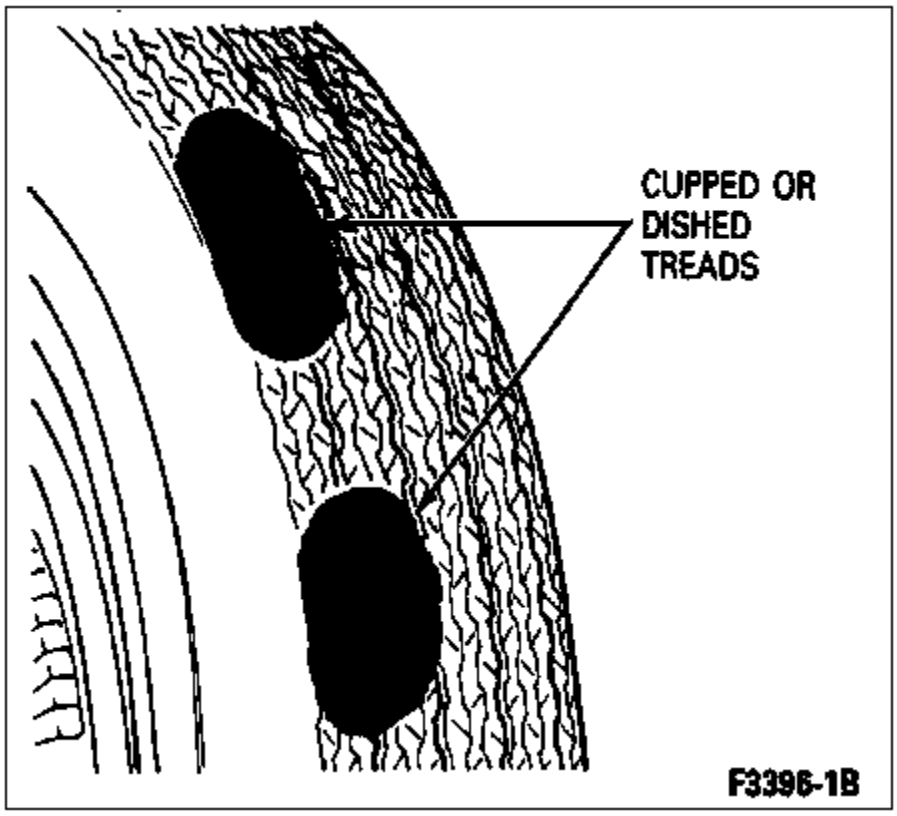
Is a vibration present?

Yes	No
GO to **G2** .	Vehicle OK.

G2 INSPECT TIRES

- Raise vehicle on a frame contact hoist. Inspect tires for extreme wear or damage, cupping or flat spots. Refer to Diagnosis and Testing, Tire Wear in this section.

Are tires OK?



Yes	No
GO to G3.	CHECK suspension components for misalignment, abnormal wear, or damage that may have contributed to the tire wear. CORRECT suspension concerns and REPLACE damaged tires. PERFORM Road Test.

G3 INSPECT WHEEL BEARINGS

- Spin tires by hand to check for wheel bearing roughness. Check wheel bearing end play.

Is wheel bearing end play OK?

Yes	No
GO to G4.	REPLACE wheel bearings as necessary. PERFORM Road Test.

G4 TIRE/WHEEL BALANCE

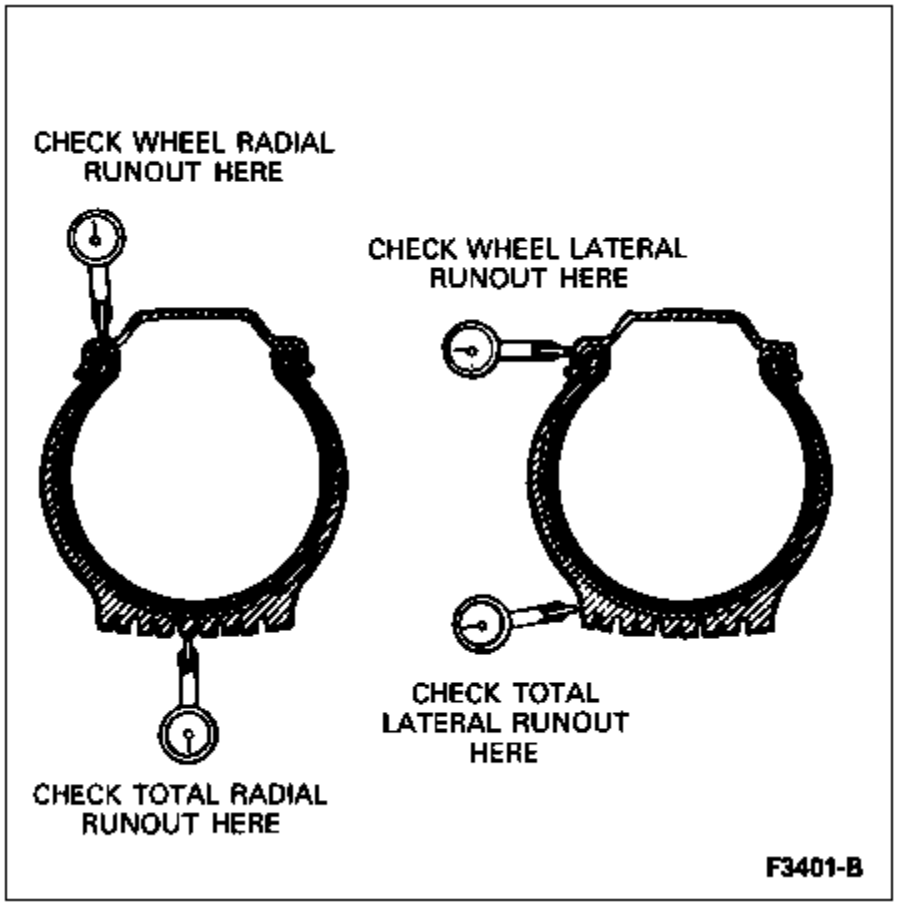
- Check tire/wheel balance, correct as needed.
- Road test.

Are tires and wheels balanced?

Yes	No
GO to **G5** .	BALANCE tires and wheels as necessary. PERFORM Road Test.

G5 MEASURE RUNOUTS

- For each wheel position measure, locate and mark:
  - High point of tire/wheel assembly total radial runout.
  - High point of wheel radial runout.
  - High point of wheel lateral runout.



- Record all measurements in chart below.

Have all tire/wheel assemblies been measured?

Assembly Position	Tire/Wheel Assembly Total Radial Runout	Wheel Radial Runout	Wheel Lateral Runout
Left Front			

Right Front			
Left Rear			
Right Rear			
Example	1.52mm (0.060 Inch)	0.50mm (0.020 Inch)	0.63mm (0.025 Inch)

Yes	No
GO to **G6** .	COMPLETE measurements and REPEAT Step **G5** .

G6 ANALYSIS OF RUNOUT MEASUREMENT

- Measurements obtained in G5 will fall within guidelines below.

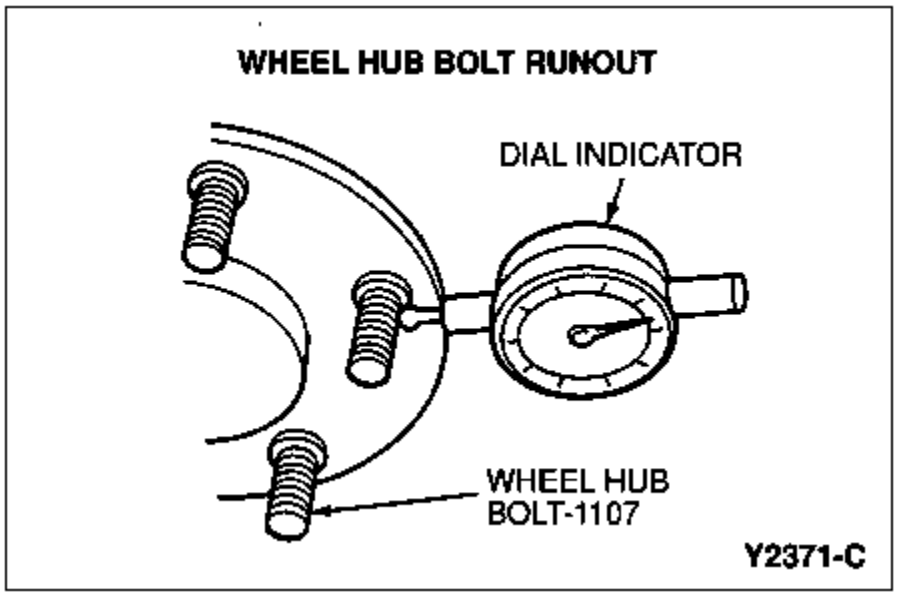
Do any of these conditions exists?

Condition	Assembly Total Radial Runout	Wheel Radial Runout	Wheel Lateral Runout
1	Less Than 1.02mm (0.040 Inch)	Less Than 1.14mm (0.045 Inch)	Less Than 1.14mm (0.045 Inch)
2	Less Than 1.02mm (0.040 Inch)	More Than 1.14mm (0.045 Inch)	Less Than 1.14mm (0.045 Inch)
3	Less Than 1.02mm (0.040 Inch)	Less Than 1.14mm (0.045 Inch)	More Than 1.14mm (0.045 Inch)
4	More Than 1.02mm (0.040 Inch)	Less Than 1.14mm (0.045 Inch)	Less Than 1.14mm (0.045 Inch)
Example	More	Less	Less

Yes	No
Condition 1; Good Assembly. GO to **G12** . Condition 2; REPLACE wheel. GO to **G7** . Condition 3; REPLACE wheel. GO to **G7** . Condition 4; INDEX tire/wheel. GO to **G9** .	RECHECK measurements.

G7 WHEEL HUB BOLT RUNOUT

- Wheel hub bolt runout can affect wheel runout. Remove wheels and inspect lug bolts.
- Measure wheel hub bolt runout. Refer to Section 04-04 .



- Wheel hub bolt circle runout should not exceed .41mm (0.016 inch). TIR (Total Indicated Runout).

Is wheel hub bolt runout within the limit?

Yes	No
GO to **G8** .	CHECK for bent or damaged lug bolts. REPLACE as necessary. CHECK wheel hub bolt runout again. If OK, GO to **G8** .

G8 REPLACING A WHEEL

- Align the runout index mark of the new wheel 180 degrees away from the previously measured total assembly radial runout high point.
- Measure the runouts on the new assembly.

Is assembly within specification from G6?

Yes	No
GO to **G11** .	FOLLOW direction from **G6** .

G9 INDEX TIRE/WHEEL ASSEMBLY

- Align high point of total assembly radial runout 180 degrees away from high point of wheel radial runout.
- Measure total assembly radial runout.

Is total radial runout less than 0.76mm (0.030 inch)?

Yes	No
GO to **G11** .	GO to **G10** .

G10 REPLACE A TIRE

- Align high point of wheel radial runout to runout index mark on new tire.
- Measure total assembly radial runout.

Is total radial runout less than 1.02mm (0.040 inch)?

Yes	No
GO to **G11** .	REPEAT procedure **G10** with another new tire.

G11 BALANCE NEW TIRE/WHEEL

- Balance new tire/wheel assembly.
- After all assemblies have been checked and corrected, road test vehicle.

Is vehicle operating correctly?

Yes	No
Vehicle OK.	GO to **G12** .

G12 SUBSTITUTE WHEELS AND TIRES

- Substitute a known good set of wheels and tires.
- Road test.
- If the vehicle still exhibits a shake or vibration, note the vehicle speed and/or engine rpm at which it occurs.

Is vibration felt?

Yes	No
GO to **G13** .	INSTALL original tire/wheel assemblies one by one, ROAD TESTING at each step until the damaged tire(s) is identified. REPLACE tire(s) as necessary and RETEST.

G13 VIBRATION DIAGNOSIS OF ENGINE/TRANSMISSION VS. DRIVESHAFT/SUSPENSION COMPONENTS

- Spin all four wheels independently to identify position generating problem vibration.
  - For rear wheels, use on car balance machine.
  - For front wheels, accelerate to half critical speed observed in road test.

Was any vibration observed at the wheels?

Yes	No
CHECK front disc brake hub and rotors or brake drums. REFER to Pinpoint Tests in Section 00-04 .	Engine/transmission imbalance. REFER to Group 02, Group 03 and Group 07.

Component Tests

Ball Joints, Front Suspension Upper and Lower, Aerostar

1. Position a floor jack under the front suspension lower arm (3078) and jack up the vehicle far enough for the tire to clear the ground.

2. Grasp the lower edge of the tire and move the wheel in and out. While the wheel is being moved, observe the lower spindle jaw and the front suspension lower arm.

A movement of 0.8mm (1/32-inch) or greater between the front suspension lower arm and the lower spindle jaw indicates the front suspension lower arm ball joint (3050) must be replaced.

3. Inspect the rubber bushings at the lower control arm attachments for wear or looseness. Repair or replace parts as necessary.

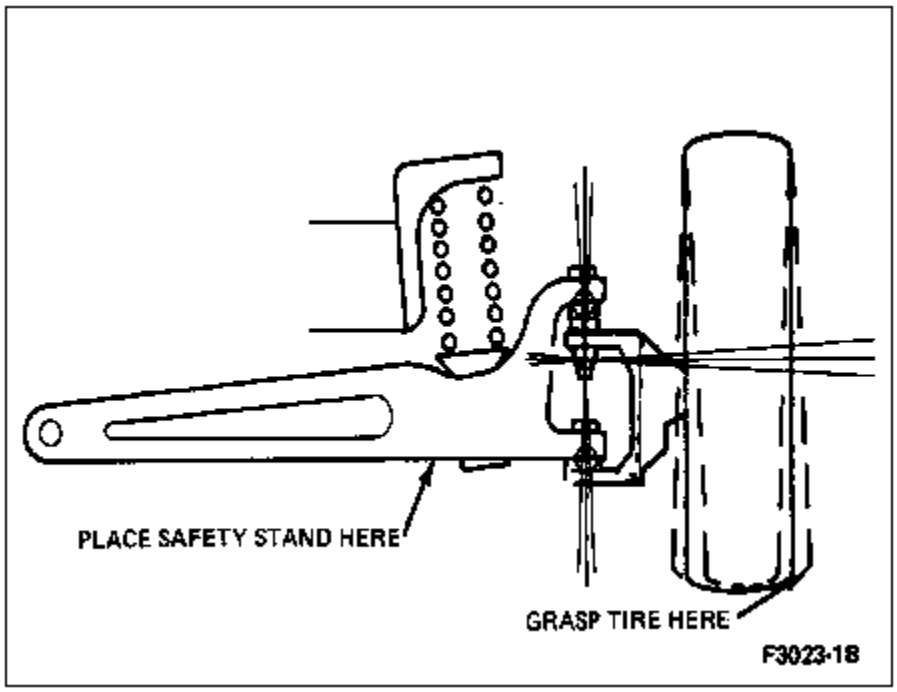
4. Grasp the upper edge of the tire and move the wheel in and out. A 0.8mm (1/32-inch) or greater movement between the upper spindle arm and the front suspension upper arm (3083) indicates that the front suspension upper ball joint (3049) must be replaced.

5. Inspect the rubber bushings at the front suspension upper arm attachments for wear or looseness. Repair or replace as necessary.

Ball Joints, Front Suspension Upper and Lower, Ranger

Prior to performing any ball joint inspection, check and adjust the front wheel bearings as described in Section 04-01A (4x2) or Section 05-03A (4x4).

1. Raise the vehicle and place safety stands under the I-beam axle beneath the front coil spring (5310) as shown.



2. Have an assistant grasp the lower edge of the tire and move the wheel in and out.

3. While the wheel is being moved, observe the lower spindle arm and the lower part of the axle jaw.

    - A 0.8mm (1/32-inch) or greater movement between the lower part of the axle jaw and lower spindle arm indicates that the front suspension lower arm ball joint must be replaced.

4. Check the front suspension upper ball joints. Grasp the upper edge of the tire and move the wheel in and out.

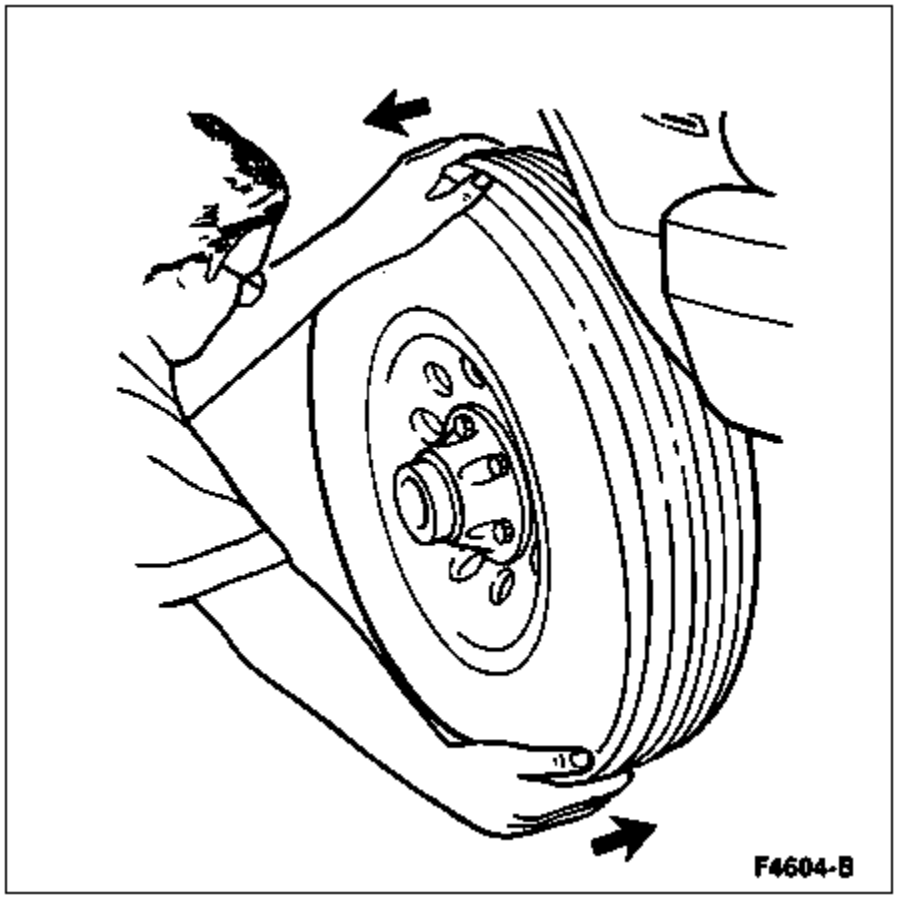
    - A 0.8mm (1/32-inch) or greater movement between the upper spindle arm and the upper part of the axle jaw indicates that the front suspension upper ball joint must be replaced.

Wheel Bearing End Play, Front

1. **NOTE: For 4x4 Aerostar vehicles, the wheel bearings are part of the spindle hub assembly and are not repairable. If end play is found to be excessive, replace the spindle hub and bearing assembly. Refer to Section 05-03C.**

   Raise the vehicle until the tire clears the floor.

2. Grasp each front tire at the top and bottom and push the wheel inward and outward while lifting the weight of the tire off the bearings.



3. Make sure the wheel (1007) rotates freely and the brake pads are retracted sufficiently to allow movement of the wheel assembly.

4. End play is adjustable to correct bearing and shoulder wear on the front wheel spindle (3105).

   - Check end play at regular intervals to ensure proper operation and long life of bearings.
   - If end play is adjusted too tightly, the bearings will overheat and wear rapidly. End play that is excessively loose can cause pounding and contribute to uneven tire wear, steering difficulties and inefficient brakes.

5. Clean, inspect and lubricate front hub assemblies and bearings whenever the hub assemblies are removed or at the mileage/time periods indicated in the maintenance schedule.

6. **NOTE: A damaged or worn seal may permit bearing lubricant to reach the brake linings, resulting in ineffective brake operation and necessitating premature replacement of linings.**

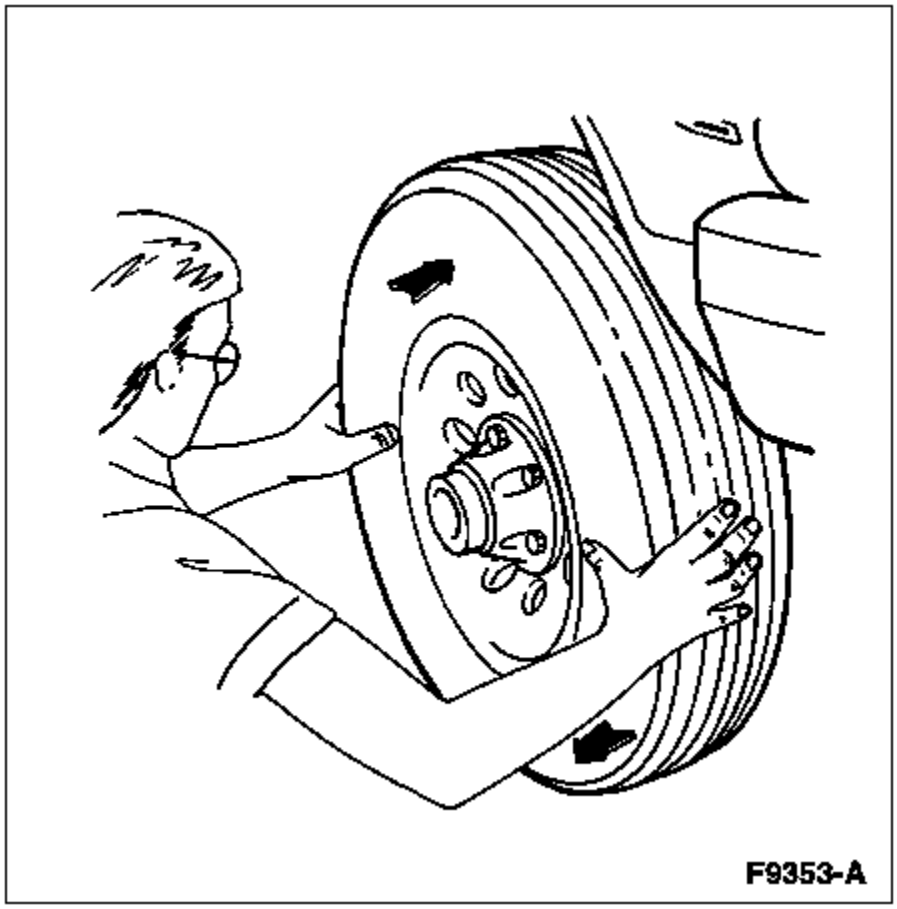
   Install new hub assembly grease seals when the hub is removed.

7. If the wheel/hub-rotor is loose on the front wheel spindle or does not rotate freely, adjust the wheel bearings as described in Section 04-01A (4x2) or Section 05-03A (Ranger 4x4).

Steering Linkage

1. With the vehicle resting on the ground and the parking brake fully applied, perform the following.

   a. Have someone turn the steering wheel back and forth 360 degrees and watch for relative motion of the studs in the steering linkage ball sockets.
      - Excessive **vertical** motion of the studs relative to the sockets may indicate excessive wear.
   b. Watch for a loose steering gear attachment to the frame. Another method is to raise the front tires off the ground.
      - Grasp the tire at the front and rear and watch for excessive play in the joints while trying to steer the wheels.



- Steel, greaseable joints (Ranger) or tie rod joints (Aerostar) can be checked for excessive wear by measuring the torque it takes to turn the stud.
- Remove the tapered stud from its seat and thread the attaching nut back onto the stud. Turn the stud with a pound-inch torque wrench and note the torque to turn the stud.

Joints	Nm	Lb-In
New Steel Joints	1.1-7.9	10-70
Good, Used Joints	0.5-4.5	5-40
Joint with Excessive Play	0.5	5

- Some joint turning torques will be as little as 0.5 Nm (5 lb-in) within the first 1000 miles and remain there for the life of the joint.
- Only replace a ball joint that requires less than 0.5 Nm (5 lb-in).
- Tighten or replace loose, worn or damaged steering parts as described in the appropriate section in Group 11.

Dogtracking

To diagnose a dogtrack situation, find a stretch of empty road or an empty parking lot and perform the following steps.

1. Drive the vehicle while sighting down the hood. Use a hood ornament or a body style line to be able to see if the vehicle is going in a straight line or dogtracking.

2. Stop the vehicle when you notice the vehicle dogtracking. Have an assistant mark the position of the center tread of both front tires with chalk on the ground.

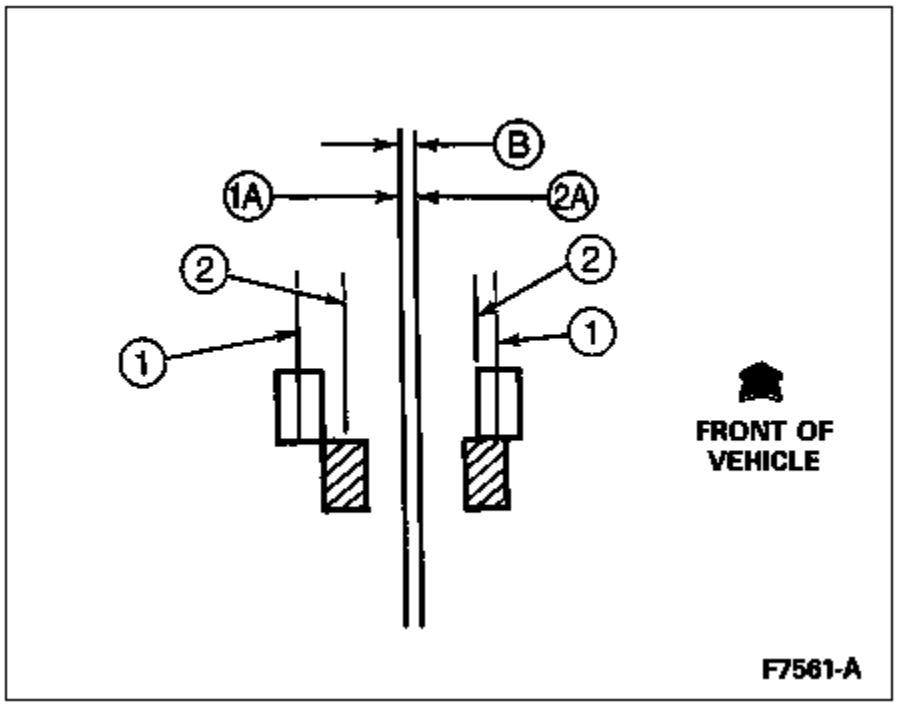
3. Slowly pull the vehicle forward until the rear tires are at the same position as the marks made for the front tires.

4. Have your assistant mark the ground as he did for the front tires, identifying which marks are for the front tires and which ones are for the rear tires.

5. Move the vehicle out of the way so all marks can be seen.

6. Proceed to measure the total amount of dogtracking as follows:

    - Measure the distance between the front tire marks.
    - Mark the ground exactly halfway between these marks.
    - Do the same for the rear tire marks.
    - The difference between the two center marks is the amount of dogtracking present in the vehicle.



Item	Part Number	Description
1	—	Centerline of Front Tire Tread
1A	—	Centerline Between Front Tires
2	—	Centerline of Rear Tire Tread
2A	—	Centerline Between Rear Tires
B	—	Dimension "B" Equals Total Amount of Dogtracking

Wheel Bearings, Front

NOTE: For Aerostar 4x4 vehicles, the wheel bearings are part of the spindle hub assembly and are not repairable. If the hub bearing is worn or damaged, replace the spindle hub and bearing as an assembly. Refer to Section or 05-03C (Aerostar).

Wheel bearings are adjustable to correct for bearing and shoulder wear on the spindle.

1. **CAUTION: If bearings are adjusted too tightly, they will overheat and wear rapidly. An adjustment that is excessively loose can cause pounding and contribute to uneven tire wear, steering difficulties and inefficient brakes.**

   NOTE: Bearing adjustment should be checked at regular inspection intervals.

   Front hub assemblies and bearings should be cleaned, inspected and lubricated whenever the hub assemblies are removed or at the mileage/time periods indicated in the maintenance schedule.

2. **CAUTION: A damaged or worn seal may permit bearing lubricant to reach the brake linings, resulting in ineffective brake operation and necessitating premature replacement of the linings.**

   New hub assembly grease seals should be installed when the hub is removed.

3. Bearing adjustment is described for Ranger 4x2, and Aerostar 4x2 in Section 04-01A . For Ranger 4x4, refer to Section 05-03A . For Aerostar E-4WD the bearings are not adjustable.

Wheel Alignment, Front

Caster and Camber, Aerostar

Caster and camber adjustment is provided by shims on the front suspension upper arm (3083). The two different shims initially provided from the assembly plant include one 2mm (.078-inch) thick shim and one 6mm (.236-inch) thick shim for a total shim stack thickness of 8mm (0.315 inch) at each leg of the front suspension upper arm. The shims are to be added, deleted or switched from the front and rear legs of the front suspension upper arms as required to adjust the alignment. Use of only these hardened shims is suggested to provide adequate reliability and durability.

- Camber adjustment is obtained by removing or adding an equal number of shims to the front and rear leg of the adjusting arm.
- Caster adjustment is obtained by removing shims from the front leg and installing them on the rear leg, or vice-versa. If the same amount is switched from one leg to the other, the caster will be revised but the camber will not be affected.
- If unequal amounts are removed and added to the front and rear legs, both the caster and camber will be revised. Refer to caster and camber charts in this section.

To ease the access from the fender opening over the tire to the front suspension upper arm assembly, the following tools are recommended.

- Wrench D87T-3068-A or equivalent.
- Pivoting ratchet.
- A 24-inch extension for the ratchet.
- Crow's foot wrenches and adapters.

1. Position unit on front end alignment equipment and check status of caster, camber and toe-in.

2. **NOTE: Do not loosen front suspension upper arm-to-frame and crossmember bolts for caster/camber adjustment unless shims do not provide adequate adjustment.**

   Adjust caster and camber by loosening the two front suspension upper arm retaining nuts, adding or removing the necessary amount of shims.

3. When using shims, refer to the following charts.

CASTER CHANGES — AEROSTAR

Caster Change	Camber Change	Shim Changes	
		Front Leg	Rear Leg
Increase Caster by 2 Degrees	None	Add One 6mm (.236 Inches) Shim	Remove One 6mm (.236 Inches) Shim
Increase Caster by 1.67 Degrees	+.1°-.2°	Add One 6mm (.236 Inches) Shim	Remove Two 2mm (.078 Inches) Shims

Increase Caster by 1.33 Degrees	None	Add Two 2mm (.078 Inches) Shims	Remove Two 2mm (.078 Inches) Shims
Increase Caster by 1 Degree	+.1°-.2°	Add Two 2mm (.078 Inches) Shims	Remove One 2mm (.078 Inches) Shim
Increase Caster by .67 Degrees	None	Add One 2mm (.078 Inches) Shim	Remove One 2mm (.078 Inches) Shim
Increase Caster by .33 Degrees	+.1°-.2°	Add One 2mm (.078 Inches) Shim	No Change
0 or Starting Position		No Change	No Change
Decrease Caster by .33 Degrees	-.1°-.2°	Remove One 2mm (.078 Inches) Shim	No Change
Decrease Caster by .67 Degrees	None	Remove One 2mm (.078 Inches) Shim	Add One 2mm (.078 Inches) Shim
Decrease Caster by 1 Degree	-.1°-.2°	Remove Two 2mm (.078 Inches) Shims	Add One 2mm (.078 Inches) Shim
Decrease Caster by 1.33 Degrees	None	Remove Two 2mm (.078 Inches) Shims	Add Two 2mm (.078 Inches) Shims
Decrease Caster by 1.67 Degrees	-.1°-.2°	Remove One 6mm (.236 Inches) Shim	Add Two 2mm (.078 Inches) Shims
Decrease Caster by 2 Degrees	None	Remove One 6mm (.236 Inches) Shim	Add One 6mm (.236 Inches) Shim

CAMBER CHANGES — AEROSTAR

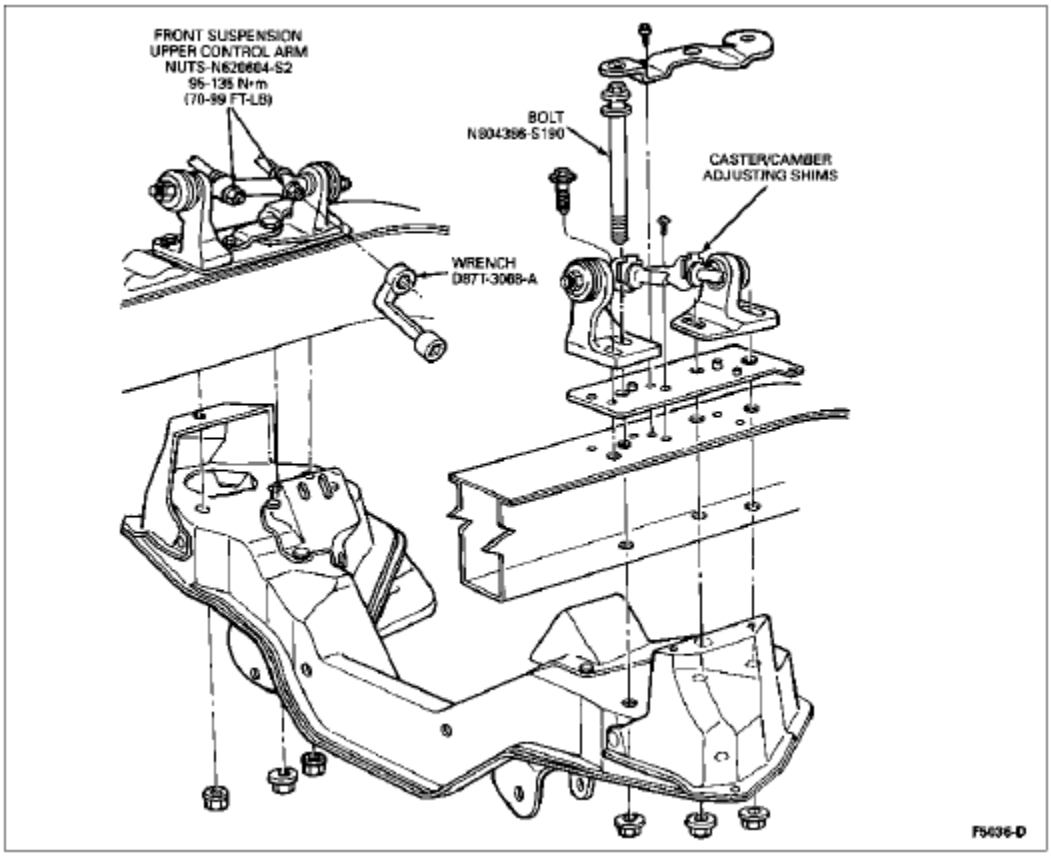
Camber Change	Shim Changes	
	Front Leg	**Rear Leg**
Increase Camber by 1.67 Degrees	Add One 6mm (.236 Inches) and Two 2mm (.078 Inches) Shims	Add One 6mm (.236 Inches) and Two 2mm (.078 Inches) Shims
Increase Camber by 1.33 Degrees	Add One 6mm (.236 Inches) and Two 2mm (.078 Inches) Shims	Add One 6mm (.236 Inches) and Two 2mm (.078 Inches) Shims
Increase Camber by 1 Degree	Add One 6mm (.236 Inches) Shim	Add One 6mm (.236 Inches) Shim
Increase Camber by .66 Degrees	Add Two 2mm (.078 Inches) Shims	Add Two 2mm (.078 Inches) Shims
Increase Camber by .33 Degrees	Add One 2mm (.078 Inches) Shim	Add One 2mm (.078 Inches) Shim
0 or Starting Position	No Change	No Change
Decrease Camber by .33 Degrees	Remove One 2mm (.078 Inches) Shim	Remove One 2mm (.078 Inches) Shim
Decrease Camber by .67 Degrees	Remove Two 2mm (.078 Inches) Shims	Remove Two 2mm (.078 Inches) Shims
Decrease Camber by 1 Degree	Remove One 6mm (.236 Inches) Shim	Remove One 6mm (.236 Inches) Shim
Decrease Camber by 1.33 Degrees	Remove One 6mm (.236 Inches) and One 2mm (.089 Inches) Shims	Remove One 6mm (.236 Inches) and One 2mm (.078 Inches) Shims

Decrease Camber by 1.67 Degrees	Remove One 6mm (.236 Inches) and One 2mm (.078 Inches) Shims	Remove One 6mm (.236 Inches) and One 2mm (.078 Inches) Shims

4. Retighten front suspension upper arm nuts to 95-135 Nm (70-100 lb-ft) to prevent the loss of shims or the movement of the front suspension upper ball joint (3049).

5. Adjust toe-in as described in Adjustments, Toe in this section.

Caster/Camber Adjustment, Aerostar



Caster and Camber, Ranger 4x2 and 4x4

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Pitman Arm Puller	T64-3590-F

Caster and camber adjustment is possible with service adjusters available in 1/2-degree, 1-degree and 1-1/2-degree increments. One adjuster is used to adjust both caster and camber depending on its orientation.

1. Measure vehicle caster and camber.

- Refer to the alignment charts in this section to determine if the vehicle is within specifications.
- Note difference between the actual measurements and the specification. This information will be used to select the correct service adjuster.

2. If adjustment is necessary, determine the amount of caster/camber in the adjuster installed in the vehicle.

   - Production adjusters have the amounts of caster and camber stamped in the top of the adjuster.
   - The first number is the amount of caster, the second number is the amount of camber in degrees if the adjuster is installed in the right axle position.
   - If the adjuster is in the left axle, the caster number is the opposite sign of the number shown.
   - For example, a positive amount in the right axle is a negative amount in the left axle, and a negative amount in the right axle is a positive in the left position.

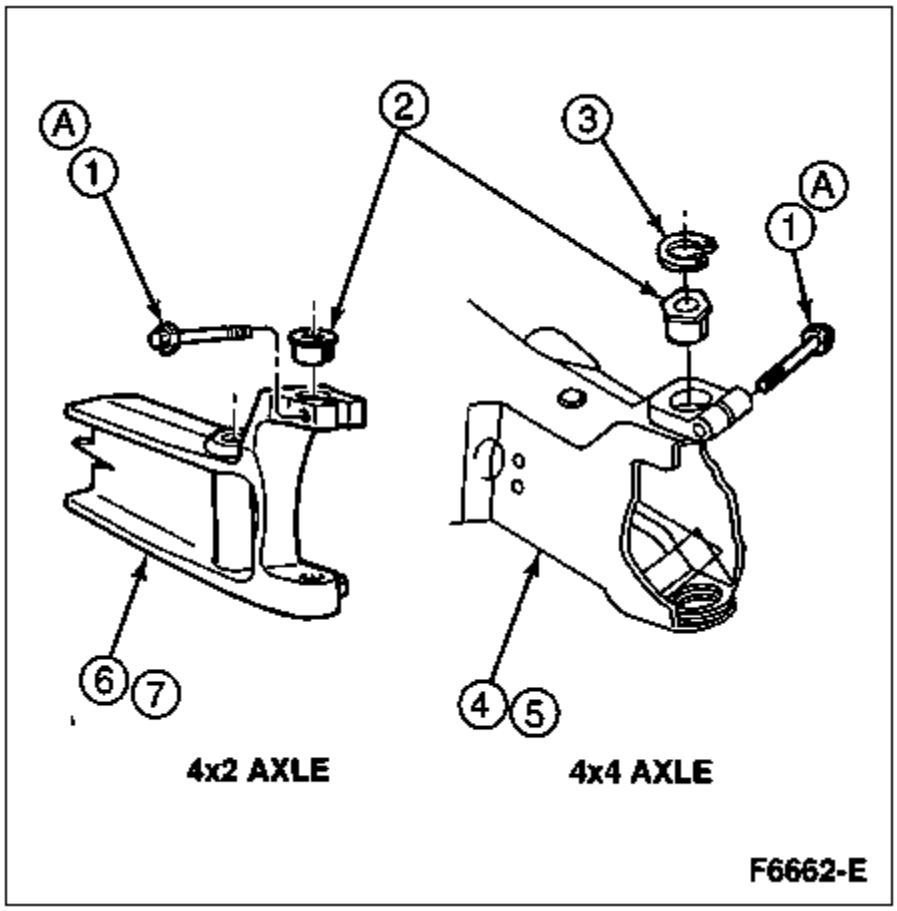
3. Refer to the following chart. Select a new service adjuster and its orientation in the axle to obtain the optimum caster/camber. Note that the caster change or camber change required to obtain the optimum settings must be added to amounts of caster/camber in the old or production adjuster.

   For example, if caster and camber must be reduced 1.0 degree, and camber increased +0.75 degree at the left wheel, and the existing adjuster has +0.25 degree caster as installed, select the 1.0 degree service adjuster and orient the slot 225 degrees from the straight-ahead position.

4. Raise the vehicle and support with jackstands.

5. Remove the front wheel.

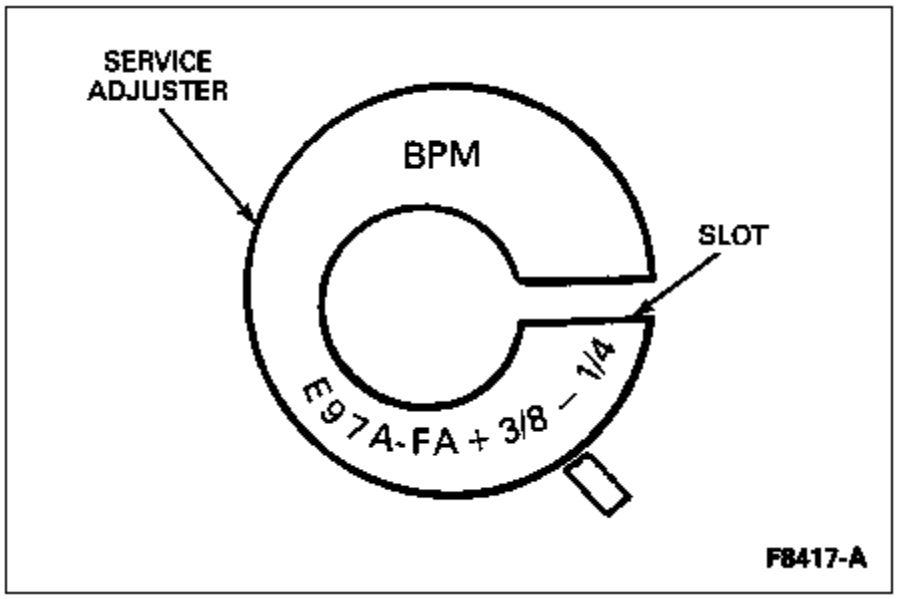
6. Loosen the pinch bolt at the upper ball joint and pry the adjuster out of the axle with the blade of a screwdriver. If required, use Pitman Arm Puller T64P-3590-F to remove the adjuster.



Item	Part Number	Description
1	60682	Pinch Bolt
2	38404	Caster and Camber Adjuster
3	—	Snap Ring (Part of 38404)
4	3B403	Left Axle Arm (Shown) (4x4)
5	3B402	Right Axle Arm (4x4)
6	3007	Left Axle (Shown) (4x2)
7	3006	Right Axle (4x2)
A	—	Tighten to 68-92 Nm (50-68 Lb-Ft)

7. **NOTE: The assembly plant sometimes builds vehicles with adjusters that are not zero-degree type to control alignment. The table shows the alignment changes that will occur if the vehicle was originally built with zero-degree adjusters. Always check to see which adjuster has been installed (and its orientation) before making changes.**

   Install the new service adjuster. Orient the slot as specified in the chart.



RANGER ADJUSTABLE CAMBER/CASTER SERVICE ADJUSTER SELECTION TABLE

Service Adjuster Type (Degrees)	Position Slot in Axle (Degrees)	LH Axle		RH Axle	
		Camber Change (Degrees)	Caster Change (Degrees)	Camber Change (Degrees)	Caster Change (Degrees)
1/2	0	-0.5	0	+0.5	0
1	0	-1.0	0	+1.0	0
1-1/2	0	-1.5	0	+1.5	0
1/2	45	-0.25	+0.25	+0.25	+0.25
1	45	-0.75	+0.75	+0.75	+0.75
1-1/2	45	-1.00	+1.00	+1.00	+1.00
1/2	90	0	+0.5	0	+0.5
1	90	0	+1.0	0	+1.0
1-1/2	90	0	+1.5	0	+1.5
1/2	135	+0.25	+0.25	-0.25	+0.25
1	135	+0.75	+0.75	-0.75	+0.75
1-1/2	135	+1.00	+1.00	-1.00	+1.00
1/2	180	+0.5	0	-0.5	0
1	180	+1.0	0	-1.0	0
1-1/2	180	+1.5	0	-1.5	0
1/2	225	+0.25	-0.25	-0.25	-0.25
1	225	+0.75	-0.75	-0.75	-0.75
1-1/2	225	+1.00	-1.00	-1.00	-1.00
1/2	270	0	-0.5	0	-0.5

1	270	0	-1.0	0	-1.0
1-1/2	270	0	-1.5	0	-1.5
1/2	315	-0.25	0.25	+0.25	-0.25
1	315	-0.75	-0.75	+0.75	-0.75
1-1/2	315	-1.00	-1.00	+1.00	-1.00

8. Tighten the pinch bolt to 68-92 Nm (50-68 lb-ft) and install a new caster/camber adjuster snap ring (4x4).

9. Install front wheel and lower vehicle.

10. Check alignment. If not optimal caster/camber setting, additional adjustment of the rotation of the adjuster may be required to obtain optimal alignment settings.

11. Once optimal caster/camber is achieved, reset front toe to specifications and check alignment.

    - In all cases, select the adjuster and orientation that will bring the alignment closest to the optimal settings.

12. Check alignment and reset toe to specification.

Toe, Aerostar

1. Start the engine. Move steering wheel into straight-ahead or centered position.

2. Turn the engine off, and lock the steering wheel in place using a steering wheel holder.

3. Check the toe reading.

4. If toe is not within specifications, remove bellows seal clamp if used.

5. **NOTE: Whenever the jam nuts are loosened for toe adjustment, the nut and tie threads must be cleaned and lubricated and the jam nut retightened to 80 Nm (59 lb-ft).**

   NOTE: Free the boot from the rod before attempting to adjust toe. Do not allow boot to twist when rod is turned for toe adjustment.

   Loosen the jam nuts and adjust toe to 0.80mm (1/32 inch) IN for the preferred setting (0.80mm [1/32 inch] OUT for Aerostar E-4WD vehicles).

6. Hold tie rod end with wrench while tightening in jam nut.

7. Replace bellows seal clamp, if used after tightening jam nut.

Toe, Ranger

1. Loosen the clamp bolts at each end of the tie rod end (3A131).

2. Rotate the sleeve until the correct toe alignment is obtained.

3. With the clamps centered between the protrusions on the adjustment sleeve lock ring, position the bolts horizontally with the clamp nuts facing in the direction shown. Tighten the clamp nuts to 40-57 Nm (30-42 lb-ft).

4. Recheck the toe alignment after tightening clamps.

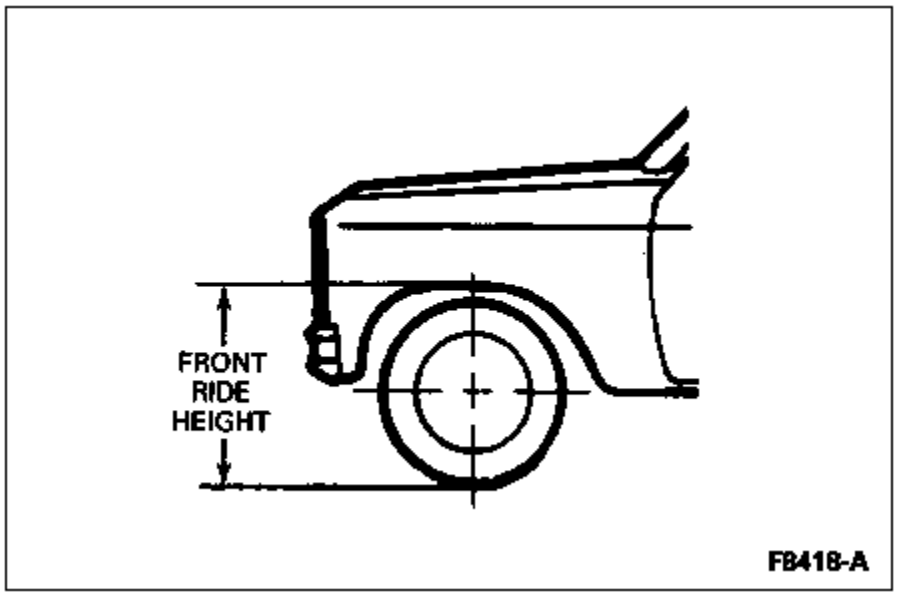
5. Check the steering wheel for clear vision.

Vehicle Lean Correction

NOTE: Codes identifying the front and rear spring options are printed on the Safety Standard Certification Label. If a spring or torsion bar requires replacement because of damage or sagging, replace only with the same part as specified on the label. In rare instances, the spring codes will not reflect the springs or torsion bars as installed due to a district special order (DSO) option or Assembly Plant substitution. If a DSO option number is shown on the certification label, the district office can establish whether springs are affected. If the factory-installed springs or torsion bars do not agree with the code printed on the Safety Standard Certification Label (right and left spring part number should match), it is advisable to replace springs or torsion bars in pairs.

Front Lean

1. Measure the left and right front ride heights by measuring the height of the right and left front fender lip openings.



2. Compute the difference between left and right ride heights as figured above.

    - For Ranger, if the difference exceeds 16mm (5/8 inch) and is less than 20mm (3/4 inch) measured at the wheelhouse opening to ground, add **one** shim to the side of the vehicle that is low.
    - The shim is to be placed under the lower spring seat; service shim (part number 389117-S2) can be used on 4x2 and 4x4 models without a front stabilizer bar.
    - If there is a computed side-to-side difference of 20mm (3/4 inch) or more in the left/right wheelhouse openings, swap front coil springs (5310) from side to side. If the lean condition

follows the spring (lean now on other side of the vehicle), replace **both** springs with new ones.
- Changing front ride height by adding the service shim also affects caster angles. Adding the 4.5mm thick shim (part number 389117-S2 or equivalent) may reduce caster by up to 0.40 degrees on the side to which the shim is added.

EXAMPLES

Ranger 4x2 Vehicles	Ranger 4x4 Vehicles
Measured LH Ride Height 25-5/16 Inch	Measured LH Ride Height 29-1/4 Inch
Measured RH Ride Height 25-1/2 Inch	Measured RH Ride Height 29-7/8 Inch
Calculated RH Ride Height 25-13/16 Inch	Calculated LH Right Height 29-3/4 Inch
Side-to-Side Difference 1/2 Inch	Side-to-Side Difference 1/8 Inch
Since the difference is larger than 1/8 Inch, one shim should be added to the side of the suspension.	Since the difference does not exceed 1/8 Inch, no shim is to be installed on the front suspension. The lean condition may be caused by a rear lean condition.

Rear Lean, Ranger

1. Measure the rear ride height by measuring the height of the right and left rear fender lip openings.

2. Compute the difference.

   - A side-to-side lean at the rear of the vehicle can be adjusted approximately 6mm (1/4 inch) by installing a shim between the rear spring (5560) and axle on the low side of the vehicle.
   - A "low at the rear" vehicle can be raised approximately 6mm (1/4 inch) by installation of one shim on each side.

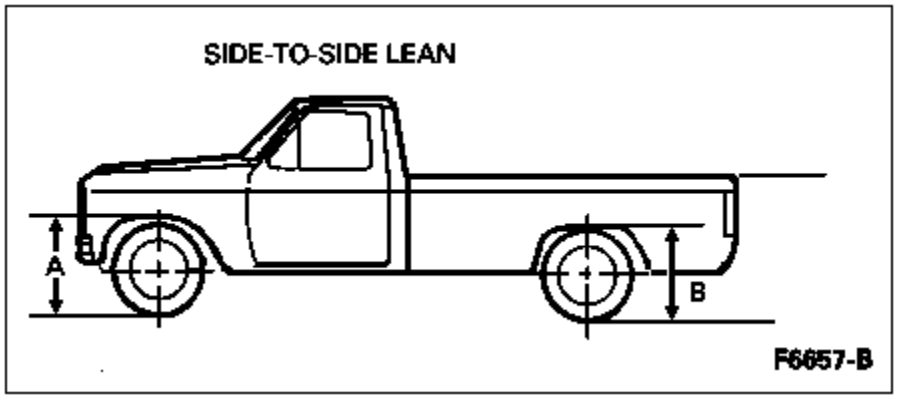
3. Use the following procedure to install the shim(s) (E37A-5742-AA).

   - Raise the vehicle until the weight is off the rear springs but with the tires still touching the floor.
   - Loosen the spring U-bolts to allow the axle to separate from the spring approximately 13mm (1/2 inch).
   - Position the shim (E37A-5742-AA) between the spring and the spring seat with the tie bolt head through the hole in the shim.
   - On 4x4 vehicles, position the shim between the rear spring and axle spacer. Tape may be used to hold the shim in position.
   - Make sure the spring leaves are properly aligned and the spring U-bolts contact the edges of the spring assembly or axle seat.
   - Tighten the spring U-bolt sufficiently and make sure the spring bolt head extends through shim into axle seat hole.
   - Tighten the U-bolt nuts to 88-102 Nm (65-75 lb-ft).

Side-to-Side Lean, Ranger

1. Side-to-side vehicle lean should be verified by measuring the fender lip-to-ground dimensions A and B.

Ranger



Normal acceptable limits are as follows:

- Maximum of 16mm (5/8 inch) variance between left and right front wheel lips to ground.
- Maximum of 20mm (3/4 inch) variance between left and right rear wheel lips to ground.

2. Once a lean condition has been verified, perform the following steps.

   a. Place the vehicle on a flat, smooth surface. Vehicles must be sitting on the wheels and tires, not on a hoist, jack or jackstands.
   b. Inspect vehicle for any heavy add-ons that may cause excessive weight on any corner of the vehicle. Vehicle should be empty, fuel tanks full, no cargo in the pickup box or rear body section.
   c. Check all wheels and tires:
      - Wheel size and design, tire size and tread should be indicated on the Vehicle Safety Standard Certification Label.
      - Wheels must be same size and design, right and left side, on each axle.
      - Tires must be same brand, tire size, tread design and equal tread wear side to side on each axle.
      - Check air pressure of all tires; inflate to specifications indicated on the Vehicle Safety Standard Certification Label.
   d. Check front and rear suspension. Verify the same spring or torsion bar is on left/right front and same spring is on left/right rear.
      - Front coil springs have I.D. tags indicating the part number.
      - Rear springs have the part number stamped on the bottom left just behind the U-bolt attachment.
      - If I.D. tags are missing from front springs, refer to the Safety Standard Certification Label on the driver's door. If the label is missing, there is no sure way of identifying which springs or torsion bars are installed on the vehicle. It is advisable to order springs or torsion bars in pairs only.
   e. Bounce the vehicle's front and rear suspension to normalize the vehicle static ride height.
   f. Measure the height of the right and left fender lip openings again. If the differences are still greater than 16mm (5/8 inch) between left or right front and/or 20mm (3/4 inch) between left and right rear, factors other than suspension are the cause.

Drive Axle Adjustments (Ranger)

1. **NOTE: A warped or bent rear axle assembly (4006) or bent frame can cause a vehicle to "dogtrack" and should be considered during diagnosis.**

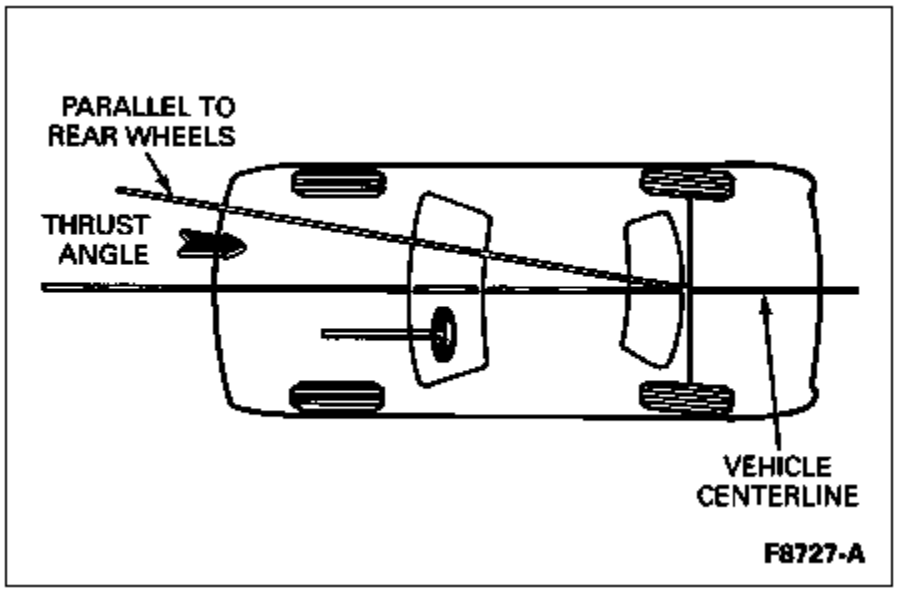
   Verify that the vehicle dogtracks by performing the diagnostic procedure as outlined in this section.

2. Raise the vehicle off the ground using a frame-mounted hoist or equivalent. Do not hoist the vehicle using the rear axle assembly as a lift point.

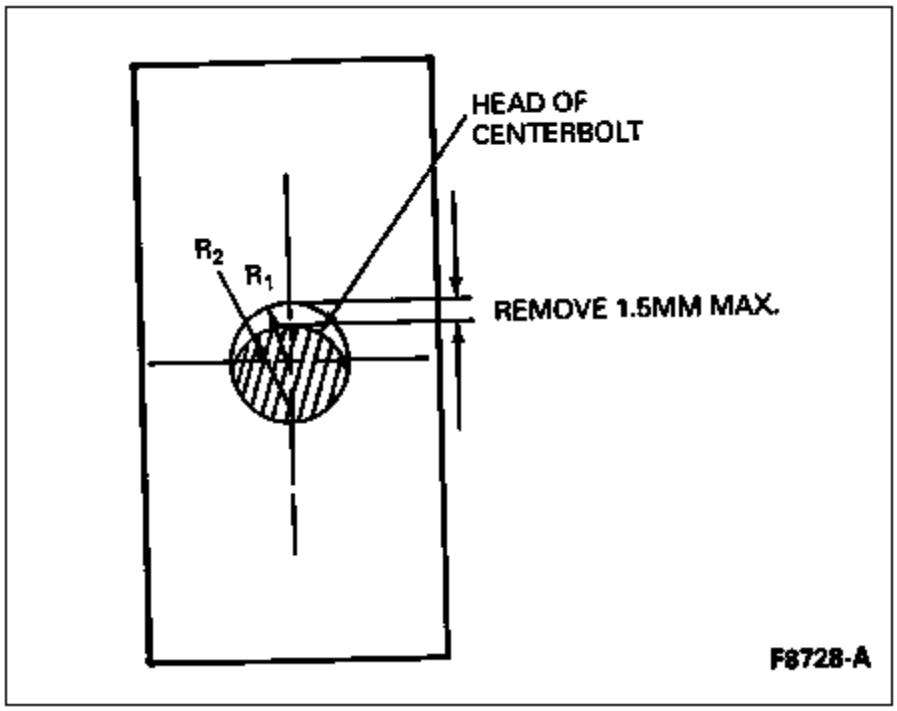
3. Remove the U-bolts which attach the rear axle assembly to the rear leaf springs on the side of the rear axle assembly which will be moved. Allow the axle to drop down. The shock absorber will support the axle assembly.

4. Using C-clamps, clamp the leafs of the leaf spring together on both sides of the center bolt and remove the bolt.

5. If thrust angle is 0 to 0.3 degrees modify the spring center bolt on the side of the axle which must be moved.



6. Grind and radius the head of the center bolt to match the radius of the hole in the spring seat.



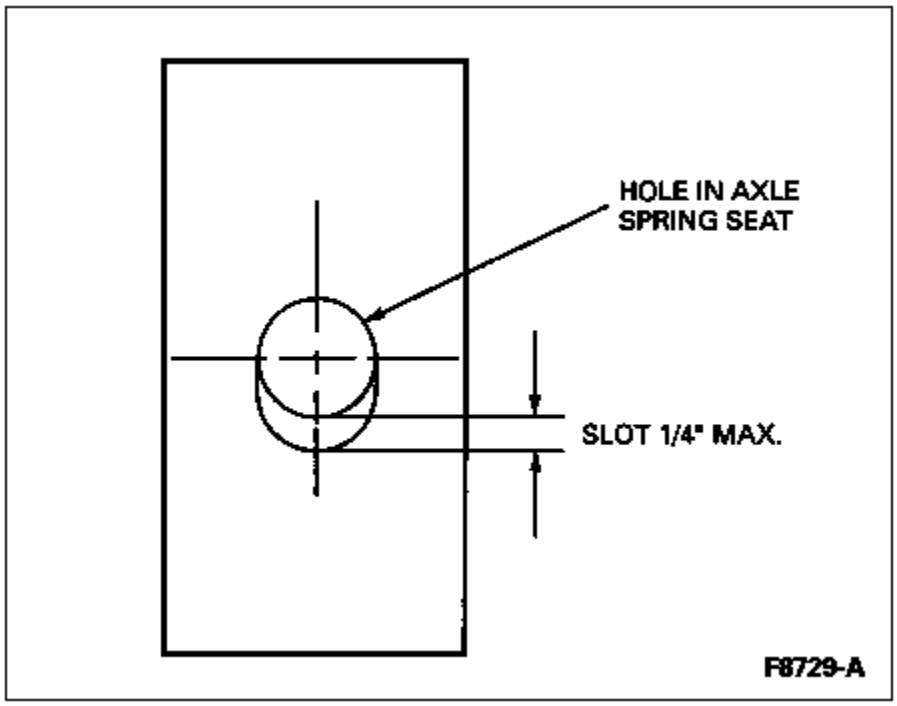
7. If thrust angle is 0.3 to 0.5 degrees, modify the spring center bolt on the sides of the axle. Adjust as required.

8. Reinstall the center bolt and tighten the nut to 60-80 Nm (44-59 lb-ft). Push the rear axle assembly the maximum distance in the direction required to reduce the thrust angle and finish tightening the M-12 U-bolt nuts to 88-102 Nm (65-75 lb-ft).

9. Verify that the vehicle no longer dogtracks using the chalk line procedure or by visual inspection while driving on a flat road.

10. **CAUTION: Do not use a cutting torch to elongate the hole in the spring seat.**

    If the vehicle still dogtracks, the hole in the axle spring seat will require slotting. Use a die grinder or equivalent to elongate the hole perpendicular to the vehicle centerline. The hole in the spring seat should be elongated no more than 6.25mm (1/4 inch).



11. Finally, check the vehicle front wheel toe and clear vision. Correct if necessary.

SPECIFICATIONS

Front Wheel Alignment Specifications

The following charts reflect vehicle alignments after shipment from the assembly plant and prior to any aftermarket and/or body-builder modifications. Alignment can be checked at any time to help diagnose a problem. Always perform an inspection of the front end components and repair where necessary prior to attempting to adjust the alignment to specification. Refer to Front End in the Diagnosis and Testing portion of this section.

Vehicle Conditions for Checking Alignment

- No driver and/or passenger
- Full fluids
- All tires set to specified pressure
- All tire sizes comparable to original equipment
- Vehicle configured to normal operated conditions (not to exceed maximum front GAWR, maximum rear GAWR, and/or maximum GVWR)

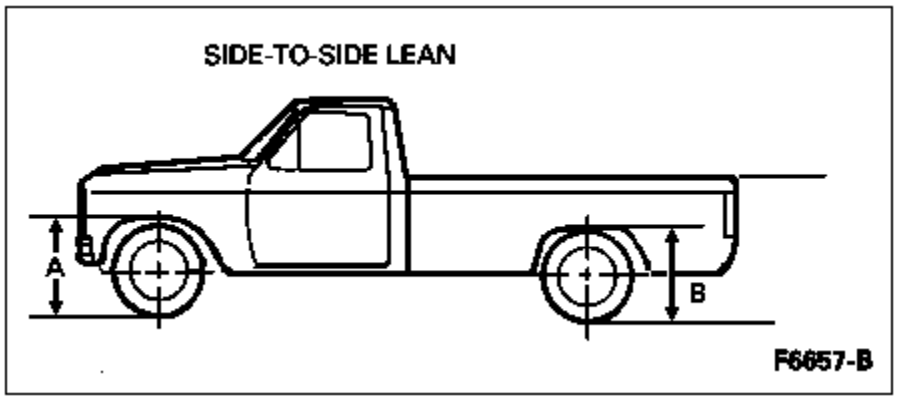
Optimum Caster, Camber, And Total Toe Settings

Model	Camber Optimum ±Range	Caster Minimum	Caster Maximum	Total Toe Optimum ±Range	Camber Split Optimum ±Range	Caster Split Optimum ±Range
Aerostar	.25°±.5°	2.0°	6.0°	.06°±.25°	.0°±.4°	.0°±.4°
E-4WD Aerostar	.25°±.5°	2.0°	6.0°	-.06°±.25°	.0°±.4°	.0°±.4°
4x2, 4x4 Ranger	.25°±.5°	2.0°	6.0°	.06°±.25°	.0°±.4°	1.0°±.4°

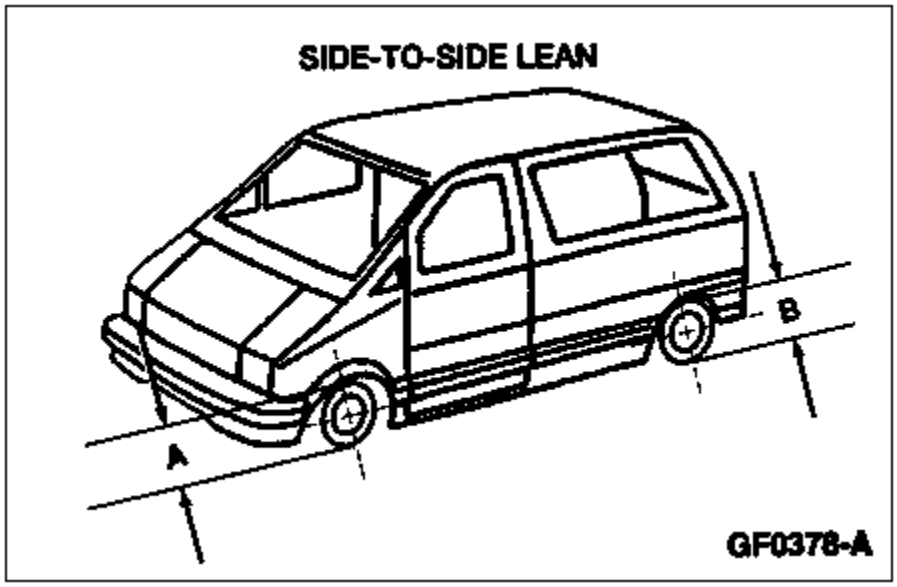
Vehicle Attitude

Lean (Side-to-Side Differences)		Dogtrack
Front Wheelhouse Opening (Dimension A)	Rear Wheelhouse Opening (Dimension B)	Centerline of Front Tires Compared to Centerline of Rear Tires
16mm (5/8 Inch) Maximum	20mm (3/4 Inch) Maximum	30mm (1-1/4 Inch) Maximum

Ranger



Explorer



Torque Specifications

Description	Nm	Lb-Ft
Centerbolt Nut	60-80	44-59
Clamp Nut	40-57	30-42
Front Suspension Upper Arm Nuts — Aerostar	95-135	70-100
Jam Nut — Aerostar	80	59
Lugnut 1/2-20 (to Frame)	135	100
Pinch Bolt — Upper Ball Joint — Ranger	68-92	50-68
U-Bolts to Rear Axle — Ranger	88-102	65-75

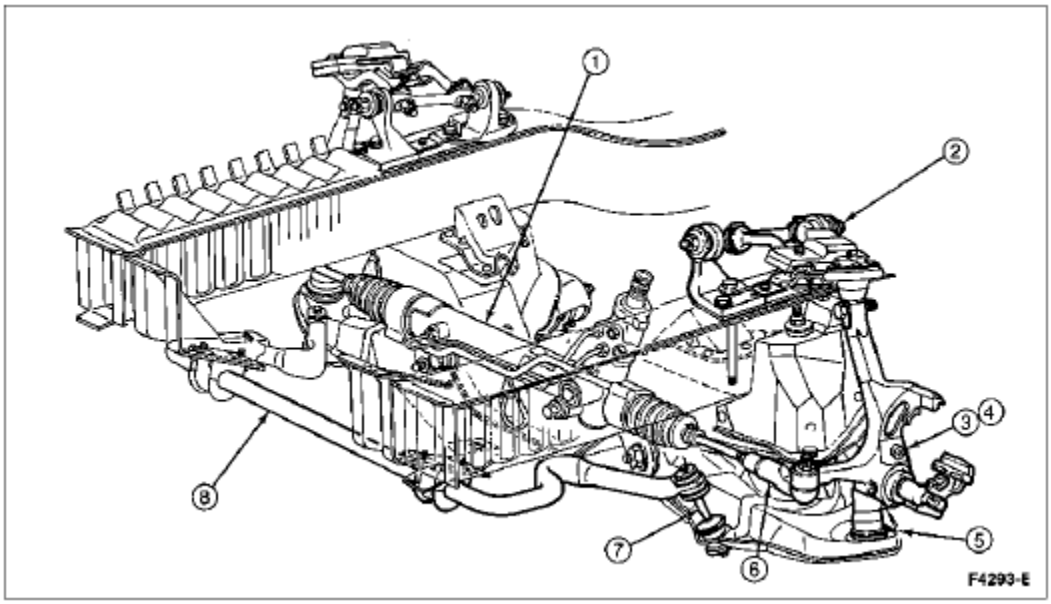
NOTE: Torque specifications are for clean, dry bolt and nut threads. Never use oil or grease on studs or nuts.

Suspension — Aerostar

NOTE: The critical joint in the front chassis area includes the front crossmember (5019), longitudinal side member, and front suspension upper arms (3083). Whenever this joint is loosened or removed (including engine service), it is imperative that new fasteners or cleaned/lubricated present fasteners be installed with the proper installation torque at this critical joint.

The front suspension is a short/long arm suspension system with helical front coil springs (5310). It consists of front wheel spindles (3105), front suspension upper arms and front suspension lower arm (3078) with integral ball joints and bushings, adjustment shims, front coil springs, front shock absorbers and a front stabilizer bar (5482). The front coil springs are computer-selected based on vehicle options.

Suspension, Front, Aerostar



Item	Part Number	Description
1	3504	Steering Gear
2	3083	Front Suspension Upper Arm
3	3105	Front Wheel Spindle (RH)
4	3106	Front Wheel Spindle (LH)
5	3079	Front Suspension Lower Arm
6	3A131	Tie Rod End
7	5K483	Front Stabilizer Bar Link
8	5482	Front Stabilizer Bar

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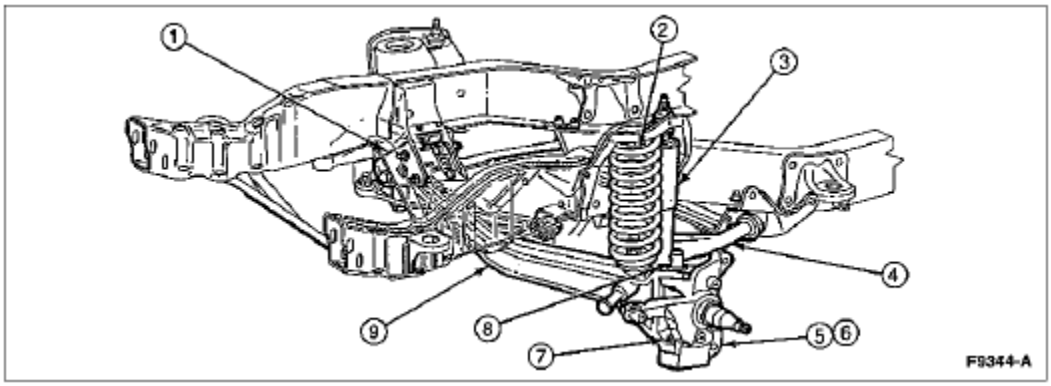
Suspension — Ranger

The suspension is the coil spring, twin I-beam type. It is composed of front coil springs (5310), I-beam axle arms, radius arms, front suspension upper ball joints (3049) and front suspension lower arm ball joints (3050), front coil springs, front shock absorbers and a front stabilizer bar (5482).

Suspension, Front, 4x2, Ranger



Item	Part Number	Description
1	3K090	Front Axle Bearing Bracket
2	5310	Front Coil Spring
3	18045	Front Shock Absorber
4	3405	Radius Arm
5	3105	Front Wheel Spindle (RH)
6	3106	Front Wheel Spindle (LH)
7	3050	Front Suspension Lower Arm Ball Joint
8	3049	Front Suspension Upper Ball Joint
9	3007	I-Beam Axle

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Wheel Spindle — Aerostar

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Pitman Arm Puller	T64P-3590-F

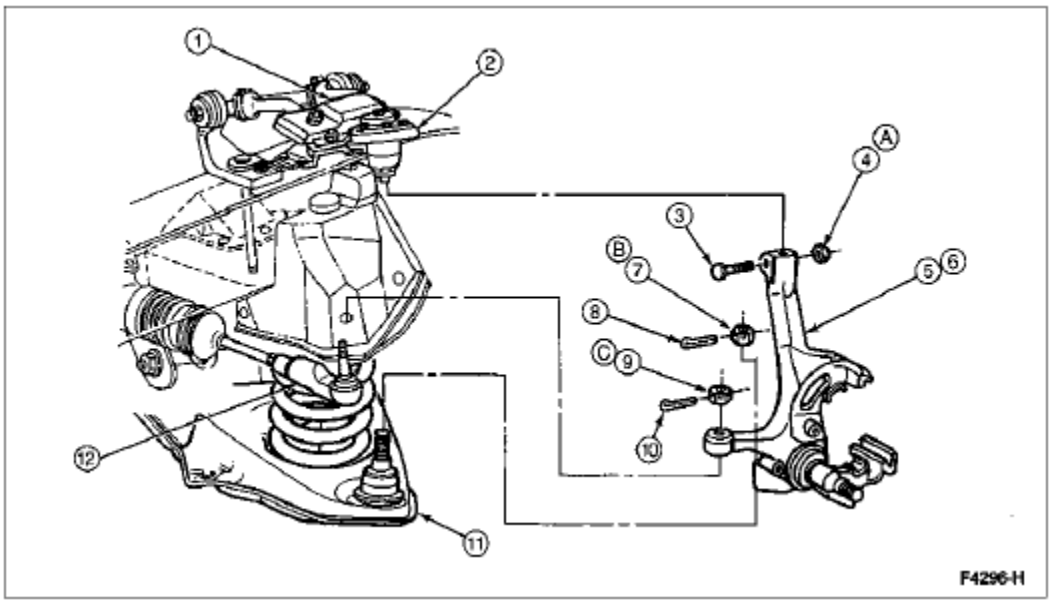
Removal

1. **NOTE: Any time the steering linkage is disconnected from the front wheel spindle (3105), the steering system must be placed in the on-center position.**

   Place the steering wheel and steering system in the on-center position.

2. Raise the vehicle on a frame hoist. Position a tall jack under the front suspension lower arm (3078) and raise the jack.

Spindle, Aerostar



Item	Part Number	Description
1	3C156	Damper
2	3083	Front Suspension Upper Arm

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3	N804806-5160	Bolt
4	N801206-S2	Nut
5	3105	Front Wheel Spindle (RH)
6	3106	Front Wheel Spindle (LH)
7	381612	Nut
8	642588	Cotter Pin
9	N800895-556	Nut
10	642589	Cotter Pin
11	3078	Front Suspension Lower Arm
12	3A131	Tie Rod End
A	—	Tighten to 36-50 Nm (27-37 Lb-Ft)
B	—	Tighten to 108-153 Nm (80-113 Lb-Ft)
C	—	Tighten to 70-100 Nm (52-74 Lb-Ft)

3. Remove the lugnuts and the wheel and tire assembly.
4. Remove the front disc brake caliper (2B121), rotor and dust shield from the spindle. Refer to procedure in this section.
5. Remove the cotter pin and nut retaining the tie rod end to the front wheel spindle front suspension lower arm.
6. Disconnect the tie rod end (3A130) from the front wheel spindle using Pitman Arm Puller T64P-3590-F.
7. Support the front suspension lower arm with a jackstand. Remove the cotter pin and loosen the nut retaining the front wheel spindle to the front suspension lower arm ball joint (3050).
8. Disconnect the front suspension lower arm ball joint using pitman arm puller and loosen the front suspension lower arm ball joint.
9. Remove the tool and front suspension lower arm ball joint retaining nut.

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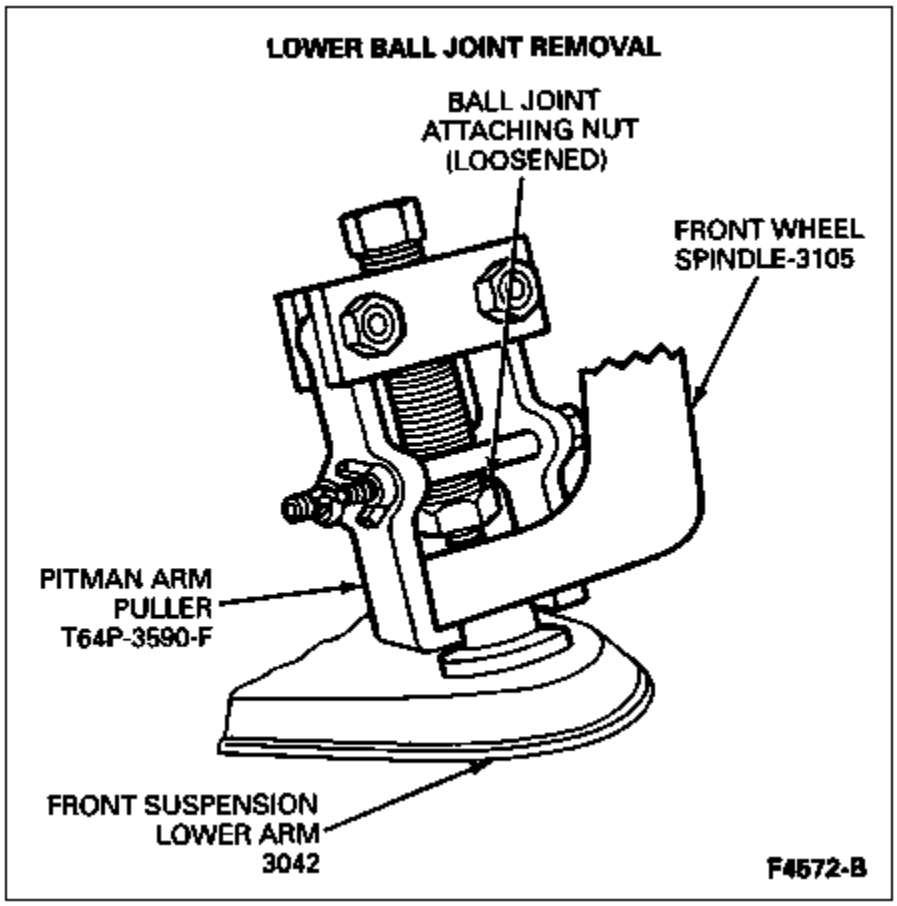

10. **WARNING: USE EXTREME CAUTION WHEN LOWERING THE JACK. THE COIL SPRING MAY QUICKLY EXPAND WITH DANGEROUS FORCE.**

    Slowly lower the jack until the front suspension lower arm ball joint is disengaged from the front wheel spindle.

11. Remove the bolt and nut retaining the front wheel spindle to the front suspension upper ball joint (3049). Remove the front wheel spindle.

Installation

1. Inspect upper and lower ball joints and seals for damage. Ball joints and seals are not serviceable. Replace control arm if required.

2. Position the front wheel spindle on the front suspension upper ball joint. Install the nut and bolt and tighten to 36-50 Nm (27-37 lb-ft).

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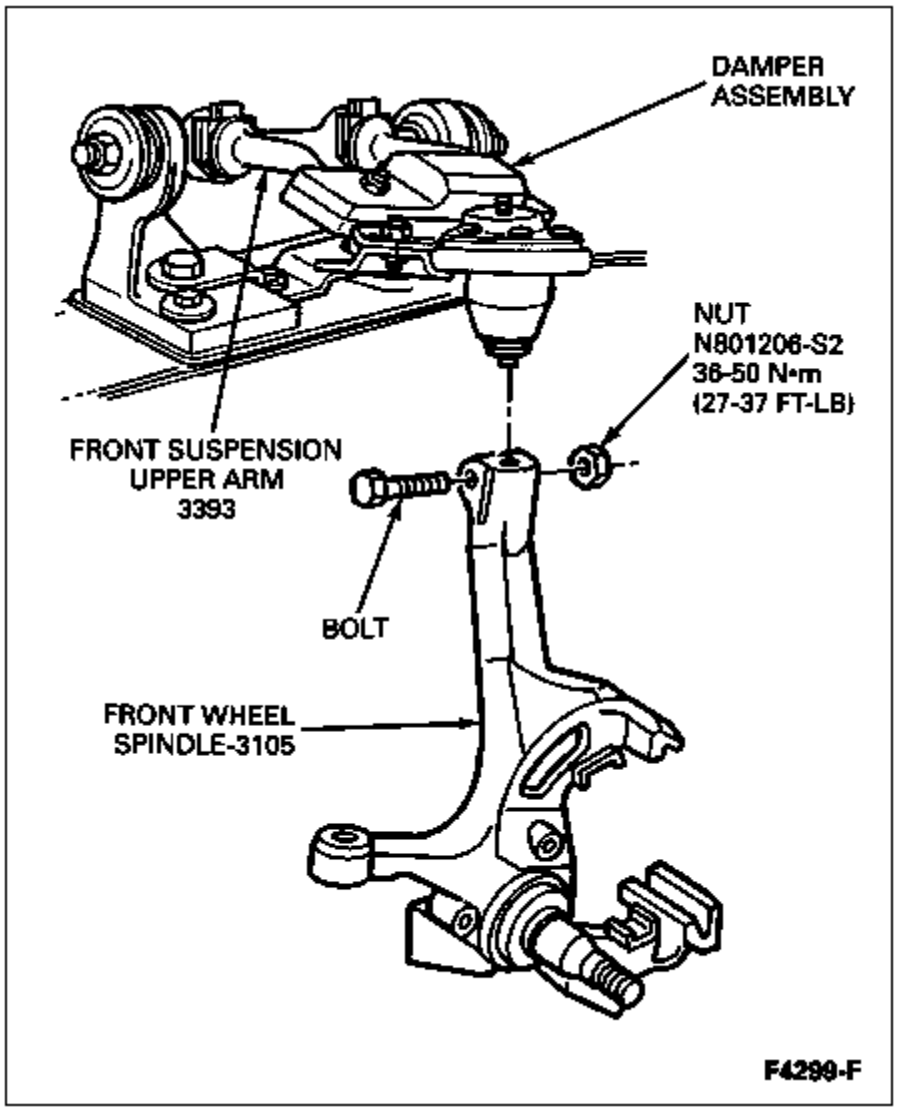

3. Position the front wheel spindle over the lower ball joint stud. With the hoist, slowly lower the vehicle until the ball joint stud extends through the front wheel spindle arm and is seated in the front wheel spindle.

4. Install nut and tighten to 108-153 Nm (80-113 lb-ft). If required, advance the nut to the next castellation and install the cotter pin.

5. Connect the tie rod end to the front wheel spindle arm. Firmly seat the tie rod end stud into the tapered hole to prevent rotation while tightening.

6. Install the nut and tighten to 70-100 Nm (52-74 lb-ft). If required, advance the nut to the next castellation and install the cotter pin.

7. Install the front disc brake rotor shield (2K004), front disc brake hub and rotor (1102) and front disc brake caliper. Refer to procedure in this section.

8. **WARNING: RETIGHTEN WHEEL LUGNUTS TO SPECIFICATION AT 800 KM (500 MILES). FAILURE TO RETIGHTEN LUGNUTS AT MILEAGES SPECIFIED COULD ALLOW THE WHEEL TO COME OFF WHILE THE VEHICLE IS IN MOTION, POSSIBLY CAUSING LOSS OF VEHICLE**

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CONTROL OR COLLISION.

Install the wheel and tire assembly. Refer to Section 04-04 . Install the lug nuts (1012) and tighten to 135 Nm (100 lb-ft).

9. Remove the safety stands and lower the vehicle.

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Wheel Spindle — Ranger

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Pitman Arm Puller	T64P-3590-F

Removal

1. Raise the front of the vehicle and install safety stands.
2. Remove the wheel and tire assembly.
3. Remove the front disc brake caliper (2B121), front disc brake hub and rotor (1102) and front disc brake rotor shield (2K004) from the front wheel spindle (3105). Refer to Front Disc Brake Hub and Rotor, Wheel Grease Seal, Bearing Cones and Cups procedure in this section.
4. Disconnect the steering linkage from the front wheel spindle by removing the cotter pin and nut.

Ranger (4x2)

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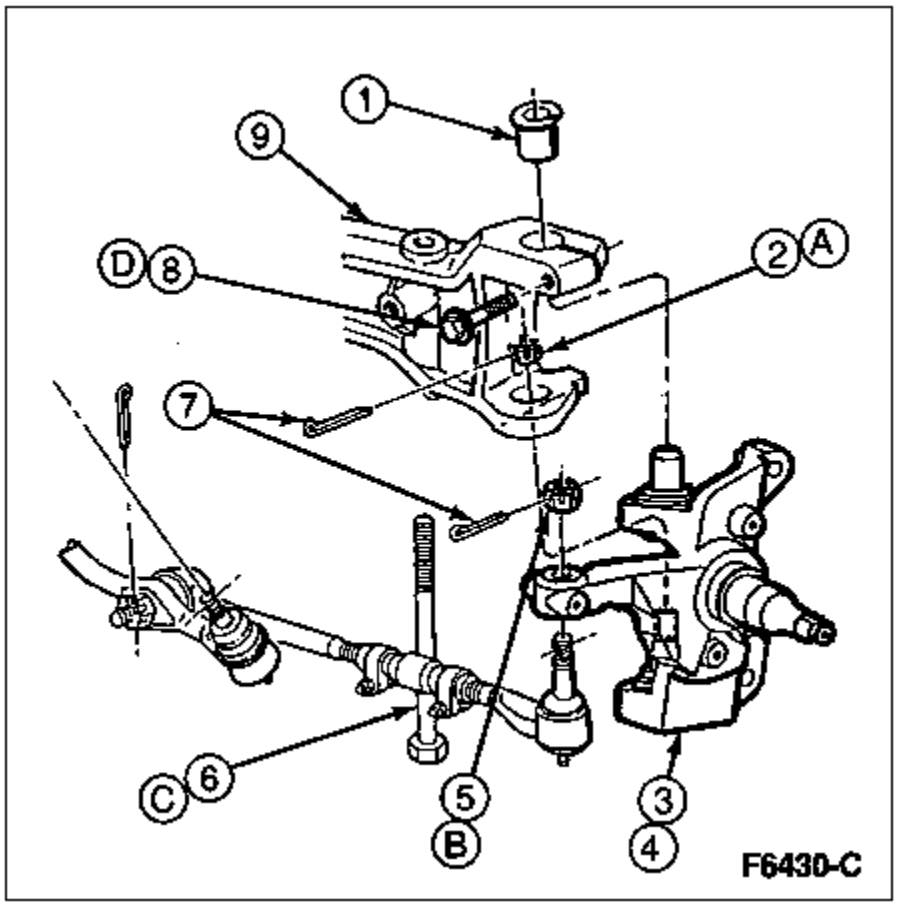

Item	Part Number	Description
1	3B404	Camber Adjuster
2	383436	Nut
3	3105	Front Wheel Spindle (RH)
4	3106	Front Wheel Spindle (LH)
5	N800895	Nut
6	390386	Bolt
7	N642569	Pin
8	N606082	Bolt
9	3007	Front Axle (LH)
A	—	Tighten to 120-180 Nm (89-133 Lb-Ft)
B	—	Tighten to 70-100 Nm (52-74 Lb-Ft)
C	—	Tighten to 255-345 Nm (188-254 Lb-Ft)
D	—	Tighten to 68-92 Nm (50-68 Lb-Ft)

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5. Remove the tie rod end (3A130) from the front wheel spindle with Tie Rod End Remover TOOL-3290-D.

6. Remove front wheel ABS sensor (if equipped).

7. Remove the cotter pin and castellated nut from the lower ball joint stud.

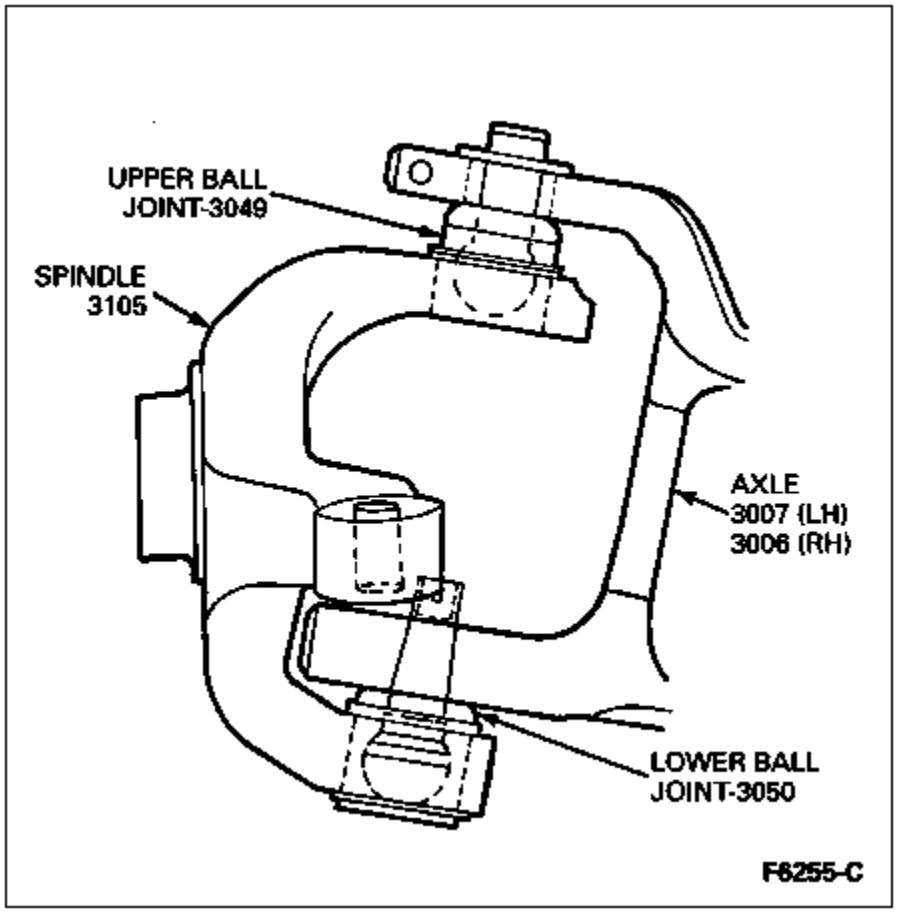
8. Mark orientation and remove the axle clamp bolt from the axle.

9. Remove the camber adjuster from the upper ball joint stud and axle beam using Ball Joint Remover Tool D81T-3010-B or equivalent.

10. **CAUTION: Do not use a pickle fork to separate the front suspension lower arm ball joint (3050) from the axle.**

    Strike the inside area of the axle to pop the front suspension lower arm ball joints loose from the axle beam. If required, use Pitman Arm Puller T64P-3590-F.

11. Remove the front wheel spindle and ball joint assembly from the axle.



Installation

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1. Prior to assembly, make sure the upper and lower ball joint seals are in place in front wheel spindle.
2. Place front wheel spindle and ball joints into axle.
3. **NOTE: Make sure adjuster is aligned properly. If camber adjustment is necessary, special adjusters must be installed. Refer to Section 04-00 .**

   Install the camber adjuster into front wheel spindle over upper ball joint stud.
4. Tighten the lower ball joint stud nut to 120-180 Nm (89-133 lb-ft).
5. Continue tightening the castellated nut until it lines up with the hole in the stud. Install the cotter pin.
6. Install the clamp bolt into the axle boss and tighten to 68-92 Nm (50-68 lb-ft).
7. Install front ABS sensor and bolt (if equipped). Tighten to 7.5-10.5 Nm (67-93 lb-in).
8. Install the front disc brake rotor shield.
9. **NOTE: If a bearing packer is unavailable, pack the bearing cone by hand, working the grease through the cage behind the rollers.**

   Pack the inner and outer bearing cones with Premium Long-Life Grease XG-1-C or -K meeting Ford specification ESA-M1C75-B or equivalent bearing grease. Use bearing packer Rotunda Bearing Packer 108-00074 or equivalent.
10. Install the front disc brake hub and rotor on the front wheel spindle.
11. Install the outer bearing cone, washer, and nut. Adjust bearing preload and install the nut retainer, cotter pin and dust cap. Refer to Adjustments in this section.
12. Install the front disc brake caliper as described in Section 06-03 .
13. Connect the steering linkage to the front wheel spindle. Tighten the nut to 70-100 Nm (52-74 lb-ft). Install cotter pin.
14. Install the wheel and tire assembly. Refer to Section 04-04 .
15. Lower the vehicle.
16. If necessary, adjust the toe setting. Refer to Section 04-00 .
17. Check brake operation before driving the vehicle.

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Hub and Rotor, Wheel Grease Seal, Bearing Cones and Cups

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Hub Seal Replacer	T83T-1175-B
Front Hub Remover/Replacer	T81P-1104-C
Bearing Cup Puller	T77F-1102-A
Driver Handle	T80T-4000-W
Bearing Cup Replacer	T73T-1202-A

Removal

Wheel bearing lubricant is a lithium-base grease, Premium Long-Life Grease XG-1-C or -K or equivalent meeting Ford specification ESA-M1C75-B.

CAUTION: Sodium-base grease is not compatible with lithium-base grease. Do not intermix. Do not lubricate front wheel bearings without first thoroughly cleaning all old grease from the bearing. Use of incompatible bearing lubricants could result in premature lubricant breakdown.

1. **NOTE: If bearing adjustment will not eliminate looseness or rough and noisy operation, the hub and bearings should be cleaned, inspected, and repacked with specified wheel bearing grease. If the bearing cups or the cone and roller assemblies are worn or damaged, they should be replaced.**

   Raise the vehicle until the tire clears the floor. Remove wheel and tire from front disc brake hub and rotor (1102).

2. Remove the front disc brake caliper (2B121) from the front wheel spindle (3105), and wire to the underbody to prevent damage to the brake hose. Refer to Section 06-03 for the front disc brake caliper removal procedure.

3. Remove the grease cap from the front disc brake hub and rotor.

4. Remove the cotter pin, retainer, adjusting nut, and flatwasher from the front wheel spindle. Discard the cotter pin.

5. Remove the front wheel bearing (1216).

6. Pull the front disc brake hub and rotor assembly off the front wheel spindle.

7. **NOTE: Perform the following steps if the original front disc brake hub and rotor assembly are to be reinstalled.**

   Using Grease Seal Remover TOOL-1175-AC or equivalent to remove and discard the grease seal.

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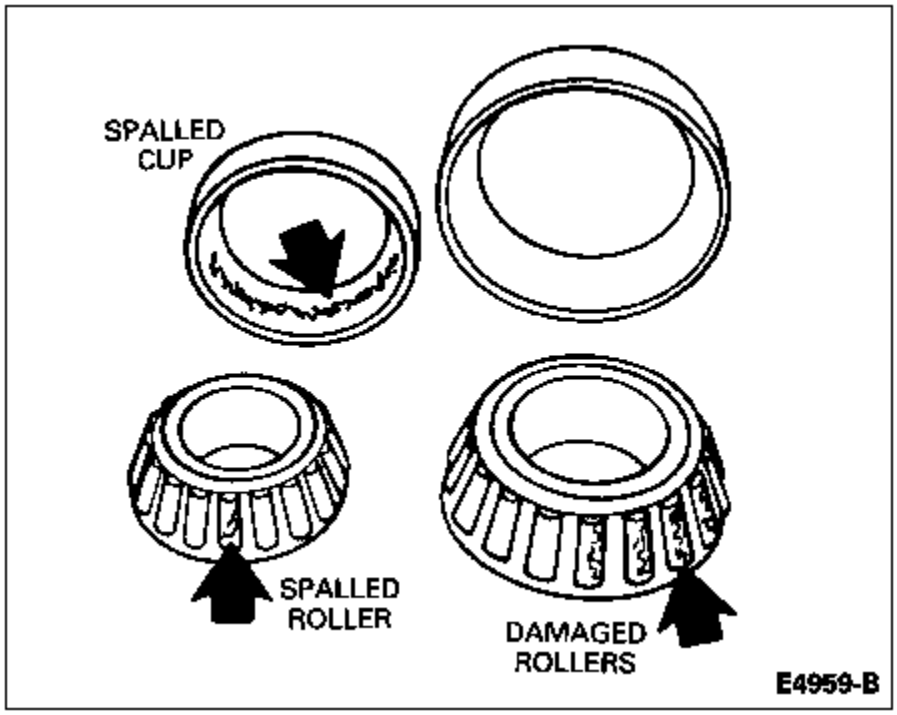
8. Remove the bearing cone and roller (1201) from the front disc brake hub and rotor.

9. Clean the inner and outer bearing cups with solvent. Inspect the cups for scratches, pits, excessive wear, and other damage. If the cups are worn or damaged, remove with Front Hub Remover/Replacer T81P-1104-C and Bearing Cup Puller T77F-1102-A.



10. Using Rotunda Asbestos Brake Drum System with Vacuum 091-00025 or equivalent remove all loose dirt and dust from the front disc brake hub and rotor. Wipe all old lubricant from the front wheel spindle and the inside of the front disc brake hub and rotor.

11. Cover the front wheel spindle with a clean cloth, and brush all loose dust and dirt from the front disc brake rotor shield (2K004).

12. Carefully remove the cloth from the front wheel spindle to prevent dirt from falling onto front wheel spindle.

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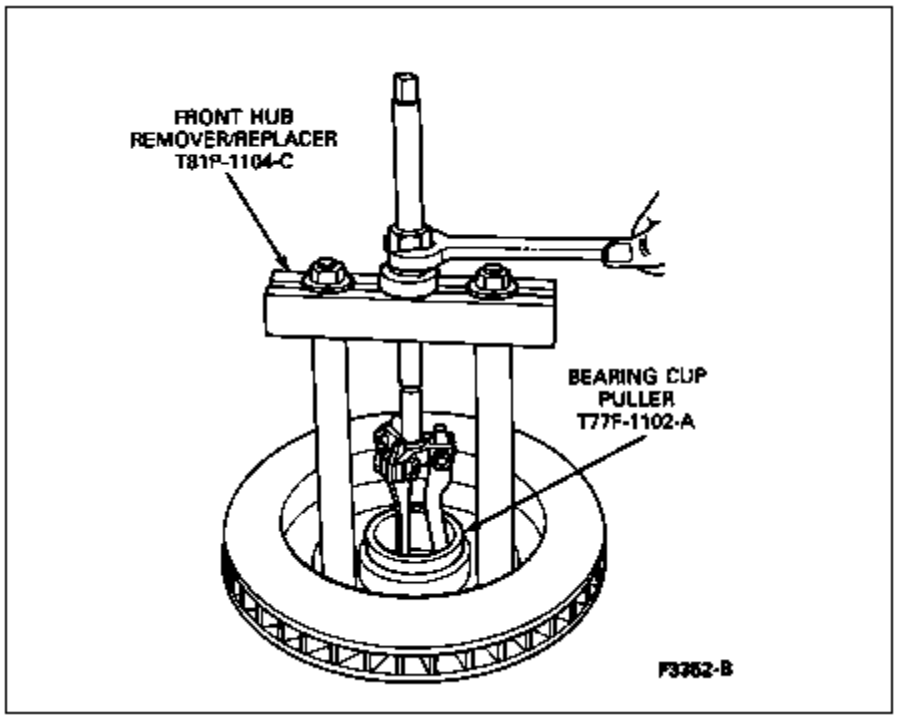

Installation

1. Thoroughly clean old grease from the surrounding surfaces. If a new front disc brake hub and rotor assembly is being installed, remove the protective coating using carburetor degreaser.

2. If the inner or outer bearing cups were removed, install replacement cups using Driver Handle T80T-4000-W and Bearing Cup Replacer T73T-1202-A. Seat cups fully against step in the hub.

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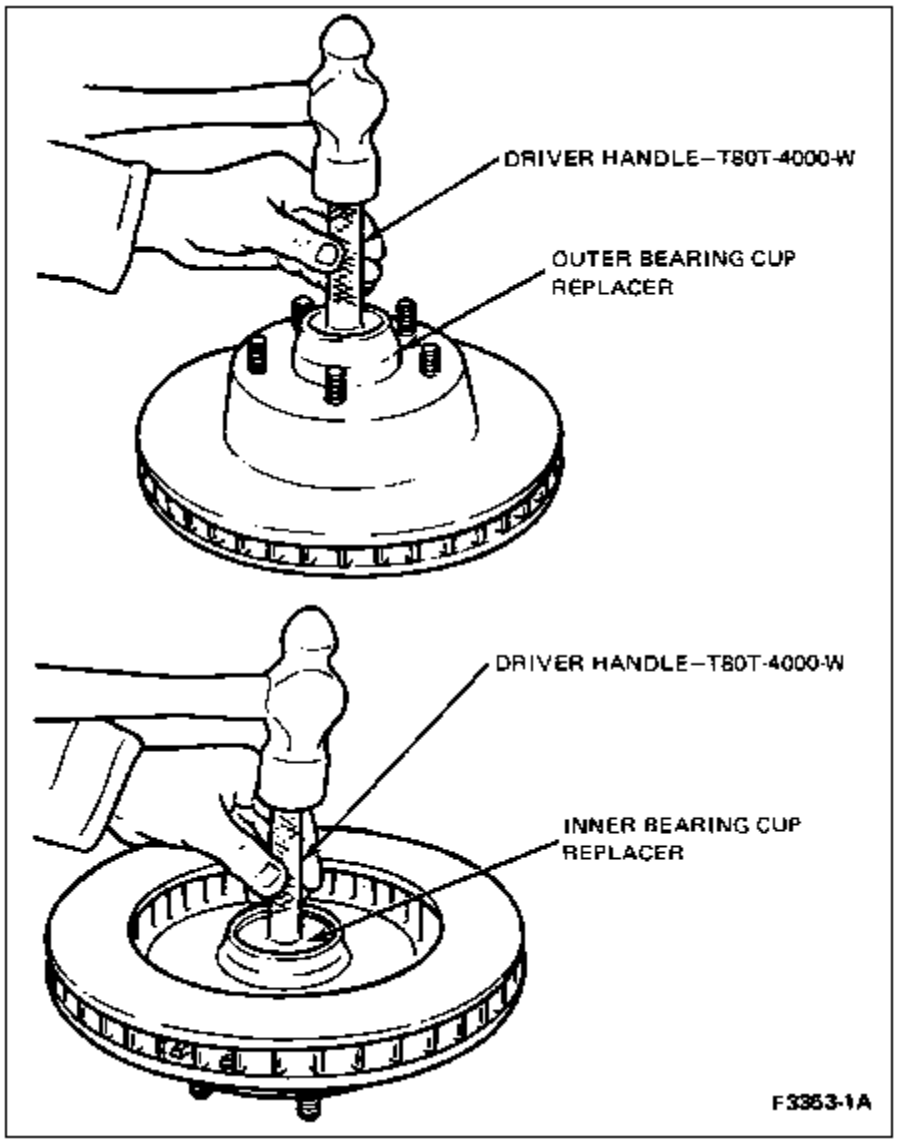

3. **NOTE: If a packer is not available, work as much grease as possible between the rollers and cages. Grease the cone surfaces.**

   Using Rotunda Bearing Packer 108-00074 or equivalent pack the bearing cone and roller assemblies with Premium Long-Life Grease XG-1-C or -K or equivalent meeting Ford specification ESA-M1C75-B.

4. Place the bearing cone and roller assembly in the inner cup. A light film of grease should be included between the lips of the new grease seal. Additional Premium Long-Life Grease XG-1-C or -K or equivalent meeting Ford specification ESA-M1C75-B may be added to the new grease seal if required.

5. **CAUTION: When installing seal, be sure it is properly seated.**

   Install the seal with Hub Seal Replacer T83T-1175-B and Driver Handle T80T-4000-W.

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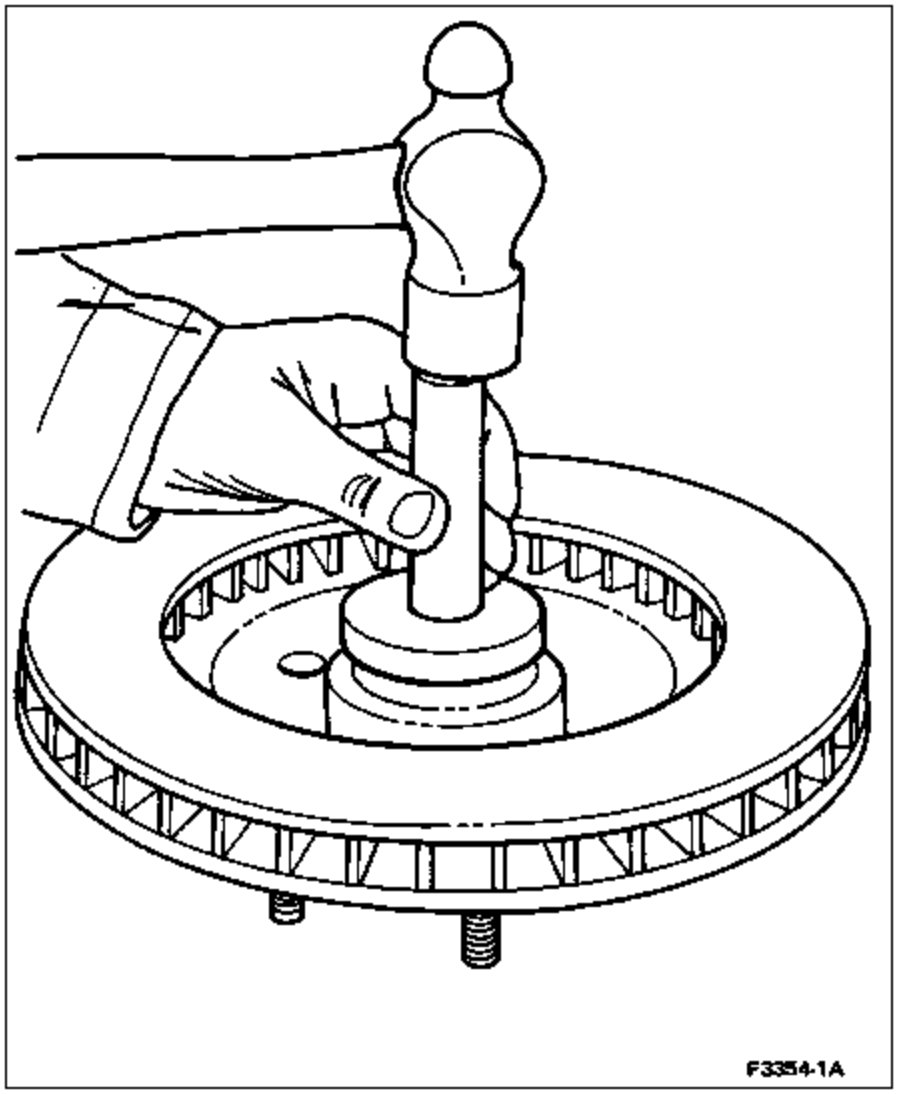

6. **NOTE: While installing front disc brake hub and rotor keep the hub centered on the front wheel spindle to prevent damage to the retainer and the front wheel spindle threads.**

   Install the front disc brake hub and rotor on the front wheel spindle.

7. Install the front wheel bearing assembly and flatwasher on the front wheel spindle.

8. Install the adjusting nut. Adjust wheel bearing as described in this section under Adjustments .

9. Install retainer, new cotter pin, and grease cap.

10. Install the front disc brake caliper to the front wheel spindle as outlined in Section 06-03 .

11. Install the wheel and tire. Refer to Section 04-04 .

12. **WARNING: RETIGHTEN WHEEL LUGNUTS TO SPECIFICATION AT 800 KM (500 MILES). FAILURE TO RETIGHTEN LUGNUTS AT MILEAGES SPECIFIED COULD ALLOW THE WHEEL TO COME OFF WHILE THE VEHICLE IS IN MOTION, POSSIBLY CAUSING LOSS OF VEHICLE CONTROL OR COLLISION.**

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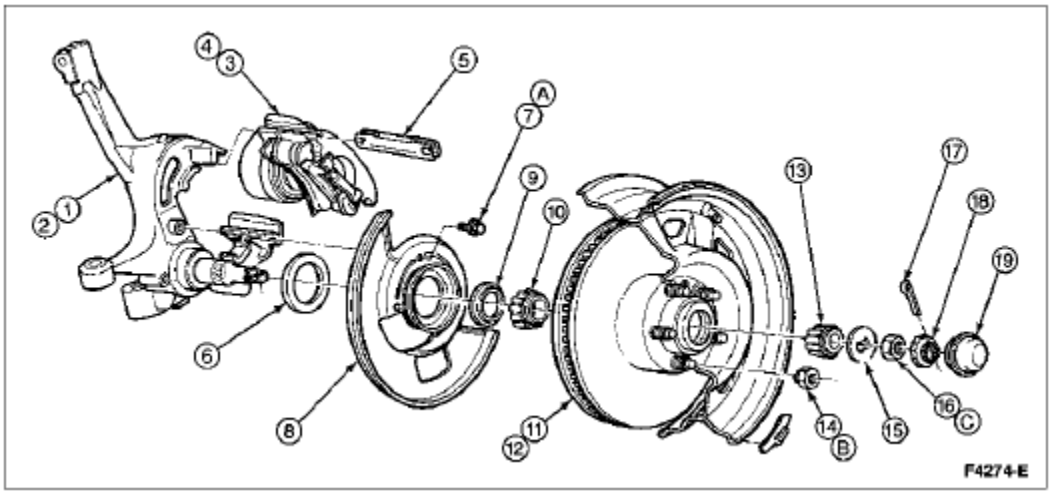
Lower the vehicle and tighten the lugnuts to 135 Nm (100 lb-ft). Install the wheelcover.

13. Before driving the vehicle, pump the brake pedal several times to restore normal brake pedal travel.

Wheel End Assembly, Aerostar



Item	Part Number	Description
1	3105	Front Wheel Spindle (RH)
2	3106	Front Wheel Spindle (LH)
3	2B120	Front Disc Brake Caliper (RH)
4	2B121	Front Disc Brake Caliper (LH)
5	2C150	Caliper Pin
6	2B160	Gasket
7	611171	Bolt
8	2K004	Front Disc Brake Rotor Shield
9	1190	Wheel Hub Grease Seal
10	1201	Bearing Cone and Roller
11	1102	Front Disc Brake Hub and Rotor (RH)
12	1103	Front Disc Brake Hub and Rotor (LH)
13	1216	Front Wheel Bearing
14	1012	Lug Nut
15	1195	Washer
16	374504	Adjusting Nut
17	642569	Cotter Pin
18	390622	Nut Retainer
19	1131	Grease Cap

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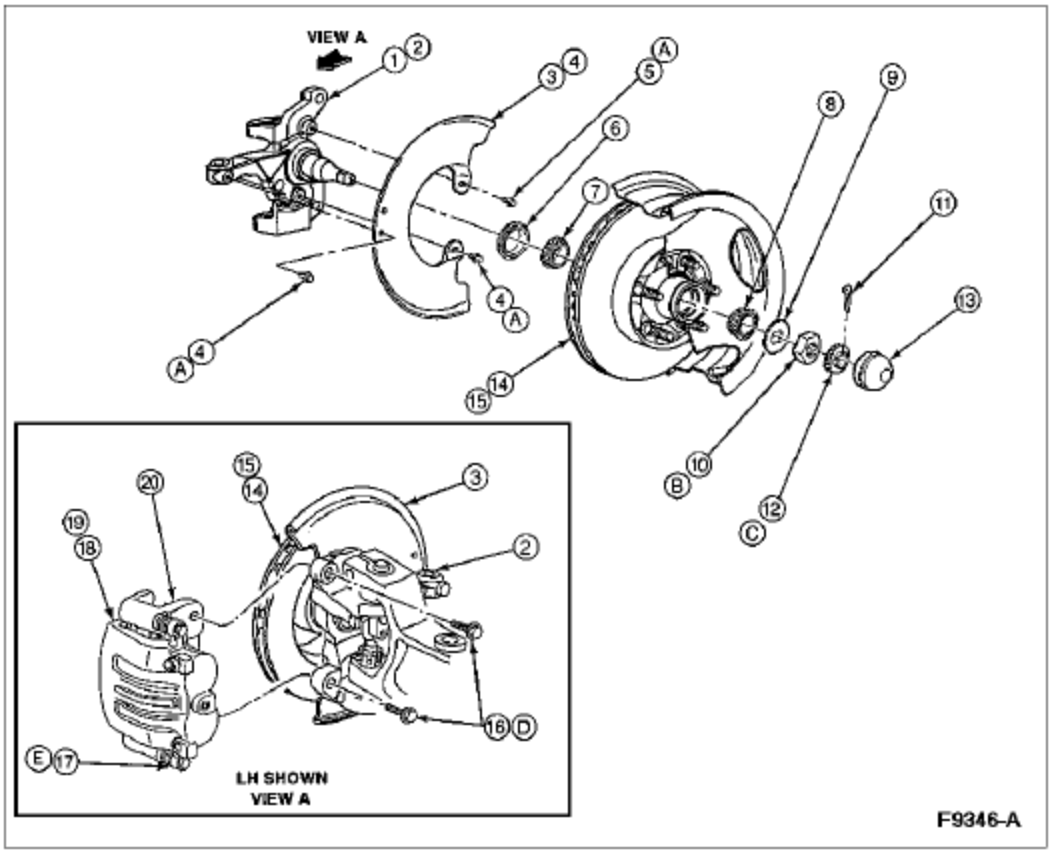
A	—	Tighten to 10-14 Nm (7-10 Lb-Ft)
B	—	Tighten to 135 Nm (100 Lb-Ft)
C	—	Tighten to 23-34 Nm (17-25 Lb-Ft) While Rotating the Front Disc Brake Hub and Rotor. Back Off 120-180 Degrees and Retighten to 2.0-2.3 Nm (18-20 Lb-In).

Wheel End Assembly, Ranger



Item	Part Number	Description
1	3106	Front Wheel Spindle (LH)
2	3105	Front Wheel Spindle (RH)
3	2K004	Front Disc Brake Rotor Shield (RH)
4	2K005	Front Disc Brake Rotor Shield (LH)
5	N611171-S2	Bolt, Rotor Shield
6	1190	Wheel Hub Grease Seal
7	1201	Bearing Cone and Roller

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8	1216	Front Wheel Bearing
9	1195	Front Wheel Outer Bearing Retainer Washer
10	—	Adjusting Nut
11	N642569-S	Cotter Pin
12	390622-S	Nut Retainer
13	1131	Hub Grease Cap
14	1102	Front Disc Brake Hub and Rotor (RH)
15	1103	Front Disc Brake Hub and Rotor (LH)
16	N805163-S190	Bolts, Caliper Anchor Plate (See Torque Note D Below)
17	2N386	Caliper Pin Bolts
18	2B120	Disc Brake Caliper (RH)
19	2B121	Disc Brake Caliper (LH)
20	—	Front Disc Brake Caliper Anchor Plate (Part of 2B120)
A	—	Tighten to 11-13 Nm (97-115 Lb-In)
B	—	Tighten to 23-34 Nm (17-25 Lb-Ft) While Rotating the Front Disc Brake Hub and Rotor. Back Off 120-180 Degrees and Retighten to 2.0-2.3 Nm (18-20 Lb-In).
C	—	Install Without Turning Hub Spindle Nut
D	—	NOTE: For Service, Install a New Bolt or Reuse the Old Bolt with Thread Locking Compound Such as Ford Threadlock and Sealer E0AZ-19554-AA or Equivalent Meeting Ford Specification WSK-M2G315-A5 (Type II). Tighten to 98-132 Nm (73-97 Lb-Ft).
E	—	Tighten to 52-65 Nm (38-48 Lb-Ft)

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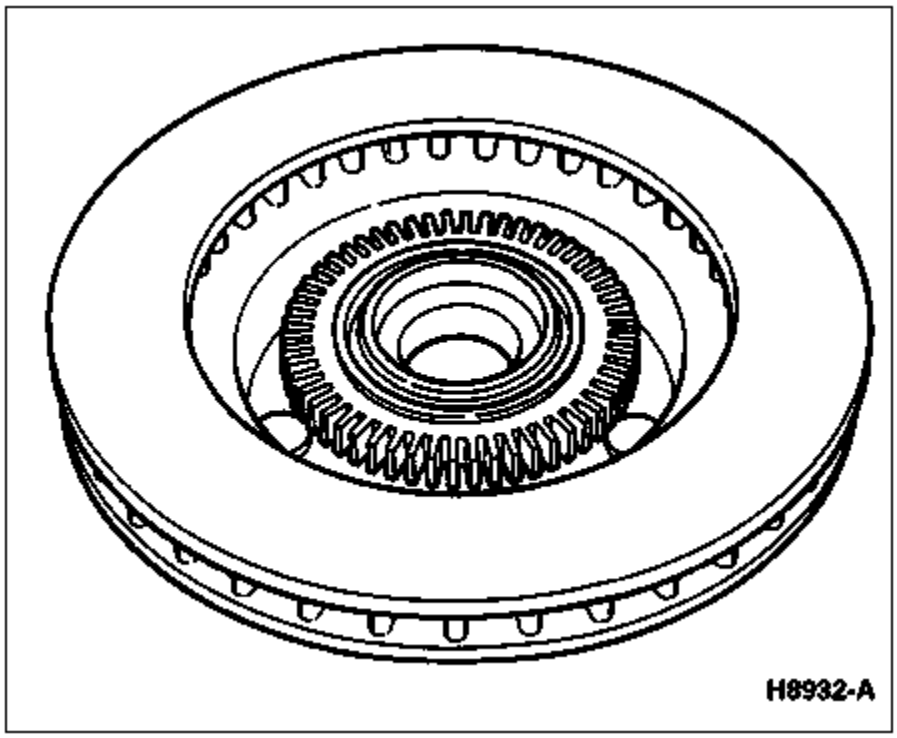
Sensor Indicator, Anti-Lock Brake

Removal

1. Raise vehicle on hoist. Refer to Section 00-02 .
2. Remove wheel and tire assembly.
3. Remove front disc brake caliper (2B121), rotor and hub assemblies. Refer to this section and Section 06-03 .



4. **CAUTION: Discard front brake anti-lock sensor indicator (2C182) after removal. Do not reuse old ring.**

   Using a 3-jaw puller and a step plate, remove front brake anti-lock sensor indicator from hub.

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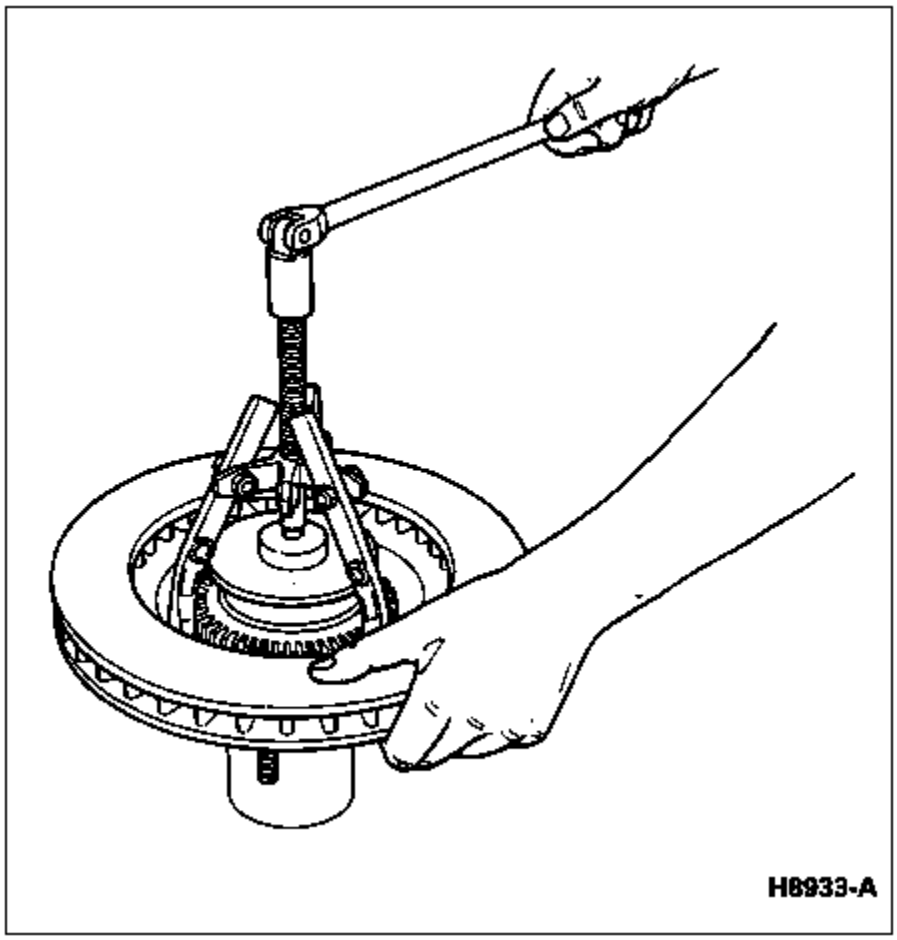

Installation

1. Support center of hub so that wheel studs do not rest on work surface.

2. **CAUTION: When performing the following step, make sure indicator ring is pressed on straight.**

   Position new front brake anti-lock sensor indicator on front disc brake hub and rotor (1102). Using a cylinder with 79mm (3.1 in.) ID and 96mm (3.8 in.) OD, press the front brake anti-lock sensor indicator onto the hub. The front brake anti-lock sensor indicator must be fully seated against the shoulder in the front disc brake hub and rotor.

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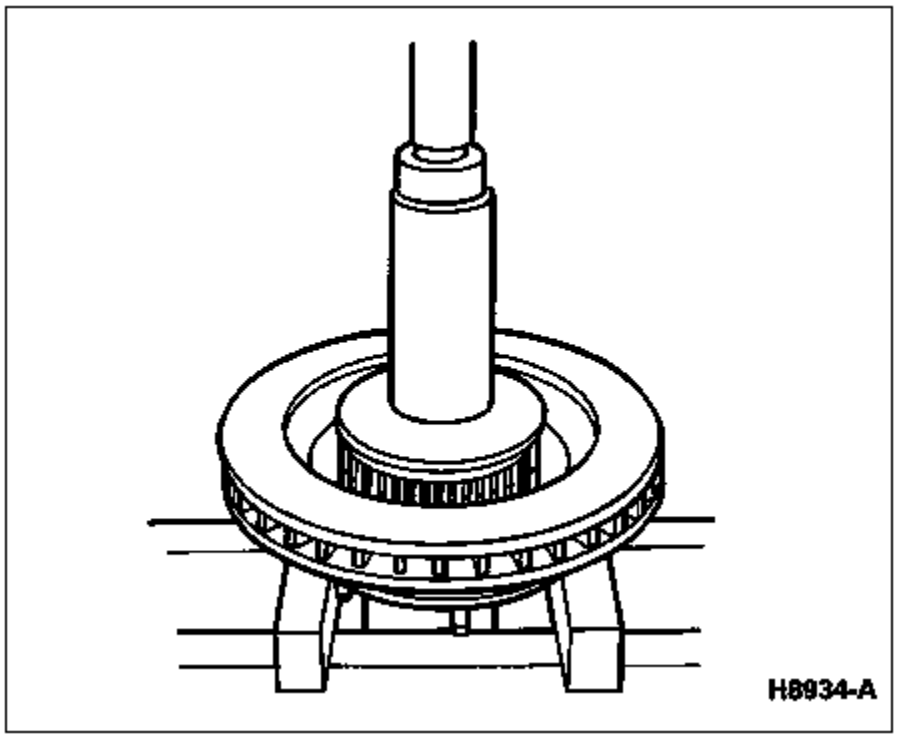

3. Install hub, rotor and caliper assemblies. Refer to Front Brake Hub and Rotor in this section and Section 06-03 .

4. Install wheel and tire assembly. Tighten wheel lugnuts to 135Nm (100 lb-ft).

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Shock Absorber — Aerostar

WARNING: THE LOW PRESSURE GAS SHOCK ABSORBERS ARE CHARGED WITH NITROGEN GAS TO 930 KPA (135 PSI). DO NOT ATTEMPT TO OPEN, PUNCTURE OR APPLY HEAT TO THE SHOCK ABSORBERS.

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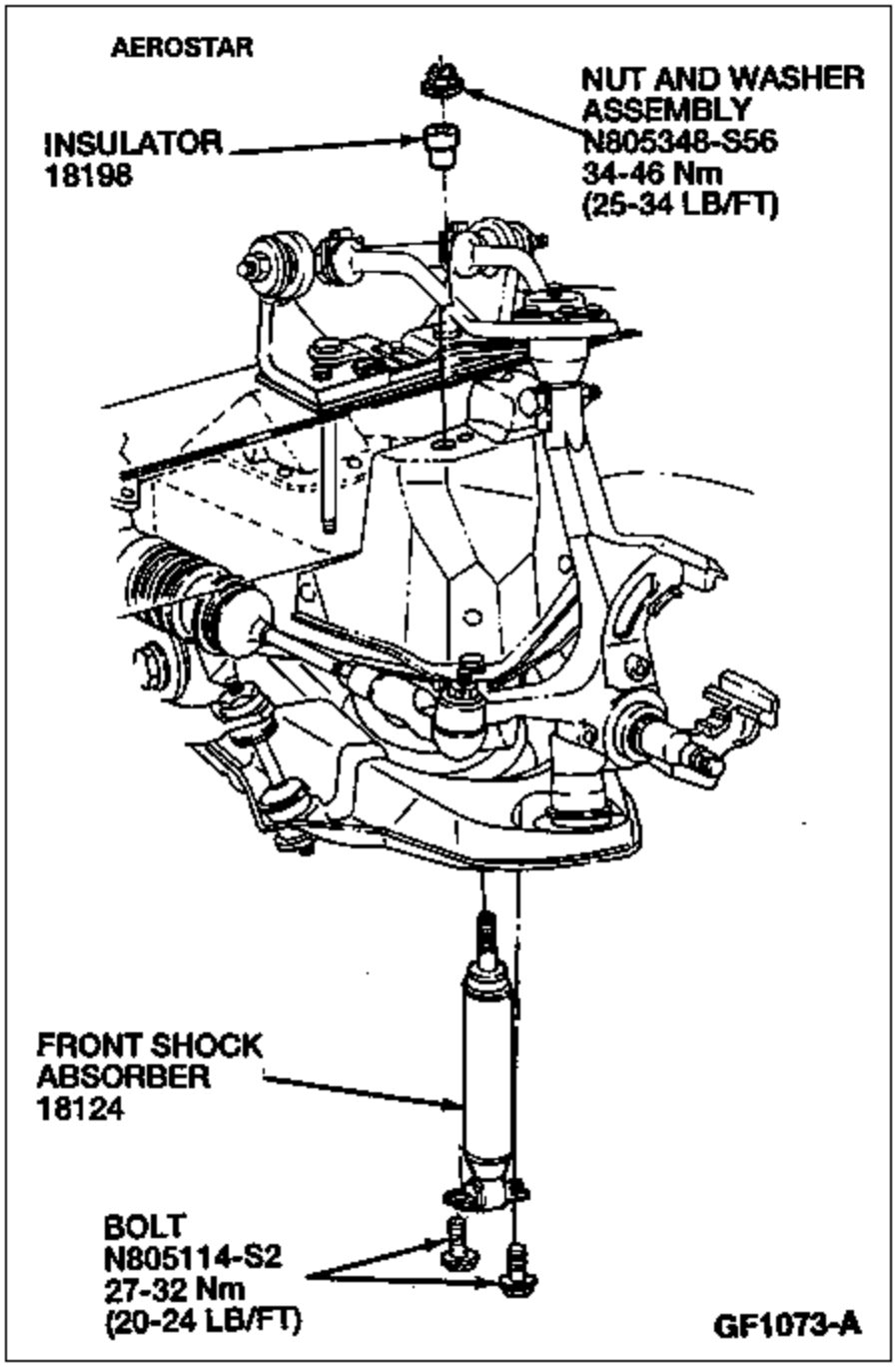

Removal

1. Raise vehicle on hoist with control arms in rebound position and position suitable safety stands under vehicle.

2. **NOTE: Inspect coil spring upper bracket insulator. If required, remove and replace.**

   Remove the nut and washer assembly retaining the front shock absorber to the coil spring upper bracket.

3. Remove two bolts retaining the front shock absorber to the bottom of the front suspension lower arm

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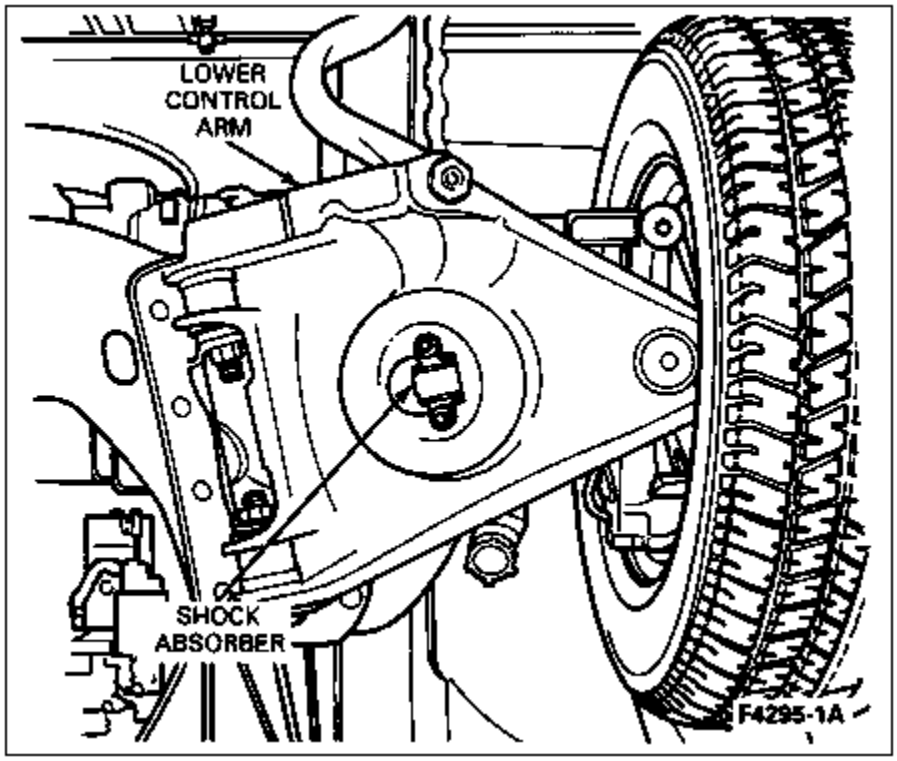
(3078).

4. Remove the front shock absorber through the front suspension lower arm.

Installation

For installation, follow removal procedures in reverse order. Tighten front shock absorber to lower control arm bolts to 27-32 Nm (20-24 lb-ft) and shock absorber to coil spring upper bracket nut 34-46 Nm (25-35 lb-ft).



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Shock Absorber — Ranger

WARNING: THE LOW PRESSURE GAS SHOCK ABSORBERS ARE CHARGED WITH NITROGEN GAS TO 930 KPA (135 PSI). DO NOT ATTEMPT TO OPEN, PUNCTURE OR APPLY HEAT TO THE SHOCK ABSORBERS.

Removal

1. Raise vehicle on hoist with axle in the rebound position and position suitable safety stands under axle to prevent it from dropping down when shock is removed.
2. Remove the shock absorber upper nut and washer from the spring seat.
3. Remove stud nut and washer that holds the front shock absorber to the radius arm.
4. Slide the front shock absorber off of the radius arm stud. Slightly compress the front shock absorber by hand and remove from the vehicle.

Installation

For installation, follow removal procedures in reverse order. Inspect the insulator in the spring seat. If the insulator requires replacement, install a new one. Tighten the lower nut to 53-72 Nm (39-53 lb-ft). Tighten the upper insulator, nut and washer to 34-46 Nm (25-34 lb-ft).

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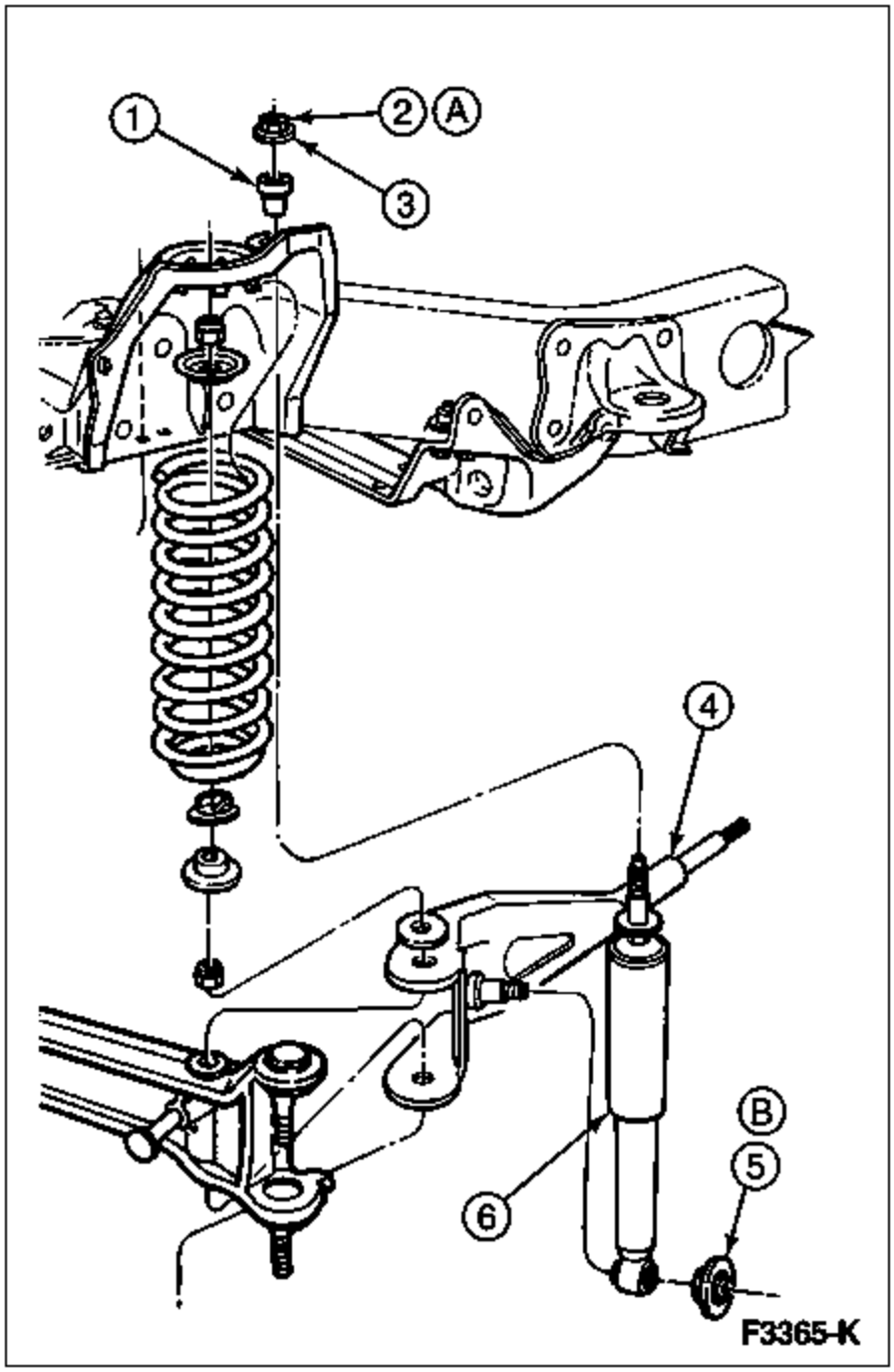

Item	Part Number	Description
1	18198	Insulator
2	620468	Nut
3	802084	Washer
4	3405	Radius Arm
5	N806372-S100	Nut and Washer
6	18045	Front Shock Absorber

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A	—	Tighten to 34-46 Nm (25-34 Lb-Ft)
B	—	Tighten to 53-72 Nm (39-53 Lb-Ft)

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Ball Joints, Upper and Lower — Ranger

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
U-Joint Tool	T74P-4635-C
Receiver Cup	T78P-5638-A3

Removal

1. **NOTE: The front suspension lower arm ball joint (3050) must be removed before removing front suspension upper ball joint (3049).**

   Remove the front wheel spindle (3105) and ball joint assembly from the axle as described in this section.

2. Install the front wheel spindle assembly in a vise, remove the snap ring from the front suspension lower arm ball joint. Remove the front suspension lower arm ball joint from the front wheel spindle using U-Joint Tool T74P-4635-C C-frame and Receiver Cup T78P-5638-A3.

3. **CAUTION: Do not heat the ball joint or the front wheel spindle to aid in removal.**

   Turn the forcing screw clockwise until the front suspension lower arm ball joint is removed from the front wheel spindle.

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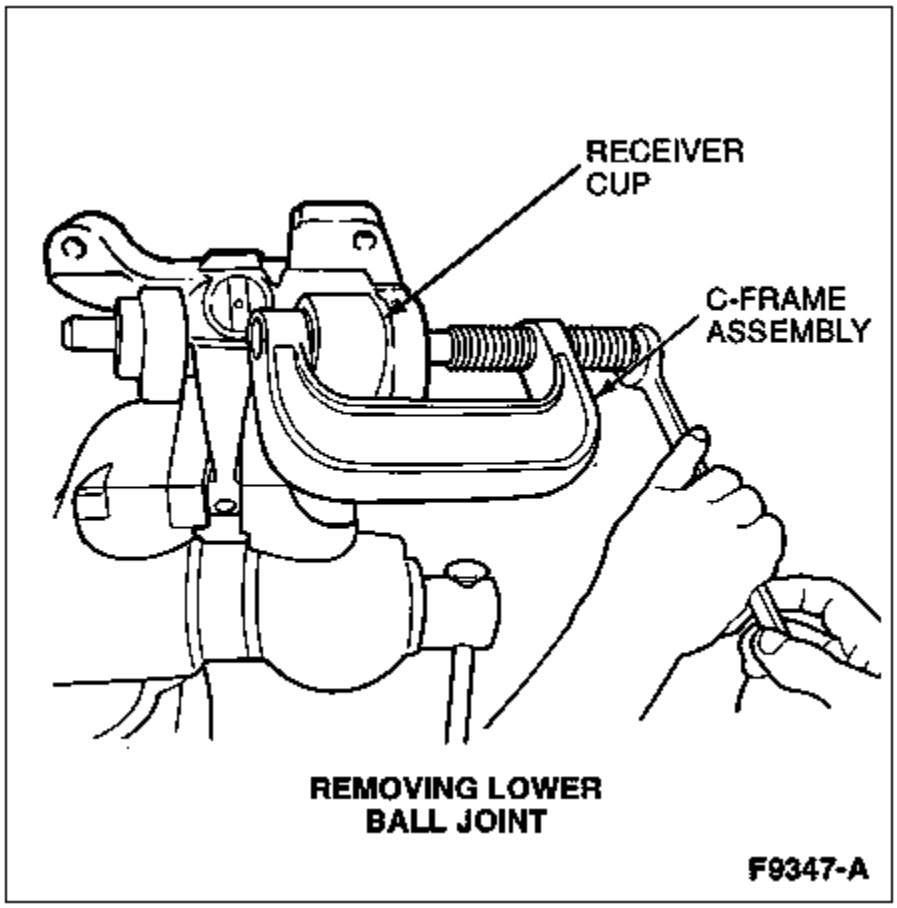

4. Assemble C-frame assembly and receiver cup on the front suspension upper ball joint and turn forcing screw clockwise until front suspension upper ball joint is removed from the front wheel spindle.

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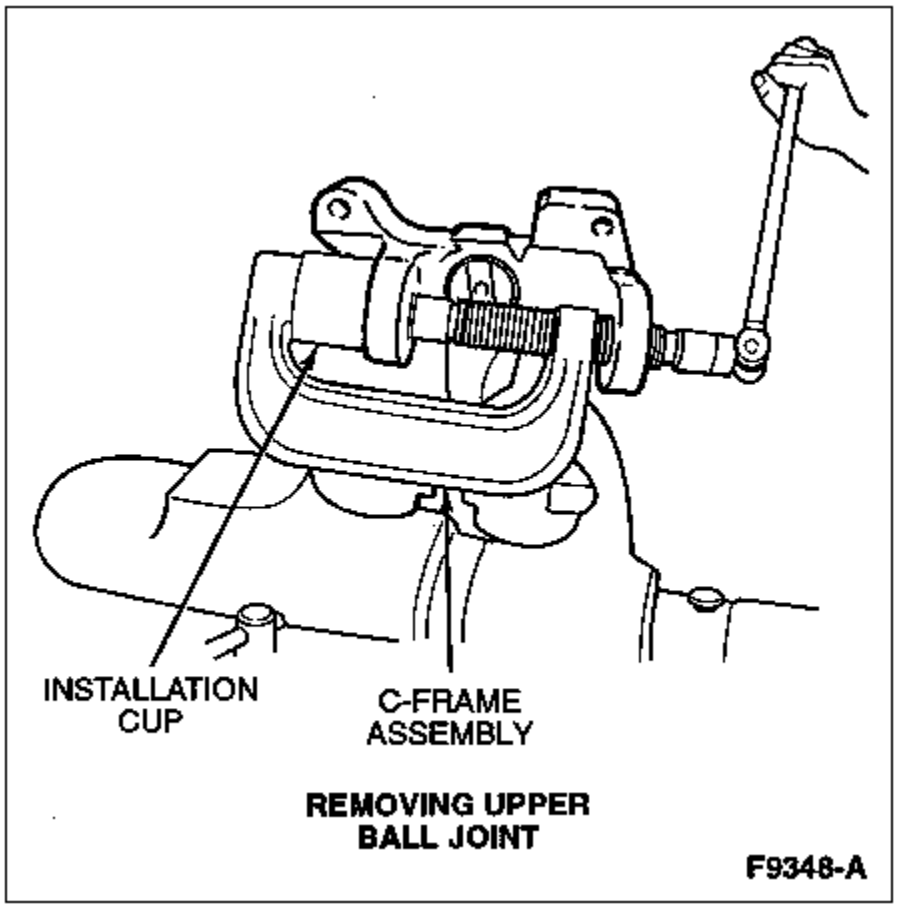

Installation

1. **NOTE: Front suspension upper ball joint must be installed into the front wheel spindle first.**

   Assemble U-Joint Tool T74P-4635-C C-frame assembly, Receiver Cup T78P-5638-A3 and suitable size ball joint installation cup from Ball Joint Adaptor Set D81T-3010-A inside cup in position on the front wheel spindle.

2. **CAUTION: Do not heat the ball joint or axle to aid in installation.**

   Turn forcing screw clockwise until front suspension upper ball joint is seated.

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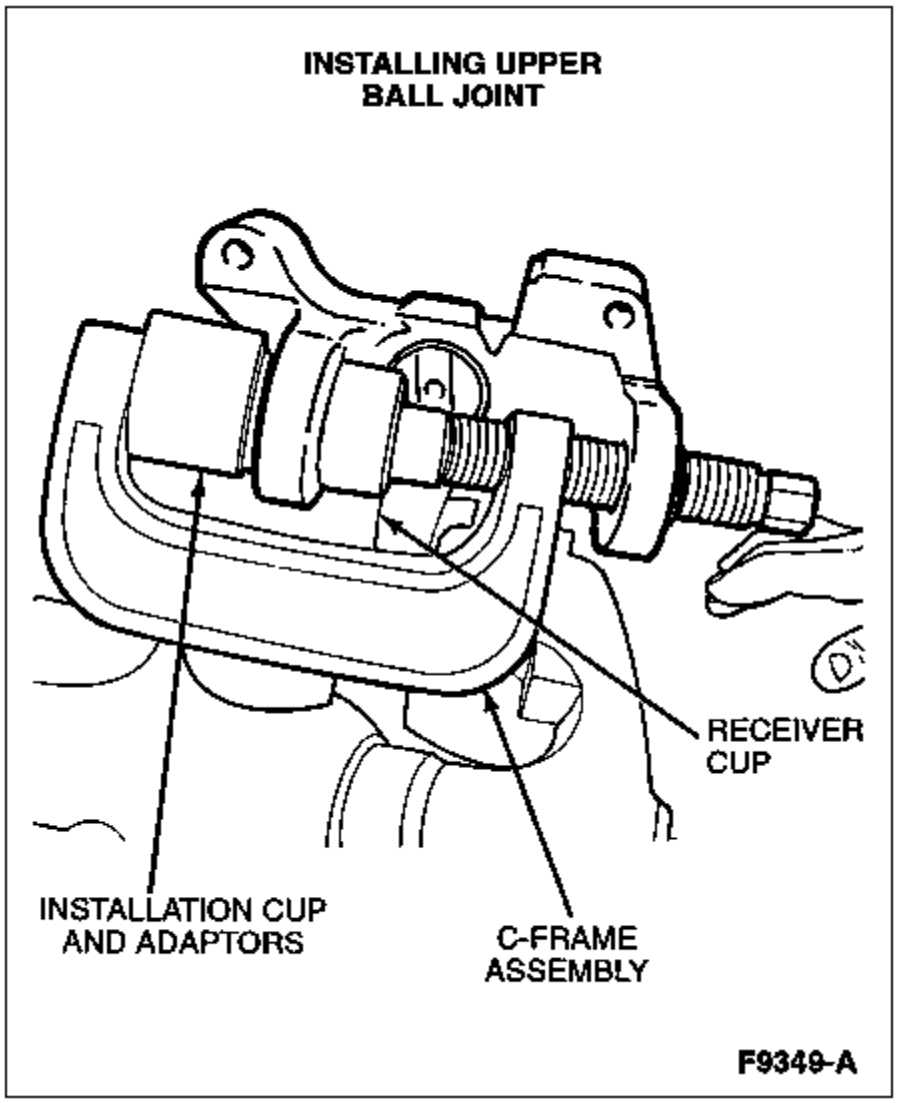

3. To install the front suspension lower arm ball joint, assemble the C-frame in position on the front wheel spindle and repeat Step 1.

4. Install the snap ring onto the front suspension lower arm ball joint.

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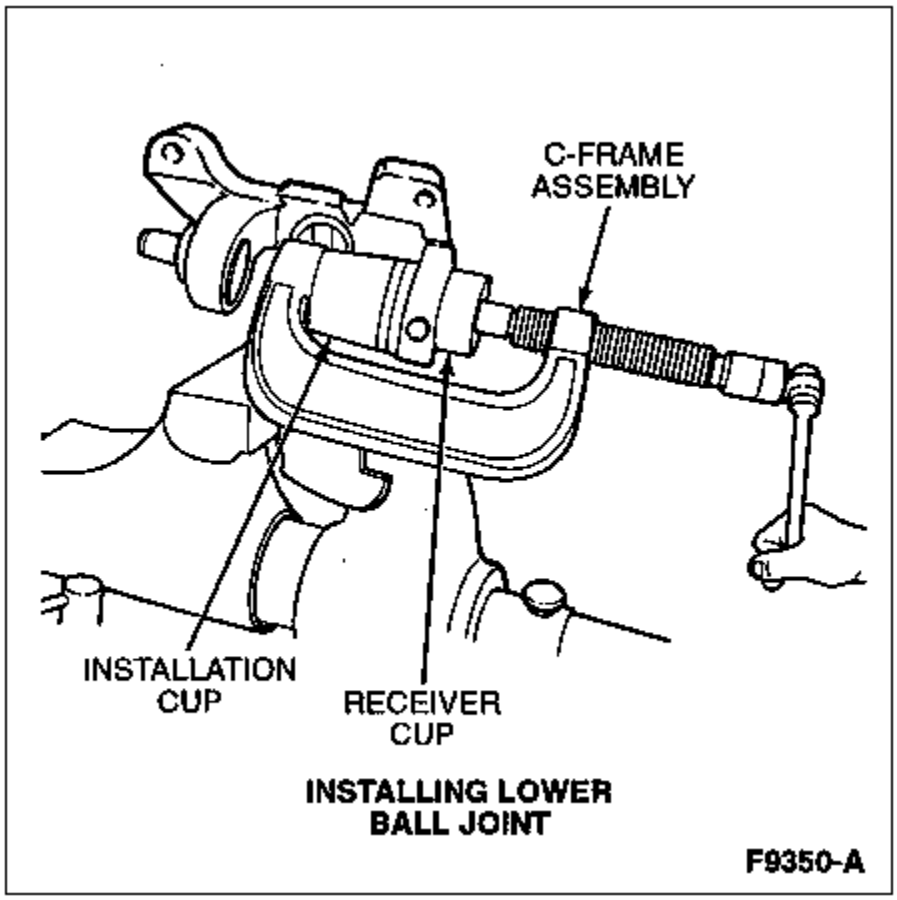

5. Install the front wheel spindle and ball joint assembly as described in this section.

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Radius Arm — Ranger

Removal and Installation

1. **CAUTION: The axle must be supported on the jack throughout front coil spring (5310) removal and installation, and must not be permitted to hang by the brake hose. If the length of the brake hose is not sufficient to provide adequate clearance for removal and installation of the front coil spring, the front disc brake caliper (2B121) must be removed from the front wheel spindle (3105) according to the procedures specified in Section 06-03 . After removal, the front disc brake caliper must be placed on the frame or otherwise supported to prevent suspending the front disc brake caliper from the brake hose. These precautions are absolutely necessary to prevent serious damage to the tube portion of the brake hose assembly.**

   Raise the front of the vehicle, place safety stands under the frame. Place a jack under the axle.

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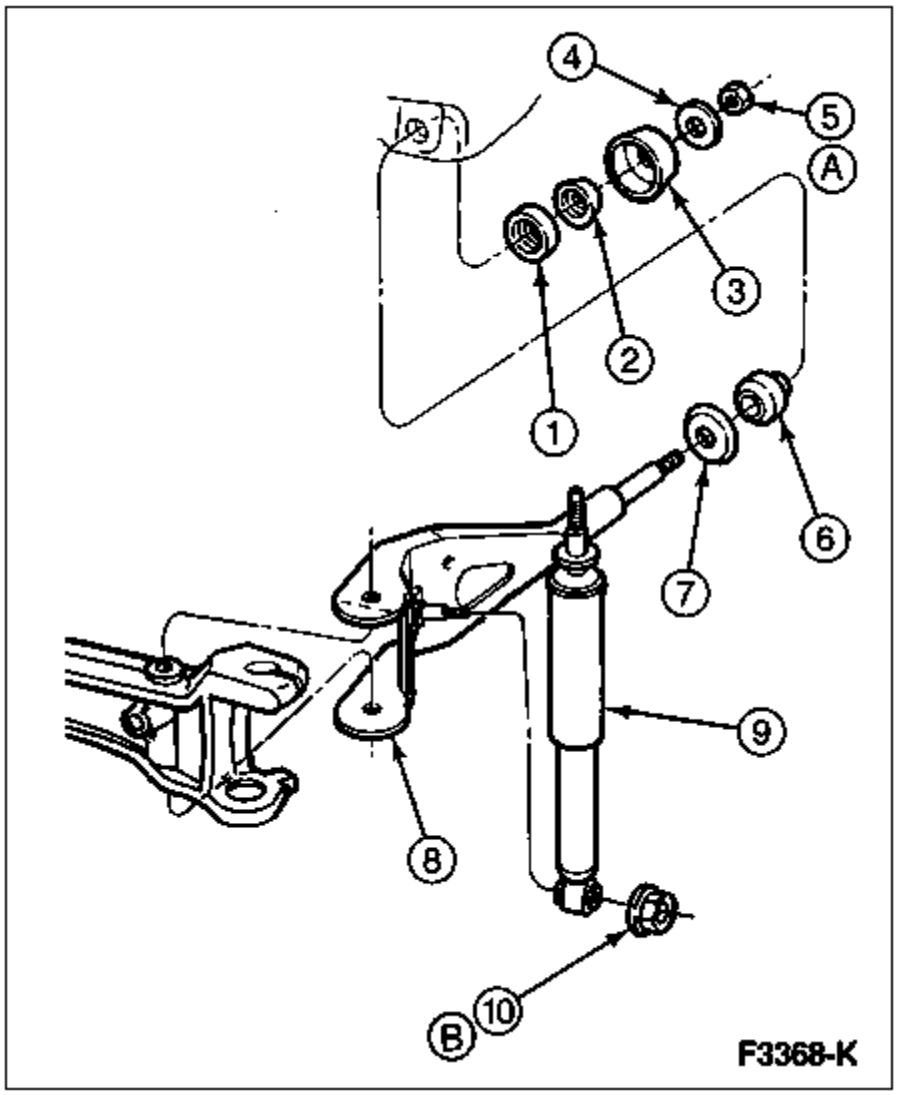

Item	Part Number	Description
1	3B244	Spacer
2	3A184	Outer Insulator
3	3B463	Shield (RH Only)
4	379572	Washer
5	34992	Nut
6	3B203	Inner Insulator
7	3B186	Retainer
8	3405	Radius Arm
9	18045	Front Shock Absorber
10	N806372	Nut Flange
A	—	Tighten to 113-153 Nm (82-113 Lb-Ft)
B	—	Tighten to 53-72 Nm

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		(39-53 Lb-Ft)

2. Remove the nut and disconnect the lower end of the front shock absorber from the shock lower stud.
3. Remove the front coil spring as described in this section.
4. Remove the spring lower seat from the radius arm.
5. Remove the bolt and nut attaching radius arm to axle and front bracket.
6. Remove the nut, rear washer shield (right side, V-6 engine only), spacer and insulator from the rear side of the radius arm rear bracket.
7. Remove the radius arm from the vehicle.
8. Remove the inner insulator and retainer from the radius arm stud.

For installation, follow removal procedures in reverse order. Tighten shock absorber-to-radius arm stud nut to 53-72 Nm (39-53 lb-ft). Tighten radius arm-to-axle bolt to 255-345 Nm (190-255 lb-ft). Tighten radius arm-to-bracket nut to 113-153 Nm (83-113 lb-ft).

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Insulators, Radius Arm — Ranger

Removal and Installation

1. Loosen the upper shock absorber pivot bolt and compress the front shock absorber.
2. Remove the nut and washer attaching the radius arm to the radius arm bracket. Remove the outer insulator and spacer and shield (on right radius arm V-6 engines only).
3. Move the radius arm and axle assembly forward out of the radius arm bracket.
4. Remove the inner insulator and retainer.

For installation follow removal procedures in reverse order. Tighten radius arm to radius arm bracket nut to 113-153 Nm (83-113 lb-ft). Tighten upper shock bolt to 34-46 Nm (25-34 lb-ft).

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Coil Spring and Arm, Lower — Aerostar

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Pitman Arm Puller	T64P-3590-F

Removal

1. **NOTE: Any time the steering linkage is disconnected from the front wheel spindle (3105), place steering system in the on-center position.**

   Place the steering wheel and steering system in the on-center position.

   Front Coil Spring and Front Suspension Lower Arm, Aerostar

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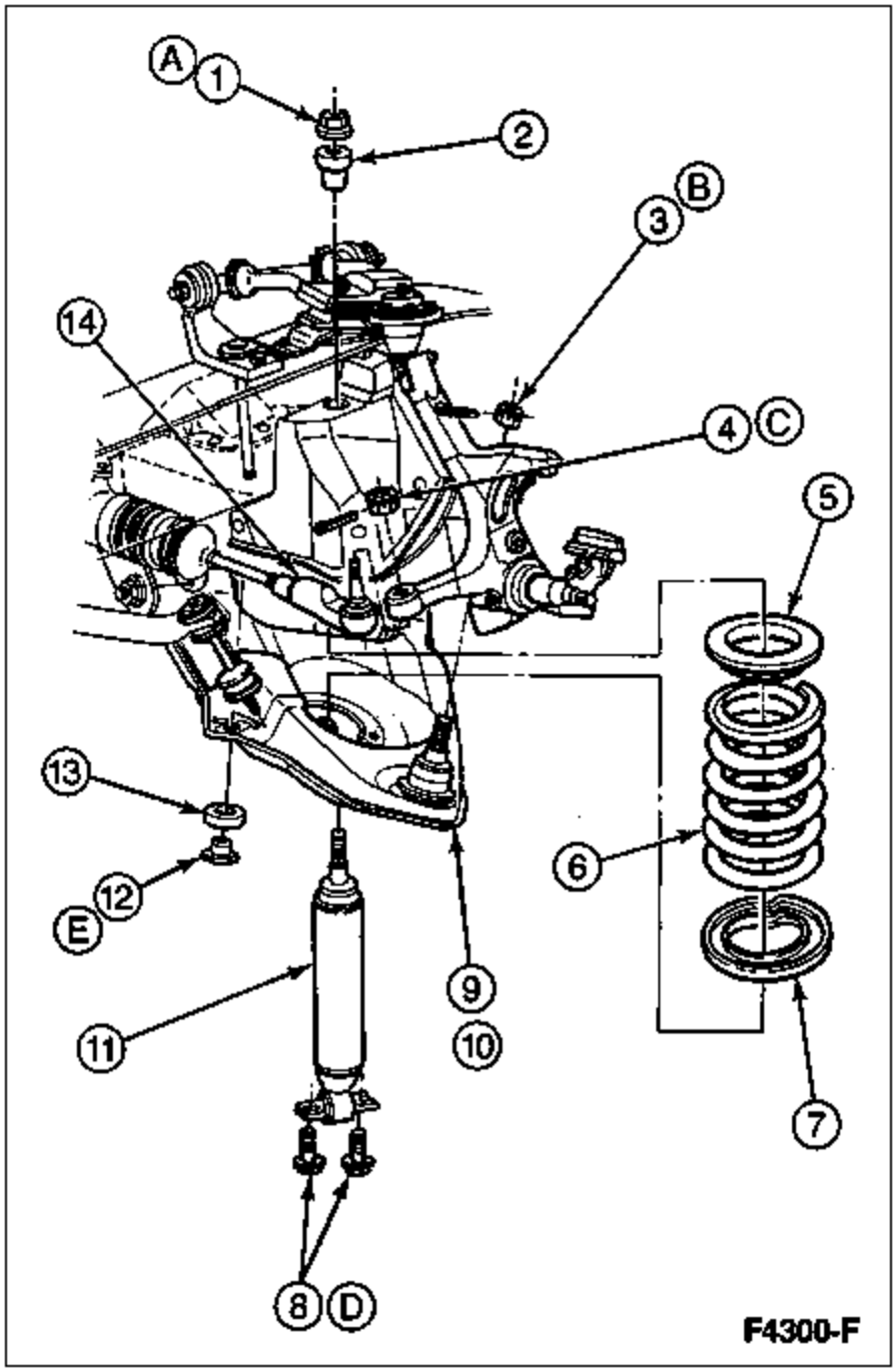

Item	Part Number	Description
1	805348	Nut
2	18198	Insulator
3	381612	Spindle Lower Nut
4	800895	Tie Rod Nut
5	5415	Front Spring Insulator
6	5310	Front Coil Spring

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7	5414	Front Spring Insulator
8	N805114-S2	Bolts (2 Req'd)
9	3078	Front Suspension Lower Arm (RH)
10	3079	Front Suspension Lower Arm (LH)
11	18045	Front Shock Absorber
12	5C491	Nut
13	803702	Insulator
14	3A130	Tie Rod End
A	—	Tighten to 34-46 Nm (25-34 Lb-Ft)
B	—	Tighten to 108-153 Nm (80-113 Lb-Ft)
C	—	Tighten to 70-100 Nm (52-74 Lb-Ft)
D	—	Tighten to 27-32 Nm (20-24 Lb-Ft)
E	—	Tighten to 8-12 Nm (71-106 Lb-In)

2. Raise vehicle on a hoist. Remove wheel and tire assembly. Refer to Section 04-04 .
3. Disconnect stabilizer bar link bolt from front suspension lower arm (3079).
4. Remove the two nuts attaching the front shock absorber to the front suspension lower arm (3078) assembly.
5. Remove the upper nut and washer retaining the front shock absorber. Remove the front shock absorber.
6. Support the vehicle with safety stands under the jacking pads, and lower the hoist but maintain working room.
7. Using Coil Spring Compressor D78P-5310-A or equivalent, install one plate with the pivot ball seat facing downward into the coils of the spring. Rotate the plate, until flush with the upper surface of the front suspension lower arm.

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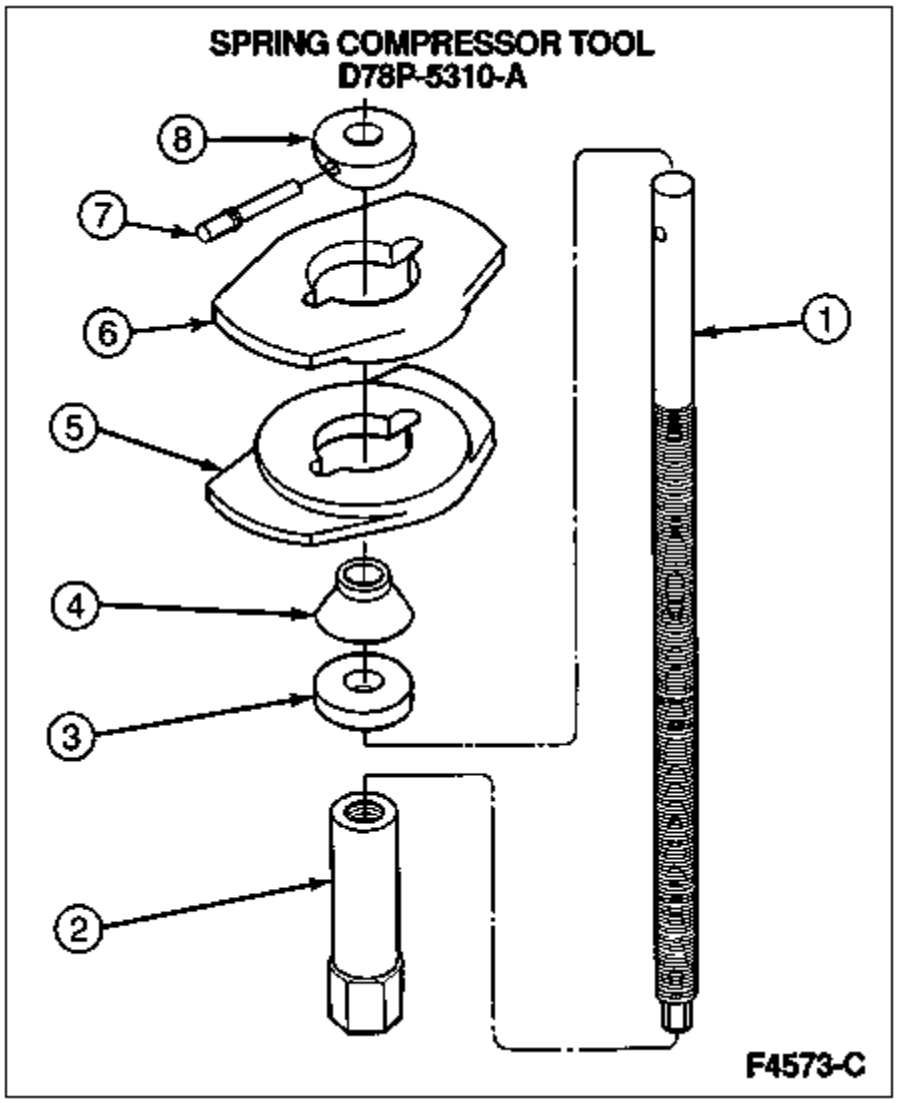

Item	Part Number	Description
1	—	Compression Rod (Part of D78P-5310-A)
2	—	Forcing Nut (Part of D78P-5310-A)
3	—	Thrust Washer (Part of D78P-5310-A)
4	—	Lower Ball Nut (Part of D78P-5310-A)
5	—	Lower Plate (Part of D78P-5310-A)
6	—	Upper Plate (Part of D78P-5310-A)
7	—	Pin (Part of D78P-5310-A)
8	—	Upper Ball Nut (Part of D78P-5310-A)

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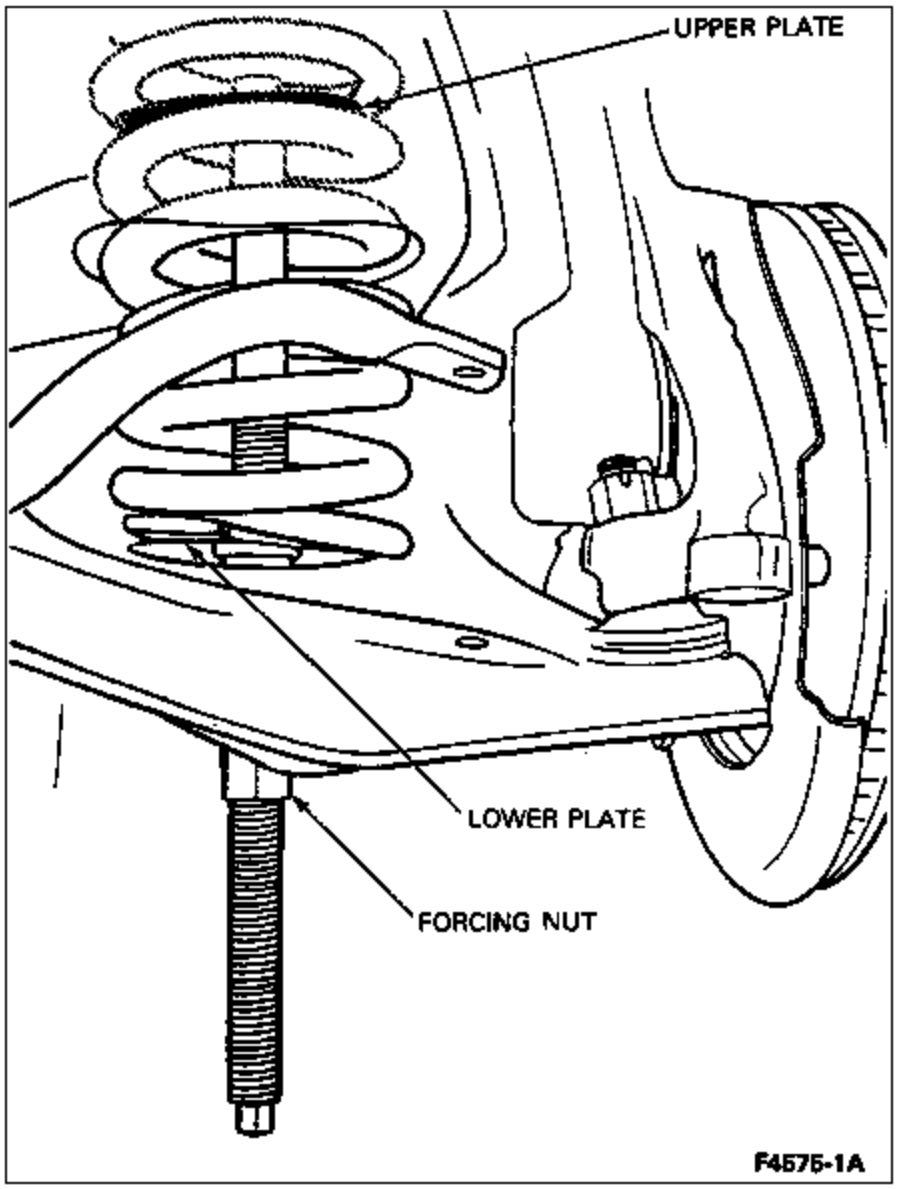
8. Install the other plate with the pivot ball seat facing upward into the spring coils. Insert the upper ball nut through the spring coils so nut rests in the upper plate.

9. Insert the compression rod into the opening in the lower arm, through the upper and lower plate and upper ball nut.

10. **NOTE: Securing pin can only be inserted one way into the upper ball nut because of a stepped hole design.**

    Insert the securing pin through the upper ball nut and compression rod.

11. With the upper ball nut secured, turn the upper plate so that it walks up the coil and contacts upper spring seat; then back off one-half turn.



12. Install lower ball nut and thrust washer onto compression rod, and screw on the forcing nut.

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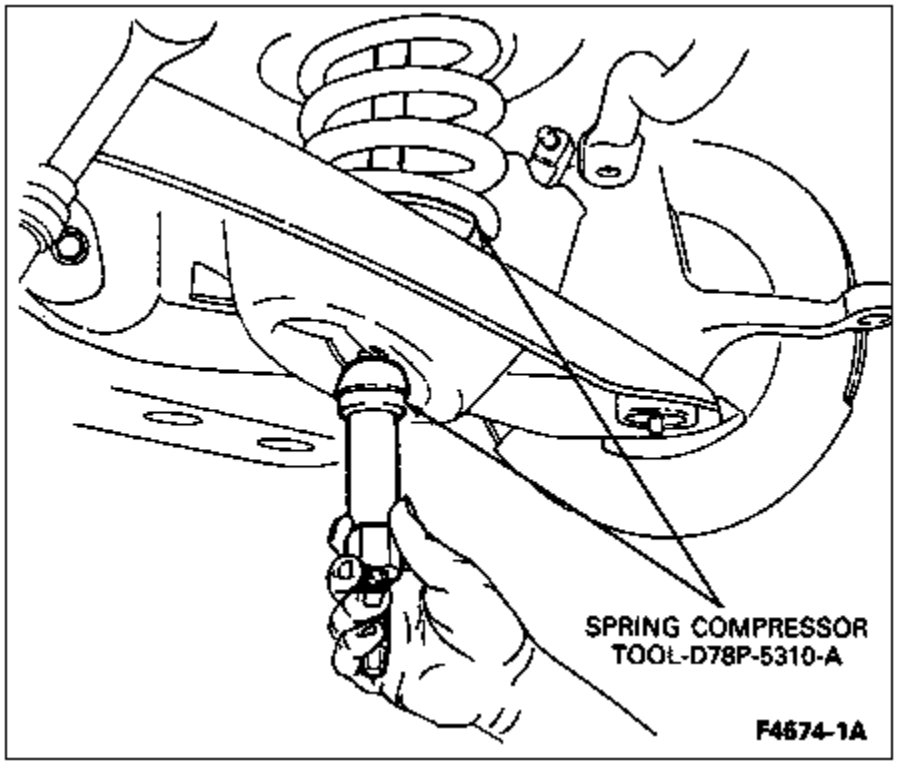
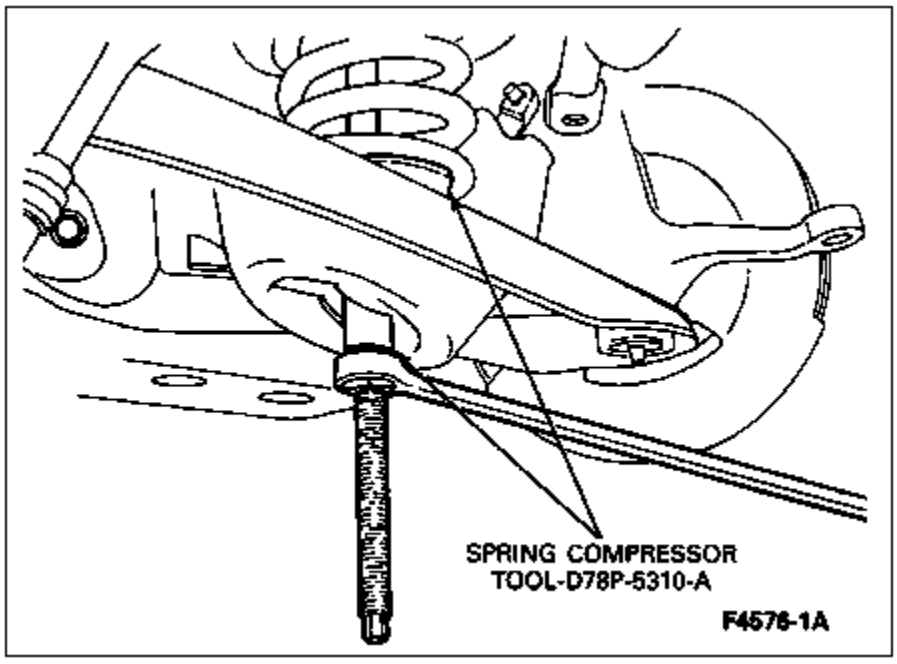


13. Tighten the forcing nut until the front coil spring (5310) is compressed.



14. Loosen the two lower arm pivot bolts.

15. Remove the cotter pin and loosen, do not remove nut attaching the front suspension lower arm ball

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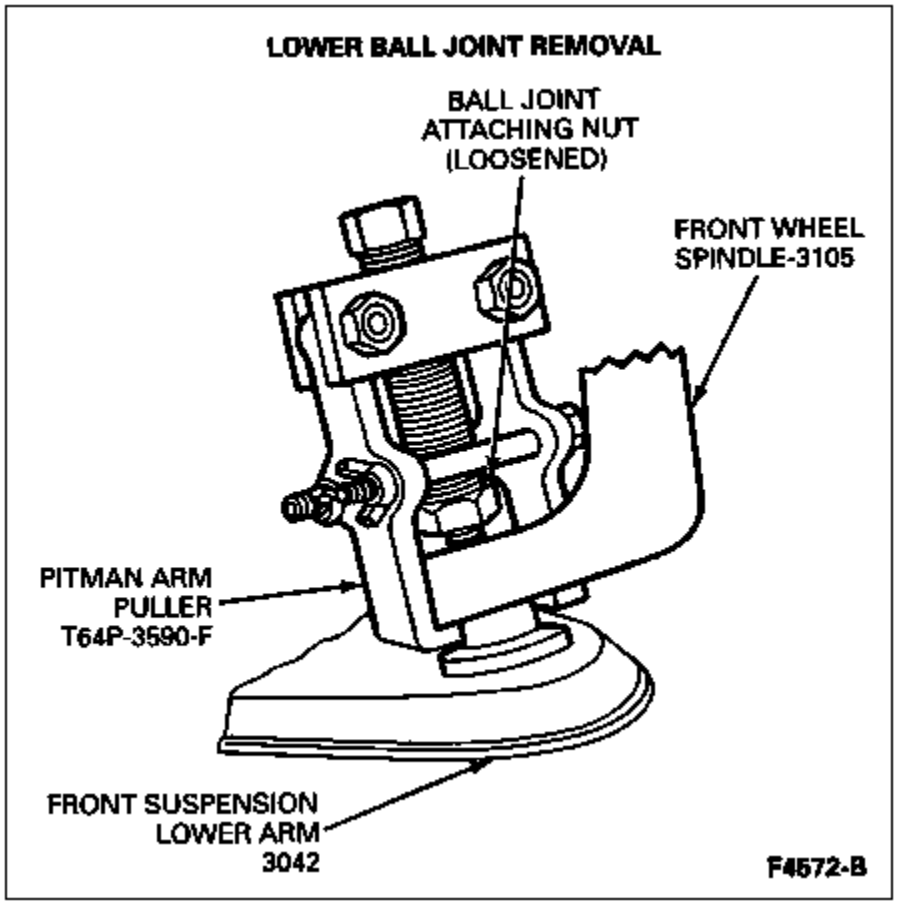
joint (3050) to the spindle.

16. Using Pitman Arm Puller T64P-3590-F loosen the lower ball joint. Remove the puller tool.
17. Supporting front suspension lower arm with a jack, and remove the ball joint nut.
18. Lower the front suspension lower arm and remove the front coil spring.



19. If a new front coil spring is to be installed, mark the position of the upper and lower plates on the front coil spring with chalk and measure the compressed length of the old front coil spring.
20. Loosen the forcing nut to relieve spring tension, and remove the tools from the front coil spring.

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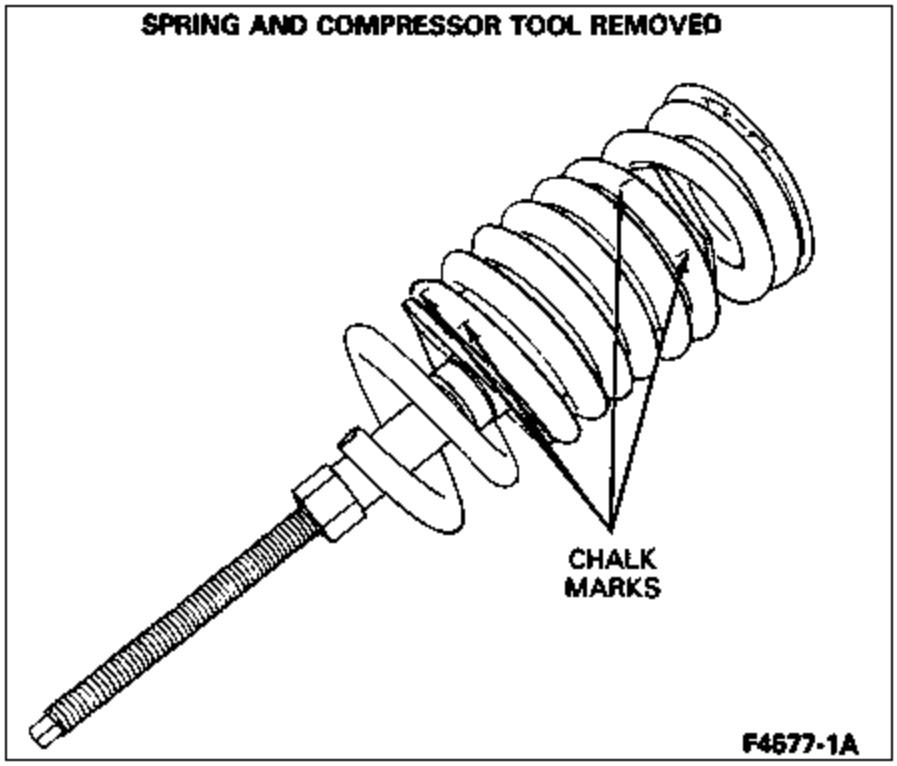

21. Remove the bolts and nuts retaining the lower control arm to the front crossmember (5019). Remove the front suspension lower arm.

22. Replace entire front suspension lower arm assembly-to-service bushings.

Installation

1. **NOTE: Do not tighten the front suspension lower arm bolts and nuts to the specified torque until the front coil spring is installed and uncaged. Install nuts and tighten until snug.**

   Inspect lower ball joint boot seal for damage and replace if required.

2. Position the front suspension lower arm in the front crossmember. Install the bolts. Install the nuts and tighten until snug.

3. Assemble the spring compressor, locate in the same positions indicated in Removal.

4. Before compressing the front coil spring, make sure upper ball nut securing pin is inserted properly.

5. Compress front coil spring until spring height reaches the dimension obtained in Removal, Step 19.

6. Position the front coil spring assembly into the front suspension lower arm.

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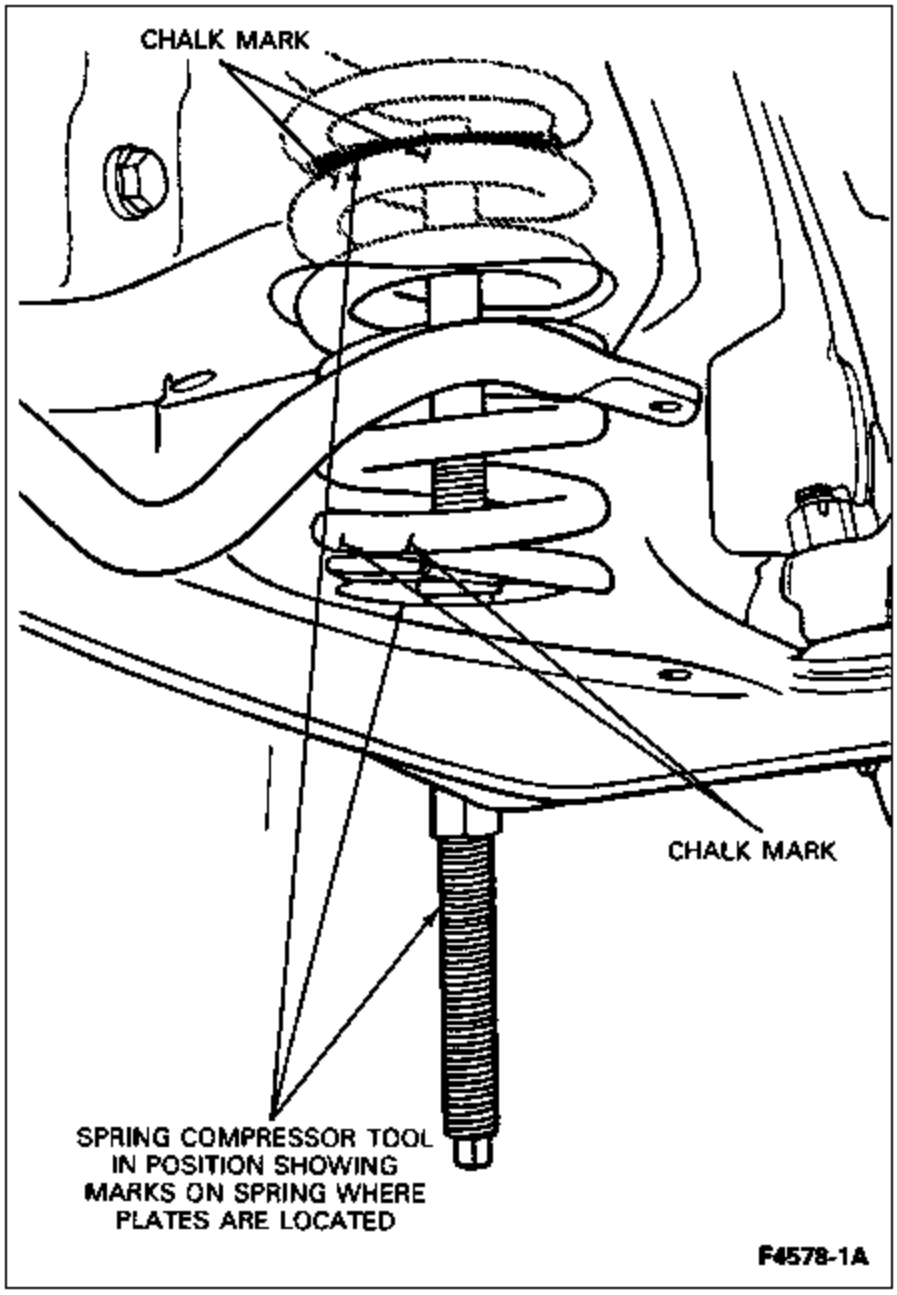

7. Raise the front suspension lower arm back up into position and make sure lower ball joint is seated in spindle bore.

8. Install the lower ball joint attaching nut and tighten to 108-153 Nm (80-113 lb-ft). Install a new cotter pin.

9. Remove the spring compression tool.

10. Verify the front coil spring is properly indexed relative to the front suspension lower arm.

11. Loosen the forcing nut to relieve spring tension and remove the tool from the front coil spring.

12. Raise vehicle. Position the front shock absorber and install the washer and upper nut. Tighten nut to 34-46 Nm (25-34 lb-ft).

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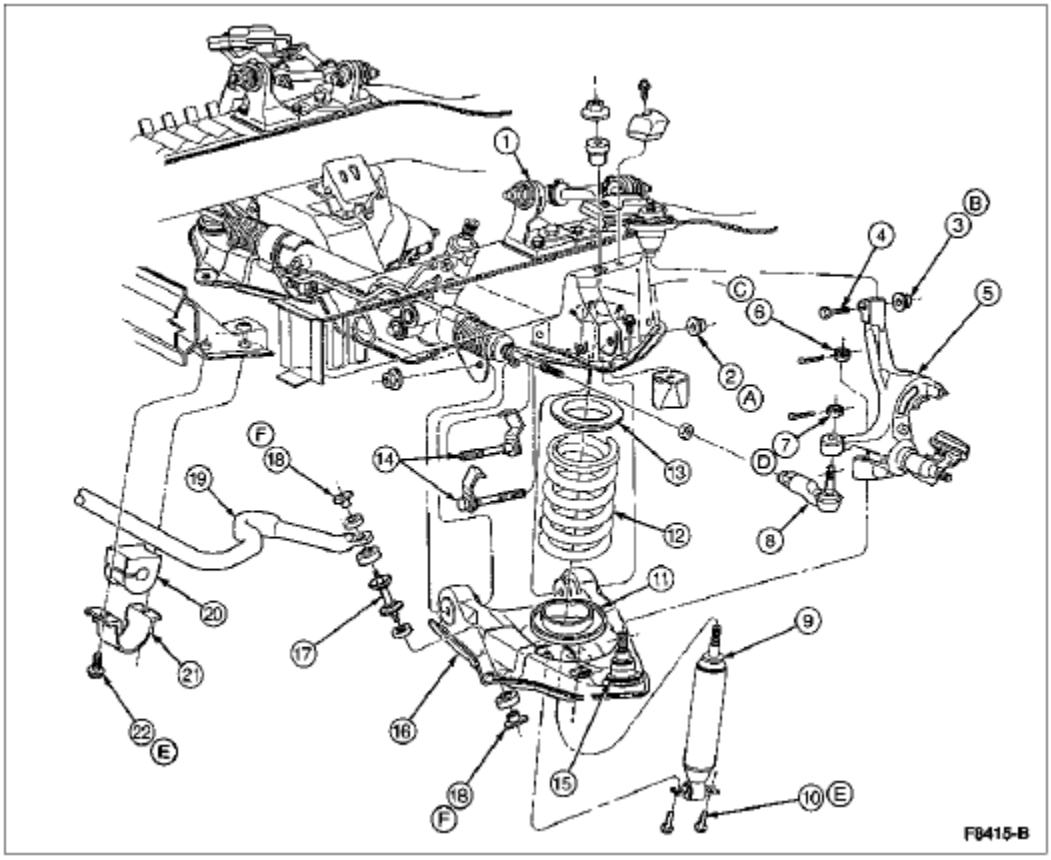
13. Install the two bolts attaching the front shock absorber to the lower control arm and tighten to 27-32 Nm (20-24 lb-ft).

14. Connect the stabilizer bar link bolt to the front suspension lower arm and tighten to 8-12 Nm (71-106 lb-in).

15. Lower the vehicle to normal ride height. Tighten nuts and lower control arm bolts to the No. 1 front crossmember to 136-190 Nm (100-140 lb-ft).

16. Lower the vehicle.

No. 1 Crossmember and Stabilizer Bar, Aerostar



Item	Part Number	Description
1	3083	Front Suspension Upper Arm
2	800237	Nut (2 Req'd)
3	801206	Nut
4	804806	Bolt
5	3105	Front Wheel Spindle
6	381612	Nut

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7	800895	Nut
8	3A130	Tie Rod End
9	18045	Front Shock Absorber
10	805114	Screw
11	5415	Front Spring Insulator
12	5310	Front Coil Spring
13	5414	Front Spring Insulator
14	805537	Bolt
15	3050	Front Suspension Lower Arm Ball Joint
16	3078	Front Suspension Lower Arm
17	5K483	Front Stabilizer Bar Link
18	5C491	Nut
19	5482	Front Stabilizer Bar
20	5484	Insulator
21	5486	Stabilizer Bar Bracket
22	806497	Bolt
A	—	Tighten to 136-190 Nm (100-140 Lb-Ft)
B	—	Tighten to 36-50 Nm (27-37 Lb-Ft)
C	—	Tighten to 108-153 Nm (80-113 Lb-Ft)
D	—	Tighten to 70-100 Nm (52-74 Lb-Ft)
E	—	Tighten to 27-32 Nm (20-24 Lb-Ft)
F	—	Tighten to 8-12 Nm (71-106 Lb-In)

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Arm, Upper — Aerostar

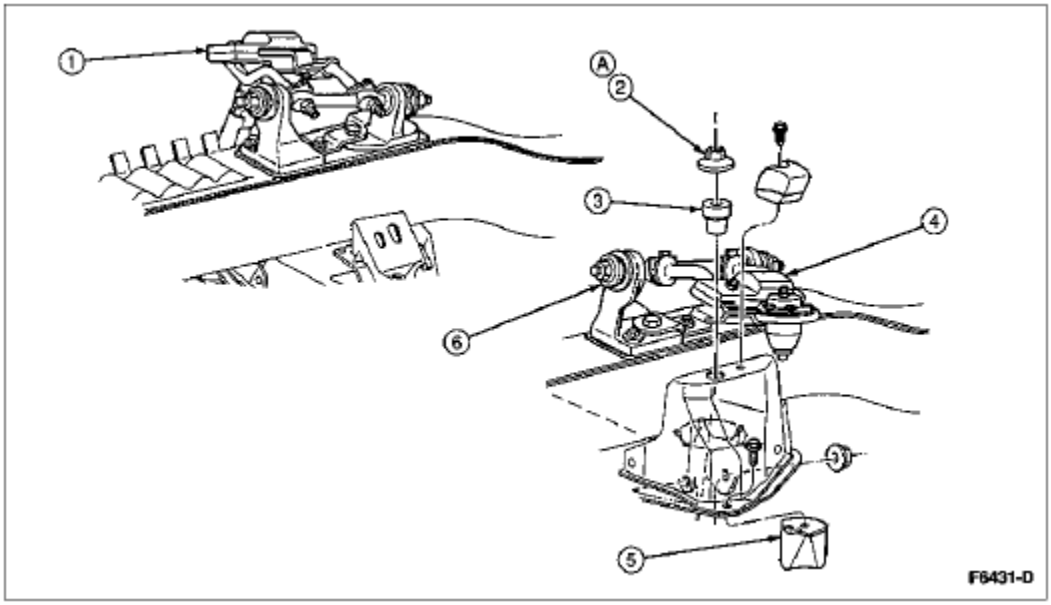
NOTE: The upper control arm assembly consists of the front suspension upper arm (3083), front suspension upper ball joint (3049), adjusting arm, brackets, bushings and nuts.

Removal

1. **NOTE: Any time the steering linkage is disconnected from the front wheel spindle (3105), the steering system must be placed in the on-center position.**

   Place the steering wheel and steering system in the on-center position.

Upper Control Arm Assembly, Aerostar



Item	Part Number	Description
1	3C156	Damper Assembly (RH)
2	805348	Nut and Washer
3	—	Shock Absorber Insulator (Part of 18198)
4	3C157	Damper Assembly (LH)
5	3020	Front Suspension Bumper
6	3083	Front Suspension Upper Arm Assembly

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A	—	Tighten to 34-46 Nm (25-34 Lb-Ft)

2. **WARNING: WHEN SERVICING ANY COMPONENT IN THE UPPER CONTROL ARM AND BALL JOINT SYSTEM, ONLY ONE SIDE OF THE VEHICLE IS SERVICED AT A TIME. NEVER SERVICE BOTH SIDES AT THE SAME TIME.**

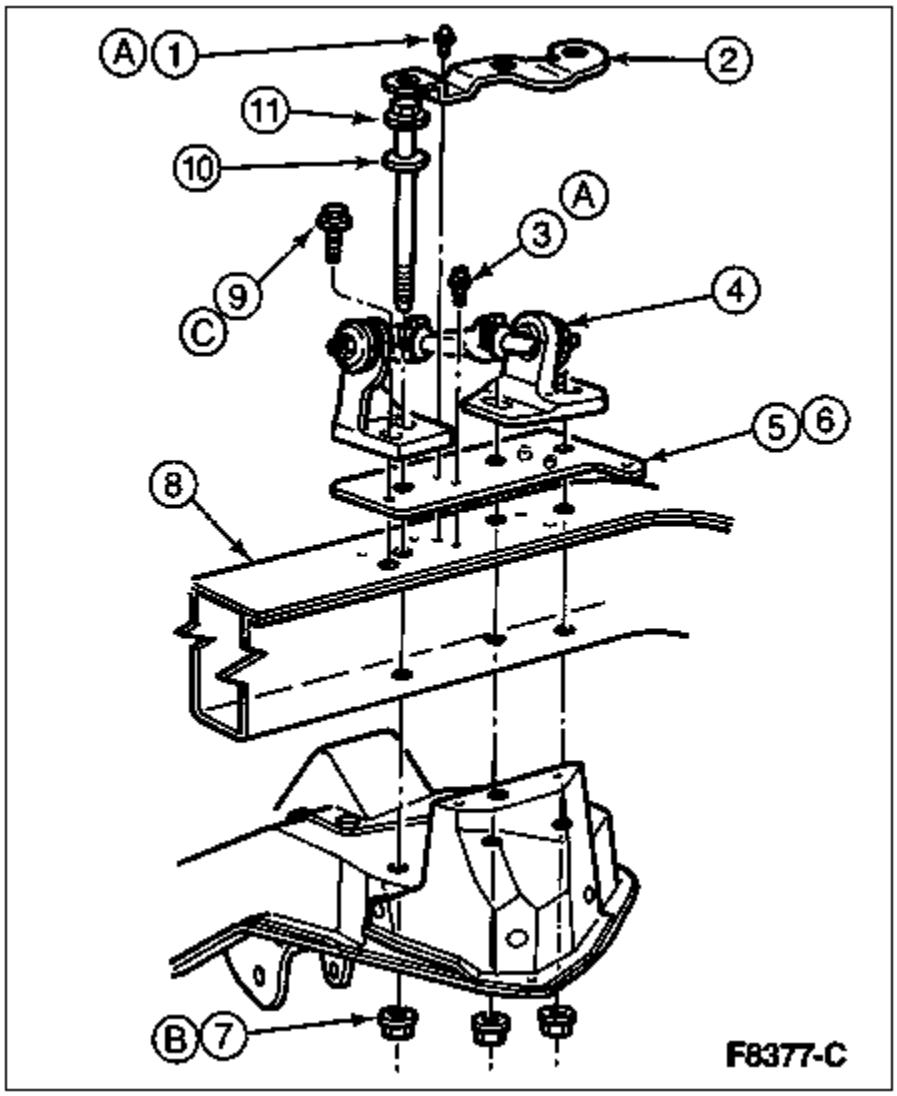
   Raise the vehicle on a frame hoist. Position a tall jack under the front suspension lower arm (3078) and raise the jack.

3. Remove the front wheel spindle as described in this section.

4. Remove retainer plate screw and the plate.

5. Mark the position of the control arm mounting brackets on the flat plate.

6. Remove the bolt and washer retaining the front mounting bracket to the flat plate.



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Item	Part Number	Description
1	611194	Screw
2	3B204	Flat Plate (LH)
	3A375	Flat Plate (RH)
3	611175	Screw
4	3083	Front Suspension Upper Arm
5	3B380	Mounting Plate (LH)
6	3A009	Mounting Plate (RH)
7	804431	Nut and Washer Assembly
8	5005	Frame
9	804618	Bolt and Washer Assembly
10	804387	Washer
11	804386	Bolt
A	—	Tighten to 14-19 Nm (10-14 Lb-Ft)
B	—	Tighten to 196-264 Nm (145-195 Lb-Ft)
C	—	Tighten to 47-64 Nm (35-47 Lb-Ft)

7. From beneath the rail, remove the three nuts from bolts retaining two front suspension upper arm mounting brackets to the body rail.

8. Remove three long bolts retaining mounting brackets to body rail. Rotate front suspension upper arm out of position in order to remove the bolts.

9. Remove the front suspension upper arm, front suspension upper ball joint and mounting bracket assembly and flat plate from the vehicle.

10. If required, remove and replace the upper and/or lower ball joint boot seal.

11. **NOTE: The front suspension upper arm and front suspension upper ball joint are serviced as an assembly.**

    If required, remove the damper assembly from the front suspension upper arm by removing the three retaining bolts.

Ball Joint and Upper Arm Assembly

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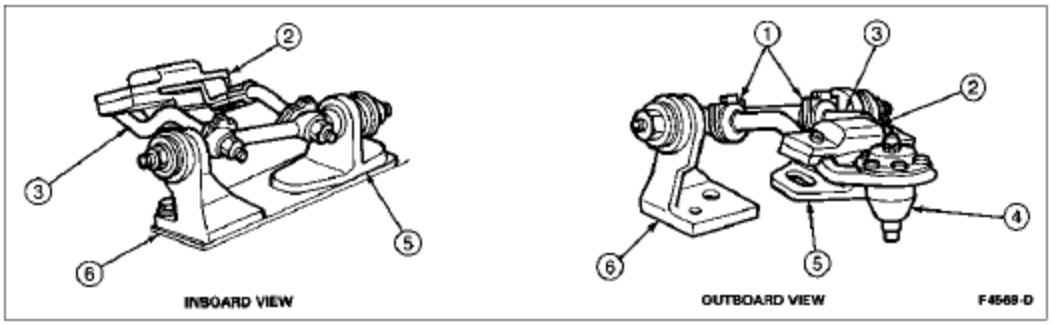
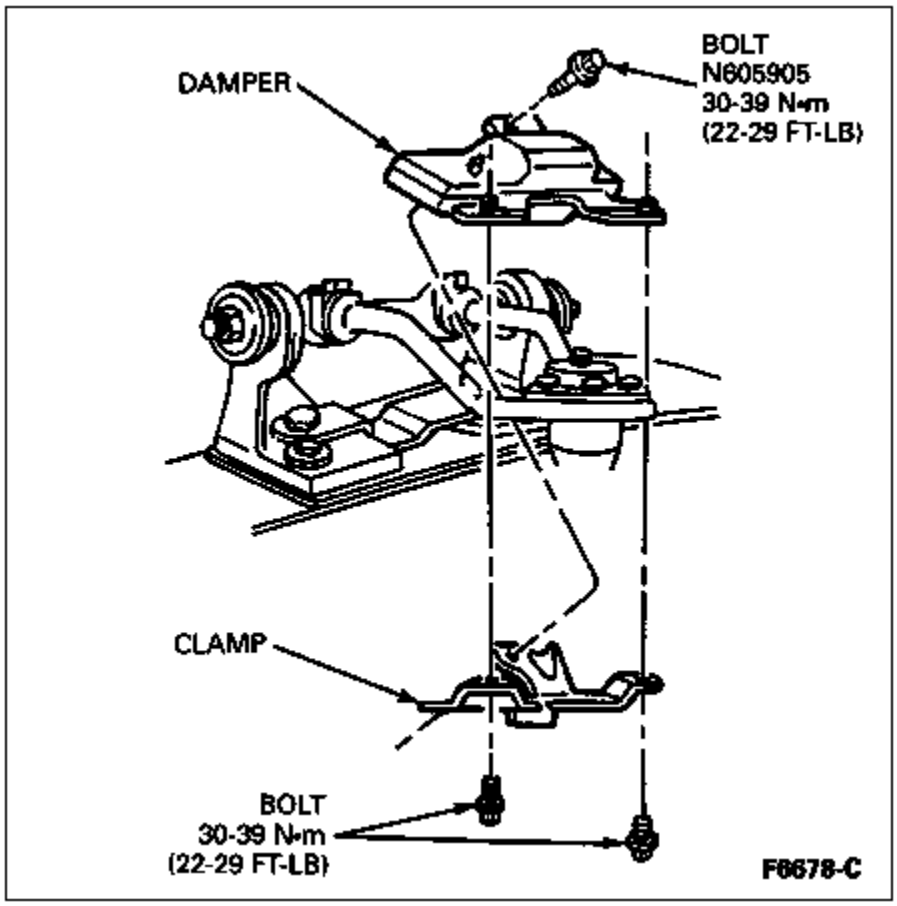


Item	Part Number	Description
1	—	Alignment Shims (Part of 3083)
2	3C157	Damper Assembly
3	3083	Front Suspension Upper Arm
4	3049	Front Suspension Upper Ball Joint
5	—	Rear Mounting Bracket (Part of 3383)
6	—	Front Mounting Bracket (Part of 3383)



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Installation

1. If removed, install the front suspension upper arm in the pivot arm.
2. Install the shims on the control arm studs using same number and location marked during removal.
3. Install and tighten the nuts retaining the shims to the front suspension upper arm to 95-135 Nm (70-100 lb-ft).
4. If removed, install the boot seal on the upper and/or lower ball joint.
5. If removed, install the damper assembly to the front suspension upper arm. Tighten the damper retaining bolts to 30-39 Nm (22-29 lb-ft).
6. Place flat plate on the frame (5005). Install bolt and tighten to 14-19 Nm (10-14 lb-ft).
7. Position mounting brackets and front suspension upper arm assembly on the flat plate.
8. Install three long bolts and washers retaining the mounting brackets to the frame.
9. Rotate or rock front suspension upper arm and mounting bracket assembly until the bolt heads rest against the mounting bracket and studs extend through the frame.
10. Align mounting brackets with marks made on flat plate during removal.
11. Position bolt retaining plate on mounting bracket and mounting plate assembly. Make sure the mounting brackets do not move from the marked position on the mounting plate. Install and tighten the screw to 14-19 Nm (10-14 lb-ft).
12. **CAUTION: The torque required for the mounting bracket to frame nuts and bolts is critical. Tighten to specified torque.**

    Install and tighten the nuts retaining the mounting bracket bolts to the frame to 196-264 Nm (145-195 lb-ft).

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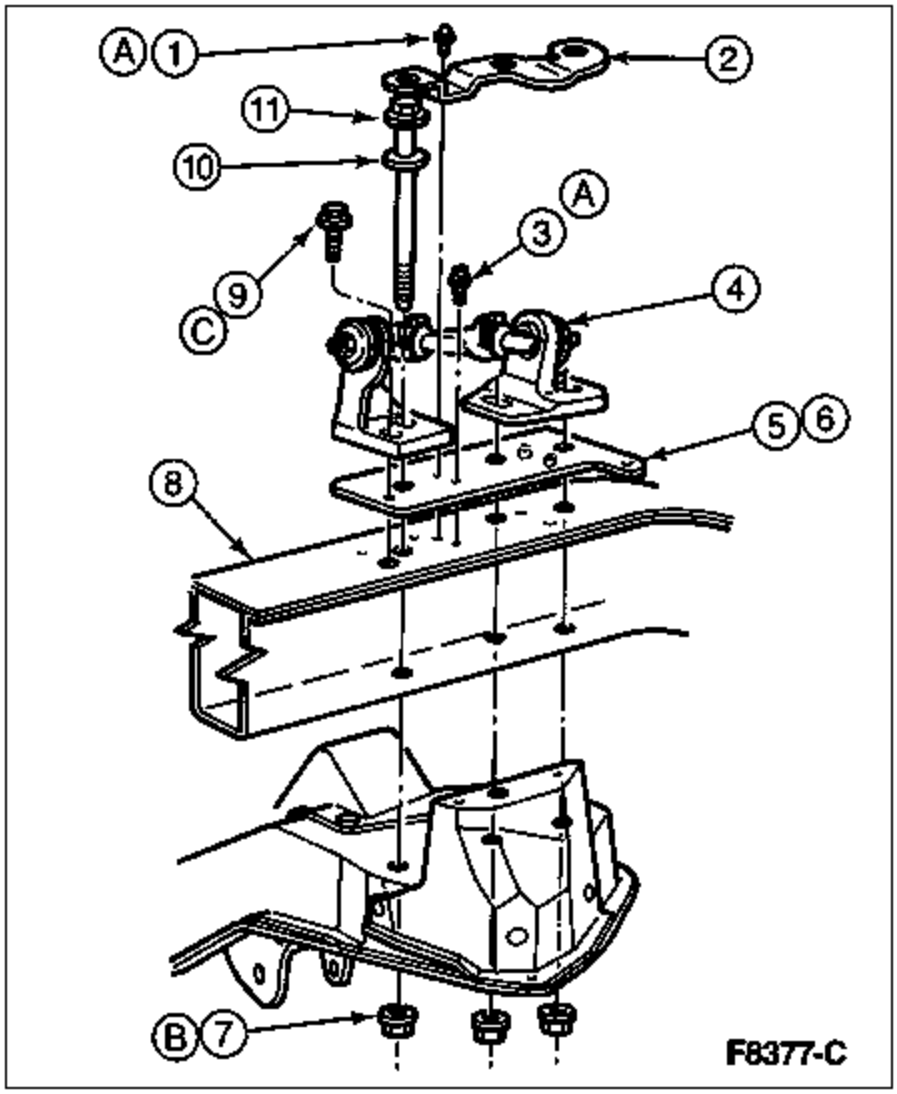

Item	Part Number	Description
1	611194	Screw
2	3B204	Flat Plate (LH)
	3A375	Flat Plate (RH)
3	611175	Screw
4	3083	Front Suspension Upper Arm
5	3B380	Mounting Plate (LH)
6	3A009	Mounting Plate (RH)
7	804431	Nut and Washer Assembly (3 Req'd)
8	5005	Frame
9	804618	Bolt and Washer Assembly
10	804387	Washer
11	804386	Bolt

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A	—	Tighten to 14-19 Nm (10-14 Lb-Ft)
B	—	Tighten to 196-264 Nm (145-195 Lb-Ft)
C	—	Tighten to 47-64 Nm (35-47 Lb-Ft)

13. Install and tighten the bolt retaining the front mounting bracket to the flat plate 47-64 Nm (35-47 lb-ft).
14. Install the front wheel spindle as described in this section.
15. If required, adjust caster, camber and toe-in as described in Section 04-00 .

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Coil Spring — Ranger

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Strut Spring Compressor	T81P-5310-A

Removal and Installation

1. **CAUTION: The axle must not be permitted to hang by the brake hose. If the length of the brake hose is not sufficient to provide adequate clearance for removal and installation of the front coil spring (5310), the front disc brake caliper (2B121) must be removed from the front wheel spindle (3105) according to the procedures specified in Section 06-03 . Strut Spring Compressor T81P-5310-A may be used to compress the front coil spring sufficiently, so the front disc brake caliper does not have to be removed. After removal, the front disc brake caliper must be placed on the frame or otherwise supported to prevent suspending the front disc brake caliper from the brake hose. These precautions are absolutely necessary to prevent serious damage to the tube portion of the caliper hose assembly.**

   Raise the front of vehicle and place safety stands under the frame and a jack under the axle.

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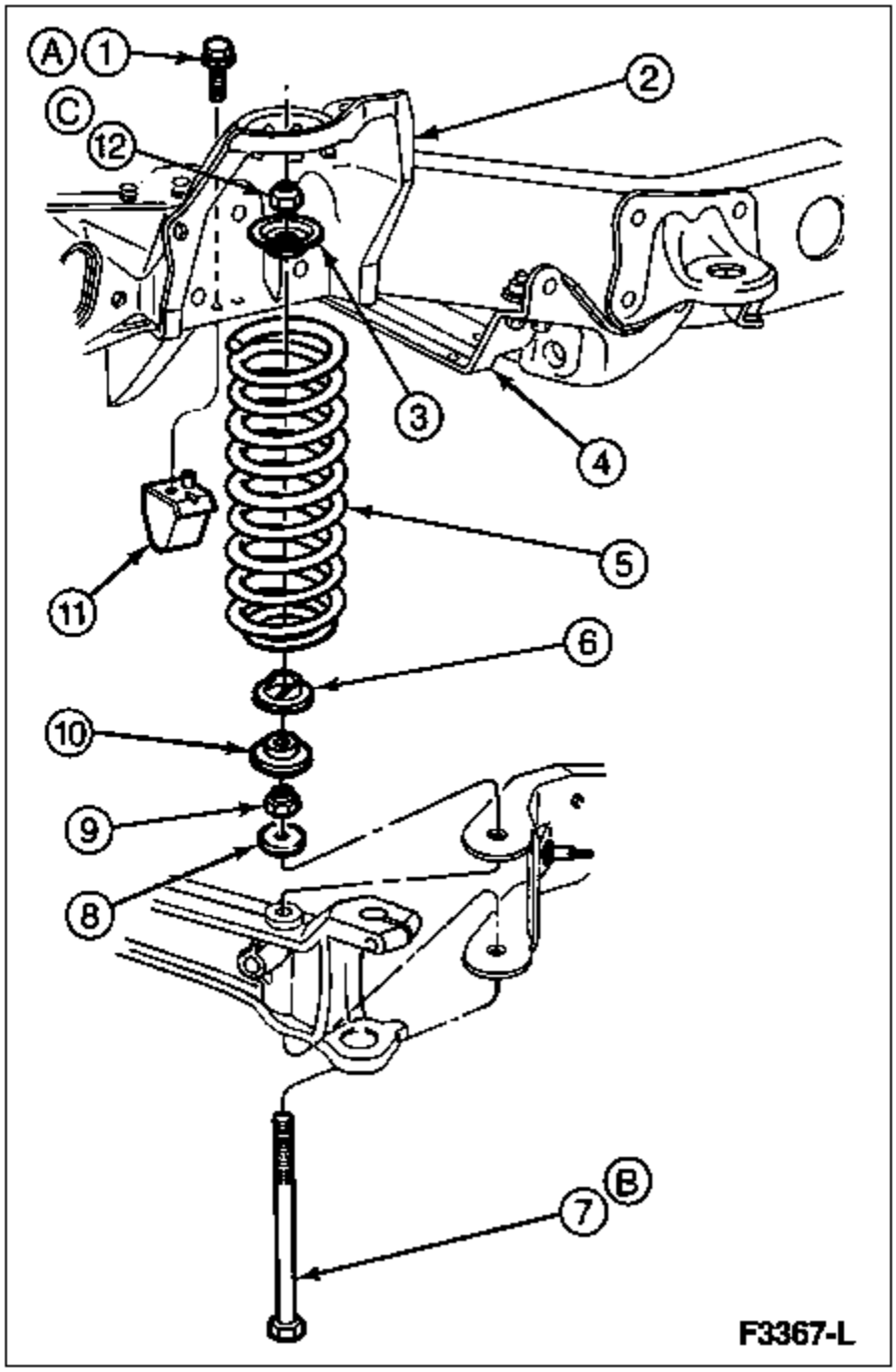

Item	Part Number	Description
1	806358	Bolt
2	5B315	Front Spring Upper Seat (LH)
3	5A349	Lower Spring Retainer
4	3B183	Radius Arm Bracket (LH)
5	5310	Front Coil Spring
6	5414	Front Spring Insulator

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7	390386	Bolt
8	379672	Washer
9	34992	Nut
10	58349	Lower Spring Seat
11	3B461	Front Suspension Bumper
12	34992	Nut
A	—	Tighten to 25-35 Nm (18-26 Lb-Ft)
B	—	Tighten to 255-345 Nm (190-255 Lb-Ft)
C	—	Tighten to 95-135 Nm (70-100 Lb-Ft)

2. Disconnect front shock absorber at lower shock stud.
3. Remove the nut securing the retainer to the lower spring seat. Remove the lower retainer.
4. Lower the axle and support without stretching the brake hose and tube assembly.
5. Either remove the front disc brake caliper or use Strut Spring Compressor T81P-5310-A. Remove front coil spring.
6. If sufficient slack exists in the brake hose assembly, a pry bar may be used to lift the front coil spring over the bolt that passes through the lower spring seat.
7. Rotate front coil spring so the built-in retainer on the upper spring seat is cleared.
8. Remove the spring lower seat and insulator.

For installation, follow removal procedures in reverse order. Tighten lower retainer and nut to 95-135 Nm (70-100 lb-ft). Tighten shock absorber-to-lower shock stud to 53-72 Nm (39-53 lb-ft).

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Axle, I-Beam — Ranger

Removal and Installation

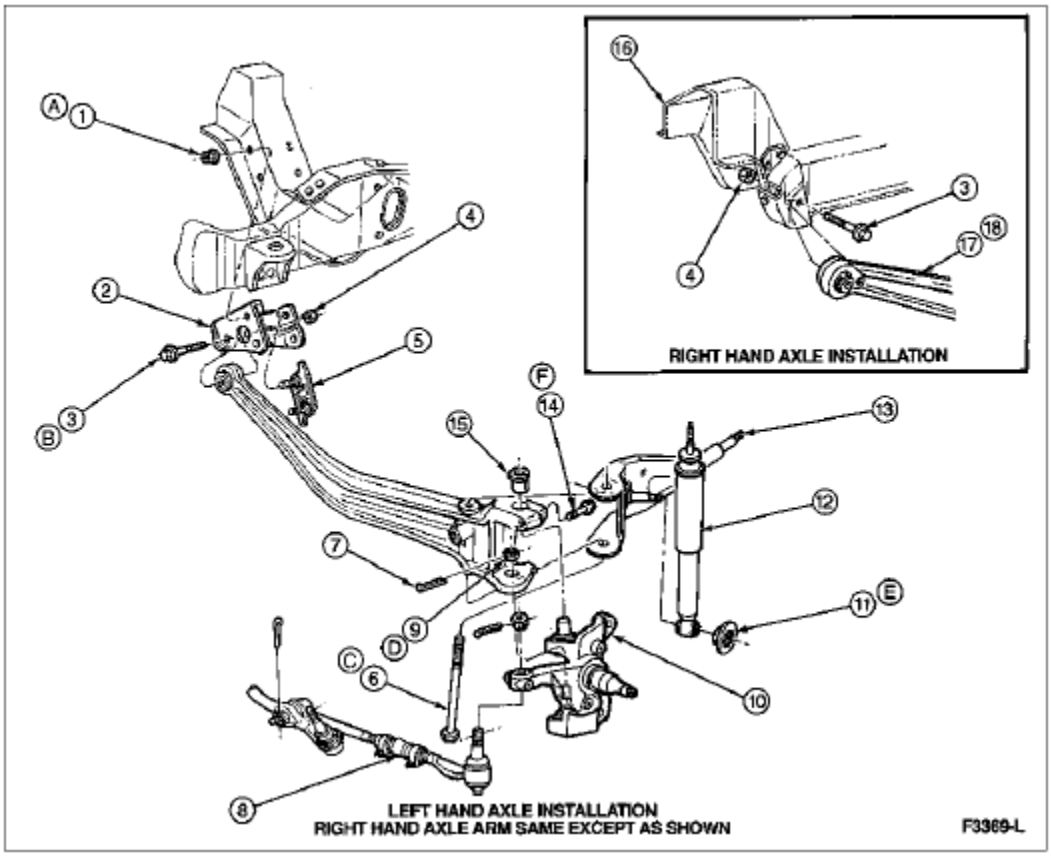
1. Remove the front wheel spindle (3105), the front coil spring (5310), and the front stabilizer bar (5482) (if so equipped) as outlined in this section.

2. Remove the spring lower seat from the radius arm, and then remove the bolt and nut that attaches the radius arm to the (I-beam) front axle.

3. Remove the axle-to-frame pivot bracket bolt and nut.

For installation, follow removal procedures in reverse order. Tighten axle-to-frame bracket bolt and nut to 150-200 Nm (111-148 lb-ft). Tighten axle to radius arm bolt to 255-345 Nm (190-255 lb-ft).

Front I-Beam Axle, Ranger 4x2



Item	Part Number	Description
1	802073	Nut

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2	3B178	Right Front Axle Pivot Bracket
3	807784	Bolt (Install in Direction Shown)
4	620604	Nut
5	806242	Bolt and Retainer
6	390386	Bolt (Install in Direction Shown)
7	642569	Cotter Pin
8	3B008	Steering Connecting Arm
9	383436	Nut
10	3105	Front Wheel Spindle
11	N806372-S100	Nut and Washer Assembly
12	18045	Front Shock Absorber
13	3405	Radius Arm
14	606082	Bolt
15	3B404	Camber Adjuster
16	5020	Crossmember Reference
17	3006	Front Right Hand Axle
18	3007	Left Axle
A	—	Tighten to 98-132 Nm (73-98 Lb-Ft)
B	—	Tighten to 150-200 Nm (111-148 Lb-Ft)
C	—	Tighten to 255-345 Nm (188-254 Lb-Ft)
D	—	Tighten to 120-180 Nm (89-133 Lb-Ft)
E	—	Tighten to 53-72 Nm (39-53 Lb-Ft)
F	—	Tighten to 68-92 Nm (50-68 Lb-Ft)

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Axle Pivot Bracket — Ranger

Removal and Installation

1. **NOTE: Proper nuts (N802073-S2) for this application have an undercut to provide clearance to bolt knurl. Use proper nuts or install one 5mm (0.20-inch) thick hardened washer under each nut if a standard nut is used.**

   Remove front coil spring (5310), radius arm, and front wheel spindle (3105). Remove I-beam axle as described in this section.

2. Remove the four attaching nuts and two bolts and retainer assemblies. Remove the axle pivot bracket.

For installation, follow removal procedures in reverse order. Tighten nuts to 98-132 Nm (73-97 lb-ft).

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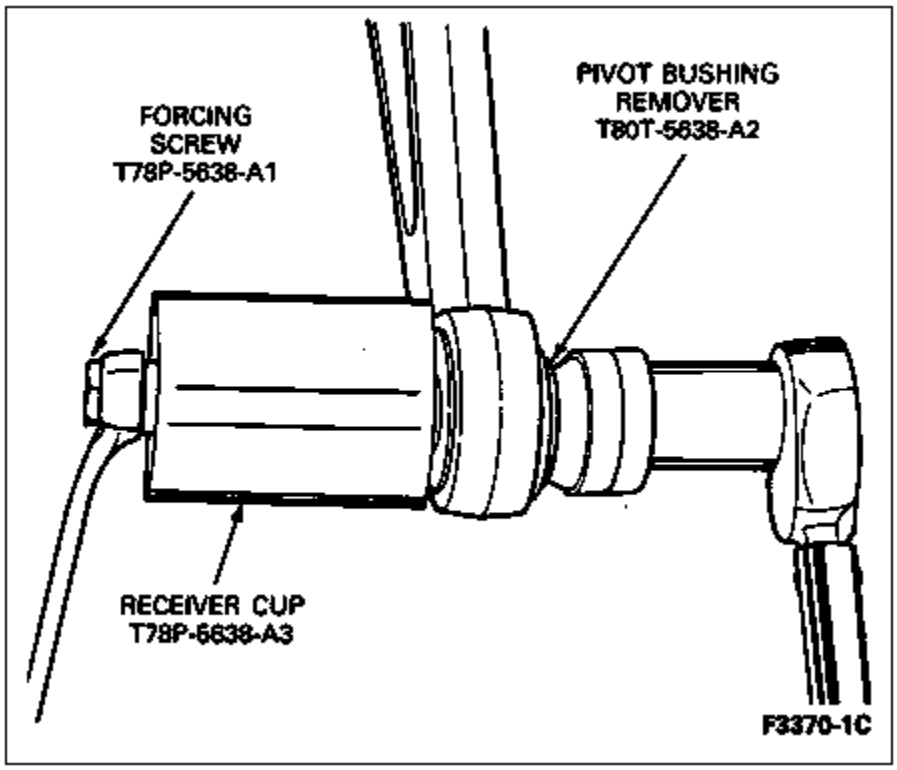
Axle Pivot Bushing — Ranger

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Forcing Screw	T78P-5638-A1
Receiver Cup	T78P-5638-A3
Front Suspension Bushing Tool	T80T-5638-A2
Twin I-Beam Pivot Bushing Spacer	T82T-3006-AH

Removal and Installation

1. Remove front coil spring (5310) as described in this section.
2. To remove left I-beam axle pivot bushing, remove axle pivot nut and bolt.
3. Pull the pivot end of the left I-beam axle down until the bushing is exposed.
4. To remove right I-beam axle pivot bushing, remove entire right I-beam axle to gain access to pivot bushing. Refer to Front I-beam Axle removal and installation procedures in this section.



5. Install Forcing Screw T78P-5638-A1, Bushing Remover T80T-5638-A2 and Receiver Cup T78P-

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5638-A3 onto pivot bushing. Place spacers T82T-3006-AH between the walls of the axle.

6. Turn the forcing screw and remove the pivot bushing.

For installation, follow removal procedures in reverse order. When installing pivot bushing in axle, use Bushing Spacer T82T-3006-AH, lower vehicle and tighten pivot bushing and nut to 150-200 Nm (111-148 lb-ft).

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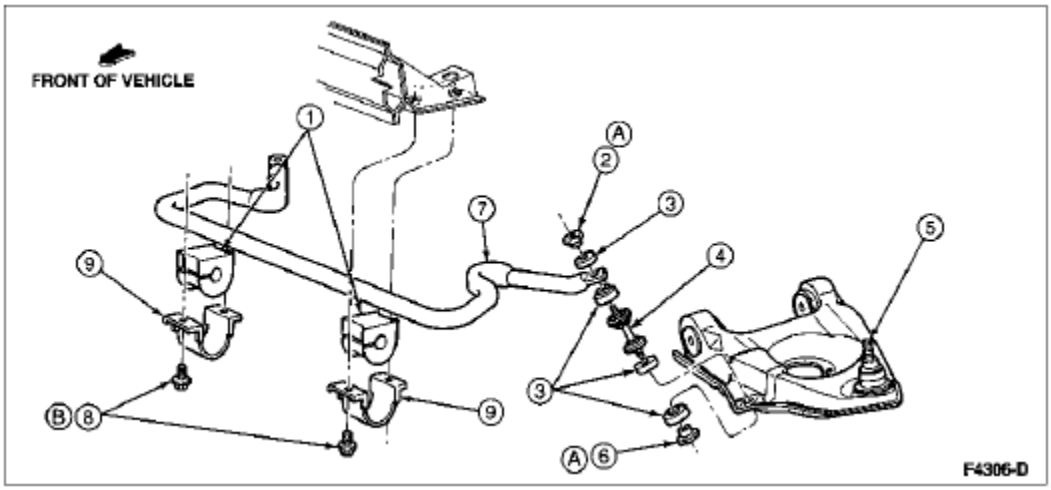
Stabilizer Bar — Aerostar

Removal and Installation

1. Raise vehicle on frame hoist and position suitable safety stands under vehicle.
2. Remove the nuts retaining the front stabilizer bar (5482) to the lower control arm link.
3. Remove the insulators and disconnect the front stabilizer bar from the links.
4. If required, remove the nuts retaining the links to the front suspension lower arm (3078).
5. Remove the insulators and remove the front stabilizer bar links (5K483).
6. Remove bar mounting bracket to frame bolts.
7. Remove the front stabilizer bar. If required, remove the insulators from the front stabilizer bar.

Front Stabilizer Bar, Aerostar



Item	Part Number	Description
1	5484	Stabilizer Bar to Frame Insulator
2	5C491	Nut
3	N803702	Insulator
4	3B439	Link Assembly
5	3050	Front Suspension Lower Arm Ball Joint
6	5C491	Nut

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7	5482	Front Stabilizer Bar
8	N806497	Bolt
9	5486	Stabilizer Bar Bracket
A	—	Tighten to 8-12 Nm (71-106 Lb-Ft)
B	—	Tighten to 22-33 Nm (16-24 Lb-Ft)

For installation, follow removal procedures in reverse order. Tighten all four stabilizer bar link nuts to 8-12 Nm (71-106 lb-in).

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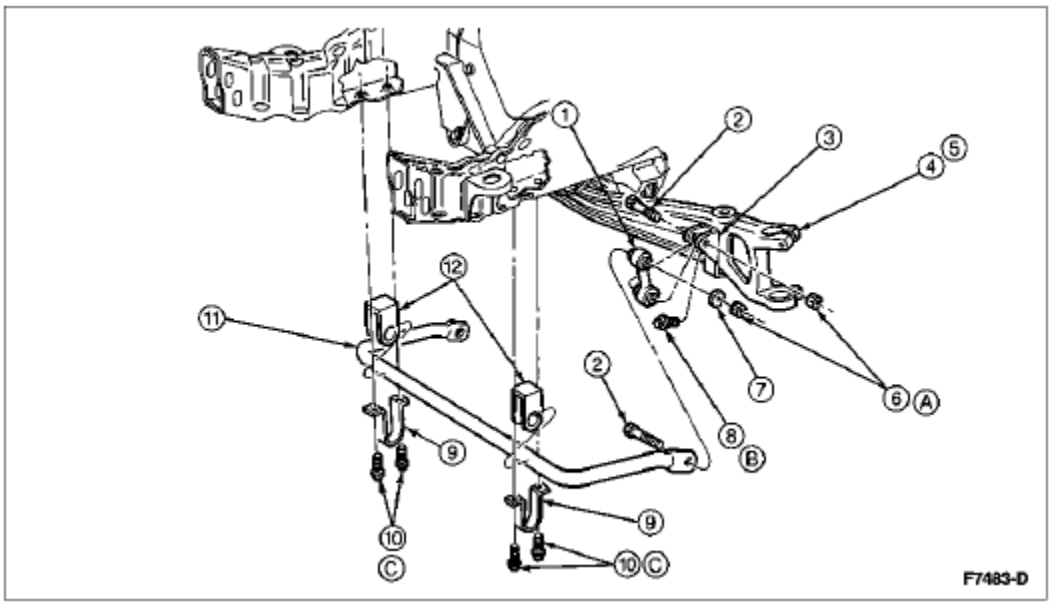
Stabilizer Bar — Ranger

Removal and Installation

1. Raise vehicle on hoist and position suitable safety stands under vehicle.
2. Remove stabilizer bar assembly nut and washer and disconnect the stabilizer link assembly from the front I-beam axle.
3. Remove the retainer-to-frame mounting bolts.
4. Remove the front stabilizer bar (5482) retainers from the stabilizer bar assembly.
5. Remove the front stabilizer bar from the vehicle.

For installation follow removal procedures in reverse order. Tighten stabilizer bar-to-I-beam mounting bracket bolt to 40-55 Nm (30-41 lb-ft). Tighten retainer bolts to 30-40 Nm (22-30 lb-ft).

Front Stabilizer Bar, Ranger



Item	Part Number	Description
1	5K483	Front Stabilizer Bar Link
2	605704	Bolt
3	5486	Stabilizer Bar Bracket
4	3007	Axle (LH)

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5	3006	Axle (RH)
6	800937	Nut
7	800916	Washer
8	605932	Bolt
9	5486	Stabilizer Bar Bracket
10	611646	Screw
11	5482	Front Stabilizer Bar
12	5484	Insulator
A	—	Tighten to 40-55 Nm (30-41 Lb-Ft)
B	—	Tighten to 68-92 Nm (50-68 Lb-Ft)
C	—	Tighten to 30-40 Nm (22-30 Lb-Ft)

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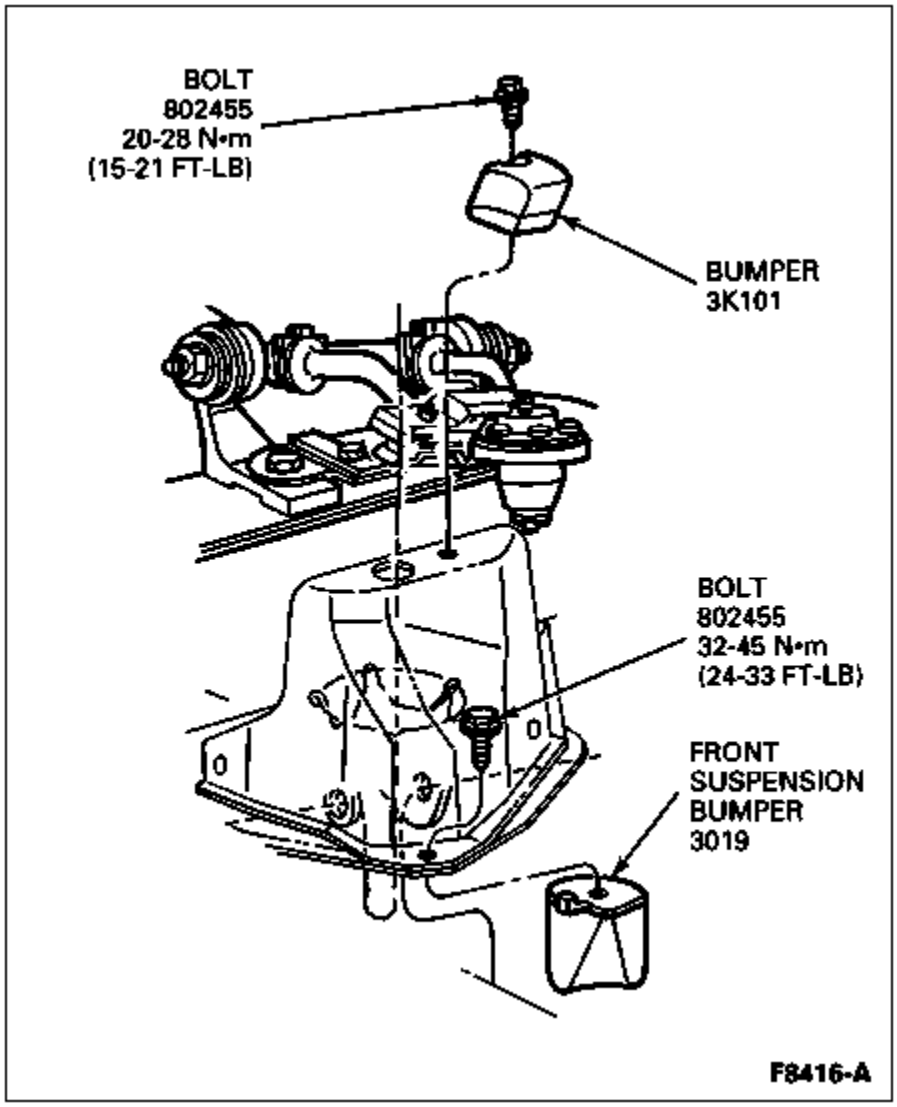
Bumper — Aerostar

Removal and Installation

1. Remove the bolts retaining the front suspension bumpers (3020) to the No. 1 front crossmember (5019). Remove the front suspension bumpers.

2. Place the front suspension bumpers in position on the front crossmember. Install the bolts and tighten to specifications.



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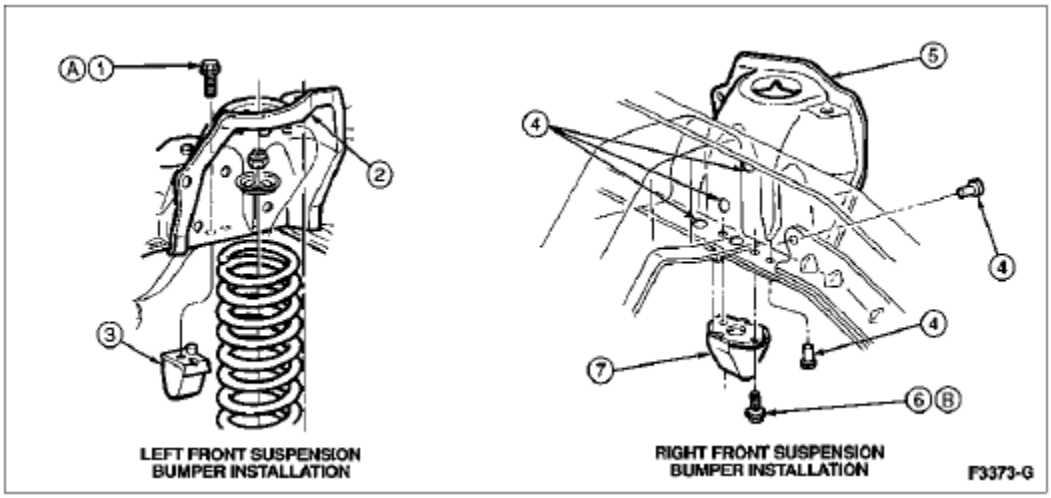
Bumper — Ranger

Removal and Installation

1. Remove hex bolts with a 10mm hex socket. Remove front suspension bumpers (3020).
2. Position front suspension bumpers on frame. Install hex bolts and tighten bolts to 25-35 Nm (18-26 lb-ft).

Front Suspension Bumper, Ranger 4x2



Item	Part Number	Description
1	806358	Bolt
2	5B315	Upper Spring Seat (LH)
3	3020	Front Suspension Bumper (LH)
4	647096	Rivet
5	5A318	Upper Spring Seat (RH)
6	611194	Bolt
7	3020	Front Suspension Bumper
A	—	Tighten to 25-35 Nm (18-26 Lb-Ft)
B	—	Tighten to 18-26 Nm (13-19 Lb-Ft)

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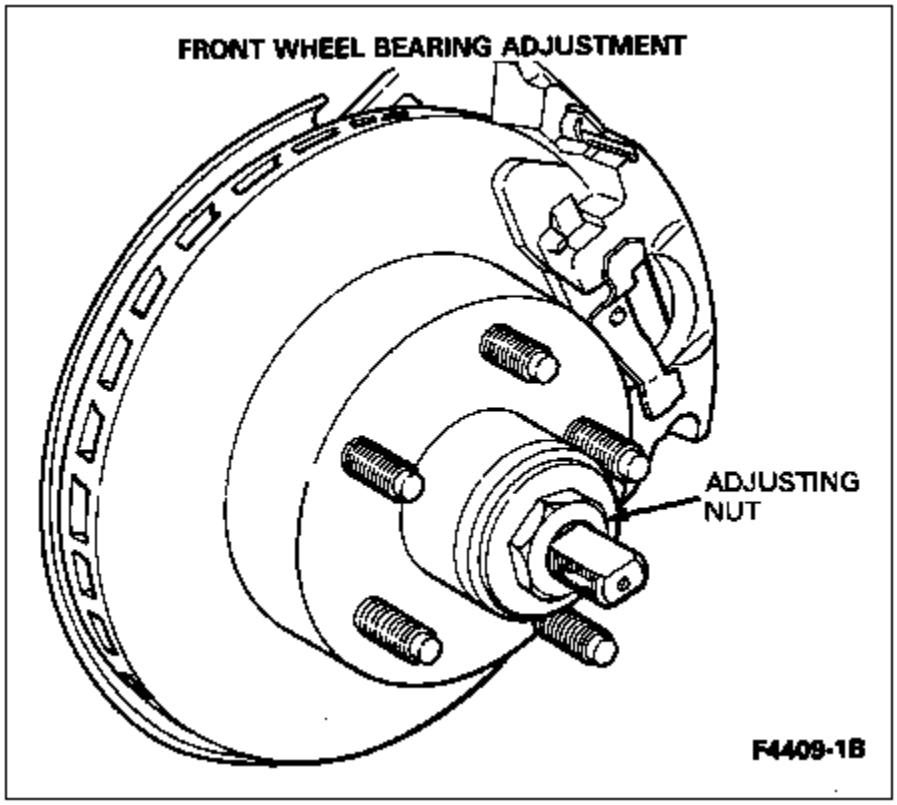
Wheel Bearings

If the wheel and tire assembly is loose on the front wheel spindle (3105) or does not rotate freely, adjust the front wheel bearings as follows:

1. Raise the vehicle until the tire clears the floor.
2. Remove the wheelcover if applicable. Remove the grease cap from the hub.
3. Wipe any excess grease from the end of the front wheel spindle. Remove the cotter pin and retainer. Discard the cotter pin.



4. Loosen the adjusting nut three turns. Obtain running clearance between the rotor brake surface and linings by rocking the entire wheel assembly in and out several times to push the front disc brake caliper (2B121) and brake pads away from the rotor. An alternate method for obtaining the proper running clearance is to lightly tap on the caliper housing. Be sure not to tap on any other area that may damage the front disc brake hub and rotor (1102) and the lining surfaces. **Do not pry on the phenolic caliper piston.**
5. **NOTE: The running clearance must be maintained throughout the bearing adjustment procedure as outlined in the following steps. If proper clearance cannot be maintained, the front disc brake caliper must be removed. Refer to Section 06-03 for removal and installation**

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procedures.

Tighten the adjusting nut to 23-34 Nm (17-25 lb-ft) while turning the rotor in the opposite direction to seat the bearings.

6. Loosen the adjusting nut one-half turn.

7. Retighten the nut to 2.0-2.3 Nm (18-20 lb-in), using a torque wrench.

8. **NOTE: Do not turn adjuster nut to make castellations line up with hole in spindle.**

   Place the retainer on the adjusting nut. The castellations on the retainer must be aligned with the cotter pin hole in the front wheel spindle.

9. Remove the retainer from the nut and reindex retainer without moving nut. Repeat until castellations line up with hole in front wheel spindle.

10. Install a new cotter pin. Bend the cotter pin ends in opposite directions around the castellated flange of the retainer.

11. Check front wheel rotation. End play should be .006-.127mm (.0002-.005 inch) or a breakaway torque of 2.8 Nm (25 lb-in) maximum. If wheel rotates properly, reinstall the grease cap and wheelcover. If rotation is noisy or rough, remove, inspect and lubricate the bearing cones and cups as described in the Removal and Installation procedure in this section.

12. Before driving the vehicle, pump the brake pedal several times to restore normal brake travel.

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SPECIFICATIONS

LUBRICANT AND MAINTENANCE MATERIALS SPECIFICATIONS

Description	Specification
Premium Long-Life Grease XG-1-C or -K	ESA-M1C75-B or equivalent

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
AEROSTAR			
Adjusting Nut [a]	2-2.3	—	18-20
Crossmember Bolt Retainer Plate Screw	14-19	10-14	—
Crossmember to Frame Rail Bolts (Six M16 Bolts, Front and Rear Upper Control Arm Brackets)	196-264	145-195	—
Damper Assembly Retainer Bolts	30-39	22-29	—
Front Disc Brake Rotor Shield Bolts	10-14	7-10	—
Front Shock Absorber to Upper Spring Seat Nut	34-46	25-34	—
Front Suspension Bumper to Frame Bolt	32-45	24-33	—
Lower Control Arm to No. 1 Crossmember Nut and Bolt	136-190	100-140	—
Rebound Bumper to Frame Bolt	20-28	15-21	—
Shock Absorber to Lower Control Arm Bolts	27-32	20-24	—
Shock Absorber to Upper Spring Seat Nut	34-46	25-34	—
Spindle to Lower Ball Joint Nut	108-153	80-113	—
Spindle to Upper Ball Joint Nut	36-50	27-37	—
Stabilizer Bar Mounting Bracket to Frame Bolts	22-33	16-24	—
Stabilizer Link to Lower Control Arm Nut	8-12	—	71-106
Stabilizer Link to Stabilizer Bar Nut	8-12	—	71-106
Tie Rod End to Spindle Arm Nut	70-100	52-74	—
Upper Control Arm Bracket-to-Body Rail Bolts	47-64	35-47	—
Upper Control Arm to Adjusting Arm Nuts	95-135	70-100	—
Wheel Lugnuts	135	100	—
RANGER			
ABS Sensor Bolt	7.5-	67-93	—

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	10.5		
Adjusting Nut [b]	2-2.3	—	18-20
Axle Arm Bracket to Frame Nut	98-132	73-98	—
Axle Arm to Bracket Nut	150-200	111-148	—
Axle Clamp Bolt (to Spindle)	68-92	50-68	—
Axle to Radius Arm Bolt	255-345	188-254	—
Caliper Pin Bolts	52-65	38-48	—
Disc Brake Caliper Bracket to Front Wheel Spindle [b]	98-132	73-97	—
Front Disc Brake Rotor Shield Bolts	11-13	—	97-115
Front Shock Absorber to Radius Arm Nut	53-72	39-53	—
Front Shock Absorber to Upper Spring Seat Nut	34-46	25-34	—
Front Suspension Bumper to Spring Seat Bolt	25-35	18-26	—
Lower Ball Joint Stud Nut	120-180	89-133	—
Lower Retainer Nut	95-135	70-100	—
Radius Arm to Bracket Nut	113-153	82-113	—
Right Front Suspension Bumper Bolts	18-26	13-19	—
Stabilizer Bar Link Bracket Bolt	68-92	50-68	—
Stabilizer Bar Link to Axle Arm Bolt and Nut	40-55	30-41	—
Stabilizer Bar to Link Assembly Nut and Bolt	40-55	30-41	—
Stabilizer Bar to Mounting Bracket Bolt	30-40	22-30	—
Tie Rod Adjusting Sleeve	40-57	30-42	—
Tie Rod to Spindle Nut	70-100	52-74	—
Wheel Lugnuts	135	100	—

[a] Refer to procedure for proper torque adjustment
[b] Refer to the procedure for proper torque adjustment.
[b] For Service, Install a New Bolt or Reuse the Old Bolt with Thread Locking Compound Such as Ford Threadlock and Sealer E0AZ-1554-AA or Equivalent Meeting Ford Specification WSK-M2G315-A5 (Type II).

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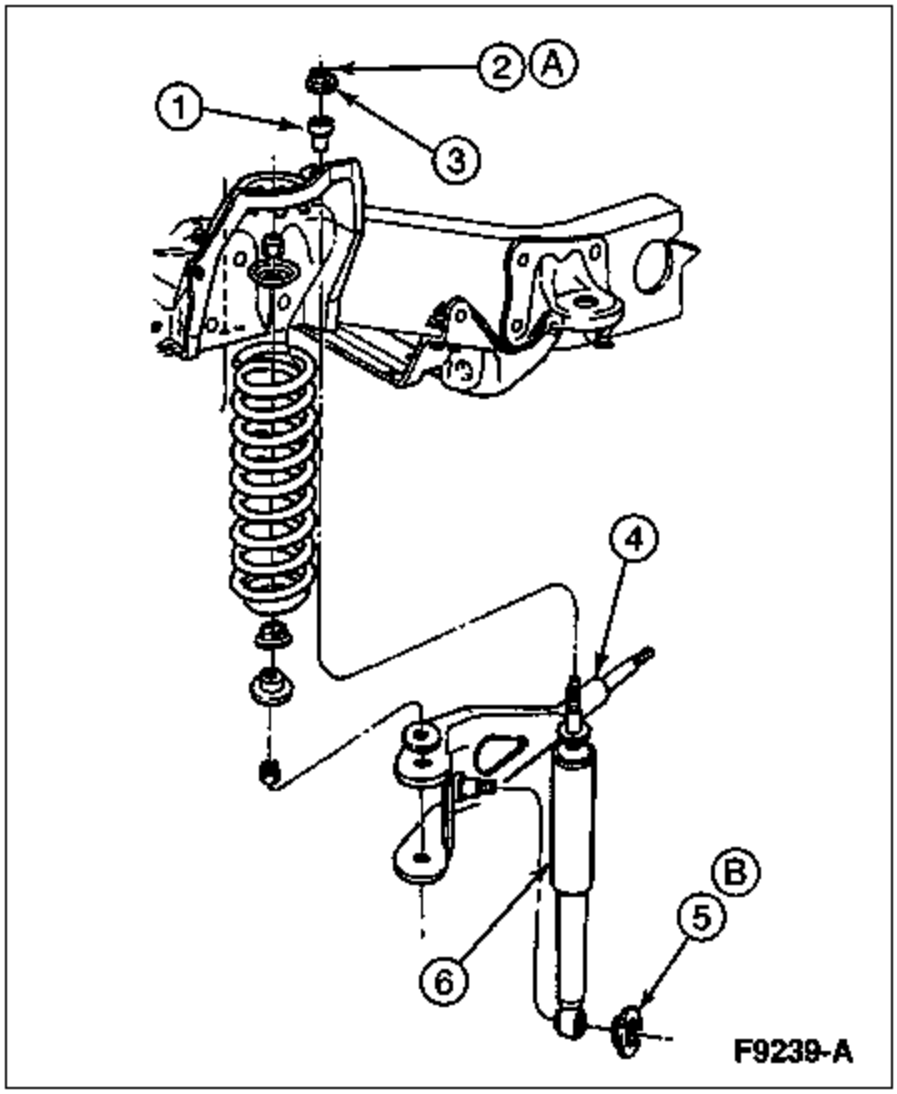
Shock Absorber

WARNING: THE LOW PRESSURE GAS SHOCK ABSORBERS ARE CHARGED WITH NITROGEN GAS TO 930 KPA (135 PSI). DO NOT ATTEMPT TO OPEN, PUNCTURE OR APPLY HEAT TO THE SHOCK ABSORBERS.

Removal and Installation

1. Raise vehicle on hoist with axle in the rebound position and place suitable safety stands under axle to prevent it from dropping down when shock is removed.
2. Remove the shock absorber upper nut and washer from the spring seat.
3. Remove stud nut and washer that holds the front shock absorber to the radius arm.
4. Slide the front shock absorber off the radius arm stud. Slightly compress the front shock absorber by hand and remove from the vehicle.

For installation, follow removal procedures in reverse order. Inspect the insulator in the spring seat. If the insulator requires replacement, install a new one. Tighten the lower nut to 53-72 Nm (39-53 lb-ft). Tighten the upper insulator, nut and washer to 34-46 Nm (25-33 lb-ft).



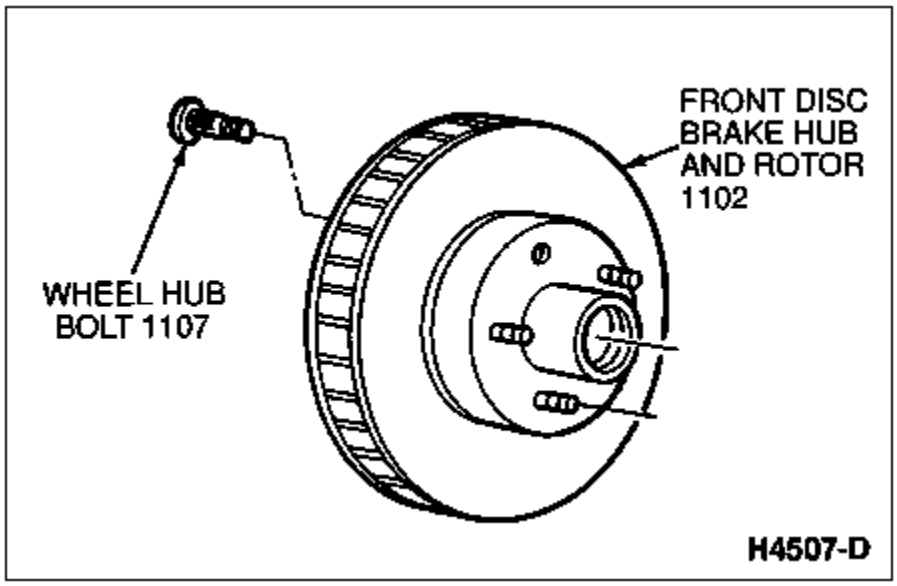
Item	Part Number	Description
1	18198	Insulator
2	N620468-S2	Nut
3	N802084-S2	Washer
4	3405	Radius Arm
5	N806372-S100	Nut and Washer
6	18045	Front Shock Absorber
A	—	Tighten to 34-46 Nm (25-33 Lb-Ft)
B	—	Tighten to 53-72 Nm (39-53 Lb-Ft)

Wheel Hub Bolt

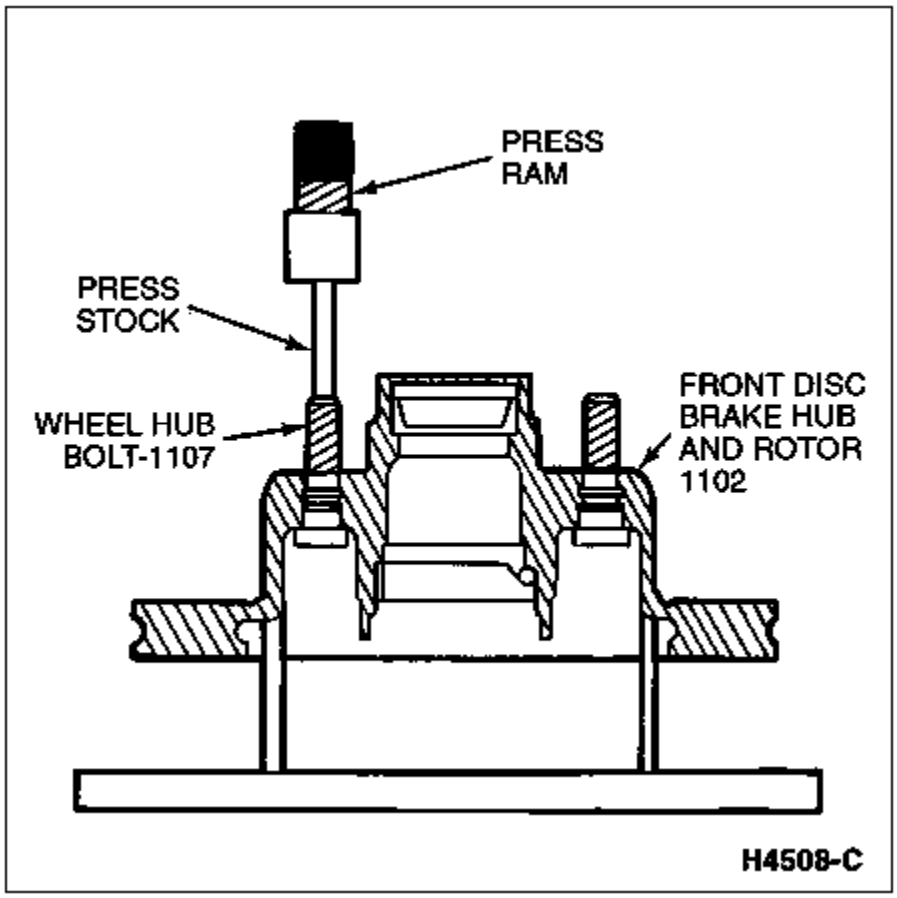
CAUTION: Service must be performed on any damaged components or the component that caused lug bolt (1107) to require replacement.

Removal

1. Raise the vehicle and install safety stands.
2. Remove the wheel and tire.
3. Remove the front front disc brake hub and rotor (1102) as described in Section 05-03A .



4. Position the front disc brake hub and rotor in a press so ram pressure is not directly exerted on the surface of front disc brake hub and rotor. With appropriate press stock, press the wheel hub bolt from the front disc brake hub and rotor. Discard the wheel hub bolt.



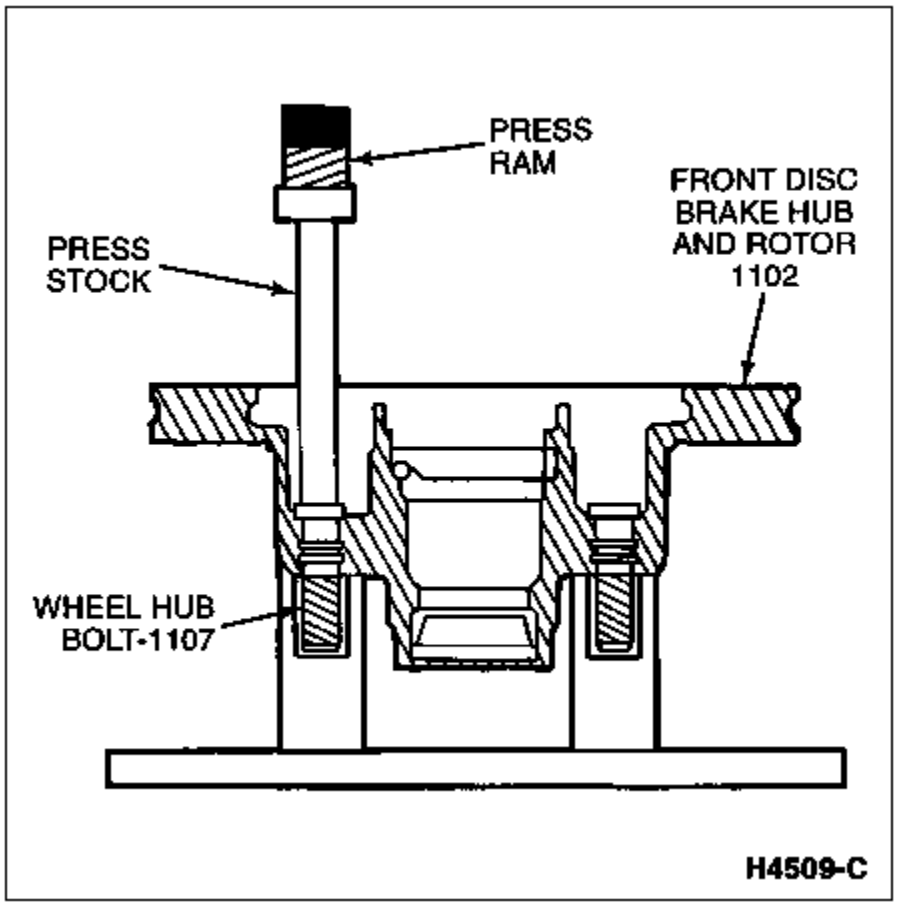
5. Inspect lug nuts (1012) for damaged threads. Discard if damaged.

Installation

1. Position a new lug bolt in the hole. Align the serrations of the new lug bolt with the serration marks from the old lug bolt. With a hammer, lightly tap the lug bolt until the serrations on the lug bolt are started in the hole. Make sure the lug bolt is not installed off-center in front disc brake hub and rotor.

2. Position the front disc brake hub and rotor in a press so the front disc brake hub and rotor is supported on the wheel mounting flange. Allow enough clearance for the lug bolt to pass through the hole. Do not apply ram pressure directly on the rotor surface of front disc brake hub and rotor.

3. With appropriate press stock, press the stud flush against the inner surface of the hub and rotor.



4. Install the front disc brake hub and rotor as described in Section 05-03A .
5. Replace any damaged lug nuts.
6. Install the wheel (1007) and tire.

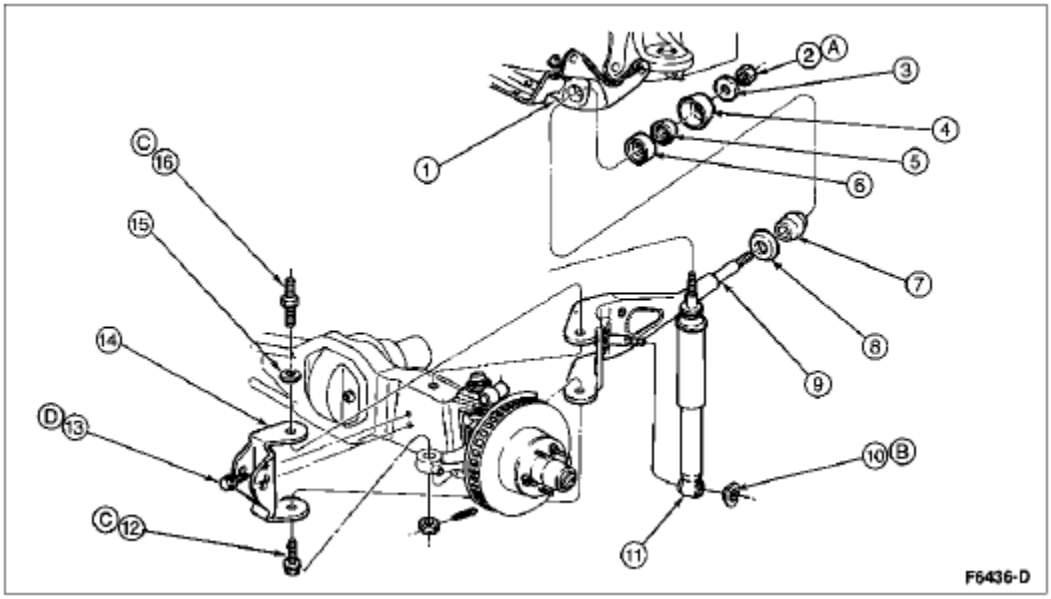
Radius Arm

CAUTION: The axle must be supported on the jack throughout spring removal and installation. Do not hang by the brake hose. If the length of the brake hose is not sufficient to provide adequate clearance for removal and installation of the spring, the front disc brake caliper (2B121) must be removed from the front wheel spindle (3105). Refer to Section 06-03 . After removal, the front disc brake caliper must be placed on the frame or otherwise supported to prevent suspending the front wheel spindle from the caliper hose. These precautions are absolutely necessary to prevent serious damage to the tube portion of the caliper hose.

Removal

1. Raise the front of the vehicle and place safety stands under the frame. Place a jack under the axle.

Radius Arm



Item	Part Number	Description
1	3B183	Bracket
2	34992	Nut
3	379572	Washer
4	3B463	Shield (RH Side Only)
5	3A184	Outer Insulator

6	3B244	Spacer
7	3B203	Inner Insulator
8	3B186	Retainer
9	3405	Radius Arm
10	N806372-S100	Nut and Washer Assembly
11	18045	Front Shock Absorber
12	391701	Bolt
13	40954	Bolt
14	5486	Stabilizer Bar Bracket
15	379572	Washer (LH Side Only)
16	390678	Stud
A	—	Tighten to 113-153 Nm (83-113 Lb-Ft)
B	—	Tighten to 53-72 Nm (39-53 Lb-Ft)
C	—	Tighten to 255-345 Nm (190-255 Lb-Ft)
D	—	Tighten to 21-29 Nm (15-21 Lb-Ft)

2. Disconnect the lower end of the front shock absorber from the shock lower stud.
3. Remove the front coil spring (5310) as described in this section. Loosen the axle pivot bolt.
4. Remove the spring lower seat and stud from the radius arm. Remove the radius arm lower attaching bolt to axle.
5. Remove nut, washer, shield (right-hand side only), outer insulator and spacer from stud at rear side of radius arm rear bracket.
6. Remove the radius arm from vehicle.
7. Remove the inner insulator and retainer from the radius arm stud.
8. Remove front bracket if necessary.

Installation

1. Install retainer and inner insulator on radius arm stud. Insert the stud through the radius arm rear bracket.
2. Position the front end of radius arm bracket to axle.
3. Install attaching bolts and stud in the bracket finger-tight.
4. Install spacer, outer insulator, shield (right-hand side only) washer and nut, in this order, on the arm stud at the rear side of the arm rear bracket. Tighten nut to 113-153 Nm (83-113 lb-ft).

5. Tighten stud to 255-345 Nm (190-255 lb-ft).

6. If removed, tighten the front bracket to axle bolts to 21-29 Nm (15-21 lb-ft) and lower bolt and washer to 255-345 Nm (190-255 lb-ft).

7. Install the spring lower seat and front spring insulator (5414) on the radius arm positioning hole in seat over the arm-to-axle bolt. Tighten the axle pivot bolt to 150-200 Nm (111-148 lb-ft).

8. Install the front coil spring as described in this section.

9. Connect the lower end of the front shock absorber to the lower stud on the radius arm with the attaching nut. Tighten the nut to 53-72 Nm (39-53 lb-ft).

Insulators, Radius Arm

Removal and Installation

1. Remove front stabilizer bar link attachment. Rotate stabilizer bar up and out of the way.

2. **CAUTION: The axle must be supported on the jack throughout spring removal and installation. Do not hang by the brake hose. If the length of the brake hose is not sufficient to provide adequate clearance for removal and installation of the spring, the front disc brake caliper (2B121) must be removed from the front wheel spindle (3105). Refer to Section 06-03 . After removal, the front disc brake caliper must be placed on the frame or otherwise supported to prevent suspending the front wheel spindle from the caliper hose. These precautions are absolutely necessary to prevent serious damage to the tube portion of the caliper hose.**

   Raise the front of the vehicle and place safety stands under the frame. Place a jack under the axle.

3. Disconnect the lower end of the front shock absorber from the shock lower stud.

4. Remove the front coil spring (5310) as described in this section. Loosen the axle pivot bolt.

5. Remove radius arm to radius arm bracket attaching nut and washer. Remove the outer insulator (and shield on right radius arm only) and spacer.

6. Move the radius arm and axle forward out of the radius arm bracket.

7. Remove the inner insulator and retainer.

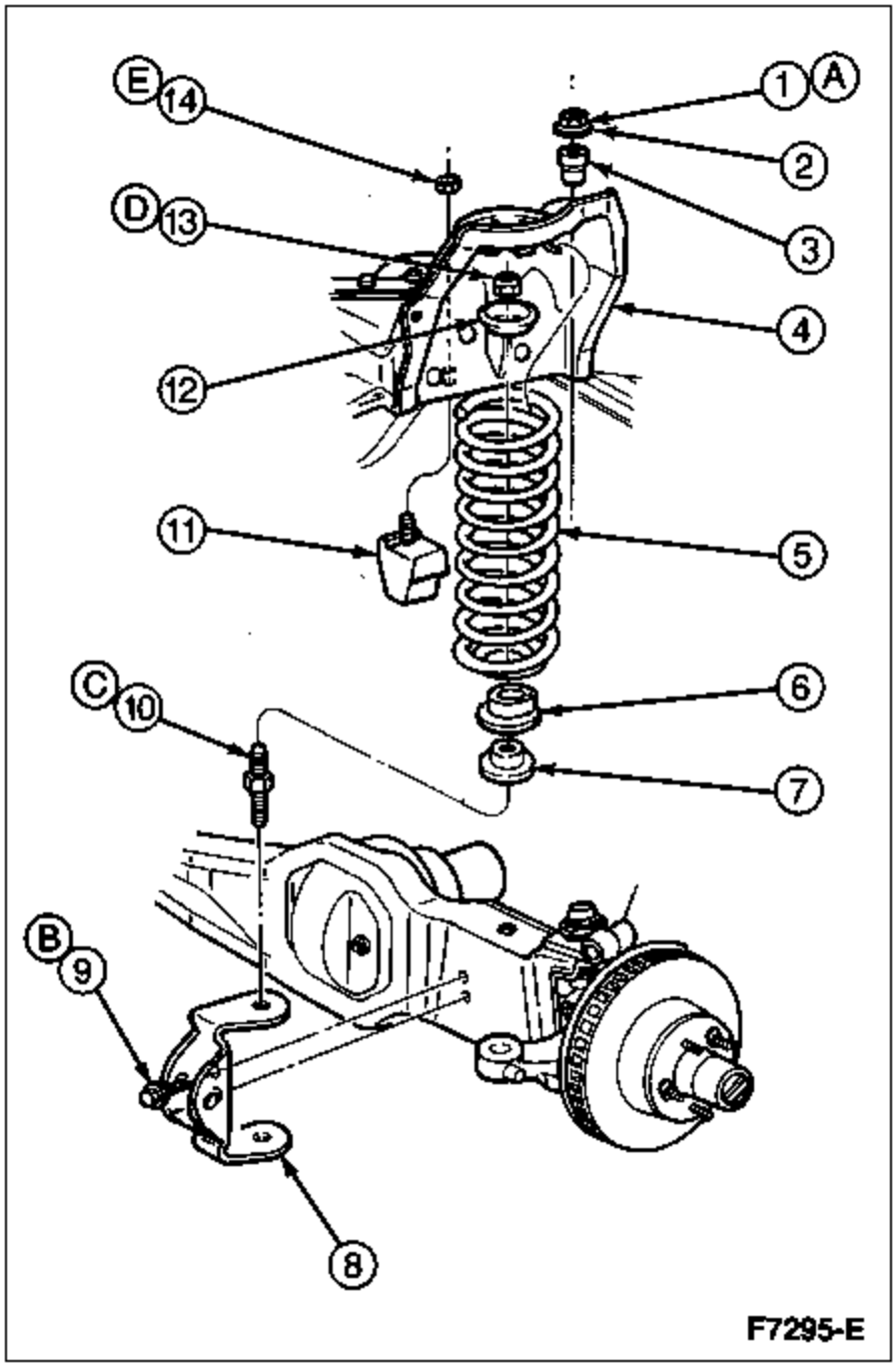
For installation, follow removal procedures in reverse order. Tighten radius arm-to-rear bracket nut 113-153 Nm (83-113 lb-ft). Tighten upper shock bolt to 34-46 Nm (25-33 lb-ft). Tighten axle pivot bolt 150-200 Nm (111-148 lb-ft).

Coil Spring

Removal and Installation

1. **CAUTION: The axle must be supported on the jack throughout spring removal and installation. Do not permit the axle to hang by the brake hose. If the length of the brake hose is not sufficient to provide adequate clearance for removal and installation of the front coil spring (5310), the front disc brake caliper (2B121) must be removed from the front wheel spindle (3105) according to the procedures specified in Section 06-03 . After removal, the front disc brake caliper must be placed on the frame or otherwise supported to prevent suspending the front disc brake caliper from the caliper hose. These precautions are absolutely necessary to prevent serious damage to the tube portion of the caliper hose.**

   Raise the vehicle and install safety stands. Position a jack beneath the front coil spring under the axle.



Item	Part Number	Description
1	N620468-S2	Nut
2	N802084	Washer
3	18198	Insulator
4	5B315	Upper Spring Seat (LH)
5	5310	Front Coil Spring
6	5414	Front Spring Insulator

7	5A307	Lower Seat
8	5486	Stabilizer Bar Bracket
9	40954	Bolt
10	390678	Stud
11	3020	Front Suspension Bumper
12	5A349	Retainer
13	388833	Nut
14	620481	Nut
A	—	Tighten to 34-46 Nm (25-33 Lb-Ft)
B	—	Tighten to 21-29 Nm (15-21 Lb-Ft)
C	—	Tighten to 255-345 Nm (190-255 Lb-Ft)
D	—	Tighten to 95-135 Nm (70-100 Lb-Ft)
E	—	Tighten to 25-35 Nm (18-26 Lb-Ft)

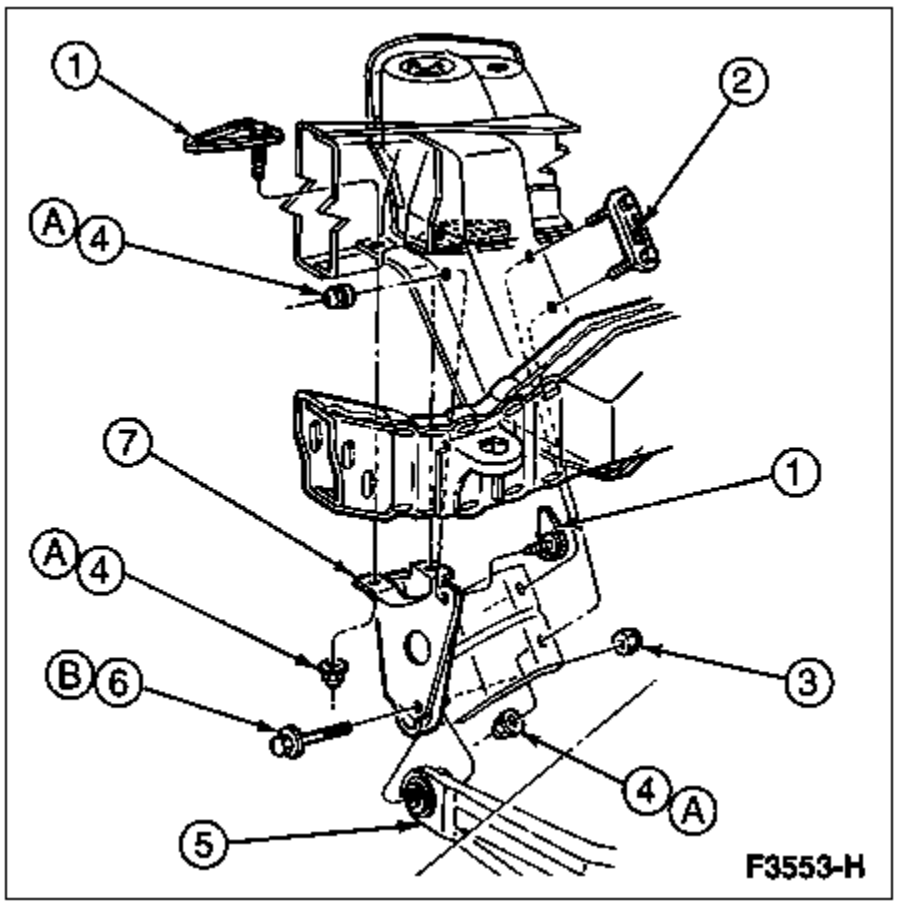
2. Raise the jack and compress the front coil spring.
3. Remove shock absorber nut to radius arm. Slide front shock absorber out from stud.
4. Remove spring-to-axle retaining nut and radius arm. Remove the retainer.
5. Slowly lower axle until all spring tension is released and adequate clearance exists to remove the front coil spring.
6. Remove the front coil spring by rotating upper front coil spring out of upper spring seat tabs. Remove the spacer and seat.

For installation, follow removal procedures in reverse order. Tighten spring retainer nut to 95-135 Nm (70-100 lb-ft). Tighten shock nut to radius arm 53-72 Nm (39-53 lb-ft).

Axle Pivot Bracket

Removal

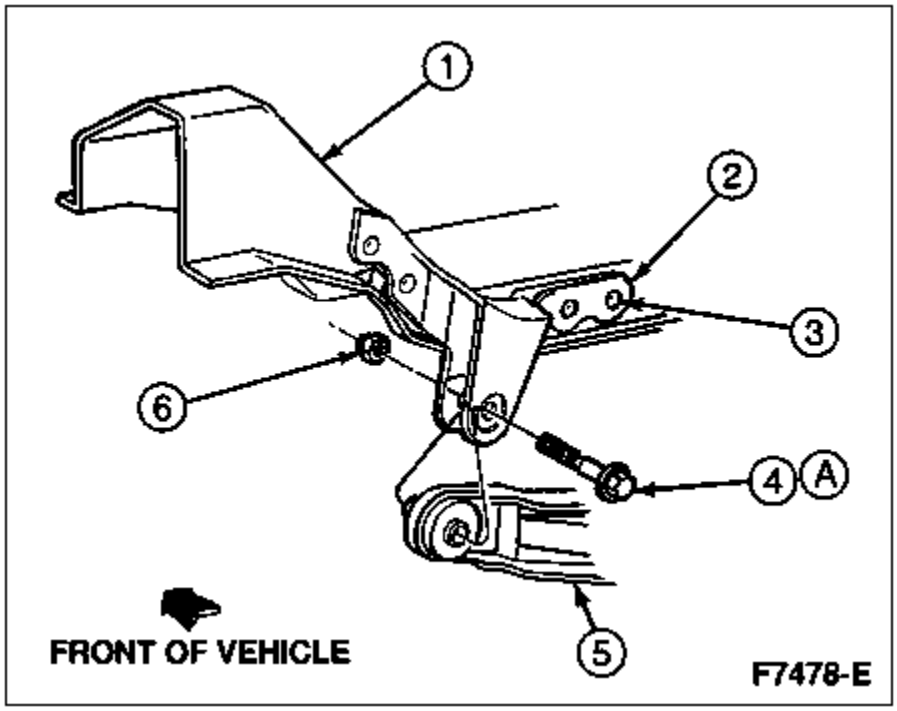
1. Raise vehicle on a frame hoist. Position a tall jackstand under the axle arm near the front axle pivot bracket. Lower the hoist until the axle is in contact with the jackstand.
2. Remove the bolt and nut attaching the axle to the front axle pivot bracket. Raise hoist and, if required, pry the axle free from the front axle pivot bracket.
3. On the right front axle pivot bracket, remove the attaching nuts.
4. Remove upper bolt and retainer and side bolt and retainer.
5. Remove and discard the lower bolt and retainer.
6. Remove the front axle pivot bracket from the front crossmember (5019).



Item	Part Number	Description
1	804933	Upper Bolt and Retainer (Install in Direction Shown)
2	807266	Side Bolt and Retainer (Install in Direction Shown)
3	620604	Nut
4	802073	Nut
5	3002	Left Axle Arm
6	801079	Bolt (Install in Direction Shown)
7	3K090	Front Axle Pivot Bracket
A	—	Tighten to 113-153 Nm (83-113 Lb-Ft)
B	—	Tighten to 150-200 Nm (111-148 Lb-Ft)

7. On the left front axle pivot bracket, drill out rivets so the mounting holes in the bracket and front crossmember are 9/16 inch in diameter.

8. Remove the left front axle pivot bracket.



Item	Part Number	Description
1	5019	Front Crossmember
2	3K090	Front Axle Pivot Bracket
3	65094	Rivet

4	801079	Bolt
5	3002	Right Front Axle
6	620604	Nut
A	—	Tighten to 150-200 Nm (111-148 Lb-Ft)

Installation

1. On the left front axle pivot bracket, position the pivot bracket on the front crossmember. Make sure the 9/16-inch drilled holes are in alignment.
2. Install the 9/16-12 x 1-1/2-inch Grade 8 replacement bolts, washers (2) and nuts. Tighten to 210 Nm (155 lb-ft).
3. On the right front axle pivot bracket, position the bracket on front crossmember.
4. Install upper bolt and retainer. Install the side bolt and retainer with the bolt heads facing toward the engine oil pan to maximize clearance. Install and tighten nuts to 113-153 Nm (83-113 lb-ft).
5. Drill out the mounting hole for the lower bolt and retainer in the bracket and front crossmember to a 9/16-inch diameter. Install 9/16-12 x 1-1/2-inch Grade 8 replacement washers (2) and nuts. Tighten to 210 Nm (155 lb-ft).
6. Lower the hoist until the axle engages bracket. Install the attaching bolt and nut. Tighten to 150-200 Nm (111-148 lb-ft).
7. Remove jackstand and lower vehicle.

Stabilizer Bar

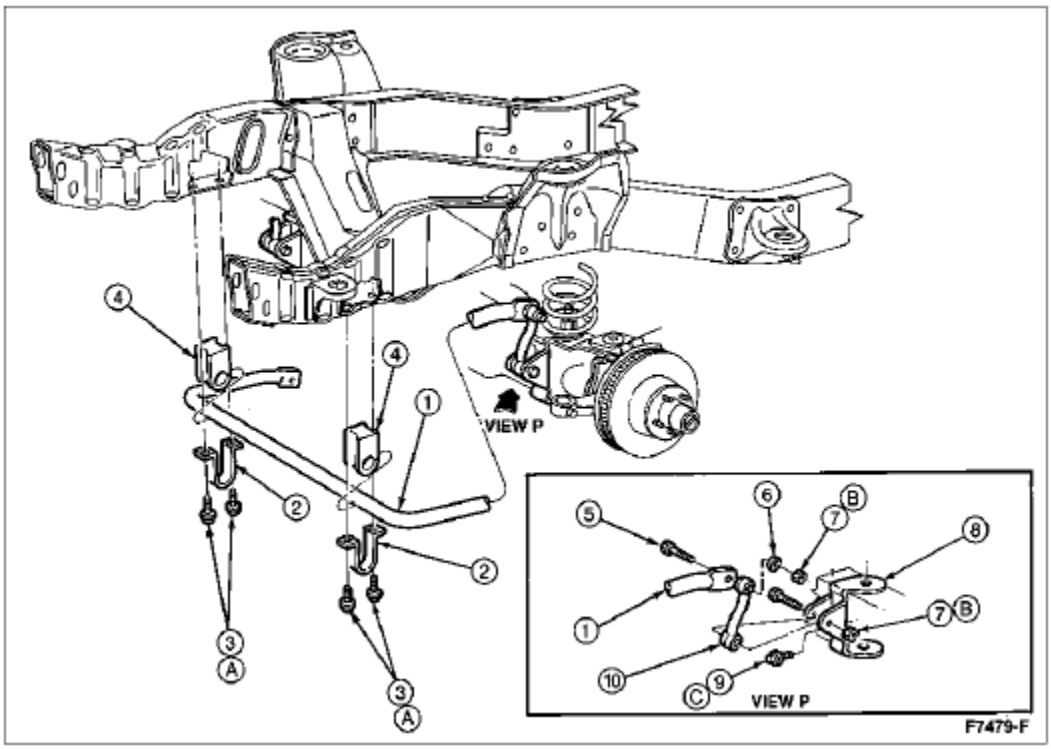
Removal

1. Remove bolts and retainers from center and right-hand end of front stabilizer bar (5482).
2. Remove nut, bolt and washer retaining front stabilizer bar to the front stabilizer bar link (5K483).
3. Remove the front stabilizer bar and insulators.

Installation

1. Place front stabilizer bar and insulators in position.
2. Install retainers, nuts and bolts. Tighten retainer bolts to 30-40 Nm (22-30 lb-ft). Tighten front stabilizer bar-to-link nut to 40-55 Nm (30-40 lb-ft).

Front Stabilizer Bar



Item	Part Number	Description
1	5482	Front Stabilizer Bar

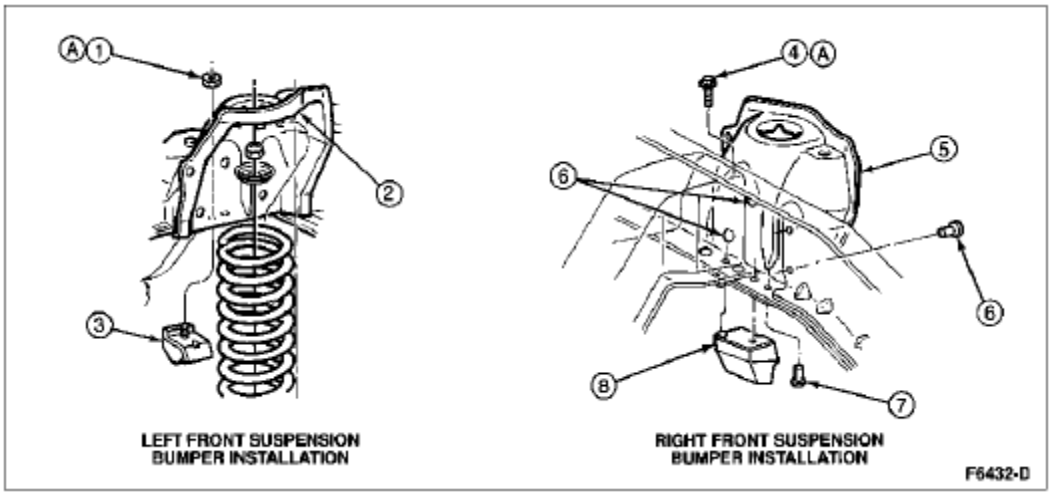
2	5486	Front Stabilizer Bracket
3	611646	Bolt
4	5484	Stabilizer Bar Insulator
5	605704	Bolt
6	800916	Washer
7	800937	Nut
8	5486	Stabilizer Bar Mounting Bracket
9	40954	Screw
10	5K483	Front Stabilizer Bar Link
A	—	Tighten to 30-40 Nm (22-30 Lb-Ft)
B	—	Tighten to 40-55 Nm (30-40 Lb-Ft)
C	—	Tighten to 21-29 Nm (15-21 Lb-Ft)

Bumper, Front

Removal and Installation

1. Remove hex bolt with a 10mm hex socket. Remove bumper.
2. Position front suspension bumper (3020) on frame. Install hex bolt and tighten bolt to 25-35 Nm (18-26 lb-ft).

Front Bumper



Item	Part Number	Description
1	620481	Nut
2	5B315	Upper Spring Seat (LH)
3	3B461	Front Suspension Bumper (LH)
4	806358	Bolt
5	5A318	Upper Spring Seat (RH)
6	647096	Rivet
7	647098	Rivet
8	3020	Front Suspension Bumper
A	—	Tighten to 25-35 Nm (18-26 Lb-Ft)

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft
Axle Pivot Bolt	150-200	111-148
Front Suspension BumperNut	25-35	18-26
Radius Arm to Rear Bracket Nut	113-153	83-113
Radius Arm Front Bracket and Axle Stud	255-345	190-255
Radius Arm Front Bracket Front Bolts	21-29	15-21
Radius Arm Front Bracket Lower Bolts	255-345	190-255
Shock Absorber to Radius Arm Nut	53-72	39-53
Shock Absorber to Upper Seat	34-46	25-33
Spring Retainer Nut	95-135	70-100
Stabilizer Bar Retainer Bolts	30-40	22-30
Stabilizer Bar Link Nuts	40-55	30-40
Tie Rod Adjusting Sleeve Clamp	40-57	30-42
Axle Pivot Bracket-to-Crossmember Nut	113-153	83-113
Bearing Inner Locknut — Manual Locking Hub. After tightening to specified torque, back off the nut 1/4 turn (90°). After backing off the nut, retighten to 1.8 Nm (16 lb-in).	47	35
Bearing Outer Locknut — Manual Locking Hub	203	150
Bearing Nut — Automatic Locknut Hub. After tightening to specified torque, back off the nut 1/4 turn (90°). After backing off the nut, retighte n to 1.8 Nm (16 lb-in).	47	35
Wheel Lugnuts. Torque specifications are for clean, dry bolt and nut threads. Never use oil or grease on studs or nuts.	135	100
Front to Crossmember Nut/Bolt	220-275	163-203
Bracket to Crossmember Bolt, Nut and Washer	210	155
Disc Brake Caliper Bracket-to-Front Wheel Spindle	100-130	74-96

Spring, Front

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Pitman Arm Puller	T64P-3590-F
Coil Spring Compressor	D78P-5310-A

Removal

1. **NOTE: Any time the steering linkage is disconnected from the steering knuckle, the steering system must be placed in the "on-center" position.**

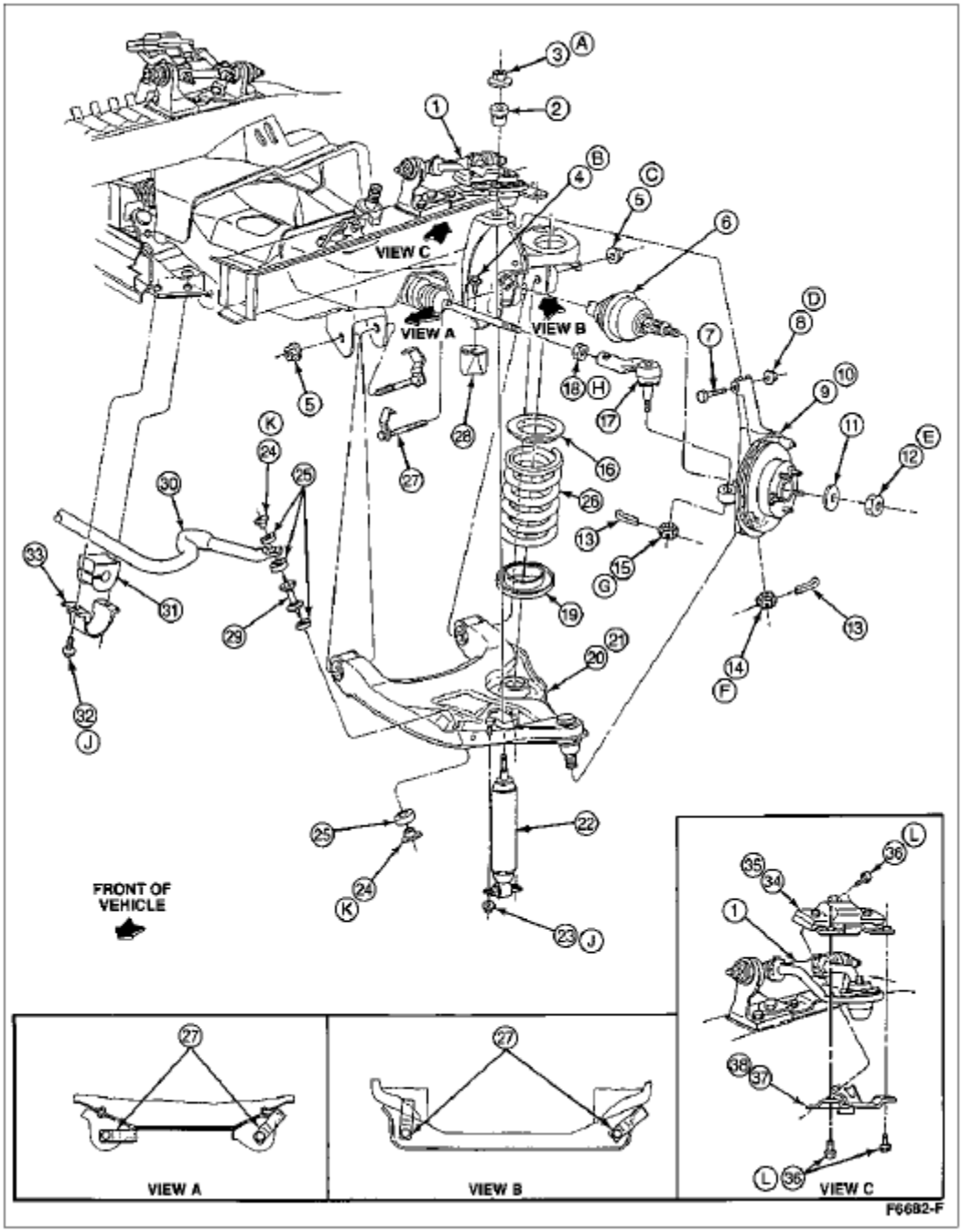
   Place the steering wheel and steering system in the "on-center" position.

2. Raise vehicle on a hoist. Remove wheel and tire assembly.

3. Disconnect stabilizer bar link nut from front suspension lower arm (3078).

4. Remove the front shock absorber as described in Removal and Installation, Shock Absorber, Front in this section.

Front Suspension, Aerostar E-4WD



Item	Part Number	Description
1	3083	Front Suspension Upper Arm
2	18198	Insulator
3	N805348-S56	Nut and Washer Assembly
4	N605905-S101	Bolt, M8-1.25 x 20
5	N800237-S101	Nut, M16-2.0
6	4A462	Shaft Assembly
7	N804806-S160	Bolt, M10-1.5 x 55

8	N801206-S2	Nut, M10-1.5
9	3B305	Steering Knuckle Assembly (RH)
10	3B306	Steering Knuckle Assembly (LH)
11	N801338-S101	Washer, M20-40 x 5.13
12	N804199-S191	Nut, M20-1.25
13	N642567-S36	Cotter Pin, 3.2 x 25
14	390924-S36	Nut, 9/16-18
15	N800895-S56	Nut, M14-1.5
16	5415	Upper Insulator
17	3A130	Tie Rod End
18	N803637	Nut, M14-1.5
19	5414	Lower Insulator
20	3078	Front Suspension Lower Arm (RH)
21	3079	Front Suspension Lower Arm (LH)
22	18045	Front Shock Absorber
23	N620481-S2	Nut, M8-1.25
24	5C491	Nut (Part of Stabilizer Bar Bushing Repair Kit)
25	N803702-S	Stabilizer Bar Bushing
26	5310	Front Coil Spring
27	N805537-S100	Bolt and Retainer, M16-2.0 x 117.5
28	3020	Front Suspension Bumper
29	5K483	Front Stabilizer Bar Link
30	5482	Front Stabilizer Bar
31	5484	Stabilizer Bar Insulator
32	N806497-S2	Bolt, M8-1.25 x 25.7
33	5486	Stabilizer Bar Bracket
34	3C156	Damper (RH)
35	3C157	Damper (LH)
36	N605905-S101	Bolt, M8-1.25 x 20
37	3C162	Clamp, Damper (RH)
38	3C163	Clamp, Damper (LH)
A	—	Tighten to 34-47 Nm (25-35 Lb-Ft)
B	—	Tighten to 17-23 Nm (13-17 Lb-Ft)
C	—	Tighten to 136-190 Nm (100-140 Lb-Ft)
D	—	Tighten to 37-50 Nm (27-37 Lb-Ft)
E	—	Tighten to 230-285 Nm(170-210 Lb-Ft)

F	—	Tighten to 80-110 Nm (59-81 Lb-Ft)
G	—	Tighten to 70-100 Nm (52-74 Lb-Ft)
H	—	Tighten to 61-88 Nm (45-65 Lb-Ft)
J	—	Tighten to 22-33 Nm (16-24 Lb-Ft)
K	—	Tighten to 8-12 Nm (71-107 Lb-In)
L	—	Tighten to 30-39 Nm (22-29 Lb-Ft)

5. If the vehicle is on a twin-post hoist, support the vehicle with safety stands under the jacking pads and lower the hoist but maintain working room.

6. Using Coil Spring Compressor D78P-5310-A, install one plate with the pivot ball seat facing downward into spring coils. Rotate the plate until flush with the upper surface of the front suspension lower arm.

7. Install the other plate with the pivot ball seat facing upward into spring coils.

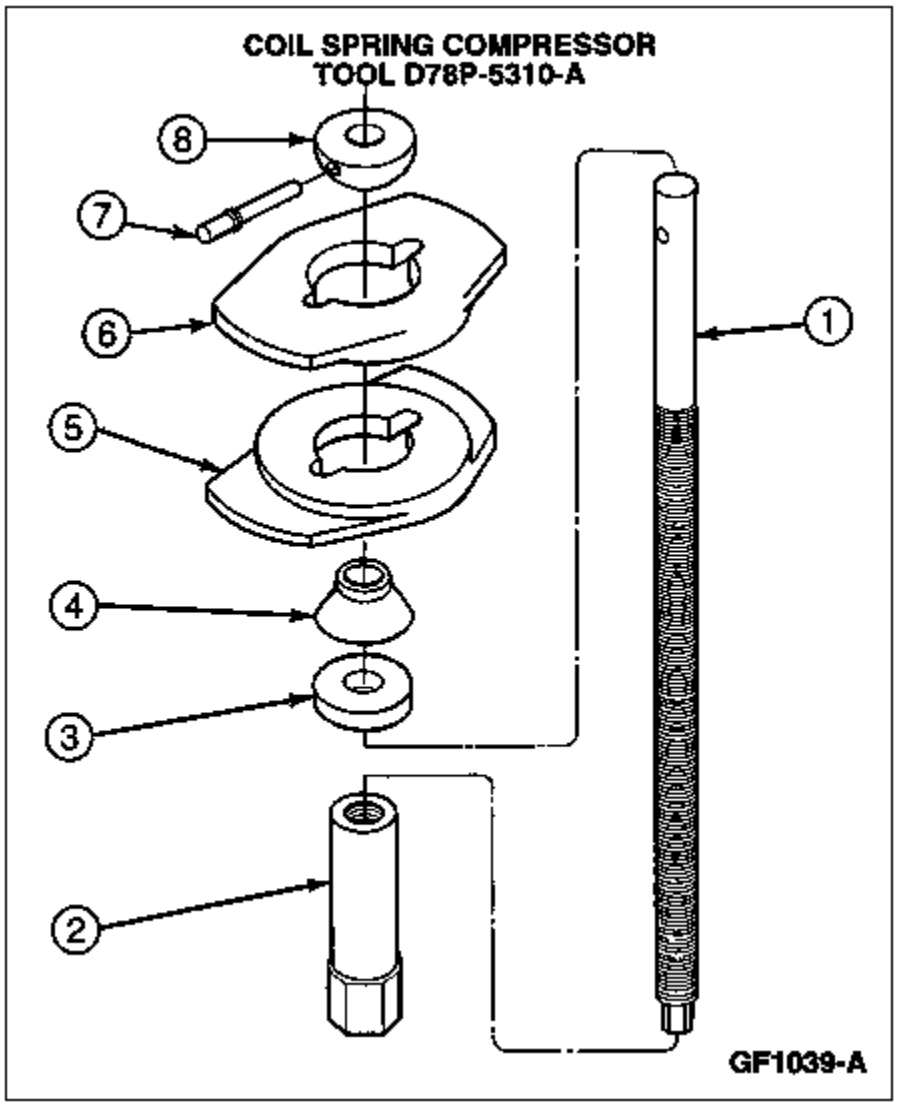
8. Insert the upper ball nut through the spring coil so nut rests in the upper plate.

9. Insert the compression rod into front suspension lower arm opening, through the upper and lower plate and upper ball nut.

10. Insert the securing pin through the upper ball nut and compression rod.

    - This pin can only be inserted one way into the upper ball nut because of a stepped hole design.

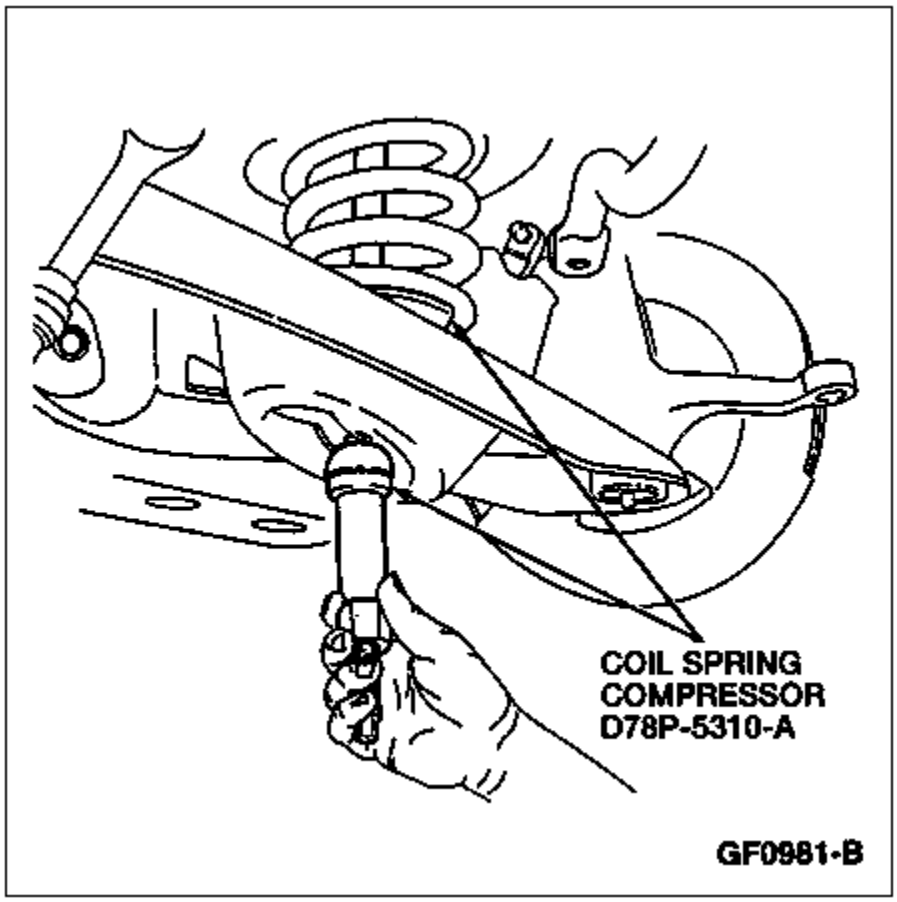
11. With the upper ball nut secured, turn the upper plate to walk up the coil until it contacts the upper spring seat; then, back off one-half turn.

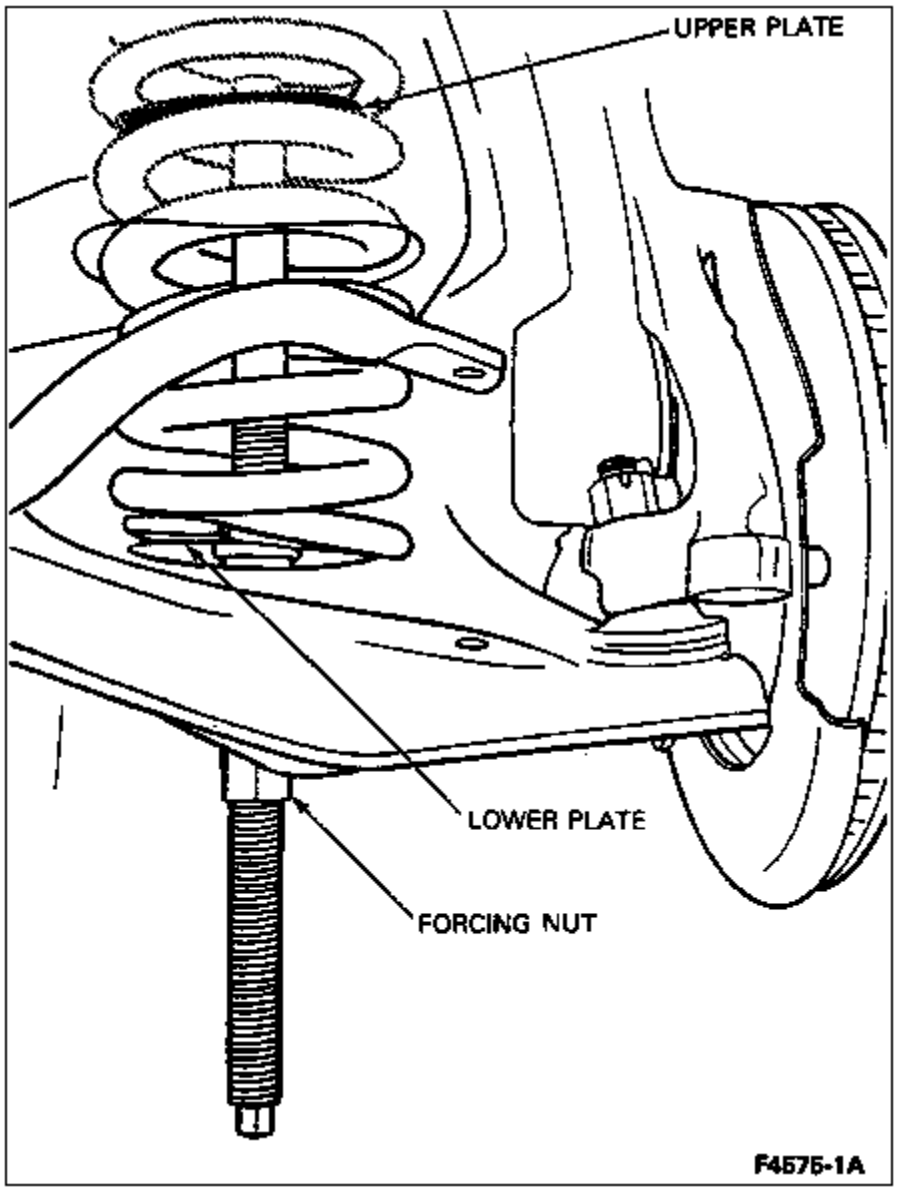


Item	Part Number	Description
1	—	Compression Rod (Part of D78P-5310-A)
2	—	Forcing Nut (Part of D78P-5310-A)
3	—	Thrust Washer (Part of D78P-5310-A)
4	—	Lower Ball Nut (Part of D78P-5310-A)
5	—	Lower Plate (Part of D78P-5310-A)
6	—	Upper Plate (Part of D78P-5310-A)
7	—	Pin (Part of D78P-5310-A)
8	—	Upper Ball Nut (Part of D78P-5310-A)

12. **NOTE: 4x2 shown in illustrations; E-4WD similar.**

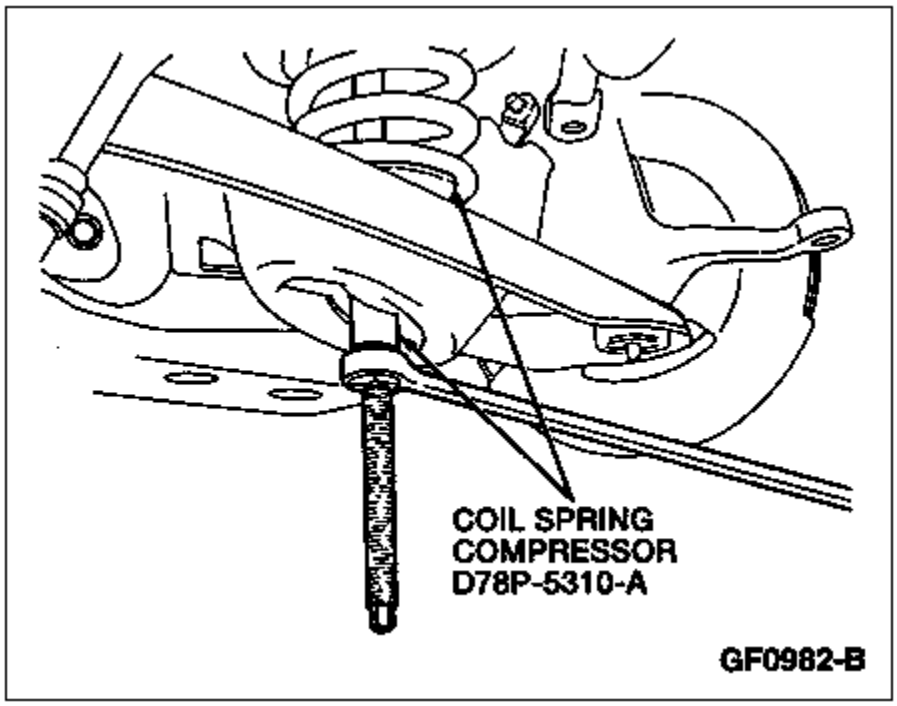
    Install lower ball nut and thrust washer to compression rod and screw on forcing nut.





13. **NOTE: 4x2 shown in illustration; E-4WD similar.**

    Tighten the forcing nut until the front coil spring (5310) is compressed enough to move in seat.



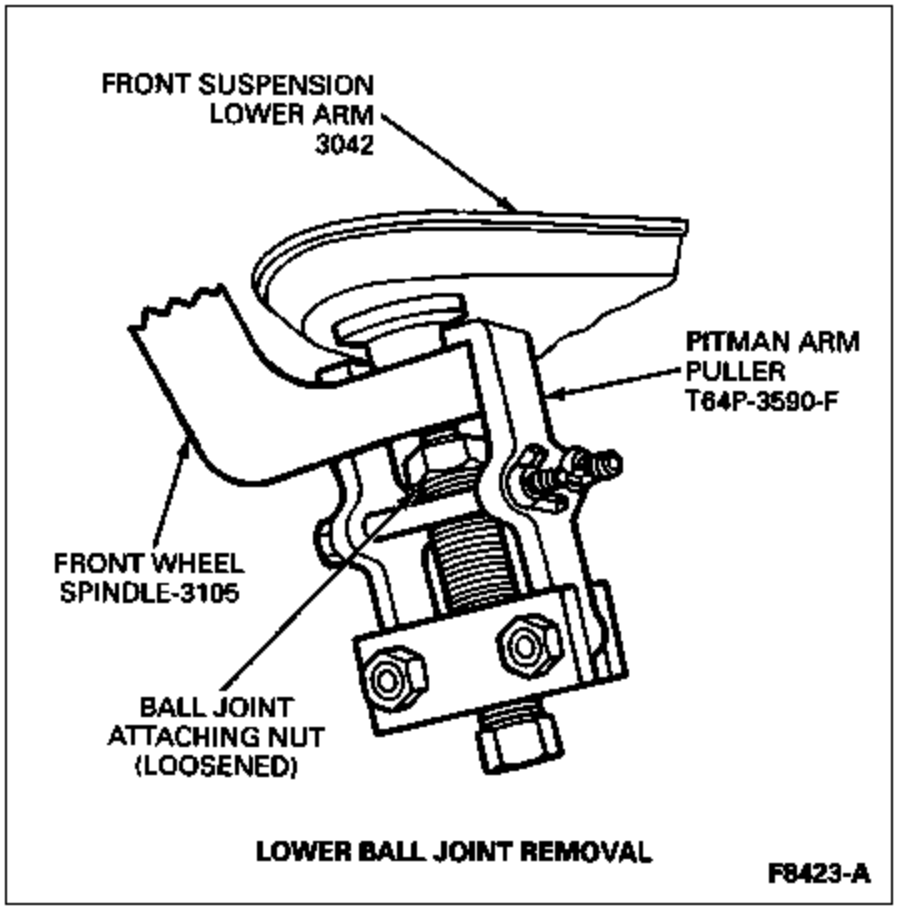
14. Loosen the two lower arm pivot bolts. Remove the cotter pin and loosen but do not remove the nut attaching the front suspension lower arm ball joint (3050) to the knuckle.

15. Using Pitman Arm Puller T64P-3590-F loosen the front suspension lower arm ball joint.

16. Remove the puller tool. Support the front suspension lower arm with a jack and remove the ball joint nut.

17. **NOTE: 4x2 shown in illustration; E-4WD must be pressed from bottom.**

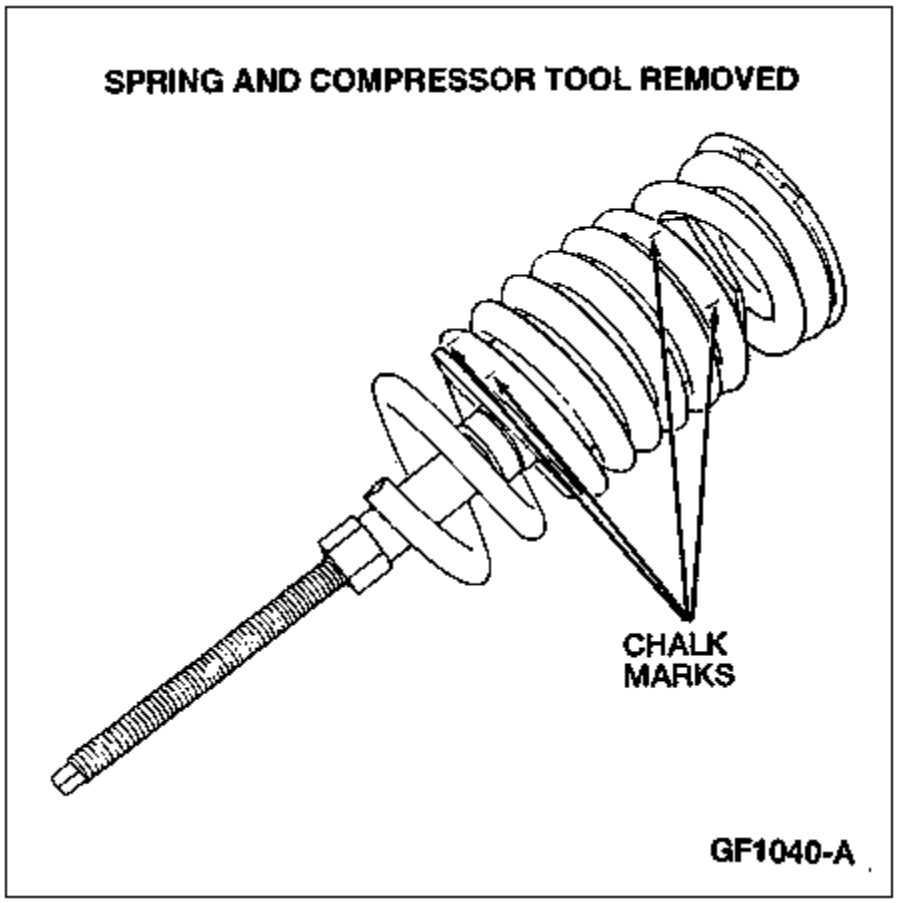
    Separate the knuckle from the front suspension lower arm ball joint, lower the control arm and remove the front coil spring.



18. If a new front coil spring is installed:

    a. Mark position of upper and lower plates on the spring with chalk.
    b. Measure the compressed length of the old front coil spring.

19. Loosen the forcing nut to relieve spring tension. Remove the tools from the front coil spring.

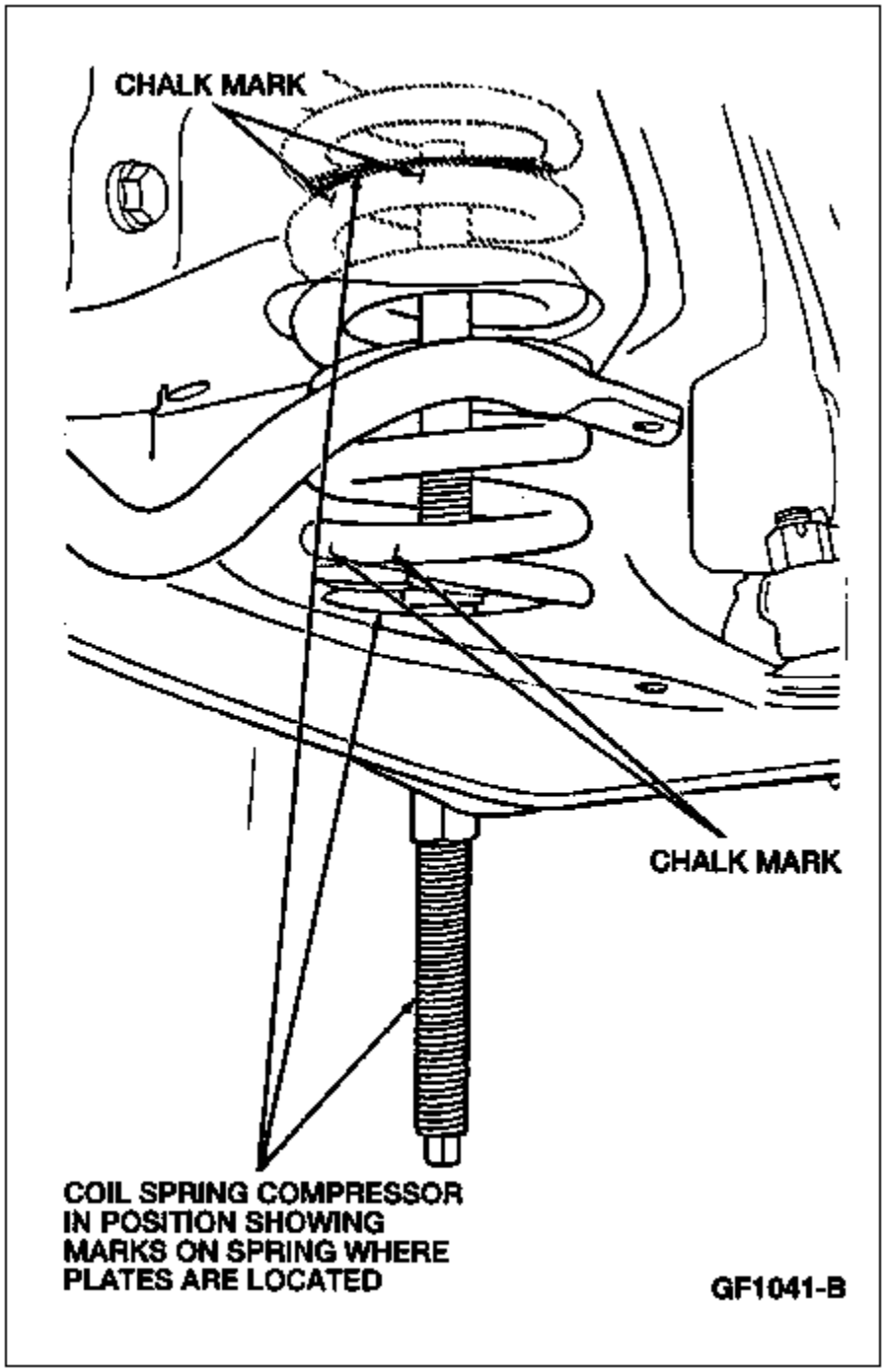


Installation

1. Assemble Coil Spring Compressor D78P-5310-A, and locate in the same positions indicated in Removal, Step 18a.
2. Before compressing the front coil spring, make sure upper ball nut securing pin is inserted properly.
3. Compress front coil spring until spring height reaches the dimension obtained in Removal, Step 18b.
4. Position the front coil spring assembly into the front suspension lower arm.
5. Verify the front coil spring is properly indexed in the front suspension lower arm.
6. To install front coil spring, reverse removal procedures.
7. **NOTE: Vehicle must be in the normal ride position.**

   NOTE: 4x2 shown in illustration; E-4WD similar.

   Tighten front suspension lower arm to No. 1 crossmember retaining nuts to 136-190 Nm (100-140 lb-ft).


CHALK MARK
CHALK MARK
COIL SPRING COMPRESSOR IN POSITION SHOWING MARKS ON SPRING WHERE PLATES ARE LOCATED
GF1041-B

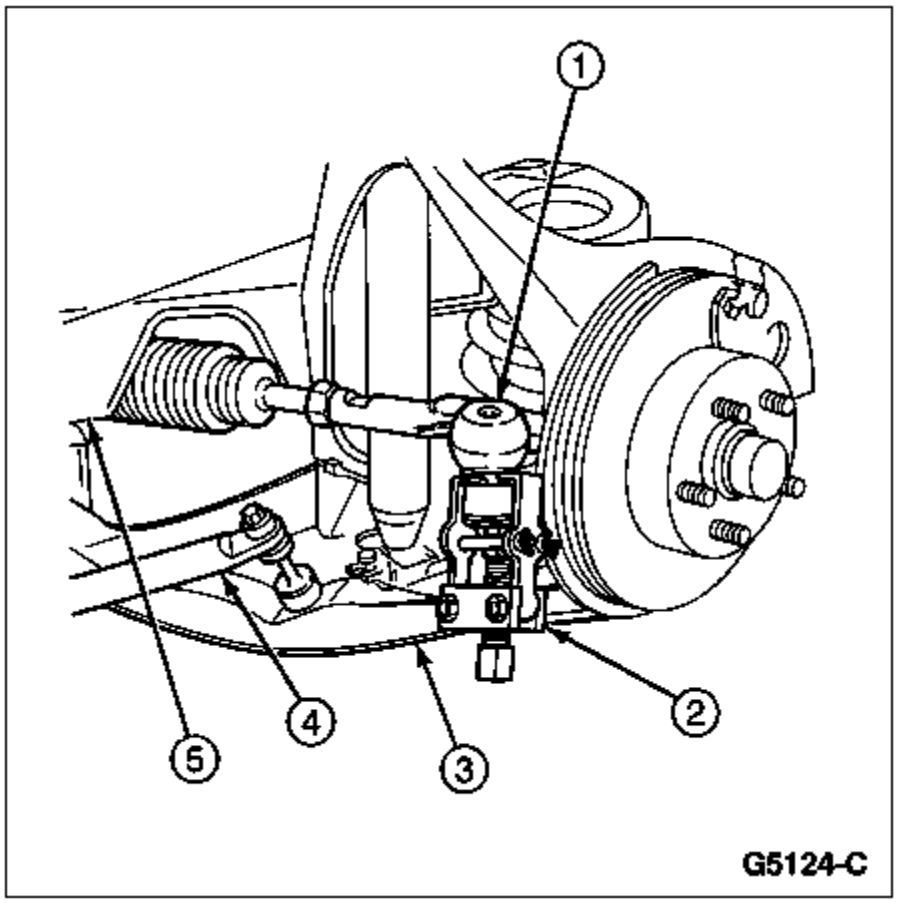
Knuckle, Front Wheel

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Pitman Arm Puller	T64P-3590-F
Front Hub Replacer	T81P-1104-A
Hub Remover Adapters Front Hub Bearing Service Set	T81P-1104-B, T86P-1104-A1
Front Hub Remover/Replacer	T81P-1104-C

Removal

1. Put steering gear in "on-center" position.
2. Put transmission in PARK and set hand brake.
3. Remove wheelcover.
4. Raise vehicle on hoist.
5. Remove wheel and tire.
6. Remove hub nut and washer.
7. Remove spring tension from upper and lower control arms. Compress spring using spring compressor tool until all spring tension is removed from control arms.
8. Remove brake rotor and disc brake caliper (2B120) as described in Section 06-03 . Do not let disc brake caliper hang by hose.
9. Remove cotter pin and tie rod nut. Using Pitman Arm Puller T64P-3590-F, disconnect tie rod end (3A130) from steering knuckle.



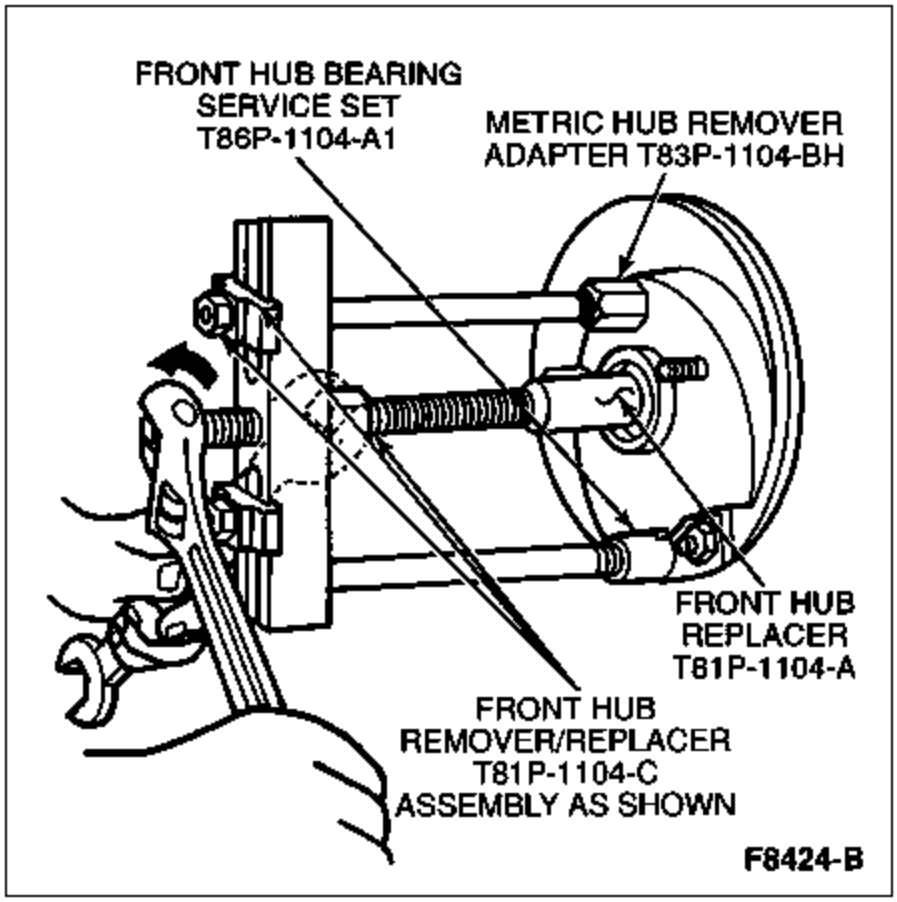
Item	Part Number	Description
1	3A130	Tie Rod End
2	T64P-3590-F	Pitman Arm Puller
3	3078	Front Suspension Lower Arm
4	5482	Front Stabilizer Bar
5	5019	Front Crossmember

10. **NOTE: Make sure adapters are fully threaded onto the hub studs and positioned opposite the other adapter.**

    Install Front Hub Remover/Replacer T81P-1104-C with Front Hub Replacer T81P-1104-A, Hub Remover Adapters T81P-1104-B and Front Hub Bearing Service Set T86P-1104-A1.

11. Free the hub, bearing, and knuckle assembly from the halfshaft by pushing in the CV joint outer shaft until it is loose from the assembly.

CV Joint-to-Hub Removal



12. Remove retaining nut and bolt and push up on front suspension upper arm (3083) until ball joint stud is out of knuckle.

13. Remove cotter pin and nut from front suspension lower arm ball joint (3050), using Pitman Arm Puller T64P-3590-F.

14. Remove ball joint stud from knuckle.

15. Remove knuckle from vehicle.

Installation

1. Put knuckle assembly onto lower and upper ball joint studs. Install nut and bolt clamping upper ball joint stud into knuckle and tighten to 37-50 Nm (27-37 lb-ft).

2. Install lower ball joint nut and tighten to 80-110 Nm (59-81 lb-ft). If necessary, advance nut to next slot. Install cotter pin.

3. Put CV joint shaft into hub and install washer and nut finger-tight.

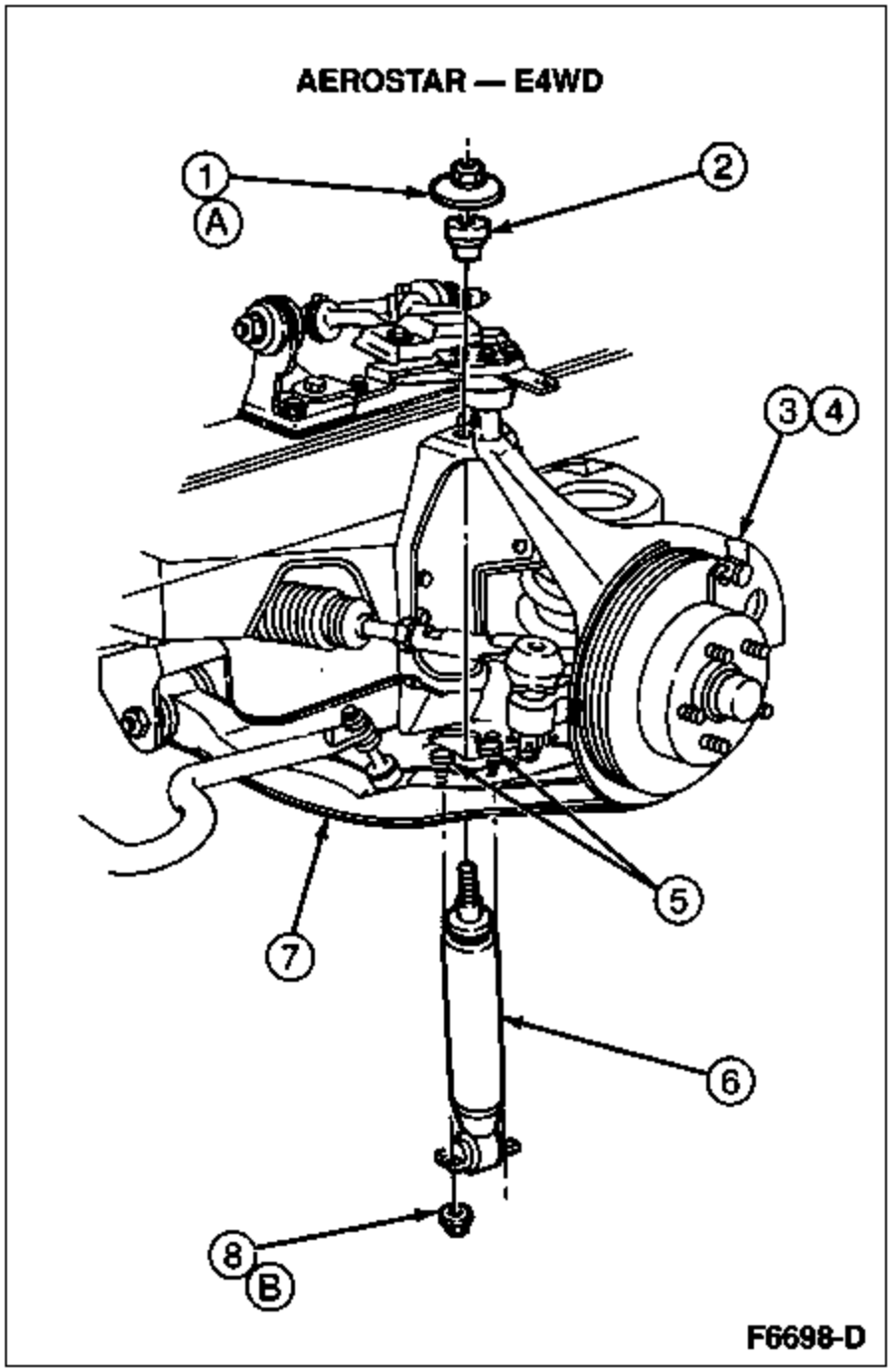
4. Install tie rod end and nut. Tighten nut to 70-100 Nm (52-74 lb-ft). If necessary advance nut to next slot. Install cotter pin.

5. Install disc brake caliper and front disc brake hub and rotor (1102) ; refer to Section 06-03 .

6. Install wheel and tire assembly.
7. Remove spring compressor.
8. Tighten hub nut to 230-285 Nm (170-210 lb-ft).
9. Check alignment; refer to Section 04-00 .
10. Install wheelcover and lower the vehicle.

Shock Absorber, Front

WARNING: THE LOW-PRESSURE GAS SHOCK ABSORBERS ARE CHARGED WITH NITROGEN GAS TO 930 KPA (135 PSI). DO NOT ATTEMPT TO OPEN, PUNCTURE OR APPLY HEAT TO THE SHOCK ABSORBERS.

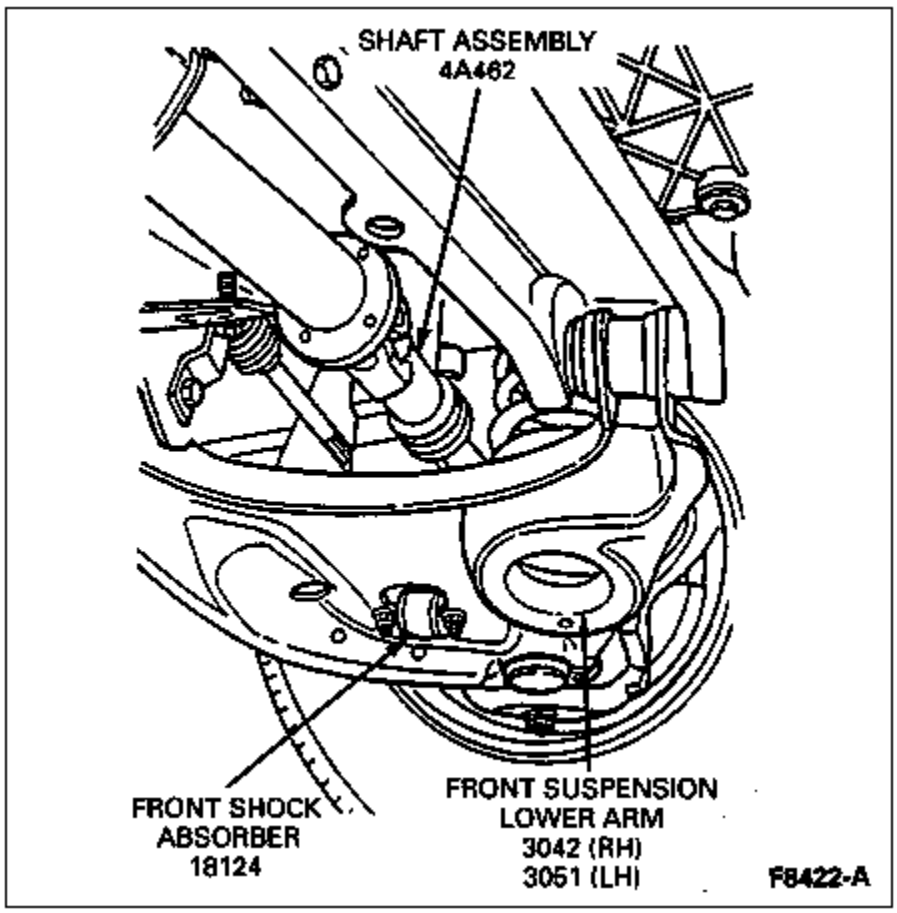


Item	Part Number	Description
1	N805348	Nut
2	18198	Insulator
3	3B305	Steering Knuckle Assembly (RH)
4	3B306	Steering Knuckle Assembly (LH)
5	N605905-S2	Shock Absorber Lower Mounting Studs
6	—	Front Shock Absorber

7	3078	Front Suspension Lower Arm
8	N620481	Nut
A	—	Tighten to 34-47 Nm (25-35 Lb-Ft)
B	—	Tighten to 22-33 Nm (16-24 Lb-Ft)

Removal and Installation

1. Remove the nut and washer assembly retaining the front shock absorber to the coil spring upper bracket.
2. Remove the two nuts retaining the front shock absorber to the bottom of the front suspension lower arm (3079).
3. Remove the front shock absorber through the front suspension lower arm.



4. Inspect the insulator in the coil spring upper bracket. If required, remove and replace the insulator.

For installation, follow removal procedures in reverse order. Tighten shock absorber-to-lower control arm nuts to 22-33 Nm (16-24 lb-ft). Tighten shock absorber-to-upper spring bracket nut to 34-47 Nm (25-35 lb-ft).

Ball Joint and Arm Assembly, Upper

Removal

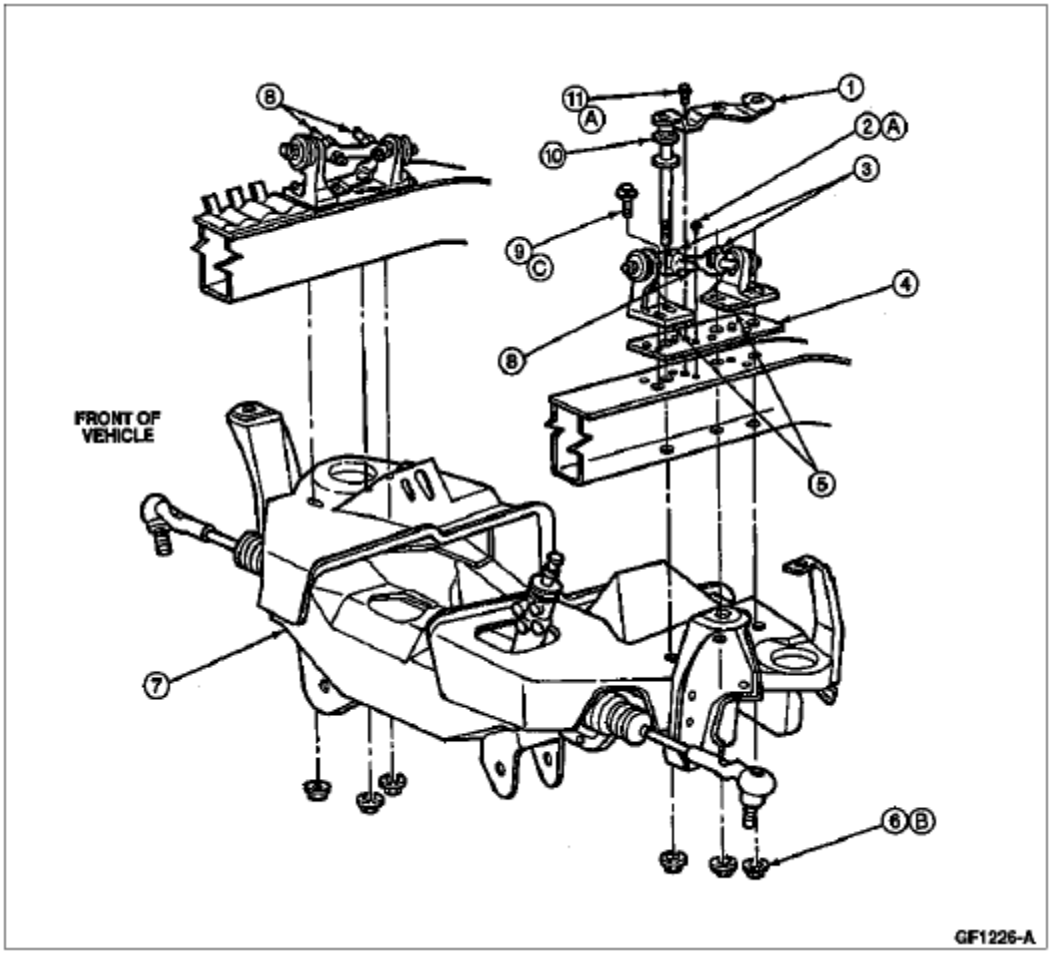
WARNING: WHEN SERVICING ANY COMPONENT IN THE UPPER CONTROL ARM AND BALL JOINT SYSTEM, ONLY ONE SIDE OF THE VEHICLE IS SERVICED AT A TIME. NEVER SERVICE BOTH SIDES AT THE SAME TIME.

1. **NOTE: Any time the steering linkage is disconnected from the steering knuckle, the steering system must be placed in the "on-center" position.**

   Place the steering wheel and steering system in the "on-center" position.

2. Raise the vehicle on a frame hoist. Place safety stands under the lower control arm. Slowly lower the hoist to maintain coil spring compression.

Front Drive Axle Crossmember and Control Arm Mounting



Item	Part Number	Description
1	38380	Bolt Bracket Retainer, If Equipped
2	N611175	Screw
3	—	Shim (Part of 3393)
4	3B204	Mounting Plate
5	—	Mounting Brackets (Part of 3393)
6	N804431	Nut
7	3C137	Front Drive Axle Crossmember Assembly
8	3083	Front Suspension Upper Arm
9	N804618	Bolt
10	N804386	Bolt
11	N611194-S	Screw
A	—	Tighten to 14-19 Nm (10-14 Lb-Ft)
B	—	Tighten to 196-264 Nm (145-195 Lb-Ft)
C	—	Tighten to 47-64 Nm

		(35-47 Lb-Ft)

3. Remove upper ball joint-to-knuckle bolt and nut. Disengage upper ball joint from knuckle.
4. Remove the bolt retainer plate screw. Remove plate.
5. Mark the position of the control arm mounting brackets on the flat plate.
6. Remove the front bolt and washer retaining the front mounting bracket to the mounting plate.
7. From beneath the rail, remove the three nuts from bolts retaining two front suspension upper arm mounting brackets to the body rail.
8. Remove the three long bolts retaining the mounting brackets to the body rail by rotating the front suspension upper arm (3083) out of position.
9. Remove the front suspension upper arm, mounting bracket assembly and mounting plate from the vehicle.
10. If required, remove and replace the upper ball joint boot seal.

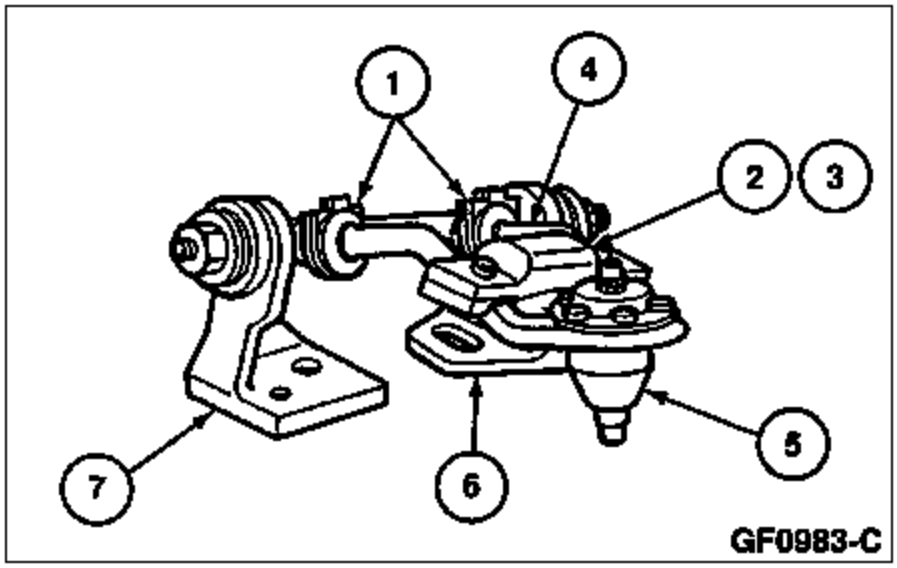
    Note the exact position and number of shims on each control arm stud. These shims control caster and camber.

11. **NOTE: The pivot shaft and mounting brackets are serviced as an assembly. The front suspension upper arm and front suspension upper ball joint (3049) are serviced as an assembly.**

    To service front suspension upper arm and front suspension upper ball joint assembly or the mounting brackets and adjusting arm assembly, remove the nuts retaining the front suspension upper arm to the adjusting arm.

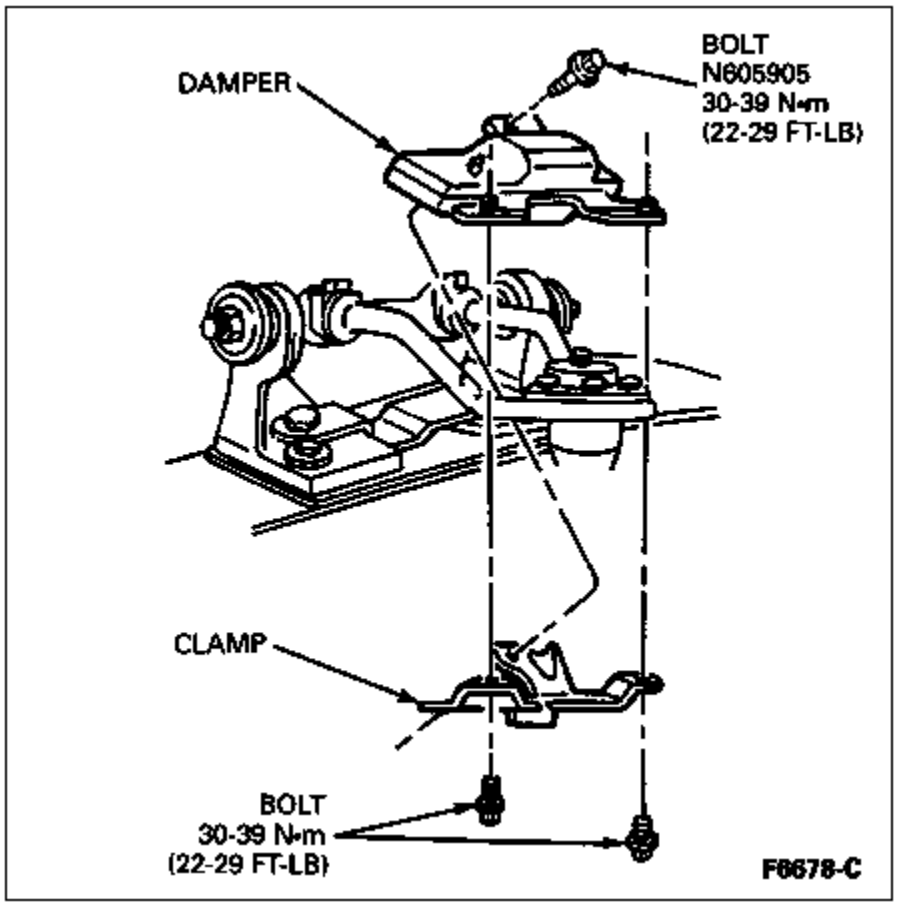
12. Remove the front suspension upper arm from the adjusting arm.

Control Arm Damper



Item	Part Number	Description
1	3043	Alignment Shims
2	3C156	Damper Assembly (RH)
3	3C157	Damper Assembly (LH)
4	3083	Front Suspension Upper Arm
5	3049	Front Suspension Upper Ball Joint
6	—	Rear Mounting Bracket (Part of 3393)
7	—	Front Mounting Bracket (Part of 3393)

13. If required, remove the damper assembly from the front suspension upper arm by removing the three retaining bolts.



Installation

1. If removed, install the front suspension upper arm and ball joint in the pivot shaft.
2. Install the shims on the control arm studs with the same number of shims in the exact position as marked during removal.
3. Install and tighten the nuts retaining the upper arm and ball joint plus the shims to the front suspension upper arm.
4. If removed, install the boot seal on the upper and/or lower ball joint and lubricate ball joint.
5. If removed, install the damper assembly to front suspension upper arm. Tighten damper retaining bolts to 30-39 Nm (22-29 lb-ft).
6. Place the flat plate for the mounting brackets in position on the body rail. Install screw and tighten to 14-19 Nm (10-14 lb-ft).
7. Place the mounting brackets and front suspension upper arm assembly in position on the flat plate.
8. Install the three long bolts and washers retaining the mounting brackets to the body rail.
9. Rotate or rock the front suspension upper arm and mounting bracket until the bolt heads rest against

the mounting bracket and the studs extend through the body rail.

10. **NOTE: Make sure the mounting brackets do not move from the marked positions on the flat plate. This minimizes corrections.**

    Move mounting brackets into position marked on mounting plate during removal.

11. **CAUTION: The torque required for the mounting bracket-to-body rail nuts and bolts is critical. They must be tightened to the specified torque.**

    If present, place the bolt retainer plate in position on the mounting bracket and flat plate assembly. Install and tighten the screw to 14-19 Nm (10-14 lb-ft).

12. Install and tighten the nuts retaining the mounting bracket bolts to the body rail to 196-264 Nm (145-195 lb-ft).

13. Install and tighten the front bolt retaining the front mounting bracket to the mounting plate, 47-64 Nm (35-47 lb-ft).

14. Connect the front suspension upper ball joint to steering knuckle. Install the bolt and nut and tighten to 37-50 Nm (27-37 lb-ft).

15. Check and if required, adjust caster, camber and toe-in as described in Section 04-00 . Use service adjustment shims as required for caster and camber revisions.

Arm, Lower

Removal

1. **NOTE: Any time the steering linkage is disconnected from the steering knuckle the steering system must be placed in the "on-center" position.**

   Place the steering wheel and steering system in the "on-center" position.

2. **WARNING: MAKE SURE THE VEHICLE IS SECURELY SUPPORTED ON THE SAFETY STANDS.**

   Raise the vehicle on a twin post hoist. Place safety stands under the frame to support the vehicle. During service procedures, the front post hoist is lowered to remove coil spring.

3. Remove the coil spring as described in Removal and Installation, Spring, Front this section.

4. **NOTE: Prior to removing the front suspension lower arm, the front post of the hoist should be rotated to support the vehicle under the No. 1 crossmember.**

   Remove the bolts and nuts retaining the front suspension lower arm to the No. 1 crossmember. Remove the front suspension lower arm.

5. Replace entire front suspension lower arm assembly to service bushings.

Installation

1. Position the front suspension lower arm in No. 1 crossmember.

2. Install but do not tighten the bolts in the direction shown in Views A and B in the illustration labeled Front Suspension, Aerostar E-4WD in the Removal and Installation portion of this section.

3. Inspect the lower ball joint boot seal for damage and replace if required.

4. Install the coil spring as described in this section.

5. With the vehicle in the normal ride position, tighten the front suspension lower arm-to-No. 1 crossmember retaining nuts to 136-190 Nm (100-140 lb-ft).

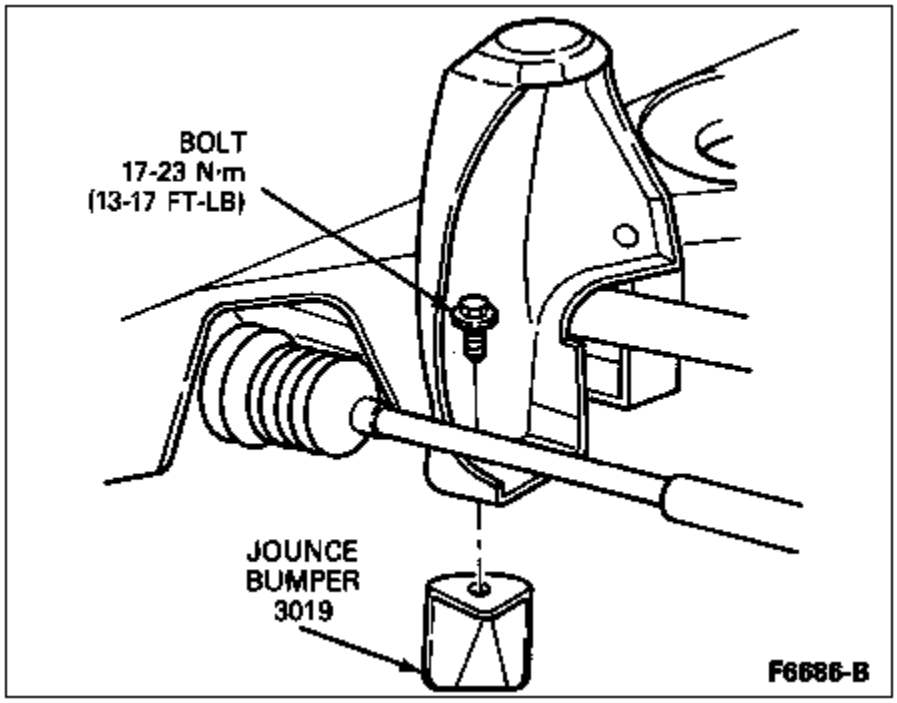
6. Remove safety stands and lower vehicle.

Bumper, Front

Removal and Installation

1. Remove the bolt retaining the front suspension bumper (3020) to the No. 1 crossmember. Remove the front suspension bumper.

2. Place the front suspension bumper in position on the crossmember. Install the bolt and tighten to 17-23 Nm (13-17 lb-ft).



SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Crossmember to Frame Rail Bolts (M16 Bolts Through Front and Rear Upper Control Arm Mounts)	196-264	145-195	—
Front Mounting Bracket Bolt (M10 Bolts Through Front Upper Control Arm Front Mount Only)	47-64	35-47	—
Bolt Retainer Bracket to Frame Screw	14-19	10-14	—
Front Suspension Bumper to Frame Bolt	17-23	13-17	—
Lower Control Arm to No. 1 Crossmember Nut and Bolt. Tighten to the Specified Torque with the Vehicle in the Normal Ride Position with All Other Fasteners Tightened to Specifications.	136-190	100-140	—
Shock Absorber to Lower Control Arm Nuts	22-33	16-24	—
Shock Absorber to Upper Spring Bracket Nut	34-47	25-35	—
Knuckle to Lower Ball Joint Nut. Tighten to Specifications and If Required, Advance the Nut to the Castellation to Install the Cotter Pin.	80-110	59-81	—
Knuckle to Upper Ball Joint Nut	37-50	27-37	—
Stabilizer Link to Lower Control Arm Link Nut	8-12	—	71-107
Stabilizer Bar Mounting Bracket to Frame Bolts	22-33	16-24	—
Stabilizer Link to Stabilizer Bar Nut	8-12	—	71-107
Tie Rod End to Steering Knuckle Nut. Tighten to Specifications and If Required, Advance the Nut to the Castellation to Install the Cotter Pin.	70-100	52-74	—
Upper Control Arm Alignment Adjustment Nuts	95-135	70-100	—
Hub Nut	230-285	170-210	—
Damper Bolts	30-39	22-29	—
Toe Set Jam Nut	61-88	45-65	—

FRONT SUSPENSION, AEROSTAR E-4WD

Symptom Chart — Rear Suspension

REAR SUSPENSION

Condition	Possible Source	Action
• Body "Rolls"	• Malfunction of rear shock absorber.	• REPLACE the rear shock absorber.
	• Worn or deteriorated rear stabilizer bar link/bushings (Ranger only).	• REPLACE the rear stabilizer bar link/bushings.
• Poor Riding Comfort	• Weak rear spring.	• REPLACE the rear spring.
	• Malfunction of rear shock absorber.	• REPLACE the rear shock absorber.
• Body Leans	• Malfunction of rear shock absorber.	• REPLACE the rear shock absorber.
	• Weak rear spring.	• REPLACE the rear spring.
• Abnormal Noise from Suspension System	• Looseness of component connections.	• TIGHTEN the component connections.
	• Malfunction of rear shock absorber or lateral shock absorber.	• REPLACE the rear shock absorber or lateral shock absorber. **NOTE: Forward and rearward motion (relative movement between rubber shock bushing and metal sleeve) at each end of the lateral shock is normal. Do not replace lateral shock if this condition exists. Relative movement between the metal shock sleeve and the frame/axle brackets is not normal. If necessary, check and tighten frame end bolt to 53-72 Nm (39-53 lb-ft) and axle end bolt to 68-92 Nm (50-68 lb-ft).**
	• Worn or deteriorated rear stabilizer bar/link bushings (Ranger only).	• REPLACE the rear stabilizer bar link/bushings (Ranger only).
• General Driving Instability	• Weak rear spring.	• REPLACE the rear spring.

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	• Malfunction of rear shock absorber.	• REPLACE the rear shock absorber.
	• Worn or deteriorated rear stabilizer bar link/bushings (Ranger only).	• REPLACE the rear stabilizer bar link/bushings (Ranger only).
	• Damaged or unbalanced wheel.	• CHECK the wheel balance. BALANCE if necessary.
	• Damaged suspension arm bushing of rear axle assembly (Aerostar only).	• REPLACE bushings or suspension arms.

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Component Tests

Rear Spring Squeak, Ranger

To correct a squeaking condition at the rear springs (5560):

- Determine whether it is the rear spring or the shackle bushings squeaking. If it is determined to be the bushings, replace them.
- If it is the rear springs, install new rear spring anti-squeak inserts (5586) to correct the squeak.
- If the original spring clip is damaged during removal, install a new service spring clip.

Rear Spring Anti-Squeak Insert

1. Raise the vehicle by the frame so rear axle hangs freely.

2. Bend the spring clip to provide clearance between the rear spring leaves, allowing insertion of the rear spring anti-squeak inserts. A pry-bar may be used between the leaves to provide additional clearance for insertion of rear spring anti-squeak inserts.

3. **NOTE: Do not attempt to install a rear spring anti-squeak insert between the lowest primary leaf and the short 12.70mm (0.50-inch) thick secondary leaf found at the bottom of the leaf stack on some assemblies.**

   Slide the rear spring anti-squeak insert between the leaves until the liner extends approximately 6.35mm (0.25 inch) beyond the tip of the lower leaf.

4. Set rear axle (4001) on a stand to load the rear leaf springs. Contact leaves at the clip locations.

5. **NOTE: On some of the rear spring anti-squeak inserts, sections of the edge used to center the liner on the spring leaves may need to be trimmed off to accommodate spring clip.**

   Reinstall production clips or install the replacement service clip.

Service Spring Clip Installation

1. **NOTE: The spring leaves should contact at the clip location.**

   Load the rear leaf springs with rear of the vehicle supported either by the rear axle (4001) or by the tires.

2. Remove the damaged clip by prying back the ends of the clip which are folded across the rear spring (5560) until the clip can be freed from the rear spring. On some clips it is necessary to pry the locating pin out of the locating hole.

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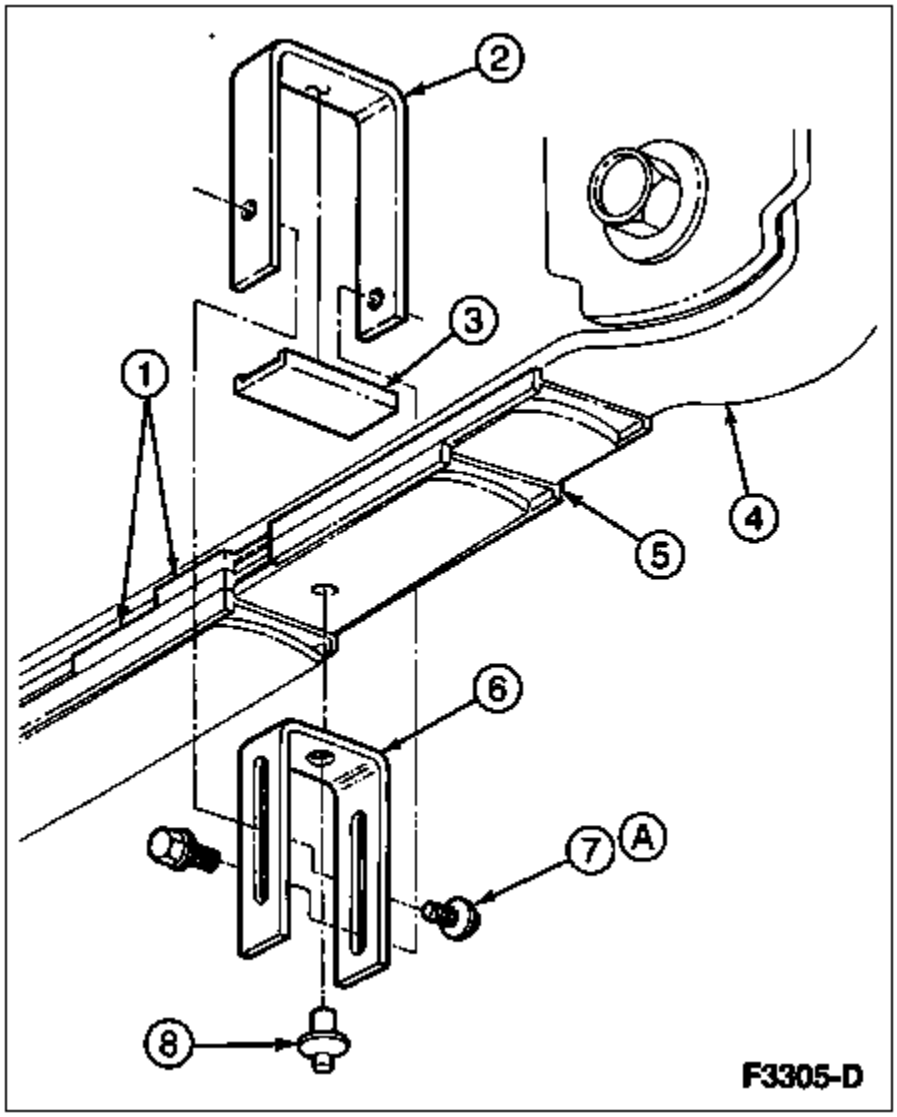
3. Make sure the locating hole is clean and free of debris.



Item	Part Number	Description
1	—	Tip Liner (Trimmed to Accommodate Rear Spring Clamp) (Part of 5586)
2	5724	Rear Spring Clamp (Upper Half)
3	—	Rubber Clamp Liner (Part of 5724)
4	5560	Rear Spring
5	—	Liner (Part of 5586)
6	5724	Rear Spring Clamp (Lower Half)

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7	—	Screw (Part of 5724)
8	—	Rivet (Part of5724)
A	—	Tighten to 21-27 Nm (15-20 Lb-Ft)

4. Position the lower part of the service clip across the width of the underside of the rear spring, so clip holes align with the locating hole in the rear spring. The legs of the clip lower half should extend down from the bottom of the rear spring.

5. Insert drive rivet that comes with the clamp through the hole in lower service clip and hole in the rear spring. The flat face of the rivet flange should rest against the clip lower half.

6. **NOTE: If there is not enough room to hit the rivet directly with a hammer, a punch may be used.**

   Fully seat the rivet with a hammer.

7. The slotted legs of the clip lower half should extend downward so the outer surface of legs is flush with rear spring sides.

8. Place the rubber service clip liner across the top of the rear spring. Align with lower clip with the flat surface against the rear spring and the clip locating edges extending upward.

9. Place the clip upper half between the locating edges of the rubber liner.

10. Align threaded holes in clip upper half with lower clip slots.

11. **NOTE: The screw heads will be located under the rear spring, ultimately pressing against the clip lower half.**

    Hand start the two screws through the clip lower half slot into the clip upper half threaded hole.

12. Squeeze the clip to the rear spring with one hand while tightening the screws. Tighten to 21-27 Nm (15-20 lb-ft).

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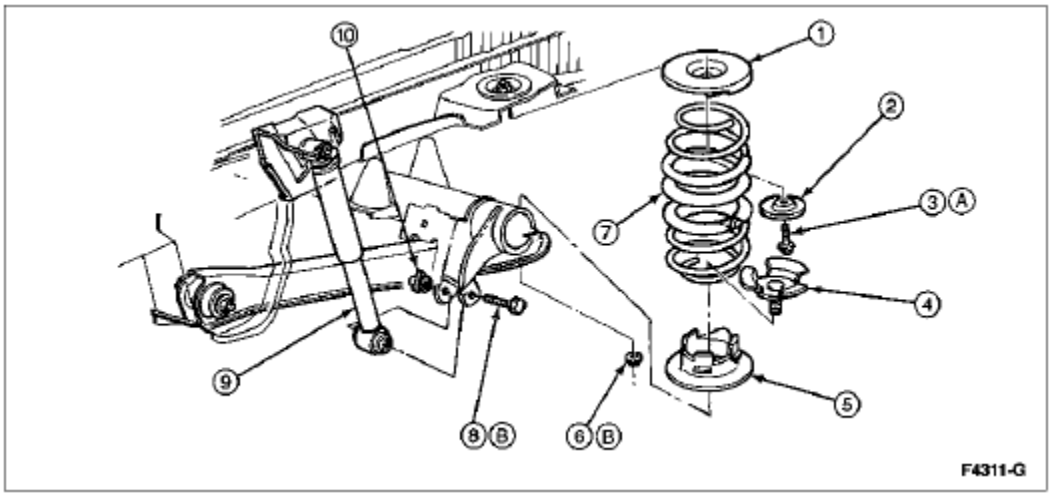
Spring, Rear, Aerostar

Removal

1. Using frame hoist, raise the vehicle and position tall jack under rear axle (4001). Raise jack until axle is raised slightly (load removed from shock absorber (18080)).

Rear Spring, Aerostar



Item	Part Number	Description
1	5536	Rear Spring Insulator
2	5A543	Rear Spring Upper Retainer
3	605919	Bolt
4	5A569	Rear Spring Lower Retainer
5	5741	Rear Spring Center Mounting Insulator
6	N620483	Nut
7	5560	Rear Spring
8	N801332	Bolt
9	18080	Shock Absorber
10	804220	Nut and Retainer
A	—	Tighten to 40-55 Nm (30-40 Lb-Ft)
B	—	Tighten to 60-80 Nm

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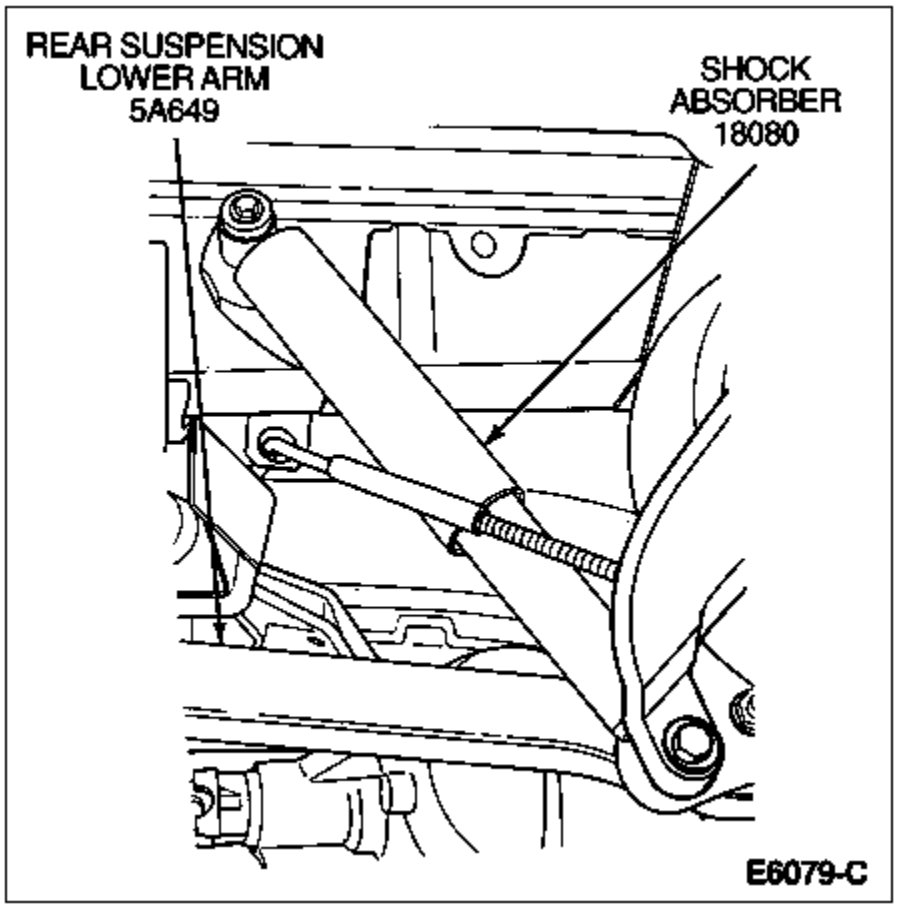
		(45-60 Lb-Ft)

2. Remove shock absorber-to-axle mount nut and bolt.
3. Disconnect the shock absorber from axle bracket.



4. Lower the rear axle until the rear springs (5560) are no longer under compression.
5. Remove lower retainer and spring-to-rear suspension lower arm nut.
6. Remove upper retainer and spring-to-frame bolt.
7. Remove the rear spring and retainers.
8. Remove the upper and lower insulators.

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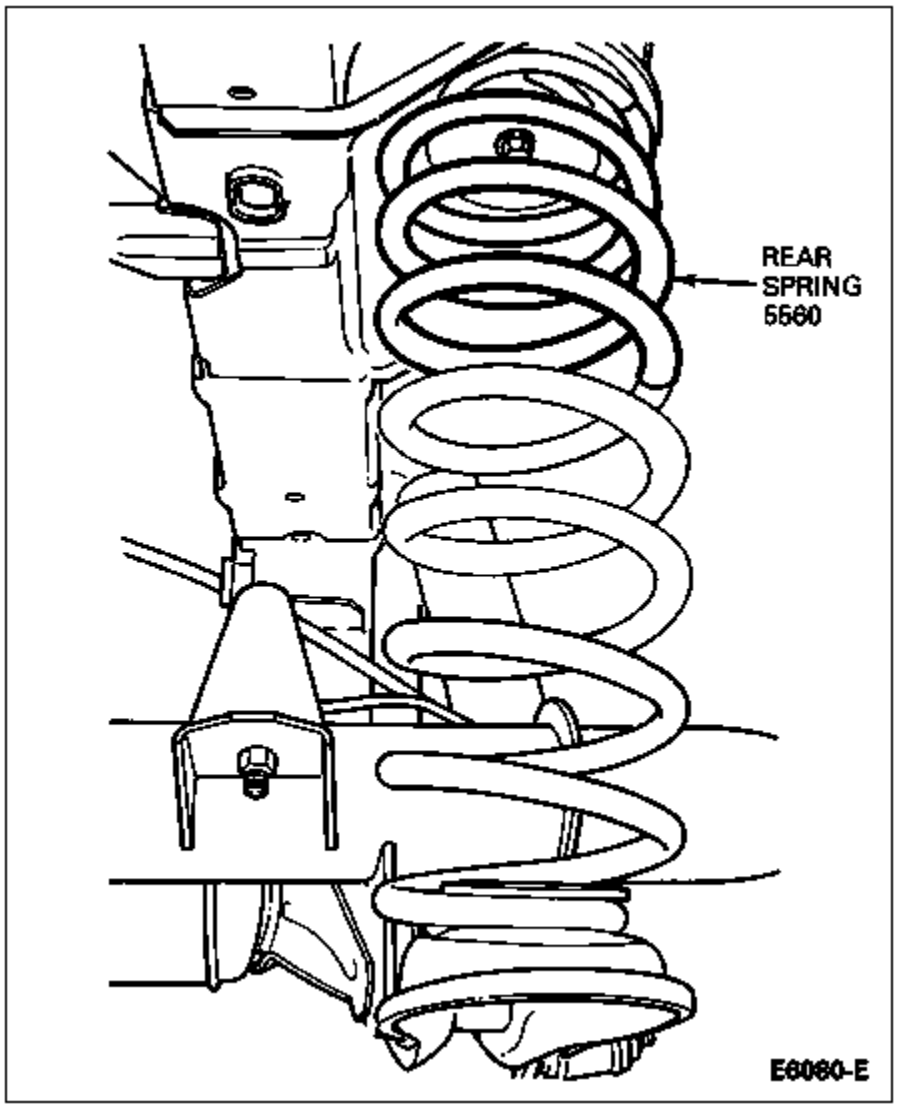

Installation

1. Make sure the rear axle is at the rear spring unloaded position. Place the rear spring center mounting insulator (5741) on the bottom of the rear spring. Place the rear spring insulator (5536) on top of the rear spring.

2. **NOTE: When installing the rear spring, the small diameter, tapered coils (with the insulating sleeve) must face upward with pigtail resting against the upper insulator rubber stop.**

   Install the coil spring in position between the shock absorber and frame (5005).

3. With the upper pigtail resting against the rubber stop, rotate spring with upper insulator until lower pigtail points in the three o'clock position. Install the upper retainer and bolt. Tighten the bolt to 40-55 Nm (30-40 lb-ft).

4. Install the lower retainer and nut. Tighten the nut to 60-80 Nm (45-60 lb-ft).

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5. Raise the axle high enough to allow installation of shock absorber.

6. Position the shock absorber in the axle bracket. Install the bolt so the head is positioned outboard of the bracket. Install the nut and tighten to 60-80 Nm (45-60 lb-ft).

7. Remove the jack and lower the vehicle.

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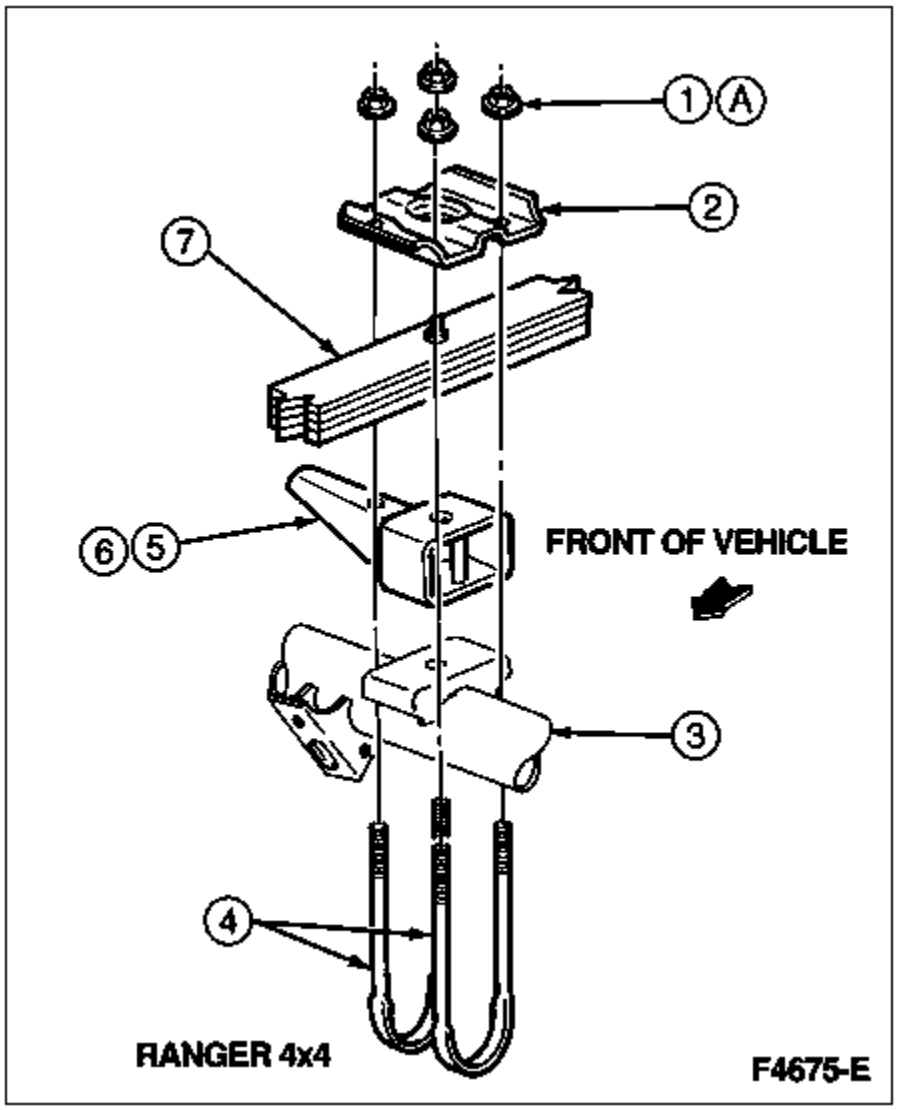
Spring, Rear, Ranger

Removal and Installation

1. Raise the vehicle on the frame hoist. Support rear axle (4001) on a jack without compressing springs.
2. Remove the nuts from spring U-bolts and drive the U-bolts from the rear spring plate (5796).



Item	Part Number	Description
1	620483	Nut

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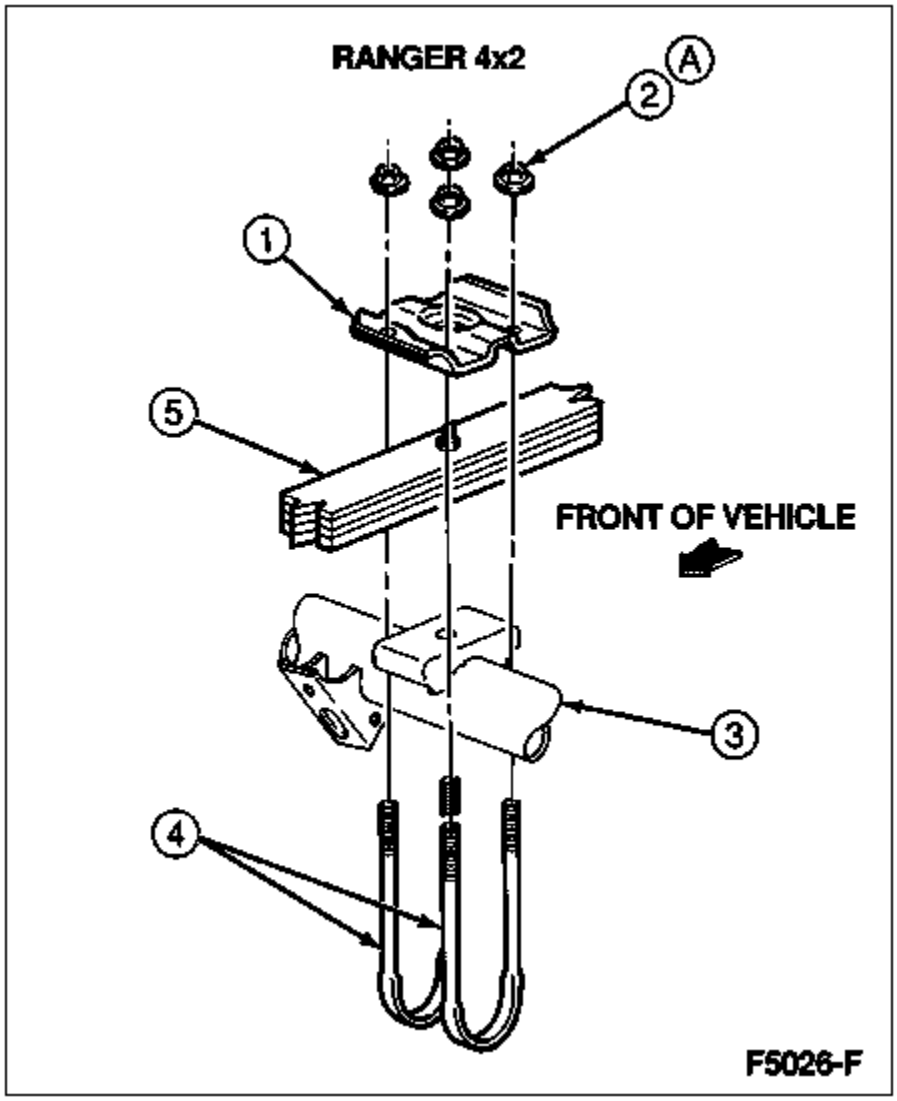
2	5796	Rear Spring Plate (Must Be Installed in Direction Shown.)
3	4001	Rear Axle
4	N802365	U-Bolt
5	5598	Spacer, Rear Spring (RH) (108- and 114-Inch Wheelbase. Parts Must Not Be Interchanged.)
6	5A918	Spacer, Rear Spring (LH) (108- and 114-Inch Wheelbase. Parts Must Not Be Interchanged.)
7	5560	Rear Spring
A	—	Tighten to 88-118 Nm (65-87 Lb-Ft)



Item	Part Number	Description

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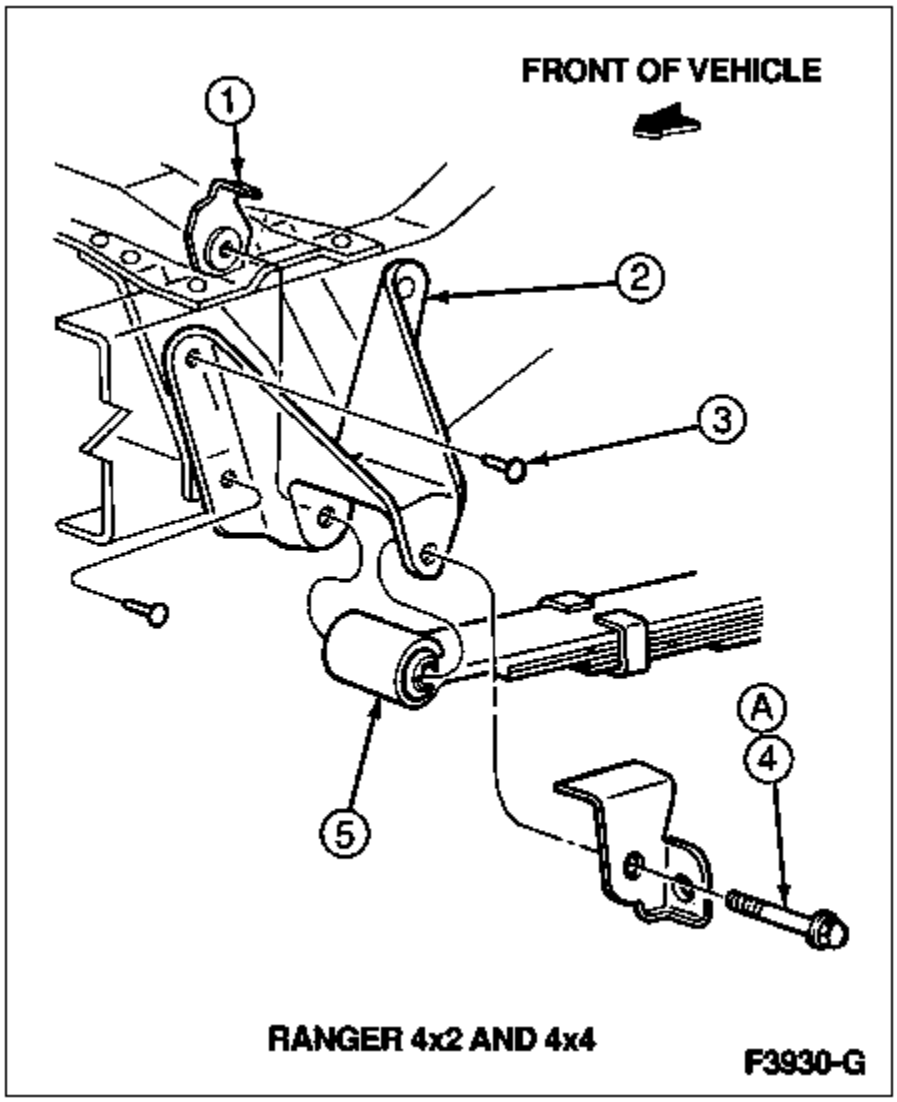
1	5796	Rear Spring Plate
2	620483	Nut
3	4001	Rear Axle
4	N807321-S101	U-Bolt
5	5560	Rear Spring
A	—	Tighten to 88-118 Nm (65-87 Lb-Ft)

3. Remove the spring-to-bracket nut and bolt at the front of rear spring (5560).



Item	Part Number	Description
1	N802819-S2	Nut and Retainer
2	5785	Rear Spring Hanger

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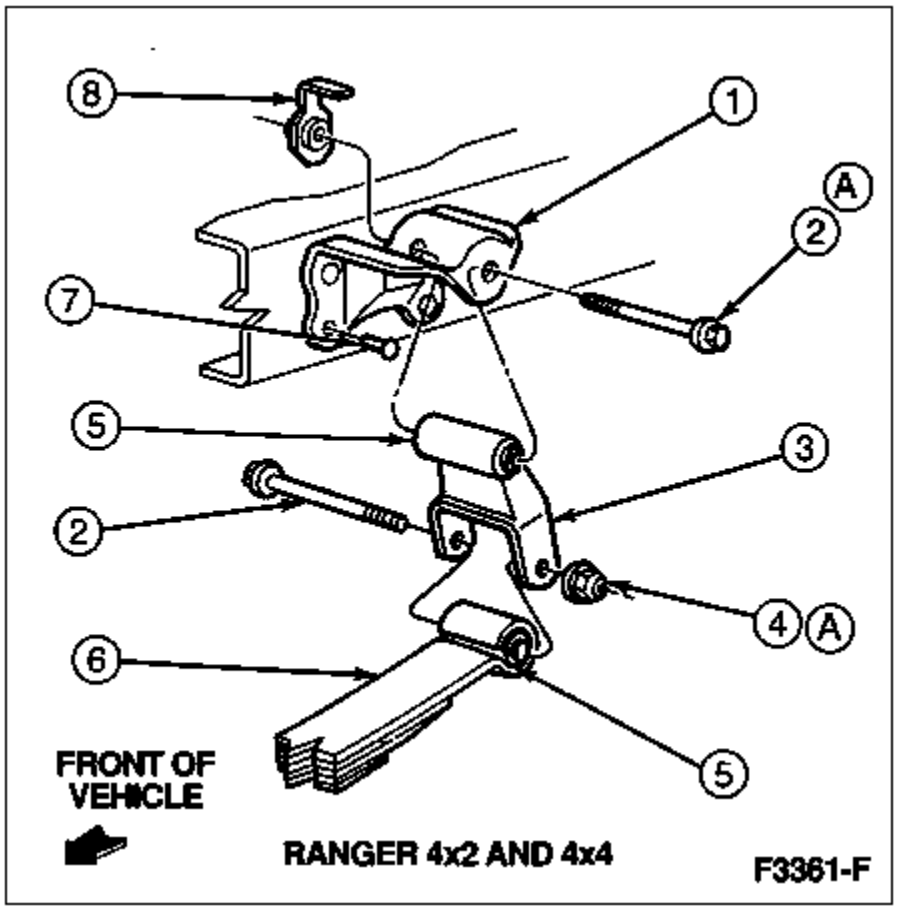
3	65092-S	Rivet
4	N807280-S412	Bolt
5	5560	Rear Spring
A	—	Tighten to 88-118 Nm (65-87 Lb-Ft)

4. Remove the shackle upper and lower nuts and bolts at the rear of the rear spring.
5. Remove the rear spring and rear spring shackle (5776) from the rear spring shackle bracket (5775).

For installation, follow removal procedures in reverse order.

- Lower the vehicle to the floor.
- Tighten the spring U-bolt nuts to 88-118 Nm (65-87 lb-ft).
- Tighten the front spring bolt to 88-118 Nm (65-87 lb-ft) and the rear shackle and hanger bolts and nuts to 88-118 Nm (65-87 lb-ft).



Item	Part Number	Description
1	5775	Rear Spring Shackle Bracket
2	N807280-S412	Bolt

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3	5776	Rear Spring Shackle
4	N620484	Nut
5	5781	Rear Spring Upper Retaining Seat
6	5560	Rear Spring
7	N647096-S	Rivet
8	N802819-S2	Nut and Retainer
A	—	Tighten to 88-118 Nm (65-87 Lb-Ft)

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Shock Absorber, Aerostar

WARNING: THE LOW PRESSURE GAS SHOCK ABSORBERS ARE CHARGED WITH NITROGEN GAS TO 930KPA (135 PSI). DO NOT ATTEMPT TO OPEN OR HEAT WITH A TORCH.

Removal and Installation

1. Raise the vehicle on a frame hoist. Place safety stands under the rear axle (4001) to take the load off the shock absorber (18080).

2. Remove the shock absorber lower attaching nut and bolt. Swing the lower end free of the mounting bracket on the axle housing.

3. Remove the attaching bolt and washer from the upper mounting bracket. Remove the shock absorber.

   For installation, follow removal procedures in reverse order.

   - Tighten shock absorber-to-lower bracket nut to 60-80 Nm (45-60 lb-ft).
   - Tighten upper mounting bracket bolt and washer to 60-80 Nm (45-60 lb-ft).

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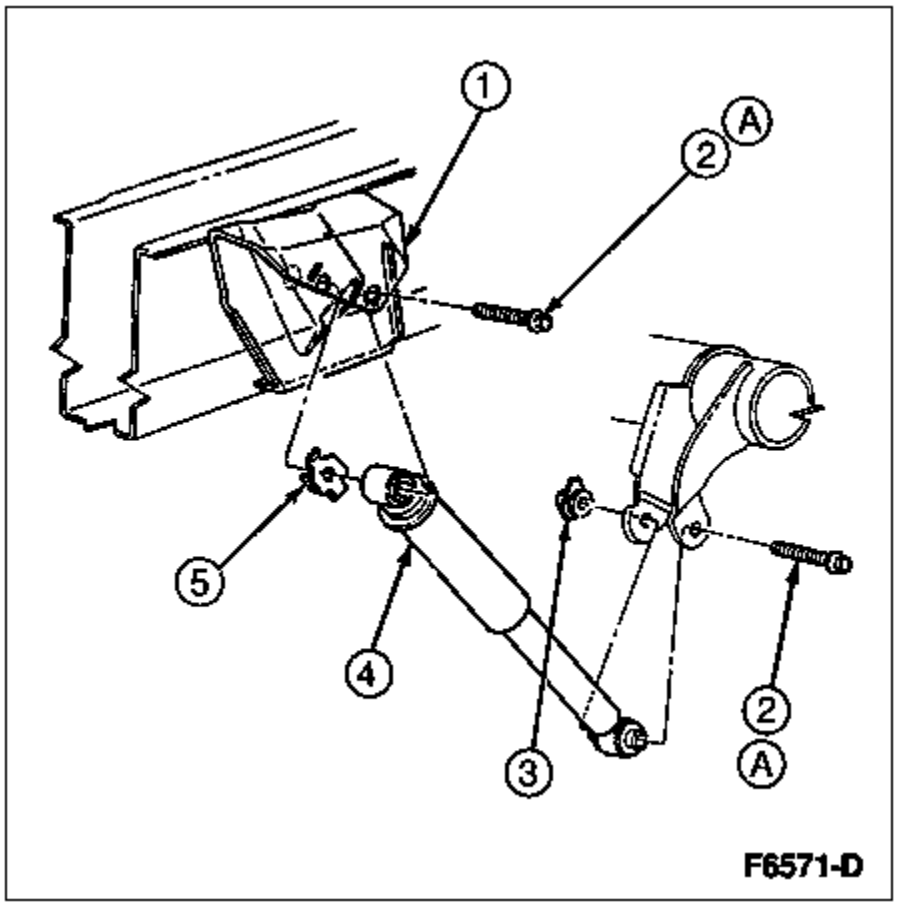

Item	Part Number	Description
1	18A004	Upper Shock Bracket
2	801332	Bolt
3	N804220	Nut
4	18080	Shock Absorber
5	N80544B	Nut
A	—	Tighten to 60-80 Nm (45-60 Lb-Ft)

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Shock Absorber, Ranger

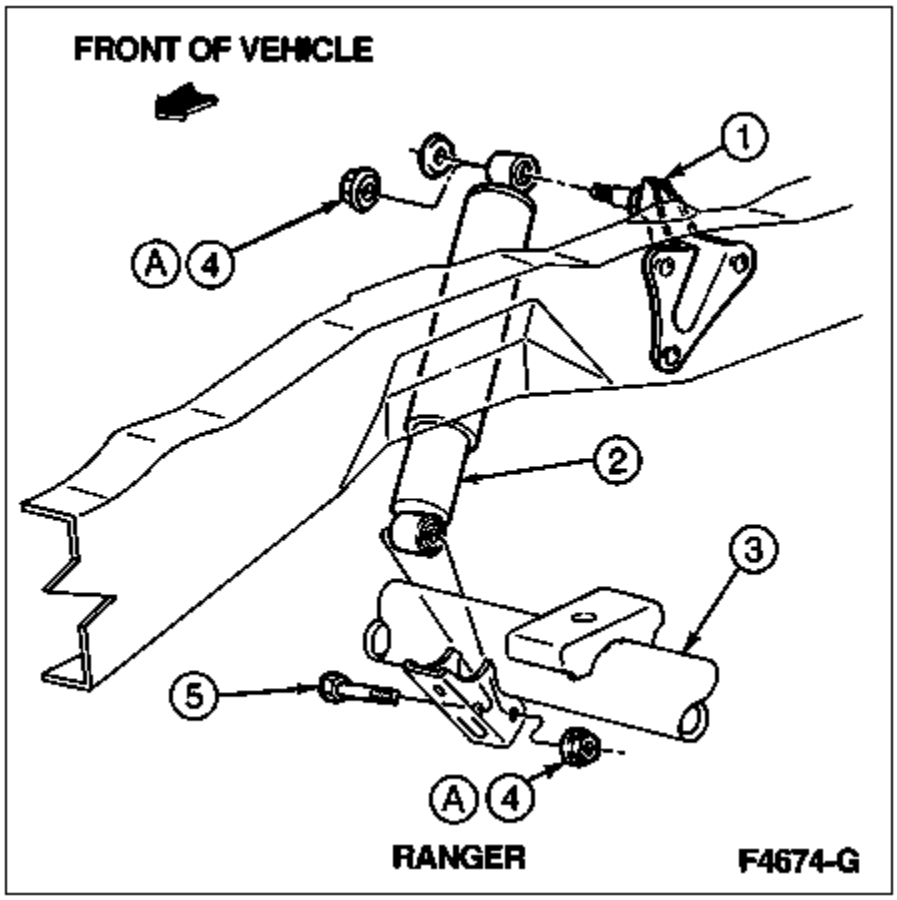
WARNING: THE LOW PRESSURE GAS SHOCK ABSORBERS ARE CHARGED WITH NITROGEN GAS TO 930 KPA (135 PSI). DO NOT ATTEMPT TO OPEN OR HEAT WITH A TORCH.

Removal and Installation

1. Raise the vehicle on a frame hoist. Place safety stands under the axle or wheel to take the load off the shock absorber (18080).
2. Remove the shock absorber lower attaching nut and bolt, and swing the lower end free of the mounting bracket on the axle housing.
3. Remove the attaching nut from the upper mounting bolt. Remove the shock absorber.

   For installation, follow the removal procedures in reverse order.

   - On Ranger, tighten shock absorber-to-axle housing mounting bracket nut to 53-72 Nm (39-53 lb-ft) and upper mounting bracket nut to 53-72 Nm (39-53 lb-ft).



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Item	Part Number	Description
1	18169	Rear Shock Bracket
2	18080	Shock Absorber
3	4001	Rear Axle
4	N806496-301	Nut
5	N804641-S301	Bolt
A	—	Tighten to 53-72 Nm (39-53 Lb-Ft)

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Rear Suspension Arm and Bushing, Aerostar

Removal

1. Raise the vehicle on a twin-post type hoist. Position jackstands on the frame rear lift points or under the rear bumper support brackets. If a frame hoist is used, raise the vehicle and position tall jackstands under the rear axle (4001).

2. Lower the hoist until the rear axle is in the normal ride height position.

3. Remove shock absorber-to-lower axle bracket nut and bolt.

4. Swing the lower end of the shock absorber (18080) free of the axle bracket.

5. **NOTE: If the vehicle is on a frame hoist, raise the vehicle until the coil springs are no longer under compression.**

   Lower the rear axle until the coil springs are no longer under compression.

6. **NOTE: To ease rear suspension arm and bushing removal, follow the exact sequence detailed in the following steps.**

   NOTE: Scribe reference mark on cam adjuster and axle bushing before removal.

   Remove rear suspension arm-to-rear axle bolt and nut. Disconnect the rear suspension arm and bushing (5500) from the rear axle.

7. **NOTE: If the left bracket attachments are loosened prior to disengaging the rear suspension arm and bushing from the right bracket, the uncompressed left bushing will force the rear suspension arm and bushing against the right-hand bracket and make removal difficult.**

   Remove rear suspension arm-to-right frame bracket bolt and nut. Rotate the rear suspension arm and bushing to disengage from the body bracket.

Rear Suspension Arm and Bushing, Aerostar

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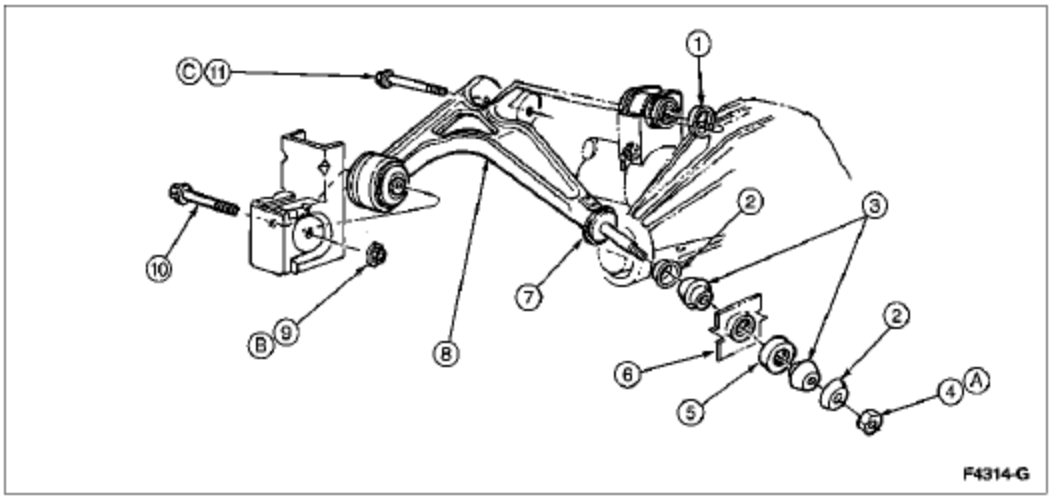

Item	Part Number	Description
1	5K679	Suspension Thrust Bushing
2	5A349	Spring Mounting Retainer
3	5K752	Body Insulator
4	801670	Nut
5	5K580	Suspension Outer Spacer
6	5546	Upper Body Bracket
7	—	Plastic Washer (Part of 5500)
8	5500	Rear Suspension Arm and Bushing
9	800237	Nut
10	804591	Bolt
11	N806946	Bolt
A	—	Tighten to 90-120 Nm (65-90 Lb-Ft)
B	—	Tighten to 135-170 Nm (100-125 Lb-Ft)
C	—	Tighten to 210-284 Nm (155-210 Lb-Ft)

8. Remove rear suspension arm-to-left frame bracket nut and washer. Remove the outer insulator and spacer. Remove the rear suspension arm and bushing from the bracket. Remove the inner insulator and spacer from the rear suspension arm stud.

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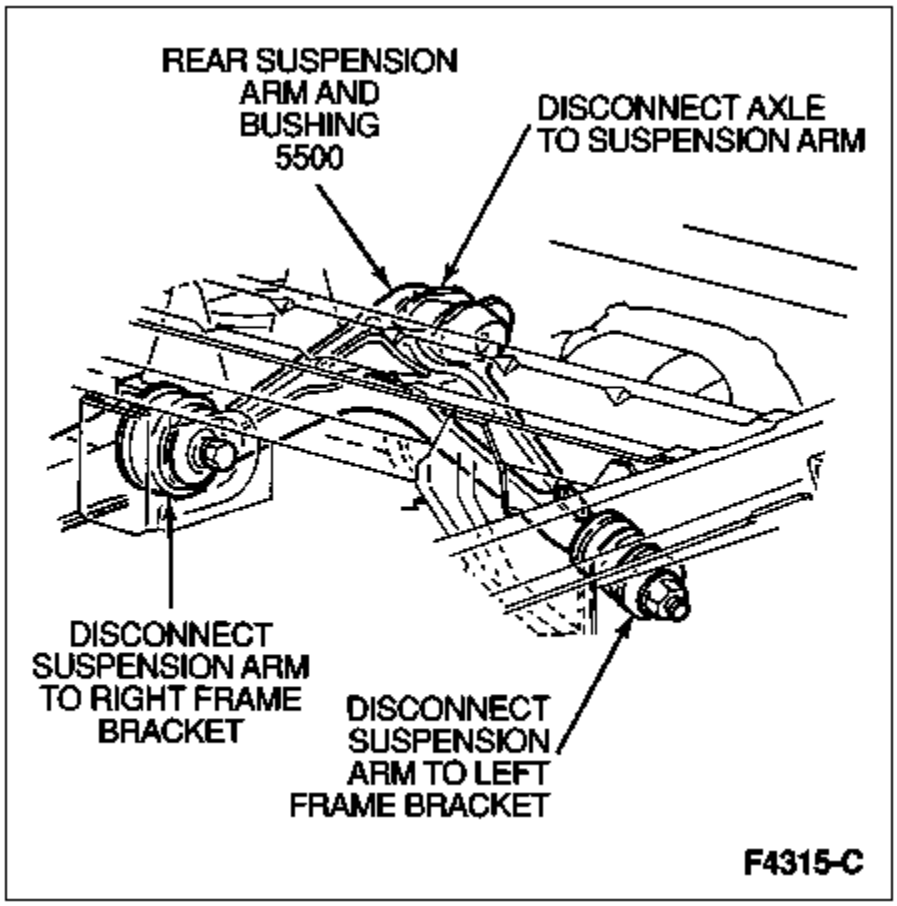

Installation

1. **NOTE: To ease rear suspension arm and bushing installation, follow the exact sequence detailed in Steps 1 through 6.**

   Position the spacer and inner insulator on the rear suspension arm stud.

2. Install the rear suspension arm and bushing so the stud extends through the left frame bracket.

3. Install the outer spacer and outer insulator over the stud.

4. **CAUTION: When performing the following step, DO NOT TIGHTEN TO THE SPECIFIED TORQUE.**

   Install the nut and washer assembly and tighten until snug.

5. Position the rear suspension arm in right frame bracket. Install the bolt and nut and tighten until snug.

6. **CAUTION: When performing the following step, DO NOT TIGHTEN TO THE SPECIFIED TORQUE.**

   Align scribe marks on the cam adjuster and axle bushing and connect the rear suspension arm and

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bushing to the rear axle.

7. Install the bolt and tighten until snug. DO NOT TIGHTEN TO THE SPECIFIED TORQUE AT THIS TIME.

8. Raise the rear axle to the normal ride position.

9. Position the shock absorber in the lower mounting bracket. Install the bolt so head is outboard of axle bracket. Install the nut and tighten to 60-80 Nm (45-60 lb-ft).

10. Tighten all rear suspension arm fasteners to the specified torque.

    - Tighten the bolt retaining the suspension arm to the axle to 210-284 Nm (155-210 lb-ft).
    - Tighten the nut and bolt retaining the suspension arm to the right frame bracket to 135-170 Nm (100-125 lb-ft).
    - Tighten the nut and washer assembly retaining the suspension arm to the left frame bracket to 90-120 Nm (65-90 lb-ft).

11. If required, check the driveline angularity or driveline angle check as described in Section 05-00 .

12. Remove the safety stands and lower the vehicle.

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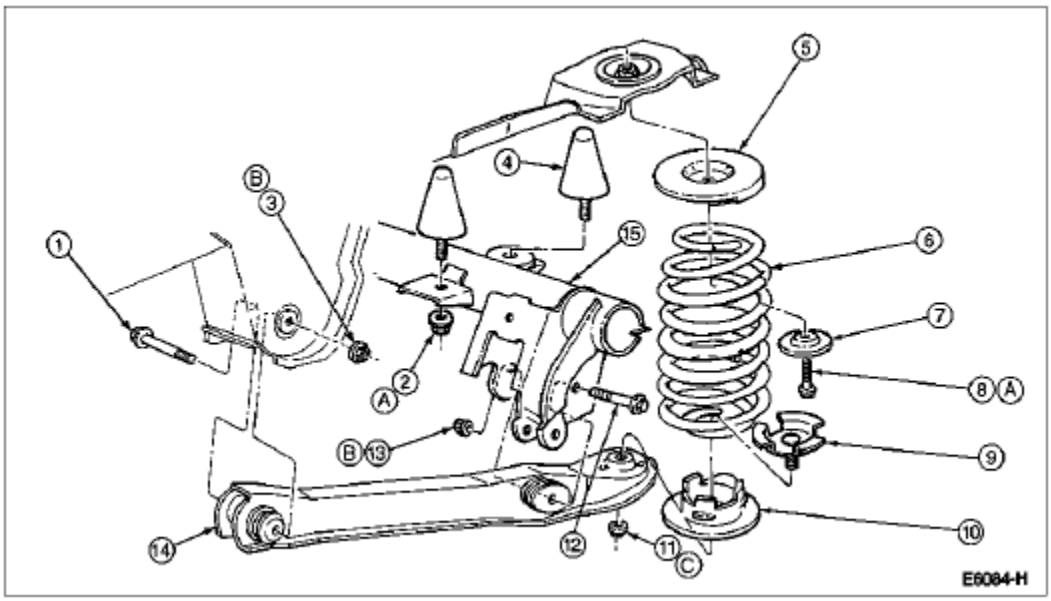
Rear Suspension Lower Arm, Aerostar

Removal

1. Use frame hoist to raise the vehicle and position tall jack under the rear axle (4001).
2. Raise the jack until the rear axle is slightly raised.
3. Remove shock absorber-to-axle bracket nut and bolt and swing the lower end of the shock absorber free of axle bracket.
4. Lower the rear axle until the coil springs are no longer under compression.
5. Remove lower retainer and coil spring-to-rear suspension lower arm nut. Remove the rear spring center mounting insulator (5741) from the rear suspension lower arm (5A649).
6. Remove rear suspension lower arm-to-axle housing bolt and nut.
7. Remove rear suspension lower arm-to-frame bracket nut and bolt. Remove the rear suspension lower arm.

Rear Suspension Lower Arm, Aerostar



Item	Part Number	Description

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1	805791	Bolt
2	800152	Nut
3	801670	Nut
4	4730	Rear Axle Bumper
5	5536	Rear Spring Insulator
6	5560	Rear Spring
7	5A543	Rear Spring Upper Retainer
8	605919	Bolt
9	5A569	Rear Spring Lower Retainer
10	5741	Rear Spring Center Mounting Insulator
11	620483	Nut
12	N803923	Bolt
13	N801670	Nut
14	5A649	Rear Suspension Lower Arm
15	4001	Rear Axle
A	—	Tighten to 40-55 Nm (30-40 Lb-Ft)
B	—	Tighten to 130-170 Nm (95-125 Lb-Ft)
C	—	Tighten to 60-80 Nm (45-60 Lb-Ft)

Installation

1. Position the rear suspension lower arm in the frame bracket. Install the bolt so the head is inboard on the frame bracket. Install the nut but do not tighten at this time.
2. Position the rear suspension lower arm in the bracket on the axle housing. Install the bolt so the head is inboard on the axle bracket. Install the nut but do not tighten at this time.
3. Install the rear spring center mounting insulator on the lower end of the coil spring.
4. With the rear axle in the spring unloaded position, install the coil spring and lower retainer on the rear suspension lower arm.
5. Install spring-to-lower arm attaching nut. Tighten the nut to 60-80 Nm (45-60 lb-ft).
6. Raise the rear axle to the normal load position. Tighten rear suspension lower arm-to-axle housing nut and bolt to 130-170 Nm (95-125 lb-ft). Tighten rear suspension lower arm-to-frame bracket nut and bolt to 130-170 Nm (95-125 lb-ft).
7. Position the shock absorber (18080) in the lower axle mounting bracket. Install the bolt so head is outboard of the axle bracket. Install the nut and tighten to 60-80 Nm (45-60 lb-ft).

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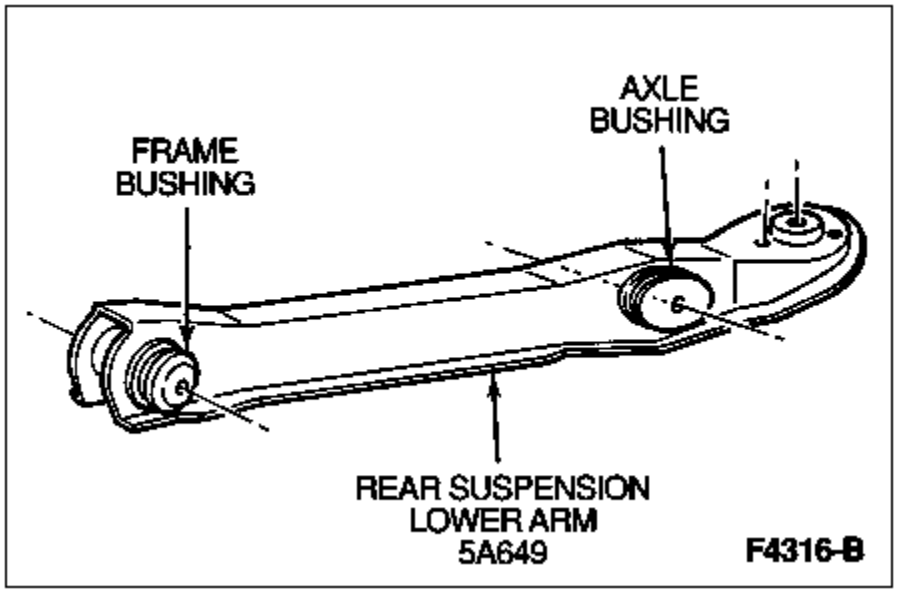
Bushings, Rear Suspension Lower Arm, Aerostar

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Oval Bushing Remover	T85T-5638-AH1
Oval Bushing Spacer	T85T-5638-AH7
Oval Bushing Receiver Cup	T85T-5638-AH2
Forcing Screw	T78P-5638-A1
Round Bushing Remover	T85T-5638-AH4
Round Bushing Spacer	T85T-5638-AH8
Round Bushing Receiver Cup	T85T-5638-AH6
Round Bushing Replacer	T85T-5638-AH5

Removal

1. Remove the rear suspension lower arm (5A649) as described in this section. Clamp the rear suspension lower arm into a vise.



2. Unstake the lower control arm axle (oval) bushing.

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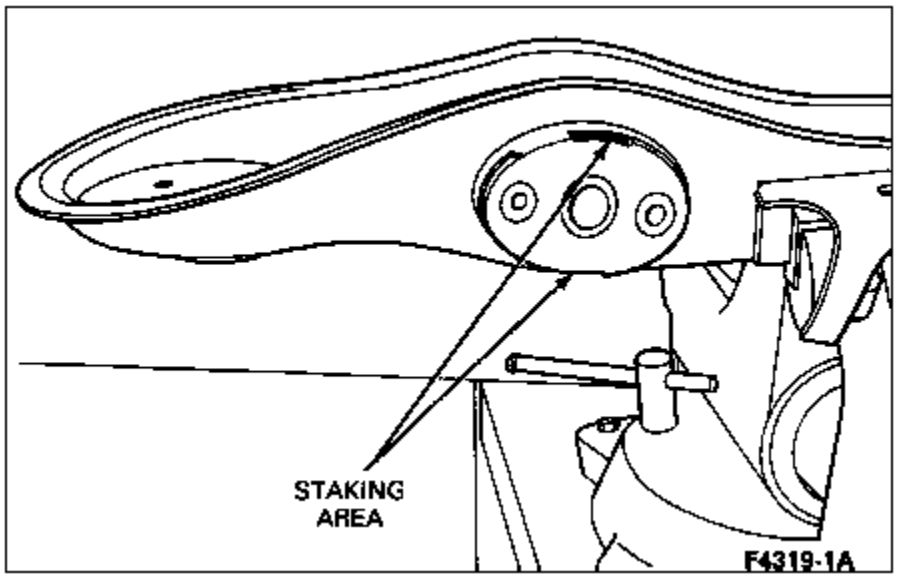
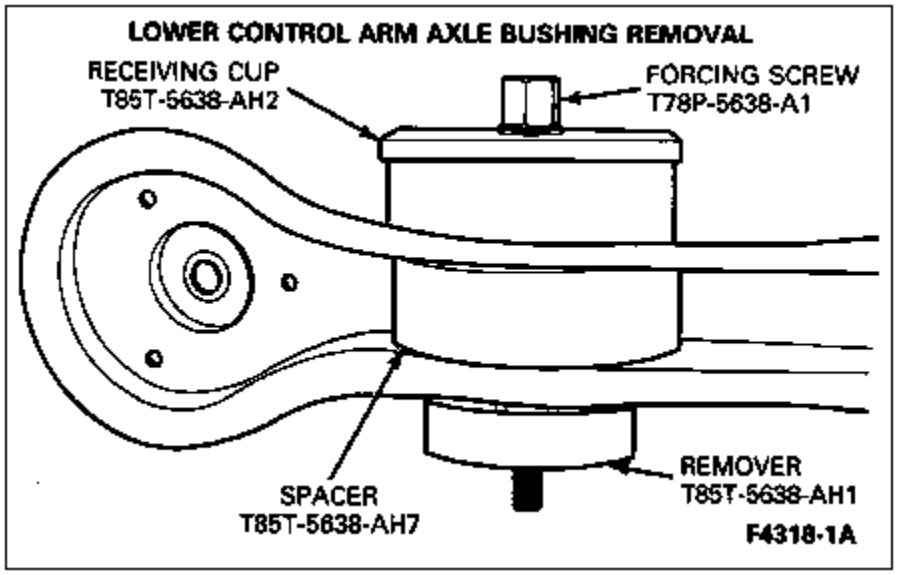


3. Press the axle bushing from the rear suspension lower arm using Bushing Remover T85T-5638-AH1, Spacer T85T-5638-AH7, Receiving Cup T85T-5638-AH2 and Forcing Screw T78P-5638-A1.



4. Unstake the rear suspension lower arm frame (round) bushing.

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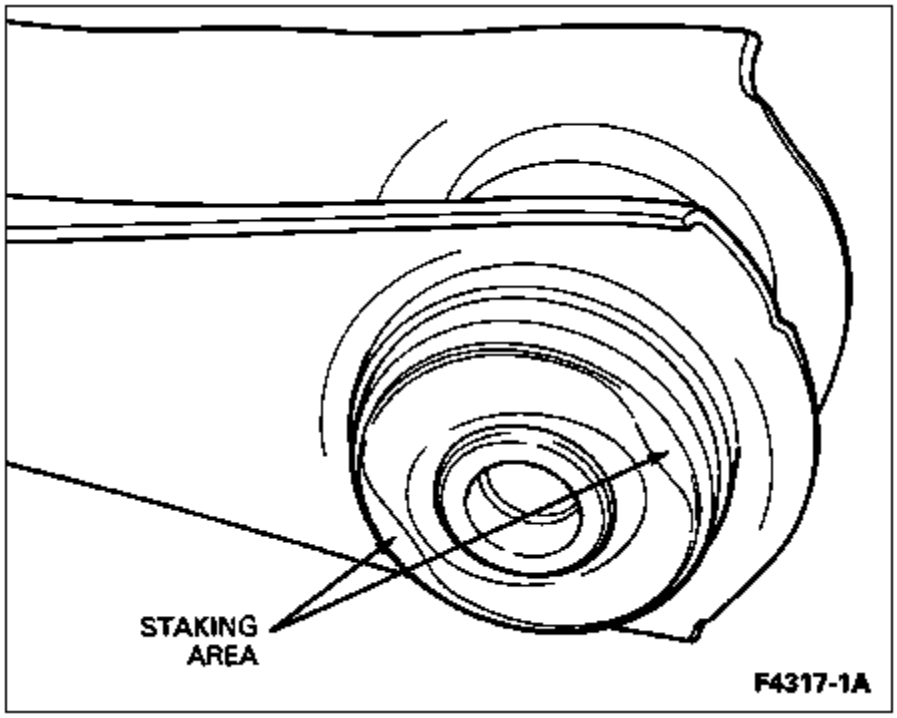

5. Press the frame bushing from the rear suspension lower arm using Bushing Remover T85T-5638-AH4, Spacer T85T-5638-AH8, Receiving Cup T85T-5638-AH6 and Forcing Screw T78P-5638-A1.

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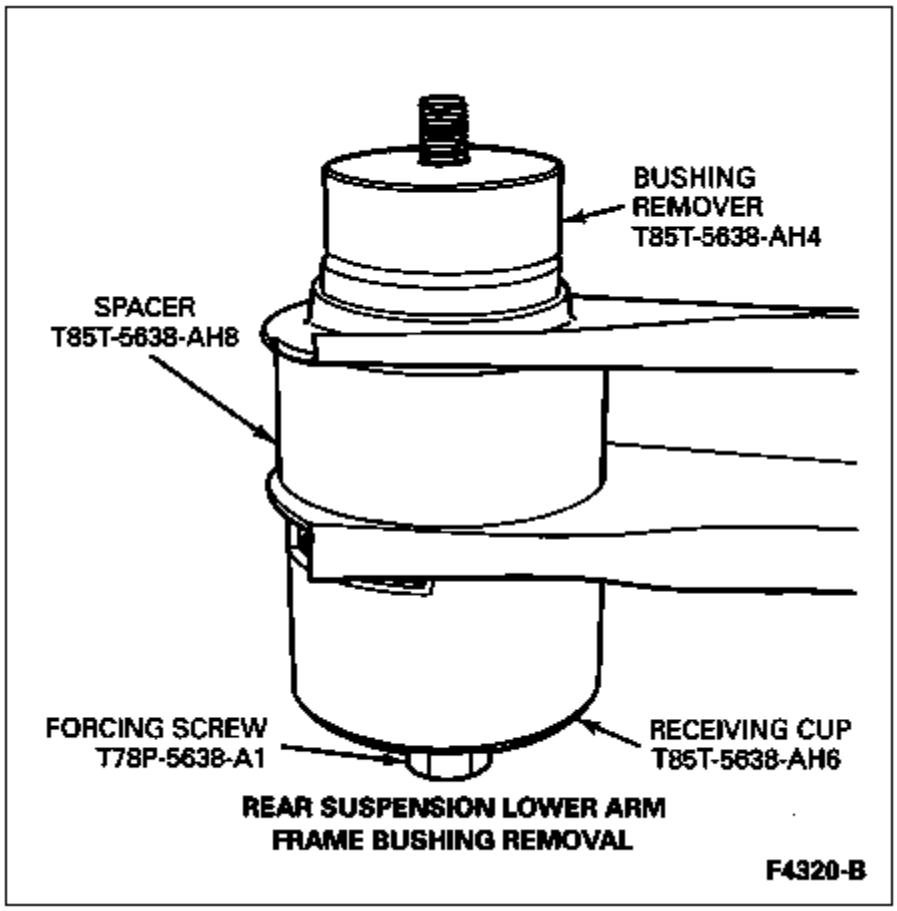

Installation

1. Press a new frame bushing in the rear suspension lower arm using Receiving Cup T85T-5638-AH6, Spacer T85T-5638-AH8, Bushing Replacer T85T-5638-AH5 and Forcing Screw T78P-5638-A1. Install bushing with notch in bushing flange toward the rear of vehicle.

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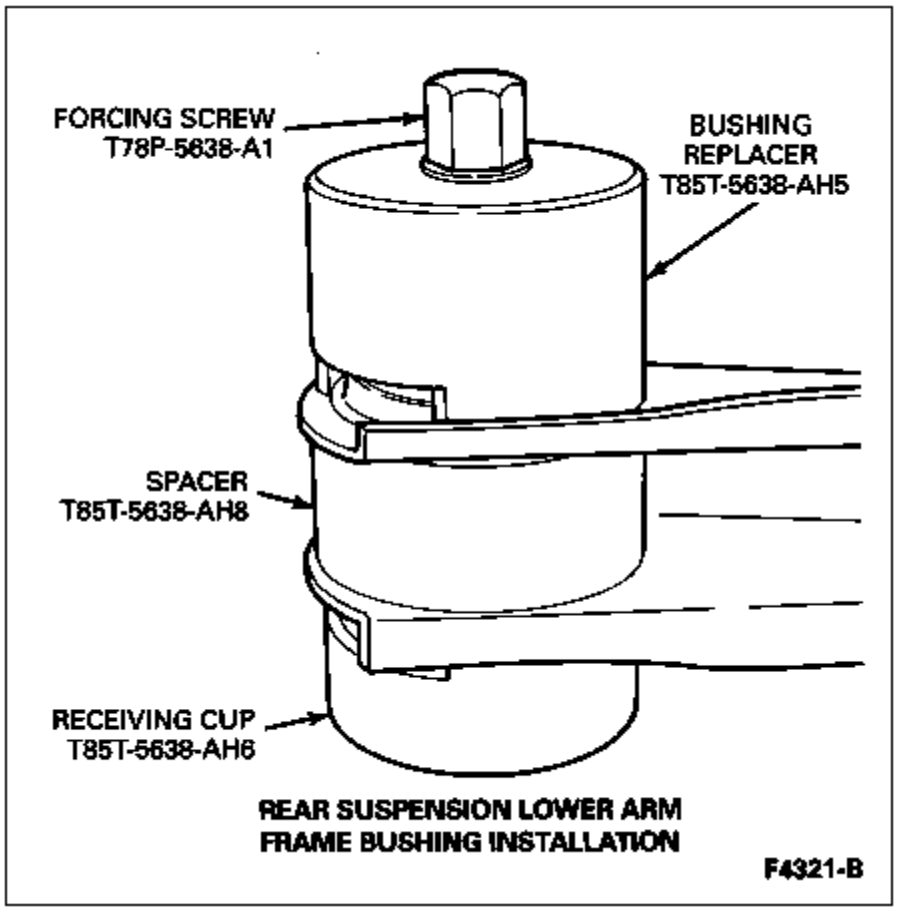

2. Stake the frame bushing in the rear suspension lower arm.

3. Press a new axle bushing in the rear suspension lower arm using Nut T78P-5638-A5, Bushing Replacer T85T-5638-AH3, Spacer T85T-5638-AH7, Receiving Cup T85T-5638-AH2 and Forcing Screw T78P-5638-A1. Install the bushing with notch in bushing flange toward the rear of vehicle.

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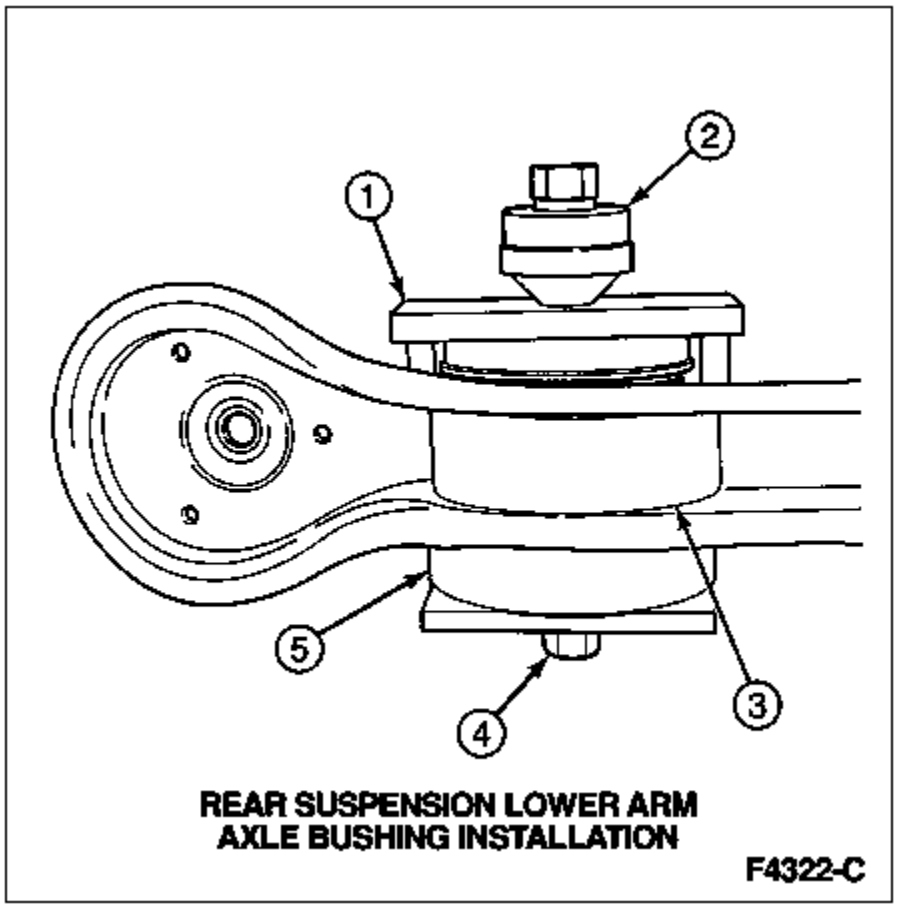

Item	Part Number	Description
1	T85T-5638-AH3	Bushing Replacer
2	T78P-5638-A5	Nut
3	T85T-5638-AH7	Spacer
4	T78P-5638-A1	Forcing Screw
5	T85T-5638-AH2	Receiving Cup

4. Stake the axle bushing in the control arm.
5. Install the rear suspension lower arm as described in this section.

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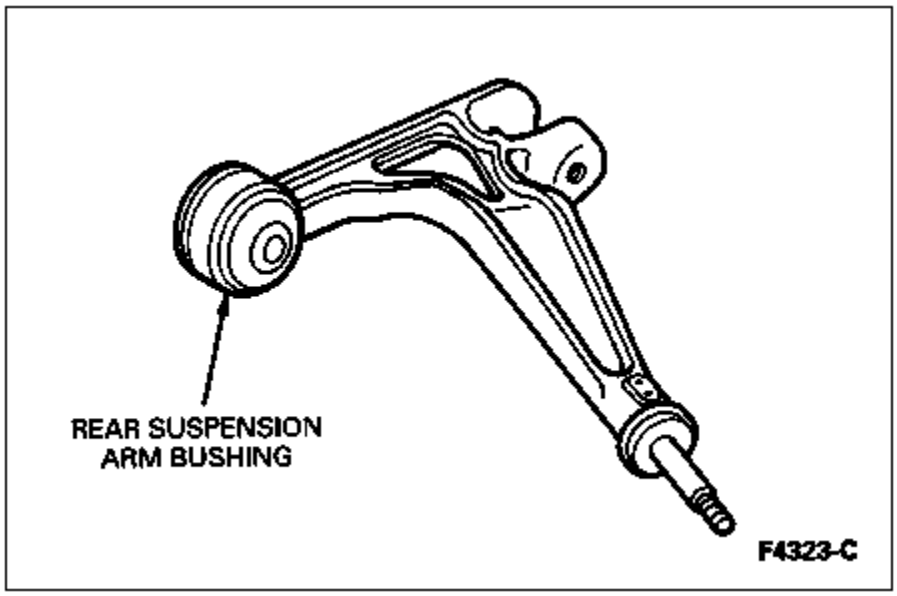
Bushing, Rear Suspension Arm, Aerostar

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Bushing Remover	T85T-5638-AH4
Receiving Cup	T85T-5638-AH6
Forcing Screw	T78P-5638-A1

Removal

1. Remove the rear suspension arm and bushing (5500) as described in this section. Clamp the arm in a vise.



2. Unstake the bushing in the rear suspension arm as shown.

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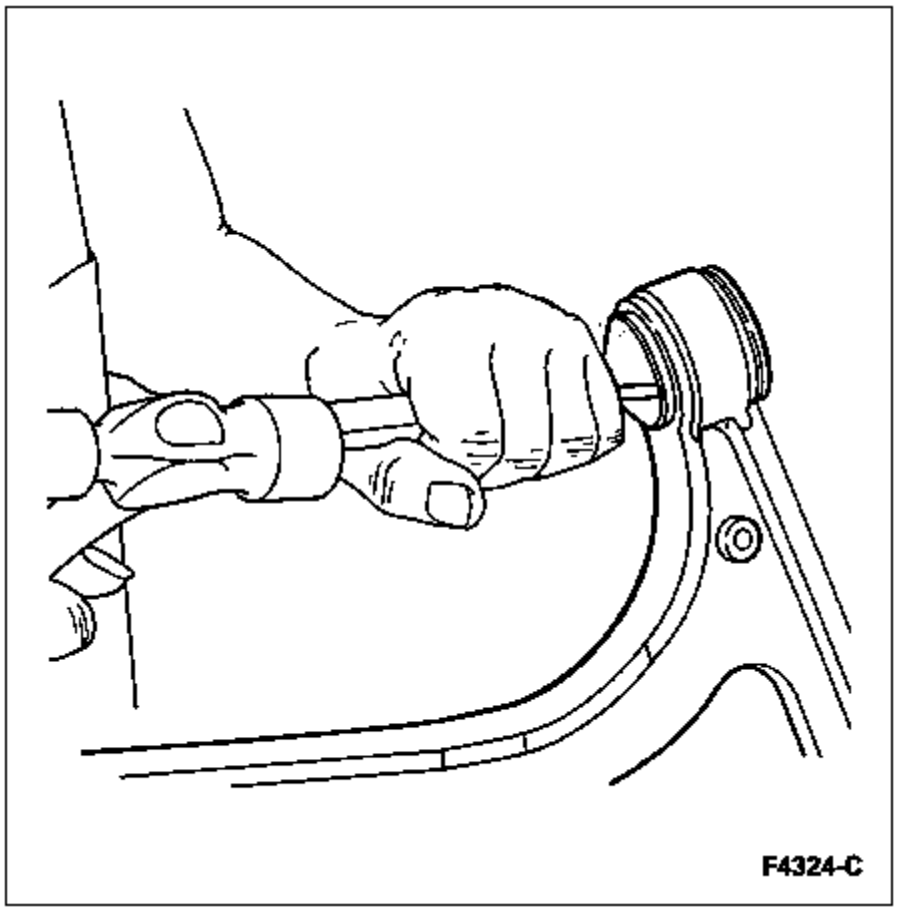

3. Press the bushing from the rear suspension arm using Bushing Remover T85T-5638-AH4, Receiving Cup T85T-5638-AH6 and Forcing Screw T78P-5638-A1. Discard the bushing.

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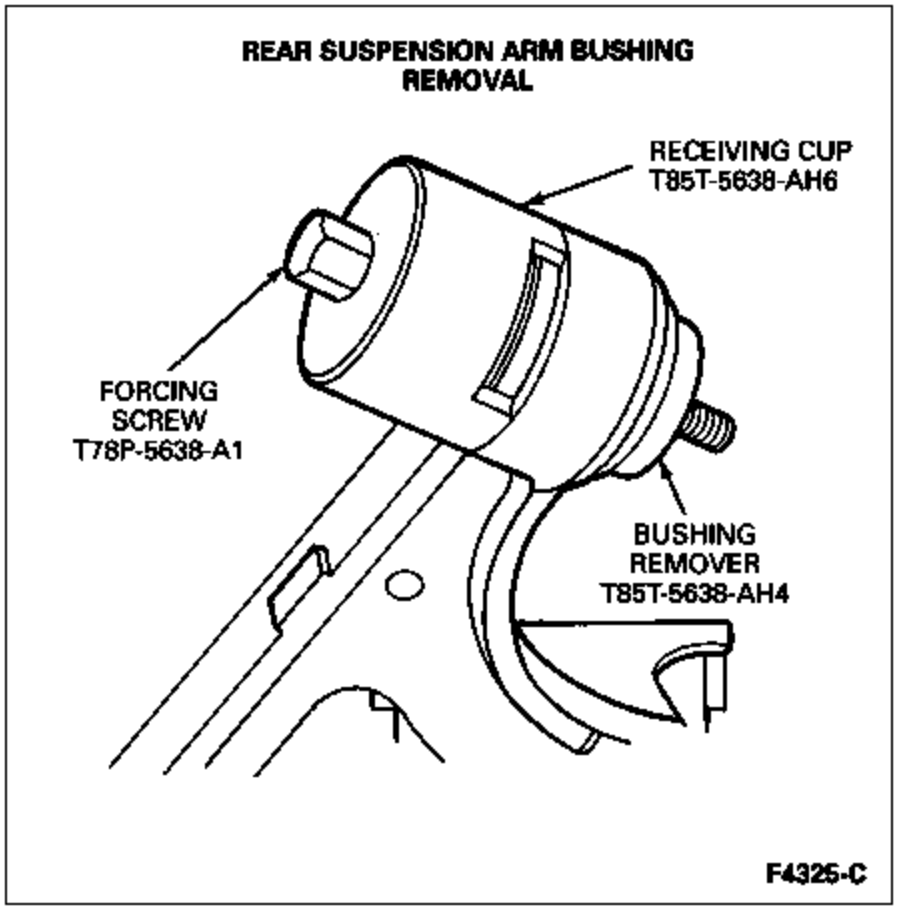

Installation

1. Press a new bushing in the rear suspension arm using Receiving Cup T85T-5638-AH6, Bushing Replacer T85T-5638-AH10 and Forcing Screw T78P-5638-A1. Install the bushing with notch in flange up.

2. Stake the bushing in the rear suspension arm.

3. Install the rear suspension arm and bushing as described in this section.

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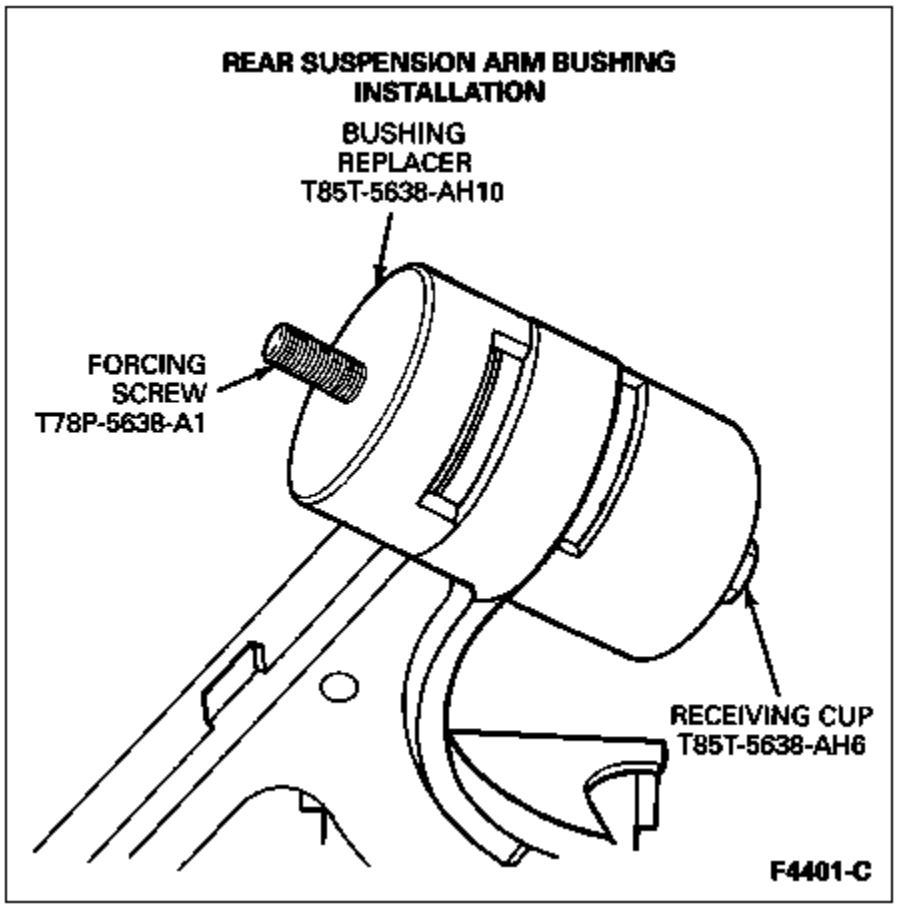

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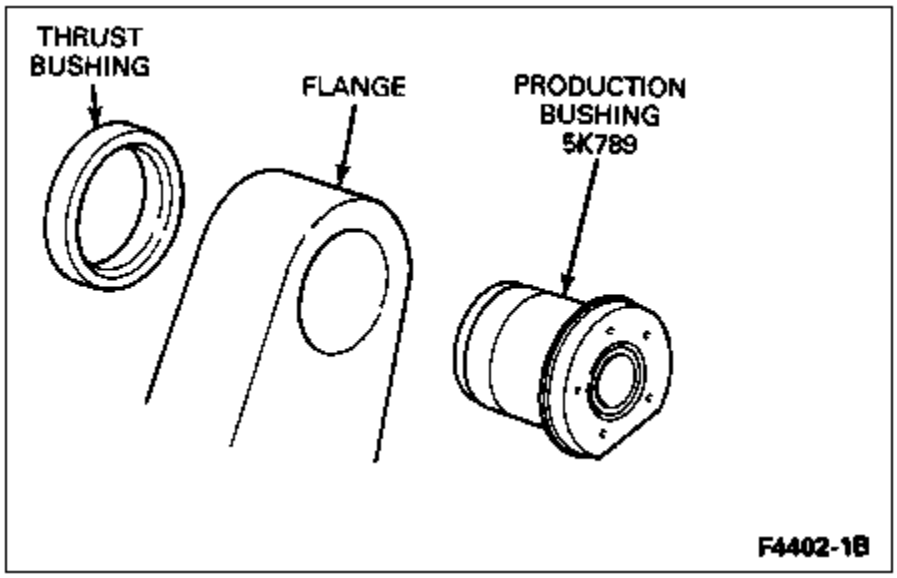
Bushing, Axle Housing-to-Rear Suspension Arm, Aerostar

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Axle Housing Bushing Mounting Adapter	T85T-5638-AH11
Forcing Screw	T78P-5638-A1
Axle Housing Bushing Remover	T85T-5638-AH12
Axle Housing Bushing Replacer	T85T-5638-AH13

NOTE: In service, the pinion angle adjustment is changed using an eccentric service bushing F09Z-5K789-B. If the bushing is being replaced due to damage or wear only, use standard production bushing F09Z-5K789-A. For pinion angle measurement procedures, refer to Driveline Angle Check in Section 05-00 .



Removal

1. **CAUTION: The axle must be securely supported on the hoist or stands. If more axle-hoist travel is required, disconnect the shock absorbers (18080) from the rear suspension lower arms.**

   Raise the vehicle on a twin-post hoist. Position jackstands on the frame rear lift points or under the rear bumper support brackets. If a frame hoist is used, raise the vehicle and position tall jackstands under the rear axle (4001). Lower the hoist until the axle is in the normal ride height position.

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2. Remove rear suspension arm-to-axle housing nut and bolt.

3. With the vehicle securely supported on safety stands, slowly lower the rear axle until the rear suspension arm and bushing (5500) disengages from the rear axle. If a frame hoist is used, raise the hoist until the rear suspension arm disengages from the rear axle.

4. On the inboard side of the flange, insert a flat-blade screwdriver between the thrust bushing and flange. Pry the thrust bushing end off the bushing and flange without damaging any surfaces.

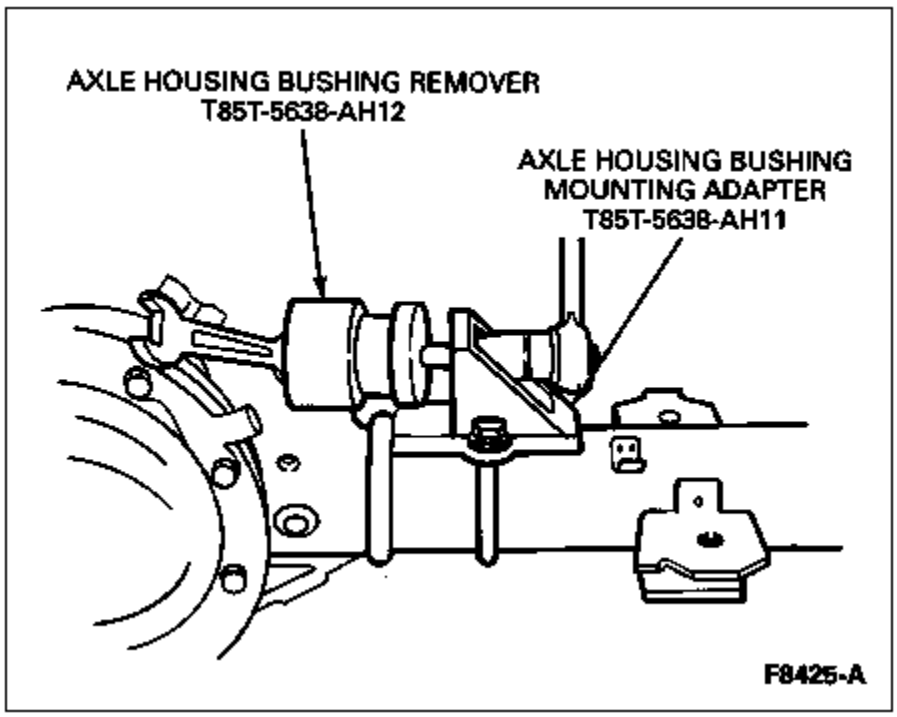
5. Attach Axle Housing Bushing Mounting Adapter T85T-5638-AH11 to the axle housing tube by using the U-bolt.

6. Place the Forcing Screw T78P-5638-A1 through the axle housing bushing to be removed.

7. Place the Axle Housing Bushing Remover T85T-5638-AH12 onto the forcing screw and thread a 7/16-20 nut onto the forcing screw.

8. Tighten the forcing screw to pull the bushing out of the axle housing.

9. Remove the forcing screw, bushing remover and mounting adapter.



Installation

1. **NOTE: The notch on the bottom of the bushing must point in a 6 or 12 o'clock position for zero pinion angle adjustment, 3 o'clock position for 1.25° pinion angle up adjustment and 9 o'clock position for -1.25° pinion angle down adjustment.**

   Lubricate the bushing to be installed and place the bushing into the axle housing bushing bore.

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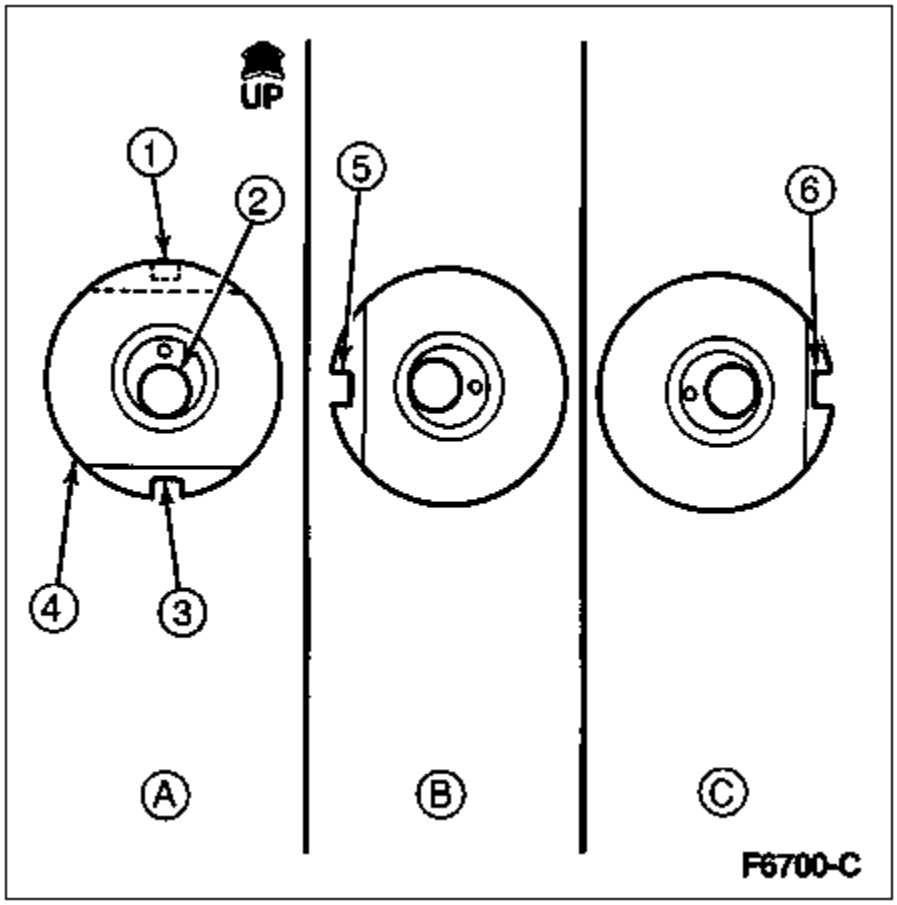

Item	Part Number	Description
1	—	12 o'Clock Position (Part of 5K789)
2	—	Bolt Hole (Part of 5K789)
3	—	6 o'Clock Position (Part of 5K789)
4	5K789	Eccentric Service Bushing
5	—	9 o'Clock Position (Part of 5K789)
6	—	3 o'Clock Position (Part of 5K789)
A	—	Nominal Position
B	—	Pinion Nose Down Position 1.25°
C	—	Pinion Nose Up Position 1.25°

2. Position 2-Jaw Puller D81L-1002-A or equivalent around the axle housing bushing bracket with Axle Housing Bushing Replacer Adapter T85T-5638-AH13 between the forcing screw and the flanged end of the bushing.

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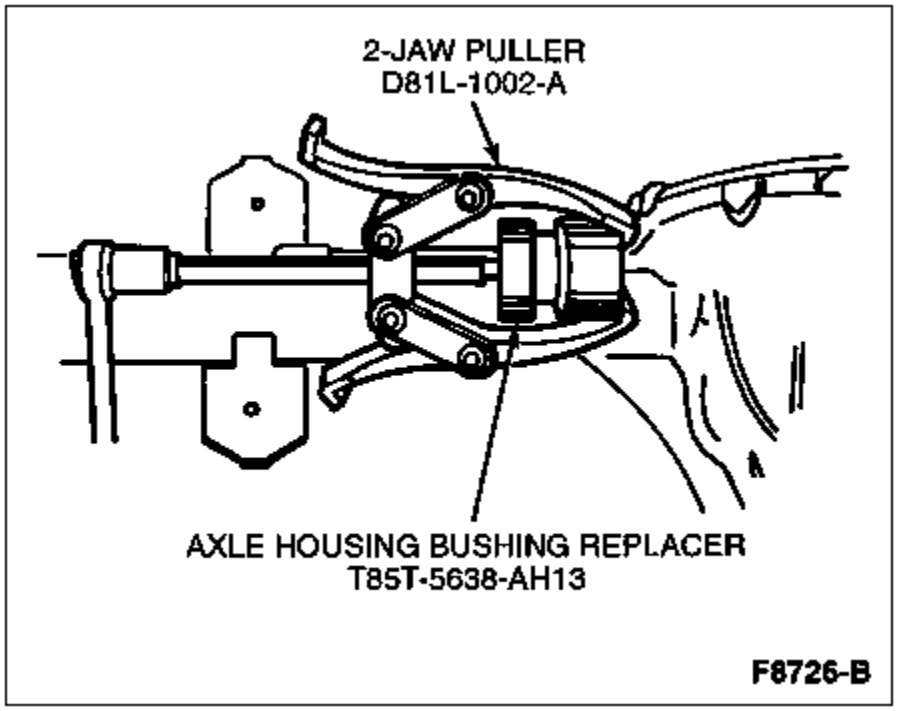
3. Turn the forcing screw to push bushing into position. Remove the installation tools.



4. On the inboard side of flange, install thrust bushing so steel washer faces the flange.
5. With the vehicle body securely supported on safety stands, raise the rear axle until the rear suspension arm engages the flange on the axle housing. If a frame hoist is used, lower the vehicle until the rear suspension arm and bushing engages the flange on the axle housing.
6. Install the nut and bolt retaining the rear suspension arm and bushing to the flange and tighten until snug. Do not tighten to the specified torque at this time.
7. If removed, connect the shock absorber to the lower axle bracket. Install and tighten the retaining nut to 60-80 Nm (45-60 lb-ft).
8. Position the rear axle in the normal ride position. Tighten the nut and bolt retaining the rear suspension arm and bushing to the flange to 210-284 Nm (155-210 lb-ft).
9. If required, check and adjust the driveline angularity or driveline angle check as described in Section 05-00 .
10. Remove the safety stands and lower the vehicle.

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Stabilizer Bar, Rear, Ranger

Removal and Installation

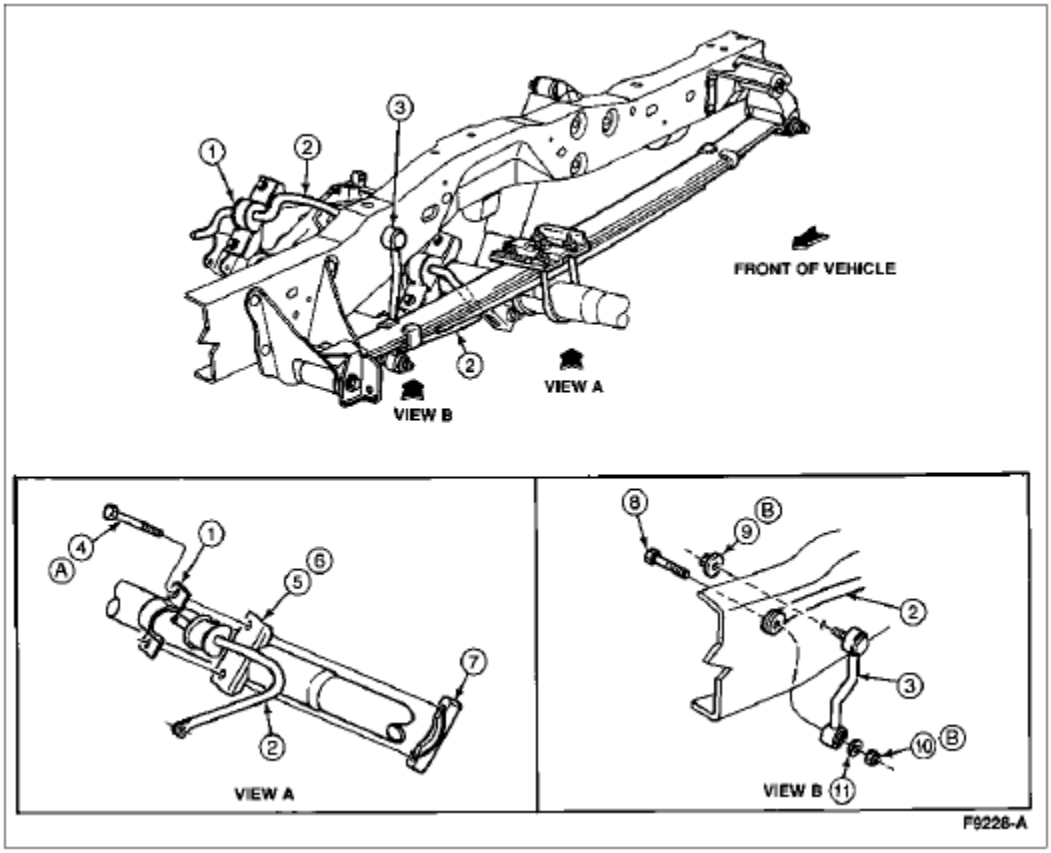
1. Raise the vehicle on a hoist.
2. Remove the nuts, bolts and washers. Disconnect the rear stabilizer bar (5A772) from the links.
3. Remove bolts and nuts from the stabilizer bar brackets and retainers. Remove the stabilizer bar brackets, retainers and rear stabilizer bar.

   For installation, follow removal procedures in reverse order.

   Tighten the stabilizer bar bracket bolts to 34-46 Nm (25-34 lb-ft).

   Tighten the stabilizer link nuts to 60-80 Nm (44-59 lb-ft).

Rear Stabilizer Bar, Ranger



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Item	Part Number	Description
1	5B491	Rear Stabilizer To Axle Retainer
2	5A772	Rear Stabilizer Bar
3	5K484	Stabilizer Bar Link
4	N808261-S60	Bolt
5	4A047	Rear Stabilizer Bar Mounting Bracket (RH)
6	4A048	Rear Stabilizer Bar Mounting Bracket (LH)
7	4A047	Rear Stabilizer Bar to Axle Retainer
8	N605704-S2	Bolt
9	N801995-S2	Nut
10	N800937-S2	Nut
11	N800916-S2	Washer
A	—	Tighten to 34-46 Nm (25-34 Lb-Ft)
B	—	Tighten to 60-80 Nm (44-59 Lb-Ft)

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Axle Bumper, Rear

Removal and Installation

1. Raise vehicle on a hoist. Refer to Section 00-02 .
2. Remove nut and rear axle bumper (4730).

   For installation follow the removal procedure in reverse order.

   - For Ranger, tighten the rear axle bumper nut to 32-39 Nm (24-29 lb-ft).
   - For Aerostar, tighten rear axle bumper nut(s) to 40-55 Nm (30-40 lb-ft).

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Wheel Hub Bolt, Rear

SPECIAL SERVICE TOOL(S) REQUIRED

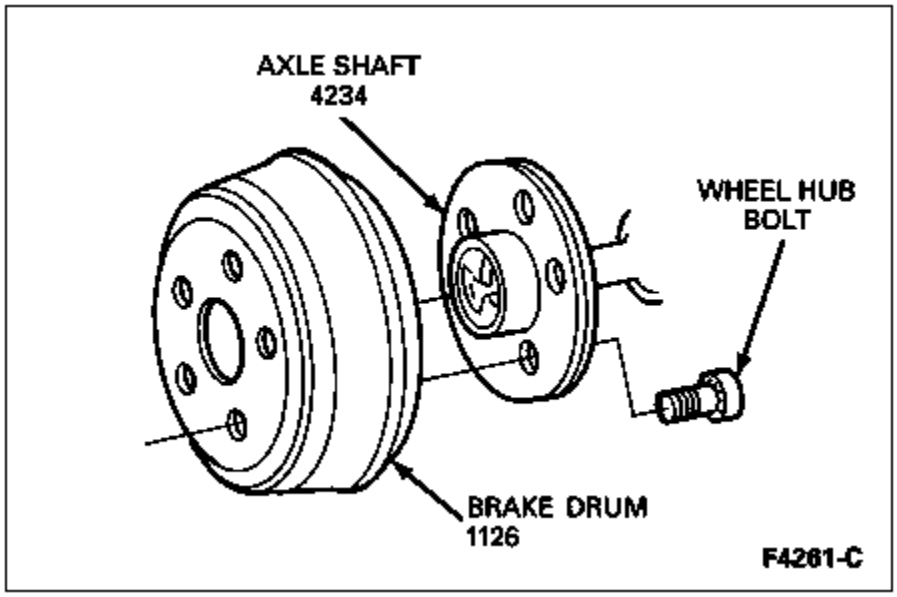
Description	Tool Number
C-Frame and Clamp Assembly Tool	T74P-3044-A1

CAUTION: Never use a hammer to remove the wheel hub bolt nut. Damage to the axle shaft flange or rear wheel bearing may result.

Removal

1. Raise the vehicle and install safety stands.
2. Remove the wheel and tire assembly.
3. Remove the brake drum (1126). Refer to Section 06-02 .

Rear Brake Drum Removal (Ranger, Aerostar)



4. Using C-Frame and Clamp Assembly Tool T74P-3044-A1, press the lug bolt (1107) from its seat in the axle flange. The lug bolt may also be removed by pressing it out using an appropriate sized socket and C-clamp. Discard the lug bolt.

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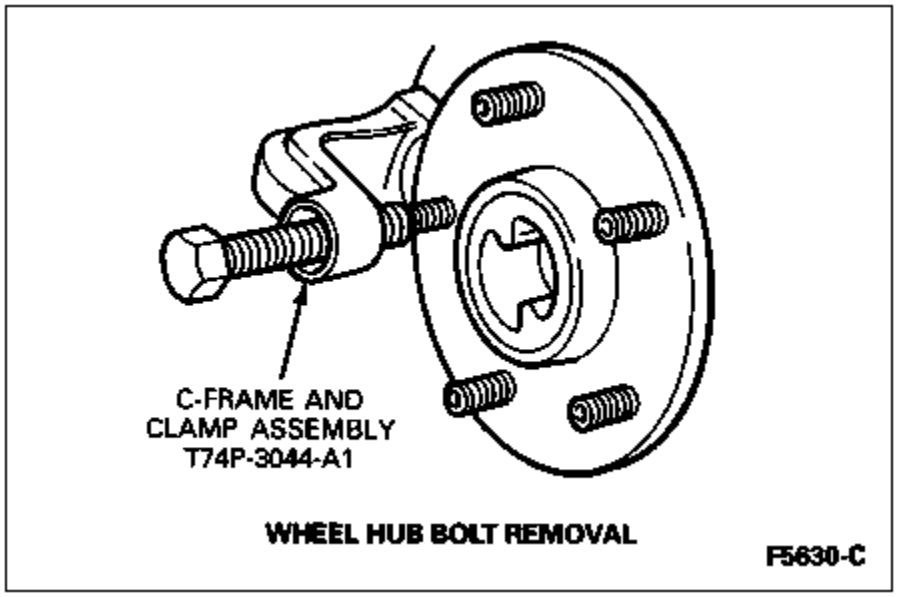

Installation

1. Insert new lug bolt in hole in flange. Rotate lug bolt slowly. Make sure serrations are aligned with those made by the original bolt.
2. Place four flat washers over the outside end of the stud and thread the lug nut (1012) with the flat side against the washers.
3. **CAUTION: DO NOT use air tools as the serrations may be stripped from the stud.**

   Tighten the lug nut until the bolt head seats against the back side of the flange.
4. Remove lug nut and washers.
5. Install brake drum. Refer to Section 06-02 .
6. Install wheel and tire assembly.
7. Lower the vehicle

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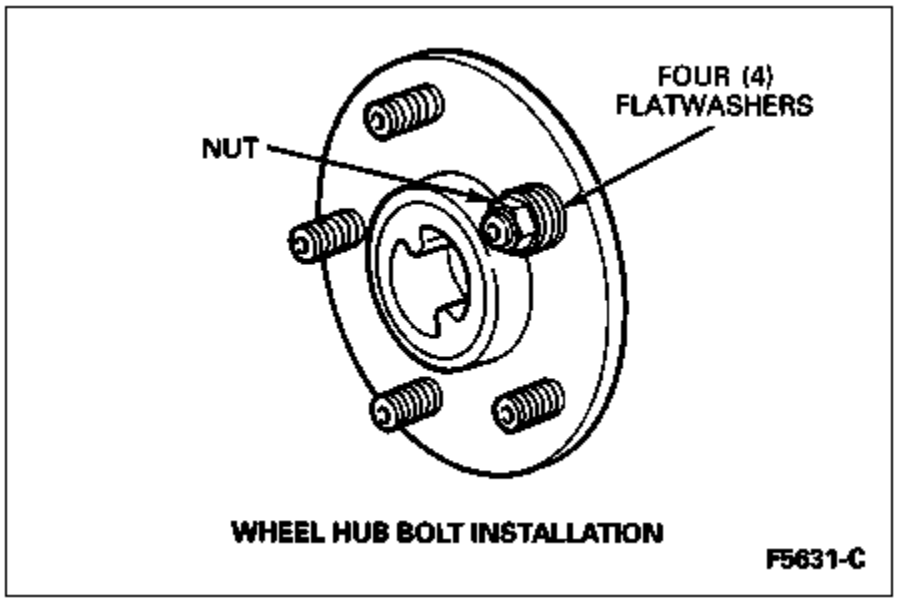

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SPECIFICATIONS

TORQUE SPECIFICATIONS, RANGER

Description	Nm	Lb-Ft
Rear Spring U-Bolt to Plate Nut	88-118	65-87
Rear Shock Absorber to Lower Bracket Nut	53-72	39-53
Rear Shock Absorber to Upper Bracket Nut	53-72	39-53
Rear Shackle to Spring Nut	88-118	65-87
Rear Spring to Front Bracket Bolt	88-118	65-87
Rear Spring Shackle to Rear Bracket Bolt	88-118	65-87
Rear Stabilizer Bar to Axle Bolts	34-46	25-34
Stabilizer Link to Bar Nut	60-80	44-59
Stabilizer Link to Frame Nut	60-80	44-59
Axle End Bolt	68-92	50-68
Rear Spring Clamp Screw	21-27	15-20
Rear Axle Bumper Nuts	32-39	24-29

TORQUE SPECIFICATIONS, AEROSTAR

Description	Nm	Lb-Ft
Rear Spring Lower Retainer Nut	60-80	45-60
Rear Spring Upper Retainer Bolt	40-55	30-40
Rear Suspension Lower Arm to Axle Nut and Bolt (Axle in Normal Ride Position)	130-170	95-125
Rear Suspension Lower Arm to Frame Bracket Nut and Bolt (Axle in Normal Ride Position)	130-170	95-125
Rear Suspension Arm to Axle Housing Bolt (Axle in Normal Ride Position)	210-284	155-210
Rear Suspension Arm to Right Frame Bracket Nut (Axle in Normal Ride Position)	135-170	100-125
Rear Suspension Arm to Left Frame Bracket (Axle in Normal Ride Height)	90-120	65-90
Shock Absorber to Lower Bracket Nut	60-80	45-60
Shock Absorber to Upper Bracket Bolt	60-80	45-60
Axle End Bolt	68-92	50-68
Upper Spring Mounting Bolt	40-55	30-40
Rear Axle Bumper Nuts	40-55	30-40

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Inspection and Verification

1. To maximize tire performance, inspect for signs of improper inflation and uneven wear, which may indicate a need for balancing, rotation, or front suspension alignment.

2. Check tires for:

    - cuts
    - stone bruises
    - abrasions
    - blisters
    - embedded objects

3. More frequent inspections are recommended when rapid or extreme temperature changes occur, or where road surfaces are rough or occasionally littered with debris.

4. Tread wear indicators are moulded into bottom of thread grooves. Replace tire when indicator bends become flush with tread.

Wheel and Tire Checking Procedure

Tire Wear Diagnosis

Inspect tires for wear. Abnormal or excessive wear may be caused by incorrect wheel alignment, wheel and tire imbalance, or improper tire pressure.

Symptom Chart — Wheel And Tire Diagnosis

WHEEL AND TIRE DIAGNOSIS

Condition	Possible Source	Action
• Cracked or Broken Wheel Discs. Cracks Develop in the Wheel Disc from Hand Hole to Hand Hole, from Hand Hole to Wheel, or from Hand Hole to Wheel Bolt. Wheel Bolt Holes Become Worn, Elongated or Deformed. Metal Builds Up Around Wheel Bolt Hole Edges, Cracks Develop from Wheel Bolt Hole to Wheel Bolt Hole. Related Driver Complaints; Unusual Operating Noise or Vibration and on the Road Failures	• Metal fatigue resulting from abusive handling.	• REPLACE wheel. CHECK position of wheel on vehicle for working load specifications.
	• Vehicle operated with loose wheel mounting.	• REPLACE wheel and CHECK for: Installation of correct wheel bolts and lug nuts, and recommended exact specifications.Cracked or broken wheel bolts, and REPLACE.Worn hub face. MACHINE if not excessive, or REPLACE if severe.Broken or cracked hub barrel, REPLACE.Worn wheel bolt holes, REPLACE or INSTALL recommended serrated bolts.CLEAN mounting surfaces and RETIGHTEN lug nuts at specified schedule.
• Cracks Develop in Wheel Base Back (Wheel Bead Seat) Flange or the Gutter Area (Drop Well Radii)	• Overloading or abusive use.	• REPLACE wheel. CHECK loading and operating conditions. AVOID overinflation of tires. CHECK specs for wheel load capacity, working loads, tire size, ply rating and tire construction.
	• Improper use of tools.	• CHECK mounting, demounting, and maintenance procedures.
• Loose Drum/Hub	• Wheel bolt too	• REPLACE wheel bolt with proper

Wheel	long. • Improper torque.	length wheel bolt. • TIGHTEN to specifications. CHECK for and repair any damage.
• Broken Wheel Bolts	• Loose lug nuts. • Overtightened lug nuts or use of lubricant. • Overloading.	• REPLACE wheel bolts. FOLLOW proper torque procedure. • REPLACE wheel bolts. COMPARE actual load against vehicle load ratings.
• Stripping Threads	• Excessive torque or use of wrong or damaged nuts.	• REPLACE wheel bolts. FOLLOW proper torque procedure. Do not use lube.
• Rust Streaks from Wheel Bolt Holes	• Loose lug nuts.	• CHECK complete assembly. REPLACE damaged parts. FOLLOW proper torque procedure.
• Damaged Lug Nuts	• Loose wheel assembly.	• REPLACE lug nuts. FOLLOW proper torque procedure. CHECK for damaged components (i.e., wheel bolts, wheel, hub, etc.). REPLACE any damaged components.
• Frozen Lug Nuts	• Corrosion or galling.	• If corrosion is slight, WIRE BRUSH away corrosion. If corrosion is excessive, REPLACE wheel bolts and nuts. **CAUTION: Do not PERMIT lubricant to get on ball seats of wheel bolt holes or on ball face of lugnuts.**
• Tires Show Excess Wear on Edge of Tread	• Underinflated tires. • Vehicle overloaded. • High-speed cornering. • Incorrect toe or camber setting. • Tire/wheel condition out of specification.	• ADJUST air pressure in tires. • CORRECT as required. • ADVISE vehicle owner of adverse effects. CORRECT as required. • SET toe or camber to specification. • GO to Pinpoint Test A .
• Tires Show Excess Wear in Center of Tread	• Tires overinflated. • Tire/wheel condition out of specification.	• ADJUST air pressure in tires according to the Safety Compliance Certification Label. • GO to Pinpoint Test A .
• Other Excessive Tire	• Improper tire	• ADJUST air pressure in tires according

Wear Problems	pressure.	to Safety Compliance Certification Label.
	• Incorrect tire/wheel usage.	• INSTALL correct tire and wheel combination.
	• Loose or leaking shock absorbers.	• TIGHTEN or REPLACE as necessary. REFER to Section 04-01A , Suspension and Wheel Hubs, Front, 4x2; Section 04-01B , Suspension and Wheel Hubs, Front, 4-Wheel Drive; Section 04-01C , Suspension and Wheel Hubs, Front, Aerostar E-4WD.
	• Front end out of alignment.	• ALIGN front end.
	• Front wheel bearings out of adjustment.	• ADJUST front wheel bearings. REFER to Section 04-01A , Suspension and Wheel, Front, 4x2; Section 05-03A , Wheel Hubs and Bearings, Front Wheels, 4-Wheel Drive.
	• Loose, worn or damaged suspension components, bushings and ball joints.	• INSPECT, REPAIR or REPLACE as required.
	• Wheels and tires out of balance.	• BALANCE wheels and tires.
	• Excessive lateral and/or radial runout of wheel or tire.	• CHECK, REPAIR or REPLACE as required. USE dial indicator to accurately DETERMINE runout.
	• Tires need rotating according to schedule.	• ROTATE tires. REFER to Cleaning and Inspection in this section.
	• Tire/wheel condition out of specification.	• GO to Pinpoint Test A .
• Excessive Vehicle Vibration, Rough Steering, or Severe Tire Wear	• Loose or improper attaching parts.	• TIGHTEN or REPLACE.
	• Overloading or unbalanced loads.	• CHECK wheel and tire specs against work load requirements. RECOMMEND correct tire and rim. CHECK on loading procedure. GO to Pinpoint Test B .
• Vehicle Vibrations	• Loose or worn driveline or suspension parts.	• IDENTIFY location of vibration carefully as it may be transmitted through frame making a rear end vibration appear to come from the front. REPAIR or REPLACE loose and worn parts.

	• Improper front end alignment.	• ALIGN front end.
	• Excessive lateral runout (wheel or tire).	• USE a dial indicator to accurately VERIFY runout reading. REPLACE wheel or tire as required.
	• Bent or distorted wheel disc from overloading, road impact hazards or improper handling.	• REPLACE wheel. Attempts to straighten wheel can result in fractures in the steel and weakening of the disc or the weld between disc and wheel. CHECK loading and operating conditions and shop practices.
	• Loose wheel mountings — damaged bolts, lug nuts, enlarged wheel bolt holes, worn or broken hub face or foreign material on mounting surfaces.	• TIGHTEN or REPLACE worn or damaged parts. CLEAN mounting surfaces.
	• Out-of-balance wheel or tire or hub and drum assembly.	• DETERMINE the out-of-balance component and BALANCE or REPLACE.
	• Out-of-round wheel or tire or excessive wheel bolt/pilot runout (excessive radial runout).	• USE a dial indicator to accurately VERIFY runout reading. REPLACE the wheel, tire, hub or axle shaft and CHECK for overloading and unbalanced loads, rugged operating conditions, proper wheel and tire specifications.
	• Water in tires.	• REMOVE water.
• Mounting of Wheels Is Difficult	• Improper application or mismatched parts, including wheel bolts and lug nuts.	• FOLLOW manufacturer's specifications.
	• Corroded or worn parts.	• CLEAN or REPLACE.
	• Damaged components.	• CHECK for damaged components (e.g., wheel, wheel bolts, lug nuts, etc.). REPLACE any damaged component.
• Rust or Corrosion on Wheels	• Poor maintenance.	• KEEP clean.

Pinpoint Tests

NOTE: On vehicles equipped with all-terrain type tires, a vibrating, drumming or beating noise is often misdiagnosed as a driveline vibration. For noise, vibration and harshness diagnosis, refer to Section 00-04 . If condition is still present, refer to the procedure below.

PINPOINT TEST A: TIRE/WHEEL CONDITIONS

A1 EXCESSIVE WEAR OR CUPPING

- Check tires for excessive wear or cupping.

Are tires OK?

Yes	No
GO to A2 .	REPLACE severely worn tires. CHECK tire inflation, vehicle alignment and suspension. REPAIR, REPLACE or ADJUST as required. GO to A2 .

A2 WHEEL BEARING END PLAY

- Check wheel bearing end play.
- Rotate wheel and check for roughness.

Is wheel bearing end play OK?

Yes	No
GO to A3 .	REPLACE rear wheel bearings or front wheel bearings, if required. ADJUST to correct end play. ROAD TEST to VERIFY correction. REFER to Group 04 for front wheel bearings or Group 05 for rear wheel bearings.

A3 TIRE WHEEL BALANCE

- Check tire/wheel balance.

Is balance OK?

Yes	No
GO to **A4** .	BALANCE tire/wheel assembly. If assembly cannot be balanced, REPLACE wheel and/or tire. ROAD TEST to VERIFY correction.

A4 TIRE RUNOUT

- Check tire runout.

Is tire runout within specifications?

Yes	No
GO to **A7** .	GO to **A5** .

A5 REINDEX TIRE

- Reindex tire 180 degrees and rebalance on wheel.

Is balance OK?

Yes	No
ROAD TEST to VERIFY correction.	GO to **A6** .

A6 WHEEL BOLT RUNOUT

- Check wheel bolt runout.

Is wheel bolt runout within specifications?

Yes	No
GO to **A7** .	REPLACE hub or axle shaft. ROAD TEST to VERIFY correction. REFER to appropriate section in Group 05.

A7 ALIGNMENT, SUSPENSION, DRIVELINE, BRAKES, ENGINE/TRANSMISSION MOUNTS

- Check front end alignment if not done during Step 1. Refer to Group 04.
- Check suspension components for looseness or wear if not done during Step 1. Refer to appropriate section in Group 04.
- Check U-joint condition. Refer to Section 05-01 .
- Check driveshaft for runout or imbalance. Refer to Section 05-01 .
- Check drums/rotors for imbalance. Refer to appropriate section in Group 06.

Are all systems operating properly?

Yes	No
GO to **A8** .	REPAIR, REPLACE, or ADJUST as required. ROAD TEST to VERIFY correction.

A8 WHEEL RUNOUT

- Check wheel runout.

Is wheel runout within specifications?

Yes	No
REPLACE tire. ROAD TEST to VERIFY correction.	REPLACE wheel and rebalance. ROAD TEST to VERIFY correction.

PINPOINT TEST B: TIRE MISMATCH CHECK

B1 TIRE MISMATCH CHECK

NOTE: On vehicle drift concerns, it may be necessary to measure tire circumference and place a matched set of tires on the rear axle.

- Compare the installed tires and wheels with the equipment listed on the certification label.

Do the tires match?

Yes	No
GO to **B2** .	INFLATE tires to the correct pressure. SWAP known good tires and wheels as specified by certification label or RPO list for evaluation only. GO to **B2** .

B2 SWAP FRONT TIRES SIDE TO SIDE

- Unlock front hubs if 4x4. Raise front tires off the ground. Spin front tires. If hubs are unlocked, the axle shaft will not rotate with the wheels.
- Swap the front tires from side to side.
- Road test the vehicle.

Is the concern corrected?

Yes	No
Bad tires or wheels should be replaced.	GO to **B3** .

B3 SWAP REAR TIRES SIDE TO SIDE

- Swap the rear tires from side to side.
- Road test the vehicle.

Is the concern corrected?

Yes	No
Bad tires or wheels should be replaced.	GO to **B4** .

B4 SWAP FRONT AND REAR TIRES

- Swap the front tires with the rear tires.
- Check tire pressure and adjust as required.
- Road test the vehicle.

Is the concern corrected?

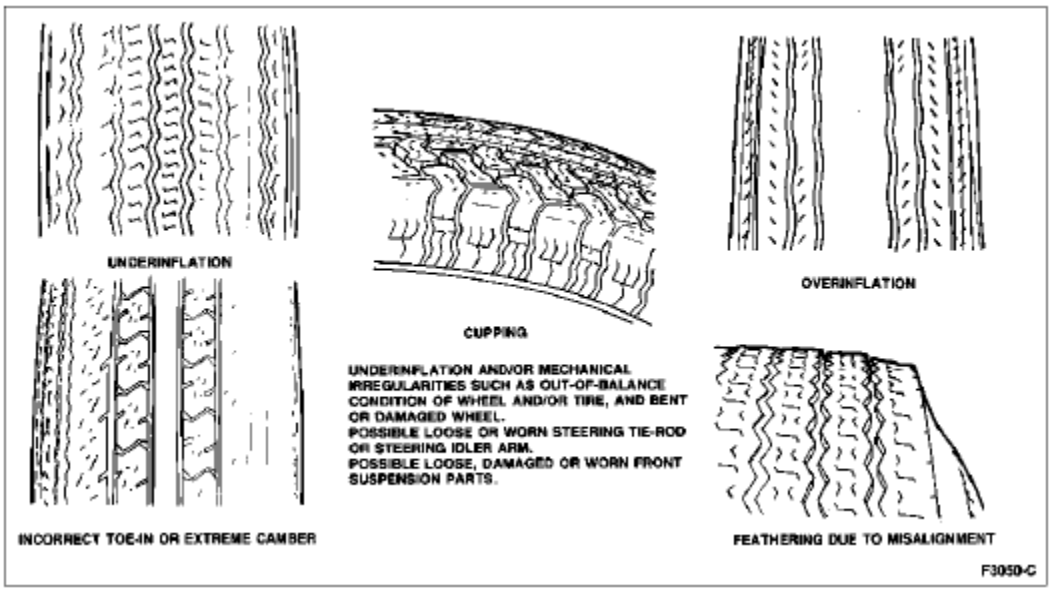
Yes	No
Bad tires or wheels should be replaced.	REFER to Section 00-04 for noise, vibration and harshness diagnosis.

Component Tests

Vibration

If vehicle vibration persists after the wheels have been balanced, it may be caused by either tire or wheel runout. The vibration may also be caused by damage to the tire tread or sidewall. Refer to Section 00-04 .

Tire Wear



Wheel and Tire Runout

Excessive radial and lateral runout of a wheel and tire assembly can cause roughness, vibration, wheel tramp, tire wear, and steering wheel tremor.

Before checking runout and to avoid false readings caused by temporary flat spots in the tires, check runout only after the vehicle has been driven far enough to warm tires.

The extent of the runout is measured with a dial indicator, Rotunda Radial Runout Gauge 007-0056A or equivalent. All measurements are made on the vehicle with the tires inflated to recommended inflation pressures and with the front wheel bearings (1215) adjusted to specifications.

Tire Runout

Using Rotunda Radial Runout Gauge 007-0056A or equivalent, measure radial runout of the tire at the center and outside ribs of the tread face. Measure lateral runout of the tire just above the buffing rib on the tire sidewall. Mark the high points of lateral and radial runout for future reference. Radial runout should not

exceed 1.02mm (0.040 inch) and lateral runout should not be more than 1.52mm (0.060 inch).

If tire runout is greater than specifications, check wheel runout, as described below. Replace the defective component if reindexing the tire does not resolve runout.

Match Mounting Tires

Match mounting is a technique used to reduce radial runout and tire spring rate on tire and wheel assemblies. Excessive runout is a source of ride complaints and match mounting can be used to minimize the runout. There are two ways to use match mounting: positioning of the tire on the wheel and positioning the wheel on the hub.

1. Measure total indicated runout on center of the tire tread rib, and record it. Mark the tire and wheel (1007) at the center of the tread rib, and record reading. Mark tire at location of the valve and cap (1700) for reference.

2. Break down tire and remount it 180 degrees on the wheel so valve and cap reference mark is opposite the valve and cap on the wheel.

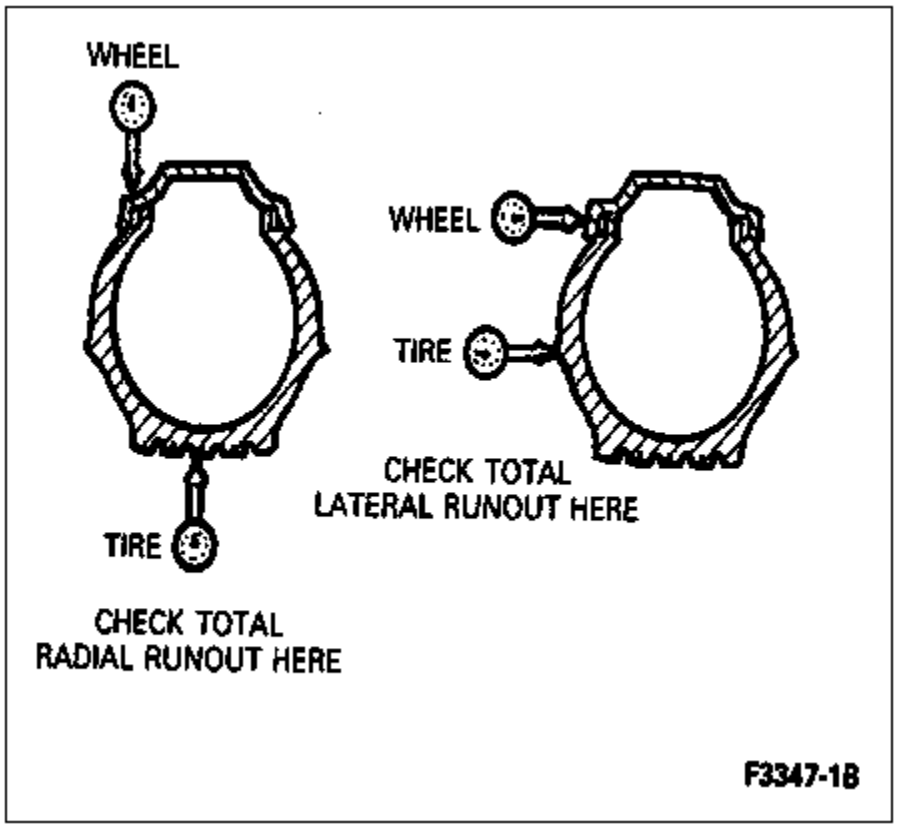
3. Reinflate tire and measure total indicated runout, and again mark the high spot.

4. If runout is reduced to acceptable guidelines the tire is ready to be put back into service. If runout is still excessive, one of the following steps must be performed:

    - If high spot is within 100mm (4 inches) of the first high spot on the wheel, the wheel may be out of tolerance, check wheel for runout.
    - If high spot is within 100mm (4 inches) of the first high spot on the tire, and is still outside of guidelines, replace tire.

Wheel Runout

Measure radial and lateral wheel runout at positions shown. Runout should not exceed 1.14mm (0.045 inch) radial or lateral.



Wheel Bolt Runout

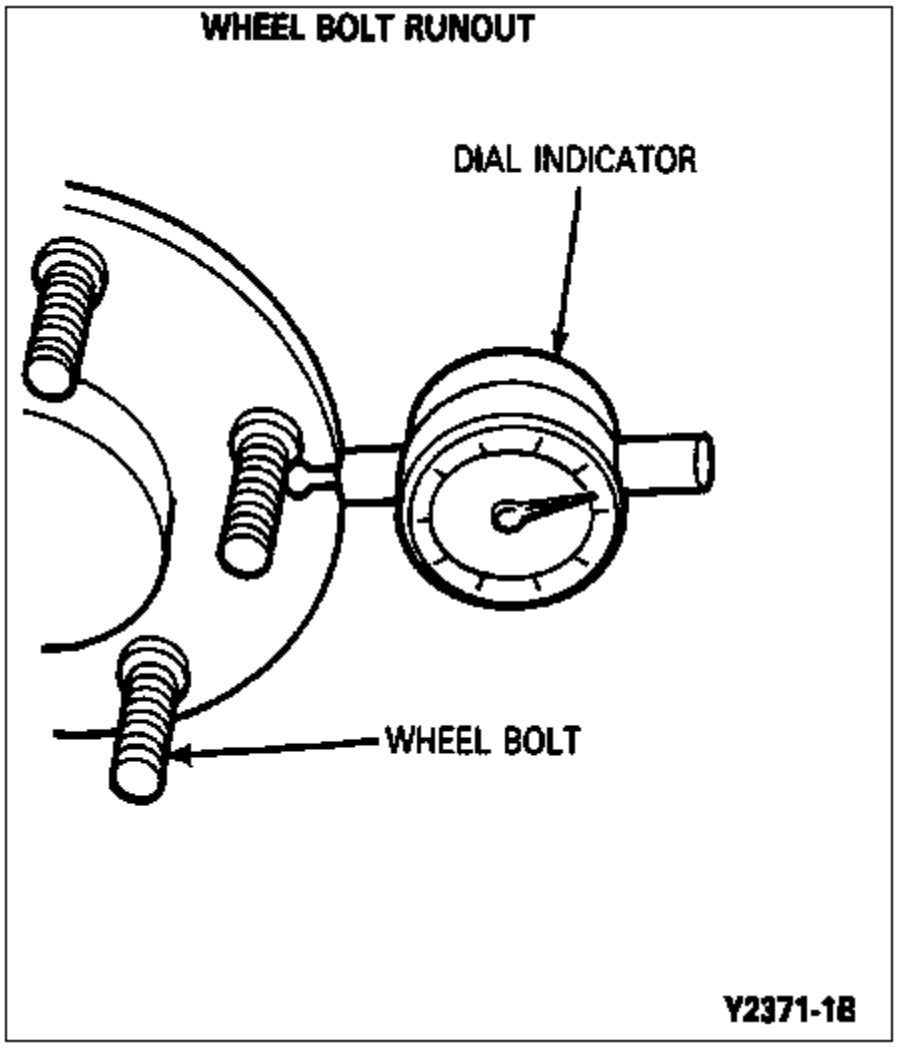
Wheel bolt runout can affect wheel runout. When measuring the runout on the wheel bolts, the feeler will not be in contact with the bolts at all times. Only the measurements taken at the high point of contact of each bolt should be considered.

1. Using a broad point indicator, locate the feeler perpendicular to the bolt as close to the flange face as possible.

2. Zero the indicator so the pointer can deflect either way, for accurate reading at lowest and highest contact point.

3. Rotate the axle shaft flange until the next bolt is contacted.

4. Again, record and continue until you have one reading for each point of contact (each bolt). The absolute difference between the maximum and minimum contact reading will be the total indicator reading (or total runout). Wheel bolt circle runout should not exceed 0.50mm (0.020 inch) TIR (Total Indicated Runout).



Tire Lead Diagnosis

"LEAD" is the movement or drift to one side of the vehicle from a straight path on a level road with no pressure on the steering wheel.

Lead is usually caused by:

- Incorrect wheel alignment.
- Uneven brake adjustment.
- Uneven or incorrect tire inflation pressures.
- Damaged/worn tire or construction of tire.

The way in which a tire is constructed can produce lead. An example of this is placement of the radial belts. Off-center belts on a radial tire can cause the tire to develop a side force while rolling straight down the road. If one side of the tire is a little larger diameter than the other, the tire will tend to roll to one side. This will develop a side force which can produce lead.

Wheel and Tire

WARNING: NEVER RUN THE ENGINE WITH ONE WHEEL (1007) OFF THE GROUND, SUCH AS WHEN CHANGING A TIRE. THE WHEELS STILL ON THE GROUND COULD CAUSE THE VEHICLE TO MOVE.

CAUTION: Replace wheels if they are bent, cracked, leaking air or heavily rusted or if the lug nuts (1012) often become loose. Do not use bent wheels that have been straightened and do not use inner tubes in leaking wheels. Do not replace wheels with used wheels. Wheels that have been straightened, are leaking air, or are used, may have structural damage and could fail without warning. Check for damage that could affect the runout of the wheels. Wobble or shimmy will eventually damage the wheel bearings.

Removal

1. Set parking brake and block diagonally opposite wheel.
    - On vehicles equipped with an automatic transmission, place selector lever in the PARK position.
    - On vehicles equipped with a manual transmission, place the shift lever in reverse.
2. If equipped, remove the wheel cover (1130) or hub cap.
3. With the weight of the vehicle still on the tires, break the lug nuts loose. DO NOT REMOVE AT THIS TIME.
4. Raise the vehicle with a jack until the wheel and tire clear the floor and support the vehicle on a jackstand. Remove the lug nuts. Remove the wheel and tire assembly.

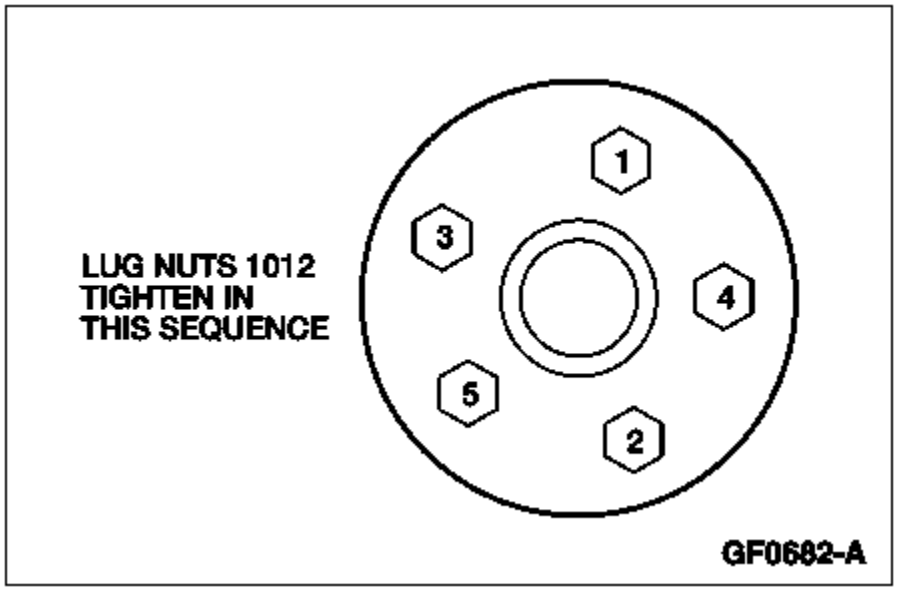
Installation

WARNING: WHENEVER A WHEEL IS INSTALLED, ALWAYS REMOVE ANY CORROSION, DIRT OR FOREIGN MATERIAL THAT MAY BE PRESENT ON THE MOUNTING SURFACES OF THE HUB, DRUM OR ROTOR THAT CONTACTS THE WHEEL. INSTALLING WHEELS WITHOUT PROPER METAL-TO-METAL CONTACT AT THE WHEEL MOUNTING SURFACES CAN CAUSE THE LUG NUTS TO LOOSEN AND COULD ALLOW THE WHEEL TO COME OFF WHILE THE VEHICLE IS IN MOTION CAUSING LOSS OF CONTROL.

1. Position the wheel on the hub and rotor or the axle flange 4W disc brakes.
2. Install the lug nuts making sure the cone end of the nuts faces inward.
3. With the lug nuts loosely installed. Tighten each lug nut until snug using sequence shown below.
4. In a criss-cross pattern, tighten the remaining lug nuts until snug to minimize runout.
5. Remove the jackstand and lower the vehicle.

6. **WARNING: IMPROPERLY TIGHTENED LUG NUTS COULD ALLOW THE WHEEL TO COME OFF WHILE THE VEHICLE IS IN MOTION, CAUSING LOSS OF CONTROL. DO NOT USE A LUBRICANT ON THE LUG NUTS TO FACILITATE FUTURE REMOVAL OF THE WHEEL ASSEMBLY.**

   Evenly tighten the lug nuts in the torque sequence shown below to 135 Nm (100 lb-ft).



7. Advise customer that wheels need to be retightened at 800 km (500 miles) after any wheel change or any other time the lug nuts have been loosened. This is required to permit the wheel clamping system to seat properly so that the lug nuts will hold a uniform clamp load and remain fully tightened.

Tires, Tubeless

Demounting and Mounting

NOTE: The air tank should incorporate a moisture trap when used with drop-center tubeless rims in order to reduce the moisture in contact with the metal wheel surfaces.

NOTE: When a tire is replaced, use the tire and wheel combination recommended on the Safety Compliance Certification Label decal attached to the vehicle or one offered as an OEM option for the specific vehicle.

Use the Rotunda Deluxe Tire Changer Model 104-00110 or equivalent to mount or demount tires. Follow the equipment manufacturer's instructions.

Wheel bead seats (steel wheels (1007) only) should be cleaned with a wire brush or coarse steel wool to remove lubricants, old rubber, and light rust.

Aluminum wheel bead seats should be cleaned with a non-abrasive cleaner to remove tire mounting lubricants and old rubber.

Before mounting or demounting a tire, the bead area should be well lubricated with Rubber Lubricant D9AZ-19583-A or equivalent meeting Ford specification ESA-M1B6-A tire lubricant. The approved Ford supplier is McGear Rohco, Inc. under trade mark McEase Tire Lube 33.

After mounting, inflate the tire to completely seat beads. Do not exceed 275 kPa (40 psi) during this operation. Install the valve core, and inflate the tire to the proper pressure as specified on the Safety Compliance Certification Label. Balance each wheel and tire assembly.

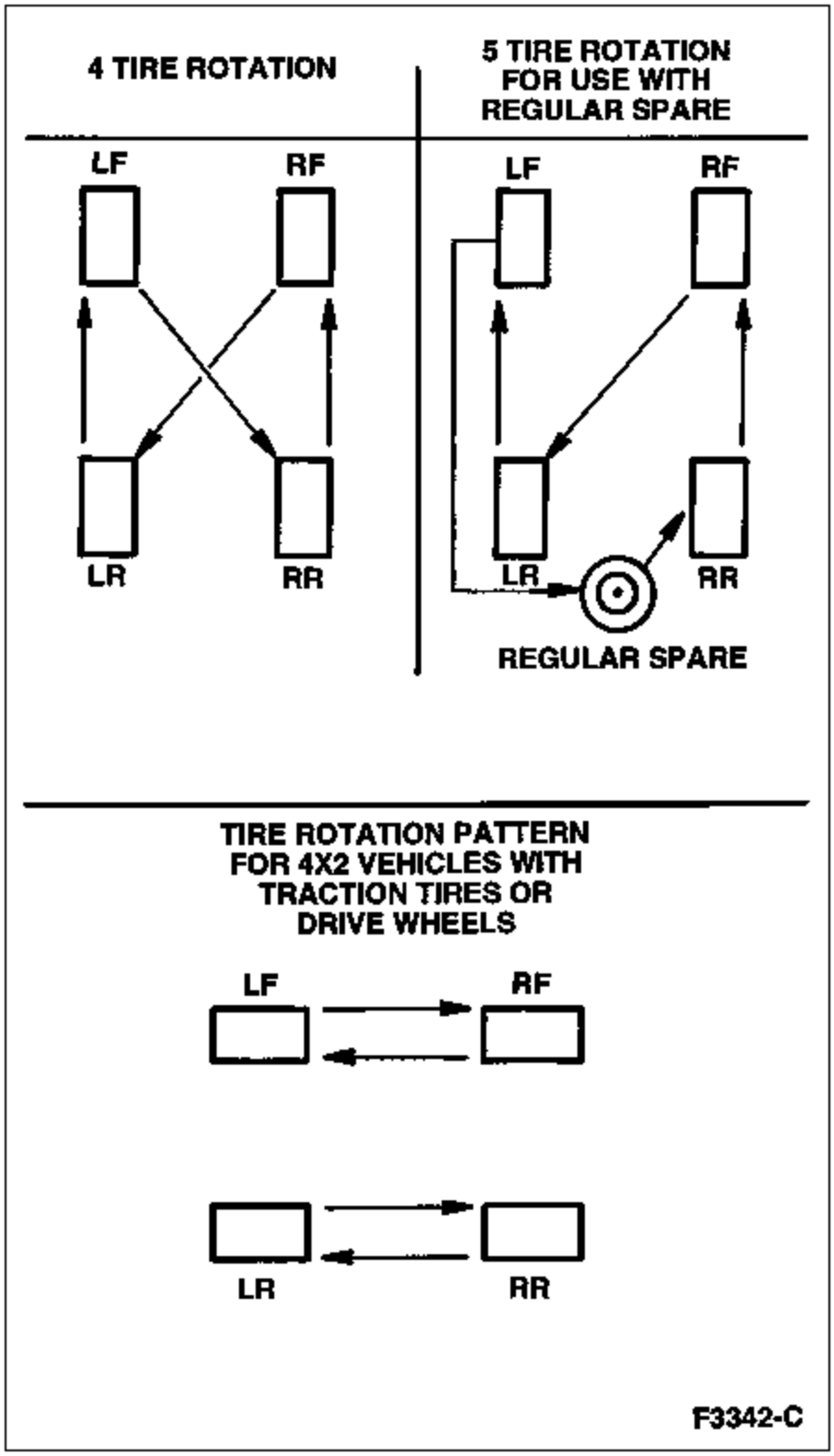
Tire Rotation

CAUTION: If the vehicle is equipped with a temporary spare tire, do not include it in the rotation of the other four tires.

NOTE: Tire tread wears fastest in the first 8,000 km (5,000 miles). Therefore it is very important to perform the first rotation within the specified mileage range to minimize uneven tire wear.

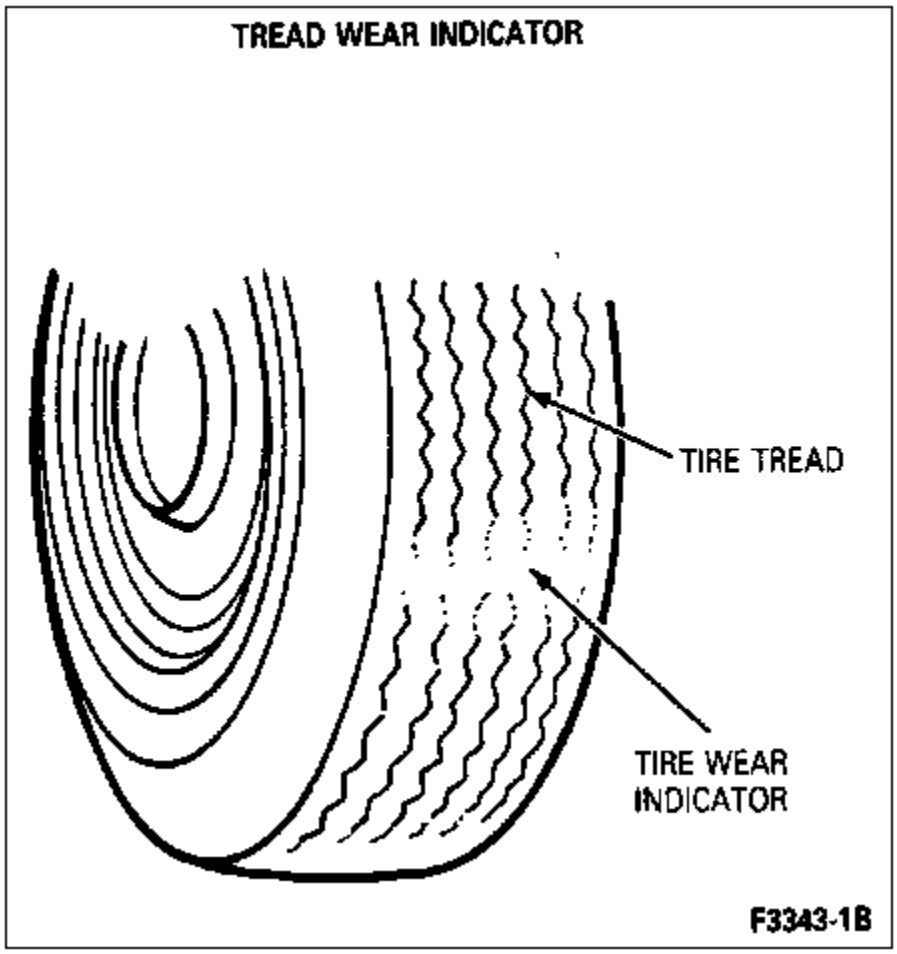
Rotate tires every 8,000 to 12,000 km (5,000 to 7,500 miles); more often if the vehicle sees a lot of turning as with city driving or if tires have an aggressive tread pattern.

A typical rotation pattern is shown. Many other rotation patterns are acceptable. However, a single pattern, once established, should be used to maximize the life of the set of tires.


4 TIRE ROTATION
5 TIRE ROTATION FOR USE WITH REGULAR SPARE
LF
RF
LR
RR
LF
RF
LR
RR
REGULAR SPARE
TIRE ROTATION PATTERN FOR 4X2 VEHICLES WITH TRACTION TIRES OR DRIVE WHEELS
LF
RF
LR
RR
F3342-C

Tread Wear Indicators

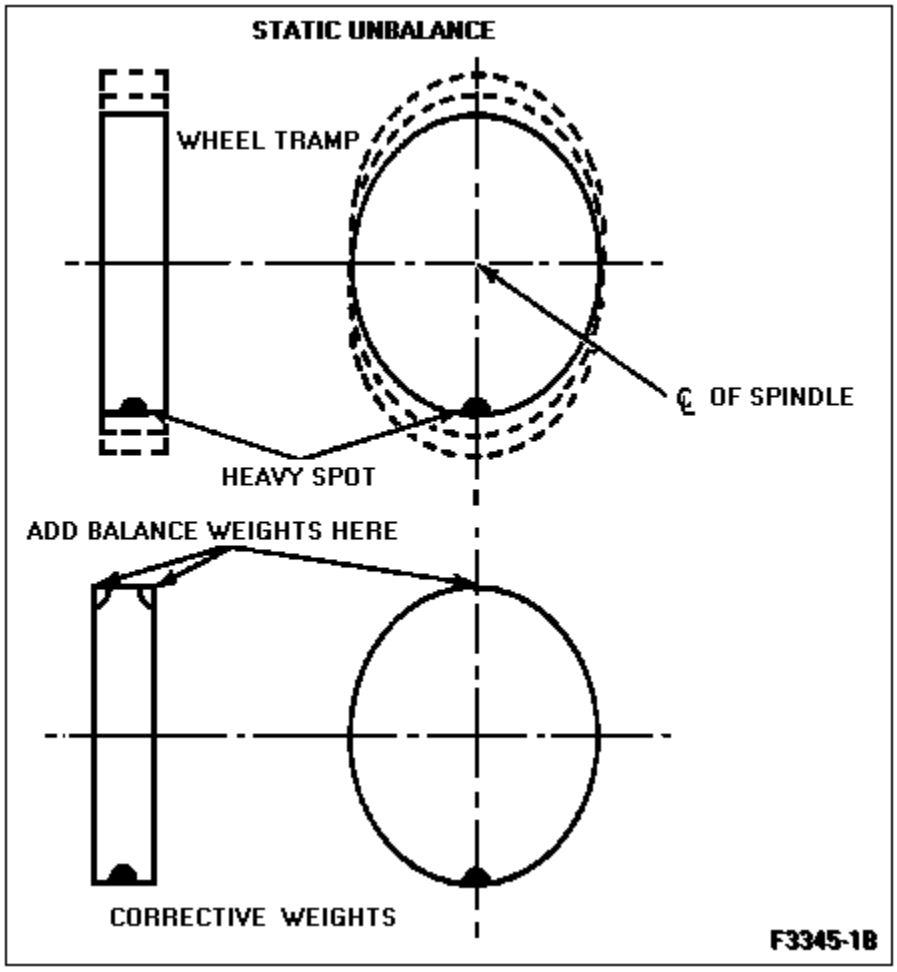
The original equipment tires have built-in tread wear indicators to show when tires need replacement. These indicators will appear as 13mm (1/2-inch) wide bands when the tire tread depth becomes 1.60mm (1/16-inch). When the indicators appear in two or more adjacent grooves, at three locations around the tire, or when cord or fabric is exposed, tire replacement due to tread wear is required.



Tire and Wheel Balance

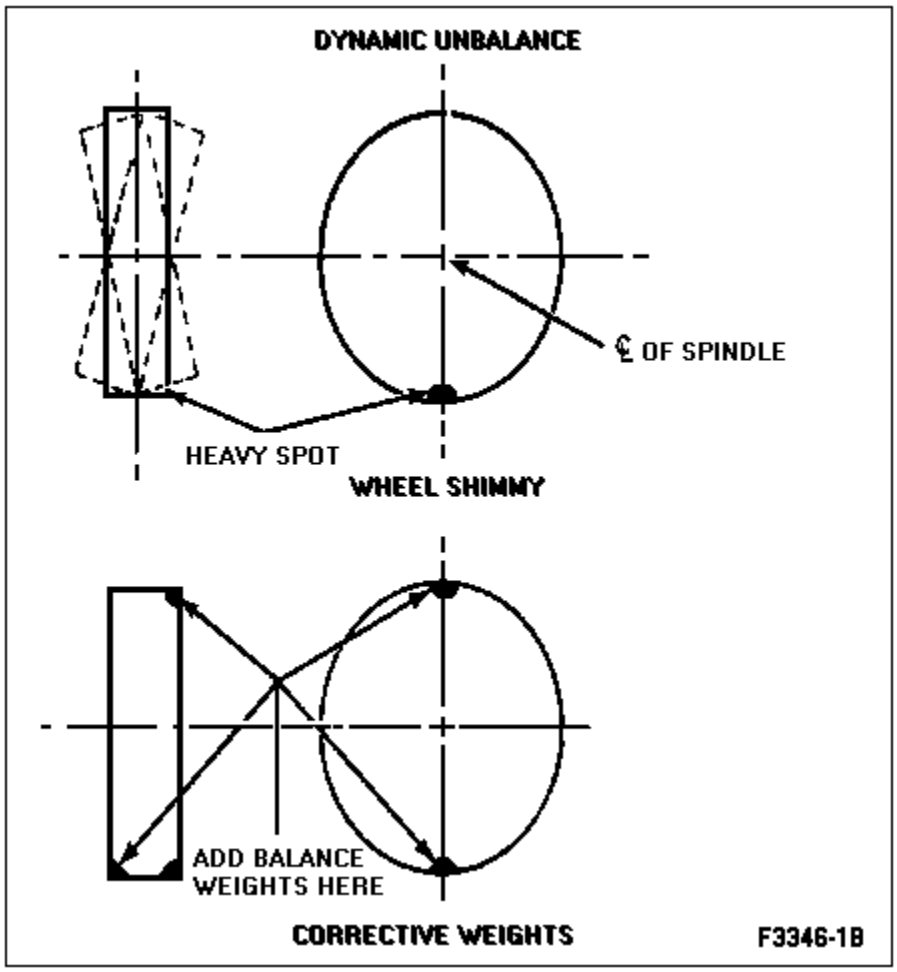
Static Balance

A static balance is the equal distribution of weight around the wheel. Wheels that are statically unbalanced cause a bouncing action called wheel tramp. This condition will eventually cause uneven tire wear.



Dynamic Balance

A dynamic balance is the equal distribution of weight on each side of the centerline, so that when the tire spins there is no tendency for the assembly to move from side to side (wobble). Wheels that are unbalanced may cause wheel shimmy.



Deposits of mud, etc., must be cleaned from the inside of the wheel. Stones should be removed from the tread. The tire should be inspected for any damage, then balanced according to the equipment manufacturer's instructions.

Refer to Section 00-04 for tire and wheel balancing procedures.

Off-Vehicle

When balancing wheels (1007) off the vehicle, use a balancer which pilots the wheels the same way the wheel is piloted on the vehicle. If the wheel tramp and vehicle vibration is not corrected by the off-vehicle balance, refer to Section 00-04 .

Vibration

If vehicle vibration persists after the wheels have been balanced, it may be caused by either tire, wheel or wheel bolt runout or other components or vehicle systems. Refer to the Diagnosis and Testing portion of this section.

SPECIFICATIONS

Tire Inflation Pressures — Aerostar

Vehicle	Wheelbase	GVW	Wheel	Tire	Recommended Cold Inflation Pressures			
					(psi) Front	(psi) Rear	(kPa) Front	(kPa) Rear
Aerostar Van	119 Inch (3022mm)	4920	14 x 5.5 JJ 14 x 6.0 JJ	P215/70R14SL	32	35	220	241
Aerostar Van	119 Inch (3022mm)	5300	14 x 6.0 JJ	P215/75R14SL	32	35	220	241
Aerostar Extended Van	119 Inch (3022mm)	5020	14 x 6.0 JJ	P215/70R14SL	32	35	220	241
Aerostar Extended Van	119 Inch (3022mm)	5300	14 x 6.0 JJ	P215/75R14SL	32	35	220	241
Aerostar Wagon 5 Pass	119 Inch (3022mm)	4700	14 x 5.5 JJ 14 x 6.0 JJ	P215/70R14SL	32	35	220	241
Aerostar Extended Wagon 5 Pass	119 Inch (3022mm)	5000	14 x 6.0 JJ	P215/70R14SL	32	35	220	241
Aerostar Wagon 7 Pass	119 Inch (3022mm)	5140	14 x 5.5 JJ 14 x 6.0 JJ	P215/70R14SL	32	35	220	241
Aerostar Extended Wagon 7 Pass	119 Inch (3022mm)	5320	14 x 6.0 JJ	P215/75R14SL	32	35	220	241
Aerostar Extended Wagon 7 Pass	119 Inch (3022mm)	5260	14 x 6.0 JJ	P215/75R14SL	35	35	241	241
Aerostar Van AWD	119 Inch (3022mm)	5340	14 x 5.5 JJ 14 x 6.0 JJ	P215/70R14SL	35	35	241	241
Aerostar Van Extended AWD	119 Inch (3022mm)	5340	14 x 5.5 JJ 14 x 6.0 JJ	P215/70R14SL	35	35	241	241
Aerostar Wagon 5 Pass AWD	119 Inch (3022mm)	4880	14 x 5.5 JJ 14 x 6.0 JJ	P215/70R14SL	35	35	241	241
Aerostar Wagon 7 Pass AWD	119 Inch (3022mm)	5380	14 x 5.5 JJ	P215/70R14SL	35	35	241	241

			14 x 6.0 JJ					
Aerostar Wagon 5 Pass Extended AWD	119 Inch (3022mm)	5000	14 x 5.5 JJ 14 x 6.0 JJ	P215/70R14SL P215/70R14SL	35 35	35 35	241 241	241 241
Aerostar Wagon 7 Pass Extended AWD	119 Inch (3022mm)	5200 5260 5300 5340 5380	14 x 5.5 JJ 14 x 6.0 JJ	P215/70R14SL P215/70R14SL	35 35	35 35	241 241	241 241

Tire Inflation Pressures — Ranger

Vehicle	Wheelbase	GVW	Wheel	Tire	Recommended Cold Inflation Pressures			
					(psi) Front	(psi) Rear	(kPa) Front	(kPa) Rear
Ranger (4x2) Regular Cab	108 Inch (2740mm)	4220	14 x 5.5 J 14 x 5.5 J 14 x 6.0 J 14 x 6.0 J 14 x 6.0 J	P195/70R14SL P215/70R14SL P225/70R14SL P195/70R14SL P215/70R14SL	35 35 35 35 35	35 35 35 35 35	241 241 241 241 241	241 241 241 241 241
Ranger (4x2) Regular Cab	108 Inch (2740mm)	4660	14 x 5.5 J 14 x 6.0 J 14 x 6.0 J	P215/70R14SL P215/70R14SL P225/70R14SL	35 35 35	35 35 35	241 241 241	241 241 241
Ranger (4x2) Regular Cab	114 Inch (2892mm)	4260	14 x 5.5 J 14 x 5.5 J 14 x 6.0 J 14 x 6.0 J 14 x 6.0 J	P195/70R14SL P215/70R14SL P195/70R14SL P215/70R14SL P225/70R14SL	35 35 35 35 35	35 35 35 35 35	241 241 241 241 241	241 241 241 241 241
Ranger (4x2) Regular Cab	108 Inch (2740mm)	4700	14 x 5.5 J 14 x 6.0 J 14 x 6.0	P215/70R14SL P215/70R14SL P225/70R14SL	35 35 35	35 35 35	241 241 241	241 241 241

			J					
Ranger (4x2) SuperCab	125 Inch (3175mm)	4460	14 x 5.5 J 14 x 5.5 J 14 x 6.0 J 14 x 6.0 J 14 x 6.0 J	P195/70R14SL P215/70R14SL P195/70R14SL P215/70R14SL P225/70R14SL	35 35 35 35 35	35 35 35 35 35	241 241 241 241 241	241 241 241 241 241
Ranger (4x2) SuperCab	125 Inch (3175mm)	4740 4820	14 x 5.5 J 14 x 6.0 J 14 x 6.0 J	P215/70R14SL P215/70R14SL P225/70R14SL	35 35 35	35 35 35	241 241 241	241 241 241
Ranger (4x4) Regular Cab	108 Inch (2740mm)	4580	15 x 6.0 J 15 x 7.0 J	P215/75R15SL P215/75R15SL	35 35	35 35	241 241	241 241
Ranger (4x4) Regular Cab	108 Inch (2740mm)	4860	15 x 6.0 J 15 x 7.0 J 15 x 7.0 J	P215/75R15SL P215/75R15SL P235/75R15SL	35 35 30	35 35 35	241 241 207	241 241 241
Ranger (4x4) Regular Cab	114 Inch (2892mm)	4580	15 x 6.0 J 15 x 7.0 J	P215/75R15SL P215/75R15SL	35 35	35 35	241 241	241 241
Ranger (4x4) Regular Cab	114 Inch (2892mm)	4880	15 x 6.0 J 15 x 7.0 J 15 x 7.0 J 15 x 7.0 J	P215/75R15SL P215/75R15SL P235/75R15SL P265/75R15SL	35 35 30 30	35 35 35 35	241 241 207 267	241 241 241 241
Ranger (4x4) SuperCab	125 Inch (3175mm)	4840	15 x 6.0 J 15 x 7.0 J 15 x 7.0 J 15 x 7.0 J	P215/75R15SL P215/75R15SL P235/75R15SL P265/75R15SL	35 35 30 30	35 35 35 35	241 241 207 267	241 241 241 241
Ranger (4x4) SuperCab	125 Inch (3175mm)	5000 5060	15 x 6.0 J 15 x 7.0 J 15 x 7.0 J	P215/75R15SL P215/75R15SL P235/75R15SL	35 35 30	35 35 35	241 241 207	241 241 241
Ranger (4x2)	108 Inch	4140	15 x 7.0	P235/60R15	35	35	242	241

Regular Flareside	(2743mm)		J					

Torque Specifications

Description	Nm	Lb-Ft	Lb-In
Screw-On Type Wheel Hub Ornament	1.9-2.4	—	17-21
Lug Nuts 1/2-20	135	100	

CAUTION: Torque specifications are for clean, dry bolt and nut threads. Never use oil or grease on wheel bolts or nuts.

Inspection and Verification

Certain rear axle assembly (4006) and driveline trouble symptoms are also common to the engine (6007), transmission (7003), rear wheel bearings (1225), tires, and other parts of the vehicle. For this reason, be sure that the cause of the trouble is in the rear axle assembly before adjusting, repairing, or replacing any of its parts. See Section 00-04 in the Body, Chassis Manual.

Certain trouble symptoms may be caused by limited slip differentials. Check the vehicle certification and axle ratio tag to determine the type of differential.

Universal (U)-Joint Inspection

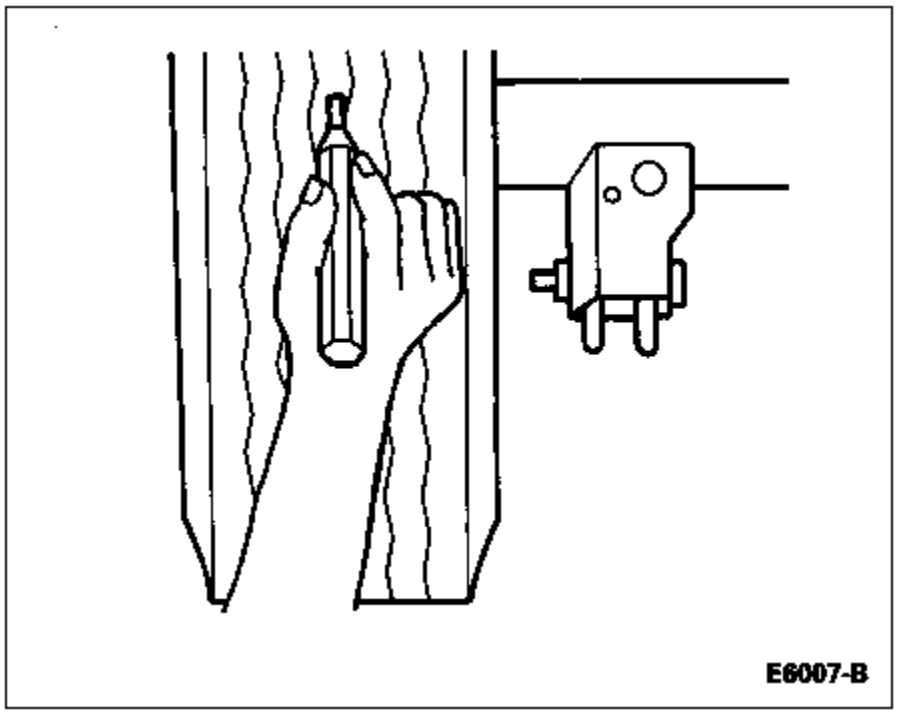
Prior to checking driveline angularity, inspect the universal joints for proper operation.

Place the vehicle on a frame hoist and rotate the driveshaft (4602) by hand. Check for rough operation or seized universal joints. If the universal joint shows signs of seizure, excessive wear or improper seating, scribe alignment marks on the driveshaft and rear axle companion flange. On Aerostar E-4WD front driveshaft, scribe alignment marks on the driveshaft and the transfer case. Remove the driveshaft and remove and replace the universal joint. Install the driveshaft in the marked original position.

CAUTION: Universal joint components from different manufacturers and new and used universal joints are never to be mixed. Universal joint kits are to be serviced as complete assemblies only.

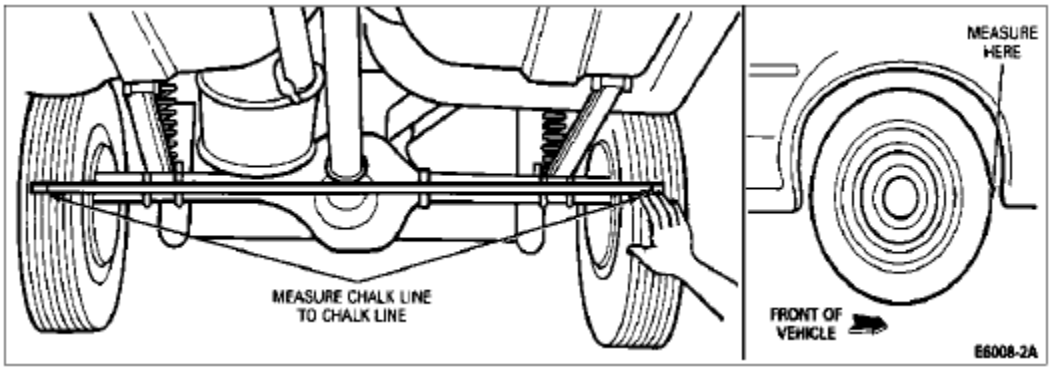
Alignment Inspection, Rear Axle

1. Raise the vehicle on a hoist to allow the rear axle assembly to be freely suspended.
2. Using white chalk or paint, mark a small area at the center of each rear tire and scribe a vertical line on it.



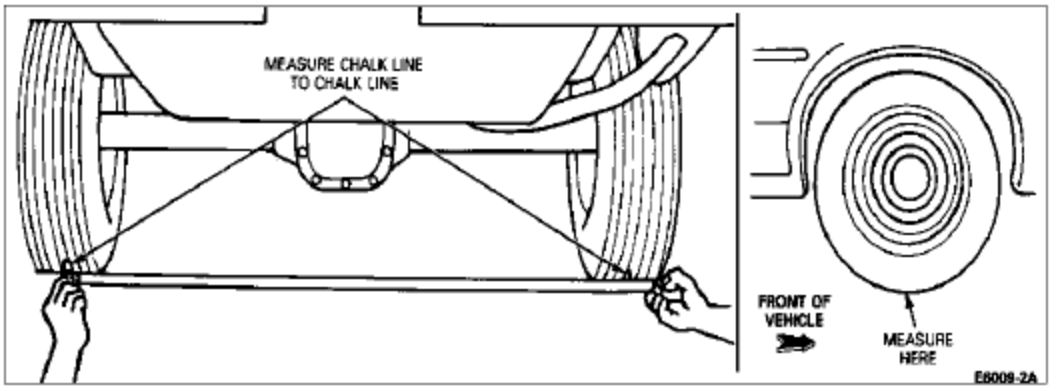
3. Adjust both wheels so that the markings face the front of the vehicle. Using a tape measure, measure the distance between scribe marks and record this reading (front reading).

Rear Axle Alignment Inspection



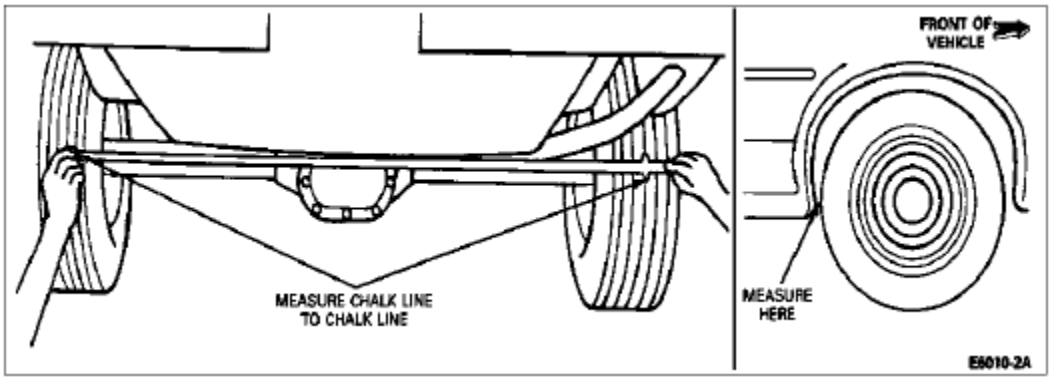
4. Rotate the rear wheels so the markings are directly underneath the vehicle. Measure the distance between the scribe marks and record this reading (bottom reading).

Bottom Reading



5. Rotate the rear wheels so the markings face the rear of the vehicle. Again, measure and record the distance between scribe marks (rear reading).

Rear Reading



6. The difference between the front and rear readings is the toe-out or toe-in condition of the axle housing (Steps 3 and 5).

   All numbers are for example only. Front reading: 52-3/16 inch Rear reading: 52-1/16 inch Toe-out: 2/16 inch or 1/8 inch Toe-in occurs when the front reading is less than the rear reading.

7. To determine camber, find the average of the front and rear readings (obtained in Steps 3 and 5). Then, subtract the bottom reading from this (obtained in Step 4).

   Average of front and rear readings: 52-2/16 inch Bottom reading: 52-2/16 inch Difference or camber: 0 inch Positive (+) camber is when the bottom reading is less than the average of the front and rear readings. Negative (-) camber is when the bottom reading is greater than the average of the front and rear readings.

8. Results of the measurements taken must conform to the following specifications: Tape measure specification: Camber: 0 ± 5/32 inch Toe-in: 0-1/16 inch Toe-out: 0-3/16 inch If the axle housing does not meet this specification, it must be replaced.

9. If the axle housing is replaced, repeat Steps 2 through 7.

Noise Acceptability

A gear-driven unit, especially an automotive drive axle, will produce a certain amount of noise. Some noise is acceptable and may be audible at certain speeds or under various driving conditions such as a newly paved blacktop road. The slight noise is not detrimental to operation of the rear axle and must be considered normal.

With the Traction-Lok® limited slip differential axle, slight chatter noise on slow turns after extended highway driving is considered acceptable and has no detrimental effect on the locking axle function.

Preliminary Diagnosis

Question the Customer

The preliminary diagnosis begins with the service technician asking the customer enough diagnostic questions, especially for conditions of noisy operation and/or vibration.

Always ask the customer about:

1. The exact nature of the symptom. If it is a vibration, how is it felt? If a noise, what kind? Is it high-pitched, a rumbling noise or some other concern?

2. The driving conditions in which the symptoms appear: road speed, drive or coast, on turns or on a grade only.

3. Whether the condition is constant or variable. Does a noise increase in pitch with speed or some other factor?

   All information should be written on the service order so that the technician will know where to start looking. The technician doing the diagnosis must be able to identify the axle concern from what is written on the order following the road test.

   It is, of course, preferable to have the customer demonstrate the symptoms in a road test whenever possible.

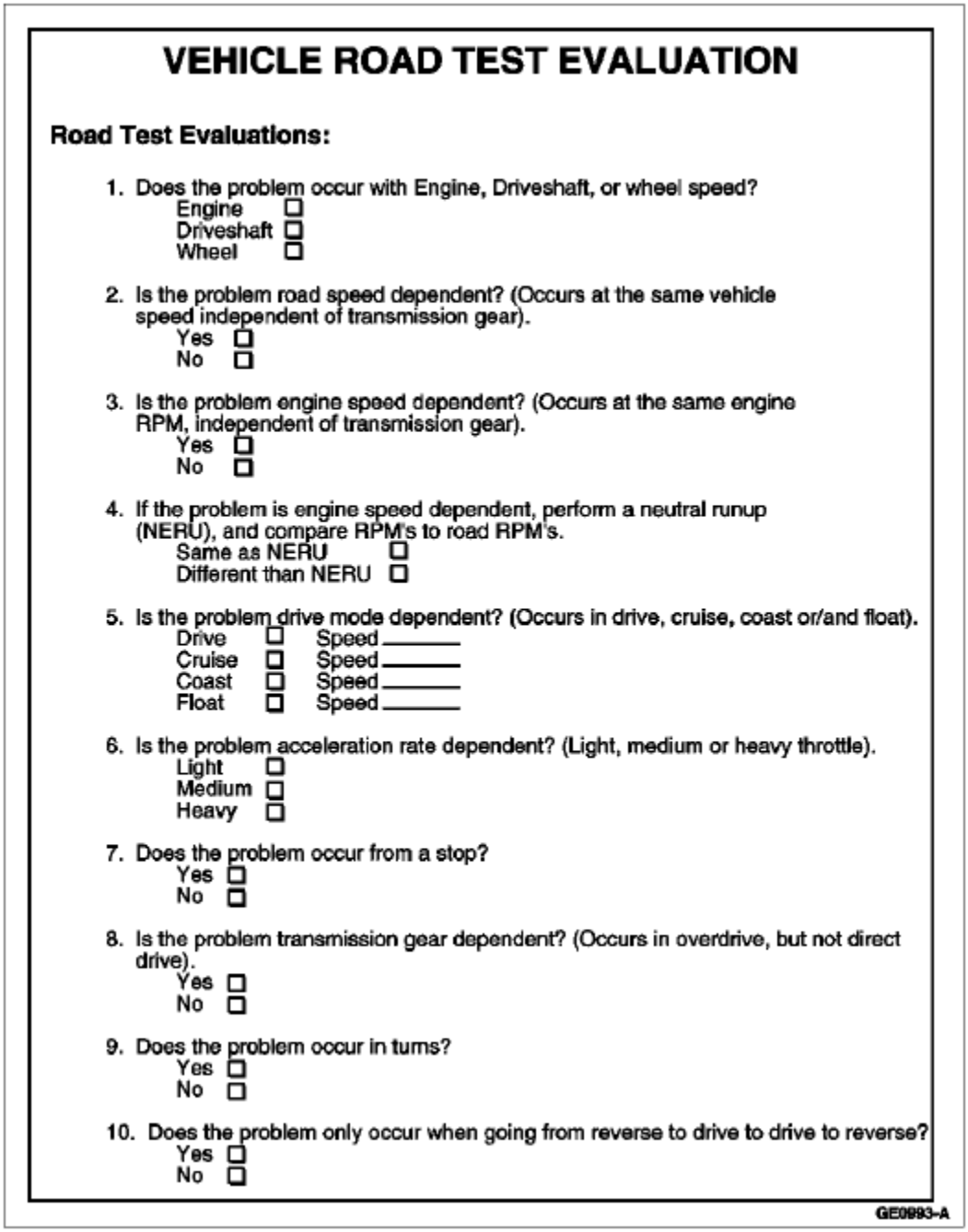
Road Test

A road test is mandatory for any customer concern of noise and/or vibration that is not eliminated by the on-hoist check of chassis components. The Road Test Form is arranged to record the conditions that may be heard or felt during this test.

The Road Test Form lists four operating conditions or modes in which some axle noises come and go: Drive, Cruise, Coast and Float.

Mode	Conditions
DRIVE	Accelerating the vehicle; a definite throttle depression applying engine torque.
CRUISE	Maintaining a constant speed with the throttle applied.
COAST	Decelerating with the throttle closed.
FLOAT	Controlled deceleration; backing the throttle continually to prevent either braking or accelerating torque from the engine.

To perform a good diagnostic check it is important to operate the vehicle in all four modes and check off those in which the noise occurs. The modes are defined in the preceding chart. Write down the kilometers-per-hour (miles-per-hour) range at which both noise and vibration occur. On vehicles equipped with overdrive transmissions, evaluate rear axle noise with the transmission in DIRECT DRIVE and not in OVERDRIVE. Transmission noise can be mistaken for rear axle noise when in overdrive.



VEHICLE ROAD TEST EVALUATION

Road Test Evaluations:

1. Does the problem occur with Engine, Driveshaft, or wheel speed?
   - Engine ☐
   - Driveshaft ☐
   - Wheel ☐
2. Is the problem road speed dependent? (Occurs at the same vehicle speed independent of transmission gear).
   - Yes ☐
   - No ☐
3. Is the problem engine speed dependent? (Occurs at the same engine RPM, independent of transmission gear).
   - Yes ☐
   - No ☐
4. If the problem is engine speed dependent, perform a neutral runup (NERU), and compare RPM's to road RPM's.
   - Same as NERU ☐
   - Different than NERU ☐
5. Is the problem drive mode dependent? (Occurs in drive, cruise, coast or/and float).
   - Drive ☐ Speed _____
   - Cruise ☐ Speed _____
   - Coast ☐ Speed _____
   - Float ☐ Speed _____
6. Is the problem acceleration rate dependent? (Light, medium or heavy throttle).
   - Light ☐
   - Medium ☐
   - Heavy ☐
7. Does the problem occur from a stop?
   - Yes ☐
   - No ☐
8. Is the problem transmission gear dependent? (Occurs in overdrive, but not direct drive).
   - Yes ☐
   - No ☐
9. Does the problem occur in turns?
   - Yes ☐
   - No ☐
10. Does the problem only occur when going from reverse to drive to drive to reverse?
    - Yes ☐
    - No ☐

GE0993-A

Analysis of Leakage

Most rear axle leakage conditions can be corrected without a teardown. However, it is important to clean up the leaking area enough to identify the exact source.

A plugged or seized rear axle housing vent (4022) will cause excessive flange yoke seal lip wear due to internal pressure buildup. When a leak occurs, check cap by pressing down on it with index finger. If the cap moves up and down freely, it is working properly. If it does not move freely, it must be replaced.

Make sure axle lubricant level is 6-14 mm (1/4-9/16 inch) below bottom of fill hole.

Flange Yoke Seal

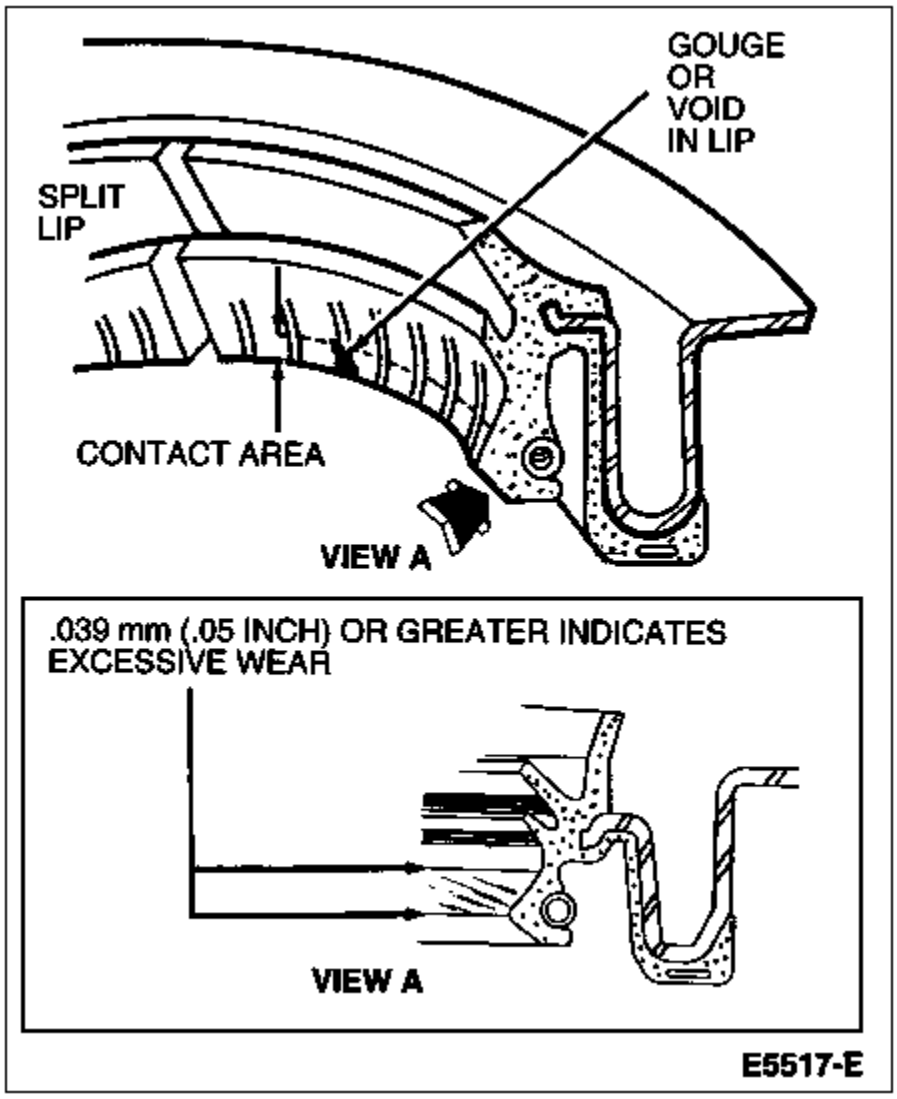
When the rear axle drive pinion seal (4676) leaks, it is usually because it was not installed carefully or properly, or because of poor quality on the seal journal surface.

Any damage to the seal bore (dings, dents, gouges or other imperfections) will distort the seal casing and allow leakage past the outer edge of the rear axle drive pinion seal.

The rear axle drive pinion seal can be torn, cut or gouged if it is not assembled carefully. The spring that holds the rear axle drive pinion seal against the rear axle universal joint flange (4851) may be knocked out and allow leakage past the lip.

The rubber lips can occasionally become hard (like plastic) with cracks at the oil lip contact point. The contact point on the rear axle universal joint flange is usually black, indicating excessive heat. Marks, nicks, gouges or rough surface texture on the seal journal of the rear axle universal joint flange will also cause leaks. Excessive rear axle drive pinion seal wear will be noted. The rear axle universal joint flange should be replaced if any of these conditions exist.

Metal chips or sand trapped at the sealing lip also may cause oil leaks. This can cause a wear groove on the rear axle universal joint flange and heavy flange yoke seal wear.



Drive Pinion Nut

On some high-mileage units, there have been instances of oil leaking past the threads of the pinion nut. The condition can be corrected by removing the nut and applying Pipe Sealant With Teflon® D8AZ-19554-A or equivalent meeting Ford specification WSK-M2G350-A2 on the threads and nut face.

NOTE: Be sure to follow the correct procedure for setting the bearing preload when the nut is installed.

Axle lubricant level should be 6-14 mm (1/4-9/16 inch) below bottom of fill plug hole. Make sure rear axle housing vent is not plugged with dirt or debris.

Axle Shaft Seals

Axle shaft inner wheel bearing oil seals (1177) are susceptible to the same kinds of damage as rear axle drive pinion seals if improperly installed. The seal bore must be clean and the lip handled carefully to avoid cutting or tearing it. Axle shaft journal surface must be free of nicks, gouges and rough surface texture.

Differential Seals

Refer to Section 05-02A .

Casting Porosity (Holes in Casting)

Occasionally there will be a rear axle housing (4010) leak through small pockets in the metal. These pockets (casting leakage) are caused by gas bubbles in the casting process and are known technically as a porous condition or porosity.

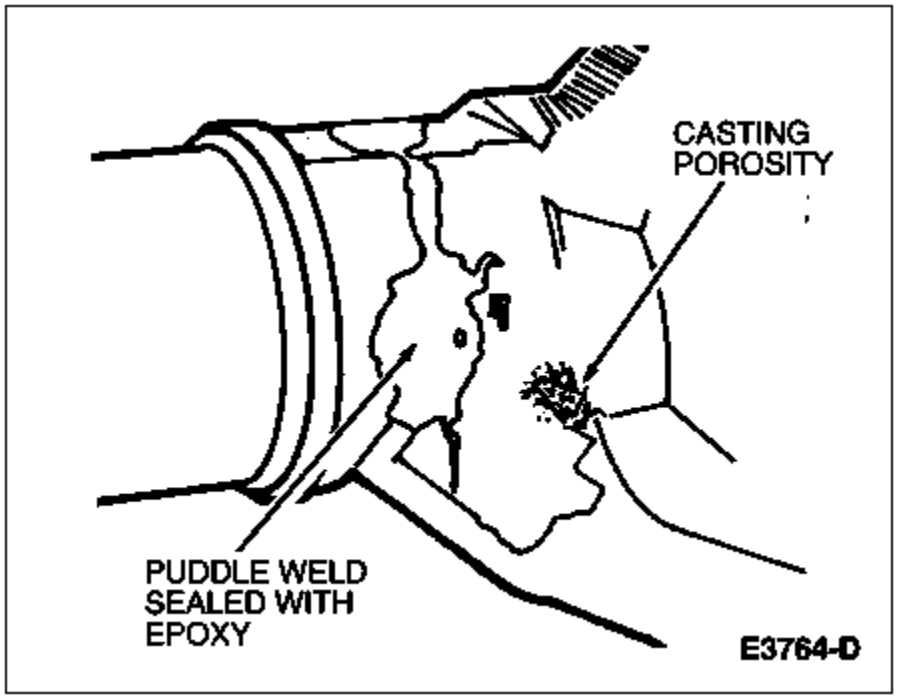
Because there is always the danger of changing the axle's sound characteristics if torn down to replace the carrier, service is preferable. There are two recommended types of service:

1. Peen in a small amount of body lead. Seal the pocket with epoxy sealer that meets Ford specification M-3D35AE.

2. In larger pockets, drill a shallow hole and tap it for a small setscrew. Install the setscrew and seal it over with epoxy sealer that meets Ford specification M-3D35AE.

Weld Leaks

Most minor weld leaks can be corrected with epoxy sealer that meets Ford specification M-3D35AE. This includes the "puddle" or fill welds that join the axle shaft tube to the rear axle housing on integral axles. They sometimes leak and can be sealed easily. If a weld is broken, the rear axle housing must be replaced. The alignment is too critical for field service.



Axle Vent

There have been some occurrences of lubricant leaking through the rear axle housing vent. This may be caused by a clogged or sticking axle vent cap. The rear axle housing vent should then be replaced, using Stud and Bearing Mount E0AZ-19554-BA or equivalent meeting Ford specification WSK-M2G349-A1 on threads to ensure retention.

Analysis of Vibration

Few vibration conditions are caused by the rear axle assembly. On a vibration concern, follow the diagnosis procedure in Section 00-04 unless there is a good reason to suspect the axle.

Most vibration in the rear end is caused by tires or driveline angle.

Traction-Lok® Differential

WARNING: A VEHICLE EQUIPPED WITH A TRACTION-LOK® DIFFERENTIAL WILL ALWAYS HAVE BOTH WHEELS DRIVING. IF, WHILE THE VEHICLE IS BEING SERVICED, ONLY ONE WHEEL IS RAISED OFF THE FLOOR AND THE REAR AXLE ASSEMBLY IS DRIVEN BY THE ENGINE, THE WHEEL ON THE FLOOR COULD DRIVE THE VEHICLE OFF THE STAND OR JACK. BE SURE BOTH REAR WHEELS ARE OFF THE FLOOR.

Tires

WARNING: DO NOT BALANCE THE REAR WHEELS AND TIRES WHILE THEY ARE MOUNTED ON THE VEHICLE. POSSIBLE TIRE DISINTEGRATION AND/OR DIFFERENTIAL FAILURE COULD RESULT, CAUSING PERSONAL INJURY AND/OR EXTENSIVE COMPONENT DAMAGE. USE OFF-VEHICLE WHEEL AND TIRE BALANCER ONLY.

Vibration is a definite concern with modern, high-mileage tires if they are not "true" both radially and laterally. They are more susceptible to vibration around the limits of radial and lateral runout of the tire and wheel assembly. They also require more accurate balancing. Wheel and tire runout checks, truing and balancing are normally done before axle inspection.

Sometimes a vibration concern can be corrected by properly rotating or inflating the tires. The **best tires** should be **on the rear** to minimize vibration, especially on vehicles with rear springs (5560).

Driveline Angle

An incorrect driveline (pinion) angle can often be detected by the driving condition when vibration occurs.

1. A vibration during coasting from 56 to 72 km/h (35 to 45 mph) is often caused by a high pinion angle.

2. A vibration during acceleration, again around 56 to 72 km/h (35 to 45 mph), may indicate a lower than specified pinion angle. Refer to Section 00-04 for pinion angle procedure.

   When it is certain that the tires and driveline angle are not the cause, inspect the axle. Refer to Section 00-04 .

U-Joint Wear

Prior to checking driveline angularity, inspect the universal joints on the driveshaft for proper operation.

Place the vehicle on a frame hoist and rotate the driveshaft by hand. Check for rough operation or seized U-joints. If the U-joint shows signs of seizure, excessive wear or improper seating, scribe alignment marks on the driveshaft and rear axle companion flange. Remove the driveshaft and remove and replace the U-joint. Install the driveshaft in the marked original position.

U-Joint Phasing

When assembling a slip between center driveshaft, the universal joint yokes must be assembled to the driveshaft on the same plane. If not, the assembly may be out of balance, causing a driveline vibration. Scribe alignment marks on the slip yoke and the driveshaft tube before removal to ensure correct phasing of

universal joints.

Axle Shaft Runout

NOTE: If the axle shaft (4234) assembly is removed, check runout of the shaft itself. The forged (unmachined) part of the shaft is allowed to have as much as 3.0 mm (0.120-inch) runout. This alone will not cause a vibration condition.

Runout of the axle shaft at either end is an infrequent, but possible, cause of rear end vibration. It is advisable to check the axle shaft for runout of:

1. the pilot (radial)
2. the flange face (lateral)
3. the bolt circle (radial)

   Refer to Section 00-04 for the checking procedures and special service tool for axle shaft runout.

Drive Pinion Stem and Rear Universal Joint Flange

Rear axle universal joint flange runout should be checked when all other checks have failed to show the cause of vibration.

Another cause of excessive rear axle universal joint flange runout is improper installation of the rear axle drive pinion seal. If the spring on the seal lip is dislodged, it will jam up and cock the flange. Check that possibility before replacing the differential ring gear and pinion (4209) because of excessiverear axle universal joint flange runout.

Two-Piece Driveshaft

The two-piece driveshaft used in longer wheelbase light truck models introduces some special considerations to diagnosis and testing. As compared with a one-piece installation, the two-piece design includes a front, or "coupling" shaft, a rubber-insulated frame-mounted driveshaft center bearing bracket, a splined slip joint and an intermediate universal joint at the front of the rear driveshaft.

Axle Noise

Non-Axle Noise

There are a few other conditions that can sound just like axle noise and have to be considered in prediagnosis.

The three most common are exhaust, tires and trim mouldings.

1. In certain conditions, the pitch of the exhaust may sound very much like gear whine. At other times, it can be mistaken for a wheel bearing rumble.
2. Tires — especially snow tires — can have a high-pitched tread whine or roar similar to gear noise. Radial tires, to some degree, have this characteristic. Any non-standard tire with an unusual tread construction may also emit a roar or whine-type noise.
3. Trim, grille and mouldings can also cause whistling or whining noises.

Make sure that none of these are the cause of the noise before proceeding with an axle teardown and diagnosis.

Analysis of Gear Noise

Gear Howl and Whine

Before disassembling the axle to diagnose and correct gear noise, eliminate the tires, exhaust, trim items, roof racks, axle shafts and rear wheel bearings as possible causes.

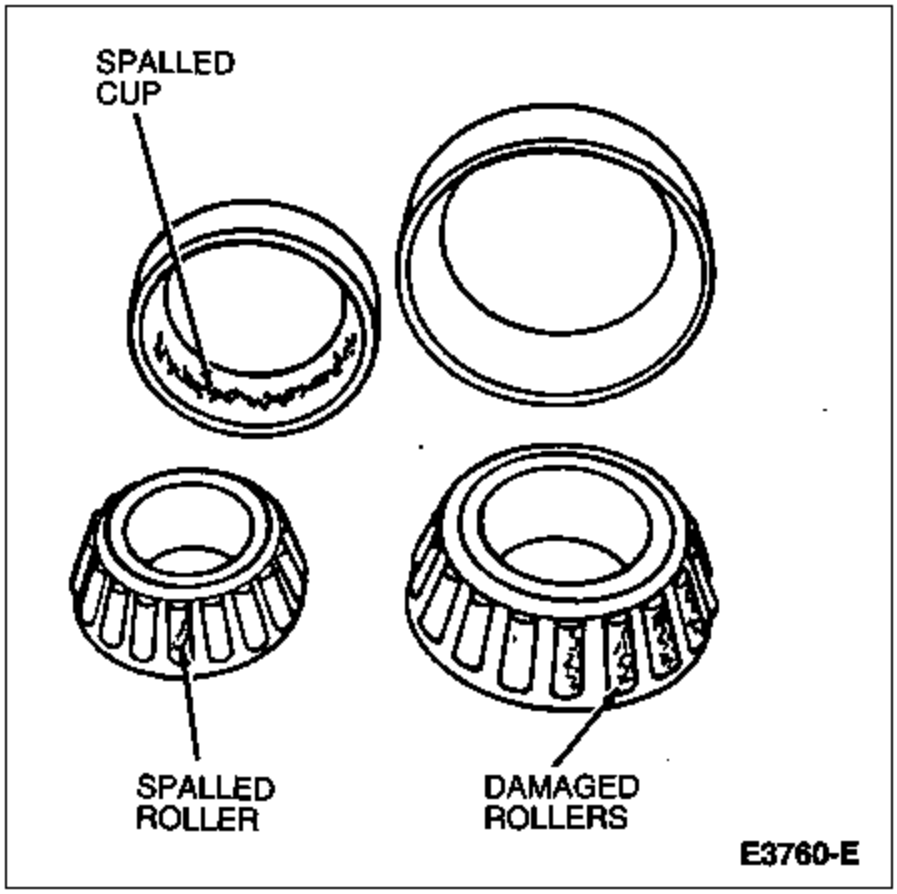
The noises described under Road Test in this section usually have specific causes that can be diagnosed by observation as the unit is disassembled. The initial clues are, of course, the type of noise heard on the road test and the driving conditions.

Bearing malfunctions will normally be obvious at disassembly. As noted earlier, differential pinion bearings (4630) make a high-pitched, whistling noise, usually at all speeds. However, if there is only one differential pinion bearing that is malfunctioning, the noise may vary in different driving phases.

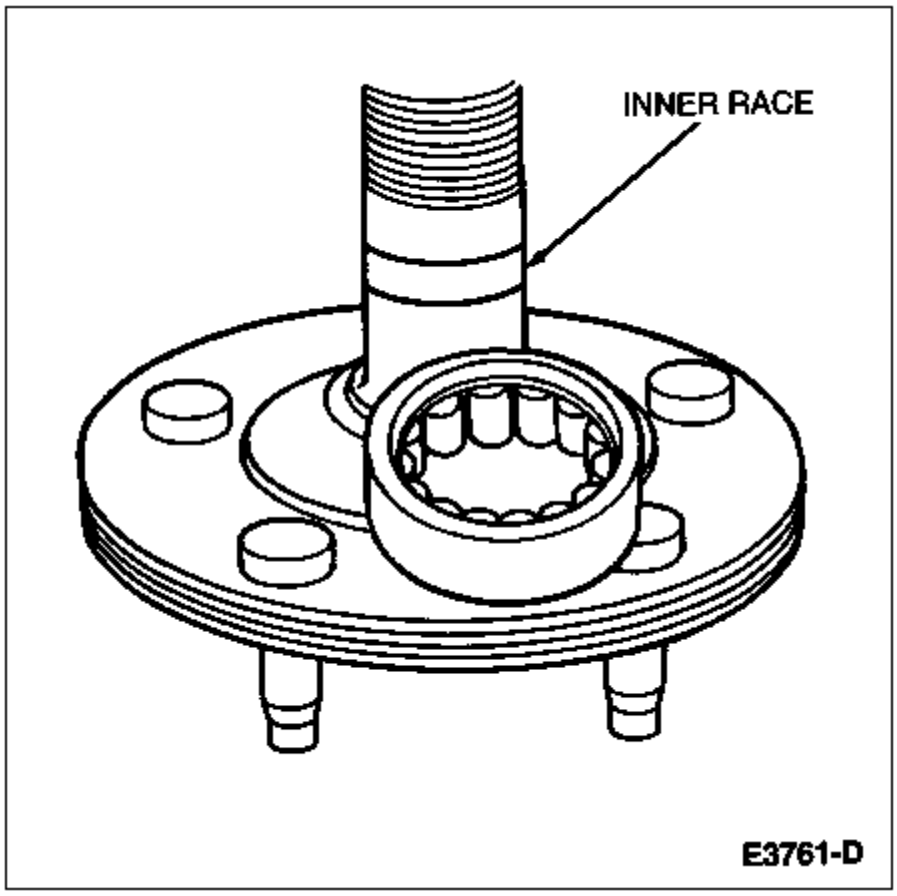
Differential pinion bearings are frequently replaced unnecessarily on axles with low mileage under 24,139 km (15,000 miles) when correcting gear noise. They should not be replaced unless they are actually scored or damaged, or there is a specific differential pinion bearing noise. Examine the large end of the rollers for wear. If the differential pinion bearings original blend radius has worn to a sharp edge, the differential pinion bearing should be replaced.

Remember that the low-pitched rumble of a malfunctioning wheel bearing can also be caused by the exterior luggage rack or tires.

Rear wheel bearing noise might be mistaken for pinion bearing noise. Look at the rear wheel bearing carefully before tearing down the axle.



Rear wheel bearings are pressed into the axle housing tubes, making them more difficult to check. However, the axle shaft is the inner race for the bearing. If the bearing is damaged, the roller surface on the axle shaft may also be damaged. The rollers run approximately on the center of the polished surface.



Chuckle

Chuckle that occurs on the coast driving phase is usually caused by excessive clearance between the differential gear hub and the differential case bore. It can also be caused by a damaged tooth on the coast side of the pinion or ring gear.

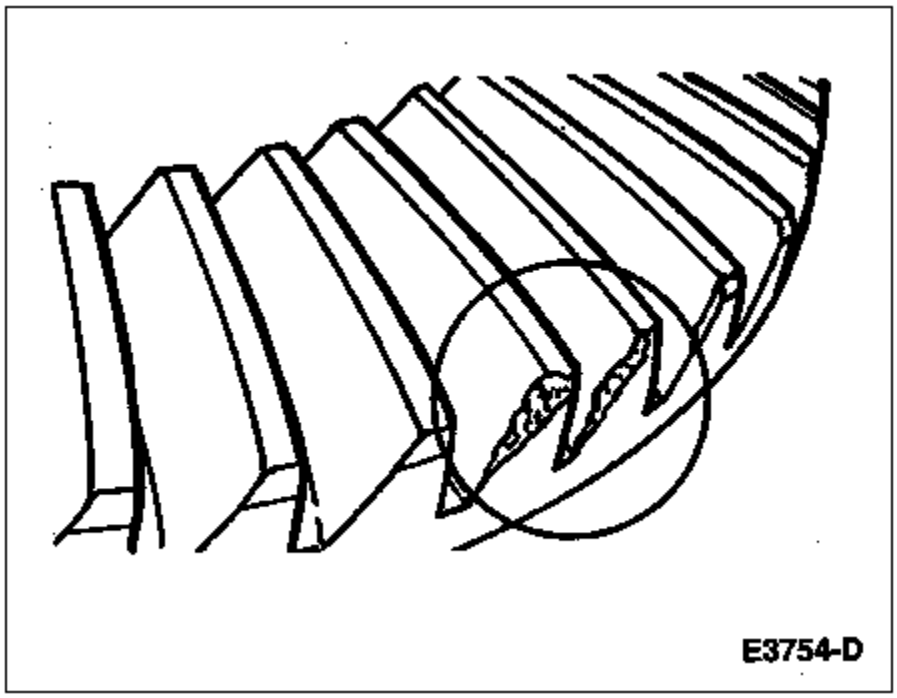
Any damage to a gear tooth on the coast side can cause a noise identical to chuckle. Even a very small tooth nick or ridge on the edge of a tooth is enough to cause the noise.

You can often correct this condition and eliminate the noise simply by cleaning up the gear tooth nick or ridge with a small grinding wheel. If the cleaned up or damaged area is larger than 3.2mm (1/8 inch), it is advisable to replace the gearset.

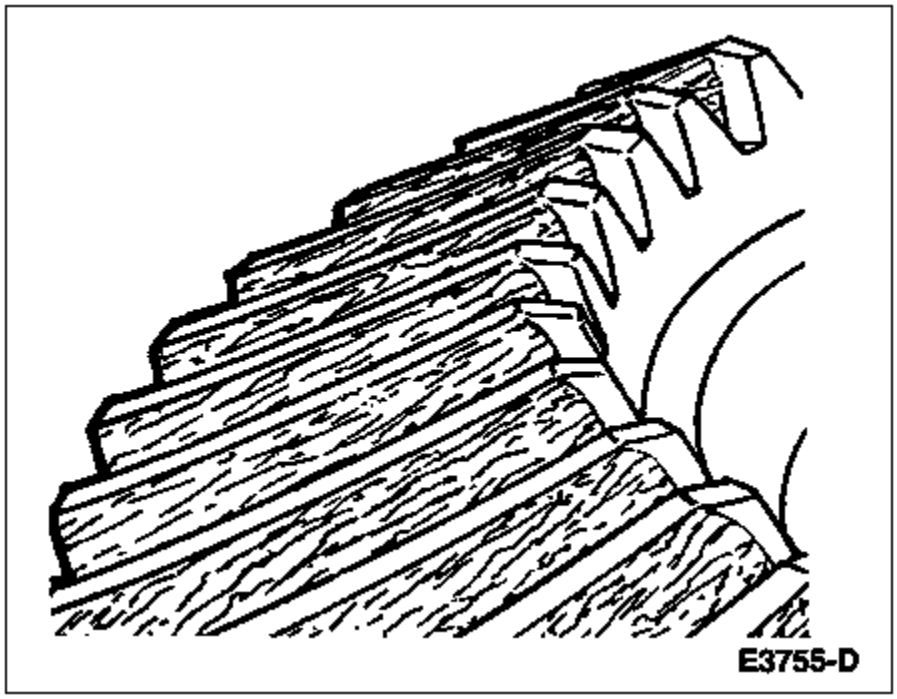
To check the differential ring gear and pinion, remove as much lubricant as possible from the gears with clean solvent. Wipe the gears dry or blow them dry with compressed air. Look for scored or damaged teeth. Also look for cracks or other damage.

If either gear is scored or damaged badly, the differential ring gear and pinion must be replaced. If there is metal broken loose, the rear axle housing must also be cleaned to remove particles that could cause damage later. Any other damaged parts in the rear axle housing must be replaced.

Damaged Gear Teeth



Scored Gear Teeth



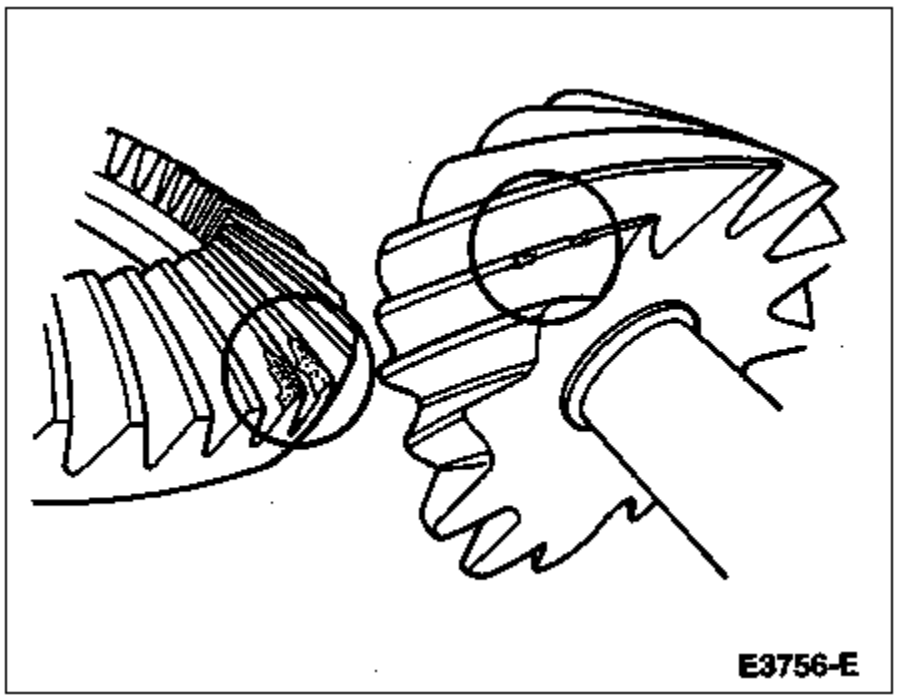
Knock

Knock, which can occur on all driving phases, has several causes. In most cases, the technician will

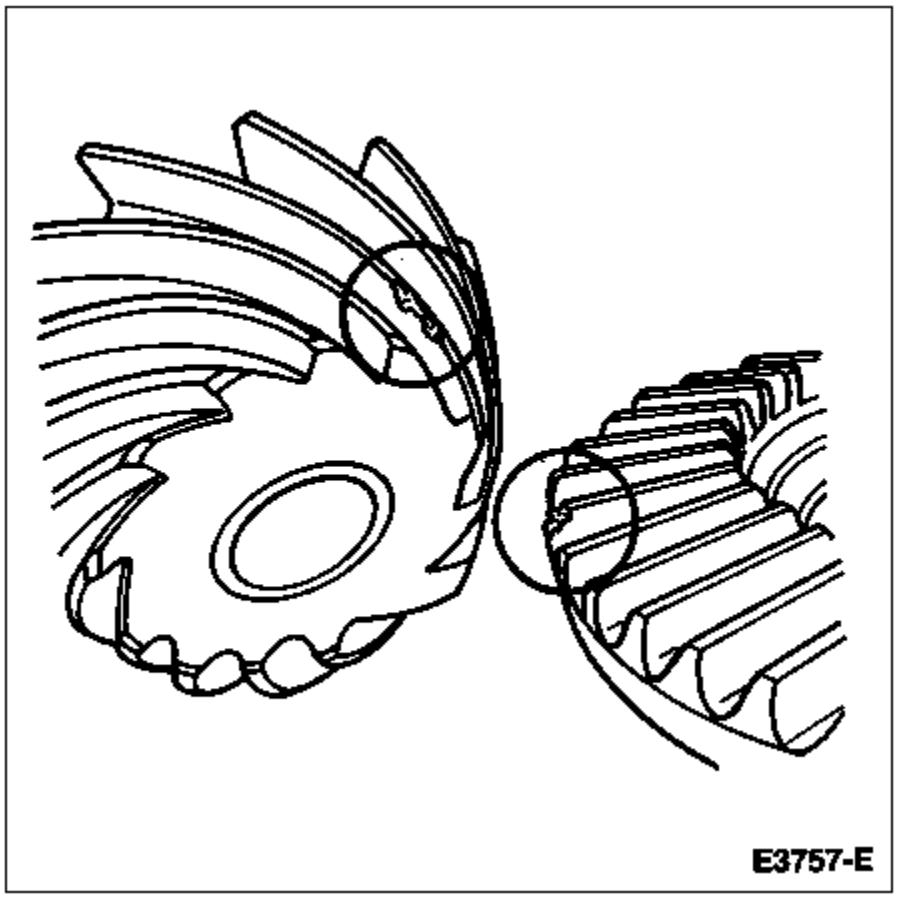
discover one of the following conditions:

1. A gear tooth damaged on the drive side is a common cause of the knock. This can usually be corrected by grinding the damaged area.

Damaged Teeth or Gearset



Drive Side Knock



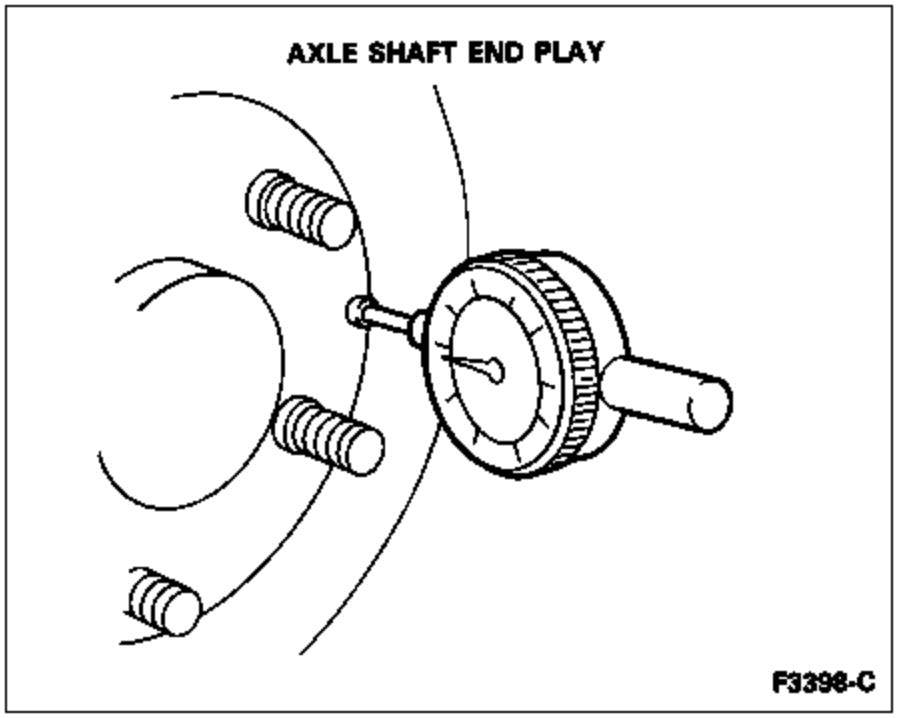
2. Occasionally, the rear axle differential gear case bolts (4216) will knock against the inside of the rear axle housing casting. The cause may be too little clearance due to casting flash or bumps. In this case, the differential case (4204) can be removed and the interference points ground out.

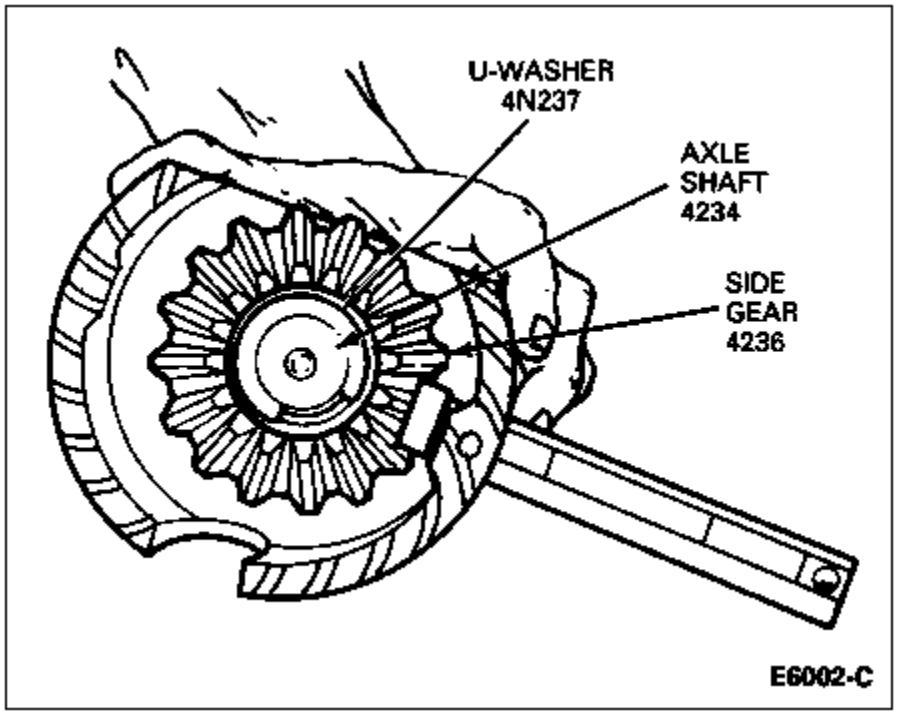
   Another possibility is simply that one or more rear axle differential gear case bolts are slightly backed-out. Remove, replace and properly tighten the rear axle differential gear case bolts using Stud and Bearing Mount E0AZ-19554-BA or equivalent meeting Ford specification WSK-M2G349-A1 on the threads.

3. **NOTE: Be sure to measure the end play with a dial indicator and not by feel. Guessing is inaccurate. The axle end play should be 0.030 in.**

   Knock is also characteristic of excessive end play in the axle shafts. The frequency of knock will be less because the axle shaft speed is slower than the driveshaft. To reduce the clearance, fabricate shims as necessary.

4. Reduce axle shaft end play by replacing differential parts as required.





Clunk

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number

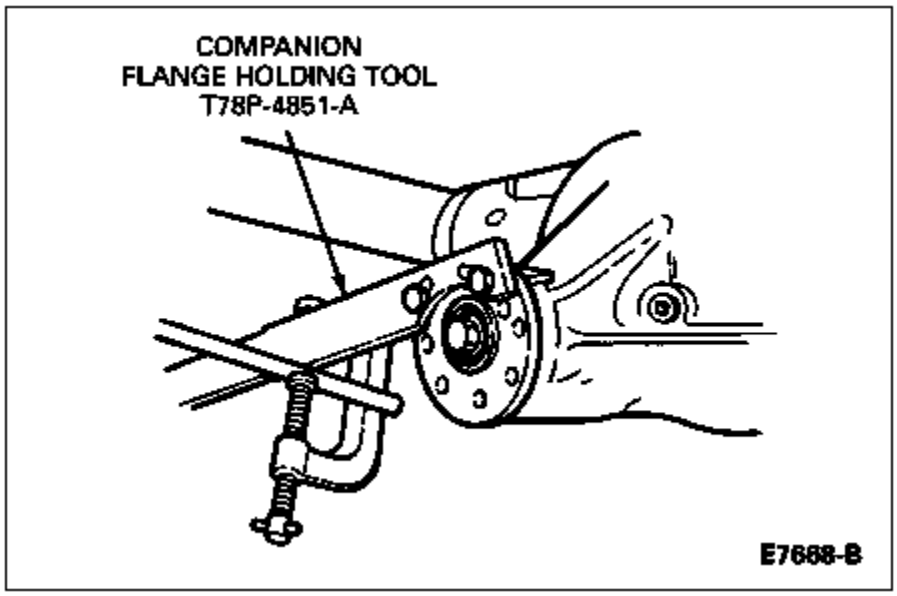
Companion Flange Holding Tool	T78P-4851-A

1. **NOTE: Remove driveshaft when performing this procedure on circular rear axle companion flange application.**

   Raise vehicle on hoist.

2. Use a rigid bar or pipe of suitable length and clamp one end to the rear axle companion flange using Companion Flange Holding Tool T78P-4851-A.

3. Clamp the other end to the frame or body member in order to prevent movement of the rear axle companion flange.



4. Lower the vehicle so that one rear wheel is resting on a wheel chock to prevent it from turning. The other rear wheel will then be used to measure total rear axle (4001) backlash.

5. Rotate the free wheel slowly, by hand, until a feel of driving the rear axle is encountered. Position a crayon or chalk firmly on the side of the tire 305mm (12 inches) from the center of the wheel. Rotate the wheel slowly in the opposite direction until the feel of driving the rear axle is encountered again.

6. Measure the length of the crayon or chalk mark on the tire. If the length of the mark is 25.4 mm (1 inch) or less, the rear axle backlash is within allowable limits.

7. If the chalk mark is greater than 25.4 mm (1 inch), check for these conditions:

   a. Elongation of the differential pinion shaft (4211) holes in the differential case.
   b. Missing differential (4026), pinion, or differential side gear thrust washer (4228).
   c. Galling of the differential pinion shaft and bore.
   d. Excessive ring gear and pinion backlash. Follow procedure for type of rear axle, to check backlash.

Bearing Whine

Bearing whine is a high-pitched sound similar to a whistle. It is usually caused by malfunctioning pinion bearings, which are operating at driveshaft speed. Bearing noise occurs at all driving speeds. This distinguishes it from gear whine which usually comes and goes as speed changes.

Chatter on Corners

Chatter on corners is a condition where the whole rear end vibrates only when the vehicle is moving. The vibration is plainly felt and heard. In conventional axles, extra differential thrust washers cause a condition of partial lockup that creates this chatter. Chatter noise on Traction-Lok® axles can usually be traced to erratic movement between adjacent clutch plates and can be corrected with a lubricant change that includes friction modifier additive.

Click at Engagement

Click at engagement is a condition on axles of a slight noise, distinct from a "clunk," that happens in REVERSE or DRIVE engagement. It can be corrected by installing a rear axle drive pinion shaft oil slinger (4670) between the rear axle universal joint flange and differential pinion bearing.

Axle Shaft Noise

Axle shaft noise is similar to gear noise and differential pinion bearing whine. However, axle shaft bearing noise will normally distinguish itself from gear noise by occurring in all driving modes (drive, coast and float), and will persist with transmission in NEUTRAL while vehicle is moving at problem speed. If the vehicle makes this noise, remove suspect axle shafts, replace rear wheel bearings and install a new set of axle seals. Re-evaluate vehicle for noise before removing any internal components.

Bearing Rumble

Bearing rumble sounds like marbles being tumbled. This condition is usually caused by a malfunctioning wheel bearing. The lower pitch is because the wheel bearing turns at only about one-third of driveshaft speed. Wheel bearing noise also may be high-pitched, similar to gear noise, but will be evident in all four driving modes.

Analysis of Inoperative Conditions

If the axle fails to operate, there will be broken or jammed-up parts. Analyze why the parts have broken to prevent the condition from recurring.

Broken Axle Shaft

Inspect a broken axle shaft (4234) for a twist in the spline next to the break.

Breaks that occur away from the spline or that are not accompanied by a twist in the spline may be caused by forging flaws and/or fatigue of the axle shaft.

Conditions that can cause a broken axle shaft include forging flaws or excessive impact load to the axle shaft as a result of a collision or other factors.

Broken Pinion Stem

The drive pinion stem can break at any time if the differential pinion bearing preload is not set up properly. If there is no preload, the differential pinion bearing (4630) will turn relative to the axle shaft. This galls the roller shaft and generates heat which can draw the temper away from the shaft.

Too much preload also generates bearing heat with the same result. The break normally occurs between the two differential pinion bearings.

Broken Welds

Rear axle housing welds, if completely broken, call for replacement of the rear axle housing (4010).

Wheel Bearing Malfunctions

Because of the severe loads they must handle, rear wheel bearings (1225) may require replacement at high mileage. If a rear wheel bearing fails at low mileage, it is often caused by overloading.

Axle Lockup

Lockup or seizure of the axle shaft usually indicates inadequate lubrication. The lubricant prevents friction and helps cool the parts as they heat up. Without enough lubricant, the heated parts get soft and may eventually weld together. Check for lubricant leaks after servicing.

Symptom Chart — Axle And Driveshaft Service

AXLE AND DRIVESHAFT SERVICE

Condition	Possible Source	Action
• Excessive Rear Axle Assembly Noise	• N.V.H. problem. (Noise, vibration and harshness.)	• PERFORM the N.V.H. tests to determine whether the noise is a N.V.H. caused by a rear axle problem. REFER to Section 00-04 .
	• Worn or damaged rear wheel bearing.	• PERFORM rear wheel bearing noise test. REFER to Section 00-04 . REPLACE rear wheel bearings if required.
	• Rear axle differential.	• ROAD TEST vehicle to ensure problem is rear axle noise rather than other system noise. REFER to Preliminary Diagnosis . REPAIR and REPLACE parts as required.
• Loud "Clunk" in the Driveline When Shifting from Reverse to Forward	• High idle speed.	• ADJUST idle speed.
	• Loose engine mounts.	• INSPECT, REPAIR as required.
	• Loose or worn driveshaft components, rear axle companion flange attaching nut below specs.	• RAISE vehicle, ROTATE driveshaft by hand to isolate problem as driveshaft or rear axle problem. REPAIR or REPLACE as required.
	• Rear axle shafts or differential.	• REMOVE and INSPECT. REPAIR as necessary.
	• Inoperative shock absorbers or loose rear springs or suspension arms.	• INSPECT, REPAIR or REPLACE as required.
	• Excessive backlash in axle, or transmission.	• PERFORM total backlash check of rear axle assembly. REPAIR or REPLACE as necessary.
	• Insufficient lubrication.	• ADD lubricant as required.
• Driveline "Clunk" as Vehicle Starts to Move Following a Brake Stop (Two-Piece Driveshaft)	• Loose rear spring U-bolts.	• TIGHTEN U-bolts to specification.

	• Worn or galled output driveshaft and coupling shaft splines. • Worn or galled driveshaft slip yoke splines. • Damaged driveshaft slip yoke seal. • Insufficient lubrication in driveshaft slip yoke.	• REMOVE the driveshaft from the vehicle. CLEAN the male splines and INSPECT for worn or galled splines. REPLACE if necessary. • CLEAN and INSPECT the female splines of the driveshaft slip yoke for worn or galled condition. REPLACE if necessary. • REPLACE seal. • Using a long handle (stencil type) brush, APPLY long life lube evenly on all the splines of the driveshaft slip yoke. REINSTALL driveshaft. **NOTE: INSTALL the driveshaft slip yoke making sure that the coupling shaft and driveshaft are in phase.**
• On Turns, the Rear Axle Has a High-Pitched Chattering Noise (Limited Slip Rear Axles Only)	• Improper lubricant. Refer to Maintenance Schedule in Section 00-03 for complete information. • Differential.	• ROAD TEST vehicle — DRIVE in tight circles, 5 clockwise and 5 counterclockwise. If chatter is still evident, FLUSH and REFILL — with specified rear axle lubricant, and dosage of friction modifier additive. (SEE Lubricant Specifications at the end of this section.) • REMOVE differential, REPAIR as required.
• Limited Slip Rear Axle Assembly Does Not Work in Snow, Mud or on Ice	• Differential.	• PERFORM Limited Slip Differential Operation Check in this section. REPAIR as required per Section 05-02C , Section 05-02D .
• Driveline Concerns	• Rear spring U-bolt loose. • Universal joint worn or improperly installed. • Coupling shaft driveshaft center bearing bracket improperly installed. • Excessive runout in rear axle companion flange or damaged universal joint. • Excessive lateral and radial tire and wheel runout.	• RETIGHTEN U-bolt. • REINSTALL or REPLACE universal joint. • Correctly INSTALL driveshaft center bearing bracket and REPLACE if damaged. • ROTATE rear axle companion flange 180 degrees and REINSTALL. RECHECK and if not acceptable, REPLACE rear axle companion flanges or rear axle shaft universal joint and REPAIR as required. • REFER to Section 04-04 .

	• Excessive driveshaft runout.	• REPLACE driveshaft or ROTATE driveshaft 180 degrees and CHECK for out-of-balance condition.
	• Driveshaft out of balance.	• REBALANCE driveshaft.
	• Driveline and pinion angles out of specification.	• ADJUST to specifications.
	• Binding, damaged or galled splines on driveshaft slip yoke.	• CHECK transmission for proper lubricant, and CLEAN and LAP splines. LUBRICATE splines with Premium Long-Life Grease XG-1-C or -K or equivalent meeting Ford specification ESA-M1C75-B.
• Noise Is the Same on Drive or Coast	• Road noise.	• Normal condition.
	• Tire noise.	• REBALANCE or REPLACE tire.
	• Front wheel bearing noise.	• ADJUST or REPLACE wheel bearings.
	• Improper driveline angles or phasing.	• ADJUST or CORRECT as required.
• Loud Clunk in the Driveline When Shifting from Reverse to Forward	• Loose or worn driveshaft components, rear axle companion flange attaching nut below specifications.	• INSPECT, REPAIR, REPLACE as required.
• Lubricant Leaking from the Pinion Seal, Axle Shaft Oil Seals or Support Arm to Housing	• Dirt or other debris is blocking vent.	• CLEAN rear axle housing vent.
	• Observe end yoke dust shield for damage in seal contact area or dust slinger.	• REPLACE end yoke and pinion seal if damage is found.
• Noise Tone Lowers as Vehicle Speed Is Lowered	• Tire noise.	• REBALANCE or REPLACE tire.
• Similar Noise Is Produced with Vehicle Standing and Driving	• Engine noise.	• REFER to Section 03-00 .
	• Transmission noise.	• REFER to appropriate transmission section.
• Vibration	• Refer to Section 00-04 .	• REFER to Section 00-04 .

• Noise Most Pronounced on Turns	• Differential side gears and pinion gears.	• REPLACE gears.
• Drive Noise, Coast Noise or Float Noise	• Wheel bearings or differential side bearings.	• ADJUST or REPLACE wheel or differential side bearings.
	• Ring gear and pinion.	• CHECK ring gear and pinion. ADJUST or REPLACE.

Component Tests

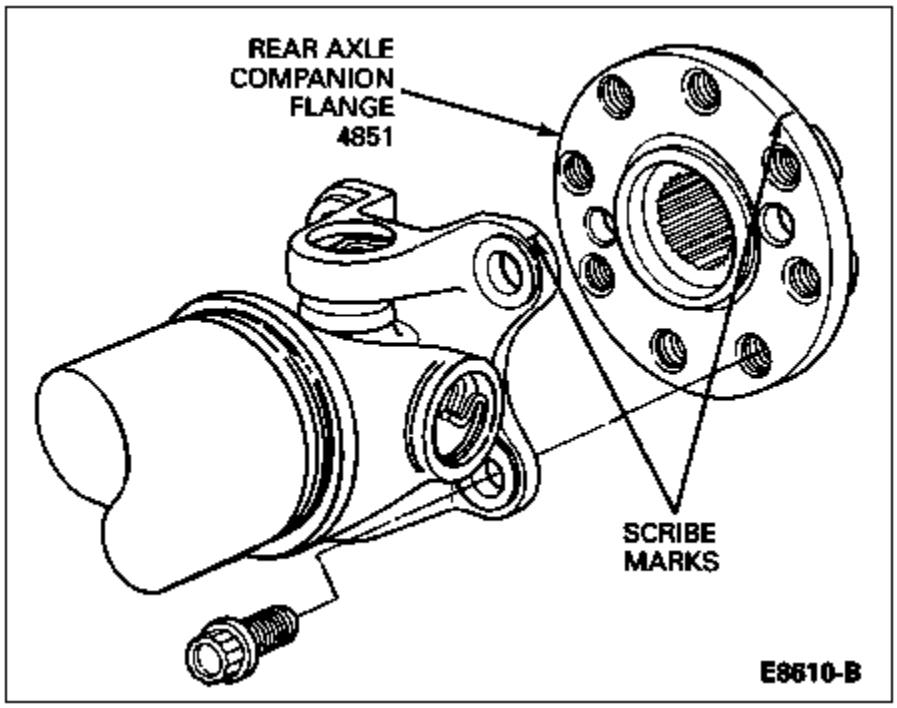
Driveline Vibration

Driveline vibration exhibits a higher frequency and lower amplitude than does high-speed shake. Driveline vibration is directly related to the speed of the vehicle and is usually noticed at speeds of 72 km/h (45 mph) or higher. Driveline vibration can be perceived as a tremor in the floor pan or is heard as a rumble, hum or boom. Driveline vibration can exist in all drive modes, but may exhibit different symptoms depending upon whether the vehicle is accelerating, decelerating, floating or coasting. If the vibration is particularly noticeable during acceleration or deceleration, especially at lower speeds, then driveline angle should be checked. Driveline vibration can be duplicated by supporting the axle upon a hoist or upon jackstands, though the brakes may need to be applied lightly in order to simulate road resistance.

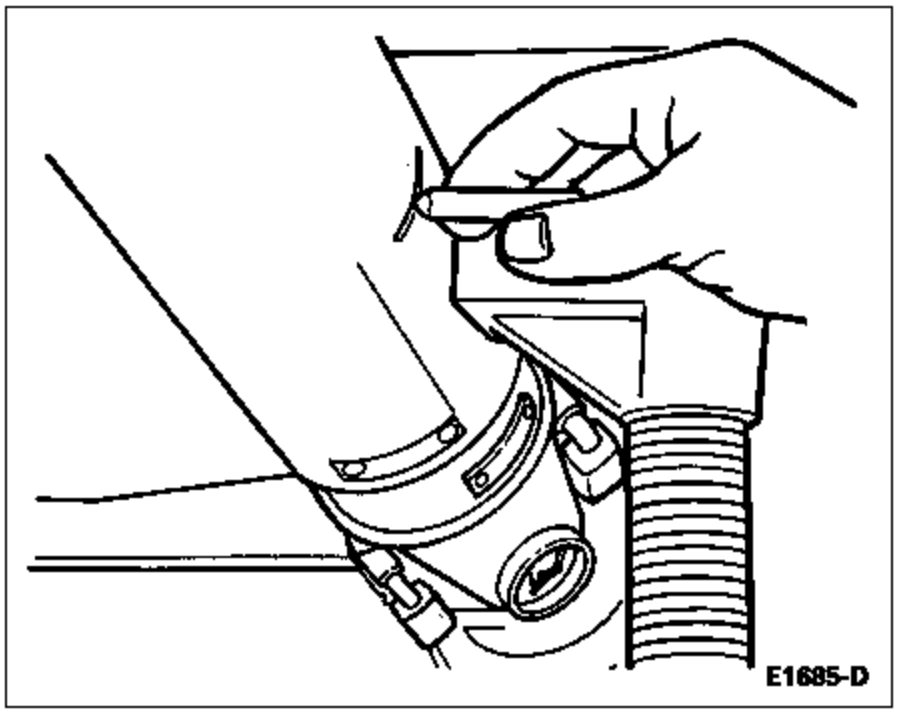
1. Raise vehicle promptly after road-testing, on twin-post hoist or jackstands, to prevent tire flat-spotting. Engage drivetrain and run-up to observed road test speed to verify presence of vibration. If not evident, check non-driving wheels with wheel-balancer spinner to rule out imbalance as a possible cause. On 4x4's, unlock front hubs or remove hub covers before spinning wheels. If required, balance non-driving wheels and repeat road test. If vibration is still evident, proceed to Step 3.

2. If vibration appeared in road-speed hoist test, mark relative position of drive wheels on rear axle assembly (4006) or hub lugs to permit reinstallation in original position, and remove wheels. Secure brake drums, if present, by installing all lugnuts in reversed position and repeat road-speed run-up. If vibration is gone, see drive wheel runout and balance procedures in Section 04-04 . If vibration persists, proceed to Step 3.

3. Inspect driveshaft (4602) for signs of physical damage, missing balance weight, undercoating, or improperly seated, worn, or binding universal joints. Check the index marks (paint spots) on rear of driveshaft and rear axle companion flange. If these marks are more than 45 degrees apart, disconnect driveshaft and reindex to align marks as close as possible. Clean driveshaft and replace universal joints as necessary, or replace driveshaft if damaged. After any corrections are made, recheck vibration at road test speed. If gone, reinstall wheels and road test. If vibration persists, proceed to Step 4.



4. With vehicle on hoist and wheels off, measure runout at front, center, and rear of driveshaft with indicator, rotating driveshaft by turning a brake drum or rotor. On a one-piece driveshaft, if runout exceeds 0.89 mm (0.035 inch) at front or center, the driveshaft must be replaced. If front and center are within this limit, but rear runout is not, mark the rear runout high point and proceed to Step 5. If runout is within limits at all points, proceed to Step 7 or Adjustments, Driveshaft Balancing .

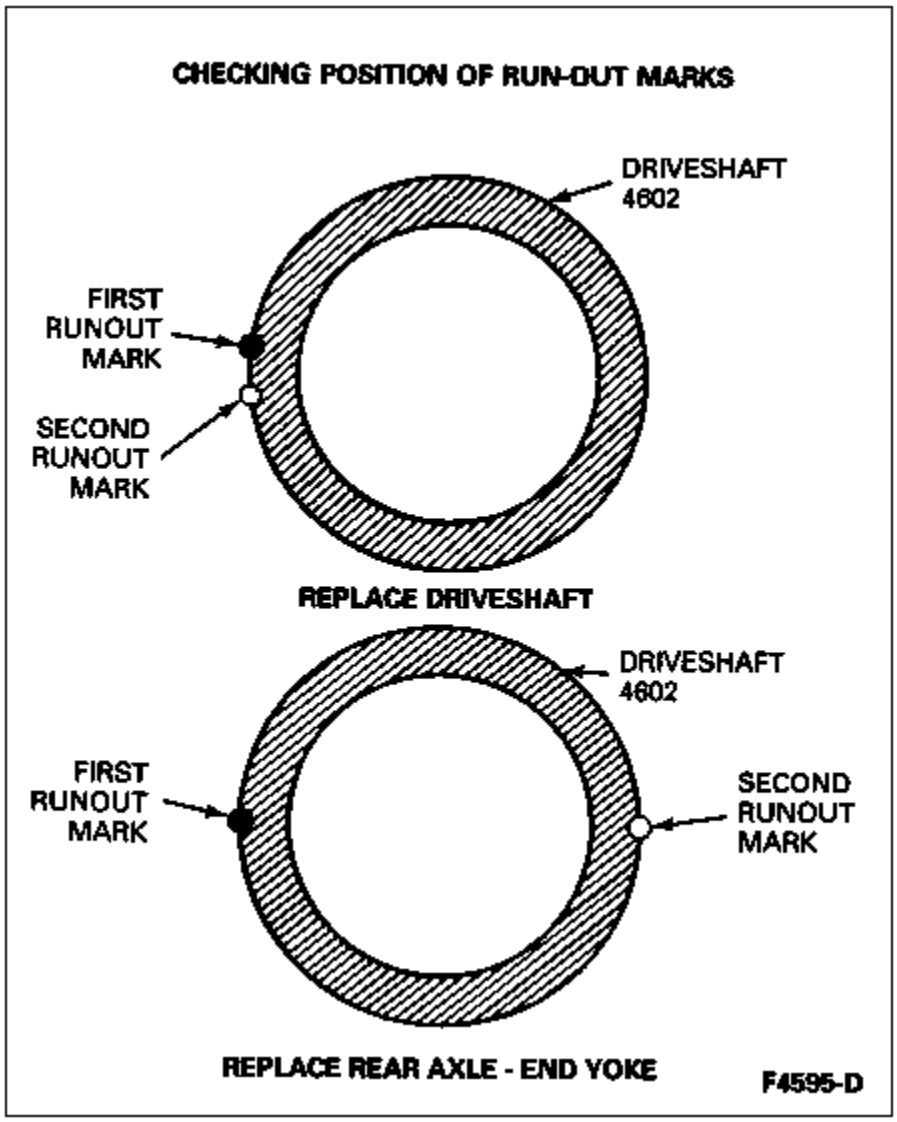


5. **NOTE: Move universal joints in each direction of rotation during reindexing. If a universal joint**

feels stiff or has a gritty feel in any direction, replace the rear axle shaft universal joint (4249).

Circular rear axle companion flanges can be indexed in 45-degree increments to fine tune the runout condition. Check runout at rear of driveshaft, and if still over 0.89 mm (0.035 inch), mark high point and see Step 6. If runout is no longer excessive, check for vibration at road test speed, and, if still present, reindex the driveshaft slip yoke (4841) on the transmission output shaft 180 degrees and road test the vehicle. If the vibration persists, proceed to Step 7 or Adjustments, Driveshaft Balancing .

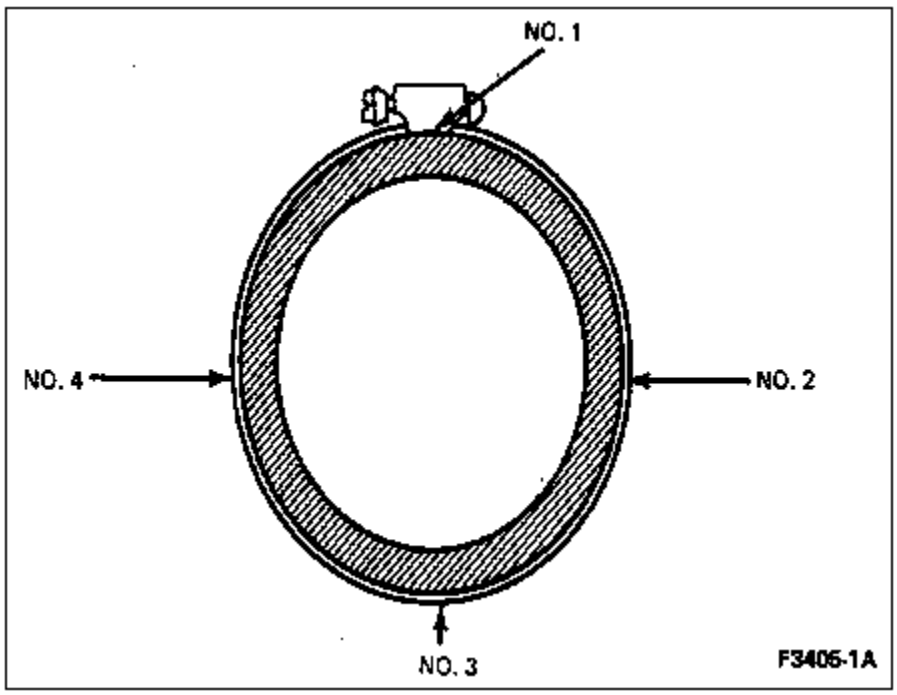
6. Excessive driveshaft runout may originate in the driveshaft itself or in the rear axle companion flange. To determine which, compare the two high points marked in Steps 4 and 5. If the marks are close together, within about 25mm or 1 inch, the shaft is eccentric, and should be replaced and checked for vibration. If the marks are on opposite sides of the driveshaft, about 180 degrees apart, the yoke or rear axle companion flange is responsible. After replacing, check for runout. When replacing a rear axle companion flange, driveshaft runout should not exceed 0.89 mm (0.035 inch). When runout is within limits, recheck for vibration at road speed. If vibration persists, balance the driveshaft.



7. Driveshaft balancing involves installing one or two hose clamps on the driveshaft, near the rear end of

a one-piece driveshaft. Best positioning of the hose clamp head(s) can be determined by trial-and-error, if special balancing equipment is not available.

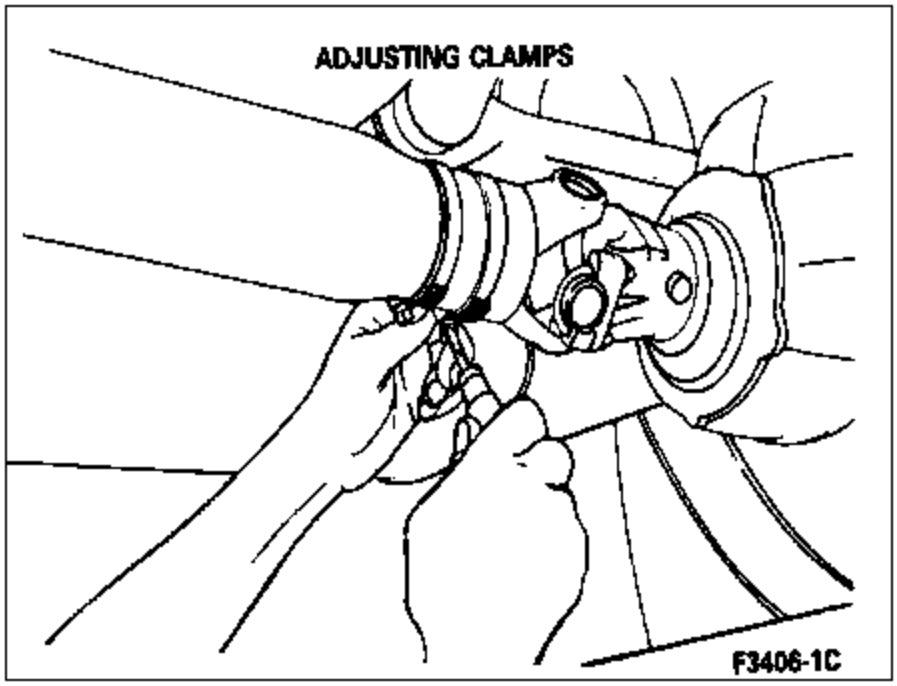
8. Mark off the rear of the driveshaft into four approximately equal sectors, and number the marks 1 through 4. Install a hose clamp on the driveshaft with its head at position No. 1. Check for vibration at road speed. Recheck with the clamp at each of the other positions, to find the position for minimum vibration. If two adjacent positions show equal improvement, position the clamp head between them.

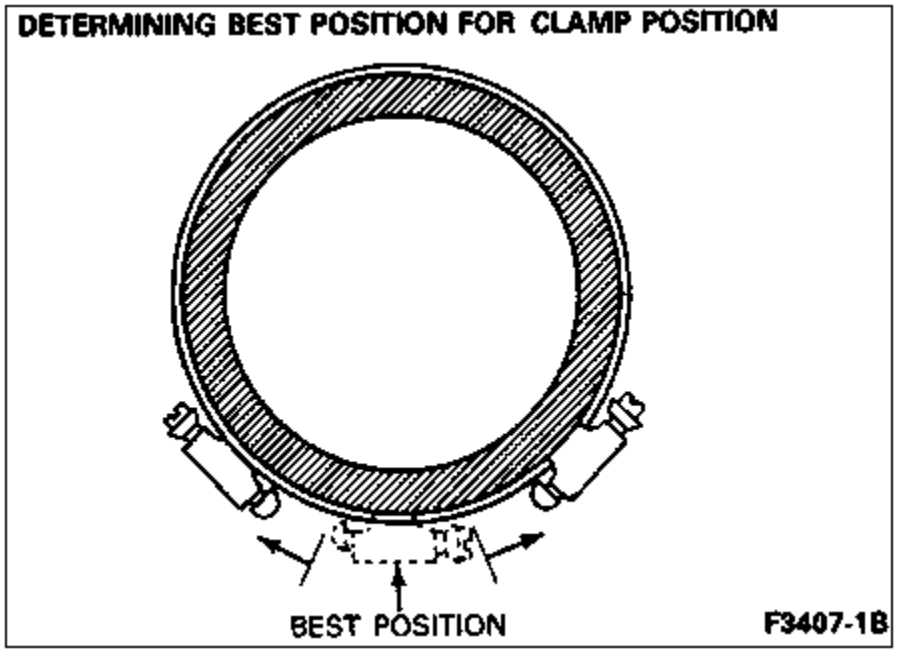


9. If condition is still not acceptable, add a second clamp at the same position and recheck vibration. If no improvement is noted, rotate the clamps in opposite directions, equal distances from the best position determined in Step 8. Initially, separate the clamp heads about 12 mm (1/2 inch), and recheck vibration at road speed.

   Repeat the process with increasing separation until the best combination is found, or vibration is reduced to an acceptable level.

10. Install wheels and road test, since vibration noticeable on the hoist may not be evident during the road test. If vibration is still not acceptable, replace the rear axle drive line vibration damper, if so equipped. If road test is not acceptable, replace ring gear and pinion.





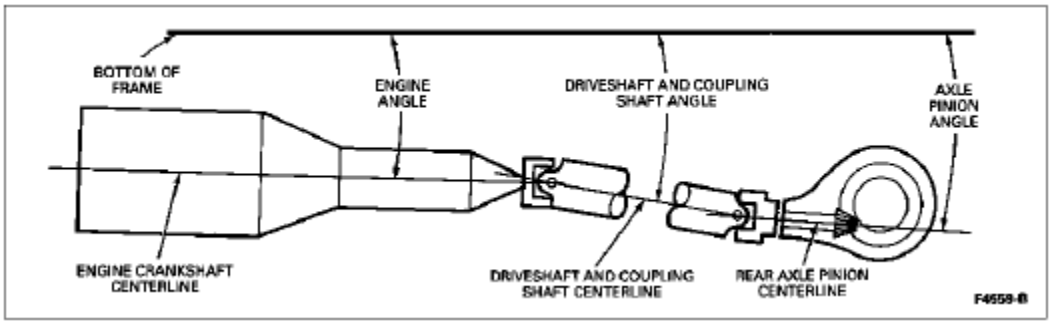
Driveline Angularity

Driveline angularity is the angular relationship between the engine crankshaft (6303), the driveshaft and the rear axle pinion. Factors determining driveline angularity include ride height (rear spring (5560)), and engine mounts.

Low speed vibration, less than 72 km/h (45 mph), especially when the vehicle is subjected to heavy acceleration or deceleration, is an indication of improper driveline angles. When these conditions exist,

check the universal joints for proper seating, mounting and operation.

Driveline Angularity



Driveshaft Vibrates

1. Road test vehicle to determine critical vibration points. Note road speed, engine rpm and shift lever positions at which vibration occurs.

2. Stop vehicle and run engine with clutch depressed (automatic transmission in neutral) through critical speed ranges determined in Step 1.

3. If vibration is gone, the driveshaft must be balanced as described in this section.

Limited Slip Differential

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Traction-Lok Torque Tool	T59L-4204-A

Bench Check

With Traction-Lok Torque Tool T59L-4204-A check the torque required to rotate one differential side gear (4236) while the other is held stationary. The initial breakaway torque should be no less than 27 Nm (20 lb-ft).

In-Vehicle Check

WARNING: A VEHICLE EQUIPPED WITH A LIMITED SLIP DIFFERENTIAL (4026) WILL ALWAYS HAVE BOTH WHEELS DRIVING. IF, WHILE THE VEHICLE IS BEING SERVICED, ONLY ONE WHEEL IS RAISED OFF THE FLOOR AND THE REAR AXLE (4001) IS DRIVEN BY THE ENGINE (6007), THE WHEEL ON THE FLOOR COULD DRIVE THE VEHICLE OFF THE STAND OR JACK.

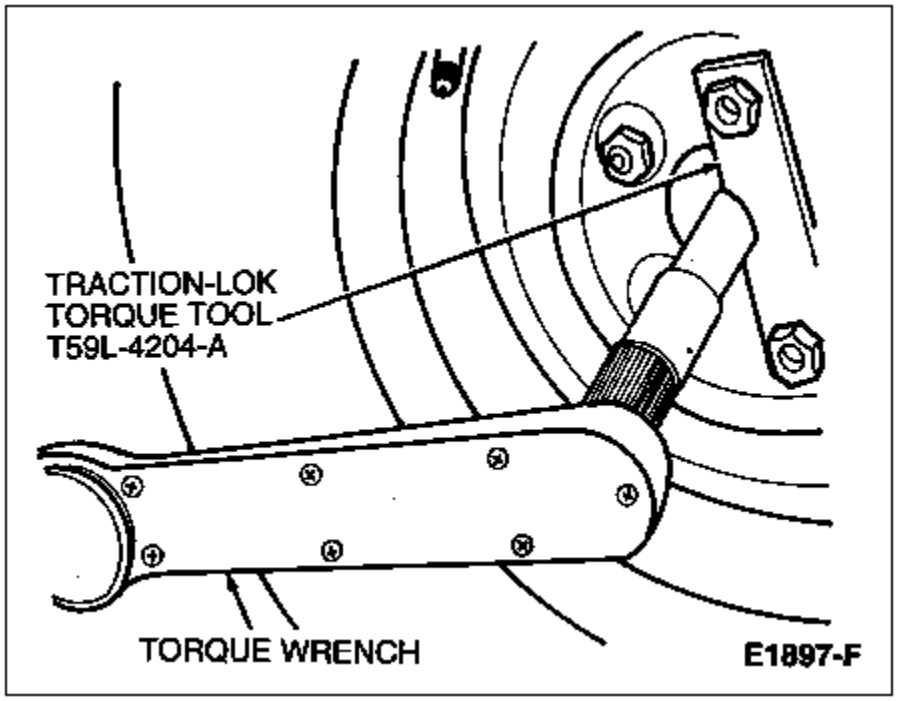
WARNING: AEROSTAR E-4WD VEHICLES WILL DRIVE OFF A JACK OR HOIST IF ANY WHEEL IS LIFTED OFF THE FLOOR, WITH THE ENGINE RUNNING AND THE TRANSMISSION (7003)

ENGAGED IN GEAR, OR MAY ROLL AWAY IF ANY WHEEL IS RAISED OFF THE FLOOR WITHOUT SETTING THE PARKING BRAKE.

A Limited Slip differential can be checked for proper operation without removing the differential case (4204) from the rear axle housing (4010).

Jack up one rear wheel and remove the wheel cover. Transmission must be in neutral and parking brake not applied.

Install Traction-Lok Torque Tool T59L-4204-A on the axle shaft flange studs as shown.



Using a torque wrench, rotate the axle shaft (4234). Be sure that the transmission is in neutral, one rear wheel is on the floor, and the other rear wheel is raised off the floor. The breakaway torque required to start rotation should be at least 27 Nm (20 lb-ft). The initial breakaway torque may be higher than the continuous turning torque, but this is normal. The axle shaft should turn with even torque throughout the check without slipping or binding. If the torque reading is less than specification, service the differential.

Differential Runout Check

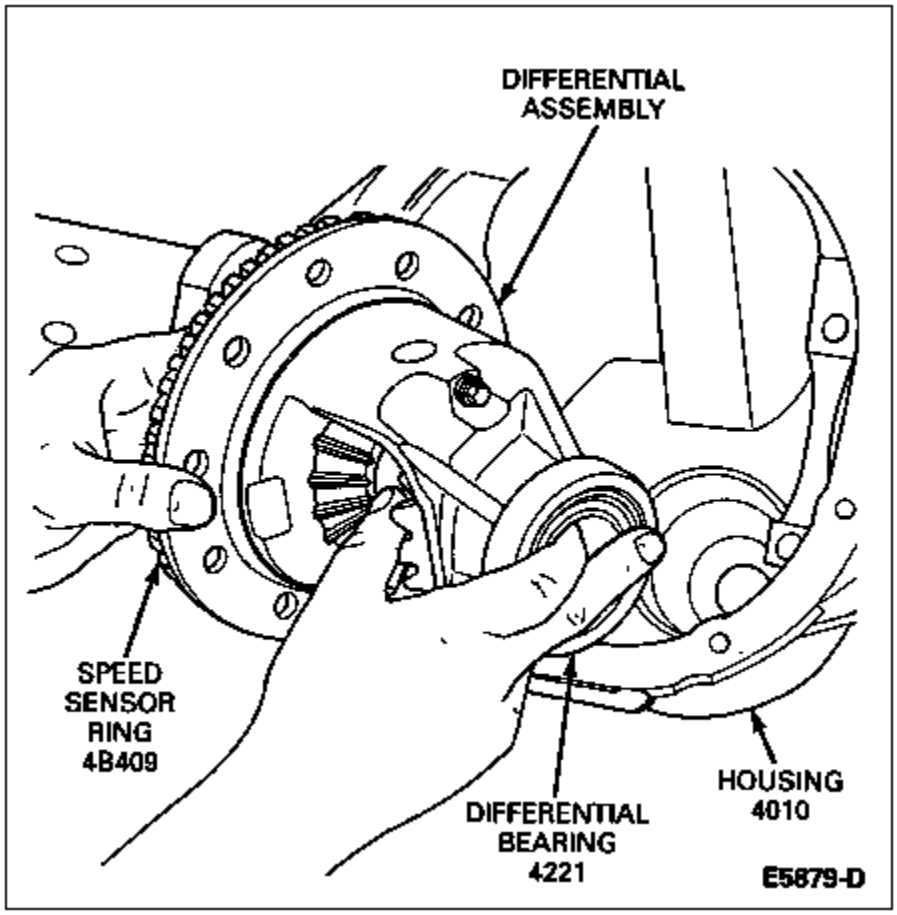
SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Differential Side Bearing Replacer	T57L-4221-A1

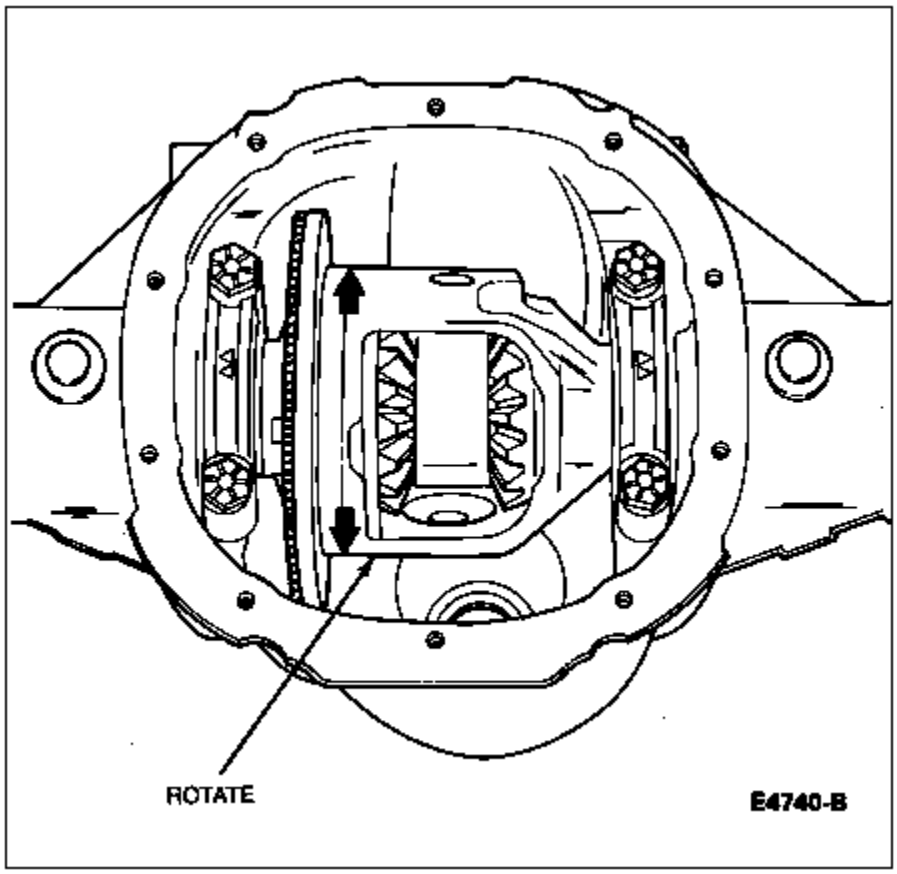
If the ring gear runout check (before disassembly) exceeds specification, the condition may be caused by a warped ring gear, a damaged differential case (4204), excessively worn differential bearings or foreign material between mating surfaces (burrs, shavings, etc.). To determine the cause of excessive runout, proceed as follows:

1. Remove the differential case from the axle housing (refer to Differential Case and Drive Pinion Removal in 05-02A or 05-02B) and remove the bolts that attach the ring gear to the differential case. Remove the ring gear from the differential case with a hammer and a drift.

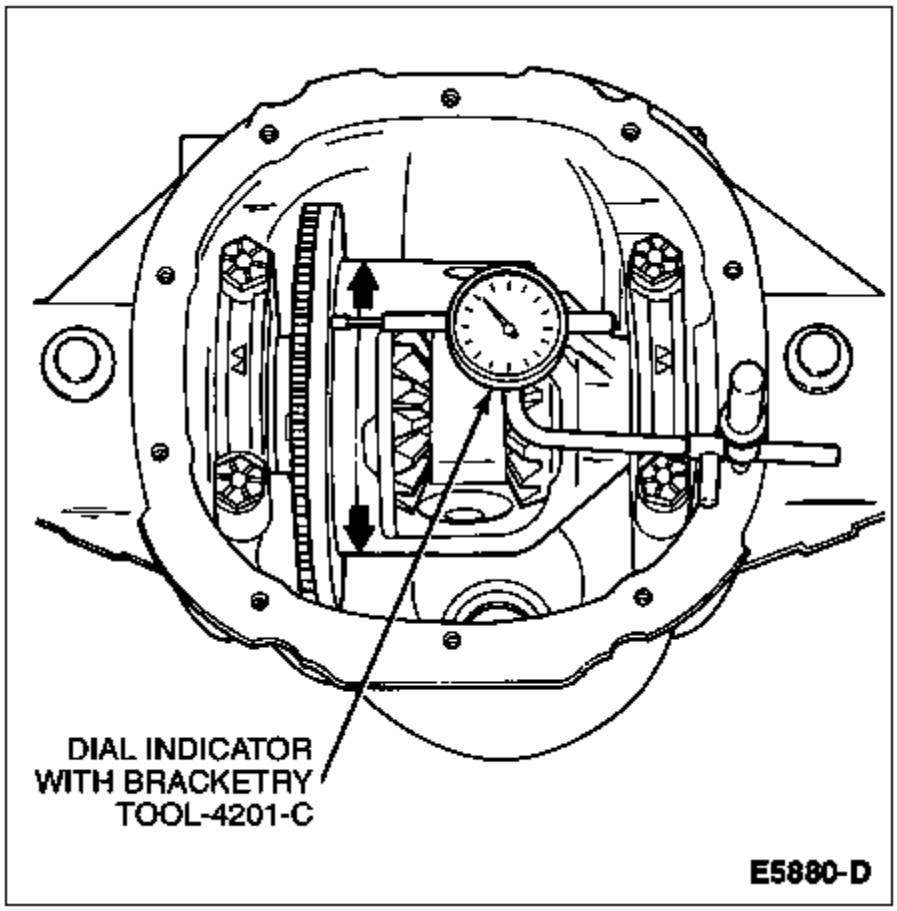
2. Install the differential assembly including the differential bearing cups (4222) and shims in the axle housing. Tighten the bearing cap bolts to 95-115 Nm (70-85 lb-ft).



3. Rotate assembly to ensure proper seating of differential bearings.



4. Check the runout of the differential case flange with a Dial Indicator with Bracketry TOOL-4201-C or equivalent. If the runout is within specification, a maximum of 0.076mm (0.003 inch), install a new ring and pinion gear. If the runout exceeds specification, the ring gear is true and the trouble is due to either a damaged differential case or differential bearings (4221). Visually inspect the differential bearings. If differential bearings are not damaged,replace both the differential case and differential bearings. Recheck the runout with new parts (differential case and differential bearings).



5. **NOTE: Press against the bearing cone only.**

   Install new differential bearings on the case hubs using Differential Side Bearing Replacer Tool T57L-4221-A1 and install the differential assembly in the carrier without the ring gear.

6. Check the differential case runout again with the new differential bearings. If the runout is now within limits, use the new differential bearings for assembly. If the runout is still excessive, the differential case is damaged and should be replaced.

Universal Joint Flange Runout Check, Rear Axle

Circular

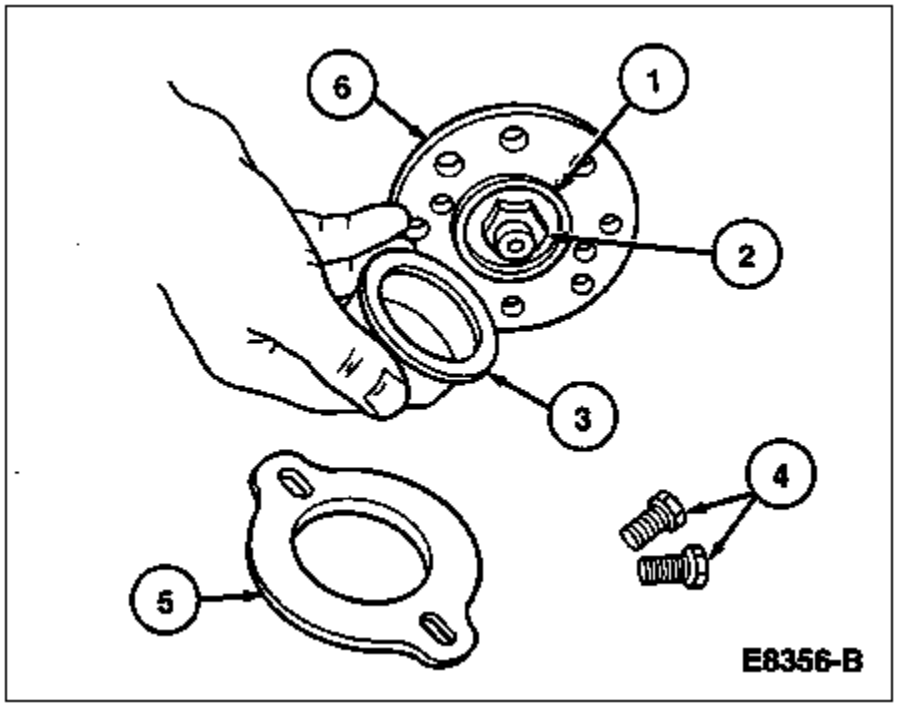
SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Companion Flange Runout Gauge	T92L-4851-B
Clamp Plate	T92L-4851-C

1. **CAUTION: This operation disturbs the pinion bearing preload. Pinion bearing preload must be reset if the pinion nut has been loosened or removed for rear axle universal joint flange (4851) reindexing or replacement.**

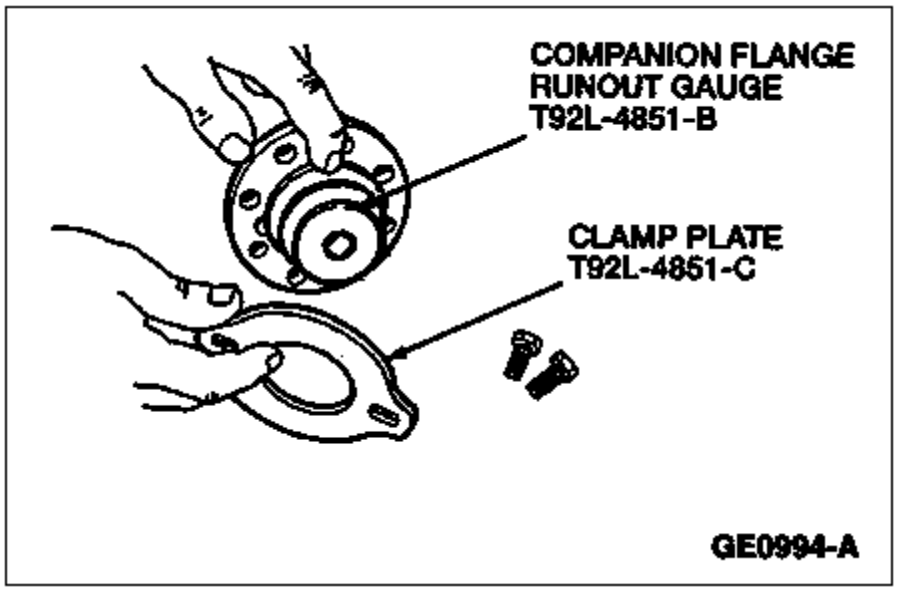
Raise the vehicle on a hoist that supports the rear axle (twin-post hoist). Refer to Section 00-02 .

2. Remove the driveshaft (4602) assembly. Refer to Section 05-01 .
3. Check the rear axle universal joint flange for damage.
4. Position Companion Flange Runout Gauge T92L-4851-B on rear axle universal joint flange.

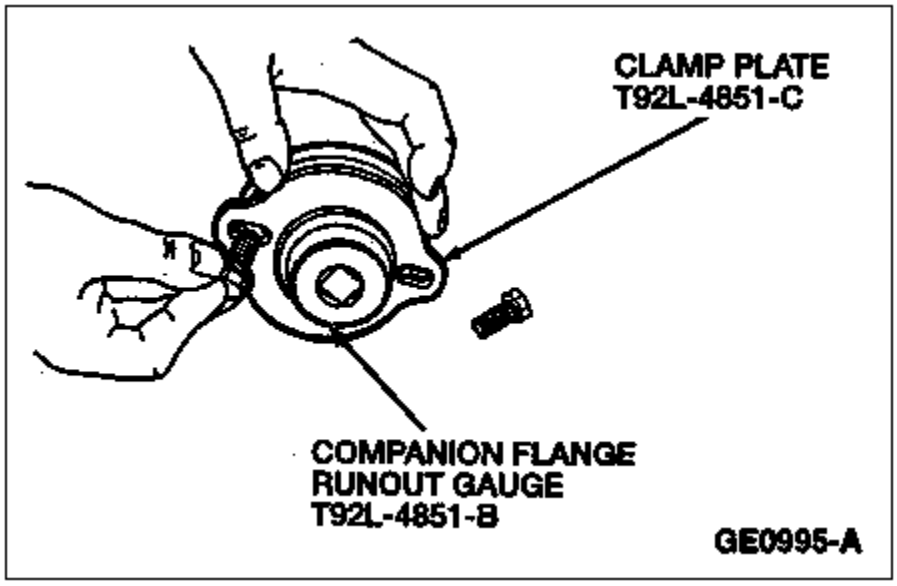


Item	Part Number	Description
1	—	Pilot (Part of 4851)
2	354845	Pinion Nut
3	T92L-4851-B	Companion Flange Runout Gauge
4	—	Bolts (2 Req'd) (Part of T92L-4851-C)
5	T92L-4851-C	Clamp Plate
6	4851	Rear Axle Universal Joint Flange

5. Install Clamp Plate T92L-4851-C on runout gauge.

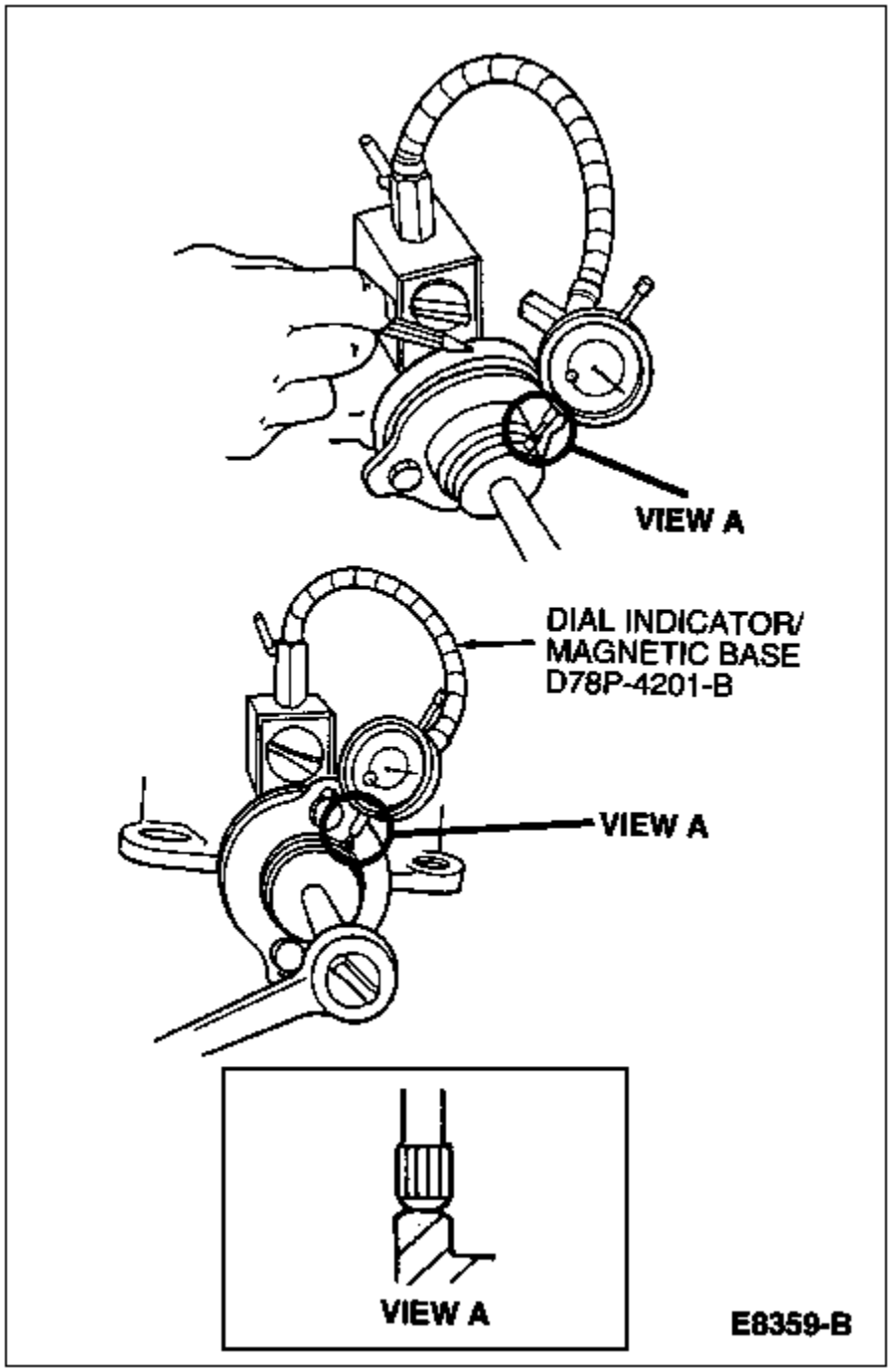


6. Align holes in clamp plate with holes in rear axle universal joint flange and install bolts. Snug bolts evenly.



7. **NOTE: Refer to Section 05-02B for rear axle universal joint flange Removal and Installation procedures.**

   Turn companion flange runout gauge as shown to locate and mark high spot on rear axle universal joint flange. If flange runout exceeds 0.010 inch, remove rear axle universal joint flange, reindex 180 degrees on pinion and reinstall. Check runout again. If necessary, rotate rear axle universal joint flange until an acceptable runout is obtained. If flange runout is still more than 0.010 inch, replace rear axle universal joint flange.



8. If excessive runout is still evident after replacement of the rear axle universal joint flange, replace the differential ring gear and pinion (4209) Repeat the above checks until runout is within specifications. Install the driveshaft assembly as outlined in Section 05-01 . Tighten bolts to 95-130 Nm (70-96 lb-ft).

Tooth Contact Pattern Check of Gearset

1. To check the gear tooth contact, paint the gear teeth with the special marking compound. A mixture that is too wet will run and smear; too dry a mixture cannot be pressed out from between the teeth.

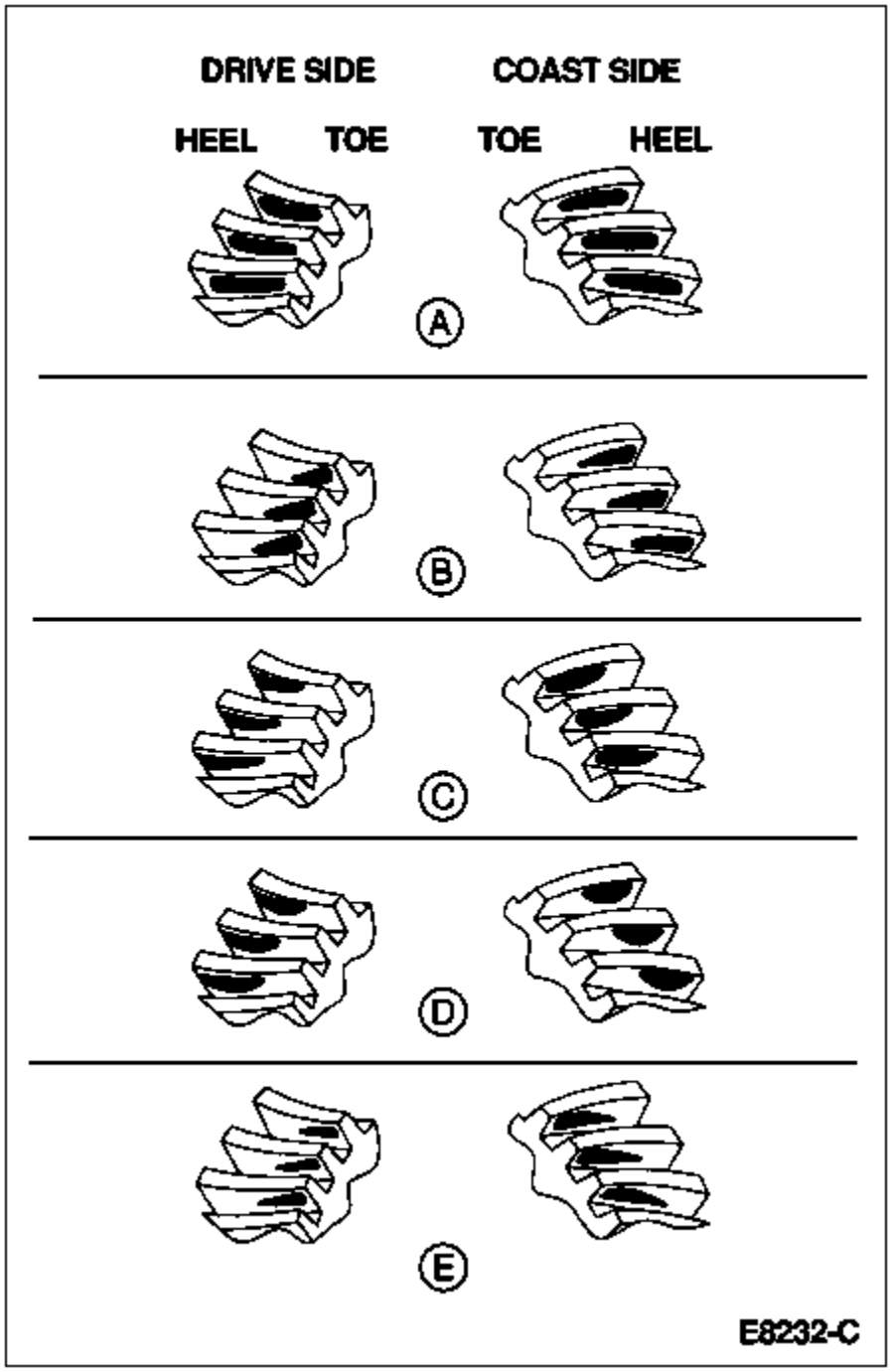
2. Rotate the ring gear (use a box wrench on the ring gear attaching bolts as a lever) several complete revolutions in both directions or until a clear tooth contact pattern is obtained.

3. Certain types of gear tooth contact patterns on the ring gear indicate incorrect adjustment. Incorrect adjustment can be corrected by readjusting the ring gear or the pinion.

4. The illustration shows acceptable tooth patterns for all axles. In general, desirable tooth patterns should have the following characteristics:

    a. The drive pattern should be fairly well centered on the tooth.
    b. The coast pattern should be fairly well centered on the tooth.
    c. Some clearance between the pattern and the top of the tooth is desirable.
    d. There should be no hard lines where the pressure is high.

    Contact Pattern Location



Item	Part Number	Description
A	—	Normal or Desirable Pattern (Part of 4209)
B	—	Backlash Correct. Thinner Pinion Position Shim Required (Part of 4209)
C	—	Backlash Correct. Thicker Pinion Position Shim Required (Part of 4209)
D	—	Pinion Position Shim Correct. Decrease Backlash

		(Part of 4209)
E	—	Pinion Position Shim Correct. Increase Backlash (Part of 4209)

Inspection Before Disassembly of Axle

Axle Backlash Check

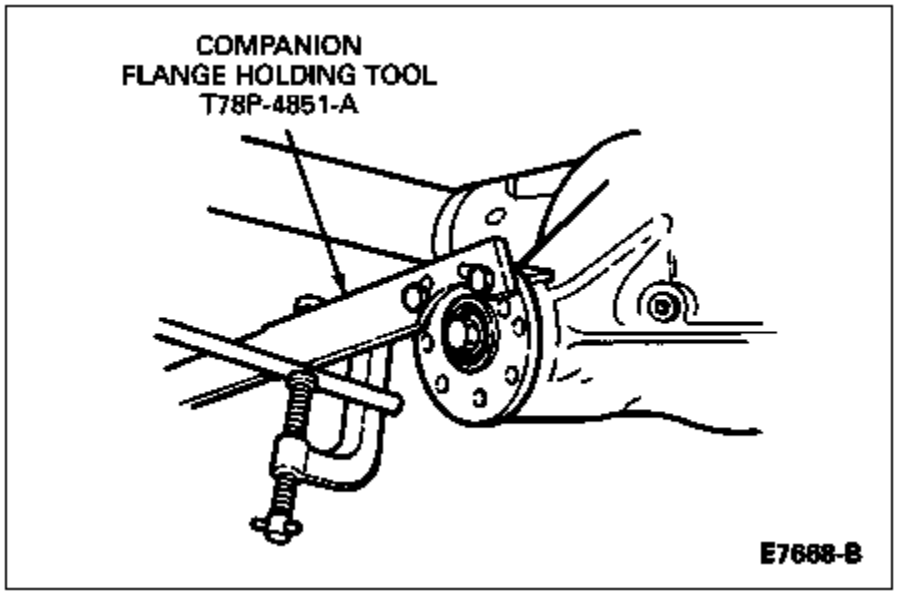
Clunk noise is due to backlash in the driveline, but not necessarily in the rear axle (4001). To determine whether driveline clunk is caused by the rear axle, make a check of the total axle backlash as follows.

1. **NOTE: Do not perform this procedure for limited slip axles. There is no effective way to check backlash on limited slip axles.**

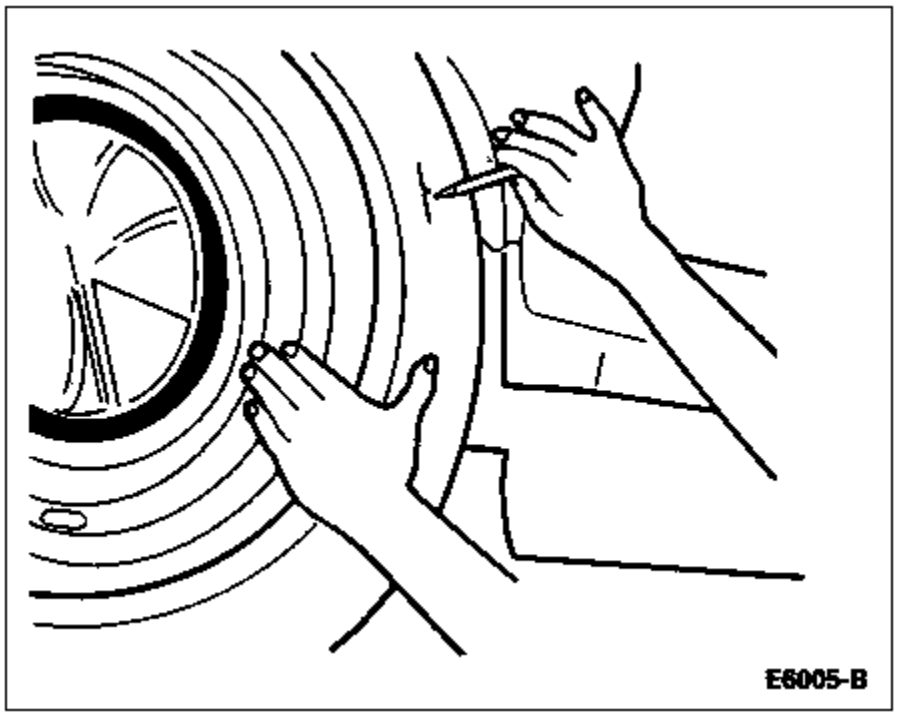
   Raise the vehicle on a frame or twin-post hoist so that the rear wheels are free.

2. Clamp a bar between the rear axle companion flange and a part of the frame or body so that the rear axle companion flange cannot move.

3. Lock the left rear wheel to keep it from turning.



4. Turn the right wheel slowly until you "feel" it in a drive condition. Hold a chalk marker on the side of the tire 304.8mm (12 inches) from the center of the wheel.



5. Turn the wheel the other way until you again feel the drive condition.

6. Measure the length of the chalk mark, which is the total axle backlash. **It should be 25.4mm (1 inch) or less.**

   If the backlash is within this limit, the clunk will not be eliminated by going into the axle.

7. Check for these conditions if the backlash is excessive:

   - Elongation of the differential pinion shaft holes in the differential case (4204).
   - Missing differential pinion thrust washer (4230) or differential side gear thrust washer (4228).
   - Galling of the differential pinion shaft (4211) and bore.

   If none of the above conditions show up, there may be a loose fit of the axle shafts (4234) to the side gear splines. You should continue as follows **until the correction is made.**

   - Install new differential side gear (4236) and recheck the backlash.
   - Install two new axle shafts.

Ring and Pinion Backlash Check

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Pinion Depth Gauge	T79P-4020-A

The differential case and drive pinion should be inspected before they are removed from the differential

carrier casting. These inspections can help find the cause of the concern and determine the correction needed.

1. Wipe the lubricant from the internal working parts and visually inspect the parts for wear or damage.

2. Rotate the gears to see if there is any roughness which would indicate worn or damaged bearings or gears.

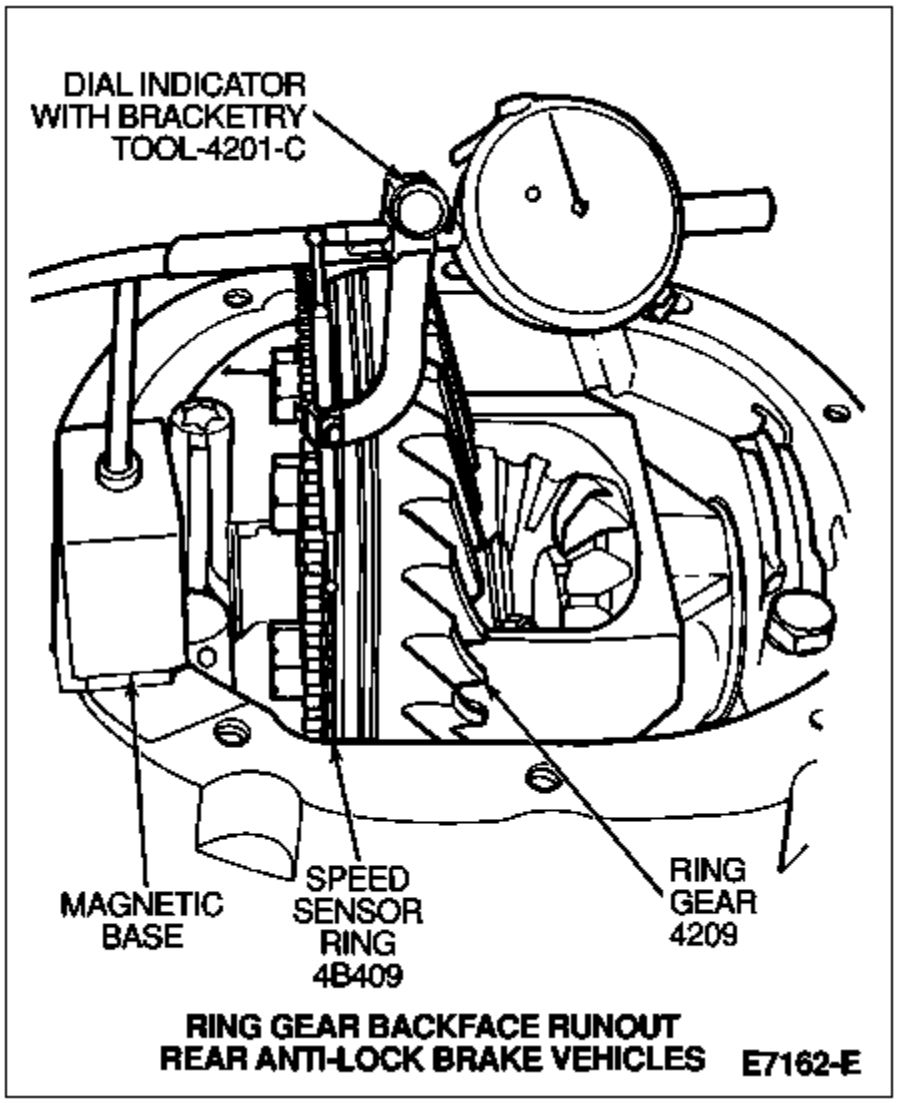
3. Check the ring gear and pinion teeth for signs of scoring, abnormal wear or nicks/chips.

4. **NOTE: On vehicles equipped with rear anti-lock brakes (RABS), mount Dial Indicator with Bracketry TOOL-4201-C or equivalent on the carrier so the tip of the dial indicator contacts the backface of the ring gear and pinion. There is a space provided between the anti-lock speed sensor ring and the ring gear and pinion for measuring ring gear and pinion backface runout.**

   Set up a dial indicator, and check ring gear and pinion backlash and ring gear and pinion backface runout.

5. **NOTE: Mount Dial Indicator with Bracketry TOOL-4201-C or equivalent on the carrier so the tip of the dial indicator contacts the backface of the ring gear (part of ring gear and pinion). There is a space provided between the anti-lock speed sensor ring and the ring gear from measuring ring gear backface runout.**

   Position dial indicator as shown and check ring gear backface runout.



RING GEAR BACKFACE RUNOUT
REAR ANTI-LOCK BRAKE VEHICLES E7162-E

Inspection After Disassembly of the Axle

Thoroughly clean all parts. The pinion seal is a synthetic rubber and must not be cleaned, soaked or washed in cleaning solvents. Always use clean solvent when cleaning bearings. Oil the bearings immediately after cleaning, to prevent rusting. Inspect the parts for wear or damage. If rust is present, remove with a wire brush mounted on a power drill or equivalent. Rinse clean with metal-prep solvent on sponge or rag to remove all particles. With a clean sponge, coat tube interior with Dupont 3012-5 Red Oxide Preparakote or equivalent. Allow to dry for a minimum of one hour.

When a scored ring gear and pinion is replaced, the axle housing should be washed thoroughly. Inspect individual parts as outlined below.

Gears

Examine the teeth of ring gear and pinion for scoring or excessive wear. Worn gears cannot be rebuilt to correct a noisy condition. Gear scoring is the result of excessive shock loading, vehicle loading, or the use of an incorrect lubricant all of which contribute to the loss of lubricating film between the two gears. Scored gears cannot be reused. Examine the teeth and thrust surfaces of the differential gears. Wear on the hub of the differential side gear can cause a chucking noise known as chuckle when the vehicle is driven at low speeds. Wear of splines, thrust surfaces, or thrust washers, can contribute to excessive driveline backlash.

Bearing Cups and Cone and Roller Assemblies

Check bearing cups for rings, scores, galling, or excessive wear. Pinion bearing cups must be solidly seated in the housing bores. Check for seating by attempting to insert a 0.04mm (0.0015-inch) feeler gauge between these cups and the bottoms of their bores.

When operated in the bearing cups, cone and roller assemblies must turn without roughness. Examine the large roller ends for wear. If the original blend radius has worn to a sharp edge, the bearing should be replaced.

If inspection reveals either a worn bearing cup or a worn cone and roller, both parts should be replaced to avoid damage.

Rear Brake Anti-Lock Sensor

Inspect the rear brake anti-lock sensor for loose metal particles, and clean if required. Note any indication of rear axle assembly (4006) lubricant leakage through core of rear brake anti-lock sensor or around perimeter. Replace as required.

Anti-Lock Speed Sensor Ring

Examine the anti-lock speed sensor ring to see that it is firmly pressed on to the differential case (4204) and check it for damaged (dented, chipped or missing) teeth that could result in erratic RABS performance. If damage is found, remove and replace anti-lock speed sensor ring.

Universal Joint Flange, Rear Axle

Be sure that the surfaces of the rear axle companion flange have not been damaged in removing the driveshaft (4602) or in removing the rear axle companion flange from the rear axle assembly. The end of the rear axle companion flange that contacts the front differential pinion bearing inner race or slinger washer, as

well as the flat surface of the pinion nut counterbore, must be smooth. Polish these surfaces if necessary. Note also the barrel of the rear axle companion flange for any damage which could permit the pinion seal to leak. Roughness aggravates backlash noises and causes wear of the rear axle companion flange and pinion nut, with a resultant loss in pinion bearing preload.

Differential Housing

Make sure that the differential bearing bores are smooth (if applicable). Remove any nicks or burrs from the mounting surfaces of the differential carrier housing.

Differential Case

Make sure that the hubs where the bearings mount are smooth. Carefully examine the differential case bearing shoulders, which may have been damaged when the bearings were removed. The bearings will fail if they do not seat firmly against the shoulders. Check the fit (free rotation) of the differential side gears in their counterbores.

NOTE: Care should be taken to prevent damage to the anti-lock speed sensor ring while handling and servicing the differential case.

Damper Assembly, Rear Axle

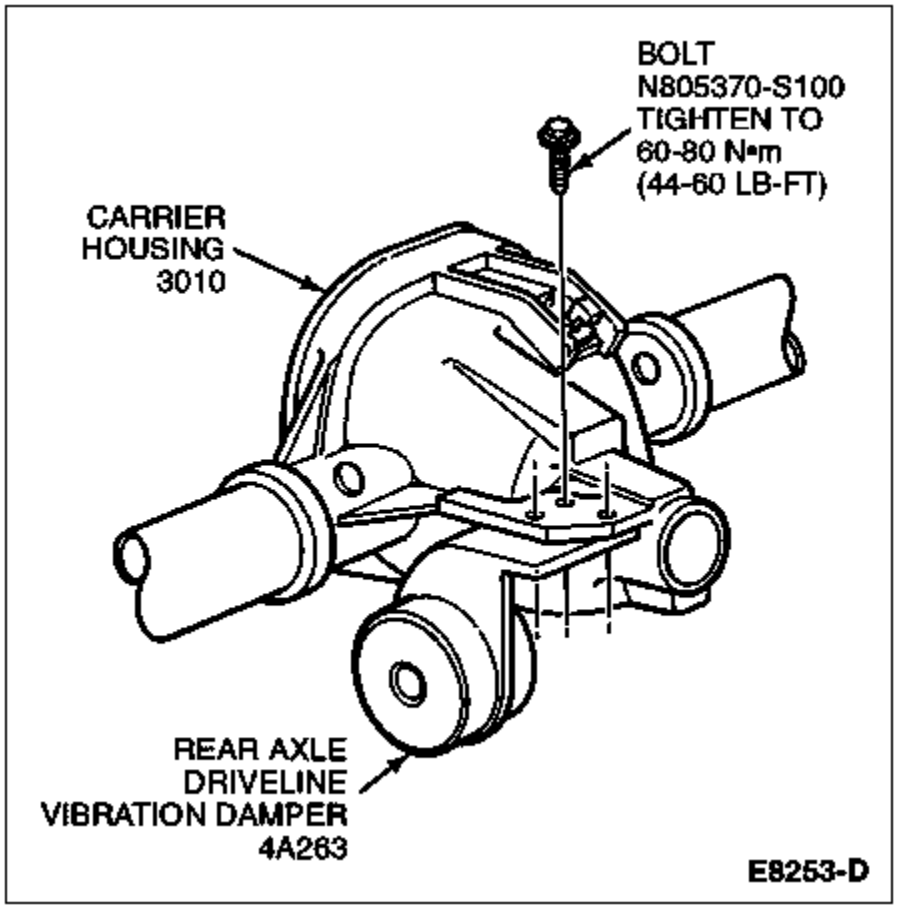
Aerostar

A rear axle drive line vibration damper (4A263) is located on the right side of the carrier. Use the following procedure for removal and installation.

Removal and Installation

1. Remove the bolts that attach the rear axle drive line vibration damper to the carrier. Discard bolts.
2. Remove damper assembly from carrier.

   For Installation, follow removal steps in reverse order. Tighten new rear axle driveline vibration damper bolts to 60-80 Nm (44-60 lb-ft).



Limited Slip Differential Parts

Inspect the differential clutch packs for uneven or extreme wear. The tanged clutch plates must be free from burrs, nicks or scratches which could cause excessive or erratic wear to the internally splined clutch plates. The internally splined clutch plates should be inspected for condition of the material, and wear. Replace the clutch plates if their thickness is less than 1.5mm (0.059 inch) or if the material is scored or badly worn. Inspect the clutch plate internal teeth for wear. Replace them, if excessive wear is evident.

Clutch plates should be replaced as a set only. Examine all thrust surfaces and hubs for wear. Abnormal wear on these surfaces can contribute to a noisy rear axle assembly (4006).

Wheel Bearing and Seal

Straight roller bearings are used in semi-floating rear axle assemblies, which are used in all light trucks under 8551 GVW. The bearing rides on the axle shaft (4234). The seal has internal lips running against the seal internal surface.

Full service procedures for these bearings and axle shaft oil seals (3254) are provided in Section 05-02A or Section 05-02B .

Axles

Certain rear axle assembly (4006) and driveline concern symptoms are also common to the engine (6007), transmission (7003), rear wheel bearing (1225), tires, and other parts of the vehicle. For this reason, be sure that the cause of the concern is in the rear axle assembly before adjusting, repairing or replacing any of the parts. Refer to Section 00-04 .

Coupling Shaft Angle Adjustment

Check coupling shaft angle (Ranger S/C only) and adjust to specification by shimming the driveshaft center bearing support (4800) or the transmission-to-rear crossmember mount.

To decrease the coupling shaft angle:

Shim the driveshaft center bearing support using flat shims until the specified coupling shaft angle is obtained. Plate stock must be used to maintain proper preload compression of the rubber insulator.

To increase the coupling shaft angle:

Place shims under the transmission-to-rear crossmember mount until the specified coupling shaft angle is obtained.

Driveline Angle Correction

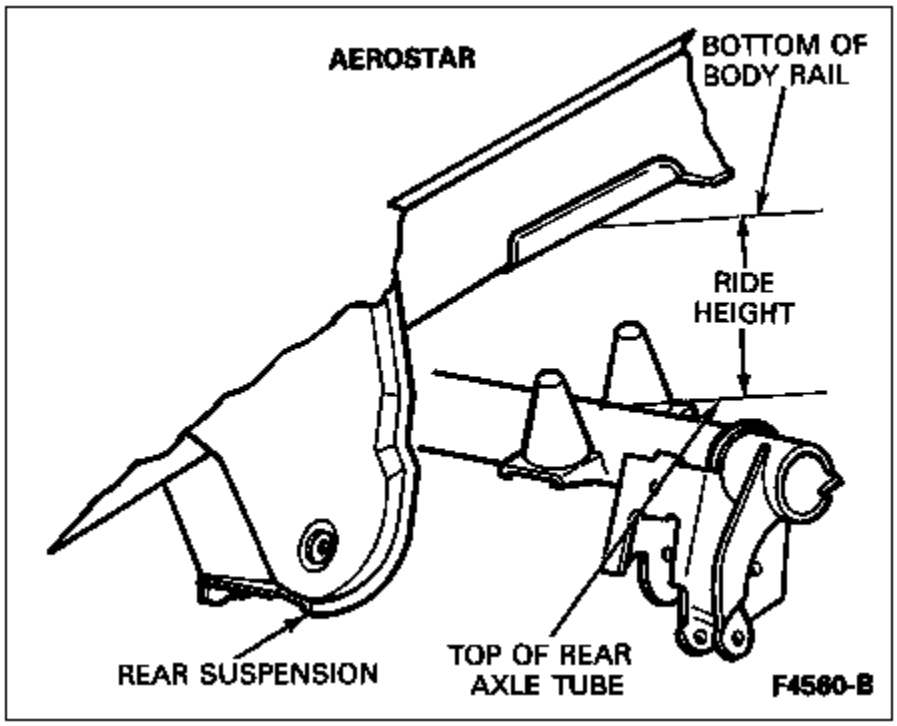
SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Pinion Angle Level Gauge	T68P-4602-A

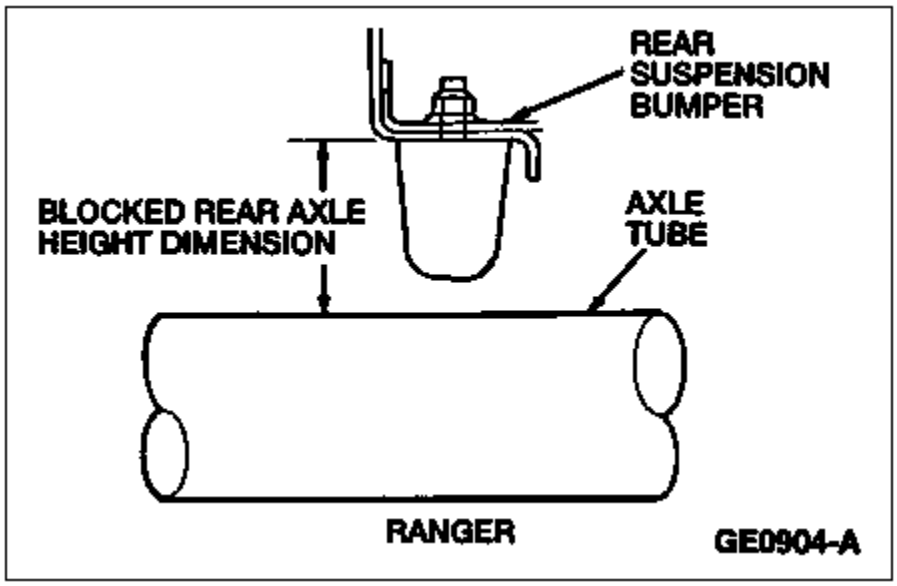
1. **NOTE: Driveline angles are given in relation to a 0-degree longitudinal (fore-aft) unibody frame rail angle and are specified for individual components. Refer to the Specifications portion of this section for the specified engine (6007), driveshaft (4602) and pinion angle.**

   Raise the vehicle on a drive-on type hoist or back onto a front-end alignment rack. Jounce the vehicle to normalize the suspension and make sure the suspension components are in the normal-load condition.

2. On Aerostar, measure the ride height between the top of the axle tube and the bottom of the unibody frame rail. The vehicle must be in the curb weight (unloaded) condition.



On Ranger measure the ride height between the top of the axle tube and the bottom of the frame rail. The vehicle must be in the curb weight (unloaded) condition.



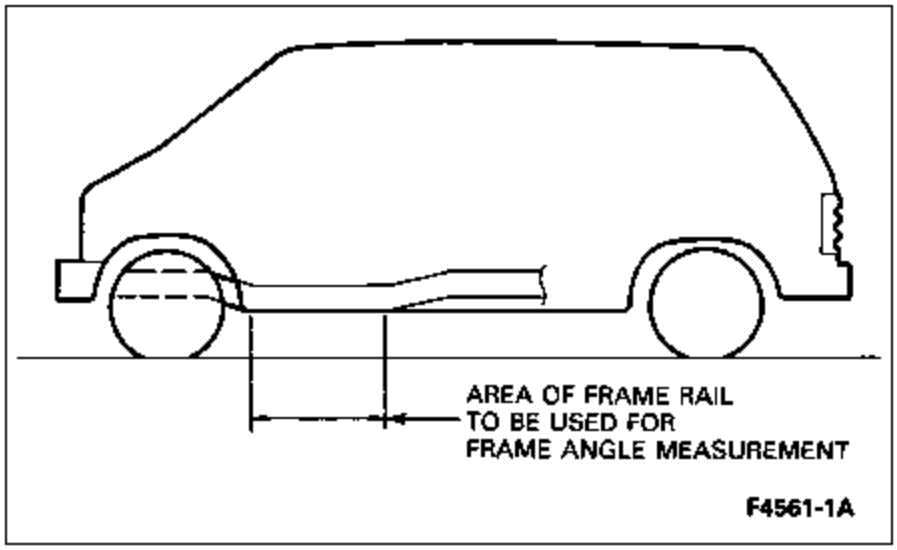
Find the recorded ride height in the Driveshaft Angle chart in the Specifications portion of this section. The specified driveshaft angles correspond to the measured ride height.

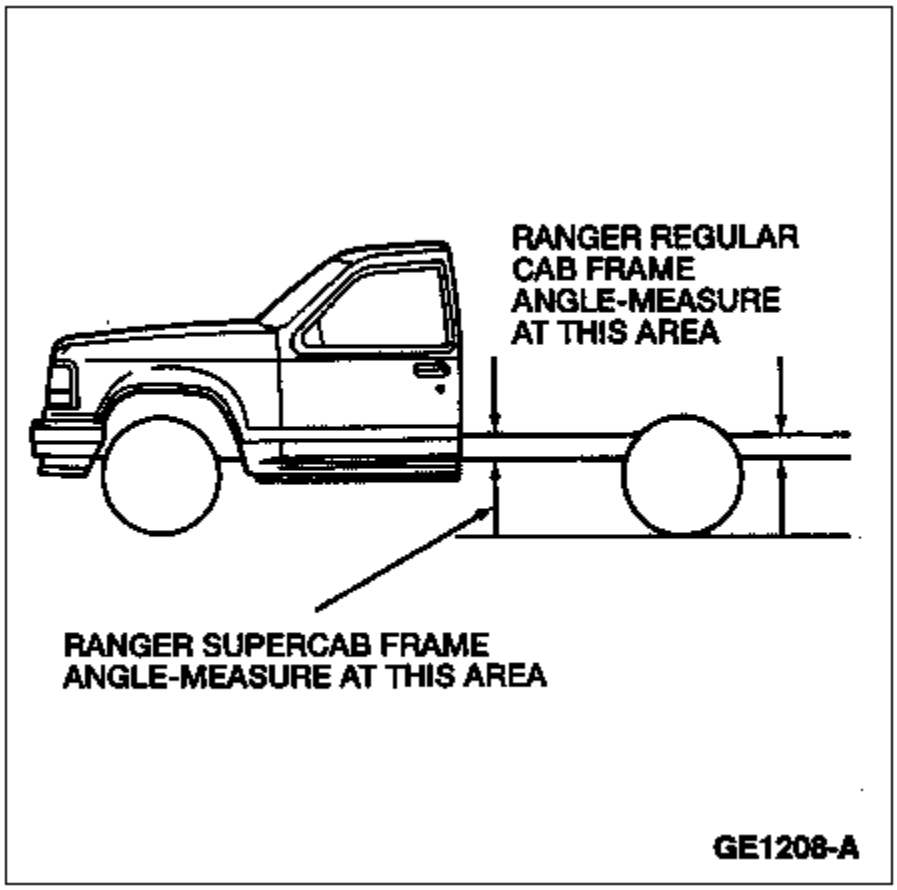
3. Check driveline angles with Pinion Angle Level Gauge T68P-4602-A as described in next step, or with an adjustable bubble (spirit level) protractor as described in Step 5.

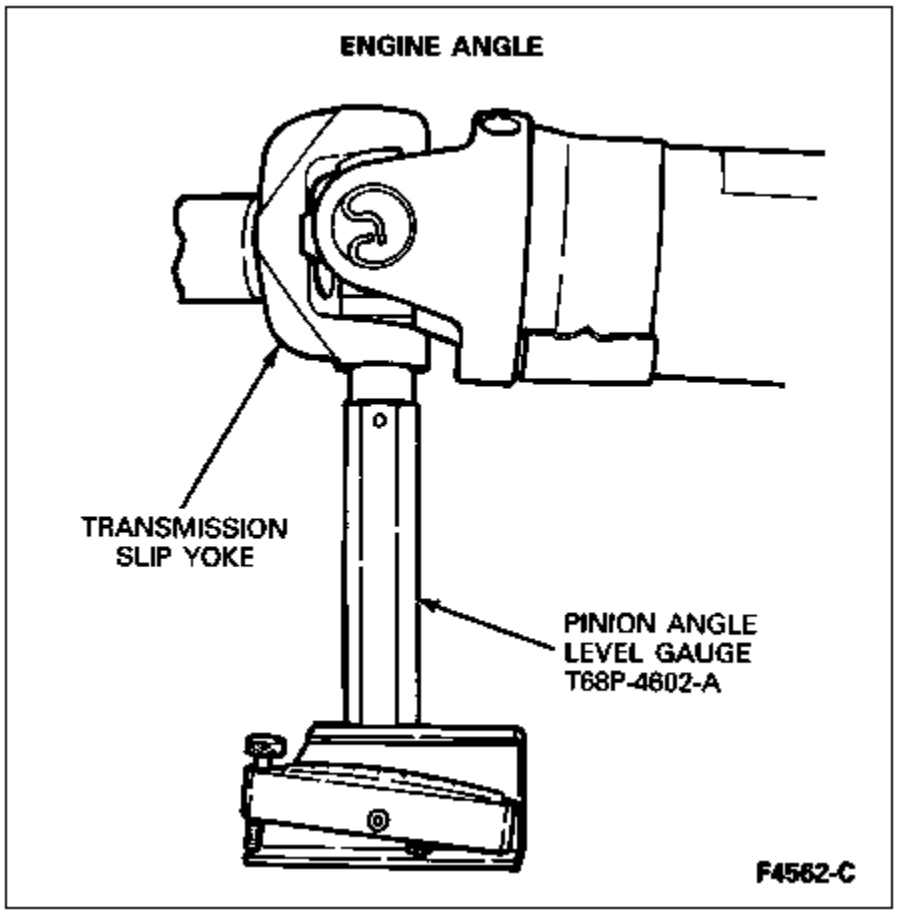
    - The protractor is used when the tool kit is not available or when the angles to be measured are more than 12 degrees.
    - All angles should be read within 1/2 degree with the tool or protractor held plumb on a clean, flat surface.

4. To check driveline angle with Pinion Angle Level Gauge T68P-4602-A:

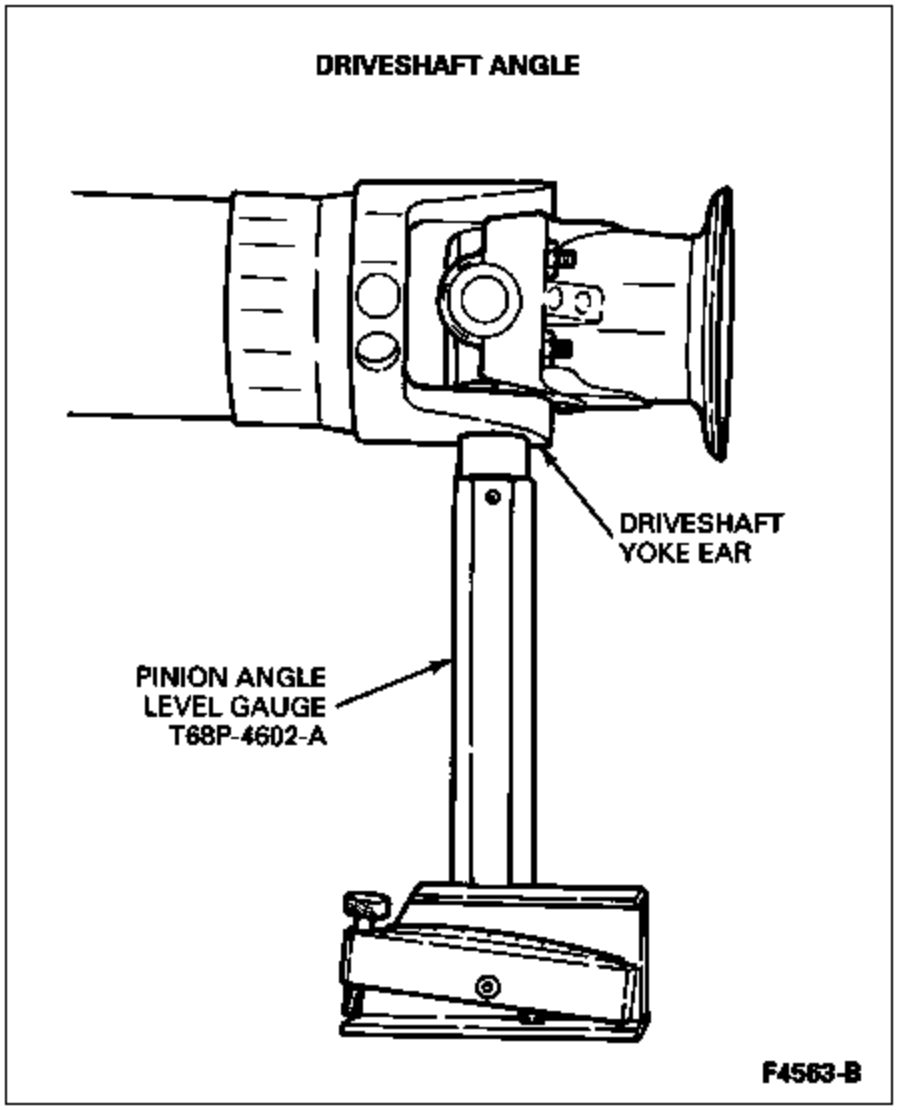
    - On Aerostar, place the vee magnet of the tool on the bottom of the vehicle unibody frame directly below the front drive/passenger seat.
    - On Ranger, place the vee magnet of the tool on the bottom of the vehicle frame directly behind the rear axle area.
    - On the Ranger SuperCab it is more accurate to measure the frame angle at the frame center bearing crossmember.
    - Calibrate the tool to a "zero" bubble reading. This gives the 0-degree frame reference angle. Take and average the readings from both sides to obtain a more accurate reading.

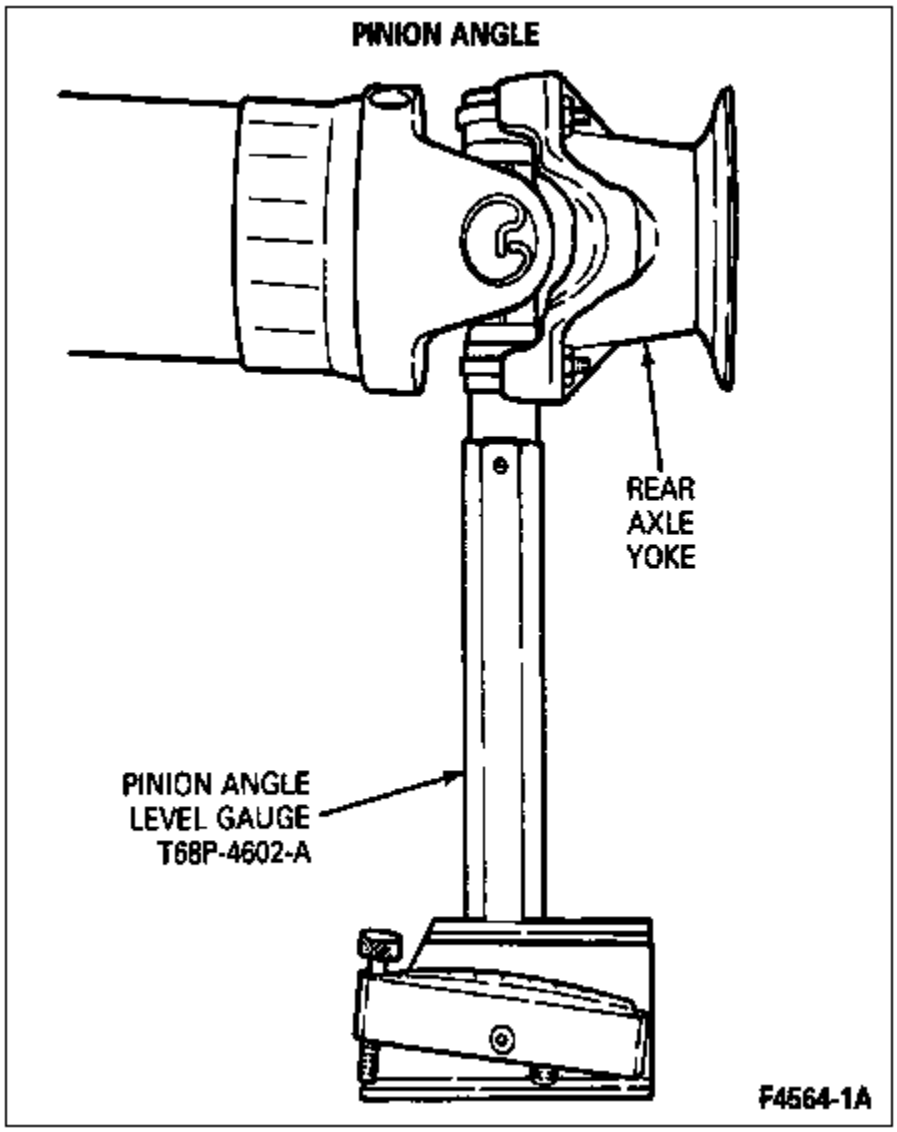

AREA OF FRAME RAIL
TO BE USED FOR
FRAME ANGLE MEASUREMENT
F4561-1A


RANGER REGULAR
CAB FRAME
ANGLE-MEASURE
AT THIS AREA
RANGER SUPERCAB FRAME
ANGLE-MEASURE AT THIS AREA
GE1208-A

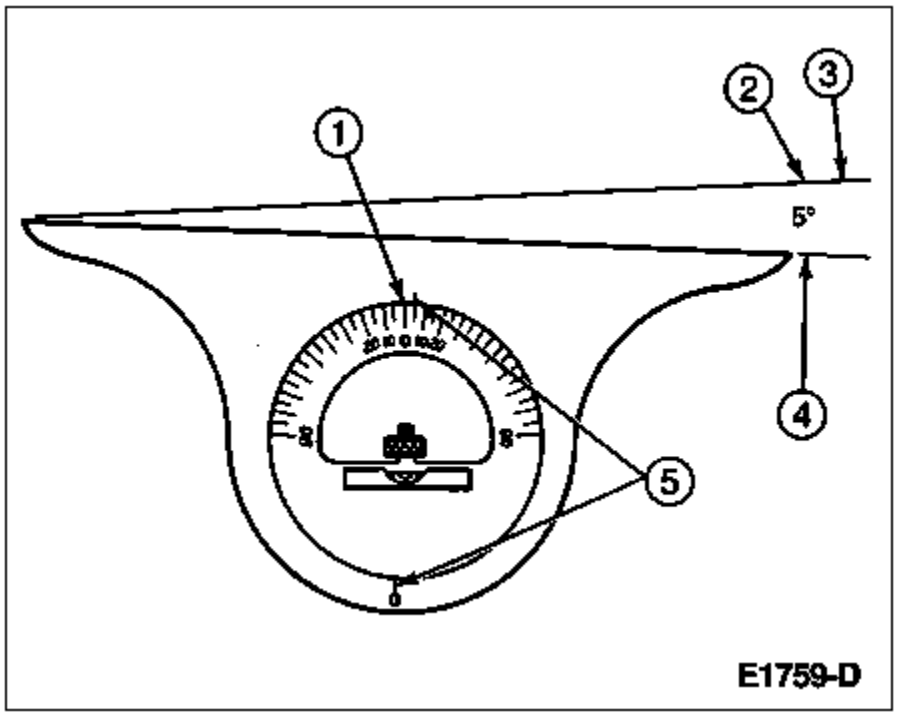


The angle of the component is measured by mounting the tool to the bearing cap of the U-joint which is mounted to the component. Engine angle is the same as the angle of the transmission/transfer case flange and measured by mounting the tool to the U-joint cap in the yoke.


DRIVESHAFT ANGLE
DRIVESHAFT
YOKE EAR
PINION ANGLE
LEVEL GAUGE
T68P-4602-A
F4563-B



Since the spirit level cannot be zeroed relative to the frame, the measured frame angle reading will have to be added/subtracted from the measured reading before comparing to specification.

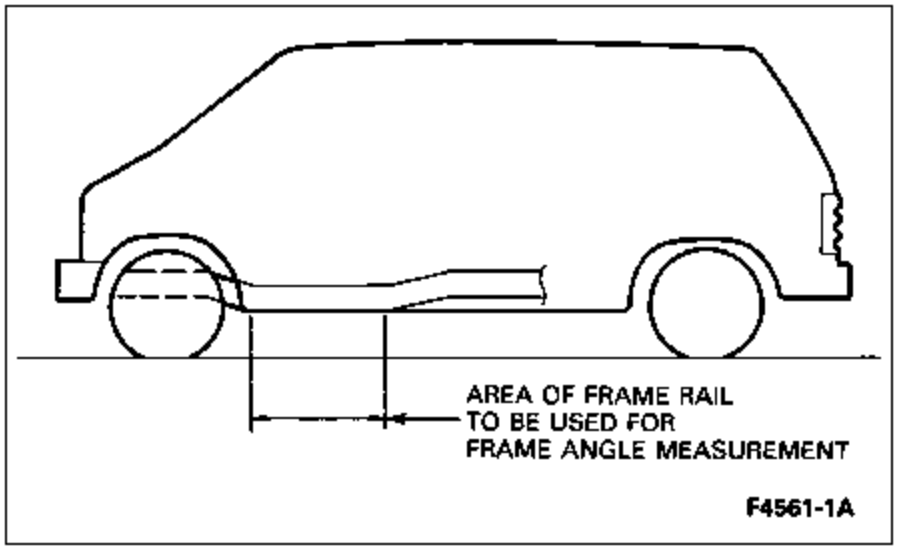


Item	Part Number	Description
1	—	Protractor Zero (0) Degree Mark
2	—	A Five (5) Degree Angle Is Read from the Zero (0) Degree Mark
3	5005	Frame
4	—	Component Angle
5	—	Protractor Indexing Marks

5. **NOTE: When using a bubble (spirit level) protractor, the angles are read from the 0-degree frame angle. When using the protractor in a vertical position, the 90-degree mark on the protractor is read as the 0-degree frame angle. For example, when the protractor is placed on the component and the protractor reads 85 degrees, the component angle is actually 5 degrees.**

   Driveline angle check with adjustable bubble (spirit level) protractor:

   - On Aerostar, place the protractor on the bottom of the vehicle unibody frame directly below the front driver/passenger seat.
   - On Ranger Regular Cab, place the protractor on the bottom of the vehicle frame directly behind the rear axle area.
   - On Ranger SuperCab, place the protractor on the bottom of the vehicle frame next to the center bearing crossmember attaching rivets. This gives the 0-degree frame angle. Take and average the readings from both sides to obtain a more accurate reading. Use this average measurement as a reference point to compare measured driveline angles.



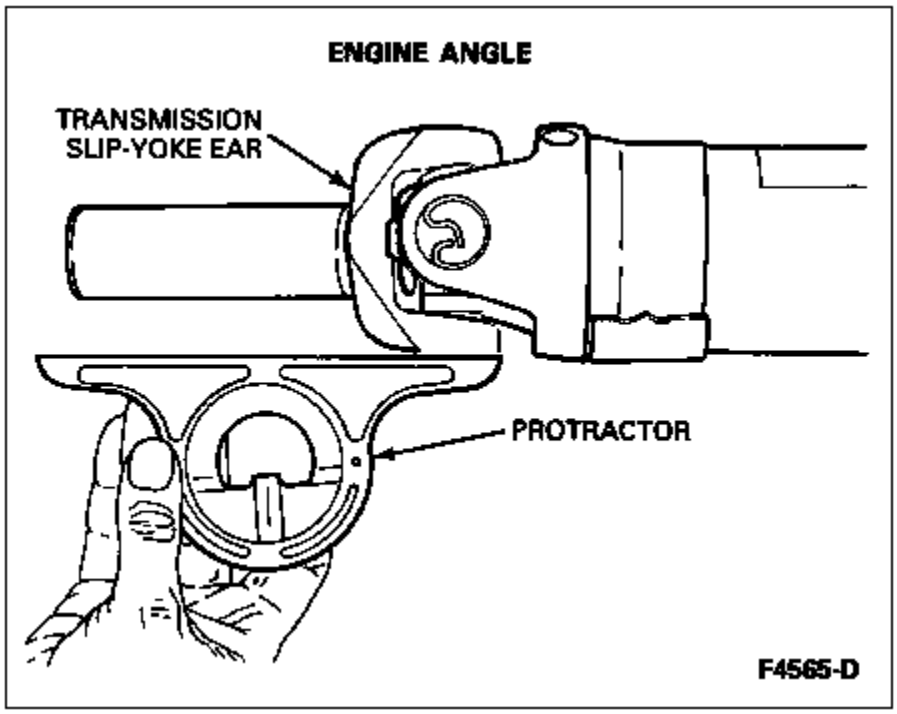
To check the engine angle, rotate the driveshaft until one transmission slip-yoke ear is parallel to the floor. Place the protractor so it is flush against the slip-yoke ear. Make sure the protractor is not resting against any portion of the driveshaft assembly. Record the angle reading. Adjust for frame angle.

- If the engine angle reading differs from the specified angle by 1 degree or more, proceed to Engine Angle Adjustment in this section and normalize the engine and transmission mounts. Refer to Diagnosis and Testing in this section.
- With the engine angle at specifications, check the driveshaft and pinion angles. Refer to Rear Driveshaft Angle Specifications at the end of this section.

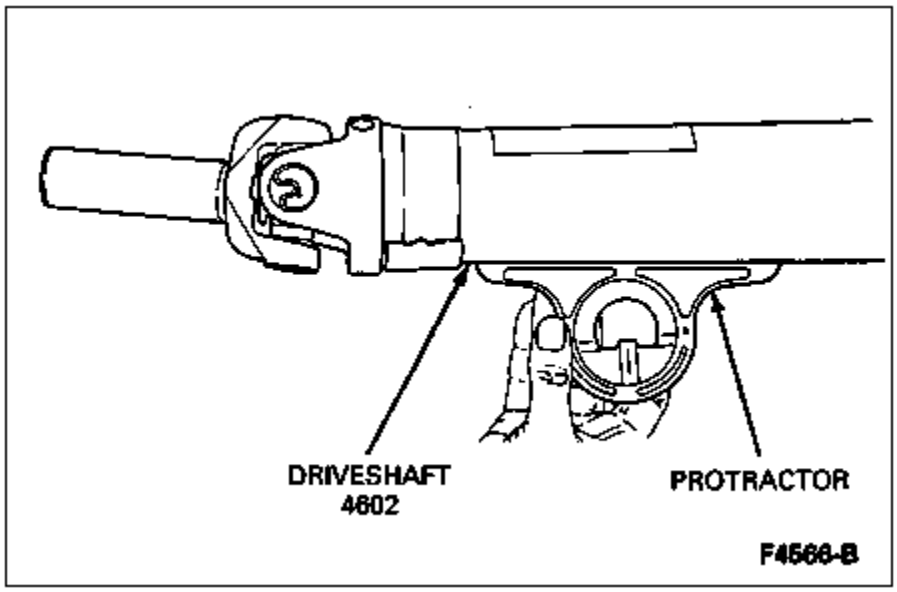
6. **NOTE: The engine angle can alternately be measured off the bottom of the starter motor (11001) if the transmission should obstruct the protractor.**

   To check the driveshaft angle, place the protractor on any portion of the driveshaft tube so the plane surface of the protractor is flush against the bottom surface of the tube and parallel to the floor.

   Record the reading. Adjust for frame angle. Check the pinion angle and if both or either reading is not to specifications, refer to Driveshaft and Pinion Angle Adjustment in this section.

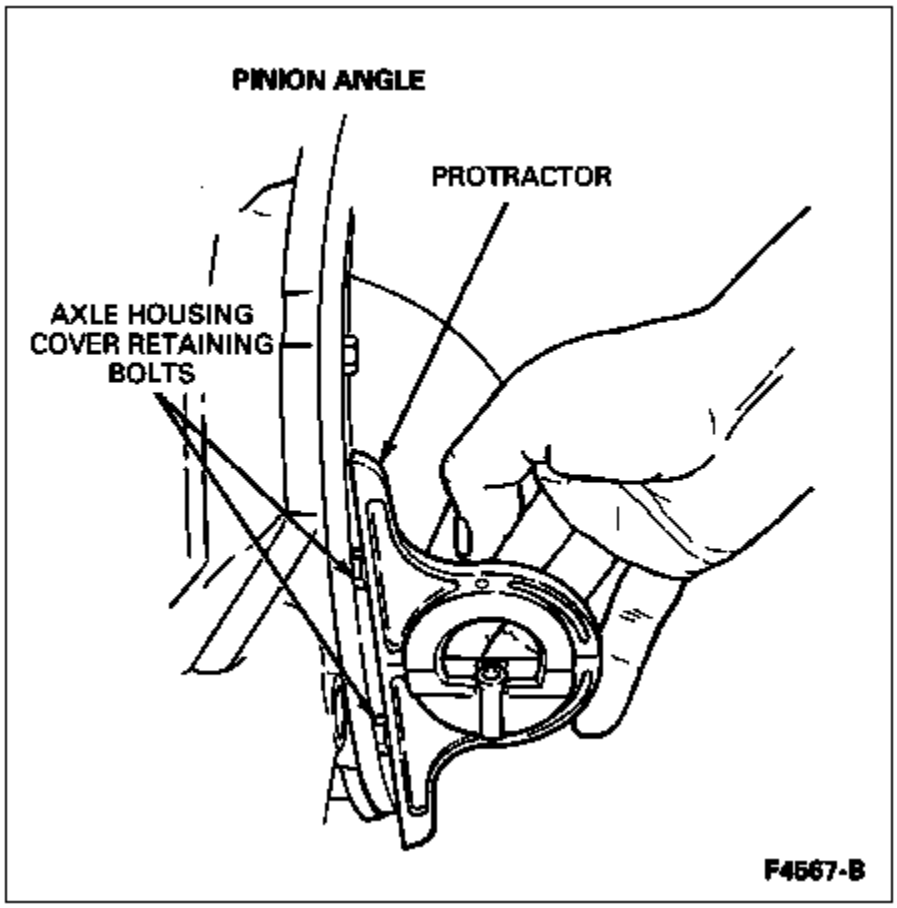


Measuring Driveshaft Angle



Pinion Axle Adjustments

To check the pinion angle, place the protractor in a vertical position so it is flush against two rear axle cover retaining bolts. Rotate the protractor bubble indicator so the 90-degree marks align with the indexing marks. Level the bubble to the level marking and read the protractor. For example, if the protractor indicates a reading of 85 degrees, the pinion angle reading is 5 degrees. Record the reading. Adjust for frame angle. If the reading is not to specifications, refer to Driveshaft and Pinion Angle Adjustment in this section.



Engine Angle Adjustments

The engine angle is adjusted by normalizing the engine mounts. The engine mounts are normalized by loosening the engine mount nuts to frame. Raise the engine up off the frame, then lower the engine and let it settle into place. Service any damaged mounts at this time. Tighten all fasteners to the specified torque. Recheck the engine angle, if the angle is still out of specification, place shims under the transmission-to-rear crossmember mount until the specified angle is obtained.

Driveshaft Runout and Balance

Vibration or shudder which is noticeable either on fast acceleration, when coasting, or when using the engine (6007) for braking, may be caused by the rear axle housing (4010) being loose on the rear suspension, improper tire balance, improper driveline installation, or driveline balance.

If driveshaft (4602) components are replaced and shaft vibration is encountered after installation, disconnect the driveshaft and remove the driveshaft. Rotate the rear axle companion flange 180 degrees; then, reconnect the driveshaft to the driveshaft slip yoke (4841) and reinstall in vehicle. If the vibration persists, disconnect the driveshaft at the rear axle companion flange. Rotate the rear axle companion flange 180 degrees and reconnect the driveshaft to the rear axle companion flange.

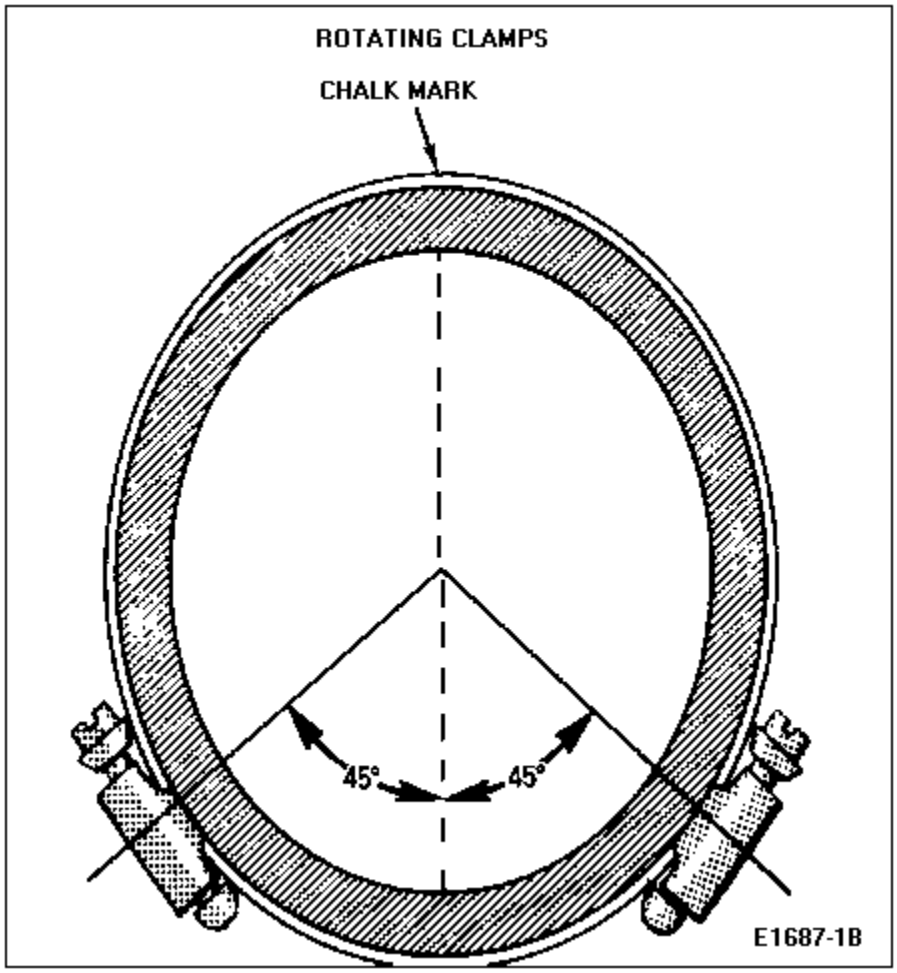
If rotating the driveshaft 180 degrees does not eliminate vibration, the driveshaft may be balanced, using the following procedure:

Driveshaft Balancing

1. Raise the vehicle on a twin-post hoist so that both the front and rear axles are safely supported with all wheels free to rotate.
2. Remove the rear wheels and tires. Reinstall lugnuts to retain brake drums or rotors.
3. With the transmission (7003) in gear, increase the vehicle speed to the maximum vibration level. Note and record the speed of this vibration period as a baseline speed.
4. With the transmission in gear, run the vehicle with the driveshaft rotating at a speedometer speed of 64-80 km/h (40-50 mph); have an assistant carefully bring a crayon, piece of chalk, or colored pencil up until it just barely contacts the rear end, center and front end of the driveshaft. The chalk marks will indicate the heavy side of the driveshaft. Use caution when checking the driveshaft near the balance weights to prevent injury to the hands.
5. Install two screw-type hose clamps on the driveshaft so that their heads are located 180 degrees from the chalk mark, starting at the pinion yoke end of the driveshaft. Tighten the clamps.
6. **CAUTION: To prevent overheating, do not run the vehicle on the hoist for an extended period.**

   Run the vehicle up to the baseline speed. If vibration is still evidenced, rotate the clamps approximately 45 degrees away from each other and test for correction of vibration.
7. If necessary, continue to rotate the clamps apart in smaller increments until the vibration is eliminated or begins to be reduced.
8. If the vibration is not completely eliminated, repeat the foregoing procedure and balance the front end of the driveshaft, checking for elimination or reduction in the vibration level.
9. Reinstall wheels and tires.

10. Remove the vehicle from the hoist and road test.

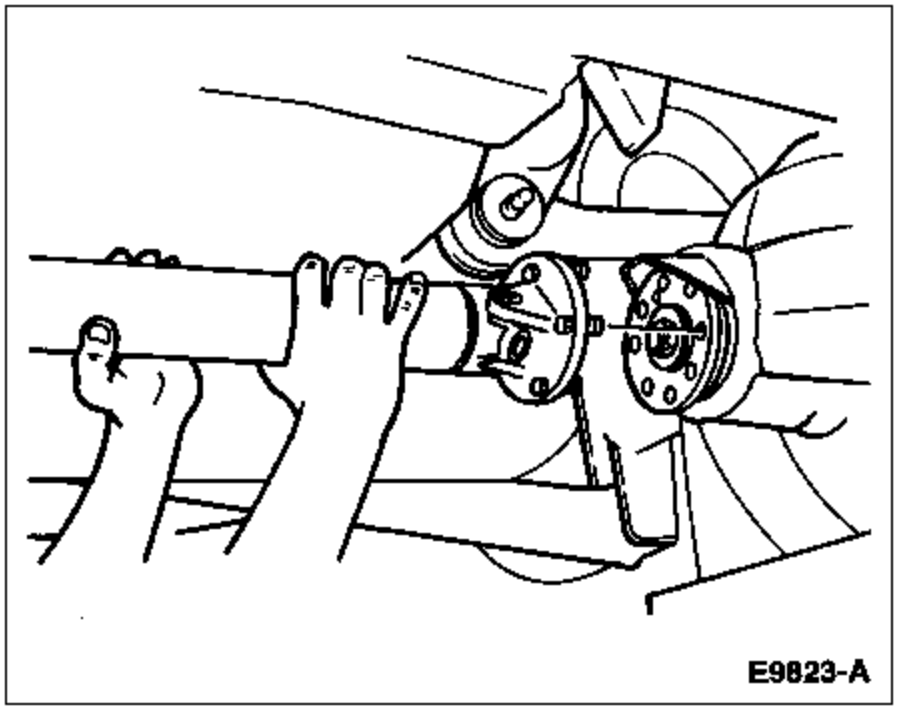


Alternate Procedure

1. Road Test — Evaluate and record road speed at which vibration occurs.

2. Raise vehicle on a frame contact hoist. Remove the wheels and tires. Reinstall lugnuts to retain drums or rotors. Re-evaluate by starting the engine, engaging the transmission and accelerating to the indicated speeds at which the vibration was most severe during the road test. Suspending the rear axle assembly (4006) makes the driveline more sensitive to vibration.

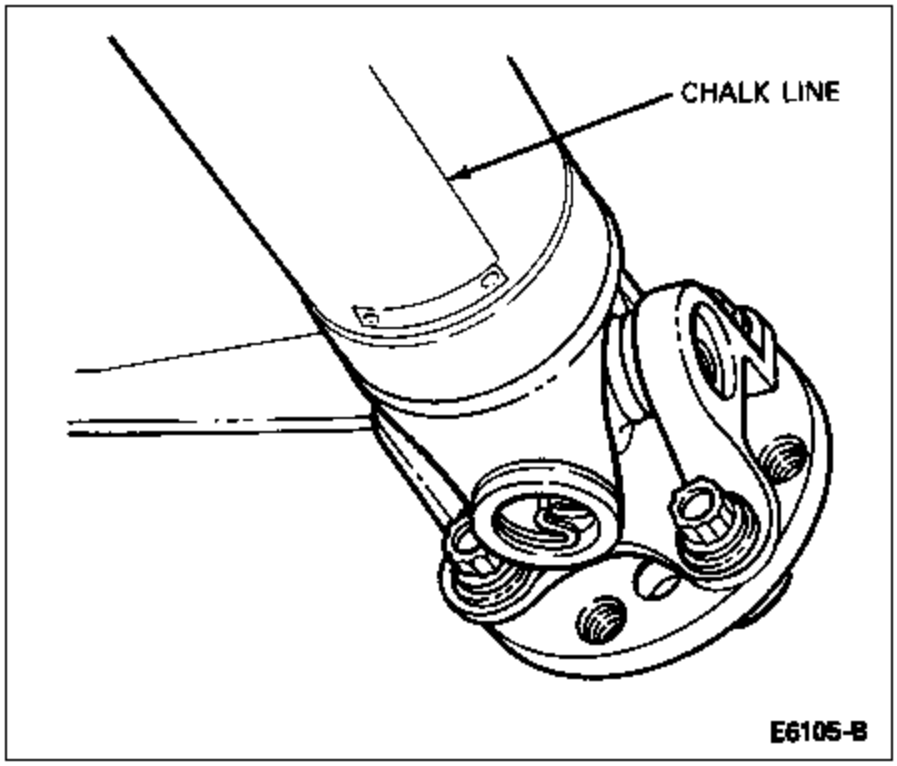
3. Disconnect the driveshaft from the rear axle companion flange. Rotate the driveshaft 180 degrees from its original position and reinstall. Repeat evaluation per Step 2 above.

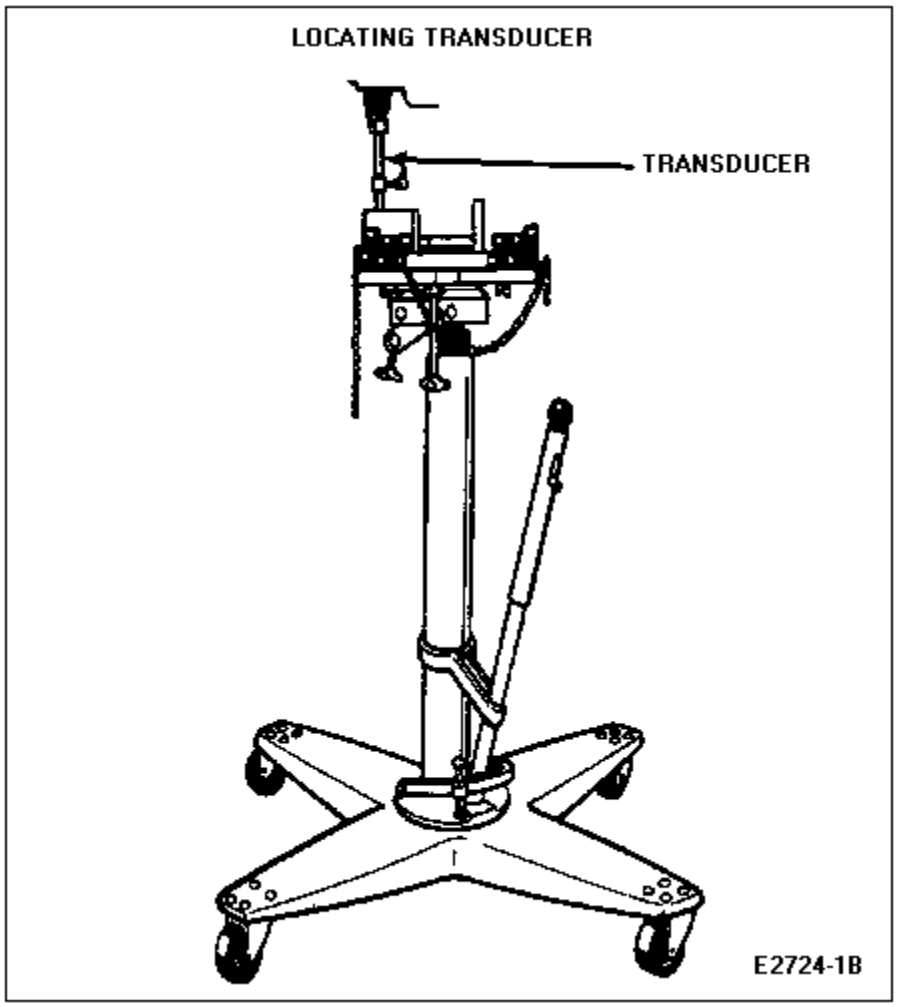


In some cases, rotating the driveshaft 180 degrees may decrease the vibration to an acceptable level. However, if the vibration level is increased, install the driveshaft in its original position and then index in 45-degree increments to fine tune the balance of the driveline system. If the vibration level does not decrease to an acceptable level, proceed to Step 4.

4. A vehicle is more sensitive to excessive imbalance or runout at the rearward end of the driveshaft, therefore, locate the heavy side of the driveshaft by the use of the strobe light and transducer, as follows:

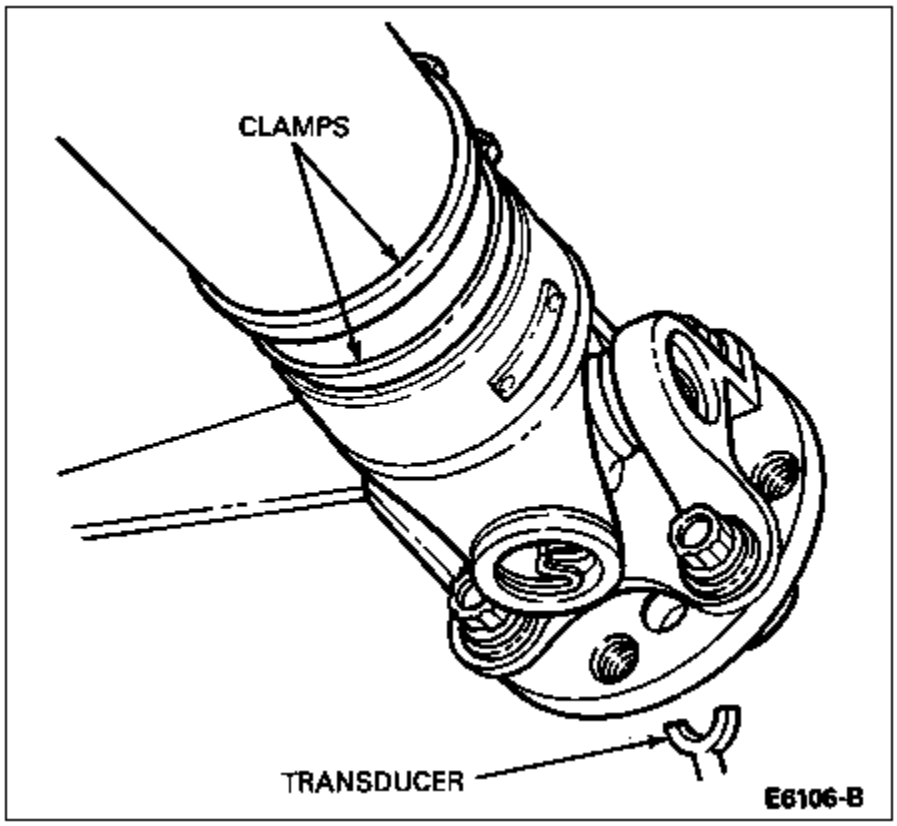
   Scribe an axial chalk line (at any radial location) approximately 101.6mm (4 inches) long at the rear of the driveshaft. Locate the transducer on the bottom side of the carrier, and secure it in place. Run the engine and driveline at the worst vibration speed noted and visually note the position of the chalk line by use of the strobe light. This provides a starting point for the initial location of the clamps.


CHALK LINE
E6105-B



5. Stop the engine and rotate the driveshaft so that the chalk line is in the same location as it was noted under the strobe light.

6. Install two (stainless steel) hose clamps on the driveshaft. Position the clamp heads 180 degrees from the transducer and tighten the clamps.



7. **CAUTION: Do not run the engine with the transmission engaged on the hoist for extended periods due to the danger of overheating the engine or transmission.**

   Run the engine and driveline through the speed range. If no vibration is felt, remove the lugnuts, install the wheels and tires and reinstall the lugnuts in the correct position and proceed to Step 9. However, if any vibration still exists, the combined weight of the two hose clamp heads may be in excess. To reduce this excess weight, rotate the clamp heads away from each other approximately 15 degrees (one each way from the original position). Run the engine and driveline and note if the vibration has been reduced.

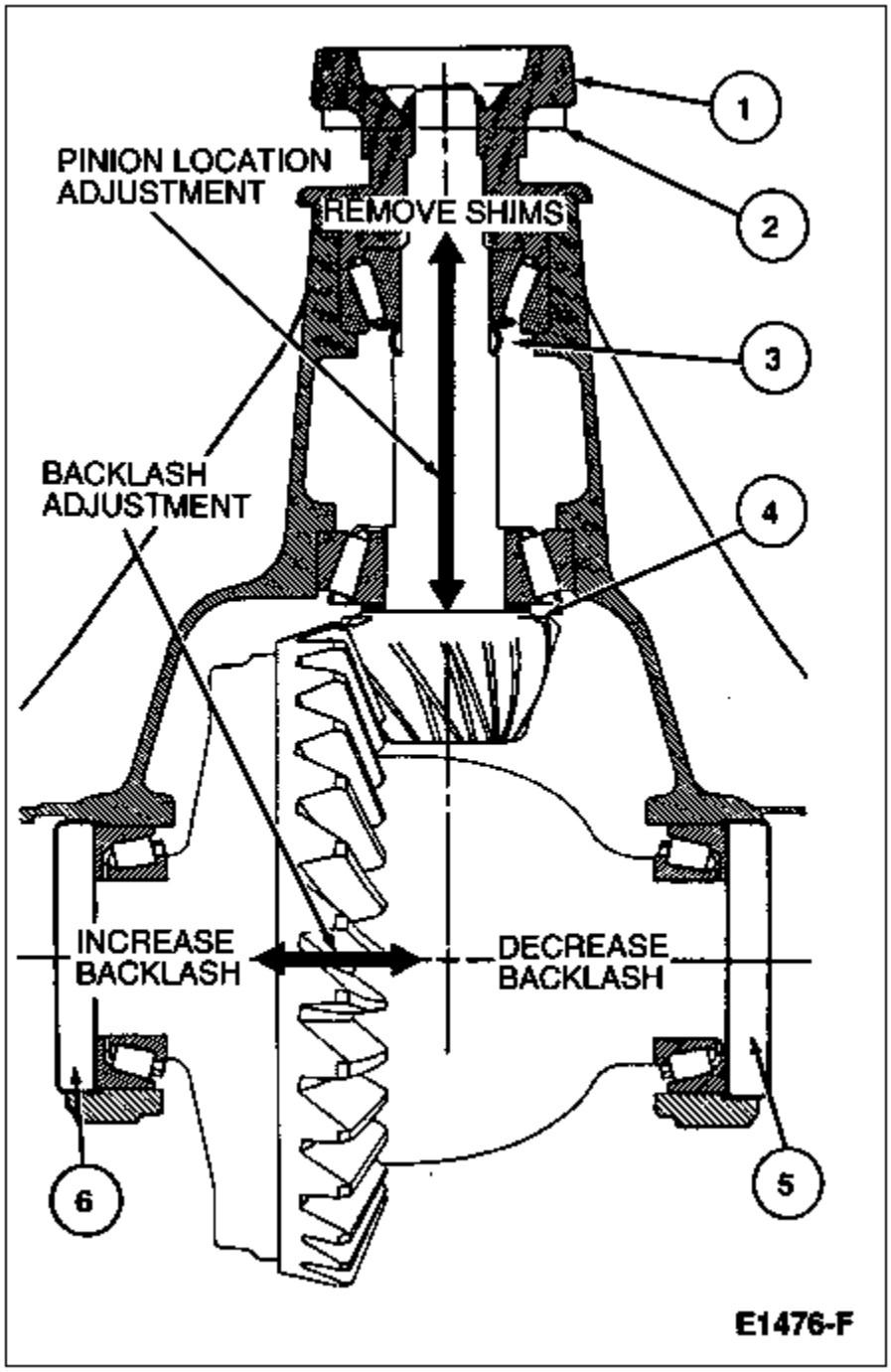
8. Continue to rotate the clamp heads apart in smaller angular increments until the vehicle feel of balance (vibration) is best. At this point, install the wheels and tires per Step 7 and road test the vehicle to determine the actual degree of improvement. If satisfactory improvement has been obtained, proceed with Step 9. If no improvement has been obtained, the clamps must be removed and diagnosis should be redirected to other areas, such as wheels, tires, driveline angle, and rear axle companion flange runout. For additional information, refer to Diagnosis and Testing in this section.

9. When the vehicle has been corrected to a satisfactory level, as determined by a road test evaluation, tighten the clamps securely. Clean thoroughly with lacquer thinner, and spray the clamps with a commercially available black paint for a finished appearance.

Pinion and Ring Gear Adjustment

Two separate adjustments affect pinion and ring gear tooth contact. They are pinion location and backlash.

Individual differences in matching the rear axle housing (4010) and the differential pinion bearings (4630) require the use of shims to locate the pinion for correct contact with the ring gear. Refer to Section 05-02A for shim selection procedures.



Item	Part Number	Description
1	4851	Rear Axle Universal Joint Flange
2	4859	Drive Pinion Oil Seal Deflector
3	4662	Differential Drive Pinion Bearing Spacer
4	4663	Drive Pinion Bearing Adjustment Shim
5	4067	Differential Bearing Shim
6	4067	Differential Bearing Shim

Slip-Yoke Spline

Vehicle noise and vibration can be caused by a seized driveshaft slip yoke (4841) spline. The service resolution to minimize driveshaft slip-yoke spline contamination and ultimate seizure is as follows:

1. Scribe alignment marks between the driveshaft (4602) and rear axle to ensure proper alignment.

2. On vehicles with 4x4 systems, disconnect the driveshaft from the transfer case. On Ranger SuperCab vehicles, remove the two bolts securing the center bearing to the center bearing crossmember. Remove the driveshaft from the vehicle.

3. On vehicles with 4x4 systems and Ranger SuperCab vehicles, scribe alignment marks between the slip-yoke and the driveshaft tube before removing the slip spline boot. Check boot for cracks or tears and replace if necessary.

4. Clean the male slip splines. Some slip splines have a blue plastic coating. Take care not to damage this coating. Fine abrasive cloth may be required to dress and polish the male spline. Remove all hardened grease deposits, dirt or rust. Inspect for worn or galled splines. The plastic coating, if installed, must not be removed. Replace driveshaft if necessary.

5. Clean and inspect the female splines of the driveshaft slip-yoke, removing any hardened grease deposits, dirt or rust. Inspect splines for worn or galled conditions. Replace driveshaft if necessary.

6. Apply a coating of Premium Long-Life Grease XG-1-C or -K or equivalent meeting Ford specification ESA-M1C75-B to the entire male slip splines prior to assembling of the driveshaft.

7. Using a clean long handle (stencil-type) brush, apply Premium Long-Life Grease XG-1-C or -K or equivalent meeting Ford specification ESA-M1C75-B spread evenly on all the female splines of the slip-yoke.

8. Reassemble the driveshaft, taking care to realign the driveshaft with the marks scribed in Step 3 to ensure proper universal joint phasing. The spline joint must slide freely by hand. Install new driveshaft slip-yoke boot clamps.

9. On 4x2 vehicles, insert the slip-yoke into the end of the transmission housing. On 4x4 vehicles, attach the driveshaft flange to the transfer case output flange. Support the rear end of the driveshaft. Never allow the driveshaft to hang unsupported from one end.

10. Attach the driveshaft to the rear axle, taking care to realign the driveshaft and the rear axle circular flange using the scribe marks from Step 1. On Ranger SuperCab vehicles, align the center bearing bracket, and attach the center bearing bracket to the crossmember.

11. Torque all bolts to the torques specified at the end of this section.

Axle Lubrication, Rear

The ability of any rear axle assembly (4006) to deliver quiet, trouble-free operation over a period of years is largely dependent upon the use of good quality gear lubricants. To make sure gears and bearings will last as long as possible, use only specified hypoid gear lubricants.

Rear Axle lube quantities must be replaced every 160,000 km (100,000 miles) or if the axle has been submerged in water. Otherwise, the lube should not be checked or changed unless a leak is suspected or repair required. High Performance Rear Axle Lubricant XY-80W90-QL or equivalent meeting Ford specification WSP-M2C197-A is available for repairs and refills in situations that fall into the severe or extreme use categories. Refer to maintenance schedules, in Section 00-03.

Draining and Filling

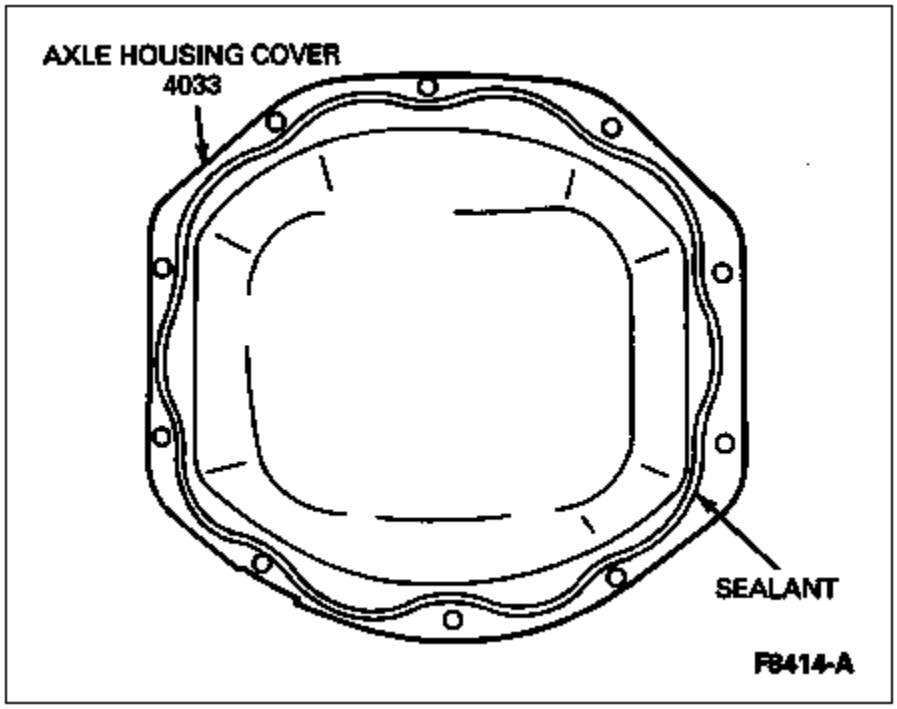
Draining

1. Raise vehicle. Refer to Section 00-02 .
2. Clean all dirt from area of axle housing cover.
3. Drain rear axle lubricant by removing axle housing cover.

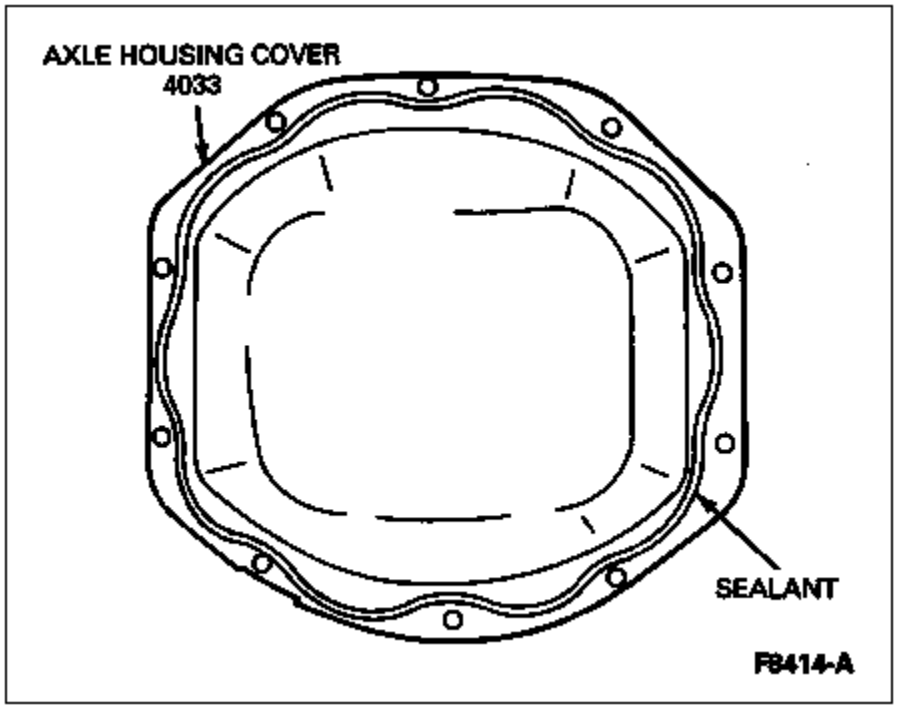
Filling

CAUTION: Make sure machined surfaces on both cover and carrier are clean before installing the new silicone sealant. Inside of axle must be covered when cleaning the machined surface to prevent axle contamination. Tighten the cover bolts in a crosswise pattern to ensure uniform draw on cover.

NOTE: Cover assembly must be installed within 15 minutes of application of the silicone rubber or new silicone rubber must be applied.



1. Apply Silicone Rubber D6AZ-19562-AA or BA or equivalent meeting Ford specification ESB-M4G92-A or ESE-M4G195-A. Install axle housing cover and tighten retaining bolts to 28-38 Nm (21-28 lb-ft).

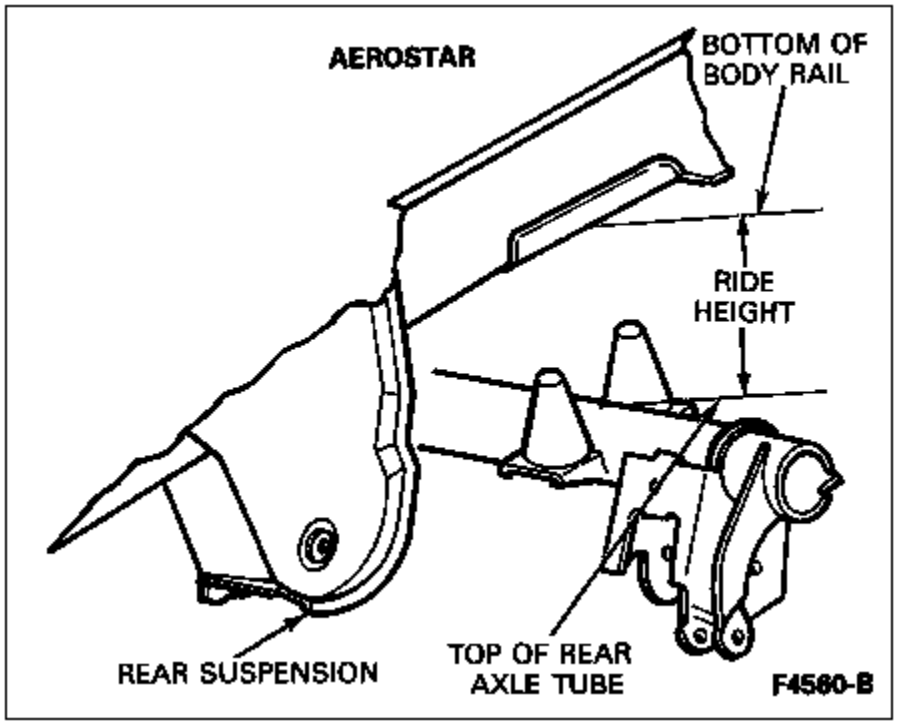


2. Add Motorcraft Rear Axle Lubricant XY-80W90-QL or KL or equivalent meeting Ford specification WSP-M2C197-A until it is 6.14mm (1/4-9/16 inch) below bottom of fill hole. Add 118.3 ml (4 oz.) of Ford Additive Friction Modifier C8AZ-19B546-A or equivalent meeting Ford specification EST-M2C118-A to Traction-Lok® axles. Install fill plug and tighten to 20-41 Nm (15-30 lb-ft).

SPECIFICATIONS

Rear Driveshaft Angles, Aerostar

Model	Engine	Transmission	Blocked Rear Ride Height (Axle/Frame)	Engine Angle (Degrees)	Driveshaft Angle (Degrees)	Pinion Angle (Degrees)
4x2	3.0L	M5OD/A4LD	5.9 Inch	4.0°	4.8°	2.9°
4x2	4.0L	A4LD	5.9 Inch	4.0°	5.3°	3.0°
E-4WD Rear	4.0L	A4LD	6.3 Inch	4.0°	5.6°	3.1°
E-4WD Front	4.0L	A4LD	N/A	4.0°	2.7°	0.0°



Driveshaft, Ranger

Model	Wheelbase (mm)	Engine (L)	Transmission	Rear Spring Part No. (5560)	Rear Axle Ring Gear
Ranger 4x2					
Regular Cab	2743	2.3/3.0	M5OD	F37A- BB	7.5

Regular Cab	2743	2.3/3.0	A4LD	F37A- BB	7.5
Regular Cab	2743	2.3/3.0	M5OD	F37A- CC	7.5
Regular Cab	2743	2.3/3.0	A4LD	F37A- CC	7.5
Regular Cab Splash	2743	2.3/3.0	M5OD	F37A- KA	7.5
Regular Cab Splash	2743	2.3/3.0	A4LD	F37A- KA	7.5
Regular Cab	2743	4.0	M5OD	F37A- BB	8.8
Regular Cab	2743	4.0	A4LD	F37A- BB	8.8
Regular Cab Splash	2743	4.0	M5OD	F37A- DB	8.8
Regular Cab	2743	4.0	A4LD	F37A- DB	8.8
Regular Cab	2743	4.0	M5OD	F37A- EC	8.8
Regular Cab	2743	4.0	A4LD	F37A- EC	8.8
Regular Cab Splash	2743	4.0	M5OD	F37A- KA	8.8
Regular Cab Splash	2743	4.0	A4LD	F37A- KA	8.8
Regular Cab	2896	2.3/3.0	M5OD	F37A- BB	7.5
Regular Cab	2896	2.3/3.0	A4LD	F37A- BB	7.5
Regular Cab	2896	2.3/3.0	M5OD	F37A- CC	7.5
Regular Cab	2896	2.3/3.0	A4LD	F37A- CC	7.5
Regular Cab	2896	2.3/3.0	M5OD	F37A- KA	7.5
Regular Cab Splash	2896	2.3/3.0	A4LD	F37A- KA	7.5
Regular Cab	2896	4.0	M5OD	F37A- BB	8.8
Regular Cab	2896	4.0	A4LD	F37A- BB	8.8
Regular Cab	2896	4.0	M5OD	F37A- DB	8.8
Regular Cab	2896	4.0	A4LD	F37A- DB	8.8
Regular Cab	2896	4.0	M5OD	F37A- EC	8.8
Regular Cab	2896	4.0	A4LD	F37A- EC	8.8
Regular Cab Splash	2896	4.0	A50D	F37A- KA	8.8
Regular Cab Splash	2896	4.0	A4LD	F37A- KA	8.8
Super Cab	3177	2.3/3.0	M5OD	F37A- BB	7.5
Super Cab	3177	2.3/3.0	A4LD	F37A- BB	7.5
Super Cab	3177	2.3/3.0	M5OD	F37A- CC	7.5
Super Cab	3177	2.3/3.0	A4LD	F37A- CC	7.5
Super Cab Splash	3177	2.3/3.0	M5OD	F37A- KA	7.5
Super Cab	3177	2.3/3.0	A4LD	F37A- KA	7.5

Splash					
Super Cab	3177	4.0	M5OD	F37A- BB	8.8
Super Cab	3177	4.0	A4LD	F37A- BB	8.8
Super Cab	3177	4.0	M5OD	F37A- EC	8.8
Super Cab	3177	4.0	A4LD	F37A- EC	8.8
Super Cab Splash	3177	4.0	M5OD	F37A- KA	8.8
Super Cab Splash	3177	4.0	A4LD	F37A- KA	8.8
Ranger 4x4					
Regular Cab	2743	2.3/3.0	M5OD	F37A- BB	7.5
Regular Cab	2743	2.3/3.0	A4LD	F37A- BB	7.5
Regular Cab	2743	4.0	M5OD	F37A- BB	8.8
Regular Cab	2743	4.0	A4LD	F37A- BB	8.8
Regular Cab	2743	4.0	M5OD	F37A- CC	8.8
Regular Cab	2743	4.0	A4LD	F37A- CC	8.8
Regular Cab	2896	2.3/3.0	M5OD	F37A- BB	7.5
Regular Cab	2896	2.3/3.0	A4LD	F37A- BB	7.5
Regular Cab	2896	4.0	M5OD	F37A- BB	8.8
Regular Cab	2896	4.0	A4LD	F37A- BB	8.8
Regular Cab	2896	4.0	M5OD	F37A- CC	8.8
Regular Cab	2896	4.0	A4LD	F37A- CC	8.8
Super Cab	3177	2.3/3.0	M5OD	F37A- BB	7.5
Super Cab	3177	2.3/3.0	A4LD	F37A- BB	7.5
Super Cab	3177	4.0	M5OD	F37A- BB	8.8
Super Cab	3177	4.0	A4LD	F37A- BB	8.8
Super Cab	3177	4.0	M5OD	F37A- CC	8.8
Super Cab	3177	4.0	A4LD	F37A- CC	8.8
Super Cab	3177	4.0	M5OD	F37A- XB	8.8
Super Cab	3177	4.0	A4LD	F37A- XB	8.8

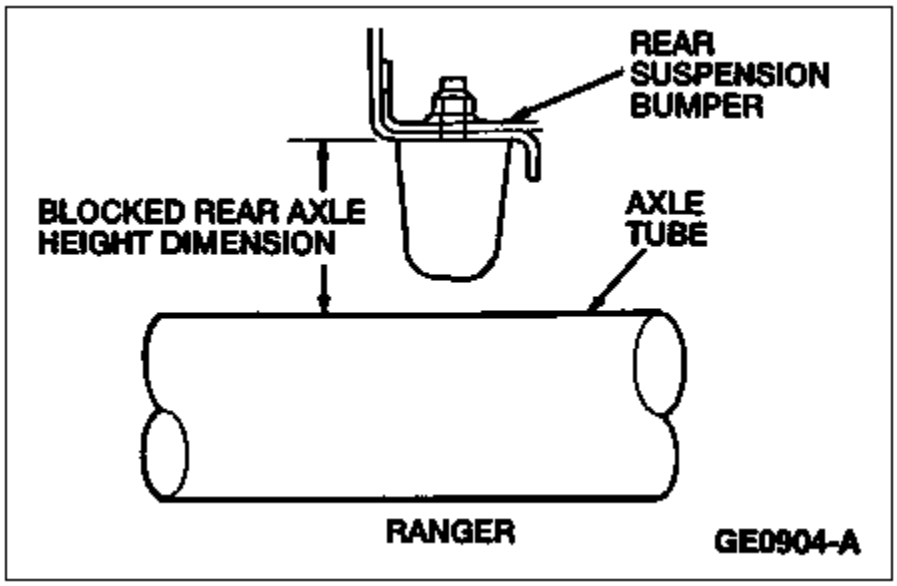
Driveshaft, Ranger (Continued)

Model	Blocked Ride Height at Rear Axle (mm)	Engine Angle (Deg.)	Coupling Shaft Angle (Deg.)	Rear D/S Angle (Deg.)	Pinion Angle (Deg.)	Front D/S Angle (Deg.)
Ranger 4x2						
Regular Cab	193	5.50	—	7.4	6.7	—
Regular	193	5.50	—	7.5	6.7	—

Cab						
Regular Cab	199	5.50	—	7.6	6.8	—
Regular Cab	199	5.50	—	7.8	6.8	—
Regular Cab Splash	154	5.50	—	5.8	6.1	—
Regular Cab Splash	154	5.50	—	5.8	6.1	—
Regular Cab	193	5.50	—	8.0	6.7	—
Regular Cab	193	5.50	—	8.1	6.7	—
Regular Cab Splash	200	5.50	—	8.7	5.0	—
Regular Cab	200	5.50	—	8.9	5.0	—
Regular Cab	205	5.50	—	8.9	5.1	—
Regular Cab	205	5.50	—	9.1	5.1	—
Regular Cab Splash	154	5.50	—	6.3	6.1	—
Regular Cab Splash	154	5.50	—	6.4	6.1	—
Regular Cab	193	5.50	—	6.6	6.7	—
Regular Cab	193	5.50	—	6.7	6.7	—
Regular Cab	199	5.50	—	6.8	6.8	—
Regular Cab	199	5.50	—	6.9	6.8	—
Regular Cab	154	5.50	—	5.2	6.1	—
Regular Cab Splash	154	5.50	—	5.2	6.1	—
Regular Cab	193	5.50	—	7.1	6.7	—
Regular Cab	193	5.50	—	7.2	6.7	—
Regular Cab	200	5.50	—	7.7	5.0	—
Regular Cab	200	5.50	—	7.9	5.0	—
Regular Cab	205	5.50	—	7.9	5.1	—

Regular Cab	205	5.50	—	8.1	5.1	—
Regular Cab Splash	154	5.50	—	5.7	6.1	—
Regular Cab Splash	154	5.50	—	5.7	6.1	—
Super Cab	193	5.50	5.6	5.5	6.7	—
Super Cab	193	5.50	5.6	5.5	6.7	—
Super Cab	199	5.50	5.6	5.7	6.8	—
Super Cab	199	5.50	5.6	5.7	6.8	—
Super Cab Splash	154	5.50	6.6	3.1	6.1	—
Super Cab Splash	154	5.50	6.8	3.1	6.1	—
Super Cab	193	5.50	5.6	6.1	6.7	—
Super Cab	193	5.50	5.6	6.1	6.7	—
Super Cab	205	5.50	5.6	7.2	5.1	—
Super Cab	205	5.50	5.6	7.2	5.1	—
Super Cab Splash	154	5.50	6.6	3.8	6.1	—
Super Cab Splash	154	5.50	6.7	3.7	6.1	—
Ranger 4x4						
Regular Cab	183	5.50	—	10.6	9.0	1.9
Regular Cab	183	5.50	—	10.6	9.0	1.9
Regular Cab	183	5.50	—	11.3	9.0	1.9
Regular Cab	183	5.50	—	11.3	9.0	1.9
Regular Cab	187	5.50	—	12.4	6.1	1.9
Regular Cab	187	5.50	—	12.4	6.1	1.9
Regular Cab	183	5.50	—	10.0	6.0	1.9
Regular Cab	183	5.50	—	10.0	6.0	1.9
Regular Cab	183	5.50	—	10.6	6.0	1.9
Regular Cab	183	5.50	—	10.6	6.0	1.9
Regular Cab	187	5.50	—	10.9	6.1	1.9

Regular Cab	187	5.50	—	10.9	6.1	1.9
Super Cab	183	5.50	9.0	7.9	6.0	1.9
Super Cab	183	5.50	9.0	7.9	6.0	1.9
Super Cab	183	5.50	9.0	8.5	6.0	1.9
Super Cab	183	5.50	9.0	8.5	6.0	1.9
Super Cab	187	5.50	9.0	8.8	6.1	1.9
Super Cab	187	5.50	9.0	8.8	6.1	1.9
Super Cab	166	5.50	8.9	7.8	5.6	1.9
Super Cab	166	5.50	8.9	7.8	5.6	1.9



Rear Axle Lubricant Capacities

Rear Axle	Lubricant Capacity	
	U.S. Pints	Liters
Ford Rear Drive Axle — 7.5 Inch Ring Gear [a b c]		
Aerostar (Rear)	3.6	1.7
Ranger	5.0	2.4
Ford Rear Drive — 8.8 Inch Ring Gear [a b c]		
Ranger	5.0	2.4

[a] For Aerostar and Ranger vehicles, fill to 6.35-14.28mm (1/4 inch to 9/16 inch) below bottom of fill hole.
[b] All conventional and Traction-Lok® rear axles use Premium Rear Axle Lubricant XY-80W90-KL, QL or equivalent meeting Ford specification WSP-M2C197-A. Important Notice: See Note "c" which applies to Traction-Lok® rear axles only.
[c] Add 118.3 ml (4 U.S. ounces) of Friction Modifier, C8AZ-19B546-A or equivalent meeting Ford

specification EST-M2C118-A for complete fill of Ford Traction-Lok® rear axles.

Torque Specifications — Ranger

Description	Nm	Lb-Ft
Double Cardan Front Driveshaft-to-Transfer Case Half Round Yoke	17-23	13-17
Driveshaft-to-Transfer Case Flange Bolts	88-119	65-87
Driveshaft-to-Rear Axle Companion Flange Attaching Bolts	95-129	70-95
Front Driveshaft-to-Front Axle Yoke Attachment Bolts	15-20	11-15
Two-Piece Driveshaft Center Bearing-to-Crossmember Attachment Bolts	37-50	27-37
Rear Axle Driveline Vibration Damper-to-Carrier Housing Flange	60-81	44-59

Driveshaft (Respective Vehicle[s])

Torque Specifications — Aerostar

Description	Nm	Lb-Ft
Front Driveshaft-to-Front Axle Yoke Attachment Bolts	30-41	22-30
Driveshaft-to-Rear Axle Companion Flange Attaching Bolts	95-129	70-95
Rear Axle Driveline Vibration Damper-to-Carrier Housing Flange	60-81	44-59

Driveshaft — Aerostar

Driveshaft, Front, Ranger 4x4

Removal

1. **NOTE: All driveshafts are balanced. Mark the driveshaft in relation to the rear universal joint yoke and transfer case yoke so that it may be installed in the original position.**

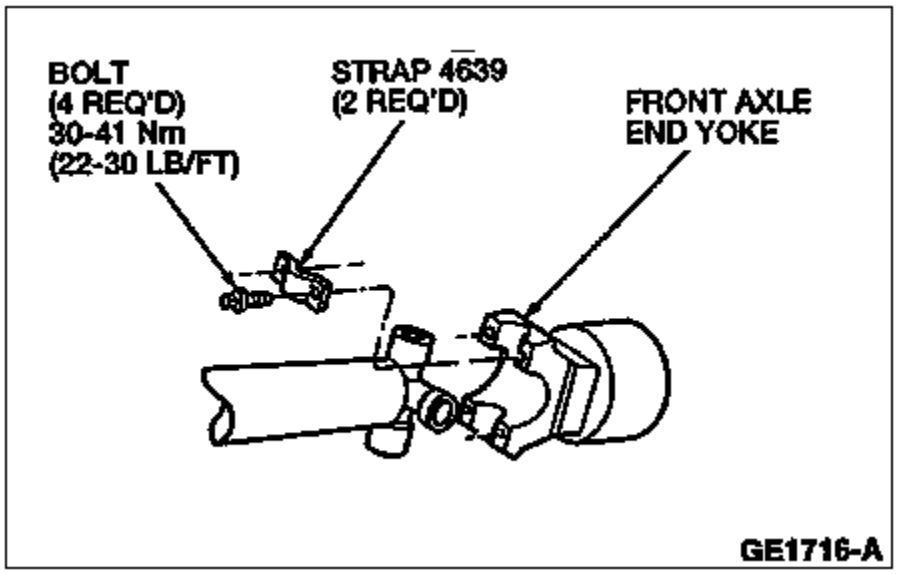
   Remove the bolts retaining the driveshaft to the transfer case (7A195).

2. Remove the bolts and straps retaining the driveshaft to the front axle.

3. Remove shaft from vehicle.

Installation

1. Install the front universal joint into the front axle yoke. Support the driveshaft during installation. DO NOT ALLOW THE DRIVESHAFT TO HANG FREE.



2. Install the straps and bolts that retain the driveshaft to the front axle yoke. Tighten the bolts to 30-41 Nm (22-30 lb-ft).

3. Position the rear of the driveshaft to the transfer case yoke. Install the bolts. Tighten the bolts to 88-119 Nm (65-87 lb-ft).

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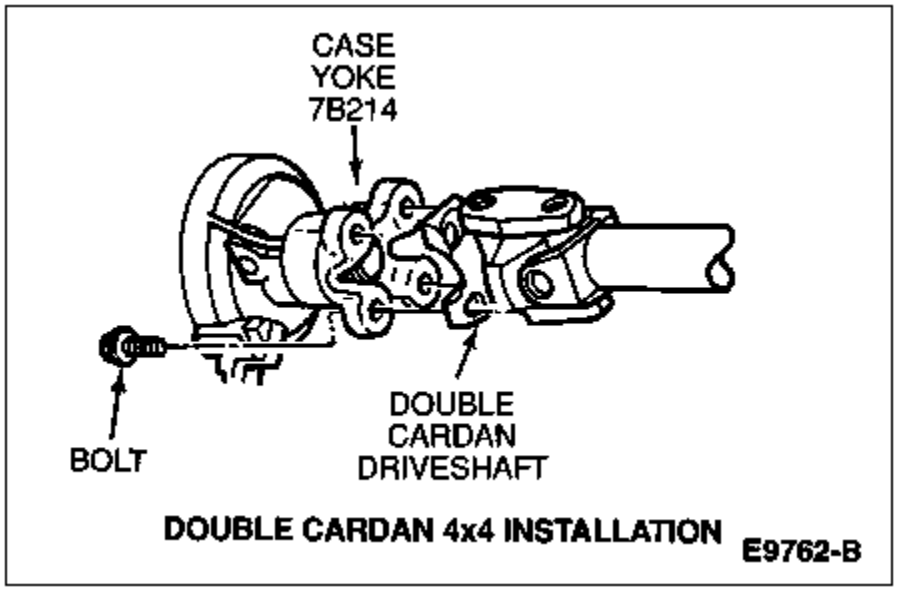

DOUBLE CARDAN 4x4 INSTALLATION E9762-B

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Driveshaft, Front, Aerostar E-4WD

Removal

1. **NOTE: All driveshafts are balanced. Mark the driveshaft in relation to the front universal joint yoke and transfer case output so that it may be installed in the original position.**

   Scribe alignment marks on the driveshaft tube and transfer case output shaft.

2. Remove the driveshaft slip-yoke boot clamp at the transfer case with end cutter pliers and discard the driveshaft slip-yoke boot clamp.

3. Remove the bolts retaining the driveshaft to the front axle companion flange.

4. Remove the shaft from vehicle.

Installation

1. Apply a light coating of Premium Long-Life Grease XG-1-C or -K or equivalent meeting Ford specification ESA-M1C75-B to the yoke splines.

2. Slide the driveshaft into the transfer case output slip splines. Make sure the yellow dot on the driveshaft tube aligns within the radial zone of yellow tape on the transfer case (or that the scribe marks in Step 1 of the removal process are aligned). Note that the driveshaft stud yoke splines have a single wide tooth, which must be aligned with one of the two wide gaps in the transfer case output slip splines. Pull the driveshaft slip-yoke boot onto its mating surface and install the slip-yoke boot clamp on the driveshaft slip-yoke boot with an appropriate tool.

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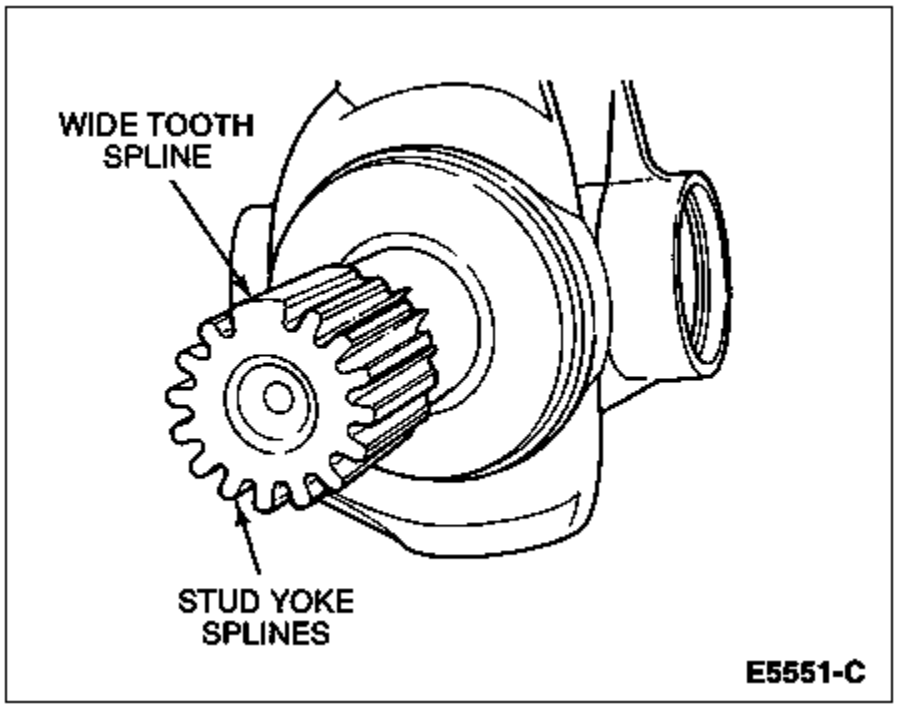
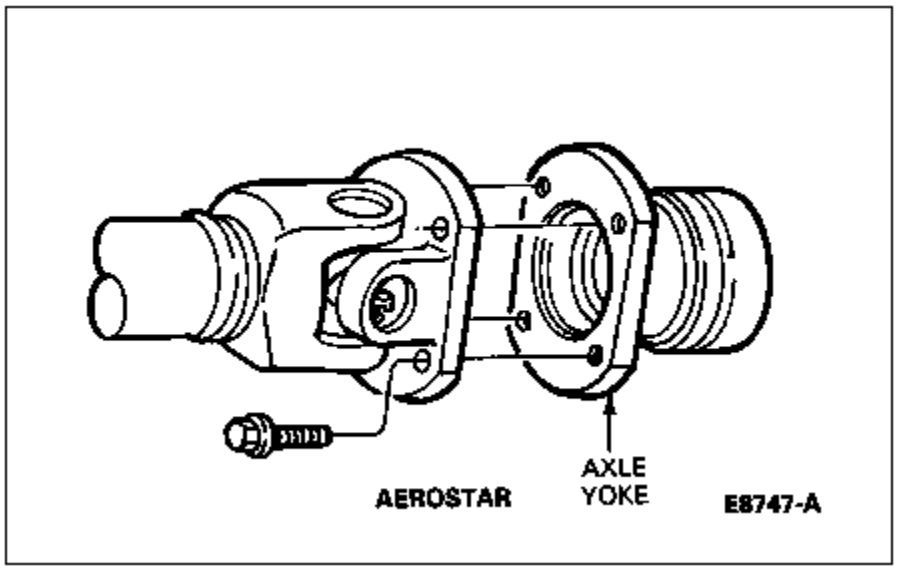


3. Install the driveshaft to the front axle flange. Tighten the bolts to 30-41 Nm (22-30 lb-ft).



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Slip-at-Transmission Driveshafts, Aerostar 4x2, SWB/LWB Ranger 4x2

Removal

1. **NOTE: All driveshafts are balanced. Mark the driveshaft in relation to the rear universal joint yoke and the rear axle circular flange so that it may be installed in the original position.**

   To maintain driveline balance, locate original paint mark on rear axle companion flange and mark driveshaft flange yoke (4866) in the same location. If original mark is not visible on rear axle companion flange, mark both the rear axle companion flange and driveshaft flange yoke at any location.

2. **CAUTION: Do not allow driveshaft to hang free. Support the driveshaft during removal procedures.**

   Remove the bolts retaining the driveshaft to the rear axle circular flange.

3. Disconnect the driveshaft from the rear axle companion flange. Pull the driveshaft toward the rear of the vehicle until the driveshaft slip yoke (4841) clears the extension housing (7A039) and seal. Install the appropriate plug in the extension housing to prevent lubricant leakage.

Installation

1. Lubricate the driveshaft slip-yoke splines with Premium Long-Life grease XG-1-C or -K or equivalent meeting Ford specification ESA-M1C75-B. Remove the plug from the transmission extension housing. Inspect the housing seal for damage; replace if required. Slide the driveshaft slip-yoke into the output extension housing of the transmission. Do not allow the driveshaft slip-yoke to bottom out on the output shaft with excessive force.

2. **NOTE: When installing a new service driveshaft, align the factory-made yellow paint mark at the rear of the driveshaft tube with the factory-made yellow paint mark on the rear axle companion flange.**

   Position the driveshaft so that the index mark on the rear yoke (or yellow dot on driveshaft tube) is in line with the index mark on the rear axle companion flange. This ensures original driveline balance. If a vibration exists after installation, refer to Section 00-04.

3. Install the bolts that retain the driveshaft to the rear axle companion flange. Tighten the bolts to 95-129 Nm (70-95 lb-ft).

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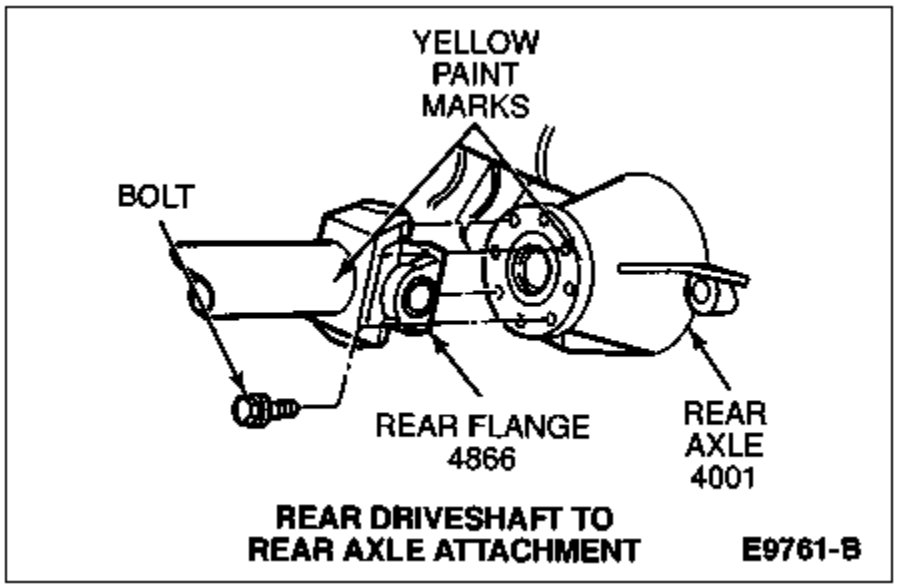

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Slip-Between-Center Driveshafts with Double Cardan Joint at the Transfer Case, SWB Ranger 4x4

Removal

1. **NOTE: All driveshafts are balanced. Mark the driveshaft in relation to the rear universal joint yoke and the rear axle circular flange so that it may be installed in the original position.**

   To maintain driveline balance, locate original paint mark on rear axle companion flange and mark driveshaft flange yoke (4866) in the same location. If original mark is not visible on rear axle companion flange, mark both the rear axle companion flange and driveshaft flange yoke at any location.

2. **CAUTION: Do not allow driveshaft to hang free. Support the driveshaft during removal procedures.**

   Remove the bolts retaining the driveshaft to the transfer case circular flange.

3. Remove the bolts retaining the driveshaft to the rear axle companion flange.

4. Remove shaft from vehicle.

Installation

1. **NOTE: When installing a new service driveshaft, align the factory-made yellow paint mark at the rear of the driveshaft tube with the factory-made yellow paint mark on the rear axle companion flange.**

   Position the driveshaft so the index mark on the rear yoke (or yellow dot on driveshaft tube) is in line with the index mark on the rear axle companion flange. This assures original driveline balance. If a vibration exists after installation, refer to Section 00-04 .

2. Install the bolts that retain the driveshaft to the rear axle companion flange. Support the driveshaft during installation. DO NOT ALLOW THE DRIVESHAFT TO HANG FREE.

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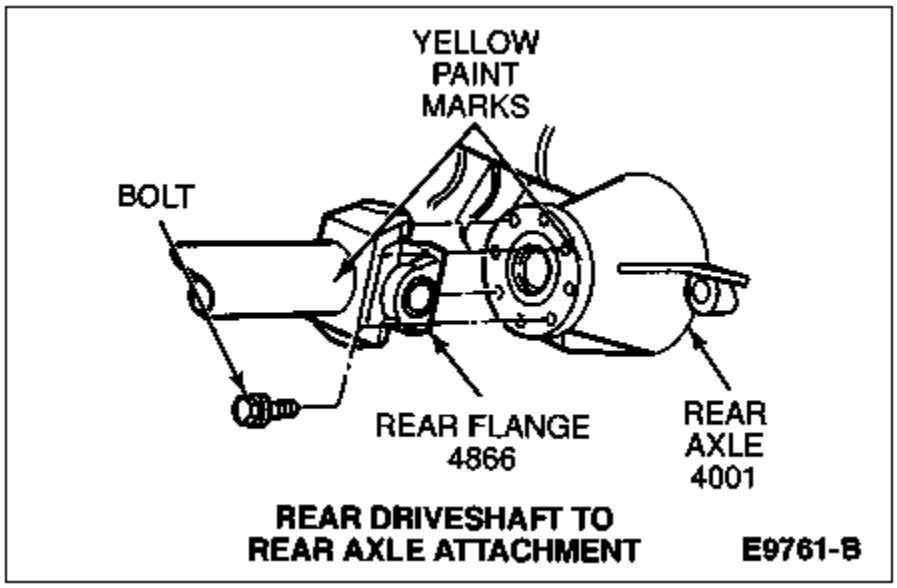
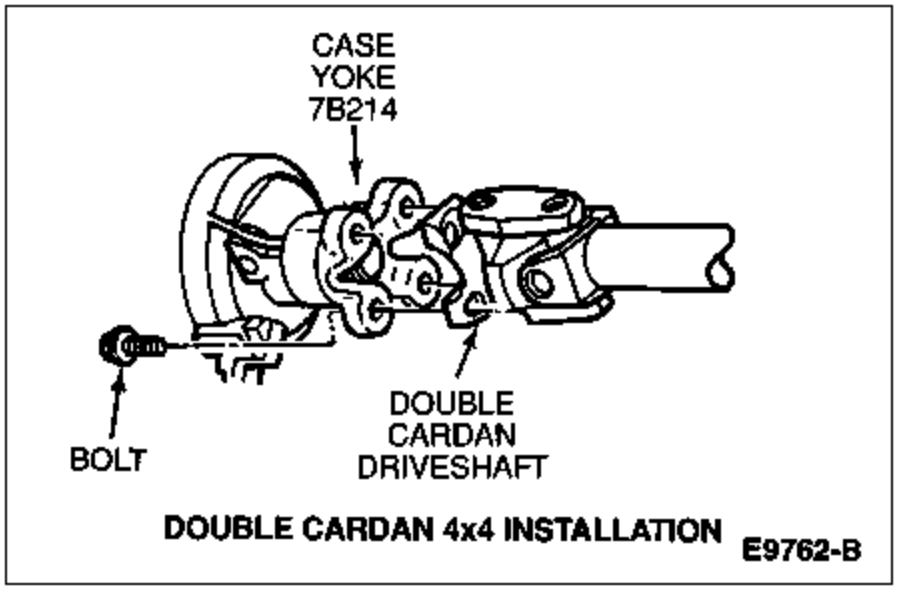


3. Position the driveshaft to the transfer case flange and install the bolts.



4. Tighten the driveshaft-to-rear axle bolts and driveshaft-to-transfer case bolts to 95-129 Nm (70-95 lb-ft).

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Two-Piece Driveshafts with Slip at Transmission Coupling Shaft and Slip Between Center Rear Shaft, Ranger SuperCab 4x2

Removal

1. **NOTE: All driveshafts are balanced. Mark the driveshaft in relation to the rear universal joint yoke and the rear axle circular flange so that it may be installed in the original position.**

   To maintain driveline balance, locate original paint mark on the rear axle companion flange and mark driveshaft flange yoke (4866) in the same location. If original mark is not visible on rear axle companion flange, mark both the rear axle companion flange and driveshaft flange yoke at any location.

2. Remove the bolts that retain the driveshaft center bearing bracket (4A499) to the frame crossmember. Remove spacers under the center bearing bracket, if installed.

3. **CAUTION: Do not allow driveshaft to hang free. Support the driveshaft during removal procedures.**

   Remove the bolts retaining the driveshaft to the rear axle circular flange.

4. Disconnect the driveshaft from the rear axle companion flange. Pull the driveshaft toward the rear of the vehicle until the driveshaft slip yoke (4841) clears the extension housing (7A039) and seal. Install the appropriate plug in the extension housing to prevent lubricant leakage.

Installation

1. **NOTE: When installing a new service driveshaft, align the factory-made yellow paint mark at the rear of the driveshaft tube with the factory-made yellow paint mark on the rear axle companion flange.**

   Lubricate the driveshaft slip-yoke splines with Premium Long-Life Grease XG-1-C or -K or equivalent meeting Ford specification ESA-M1C75-B. Remove the plug from the transmission extension housing. Inspect the housing seal for damage; replace if required. Slide the driveshaft slip-yoke into the output extension housing of the transmission. Do not allow the driveshaft slip-yoke to bottom out on the output shaft with excessive force.

2. **NOTE: Make sure that the center bearing bracket is reinstalled "square" to the driveshaft. If spacers were installed under the center bearing bracket, make sure they are reinstalled.**

   Position the driveshaft so that the index mark on the rear yoke (or yellow dot on driveshaft tube) is in line with the index mark on the rear axle companion flange. This ensures original driveline balance. If a vibration exists after installation, refer to Section 00-04 .

3. Install the bolts that retain the driveshaft to the rear axle companion flange. Tighten to 95-129 Nm (70-95 lb-ft).

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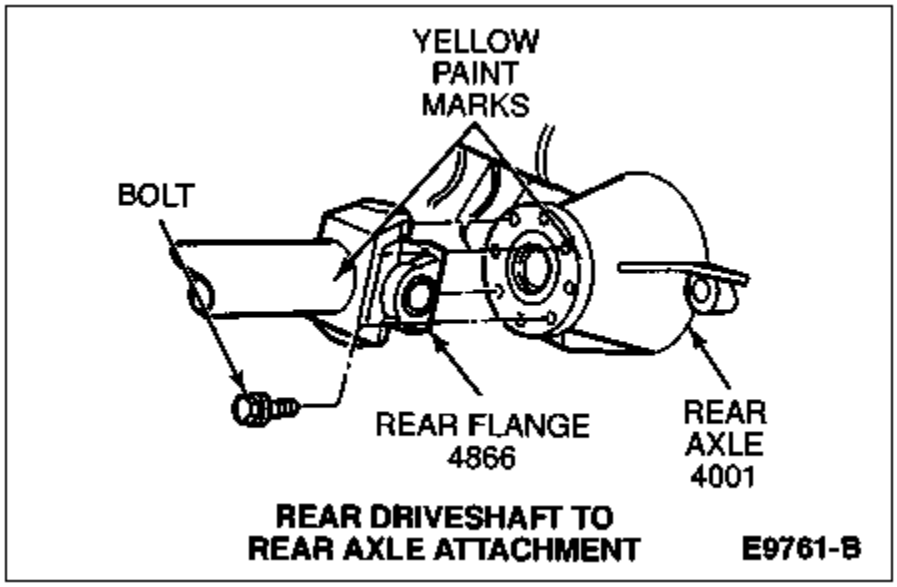
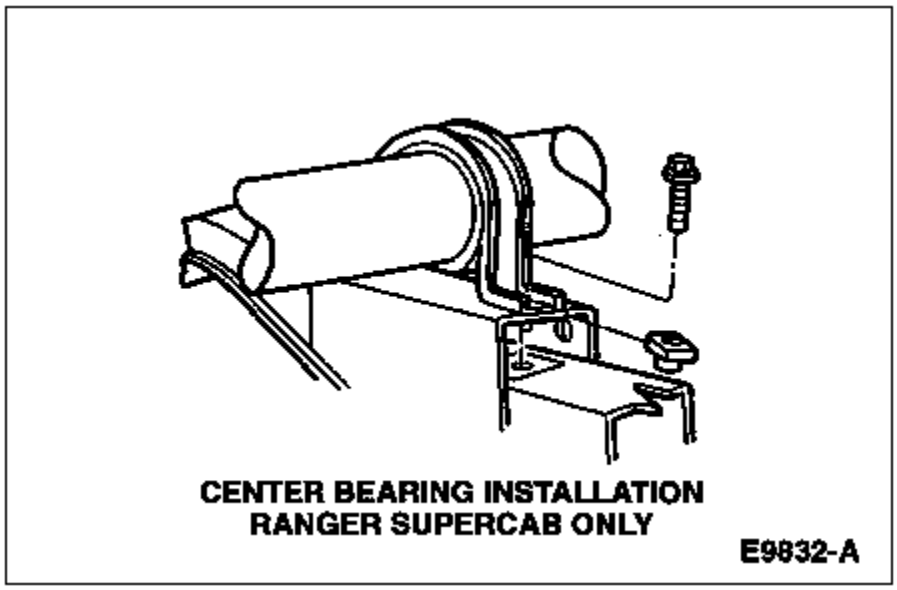
4. Install the bolts that retain the driveshaft center bearing bracket to the frame crossmember. Tighten to 37-50 Nm (27-37 lb-ft).



REAR DRIVESHAFT TO
REAR AXLE ATTACHMENT E9761-B



CENTER BEARING INSTALLATION
RANGER SUPERCAB ONLY
E9832-A

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Two-Piece Driveshafts with Slip at Transmission Coupling Shaft and Slip Between Center Rear Shaft, Ranger SuperCab 4x2

Removal

1. **NOTE: All driveshafts are balanced. Mark the driveshaft in relation to the rear universal joint yoke and the rear axle circular flange so that it may be installed in the original position.**

   To maintain driveline balance, locate original paint mark on the rear axle companion flange and mark driveshaft flange yoke (4866) in the same location. If original mark is not visible on rear axle companion flange, mark both the rear axle companion flange and driveshaft flange yoke at any location.

2. Remove the bolts that retain the driveshaft center bearing bracket (4A499) to the frame crossmember. Remove spacers under the center bearing bracket, if installed.

3. **CAUTION: Do not allow driveshaft to hang free. Support the driveshaft during removal procedures.**

   Remove the bolts retaining the driveshaft to the rear axle circular flange.

4. Disconnect the driveshaft from the rear axle companion flange. Pull the driveshaft toward the rear of the vehicle until the driveshaft slip yoke (4841) clears the extension housing (7A039) and seal. Install the appropriate plug in the extension housing to prevent lubricant leakage.

Installation

1. **NOTE: When installing a new service driveshaft, align the factory-made yellow paint mark at the rear of the driveshaft tube with the factory-made yellow paint mark on the rear axle companion flange.**

   Lubricate the driveshaft slip-yoke splines with Premium Long-Life Grease XG-1-C or -K or equivalent meeting Ford specification ESA-M1C75-B. Remove the plug from the transmission extension housing. Inspect the housing seal for damage; replace if required. Slide the driveshaft slip-yoke into the output extension housing of the transmission. Do not allow the driveshaft slip-yoke to bottom out on the output shaft with excessive force.

2. **NOTE: Make sure that the center bearing bracket is reinstalled "square" to the driveshaft. If spacers were installed under the center bearing bracket, make sure they are reinstalled.**

   Position the driveshaft so that the index mark on the rear yoke (or yellow dot on driveshaft tube) is in line with the index mark on the rear axle companion flange. This ensures original driveline balance. If a vibration exists after installation, refer to Section 00-04 .

3. Install the bolts that retain the driveshaft to the rear axle companion flange. Tighten to 95-129 Nm (70-95 lb-ft).

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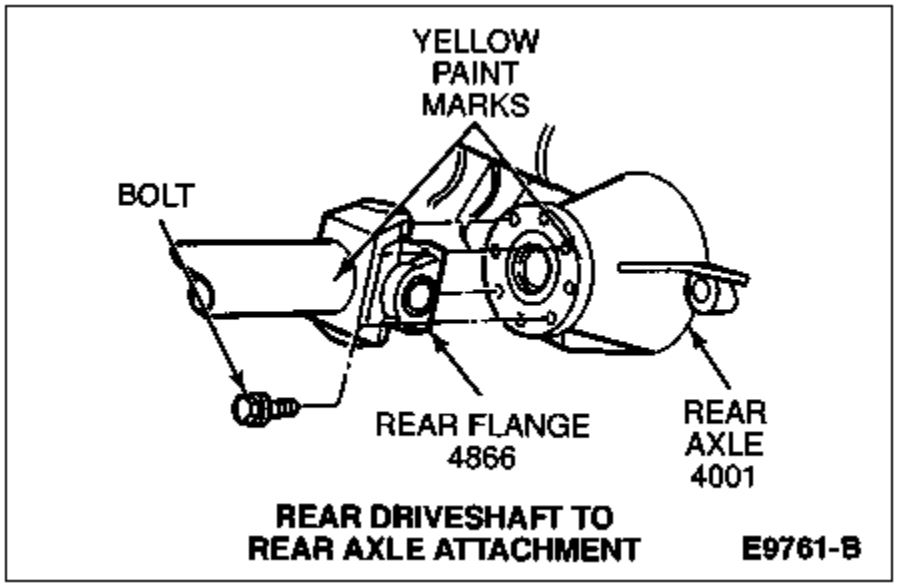
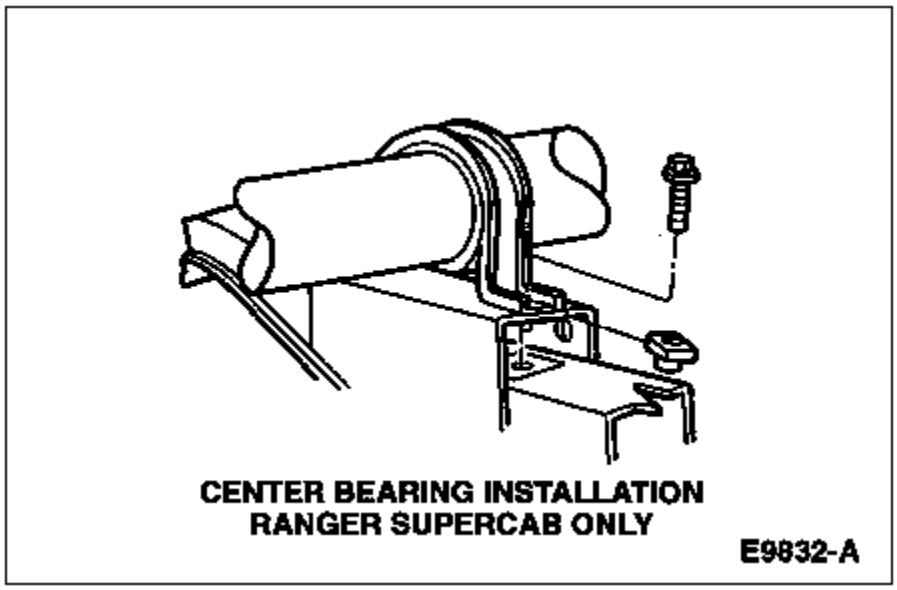
4. Install the bolts that retain the driveshaft center bearing bracket to the frame crossmember. Tighten to 37-50 Nm (27-37 lb-ft).



REAR DRIVESHAFT TO
REAR AXLE ATTACHMENT E9761-B



CENTER BEARING INSTALLATION
RANGER SUPERCAB ONLY
E9832-A

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Two-Piece Driveshafts with Fixed Coupling Shaft and Slip-Between-Center Rear Shaft, Ranger SuperCab 4x4

Removal

1. **NOTE: All driveshafts are balanced. Mark the driveshaft in relation to the rear universal joint yoke and the rear axle circular flange so that it may be installed in the original position.**

   To maintain driveline balance, locate original paint mark on rear axle companion flange and mark driveshaft flange yoke (4866) in the same location. If original mark is not visible on rear axle companion flange, mark both the rear axle companion flange and driveshaft flange yoke at any location.

2. Remove the bolts that retain the driveshaft center bearing bracket (4A499) to the frame crossmember. Remove spacers under the center bearing bracket, if installed.

3. **CAUTION: Do not allow driveshaft to hang free. Support the driveshaft during removal procedures.**

   Remove the bolts retaining the driveshaft to the rear axle companion flange.

4. Remove the bolts retaining the driveshaft to the transfer case circular flange. Remove driveshaft from vehicle.

Installation

1. **NOTE: When installing a new service driveshaft, align the factory-made yellow paint mark at the rear of the driveshaft tube with the factory-made yellow paint mark on the rear axle companion flange.**

   Position the driveshaft to the transfer case circular flange and install the bolts. Support the driveshaft during installation. DO NOT ALLOW THE DRIVESHAFT TO HANG FREE.

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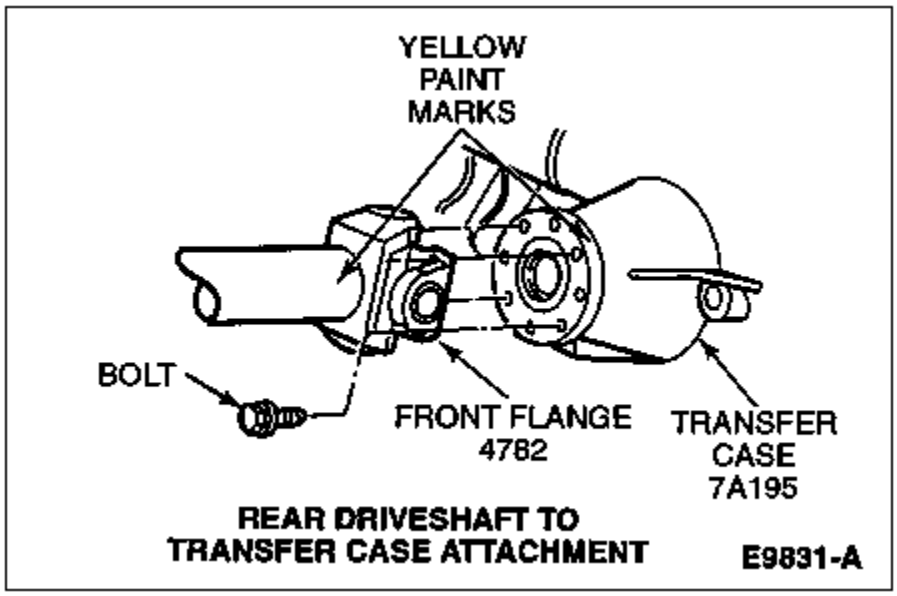
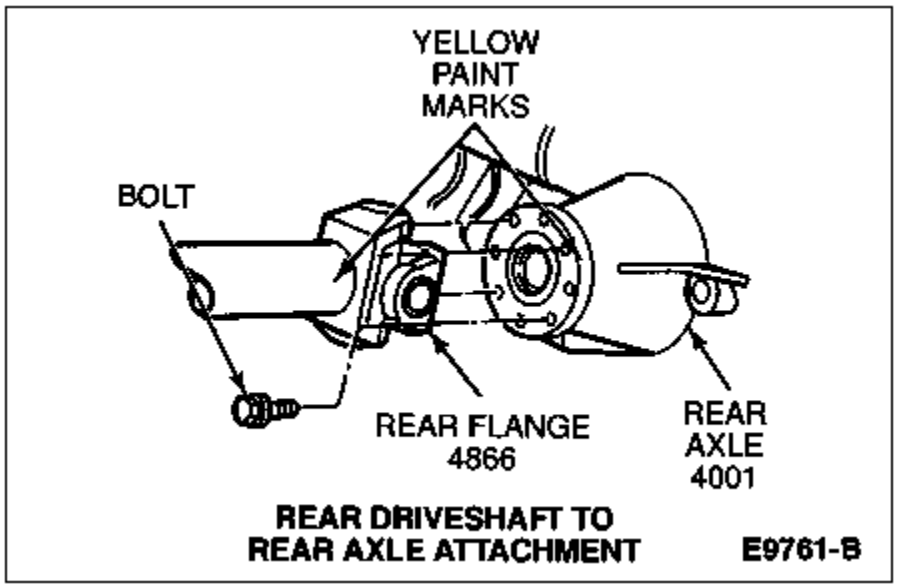


2. **NOTE: Make sure that the center bearing bracket is reinstalled "square" to the driveshaft. If spacers were installed under the center bearing bracket, make sure they are reinstalled.**

   Position the driveshaft so that the index mark on the rear yoke (or yellow dot on driveshaft tube) is in line with the index mark on the rear axle companion flange. This ensures original driveline balance. If a vibration exists after installation, refer to Section 00-04 .

3. Install the bolts that retain the driveshaft to the rear axle companion flange. Tighten to 95-129 Nm (70-95 lb-ft).

4. Install the bolts that retain the driveshaft center bearing bracket to the frame crossmember. Tighten to 37-50 Nm (27-37 lb-ft).



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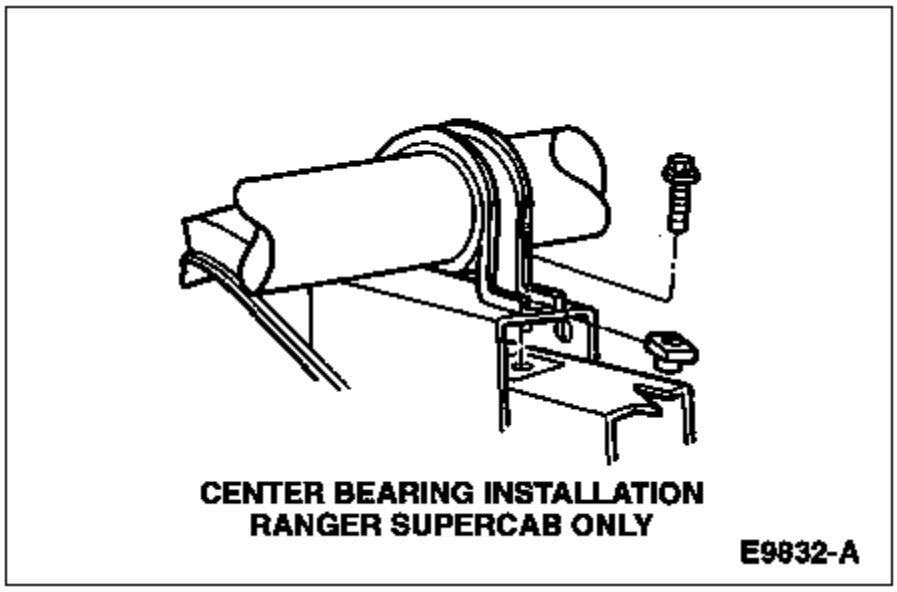

CENTER BEARING INSTALLATION
RANGER SUPERCAB ONLY
E9832-A

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Driveshaft, Rear, with Single Cardan Universal Joint

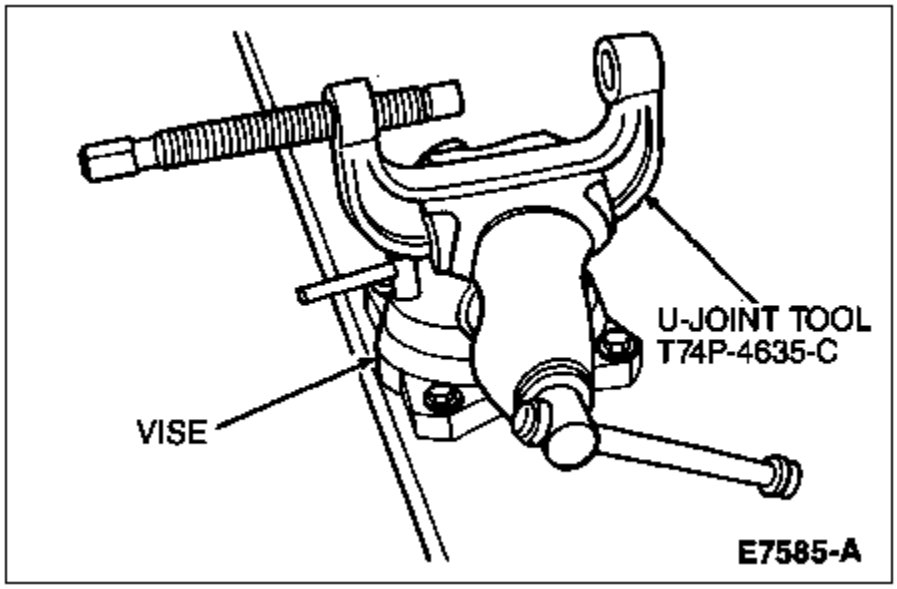
WARNING: UNDER NO CIRCUMSTANCES IS THE DRIVESHAFT TO BE CLAMPED IN THE JAWS OF A VISE OR SIMILAR HOLDING FIXTURE. DENTING OR LOCALIZED FRACTURE OF THE TUBE MAY RESULT, WHICH COULD CAUSE DRIVESHAFT FAILURE DURING VEHICLE OPERATION.

SPECIAL SERVICE TOOL (S) REQUIRED

Description	Tool Number
U-Joint Tool	T74P-4635-C

Disassembly

1. Place the driveshaft on a suitable workbench, being careful not to damage the tube.
2. Prior to disassembly, mark the positions of the driveshaft components relative to the driveshaft tube. All components must be reassembled in the same relationship to maintain proper balance.
3. Clamp U-joint Tool T74P-4635-C in vise.



4. Remove the snap rings that retain the bearing cups.

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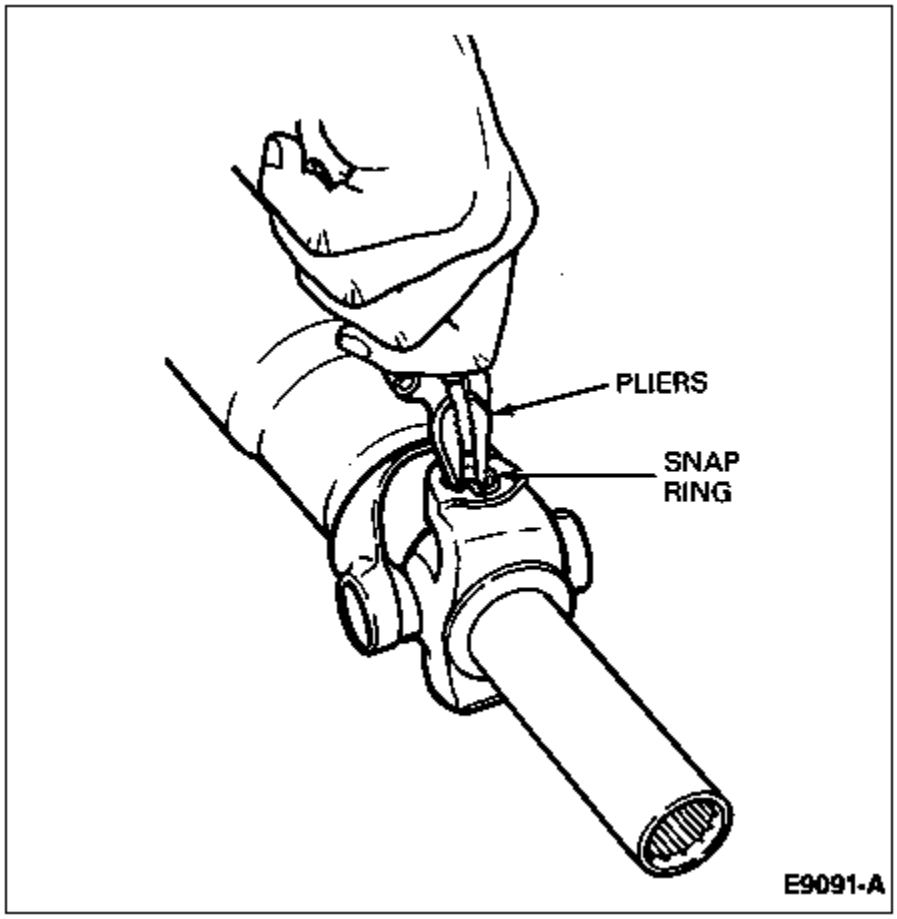

5. Position the driveshaft slip yoke (4841) or flange yoke in U-joint Tool T74P-4635-C and press out bearing. If bearing cup cannot be pressed all the way out of the driveshaft slip yoke or flange yoke, remove it with vise grip or channel lock pliers.

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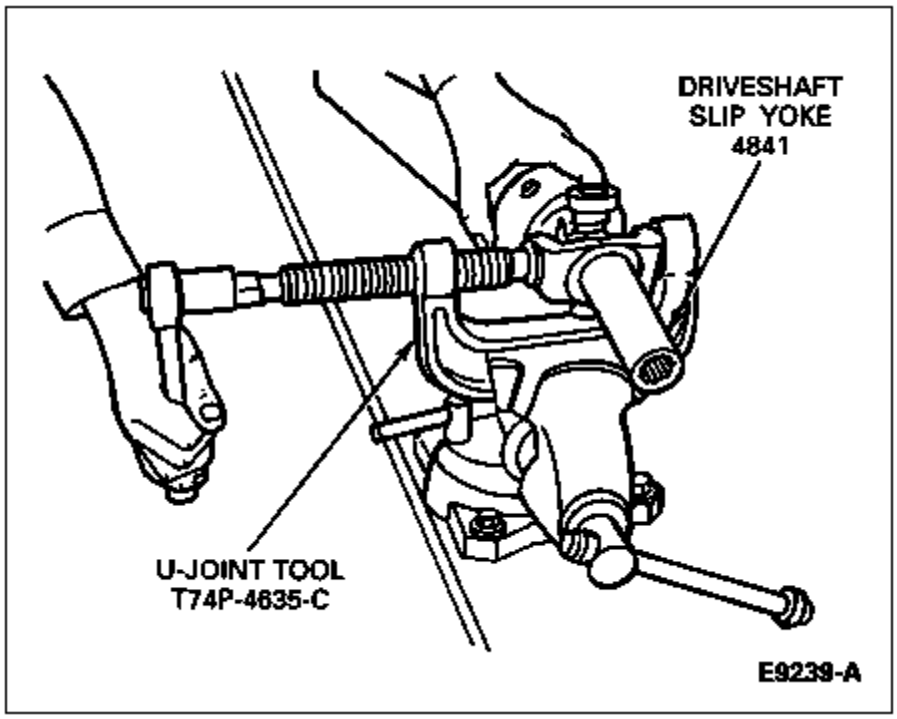

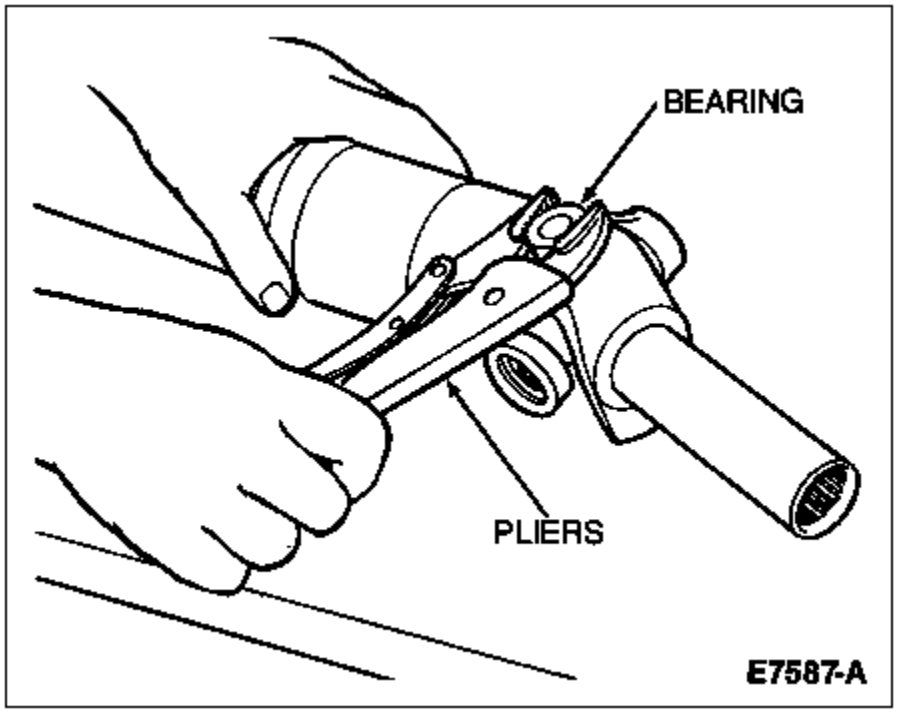

6. Reposition the driveshaft slip yoke or flange yoke in U-joint Tool T74P-4635-C 180 degrees to press on the spider and remove the remaining bearing cup from the opposite side.

7. Remove driveshaft slip yoke or flange yoke from the spider.

8. Remove the remaining bearing cups, spiders and rear flange from the driveshaft in the same manner.

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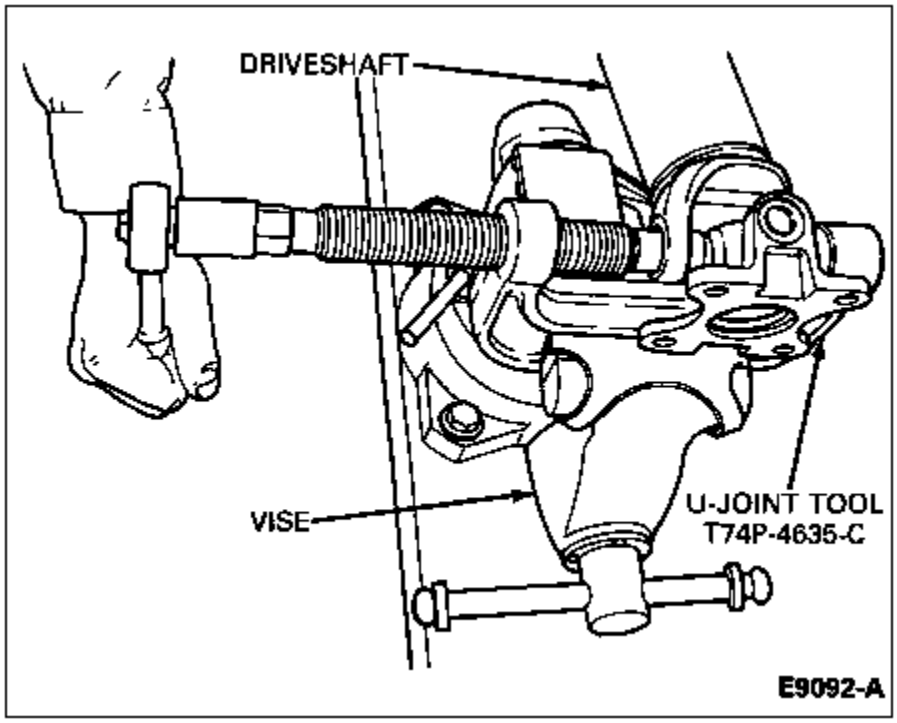
9. Clean all foreign matter from the yoke area at each end of the driveshaft.



Assembly

NOTE: Universal joint kits are to be installed as complete assemblies only. Do not mix components from other universal joints.

1. Start a new bearing cup into the yoke of the driveshaft.

2. Position the new spider in the driveshaft yoke and press the bearing cup 6.3mm (1/4 inch) below the yoke surface using U-joint Tool T74P-4635-C.

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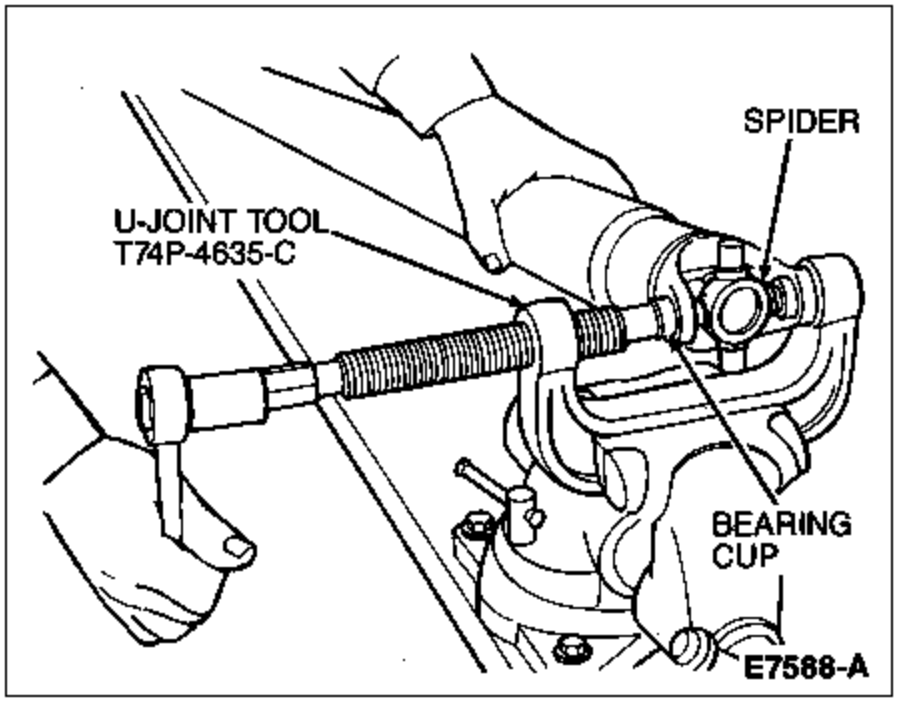

3. Remove U-joint Tool T74P-4635-C and install a new snap ring.

4. Start a new bearing cup into the opposite side of the yoke. Check needles for proper position.

5. **NOTE: Make sure the driveshaft slip yoke or flange are installed in the same position as marked before disassembly. Assemble universal joint using the yellow snap rings supplied in the kit. If difficulty is encountered with yellow snap rings, install the black snap rings supplied in the kit.**

   Position driveshaft in U-joint Tool T74P-4635-C and press on the bearing cup until the opposite bearing cup contacts the snap ring.

6. Remove the driveshaft from tool and install a new snap ring. Check snap ring for proper seating.

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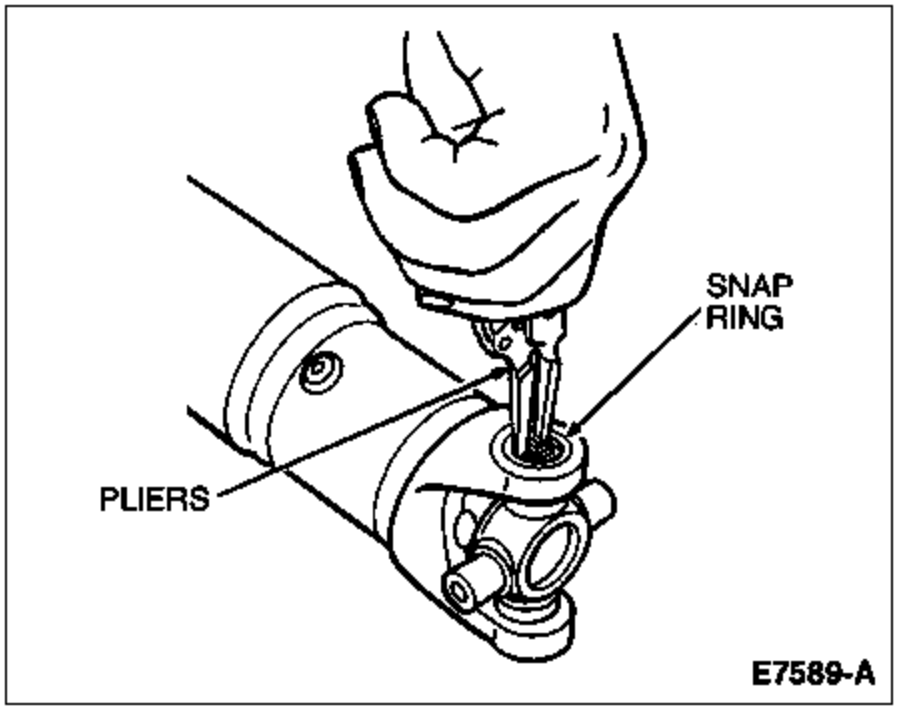
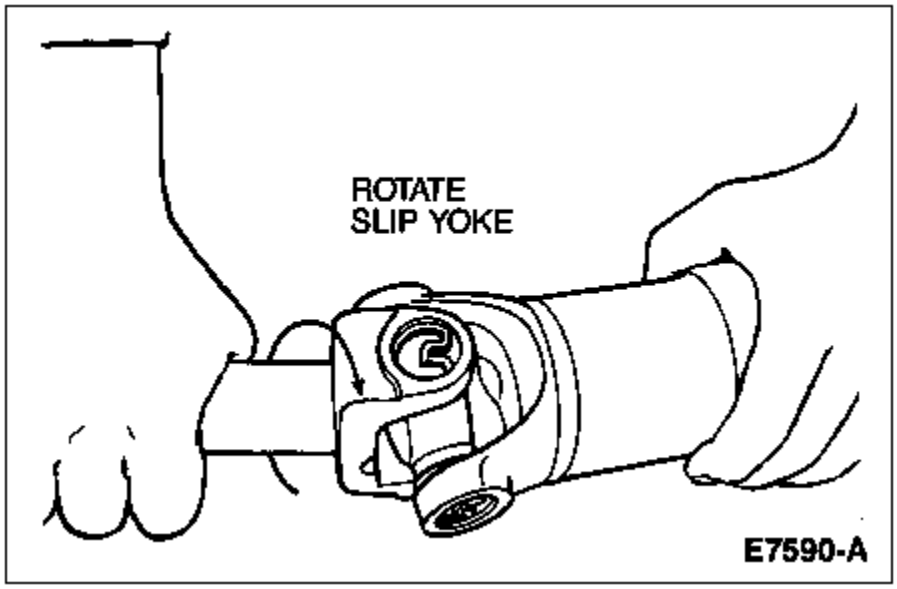


7. Install the remaining new bearing cups, spider, rear flange, driveshaft slip yoke or flange yoke and snap rings to the spider in the same manner.

8. **CAUTION: When performing the following procedure, take care to support the shaft end and do not strike the bearings during this procedure.**

   Check universal joint kit for freedom of movement. If binding has resulted from misalignment during assembly, a sharp rap on the yokes with a brass or plastic hammer will seat bearing needles. Make sure universal joints rotate easily without binding before installing driveshaft.



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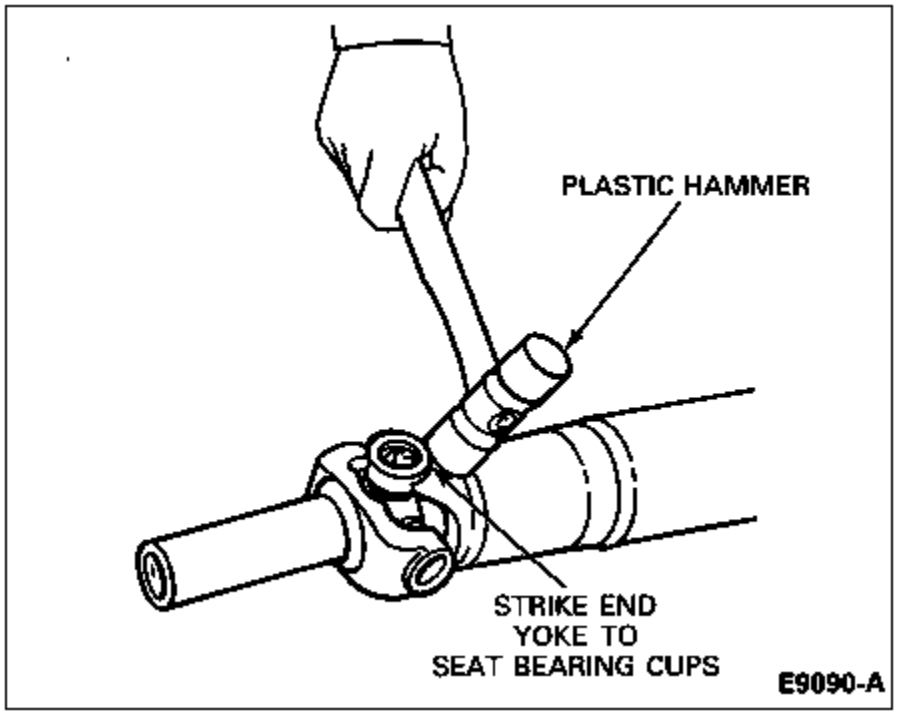

9. Lubricate the universal joint (if equipped with grease fittings) with Premium Long-Life Grease XG-1-C or -K or equivalent meeting Ford specification ESA-M1C75-B.

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Driveshaft, with Double Cardan Universal Joint

WARNING: UNDER NO CIRCUMSTANCES IS THE DRIVESHAFT TO BE CLAMPED IN THE JAWS OF A VISE OR SIMILAR HOLDING FIXTURE. DENTING OR LOCALIZED FRACTURE OF THE TUBE MAY RESULT WHICH COULD CAUSE DRIVESHAFT FAILURE DURING VEHICLE OPERATION.

SPECIAL SERVICE TOOL (S) REQUIRED

Description	Tool Number
U-Joint Tool	T74P-4635-C

Disassembly

1. Place the driveshaft on a suitable workbench being careful not to damage the tube.
2. **CAUTION: The spiders must be assembled with the bosses in their original position to provide proper clearance.**

   Mark the positions of the spiders, the driveshaft center yoke (4784), and the driveshaft centering socket yoke (4782) as related to the stud yoke which is welded to the front of the driveshaft tube.
3. Remove the snap rings that secure the bearings in the front of the driveshaft center yoke.
4. Position the U-joint Tool T74P-4635-C as shown. Thread the tool clockwise until the bearing protrudes approximately 9.525mm (3/8 inch) out of the driveshaft center yoke.

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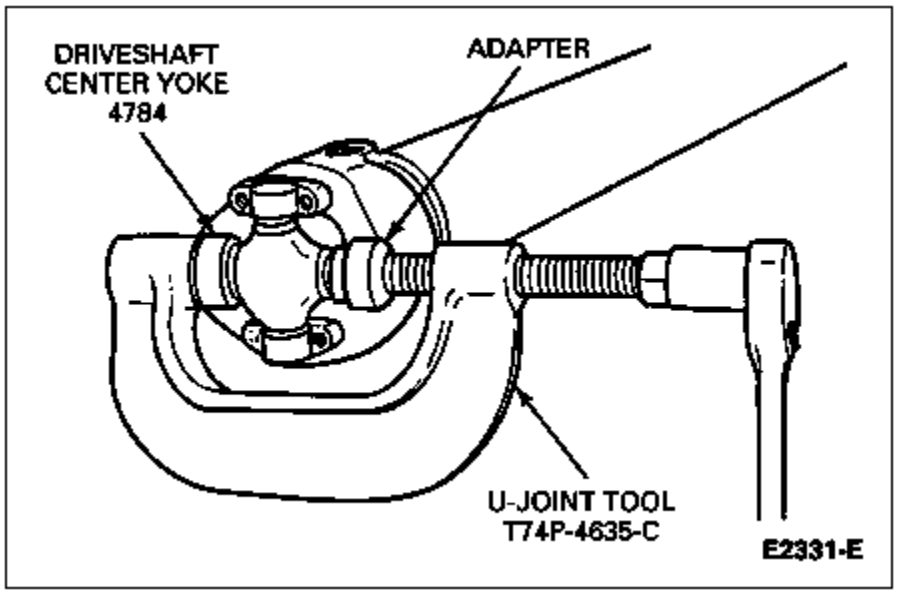
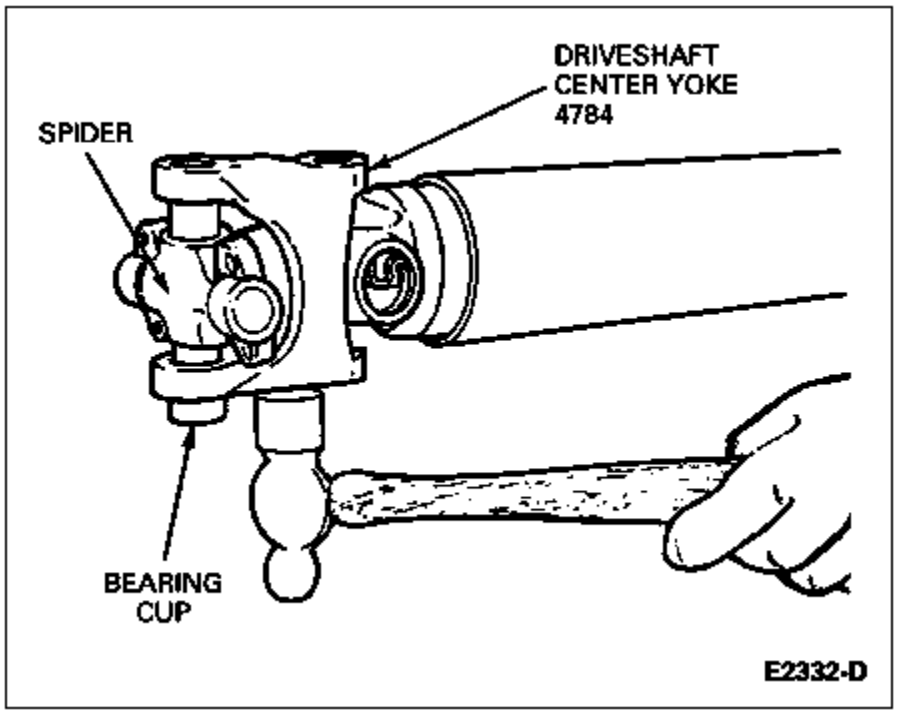


5. Position the bearing in a vise and tap on the driveshaft center yoke as shown to free it from the bearing.



6. Lift the two bearing cups from the spider.

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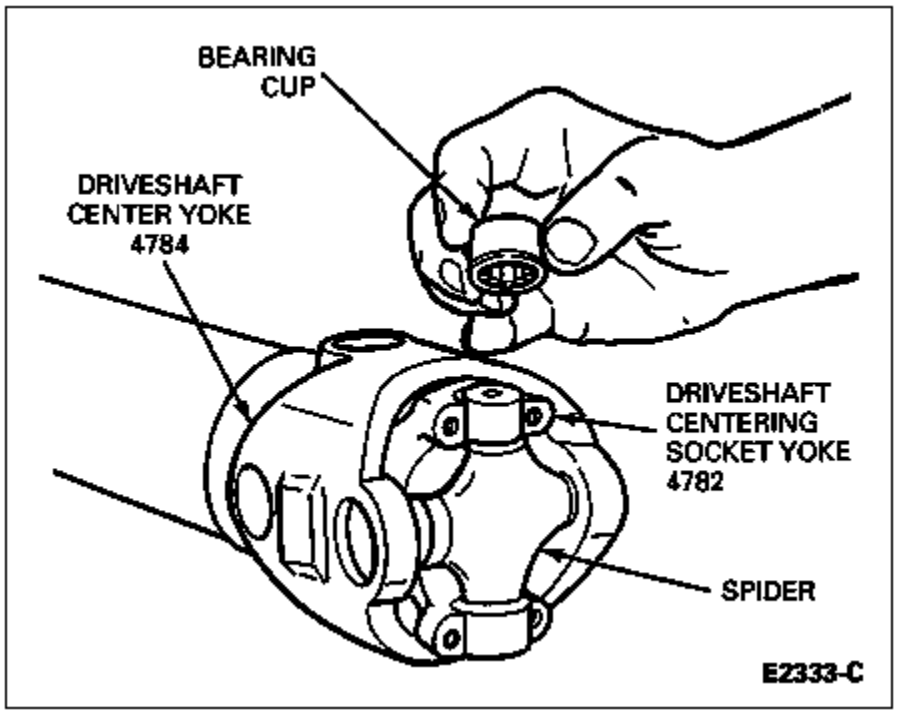

7. Reposition the tool on the driveshaft center yoke and move the remaining bearing in the opposite direction so that it protrudes approximately 9.525mm (3/8 inch) out of the driveshaft center yoke.

8. Grip the bearing in a vise. Tap on the driveshaft center yoke to free it from the bearing.

9. Remove the spider from the driveshaft center yoke.

10. Pull the driveshaft centering socket yoke off the center stud. Remove the rubber seal from the centering ball stud.

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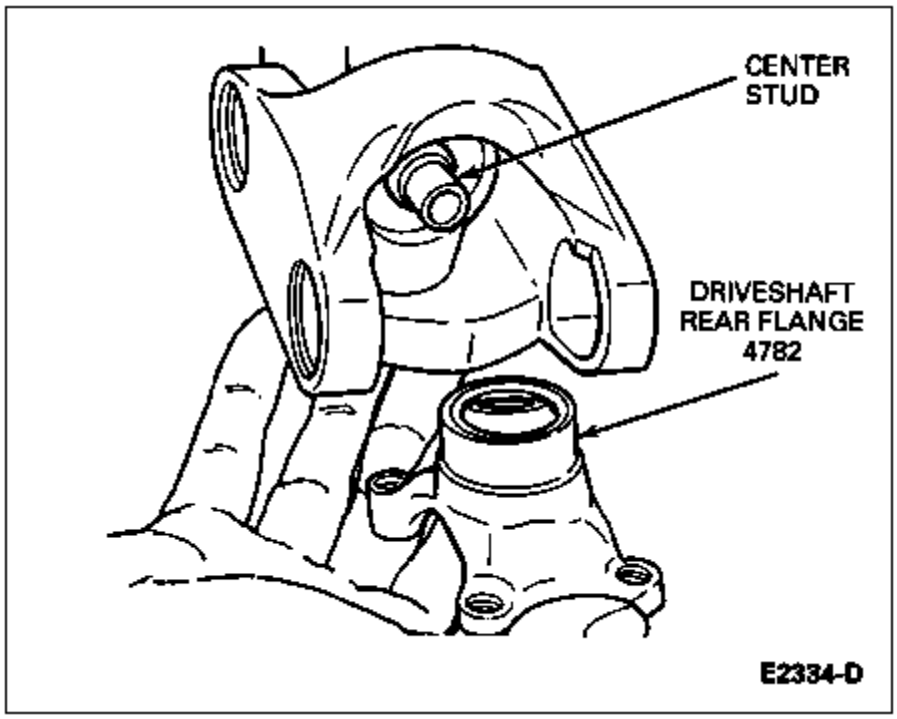
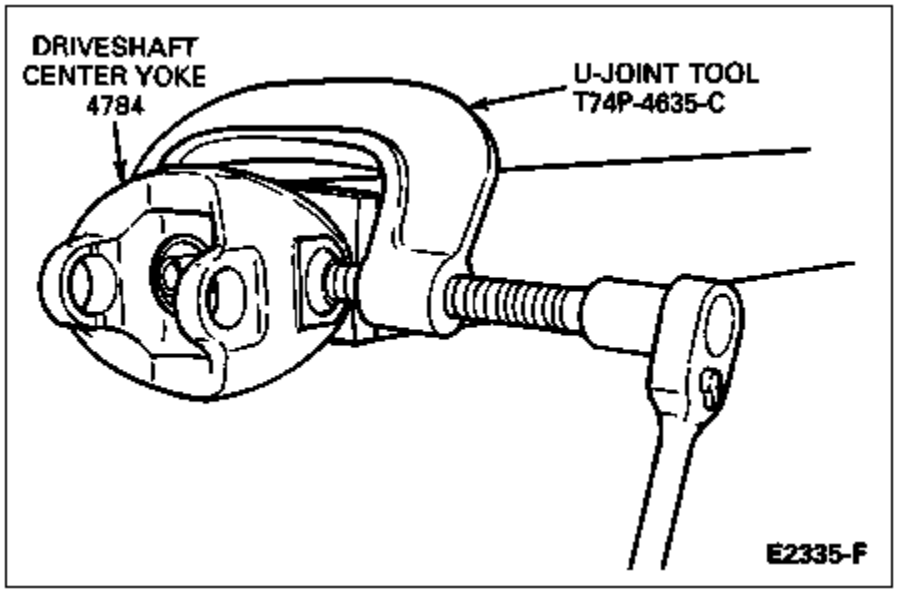


11. Remove the snap rings from the driveshaft center yoke and from the driveshaft yoke.

12. Position the tool on the driveshaft yoke and press the bearing outward until the inside of the driveshaft center yoke almost contacts the slinger ring at the front of the driveshaft yoke.



Pressing beyond this point can distort the slinger ring. The arrow shown illustrates the interference point.

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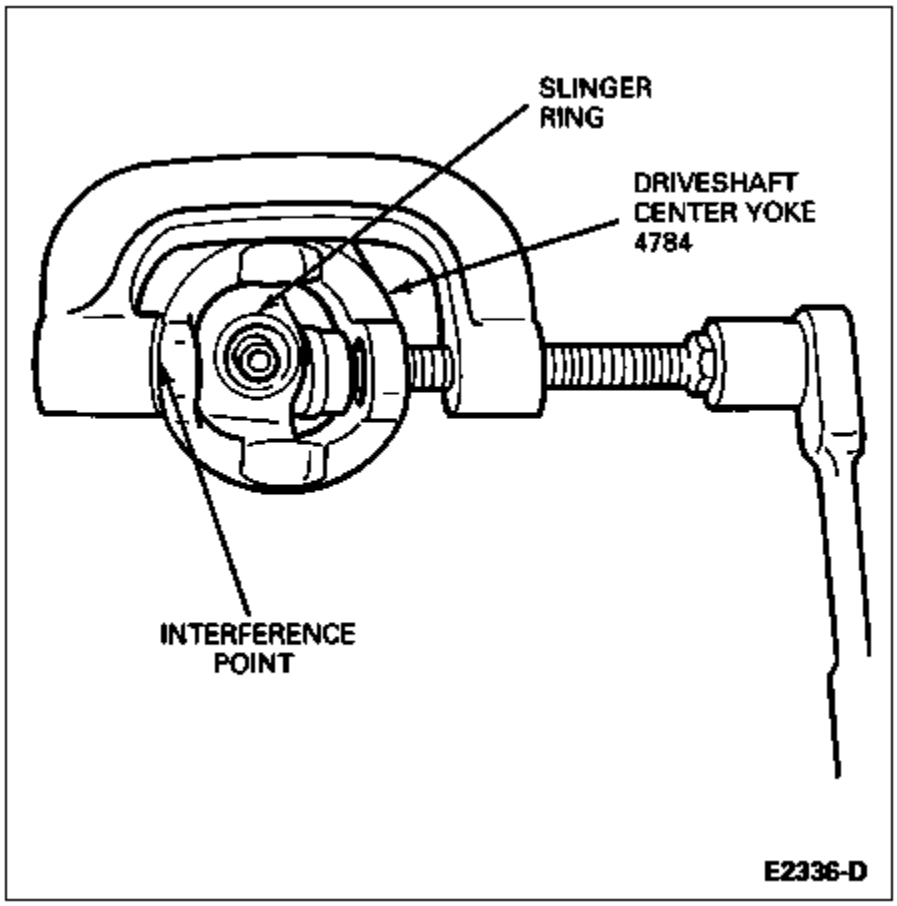

13. Clamp the exposed end of the bearing in a vise and drive on the driveshaft center yoke with a soft-faced hammer to free it from the bearing.

14. Reposition the tool and press on the spider to remove the opposite bearing.

15. Remove the driveshaft center yoke from the spider.

16. Remove the spider from the driveshaft yoke in the same manner.

17. Clean all serviceable parts in cleaning solvent. If using a repair kit, install all of the parts supplied in the kit. If the driveshaft is damaged, replace the complete shaft to be assured of a balanced assembly.

Assembly

1. To assemble the universal joint, position the spider in the driveshaft yoke. Make sure the spider bosses (or lubrication plugs on kits) will be in the same position as originally installed. Press in the bearing using U-joint Tool T74P-4635-C. Install the snap rings.

2. Pack the socket relief and the ball with Premium Long-Life Grease XG-1-C- or -K or equivalent meeting Ford specification ESA-M1C75-B, then position the driveshaft center yoke over the spider ends and press in the bearing. Install the snap rings.

3. Install a new seal on the centering ball stud. Position the driveshaft centering socket yoke on the stud.

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4. Place the front spider in the driveshaft center yoke. Make sure the spider bosses (or lubrication plugs on kits) are properly positioned.

5. With the spider loosely positioned on center stop, proceed to seat the first pair of bearings into the driveshaft centering socket yoke, then press the second pair into the driveshaft center yoke. Install the snap rings.

6. Apply pressure on the driveshaft centering socket yoke and install the remaining bearing cup.

7. On universal joint kits equipped with grease fittings lubricate the universal joints using Premium Long-Life Grease XG-1-C or -K or equivalent meeting Ford specification ESA-M1C75-B.

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Center Bearing, SuperCab 4x2 and 4x4

Disassembly and Assembly

1. Unbolt the center bearing mount and spin the bearing. If bearing does not rotate freely it must be replaced.

2. Inspect the rubber insulator for evidence of hardening, cracking or deterioration before removing shaft. Replace if damaged.

3. Remove driveshaft from vehicle.

4. Separate driveshaft from coupling shaft as described above. Make sure to mark driveshaft and coupling shaft.

5. Remove the nut retaining the half-round yoke to the coupling shaft and remove yoke.

6. **NOTE: Make sure the yoke is reinstalled on the coupling shaft in the same orientation as it was originally installed. The orientation is critical so that proper driveshaft balance and universal joint phasing is maintained. Tighten the attaching nut to 135-162 Nm (100-120 lb-ft).**

   Reinstall the coupling shaft yoke.

7. Reassemble driveshaft to coupling shaft, again maintaining proper orientation of driveshaft to coupling shaft.

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Driveshaft Slip-Yoke Boot

Slip-At-Transfer Case Slip-Yoke Boot Replacement, Aerostar E-4WD

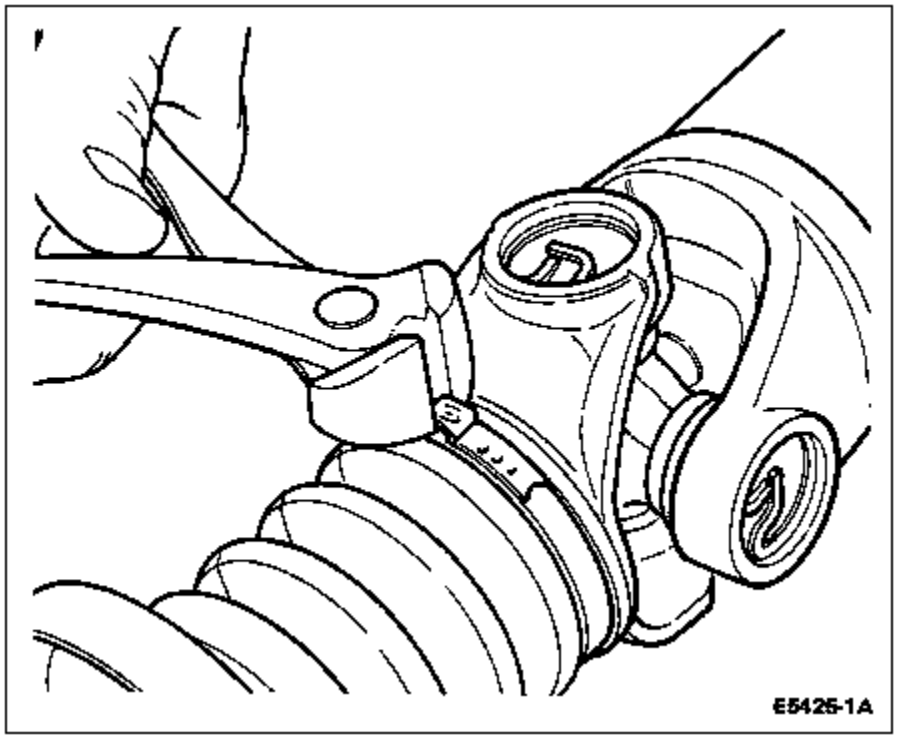
SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Keystone Clamp Pliers	T63P-9171-A

Removal

1. Remove driveshaft from vehicle as illustrated in Removal and Installation, Driveshaft, Front in this section.

2. Remove the driveshaft slip-yoke boot clamp with the end cutter pliers as shown. Discard the driveshaft slip-yoke boot clamp. Remove the driveshaft slip-yoke boot from the stud yoke.



Installation

1. Install new driveshaft slip-yoke boot on the stud yoke, making sure the driveshaft slip-yoke boot is seated in the groove in the stud yoke.

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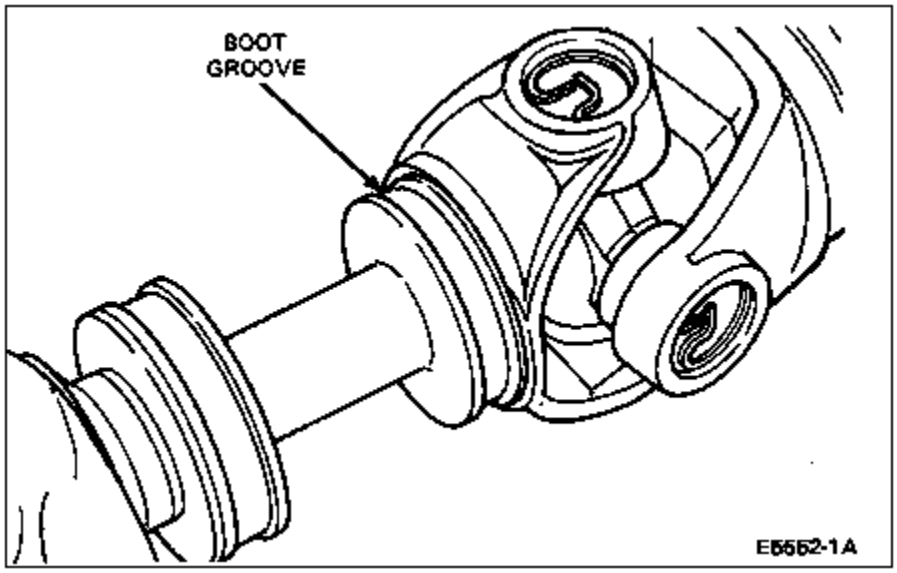
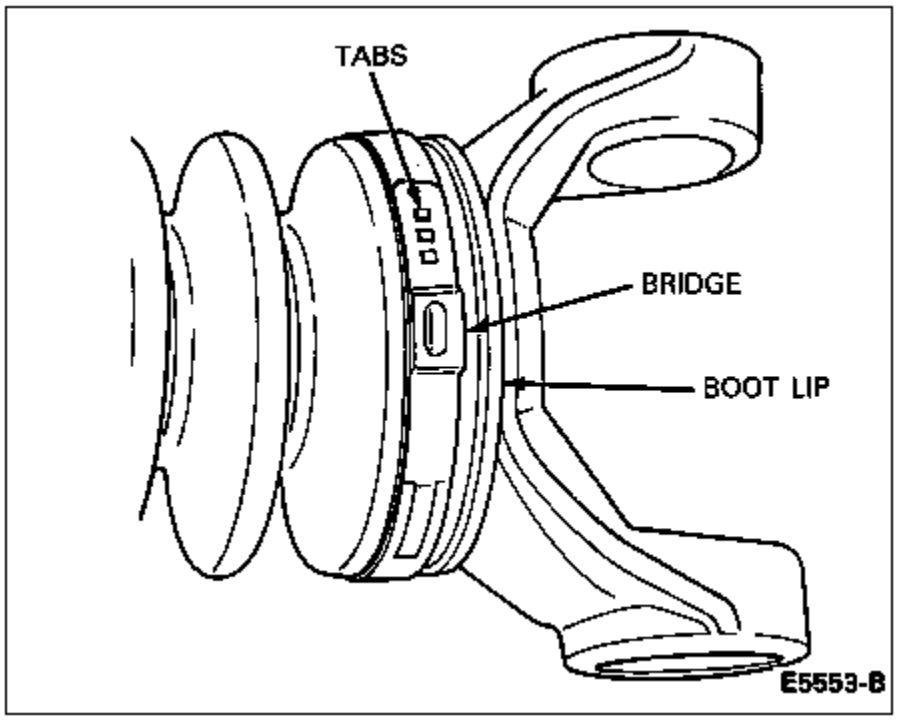


2. Install a new driveshaft slip-yoke boot clamp on the driveshaft slip yoke boot. Locate the clamp tabs in the slots so each tab fits into a slot. Crimp the driveshaft slip-yoke boot clamp securely using Keystone Clamp Pliers T63P-9171-A. Do not crimp to the point where the clamp bridge is cut or the driveshaft slip-yoke boot is damaged.

3. Install driveshaft into vehicle as illustrated in this section.



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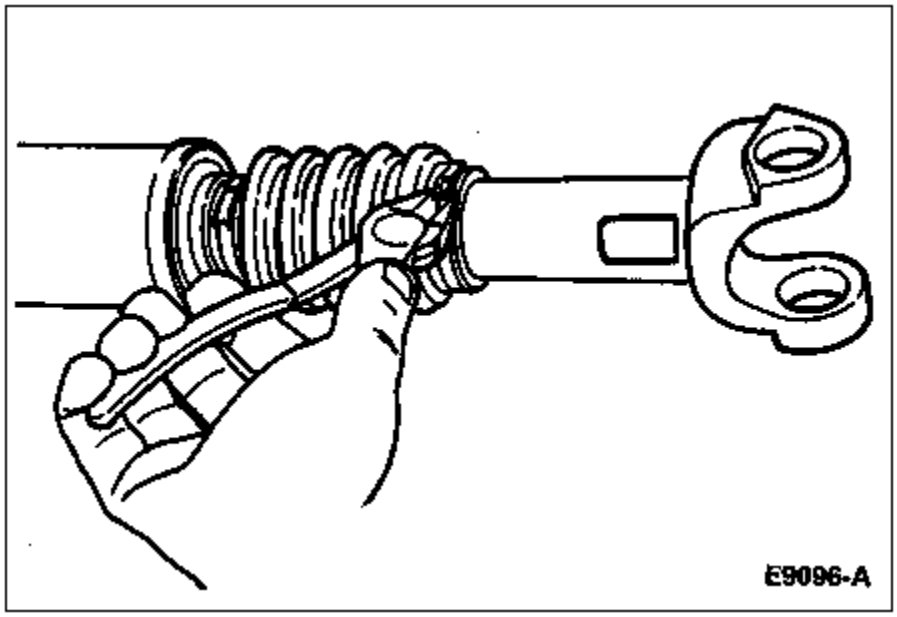
Slip Between Center Driveshaft Slip Yoke Boot, Ranger 4x4 Front and Rear Driveshafts, Ranger SuperCab 4x2 Rear Driveshafts

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Keystone Clamp Pliers	T63P-9171-A

Removal

1. Remove driveshaft as illustrated in this section.
2. Scribe alignment marks on the driveshaft slip-yoke and the driveshaft tube to ensure proper U-joint phasing when reassembled.
3. Remove the driveshaft slip-yoke boot clamps with the end cutter pliers as shown. Discard the driveshaft slip-yoke boot clamps.



4. Remove the driveshaft slip-yoke boot from the driveshaft tube neck and the driveshaft slip yoke. Pull driveshaft slip-yoke off driveshaft stub shaft splines. Discard driveshaft slip-yoke boot.
5. If the driveshaft slip-yoke boot is found to be cracked or split, the grease should be checked for contamination. If driveshaft was operating satisfactorily and grease does not appear to be contaminated, continue with the installation procedure.

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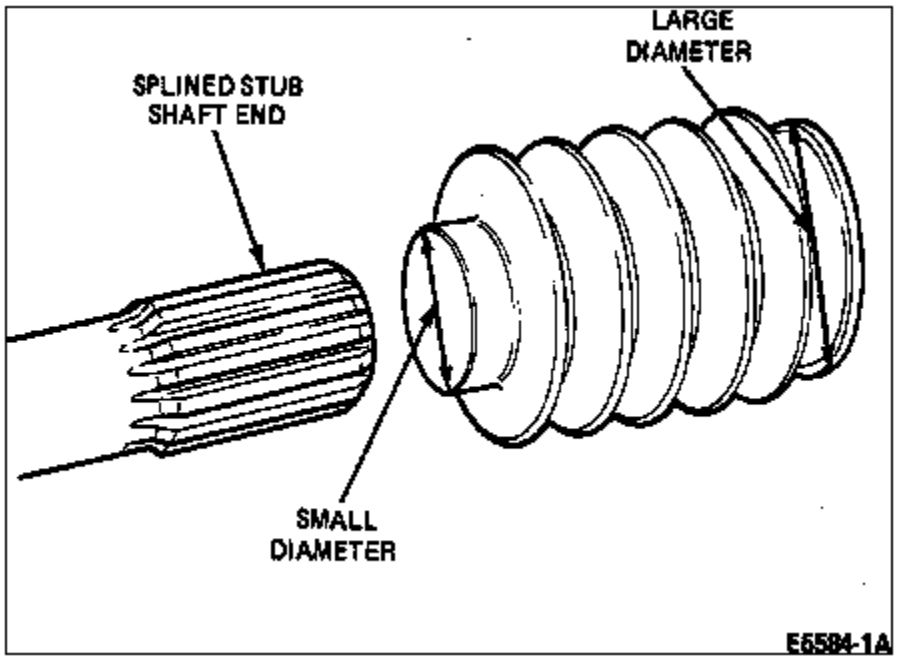
6. Check the lubricant for contamination by rubbing between two fingers. Any gritty feeling indicates a contaminated driveshaft slip-yoke and stub shaft. If the grease appears to be contaminated, inspect the stub shaft and driveshaft slip-yoke for wear. Clean all foreign matter from the driveshaft splines.

Installation

1. Install the driveshaft slip-yoke boot with the small diameter facing the splined stub shaft end. Push the driveshaft slip-yoke boot as far as it will travel on the stub shaft.



2. Install a new small driveshaft slip-yoke boot clamp and crimp the driveshaft slip yoke boot clamp using Keystone Clamp Pliers T63P-9171-A.

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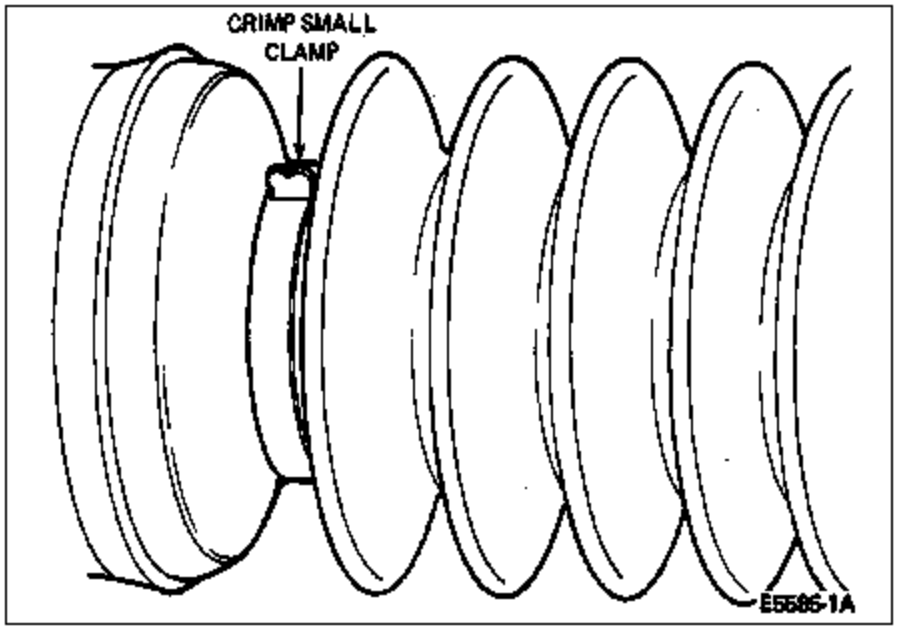

3. Pull the driveshaft slip-yoke boot toward the driveshaft and coat the stub shaft splines with Premium Long-Life Grease XG-1-C or -K or equivalent meeting Ford specification ESA-M1C75-B.

4. Fill the driveshaft slip-yoke boot with approximately 10 grams (.36 ounce) of Premium Long-Life Grease XG-1-C or -K or equivalent meeting Ford specification ESA-M1C75-B.

5. Slide the large slip-yoke boot clamp onto the barrel of the driveshaft slip-yoke before assembling shaft together.

6. Align the driveshaft slip-yoke and driveshaft tube using the alignment marks scribed in Step 2 of the Removal procedure. Push the driveshaft slip-yoke onto the stub shaft.

7. Remove all excess grease from the driveshaft slip-yoke boot and driveshaft slip-yoke. Position the driveshaft slip-yoke boot over the groove.

8. Move the driveshaft slip-yoke in or out in order to position the slip-yoke about 25-38mm (1-1.5 inches) from the collapsed position.

9. Using Keystone Clamp Pliers T63P-9171-A, crimp the large driveshaft slip-yoke boot clamp.

10. Reinstall driveshaft as illustrated in this section.

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SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft
Double Cardan Front Driveshaft-to-Transfer Case Half Round Yoke	17-23	13-17
Driveshaft-to-Transfer Case Flange Bolts	88-119	65-87
Driveshaft-to-Rear Axle Companion Flange Attaching Bolts	95-129	70-95
Front Driveshaft-to-Front Axle Yoke Attachment Bolts	15-20	11-15
Two-Piece Driveshaft Center Bearing-to-Crossmember Attachment Bolts	37-50	27-37
Rear Axle Driveline Vibration Damper-to-Carrier Housing Flange	60-81	44-59
Two-Piece Driveshaft Half-Round Yoke to Coupling Shaft Nut	135-162	100-120
Front Driveshaft-to-Front Axle Yoke Attachment Bolts	30-41	22-30

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Axle Shaft

Removal

1. **NOTE: Whenever a plastic axle housing cover (4033) is removed, it must be replaced with a new cover and bolts. Steel axle housing covers may be reused after thorough cleaning and removing all old gasket material from cover and carrier face.**

   NOTE: For 3.08:1, 3.27:1 and 3.45:1 ratio axles, refer to Steps 4-6. For 3.73:1 and 4.10:1 ratio axles, refer to Steps 7-10.

   Raise vehicle to the desired working height, and remove the rear wheel and tire assemblies. Remove the brake drums (1126).

2. Clean all dirt from the area of carrier axle housing cover with a wire brush and/or cloth.

3. Remove axle housing cover and drain lubricant.

4. Remove differential pinion shaft lock bolt and differential pinion shaft. The pinion gears may be left in place. Once the axle shafts (4234) are removed, reinstall the differential pinion shaft and differential pinion shaft lock bolt.

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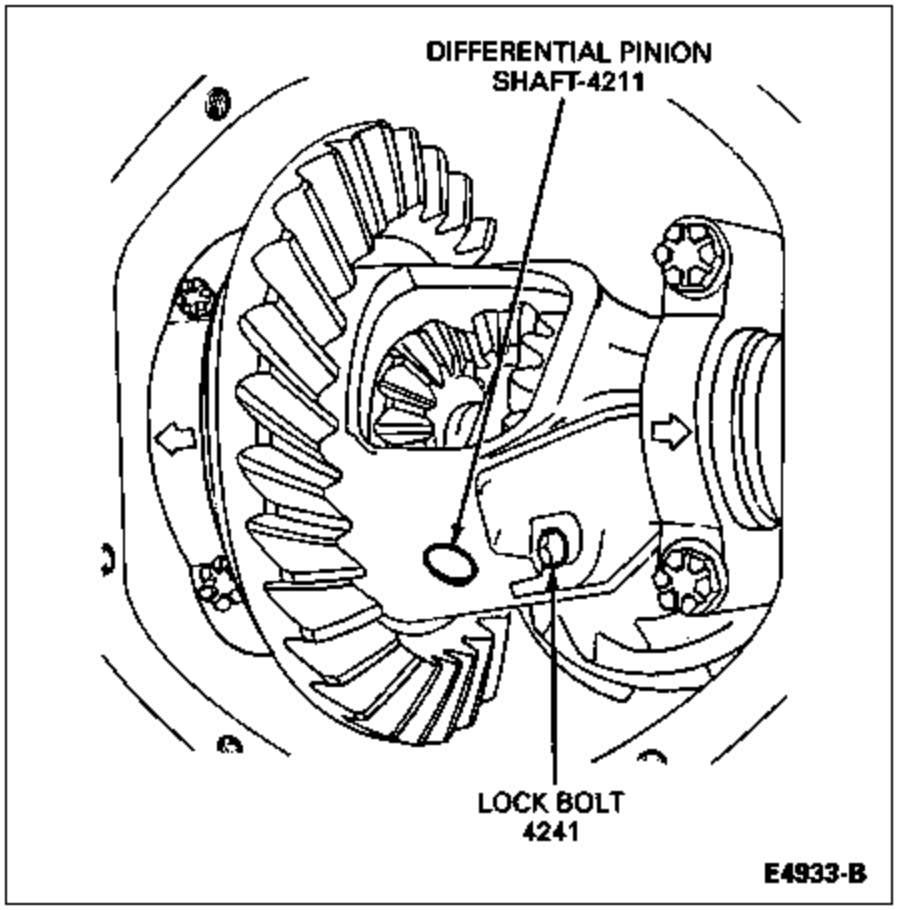

5. Push the flanged end of the axle shafts toward the center of the vehicle and remove the U-washer from the button end of the axle shaft.

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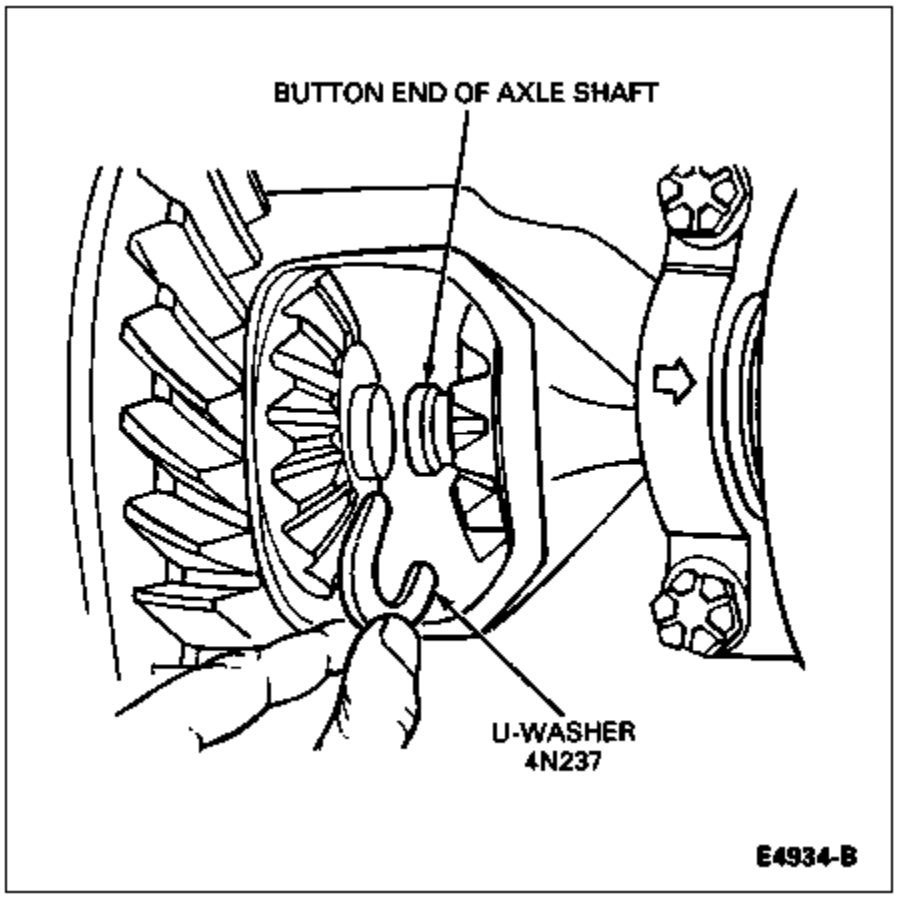

6. **CAUTION: Always remove axle shafts completely from housing or damage to inner wheel bearing oil seal (1177) may result.**

   Remove the axle shaft from the housing, being careful not to damage the inner wheel bearing oil seal.

7. For 3.73:1 and 4.10:1 ratio rear axle assemblies (4006), remove the differential pinion shaft lock bolt.

8. Place hand behind differential case (4204) and push out part of differential pinion shaft until the step on the shaft contacts the ring gear.

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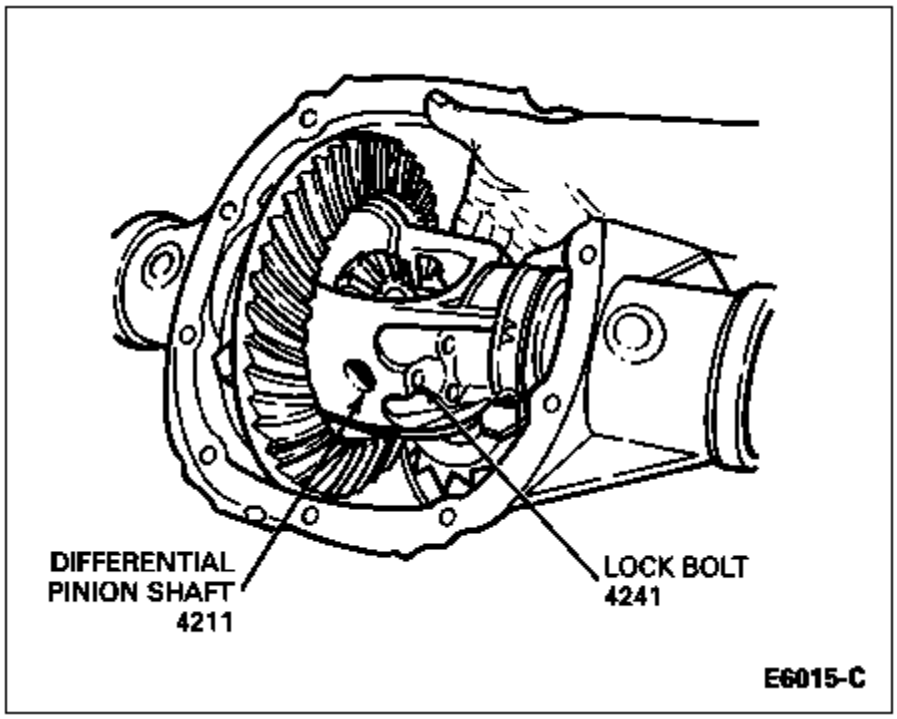
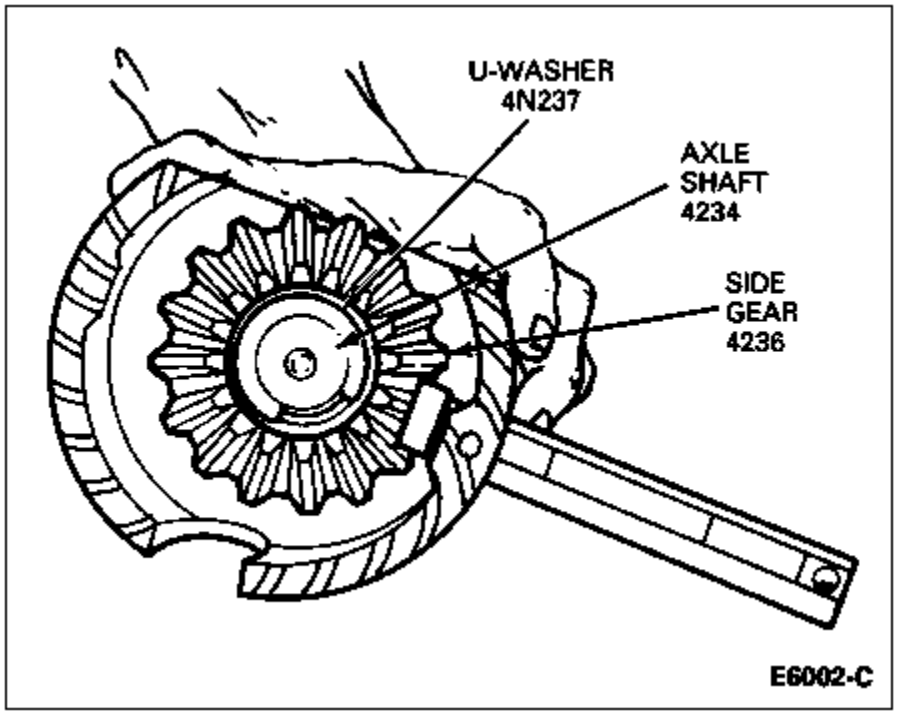


9. Remove the U-washer from the axle shafts.

10. Remove the axle shafts from the rear axle housing, being careful not to damage the inner wheel bearing oil seal.



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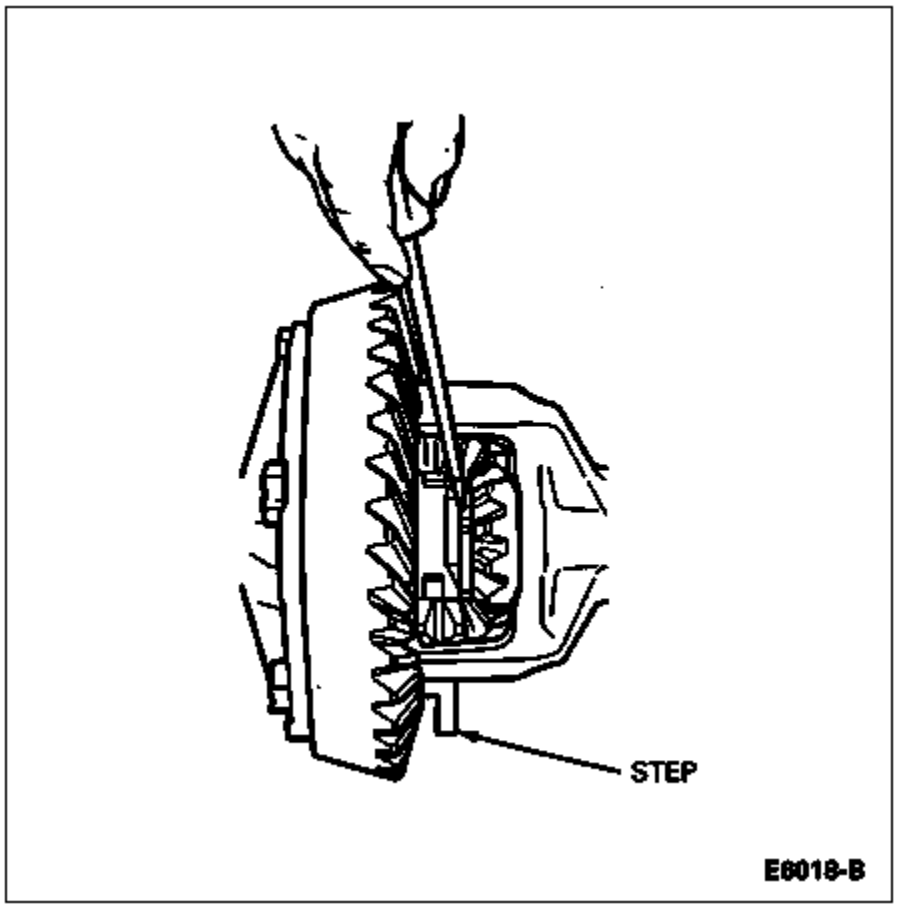
Installation

NOTE: To permit installation ofaxle shaft on 3.73:1 and 4.10:1 axle ratios, make sure the step in the differential pinion shaft contacts the ring gear.



1. **CAUTION: When performing the next step, care must be taken not to let the axle shaft splines damage the oil seal or wheel bearing.**

   Carefully slide the axle shaft into the axle housing. Start the splines into the differential side gear (4236) and push firmly until the button end of the axle shaft can be seen in the differential case.

2. Install the U-washers on the button end of the axle shaft splines, then pull the axle shaft outboard until the splines engage and the U-washer seats in the counterbore of the differential side gear.

3. **CAUTION: Replace differential pinion shaft lock bolt after removal. If new bolt is not available, thoroughly clean threads of used bolt and coat with Threadlock and Sealer E0AZ-19554-A or equivalent meeting Ford specification WSK-M2G351-A5 before installation.**

   Position the differential pinion shaft through the differential case and pinion gears, aligning the hole in the shaft with the lock bolt hole. Install differential pinion shaft lock bolt and tighten to 20-40 Nm (15-30 lb-ft).

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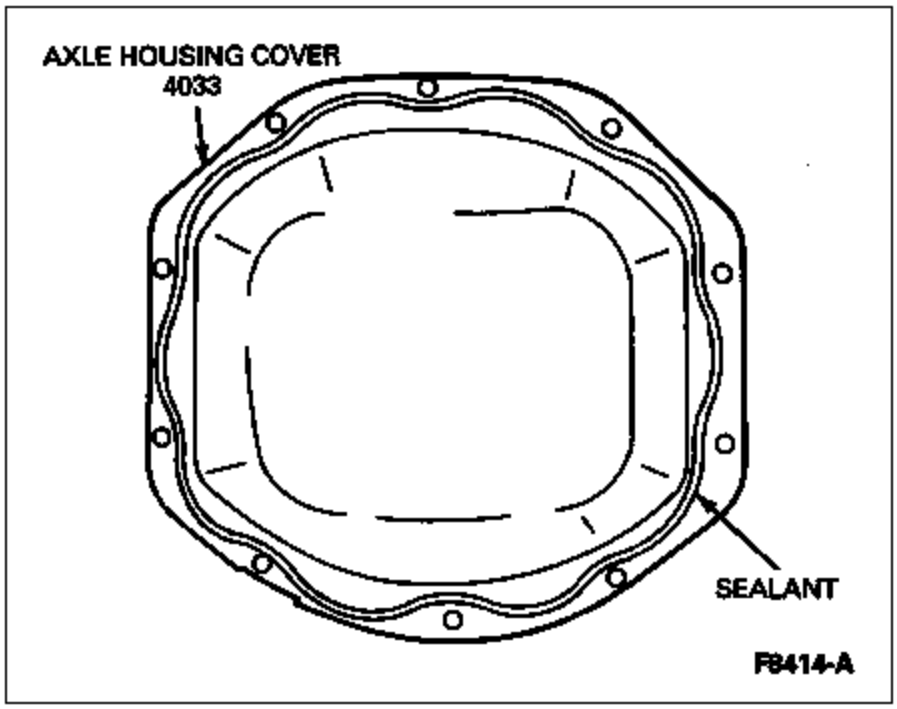
4. **CAUTION: Make sure machined surface on carrier is clean before installing the cover. Inside of rear axle (4001) must be covered when cleaning the machined surface to prevent axle contamination.**

   On Ranger vehicles with steel axle housing covers, clean cover thoroughly. Apply a new continuous bead of Silicone Rubber Sealant D6AZ-19562-BA or equivalent meeting Ford specification ESB-M4G92-A or ESE-M4G195-A to the axle housing cover.

5. **CAUTION: Always replace plastic axle housing cover with a new one, using new bolts whenever axle housing cover is removed.**

   On Aerostar vehicles, install a new plastic axle housing cover and new bolts. Tighten all cover screws including ratio tag bolt to 21-27 Nm (15-20 lb-ft).

6. On Ranger vehicles equipped with steel axle housing covers, tighten cover screws to 38-52 Nm (28-38 lb-ft). Cover assembly must be installed within 15 minutes of application of the silicone or new sealant must be applied.



7. Add Rear Axle Lubricant XY-80W90-QL or equivalent WSP-M2C197-A until it is 6-14mm (1/4-9/16 inch) below bottom of fill hole. Add four ounces of Friction Modifier C8AZ-19B546-A or equivalent meeting Ford specification EST-M2C118-A for Traction-Lok® rear axle assemblies. Install fill plug and tighten to 20-41 Nm (15-30 lb-ft).

   Make sure axle housing vent is not plugged with debris.

8. Install the brake drums, wheels and tires. Tighten lug nuts to 115-156 Nm (85-115 lb-ft).

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Sensor Indicator, Anti-Lock Brake

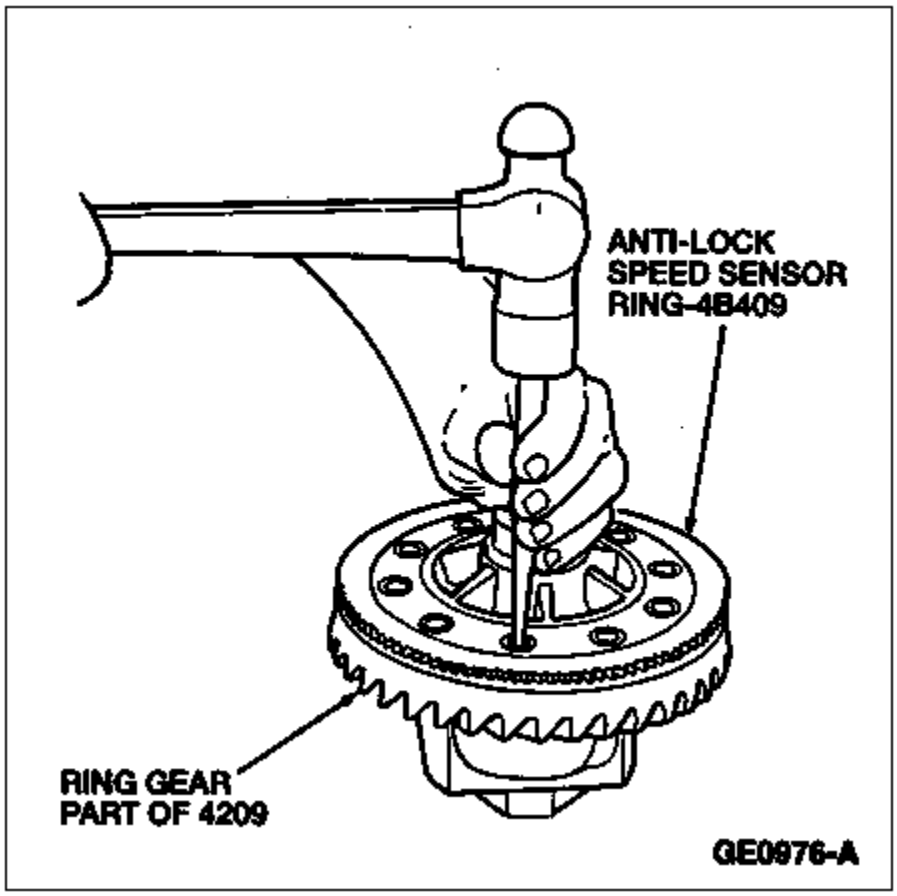
Removal

1. **NOTE: Do not remove anti-lock speed sensor ring unless replacement is required. It does not have to be removed for ring gear replacement.**

   CAUTION: Extreme care should be taken not to scratch, dent, chip or otherwise cause damage to anti-lock brake sensor ring teeth while handling or during assembly.

   NOTE: Before removing ring gear inspect it and determine if ring runout check is necessary. If so, refer to Section 05-00 .

   Remove the bolts retaining the ring gear to the differential case (4204). Remove the ring gear by striking at alternate holes around the gear.



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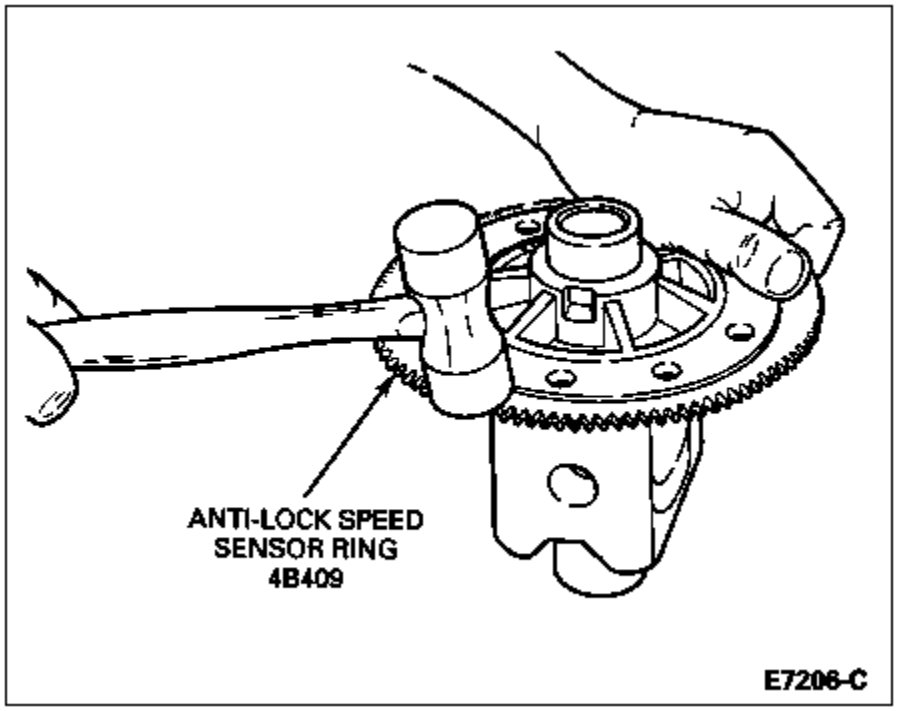
2. **CAUTION: The anti-lock speed sensor ring must be discarded upon removal. If removed, a new anti-lock brake sensor ring must be installed.**

   If replacement is required remove the anti-lock brake sensor ring by tapping with a soft-faced hammer. Discard the anti-lock speed sensor ring.



Installation

1. **CAUTION: Extreme care should be taken not to scratch, dent, chip or otherwise cause damage to anti-lock speed sensor ring teeth while handling or during assembly.**

   CAUTION: The tab on the anti-lock speed sensor ring must be aligned with the slot in the differential case.

   Position the ring gear and anti-lock speed sensor ring on the differential case. The tab on the anti-lock speed sensor ring must be aligned with the slot in the differential case as shown. Start two ring gear retaining bolts through the differential case into the ring gear to make sure case-to-ring gear bolt hole alignment is achieved.

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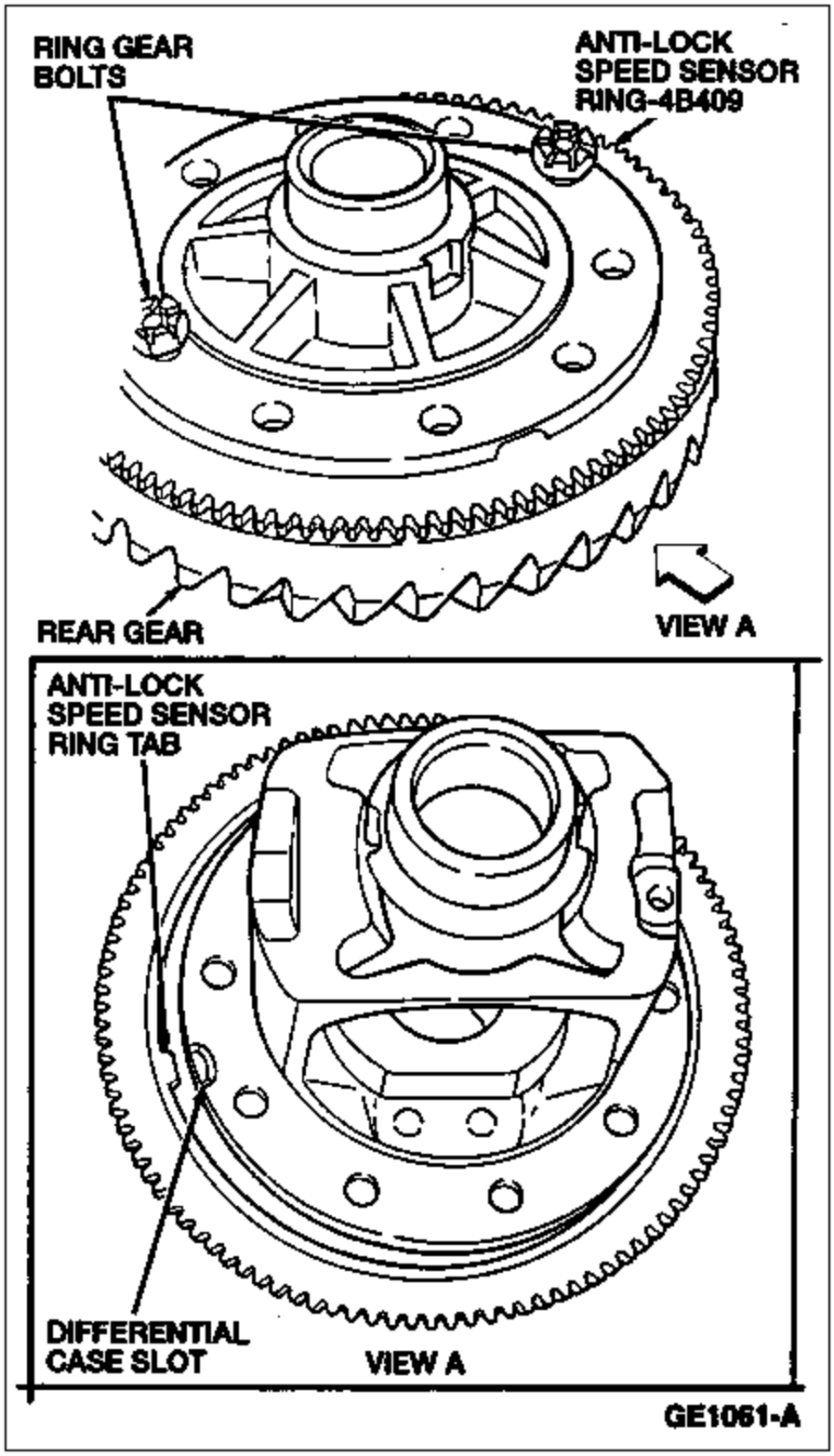

2. Press the ring gear and anti-lock speed sensor ring on the differential case using the ring gear as a pilot.

3. Coat the threads of the ring gear retaining bolts with Stud and Bearing Mount E0AZ-19554-BA or equivalent meeting Ford specification WSK-M2G349-A1. Install the bolts and alternately and evenly tighten to 95-115 Nm (70-85 lb-ft).

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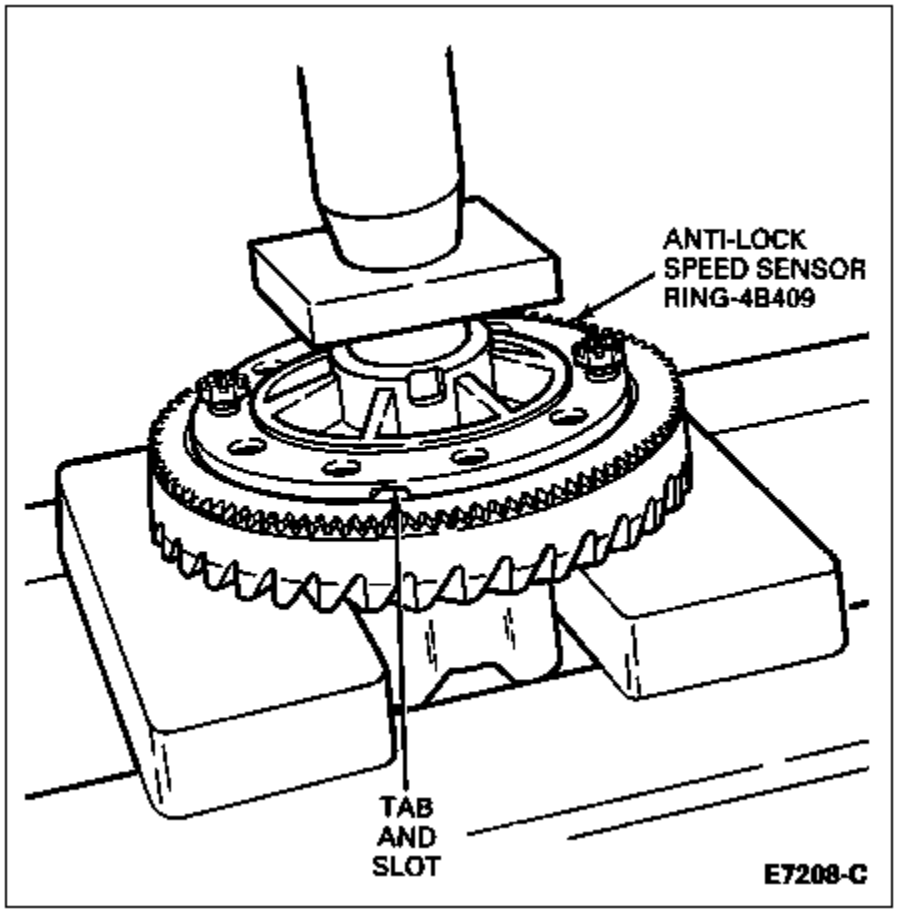

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Seal and Bearing Replacement

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Rear Axle Bearing Remover	T85L-1225-AH
Impact Slide Hammer	T50T-100-A
Axle Tube Seal Replacer	T78P-1177-A
Axle Tube Bearing Replacer	T78P-1225-A

Removal

1. Remove the axle shaft (4234) as described in this section.

2. Insert Rear Axle Bearing Remover T85L-1225-AH and Impact Slide Hammer T50T-100-A into the bore as shown and position it behind the rear wheel bearing (1225) so the tangs on the tool engage the bearing outer race. Remove the rear wheel bearing and inner wheel bearing oil seal (1177) as a unit, using the Impact Slide Hammer Tool T50T-100-A and Rear Axle Bearing Remover T85L-1225-AH.

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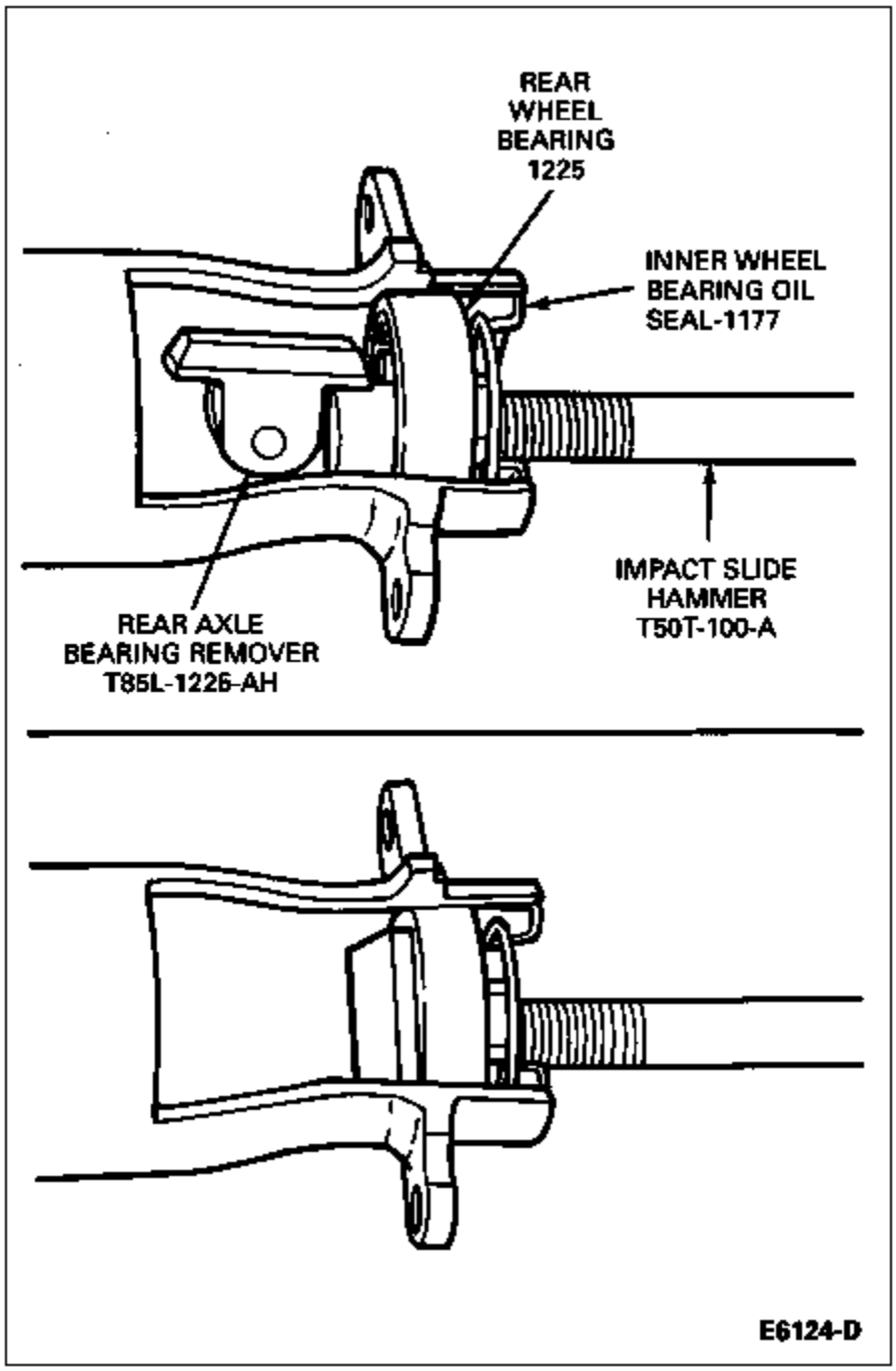

Installation

1. Lubricate the new rear wheel bearing with rear axle lubricant and install into the housing bore using Axle Tube Bearing Replacer T78P-1225-A.

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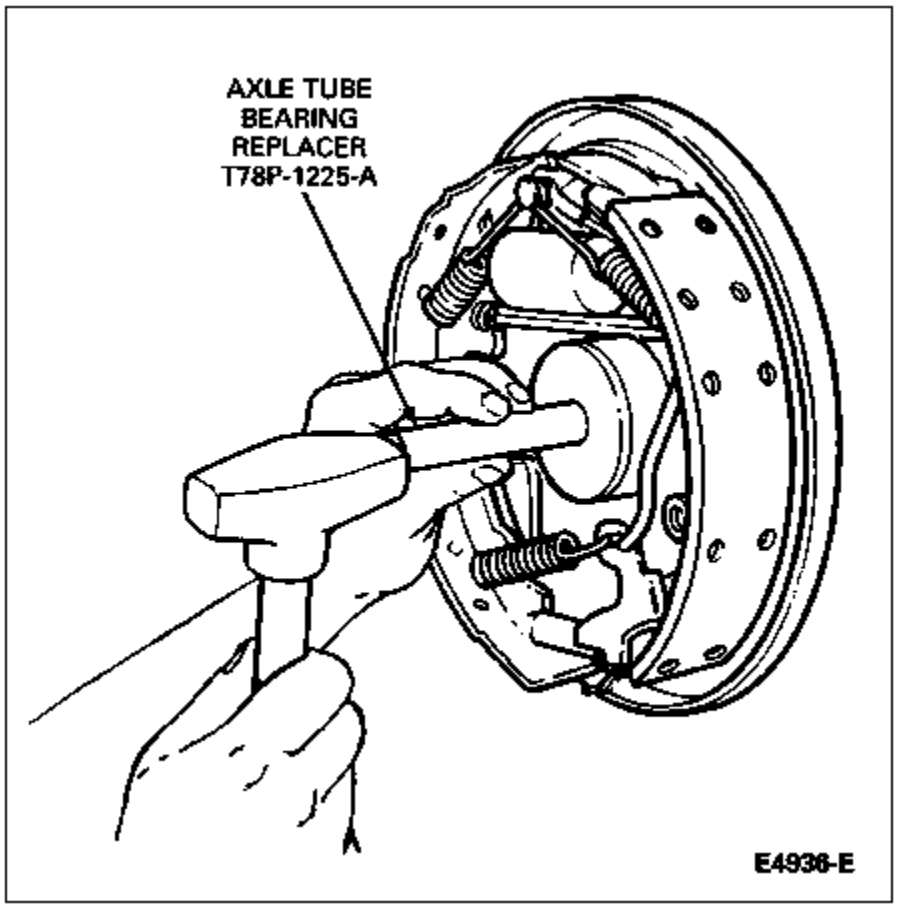

2. Apply Premium Long-Life Grease XG-1-C or -K or equivalent meeting Ford specification ESA-M1C75-B between the lips of the inner wheel bearing oil seal.

3. **CAUTION: Installation of the rear wheel bearing or inner wheel bearing oil seal assembly without the proper tool may result in an early failure. If inner wheel bearing oil seal becomes cocked in the bore during installation, remove it and install a new one.**

   Install a new inner wheel bearing oil seal using Axle Tube Seal Replacer T78P-1177-A.

4. Install the axle shaft; refer to the procedure in this section.

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Drive Pinion Seal and Universal Joint Flange, Rear Axle

SPECIAL SERVICE TOOL(S) REQUIRED

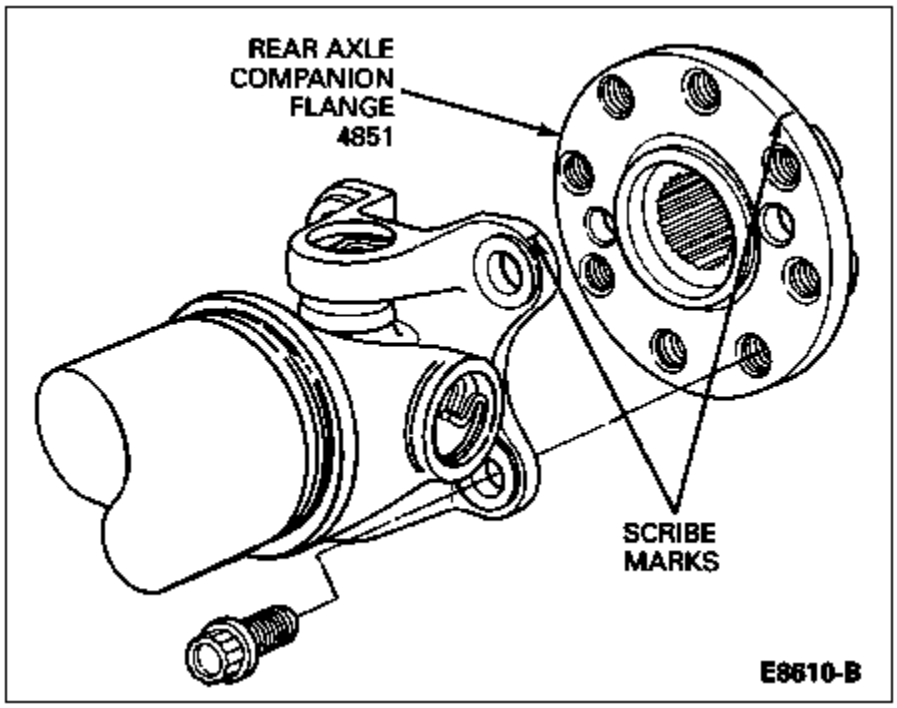
Description	Tool Number
Companion Flange Holding Tool	T78P-4851-A
Differential Side Bearing Puller	T77F-4220-B1
Drive Pinion Oil Seal Replacer	T79P-4676-A

Removal

Replacement of the pinion seal involves removal and installation of only the pinion nut and the rear axle companion flange.

1. **CAUTION: This operation disturbs the pinion bearing preload, which must be carefully reset when assembling.**

   Raise the vehicle and install safety stands. Remove the rear wheels and brake drums (1126). Make scribe marks on the driveshaft end yoke and rear axle companion flange to ensure proper position of the driveshaft and rear axle companion flange at assembly. Disconnect the driveshaft from the rear axle companion flange and support it out of the way.



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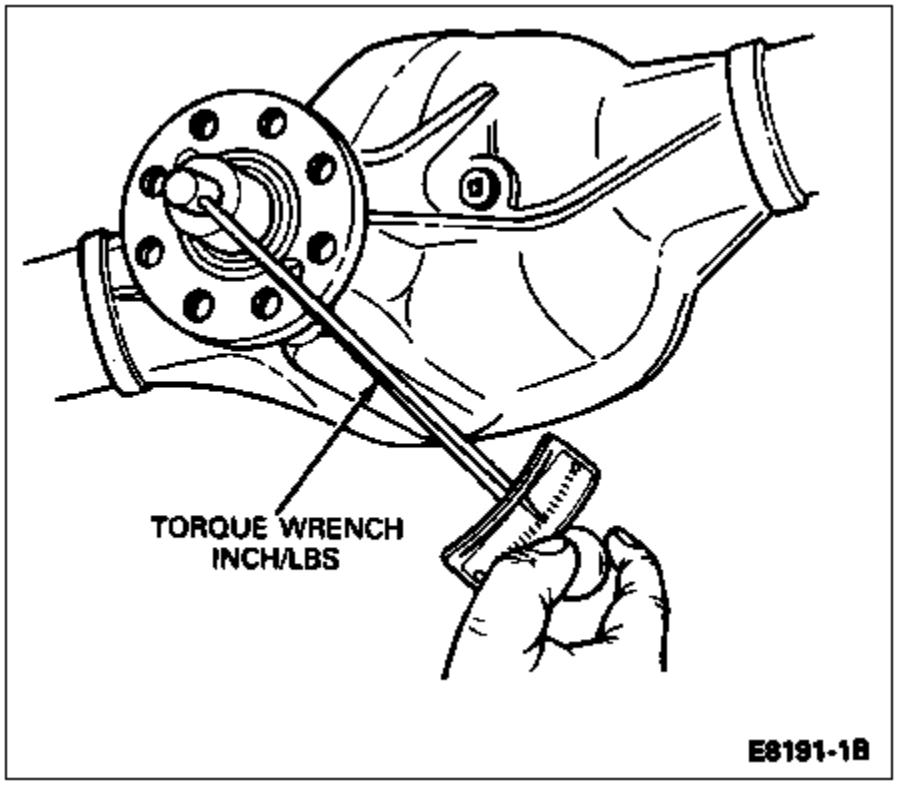
2. Install Nm (inch-pound) torque wrench on the pinion nut. Record the torque required to maintain rotation of the ring gear and pinion through several revolutions.



3. While holding the rear axle companion flange with Companion Flange Holding Tool T78P-4851-A remove the pinion nut. Clean the area around the pinion seal. Place a drain pan under the pinion seal to catch any lubricant that may spill out of rear axle assembly (4006) when rear axle companion flange and pinion seal are removed.

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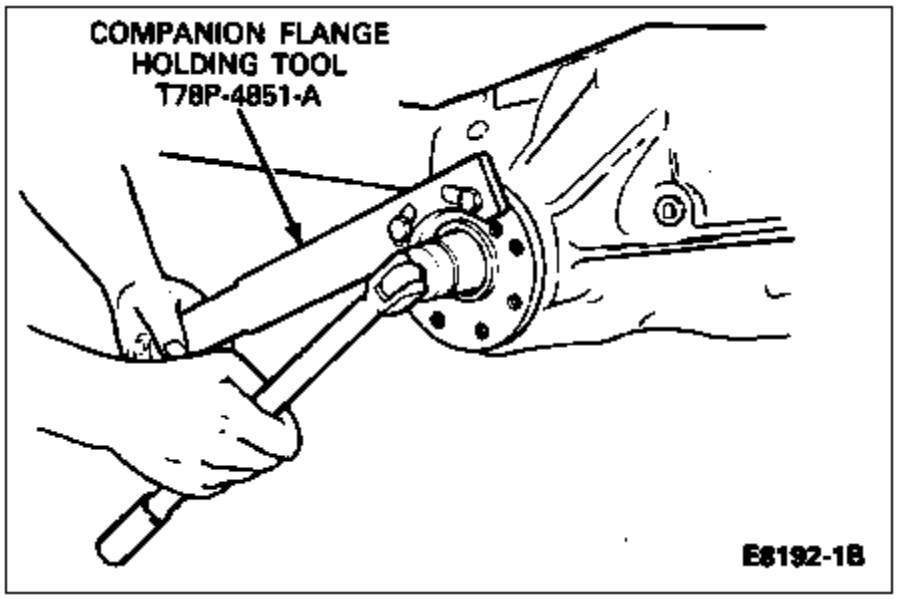
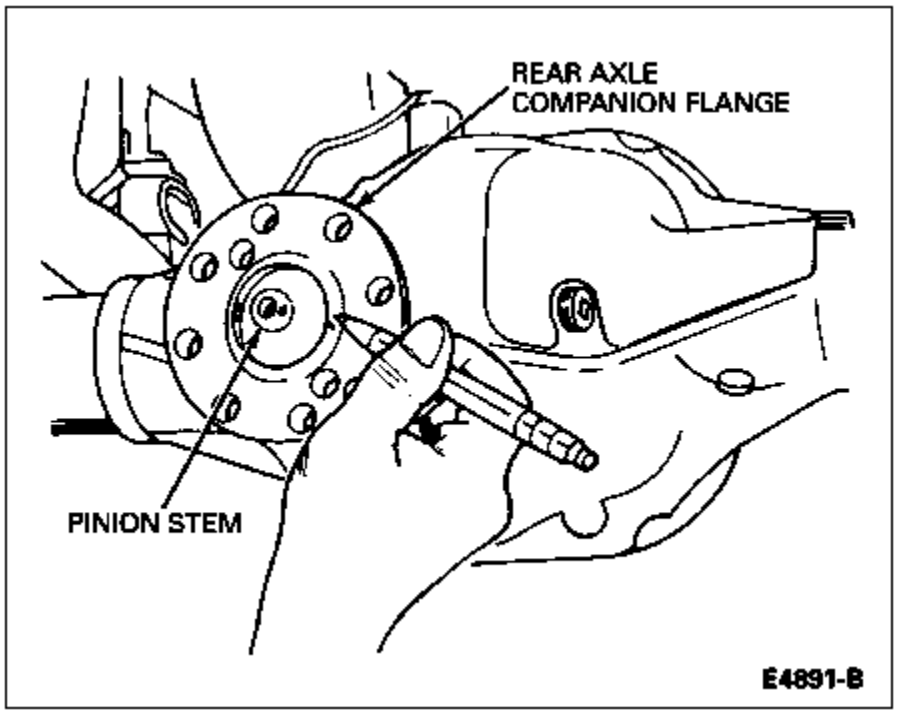


4. Mark the rear axle companion flange in relation to the drive pinion stem so the flange can be reinstalled in the same position.



5. **CAUTION: Never hammer on the companion flange.**

Using Differential Side Bearing Puller T77F-4220-B1 remove the rear axle companion flange.

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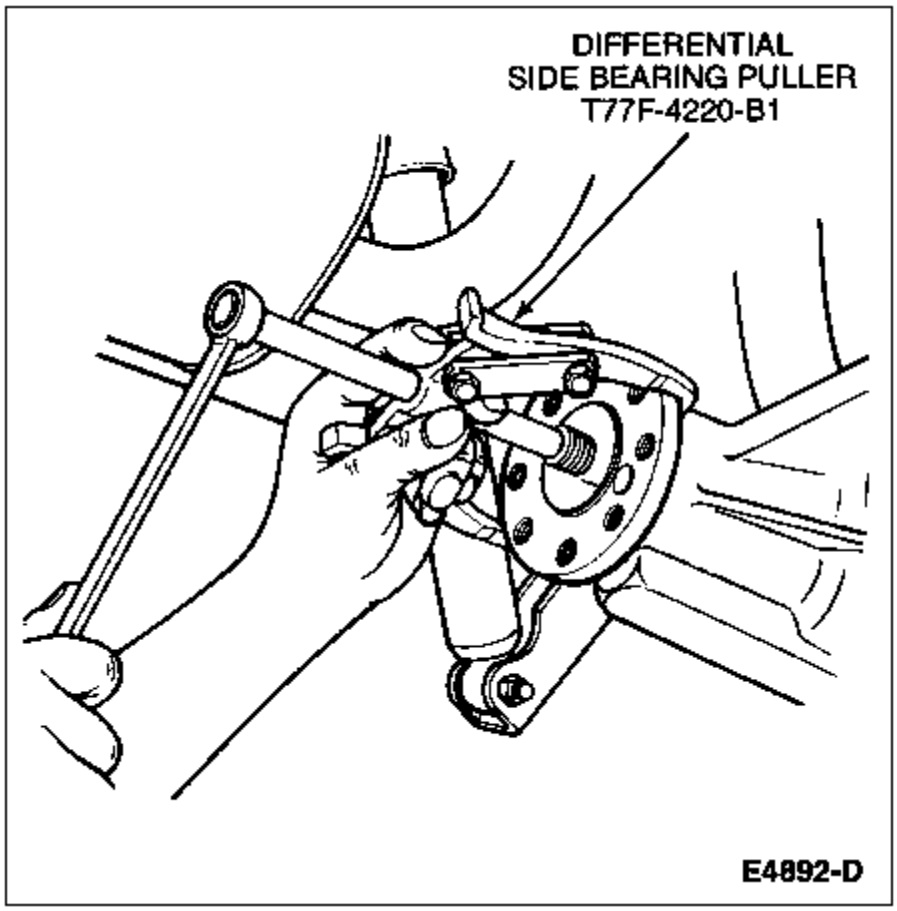

6. **CAUTION: Care should be taken not to damage housing during pinion seal removal.**

   Pry up on metal flange of pinion seal. Install gripping pliers and strike with hammer until pinion seal is removed.

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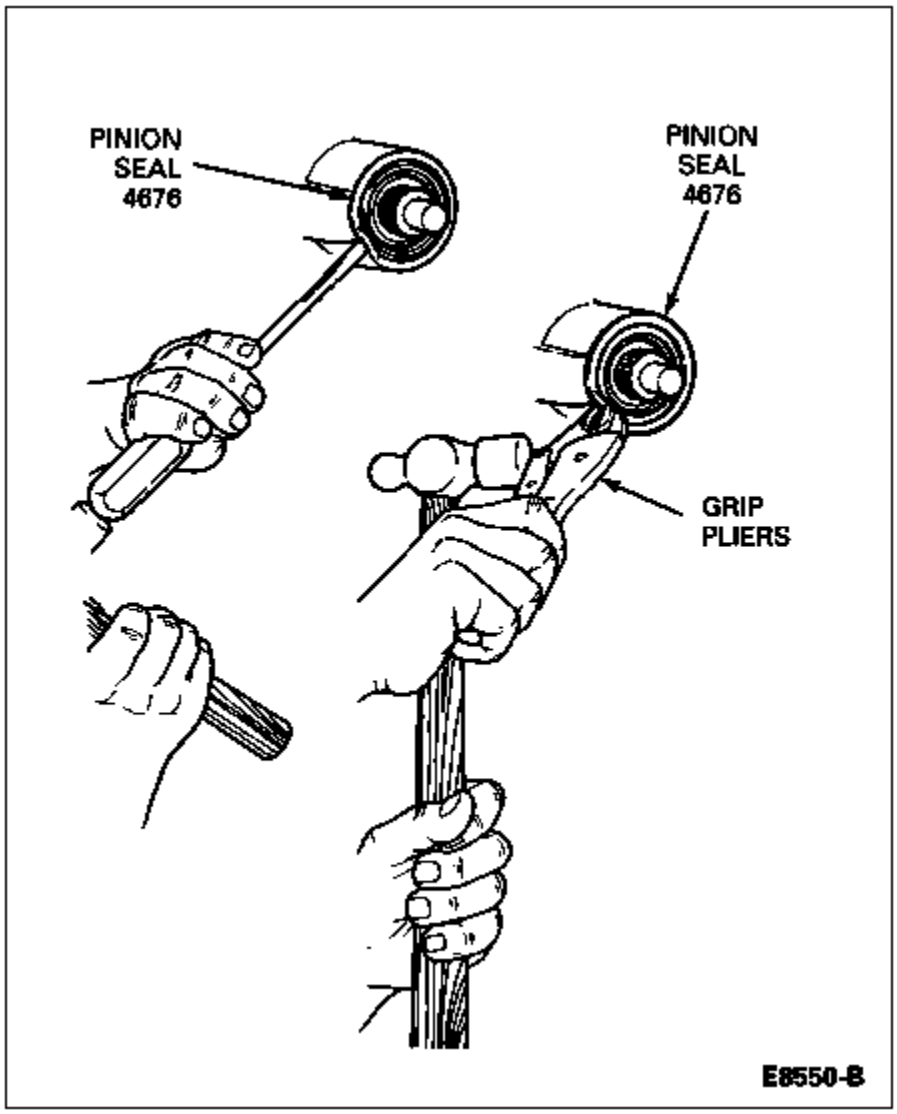

Installation

1. Check the splines on the drive pinion stem to be sure they are free of burrs. If burrs are evident, remove them by using a fine crocus cloth, working in a rotational motion.

2. Apply Premium Long-Life Grease XG-1-C or -K or equivalent meeting Ford specification ESA-M1C75-B between the lips of the pinion seal. Install seal on Pinion Seal Replacer T79P-4676-A.

3. **CAUTION: Installation of the pinion seal without the proper tool may result in early failure. If pinion seal becomes cocked during installation, remove it and install a new one. Never hammer on pinion seal metal casing.**

   Install the pinion seal in the housing using Pinion Seal Replacer T79P-4676-A.

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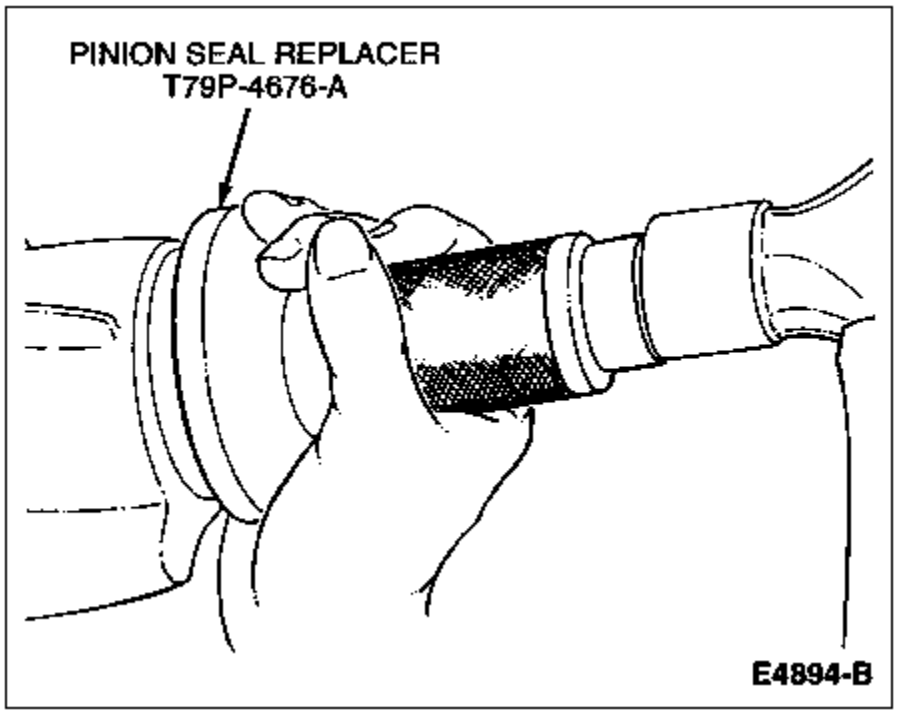

4. Check the seal surface of the rear axle companion flange for scratches, nicks or a groove around the diameter. If any of these conditions exist, replace with a new rear axle companion flange. Apply a small amount of lubricant to the splines. Align the mark on the rear axle companion flange with the mark on the drive pinion stem.

5. **NOTE: If a new rear axle companion flange is being installed, disregard the scribe mark on the drive pinion stem.**

   NOTE: The rear axle companion flange must never be hammered on or installed with power tools.

   Install rear axle companion flange using Companion Flange Replacer TOOL-4858-E or equivalent.

6. Wipe the drive pinion stem clean.

7. Install a new nut on the drive pinion stem. Hold the rear axle companion flange with Companion Flange Holding Tool T78P-4851-A while tightening the nut.

8. Tighten the pinion nut, rotating the pinion occasionally to make sure bearings are seated properly. Also, take frequent pinion bearing torque preload readings until the original recorded preload reading is obtained or to specification 0.9-1.6 Nm (8-14 lb-in). **Under no circumstances should the pinion nut be backed off to reduce preload. If reduced preload is required, a new collapsible spacer and pinion nut must be installed.**

9. Connect the rear driveshaft end yoke to the rear axle companion flange, aligning the scribe marks on the driveshaft end yoke and rear axle companion flange. Install bolts and tighten to 95-128 Nm (70-95 lb-ft).

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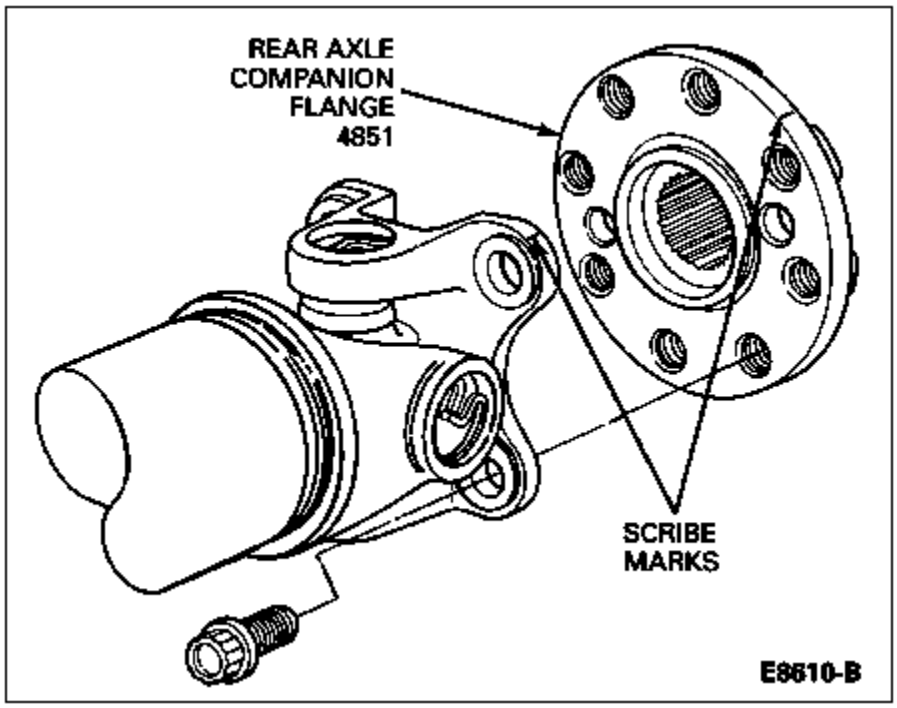

10. **NOTE: Use Premium Rear Axle Lubricant XY-80W90-QL or equivalent meeting Ford specification WSP-M2C197-A.**

    Add lubricant through the filler hole until the lubricant level reaches 6-14 mm (1/4 to 9/16 inch) below the bottom of the filler hole with the axle in the running position and the vehicle level on the hoist. Install fill plug and tighten to 20-41 Nm (15-30 lb-ft).

11. Reinstall brake drums and rear wheels. Remove safety stands and lower vehicle. Tighten the lug nuts to 115-156 Nm (85-115 lb-ft).

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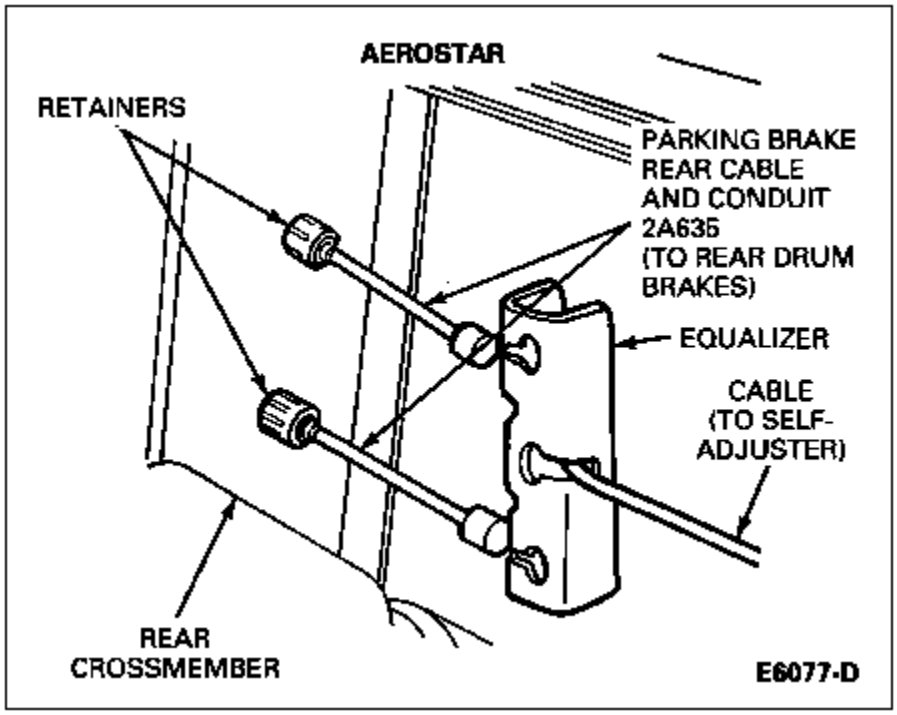
Rear Axle, Aerostar

Removal

NOTE: Use a twin-post type hoist to remove the rear axle (4001).

1. Release the tension of the parking brake rear cable and conduit (2A635) as follows:
    a. Raise the vehicle.
    b. Pull rearward on the front cable, from underneath the vehicle, approximately 50.8mm (2 inches). Clamp the cable, part of parking brake rear cable and conduit behind the crossmember taking care to make sure the plastic coating on the parking brake rear cable and conduit is not damaged. This will release tension on the parking brake rear cable and conduit.
2. Remove the parking brake rear cable and conduit from the equalizer. Compress the tabs on the retainers and pull the parking brake rear cable and conduit through the rear crossmember.



3. Position jackstands on the frame rear lift points or under the rear axle bumper brackets (4731).
4. Scribe a mark aligning the driveshaft end yoke and rear axle companion flange to the rear axle. Remove the driveshaft assembly. Plug the extension housing (7A039) to prevent fluid spillage.

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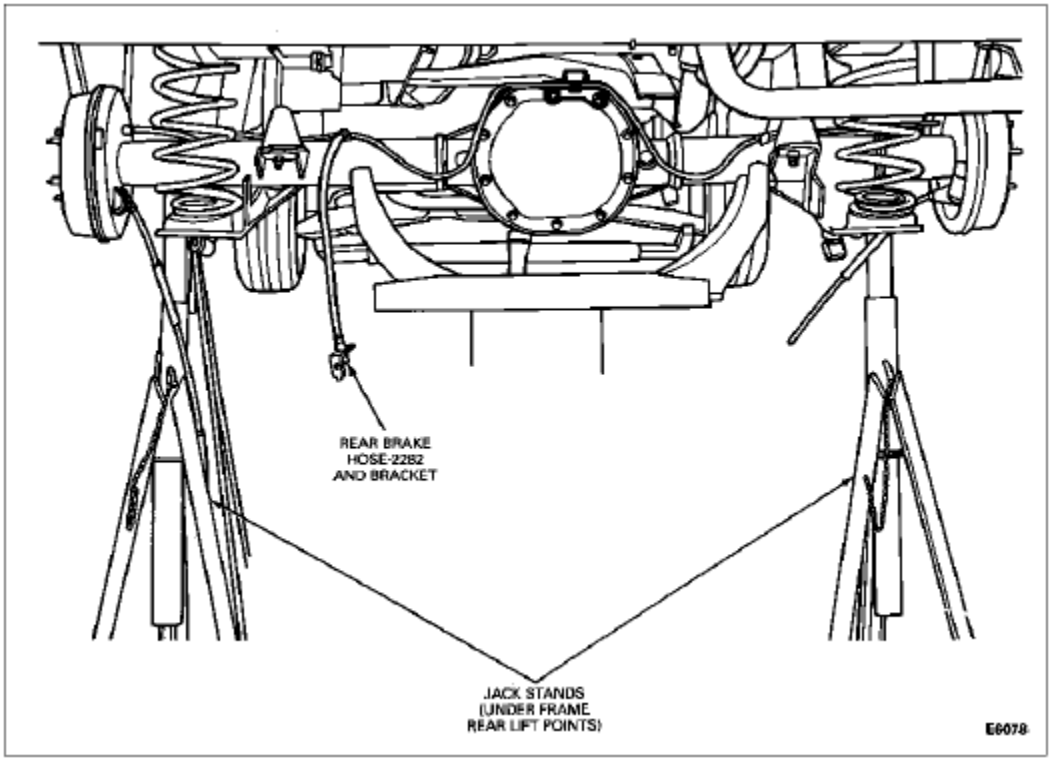
5. Disconnect RABS connector from rear brake anti-lock sensor. Disconnect wiring from locator clip and position out of way.

6. Remove the wheel and tire assemblies.

7. Disconnect the brake lines by disconnecting the brake jounce hose from the master cylinder rear tube. Plug the tube. Remove the jounce hose and rear axle bumper bracket from the frame.

Rear Axle



8. Disconnect the shock absorber from the lower rear suspension arm and bushing (5500).

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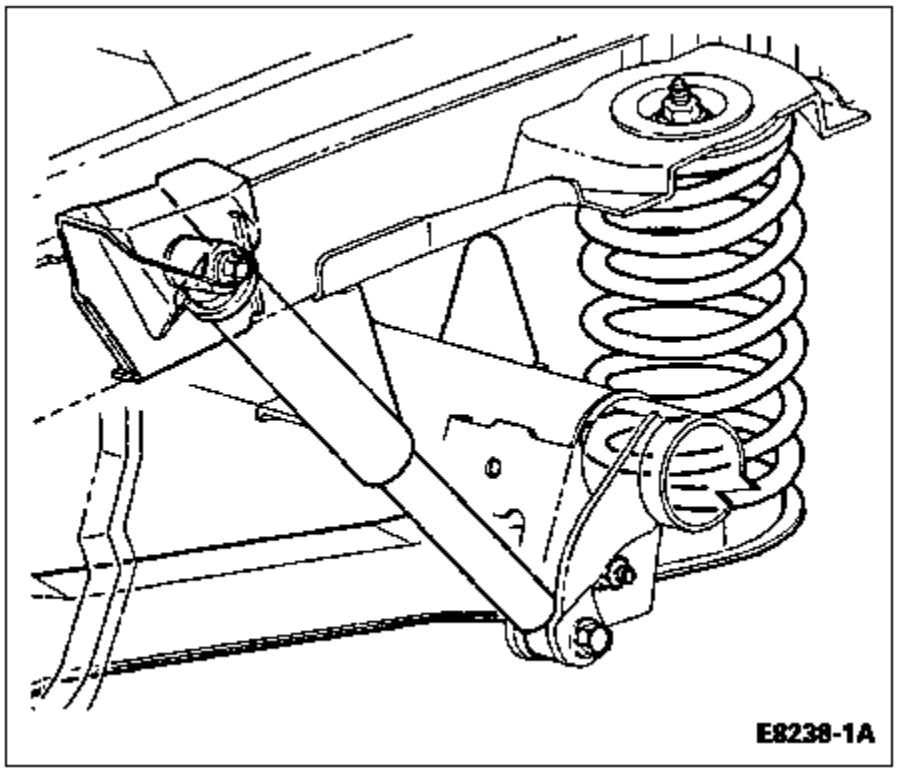

9. Lower the rear axle assembly (4006) until the rear springs are no longer under compression.

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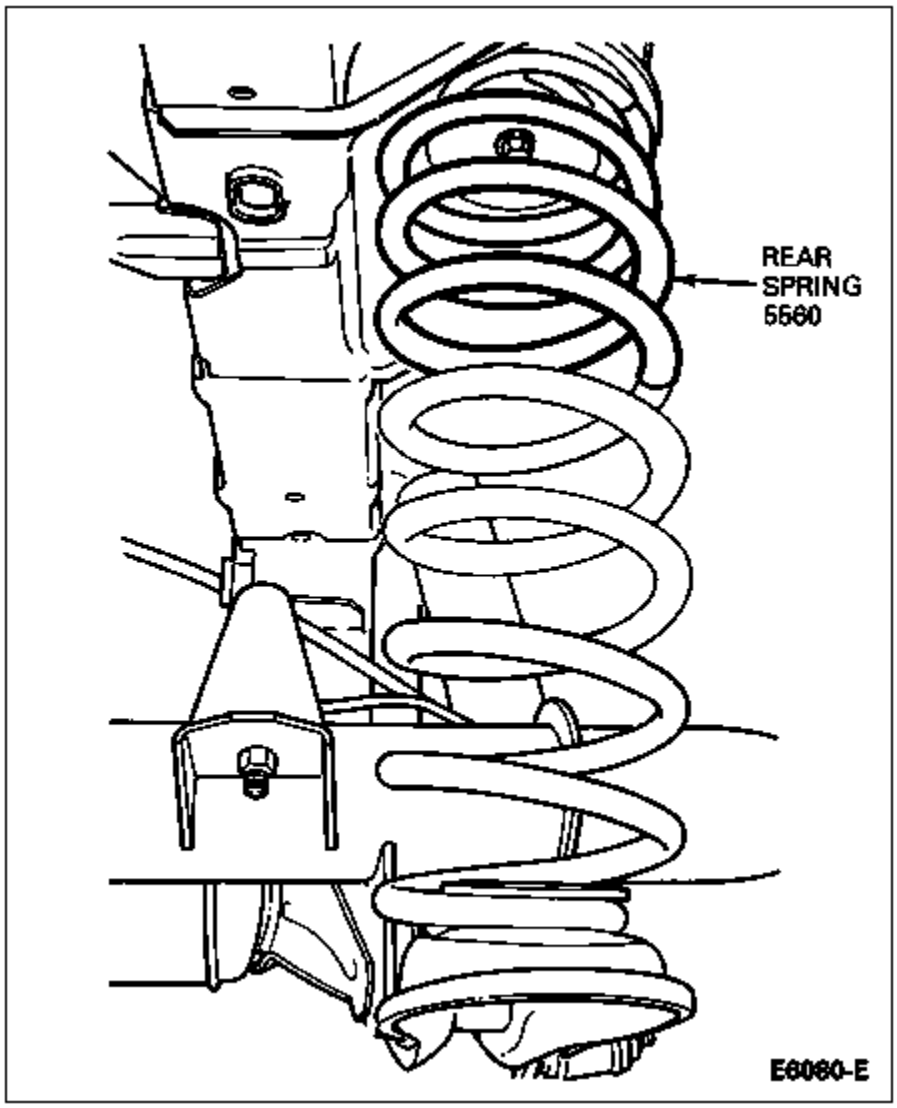

10. Remove the lower spring retainer, then the upper retainer and remove the rear spring.

11. **NOTE: Make sure adequate clearance exists to remove the bolts retaining the rear suspension arm and bushing at therear axle assembly.**

    Raise the axle to the normal load position and disconnect the rear suspension arm and bushings at the rear axle assembly.

Rear Axle, Aerostar

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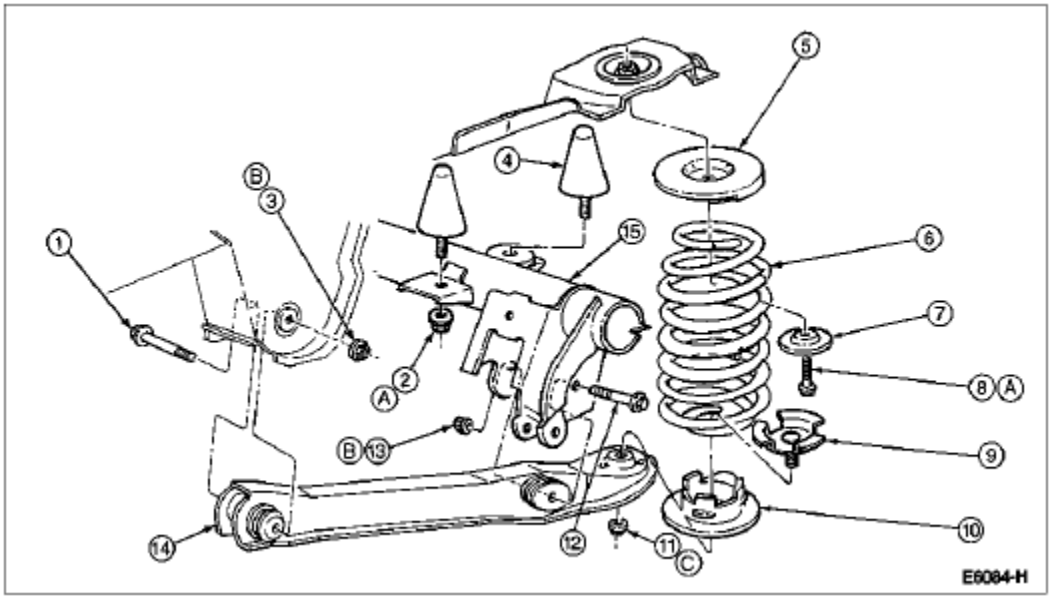

Item	Part Number	Description
1	805791	Lower Rear Suspension Arm and Bushing to Frame Nut
2	800152	Rear Axle Bumper Nut
3	801670	Lower Rear Suspension Arm and Bushing to Frame Nut
4	4730	Rear Axle Bumper
5	5536	Rear Spring Insulator
6	5560	Rear Spring
7	5A543	Rear Spring Upper Retainer
8	605919	Upper Spring Retainer Bolt
9	5A569	Rear Spring Lower Retainer
10	5741	Rear Spring Center Mounting Insulator
11	620483	Lower Spring Retainer Nut
12	N803923	Lower Rear Suspension Arm and Bushing to Rear Axle Retaining Bolt
13	N801670	Lower Rear Suspension Arm and Bushing to Rear Axle Nut
14	5500	Rear Suspension Arm and Bushing, Lower
15	4001	Rear Axle
A	—	Tighten to 40-55 Nm (30-40 Lb-Ft)
B	—	Tighten to 129-177 Nm (95-130 Lb-Ft)
C	—	Tighten to 55-85 Nm (41-63 Lb-Ft)

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12. Remove the bolt and nut retaining the upper rear suspension arm and bushing to the rear axle. Remove the upper rear suspension arm and bushing from the axle.

13. Lower the rear axle assembly from the vehicle.

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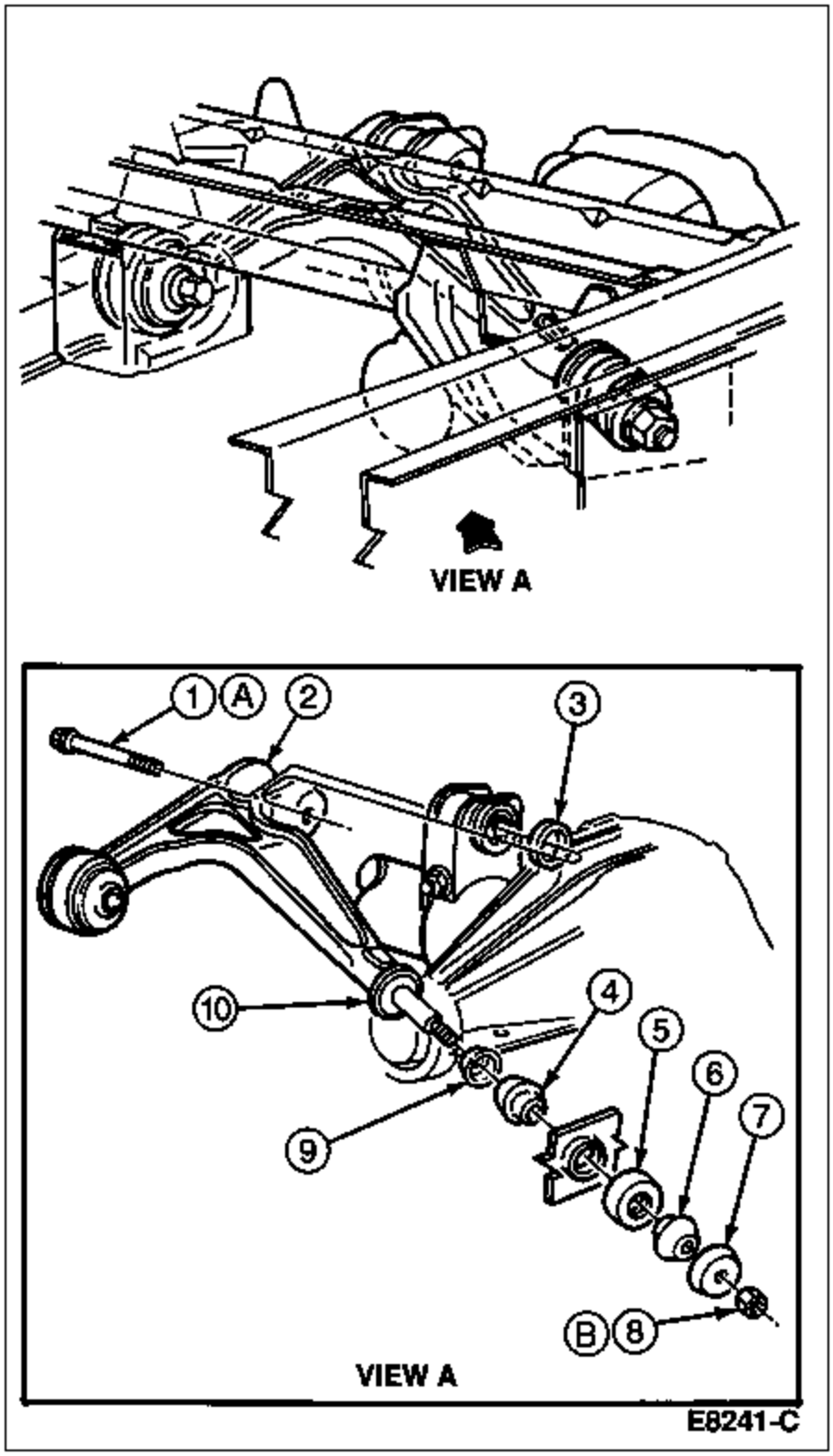

Item	Part Number	Description
1	806054	Upper Rear Suspension Arm and Bushing to Axle Housing Bolt

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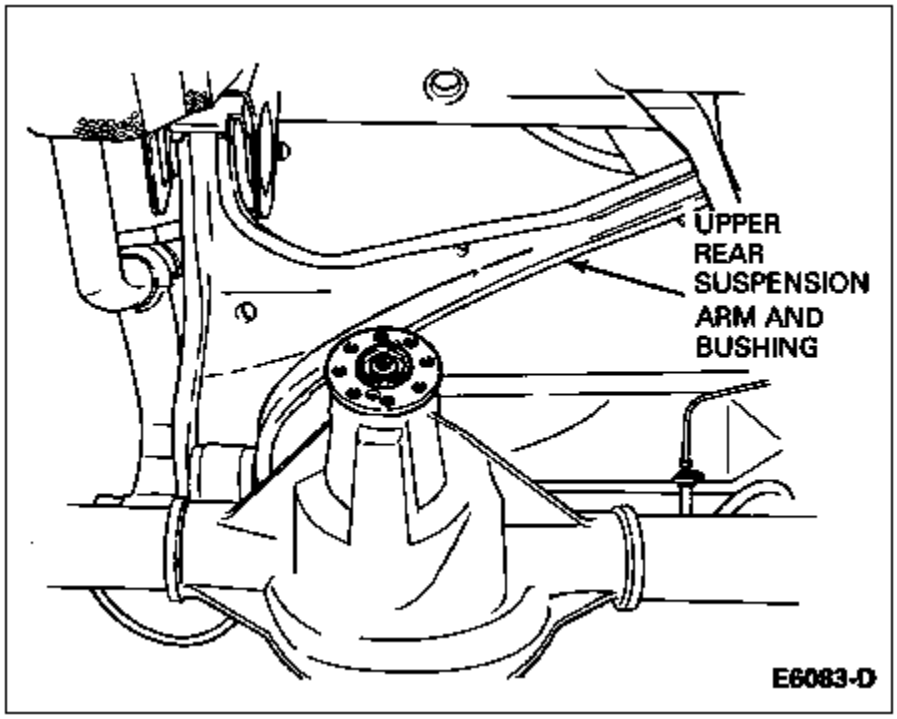
2	5500	Rear Suspension Arm and Bushing, Upper
3	5K679	Bushing
4	5K752	Insulator
5	5K580	Spacer
6	5K752	Insulator
7	5A349	Retainer
8	801670	Nut
9	5A349	Retainer
10	5500	Plastic Washer
A	—	Tighten to 210-285 Nm (155-210 Lb-Ft)
B	—	Tighten to 81-135 Nm (80-100 Lb-Ft)

Installation

1. Raise the rear axle assembly into position in the vehicle.
2. **NOTE: Do not tighten to specified torque at this time.**

   Position the upper rear suspension arm and bushing and install the bolt. Tighten until snug.



3. Lower the rear axle assembly to the spring unloaded position. Place the lower insulator on the lower

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rear suspension arm and bushing. Place the upper insulator on top of the rear spring. The rear spring (white colored) must face upward. Install the rear spring in position on the lower rear suspension arm and bushing and rear axle assembly.

4. Install the lower retainer and lower spring retainer nut. Tighten the nut to 55-85 Nm (41-63 lb-ft).
5. Install the upper retainer and upper spring retainer bolt. Tighten the bolt to 40-55 Nm (30-40 lb-ft).
6. Raise the rear axle assembly to the normal load position and tighten the lower rear suspension arm and bushing to rear axle retaining bolt and nut to 129-177 Nm (95-130 lb-ft). Tighten upper rear suspension arm and bushing bolt to 210-285 Nm (155-210 lb-ft).
7. Connect the shock absorber to the lower control arm bracket . Install the shock bolt nut on the inside of the lower control arm bracket. Install the nut and tighten to 54-82 Nm (40-60 lb-ft).
8. Position RABS wiring harness in locator clip and connect to rear brake anti-lock sensor.
9. Attach the rear brake hose (2282) and rear axle bumper bracket to the frame. Connect the rear brake hose to the tube from the master cylinder.
10. Install the wheel and tire assemblies on the brake drums (1126). Tighten the lug nuts to 115-156 Nm (85-115 lb-ft).
11. Install the driveshaft assembly, making sure the scribed marks on the rear axle companion flange and driveshaft end yoke are in alignment. Install the bolts and tighten to 95-128 Nm (70-95 lb-ft).
12. Raise the vehicle and remove the jackstands.
13. Pull the parking brake rear cable and conduits through the clips on the vehicle underbody side rails and through the rear crossmember. Connect the parking brake rear cable and conduits to the equalizer.
14. Unclamp the front parking brake cable to restore cable tension.
15. Bleed the brakes as described in Section 06-06 .
16. Check and, if required, adjust pinion rear axle angle as described in Section 05-00 .
17. Lower the vehicle.

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Rear Axle, Ranger

Removal

1. Raise and support the vehicle.
2. Remove the wheel and tire assemblies.
3. Remove the brake drums. Refer to Section 06-02 .
4. Remove the rear stabilizer bar (5A772). Refer to Section 04-02 .
5. Disengage the brake lines from the clips on the axle housing.
6. **NOTE: Do not open the hydraulic brake system lines.**

   Remove the hydraulic brake T-fitting bolt from the axle housing.
7. Position a drain pan under the axle housing cover (4033).
8. Remove the axle housing cover screws and the axle housing cover and allow the lubricant to drain from the rear axle assembly (4006). Clean and remove all the gasket material from the axle housing cover.
9. Remove the axle shafts (4234). Refer to the procedure in this section.
10. Remove the four nuts and bolts from each brake backing plate to the axle housing flange.
11. Support each backing plate with wire.
12. Disconnect the rear anti-lock brake sensor electrical connector.
13. Disconnect the vent from the axle housing.
14. **NOTE: Scribe marks on the driveshaft end yoke and on the rear axle companion flange to ensure proper position of the driveshaft at installation.**

    Remove the driveshaft-to-rear axle companion flange bolts and separate the driveshaft from the companion flange.

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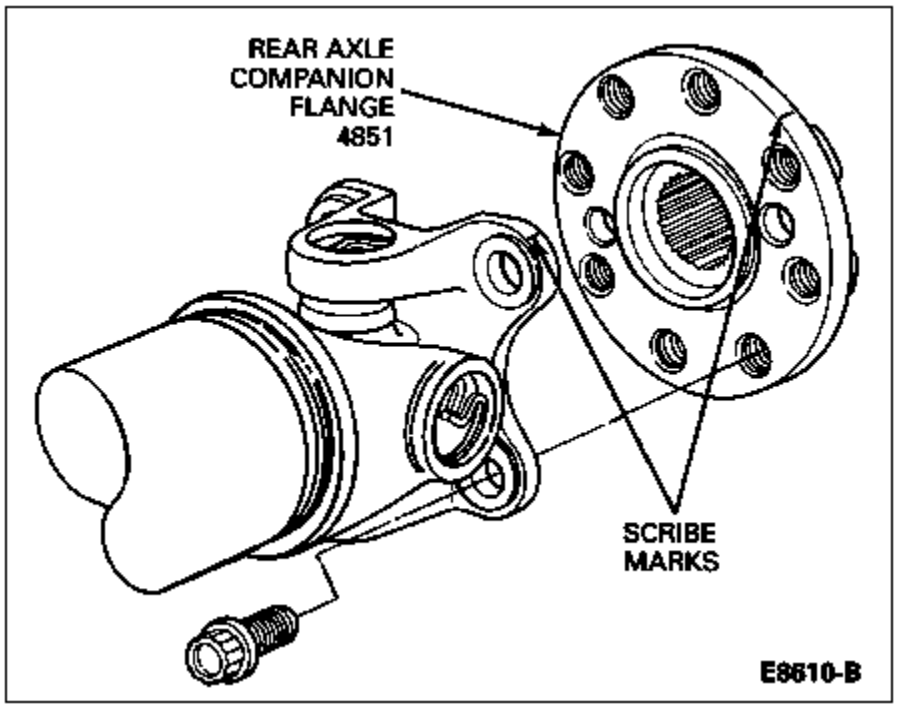

15. Position the driveshaft out of the way and support it with wire.
16. Support the rear axle assembly with a jack.
17. Remove the lower nut and bolt from each rear shock absorber and swing the lower end free of the mounting bracket on the axle housing.
18. Remove the nuts from the LH and RH spring U-bolts and drive the U-bolts from the rear spring plates (5796).
19. Lower the rear axle assembly and carefully remove it from the vehicle.

Installation

1. Raise the rear axle assembly and carefully position it to the vehicle.
2. Install the rear spring plates, the LH and RH spring U-bolts, and the U-bolt nuts. Tighten the U-bolt nuts to 88-118 Nm (65-80 lb-ft).
3. Position each rear shock absorber to the mounting bracket on the axle housing and install the lower nuts and bolts. Tighten the shock absorber lower bolt nuts to 53-72 Nm (39-53 lb-ft).
4. Connect the driveshaft end yoke to the rear axle companion flange, making sure to verify that the marks made during removal align, and that the driveshaft is installed in its original position.
5. Apply Loctite® Stud and Bearing Mount E0AZ-19554-BA or equivalent meeting Ford specification WSK-M2G349-A1 to the threads of the driveshaft end yoke-to-rear axle companion flange bolts. Tighten the bolts to 95-128 Nm (70-95 lb-ft).
6. Position the hydraulic brake T-fitting bolt to the axle housing and install the bolt. Tighten the hydraulic

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brake T-fitting bolt securely.

7. Install the brake lines to the clips on the axle housing.

8. Position the brake backing plates to the axle housing flanges and install the four nuts and bolts. Tighten the brake backing plate-to-axle housing nuts to 27-54 Nm (20-40 lb-ft).

9. **NOTE: Make sure that the axle vent is not plugged with debris.**

   Apply Loctite® Stud and Bearing Mount E0AZ-19554-BA or equivalent meeting Ford specification WSK-M2G349-A1 to the threads on the axle housing vent. Install the vent to the axle housing.

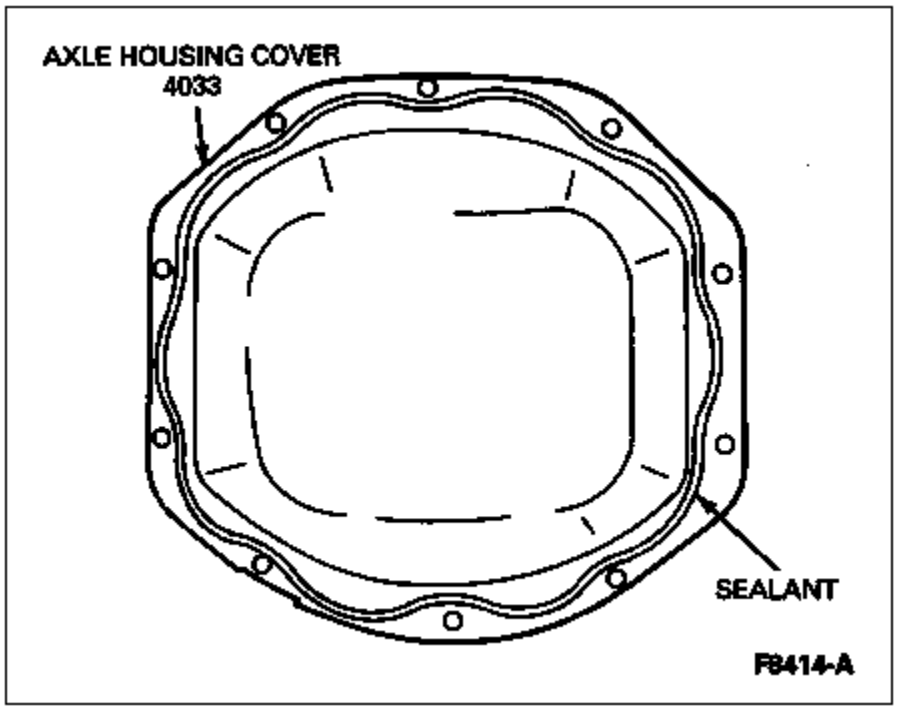
10. Install the rear stabilizer bar. Refer to Section 04-02 .

11. Connect the rear anti-lock brake sensor electrical connector.

12. Install the axle shafts. Refer to Section 05-02A .

13. **CAUTION: Make sure that the machined surface on the carrier is clean and free of the gasket material before installing the axle housing cover. The inside of the rear axle assembly must be covered when cleaning the machined surface to prevent contamination.**

    Apply a new continuous bead of Silicone Rubber Sealant D6AZ-19562-BA or -AA or equivalent meeting Ford specification ESB-M4G92-A or ESE-M4G195-A to the axle housing cover.



14. Tighten the axle housing cover screws to 38-52 Nm (28-38 lb-ft).

15. Install the brake drums. Refer to Section 06-02 .

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16. Install the wheel and tire assemblies. Tighten the lug nuts to 115-156 Nm (85-115 lb-ft).

17. Remove the rear axle assembly fill plug and add Premium Rear Axle Lubricant XY-80W90-QL or equivalent meeting Ford specification WSP-M2C197-A until the lubricant level is 6-14mm (1/4-9/16 inch) below the bottom of the fill hole. Add 4 ounces of Friction Modifier C8AZ-19B546-A or equivalent meeting Ford specification EST-M2C118-A for Traction-Lok® rear axle assembly. Install the fill plug and tighten to 20-41 Nm (15-30 lb-ft).

18. Lower the vehicle.

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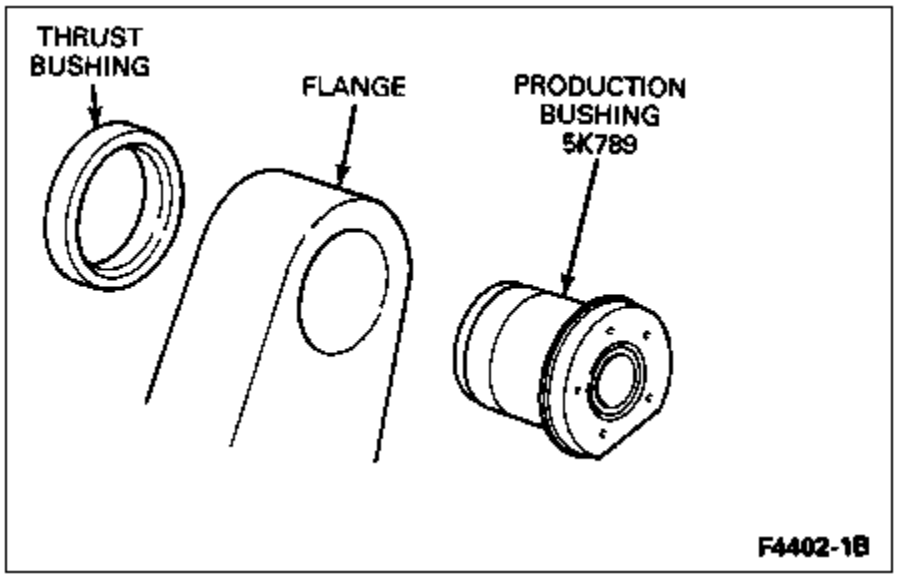
Axle Housing-to-Upper Control Arm Bushing, Aerostar

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Axle Housing Bushing Mounting Adapter	T85T-5638-AH11
Forcing Screw	T78P-5638-A1
Axle Housing Bushing Remover	T85T-5638-AH12
Axle Housing Bushing Replacer	T85T-5638-AH13

NOTE: In service, the pinion angle adjustment is changed using an eccentric service bushing F09Z-5K789-B. If the bushing is being replaced due to damage or wear only, use standard production bushing F09Z-5K789-A. For pinion angle measurement procedures, refer to Driveline Angle Checking in Section 05-00 .



Removal

1. **CAUTION: The axle must be securely supported on the hoist or stands. If more axle-hoist travel is required, disconnect the shock absorbers (18080) from the rear suspension lower arms.**

   Raise the vehicle on a twin post hoist. Position jackstands on the frame rear lift points or under the rear bumper support brackets. If a frame hoist is used, raise the vehicle and position tall jackstands under the rear axle (4001). Lower the hoist until the axle is in the normal ride height position.

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2. Remove upper rear suspension arm-to-axle housing bolt.

3. With the vehicle securely supported on safety stands, slowly lower the rear axle until the upper rear suspension arm and bushing (5500) disengages from the rear axle. If a frame hoist is used, raise the hoist until the rear suspension arm disengages from the rear axle.

4. On the inboard side of the flange, insert a flat-blade screwdriver between the thrust bushing and flange. Pry the thrust bushing end off the bushing and flange without damaging any surfaces.

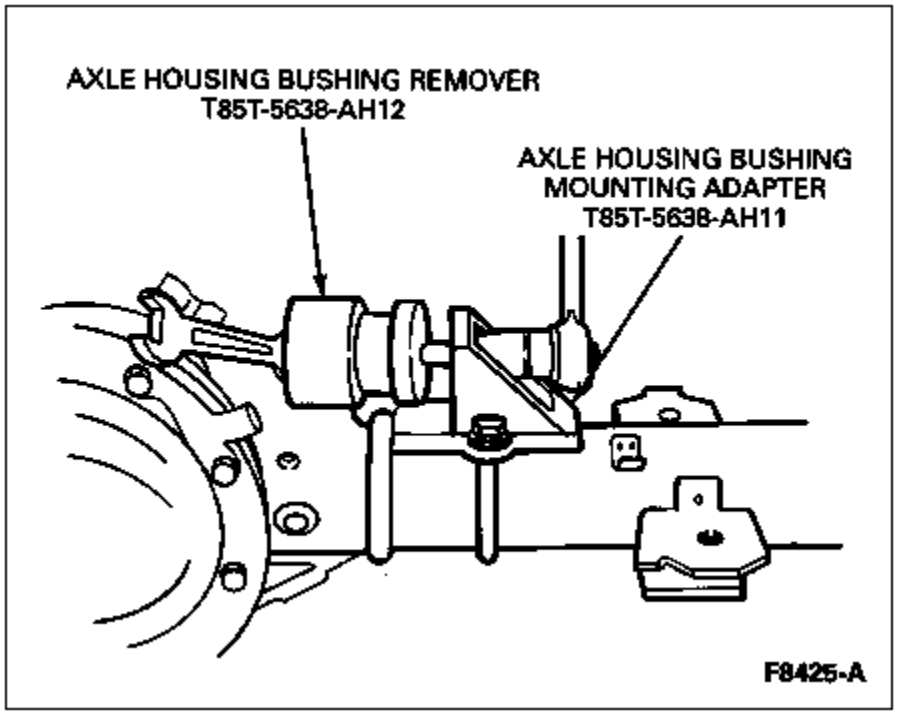
5. Attach Axle Housing Bushing Mounting Adapter T85T-5638-AH11 to the axle housing tube by using the U-bolt.

6. Place the Forcing Screw T78P-5638-A1 through the axle housing bushing to be removed.

7. Place the Axle Housing Bushing Remover T85T-5638-AH12 onto the forcing screw and thread a 7/16-20 nut onto the forcing screw.

8. Tighten the forcing screw to pull the bushing out of the axle housing.

9. Remove the forcing screw, bushing remover and mounting adapter.



Installation

1. **NOTE: The notch on the bottom of the bushing must point in a 6 or 12 o'clock position for zero pinion angle adjustment, 3 o'clock position for 1.25° pinion angle up adjustment and 9 o'clock position for -1.25° pinion angle down adjustment.**

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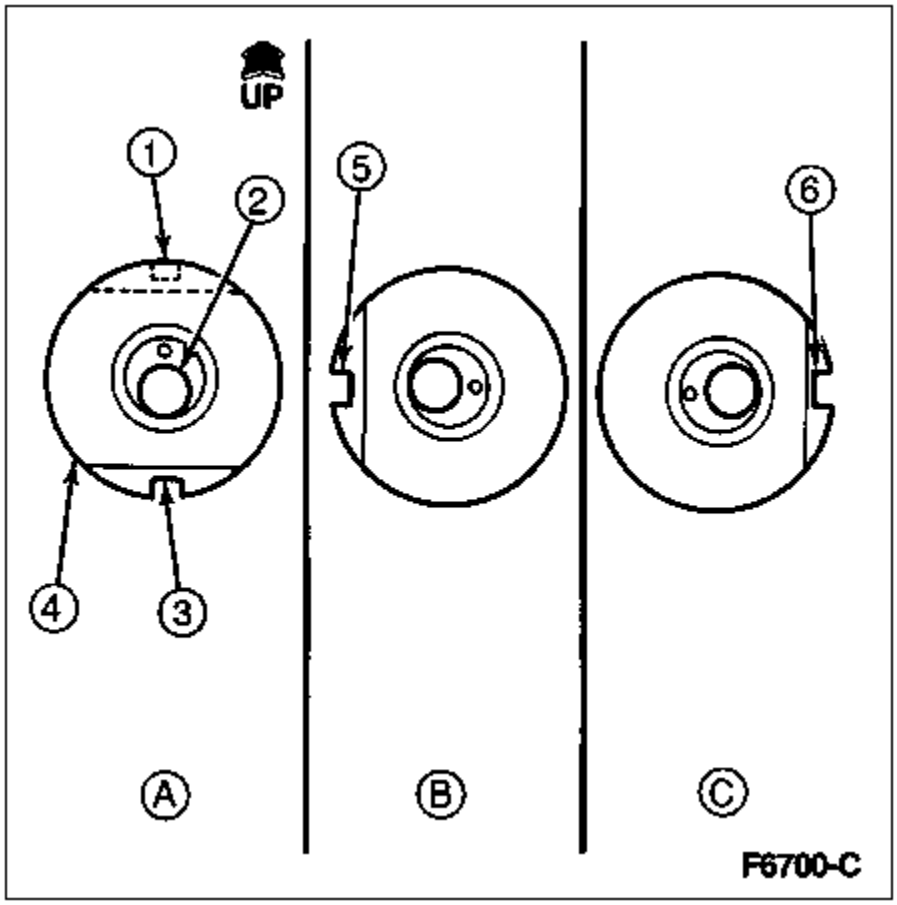

Item	Part Number	Description
1	—	12 O'Clock Position (Part of 5K789)
2	—	Bolt Hole (Part of 5K789)
3	—	6 O'Clock Position (Part of 5K789)
4	5K789	Eccentric Service Bushing
5	—	9 O'Clock Position (Part of 5K789)
6	—	3 O'Clock Position (Part of 5K789)
A	—	Nominal Position
B	—	Pinion Nose Down Position 1.25°
C	—	Pinion Nose Up Position 1.25°

Lubricate the bushing to be installed and place the bushing into the axle housing bushing bore.

2. Position 2-Jaw Puller D81L-1002-A or equivalent around the axle housing bushing bracket with Axle Housing Bushing Replacer Adapter T85T-5638-AH13 between the forcing screw and the flanged end of the bushing.

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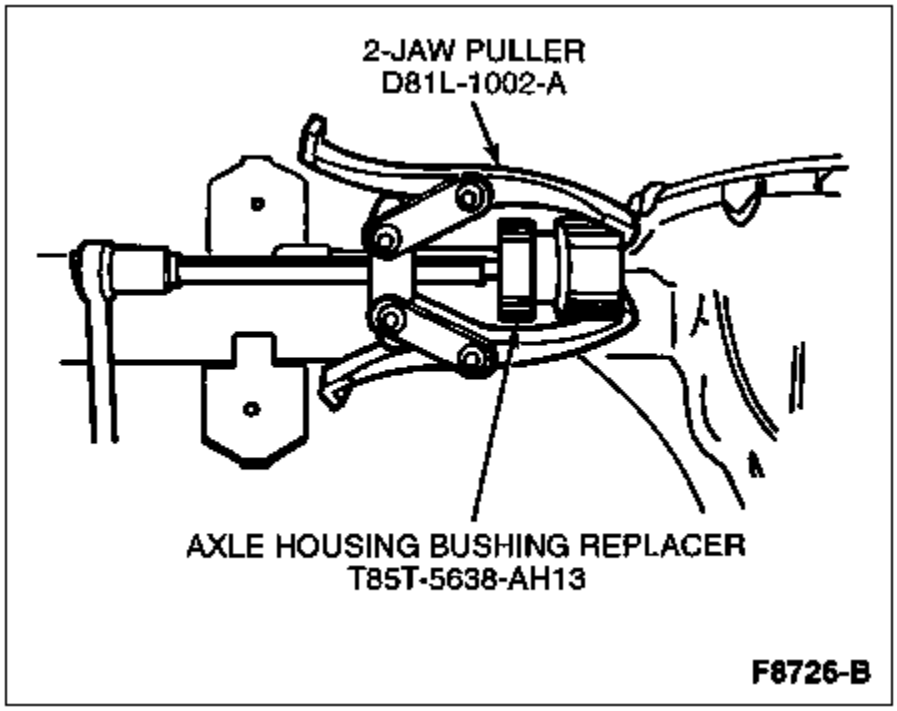
3. Turn the forcing screw to push bushing into position. Remove the installation tools.



4. On the inboard side of flange, install thrust bushing so steel washer faces the flange.
5. With the vehicle body securely supported on safety stands, raise the rear axle until the rear suspension arm engages the flange on the axle housing. If a frame hoist is used, lower the vehicle until the rear suspension arm and bushing engages the flange on the axle housing.
6. Install the nut and bolt retaining the rear suspension arm and bushing to the flange and tighten until snug. Do not tighten to the specified torque at this time.
7. If removed, connect the shock absorber to the lower axle bracket. Install and tighten the retaining nut to 54-82 Nm (40-60 lb-ft).
8. Position the rear axle in the normal ride position. Tighten the bolt retaining the upper rear suspension arm and bushing to the axle housing to 210-285 Nm (155-210 lb-ft).
9. If required, check and adjust the driveline angularity or driveline angle check as described in Section 05-00 .
10. Remove the safety stands and lower the vehicle.

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Axle Disassembly

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Differential Side Bearing Puller	T77F-4220-B1
Impact Slide Hammer	T50T-100-A
Pinion Bearing Cone Remover	T71P-4621-B
Pinion Depth Gauge Set	T79P-4020-A

Sensor, Anti-Lock Brake

1. Clean axle mounting surface, using caution to prevent dirt from entering axle housing.

2. Remove hold-down bolt. Remove rear brake anti-lock sensor.

Differential Case Removal

1. All service operations on the differential case (4204) and the drive pinion can be performed with the axle housing installed in the vehicle.

   Raise the vehicle on drive thru hoist and place jackstands under the rear frame crossmember. Lower the hoist so that the rear axle assembly (4006) drops down far enough for working ease.

2. **NOTE: The next step requires removal of the axle housing cover (4033). On Aerostar, once removed, the plastic axle housing cover must be replaced with a new one.**

   Remove the axle housing cover from the carrier rear face and drain the lubricant. Inspect the differential case and drive pinion before removal following the procedures under Cleaning and Inspection in this section.

3. Check and record the ring gear runout as described in Section 05-00 .

   - Check and record the ring gear backlash as described in this section.

4. Remove the rear wheels and brake drums (1126).

5. Remove the axle shafts (4234) as described in this section under Axle Shaft Removal and Installation.

6. Make scribe marks on the driveshaft end yoke and the rear axle companion flange to ensure proper alignment at assembly. If required, remove the damper assembly from the carrier. Disconnect the driveshaft end yoke from the rear axle companion flange. Remove the driveshaft assembly from the vehicle.

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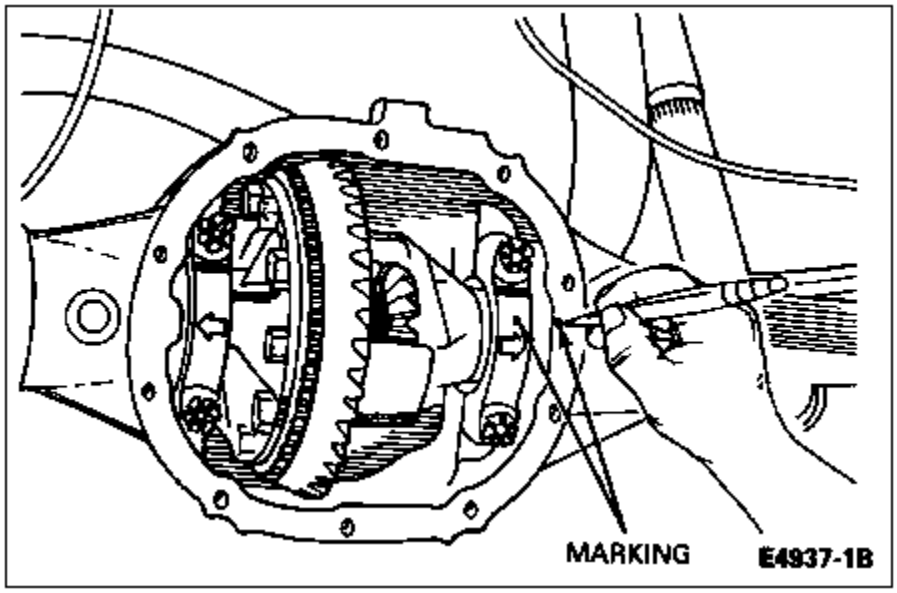
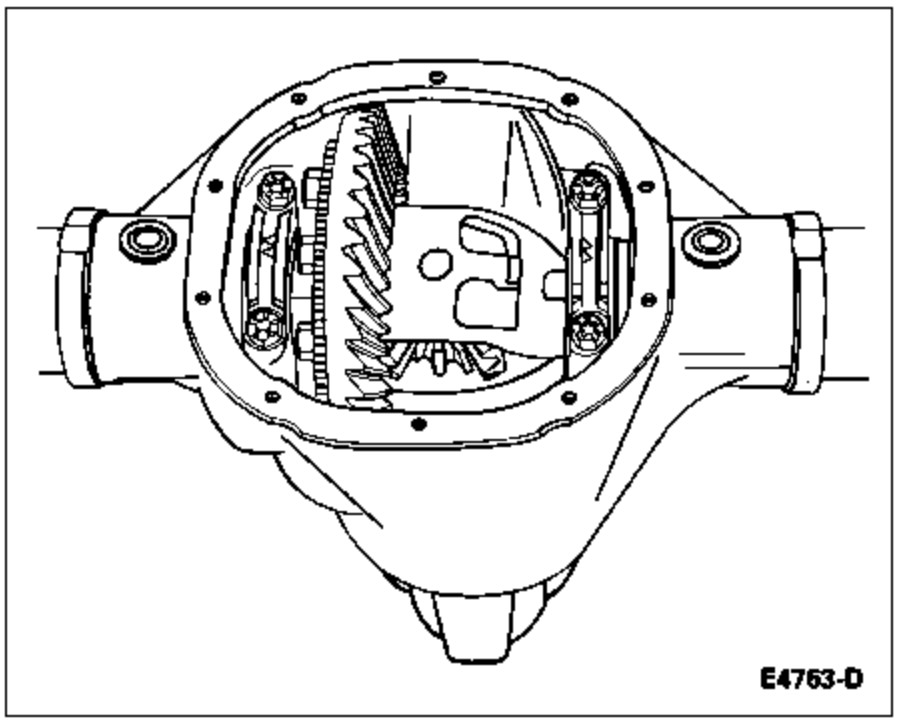
7. Mark differential bearing caps to make sure they are installed in original positions during assembly.



8. Loosen the differential bearing cap bolts.

   - Bearing caps **must** be installed in their original positions and locations. Triangles embossed on bearing caps must face outboard toward the axle shafts.



9. **NOTE: Before removing differential case from carrier, inspect it and determine if differential case runout check is necessary. If so, refer to Section 05-00 .**

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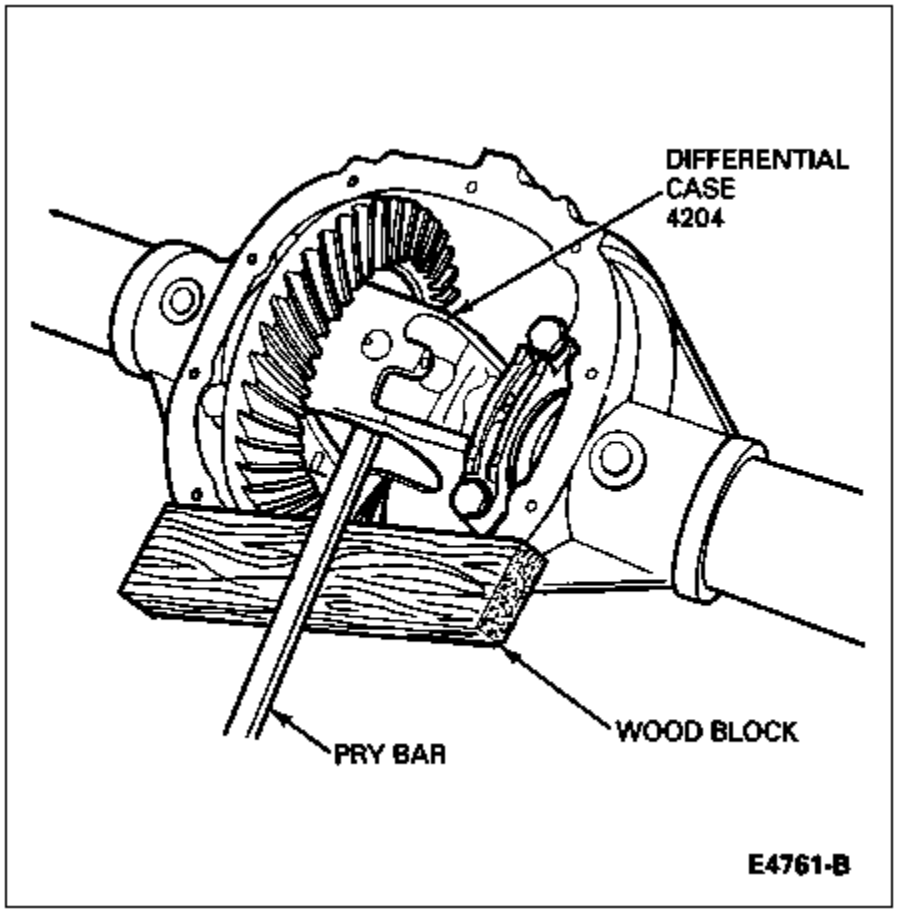
Pry the differential case, differential bearing cups (4222) and differential bearing shims (4067) out until they are loose in the bearing caps. Remove the bearing caps and remove the differential case from the carrier. If the ring gear is removed from the differential case, coat ring gear bolts with Stud and Bearing Mount E0AZ-19554-BA or equivalent meeting Ford specification WSK-M2G349-A1 prior to installation. Tighten to 95-115 Nm (70-85 lb-ft). For rear anti-lock brake sensor replacement, refer to Sensor Indicator, Anti-Lock Brake in the Removal and Installation portion of this section. For Traction-Lok® Differentials, refer to Section 05-02C .

- If a high ratio ring gear (3.73:1-4.10:1) is removed, make sure the drive pinion shaft is installed in the differential case before installing the ring gear on the differential case.



Drive Pinion Removal

1. Mark the rear axle companion flange in relation to the drive pinion stem. Hold the rear axle companion flange with the proper tool and remove the pinion nut. If a new rear gear and pinion is being installed, the driveshaft centering socket yoke (4782) need not be marked.

2. **NOTE: Before removing rear axle companion flange, inspect it and determine if companion flange runout check is necessary. If so, refer to Section 05-00 .**

   Remove the rear axle companion flange with Differential Side Bearing Puller T77F-4220-B1. With a soft-faced hammer, drive the pinion out of the bearing cone and roller and remove it through the rear of the carrier casting.

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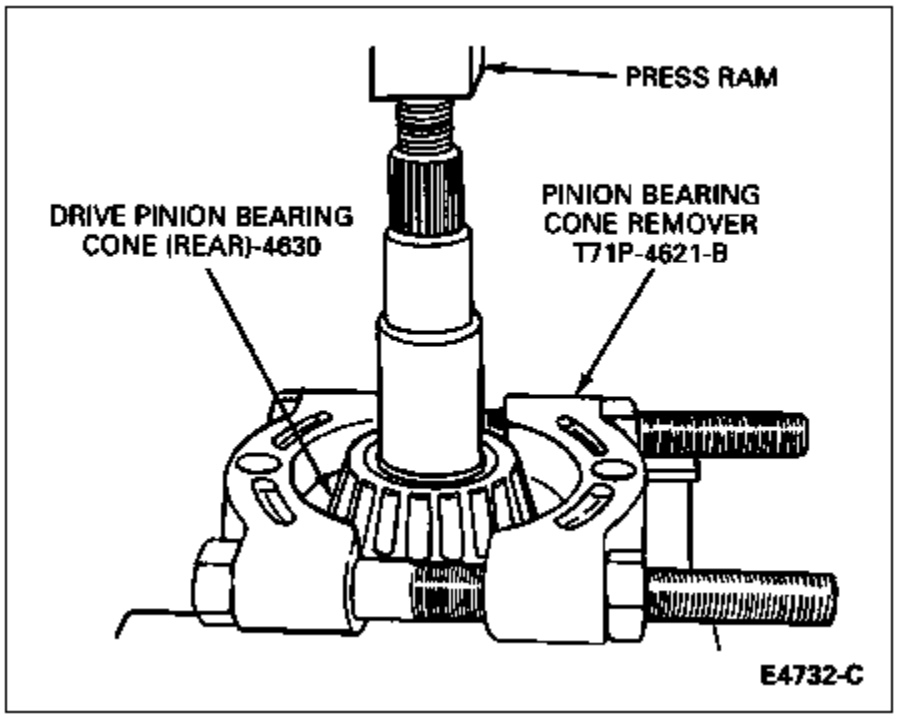
3. Remove the pinion seal with Seal Remover TOOL-1175-AC or equivalent and Impact Slide Hammer T50T-100-A. Remove the bearing cone and roller and oil slinger from the carrier casting.

4. Remove the drive pinion, front bearing cone, spacer and pinion seal as described in this section under Rear Axle, Disassembly.

5. To remove the rear drive pinion bearing cone, use Pinion Bearing Cone Remover T71P-4621-B as shown. Measure the shim found under the differential pinion bearing (4630) with a micrometer. Record the thickness.

6. Before installing the drive pinion bearing cone on the drive pinion, a drive pinion shim must be selected as described below.



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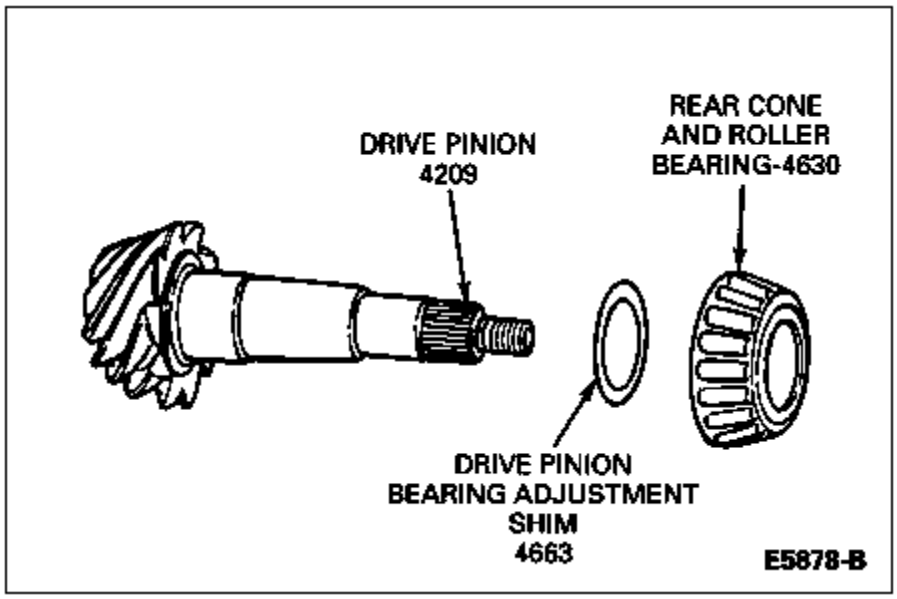

Pinion Bearing Cup Removal

1. **NOTE: Do not remove the pinion bearing cups from the differential carrier unless damaged or unless new bearings are to be installed.**

   If the pinion bearing cups are to be replaced, tap alternately (with a brass drift of suitable length) on each side of the pinion bearing cups during removal to prevent them from becoming cocked in the differential carrier bore.

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Axle Assembly

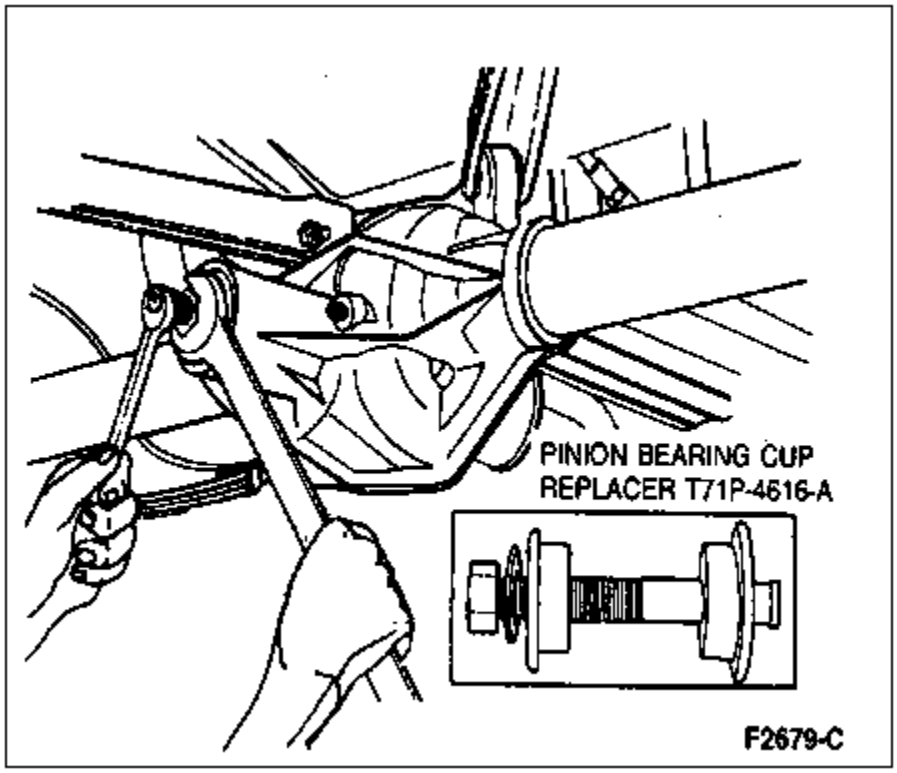
SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Pinion Bearing Cup Replacer	T71P-4616-A
Pinion Seal Replacer	T79P-4676-A
Companion Flange Holding Tool	T78P-4851-A
Shim Driver	T85L-4067-AH

Pinion Bearing Cup Installation

1. **NOTE: To make sure pinion bearing cups will seat properly, clean bores before installing.**

   Install the new pinion bearing cups with Pinion Bearing Cup Replacer T71P-4616-A. Make sure the pinion bearing cups are properly seated in their bores. If a 0.038mm (0.0015-inch) feeler gauge can be inserted between a pinion bearing cup and the bottom of its bore at any point around the pinion bearing cup, the pinion bearing cup is not properly seated. Whenever the pinion bearing cups are replaced, the pinion bearings should also be replaced.



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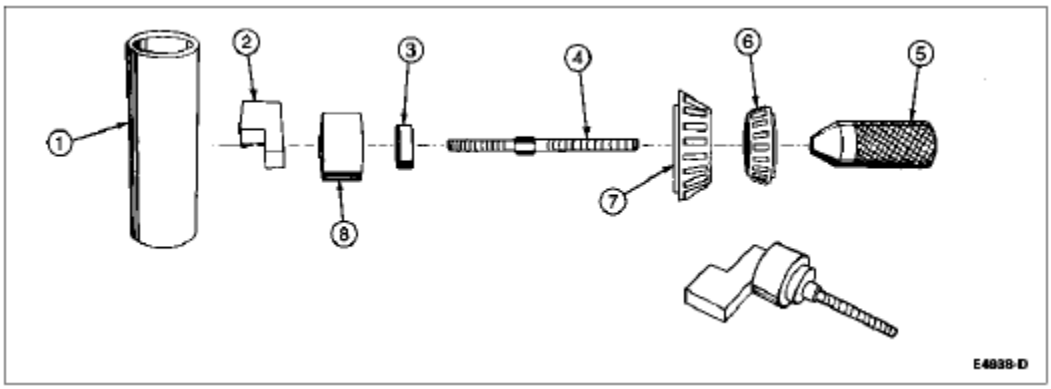
Drive Pinion Shim Selection

Individual differences in machining the carrier casting and the ring gear and pinion and variation in bearing widths require a pinion shim between the rear bearing and pinion head, in order to locate the pinion for correct tooth contact with the ring gear. When replacing a ring gear and pinion, the correct shim thickness for the new ring rear and pinion to be installed, is determined by the following procedure using Pinion Depth Gauge Set T79P-4020-A as shown below.

Pinion Depth Gauge Set T79P-4020-A



Item	Part Number	Description
1	D80T-4020-F49	Gauge Tube (2.892 Inch Thick)
2	T76P-4020-A10	Gauge Block (1.700 Inch Thick)
3	T76P-4020-A3	Aligning Adapter (1.612 Inch O.D.)
4	T76P-4020-A9	Screw
5	T76P-4020-A11	Handle
6	4621	Bearing Cone and Roller (Front)
7	4630	Differential Pinion Bearing Cone (Rear)
8	T78P-4020-A15	Gauge Disc

1. **NOTE: The gauge block must be offset to obtain an accurate reading.**

   Place the rear drive pinion bearing cone (new or used if in good condition) over the aligning tool and insert it into the rear axle pinion bearing cup (4628) of the carrier. Place the front bearing into the front pinion bearing cup and assemble the tool handle into the screw and tighten to 27 Nm (20 lb-ft).

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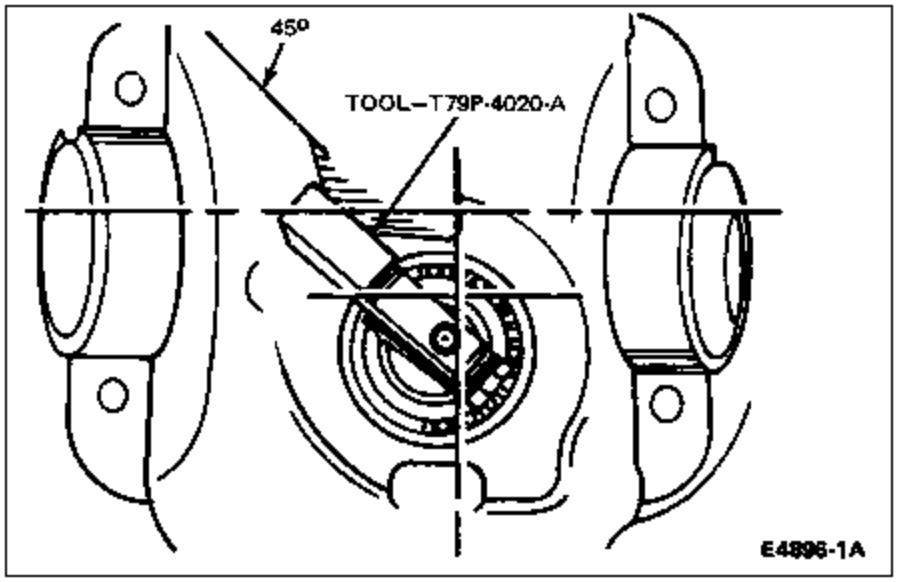

2. **NOTE: Shims must be flat. Do not use dirty, bent, nicked or mutilated shims as a gauge.**

   Center the gauge tube into the differential bearing bore. Install the bearing caps with the arrows pointing outward and the caps in their original locations. Tighten the bolts to 95-115 Nm (70-85 lb-ft).

   - Make sure that the gauge handle adapter screw, aligning adapter, gauge disc and gauge block assembly are securely mounted between front and rear bearing. Recheck tool handle torque prior to gauging to make sure that bearings are properly seated. This can affect final shim selection if improperly assembled. Clean bearing cup and differential pedestal surfaces thoroughly. Apply only **light** oil film on bearing assemblies prior to gauging.
   - Gauge block should then be rotated several half turns to make sure rollers are properly seated in bearing cups. Rotational torque on the gauge assembly should be 4.5 Nm (40 lb-in) with new bearings. Final position should be approximately 45 degrees across gauge tube to make sure that gauge block is in line with gauge tube high point. This area should be utilized for pinion shim selection. Selection of pinion shim with gauge block not lined up with tube high point will cause improper shim selection and may result in axle noise.
   - Utilize pinion shims as the gauge for shim selection. This will minimize errors in attempting to stack feeler gauge stock together or simple addition errors in calculating correct shim thickness.
   - **It is important to feel a slight drag on the shim for the correct selection.** Do not attempt to force the shim between the gauge block and gauge tube. This will reduce the chance of selecting a shim thicker than required which results in a deep tooth contact in final assembly for integral rear axles (4001).

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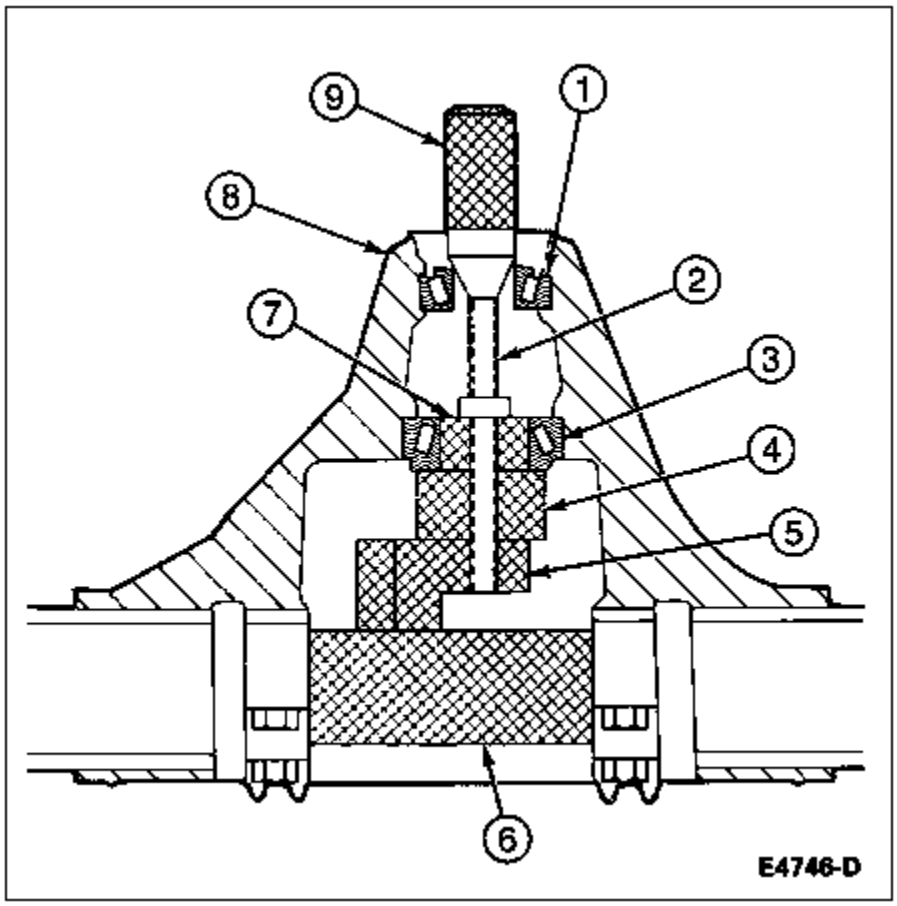

Item	Part Number	Description
1	4621	Bearing Cone and Roller (Front)
2	T76P-4020-A11	Handle
3	4630	Drive Pinion Bearing Cone (Rear)
4	T78P-4020-A15	Gauge Disc
5	T76P-4020-A10	Gauge Block
6	D80T-4020-F49	Gauge Tube
7	T76P-4020-A3	Aligning Adapter
8	4204	Differential Case
9	T76P-4020-A11	Handle

3. **NOTE: The same rear pinion bearing used in this procedure must be used in final assembly of the rear axle.**

   Place the selected shims on the drive pinion shaft and press the pinion bearing until firmly seated on the shaft.

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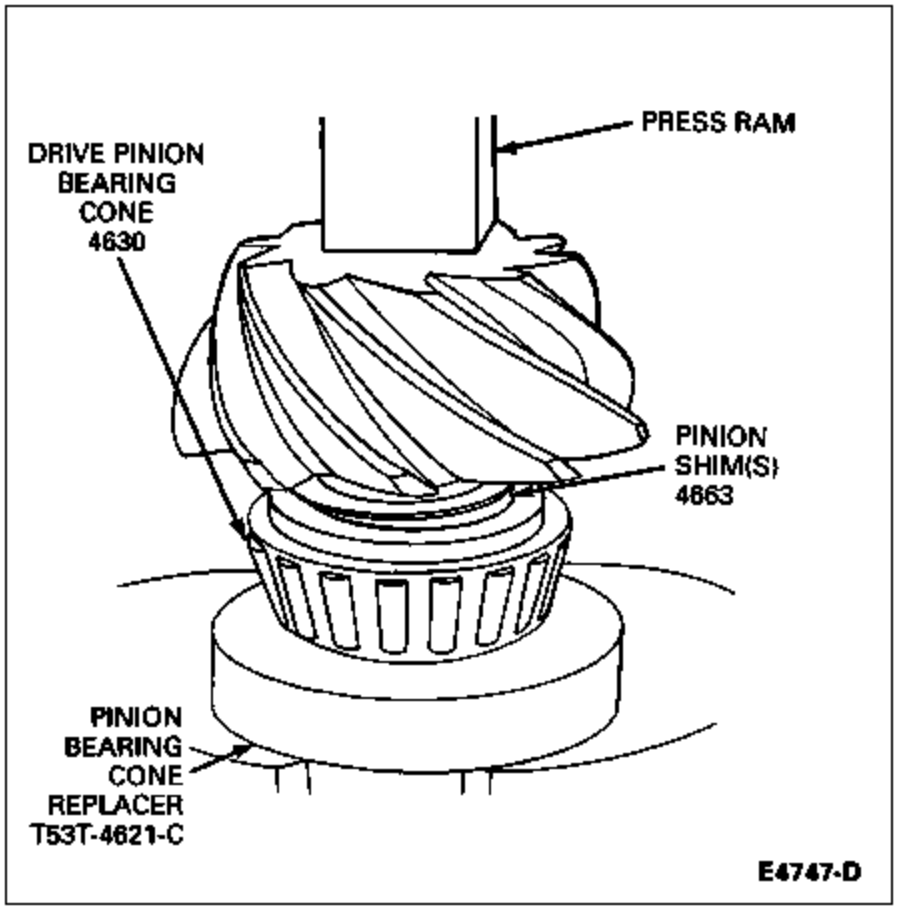

Drive Pinion Installation

1. Check splines on the drive pinion stem to be sure they are free of burrs. If burrs are evident, remove them by using a fine crocus cloth, working in a rotational motion. Wipe the pinion clean.

2. Place a new collapsible spacer on the pinion stem against the pinion stem shoulder.

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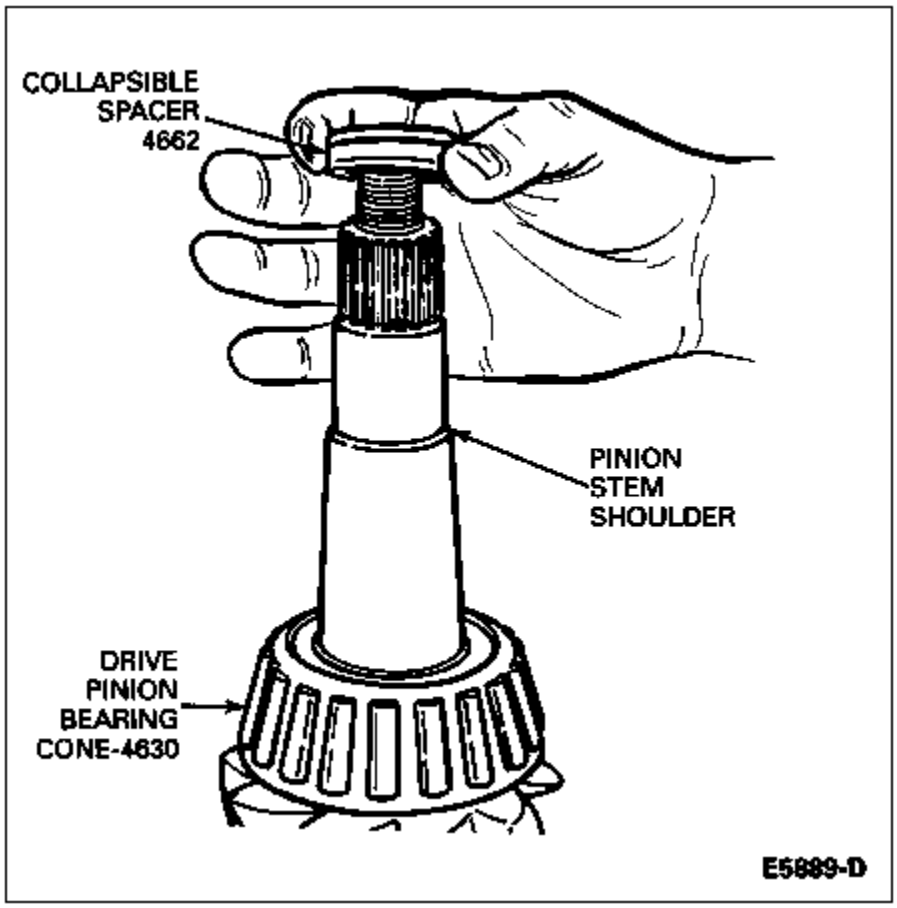

3. Install the front pinion bearing and oil slinger in the axle housing bore and install the pinion seal on the Pinion Seal Replacer T79P-4676-A.

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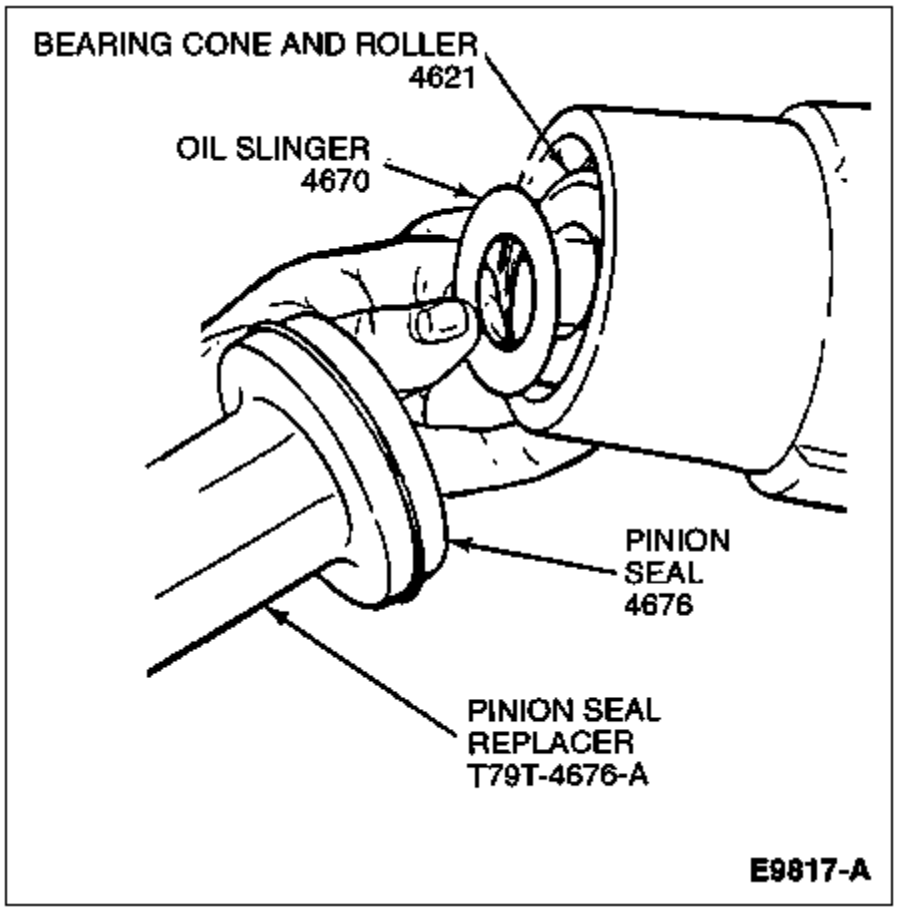

4. **CAUTION: Installation without the proper tool may result in early seal failure. If pinion seal becomes cocked during installation, remove it and install new one.**

   Clean the pinion seal seat surface. Install the pinion seal in the housing bore using Pinion Seal Replacer T79P-4676-A. Coat the lips of the pinion seal with Premium Long-Life Grease XG-1-C or -K or equivalent meeting Ford specification ESA-M1C75-B.

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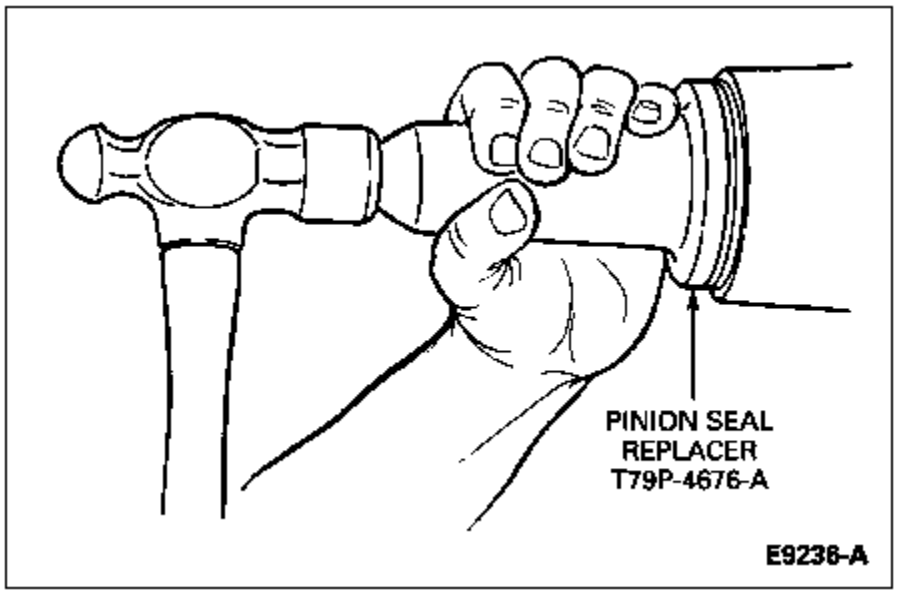
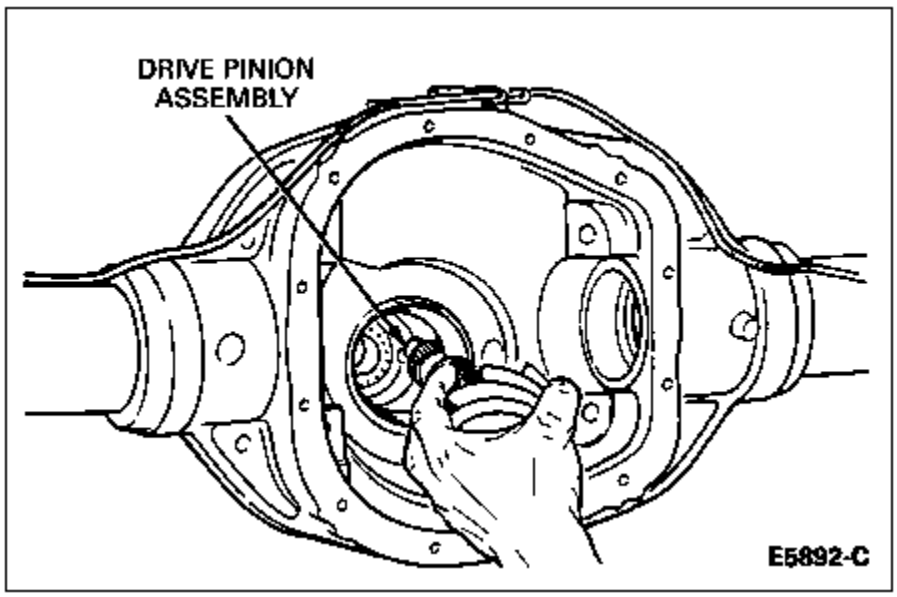


5. **NOTE: Differential bearing preload and ring gear backlash is adjusted with the drive pinion and differential case (4204) installed. Adjustment is performed by the installation of shims between the differential bearing cup and axle housing.**

   From the rear of the axle housing, install the drive pinion assembly (drive pinion, shims, rear bearing cone and roller, and collapsible spacer) into the rear axle housing pinion shaft bore.



6. **NOTE: If a new rear axle companion flange is being installed, disregard the scribe mark on the pinion stem.**

   Apply a small amount of lubricant to the companion flange shaft splines of rear axle companion flange. Align the mark on the rear axle companion flange with the mark on the pinion stem.

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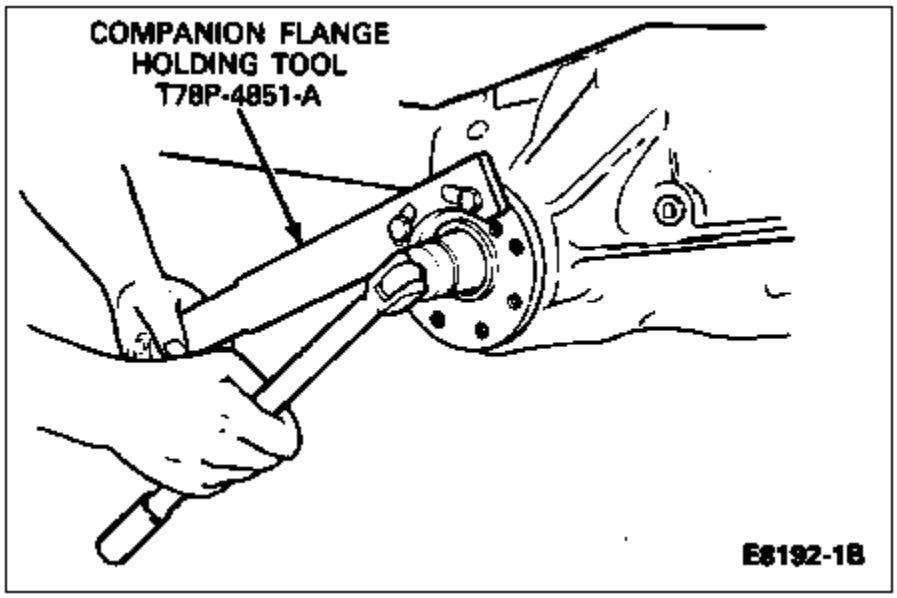
Universal Joint Flange Installation

1. **NOTE: The rear axle companion flange must never be hammered on or installed with power tools.**

   With the drive pinion in place in the axle housing, install rear axle companion flange using Companion Flange Replacer TOOL-4858-E or equivalent.

2. Start a new pinion nut. Hold the rear axle companion flange with Companion Flange Holding Tool T78P-4851-A.



3. Tighten the pinion nut, rotating the pinion occasionally to make sure pinion bearing is properly seated. Take frequent pinion bearing torque preload readings until the original recorded preload reading is obtained by rotating the pinion with an inch-pound torque wrench.

   If the original recorded preload is lower than specification (used bearings .9-1.5 Nm [8-14 lb-in]; new bearings 1.8-3.3 Nm [16-28 lb-in]), tighten to specification. If the preload is higher than specification, tighten to original reading as recorded. **Under no circumstances should the pinion nut be backed off to reduce preload. If reduced preload is required, a new collapsible spacer and pinion nut must be installed.**

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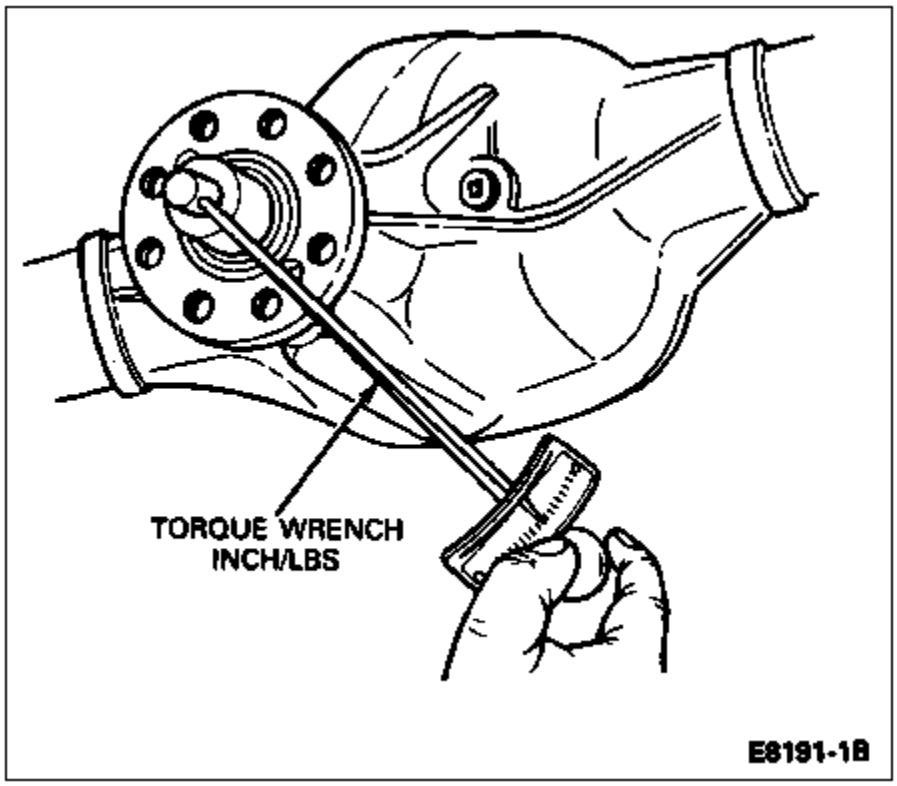

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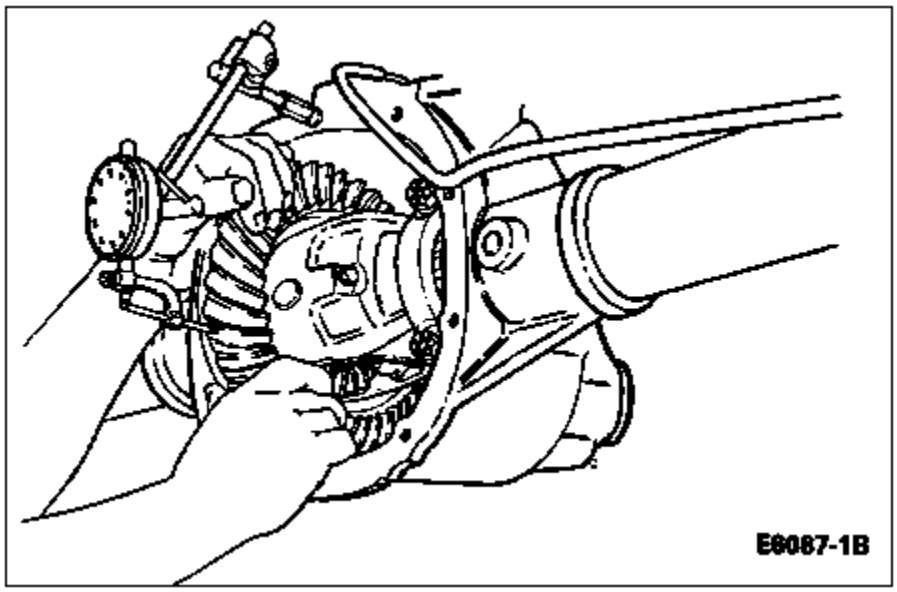
Differential Case Installation

For shim selection after a complete replacement of the axle housing, the differential (4026) or differential bearings (4221), use the following instructions. For replacement only of a ring gear and pinion, or a backlash adjustment, follow Steps 9 through 13 and Step 15, using the differential bearing shims (4067) that were originally in the rear axle (4001).

1. With pinion depth set and pinion installed, place differential case gear assembly with differential bearings and cups in the carrier.
2. Install a 6.73mm (0.265-inch) differential bearing shim on left side.
3. Install left bearing cap and tighten bolts finger-tight.
4. Install progressively larger differential bearing shims on the right side until the largest one selected can be assembled with a slight drag feel.
    - Apply pressure toward left side to make sure differential bearing cup (4222) is seated.
5. Install right side bearing cap and tighten all four (4) bolts to 95-115 Nm (70-85 lb-ft).
6. Rotate assembly to make to free rotation.
7. Check ring gear and pinion backlash. If the backlash is 0.20-0.38mm (0.008-0.015 inch) with 0.304-0.381mm (0.012-0.015 inch) preferred, proceed to Step 14. If backlash is not within specifications, go to Step 10, unless zero backlash is measured, then go to Step 8.



8. If a zero backlash condition occurs, add .508mm (0.020 inch) to the right side and subtract .508 mm

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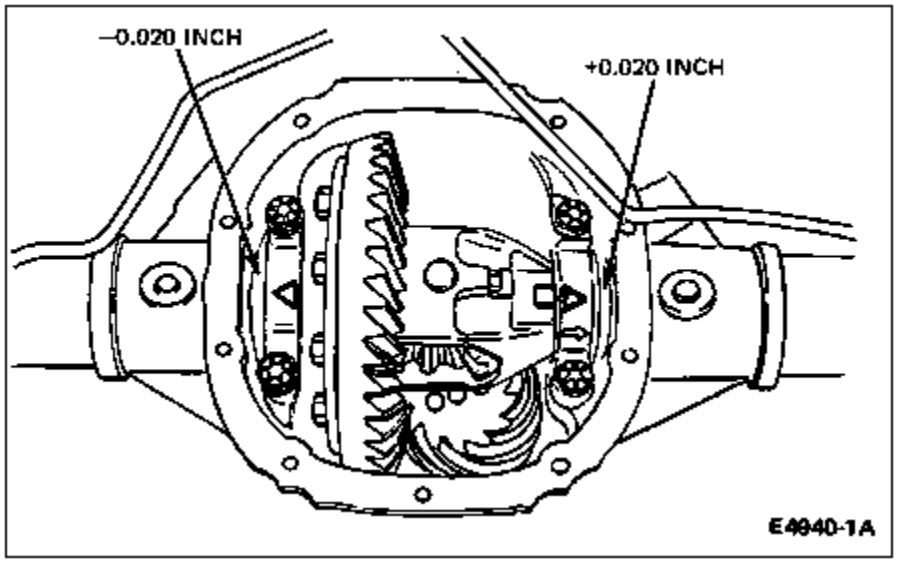
(0.020 inch) from the left side to allow backlash indication.



9. Recheck backlash.

10. If backlash is not to specification, correct backlash by increasing thickness of one differential bearing shim and decreasing thickness on the other differential bearing shim the same amount. Refer to chart for approximate change of differential bearing shim.

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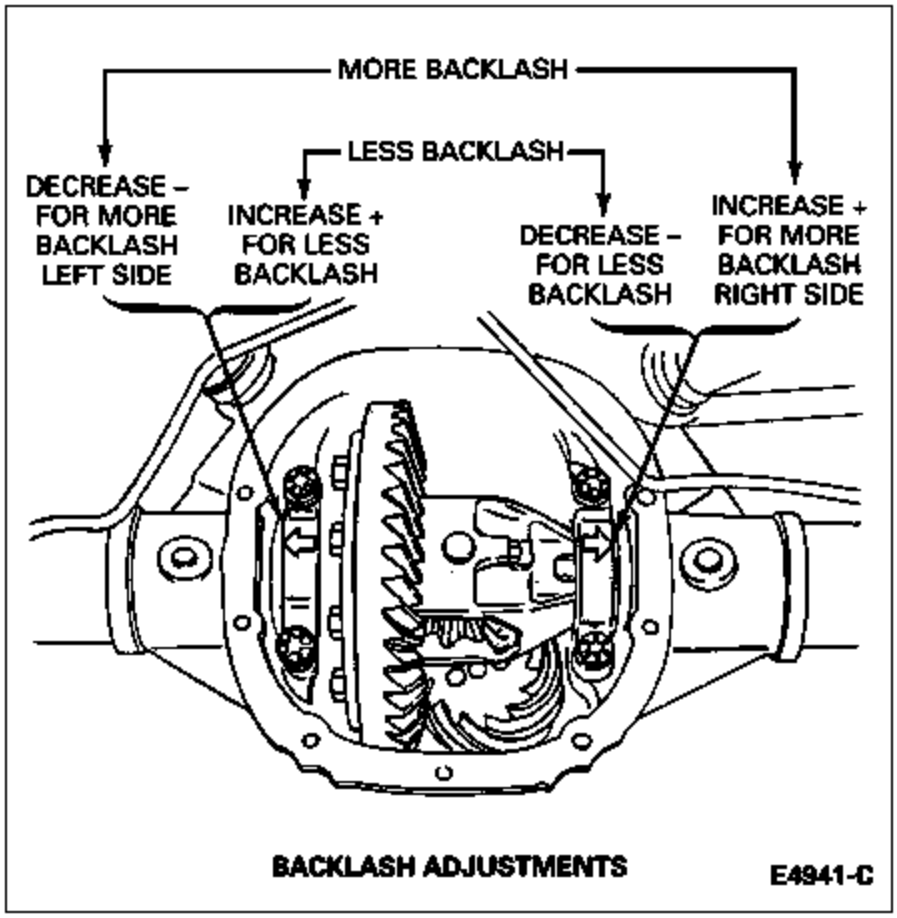

SHIM CODE CHART DIFFERENTIAL SIDE BEARING

Number of Stripes and Color Code	Dim. A
2 - C-COAL	.3070-.3075
1 - C-COAL	.3050-.3055
5 - BLU	.3030-.3035
4 - BLU	.3010-.3015
3 - BLU	.2990-.2995
2 - BLU	.2970-.2975
5 - PINK	.2930-.2935
4 - PINK	.2910-.2915
3 - PINK	.2890-.2895
2 - PINK	.2870-.2875
1 - PINK	.2850-.2855
5 - GRN	.2830-.2835
4 - GRN	.2810-.2815
3 - GRN	.2790-.2795

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2 - GRN	.2770-.2775
1 - GRN	.2750-.2755
5 - WH	.2730-.2735
4 - WH	.2710-.2715
3 - WH	.2690-.2695
2 - WH	.2670-.2675
1 - WH	.2650-.2655
5 - YEL	.2630-.2635
4 - YEL	.2610-.2615
3 - YEL	.2590-.2595
2 - YEL	.2570-.2575
1 - YEL	.2550-.2555
5 - ORNG	.2530-.2535
4 - ORNG	.2510-.2515
3 - ORNG	.2490-.2495
2 - ORNG	.2470-.2475
1 - ORNG	.2450-.2455
2 - RED	.2430-.2435
1 - RED	.2410-.2415

BACKLASH SPECIFICATIONS

Backlash Change Required (Inch)	Thickness Change Required (Inch)	Backlash Change Required (Inch)	Thickness Change Required (Inch)
.001	.002	.009	.012
.002	.002	.010	.014
.003	.004	.011	.014
.004	.006	.012	.016
.005	.006	.013	.018
.006	.008	.014	.018
.007	.010	.015	.020
.008	.010	—	—

11. Install the differential bearing shims by driving into position with Shim Driver T85L-4067-AH. Install and tighten the bearing cap bolts to 95-115 Nm (70-85 lb-ft).

12. Rotate assembly several times.

13. Recheck backlash. If backlash is within specification, go to Step 14. If backlash is not within specification, repeat Step 10. Backlash specification is 0.20-0.38mm (0.008-0.015 inch). Preferred range is 0.304-0.381mm (0.012-0.015 inch).

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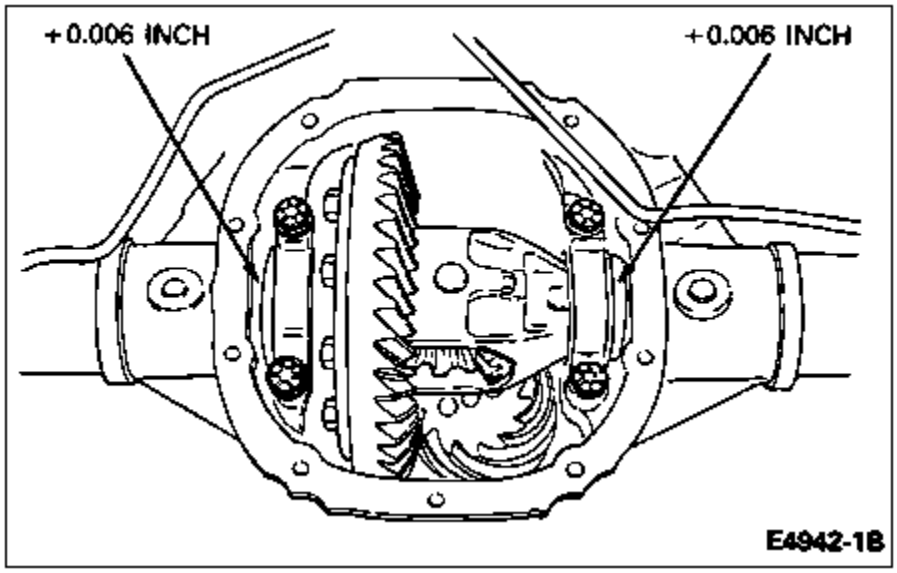
14. Remove bearing caps and bolts. To establish differential bearing preload, increase both left and right shim sizes by 0.006 inch. Make sure differential bearing shims are fully seated and assembly turns freely.



15. Install bearing caps and tighten bolts to 95-115 Nm (70-85 lb-ft).

16. Utilize white marking compound to obtain a tooth mesh contact pattern in your assembly.

    Pattern inspection is intended to allow technicians the ability to detect gross errors in set-up prior to complete reassembly. Pattern contact should be within the primary area of the ring gear tooth surface avoiding any narrow or hard contact with outer perimeter of tooth (top to root, toe to heel). Pattern inspection should be on the drive (pull) side. Correct assembly of drive pattern will result in satisfactory coast performance. If gross pattern error is detected, with preferred backlash of 0.30-0.38mm (0.012-0.015 inch), recheck pinion shim selection.

Axle Shaft Installation

1. Install the axle shafts (4234); refer to the procedure in this section.

2. Remove the oil seal replacer from the transmission extension housing (7A039). Install the driveshaft in the extension housing. Align the scribe marks and connect the driveshaft end yoke at the rear axle companion flange. Install bolts and tighten to 95-128 Nm (70-95 lb-ft).

Sensor, Anti-Lock Brake

Installation

1. If new rear brake anti-lock sensor is to be installed, lightly lubricate O-ring with motor oil. If old rear brake anti-lock sensor is to be reinstalled, clean and blow off metal particles using compressed air. Remove and replace O-ring with a new O-ring.

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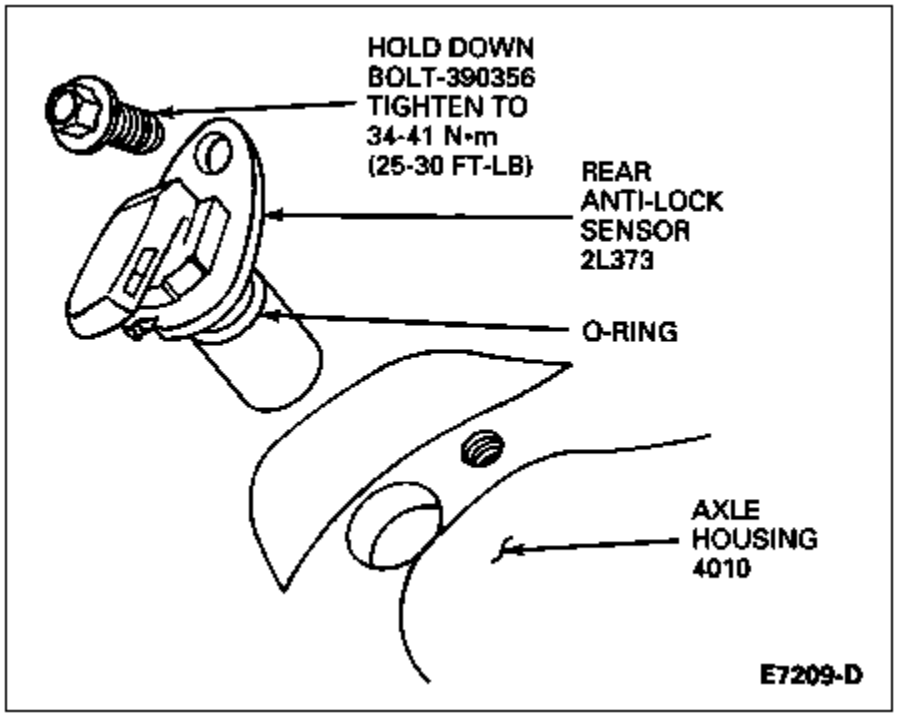
- Apply a light film of motor oil to the O-ring.

2. Firmly grasp rear brake anti-lock sensor at sides (do not install by applying force on connector) and push into axle housing, aligning mounting flange hole with threaded hole in axle housing.

3. Install hold-down bolt and tighten to 34-41 Nm (25-30 lb-ft).



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Inspection Before Disassembly of Carrier

The differential case (4204) and drive pinion should be inspected before they are removed from the carrier. These inspections may find the cause of the concern and determine the resolution.

1. Wipe the lubricant from the internal working parts and visually inspect the parts for wear and/or damage.

2. Rotate the gears to see if there is any roughness which would indicate worn or damaged bearings or gears.

3. Check the ring gear teeth for signs of scoring, abnormal wear or nicks/chips.

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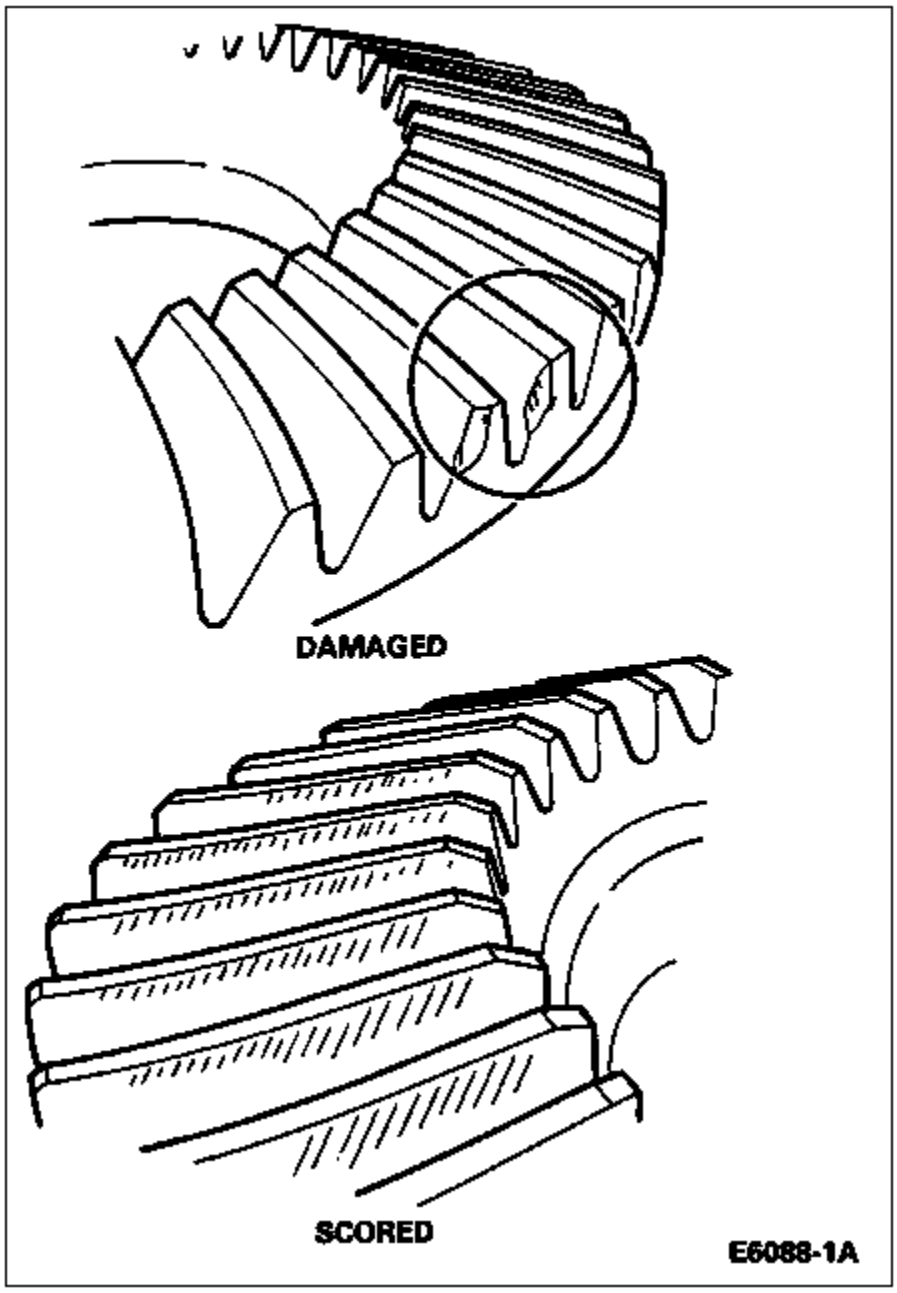

4. Set up Dial Indicator With Bracketry TOOL-4201-C or equivalent and check ring gear backlash and ring gear backface runout. Refer to the Specifications at the end of this section for allowable conditions.

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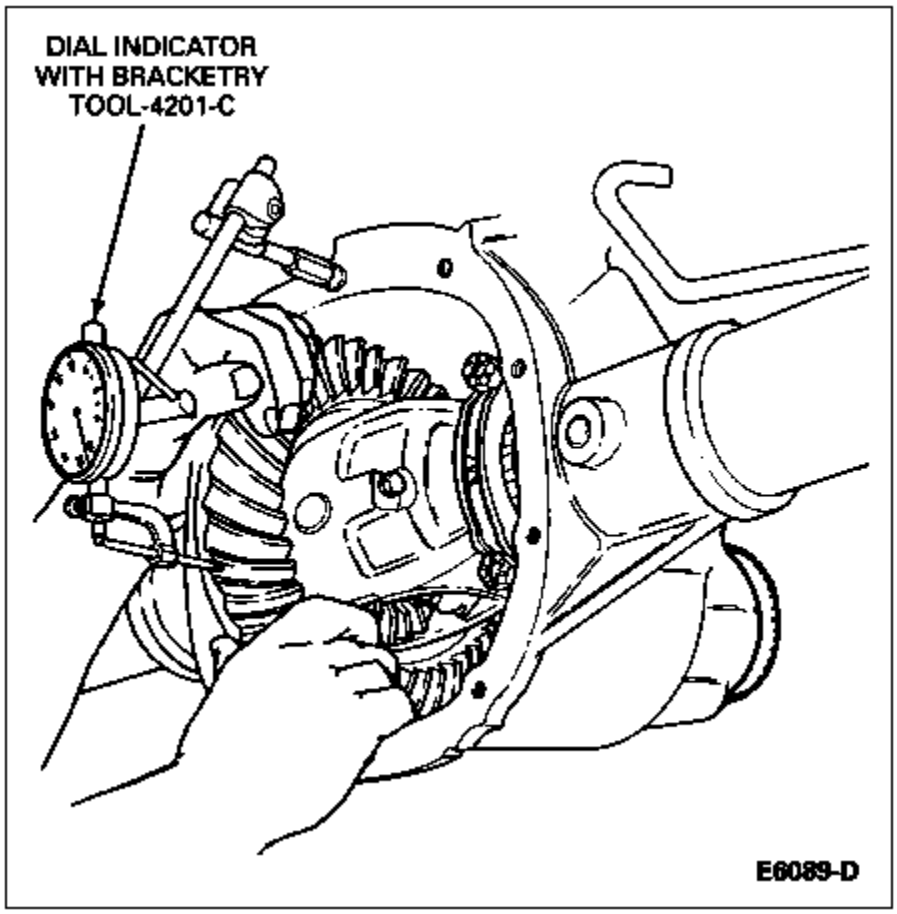

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Inspection After Disassembly of Carrier

Thoroughly clean all parts. Always use new solvent when cleaning bearings. Do not spin dry bearings with compressed air. Oil the bearings immediately to prevent rusting. Inspect the parts for any major wear or damage. Clean the inside of the axle housing before rebuilding. When a scored or chipped ring gear and pinion is replaced, the axle housing must be washed thoroughly. Inspection procedures for individual parts are outlined below.

Sensor Indicator, Anti-Lock Brake

Discard and replace if damaged or removed from the ring gear.

Gears

Examine the ring gear and pinion teeth for scoring, excessive wear, nicks and chipping. Worn, scored and damaged gears cannot be rebuilt to correct a noisy condition.

Bearing Cups

Check pinion bearing cup for deep scores, galling, or spalling. If a 0.038mm (0.0015-inch) feeler gauge can be inserted between a pinion bearing cup and the bottom of its bore at any point around the pinion bearing cup, the pinion bearing cup must be reseated.

Universal Joint Flange, Rear Axle

Make sure that the surfaces of the rear axle companion flange have not been damaged in removing the driveshaft or in removing the rear axle companion flange from the pinion.

In addition, the following areas must be smooth and free of nicks:

- The pinion nut counterbore and seal surface.
- The back face of the rear axle companion flange that contacts the slinger.

Cone and Roller Assemblies

When operated in the differential bearing cups (4222), bearing rollers must turn without roughness. Examine the roller ends for step wear. If inspection reveals either a damaged pinion bearing cup or a damaged cone and roller, both parts should be replaced.

Carrier Housing

Make sure that the differential bearing bores are smooth. Remove any nicks or burrs from the mounting surfaces of the differential housing.

Differential Case

Make sure that the hubs where the bearings mount are smooth. Carefully examine the differential case bearing shoulders, which may have been damaged when the differential bearings (4221) were removed. The bearing assemblies will fail if they do not seat firmly against the shoulders. Check the fit (free rotation) of

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the differential side gears (4236) in their counterbore.

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SPECIFICATIONS

Clearance, Tolerance And Adjustments Backlash Specifications

Backlash Change Required (Inch)	Thickness Change Required (Inch)	Backlash Change Required (Inch)	Thickness Change Required (Inch)
.001	.002	.009	.012
.002	.002	.010	.014
.003	.004	.011	.014
.004	.006	.012	.016
.005	.006	.013	.018
.006	.008	.014	.018
.007	.010	.015	.020
.008	.010	—	—

Axle Adjustment Specifications

Adjustment	Specification
Ring Gear Backface Runout	
Maximum	0.102mm (0.004 Inch)
Nominal Shim Size to Be Installed on Left Side During Diagnosis	6.73mm (0.265 Inch)
Ring Gear Backlash	
Backlash Between Ring Gear and Pinion Teeth	0.20-0.38mm (0.008-0.015 Inch) NOTE: Preferred Setting Is 0.304-0.381mm (0.012-0.15 Inch)
Maximum Backlash Variation Between Teeth	0.10mm (0.004 Inch)
Drive Pinion Depth	
Use Pinion Depth Tool Set T79P-4020-A to Determine Drive Pinion	—
Differential Bearing Preload	
Add 0.152mm (0.006 Inch) to Each Side of Differential Case Shim Stack Determined for Correct Ring Gear Backlash	—
Differential Case Flange Runout	0.076mm (0.003 Inch) Max.
Companion Flange Runout	
Total Indicated Runout	0.25mm (0.010 Inch)

Lubricant Capacities

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Vehicle	Capacities [a] [b]		
	U.S. Pints	Imperial Pints	Liters
Aerostar	3.5	2.9	1.7
Ranger	5.0	4.2	2.5

[a] Approximate refill capacity. Axles should be filled with Premium Rear Axle Lubricant XY-80W90-QL or equivalent meeting Ford specification WSP-M2C197-A to 1/4-9/16 inch below the filler hole.
[b] Plus 4 ounces Friction Modifier, C8AZ-19B546-A (EST-M2C118-A) or equivalent meeting Ford specification for Traction-Lok® limited slip applications.

Torque Specifications, Retaining — Aerostar

Description	Nm	Lb-Ft
Differential Bearing Cap Bolts	95-115	70-85
Differential Pinion Shaft Lock Bolt	20-40	15-30
Cover Screws — Always replace with new cover and bolts whenever removed	21-27	15-20
Filler Plug	20-41	15-30
Driveshaft to Rear Axle Companion Flange Bolts	95-128	70-95
Shock Absorber to Rear Axle Bumper Bracket	54-82	40-60
Ring Gear Bolts — Coat bolt threads with stud and Bearing Mount E0AZ-19554-BA or equivalent meeting Ford specification WSK-M2G349-A1	95-115	70-85
Brake Backing Plate Bolts	27-54	20-40
Rear Brake Anti-Lock Sensor to Rear Axle Housing	34-41	25-30
Upper Spring Retainer Bolt	40-55	30-40
Lower Rear Suspension Arm and Bushing to Rear Axle Nut	129-177	95-130
Lower Spring Retainer Nut	55-85	41-63
Upper Rear Suspension Arm and Bushing to Axle Housing Bolt	210-285	155-210
Upper Rear Suspension Arm to Frame Nut	81-135	80-100
Lug Nuts	115-156	85-115
Lower Rear Suspension Arm and Bushing to Frame Nut	129-177	95-130
Rear Axle Bumper Nut	40-55	30-40

Torque Specifications, Retaining — Ranger

Description	Torque	
	Nm	Lb-Ft
Differential Bearing Cap Bolts	95-115	70-85

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Differential Pinion Shaft Lock Bolt	20-40	15-30
Filler Plug	20-41	15-30
Leaf Spring U-Bolts Nuts	75-102	55-75
Shock Absorber to Rear Axle Bumper Bracket	54-82	40-60
Ring Gear Bolts — Coat bolt threads with stud and bearing mount E0AZ-19954-BA or equivalent meeting Ford specification WSK-M2G349-A1	95-115	70-85
Brake Backing Plate Bolts	27-54	20-40
Rear Brake Anti-Lock Sensor to Rear Axle Housing	34-41	25-30
U-Bolts Nuts	88-118	65-80
Shock Absorber Lower Bolt Nuts	53-72	39-53
Driveshaft-to-Rear Axle Companion Flange Bolts	95-128	70-95
Axle Housing Cover Screws	38-52	28-38
Lug Nuts	115-156	85-115

Torque Specifications, Adjustment

Description	Rotational Torque [a]	
	Nm	Lb-In
Pinion Bearing Preload — (Collapsible Spacer)		
Original Bearings — 191mm (7.5 Inches)	0.9-1.6	(8-14)
New Bearings — 191mm (7.5 Inches)	1.8-3.2	(16-28)

[a] Rotational torque reading taken on pinion nut with inch-pound torque wrench with pinion seal installed.

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Axle, Integral Carrier, 8.8-Inch Ring Gear

NOTE: Procedures for removal of rear axles (4001) are different between Aerostar and Ranger vehicles. Therefore, each procedure is shown in this section. Internally, the rear axles are the same.

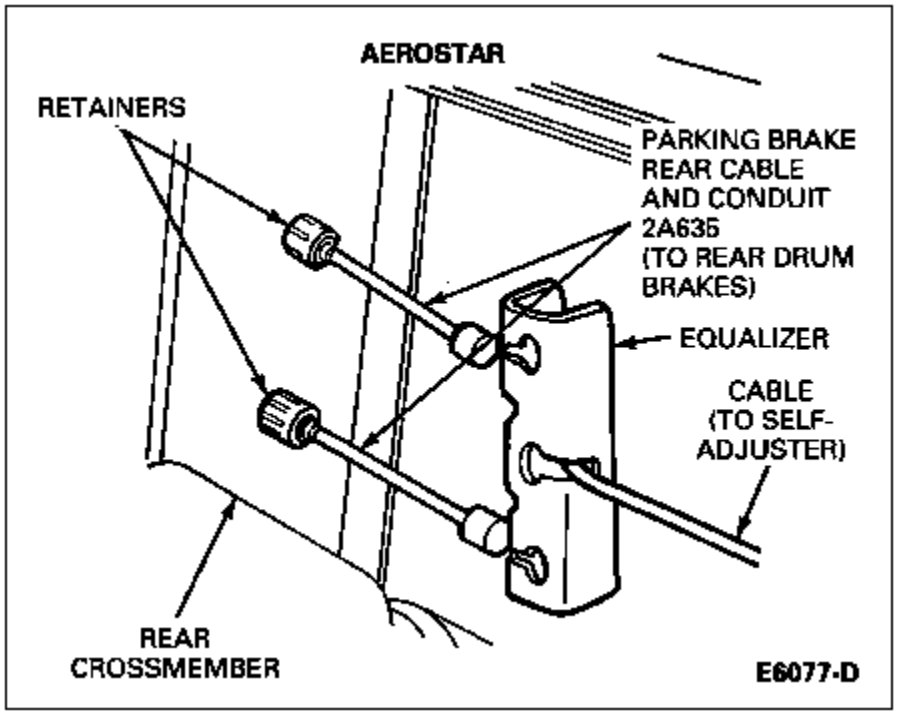
Rear Axle, Aerostar

Removal

1. Release tension on parking brake rear cable and conduit (2A635) as follows:

    a. Raise the vehicle.
    b. Pull rearward on the front parking brake cable, from underneath the vehicle, approximately 50.8mm (2 inches). Clamp the cable behind the crossmember making sure the plastic coating on the cable is not damaged. This will release tension on the parking brake rear cable and conduits.

2. Remove the parking brake rear cable and conduits from the equalizer. Compress the tabs on the outer rear wheel bearing retainers and pull the parking brake rear cable and conduits through the rear crossmember.



3. Position jackstands on the frame rear lift points or under the rear axle bumper brackets (4731).

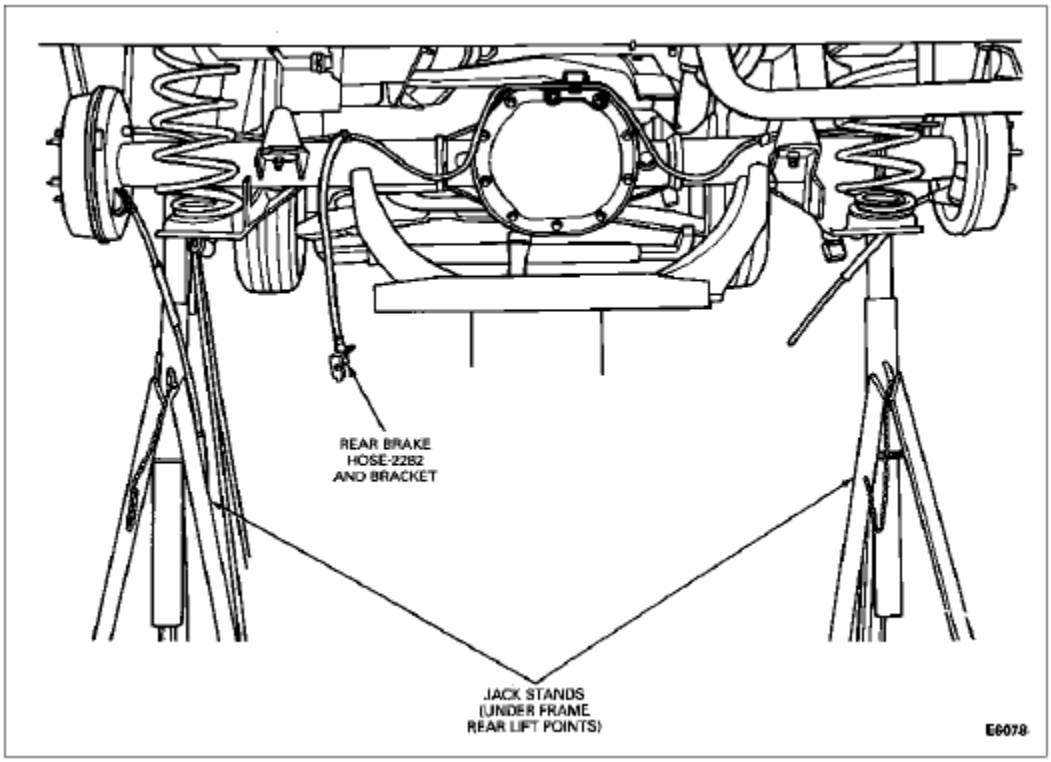
4. Disconnect rear brake anti-lock sensor harness connector.

5. Scribe a mark aligning the driveshaft to the rear axle companion flange. Remove the driveshaft. On 4x2 models, plug the extension housing (7A039) to prevent fluid spillage.

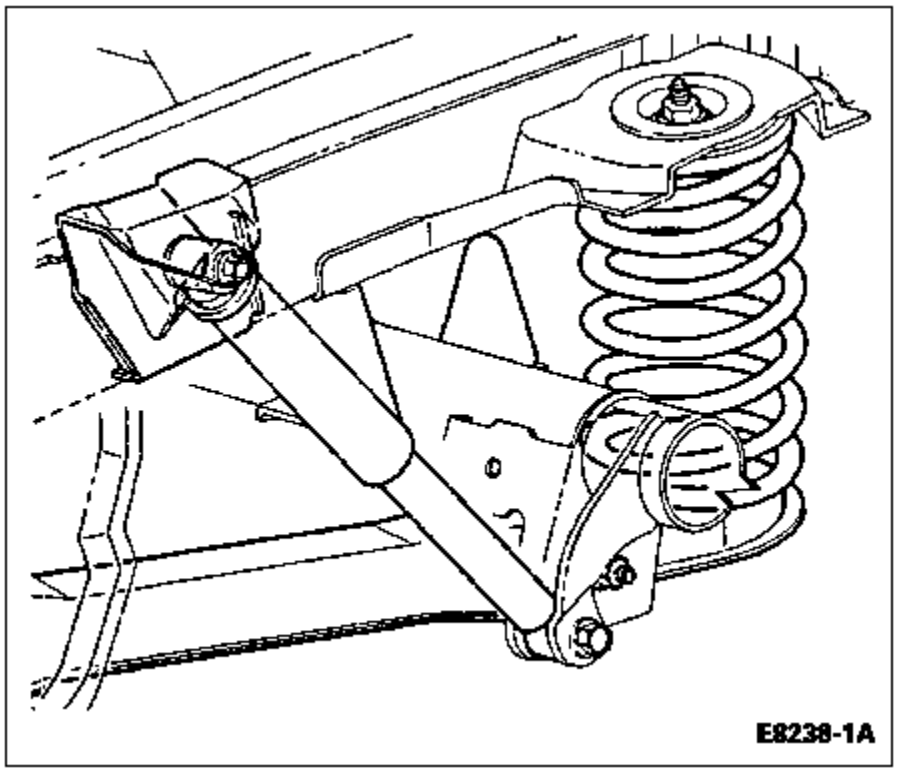
6. Remove the wheels and tires from the brake drums (1126).

7. Disconnect the brake tubing by disconnecting the rear brake hose (2282) from the rear brake tube (2267). Plug the rear brake tube. Remove the rear brake hose and bracket from the frame.

Rear Axle Removal, Aerostar



8. Disconnect the shock absorber from the rear suspension lower arm.



9. Lower the rear axle (4001) until the rear springs (5560) are no longer under compression.

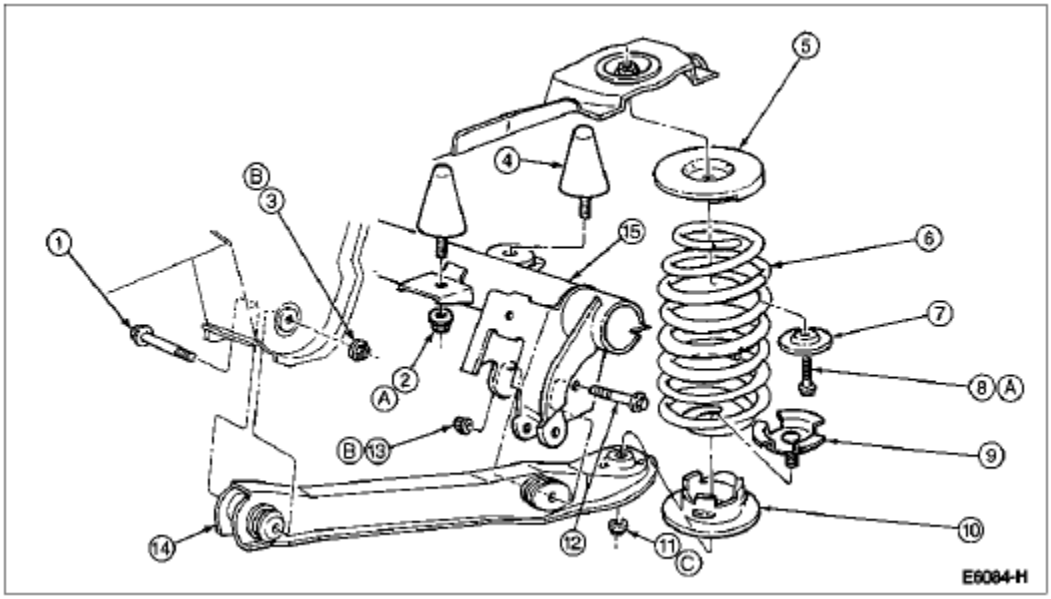
10. Remove the lower spring retainer, then the upper retainer and remove the rear spring. Repeat for the other rear spring.

11. Raise the rear axle to the normal load position.

12. **NOTE: Make sure adequate clearance exists to remove the bolts retaining the rear suspension lower arm to the rear axle.**

    Disconnect the rear suspension lower arms at the rear axle.

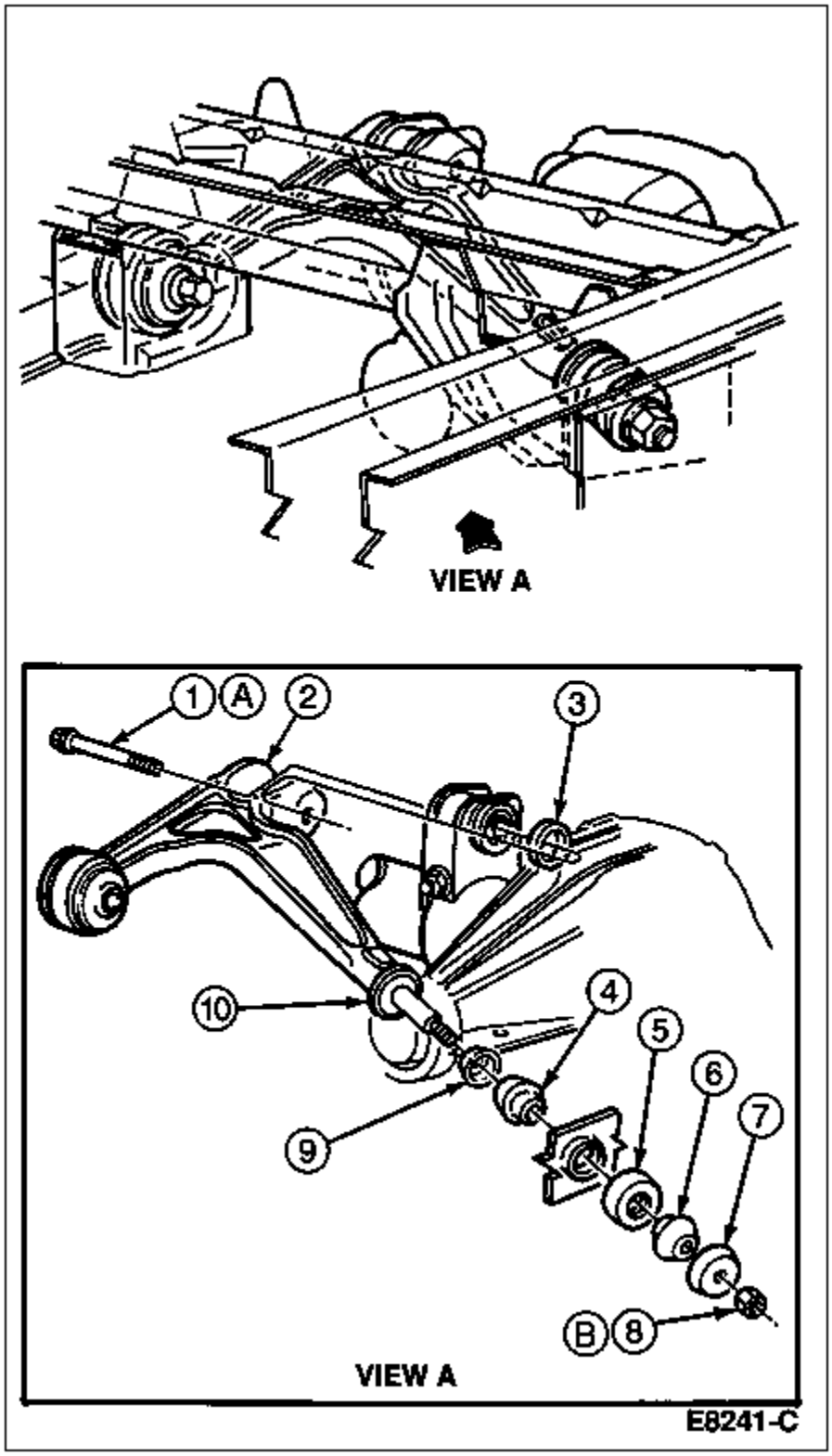
Rear Spring and Lower Control Arm, Aerostar



Item	Part Number	Description
1	805791	Bolt
2	800152	Nut
3	801670	Nut
4	4730	Rear Axle Bumper
5	5536	Rear Spring Insulator
6	5560	Rear Spring
7	5A543	Rear Spring Upper Retainer
8	605919	Bolt
9	5A569	Rear Spring Lower Retainer
10	5741	Rear Spring Center Mounting Insulator
11	620483	Nut
12	N803923	Bolt
13	N801670	Nut
14	5500	Rear Suspension Arm and Bushing
15	4001	Rear Axle
A	—	Tighten to 40-55 Nm (30-40 Lb-Ft)
B	—	Tighten to 136-175 Nm (100-129 Lb-Ft)
C	—	Tighten to 55-88 Nm (41-65 Lb-Ft)

13. Remove the bolt and nut retaining the upper control arm to the rear axle. Remove the upper control arm from the rear axle.

14. Lower the rear axle from the vehicle.

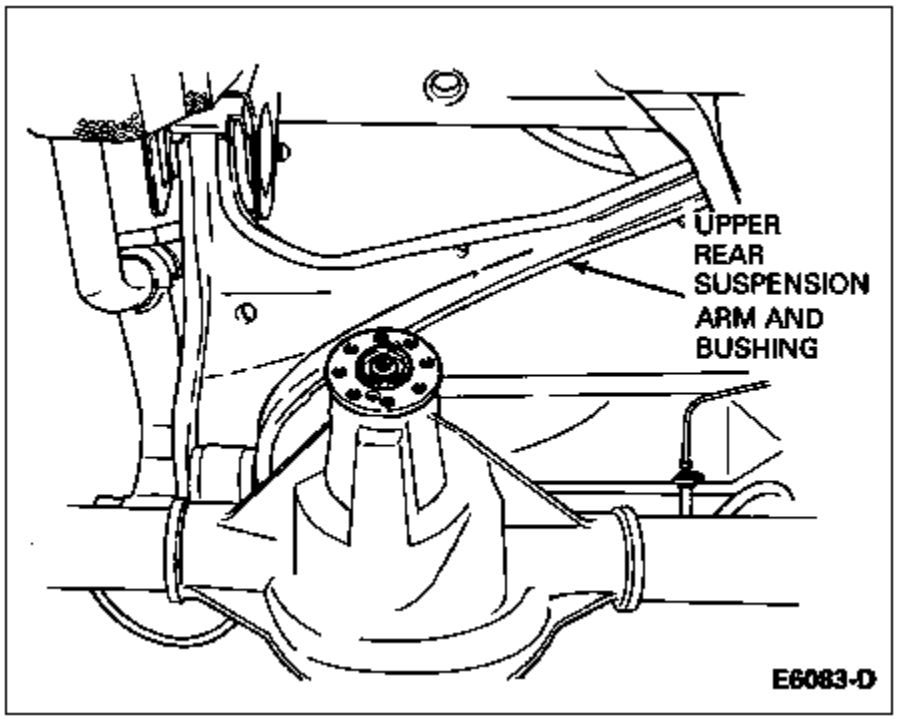


Item	Part Number	Description
1	806054	Bolt

2	5500	Rear Suspension Arm and Bushing
3	5K679	Bushing
4	5K752	Insulator
5	5K580	Spacer
6	5K752	Insulator
7	5A349	Retainer
8	801670	Nut
9	5A349	Retainer
10	—	Plastic Washer (Part of 5500)
A	—	Tighten to 210-285 Nm (155-210 Lb-Ft)
B	—	Tighten to 81-135 Nm (60-100 Lb-Ft)

Installation

1. Raise the rear axle into position in the vehicle.
2. Position the upper control arm over the cam adjuster and bushing. Install the bolt, nut and retainer. Tighten until snug. DO NOT TIGHTEN TO SPECIFIED TORQUE AT THIS TIME.



3. Lower the rear axle to the spring unloaded position. Place the lower rear spring insulator on the lower

rear suspension arm and bushing (5500). Place the upper rear spring insulator on top of the rear spring. The tapered coil (white colored) must face upward. Install the rear spring in position on the control arm and rear axle.

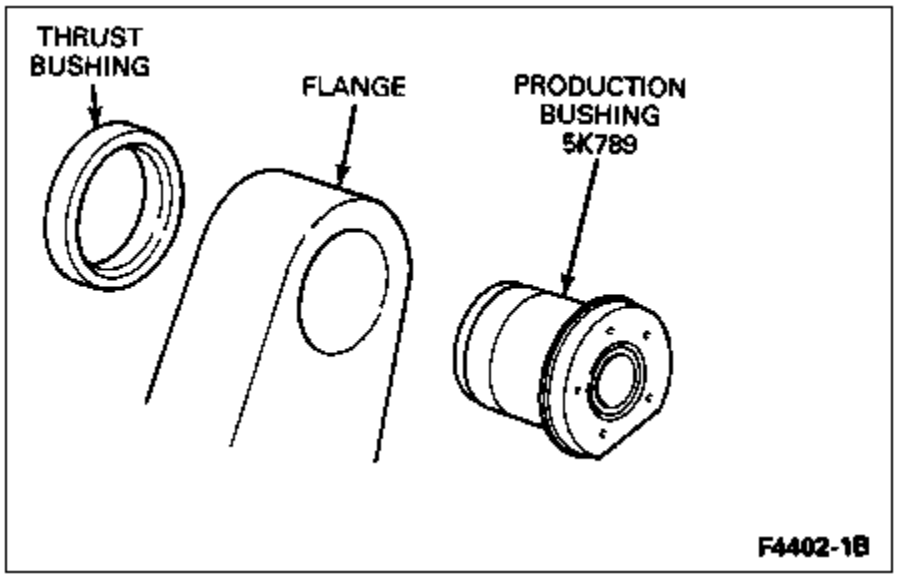
4. Install the lower retainer and nut. Tighten the nut to 55-88 Nm (40-65 lb-ft).
5. Install the upper retainer and bolt. Tighten the bolt to 40-55 Nm (30-40 lb-ft).
6. Raise the rear axle to the normal load position and tighten the bolt and nut retaining the rear suspension lower arm to the rear axle to 136-175 Nm (100-129 lb-ft).
7. Connect the shock absorber to the rear suspension lower arm. Install the shock bolt nut on the inside of the rear suspension lower arm bracket. Install the nut and tighten to 54-82 Nm (40-60 lb-ft).
8. Tighten all upper control arm fasteners to the specified torque.
    - Tighten the bolt retaining the control arm to the axle to 210-285 Nm (155-210 lb-ft).
    - Tighten the nut and bolt retaining the control arm to the right frame bracket to 125-170 Nm (92-125 lb-ft).
    - Tighten the nut and washer assembly retaining the control arm to the left frame bracket to 81-135 Nm (60-100 lb-ft).
9. Attach the brake jounce hose and bracket to the frame. Connect the hose to the rear brake tube.
10. Install the wheel and tire assemblies on the brake drums. Tighten the lugnuts to 115-156 Nm (85-115 lb-ft).
11. Connect harness connector on rear brake anti-lock sensor.
12. On 4x2 vehicles, install the driveshaft making sure the scribed marks on the companion flange and driveshaft are in alignment. Install the bolts and tighten to 95-128 Nm (70-95 lb-ft).
13. Raise the vehicle and remove the jackstands.
14. Pull the parking brake rear cable and conduits and retainers through the clips on the vehicle underbody side rails and through the rear crossmember. Connect the parking brake rear cable and conduits to the equalizer.
15. Unclamp the front parking brake cable to restore cable tension.
16. Bleed the brakes as described in Section 06-06.
17. Check and, if required, adjust pinion rear axle angle as described in Section 05-00.

Axle Housing-to-Upper Control Arm Bushing, Aerostar

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Axle Housing Bushing Mounting Adapter (Part of Set T85T-5638-AH)	T85T-5638-AH11
Forcing Screw (Part of Set T78P-5638-A)	T78P-5638-A1
Axle Housing Bushing Remover (Part of Set T85T-5638-AH)	T85T-5638-AH12
Axle Housing Bushing Replacer (Part of Set T85T-5638-AH)	T85T-5638-AH13

NOTE: In service, the pinion angle adjustment is changed using an eccentric service bushing F09Z-5K789-B. If the bushing is being replaced due to damage or wear only, use standard production bushing F09Z-5K789-A. For pinion angle measurement procedures, refer to Driveline Angle Checking in Section 05-00 .



Removal

1. **CAUTION: The axle must be securely supported on the hoist or stands. If more axle-hoist travel is required, disconnect the shock absorbers (18080) from the rear suspension lower arms.**

   Raise the vehicle on a twin-post hoist. Position jackstands on the frame rear lift points or under the rear bumper support brackets. If a frame hoist is used, raise the vehicle and position tall jackstands under the rear axle (4001). Lower the hoist until the axle is in the normal ride height position.

2. Remove rear suspension arm-to-axle housing nut and bolt.

3. With the vehicle securely supported on safety stands, slowly lower the rear axle until the rear suspension arm and bushing (5500) disengages from the rear axle. If a frame hoist is used, raise the hoist until the rear suspension arm disengages from the rear axle.

4. On the inboard side of the flange, insert a flat-blade screwdriver between the thrust bushing and flange. Pry the thrust bushing end off the bushing and flange without damaging any surfaces.

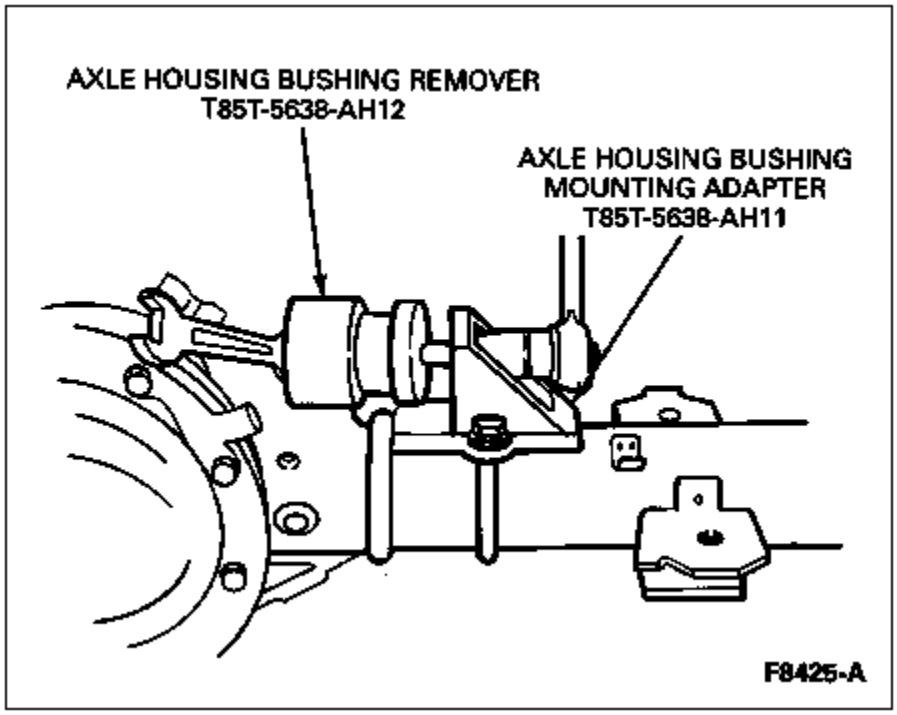
5. Attach Axle Housing Bushing Mounting Adapter T85T-5638-AH11 to the axle housing tube by using the U-bolt.

6. Place the Forcing Screw T78P-5638-A1 through the axle housing bushing to be removed.

7. Place the Axle Housing Bushing Remover T85T-5638-AH12 onto the forcing screw and thread a 7/16-20 nut onto the forcing screw.

8. Tighten the forcing screw to pull the bushing out of the axle housing.

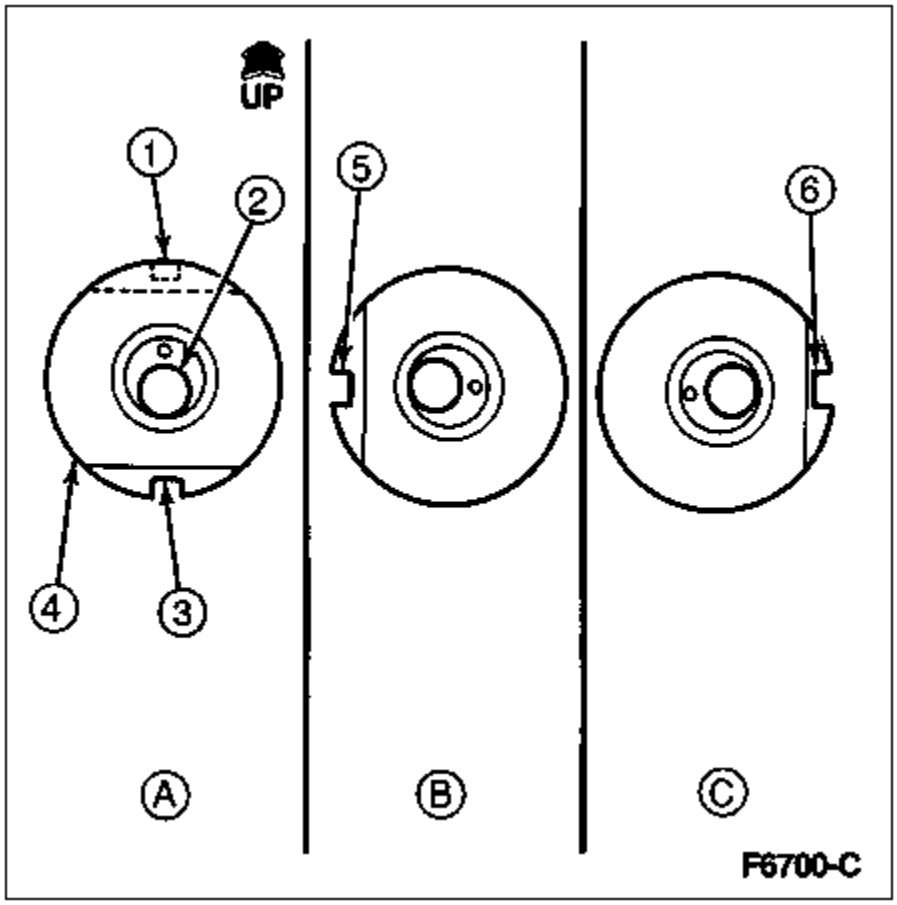
9. Remove the forcing screw, bushing remover and mounting adapter.



Installation

1. **NOTE: The notch on the bottom of the bushing must point in a 6 or 12 o'clock position for zero pinion angle adjustment, 3 o'clock position for 1.25° pinion angle up adjustment and 9 o'clock position for -1.25° pinion angle down adjustment.**

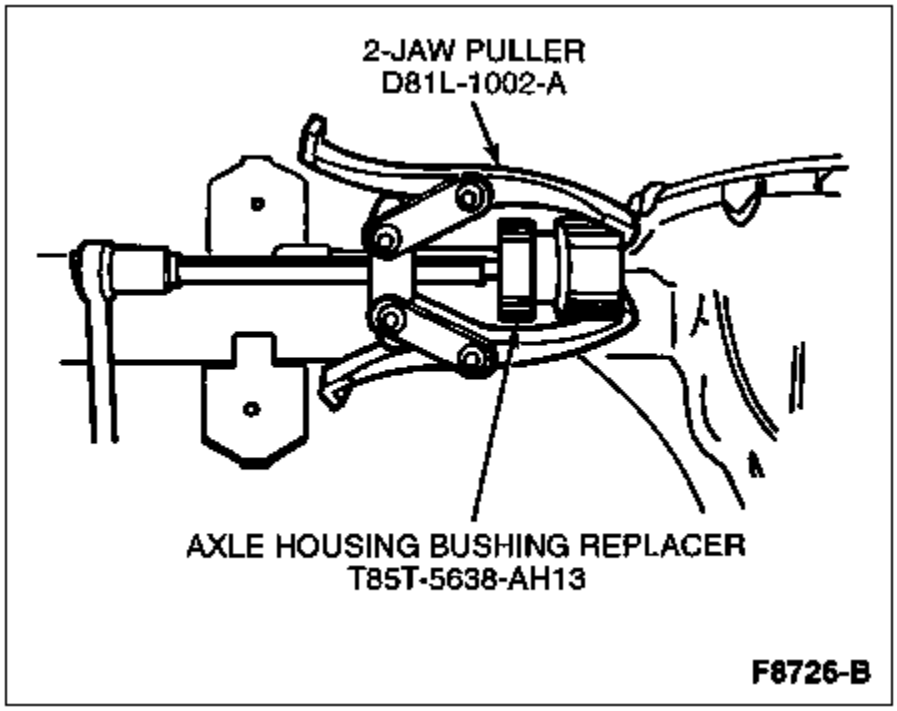
   Lubricate the bushing to be installed and place the bushing into the axle housing bushing bore.



Item	Part Number	Description
1	—	12 O'Clock Position (Part of 5K789)
2	—	Bolt Hole (Part of 5K789)
3	—	6 O'Clock Position (Part of 5K789)
4	5K789	Eccentric Service Bushing
5	—	9 O'Clock Position (Part of 5K789)
6	—	3 O'Clock Position (Part of 5K789)
A	—	Nominal Position
B	—	Pinion Nose Down Position 1.25°
C	—	Pinion Nose Up Position 1.25°

2. Position 2-Jaw Puller D81L-1002-A or equivalent around the axle housing bushing bracket with Axle Housing Bushing Replacer T85T-5638-AH13 between the forcing screw and the flanged end of the bushing.

3. Turn the forcing screw to push bushing into position. Remove the installation tools.



4. On the inboard side of flange, install thrust bushing so steel washer faces the flange.

5. With the vehicle body securely supported on safety stands, raise the rear axle until the rear suspension arm engages the flange on the axle housing. If a frame hoist is used, lower the vehicle until the rear suspension arm and bushing engages the flange on the axle housing.

6. Install the nut and bolt retaining the rear suspension arm and bushing to the flange and tighten until snug. Do not tighten to the specified torque at this time.

7. If removed, connect the shock absorber to the suspension lower arms. Install and tighten the retaining nut to 54-82 Nm (40-60 lb-ft).

8. Position the rear axle in the normal ride position. Tighten the nut and bolt retaining the rear suspension arm and bushing to the flange to 210-285 Nm (155-210 lb-ft).

9. If required, check and adjust the driveline angularity or driveline angle check as described in Section 05-00 .

10. Remove the safety stands and lower the vehicle.

Rear Axle, Ranger

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Companion Flange Holding Tool	T78P-4851-A
Differential Bearing Cone Remover/Replacer	T77F-4220-B1

Removal

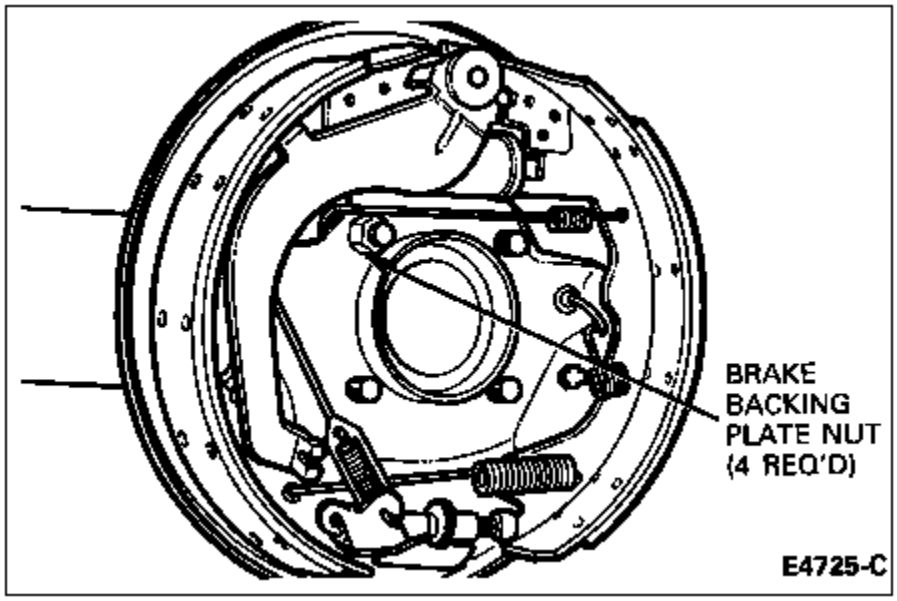
1. Raise the vehicle on a hoist, position safety stands under the rear frame crossmember. Remove the wheels and brake drums (1126).

2. **NOTE: Discard axle housing cover in this procedure if cover is plastic.**

   Drain the lubricant from the rear axle (4001) by removing the axle housing cover (4033). Discard axle housing cover. A new axle housing cover must be installed at assembly time.

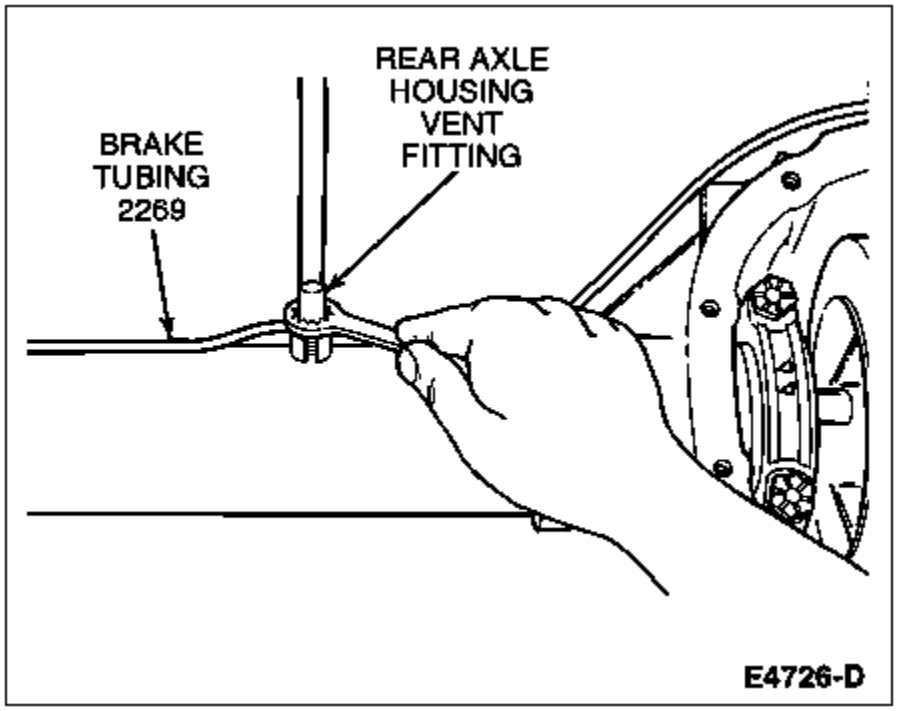
3. Remove the axle shafts (4234). Refer to the procedure in this section.

4. Remove the four retaining nuts from each brake backing plate and wire the brake backing plate to the underbody.

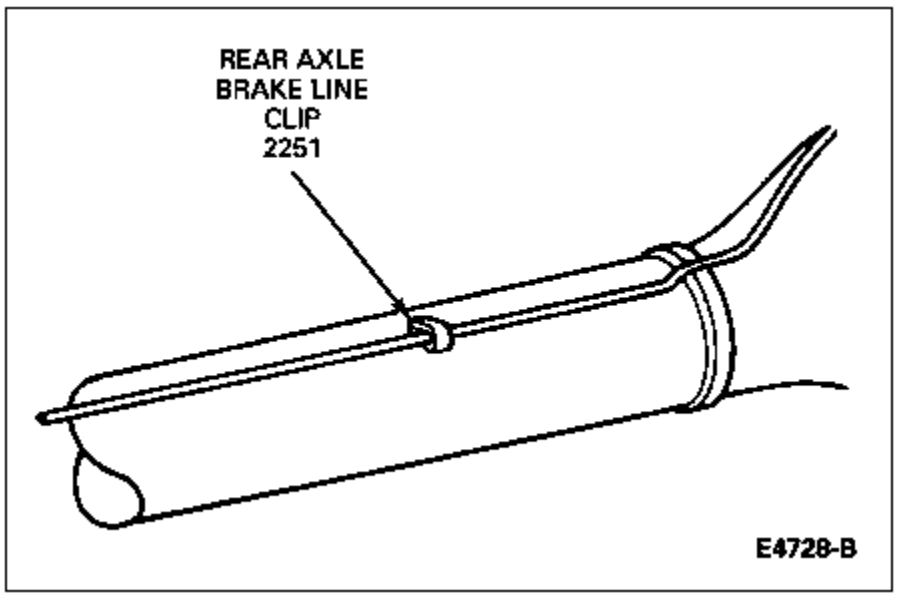


5. **NOTE: The axle housing vent is secured to the axle housing through the brake junction block.**

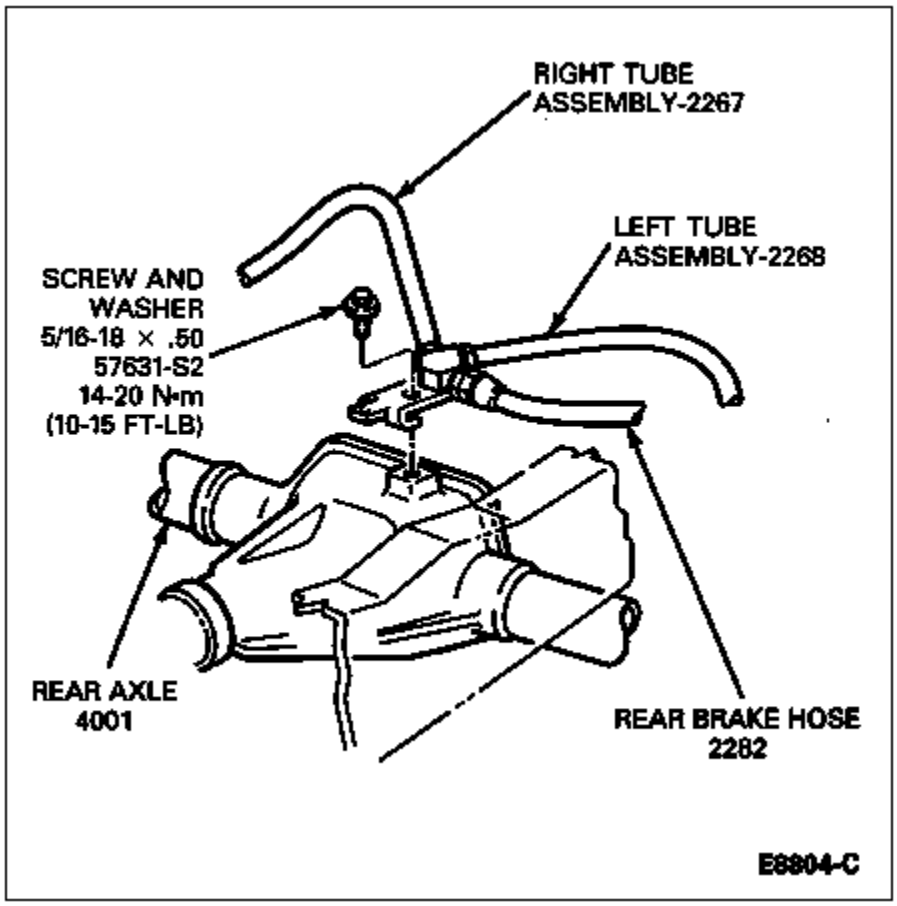
   Disconnect the axle hose from the axle housing vent and the axle housing vent from the axle housing.



6. Disengage the brake backing plate from the rear axle brake line clips (2251) that retains the brake backing plate (2211) to the axle housing and carrier.

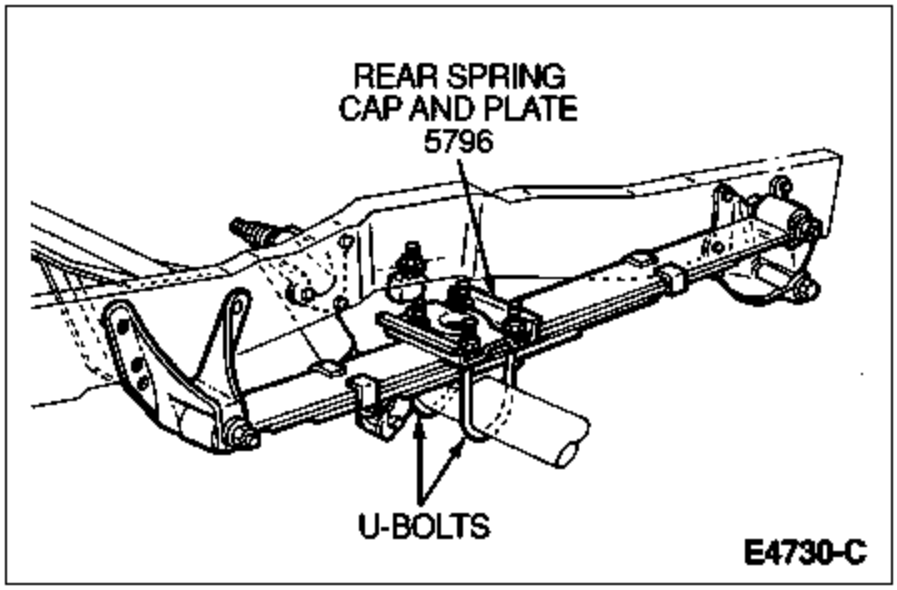


7. Remove the hydraulic brake junction block from the axle housing. **Do not open the hydraulic brake system lines.**



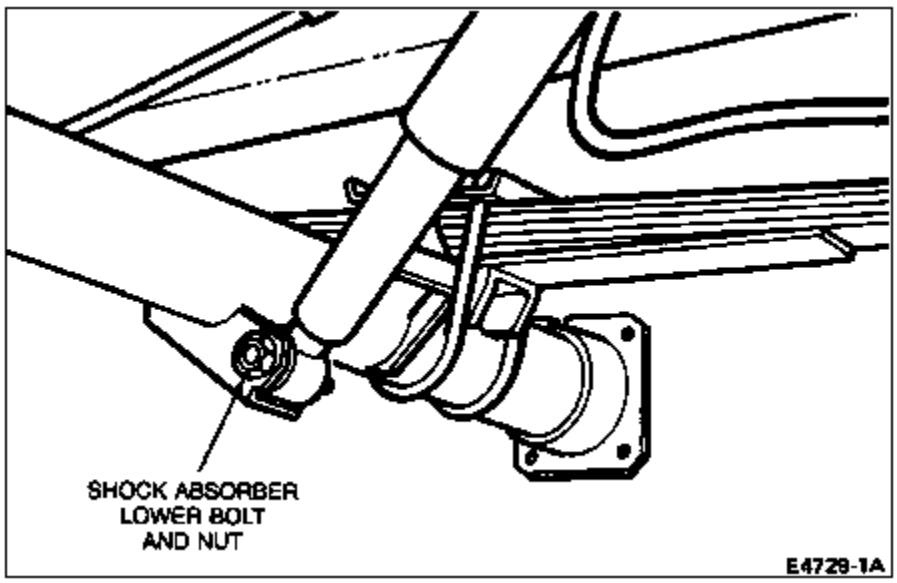
8. Make scribe marks on the driveshaft and the rear axle companion flange to make sure proper position of the driveshaft is obtained at assembly. Disconnect the driveshaft at the rear axle companion flange and support.

9. Support the axle housing on a jack, and then remove the U-bolt nuts. Remove the U-bolts and rear spring plates (5796).



10. Disconnect the shock absorber lower bolts from the mounting brackets on the axle housing.

11. Remove the axle housing from the vehicle.



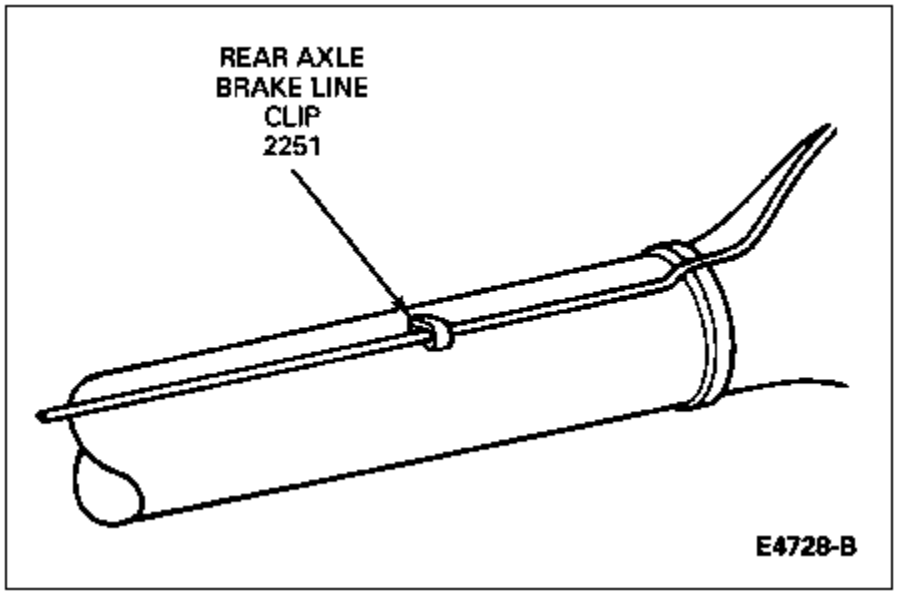
Installation

1. Raise the axle housing into position so that the rear spring plate can be installed. Install U bolts and nuts. Tighten to 88-118 Nm (65-87 lb-ft).

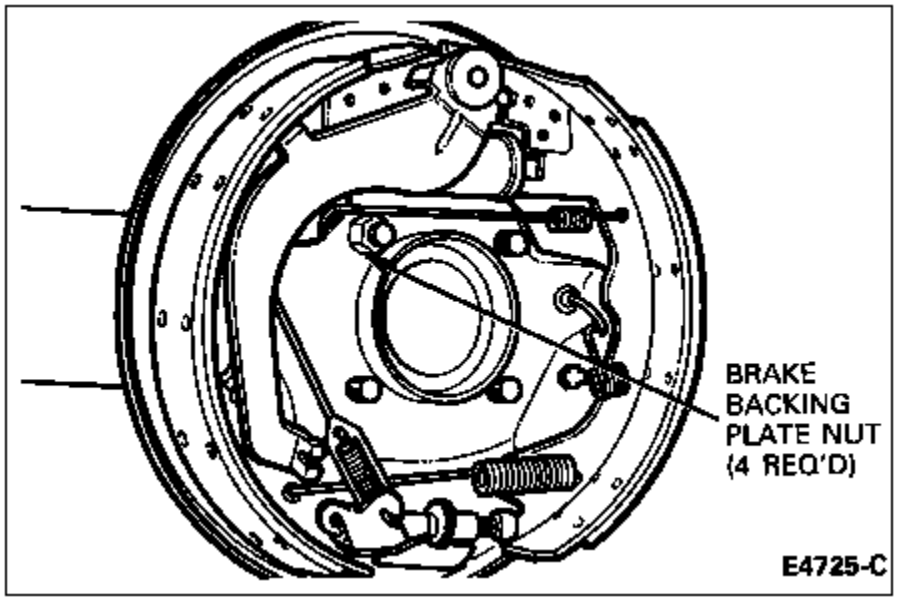
2. Connect the shock absorber lower bolts to the mounting bracket on the axle housing. Install the attaching nuts and tighten to 54-82 Nm (40-60 lb-ft).

3. Insert the axle housing vent fitting into the hydraulic junction block and position the assembly over the axle housing vent hole. Hand start the axle housing vent fitting and tighten.

4. Position the brake tubing to the axle housing and secure with the rear axle brake line clip at the right-hand axle tube and axle housing vent fitting through the junction block.



5. Install the brake backing plate on the axle housing flanges (no gaskets required). Tighten the attaching nuts to 28-54 Nm (21-40 lb-ft).



6. Install the axle shaft as described under the Disassembly and Assembly portion of this section.

7. Install the brake drums, wheels and tires.

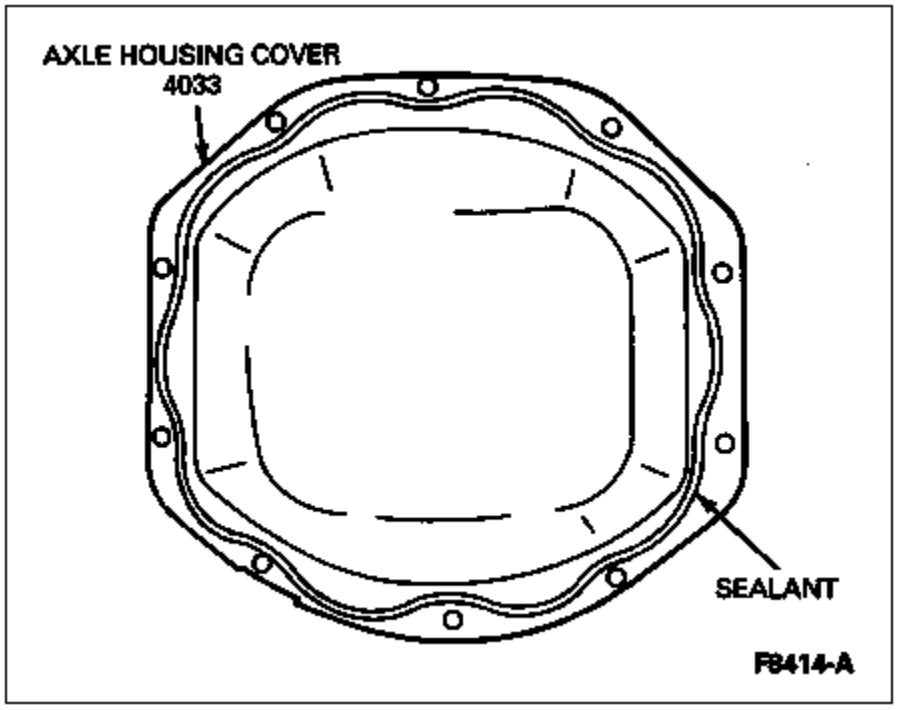
8. **CAUTION: Make sure machined surface on carrier is clean and free of oil before applying silicone sealant. Inside of rear axle must be covered when cleaning the machined surface to prevent rear axle contamination.**

   Connect the rear end of the driveshaft to the rear axle companion flange, making sure the driveshaft is installed in its original position.

   Apply Stud and Bearing Mount E0AZ-19554-BA or equivalent meeting Ford specification WSK-M2G349-A1 to the threads on the attaching bolts. Tighten bolts to 95-128 Nm (70-95 lb-ft).

9. **NOTE: Ranger vehicles are equipped with SMC plastic axle housing covers. A new SMC plastic axle housing cover and bolts must be installed whenever removed.**

   Clean the gasket mounting surface of the axle housing. Apply a new continuous bead of Silicone Rubber Sealant D6AZ-19562-AA or equivalent meeting Ford specification ESB-M4G92-A or ESE-M4G195-A to the new SMC plastic cover. Allow one hour cure time before filling the carrier with proper amount of the specified lubricant.



10. Install new axle housing cover and tighten all cover bolts to 21-27 Nm (15-20 lb-ft).

11. Add Premium Rear Axle Lubricant XY-80W90-QL or equivalent meeting Ford specification WSP-M2C197-A for all rear axles until the lubricant level is 6.35-14.28mm (1/4 to 9/16 inch) below the bottom of the filler hole with the rear axle in the running position. Lower the vehicle and road test.

Axle Disassembly

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Shim Driver	T85L-4067-AH
Axle Tube Bearing Replacer	T78P-1225-A
Differential Side Bearing Remover	T70P-4221-A or T57L-4220-A
Differential Side Bearing Replacer	T57L-4221-A2
Pinion Depth Gauge	T79P-4020-A
Pinion Bearing Cup Replacer	T67P-4616-A
Axle Tube Seal Replacer	T78P-1177-A
Companion Flange Holding Tool	T78P-4851-A
Differential Bearing Cone Remover/Replacer	T77F-4220-B1
Rear Axle Bearing Remover	T85L-1225-AH
Impact Slide Hammer Pinion Bearing Cone Remover	T50T-100-A T71P-4621-B

Companion Flange and Pinion Oil Seal Removal

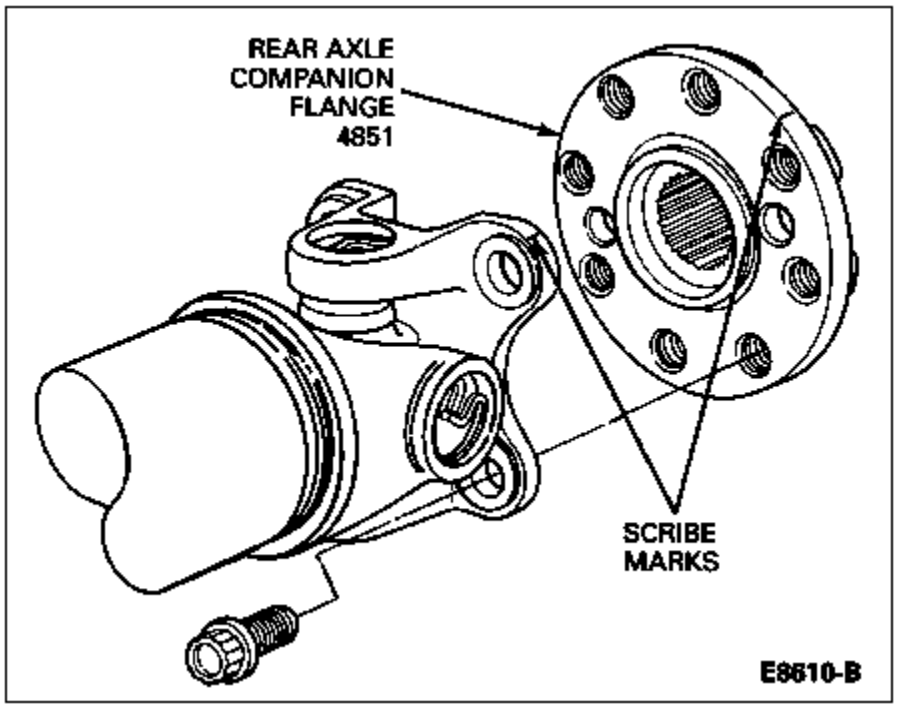
Replacement of the pinion seal involves removal and installation of only the drive pinion nut and the rear axle companion flange.

1. **CAUTION: This operation disturbs the rear bearing cone and roller preload, and this preload must be carefully reset when assembling.**

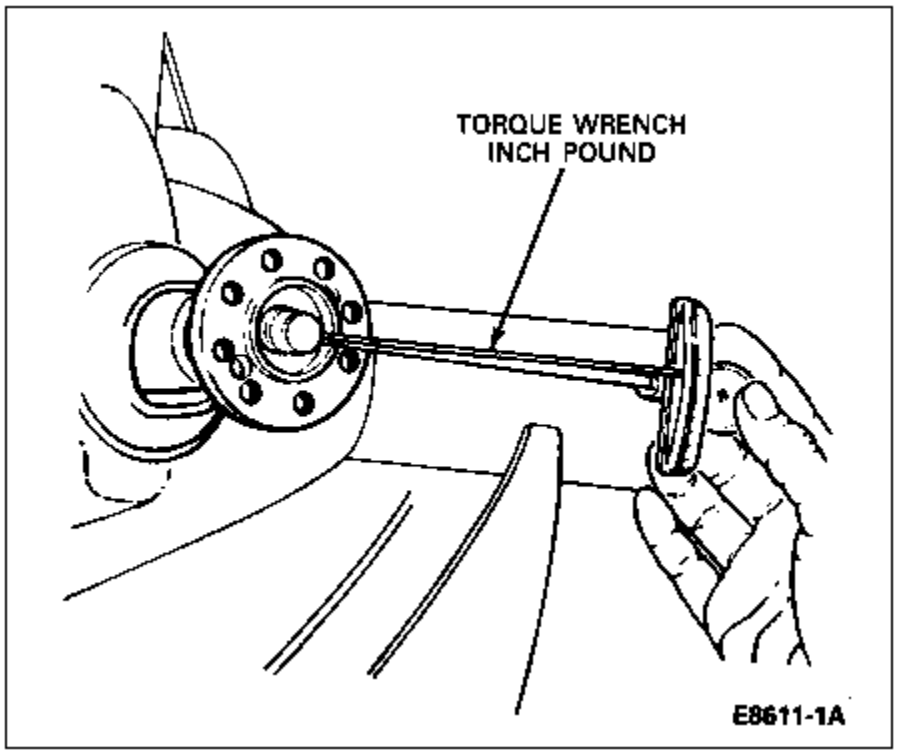
   Raise the vehicle and install safety stands. Remove the wheel covers (if equipped), rear wheels and brake drums (1126) to prevent brake drag during differential pinion bearing preload adjustment.

2. Mark the driveshaft axle end flange and the rear axle companion flange to ensure proper position of the driveshaft during assembly. On 4x2 vehicles, disconnect the driveshaft from the rear axle companion flange. Remove the driveshaft from the extension housing (7A039). Install an oil seal replacer tool in the extension housing to prevent oil leakage.

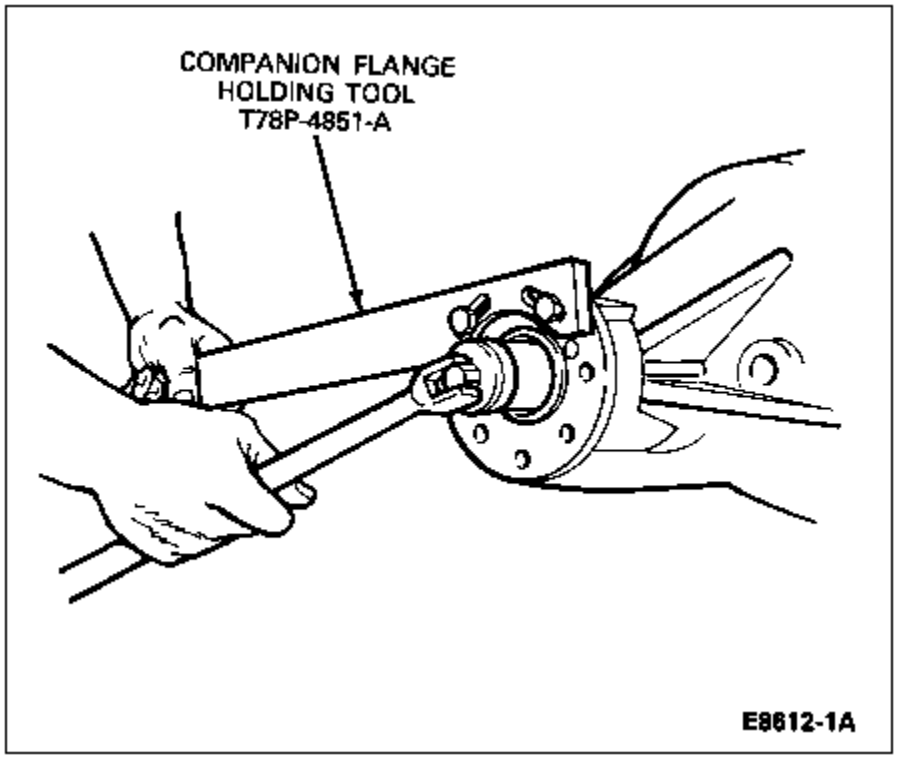
   On 4x4 vehicles, mark the driveshaft in relation to the flange on the transfer case (7A195) and the flange on the rear axle (4001). Remove bolts securing driveshaft to transfer case flange. Remove bolts securing driveshaft to axle flange and remove the driveshaft.



3. Install a pound-inch torque wrench on the pinion nut. Record the torque required to maintain rotation of the drive pinion shaft through several revolutions.

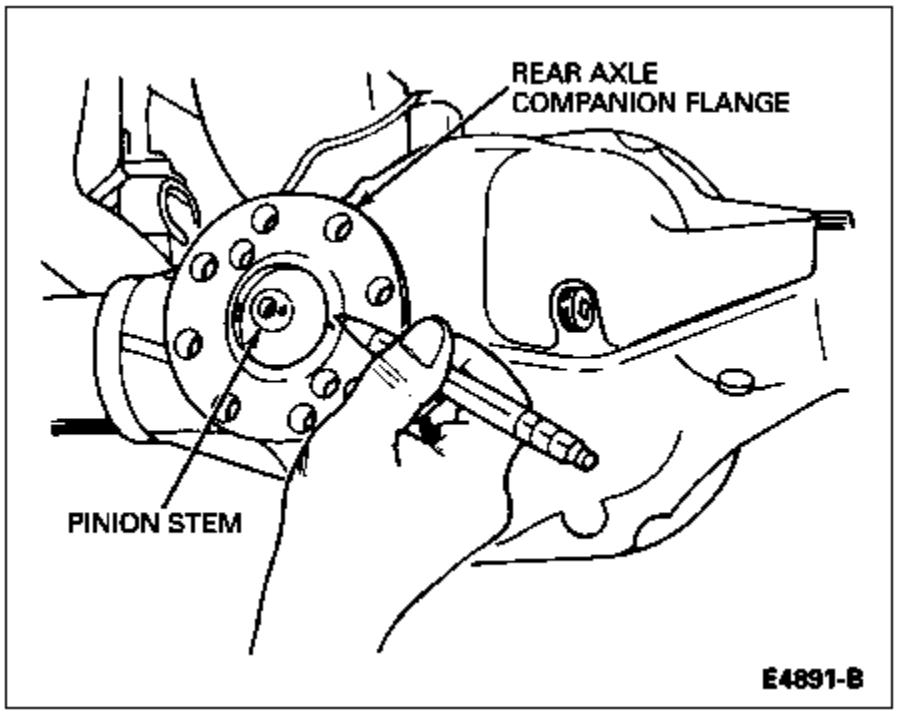


4. While holding the rear axle companion flange with Companion Flange Holding Tool T78P-4851-A, remove the pinion nut.

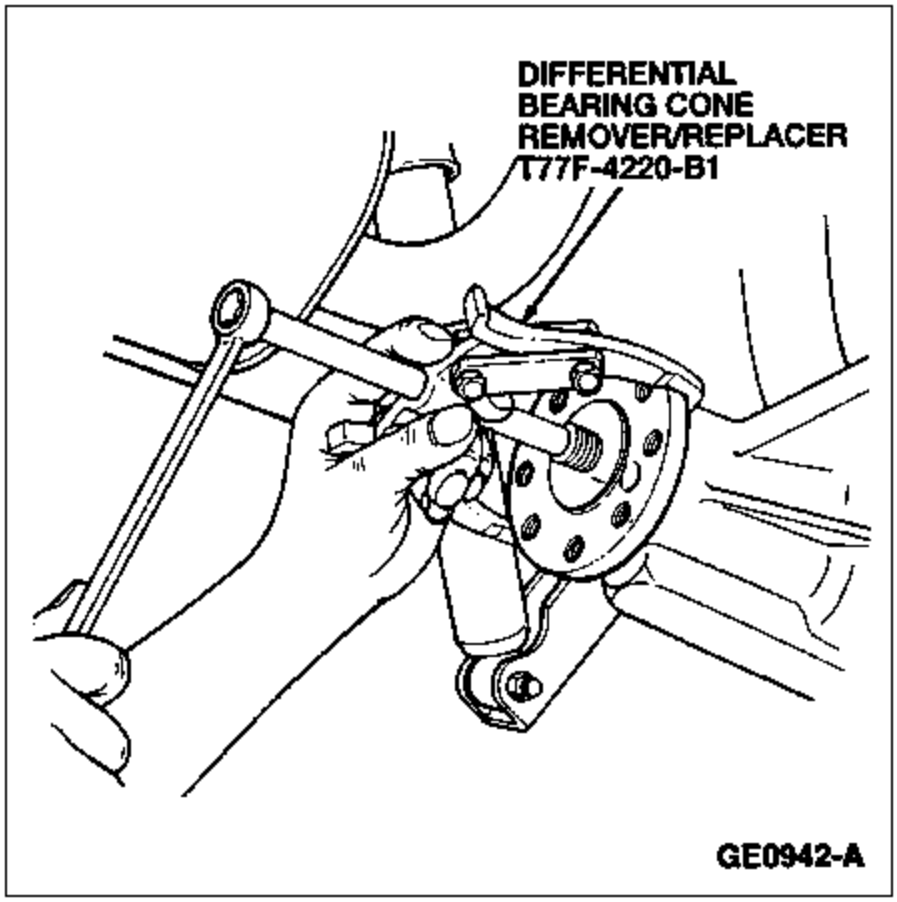


5. Clean the area around the pinion oil seal. Place a drain pan under the pinion oil seal, or raise the front of the vehicle higher than the rear.

   Mark the rear axle companion flange in relation to drive pinion shaft so flange can be reinstalled in the same position.

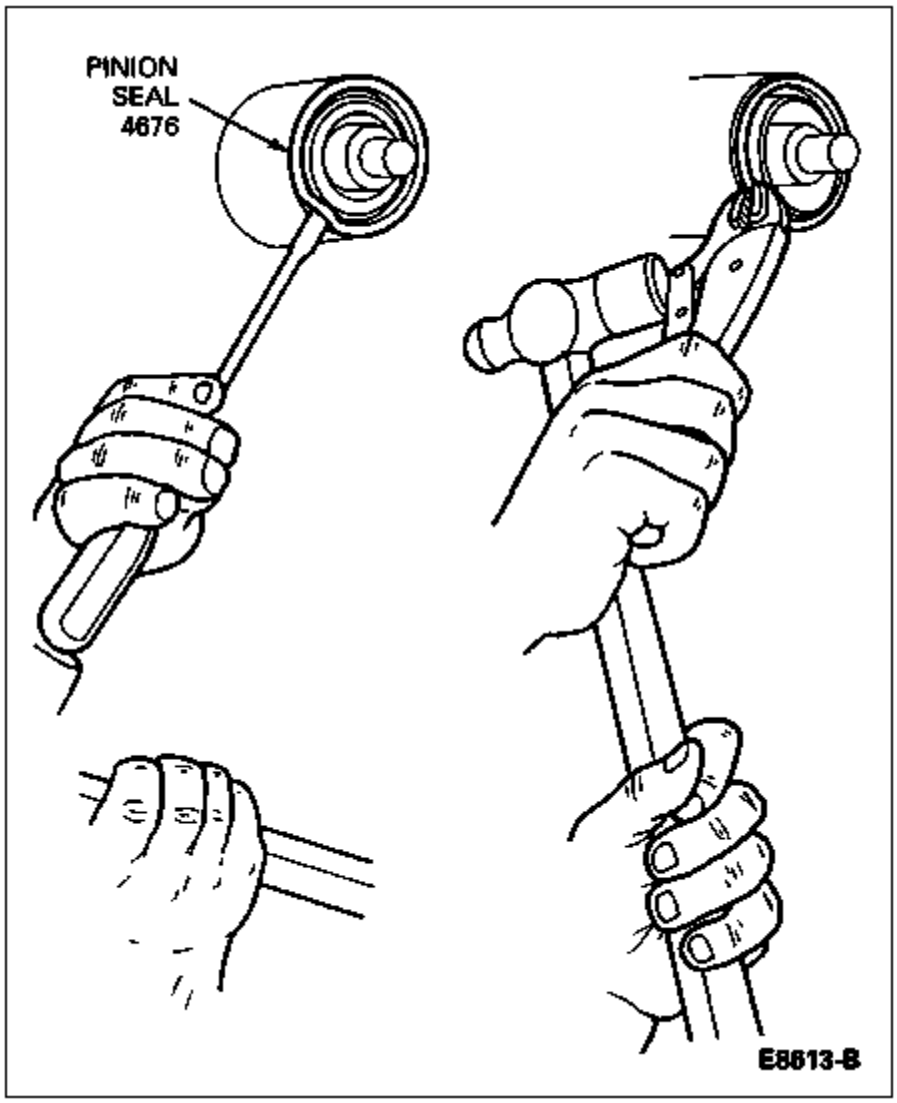


6. Using Differential Bearing Cone Remover/Replacer T77F-4220-B1, remove the rear axle companion flange.



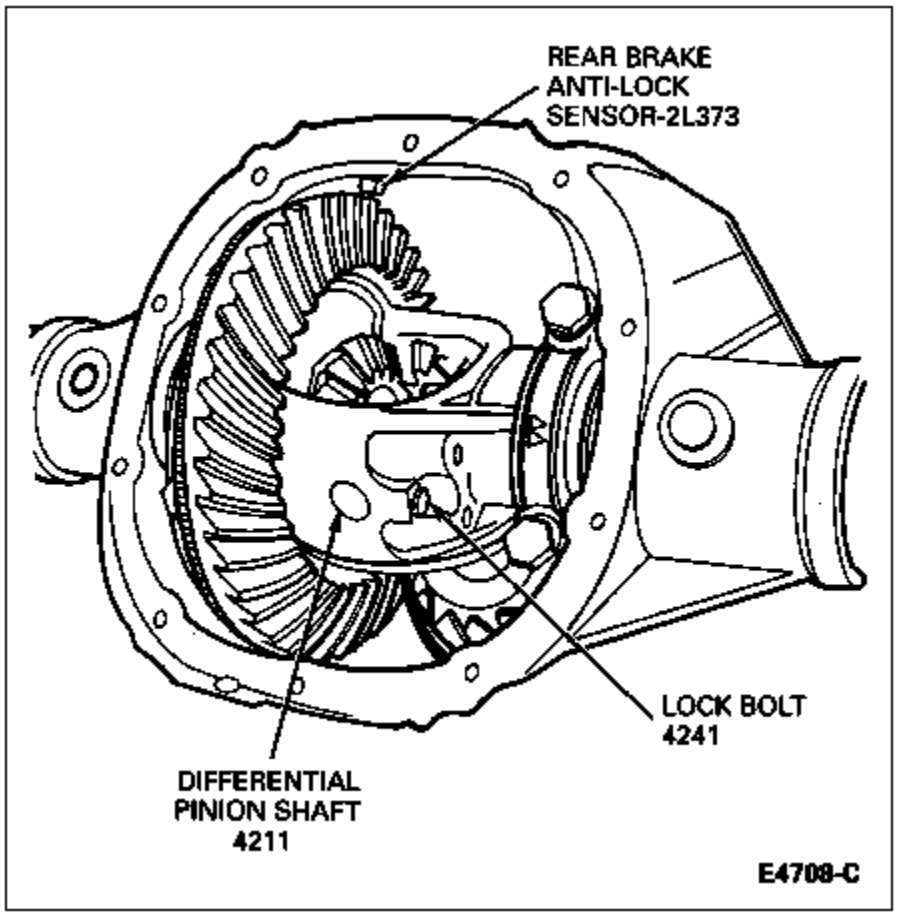
7. **CAUTION: Do not damage axle housing while removing pinion oil seal.**

   Pry up on metal flange of pinion oil seal. Install gripping pliers and strike with hammer until pinion seal is removed.



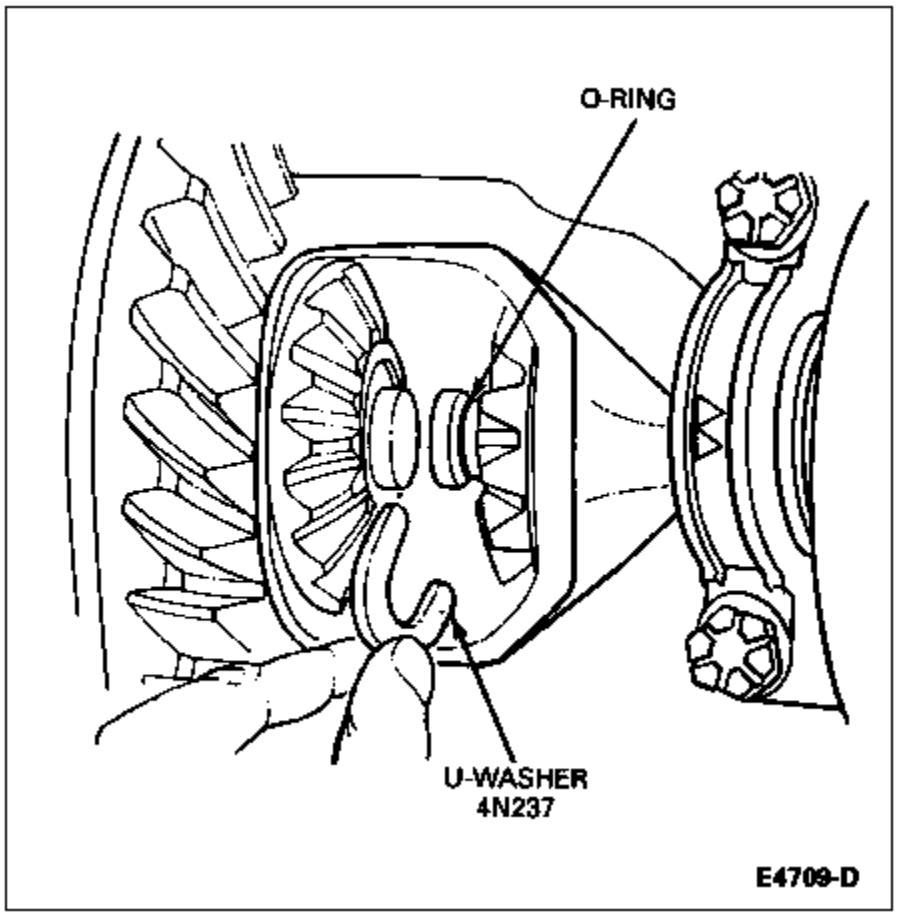
Axle Shaft Removal

1. Clean all dirt from the area of rear axle differential carrier cover with a wire brush or cloth.
2. Drain rear axle lubricant by removing the axle housing cover (4033).
3. Remove lock bolt and pinion shaft.

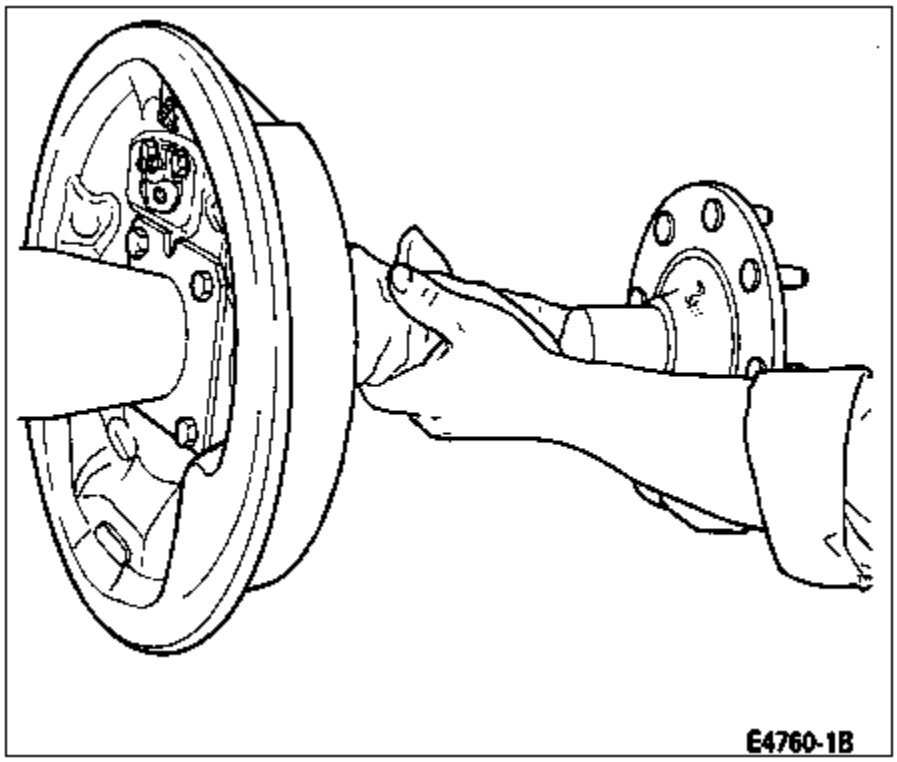


4. **NOTE: When removing U-washer, be careful not to lose or damage the rubber O-ring which is in the axle shaft groove under the U-washer.**

   Push the flanged end of the axle shafts (4234) inboard and remove the U-washer from each axle shaft.

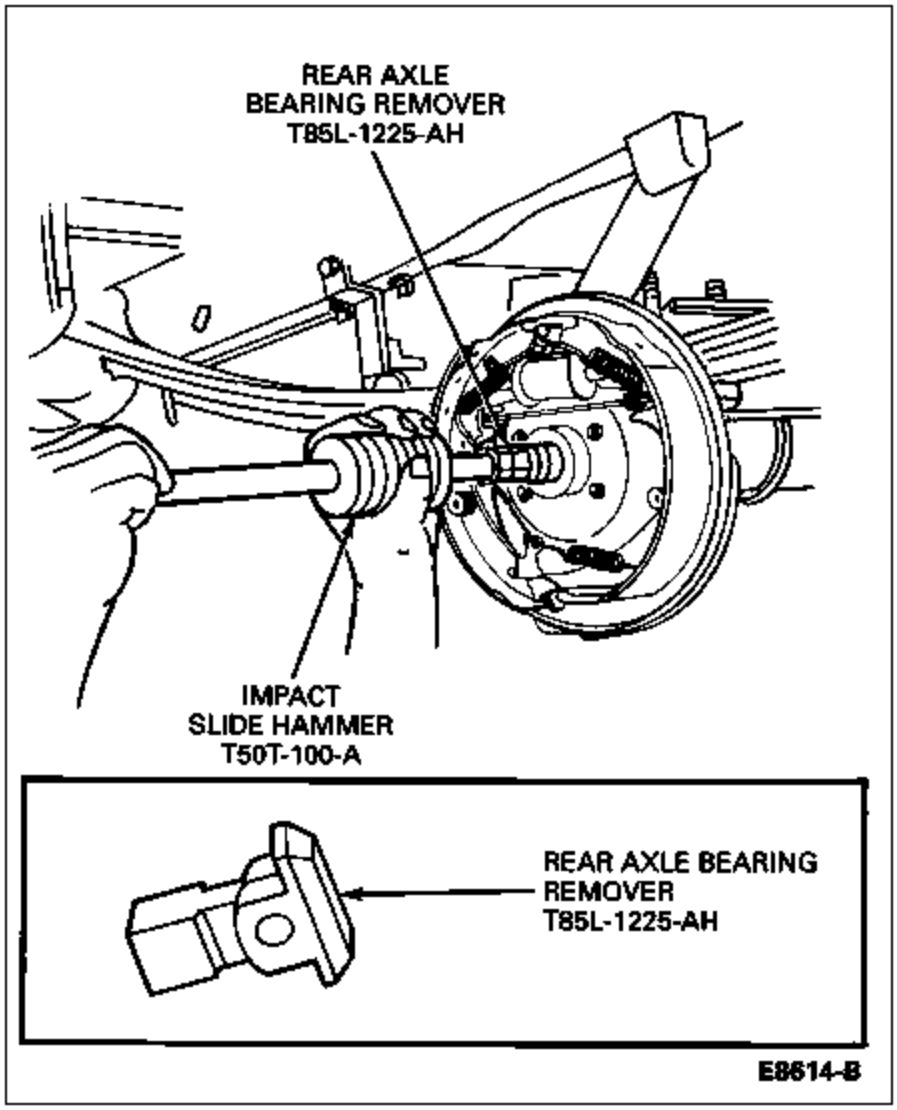


5. Remove the axle shaft from the axle housing, being careful not to damage the oil seal.



Wheel Bearing and Oil Seal Removal

1. Using Impact Slide Hammer T50T-100-A and Rear Axle Bearing Remover T85L-1225-AH, insert into the bore as shown and position it behind the rear wheel bearing (1225) so the tangs on the tool engage the rear wheel bearing outer race. Remove the rear wheel bearing and inner wheel bearing oil seal (1177) as a unit.



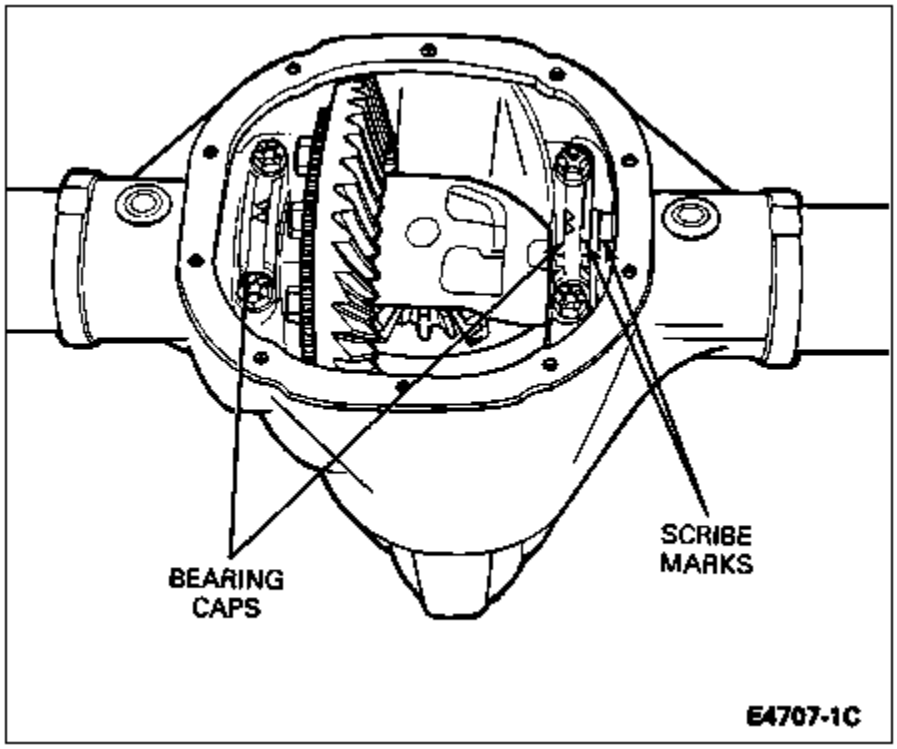
Differential Case Removal

NOTE: Before removing the differential case (4204), check the ring gear runout as described under Inspection Before Disassembly in the Cleaning and Inspection portion of this section. If ring gear runout exceeds 0.10mm (0.004 inch), the differential case and ring gear and pinion must be removed to perform the Differential Runout Check. The Differential Case Runout Check in this section will isolate the cause of excessive ring gear runout.

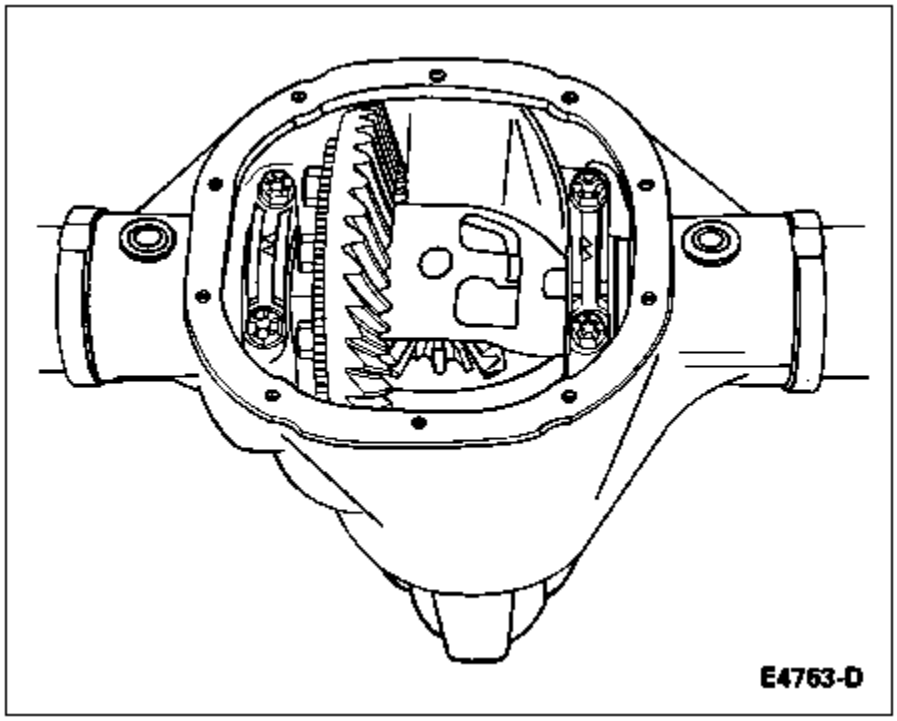
1. **CAUTION: Right and left bearing caps MUST NOT be interchanged.**

   NOTE: The direction and location of triangles on bearing retaining caps must be noted. When reassembled the triangles must be pointing in the same direction (outboard) as before removal.

   Mark one bearing cap to make sure the bearing caps will be installed in their original locations and positions with triangles pointing outboard.



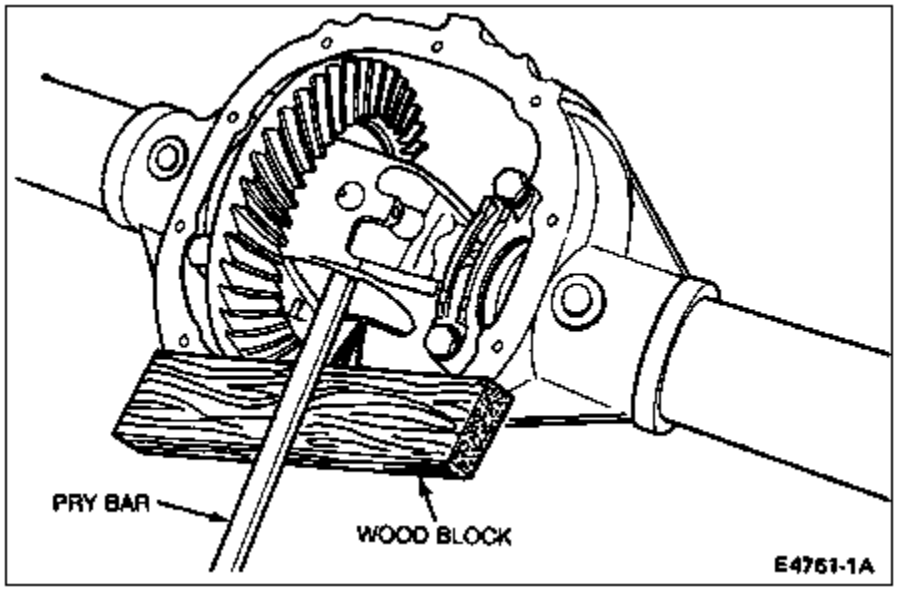
2. Loosen the differential bearing cap bolts.



3. **CAUTION: When using the pry bar in the following procedure, place a wood block**

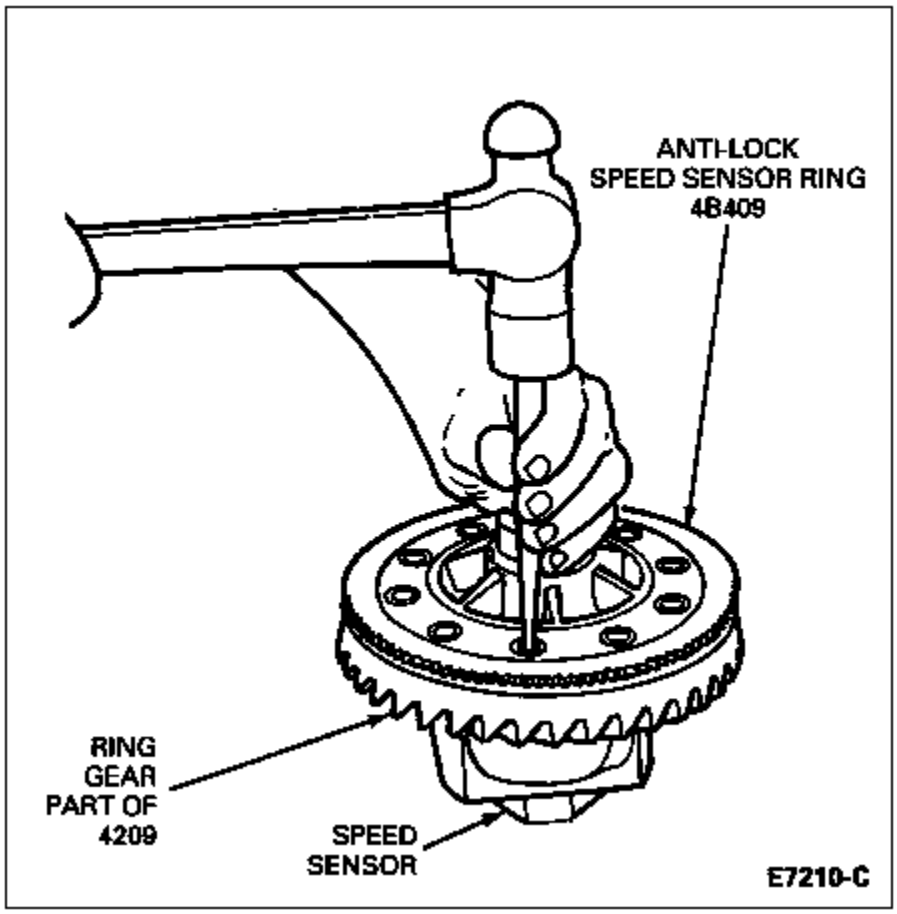
between the pry bar and the axle housing to protect the carrier from damage.

Pry the differential case, differential bearing cups (4222) and differential bearing shims (4067) out until they are loose in the bearing caps. Remove the bearing caps and remove the differential (4026) from the axle housing.



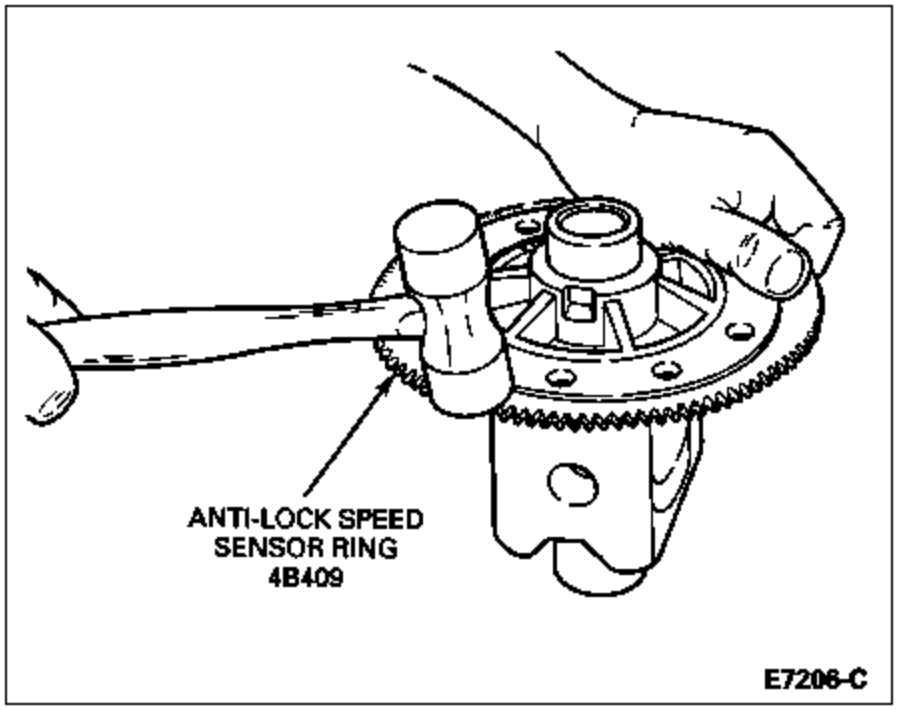
Ring Gear and Pinion Removal

1. Remove the bolts that attach the ring gear to the differential case. Remove the ring gear from the differential case by striking at alternate holes around the ring gear.



Anti-Lock Speed Sensor Ring Removal

1. If required, remove the anti-lock speed sensor ring with a soft faced hammer and discard. **Once removed, the anti-lock speed sensor ring cannot be reused. A new anti-lock speed sensor ring must be installed.**

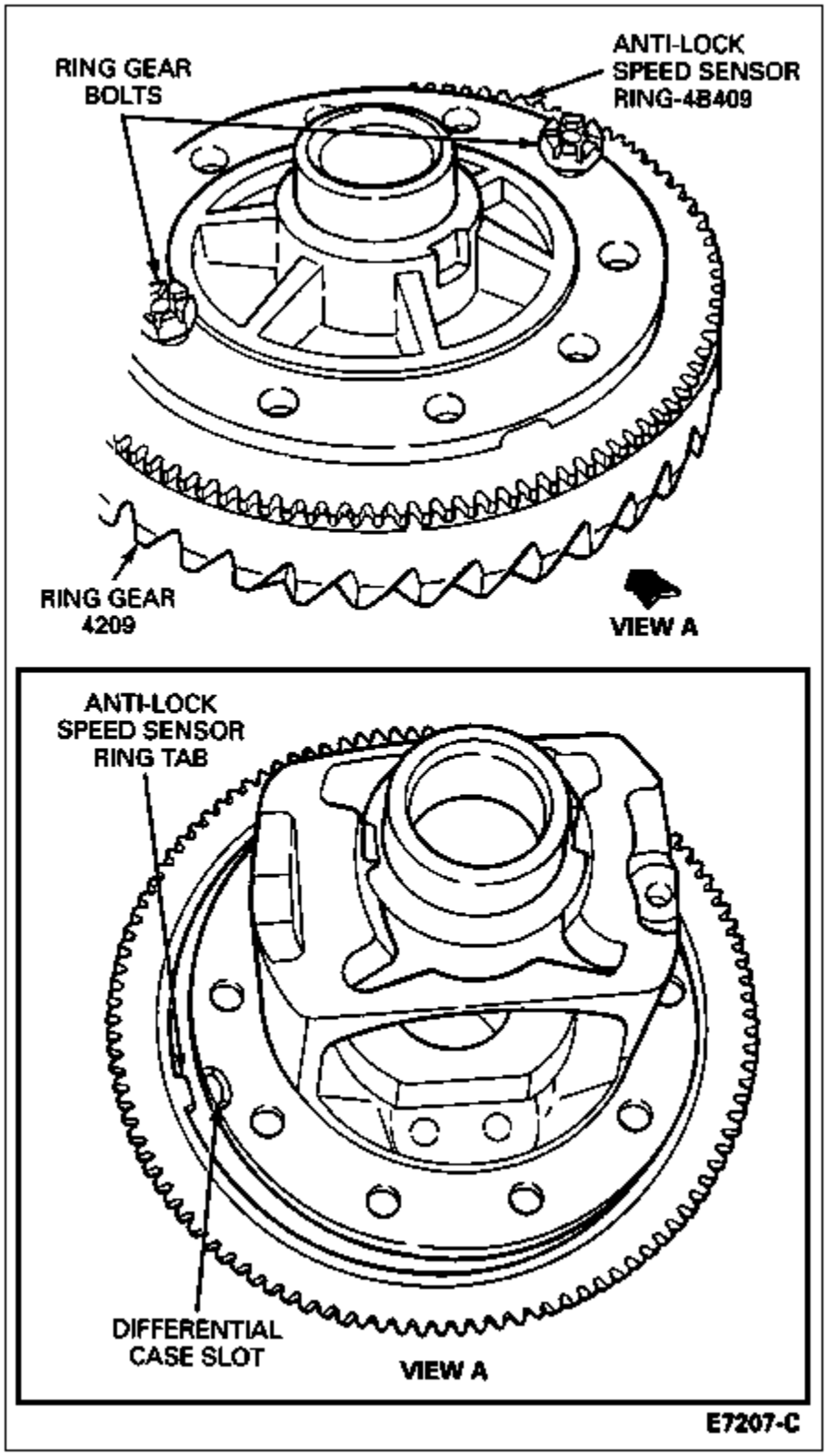


Anti-Lock Speed Sensor Ring Installation

1. **CAUTION: Tab on anti-lock speed sensor ring MUST BE aligned with slot in differential case.**

   Align tab on anti-lock speed sensor ring with slot in differential case.

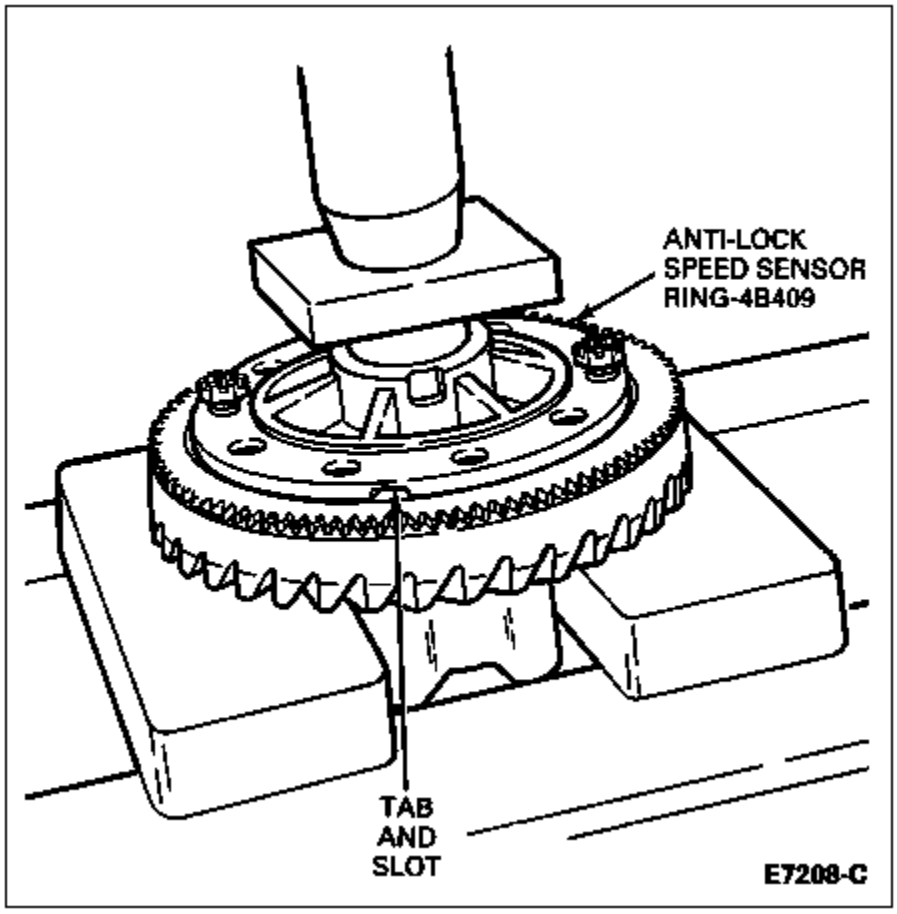
2. Start two ring gear bolts through the differential case into the ring gear to make sure differential case-to-ring gear bolt hole alignment is obtained.



3. Press the anti-lock speed sensor ring on the differential case using the ring gear as a pilot.

4. Apply Stud and Bearing Mount E0AZ-19554-BA or equivalent meeting Ford specification WSK-M2G349-A1 to ring gear bolts.

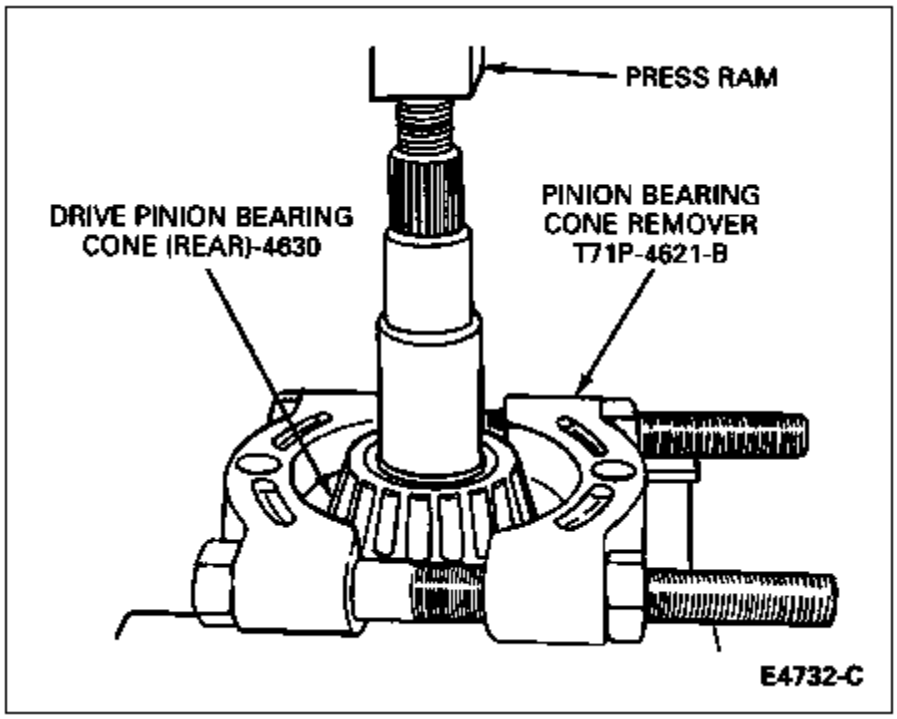
5. Install ring gear bolts and tighten to 95-115 Nm (70-85 lb-ft).



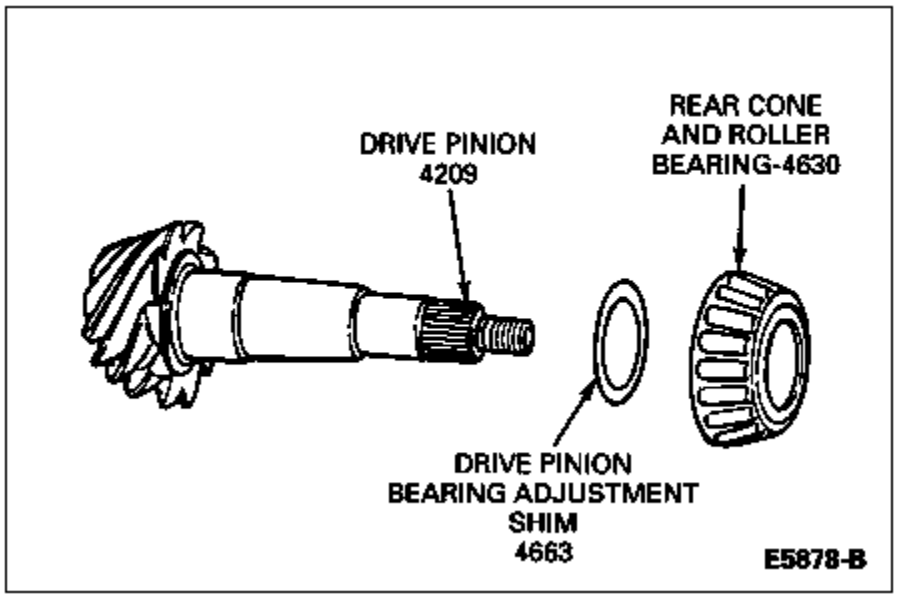
Drive Pinion Removal

1. With a soft-faced hammer, drive the pinion out of the drive pinion bearing cone and remove it through the rear of the carrier.

   To remove the pinion bearing cone and roller assembly, use the Pinion Bearing Cone Remover T71P-4621-B as shown.



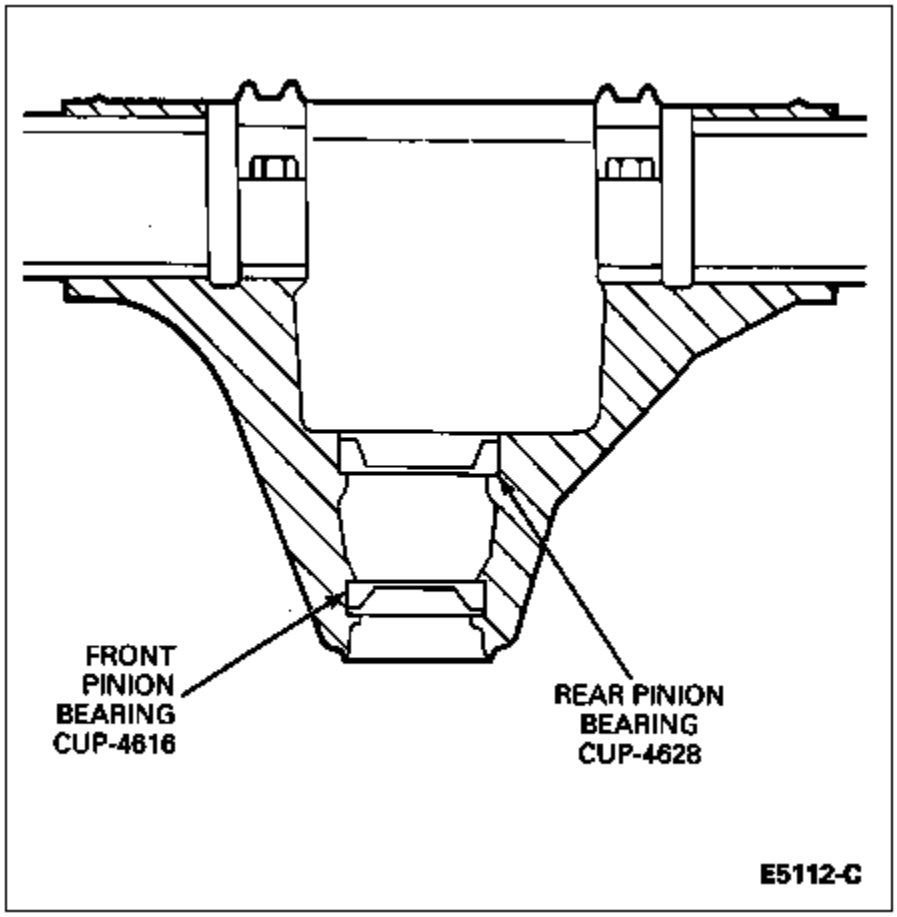
2. Measure the pinion shim, which is found under the drive pinion bearing cone and roller, with a micrometer and record the thickness (as a reference to be compared to the drive pinion bearing adjustment shim gauge reading prior to installing the drive pinion bearing cone and roller).



Pinion Bearing Cup Removal

1. **NOTE: Do not remove the pinion bearing cups from the axle housing casting unless the cups are damaged.**

If the pinion bearing cups are to be replaced, tap alternately (with a brass drift of suitable length) on the opposite side of the cups during removal to prevent cups from cocking in the casting.

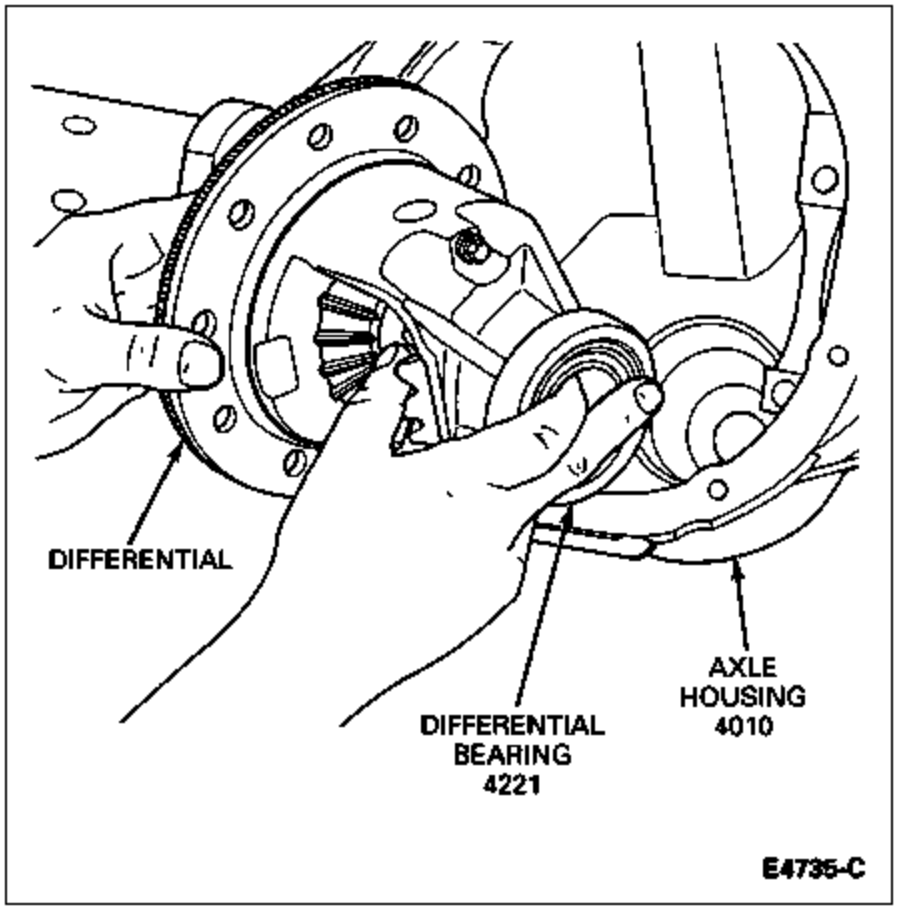


Differential Case Runout Check

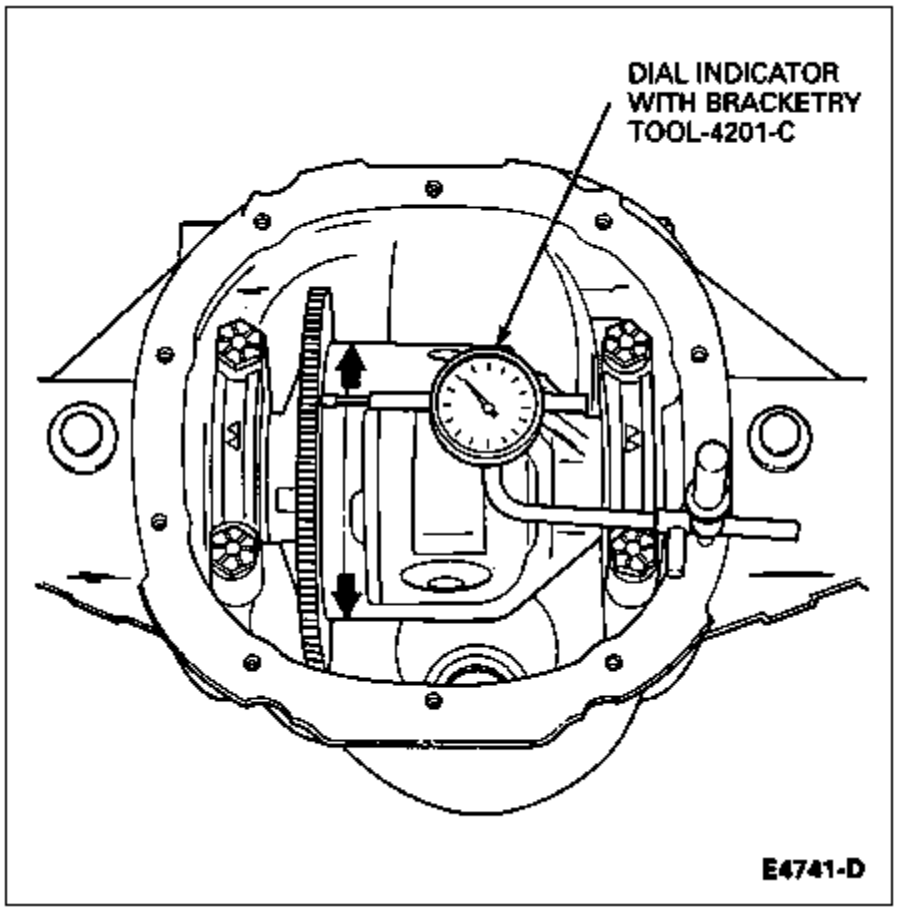
If the ring gear runout check (before disassembly) exceeds specification, the condition may be caused by a warped ring gear, a damaged differential case, excessively worn differential bearings (4221) or foreign material between mating surfaces (burrs, shavings, etc.). To determine the cause of excessive runout, proceed as follows:

1. Remove the differential case from the axle housing (refer to Differential Case Removal or Drive Pinion Removal in this section) and remove the bolts that attach the ring gear and pinion to the differential case. Remove the ring gear from the differential case with a hammer and drift.

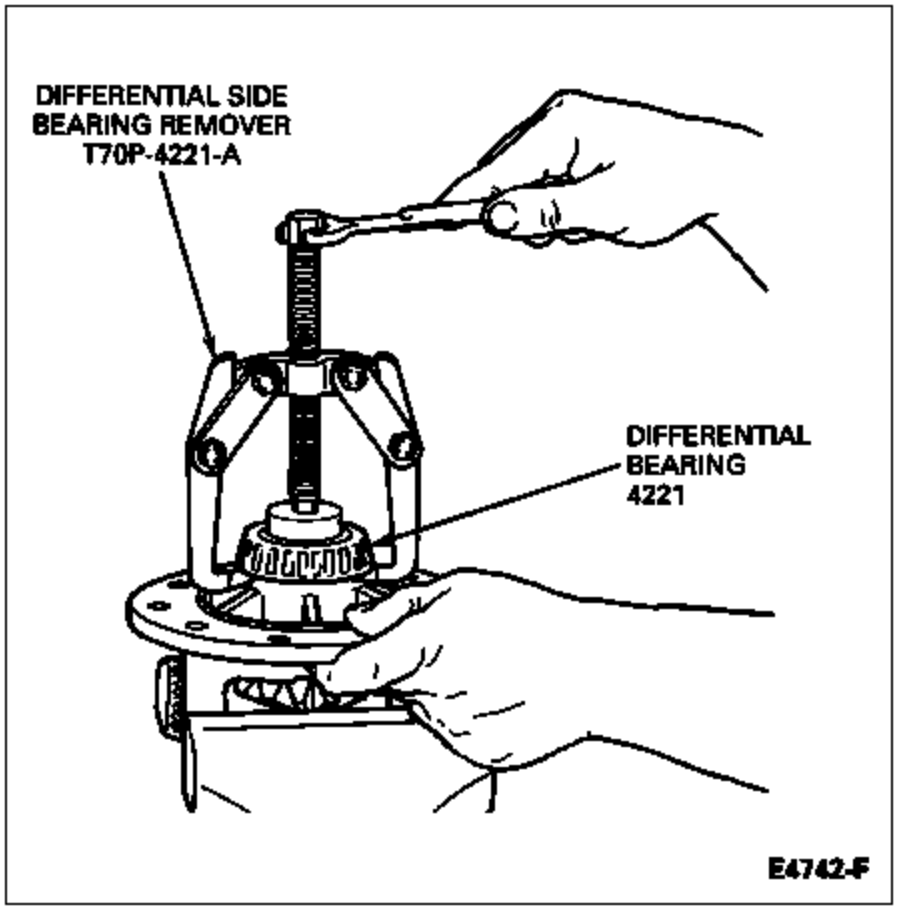
2. Install the differential case with the differential bearing cups, differential bearing caps, and differential bearing shims. Tighten the differential bearing cap bolts to 95-115 Nm (70-85 lb-ft).



3. Check the runout of the differential case flange using Dial Indicator with Bracketry TOOL-4201-C or equivalent. If the runout is within specification (maximum 0.076mm [0.003 inch]), install a new ring gear and pinion. If the runout exceeds specification, the ring gear and pinion is true and the concern is due to either a damaged differential case or differential bearings. Visually inspect the differential bearings. If differential bearings are not damaged replace both the differential case and differential bearings. Recheck the runout with new parts (differential case and differential bearings). Visually inspect the anti-lock speed sensor ring for damage and replace if required.

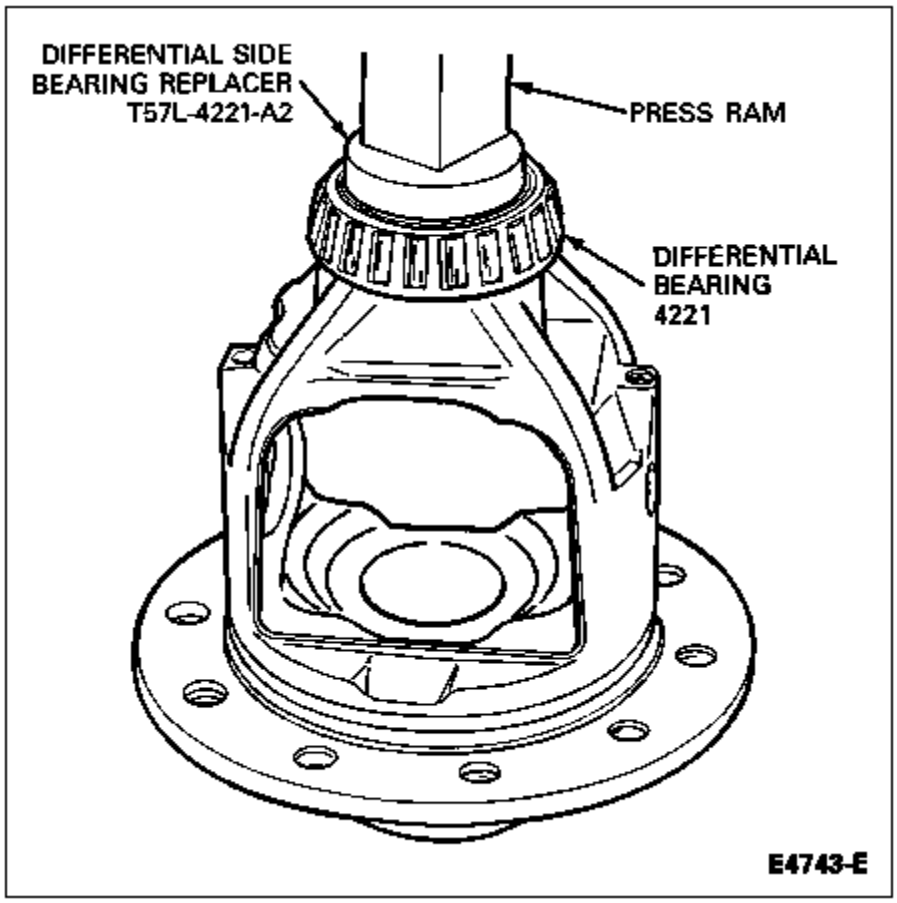


4. Remove the differential case from the carrier and remove the differential bearings from the differential case using Differential Side Bearing Remover T70P-4221-A or T57L-4220-A.

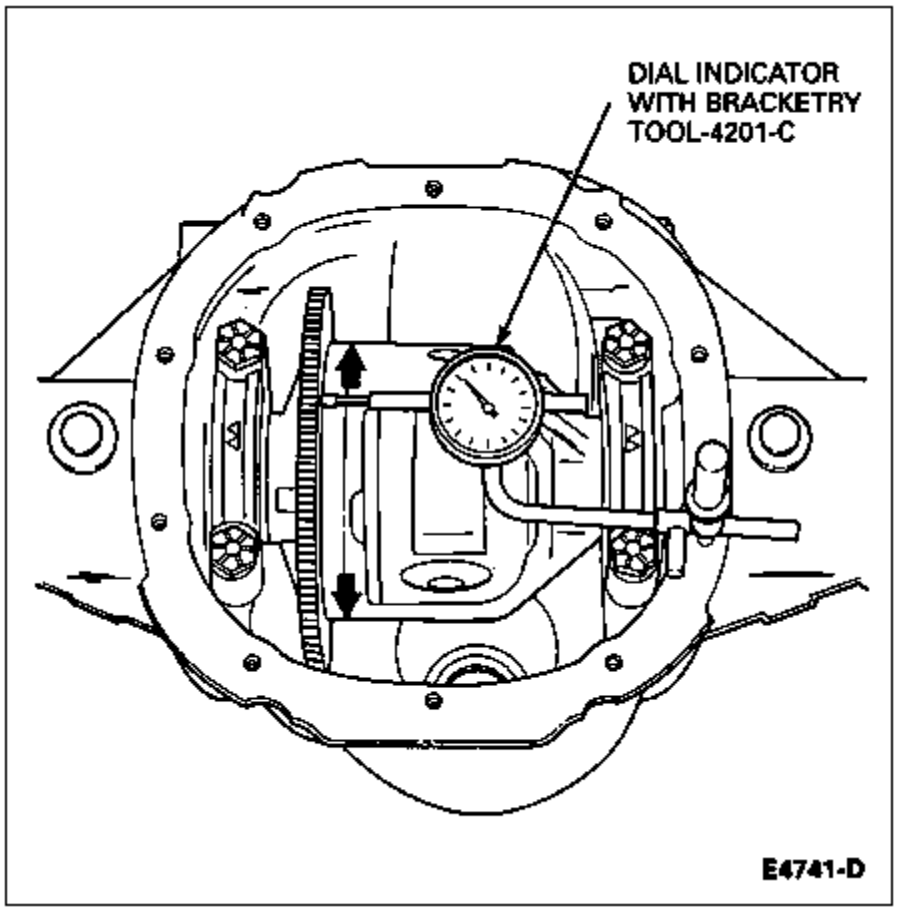


5. **NOTE: Press against the bearing cone only.**

   Install new differential bearings on the rear hubs (1109) using Differential Side Bearing Replacer T57L-4221-A2 and install the differential in the carrier without the ring gear and pinion.



6. Check the differential case runout again with the new differential bearings. If the runout is now within 0.076mm (max. 0.003 inch), use the new differential bearings for assembly. If the runout is still excessive, the differential case is damaged and should be replaced.

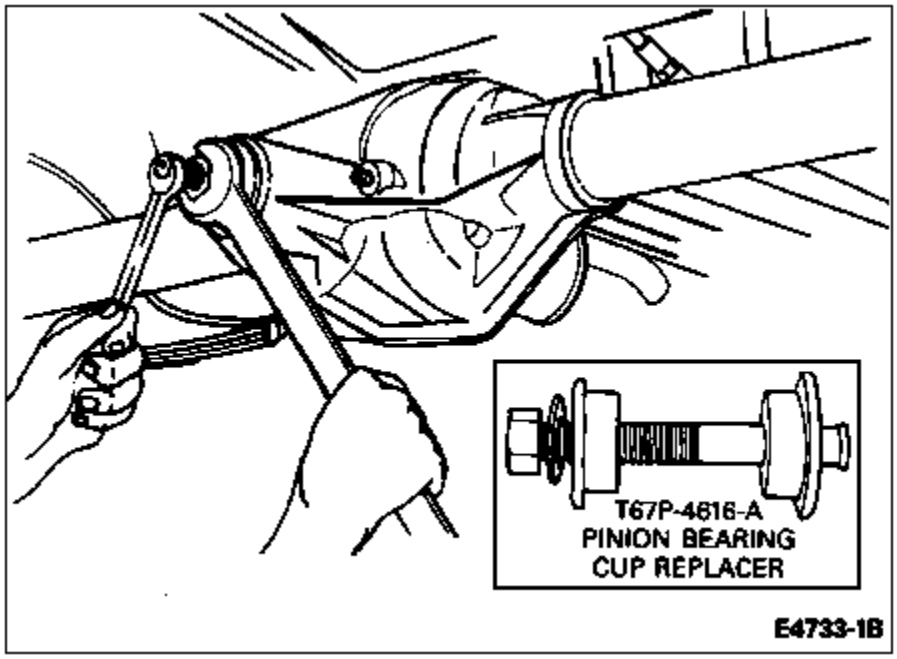

DIAL INDICATOR
WITH BRACKETRY
TOOL-4201-C
E4741-D

Axle Assembly

Pinion Bearing Cup Installation

1. **NOTE: Do not remove the pinion bearing cups from the carrier casting unless the pinion bearing cups are damaged.**

   Install the new cups with Pinion Bearing Cup Replacer T67P-4616-A as shown. Make sure the pinion bearing cups are properly seated in their bores. If a 0.038mm (0.0015 inch) feeler gauge can be inserted between a pinion bearing cup and the bottom of its bore at any point around the pinion bearing cup, the pinion bearing cup is not properly seated. Whenever the pinion bearing cups are replaced, the differential bearing (4221) should also be replaced.

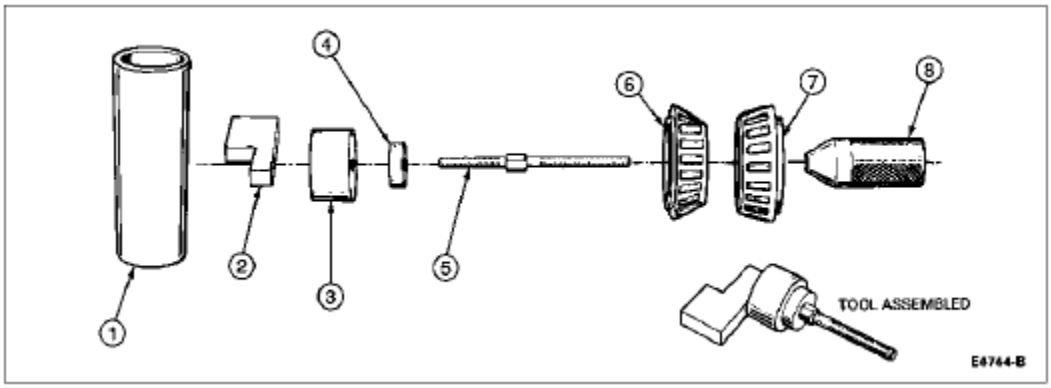


Drive Pinion Shim Selection

Individual differences in machining the rear axle differential carrier casting and the ring gear and pinion and variation in bearing widths require a pinion shim between the differential pinion bearing (4630) and pinion head, in order to locate the drive pinion shaft for correct tooth contact with the ring gear.

When replacing a ring gear and pinion, the correct pinion shim thickness for the new ring gear and pinion to be installed is determined by the following procedure using Pinion Depth Gauge T79P-4020-A.

Pinion Depth Gauge Set

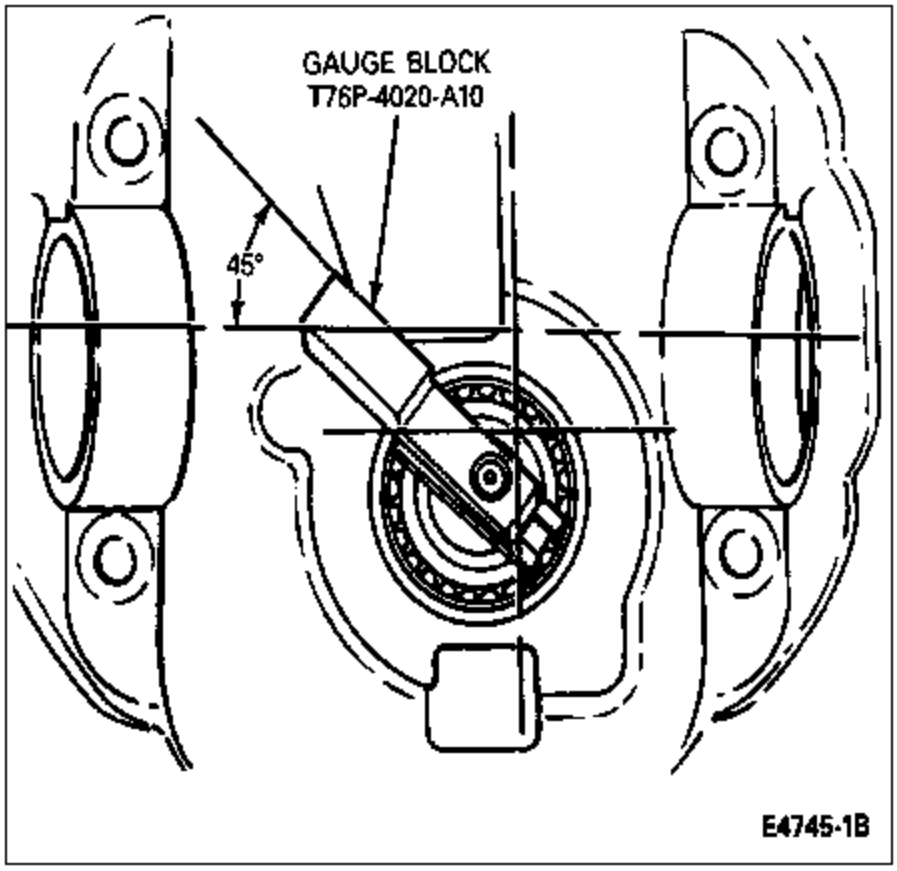


Item	Part Number	Description
1	T89P-4020-A	Gauge Tube
2	T76P-4020-A10	Gauge Block (Part of T79P-4020-A)
3	T79P-4020-A18	Gauge Disc (Part of T79P-4020-A)
4	T76P-4020-A3	Aligning Adapter (Part of T79P-4020-A)
5	T79P-4020-A9	Screw (Part of T79P-4020-A)
6	4630	Drive Pinion Bearing Cone and Roller (Rear)
7	4621	Front Bearing Cone and Roller
8	T76P-4020-A11	Handle (Part of T79P-4020-A)

1. **NOTE: The gauge block must be offset 45 degrees to obtain an accurate reading.**

   Assemble the appropriate aligning adapter, gauge disc and gauge block to the screw.

2. Place the drive pinion bearing cone and roller (new, or used if in good condition) over the aligning tool and insert it into the rear pinion bearing cup of the rear axle differential carrier. Place the front bearing cone and roller into the front pinion bearing cup and assemble the tool handle into the screw (refer to illustration).

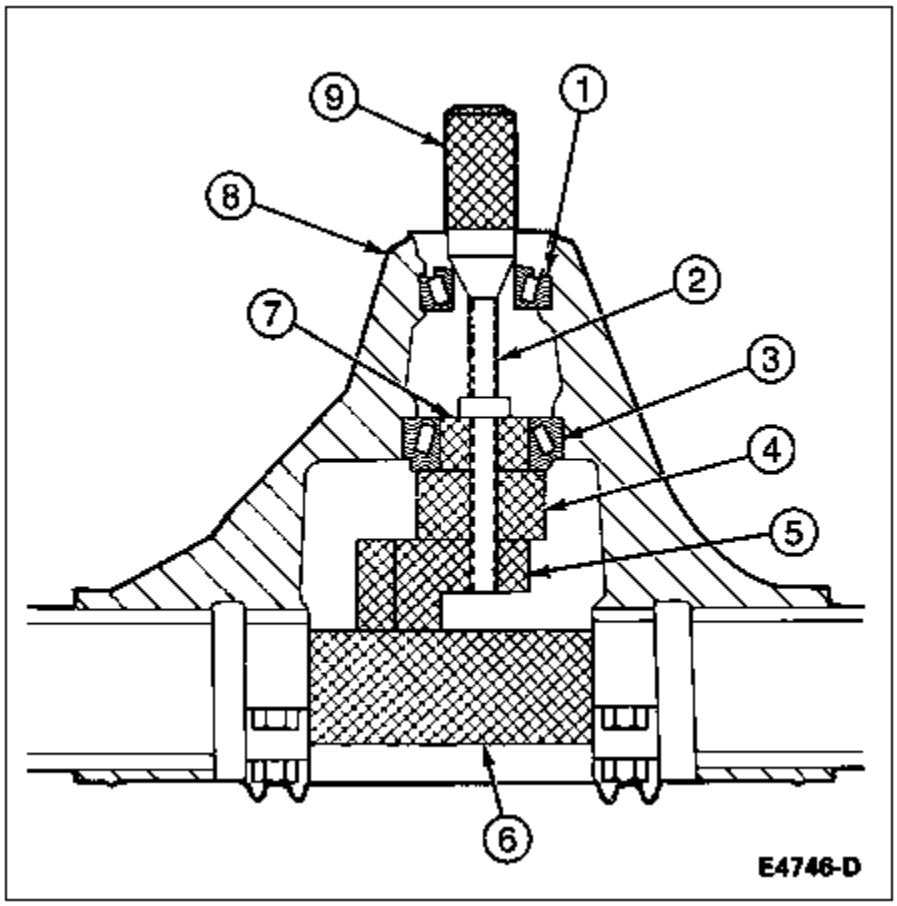


3. Roll the assembly back and forth a few times to seat the bearings while tightening the tool handle by hand. Tighten the tool handle to 27 Nm (20 lb-ft).

4. Center the gauge tube into the differential bearing bore. Install the bearing retaining caps and tighten the bolts to 95-115 Nm (70-85 lb-ft). (Bearing retaining caps are to be installed with the triangles pointing outboard.)

5. **NOTE: Shims must be flat. Do not use dirty, bent, nicked or mutilated shims as a gauge.**

   Utilize pinion shims as the gauge for shim selection. This will minimize errors in attempting to stack feeler gauge stock together or simple addition errors in calculating correct shim thickness. It is important to feel a slight drag on the shim for correct selection. Do not attempt to force the shim between the gauge block and the gauge tube. This will minimize the undesirable selection of a shim thicker than required, which results in deep tooth contact in final assembly of integral rear axles (4001).

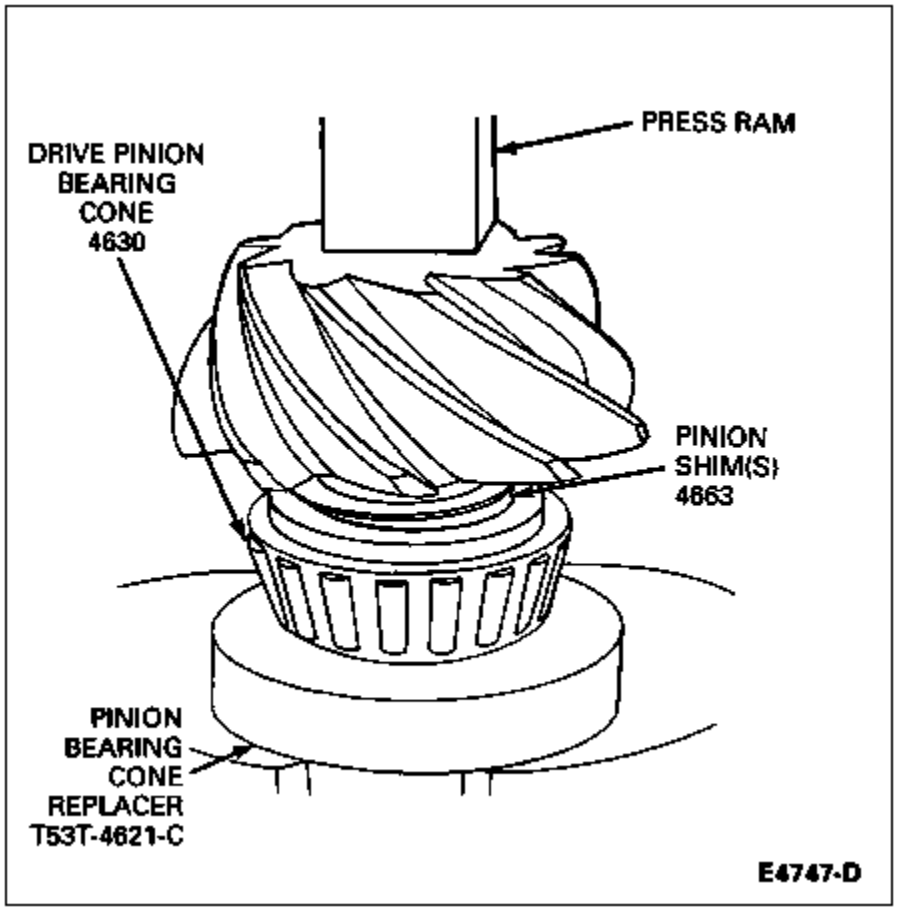


Item	Part Number	Description
1	4621	Front Bearing Cone and Roller
2	T79P-4020-A9	Screw (Part of T79P-4020-A)
3	4630	Drive Pinion Bearing Cone and Roller
4	T79P-4020-A18	Gauge Disc (Part of T79P-4020-A)
5	T76P-4020-A10	Gauge Block (Part of T79P-4020-A)
6	T89P-4020-A	Gauge Tube (Part of T79P-4020-A)
7	T76P-4020-A3	Aligning Adapter (Part of T79P-4020-A)
8	4010	Axle Housing
9	T76P-4020-A11	Handle (Part of T79P-4020-A)

6. **NOTE: The same drive pinion bearing cone and roller used in this procedure must be used in final assembly of the rear axle.**

   NOTE: Be sure that press load is not applied to the pinion bearing cage.

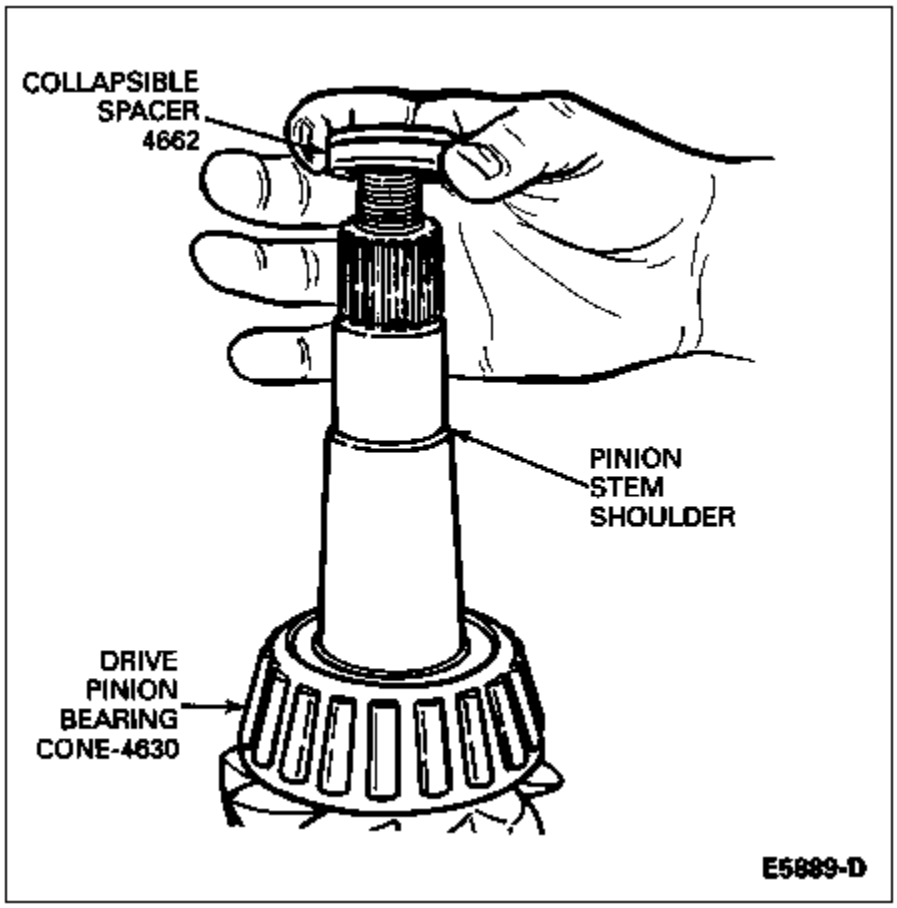
Place the selected pinion shims on the drive pinion shaft and press the drive pinion bearing cone and roller until it is firmly seated on the drive pinion shaft.



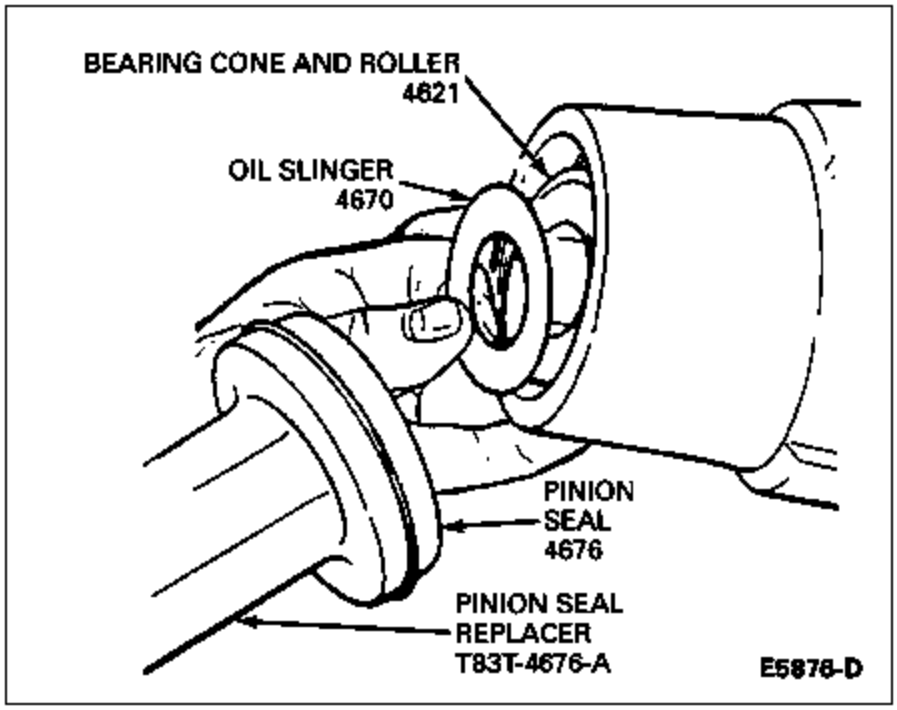
Drive Pinion and Flange Yoke Seal Installation

1. Check splines on the drive pinion shaft to be sure they are free of burrs. If burrs are evident, remove them by using a fine crocus cloth, working in a rotational motion. Wipe the pinion shaft clean.

2. Place the collapsible spacer on the pinion stem against the pinion stem shoulder.

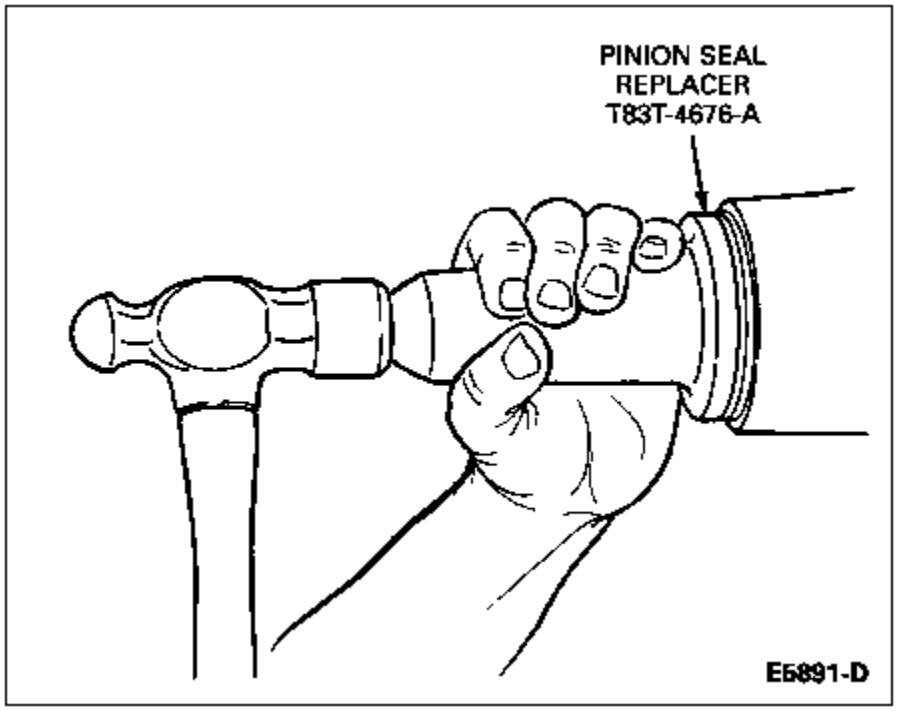


3. Install the bearing cone and roller and oil slinger in the axle housing bore, and install the pinion seal on the Pinion Seal Replacer T83T-4676-A.

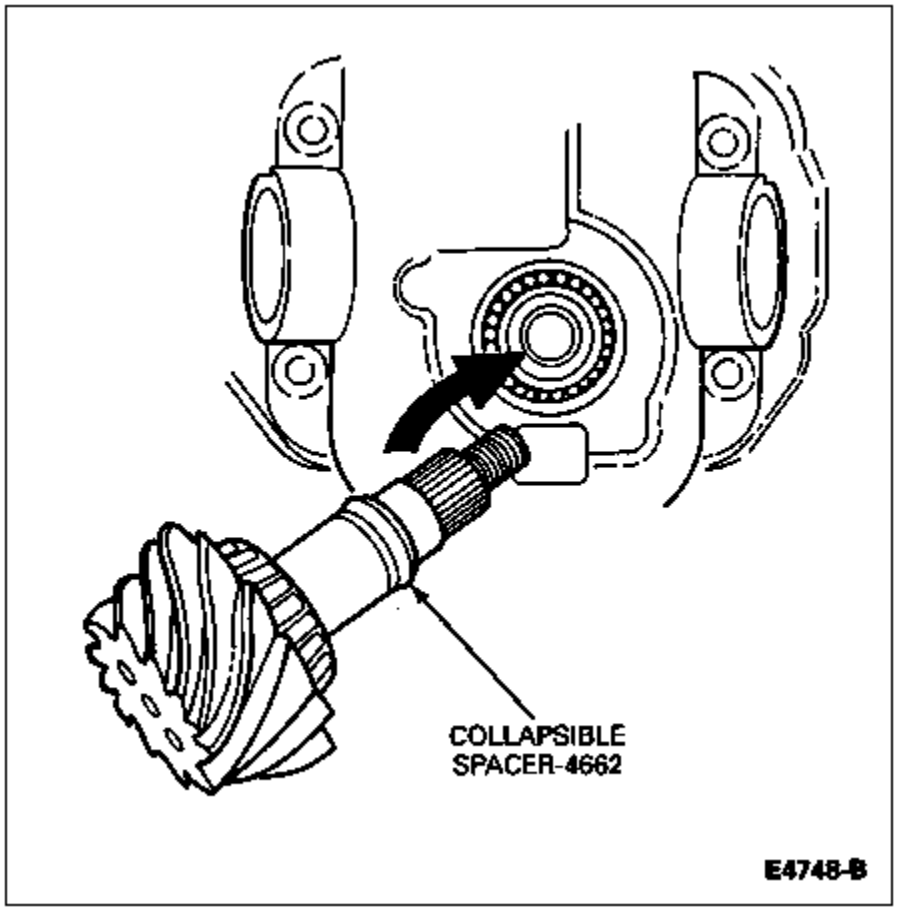


4. **CAUTION: Installation without the proper tool may result in early pinion seal failure. If pinion seal becomes cocked during installation, remove it and install a new one.**

   Clean the pinion seal seat surface. Install the pinion seal in the front bearing cone and roller using Pinion Seal Replacer T83T-4676-A. Coat the lips of the seal with Premium Long-Life Grease XG-1-C or -K or equivalent meeting Ford specification ESA-M1C75-B.



5. From the rear of the axle housing, install the drive pinion with pinion shims, cone and roller bearings, and collapsible spacer into the axle housing pinion bore.



Rear Axle Companion Flange Installation

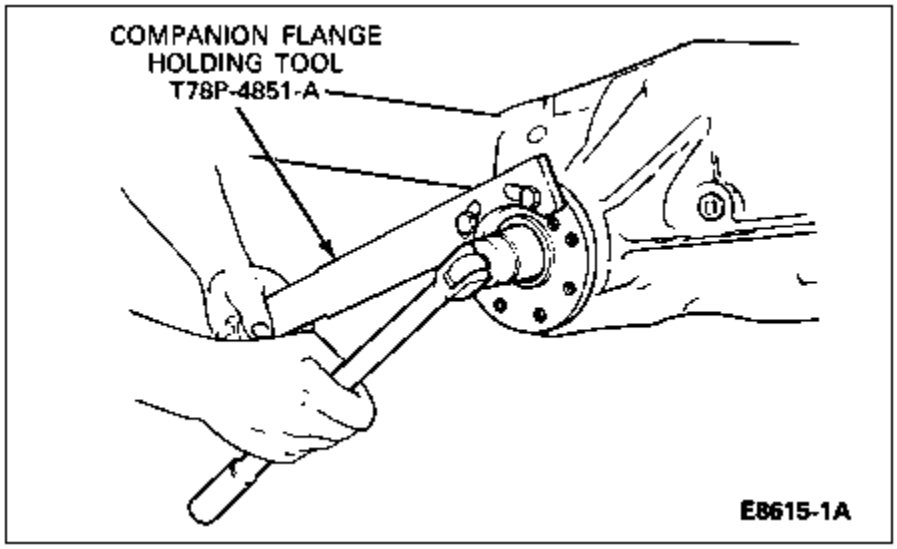
1. Apply a small amount of lubricant to the rear axle universal joint flange shaft splines. Align the mark on the rear axle companion flange with the mark on the drive pinion shaft. Install the rear axle companion flange using Companion Flange Replacer TOOL-4858-E or equivalent.

2. Install a new pinion nut on the pinion stem.

3. **NOTE: If a new rear axle companion flange is being installed, disregard the scribe mark on the drive pinion shaft.**

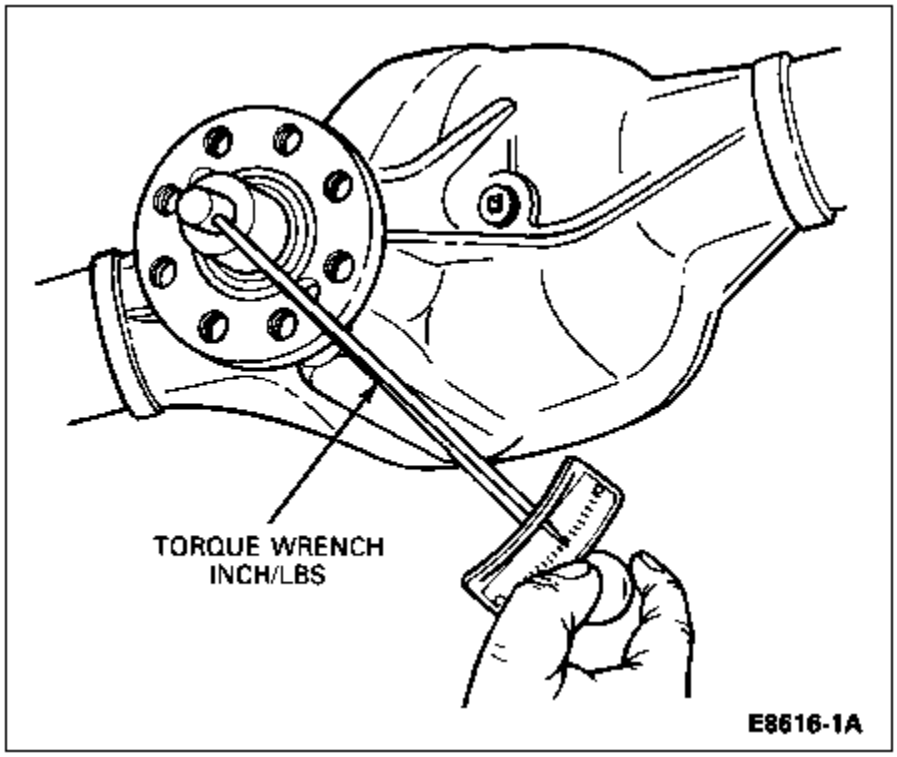
   NOTE: The rear axle companion flange must never be hammered on or installed with power tools.

   Using Companion Flange Holding Tool T78P-4851-A tighten the pinion nut, rotating the drive pinion occasionally to make sure proper pinion bearings are seated properly. Take frequent pinion bearing torque preload readings until the original recorded preload reading is obtained.



4. If the original recorded preload is lower than specification (used bearings 0.9-1.5 Nm [8-14 lb-in]; new bearings 1.8-3.3 Nm [16-29 lb-in]) tighten to specification. If the preload is higher than specification, tighten to original reading as recorded.

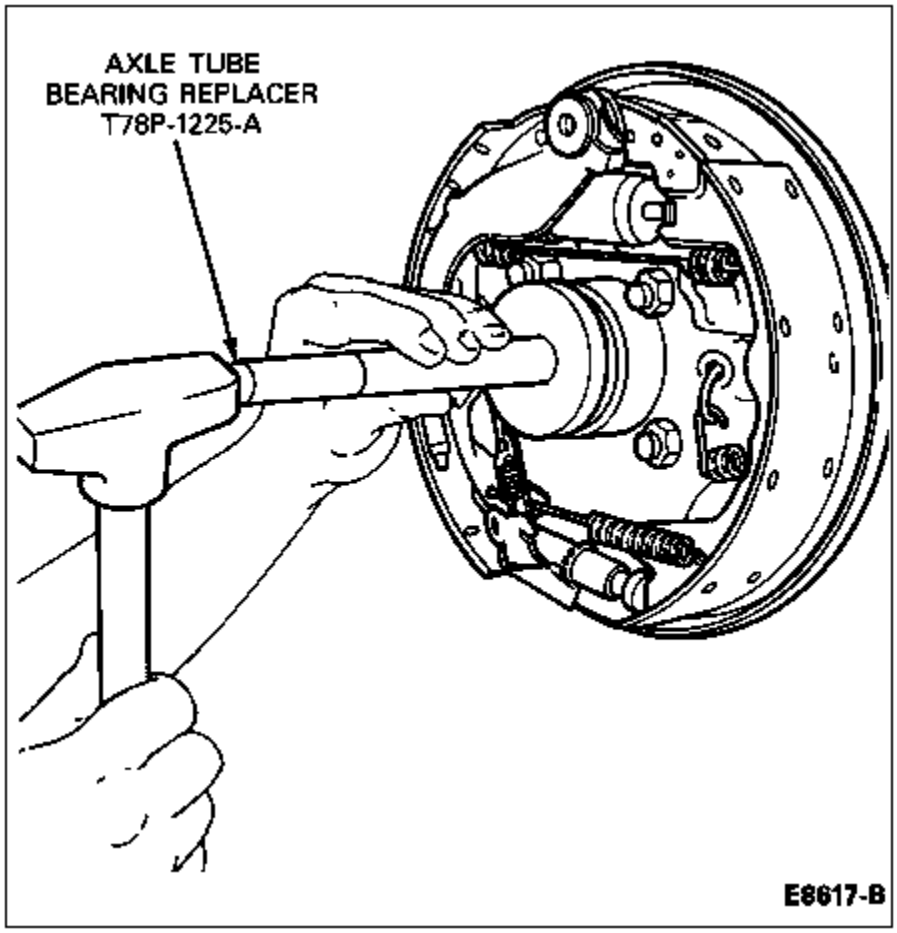
   Under no circumstances should the pinion nut be backed off to reduce preload. If reduced preload is required, a new collapsible spacer and pinion nut must be installed.



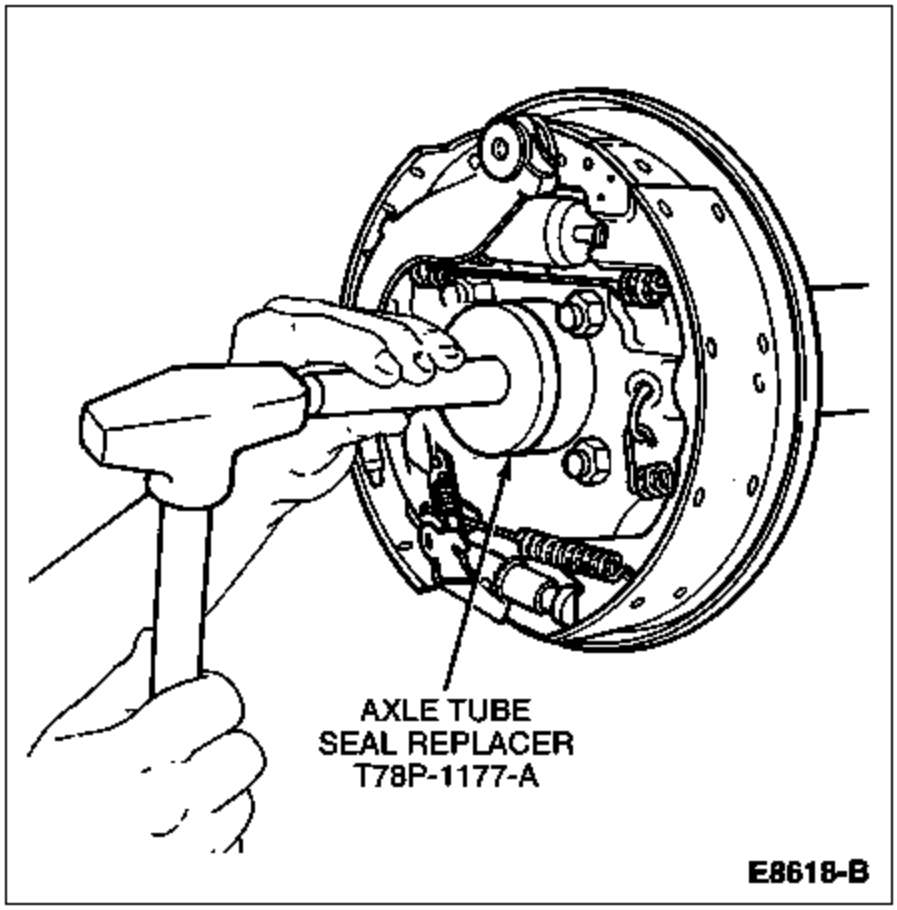
Wheel Bearing and Oil Seal Installation

1. **CAUTION: Installation of the rear wheel bearing (1225) or inner wheel bearing oil seal (1177) without the proper tool may result in an early rear wheel bearing or inner wheel bearing oil seal failure. If inner wheel bearing oil seal becomes cocked in the bore during installation, remove it and install a new one.**

   Lubricate the new rear wheel bearing with axle lubricant and install the rear wheel bearing into the axle housing bore using Axle Tube Bearing Replacer T78P-1225-A.

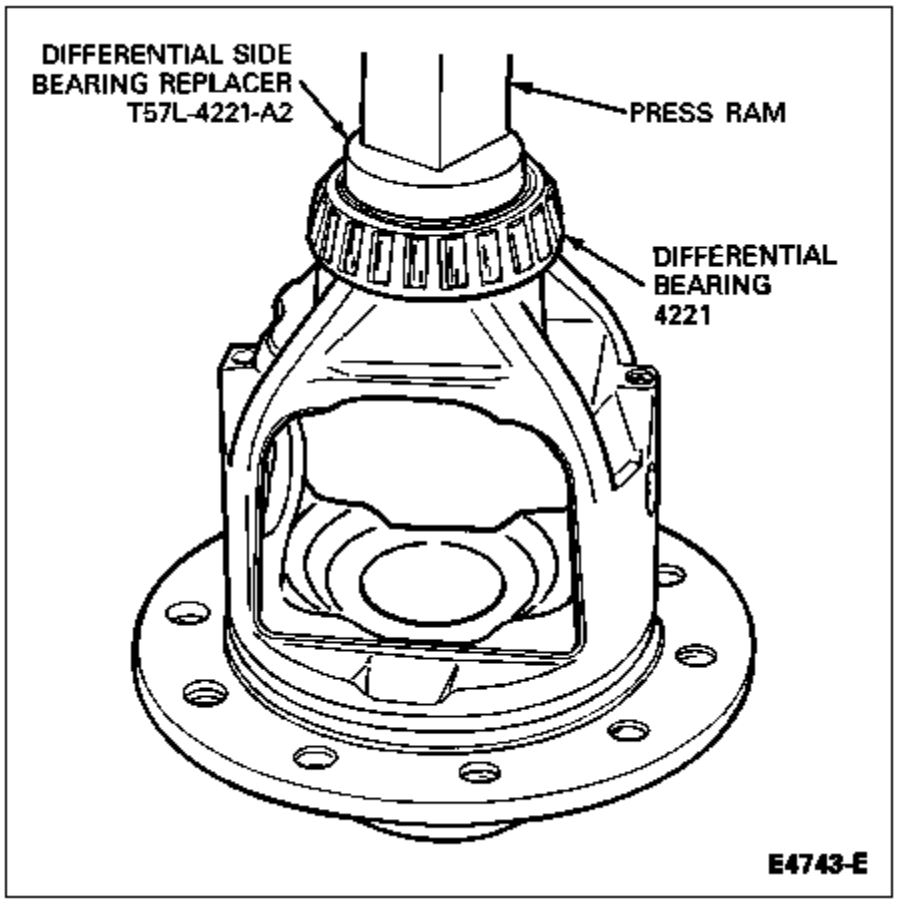


2. Coat the lips of the inner wheel bearing oil seal with Premium Long-Life Grease XG-1-C or -K or equivalent meeting Ford specification ESA-M1C75-B and install the inner wheel bearing oil seal using Axle Tube Seal Replacer T78P-1177-A.



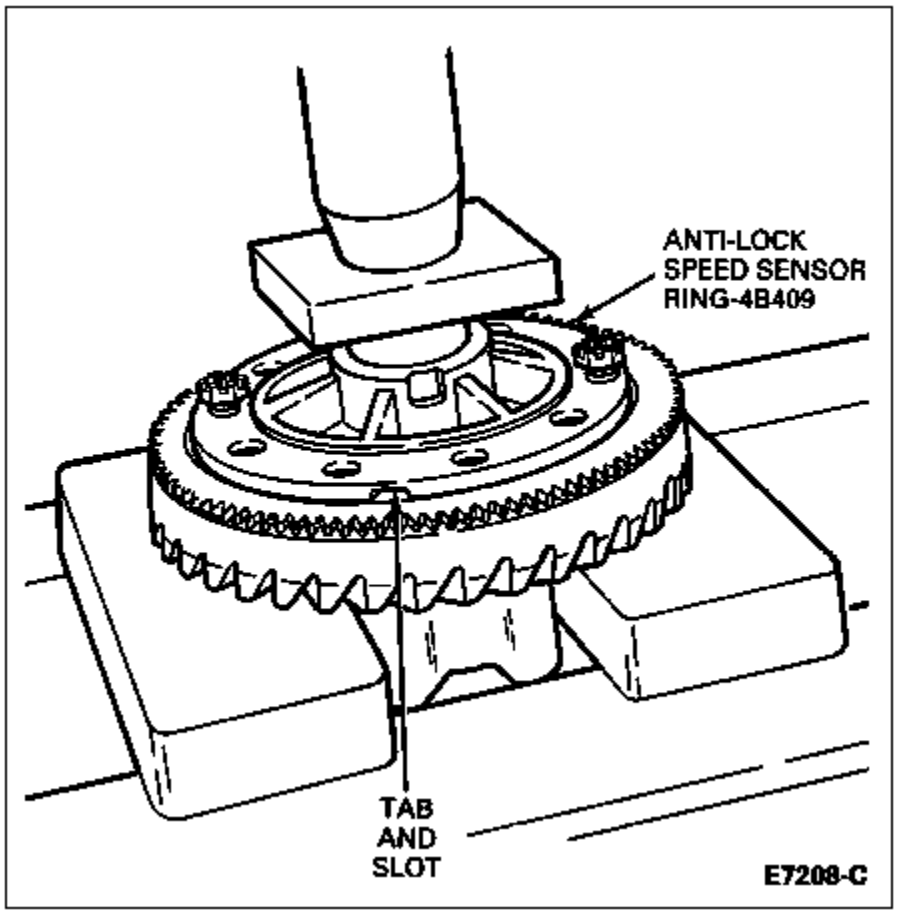
Differential Case Installation

1. Install differential bearings on the rear hubs (1109) using Differential Side Bearing Replacer T57L-4221-A2. Press against the differential bearing cones only.

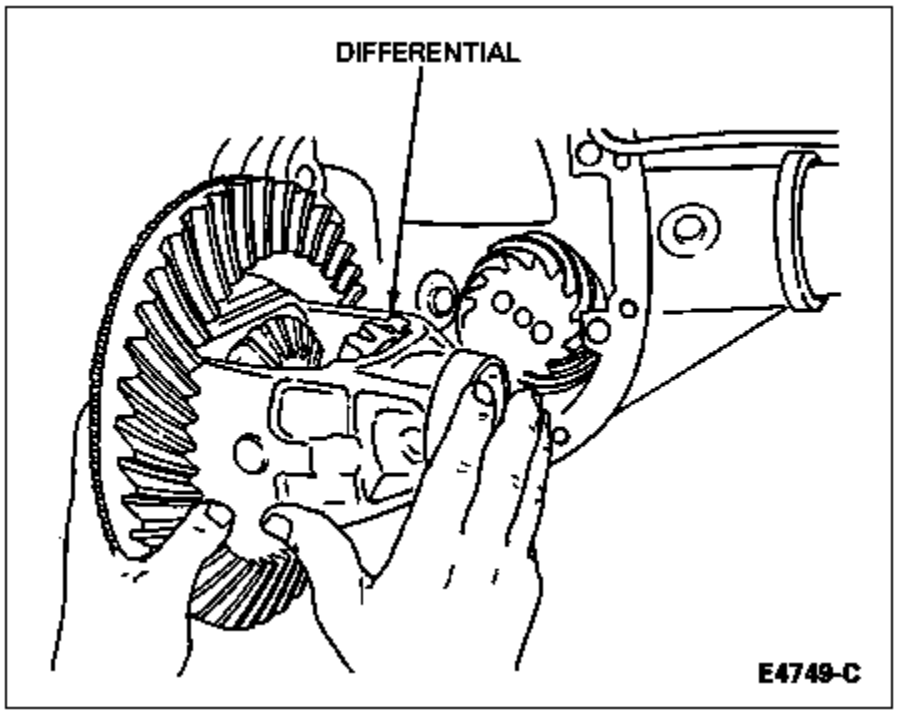


2. **CAUTION: Extreme care should be taken not to scratch, dent, chip or otherwise cause damage to speed sensor ring or teeth while handling or during assembly.**

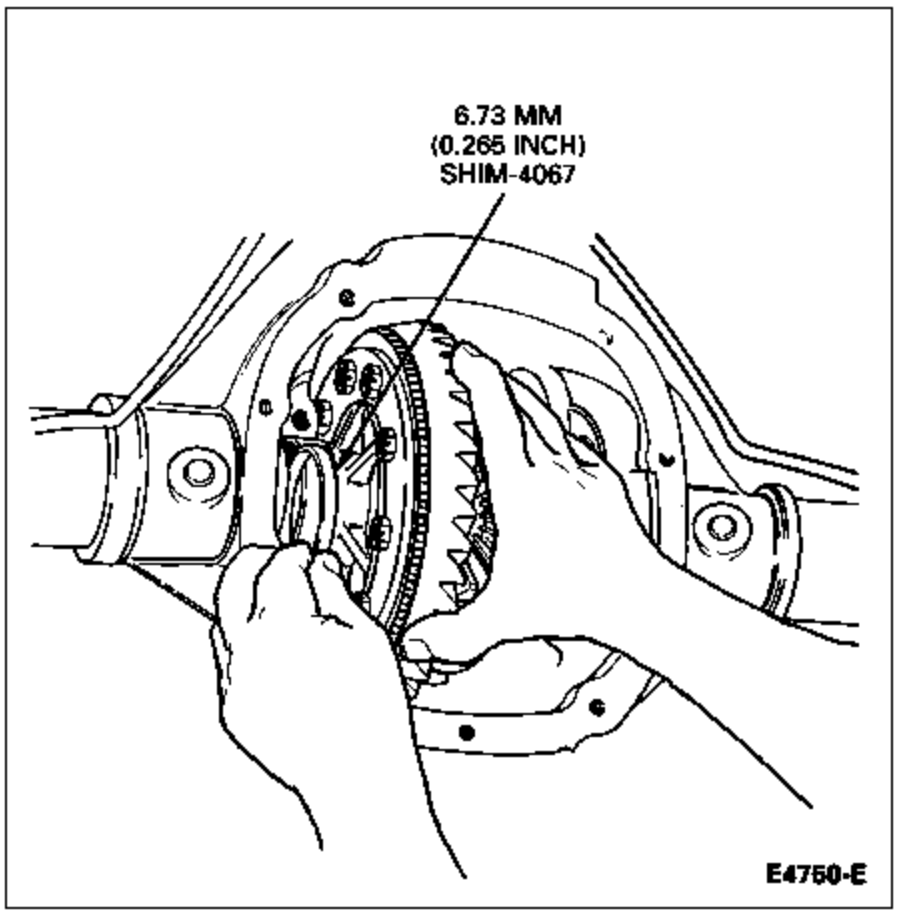
   Press on the NEW anti-lock speed sensor ring if removed, and ring gear onto the differential case (4204). Refer to procedure in this section. Apply Stud and Bearing Mount E0AZ-19554-BA or equivalent meeting Ford specification WSK-M2G349-A1 to ring gear and pinion bolts and install. Tighten the bolts to 95-115 Nm (70-85 lb-ft).



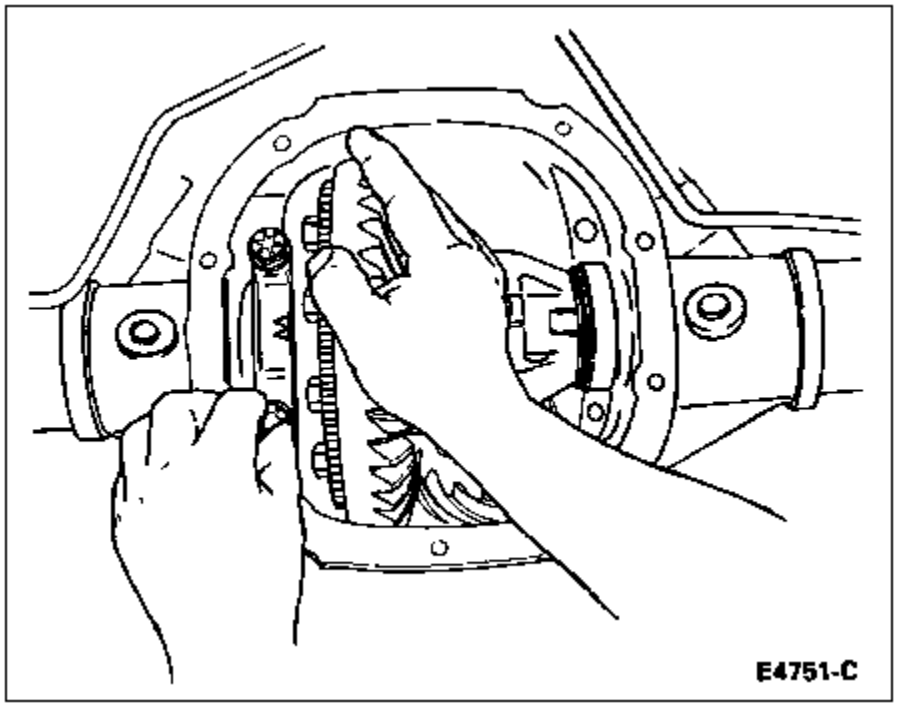
3. With pinion depth set and drive pinion installed, place differential assembly with bearings and cups in carrier.



4. Install a 6.73mm (0.265-inch) shim on left side.

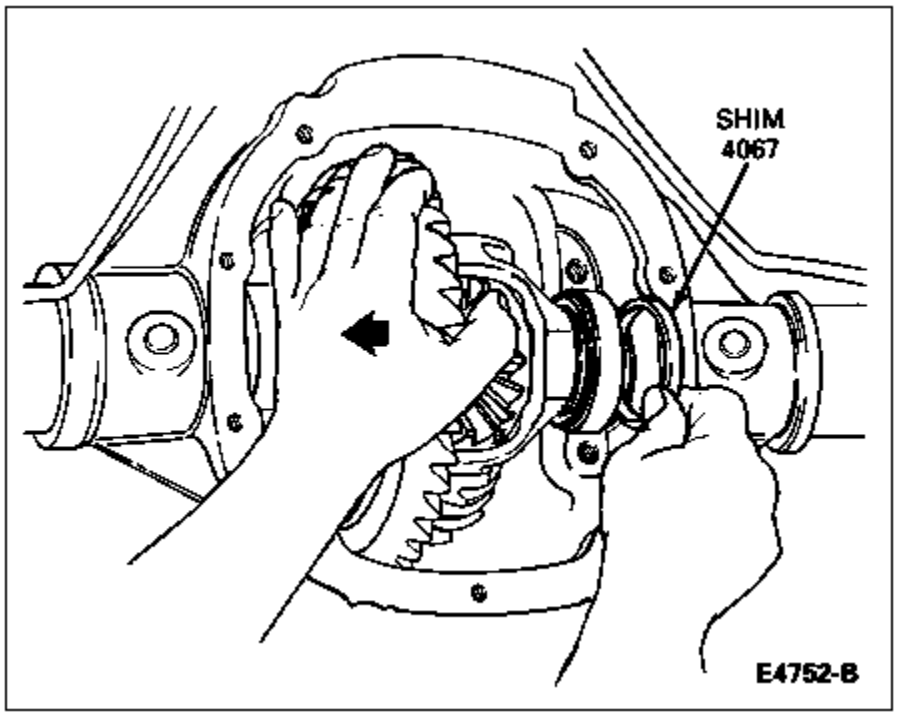


5. Install left bearing retaining cap and tighten bolts finger-tight.

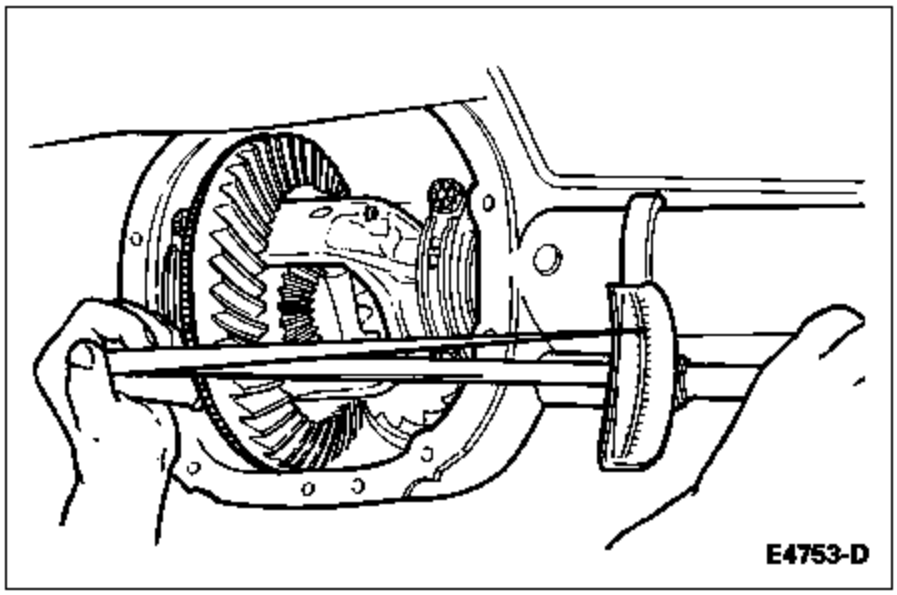


6. **NOTE: Triangles on bearing cups must point outboard.**

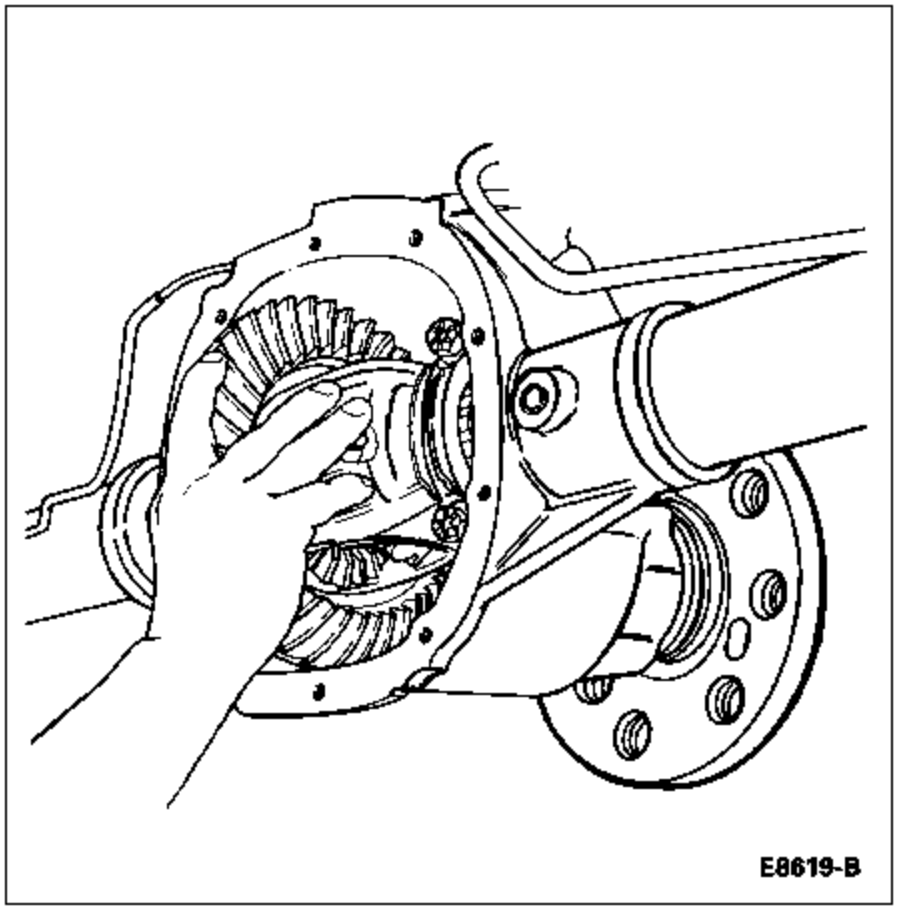
   Install progressively larger shims on the right side until the largest shim selected can be assembled with a slight drag feel. Apply pressure toward left side to make sure the left bearing cup is seated.



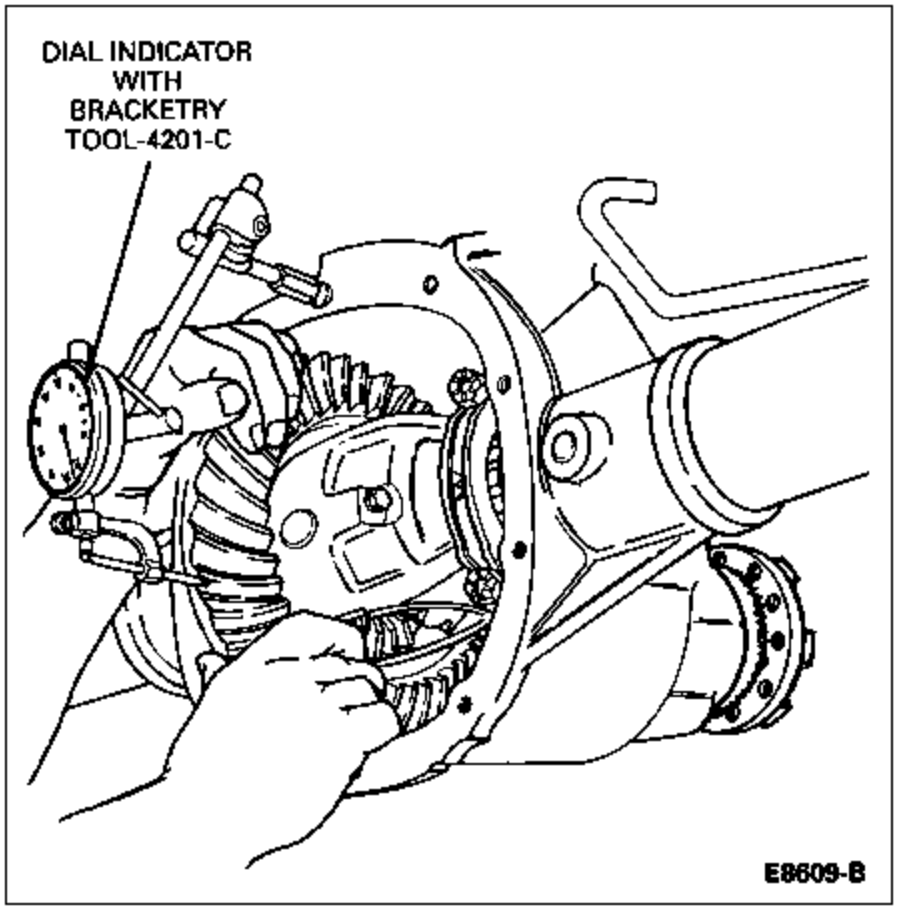
7. Install right side bearing cap and tighten bearing cap bolts to 95-115 Nm (70-85 lb-ft).



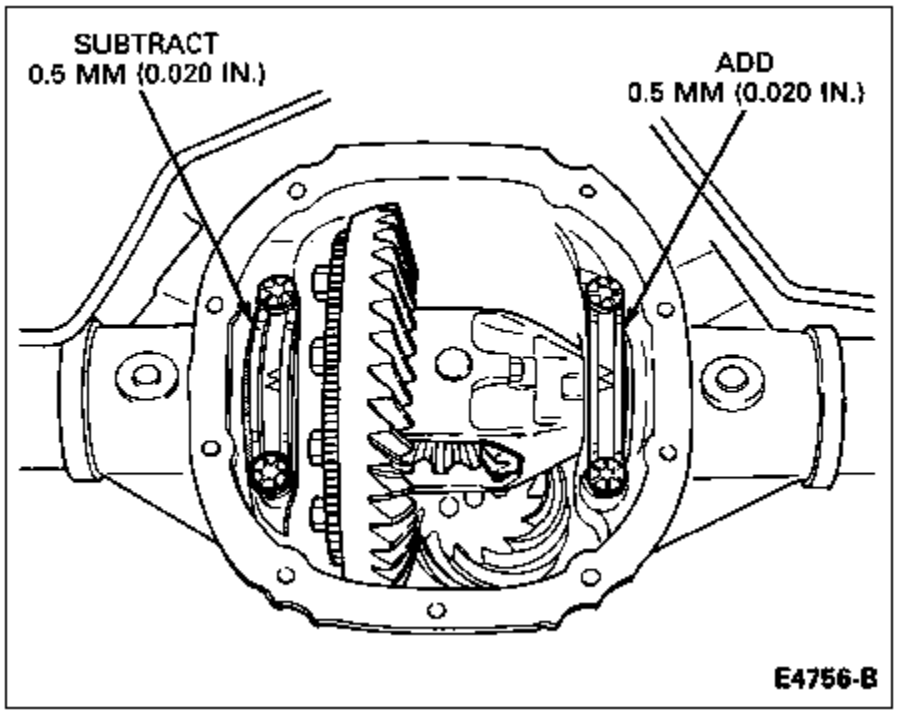
8. Rotate assembly to make sure free rotation is maintained.



9. Check ring gear and pinion backlash. If the backlash is 0.20-0.38mm (0.008-0.015 inch) (0.30-0.38mm [0.012-0.015 inch] preferred), proceed to Step 13. If the backlash is zero, go to Step 10. If the backlash is not zero, but is less than 0.20mm (0.008 inch) or more than 0.38mm (0.015 inch), go to Step 12.



10. If a zero backlash condition occurs, add 0.5mm (0.020 inch) to the right side and subtract 0.5mm (0.020 inch) from the left side to allow for a backlash reading.

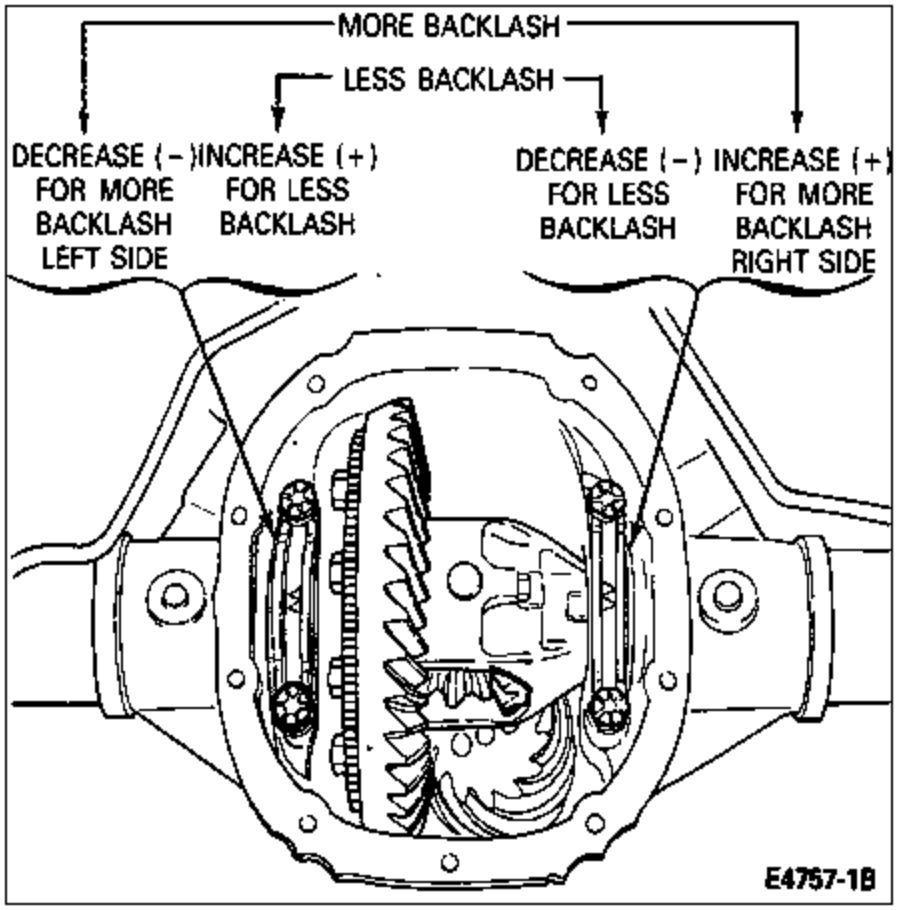


11. Recheck backlash. See Step 12 if backlash is not within specification. Backlash specification: 0.20-0.38mm (0.008-0.015 inch) (0.30-0.38mm [0.012-0.015 inch] preferred).

    If backlash is within specification, go to Step 13.

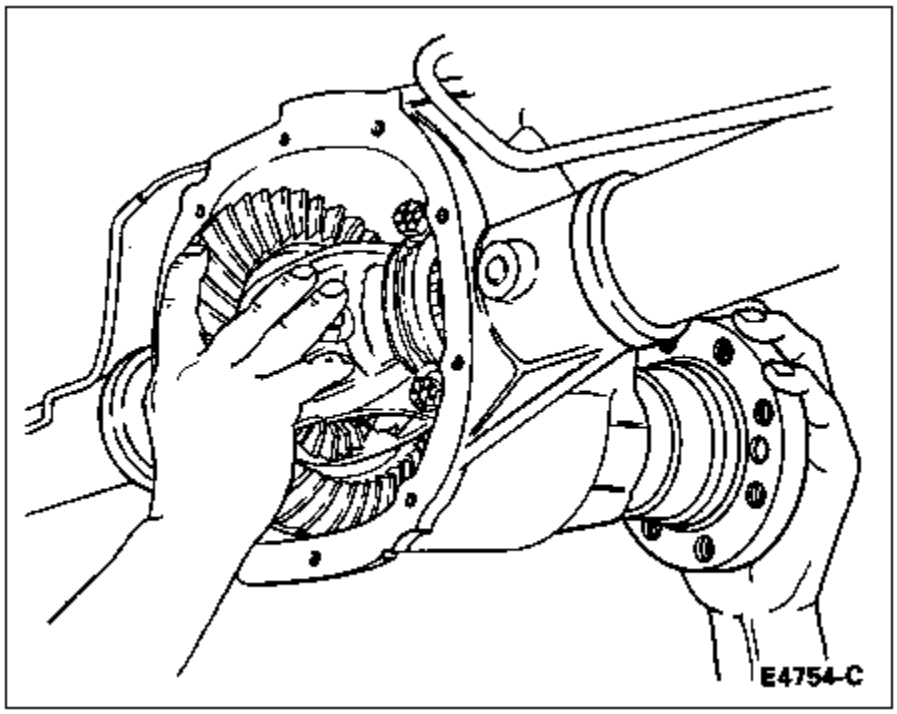
12. If backlash is not to specification, correct backlash by increasing thickness of one shim and decreasing thickness of the other shim by the same amount. Refer to chart for approximate shim change.

Backlash Change Required		Thickness Change Required		Backlash Change Required		Thickness Change Required	
mm	Inches	mm	Inches	mm	Inches	mm	Inches
.025	.001	.050	.002	.228	.009	.304	.012
.050	.002	.050	.002	.254	.010	.355	.014
.076	.003	.101	.004	.279	.011	.355	.014
.101	.004	.152	.006	.304	.012	.406	.016
.127	.005	.152	.006	.330	.013	.457	.018
.152	.006	.203	.008	.355	.014	.457	.018
.178	.007	.254	.010	.381	.015	.508	.020
.203	.008	.254	.010	—	—	—	—



13. Install shim and bearing retaining caps. Tighten cap bolts to 95-115 Nm (70-85 lb-ft).

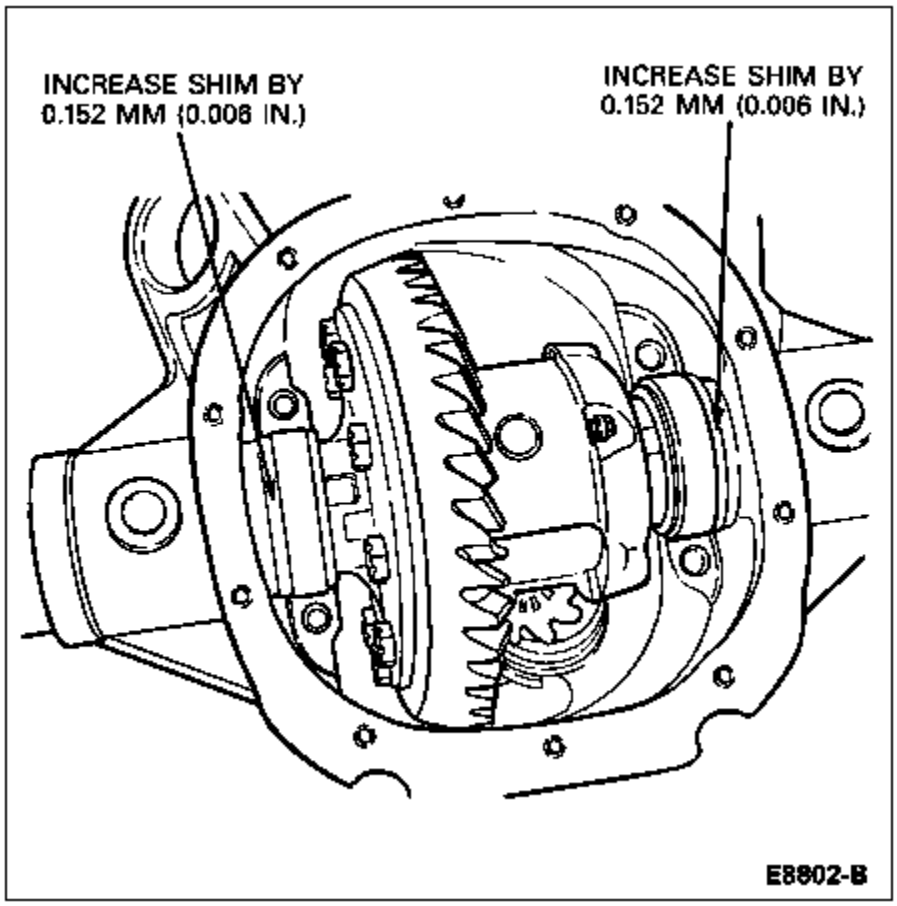
14. Rotate assembly several times to make sure differential bearings are properly seated.

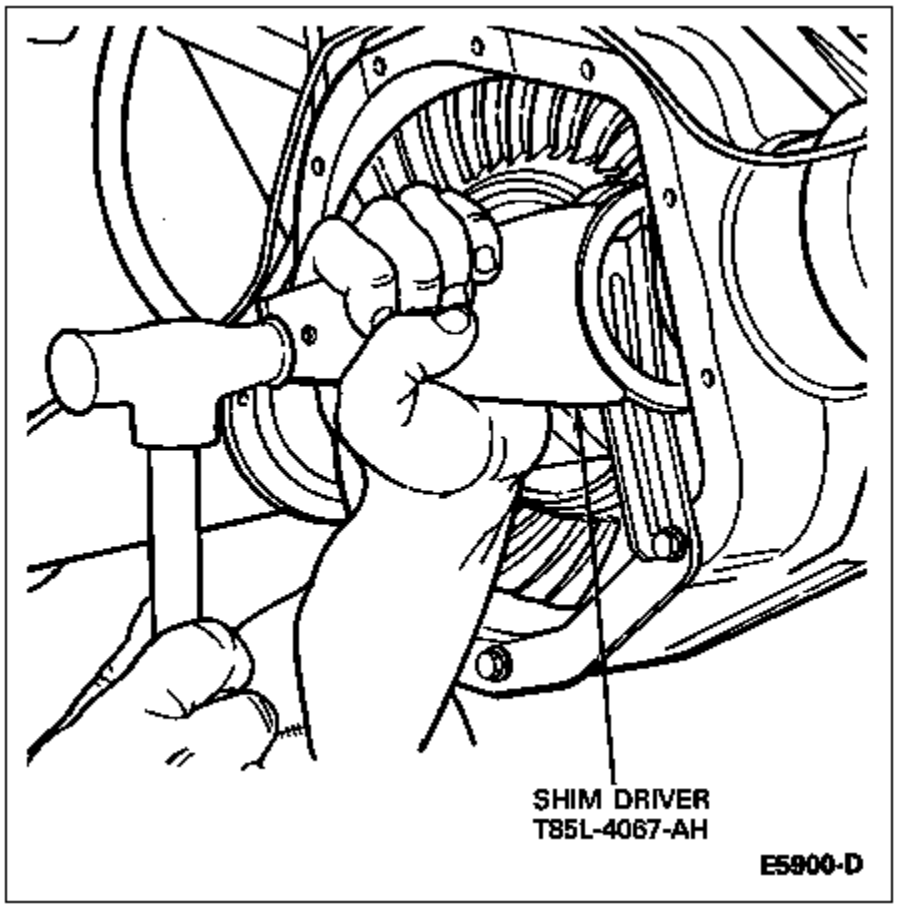


15. Recheck backlash. If backlash is within specification, go to Step 16. If backlash is not within specification, repeat Step 12.

    Backlash Specification: 0.20-0.38mm (0.008-0.015 inch) (0.30-0.38mm [0.012-0.015 inch] preferred).

16. Remove bearing caps and bolts. To establish differential bearing preload, increase both left and right shim sizes by 0.152mm (0.006 inch) and install using Shim Driver T85L-4067-AH. Make sure shims are fully seated and assembly turns freely.


INCREASE SHIM BY
0.152 MM (0.006 IN.)
INCREASE SHIM BY
0.152 MM (0.006 IN.)
E8802-B

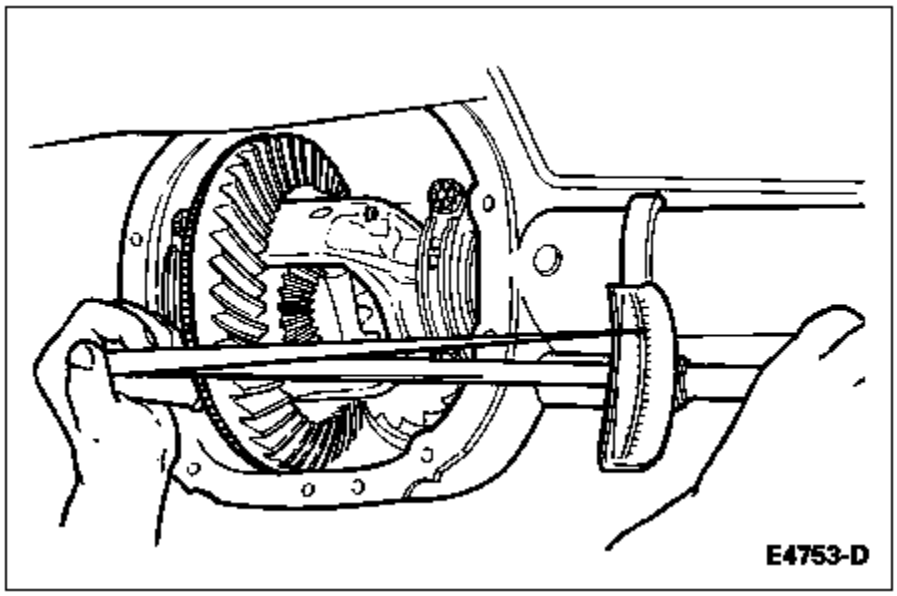


17. **NOTE: Triangles on bearing caps must point outboard.**

    Install bearing caps and tighten bolts to 95-115 Nm (70-85 lb-ft). Recheck backlash. If not to specification, repeat Step 12.

18. Utilize white marking compound to obtain a tooth mesh contact pattern in your assembly. Pattern legibility can be improved by connecting the driveshaft and rotating both tires in drive and coast direction.

    Reincorporation of pattern inspection is intended to allow technician the ability to detect gross errors in setup prior to complete reassembly. Pattern contact should be within the primary area of the ring gear and pinion tooth surface avoiding any "narrow" or "hard" contact with outer perimeter of tooth (top to root, toe to heel). Pattern inspection should be on the drive (pull) side. Assembly with correct drive pattern will result in satisfactory coast performance. If gross pattern error is detected with preferred backlash (0.30-0.38mm [0.012-0.015 inch]), recheck pinion shim selection.

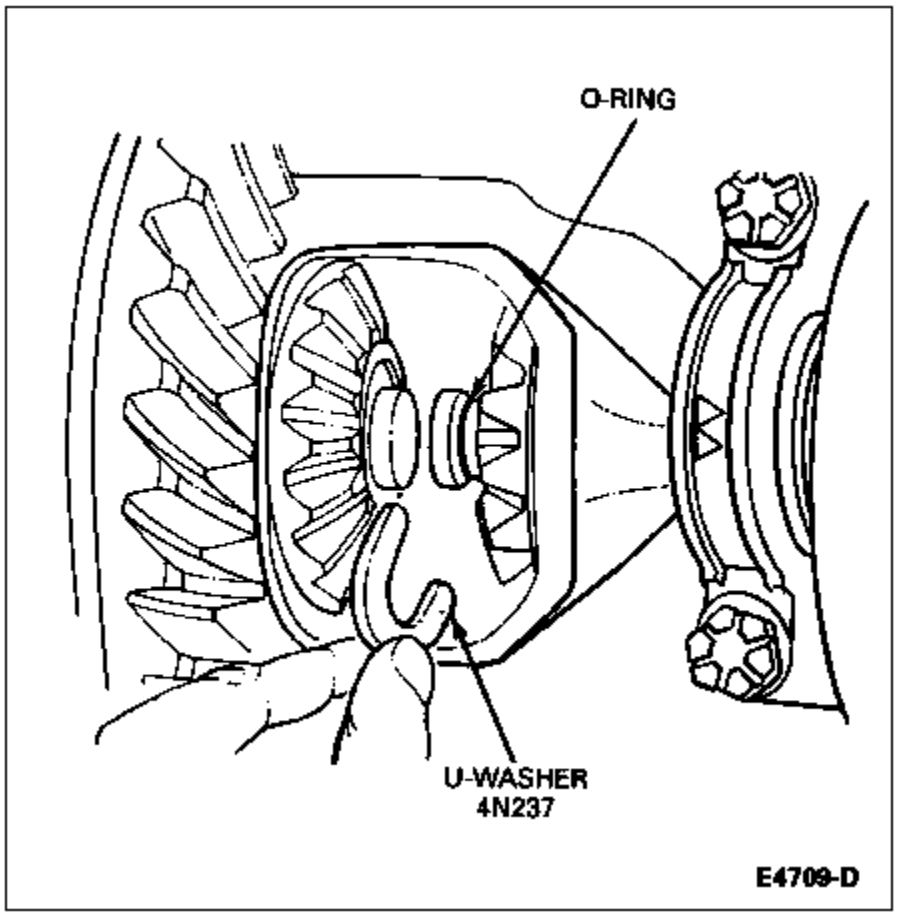


Axle Shaft Installation

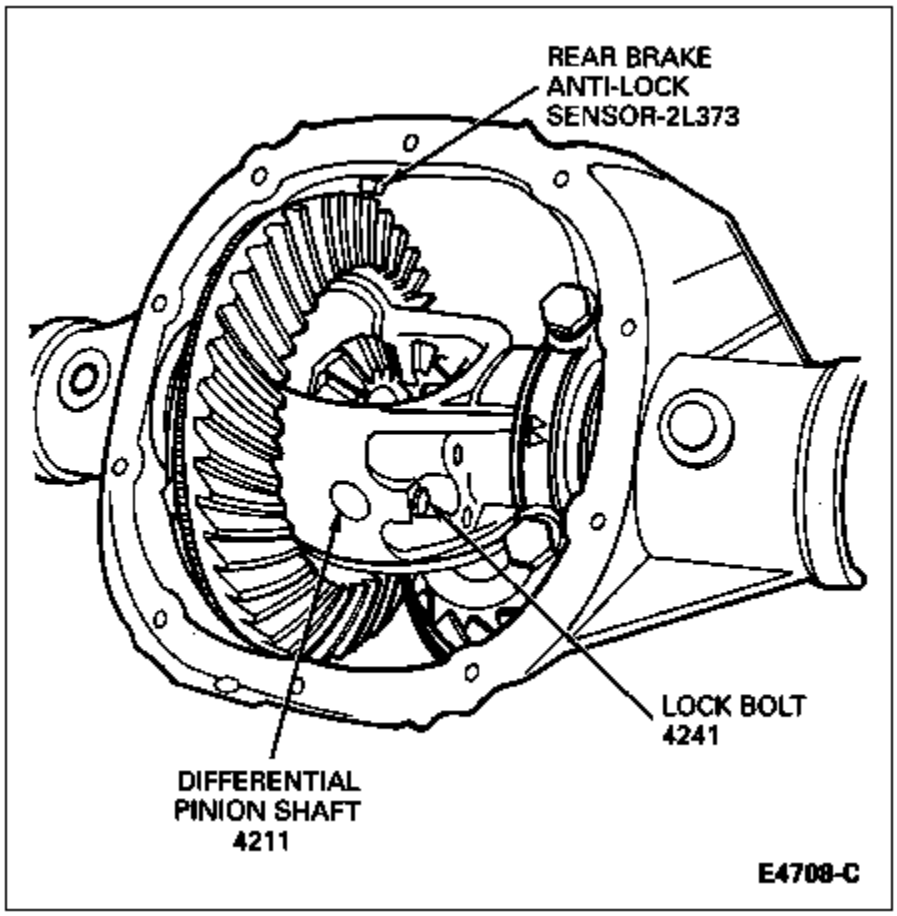
1. Slide the axle shafts (4234) into place in the axle housing. Exercise care so that the splines or any portion of the axle shafts do not damage the oil seals. Push the axle shafts inboard enough to allow installation of the U-washer.

2. **NOTE: A rubber O-ring is used to hold the U-washer in position on the axle shaft. Be sure that the O-ring is in the groove at the end of the axle shaft before installing the U-washer.**

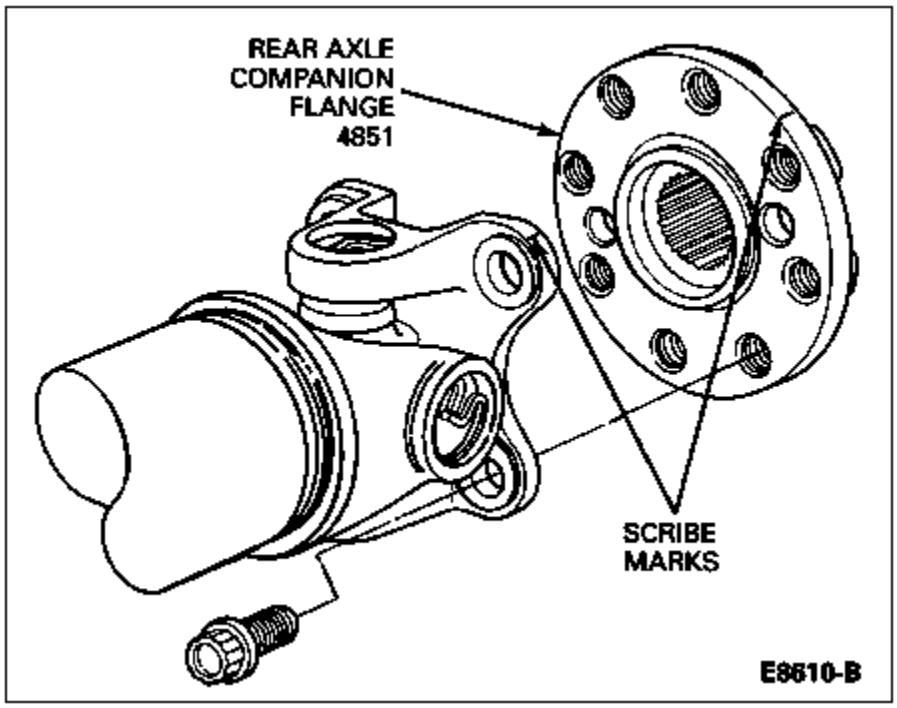
   Install the axle shaft U-washer on the button end of the axle shafts, and push the axle shafts outboard so that the axle shaft U-washer seats in the counterbore of the differential side gear (4236).



3. Position the differential pinion shaft (4211) through the differential case and pinions, aligning the hole in the differential pinion shaft with the lock bolt hole. Apply Stud and Bearing Mount E0AZ-19554-BA or equivalent meeting Ford specification WSK-M2G349-A1 to the lock bolt threads. Install lock bolt and tighten to 20-40 Nm (15-30 lb-ft).



4. Remove the oil seal replacer from the extension housing (7A039). Install the driveshaft in the extension housing. Align the scribe marks on the flange and driveshaft and connect the driveshaft at the rear axle companion flange. Tighten attaching bolts and nuts to companion 11-20 Nm (8-15 lb-ft) for half round rear axle companion flange and 95-128 Nm (70-95 lb-ft) for circular rear axle companion flange.



5. Install the brake drums (1126).

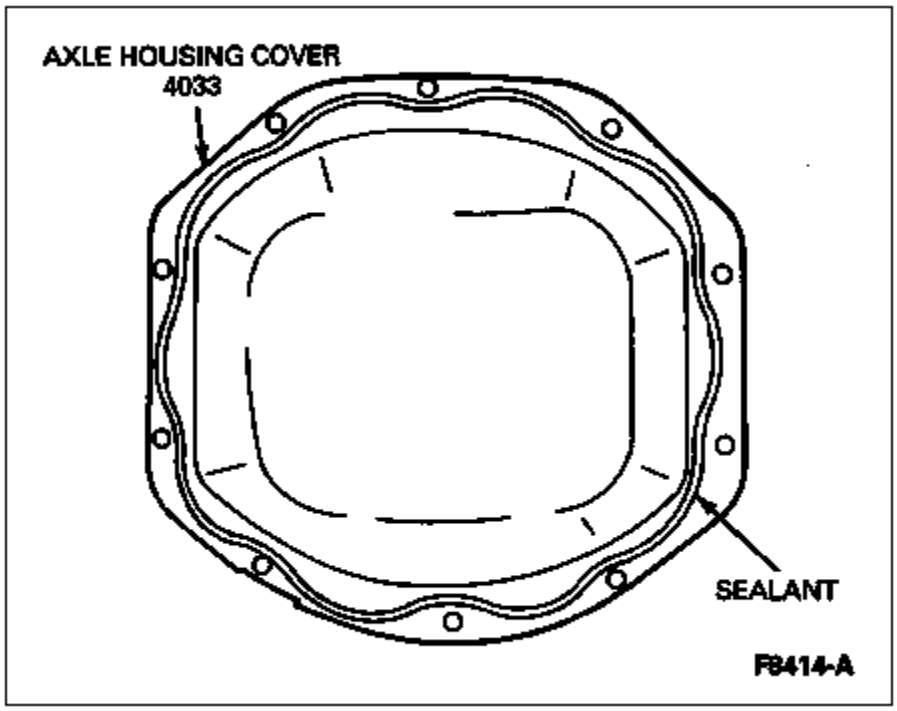
6. Install the wheels and tires. Tighten the wheel lug nuts to 115-156 Nm (85-115 lb-ft). Install the wheel covers.

Cover Installation

1. **CAUTION: Make sure machined surfaces on the carrier are clean and free of oil. Inside of rear axle must be covered when cleaning the machined surface to prevent contamination.**

   Thoroughly clean the gasket mating surface of the rear axle differential carrier casting.

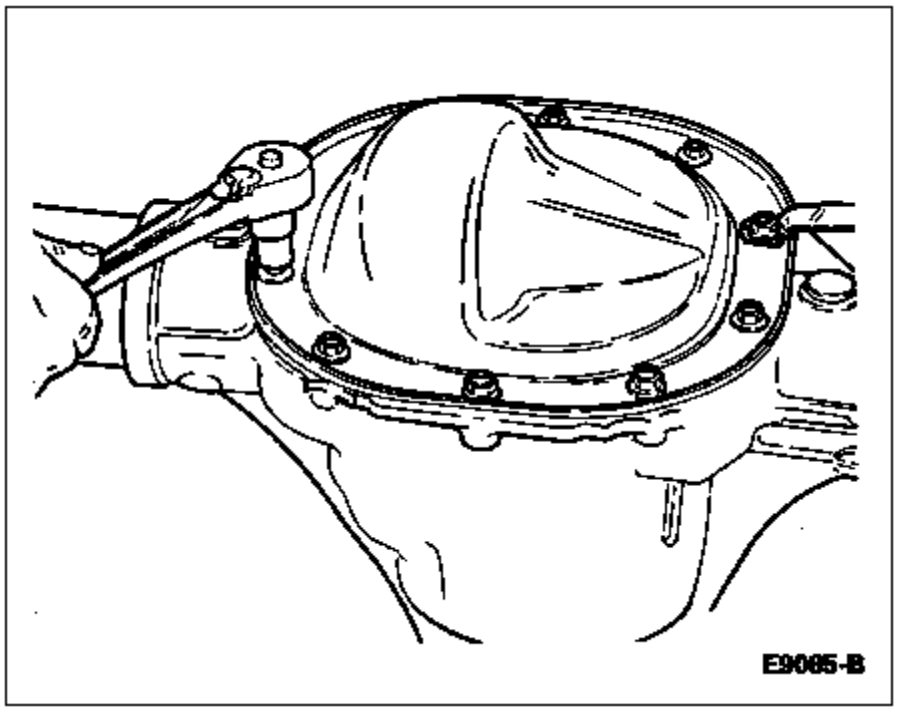
2. Apply a new continuous bead of Silicone Rubber D6AZ-19562-AA or equivalent meeting Ford specification ESB-M4G92-A or ESE-M4G195-A to the new axle housing cover (4033).



3. **NOTE: Ranger and Aerostar vehicles are equipped with SMC plastic axle housing covers. Always install new SMC plastic axle housing cover and bolts whenever removed.**

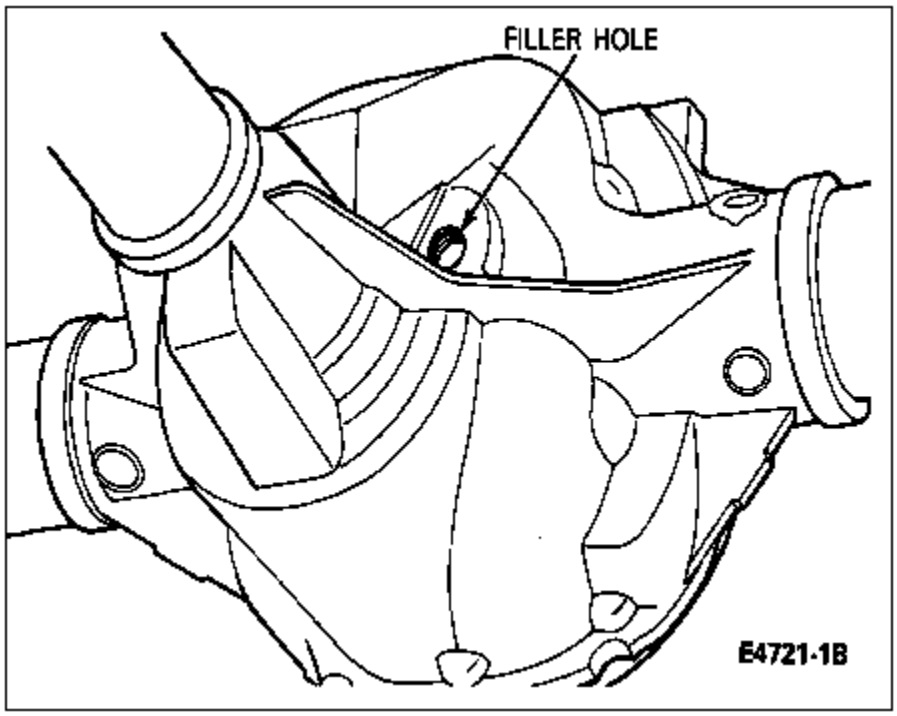
   NOTE: Axle housing cover must be installed within 15 minutes of application of the silicone or new sealant must be applied.

   Install new axle housing cover and tighten new rear axle housing cover bolts to 21-27 Nm (15-20 lb-ft) as shown. Tighten the bolts in a crosswise pattern to make sure axle housing cover seals properly.



4. Add lubricant through the filler hole until the lubricant level is 6.35mm (1/4 inch) to 14.28mm (9/16 inch) below the bottom of the filler hole with the rear axle in the running position. Use Premium Rear Axle Lubricant XY-80W90-QL or equivalent meeting Ford specification WSP-M2C197-A, plus two ounces of Friction Modifier F3TZ-19B546-MA or equivalent meeting Ford specification WSP-M2C196-A, for complete refill of Traction-Lok® Rear Axles. Install the filler plug and tighten to 20-40 Nm (15-30 lb-ft).

5. Lower vehicle and road test.


FILLER HOLE
E4721-1B

Sensor, Anti-Lock Brake

Removal

1. Remove rear anti-lock sensor hold-down bolt. Remove rear brake anti-lock sensor.

2. Clean rear axle mounting surface, using caution to prevent dirt from entering axle housing.

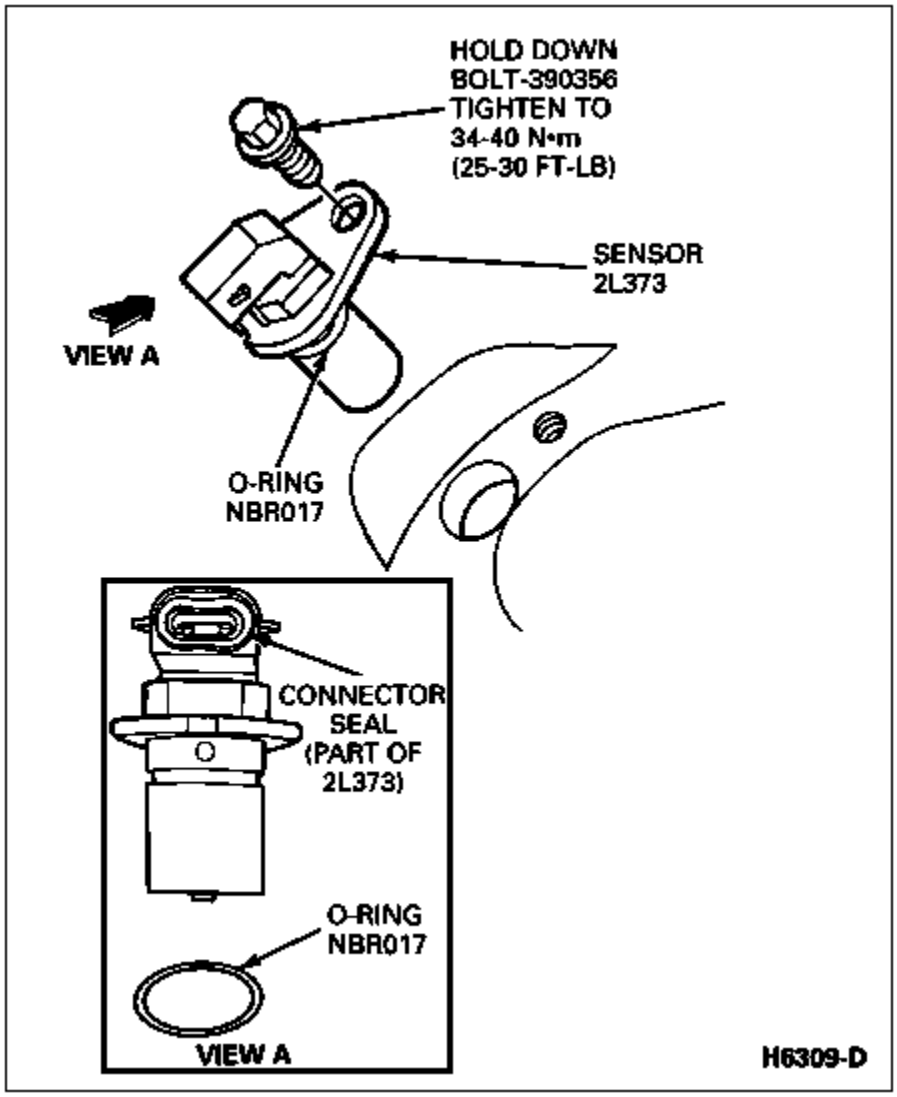
Installation

1. If new rear brake anti-lock sensor is to be installed, lightly lubricate O-ring with motor oil.

    a. Firmly grasp rear brake anti-lock sensor at sides (do not install by applying force on connector) and push into axle housing, aligning mounting flange hole with threaded hole in axle housing.
    b. Install hold-down bolt and tighten to 34-40 Nm (25-30 lb-ft).

2. If old rear brake anti-lock sensor is to be reinstalled, clean and blow off metal particles using shop air.

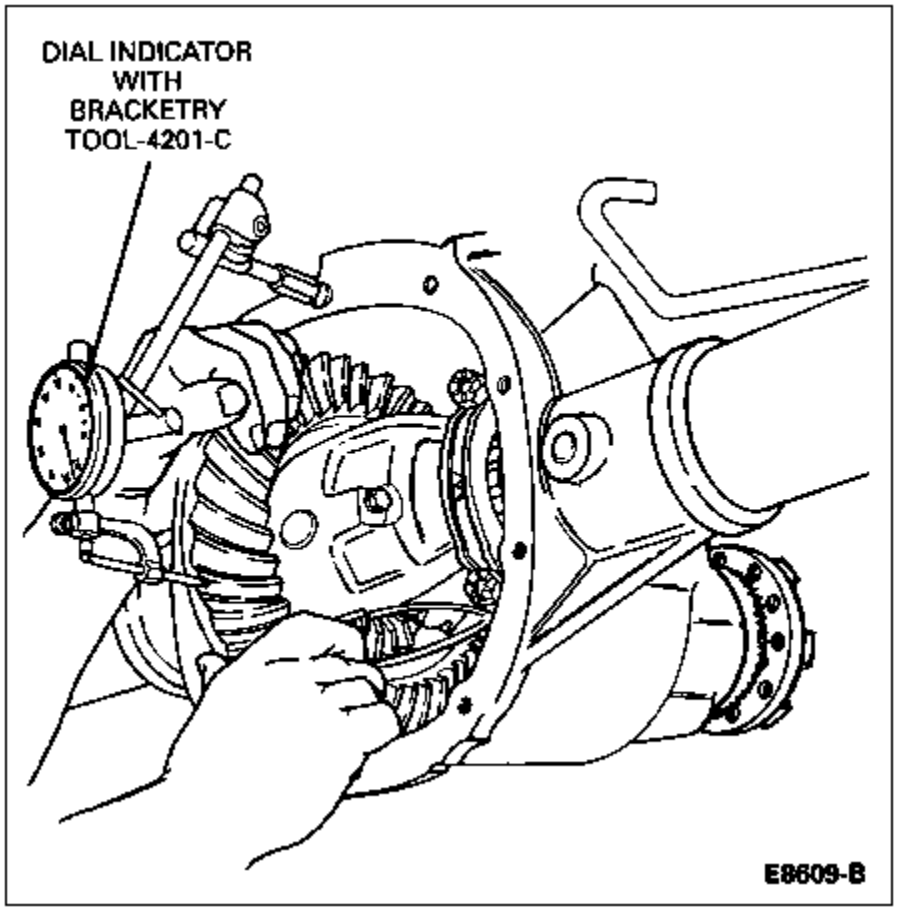
    a. Remove and replace O-ring with a new O-ring.
    b. Apply a light film of motor oil to O-ring.
    c. Firmly grasp rear brake anti-lock sensor at sides (do not install by applying force on connector) and push into axle housing, aligning mounting flange hole with threaded hole in axle housing.
    d. Install hold-down bolt and tighten to 34-40 Nm (25-30 lb-ft).

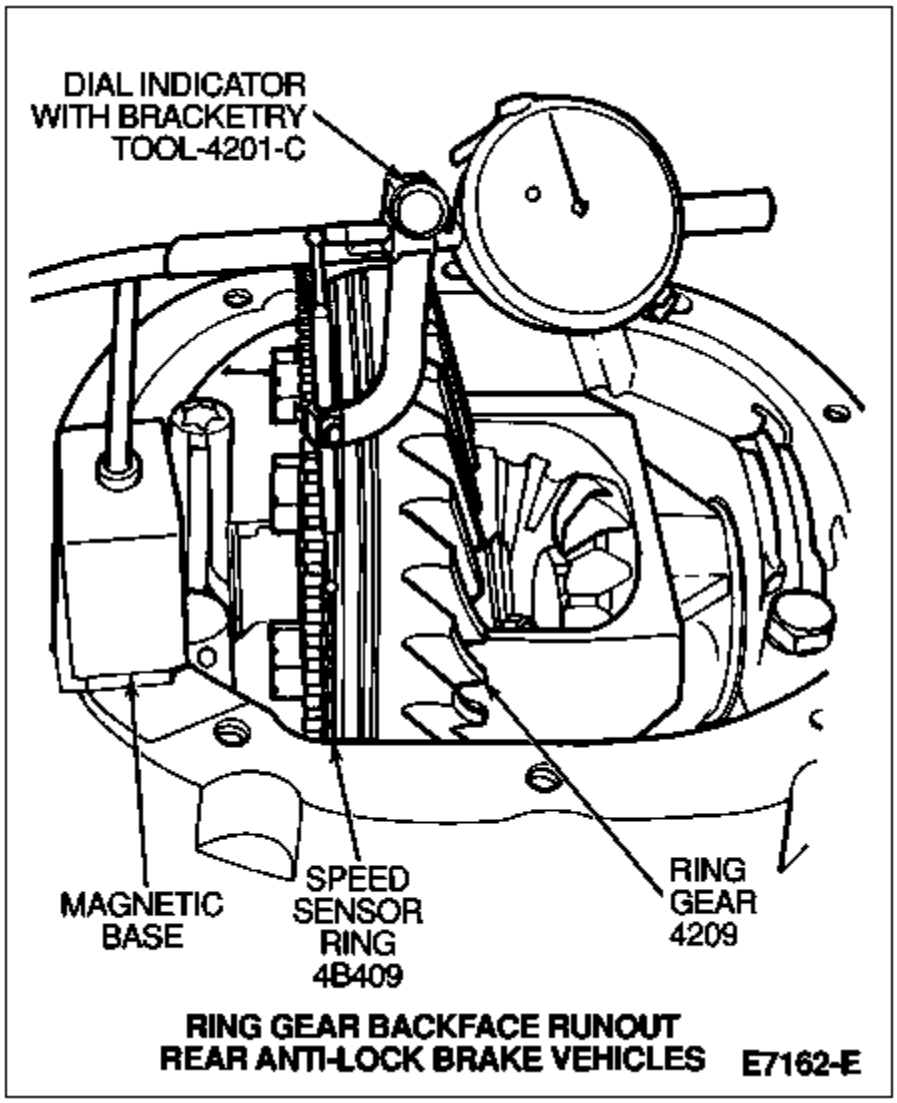

HOLD DOWN
BOLT-390356
TIGHTEN TO
34-40 N•m
(25-30 FT-LB)
SENSOR
2L373
VIEW A
O-RING
NBR017
CONNECTOR
SEAL
(PART OF
2L373)
O-RING
NBR017
VIEW A
H6309-D

Inspection Before Disassembly of Carrier

The differential case (4204) and ring gear and pinion should be inspected before they are removed from the carrier. These inspections can find the cause of the concern and determine the resolution.

1. Remove axle housing cover. Refer to procedure in this section.
2. Wipe the lubricant from the internal working parts and visually inspect the parts for wear or damage.
3. Rotate the gears to see if there is any roughness which would indicate damaged bearings or gears.
4. Check the ring gear teeth for signs of scoring, abnormal wear, nicks or chips.
5. Set up a dial indicator, and check ring gear backlash and ring gear backface runout. Backlash should be 0.008-0.015 inch (0.012-0.015 inch preferred).





6. **NOTE: There is a space provided between the anti-lock speed sensor ring and the ring gear and pinion for measuring ring gear backface runout.**

   To check ring gear backface runout, mount Dial Indicator with Bracketry TOOL-4201-C or equivalent on the carrier so the tip of the dial indicator contacts the backface of ring gear and pinion. Backface runout should be no more than 0.101mm (0.004 inch).

7. A contact pattern may not always be an acceptable guide to check for noise. However, if the pattern is incorrect, the rear axle (4001) will probably be noisy. Refer to Section 00-04 for contact pattern example. Proper ring gear and pinion assembly must be checked using the Rear Axle Pinion Depth Gauge Tool set which shows the correct pinion shim required to assure acceptable running condition. Refer to Axle Assembly in this section.

8. Inspect the rear brake anti-lock sensor for loose metal particles and clean if required.

9. Examine the anti-lock speed sensor ring to see that it is firmly pressed onto the differential case and check it for dented, chipped or missing teeth that could result in erratic anti-lock brake systems performance. If damage is found, remove and replace anti-lock speed sensor ring.

Inspection After Disassembly of Carrier

1. Thoroughly clean all parts. Always use new solvent when cleaning bearings. Do not spin-dry bearings with compressed air.

2. Oil the bearings immediately to prevent rusting.

3. Inspect the parts for any major damage.

4. Clean the inside of the differential case (4204) before rebuilding. When a scored or chipped ring gear and pinion is replaced, the differential case must be washed thoroughly.

   Inspection procedures for individual parts follow.

Gears

Examine the pinion and ring gear and pinion teeth for scoring, excessive wear, nicks and excessive chipping. Worn, scored and damaged gears cannot be rebuilt to correct a noisy condition.

Bearing Cups

Check pinion bearing cups for deep scores, galling, or spalling. If a 0.038mm (0.0015 inch) feeler gauge can be inserted between a pinion bearing cup and the bottom of its bore at any point around the pinion bearing cup, the pinion bearing cup must be reseated.

Cone and Roller Assemblies

When operated in the pinion bearing cups, cone and roller bearings must turn without roughness. Examine the roller ends for step wear. If inspection reveals either a damaged pinion bearing cup or a damaged cone and roller, both parts should be replaced.

Carrier Housing

Make sure that the differential and differential pinion bearing bores are smooth. Remove any nicks or burrs from the mounting surfaces of the carrier housing.

Differential Case

Make sure the hubs where the differential bearings (4221) mount are smooth. Carefully examine the differential case bearing shoulders, which may have been damaged when the differential cases was removed. The differential bearings will fail if they do not seat firmly against the shoulders. Check the fit (free rotation) of the differential side gear (4236) in their counterbores.

SPECIFICATIONS

Clearance, Tolerance And Adjustments

Description	mm	Inches
Available Drive Pinion Bearing Adjustment Shims in Steps of 0.001 Inch	0.53-0.94	0.021-0.037
Backlash Between Ring Gear and Pinion Teeth	0.20-0.38 (0.30-0.38 Preferred)	0.008-0.015 (.012-.015 Preferred)
Maximum Backlash Variation Between Teeth	0.10	0.004
Maximum Runout of Back Face of Differential Case Flange	0.076	0.003
Maximum Runout of (Circular) Rear Axle Universal Companion Flange in Assembly	0.30 T.I.R.	0.012 T.I.R.
Maximum Runout of Back Face of Ring Gear	0.10	0.004
Nominal Drive Pinion Shaft Locating Shim	0.76	0.030
Pinion Gear Thrust Washer Thickness	0.76-0.81	0.030-0.032
Sensor Pole to Top of Anti-Lock Ring Gap	0.13-1.14	0.005-0.045
Side Gear Thrust Washer Thickness	0.76-0.81	0.030-0.032

Lubricant Specifications

Premium Long-Life Grease XG-1-C or K or equivalent Ford specifications ESA-M1C75-B.
Silicone Rubber Sealant D6AZ-19562-AA or equivalent meeting Ford specifications ESB-M4G92-A or ESE-M4G195-A.

Lubricant Capacities

Vehicle	Engine	Axle	Approximate Lubricant Capacity [a]			Lubricant Level [b]
			U.S. Pints	Imperial Pints	Liters	
Aerostar, Ranger	All	8.8 Inch Ring Gear	5.0	4.2	2.4	1/4-9/16

[a] All conventional and Traction-Lok® Axles use Premium Rear Axle Lubricant, XY-80W90-QL or equivalent meeting Ford specification WSP-M2C197-A plus 2 ounces of friction modifier F3TZ-19B546-MA or equivalent meeting Ford specification WSP-M2C196-A for complete refill of Traction-Lok® rear axles.
[b] Lubricant level is determined by filling the rear axle 1/4 inch to 9/16 inch below the bottom of the filler hole with the vehicle on a level surface.

Note: Rear axle lube quantities must be replaced every 160,000 km (100,000 miles) or if the rear axle has been submerged in water. Otherwise, the lube should not be checked or changed unless a leak is suspected or repair required.

Torque Specifications

Description	Nm	Lb-Ft
Axle Housing Cover Bolts	21-27	15-20
Bolts, Driveshaft to Half-Round Companion Flange	11-20	8-15
Bolt, Rear Brake Anti-Lock Sensor	34-40	25-30
Bolt, Upper Spring Retainer, Aerostar	40-55	30-40
Brake Backing Plate Nuts	28-54	21-40
Control Arm to Axle Retaining Bolt, Aerostar	210-285	155-210
Control Arm to Left Frame Bracket Retaining Nut, Aerostar	81-135	60-100
Control Arm to Right Frame Bracket Retaining Nut, Aerostar	125-170	92-125
Differential Bearing Cap Bolt	95-115	70-85
Differential Pinion Shaft Nut Minimum Torque	217	160
Differential Pinion Shaft Lock Bolt [a]	20-40	15-30
Driveshaft and Coupling Shaft to (Circular) Rear Axle Universal Joint Flange Attaching Bolts [a]	95-128	70-95
Nut, Lower Spring Retainer, Aerostar	55-88	41-65
Nut, Rear Axle Bumper, Aerostar	40-55	30-40
U-Bolts, Nuts, Ranger	88-118	65-87
Nut, Rear Suspension Lower Arm-to-Body, Aerostar	136-175	100-129
Nut, Rear Suspension Lower Arm-to-Rear Axle, Aerostar	136-175	100-129
Oil Filler Plug	20-40	15-30
Rear Axle Housing Vent	20-34	15-25
Ring Gear Attaching Bolts [a]	95-115	70-85
Shock Absorber, Lower [a]	54-82	40-60
Wheel Lug Nuts	115-156	85-115

[a] Using Ford Stud and Bearing Mount E0AZ-19554-BA or equivalent meeting Ford specification WSK-M2G349-A1.

Torque Specifications Adjustment

Description	Rotational Torque [a]	
	Nm	(Lb-In)

Differential Pinion Bearing Preload — Collapsible Spacer	—	—
New Differential Pinion Bearings — 8.8-Inch	1.8-3.3	16-29
Used Differential Pinion Bearings — 8.8-Inch	.9-1.5	8-14

[a] Rotational torque reading taken on pinion nut with pound-inch torque wrench with pinion seal installed. Pinion Bearing Cup Tool 27Nm (20 lb/ft).

Differential Case

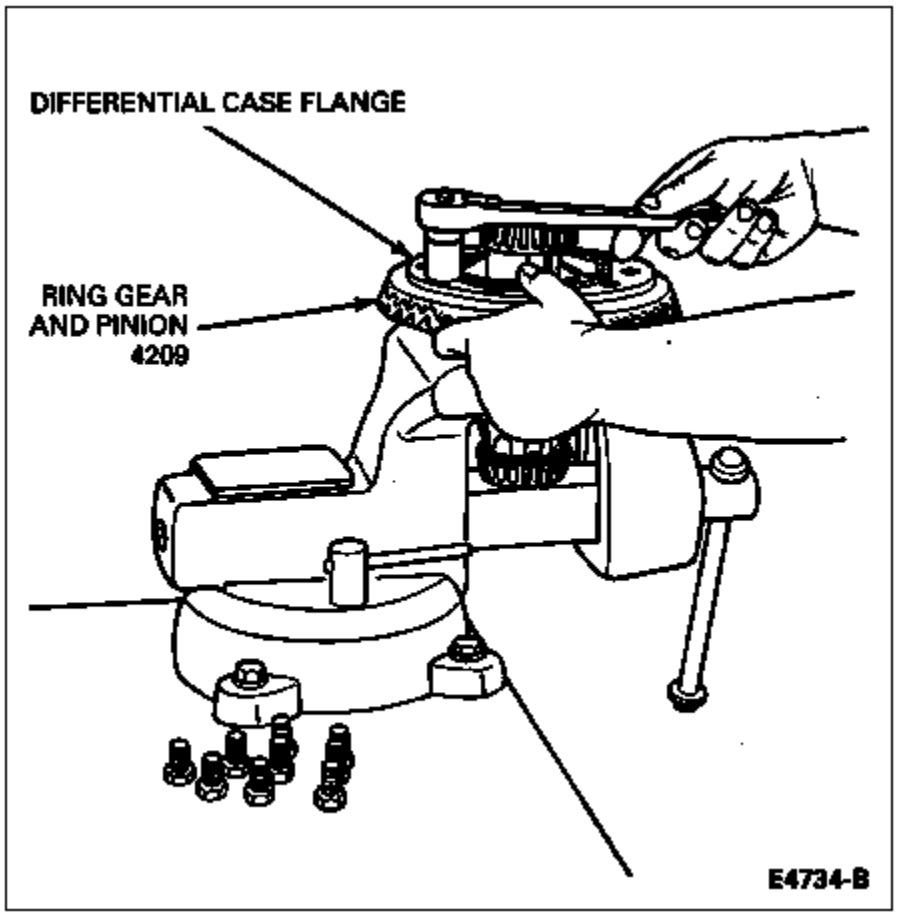
SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Gear Rotator	T84P-4205-A
Traction-Lok Torque Tool	T59L-4204-A

Disassembly

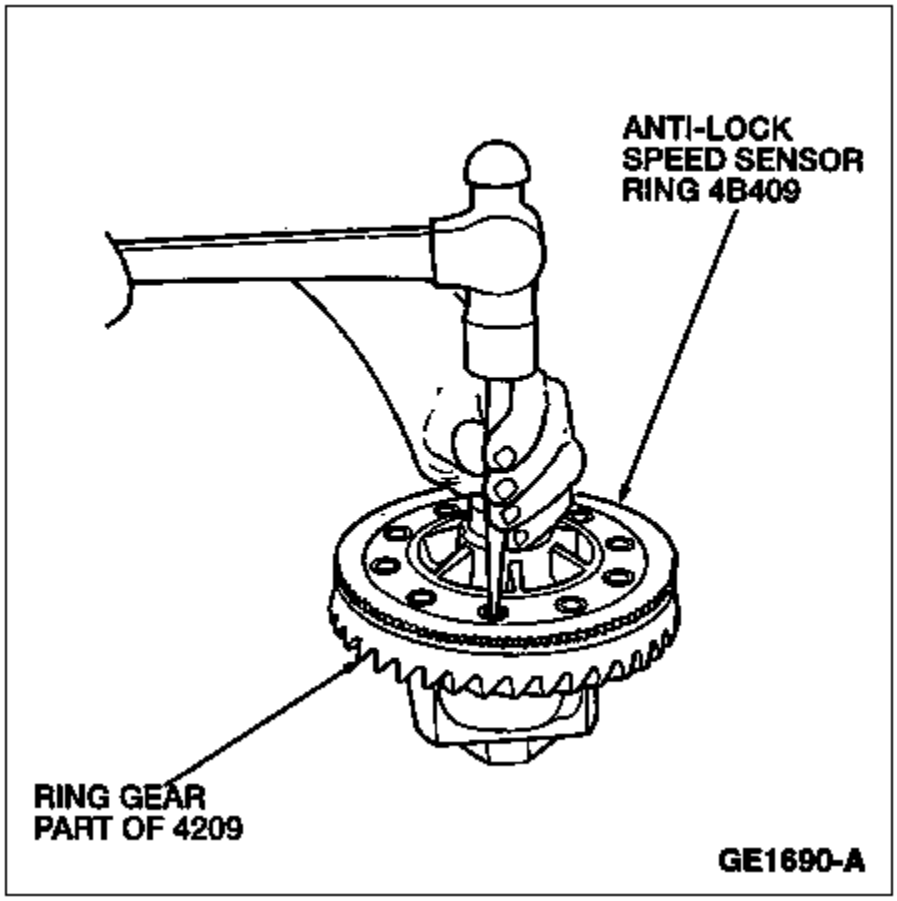
1. **NOTE: Refer to Section 05-02A , Axle, Integral Carrier, 7.5-Inch Ring Gear for Removal and Installation procedure.**

   Remove the bolts that attach the ring gear to the differential case (4204).



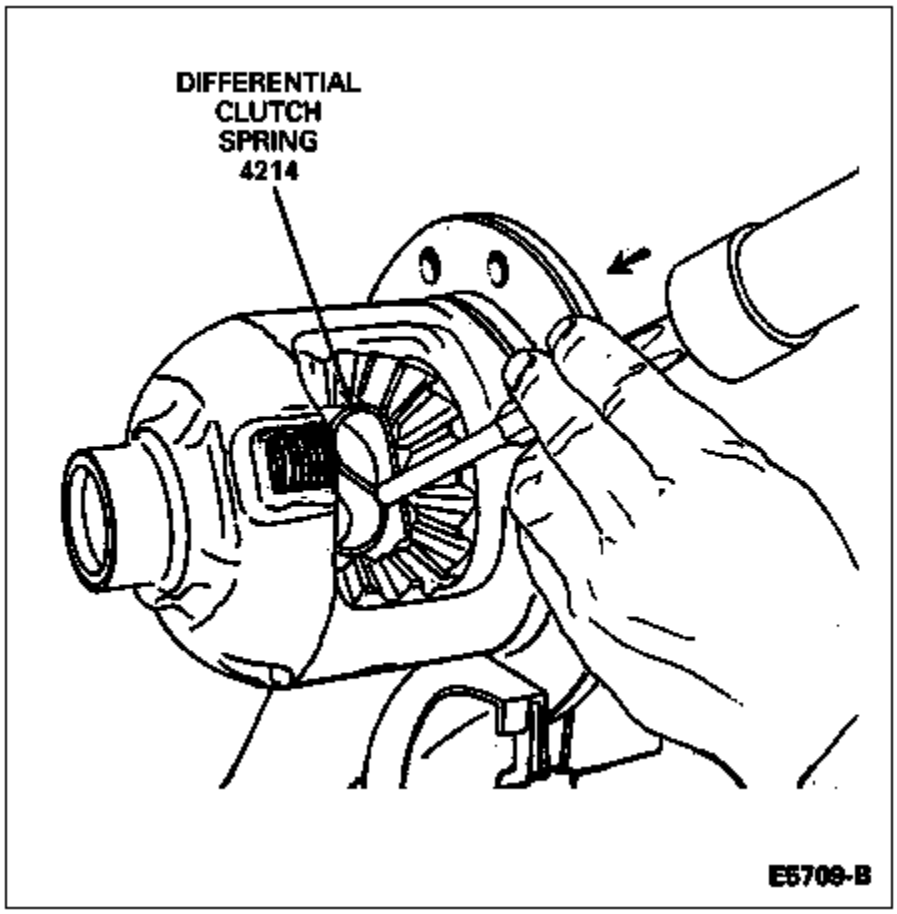
2. **CAUTION: If equipped, do not damage anti-lock speed sensor ring when removing ring gear. If anti-lock speed sensor ring is removed, it must be replaced with a new one.**

   Remove the ring gear from the differential case by striking at alternate holes around the gear.

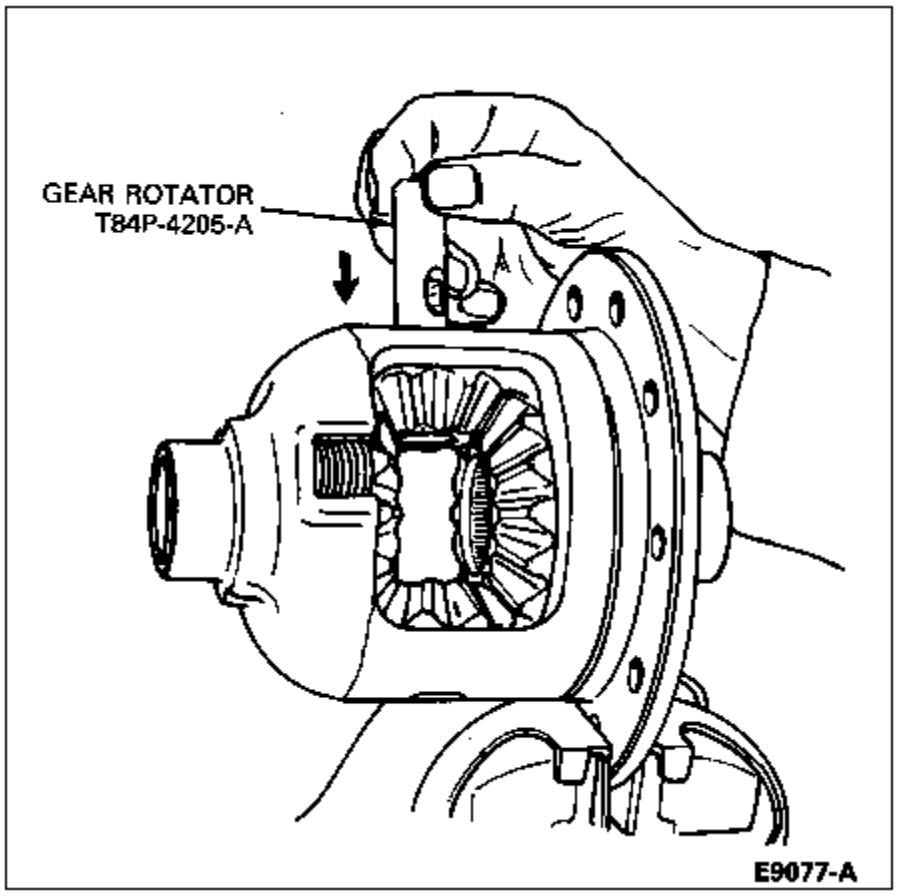


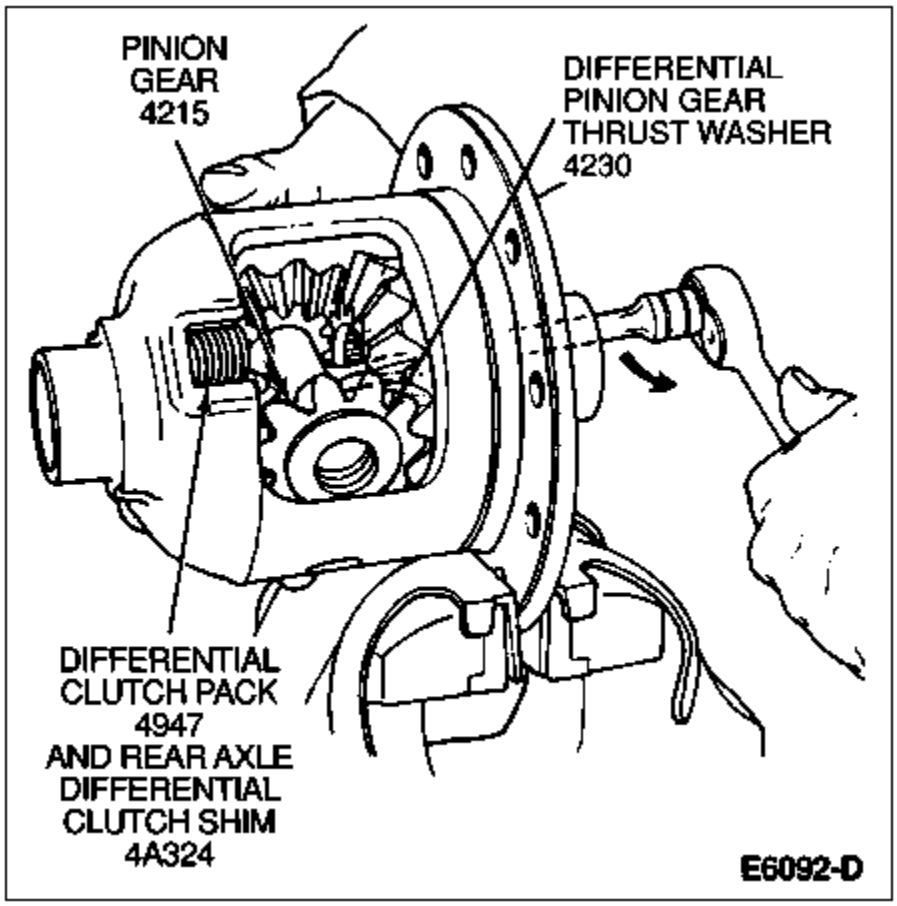
3. **WARNING: CARE MUST BE USED WHEN REMOVING THE DIFFERENTIAL CLUTCH SPRING (4214) DUE TO THE SPRING TENSION.**

   With a suitable drift, drive out the differential clutch spring.



4. Using Gear Rotator T84P-4205-A rotate the differential pinion gears until the gears and differential pinion thrust washer (4230) can be removed.


GEAR ROTATOR
T84P-4205-A
E9077-A



5. Remove the differential side gears (4236), differential side gear thrust washers, clutch packs and rear axle differential clutch shims (4A324) from the right and left cavities and tag them "right" and "left."

6. **CAUTION: Do not use cleaning solvents on clutch plate friction surfaces. Wipe clean with a lint free cloth only.**

   Clean and inspect all parts for wear or damage and replace as necessary.

Assembly

1. **NOTE: Prior to differential case assembly, be sure the clutch pack shim selection has been determined.**

   Soak all friction plates for at least 15 minutes in Additive Friction Modifier C8AZ-19B546-A meeting Ford specification EST-M2C118-A.

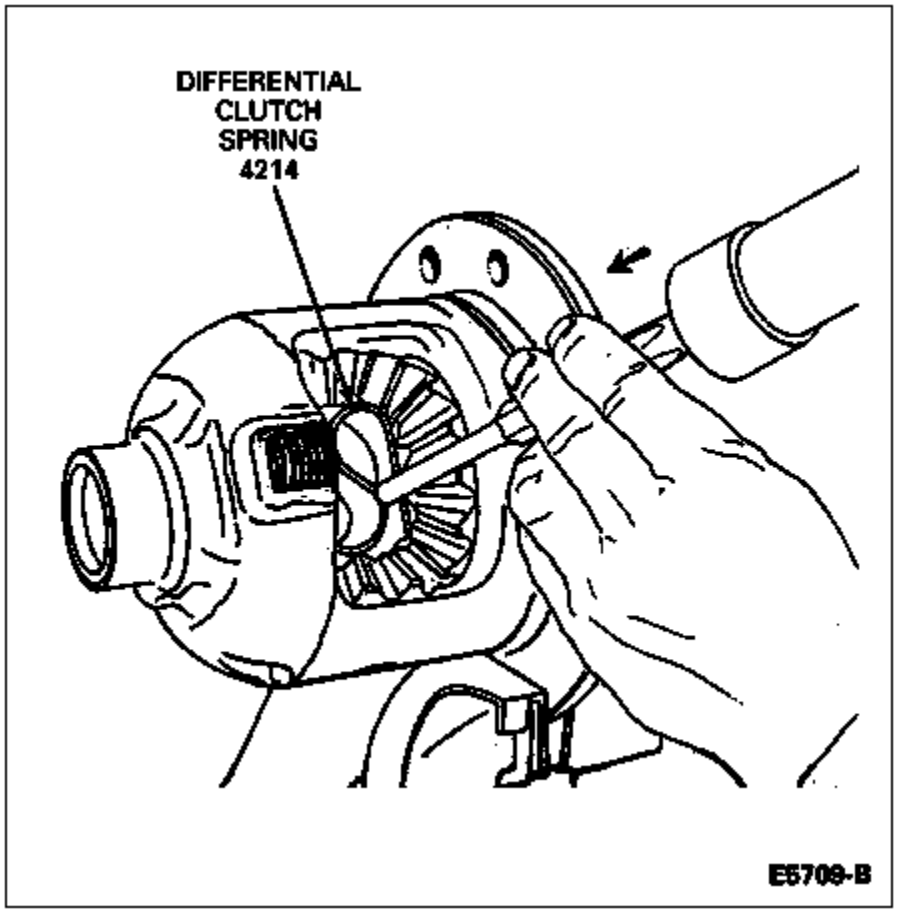
2. Mount the differential case in a soft-jawed vise and place the rear axle insulating spacers (4A947) and differential side gear in their proper cavities in the differential case.

3. Place the pinion gears and differential pinion thrust washers on the differential side gears.

4. Install Gear Rotator T84P-4205-A in the differential case, shown in Disassembly in this section.

5. Rotate the pinion gears until the bores in the gears are aligned with the pinion shaft holes in the differential case. Remove the tool from the differential case.

6. With a soft-faced hammer, install the differential clutch spring in the differential case. Inspect the differential clutch spring for damage.



7. **NOTE: Differential pinion shaft (4211) must be partially removed in order to install axleshafts.**

   Install the differential pinion shaft and lock bolt. Tighten lock bolt to specifications after the differential assembly and axleshafts have been installed in the axle housing.

8. Perform Bench Torque Test. Refer to Adjustments in this section.

9. Install differential case and differential ring gear and pinion (4209). Refer to Section 05-02A .

In-Vehicle Adjustments

SPECIAL SERVICE TOOL(S) REQUIRED

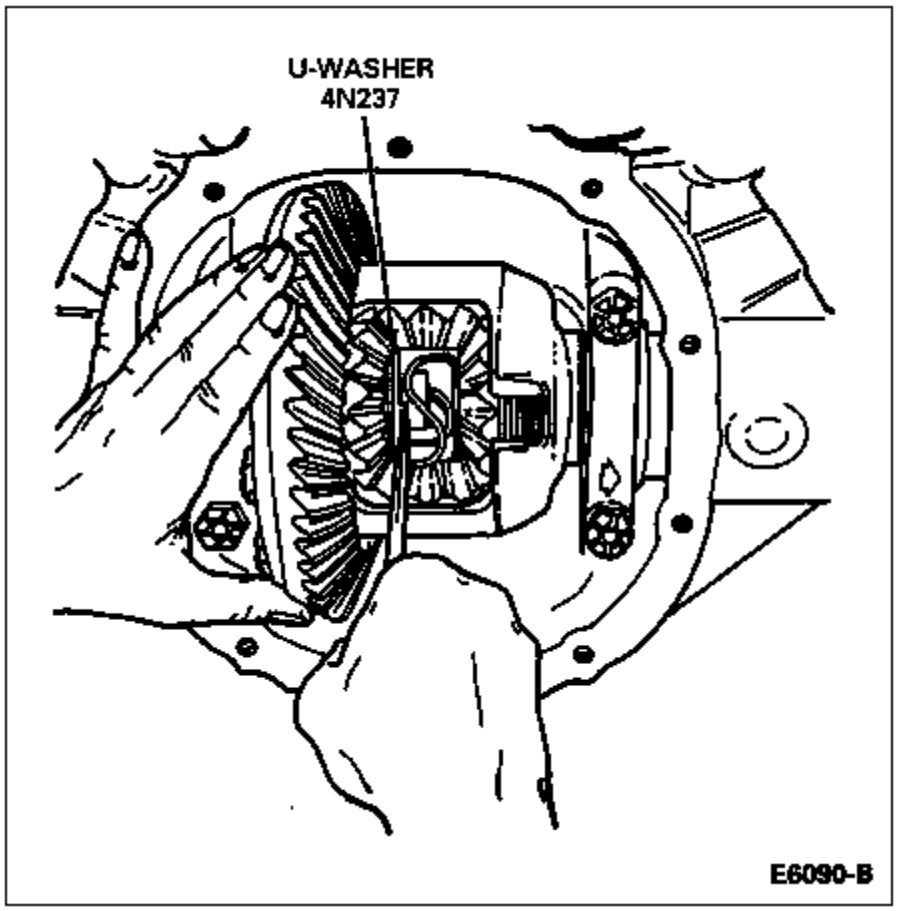
Description	Tool Number
Gear Rotator	T84P-4205-A
Traction-Lok Clutch Gauge Mandrel	T84P-4946-A
Traction-Lok Clutch Gauge Assembly	T80P-4946-A

In-vehicle adjustments are possible on this unit without removing the differential case (4204) from the axle housing. If the testing check was not to specification, the following procedure can be used to correct the condition.

Removal

1. Raise the vehicle on a hoist and install safety stands. Remove rear wheels and brake drums (1126).
2. Remove the axle housing cover (4033) from the rear face of carrier and drain the lubricant.
3. Perform the inspection before disassembly.
4. Working through the cover opening, remove the lock bolt and remove the differential pinion shaft (4211).
5. Push the axle shafts (4234) inward until the U-washer at the button end of the shafts is clear of the side gear recess.
6. **CAUTION: Care should be taken not to damage the inner wheel bearing oil seals (1177) when removing the axle shaft from the axle housing. In addition, the axle shaft must be completely removed from the axle housing.**

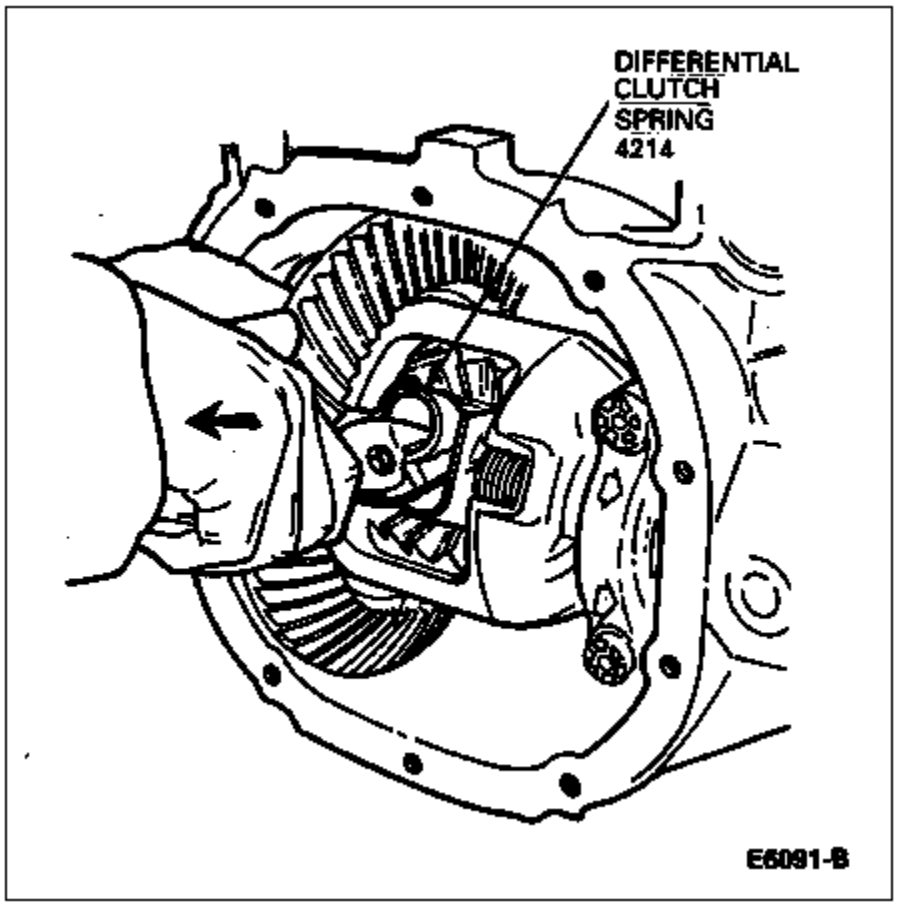
   Remove the U-washers and pull the axle shaft out of the axle housing.



7. With a suitable drift, drive the differential clutch spring (4214) half-way out of the differential case. Rotate the case 180 degrees.

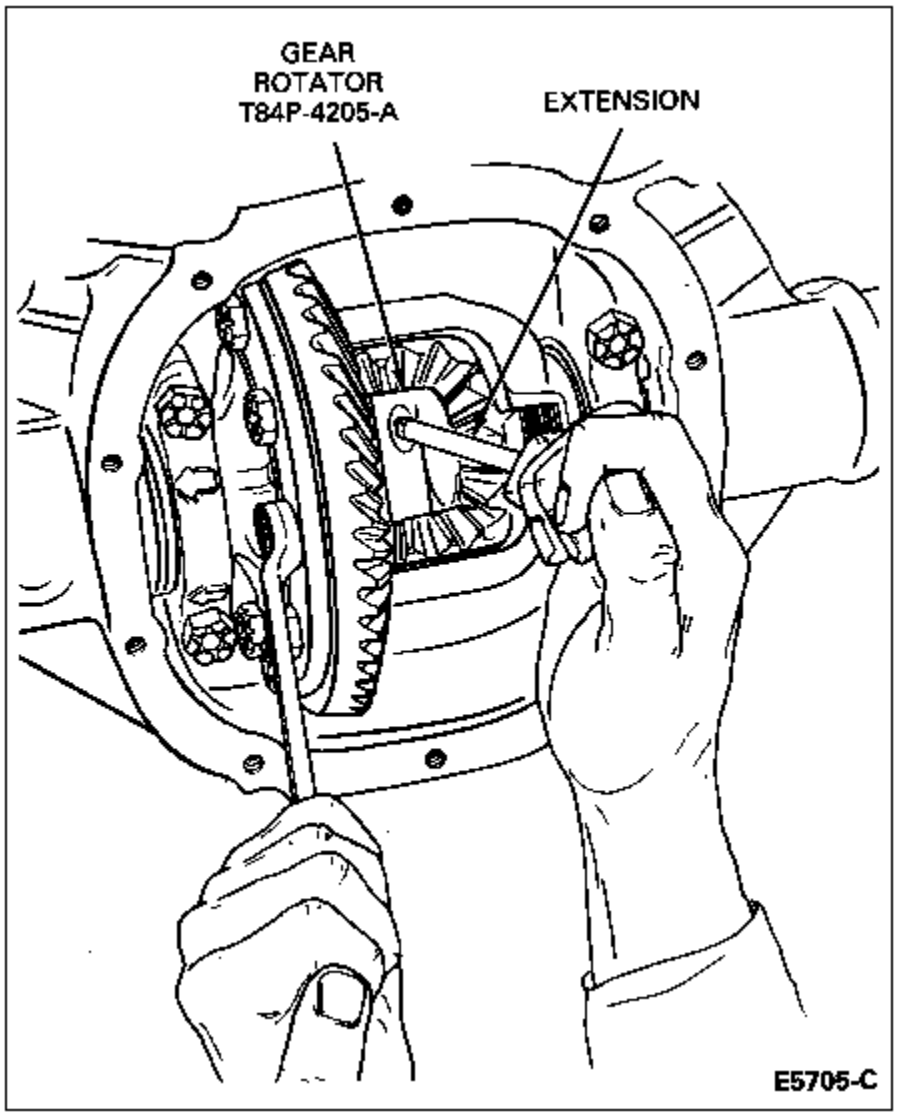
8. **WARNING: CARE MUST BE USED WHEN REMOVING THE DIFFERENTIAL CLUTCH SPRING DUE TO THE SPRING TENSION.**

   Hold the differential clutch spring with a pair of pliers and tap until it slides out of the differential case.



9. **NOTE: A 304.8mm (12-inch) extension is required to remove the pinion gears.**

   Using Gear Rotator T84P-4205-A rotate the pinion gears until they can be removed from the differential case.



10. Remove the right and left differential side gears (4236) and rear axle insulating spacers (4A947) with the rear axle differential clutch shim (4A324) and tag them "right" and "left."

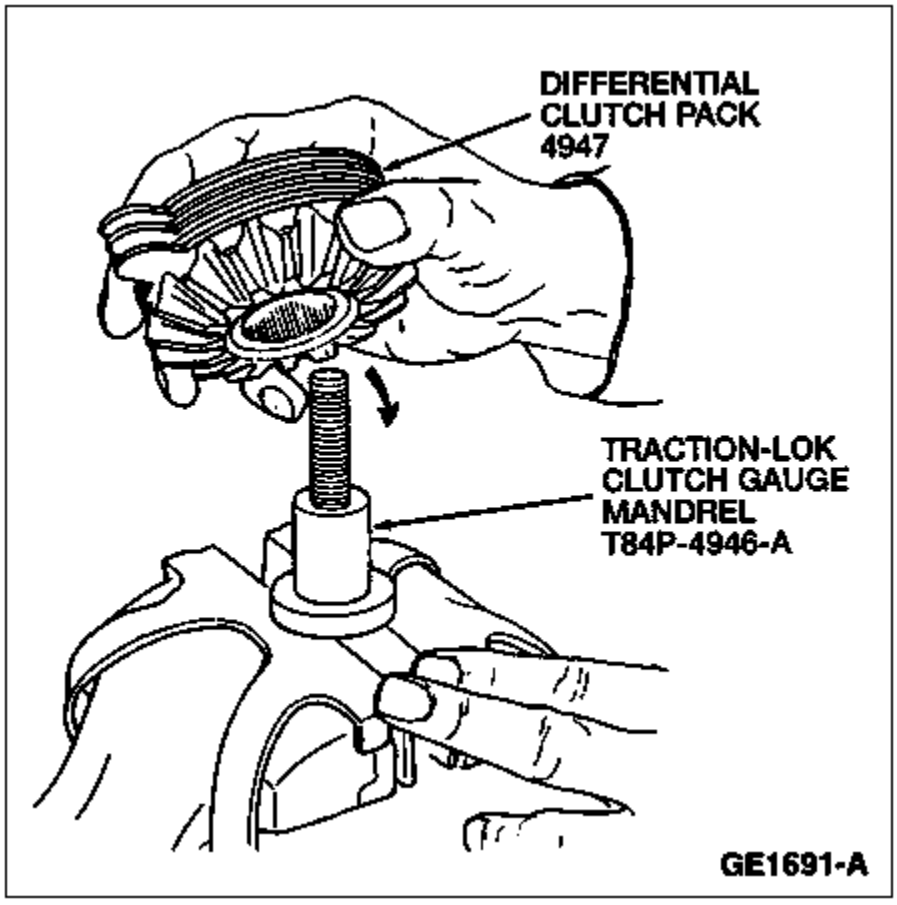
Clutch Pack Preload Adjustments

1. **NOTE: Do not use cleaning solution on clutch plate surfaces. Wipe clean with a dry cloth only.**

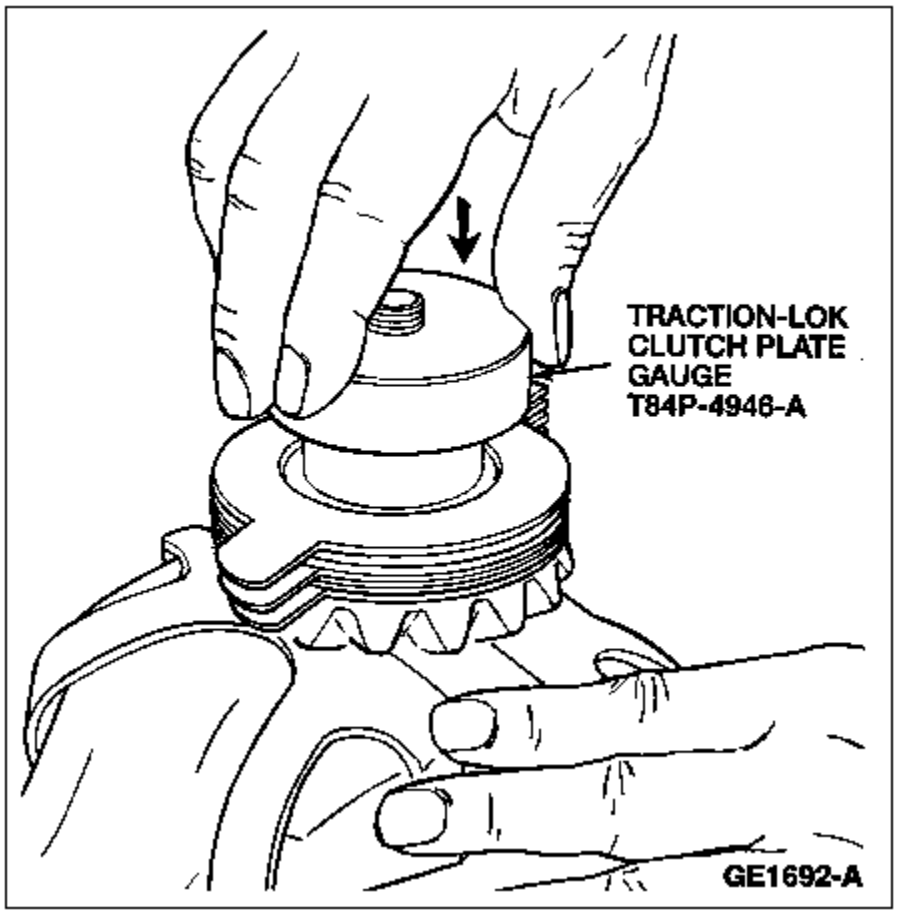
   Clean and inspect the rear axle insulating spacers (4A947) for wear and replace parts as necessary.

2. Proceed as outlined to determine the correct shim thickness required for each side gear differential clutch pack (4947).

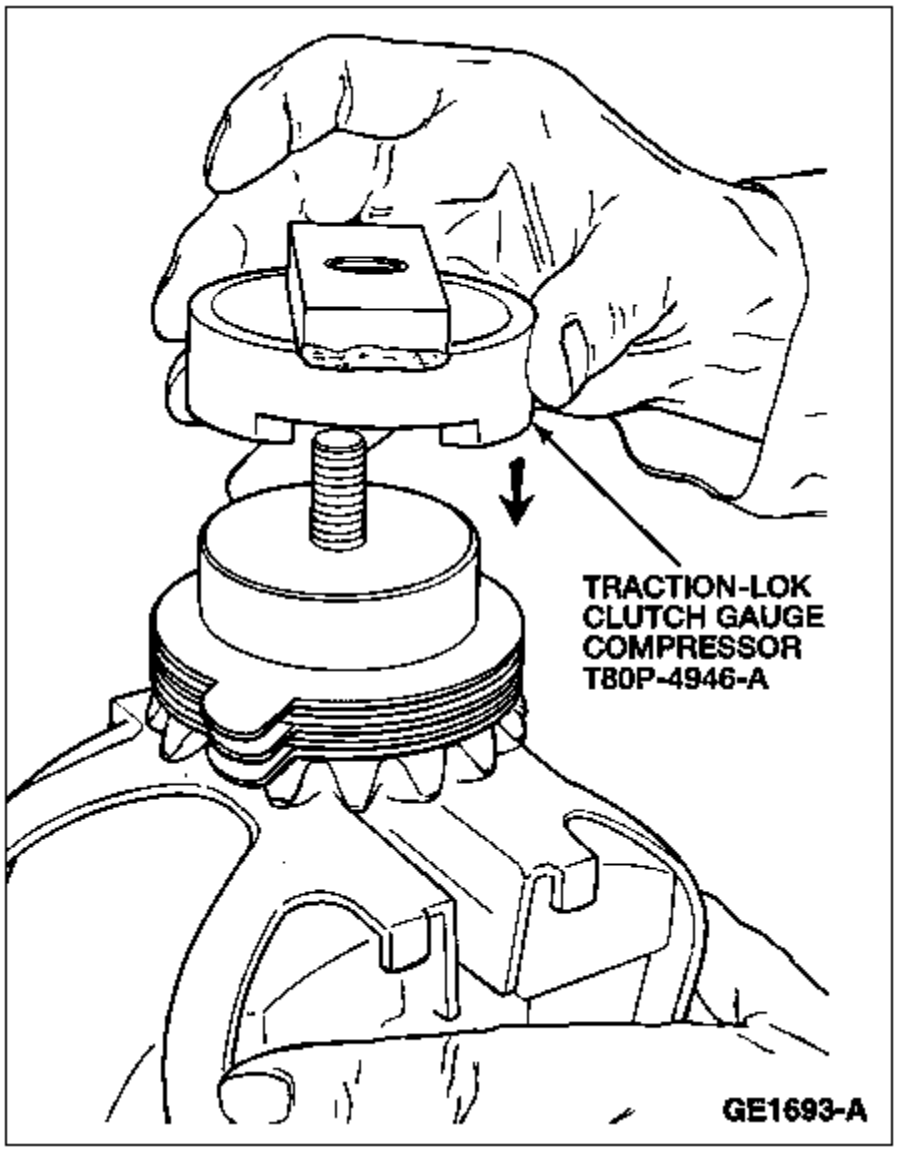
3. Clamp Traction-Lok Clutch Gauge Mandrel T84P-4946-A into a vise as shown. Assemble the differential clutch pack on the differential side gear (4236), without the rear axle differential clutch shim (4A324), over the shaft of the gauge mandrel.



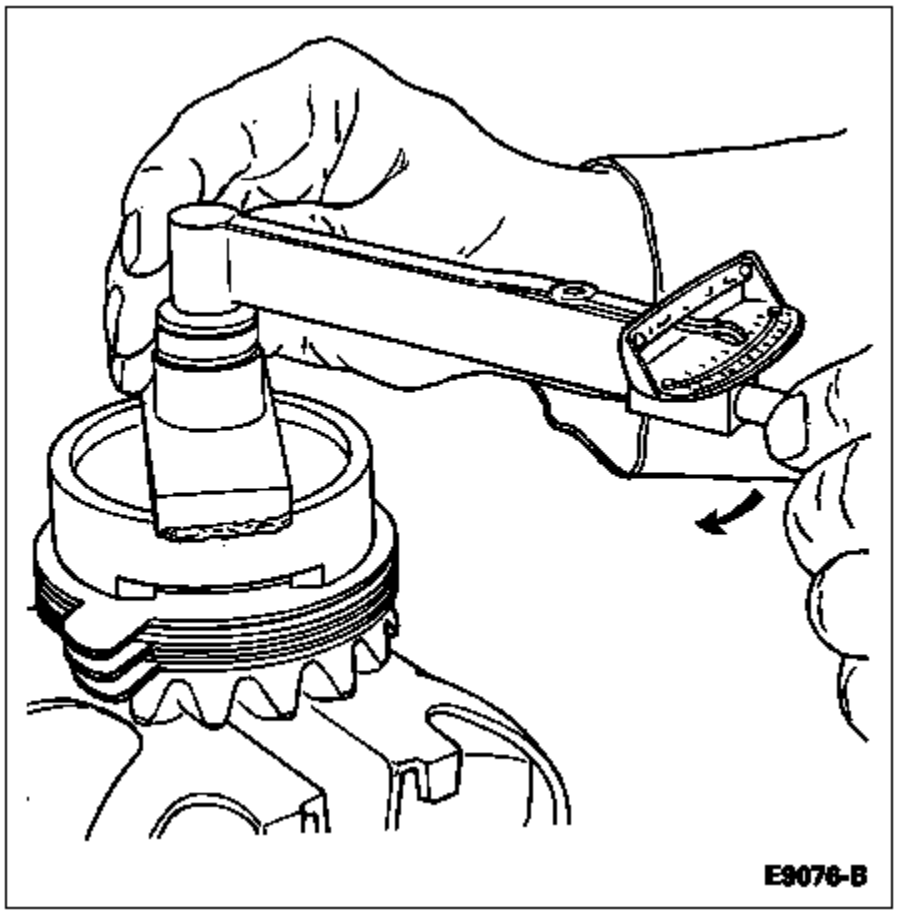
4. Install the gauge plate from Traction-Lok Clutch Gauge T80P-4946-A over the differential clutch pack as shown.



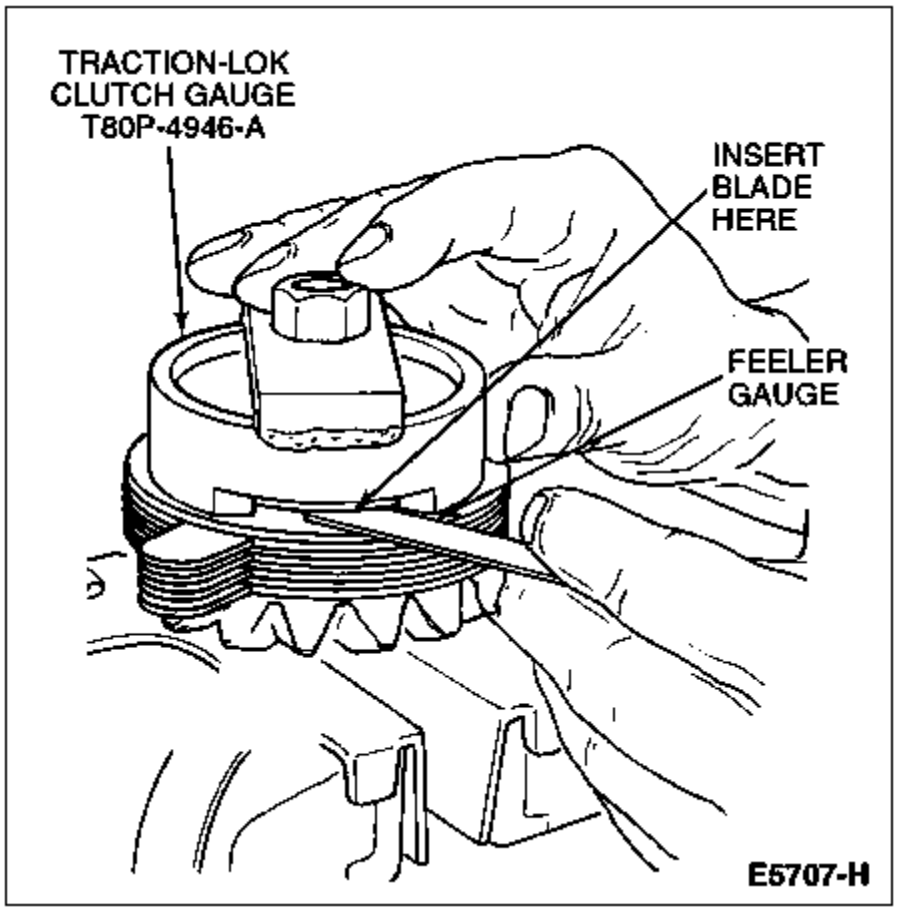
5. Position the Traction-Lok Clutch Gauge T80P-4946-A over the gauge plate.



6. Secure the assembly using the nut from the Traction-Lok Clutch Gauge T84P-4946-A and tighten to 7 Nm (60 lb-in).



7. Using a feeler tool, select the thickest blade that will enter between the tool and the differential clutch pack. This reading will be the thickness of the new rear axle differential clutch shim.



Installation

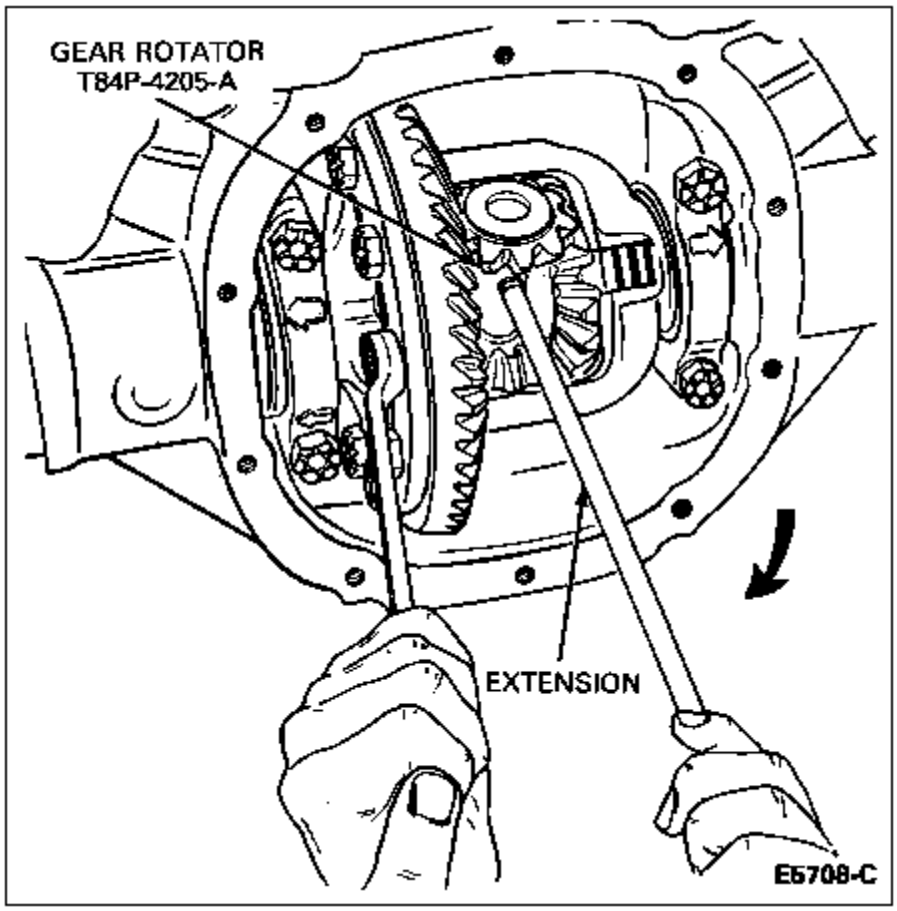
NOTE: Be sure all friction plates have been soaked for at least 15 minutes in Additive Friction Modifier C8AZ-19B546-A or equivalent meeting Ford specification EST-M2C118-A prior to reassembly.

1. Install the left side gear differential clutch pack and new rear axle differential clutch shim into the cavity in the differential case (4204). Repeat this step for the right side.

2. Place the pinion gears and differential pinion thrust washers (4230) 180 degrees apart on the differential side gears as shown.

3. **NOTE: A 304.8mm (12-inch) extension is required to install the differential pinion gears.**

   Install Gear Rotator T84P-4205-A as shown.



4. Rotate the tool until the pinion gears are aligned with the pinion shaft hole. Remove the tool from the differential case.

5. Hold the differential clutch spring (4214) up to the differential case window and with a soft-faced hammer, hammer the spring into position. Inspect the differential clutch spring for damage.

6. Install the axle shafts (4234) and U-washers into position. Push each axle shaft outboard as far as possible.

7. Install the differential pinion shaft (4211) and lock bolt and tighten the bolt to 20-40 Nm (15-30 lb-ft) using Stud and Bearing Mount E0AZ-19554-BA or equivalent meeting Ford specification WSK-M2G349-A1.

8. Install the rear brake drums (1126) and wheels. Perform the limited slip differential in-vehicle check to make sure that the unit is within specification. Refer to Section 05-00 .

9. **CAUTION: On Aerostar vehicles, always replace the plastic rear cover and bolts with a new rear cover and new bolts.**

   Using Silicone Rubber D6AZ-19562-BA or -AA or equivalent meeting Ford specification ESB-M4G92-A or ESE-M4G195-A install the axle housing cover (4033) and bolts and tighten steel cover bolts to 34-47 Nm (25-35 lb-ft). Tighten plastic cover bolts to 21-27 Nm (15-20 lb-ft).

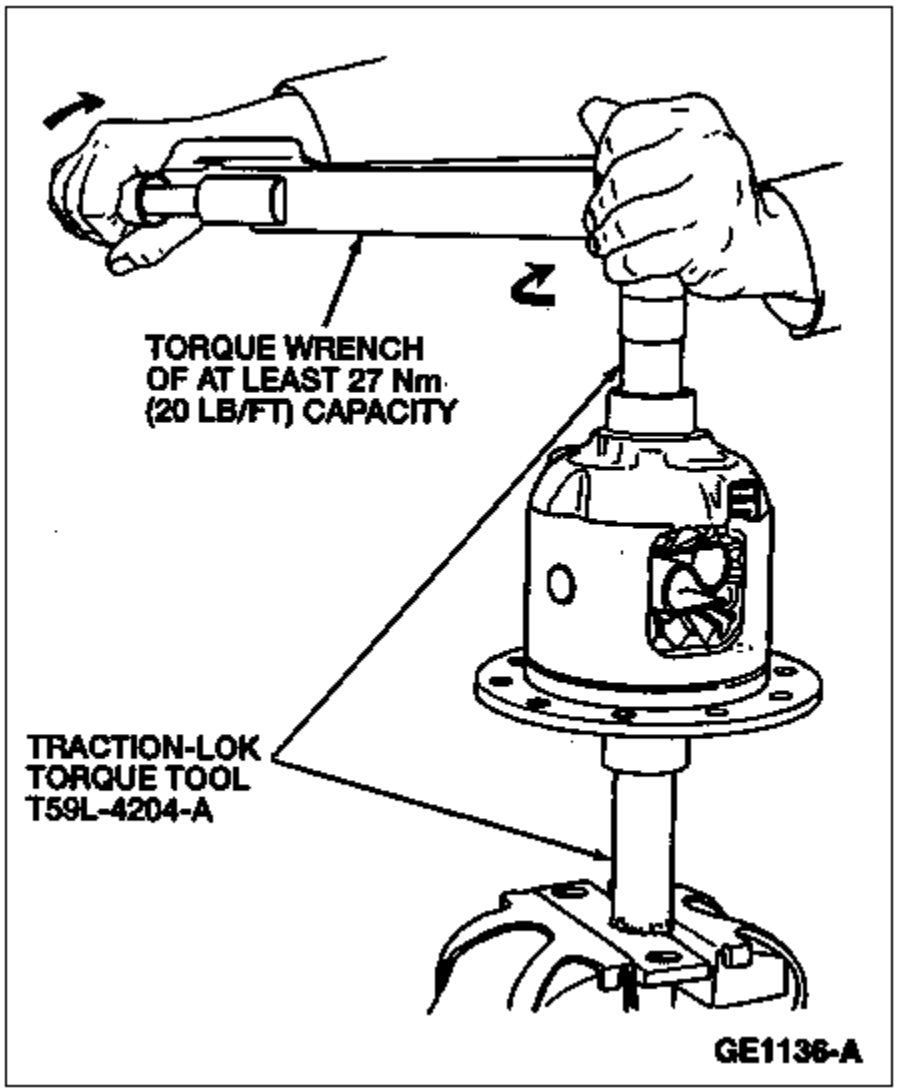
10. Service refill capacities are determined by filling the rear axle 6.4-14.2mm (1/4-9/16 inch) below the bottom of the filler space with the rear axle (4001) in the running position. The capacity for Aerostar

vehicles is 1.7 liters (3.5 pints). The capacity for Ranger vehicles is 2.4 liters (5 pints).

11. Install the filler plug and tighten to 20-40 Nm (15-30 lb-ft). Refer to Specifications for the quantity recommended.

Bench Torque Test

1. Prior to installation of the locking differential into a vehicle, a bench torque check must be made. With Traction-Lok Torque Tool T59L-4204-A check the torque required to rotate one differential side gear (4236) while the other is held stationary. The initial breakaway torque, if original clutch plates are used, should be no less than 27 Nm (20 lb-ft). The rotating torque required to keep the differential side gear turning with new clutch plates may fluctuate, with initial breakaway torque at least 27 Nm (20 lb-ft).



2. Lightly coat lock bolt threads with Threadlock and Sealer E0AZ-19554-AA or equivalent meeting Ford specification WSK-M2G315-A5. Install lock bolt in differential case (4204) and tighten to 20-40 Nm (15-30 lb-ft).

3. Clean the tapped holes in the ring gear and pinion with a suitable solvent. If the new bolts show a green coating over approximately 12.7mm (1/2 inch) of the threaded area, use as is. If not coated, apply a small amount of Threadlock and Sealer E0AZ-19554-AA or equivalent meeting Ford specification WSK-M2G315-A5. Tighten to 95-115 Nm (70-85 lb-ft).

SPECIFICATIONS

LUBRICANT CAPACITY

Vehicle	Capacity	
	Liters	Pints
Aerostar	1.7	3.5
Ranger	2.4	5.0
Use Premium Rear Axle Lubricant XY-80W90-QL or equivalent meeting Ford specification WSP-M2C197-A.		
Add 4 ounces of Friction Modifier C8AZ-19B546-A or equivalent meeting Ford specification EST-M2C118-A or equivalent for complete fill of Traction-Lok® rear axles.		

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft
Filler Plug	20-40	15-30
Axle Housing Steel Cover Bolts	34-47	25-35
Axle Housing Plastic Cover Bolts	21-27	15-20
Pinion Shaft Lock Bolt	20-40	15-30
Ring Gear and Pinion Bolts	95-115	70-85
Clutch Pressure Plates — Original	27 Minimum	20 Minimum
Clutch Pressure Plates — New	27 Minimum	20 Minimum

Differential Case

Refer to Section 05-02B for the procedures for removing and installing the limited slip differential (4026).

The limited slip differential is removed and installed in the same manner as a conventional differential.

To disassemble and assemble the differential case (4204), remove and install the ring gear and pinion and the differential bearing (4221) following the procedures used for the conventional differential.

NOTE: Do not remove the differential bearings from the case journals unless the differential bearings are damaged. If the bearings remain on the case during repair, keep them clean and free from foreign material.

To remove and install the differential clutch spring (4214), differential pinion shaft (4211), pinion gear and differential clutch pack (4947), follow the procedure under Adjustments in this section.

In-Vehicle Adjustments

NOTE: Refer to Section 05-02B for speed sensor ring service.

In-vehicle adjustments are possible on this unit without removing the differential case (4204) from the rear axle housing. If the operation check was not to specification, use the following procedure to correct the condition.

Clutch Pack Preload Adjustment

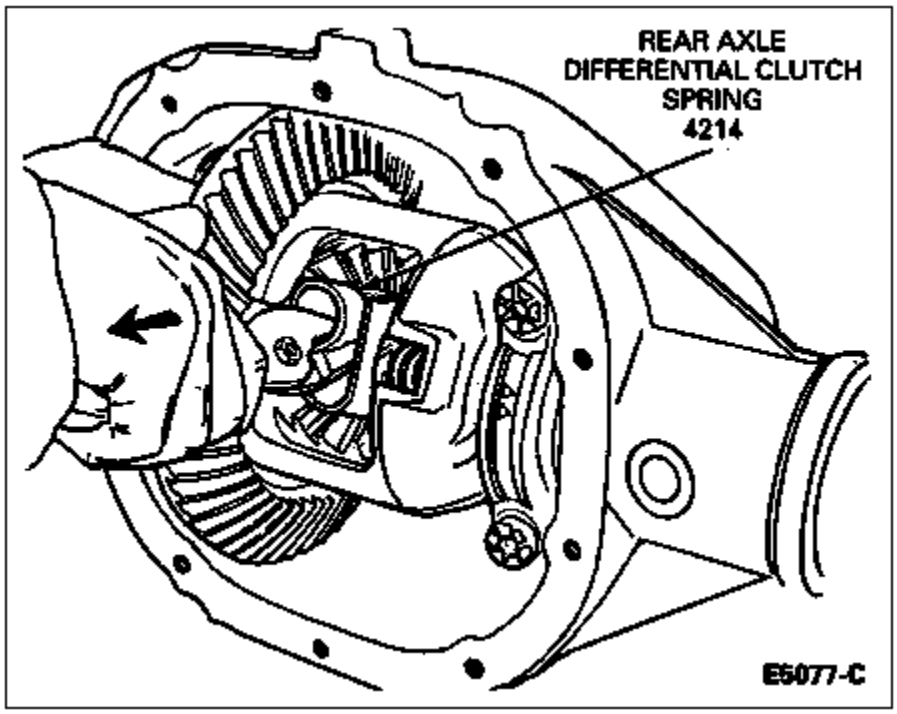
SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Gear Rotator	T80P-4205-A
Traction-Lok Clutch Gauge	T87T-4946-A

1. **NOTE: Before preload can be adjusted, the axle shafts (4234) must be removed following the procedure in Section 05-02B . The axle shafts must be removed completely from the housing so that the inner wheel bearing oil seals (1177) will not be damaged. After adjustment, install the axle shafts following the procedure in Section 05-02B .**

   WARNING: DUE TO THE SPRING TENSION, CARE MUST BE USED WHEN REMOVING THE DIFFERENTIAL CLUTCH SPRING (4214).

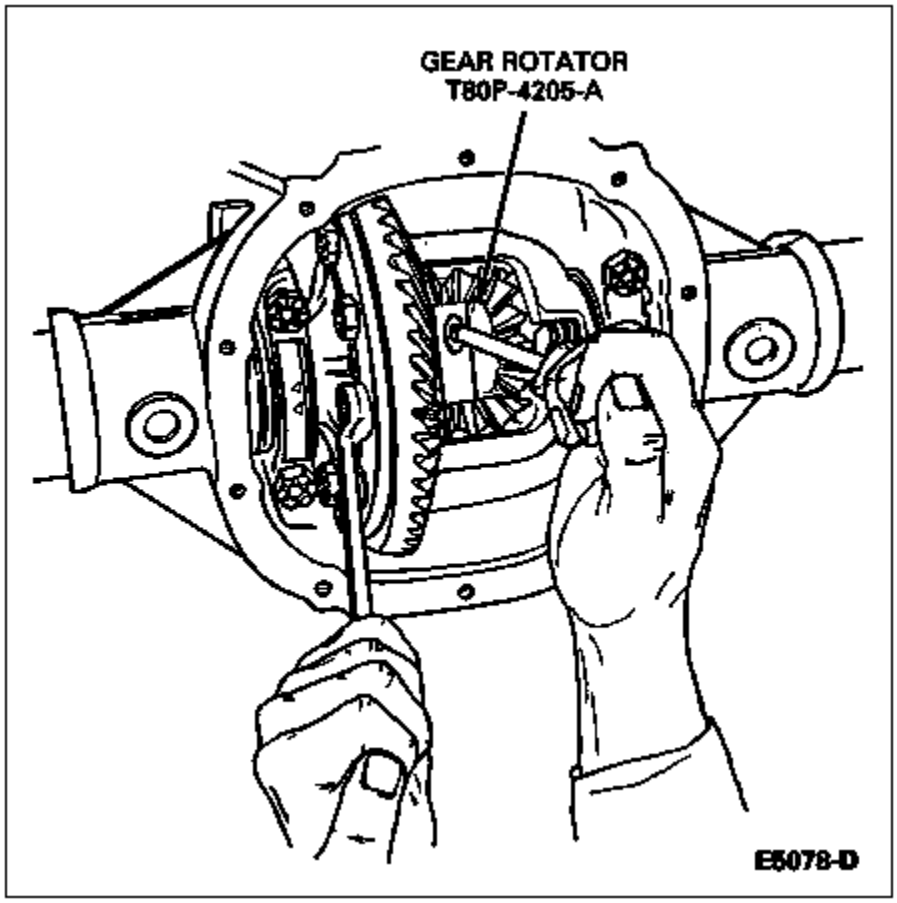
   With a suitable drift, drive the differential clutch spring half-way out of the differential (4026). Rotate the differential 180 degrees. Hold the differential clutch spring with a pair of pliers and tap the differential clutch spring until it is removed from the differential.



2. **NOTE: A 304.8mm (12 inch) extension is required to remove the pinion gears.**

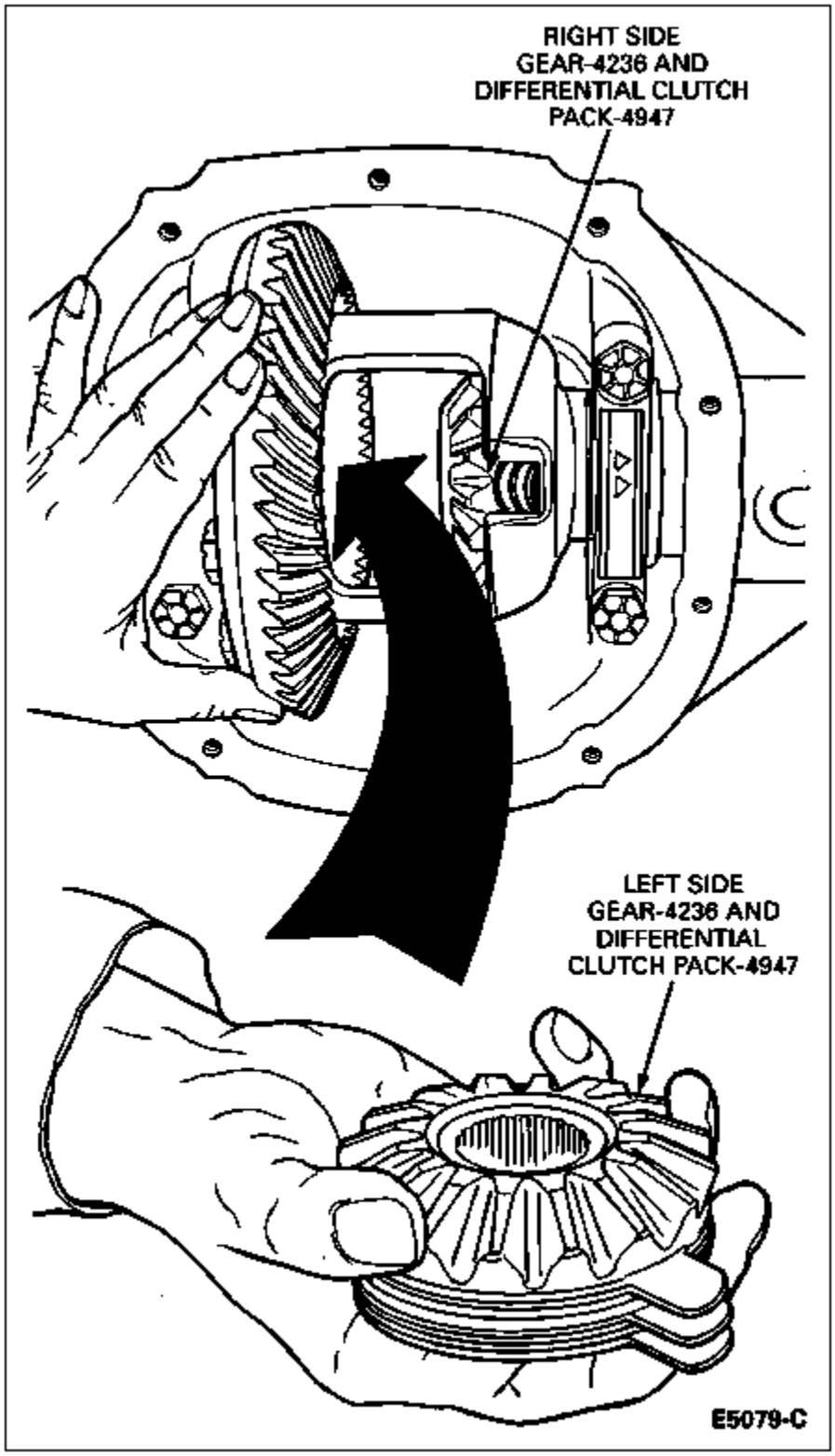
   Using Gear Rotator T80P-4205-A rotate the pinion gears until they can be removed from the

differential.



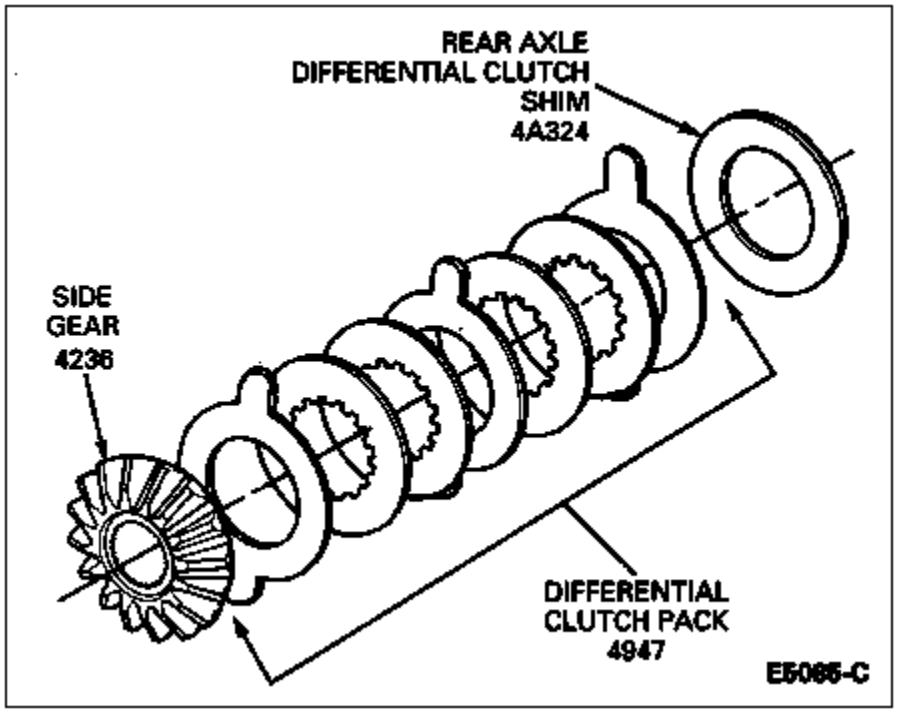
3. **NOTE: Do not mix differential clutch packs (4947) or rear axle differential clutch shims (4A324) from one side with the other.**

   Remove the right and left differential side gears (4236) and differential clutch pack with the rear axle differential clutch shim and tag them "right" and "left." Set them aside until Step 4. Clean and inspect the remaining parts of the differential case (4204) for wear or damage. Replace parts as required.



4. **NOTE: Do not use acids or solvents when cleaning clutch components. Wipe components with a clean lint-free cloth.**

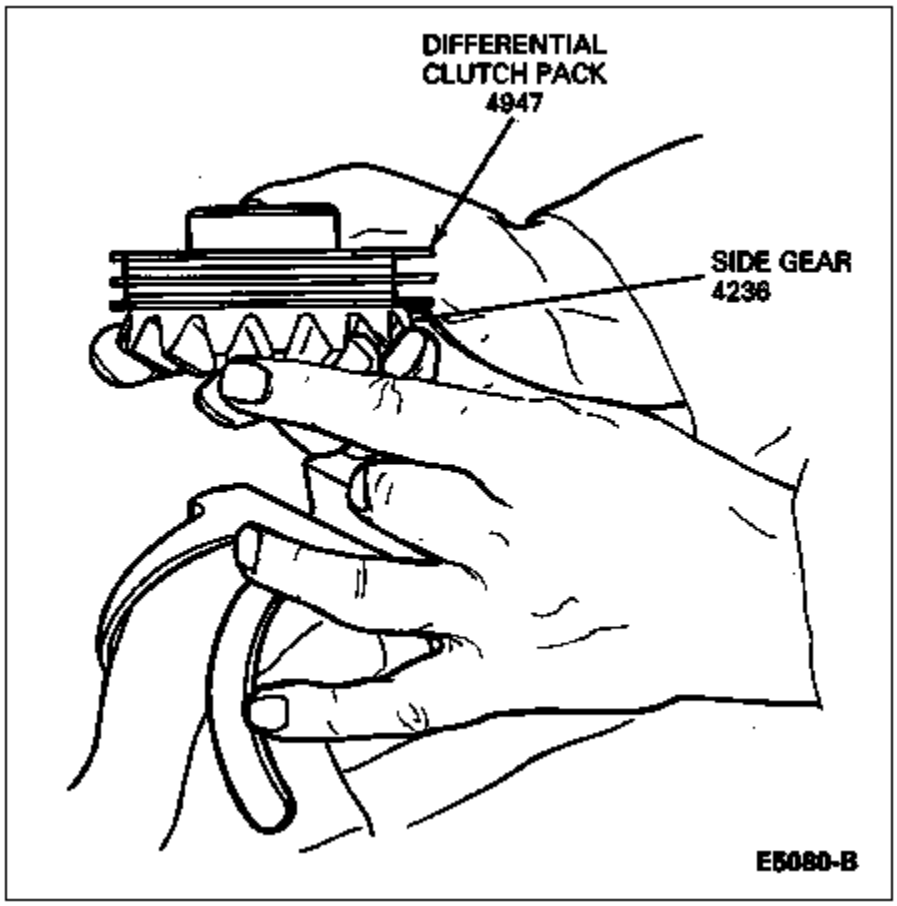
   Clean and inspect the differential clutch packs for wear and replace parts as necessary.



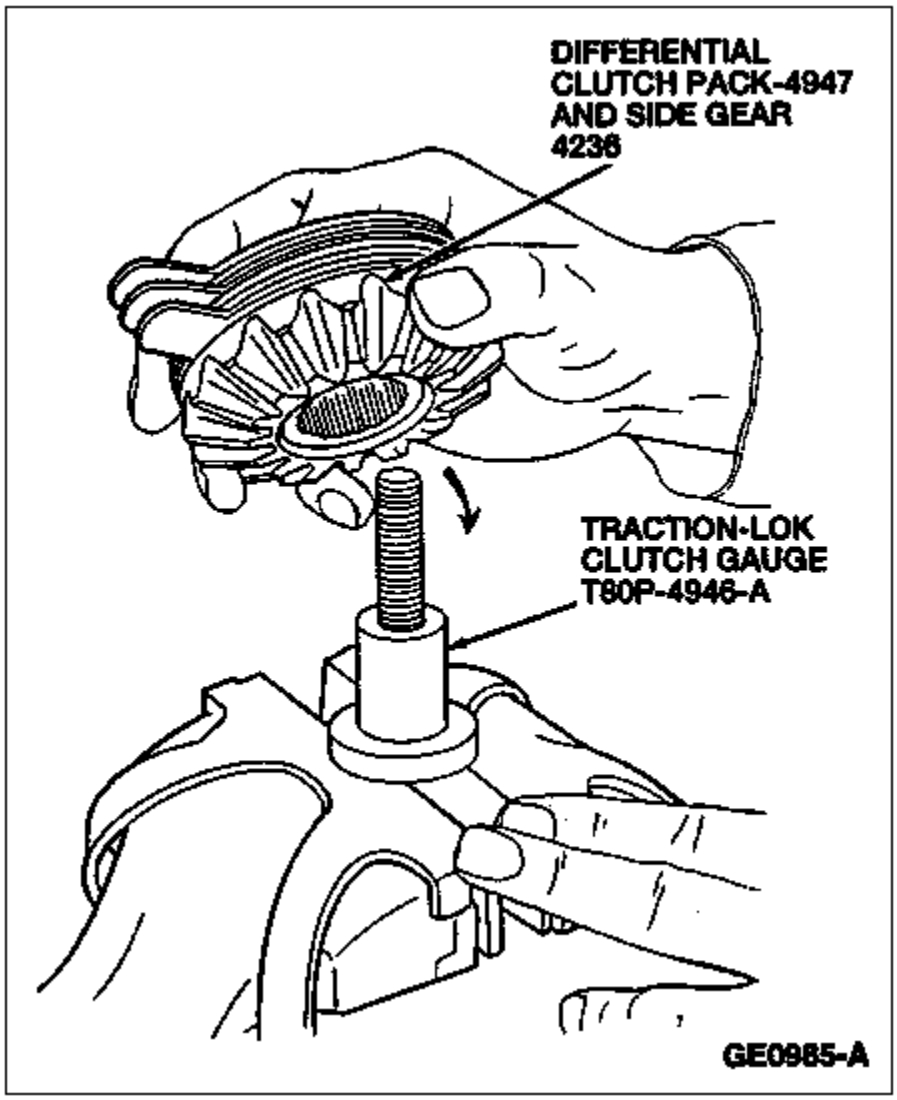
5. **CAUTION: Prelubricate all friction plates with Additive Friction Modifier C8AZ-19B546-A or equivalent meeting Ford specification EST-M2C118-A.**

   NOTE: Do not mix differential clutch packs or shims from one side with the other.

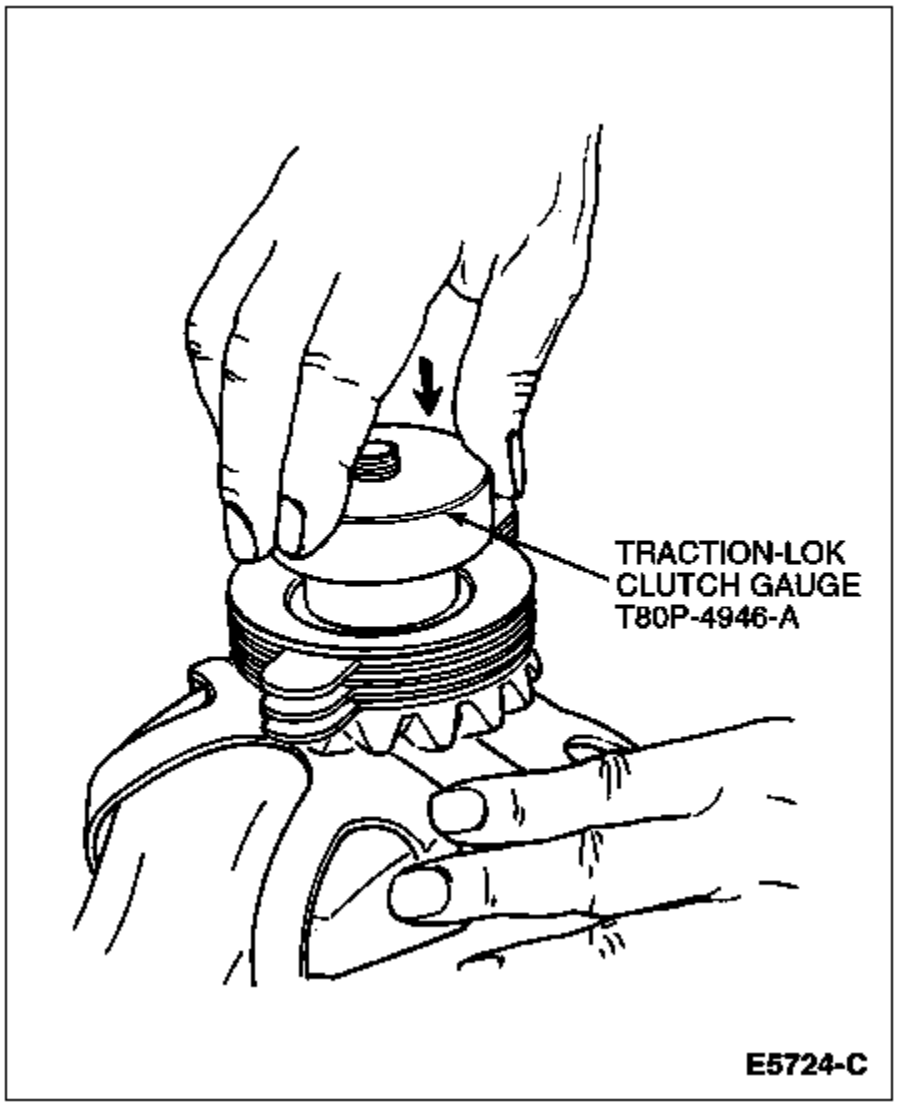
   Assemble the differential clutch packs (without rear axle differential clutch shims) on the respective differential side gears.



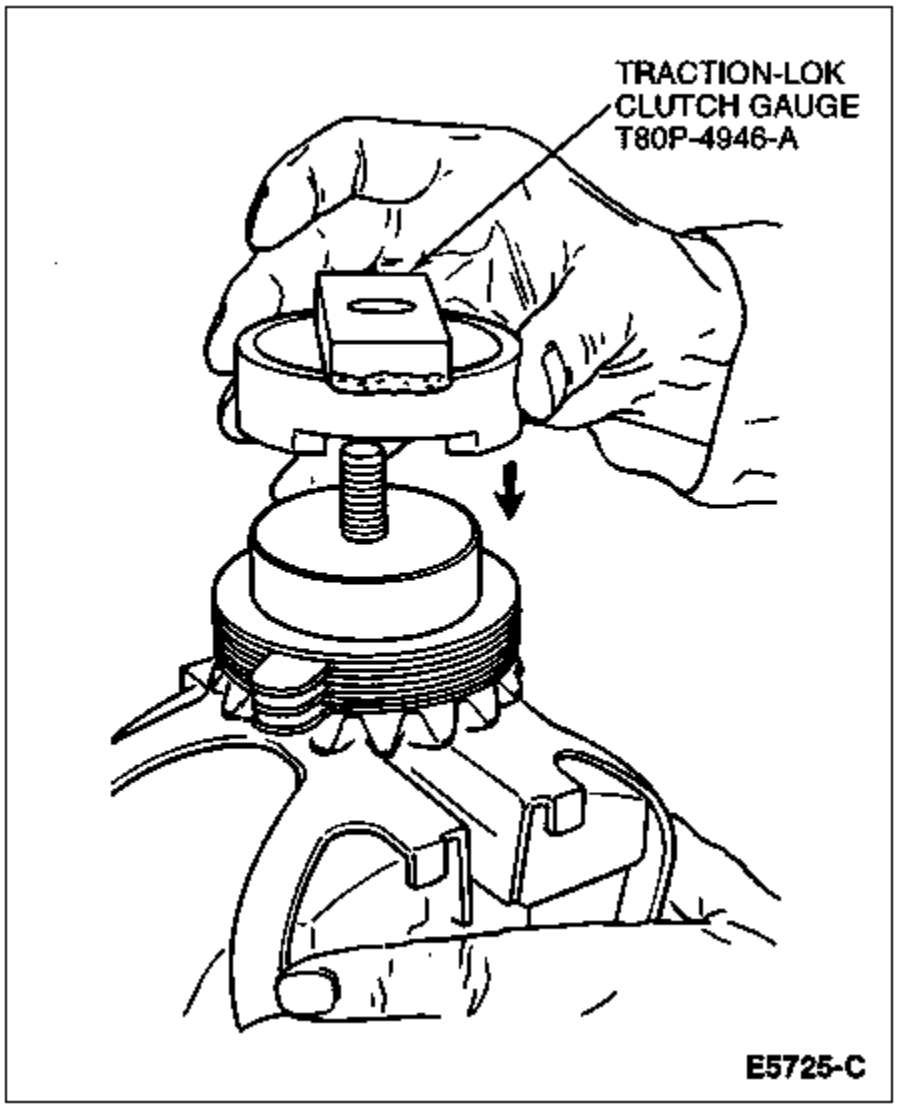
6. Place the base portion of Traction-Lok Clutch Gauge T80P-4946-A in a vise. Install the differential clutch pack and differential side gear (without the rear axle differential clutch shim) over the base.



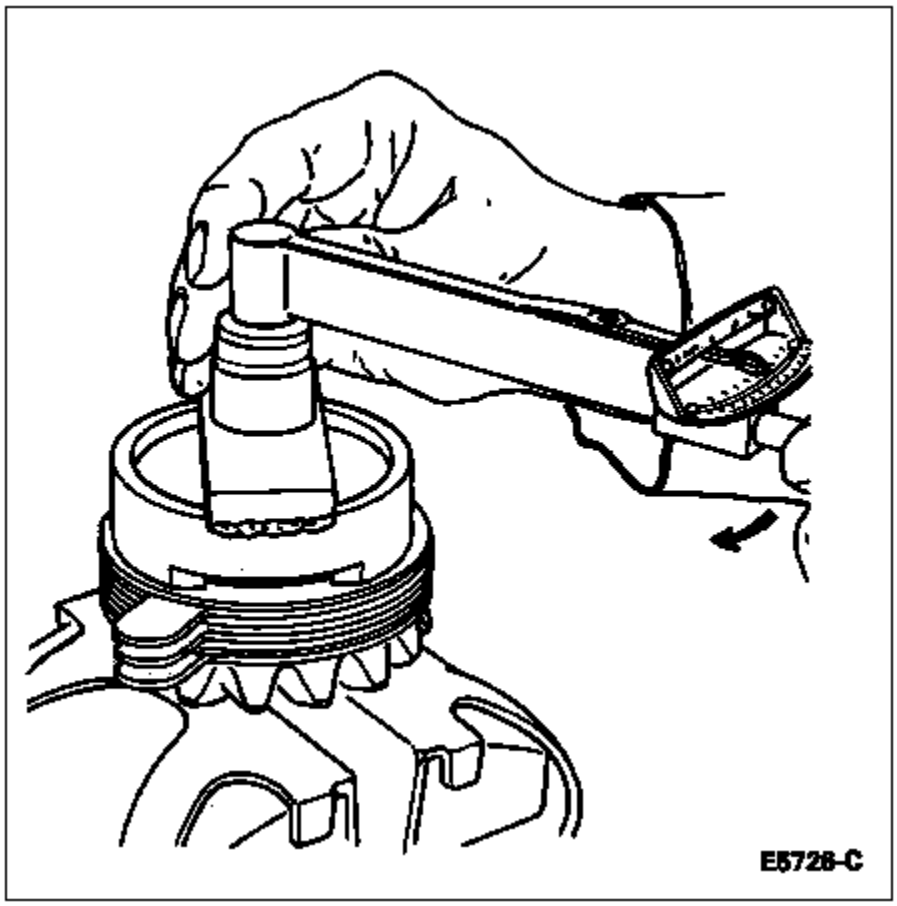
7. Install the disc of the Traction-Lok Clutch Gauge T80P-4946-A over the base and on top of the differential clutch pack.



8. Install the top portion of the Traction-Lok Clutch Gauge T80P-4946-A over the disc and base stud.



9. Install the nut of the Traction-Lok Clutch Gauge T80P-4946-A over the top and base stud. Tighten the nut to 6.7 Nm (60 lb-in).

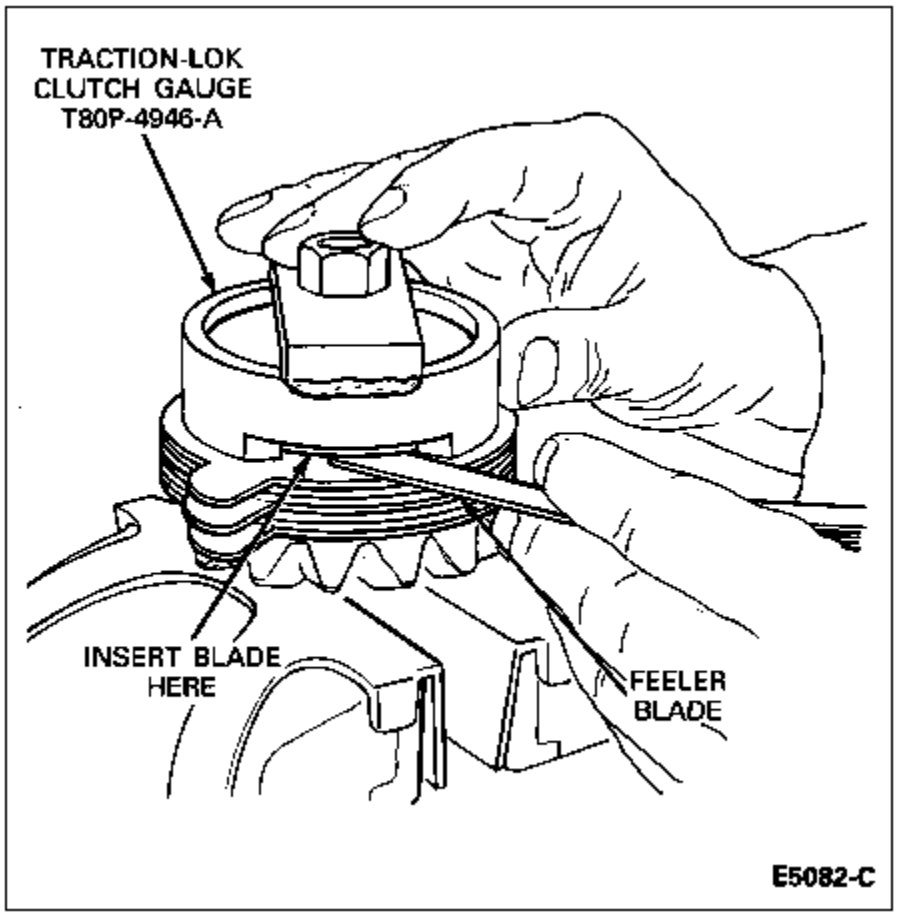


10. **NOTE: Be sure to lubricate friction clutch plates with Additive Friction Modifier C8AZ-19B546-A or equivalent meeting Ford specification EST-M2C118-A prior to reassembly.**

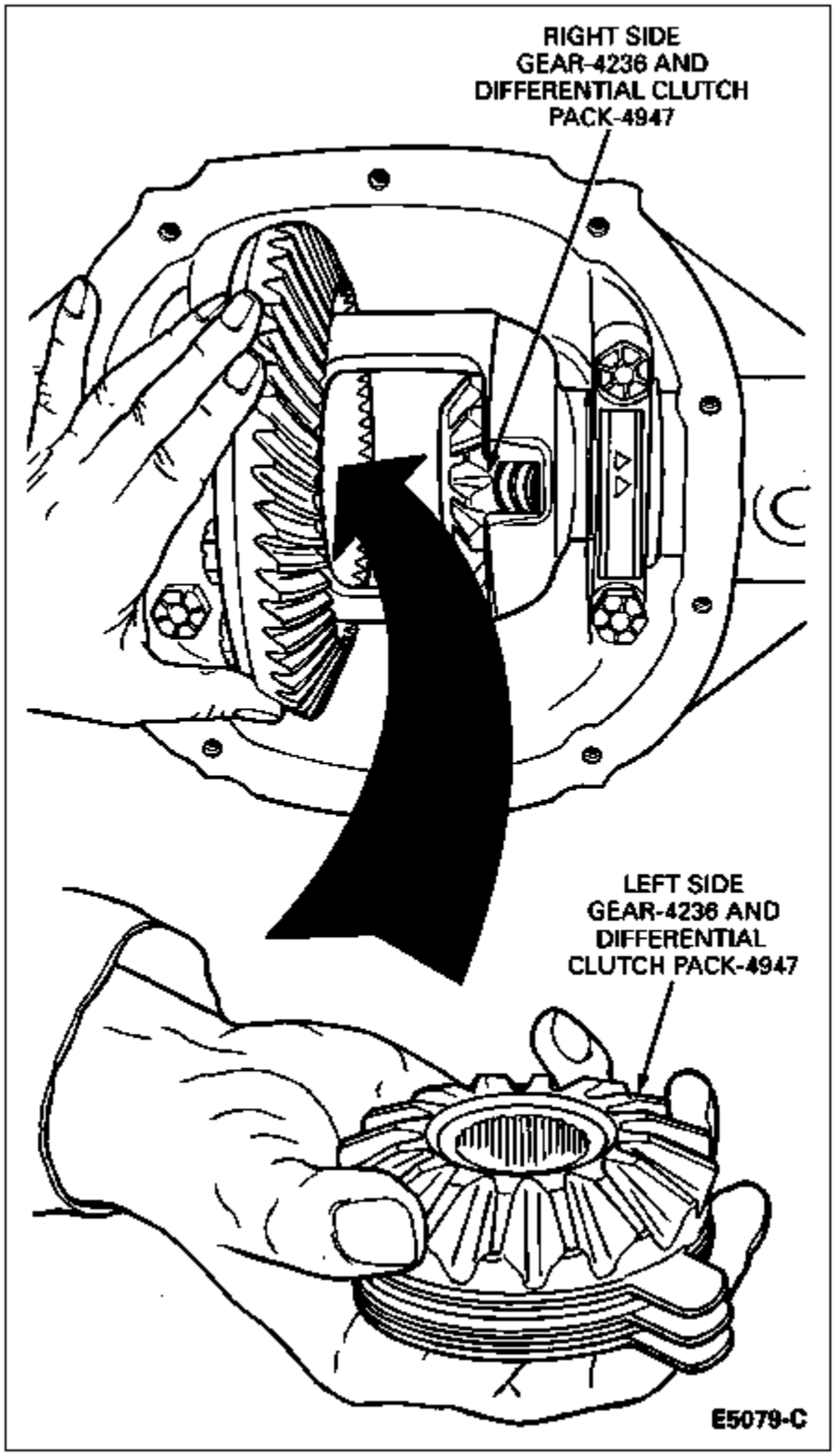
    NOTE: Only one shim should be required per clutch pack. However, two shims (maximum) per clutch pack may be used if necessary.

    Using a feeler gauge, select the thickest blade that will enter between the tool and the differential clutch pack. This reading will be the thickness of the new rear axle differential clutch shim.

Item	Specification
E4DZ-4A324-A	0.025 inch
E4DZ-4A324-B	0.030 inch
E4DZ-4A324-C	0.035 inch
E4DZ-4A324-D	0.040 inch
E4DZ-4A324-E	0.045 inch

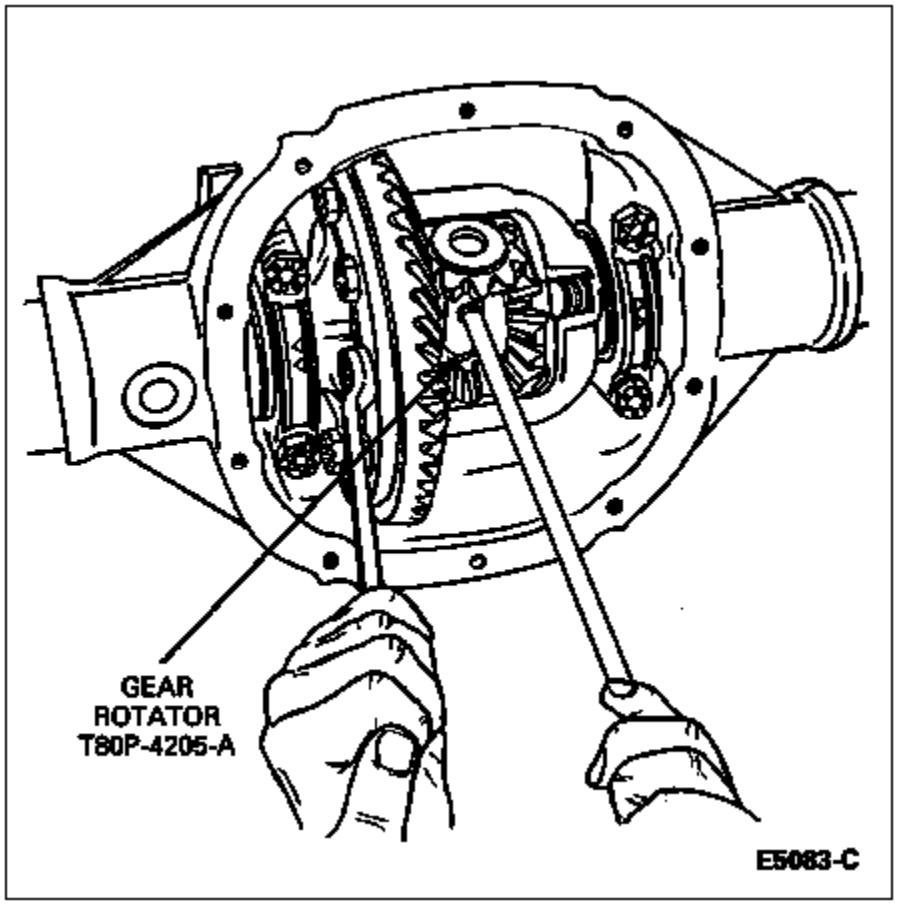


11. Install the right differential side gear, differential clutch pack and new rear axle differential clutch shim into the cavity in the differential case. Repeat this step for the left side.

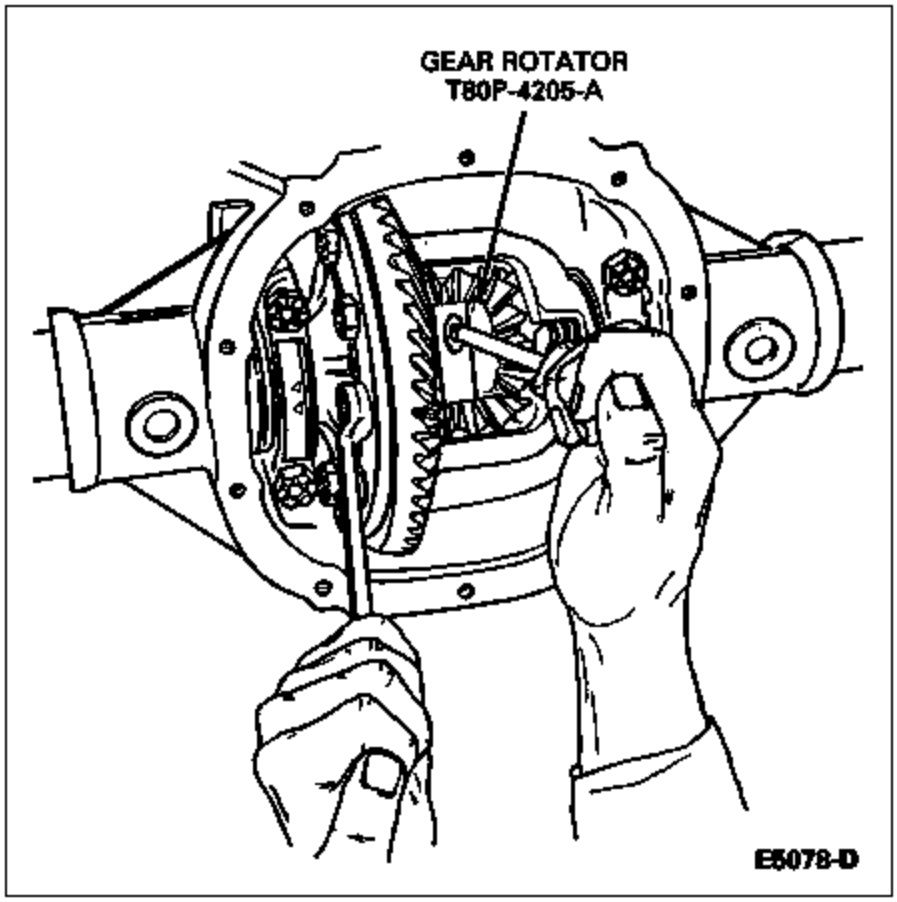


12. **NOTE: A 304.8mm (12-inch) extension is required to install the pinion gears.**

    Place the pinion gears and differential pinion thrust washers (4230) 180 degrees apart on the differential side gears. Install Gear Rotator T80P-4205-A as shown.

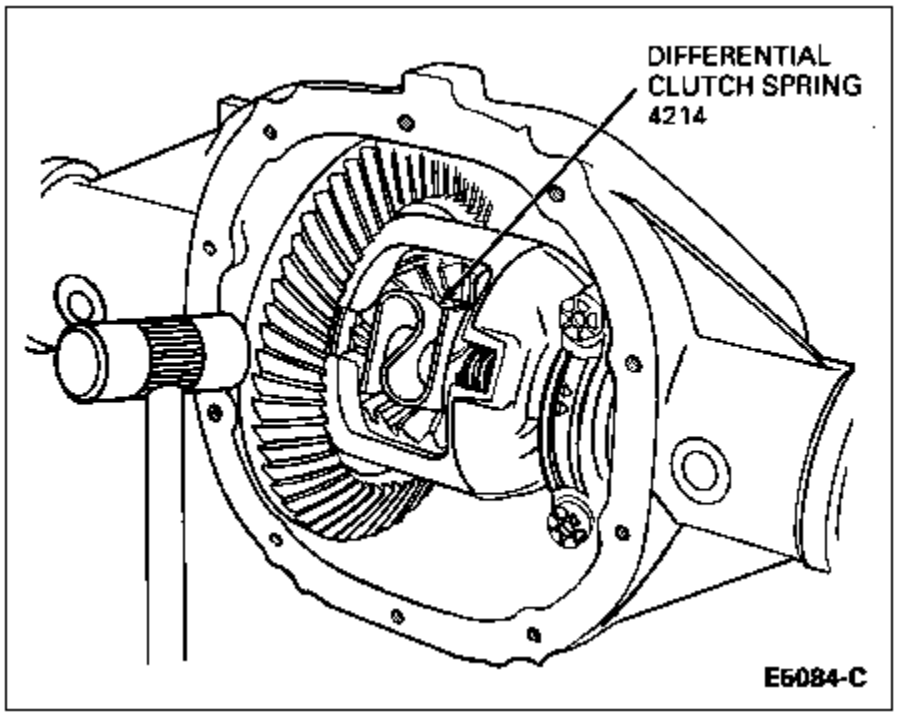


13. Rotate the tool until the pinion gears are aligned with the pinion shaft hole as shown. Remove the tool from the differential case.



14. **NOTE: Inspect the rear axle differential clutch spring for damage.**

    Hold the differential clutch spring up to the differential case window and, with a soft-faced hammer, hammer the differential clutch spring into position.


DIFFERENTIAL
CLUTCH SPRING
4214
E6084-C

Bench Torque Test

SPECIAL SERVICE TOOL(S) REQUIRED

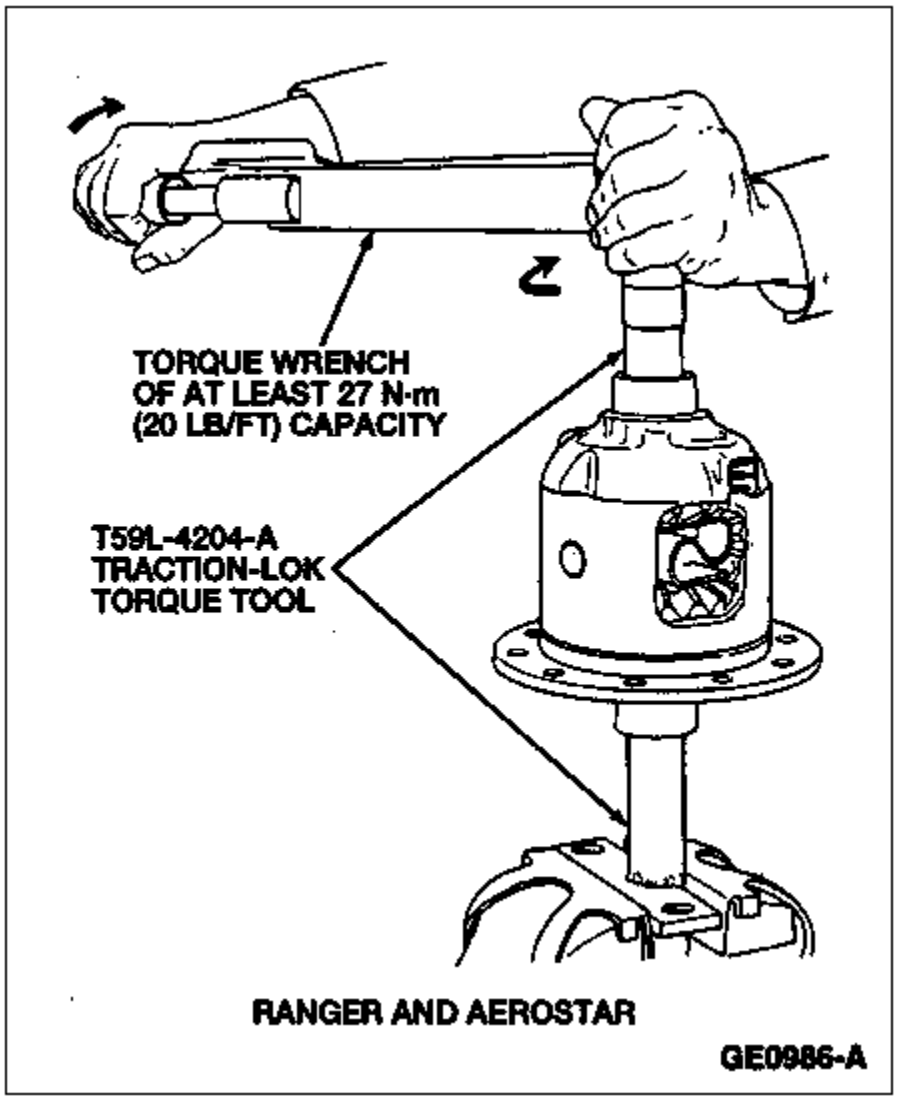
Description	Tool Number
Traction-Lok Torque Tool (Ranger and Aerostar)	T59L-4204-A

A bench torque test must be made if the differential has been removed from the axle housing and adjustments have been made.

With Traction-Lok Torque Tool T59L-4204-A, check the torque required to rotate one differential side gear (4236) while the other is held stationary.

The initial breakaway torque, if original clutch plates are used, should be at least 27 Nm (20 lb-ft). The rotating torque required to keep the differential side gear turning with new clutch plates may fluctuate with initial breakaway torque at least 27 Nm (20 lb-ft).

Bench Torque Test


TORQUE WRENCH
OF AT LEAST 27 N·m
(20 LB/FT) CAPACITY
T59L-4204-A
TRACTION-LOK
TORQUE TOOL
RANGER AND AEROSTAR
GE0986-A

SPECIFICATIONS

Lubricant Capacity

Vehicle	Engine	Axle	U.S. Measure Capacity (Pints) [a]	Imperial Capacity (Pints) [a]	Liters [a]
Ranger	All	8.8 Inch	5.0	4.2	9.5
Aerostar		Ring Gear	5.0	4.2	9.5

[a] Use Premium Rear Axle Lubricant XY-80W90-QL or equivalent meeting Ford specification WSP-M2C197-A. Add 4 U.S. ounces of Additive Friction Modifier C8AZ-19B546-A or equivalent meeting Ford specification EST-M2C118-A.

Backlash Between Ring Gear and Pinion

Backlash — 0.20-0.38mm (0.008-0.015 inch [0.012-0.015 inch preferred])

Maximum runout of backface of ring gear and pinion — 0.1mm (0.004 inch)

Torque Specifications

Description	Nm	Lb-Ft
Differential Bearing Cap Bolt — Inch	95-115	70-85
Differential Pinion Shaft Lock Bolt	20-40	15-30
Ring Gear Attaching Bolts — Inch (Using Loctite® or Equivalent)	95-115	70-85
Rear Cover Screw (Plastic Cover)	21-27	15-20
Rear Cover Screw (Steel Cover)	34-47	25-35
Oil Filler Plug	20-40	15-30
Brake Backing Plate Nuts	28-54	21-40
Driveshaft to Axle Circular Companion Flange	95-129	70-95

INTEGRAL CARRIER — LIMITED-SLIP

General Specifications

Description	Nm	Lb-Ft
Minimum rotating torques required during bench check after assembly or in vehicle with one wheel on the ground for original or new clutch packs.	27	20

ADJUSTMENT, INTEGRAL CARRIER — LIMITED- SLIP

Inspection and Verification, Ranger

Visually inspect hubs and check for cracks or leaks. Verify hub operation by road testing and shifting from 2WD to 4WD several times.

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Symptom Chart — Noise Concerns

NOISE CONCERNS

Condition	Possible Source	Action
• Ratcheting or Buzzing Noise in Front Axle in Two-Wheel Drive, Shortly After Four-Wheel Drive Usage	• Right or left side hublock.	• REPLACE hublocks as necessary.
• Popping Sound from Front Axle When in Four-Wheel Drive, Especially While Cornering	• Right or left side hublock.	• REPLACE hublocks as necessary. REFER to Pinpoint Test A .

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Pinpoint Test (for Automatic Locking Hubs Only)

PINPOINT TEST A: NOISE WHILE ENGAGING IN FOUR-WHEEL DRIVE

A1 VERIFY LUBRICANT

- Drain and refill front axle differential with 1.66 liters (56 oz.) of 4x4 gear oil F1TZ-19580-A meeting Ford specification WSL-M2C191-A.

  NOTE: There is no equivalent for F1TZ-19580-A meeting Ford specification WSL-M2C191-A. Do not substitute any other lubricant.

Is lubricant to specifications?

Yes	No
GO to **A2** .	REPLACE differential lubricant with 1.66 liters (56 oz.) of 4x4 gear oil F1TZ-19580-A meeting Ford specification WSL-M2C191-A. GO to **A2** .

A2 VERIFY HUBLOCKS ARE OPERATIONAL

- Verify that the hubs lock and unlock using the procedure in this section.

Do hublocks work properly?

Yes	No
ROAD TEST vehicle. GO to **A3** .	INSPECT right and left side hublocks and REPLACE as necessary. REPEAT **A2** . If hublock is satisfactory, GO to **A3** .

A3 VERIFY OUTPUT OF TRANSFER CASE CLUTCH

- While road testing vehicle, push 4x4 button.

Does vehicle shift to 4x4 mode without ratcheting?

Yes	No
	REPLACE clutch coil, housing, lockup collar, lockup fork, return spring and sleeve spring.

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REPAIR is complete.	REFER to Section 07-07D Disassembly and Assembly. REPEAT road test procedure.

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Hub Diagnosis, Locking and Unlocking Hubs

Hubs, Manual Locking

Manual locking hubs are simple to diagnose. Place the transfer case (7A195) in two-wheel drive and raise the front wheels (1007) off the ground. When in the unlocked position, the wheels should be able to turn freely. Then lock each of the front hubs and rotate the front wheels. The additional load of the drivetrain components should be felt once the hub has been engaged. In addition, the front axle and front driveshaft should be moving along with the wheel. Disengage the hubs and repeat the procedure to check that the hubs have smoothly disengaged.

Hubs, Automatic Locking

Raise vehicle on hoist with engine off. Turn front driveshaft by hand to engage front hubs. Front wheels should turn if hubs lock properly. Spin front wheels by hand in opposite direction to disengage hubs (an audible "click" should be heard). Turn front driveshaft by hand in opposite direction and wheels should turn in opposite direction also if the hubs are locking properly. Disengage hubs by spinning front wheels by hand opposite of the direction they spun while turning the driveshaft.

When checking front hubs for proper operation, road test the vehicle to ensure that the hubs will remain engaged while under load. This can be accomplished by engaging four-wheel drive and taking the vehicle through several turns (both forward and backward) on dry pavement.

Driving through several turns while traveling in different directions will ensure that both sides of the hub teeth have been tested under load. Hubs that are not sufficiently engaged will "pop" out when loaded. This is due to the driveline releasing windup and is an indication of hub malfunction.

If slippage is suspected, mark the tire and axle with chalk (after locking the hub) and apply a heavy torque load several times. Then inspect your original indexing marks. If they are no longer aligned, the hubs are not remaining locked when under load. They will have to be replaced.

Should manual or automatic hublocks become submerged in water or mud for a long period of time, water may get past the seals and into the hubs and axle. In this case, all water must be expelled from the system. For automatic hublocks, the axle must be drained by siphoning out old lubricant through the drain hole in the axle arm which also serves as the carrier cover. Use new 4x4 Gear Oil F1TZ-19580-A meeting Ford specification WSL-M2C191-A to refill the axle (F1TZ-19580-A has no equivalent). Replace hubs using Automatic Locking Hub Front Wheel Bearing Adjustments procedure in this section.

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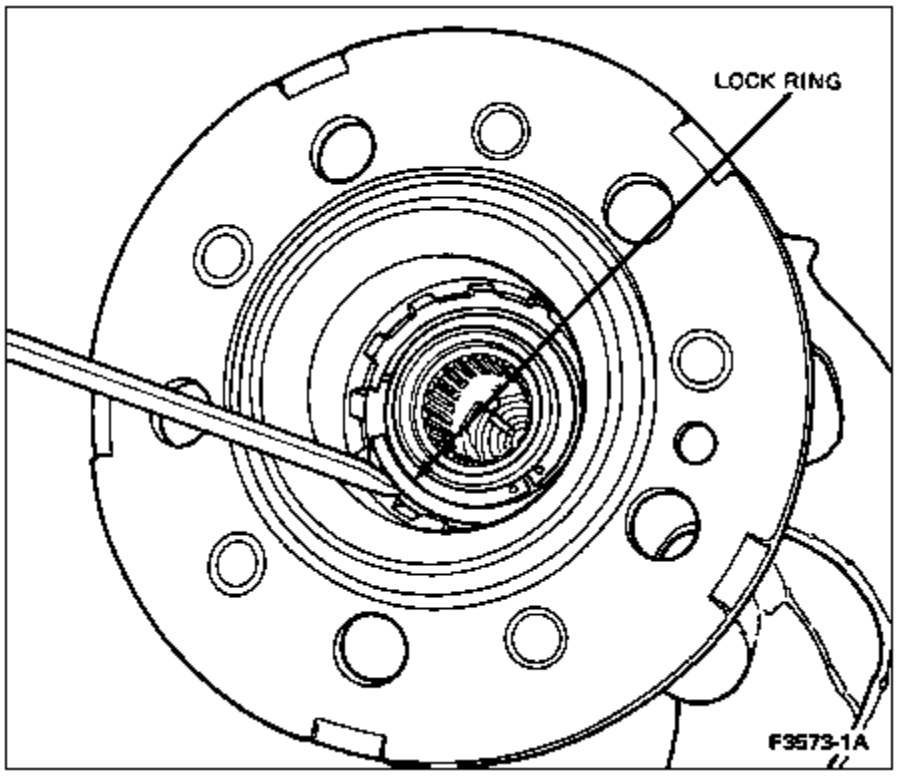
Locking Hubs, Manual, Ranger

Removal and Installation

1. Raise the vehicle and install Rotunda Car/Truck Stands 077-00018 or equivalent.
2. Remove lug nuts (1012) and the wheel and tire assembly. Refer to Section 04-04 .
3. Remove lugnut retainer washer from studs.
4. Remove the manual locking hub assembly.
5. **CAUTION: Do not remove the screw from the plastic dial.**

   Slide internal hub lock assembly, spring and clutch gear out of hub body.

   For installation, follow removal procedures in reverse order. Tighten lugnuts to 135 Nm (100 lb-ft).



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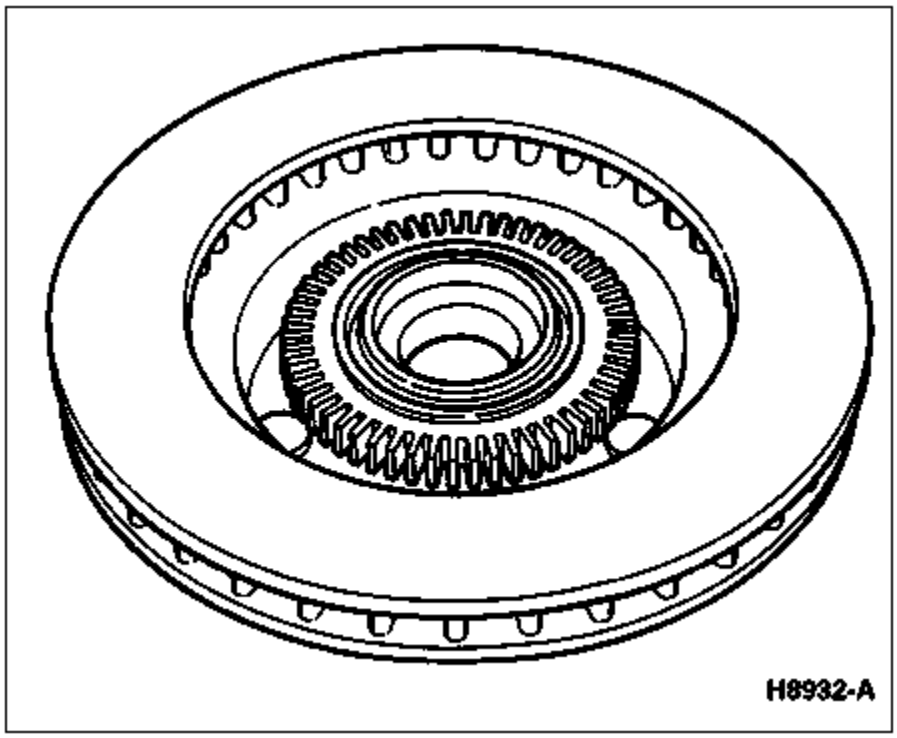
Speed Sensor Indicator Ring, Ranger

Removal

1. Raise vehicle on hoist.
2. Remove wheel and tire assembly.
3. Remove front disc brake caliper (2B121), and hub and rotor assemblies. Refer to Section 06-03 . Refer also to Ranger Locking Hub exploded views in this section.



4. **CAUTION: Discard speed sensor ring after removal. Do not reuse old ring.**

   Using a 3-jaw puller, remove front brake anti-lock sensor indicator (2C182) from hub.

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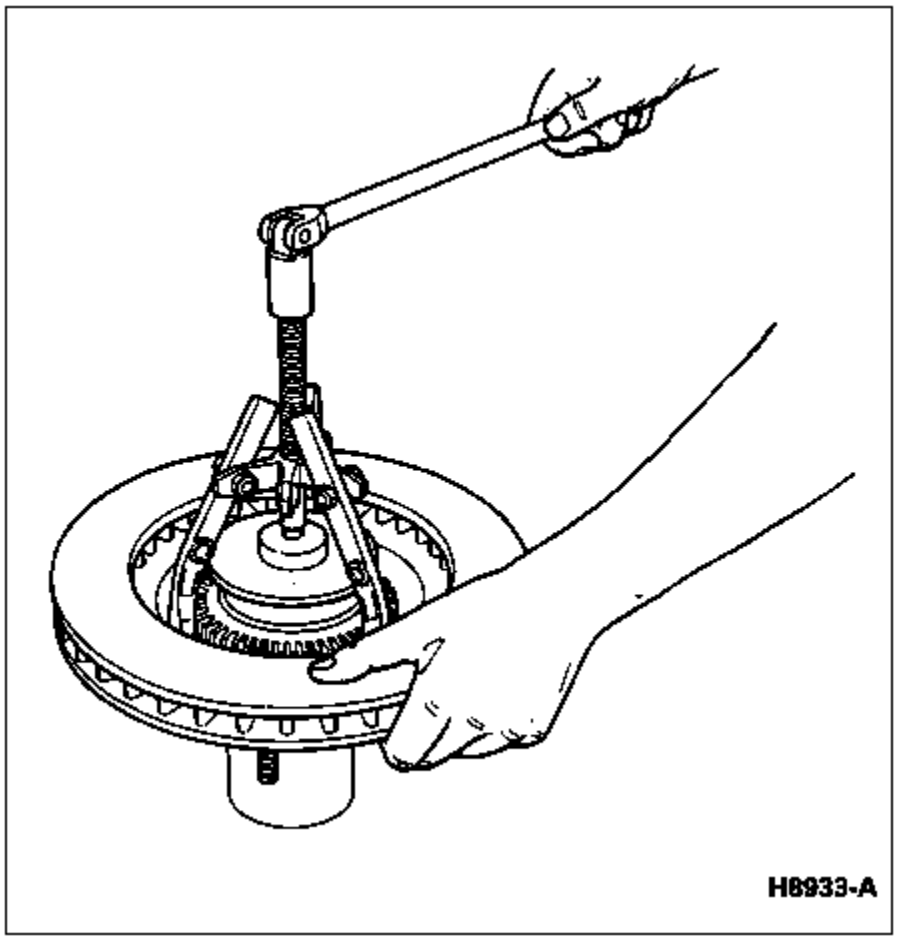

Installation

1. Support center of hub so that wheel studs do not rest on work surface.

2. **CAUTION: When performing the following step, make sure indicator ring is pressed on straight.**

   Position new front brake anti-lock sensor indicator on hub. Using a cylinder with 79mm (3.1-in.) ID and 96mm (3.8-in.) OD, press the front brake anti-lock sensor indicator onto the hub. The front brake anti-lock sensor indicator must be fully seated against the shoulder in the hub.

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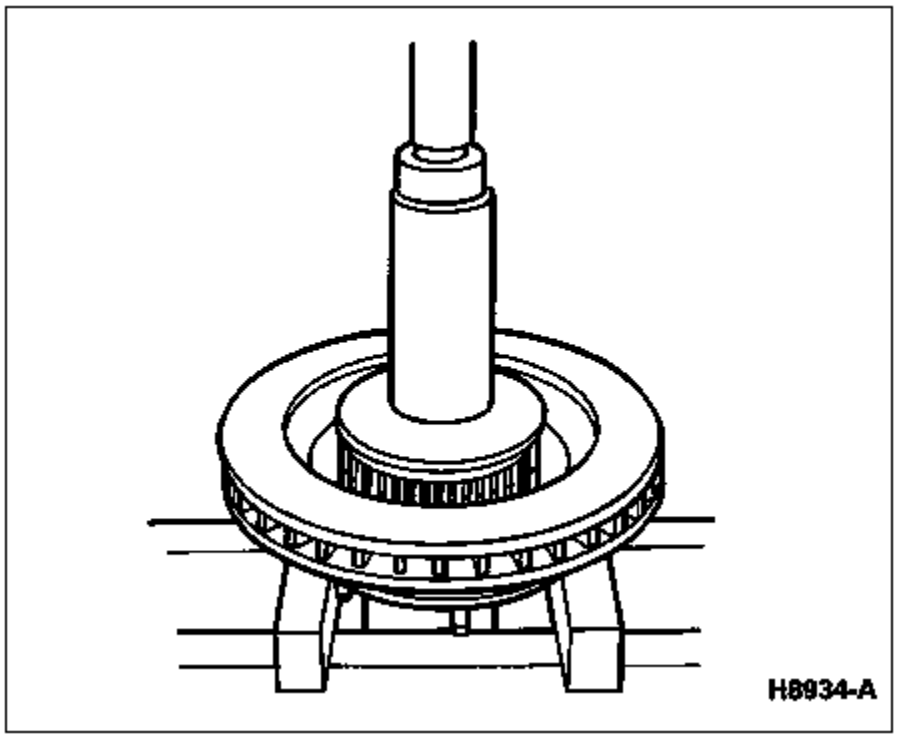

3. Install hub, rotor and caliper assemblies. Refer to Section 06-03 .
4. Install wheel and tire assembly. Tighten wheel lugnuts to 135 Nm (100 lb-ft).

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Wheel Grease Seal and Bearing, Front

Replacement and Repacking

SPECIAL SERVICE TOOL(S) REQUIRED

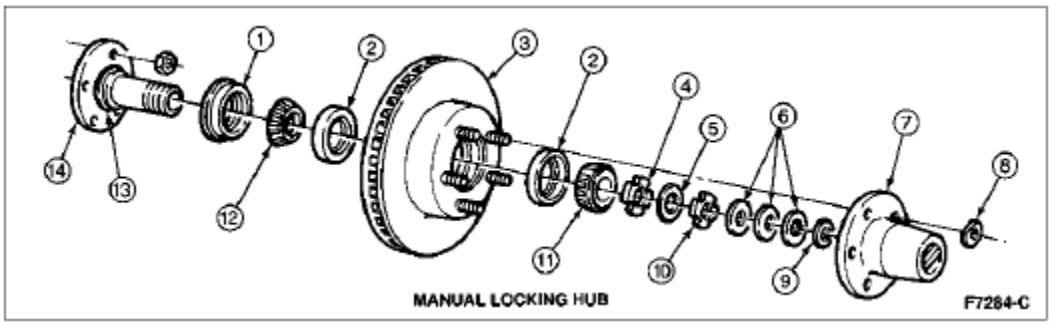
Description	Tool Number
Impact Slide Hammer	T50T-100-A
Bearing Cup Replacer	T80T-4000-P
Driver Handle	T80T-4000-W
Seal Replacer	T80T-4000-T
Spindle Seal Replacer	T95T-3132-D

The recommended wheel bearing lubricant is lithium-base High-Temperature Constant Velocity Joint Grease E43Z-19590-A or equivalent meeting Ford specification ESP-M1C207-A.

CAUTION: Sodium-base grease is not compatible with lithium-base grease. Do not intermix. Clean all old lubricant grease prior to lubricating front/rear wheel bearing. Use of incompatible bearing lubricant could result in premature lubricant breakdown.

NOTE: If bearing adjustment does not eliminate looseness or rough and noisy operation, clean, inspect and repack the hub and wheel bearings with specified wheel grease. If wheel bearing cup or the cone and roller assemblies are worn or damaged, they should be replaced.

Manual Locking Hub, Ranger



Item	Part Number	Description
1	1175B	Wheel Hub Grease Seal
2	4222	Wheel Bearing Cup

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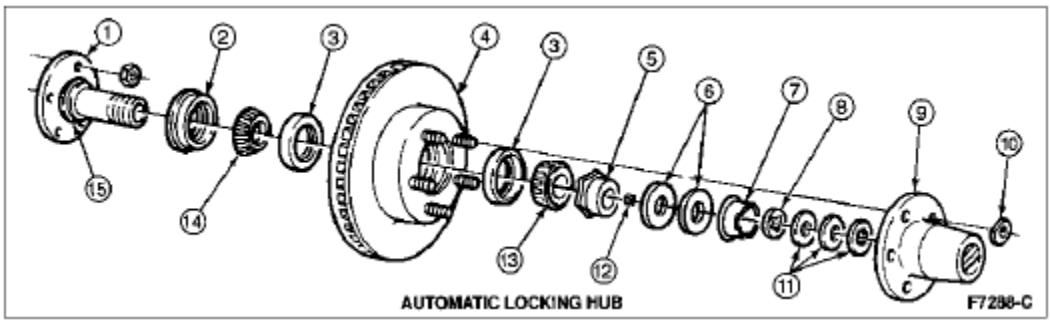
3	1102	Rotor
4	1197	Inner Locknut
5	3B549	Washer
6	3B548	Axle Shaft Spacer
7	3B396	Hub
8	1A107	Retainer Washer
9	3B457	Snap Ring
10	1197	Outer Locknut
11	4221	Wheel Bearing Outer
12	4221	Wheel Bearing Inner
13	1175A	Excluder Seal
14	3105	Front Wheel Spindle

Automatic Locking Hub, Exploded View, Ranger



Item	Part Number	Description
1	3105	Front Wheel Spindle
2	1175B	Wheel Hub Grease Seal
3	4222	Wheel Bearing Cup
4	1102	Rotor
5	3N105	Wheel Bearing Adjusting Nut
6	3N105	Thrust Spacers
7	3B477	Front Axle Wheel Hub Retainer
8	3B458	Axle Shaft Spacer
9	3B396	Hub
10	1A107	Retaining Washer
11	3B548	Axle Shaft Spacer
12	3B549	Single Hump Locking Key
13	4221	Wheel Bearing Outer

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14	4221	Wheel Bearing Inner
15	1175A	Excluder Seal

Disassembly

1. Raise the vehicle and install Rotunda Car/Truck Stands 077-00018 or equivalent.
2. Remove the wheel and tire assembly.
3. Remove the retainer washers and remove the hub assembly. Refer to Manual Locking or Automatic Locking Hubs under Front Wheel Bearing Adjustment in this section for removal.
4. Remove the disc brake caliper (2B120) as described in Section 06-03 .
5. Remove the hub and rotor. Remove the outer wheel bearing cone.
6. Remove the wheel hub grease seal (1190) from the rotor with Seal Remover TOOL-1175-AC or equivalent and Impact Slide Hammer T50T-100-A. Discard wheel hub grease seal and replace upon assembly.
7. Remove excluder seal.
8. Remove the inner wheel bearing.
9. **NOTE: If new wheel bearing cups are installed, install new cone and roller assemblies.**

   Inspect the wheel bearing cups for pits or cracks. If necessary, remove them with Internal Puller D80L-943-A or equivalent and Impact Slide Hammer T50T-100-A.

Assembly

1. Lubricate the wheel bearings with High Temperature Constant Velocity Grease E43Z-19590-A or equivalent meeting Ford specification ESP-M1C207-A. Clean all grease from the hub. Pack the cones and rollers. If a bearing packer is not available, work as much lubricant as possible between the rollers and the cages.
2. If wheel bearing cups are to be installed, position wheel bearing cups in rotor and drive in place with Bearing Cup Replacer T80T-4000-P and Driver Handle T80T-4000-W.
3. Position excluder seal on spindle and drive into position using Spindle Seal Replacer T95T-3132-D.
4. Position the inner wheel bearing in the inner wheel bearing cup in the rotor. Install the wheel hub grease seal by driving in place with Seal Replacer T80T-4000-T and Driver Handle T80T-4000-W.
5. Carefully install the rotor onto the front wheel spindle (3105). Refer to Section 06-03 .
6. Install outer wheel bearing into rotor.
7. Refer to Automatic Locking Hubs under Front Wheel Bearing Adjustment in this section for remainder of installation.

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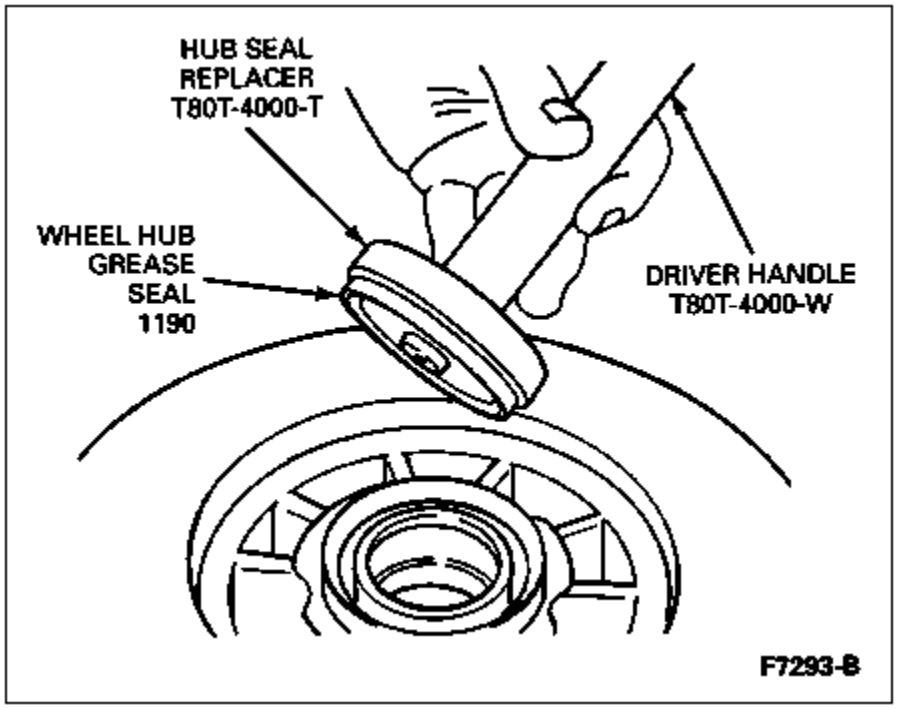

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Front Wheel Bearing

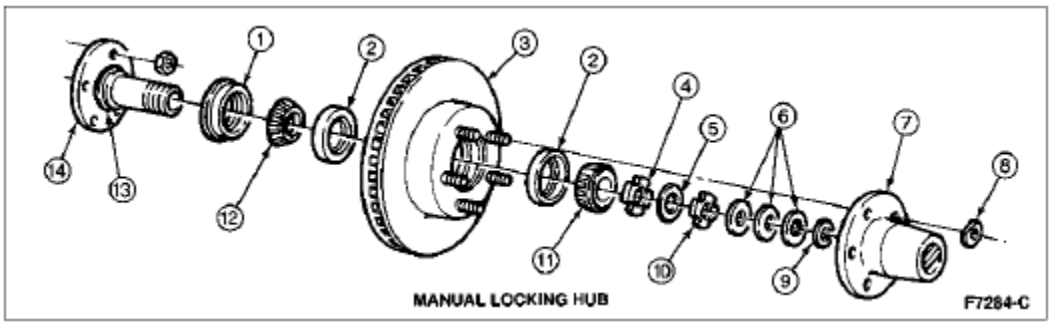
SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Hub Locknut Wrench Prong	T83T-1197-B
Hex Locknut Wrench	T70T-4252-B

Manual Locking Hubs, Ranger

1. Raise the vehicle and install safety stands.
2. Remove the lug nuts (1012) and wheel and tire assembly. Refer to Section 04-04 in the Body, Chassis Manual.
3. Remove the retainer washers from the wheel hub bolt nut studs and the manual locking hub assembly from the front wheel spindle (3105).
4. Remove the snap ring from the end of the shaft of the front wheel spindle.

Manual Locking Hub, Exploded View, Ranger



Item	Part Number	Description
1	1175B	Wheel Hub Grease Seal
2	4222	Wheel Bearing Cup
3	1102	Rotor
4	1197	Inner Locknut
5	3B549	Washer

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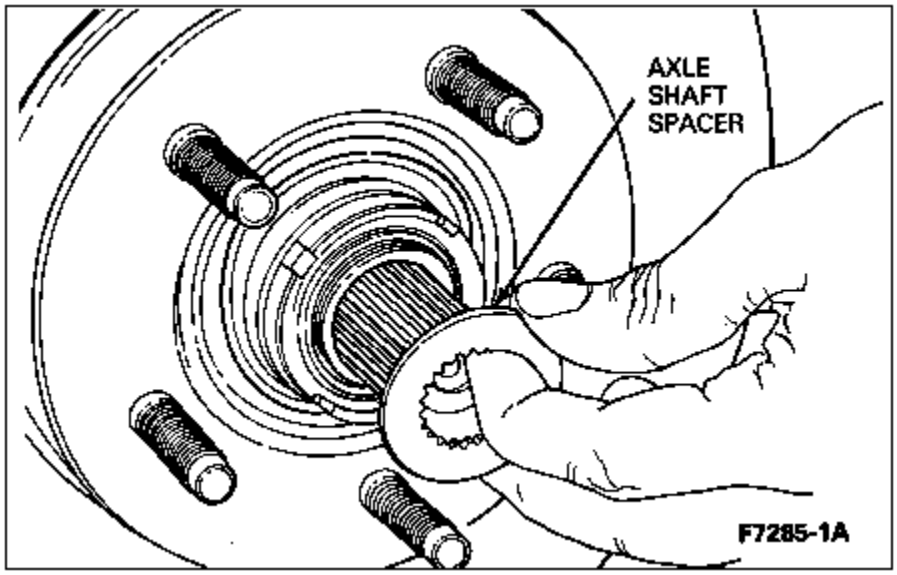
6	3B548	Axle Shaft Spacer
7	3B396	Hub
8	1A107	Retainer Washer
9	3B457	Snap Ring
10	1197	Outer Locknut
11	4221	Wheel Bearing (Outer)
12	4221	Wheel Bearing (Inner)
13	1175A	Excluder Seal
14	3105	Front Wheel Spindle

5. Remove the axle shaft spacers.



6. Remove the outer wheel bearing locknut from the front wheel spindlej using Hub Locknut Wrench Prong T83T-1197-B. Engage tool tabs into locknut slots.

7. Remove locknut washer from front wheel spindle.

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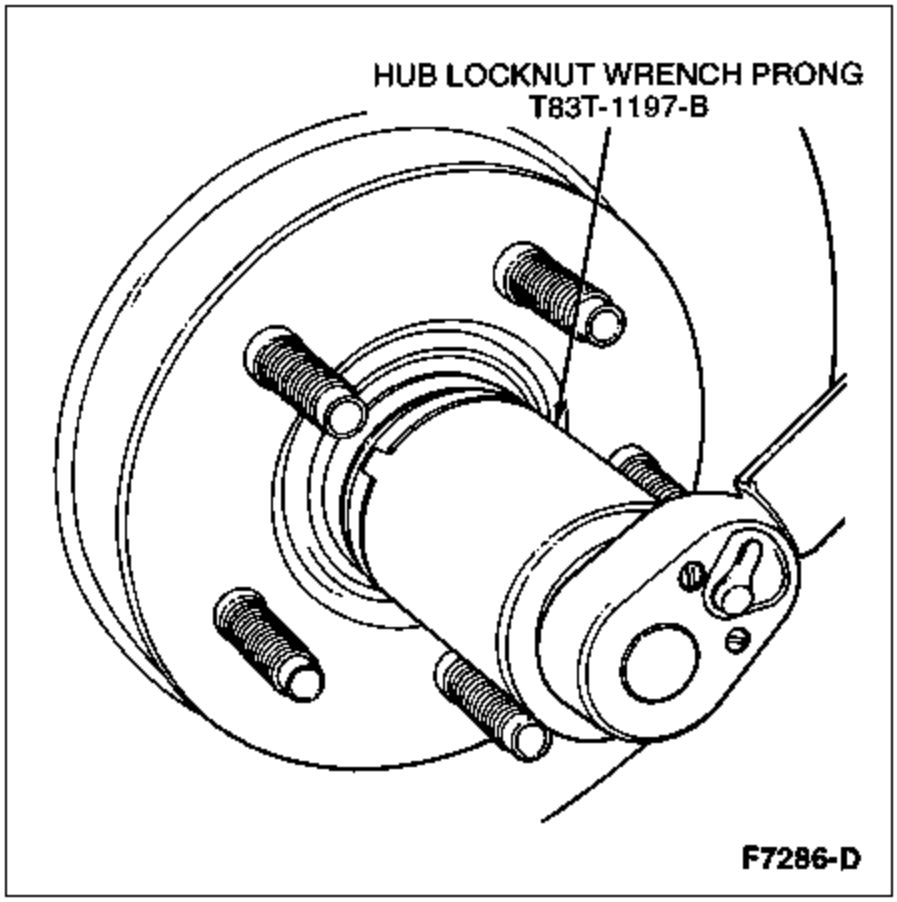

8. Loosen the inner wheel bearing locknut. Engage tool tab in locknut slots. Make sure tool is centered over the locknut pin.

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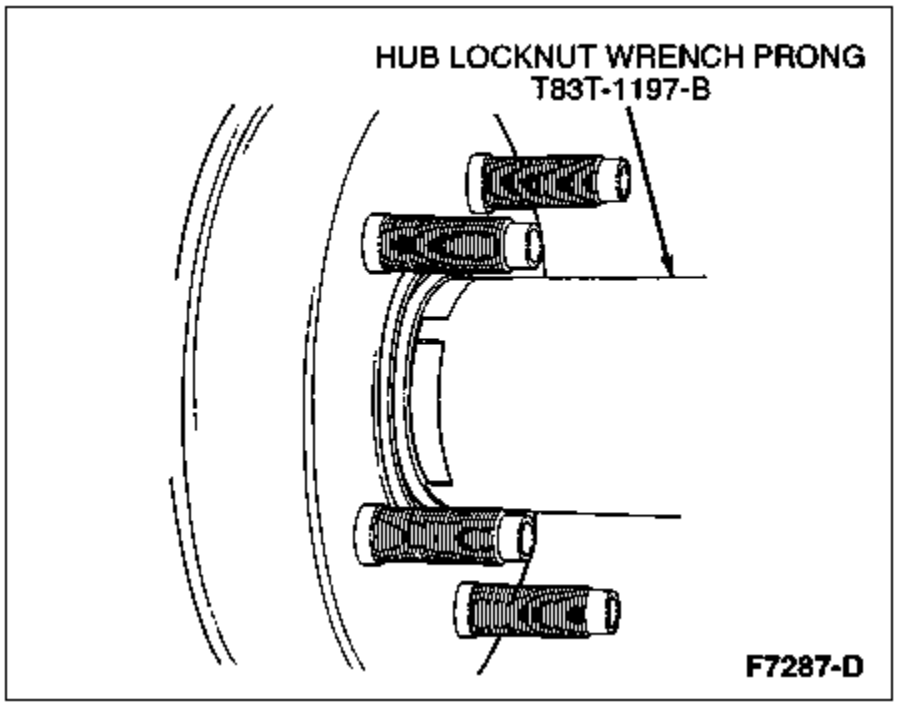

9. Tighten the inner locknut to 47 Nm (35 lb-ft) while turning the rotor in the opposite direction to seat wheel bearings.

10. **NOTE: If necessary, tighten inner locknut slightly to align the locknut pin with lockwasher hole.**

    Spin the rotor and back off the inner locknut one-quarter turn. Retighten the inner locknut to 1.8 Nm (16 lb-in).

11. Install the lockwasher on the front wheel spindle.

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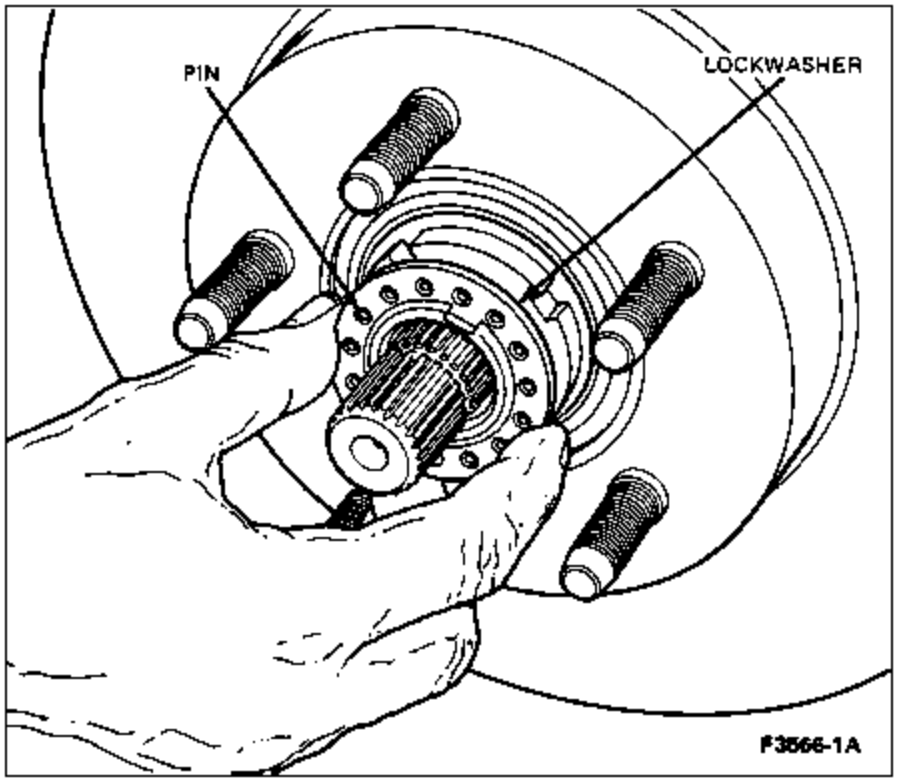

12. Install the outer wheel bearing locknut using locknut wrench. Tighten locknut to 203 Nm (150 lb-ft).
13. Check the end play of the wheel and tire assembly on the front wheel spindle. Final end play should be 0.00-0.08mm (0.000-0.003 inch). The maximum torque to rotate the hub is 2.8 Nm (25 lb-in).
14. Install the axle shaft spacer.
15. Clip the snap ring onto the end of the shaft of the front wheel spindle.
16. Install the manual hub assembly over the front wheel spindle. Install the retainer washers.
17. Install the wheel and tire assembly. Install and tighten lug nuts to 135 Nm (100 lb-ft).

Automatic Locking Hubs, Ranger

1. Raise the vehicle and install safety stands.
2. Remove the lug nuts and the wheel and tire assembly. Refer to Section 04-04 .
3. Remove the retainer washers from the wheel hub bolt nut studs. Remove the automatic locking hub assembly from the front wheel spindle.

Automatic Locking Hub, Ranger

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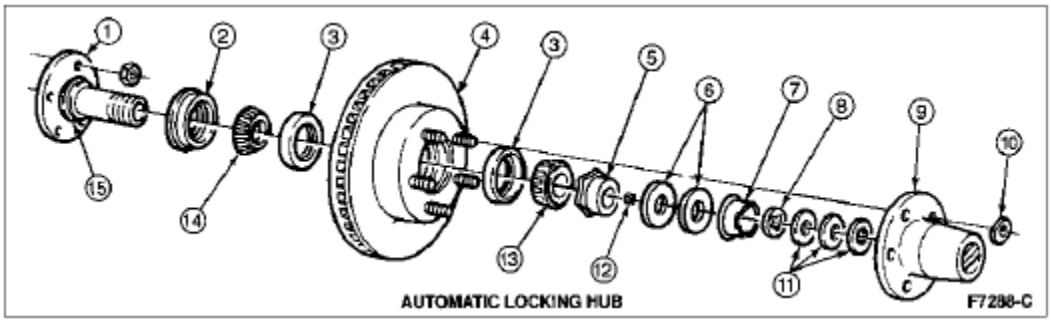

Item	Part Number	Description
1	3105	Front Wheel Spindle
2	1175B	Wheel Hub Grease Seal
3	4222	Wheel Bearing Cup
4	1102	Rotor
5	3N105	Wheel Bearing Adjusting Nut
6	3N105	Thrust Spacers
7	3B477	Front Axle Wheel Hub Retainer
8	3B458	Axle Shaft Spacer
9	3B396	Hub
10	1A107	Retaining Washer
11	3B548	Axle Shaft Spacers
12	3B549	Single Hump Locking Key
13	4221	Wheel Bearing (Outer)
14	4221	Wheel Bearing (Inner)
15	1175A	Excluder Seal

4. Remove the snap ring from the end of the shaft of the front wheel spindle.
5. Remove the axle shaft spacer.

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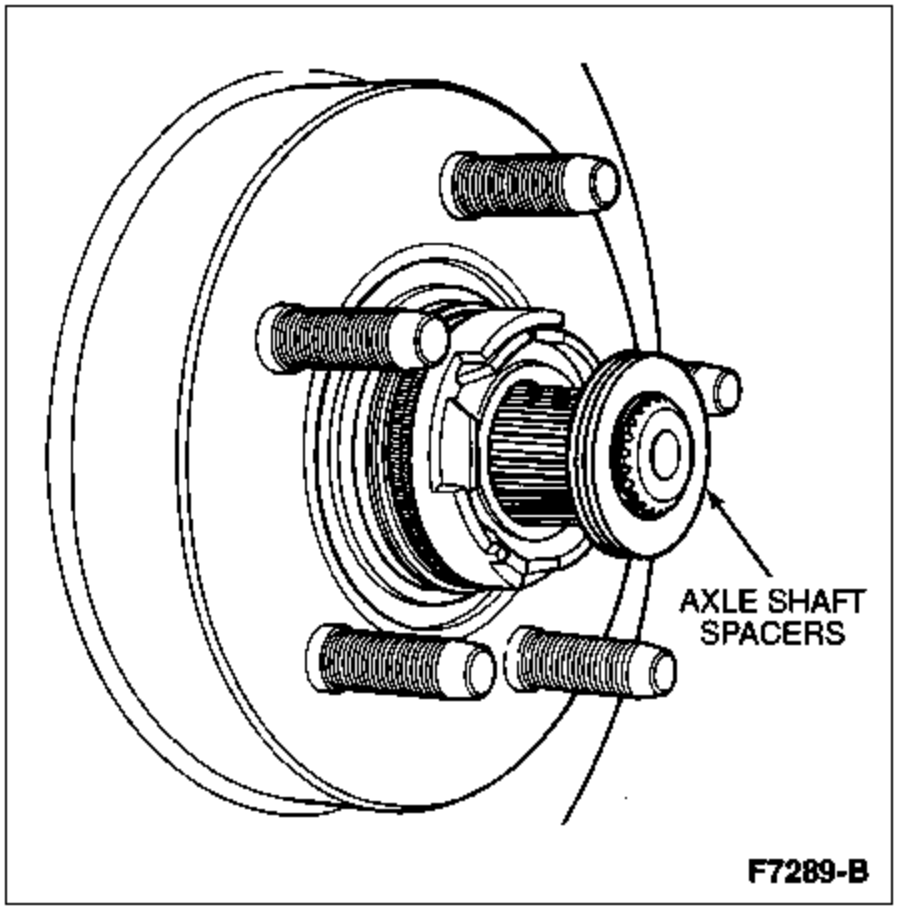

6. **CAUTION: Do not pry on the cam or thrust spacers during removal. Prying may damage the cam or spacers.**

   Pull cam assembly off the wheel bearing adjusting nut and remove the two metal thrust spacers from the adjusting nut.

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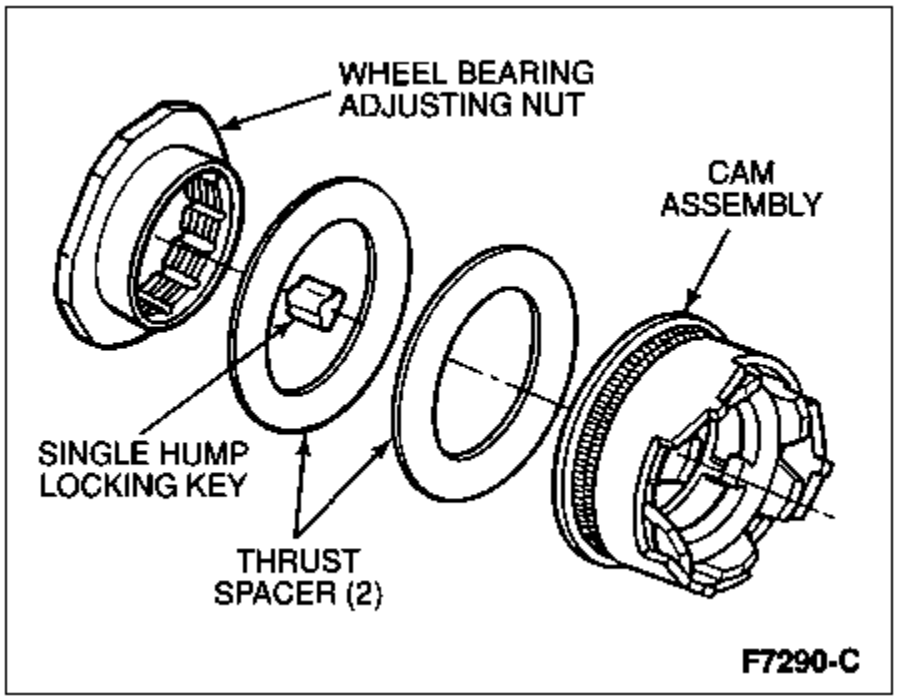

7. **CAUTION: To prevent damage to the threads of the front wheel spindle, look into the keyway of the front wheel spindle under the adjusting nut and remove the separate locking key before removing the adjusting nut.**

   NOTE: If required, rotate the adjusting nut slightly to relieve pressure against the locking key, before the key can be removed.

   Using a magnet, remove the locking key.

8. Loosen the wheel bearing adjusting nut from the front wheel spindle using a Hex Locknut Wrench T70T-4252-B.

9. While rotating the hub and rotor assembly, tighten the wheel bearing adjusting nut to 47 Nm (35 lb-ft) to seat the wheel bearings. Spin the rotor and back off the nut one-quarter turn (90 degrees).

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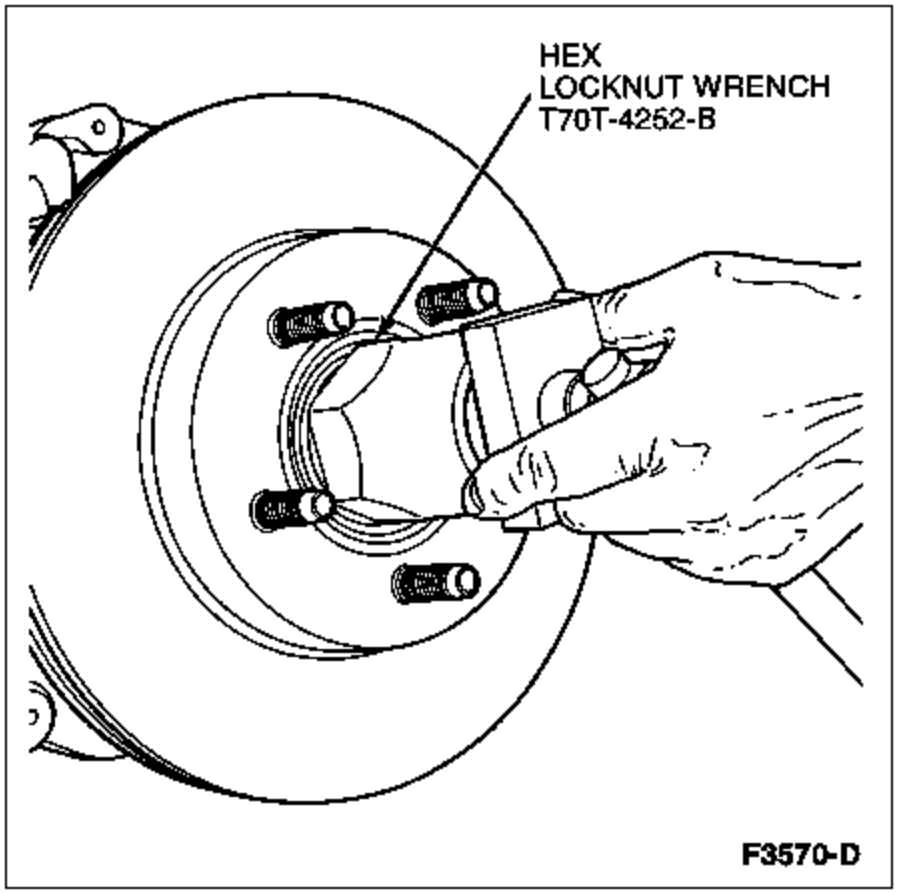

10. Retighten the adjusting nut to 1.8 Nm (16 lb-in) using a torque wrench.

11. Make sure the final end play of the wheel on the front wheel spindle is 0.00-0.08mm (0.000-0.003 inch). The maximum torque to rotate the hub is 2.8 Nm (25 lb-in).

12. **WARNING: EXTREME CARE MUST BE TAKEN WHEN ALIGNING THE NUT OF THE FRONT WHEEL SPINDLE ADJUSTMENT LUG WITH THE CENTER OF THE KEYWAY SLOT OF THE FRONT WHEEL SPINDLE TO PREVENT DAMAGE TO THE SEPARATE LOCKING KEY. THE WHEEL AND TIRE ASSEMBLY MAY COME OFF WHILE THE VEHICLE IS IN MOTION IF THE KEY IS DAMAGED.**

    Align the closest lug in the wheel bearing adjustment nut with the center of the keyway slot of the front wheel spindle. Advance the nut to the next lug if required. Install the separate locking key in the keyway of the front wheel spindle under the adjusting nut.

13. **CAUTION: Extreme care must be taken when aligning the fixed cam key with the keyway of the front wheel spindle to prevent damage to the fixed cam.**

    Install the two thrust spacers and push or press the cam assembly onto the locknut by lining up the key in the fixed cam with the keyway of the front wheel spindle.

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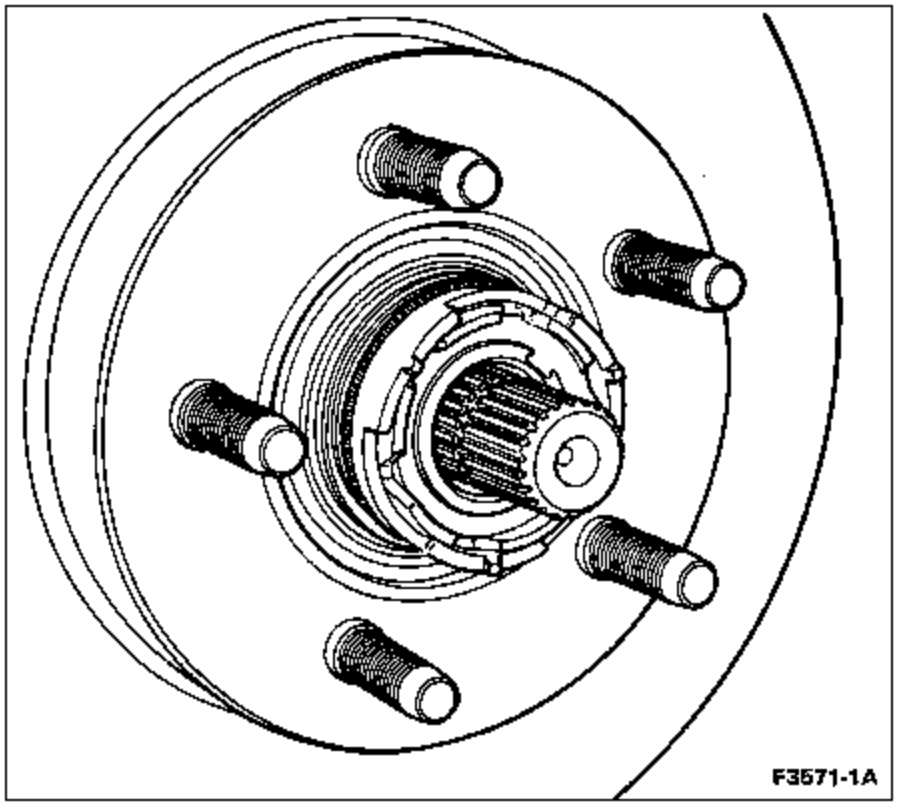

14. Install the axle shaft spacer.

15. Clip the snap ring onto the end of the shaft of the front wheel spindle.

16. Install the automatic locking hub assembly over the front wheel spindle. Align three hub assembly legs with three pockets in cam assembly. Install the retainer washers.

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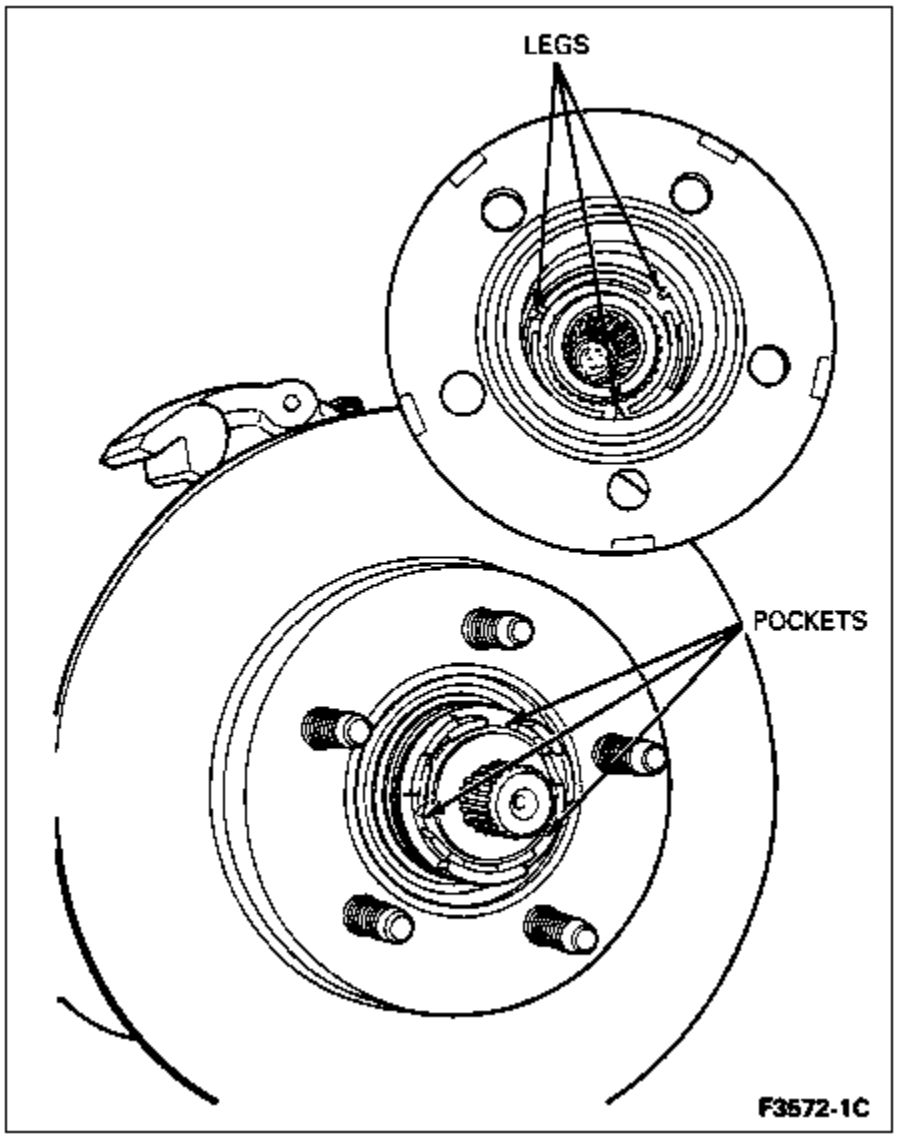

17. Install the wheel and tire assembly. Install and tighten lug nuts to 135 Nm (100 lb-ft).

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SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Lugnuts	135	100	—
Outer Wheel Bearing Locknut	203	150	—
Wheel Bearing Nut	1.8	—	16

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Axle, Front Drive

Removal

1. From inside the engine compartment, disconnect sensor two-pin connector from wiring harness.
2. Separate sensor cable from brake hose clips.
3. Remove retaining bolt of the front brake anti-lock sensor (2C204) from front wheel spindle (3105) and slide front brake anti-lock sensor out of mounting hole.
4. Raise the vehicle on a hoist or jack. Place safety stands under the radius arm brackets.
5. **NOTE: Before removing the driveshaft from the front axle yoke, mark the yoke and driveshaft for reassembly, eliminating driveshaft imbalance.**

   Remove the driveshaft from the front axle yoke. Refer to Section 05-01 .
6. **NOTE: Do not let the front disc brake caliper (2B121) hang by the brake lines. Support the front disc brake caliper on a frame rail and tie it in place with a piece of wire.**

   Remove the wheels (1007) and tires.
7. Remove the cotter pin and nut retaining the steering linkage to the knuckle. Disconnect the linkage from the knuckle and position it out of the way.
8. Remove the front stabilizer bar (5482) and front stabilizer bar links (5K483). Refer to Section 04-01B .
9. Position a jack under the axle arm assembly and slightly compress the front coil spring (5310). Remove the nut which retains the lower portion of the front coil spring to the axle arm.
10. Slowly lower the jack, and remove the front coil spring, spacer and seat.
11. Remove the nut and disconnect the shock absorber from the radius arm bracket.
12. Remove the radius arm bracket and radius arm stud and bolts to the axle arm.
13. Remove the bracket and radius arm.
14. Remove the pivot bolt securing the right axle arm to the front crossmember (5019). Remove the front wheel driveshaft joint boot clamps (3B478) securing the axle shaft boot to the axle shaft slip-yoke and axle shaft.
15. Disconnect the outer axle shaft from the slip-yoke.
16. Lower the jack and remove the right axle arm.
17. Position another jack under the differential housing. Remove bolt connecting the left axle arm to front

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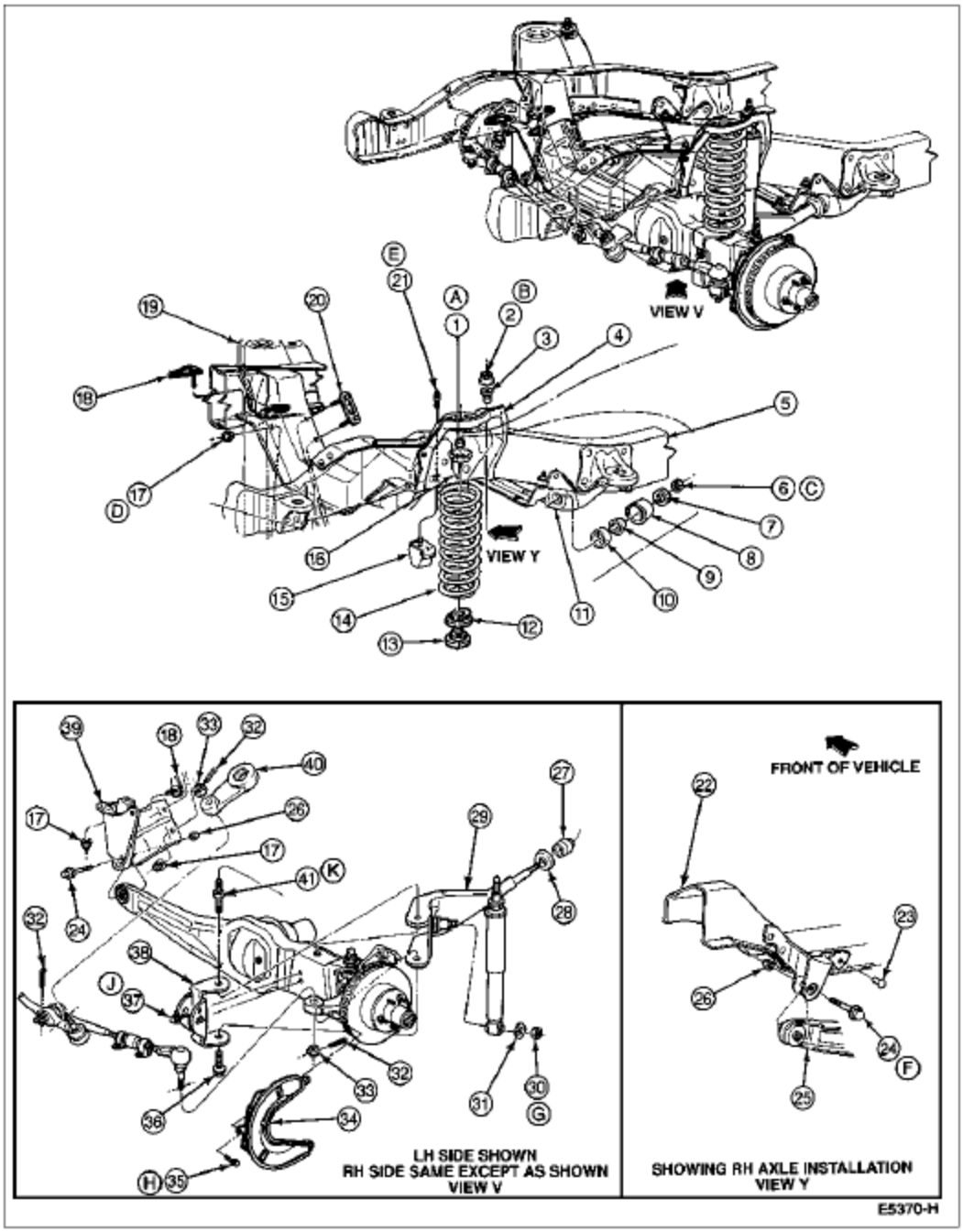
crossmember.

18. Lower jacks and remove left axle arm.

Front Axle Assembly Installation



Item	Part Number	Description
1	388833	Lower Spring Seat Nut

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2	805348	Upper Shock Absorber Nut
3	—	Shock Absorber Bushing
4	5B315	Upper Spring Seat (LH)
5	5605	Frame (LH)
6	34992	Radius Arm Nut
7	379572	Radius Arm Washer
8	3B463	Radius Arm Shield (RH)
9	3A184	Radius Arm Insulator
10	3B244	Radius Arm Spacer
11	3B183	Radius Arm Bracket
12	5414	Front Spring Insulator
13	5A307	Front Spring Seat
14	5310	Front Coil Spring
15	3020	Front Suspension Bumper
16	5A349	Retainer
17	802073	Axle Pivot Bracket Nut
18	804933	Bolt and Retainer
19	5A318	Front Suspension Seal
20	802453	Bolt and Retainer
21	803500	Front Suspension Bumper Bolt
22	5019	Front Crossmember
23	65094	Rivet
24	801079	Axle Pivot Bolt
25	3002	Front Axle Assembly
26	620604	Axle Pivot Nut
27	3B203	Insulator
28	3B186	Retainer
29	3405	Radius Arm
30	18198	Lower Shock Absorber to Radius Arm Nut
31	18177	Lower Shock Absorber to Radius Arm Washer
32	642569	Cotter Pin
33	800895	Nut
34	2K004	Front Disc Brake Rotor Shield (RH)
35	611171	Front Disc Brake Rotor Shield Bolt
36	58740	Radius Arm and Front Bracket Bolt
37	40954	Stabilizer Bar Bracket Bolt
38	—	Radius Arm and Front Bracket
39	3B178	Axle Pivot Bracket (RH)
40	3590	Steering Gear Sector Shaft Arm

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	390678	Radius Arm and Front Bracket to Support Arm Stud
A	—	Tighten to 95-135 Nm (70-100 Lb-Ft)
B	—	Tighten to 34-47 Nm (25-35 Lb-Ft)
C	—	Tighten to 109-162 Nm (80-120 Lb-Ft)
D	—	Tighten to 105-149 Nm (77-110 Lb-Ft)
E	—	Tighten to 15-25 Nm (11-18 Lb-Ft)
F	—	Tighten to 163-203 Nm (120-150 Lb-Ft)
G	—	Tighten to 57-97 Nm (42-72 Lb-Ft)
H	—	Tighten to 7-10 Nm (62-89 Lb-In)
J	—	Tighten to 37-50 Nm (27-37 Lb-Ft)
K	—	Tighten to 258-311 Nm (190-229 Lb-Ft)

Installation

1. **NOTE: Do not yet remove the jack from under the differential housing.**

   With the vehicle on a hoist or jacked up, position a jack under the left support arm assembly. Raise the support arm until the arm is in position in the left pivot bracket. Install the nut and bolt and tighten to 163-203 Nm (120-150 lb-ft).

2. Place new front wheel driveshaft joint boot clamps for the axle shaft boot on the axle shaft assembly.

3. **NOTE: When installing the outer axle shaft into the inner slip-yoke, the yoke ears must be in alignment with each other to ensure proper phasing.**

   Position the right support arm on a jack and raise the right support arm so the right outer axle shaft slides onto the slip-yoke and the support arm is in position in the right pivot bracket. Install the nut and bolt and tighten to 163-203 Nm (120-150 lb-ft).

4. **NOTE: Do not remove the jack from the right support arm at this time.**

   Position the radius arm and front bracket on the support arms.

5. Install a new support arm stud on the top of the axle and radius arm assembly and tighten to 258-311 Nm (190-229 lb-ft).

6. Install the radius arm and front bracket bolts and tighten to 37-50 Nm (27-37 lb-ft).

7. Install the seat, spacer retainer and front coil spring on the stud. Raise the jack to compress the front coil spring. Install the nut and tighten to 95-135 Nm (70-100 lb-ft).

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8. Connect the shock absorber to the radius arm. Install nut and tighten to 57-97 Nm (42-72 lb-ft).
9. Connect the tie rod ball joint to the knuckle. Install nut and tighten to 68-101 Nm (50-75 lb-ft).
10. Lower the jacks from the support arms.
11. Install the front stabilizer bar. Refer to Section 04-01B .
12. Install the front disc brake caliper as described in Section 06-03 .
13. Install the wheels. Tighten the lug nuts to 115-155 Nm (85-115 lb-ft).
14. **NOTE: Reassemble the yoke and driveshaft to the marks made during disassembly.**

    Connect the front drive shaft to the front axle yoke. Install U-bolts and tighten the front driveshaft U-bolt nuts to 11-20 Nm (8-15 lb-ft).
15. Remove the jacks and lower the vehicle.
16. From inside the engine compartment, slide front brake anti-lock sensor into mounting hole and install the bolt. Tighten the front brake anti-lock sensor bolt to 5-6 Nm (44-53 lb-in).
17. Install sensor cable inside brake hose clips.
18. Connect sensor two-pin connector into wiring harness.

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Spindle, Shaft and Joint

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Keystone Clamp Pliers	T63P-9171-A
Spindle Bearing Replacer	T80T-4000-S
Driver Handle	T80T-4000-W
Spindle/Axle Seal Installer	T83T-3132-A

Removal

1. Raise the vehicle and place on safety stands.
2. Remove the wheels (1007) and tires.
3. Remove the front disc brake caliper (2B121) as described in Section 06-03 .
4. Remove hub locks, wheel bearings, and locknuts as described in Section 05-03A .
5. Remove the front disc brake hub and rotor (1102). Remove the front wheel bearing (1216).

Spindle and Left Shaft and Joint Assembly

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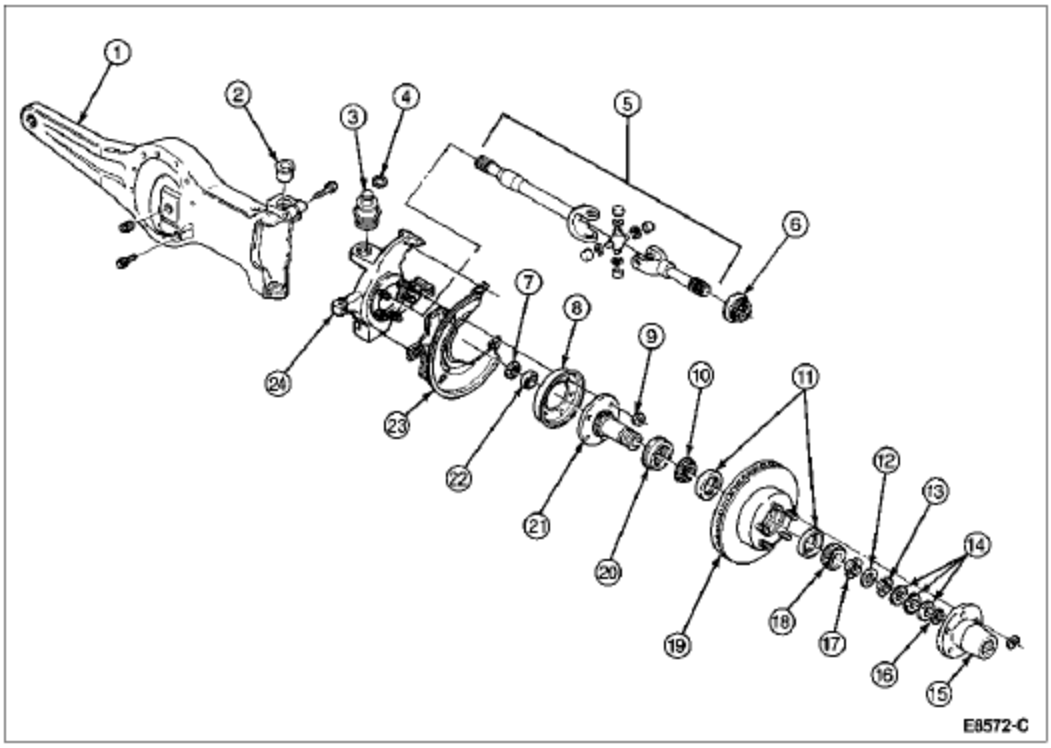

Item	Part Number	Description
1	3B403	Left Axle Arm
2	3B440	Camber Adjuster
3	3049	Front Suspension Upper Ball Joint
4	3R049	Snap Ring
5	3220	Left Shaft and Joint
6	1175	Slinger
7	3299	Spindle Seal
8	1214	Spindle Seat
9	3K140	Nut
10	4221	Differential Bearing (Inner)
11	4222	Differential Bearing Cup
12	3B459	Locknut Thrust Washer
13	1197	Bearing Locknut (Inner)
14	3B458	Axle Shaft Spacer
15	3B396	Manual Locking Hub
16	3B457	Snap Ring
17	1197	Bearing Locknut (Outer)
18	4221	Differential Bearing (Outer)
19	1102	Rotor
20	1175B	Wheel Hub Grease Seal

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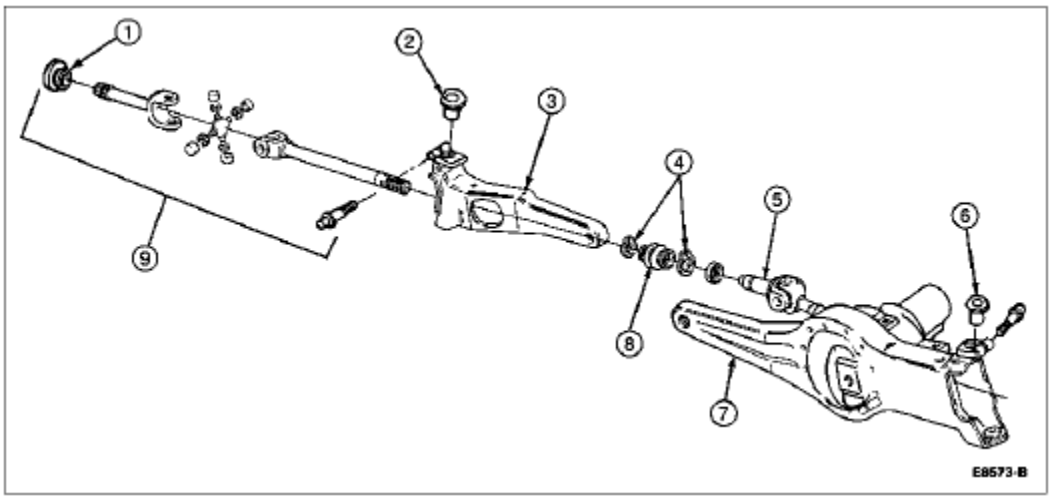
21	3105	Front Wheel Spindle
22	3123	Spindle Needle Bearing
23	2K005	Front Disc Brake Rotor Shield
24	3130	Knuckle
25	1175A	Excluder Seal

Right Shaft and Stub Shaft Assembly



Item	Part Number	Description
1	1175	Seal
2	3B440	Camber Adjuster
3	3B402	Right Axle Arm
4	3B478	Front Wheel Driveshaft Joint Boot Clamp
5	3L387	Slip Yoke and Stub Shaft
6	3B440	Camber Adjuster
7	3B403	Left Axle Arm
8	3A429	Rubber Boot
9	3219	Right Shaft and Joint

6. Remove the nuts retaining the front wheel spindle (3105) to the steering knuckle. Tap the spindle with a plastic or rawhide hammer to jar the spindle from the knuckle.

7. Remove the front disc brake rotor shield (2K004).

8. On the left side of the vehicle remove the shaft and joint by pulling the assembly out of the carrier.

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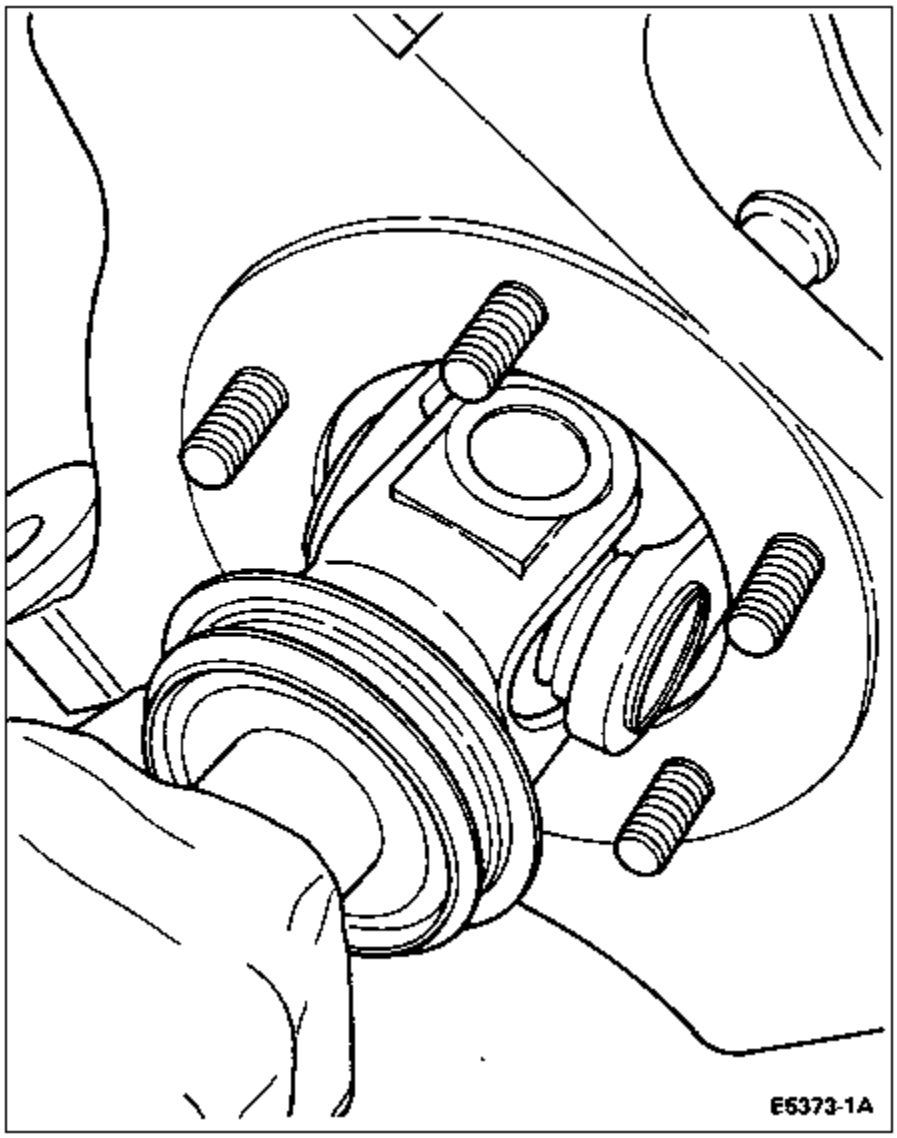

9. On the right side of the carrier, remove and discard the front wheel driveshaft joint boot clamp (3B478) from the outer shaft and joint assembly.

10. **NOTE: Stub shaft will remain engaged to carrier. For stub shaft removal, refer to Removal and Installation, Slip-Yoke, RH and Stub Shaft Assembly, Carrier, Carrier Oil Seal and Bearing in this section.**

    Pull the shaft and joint from the splines of the stub shaft.

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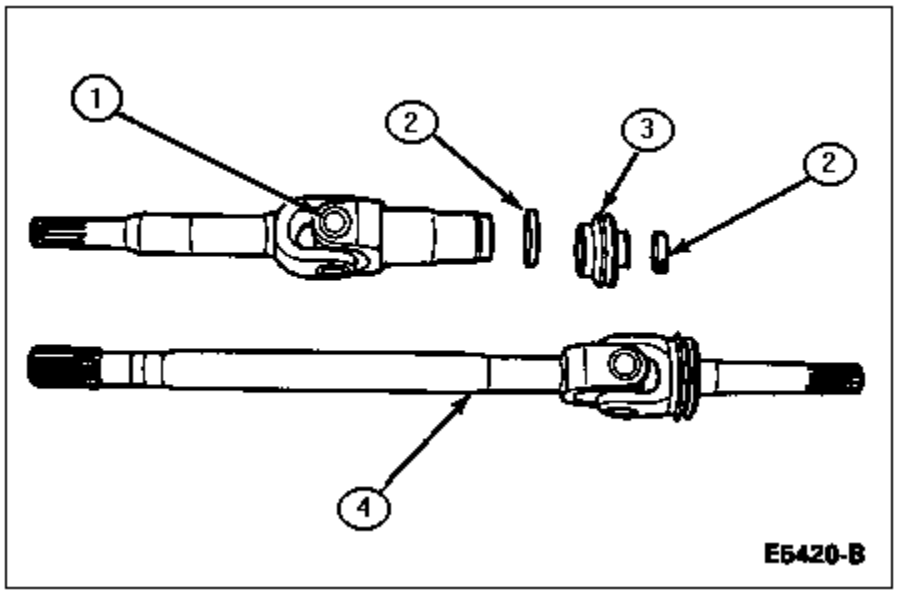

Item	Part Number	Description
1	3L387	Axle Shaft Slip Yoke
2	3B478	Front Wheel Driveshaft Joint Boot Clamp
3	3A429	Rubber Boot
4	3220	Shaft and Joint

11. Place the front wheel spindle in a vise on the second step of the spindle. Wrap a shop towel around the spindle or use a brass-jawed vise to protect the spindle.

12. Remove the wheel hub grease seal and needle bearing from the front wheel spindle with an impact slide hammer and a suitable seal puller.

13. If required, remove the slinger from the shaft, by driving off with a hammer.

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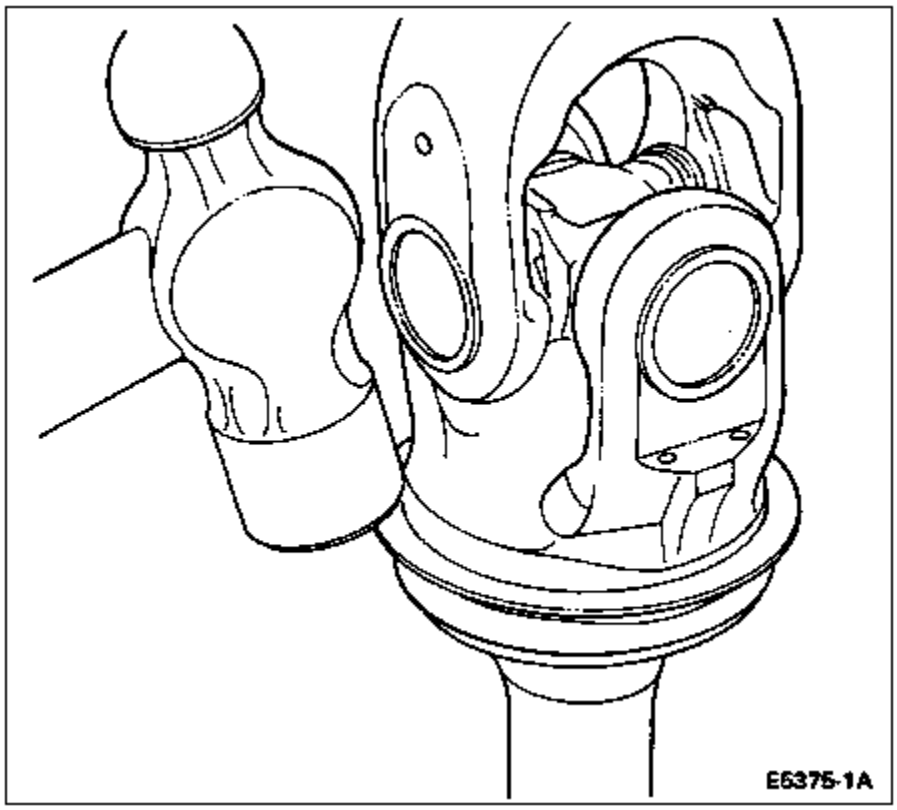

Installation

1. Clean all dirt and grease from the bearing bore of the front wheel spindle. Bearing bores must be free from nicks and burrs.

2. Place the spindle needle bearing in the bore with the manufacturer's identification facing outward. Drive the spindle needle bearing into the bore using Spindle Bearing Replacer T80T-4000-S and Driver Handle T80T-4000-W.

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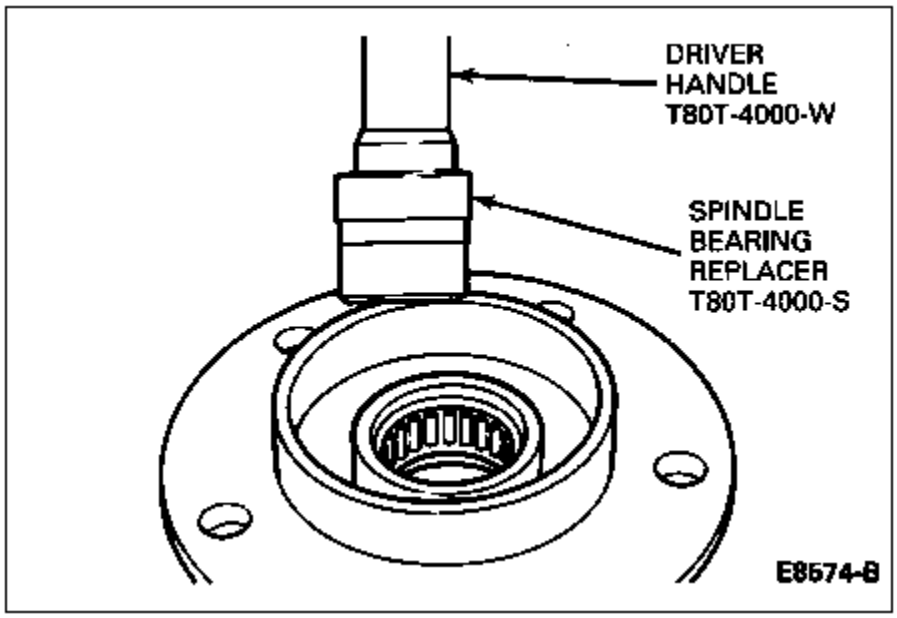
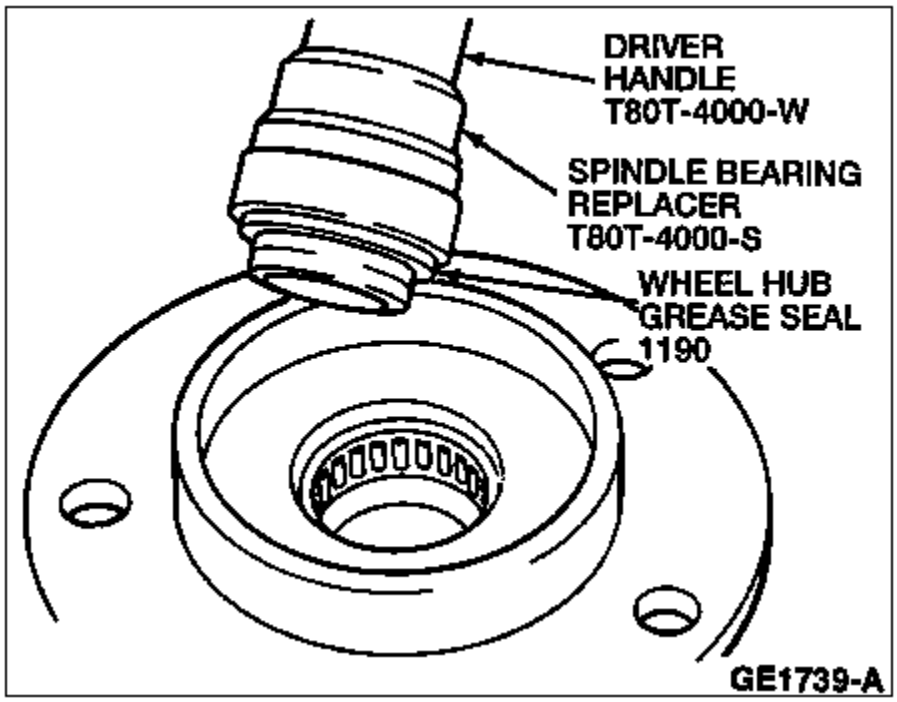


3. Install the wheel hub grease seal (1190) in the bearing bore with the lip side of the seal facing towards the tool. Drive the seal in the bore with Spindle Bearing Replacer T80T-4000-S and Driver Handle T80T-4000-W. Coat the bearing seal lip with High Temperature Lubricant E8TZ-19590-A or equivalent meeting Ford specification ESA-M1C198-A.



4. If removed, install a new shaft slinger. Place the axle shaft in a press, and install the slinger with Spindle/Axle Seal Installer T83T-3132-A.

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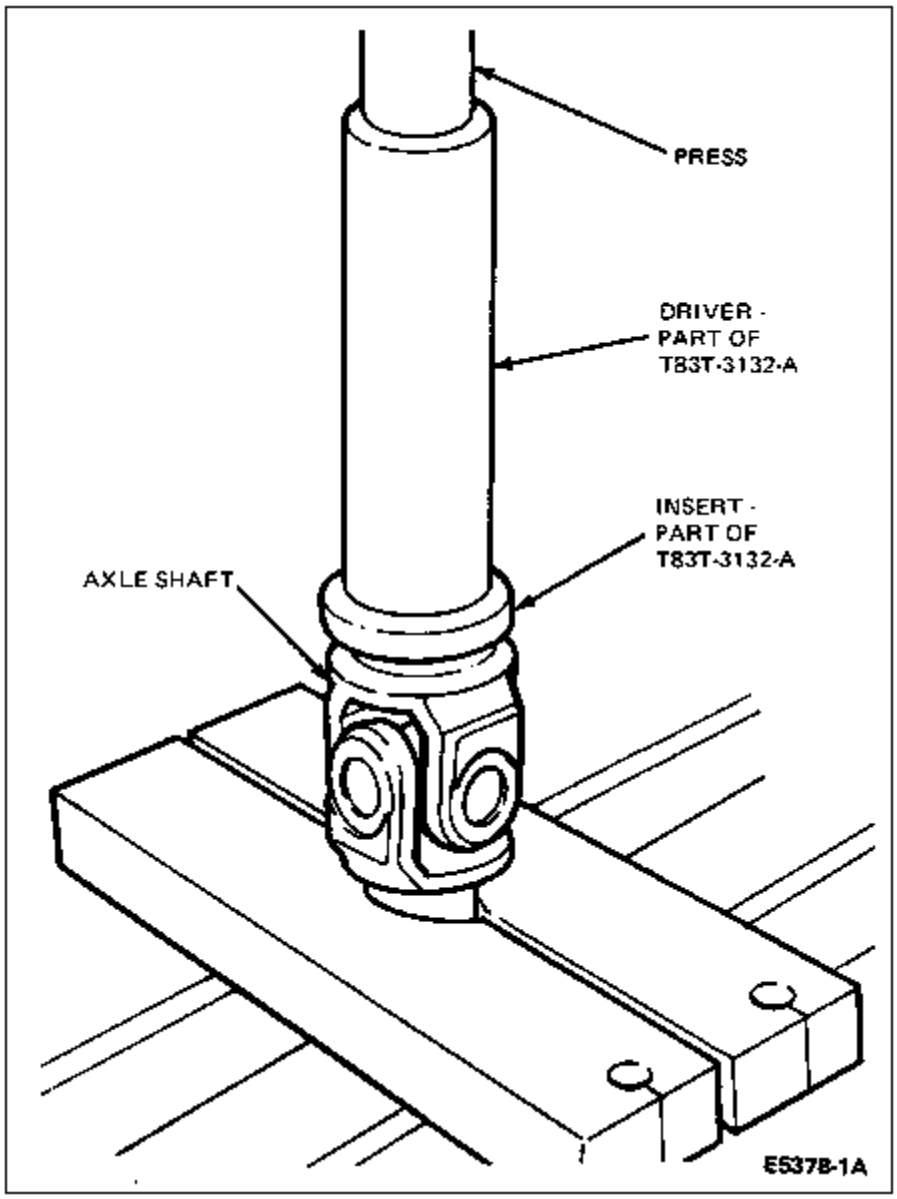

5. On the right side of the carrier, install the rubber boot and new front wheel driveshaft joint boot clamps on the stub shaft slip-yoke.

6. **NOTE: The Model 35 axle does not have a blind spline. Therefore, special attention should be made to make sure the yoke ears are in line (in phase) during assembly.**

   Slide the right shaft and joint into the slip-yoke. Engage splines fully.

7. Slide the boot over the assembly and crimp the front wheel driveshaft joint boot clamp using Keystone Clamp Pliers T63P-9171-A.

8. On the left side of the carrier, slide the shaft and joint through the knuckle and engage the splines on the shaft in the carrier.

9. Install the front disc brake rotor shield (2K005) and front wheel spindle onto the steering knuckle. Install and tighten the spindle nuts to 54-68 Nm (40-50 lb-ft).

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10. Install the rotor on the front wheel spindle. Install the outer differential bearing into differential bearing cup (4222).

11. Install the wheel bearing, locknut, thrust bearing, snap ring, and locking hubs. Refer to Section 05-03A for service procedures for either manual or automatic locking hubs.

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Slip-Yoke, RH and Stub Shaft Assembly, Carrier, Carrier Oil Seal and Bearing

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Bench Mounted Holding Fixture	T57L-500-B
Spreader Adapters	T90T-4000-A
Seal Puller	T74P-77248-A
Axle Bearing Remover	T90T-1225-A
Axle Bearing and Seal Replacer	T90T-1175-A
Driver Handle	T80T-4000-W

Removal

1. **NOTE: Mark the axle companion flange and driveshaft to assure reassembly in the same location.**

   Remove the nuts and U-bolts connecting the driveshaft to the axle companion flange.

2. Disconnect the driveshaft from the axle companion flange. Wire the driveshaft out of the way.

3. Remove both front wheel spindles (3105) and the left and right shaft and U-joints; refer to the procedure in this section.

4. Support the carrier with a suitable jack and remove the bolts retaining the carrier housing to the support arm.

5. Separate the carrier from the support arm and drain the lubricant from the carrier housing.

6. Remove the carrier housing from the vehicle.

Carrier, Right Slip-Yoke and Stub Shaft Assembly

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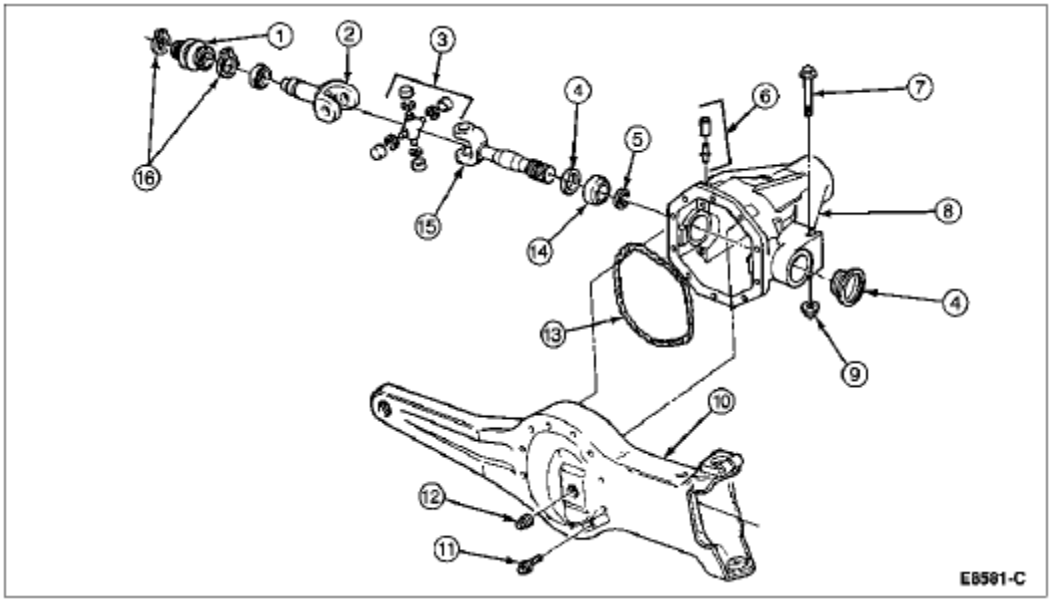

Item	Part Number	Description
1	3A429	Rubber Boot
2	3L387	Slip Yoke
3	3249	Front Axle Shaft Universal Joint
4	3254	Axle Shaft Oil Seal
5	3167	C-Clip
6	4022	Breather Vent
7	3E323	Pinch Bolt
8	3010	Carrier Housing
9	3E323	Pinch Bolt Nut
10	3B403	Left Axle Arm
11	3C323	Carrier to Axle Arm Bolt
12	358035	Fill Plug
13	D6AZ-19562-AA or -BA	RTV Sealant
14	3C123	Bearing
15	3N387	Stub Shaft
16	3B478	Front Wheel Driveshaft Joint Boot Clamp

7. Place the carrier in Bench Mounted Holding Fixture T57L-500-B with Spreader Adapters T90T-4000-A and suitable spacers.

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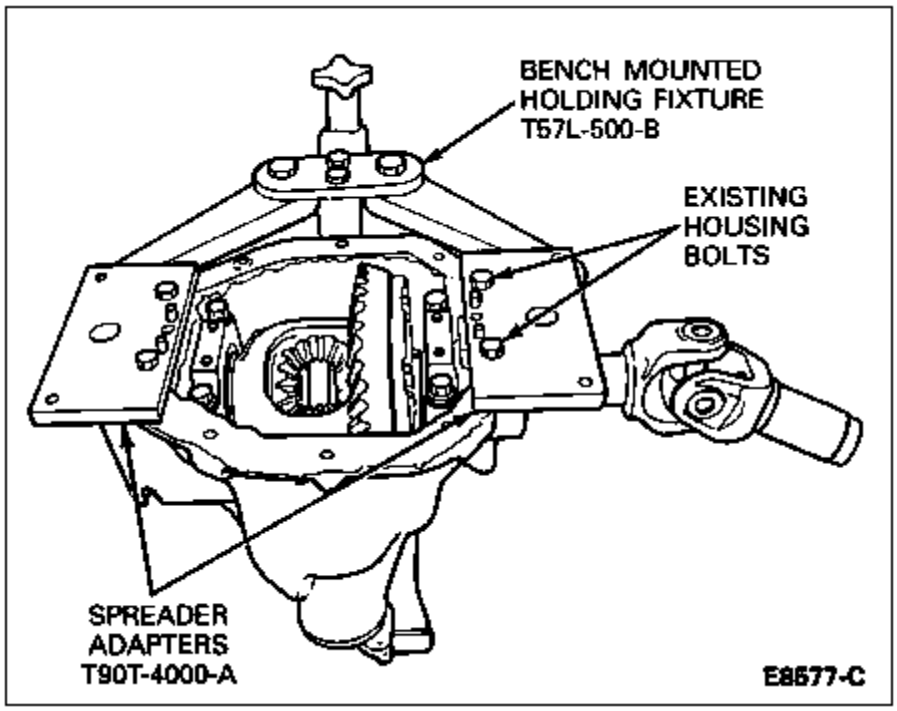

8. Rotate the slip-yoke and shaft so the open side of the snap ring is exposed. Remove the snap ring from the shaft.

9. Remove the slip-yoke and shaft from the carrier.

10. Remove the right side axle shaft oil seal (3254) using Impact Slide Hammer T50T-100-A and a suitable seal remover.

11. Remove the left side axle shaft oil seal using an impact slide hammer and Axle Bearing Puller T90T-1225-A.

12. Remove both caged needle bearings using an impact slide hammer and Axle Bearing Remover T90T-1225-A.

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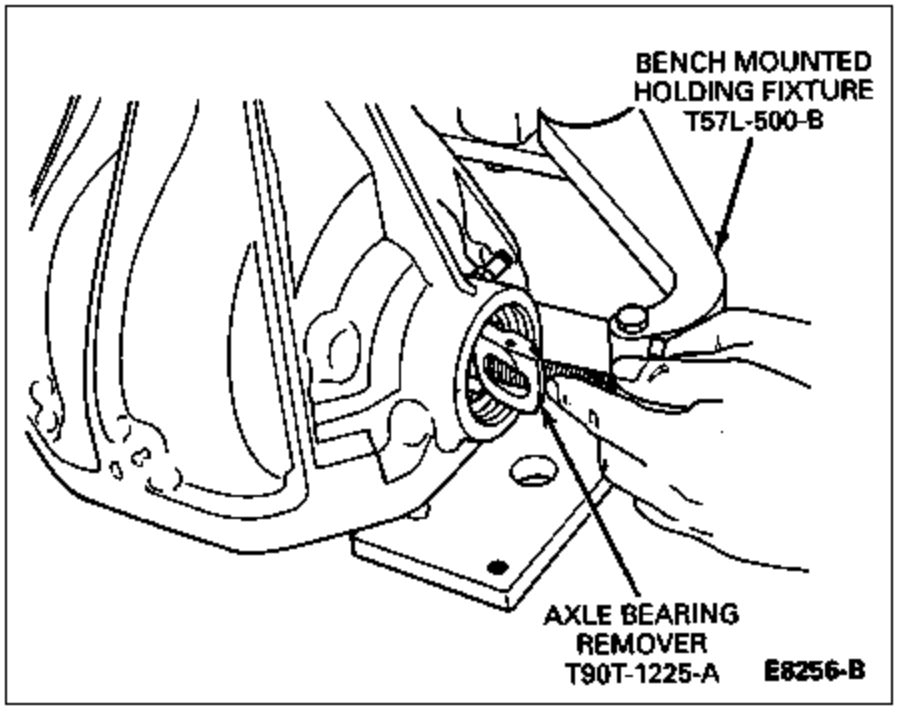

Installation

1. Inspect bearing bore for nicks and burrs.
2. Install a new caged needle bearing on Axle Bearing and Seal Replacer T90T-1175-A with the manufacturer name and part number facing outward towards the tool.
3. Using Driver Handle T80T-4000-W, drive the needle bearing until it is seated in the bore.

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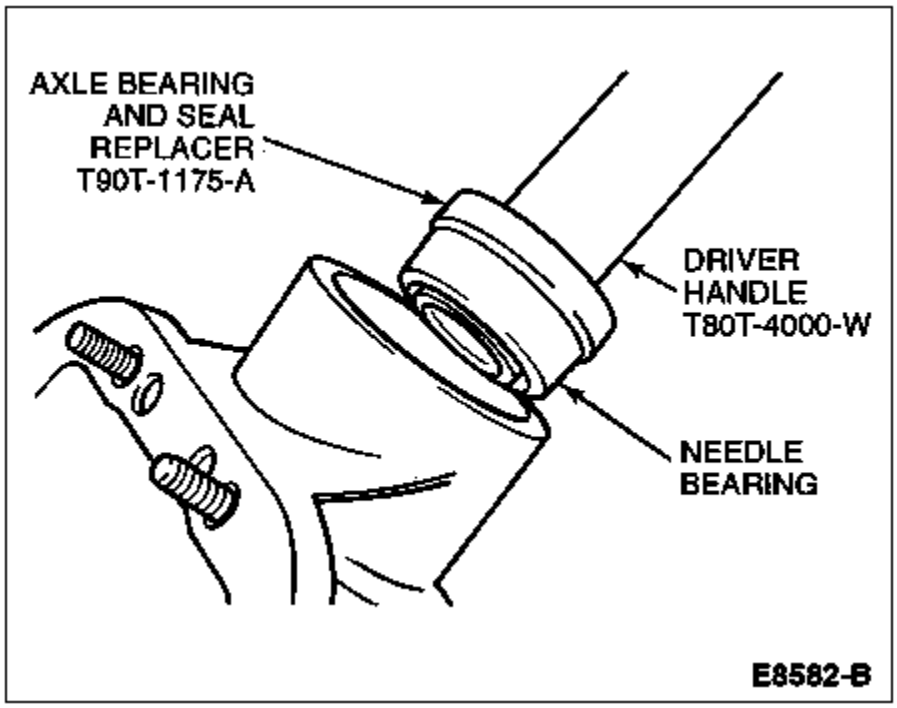
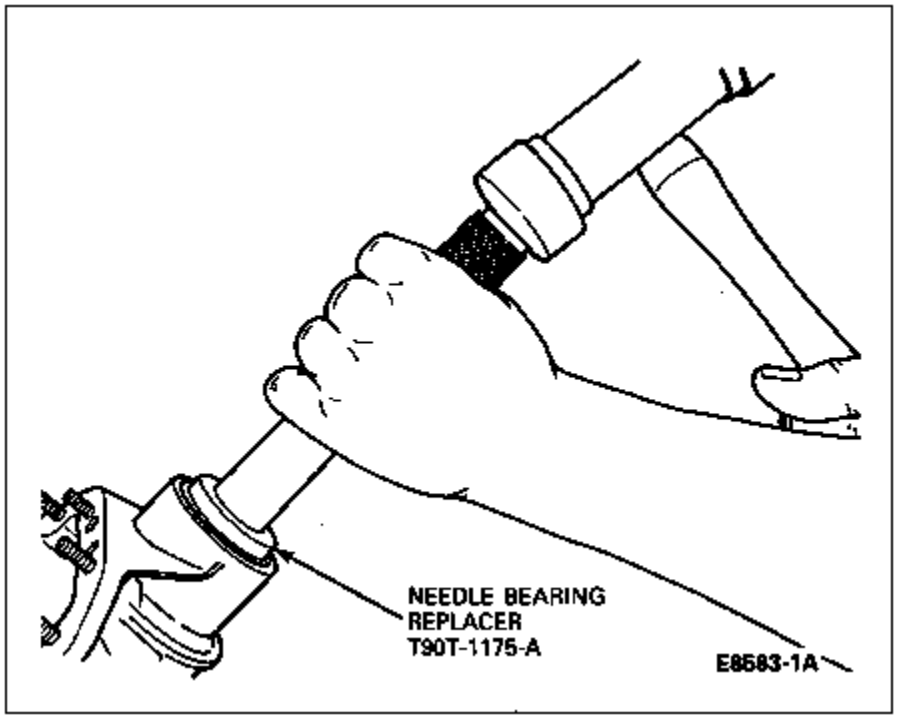


4. Coat the axle shaft oil seal with High Temperature 4x4 Front Axle and Wheel Bearing Grease E8TZ-19590-A or equivalent meeting Ford specification ESA-M1C198-A. Drive the seal into the carrier using Driver Handle T80T-4000-W and Axle Bearing and Seal Replacer T90T-1175-A.



5. Install the slip-yoke and shaft into the carrier so the groove in the shaft is visible in the differential case.

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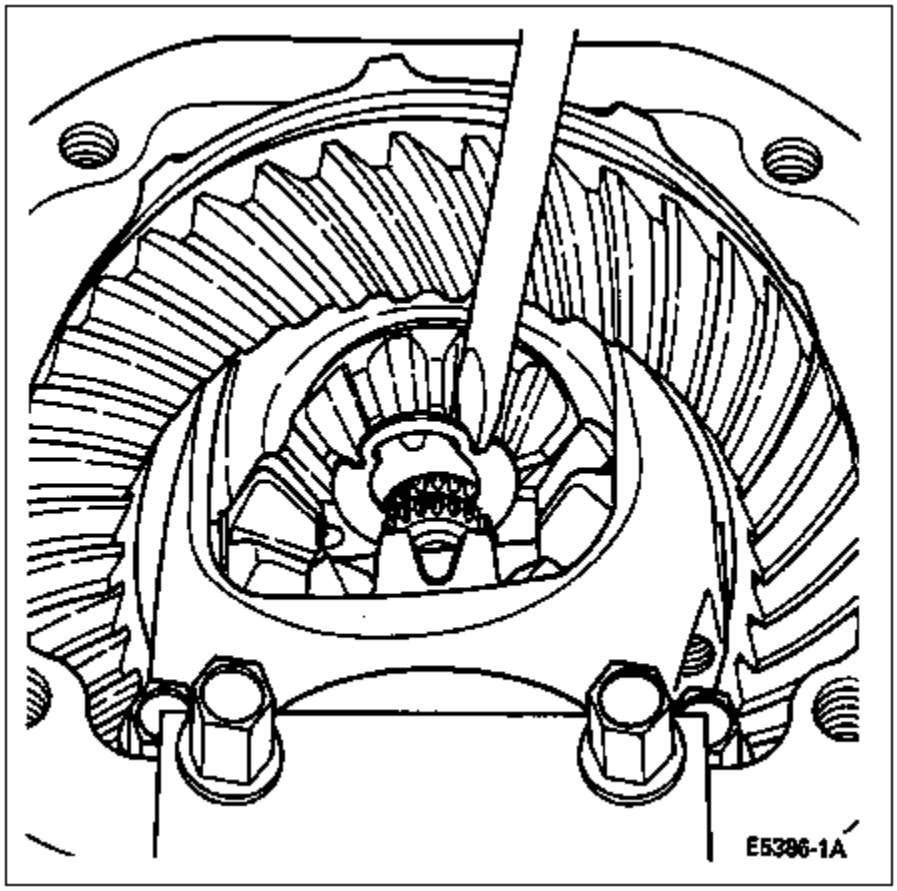
6. **NOTE: Do not tap on the center of the snap ring. This may damage the snap ring.**

   Install snap ring into groove in the shaft. Force the snap ring into position with a screwdriver.

7. Remove the carrier from the holding fixture.



8. **NOTE: Clean all traces of gasket RTV sealant from the surfaces of the carrier and support arm and make sure the surfaces are free of dirt and oil.**

   Apply a bead of Silicone Rubber RTV sealant D6AZ 19562-AA (clear) or equivalent meeting Ford specification ESB-M4G92-A or ESE-M4G195-A, in a bead between 6.35-9.53mm (1/4-3/8 inch) wide. The bead should be continuous and should not pass through or outside the holes.

9. **NOTE: The carrier must be installed on the support arm within five minutes after applying the RTV sealant.**

   Position the carrier on a suitable jack. Position carrier on the support arm using guide pins to align. Hand-tighten carrier to support arm attaching bolts. Tighten the carrier to support arm attaching bolts in a clockwise or counterclockwise pattern to 54-68 Nm (40-50 lb-ft).

10. Install the carrier shear bolt retaining the carrier to the axle arm and tighten to 102-129 Nm (75-95 lb-ft).

11. Install both front wheel spindles and the left and right shaft and joint; refer to the procedure in this

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section.

12. Connect the driveshaft to the yoke. Install the nuts and U-bolts and tighten the front driveshaft U-bolt nuts to 11-20 Nm (8-15 lb-ft).

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Steering Knuckle and Ball Joints

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Pitman Arm Puller	T64P-3590-F
U-Joint Tool	T74P-4635-C
4WD Ball Joint Set	T80T-3010-A
Axle Service Set	T83T-4000-A

Removal

1. **NOTE: Refer to Section 04-00 for caster and camber adjustment.**

   Remove the front wheel spindle (3105) and shaft and joint; refer to the procedure in this section.

2. If the steering linkage has not been removed, remove cotter pin from the tie rod nut and remove the tie rod nut.

3. Tap on the tie rod stud to free it from the steering arm.

4. Remove the snap ring and the upper ball joint pinch bolt.

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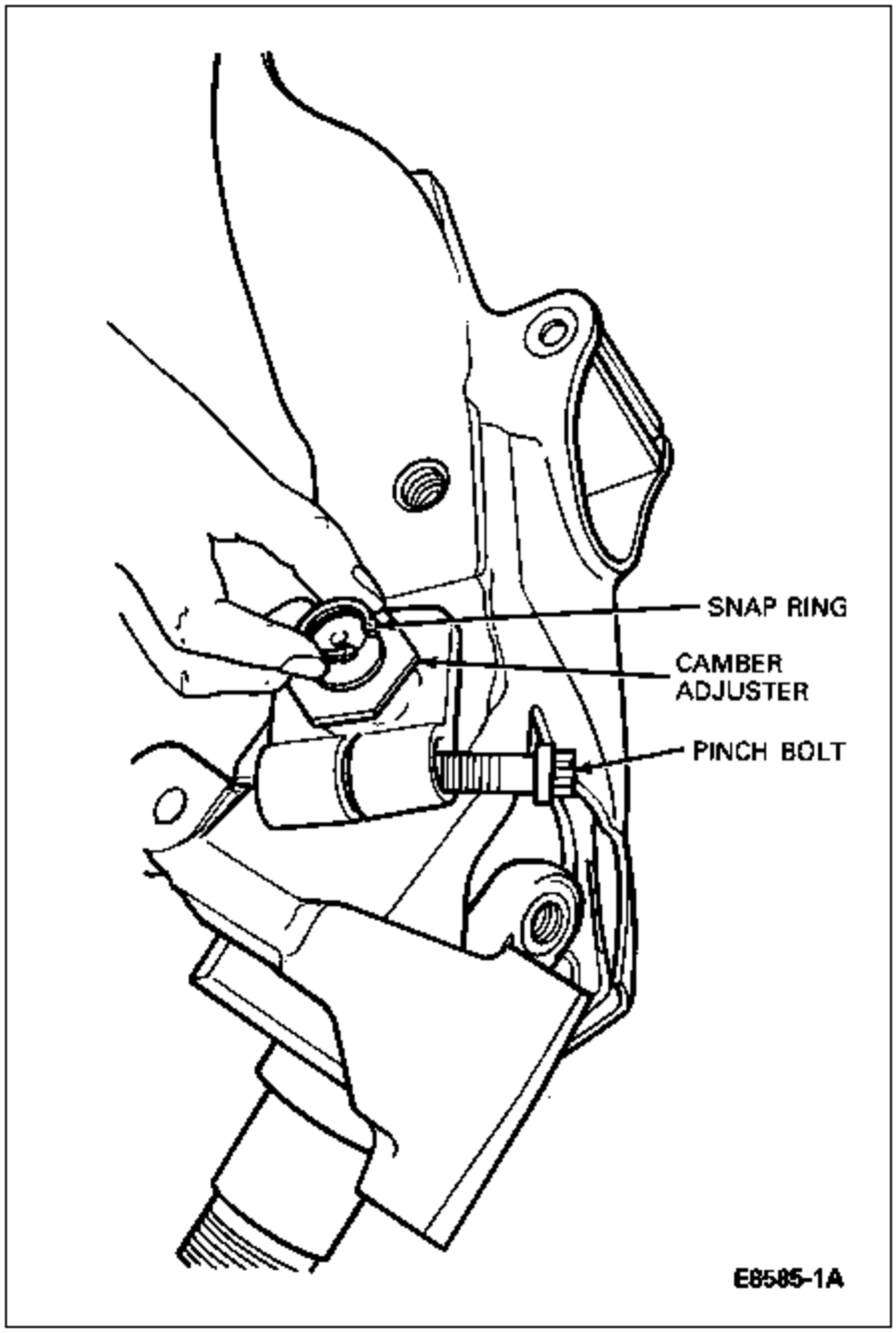

5. Loosen the lower ball joint nut to the end of the stud.

6. Strike the inside of the knuckle near the front suspension upper ball joint (3049) and front suspension lower arm ball joint (3050) to break the knuckle loose from the ball joint studs.

7. **NOTE: Mark the orientation of the slot in the camber adjuster. If necessary, scribe a line or mark the position with a grease pencil. The slot should be installed in the same position during reassembly to maintain alignment.**

   Remove the camber adjuster sleeve. If required, use Pitman Arm Puller T64P-3590-F to remove the adjuster out of the knuckle.

8. Remove lower ball joint nut.

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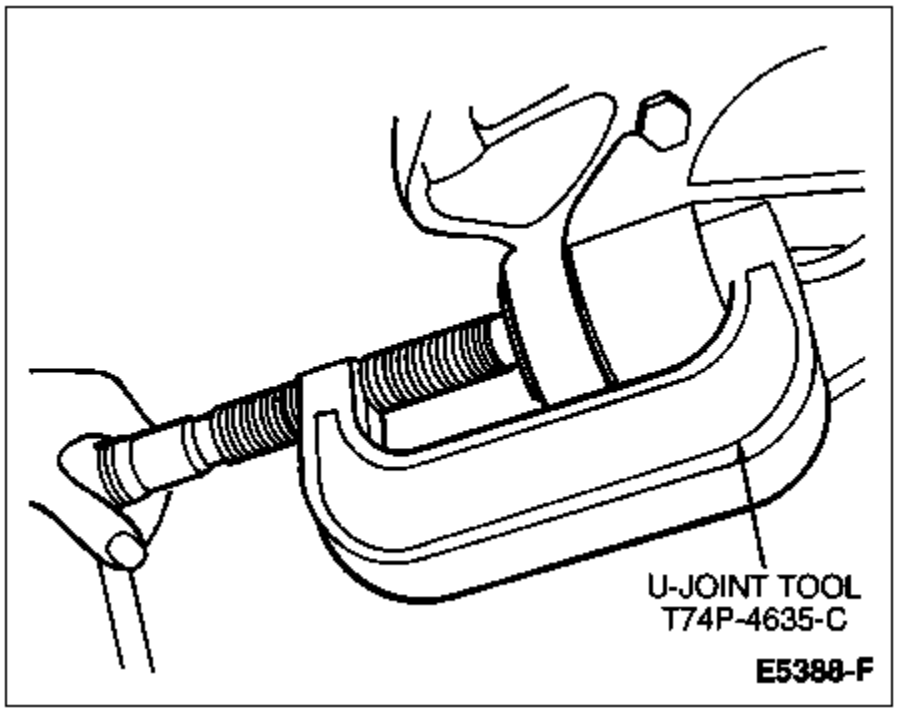
9. Place knuckle in vise and remove snap ring from bottom ball joint socket if so equipped.

10. Assemble U-Joint Tool T74P-4635-C and suitable ball joint remover on the front suspension lower arm ball joint.



11. Turn forcing screw clockwise until the front suspension lower arm ball joint is removed from the steering knuckle.

12. **NOTE: Always remove front suspension lower arm ball joint first.**

    Assemble U-Joint Tool T74P-4635-C and suitable ball joint remover on the upper front suspension upper ball joint.

13. Turn forcing screw clockwise until the front suspension upper ball joint is removed from the knuckle.

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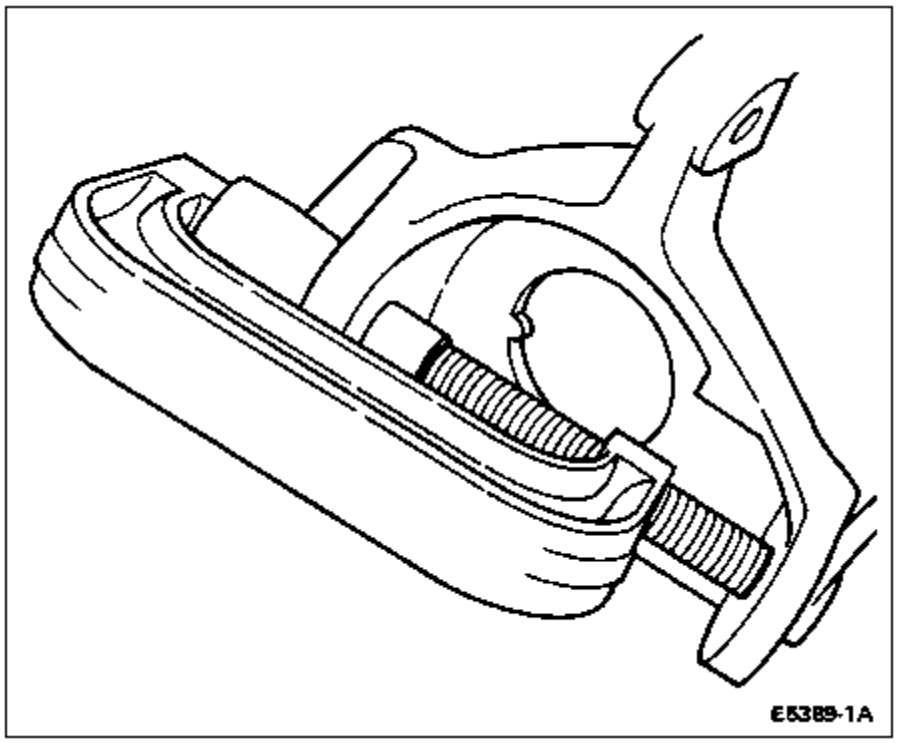

Installation

1. **NOTE: The front suspension lower arm ball joint must always be installed first.**

   Clean the steering knuckle bore and insert front suspension lower arm ball joint in knuckle as straight as possible.

2. Assemble U-Joint Tool T74P-4635-C and Receiver Cup to install the front suspension lower arm ball joint.

3. Turn the forcing screw clockwise until the front suspension lower arm ball joint is firmly seated.

4. **NOTE: If the ball joint cannot be installed to the proper depth, realignment of the receiver cup and C-Frame tool will be necessary.**

   Install the snap ring on the front suspension lower arm ball joint.

5. To install the front suspension upper ball joint, install the U-Joint Tool T74P-4635-C and Replacer T80T-3010-A3 in the knuckle.

6. Turn the forcing screw clockwise until the ball joint is firmly seated.

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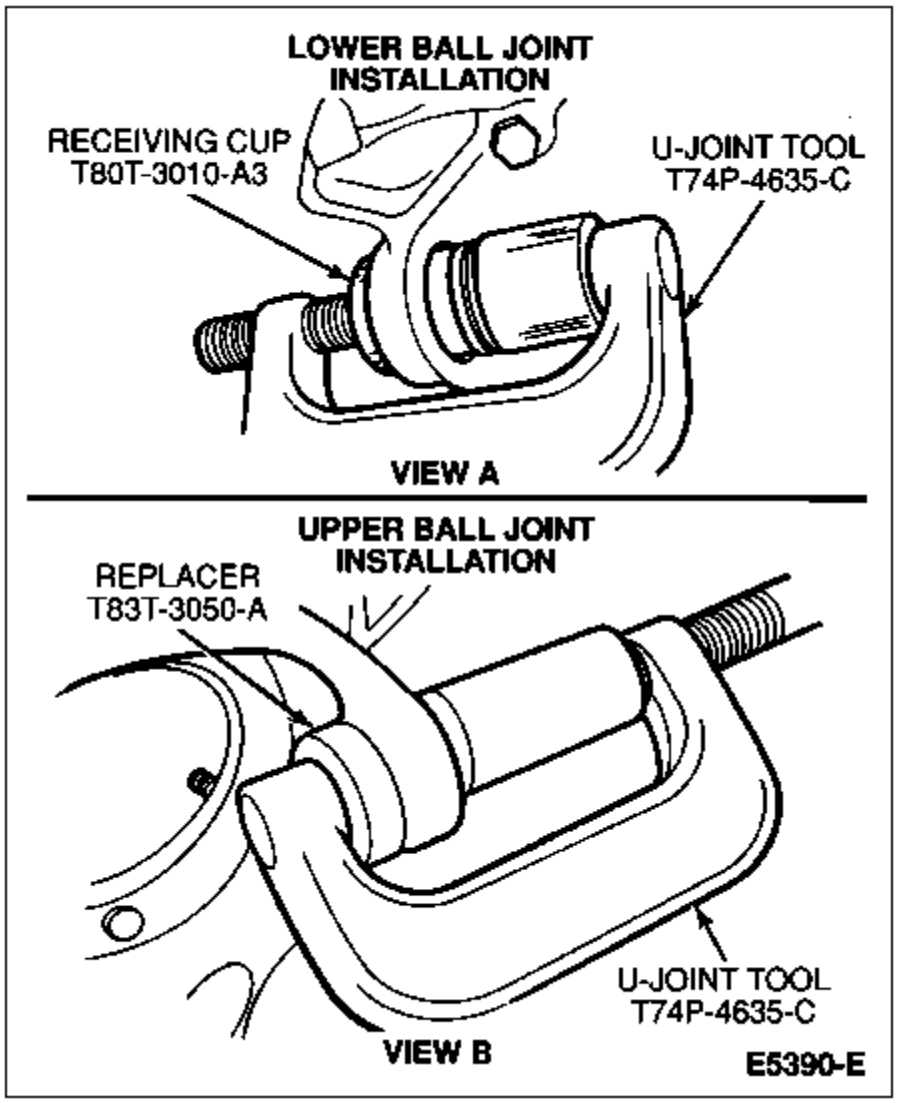

7. Position the knuckle in the axle arm and install the camber adjuster into the support arm. Position the slot in the original position.

8. **NOTE: Nut on lower ball joint stud must be tightened before pinch bolt or binding of the steering system will result.**

   Install a new lower ball joint nut on the bottom ball joint stud. Tighten the lower ball joint nut to 129-149 Nm (95-110 lb-ft) minimum. Then tighten to align to the next slot in the lower ball joint nut with the hole in the stud. Install a new cotter pin.

9. Install the snap ring on the upper ball joint stud.

10. Install the upper ball joint pinch bolt and tighten to 88-115 Nm (65-85 lb-ft).

11. Connect the steering linkage to the steering arm. Install the steering linkage to steering arm nut and tighten to 70-100 Nm (52-74 lb-ft).

12. Install the front wheel spindle and shaft and arm assembly; refer to the procedure in this section.

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Axle Pivot Bushing

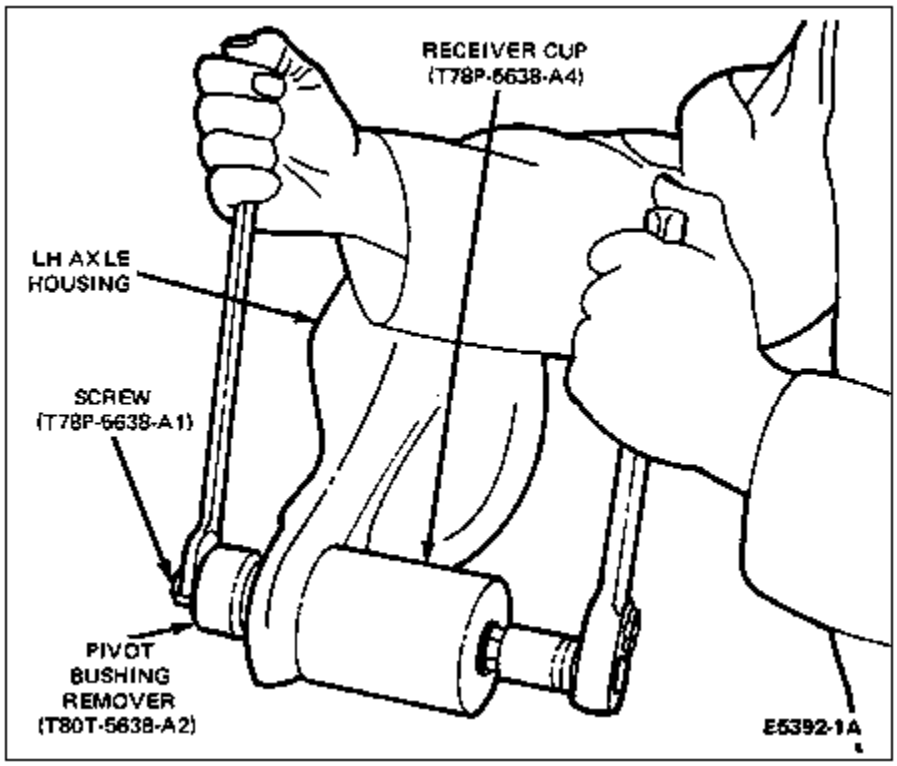
SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Forcing Screw	T78P-5638-A1
Receiver Cup	T78P-5638-A4
Front Suspension Bushing Pivot Bushing Remover	T80T-5638-A T80T-5638-A2

Removal

1. Lower the axle housing after removing the axle pivot bolt and nut, loosening the radius arm bushing.

2. Install Forcing Screw T78P-5638-A1, Pivot Bushing Remover T80T-5638-A2 and Receiver Cup T78P-5638-A4 onto the pivot bushing. Turn the forcing screw and remove the pivot bushing.



Installation

1. Place pivot bushing in axle housing. Install Receiver Cup T78P-5638-A4, Forcing Screw T78P-5638-A1 and Front Suspension Bushing Tool T80T-5638-A into housing and install bushing.

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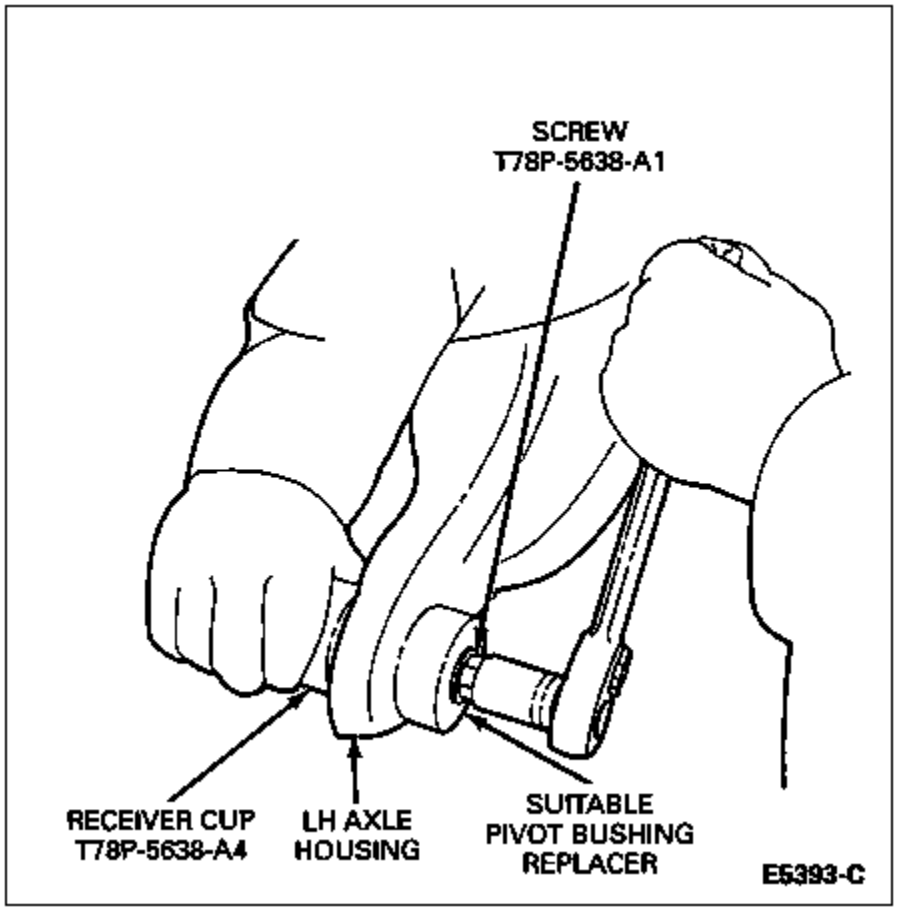

2. After installing, the "lead in" end of the bushing must be flared to prevent movement. Install Forcing Screw T78P-5638-A1, suitable Flaring Tool and suitable Receiving Cup and flare the bushing.

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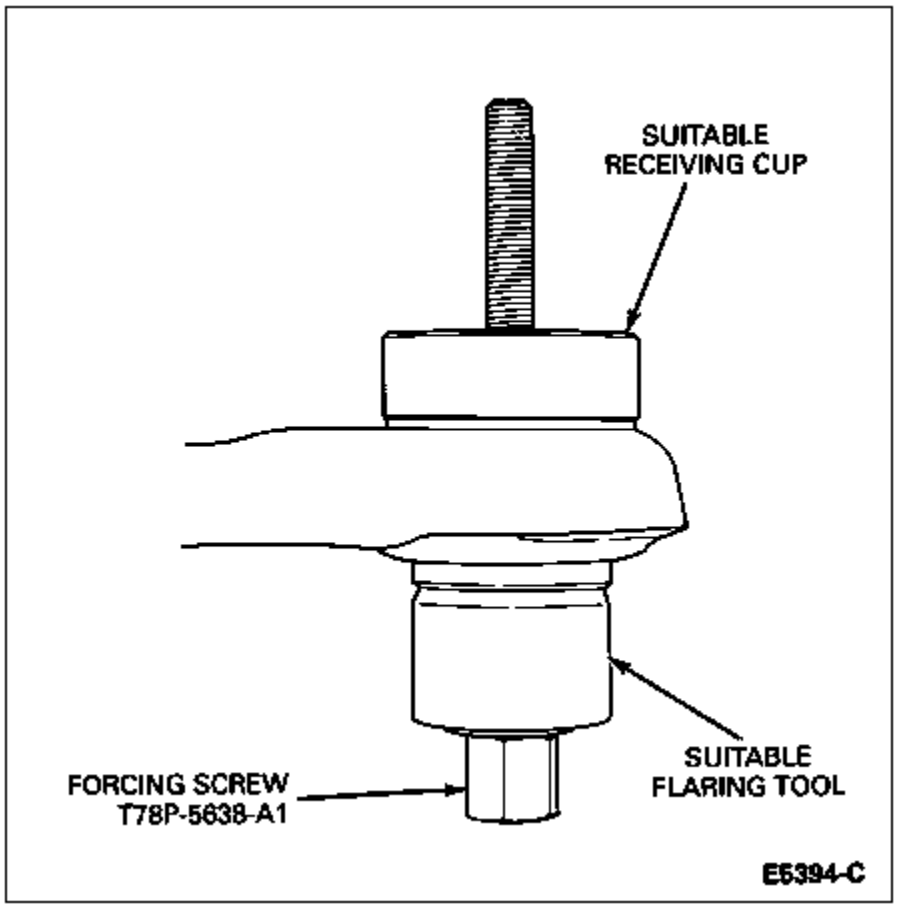

3. Install the axle pivot bolt and nut; tighten the axle pivot nut to 163-203 Nm (120-150 lb-ft).

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Driveshaft, Front

Removal

1. **NOTE: Mark the driveshaft and the axle companion flange before removal so that they can be installed in the same position.**

   Remove the nuts and U-bolts retaining the front driveshaft to the axle companion flange.

2. Remove attaching bolts retaining driveshaft to the transfer case (7A195). Remove driveshaft from the vehicle.

Installation

1. Position driveshaft to transfer case companion flange and install driveshaft to transfer case flange bolts; tighten to 88-119 Nm (65-87 lb-ft).

2. Position driveshaft to the axle companion flange. Install the U-bolts and nuts. Tighten the front driveshaft U-bolt nuts to 11-20 Nm (8-15 lb-ft).

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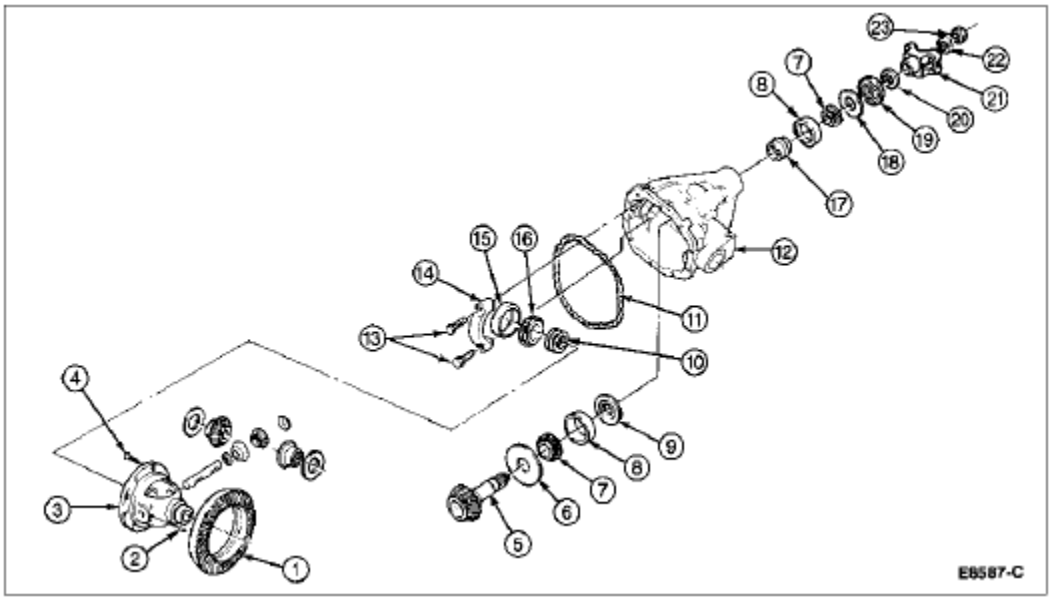
Carrier Disassembly

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Bench Mounted Holding Fixture	T57L-500-B
Companion Flange Holding Tool	T57T-4851-B
Differential Side Bearing Puller	T77F-4220-B1
Differential Housing Spreader Adapter	T80T-4000-B
Driver Handle	T80T-4000-W
Inner Pinion Bearing Cup Remover	T86T-4628-AH
Outer Pinion Bearing Cup Remover	T86T-4628-BH
Spreader Adapter	T90T-4000-A

1. Remove carrier and the right hand stub shaft as described under Removal and Installation Slip-Yoke, RH and Stub Shaft Assembly, Carrier, Carrier Oil Seal and Bearing , in this section.

Dana 35 IFS Axle Carrier Assembly



Item	Part Number	Description
1	—	Differential Ring Gear (Part of 3222)
2	357228-S	Lock Pin
3	3204	Differential Case

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4	3L222	Ring Gear Bolt
5	—	Drive Pinion (Part of 3222)
6	3B067	Oil Slinger/Selective Shim
7	4621	Pinion Bearing Cone and Roller
8	4616	Drive Pinion Bearing Cup
9	3070	Oil Baffle
10	3A067	Differential Bearing Shims
11	D6AZ-19562-AA or -BA	RTV Gasket Sealant
12	3010	Carrier Housing
13	—	Bearing Cap Bolts (Part of 3010)
14	—	Bearing Cap (Part of 3010)
15	4222	Differential Bearing Cup
16	4221	Differential Bearing
17	3A222	Collapsible Spacer
18	3070	Oil Slinger
19	4676	Pinion Seal
20	4859	Drive Pinion Oil Seal Deflector
21	4851	Axle Companion Flange
22	356504-S	Companion Flange Washer
23	3T222	Companion Flange Nut

2. Place the carrier housing in a holding fixture such as Bench Mounted Holding Fixture T57L-500-B, using Spreader Adapter T90T-4000-A and Suitable Spacers.

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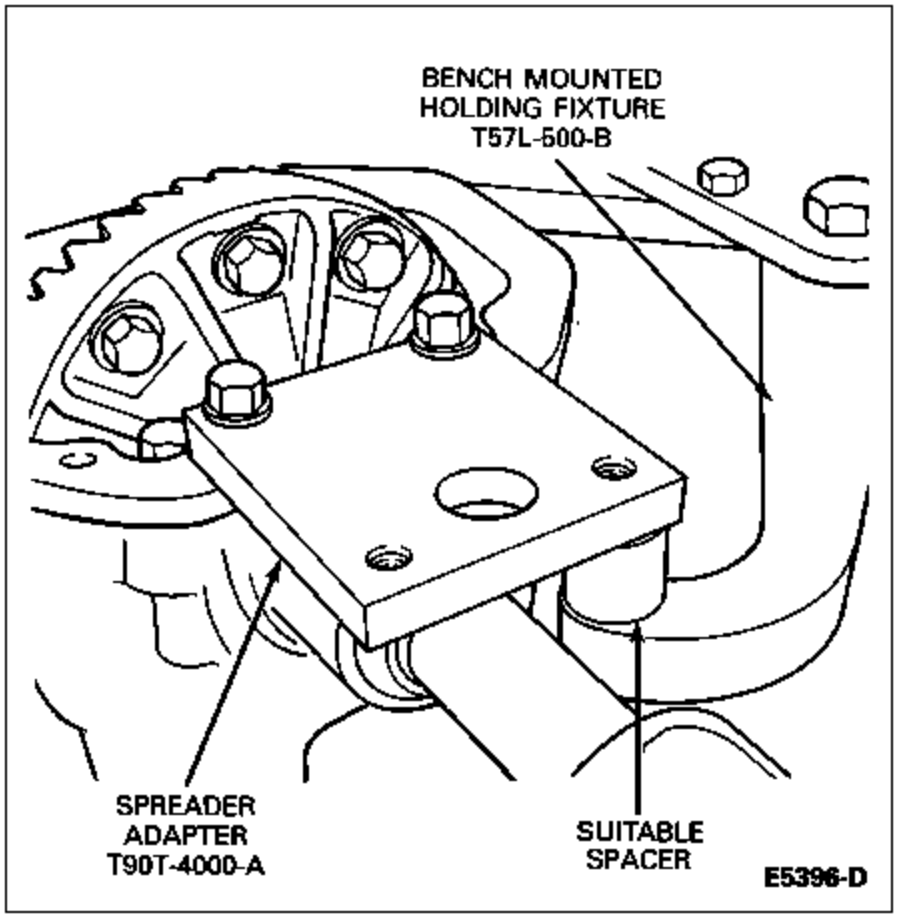

3. **NOTE: The matched numbers or letters stamped on the bearing cap and carrier housing must correspond in both position and direction upon assembly.**

   Remove and clean all gasket surfaces and remove the bearing caps.

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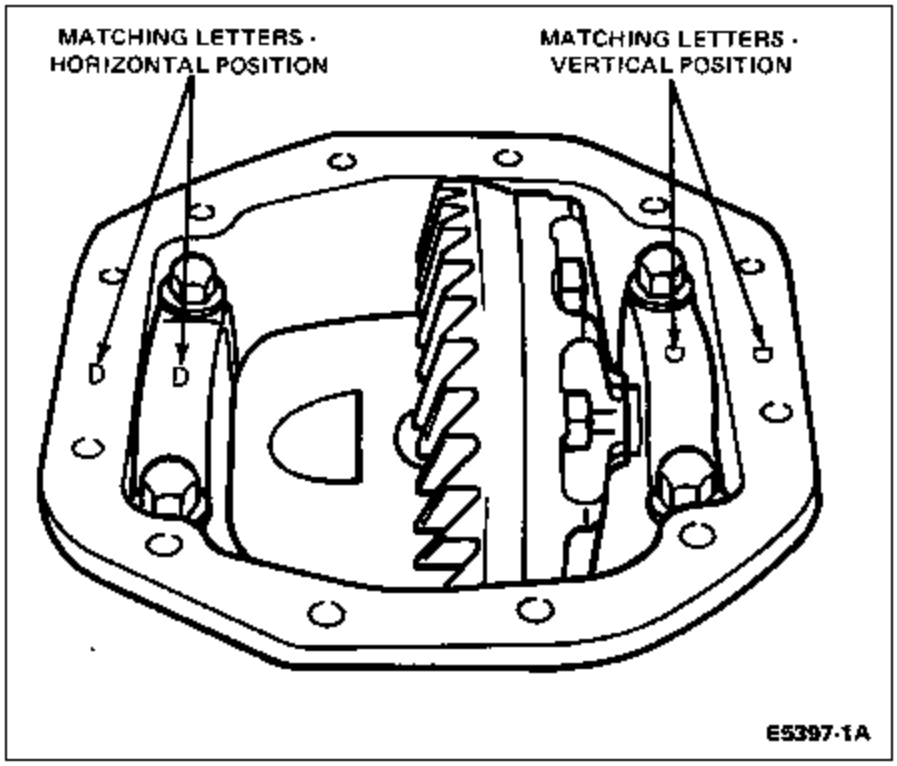

4. **NOTE: Do not spread the carrier housing over 0.25mm (0.010 inch).**

   Mount the Differential Housing Spreader TOOL-4000-E or equivalent and Spreader Adapter T80T-4000-B on the carrier housing. Place Dial Indicator with Bracketry TOOL-4201-C or equivalent on the carrier housing and spread the carrier housing.

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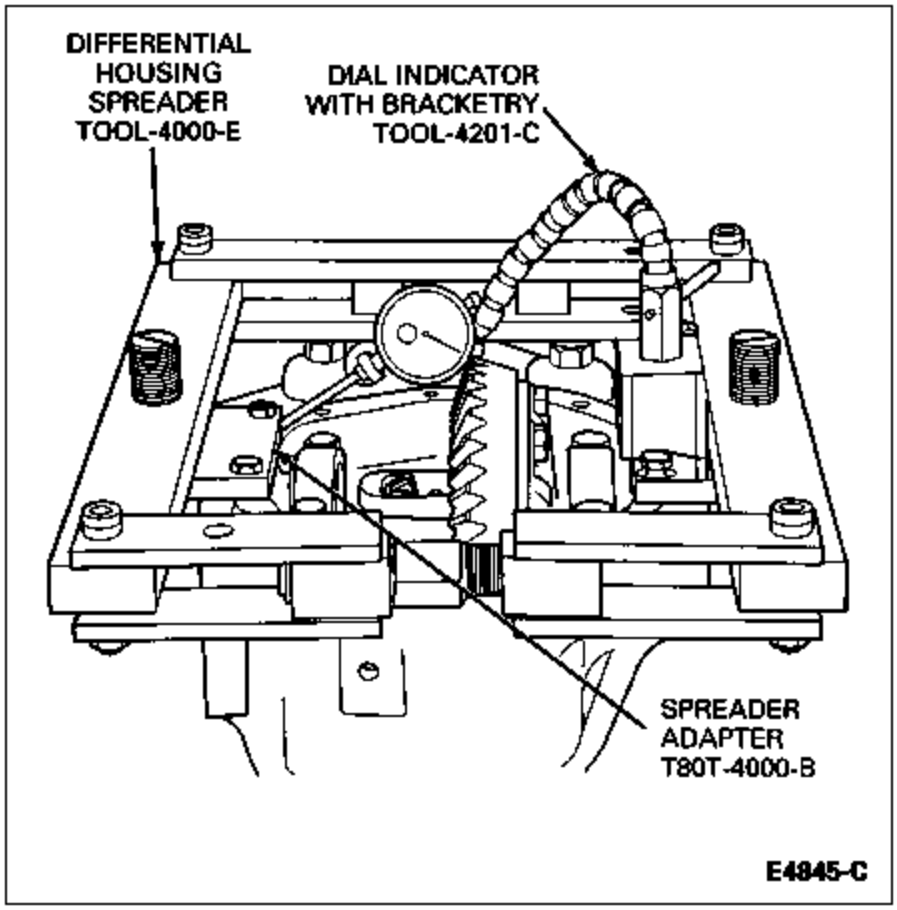

5. **CAUTION: Avoid damaging any machined surfaces.**

   Remove the differential case from the carrier housing. It may be necessary to pry the differential case from the carrier housing with pry bars.

6. Remove and tag differential bearing cups (4222) to indicate from which side of the carrier housing they were removed.

7. Remove the spreader tool.

8. **NOTE: Check outboard differential bearing shims for damage (bent or deep grooves caused by worn bearings). If damaged, replace with new shims during reassembly.**

   Remove and tag the outboard differential bearing shims located on each side of the differential bearing bore. Shims will be reused during assembly, unless damaged or worn.

9. Turn the nose of the carrier housing up. Hold the rear axle companion flange with Companion Flange Holding Tool T57T-4851-B and remove the companion flange nut and washer from the pinion shaft.

10. Remove the axle companion flange with Differential Side Bearing Puller T77F-4220-B1. If the axle companion flange shows any signs of wear in the area of seal contact, replace the axle companion flange.

11. **WARNING: GEAR TEETH MAY HAVE SHARP EDGES. WHEN HANDLING GEAR, USE**

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CARE TO AVOID PERSONAL INJURY.

Remove the drive pinion by tapping on the drive pinion shaft with a rawhide or plastic hammer. Catch the drive pinion to prevent damage to the drive pinion teeth.

12. Remove the pinion seal from the carrier bore by using suitable seal puller and impact slide hammer. Replace the oil seal with a new seal during assembly.

13. Remove the pinion bearing cone and roller, oil baffle and collapsible spacer from the carrier. Discard the collapsible spacer. Replace with a new collapsible spacer upon assembly.

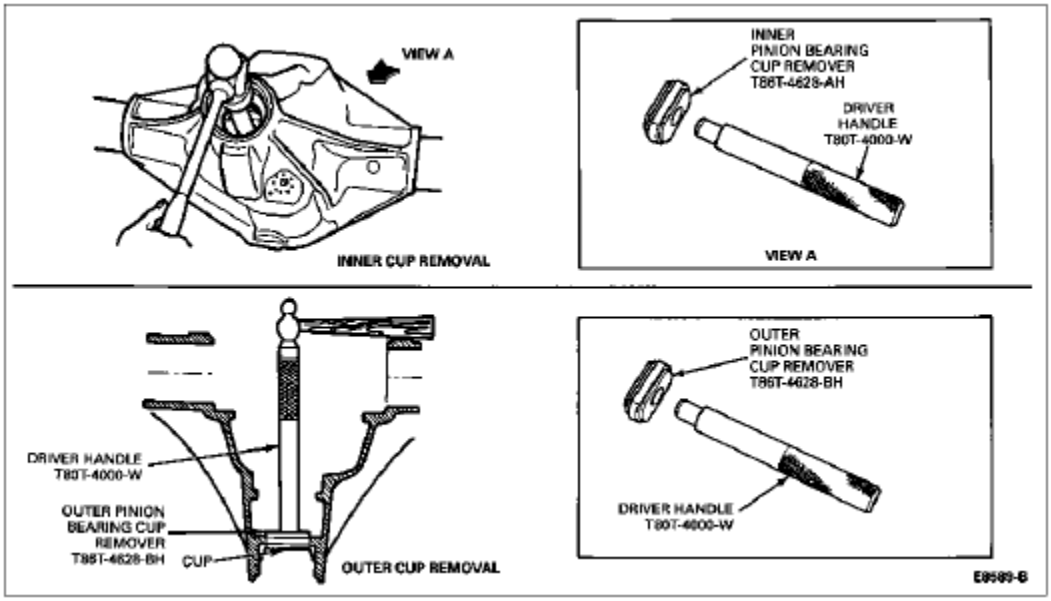
14. To remove the rear drive pinion bearing cup, pass Inner Pinion Bearing Cup Remover T86T-4628-AH and Driver Handle T80T-4000-W through the front drive pinion bearing cup and against the rear drive pinion bearing cup. Drive out the rear drive pinion bearing cup.

15. **NOTE: An oil baffle is located between the rear drive pinion bearing cup and carrier bore. Replace with an oil baffle of equal thickness. If an oil baffle of the same thickness cannot be obtained, select adjustment shims, located behind the head of the drive pinion, to compensate for the difference.**

    Remove the oil baffle from the drive pinion bearing cup bore.

16. To remove the front drive pinion bearing cup, pass the Outer Pinion Bearing Cup Remover T86T-4628-BH and Driver Handle T80T-4000-W through the rear cup bore and against the drive pinion bearing cup. Drive the front drive pinion bearing cup out with a hammer.

Pinion Bearing Cup Removal



17. **NOTE: It is recommended that bearings be replaced.**

    Remove the differential bearings (4221) from the differential case. Place Step Plate D80L-630-4 or equivalent under bearing to protect the bearing. Install Pinion and Carrier Bearing Puller D81L-4220-A or equivalent and remove the bearing. Turn the differential case over and remove the other bearing.

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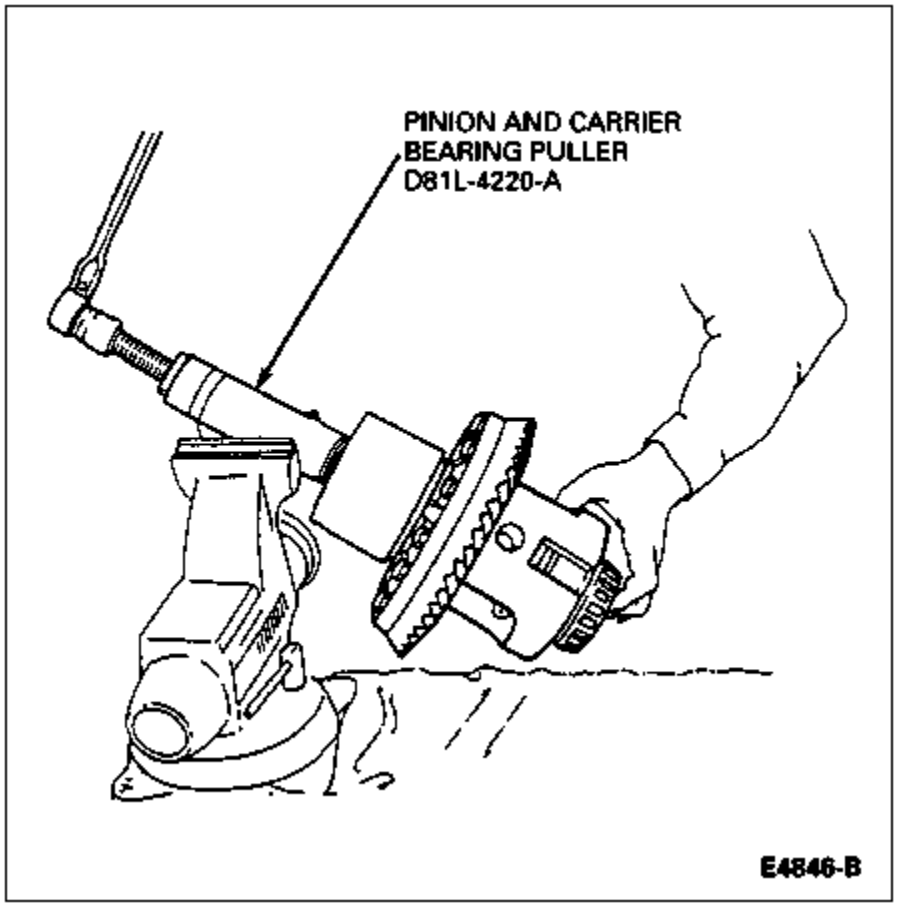

18. Wire the differential bearing cup and cone together and identify from which side of the differential case they were removed.

19. **NOTE: Place a few shop towels over the vise to prevent the ring gear teeth from being nicked, after it is free from the case.**

    NOTE: Whenever removing the ring gear bolts, discard the bolts. Replace with new bolts upon assembly.

    Place the differential case in a vise. Remove the ring gear bolts. Tap the ring gear with a rawhide hammer to free it from the differential case.

20. Remove the differential case and ring gear from the vise.

21. **NOTE: For controlling drive pinion depth, an oil baffle with a selected thickness is located between the inner pinion bearing cone and drive pinion head. Be careful not to damage the oil baffle when removing the bearing. If the oil baffle is damaged, measure the thickness and replace with an oil baffle of equal thickness.**

    Remove the inner differential pinion bearing and oil baffle from the drive pinion with Pinion and Carrier Bearing Puller D81L-4220-A or equivalent.

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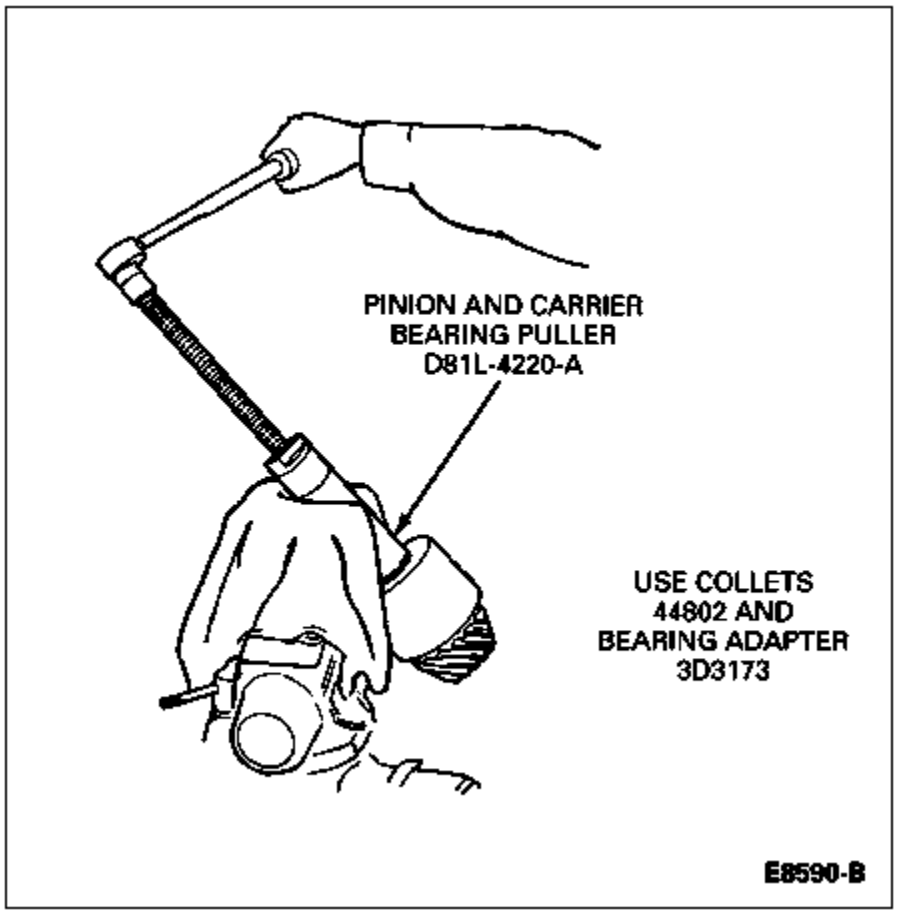

22. Inspect all parts for damage and replace as required.

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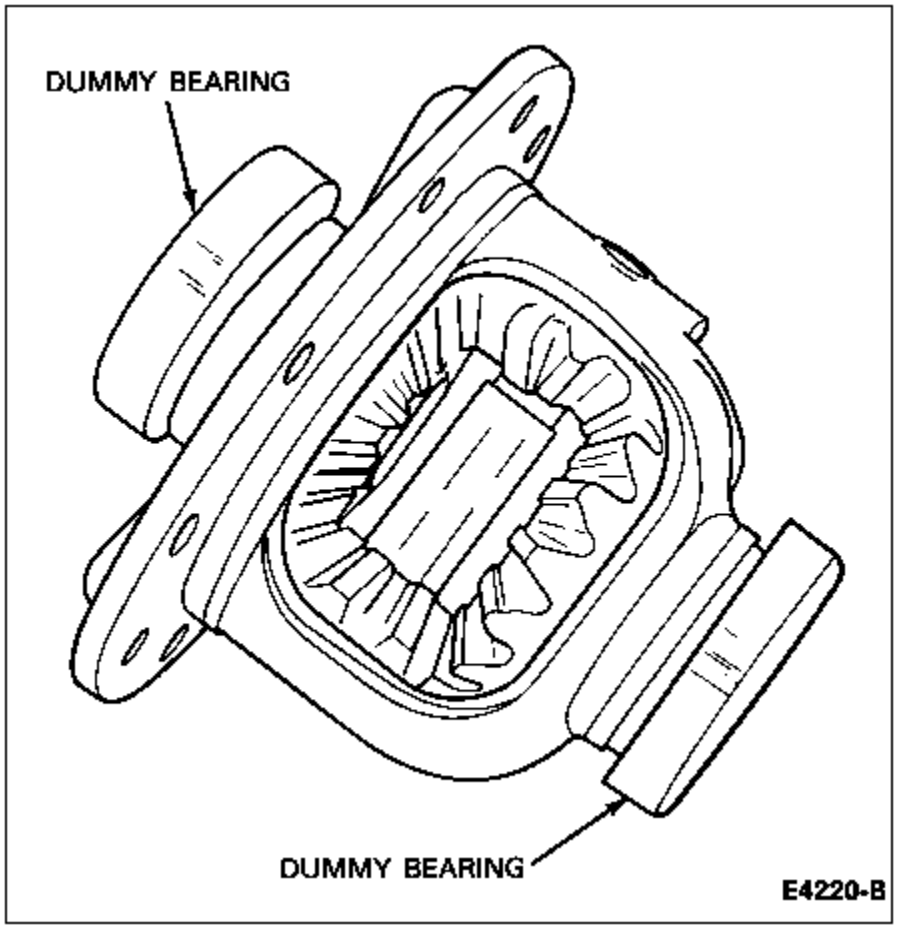
Total Differential Case End Play

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Dummy Bearings	T86T-4222-AH

1. **NOTE: Remove all burrs and nicks from hubs so master bearings rotate freely.**

   Clean the trunnions on the differential and install the Dummy Bearings T86T-4222-AH onto the differential case.



2. Place the differential case into carrier (without pinion). The differential case should move freely in the carrier. Mount Dial Indicator D78P-4201-B or TOOL-4201-C or equivalent against the differential case flange.

3. Locate the tip of the indicator on the flat surface of one ring gear bolt.

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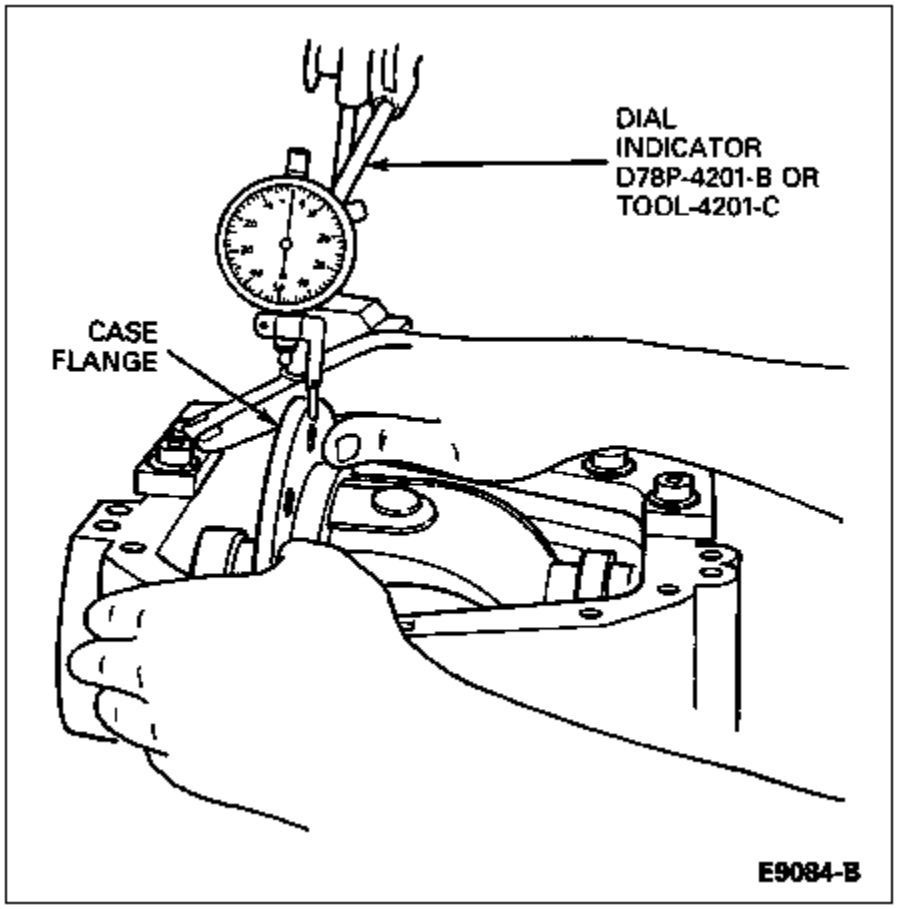

4. **NOTE: Dial indicator should have a minimum travel capability of 8.89mm (0.350 inch).**

   Force the differential case toward the dial indicator as far as possible and zero the dial indicator with force still applied.

5. **NOTE: This reading indicates the amount of shims needed behind the differential side bearings to take up total clearance between the differential bearing cup and carrier. This reading will be used under Pinion and Ring Gear Backlash .**

   Force the differential case away from the dial indicator as far as it will go. Repeat this procedure until the same reading is obtained. Record the dial indicator reading as Measurement "A" on the worksheet for calculating ring gear backlash and differential bearing preload shims.

6. Remove the differential case from the carrier housing. Do not remove the master differential bearings at this time.

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Drive Pinion Installation

Two separate adjustments affect contact between the ring gear and drive pinion: pinion depth and pinion to ring gear backlash. Refer to Adjustments in this section.

Pinion depth is controlled by an oil slinger (with a selective thickness) located between drive pinion head and inner differential pinion bearing and an oil baffle located between the rear drive pinion bearing cup and carrier bore.

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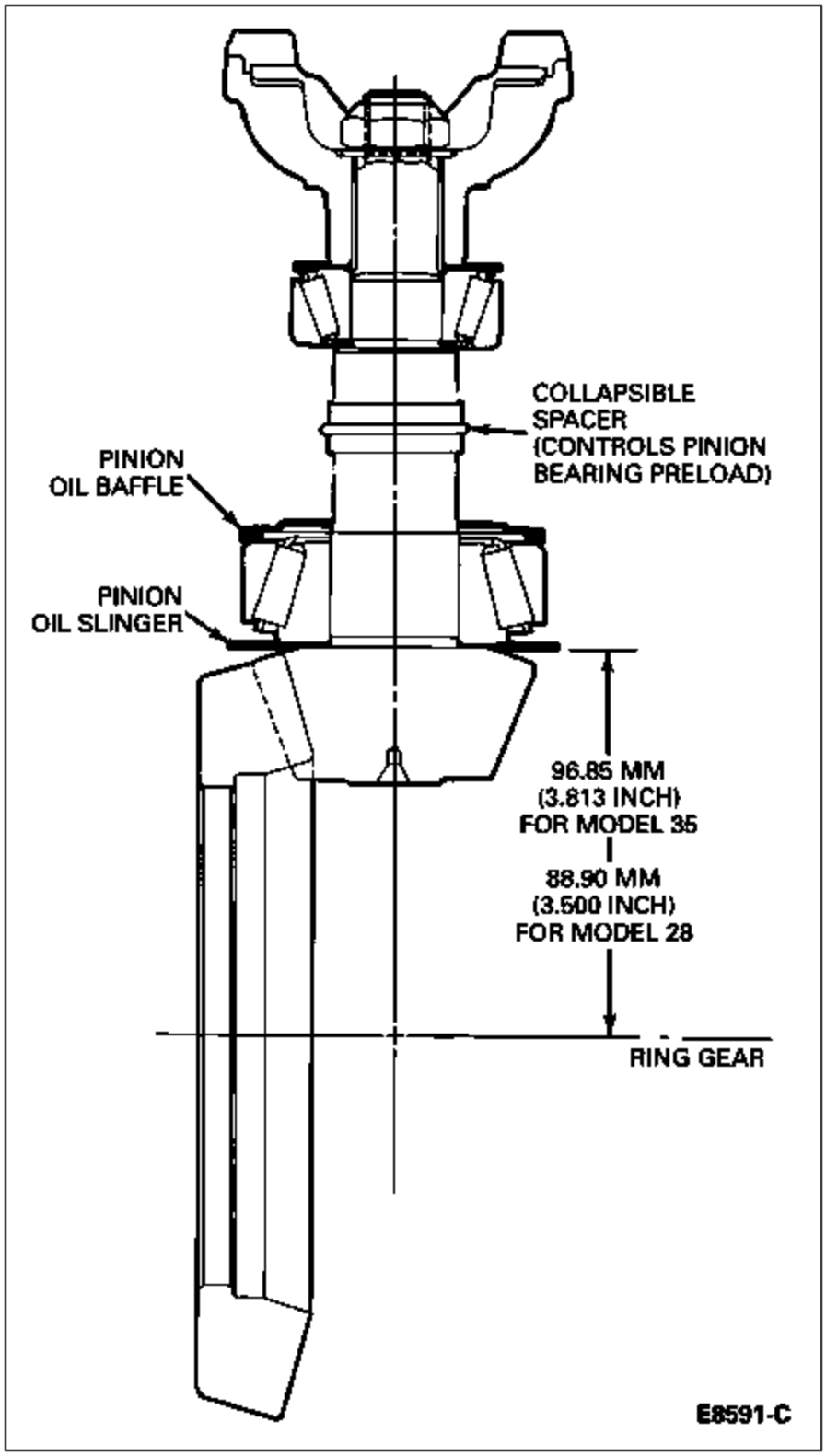

Pinion to ring gear backlash is controlled by a selective preload spacer located between the drive pinion bearing cup and the carrier. This adjustment is described in Assembly to Carrier, Pinion and Ring Gear Backlash in this section.

In the pinion depth adjustment, the size of the selected thickness oil slinger and the oil baffle controls the

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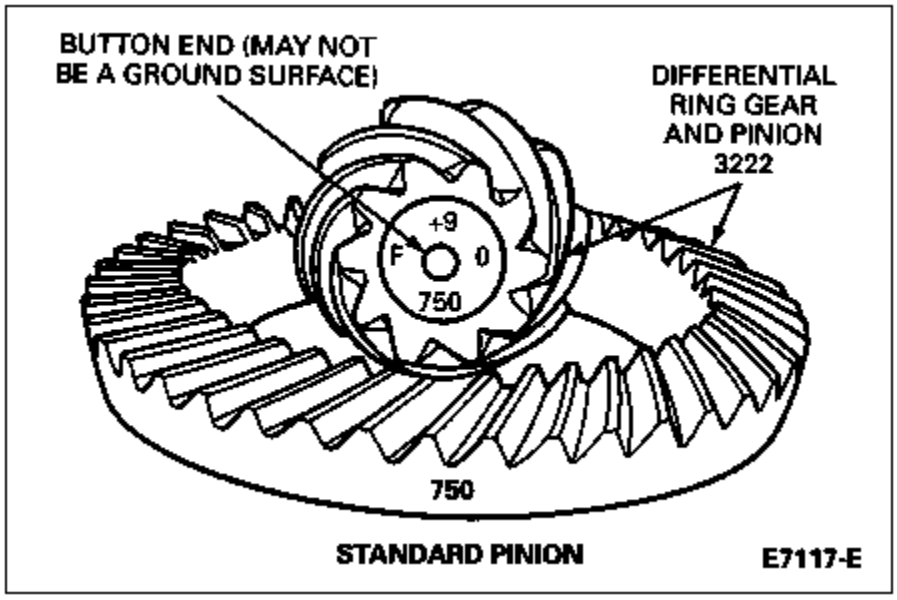
pinion position. Increasing the oil slinger thickness moves the pinion toward the ring gear (-). Decreasing the oil slinger thickness moves the pinion away from the ring gear (+).



On the button of each drive pinion is marked a plus figure (+), a minus figure (-) or a zero (0). These figures indicate the position for each gear set. The position is determined by the thickness of the baffle between the inner pinion bearing cup and carrier bearing bore and the thickness of the selective oil slinger between the pinion head and inner pinion bearing. Any pinion depth change is made by changing the thickness of the selective oil slinger. Refer to the charts shown below.

- For example, a drive pinion that is etched "0" should be 96.85mm (3.813 inch) from the centerline of the ring gear to the back face of the pinion. A pinion that is etched +3 (m+8) should be 96.93mm (3.816 inch) from the ring gear centerline. If the baffle thickness remains the same, then the +3 (m+8) pinion requires a selective oil slinger that is 0.08mm (0.003 inch) thinner than the selective slinger used with the "0" etched drive pinion.

If the original gear set is being reused, measure the original baffle and selective slinger. If either the baffle or selective slinger needs to be replaced, use a new one of the exact same thickness.

If a new gear set is used, notice the plus (+), minus (-), or zero (0) etching on both the original and the new drive pinion and adjust the thickness of the new selective oil slinger according to the charts shown below.

- For example, if the original pinion is etched +4 (m+ 10) and the new pinion is etched "0", then the new selective slinger is 0.08mm (0.004 inch) thicker than the original selective oil slinger.

If the original pinion is etched "0" and the new pinion is etched + 3 (m+8), the new selective slinger should be 0.08mm (0.003 inch) thinner than the original slinger.

	New Pinion Marking (Metric)								
Old Pinion Marking	**-10**	**-8**	**-5**	**-3**	**0**	**+3**	**+5**	**+8**	**+10**
+10	+.20	+.18	+.15	+.13	+.10	+.08	+.05	+.03	0
+8	+.18	+.15	+.13	+.10	+.08	+.05	+.03	0	-.03
+5	+.15	+.13	+.10	+.08	+.05	+.03	0	-.03	-.05
+3	+.13	+.10	+.08	+.05	+.03	0	-.03	-.05	-.08

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0	+.10	+.08	+.05	+.03	0	-.03	-.05	-.08	-.10
-3	+.08	+.05	+.03	0	-.03	-.05	-.08	-.10	-.13
-5	+.05	+.03	0	-.03	-.05	-.08	-.10	-.13	-.15
-8	+.03	0	-.03	-.05	-.08	-.10	-.13	-.15	-.18
-10	0	-.03	-.05	-.08	-.10	-.13	-.15	-.18	-.20

	New Pinion Marking (English)								
Old Pinion Marking	**-4**	**-3**	**-2**	**-1**	**0**	**+1**	**+2**	**+3**	**+4**
+4	+0.008	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0
+3	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001
+2	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002
+1	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003
0	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004
-1	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005
-2	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006
-3	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006	-0.007
-4	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006	-0.007	-0.008

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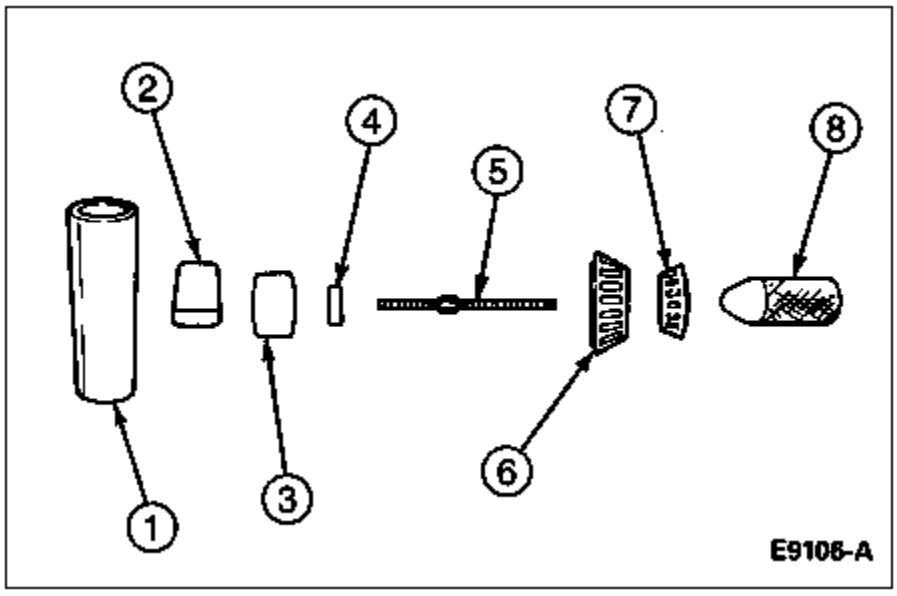
Depth Gauge Check

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Pinion Bearing Cups Replacer	T60K-4616-A
Pinion Bearing Cups Replacer	T71P-4616-A
Axle Bearing/Seal Plate	T75L-1165-B
Aligning Adapter	T75P-4020-A2
Threaded Drawbar	T75T-1176-A
Screw	T76P-4020-A9
Gauge Block	T76P-4020-A10
Handle	T76P-4020-A11
Pinion Depth Gauge	T79P-4020-A
Pinion Bearing Replacer	T85M-4221-B
Gauge Disc	T90T-4020-B

1. **NOTE: If any of the gauge surfaces become nicked, the high spots must be removed with a medium india oilstone to make sure there will be no erroneous readings.**

   Refer to chart shown below for the correct tools for the particular axles.



Item	Part Number	Description
1	D80T-4020-F49	Gauge Tube

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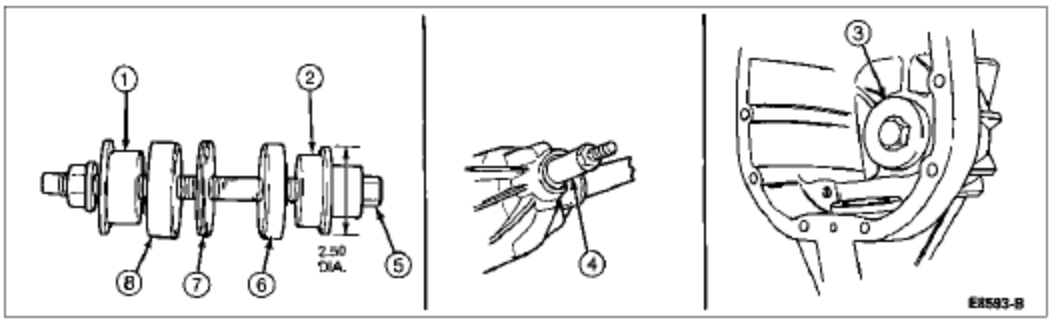
2	T76P-4020-A10	Gauge Block
3	T90T-4020-B	Gauge Disc
4	T75P-4020-A2	Aligning Adapter
5	T76P-4020-A9	Screw
6	4621	Inner Pinion Bearing
7	4621	Outer Pinion Bearing
8	T76P-4020-A11	Handle

2. Install the oil baffle in the inner bearing cup bore in the carrier.

3. **NOTE: Prior to installing pinion bearing cups into aluminum or magnesium housings, a dry graphite lubricant such as Lubrikote Type A-1040 CR (Mealy Industrial Lubricants) or equivalent should be applied to the bearing cup bore to prevent metal particles from being picked up as the cup is pressed into the bore.**

   Install inner and outer pinion cups with Threaded Draw Bar T75T-1176-A, Pinion Bearing Cup Replacer T60K-4616-A and Pinion Bearing Cup Replacer T71P-4616-A.

Pinion Bearing Cups Installation



Item	Part Number	Description
1	T60K-4616-A	Pinion Bearing Cups Replacer
2	T71P-4616-A	Pinion Bearing Cups Replacer
3	4621	Inner Cup Installation View
4	4621	Outer Cup Installation View
5	T75T-1176-A	Threaded Drawbar
6	4616	Outer Cup
7	3070	Shims
8	4616	Inner Cup

4. Place a new inner pinion bearing over the proper aligning adapter and insert into the pinion bearing retainer.

5. Place the outer differential pinion bearing (new or used if in good condition) into the drive pinion

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bearing cup in the carrier and assemble the handle onto the screw and hand tighten. Note the 3/8-inch square drive in the handle to be used for obtaining the proper pinion bearing preload.

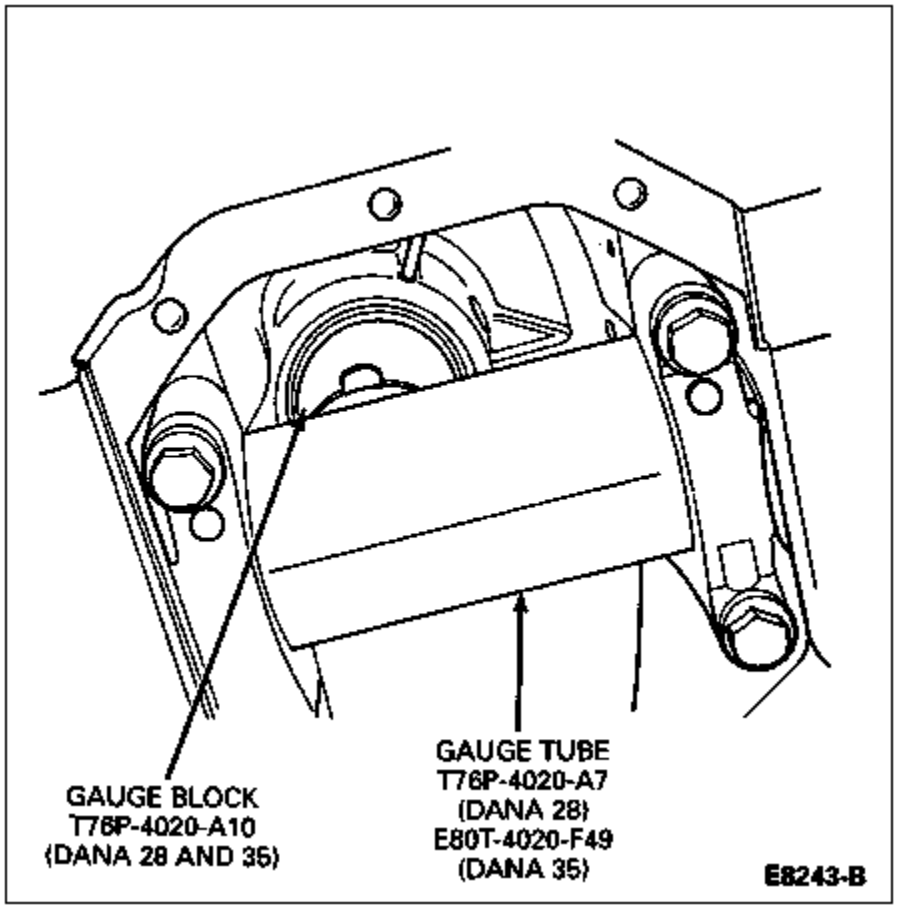
6. Center the proper gauge tube into the differential bearing bore. Install the bearing caps and bolts and tighten to 64-91 Nm (47-67 lb-ft) for the Model 35 or 41-61 Nm (30-45 lb-ft) for the Model 28.

7. To preload the differential pinion bearing, tighten the handle to 1.7-3.9 Nm (15-35 lb-in).

8. Using a feeler gauge tool, select the thickest feeler shim that will enter between the gauge tube and the gauge block.

9. **NOTE: The feeler gauge fit between the gauge tube and the gauge block should have a slight drag-type feeling.**

   Insert the feeler gauge directly along the gauge block. Verify correct reading.



10. **NOTE: If the service pinion gear is marked with a plus (+) reading, this amount must be subtracted from the thickness dimension obtained in Steps 8 and 9. (Example: +2 [+ 0.002]). If the service pinion gear is marked with a minus (-) reading, this amount must be added to the thickness dimension obtained in Steps 8 and 9. (Example: -2 [0.002]). In addition, use same new inner differential pinion bearing as in the previous steps.**

    After the correct feeler gauge feel is obtained, check the reading and this is the thickness of the oil slinger required providing that upon inspection of the service pinion gear, there are no markings.

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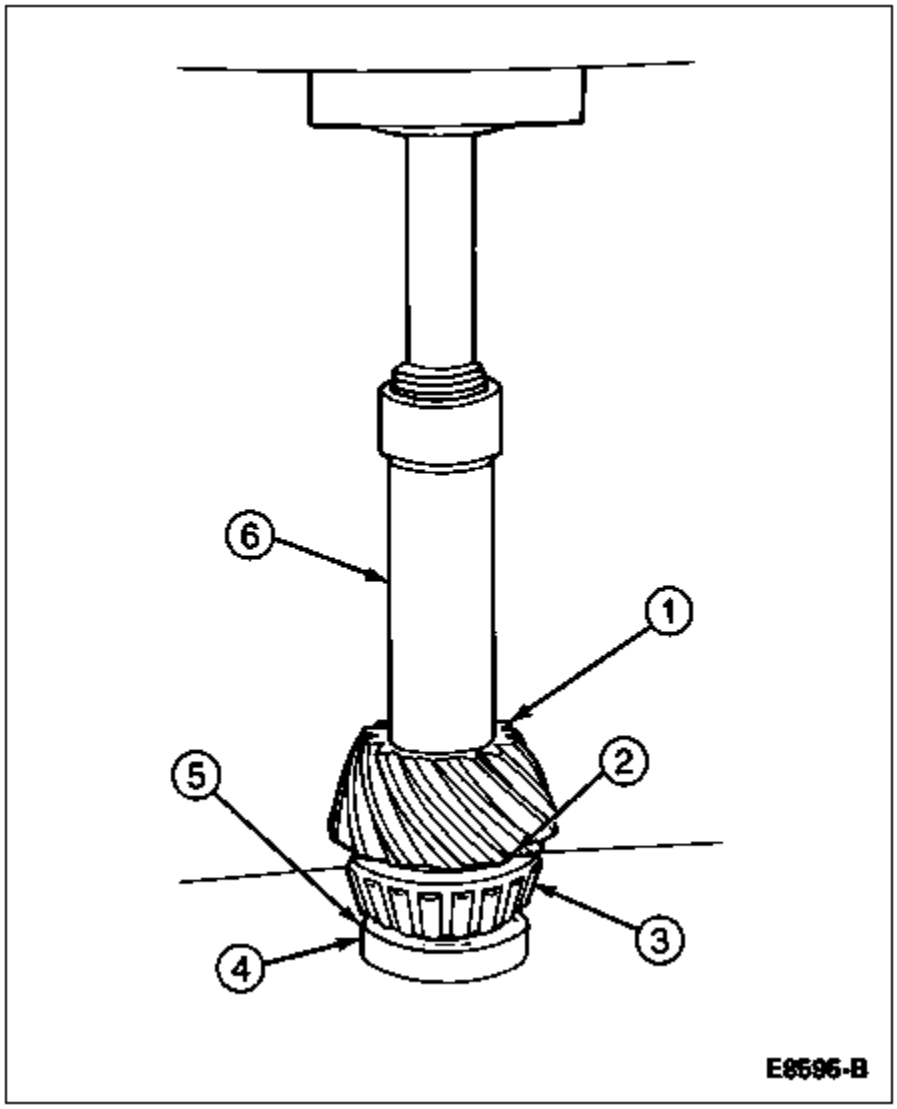
11. Measure oil slinger with a micrometer to verify the slinger size. Place the oil slinger on the pinion and press on the bearing using suitable pinion bearing replacer and Axle Bearing/Seal Plate T75L-1165-B as shown.



Item	Part Number	Description
1	—	Drive Pinion (Part of 3222)
2	3B067	Oil Slinger
3	4621	Rear Pinion Bearing Cone and Roller
4	T75L-1165-B	Axle Bearing Seal Plate
5	T85M-4221-B	Differential Bearing Replacer
6	—	Press

12. Lubricate the ends of outer pinion bearing rollers with High Temperature 4x4 Front Axle and Wheel Bearing Grease E8TZ-19590-A or equivalent meeting Ford specification ESA-M1C198-A.

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Drive Pinion Preload Check and Final Depth Check

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Pinion Seal Replacer	T79P-4676-A
Companion Flange Replacer	T85T-4851-AH

1. Install the drive pinion into the carrier housing.

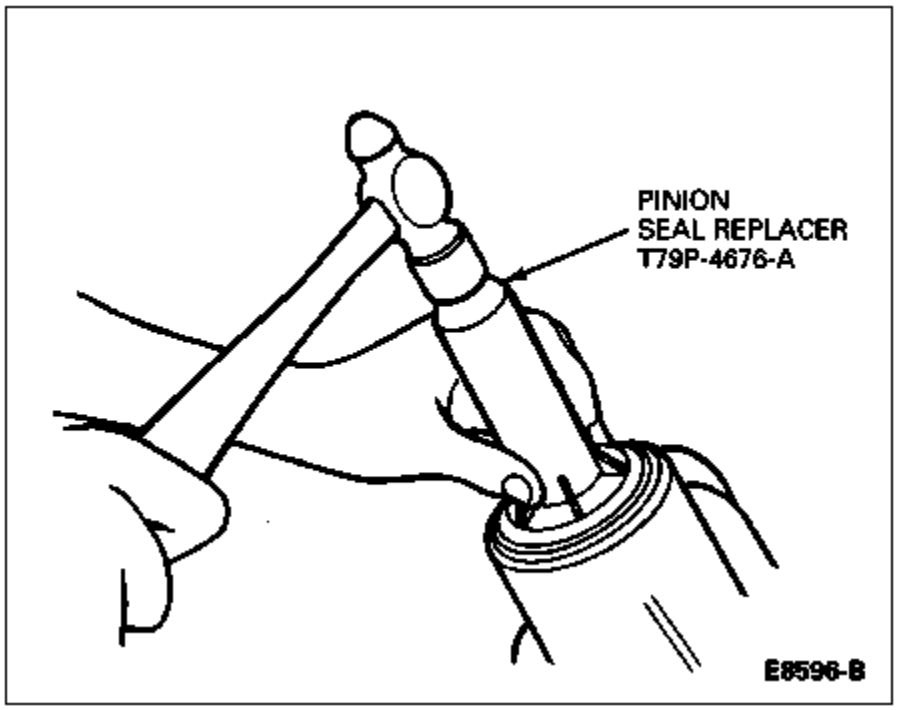
2. **CAUTION: Never reuse a collapsible spacer. Upon removal, always discard the old spacer and install the new spacer for assembly.**

   Install a new collapsible spacer.

3. Assemble the outer pinion bearing cone and roller and thrust washer.

4. **NOTE: After installation, make sure the garter spring did not pop off. If the garter spring pops off, remove and replace the seal.**

   Coat the pinion seal with Motorcraft Synthetic Rear Axle Lubricant F1TZ-19580-A meeting Ford specification WSL-M2C192-A. Install the seal with Pinion Seal Replacer T79P-4676-A.



5. Install the rear axle companion flange with Companion Flange Replacer T85T-4851-AH. Install the

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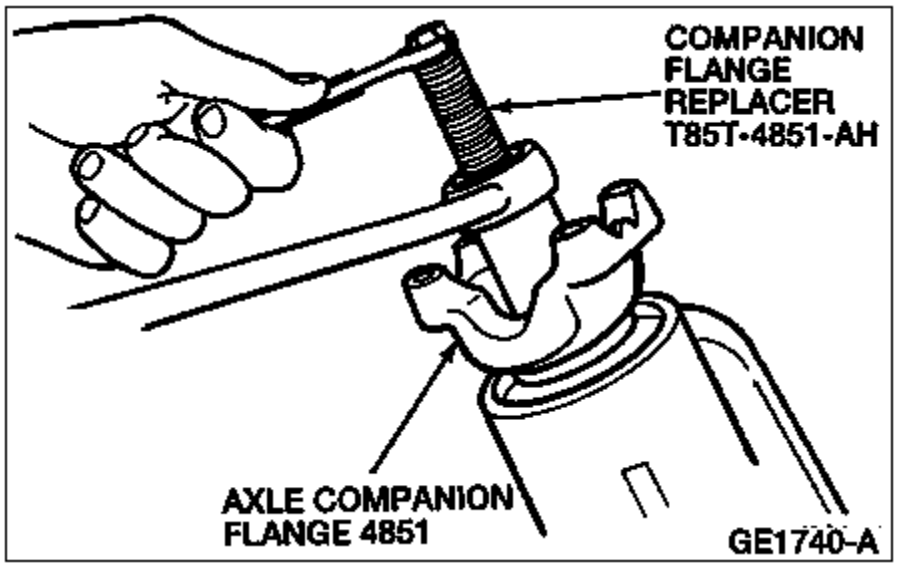
companion flange washer and nut and tighten the companion flange nut to 271 Nm (200 lb-ft). Check torque required to rotate pinion 1.7-2.8 Nm (15-25 lb-in). If required torque is not to specifications, continue to tighten companion flange nut in small increments until proper torque is obtained.

6. **CAUTION: Never tighten the pinion nut more than 475 Nm (350 lb-ft), or the collapsible spacer will be compressed too far.**

   If the reading is more than 1.7-2.8 Nm (15-25 lb-in), the collapsible spacer must be replaced.



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Differential Case

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Dummy Bearings	T86T-4222-AH
Driver Handle	T80T-4000-W
Differential Bearing Replacer	T85M-4221-A
Pinion Bearing Cone Replacer	T53T-4621-C
Spreading Adapters	T90T-4000-A

Disassembly

1. Remove retainer bolts and remove ring gear from the carrier housing.

2. Place the differential case in a vise and drive out the lock pin that retains the differential pinion shaft (4211) to the differential case.

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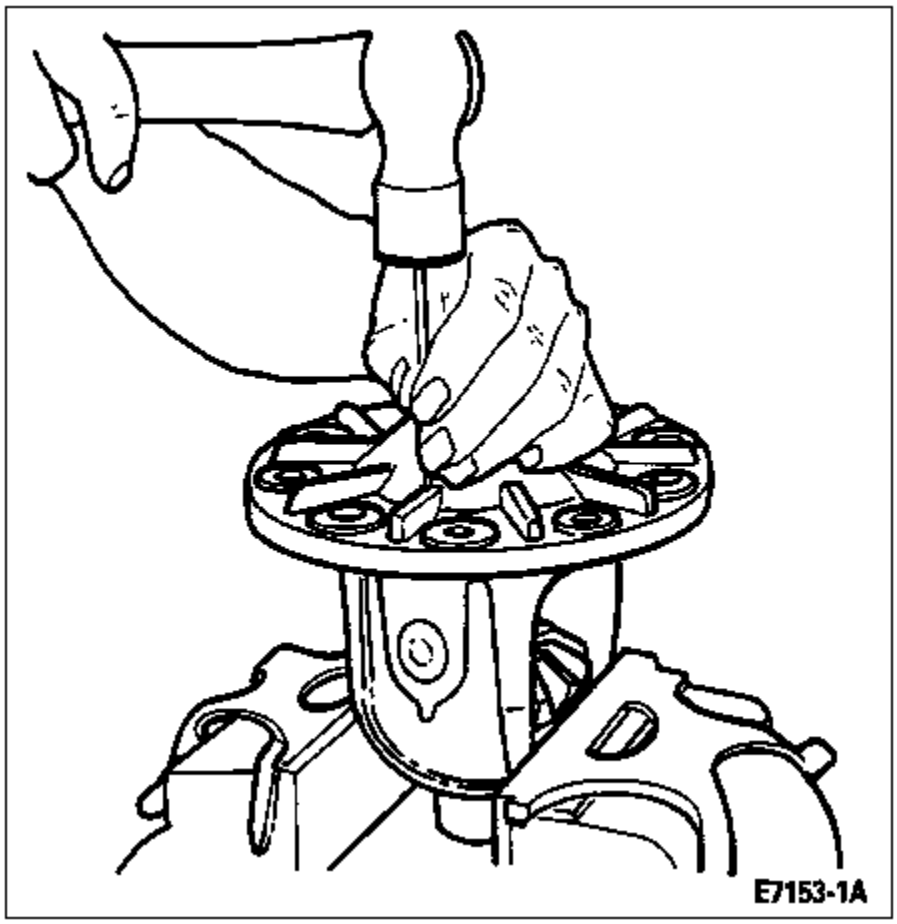
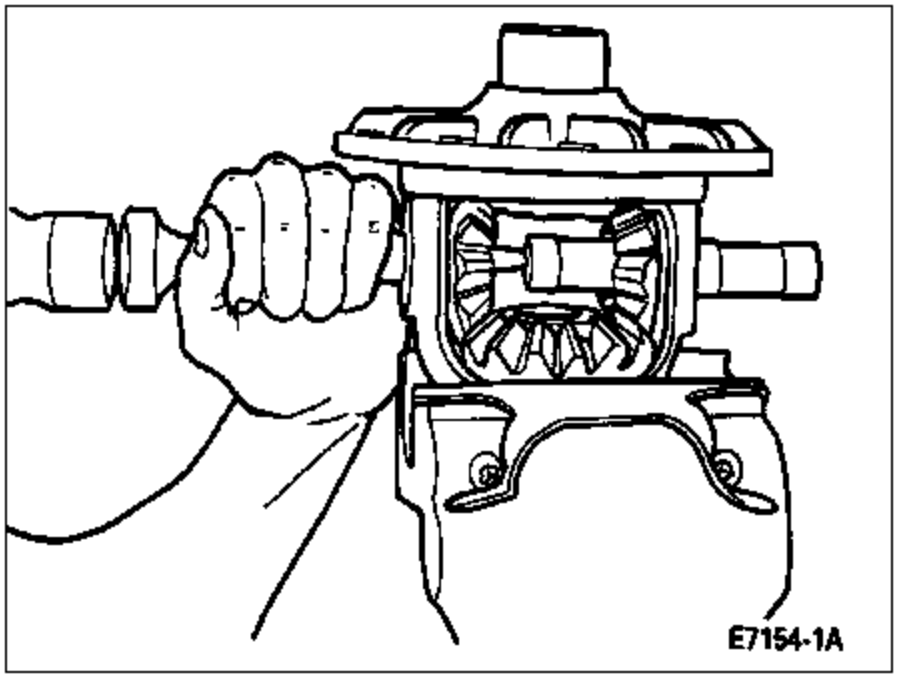


3. Remove differential pinion shaft with a drift.



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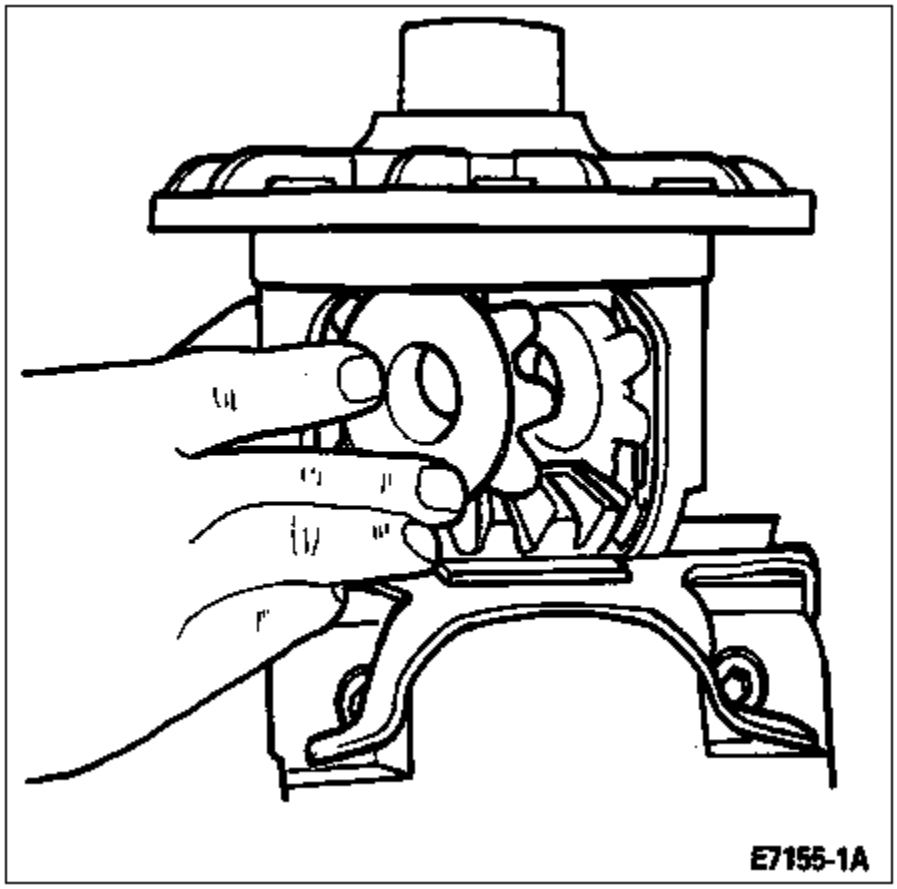
4. Rotate the pinion mate gears and side gears until the pinion mate gears turn to the differential case windows.

5. Remove a pinion mate gears and differential pinion thrust washers (4230).

6. Lift side gears and thrust washers from differential case.



Assembly

1. **NOTE: Always replace gears as a complete set. Do not mix new gears with old gears, as this may cause uneven wear and short gear life.**

   Inspect components for wear and replace as required.

2. Apply High Temperature 4x4 Front Axle and Wheel Bearing Grease E8TZ-19590-A or equivalent meeting Ford specification ESA-M1C198-A to side gear thrust washers, hub and thrust face of side gears.

3. Lubricate pinion mate gears and differential pinion thrust washer with High Temperature 4x4 Front Axle and Wheel Bearing Grease E8TZ-19590-A or equivalent meeting Ford specification ESA-M1C198-A.

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4. Hold side gears in place in the differential case with one hand and install pinion mate gears and differential pinion thrust washers with other hand.

5. Rotate the side gears and pinion mate gears until holes in washers and pinion mate gears line up exactly with holes in the differential case.

6. Insert the differential pinion shaft in the differential case. Align the lock pin hole in the shaft with lock pin holes in the differential case.

7. Insert lock pin. Note the location of the slot in the roll pin. Peen some metal of the differential case over the pin in two places, 90 degrees away from the slot, to lock it in place.

8. Install the ring gear and ring gear bolts. Tighten to 95-122 Nm (70-90 lb-ft).

Assembly to Carrier, Pinion and Ring Gear Backlash

1. Assemble ring gear to differential case. Use new bolts and tighten alternately and evenly to 95-122 Nm (70-90 lb-ft).

2. Place the differential case into position in the carrier. Dummy Bearings T86T-4222-AH should still be installed.

3. Force the differential case away from the drive pinion gear until it is completely seated against the cross bore face of the carrier housing.

4. Position a dial indicator so the indicator tip rests on a ring gear bolt head, or a flat machined surface. Zero the dial indicator.

5. Force ring gear against pinion gear. Rock ring gear slightly to make sure gear teeth are in contact.

6. Force ring gear away from drive pinion gear, making sure the dial indicator returns to zero.

7. Repeat this procedure, until the dial indicator reading is the same. This reading should be recorded on the worksheet as Measurement "B".

   Measure master differential bearing (tool) width. Use A or B depending on width.

Dana Model	Bearing Assembly/Cone	Bearing Stack Height 20/-0mm (.008/-0 In.)	Tool Width	Step or Example
28	LM29710/LM20749	18mm (.710 In.)	18.1mm (.710 In.) 18mm (.714 In.)	A B
35	LM501314/LM501349	21.4mm (.8437 In.)	21.4mm (.8437 In.) 21.5mm (.8477 In.)	A B

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Worksheet for Calculating Ring Gear Backlash and Differential Bearing Preload Shims

EXAMPLE "A"

1. Total amount of space measured without gear set assembled into carrier (Housing). Measurement A

2. Total amount of space measured with gear set assembled into carrier (Housing). Measurement B

   ADJUSTMENTS:

3. Measurement A less .20mm (.008 In.) = C

4. Measurement B less .10mm (.004 In.) = D

5. C - D = E

   After measurements and calculations have been made, assemble the shim packs using the figures determined in D and E and adjusting the pack as described.

   RING GEAR SIDE:

   D - .13mm (.005 In.) = Total shim pack thickness.

   OPPOSITE SIDE:

   E + .25mm (.010 In.) = Total shim pack thickness.

   Assemble shim packs onto differential case hubs and assemble new differential bearing cones. Continue to build the axle assembly as described.

Worksheet for Calculating Ring Gear Backlash and Differential Bearing Preload Shims

EXAMPLE "B"

1. Total amount of space measured without gear set assembled into carrier (Housing). Measurement A

2. Total amount of space measured with gear set assembled into carrier (Housing). Measurement B

3. Measurement A minus Measurement B = Measurement C

   After the measurements and calculations have been made, assemble the shim packs using figures determined in A, B and C and adjusting the pack as described below.

   RING GEAR SIDE:

   B - .13mm (.005 In.) = Total shim pack thickness.

   OPPOSITE SIDE:

   C + .25mm (.010 In.) = Total shim pack thickness.

   Assemble shim packs onto differential case hubs and assemble new differential bearing cones.

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Continue to build the axle assembly as described.

4. **NOTE: Dana Model 35 axles use outboard selective spacers.**

   Remove the differential case from the carrier and remove the dummy bearings from the case.

5. **NOTE: Outboard shims are used on the Model 35 I.F.S.**

   As determined in Steps 5 through 7, place the required amount of shims on the ring gear side and opposite side of the differential case. For example, if the reading was 4.04mm (0.159 inch) minus 0.20mm (.008 inch), place 3.84mm (0.151 inch) shim on the ring gear side between the differential bearing cup (4222) and housing.

6. Install the differential bearings (4221) on both hubs of the differential case. Drive the bearing onto the hub using Driver Handle T80T-4000-W and Differential Bearing Replacer T85M-4221-A.

7. **NOTE: Dana Model 35 axles use outboard selective spacers.**

   Install the differential bearing on the hub of the drive pinion side of the differential case. Place Step Plate D80L-630-4 or equivalent on the ring gear side differential bearing to protect the bearing.

8. Drive the differential bearing onto the hub of the drive pinion side of the differential case using Driver Handle T80T-4000-W and Differential Driver Bearing Replacer T85M-4221-A.

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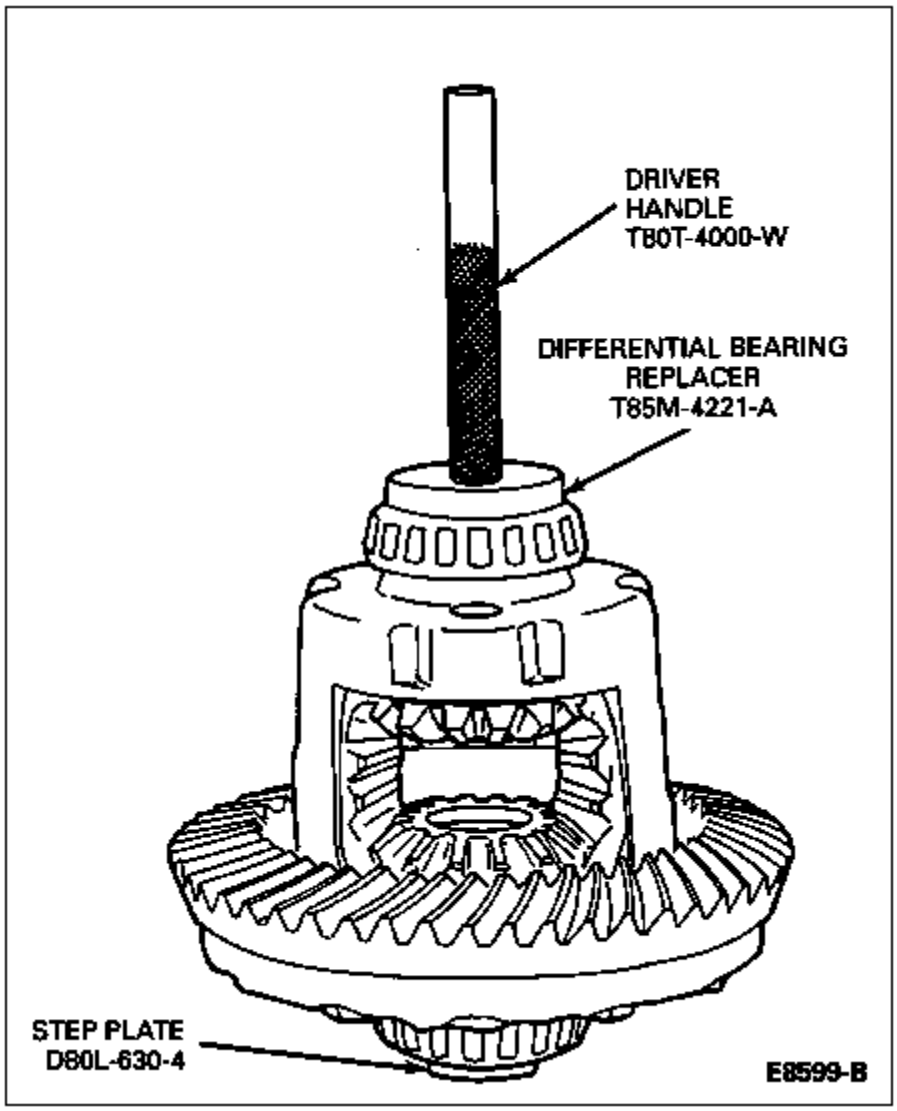

9. Install bearing cone on the pinion side of the differential case with Differential Bearing Replacer T85M-4221-A. Place the Pinion Bearing Cone Replacer T53T-4621-C on the ring gear bearing to prevent damage.

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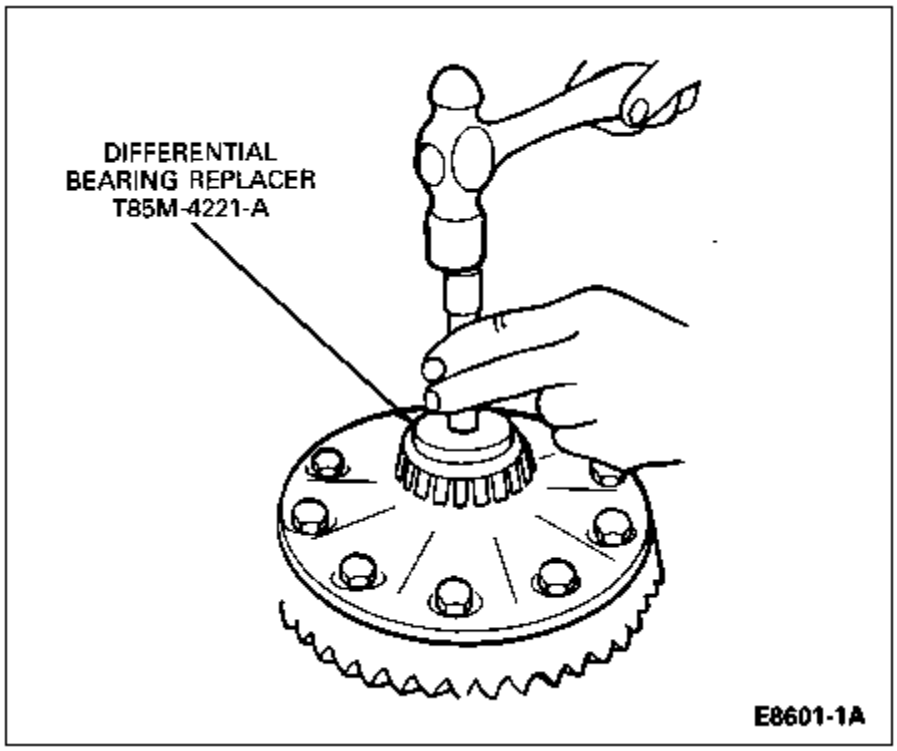

10. Install the differential bearing cups on the bearing cones.

11. Place Differential Housing Spreader TOOL-4000-E or equivalent on the differential case, using Spreading Adapters T90T-4000-A and suitable spacers. Install Dial Indicator TOOL-4201-C or equivalent on the carrier housing. Do not spread the housing more than 0.25mm (0.010 inch).

12. **NOTE: Be careful to not nick the teeth of the ring gear or drive pinion.**

    Install the differential case in the carrier housing. If necessary, use a rawhide or plastic hammer to seat the differential case into the carrier housing cross bore.

13. With partial and non-hunting/partial ring gear and pinion sets, align the marks on the ring gear and drive pinion if applicable. Some gear sets do not have marks, depending upon ratio.

14. Remove the spreader and dial indicator from the differential case.

15. **NOTE: The matched numbers or letters stamped on the cap and carrier must correspond in both position and direction upon assembly.**

    Install bearing caps and bolts. Tighten bolts to 64-91 Nm (47-67 lb-ft) for the Model 35 and 41-61 Nm (30-45 lb-ft) for the Model 28.

16. **NOTE: Backlash tolerance is 0.13-0.20mm (0.005-0.008 inch) and cannot vary more than 0.08mm (0.003 inch) between the three points. If backlash is high, the ring gear must be moved closer to the pinion by increasing the thickness of the outboard spacer on the ring gear side and decreasing the thickness of the spacer on the opposite side by an equal amount. If backlash is low, the ring gear must be moved away from the pinion by decreasing the thickness of the outboard spacer on the ring gear side and increasing the thickness of the spacer on the opposite side by an equal amount.**

    Install the dial indicator on the case. Check ring gear and pinion backlash at three equally spaced

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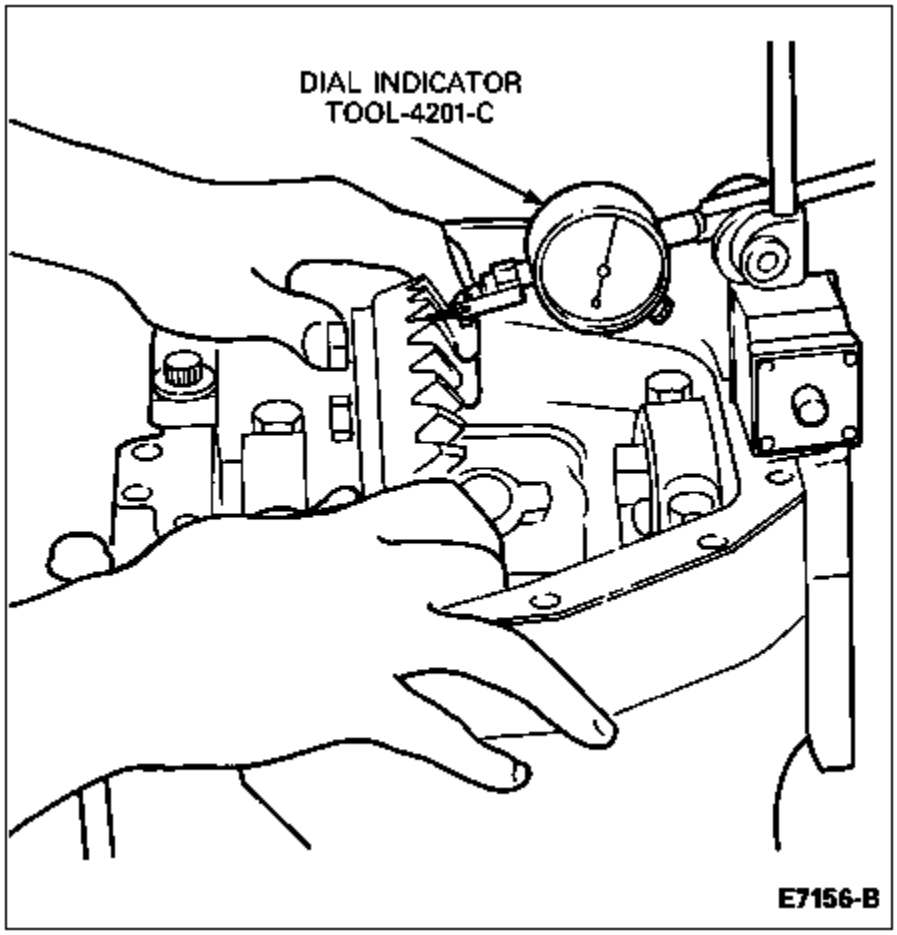
points on the ring gear.



Ring Gear and Pinion Tooth Pattern Interpretation

1. The final pinion position will be verified by using the gear contact pattern method described as follows:

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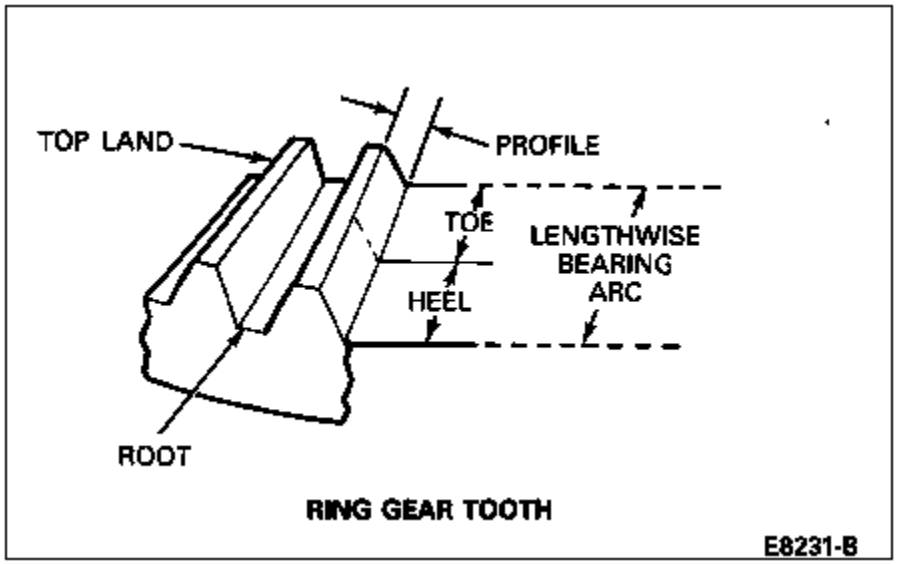

2. **NOTE: When making pinion position changes, shims should be changed in the range of .05-.10mm (.002-.004 inch) until correct pattern has been obtained.**

   The toe of the gear tooth is the portion of the tooth surface at the end towards the center. The heel of the gear tooth is the portion of the tooth surface at the outer end. The top land of a gear tooth is the surface of the top of the tooth. Every gear has a characteristic pattern. The illustrations show typical patterns only, and explain how patterns shift as gear location is changed.

3. **WARNING: GEAR TEETH MAY HAVE SHARP EDGES. WHEN HANDLING GEARS, USE CARE TO AVOID PERSONAL INJURY.**

   NOTE: When making changes, note that two variables are involved. For example, if you have the backlash set correctly to specifications and you change the pinion position shim, you may have to readjust the backlash to the correct specification before checking the pattern. Refer to pattern interpretation.

   When a change in backlash is required, backlash shims should be changed in the range of 1-1/2 times the amount of backlash required to bring the gears into specification. For example, if the backlash needed to be changed by .10mm (.004 inch), the shim pack should be changed by .15mm (.006 inch) as a starting point. The actual amount of backlash change obtained will vary depending upon the ratio and gear size. High backlash is corrected by moving the ring gear closer to the pinion. Low backlash is corrected by moving the ring gear away from the pinion. These corrections are made by increasing or decreasing the thickness of the outboard spacers.

4. Paint ring gear teeth with a marking compound on both the drive and coast side.

5. Rotate ring gear one complete revolution in both directions while load is being applied with a large screwdriver or similar tool between the carrier casting and differential case flange.

Ring Gear Patterns

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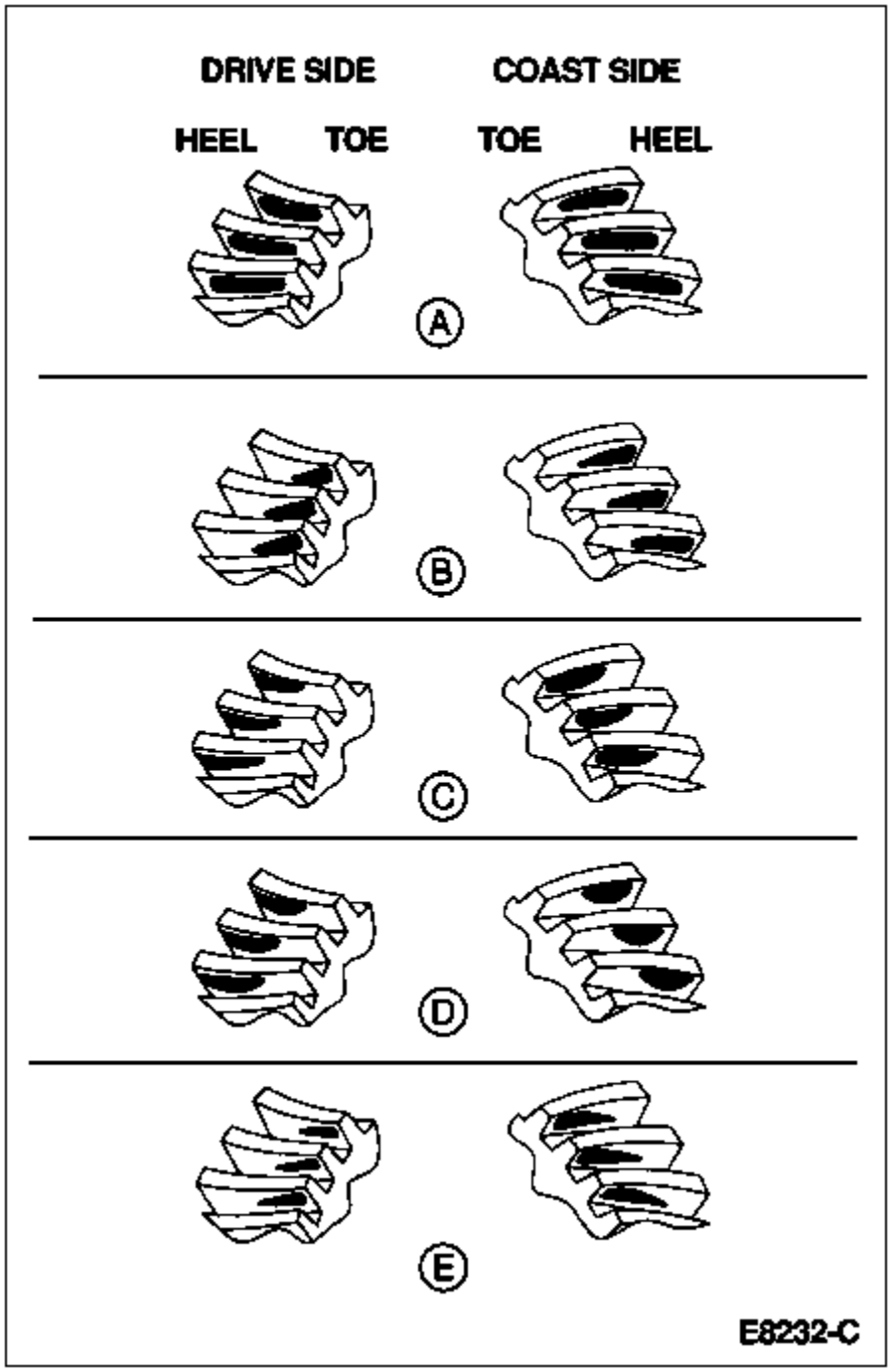

Item	Part Number	Description
A	—	Normal or Desirable Pattern
B	—	Backlash Correct. Thinner Pinion Position Shim Required
C	—	Backlash Correct. Thicker Pinion Position Shim Required
D	—	Pinion Position Shim Correct. Decrease Backlash

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E	—	Pinion Position Shim Correct. Increase Backlash

Pattern Movements Summarized

1. The following summarizes how pinion and ring gear movements will obtain satisfactory roll patterns:

    a. Decreasing backlash moves the ring gear closer to the pinion.

    Drive pattern (convex side of gear) moves slightly lower and toward the toe.

    Coast pattern (concave side of gear) moves lower and toward the toe.

    b. Increasing backlash moves the ring gear away from the pinion.

    Drive pattern moves slightly higher and toward the heel.

    Coast pattern moves higher and towards the heel.

    c. Thicker pinion position shim with the backlash constant moves the pinion closer to the ring gear.

    Drive pattern moves deeper on the tooth (flank contact) and slightly toward the toe.

    Coast pattern moves deeper on the tooth and toward the heel.

    d. Thinner pinion position shim with the backlash constant moves the pinion further from the ring gear.

    Drive pattern moves toward the top of the tooth (face contact) and toward the heel.

    Coast pattern moves toward the top of the tooth and slightly toward the toe.

2. Apply a bead 3.175-6.35mm (1/8-1/4 inch) high and 3.175-6.35mm (1/4-1/2 inch) wide of Silicone Rubber RTV sealant D6AZ-19562-AA (clear) or equivalent meeting Ford specification ESB-M4G92-A or ESE-M4G195-A on the mating surfaces of the carrier mounting face support arm.

3. Mount the differential assembly to the left hand axle arm, using two guide pins being careful not to smear gasket sealant. Install and tighten bolts to 54-68 Nm (40-50 lb-ft). Tighten one bolt and then tighten the bolt directly opposite it. Tighten the rest of the bolts in either a clockwise or counterclockwise direction.

4. **NOTE: Allow one hour curing time after the axle carrier is assembled to the axle arm before adding lubricant and operating vehicle.**

    Assemble the carrier shear bolt and nut. Tighten to 102-129 Nm (75-95 lb-ft).

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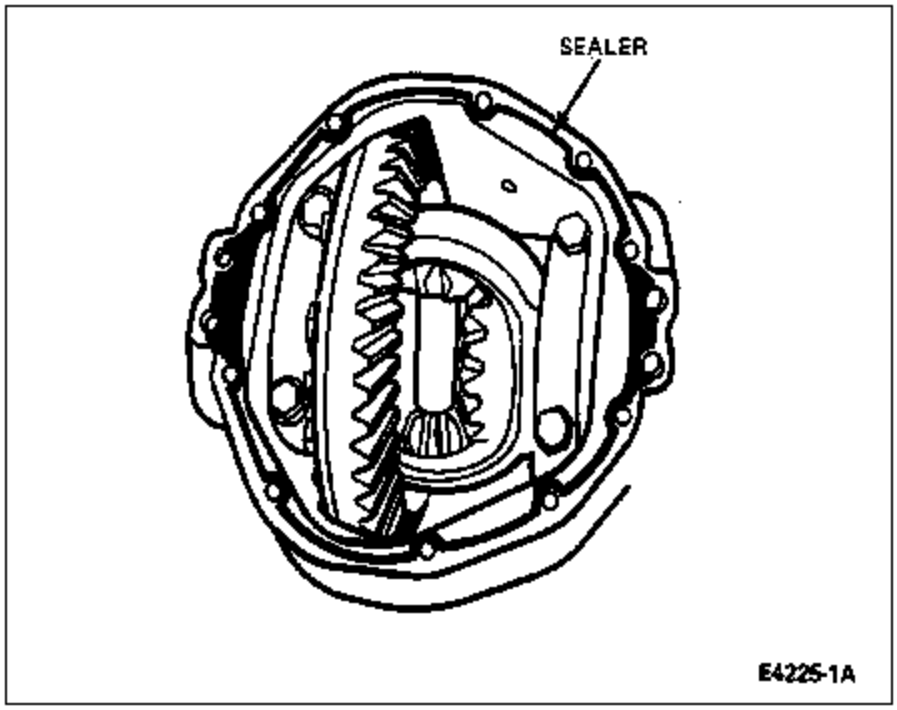

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Axle Shaft U-Joint

SPECIAL SERVICE TOOL (S) REQUIRED

Description	Tool Number
U-Joint Tool	T74P-4635-C

Disassembly

1. Place the axle shaft assembly in a vise, being careful not to damage it.
2. Remove the snap rings that retain the U-joint bearings in the axle companion flange in the axle shafts.
3. Position U-Joint Tool T74P-4635-C on the shaft and press the bearing out of the axle companion flange. If the bearing cannot be pressed all the way out of the axle companion flange, remove it with vise grip or channel lock pliers.
4. Reposition the tool to press on the journal cross in order to remove the bearing from the opposite side of the axle companion flange.
5. Remove the axle companion flange from the journal cross.
6. Remove the bearing and journal cross from the axle shaft in the same manner.

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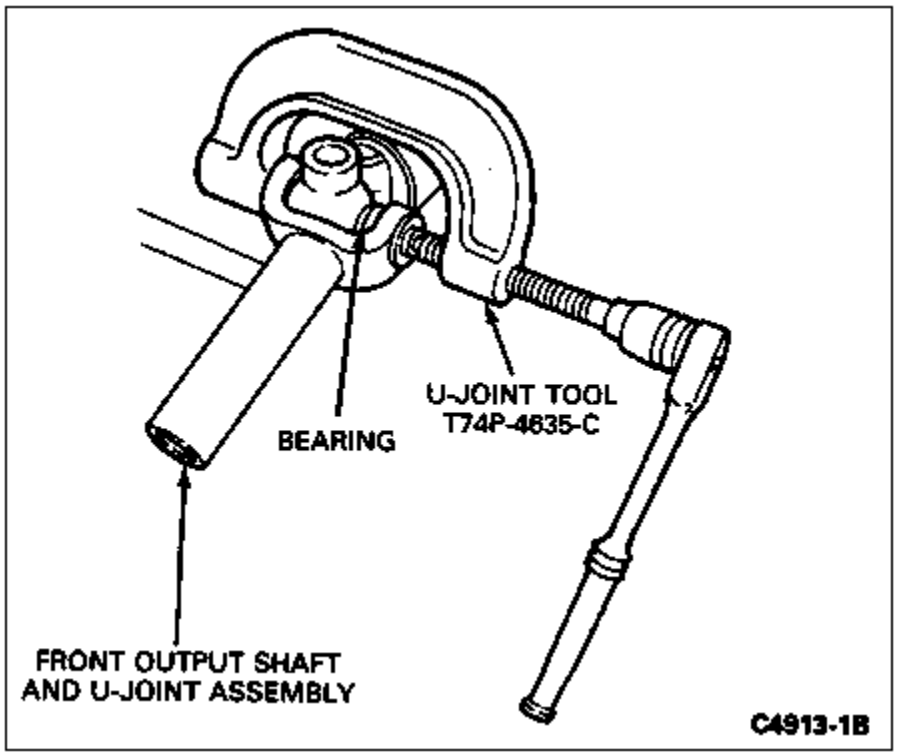

Assembly

1. Start a new bearing into the axle companion flange of the axle shaft.
2. Position the journal cross in the axle companion flange and press the bearing 6.35mm (1/4 inch) flush with the surface of the axle companion flange.
3. Remove the tool and install a new snap ring.
4. Start a new bearing into the opposite side of the axle companion flange.
5. Install the tool and press on the bearing until the opposite bearing is flush.
6. Remove the tool and install a new snap ring.
7. Position the flange on the journal cross and install two new bearings and snap rings.
8. **NOTE: Do not install the driveshaft if the U-joints show any signs of binding.**

   Check the joint for freedom of movement. If a bind has resulted from misalignment during the foregoing procedures, tap the ears of the driveshaft sharply to relieve the bind.

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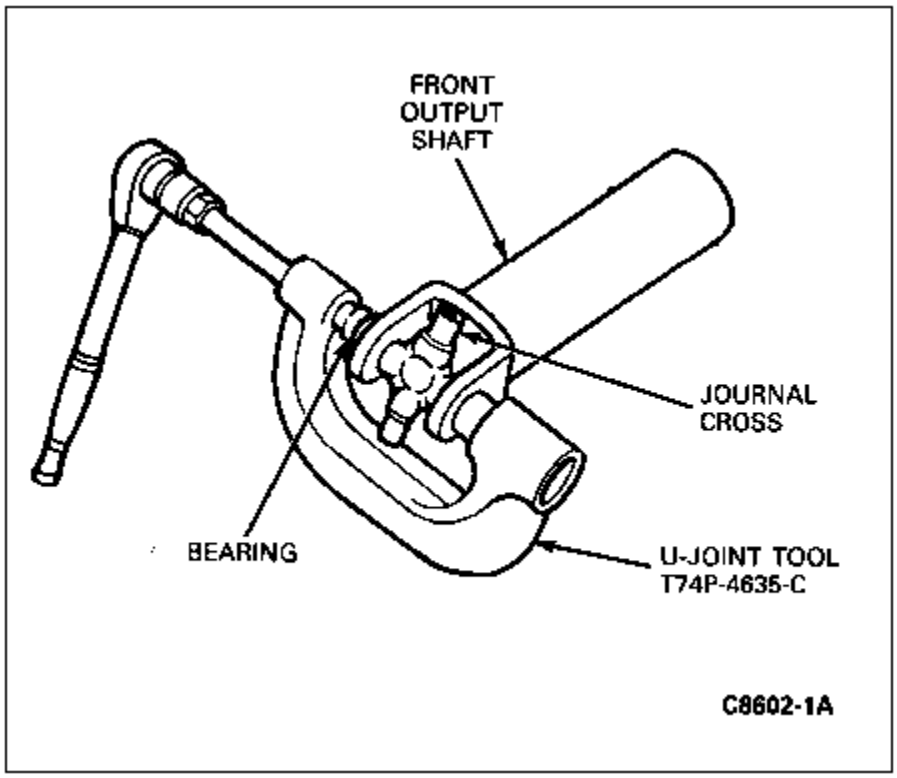

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Inspection Before Disassembly of Carrier

The differential case assembly and drive pinion should be inspected prior to removal from the carrier casting. These inspections can determine the cause of the complaint and the resolution.

1. Wipe the lubricant from the internal working parts and visually inspect the parts for wear or damage.
2. Rotate the gears. Check any roughness which would indicate worn or damaged bearings or gears.
3. Check the ring gear teeth for signs of scoring, abnormal wear or nicks/chips.

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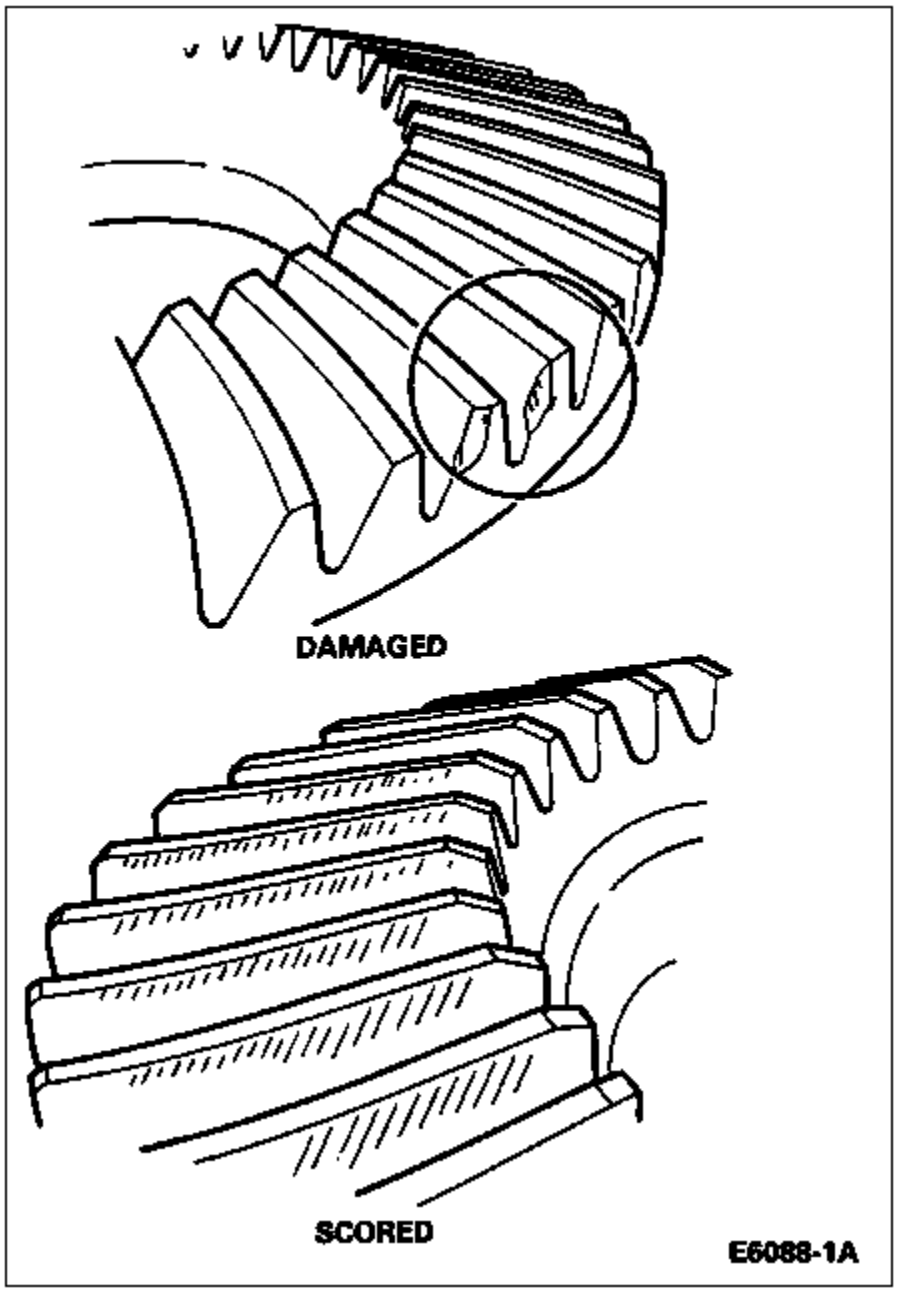

4. Set up Dial Indicator with Bracketry TOOL-4201-C or equivalent and check ring gear backlash and ring gear backface runout. Refer to the Specification at the end of this section for allowable conditions.

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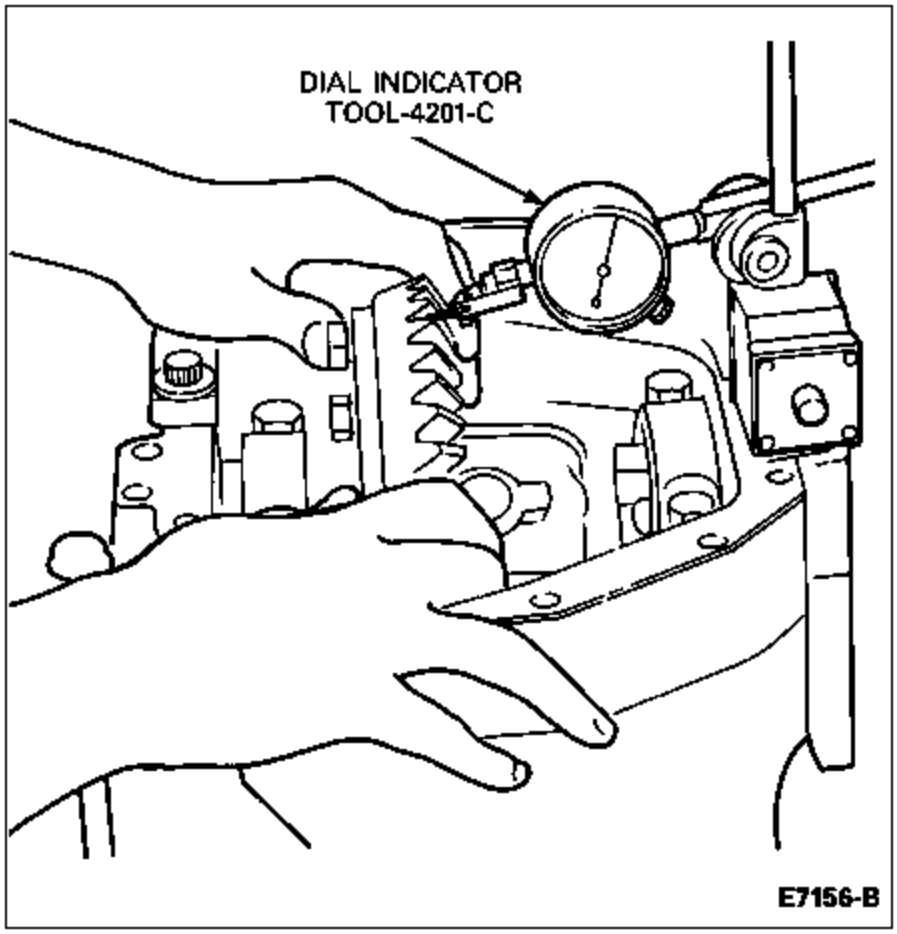

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Inspection After Disassembly of Carrier Housing

- Thoroughly clean all parts. Always use new solvent when cleaning bearings.
- Do not spin dry bearings with compressed air.
- Oil the bearings immediately to prevent rusting.
- Inspect the parts for any major damage.
- Clean the inside of the housing before rebuilding.
- When a scored or chipped gear set is replaced, the axle housing must be washed thoroughly.

Inspection procedures for individual parts are outlined below.

Gears

Examine the pinion and ring gear teeth for scoring, excessive wear, nicks and chipping. Worn, scored and damaged gears cannot be rebuilt to correct a noisy condition.

Bearing Cups

NOTE: If disassembly is required, it is recommended that new bearings be installed.

Check bearing cups for deep scores, galling, or spalling. If a 0.038mm (0.0015 inch) feeler gauge can be inserted between a cup and the bottom of its bore or any point around the cup, the cup must be reseated.

Cone and Roller Assemblies

When operated in the cups, bearing rollers must turn without roughness. Examine the roller ends for step wear. If inspection reveals either a damaged cup or a damaged cone and roller assembly, both parts should be replaced.

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Axle, Front Drive Housed

A number of adjustments involve the front drive axle. For front wheel bearing adjustment, refer to Section 05-03A . For caster and camber alignment adjustment, refer to Section 04-00 .

To correctly assemble the ring and pinion and carrier assembly, the following procedures must be performed:

- Obtain correct pinion depth.
- Check pinion preload.
- Check total differential case travel from side to side.
- Determine correct differential preload and backlash shims.
- Check pinion and ring gear backlash.
- Confirm correct gear contact pattern using gear marking compound.

Adjustment of the differential bearings (4221) is accomplished by a selective shim between the differential bearing cup (4222) and carrier housing. The differential bearings are preloaded by the squeezing action of the carrier housing. A spreader must be used on the carrier to relieve the tension on the differential bearings and permit removal or installation of the differential.

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SPECIFICATIONS

General Specifications

Item	Specification
Lubrication	
4x4 Gear Oil F1TZ-19580-A	WSL-M2C192-A
High Temperature 4x4 Front Axle and Wheel Bearing Grease E8TZ-19590-A	ESA-M1C198-A
Silicone Rubber Sealant D6AZ-19562-AA (clear)	ESB-M4G92-A or ESE-M4G195-A

Lubricant Capacities

Axle	Approximate Capacity		
	U.S. Ounces	Imperial Pints	Liters
Dana Model 35 Front Drive Axle	56	2.9	1.65
Dana Model 28 Front Drive Axle	48	2.5	1.41

Note: Use 4x4 Gear Oil, F1TZ-19580-A meeting Ford specification WSL-M2C191-A (F1TZ-19580-A has no equivalent).

Dana Model 35 And 28 Front Drive Axle Specifications

Description	Specification
Carrier Spread	Removal 0.25mm (0.010 Inch) Installation 0.37mm (0.015 Inch)
Drive Pinion Rotational Torque	1.7-2.8 Nm (15-25 Lb-In)
Drive Pinion Nut Torque	271-475 Nm (200-350 Lb-Ft)
Ring Gear and Pinion Backlash	0.13-0.20mm (0.005-0.008 Inch)

Torque Specifications

Description	Nm	Lb-Ft	Lb-In
Axle Pivot Nut	163-203	120-150	—
Axle Pivot Bracket to Frame Nut	95-124	70-92	—

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Support Arm Stud	258-311	190-229	—
Ball Joint Nut — Lower	129-149	95-110	—
Bearing Cap Bolts (Model 35)	64-91	47-67	—
Bearing Cap Bolts (Model 28)	41-61	30-45	—
Carrier to Axle Arm Bolts	52-72	38-53	—
Carrier Shear Bolt	102-129	75-95	—
Front Driveshaft U-Bolt Nuts	11-20	8-15	—
Lower Shock Absorber to Radius Arm Nut	57-97	42-72	—
Lower Spring Seat Nut	95-135	70-100	—
Driveshaft to Transfer Case Flange Bolts	89-119	65-87	—
Radius Arm and Front Bracket Bolt	37-50	27-37	—
Radius Arm Bracket Lower Bolt	217-298	160-220	—
Ring Gear Bolts	95-122	70-90	—
Carrier to Support Arm Attaching Bolts	54-68	40-50	—
Lug Nuts	115-155	85-115	—
Spindle Nuts	54-68	40-50	—
Ball Joint Nut — Tie Rod	68-101	50-75	—
Ball Joint Stub Nut — Lower	122	90	—
Ball Joint Pinch Bolt — Upper	88-115	65-85	—
Steering Linkage to Steering Arm Nut	70-100	52-74	—
Companion Flange Nut	271	200	—
Radius Arm and Front Bracket to Support Arm Stud	258-311	190-229	—
Front Brake Anti-Lock Sensor Bolt	5-6	—	44-53
Front Disc Brake Rotor Shield Bolt	7-10	—	62-89
Front Suspension Bumper Bolt	15-25	11-18	—
Upper Shock Absorber Nut	34-47	25-35	—
Radius Arm Nut	109-162	80-120	—
Axle Pivot Bracket Nut	105-149	77-110	—

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Axle, Front Drive — Front Drive Axle Diagnosis

NOTE: The outboard CV joint internal components are not serviceable. If service is required the CV joint and shaft are replaced as an assembly.

For noise, harshness and vibration concerns, refer to the Diagnosis and Testing portion of Section 05-00 .

FRONT DRIVE AXLE DIAGNOSIS

Condition	Possible Source	Action
• Noise/Vibration in Turns (Clicking, Popping and Grinding)	• Cut or damaged CV joint boots resulting from inadequate or contaminated lube in CV joint.	• REFER to the Disassembly and Assembly portion of this section.
	• Loose CV joint boot clamps.	• REFER to the Disassembly and Assembly portion of this section.
	• Another component contacting halfshaft.	• REFER to the Disassembly and Assembly portion of this section.
	• Worn, damaged or improperly installed wheel bearing.	• REFER to the Removal and Installation portion of this section.
• Vibration at Highway Speed **NOTE: Halfshafts are not balanced and do not contribute to rotational vibration disturbances.**	• Out of balance front wheels or tires.	• REFER to Section 04-04 .
	• Out-of-round front tires.	• REFER to Section 04-04 .
	• Out of balance front or rear driveshaft.	• REFER to Section 05-01 .
• Shudder/Vibration During Acceleration	• Excessively worn or damaged CV joints.	• REFER to Disassembly and Assembly portion of this section.
	• Excessively high CV joint operating angles caused by improper ride height.	• CHECK ride height. VERIFY proper spring rate. CHECK items 1, 2 and 3 under Disassembly and Assembly, CV/CV Halfshaft .
• Halfshaft or CV Joint Pullout	• Differential mispositioned.	• CHECK differential mounts for proper location, damage or wear.

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	• Frame rail or strut tower out of position or damaged. • Front suspension components worn or damaged.	• REFER to appropriate section in Group 02. • CHECK for worn bushings or bent components (front stabilizer bar, control arm, etc.). REFER to Section 04-01B .

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Driveshaft, Front

Removal

1. Mark the driveshaft and axle companion flanges as well as the driveshaft boot and transfer case front output, so the driveshaft can be reinstalled in the same position.
2. Release Oetiker low-profile clamp on the driveshaft boot with the Boot Clamp Pliers D87P-1090-A or equivalent and free the boot from the transfer case (7A195).
3. Remove the axle snubber from beneath the pinion.
4. Remove the four bolts retaining the front driveshaft to the front axle companion flange.
5. Remove the nuts from the transmission mount studs in the front crossmember (5019).
6. Raise (jack) transfer case so the transmission mount studs are almost out of the front crossmember.
7. Slide the driveshaft front flange between the front axle and the starter motor (11001).
8. When the front flange has cleared, slide the boot and splined yoke out of the transfer case front output.
9. Remove the front driveshaft.

Installation

1. The transfer case should be raised on a jack so the transmission mount studs are almost out of the front crossmember.
2. Align the marks made at removal and slide the boot and splined yoke assembly into the transfer case front output.
3. Slide the driveshaft front flange between the front axle and the starter motor.
4. Lower the transfer case so the transmission studs are returned to their original positions.
5. Tighten the transmission mount nuts to specifications.
6. Align the companion flanges as marked during removal and install the attachment bolts and tighten to 30-40 Nm (22-30 lb-ft).
7. Position the axle snubber on the crossmember just below the axle pinion, install the fasteners and tighten to 23-33 Nm (17-24 lb-ft).
8. Install the Oetiker low-profile clamp with the Boot Clamp Pliers D87P-1090-A or equivalent.

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Axle, Front Drive

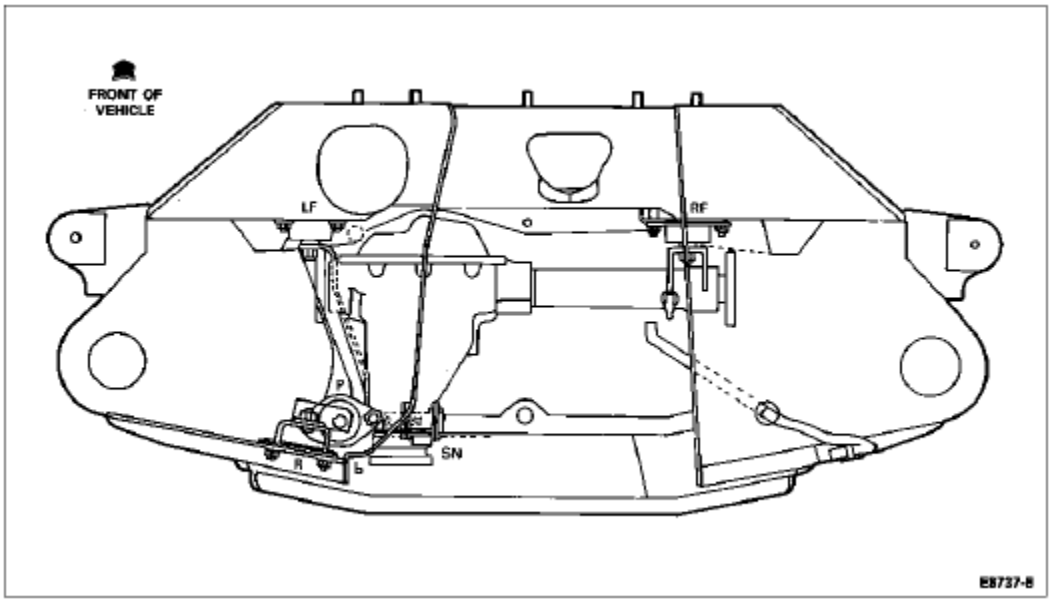
Removal

1. Raise the vehicle on a hoist or jack and install safety stands under the front lift points.
2. **NOTE: Mark the driveshaft and axle flanges so they can be reassembled in their original orientation.**

   Disconnect the front driveshaft from the front axle companion flange.
3. **NOTE: Only four of the six bolts hold the CV halfshaft to the axle shaft. The other two bolts retain the spacer.**

   Remove the bolts that connect the inboard halfshaft flange to the axle shaft (right and left). Wire the halfshafts to the body maintaining a level position.
4. Remove the vent hose from the vent fitting on the axle tube and cap the fitting to prevent any fluid leakage.
5. Remove snubber (SN) from the crossmember rear lateral support, located below the axle pinion.

Front Drive Axle



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6. Make sure the front axle is supported by a hoist. Remove the locknuts that connect the axle mounting brackets to the front crossmember (5019) (four places).

7. Lower the hoist and remove the front axle.

8. If necessary, remove the bolts holding the mounting bracket to the axle housing. Remove the bracket.

Installation

1. If removed, attach the axle mounting bracket to the axle housing, using Threadlock and Sealer E0AZ-19554-AA or equivalent meeting Ford specification WSK-M2G351-A5 (Type II) on the two capbolts. Tighten to 95-108 Nm (70-80 lb-ft).

2. With the vehicle on jack stands, raise the axle into position in the vehicle.

3. **NOTE: When installing the axle with new mounting bushings, each nut must be tightened to full torque in one step to avoid scoring of the locking patch on the stud, before the nut is fully tightened.**

   Insert four axle mounting bushing studs through the axle mounting brackets. Install the locknuts using Threadlock and Sealer E0AZ-19554-AA or equivalent meeting Ford specification WSK-M2G351-A5 (Type II). Tighten to 88-115 Nm (65-85 lb-ft). Tighten down in the following order:

   a. Left front (LF)
   b. Right front (RF)
   c. Pinion (P)
   d. Rear (R)

4. Attach the vent hose to the vent fitting on the axle tube. Make sure the hose is not kinked.

5. Position and align the inboard halfshaft flange (right and left) with the axle shaft flange (align marks made during disassembly). Install the bolts and tighten to 30-40 Nm (22-30 lb-ft). Remove the wire that was supporting the halfshafts.

6. Position and align the front driveshaft flange to the front axle flange. Align marks made during removal. Install bolts and tighten to 30-40 Nm (22-30 lb-ft).

7. Position the axle snubber (SN) on the front crossmember just below the axle pinion. Install the fasteners and tighten to 23-33 Nm (17-24 lb-ft).

8. Remove the jack stands and lower the vehicle.

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Hub and Bearing Assembly

Removal and Installation

1. **NOTE: The hub and bearing assembly is not serviceable. If the bearing requires replacement, replace as an assembly.**

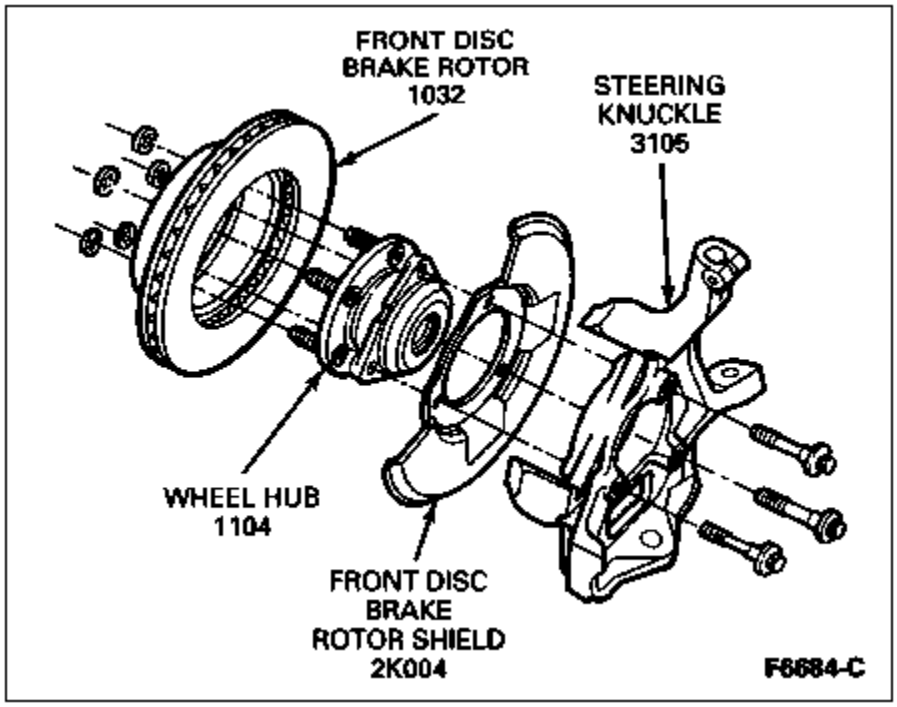
   Raise vehicle on a hoist and position suitable safety stands under vehicle. Remove wheel and tire assembly. Refer to Section 04-04 .

2. Remove disc brake caliper (2B120) and rotor. Refer to Section 06-03 .

3. Remove the three bolts retaining the hub assembly to the steering knuckle.

4. Remove the hub assembly.

For installation, follow removal procedure in reverse order.



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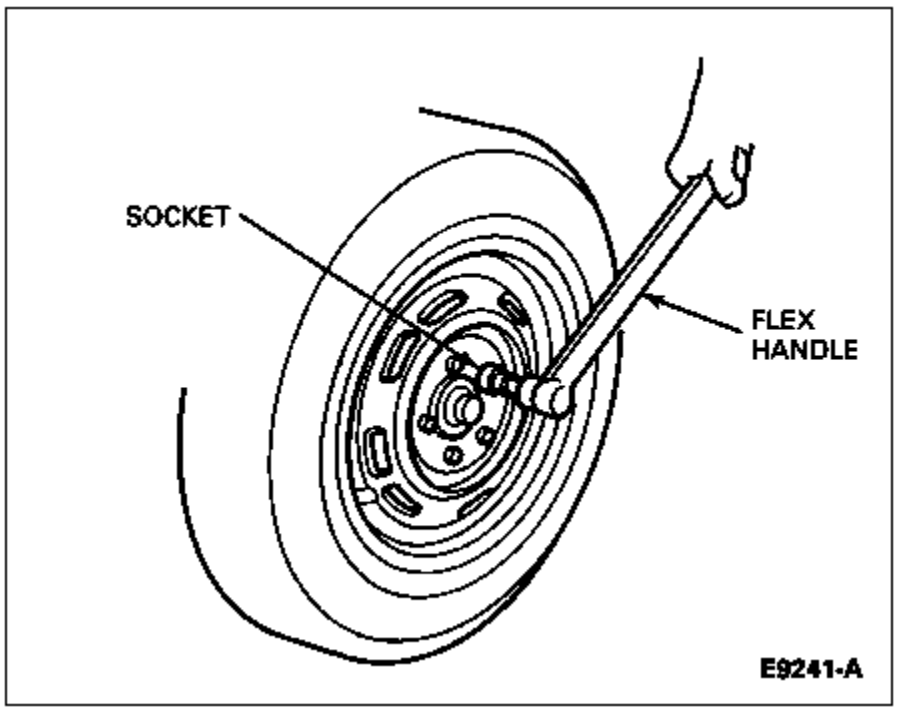
Halfshafts, Inboard U-Joint and Outboard CV Joint

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Front Hub Replacer	T81P-1104-A
Front Hub Remover/Replacer	T81P-1104-C
Metric Hub Remover Adapters	T83P-1104-BH
Front Hub Bearing Service Set	T86P-1104-A

Removal

1. Remove wheel cover/hub cover from wheel (1007) and tire and loosen lug nuts (1012).



2. Raise the vehicle on a frame contact hoist.

3. **CAUTION: Discard the hub retainer nut. It is a torque prevailing design and cannot be reused.**

   Remove the wheel and tire, and the hub retainer nut and washer.

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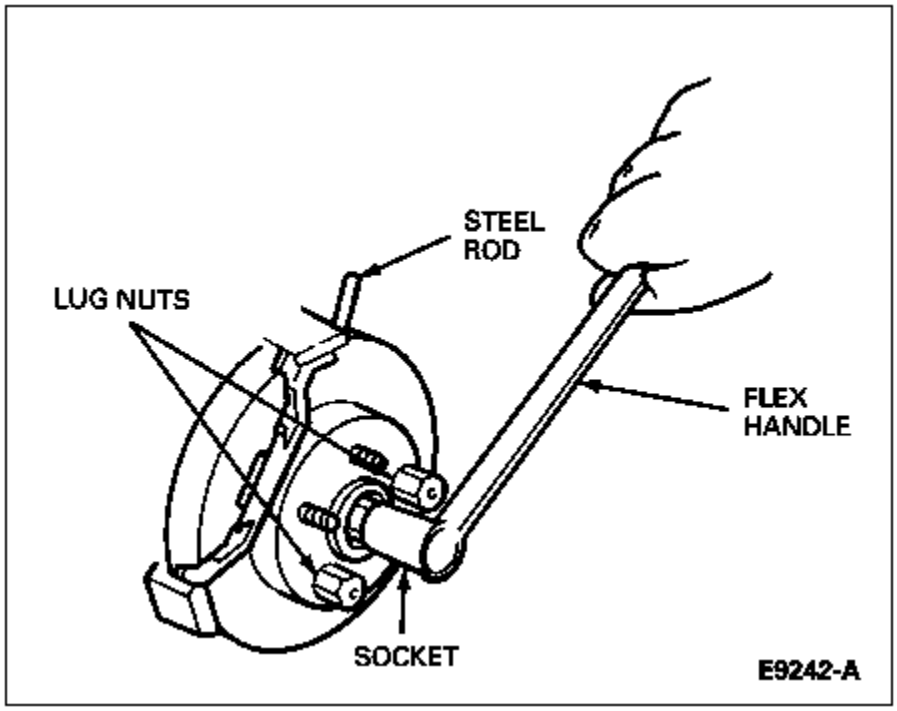

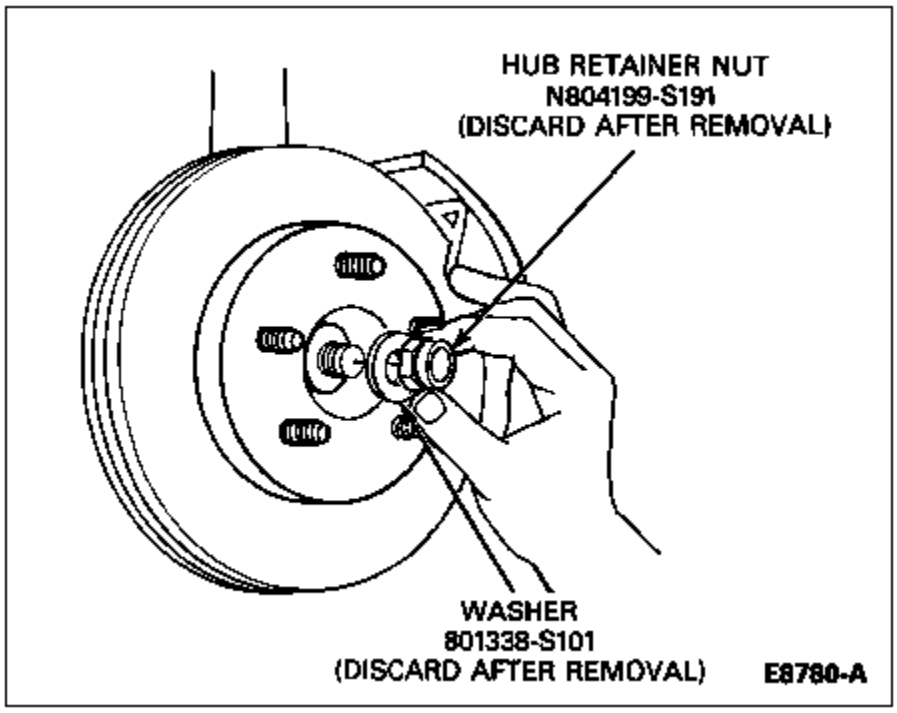

4. Mark the differential shaft flange in relation to the halfshaft so they may be installed in their original position.

5. **NOTE: Only four of the six bolts hold the CV halfshaft to the axle shaft. The other two bolts retain the spacer.**

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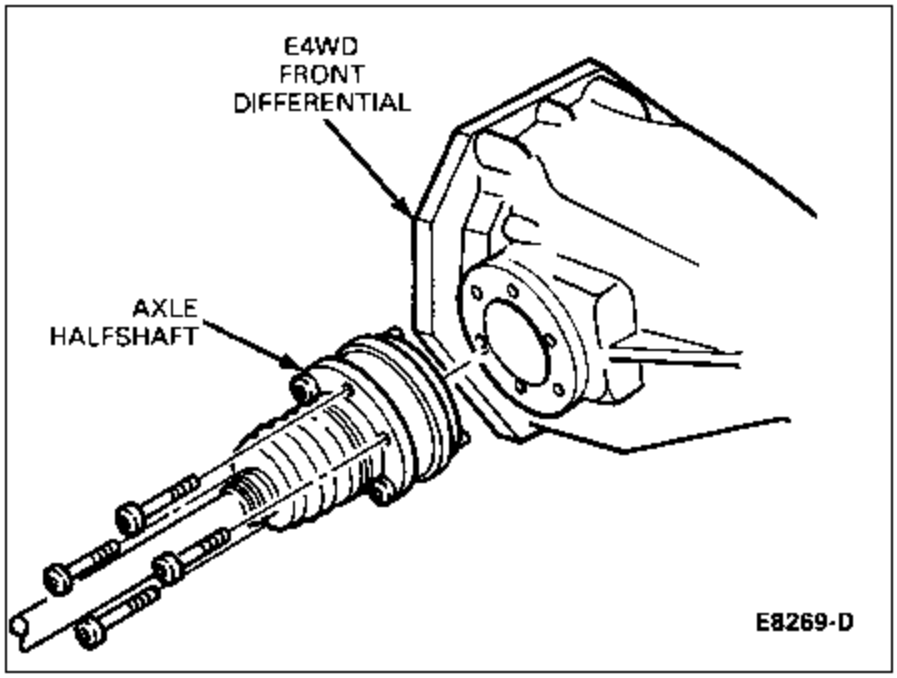
Remove the four bolts and disconnect the halfshaft inboard joint from the differential axle shaft flanges.

6. **CAUTION: Do not allow the shaft to hang unsupported. Damage to the outboard CV joint may result.**

   Support the end of the shaft by suspending it from a convenient underbody component with a length of wire.



7. Loosen the shock absorber attachment on the lower control arm and move to the side.

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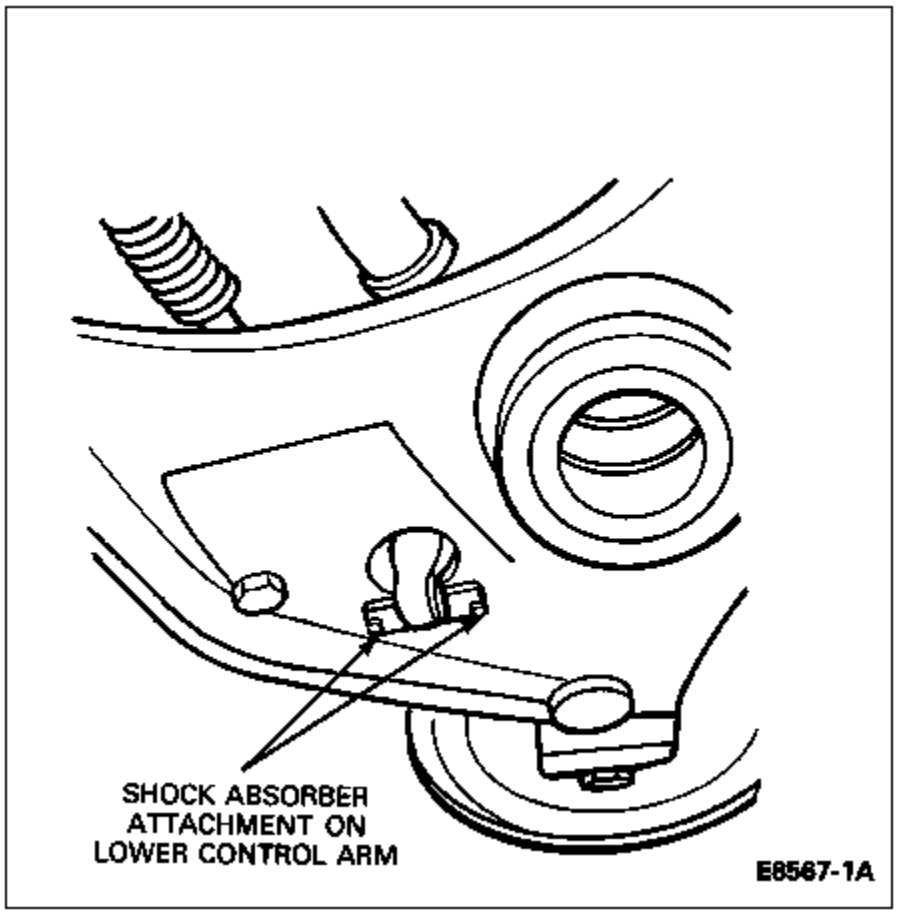

8. Remove the front suspension bumper (3020).

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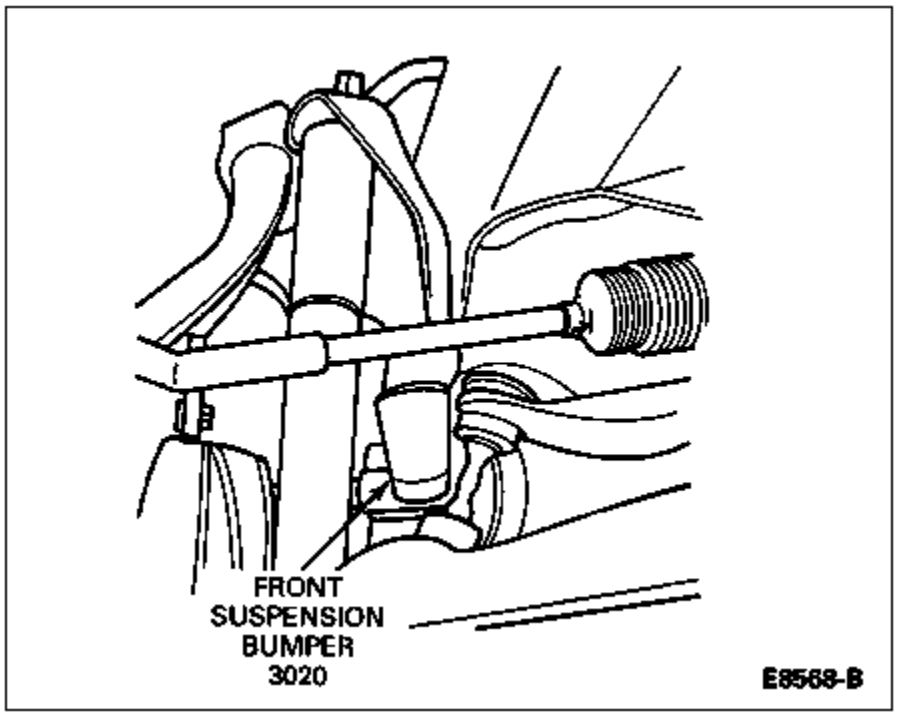

9. **CAUTION: Never use a hammer to separate the outboard CV joint stub shaft from the hub. Damage to the CV joint threads and internal components may result.**

   NOTE: Make sure adapters are fully threaded onto the hub studs and are positioned opposite the other adapter.

   Separate the outboard CV joint from the wheel hub (1104) using Front Hub Remover/Replacer T81P-1104-C with T81P-1104-A and Metric Hub Remover Adapters T83P-1104-BH and Front Hub Bearing Service Set T86P-1104-A.

10. Free the wheel hub, bearing and knuckle assembly from the halfshaft by pushing in the CV joint outer shaft until it is loose in the assembly.

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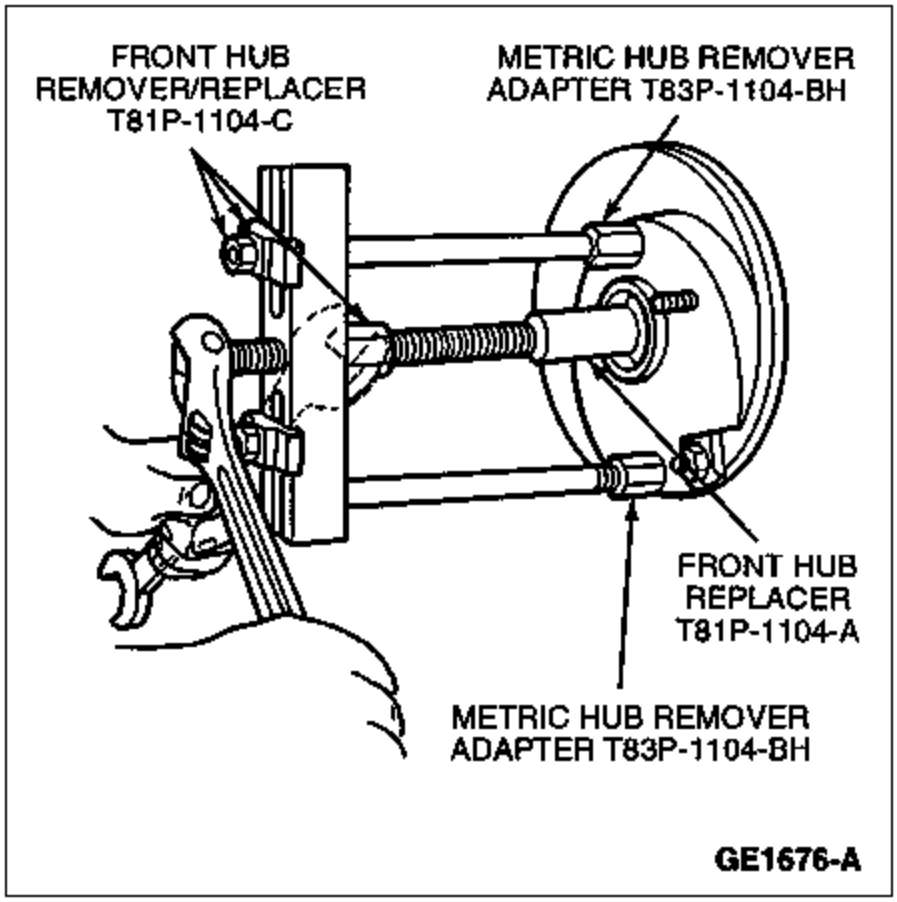

11. **CAUTION: Once the halfshaft(s) have been removed, the vehicle must not be driven, or rolled with the vehicle weight supported by the hub bearing.**

    Remove halfshaft assembly from vehicle.

Installation

1. Carefully align splines of outboard CV joint stub shaft with splines in wheel hub and push the shaft into the hub as far as possible.
2. Temporarily fasten front disc brake rotor to hub with washers and two lug nuts.
3. Insert a steel rod into the rotor and rotate clockwise to contact the knuckle to prevent the rotor from turning during CV joint installation.
4. **CAUTION: A new hub retainer nut must be installed.**

   Install the hub nut washer and a new hub retainer nut. Manually thread the retainer onto the halfshaft as far as possible.
5. **CAUTION: Do not use power or impact tools to tighten the hub nut.**

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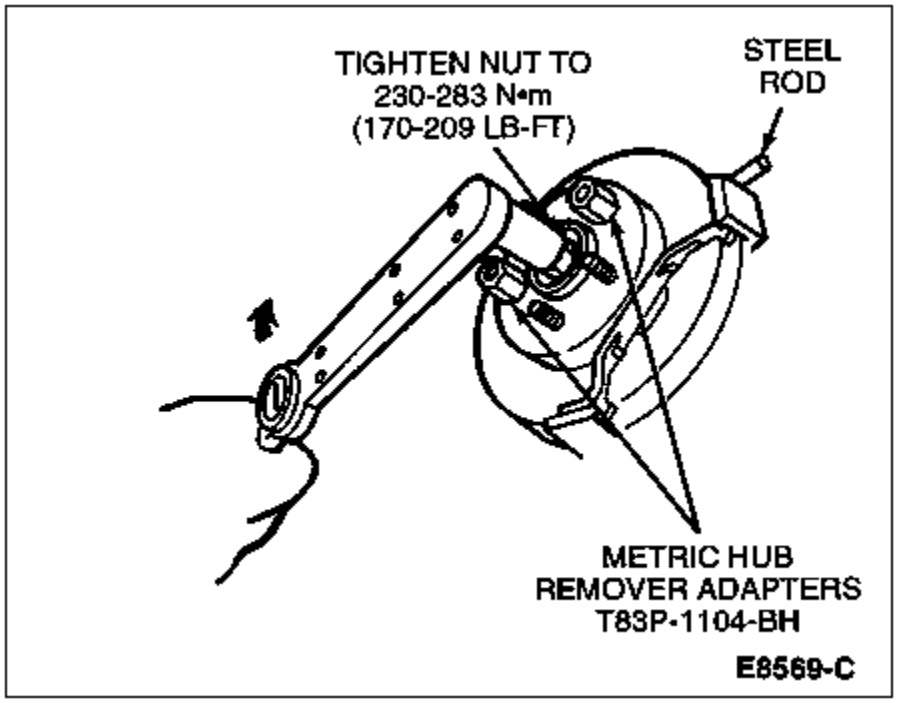
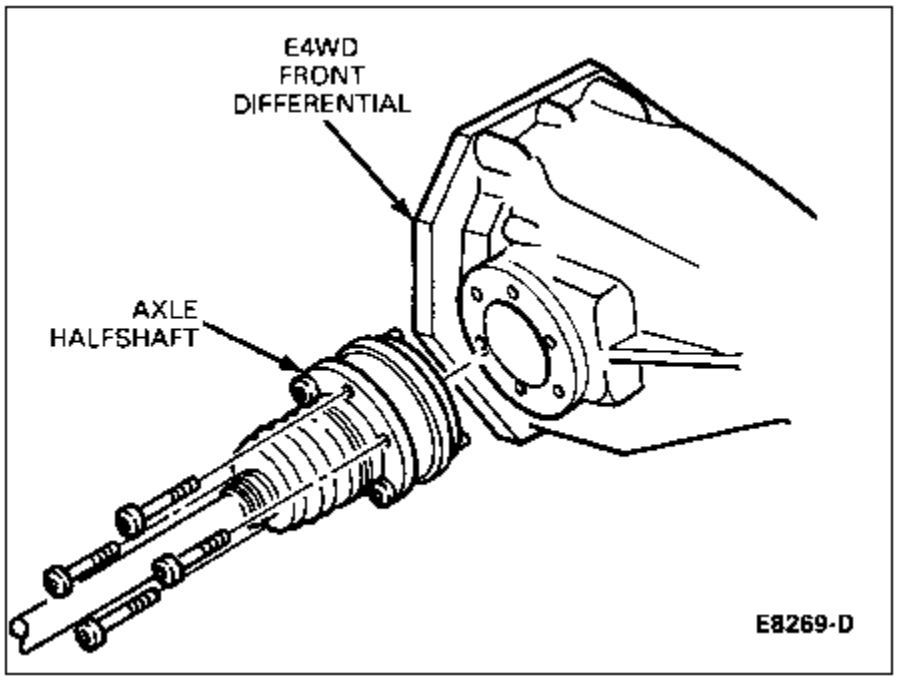
Tighten hub retainer nut to 230-283 Nm (170-209 lb-ft).



6. Install the inboard flange of the halfshaft to the differential output flange aligning index mark on the halfshaft with index mark on the differential output flange. This ensures original halfshaft position.

7. Install the flange bolts and tighten to 30-40 Nm (22-30 lb-ft).



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8. Install wheel and tire and lower the vehicle.
9. Tighten lug nuts to 115-156 Nm (85-115 lb-ft).

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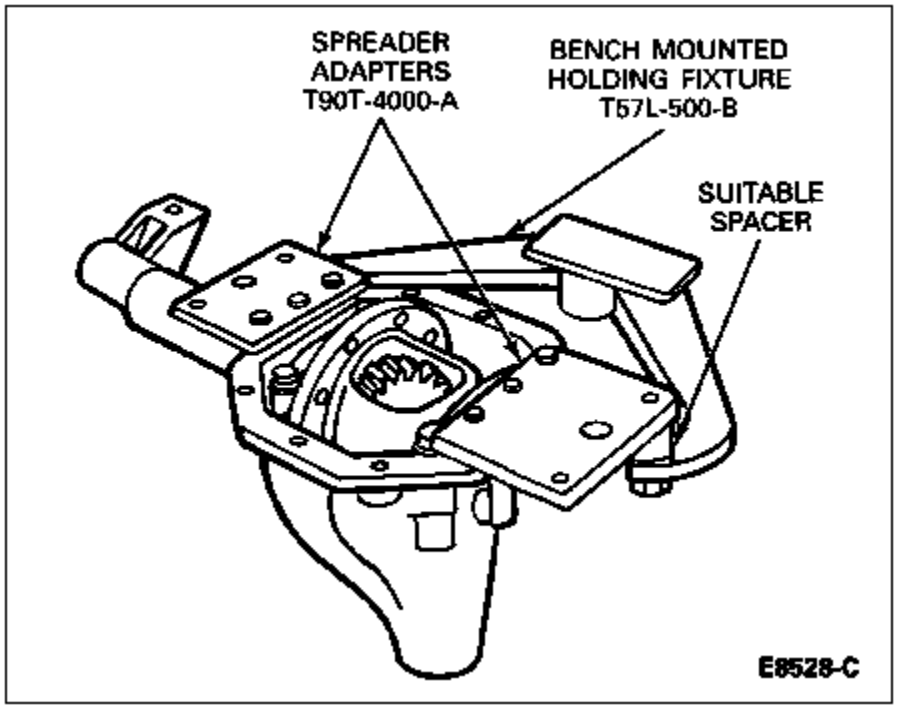
Axle Shafts, Carrier Oil Seal and Bearing

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Bench Mounted Holding Fixture	T57L-500-B
Impact Slide Hammer	T50T-100-A
Needle Bearing Replacer	T83T-1244-A
Driver Handle	T80T-4000-W
Axle Seal Replacer	T90T-3110-A
Spreader Adapter	T90T-4000-A

Removal

1. Remove the axle from the front sub-frame (5C145) and vehicle. Refer to the procedure in this section.
2. Remove cover plate and drain lubricant.
3. Mount the axle in Bench Mounted Holding Fixture T57L-500-B as shown.



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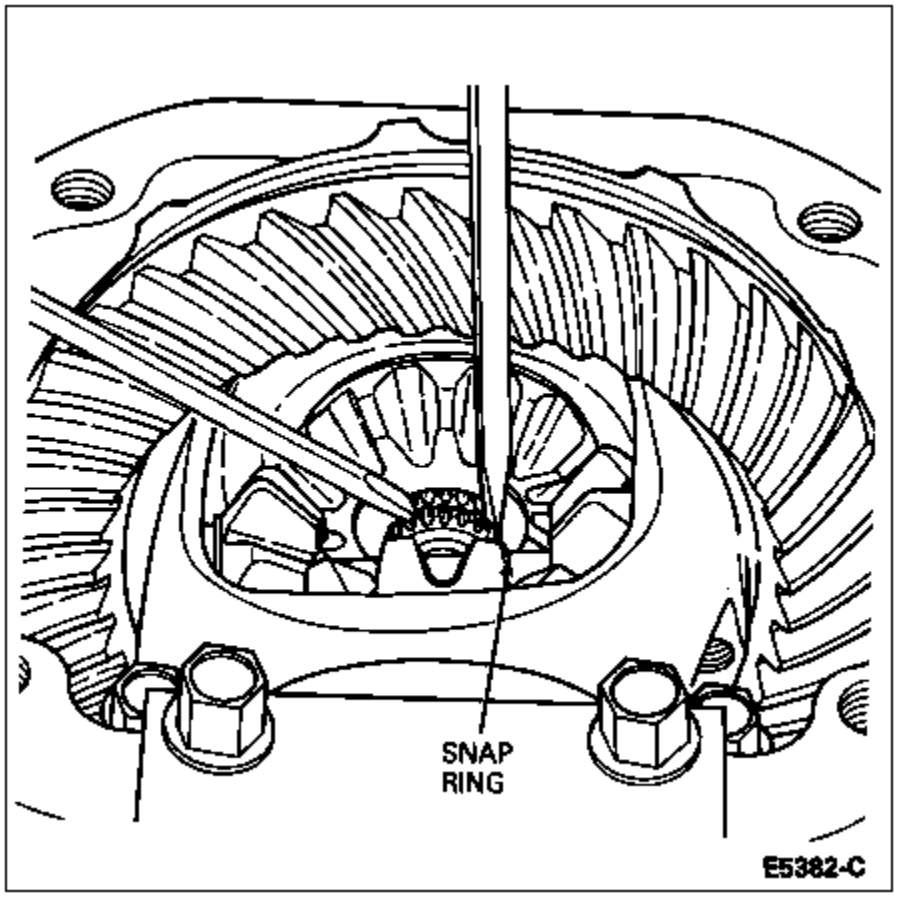
4. Rotate the shafts so the open side of the snap ring is exposed as shown. Remove snap rings from the shafts.



5. Remove shafts from the assembly.

6. Using Collet D80L-100-T, Actuator Pin D80L-100-H or equivalents and Impact Slide Hammer T50T-100-A remove the axle shaft oil seal (3254) and caged needle bearings as shown. Discard the seal and needle bearing (both sides).

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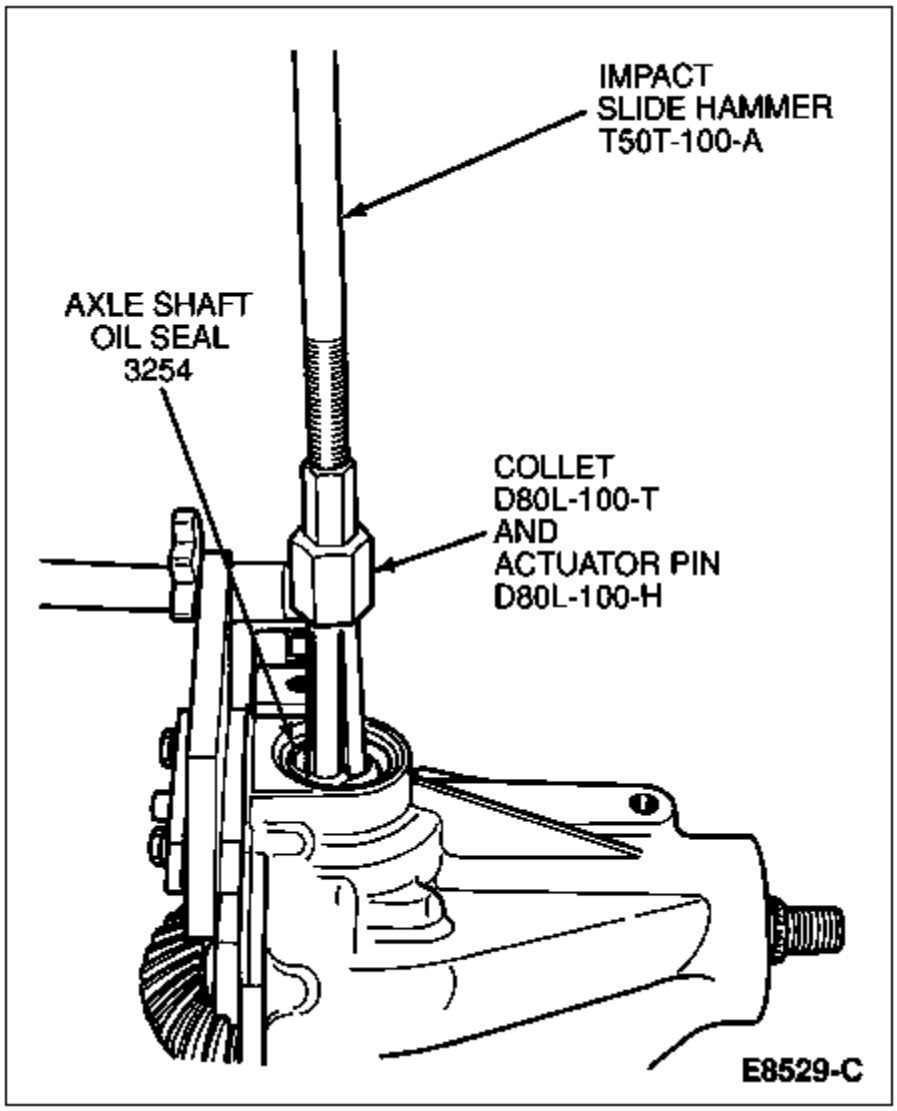

Installation

1. Make sure the bearing bore is free from nicks and burrs. Install a new caged needle bearing on Needle Bearing Replacer T83T-1244-A, with the manufacturer name and part number facing outward toward the tool.

2. **NOTE: Tool controls the installation depth of seal and bearing.**

   Using Driver Handle T80T-4000-W drive the needle bearing until it is seated in the bore.

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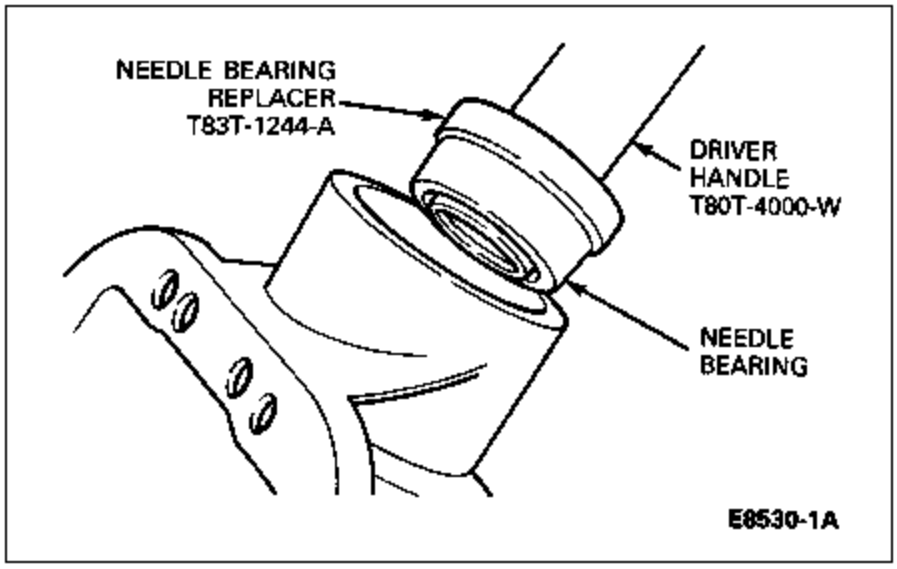
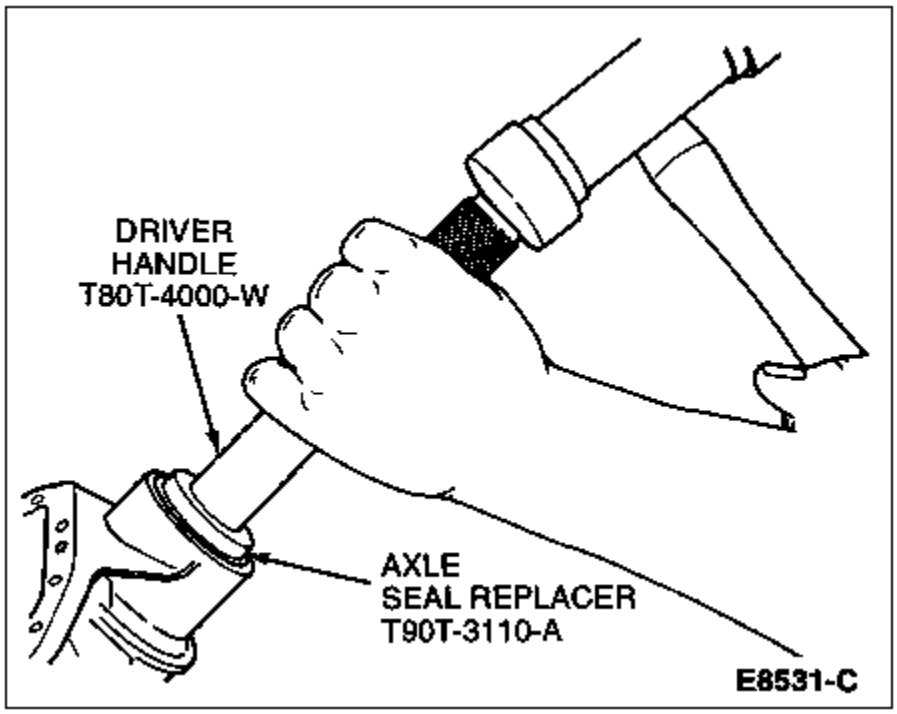


3. Coat the seal with Premium Long-Life Grease XG-1-C or -K or equivalent meeting Ford specification ESA-M1C75-B. Drive the axle shaft oil seal into the carrier using Axle Seal Replacer T90T-3110-A and Driver Handle T80T-4000-W.



4. Install the axle shafts into the carrier so the groove in the shaft is visible in the differential case.

5. **NOTE: Do not tap on the center of the snap ring. This may damage the snap ring.**

   Install the snap ring in the groove in the shaft. Force the snap ring into position with a screwdriver as shown.

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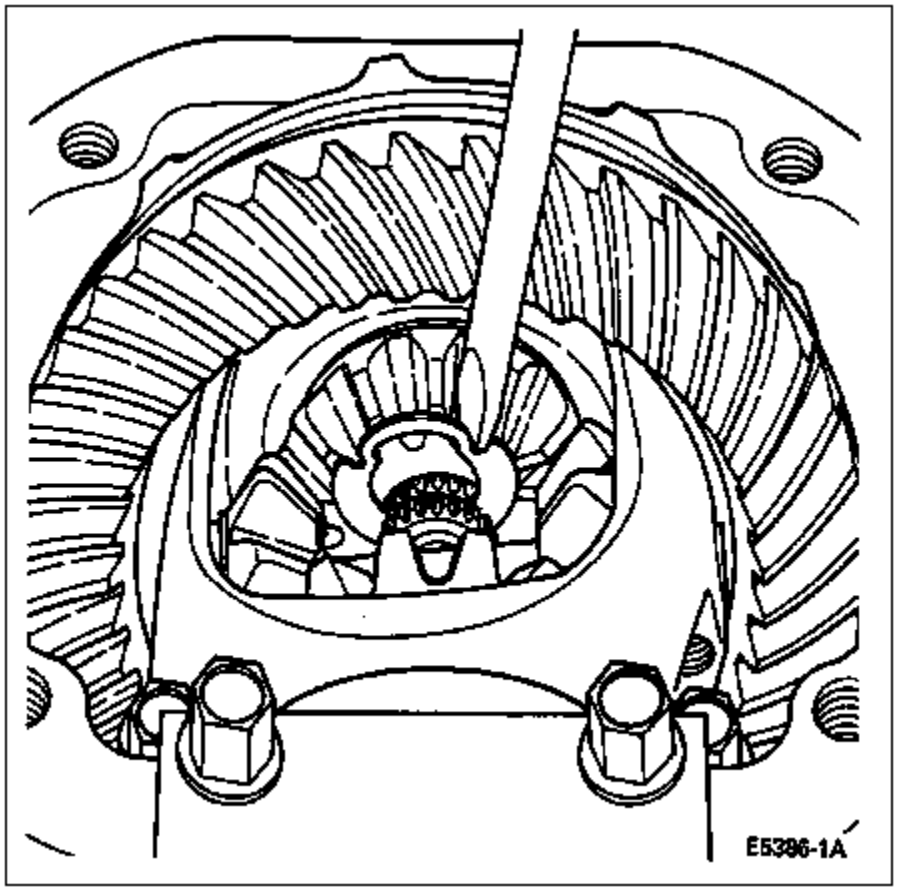

6. Remove the axle from the holding fixture.

7. **CAUTION: Apply only enough RTV to prevent leakage. Excess amounts of RTV may mix with axle lubricant which might cause damage to axle component.**

   NOTE: Allow one hour cure time before filling carrier with the proper amount of Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid, XT-2-QDX or -DDX or equivalent MERCON® fluid.

   Clean all traces of gasket RTV sealant from the surfaces of the carrier and cover and make sure the surfaces are free from dirt and oil. Apply a bead of RTV sealant D6AZ-19562-AA (clear) or -BA (black) or equivalent meeting Ford specification ESB-M4G92-A and ESE-M4G195-A, in a bead 3.18-6.35mm (1/8-1/4 inch) wide. The bead should be continuous and should not pass through or outside the holes.

8. **CAUTION: If any RTV enters cover screw holes, it may cause incorrect torque readings when installing the cover screws.**

   NOTE: The cover must be installed on the carrier within five minutes after applying the RTV sealant.

   Install the cover plate. Assemble cover bolts and tighten to 19-26 Nm (14-19 lb-ft).

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9. Fill the carrier with the proper amount of Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid, XT-2-QDX or -DDX or equivalent MERCON® fluid.

10. Install the axle in the vehicle. Refer to the procedure in this section.

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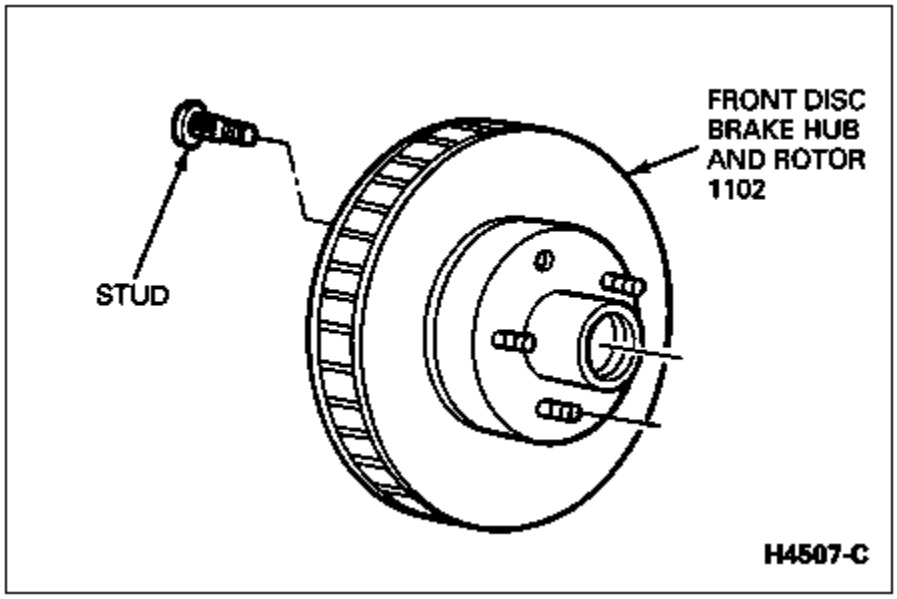
Wheel Hub Bolt

CAUTION: Service must be performed on any damaged components or the component that caused stud to require replacement.

Removal

1. Raise the vehicle and install safety stands.
2. Remove the wheel and tire assembly as described in Section 04-04 .
3. Remove the front disc brake hub and rotor (1102) as described in Section 06-03 .



4. Position the front disc brake hub and rotor in a press so ram pressure is not directly exerted on the surface of front disc brake hub and rotor. With appropriate press stock, press the stud from the front disc brake hub and rotor. Discard the stud.

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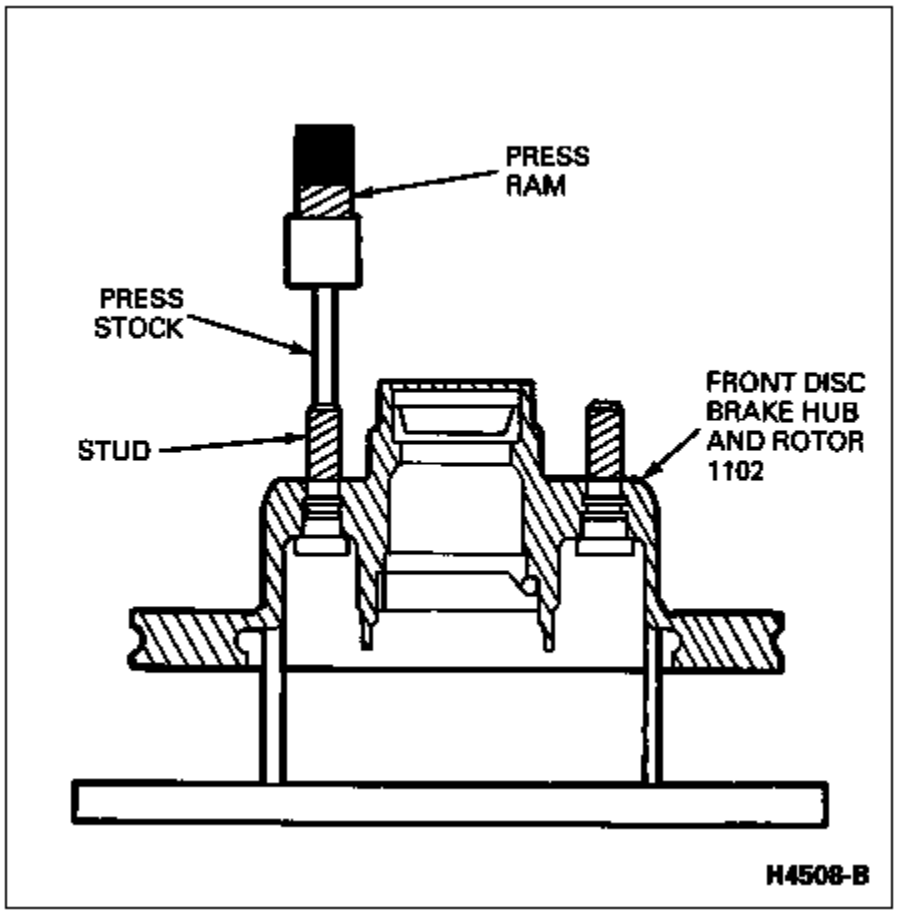

5. Inspect the stud for damaged threads. Discard if damaged.

Installation

1. Position a new stud in the hole. Align the serrations of the new stud with the serration marks from the old stud. With a hammer, lightly tap the stud until the serrations on the stud are started in the hole.
    - Make sure the stud is not installed in an "off-center" position in front disc brake hub and rotor.
2. Position the front disc brake hub and rotor in a press so the front disc brake hub and rotor is supported on the wheel mounting flange. Allow enough clearance for the stud to pass through the hole. Do not apply ram pressure directly on the rotor surface of front disc brake hub and rotor.
3. With appropriate press stock, press the stud flush against the inner surface of the hub and rotor.

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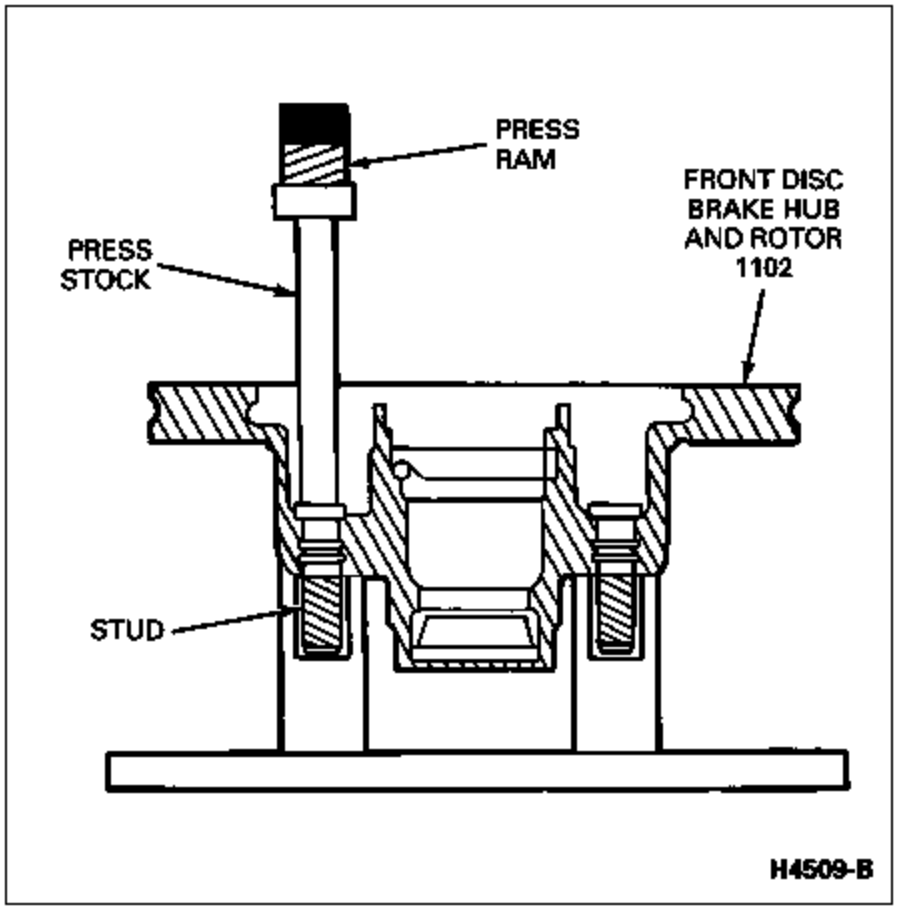

4. Install the front disc brake hub and rotor as described in Section 06-03 .
5. Replace any damaged lug nuts (1012).
6. Install the wheel (1007) and tire as described in Section 04-04 .

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Carrier Disassembly

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Bench Mounted Holding Fixture	T57L-500-B
Spreader Adapters	T90T-4000-A
Companion Flange Holding Tool	T78P-4851-A
Impact Slide Hammer	T50T-100-A
Outer Pinion Bearing Cup Remover	T86T-4628-BH
Driver Handle	T80T-4000-W

1. Remove the axle from the front sub-frame (5C145) as described in Removal and Installation, Axle, Front-Drive in this section.

2. Remove the cover plate and drain lubricant.

Carrier Disassembly

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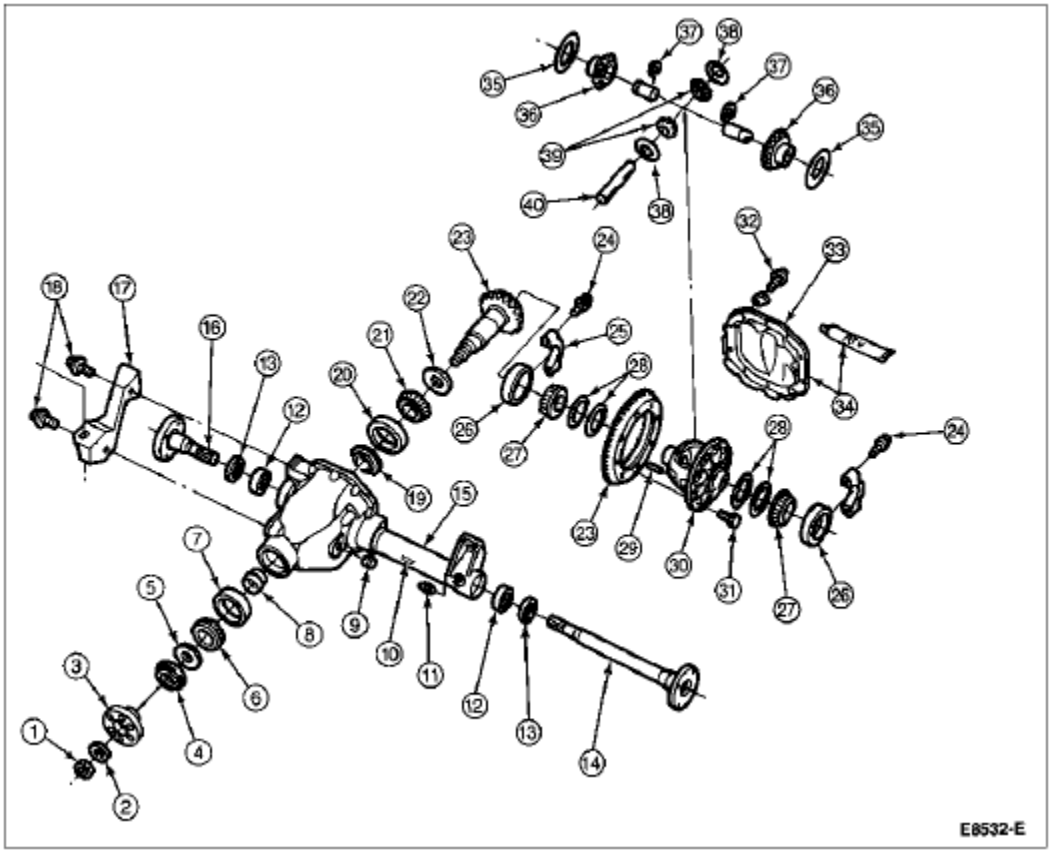

Item	Part Number	Description
1	351126-S	Nut (Pinion)
2	356504-S	Washer (Pinion)
3	4851	Rear Axle Companion Flange
4	4676	Pinion Seal
5	—	Thrust Washer (Outer Pinion Bearings, Part of 3222)
6	4621	Front Pinion Bearing
7	4616	Front Drive Pinion Bearing Cup
8	3A222	Collapsible Spacer (Pinion Bearing Preload)
9	—	Fill Plug (Part of 3010)
10	—	Identification Tag (Part of 3010)
11	7034	Vent
12	3C123	Bearing
13	3254	Axle Shaft Oil Seal
14	3219	Axle Shaft
15	3010	Housing
16	3220	Axle Shaft (Left)
17	—	Mounting Bracket

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		(Part of 3W040)
18	—	Bolt (Mounting Bracket) (Part of 3W040)
19	3070	Baffle
20	4616	Rear Drive Pinion Bearing Cup
21	4621	Rear Pinion Bearing
22	3B067	Pinion Position Shim (Part of 3722)
23	3222	Ring Gear and Drive Pinion
24	—	Differential Bearing Capbolt (Part of Carrier Housing)
25	—	Differential Bearing Cap (Part of Carrier Housing)
26	4222	Differential Bearing Cup
27	4221	Differential Bearing
28	3067	Differential Bearing Preload and Backlash Shims (Part of 3722)
29	—	Roll Pin (Pinion Mate Shaft, Part of 3215)
30	3204	Differential Case
31	350672-S	Ring Gear Bolt
32	—	Cover Bolt (Part of 3R002)
33	—	Cover Plate (Part of 3R002)
34	—	RTV Sealant
35	—	Side Gear Thrust Washer (Part of 3215)
36	—	Side Gear (Part of 3215)
37	3167	Snap Ring (Axle Shaft Retention)
38	4230	Differential Pinion Thrust Washer
39	—	Differential Pinion Mate Gear (Part of 3215)
40	4211	Differential Pinion Shaft

3. Mount the axle in Bench Mounted Holding Fixture T57L-500-B and Spreader Adapters T90T-4000-A and suitable spacers.

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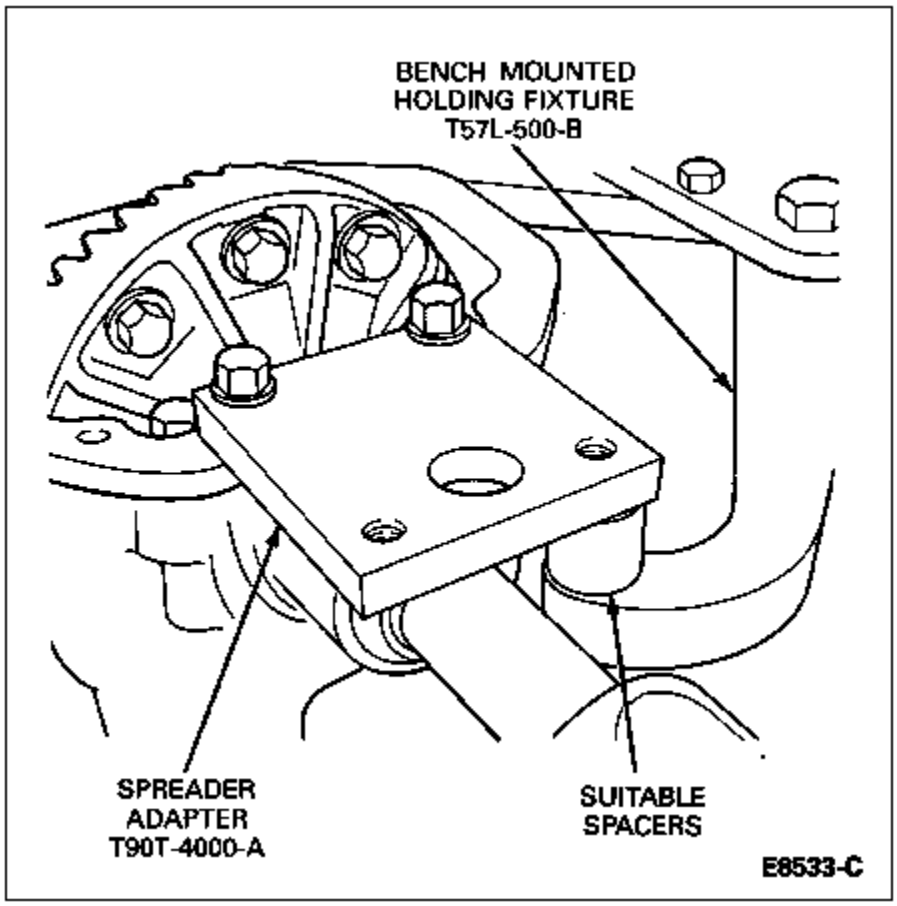

4. Remove old sealant and clean all gasket surfaces.
5. Rotate the shafts so the open side of the snap ring is exposed. Refer to Axle Shafts, Carrier Oil Seal and Bearing Removal in this section.
6. Remove snap rings from the shafts.
7. Remove shafts from the assembly.

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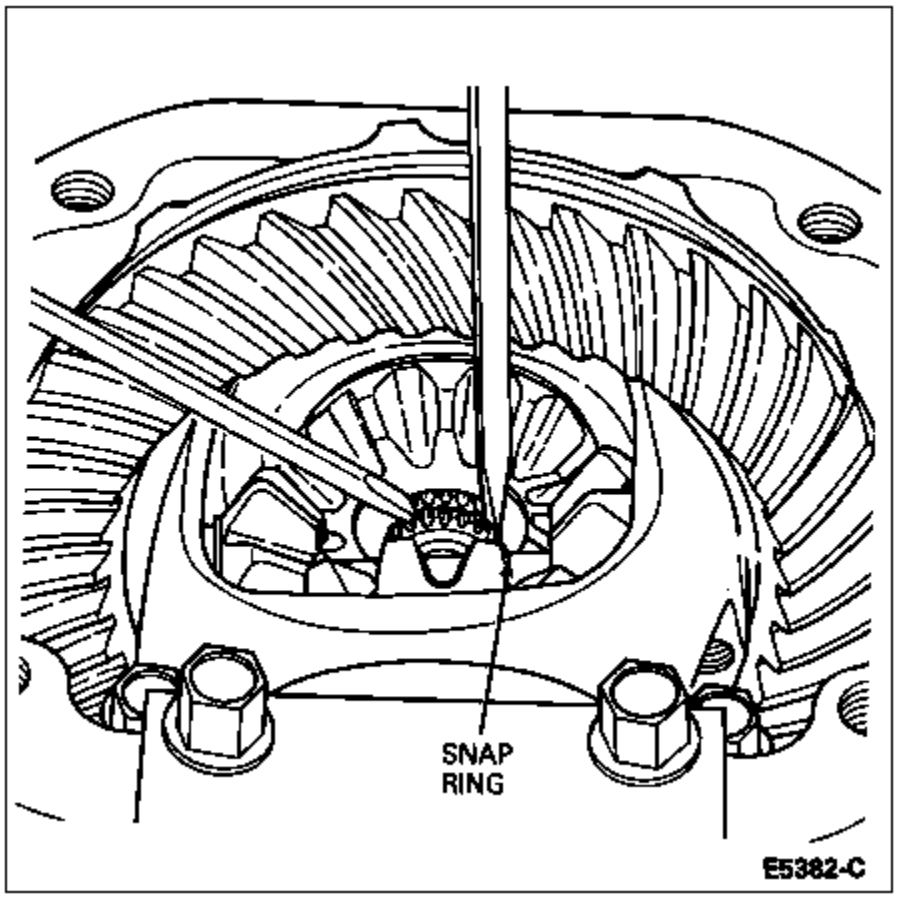

8. Remove the bearing caps.

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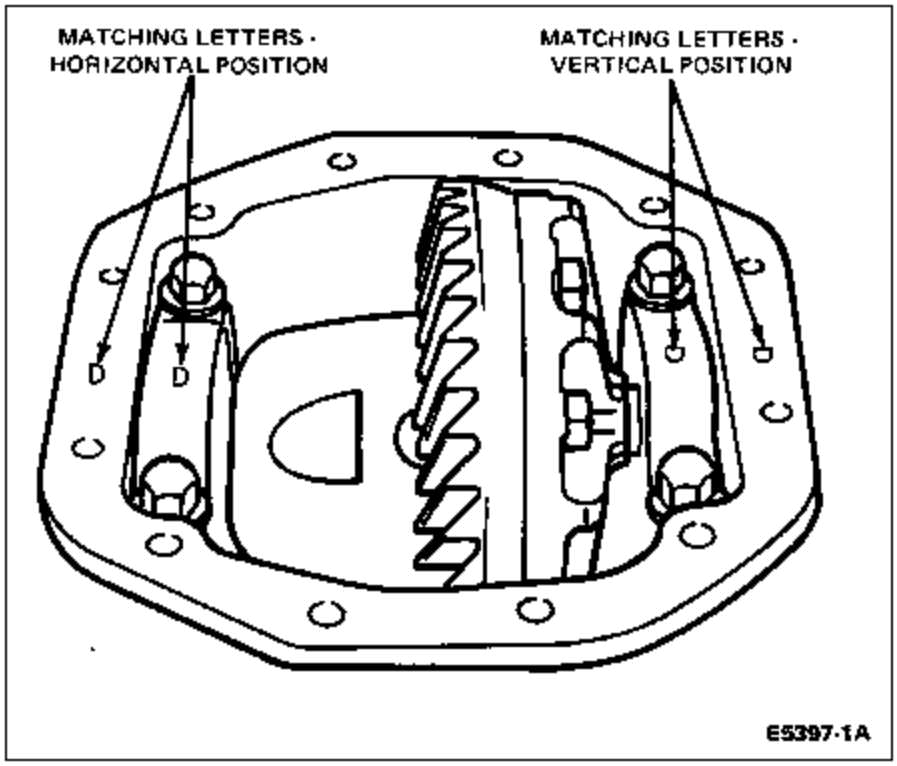

9. **CAUTION: Do not spread the carrier beyond .381mm (.015 inch).**

   CAUTION: Prybars may be necessary to remove the carrier from the case.

   NOTE: Numbers or letters stamped on cap and carrier must be matched and correctly repositioned upon assembly.

   Install Spreader Adapters T90T-4000-A, and spread carrier .381mm (.015 inch). Remove the differential case from the carrier.

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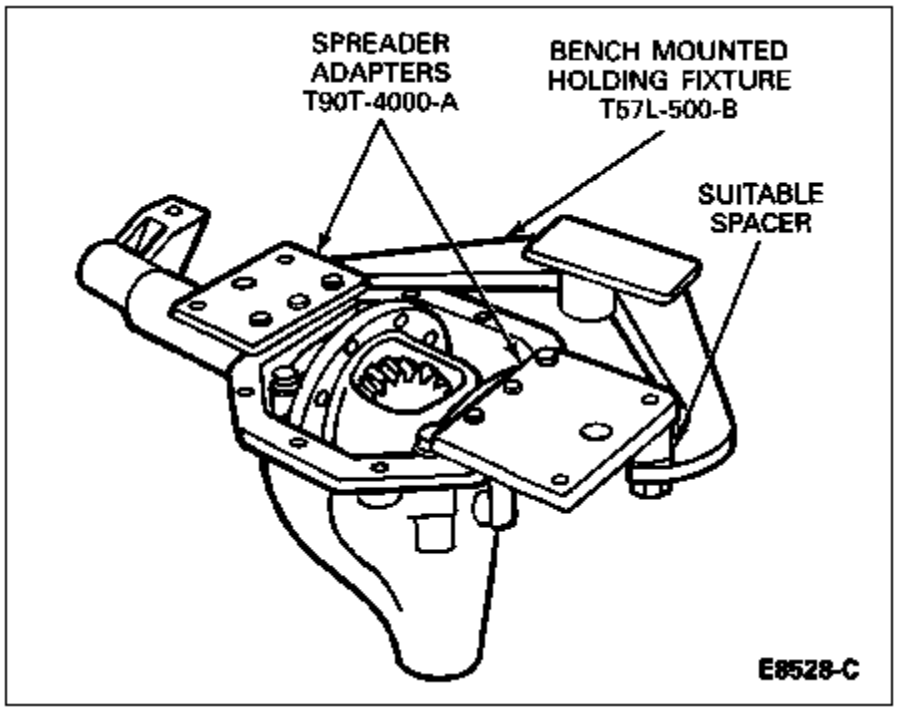

10. Remove and tag differential bearing cups (4222) to indicate from which side of the carrier they were removed.

11. **NOTE: Before removing companion flange, mark flange yoke spline orientation to pinion gear spline to assure same position during reassembly.**

    Rotate holding fixture so pinion is facing up. Hold the rear axle companion flange with Companion Flange Holding Tool T78P-4851-A and remove the pinion nut and washer from the pinion shaft.

12. Remove the rear axle companion flange, using a 2-Jaw Puller D81L-1002-A or equivalent. If the flange shows any signs of wear in the area of seal contact, replace the flange.

13. **CAUTION: Pinion gear teeth have sharp edges. Use care to avoid cuts or injury.**

    Remove the drive pinion by tapping on the drive pinion shaft with a rawhide or plastic hammer. Catch the pinion to prevent damage to the pinion.

14. Remove the pinion seal from the carrier bore by using Bearing Cup Puller T77F-1102-A and Impact Slide Hammer T50T-100-A. Discard seal.

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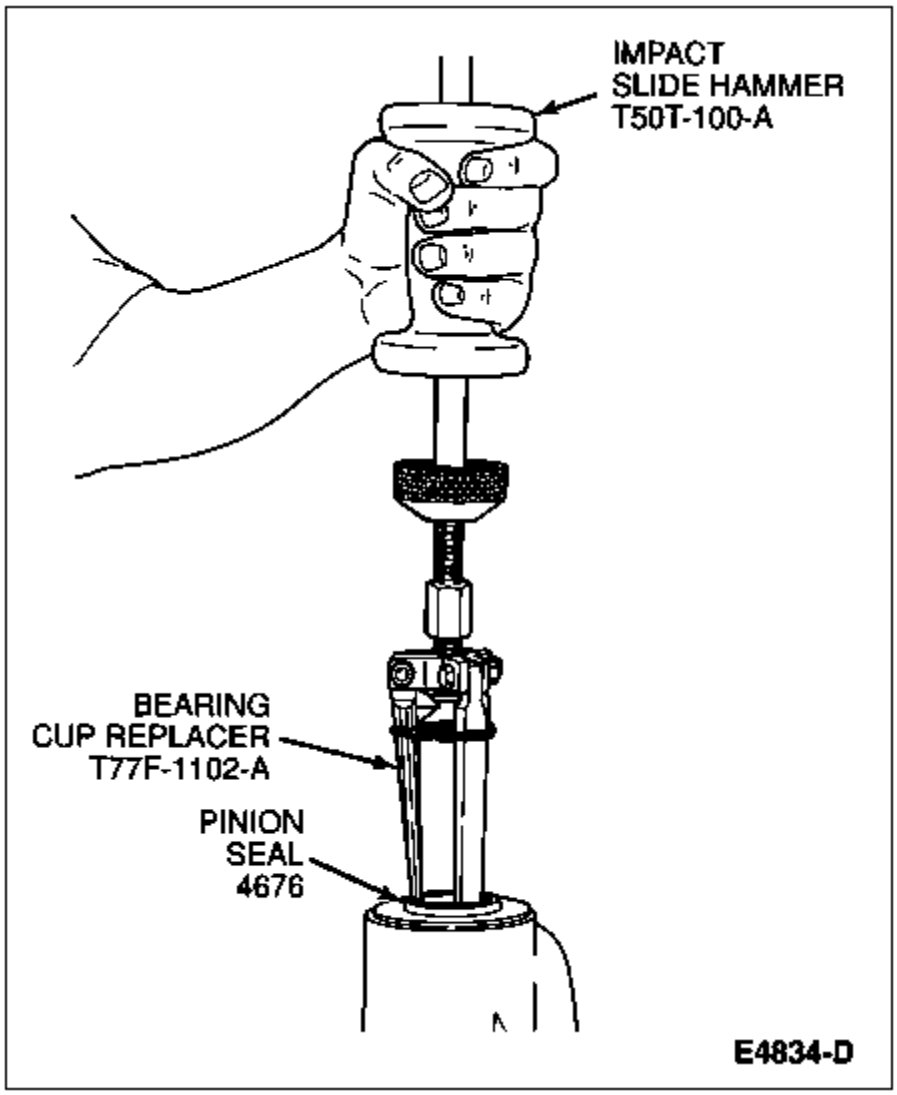

15. Remove the front bearing cone and roller, oil slinger and collapsible spacer and discard.

16. To remove the rear drive pinion bearing cup, pass Outer Pinion Bearing Cup Remover T86T-4628-BH and Driver Handle T80T-4000-W through the front drive pinion bearing cup and against the rear bearing cup. Drive out the rear bearing cup.

17. **NOTE: An oil baffle is located between the rear bearing cup and carrier bore. If the baffle is damaged during cup removal, replace with a new one.**

    NOTE: Baffles do not have selective thicknesses.

    Remove the oil baffle from the rear bearing cup bore.

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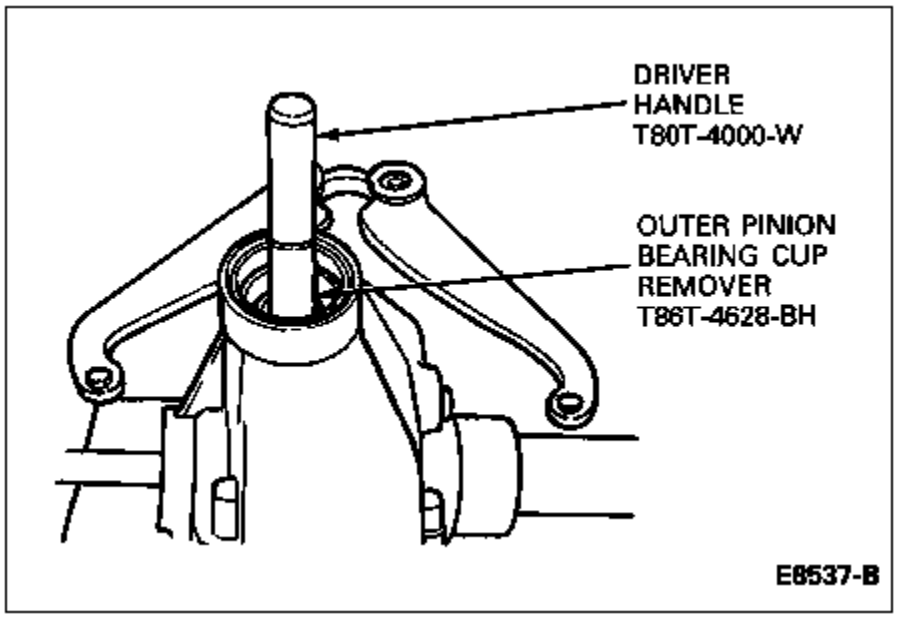
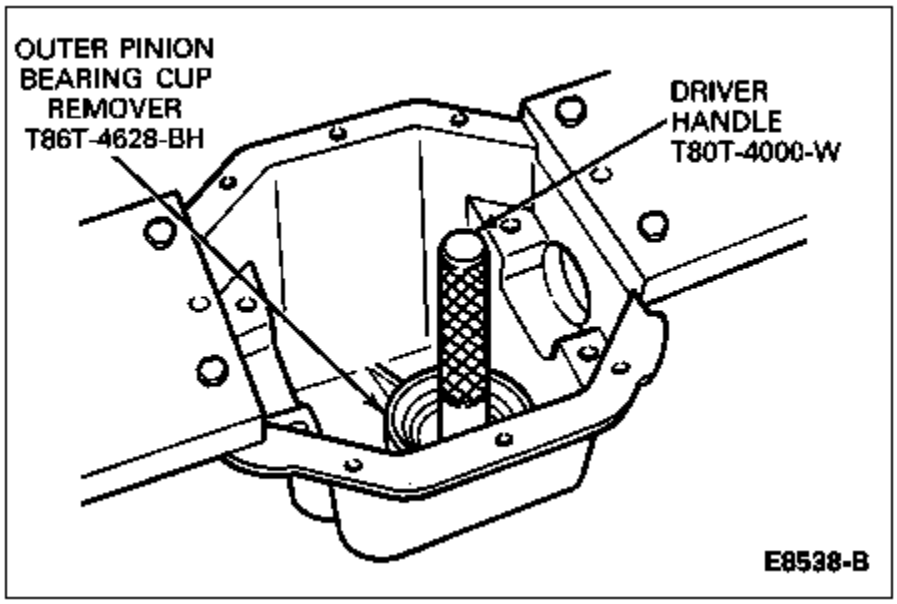


18. Turn the nose of the carrier down and remove the drive pinion bearing cup. Pass the Outer Pinion Bearing Cup Remover T86T-4628-BH and Driver Handle T80T-4000-W through the rear bearing bore and against the front bearing cup as shown. Drive the front pinion bearing cup out with a hammer.



19. Remove the differential case bearings and shims from the case. Place Step Plate D80L-630-3 or equivalent under bearing to protect the bearing. Install Pinion and Carrier Bearing Puller D81L-4220-A or equivalent and remove the bearing as shown. Turn the case over to remove the other bearing.

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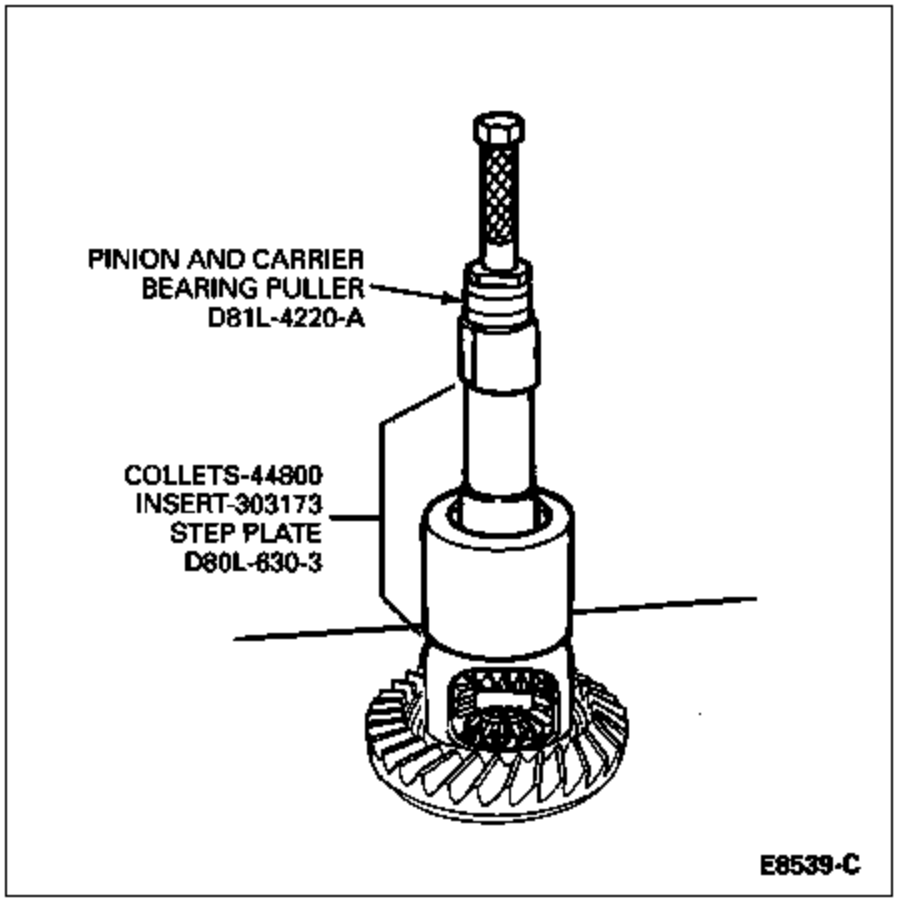

20. Wire the shims, bearing cup and cone together and identify from which side of the differential case they were removed. If any shims are damaged discard and replace at assembly.

21. Place a few shop towels over the vise to prevent the ring gear teeth from being nicked, after removal from the case.

22. Place the case in a vise. Remove the ring gear bolts and discard. Tap the ring gear with a rawhide hammer to free it from the case.

23. **NOTE: If side gears and pinion mate gears need to be replaced, refer to Disassembly and Assembly, Differential Case in this section.**

    NOTE: Whenever removing the ring gear bolts, discard the bolts and replace with new bolts upon assembly.

    Remove the case and ring gear from the vise.

24. **NOTE: For controlling drive pinion depth, an oil slinger with a selected thickness is located between the inner differential pinion bearing and drive pinion head. Be careful not to damage the oil slinger when removing the bearing. If the oil slinger is damaged, measure the thickness and replace with an oil slinger of equal thickness.**

    Remove the inner pinion bearing cone and oil slinger/pinion position shim from the drive pinion with Pinion and Carrier Bearing Puller D81L-4220-A or equivalent.

25. Inspect all parts for damage and replace as required.

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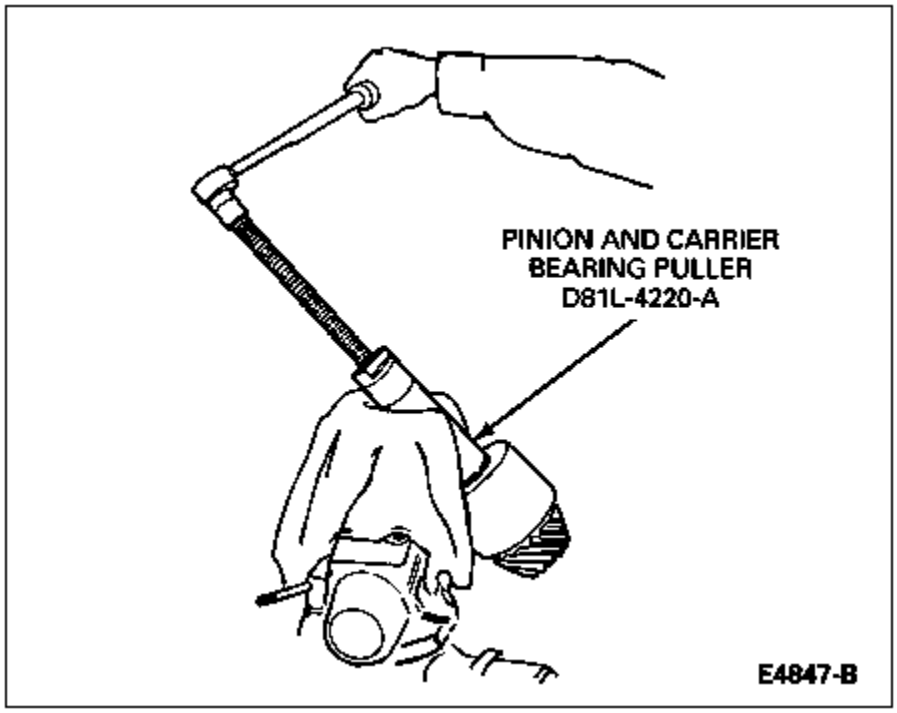

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Total Differential Case End Play

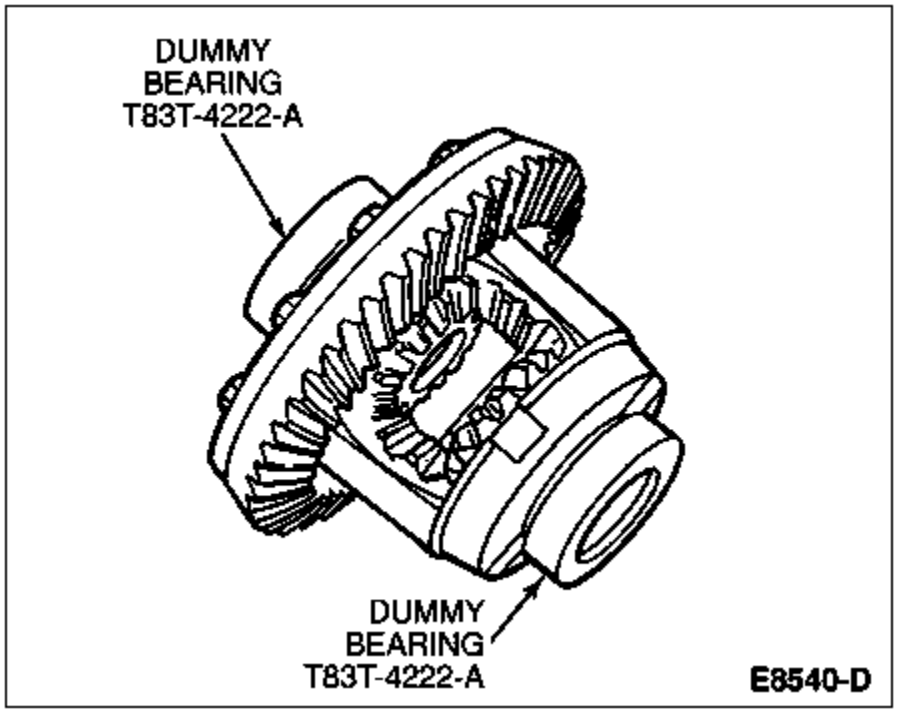
SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Dummy Bearings	T83T-4222-A

1. Attach the ring gear to the differential case using new bolts. Tighten bolts alternately and evenly to 61-88 Nm (45-65 lb-ft).

2. **NOTE: Remove all burrs and nicks from hubs so master bearings rotate freely.**

   Clean the trunnion on the differential and install Dummy Bearings T83T-4222-A onto the differential case.



3. Place the differential case into carrier (without pinion). The differential case should move freely in the carrier.

4. Mount Dial Indicator with Bracketry TOOL-4201-C or equivalent against the differential case flange. Locate the tip of the indicator on the flat surface of one ring gear bolt.

5. **NOTE: Dial indicator should have a minimum travel capability of 5.08mm (0.200 inch).**

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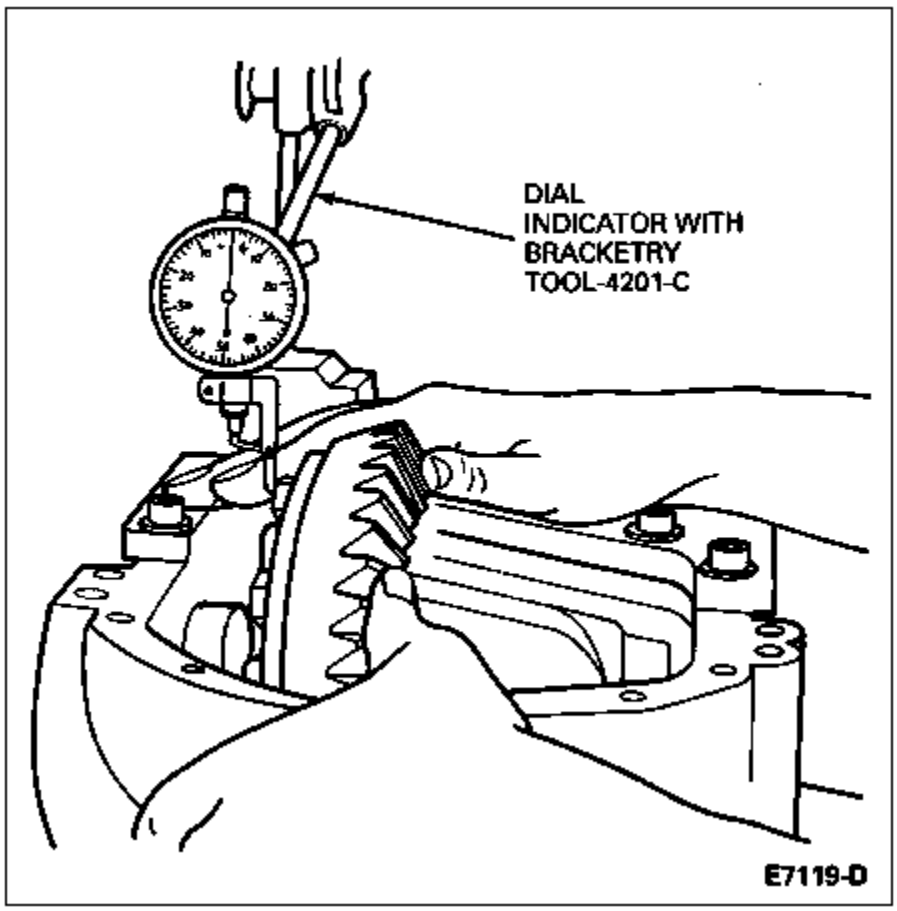
Force the differential case toward the dial indicator as far as possible and zero the dial indicator with force still applied.



6. Force the differential case away from the dial indicator as far as it will go. Repeat this procedure until the readings repeat.

7. Record the dial indicator reading. This reading indicates the amount of shims needed behind the differential side bearings to take up total clearance between the differential bearing (4221) and case. Enter this reading into the ring gear backlash and differential bearing preload worksheet as Measurement "A."

8. Remove the differential case from the carrier. Do not remove the dummy bearings at this time.

Worksheet for Calculating Ring Gear Backlash and Differential Bearing Preload Shims

Measure the width of the master differential bearings (T83T-4222-A) with a micrometer. If they measure 18-18.05mm (.710-.711 inch), follow the procedure and example that makes adjustment to the measurements obtained with the tools prior to making the final calculations for proper shim selection. This is shown in Example "A."

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If the master bearings measure 18.11-18.16mm (.713-.715 inch), adjustments do not have to be made. Follow procedure and example as shown in example "B."

Example "A"

Steps:

1. Total amount of space measured without gearset assembled into carrier (Housing)
    - Measurement A **2.5mm (.098 inch)**
2. Total amount of space measured with gearset assembled into carrier (Housing)
    - Measurement B **1.24mm (.049 inch)**

Adjustments:

1. Measurement A less 20mm (.008 inch) = C **2.28mm (.090 inch)**
2. Measurement B less .10mm (.004 inch) = D **1.14mm (.045 inch)**
3. C - D = E **1.14mm (.045 inch)**

After measurements and calculations have been made, assemble the shim packs using the figures determined in D and E, and adjusting the pack as described.

Ring Gear Side:

D - .13mm (.005 inch) = **1.01mm (.040 inch)** Total shim pack thickness.

Opposite Side:

E + .25mm (.010 inch) = **1.4mm (.055 inch)** Total shim pack thickness.

Assemble shim packs onto differential case hubs, and assemble new differential bearing cones. Continue axle assembly. Refer to the procedure in this section.

Example "B"

Steps:

1. Total amount of space measured without gearset assembled into carrier (Housing)
    - Measurement A **2.28mm (.090 inch)**
2. Total amount of space measured with gearset assembled into carrier (Housing)
    - Measurement B **1.14mm (. 045 inch)**
3. Measurement A minus Measurement B =
    - Measurement C **1.14mm (.045 inch)**

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After the measurements and calculations have been made, assemble the shim packs using the figures determined in A, B, & C, and adjusting the pack as described below.

Ring Gear Side:

B - .13mm (.005 inch) = **1.01mm (.040 inch)** Total shim pack thickness.

Opposite Side:

C + .25mm (.010 inch) = **1.4mm (.055 inch)** Total shim pack thickness.

Assemble shim packs onto differential case hubs, and assemble new differential bearing cones. Continue the axle assembly. Refer to the procedure in this section.

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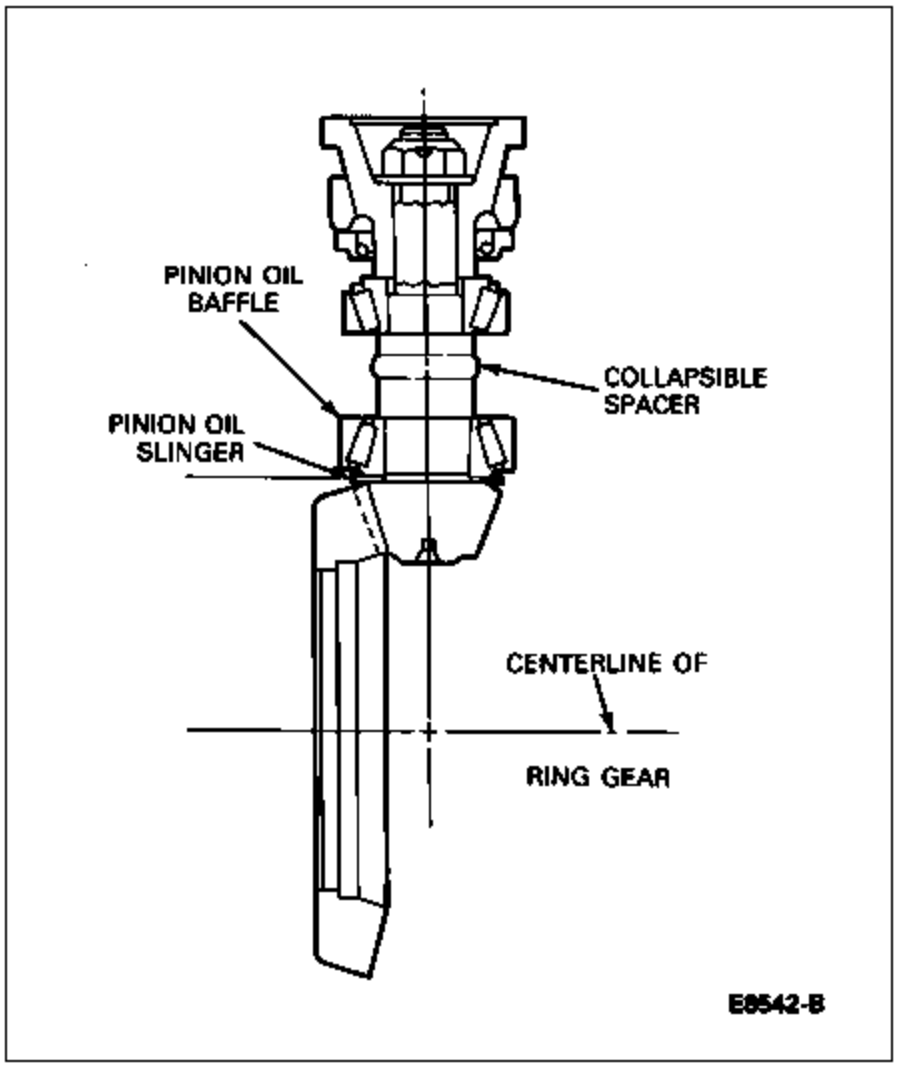
Drive Pinion Installation

Two separate adjustments affect contact between the ring gear and drive pinion: pinion depth and pinion and ring gear backlash.

Pinion depth is controlled by an oil slinger (with a selective thickness) located between drive pinion head and rear pinion bearing and an oil baffle located between the rear drive pinion bearing cup and carrier bore.



Pinion and ring gear backlash is controlled by preload shims located between the differential bearings (4221) and the differential case. This adjustment is described in Disassembly and Assembly, Differential Case to Carrier in this section.

In the pinion depth adjustment, the size of the selected thickness oil slinger and the oil baffle controls the pinion position. Increasing the oil slinger thickness moves the pinion toward the ring gear. Decreasing the oil slinger thickness moves the pinion away from the ring gear.

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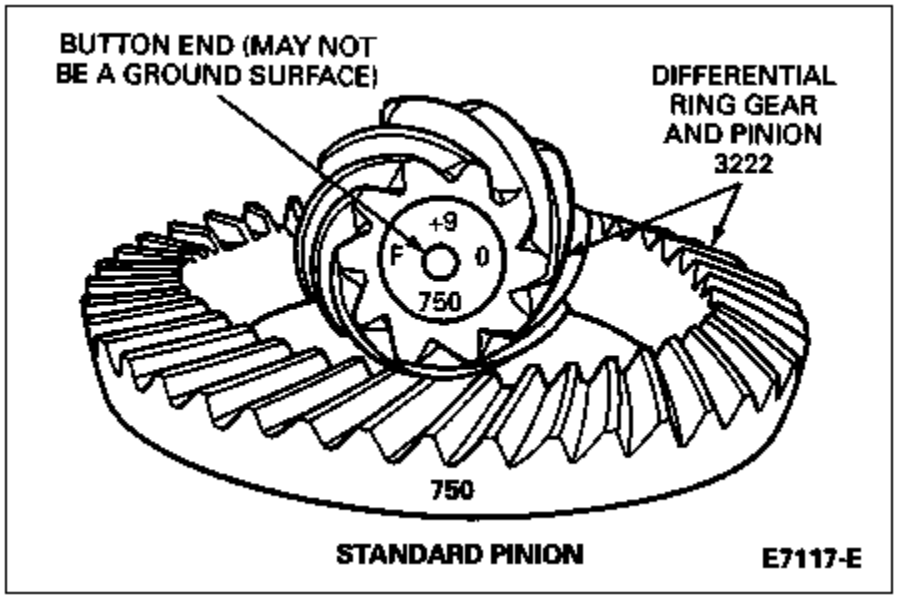
Ring gears and pinions are supplied in matched sets with standard or metric markings.



On the end of each drive pinion is marked a plus figure (+), a minus figure (-) or a zero (0). These figures best indicate the position for each gearset. The position is determined by the thickness of the baffle between the rear pinion bearing cup and carrier bearing bore and the thickness of the selective oil slinger between the pinion head and rear pinion bearing. Any pinion depth change is made by changing the thickness of the selective oil slinger. Refer to the charts.

METRIC

	New Pinion Marking (Metric)								
Old Pinion Marking	**-10**	**-8**	**-5**	**-3**	**0**	**+3**	**+5**	**+8**	**+10**
+10	+.20	+.18	+.15	+.13	+.10	+.08	+.05	+.03	0
+8	+.18	+15	+.13	+.10	+.08	+.05	+.03	0	-.03
+5	+.15	+.13	+.10	+.08	+05	+.03	0	-.03	-.05
+3	+.13	+.10	+.08	+.05	+.03	0	-.03	-.05	-.08
0	+.10	+.08	+.05	+.03	0	-.03	-.05	-.08	-.10
-3	+.08	+.05	+.03	0	-.03	-.05	-.08	-.10	-.13
-5	+.05	+.03	0	-.03	-.05	-.08	-.10	-.13	-.15
-8	+.03	0	-.03	-.05	-.08	-.10	-.13	-.15	-.18
-10	0	-.03	-.05	-.08	-.10	-.13	-.15	-.18	-.20

STANDARD

	New Pinion Marking (English)								
Old Pinion Marking	**-4**	**-3**	**-2**	**-1**	**0**	**+1**	**+2**	**+3**	**+4**
+4	+0.008	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0
+3	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001
+2	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002

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+1	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003
0	+0.004	+0.003	+0.00 2	+0.001	0	-0.001	-0.002	-0.003	-0.004
-1	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005
-2	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006
-3	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006	-0.007
-4	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006	-0.007	-0.008

If the original gearset is being reused, measure the original baffle and selective slinger. If either the baffle or selective slinger needs to be replaced, use a new one of the exact same thickness.

If a new gearset is used, notice the plus (+), minus (-), or zero (0) etching on both the original and the new drive pinion and adjust the thickness of the new selective oil slinger according to the charts.

For example, if the original pinion is etched +4 (m+ 10) and the new pinion is etched "0," then the new selective slinger is .10mm (0.004 inch) thicker than the original selective oil slinger. If the original pinion is etched "0" and the new pinion is etched + 3 (m+8), the new selective slinger should be 0.08mm (0.003 inch) thinner than the original slinger.

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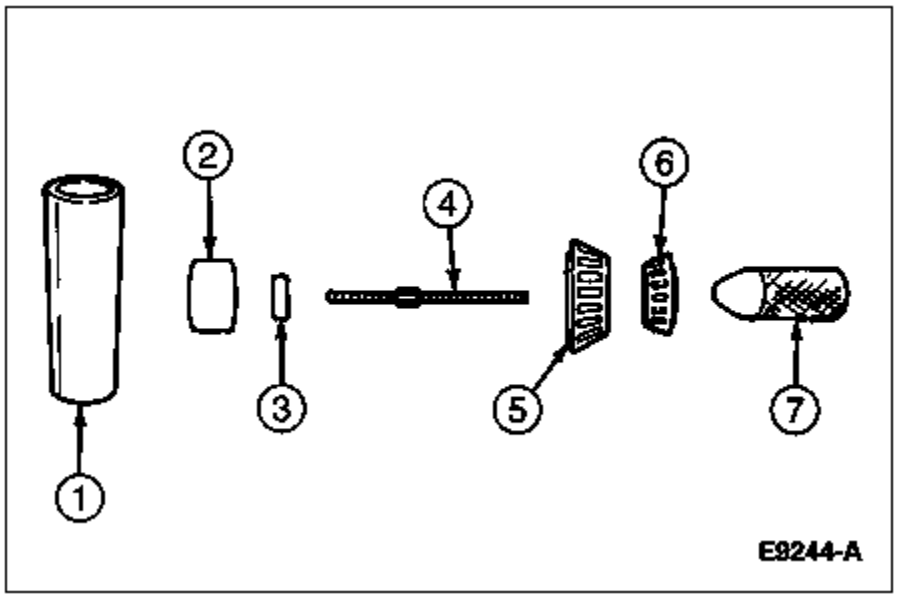
Depth Gauge Check

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Truck Pinion Depth Gauge — Dana Only	T80T-4020-A
Gauge Disc	T90T-4020-A
Pinion Bearing Cups Replacer, Inner and Outer	T71P-4616-A
Spacer	T75T-1176-A
Pinion Bearing Cone Replacer	T57L-4621-B
Axle Bearing/Seal Plate	T75L-1165-B

1. **NOTE: If any of the gauge surfaces become nicked, the high spots must be removed with a medium india oilstone to make sure there will be no erroneous readings.**

   Refer to the correct tools for the particular axles.



Item	Part Number	Description
1	T76P-4020-A7	Gauge Tube
2	T90T-4020-A	Gauge Disc
3	T76P-4020-A1	Aligning Adapter
4	T76P-4020-A9	Screw

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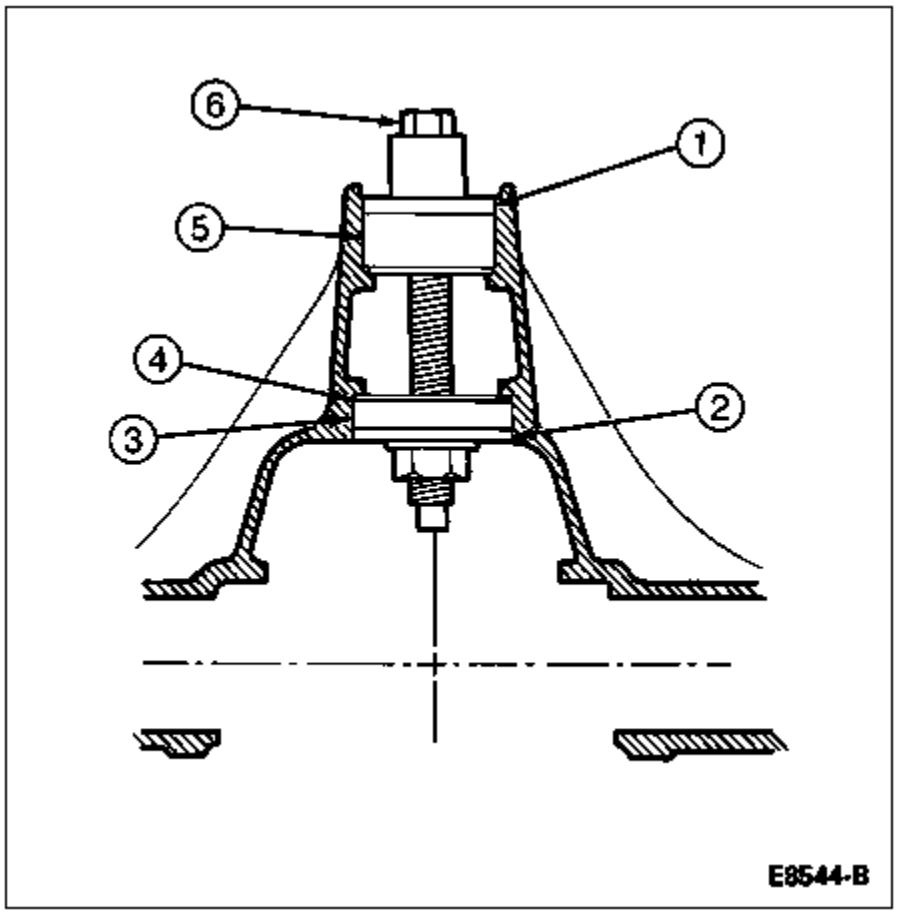
5	4621	Front Pinion Bearing
6	4621	Rear Pinion Bearing
7	T76P-4020-A11	Handle

2. Install the oil baffle in the rear bearing cup bore in the carrier.

3. Install front and rear drive pinion bearing cup with forcing screw and Pinion Bearing Cups Replacer T71P-4616-A. Also use Spacer from T75T-1176-A.



Item	Part Number	Description
1	T71P-4616-A	Pinion Bearing Cups Replacer (Front)
2	T71P-4616-A	Pinion Bearing Cups Replacer (Rear)
3	4621	Rear Pinion Bearing
4	3B067	Oil Baffle
5	4621	Front Pinion Bearing
6	T75T-1176-A	Spacer

4. Place a new rear pinion bearing over the proper aligning adapter and insert into the pinion bearing

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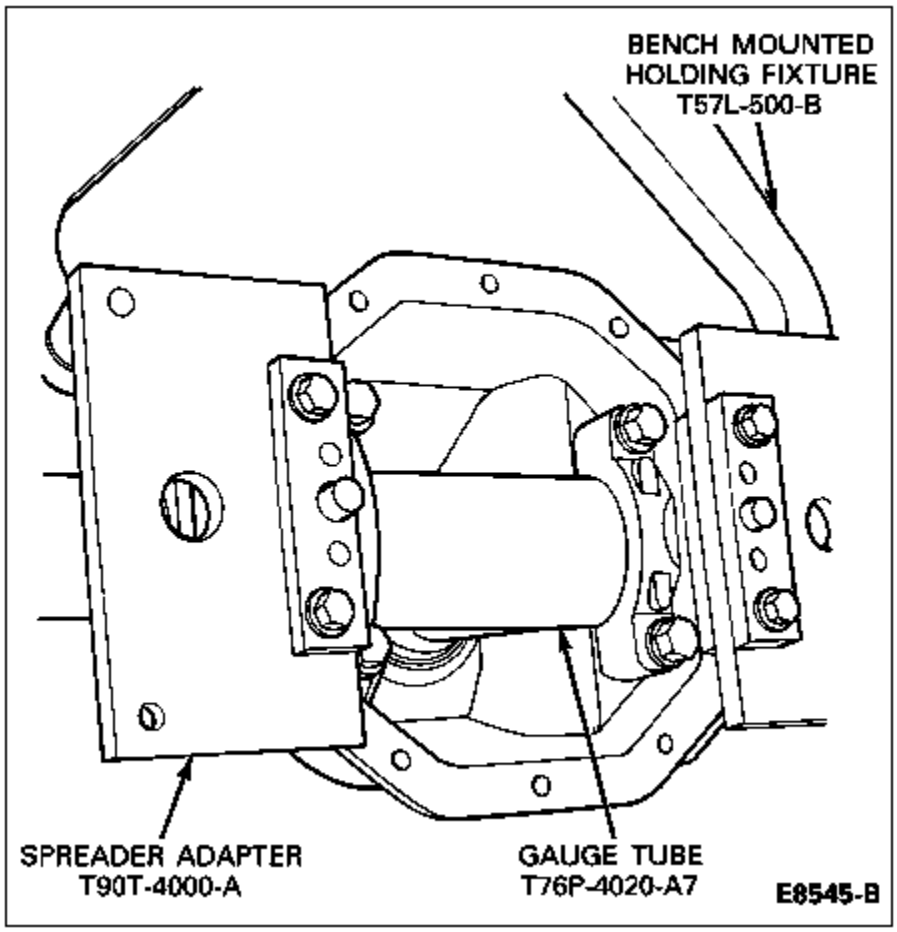
retainer.

5. **NOTE: The 3/8-inch square drive in the handle is to be used for obtaining the proper pinion bearing preload.**

   Place the front pinion bearing into the drive pinion bearing cup in the carrier and assemble the handle onto the screw and hand tighten.

6. Center the proper gauge tube into the differential bearing bore. Install the bearing caps and tighten to proper specifications. To preload the bearing, tighten the handle to 2.3-4.5 Nm (20-40 lb-in).



7. **NOTE: The feeler gauge fit between the gauge tube and the gauge block should have a slight drag-type feeling.**

   Using a feeler gauge tool, select the thickest feeler shim that will enter between the gauge tube and the gauge block. Insert the feeler gauge directly along the gauge block to make sure a correct reading can be made.

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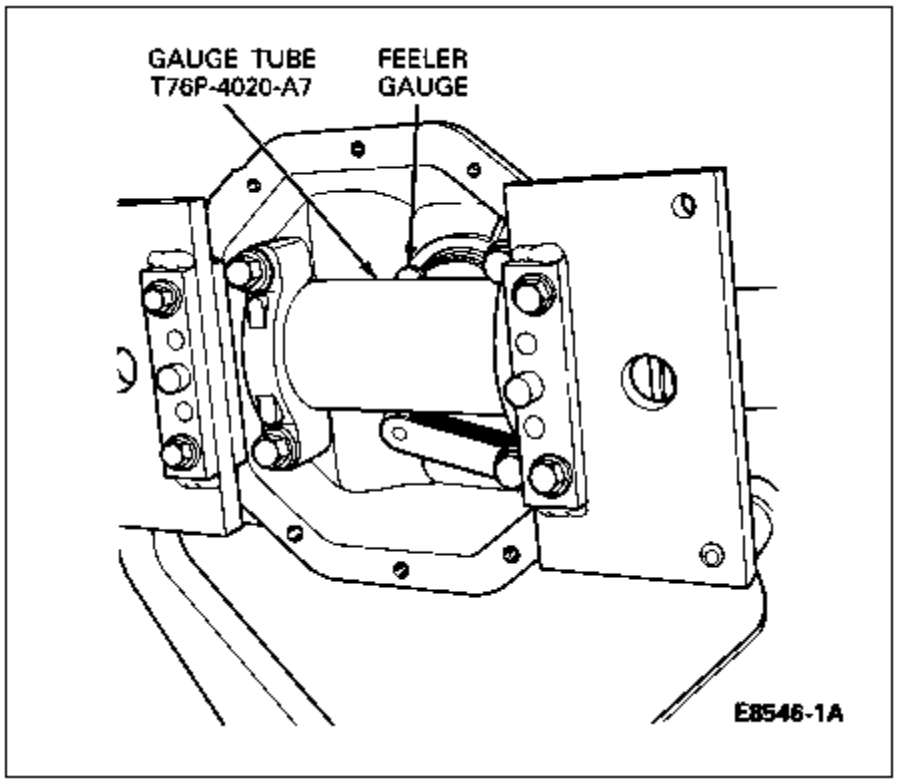

8. **NOTE: If the service pinion gear is marked with a plus (+) reading, this amount must be subtracted from the thickness dimension obtained. If the service pinion gear is marked with a minus (-) reading, this amount must be added to the thickness dimension obtained. In addition, you must use the same new rear pinion bearing that was used in the previous measuring steps.**

   After the correct feeler gauge feel is obtained, check the reading. This is the required oil slinger thickness, provided the service pinion gear has no markings.

9. After following these procedures, continue to build the remaining components with proper pinion and differential bearing preload torques and ring gear backlash.

10. Measure oil slinger with a micrometer to verify the slinger size. Place the oil slinger on the pinion and press on the bearing using Pinion Bearing Cone Replacer T57L-4621-B and Axle Bearing/Seal Plate T75L-1165-B.

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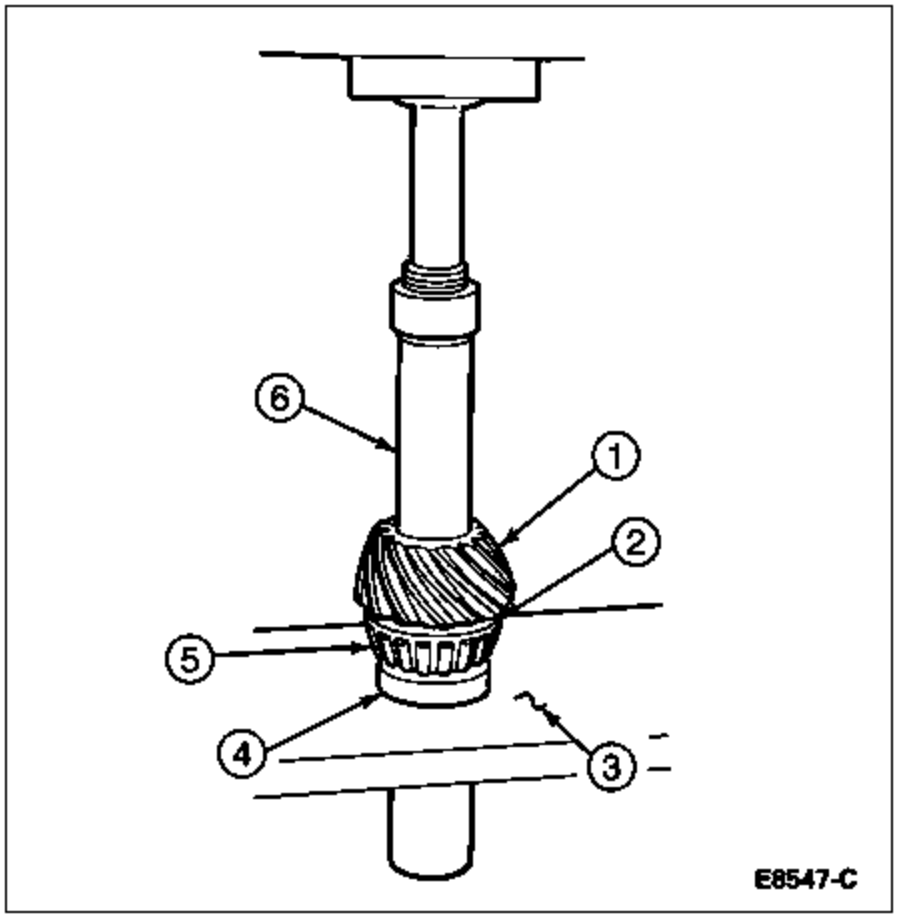

Item	Part Number	Description
1	3222	Drive Pinion
2	3B067	Oil Slinger
3	T75L-1165-B	Axle Bearing/Seal Plate
4	T75L-4621-B	Pinion Bearing Cone Replacer
5	4621	Rear Bearing Cone and Roller
6	—	Press

Drive Pinion Preload Check

1. **CAUTION: Never reuse a collapsible spacer. Upon removal, always discard the spacer and install new spacer for assembly.**

   Install a new collapsible spacer and front pinion bearing, and thrust washer into housing.

2. Coat the oil seal with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX or equivalent MERCON® fluid. Install the pinion seal with suitable oil seal replacer.

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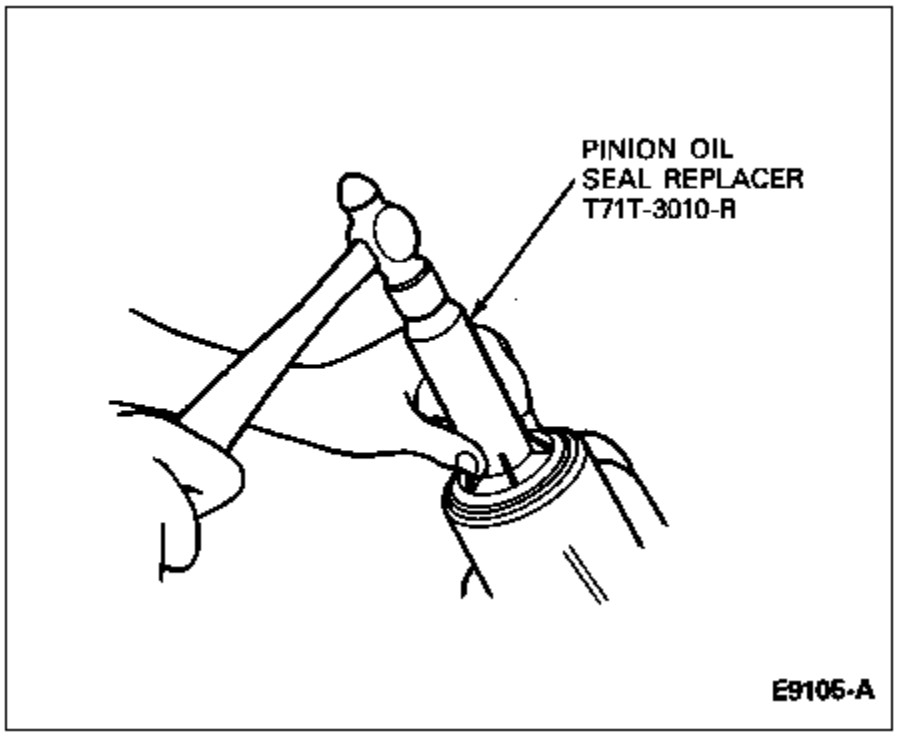

3. After installation, make sure the garter spring didn't pop out.
    - If the garter spring pops out, remove and replace the pinion seal.

Pinion Installation

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Companion Flange Replacer	T83T-4851-A

1. **NOTE: Before installing rear axle companion flange, align marks on flange spline and pinion gear spline to assure original position.**

   Install the rear axle companion flange with Companion Flange Replacer T83T-4851-A. Install washer and new nut and tighten nut to 190-373 Nm (140-275 lb-ft).

2. **CAUTION: Never tighten the pinion nut more than 373 Nm (275 lb-ft) or the collapsible spacer will be compressed too far.**

   Place an inch-pound torque wrench on the pinion nut. Check the pinion rotational torque. Rotational torque should be 1.7-4.0 Nm (15-35 lb-in). If the reading is less than 15 lb-in, tighten the pinion nut in small increments until a rotational torque of 1.7-4.0 Nm (15-35 lb-in) is reached.

3. If the reading is more than 1.7-4.0 Nm (15-35 lb-in), the collapsible spacer has been compressed too

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far. The spacer must be removed and a new collapsible spacer installed.

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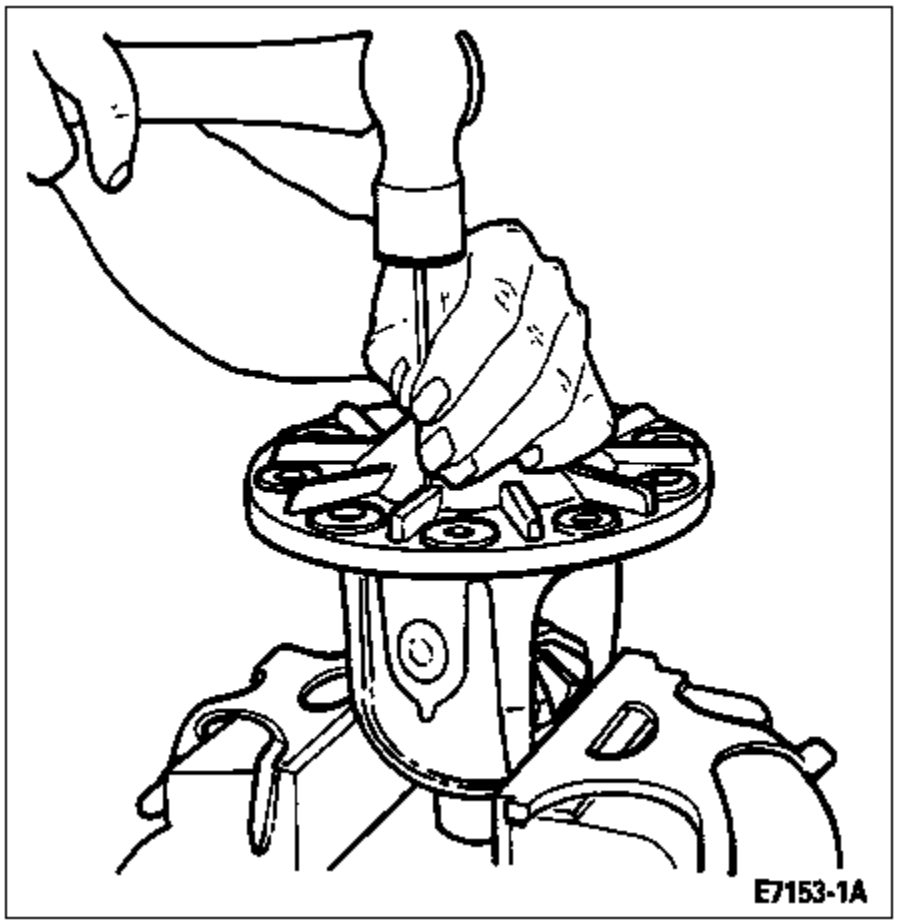
Differential Case

Disassembly

1. Place differential case in vise and drive out lock pin that retains the differential pinion shaft (4211) to case.



2. Remove shaft with a drift.

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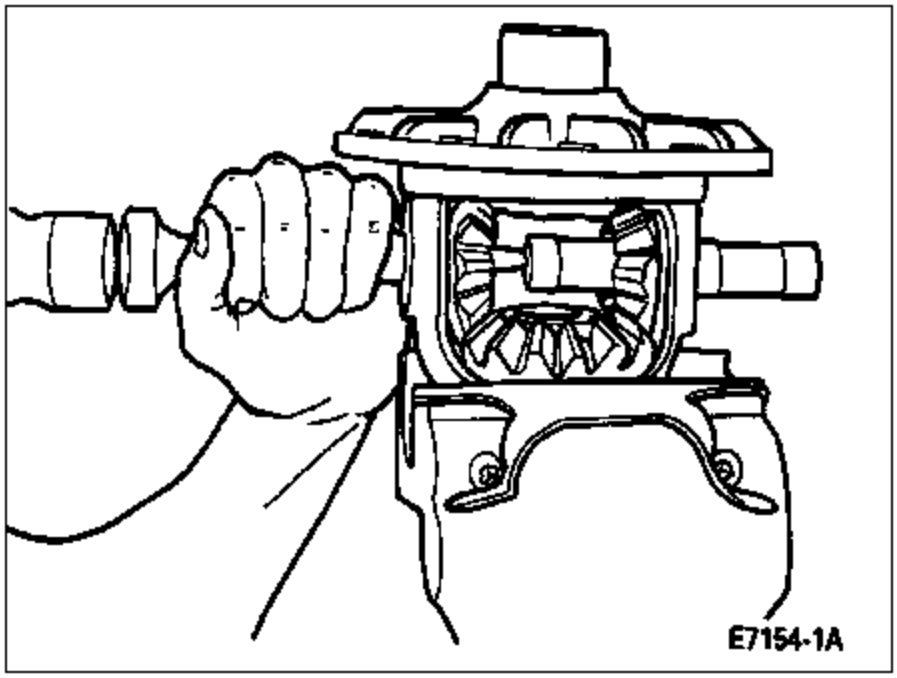

3. Rotate the pinion mate gears and side gears until the pinion mate gears turn to the windows of the case.

4. Remove pinion mate gears and differential pinion thrust washers (4230).

5. Lift side gears and thrust washers from case.

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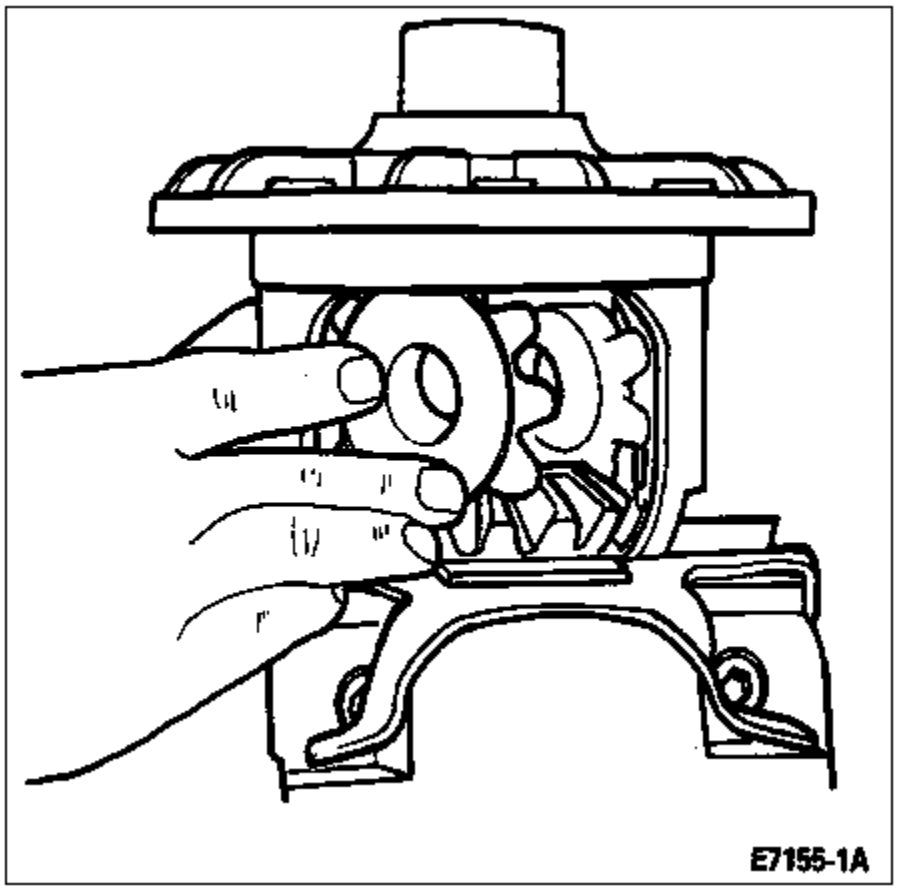

Assembly

1. Inspect case parts for signs of wear. If wear exists on all parts, replace the entire differential case. If one gear shows signs of wear, replace both pinion mate and side gears as a set.

2. Apply Premium Long-Life Grease XG-1-C or -K or equivalent meeting Ford specification ESW-M1C75-B to side gear thrust washers, hub and thrust face of side gears. Lubricate pinion mate gears and differential pinion thrust washer with Premium Long-Life Grease XG-1-C or -K or equivalent meeting Ford specification ESA-M1C75-B.

3. Hold side gears in place in case with one hand and install pinion mate gears and differential pinion thrust washers with the other hand.

4. Rotate the side gears and pinion mate gears until the holes in the differential pinion thrust washers and pinion mate gears line up exactly with the holes in the case.

5. Insert the differential pinion shaft in the case. Make sure the lock pin hole in the shaft lines up with the lock pin holes in the case.

6. Insert lock pin. Peen some metal of the case over the pin to lock it in place.

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Differential Case Assembly to Carrier

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Differential Bearing Replacer	T83T-4221-A
Driver Handle	T80T-4000-W
Spreader Adapters	T90T-4000-A

Pinion and Ring Gear Backlash

1. **NOTE: The following measurements are to be made only after the pinion is installed.**

   Assemble ring gear to differential case. Use new bolts and tighten alternately and evenly to 61-88 Nm (45-65 lb-ft).

2. Position differential case into carrier. Master bearing should still be installed.

3. Mount dial indicator onto housing.

4. Force the differential case away from the drive pinion gear, until it is completely seated against the cross bore face of the carrier.

5. Position dial indicator so the indicator tip rests on a differential case bolt. Zero the dial indicator.

6. Force ring gear against pinion gear. Rock ring gear slightly to make sure gear teeth are in contact.

7. Force ring gear away from drive pinion gear, making sure the dial indicator returns to zero.

8. Repeat this procedure until the dial indicator reading is the same. Record this reading on the Worksheet for Calculating Ring Gear Backlash and Differential Bearing Preload as Measurement B.

9. Remove the differential case from the carrier and remove the master bearings from the case.

10. Refer to the Worksheet and make the necessary calculations for proper shim selection.

11. As determined in Steps 5 through 7, place the required amount of shims in the ring gear hub of the differential case. For example, if the reading in Step 4 was 1.14mm (0.045 inch) minus 0.13mm (0.005 inch), place 1.02mm (0.040 inch) amount of shims on the hub of the ring gear side of the differential case.

12. Install the differential bearing (4221) on the hub of the ring gear side of the differential case. Drive the bearing onto the hub using Differential Bearing Replacer T83T-4221-A and Driver Handle T80T-4000-W.

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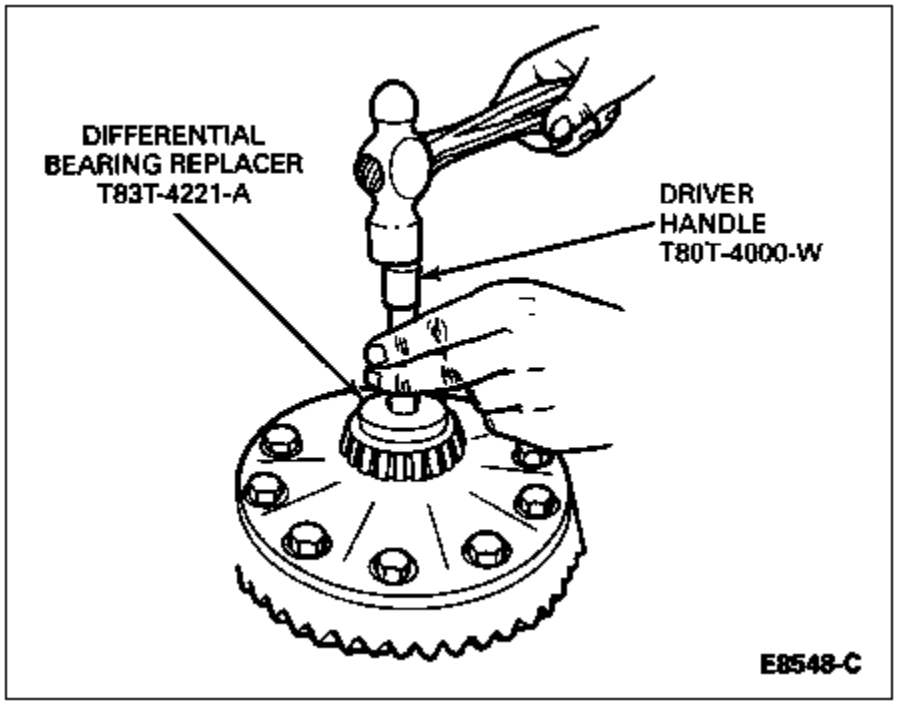
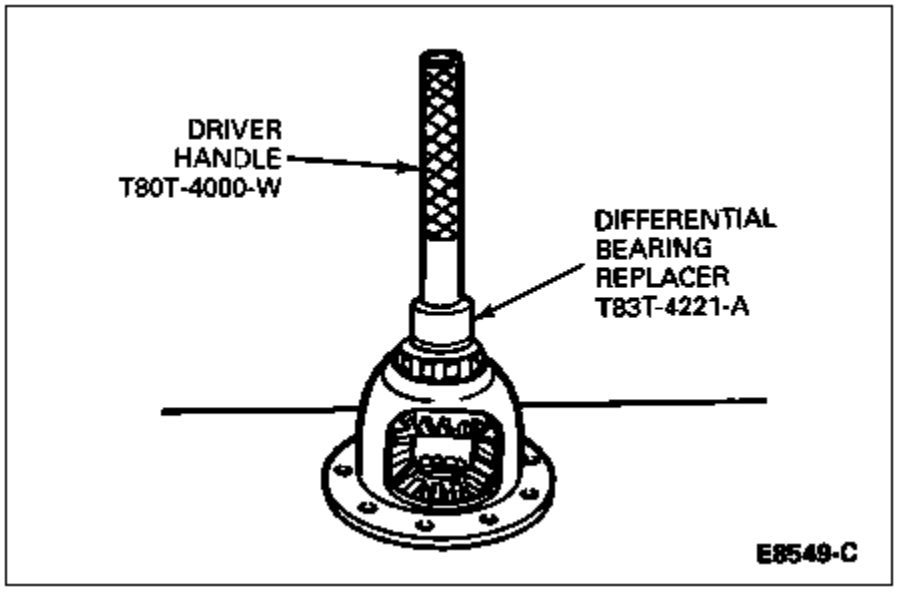


13. Place the required amount of shims on the hub of the drive pinion side of the differential case.

14. Install the differential bearing on the hub of the drive pinion side of the differential case.

    - Place Step Plate D80L-630-3 or equivalent on the ring gear side bearing to protect the bearing.

15. Drive the bearing onto the hub of the drive pinion side of the differential case using Differential Bearing Replacer T83T-4221-A and Driver Handle T80T-4000-W.



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16. Install the differential bearing cups on the bearing cones.

17. **NOTE: Do not spread carrier beyond 0.381mm (.015 inch).**

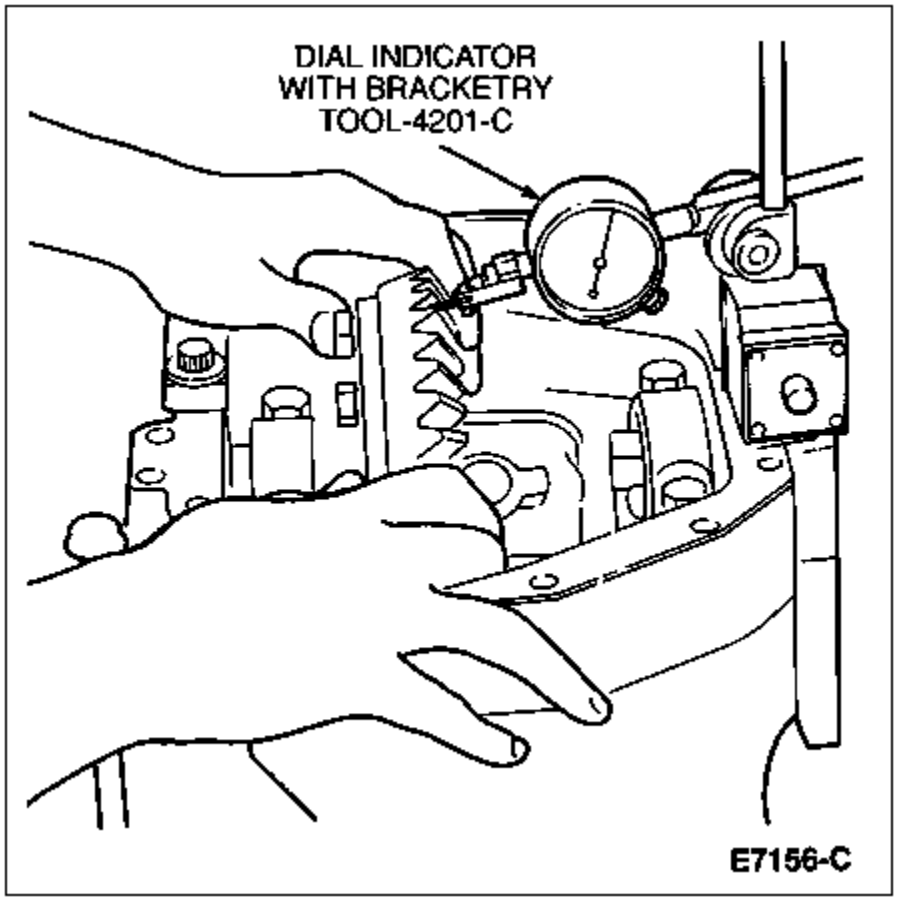
    NOTE: Be careful not to nick the teeth of the ring gear or pinion

    Spread the carrier 0.381mm (.015 inch) using Spreader Adapter T90T-4000-A and install the differential case in the carrier. If necessary, use a rawhide or plastic hammer to seat the differential case into the carrier housing cross bore.

18. Remove the spreader and dial indicator from the carrier housing.

19. Install bearing caps and bolts. Make sure the letters or numbers stamped on the caps correspond in both position and direction with the letters or numbers stamped into the carrier. Tighten bolts to 41-61 Nm (30-45 lb-ft).

20. Install the dial indicator on the case as shown. Check ring gear and pinion backlash at three equally spaced points on the ring gear. Backlash should be to specification. If backlash is high, the ring gear must be moved closer to the pinion, by moving differential bearing shims to the ring gear side from the pinion side. If backlash is low, the ring gear must be moved away from the pinion by moving differential bearing shims from the ring gear side to the pinion side.



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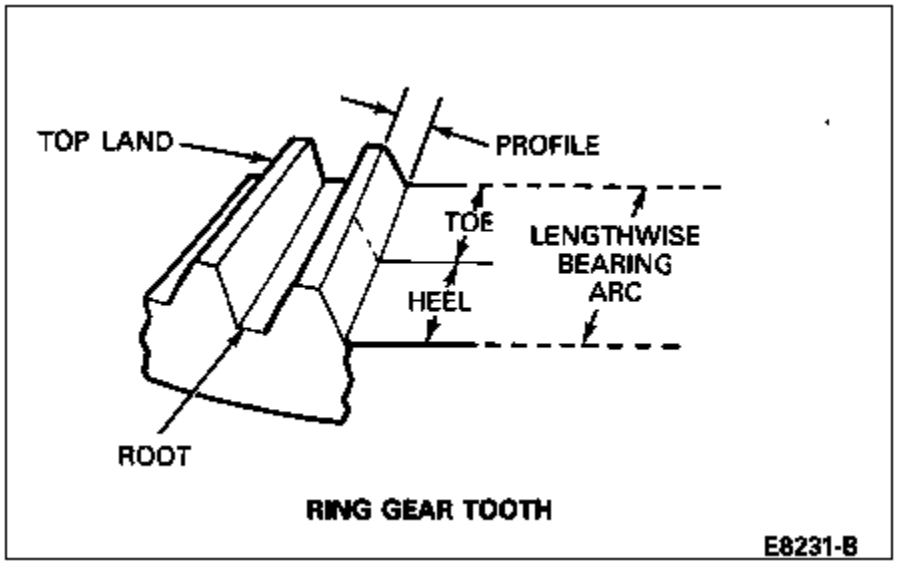
Ring Gear and Pinion Tooth Pattern Interpretation

NOTE: When making changes, note that two variables are involved. For example, if you have the backlash set correctly to specifications and you change the pinion position shim, you may have to readjust the backlash to the correct specification before checking the pattern. Refer to pattern interpretation.



The final pinion position will be verified by using the gear contact pattern method described as follows:

WARNING: GEAR TEETH MAY HAVE SHARP EDGES. WHEN HANDLING GEARS, USE CARE TO AVOID PERSONAL INJURY.

The toe of the gear tooth is the portion of the tooth surface at the end toward the center. The heel of the gear tooth is the portion of the tooth surface at the outer end. The top land of a gear tooth is the surface of the top of the tooth. Every gear has a characteristic pattern. The illustrations show typical patterns only, and explains how patterns shift as gear location is changed. When making pinion position changes, shims should be changed in the range of .05mm (.002 inch) to .10mm (.004 inch) until correct pattern has been obtained.

When a change in backlash is required, backlash shims should be changed in the range of 1-1/2 times the amount of backlash required to bring the gears into specification. For example, if the backlash needed to be changed by .10mm (.004 inch), the shim pack should be changed by .15mm (.006 inch) as a starting point. The actual amount of backlash change obtained will vary depending upon the ratio and gear size.

High backlash is corrected by moving the ring gear closer to the pinion. Low backlash is corrected by moving the ring gear away from the pinion. These corrections are made by switching shims from one side of the differential case to the other.

1. Paint ring gear teeth with a marking compound to both the drive and coast side.

2. Rotate ring gear one complete revolution in both directions while load is being applied with a large screwdriver or similar tool between the carrier casting and differential case flange.

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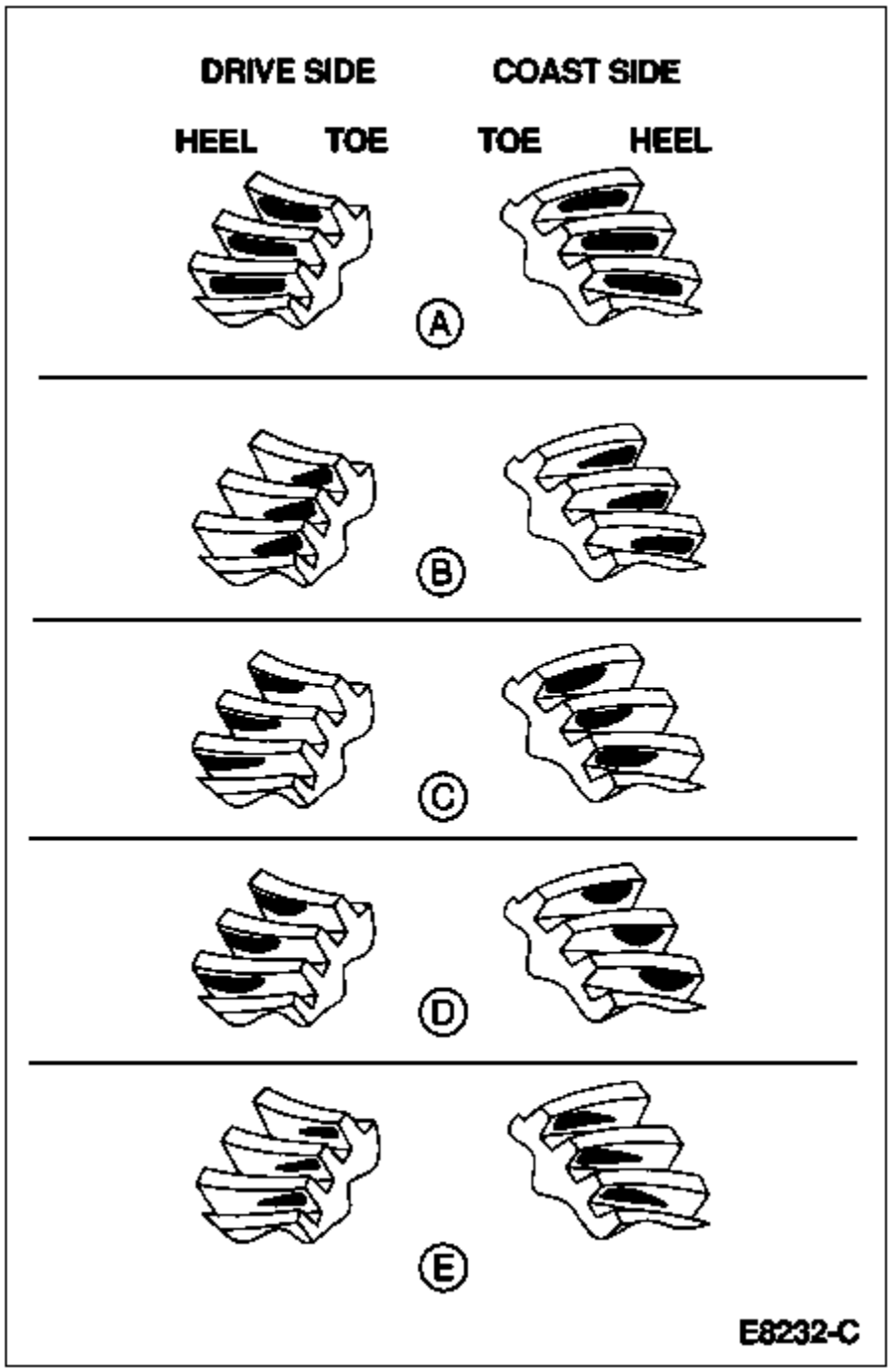
Ring Gear Patterns



Item	Part Number	Description
A	—	Normal or Desirable Pattern
B	—	Backlash Correct. Thinner Pinion Position Shim Required

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C	—	Backlash Correct. Thicker Pinion Position Shim Required
D	—	Pinion Position Shim Correct. Decrease Backlash
E	—	Pinion Position Shim Correct. Increase Backlash

Pattern Movements Summarized

1. The following summarizes how pinion and ring gear movements will obtain satisfactory roll patterns:

   a. Decreasing backlash moves the ring gear closer to the pinion.

      Drive pattern (convex side of gear) moves slightly lower and toward toe.

      Coast pattern (concave side of gear) moves lower and toward the toe.

   b. Increasing backlash moves the ring gear away from the pinion.

      Drive pattern moves slightly higher and toward the heel.

      Coast pattern moves higher and towards the heel.

   c. Thicker pinion position shim with the backlash constant moves the pinion closer to the ring gear.

      Drive pattern moves deeper on the tooth (flank contact) and slightly toward the toe.

      Coast pattern moves deeper on the tooth and toward the heel.

   d. Thinner pinion position shim with the backlash constant moves the pinion further from the ring gear.

      Drive pattern moves toward the top of the tooth (face contact) and toward the heel.

      Coast pattern moves toward the top of the tooth and slightly toward the toe.

Axle Shaft and Cover Assembly to Carrier

1. Assemble axle shafts into the carrier. Refer to Removal and Installation, Axle Shafts, Carrier Oil Seal and Bearing in this section.

2. **CAUTION: Apply only enough RTV to prevent leakage. Excess amounts of RTV may mix with axle lubricant which might cause damage to axle components.**

   CAUTION: If RTV enters cover bolt holes, it may cause erroneous torque readings when installing the cover bolts.

   Apply a continuous bead 3.18-6.35mm (1/8-1/4 inch) high and 3.18-6.35mm (1/8-1/4 inch) wide of RTV sealant D6AZ-19562-AA (clear) or -BA (black) or equivalent meeting Ford specification ESB-M4G92-A or ESE-M4G195-A on the cover plate.

3. Install the cover plate and cover plate bolts and tighten to 19-26 Nm (14-19 lb-ft).

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4. **NOTE: The cover must be installed on the carrier within five minutes after applying the RTV sealant.**

   NOTE: Allow one hour cure time before filling carrier with the proper amount of specified lubricant and vehicle operation.

   Fill the carrier with 1.04 liters (35 ounces) of Mercon® Multi-Purpose Automatic Transmission Fluid E6AZ-19582-B or equivalent meeting Ford specification ESR-M2C163-A2.

5. Install the axle assembly in the vehicle. Refer to Removal and Installation, Axle, Front Drive in this section.

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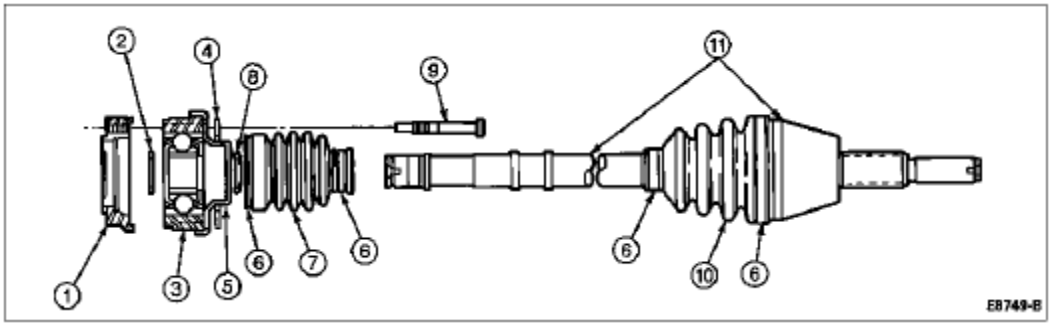
CV/CV Halfshaft

NOTE: The halfshaft can be serviced only to the following levels of detail:

- the inboard CV joint
- the inner boot alone
- the outboard CV joint and interconnecting shaft
- the outer boot and inner boot together

CV/CV Halfshaft



Item	Part Number	Description
1	3L387	Spacer and Grease Cap
2	—	Snap Ring (Part of 3L387)
3	3A466	Inboard CV Joint and Interconnecting Shaft
4	—	Bolt Plate (2) (Part of 3L387)
5	—	Boot Adapter (Part of 3A466)
6	—	Clamp (Part of 3A429)
7	3A429	Inboard Boot
8	—	Belleville Washer (Part of 3A429)
9	—	Assembly Bolt (Part of 3A466)
10	3A429	Outboard Boot
11	3A406	Outboard CV Joint

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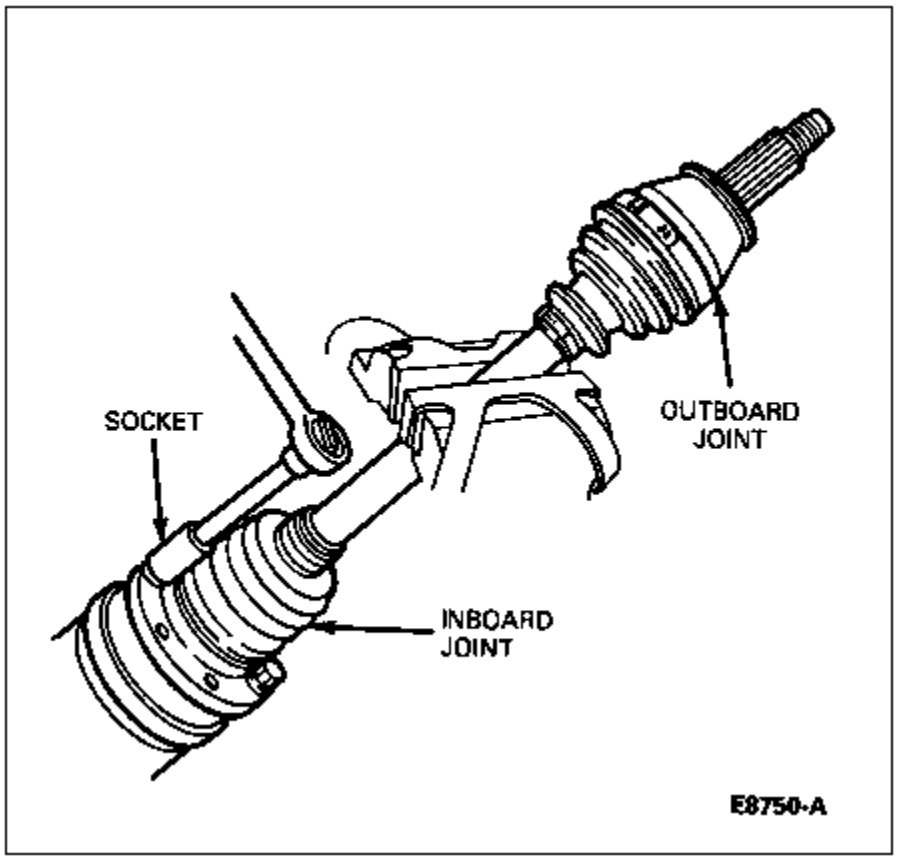
Disassembly

1. Remove halfshaft from vehicle. Refer to the procedure in this section.
2. Clamp halfshaft in a vise with the inboard joint lower than the outboard joint. Do not allow vise jaws to contact the boots or clamps.



3. Cut the inner boot clamps with side cutters and peel away the clamps from the boot.
4. Pull the larger boot end off the joint to provide increased access to the assembly bolts.
5. Remove the inboard CV joint assembly bolts (2) and separate the spacer and grease cap from the joint assembly retaining the bolt plates (2) for reassembly.
6. Remove the snap ring retaining the interconnecting shaft end into the CV joint cage and discard.
7. Remove the joint assembly from the shaft.
8. Remove the Belleville washer from the shaft and discard.
9. Remove the inner boot from the shaft and discard.
10. Cut the outer boot clamps with side cutters and peel away the clamps from the boot.
11. **NOTE: The outboard CV joint is non-serviceable beyond this point.**

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Remove the outboard joint and shaft from the vise and pull the outer boot off the shaft and discard.

12. Clean all parts in a suitable parts cleaning solvent.

13. Inspect CV joints for excessive wear, pitting, rust and broken parts. If inspection determines that a CV joint is unusable, the entire inboard CV joint or the complete outboard CV joint and interconnecting shaft must be replaced.

Assembly

1. Slide new outer boot over shaft.

2. Fill CV joint area around the balls with 80 grams (2.8 oz.) of Constant Velocity Joint Grease E2FZ-19590-B or equivalent meeting Ford specification ESP-M1C187-A.

3. Spread 40 grams (1.4 oz.) of grease evenly inside large boot for a total combined fill of 120 grams (4.2 oz.).

4. Assemble outer boot onto outboard CV joint and interconnecting shaft, making sure boot is seated in the boot grooves on the joint's outer race and on the shaft.

5. **CAUTION: Do not overtighten clamps. This may damage clamp or boot.**

   Tighten clamps using crimping pliers.

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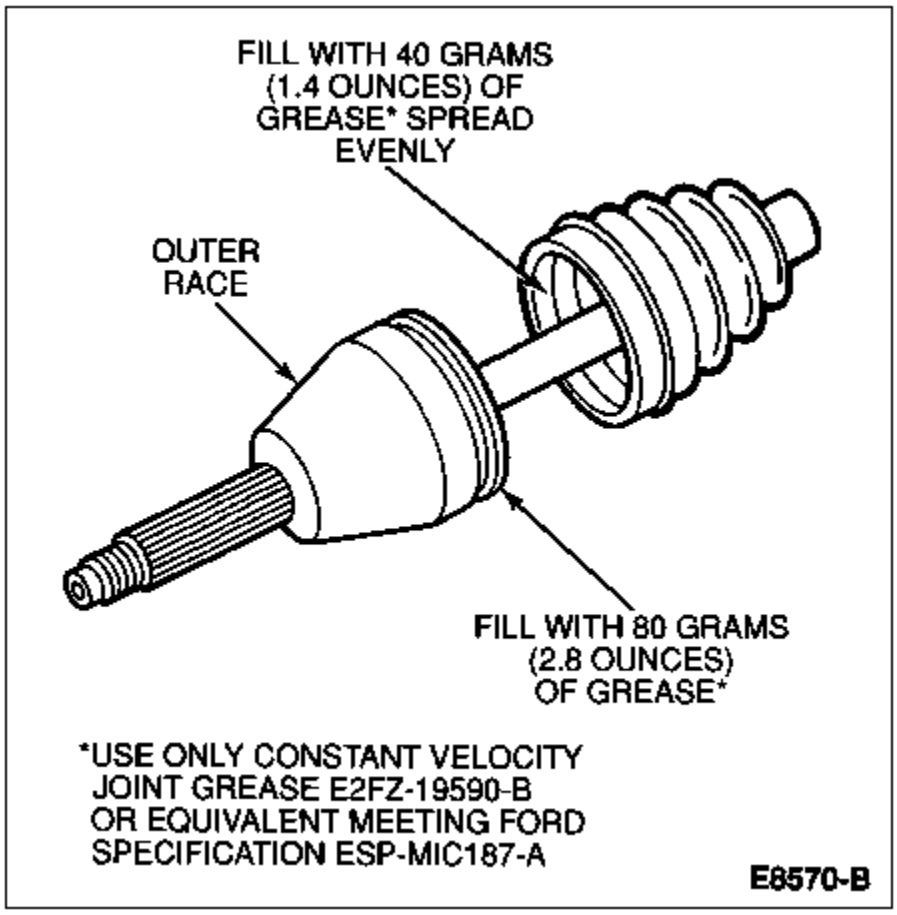

6. Slide new inner boot over shaft.
7. Slide Belleville washer onto shaft end. Check for proper orientation.
8. Assemble inboard CV joint onto interconnecting shaft spline until resting on Belleville washer.
9. Install snap ring.
10. **CAUTION: Do not overtighten. It may damage clamp or boot.**

    Spread evenly 40 grams (1.4 oz.) of grease inside inner boot. Slip boot into place, making sure boot is seated in the boot grooves on the joint's boot adapter and on the shaft. Tighten the clamps using crimping pliers.
11. **NOTE: Be sure not to contaminate bolt holes with grease.**

    Fill the spacer and grease cap with remaining 40 grams (1.4 oz.) of Constant Velocity Joint Grease E2FZ-19590-B or equivalent meeting Ford specification ESP-M1C187-A.
12. Fit spacer to CV joint end pilot and install assembly bolts. Tighten bolts to 26-34 Nm (19-25 lb-ft).
13. Work inboard joint a few times by plunging to spread grease evenly within joint.
14. Install complete halfshaft into the vehicle. Refer to the procedure in this section.

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CV Joint Boot

1. **NOTE: While inspecting the boots, watch for indentations (dimples) in the boot convolutions. If an indentation is observed, it must be removed. Refer to CV Joint Boot Indentation removal procedure.**

   Inspect boots for evidence of cracks, holes or splits.

2. Inspect underbody for any indication of grease splatter in vicinity of CV joint boots which is an indication of boot or clamp damage.

3. Make sure wheel hub retainer nut is the correct prevailing torque type.

4. The neoprene rubber boot will sweat during operation, causing a light film of grease to show on the outside of the boot. This condition is normal.

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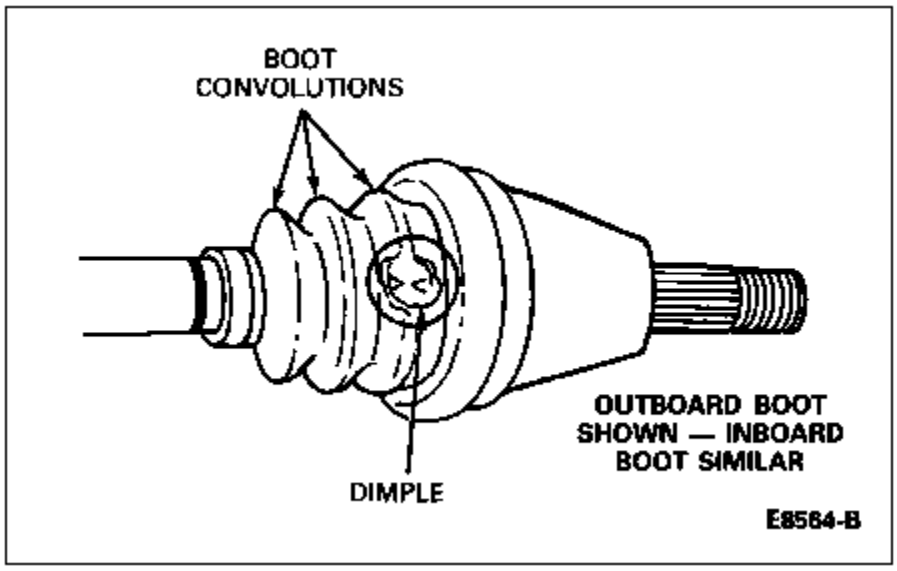
CV Joint Boot Indentation

Removal

Indentations or dimples in the CV joint boots may occur due to improper handling during storage or service of the halfshafts. If, during inspection, a boot is observed to be dimpled, perform the following procedure.

1. **CAUTION: Extreme care should be taken not to allow CV joint boots to come in forceful contact with foreign objects that may cause the external boot convolutions to become indented.**

   Inspect the boot(s) for any sign of grease leakage in the dimple which would indicate a cut. Replace the boot if a cut exists or if there is evidence of other damage.



2. If the boot is in good condition, the dimple can be removed as follows:

   a. Grasp the dimpled convolution on either side of the dimple using the forefinger and thumb of each hand.

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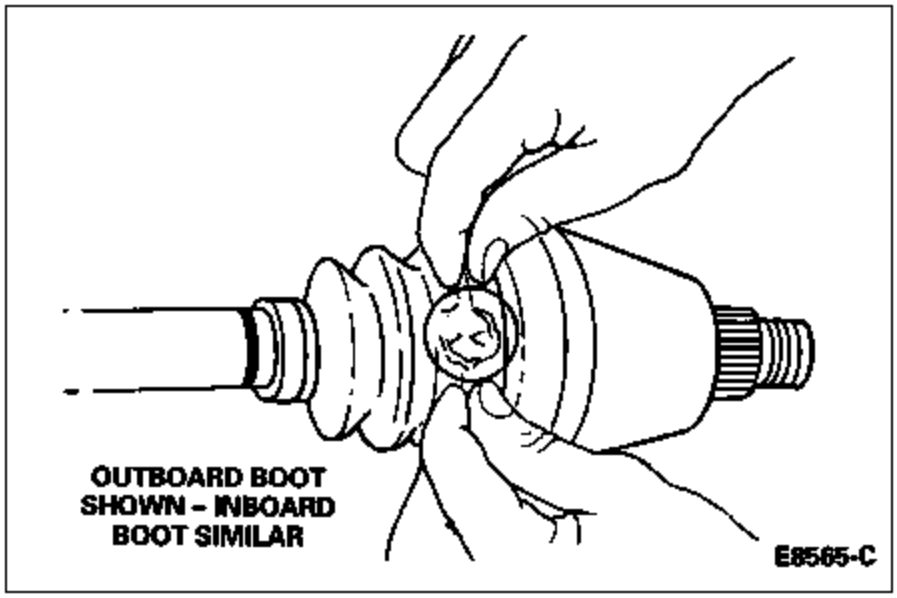
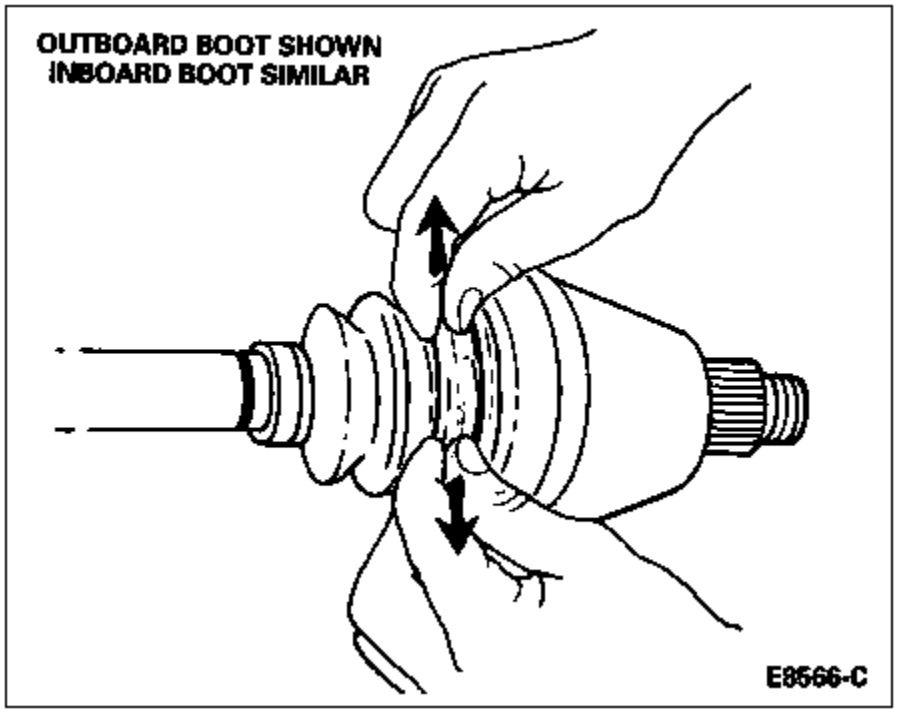


b. While grasping boot, pull the convolution by moving hands in opposite directions. The dimple should pop out. If the dimple does not invert or if it dimples again, one clamp should be removed and the internal and external air pressure equalized.



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SPECIFICATIONS

Lubricant Capacities — Halfshaft Assemblies

Vehicle	Joint Location	Specification	Total Fill	
			Grams	Ounces
Aerostar E-4WD	Inboard	ESP-M1C187-A Ford Part No. E2FZ-19590-A	80	2.8
Aerostar E-4WD	Outboard	ESP-M1C187-A Ford Part No. E2FZ-19590-A	120	4.2

Lubricant Capacities

Axle	Approximate Capacity	
	U.S. Ounces	Liters
Dana Model 28-2 Front Drive Axle	35	1.04

NOTE: Use Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX or equivalent MERCON® fluid.

Dana Model 28-2 Front Drive Axle Specifications

Carrier Spread	Removal: 0.25mm (0.010 Inch) Installation: 0.37mm (0.015 Inch)
Drive Pinion Rotational Torque [a] (Pinion Only - New Bearings)	1.7-4.0 Nm (15-35 Lb-In)
Ring Gear and Pinion Backlash [b]	13-20mm (.005-.008 Inch)

[a] Torque to rotate drive pinion only plus .23-.45 Nm (2-4 lb-in) for 3.73 ratio axle.
[b] Backlash cannot vary more than: .08mm (.003 inch) between checkpoints.

Lubrication Specifications

Description	Ford Specifications
Constant Velocity Joint Grease E2FZ-19590-B	ESP-M1C187-A
Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX	MERCON®
RTV Sealant D6AZ-19562-AA (Clear) or -BA (Black)	ESB-M4G92-A, ESE-M4G195-A
Threadlock and Sealer E0AZ-19554-AA	WSK-M2G351-A5

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Premium Long-Life Grease XG-C or -K	ESA-M1C75-B

Torque Specifications

Description	Nm	Lb-Ft
Axle Snubber-to-Crossmember Fasteners	23-33	17-24
Axle to Crossmember Mounting Bushing Nuts	88-115	65-85
Bearing Capbolts	41-61	30-45
Cover Bolts	19-26	14-19
Cover Plate Bolts	19-26	14-19
Driveshaft Flange to Axle Pinion Flange Bolts	30-40	22-30
Fill Plug	20-34	15-25
Front Hub Retainer Assembly — Nut	230-283	170-209
Inboard Halfshaft CV Joint to Axle Flange — Bolts	30-40	22-30
Inboard Halfshaft CV Joint to Spacer — Bolts	26-34	19-25
Inboard Halfshaft Flange to Axle Flange Bolts	30-40	22-30
Lug Nuts	115-156	85-115
Mounting Bracket Bolts	95-108	70-80
Pinion Nut	190-373	140-275
Ring Gear Bolts	61-88	45-65

NOTE: For pinion nut, collapsible spacer is used. Tighten nut until torque to rotate pinion is 1.7-4.0 Nm (15-35 lb-in).

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Inspection and Verification

When it comes to today's electrically controlled RABS/4WABS, the diagnosis of many concerns requires following the diagnostic procedures exactly as they are outlined in the service manual. But there is more to it than that. You have to take the information given you by the customer, and combine it with your understanding of brake systems in general. This knowledge and information will help you make the most efficient use of the diagnostic procedures in this manual.

Getting Started

Brake system diagnosis starts with the customer's concern. It is best to get this information directly from the customer, not just from a service write-up. Customers usually do their best to describe what they have been experiencing and what their concerns are. But it is often necessary to ask questions and probe further in order to get a complete picture of the problem.

Customers may report that the brake pedal (2455) went to the floor, when it actually only dropped part way. Remember, customers get used to how their vehicle's brakes are performing. If the system suddenly behaves differently, they may become alarmed. Under these circumstances, what they report may not be as clearly stated as it could be. Your job is to listen carefully and ask probing questions about anything that doesn't fit your experience and understanding of brake system functioning.

Verify the Complaint

Once you are satisfied that you understand the customer's concerns, take the vehicle on the road yourself. Many brake concerns involve a wide variety of noises and pulsations that can only be experienced while operating the vehicle. Make sure the vehicle's tires are inflated properly. Make your brake application evaluation on level, dry, hard, smooth pavement that is free from oil, grease or loose dirt.

Back in the Shop

The next step in servicing a brake complaint is a thorough inspection of the system.

Brake Master Cylinder

Look for leaks. Clean the unit and remove the brake master cylinder filler cap. Check the fluid level. Check the condition of the gasket.

Hydraulic Leaks

On vehicles with power brakes, with the engine (6007) running, apply 667 N (150 lbs.) force to the brake pedal and hold for ten seconds. If brake pedal height cannot be maintained for 10 seconds or the brake warning light comes on, service is required.

Occasional brake squeal can be caused by environmental conditions such as cold ambient temperatures, heat, rain, snow, salt, mud, hot ambient temperatures or high humidity. This occasional squeal is not a functional problem and does not indicate any loss in brake effectiveness.

Visually examine front and rear tires and wheel assemblies for damage such as uneven wear, tread washouts, or sidewall damage. Make sure the tires are of the same size, type and, where possible, same manufacturer. Any tire or wheel (1007) that is damaged should be replaced. Refer to Section 04-04 .

Wheels and tires must be cleared of any foreign matter, and tire pressures adjusted to the correct

specification as detailed in Section 04-04 .

If tires exhibit uneven wear or feathering, the cause must be corrected. Check steering and suspension components for damage/wear and, if necessary, check and adjust steering alignment. Refer to Section 04-00 .

Road Test

A road test should be performed to compare actual vehicle braking performance with the performance standards expected by the driver. The ability of the test driver to make valid comparisons and detect performance deficiencies will depend on experience.

The driver should have a thorough knowledge of brake system operation and accepted general performance guidelines, in order to make good comparisons and detect performance problems.

An experienced brake technician will always establish a route that will be used for all brake diagnosis road tests. The road selected will be reasonably smooth and level. Gravel or bumpy roads are not suitable because the surface does not allow the tires to grip the road equally. Crowned roads should be avoided because of the large amount of weight shifted to the low set of wheels on this type of road. Once the route is established and consistently used, the road surface variable can be eliminated from the test results.

A key factor in evaluating brake concerns is the deceleration rate. During braking, all of us are sensitive to whether or not the vehicle is slowing at the rate we have come to expect. This varies from vehicle to vehicle and with changes in operating conditions. It is evident how well the brakes on a particular vehicle are working after just a few applications.

Stopping Distance Method

For this test, you need to mark out or find a driving lane that is 3.7m (12 ft.) wide. You also need to place two markers along this lane, 7.5m (25 ft.) apart. At a speed of 32 km/h (20 mph), drive down the center of the lane and apply the service brakes when you reach the first marker. Observe whether the vehicle comes to a smooth stop before the second marker. Also note whether it pulled to the right or left and whether it went beyond the 3.7m (12 ft.) width. For trucks under 4500 kg (10,000 lbs.) a commonly accepted standard is a smooth stop within 7.5m (25 ft.), while staying within the lane.

Before a road test, get a complete description of the customer concerns or suspected condition. From the description, experience will allow possible causes to be matched with symptoms. Certain components will be tagged as possible suspects while others will be eliminated by the evidence. More importantly, the customer's description can reveal unsafe conditions which should be checked or corrected before the road test. The description will also help form the basic approach to the road test by narrowing the problem to specific components, vehicle speed or conditions.

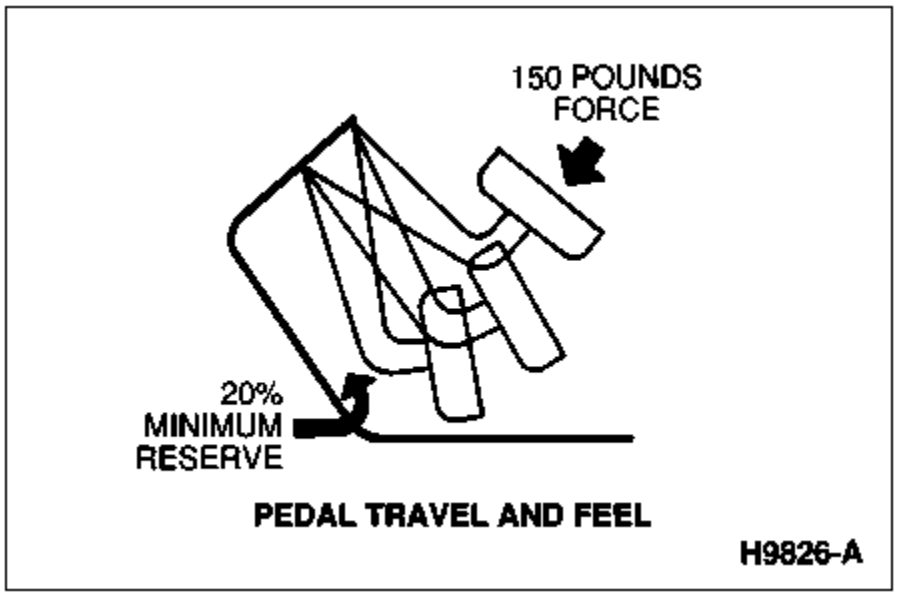
The road test should begin with a general brake performance check. With the customer's description as a guide, the brake system should be tested at different vehicle speeds using both light and heavy brake pedal pressure. On vehicles with rear drum brakes, to determine if the problem is in the front or rear braking system, the service brake pedal is used first, then the parking brake. If the condition (i.e., pull, vibration, pulsation) occurs only with the parking brake, the problem is in the rear system. If the condition occurs when the service brake pedal is pressed, the problem is in the front system. Vehicles with rear disc brakes require further testing to determine problem location.

Locking the brakes and sliding the tires should be avoided. Locked brakes and sliding tires do not indicate brake efficiency: A heavily braked and turning wheel will stop the vehicle in less distance than locked brakes. If the problem becomes evident during this check, it should be determined if it fits the description given before the road test. If the problem is not evident, an attempt should be made to duplicate the condition using the information from the description.

If a concern exists, the brake system symptom chart in this section should be used, in order to isolate it to a specific subsystem and condition description. From this description, a list of possible causes can be used to further narrow the cause to a specific component or condition.

Pedal Reserve

To check brake pedal reserve with the engine running, apply 667 N (150 lbs.) force and observe the extent of brake pedal travel. There should be at least 20% reserve travel distance available.



Hydraulic Parts

Check hydraulic hoses and tubes for leaks, cracks, chafing, and distortions. The fasteners that hold these components in place should also be checked.

Wheel Cylinder — Drum Brakes

NOTE: Don't pry under or otherwise disturb the dust boot. This may destroy a very important seal. If there is leakage, it will find its way around the dust boot.

With the brake drum (1126) removed, check for loose or worn parts. Check the rear wheel cylinder (2261) for leakage around the dust boot.

Disc Brake Caliper

Check for proper installation, leakage, caliper slide lubrication and excessive wear along caliper supports.

Dual Circuit Warning Light

Functions:

- Apply the parking brake.
- Check that the light comes on when you start the engine.
- Release the parking brake. Check that the brake warning light goes off.

Detecting Causes of Brake Problems

ABS brake systems, with their electronically-controlled components, provide a greater degree of braking control than ever before. The fault codes generated by the built-in diagnostics make solving many concerns a simple matter. However, it isn't always possible to immediately nail the culprit when something isn't working properly. Eliminate the obvious first, and gradually close in on the real concern.

Start with the clues found during basic inspection. Correct the obvious problems and see how that affects the performance of the system. Save the potentially difficult possibilities for last. Many times, the concern will be corrected before you have to get into more challenging areas.

The most difficult concerns are often intermittent. Make sure the problem is really an intermittent brake issue and not an intermittent operating condition. Get as much information as possible.

Talk to the primary driver. Find out how often it actually happens, what time of day, what the load is, what the road conditions are and what the weather is like. Listen carefully. There may be important clues in the answers.

Isolating ABS

WARNING: DO NOT DISABLE THE FRONT BRAKES. IF YOU DO, STOPPING DISTANCES MAY BE EXTREMELY LONG, ESPECIALLY IN VEHICLES THAT ARE UNLOADED.

Many concerns that seem at first to be ABS related are actually problems with the base brake system. On the rear anti-lock systems (RABS) pull the brake fluid level sensor connector and fasten it safely out of the way. This will effectively disable the RABS, but leave the normal power assisted brake system functioning normally.

Road test the vehicle. With RABS disabled, you will get a good feel for the functioning of the base brake system and any concerns. Fix these concerns before testing the ABS itself.

This procedure will demonstrate the vehicle's deceleration before lockup. This will help evaluate the vehicle's braking performance after correcting all concerns. Use one of the deceleration tests referred to earlier for accurate measure of the deceleration rate.

With the RABS disconnected, test for brake imbalance. Apply pressure quickly to detect one wheel locking up before the other. With RABS functioning, this judgment can't be made.

Reactivate the RABS to check for the pedal pulsation. Remember that the RABS shuts off below approximately 8 km/h (5 mph), which can result in lockup at the conclusion of a stop. Operate vehicle safely to reach speed when testing.

Premature RABS Activation

One concern that may be a challenge to isolate is premature RABS activation. The first step is to thoroughly check out the base brake system. If the base brake system checks out and there is still premature RABS activation, there are several areas to take a close look at:

- **A weak sensor signal:** Look for a bad wheel speed sensor, chips on the pole piece or an air gap that's too high.
- **A wiring problem:** Look for chafed wires that might be causing a faulty electrical circuit.
- **A rear axle problem:** Rear axle malfunctions account for many premature RABS activation

problems. Look for rear axle speed sensor ring damage and for play in the differential that allows the rear axle speed sensor ring to move away from the wheel speed sensor.

The "Rolling Skid"

NOTE: Some initial, momentary wheel lockup is permissible during this test.

ABS are designed to sense the RAPID deceleration rate of a wheel. This is what warns of possible lockup. Some tires have high peak traction which tends to fall off rapidly. When a tire has this characteristic, the ABS can easily perform as designed. When increasing the braking force, the tires rapidly decelerate, and at the appropriate point, the ABS kicks in at the wheel or axle that needs reduced pressure. Brake pedal pulsations can be felt, and on 4WABS the pump motor can be heard.

Tires with a tendency to develop peak traction which then falls off more slowly may slip some as they decelerate (sometimes referred to as a "rolling skid"). This was a typical characteristic of bias belted tires. This condition may cause the ABS system not to activate, because the wheel isn't fully locking up. There may, however, be considerable squealing and smoking of the tires, and sometimes even skid marks. This is a concern the customer may report.

Have the customer take you for a drive to demonstrate. Observe how the driver activates the brakes. Before beginning the test, adjust the outside rearview mirrors so you can observe the rear wheels.

Have the owner apply the brakes normally during a hard stop. Ford recommends speeds of no more than 24 km/h (15 mph) for this test. If you feel the ABS activate, rolling skid isn't the problem.

If the ABS doesn't activate, have the driver increase the pressure until they squeal and smoke. Hold in this position. Observe rearview mirrors for evidence of smoke. It is also helpful to have an assistant standing nearby who can watch the wheels from a better angle during the test.

Check to see if the wheels continue to rotate for the duration of the stop.

Finally, see if increasing the pressure even more will cause the ABS to activate. If it does, the vehicle is experiencing the slow drop-off from peak traction discussed above.

This last step, applying extra pressure, is very important to the diagnosis. Many drivers back off on the brakes when they hear the squeal because they think, and understandably so, that a wheel or wheels are locking up. Correcting this problem may mean explaining that the system is functioning fine and the wheels are not locking up.

RABS and 4-Wheel Drive

When diagnosing RABS concerns on a 4-wheel drive vehicle, remember that the front and rear drivetrains are mechanically locked together in 4-wheel drive. If the front wheels turn, the rear wheels turn. If the front wheels lock up, the rear wheels lock up. The RABS can't prevent lockup in the rear when the front brakes are applied hard enough to cause lockup on low-traction surfaces.

For more information on the rear anti-lock brake system (RABS), refer to Section 06-09A . For more information on the four wheel anti-lock brake system (4WABS), refer to Section 06-09B .

The Vehicle That Keeps Coming Back

If you get a vehicle that has been brought in for brake service frequently, take a close look at the service history. How long did that vehicle go before its first brake service? What has happened since? If components have been replaced, are they the correct parts? Recurring problems can be the result of some mistake made earlier in the service history.

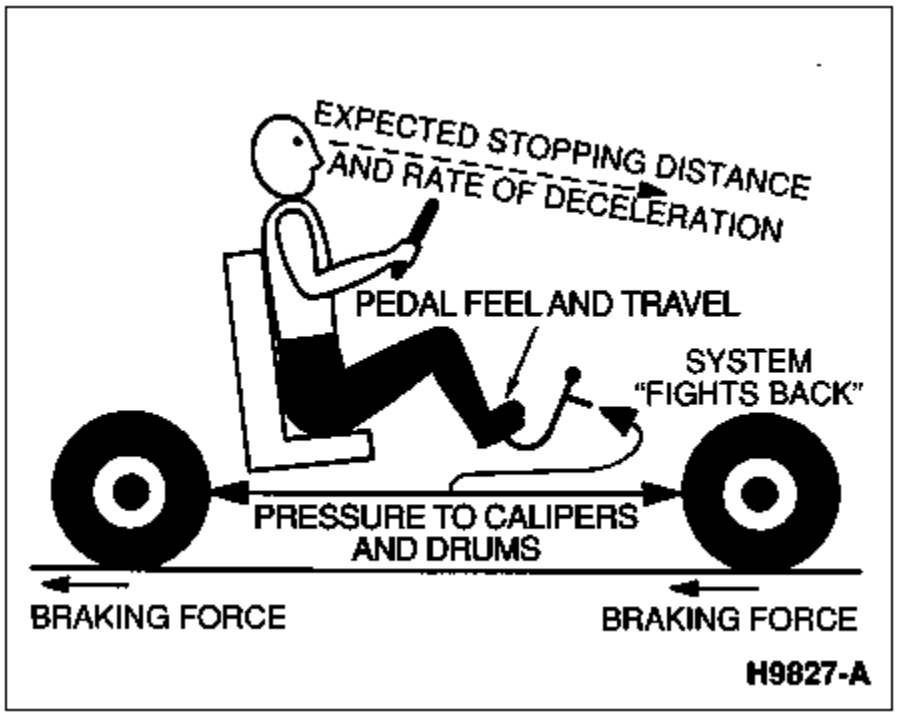
Brake Pedal Feel and Stopping Distance

A combination of things indicates whether brakes are working properly: The feel of the brake pedal, how rapidly the vehicle slows down and distance travelled before stopping. If the brakes are working properly and we experience the expected feel and results, we are confident. If the brakes feel different and/or the vehicle doesn't slow or stop as expected, we feel uneasy. . .even panicked. This panic will be heightened in emergency stopping situations.

Customers often report brake problems in terms of brake pedal feel. "My brakes feel spongy" or "The brake pedal went to the floor" or "The brakes feel hard and I have to apply much more force than usual" are all possible customer complaints. These complaints are often accompanied by reports that the vehicle "Just didn't stop the way it should." These simple complaints may indicate problems that are much more complex to diagnose and correct.

What makes understanding brake feel and stopping distance a challenge is that different brake systems have a different feel and a different braking response. Feel is the result of several factors:

Stopping Perceptions



Design

Brake feel will vary from vehicle to vehicle, even of the same design depending on how the vehicle is equipped.

Operation

How the vehicle is used may also change the feel of the brakes. Factors such as loading, trailer towing and operating on steep grades or gravel roads can all affect the feel of the brakes.

Pedal Force and Travel

The amount of force applied, combined with the amount of brake pedal travel will affect the feel and stopping response. Some drivers are stronger than others and can force the brake pedal down further.

Spring or Give in the System

This is a very important concept. A braking system isn't rigid. Every part has some give. For example, the disc brake calipers (2B120) flex a little as force is applied, flexible hoses swell a little under pressure, and shoe return springs are extended. The combination of these and other points where the system gives a little results in a "springiness" that "fights back" against the hydraulic pressure. This "fighting back" is felt through the brake pedal. As parts of the system become worn or corroded, this "fighting back" feel may change.

Symptom Chart — Brake System Service

BRAKE SYSTEM SERVICE

Condition	Possible Source	Action
• Brakes Not Working, Excessive Pedal Travel, Brake Pedal Feels Spongy When Fully Applied	• Low fluid level.	• ADD fluid, BLEED system, CHECK for leaks, and BLEED system.
	• Worn or damaged four wheel ABS hydraulic control unit (Ranger only).	• REFER to Section 06-09B , Symptom Chart.
	• Worn or damaged RABS valve accumulator or outlet (dump) valve	• REFER to Section 06-09A , Symptom Chart.
	• Rear brakes out of adjustment.	• ADJUST rear brakes. REFER to Section 06-02 .
	• Front wheel bearing out of adjustment.	• ADJUST front wheel bearings. REFER to Section 04-01A for all 4x2 vehicles, Section 05-03A for Ranger and Section 04-01C for Aerostar 4x4.
	• Brake master cylinder or booster dash unit mounting loose.	• TIGHTEN nuts and bolts to specification.
	• Disc brake caliper attachment loose.	• REPLACE or TIGHTEN as required.
	• Worn or damaged brake shoe adjusting lever cables .	• REMOVE drum and CHECK lining for proper adjustment. REPLACE brake shoe adjusting lever cables. REFER to Section 06-02 .
	• Glazed, worn, scored or damaged brake linings.	• REPLACE rear brake shoes and linings. REFER to Section 06-02 .
	• Drums out of round or rotors with excessive runout.	• REFINISH, or REPLACE if wear exceeds limits. REFER to Section 06-03 , Section 06-02 .
	• Front brake hose improperly positioned.	• CHECK front brake

		hose for misposition near heat source. REPOSITION as required.
	• Air in system.	• BLEED system. REFER to Section 06-06.
	• Reservoir cap vent hole clogged.	• SERVICE or REPLACE brake master cylinder filler cap as required.
• Excessive Pedal Travel or Brake Pedal Goes to Floor Consistently	• Hydraulic system.	• PERFORM master cylinder diagnosis test. REFER to Pinpoint Test R and Pinpoint Test T. REPAIR as required.
	• Brake drums worn, bad wear pattern, or cracked.	• REPAIR or REPLACE as required. REFER to Section 06-02.
	• Loose or improper attachment of brake pedal, pedal support booster and brake master cylinder.	• REPAIR or REPLACE as required. REFER to Section 06-07.
	• External leak.	• REPAIR as required.
	• Air in system.	• BLEED system. REFER to Section 06-06.
• Excessive Pedal Effort to Fully Apply Brakes	• Overloaded vehicle.	• LIGHTEN load and ADVISE owner of correct load limits of vehicle.
	• Insufficient vacuum to power brake booster.	• REPLACE damaged or leaking vacuum booster hoses.
	• Restricted air filter on power brake booster.	• CLEAN or REPLACE filter.
	• Booster and brake pedal linkage binding caused by worn bushings or corrosion.	• REPLACE worn bushings or CLEAN and LUBRICANT linkage.
	• Worn or damaged power brake booster.	• REPLACE power brake booster. REFER to Section 06-07.
	• Brake lining worn, glazed, contaminated or improper type.	• REPLACE brake lining in axle sets.
	• Rear brake shoe and lining improperly installed.	• REPOSITION brake shoes properly and ELIMINATE any binding. REFER to Section 06-02.

	• Seized caliper pistons in rear wheel cylinders or disc brake calipers. • Restricted brake lines or hoses.	• REPAIR or REPLACE as required. • REPAIR or REPLACE as required.
• Brakes Drag, Slow or Incomplete Release	• Parking brake control or parking brake rear cable and conduits binding. • Rear brake components binding. • Damaged front wheel bearing. • Worn or damaged brake master cylinder. • Caliper slides binding. • Brakes out of adjustment. • Restriction in hydraulic system. • Binding/seized rear wheel cylinders or caliper pistons.	• REPAIR, LUBRICATE, or REPLACE parts as required. REFER to Section 06-05 . • REPAIR, LUBRICATE, or REPLACE parts as required. • CHECK bearings for adjustment, wear, damage. ADJUST bearings. • PERFORM master cylinder diagnosis test. REFER to Pinpoint Test R and Pinpoint Test T . REPAIR as required. • REPLACE slide pins, CLEAN grooves, LUBRICATE slides. • ADJUST rear brakes. REFER to Section 06-02 . • REPAIR or REPLACE as required. REFER to Section 06-06 . • REPAIR or REPLACE as required. REFER to Section 06-03 , or Section 06-02 .
• Empty Reservoir	• Damaged brake master cylinder reservoir. • Leaking mounting grommets. • Leaking components (lines, hoses, disc brake calipers, rear wheel cylinder, etc.).	• REPLACE brake master cylinder reservoir. REFER to Section 06-06 . • REPLACE grommets and brake master cylinder reservoir. • REPAIR as required. BLEED system as required.
• Noise at Wheels When Brakes Are Applied — Snap or Clicks	• Cracked welds at brake shoe web.	• REPLACE rear brake shoe and lining in axle sets.

	• Brake shoes binding at backing plate ledges.	• CLEAN and LUBRICATE ledges.
	• Machining marks on brake drums.	• REFINISH, or REPLACE brake drums. REFER to Section 06-02 .
	• Backing plate ledges worn.	• REPLACE brake backing plate and LUBRICATE ledges. REFER to Section 06-02 .
	• Loose or missing disc brake pad anti-rattle clips.	• REPLACE. REFER to Section 06-03 .
	• Improper rotor finish after turning.	• REFINISH or REPLACE disc brake rotors. REFER to Section 06-03 .
	• Improper positioning, wear or damage of disc brake caliper.	• INSPECT, REPAIR or REPLACE. REFER to Section 06-03 .
• Noise at Wheels When Brakes Are Applied — Scrape or Grind	• Worn brake linings, loose rivets or foreign material scraping brake components.	• REPLACE rear brake shoes and linings. REFINISH or REPLACE brake drums or disc brake rotors if excessively scored. REFER to Section 06-03 , Section 06-02 .
	• Brake shoe interference with back of brake drum, shield-to-rotor clearance or binding at backing plate guide ledges.	• INSPECT. REPLACE as necessary. LUBRICATE. REFER to Section 06-02 , Section 06-03 .
	• Other brake system components. Warped or bent brake backing plate causing interference with brake drum.Cracked brake drums or disc brake rotors.Loose brake shoe hold-down springs.	• INSPECT and REPAIR as necessary. REFER to Section 06-02 , Section 06-03 .
	• Tires rubbing against chassis, body, or loose brake shoe hold-down springs.	• INSPECT. REPAIR as necessary. REFER to Section 04-04 .
• Noise at Wheels When Brakes Are Applied — Squeaks, Squeals or Chatter	• Worn or scored brake drums and lining or disc brake rotors.	• INSPECT, REPAIR or REPLACE as required. REFER to Section 06-03 , or Section 06-02 .
	• Burrs or rust on disc brake caliper that would obstruct seating of shoe to disc brake caliper.	• CLEAN or DEBURR disc brake caliper.

	• Dirty, greased or glazed linings. • Improper lining parts or loose rear brake adjustment. • Other brake system components.Loose lining rivets.Weak, damaged or incorrect brake shoe retracting springs.Loose or damaged shoe retaining pins, brake shoe retracting springs and clips.Grooved backing plate ledges.	• CLEAN or REPLACE. • INSPECT for correct usage. If necessary REPLACE with correct type in axle sets. REFER to Section 06-02 , Section 06-03 . • INSPECT, REPAIR or REPLACE as required. REFER to Section 06-02 .
• Noise at Wheels, Brakes Not Applied — Squeak or Squeal	• Wheel covers improperly attached. • Loose wheel attaching lug nuts. • Worn, dry or improperly adjusted wheel bearings. • Glazed linings — adjustment too tight. • Other brake system components.Stretched brake shoe retracting springs.Bent or warped brake backing plate causing interference with brake drum.Improper positioning of disc brake pad in disc brake caliper.Excessive runout of front disc brake rotor.	• SEAT covers with a rubber mallet. REPAIR flanges or REPLACE cover. • TIGHTEN to proper torque. REPLACE wheel if stud holes are damaged. • REPLACE worn or damaged wheel bearings. LUBRICATE and ADJUST. • REMOVE glaze from linings. ADJUST brakes properly. • INSPECT, REPAIR or REPLACE as required. REFER to Section 06-02 , or Section 06-03 as required.
• Noise at Wheels, Brakes Not Applied — Growling, Click or Rattle	• Stones or foreign material trapped inside wheelcovers. • Loose wheel lug nuts. • Damaged, worn, or improperly adjusted wheel bearings.	• REMOVE stones, etc. • TIGHTEN to correct torque. REPLACE wheel if stud holes are elongated. REFER to Section 04-04 . • ADJUST or REPLACE as

		required.
• Noise at Wheels, Brakes Not Applied — Squeaks, Squeals or Chatter	• Loose or missing anti-rattle clips, or caliper pins.	• INSPECT, REPAIR or REPLACE as required. REFER to Section 06-03 .
	• Drum brake linings/shoes loose or extra parts.	• INSPECT, REMOVE or REPAIR. REFER to Section 06-02 .
	• Worn, damaged or dry wheel bearings.	• INSPECT, LUBRICATE or REPLACE. ADJUST bearings properly.
• Grinding Noise	• Improperly lubricated wheel bearings.	• SERVICE as required. REFER to Section 04-01A for 4x2 and Section 05-03A for Ranger, and Section 04-01C for Aerostar 4x4.
• Excessive Brake Lining Wear	• Improperly adjusted wheel bearings.	• ADJUST or REPLACE as required. REFER to Section 04-01A for 4x2 and Section 05-03A for Ranger.
	• Binding caliper sliders.	• SERVICE as required.
• Brake Roughness, Vibration or Pulsation	• Improperly adjusted wheel bearings.	• ADJUST or REPLACE as required. REFER to Section 04-01A for 4x2, Section 05-03A for Ranger and Section 04-01C for Aerostar 4x4.
	• Excessive rotor runout, or thickness variation.	• SERVICE or REPLACE as required.
• Groan, Roughness or Chatter at Wheel (Brakes Applied)	• Loose wheel lug nuts.	• TIGHTEN to correct torque. REPLACE wheel if stud holes are elongated. REFER to Section 04-04 .
	• Worn, damaged, dry or improperly adjusted wheel bearings.	• INSPECT, LUBRICATE or REPLACE.
	• Loose or worn front suspension components.	• INSPECT, REPAIR or REPLACE as required. REFER to

		Section 04-00 .
	• Brake drum cracked or out of round.	• REPLACE drum if required. REFER to Section 06-02 .
	• Disc brake caliper loose, or missing parts — also loose or bent dust shield.	• REPAIR or REPLACE as required. REFER to Section 06-03 .
	• Excessive wear or lateral runout of disc brake rotor.	• REPLACE rotor. REFER to Section 06-03 .
	• Worn tires.	• REPLACE tires. REFER to Section 04-04 .
• Brakes Pull to One Side	• Unequal air pressure in tires.	• INFLATE tires to correct pressure.
	• Grease or fluid on linings. Glazed linings.	• CLEAN, SAND or REPLACE linings. CLEAN disc brake rotors.
	• Loose or missing disc brake caliper pin.	• REPLACE missing pin. REFER to Section 06-03 .
	• Improper size or type of lining on one wheel.	• REPLACE with correct brake linings in sets.
	• Improper size wheel cylinder on one wheel.	• REPLACE with correct wheel cylinder. REFER to Section 06-02 .
	• Stuck or seized pistons in wheel cylinders or seized calipers.	• REPAIR or REPLACE as required. REFER to Section 06-03 , or Section 06-02 .
	• Restricted brake lines or hoses.	• REPAIR or REPLACE as required.
	• Other brake components.Improper adjustment of drum brakes.Improper positioning of disc brake shoe and lining in the caliper.Fit of caliper to knuckle.Improperly adjusted, damaged or worn wheel bearings.Distorted drum brake shoes.Worn brake linings or scored rotor.Missing, broken or stretched retracting or retaining springs and clips.	• INSPECT, ADJUST, REPAIR or REPLACE as required. REFER to Section 06-02 or Section 06-03 .
	• Suspension or steering.	• REPAIR as required.
• Brakes Grab or Lock When Applied	• Tires worn or incorrect pressure.	• INFLATE tires to correct pressure. REPLACE tires with worn tread. REFER to Section 04-04 .

	• Grease or fluid on linings — damaged linings.	• REPLACE lining in sets. CLEAN rotors.
	• Improper size or type of linings.	• REPLACE with correct brake linings in sets.
	• Over-reaction of brake booster.	• REPLACE brake booster if required. REFER to Section 06-07 .
	• Lining sensitivity to moisture.	• DRY linings by applying brakes while moving.
	• Other brake system components.Loose or missing pins for caliper attachment.Worn, damaged or dry wheel bearings.	• INSPECT, REPAIR, REPLACE or LUBRICATE if required. REFER to Section 06-03 , or Section 06-02 .
	• ABS HCU: defective outlet (dump) valve Ranger 4x4.	• REFER to Section 06-09B .
	• RABS Valve: defective outlet (dump) valve.	• REFER to Section 06-09A .
• Brake Warning Light On	• Low brake fluid level.	• ADD fluid, CHECK for leaks, and BLEED system as required.
	• Parking brake applied or not returning completely.	• RELEASE parking brake.
	• Shorted light circuit.	• CORRECT short in brake warning light circuit.
	• Damaged fluid level switch or float assembly.	• REPLACE plastic brake master cylinder reservoir.
	• Differential pressure switch shuttled (Aerostar only) due to leakage in hydraulic circuit or damaged differential switch.	• REPAIR leakage in hydraulic circuit or REPLACE combination valve.
	• Anti-lock light does self check.	• REFER to Diagnostic Charts in Section 06-09A or Section 06-09B .
• Vibration When Brakes Are Applied.	• Loose lug nuts.	• TIGHTEN lugnuts to specification. REPLACE rim if stud holes are elongated. REFER to Section 04-04 .
	• Cracked disc brake rotors.	• REPLACE front disc brake rotor. REFER to Section 06-03 .

	• Front disc brake rotors/brake drums out of round or improper machining.	• MACHINE disc brake rotors or brake drums or REPLACE as required.
	• Worn or improperly adjusted wheel bearings.	• ADJUST or REPLACE wheel bearings as required.
	• Loose or worn front suspension components.	• TIGHTEN loose components to specifications. REPLACE worn or damaged components.
	• Excessive radial or lateral runout on wheel and tire.	• ADJUST or REPLACE tire or wheel to ELIMINATE excessive runout on tire or wheel as required. REFER to Section 04-04 .

Pinpoint Tests

DIAGNOSTIC PINPOINT TEST INDEX

Description	Test
Brakes Pull or Drift	Test A
Brake Warning Indicator Always On	Test B
Vibration When Brakes Are Applied	Test C
Pedal Goes Down Fast	Test D
Pedal Goes Down Slowly	Test E
Pedal Is Low or Feels Spongy	Test F
Brake Lockup During Light Brake Pedal Force	Test G
Excessive and/or Erratic Pedal Travel	Test H
Brakes Drag	Test J
Brakes Shudder	Test K
Brake Pedal Excessive Effort, Booster System OK	Test L
Brake Noise	Test M
Slow or Incomplete Brake Pedal Return	Test N
Vibration, Pedal Pumping, Low Pedal or Brake Chatter	Test P
Hydraulic Leak Test	Test Q
Brake Master Cylinder Bypass Condition Check	Test R
Excessive Pedal Effort	Test S
Brake Fluid Loss, Brake Master Cylinder Internal Test OK	Test T

PINPOINT TEST A: BRAKES PULL OR DRIFT

A1 INSPECT TIRE PRESSURE

- Measure air pressure in all four tires.

Is tire pressure within specifications?

Yes	No
GO to **A2** .	ADJUST tire pressure.

A2 CHECK CALIPER AND REAR WHEEL CYLINDERS

- Check the front disc brake caliper pistons, pins or rear wheel cylinders for binding, leakage or sticking.

Do the front disc brake caliper pistons, pins or rear wheel cylinders bind or stick?

Yes	No
REPAIR or REPLACE components as necessary.	GO to **A3** .

A3 INSPECT FRONT DISC BRAKE ROTORS AND BRAKE DRUMS

- Inspect the disc brake rotors and/or brake drums for excessive runout or damage.

Does excessive runout or damage exist?

Yes	No
REPAIR or REPLACE disc brake rotor or brake drum as necessary.	GO to **A4** .

A4 INSPECT WHEEL BEARINGS

- Inspect front and rear wheel bearings for excessive end play or improper preload.

Does excessive end play or improper wheel bearing preload exist?

Yes	No
ADJUST wheel bearing preload or REPLACE wheel bearings.	INSPECT for and REPAIR hydraulic leaks. RETEST system.

PINPOINT TEST B: BRAKE WARNING INDICATOR ALWAYS ON

B1 CHECK PARKING BRAKE SWITCH

- With parking brake fully released, disconnect the parking brake switch C202 (Ranger) or C309 (Aerostar).

Did brake warning indicator light go out?

Yes	No
REPLACE the parking brake switch. RETEST.	GO to **B2** .

B2 ISOLATE CIRCUITS, 531 (DG/R), 977 (P/W), AND 162 (LG/R)

- With brake master cylinder reservoir fluid level OK, disconnect the brake master cylinder fluid level switch C137 (Ranger) or C165 (Aerostar).

Does the brake warning indicator light go out?

Yes	No
GO to **B3** .	SERVICE ground short in Circuit 531 (DG/Y), 977 (P/W), or 162 (LG/R).

B3 TEST BRAKE FLUID LEVEL INDICATOR SWITCH

- Test for continuity between fluid level switch C137 (Ranger) or C165 (Aerostar), circuit 512 (T/LG) and ground .

Is there 10,000 ohms or more?

Yes	No
REPLACE the brake master cylinder reservoir.	SERVICE short to ground in Circuit 512 (T/LG).

PINPOINT TEST C: VIBRATION WHEN BRAKES ARE APPLIED

C1 ISOLATE VIBRATION/SHUDDER

- Determine if vibration/shudder is induced by the rear brakes by using the parking brake to slow the vehicle from approximately 80 to 56 km/h (50 to 35 mph). To use the parking brake:
- Hold the release handle out, or press release button in, while applying the parking brake.

Is vibration/shudder present?

Yes	No
CHECK the rear brakes. GO to **C2** for disc brakes. GO to **C3** for drum brakes.	CHECK the front brakes. GO to **C2** .

C2 RESURFACE DISC BRAKES

- Resurface front disc brake rotors and road test vehicle.

Is shudder/vibration present?

Yes	No
GO to **C4** .	Brake system repaired.

C3 REFINISH BRAKE DRUMS

- Refinish brake drums and road test vehicle.

Is shudder/vibration present?

Yes	No
GO to **C5** .	Brake system repaired.

C4 REPLACE DISC BRAKE PADS

- Replace disc brake pads and road test vehicle.

Is shudder/vibration present?

Yes	No
REPLACE front disc brake rotors.	Brake system repaired.

C5 REPLACE BRAKE SHOES AND LININGS

- Replace rear brake shoes and linings and road test vehicle.

Is shudder/vibration present?

Yes	No
DETERMINE which brake drum is at fault and REPLACE.	Brake system repaired.

PINPOINT TEST D: PEDAL GOES DOWN FAST

D1 ROAD TEST

- Road test vehicle only if condition cannot be verified in shop.
- Statically depress brake pedal.

Does brake pedal operate properly?

Yes	No
Vehicle OK.	GO to **D2** .

D2 CHECK BRAKE FLUID LEVEL

- Check brake fluid level.

Is fluid level within specifications?

Yes	No
GO to **D3** .	CHECK reservoir sealing points. ADD fluid and BLEED system. REPEAT Test **D1** .

D3 PRESSURIZE SYSTEM

- Pump brake pedal rapidly (five times).

Does brake pedal maintain height throughout test?

Yes	No
CHECK rear brake adjustment and ADJUST if necessary. If condition still exists, BLEED system. REPEAT Test **D1** .	GO to **D4** .

D4 INSPECT FOR BRAKE SYSTEM LEAKS

- Perform Hydraulic Leak Test — Pinpoint Test Q in this section.

Does system leak?

Yes	No
SERVICE as necessary. ADD fluid and BLEED system. REPEAT Test **D1** .	GO to **D5** .

D5 BRAKE MASTER CYLINDER BYPASS TEST

- Perform Brake Master Cylinder Bypass Condition Check — Pinpoint Test R in this section.

Is test OK?

Yes	No
System OK.	REPLACE damaged parts. ADD fluid and BLEED system. REPEAT Test **D1** .

PINPOINT TEST E: PEDAL GOES DOWN SLOWLY

E1 ROAD TEST

- Check if condition occurs during actual stopping application by depressing the brake pedal while the vehicle is moving.

Does condition occur when vehicle is moving?

Yes	No
GO to **E2** .	Condition occurs only when vehicle is stationary. Normal condition. No action required.

E2 RECHECK BRAKE SYSTEM LEAKS

- Perform Hydraulic Leak Test — Pinpoint Test Q in this section.

Does system leak?

Yes	No
SERVICE as necessary, ADD fluid and BLEED system. REPEAT Test **E1** .	GO to **E3** .

E3 MASTER CYLINDER BYPASS TEST

- Perform Brake Master Cylinder Bypass Condition Check — Pinpoint Test R in this section.

Is test OK?

Yes	No
System OK.	REPLACE damaged parts, ADD fluid and BLEED system. REPEAT Test **E1** .

PINPOINT TEST F: PEDAL IS LOW OR FEELS SPONGY

F1 BRAKE PEDAL CHECK

- Statically apply brake pedal.
- Road test vehicle only if condition cannot be verified in shop.

Does brake pedal operate properly?

Yes	No
Vehicle OK.	GO to **F2** .

F2 BRAKE PEDAL RESERVE CHECK

- Key ON, engine running at idle with transmission in PARK or NEUTRAL.
- Depress brake pedal lightly three or four times.
- Wait 15 seconds to allow the vacuum to replenish.
- Push down on brake pedal until it stops moving downward or an increased resistance to the brake pedal travel occurs.

  NOTE: This increased resistance may feel like the pedal has bottomed out.

- Hold the brake pedal in the applied position while increasing the engine speed to 2000 rpm.
- Release the accelerator pedal.

Does the brake pedal move downward as engine speed returns to normal?

Yes	No
GO to **F3** .	CHECK vacuum to power brake booster. REFER to Section 06-07 .

F3 BRAKE FLUID LEVEL CHECK

- Check brake fluid level.

Is brake fluid level within specifications?

Yes	No
GO to **F4** .	CHECK brake master cylinder reservoir sealing points. ADD fluid and BLEED system.

F4 FILLER CAP VENT CHECK

- Check if brake master cylinder filler cap vent holes are clogged or dirty.

Are holes clogged or dirty?

Yes	No
CLEAN as necessary. REPEAT Test **F1** .	GO to **F5** .

F5 BLEED BRAKE SYSTEM

- Bleed brake system. Refer to Section 06-06 .

Has the condition been corrected?

Yes	No

Vehicle OK.	GO to **F6** .

F6 FRONT WHEEL BEARING ADJUSTMENT

- Check front wheel bearings for proper adjustment.

Are bearings properly adjusted?

Yes	No
CHECK rear brake adjustment and ADJUST if necessary. REPEAT Test **F1** .	ADJUST front wheel bearings. REPEAT Test **F1** .

PINPOINT TEST G: BRAKE LOCKUP DURING LIGHT BRAKE PEDAL FORCE

G1 TIRE CHECK

- Check tires for uneven wear and correct pressure.

Is there a wear or pressure concern?

Yes	No
CORRECT tire concern. REFER to Section 04-04 .	GO to **G2** .

G2 BRAKE SHOE AND LINING CHECK

- Inspect brake shoe and linings for contamination, correct installation, damage, correct size and type.

Is there a brake shoe and lining concern?

Yes	No
REPAIR or REPLACE brake shoe and lining. REFER to Section 06-02 , Section 06-03 .	GO to **G3** .

G3 PARKING BRAKE CHECK

- Inspect parking brake components for damage or seized condition.

Is there a parking brake concern?

Yes	No

CORRECT parking brake concern. REFER to Section 06-05 .	GO to **G4** .

G4 WHEEL BEARING CHECK

- Raise vehicle enough to relieve weight on tires.
- Pull alternately on front and rear of each tire to check for loose or damaged wheel bearings.

Is there a wheel bearing concern?

Yes	No
CORRECT the wheel bearing concern. REFER to the appropriate section in Group 04 or Section 05.	GO to **G5** .

G5 POWER BRAKE BOOSTER PUSH ROD CHECK

- Support the brake master cylinder and remove the brake master cylinder mounting nuts.
- Position the brake master cylinder out of the way.
- With a shop-fabricated gauge, check the power brake booster push rod adjustment.
- The exposed end of the power brake booster push rod should be within 24.89-25.27mm (0.980-0.995 in.) of the brake master cylinder mounting surface on the power brake booster.

Does the power brake booster push rod require adjustment?

Yes	No
ADJUST as necessary. REFER to Section 06-07 .	GO to **G6** .

G6 ABS CHECK

- Perform the appropriate diagnostic tests in Section 06-09A or Section 06-09B to check for defective dump valve.

Is there an anti-lock brake system concern?

Yes	No
REPAIR or REPLACE the worn or damaged anti-lock brake system component. REFER to Section 06-09A or Section 06-09B .	To CHECK for possible missed symptoms, GO to **G1** .

PINPOINT TEST H: EXCESSIVE AND/OR ERRATIC PEDAL TRAVEL

H1 ROUGH ROAD TEST

- Road test vehicle under rough road conditions.
- Apply brakes slowly.

Are brakes good?

Yes	No
Vehicle OK.	GO to **H2** .

H2 WHEEL BEARING CHECK

- Check for loose front wheel bearings.

Are front wheel bearings loose?

Yes	No
REPLACE front wheel bearing if damaged. TIGHTEN front wheel bearing assembly to specification. REPEAT **H1** .	CHECK front disc brake rotor for thickness variances. REFER to Section 06-03 .

PINPOINT TEST J: BRAKES DRAG

J1 BRAKE FUNCTION TEST

- Road test vehicle and apply brakes.

Are brakes functional?

Yes	No
Vehicle OK.	CHECK power brake vacuum booster push rod. REPEAT **J1** .

PINPOINT TEST K: BRAKE SHUDDER

K1 ROAD TEST

- With standard wheels and tires installed, road test the vehicle and verify the condition.

Do the front brakes chirp, shudder or vibrate?

Yes	No
If shudder or vibration occurs, GO to **K2** .	A front brake chirp is normal condition. No repair required.

K2 APPLY PARKING BRAKE

- Lightly apply the parking brake while road testing the vehicle.

Does the vehicle shudder or vibrate when braking?

Yes	No
CHECK the rear brakes. GO to **K4** .	CHECK the front brakes. GO to **K3** .

K3 RESURFACE DISC BRAKES

- Resurface front disc brake rotors and road test vehicle.

Does the condition persist?

Yes	No
REPLACE front disc brake rotors.	Brakes check OK.

K4 REFINISH DRUM BRAKES

- Refinish brake drums and road test vehicle.

Does the condition persist?

Yes	No
REPLACE brake drums. REPEAT **K1** .	Brakes check OK.

PINPOINT TEST L: EXCESSIVE BRAKE PEDAL EFFORT, BOOSTER SYSTEM OK

L1 BRAKE PEDAL LINKAGE TEST

- Detach booster push rod from brake pedal pin and depress brake pedal fully.

Has condition been corrected?

Yes	No
CHECK power brake booster vacuum	SERVICE or REPLACE brake pedal linkage.

availability. REFER to Section 06-07 .	VERIFY system OK.

PINPOINT TEST M: BRAKE NOISE

M1 CHECK PEDAL NOISE

- Run engine at fast idle for 10 seconds or longer. Apply brake pedal and listen for noise. Compare results with known good system.

Was a noise present?

Yes	No
GO to **M2** .	Vehicle OK.

M2 PUSH ROD ADJUSTMENT

- Check and adjust power brake booster push rod. Refer to Section 06-07 .

Is push rod OK?

Yes	No
BLEED brake system.	REPLACE power brake booster. REPEAT Step **M1** .

PINPOINT TEST N: SLOW OR INCOMPLETE BRAKE PEDAL RETURN

N1 CHECK BRAKE PEDAL RETURN

- Run engine at fast idle while making several brake applications. Pull brake pedal rearward with approximately 44.5N (10 lbs.) force. Release the brake pedal and measure the distance to the toe board. Make a hard brake application. Release the brake pedal and measure the brake pedal to toe board distance. The brake pedal should return to its original position.

Did brake pedal return to original position?

Yes	No
Vehicle OK.	GO to **N2** .

N2 CHECK BRAKE PEDAL BINDING

- Check brake pedal to be sure it is operating freely.

Is the brake pedal operating freely?

Yes	No
REPLACE power brake booster.	CORRECT any sticking or binding. REPEAT N2.

PINPOINT TEST P: VIBRATION, PEDAL PUMPING, LOW PEDAL, BRAKE CHATTER

P1 ISOLATION TEST

- Perform road tests and static tests to isolate trouble to the front, rear or parking brake system.

Has the condition been isolated?

Yes	No
REPAIR, REPLACE or ADJUST components of system as necessary. REFER to the appropriate section in Group 06.	REPEAT P1.

PINPOINT TEST Q: HYDRAULIC LEAK TEST

Q1 CHECK FOR LEAKS

- Apply the brakes and check for leaks.

Are any leaks found?

Yes	No
REPLACE leaking parts as required.	GO to Q2.

Q2 REAR BRAKE LEAK CHECK

- Inspect all rear wheel cylinders or rear disc brake calipers for leaks.

Do rear wheel cylinders or rear disc brake calipers check OK?

Yes	No
GO to Q3.	REPLACE or REBUILD rear wheel cylinders or rear disc brake calipers as required.

Q3 FRONT BRAKE LEAK CHECK

- Inspect front disc brake calipers for leaks.

Do front disc brake calipers check OK?

Yes	No
GO to **Q4** .	REPLACE or REBUILD front disc brake calipers as required. RETEST.

Q4 MASTER CYLINDER LEAK CHECK

- Disconnect the brake master cylinder connector tubes from the brake master cylinder.
- Plug the output ports using the appropriate size flared tube type plugs.
- Push down hard on the brake pedal.

Does the brake pedal slowly move downward?

Yes	No
REPLACE or REBUILD the brake master cylinder as required.	Hydraulic system checks OK.

PINPOINT TEST R: BRAKE MASTER CYLINDER BYPASS CONDITION CHECK

R1 FLUID LEVEL CHECK

- Check the fluid level in the brake master cylinder reservoir.

Is the reservoir low or empty?

Yes	No
FILL the brake master cylinder reservoir to the correct level. GO to **R2** .	GO to **R2** .

R2 FLUID LEVEL CHECK, BRAKES APPLIED

- Apply brakes very slowly several times while observing the brake fluid level in the brake master cylinder reservoir.

  NOTE: Brake master cylinder bypass typically occurs when the brakes are applied very slowly and line pressures are low. A "hard" application can flare the internal lip seals out and result in a passing test where the concern may in fact be valid.

Does the level remain the same?

Yes	No
GO to **R3** .	Brake master cylinder checks OK.

R3 WHEEL TURNING TORQUE CHECK, FRONT WHEELS

- Place transmission in NEUTRAL.
- Raise front wheels off of ground.
- Apply 445 N (100 lbs.) evenly over a period of 30 seconds to the brakes and hold for approximately 15 seconds.
- While holding brakes, exert 101 N (75 lbs.) force to front wheels.

Does either wheel rotate?

Yes	No
SERVICE brake master cylinder as required.	Front chamber of brake master cylinder checks OK. GO to **R4** .

R4 WHEEL TURNING TORQUE CHECK, REAR WHEELS

- Place transmission in NEUTRAL.
- Raise rear wheels off of ground.
- Apply 445 N (100 lbs.) evenly over a period of 30 seconds to the brakes and hold for approximately 15 seconds.
- While holding brakes, exert 101 N (75 lbs.) force to rear wheels.

Does either wheel rotate?

Yes	No
SERVICE brake master cylinder as required.	Rear chamber of brake master cylinder checks OK.

PINPOINT TEST S: EXCESSIVE PEDAL EFFORT, VACUUM BOOST SYSTEM

S1 VACUUM CHECK

- Disconnect vacuum booster hose from booster.
- Connect Rotunda Vacuum/Pressure Tester 059-00008 or equivalent to the vacuum hose with a T-fitting.
- Key on, engine running. Allow engine to reach normal operating temperature.
- Record the vacuum reading.

Is the vacuum reading at least 51-64 kPa (15-19 in-Hg)?

Yes	No
GO to S2 .	LOCATE and REPAIR source of low vacuum.

S2 SYSTEM INSPECTION

- Key OFF.
- Reconnect the vacuum line.
- Inspect power brake booster check valve, rubber grommet and all vacuum plumbing for cracks, holes, bad connections or missing clamps.
- Push down on brake pedal and hold.
- Key ON, engine running.

Does the brake pedal move downward when the engine is started?

Yes	No
Vacuum system is OK.	GO to S3 .

S3 COMPONENT ISOLATION CHECK

- Key OFF.
- Reconnect the vacuum gauge to the same point as in Step S1, but leave the rest of the system connected.
- Key ON, engine running at idle until vacuum reaches 51-64 kPa (15-19 in-Hg).
- Key OFF.
- Observe vacuum gauge for 1 minute.

Does vacuum pressure drop more than 3.4 kPa (1 in-Hg)?

Yes	No
DISCONNECT each component one at a time and REPEAT the test procedures in Step S3 until the leaking component is found. PLUG the disconnected vacuum line while performing the test procedures. REPAIR or REPLACE as required.	GO to S4 .

S4 BOOSTER LEAK CHECK

- Key ON.
- Run engine until vacuum reaches 51-64 kPa (15-19 in-Hg).
- Key OFF.
- Push down on the brake pedal and hold for a few seconds and release.

Does the vacuum drop to 0 kPa (0 in-Hg)?

Yes	No

REPLACE or REBUILD power brake booster as required.	System checks OK. REMOVE vacuum gauge and RECONNECT all vacuum lines.

PINPOINT TEST T: BRAKE FLUID LOSS, BRAKE MASTER CYLINDER INTERNAL TEST OK

T1 FLUID LEVEL CHECK

- Check fluid level in brake master cylinder reservoir.

Is fluid level in brake master cylinder reservoir full?

Yes	No
GO to **T2** .	Low or empty brake master cylinder reservoir with no brake warning indicator. REPLACE brake master cylinder reservoir.

T2 FLUID LEVEL CONDITION

- Apply and release brake pedal one full stroke. Observe reservoir fluid level as brake pedal is released.

Does fluid level change?

Yes	No
External leak outside of the brake master cylinder. REPAIR leak.	GO to **T3** .

T3 MASTER CYLINDER CONDITION

- Wipe off exterior of brake master cylinder, brake master cylinder filler cap and gasket with clean cloth.
- Road test vehicle and pump brakes.
- Check if brake master cylinder exterior is dry or wet.
- Check for fluid from bore end of power brake booster at dash.

Is brake master cylinder dry?

Yes	No
GO to **T4** .	External leak in brake master cylinder. REPAIR brake master cylinder.

T4 BRAKE PEDAL CONDITION CHECK

- Apply pressure to brake pedal one full stroke and release, repeat 3 more cycles.

Does brake pedal go down 3.175mm (0.125 inch) each time?

Yes	No
CHECK entire brake system for major leak. REPAIR as required.	Brake master cylinder OK.

Component Tests

WARNING: USE OF ANY OTHER THAN THE APPROVED DOT 3 BRAKE FLUID WILL CAUSE PERMANENT DAMAGE TO BRAKE COMPONENTS AND WILL RENDER THE BRAKES INOPERATIVE.

NOTE: Always check the fluid level in the brake master cylinder reservoir (2K478) before performing the test procedures.

If the fluid level is not at the MAX line on the brake master cylinder reservoir, add High Performance DOT 3 Brake Fluid C6AZ-19542-AB or DOT 3 equivalent fluid meeting Ford specification ESA-M6C25-A, DOT 3.

If a brake is locked and the vehicle must be moved, open a bleeder screw at the locked wheel (1007) to let out enough fluid to relieve the pressure. Close the bleeder screw. This bleeding operation may release the brakes but will not correct the cause of trouble. If this does not relieve the locked wheel condition, service the locked components before proceeding.

Brake Booster Functional Test

Inspect all hoses and connections. All unused vacuum connectors should be capped. Hoses and their connections should be properly secured and in good condition with no holes or collapsed areas.

Brake Booster Operation Check

1. Check hydraulic brake system for leaks or insufficient fluid.
2. With transmission (7003) in NEUTRAL, stop engine (6007) and apply parking brake control (2780). Apply brake pedal (2455) several times to exhaust all vacuum in the system.
3. Apply brake pedal and hold it in the applied position. Start engine. If vacuum system is operating, brake pedal will tend to move downward under constant foot pressure. If no motion is felt, the power brake booster system is not functioning.

Brake Booster

1. Remove vacuum booster hose from power brake booster and check valve connection. Manifold vacuum should be available at the check valve end of the vacuum booster hose with engine at idle speed and transmission in NEUTRAL. If manifold vacuum is available to the power brake booster, connect vacuum booster hose to power brake booster and repeat Steps 2 and 3 of the brake booster functional test. If no downward movement of brake pedal is felt, replace power brake booster.
2. Operate engine a minimum of 10 seconds at fast idle. Stop engine, and let vehicle stand for 10 minutes. Then, apply brake pedal with approximately 89 N (20 lbs.) of force. Brake pedal feel should be the same as that noted with engine operating. If brake pedal feels hard (no power assist), replace check valve and retest. If brake pedal feels spongy, bleed hydraulic system to remove air. Refer to Section 06-06 for Hydraulic System Bleeding.

Check Valve

The function of the power brake booster check valve is to allow manifold vacuum to enter the power brake booster and prevent the escape of vacuum in case manifold vacuum is lost during sustained full throttle operation.

To test the functioning of the power brake booster check valve:

- Start and run the engine for at least 10 seconds.
- Operate the brake pedal to check for power assist.
- Disconnect the vacuum booster hose from the power brake booster.
- There should be enough vacuum retained in the power brake booster for at least one more power-assisted brake operation.

Vacuum System Test

To test the vacuum system, refer to Pinpoint Test S in this section.

Brake Master Cylinder

Normal Conditions

The following conditions are considered normal and are not indications that the brake master cylinder (2140) is in need of service.

Condition 1: During normal operation of the brake master cylinder, the fluid level in the brake master cylinder reservoir will rise during brake application and fall during release. The net fluid level, i.e., after brake application and release, will remain unchanged.

Condition 2: A trace of brake fluid will exist on the power brake booster shell below the brake master cylinder mounting flange. This results from the normal lubricating action of the brake master cylinder bore and seal.

Condition 3: Brake fluid level will decrease with disc brake pad wear.

Abnormal Conditions

Changes in brake pedal feel or travel are indicators that something could be wrong in the brake system. Refer to the Symptom Chart for abnormal condition diagnosis.

Bypass Condition Test

For the bypass condition test, refer to Pinpoint Test R in this section.

Non-Pressure Leaks

The only part of the brake system that could have a brake fluid loss that did not appear when the system is under pressure is the brake master cylinder reservoir area. Brake fluid loss could be caused by a missing or poorly fitted brake master cylinder filler cap, from a punctured or otherwise damaged brake master cylinder reservoir, by a missing or damaged brake master cylinder filler cap gasket, or at the sealing grommets between the brake master cylinder and the brake master cylinder reservoir.

The brake master cylinder reservoir grommets are not separately serviceable and must be replaced with a new brake master cylinder reservoir.

NOTE: The wet appearance of the outer cover of rubber brake hoses is called "sweating." This is a normal condition for neoprene rayon braid hose. The "sweating" condition is not evidence of a brake fluid leak and will not result in a loss of pressure in the system.

Replace a flexible brake hose if it shows signs of softening, cracking or other damage.

When installing a new brake hose, position the hose to avoid contact with other vehicle parts.

Compensator Port Check

The purpose of the compensator ports in the brake master cylinder is to supply any additional brake fluid required by the system due to brake pad wear and to allow brake fluid returning from the brake lines to the brake master cylinder to enter the brake master cylinder reservoir.

The returning brake fluid will cause a slight turbulence in the brake master cylinder reservoir. If turbulence is seen in the brake master cylinder reservoir upon release of the brake pedal, this is normal and shows that the compensating ports are not plugged.

Brake Combination Valve, Aerostar

If there is a brake system concern such as premature rear brake lockup, that cannot be attributed to the rear anti-lock brake system (RABS), the cause may be a malfunctioning brake combination valve.

Check the brake combination valve by substituting the suspected bad valve with a known good one. If the condition persists, recheck the RABS. Refer to Section 06-09A .

Brakes, Disc

Front

1. **NOTE: For service, install a new disc brake caliper bracket bolt (Ranger only) or reuse the old bolt with thread locking compound such as Ford Threadlock and Sealer E0AZ-19554-AA or equivalent meeting Ford specification WSK-M2G315-A5 (Type II). Tighten to 100-130 Nm (74-96 lb-ft).**

   Inspect the disc brake caliper (2B120) and mounting for loose or damaged parts.

2. Check the front brake hose (2078) and front disc brake caliper fitting for leaks or damage.

3. Check the disc brake caliper closely for wet areas that might indicate a leaking seal.

4. Measure front disc brake rotor thickness, parallelism and runout carefully. Refer to Section 06-03 .

5. Resurface, recondition or replace the front disc brake hub and rotor (1102). A visual inspection will not determine the required service unless the damage is obvious.

6. Check for brake fluid contamination when inspecting the brake shoes and linings (2001). This may indicate a leaking piston seal assembly. If a seal is leaking, the disc brake caliper must be disassembled and inspected. Refer to Section 06-03 .

7. Check for even wear from side to side. If the set of brake shoes and linings on one side of the vehicle is excessively worn, the caliper piston may be seized in the bore on the opposite side of the vehicle. If a seized caliper piston is suspected, the disc brake caliper must be disassembled and inspected. Refer to Section 06-03 .

Brakes, Drum

In order to properly inspect the rear brakes, the brake drum (1126) must be removed. Refer to Section 06-02 . Check for the following conditions during a drum brake diagnosis:

1. Inspect the brake shoe and lining material for:

   - wear beyond service limits,
   - uneven wear,
   - cracks,
   - scoring,
   - gouges,
   - contamination from grease or brake fluid.

2. Inspect the rear wheel cylinder (2261) for signs of leakage.

3. **NOTE: A good spring will make a dull thud when dropped on a concrete floor. A heat-damaged spring that has lost tension will make a distinctive ringing sound when dropped on a concrete floor.**

   Check the brake shoe adjusting screw springs and brake shoe retracting springs (2296) for signs of:

   - heat damage,
   - bends or damage to coils or shank,
   - loss of tension.

4. Check the brake backing plate shoe support pads for signs of scoring. The support pads must be smooth and have a light coating of lithium grease.

5. Inspect the brake drum for scratches, scoring, bell mouth and out-of-round conditions.

6. Refer to Section 06-02 for additional service and repair procedures.

Brake Thickness

FRONT DISC

Description	4x2	4x4
Lining Thickness Inboard and Outboard	9.9mm (0.39 In.)	9.9mm (0.39 In.)

REAR DISC

Description	mm	Inch
Lining Minimum Thickness	3.12	1/8

REAR DRUM

Truck Series	Ranger Reg. and SuperCab Under 4580 GVWR	Ranger Reg. SuperCab over 4580 GVWR	All Aerostar
Lining Thickness Primary	4.8mm (.19 In.)	4.8mm (.189 In.)	4.8mm (.189 In.)
Lining Thickness Secondary	7.1mm (.28 In.)	6.2mm (.245 In.)	6.2mm (.245 In.)
Lining Length Primary	154.9mm (6.10 In.)	214.9mm (8.46 In.)	214.9mm (8.46 In.)
Lining Length Secondary	223.5mm (8.80 In.)	243.8mm (9.6 In.)	243.6mm (9.59 In.)

Hydraulic System

1. **NOTE: If dirt is found in any part of the hydraulic system, flush the entire system with clean isopropyl alcohol.**

   Clean brake parts in clean isopropyl alcohol or use the Rotunda Brake Parts Washer 065-00016 or equivalent.

2. Inspect all parts for wear or damage.

3. Check the wheel cylinder or caliper bore for rust, scores, or other damage.

4. Be sure the bleeder screw passage is clean and open.

5. Replace all parts that are worn or damaged.

Brake Master Cylinder

Clean all brake master cylinder parts in clean isopropyl alcohol, or use the Rotunda Brake Parts Washer 065-00016 or equivalent and inspect the parts for wear or damage. Replace them if required. When a master cylinder repair kit is used, follow the instructions in the kit and install all of the parts provided.

The following conditions are considered normal and are not indications that the brake master cylinder reservoir (2K478) is in need of service:

- Low brake fluid level detected without signs of leakage. This condition is caused by displacement of brake fluid from the brake master cylinder reservoir into the front disc brake calipers (2B120) to compensate for normal brake wear. Add brake fluid as needed.
- A momentary or slight squirt of brake fluid from the brake master cylinder reservoir upon application of the brake pedal (2455). This condition is caused by brake fluid displacement through the brake master cylinder reservoir compensating port as the brake master cylinder pistons move forward in the bore when the brakes are applied.
- Slight turbulence in the brake fluid when the brake pedal is released. Turbulence occurs as brake fluid returns to the brake master cylinder (2140) after releasing the brakes.
- A trace of brake fluid found on the outside of the power brake booster (2005) below the brake master cylinder mounting flange. This condition results from the lubricating action of the master cylinder wiping seal.

Make sure all ports and vents in the brake master cylinder are open and free of foreign matter.

Brake Tubing

Clean new brake tubing with isopropyl alcohol. Inspect for cracks, kinks or other damage. Replace as necessary.

Brake Booster

Inspect the power brake booster for damage, misalignment, or loose mounting nuts. Make sure the vacuum supply hose connection is secure. A trace of brake fluid below the brake master cylinder mounting is normal and is caused by the wiping action of the brake master cylinder piston seals.

Parking Brake

- Inspect the parking brake control (2780) and look for loose mounting bolts, damaged or missing parts.
- Operate the parking brake and check for binding or seized components.
- Raise and support the vehicle and remove any debris that may interfere with parking brake operation.
- Check the condition of the parking brake cables. Look for abrasion or cables rubbing on body or frame parts. Repair, replace or reroute as necessary.
- Remove the brake drums (1126) and have an assistant operate the parking brake just enough to observe operation. Look for damaged or missing parts.
- Lubricate parking brake parts with Disc Brake Caliper Slide Grease D7AZ-19590-A or equivalent meeting Ford specification ESA-M1C172-A.

Brake Pedal

On dual brake master cylinder (2140) with power brake booster-equipped vehicles, the brake systems are designed to permit a full stroke of the brake master cylinder when the brake pedal (2455) is fully depressed. A brake pedal clearance adjustment is not required.

If brake pedal travel seems restricted, check for obstructions.

Free Play

To release the brakes, fluid must flow back to the brake master cylinder (2140) through a return port when brake pedal pressure is released. To be sure the brake master cylinder piston moves back far enough to expose the return port, free play is built into the brake pedal linkage on power brake booster systems. This prevents the caliper piston or wheel cylinder piston from becoming trapped in a partially released position. If a problem is suspected, the push rod and brake pedal (2455) should be checked to make sure they are not binding. Pedal free play is not always perceptible in dash-mounted booster systems, because the operating clearance for the brake master cylinder piston is adjusted at the booster push rod, rather than the brake pedal linkage. Refer to Section 06-07 for instructions on dash-mounted booster push rod adjustment.

Brakes, Rear, Drum

WARNING: BRAKE FLUID CONTAINS POLYGLYCOL ETHERS AND POLYGLYCOLS. AVOID CONTACT WITH EYES. WASH HANDS THOROUGHLY AFTER HANDLING. IF BRAKE FLUID CONTACTS EYES, FLUSH WITH RUNNING WATER FOR 15 MINUTES. GET MEDICAL ATTENTION IF IRRITATION PERSISTS. IF TAKEN INTERNALLY, DRINK WATER AND INDUCE VOMITING. GET MEDICAL ATTENTION IMMEDIATELY.

Rear brake shoes and linings (2200) are adjusted automatically by sharply applying brake while alternately driving the vehicle forward and reverse. Brake adjustment occurs during reverse stops only. Manual brake adjustment is required when the brake shoes are replaced, or if the brake shoe adjusting lever cables (2A178) have malfunctioned. Refer to Section 06-02 .

Keep the brake master cylinder reservoir (2K478) filled with High Performance DOT 3 Brake Fluid C6AZ-19542-AB or DOT 3 equivalent fluid meeting Ford specification ESA-M6C25-A, DOT 3. **Never use brake fluid that has been drained from the system.**

Hydraulic Brake Fluid Color

NOTE: Brake fluid contaminated with a hydrocarbon/mineral based fluid (power steering or transmission fluid) can be detected by an obvious swelling of the brake master cylinder filler cap gasket. If the swollen gasket condition is present, all brake system rubber parts must be replaced. All brake tubes must be thoroughly flushed with High Performance DOT 3 Brake Fluid C6AZ-19542-AB or DOT 3 equivalent fluid meeting Ford specification ESA-M6C25-A DOT 3 before the vehicle goes back into service.

Hydraulic brake fluid color must conform with the requirements of Federal Motor Vehicle Safety Standard 116. Under this standard, brake fluids are visually different from other automotive fluids such as transmission, power steering and engine oil.

The color of the brake fluid in a normal brake system in service can vary from its original color for many reasons. Sometimes a brake master cylinder (2140) may show significantly different shades of color of brake fluid in the brake master cylinder reservoir (2K478). Some of the reasons for the apparent difference in color in a system are listed below.

- Brake fluid discoloration can occur due to heat and/or aging.
- Brake fluid discoloration can exist when different brands/shades of brake fluid are used in topping off during normal service.
- Brake fluid discoloration can occur through the dissolving of color dye used on brake master cylinder internal springs in manufacturer's assembly procedure.

Brake Fluid Level Check

WARNING: BRAKE FLUID CONTAINS POLYGLYCOL ETHERS AND POLYGLYCOLS. AVOID CONTACT WITH EYES. WASH HANDS THOROUGHLY AFTER HANDLING. IF BRAKE FLUID CONTACTS EYES, FLUSH EYES WITH RUNNING WATER FOR FIFTEEN MINUTES. GET MEDICAL ATTENTION IF IRRITATION PERSISTS. IF TAKEN INTERNALLY, DRINK WATER AND INDUCE VOMITING. GET MEDICAL ATTENTION IMMEDIATELY.

Check the brake fluid level in the brake master cylinder reservoir (2K478) on the brake master cylinder (2140). The brake fluid level should be at or near the MAX mark. If the brake fluid level is low, inspect the brake system and add brake fluid as directed in the following procedure.

Brake System Service

1. **WARNING: USE OF A BRAKE FLUID THAT DOES NOT MEET DOT 3 SPECIFICATION, COULD DAMAGE THE HYDRAULIC BRAKE SYSTEM AND CAUSE BRAKE FAILURE.**

   Clean and remove the brake master cylinder filler cap from the brake master cylinder reservoir.

2. Fill the brake master cylinder reservoir to the MAX line with High Performance DOT 3 Brake Fluid C6AZ-19542-AB or DOT 3 equivalent fluid meeting Ford specification ESA-M6C25-A, DOT 3.

3. Install the brake master cylinder filler cap on the brake master cylinder reservoir.

Brake Rotor, Disc

Each time the brakes are serviced, the disc brake rotor should be checked for scoring, runout, parallelism and thickness.

Disc brake rotor scoring and runout may be checked on most brakes with the disc brake rotor either on or off.

Disc brake rotor specifications are listed in the Specifications at the end of this section.

Runout

Disc brake rotor lateral runout is the side-to-side movement or wobble of the disc brake rotor as it rotates. Excessive runout may cause vibration, brake pedal pumping, low brake pedal (2455) or brake chatter. Use the following procedure to check disc brake rotor runout.

1. Tighten the wheel hub retainer to eliminate all end play from the wheel bearing. Be sure the disc brake rotor can be turned.

2. Attach Dial Indicator with Bracketry TOOL-4201-C or equivalent to some part of the vehicle suspension so the stylus of the indicator touches the surface of the disc brake rotor approximately 25.4mm (one inch) from outer edge of the disc brake rotor.

3. Adjust the dial indicator to mid travel. Zero the scale on the dial indicator. Slowly turn the disc brake rotor one complete turn and note the high and low readings on the dial. The total between the high

and low reading must not exceed the specified runout limit.

4. **CAUTION: Be sure to adjust the wheel hub retainer to specifications after the runout check.**

   Refinish or replace the disc brake rotor as required.

Parallelism

Parallelism is the variations in the thickness of the disc brake rotor. If the two rubbing surfaces of the disc brake rotor are not parallel, the disc brake rotor may cause excessive brake pedal travel, a pulsating brake pedal, or noise.

Two methods can be used to check if the two faces of a disc brake rotor are parallel. A micrometer can be used to measure the disc brake rotor thickness at 12 points approximately 30 degrees apart and 25.4mm (1 inch) from the outer edge of the disc brake rotor.

The other method is to measure the disc brake rotor on a precision lathe designed for machining disc brake rotors. Attach two dial indicators, one on each side of the disc brake rotor, so that the stylus on each indicator contacts the rubbing surface, directly opposite each other, approximately 25.4mm (1 inch) from the outer edge of the disc brake rotor.

Zero both indicators and rotate the disc brake rotor while watching both dials. If the total readings of both indicators exceed the specified limit for parallelism, the disc brake rotor must be refinished or replaced.

Refinishing

Use a disc brake lathe to refinish the disc brake rotor. (Follow manufacturer's instructions.)

Replace the disc brake rotor when the overall thickness is at or below the specified minimum thickness shown on the disc brake rotor. Refer to Specifications at the end of this section for minimum (discard) disc brake rotor thickness, maximum brake surface lateral runout, thickness variation, and surface finish.

Service Limits

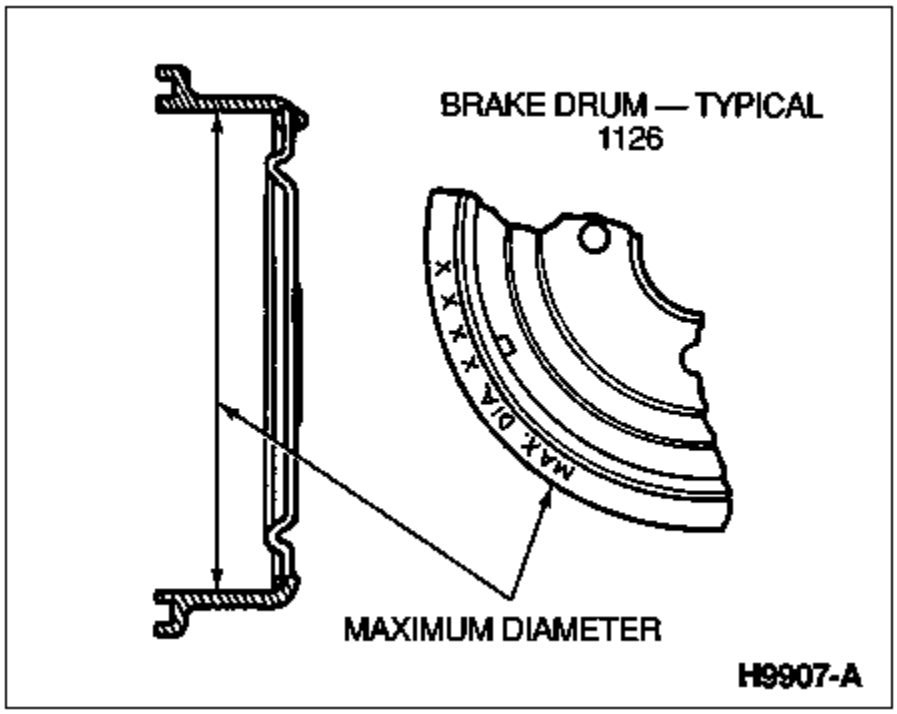
WARNING: NEVER INSTALL A DISC BRAKE ROTOR THAT HAS BEEN TURNED TO MINIMUM WEAR OR DISCARD THICKNESS.

Measure the thickness of the disc brake rotor to determine if it is within Specifications listed at the end of this section. Disc brake rotor minimum (discard) thickness is stamped on the disc brake rotor. Disc brake rotors have a minimum thickness dimension (minimum wear thickness or discard thickness). This is not the refinishing dimension.

Brake Drum

Maximum Diameter

Brake drum maximum diameter is molded into the rim of the brake drum (1126). The brake drum may be machined enough to correct scoring but only up to the MAX. DIA. dimension. If, after machining, the brake drum inside braking surface diameter exceeds the specification, it must be discarded.



SPECIFICATIONS

Brake System Component Specifications

Front Disc Brake Lining And Rotor Dimensions, Aerostar

Truck Series	Aerostar 4x2	Aerostar 4x4
Caliper Part Number (RH) [a]	F09A-AA	F09A-AA
Caliper Part Number (LH) [a]	F09A-AA	F09A-AA
Outer Dia. of Rotor Braking Surface	261.2mm (10.28 In.)	276.0mm (10.86 In.)
Inner Dia. of Rotor Braking Surface	165.7mm (6.52 In.)	168.0mm (6.61 In.)
Swept Area per Front Brake	56192mm (87.09 In.)	60721mm (94.11 In.)
Lining Width Inboard	41.5mm (1.63 In.)	41.5mm (1.63 In.)
Lining Width Outboard	41.5mm (1.63 In.)	42.1mm (1.63 In.)
Lining Area per Brake — Inboard	4432mm (6.87 In.)	5388mm (8.35 In.)
Lining Area per Brake — Outboard	5258mm (8.15 In.)	5887mm (9.12 In.)
Lining Thickness Inboard	9.32mm (.367 In.)	9.32mm (.376 In.)
Lining Thickness Outboard	8.46mm (.333 In.)	8.46mm (.333 In.)
Rotor Width	22.1mm (.87 In.)	22.1mm (.87 In.)
Rotor Type	Vented	Vented
Caliper Type	Pin-Rail	Pin-Rail
No. of Piston(s) per Brake	One	One
Caliper Piston Diameter	65.95mm (2.59 In.)	65.95mm (2.59 In.)
Effective Radius	107.14mm (4.22 In.)	115.14mm (4.53 In.)
Rotor Minimum Thickness	20.6mm (0.81 In.)	20.6mm (0.81 In.)

[a] Caliper Base Part Number: RH = 2B120; LH = 2B121.

Brake Lining And Rotor Dimensions, Ranger

Truck Series	Ranger 4x2	Ranger 4x4
Caliper Part Number (RH)	F57A-2B120-DC	F57A-2B120-AC
Caliper Part Number (LH)	F57A-2B121-DC	F57A-2B121-AC
Outer Dia. of Rotor Braking Surface	261.2mm (10.28 In.)	286.6mm (11.28 In.)
Inner Dia. of Rotor Braking Surface	165mm (6.5 In.)	180mm (7.1 In.)
Swept Area per Front Brake	58746mm ^{2} (41.1 In. ^{2})	65686mm ^{2} (101.8 In. ^{2})
Lining Dim. Inboard	136 x 33.6mm (5.35 x 1.32 In.)	136 x 33.6mm (5.35 x 1.32 In.)
Lining Dim. Outboard	136 x 33.6mm (5.35 x 1.32 In.)	136 x 33.6mm (5.35 x 1.32 In.)
Lining Area per Brake Inboard	54.5cm ^{2} (8.45 In. ^{2})	54.5cm ^{2} (8.45 In. ^{2})
Lining Area per Brake Outboard	54.5cm ^{2} (8.45 In. ^{2})	54.5cm ^{2} (8.45 In. ^{2})
Lining Thickness Inboard and Outboard	9.9mm (0.39 In.)	9.9mm (0.39 In.)
Rotor Width	26.0mm (1.023 In.)	26.0mm (1.023 In.)
Min. Service	24.5mm (0.964 In.)	24.5mm (0.964 In.)
Rotor Type	Vented Rad. Fins	Vented Rad. Fins
Caliper Type	Pin-Slider Bolt-On-Anchor	Pin-Slider Bolt-On-Anchor
Number of Pistons per Brake	2	2
Caliper Piston Dia.	46mm (1.81 In.)	46mm (1.81 In.)
Effective Radius	107.8mm (4.21 In.)	120.7mm (4.75 In.)

Rear Drum Brake Specifications

Truck Series	Ranger Reg. and SuperCab Under 4580 GVWR	Ranger Reg. SuperCab over 4580 GVWR	All Aerostar
Axle Usage, Front	2540/ 2580/2650	2750 2800	2650
Axle Usage, Rear	2750/2950	2750/3200	2950
Type	DSSA	DSSA	DSSA
Size	228.6 x 44.45mm (9 x 1.75 In.) [a]	254 x 63.5mm (10 x 2.5 In.) [b]	254 x 63.5mm (10 x 2.5 In.)

[a] Ranger SuperCab with Limited Slip axles have 254 x 63.5mm (10 x 2.5 inch) rear brake regardless of

GVWR.
[b] 228.6 x 44.45mm (9 x 1.75 In.) standard with 2.3L engine.

Bore Diameters — Rear Wheel Cylinders

Truck Series	Ranger Reg. and SuperCab Under 4580 GVWR	Ranger Reg. SuperCab over 4580 GVWR	All Aerostar
Rear Wheel Cylinder Bore (Inches)	19.0mm (0.75)	19.0mm (0.75)	22.23mm (.875 In.)

Rear Drum Brake Lining Dimensions

Truck Series	Ranger Reg. and SuperCab Under 4580 GVWR	Ranger Reg. SuperCab over 4580 GVWR	All Aerostar
Lining Thickness Primary	4.82mm (.19 In.)	4.80mm (.189 In.)	4.80mm (.189 In.)
Lining Thickness Secondary	7.1mm (.28 In.)	6.2mm (.245 In.)	.6.2mm (.245 In.)
Lining Length Primary	154.9mm (6.10 In.)	214.9mm (8.46 In.)	214.9mm (8.46 In.)
Lining Length Secondary	223.5mm (8.80 In.)	243.8mm (9.6 In.)	243.6mm (9.59 In.)

General Specifications

Description	Specification
Adjustments	
Power Brake Booster Push Rod Length mm (in)	24.89-25.27 (0.980-0.995)
Lubrication	
High Performance DOT 3 Brake Fluid C6AZ-1954-AB	ESA-M6C25-A, DOT 3
Disc Brake Caliper Slide Grease D7AZ-19590-A	ESA-M1C172-A
Sealants	
Ford Thread Lock & Sealant E0AZ-19554-AA	WSK-M2G315-A5 (Type II)

Torque Specifications

Description	Nm	Lb-Ft	Lb-In
Brake Tube-To-Brake Master Cylinder Nuts	15-20	11-14	—
Hub Spindle Nut, Initial Torque	23-34	17-25	—
Hub Spindle Nut, Final Torque: Back Off from Initial Setting 120 to 180 Degrees and	2.03-	—	18-

Retighten to	2.26		20
Front Disc Brake Caliper Bracket Bolts (Ranger) NOTE: For service, install a new bolt or reuse the old bolt with thread locking compound such as Ford Threadlock and Sealer E0AZ-19554-AA or equivalent meeting Ford specification WSK-M2G315-A5 (Type II).	100-130	74-96	—
Front Disc Brake Caliper Pin Bolts (Ranger)	52-65	38-48	—

Lugnut Torque Requirement

NOTE: Torque specification is for nut and bolt threads free of dirt and rust. Do NOT use oil or grease on threads. Use only Ford recommended replacement fasteners.

Tighten lugnuts to 135 Nm (100 lb-ft).

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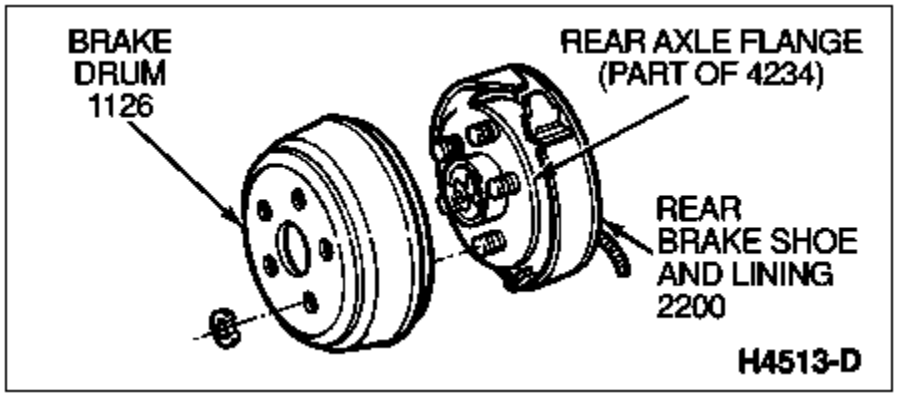
Brake Drum

WARNING: DO NOT INHALE DUST FROM BRAKES OR ASSOCIATED COMPONENTS. INHALATION OF DUST CAN BE INJURIOUS TO YOUR HEALTH. COMPRESSED AIR OR BRUSHES MUST NOT BE USED TO CLEAN BRAKES, BRAKE DRUMS (1126) AND ASSOCIATED COMPONENTS. A VACUUM CLEANER, SUCH AS ROTUNDA BRAKE/CLUTCH/SERVICE VACUUM 091-R0001 OR EQUIVALENT, EQUIPPED FOR THIS PURPOSE SHOULD BE CAREFULLY USED TO REMOVE ANY DUST. ADHERENT DUST SHOULD BE REMOVED WITH A DAMP RAG. ANY DUST SHOULD BE CONTAINED IN A SEALED AND LABELED BAG FOR DISPOSAL. WEAR AN APPROVED HIGH EFFICIENCY CARTRIDGE OR AIR LINE RESPIRATOR AND USE EXTRA CAUTION TO AVOID BREATHING THIS DUST. ALWAYS USE NON-ASBESTOS REPLACEMENT PARTS.



Removal

1. Raise and support the vehicle so the wheel (1007) is clear of the floor.
2. **CAUTION: Use of a drum puller or a torch is not recommended. Drum distortion may result.**

   Remove the hub cap, if equipped, and wheel.
3. Remove the retaining nut and remove the brake drum.
4. **CAUTION: Loosen the adjusting screw only if the brake drum cannot be removed. Do not burr, chip or damage the notches in the adjusting screw assembly or the self adjusting mechanism will not function properly.**

   If the brake drum is rusted to the axle shaft pilot, use coarse sandpaper or file to remove the rust buildup, then work the brake drum off.

   - If the brake drum will not come off, insert a narrow screwdriver through the brake adjusting hole in the brake backing plate (2211), and disengage the adjusting lever from the brake adjusting screw assembly. While holding the adjusting lever away from the brake adjusting

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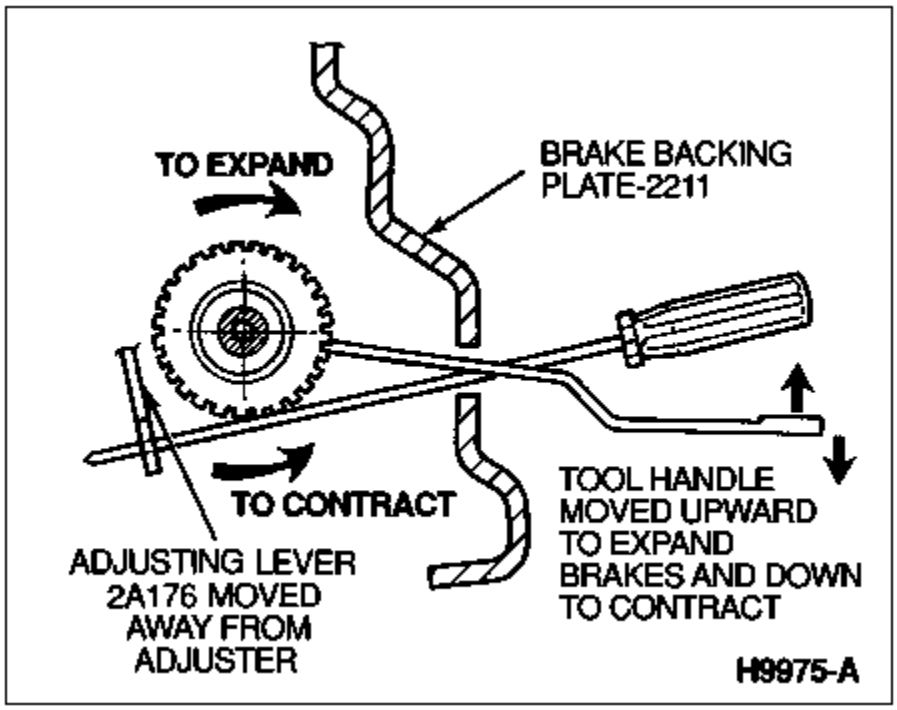
screw assembly, loosen the brake adjusting screw assembly with Brake Adjustment Tool D81L-1103-C or equivalent.

Ranger



Aerostar

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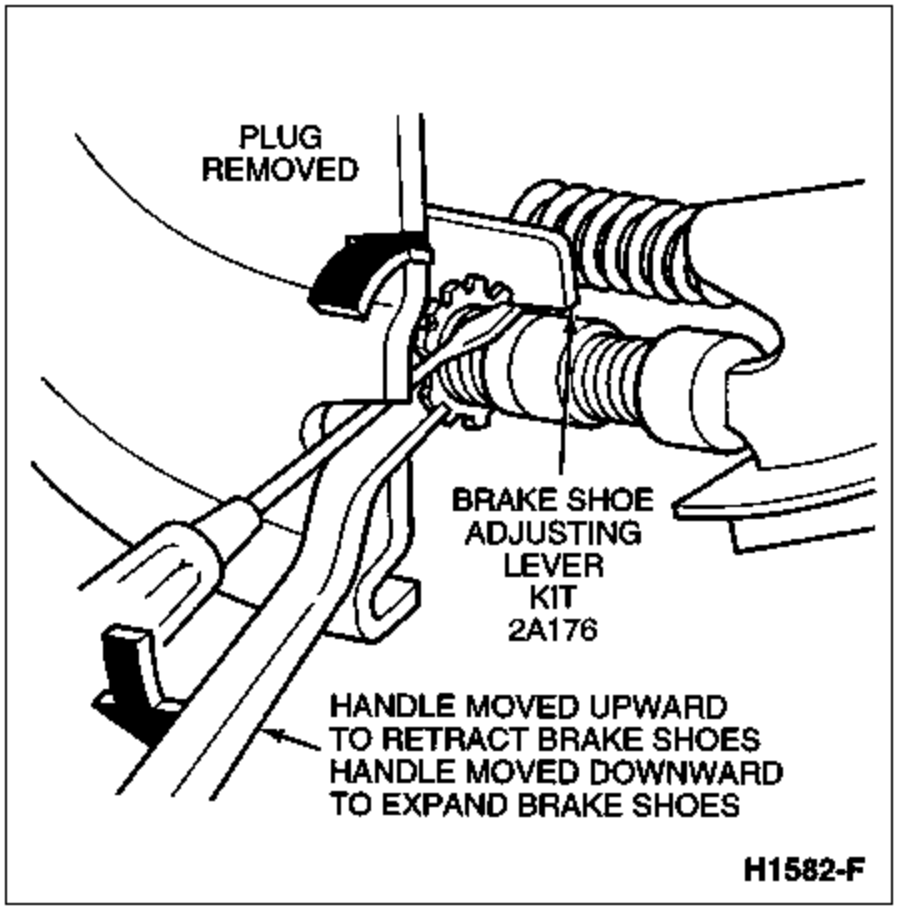

Installation

1. If a new brake drum is to be installed, remove the protective coating from the new brake drum with carburetor degreaser or equivalent.

2. Adjust the rear brake shoe and lining (2200) as described in this section using Brake Adjustment Gauge D81L-1103A or equivalent. Brake drum turning may be performed as long as the maximum inside diameter is not exceeded. The maximum inside diameter is cast into the drum face.

3. Install the brake drum.

4. Install the wheel on the wheel hub bolts against the brake drum, and tighten the lug nuts (1012) to 135 Nm (100 lb-ft).

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Brake Shoes and Lining

SPECIAL SERVICE TOOL(S) REQUIRED

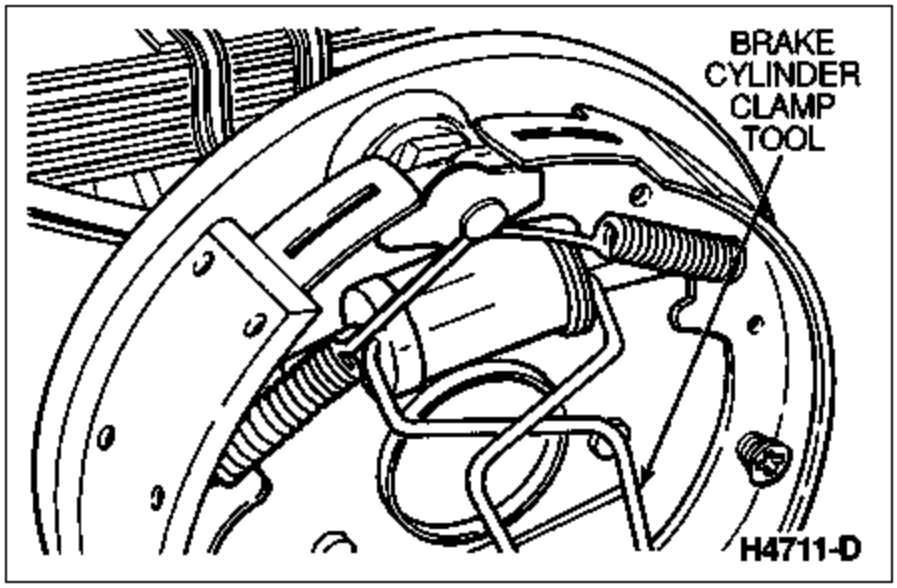
Description	Tool Number
Hold-Down Spring Tool	T73T-2300-A

CAUTION: To ensure correct assembly, note the position of each part removed.

Removal

1. Remove the wheel (1007) and brake drum (1126).
2. **NOTE: If the boots are not removed, brake fluid leakage past the cups may go undetected because the boots may seal the fluid in the rear wheel cylinder. If leaks are found, the rear wheel cylinder must be repaired or replaced.**

   Inspect rear wheel cylinder for signs of leaks or presence of rust by removing the boots and inspecting interior surfaces. Water leaking into the rear wheel cylinder past the boots will cause rust to form and may cause the rear wheel cylinder to seize.
3. If no leaks are found, install brake cylinder clamp over the ends of the rear wheel cylinder as shown.



4. Remove the brake shoe retracting springs.

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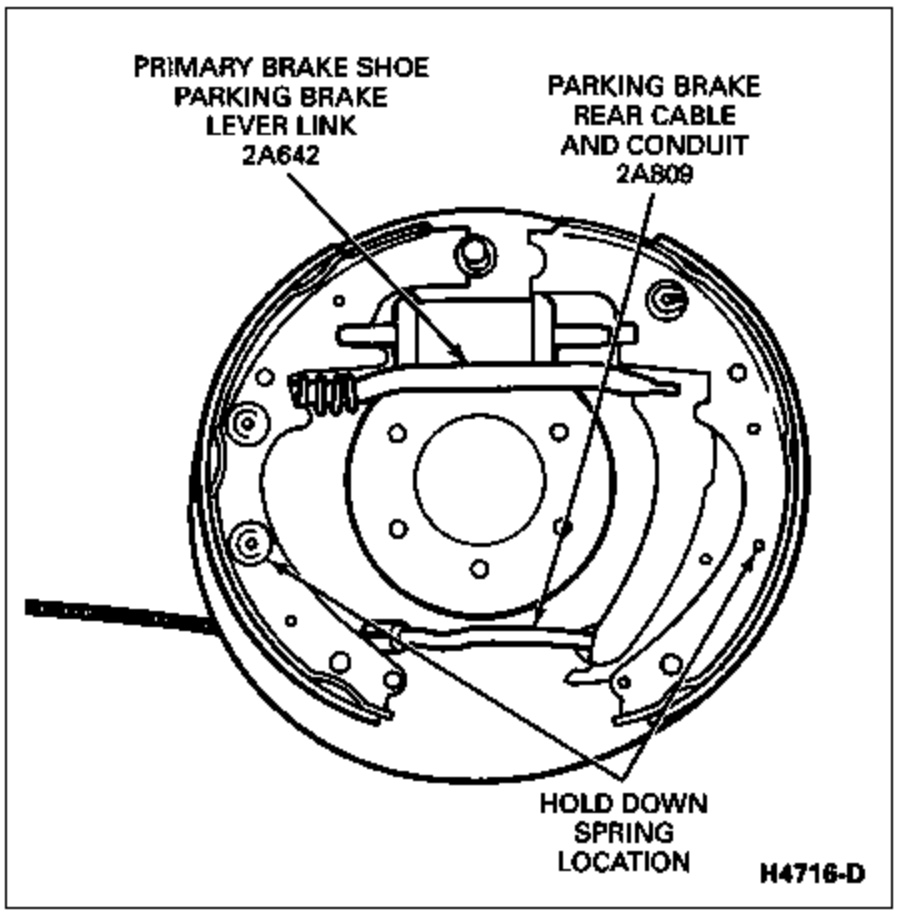
5. Remove the brake shoe adjusting lever cable from the anchor pin, cable guide and adjusting lever.
6. Remove the cable guide from the secondary brake shoe and lining web.
7. Remove the adjusting lever and adjusting lever return spring.
8. Remove the brake shoe adjusting screw spring.
9. Using Hold-Down Spring Tool T73T-2300-A, remove the brake shoe hold-down spring and pin from each rear brake shoe and lining (2200).
10. Remove the brake shoe adjuster assembly.
11. Remove the primary brake shoe parking brake lever link and parking brake link spring.



12. Remove the parking brake rear cable and conduit (2A635) from the parking brake lever.
13. Remove the rear brake shoe and lining from the vehicle.
14. Remove the parking brake lever from the secondary rear brake shoe and lining.

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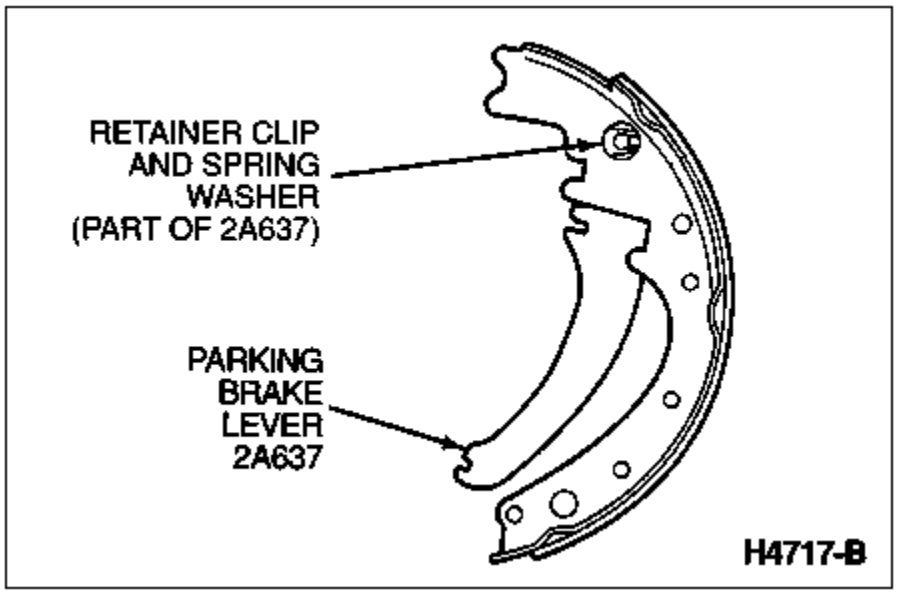
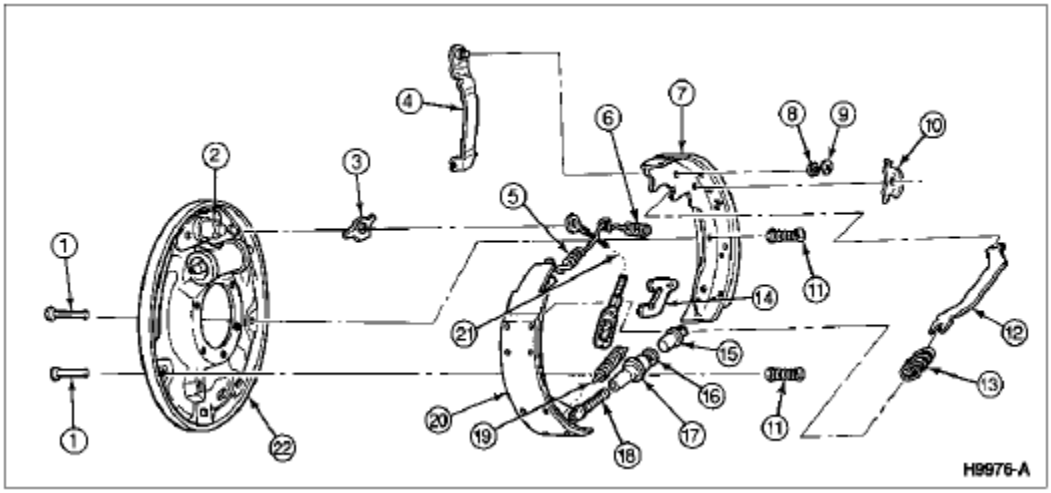


Rear Brake, Ranger



Item	Part Number	Description
1	2069	Brake Shoe Hold-Down Spring Pin
2	—	Anchor Pin (Part of 2211)
3	2028	Brake Shoe Anchor Pin Guide Plate
4	2A637	Parking Brake Lever
5	2296	Brake Shoe Retracting Spring (Short)
6	2296	Brake Shoe Retracting Spring (Long)
7	2200	Rear Brake Shoe and Lining (Secondary)
8	351467-S	Washer
9	2106	Parking Brake Lever Pin Retainer

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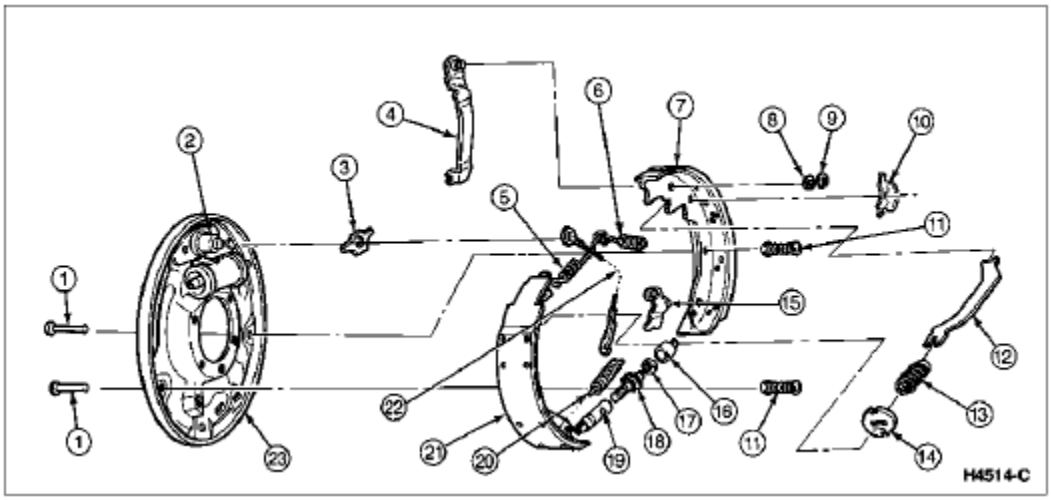
10	2A179	Cable Guide
11	2068	Brake Shoe Hold-Down Spring
12	2A642	Primary Brake Shoe Parking Brake Lever Link
13	2A601	Parking Brake Link Spring
14	2A176	Brake Shoe Adjusting Lever
15	2048	Brake Shoe Adjusting Screw Stud
16	372583-S	Thrust Washer
17	2047	Brake Shoe Adjusting Screw Nut
18	2041	Brake Adjuster Screw
19	2049	Brake Shoe Adjusting Screw Spring
20	2200	Rear Brake Shoe and Lining (Primary)
21	2A178	Brake Shoe Adjusting Lever Cable
22	2211	Brake Backing Plate

Rear Brake, Aerostar



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8	351467-S	Washer
9	2106	Parking Brake Lever Pin Retainer

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10	2A179	Cable Guide
11	2068	Brake Shoe Hold-Down Spring
12	2A642	Primary Brake Shoe Parking Brake Lever Link
13	2A601	Parking Brake Link Spring
14	2A787	Parking Brake Spring Retainer
15	2A176	Brake Shoe Adjusting Lever
16	2048	Brake Shoe Adjusting Screw Socket
17	372583-S	Thrust Washer
18	2041	Brake Adjuster Screw
19	2047	Brake Shoe Adjusting Screw Nut
20	2049	Brake Shoe Adjusting Screw Spring
21	2200	Rear Brake Shoe and Lining (Primary)
22	2A178	Brake Shoe Adjusting Lever Cable
23	2211	Brake Backing Plate

Installation

1. Clean the ledge pads on the brake backing plate.

2. Apply a light coating of Disc Brake Caliper Slide Grease D7AZ-19590-A or equivalent meeting Ford specification ESA-M1C172-A at the points where the brake shoes touch the brake backing plate.

3. Before installing the rear brake shoes and linings, assemble the parking brake lever on the secondary shoe and, on ten-inch brakes, secure with the spring washer and parking brake lever pin retainer.

4. Position the rear brake shoe and lining on the brake backing plate (2211), and install the brake shoe hold-down spring pins, brake shoe hold-down springs, and brake shoe hold-down spring cups using Hold-Down Spring Tool T73T-2300-A. Install the primary brake shoe parking brake lever link, parking brake link spring, and washer. Connect the parking brake rear cable and conduit to the parking brake lever.

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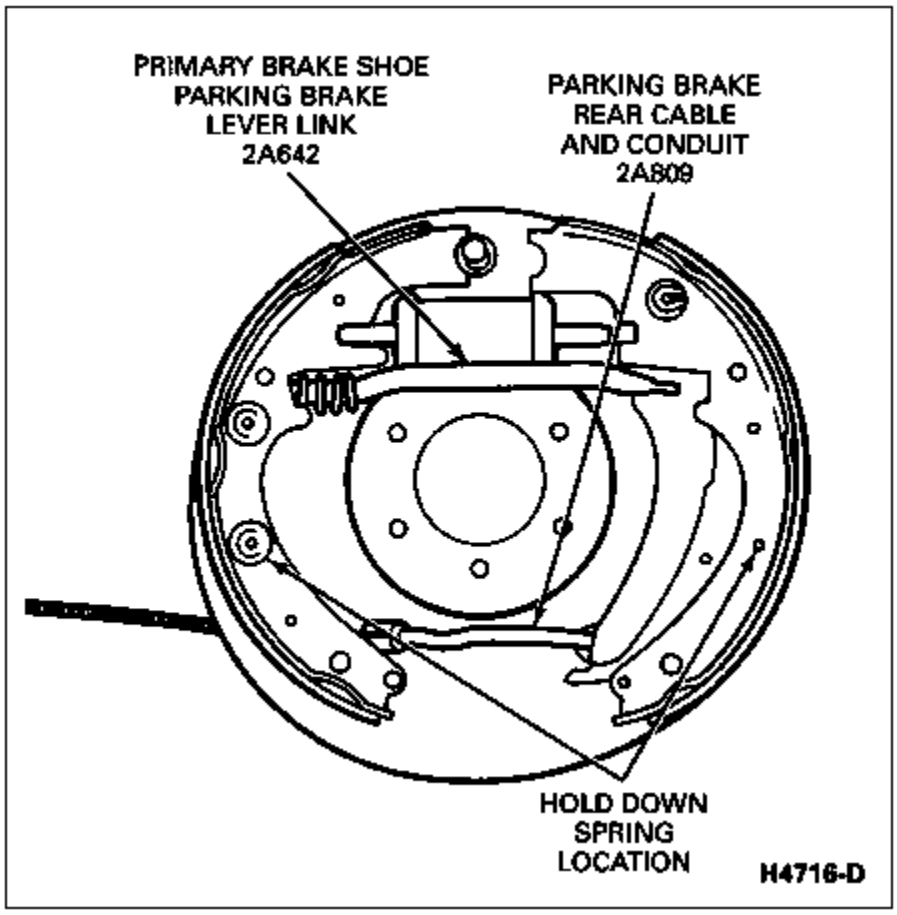
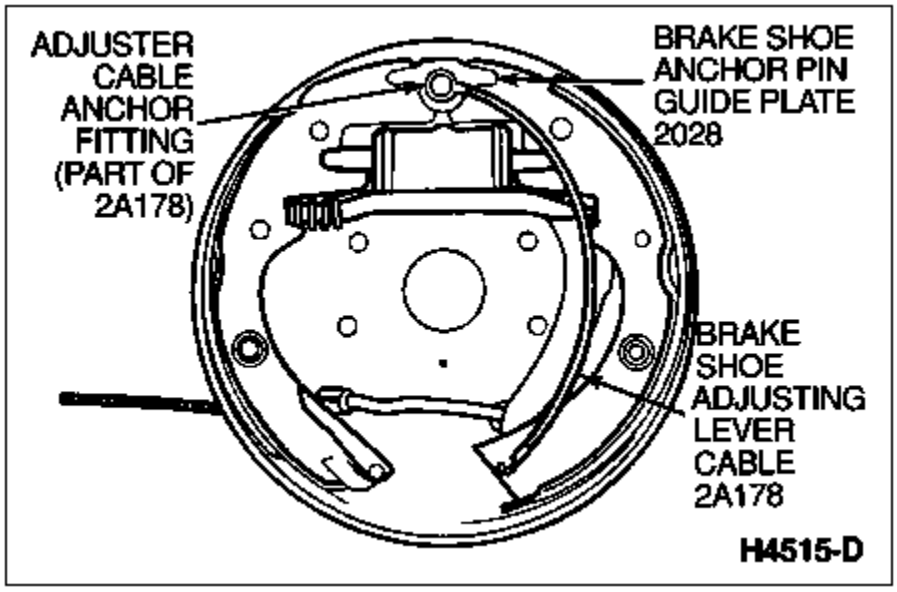


5. Install the brake shoe anchor pin guide plate. Place the brake shoe adjusting lever cable anchor over the anchor pin with the crimped side away from the brake backing plate.

Aerostar



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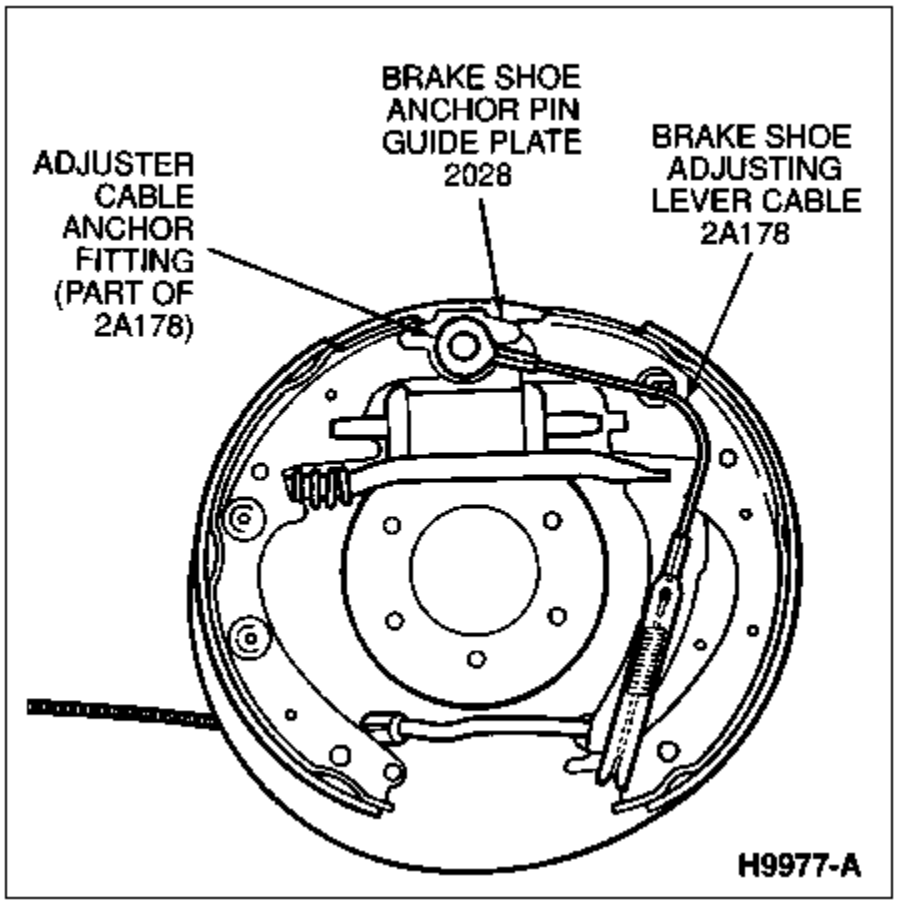
Ranger



6. Install the primary shoe-to-anchor (short) spring using a brake spring removal/installation tool.

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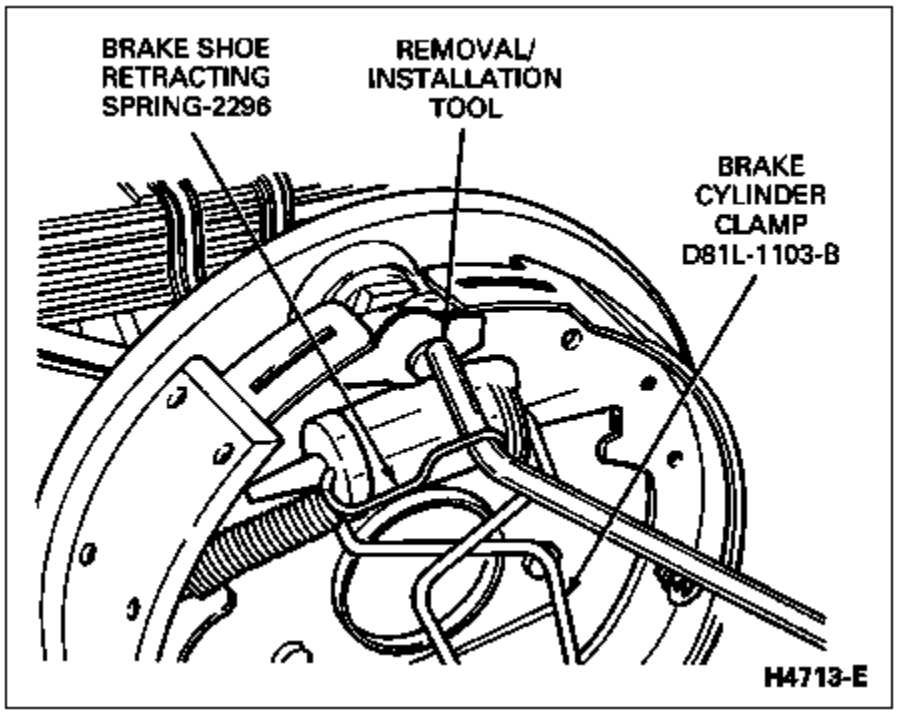

7. **NOTE: Make sure the brake shoe adjusting lever cable is positioned in the groove, and not between the cable guide and the shoe web.**

   Install the cable guide on the secondary shoe web with the flanged holes fitted into the hole in the secondary shoe web. Thread the brake shoe adjusting lever cable around the cable guide groove.

8. **NOTE: Make sure the cable end is not cocked or binding on the anchor pin when installed. All parts should be flat on the anchor pin.**

   Install the secondary shoe-to-anchor (long) spring.

9. Remove the wheel cylinder clamp.

10. **CAUTION: Install the brake adjuster screw in the same location from which it was removed. Interchanging the brake adjuster screws from one side of the vehicle to the other will cause the rear brake shoe and lining to retract rather than expand each time the automatic adjusting mechanism is operated.**

    NOTE: For Aerostar, to prevent incorrect installation, the socket end of each brake shoe adjusting screw is stamped with R or L to indicate their installation on the right or left side of the vehicle. The brake shoe adjusting screw nuts can be distinguished by the number of lines machined around the body of the nut. Two lines indicate a right-hand nut; one line indicates a left-hand nut. Another way to identify adjusters is to check thread pitch. The right side adjuster has right-hand threads while the left side adjuster has left-hand threads. The adjuster will also increase in length when the adjusting lever is operated if properly installed.

    Apply Premium Long-Life Grease XG-1-C or -K or equivalent meeting Ford specification ESA-M1C75-B to the threads of the brake adjuster screw, the thrust washer and the brake shoe adjusting screw stud or socket. Turn the adjusting screw into the brake shoe adjusting screw nut to the end of the threads and then loosen it one-half turn. Refer to illustrations.

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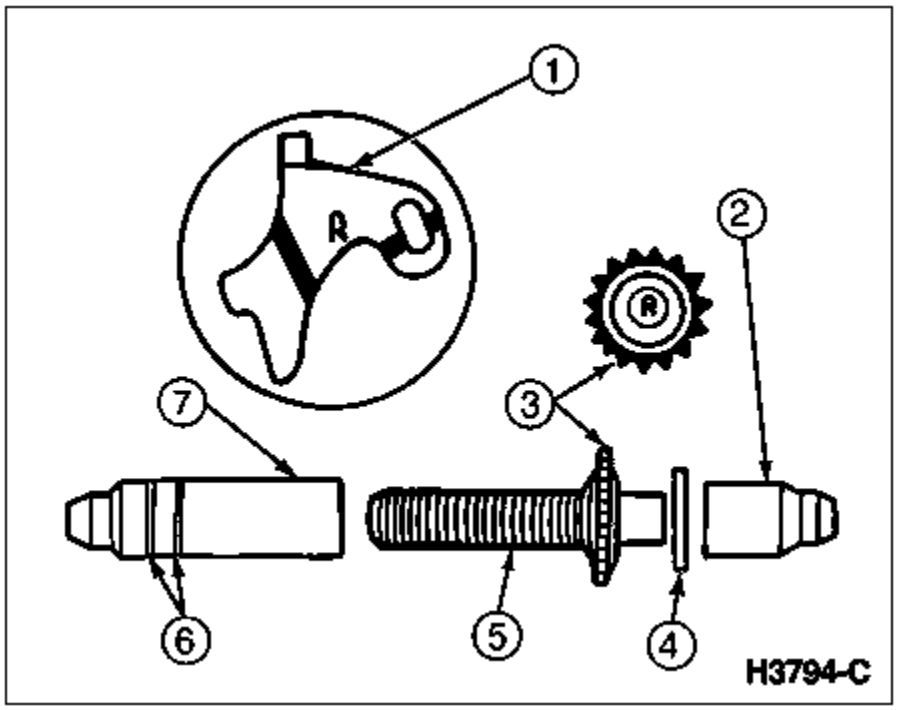
Aerostar



Item	Part Number	Description
1	2A176	Adjusting Lever
2	2048	Brake Shoe Adjusting Screw Socket
3	—	Adjustment Notches (Part of 2041)
4	372583-S	Thrust Washer
5	2041	Brake Shoe Adjusting Screw
6	—	Identification Lines, RH (Part of 2047)
7	2047	Brake Adjuster Screw Nut

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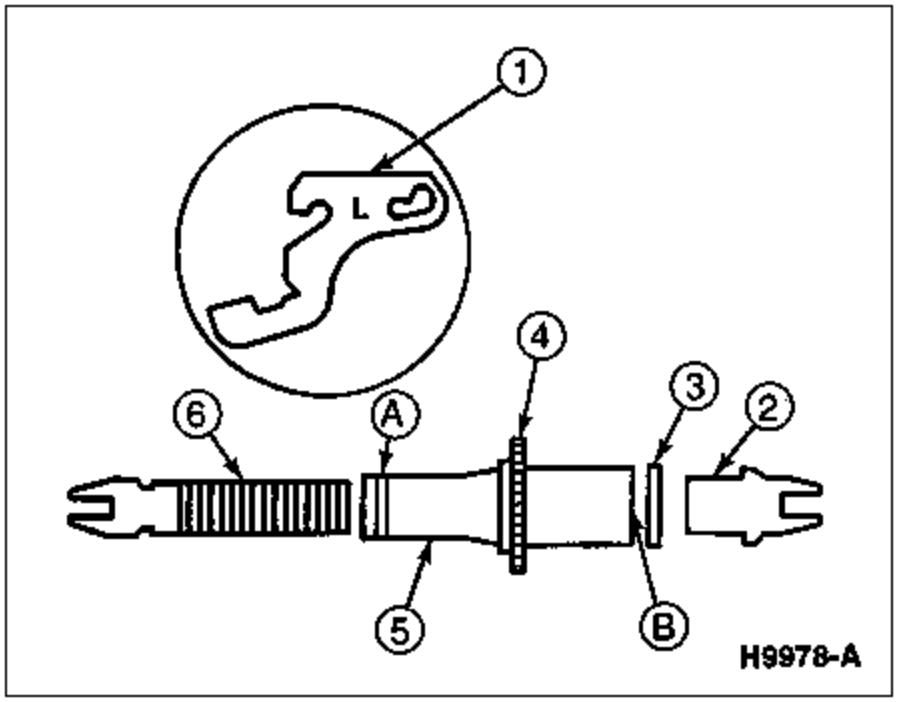

Item	Part Number	Description
1	2A176	Adjusting Lever
2	2048	Brake Shoe Adjusting Screw Stud
3	372583-S	Thrust Washer
4	—	Adjustment Notches (Part of 2047)
5	2047	Brake Adjuster Screw Nut
6	2041	Brake Shoe Adjusting Screw
A	—	Left-Hand Identifier Ring
B	—	"L" at Base of Socket

11. Assemble the adjuster and install the assembly between the shoe ends. Refer to illustrations.

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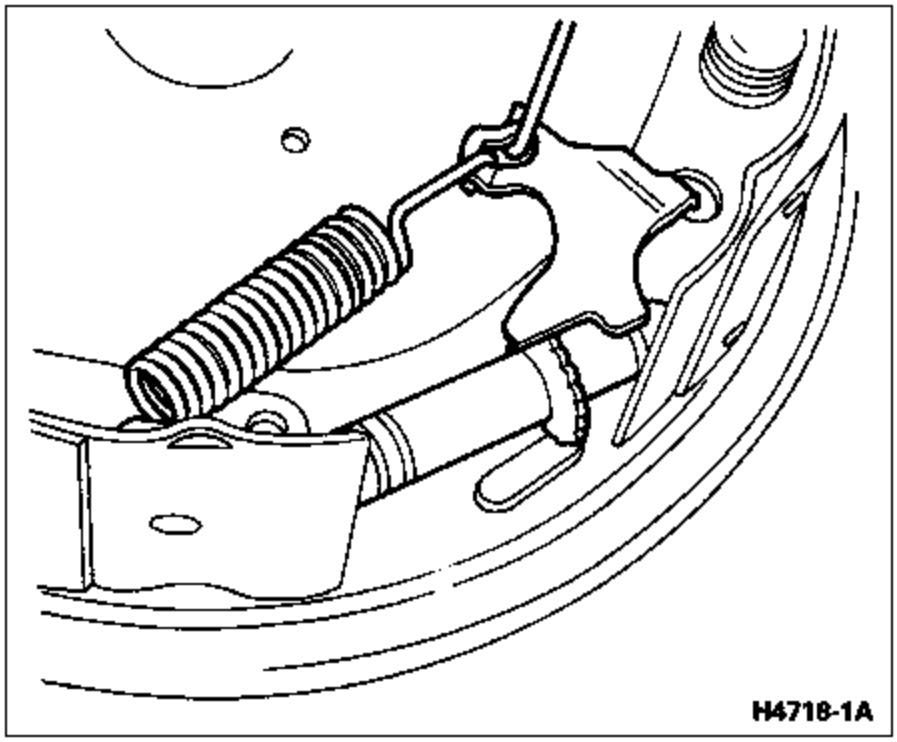

12. On the Aerostar, hook the cable hook into the hole in the brake shoe adjusting lever from the outboard plate side. The brake shoe adjusting levers are also stamped with an R or L to indicate their installation on the right- or left-hand brake assembly.

13. On the Ranger, after installation, the brake shoe adjusting lever should engage the brake adjuster screw nut just below the centerline. Hook the brake shoe adjusting lever cable into the notch in the brake shoe adjusting lever from the inboard side and install the brake shoe adjusting lever and adjusting lever return spring on the pin on the web of the secondary rear brake shoe and lining

Ranger

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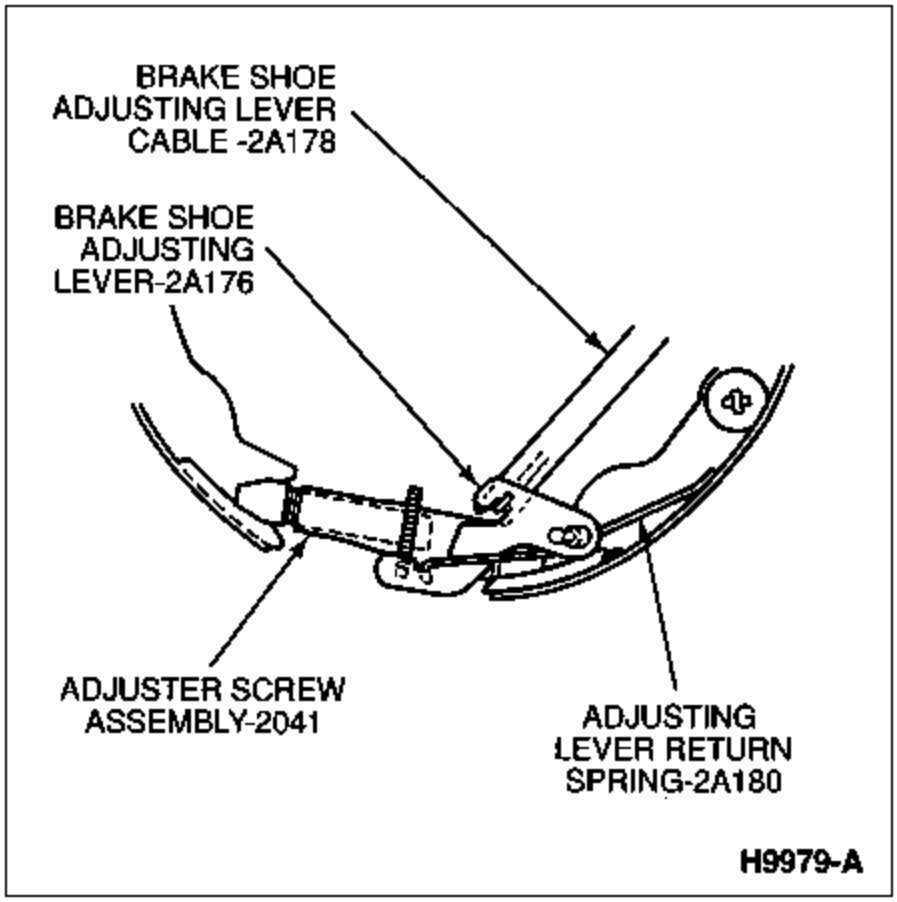

14. On the Aerostar, install the hooked end of the brake shoe adjusting screw spring in the large hole in the primary shoe web. Connect the loop end of the brake shoe adjusting screw spring to the adjuster lever hole.

15. On the Ranger, install the brake shoe adjusting screw spring in the rear brake shoe and lining.

16. On the Aerostar, pull the brake shoe adjusting lever, brake shoe adjusting lever cable and brake shoe adjusting screw spring down toward the rear to engage the pivot hook in the large hole in the secondary shoe web.

17. On the Aerostar, check the action of the adjuster by pulling brake shoe adjusting lever cable toward secondary shoe, activating brake shoe adjusting lever. Brake shoe adjusting lever should snap in above the next tooth of adjuster. Release brake shoe adjusting lever cable to return brake shoe adjusting lever to original position and the adjuster should turn one notch.

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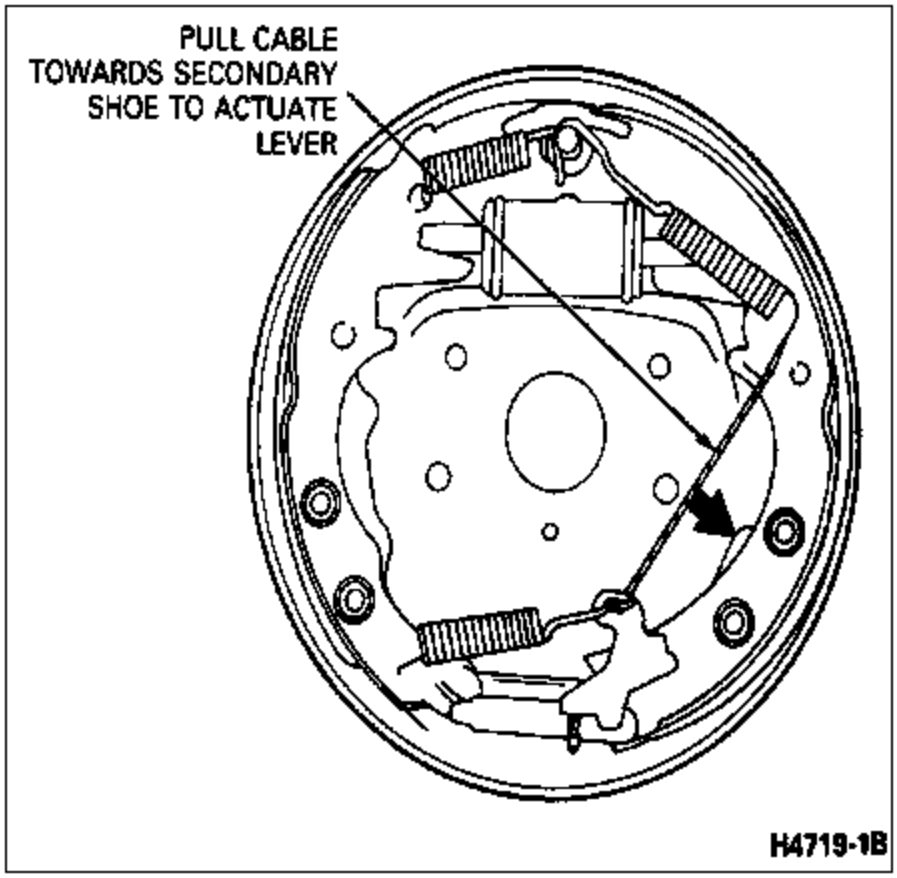

If pulling the brake shoe adjusting lever cable does not produce the action described, or if brake shoe adjusting lever kit action is sluggish instead of positive and sharp, check the position of the brake shoe adjusting lever on the adjusting screw toothed wheel. The brake shoe adjusting lever should contact the adjusting wheel one tooth above the centerline of the brake adjuster screw. If the contact point is below this centerline, the brake shoe adjusting lever will not lock on the teeth in the adjusting screw wheel, and the brake adjuster screw will not be turned as the brake shoe adjusting lever is actuated by the brake shoe adjusting lever cable. Refer to Diagnosis and Testing in Section 06-00 for adjuster diagnosis.

18. Check the action of the Ranger adjuster mechanism:

    - Pull the brake shoe adjusting lever cable toward the secondary rear brake shoe and lining.
    - The brake shoe adjusting lever should turn the adjuster screw nut one tooth.
    - Release the brake shoe adjusting lever cable and the brake shoe adjusting lever should drop below the next tooth on the adjuster screw nut.
    - If the action is not sharp and definite, check for binding or lack of lubrication.

Adjuster Test, Ranger

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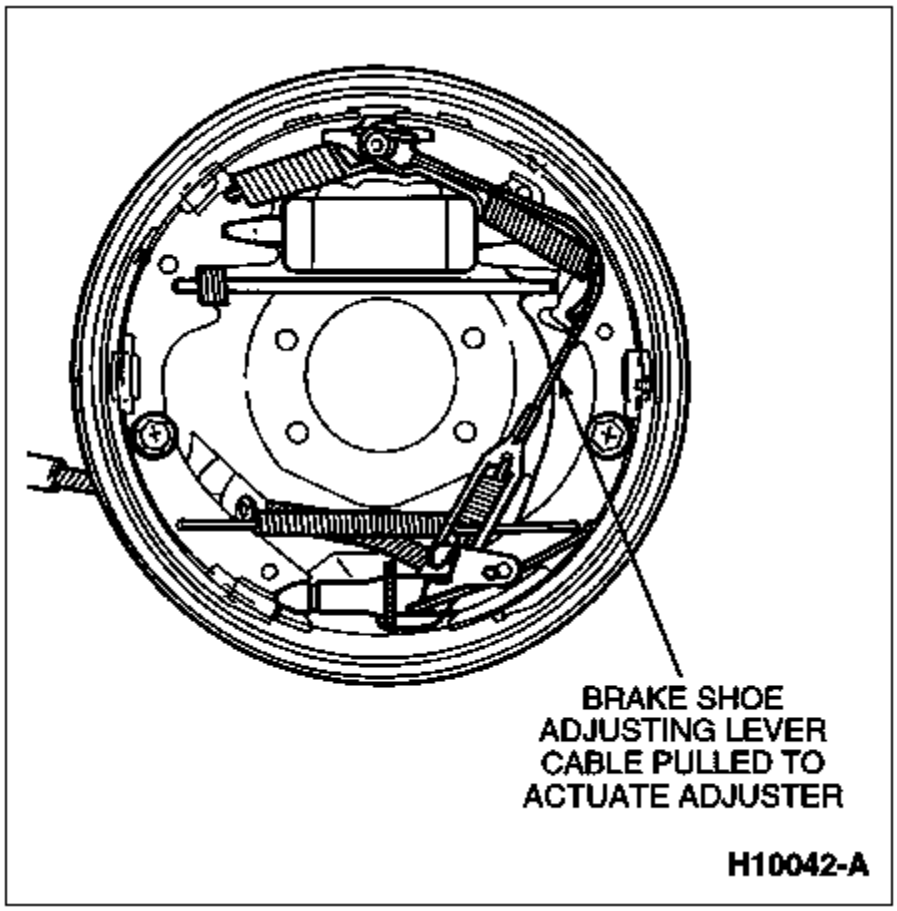

19. Using Brake Adjustment Gauge D81L-1103-A or equivalent, measure the inside diameter of the brake drum.

Measuring Brake Drum

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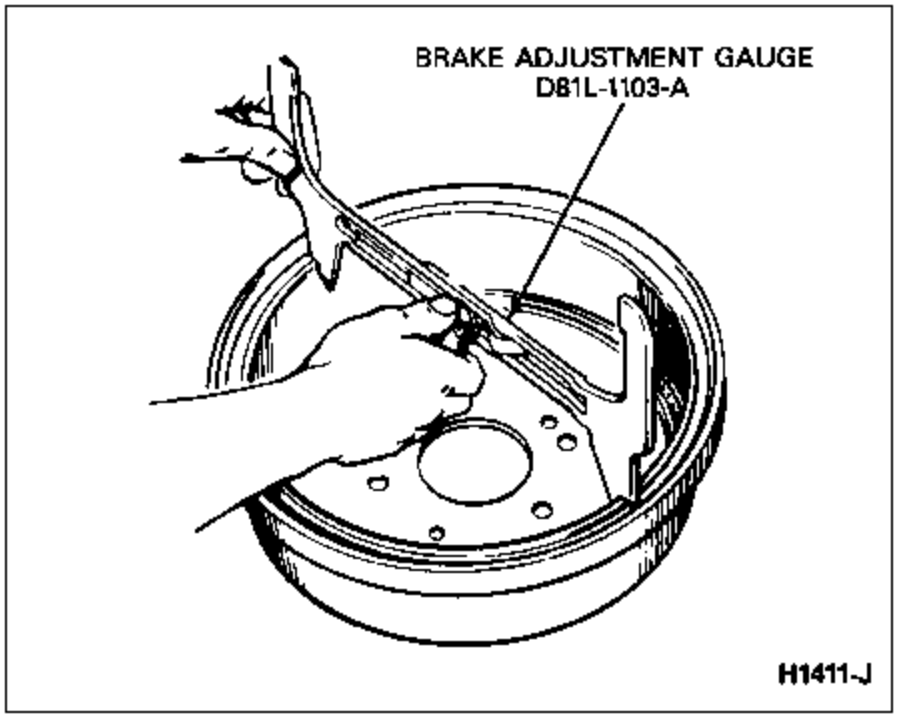
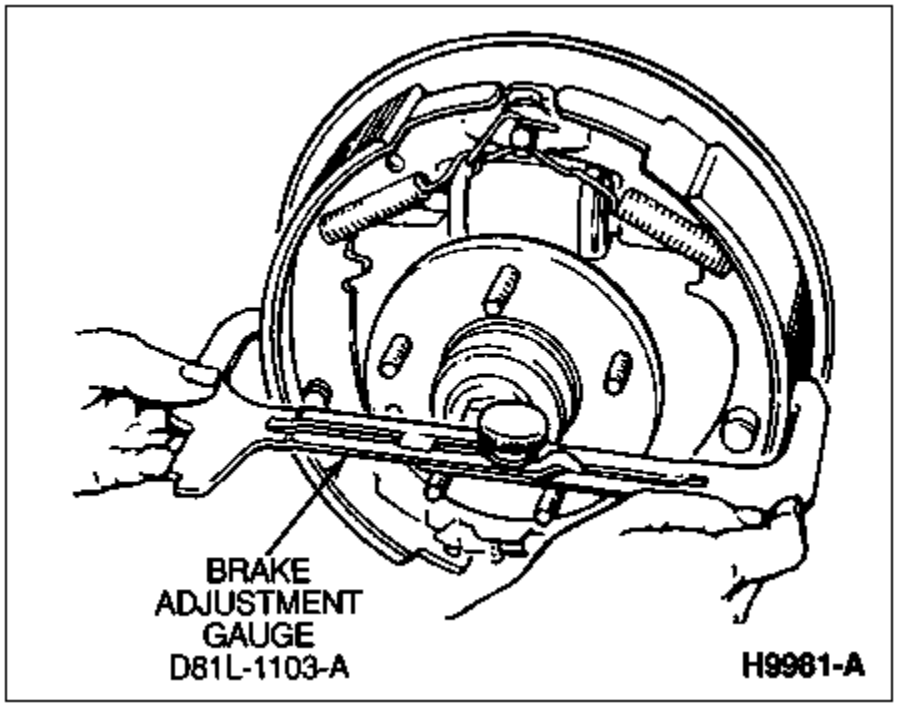


20. Using the brake adjuster screw, adjust the rear brake shoe and lining to the brake drum inside diameter.

Measuring Rear Brake Shoe and Lining



21. Install the brake drum.

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22. Install the wheel and tire assembly. Tighten the lug nuts (1012) to 135 Nm (100 lb-ft).

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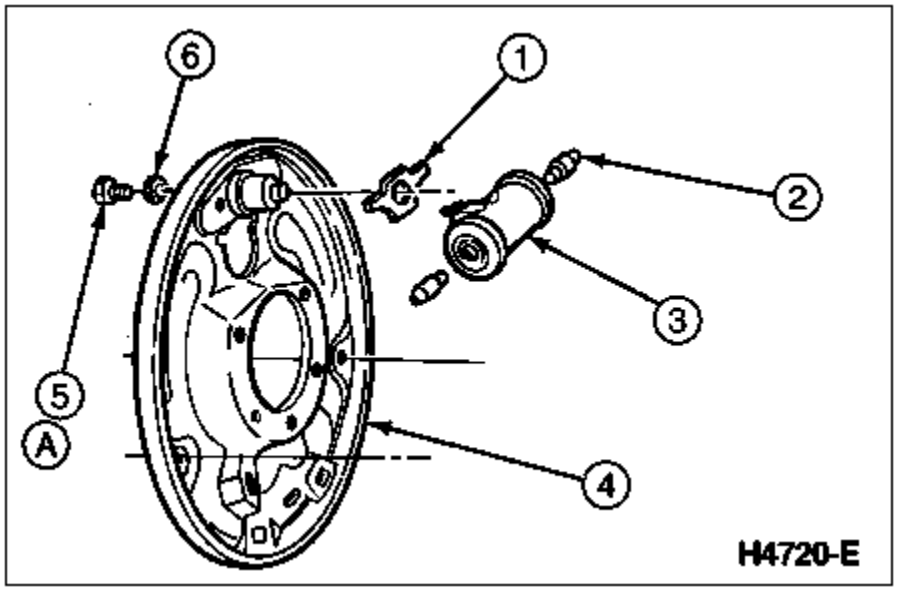
Wheel Cylinder

Removal

1. Raise and support vehicle. Remove wheel (1007).



Item	Part Number	Description
1	2028	Brake Shoe Anchor Pin Guide Plate
2	2042	Wheel Cylinder Brake Shoe Link
3	2261	Rear Wheel Cylinder
4	2211	Brake Backing Plate
5	20310-S	Bolt, Wheel Cylinder-to-Backing Plate
6	34941-S	Washer
A	—	Tighten to 12-18 Nm (106-159 Lb-In)

2. Remove the brake drum (1126), and rear brake shoes and linings (2201) as described in this section.

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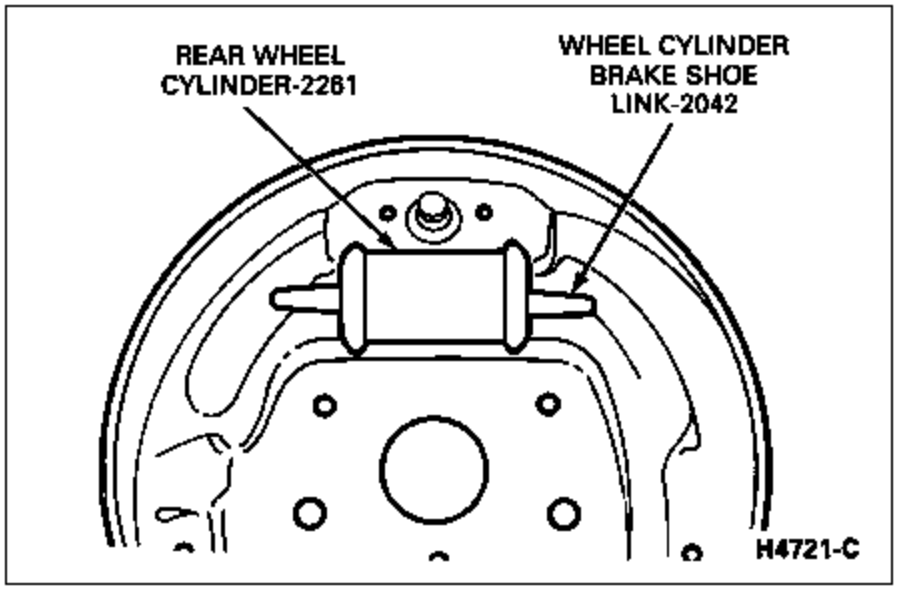

3. Disconnect the brake line from the rear wheel cylinder. Connect a length of hose to the line and submerge end of hose in a can containing a small amount of brake fluid to prevent air from entering the system.

4. Remove the rear wheel cylinder retaining bolts and lockwashers, and then remove the rear wheel cylinder from the brake backing plate.

Installation

1. Apply Silicone Rubber D6AZ-19562-AA or -BA or equivalent meeting Ford specification ESB-M4G92-A or ESE-M4G195-A to wheel cylinder mounting area to seal backing plate mounting area.

2. Place the rear wheel cylinder on the brake backing plate and install the retaining bolts and lockwashers. Tighten the wheel cylinder-to-backing plate bolts to 12-18 Nm (106-159 lb-in).

3. Connect the brake line to the rear wheel cylinder.

4. Install the rear brake shoe and lining (2200) as described in this section. Install the brake drum and adjust the brakes as described in this section.

5. Install the wheel and tire assembly.

6. Bleed the system as described in Section 06-06 . Check brake operation before moving the vehicle.

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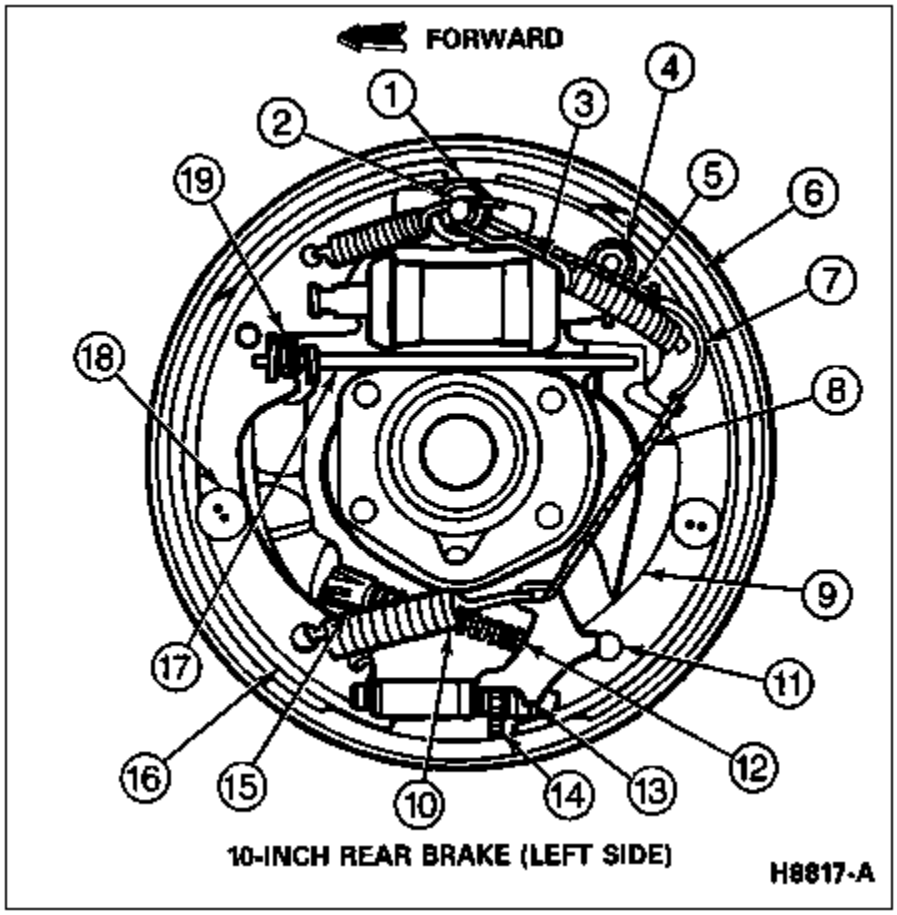
Brake Backing Plate

Removal

1. Raise and support the vehicle.
2. Remove the rear brake shoe and lining (2200) and the rear wheel cylinder. Refer to the procedures in this section.
3. Disconnect parking brake rear cable and conduit (2A635) from brake backing plate by squeezing locking fingers together using a 9/16-inch flare nut wrench and pulling parking brake rear cable and conduit through brake backing plate.

Aerostar



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Item	Part Number	Description
1	2028	Brake Shoe Anchor Pin Guide Plate
2	2027	Anchor Pin
3	2261	Rear Wheel Cylinder
4	351467-S	Washer
5	2296 or 2035	Retracting Spring
6	2200	Rear Brake Shoe and Lining
7	2A179	Cable Guide
8	2A178	Brake Shoe Adjusting Lever Cable
9	2A637	Parking Brake Lever
10	2049	Brake Shoe Adjusting Screw Spring
11	—	Pivot Hook (Part of 2A176)
12	2A635	Parking Brake Rear Cable and Conduit
13	2A176	Brake Shoe Adjusting Lever
14	2041	Adjuster Assembly
15	—	Parking Brake Cable Housing Retainer (Part of 2A809 and 2A635 Cables)
16	2200	Rear Brake Shoe and Lining
17	2A642	Parking Brake Link
18	2A094	Brake Shoe Hold-Down Retainer Repair Kit
19	2A601	Parking Brake Link Spring

Ranger

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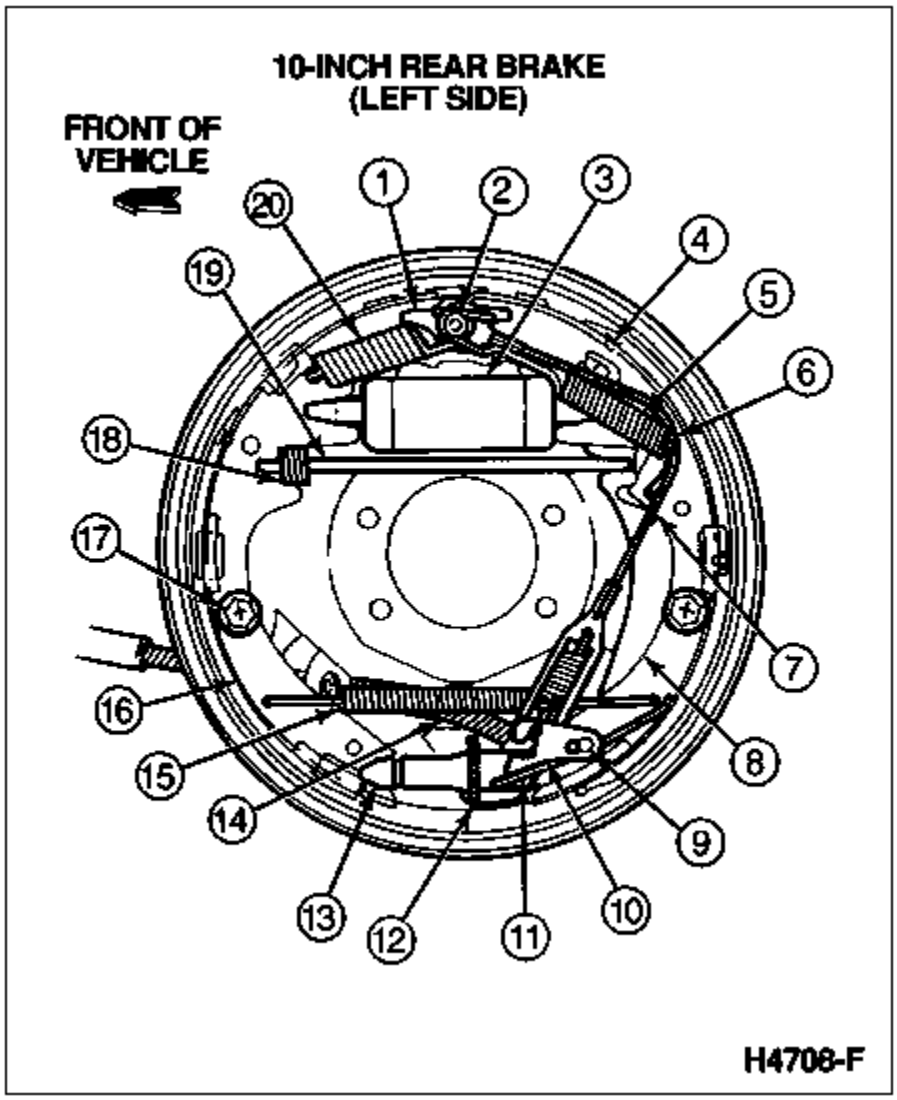

Item	Part Number	Description
1	2028	Brake Shoe Anchor Pin Guide Plate
2	2027	Anchor Pin (Part of 2211)
3	2261	Rear Wheel Cylinder
4	2200	Rear Brake Shoe and Lining (Secondary)
5	2296	Brake Shoe Retracting Spring (Long)
6	2A179	Cable Guide
7	2A178	Brake Shoe Adjusting Lever Cable
8	2A637	Parking Brake Lever
9	—	Adjusting Lever Pin (Part of 2200)
10	2A176	Brake Shoe Adjusting Lever
11	2A180	Adjusting Lever Return Spring
12	2047	Brake Shoe Adjusting Screw Nut

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13	2041	Brake Adjuster Screw
14	2A635	Parking Brake Rear Cable and Conduit
15	2049	Brake Shoe Adjusting Screw Spring
16	2200	Rear Brake Shoe and Lining (Primary)
17	2068	Brake Shoe Hold-Down Spring
18	2A601	Parking Brake Link Spring
19	2A642	Primary Brake Shoe Parking Brake Lever Link
20	2296	Brake Shoe Retracting Spring (Short)

4. Remove the axle shaft (4234). Refer to Section 05-02A or Section 05-02B . Use care not to damage the oil seal.

5. Remove the nuts retaining the brake backing plate to the rear axle housing and remove the brake backing plate and the rear wheel gasket from the rear axle housing.

Installation

1. Apply Silicone Rubber D6AZ-19562-AA or -BA or equivalent meeting Ford specification ESB-M4G92-A or ESE-M4G195-A to braking plate mounting hole to seal axle shaft flange mounting area.

2. Position the brake backing plate and rear wheel gasket on the rear axle housing.

3. Install the backing plate retaining nuts. Alternately and evenly tighten the nuts to 34-47 Nm (25-35 lb-ft).

4. Apply a light coating of Disc Brake Caliper Slide Grease D7AZ-19590-A or equivalent meeting Ford specification ESA-M1C172-A to the ledge pads at the points where the rear brake shoe and lining contact the brake backing plate.

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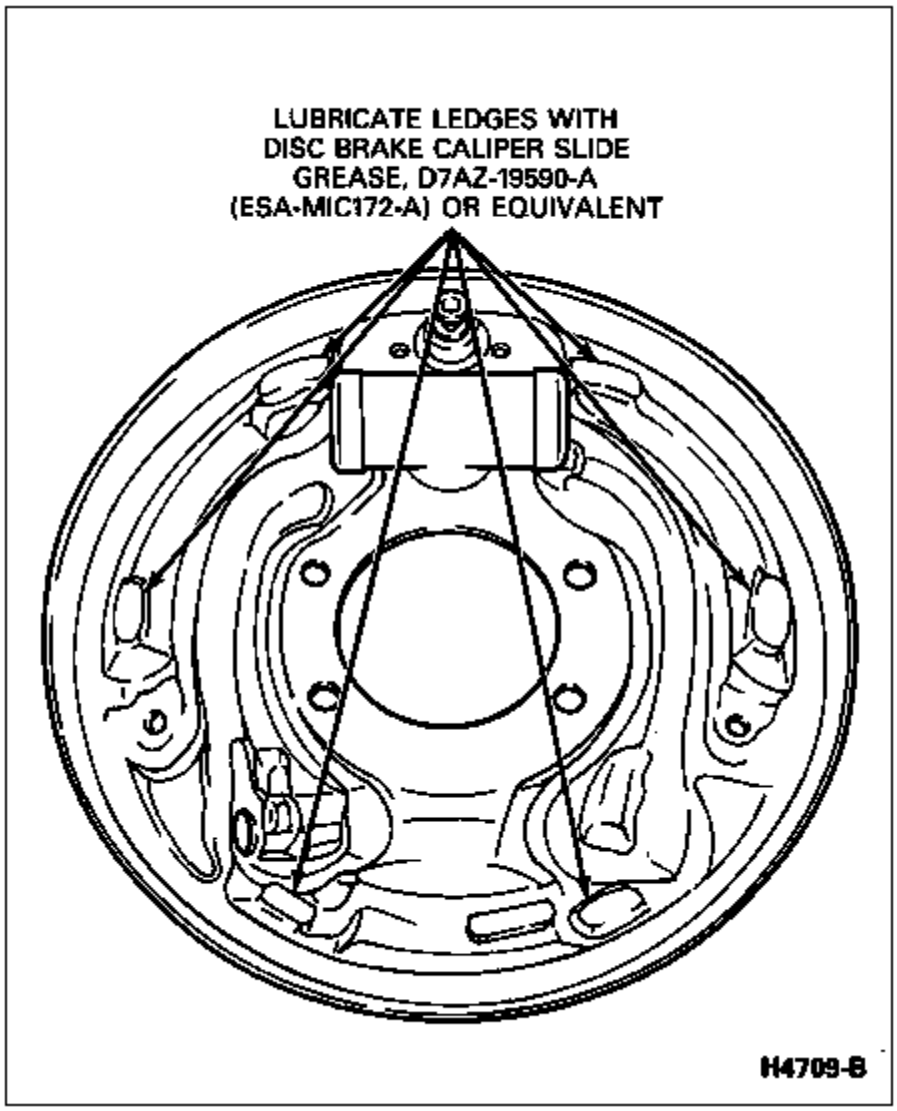

5. Feed the parking brake rear cable and conduit through its hole in the brake backing plate and engage locking fingers.

6. Install the axle shaft. Refer to Section 05-02A or Section 05-02B as required in the Powertrain, Drivetrain Service Manual. Use care not to damage the oil seal.

7. Install the rear wheel cylinder and rear brake shoe and lining and adjust using Brake Adjustment Tool D81L-1103-C or equivalent. Connect the parking brake rear cable and conduit to the parking brake lever.

8. Install the rear brake shoe and lining. Refer to the procedure in this section.

9. Connect the brake line to the rear wheel cylinder. Tighten the brake line fitting to 15-20 Nm (11-14 lb-ft).

10. Install the brake drum (1126) and wheel and tire assembly. Tighten the lugnuts to 135 Nm (100 lb-ft).

11. Bleed air from the system as described in Section 06-06 .

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Wheel Cylinder

Rear wheel cylinders should be rebuilt in full axle sets only. If one side of the vehicle is done, the other side should also be rebuilt.

Rear wheel cylinders should not be disassembled unless they are leaking. Carefully pull lower edges of wheel cylinder boots away from rear wheel cylinder, and note whether interior is wet with brake fluid. Excessive brake fluid at this point indicates leakage past piston cups and a need for rear wheel cylinder overhaul.

NOTE: A slight amount of brake fluid is nearly always present and acts as a lubricant for the wheel cylinder piston. It is not necessary to remove the rear wheel cylinder from the backing plate to disassemble, inspect, hone, and overhaul the rear wheel cylinder. Removal is necessary only if the rear wheel cylinder is damaged or scored beyond service.

Disassembly

1. Remove the rear brake shoe and lining (2200). Refer to the procedure in this section.
2. On ten-inch brakes, remove the wheel cylinder brake shoe links.
3. Disengage rear wheel cylinder boots from retaining grooves in rear wheel cylinder casting. Remove each wheel cylinder boot and wheel cylinder piston from rear wheel cylinder as an assembly.
4. Remove rear wheel cylinder piston cups and wheel cylinder piston cup spring from wheel cylinder bore.
5. Discard all rubber parts.
6. Remove wheel cylinder bleeder screw from rear wheel cylinder.
7. Wash all parts in clean, denatured alcohol.
8. Inspect pistons for scratches, scoring, or other visible damage. Replace if necessary. Always replace rubber parts.
9. Inspect the rear wheel cylinder bore for score marks or rust. If either condition is present, the rear wheel cylinder bore must be honed. **However, the rear wheel cylinder should not be honed more than 0.08mm (0.003 inch) beyond its original diameter.**
10. Wash rear wheel cylinder with clean, denatured alcohol after honing, dry it with compressed air.
11. Inspect the bleeder hole to ensure it is free of obstructions.

Assembly

Use all parts in the wheel cylinder service kit.

1. Apply a light coating of High Performance DOT 3 Brake Fluid C6AZ-19542-AA or equivalent DOT 3 fluid meeting Ford specification ESA-M6C25-A, DOT 3 to all internal parts.

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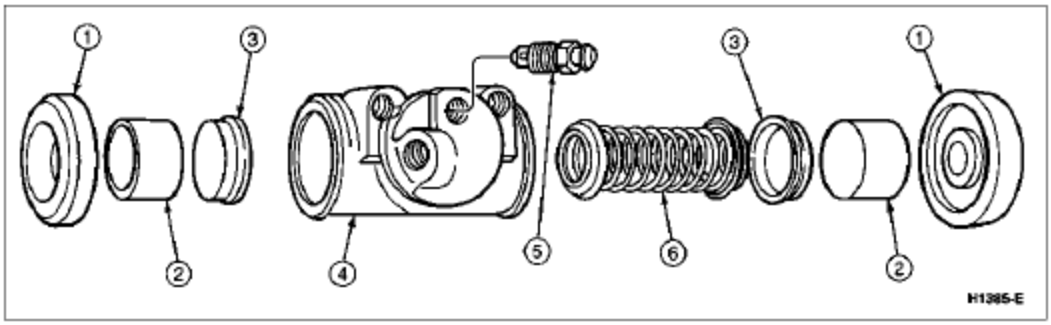
2. Thread bleeder screw into rear wheel cylinder. Tighten to 7-9 Nm (61-79 lb-in).
3. Insert the wheel cylinder piston cup spring, wheel cylinder piston cups and wheel cylinder pistons into their respective positions in the wheel cylinder bore. Place a wheel cylinder boot over each end of the wheel cylinder.
4. Install the bleeder screw.
5. Install the wheel cylinder brake shoe links, if required.
6. Install rear brake shoe and lining. Refer to the procedure in this section.
7. Install brake drum (1126) and wheel (1007).
8. Bleed brake system. Refer to Section 06-06 .

Brake Wheel Cylinder, Disassembled



Item	Part Number	Description
1	—	Wheel Cylinder Boot (Part of 2261)
2	2196	Wheel Cylinder Piston
3	2201	Wheel Cylinder Piston Cup
4	2261	Rear Wheel Cylinder
5	2208	Wheel Cylinder Bleeder Screw
6	2204	Wheel Cylinder Piston Cup Spring

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Cleaning

WARNING: BRAKES CONTAIN ASBESTOS FIBERS. AVOID BREATHING DUST. BREATHING ASBESTOS DUST MAY CAUSE ASBESTOSIS AND CANCER.

BREATHING ASBESTOS DUST IS HAZARDOUS TO YOUR HEALTH.

DUST AND DIRT PRESENT ON WHEEL BRAKE AND CLUTCH ASSEMBLIES MAY CONTAIN ASBESTOS FIBERS THAT ARE HAZARDOUS TO HEALTH WHEN MADE AIRBORNE BY CLEANING WITH COMPRESSED AIR OR BY DRY BRUSHING.

WHEEL BRAKE ASSEMBLIES AND CLUTCH FACINGS SHOULD BE CLEANED USING A VACUUM CLEANER RECOMMENDED FOR USE WITH ASBESTOS FIBERS SUCH AS ROTUNDA BRAKE/CLUTCH/SERVICE VACUUM 091-R0001 OR EQUIVALENT. DUST AND DIRT FROM VACUUM SHOULD BE DISPOSED OF IN SUCH A MANNER THAT PREVENTS DUST EXPOSURE, SUCH AS SEALED BAGS. THE BAG MUST BE LABELED AS PER OSHA INSTRUCTIONS AND THE TRASH HAULER NOTIFIED AS TO THE BAG'S CONTENTS.

IF A VACUUM SUITABLE FOR ASBESTOS IS NOT AVAILABLE, CLEANING SHOULD BE DONE WET. IF DUST GENERATION IS STILL POSSIBLE, TECHNICIANS SHOULD WEAR GOVERNMENT-APPROVED TOXIC DUST PURIFYING RESPIRATORS.

GRINDING OR SANDING ON BRAKE LININGS, PADS, ROTORS, DRUMS OR CLUTCH FACINGS SHOULD BE DONE ONLY WHILE USING PROPERLY EXHAUST-VENTILATED EQUIPMENT.

OSHA REQUIRES AREAS WHERE ASBESTOS DUST GENERATION IS POSSIBLE TO BE ISOLATED AND POSTED WITH WARNING SIGNS. ONLY TECHNICIANS CONCERNED WITH PERFORMING BRAKE OR CLUTCH SERVICE SHOULD BE PRESENT IN THE AREA.

CAUTION: Do not use denatured alcohol for flushing the system or cleaning assemblies where alcohol could be trapped and cause eventual failure of rubber components in the system.

1. Denatured alcohol is acceptable for cleaning parts, provided the parts are completely air-dried and coated with brake fluid before installation.

2. To remove brake fluid contamination, clean all parts with denatured alcohol. Do not attempt to clean contaminated lining. Contaminated brake lining must be replaced.

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Inspection

Use Rotunda Brake/Clutch/Service Vacuum 091-R0001 or equivalent to remove all dust from backing plates and interior of brake drums (1126).

Wheel Cylinders

1. Rear wheel cylinders should not be disassembled unless they are leaking. Pull back each rear wheel cylinder dust boot and inspect for leakage.

2. Excessive brake fluid at this point indicates leakage past the piston cups and a need for rear wheel cylinder (2261) overhaul. A slight amount of fluid is nearly always present and acts as a lubricant for the pistons. If evidence of leakage is noted, the rear wheel cylinder should be disassembled, inspected and overhauled.

3. Inspect the rear wheel cylinder bore for scratches and pitting. If the rear wheel cylinder is pitted or has deep scratches, the rear wheel cylinder must be replaced.

Brake Drums

1. A brake drum should be visually inspected and measured with Rotunda Brake Drum Micrometer 104-00046 or equivalent. Before making an inspection or measurement, remove grease, brake fluid, or other contaminants from the brake drum using denatured alcohol.

2. Best shop practice requires measuring every brake drum with a brake drum micrometer regardless of visual inspection. The brake drum micrometer is set to the drum diameter and measures the amount and type of wear. Measure the diameter at various points 45-degrees apart around the brake shoe and lining contact area, and at the bottom of the deepest groove to determine if the brake drum requires replacement.

Brake Lining

1. Inspect rear brake shoes and linings (2200) for excessive lining wear or shoe damage. If lining is damaged or worn within 0.79mm (1/32 inch) of the rivet heads on riveted linings, it must be replaced. Replace any rear brake shoe and lining that has been contaminated with oil, grease or brake fluid. Replace rear brake shoe and lining in axle sets only. Never replace just one rear brake shoe and lining of a brake assembly. Replace both primary and secondary shoes. Prior to replacement of lining, brake drum diameter should be checked to determine that brake drum diameter is within specification. If braking surface diameter exceeds specification, the brake drum must be replaced.

2. Check condition of rear brake shoes and linings, retracting spring, hold-down springs, and brake drum for signs of overheating. If rear brake shoe and lining metal parts have a slight blue coloring, indicating overheating, retracting and hold-down springs should be replaced. Overheated springs lose their tension and could allow new rear brake shoe and lining to drag and wear prematurely, if not replaced.

Springs

Check springs for:

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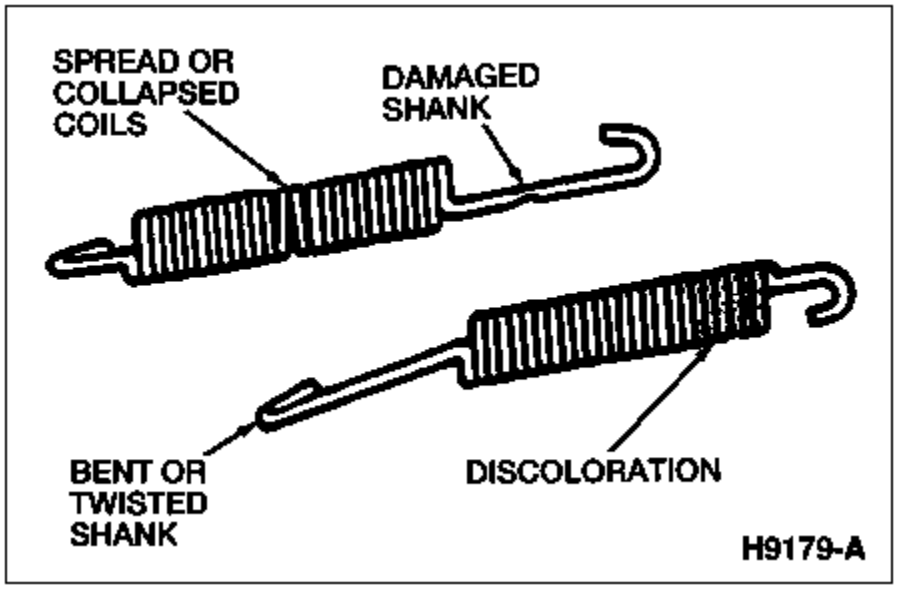
- Spread or collapsed coils
- Twisted, bent or damaged shanks
- Discoloration — This is a sign of brake overheating. Overheated springs lose some of their tension and should be replaced.



Brake Backing Plate

1. Inspect the brake backing plate for correct mounting and securely tightened mounting nuts.

2. Inspect the brake shoe and lining contact pads (where the rear brake shoe and lining rest).

    - Deep grooves in the brake shoe and lining contact pads could restrict brake shoe and lining movement.
    - If grooves exist, hand sand the brake shoe and lining contact pads.
    - If the grooves are still present after hand sanding, the rear brake backing plate must be replaced. Any attempt to remove the grooves by grinding may result in improper brake shoe and lining-to-brake drum contact.

3. Inspect all other brake parts and replace any that are worn or damaged.

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Brake Drum

Refinishing

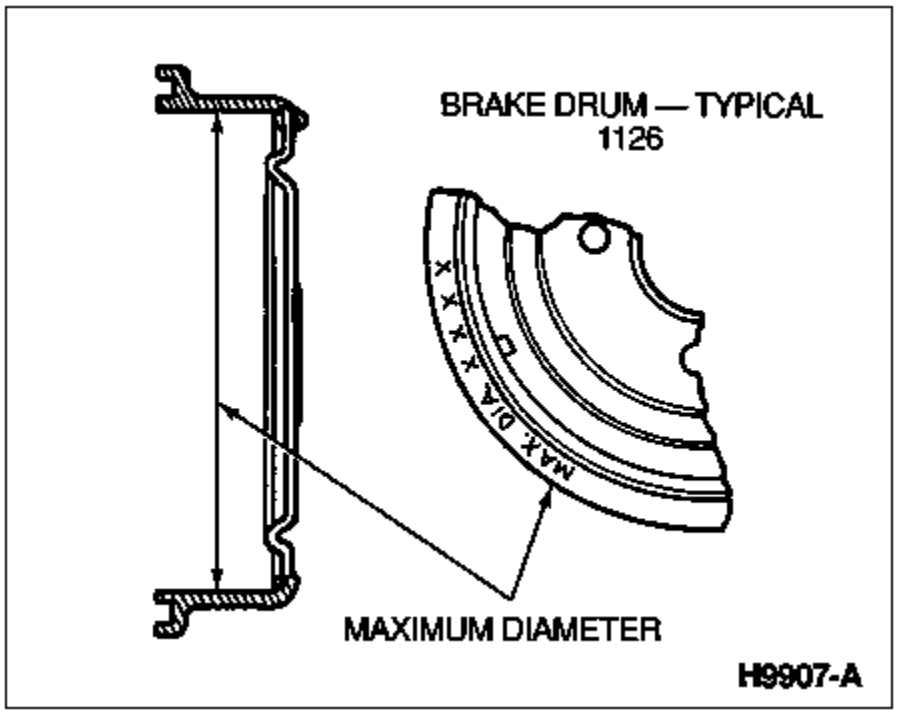
Minor scores on brake drums (1126) can be removed with sandpaper. Do not refinish brake drums to remove score marks. A drum surface which is highly polished can cause brake lockup or noise. This polished condition should be removed with sandpaper. A brake drum that is out of round sufficient to cause vehicle vibration or roughness when braking should be refinished. Remove only enough stock to true-up the brake drum. When brake drum maximum inside diameter shown on the brake drum is exceeded either through wear or refinishing, the brake drum must be replaced.

Check inside diameter of brake drum with Brake Adjustment Gauge D81L-1103-A or Rotunda Brake Drum Micrometer 104-00046 or equivalent.

After a brake drum is refinished, wipe refinished surface with a cloth soaked in clean, denatured alcohol.

Maximum Diameter

Brake drum maximum diameter is cast into the rim of the brake drum. The brake drum may be machined enough to correct scoring but only up to the MAX. DIA. dimension. If, after machining, the brake drum inside braking surface diameter exceeds the specification, it must be discarded.



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Brake Shoe and Lining

Drums Removed

WARNING: DO NOT INHALE DUST FROM BRAKES OR ASSOCIATED COMPONENTS. INHALATION OF DUST CAN BE INJURIOUS TO YOUR HEALTH. COMPRESSED AIR OR BRUSHES MUST NOT BE USED TO CLEAN BRAKES, BRAKE DRUMS AND ASSOCIATED COMPONENTS. A VACUUM CLEANER SUCH AS ROTUNDA BRAKE/CLUTCH/SERVICE VACUUM 091-R0001 OR EQUIVALENT EQUIPPED FOR THIS PURPOSE SHOULD BE CAREFULLY USED TO REMOVE ANY DUST. ADHERENT DUST SHOULD BE REMOVED WITH A DAMP RAG. ANY DUST SHOULD BE CONTAINED IN A SEALED AND LABELED BAG FOR DISPOSAL. WEAR AN APPROVED HIGH EFFICIENCY CARTRIDGE OR AIR LINE RESPIRATOR AND USE EXTRA CAUTION TO AVOID BREATHING THIS DUST. ALWAYS USE NON-ASBESTOS REPLACEMENT PARTS.

The rear brakes are automatically adjusted while driving the vehicle in reverse and sharply applying the brakes, and then driving forward. It may be necessary to do this several times to obtain the proper rear brake adjustment. Manual brake adjustment is required only after the brake shoes have been replaced, or if brake shoe adjusting lever has malfunctioned and has been repaired or replaced. Perform the manual adjustment with the brake drums (1126) removed, using Brake Adjustment Gauge D81L-1103-A or equivalent and the procedure described below.

When adjusting the rear brake shoes, check the parking brake rear cable and conduit (2A635) for proper operation. Make sure the equalizer operates freely. For parking brake service, refer to Section 06-05 .

1. Raise vehicle on hoist. Position suitable safety stands under vehicle. Remove wheel (1007). Remove brake drum as described in this section.

2. Use Rotunda Brake/Clutch/Service Vacuum 091-R0001 or equivalent to remove any dust present on the brake assembly.

3. Carefully remove the brake shoe hold-down spring. Using sandpaper, clean the shoe-to-backing plate contact points while holding the shoe away from the brake backing plate.

4. Check brake backing plate for damage. If any damage is found, it must be replaced. Refer to procedure in this section. If no damage is found, apply a small amount of Disc Brake Caliper Slide Grease D7AZ-19590-A or equivalent meeting Ford specification ESA-M1C172-A to the points where the shoes touch the brake backing plate. Be careful not to get the lubricant on the linings.

    - The following illustration is simplified to show contact point location.

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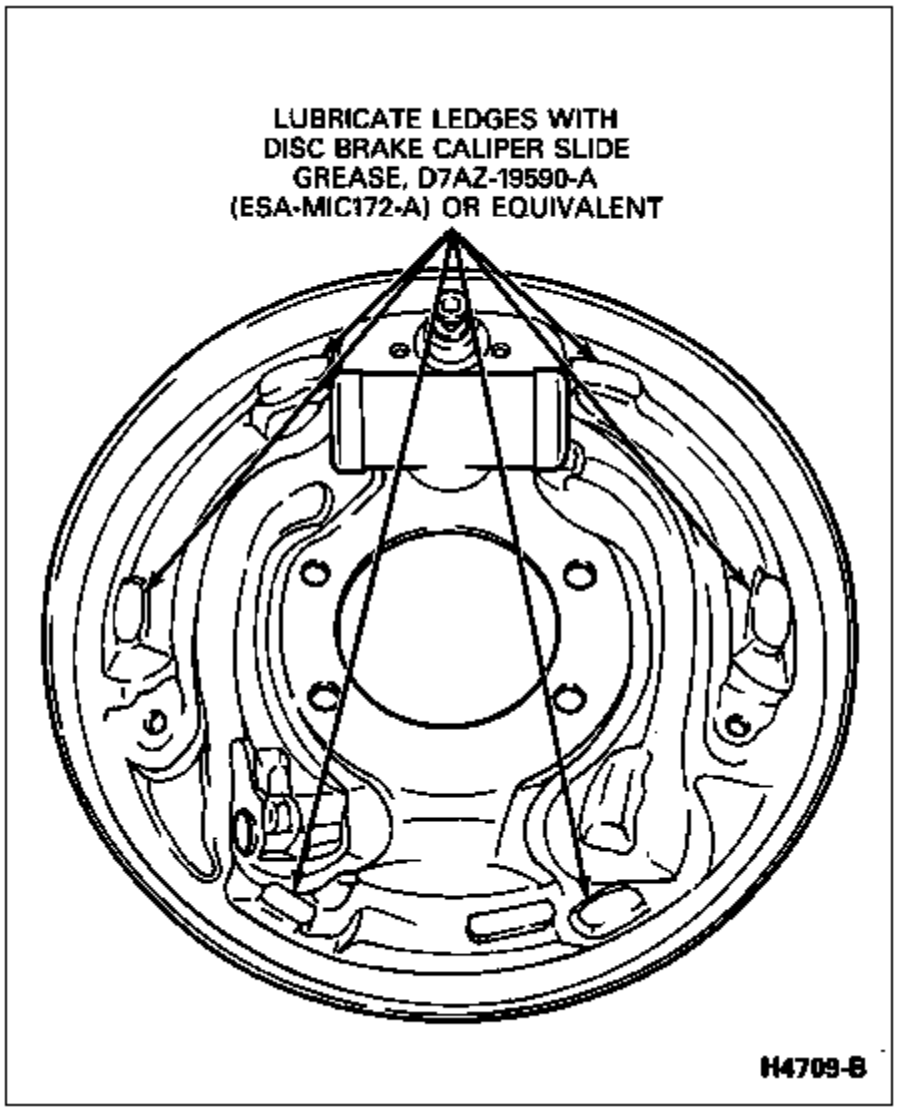

5. Reinstall brake shoe hold-down spring.

6. Set the Brake Adjustment Gauge D81L-1103-A or equivalent to the inside diameter of the drum braking surface.

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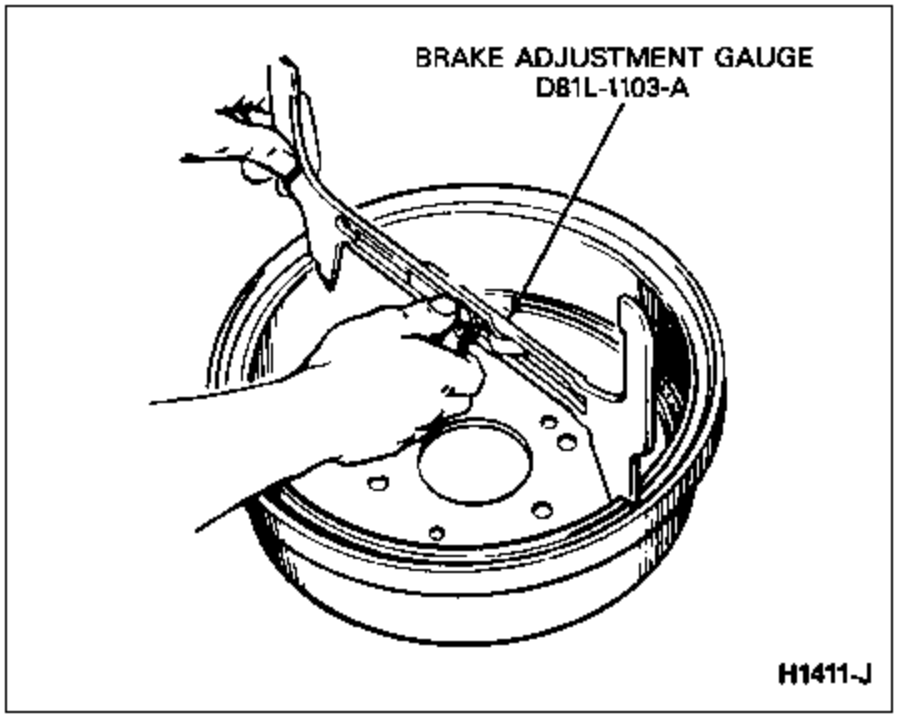

7. Reverse the tool as shown and adjust the rear brake shoe and lining (2200) until they match the gauge setting. The gauge contact points on the rear brake shoe and lining must be parallel to the vehicle with the center line through the center of the axle.

8. Hold the brake shoe adjusting lever out of engagement while rotating the notched part of the adjuster screw assembly, to prevent burring the notches. Make sure the adjuster rotates freely.

9. If necessary, remove the adjuster for disassembly and cleaning, then lubricate the adjusting screw threads and pilot end with a thin, uniform coating of Disc Brake Caliper Slide Grease D7AZ-19590-A or equivalent meeting Ford specification ESA-M1C172-A.

Checking Adjustment, Typical

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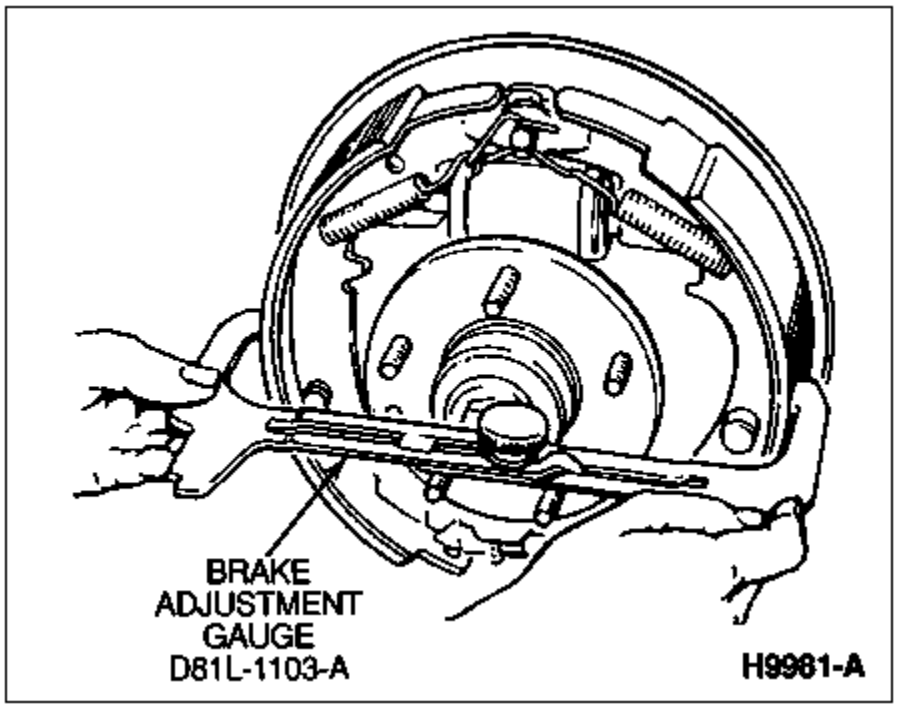

10. Install the brake drums.

11. Install the wheel on the brake drum and tighten the lug nuts (1012) to 135 Nm (100 lb-ft). Remove the safety stands and lower the vehicle.

12. After adjusting the brake shoes, check brake operation before moving the vehicle.

13. Complete the adjustment by sharply applying the brakes several times while driving the vehicle alternately in forward and reverse.

Drums Installed

Adjust the single anchor brake by turning the adjusting screw located between the lower ends of the shoes.

1. Place transmission (7003) in neutral. Raise the vehicle until the tires clear the floor. Install safety stands.

2. Remove the cover from the adjusting hole at the bottom of the brake backing plate, and turn the brake shoe adjuster assembly using Brake Adjustment Tool D81L-1103-C or equivalent inside the hole to expand the brake shoes until they lock the brake drum. Refer to illustration.

Ranger

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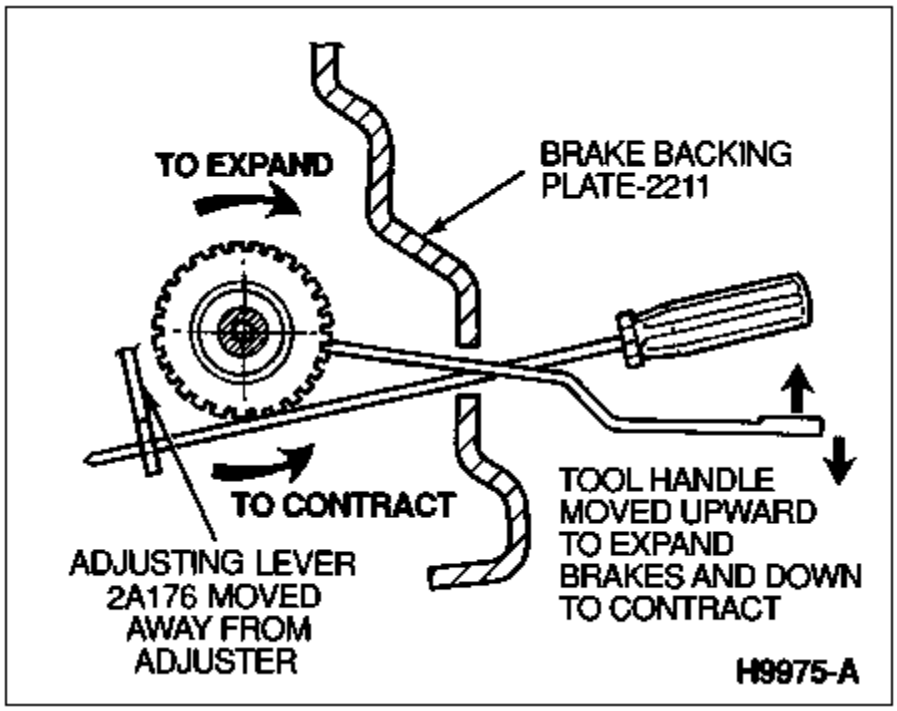

Aerostar

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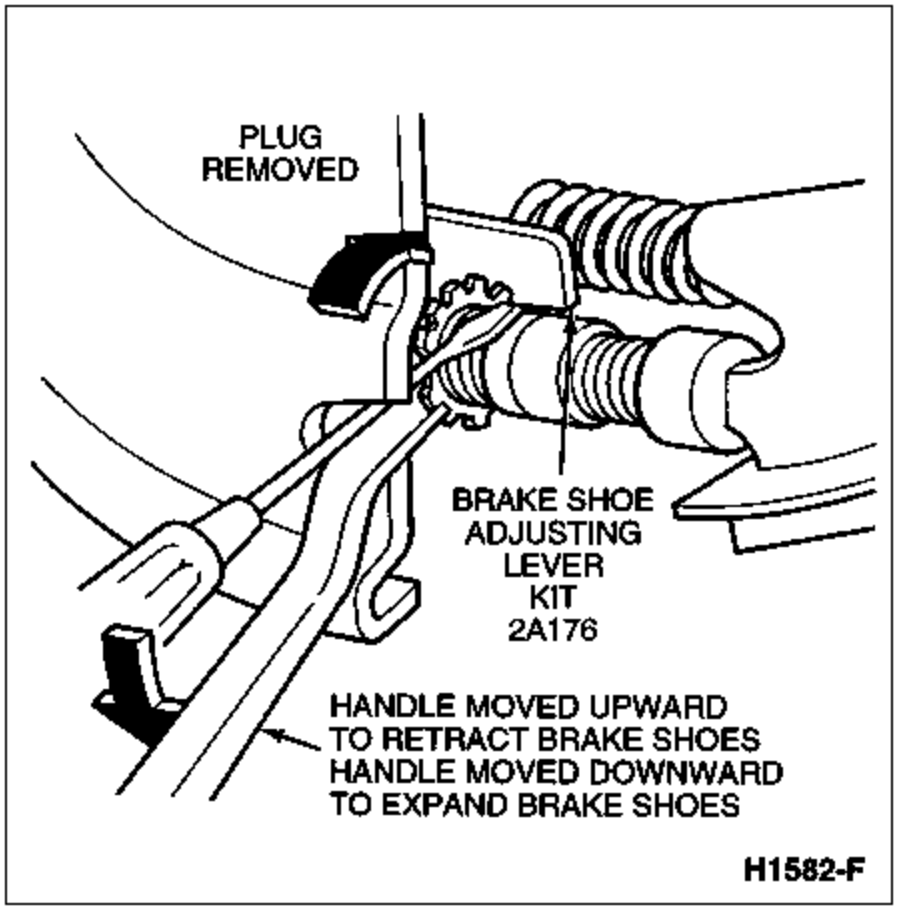

3. When the rear brake shoes and linings are against the brake drum, loosen the brake shoe adjusting screw nut 10 to 12 notches so that the brake drum rotates freely without drag.

4. If the brake drum does not rotate freely, remove the wheel and brake drum, and vacuum out any dust and dirt from the linings using Rotunda Brake/Clutch/Service Vacuum 091-R0001 or equivalent.

5. Using sandpaper, remove any rust from the points where the shoes touch the brake backing plate.

6. Check brake backing plate for damage. If none is found, apply a light coating of Disc Brake Caliper Slide Grease D7AZ-19590-A or equivalent meeting Ford specification ESA-M1C172-A . Do not get the lubricant on the rear brake shoe and lining.

7. Install the wheel and brake drum and adjust the rear brake shoe and lining.

8. Install the adjusting hole cover in the brake backing plate.

9. Check and adjust the other rear brake assembly.

10. Apply the brakes. If the pedal travels more than halfway to the floor, there is too much clearance between the brake shoes and the brake drums. Repeat Steps 2 and 3 of this procedure.

11. **WARNING: PERFORM THE ROAD TEST ONLY WHEN THE BRAKES WILL APPLY AND THE VEHICLE CAN BE SAFELY STOPPED.**

    When the rear brake shoes and linings have been properly adjusted, lower the vehicle and road test

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to check brake operation.

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SPECIFICATIONS

Fluid Specifications

Part Number	Description	Specification
C6AZ-19542-AA	Ford High Performance DOT 3 Brake Fluid	ESA-M6C25-A
D7AZ-19590-A	Disc Brake Caliper Slide Grease	ESA-M1C172-A
XG-1-C or K	Premium Long-Life Grease	ESA-M1C75-B
D6AZ-19562-AA or BB	Silicone Rubber Sealant	ESB-M4G92-A or ESE-M4G195-A

Brake Specifications

Truck Series	Ranger Reg. and SuperCab Under 4580 GVWR	Ranger Reg. SuperCab Over 4580 GVWR	All Aerostar
Axle Usage, Front	2540/ 2580/2650	2750 2800	2650
Axle Usage, Rear	2750/2950	2750/3200	2950
Type	DSSA	DSSA	DSSA
Size (Inches)	9x1.75 [a]	10x2.5 [b]	10x2.5

[a] Ranger SuperCab with limited slip axles have 10x2.5 inch rear brake regardless of GVWR.
[b] 9x1.75 standard with 2.3L engine.

Bore Diameters — Rear Wheel Cylinders

Truck Series	Ranger Reg. and SuperCab Under 4580 GVWR	Ranger Reg. SuperCab Over 4580 GVWR	All Aerostar
Rear Wheel Cylinder Bore (Inches)	0.75	0.75	0.9375

Rear Drum Brake Lining Dimensions

Truck Series	Ranger Reg. and SuperCab Under 4580 GVWR	Ranger Reg. SuperCab Over 4580 GVWR	All Aerostar
Lining Thickness Primary (Inches)	.19	.189	.189
Lining Thickness Secondary (Inches)	.28	.245	.245
Lining Length Primary (Inches)	6.10	8.46	8.46
Lining Length Secondary (Inches)	8.80	10.88	9.59

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NOTE: The following torque specifications are for clean, dirt-free and paint-free dry bolt and nut threads.

Torque Specifications

Description	Nm	Lb-Ft	Lb-In
Backing Plate-to-Rear Axle Housing Nuts	34-47	25-35	—
Lugnuts	135	100	—
Wheel Cylinder-to-Backing Plate Bolts	12-18	—	106-159
Brake Line-to-Wheel Cylinder Fitting	15-20	11-14	—
Wheel Cylinder Bleeder Screw	7-9	—	61-79

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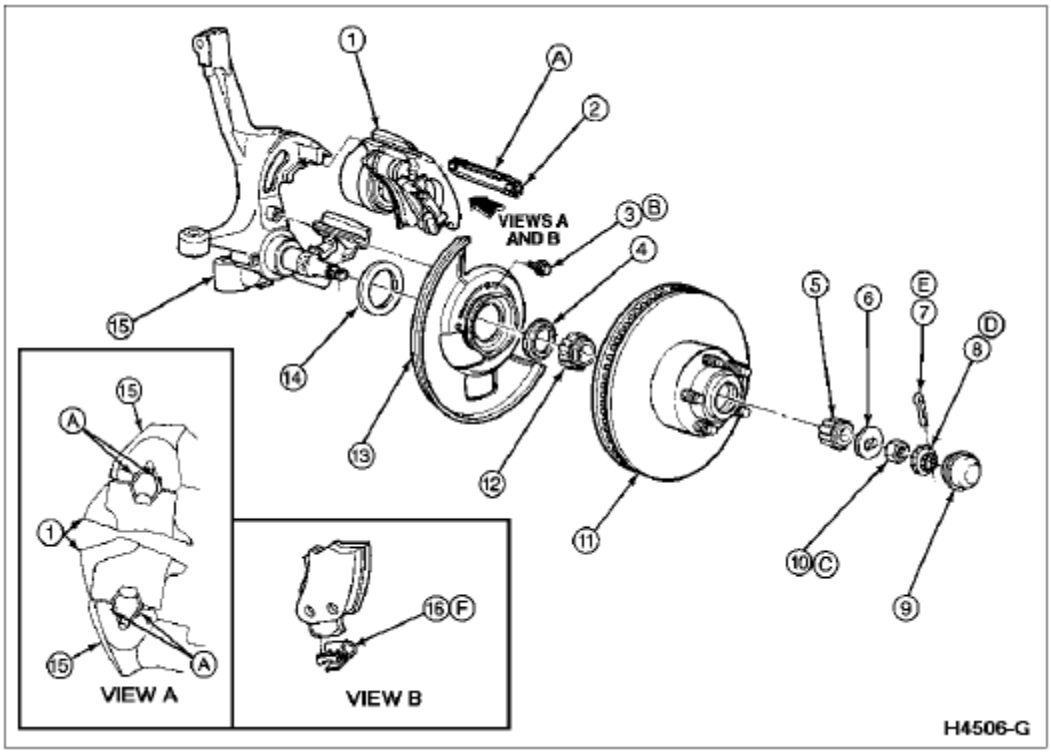
Service Precautions

When servicing the front disc brakes, observe the following precautions:

- Always replace brake shoes and linings (2001) in full axle sets. Never replace brake shoe and lining on just one side of the vehicle.
- Before compressing caliper pistons into the caliper bore, remove and discard enough brake fluid from the brake master cylinder reservoir (2K478) to allow for piston displacement.
- Never allow the weight of the disc brake caliper (2B120) to hang from the front brake hose (2078).
- After servicing the brakes, always test brakes before attempting to move the vehicle.
- When installing disc brake caliper, the caliper pin must be installed so the retention tabs are in contact with the spindle surface to make sure pin is fully inserted (four places). Caliper pin may be installed from the inboard or outboard side with the pins oriented in grooves.

Spindle, Wheel and Caliper Assembly, Aerostar 4x2



Item	Part Number	Description

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1	2B121	Front Disc Brake Caliper
2	2C150	Caliper Pin
3	N611171-S2	Screw, Rotor Shield-to-Spindle
4	1190	Grease Seal
5	1216	Front Wheel Bearing
6	1195	Washer
7	N642569-S36	Cotter Pin
8	390622-S	Nut Retainer
9	1131	Hub Grease Cap
10	374504-S100	Nut, Hub Spindle
11	1102	Front Disc Brake Hub and Rotor
12	1201	Bearing Cone and Roller
13	2K004	Front Disc Brake Rotor Shield
14	2B160	Front Brake Splash Shield Gasket
15	3105	Front Wheel Spindle
16	2068	Brake Shoe Hold-Down Spring
A	—	Install Caliper Pin so Retention Tabs Are in Contact with Spindle, Not Caliper
B	—	Tighten to 11-13 Nm (97-115 Lb-In)
C	—	For Bearing Preload, Tighten to 23-34 Nm (17-25 Lb-Ft). Back Off 120-180°. Retighten to 2.0-2.3 Nm (18 -20 Lb-In).
D	—	Must Be Installed Without Altering Hub Spindle Nut Setting
E	—	Must Be Installed as Shown
F	—	Must Be Installed on Lower End of Inner Shoe Only, with Loop Facing Away from Rotor

Spindle, Wheel and Caliper Assembly, Ranger 4x2

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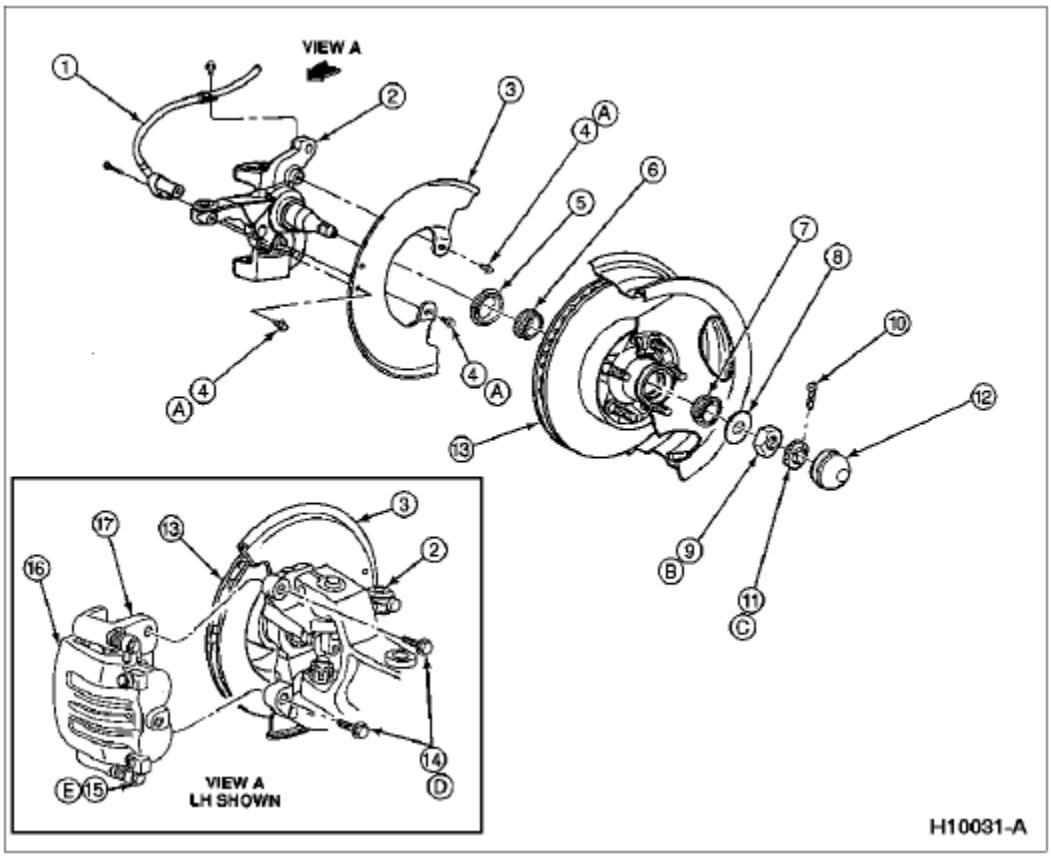

Item	Part Number	Description
1	2C204	Front Brake Anti-Lock Sensor
2	3105	Front Wheel Spindle
3	2K004	Front Disc Brake Rotor Shield
4	N611171-S2	Screw, Rotor Shield
5	1190	Grease Seal
6	1201	Bearing Cone and Roller
7	1216	Front Wheel Bearing
8	1195	Front Wheel Outer Bearing Retainer Washer
9	374504-S36	Hub Spindle Nut
10	N642569-S	Cotter Pin
11	390622-S	Nut Retainer
12	1131	Hub Grease Cap
13	1102	Front Disc Brake Hub and Rotor
14	N805163-S190	Bolts, Caliper Anchor Plate (See Torque Note D Below)
15	2N386	Caliper Pin Bolts

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16	2B120	Disc Brake Caliper
17	—	Front Disc Brake Caliper Anchor Plate (Part of 2B120)
A	—	Tighten to 11-13 Nm (97-115 Lb-In)
B	—	Tighten to 23-34 Nm (17-25 Lb-Ft) While Rotating the Front Disc Brake Hub and Rotor. Back Off 120-180 Degrees and Retighten to 2.0-2.3 Nm (18-20 Lb-In).
C	—	Install Without Turning the Hub Spindle Nut
D	—	Tighten to 98-132 Nm (73-97 Lb-Ft).
E	—	Tighten to 52-65 Nm (38-48 Lb-Ft)

Spindle, Wheel End and Caliper, Ranger 4x4

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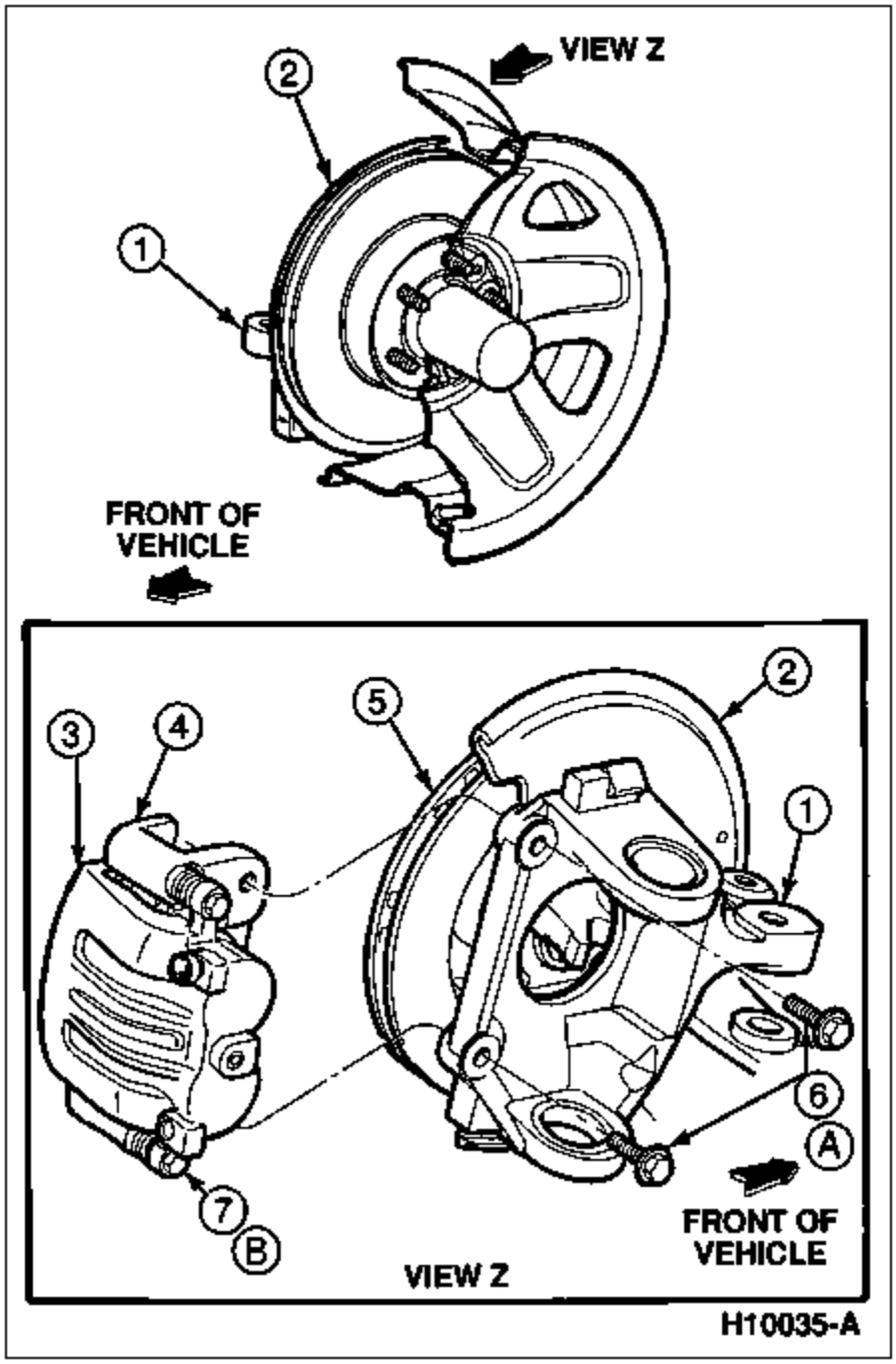

Item	Part Number	Description
1	3K206	Front Wheel Hub and Spindle
2	2K004	Front Disc Brake Rotor Shield
3	2B120	Disc Brake Caliper
4	—	Front Disc Brake Caliper Anchor Plate (Part of 2B120)
5	1102	Front Disc Brake Hub and Rotor
6	N805163-	Bolt, Caliper Anchor Plate (See Torque Note A

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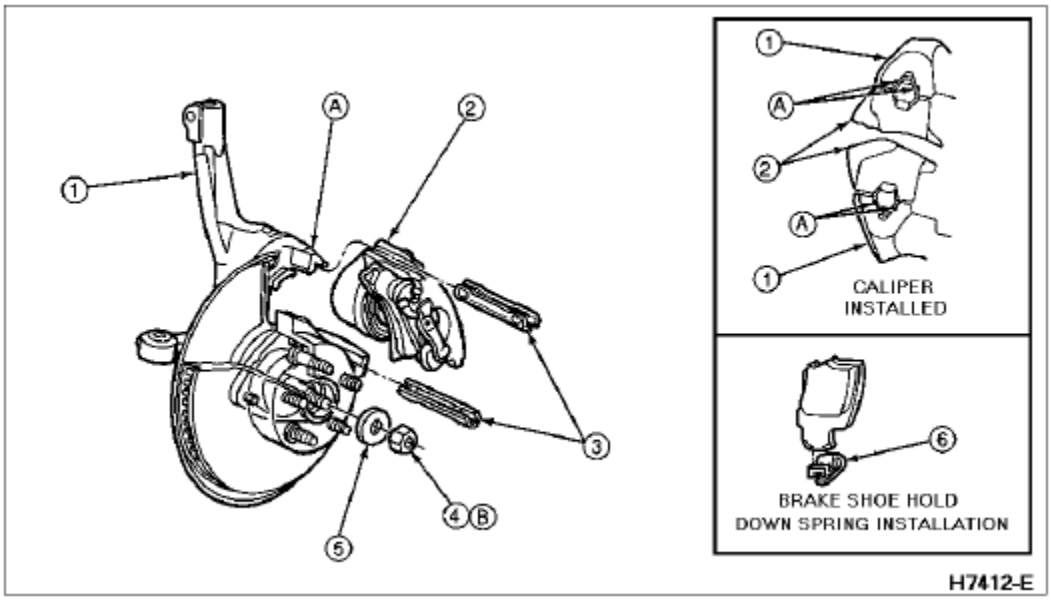
	S190	Below)
7	2N386	Caliper Pin Bolt
A	—	Tighten to 98-132 Nm (73-97 Lb-Ft)
B	—	Tighten to 52-65 Nm (38-48 Lb-Ft)

Spindle and Caliper Assembly, Aerostar E4WD



Item	Part Number	Description
1	3105	Knuckle
2	2B121	Front Disc Brake Caliper
3	2C150	Caliper Pin
4	N804199	Nut, Hub Retainer
5	N801338	Washer
6	2068	Brake Shoe Hold-Down Spring
A	—	Install Caliper Pins so Retention Tabs Are in Contact with Knuckle, Not Caliper
B	—	Tighten to 230-283 Nm (170-208 Lb-Ft)

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Caliper and Lining, Aerostar

NOTE: If the disc brake calipers (2B120) are to be removed for service other than to replace the brake shoe and lining (2001), fluid removal from the reservoir brake master cylinder reservoir (2K478) may not be required. Go to Step 2.

CAUTION: System contamination may result if anything other than a CLEAN device is used to remove fluid from reservoir brake master cylinder reservoir.

NOTE: Removing some fluid will prevent fluid from overflowing from the brake master cylinder reservoir when the caliper piston is pressed into the bore.

Removal

1. Use a clean siphon or suction hose to remove a portion of the fluid from the brake master cylinder reservoir. Discard the removed fluid.

2. Raise the vehicle and install safety stands. Remove a front wheel and tire assembly.

3. **CAUTION: Do not position C-clamp on the outboard anti-rattle spring. Also, do not compress the caliper piston further than is required to disengage torque buttons from disc brake caliper. Replace the brake shoe and lining if the outboard anti-rattle spring is bent or damaged. Do not pry with screwdriver or other tool to gain clearance.**

   CAUTION: Do not attempt to "bottom" the caliper piston in the bore at this time. Use an old, worn out brake shoe or block of wood and the C-clamp to bottom the caliper piston once the disc brake caliper is removed from the front disc brake hub and rotor (1102), and the brake shoe and lining are removed from the disc brake caliper.

   Use an eight-inch C-clamp to move the caliper piston back into its bore as follows:

   - Place the frame of the C-clamp against the disc brake caliper, and the screw end of the C-clamp against the outer shoe BELOW THE SPRING CLIP.
   - Tighten the clamp until the torque buttons just clear the disc brake caliper (about 3mm [1/8 inch]). Remove the C-clamp.

   Aerostar

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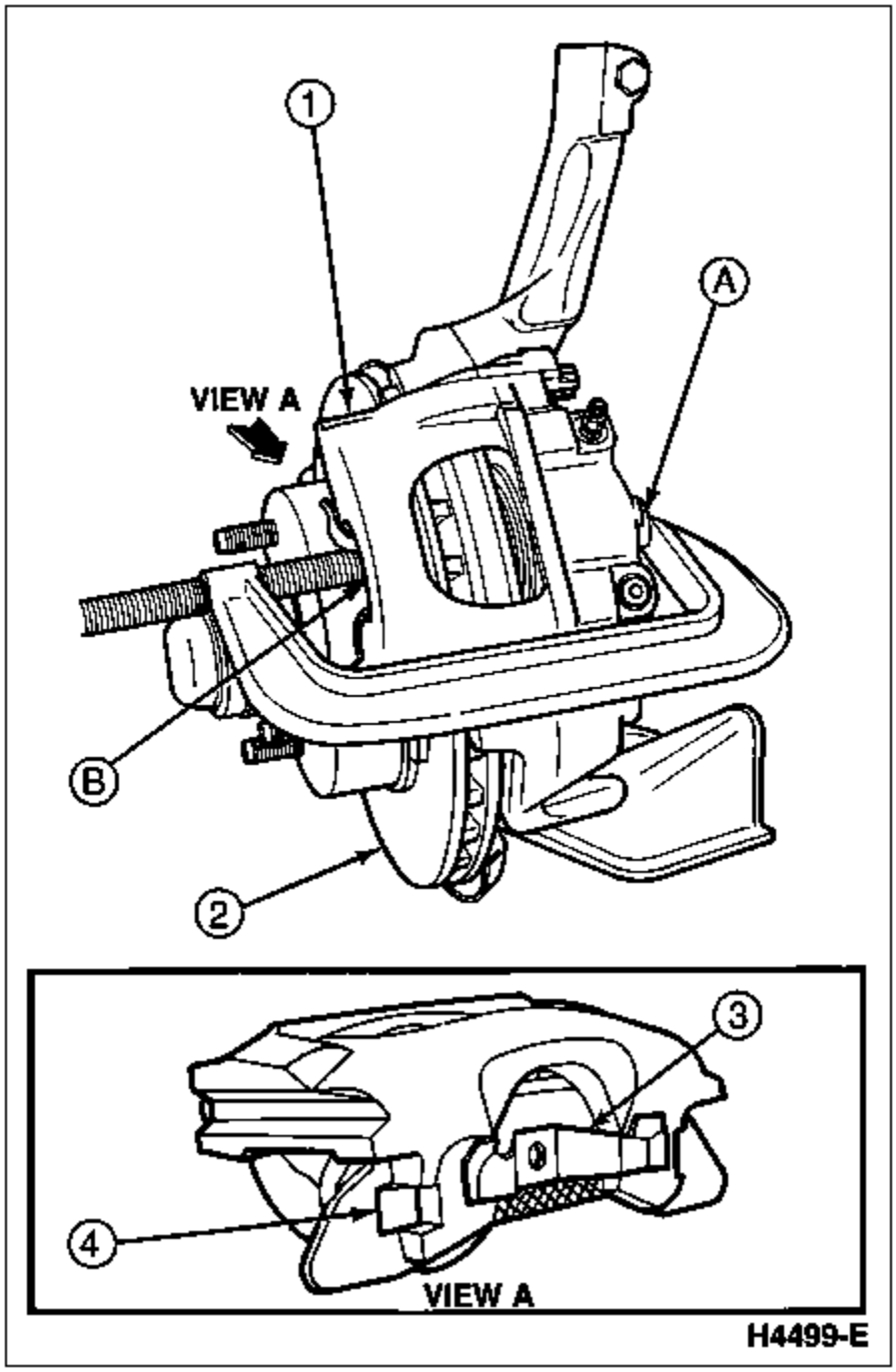

Item	Part Number	Description
1	2B120	Disc Brake Caliper
2	1102	Front Disc Brake Hub and Rotor
3	—	Outboard Anti-Rattle Spring (Part of 2001)
4	—	Torque Button (Part of 2001)
A	—	C-Clamp Frame Against Front Disc Brake Caliper
B	—	C-Clamp Screw Against Outboard Brake Shoe and

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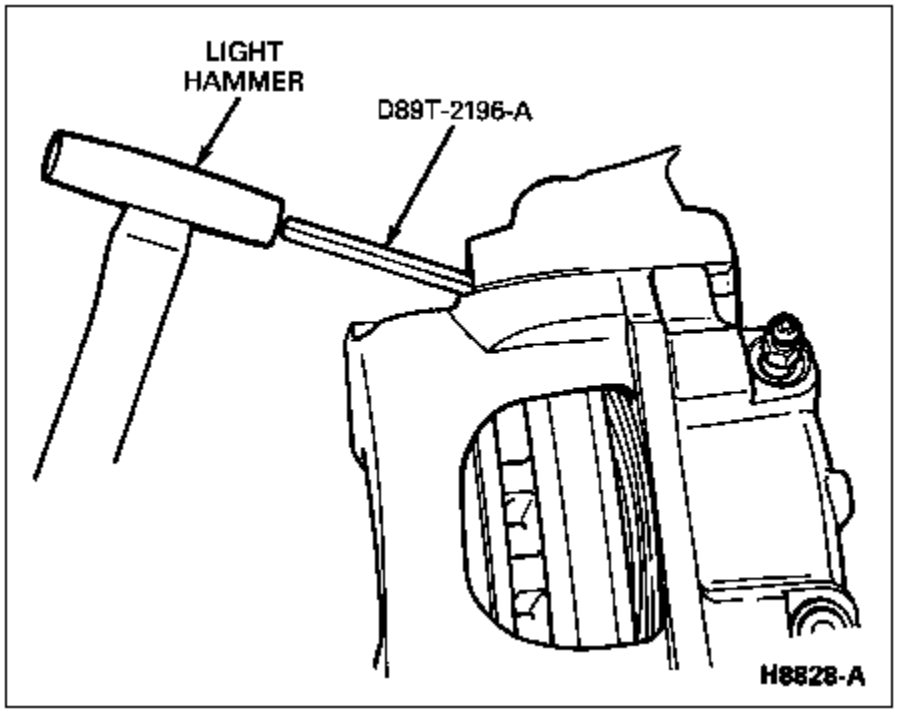
		Lining (Not on Anti-Rattle Spring)

4. Clean excess dirt from area around pin tabs.

5. Using Hydraulic Caliper Pin Remover D89T-2196-A or equivalent and a light hammer, drive the caliper pin from the disc brake caliper as follows:

   - Position the notched end of the tool against the caliper pin (retention tab half), at a 45-degree angle from the pin retention tabs.



   - Tap the tool with the hammer to compress the retention tabs.
   - As the retention tabs are compressed, move the tool to gain a straight approach to the caliper pin, and continue tapping to drive the caliper pin through the caliper/spindle groove.

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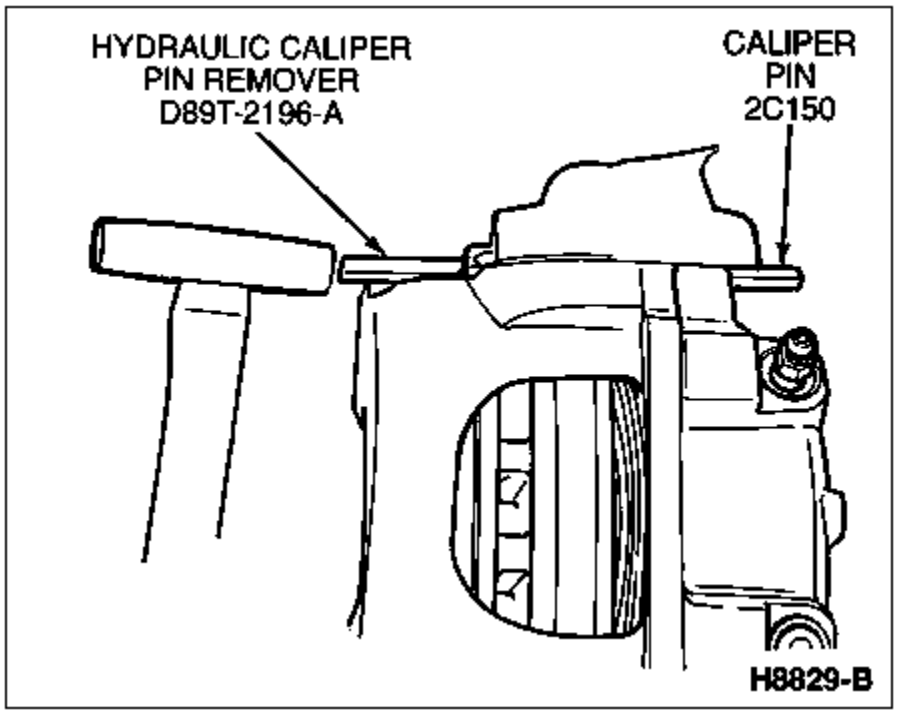
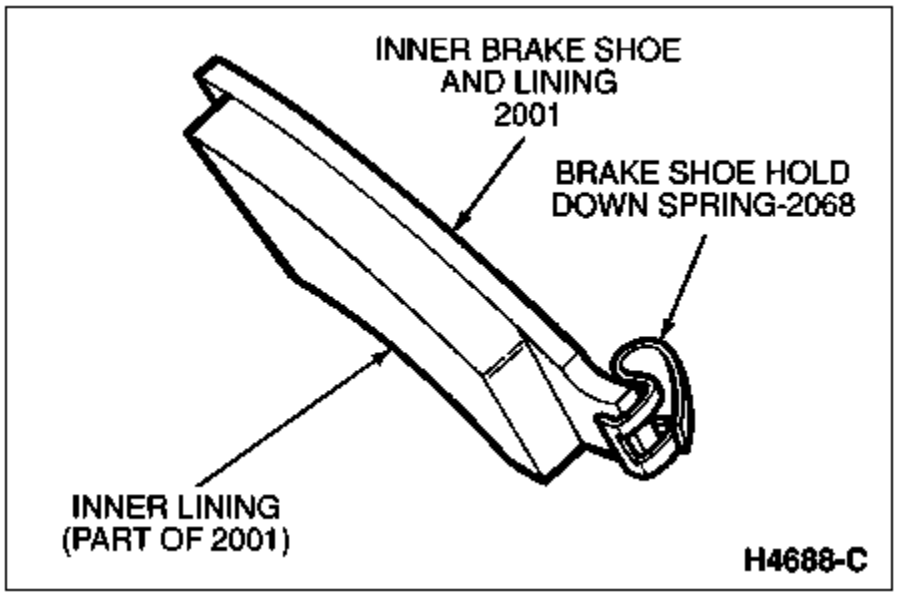


6. **CAUTION: DO NOT let the disc brake caliper hang with its weight on the front brake hose (2078).**

   Remove the disc brake caliper from the rotor. If the disc brake caliper is to be serviced, disconnect the front brake hose from the disc brake caliper. If not, support the disc brake caliper with wire.

7. Compress the brake shoe hold-down spring (2068) and remove the inner brake shoe and lining from the disc brake caliper.



8. To remove the outer brake shoe and lining from the disc brake caliper, press each ear of the outboard

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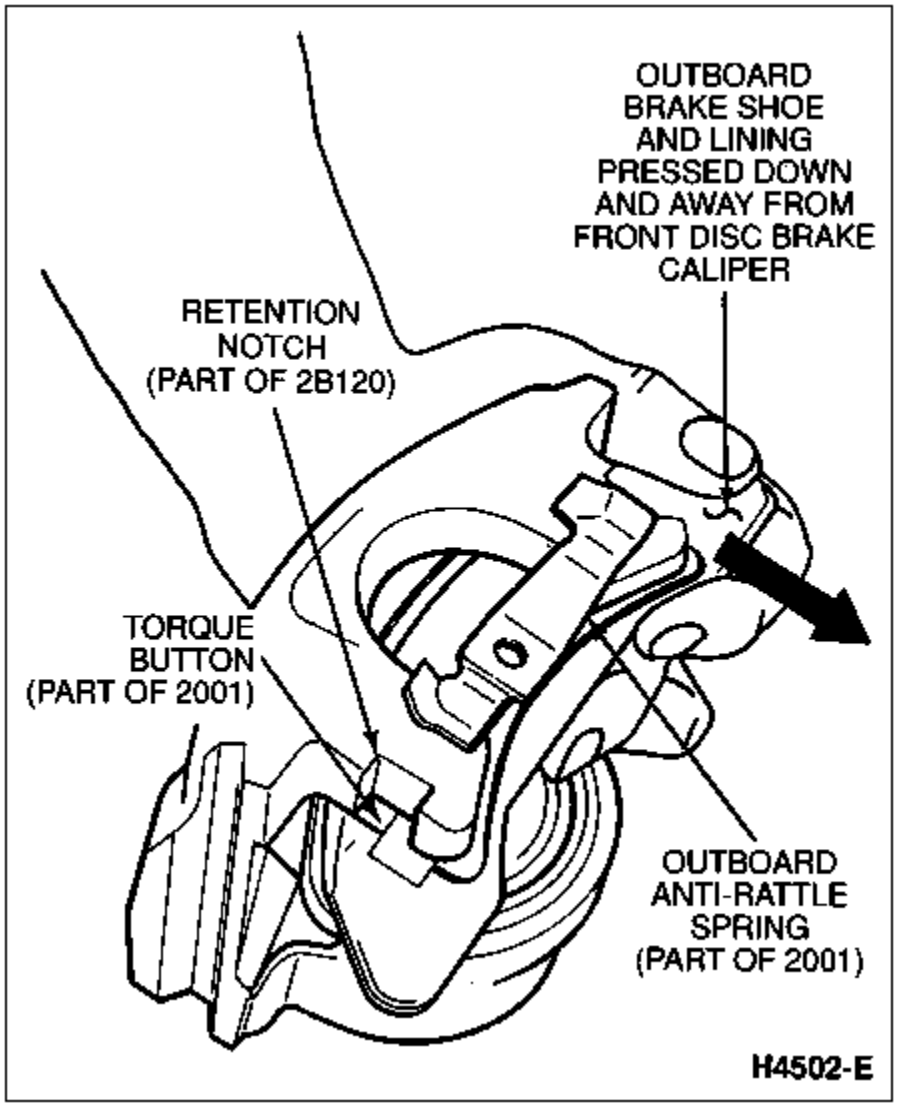
brake shoe and lining away from the disc brake caliper, slide the torque buttons out of the retention notches and slide the brake shoe and lining off.



Installation

1. **CAUTION: Never attempt to bottom out the caliper piston with the outer brake shoe and lining installed.**

   The caliper must be bottomed out when installing new brake shoes and linings. Be sure that enough fluid has been removed from reservoir brake master cylinder reservoir (see Step 1 of Removal) to prevent fluid overflow. Bottom out the caliper piston with an eight-inch C-clamp using a worn-out inner shoe or a block of wood to push against the caliper piston.

2. Place a new brake shoe hold-down spring on the lower end of the inner brake shoe and lining. Be sure the tabs are positioned properly (spring loop away from the pad material) and the brake shoe

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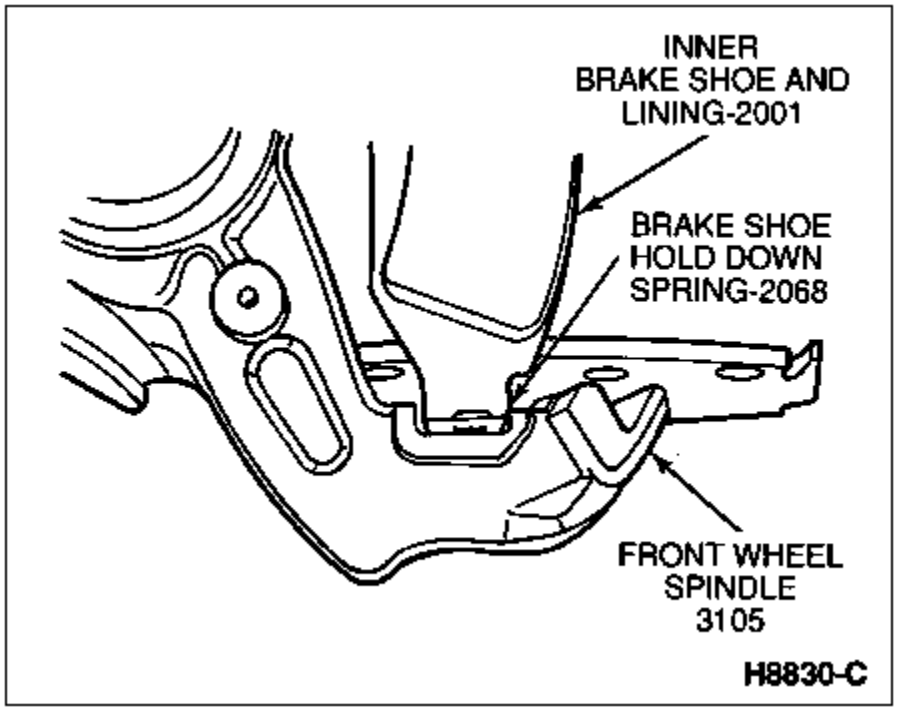
hold-down spring is fully seated.

3. Position the inner brake shoe and lining and brake shoe hold-down spring in the lower shoe abutment of the front wheel spindle (3105) with the brake shoe hold-down spring tab against the shoe abutment and the loop of the spring away from the front disc brake hub and rotor.

4. Compress the brake shoe hold-down spring and slide the upper end of the brake shoe and lining into position in the front wheel spindle.



5. **WARNING: OUTER SHOE TORQUE BUTTONS MUST BE SOLIDLY SEATED IN CALIPER HOLES OR TEMPORARY LOSS OF BRAKES MAY OCCUR.**

   Install the outer brake shoe and lining in the disc brake caliper, making sure the torque buttons on the shoe are seated solidly in the matching holes in the disc brake caliper.

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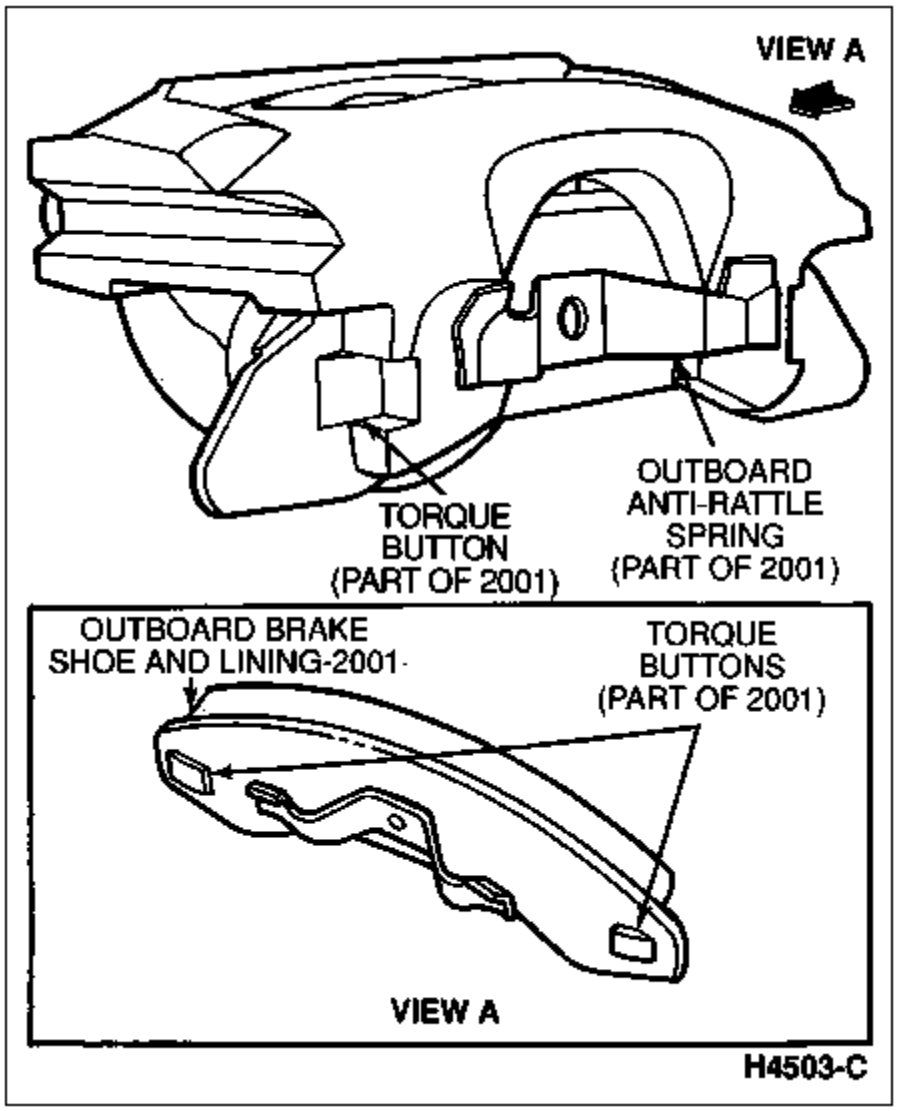

6. **CAUTION: Be sure to install the caliper pins so the retention tabs will be in contact with the front wheel spindle, not the disc brake caliper. When the upper pin is properly positioned, the retention tabs will be at the top, against the front wheel spindle. When the lower caliper pin is properly positioned, the retention tabs will be at the bottom, also in contact with the front wheel spindle.**

   Lubricate the caliper grooves with Disc Brake Caliper Slide Grease D7AZ-19590-A or equivalent lubricant meeting Ford specification ESA-M1C172-A. Position the disc brake caliper on the front wheel spindle.

7. **CAUTION: During the installation procedure, do not allow the tabs of the caliper pin to be tapped too far into the front wheel spindle groove. If this happens, it will be necessary to tap the other end of the caliper pin until the tabs snap into place. The tabs on each end of the caliper pin must be free to catch on the front wheel spindle face.**

   From the outboard side, position the caliper pin between the disc brake caliper and the front wheel spindle grooves. The caliper pin must be positioned so the tabs will be installed against the front wheel spindle outer face.

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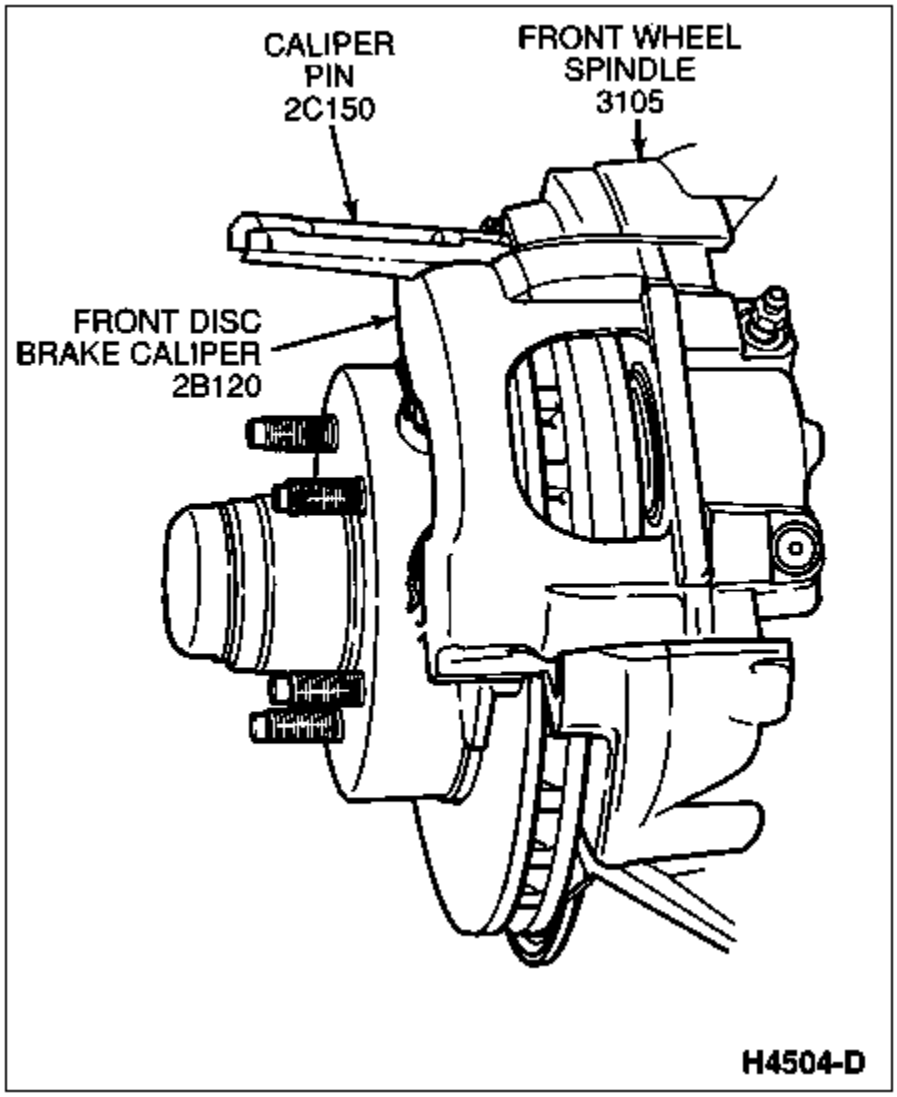

8. Tap the caliper pin on the outboard end with a hammer. Continue tapping the caliper pin inward until the retention tabs on the sides of the caliper pin contact the front wheel spindle face. Repeat procedure for the lower caliper pin.

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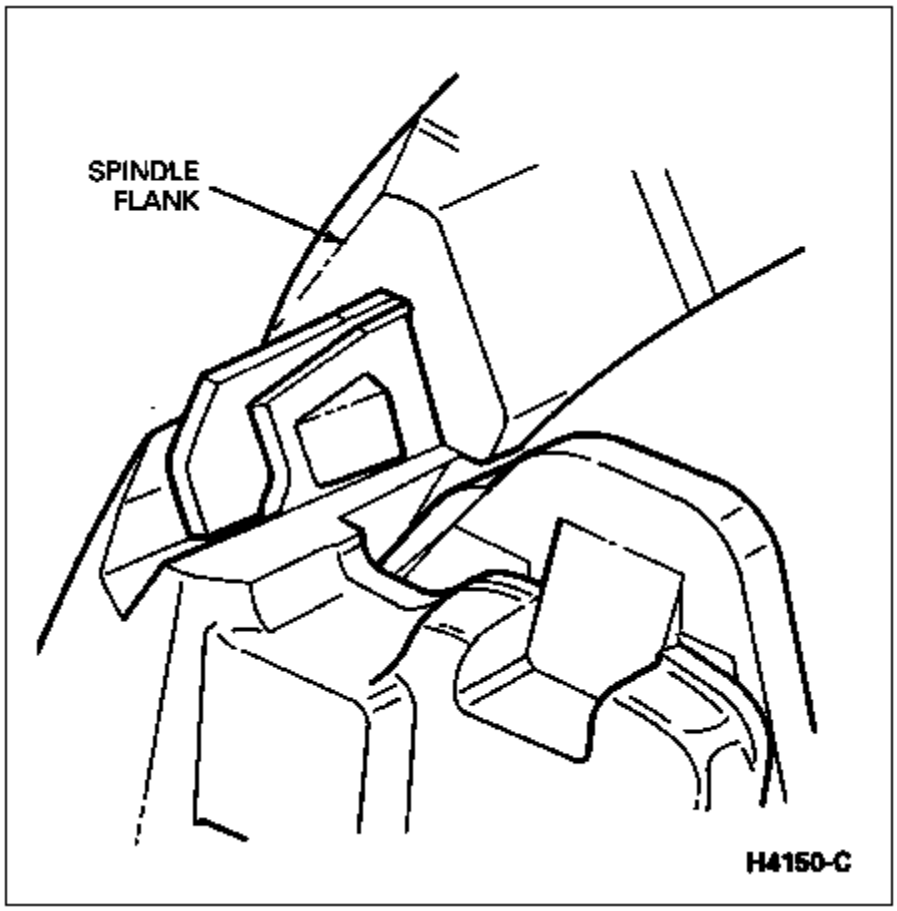

9. If removed, install the front brake hose to the disc brake caliper.
10. If the front brake hose was removed, bleed the brakes as described in Section 06-06 .
11. Install the wheel and tire assembly. Tighten lug nuts to 115-155 Nm (85-115 lb-ft).
12. Lower the vehicle, check the brake fluid level and fill as necessary. Check brakes for proper operation then recheck brake fluid level in brake master cylinder reservoir. Fill as necessary.

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Caliper, Lining and Front Disc Brake Caliper Anchor Plate, Ranger

NOTE: Refer to the Spindle, Wheel and Caliper Assembly illustration in this section.

Removal

1. Remove and discard sufficient brake fluid from the brake master cylinder reservoir (2K478) to allow for caliper piston displacement.
2. Raise and support the vehicle.
3. Remove the tire and wheel assembly.
4. Using a C-clamp:
    - Position the frame of the C-clamp on the inboard side of the disc brake caliper (2B120). Do not place the clamp frame over the front brake hose.
    - Position the C-clamp screw on the outboard brake shoe and lining.
    - Compress the C-clamp only enough to give removal clearance for the disc brake caliper.

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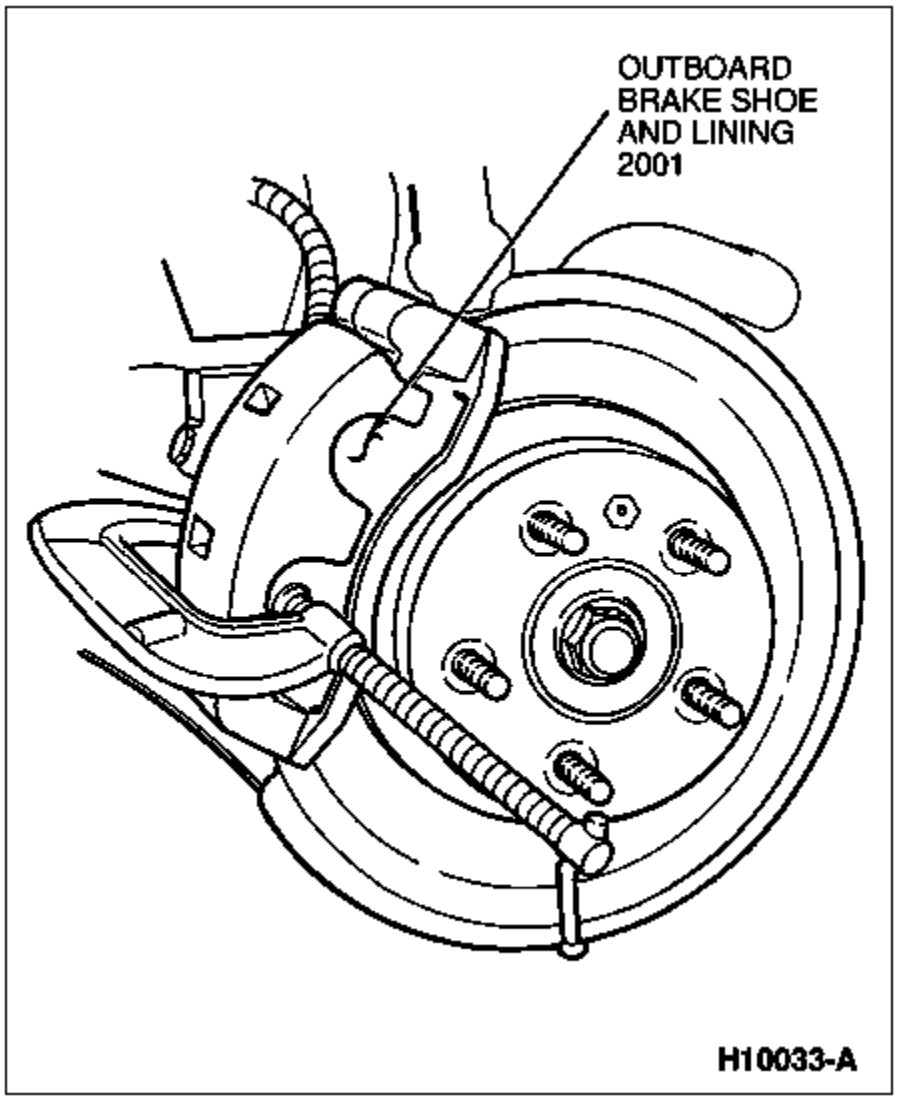

5. Remove the front brake hose flow bolt.
6. Disconnect and plug the front brake hose (2078). Discard the copper washers.
7. **CAUTION: Use care to retain as much of the original caliper slide pin grease as possible.**

   From the inboard side of the disc brake caliper, remove the two caliper slide pins.
8. Slide the disc brake caliper off the front disc brake hub and rotor (1102).
9. Slide the brake shoe and lining out of the front disc brake caliper anchor plate.
10. Remove the two caliper anchor plate bolts.
11. Remove the front disc brake caliper anchor plate from the front wheel hub and spindle (3K206).

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Installation

1. Position the front disc brake caliper anchor plate on the front wheel hub and spindle.
2. Install the two caliper anchor plate bolts. Tighten the bolts to 98-132 Nm (73-97 lb-ft).
3. Position the brake shoe and lining in the front disc brake caliper anchor plate.
4. Slide the disc brake caliper over the brake shoe and lining.
5. Install the caliper slide pins. Tighten to 30-36 Nm (23-26 lb-ft).
6. Using new copper washers, install the flow bolt through the front brake hose fitting and into the disc brake caliper. Tighten the flow bolt to 30-40 Nm (22-29 lb-ft).
7. Install the tire and wheel assembly.
8. Lower the vehicle.
9. Refill the brake master cylinder reservoir with clean Ford High Performance DOT 3 Brake Fluid C6AZ-19542-AA or equivalent DOT 3 fluid meeting Ford specification ESA-M6C25-A.
10. Bleed the brake system. Refer to Section 06-06 .
11. Test the brakes before moving the vehicle.

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Rotor, Ranger

NOTE: Refer to the Spindle, Wheel and Caliper illustration in this section.

Removal

1. Remove and discard sufficient brake fluid from the brake master cylinder reservoir (2K478) to allow for caliper piston displacement.
2. Raise and support the vehicle.
3. Remove the tire and wheel assembly.
4. Using a C-clamp:
   - Position the frame of the C-clamp on the inboard side of the disc brake caliper. Do not place the clamp frame over the front brake hose.
   - Position the C-clamp screw on the outboard brake shoe and lining.
   - Tighten the C-clamp only enough to give removal clearance for the disc brake caliper.
5. Remove the two front disc brake caliper anchor plate bolts.
6. **CAUTION: Do not allow the weight of the disc brake caliper (2B120) to hang from the front brake hose (2078).**

   Slide the caliper and anchor bracket assembly off the front disc brake hub and rotor (1102). Using a wire, support the disc brake caliper from a convenient underbody component.

NOTE: Steps 7 through 10 apply to 4x2 vehicles. For 4x4 vehicles, go to Step 11.

7. Remove the hub grease cap (1131), cotter pin, nut retainer, hub spindle nut and the front wheel outer bearing retainer washer (1195).
8. Carefully pull outward and push back the front disc brake hub and rotor to expose the front wheel bearing (1216).
9. Remove the front wheel bearing and protect it from contamination.
10. Remove the front disc brake hub and rotor, inner bearing cone and roller (1201) and the grease seal as an assembly from the front wheel spindle (3105).
11. On 4x4 vehicles, remove the front disc brake hub and rotor from the front hub.
12. If necessary, remove the grease seal and the inner bearing cone and roller from the front disc brake hub and rotor. Discard the grease seal.

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Installation

1. Inspect the front disc brake hub and rotor for cracks or other damage. Replace as necessary.
2. If necessary, install the inner bearing cone and roller and a new grease seal in the front disc brake hub and rotor.
3. Position the front disc brake hub and rotor on the front hub (4x4 vehicles) or the front wheel spindle (4x2 vehicles).
4. Install the front wheel bearing.
5. Install the front wheel outer bearing retainer washer.
6. Install the hub spindle nut. Tighten the hub spindle nut to 23-34 Nm (17-25 lb-ft) while rotating the front disc brake hub and rotor, back off 120-180 degrees and retighten to 2.0-2.3 Nm (18-20 lb-in).
7. Without changing the position of the hub spindle nut, install the nut retainer, cotter pin and hub grease cap.
8. Install the disc brake caliper and front disc brake caliper anchor plate assembly. Refer to the procedure in this section.
9. Install the tire and wheel assembly. Tighten the lug nuts to 115-155 Nm (85-115 lb-ft).
10. Lower the vehicle. Test the brakes.

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Rotor, Aerostar

Refer to the Exploded Views at the beginning of the Removal and Installation procedures in this section.

Removal

1. Raise the front of the vehicle and install safety stands.
2. Remove the wheel and tire assembly.
3. Remove the disc brake caliper (2B120) from the front disc brake hub and rotor (1102) and support it out of the way with wire. Refer to Caliper and Lining removal procedure in this section.
4. On 4x2 vehicles, remove the hub grease cap (1131), cotter pin, retainer, hub spindle nut, washer, and outer front wheel bearing (1216), and remove the front disc brake hub and rotor , the inner bearing cone and roller (1201) and the grease seal as an assembly from the front wheel spindle (3105).

    - On 4x4 vehicles, refer to Section 04-01B for procedures.
    - On Aerostar E-4WD vehicles, refer to Section 04-01C for hub removal procedures.

Installation

1. If a new front disc brake hub and rotor will be installed, remove the protective coating or any dirt or grease deposits with degreaser.
2. If a new front disc brake hub and rotor is being installed, pack the new inner bearing cone and roller with Premium Long-Life Grease XG-1-C or -K or equivalent lubricant meeting Ford specification ESA-M1C75-B.
3. If a new front disc brake hub and rotor are being installed, install the bearing cone and roller as described here.
4. Install the front disc brake hub and rotor on the front wheel spindle.
5. On 4x2 vehicles, install the bearing cone and roller, washer, and nut. Adjust bearing end play and install the cotter pin and dust cap as described in Section 04-01A . On 4x4 vehicles, refer to Section 04-01B .
6. Install the disc brake caliper as described in this section.
7. Install the wheel and tire assembly. Tighten lug nuts to 115-155 Nm (85-115 lb-ft).
8. Lower the vehicle. Check the brakes for proper operation.

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Rotor Shield

NOTE: Refer to the applicable front brake Exploded Views at the beginning of Removal and Installation.

Removal

1. Remove the front disc brake hub and rotor (1102). Refer to the procedure in this section.
2. Remove the three bolts and the front disc brake rotor shield (2K004) from the front wheel spindle (3105).

Installation

To install, reverse the removal procedure. Tighten the front disc brake rotor shield bolts to 11-13 Nm (97-115 lb-in).

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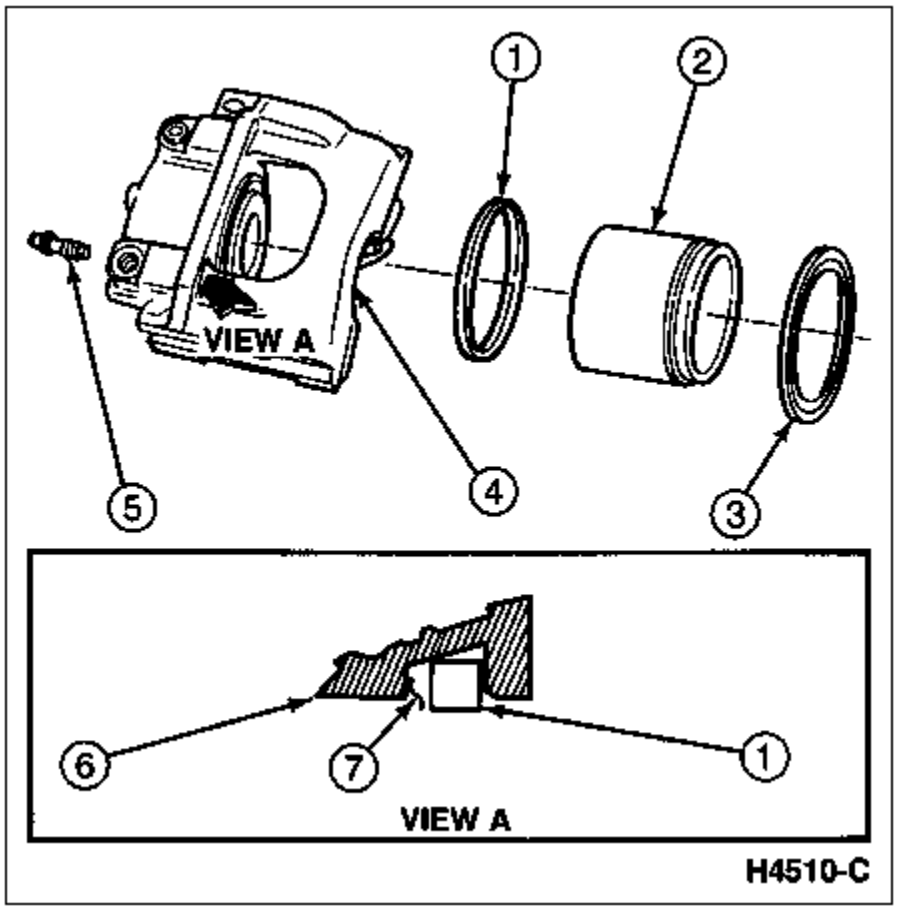
Caliper, Aerostar

Disassembly

1. Remove the disc brake caliper (2B120) from the vehicle as outlined in Caliper and Lining Removal in this section. Place a block of wood over the caliper piston (2196) before applying air pressure to prevent damage to the caliper piston.



Item	Part Number	Description
1	2B115	Piston Seal
2	2196	Caliper Piston
3	2207	Dust Boot
4	2B120	Disc Brake Caliper
5	2208	Bleeder Screw
6	—	Caliper Bore (Part of 2B120)

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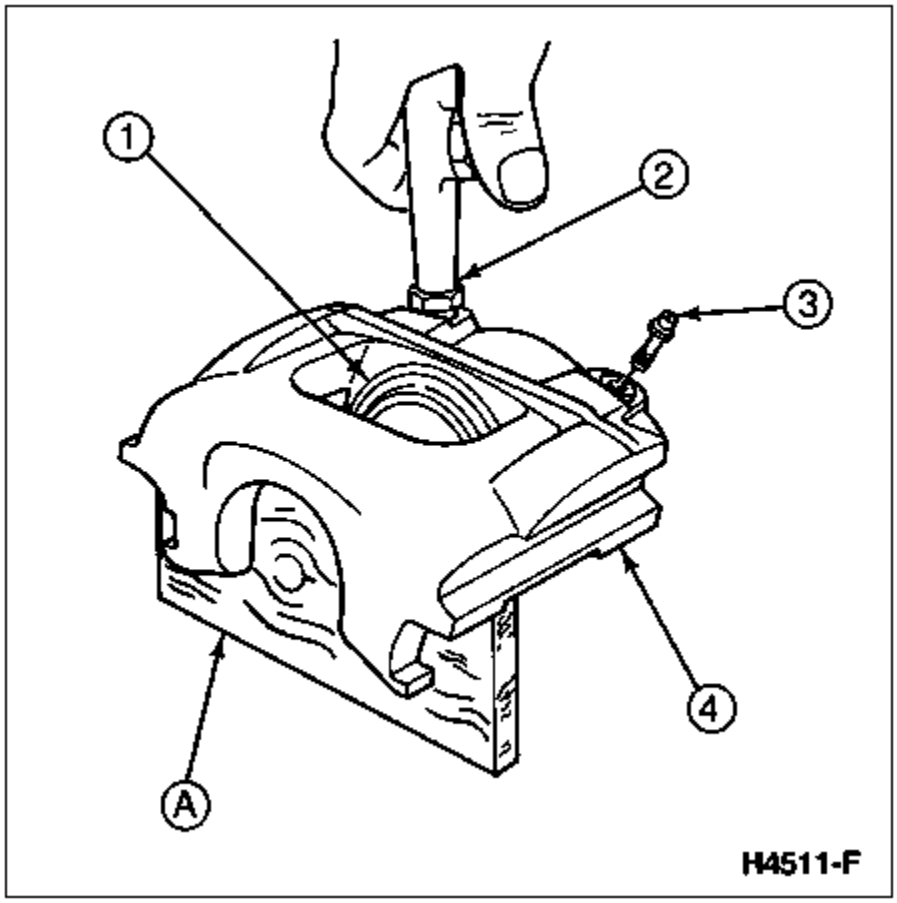
7	—	Seal Groove (Part of 2B120)

2. **NOTE: Use care because the caliper piston can develop considerable force from pressure buildup.**

   Apply air pressure to the fluid port in the disc brake caliper with Rubber-Tipped Air Gun D93L-7000-A or equivalent to remove the caliper piston. If the caliper piston is seized and cannot be forced from the disc brake caliper, tap lightly around the caliper piston while applying air pressure.



Item	Part Number	Description
1	2196	Caliper Piston
2	D93L-7000-A	Air Gun
3	2208	Bleeder Screw
4	2B120	Disc Brake Caliper, Front
A	—	Wood Block (To Prevent Piston Damage)

3. Remove the dust boot from the disc brake caliper.

4. **CAUTION: To prevent damage to the seal groove, do not use a metal tool to remove the**

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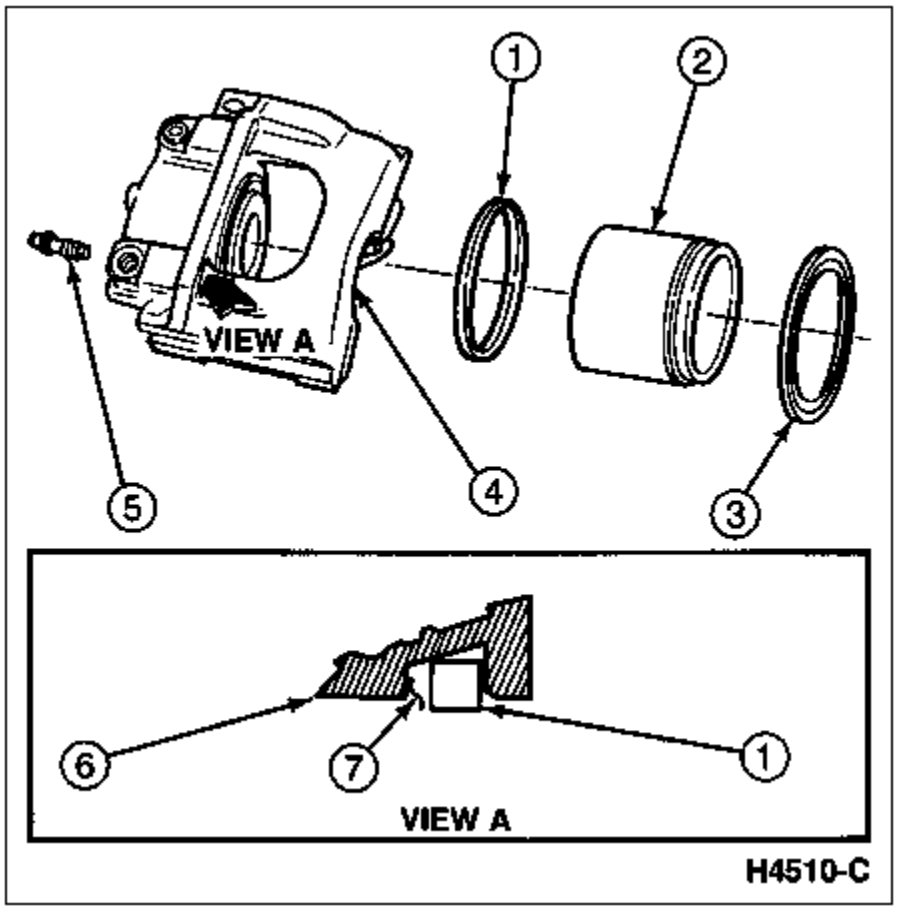
piston seal.

Remove the rubber piston seal from the caliper piston and discard it.

Assembly

1. Apply a film of clean brake fluid to the new caliper piston seal, and install it in the caliper bore. Be sure the seal does not become twisted but is firmly seated in the groove.
2. Coat the caliper piston with brake fluid. Spread the dust boot over the caliper piston seating the dust boot in the caliper piston groove.
3. Install the caliper piston into the caliper bore.
4. The dust boot flange should set squarely in the outer groove of the caliper bore when the wheel cylinder piston is completely installed.



Item	Part Number	Description
1	2B115	Piston Seal
2	2196	Caliper Piston
3	2207	Dust Boot

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4	2B120	Disc Brake Caliper
5	2208	Bleeder Screw
6	—	Caliper Bore (Part of 2B120)
7	—	Seal Groove (Part of 2B120)

5. Install the disc brake caliper as outlined in this section.

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Caliper, Ranger

Disassembly

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Piston Dust Seal Replacer	T92P-2588-AH
Driver Handle	T80T-4000-W

1. Remove the disc brake caliper (2B120) from the vehicle. Refer to the procedure in this section.

2. **CAUTION: Use care to retain as much of the original caliper slide pin grease as possible.**

   Remove the caliper slide pins and caliper slide pin dust boots from the front disc brake caliper anchor plate.

3. **NOTE: Because there are two caliper pistons, it is desired to have both pistons nearly expelled before the seal is broken. Therefore, the dimensions of the wood block used to assist removal are important. A block 38 x 38 x 150mm (1.5 x 1.5 x 6 inches) is recommended.**

   Place a wood block in the disc brake caliper jaws to avoid damage to the disc brake caliper pistons when they are forced out of the disc brake caliper bores.

4. **WARNING: TO AVOID DAMAGE OR INJURY, USE ONLY ENOUGH AIR PRESSURE TO EXPEL THE PISTON. DO NOT ATTEMPT TO CATCH THE CALIPER PISTON AS IT IS FORCED OUT OF THE DISC BRAKE CALPIER.**

   Using a rubber nosed air nozzle at the brake fluid inlet port, apply low pressure air to force the disc brake caliper pistons out of the disc brake caliper bores.

5. To encourage the removal of a reluctant caliper piston, tap gently around it. If a caliper piston cannot be removed from the disc brake caliper, replace the disc brake caliper.

6. Using a suitable tool, pry the caliper piston dust boots out of the disc brake caliper bores. Discard the caliper piston dust boots.

7. **CAUTION: To avoid damage to the bores or seal seats, use only a non-metallic tool to remove the piston seals.**

   Remove and discard the disc brake caliper piston seals from the caliper bores.

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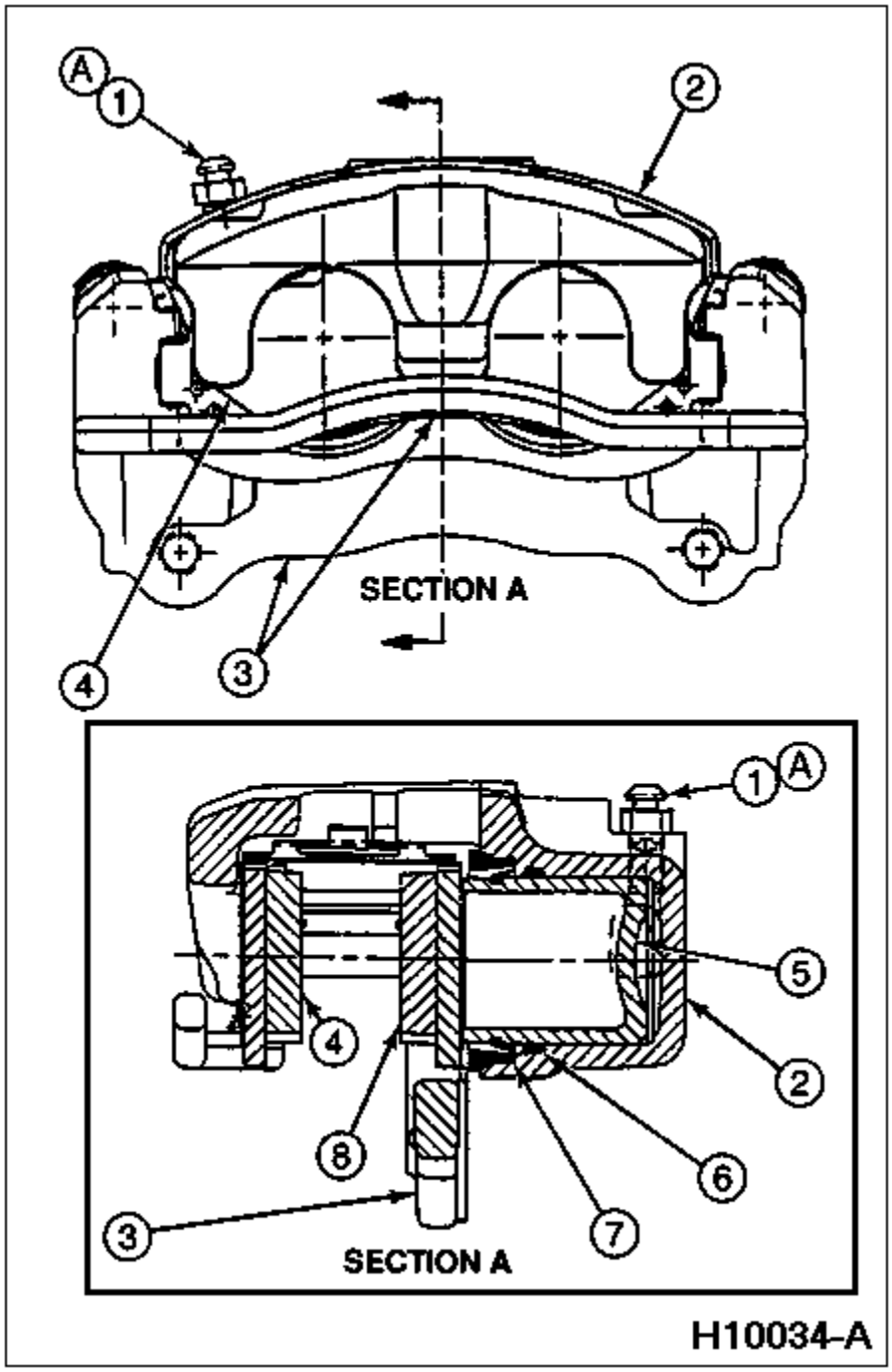

Item	Part Number	Description
1	2208	Bleeder Screw
2	2B120	Disc Brake Caliper Housing
3	2B292	Front Disc Brake Caliper Anchor Plate
4	2001	Brake Shoe and Lining, Outboard
5	2196	Caliper Piston
6	2B115	Piston Seal

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7	2207	Dust Boot
8	2001	Brake Shoe and Lining, Inboard
A	—	Tighten to 11-17 Nm (97-150 Lb-In)

Assembly

1. Clean and inspect the disc brake caliper bores for scoring, rust, pitting or other damage. Do not hone a worn or damaged caliper bore. A new disc brake caliper must be used.

2. Clean and inspect the caliper pistons for cracks or other damage. Do not attempt to repair a worn or damaged caliper piston. A new one must be installed.

3. Clean and inspect the caliper pin bolt bushings. Replace if worn or damaged.

4. **CAUTION: Do not use anything but clean brake fluid to lubricate the caliper pistons, seals and caliper bores. Use of any other lubricant may cause premature failure of brake components.**

   Lubricate the caliper bores, new piston seals and the caliper pistons with clean Ford High Performance DOT 3 Brake Fluid C6AZ-19542-AA or equivalent DOT 3 fluid meeting Ford specification ESA-M6C25-A.

5. Install the new piston seals into the caliper bore seal grooves. Make sure the seals are not twisted and are fully seated.

6. Install the caliper pistons into the caliper bores past the piston seals. Use a rocking, twisting motion and use care not to distort the piston seals.

7. After the caliper pistons are past the piston seals, press the caliper pistons about 2/3 into the caliper bores.

8. **CAUTION: Effective operation of the disc brake caliper is directly affected by the condition of the caliper piston dust boots. Use care not to dislodge or damage them.**

   Install the new dust boots on the caliper pistons.

9. Using Piston Dust Seal Replacer T92P-2588-AH and Driver Handle T80T-4000-W seat the dust boots into the caliper bores. Make sure the dust boots are fully seated into the caliper piston grooves and caliper bore grooves. After installation, the dust boots should not extend beyond the face of the caliper piston.

10. After installing the dust boots, press the caliper pistons to the bottom of the caliper bores.

11. **CAUTION: For Ranger and Explorer disc brakes, the caliper slide pins are covered by a flexible boot and are intended to be lubed for life. At time of publication, there was no approved material or procedure for re-lubing the caliper slide pins. For routine service such as brake pad replacement, the slide pins, grease and boots should be reused as are, if not damaged. If damaged, new pins (with new boots and grease included) must be installed.**

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CAUTION: Do not use petroleum or mineral based service greases (such as Ford Disc Brake Caliper Slide Grease D7AZ-19590-A or equivalent meeting Ford specification ESA-M1C172-A) for this application. Such greases will cause rapid deterioration of the slide pin boots. Service life of the disc brakes could be reduced as a result.

Install the caliper slide pin dust boots into the disc brake caliper anchor plate. Make sure the boots are fully seated in the grooves.

12. Install the caliper slide pins into the caliper slide pin boots. Make sure the caliper slide pin boots are seated in the grooves in the caliper slide pins.

13. Expel the air from the caliper slide pin boots and make sure the caliper slide pins are fully coated with lubricant.

14. Install the disc brake caliper on the front disc brake caliper anchor plate. Refer to the procedure in this section.

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Rotor Service

Rotor Minimum Thickness

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Disc Rotor Surface Gauge and Ball	T71P-1102-A

WARNING: FRONT DISC BRAKE HUB AND ROTOR MINIMUM THICKNESS MUST NOT BE LESS THAN SHOWN IN THE SPECIFICATIONS PORTION OF THIS SECTION, NOR LESS THAN THE NUMBER CAST ON THE INSIDE OF THE FRONT DISC BRAKE HUB AND ROTOR AFTER REFINISHING.

NOTE: The 53.975mm (2.125-inch) gauge ball that is part of T71P-1102-A is used for Aerostar 4x2 and E-4WD rotor measurement. A 70mm (2.756-inch) gauge ball used in conjunction with the micrometer gauge bar is required to make this measurement on Ranger 4x4 front rotors. Tool number for 70mm (2.756-inch) gauge ball not available at time of printing.

NOTE: Maximum allowable stock removal of the rotor braking surface is determined by the use of Disc Rotor Surface Gauge and Ball T71P-1102-A as follows:

1. Remove the inner grease seal and the inner bearing cone and roller (1201) from the front disc brake hub and rotor (1102). Wipe the inner and outer bearing cups clean.

2. Carefully place the gauge ball in the inner bearing cup **(do not drop)** .

3. Set the micrometer to the baseline setting dimension. Refer to the Specifications portion of this section.

4. **NOTE: If the micrometer must be retracted from the baseline setting to allow the legs to set on the rotor surface, the front disc brake hub and rotor has had more than allowable stock removed and the front disc brake hub and rotor must be replaced.**

   Position the micrometer gauge bar on the rotor inner braking surface with the micrometer centered over the ball. To measure the distance between the micrometer baseline setting and the ball, turn the micrometer down to touch the top of the ball, and calculate the difference between the reading and the baseline setting. This distance is equal to the maximum allowable stock removal from the inside braking surface only. If the micrometer end at the baseline setting touches the ball, no additional stock removal is allowed.

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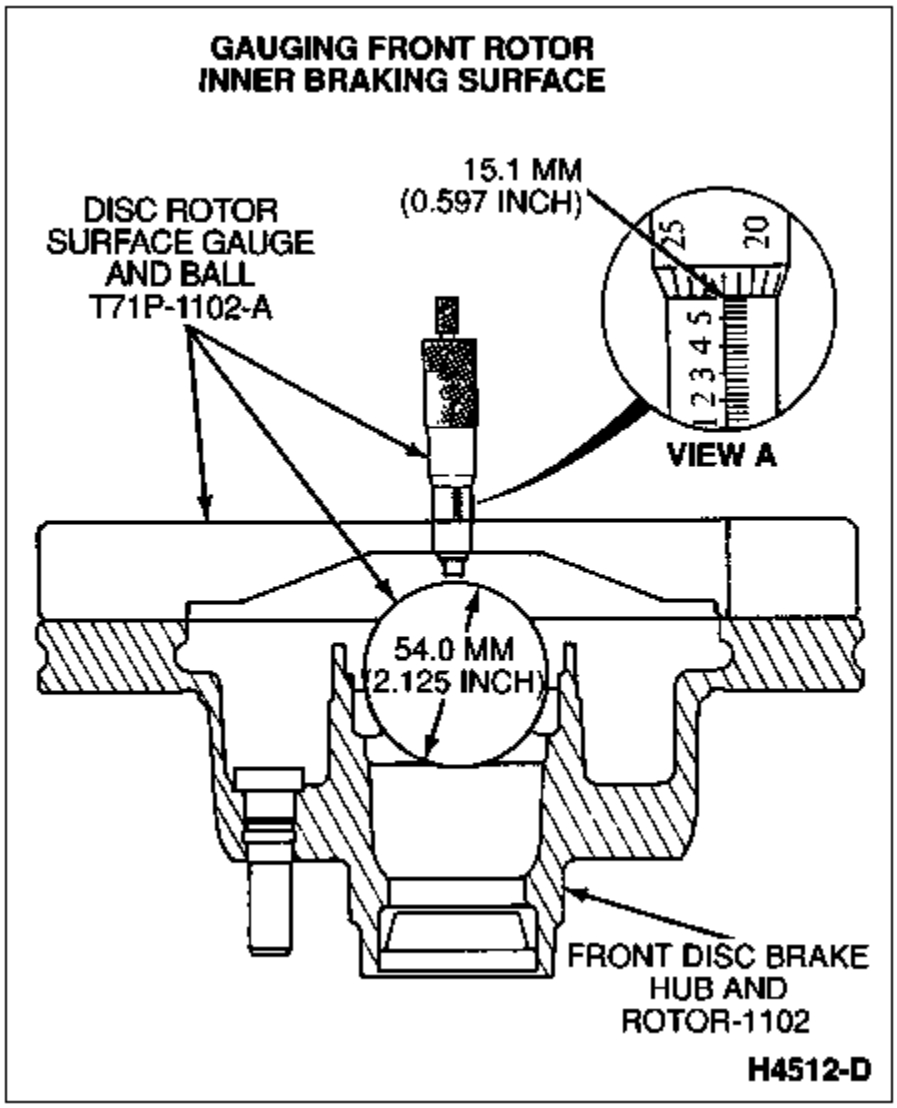

5. **CAUTION: If the rotor thickness is less than the minimum, the front disc brake hub and rotor must be replaced, regardless of the gauge bar and ball measurement. Rotor minimum thickness is also shown on each rotor.**

   Check the front disc brake hub and rotor for the maximum amount of stock that can be removed from the rotor thickness. Measure actual rotor thickness with micrometer and subtract minimum allowable thickness (cast in individual rotor). Total material removal (combination of both sides) must not exceed this amount.

6. Never use a lathe that cuts only one face of the front disc brake hub and rotor at a time; it must be a simultaneous straddle cut.

7. Set the cutting tool to just contact the high spots on the front disc brake hub and rotor, then adjust the cutting tool to the minimum depth required to clean up the rotor face.

Do not exceed the allowable stock removal for the inner braking surface or total rotor thickness. Before installing the front disc brake hub and rotor on the front wheel spindle (3105), clean all chips from the front disc brake hub and rotor and flush new grease through the bearing with a bearing packing tool. A new inner grease seal must be coated with wheel bearing grease and installed in the front disc brake hub and rotor.

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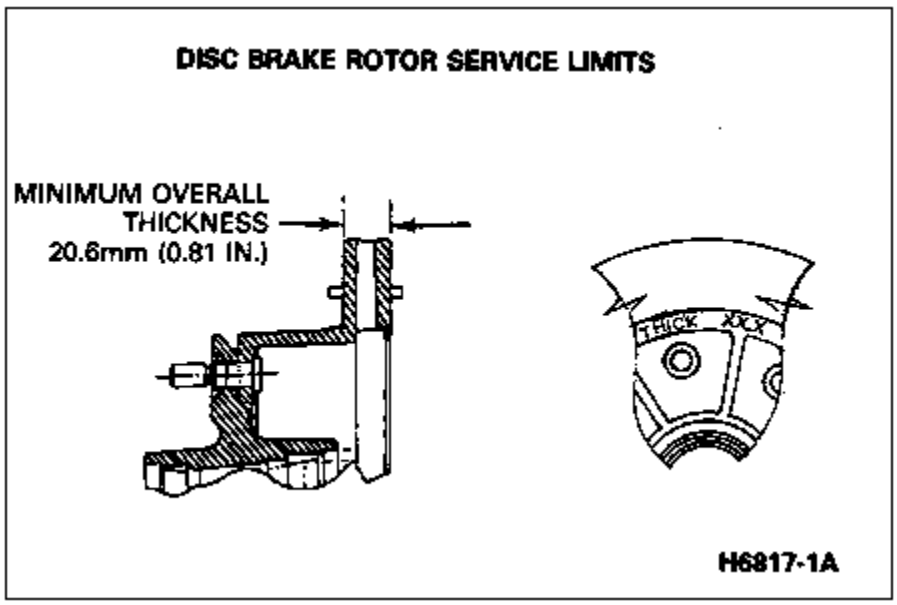
The front disc brake hub and rotor must be installed on the same side of the vehicle from which it was removed. Measure the thickness of the brake shoe and lining (2001). If the lining thickness at any point on the assembly is less than 1.5mm (1/16 inch) above the backing plate or if the lining shows evidence of brake fluid or oil contamination, replace both sets of brake shoes and linings.

Removal of dust and dirt from brake assemblies should be done by using the Rotunda Brake Clutch Service Vacuum model 164-R3600 or Rotunda Brake Parts Washer model 065-00016 or an equivalent.

WARNING: BRAKE ASSEMBLY DUST AND DIRT SHOULD NOT BE REMOVED BY EITHER BLOWING OFF WITH AN AIR GUN OR VACUUMING WITH A STANDARD INDUSTRIAL VACUUM CLEANER BECAUSE A HEALTH HAZARD FROM BREATHING IN ASBESTOS DUST MAY DEVELOP. ALSO, ANY MACHINING DONE ON BRAKE LININGS OR PADS SHOULD BE DONE USING PROPERLY EXHAUST VENTILATED EQUIPMENT.



Rotor Machining

Lathe turn the rotor in order to perform the following:

- Remove rotor scoring, scratching too deep to repair by hand sanding. Deep scoring/scratching usually occurs after brake use with linings fully worn to the rivets. Stock removal must not reduce rotor thickness to below the specified minimum thickness.
- Correct a shudder/vibration/pulsation condition if due to rotor distortion. Check the wheel bearing adjustment and correct as required and verify if the condition is corrected. If there is any buildup of foreign material on the linings or rotor surfaces, the condition may not be due to rotor distortion. Hand sand the surfaces and determine if the condition is corrected before resorting to lathe turning. Check the lateral runouts of the brake surfaces. Lathe turn the rotor if hand sanding of any foreign matter on friction surfaces does not correct the condition, or if measured runout exceeds .254mm (0.010 inch) total indicator reading.

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Runout Check

To check rotor runout, first eliminate the wheel bearing end play by tightening the adjusting nut to specifications. Then check to be sure the front disc brake hub and rotor can still be rotated.

- Clamp a dial indicator to the spindle knuckle assembly so the stylus contacts the front disc brake hub and rotor approximately 25.4mm (1 inch) from the outer edge. Rotate the rotor one turn (360 degrees) and take an indicator reading. If the reading exceeds 0.08mm (0.003 inch) total lateral runout, replace or resurface the front disc brake hub and rotor.

The following requirements must be met when resurfacing front disc brake hub and rotors.

- Use a disc brake lathe to resurface the front disc brake hub and rotors. Follow the manufacturer's instructions.
- The minimum overall thickness specification shown on each rotor allows for a 0.762mm (0.030 inch) machining cut plus 0.762mm (0.030 inch) additional wear. If rotor thickness falls below the minimum, it must be replaced.
- After lathe turning, the finished brake surfaces of the rotor should be flat and parallel within 0.05mm (0.002 in.); lateral runout should not exceed 0.076mm (0.003 inch) total indicator reading.
- To adjust wheel bearings after runout check or resurfacing, refer to the appropriate section in Group 04.
- Measure the thickness of the brake linings. If the lining thickness at any point on the assembly is less than 1.5mm (1/16 inch) above the backing plate or if the lining shows evidence of brake fluid or oil contamination, replace all four brake shoes and linings.
- Thickness on each face must be uniform.

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Caliper

Clean all metal parts with isopropyl alcohol. Clean out and dry the grooves and passageways with compressed air. Make sure caliper bore and component parts are thoroughly clean.

Wipe off the disc brake caliper (2B120) and inspect for cracks or other damage. While disassembled, inspect the caliper bore and caliper piston for pitting, rust or other damage. Inspect the seal groove for nicks or other damage caused by using a metal tool to remove the piston seal. Replace as necessary. Do not attempt to hone a damaged caliper bore.

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Brake Shoe and Lining

Remove any dirt or debris on or around the brake shoe and lining (2001). Inspect the brake shoe and lining for brake fluid, grease, oil or other contaminants. Do not put contaminated brake shoe and lining into service. Do not attempt to remove any contaminant that has soaked into the lining material. Inspect the brake shoe and lining pad material for minimum thickness. Do not put brake shoes and linings into service that have lining thickness less than 1.5mm (1/16 inch).

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Rotor

Inspect the front disc brake hub and rotor (1102) for grease, oil or other contamination. Clean with an approved solvent that will not leave any residue. Inspect the front disc brake hub and rotor for cracks, heat discoloration or other damage. Replace as necessary. Inspect for minimum thickness. Refer to rotor service procedures and specifications in this section.

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SPECIFICATIONS

Brake Lining And Rotor Dimensions, Aerostar

Truck Series	Aerostar, 4x2	Aerostar, 4x4
Caliper [a] Part Number (RH)	FO9A-AA	FO9A-AA
Caliper Part Number (LH)	FO9A-AA	FO9A-AA
Outer Dia. of Rotor Braking Surface	261.2mm (10.28 In.)	276.0mm (10.86 In.)
Inner Dia. of Rotor Braking Surface	165.7mm (6.52 In.)	168.0mm (6.61 In.)
Swept Area Per Front Brake	56192mm (87.09 In.)	60721mm (94.11 In.)
Lining Width Inboard	41.5mm (1.63 In.)	41.5mm (1.63 In.)
Lining Width Outboard	41.5mm (1.63 In.)	42.1mm (1.63 In.)
Lining Area Per Brake — Inboard	4432mm (6.87 In.)	5388mm (8.35 In.)
Lining Area Per Brake — Outboard	5258mm (8.15 In.)	5887mm (9.12 In.)
Lining Thickness Inboard	9.32mm (.367 In.)	9.32mm (.367 In.)
Lining Thickness Outboard	8.46mm (.333 In.)	8.46mm (.333 In.)
Rotor Width	22.1mm (.87 In.)	22.1mm (.87 In.)
Rotor Type	Vented	Vented
Caliper Type	Pin-Rail	Pin-Rail
No. of Piston(s) Per Brake	One	One
Caliper Piston Diameter	65.95mm (2.59 In.)	65.95mm (2.59 In.)
Effective Radius	107.14mm (4.22 In.)	115.14mm (4.53 In.)

[a] Caliper Base Part number: RH = 2B120, LH = 2B121.

Brake Lining And Rotor Dimensions, Ranger

Truck Series	Ranger 4x2	Ranger 4x4
Caliper Part Number (RH)	F57A-2B120-DC	F57A-2B120-AC
Caliper Part Number (LH)	F57A-2B121-DC	F57A-2B121-AC
Outer Dia. of Rotor Braking Surface	261.2mm	286.6mm

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	(10.28 In.)	(11.28 In.)
Inner Dia. of Rotor Braking Surface	165mm ^{2} (6.5 In. ^{2})	180mm ^{2} (7.1 In. ^{2})
Swept Area per Front Brake	58746mm (91.1 In.)	65686mm (101.8 In.)
Lining Dim. Inboard	136 x 33.6mm (5.35 x 1.32 In.)	136 x 33.6mm (5.35 x 1.32 In.)
Lining Dim. Outboard	136 x 33.6mm (5.35 x 1.32 In.)	136 x 33.6mm (5.35 x 1.32 In.)
Lining Area per Brake Inboard	54.5cm ^{2} (8.45 In. ^{2})	54.5cm (8.45 In. ^{2})
Lining Area per Brake Outboard	54.5cm (8.45 In. ^{2})	54.5cm (8.45 In. ^{2})
Lining Thickness Inboard and Outboard	9.9mm (0.39 In.)	9.9mm (0.39 In.)
Rotor Width	26.0mm (1.023 In.)	26.0mm (1.023 In.)
Min. Service	24.5mm (0.964 In.)	24.5mm (0.964 In.)
Rotor Type	Vented Rad. Fins	Vented Rad. Fins
Caliper Type	Pin-Slider Bolt-On-Anchor	Pin-Slider Bolt-On-Anchor
Number of Pistons per Brake	2	2
Caliper Piston Dia.	46mm (1.81 In.)	46mm (1.81 In.)
Effective Radius	107.8mm (4.21 In.)	120.7mm (4.75 In.)

Fluid Specifications

Description	Specification
Ford High Performance DOT 3 Brake Fluid C6AZ-19542-AA or Equivalent DOT 3	ESA-M6C25-A

Front Rotor Measurement Specifications

Vehicle	Gauge Ball Size	Base Line Setting	Rotor Minimum Thickness
Aerostar 4x2 and E-4WD	54mm (2.125 In.)	6.50mm (.256 In.)	20.6mm (0.81 In.)
Ranger 4x2	57.15mm (2.25 In.)	—	24.5mm (0.96 In.)
Ranger 4x4	70mm (2.756 In.)	6.50mm (.256 In.)	20.6mm (0.81 In.)

Note: Rotors having a thickness less than 20.6mm (0.81 inch) must be replaced regardless of micrometer gauge bar and ball measurement.

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Torque Specifications

Description	Nm	Lb-Ft	Lb-In
Bleeder Screw	11-17	—	97-150
Caliper Anchor Plate Bolts	98-132	73-97	—
Caliper Pin Bolt — Ranger	52-65	38-48	
Caliper Slide Pin — Ranger	30-36	23-26	
Flow Bolt	30-40	22-29	
Hub Retainer Nut	230-283	170-208	—
Hub Spindle Nut, Final Torque: Back Off from Initial Setting 120°to 180°and Retighten to	2.0-2.3	—	18-20
Hub Spindle Nut, Initial Torque	23-34	17-25	—
Lug Nut	115-155	85-115	—
RotorShield-to-Spindle Screw	11-13	—	97-115
Speed Sensor Clamp Bolt	6-7	—	53-62
Speed Sensor-to-Spindle Bolt	7-10	—	61-90

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Inspection and Verification

Check operation of the parking brake with vehicle on a hoist and parking brake fully released. If there is any slack in the cables or if the rear brakes drag when the wheels are turned, adjust as required. Check for any cable damage and replace as necessary.

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Symptom Chart — Parking Brake System

PARKING BRAKE SYSTEM

Condition	Possible Source	Action
• Squeals or Groans	• Glazed linings.	• REMOVE glaze from linings using sandpaper or emery cloth.
	• Misaligning of parts.	• CORRECT misalignment with correct installation. REFER to Section 06-02 .
	• Dirt in brake drum.	• REMOVE brake drum and CLEAN OUT lining dust and dirt.
• Scraping Noise	• Worn out lining part of rear brake shoe and lining.	• CHECK for lining worn down to rivets — REPLACE shoes if necessary.
	• Bent or misaligned shoe part of rear brake shoe and lining.	• CHECK for misaligned shoe, rubbing against brake drum. REPLACE shoes if necessary. REFER to Section 06-02 .
• Clicks	• Excessive clearance.	• CHECK parking brake shoe and lining installation specification.
	• Eccentric or wobbling brake drum. .	• INSPECT drum runout.
	• Excessive linkage friction.	• CHECK linkage pivot points for rust, binding, or lack of lubrication.
• Brake Does Not Apply or Hold	• Excessive clearance prevents complete brake application.	• CHECK brake cable for slack. REFER to Pinpoint Test A .
	• Grease soaked linings.	• REPAIR source of leak, INSTALL new linings. REFER to Section 06-02 .
	• Excessive linkage friction.	• CHECK for linkage binding, and misalignment. LUBRICATE all friction points.
	• Worn out linings.	• REPLACE rear brake shoe and lining. CHECK brake drum for scoring and REPLACE if necessary. REFER to Section 06-02 .
• Excessive Lining Wear	• Brake drag.	• CHECK parking brake cables or binding condition. INSPECT for broken or missing springs.
	• Rough brake drum surface.	• SMOOTH brake drum with emery paper, or REPLACE brake drum, if brake drum is badly scored.
		CAUTION: Brake drum to be replaced if inside diameter exceeds 229.36mm (9.030 inches).

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	• Several dynamic stops.	• INSPECT the brake shoe and lining. REPLACE as necessary.
• Parking Brake Will Not Release	• Brake drag. • Worn or damaged parking brake control.	• REFER to Pinpoint Test B .

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Pinpoint Tests

PINPOINT TEST A: PARKING BRAKE WILL NOT APPLY

A1 CHECK PARKING BRAKE CONTROL

- Operate the parking brake control.

Does parking brake control operate smoothly?

Yes	No
GO to **A2** .	SERVICE binding condition in parking brake control and RETEST system.

A2 CHECK PARKING BRAKE CABLES

- Raise and support vehicle.
- Inspect for broken or binding parking brake cables.

Is there a parking brake cable concern?

Yes	No
SERVICE parking brake cables as required. RETEST system.	GO to **A3** .

A3 CHECK PARKING BRAKE COMPONENTS

- Raise and support the vehicle.
- Remove the brake drums.
- Operate the parking brake control and observe the parking brake components.

Do the parking brake components operate?

Yes	No
CHECK the parking brake shoe and lining installation specification. REFER to the procedure in this section. RETEST system.	SERVICE worn or damaged parts. RETEST the system.

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PINPOINT TEST B: PARKING BRAKE WILL NOT RELEASE

B1 CHECK PARKING BRAKE CABLE

- Release parking brake control.
- If the vehicle can't be moved, raise and support the vehicle.
- Release parking brake cable tension.
- Remove brake drum or rear disc brake rotor and disconnect parking brake rear cable and conduit.

Does the parking brake release?

Yes	No
GO to **B2** .	SERVICE the worn or damaged rear brake component. RETEST the system.

B2 PARKING BRAKE CABLE CHECK

- Release the parking brake control.

Does the parking brake control release?

Yes	No
INSPECT parking brake cable for binding. SERVICE as necessary. RETEST system.	SERVICE the worn or damaged parking brake control. RETEST the system.

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Control, Aerostar

Removal

1. Remove the front and inboard rear screws attaching the boot to the floor. Pivot boot back on hinge and remove two rear screws. Remove the boot.

2. Disconnect the parking brake indicator light switch connector.

3. Place the control in the "released" position and insert the lock pin in the parking brake control (2780). Refer to Adjustments, Cable Tension Release in this section for procedure.

4. **CAUTION: Do not remove the steel lock pin from the parking brake control until the cable is connected to the control assembly. Pin removal releases the tension in the ratchet wheel causing the spring to unwind and release tension. If the pin is prematurely removed, spring tension in the parking brake control must be reset. Refer to Adjustments, Cable Tension, Resetting in this section.**

   Remove the cable anchor pin from the pivot hole in the control assembly ratchet plate. Guide the front parking brake cable and conduit (2853) from the parking brake control.

5. Remove the bolts retaining the parking brake control to the floor panel. Remove the parking brake control.

Installation

1. Route the front parking brake cable and conduit around the control assembly pulley and insert the cable anchor pin in the pivot hole in the ratchet plate.

2. Position the parking brake control with the front parking brake cable and conduit attached to it on the floor panel. The floor support is installed between the parking brake control and the floor. Install and tighten the retaining bolts.

3. Connect the parking brake light switch connector.

4. Remove the lock pin from the parking brake control to reset cable tension. Remove self-adjusting pawl lockout pin also, if one is installed.

5. **NOTE: For proper adjustment procedure, both pins must be removed from the parking brake control.**

   Position the boot over the parking brake control. Install and tighten the screws.

6. Apply and release the parking brake control several times. Make sure the parking brakes are applied and released and not dragging. Make sure the brake warning lamp is illuminated when the parking brake is applied.

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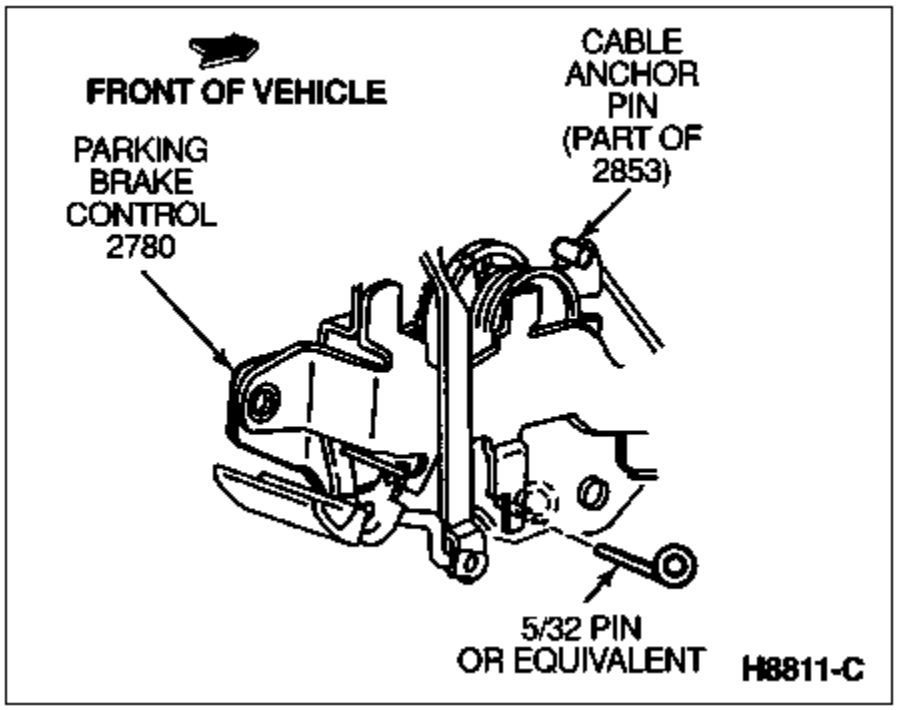
Control, Ranger

Removal

1. Remove the left cowl side trim panel (02345).
2. Disconnect the parking brake indicator light switch connector from the control assembly connector.
3. While an assistant relieves tension on the system by pulling on the parking brake intermediate cable or front parking brake cable and conduit (2853), insert a 4mm (5/32-inch) steel pin or equivalent drill bit into the hole provided in the parking brake control (2780).



4. Remove the cable anchor pin from the pivot hole in the control assembly ratchet plate. Guide the front parking brake cable and conduit from the parking brake control.
5. **CAUTION: Do not remove the steel lock pin from the parking brake control until the cable is connected to the parking brake control. Pin removal releases the tension in the ratchet wheel causing the spring to unwind and release tension. If the pin is prematurely removed, spring tension in the parking brake control must be reset. Refer to Adjustments, Cable Tension, Resetting in this section.**

   Remove the screw attaching the instrument panel to the parking brake control.

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6. Remove bolts retaining the parking brake control to the left side cowl and remove the parking brake control from the vehicle.

Installation

1. Route the front parking brake cable and conduit around the parking brake control and insert the cable anchor pin in the pivot hole provided in the ratchet plate.

2. Position the parking brake control and install the attaching bolts. Tighten bolts to 17-23 Nm (13-17 lb-ft).

3. Install the screw attaching the instrument panel to the parking brake control.

4. Connect the parking brake warning indicator light switch to the parking brake control connector.

5. Carefully remove the lock pin (drill bit) from the parking brake control.

    - The system will automatically tension itself when the pin is removed.

6. Install the left cowl side trim panel.

7. Apply and release the parking brake several times to verify correct operation. Also, verify proper operation of the parking brake warning indicator light.

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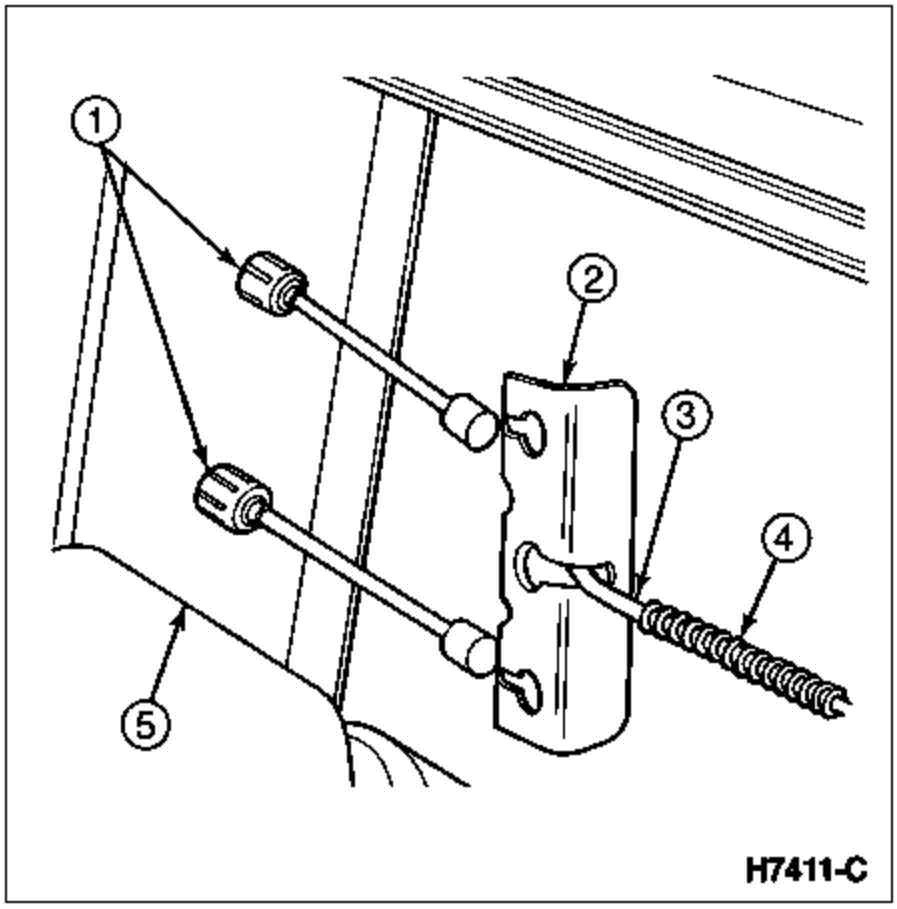
Cable and Conduit, Front, Aerostar

Removal

1. Place parking brake control (2780) in the "released" position and insert the lock pin in the control assembly. Refer to Adjustments, Cable Tension, Release in this section for procedure.

2. **NOTE: It may be necessary to loosen the fuel tank straps and partially lower the fuel tank to gain access to the cover.**

   Disconnect the parking brake rear cable and conduits (2A635) from the parking brake cable equalizer (2A602). Remove the parking brake cable equalizer from the front parking brake cable and conduit (2853).



Item	Part Number	Description
1	2A635	Parking Brake Rear Cable and Conduit

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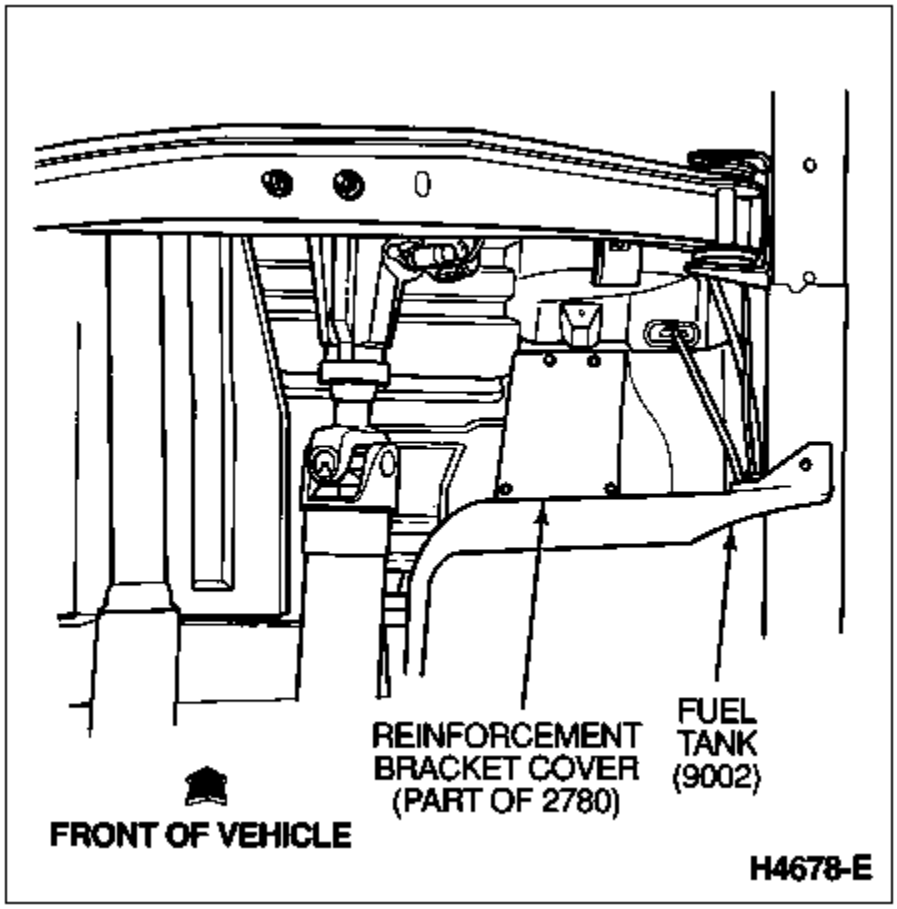
2	2A602	Parking Brake Cable Equalizer
3	2853	Front Parking Brake Cable and Conduit
4	2A651	Parking Brake Equalizer Cable Spring
5	5035	Rear Frame Crossmember

3. Remove the bolts retaining the cover to the underbody reinforcement bracket. Remove the cover.



4. Remove the cable anchor pin from the pivot hole in the control assembly ratchet plate. Guide the front parking brake cable and conduit from the parking brake control.

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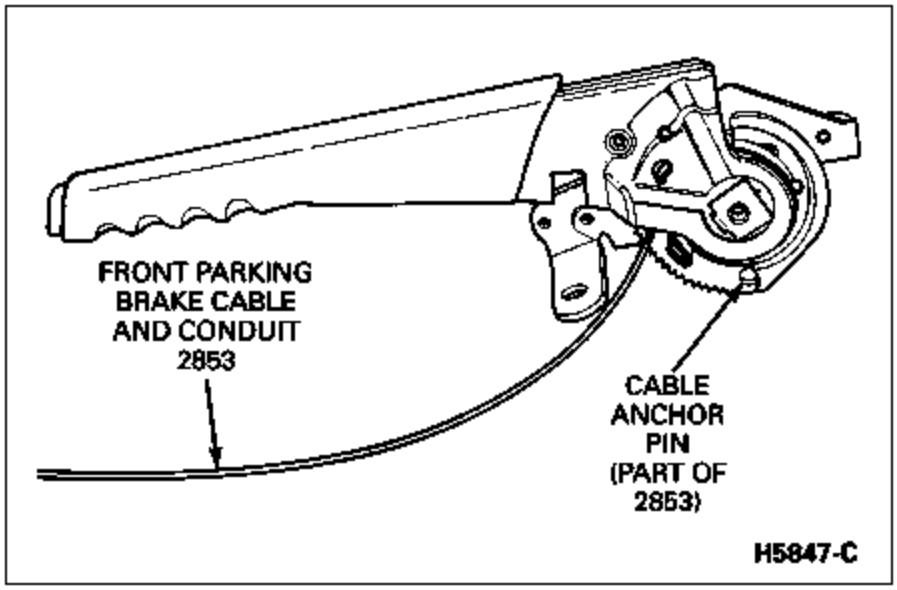

5. Insert a 1/2-inch box end 12-point distributor lock bolt wrench over the front fitting of the front parking brake cable and conduit. Push the wrench onto the rear parking brake cable retainer (2A709) in the rear frame crossmember (5035). Compress the retainer fingers and push the rear parking brake cable retainer rearward through the hole.

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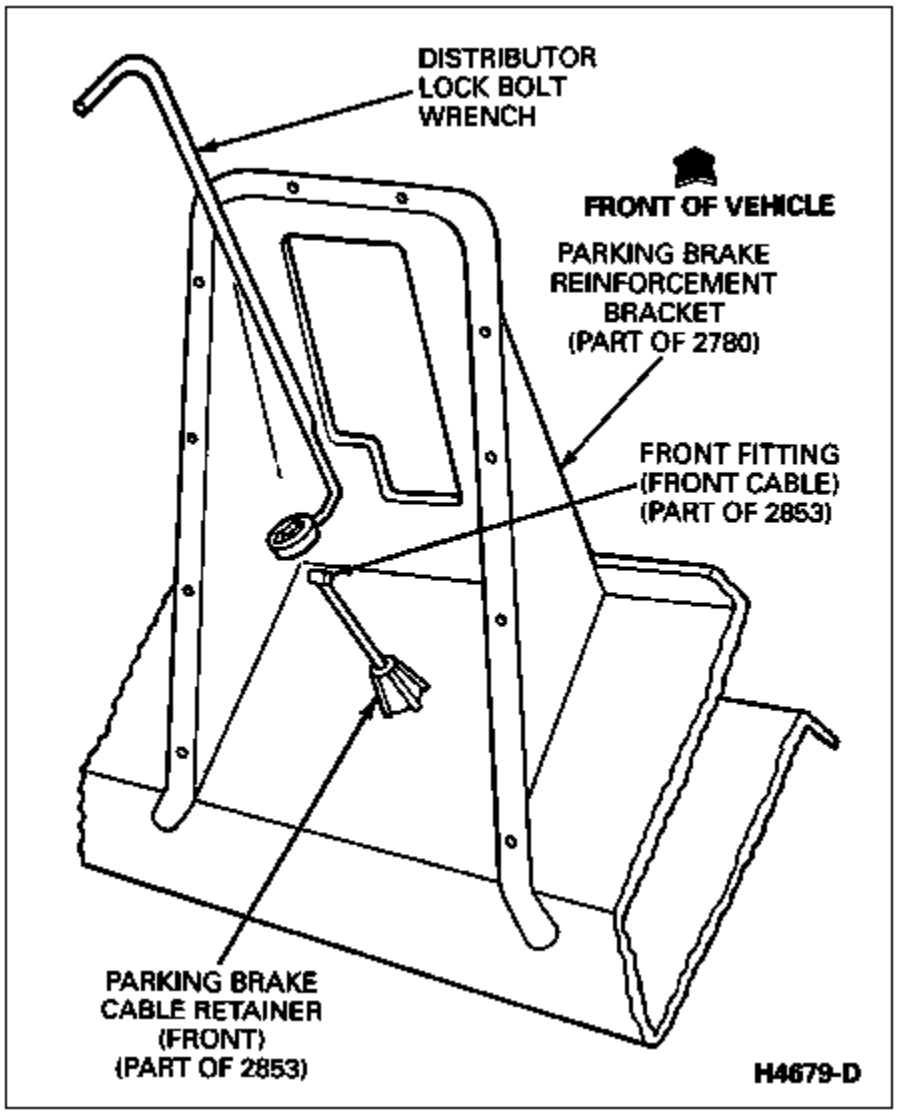

6. Insert a 1/2-inch box end 12-point wrench over the rear fitting of the front parking brake cable and conduit. Push the wrench onto the rear parking brake cable retainer fitting in the rear frame crossmember. Compress the retainer fingers and push the rear parking brake cable retainer forward through the hole. Pull the cable ends through the rear frame crossmembers and remove the front parking brake cable and conduit.

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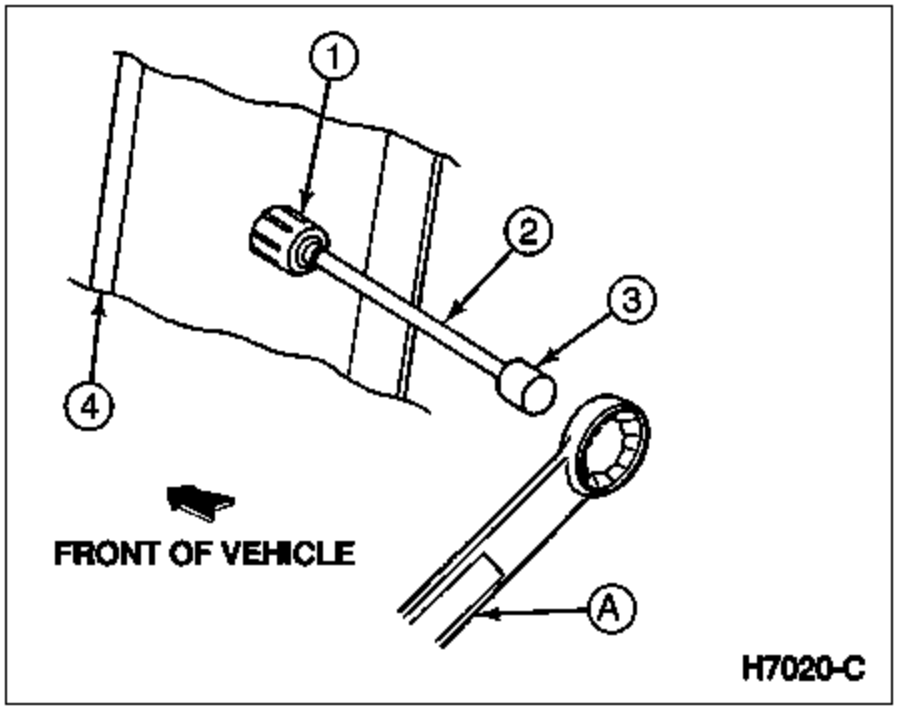

Item	Part Number	Description
1	—	Parking Brake Cable Retainer (Front) (Part of 2853)
2	2853	Front Parking Brake Cable and Conduit
3	—	Rear Fitting, Front Parking Brake Cable and Conduit (Part of 2853)
4	5035	Rear Frame Crossmember
A	—	Wrench, 12-Point Box End

Installation

1. Feed the front parking brake cable and conduit through the holes in both rear frame crossmembers. Push the rear parking brake cable retainers through the holes so the fingers expand over each hole.

2. Route the front parking brake cable and conduit around the control assembly pulley and insert the cable anchor pin in the pivot hole in the ratchet plate.

3. **NOTE: Before connecting front and rear cables verify that both rear cables are routed in front of the shocks and through clips.**

   Slide rear parking brake cable retainer over rear end of front parking brake cable and conduit.

4. Connect the equalizer to front and rear cables by bending and inserting cables into equalizer then straighten.

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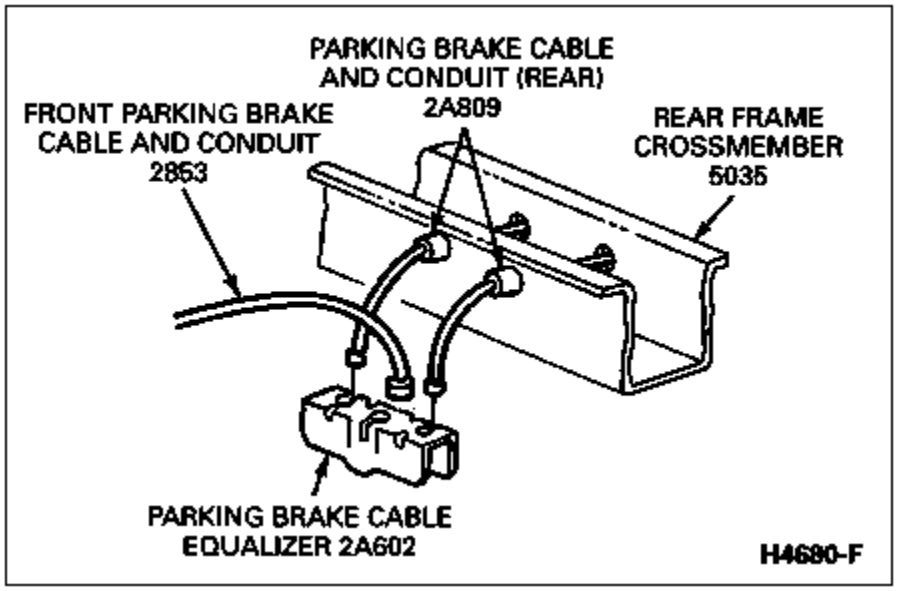
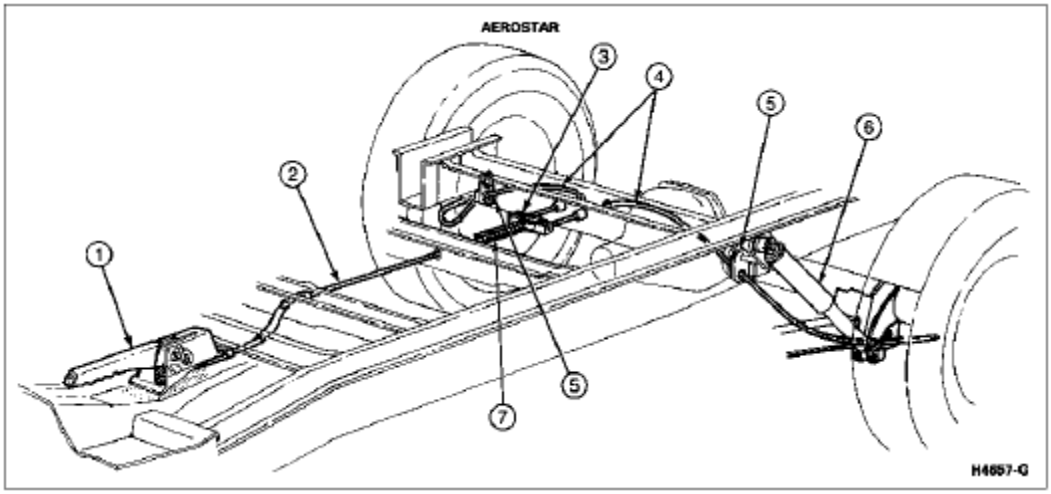
5. Remove the lock pin from the parking brake control to apply cable tension.
6. Position the cover on the reinforcement bracket.
    - **Install and tighten the bolts AFTER visually checking to be sure the front parking brake cable and conduit is attached to the parking brake control.**
7. Position the boot over the parking brake control. Install and tighten the screws.
8. Apply and release the parking brake control several times. Make sure the parking brakes are applied, and not dragging when released.
    - Pin must be removed for proper adjustment.



Parking Brake System, Aerostar



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Item	Part Number	Description
1	2780	Parking Brake Control
2	2853	Front Parking Brake Cable and Conduit
3	2A602	Parking Brake Cable Equalizer
4	2A635	Parking Brake Rear Cable and Conduit
5	N805422-S100	Clip
6	18125	Rear Shock Absorber
7	2A651	Parking Brake Equalizer Cable Spring

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Cable and Conduit, Front (Ranger)

Removal

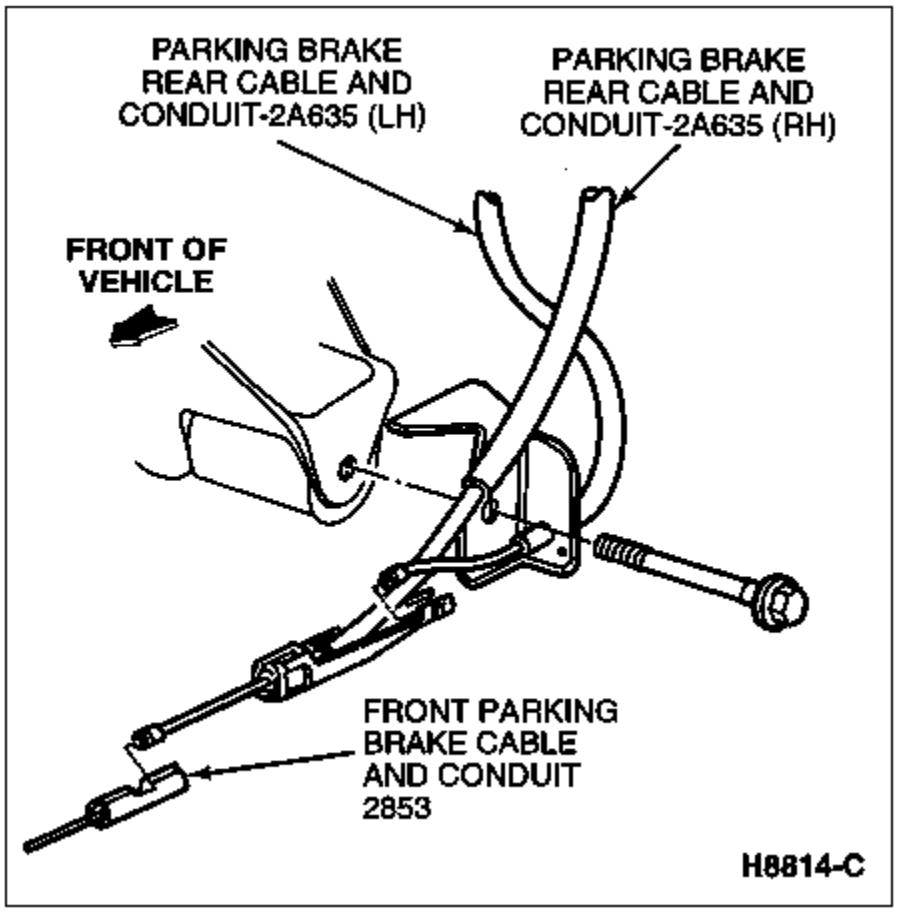
1. While an assistant relieves tension on the system by pulling on the parking brake intermediate cable or front parking brake cable and conduit (2853) insert a 4mm (5/32-inch) steel pin or equivalent drill bit into the hole provided in the parking brake control (2780).

2. Disconnect the parking brake intermediate cable or front parking brake cable and conduit from the LH parking brake rear cable and conduit (2A635).

3. To replace the front parking brake cable and conduit , remove the cable anchor pin from the pivot hole in the control assembly ratchet pin.

4. Guide the front parking brake cable and conduit from the parking brake control and disconnect it from the frame mounting bracket. Remove cable-to-frame attaching bolt, if bolt is present, and slide front parking brake cable and conduit from vehicle.

Ranger



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Installation

1. Feed the front parking brake cable and conduit through the hole in the front frame mounting bracket. Push the retainer through the hole so the fingers expand over the hole.

2. Route the front parking brake cable and conduit around the control assembly pulley and insert the cable anchor pin in the pivot hole in the ratchet assembly.

3. If removed, install cable-to-frame attaching bolt.

4. Connect the front parking brake cable and conduit to the left rear parking brake rear cable and conduit.

5. For intermediate cable installation, feed cable through holes in center frame bracket.

6. Attach cable to front parking brake cable and conduit and to left rear parking brake rear cable and conduit.

7. Carefully remove the lock pin (drill bit) from the parking brake control.

    a. The system will automatically tension itself when the pin is removed.

8. Apply and release the parking brake several times to verify correct operation. Also, verify proper operation of the parking brake warning indicator light.

Parking Brake System, Ranger

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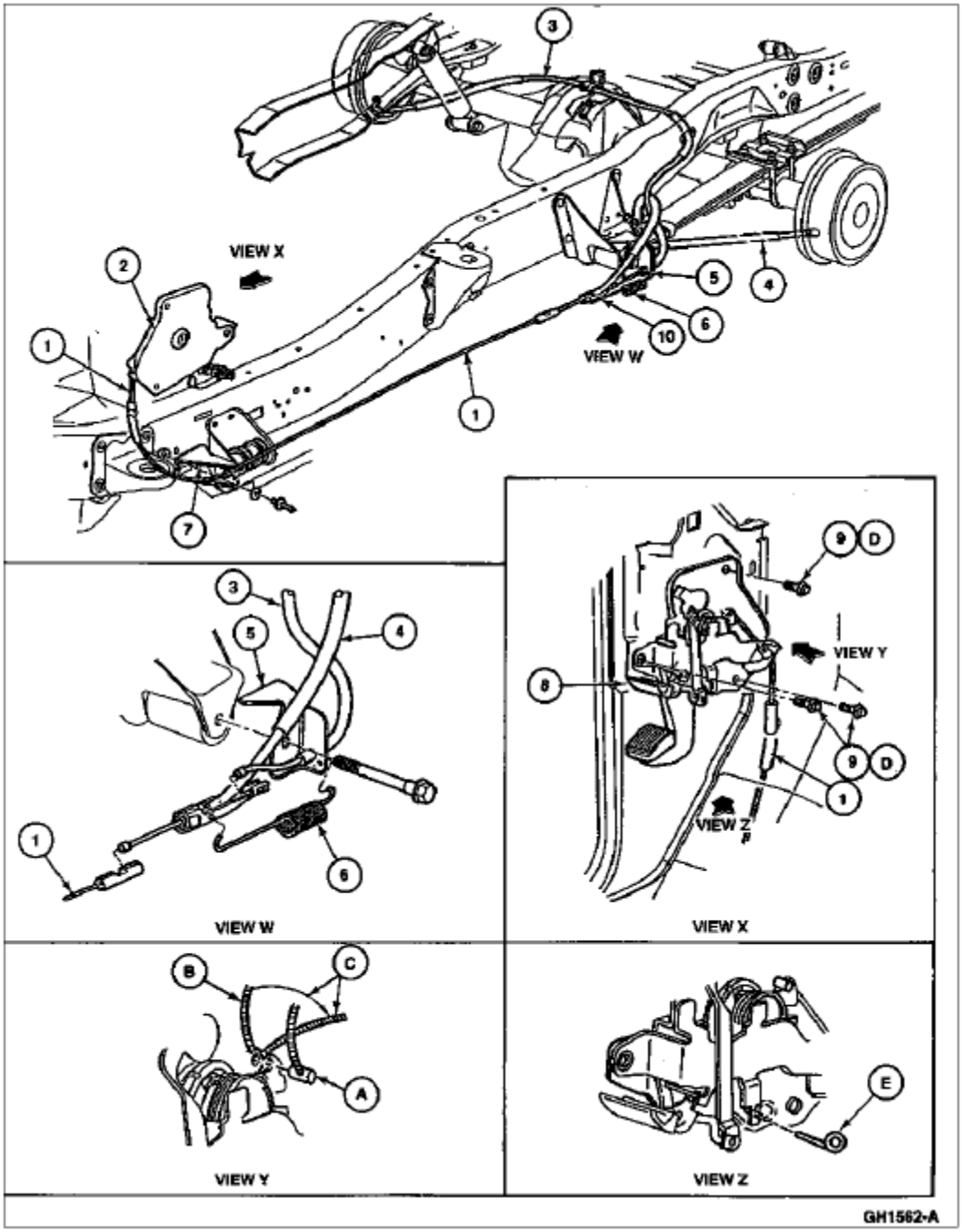

Item	Part Number	Description
1	2853	Front Parking Brake Cable and Conduit
2	2780	Parking Brake Control
3	2A635	Parking Brake Rear Cable and Conduit (RH)
4	2A635	Parking Brake Rear Cable and Conduit (LH)
5	2530	Parking Brake Cable Bracket (Rear)
6	2A651	Parking Brake Equalizer Cable Spring

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7	2530	Parking Brake Cable Bracket (Front)
8	—	Parking Brake Release Handle (Part of 2780)
9	N806497-S2	Bolt, Parking Brake Control-to-Cowl Side
10	2A602	Parking Brake Cable Equalizer
A	—	Parking Brake Front Cable and Conduit, Before Inserting into Ratchet Plate Pivot Hole
B	—	Parking Brake Front Cable and Conduit, After Inserting into Ratchet Plate Pivot Hole
C	—	Parking Brake Front Cable and Conduit, Installed
D	—	Tighten to 17-23 Nm (13-17 Lb-Ft)
E	—	4mm (5/32-Inch) Steel Pin or Equivalent Size Drill Bit

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Cable and Conduit, Rear

Removal

1. While an assistant relieves tension on the system by pulling on the parking brake intermediate cable or front parking brake cable and conduit (2853), insert a 4mm (5/32-inch) steel pin or equivalent size drill bit into the hole provided in the parking brake control (2780).

2. Raise the vehicle and remove the hub cap, wheel and tire, and remove the brake drum (1126).

3. Disconnect the left parking brake rear cable and conduit (2A635) from the front parking brake cable and conduit (Ranger). For Aerostar, disconnect the left and right rear cables from the parking brake cable equalizer (2A602).

4. Using a 9/16-inch flare nut wrench, compress the prongs that retain the cable housing to the rear frame crossmember (5035) (Aerostar) and pull out the parking brake rear cable and conduit and housing.

5. For Ranger, disconnect right parking brake rear cable and conduit from the parking brake cable equalizer and from the rear guide bracket.

6. At the wheel side of the brake backing plate (2211), compress the retainer fingers with a 9/16-inch flare nut wrench and remove the parking brake rear cable and conduit through the hole in the brake backing plate.

7. Lift the parking brake rear cable and conduit out of the slot in the parking brake lever (attached to the brake secondary shoe). Remove the parking brake rear cable and conduit through the backing plate hole.

Parking Brake Components

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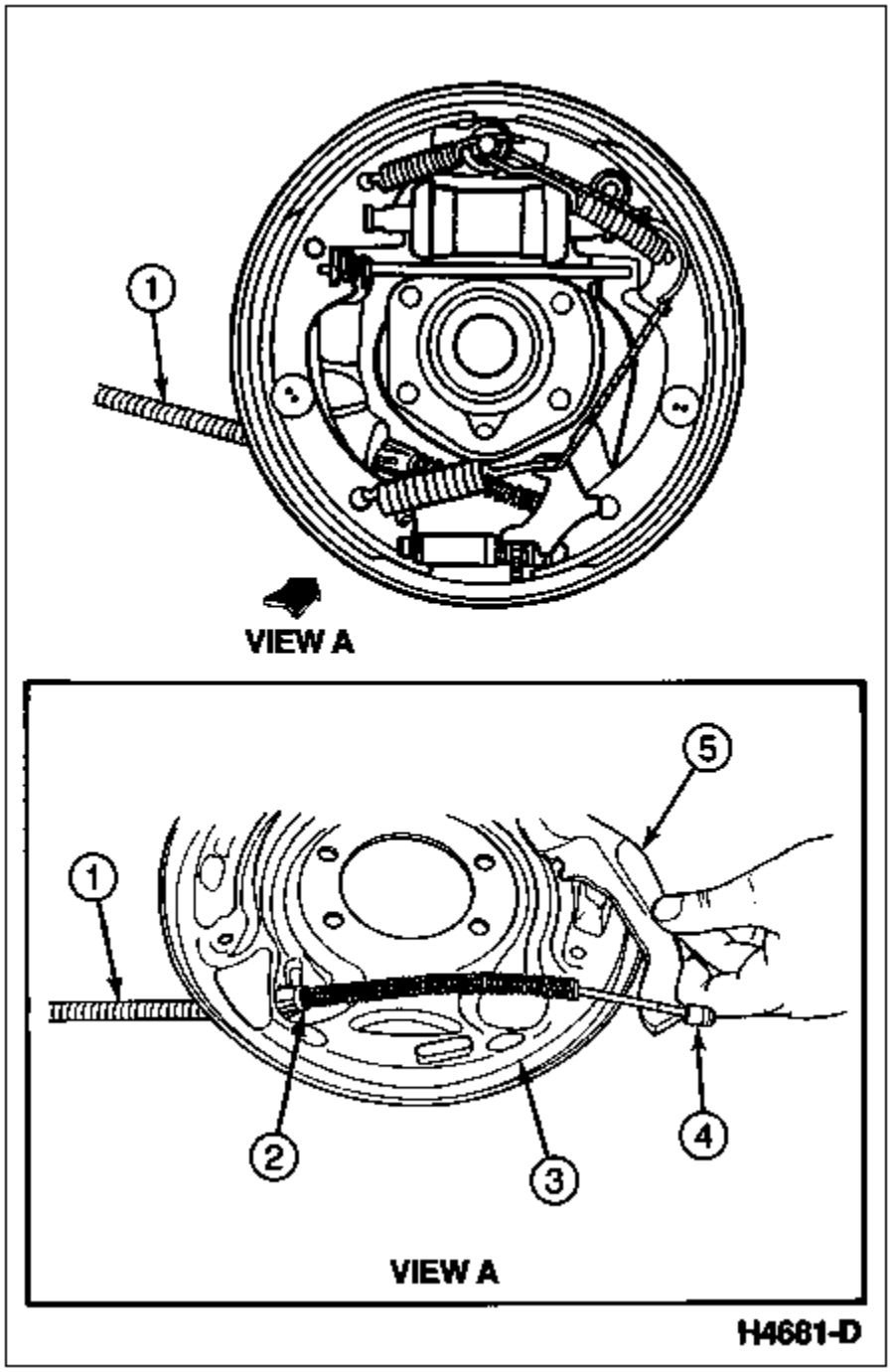

Item	Part Number	Description
1	2A635	Parking Brake Rear Cable and Conduit
2	—	Parking Brake Cable Retainer (Part of 2A635)
3	2211	Brake Backing Plate
4	—	Cable Anchor (Part of 2A635)
5	2A637	Parking Brake Lever

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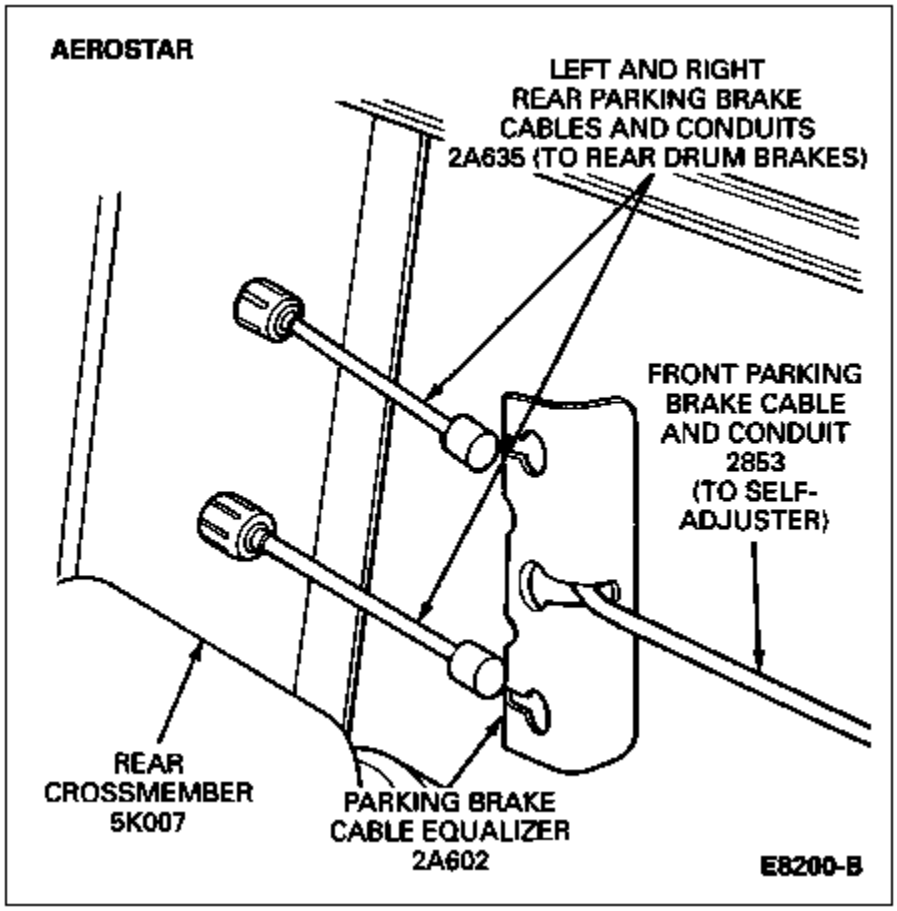
Installation

1. Route the parking brake rear cable and conduit through the hole in the brake backing plate.
2. Insert the cable anchor behind the slot in the parking brake lever. Make sure the parking brake rear cable and conduit is securely engaged in the parking brake lever so the rear parking brake cable retainer (2A709) is holding the parking brake rear cable and conduit in the parking brake lever.
3. Push the parking brake cable retainer clip (2A826) through the hole in the brake backing plate so the retainer fingers engage the brake backing plate.
4. Route the parking brake rear cable and conduit as shown in the illustrations.
5. Insert the front of the left and right parking brake rear cable and conduits through the rear frame crossmember until the prongs expand (Aerostar). For Ranger insert the front of the right parking brake rear cable and conduit into the rear guide bracket until the prongs expand.
6. For Aerostar, connect both right and left rear cables to the parking brake cable equalizer.



7. Connect the left rear parking brake cable to the front parking brake cable and conduit (Ranger).
8. Remove the lock pin from the parking brake control to apply cable tension.

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9. Adjust rear brakes. Refer to Section 06-02 .
10. Install the brake drum, wheel, and hub cap.
11. Apply and release the parking brake control several times. Rotate both wheels to be sure that the parking brakes are not dragging.

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Warning Indicator Switch, Aerostar

Removal

1. Remove the screws attaching the boot to the floor panel (remove the front screw first). Remove the boot.
2. Place the parking brake control (2780) in the released position and disconnect the wire from the parking brake warning indicator switch.
3. Remove the screw from the parking brake warning indicator switch and remove the parking brake warning indicator switch.

Installation

1. Position the parking brake warning indicator switch. Make sure the locator tab on the parking brake warning indicator switch is in the locator hole on the parking brake control. Tighten the screw to 1.4-2.3 Nm (12-20 lb-in).
2. Install the wire connector to the parking brake warning indicator switch and place the parking brake lever in the released position.
3. Install the boot over the lever and tighten the screws.

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Warning Indicator Switch, Ranger

Removal

NOTE: The parking brake warning indicator switch is located on the parking brake pedal assembly.

1. From under the instrument panel, disconnect the wire from the parking brake warning indicator switch.

2. Remove the screw securing the parking brake warning indicator switch to the pedal assembly, and remove the switch.

Installation

1. Position the parking brake warning indicator switch carefully, making sure that locator tab on switch is in locator hole on parking brake control (2780). Tighten the retaining screw to 1.4-2.3 Nm (12-20 Lb-In).

2. Connect the wire to the parking brake warning indicator switch and test for parking brake warning indicator operation.

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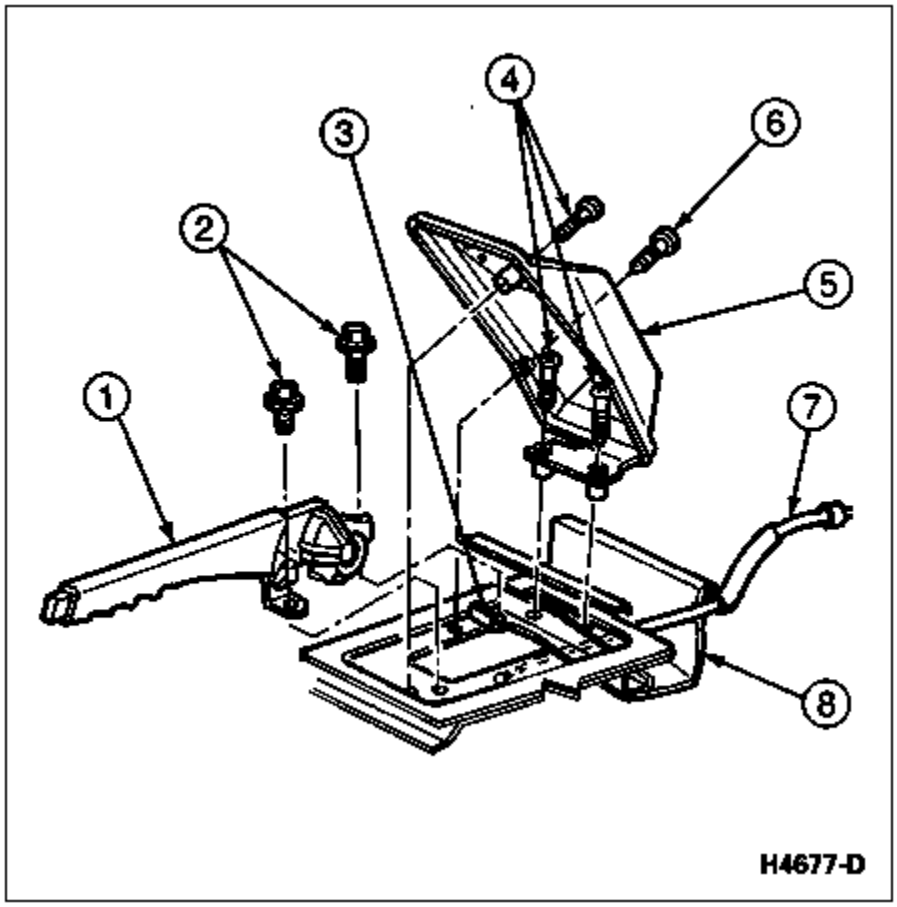
Cable Tension

If any component in the parking brake system requires servicing, the cable tension must be released. After servicing is completed, the front parking brake cable and conduits (2853) and parking brake rear cable and conduits (2A635) are connected to the parking brake cable bracket (2530) and tension is reset. Refer to the following procedures for releasing and resetting cable tension.

Aerostar



Item	Part Number	Description
1	2780	Parking Brake Control
2	N602549-S51M	Bolt (2 Req'd)
3	2A707	Support
4	N610131-S2	Screw
5	2A713	Parking Brake Lever Boot
6	388695-S2	Screw
7	2853	Front Parking Brake Cable and Conduit

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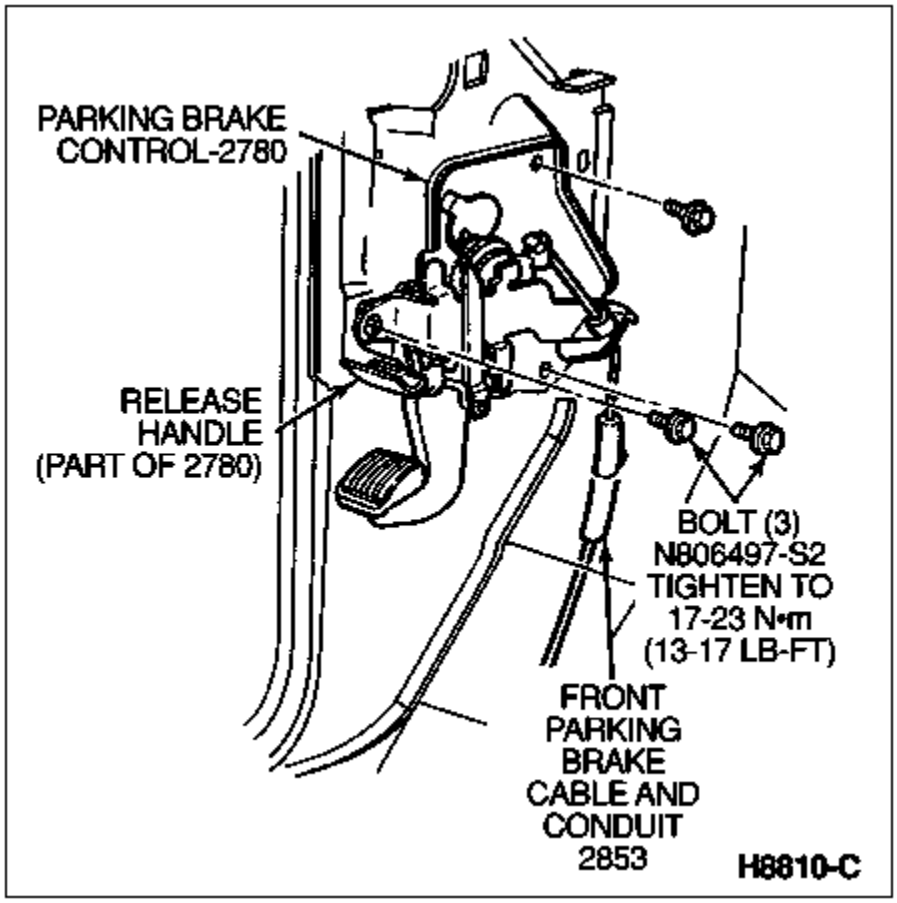
8	5035	Rear Frame Crossmember

Ranger



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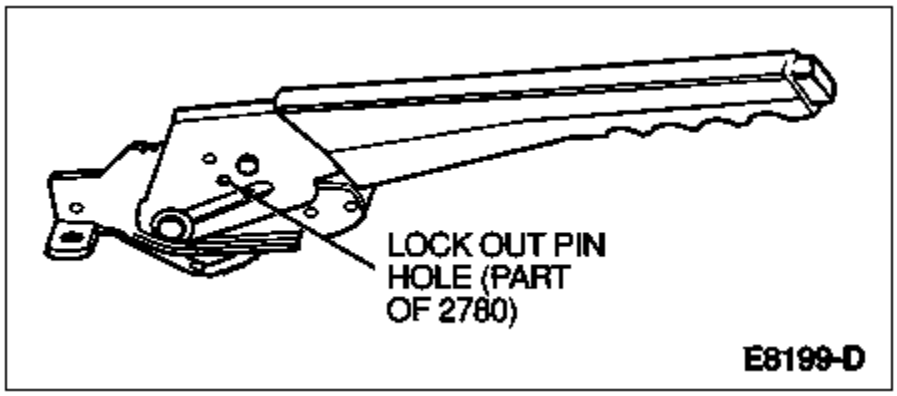
Cable Tension, Release

Release the parking brake cable tension as follows:

1. Place the parking brake control (2780) in the "released" position.
2. While an assistant relieves tension on the system by pulling on the parking brake intermediate cable, insert a 4mm (5/32-inch) steel pin or equivalent drill bit into the hole provided in the parking brake control.
3. On the Aerostar, insert a steel pin through the pawl lock out pin hole. The pin must be inserted from the inboard side of the parking brake control (larger hole) at a slightly upward and forward angle, then swept downward and rearward to displace the self-adjusting pawl. This locks out the self-adjusting pawl.

Aerostar



Ranger

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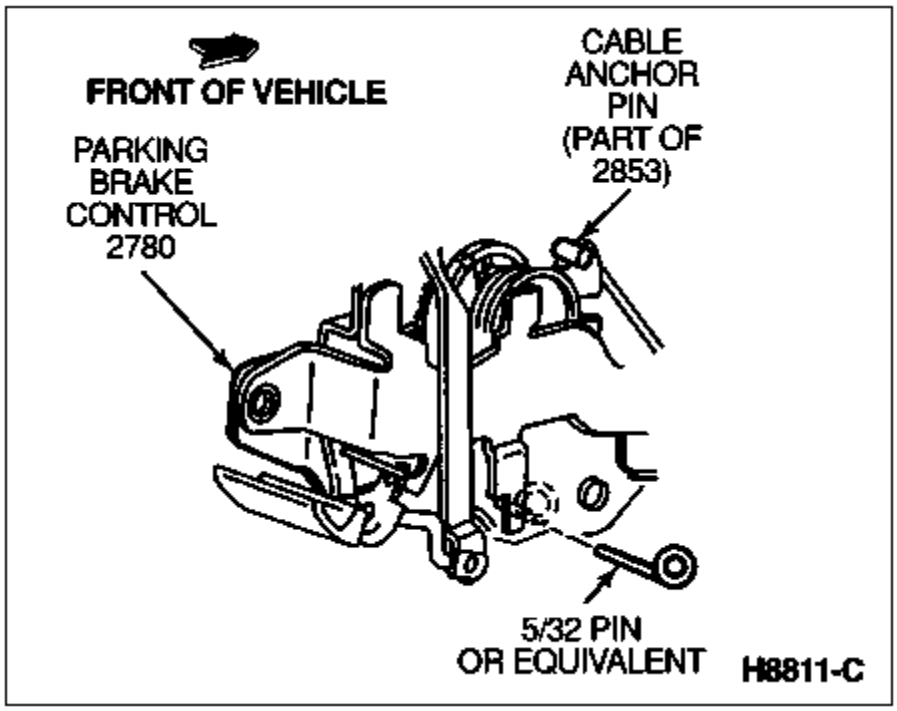


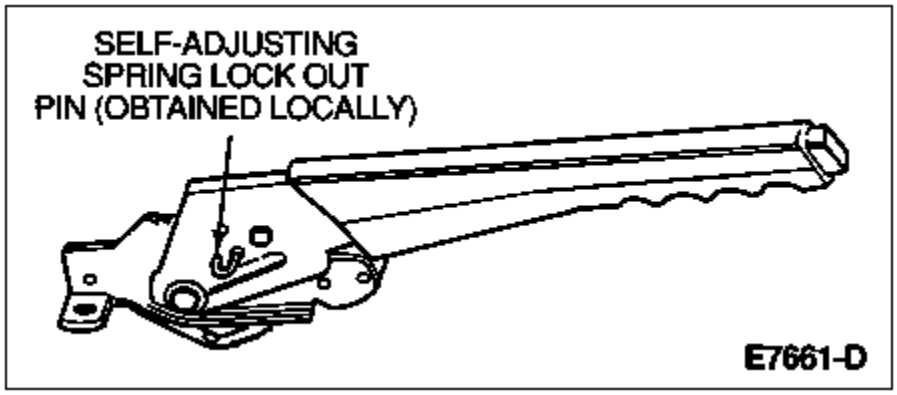
NOTE: Be careful not to damage the plastic coating on the cable strand. Remove the parking brake rear cable and conduits (2A635) from the parking brake cable bracket (2530).

4. Another method, which releases tension on the parking brake rear cable and conduits only, is to pull rearward on the parking brake rear cable and conduit about 25-50mm (1.0-2.0 inches) and place a clamp on the parking brake rear cable and conduit behind the rear frame crossmember (5035).

5. To reapply tension, connect all cables and remove the clamping device.

6. Another method which can be used on Aerostar vehicles is to remove the bolts attaching the parking brake control to the floor pan, and pull the parking brake control upward and forward to rotate the spring-loaded ratchet wheel as far as possible.

Aerostar



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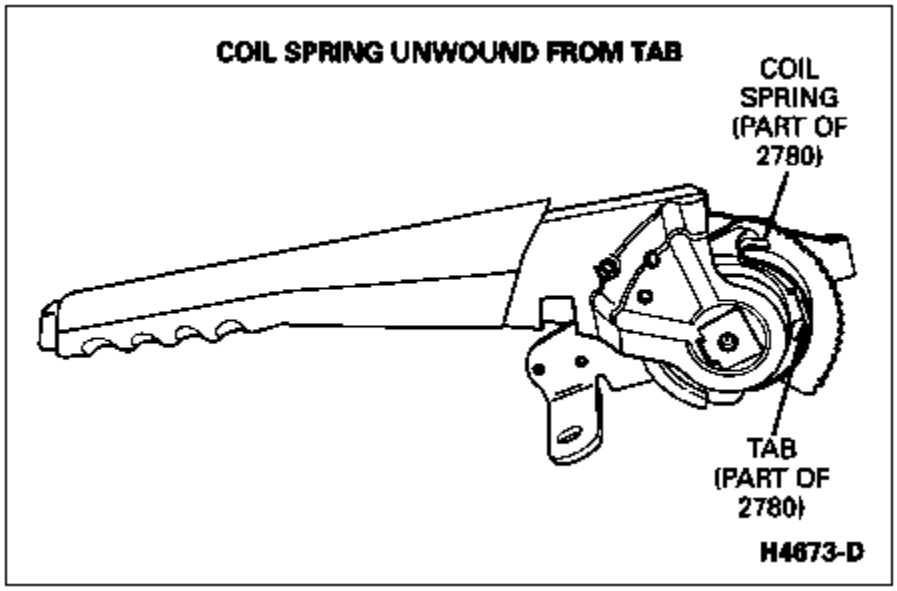
Cable Tension, Resetting

NOTE: Parking brake control spring tension is lost when the coil spring unwinds and disengages from the tab on the wheel. This can occur when the cables break, when servicing the system without inserting the lock pin or when the lock pin is removed before the cables are connected. DO NOT SERVICE THE PARKING BRAKE SYSTEM WITHOUT INSERTING THE LOCK PIN IN THE CONTROL ASSEMBLY. DO NOT REMOVE THE LOCK PIN FROM THE CONTROL WITH THE CABLES DISCONNECTED.

Aerostar



1. Remove the parking brake control as described in Removal and Installation, Control, Aerostar or Ranger in this section.
2. Engage the coil spring on the tab on the wheel in the parking brake control.

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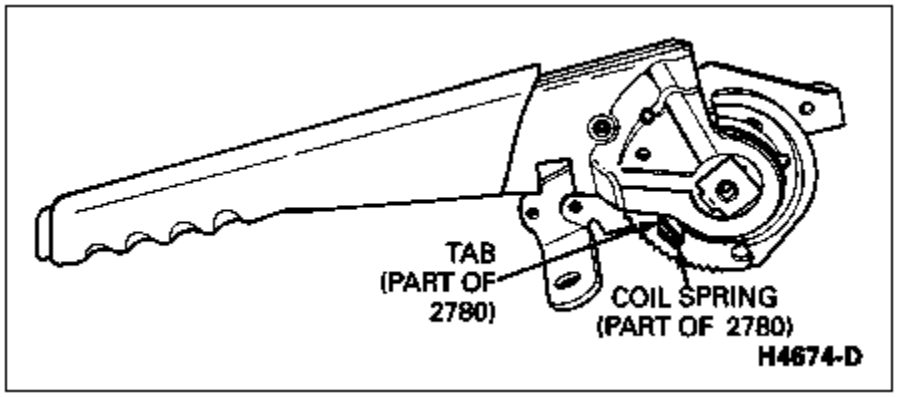
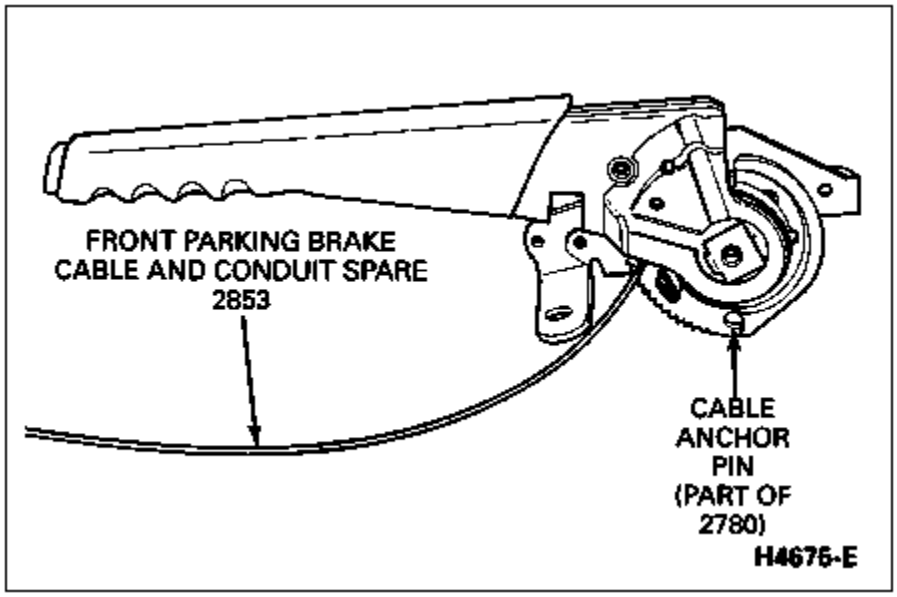


3. Place the control handle in the released position to unlock the self-adjusting pawl.

4. Slip a spare front parking brake cable and conduit (2853) around the pulley and insert the cable anchor pin into the pivot hole in the ratchet plate assembly.

Aerostar



Ranger

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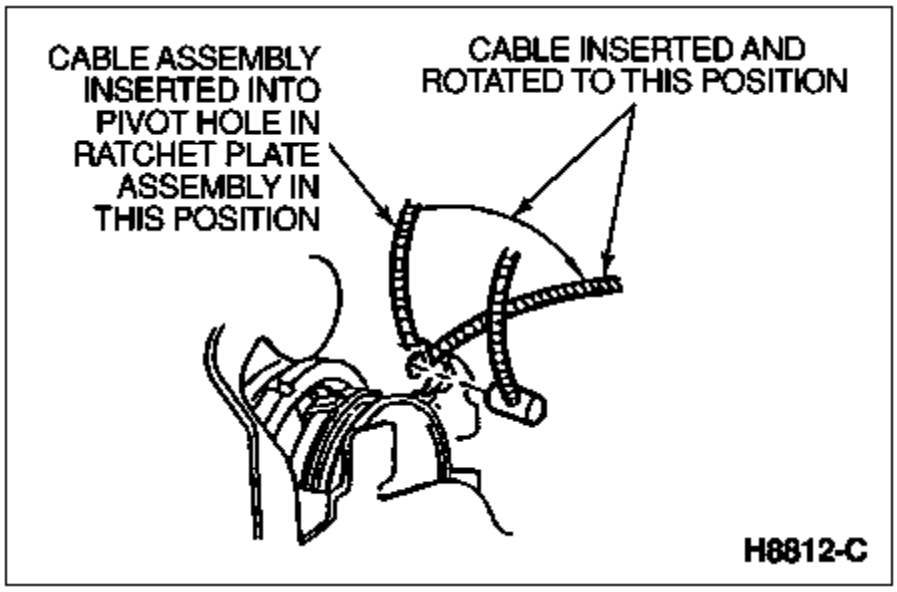

5. With the front parking brake cable and conduit on the floor, step on the front parking brake cable and conduit or clamp the end of the front parking brake cable and conduit in a vise.

6. Pull on the assembly, holding the mounting bracket tightly against the body of the control, until cable tension rotates the cable track assembly so the lock pin can be fully seated through the plate.

7. Insert the lock pin so the assembly is in the "cable released" position.

8. Install the parking brake control. Refer to the Removal and Installation, Control, Aerostar or Ranger procedure in this section.

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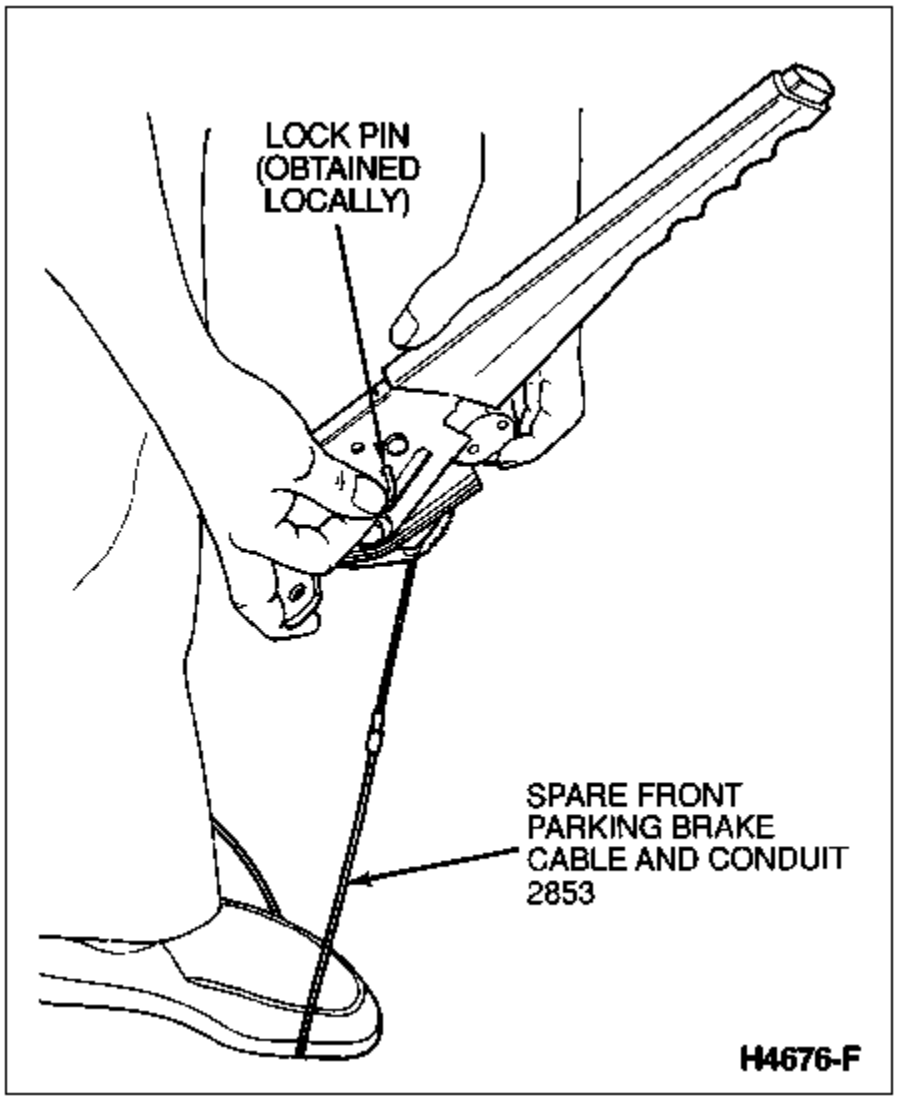

Ranger

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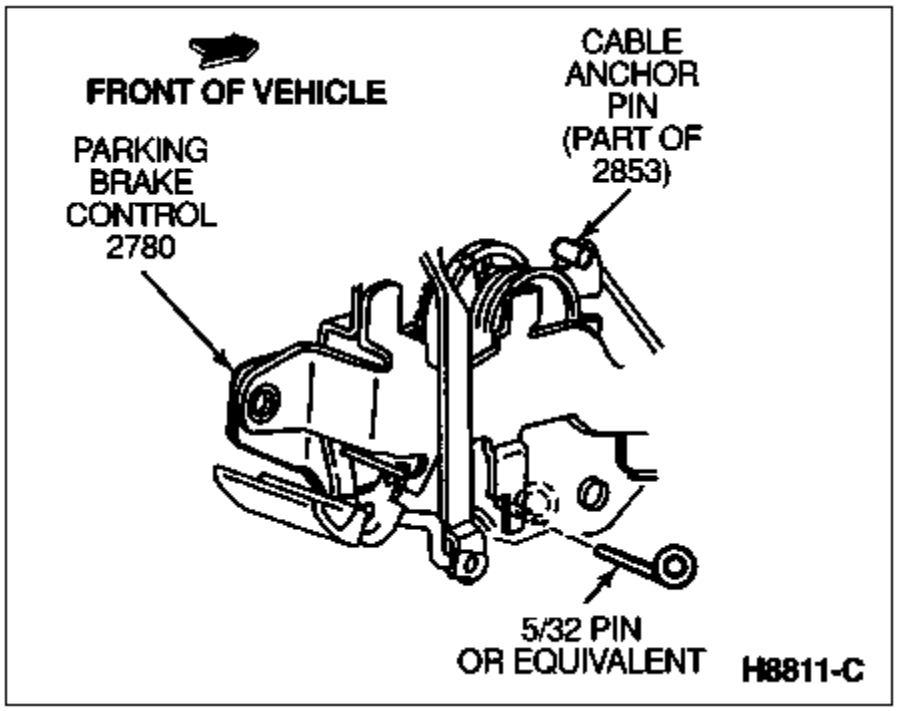

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Brake Fluid Level Check

Check the brake fluid level in the brake master cylinder reservoir and if necessary, fill to the MAX FILL line with High Performance DOT 3 Brake Fluid C6AZ-19542-AB or DOT 3 equivalent fluid meeting Ford specification ESA-M6C25-A, DOT 3.

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SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Bolt, Front Parking Brake Cable Clamp	15-20	11-14	—
Bolt, Parking Brake Control-to-Cowl Side	17-23	13-17	—
Bolt, Parking Brake Cable Retainer Clip	6-8	—	54-70
Screw, Parking Brake Warning Indicator	1.4-2.3	—	12-20

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Brake Pedal and Bracket

Automatic Transmission

Removal

1. **NOTE: Locking tab must be lifted before connector can be removed.**

   Disconnect wiring harness from the stoplight switch (13480) at the connector.

2. Remove the hairpin clip, slide the stoplight switch, push rod, brake master cylinder push rod spacer (2B129) and brake master cylinder push rod bushing (2474) away from the brake pedal (2455).

3. Remove the brake master cylinder push rod bushing and the stoplight switch from the brake pedal push rod by sliding switch up or down.

4. Remove one of the retainers holding the brake pedal shaft in the bracket.

5. Slide the brake pedal shaft out of the bracket and remove the brake pedal, inner brake master cylinder push rod bushings and spring washer.

6. Remove the outer brake master cylinder push rod bushings from the bracket.

Installation

1. Inspect the brake master cylinder push rod bushings for signs of wear or damage and replace if required. Relubricate the brake master cylinder push rod bushings with a light coating of Motorcraft SAE 30 X0-30-QSD or -DSD or -BSD or equivalent meeting Ford specification ESE-M2C153-E.

2. Insert the two outer brake master cylinder push rod bushings in the bracket. Place the brake pedal, inner brake master cylinder push rod bushings and spring washer in position inside the bracket.

3. Insert the brake pedal shaft through the bracket and brake pedal.

4. Install the retainer on the end of the brake pedal shaft.

5. **CAUTION: On Aerostar, make sure push rod orientation is correct. See illustration for correct orientation.**

   Position stoplight switch so the U-shaped side is nearest the brake pedal and directly over/under the pin. Then slide stoplight switch up/down trapping the brake pedal push rod and bushing between the switch side plates.

6. Push stoplight switch and brake pedal push rod assembly firmly toward brake pedal pin.

7. **CAUTION: When assembling, do not substitute other types of pin clips. Use only factory**

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supplied hairpin clips.

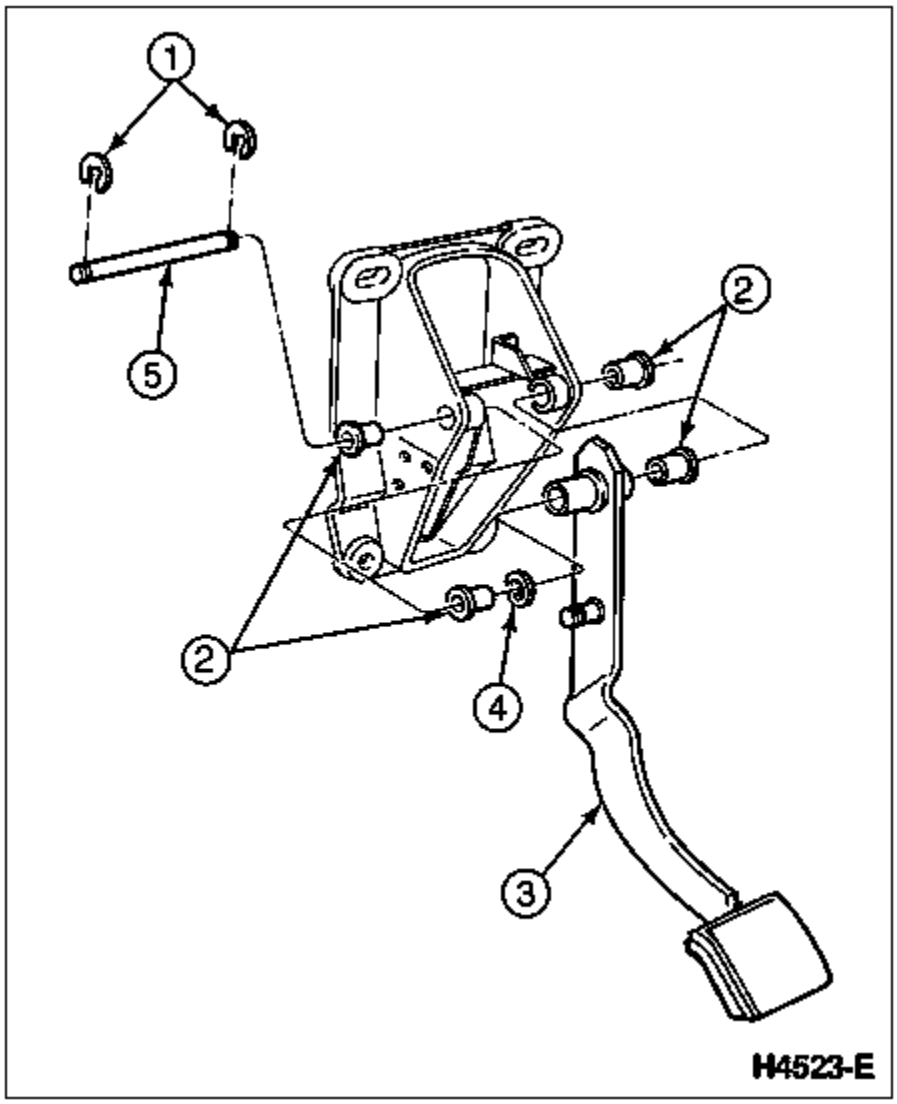
Assemble outside white plastic brake master cylinder push rod spacer to pin and install hairpin clip to hold entire assembly.

8. **CAUTION: The stoplight switch wire harness must have sufficient length to travel with the stoplight switch during full stroke of brake pedal. If wire length is too short, reroute or repair harness as required.**

   Assemble the connector to the stoplight switch.

9. Check stoplight switch for proper operation.

Brake Pedal, Automatic Transmission, Aerostar



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Item	Part Number	Description
1	97414	Brake Pedal Shaft Retainer
2	2471	Brake Pedal Bushing
3	2455	Brake Pedal
4	353474	Spring Washer
5	2478	Brake Pedal Shaft

Brake Pedal Push Rod Attachment, Aerostar

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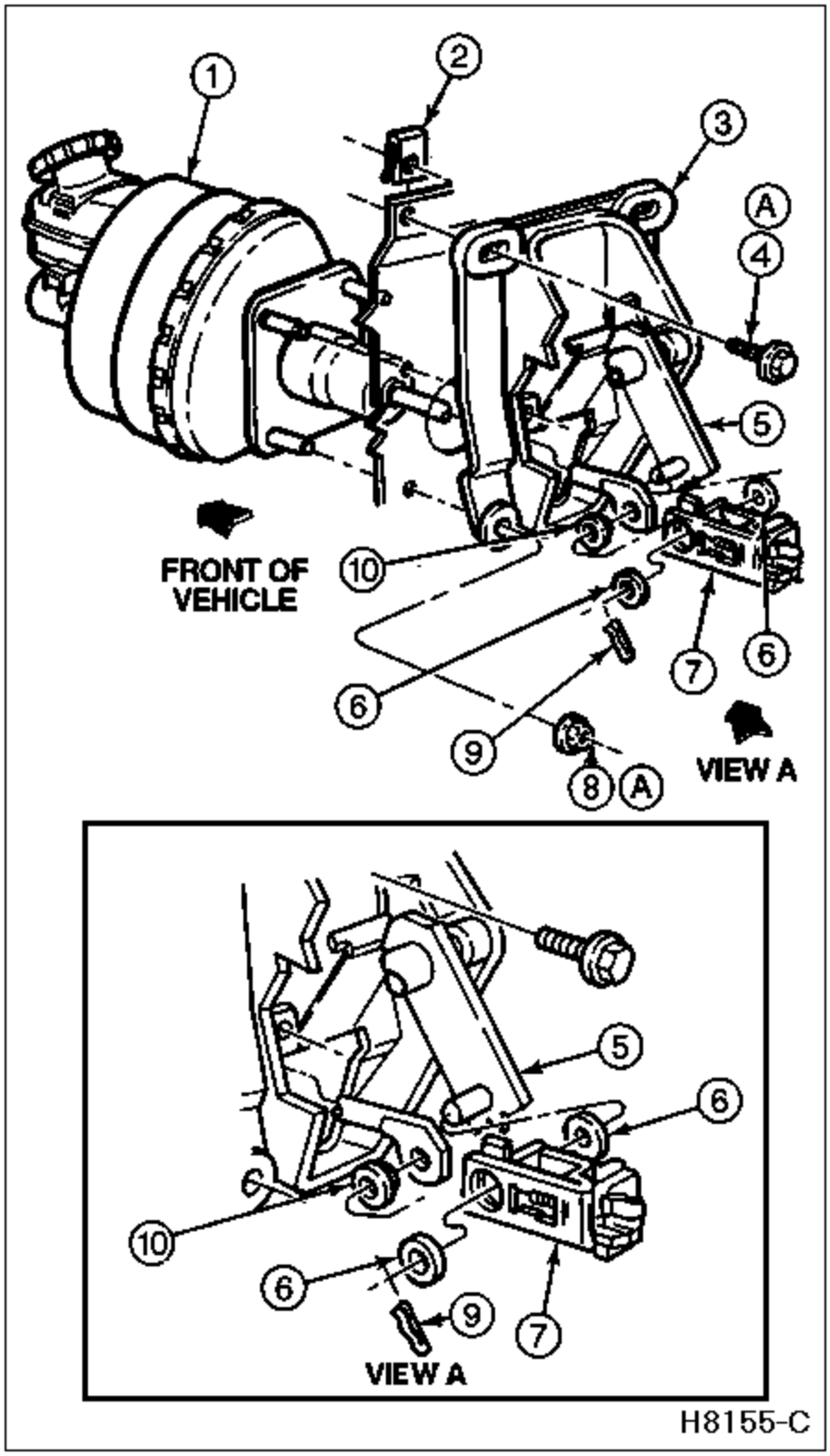

Item	Part Number	Description
1	2005	Power Brake Booster

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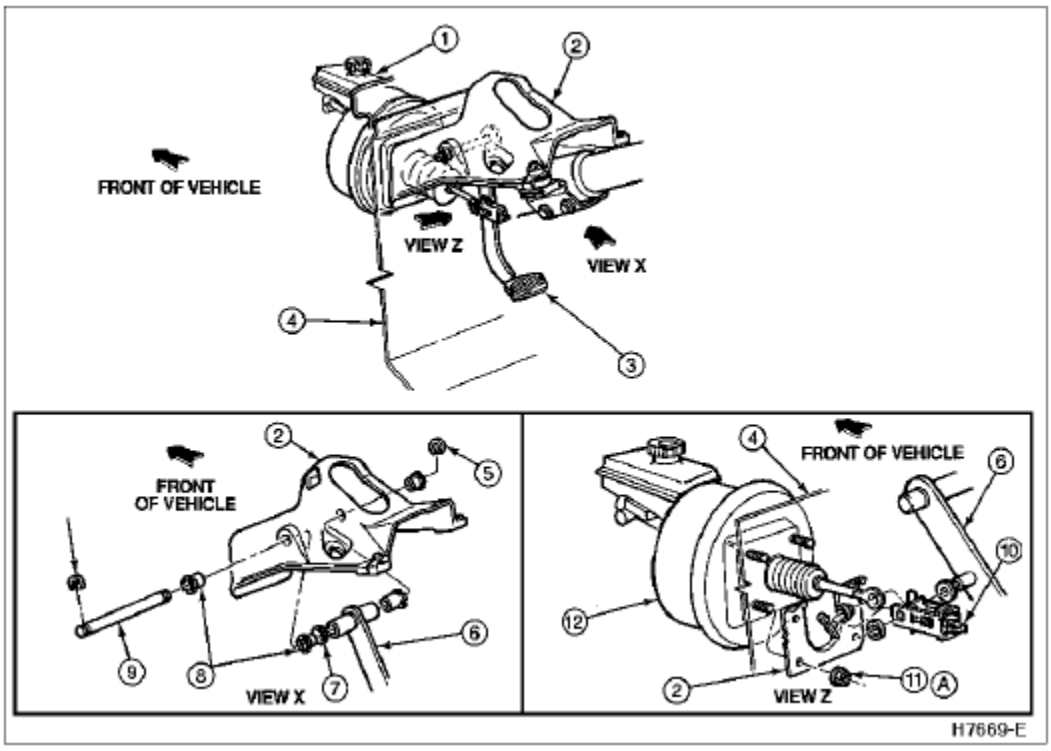
2	45265-S2	U-Nut, 3/8-16
3	2L252	Bracket, Brake and Clutch Pedal
4	57048-S2	Brake and Clutch Pedal Bracket-to-Power Brake Booster Bolt, 3/8-16 x 1.0 Hex Flange
5	2455	Brake Pedal
6	2B129	Brake Master Cylinder Push Rod Spacer
7	13480	Stoplight Switch
8	382808-S2	Brake and Clutch Pedal Bracket-to-Power Brake Booster Nut, 3/6-16
9	380699-S100	Pin
10	2474	Brake Master Cylinder Push Rod Bushing
A	—	Tighten to 22-28 Nm (16-21 Lb-Ft)

Brake Pedal, Automatic Transmission, Ranger



Item	Part Number	Description
1	2K478	Brake Master Cylinder Reservoir
2	2L252	Brake and Clutch Pedal Bracket
3	2457	Brake Pedal Pad

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4	02340	Dash Panel (Reference)
5	97414-S	Retainer
6	2455	Brake Pedal
7	353574-S57M	Washer
8	2471	Brake Pedal Bushing
9	2478	Brake Pedal Shaft
10	13480	Stoplight Switch
11	382802	Brake and Clutch Pedal Bracket-to-Power Brake Booster Nut
12	2005	Power Brake Booster
A	—	Tighten to 22-28 Nm (16-21 Lb-Ft)

Manual Transmission

Removal

1. Disconnect the wires to the stoplight switch located below instrument panel.
2. Remove the hairpin clip, slide the stoplight switch, the brake pedal push rod, the nylon brake master cylinder push rod spacer and brake master cylinder push rod bushing away from the brake pedal pin.
3. Remove the brake master cylinder push rod bushing and then the stoplight switch from the brake pedal push rod by sliding stoplight switch up or down.
4. Disconnect the clutch master cylinder push rod from the clutch pedal (7519).
5. Disconnect the clutch pedal position switch (CPP) (11A152) from the clutch master cylinder push rod.
6. Remove the retainer from the clutch pedal shaft.
7. Remove the clutch pedal and clutch pedal shaft from the brake and clutch bracket.
8. Remove the brake pedal.
9. Remove the spring washer and inner brake master cylinder push rod bushings from the brake pedal.
10. Remove the outer brake master cylinder push rod bushings from the brake and clutch pedal bracket.

Installation

1. Inspect the brake master cylinder push rod bushings for signs of wear or damage; replace if required. Relubricate the brake master cylinder push rod bushings with a light coating of SAE 30 XO-30-QSD or -DSD, -BSD or equivalent meeting Ford specification ESE-M2C153-E.
2. Insert the two outer brake master cylinder push rod bushings in the brake and clutch pedal bracket.

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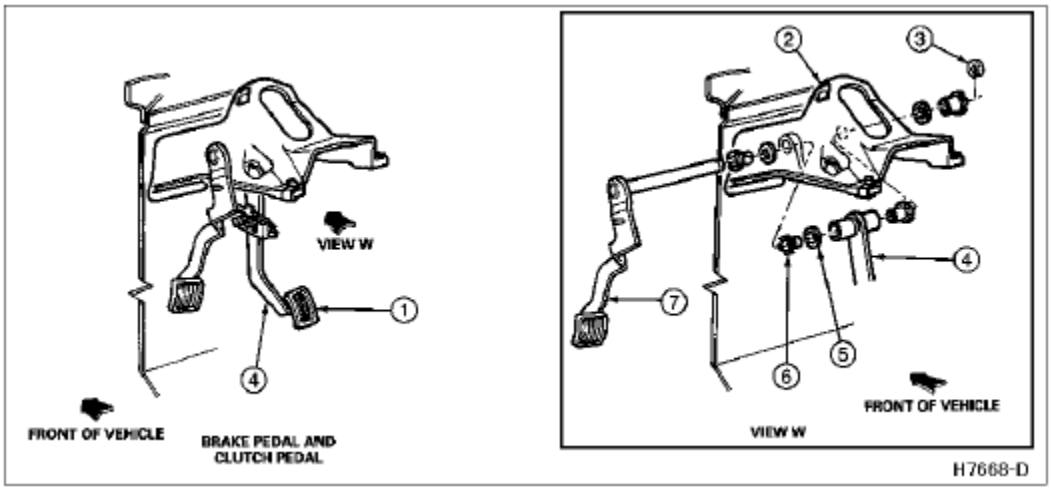
3. Place the brake pedal, inner brake master cylinder push rod bushings and spring washer in position inside the brake and clutch pedal bracket.
4. Insert the clutch pedal and clutch pedal shaft through the bracket and brake pedal sleeve.
5. Install the retainer on the end of the clutch pedal shaft.
6. Connect the clutch pedal position switch on the clutch master cylinder push rod.
7. Connect the clutch master cylinder push rod to the clutch pedal.
8. Install the stoplight switch on the brake pedal.
9. Connect the brake pedal push rod and stoplight switch to the pin on the brake pedal.
10. Install the brake master cylinder push rod spacer and spring retainer attaching the stoplight switch and brake pedal push rod to the brake pedal.
11. Connect the wires to the stoplight switch.
12. Adjust the clip on the clutch pedal position switch.
13. Check system for correct operation.

Brake Pedal and Clutch Pedal Installation, Ranger Manual Transmission



Item	Part Number	Description
1	2457	Brake Pedal Pad
2	2L252	Brake and Clutch Pedal Bracket
3	97414-S	Retainer
4	2455	Brake Pedal
5	353574-S7M	Washer

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6	2471	Brake and Clutch Pedal Bushing
7	7519	Clutch Pedal

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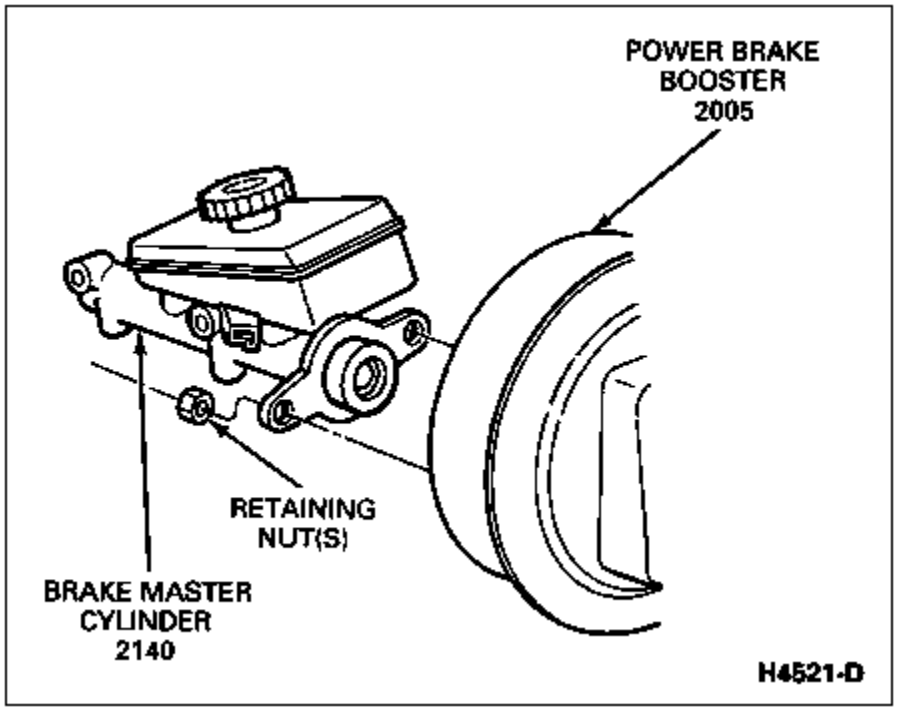
Brake Master Cylinder, Ranger

Removal

1. Disconnect the brake warning lamp indicator wire from the plastic reservoir low fluid level warning switch socket.
2. With the engine (6007) turned off, push the brake pedal (2455) down to expel vacuum from the power brake booster.
3. Disconnect the front brake tube (2264) and rear brake tube from the brake master cylinder (2140).
4. Remove the wraparound clip and attaching nut from the booster master cylinder mounting stud.
5. Remove the brake booster-to-master cylinder retaining nuts. Remove the brake master cylinder from the power brake booster.



Installation

NOTE: Before installing the brake master cylinder, check the distance from the outer end of the booster assembly push rod to the front face of the power brake booster. Turn the push rod adjustment screw in or out as required to obtain a length of 24.89-25.27mm (0.980-0.995 inch). Fabricate a gauge block using dimensions shown in the following illustration.

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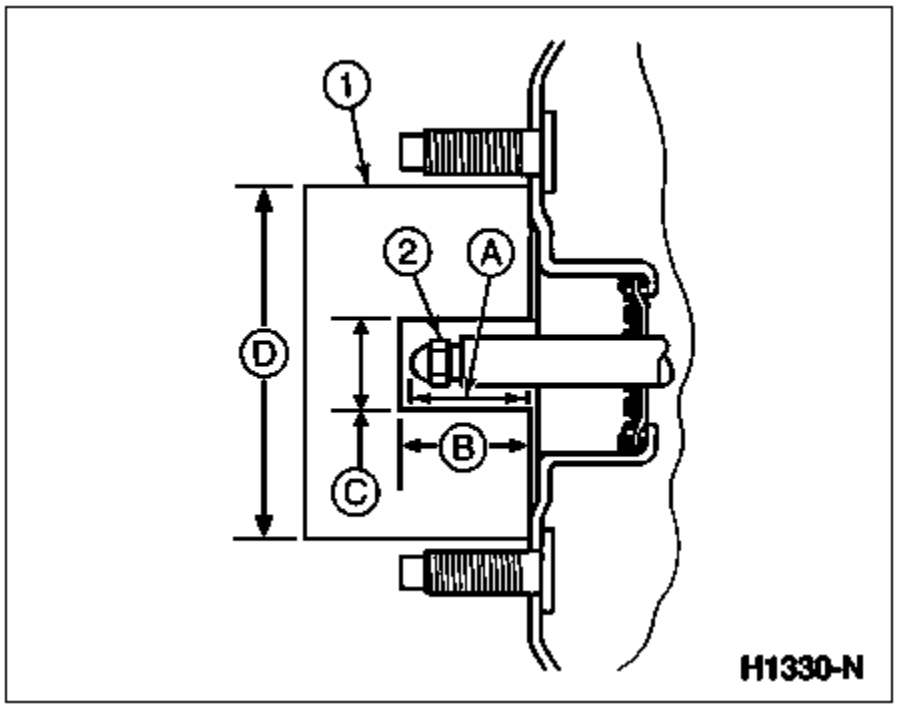

Item	Part Number	Description
1	—	Shop Fabricated Gauge
2	—	Adjustment Screw (Part of 2005)
A	—	24.89-25.27mm (0.980-0.995 Inch)
B	—	25.27mm (0.995 Inch)
C	—	19.05mm (0.75 Inch)
D	—	74.61mm (2.94 Inch)

1. Position the brake master cylinder over the booster push rod and onto the two studs on the power brake booster. Install the attaching nuts and tighten to 18-33 Nm (14-24 lb-ft).
2. Loosely connect the front brake tube and the rear brake tube to the brake master cylinder.
3. Position the wrap-around clip on the mounting stud. Install and tighten the attaching nut.
4. Tighten the tube nuts to 15-20 Nm (11-14 lb-ft).
5. Connect fluid level indicator switch.
6. Bleed the brake master cylinder as described in this section. Then fill the brake master cylinder reservoir (2K478) of the brake master cylinder with High Performance DOT 3 Brake Fluid C6AZ-19542-AB or DOT 3 equivalent meeting Ford specification ESA-M6C25-A, DOT 3 to the fluid fill line.

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7. Install the gasket and brake master cylinder filler cap.

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Brake Master Cylinder, Aerostar

Removal

NOTE: Care should be taken when removing the brake master cylinder (2140) to not scratch the exposed primary piston.

1. Disconnect wiring harness from low fluid level warning switch in the brake master cylinder reservoir (2K478).
2. Disconnect low fluid warning switch from brake master cylinder.
3. Disconnect brake pressure differential valve warning lamp switch (2B264) from combination valve.
4. Disconnect front and rear brake tubes from brake master cylinder.
5. Remove the two nuts that attach the brake master cylinder and master cylinder and booster bracket holder (2A248) to the power brake booster.
6. **CAUTION: Never reuse any brake fluid removed from the brake system during any repair operation. Always discard old brake fluid and replenish system with fresh brake fluid.**

   Discard fluid from brake master cylinder by turning over brake master cylinder and allowing fluid to pour through the filler opening of the brake master cylinder reservoir.

Installation

NOTE: DO NOT assemble brake master cylinder to power brake booster without square section interface seal.

1. Make sure the interface seal is located in the annular groove in the brake master cylinder body where the brake master cylinder seals with the booster.
2. Install brake master cylinder to power brake booster.
3. Install combination valve bracket.
4. **NOTE: Use care to prevent scratching or other damage to exposed primary piston during handling.**

   Engage the primary piston socket to booster push rod before tightening. Tighten retaining nuts to 18-33 Nm (14-24 lb-ft).
5. Connect wiring harness to low fluid level warning switch. Connect differential pressure switch harness.
6. Attach front and rear brake tubes to brake master cylinder. Tighten tube fittings to 15-20 Nm (11-14

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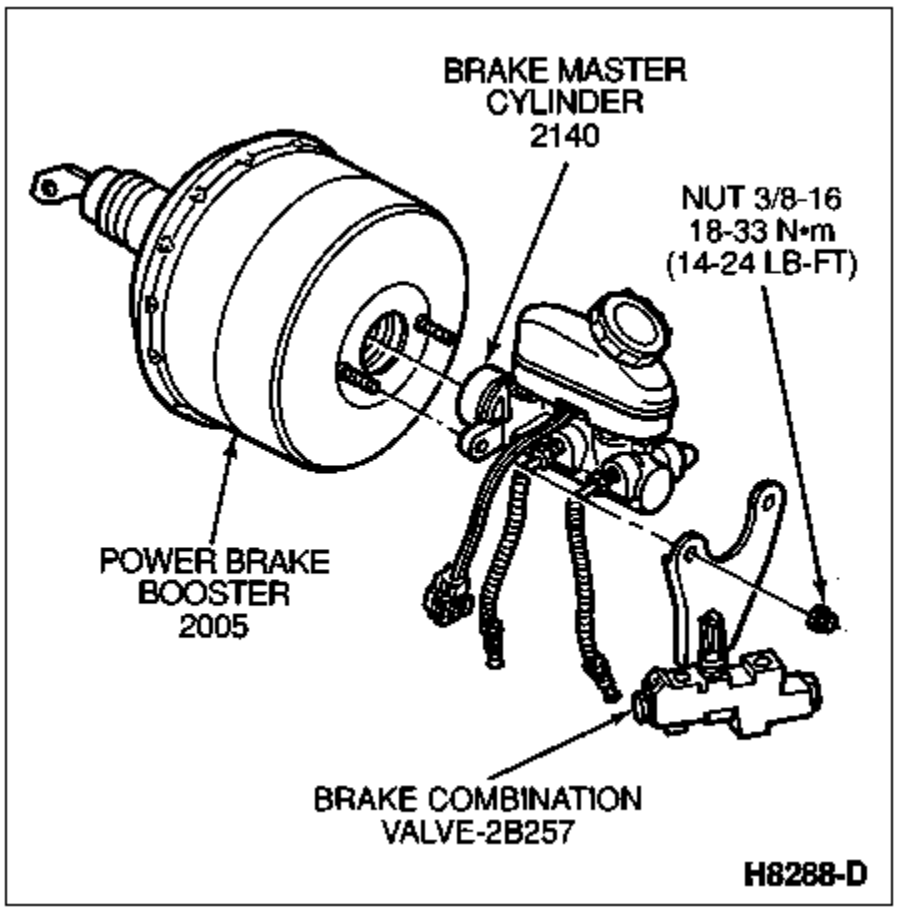
lb-ft).

7. Fill unit High Performance DOT 3 Brake Fluid C6AZ-19542-AB or DOT 3 equivalent meeting Ford specification ESA-M6C25-A, DOT 3 and bleed entire brake system to remove all entrapped air. Refer to Service Procedures, Hydraulic System Bleeding in this section.



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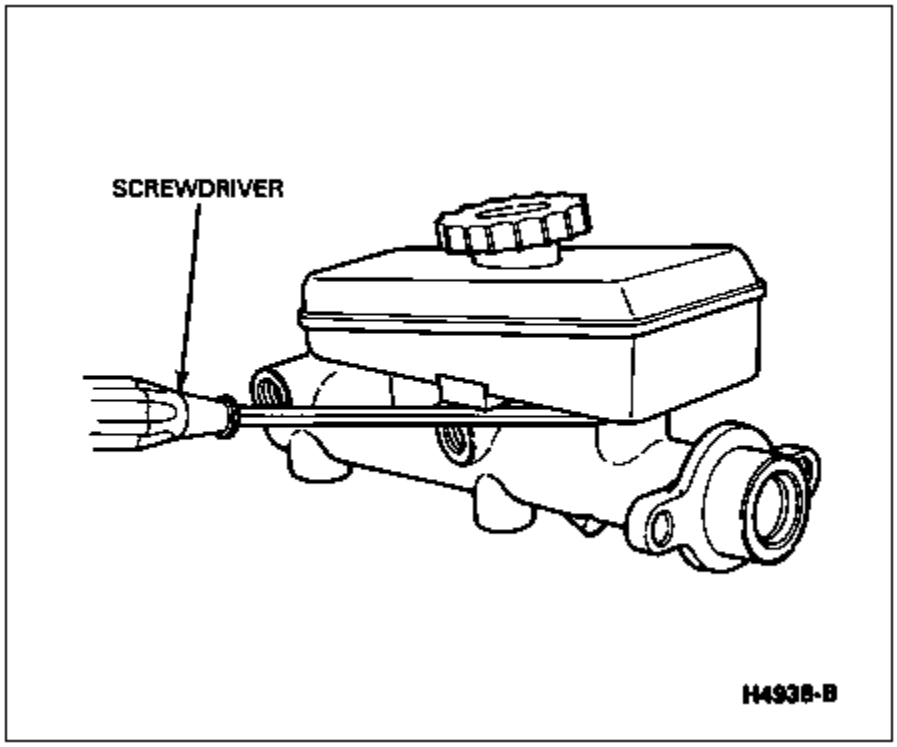
Brake Master Cylinder Reservoir, Ranger

Removal

1. Disconnect the brake warning lamp indicator wire from the plastic reservoir fluid level indicator socket. Drain the brake fluid from the brake master cylinder reservoir (2K478).

2. Using a large screwdriver, pry between the brake master cylinder reservoir and the brake master cylinder (2140) and remove the brake master cylinder reservoir.



Installation

1. **WARNING: WHENEVER THE BRAKE MASTER CYLINDER IS REPLACED, THE BRAKE TUBE GROMMETS MUST ALSO BE REPLACED OR LEAKAGE MAY OCCUR CAUSING BRAKE SYSTEM FAILURE.**

   Lubricate the two brake tube grommets included in Service Kit 2K478 with High Performance DOT 3 Brake Fluid C6AZ-19542-AB or DOT 3 equivalent meeting Ford specification ESA-M6C25-A, DOT 3. Insert the brake tube grommets into the brake master cylinder.

2. Press the brake master cylinder reservoir into the brake tube grommets with the fluid level indicator socket facing inboard. The brake master cylinder reservoir should snap in place indicating that it is secure.

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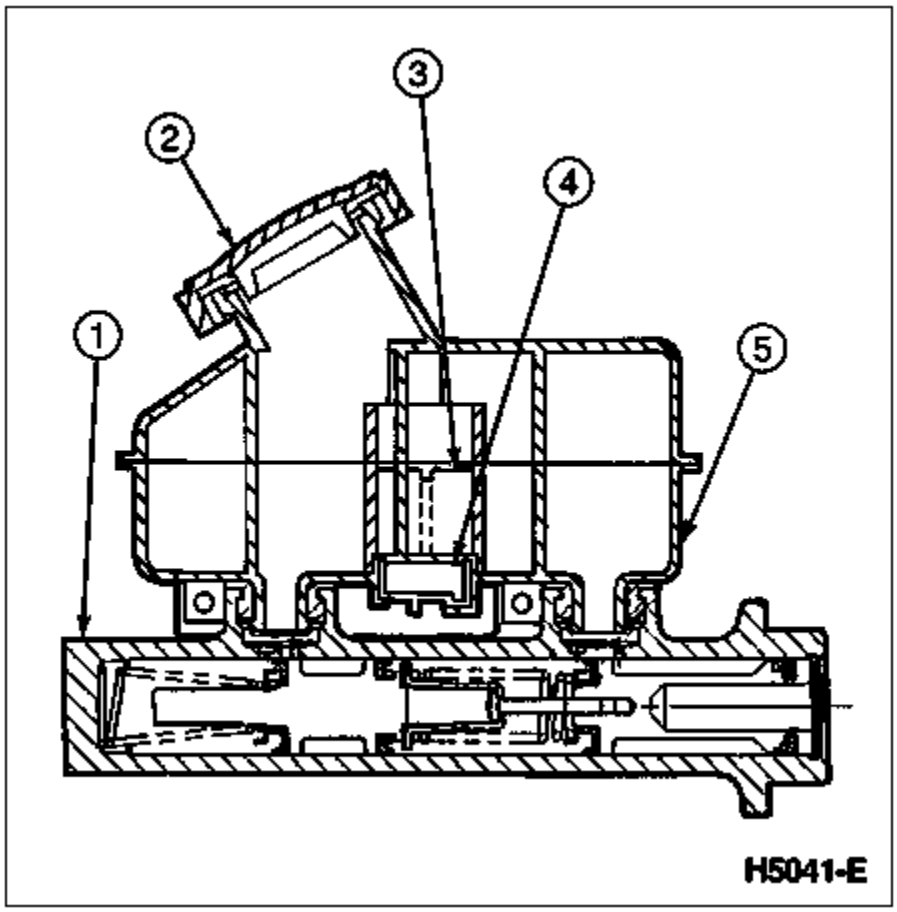
3. Connect the brake warning lamp indicator wire to the fluid level indicator socket.

4. Fill the brake master cylinder reservoir with High Performance DOT 3 Brake Fluid C6AZ-19542-AB or DOT 3 equivalent meeting Ford specification ESA-M6C25-A, DOT 3.



Item	Part Number	Description
1	2140	Brake Master Cylinder
2	2162	Brake Master Cylinder Filler Cap
3	—	Float (Part of 2K478)
4	—	Fluid Level Indicator Switch (Part of 2K478)
5	2K478	Brake Master Cylinder Reservoir

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Brake Master Cylinder Reservoir, Aerostar

Removal

1. Disconnect wiring harness from fluid level warning switch.
2. Disconnect wiring harness from differential pressure switch at combination valve.
3. Remove brake master cylinder filler cap (2162). Place shop rags under brake master cylinder (2140). Dip or siphon as much fluid out of the brake master cylinder reservoir (2K478) as possible.
4. Using a 5mm (.19-inch) punch and a light hammer, drive out retainer pins that hold brake master cylinder reservoir to brake master cylinder.
5. Using a large screwdriver, pry between the brake master cylinder reservoir and brake master cylinder and remove brake master cylinder reservoir from brake master cylinder.
6. Remove brake tube grommets if they didn't come off with the brake master cylinder reservoir. Discard brake tube grommets.

Installation

1. **CAUTION: Whenever the brake master cylinder reservoir is replaced, the brake tube grommets must be replaced.**

   Lubricate the two brake tube grommets included in service kit 2K478 with High Performance DOT 3 Brake Fluid C6AZ-19542-AB or DOT 3 equivalent meeting Ford specification ESA-M6C25-A, DOT 3. Insert brake tube grommets into the brake master cylinder.
2. Press the brake master cylinder reservoir into the brake tube grommets with the fluid level warning switch socket facing outboard (toward the driver's side of the vehicle). Snap brake master cylinder reservoir into place.
3. Using a 5mm (.19-inch) punch and a hammer, insert the reservoir retainer pins.
4. Connect the wiring harness for the fluid level warning switch.
5. **CAUTION: Never reuse any brake fluid removed from the brake system during any repair operation. Always discard old brake fluid and replenish system with fresh brake fluid.**

   Connect wiring harness for differential pressure switch at the brake combination valve.
6. Fill brake master cylinder reservoir to the MAX fill line with High Performance DOT 3 Brake Fluid C6AZ-19542-AB or DOT 3 equivalent meeting Ford specification ESA-M6C25-A, DOT 3.
7. Reinstall brake master cylinder filler cap. Check brake operation and system for leaks before road testing vehicle.

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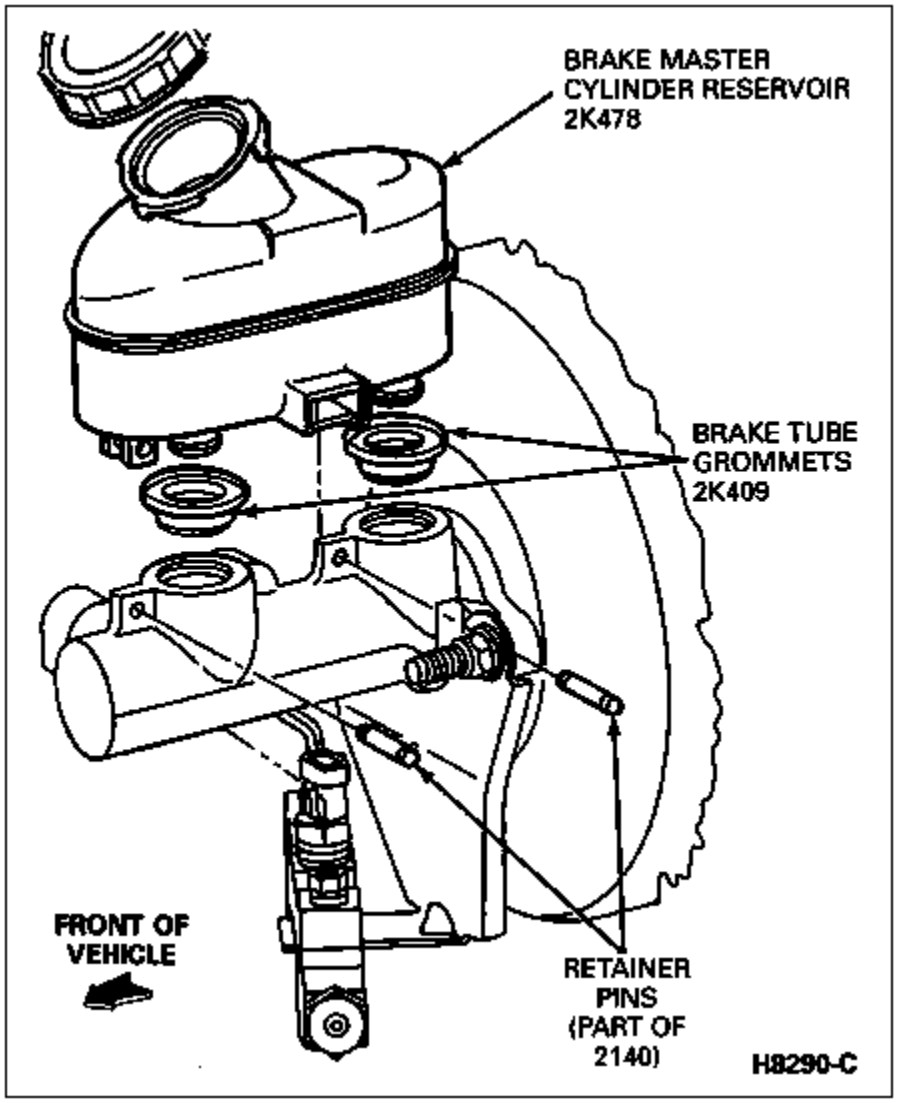

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Caliper Hose

Removal

1. Raise and support the vehicle.
2. At the frame mounting point of the LH front brake hose (2078), disconnect the two front brake tube fittings.
3. At the frame mounting point, remove the front brake hose mounting clip.
4. At the front disc brake caliper (2B121), remove the front disc brake caliper flow bolt. Discard the copper washers.
5. Remove the front brake hose bolt securing the front brake hose to the front disc brake caliper.
6. Remove the front brake hose from the vehicle.

Installation

To install, reverse the removal procedure. Use new copper washers and tighten the front disc brake caliper flow bolt to 29.7-40.3 Nm (22-29 lb-ft). Tighten the front brake hose bolt to 3.4-4.5 Nm (30-39 lb-in). Tighten the two front brake tube fittings to 15-20 Nm (11-14 lb-ft).

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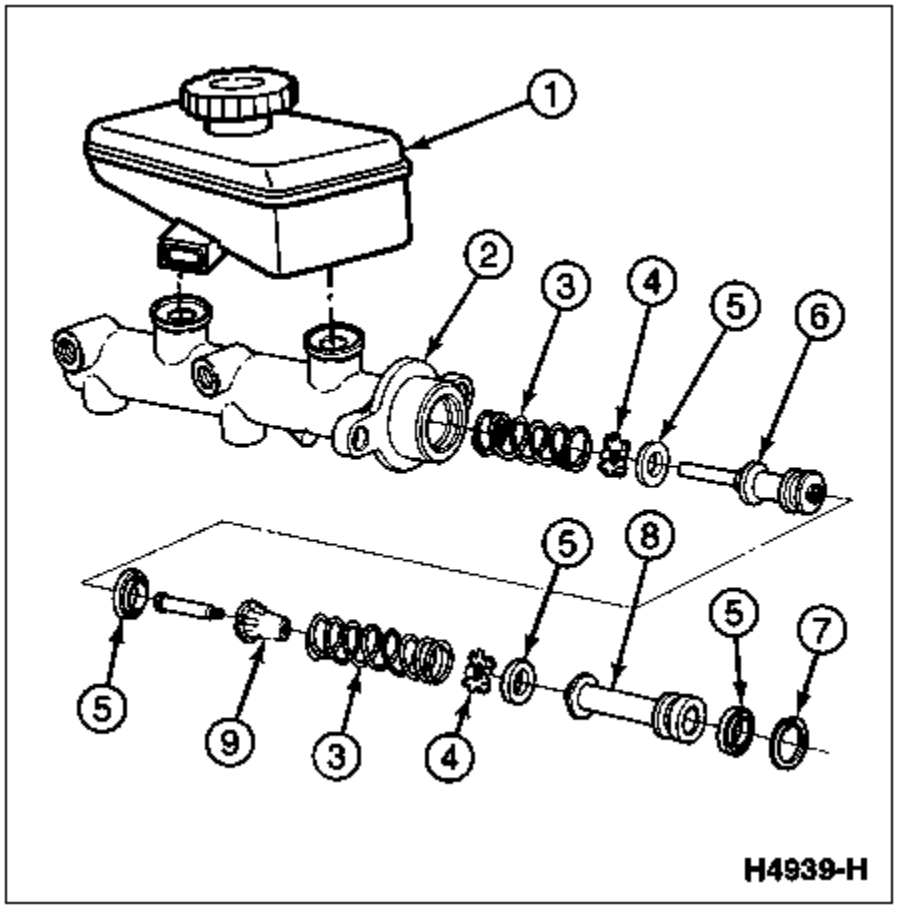
Brake Master Cylinder

Remove the brake master cylinder (2140) from the vehicle. Refer to Removal and Installation, Brake Master Cylinder in this section.

Ranger Shown, Aerostar Similar



Item	Part Number	Description
1	2K478	Brake Master Cylinder Reservoir
2	2140	Brake Master Cylinder
3	—	Spring (Part of 2140)
4	—	Spring Seat (Part of 2140)
5	—	Piston Cup (Part of 2140)
6	—	Secondary Piston (Part of 2140)
7	—	Snap Ring (Part of 2140)

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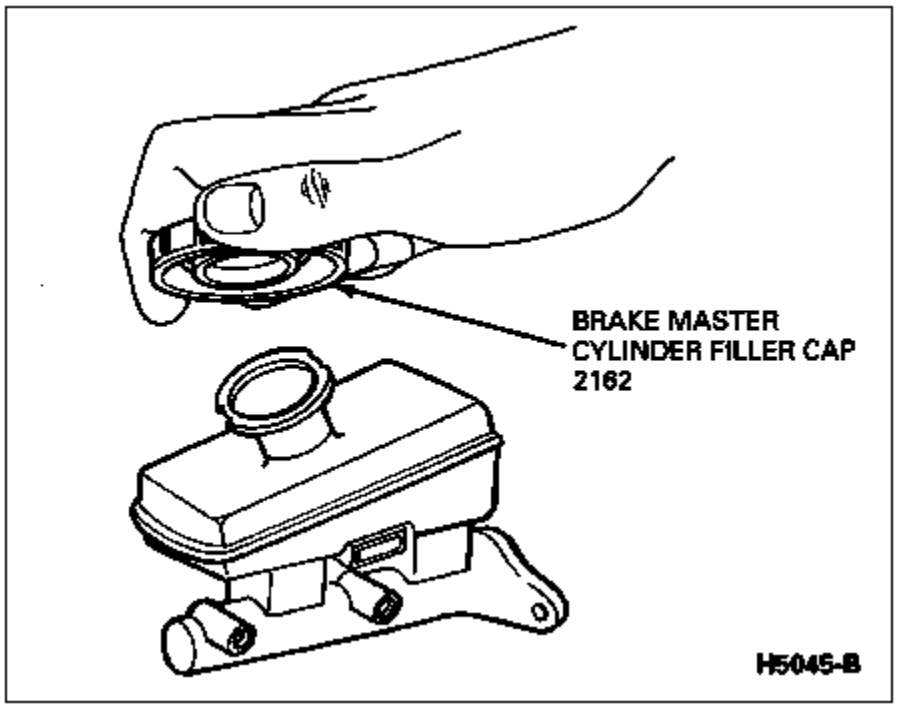
8	—	Primary Piston (Part of 2140)
9	—	Spring Retainer (Part of 2140)

Disassembly

1. Clean the outside of the brake master cylinder and remove the brake master cylinder filler cap and diaphragm. Drain and discard any brake fluid that remains in the brake master cylinder.



2. Depress the primary piston and remove snap ring from retaining groove at the rear of the master cylinder bore.

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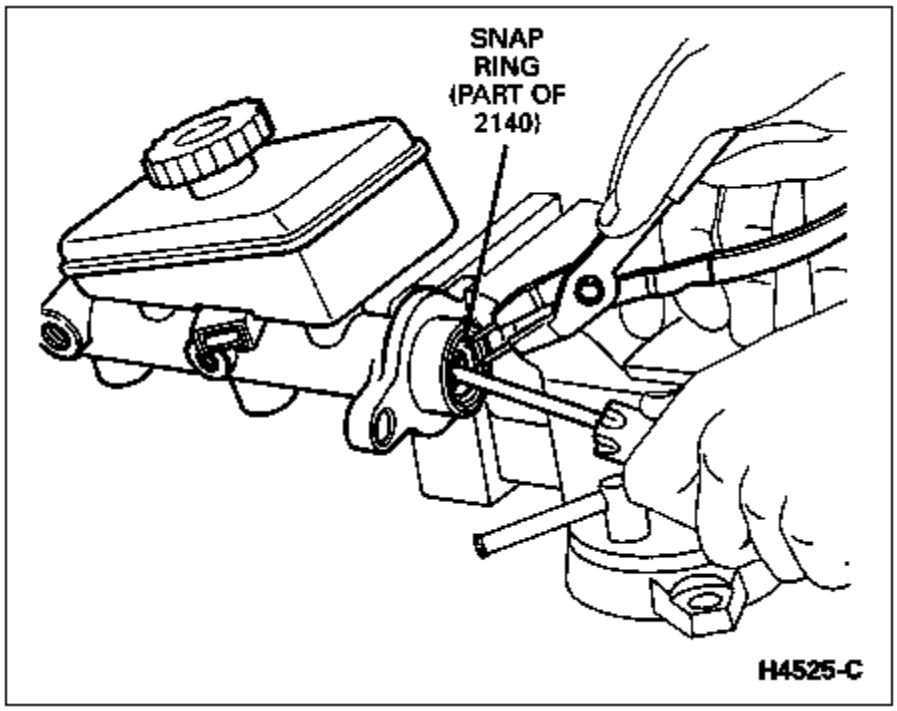
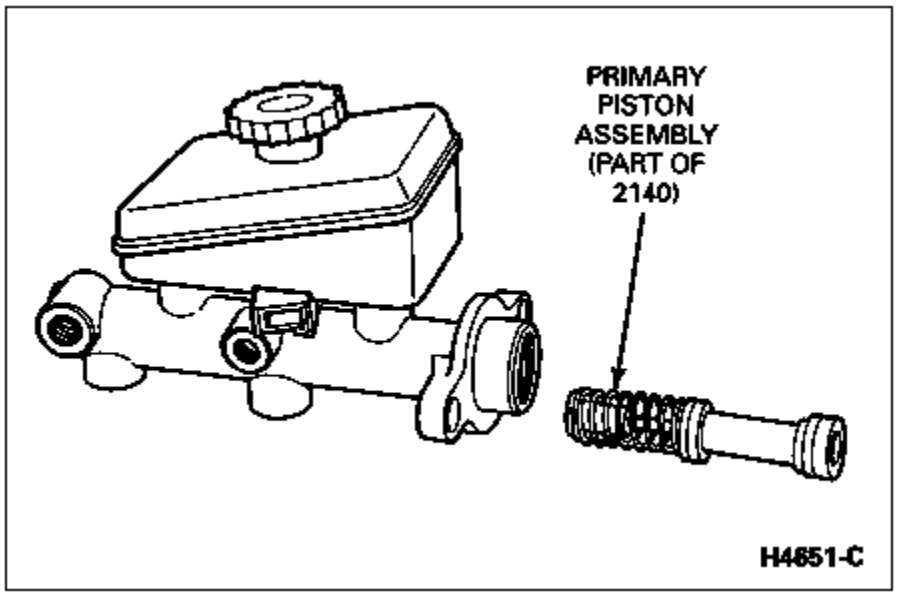


3. On Ranger, remove primary piston assembly from the master cylinder bore. Inspect for seal damage or twisting. Discard assembly.

   On Aerostar, remove the rear washer, seal and guide, along with the primary piston assembly from the bore.



4. Remove the secondary piston assembly by directing compressed air into the outlet port at the blind end of the bore while plugging the other port. Inspect for seal damage or twisting. Discard assembly.

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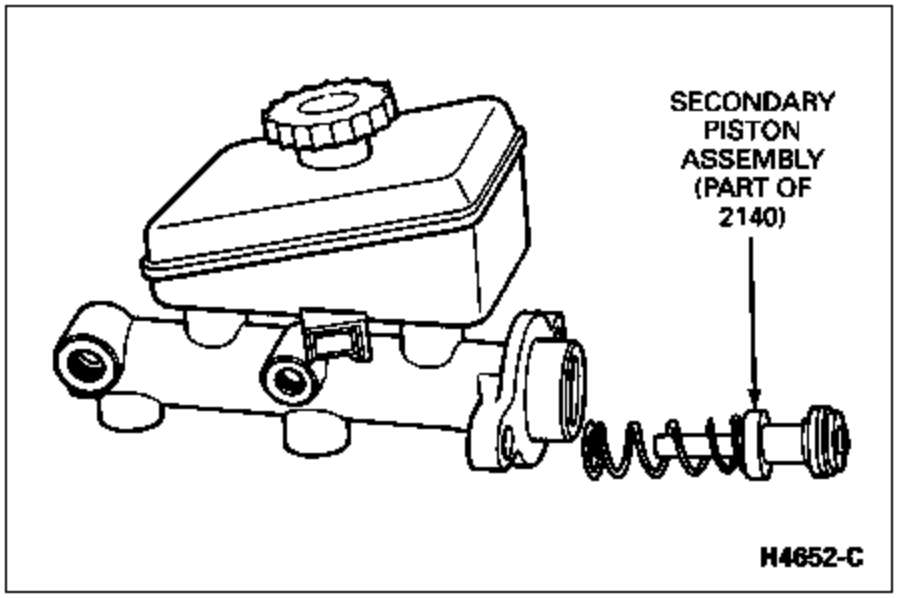

5. **WARNING: DO NOT ATTEMPT TO HONE A MASTER CYLINDER BORE IF DAMAGE IS FOUND. IF BORE IS FOUND TO BE IN GOOD CONDITION, CHECK WITH YOUR FORD DEALER FOR AVAILABILITY OF SERVICE REPAIR KITS. IF NONE ARE AVAILABLE, BRAKE MASTER CYLINDER MUST BE REPLACED.**

   Inspect the master cylinder bore for signs of etching, pitting, scoring or other damage.

Assembly

1. Clean the master cylinder body with clean isopropyl alcohol to remove any contamination.
2. Dip the repair kit piston assemblies in clean brake fluid High Performance DOT 3 Brake Fluid C6AZ-19542-AB or equivalent DOT 3 fluid meeting Ford specification ESA-M6C25-A, DOT 3 to lubricate seals.
3. Carefully insert the complete secondary piston assembly in the master cylinder bore.
4. On Ranger, carefully insert the primary piston assembly in the master cylinder bore.

   On Aerostar, assemble the washer, rear seal and guide over the primary piston. Be careful not to scratch or damage the exposed section of the primary piston. Install into cylinder bore.
5. Depress the primary piston and install the snap ring in the cylinder bore groove.
6. Install the cap and diaphragm on the brake master cylinder reservoir (2K478).

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Hydraulic System Bleeding

WARNING: BRAKE FLUID CONTAINS POLYGLYCOL ETHERS AND POLYGLYCOLS. AVOID CONTACT WITH EYES. WASH HANDS THOROUGHLY AFTER HANDLING. IF BRAKE FLUID CONTACTS EYES, FLUSH WITH RUNNING WATER FOR 15 MINUTES. GET MEDICAL ATTENTION IF IRRITATION PERSISTS. IF TAKEN INTERNALLY, DRINK WATER AND INDUCE VOMITING. GET MEDICAL ATTENTION IMMEDIATELY.

When any part of the hydraulic system has been disconnected for repair or replacement, air may get into the lines and cause spongy pedal action. This requires the bleeding of the hydraulic system after it has been properly connected to be sure all air is expelled from the brake cylinders and lines. The hydraulic system can be bled manually or with pressure bleeding equipment such as Rotunda Brake Bleeder 104-00064 or equivalent.

Bleed one wheel location at a time. Start the bleeding at the right rear wheel and then the left rear wheel. Then proceed to bleed the front brakes, starting with the right front brake and finish bleeding on the left front brake.

System Priming

When a brake master cylinder (2140) has been installed, or the brake system emptied or partially emptied, fluid may not flow from the bleeder screws during normal bleeding. It may be necessary to prime the brake master cylinder using the following procedure:

1. Use a tubing wrench to remove the front brake tube (2264) and the brake master cylinder outlet rear tube from the brake master cylinder.

2. Install short brake tubes in the brake master cylinder and position them so that they curve into the brake master cylinder reservoir (2K478), and the ends of the tubes are submerged in brake fluid.

3. Fill the brake master cylinder reservoir with new High Performance DOT 3 Brake Fluid C6AZ-19542-AB or DOT 3 equivalent meeting Ford specification ESA-M6C25-A, DOT 3.

4. **CAUTION: Brake fluid is harmful to painted and plastic surfaces. If brake fluid is spilled onto a painted or plastic surface, immediately wash it with water.**

   Have an assistant pump the brakes until clear, bubble-free fluid flows from both brake tubes.

5. Remove the short brake tubes and reinstall the front brake tube and brake master cylinder outlet rear tube on the brake master cylinder.

6. Bleed each brake tube at the brake master cylinder using the following procedure:

   a. Have an assistant pump the brake pedal (2455) 10 times and then hold firm pressure on the brake pedal.
   b. On the brake master cylinder, loosen the rearmost brake tube fitting with a tubing wrench until a stream of brake fluid comes out. Have an assistant maintain pressure on the brake pedal until the brake tube fitting is tightened again.
   c. Repeat this operation until clear, bubble-free fluid comes out from around the tube fitting.

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Refill the brake master cylinder reservoir as necessary.

d. Repeat this bleeding operation at the front brake tube fitting.

7. If any of the brake tubes, disc brake calipers, or rear wheel cylinders have been removed, it may be helpful to prime the system by gravity bleeding. This should be done after the brake master cylinder is primed and bled.

   To gravity bleed the brake system:

   a. Fill the brake master cylinder with new High Performance DOT 3 Brake Fluid C6AZ-19542-AB or DOT 3 equivalent meeting Ford specification ESA-M6C25-A, DOT 3.
   b. Loosen both of the rear bleeder screws and leave them open until clear brake fluid flows. Be sure to check the brake master cylinder reservoir fluid level often and do not let it run dry.
   c. Tighten the wheel cylinder bleeder screws to 7-9 Nm (62-79 lb-in).
   d. One at a time, loosen the front caliper bleeder screws. Leave the bleeder screws open until clear fluid flows. Check the fluid level often in the brake master cylinder reservoir and do not let it run dry.
   e. Tighten the front caliper bleeder screws to 17-24 Nm (13-17 lb-ft).

8. After the brake system has been primed, bleed the brake system at each wheel (1007).

   Keep the brake master cylinder reservoir filled with High Performance DOT 3 Brake Fluid C6AZ-19542-AB or DOT 3 equivalent meeting Ford specification ESA-M6C25-A, DOT 3. **Never use brake fluid that has been drained from the system.**

Anti-Lock Brake System Bleeding

NOTE: The anti-lock brake system must be bled in two steps.

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Anti-Lock Brake Adapter	T90P-50-ALA
Jumper	T93T-50-ALA

1. **NOTE: The brake master cylinder and Hydraulic Control Unit must be bled using Anti-lock Brake Adapter T90P-50-ALA and Jumper T93T-50-ALA. If this procedure is not followed, air will be trapped in the HCU which eventually leads to a spongy brake pedal.**

   To bleed the brake master cylinder and HCU, disconnect the 40-pin plug from the Electronic Control Unit and install the anti-lock brake adapter to the wire harness 40-pin plug.

   Anti-Lock Brake Adapter Controls

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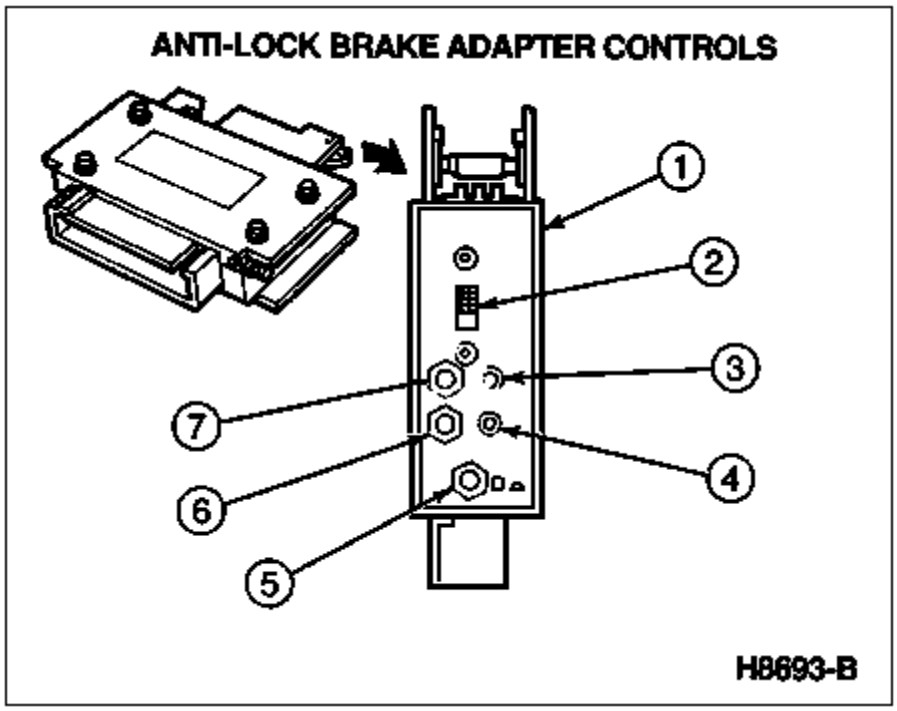

Item	Part Number	Description
1	T90P-50-ALA	Anti-Lock Brake Adapter
2	—	Bleed/Harness Selector (Part of T90P-50-ALA)
3	—	Green "Motor On" Lamp (Part of T90P-50-ALA)
4	—	Red "Motor Off" Lamp (Part of T90P-50-ALA)
5	—	Valve Button (Part of T90P-50-ALA)
6	—	Abort Button (Part of T90P-50-ALA)
7	—	Motor Start Button (Part of T90P-50-ALA)

a. Place the bleed/harness selector in bleed position.
b. Turn the ignition switch (11572) ON. At this point the red OFF indicator on the adapter should turn on.
c. Push the motor button on the adapter down. This starts the pump motor. The red OFF indicator turns off and the green ON indicator turns on. The pump motor will run for 60 seconds once the motor button is pushed (you do not need to hold the button down). If the pump motor is to be turned off for any reason before this 60 seconds has elapsed, push the abort button and the pump motor will turn off.
d. After the first 20 seconds have passed, push and hold the valve button for 20 seconds. This bleeds any trapped air from the brake master cylinder and HCU.
e. The pump continues to run for an additional 20 seconds after the valve button is released.

2. Bleed the brake lines in the following order.

- Right rear

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- Left rear
- Right front
- Left front

Manual Bleeding

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CAUTION: DO NOT allow the brake master cylinder reservoir to run dry during the bleeding operation. Keep the master cylinder reservoirs filled with the specified brake fluid. Never reuse the fluid that has been drained from the hydraulic system.

NOTE: Bleed the primary and secondary hydraulic brake systems separately.

1. On the brake master cylinder reservoir, loosen the master cylinder-to-hydraulic line fittings.
2. Wrap a shop cloth around the tubing below the fitting to absorb escaping brake fluid.
3. Push the brake pedal down slowly to the floor of the cab. This will force air trapped in the brake master cylinder to escape at the fitting.
4. Hold the brake pedal down and tighten the fitting. Release the brake pedal. Do not release the brake pedal until the fitting is tightened or air will re-enter the brake master cylinder reservoir.
5. Repeat this procedure until air ceases to escape at the fitting.
6. Place a box wrench on the bleeder screw on the rear anti-lock brake (RABS) system valve (if equipped). Attach a rubber drain tube to the bleeder fitting making sure the end of the tube fits snugly around the bleeder screw.
    a. Submerge the free end of the tube in a container partially filled with clean brake fluid. Loosen the bleeder screw approximately three-quarters of a turn.

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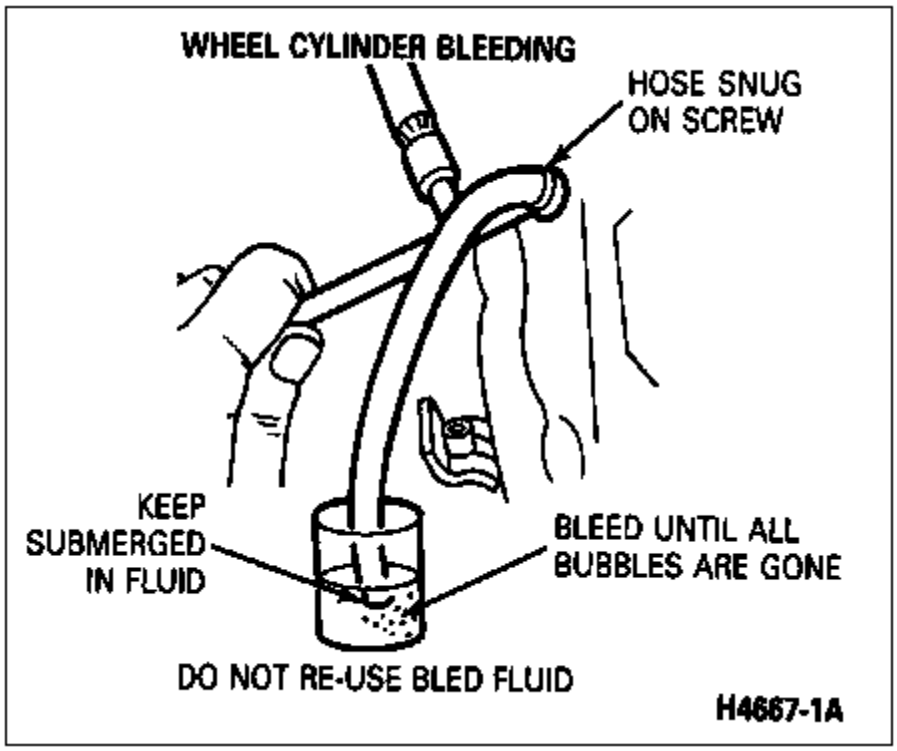

b. Slowly press the brake pedal all the way down. Close the bleeder screw, and return the brake pedal to the fully-released position. Repeat this operation until air bubbles no longer appear at the submerged end of the bleeder tube.
c. When the fluid being expelled is completely free of air bubbles, close the bleeder screw and remove the bleeder tube.

7. Place a box wrench on the RH rear bleeder screw. Attach a rubber drain tube to the bleeder screw making sure the end of the tube fits snugly around the bleeder screw.

8. Submerge the free end of the tube in a container partially filled with clean brake fluid. Loosen the bleeder screw approximately three-quarters of a turn.

9. Slowly push the brake pedal all the way down. Close the bleeder screw, and return the brake pedal to the fully released position. Repeat this operation until air bubbles no longer appear at the submerged end of the bleeder tube.

10. When the fluid being expelled is completely free of air bubbles, close the bleeder screw and remove the bleeder tube.

11. Repeat this procedure at the LH rear bleeder screw. Refill the brake master cylinder reservoir after each wheel location is bled.

12. Bleed the front brakes starting with the right front brake and then the left front brake as described in Steps 7-11 of this procedure.

13. When the bleeding operation is complete, fill the brake master cylinder reservoir to the maximum level line.

Pressure Bleeding

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WARNING: BRAKE FLUID CONTAINS POLYGLYCOL ETHERS AND POLYGLYCOLS. AVOID CONTACT WITH EYES. WASH HANDS THOROUGHLY AFTER HANDLING. IF BRAKE FLUID CONTACTS EYES, FLUSH WITH RUNNING WATER FOR 15 MINUTES, GET MEDICAL ATTENTION IF IRRITATION PERSISTS. IF TAKEN INTERNALLY, DRINK WATER AND INDUCE VOMITING. GET MEDICAL ATTENTION IMMEDIATELY.

CAUTION: Be sure the bleeder tank contains enough specified brake fluid High Performance DOT 3 Brake Fluid C6AZ-19542-AB or DOT 3 equivalent meeting Ford specification ESA-M6C25-A, DOT 3 to complete the bleeding operation. Charge the tank with approximately 69-206 kPa (10-30 psi) of air pressure. Never exceed 345 kPa (50 psi) of pressure. Never reuse brake fluid that has been drained from the hydraulic system.

NOTE: Bleed the longest line first.

1. Clean all dirt from the brake master cylinder filler cap.

2. **NOTE: Master cylinder pressure bleeder adapter tools are available from various manufacturers of pressure bleeding equipment. Follow the instructions of the manufacturer when installing the adapter.**

   Remove the brake master cylinder filler cap, and fill the brake master cylinder reservoir with the specified brake fluid. Install the pressure bleeder adapter tool, Rotunda Brake Bleeder 104-00064 or equivalent to the brake master cylinder, and attach the bleeder tank hose to the fitting on the adapter.

3. Place a 3/8-inch box wrench on the bleeder fitting on the right rear bleeder screw. Attach a bleeder tube snugly around the bleeder screw.

4. Open the valve on the bleeder tank to admit pressurized brake fluid to the brake master cylinder reservoir.

5. Submerge the free end of the tube on the bleeder screw in a partially filled container of clean brake fluid. Loosen the bleeder screw.

6. When air bubbles no longer appear in the fluid at the submerged end of the bleeder tube, close the bleeder screw and remove the tube. Repeat the bleed operation at the left rear, the right front, and the left front.

7. When the bleeding operation is completed, close the bleeder tank valve and remove the tank hose from the adapter fitting.

8. Remove the pressure bleeder adapter tool. Fill the brake master cylinder reservoir to the maximum level line. Install the brake master cylinder filler cap.

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Brake Master Cylinder

Check the brake tubes and brake master cylinder (2140) mounting. The brake tubes and brake tube nuts must be tight without any signs of leakage. Tighten the brake tube fittings at the brake master cylinder to 15-20 Nm (11-14 lb-ft).

The following conditions are considered normal and are not indications that the brake master cylinder is in need of service:

- Low brake fluid level detected without signs of leakage. This condition is caused by displacement of brake fluid from the brake master cylinder reservoir (2K478) into the disc brake calipers to compensate for normal brake wear. Add brake fluid as needed.
- A momentary or slight squirt of brake fluid from the brake master cylinder reservoir upon application of the brake pedal (2455). This condition is caused by brake fluid displacement through the brake master cylinder reservoir compensating port as the brake master cylinder pistons move forward in the bore when the brakes are applied.
- Slight turbulence in the brake master cylinder reservoir fluid when the brake pedal is released. Turbulence occurs as brake fluid returns to the brake master cylinder after releasing the brakes.
- A trace of brake fluid found on the outside of the power brake booster below the brake master cylinder mounting flange. This condition results from the lubricating action of the brake master cylinder wiping seal.

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Brake Lines and Hose

Inspect the brake tubes and hoses under the vehicle for damage and proper routing. Check the brake hoses routed to the disc brake calipers, and/or to the rear wheel cylinders (2261) for any signs of damage. The tube and hose fittings must be tight without signs of leakage.

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Brake Fluid Leakage

The wet appearance of the outer cover of rubber brake hoses is called "sweating." This is a normal condition for neoprene rayon braid hose. The "sweating" condition is not evidence of a brake fluid leak and will not result in a loss of pressure in the system.

Replace a flexible brake hose if it shows signs of softening, cracking or other damage.

When installing a new brake hose, position the hose to avoid contact with other vehicle parts.

If signs of leakage are not present but the brake fluid level is low, it is possible that evidence of brake fluid leakage may have been washed off by rain or snow because brake fluid is water soluble. To determine if a leak exists, proceed as follows:

a. Fill the system
b. Bleed the system
c. Apply the brakes several times
d. Examine the system to verify that the brake fluid level is actually dropping
e. Locate and correct any external leak

Internal and external leaks are two problems that can affect a hydraulic brake system. The hydraulic brake system will not cause the vehicle to do any of the following:

- Vibrate
- Pull
- Grab
- Squeal
- Allow the brake pedal (2455) to pulse

In most cases the hydraulic system will not cause the brakes to drag. The sources of these problems are found elsewhere in the brake system, but it is a good policy to first check the entire hydraulic system for leaks before continuing to diagnose any other brake problems.

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Brake Pedal Linkage

On dual-brake brake master cylinder (2140) with power brake booster (2005) equipped vehicles, the brake systems are designed to permit a full stroke of the brake master cylinder when the brake pedal (2455) is fully depressed. A brake pedal clearance adjustment is not required.

If pedal travel seems restricted, check for obstructions.

To release the brakes, fluid must flow back to the brake master cylinder through a return port when pedal pressure is released. To be sure the brake master cylinder piston moves back far enough to expose the return port, free play is built into the brake pedal linkage. This prevents the brake master cylinder piston from becoming trapped in a partially released position. If a problem is suspected, the brake pedal push rod and brake pedal should be checked to make sure they are not binding. Pedal free play is not always perceptible in dash-mounted booster systems, because the operating clearance for the brake master cylinder piston is adjusted at the booster push rod, rather than the pedal linkage.

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SPECIFICATIONS

GENERAL SPECIFICATIONS

Item	Specification
Fluids	
High Performance DOT 3 Brake Fluid C6AZ-19542-AB	ESA-M6C25-A DOT 3
Lubricants	
Motorcraft SAE 30XO-30-QSD or -DSD or -BSD	ESE-M2C153-E

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Brake and Clutch Pedal Bracket-to-Power Brake Booster Nut and Bolt	22-28	16-21	—
Brake Master Cylinder-to-Brake Tube Fittings	15-20	11-14	—
Caliper Bleeder Screws	17-24	13-17	—
Caliper Flow Bolt	29.7-40.3	22-29	—
Front Brake Hose Bolt	3.4-4.5	—	30-39
Front Brake Tube Fittings	15-20	11-14	—
Master Cylinder to Vacuum Booster Nut	18-33	14-24	—
Master Cylinder to Vacuum Booster Nuts, Aerostar	18-33	14-24	—
Vacuum Booster to Dash and Pedal Support Nut	18-33	14-24	—
Wheel Cylinder Bleeder Screws	7-9	—	62-79

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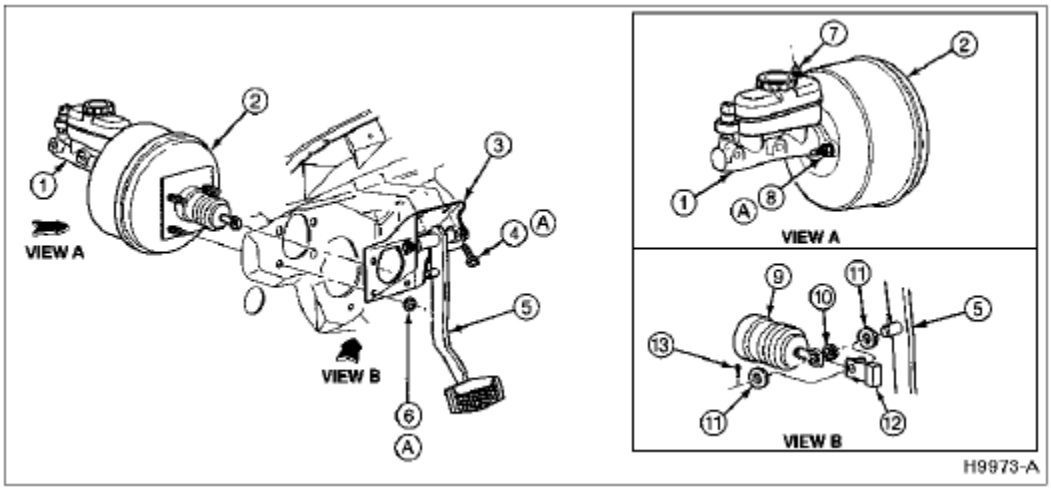
Brake Booster, Power

The only serviceable components of the power brake booster are the power brake booster check valve, the check valve grommet and the adjustable master cylinder push rod (Ranger only).

Power Brake Booster



Item	Part Number	Description
1	2140	Brake Master Cylinder
2	2005	Power Brake Booster
3	2L252	Brake Pedal Bracket
4	N804804-S102	Bolt, Brake Pedal Bracket-to-Dash Panel
5	2455	Brake Pedal
6	N620482-S2	Nut, Power Brake Booster-to-Brake Pedal Bracket
7	—	Vacuum Inlet Port (Part of 2005)
8	3828020-S	Nut, Brake Master Cylinder-to-Power Brake Booster
9	—	Boot (Part of 2005)
10	2474	Brake Master Cylinder Push Rod Bushing
11	2B129	Brake Master Cylinder Push Rod Spacer
12	13480	Stoplight Switch
13	38069-S100	Self-Locking Pin
A	—	Tighten to 22-28 Nm (16-21 Lb-Ft)

Removal

1. Disconnect the battery ground cable (14301).
2. To prevent strain on the brake lines, support the brake master cylinder with a wire or prop.
3. Remove the two brake master cylinder-to-power brake booster nuts.
4. Carefully pull the brake master cylinder off the power brake booster.
5. Using care not to strain the brake lines, position the brake master cylinder out of the way.
6. Disconnect the vacuum hose from the power brake booster vacuum inlet port.
7. Working under the instrument panel (04320), disconnect the electrical connector from the stoplight switch (13480).
8. Remove the self-locking clip from the brake pedal pin.
9. **NOTE: Before the next step, observe the position of the brake pedal push rod. The Aerostar brake pedal push rod has the large loop pointing down.**

   Remove the brake master cylinder push rod spacers (2B129), the brake pedal push rod, the stoplight switch and the brake master cylinder push rod bushing (2474) from the brake pedal pin.
10. Remove the four power brake booster-to-brake pedal bracket nuts.
11. At the engine compartment, pull the power brake booster off the dash panel (01610).

Installation

To install, reverse the removal procedure. Tighten all mounting nuts to 22-28 Nm (16-21 lb-ft). If necessary, adjust the brake master cylinder push rod. Refer to the Adjustments, Brake Booster to Master Cylinder Push Rod procedure in this section.

Brake Booster Check Valve

Removal and Installation

1. Remove the vacuum hose from the power brake booster check valve (2365).
2. Pull the power brake booster check valve from the power brake booster.
3. Remove the check valve grommet from the power brake booster.

To install, reverse the removal procedure.

A new check valve grommet must be installed whenever the power brake booster check valve is serviced.

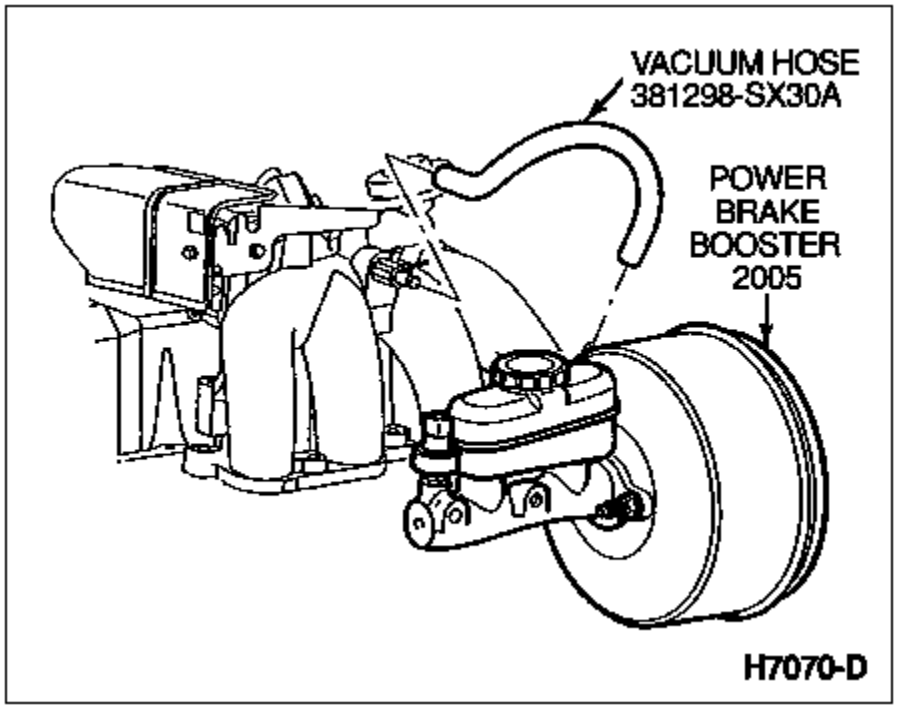
Brake Booster, Power

Wipe off the power brake booster and inspect for improper mounting or damage. After wiping, inspect for brake fluid leakage on the power brake booster that may have come from the brake master cylinder. Verify that all mounting nuts are securely tightened to the specified torque.

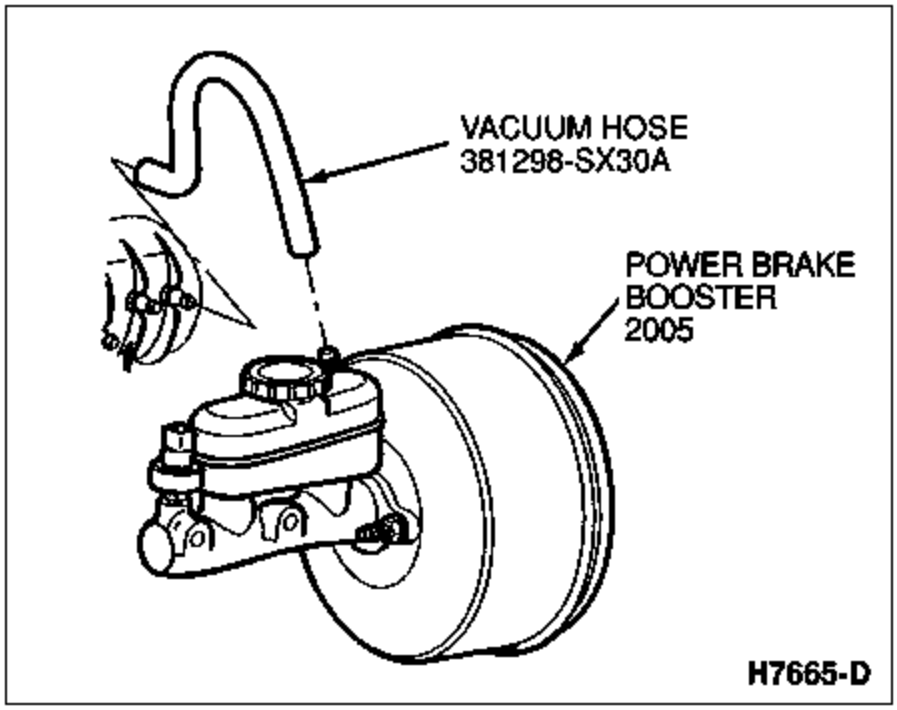
Vacuum Hose and Check Valve

Inspect the power brake booster vacuum hose for cracks, damage or collapse. Replace as necessary. Verify proper routing of the vacuum hose. Reroute as necessary. Remove the vacuum hose from the vacuum inlet port on the power brake booster and inspect the power brake booster check valve for damage and improper mounting. Apply vacuum and pressure to the power brake booster check valve and verify that air would flow only toward the engine. Check that all hose clamps are tightened securely.

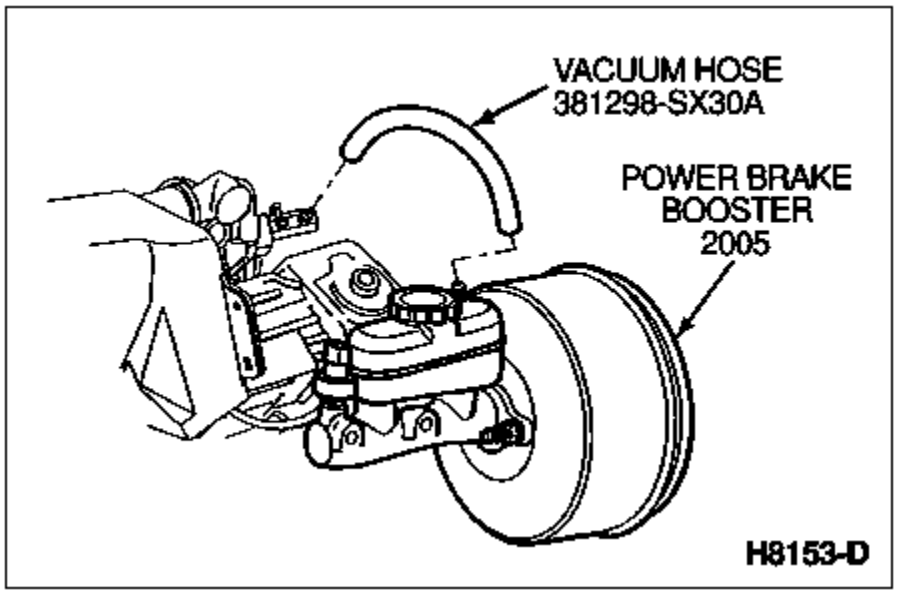
Vacuum Hose, 2.3L MFI Engine



Vacuum Hose, 4.0L MFI Engine



Vacuum Hose, 3.0L MFI Engine

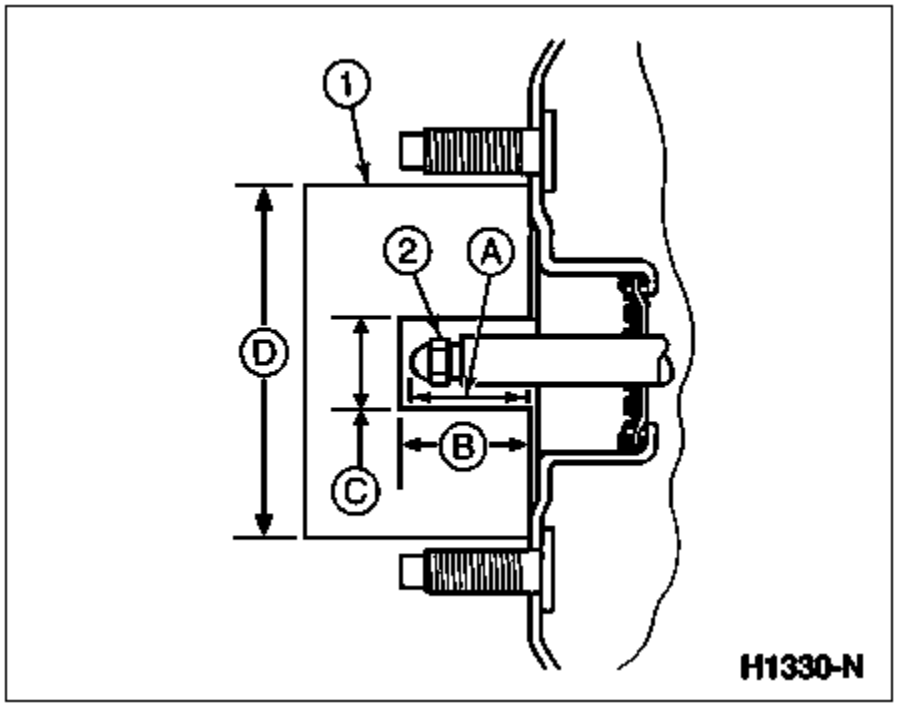


Brake Booster to Master Cylinder Push Rod, Ranger

NOTE: Brake master cylinder push rod adjustment on Aerostar vehicles should not be attempted due to lack of accessibility.

The master cylinder push rod has an adjustment screw to maintain the correct relationship between the master cylinder push rod and the brake master cylinder piston. If the master cylinder push rod is too long, it will prevent the brake master cylinder piston from completely releasing hydraulic pressure, causing the brakes to drag. If the master cylinder push rod is too short it will cause excessive brake pedal travel and an undesirable clunk in the power brake booster area. Remove the brake master cylinder for access to the master cylinder booster push rod.

To check the adjustment of the adjustment screw, fabricate a gauge using the dimensions shown in the following illustration, and place it against the brake master cylinder mounting surface of the power brake booster body as shown below. The engine (6007) must be running, with the vacuum hose connected to the power brake booster, while checking the adjustment. Adjust the push rod screw by turning the adjustment screw to meet the specifications shown.



Item	Part Number	Description
1	—	Gauge (Fabricate Locally)
2	—	Adjustment Screw (Part of 2005)
A	—	24.89mm (0.980 In.)

B	—	25.27mm (0.995 In.)
C	—	19.05mm (0.75 In.)
D	—	74.61mm (2.94 In.)

SPECIFICATIONS

BRAKE BOOSTER APPLICATION

Truck Series	Ranger 4x2 & 4x4 mm (In.)	Aerostar mm (In.)
Part Number	F57A-2B559-FL F57A-2B559-GC F57A-2B559-KB F57A-2B559-JB	F39A-2B559-BA
Type	Dual Diaphragm	Dual Diaphragm
Make	Bendix	Bendix
O/S Diameter	245 (9.64)	245 (9.64)
Effective Diameter	290 (11.42)	290 (11.42)

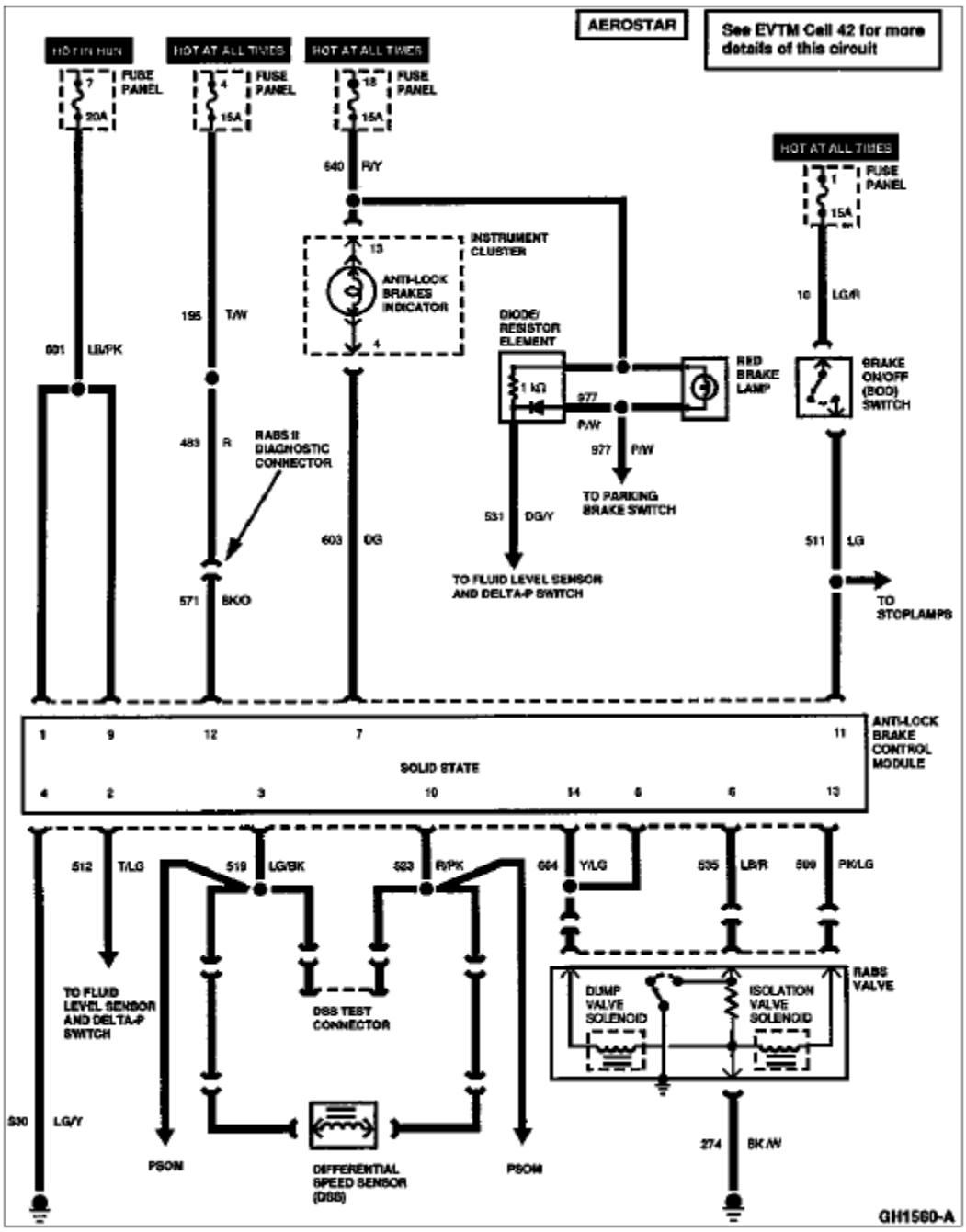
TORQUE SPECIFICATIONS

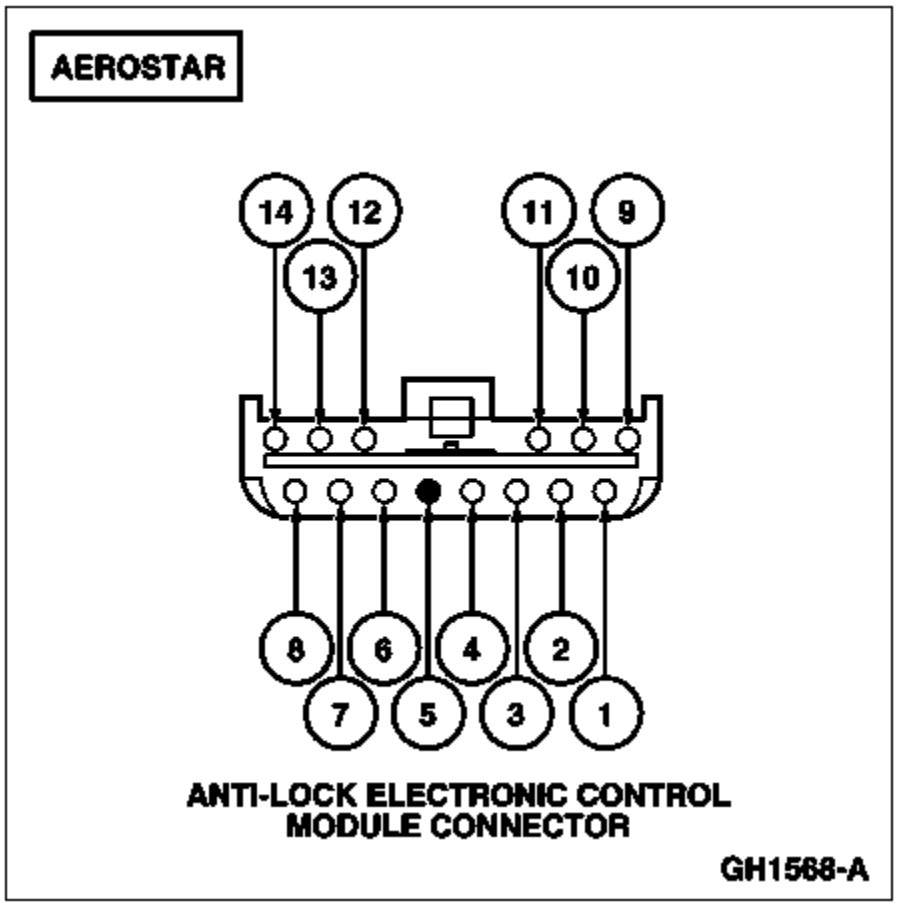
Description	Nm	Lb-Ft
Power Brake Booster-to-Dash Panel	22-28	16-21
Brake Master Cylinder-to-Power Brake Booster	22-28	16-21
Brake Pedal Bracket to Dash Panel, Aerostar	22-28	16-21

Electrical Schematics

CAUTION: Following the wrong sequence or bypassing steps will lead to unnecessary replacement of parts or incorrect resolution of the symptom.

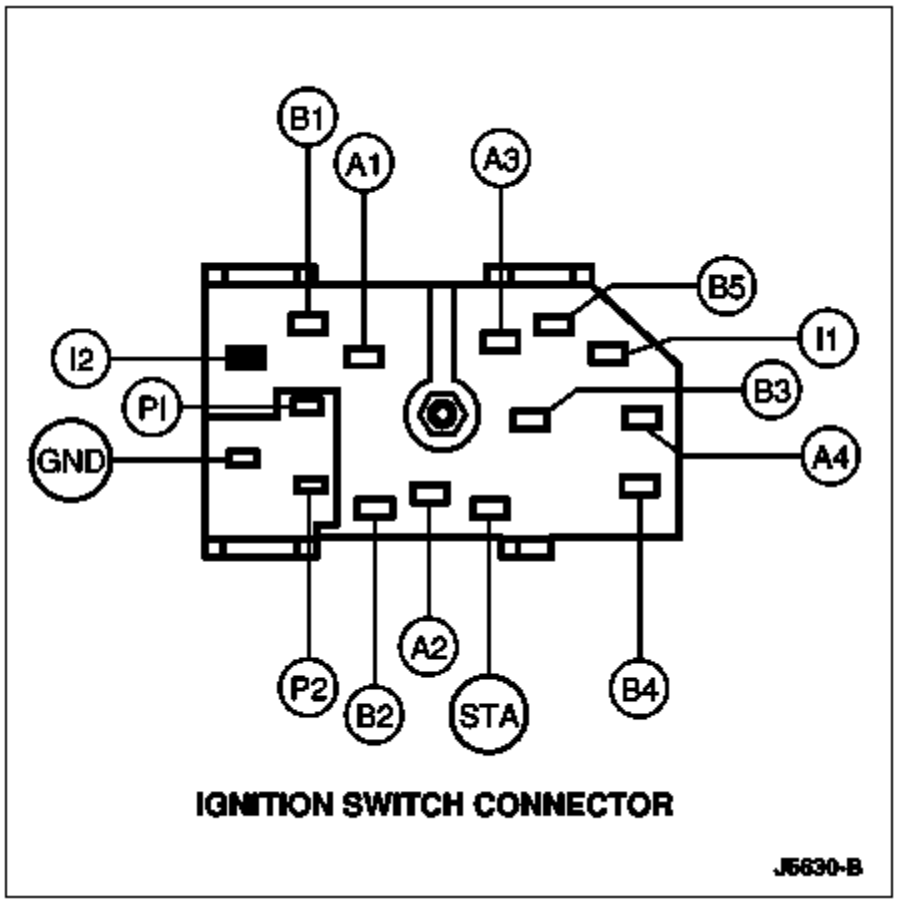
Rear Brake Anti-Lock Control, Aerostar


AEROSTAR
See EVTM Cell 42 for more details of this circuit
HOT IN RUN
HOT AT ALL TIMES
HOT AT ALL TIMES
FUSE PANEL
7
20A
4
15A
18
15A
640 R/Y
INSTRUMENT CLUSTER
13
ANTI-LOCK BRAKES INDICATOR
1
195 T/W
DIODE/ RESISTOR ELEMENT
1 kΩ
977
RED BRAKE LAMP
977 P/W
TO PARKING BRAKE SWITCH
531 DG/Y
TO FLUID LEVEL SENSOR AND DELTA-P SWITCH
HOT AT ALL TIMES
FUSE PANEL
1
15A
10 LG/R
BRAKE ON/OFF (BOO) SWITCH
511 LG
TO STOPLAMPS
601 LB/PK
483 R
RABS II DIAGNOSTIC CONNECTOR
571 BK/O
603 DG
ANTI-LOCK BRAKE CONTROL MODULE
SOLID STATE
1 9 12 7 11
4 2 3 10 14 6 5 13
512 T/LG
519 LG/BK
523 R/PK
664 Y/LG
535 LB/R
509 PK/LG
TO FLUID LEVEL SENSOR AND DELTA-P SWITCH
DSS TEST CONNECTOR
RABS VALVE
DUMP VALVE SOLENOID
ISOLATION VALVE SOLENOID
530 LG/Y
PSOM
DIFFERENTIAL SPEED SENSOR (DSS)
PSOM
274 BK/W
GH1560-A



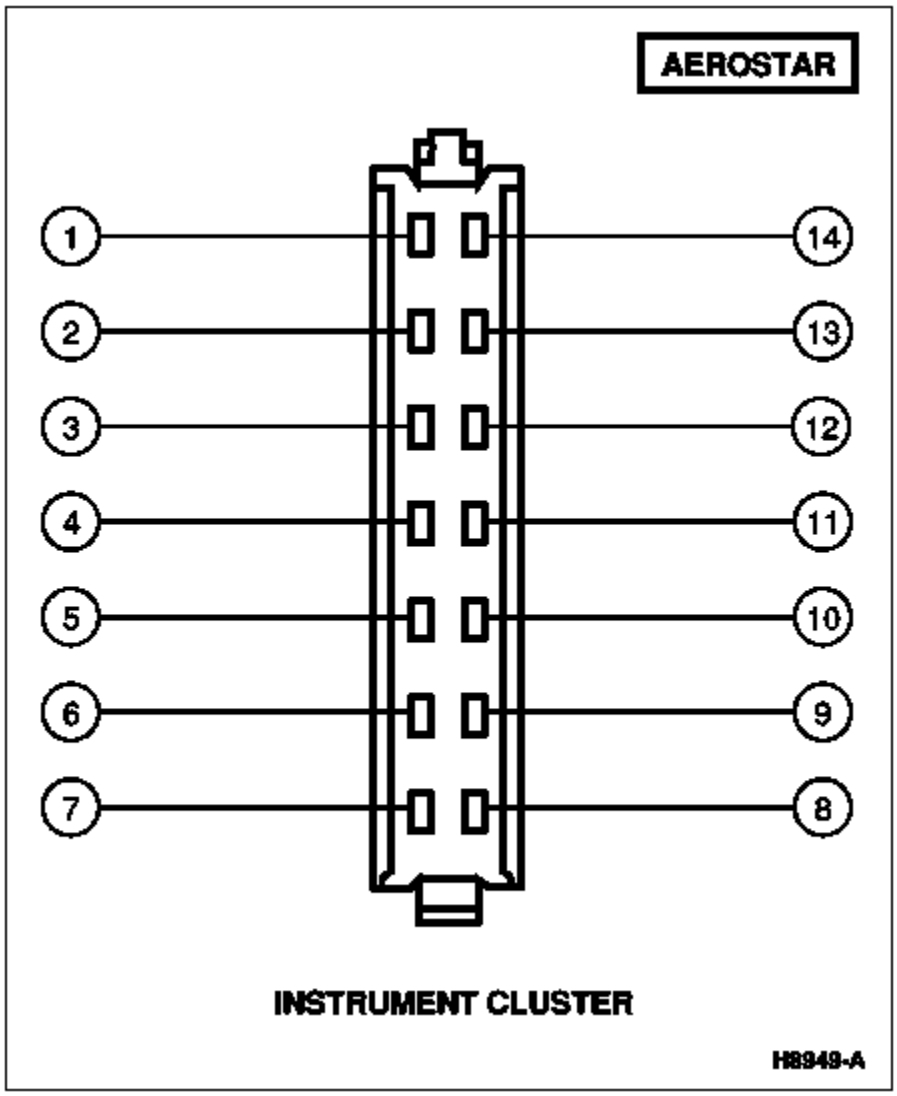
Pin Number	Circuit	Circuit Function
1	601 (LB/PK)	Anti-Lock Electronic Control Module Feed
2	512 (T/LG)	Fluid Level and Delta-P Switch
3	519 (LG/BK)	Rear Speed Sensor (Low) to Module
4	530 (LG/Y)	Dedicated Ground
5	—	Not Used
6	535 (LB/R)	Reset Switch to Module
7	603 (DG)	RABS Warning Light
8	664 (Y/LG)	Module to Dump Solenoid
9	601 (LB/PK)	Anti-Lock Electronic Control Module Feed
10	523 (R/PK)	Rear Speed Sensor (High) to Module
11	511 (LG)	Stoplamp Switch to Module
12	571 (BK/O)	KAM
13	599 (PK/LG)	Module to ISO Solenoid
14	664 (Y/LG)	Module to Dump Solenoid

Aerostar



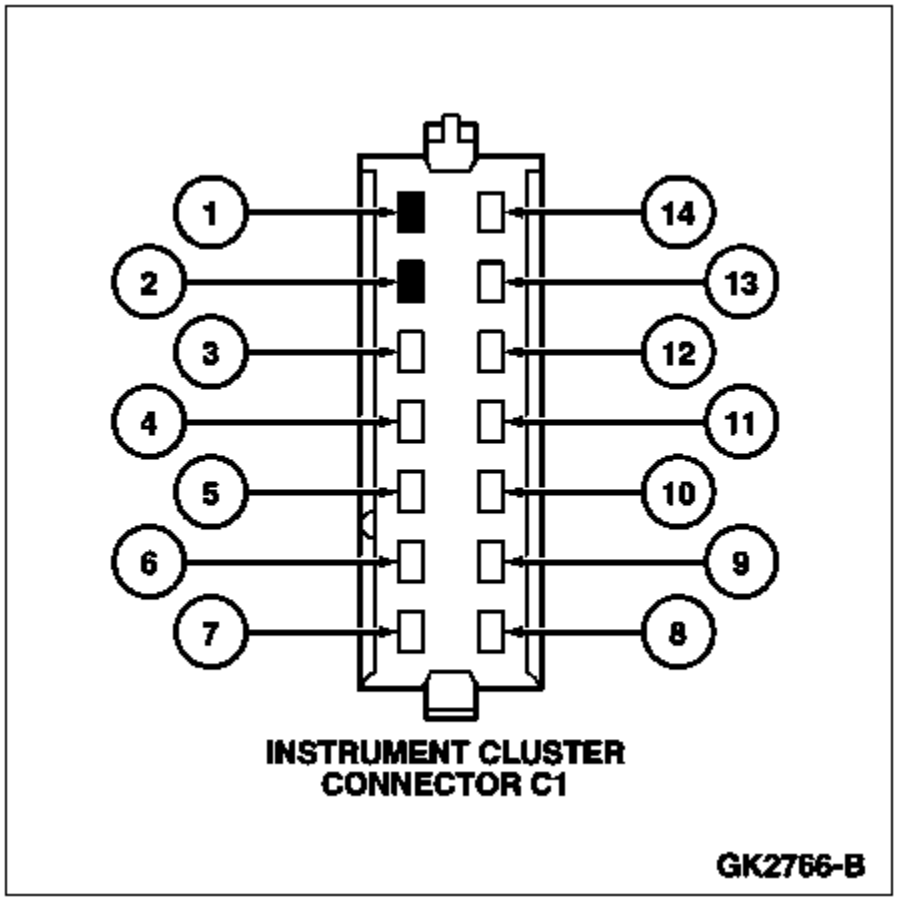
Pin Number	Circuit	Circuit Function
A1	297 (BK/LG)	Fused Run/Accessory Feed
A2	687 (GY/Y)	Accessory Feed
A3	687 (GY/Y)	Accessory Feed
A4	687 (GY/Y)	Accessory Feed
B1	37 (Y)	Battery to Load
B2	37 (Y)	Battery to Load
B3	37 (Y)	Battery to Load
B4	37 (Y)	Battery to Load
B5	37 (Y)	Battery to Load
I1	16 (R/LG)	Ignition Switch to Ignition Coil
I2	—	Not Used
P1	512 (T/LG)	Brake Indicator Prove Out
P2	41 (BK/LB)	Bulb Prove Out

STA	33 (W/PK)	Starter Control
GND	57 (BK)	Ground Circuit



Pin Number	Circuit	Circuit Function
1	—	Not Used
2	627 (BK/O)	Open Door Warning Lamp to Open Door Warning Switch
3	977 (P/W)	Dual Brake Warning Switch to Indicator Lamp
4	603 (DG)	Failure Warning Light
5	658 (PK/LG)	PCM to Check Engine Indicator Lamp
6	29 (Y/W)	Fuel Gauge to Fuel Gauge Sender
7	3 (LG/W)	Front Turn Signal Lamp (LH)

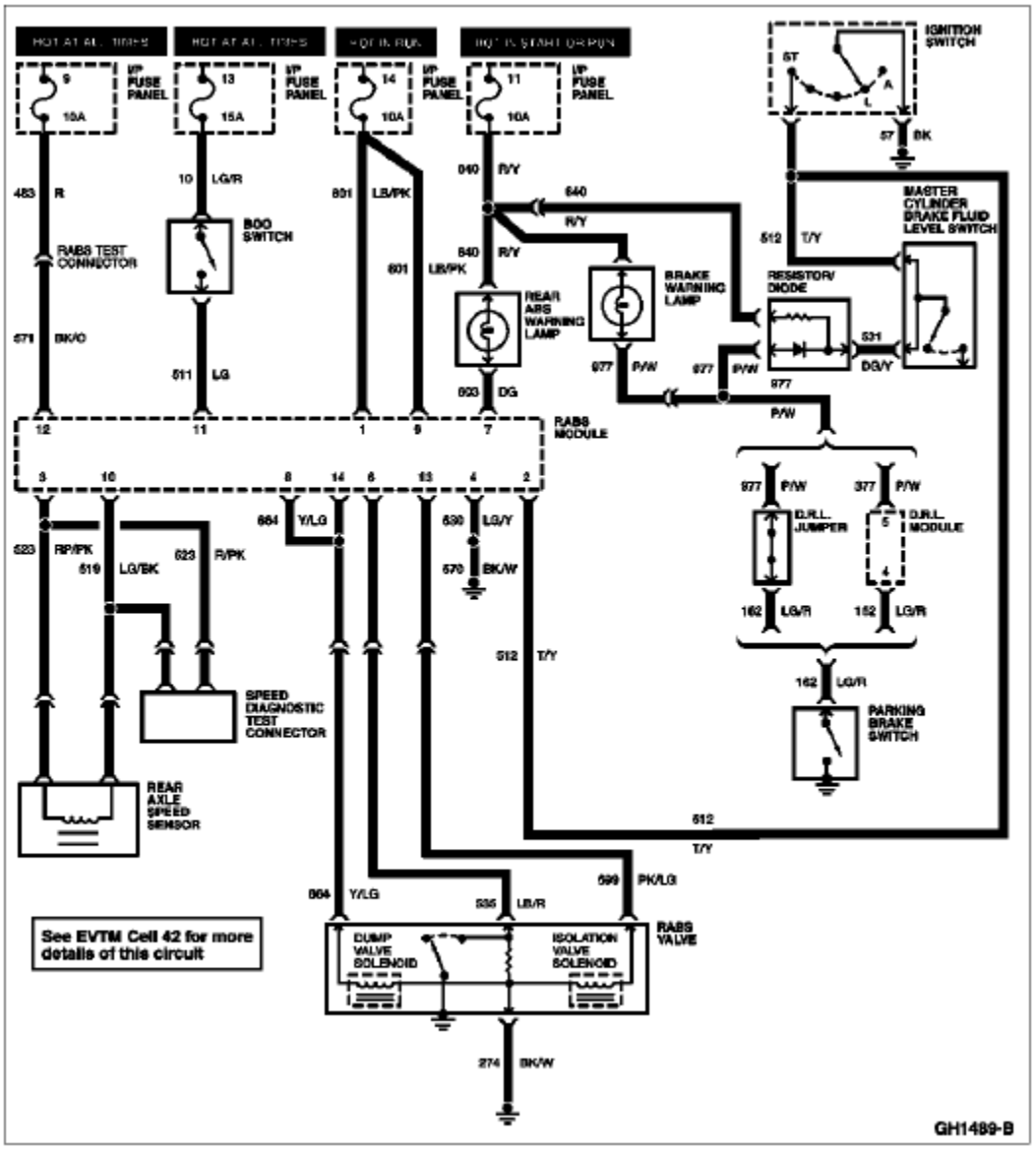
8	31 (W/R)	Oil Pressure Indicator to Oil Pressure Sending Unit
9	570 (BK/W)	Dedicated Ground — Closed Loop
10	39 (R/W)	Temperature Gauge to Temperature Sending Unit
11	904 (LG/R)	Ignition Switch "COIL"/"ACCY" to Generator Regulator "IGN" Terminal
12	16 (R/LG)	Ignition Switch to Ignition Coil "Battery" Terminal
13	640 (R/Y)	Warning Lamps Feed
14	—	Not Used



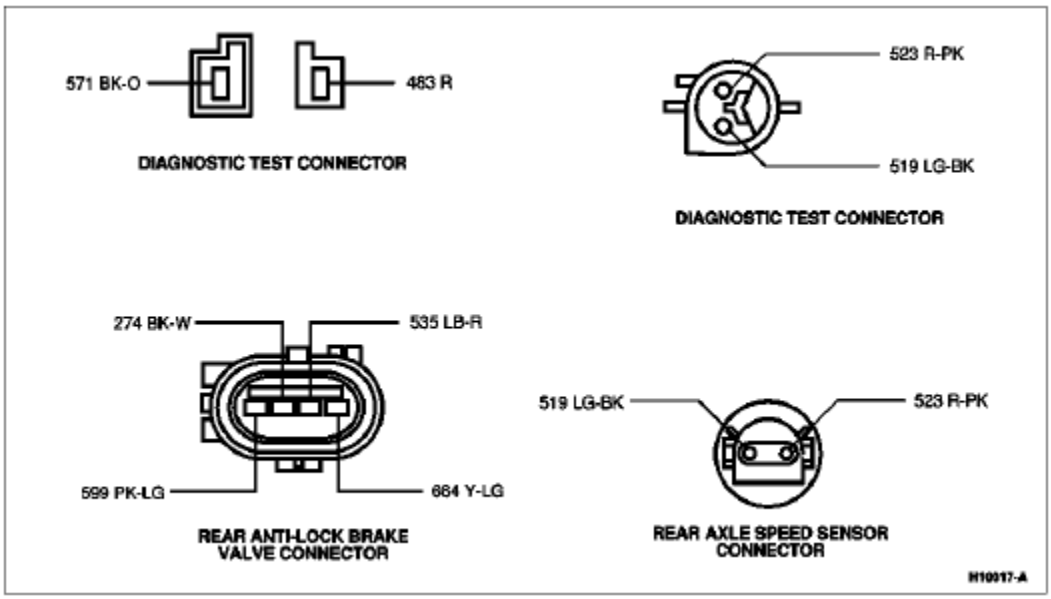
Pin Number	Circuit	Circuit Function
1	—	NOT USED
2	—	NOT USED
3	932 (GY/W)	Power to High Beam Indicator
4	450 (DG/LG)	Power to Fasten Belts Indicator
5	57 (BK)	Illumination High Beam and Fasten Belts to Ground
6	19 (LB/R)	Power to Illumination

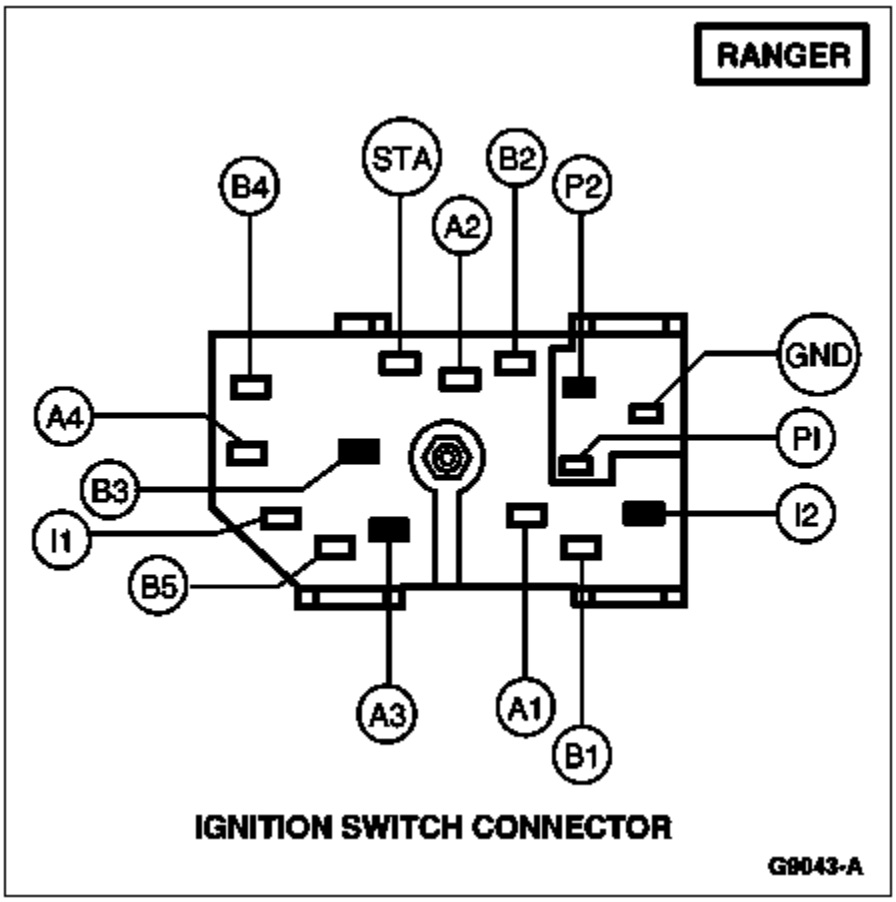
7	57 (BK)	Turn Indicators to Ground
8	2 (W/LB)	Power to Right Turn Indicator
9	57 (BK)	Ground
10	994 (W)	Power to Electronic 4WD Indicator
11	608 (BK/Y)	Air Bag to Air Bag Module
12	640 (R/Y)	Power to Gauges, Hot in Start or Run
13	570 (BK)	Fuel Gauge to Ground
14	397 (BK/W)	Voltmeter to Ground

Rear Brake Anti-Lock Control, Ranger

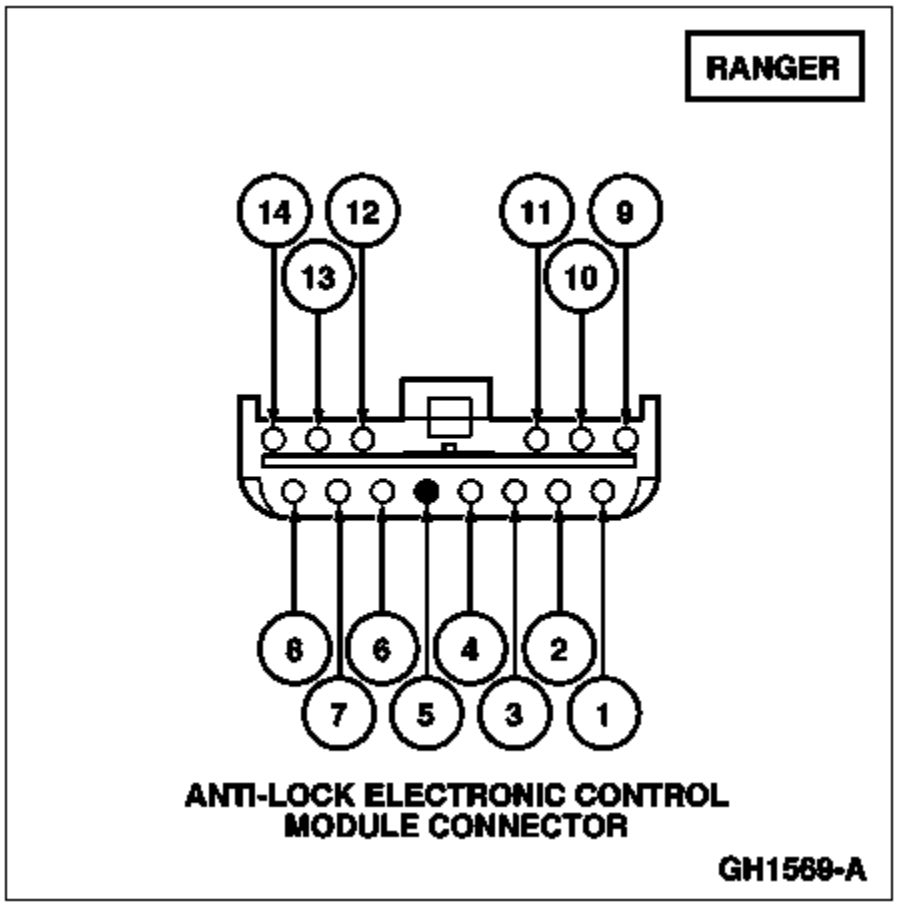


RABS System Connectors





Pin Number	Circuit	Circuit Function
A1	297 (BK/LG)	Fused Run/Accessory Feed
A2	687 (GY/Y)	Accessory Feed
A3	—	Not Used
A4	687 (GY/Y)	Accessory Feed
B1	37 (Y)	Battery to Load
B2	37 (Y)	Battery to Load
B3	—	Not Used
B4	37 (Y)	Battery to Load
B5	37 (Y)	Battery to Load
I1	1050 (LG/P)	Fused Ignition Switch Feed to Run/Run Start
I2	—	Not Used
P1	512 (T/LG)	Brake Fluid Reservoir Switch to Module
P2	—	Not Used
STA	33 (R/LB)	Starter Control
GND	57 (BK)	Ground Circuit



Pin Number	Circuit	Circuit Function
1	601 (LB/PK)	Anti-Lock Electronic Control Module Feed
2	512 (T/LG)	Brake Fluid Reservoir Switch to Module
3	519 (LG/BK)	Rear Speed Sensor (Low) to Module (LH)
4	530 (LG/Y)	ABS Controller to Chassis Ground
5	—	Not Used
6	535 (LB/R)	Pressure Switch to Module
7	603 (DG)	Failure Warning Light
8	664 (Y/LG)	Module to Release Solenoid
9	601 (LB/PK)	Anti-Lock Electronic Control Module Feed
10	523 (R/PK)	Rear Speed Sensor (High) to Module (RH)
11	511 (LG)	Stoplamp (Brake On/Off) Switch to Stoplamps
12	571 (BK/O)	ABS Module Diagnostic Ground
13	599 (PK/LG)	Module to Solenoid
14	664 (Y/LG)	Module to Release Solenoid

Symptom Chart

NOTE: Both the red BRAKE warning light diagnosis procedure and test drive are required prior to entering this section. Failure to perform these procedures will greatly diminish the effectiveness of this method of diagnosis.

There are times when a customer concern will not cause the REAR ABS warning light to illuminate or a code to be stored.

The symptom chart is intended to give the technician a starting point in resolving these types of concerns.

Symptom Description	Refer to
Unwarranted RABS activity	Symptom A
One or both rear wheels lock up	Symp tom B
Hard/soft brake pedal	Symptom C
Lack of decel. (med./hard braking)	Symptom D

WARNING: PERFORM INDICATED PINPOINT TEST OR DRIVE TEST STEPS ONLY. DO NOT PERFORM OTHER STEPS, ALTHOUGH WITHIN THE TEST BOX YOU MAY APPEAR TO BE DIRECTED TO DO SO. ALWAYS RETURN TO THE SYMPTOM CONDITION CHART IF NO RESOLUTION IS REACHED BY PERFORMING A PARTICULAR TEST.

SYMPTOM A: UNWARRANTED RABS ACTIVITY

Condition	Possible Source	Action
• Premature Loss of Rear Axle Speed Sensor Signal During Decel	• Metal chips on speed sensor pole piece.	• REFER to Pinpoint Test Step **6.6** .
	• Gap between speed sensor and speed sensor ring is greater than 1.14mm (0.045 inches).	• REFER to Drive Test Code 6, Step DT6.3 -DT6.5.
	• Missing or damaged speed sensor ring teeth.	• REFER to Drive Test Code 6, Step DT6.6 .
	• Speed sensor/speed sensor ring interference (gap is less than 0.127mm (0.005 inches).	• REFER to Drive Test Code 6, Step DT6.6 only.
• Intermittent Speed Sensor Signal to Anti-Lock Electronic Control Module During Decel	• Intermittent open or shorted speed sensor circuit.	• PERFORM intermittent diagnosis for Circuits 519 (LG/BK) and 523 (R/PK) between anti-lock electronic control module and speed sensor.

	• Intermittent open speed sensor circuit at intermediate connections especially bulkhead. • Chafed wire insulation or pinched wire due to improper routing causing intermittent short. • Underhood speed sensor test connector shorted.	• PERFORM intermittent diagnosis for Circuit 519 (LG/BK) and 523 (R/PK) at intermediate connectors. • INSPECT wiring harness from rear axle housing to frame side rail for chafing or rub marks. • INSPECT underhood speed sensor test connector for presence of cap, corrosion, and excessive dirt in the terminal cavities.
• Misadjusted rear brake shoes and linings or "Grabby" Brake Shoe Linings	• Rear brake adjustment too tight. • Linings are "grabby."	• REFER to Section 06-00 . • REFER to Section 06-00 .

SYMPTOM B: ONE OR BOTH REAR WHEELS LOCK UP

Condition	Possible Source	Action
• RABS Valve Failure	• Damaged RABS valve reset switch. • Leaky dump valve. • Hydraulically inoperative RABS valve.	• REFER to Drive Test Code 4, Steps DT4.2 and DT4.4 . • REFER to Drive Test Code 4, Step DT4.3 . • REFER to Drive Test Code 4, Step DT4.5 .
• RABS Speed Sensor Output Low or Lost at Lower Vehicle Speeds	• Speed sensor air gap too large. • Speed sensor/speed sensor ring assembly does not produce sufficient output.	• REFER to Drive Test Code 6, Step DT6.3 . • REFER to Drive Test Code 6, Step DT6.2 . PERFORM intermittent diagnosis for Circuit 519 (LG/BK) and 523 (R/PK) between anti-lock electronic control module and speed sensor. PERFORM intermittent diagnosis for Circuit 519 (LG/BK) and 523 (R/PK) at intermediate connectors.
• Base Brake Mechanical	• Brake related concern: Damp or contaminated rear	• REFER to Section 06-00 .

Concern	brake shoe linings.Stuck/leaking rear wheel cylinder.Overadjusted rear brake shoes and linings. • Hung-up parking brake. • Leaking rear axle seal.	• REFER to Section 06-05 . • REFER to the appropriate section in Group 05.
• 4x4 System Mechanical Electrical Concern (Aerostar Only)	• Hubs engaged although shift lever is in 4x2 position. • Faulty 4x4 indicator switch or short to 12V in 4x4 circuit 210 (LB).	• REFER to Section 07-07D . • REFER to Pinpoint Test Steps **5.3** and **5.5** .
• Vehicle Electrical Concern	• Stoplight input to anti-lock electronic control module not present. • Stoplights inoperative.	• REFER to Pinpoint Test Steps **11.1** -11.4. • REFER to Section 17-01 .

SYMPTOM C: HARD/SOFT BRAKE PEDAL

Condition	Possible Source	Action
• RABS Valve Inoperative (Hard/Soft)	• Stuck shut isolation valve (hard). • Leaky dump valve (soft). • Leaky isolation valve during RABS stop (soft).	• REFER to Drive Test Code 4, Step DT4.5 only. • REFER to Drive Test Code 4, Step DT4.3 only. • REFER to Drive Test Code 5, Step DT5.4 only.
• Vehicle Electrical Concern	• Stoplight switch always on while driving.	• REFER to Pinpoint Test Steps **11.1** -11.4.
• Base Brake Hydraulic Concern (Soft)	• Hydraulic leak in brake line tubing or rear brake hose, fitting, brake master cylinder, rear wheel cylinder, or disc brake caliper. • Air in brake system.	• REFER to Section 06-00 . • REFER to Section 06-00 .
• Base Brake Mechanical Concern (Hard)	• Brake related concern:Little or no vacuum boost.Stuck or inoperative rear wheel cylinder or disc brake caliper.Pinched or crimped brake tubing or rear brake hose.	• REFER to Section 06-00 .

SYMPTOM D: LACK OF DECELERATION DURING MEDIUM/HARD BRAKE APPLICATIONS

Condition	Possible Source	Action
• RABS Valve Inoperative	• Leaky dump valve.	• REFER to Drive Test Code 4, Step DT4.3 .
	• Stuck shut isolation valve.	• REFER to Drive Test Code 4, Step DT4.5 ONLY.
• RABS Speed Sensor Input to Anti-Lock Electronic Control Module Intermittent or Improper	• Short/open in frame or instrument panel harness (Circuits 519 and/or 523)At anti-lock electronic control module connector (Pins 3 and 10)At RABS speed sensor connectorAt bulkhead or other interconnectionPinched wire or worn insulation due to improper routingTest connector (in engine compartment)	• REFER to Pinpoint Test Steps 6.1-6.5 .
	• Metal chips on speed sensor.	• REFER to Pinpoint Test Step 6.6 .
	• Borderline speed sensor to speed sensor ring air gap, excessive speed sensor ring radial runout, damaged or missing speed sensor ring teeth.	• REFER to Drive Test Code 6, Steps DT6.3 - DT6.5 only.
• Base Brake Hydraulic Concern	• Hydraulic leak in rear brake hose or brake tubing, fitting, brake master cylinder, rear wheel cylinder, or disc brake caliper.	• REFER to Section 06-00 .
	• Air in brake system.	• REFER to Section 06-00 .
• Base Brake Mechanical Concern	• Brake related concern:Little or no vacuum boost.Stuck or inoperative brake tubing or rear brake hose.Pinched or crimped brake tubing or rear brake hose.Ineffective brake shoe or pad linings.	• REFER to Section 06-00 .

Inspection and Verification

System Pre-Check

NOTE: It is important that this procedure be performed first. Failure to do so may result in incorrect diagnosis of problem, wasted time, and improper replacement of good components.

The System Pre-Check is used to screen a vehicle for relatively simple diagnostic repairs, such as loose connectors, blown fuses, etc. However, the System Pre-Check is also used to prepare the vehicle for further diagnostics. In addition, warning light concerns are dealt with in this check.

NOTE: This repair procedure is written for REAR ABS II (RABS II) systems (as opposed to REAR ABS I [RABS I] systems). RABS II systems are standard for 1992 and later Aerostar, as well as 1993 and later Rangers. In the event that you are not sure if you have a RABS I or a RABS II system in your vehicle, check the module part number. Anti-lock electronic control module part numbers for RABS II will begin with either: F29F-2C018- or F37F-2C018-. All other part numbers should be considered to be a RABS I. Refer to the repair manual for that model year vehicle.

The anti-lock electronic control module (2C018) uses both the red BRAKE and yellow REAR ABS instrument panel warning lights to alert the driver to a system malfunction. Both lights must be working properly to assist in concern diagnosis. The steps listed below must be followed prior to beginning the RABS II diagnostic procedure.

Warning Lamp Indicators

The red BRAKE warning light is constantly monitored by the anti-lock electronic control module. If the red light illuminates, the anti-lock electronic control module will disable the RABS II system. For this reason, diagnosing and resolving any base brake concerns illuminating the red BRAKE warning light will, in most cases, resolve a perceived RABS II concern.

Pinpoint Tests

Assuming the red BRAKE warning light diagnosis has been performed and passed, and the REAR ABS warning light is illuminated, the code retrieved is used to designate the appropriate pinpoint test. The pinpoint tests are relatively simple and will be effective in most situations. If resolution is not reached by the end of the pinpoint test, additional, more in-depth procedures are provided in the drive tests.

Drive Tests

The drive tests will aid in diagnosing more complex concerns, and in general, are more time consuming to perform than the pinpoint tests.

NOTE: Do not proceed to any pinpoint test unless directed to do so.

At times, running completely through both pinpoint and drive tests will not lead to concern resolution. Often, the concern is due to an intermittent connection, termination, or a damaged circuit. An attempt has been made to point out obvious sources for potential intermittents within the pinpoint tests. However, it should be noted that several circuits pass through one or more connections between components. These are also areas of potential concern and should be considered. Refer to the Intermittent Diagnosis procedure.

Vehicle Setup

For 4-wheel drive vehicles, shift into 2-wheel drive. Drive the vehicle to a level area, and place the shift lever in PARK for automatic transmissions and NEUTRAL for manual transmissions. Turn the ignition off, set the parking brake and turn on the running lamps. Place blocks behind the wheels.

WARNING: PLACE BLOCKS BEHIND THE REAR WHEELS AND IN FRONT OF THE FRONT WHEELS TO PREVENT THE VEHICLE FROM MOVING WHILE THE SYSTEM PRE-CHECK IS BEING DONE.

Release the parking brake and continue to Brake Light Self-Check.

Brake Light Self-Check

The red BRAKE warning light is used to indicate a low brake fluid level condition or parking brake applied condition. To check this light, insert the key in the ignition lock cylinder and turn it to the START position. The BRAKE warning light should glow in this position. If it fails to glow, service the electrical system as required. Go to System Pre-Check Test B , Red Brake Light OFF and Does Not Self-Check.

Allow the key to spring back from the START position to the RUN position. At this time the red BRAKE warning light should turn off. If it does not turn off, recheck the parking brake switch to make sure that it is fully disengaged. If the red BRAKE warning light is still on, service the base brake system. In the event that the red brake warning light remains on, go to System Pre-Check Test E , Red Brake Light ON.

Rear Anti-Lock Bulb Diagnostics

The yellow REAR ABS warning light is used to indicate a malfunction and a deactivation of the RABS II system. To check this light, first follow the procedure above for Brake Light Self-Check, and allow the key to spring back from START position to the RUN position. The REAR ABS light should perform a self-check by glowing for approximately two seconds and then turn off. If it fails to glow, service the RABS lamp electrical system . Go to System Pre-Check Test A , Yellow REAR ABS Light OFF and Does Not Self-Check. If it turns back on and does not flash, then a system concern has been detected. Refer to procedures for obtaining diagnostic trouble code.

On-Board Diagnostics

If the yellow REAR ABS warning light begins to flash, this indicates that the keep-alive memory (KAM) power to the anti-lock electronic control module has been disrupted. If this condition occurs, service the RABS II KAM power system as required. Go to System Pre-Check Test C , Yellow REAR ABS Light Self-Check OK, but Light Automatically Begins Flashing.

Diagnostic Trouble Codes (DTC), Retrieving

NOTE: Verify the ignition switch (11572) is in the RUN position (engine does not need to be running). Next, locate the black RABS II diagnostic connector. The diagnostic connector has two mating halves (one of which has a black/orange wire connected to it). Disconnect the two halves.

1. Attach one end of a jumper wire to the black with orange stripe wire side of the diagnostic connector.
2. Momentarily ground the opposite end of the jumper wire by connecting it to a good chassis ground for 1-2 seconds.

Grounding this wire should start the REAR ABS lamp flashing. If grounding this wire does not start the REAR ABS lamp flashing, go to System Pre-Check Test D , Yellow REAR ABS Light Self-Check OK, but No Diagnostic Trouble Code When Diagnostics started.

CAUTION: Care must be taken to connect only the black/orange stripe wire to ground. Connecting the mating connector wire to ground will result in a blown fuse.

The code consists of a number of short flashes and ends with a long flash. Count the short flashes and include the following long flash in the count to obtain the code number. For example, three short flashes followed by one long flash indicates diagnostic trouble Code 4. The code will continue to repeat itself until the key is turned off. It is recommended that the code be verified by reading it several times. This code will be used later for system repair instructions, it should be written down for future use. A diagnostic trouble code of 16 will be obtained when the module detects normal system operation.

Diagnostic Trouble Codes (DTC), Erasing

The last step of the System Pre-Check always includes clearing the keep-alive memory (KAM). To do this, simply turn off the ignition while the diagnostic connector halves are separated as described in the procedures for obtaining the diagnostic trouble code above, after which the diagnostic connector should be reassembled to provide KAM power to the anti-lock electronic control module. If at this time a valid code has been obtained, go to the appropriate pinpoint test for that code.

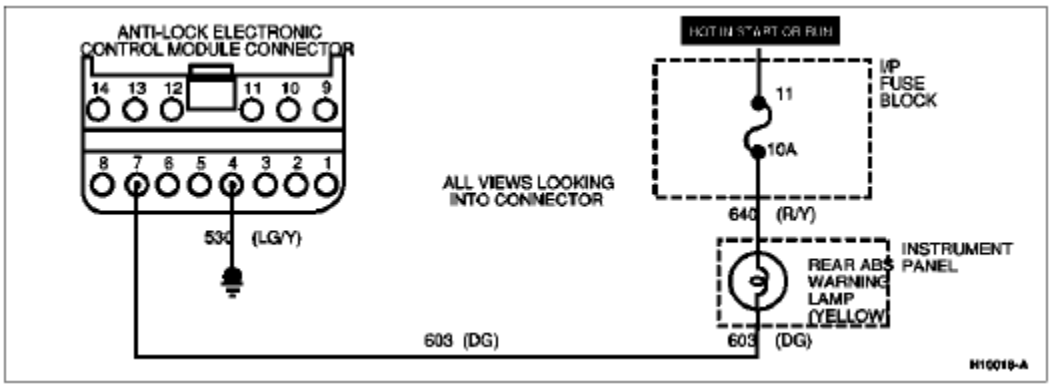
Pinpoint Tests, System Pre-Check

CONDITIONS AND ACTIONS

CONDITION	ACTION TO TAKE
Yellow REAR ABS light OFF and does not self-check.	See System Pre-Check Test A.
Red brake light OFF and does not self-check.	See System Pre-Check Test B.
Yellow REAR ABS light self-check OK, but light automatically begins flashing.	See System Pre-Check Test C.
Yellow REAR ABS light self-check OK, but no diagnostic trouble code when diagnostics started.	See System Pre-Check Test D.
Red brake light ON when key in RUN position.	See System Pre-Check Test E.

SYSTEM PRE-CHECK TEST A: YELLOW REAR ABS LIGHT OFF AND DOES NOT SELF-CHECK

Affected Circuits(s)/Electrical Component(s)



Description

The anti-lock electronic control module (2C018) will turn on the REAR ABS light for 1-2 seconds after the key has been turned from the OFF to the RUN position. If REAR ABS light prove out fails to occur, it may be caused by a burned-out bulb or an open fuse to Circuit 640 (R/Y). An open in Circuit 603 (DG) will also keep the light prove out from occurring.

Possible Contributing Base Brake Component/Vehicle Wiring Concerns

- Open fuse Circuit 640 (R/Y)
- Missing power to warning lamp (open Circuit 640 [R/Y])
- Open Circuit 603 (DG)
- Burned out REAR ABS warning lamp bulb
- Terminal backout in the module harness connector at Pin 7
- Module connector not fully mated with anti-lock electronic control module
- Defective anti-lock electronic control module
- Open REAR ABS ground (Circuit 530 [LG/Y])

NOTE: Use Rotunda 73 digital Multimeter 105-R0051 or equivalent for electrical tests.

A1 REAR ABS LIGHT FUSE

- Remove and inspect REAR ABS light fuse.

Is the fuse blown?

Yes	No
CHECK for short to ground between fuse panel and warning lights. REPAIR short and REPLACE fuse. REPEAT System Pre-Check.	REINSTALL fuse and GO to **A2** .

A2 MODULE HARNESS CONNECTOR

- Check to make sure module harness is fully plugged into anti-lock electronic control module.

Are connections secure?

Yes	No
GO to **A3** .	CONNECT harness to anti-lock electronic control module. REPEAT System Pre-Check.

A3 ANTI-LOCK ELECTRONIC CONTROL MODULE GROUND

NOTE: When checking resistance in the anti-lock system, always disconnect the battery to starter relay cable. Improper resistance may occur with the vehicle battery connected.

- Check for good anti-lock electronic control module ground:
  - Disconnect battery to starter relay cable.
  - Remove harness connector from anti-lock electronic control module.
  - Set multimeter on the 200-ohm scale.
  - Check for resistance between harness connector Pin 4 and chassis ground.

Is resistance less than 1.0 ohm?

Yes	No
RECONNECT battery ground cable. GO to **A4** .	CHECK for open in anti-lock electronic control module ground wire. CHECK for loose, dirty or broken connector pins. REPAIR as necessary. REPEAT System Pre-Check.

A4 REAR ABS LIGHT POWER

- Check for voltage to REAR ABS light:
  - Remove harness connector from anti-lock electronic control module.
  - Set multimeter on 20 VDC scale position.
  - Turn ignition to the ON position.
  - Check voltage between harness connector Pin 7 and a known good chassis ground.

Are 9 volts present?

Yes	No
REPLACE anti-lock electronic control module. REPEAT System Pre-Check.	GO to **A5** .

A5 POWER TO REAR ABS LIGHT FUSE

- Check for voltage to fuse.
  - Set multimeter to 20 VDC scale.
  - Turn ignition to the ON position.
  - Check voltage between panel fuse connector and known good chassis ground.

Are 9 volts present?

Yes	No
GO to **A6** .	REPAIR fuse panel or vehicle electrical system. REPEAT System Pre-Check.

A6 RABS LIGHT BULB

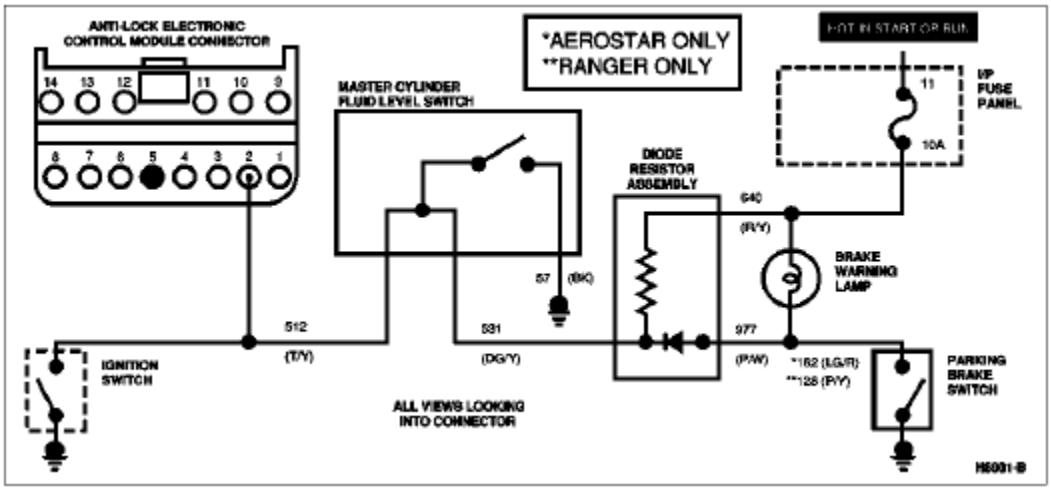
- Check REAR ABS light bulb.

Is the bulb OK?

Yes	No
REPAIR open between RABS light fuse and Pin 7 of the anti-lock electronic control module wiring harness connector. REPEAT System Pre-Check.	REPLACE bulb. REPEAT System Pre-Check.

SYSTEM PRE-CHECK TEST B: RED BRAKE LIGHT OFF AND DOES NOT SELF-CHECK

Affected Circuit(s)/Electrical Component(s)



Description

If the red BRAKE light does not turn on when the key is in the START position, service the warning bulb system as required. The most likely cause of non-functioning red BRAKE light(s) is a burned-out bulb or an open fuse.

Possible Contributing Base Brake Component/Vehicle Wiring Concerns

- Open brake warning light bulb (RED)
- Open power fuse
- Open Circuits 640 (R/Y), 977 (P/W), 512 (T/LG), 531 (DG/Y), 162 (LG/R) (Aerostar), 128 (P/Y) (Ranger)
- Open resistor/diode circuit
- Unseated master cylinder fluid level switch connector
- Defective ignition bulb prove out switch.

NOTE: Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent for electrical tests.

B1 RED BRAKE WARNING LIGHT/FUSE

- Turn ignition to RUN position.
- Apply parking brake.

- Observe red BRAKE warning light.

Does the BRAKE warning light function?

Yes	No
RELEASE parking brake GO to **B2** .	REPAIR brake warning circuit. CHECK for open fuse. CHECK for burned-out bulb or open Circuits 640 (R/Y), 162 (LG/R). REPEAT System Pre-Check.

B2 CHECK FOR CORRODED FLUID LEVEL CONNECTOR PINS

- Remove fluid level switch connector located on brake master cylinder.
- Inspect both halves of fluid level switch connector for corrosion or connector pin back-out.

Are the connections clean and secure?

Yes	No
GO to **B3** .	REPAIR/REPLACE connector as needed. REPEAT System Pre-Check.

B3 CHECK FOR UNSEATED CONNECTOR

- Key OFF.
- Firmly reconnect fluid level switch connector located on brake master cylinder.
- Turn key to START position.
- Observe red BRAKE light.

Does the BRAKE light function?

Yes	No
Condition is resolved. REPEAT System Pre-Check.	GO to **B4** .

B4 DIODE RESISTOR ELEMENT/CIRCUIT 531

- Disconnect fluid level switch.
- Connect jumper wire from Circuit 531 (DG/Y) to known chassis ground.
- Observe red BRAKE light.

Does the BRAKE light function?

Yes	No
LEAVE fluid level switch disconnected. GO to **B5** .	REPAIR open Circuits 977 (P/W), 531 (DG/Y) or open diode/resistor element. REPEAT System Pre-Check.

B5 MASTER CYLINDER FLUID LEVEL SWITCH

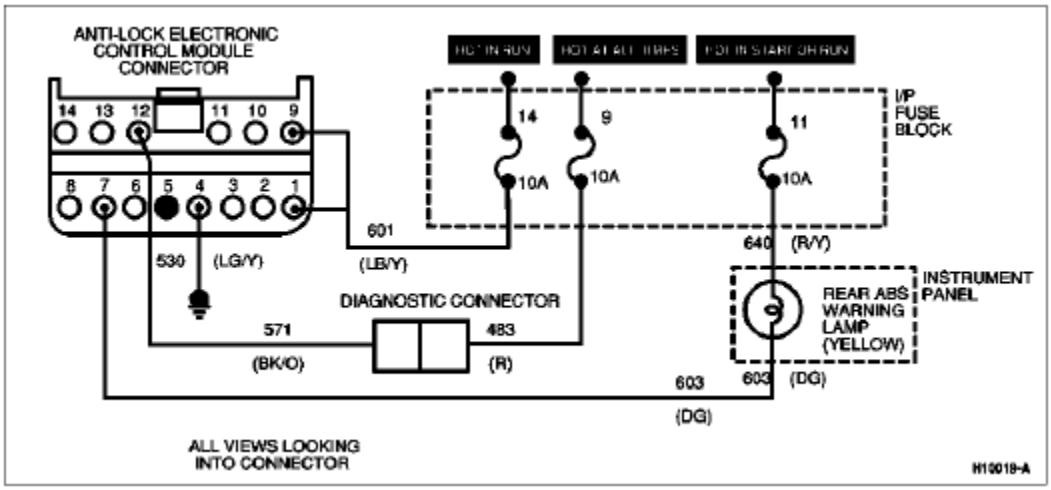
- Connect jumper wire from Circuit 531 (DG/Y) to Circuit 512 (T/LG).
- Turn key to START position.
- Observe red BRAKE light.

Does the BRAKE light function?

Yes	No
Master cylinder fluid level switch is defective. REFER to Section 06-06 for fluid level switch removal and installation procedures. REPEAT System Pre-Check.	Open in Circuit 512 (T/LG) or defective ignition switch. REPAIR/REPLACE and REPEAT System Pre-Check.

SYSTEM PRE-CHECK TEST C: YELLOW REAR ABS LIGHT SELF-CHECK OK, BUT LIGHT AUTOMATICALLY BEGINS FLASHING

Affected Circuit(s)/Electrical Component(s)



Description

The RABS warning light will automatically begin a flash-out sequence if the diagnostic line Circuit 571 or 483 is shorted to ground. This will result in a blown fuse for the keep-alive memory power for the anti-lock electronic control module. An open keep-alive memory (KAM) fuse is most likely caused by a grounded diagnostic connector.

Possible Contributing Base Brake Component/Vehicle Wiring Concerns

- Intermittent anti-lock electronic control module power circuit
- Intermittent anti-lock electronic control module ground circuit
- Intermittent anti-lock electronic control module light circuit
- Blown fuse

NOTE: Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent for electrical tests.

C1 OBSERVE REAR ABS LIGHT FOR FLASH SEQUENCE

- Observe REAR ABS light and determine if the flashing is a diagnostic trouble code (one or more short pulses followed by one long pulse).

Is the flash sequence a diagnostic trouble code?

Yes	No
INSPECT Circuits 571 (BK/O) and 483 (R) for short to ground. REPAIR circuit and REPLACE RABS KAM fuse. (See Owner's Manual.) REPEAT System Pre-Check.	GO to **C2** .

C2 INTERMITTENT POWER TO ANTI-LOCK ELECTRONIC CONTROL MODULE

- Remove the anti-lock electronic control module harness connector from the anti-lock electronic control module.
- Set multimeter to 20VDC scale.
- Turn the ignition to the ON position.
- Shake the instrument panel harness while measuring battery voltage between Pin 1, Pin 9 and chassis ground.

Is voltage steady and greater than 9 volts?

Yes	No
GO to **C3** .	REPAIR Circuit 601 (LB/PK). REPEAT System Pre-Check.

C3 DAMAGED ANTI-LOCK ELECTRONIC CONTROL MODULE GROUND

- Disconnect the battery ground cable.
- Set the multimeter on the 200-ohm scale.
- Shake the anti-lock electronic control module harness while reading the resistance between Pin 4 and chassis ground.

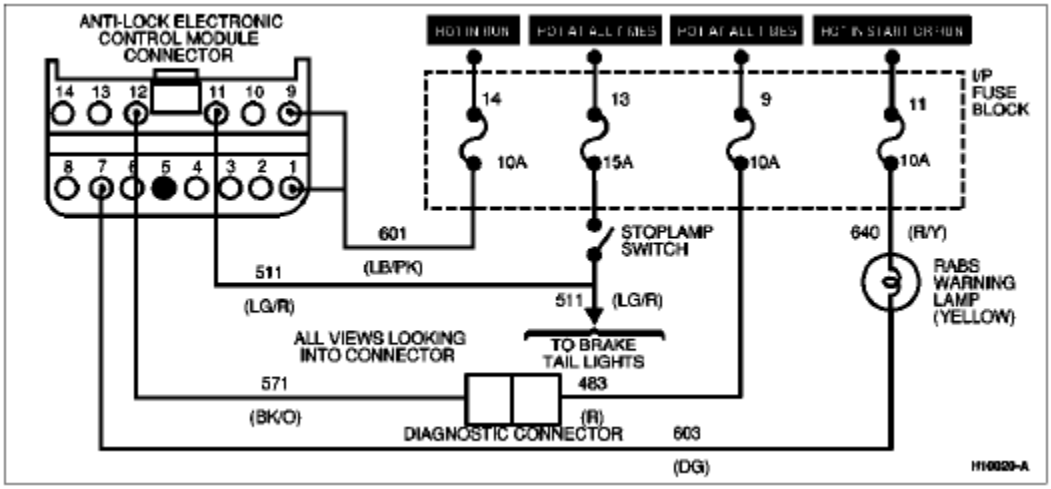
Is resistance steady and less than 1 ohm?

Yes	No

REPLACE anti-lock electronic control module. RECONNECT the battery ground cable. REPEAT System Pre-Check.	REPAIR poor ground in Circuit 530 (BK/W). RECONNECT the battery ground cable. REPEAT System Pre-Check.

SYSTEM PRE-CHECK TEST D: YELLOW REAR ABS LIGHT SELF-CHECK OK, BUT NO FLASHOUT CODE WHEN DIAGNOSTICS IS STARTED

Affected Circuit(s)/Electrical Component(s)



Description

The RABS warning light should automatically begin a flash-out sequence if the diagnostic connector is shorted to ground for at least one second. This flashout sequence can be observed by watching the REAR ABS light. There are a few conditions which will prevent the flashout from occurring. These must be resolved before continuing the RABS repair process.

Possible Contributing Base Brake Component/Vehicle Wiring Concerns

- Burned-out brake taillights
- Missing RABS power (Circuit 601 [LB/PK]) and associated fuse
- Shorted RABS light circuit (Circuit 603 [DG])
- Incorrect anti-lock electronic control module type (RABS I vs. RABS II)

TABLE I. ORIGINAL EQUIPMENT — RABS I VS. RABS II

Vehicle Type	Model Year	RABS System
Aerostar	91	RABS I (See Note)

Aerostar	92-93	RABS II
Ranger	89-92	RABS I (See Note)
Ranger	93	RABS II

NOTE: A RABS I system which has previously been serviced may have its anti-lock electronic control module upgraded to a RABS II. In the event that you are uncertain whether you have a RABS I or RABS II anti-lock electronic control module, check the anti-lock electronic control module part number to be certain of the type of system you have. Part number F29F-2C018 — RABS II anti-lock electronic control module; part number F37F-2C018 — RABS II anti-lock electronic control module; all others — RABS I anti-lock electronic control module.

WARNING: DO NOT INSTALL A RABS I ANTI-LOCK ELECTRONIC CONTROL MODULE IN A RABS II SYSTEM.

CAUTION: RABS I vehicles which have been upgraded with RABS II anti-lock electronic control module will NOT have keep-alive memory and therefore will not be able to store codes when the vehicle is turned off.

NOTE: Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent for electrical tests.

D1 DETERMINE IF SYSTEM IS RABS I OR RABS II

- Determine if the ABS system is a RABS I or a RABS II system. (See TABLE 1 after this test for assistance.)

Is module RABS I?

Yes	No
This shop manual does not cover RABS I anti-lock electronic control module. SEE appropriate shop manual for vehicle which you are servicing.	GO to **D2** .

D2 CHECK FOR SHORTED BRAKE SWITCH

- Observe rear brake lights.

Are the brake lights on continuously?

Yes	No
REPAIR shorted stoplight switch. REPEAT System Pre-Check.	GO to **D3** .

D3 CHECK FOR BURNED-OUT REAR BRAKE LIGHTS

- Press on brake pedal while observing rear brake lights.

Do the brake lights function?

Yes	No
GO to **D4** .	REPAIR brake light system: Burned-out bulbs or open Circuit 511 (LG). REPEAT System Pre-Check.

D4 CHECK FOR LOSS OF BRAKE INPUT TO ANTI-LOCK ELECTRONIC CONTROL MODULE

- Remove the anti-lock electronic control module harness connector from the anti-lock electronic control module. Check for terminal back-out.
- Set multimeter to 20 VDC range.
- Press on brake pedal hard enough to turn on rear brake lights.
- Measure voltage from RABS harness connector Pin 11 to chassis ground while brake pedal is pressed.

Are 9 volts or more present?

Yes	No
LEAVE anti-lock electronic control module disconnected. GO to **D5** .	REPAIR open in Circuit 511 (LG). RECONNECT anti-lock electronic control module. REPEAT System Pre-Check.

D5 CHECK POWER TO THE ANTI-LOCK ELECTRONIC CONTROL MODULE

- Turn the ignition to the ON position.
- Measure the voltage between RABS harness connector Pin 1 (or Pin 9) and chassis ground.

Are 9 volts or more present?

Yes	No
LEAVE anti-lock electronic control module disconnected. GO to **D6** .	REPAIR Circuit 601 (LB/PK) or associated fuse. RECONNECT anti-lock electronic control module. REPEAT System Pre-Check.

D6 CHECK FOR SHORTS IN ANTI-LOCK ELECTRONIC CONTROL MODULE HARNESS CONNECTOR

- With same set up as in Step D5, observe yellow REAR ABS light.

Is the REAR ABS light on?

Yes	No

CHECK for short to ground in Circuit 603 (DG). RECONNECT the anti-lock electronic control module. REPEAT System Pre-Check.	LEAVE anti-lock electronic control module disconnected. GO to **D7**.

D7 CHECK CIRCUIT 571 (BK/O) CONTINUITY

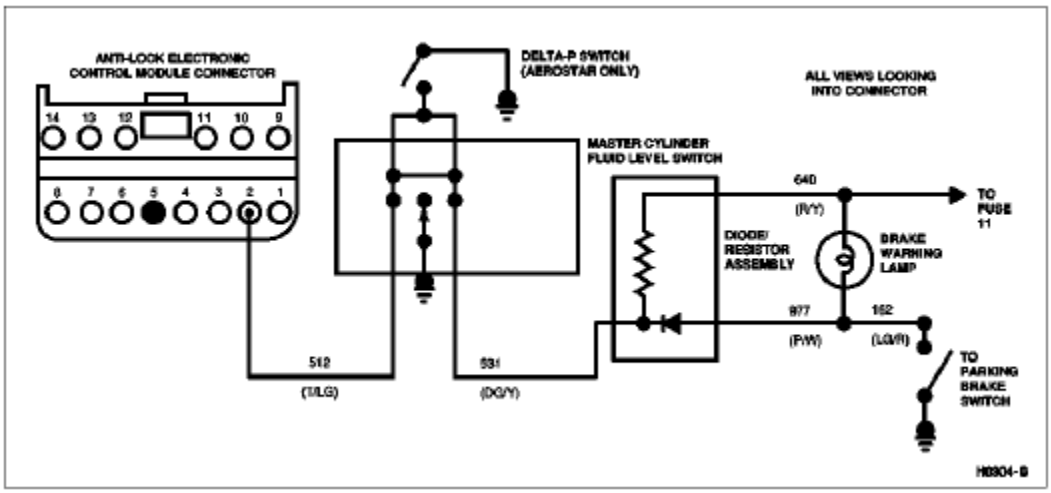
- Set the multimeter to the 200-ohm scale.
- Disconnect the RABS diagnostic connector from its mating half (Circuits 571 [BK/O] and 483 [R]).
- Measure resistance of Circuit 571 (BK/O) from diagnostic connector to module harness connector Pin 12.

Is the resistance less than 20 ohms?

Yes	No
REPLACE anti-lock electronic control module.	REPAIR Circuit 571 (BK/O). RECONNECT RABS II anti-lock electronic control module. REPEAT System Pre-Check.

SYSTEM PRE-CHECK TEST E: RED BRAKE WARNING LIGHT STAYS ON WHEN KEY IS IN RUN POSITION

Affected Circuit(s)/Electrical Component(s)



Description

Red BRAKE light ON with ignition switch ON and parking brake released.

Possible Contributing Component/Vehicle Wiring Faults

- Ground short on Circuit 977 (P/W)
- Ground short on Circuit 162 (LG/R)
- Damaged parking brake switch
- Damaged Delta-P switch (Aerostar Only)

NOTE: Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent for electrical tests.

E1 CHECK IF BOTH WARNING LIGHTS ARE ON

- Disengage parking brake.
- Key ON.

Do both the red BRAKE warning light and yellow RABS light come on?

Yes	No
PULL code. DTC 4: GO to Pinpoint Test 4 . DTC 12: GO to Pinpoint Test 12 .	GO to **E2** .

E2 CHECK PARKING BRAKE SWITCH

- Key OFF.
- Disconnect parking brake switch from harness connector.
- Key ON.

Does the red BRAKE warning light remain on?

Yes	No
Aerostar: GO to **E3** . Ranger: REPAIR ground short in Circuits 977 or 162.	REPEAT System Pre-Check.

E3 CHECK DELTA-P SWITCH (AEROSTAR ONLY)

- Key OFF.
- Disconnect low vacuum switch from harness connector.
- Key ON.

Does the red BRAKE warning light remain on?

Yes	No
REPAIR ground short in Circuits 977 or 162. REPEAT System Pre-Check.	REPLACE Delta-P switch. REPEAT System Pre-Check.

Intermittent Diagnosis Guidelines

An understanding of code storage and automatic code erasure is important.

First, codes can only be stored if the anti-lock electronic control module (2C018) has power. The anti-lock electronic control module gets primary power from the ignition feed into Pins 1 and 9. If this voltage is missing or less than 11V, the anti-lock electronic control module will not initialize and therefore, a code cannot be stored. However, any code already in memory will be retained as long as the keep-alive memory power is available. Code 16 (system OK) is present whenever the anti-lock electronic control module sees the required voltage (assuming no other diagnostic trouble codes are present).

Some codes read out in the System Pre-Check may not result in any trouble found in the pinpoint test performed. Most likely, this is an indication of an intermittent electrical concern.

To minimize misdiagnosis, refer to the Intermittent Diagnosis procedure if no resolution has been reached by the end of a particular pinpoint test.

NOTE: Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent for electrical tests.

PINPOINT TEST ID: INTERMITTENT DIAGNOSIS PROCEDURE

ID1 CLEAR CODES, RECONNECT COMPONENTS

- Remove the pinout box.
- Reinstall any components removed and reconnect all connections.
- Clear all codes.
- Key ON.

Does the REAR ABS warning light prove out?

Yes	No
GO to **ID3** .	GO to **ID2** .

ID2 SERVICE CONNECTOR/TERMINAL FAULT

- Most likely problem is at one of the affected component connectors such that terminals unseat or back out upon installation. At each affected connection, look for:
  - Bent terminals.
  - Damaged connector terminal locks.
  - Damaged connector wedge.

    NOTE: If one of the above conditions is found, check the length of the affected circuit

once the connection is remade. If the wire is too tight (short), damage is likely to recur once vehicle is given back to the customer. Repair the wire as necessary to correct tight wire conditions.

Are any of the above conditions noted?

Yes	No
REPAIR connector and terminal as necessary. GO to **ID7** .	GO to **ID6** .

ID3 WIGGLE TEST

- Leave key on.

  NOTE: Start at one component and wiggle connector by connector until the whole circuit has been tested.

- Wiggle an affected circuit in one location only.
- Observe REAR ABS warning light.

Is the REAR ABS warning light on?

Yes	No
REPAIR the wire terminal or connector as identified in the wiggle test. GO to **ID5** .	GO to **ID4** .

ID4 VERIFY ALL CIRCUITS HAVE BEEN TESTED

Have all affected circuits for the code being serviced been tested?

Yes	No
Key OFF. GO to **ID6** .	GO to **ID3** and CHECK next circuit.

ID5 RETRIEVE CODE

- Retrieve code.

Is this code different than the code being serviced?

Yes	No
GO to the appropriate pinpoint test.	REPAIR the wire, terminal, or connector as necessary. GO to **ID7** .

ID6 VERIFY ALL APPROPRIATE DIAGNOSTIC PROCEDURES HAVE BEEN RUN

NOTE: All steps of the pinpoint test for the code being serviced must be completed. (If some tests were performed, then go to the pinpoint step last completed and continue.)

Has the System Pre-Check been run and a code been retrieved?

Yes	No
RETURN to the pinpoint test and PROCEED.	RETURN to procedure(s) not yet performed and PROCEED.

ID7 VERIFY CONDITION RESOLVED

- Clear all codes.
- Key OFF.
- Retrieve code.

Is Code 16 set?

Yes	No
STOP. Concern has been corrected.	If code being repaired still exists, GO to **ID4** . If different code is set, GO to appropriate pinpoint test for the code obtained.

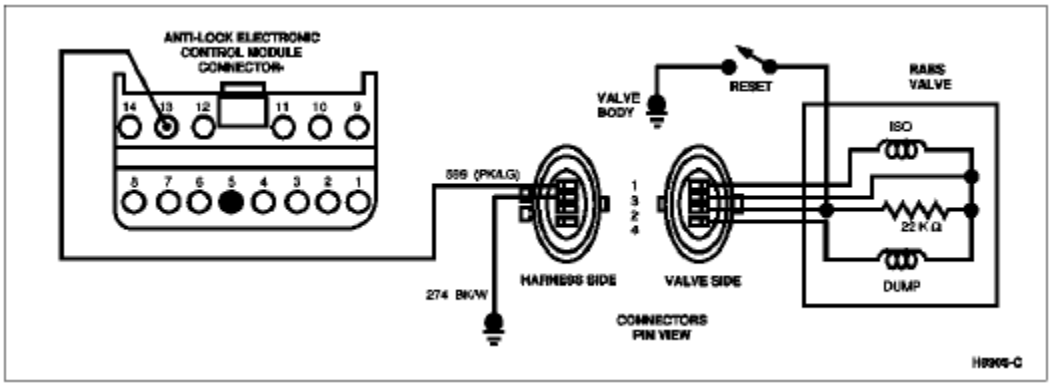
Pinpoint Tests, After System Pre-Check

CONDITION CHART

CONDITION	ACTION TO TAKE
Yellow REAR ABS light flashes 2 times. Open RABS 11 isolation solenoid circuit.	See Pinpoint Test Code 2.
Yellow REAR ABS light flashes 3 times. Open RABS 11 dump solenoid circuit.	See Pinpoint Test Code 3.
Yellow REAR ABS light flashes 4 times. Red BRAKE warning light illuminated. Open/grounded RABS valve reset circuit.	See Pinpoint Test Code 4.
Yellow REAR ABS light flashes 5 times. Excessive dump solenoid activity.	See Pinpoint Test Code 5.
Yellow REAR ABS light flashes 6 times. Erratic rear brake anti-lock sensor circuit.	See Pinpoint Test Code 6.
Yellow REAR ABS light flashes 7 times. No isolation solenoid during self-check.	See Pinpoint Test Code 7.
Yellow REAR ABS light flashes 8 times. No dump solenoid during self-check.	See Pinpoint Test Code 8.
Yellow REAR ABS light flashes 9 times. High speed sensor resistance.	See Pinpoint Test Code 9.
Yellow REAR ABS light flashes 10 times. Low speed sensor resistance.	See Pinpoint Test Code 10.
Yellow REAR ABS light flashes 11 times. Stoplamp switch always closed.	See Pinpoint Test Code 11.
Yellow REAR ABS light flashes 12 times. Loss of hydraulic brake fluid during anti-lock stop.	See Pinpoint Test Code 12.
Yellow REAR ABS light flashes 13 times. RABS 11 module failure.	See Pinpoint Test Code 13.
Yellow REAR ABS light flashes 16 times or more. Drive test.	See Pinpoint Test Code 16.

PINPOINT TEST CODE 2: OPEN RABS II ISOLATION SOLENOID CIRCUIT

Affected Circuit(s)/Electrical Component(s)



Description

NOTE: Refer to Obtaining the Diagnostic Trouble Code in this section for procedure to obtain flashout code.

NOTE: For easier access to the Aerostar RABS valve connector, construct a jumper harness with a 4-pin connector F07Z-14A464-B and four sections of 18-inch long wire. The wire sections should be of different colors or labeled for quick reference.

CAUTION: When checking resistance in the RABS II system, always disconnect the battery ground cable (14301). Improper resistance readings may occur with the vehicle battery connected.

Code 2 is generated by the anti-lock electronic control module's detection of an open circuit in Circuit 599 (PK/LG). The code may also be generated by a failed isolation solenoid (open coil) internal to the RABS valve or a failed internal anti-lock electronic control module circuit.

Possible Contributing Base Brake Component/Vehicle Wiring Concerns

- Terminal backout in the anti-lock electronic control module harness connector at Pin 13
- Terminal backout in the RABS valve harness connector at Pin 1
- Bulkhead connector (between engine compartment and instrument panel (04320)) terminal backout or loose connection
- Anti-lock electronic control module (2C018) or RABS valve connectors not fully mated with component
- Intermittent open circuit in Circuit 599 (PK/LG)

NOTE: Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent for electrical tests.

2.1 VERIFY INTEGRITY OF ANTI-LOCK ELECTRONIC CONTROL MODULE CONNECTION

- Turn the ignition OFF.
- Disconnect battery ground cable.
- Remove the module connector.
- Pull gently on Pin 13 (PK/LG) just behind the harness connector.

Is connector clean and secure?

Yes	No
LEAVE anti-lock electronic control module connector disconnected. GO to 2.2 .	REPAIR terminal or connector as needed. If terminals are not serviceable, REPLACE anti-lock electronic control module. GO to 2.6 .

2.2 VERIFY INTEGRITY OF RABS VALVE CONNECTION

- Remove RABS valve connector.
- Inspect RABS valve component connector for contamination or loose terminals.
- Pull gently on Pin 1 (PK/LG) just behind the harness connector.

Is terminal clean and secure?

Yes	No
LEAVE RABS valve connector disconnected. GO to 2.3 .	REPAIR terminal or connector as needed. If not repairable, REPLACE RABS valve. GO to 2.6 .

2.3 CHECK FOR CONTINUITY ALONG HARNESS CIRCUIT 599 (PK/LG)

- Verify multimeter is on 200-ohm scale.
- Measure resistance between anti-lock electronic control module harness connector Pin 13 and RABS valve harness connector Pin 1.

Is resistance less than 10 ohms?

Yes	No
Circuit is not open. GO to 2.4 .	FIND and REPAIR open circuit along Circuit 599 (PK/LG). GO to 2.6 .

2.4 CHECK FOR OPEN RABS VALVE ISOLATION SOLENOID

- Verify multimeter is on 200-ohm scale.
- Measure resistance between RABS valve Pins 1 and 3.

Is resistance less than 6 ohms?

Yes	No
Circuit is not open. GO to 2.5 .	OPEN circuit in RABS valve. REPLACE RABS valve. GO to 2.6 .

2.5 MAKE SURE ALL STEPS ARE COMPLETED

CAUTION: Be sure to complete all steps. Failure to do so could lead to replacement of

good components.

- This step requires that a valid diagnostic trouble code has been obtained, ALL prior diagnostic steps have been completed, and the affected wiring integrity has been verified.

Have all prior diagnostic steps been completed as described above?

Yes	No
REPLACE anti-lock electronic control module. GO to Step **2.6** . If anti-lock electronic control module has been replaced and no resolution has been reached, REPLACE RABS valve. GO to Step **2.6** .	GO to diagnostic step last completed and continue.

2.6 CLEAR CODE/PULL CODE

- Turn ignition OFF.
- Reconnect battery ground cable.

NOTE: When the battery ground cable has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.

- Verify all connectors are installed.
- Locate and disconnect the diagnostic connector from its mating half (Circuits 571 [BK/O] and 483 [R]).
- Turn ignition ON.
- Begin diagnostic trouble code flashout by connecting Circuit 571 (BK/O) to a chassis ground for at least 1 second.
- Observe and count code.

Is Code 16 set?

Yes	No
GO to Drive Test Code 16 .	If Code 2, GO to **2.7** . If different code, GO to pinpoint test for corresponding code.

2.7 PINPOINT TEST STATUS

Has pinpoint test been completed?

Yes	No
GO to **2.8** .	RETURN to last pinpoint test completed.

2.8 VERIFY INTEGRITY OF VEHICLE WIRING

If the above steps have been completed, the MOST LIKELY cause of the concern is wiring related.

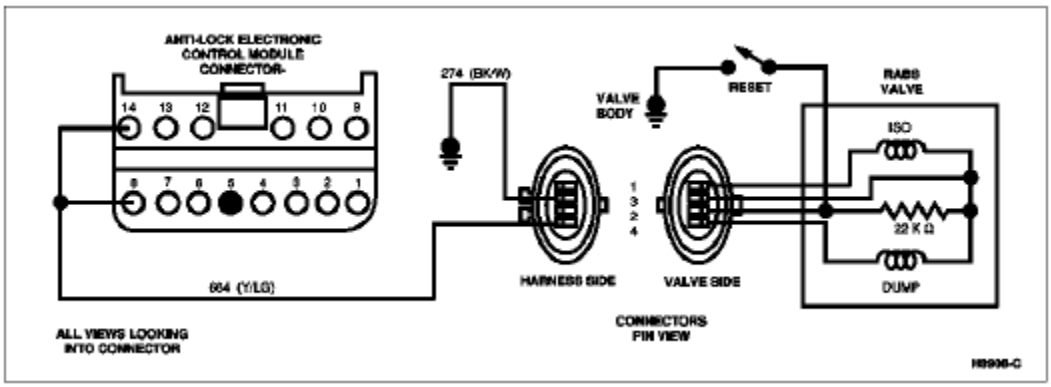
- Refer to Pinpoint Test ID , Intermittent Diagnosis Procedure and perform for ALL affected circuits as shown on this pinpoint test system schematic.

Is resolution achieved?

Yes	No
STOP. Repair is complete. GO to Drive Test Code 16 .	GO to **2.5** .

PINPOINT TEST CODE 3: OPEN RABS II DUMP SOLENOID CIRCUIT

Affected Circuit(s)/Electrical Component(s)



Description

Code 3 is generated by the anti-lock electronic control module's detection of an open circuit in line 664 (Y/LG) or 274 (BK/W). The code may also be generated by a failed dump solenoid (open coil) internal to the RABS valve or a failed internal anti-lock electronic control module circuit.

Possible Contributing Base Brake Component/Vehicle Wiring Concerns

- Terminal backout in the anti-lock electronic control module harness connector at Pins 8 or 14
- Terminal backout in the RABS valve harness connector at Pin 4
- Bulkhead connector (between engine compartment and instrument panel) terminal backout or loose connection
- Anti-lock electronic control module or RABS valve connectors not fully mated with component
- Intermittent open circuit in line 664 (Y/LG)

NOTE: Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent for electrical tests.

3.1 VERIFY INTEGRITY OF ANTI-LOCK ELECTRONIC CONTROL MODULE CONNECTION

- Turn ignition to the OFF position.
- Disconnect battery ground cable.
- Remove the anti-lock electronic control module connector.
- Inspect anti-lock electronic control module Pins 8 and 14.
- Pull gently on each wire just behind Pins 8 and 14 on harness connector.

Are connections clean and secure?

Yes	No
LEAVE anti-lock electronic control module connector disconnected. GO to **3.2** .	Terminal(s) in anti-lock electronic control module connector are loose, bent, deformed, corroded, or missing. REPAIR terminal or connector as needed. If not repairable, REPLACE anti-lock electronic control module. GO to **3.6** . Terminals 8 or 14 in harness connector move back or come free of connector. REPAIR terminal or connector as needed. GO to **3.6** .

3.2 VERIFY INTEGRITY OF RABS VALVE CONNECTION

- Remove RABS valve connector.
- Inspect RABS valve connector Pin 4.
- Gently pull on Pin 4 wire just behind harness connector.

Are connections clean and secure?

Yes	No
LEAVE RABS valve connector disconnected. GO to **3.3** .	Terminal(s) in RABS valve connector are loose, bent, deformed, corroded, or missing. REPAIR terminal or connector as needed. If not repairable, REPLACE RABS valve. GO to **3.6** Terminal(s) in harness connector move back or come free of connector. REPAIR terminal or connector as needed. GO to **3.6** .

3.3 CHECK FOR CONTINUITY ALONG HARNESS CIRCUIT 664 (Y/LG) FROM ANTI-LOCK ELECTRONIC CONTROL MODULE CONNECTOR PINS 8 AND 14

- Set multimeter on 200-ohm scale.
- Measure resistance between anti-lock electronic control module harness connector Pin 8 and RABS valve harness connector Pin 4.
- Measure resistance between anti-lock electronic module harness connector Pin 14 and RABS valve

harness connector Pin 4.

Is resistance less than 1 ohm?

Yes	No
Circuit is not open. GO to **3.4** .	FIND and REPAIR open circuit along 664 (Y/LG). GO to **3.6** .

3.4 CHECK FOR OPEN RABS DUMP VALVE SOLENOID

- Verify multimeter is on 200-ohm scale.
- Measure resistance between RABS valve Pins 4 and 3.

Is resistance less than 3 ohms?

Yes	No
Circuit is not open. GO to **3.5** .	Open circuit in RABS is indicated. REPLACE RABS valve. GO to **3.6** .

3.5 MAKE SURE ALL STEPS ARE COMPLETED

CAUTION: Be sure to complete all steps. Failure to do so may lead to replacement of good parts.

- This step requires that a valid diagnostic trouble code has been obtained, ALL prior diagnostic steps have been completed, and the affected wiring integrity has been verified.

Have all prior diagnostic steps been completed as described above?

Yes	No
REPLACE anti-lock electronic control module. GO to Step **3.6** . If anti-lock electronic control module has been replaced and no resolution has been reached, REPLACE RABS valve. GO to Step **3.6** .	GO to diagnostic step last completed and CONTINUE.

3.6 CLEAR CODE/PULL CODE

- Turn ignition OFF.

NOTE: When the battery ground cable has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.

- Reconnect battery ground cable.
- Verify all connectors are installed.
- Locate and disconnect the diagnostic connector from its mating half (Circuits 571 [BK/O] and 483 [R]).
- Turn ignition ON.
- Begin diagnostic trouble code flashout by connecting Circuit 571 (BK/O) to a chassis ground for at least 1 second.
- Observe and count code.

Is Code 16 set?

Yes	No
GO to Drive Test Code 16 .	If Code 2, GO to **3.7** . If different code, GO to pinpoint test for corresponding code.

3.7 PINPOINT TEST STATUS

Have all prior pinpoint tests been completed?

Yes	No
GO to **3.8** .	RETURN to last pinpoint test completed.

3.8 VERIFY INTEGRITY OF VEHICLE WIRING

If the above steps have been completed, the MOST LIKELY cause of the concern is wiring related.

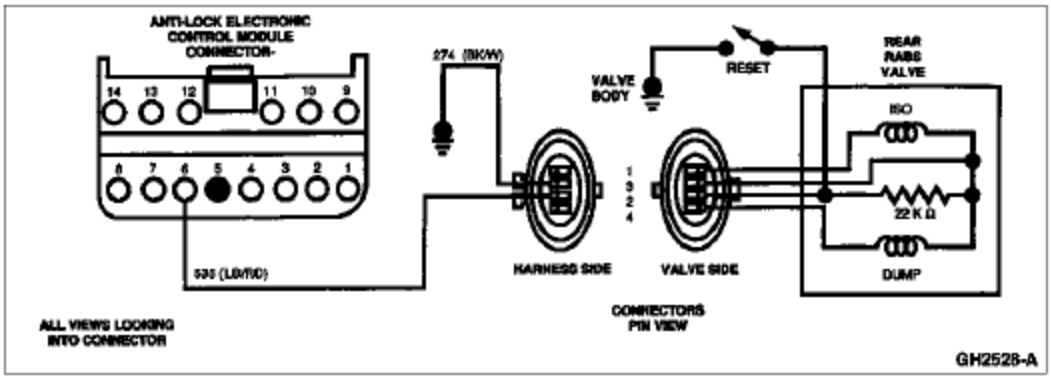
- Refer to Pinpoint Test ID , Intermittent Diagnosis Procedure and perform for ALL affected circuits as shown on this pinpoint test system schematic.

Is resolution achieved?

Yes	No
STOP. Repair is complete. GO to Drive Test Code 16 .	GO to **3.5** .

PINPOINT TEST CODE 4: OPEN/GROUNDED RABS VALVE RESET CIRCUIT

Affected Circuit(s)/Electrical Component(s)



Description

Code 4 is generated by the anti-lock electronic control module's detection of a resistance falling below 18 k Ohms (short) or above 26 k Ohms (open) in Circuit 535 (LB/R). This can indicate an open or short in the reset switch circuit, or a hydraulic leak into dump section of the valve.

Possible Contributing Base Brake Component/Vehicle Wiring Concerns

- Terminal backout in the module harness connector at Pin 6
- Terminal backout in the RABS valve harness connector at Pins 2 or 3
- Bulkhead connector (between engine compartment and instrument panel) terminal backout or loose connection
- Anti-lock electronic control module or RABS valve connectors not fully mated with component
- Intermittent open or open circuit in Circuits 535 (LB/R), or 274 (BK/W)
- Intermittent short or short circuit in Circuit 535 (LB/R)
- Defective RABS valve

NOTE: Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent for electrical tests.

4.1 VERIFY INTEGRITY OF RABS VALVE CONNECTION

- Remove RABS valve connector.
- Inspect RABS valve component connector Pins 2 and 3.
- Inspect RABS valve harness connector Pins 2 and 3.
- Pull gently on Pin 2 wire just behind the harness connector.
- Pull gently on Pin 3 just behind the harness connector.

Are connections clean and secure?

Yes	No
LEAVE RABS valve connector disconnected. GO to **4.2** .	Terminals in RABS valve connector are loose, bent, deformed, corroded, or missing. REPAIR terminal or connector as needed. If not repairable, REPLACE RABS valve. GO to **4.10** .

	Terminal(s) in harness connector move back or come free of connector. REPAIR terminal or connector as needed. GO to **4.10** .

4.2 VERIFY INTEGRITY OF ANTI-LOCK ELECTRONIC CONTROL MODULE CONNECTION

- Turn the ignition OFF.
- Disconnect battery ground cable.
- Inspect anti-lock electronic control module component connector Pin 6.
- Inspect anti-lock electronic control module harness connector Pin 6.
- Pull gently on Pin 6 wire just behind the harness connector.

Are connections clean and secure?

Yes	No
LEAVE anti-lock electronic control module connector disconnected. GO to **4.3** .	Terminal(s) in anti-lock electronic control module connector are loose, bent, deformed, corroded, or missing. REPAIR terminal or connector as needed. If not repairable, REPLACE anti-lock electronic control module. GO to **4.10** . Terminal 6 in harness connector moves back or comes free of connector. REPAIR terminal or connector as needed. GO to **4.10** .

4.3 CHECK FOR CLOSED RABS VALVE RESET SWITCH

- Verify multimeter is on 200k Ohm scale.
- Measure resistance between RABS valve connector Pin 2 and RABS valve body.

Is resistance greater than 10 k Ohms?

Yes	No
Reset switch is not closed. GO to **4.4** .	Shorted circuit in RABS valve is indicated. REPLACE RABS valve. GO to **4.10** .

4.4 CHECK RESISTANCE BETWEEN RABS VALVE RESET SWITCH AND RABS VALVE COMMON

- Verify multimeter is on 30k Ohm scale.
- Measure resistance between RABS valve Pins 2 and 3.

Is resistance between 18-26 k Ohms for aluminum RABS valve?

Yes	No

GO to 4.5.	Shorted or open circuit in RABS valve is indicated. REPLACE RABS valve. GO to 4.9.

4.5 CHECK FOR CONTINUITY ALONG GROUND CIRCUIT 274 (BK/W)

- Set multimeter on 200-ohm scale.
- Measure resistance between RABS valve harness connector Pin 3 and negative battery post.

Is resistance 3 ohms or less?

Yes	No
Circuit is not open. GO to 4.6.	FIND and REPAIR open circuit along Circuit 274 (BK/W). GO to 4.10.

4.6 CHECK FOR SHORT ALONG HARNESS CIRCUIT 535 (LB/R)

- Set multimeter on 200-ohm scale.
- Measure resistance between module harness connector Pin 6 and chassis ground.

Is resistance greater than 12 ohms?

Yes	No
Circuit is not shorted. GO to 4.7.	FIND and REPAIR short circuit along Circuit 535 (LB/R). GO to 4.10.

4.7 CHECK FOR CONTINUITY ALONG HARNESS CIRCUIT 535 (LB/R)

- Set multimeter on 200-ohm scale.
- Measure resistance between anti-lock electronic control module harness connector Pin 6 and RABS valve harness connector Pin 2.

Is resistance less than 10 ohms?

Yes	No
Circuit is not open. GO to 4.8.	FIND and REPAIR open circuit along Circuit 535 (LB/R). GO to 4.10.

4.8 MAKE SURE ALL STEPS ARE COMPLETED

- This step requires that a valid diagnostic trouble code has been obtained, ALL prior diagnostic steps have been completed, and the affected wiring integrity has been verified.

CAUTION: Make sure to complete all steps. Failure to do so could lead to replacement of

good parts.

Have all prior diagnostic steps been completed as described above?

Yes	No
GO to Step **4.9** .	GO to diagnostic step last completed and CONTINUE.

4.9 ISOLATE RABS MODULE

- Verify all wiring is connected.
- Reconnect battery ground cable.

NOTE: When the battery ground cable has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.

- Clear codes.
- Turn ignition key to ON position.

Is ABS indicator light on?

Yes	No
REPLACE anti-lock electronic control module. GO to **4.10** .	GO to Drive Test Code 16 . If code 4 is reset, REPLACE RABS valve. GO to **4.10** .

4.10 CLEAR CODE/PULL CODE

- Locate and disconnect the diagnostic connector from its mating half (Circuits 571 (BK/O) and 483 (R).
- Turn ignition ON.
- Begin diagnostic trouble code flashout by connecting Circuit 571 (BK/O) to a chassis ground for at least 1 second.
- Observe and count code.

Is Code 16 set?

Yes	No
GO to Drive Test Code 16 .	If no code is set, GO to **4.11** . If different code is set, GO to pinpoint test for corresponding code.

4.11 VERIFY PINPOINT TEST IS COMPLETE

Have all prior pinpoint tests been completed?

Yes	No

GO to **4.12** .	GO to **4.3** .

4.12 VERIFY INTEGRITY OF VEHICLE WIRING

If the above steps have been completed, the most likely cause of the concern is wiring related.

- Refer to Pinpoint Test ID , Intermittent Diagnosis Procedure and perform for all affected circuits as shown on the Pinpoint Test system schematic.

Is resolution achieved?

Yes	No
GO to Drive Test Code 16 .	GO to Drive Test Code 4 .

PINPOINT TEST CODE 5: EXCESSIVE DUMP SOLENOID ACTIVITY, AEROSTAR ONLY

Description

Code 5 is generated when the maximum number of allowable dump pulses has be en exceeded. The system will only recognize this condition during an anti-lock stop in 2WD mode. The code may be caused by a blocked RABS dump valve orifice, a stuck dump valve, an open circuit in Circuit 210 (LB), a worn or damaged 4x4 transfer case that causes the vehicle to remain in 4x4 after 4x2 has been selected, or mechanical problems in the rear brake system. (Brake drums (1126) may lock.)

Possible Contributing Base Brake Component/Vehicle Wiring Concerns

- Parking brake drag
- Rear brake assembly grabbing or hanging up
- Connector corrosion or contamination
- Intermittent open circuit in Circuit 210 (LB)
- Pierced wire insulation to battery power (4x4 only)

NOTE: Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent for electrical tests.

5.1 DRIVE STATUS

- Determine if vehicle is in 2- or 4-wheel drive when code occurs.

Is vehicle in 4-wheel drive?

Yes	No
GO to **5.2** .	GO to **5.3** .

5.2 CHECK FOR INCORRECT 4WD SWITCH SIGNAL, OR SHORT TO POWER TO ANTI-LOCK ELECTRONIC CONTROL MODULE

- Disconnect anti-lock electronic control module harness connector from anti-lock electronic control module to deactivate RABS.
- Key ON.
- Shift into 4x4 mode.
- Set multimeter to 20VDC scale.
- Measure voltage between Pin 5 of the anti-lock electronic control module harness and chassis ground.

Is the measured voltage less than 1V?

Yes	No
GO to **5.3** .	REPAIR 4x4 indicator switch or REPAIR short in Circuit 210 (LB). REFER to the appropriate section in Group 07 for procedures. GO to **5.4** .

5.3 CHECK FOR LOW OR ERRATIC SPEED SENSOR SIGNAL

- Disconnect anti-lock electronic control module harness connector.
- Position vehicle on hoist and raise both front and rear wheels just enough to clear the floor.
- Start the engine and turn the wheels at 8 km/h (5 mph).
- Place multimeter on 2000mV AC scale.
- Measure the voltage across anti-lock electronic control module harness connector Pins 3 and 10.

Is the voltage less than 650mV RMS or is speed sensor signal erratic?

Yes	No
COMPLETE pinpoint test for Code 6, Steps 6.2 through 6.8, then RETURN. GO to **5.4** to verify.	REINSTALL anti-lock electronic control module connector. GO to Drive Test Code 5 .

5.4 MAKE SURE ALL STEPS ARE COMPLETED

- This step requires that a valid diagnostic trouble code has been obtained, ALL prior diagnostic steps have been completed, and the affected wiring integrity has been verified.

CAUTION: Make sure to complete all pinpoint test steps. Failure to do so could cause replacement of good parts.

Have all prior diagnostic steps been completed as described above?

Yes	No
REPLACE anti-lock electronic control module. GO to Step **5.5** . If anti-lock electronic control module has been	GO to diagnostic step last completed and CONTINUE.

replaced and no resolution has been reached, REPLACE RABS valve. GO to Step **5.5** .	

5.5 CLEAR CODE/PULL CODE

- Turn ignition OFF.

NOTE: When the battery ground cable has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.

- Reconnect battery ground cable.
- Verify all connectors are installed.
- Locate and disconnect the diagnostic connector from its mating half (Circuits 571 [BK/O] and 483 [R]).
- Turn ignition ON.
- Begin diagnostic trouble code flashout by connecting Circuit 571 (BK/O) to a chassis ground for at least 1 second.
- Observe and count code.

Is Code 16 set?

Yes	No
GO to Drive Test Code 16 .	If Code 5, GO to **5.6** . If different GO to pinpoint test for corresponding code.

5.6 PINPOINT TEST STATUS

Have all prior pinpoint tests been completed?

Yes	No
GO to **5.7** .	RETURN to last pinpoint test completed.

5.7 VERIFY INTEGRITY OF VEHICLE WIRING

If the above steps have been completed, the MOST LIKELY cause of the concern is wiring related.

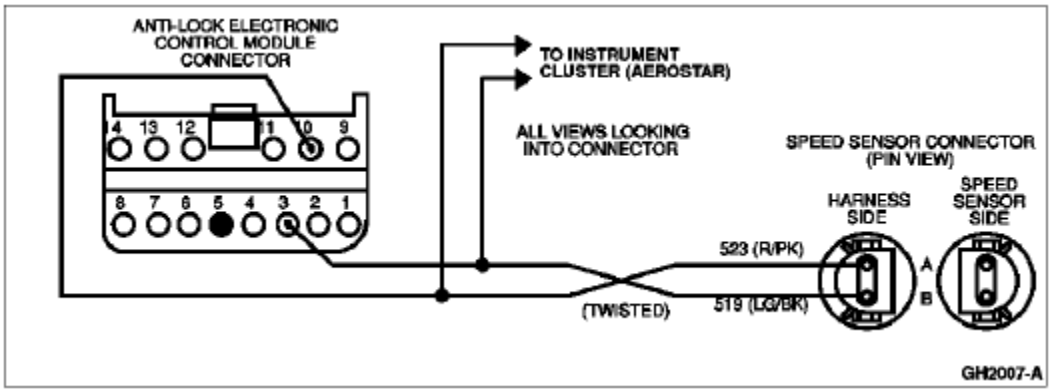
- Refer to Pinpoint Test ID , Intermittent Diagnosis Procedure and perform for ALL affected circuits as shown on the main schematic.

Is resolution achieved?

Yes	No
STOP. Repair is complete. GO to Drive Test Code 16 .	GO to Drive Test Code 5 .

PINPOINT TEST CODE 6: ERRATIC REAR BRAKE ANTI-LOCK SENSOR CIRCUIT

Affected Circuit(s)/Electrical Component(s)



Description

Code 6 is generated by the anti-lock electronic control module's detection of an interruption in the continuous signal from the speed sensor while rolling, caused by an intermittent open internal to the speed sensor, Circuit 519 (LG/BK) or Circuit 523 (R/PK), or a damaged speed sensor ring. This condition can be detected anytime the brake pedal (2455) is not applied and 20 seconds has elapsed since the ignition self-test.

Possible Contributing Base Brake Component/Vehicle Wiring Concerns

- Terminal backout in the anti-lock electronic control module harness connector at Pins 3 and 10
- Terminal backout in the RABS speed sensor harness connector at Pins A and B
- Bulkhead connector (between engine compartment and instrument panel) terminal backout or loose connection
- Anti-lock electronic control module or RABS speed sensor connectors are not fully mated with component
- Intermittent open/short circuit in Circuits 519 (LG/BK) or 523 (R/PK)
- Damaged speed sensor (possibly metal shavings on pole piece)
- Damaged speed sensor ring (possibly teeth missing)

NOTE: Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent for electrical tests.

6.1 VERIFY INTEGRITY OF ANTI-LOCK ELECTRONIC CONTROL MODULE CONNECTION

- Turn ignition OFF.
- Disconnect battery ground cable.
- Remove the anti-lock electronic control module connector.

- Inspect anti-lock electronic control module component connector for contamination and loose or bent terminals.
- Pull gently on Circuit 519 (LG/BK) just behind Pin 3 on the harness connector.
- Pull gently on Circuit 523 (R/PK) just behind Pin 10 on the harness connector.

Are all connections clean and secure?

Yes	No
LEAVE anti-lock electronic control module connector disconnected. GO to **6.2** .	Terminal(s) in component connector are corroded, bent, or loose. REPAIR terminals or connector as needed. If not repairable, REPLACE anti-lock electronic control module. GO to **6.7** . Terminal(s) in harness connector are corroded, bent, or move back or come free of connector. REPAIR terminals or connector as needed. GO to **6.7** .

6.2 VERIFY INTEGRITY OF SPEED SENSOR CONNECTION

- Verify ignition is OFF.
- Remove speed sensor connector.
- Inspect speed sensor component connector for contamination and bent or loose terminals.
- Gently pull on Circuit 519 (LG/BK) behind Pin B of harness connector.
- Gently pull on Circuit 523 (R/PK) behind Pin A of harness connector.

Are all connections clean and secure?

Yes	No
REINSTALL RABS speed sensor connector. GO to **6.3** .	Terminal(s) in component connector are corroded, bent, or loose. REPAIR terminal or connector as needed. If not repairable, REPLACE RABS speed sensor. GO to **6.7** . Terminal(s) in harness connector are corroded, bent, or move back or come free of connector. REPAIR terminal or connector as needed. GO to **6.7** .

6.3 VERIFY PROPER SPEED SENSOR WIRE ROUTING

- Inspect wire routing.

Are wires clean and secure?

Yes	No
GO to **6.4** .	REPAIR as necessary. GO to **6.7** .

6.4 VERIFY SPEED SENSOR INTEGRITY

- Set multimeter on the 20k Ohm scale.
- Check resistance between Pins A and B of the sensor connector.

Is resistance between 800 and 3500 ohms?

Yes	No
GO to 6.5 .	REPLACE RABS speed sensor. GO to 6.6 .

6.5 CHECK FOR ERRATIC SPEED SENSOR SIGNAL AND LOOSE WIRE CONNECTORS

- Set multimeter on the 20k Ohm scale.
- Check resistance between Pin 10 and Pin 3 of the harness connector while shaking the harness from sensor to anti-lock electronic control module.

Is reading steady and between 800 and 3500 ohms?

Yes	No
Signal is not erratic. GO to 6.6 .	FIND and REPAIR open/short circuit along Circuits 519 (LG/BK) and 523 (R/PK). GO to 6.7 .

6.6 CHECK FOR METAL CHIPS ON SPEED SENSOR MAGNET POLE PIECE

- Verify ignition is OFF.
- Remove the speed sensor from the rear axle housing and inspect for a buildup of metal chips on speed sensor magnetic pole.

Are metal chips present?

Yes	No
DRAIN and CLEAN rear axle housing. GO to 6.7 .	LEAVE speed sensor out. GO to 6.7 .

6.7 MAKE SURE ALL STEPS ARE COMPLETED

- This step requires that a valid diagnostic trouble code has been obtained, ALL prior diagnostic steps have been completed, and the affected wiring integrity has been verified.

CAUTION: Make sure to complete all test steps. Failure to do so could cause replacement of good parts.

Have all prior diagnostic steps been completed as described above?

Yes	No
REPLACE anti-lock electronic control module. GO to Step **6.8** . If anti-lock electronic control module has been replaced and no resolution has been reached, REPLACE rear axle speed sensor. GO to Step **6.8** .	GO to diagnostic step last completed and CONTINUE.

6.8 CLEAR CODE/PULL CODE

- Turn ignition OFF.

  NOTE: When the battery ground cable has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.

- Reconnect battery ground cable.
- Verify all connectors are installed.
- Locate and disconnect the diagnostic connector from its mating half (Circuits 571 [BK/O] and 483 [R]).
- Turn ignition ON.
- Begin diagnostic trouble code flashout by connecting Circuit 571 (BK/O) to a chassis ground for at least 1 second.
- Observe and count code.

Is Code 16 set?

Yes	No
GO to Drive Test Code 16 .	If Code 6, GO to **6.9** . If different code, GO to pinpoint test for corresponding code.

6.9 PINPOINT TEST STATUS

Have all prior pinpoint tests been completed?

Yes	No
GO to **6.10** .	RETURN to last pinpoint test completed.

6.10 VERIFY INTEGRITY OF VEHICLE WIRING

If the above steps have been completed, the MOST LIKELY cause of the concern is wiring related.

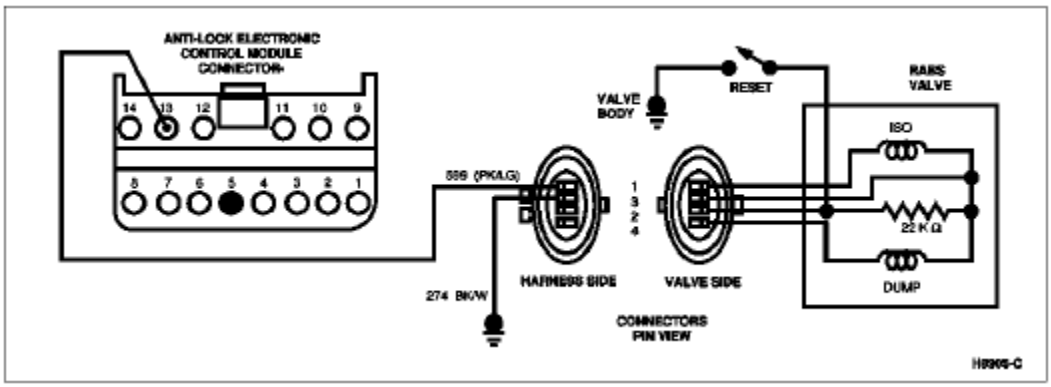
- Refer to Pinpoint Test ID , Intermittent Diagnosis Procedure and perform for ALL affected circuits as shown on this pinpoint test system schematic.

Is resolution achieved?

Yes	No
STOP. Repair is complete GO to Drive Test Code 16 .	GO to Drive Code Test 6 .

PINPOINT TEST CODE 7: NO ISOLATION SOLENOID DURING SELF-CHECK

Affected Circuit(s)/Electrical Component(s)



Description

Code 7 is generated when the anti-lock electronic control module detects a missing isolation solenoid output. This can only be detected during an ignition self-check or during a RABS stop.

Possible Contributing Base Brake Component/Vehicle Wiring Concerns

- Module internal fuse blown or internal open circuit
- Shorted isolation solenoid internal to the RABS valve
- Intermittent short or shorted circuit in Circuit 599 (PK/LG)
- Contamination or bent Pins 1 and 3 of RABS valve connector shorting together

NOTE: Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent for electrical tests.

7.1 CHECK FOR RABS VALVE ISOLATION SOLENOID OR WIRING SHORTED TO GROUND

- Turn the ignition OFF.
- Disconnect battery ground cable.
- Remove the anti-lock electronic control module connector.
- Set the multimeter on the 200-ohm scale.
- Measure the resistance between anti-lock electronic control module harness connector Pin 13 and

chassis ground.

Is resistance less than 3 ohms?

Yes	No
Circuit is shorted. LEAVE module connector disconnected. GO to 7.2 .	Circuit is not shorted. Leave module connector disconnected. GO to 7.5 .

7.2 CHECK INTEGRITY OF RABS VALVE CONNECTION

- Remove RABS valve connector.
- Inspect RABS valve component connector and Pins 1 and 3.

Are connections clean and secure?

Yes	No
LEAVE RABS valve connector disconnected. GO to 7.3 .	REPAIR terminals or connector as needed. If not repairable, REPLACE RABS valve. GO to 7.6 .

7.3 CHECK FOR SHORTED RABS ISOLATION SOLENOID

- Verify RABS valve connector removed.
- Set the multimeter on the 200-ohm scale.
- Measure the resistance between Pins 1 and 3 of RABS valve connector.

Is resistance 3-6 ohms?

Yes	No
LEAVE RABS valve connector disconnected. GO to 7.4 .	REPLACE RABS valve. GO to 7.6 .

7.4 CHECK FOR SHORT TO GROUND ALONG HARNESS CIRCUIT 599 (PK/LG)

- Set multimeter on 20k Ohm scale.
- Measure resistance between anti-lock electronic control module harness connector Pin 13 (PK/LG) and chassis ground.

Is resistance less than 20 k Ohms?

Yes	No
REPAIR short in Circuit 599 (PK/LG) between anti-lock electronic control module and RABS valve. GO to 7.6 .	Conflict of information. REPEAT 7.2 .

7.5 MAKE SURE ALL STEPS ARE COMPLETED

- This step requires that a valid diagnostic trouble code has been obtained, ALL prior diagnostic steps have been completed, and the affected wiring integrity has been verified.

CAUTION: Make sure to complete all steps. Failure to do so could lead to replacement of good parts.

Have all prior diagnostic steps been completed as described above?

Yes	No
REPLACE anti-lock electronic control module. GO to Step **7.6**. If anti-lock electronic control module has been replaced and no resolution has been reached, REPLACE RABS valve. GO to Step **7.6**.	GO to diagnostic step last completed and CONTINUE.

7.6 CLEAR CODE/PULL CODE

- Turn ignition OFF.

NOTE: When the battery ground cable has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.

- Reconnect battery ground cable.
- Verify all connectors are installed.
- Locate and disconnect the diagnostic connector from its mating half (Circuits 571 [BK/O] and 481 [R]).
- Turn ignition ON.
- Begin diagnostic trouble code flashout by connecting Circuit 571 (BK/O) to a chassis ground for at least 1 second.
- Observe and count code.

Is DTC 16 present?

Yes	No
GO to Drive Test Code 16.	If Code 7, GO to **7.7**. If different code, GO to pinpoint test for corresponding code.

7.7 PINPOINT TEST STATUS

Have all prior pinpoint tests been completed?

Yes	No

GO to **7.8** .	RETURN to last pinpoint test completed.

7.8 VERIFY INTEGRITY OF VEHICLE WIRING

If the above steps have been completed, the MOST LIKELY cause of the concern is wiring related.

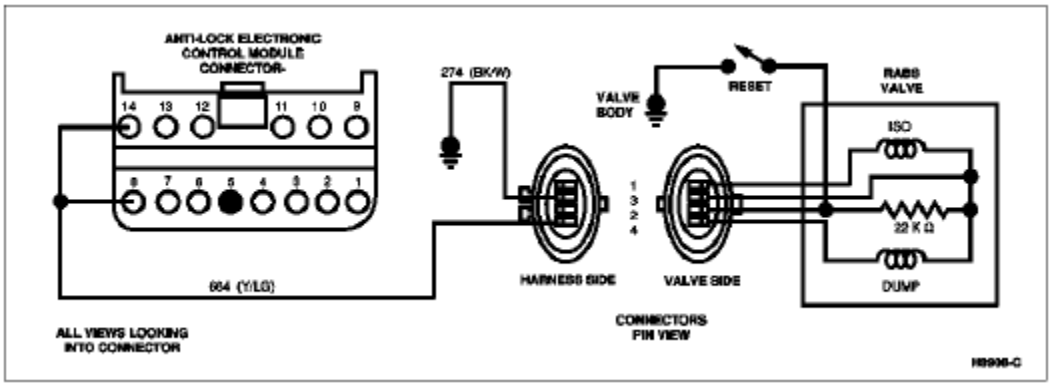
- Refer to Pinpoint Test ID , Intermittent Diagnosis Procedure and perform for ALL affected circuits as shown on this pinpoint test system schematic.

Is resolution achieved?

Yes	No
STOP. Repair is complete, GO to Drive Test Code 16 .	GO to **7.5** .

PINPOINT TEST CODE 8: NO DUMP SOLENOID DURING SELF-CHECK

Affected Circuit(s)/Electrical Component(s)



Description

Code 8 is generated when the anti-lock electronic control module detects a missing dump solenoid output. This concern can only be detected during an ignition self-test or during a RABS stop.

Possible Contributing Base Brake Component/Vehicle Wiring Concerns

- Anti-lock electronic control module internal fuse blown or internal open circuit
- Shorted dump solenoid internal to RABS valve
- Intermittent short or shorted circuit in Circuit 664 (Y/LG)
- Bulkhead connector between engine compartment and instrument panel terminals shorted

NOTE: Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent for electrical tests.

8.1 CHECK FOR RABS VALVE DUMP SOLENOID OR WIRING SHORTED TO GROUND

- Turn the ignition OFF.
- Disconnect battery ground cable.
- Remove the anti-lock electronic control module connector.
- Set the multimeter on the 200-ohm scale.
- Measure the resistance between anti-lock electronic control module harness connector Pin 8 and chassis ground.
- Measure the resistance between anti-lock electronic control module harness connector Pin 14 and chassis ground.

Is resistance between 1 and 3 ohms?

Yes	No
LEAVE anti-lock electronic control module connector disconnected. GO to **8.4** .	LEAVE anti-lock electronic control module connector disconnected. GO to **8.2** .

8.2 CHECK FOR SHORTED RABS DUMP SOLENOID

- Remove RABS valve connector.
- Set the multimeter on the 200-ohm scale.
- Measure the resistance between Pins 3 and 4 of RABS valve connector.

Is resistance greater than 1 ohm?

Yes	No
LEAVE RABS valve connector disconnected. GO to **8.3** .	REPLACE RABS valve. GO to **8.5** .

8.3 CHECK FOR SHORT TO GROUND ALONG HARNESS CIRCUIT 664 (Y/LG)

- Set multimeter on 20-ohm scale.
- Measure resistance to ground between anti-lock electronic control module harness connector Pin 8 and valve harness connector Pin 4.
- Measure resistance to ground between module harness connector Pin 14 and valve harness connector Pin 4.

Is resistance less than 10 ohms?

Yes	No
REPAIR short in Circuit 664 (Y/LG) between anti-lock electronic control module and RABS valve. GO to **8.5** .	Conflict of information. REPEAT **8.1** .

8.4 MAKE SURE ALL STEPS ARE COMPLETED

- This step requires that a valid diagnostic trouble code has been obtained, ALL prior diagnostic steps have been completed, and the affected wiring integrity has been verified.

CAUTION: Make sure to complete all steps. Failure to do so could lead to replacement of good parts.

Have all prior diagnostic steps been completed as described above?

Yes	No
REPLACE anti-lock electronic control module. GO to Step **8.5**. If anti-lock electronic control module has been replaced and no resolution has been reached, REPLACE RABS valve. GO to Step **8.5**.	GO to diagnostic step last completed and CONTINUE.

8.5 CLEAR CODE/PULL CODE

- Turn ignition OFF.

NOTE: When the battery ground cable has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.

- Reconnect battery ground cable.
- Verify all connectors are installed.
- Locate and disconnect the diagnostic connector from its mating half (Circuits 571 [BK/O] and 483 [R]).
- Turn ignition ON.
- Begin diagnostic trouble code flashout by connecting Circuit 571 (BK/O) to a chassis ground for at least 1 second.
- Observe and count code.

Is DTC 16 present?

Yes	No
GO to Drive Test Code 16.	If Code 8, GO to **8.6**. If different code, GO to pinpoint test for corresponding code.

8.6 PINPOINT TEST STATUS

Have all prior pinpoint tests been completed?

Yes	No

GO to **8.7** .	RETURN to last pinpoint test completed.

8.7 VERIFY INTEGRITY OF VEHICLE WIRING

If the above steps have been completed, the MOST LIKELY cause of the concern is wiring related.

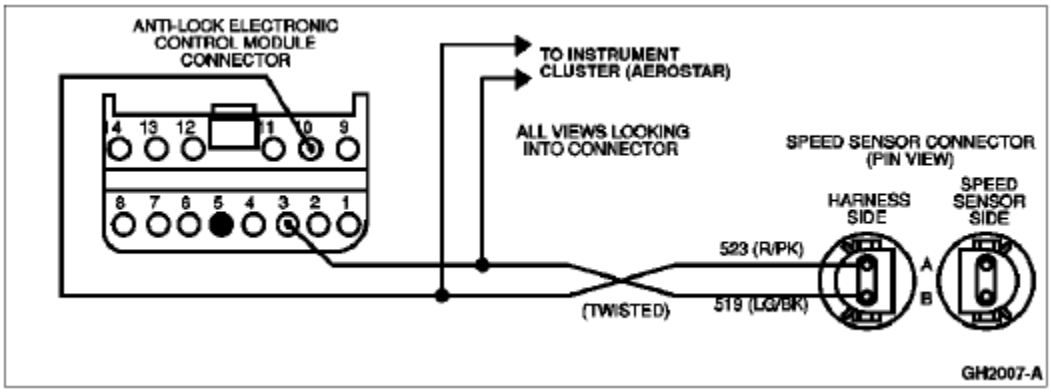
- Refer to Pinpoint Test ID , Intermittent Diagnosis Procedure and perform for ALL affected circuits as shown on this pinpoint test system schematic.

Is resolution achieved?

Yes	No
STOP. Repair is complete, GO to Drive Test Code 16 .	GO to **8.4** .

PINPOINT TEST CODE 9: HIGH SPEED SENSOR RESISTANCE

Affected Circuit(s)/Electrical Component(s)



Description

Code 9 is generated by the anti-lock electronic control module's detection of high speed sensor resistance. The anti-lock electronic control module will consider the speed sensor circuit to have a high resistance when it exceeds approximately 3 k Ohms. The code may also be generated by a failed internal anti-lock electronic control module circuit.

Possible Contributing Base Brake Component/Vehicle Wiring Concerns

- Terminal backout in the anti-lock electronic control module harness connector at Pin 3 or Pin 10
- Terminal backout in the RABS speed sensor harness connector at Pins A or B
- Module or RABS speed sensor connector not fully mated with component
- Open or intermittent open circuit in Circuits 519 (LG/BK) or 523 (R/PK)

NOTE: Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent for electrical tests.

9.1 VERIFY INTEGRITY OF ANTI-LOCK ELECTRONIC CONTROL MODULE CONNECTION

- Turn ignition OFF.
- Disconnect battery ground cable.
- Remove the anti-lock electronic control module connector.
- Pull gently on Circuit 519 (LG/BK) just behind Pin 10 on the harness connector.
- Pull gently on Circuit 523 (R/PK) just behind Pin 3 on the harness connector.

Is terminal fully engaged?

Yes	No
LEAVE anti-lock electronic control module connector disconnected. GO to **9.2** .	REPAIR terminal or connector as needed. GO to **9.6** .

9.2 VERIFY INTEGRITY OF SPEED SENSOR CONNECTION

- Remove speed sensor connector.
- Inspect speed sensor component connector for contamination or loose terminals.
- Gently pull on Circuit 519 (LG/BK) behind Pin B of harness connector.
- Gently pull on Circuit 523 (R/PK) behind Pin A of harness connector.

Are terminals clean and secure?

Yes	No
LEAVE speed sensor connector disconnected. GO to **9.3** .	REPAIR terminal or connectors as needed, if not repairable, REPLACE RABS speed sensor. GO to **9.6** .

9.3 CHECK FOR CONTINUITY ALONG HARNESS CIRCUITS 519 (LG/BK) and 523 (R/PK)

- Set multimeter on 200-ohm scale.
- Measure resistance between anti-lock electronic control module harness connector Pin 3 and speed sensor harness connector Pin B.
- Measure resistance between anti-lock electronic control module harness connector Pin 10 and speed sensor harness connector Pin A.

Is resistance less than 10 ohms?

Yes	No
Circuit is not open. GO to **9.4** .	FIND and REPAIR open circuit along Circuit 519 (LG/BK) and 523 (R/PK). GO to **9.6** .

9.4 CHECK FOR OPEN SPEED SENSOR

- Verify multimeter is on 20k Ohm scale.
- Measure resistance between RABS speed sensor Pins A and B.

Is resistance less than 3500 ohms?

Yes	No
GO to 9.5 .	REPLACE RABS speed sensor. GO to 9.6 .

9.5 MAKE SURE ALL STEPS ARE COMPLETED

- This step requires that a valid diagnostic trouble code has been obtained, ALL prior diagnostic steps have been completed, and the affected wiring integrity has been verified.

CAUTION: Make sure to complete all steps. Failure to do so could cause replacement of good parts.

Have all prior diagnostic steps been completed as described above?

Yes	No
REPLACE anti-lock electronic control module. GO to Step 9.6 . If anti-lock electronic control module has been replaced and no resolution has been reached, REPLACE rear axle speed sensor. GO to Step 9.6 .	GO to diagnostic step last completed and CONTINUE.

9.6 CLEAR CODE/PULL CODE

- Turn ignition OFF.

NOTE: When the battery ground cable has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.

- Reconnect battery ground cable.
- Verify all connectors are installed.
- Locate and disconnect the diagnostic connector from its mating half (Circuits 571 [BK/O] and 483 [R]).
- Turn ignition ON.
- Begin diagnostic trouble code flashout by connecting Circuit 571 (BK/O) to a chassis ground for at least 1 second.

- Observe and count code.

Is DTC 16 present?

Yes	No
GO to Drive Test Code 16 .	If Code 9, GO to **9.7** . If different code, GO to pinpoint test for corresponding code.

9.7 PINPOINT TEST STATUS

Have all prior pinpoint tests been completed?

Yes	No
GO to **9.8** .	RETURN to last pinpoint test completed.

9.8 VERIFY INTEGRITY OF VEHICLE WIRING

If the above steps have been completed, the MOST LIKELY cause of the concern is wiring related.

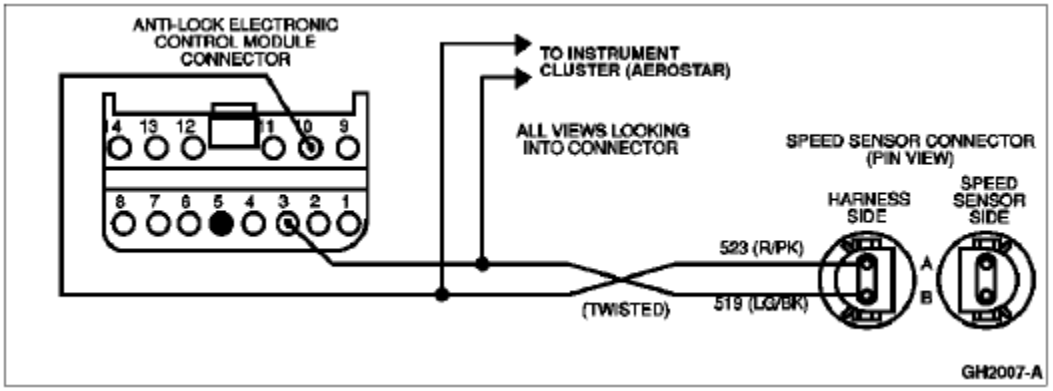
- Refer to Pinpoint Test ID , Intermittent Diagnosis Procedure and perform for ALL affected circuits as shown on this pinpoint test system schematic.

Is resolution achieved?

Yes	No
STOP. Repair is complete, GO to Drive Test Code 16 .	GO to **9.5** .

PINPOINT TEST CODE 10: LOW SPEED SENSOR RESISTANCE

Affected Circuit(s)/Electrical Component(s)



Description

Code 10 is generated by the anti-lock electronic control module's detection of low speed sensor resistance. The code may also be generated by a short circuit in the Circuits 519 (LG/BK) or 523 (R/PK), or a failed internal anti-lock electronic control module circuit.

Possible Contributing Base Brake Component/Vehicle Wiring Concerns

- Short between anti-lock electronic control module harness connector Pin 3 and Pin 10
- Short between RABS speed sensor connector Pins A and B
- Bulkhead connector (between engine compartment and instrument panel) speed sensor terminals shorted together
- Intermittent short circuit in Circuits 519 (LG/BK) or 523 (R/PK)
- Short in instrument cluster (Aerostar)

NOTE: Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent for electrical tests.

10.1 VERIFY INTEGRITY OF ANTI-LOCK ELECTRONIC CONTROL MODULE CONNECTION

- Turn ignition OFF.
- Disconnect battery ground cable.
- Remove the anti-lock electronic control module connector.
- Pull gently on wire just behind Pin 3 on the harness connector.
- Pull gently on wire just behind Pin 10 on the harness connector.

Is terminal fully engaged?

Yes	No
LEAVE anti-lock electronic control module connector disconnected. GO to **10.2** .	REPAIR terminal or connector as needed. GO to **10.7** .

10.2 VERIFY INTEGRITY OF SPEED SENSOR CONNECTION

- Remove speed sensor connector.
- Inspect speed sensor component connector.
- Gently pull on wire behind Pin B of harness connector.
- Gently pull on wire behind Pin A of harness connector.

Are all connections clean and secure?

Yes	No
LEAVE speed sensor connector disconnected.	Terminal(s) in component connector are loose, bent, deformed, or corroded. REPAIR terminal or connectors as needed, if not repairable, REPLACE speed sensor. GO to **10.7** .

GO to **10.3** .	Terminal(s) in harness connector move back or come free of connector. REPAIR terminal or connector as needed. GO to **10.7** .

10.3 CHECK FOR SHORT ALONG HARNESS CIRCUIT 519 (LG/BK) WITH CIRCUIT 523 (R/PK)

- Set multimeter on 20k Ohm scale.
- Verify instrument cluster connection is disconnected (Aerostar).
- Verify speed sensor connector is disconnected.
- Measure resistance between anti-lock electronic control module harness connector Pin 3 and Pin 10.

Is resistance greater than 20k Ohms?

Yes	No
Circuits are not shorted. GO to **10.4** .	FIND and REPAIR short along Circuits 519 (LG/BK) and 523 (R/PK). GO to **10.7** .

10.4 CHECK FOR SHORT TO CHASSIS GROUND ALONG CIRCUIT 523 (R/PK)

- Verify multimeter is on 20k Ohm scale.
- Measure resistance between anti-lock electronic control module harness connector Pin 10 and chassis ground.

Is resistance greater than 20k Ohms?

Yes	No
Circuit is not shorted. GO to **10.5** .	FIND and REPAIR short circuit along Circuit 523 (R/PK). GO to **10.7** .

10.5 CHECK FOR SHORTED SPEED SENSOR

- Verify multimeter is on 20k Ohm scale.
- Measure resistance between RABS speed sensor Pins A and B.

Is resistance steady and 800-3500 ohms?

Yes	No
GO to **10.6** .	REPLACE speed sensor. GO to **10.7** .

10.6 MAKE SURE ALL STEPS ARE COMPLETED

- This step requires that a valid diagnostic trouble code has been obtained, ALL prior diagnostic steps have been completed, and the affected wiring integrity has been verified.

CAUTION: Make sure to complete all steps. Failure to do so could cause replacement of good parts.

Have all prior diagnostic steps been completed as described above?

Yes	No
If Aerostar, GO to Step **10.7**. If Ranger, REPLACE anti-lock electronic control module. GO to Step **10.7**. If anti-lock electronic control module has been replaced and no resolution has been reached, REPLACE rear axle speed sensor. GO to Step **10.7**.	GO to diagnostic step last completed and CONTINUE.

10.7 CLEAR CODE/PULL CODE

- Turn ignition OFF.

NOTE: When the battery ground cable has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.

- Reconnect battery ground cable.
- Verify all connectors are installed (leave instrument cluster disconnected Aerostar only).
- Locate and disconnect the diagnostic connector from its mating half (Circuits 571 [BK/O] and 483 [R]).
- Turn ignition ON.
- Begin diagnostic trouble code flashout by connecting Circuit 571 (BK/O) to a chassis ground for at least 1 second.
- Observe and count code.

Is Code 16 set?

Yes	No
If Aerostar, REPLACE instrument cluster. GO to Drive Test Code 16. If Ranger, GO to Drive Test Code 16.	If Ranger, Code 10, GO to **10.8**. If Aerostar, Code 10, REPLACE anti-lock electronic control module. GO to **10.8**. If different code, GO to pinpoint test for corresponding code.

10.8 PINPOINT TEST STATUS

Have all prior pinpoint tests been completed?

Yes	No
GO to **10.9**.	RETURN to last pinpoint test completed.

10.9 VERIFY INTEGRITY OF VEHICLE WIRING

If the above steps have been completed, the MOST LIKELY cause of the concern is wiring related.

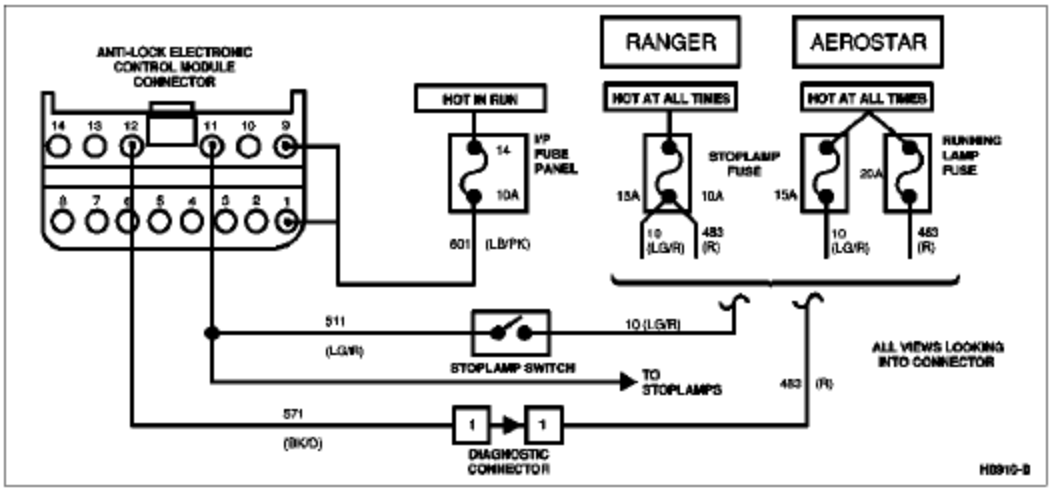
- Refer to Pinpoint Test ID , Intermittent Diagnosis Procedure and perform for ALL affected circuits as shown on this pinpoint test system schematic.

Is resolution achieved?

Yes	No
STOP. Repair is complete GO to Drive Test Code 16 .	GO to **10.6** .

PINPOINT TEST CODE 11: STOPLAMP SWITCH ALWAYS CLOSED

Affected Circuit(s)/Electrical Component(s)



Description

Code 11 is caused by the stoplight switch (13480) being closed prior to the vehicle moving. If the stoplight switch remains closed when the vehicle begins to move, the REAR ABS warning light will turn on at approximately 26 km/h (16 mph). Code 11 will not be latched in the anti-lock electronic control modules memory until the speed of the vehicle exceeds 60 km/h (37 mph) for at least 10 seconds. If the vehicle does not exceed 60 km/h (37 mph) for at least 10 seconds, then the REAR ABS warning light will turn on but the anti-lock electronic control module will not latch a code. Code 11 can be caused by a driver who is resting his or her foot on the brake pedal with just enough pressure to close the stoplight switch, while driving at least 60 km/h (37 mph) for a minimum of 10 seconds. When this occurs, a Code 11 will be latched by the anti-lock electronic control module.

Possible Contributing Base Brake Component/Vehicle Wiring Concerns

- Terminal backout in the anti-lock electronic control module harness connector at Pin 11
- Missing (burned-out) stoplight bulbs. All stoplight bulbs must be missing or burned-out to cause a Code 11
- An intermittent/continuous open in Circuit 810 (R/LG) for Aerostar or 511 (LG) for Ranger. This open

would be between module connector Pin 11 and the stoplight switch
- Worn or damaged stoplight switch

NOTE: Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent for electrical tests.

11.1 CHECK VEHICLE STOPLIGHT OPERATION

- Turn ignition to the OFF position.
- Apply pressure to the brake pedal and then release pressure while observing the stoplights.

Do lights work properly?

Yes	No
GO to **11.4** .	Lights do not illuminate. GO to **11.2** . Lights always illuminated. REPAIR or REPLACE stoplight switch. GO to **11.6** .

11.2 CHECK VEHICLE STOPLIGHTS

- Check vehicle stoplight bulbs.

  NOTE: Both stoplight bulbs need to be burned out to cause a Code 11.

Are the stoplight bulbs burned out?

Yes	No
REPLACE stoplight bulbs and GO to **11.6** .	GO to **11.3** .

11.3 CHECK FOR BLOWN STOPLIGHT FUSE

- Remove and visually inspect stoplight fuse located in the fuse panel.

Is the fuse blown?

Yes	No
REPLACE fuse and investigate reason for blown fuse. GO to **11.6** .	CHECK Circuit 511 (LG) for open condition. If none found, then REPAIR or REPLACE stoplight switch. GO to **11.6** .

11.4 CHECK FOR CONTINUITY BETWEEN ANTI-LOCK ELECTRONIC CONTROL MODULE CONNECTOR PIN 11 AND THE STOPLIGHT SWITCH

- Set multimeter on 20-volt scale.
- Step on brake pedal.
- Measure voltage between module connector Pin 11 and chassis ground.

Is the voltage greater than 9 volts?

Yes	No
REINSTALL all connectors. CALL the Hotline.	Voltage is less than 2 volts. FIND and REPAIR open circuit between anti-lock electronic control module connector (Pin 11), and stoplight switch. REINSTALL all connectors. GO to **11.5** .

11.5 MAKE SURE ALL STEPS ARE COMPLETED

- This step requires that a valid diagnostic trouble code has been obtained, ALL prior diagnostic steps have been completed, and the affected wiring integrity has been verified.

  CAUTION: Make sure to complete all steps. Failure to do so could cause replacement of good components.

Have all prior diagnostic steps been completed as described above?

Yes	No
REPLACE anti-lock electronic control module. GO to **11.6** . If anti-lock electronic control module has been replaced and no resolution has been reached, REPLACE stoplight switch. GO to **11.6** .	GO to diagnostic step last completed and continue.

11.6 CLEAR CODE/PULL CODE

- Turn ignition OFF.

  NOTE: When the battery ground cable has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.

- Reconnect battery ground cable.
- Verify all connectors are installed.
- Locate and disconnect the diagnostic connector from its mating half (Circuits 571 [BK/O] and 483 [R]).
- Turn ignition switch ON.
- Begin diagnostic trouble code flashout by connecting Circuit 571 (BK/O) to a chassis ground for at least 1 second.
- Observe and count code.

Is Code 16 set?

Yes	No
GO to Drive Test Code 16 .	If Code 11, GO to **11.7** . If different code, GO to pinpoint test for corresponding code.

11.7 PINPOINT TEST STATUS

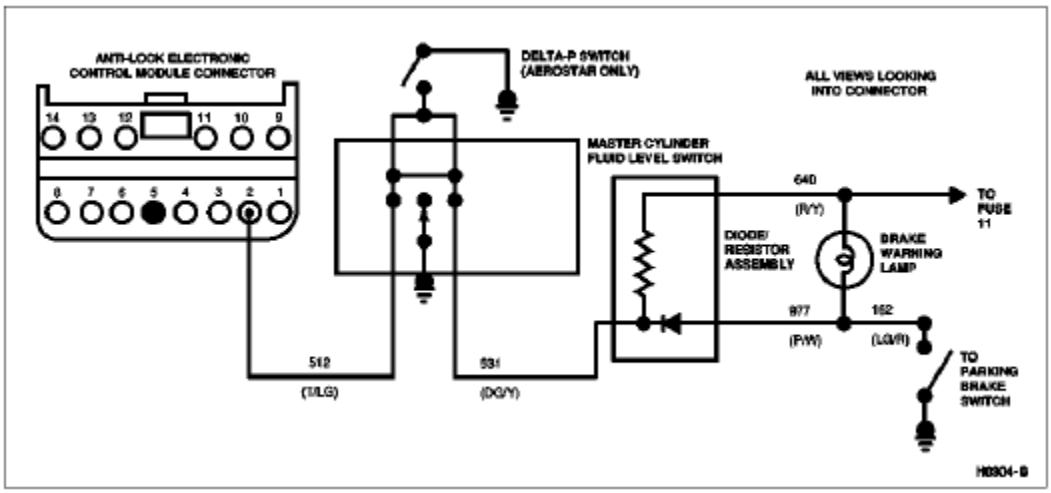
Have all pinpoint tests been completed?

Yes	No
GO to Drive Test Code 16 .	RETURN to last pinpoint test completed.

PINPOINT TEST CODE 12: LOSS OF HYDRAULIC BRAKE FLUID DURING AN ANTI-LOCK STOP

Pinpoint Test 12: Yellow Rear ABS Warning Light Flashes 12 Times When Retrieving Diagnostic Trouble Codes (Code 12)

Affected Circuit(s)/Electrical Component(s)



Description

Code 12 is generated when the anti-lock electronic control module detects that the brake fluid level in the brake master cylinder reservoir (2K478) is low for one or more seconds. It can also be generated by a short in the stoplight circuit.

Possible Contributing Base Brake Component/Vehicle Wiring Concerns

- Low brake master cylinder fill level
- Brake fluid leaks in vehicle brake system

- Worn or damaged master cylinder brake fluid level switch, or brake fluid level circuit shorted to ground
- Brake master cylinder reservoir float that sticks in the bottom of brake master cylinder reservoir or does not float
- Failed diode-resistor element in stoplight circuit
- Damaged ignition switch
- Ground short in Circuits 512 (T/LG) or 531 (DG/Y)
- Damaged anti-lock electronic control module

NOTE: Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent for electrical tests.

12.1 CHECK WARNING LIGHTS

- Key OFF.
- Locate and disconnect the diagnostic connector from its mating half (Circuits 571 [BK/O] and 483 [R]).
- Reconnect diagnostic connector.
- Key ON.

Do BOTH the red BRAKE and yellow RABS lamps come on?

Yes	No
HARD fault. GO to **12.2** .	If the brakes have been repaired recently, or if brake fluid has been added to the system recently, MOST likely, the Code 12 was falsely set at that time and the RABS is OK. If this is NOT the case, GO to Pinpoint Test ID for intermittent diagnosis procedures for the affected circuits. REFER to the system schematic for this pinpoint test. If yellow RABS lamp is ON and Code 12 is present, REPAIR open circuit on Pin 2, Circuit 512 (T/LG).

12.2 CHECK BRAKE FLUID LEVEL IN MASTER CYLINDER

- Key OFF.
- Check the brake fluid level in the brake master cylinder reservoir.

Is the fluid level within specification?

Yes	No
GO to **12.3** .	CHECK for leaks in the brake system. REPAIR as required. FILL brake master cylinder reservoir to the required level. GO to **12.9** .

12.3 VERIFY FLOAT BUOYANCY

- Remove the brake master cylinder filler cap.
- Attempt to push down the float with a clean, blunt steel implement, then let it float back up.

Does the float go down then float back up?

Yes	No
GO to 12.4 .	The float stays on the bottom of the brake master cylinder reservoir. REPLACE the brake master cylinder reservoir. BLEED the brake system. GO to 12.9 .

12.4 CHECK CIRCUIT 531 (DG/Y) FOR GROUND SHORT

- Key OFF.
- Disconnect brake fluid level switch harness connector.
- Disengage parking brake.
- Check for ground short on Circuit 531 (DG/Y) at brake fluid level switch harness connector.

Is there a ground short?

Yes	No
REPAIR ground short in Circuit 531 (DG/Y). RECONNECT all components. GO to 12.9 .	GO to 12.5 .

12.5 CHECK DIODE/RESISTOR ELEMENT

- Engage parking brake.
- Check for ground short on Circuit 531 (DG/Y) at brake fluid level switch harness connector.

Is there a ground short?

Yes	No
REPLACE resistor/diode element. RECONNECT all components. GO to 12.9 .	GO to 12.6 .

12.6 CHECK CIRCUIT 512 (T/LG) FOR GROUND SHORT

- Key OFF.
- Disconnect battery ground cable.
- Disconnect fluid level switch.
- Disconnect ignition switch.
- Disconnect anti-lock electronic control module.
- Check for short to ground on Pin 2 of anti-lock electronic control module harness connector (Circuit 512 [T/LG]).

Is there a ground short?

Yes	No
REPAIR ground short in Circuit 512 (T/LG). RECONNECT all components. GO to **12.9** .	GO to **12.7** .

12.7 CHECK IGNITION SWITCH

- Reconnect ignition switch.
- Check for short to ground on Pin 2 of anti-lock electronic control module harness connector (Circuit 512 [T/LG]).

Is there a ground short?

Yes	No
REPLACE ignition switch. RECONNECT all components. GO to **12.9** .	GO to **12.8** .

12.8 CHECK BRAKE FLUID LEVEL SWITCH

- Reconnect brake fluid level switch.
- Check for short to ground on Pin 2 of anti-lock electronic control module harness connector (Circuit 512 [T/LG]).

Is there a ground short?

Yes	No
REPLACE brake fluid level switch. RECONNECT all components. GO to **12.9** .	REPLACE anti-lock electronic control module. GO to **12.9** .

12.9 CLEAR CODE/PULL CODE

- Key OFF.

  NOTE: When the battery ground cable has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.

- Verify all connectors are installed.
- Locate and disconnect the diagnostic connector from its mating half (Circuits 571 [BK/O] and 483 [R]).
- Key ON.
- Begin diagnostic trouble code flashout by grounding Circuit 571 (BK/O) for 1 second.

Was DTC 16 or 12 retrieved?

Yes	No

DTC 16. GO to Pinpoint Test DT4 .DTC 12. If all steps are complete, GO to Pinpoint Test ID . If all steps are not complete, return to the last step completed and continue.	A different code. GO to pinpoint test for corresponding DTC.

Code 13, RABS II Module Failure

Description

Code 13 is generated when a fault is found with the anti-lock electronic control module. The anti-lock electronic control module must be replaced and Drive Test Code 16 must be performed.

Code 16

Description

Code 16 is always present, unless a system concern has been detected and a diagnostic trouble code has been stored. This code should be used by the technician to verify that the RABS system is OK.

Code 16 will be output by the anti-lock electronic control module (2C018) when one of two conditions exist:

1. The technician grounds Circuit 571 (BK/O).

2. The RABS keep-alive memory (KAM) fuse has blown.

   If the KAM fuse has blown, the REAR ABS warning light will begin flashing Code 16 (or a diagnostic trouble code if a concern has been detected) if the stoplight switch (13480) is depressed (Ranger), or the running lamps are turned on (Aerostar).

   Therefore, check the KAM fuse when diagnosing complaints of REAR ABS light flashing.

PINPOINT TEST DT4: DRIVE TEST CODE 4

Purpose

CAUTION: Perform this test only when directed to do so. This drive test is only designed to resolve a Code 4 condition. Performing this test for any other reason will often lead to incorrect diagnosis of system problem and incorrect replacement of components.

This drive test assumes that pinpoint test Code 4 has been completed. If this is not the case, complete the test before proceeding.

If Pinpoint Test Code 4 is not successful in resolving the system concern, this drive test can be used to conduct additional, more in depth, diagnostics.

Drive Description

This drive test is designed to induce a Code 4 if there is a system concern that can create a Code 4 on a repeatable basis. Carefully record the data when performing the drive test. Know what part of the drive test you are in when a diagnostic trouble Code 4 is detected.

DT4.1 VERIFY PROPER WARNING LIGHT PROVE OUT

- Start the vehicle and observe the REAR ABS warning light for proper warning light prove out.

Does the REAR ABS warning light prove out properly?

Yes	No
GO to **DT4.2** .	GO to System Pre-Check Pinpoint Test A . RETURN to this step after completion.

DT4.2 RABS VALVE RESET SWITCH CHECK

CAUTION: Do not exceed 16 km/h (10 mph) to prevent flat-spotting of tires.

- Drive the vehicle at approximately 16 km/h (10 mph) on dry pavement.
- Press on brake pedal hard enough to lock all four wheels.
- After the vehicle has stopped, place the vehicle in PARK and take foot off the brake pedal.
- Wait 30 seconds.

Does the RABS warning light come on?

Yes	No
Key OFF. GO to **DT4.4** .	Key OFF. GO to **DT4.3** .

DT4.3 RABS HYDRAULIC VALVE LEAK TEST

- Press hard on the brake pedal and keep pressure on the brake pedal for 30 seconds.
- While keeping pressure on the brake pedal, monitor the height of the brake pedal.

NOTE: The condition is similar to the master cylinder bypass condition. It is important that the brake pedal be quickly and forcefully applied to rule out master cylinder bypass as the cause if a hydraulic leak is detected. Typically, master cylinder bypass only occurs at low line pressures.

Does the brake pedal drop slowly toward the floor?

Yes	No
REPLACE RABS valve. GO to Drive Test Code 16 to verify concern is resolved.	RETURN to **DT4.1** .

DT4.4 OBTAIN DIAGNOSTIC TROUBLE CODE

- Obtain Diagnostic Trouble Code.

Is Code 4 obtained?

Yes	No

Key OFF. GO to **DT4.5** .	If Code 16 is obtained: inconsistent result If RABS warning light did come on in **DT4.2** then a Diagnostic Trouble Code other than Code 16 should be stored. REPEAT **DT4.4** and VERIFY Code 16 is obtained. If any other code is obtained, GO to the pinpoint test for the code obtained. If no code is obtained, GO to System Pre-Check Pinpoint Test D .

DT4.5 BLOCKED ISOLATION ORIFICE

- Disconnect anti-lock electronic control unit.
- Raise the vehicle on a hoist far enough to allow all wheels to spin freely.
- Verify that the vehicle is in 4x2 mode and the hubs are unlocked (4x4 only).
- Start the vehicle, place in DRIVE and allow rear wheels to spin at idle for at least 30 seconds.
- Apply the brake pedal with the force of a normal traffic stop.

Do the rear wheels react uncharacteristically slowly or continue to spin?

Yes	No
RECONNECT anti-lock electronic control unit. REPLACE anti-lock brake control module. GO to Drive Test—Code 16 to verify concern is resolved.	Anti-lock brake control module valve is OK. RECONNECT anti-lock electronic control unit. RETURN to Pinpoint Test — Code 4 (Step **4.11**).

PINPOINT TEST DT5: DRIVE TEST CODE 5

Purpose

CAUTION: Only perform this test when directed to do so. This drive test is only designed to resolve a Code 5 condition. Performing this test for any other reason will often lead to incorrect diagnosis of system problem and incorrect replacement of components.

This drive test assumes that pinpoint test Code 5 has been completed. If this is not the case, complete the test before proceeding.

If the pinpoint test Code 5 is not successful in resolving the system concern, this drive test can be used to conduct additional, more in depth, diagnostics.

Drive Description

NOTE: 4-wheel drive issue Aerostar only.

This drive test is designed to induce a Code 5 if there is a condition that can create a Code 5 on a repeatable basis. Carefully record the data when performing the drive test. It is important to know what part of the drive test you are in when diagnostic trouble Code 5 is detected.

Discuss with the customer to determine if the vehicle was in four-wheel drive when the light came on (Aerostar only). During normal 4x2 anti-lock operation, the anti-lock electronic control module energizes the dump solenoid a maximum of 16 times without interruption. Conditions experienced in 4x2 operation will not require more than 16 dump pulses. If the anti-lock electronic control module notices that conditions call for a 17th dump pulse, it assumes there is a problem with RABS II system, deactivates the system (turning the REAR ABS warning light on), and sets a Code 5. During normal 4x4 operation, (Aerostar only) the anti-lock electronic control module only allows 16 dump pulses but does not deactivate the anti-lock electronic control module or light the yellow REAR ABS warning light if more than 16 dump pulses are requested. If, for reasons described below, the anti-lock electronic control module receives incorrect information from the 4x4 switch, and therefore improperly assumes the vehicle is in 4x2, a Code 5 will often be improperly set. The most common reasons for incorrect information being sent to the anti-lock electronic control module are:

- 4x4 indicator switch worn or damaged.
- Vehicle wiring concern in Circuit 210 (LB) between the 4x4 indicator switch and the anti-lock electronic control module.
- Customer has switched from 4x4 to 4x2 but the transfer case has not yet disengaged.

  NOTE: The customer must also enter an anti-lock stop, at the same time, for this event to occur.

- AWD system does not properly disengage upon brake application (Aerostar AWD ONLY).

DT5.1 VERIFY PROPER WARNING LIGHT PROVE OUT

- Start the vehicle and observe the REAR ABS warning light for proper warning light prove out.

Does the REAR ABS warning light prove out properly?

Yes	No
GO to **DT5.2** .	GO to System Pre-Check Pinpoint Test A . RETURN.

DT5.2 BASE BRAKE STOPPING TEST

- Remove the harness connector from the anti-lock electronic control module.
- Drive the vehicle at approximately 32 km/h (20 mph).
- Perform a light to medium (normal traffic) stop.

Do the rear wheels lock up?

Yes	No
RECONNECT anti-lock electronic control module. REFER to Base Brake Diagnosis in Section 06-00 for Rear-Wheel Lock.	RECONNECT anti-lock electronic control module. GO to **DT5.3** .

DT5.3 DRY ROAD STOP TEST

CAUTION: Do not exceed 16 km/h (10 mph) to prevent flat-spotting of tires.

- Drive the vehicle at approximately 16 km/h (10 mph) on dry pavement.
- Press on brake pedal hard enough to lock all four wheels and observe the left rear wheel in the driver's mirror.

Do the rear wheels lock up? (Momentary lockup followed by spinup is permissible.)

Yes	No
REPLACE anti-lock electronic control module. GO to Drive Test—Code 16 to verify concern is resolved.	GO to **DT5.4** .

DT5.4 VERIFY PROPER RABS OPERATION IN 4X2

WARNING: PERFORM THIS TEST ON AN AXLE HOIST ONLY.

NOTE: Because vehicle is not on the ground, wheels will spin for a significant time. This is not indicative of vehicle braking performance.

- Place vehicle on the hoist and raise high enough to clear all wheels off the ground.
- Verify vehicle is in 4x2 mode. (Aerostar only)
- Place vehicle transmission in Drive Low (automatic) or First gear (manual).
- Accelerate vehicle drive wheels to 16 km/h (10 mph).
- Press hard on the brake pedal until wheels stop.

Do the rear wheels first lock up and then spin?

Yes	No
LEAVE key ON. GO to **DT5.5** .	REPLACE anti-lock electronic control module. GO to Drive Test Code 16 to verify concern is resolved.

DT5.5 OBTAIN DIAGNOSTIC TROUBLE CODE

- Obtain diagnostic trouble code.

Is Code 5 obtained?

Yes	No
Inconsistent result DT5.4 indicates RABS valve is functioning correctly. CLEAR code REPEAT DT5.4. If result repeats, RETURN to pinpoint	Code obtained is Code 16. RETURN to pinpoint test — Code 5, Step **5.6** . Code obtained is NOT Code 5. GO to the pinpoint test for the code obtained.

test — Code 5, Step **5.6** .	No code is obtained. GO to System Pre-Check, Pinpoint Test D .

PINPOINT TEST DT6: DRIVE TEST CODE 6

Purpose

CAUTION: Only perform this test when directed to do so. This drive test is only designed to resolve a Code 6 condition. Performing this test for any other reason will often lead to incorrect diagnosis of system problem and incorrect replacement of components.

This drive test assumes that pinpoint test Code 6 has been completed. If this is not the case, complete the test before proceeding.

If pinpoint test Code 6 is not successful in resolving the system concern, this drive test can be used to conduct additional, more in depth, diagnostics.

Drive Description

This drive test is designed to induce a Code 6 if there is a system concern that can create a Code 6 on a repeatable basis. Carefully record the data when performing the drive test. It is important to know what part of the drive test you are in when a Code 6 diagnostic trouble code is detected.

DT6.1 VERIFY INTEGRITY OF ANTI-LOCK ELECTRONIC CONTROL MODULE CONNECTION

- Turn ignition OFF.
- Disconnect battery ground cable.
- Remove the anti-lock electronic control module connector.
- Inspect anti-lock electronic control module component connector for contamination and loose or bent terminals.
- Pull gently on Circuit 519 (LG/BK) just behind Pin 10 on the harness connector.
- Pull gently on Circuit 523 (R/PK) just behind Pin 3 on the harness connector.

Are all connections clean and secure?

Yes	No
LEAVE anti-lock electronic control module connector disconnected. GO to **DT6.2** .	Terminal(s) in component connector are corroded, bent, or loose. REPAIR terminals or connector as needed. If not repairable, REPLACE anti-lock electronic control module. GO to **DT6.7** . Terminal(s) in harness connector are corroded, bent, or move back or come free of connector. REPAIR terminals or connector as needed. GO to **DT6.7** .

DT6.2 VERIFY INTEGRITY OF SPEED SENSOR CONNECTION

- Verify ignition is OFF.
- Remove speed sensor connector.
- Inspect speed sensor component connector for contamination and bent or loose terminals.
- Gently pull on Circuit 519 (LG/BK) behind Pin A of harness connector.
- Gently pull on Circuit 523 (R/PK) behind Pin B of harness connector.

Are all connections clean and secure?

Yes	No
REINSTALL speed sensor connector. GO to **DT6.3** .	Terminal(s) in component connector are corroded, bent, or loose. REPAIR terminal or connector as needed. If not repairable, REPLACE speed sensor. GO to **DT6.7** . Terminal(s) in harness connector are corroded, bent, or move back or come free of connector. REPAIR terminal or connector as needed. GO to **DT6.7** .

DT6.3 VERIFY PROPER SPEED SENSOR WIRE ROUTING

- Inspect wire routing.

Are wires secure and properly routed?

Yes	No
GO to **DT6.4** .	FIND and REPAIR as necessary. GO to **DT6.7** .

DT6.4 VERIFY SPEED SENSOR INTEGRITY

- Set multimeter on the 20k Ohm scale.
- Check resistance between Pins A and B of the sensor connector.

Is resistance between 900 and 2500 ohms?

Yes	No
GO to **DT6.5** .	REPLACE RABS speed sensor. GO to **6.6** .

DT6.5 CHECK FOR ERRATIC SPEED SENSOR SIGNAL AND LOOSE WIRE CONNECTORS

- Set multimeter on the 20k Ohm scale.

- Check resistance between Pin 10 and Pin 3 of the harness connector while shaking the harness from speed sensor to anti-lock electronic control module.

Is reading steady and between 900 and 2500 ohms?

Yes	No
Signal is not erratic. GO to **DT6.6** .	FIND and REPAIR open/short circuit along Circuits 519 (LG/BK) and 523 (R/PK). GO to **DT6.7** .

DT6.6 CHECK FOR METAL CHIPS ON SPEED SENSOR MAGNET POLE PIECE

- Verify ignition is OFF.
- Remove the speed sensor from the rear axle housing and inspect for a buildup of metal chips on speed sensor magnetic pole.

Are metal chips present?

Yes	No
LEAVE speed sensor out. GO to **DT6.7** .	DRAIN and CLEAN rear axle housing. GO to **DT6.7** .

DT6.7 MAKE SURE ALL STEPS ARE COMPLETED

CAUTION: Be sure to complete all steps. Failure to do so could lead to replacing good components.

- This step requires that a valid diagnostic trouble code has been obtained, ALL prior diagnostic steps have been completed, and the affected wiring integrity has been verified.

Have all prior diagnostic steps been completed as described above?

Yes	No
REPLACE anti-lock electronic control module. GO to **DT6.8** . If anti-lock electronic control module has been replaced and no resolution has been reached, REPLACE rear axle speed sensor. GO to **DT6.8** .	GO to diagnostic step last completed and CONTINUE.

DT6.8 CLEAR CODE/PULL CODE

- Turn ignition OFF.

NOTE: When the battery ground cable has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the

strategy.

- Reconnect battery ground cable.
- Verify all connectors are installed.
- Locate and disconnect the diagnostic connector from its mating half (Circuits 571 [BK/O] and 483 [R]).
- Turn ignition ON.
- Begin diagnostic trouble code flashout by connecting Circuit 571 (BK/O) to a chassis ground for at least 1 second.

Can DTC 16 or 6 be determined?

Yes	No
Diagnostic trouble code = 16. GO to Pinpoint Test DT1 .Diagnostic trouble code = 6. GO to **DT6.9** .	Diagnostic trouble code is different than before. GO to Pinpoint Test for corresponding code.

DT6.9 PINPOINT TEST STATUS

Has pinpoint test been completed?

Yes	No
GO to **DT6.10** .	RETURN to last pinpoint test completed.

DT6.10 VERIFY INTEGRITY OF VEHICLE WIRING

If the above steps have been completed, the MOST LIKELY cause of the concern is wiring related.

- REFER to Pinpoint Test ID , Intermittent Diagnosis Procedure and perform for ALL affected circuits as shown on system schematic.

Is resolution achieved?

Yes	No
STOP. Repair is complete. GO to Pinpoint Test DT1 .	Problem is intermittent. GO to Drive Test Code 6 .

PINPOINT TEST DT1: DRIVE TEST CODE 16

Purpose

This drive test will be used when either of the two conditions listed below exists.

- Required Repair Verification

This drive procedure will be used after all vehicle repairs. Once a vehicle has been repaired, it is necessary to verify the repair by driving the vehicle. This is because the anti-lock electronic control module is unable to

detect some system concerns until the vehicle is being driven a certain way. Therefore the drive verification test is a very important step.

- Symptom Evaluation Drive

When a vehicle is brought to the dealer, the customer may only have a general concern about the way their vehicle is braking. In these situations there may not be a clear system concern to troubleshoot. In this type of situation, this drive test is designed to produce common system concern symptoms. Use this drive test to determine a symptom. Once a symptom is found, a symptom troubleshooting procedure can be followed to repair the vehicle.

Drive Description

This drive test is designed to be a generic drive test that is used for three purposes listed below.

- To verify a repair of the RABS system on a vehicle.
- To attempt to recreate an intermittent concern.
- To attempt to detect a symptom when a diagnostic trouble code or a concern symptom is not known.

DT1.1 KEEP-ALIVE MEMORY (KAM) FUSE CHECK

- Key ON. Observe REAR ABS light prove out.
- Turn on headlamps and press on the brake pedal.
- With the headlamps ON and while pushing on the brake pedal, monitor the yellow REAR ABS light in the dash for 10 seconds.

Does the REAR ABS light prove out normally?

Yes	No
GO to **DT1.2** .	REPLACE KAM fuse (SEE Owner's Manual for fuse location). REPEAT **DT1.1** .

DT1.2 LOW SPEED REAR ABS STOP

NOTE: Wetting down the area where stop is to be performed will aid this test.

- An assistant to observe rear wheels would be helpful.
- Drive vehicle at approximately 16 km/h (10 mph).
- Press on brake pedal hard enough to lock all four wheels, and observe the left rear wheel in the driver's mirror.
- Repeat the second step, except observe right rear wheel in passenger mirror.

Do either or both rear wheels lock consistently and is REAR ABS light on? (Momentary lockup is permissible.)

Yes	No
GO to Symptom Chart B . One or both rear	GO to **DT1.3** . If other symptoms are detected, GO to **DT1.6** . If REAR ABS light comes on and

wheels lock up.	stays on, GO to **DT1.7** .

DT1.3 CHECK FOR UNWARRANTED RABS ACTIVITY

NOTE: Stop should be performed on dry pavement.

- Drive vehicle at approximately 32 km/h (20 mph).
- Perform a light to medium (normal traffic) stop.
- Turn off the windshield wipers if they are on. (Wipers can cause a pulsation in the brake pedal that can be mistaken for RABS activity.) Feel for pulsation in the brake pedal within 10 seconds after the vehicle has come to a stop.

Is there any pulsation in the brake pedal any time during the stop or within 10 seconds after the vehicle has stopped and is REAR ABS light on?

Yes	No
GO to Symptom Chart A , Unwarranted RABS Activity.	GO to **DT1.4** . If other symptoms are detected, GO to **DT1.6** . If REAR ABS light comes on and stays on, GO to **DT1.7** .

DT1.4 BRAKE STOP LAMP/SWITCH CHECK

- Turn ignition switch ON.
- Press on the brake pedal.
- Release brake pedal.

Do the stoplamps come on and then turn off properly?

Yes	No
GO to **DT1.5** .	GO to Pinpoint Test Code 11 .

DT1.5 DETERMINE DRIVE TEST IS COMPLETE

Has customer concern been addressed and corrected by previous actions?

Yes	No
STOP. Vehicle RABS function has been verified.	REFER to Symptom Chart A , Unwarranted RABS Activity.

DT1.6 DETERMINE NEXT DIAGNOSTIC STEP BASED ON BRAKE SYMPTOM

- Hard or soft brake pedal
- Lack of sufficient vehicle deceleration upon brake application

Are any of the above symptoms present?

Yes	No
GO to Symptom Chart C , Hard or Soft Brake Pedal.	Concern is not in the RABS system. REFER to Section 06-00 for diagnosis.

DT1.7 OBTAIN DIAGNOSTIC TROUBLE CODE

- Obtain diagnostic trouble code.

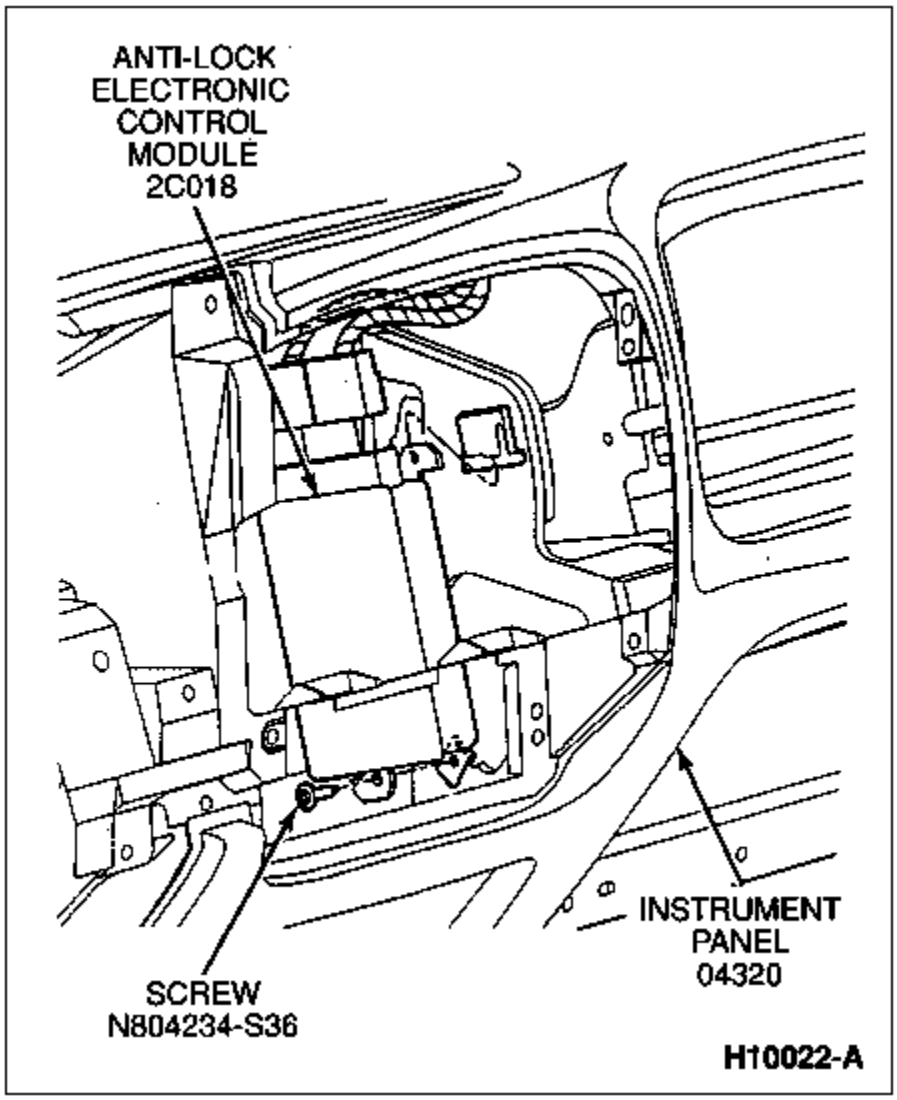
Is the diagnostic trouble code the same as before and has the entire pinpoint test for the code been completed?

Yes	No
REDO steps once more.	RETURN to the last step completed in the pinpoint test. If different code is obtained, GO to the pinpoint test for the code obtained. If no code is obtained, GO to System Pre-Check Test Pinpoint D.

Anti-Lock Electronic Control Module

Removal

1. Remove the instrument panel finish panel (044D70). Refer to Section 01-12 .
2. Remove the anti-lock electronic control module-to-instrument panel screw.



3. Slide the anti-lock electronic control module (2C018) to release the upper tab from the instrument panel brace.

4. Disconnect the electrical connectors and remove the anti-lock electronic control module.

Installation

To install, reverse the removal procedure.

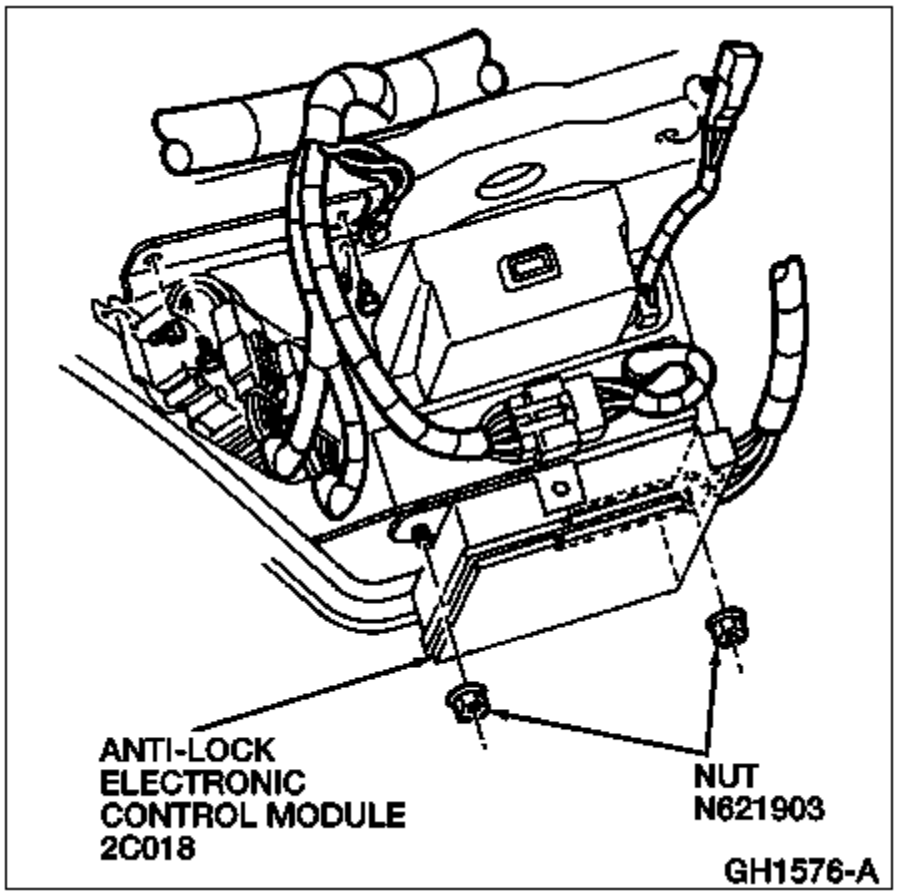
Anti-Lock Electronic Control Module, Aerostar

Removal

1. Disconnect the wiring harness from the RABS II connector by depressing the plastic tab on the connector and pulling the connector off.
2. Remove the two nuts that retain the anti-lock electronic control module (2C018) to the instrument panel anti-shake brace.
3. Remove the anti-lock electronic control module from the anti-shake brace.

Installation

1. Position the anti-lock electronic control module on the anti-shake brace.
2. Install the two nuts that hold the anti-lock electronic control module to the anti-shake brace.
3. Connect the wiring harness to the anti-lock electronic control module.
4. Check the system for proper operation.


ANTI-LOCK
ELECTRONIC
CONTROL MODULE
2C018
NUT
N621903
GH1576-A

RABS Valve, Ranger

Removal

1. At the RABS valve, disconnect and plug the RABS valve input and output tubes.
2. Disconnect the wiring harness to the RABS valve.
3. Remove the bolt retaining the RABS valve to the frame side rail (5015) and remove the RABS valve.

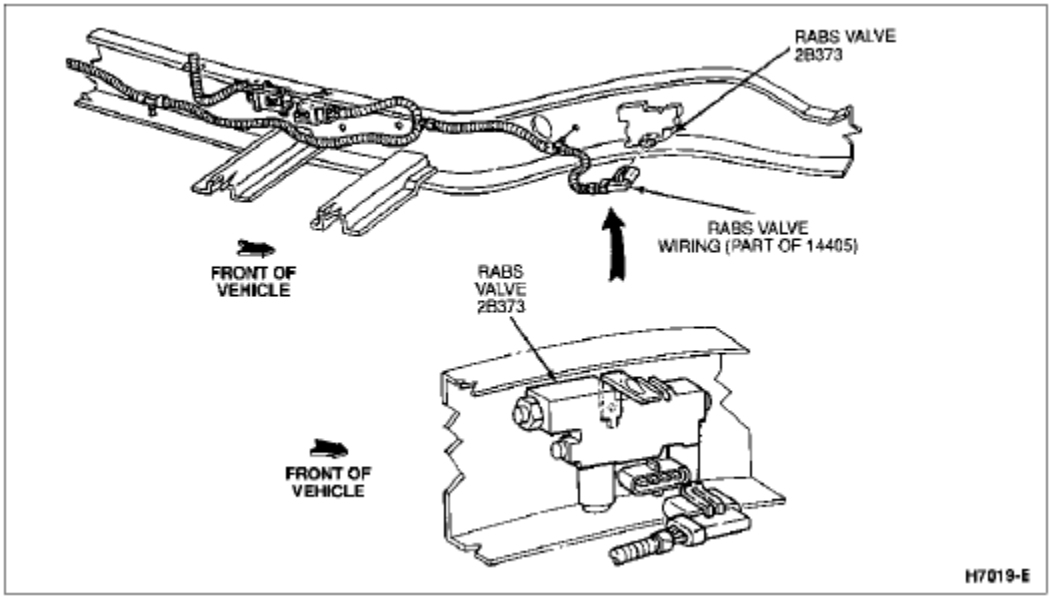
Installation

1. Position the RABS valve on the frame side rail. Install the bolt and tighten to 20-25 Nm (14-19 lb-ft).
2. Connect the wiring harness connector to the RABS valve.
3. **CAUTION: Do not overtighten the fittings.**

   Connect the RABS valve input and output tubes to the RABS valve. Tighten the fittings to 15-20 Nm (11-14 lb-ft).
4. **NOTE: It is not necessary to energize the RABS system electrically to bleed the rear brakes.**

   Bleed the rear brake system as described in Section 06-06 .

RABS Valve, Ranger



RABS Valve, Aerostar

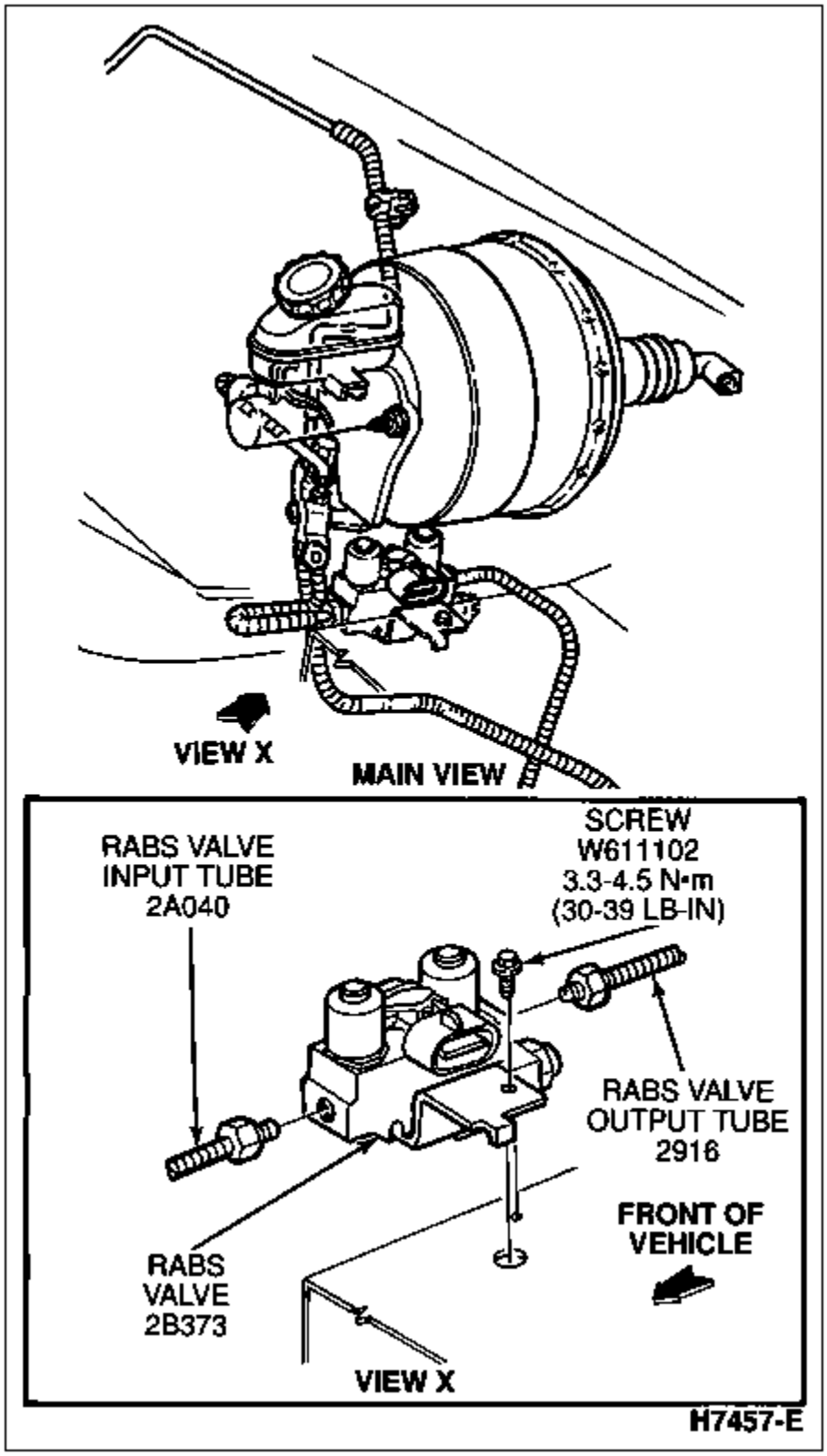
Removal

1. At the RABS valve, disconnect and plug the RABS valve input and output tubes.
2. Disconnect the wiring harness connector from the RABS valve.
3. Remove the screw that retains the RABS valve to the fender apron. Remove the RABS valve.

Installation

1. Position the RABS valve on the fender apron. Install the retaining screw and tighten to 3.3-4.5 Nm (30-39 lb-in).
2. Connect the wiring harness connector to the RABS valve.
3. **CAUTION: Do not overtighten the fittings.**

   Connect the RABS valve input and output tubes to the RABS valve. Tighten the tube fittings to 15-20 Nm (11-14 lb-ft).
4. Bleed the brake system as described in Section 06-06 . It is not necessary to energize the RABS system electrically to bleed the rear brakes.


VIEW X
MAIN VIEW
RABS VALVE
INPUT TUBE
2A040
SCREW
W611102
3.3-4.5 N•m
(30-39 LB-IN)
RABS VALVE
OUTPUT TUBE
2916
FRONT OF
VEHICLE
RABS
VALVE
2B373
VIEW X
H7457-E

RABS Sensor

Removal

1. At the rear axle housing (4010) pull the wiring harness connector from the speed sensor.

2. Remove the speed sensor hold down bolt and remove the speed sensor from the rear axle housing.

Installation

1. Clean the rear axle housing mounting surface. Use care to prevent dirt from entering the rear axle housing.

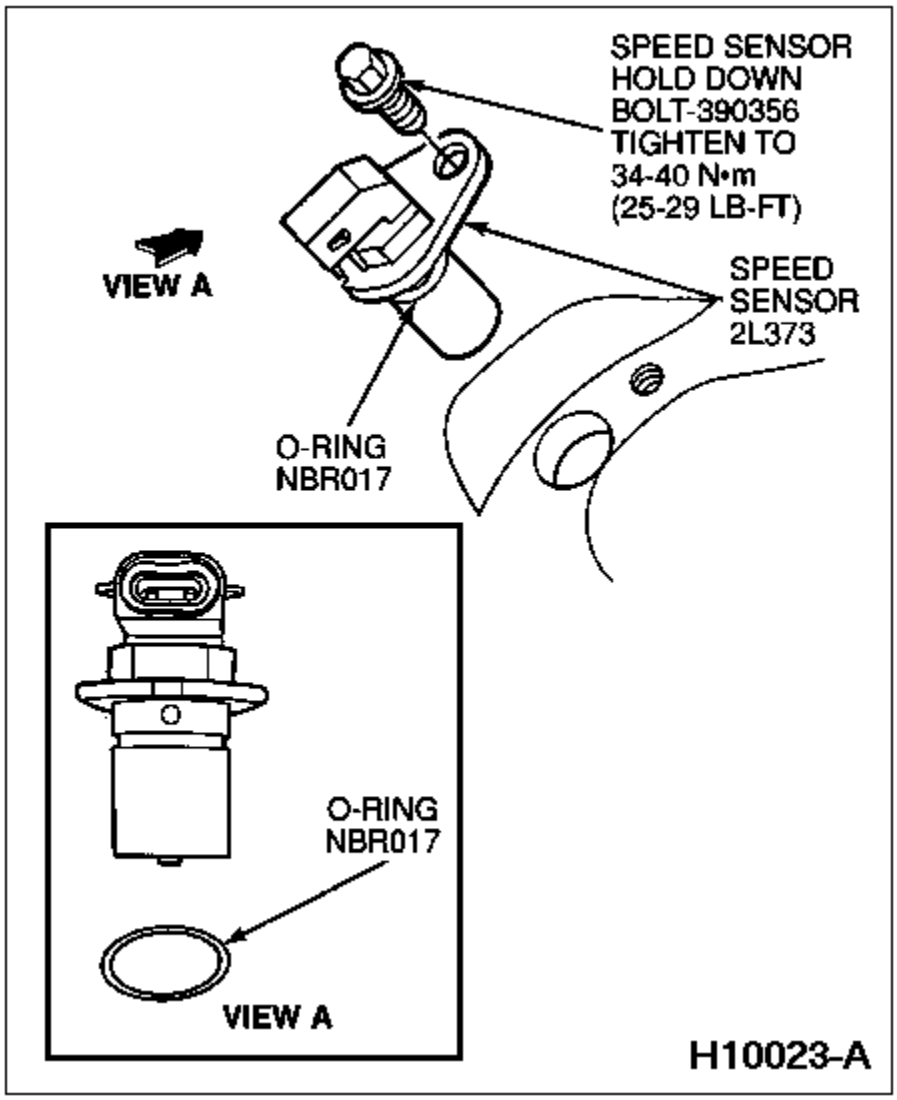
2. Inspect and clean the magnetized sensor pole piece to make sure that it is free from loose metal particles which could cause erratic system operation. Inspect the speed sensor O-ring for damage and replace if necessary.

3. **NOTE: Do not apply force to the plastic sensor connector. The sensor flange should slide to the mounting surface. This will make sure the air gap setting is between 0.127-1.143mm (0.005-0.045 inches).**

   Lightly lubricate the speed sensor O-ring with motor oil, align the bolt hole, and install.

4. Install the speed sensor hold-down bolt and tighten to 34-40 Nm (25-29 lb-ft).

5. Push the connector on the speed sensor.


SPEED SENSOR
HOLD DOWN
BOLT-390356
TIGHTEN TO
34-40 N•m
(25-29 LB-FT)
VIEW A
SPEED
SENSOR
2L373
O-RING
NBR017
O-RING
NBR017
VIEW A
H10023-A

Brake Master Cylinder Reservoir Checking and Filling

Brake fluid level in the brake master cylinder reservoir (2K478) should be between 4mm (0.16 inch) below the MAX line on the side of the brake master cylinder reservoir and the MAX line. If brake fluid is low, the red BRAKE warning indicator will illuminate. To add brake fluid, clean and remove the brake master cylinder reservoir cap and pour clean brake fluid up to the MAX line. Use Ford High Performance DOT 3 Brake Fluid C6AZ-19552-AA or DOT 3 equivalent fluid meeting Ford specification ESA-M6C25-A, DOT3. If brake fluid has to be added often, check all hydraulic connections for leaks.

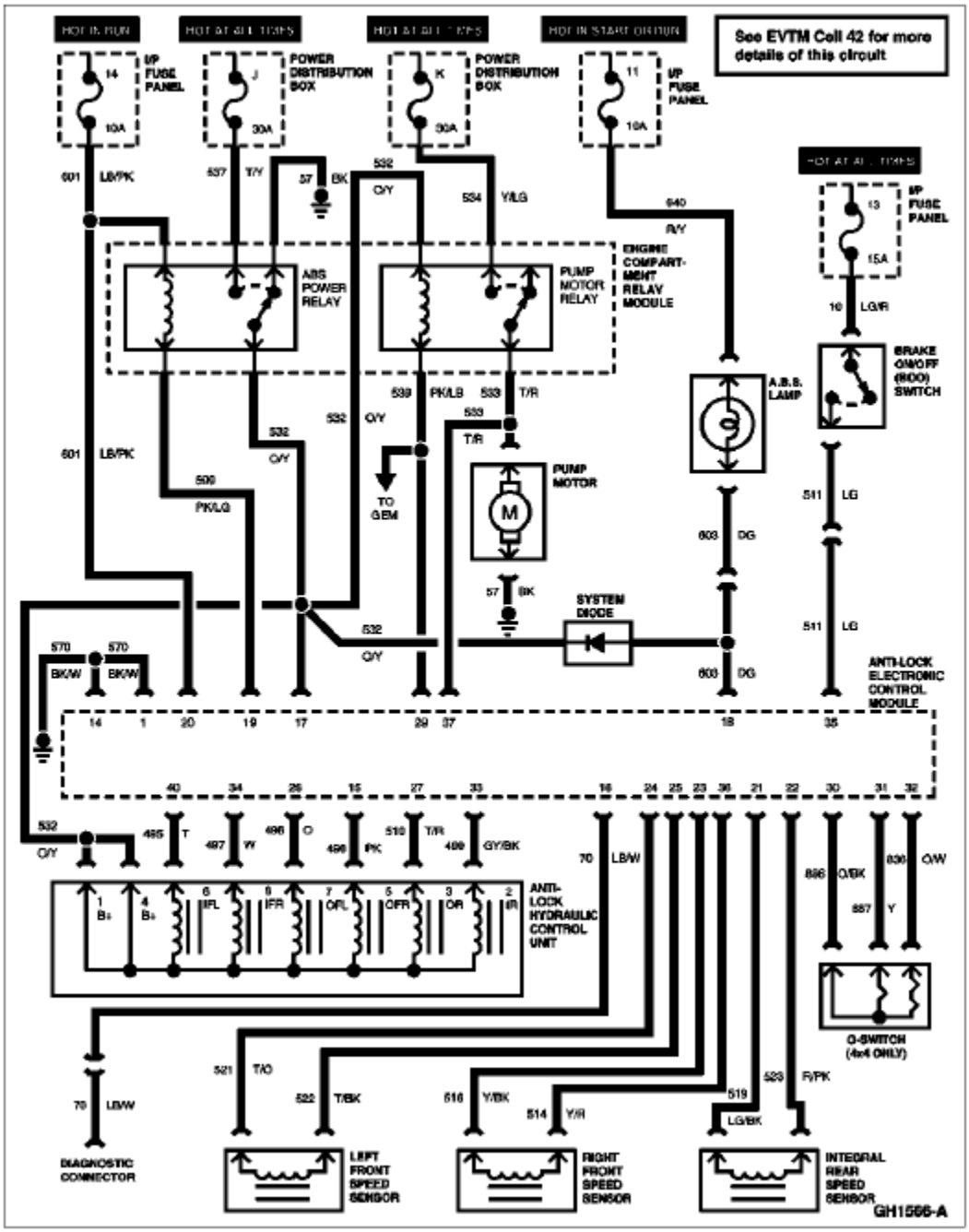
SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
RABS Valve-to-Frame Side Rail Bolt	20-25	14-19	—
RABS Valve Tube Fittings	15-20	11-14	—
RABS Valve-to-Fender Apron Screw, Aerostar	3.3-4.5	—	30-39
Speed Sensor Hold-Down Bolt	34-40	25-29	—

Electrical Schematics

Brake, 4-Wheel Anti-Lock



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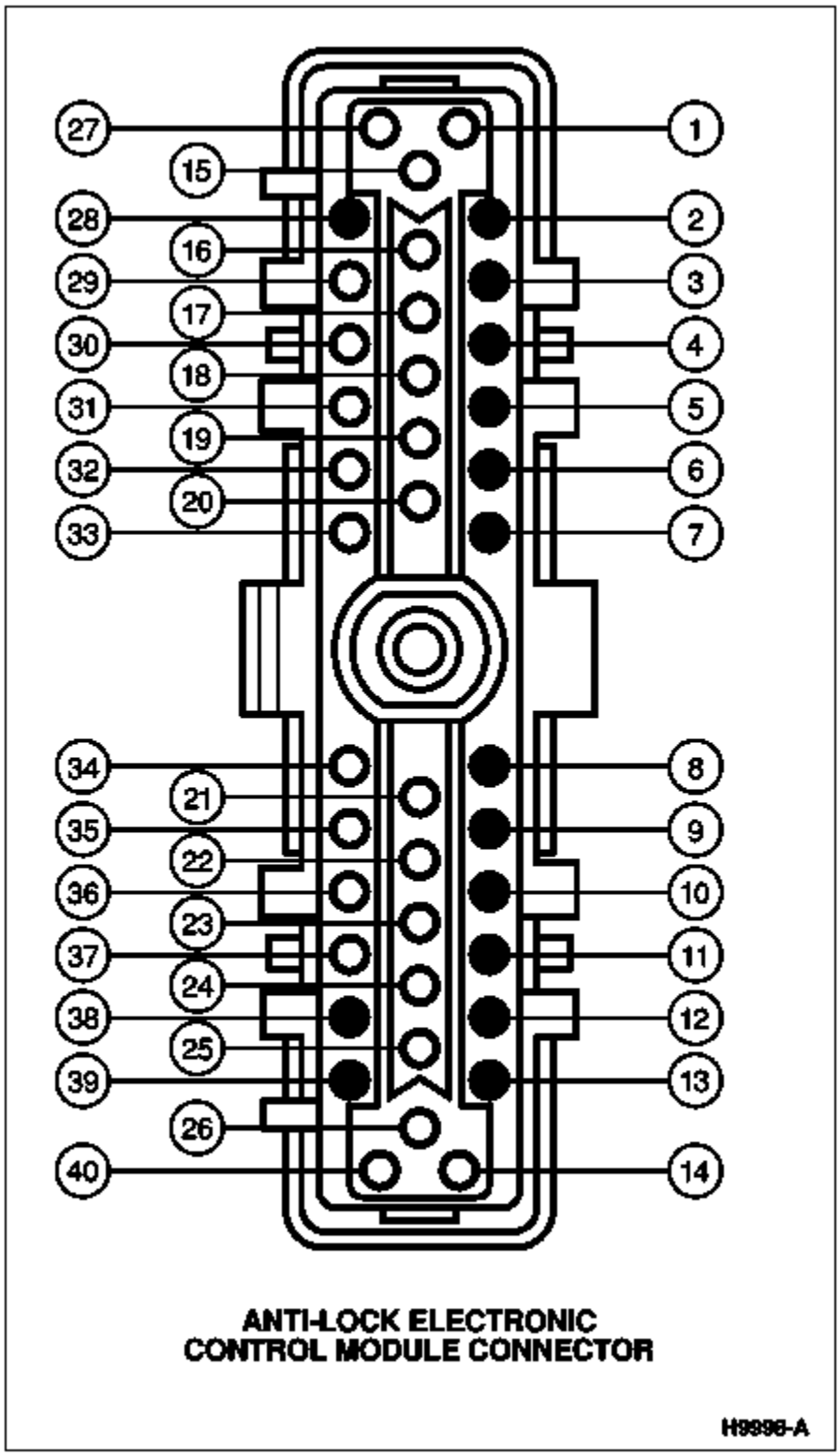
Anti-Lock Electronic Control Module



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Pin Number	Circuit	Circuit Function
1	570 (BK/W)	ABS Ground
2	—	Not Used
3	—	Not Used
4	—	Not Used
5	—	Not Used
6	—	Not Used
7	—	Not Used
8	—	Not Used
9	—	Not Used
10	—	Not Used
11	—	Not Used
12	—	Not Used
13	—	Not Used
14	570 (BK/W)	ABS Ground
15	498 (PK)	Front Right Dump Solenoid
16	70 (LB/W)	ISO 9141
17	532 (O/Y)	Solenoid Battery Input
18	603 (DG)	ABS Lamp Return
19	599 (PK/LG)	Control Module to ABS Power Relay Coil Return
20	601 (LB/PK)	Hot in RUN
21	519 (LG/BK)	Control Module to Rear Sensor
22	523 (R/PK)	Control Module to Rear Sensor
23	516 (Y/BK)	Control Module to Right Front Sensor
24	521 (T/O)	Control Module to Left Front Sensor
25	522 (T/BK)	Control Module to Left Front Sensor
26	496 (O)	Front Left Dump Solenoid
27	510 (T/R)	Rear Dump Solenoid
28	—	Not Used
29	539 (PK/LB)	Control Module to Pump Relay Coil Return
30	886 (O/BK)	Control Module to G-Switch
31	887 (Y)	Control Module to G-Switch
32	836 (O/W)	Control Module to G-Switch
33	499 (GY/BK)	Rear Isolation Solenoid
34	497 (W)	Front Right Isolation Solenoid
35	511 (LG)	Stoplamp Switch
36	514 (Y/R)	Control Module to Right Front Sensor
37	533 (T/R)	Pump Motor Trigger Input

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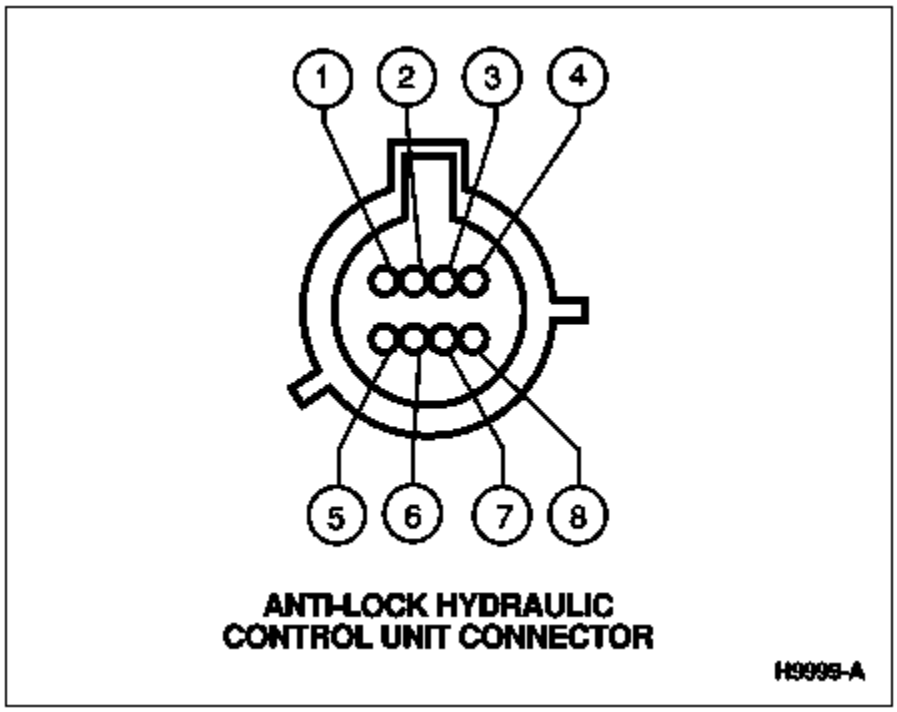
38	—	Not Used
39	—	Not Used
40	495 (T)	Front Left Isolation Solenoid



Pin Number	Circuit	Circuit Function
1	532 (O/Y)	Solenoid Battery Input
2	499 (GY/BK)	Rear Isolation Solenoid
3	510 (T/R)	Rear Dump Solenoid
4	532 (O/Y)	Solenoid Battery Input
5	498 (PK)	Front Right Dump Solenoid
6	495 (T)	Front Left Isolation Solenoid
7	496 (O)	Front Left Dump Solenoid
8	497 (W)	Front Right Isolation Solenoid

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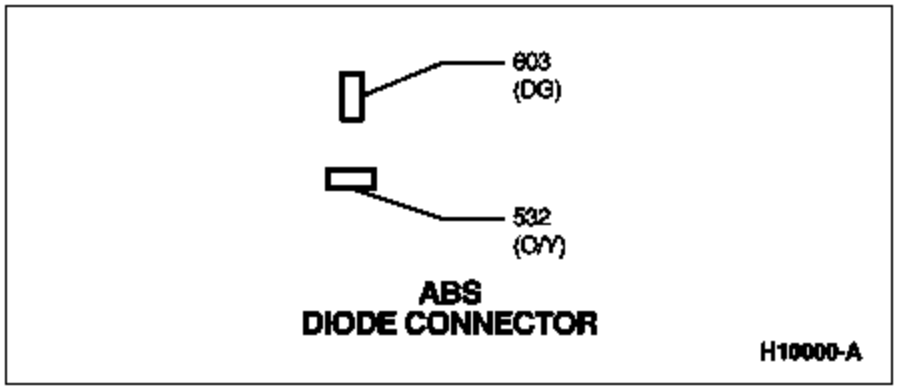
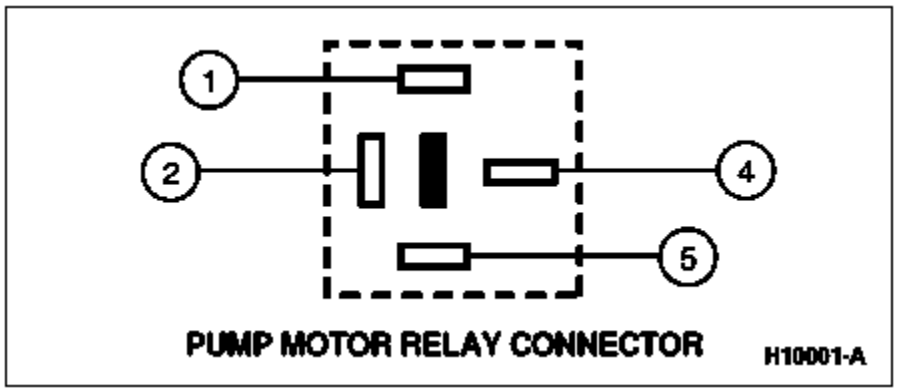
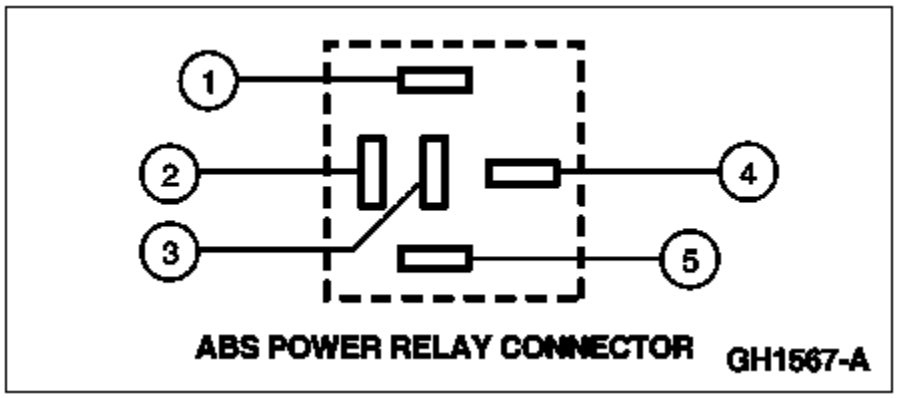




Pin Number	Circuit	Circuit Function
1	539 (PK/LB)	Relay Coil to Anti-Lock Electronic Control Module
2	534 (Y/LG)	Relay Switch Power Feed
3	—	Not Used
4	533 (T/R)	Relay Switch to Pump Motor
5	532 (O/Y)	Relay Coil Power Feed



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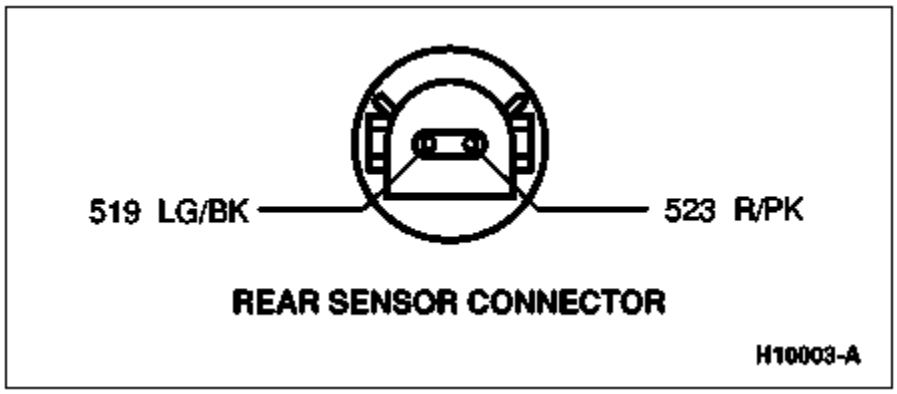
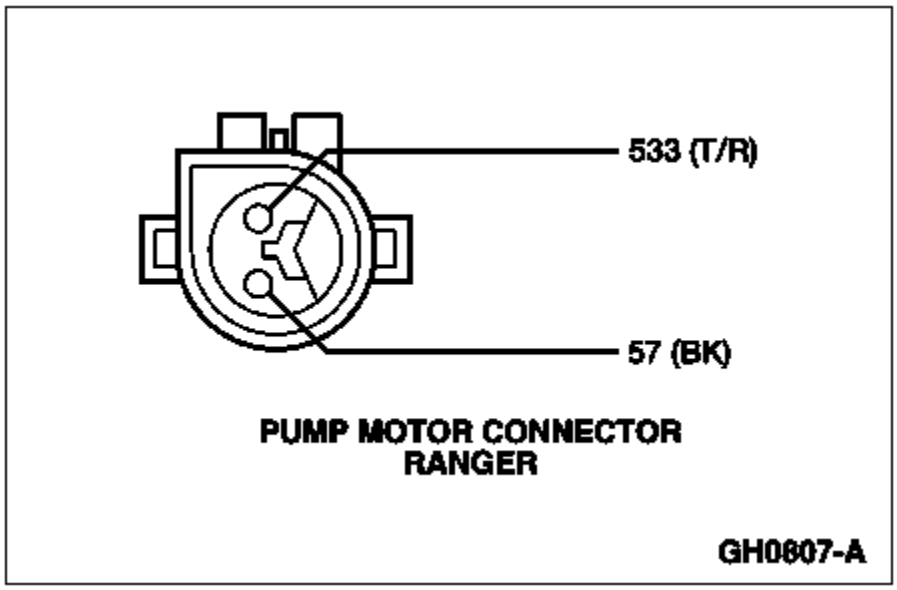
Pin Number	Circuit	Circuit Function
1	599 (PK/LG)	Relay Coil to Anti-Lock Electronic Control Module
2	537 (T/Y)	Relay Switch Power Feed
3	57 (BK)	Relay Switch Ground
4	532 (O/Y)	Relay Switch to Anti-Lock Electronic Control Module
5	601 (LB/PK)	Relay Coil Power Feed





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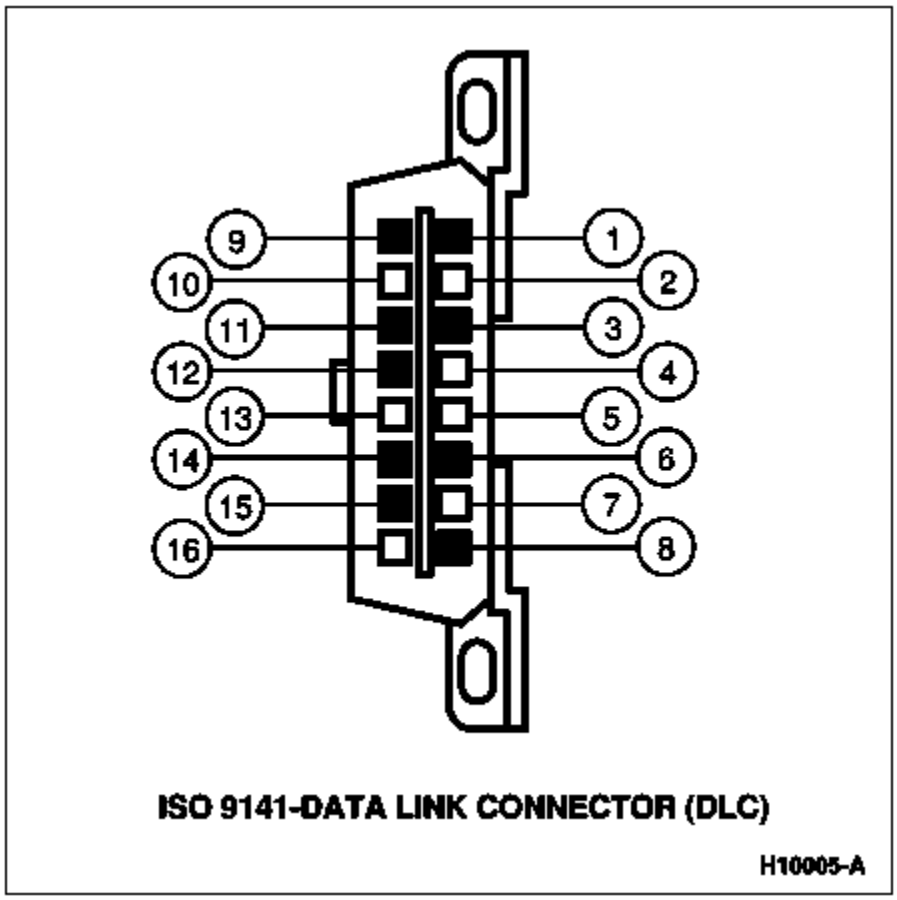

Pin Number	Circuit	Circuit Function
1	—	Not Used
2	914 (T/O)	J1850 Bus (+)
3	—	Not Used
4	57 (BK)	Chassis Ground Feed
5	570 (BK/W)	Control Module Ground Feed
6	—	Not Used
7	70 (LB/W)	ISO 9141
8	—	Not Used
9	—	Not Used
10	915 (PK/LG)	J1850 Bus (-)
11	—	Not Used
12	—	Not Used
13	107 (P)	Reprogramming Power Supply
14	—	Not Used
15	—	Not Used
16	693 (O)	Battery Power

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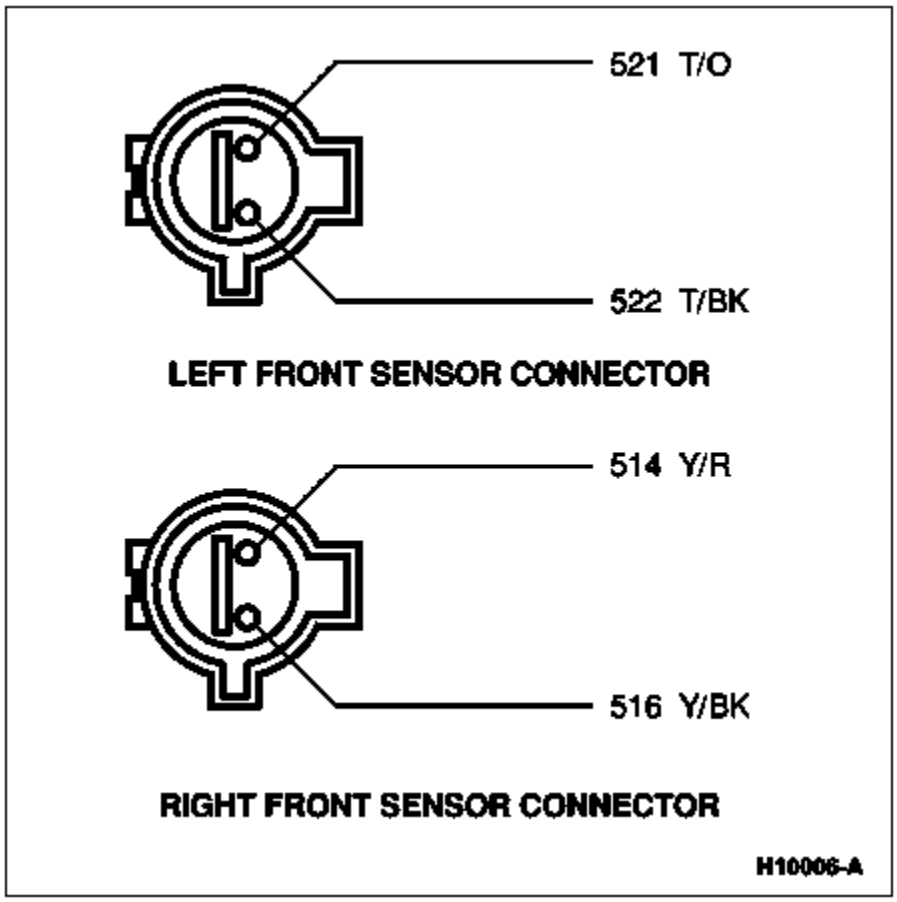

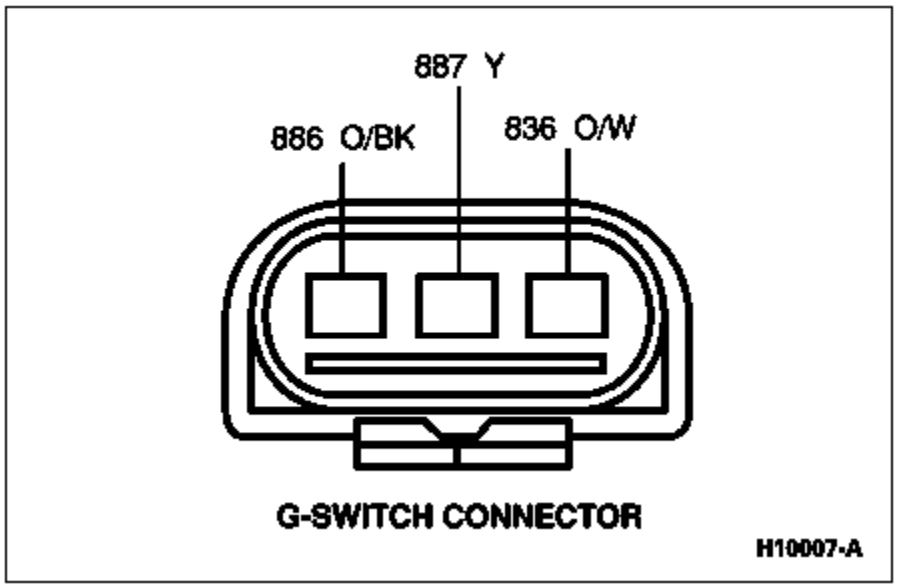

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Symptom Charts

- Unwarranted ABS Activity—Refer to Symptom A .
- Wheels Lock Up—Refer to Symptom B .
- Hard/Soft Brake Pedal—Refer to Symptom C .
- Lack of Decel. (Med./Hard Braking)—Refer to Symptom D .
- Vehicle Pulls During Braking—Refer to Symptom E .
- ABS Warning Light ON Intermittently with Code System Pass—Refer to Symptom F .

WARNING: PERFORM INDICATED PINPOINT TEST OR DRIVE TEST STEPS ONLY — DO NOT PERFORM OTHER STEPS (ALTHOUGH WITHIN THE TEST BOX, YOU MAY APPEAR TO BE DIRECTED TO DO SO). ALWAYS RETURN TO THE SYMPTOM CONDITION CHART IF NO RESOLUTION IS REACHED BY PERFORMING A PARTICULAR TEST.

SYMPTOM A: UNWARRANTED ABS ACTIVITY

Condition	Possible Source	Action
• Loss of Sensor Signal During Vehicle Deceleration. Sensor Signal Drops Out at Low Speed	• Tone ring is damaged. • Sensor output is weak. • Air gap too large.	• INSPECT both front wheel end tone rings and the rear axle tone ring. • Left Front Sensor — GO to Pinpoint Test LL . • Right Front Sensor — GO to Pinpoint Test MM . • Rear Axle Sensor — GO to Pinpoint Test NN .
• Maladjusted Rear Brakes or "Grabby" Brake Shoe or Pad Linings	• Rear brake adjustment too tight. • Linings are "contaminated".	• REFER to Section 06-00 . • REFER to Section 06-00 .

SYMPTOM B: WHEELS LOCK UP

Condition	Possible Source	Action
• Base Brake Mechanical Concern	• Damp or contaminated rear brake shoe linings, stuck/leaking wheel cylinder, over-adjusted rear brakes. • Hung-up parking brake. • Leaking rear axle seal.	• REFER to Section 06-00 . • REFER to Section 06-05 . • REFER to the appropriate section in Group 05.

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SYMPTOM C: HARD OR SOFT BRAKE PEDAL

Condition	Possible Source	Action
• Base Brake Hydraulic Concern (Soft)	• Hydraulic leak in brake line or hose, fitting, master cylinder, wheel cylinder, or caliper. • Air in brake system.	• REFER to Section 06-00 . • REFER to Section 06-00 .
• Base Brake Mechanical Concern (Hard)	• Little or no vacuum boost. • Stuck or inoperative wheel cylinder or caliper. • Pinched or crimped brake line or hose.	• REFER to Section 06-00 .

SYMPTOM D: LACK OF DECELERATION DURING MEDIUM/HARD BRAKE APPLICATIONS

Condition	Possible Source	Action
• Base Brake Hydraulic Concern	• Hydraulic leak in brake line or hose, fitting, master cylinder, wheel cylinder, or caliper. • Air in brake system.	• REFER to Section 06-00 . • REFER to Section 06-00 .
• Base Brake Mechanical Concern	• Little or no vacuum boost. • Stuck or inoperative wheel cylinder or caliper. • Pinched or crimped brake line or hose. • Ineffective brake shoe or pad linings.	• REFER to Section 06-00 .

SYMPTOM E: VEHICLE PULLS DURING BRAKING

Condition	Possible Source	Action
• Base Brake Mechanical Concern	• Improperly adjusted rear brake. • Frozen or binding caliper (one side of vehicle). • Uneven brake pad or shoe wear.	• REFER to Section 06-00 . • REFER to Section 06-00 . • REFER to Section 06-00 .
• Base Brake Hydraulic Concern	• Pinched or crimped brake line or hose.	• REFER to Section 06-00 .

SYMPTOM F: ABS WARNING LIGHT ON INTERMITTENTLY WITH SYSTEM PASS CODE

Condition	Possible Source	Action

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• Intermittent Loss of Power to Anti-Lock Brake Control Module	• Ignition Circuit 601 loose or shorted. • Loose anti-lock brake control module grounds. • Loose power lug at power distribution box.	• INSPECT Circuit 601 from ignition switch to anti-lock brake control module harness connector for opens/shorts especially at the bulkhead connector. CORRECT as necessary. • INSPECT anti-lock brake control module grounds for looseness, corrosion or excessive dirt. CORRECT as necessary. • CORRECT condition.

Inspection and Verification, System Precheck

NOTE: It is imperative that this procedure be performed first. Failure to do so may result in incorrect diagnosis of problem, wasted time, and improper replacement of good components.

If not using a Rotunda Fluke Frequency Meter, 105-R0053, higher wheel speed may be required in order for the frequency meter to function correctly.

The System Precheck is used to screen a vehicle for relatively simple diagnostic repairs such as loose connectors, blown fuses, etc. However, the System Precheck is also used to prepare the vehicle for further diagnostics. In addition, warning lamp faults are dealt with in this test.

PINPOINT TEST PC: SYSTEM PRECHECK

PC1 PERFORM UNDERHOOD SYSTEM PRECHECK

- Verify that all of the following connectors are connected and the terminals are secure and free of contaminants or corrosion.
  - 40-pin ECU connector
  - 8-pin HCU connector
  - 2-pin pump motor connector
  - 2-pin front sensor connectors (2)
- Open power distribution box and verify that both the ABS power relay and pump motor relay and diode are fully seated.
- Gently pull on relay and diode terminals beneath power distribution box to make sure all are secure.
- Verify that both the system fuse and pump motor fuse are present and intact.
- Verify that the system ground eyelet at the left-hand radiator support is firmly attached to the weld stud and is free of corrosion and excessive dirt.

Are all connections secure and fuses operational?

Yes	No
GO to **PC2** .	CORRECT condition. GO to **PC2** .

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PC2 PERFORM UNDER-VEHICLE SYSTEM PRECHECK

- Verify that the 3-pin acceleration connector (4x4 only) and the 2-pin rear axle sensor connector are connected and the terminals are secure and free of contaminants or corrosion.

Are all connectors, terminals and grounds secure?

Yes	No
GO to **PC3** .	REPAIR as required. GO to **PC3** .

PC3 CHECK ABS WARNING LIGHT SEQUENCE (KEY ON/ENGINE OFF)

- Observe ABS warning light on dash.
- Turn ignition to ON.

Does ABS warning light come on?

Yes	No
Light flashes. Diagnostic circuit grounded. CORRECT condition. Stays on for 3 seconds and goes out (normal bulb prove-out). GO to **PC6** . Comes on and stays on (hard light). GO to **PC4** .	GO to **PC7** .

PC4 CODE RETRIEVAL EQUIPMENT HOOKUP

- Verify that an ABS concern has been detected (ABS warning light ON).
- Key OFF.
- Using Rotunda New Generation Star (NGS) Tester 007-00500 or equivalent.
  - Connect tester to ISO-9141 connector located under steering column.

Is equipment hooked up properly?

Yes	No
GO to **PC5** .	REATTEMPT **PC4** . REPAIR as required.

PC5 RETRIEVE ABS DIAGNOSTIC TROUBLE CODES

- Using Rotunda New Generation Star (NGS) Tester 007-00500 or equivalent:
  - Key in RUN.
  - Read out and record all diagnostic trouble codes.

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CAUTION: Be sure to read out and record all codes. Failure to do so may result in improper diagnosis and unnecessary repairs.

Are codes present?

Yes	No
Starting with the first code recorded, GO to the pinpoint test for that code.	System pass. If previous action has been taken, concern most likely has been corrected and ABS system is OK. Otherwise, GO to Symptom Chart F . Cannot communicate. GO to Pinpoint Test V .

PC6 ROAD TEST VEHICLE

NOTE: Step PC6 is optional, for additional information only.

- Drive vehicle and observe ABS warning light.

Does ABS warning light come on during any of the following?

- **When vehicle moves initially (light comes on at or near 6 mph)**
- **While driving under 40 km/h (25 mph)**
- **While driving at or over 40 km/h (25 mph)**
- **While in an anti-lock stop**

Yes	No
At or near 10 km/h (6 mph), concern most likely found during pump check. GO to **PC4** . VERIFY pump diagnostic trouble code has been set. While driving under 40 km/h (25 mph), most likely cause is missing wheel speed sensor output. GO to **PC4** . VERIFY sensor diagnostic trouble code has been set. While driving over 40 km/h (25 mph), most likely cause is an erratic wheel speed sensor output. GO to **PC4** . VERIFY sensor diagnostic trouble code has been set.	Vehicle has abnormal ABS or brake system operation. GO to Symptom Chart . No abnormal operation or symptoms detected. GO to **PC4** . VERIFY No Code (System OK) is present.

PC7 ABS WARNING LIGHT DOES NOT PROVE OUT/CHECK BULB

- Inspect ABS warning light bulb in dash.

Is the bulb blown?

Yes	No

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REPLACE bulb. GO to **PC3** .	LEAVE bulb out. GO to **PC8** .

PC8 VERIFY ABS WARNING LAMP FEED IS INTACT

- Key OFF.
- Insert 12V test light between ABS bulb socket (+) and a known good chassis ground.
- Key ON.

Does test light illuminate?

Yes	No
GO to **PC9** .	REPAIR open circuit or short to ground on warning light feed. REINSERT bulb back into socket. GO to **PC3** .

PC9 VERIFY ABS WARNING LAMP GROUND BETWEEN BULB AND ABS DIODE

- Open power network box and remove ABS diode.
- Verify diode terminals are clean and firmly in place.
- Check for continuity between ABS bulb socket ground and diode terminal in power network box for Circuit 603 (DG).

Is there continuity?

Yes	No
GO to **PC10** .	REPAIR open circuit in warning light ground or loose terminal. REINSERT ABS diode. GO to **PC3** .

PC10 VERIFY INTACT ABS WARNING LAMP GROUND BETWEEN ABS DIODE AND ABS POWER RELAY

- Remove ABS power relay.
- Verify relay terminals are clean and firmly in place.
- Check for continuity between ABS diode Circuit 532 (O/Y) and ABS Power Relay Circuit 532 (O/Y).

Is there continuity?

Yes	No
GO to **PC11** .	REPAIR open circuit in Circuit 532 (O/Y) between ABS diode and ABS power relay or loose terminals. REINSERT ABS diode and system relay. GO to **PC3** .

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PC11 CHECK GROUND BETWEEN ABS POWER RELAY AND CHASSIS GROUNDS

- Inspect chassis ground stud at left-hand radiator support for loose or corroded eyelets.
- Clean and tighten any loose or dirty ground eyelets.
- Check for continuity between ABS power relay Circuit 57 (BK) and left-hand radiator support chassis ground stud.

Is there continuity?

Yes	No
REINSERT ABS power relay. REPLACE ABS warning bulb. REPEAT Steps PC8 -PC11 looking for intermittent condition (see Intermittent Diagnosis).	REPAIR open circuit between ABS power relay and chassis ground. REINSERT ABS power relay. GO to **PC3** .

Manually Clearing Diagnostic Codes

The Rotunda New Generation Star (NGS) Tester 007-00500 is used to clear diagnostic trouble codes (DTCs) by performing the ABS code clear procedure. **No other manual method can be used to clear DTCs** .

Automatic Memory Erasing

A diagnostic trouble code will be automatically erased if no system concerns occur for 80 ignition cycles.

Warning Lamp Indicators

The anti-lock brake system uses one amber ABS warning light to alert the driver of malfunctions in the system.

The amber ABS warning light will come on for numerous reasons. It warns the driver that the ABS has been disabled. Normal power-assisted braking remains but the wheels can lock during a panic stop while the indicator is on. Certain procedures must be followed to find the concern in this situation. They are explained in this section.

If system is OK, Code System Pass will be present.

On-Board Diagnostics

The anti-lock brake control module is capable of performing on-board diagnostics using Rotunda NGS Tester 007-00500 or equivalent.

The anti-lock brake control module monitors system operation and can store all defined diagnostic trouble codes in its memory. It is important to understand that there are some concerns the anti-lock brake control module cannot recognize. Therefore, if a symptom exists and no diagnostic trouble codes are stored by the anti-lock brake control module, other diagnostic steps must be followed.

The module cannot store a diagnostic trouble code if there is no power to the module. This concern can be found by following the System Precheck procedures.

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Diagnostic Trouble Codes, Retrieving

The diagnostic trouble codes can be retrieved from the anti-lock brake control module in the following manner.

1. Connect the New Generation Star (NGS) Tester or equivalent to the ISO-9141 connector located under the steering column.
2. Turn on the tester and follow the menus provided to perform ABS code retrieval.
3. Record all the codes. "System Pass" indicates that no codes are stored.

Breakout Box Function

1. Disconnect the 40-pin plug from the anti-lock brake control module.
2. Connect the Anti-Lock Brake Adapter T93T-50-ALA to the 40-pin plug on the vehicle harness.
3. Connect the adapter's 60-pin plug to the Breakout Box cable.
4. Install overlay box.
5. Refer to pinpoint test procedures for specific repair directions.

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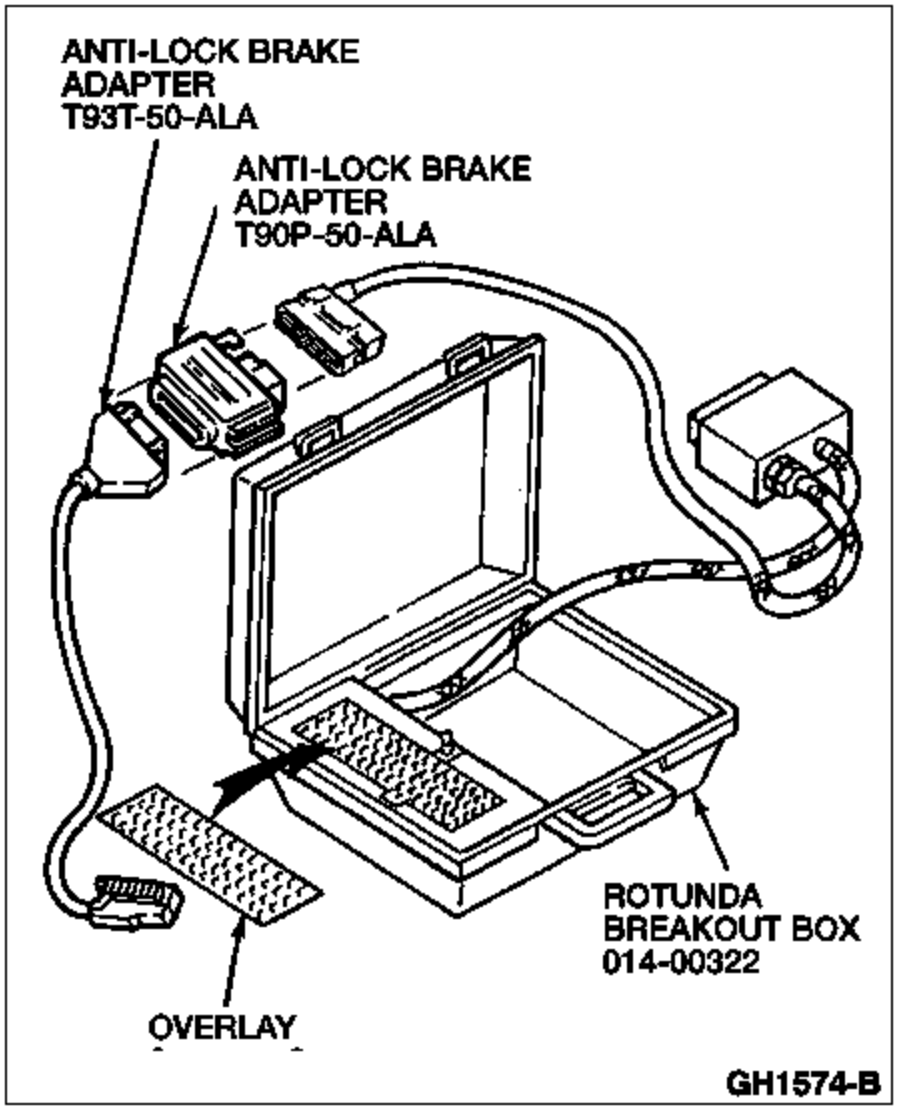

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Anti-Lock Electrical Quick Check Chart

This chart is used as a reference and is meant to be used in conjunction with the Rotunda Breakout Box 014-00322 or equivalent, the overlay and Anti-Lock Brake Adapter T93T-50-ALA.

Many of the values given for various components depend on the presence of a good ground at Pin 1.

NOTE: The Pin 1 chassis ground must be verified as sound before any quick electrical check involving Pin 1 may be used. At any time, any known good chassis ground may be substituted for a Pin 1 designation.

NOTE: Connections between components must be verified as sound before replacement of affected components. Failure to observe above will often lead to improper replacement of components and incorrect resolution of concern. Replacement of good components will not resolve a vehicle wiring concern.

Keep in mind that a measurement falling outside the specification can mean one of two things:

1. The wiring between two components is worn or damaged, or
2. The component is not electrically correct.

NOTE: Perform the following measurements with Rotunda Digital/Analog Volt-Ohmmeter 105-R0053 or equivalent. Check DVOM accuracy.

ANTI-LOCK QUICK CHECK CHART
NOTE: The correct overlay MUST be installed before making electrical checks.

Measure Between				
Item to Be Tested	**Ignition Mode**	**Pin Number(s)**	**Scale/Range**	**Specification**
Anti-Lock Brake Control Module Ground Check	Off Off Off	1 + Chassis Gnd 14 + Chassis Gnd 17 + Chassis Gnd	Ohms Ohms Ohms	Continuity Continuity Continuity
Battery Power to Anti-Lock Brake Control Module Check	On	20 + 1	Volts	9.5V Minimum
Jumper Pins 1 + 19 (Energizing ABS Power Relay)	On	17 + 1	Volts	9.5V Minimum
Power from ABS Power Relay				Verify ABS Warning Lamp is OFF
ABS Power Relay Coil	Off	19 + 20	Ohms	52-68 Ohms
Pump Motor Relay Coil	Off	17 + 29	Ohms	52-68 Ohms
ABS Warning Light Ground Through System Relay	Off	17 + 1	Ohms	Continuity
IFR Isolation (Inlet) Valve	Off	17 + 34	Ohms	5-8 Ohms

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Resistance				
IFL Isolations (Inlet) Valve Resistance	Off	17 + 40	Ohms	5-8 Ohms
IRA Isolation (Inlet) Valve Resistance	Off	17 + 33	Ohms	5-8 Ohms
OFR Dump (Outlet) Valve Resistance	Off	17 + 15	Ohms	3-6 Ohms
OFL Dump (Outlet) Valve Resistance	Off	17 + 26	Ohms	3-6 Ohms
ORA Dump (Outlet) Valve Resistance	Off	17 + 27	Ohms	3-6 Ohms
FR Wheel Speed Sensor Resistance	Off	23 + 36	k Ohms	1.0-1.4 k Ohms
FL Wheel Speed Sensor Resistance	Off	24 + 25	k Ohms	1.0-1.4 k Ohms
Sensor Output				
Rotate Front Wheels and Rear Axle @ 60 rpm				
FR (4x4)	Off	23 + 36	Hz and mV	5.8 mV/Hz or Greater
FR (4x2)	Off	23 + 36	Hz and mV	5.0 mV/Hz or Greater
FL (4x4)	Off	24 + 25	Hz and mV	5.8 mV/Hz or Greater
FL (4x2)	Off	24 + 25	Hz and mV	5.0 mV/Hz or Greater
Diode	Off	18 (Meter Polarity +) or 17 (Meter Polarity -)	Diode Check	0.5 Volts
Remove ABS Power Relay	Off	18 (Meter Polarity +) or 17 (Meter Polarity -)	Diode Check	Infinity m Ohms

Note: Check for continuity between Pin 1 and chassis ground or invalid results may be obtained. Results not matching specification indicate either a wiring or component concern. Further analysis is needed before any component is replaced. Refer to pinpoint tests for proper diagnostic procedures.

Note: To check wheel speed sensor output, measurements of BOTH the frequency and the voltage output must be taken. The actual speed the wheels are turning is not important — the result of voltage output divided by the frequency will not change with wheel speed. However, it is crucial that both the frequency measurement and the voltage output measurement be taken at the SAME wheel speed. If not using a Rotunda Fluke Frequency Meter 105-R0053, higher wheel speed may be required in order for the frequency meter to function correctly.

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Drive Test

Purpose

This drive test will be used when either of two conditions exists.

1. Recommended Repair Verification

   This drive procedure can be used after all vehicle repairs. Because the anti-lock brake control module is unable to detect some system concerns until the vehicle is being driven in a certain way, this drive test can be helpful in developing further confidence in the 4WABS system operation before delivery to the customer.

2. Symptom Evaluation Drive

   When a vehicle is brought to the dealer, the customer may only have a general concern about the way the vehicle is braking. In these situations there may not be a clear system concern to troubleshoot. This drive test is designed to produce common system concern symptoms. Use this drive test to determine a symptom. Once a symptom is found, a symptom troubleshooting procedure can be followed to repair the vehicle.

Drive Description

This is designed to be a generic drive test that is used for three purposes listed below.

1. To verify a repair of the ABS system on a vehicle.
2. To attempt to recreate an intermittent concern.
3. To attempt to detect a symptom when a diagnostic trouble code or a concern symptom is not known.

PINPOINT TEST DT1: DRIVE TEST — CODE SYSTEM PASS

DT1.1 LOW SPEED ABS STOP

NOTE: Wetting down the area where stop is to be performed will aid this test.

- Drive vehicle at approximately 16 km/h (10 mph).
- Spike brake pedal hard enough to lock all four wheels.

NOTE: Momentary lockup is permissible.

Does ABS cycle?

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Yes	No
ABS light is not on. GO to Symptom B , Wheel Lockup. ABS light comes on and stays on. GO to **DT1.7** .	Other symptoms are detected. GO to **DT1.6** . ABS light is not on. GO to **DT1.2** .

DT1.2 CHECK FOR UNWARRANTED ABS ACTIVITY

- Drive vehicle at approximately 32 km/h (20 mph).
- Perform a light to medium (normal traffic) stop.
- Turn off the windshield wipers if they are on. Feel for pulsation in the brake pedal.

  NOTE: In this event, the vehicle may pull as soon as the pump motor begins to run. If the vehicle does pull when the pump motor turns on, the front sensor opposite the pull should be checked using the UNWARRANTED ABS ACTIVITY Symptom Chart. If the pump motor turns on and no pull is felt, the rear speed sensor should be checked using the UNWARRANTED ABS ACTIVITY Symptom Chart.

- If a vehicle pulls immediately upon braking and the pump motor does not run, use the VEHICLE PULLS WHILE BRAKING Symptom to diagnose the concern.

Does the pump motor turn on and are brake pedal pulsations felt any time during the stop?

Yes	No
ABS light is not on. GO to Symptom A , Unwarranted ABS Activity. ABS light comes on and stays on. GO to **DT1.7** .	Other symptoms are detected. GO to **DT1.6** . ABS light is not on. GO to **DT1.3** .

DT1.3 CHECK FOR HIGH SENSOR GAP

- Clear all codes.
- Key OFF.
- Start vehicle and select Drive Low (Automatic) or 1st forward gear (Manual).
- Allow vehicle to creep forward at idle for at least 45 seconds.

Does the ABS warning light come on?

Yes	No
GO to **DT1.8** .	GO to **DT1.4** .

DT1.4 CHECK FOR MARGINALLY HIGH SENSOR GAP

- Clear all codes.

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- Key OFF.
- Start vehicle and accelerate slowly to 40 km/h (25 mph). Let at least 45 seconds elapse before reaching 40 km/h (25 mph).

Does the ABS warning light come on?

Yes	No
GO to **DT1.8** .	GO to **DT1.5** .

DT1.5 DRIVE TEST IS COMPLETE

Has customer concern been addressed and corrected by previous actions?

Yes	No
STOP. Vehicle ABS function has been verified.	GO to Intermittent Test .

DT1.6 DETERMINE NEXT DIAGNOSTIC STEP BASED ON BRAKE SYMPTOM

- Hard or soft brake pedal.
- Lack of sufficient vehicle deceleration upon brake application.
- Vehicle pulls during braking and pump motor does NOT run.

Are any of the above symptoms present?

Yes	No
GO to Symptom Chart .	Concern is NOT in the ABS system. REFER to Section 06-00 for diagnosis.

DT1.7 OBTAIN DIAGNOSTIC TROUBLE CODE

- Obtain ABS diagnostic trouble code.

Is the diagnostic trouble code the same as before and the ENTIRE pinpoint test for the code completed?

Yes	No
PERFORM Intermittent Diagnosis .	Pinpoint test is NOT complete. RETURN to the last step completed in the pinpoint test. Code obtained is NOT the same. GO to the pinpoint for the code obtained. No code or Code System Pass is obtained. GO to System Precheck .

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DT1.8 DETERMINE WHICH SENSOR SIGNAL IS INCORRECT

- Obtain diagnostic trouble code.

Is code obtained C1155, C1145, C1230, C1158, C1148, C1229, C1258, C1259, C1260, C1233, C1234, C1237?

Yes	No
GO to appropriate sensor output pinpoint test.	Code System Pass is not obtained. GO to the pinpoint test for the code obtained. No code or Code System Pass is obtained. GO to Inspection and Verification System Precheck .

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Intermittent Diagnostic Guidelines

As previously mentioned, intermittent concerns are the most difficult concerns to diagnose.

An understanding of code storage and automatic code erasure is important.

First, codes can only be stored if the anti-lock brake control module has power. The anti-lock brake control module gets primary power from the ignition feed into Pin 20. If this voltage is missing or less than 9.5V, the anti-lock brake control module will not initialize and therefore, a code cannot be stored. A System Pass (system OK) will be present whenever the module sees the required voltage assuming no other failures are present.

A previously stored diagnostic trouble code will be automatically erased if no system concerns occur for 80 ignition cycles.

Therefore, some codes read out in the System Precheck may not result in any trouble found in the pinpoint test performed. In most cases, this is an indication of an intermittent electrical concern.

To minimize misdiagnosis, use the Intermittent Diagnosis Procedure if no resolution has been reached by the end of a particular pinpoint test.

If you are at this point because the warning light is on and you have been unable to obtain any code, go to Pinpoint Test V. This procedure is only meant to address those problems that have been reduced to an intermittent wiring concern.

PINPOINT TEST ID: INTERMITTENT DIAGNOSIS PROCEDURE

ID1 CLEAR CODES, RECONNECT COMPONENTS

- Remove the Rotunda Breakout Box 014-00322 or equivalent.
- Reinstall any components removed and remake all connections.
- Clear all codes.
- Key ON.

Does the ABS warning light prove out?

Yes	No
GO to **ID3**.	GO to **ID2**.

ID2 SERVICE CONNECTOR/TERMINAL CONCERN

- Most likely concern is at one of the affected component connectors such that terminals unseat or

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back out upon installation. At EACH affected connection, including intermediate connections, look for:

- Bent terminals.
- Damaged connector terminal locks.
- Damaged connector wedge.

NOTE: If one of the above conditions is found, check the tightness of the affected circuit once the connection is remade. If the wire is too tight (short), damage is likely to recur once vehicle is given back to the customer. Service the wire as necessary to correct tight wire conditions.

Are any of the above conditions noted?

Yes	No
SERVICE connector and terminal as necessary. GO to **ID5** .	GO to **ID6** .

ID3 WIGGLE TEST

- Leave key ON.
- Wiggle an affected circuit in one location only.

NOTE: Start at one component and wiggle connector by connector until the whole circuit has been tested.

- Observe ABS warning light.

Is the ABS warning light on?

Yes	No
Key off. GO to **ID5** .	GO to **ID4** .

ID4 VERIFY ALL CIRCUITS HAVE BEEN TESTED

Have all affected circuits for the code being serviced been tested?

Yes	No
Key off. GO to **ID6** .	GO to **ID3** and CHECK next circuit.

ID5 RETRIEVE CODE

- Retrieve code.

Is this code different than the code being serviced?

Yes	No
	REPAIR the wire, terminal, or connector as

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GO to the appropriate pinpoint test.	necessary. RETURN to the pinpoint test and PROCEED.

ID6 VERIFY ALL APPROPRIATE DIAGNOSTIC PROCEDURES HAVE BEEN RUN

- Has the System Precheck been run and a code been retrieved?

NOTE: If only some tests were performed, go to the pinpoint step last completed and continue.

Have all steps of the pinpoint and symptom tests for the codes being serviced been performed?

Yes	No
RETURN to the pinpoint test and PROCEED.	RETURN to procedure(s) not yet performed and PROCEED.

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DIAGNOSTIC TROUBLE CODE INDEX

DIAGNOSTIC TROUBLE CODE INDEX

DTC	Concern	Sets At	Pinpoint Test
B1342	Anti-Lock Brake Control Module Failure	Key On	Replace Anti-Lock Brake Control Module
C1101	ABS Hydraulic Valve Circuit Failure	Key On	A
C1185	ABS Power Relay Output Circuit Failure	Key On	B
B1317	Battery Voltage High	Key On	C
B1318	Battery Voltage Low	Key On	D
C1198	LF Inlet Valve Coil Circuit Failure	Key On	E
C1194	LF Outlet Valve Coil Circuit Failure	Key On	F
C1214	RF Inlet Valve Coil Circuit Failure	Key On	G
C1210	RF Outlet Valve Coil Circuit Failure	Key On	H
C1206	Rear Axle Inlet Valve Coil Circuit Failure	Key On	J
C1202	Rear Axle Outlet Valve Coil Circuit Failure	Key On	K
C1155	LF Wheel Speed Sensor Input Circuit Failure	Key On	L
C1158	LF Wheel Speed Sensor Coherency Fault	40 km/h (25 mph)	LL
C1258	LF Wheel Speed Comparison Failure	19 km/h (12 mph)	LL
C1233	LF Wheel Speed Sensor Input Missing	>2 Min.	LL
C1145	RF Wheel Speed Sensor Input Circuit Failure	Key On	M
C1148	RF Wheel Speed Sensor Coherency Fault	40 km/h (25 mph)	MM
C1259	RF Wheel Speed Comparison Fault	19 km/h (12 mph)	MM
C1234	RF Wheel Speed Sensor Input Missing	>2 Min.	MM
C1230	Rear Axle Wheel Speed Sensor Input Circuit Failure	Key On	N
C1229	Rear Axle Wheel Speed Sensor Coherency Fault	40 km/h (25 mph)	NN
C1260	Rear Axle Wheel Speed Sensor Wheel Speed Comparison Fault	19 km/h (12 mph)	NN
C1237	Rear Axle Wheel Speed Sensor Input Missing	>2 Min.	NN
C1096	ABS Hydraulic Pump Motor Circuit	7 km/h (4 mph)	S
C1102	ABS Acceleration Switch Circuit Failure	See NOTE Below	T
C1095	ABS Hydraulic Pump Motor Circuit Failure	Key On	U

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Note: DTC C1102 indicates a G-Switch circuit failure. If the yellow ABS warning lamp comes on at key ON, check for a ground short on Pins 30, 31, or 32. If the yellow ABS lamp comes on at approximately 32 km/h (20 mph), there is either: 1) a battery short on Pins 30, 31 or 32; 2) an open on Pins 30 and 31; or 3) an open on Pin 32. If the yellow ABS lamp comes on after driving the vehicle for 2 minutes at approximately 72 km/h (45 mph), check for an open on Pin 30 or 31 (one pin only).

The G-Switch is installed on 4x4 vehicles only. If an anti-lock brake control module from a 4x4 vehicle is installed on a 4x2 vehicle, the DTC 1102 will be stored and the yellow ABS lamp will be illuminated. The anti-lock brake control module can be reprogrammed with the New Generation Star (NGS) Tester.

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Pinpoint Tests

NOTE: Do not proceed to any pinpoint test unless directed to do so.

These tests are specific for each code. However, jumping to a pinpoint test as a first step can be misleading. The tests have been written under the assumption that the System Precheck has been performed and passed.

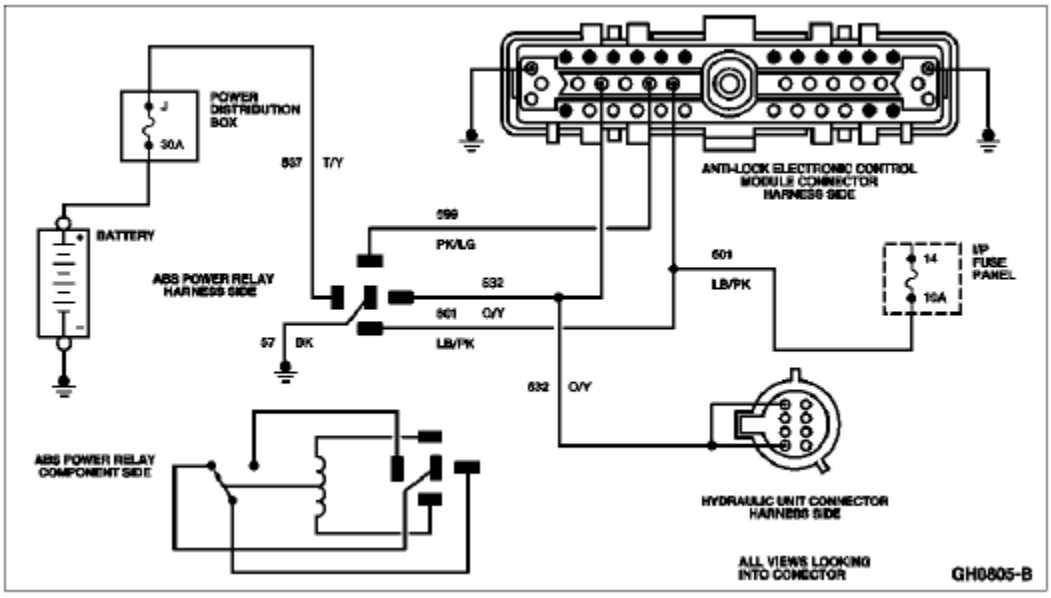
At times, running completely through the pinpoint test will not lead to problem resolution. Often, the concern is due to an intermittent connection, termination, or circuit concern. Refer to the Intermittent Diagnosis Guides in this section when situations like this arise.

It should be also noted that several circuits pass through one or more interconnections between components. These are also areas of potential concern and should be considered.

NOTE: Use Rotunda New Generation Star (NGS) Tester 007-00500 or equivalent to perform electrical tests.

PINPOINT TEST A: ABS HYDRAULIC VALVE CIRCUIT FAILURE (CODE C1101)

Affected Circuit(s)/Electrical Component(s)



Description

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DTC C1101 is generated when the ECU detects an intermittent circuit failure in the HCU valves or valve wiring harness.

Possible Contributing Component/Vehicle Wiring Faults

DTC C1101

- Intermittent valve failures.
- Intermittent wiring condition in Circuit 532 (O/Y) to both Pins 1 and 4 of the 8-pin HCU valve block connector.

A1 MEASURE VALVE RESISTANCE AT HCU

- Disconnect 8-pin connector from HCU.
- Measure resistance between the following on the COMPONENT side of the 8-way:
  - Pin 1, Pin 4 and Pin 2 (RA Inlet) 5-8 Ohms
  - Pin 1, Pin 4 and Pin 3 (RA Outlet) 3-6 Ohms
  - Pin 1, Pin 4 and Pin 5 (FR Inlet) 5-8 Ohms
  - Pin 1, Pin 4 and Pin 6 (FR Outlet) 3-6 Ohms
  - Pin 1, Pin 4 and Pin 7 (FL Inlet) 5-8 Ohms
  - Pin 1, Pin 4 and Pin 8 (FL Outlet) 3-6 Ohms

NOTE: The valve resistance will change rapidly. While monitoring valve coil resistance, tap the anti-lock hydraulic control unit lightly with a rubber mallet to simulate conditions of rough road driving.

Does the resistance on any valve move out of specification at any time?

Yes	No
High or low valve resistance detected. REPLACE HCU. PERFORM ABS brake bleed procedure with bleeder box. GO to **A5** .	GO to **A2** .

A2 TEST FOR INTERMITTENT INTERNAL VALVE BLOCK SHORT

- Measure resistance between the following on the COMPONENT side of the HCU 8-pin connector:
  - Pin 1 and valve block.
  - Pin 4 and valve block.

NOTE: The valve resistance will change rapidly. While monitoring valve coil resistance, tap the anti-lock hydraulic control unit lightly with a rubber mallet to simulate conditions of rough road driving.

Is the measured resistance less than 10M ohms at any time?

Yes	No
REPLACE HCU. PERFORM ABS brake bleed procedure with bleeder box. GO to **A5** .	GO to **A3** .

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A3 CHECK FOR INTERMITTENT BATTERY VOLTAGE AT HCU CONNECTOR

NOTE: The voltage reading will change rapidly.

- Install breakout box (BOB). Ensure that correct overlay is installed.
- Jumper BOB Pin 19 to Pin 1 or Pin 14.
- Set up DVOM to measure voltage between BOB Pin 17 and Pin 1 or Pin 14.
- While monitoring the voltage, tap the anti-lock hydraulic control unit lightly with a rubber mallet to simulate conditions of rough road driving.

Does the voltage fall below 9 volts at any time?

Yes	No
REPAIR source of high resistance or open circuit in one of the following: Circuit 532 (O/Y) between HCU and ABS power relay, Circuit 537 (T/Y) between battery and ABS power relay. GO to **A5**.	GO to **A4**.

A4 CONCLUDE INTERMITTENT DIAGNOSIS

- Perform Pinpoint Test ID, Intermittent Diagnosis Procedure for the affected circuits. Refer to the mini-schematic.

Is wiring fault located?

Yes	No
REPAIR wiring fault as required. GO to **A5**.	REPLACE ECU. GO to **A5**.

A5 VERIFY CONCERN IS RESOLVED

- Key OFF.
- Reconnect and reassemble all components.
- Install NGS Tester.
- Key ON. Clear codes.
- Drive over rough road and through a car wash.
- Pull codes.

Is System Pass obtained?

Yes	No
STOP. Repair is complete.	Same code is present. REPEAT **A1** to CHECK for second related concern. A new code is present. GO to the appropriate

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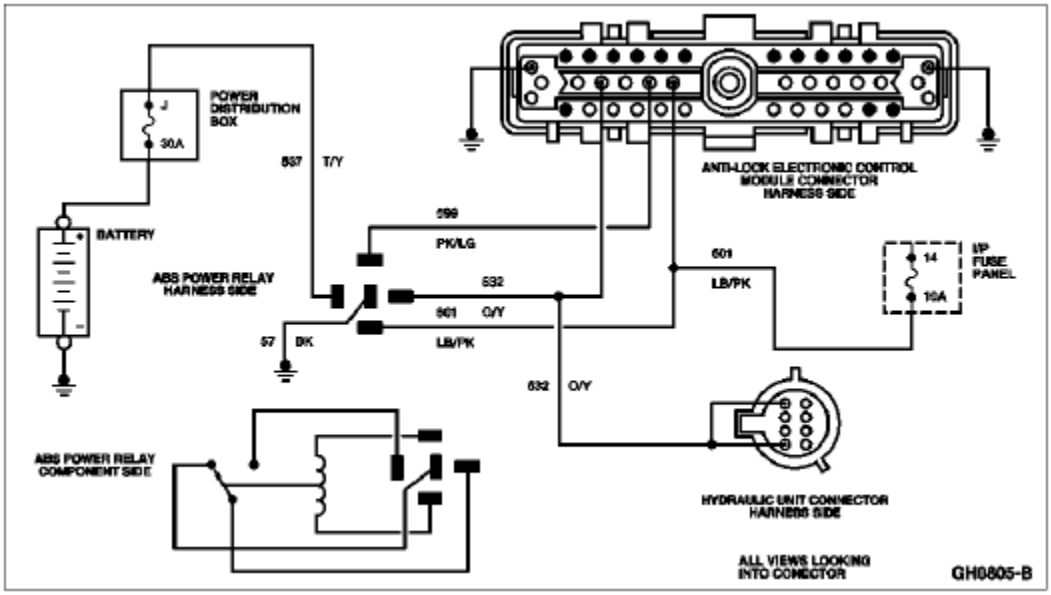
	pinpoint test.

PINPOINT TEST B: ABS POWER RELAY CIRCUIT OUTPUT FAILURE (CODE C1185)

Affected Circuit(s)/Electrical Component(s)



Description

DTC C1185 is generated when the ECU detects an open or ground short on Circuits 537 (T/Y), 599 (PK/LG) or 532 (O/Y).

Possible Contributing Component/Vehicle Wiring Faults

DTC C1185

- Open or short to ground on Circuits 537 (T/Y), 599 (PK/LG) or 532 (O/Y).
- Open in Circuit 601 (LB/BK) to relay coil only. Circuit 601 to module intact.
- 30 amp fuse open.
- ABS power relay coil or contacts open.

B1 CHECK FOR VOLTAGE AT PIN 17

- Measure and record battery voltage.
- Install breakout box (BOB). Ensure that correct overlay is installed.

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- Jumper breakout box Pin 19 to Pin 1 or Pin 14.
- Key ON. Measure voltage at BOB Pin 17.

Is voltage between 9.5 and 18 volts and within .5 volts of battery voltage?

Yes	No
GO to **B2** .	GO to **B4** .

B2 VERIFY DTC C1185

- Key OFF.
- Reconnect ECU.
- Key ON.

Is ABS light on?

Yes	No
GO to **B3** .	Intermittent fault. REFER to Pinpoint Test ID , Intermittent Diagnosis Procedure for all affected circuits (REFER to mini-schematic).

B3 RETRIEVE DTCS

- Connect NGS Tester and pull DTCs.

Is DTC C1185 present?

Yes	No
REPLACE ECU. GO to **B14** .	GO to appropriate pinpoint test.

B4 CHECK 30A FUSE

- Inspect 30A fuse for open.

Is fuse OK?

Yes	No
GO to **B7** .	GO to **B5** .

B5 CHECK CIRCUIT 537 (T/Y) FOR GROUND SHORT

- Remove ABS power relay.
- Check for ground short on Circuit 537 (T/Y) between 30A fuse and relay connector.

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Is a ground short detected?

Yes	No
REPAIR as required. GO to **B14** .	GO to **B6** .

B6 CHECK CIRCUIT 532 (O/Y) FOR GROUND SHORT

- Remove ABS power relay.
- Disconnect 8-way HCU valve connector.
- Check for ground short on Circuit 532 (O/Y) between relay connector, BOB Pin 17, and HCU 8-way connector Pins 1 and 4.

Is a ground short detected?

Yes	No
REPAIR as required. GO to **B14** .	REPLACE relay. GO to **B14** .

B7 CHECK POWER TO 30A FUSE

- Remove 30A fuse.
- Key ON. Measure voltage at power side of fuse.
- Key OFF.

Is B+ present?

Yes	No
GO to **B8** .	REPAIR power feed to 30A fuse. REFER to EVTM for power distribution. GO to **B14** .

B8 CHECK CIRCUIT 537 (T/Y) FOR OPEN

- Key OFF.
- Remove ABS power relay.
- Measure resistance between relay and 30A fuse along Circuit 537 (T/Y).
- Install fuse.

Is resistance less than 1 ohm?

Yes	No
GO to **B9** .	REPAIR open/high resistance in Circuit 537 (T/Y) as required. GO to **B14** .

B9 CHECK CIRCUIT 599 (PK/LG) FOR GROUND SHORT

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- Key OFF.
- Check for ground short at Circuit 599 (PK/LG) (BOB Pin 19).

Is circuit OK?

Yes	No
GO to **B10** .	REPAIR Circuit 599 (PK/LG) for ground short. GO to **B14** .

B10 CHECK CIRCUIT 599 (PK/LG) FOR OPEN

- Key OFF.
- Measure resistance between ABS power relay and BOB Pin 19 along Circuit 599 (PK/LG).

Is resistance less than 1 ohm?

Yes	No
GO to **B11** .	REPAIR open/high resistance in Circuit 599 (PK/LG) as required. GO to **B14** .

B11 CHECK CIRCUIT 532 (O/Y) FOR OPEN

- Key OFF.
- Measure resistance between ABS power relay and BOB Pin 17 along Circuit 532 (O/Y).

Is resistance less than 1 ohm?

Yes	No
GO to **B12** .	REPAIR open/high resistance in Circuit 532 (O/Y) as required. GO to **B14** .

B12 CHECK RELAY COIL

- Remove ABS power relay.
- Measure resistance across relay coil (terminals 85 and 86).

Is resistance between 60 and 80 ohms?

Yes	No
GO to **B13** .	REPLACE relay. GO to **B14** .

B13 CHECK VOLTAGE TO RELAY COIL

- Key ON. Measure voltage at Circuit 601 (LB/BK) on ABS power relay connector.

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- Key OFF.

Is B+ present?

Yes	No
REPLACE ABS power relay. RETEST.	REPAIR open in Circuit 601 (LB/BK) between splice and relay. REFER to mini-schematic. GO to **B14** .

B14 VERIFY CONCERN IS RESOLVED

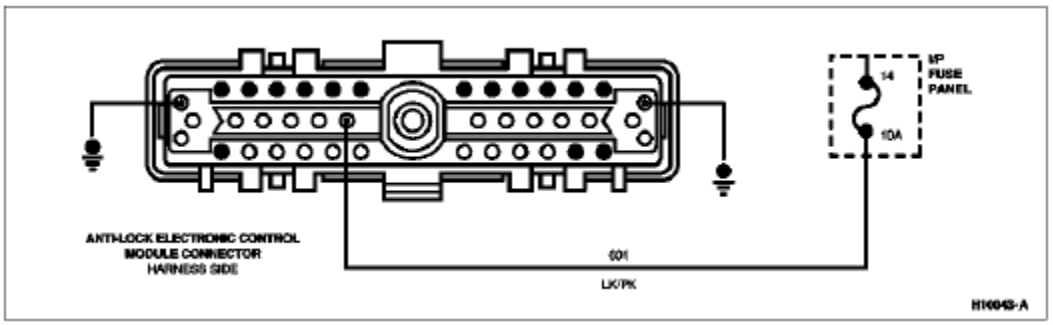
- Key OFF.
- Reconnect and reassemble all components.
- Connect NGS Tester.
- Key ON. Clear codes.
- Perform Drive Test DT1.
- Pull codes.

Is System Pass obtained?

Yes	No
STOP. Repair is complete.	Same code is present. REPEAT **B1** to CHECK for second related concern. A new code is present. GO to the appropriate pinpoint test.

PINPOINT TEST C: BATTERY VOLTAGE HIGH (CODE B1317)

Affected Circuit(s)/Electrical Component(s)



Description

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DTC B1317 is generated when the ECU detects system voltage was greater than 18.0 volts for more than 5 seconds.

Possible Contributing Component/Vehicle Wiring Faults

DTC B1317

- 24 volt jump.
- Charging system over-voltage condition.

C1 CHECK RECENT VEHICLE HISTORY

- The most likely cause for DTC B1317 is jump-starting the vehicle with a 24 volt system used on many towing repairs.

Has the vehicle been jump-started by a towing service within the past two weeks?

Yes	No
STOP. Repair is complete.	GO to **C2** .

C2 MEASURE VOLTAGE AT PIN 20

- Key ON, engine running. Measure voltage at BOB Pin 20.

Is voltage 18 volts or greater?

Yes	No
REPAIR charging system for over-voltage condition.	GO to **C3** .

C3 CHECK ECU

- Key OFF.
- Reconnect and reassemble all components.
- Install NGS Tester.
- Key ON. Clear codes.
- Key OFF.
- Key ON, pull codes.

Is System Pass obtained?

Yes	No
REPAIR charging system for intermittent over-voltage condition.	DTC B1317 is present. REPLACE ECU. A new code is present. GO to the appropriate pinpoint test.

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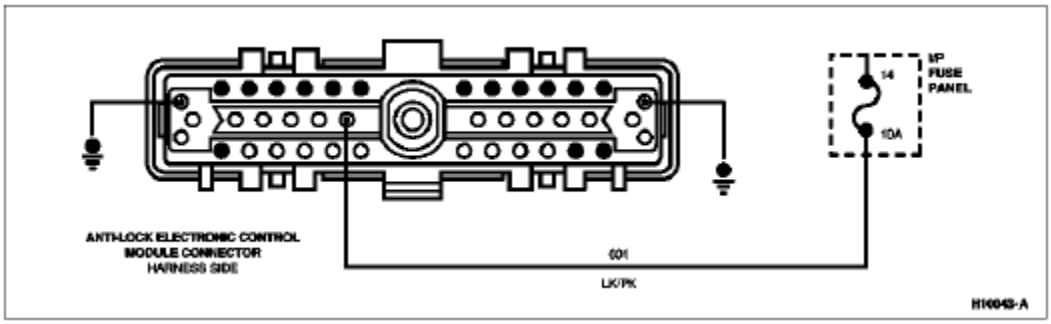
PINPOINT TEST D: BATTERY VOLTAGE LOW (CODE B1318)

Affected Circuit(s)/Electrical Component(s)



Description

DTC B1318 is generated when the ECU detects system voltage was less than 9.5 volts for more than 5 seconds.

Possible Contributing Component/Vehicle Wiring Faults

DTC B1318

- Charging system under-voltage condition.
- Excessive resistance in ECU ground circuits (Pins 1 and 14).
- Excessive resistance in Circuit 601 (LB/PK) to Pin 20.

D1 MEASURE BATTERY VOLTAGE B+

- Measure and record battery voltage

Is battery voltage greater than 9.5 volts?

Yes	No
GO to **D2** .	REPAIR charging system for under-voltage condition.

D2 VERIFY DTC B1318

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- Connect NGS Tester.
- Key ON, clear codes.
- Key OFF.
- Key ON, pull codes.

Is DTC B1318 present?

Yes	No
GO to **D3** .	A new code is present. GO to appropriate pinpoint test. System Pass is obtained. Concern is intermittent. PERFORM Pinpoint Test ID , Intermittent Diagnosis Procedure on all affected circuits. REFER to mini-schematic.

D3 CHECK ECU GROUND

- Install breakout box (BOB). Ensure that correct overlay is installed.
- Inspect ground stud for corrosion.
- Measure resistance between BOB Pins 1 and 14 and chassis ground.

Is resistance less than 0.5 ohm?

Yes	No
REPLACE ECU. GO to **D4** .	REPAIR high resistance in ECU ground circuit. GO to **D4** .

D4 VERIFY CONCERN IS RESOLVED

- Key OFF.
- Reconnect and reassemble all components.
- Install NGS Tester.
- Key ON. Clear codes.
- Perform Drive Test DT1 .
- Pull codes.

Is System Pass obtained?

Yes	No
STOP. Repair is complete.	Same code is present. REPEAT **D1** to CHECK for second related concern. A new code is present. GO to the appropriate pinpoint test.

PINPOINT TEST E: LF INLET SOLENOID VALVE CONCERN DIAGNOSIS (CODE

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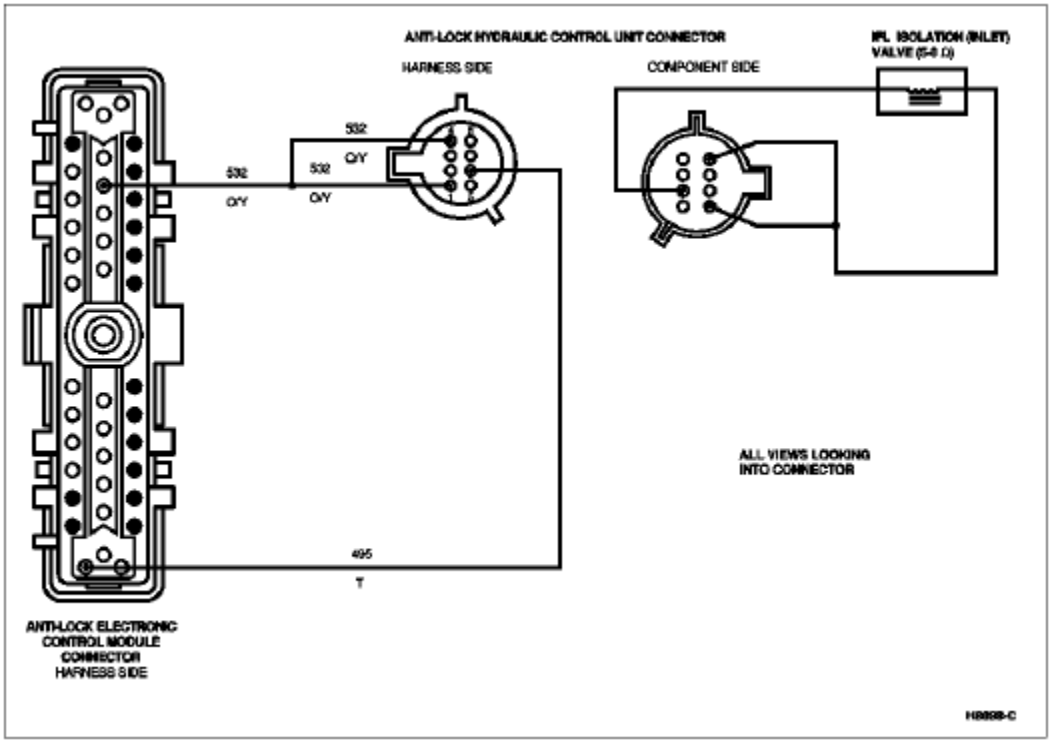
C1198)

Possible Code(s)

DTC C1198 — Open circuit to valve block or anti-lock brake control module, open or shorted valve coil or internal anti-lock electronic control module defect.

Affected Circuit(s)/Electrical Component(s)



Description

Code C1198 is generated by the ECU's detection of an open or shorted Circuit 495 (T) and by an open or shorted inlet front left (IFL) valve coil or an open or shorted driver in the anti-lock brake control module.

Possible Contributing Component/Vehicle Wiring Concerns

- Intermittent open Circuit 495 (T).
- Terminal backout in anti-lock brake control module connector Pins 17 and 40.
- Terminal backout in valve block connector Pins 1, 4 and 6.
- Open or shorted inlet front left (IFL) valve coil.
- Open or shorted driver in anti-lock brake control module.

E1 DIAGNOSTIC TROUBLE CODE C1198: CHECK VALVE COIL, CIRCUIT 495 (T) AND THE ANTI-LOCK ELECTRONIC CONTROL MODULE

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- Ignition OFF.
- Install Rotunda Breakout Box 014-00322 or equivalent and Overlay.
- Verify terminals at Pins 17 and 40 are clean and secure in the anti-lock brake control module harness connector.
- Measure resistance between Pins 17 and 40.

Is reading between 5 and 8 ohms?

Yes	No
GO to **E5** .	GO to **E2** .

E2 CHECK VALVE COIL

- Disconnect 8-pin valve block connector.
- Verify terminals on both halves of the 8-way connector are clean and secure.
- Measure resistance between Pins 1 and 6 and Pins 4 and 6 on the valve block.

Are both readings between 5 and 8 ohms?

Yes	No
REMOVE ABS power relay. REPAIR open or short to ground in Circuits 495 (T) and 532 (O/Y) between valve block harness connector and anti-lock brake control module connector. INSTALL relay. GO to **E4** .	REPLACE HCU. GO to **E4** .

E3 CHECK IF ALL STEPS HAVE BEEN COMPLETED

- This step requires that a valid diagnostic trouble code has been obtained, ALL prior diagnostic steps have been completed, and the affected wiring integrity has been verified.

  CAUTION: If the above is not complete, chances are that replacement of this or any other system component without specific direction will not, in most circumstances, resolve the concern and will consequently result in customer dissatisfaction.

Have all prior diagnostic steps been completed as described above?

Yes	No
REPLACE anti-lock brake control module. GO to **E4** .	GO to last diagnostic step completed and CONTINUE.

E4 CHECK FOR CODE REPEATABILITY

- Clear all codes.
- Key OFF.
- Key ON.

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- Retrieve code(s).

Is Code System Pass set?

Yes	No
Concern has been corrected. Go to **E5** .	Code C1198 still exists. GO to **E3** . Different code is set. GO to appropriate pinpoint test. Code C1198 still exists and anti-lock brake control module has been replaced. **NOTE: The anti-lock system is disabled with the Rotunda Breakout Box 014-00322 or equivalent installed.** INSTALL Rotunda Breakout Box 014-00322 with overlay. REPEAT Test Step **E1** while DRIVING vehicle. LOOK for any change in indicated continuity (turning on the DVOM beeper will help). INSPECT Circuits 532 and 495 along their entire length from the sensor connector to the anti-lock brake control module harness connector for chafing or any other damage that could lead to any open or shorted condition. REPAIR as required.

E5 VERIFY INTEGRITY OF VEHICLE WIRING

NOTE: If the above steps have been completed, the MOST LIKELY cause of the concern is wiring related.

- Refer to Pinpoint Test ID , Intermittent Diagnosis Procedure and perform for ALL affected circuits as shown on the pinpoint test mini-schematic.

Is resolution achieved?

Yes	No
GO to **E4** for system OK verification.	Most likely concern is HCU. REPLACE HCU. PERFORM anti-lock bleed procedure. GO to **E4** .

PINPOINT TEST F: LF OUTLET SOLENOID CONCERN DIAGNOSIS (CODE C1194)

Possible Code(s)

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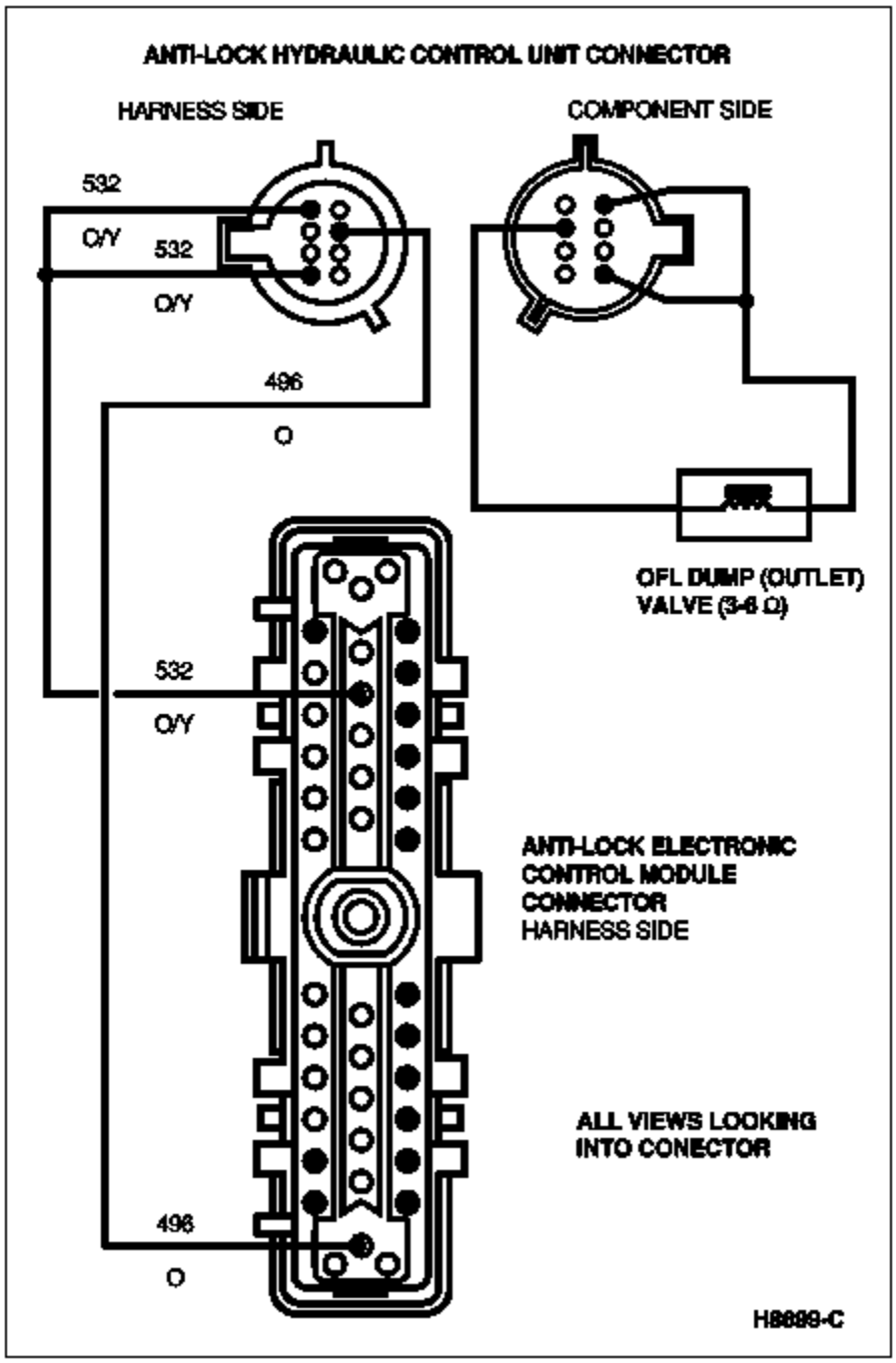
C1194 — Open circuit to valve block or anti-lock brake control module, open or shorted valve coil or internal anti-lock electronic control module damage.

Affected Circuit(s)/Electrical Component(s)



Description

Code C1194 is generated by the anti-lock electronic control module's detection of an open or shorted Circuit 496 (O) and by an open or shorted outlet front left (OFL) valve coil or an open or shorted driver in the anti-lock brake control module.

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Possible Contributing Component/Vehicle Wiring Concerns

- Intermittent open Circuit 496 (O).
- Terminal backout in anti-lock brake control module connector Pins 17 and 26.
- Terminal backout in valve block connector Pins 1, 4, and 7.
- Open or shorted outlet front left (OFL) valve coil.
- Open or shorted driver in anti-lock brake control module.

F1 DIAGNOSTIC TROUBLE CODE C1194: CHECK VALVE COIL, CIRCUIT 496 AND THE ANTI-LOCK ELECTRONIC CONTROL MODULE

- Ignition OFF.
- Install Rotunda Breakout Box 014-00322 or equivalent and Overlay.
- Verify terminals at Pins 17 and 26 are clean and secure in the anti-lock brake control module harness connector.
- Measure resistance between Pins 17 and 26.

Is reading between 3 and 6 ohms?

Yes	No
GO to **F5** .	GO to **F2** .

F2 CHECK VALVE COIL

- Disconnect 8-pin valve block connector.
- Verify terminals on both halves of the valve block 8-way connector are clean and secure.
- Measure resistance between Pins 1 and 7 and Pins 4 and 7 on the valve block.

Are both readings between 3 and 6 ohms?

Yes	No
REMOVE ABS power relay. SERVICE open or short to ground in Circuits 496 (O) and 532 (O/Y) between valve block harness connector and anti-lock brake control module connector. INSTALL relay. GO to **F4** .	REPLACE HCU. GO to **F4** .

F3 CHECK IF ALL STEPS HAVE BEEN COMPLETED

- This step requires that a valid diagnostic trouble code has been obtained, ALL prior diagnostic steps have been completed, and the affected wiring integrity has been verified.

CAUTION: If the above is not complete, chances are that replacement of this or any other system component without specific direction will not, in most circumstances, resolve the concern and will consequently result in customer dissatisfaction.

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Have all prior diagnostic steps been completed as described above?

Yes	No
REPLACE anti-lock brake control module. GO to **F4** .	GO to last diagnostic step completed and CONTINUE.

F4 CHECK FOR CODE REPEATABILITY

- Clear all codes.
- Key OFF.
- Key ON.
- Retrieve code(s).

Is Code System Pass set?

Yes	No
Concern has been corrected. GO to **F5** .	Code C1194 still exists. GO to **F3** . Different code is set. GO to appropriate pinpoint test. Code C1194 still exists and ECU has been replaced. **NOTE: The anti-lock system is disabled with the Rotunda Breakout Box 014-00322 or equivalent installed.** INSTALL Rotunda Breakout Box 014-00322 with overlay. REPEAT Test Step **F1** while DRIVING vehicle. LOOK for any change in indicated continuity (turning on the DVOM beeper will help). INSPECT Circuits 532 (O/Y) and 496 (O) along their entire length from the sensor connector to the anti-lock brake control module harness connector for chafing or any other damage that could lead to any open or shorted condition. REPAIR as required.

F5 VERIFY INTEGRITY OF VEHICLE WIRING

NOTE: If the above steps have been completed, the MOST LIKELY cause of the concern is wiring related.

- Refer to Pinpoint Test ID , Intermittent Diagnosis Procedure and perform for ALL affected circuits as shown on the pinpoint test mini-schematic.

Is resolution achieved?

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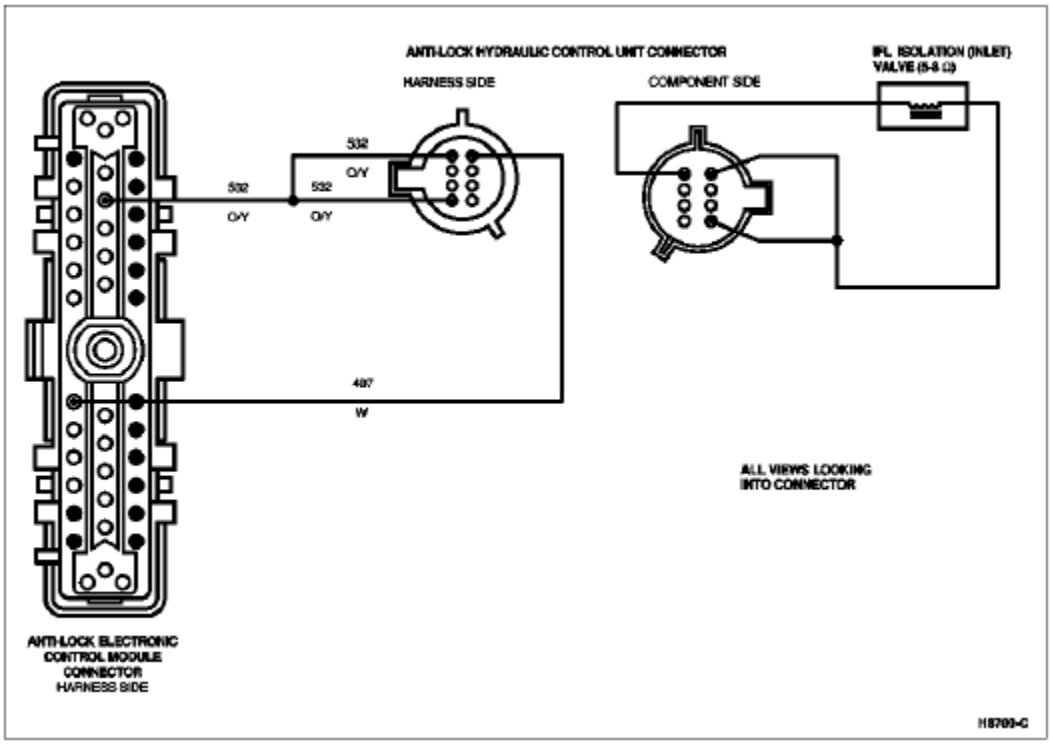
Yes	No
GO to F4 for system OK verification.	Most likely concern is in HCU. REPLACE HCU and PERFORM anti-lock bleed procedure. GO to F4 .

PINPOINT TEST G: RF INLET SOLENOID VALVE CONCERN DIAGNOSIS (CODE C1214)

Possible Code(s)

C1214 — Open circuit to valve block or anti-lock brake control module, open or shorted valve coil or internal anti-lock electronic control module damage.

Affected Circuit(s)/Electrical Component(s)



Description

Code C1214 is generated by the anti-lock electronic control module's detection of an open or shorted Circuit 497 (W) and by an open or shorted inlet front right (IFR) valve coil or an open or shorted driver in the anti-lock brake control module.

Possible Contributing Component/Vehicle Wiring Concerns

- Intermittent open Circuit 497 (W).

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- Terminal backout in anti-lock brake control module connector Pins 17 and 34.
- Terminal backout in valve block connector Pins 1, 4, and 8.
- Open or shorted inlet front right (IFR) valve coil.
- Open or shorted driver in anti-lock brake control module.

G1 DIAGNOSTIC TROUBLE CODE C1214: CHECK VALVE COIL CIRCUIT 497 (W) AND THE ECU

- Ignition OFF.
- Install Rotunda Breakout Box 014-00322 or equivalent and Overlay.
- Verify terminals at Pins 17 and 34 are clean and secure in the anti-lock brake control module harness connector.
- Measure resistance between Pins 17 and 34.

Is reading between 5 and 8 ohms?

Yes	No
GO to **G5** .	GO to **G2** .

G2 CHECK VALVE COIL

- Disconnect 8-pin valve block connector.
- Verify terminals on both halves of the valve block 8-way connector are clean and secure.
- Measure resistance between Pins 1 and 8 and Pins 4 and 8 on the valve block.

Are both readings between 5 and 8 ohms?

Yes	No
REMOVE ABS power relay. REPAIR open or short to ground in Circuits 497 (W) and 532 (O/Y) between valve block harness connector and anti-lock brake control module connector. INSTALL relay. GO to **G3** .	REPLACE HCU. GO to **G4** .

G3 CHECK IF ALL STEPS HAVE BEEN COMPLETED

- This step requires that a valid diagnostic trouble code has been obtained, ALL prior diagnostic steps have been completed, and the affected wiring integrity has been verified.

CAUTION: If not complete, chances are that replacement of this or any other system component without specific direction will not, in most circumstances, resolve the concern and will consequently result in customer dissatisfaction.

Have all prior diagnostic steps been completed as described above?

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Yes	No
REPLACE anti-lock brake control module. GO to **G4** .	GO to last diagnostic step completed and CONTINUE.

G4 CHECK FOR CODE REPEATABILITY

- Clear all codes.
- Key OFF.
- Key ON.
- Retrieve code(s).

Is Code System Pass set?

Yes	No
Concern has been corrected. GO to **G5** .	Code C1214 still exists. GO to **G3** . Different code is set. GO to appropriate pinpoint test. Code C1214 still exists and ECU has been replaced. **NOTE: The anti-lock system is disabled with the Rotunda Breakout Box 014-00322 or equivalent installed.** INSTALL Rotunda Breakout Box 014-00322 with overlay. REPEAT Test Step **G1** while driving vehicle. LOOK for any change in indicated continuity (turning on the DVOM beeper will help). INSPECT Circuits 532 (O/Y) and 497 (W) along their entire length from the sensor connector to the anti-lock brake control module harness connector for chafing or any other damage that could lead to any open or shorted condition. REPAIR as required.

G5 VERIFY INTEGRITY OF VEHICLE WIRING

NOTE: If the above steps have been completed, the MOST LIKELY cause of the concern is wiring related.

- Refer to Pinpoint Test ID , Intermittent Diagnosis Procedure and perform for ALL affected circuits as shown on the pinpoint test mini-schematic.

Is resolution achieved?

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Yes	No
GO to **G4** for system OK verification.	Most likely concern is in HCU. REPLACE HCU and PERFORM anti-lock bleed procedure. GO to **G4** .

PINPOINT TEST H: RF OUTLET SOLENOID VALVE CONCERN DIAGNOSIS (CODE C1210)

Possible Code(s)

C1210 — Open circuit to valve block or anti-lock brake control module, open or shorted valve coil or internal anti-lock electronic control module damage.

Affected Circuit(s)/Electrical Component(s)

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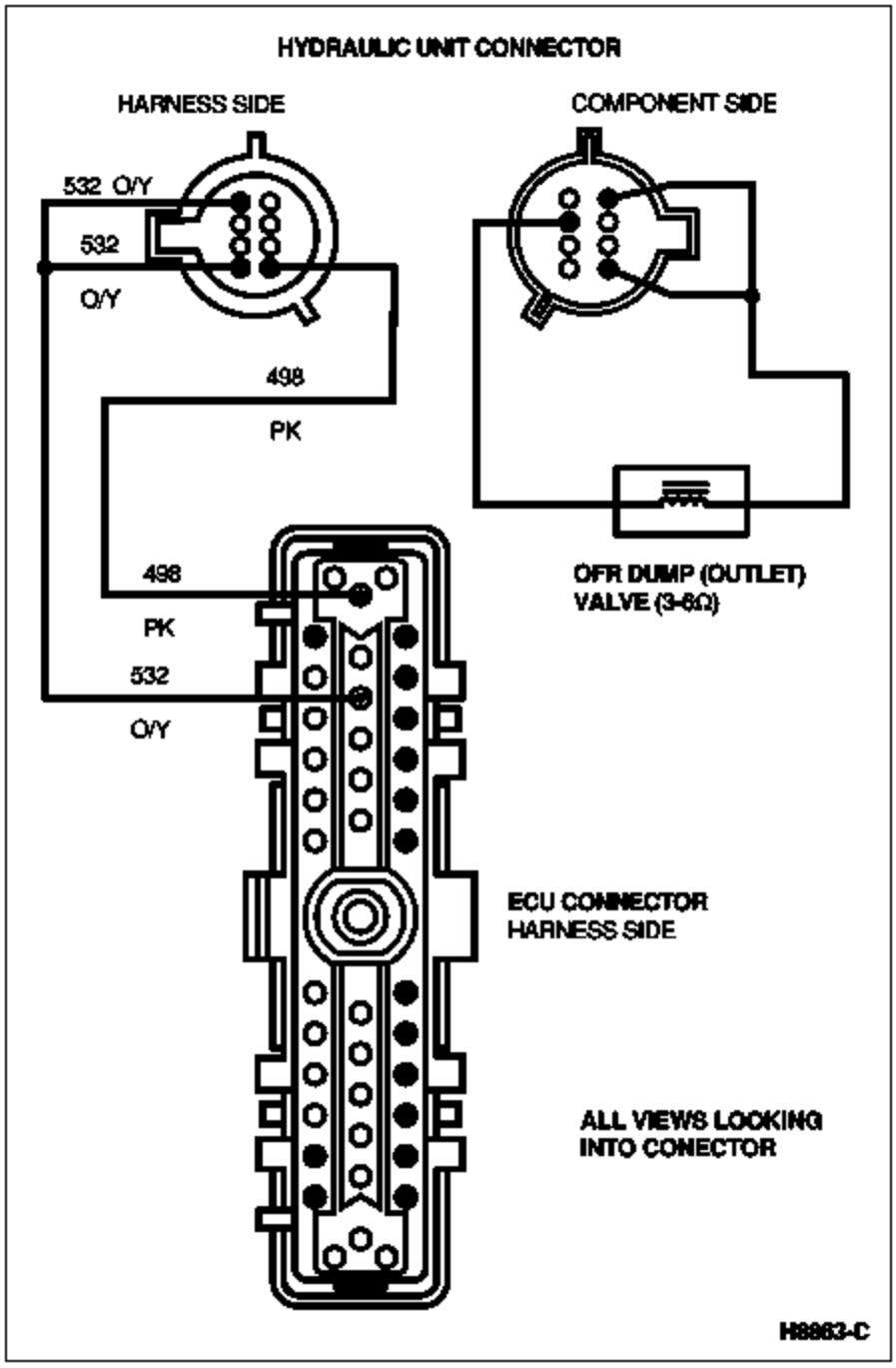

Description

Code C1210 is generated by the anti-lock electronic control module's detection of an open or shorted Circuit 498 (PK) and by an open or shorted outlet front right (OFR) valve coil or an open or shorted driver in the anti-lock brake control module.

Possible Contributing Component/Vehicle Wiring Concerns

- Intermittent open Circuit 498 (PK).
- Terminal backout in anti-lock brake control module connector Pins 17 and 15.

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- Terminal backout in valve block connector Pins 1, 4, and 5.
- Open or shorted outlet front right (OFR) valve coil.
- Open or shorted driver in anti-lock brake control module.

H1 DIAGNOSTIC TROUBLE CODE C1210: CHECK VALVE COIL, CIRCUIT 498 AND THE ANTI-LOCK ELECTRONIC CONTROL MODULE

- Ignition OFF.
- Install Rotunda Breakout Box 014-00322 or equivalent and Overlay.
- Verify terminals at Pins 17 and 15 are clean and secure in the anti-lock brake control module harness connector.
- Measure resistance between Pins 17 and 15.

Is reading between 3 and 6 ohms?

Yes	No
GO to **H5** .	GO to **H2** .

H2 CHECK VALVE COIL

- Disconnect 8-pin valve block connector.
- Verify terminals on both halves of the valve block 8-way connector are clean and secure.
- Measure resistance between Pins 1 and 5 and Pins 4 and 5 on the valve block.

Are both readings between 3 and 6 ohms?

Yes	No
REMOVE ABS power relay. REPAIR open or short to ground in Circuits 498 (PK) and 532 (O/Y) between valve block harness connector and anti-lock brake control module connector. INSTALL relay. GO to **H4** .	REPLACE HCU. GO to **H4** .

H3 CHECK IF ALL STEPS HAVE BEEN COMPLETED

- This step requires that a valid diagnostic trouble code has been obtained, ALL prior diagnostic steps have been completed, and the affected wiring integrity has been verified.

CAUTION: If the above is not complete, chances are that replacement of this or any other system component without specific direction will not, in most circumstances, resolve the concern and will consequently result in customer dissatisfaction.

Have all prior diagnostic steps been completed as described above?

Yes	No

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REPLACE anti-lock brake control module. GO to **H4**.	GO to last diagnostic step completed and CONTINUE.

H4 CHECK FOR CODE REPEATABILITY

- Clear all codes.
- Key OFF.
- Key ON.
- Retrieve code(s).

Is Code System Pass set?

Yes	No
Concern has been corrected. GO to **H5**.	Code C1210 still exists. GO to **H3**. Different code is set. GO to appropriate pinpoint test. Code C1210 still exists and anti-lock brake control module has been replaced. **NOTE: The anti-lock system is disabled with the Rotunda Breakout Box 014-00322 or equivalent installed.** INSTALL Rotunda Breakout Box 014-00322 with overlay. REPEAT Test Step **H1** while driving vehicle. LOOK for any change in indicated continuity (turning on the DVOM beeper will help). INSPECT Circuits 532 (O/Y) and 498 (PK) along their entire length from the sensor connector to the anti-lock brake control module harness connector for chafing or any other damage that could lead to any open or shorted condition. REPAIR as required.

H5 VERIFY INTEGRITY OF VEHICLE WIRING

NOTE: If the above steps have been completed, the MOST LIKELY cause of the concern is wiring related.

- Refer to Pinpoint Test ID, Intermittent Diagnosis Procedure and perform for ALL affected circuits as shown on the pinpoint test mini-schematic.

Is resolution achieved?

Yes	No

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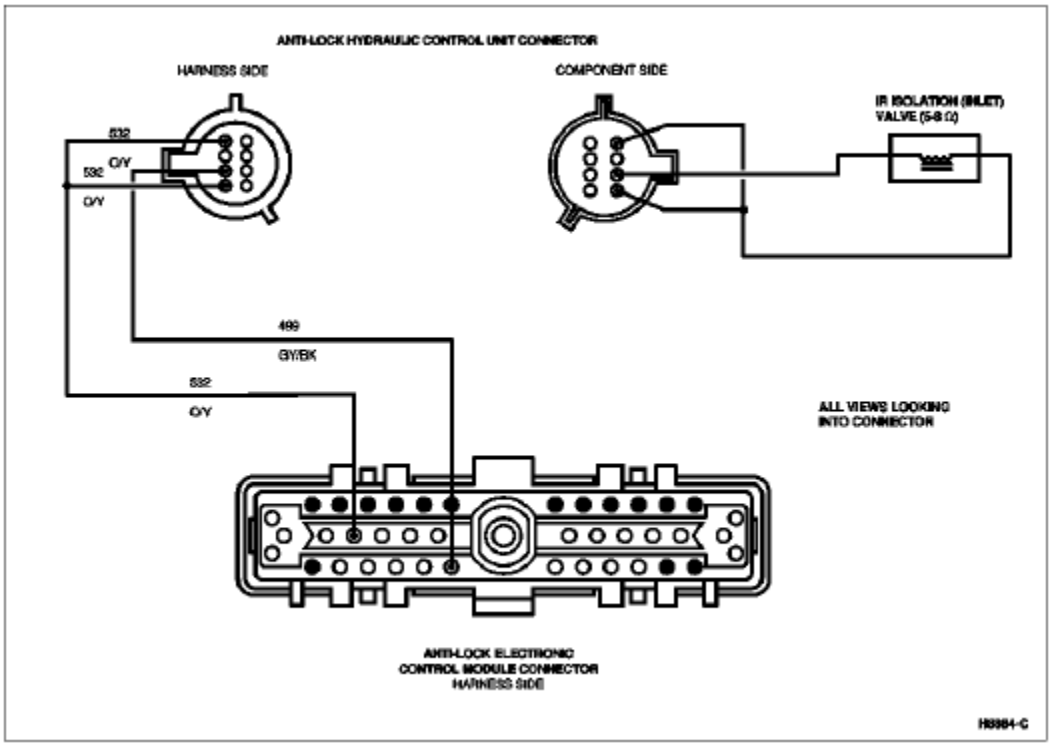
GO to **H4** for system OK verification.	Most likely concern was in HCU. REPLACE HCU and PERFORM anti-lock bleed procedure. GO to **H4** .

PINPOINT TEST J: REAR AXLE INLET SOLENOID VALVE CONCERN DIAGNOSIS (CODE C1206)

Possible Code(s)

C1206 — Open circuit to valve block or anti-lock brake control module, open or shorted valve coil or internal anti-lock electronic control module damage.

Affected Circuit(s)/Electrical Component(s)



Description

Code C1206 is generated by the anti-lock electronic control module's detection of an open or shorted Circuit 499 (GY/BK) and by an open or shorted inlet rear axle (IRA) valve coil or an open or shorted driver in the anti-lock brake control module.

Possible Contributing Component/Vehicle Wiring Concerns

- Intermittent open Circuit 499 (GY/BK).
- Terminal backout in ECU connector Pins 17 and 33.

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- Terminal backout in valve block connector Pins 1, 4, and 2.
- Open or shorted inlet rear axle (IRA) valve coil.
- Open or shorted driver in anti-lock brake control module.

J1 DIAGNOSTIC TROUBLE CODE C1206: CHECK VALVE COIL, CIRCUIT 499 (GY/BK) AND THE ANTI-LOCK ELECTRONIC CONTROL MODULE

- Ignition OFF.
- Install Rotunda Breakout Box 014-00322 or equivalent and Overlay.
- Verify terminals at Pins 17 and 33 are clean and secure in the anti-lock brake control module harness connector.
- Measure resistance between Pins 17 and 33.

Is reading between 5 and 8 ohms?

Yes	No
GO to **J5** .	GO to **J2** .

J2 CHECK VALVE COIL

- Disconnect 8-pin valve block connector.
- Verify terminals in both halves of the valve block 8-way connector are clean and secure.
- Measure resistance between Pins 1 and 2 and Pins 4 and 2 on the valve block.

Are both readings between 5 and 8 ohms?

Yes	No
REMOVE ABS power relay. REPAIR open or short to ground in Circuits 499 (GY/BK) or 532 (O/Y) between valve block harness connector and anti-lock brake control module connector. GO to **J4** .	REPLACE HCU. GO to **J4** .

J3 CHECK IF ALL STEPS HAVE BEEN COMPLETED

- This step requires that a valid diagnostic trouble code has been obtained, ALL prior diagnostic steps have been completed, and the affected wiring integrity has been verified.

CAUTION: If the above is not complete, chances are that replacement of this or any other system component without specific direction will not, in most circumstances, resolve the concern and will consequently result in customer dissatisfaction.

Have all prior diagnostic steps been completed as described above?

Yes	No

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REPLACE anti-lock brake control module. GO to J4 .	GO to last diagnostic step completed and CONTINUE.

J4 CHECK FOR CODE REPEATABILITY

- Clear all codes.
- Key OFF.
- Key ON.
- Retrieve code(s).

Is Code System Pass set?

Yes	No
Concern has been corrected. GO to J5 .	Code C1206 still exists. GO to J3 . Different code is set. GO to appropriate pinpoint test. Code C1206 still exists and anti-lock brake control module has been replaced. **NOTE: The anti-lock system is disabled with the Rotunda Breakout Box 014-00322 or equivalent installed.** INSTALL Rotunda Breakout Box 014-00322 with overlay. REPEAT Test Step J1 while driving vehicle. LOOK for any change in indicated continuity (turning on the DVOM beeper will help). INSPECT Circuits 532 (O/Y) and 499 (GY/BK) along their entire length from the sensor connector to the anti-lock brake control module harness connector for chafing or any other damage that could lead to any open or shorted condition. REPAIR as required.

J5 VERIFY INTEGRITY OF VEHICLE WIRING

NOTE: If the above steps have been completed, the MOST LIKELY cause of the concern is wiring related.

- Refer to Pinpoint Test ID , Intermittent Diagnosis Procedure and perform for ALL affected circuits as shown on the pinpoint test mini-schematic.

Is resolution achieved?

Yes	No

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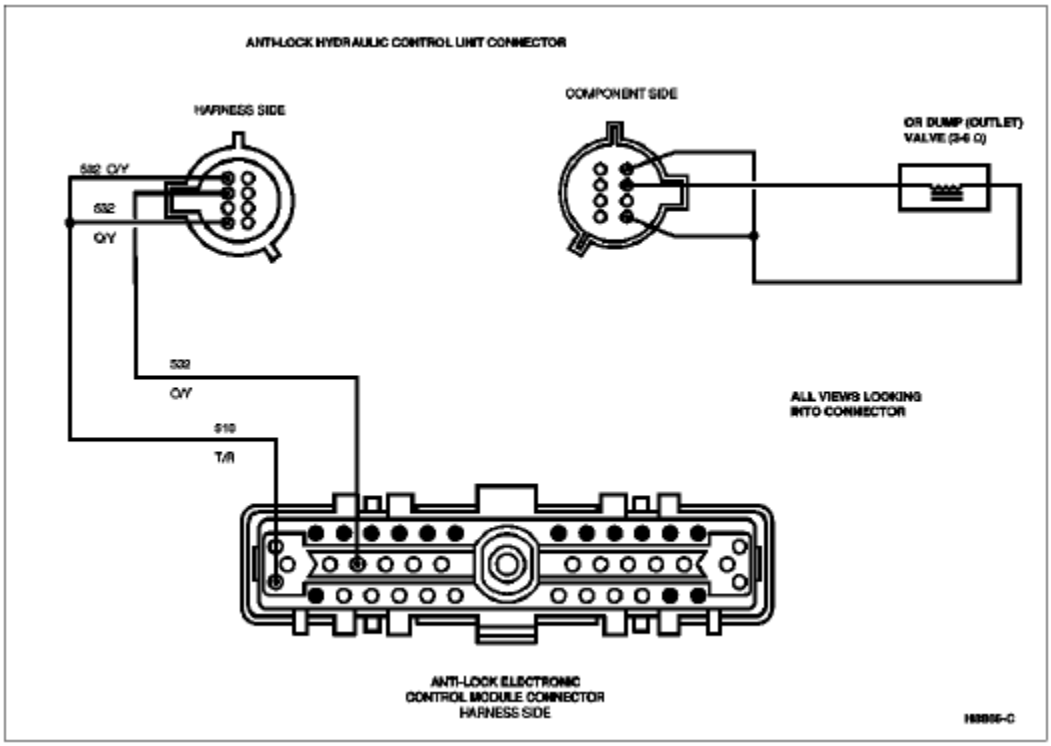
GO to **J4** for system OK verification.	Most likely concern is in HCU. REPLACE HCU and PERFORM anti-lock bleed procedure. GO to **J4**.

PINPOINT TEST K: REAR AXLE OUTLET SOLENOID CONCERN DIAGNOSIS (CODE C1202)

Possible Code(s)

C1202 — Open circuit to valve block or anti-lock brake control module, open or shorted valve coil or internal anti-lock electronic control module damage.

Affected Circuit(s)/Electrical Component(s)



Description

Code C1202 is generated by the anti-lock electronic control module's detection of an open or shorted Circuit 510 (T/R) and by an open or shorted outlet rear axle (ORA) valve coil or an open or shorted driver in the anti-lock brake control module.

Possible Contributing Component/Vehicle Wiring Concerns

- Intermittent open Circuit 510 (T/R).
- Terminal backout in anti-lock brake control module connector Pins 17 and 27.

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- Terminal backout in valve block connector Pins 1, 4, and 3.
- Open or shorted outlet rear axle (ORA) valve coil.
- Open or shorted driver in anti-lock brake control module.

K1 DIAGNOSTIC TROUBLE CODE C1202: CHECK VALVE COIL, CIRCUIT 510 (T/R) AND THE ANTI-LOCK ELECTRONIC CONTROL MODULE

- Ignition OFF.
- Install Rotunda Breakout Box 014-00322 or equivalent and Overlay.
- Verify terminals at Pins 17 and 27 are clean and secure in the anti-lock brake control module connector.
- Measure resistance between Pins 17 and 27.

Is reading between 3 and 6 ohms?

Yes	No
GO to **K5** .	GO to **K2** .

K2 CHECK VALVE COIL

- Disconnect 8-pin valve block connector.
- Verify terminals on both halves of the valve block 8-way connector are clean and secure.
- Measure resistance between Pins 1 and 3 and Pins 4 and 3 on the valve block.

Are both readings between 3 and 6 ohms?

Yes	No
REMOVE ABS power relay. REPAIR open or short to ground in Circuits 510 (T/R) or 532 (O/Y) between valve block harness connector and anti-lock brake control module connector. INSTALL relay. GO to **K4** .	REPLACE HCU.

K3 CHECK IF ALL STEPS HAVE BEEN COMPLETED

- This step requires that a valid diagnostic trouble code has been obtained, ALL prior diagnostic steps have been completed, and the affected wiring integrity has been verified.

CAUTION: If the above is not complete, chances are that replacement of this or any other system component without specific direction will not, in most circumstances, resolve the concern and will consequently result in customer dissatisfaction.

Have all prior diagnostic steps been completed as described above?

Yes	No

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REPLACE anti-lock brake control module. GO to **K4**.	GO to last diagnostic step completed and CONTINUE.

K4 CHECK FOR CODE REPEATABILITY

- Clear all codes.
- Key OFF.
- Key ON.
- Retrieve code(s).

Is Code System Pass set?

Yes	No
Concern has been corrected. GO to **K5**.	Code C1202 still exists. GO to **K3**. Different code is set. GO to appropriate pinpoint test. Code C1202 still exists and Step K2 is complete. **NOTE: The anti-lock system is disabled with the Rotunda Breakout Box 014-00322 or equivalent installed.** INSTALL Rotunda Breakout Box 014-00322 with overlay. REPEAT Test Step **K1** while driving vehicle. LOOK for any change in indicated continuity (turning on the DVOM beeper will help). INSPECT Circuits 532 (O/Y) and 499 (GY/BK) along their entire length from the sensor connector to the anti-lock brake control module harness connector for chafing or any other damage that could lead to any open or shorted condition. REPAIR as required.

K5 VERIFY INTEGRITY OF VEHICLE WIRING

NOTE: If the above steps have been completed, the MOST LIKELY cause of the concern is wiring related.

- Refer to Pinpoint Test ID, Intermittent Diagnosis Procedure and perform for ALL affected circuits as shown on the pinpoint test mini-schematic.

Is resolution achieved?

Yes	No

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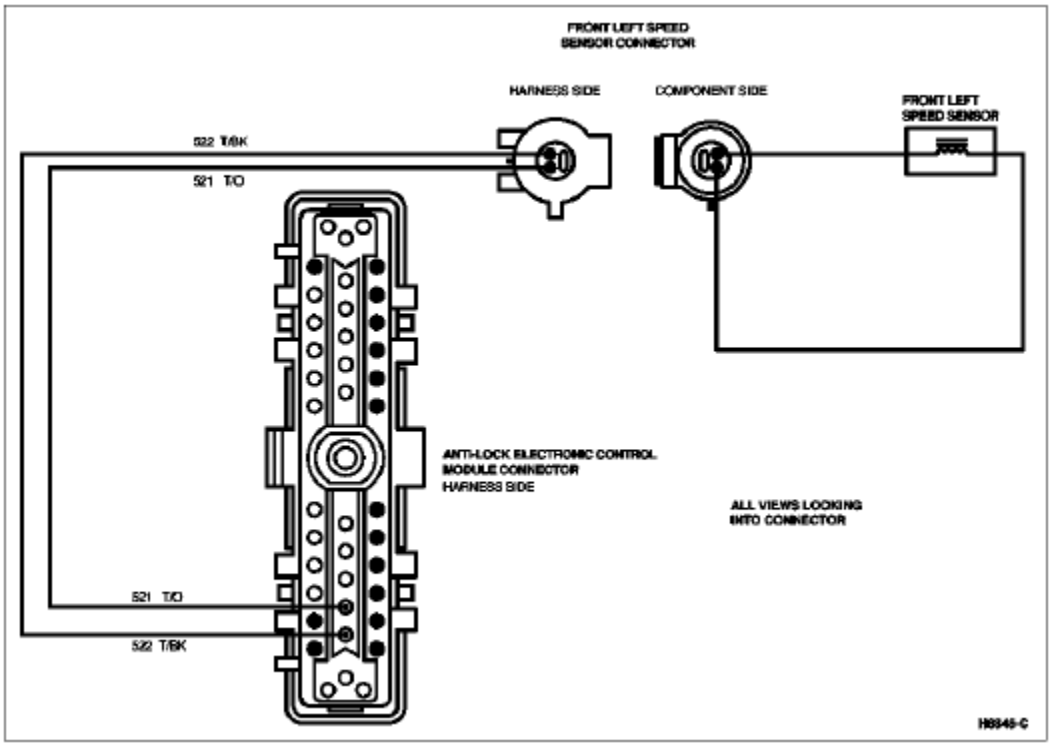
GO to **K4** for system OK verification.	Most likely concern is in HCU. REPLACE HCU and PERFORM anti-lock bleed procedure. GO to **K4** .

PINPOINT TEST L: LF WHEEL SPEED SENSOR INPUT CIRCUIT FAILURE (STATIC) (CODE C1155)

Possible Code(s)

C1155 — Electrically shorted or open front left speed sensor circuit or coil.

Affected Circuit(s)/Electrical Component(s)



Description

Code C1155 is generated by the anti-lock electronic control module's detection of an open or shorted wheel speed sensor coil or an open or shorted condition in Circuits 521 (T/O) or 522 (T/BK) between the wheel speed sensor and the anti-lock brake control module. If this fault is detected during the anti-lock electronic control module's self-check after KEY ON, the ABS warning lamp will come on immediately. This is generally an indication of a constant wiring or component fault. If the ABS warning lamp proves out normally and comes on later when the vehicle is driven, this is generally an indication of an intermittent wiring or component fault.

Possible Contributing Component/Vehicle Wiring Concerns

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- Poor connection at front left wheel sensor
- Terminal damage or backout in anti-lock brake control module connector Pins 24 or 25
- Terminal damage or backout in two-pin sensor connector
- Open or shorted front left speed sensor coil
- Open or shorted Circuit 521 (T/O) or 522 (T/BK)
- Improper front left wheel speed sensor cable routing leading to above
- Defective front left wheel speed sensor electrical test circuit in anti-lock brake control module

L1 DIAGNOSTIC TROUBLE CODE C1155: CHECK FRONT LEFT SPEED SENSOR ELECTRICAL FAULT

- Ignition OFF.
- Install Rotunda Breakout Box 014-00322 or equivalent and Overlay.
- Measure resistance between Pins 24 and 25.

Is reading between 1.0-1.4 k Ohms?

Yes	No
GO to **L8** .	GO to **L2** .

L2 CHECK RESISTANCE AT FRONT LEFT WHEEL SPEED SENSOR

- Disconnect left front speed sensor connector.
- Measure resistance between the two pins on the speed sensor component connector.

Is reading between 1.0-1.4 k Ohms?

Yes	No
Speed sensor checks good. GO to **L3** .	REPLACE speed sensor. GO to **L11** .

L3 CHECK CIRCUIT 521 (T/O) CONTINUITY

- Measure resistance between Pin 24 on the Rotunda Breakout Box 014-00322 or equivalent and wheel speed sensor harness connector pin for Circuit 521 (T/O).

Is there continuity (zero or near zero ohms)?

Yes	No
Circuit 521 (T/O) checks OK. GO to **L4** .	REPAIR open or high resistance on Circuit 521 (T/O). GO to **L11** .

L4 CHECK CIRCUIT 522 (T/BK) CONTINUITY

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- Measure resistance between Pin 25 on the Rotunda Breakout Box 014-00322 or equivalent and wheel speed sensor harness connector pin for Circuit 522 (T/BK).

Is there continuity (zero or near zero ohms)?

Yes	No
Circuit 522 (T/BK) checks OK. GO to **L5** .	REPAIR open or high resistance on Circuit 522 (T/BK). GO to **L11** .

L5 CHECK CIRCUIT 521 (T/O) SHORT TO GROUND

- Measure resistance between Pins 1 and 24 on the Rotunda Breakout Box 014-00322 or equivalent.

Is there continuity?

Yes	No
REPAIR short to ground on Circuit 521 (T/O). GO to **L11** .	Circuit 521 (T/O) checks OK. GO to **L6** .

L6 CHECK CIRCUIT 522 (T/BK) SHORT TO GROUND

- Measure resistance between Pins 1 and 25 on the Rotunda Breakout Box 014-00322 or equivalent.

Is there less than 10 ohms measured?

Yes	No
REPAIR short to ground on Circuit 522 (T/BK). GO to **L7** .	Circuit 522 (T/BK) checks OK. GO to **L8** .

L7 CHECK FOR SHORT TO CAN

- Measure resistance between spindle near sensor can and either coil circuit at sensor connector.

Is resistance less than 10 ohms?

Yes	No
Internal short in speed sensor detected. REPLACE speed sensor. GO to **L11** .	GO to **L8** .

L8 CHECK WHEEL END ROUTING FOR DAMAGE

- Inspect the wheel speed sensor cable at the affected wheel end for chafing or other wiring damage.

Is damage found?

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Yes	No
REPLACE speed sensor. CORRECT any obvious routing issues. GO to **L11** .	GO to **L9** .

L9 CHECK FOR WIRING INTERMITTENTS

NOTE: If the above steps have been completed, the MOST LIKELY cause of the concern is wiring related.

- Refer to Pinpoint Test ID , Intermittent Diagnosis Procedure and perform for ALL affected circuits as shown on the pinpoint test mini-schematic.

Is resolution obtained?

Yes	No
GO to **L11** for system verification.	Wiring system has been verified as intact. GO to **L10** .

L10 CHECK IF ALL STEPS HAVE BEEN COMPLETED

- This step requires that a valid diagnostic trouble code has been obtained, ALL prior diagnostic steps have been completed, and the affected wiring integrity has been verified.

CAUTION: If the above is not complete, chances are that replacement of this or any other system component without specific direction will not, in most circumstances, resolve the concern and will consequently result in customer dissatisfaction.

Have all prior diagnostic steps been completed as described above?

Yes	No
REPLACE speed sensor. GO to **L11** for system verification. If no resolution, REPLACE anti-lock brake control module. GO to **L11** for system verification.	GO to last diagnostic step completed and CONTINUE.

L11 CHECK FOR CODE REPEATABILITY

- Remove Rotunda Breakout Box 014-00322 or equivalent and reinstall all components.
- Clear all codes.
- Key OFF.
- Key ON.
- Retrieve code(s).

Is Code System Pass set?

Yes	No

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STOP. Concern has been corrected.	Code being repaired still exists. Concern has NOT been corrected. RETURN to last diagnostic step completed and PROCEED. Different code is set. GO to appropriate pinpoint test. Code being serviced still exists and Test L9 is completed. **NOTE: The anti-lock system is disabled with the Rotunda Breakout Box 014-00322 or equivalent installed.** INSTALL Rotunda Breakout Box 014-00322 or equivalent with Overlay. REPEAT Test Steps **L3** -L6 while driving vehicle. LOOK for any change in indicated continuity (turning on the DVOM beeper will help). INSPECT Circuits 521 (T/O) and 522 (T/BK) along their entire length from the speed sensor connector to the anti-lock brake control module harness connector for chafing or any other damage that could lead to any open or shorted condition. REPAIR as required.

PINPOINT TEST LL: LF WHEEL SPEED SENSOR COHERENCY FAULT (DYNAMIC) (CODES C1158, C1258, and C1233)

Possible Code(s)

C1158, C1258, C1233

Affected Circuit(s)/Electrical Component(s)

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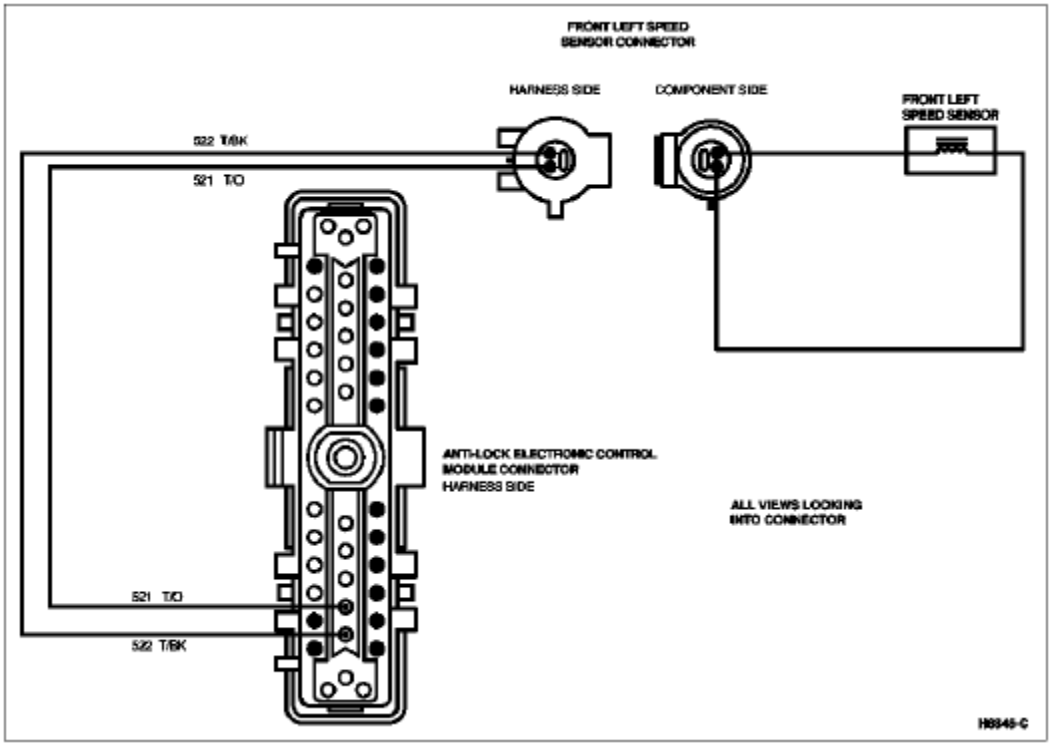

Description

Codes C1158, C1258, and C1233 are generated by the anti-lock electronic control module's detection of a missing, erratic, or otherwise improper wheel speed signal from the left front wheel speed sensor. The codes are set for specific faults at various vehicle speeds that are as follows:

Code C1158: Anti-lock brake control module detects that the front left wheel speed information is erratic.

Code C1258: Anti-lock brake control module detects that the front left wheel speed information does not match the right front and rear axle wheel speed information.

Code C1233: Anti-lock brake control module detects that the front left wheel speed signal has dropped out when it was previously there. This code is not dependent upon vehicle speed.

Codes C1158, C1258 and C1233 CANNOT be set with the vehicle stationary. The vehicle should be driven when attempting to duplicate the concern. If Code C1158, C1258 or C1233 is set, then the ABS warning lamp will come on and will remain on until the vehicle is shut off. However, if the condition is corrected, the ABS warning lamp will be turned off by the anti-lock brake control module and the system will again be operational.

Possible Contributing Component/Vehicle Wiring Concerns

- Damaged/missing tone ring teeth or missing tone ring
- Air gap too small or too large
- Excessive rear axle vibration
- Weak speed sensor
- Loose speed sensor
- INTERMITTENT short or open in Circuit 521 (T/O) or 522 (T/BK)

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NOTE: If above codes are stored with C1155, check for intermittent short to ground or open. If above codes only are stored, the concern is output related and it is not necessary to check for intermittent open/short conditions.

- Disturbances caused by electrical interference induced into the sensor circuit from nearby ungrounded source (static charges)
- Defective trigger circuit in anti-lock brake control module

LL1 DIAGNOSTIC TROUBLE CODES C1158, C1258 or C1233: INSPECT SPEED SENSOR MOUNTING/TONE RING

- Install Rotunda Breakout Box 014-00322 or equivalent and Overlay.
- Raise vehicle on hoist.
- Inspect the left front tone ring for any damaged or missing teeth. Rotate wheel to ensure all teeth are checked.
- Inspect the speed sensor mounting in the wheel end for looseness.

CAUTION: Examine the ring carefully with good light. Failure to catch issues with the tone ring will lead to unnecessary component replacement and wasted diagnosis time.

Is tone ring damage or sensor looseness found?

Yes	No
Tone ring is damaged or missing. REPLACE tone ring. GO to **LL5** to CHECK for proper sensor output. Sensor is loose. TIGHTEN speed sensor bolt to specifications. GO to **LL5** to CHECK for proper sensor output.	GO to **LL2** .

LL2 CHECK FRONT LEFT SPEED SENSOR OUTPUT AT ANTI-LOCK ELECTRONIC CONTROL MODULE

- Lower vehicle so that wheels are just far enough off the ground to permit all wheels to turn.
- Remove left front wheel. Knock back the front disc brake caliper so that the wheel can move as freely as possible. Remount the wheel.
- 4x2s ONLY, spin front left wheel and maintain a constant speed of 60 rpm (1 revolution per second).
- 4x4s ONLY, place in 4x4 low mode. Start engine and allow wheels to spin and stabilize at engine idle speed.

NOTE: Perform the following measurements with Rotunda 105-R0053 Digital/Analog Volt-Ohmmeter or equivalent. If not using Rotunda 105-R0053 or Fluke Frequency Meter, higher wheel speed may be required in order for the frequency meter to function correctly.

- Set the Rotunda Digital/Analog Volt-Ohmmeter 105-R0053 or equivalent, to the frequency counter (Hz) setting. Measure and record the frequency between Pins 24 and 25 on the Rotunda Breakout Box 014-00322 or equivalent.

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- Change the meter to the A/C mV setting. Measure and record the voltage output between Pins 24 and 25 on the Rotunda Breakout Box 014-00322 or equivalent.

  NOTE: Measurements of BOTH the frequency and the voltage output must be taken. The actual speed the wheels are turning is not important — the result of voltage output divided by the frequency will not change with wheel speed. However, it is crucial that both the frequency measurement and the voltage measurement be taken at the SAME wheel speed.

- Determine the sensor output in mV/Hz:
- Output — A/C Voltage/Frequency

Is the sensor output greater than 5.0 mV/Hz (4x2), 5.8 mV/Hz (4x4)?

Yes	No
Output at anti-lock brake control module indicates that the air gap and speed sensor strength are OK. GO to **LL7** .	Speed sensor output at anti-lock brake control module is insufficient. GO to **LL3** .

LL3 CHECK FRONT LEFT SENSOR OUTPUT AT SPEED SENSOR

- Disconnect the speed sensor connector at the left radiator support.
- 4x2s ONLY, spin front left wheel and maintain a constant speed of 60 rpm (1 revolution per second).
- 4x4s ONLY, place in 4x4 low mode. Key ON and allow wheels to spin and stabilize at engine idle speed.
- Set the meter to the frequency counter (Hz) setting. Measure and record the frequency between the two pins of the speed sensor component connector.

  NOTE: Measurements of BOTH the frequency and the voltage output must be taken. The actual speed the wheels are turning is not important — the result of voltage output divided by the frequency will not change with wheel speed. However, it is crucial that both the frequency measurement and the voltage measurement be taken at the SAME wheel speed.

- Change the meter to the A/C mV setting. Measure and record the voltage output between the two pins of the speed sensor component connector.
- Determine the sensor output in mV/Hz:
- Output — A/C Voltage/Frequency

Is the sensor output greater than 5.0 mV/Hz (4x2), 5.8 mV/Hz (4x4)?

Yes	No
Output indicates that air gap and speed sensor strength are OK at the speed sensor. GO to **LL7** .	GO to **LL4** .

LL4 CHECK SPEED SENSOR/TONE RING AIR GAP

- Remove the speed sensor from the front wheel hub and spindle.
- Inspect mounting boss and speed sensor mounting plate for any metal flash or debris. Clean as necessary.

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- Remount speed sensor securely.
- Measure the air gap between the speed sensor and tone ring teeth. Repeat in at least two more wheel positions to ensure that gap does not vary as the wheel is turned.

  NOTE: Feeler gauges can be mounted to a welding rod and inserted between the vanes of the front disc brake hub and rotor to measure air gap precisely.

Is the gap consistent and less than 1.78mm (0.070 inch)?

Yes	No
REPLACE speed sensor. GO to **LL5** .	Gap is greater than 1.78mm (0.070 inch). Air gap is too large. REPLACE tone ring. GO to **LL5** . Gap is not consistent. Tone ring is not pressed on straight or axle end play is too great. GO to **LL6** .

LL5 RECHECK FRONT LEFT SPEED SENSOR OUTPUT

- 4x2s ONLY, spin front left wheel and maintain a constant speed of 60 RPM (1 revolution per second).
- 4x4s ONLY, place in 4x4 low mode. Start engine and allow wheels to spin and stabilize at engine idle speed.
- Set the meter to the frequency counter (Hz) setting. Measure and record the frequency between the two pins of the sensor component connector.

  NOTE: Measurements of BOTH the frequency and the voltage output must be taken. The actual speed the wheels are turning is not important — the result of voltage output divided by the frequency will not change with wheel speed. However, it is crucial that both the frequency measurement and the voltage measurement be taken at the SAME wheel speed.

- Change the meter to the A/C mV setting. Measure and record the voltage output between the two pins of the sensor component connector.
- Determine the sensor output in mV/Hz:
- Output — A/C Voltage/Frequency

Is sensor output greater than 5.0 mV/Hz 4x2, or 5.8 mV/Hz 4x4?

Yes	No
Output is now OK. Concern is most likely resolved. A drive test is recommended to VERIFY sensor output is OK for customer driving conditions.	VERIFY tone ring is pressed straight and fully onto the rotor hub. CORRECT as needed. REPEAT **LL5** . If no resolution, REPLACE speed sensor. DO NOT leave this test until output is OK.

LL6 RESOLVE INCONSISTENT AIR GAP CONCERN

- Remove the front disc brake hub and rotor and inspect the tone ring/hub mounting surface. Verify the tone ring is pressed straight and fully onto the hub. Correct before proceeding.
- Reinstall the front disc brake hub and rotor.

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- Verify wheel end play is within allowable limits (refer to Section 04-01A or Section 04-01B). Correct as necessary.
- Measure the air gap between the speed sensor and tone ring teeth. Repeat in at least two more wheel positions to ensure that gap does not vary as the wheel is turned.

NOTE: Feeler gauges can be mounted to a welding rod and inserted between the vanes of the front disc brake hub and rotor to measure air gap precisely.

Is the gap consistent and less than 1.78mm (0.070 inch)?

Yes	No
GO to **LL5** to RECHECK speed sensor output.	Gap is greater than 1.78mm (0.070 inch). Air gap is too large. GO to **LL4** to RESOLVE large air gap concern. Gap is not consistent. REPEAT **LL6** . DO NOT leave this step until a consistent air gap is obtained.

LL7 CHECK FOR WIRING INTERMITTENTS

NOTE: If the above steps have been completed, the MOST LIKELY cause of the concern is wiring related.

- Refer to Pinpoint Test ID , Intermittent Diagnosis Procedure and perform for Circuits 521 (T/O) and 522 (T/BK).

Is resolution obtained?

Yes	No
Concern is most likely resolved. A drive test is recommended to VERIFY speed sensor output is OK during customer driving conditions.	GO to **LL8** .

LL8 CHECK IF ALL STEPS HAVE BEEN COMPLETED

- This step requires that a valid diagnostic trouble code has been obtained, ALL prior diagnostic steps have been completed, and the affected wiring integrity has been verified.

CAUTION: If the above is not complete, chances are that replacement of this or any other system component without specific direction will not, in most circumstances, resolve the concern and will consequently result in customer dissatisfaction.

Have all prior diagnostic steps been completed as described above?

Yes	No
REPLACE speed sensor. GO to **LL9** for drive test. If no resolution, REPLACE anti-lock brake control module. GO to **LL9** for drive test.	GO to last diagnostic step completed and CONTINUE.

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LL9 SPEED SENSOR OUTPUT DRIVE TEST

- Reinstall all components and remove Rotunda Breakout Box 014-00322 or equivalent.
- Clear all codes.
- Key OFF.
- Key ON.
- Drive vehicle and perform the following:
  - Complete at least one hard left and one hard right turn.
  - Travel over a stretch of rough road at normal vehicle speed.
  - Perform one hard acceleration from a stop.
- Retrieve code(s).

Is Code System Pass set?

Yes	No
STOP. Repair is complete.	Code being repaired still exists. GO to **LL8** . Different code is set (other than C1158, C1258 or C1233). GO to appropriate pinpoint test. Code being repaired still exists and anti-lock brake control module has been replaced. GO to **LL10** .

LL10 POSSIBLE CONDITIONS NOT CHECKED

At this point the following have been verified or are true if the above steps are complete:

- Sensor strength is OK.
- Tone ring is intact with no damaged teeth and is correctly seated against the rotor hub.
- Air gap is within allowable limits and is consistent as the wheel rotates.
- Wiring between speed sensor and anti-lock brake control module is intact.
- The anti-lock brake control module has been replaced.
- The speed sensor has been replaced.
- The following are time consuming and should be performed only after all previous options have been exhausted.
- Verify Circuits 521 (T/O) and 522 (T/BK) are twisted throughout the wire loom. If the wires are not twisted, the anti-lock brake control module may be sensitive to any outside interference.
- Excessive axle vibration, especially over rough road can cause this issue. Verify front axle is not excessively noisy or otherwise performing abnormally.

NOTE: Blips or fallout indicate intermittent issue.

Does signal rise consistently and evenly?

Yes	No
STOP. Repair is complete.	GO to **LL8** .

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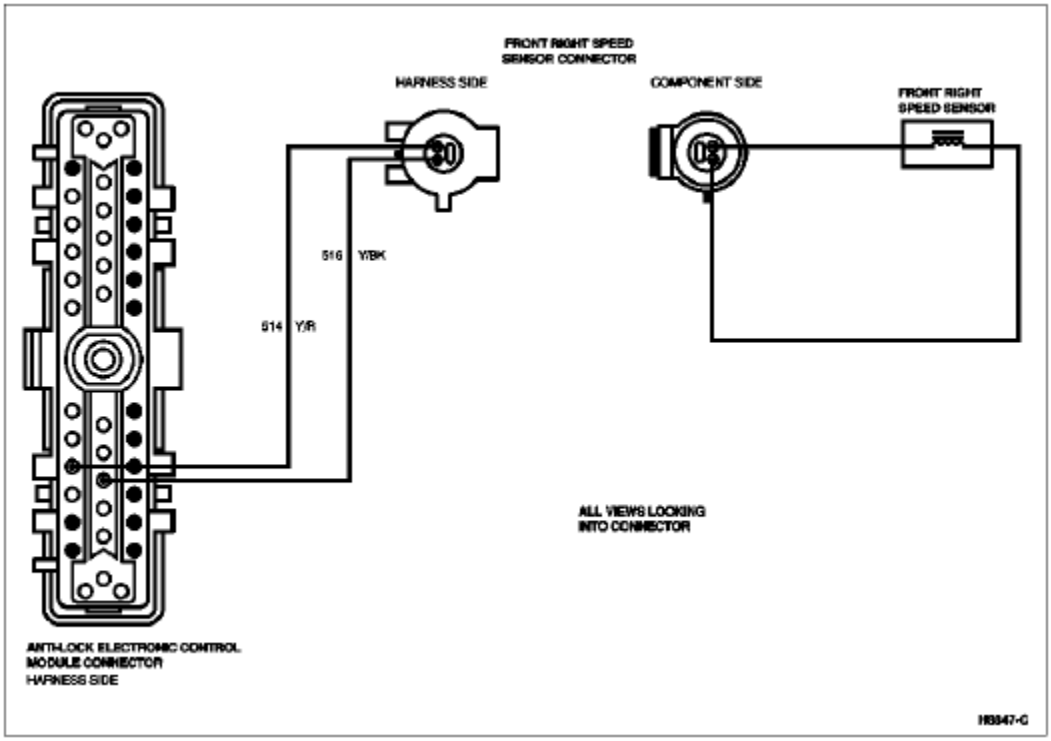
PINPOINT TEST M: RF WHEEL SPEED SENSOR INPUT CIRCUIT FAILURE (STATIC) (CODE C1145)

Possible Code(s)

C1145 — Electrically shorted or open front right speed sensor circuit or coil.

Affected Circuit(s)/Electrical Component(s)



Description

Code C1145 is generated by the anti-lock electronic control module's detection of an open or shorted wheel speed sensor coil or an open or shorted condition in Circuits 514 (Y/T) or 516 (Y/BK) between the wheel speed sensor and the anti-lock brake control module. If this fault is detected during the anti-lock electronic control module's self-check after key ON, the ABS warning lamp will come on immediately. This is generally an indication of a constant wiring or component fault. If the ABS warning lamp proves out normally and comes on later when the vehicle is driven, this is generally an indication of an intermittent wiring or component fault.

Possible Contributing Component/Vehicle Wiring Concerns

- Poor connection at front right wheel sensor
- Terminal damage or backout in anti-lock brake control module connector Pins 36 or 23
- Terminal damage or backout in two-pin sensor connector
- Open or shorted front right speed sensor coil
- Open or shorted Circuit 514 (Y/R) or 516 (Y/BK)

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- Improper front right wheel speed sensor cable routing leading to above
- Defective front right wheel speed sensor electrical test circuit in anti-lock brake control module

M1 DIAGNOSTIC TROUBLE CODE C1145: CHECK FRONT RIGHT SPEED SENSOR ELECTRICAL FAULT

- Ignition OFF.
- Install Rotunda Breakout Box 014-00322 or equivalent and Overlay.
- Measure resistance between Pins 36 and 23.

Is reading between 1.0-1.4 k Ohms?

Yes	No
GO to **M7** .	GO to **M2** .

M2 CHECK RESISTANCE AT FRONT RIGHT WHEEL SPEED SENSOR

- Disconnect right front speed sensor connector.
- Measure resistance between the two Pins on the speed sensor component connector.

Is reading between 1.0-1.4 k Ohms?

Yes	No
Speed sensor checks good. GO to **M3** .	REPLACE speed sensor. GO to **M10** .

M3 CHECK CIRCUIT 514 (Y/R) CONTINUITY

- Measure resistance between Pin 36 on the Rotunda Breakout Box 014-00322 or equivalent and wheel speed sensor harness connector pin for Circuit 514 (Y/R).

Is there continuity (zero or near zero ohms)?

Yes	No
Circuit 514 (Y/R) checks OK. GO to **M4** .	REPAIR open or high resistance on Circuit 514 (Y/R). GO to **M10** .

M4 CHECK CIRCUIT 516 (Y/BK) CONTINUITY

- Measure resistance between Pin 23 on the Rotunda Breakout Box 014-00322 or equivalent and wheel speed sensor harness connector pin for Circuit 516 (Y/BK).

Is there continuity (zero or near zero ohms)?

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Yes	No
Circuit 516 (Y/BK) checks OK. GO to **M5** .	REPAIR open or high resistance on Circuit 516 (Y/BK). GO to **M10** .

M5 CHECK CIRCUIT 514 (Y/R) SHORT TO GROUND

- Measure resistance between Pins 1 and 36 on the Rotunda Breakout Box 014-00322 or equivalent.

Is there continuity (zero or near zero ohms)?

Yes	No
REPAIR short to ground on Circuit 514 (Y/R). GO to **M10** .	Circuit 514 (Y/R) checks OK. GO to **M6** .

M6 CHECK CIRCUIT 516 (Y/BK) SHORT TO GROUND

- Measure resistance between Pins 1 and 23 on the Rotunda Breakout Box 014-00322 or equivalent.

Is there continuity (zero or near zero ohms)?

Yes	No
REPAIR short to ground on Circuit 516 (Y/BK). GO to **M10** .	Circuit 516 (Y/BK) checks OK. GO to **M7** .

M7 CHECK FOR SHORT TO CAN

- Measure resistance between spindle near sensor can and either coil circuit at sensor connector.

Is resistance less than 10 ohms?

Yes	No
REPLACE speed sensor. CORRECT any obvious routing issues. GO to **M10** .	GO to **M8** .

M8 CHECK FOR WIRING INTERMITTENTS

NOTE: If the above steps have been completed, the MOST LIKELY cause of the concern is wiring related.

- Refer to Pinpoint Test ID , Intermittent Diagnosis Procedure and perform for ALL affected circuits as shown on the pinpoint test mini-schematic.

Is resolution obtained?

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Yes	No
GO to **M10** for system verification.	Wiring system has been verified as intact. GO to **M9** .

M9 CHECK IF ALL STEPS HAVE BEEN COMPLETED

- This step requires that a valid diagnostic trouble code has been obtained, ALL prior diagnostic steps have been completed, and the affected wiring integrity has been verified.

CAUTION: If the above is not complete, chances are that replacement of this or any other system component without specific direction will not, in most circumstances, resolve the concern and will consequently result in customer dissatisfaction.

Have all prior diagnostic steps been completed as described above?

Yes	No
REPLACE speed sensor. GO to **M10** for system verification. If no resolution, REPLACE anti-lock brake control module. GO to **M10** for system verification.	GO to last diagnostic step completed and CONTINUE.

M10 CHECK FOR CODE REPEATABILITY

- Remove Rotunda Breakout Box 014-00322 or equivalent and reinstall all components.
- Clear all codes.
- Key OFF.
- Key ON.
- Retrieve code(s).

Is Code System Pass set?

Yes	No
STOP. Concern has been corrected.	Code being repaired still exists. Concern has NOT been corrected. RETURN to last diagnostic step completed and PROCEED. Different code is set. GO to appropriate pinpoint test. Code being repaired still exists and Test M8 is completed. **NOTE: The anti-lock system is disabled with the Rotunda Breakout Box 014-00322 or equivalent installed.** INSTALL Rotunda Breakout Box 014-00322 or equivalent with Overlay. REPEAT Test Steps

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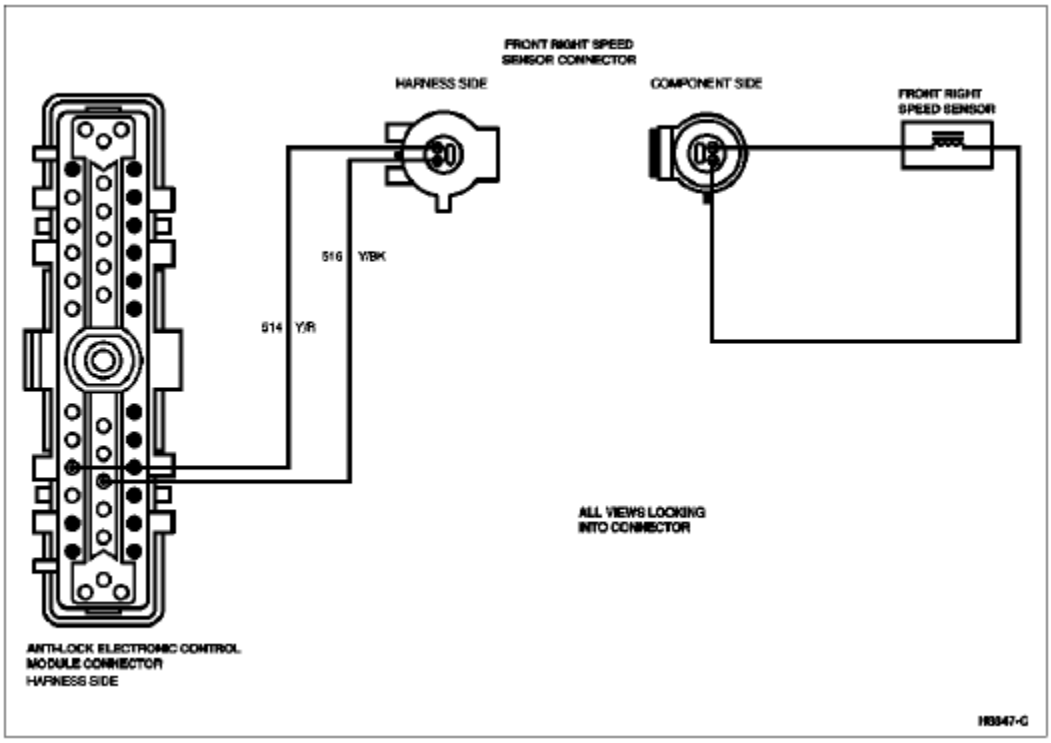
	M3 -M6 while driving vehicle. LOOK for any change in indicated continuity (turning on the DVOM beeper will help). INSPECT Circuits 514 (Y/R) and 516 (Y/BK) along their entire length from the speed sensor connector to the anti-lock brake control module harness connector for chafing or any other damage that could lead to any open or shorted condition. REPAIR as required.

PINPOINT TEST MM: RF WHEEL SPEED SENSOR COHERENCY FAULT (DYNAMIC) (CODES C1148, C1259 and C1234)

Possible Code(s)

C1148, C1259 or C1234

Affected Circuit(s)/Electrical Component(s)



Description

Codes C1148, C1259 and C1234 are generated by the anti-lock electronic control module's detection of a missing, erratic, or otherwise improper wheel speed signal from the right front wheel speed sensor. The codes are set for specific faults at various vehicle speeds that are as follows:

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Code C1148: Anti-lock brake control module detects that the front right wheel speed information is erratic.

Code C1259: Anti-lock brake control module detects that the front right wheel speed information does not match the left front and rear axle wheel speed information.

Code C1234: Anti-lock brake control module detects that the front right wheel speed signal has dropped out when it was previously there. This code is not dependent upon vehicle speed.

Codes C1148, C1259 and C1234 CANNOT be set with the vehicle stationary. The vehicle should be driven when attempting to duplicate the concern. If Codes C1148, C1259 or C1234 are set, then the ABS warning lamp will come on and will remain on until the vehicle is shut off. However, if the condition is corrected, the ABS warning lamp will be turned off by the anti-lock brake control module and the system will again be operational.

Possible Contributing Component/Vehicle Wiring Concerns

- Damaged/missing tone ring teeth or missing tone ring
- Air gap too small or too large
- Excessive axle vibration
- Weak speed sensor
- Loose speed sensor
- INTERMITTENT short or open in Circuit 514 (Y/R) or 516 (Y/BK)

NOTE: If above codes are stored with C1155, check for intermittent short to ground or open. If above codes only are stored, the concern is output related and it is not necessary to check for intermittent open/short conditions.

- Disturbances caused by ignition or Radio Frequency Interference (RFI)
- Defective trigger circuit in anti-lock brake control module

MM1 DIAGNOSTIC TROUBLE CODES C1148, C1259 or C1234: INSPECT SPEED SENSOR MOUNTING/TONE RING

- Install Rotunda Breakout Box 014-00322 or equivalent and Overlay.
- Raise vehicle on hoist.
- Inspect the right front tone ring for damaged or missing teeth. Rotate wheel to ensure all teeth are checked.
- Inspect the speed sensor mounting in the wheel end for looseness.

CAUTION: Examine the ring carefully with good light. Failure to catch issues with the tone ring will lead to unnecessary component replacement and wasted diagnostic time.

Is tone ring damage or speed sensor looseness found?

Yes	No
Tone ring is damaged or missing. REPLACE tone ring. GO to **MM5** to CHECK for proper speed sensor output.	GO to **MM2** .

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Speed sensor is loose. TIGHTEN speed sensor bolt to specifications. GO to **MM5** to CHECK for proper speed sensor output.	

MM2 CHECK FRONT RIGHT SPEED SENSOR OUTPUT AT ANTI-LOCK ELECTRONIC CONTROL MODULE

- Lower vehicle so that wheels are just far enough off the ground to permit all wheels to turn.
- Remove right front wheel. Knock back the disc brake caliper so that the wheel can move as freely as possible. Remount the wheel.
- 4x2s ONLY, spin front right wheel and maintain a constant speed of 60 rpm (1 re volution per second).
- 4x4s ONLY, place in 4x4 low mode. Key ON and allow wheels to spin and stabilize at engine idle speed.

NOTE: Perform the following measurements with Rotunda 105-R0053 Digital/Analog Volt-Ohmmeter or equivalent. If not using Rotunda 105-R0053 or Fluke Frequency Meter, higher wheel speed may be required in order for the frequency meter to function correctly.

- Set the Rotunda Digital/Analog Volt-Ohmmeter 105-R0053 or equivalent, to the frequency counter (Hz) setting. Measure and record the frequency between Pins 36 and 23 on the Rotunda Breakout Box 014-00322 or equivalent.
- Change the meter to the A/C mV setting. Measure and record the voltage output between Pins 36 and 23 on the Rotunda Breakout Box 014-00322 or equivalent.
- Determine the sensor output in mV/Hz:
- Output — A/C Voltage/Frequency

NOTE: Measurements of BOTH the frequency and the voltage output must be taken. The actual speed the wheels are turning is not important — the result of voltage output divided by the frequency will not change with wheel speed. However, it is crucial that both the frequency measurement and the voltage measurement be taken at the SAME wheel speed.

Is the sensor output greater than 5.0 mV/Hz (4x2), 5.8 mV/Hz (4x4)?

Yes	No
Output at anti-lock brake control module indicates that the air gap and speed sensor strength are OK. GO to **MM7**.	Speed sensor output at anti-lock brake control module is insufficient. GO to **MM3**.

MM3 CHECK FRONT RIGHT SPEED SENSOR OUTPUT AT SPEED SENSOR

- Disconnect the sensor connector at the RH radiator support.
- 4x2s ONLY, spin front right wheel and maintain a constant speed of 60 rpm (1 revolution per second).
- 4x4s ONLY, place in 4x4 low mode. Start engine and allow wheels to spin and stabilize at engine idle speed.
- Set the meter to the frequency counter (Hz) setting. Measure and record the frequency between the two pins of the speed sensor component connector.
- Change the meter to the A/C mV setting. Measure and record the voltage output between the two pins of the speed sensor component connector.

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- Determine the speed sensor output in mV/Hz:
- Output — A/C Voltage/Frequency

NOTE: Measurements of BOTH the frequency and the voltage output must be taken. The actual speed the wheels are turning is not important — the result of voltage output divided by the frequency will not change with wheel speed. However, it is crucial that both the frequency measurement and the voltage measurement be taken at the SAME wheel speed.

Is the speed sensor output greater than 5.0 mV/Hz (4x2), 5.8 mV/Hz (4x4)?

Yes	No
Output indicates that air gap and sensor strength are OK at the speed sensor. GO to **MM7** .	GO to **MM4** .

MM4 CHECK SPEED SENSOR/TONE RING AIR GAP

- Remove the speed sensor from the wheel end.
- Inspect mounting boss and speed sensor mounting plate for any metal flash or debris. Clean as necessary.
- Remount speed sensor securely.
- Measure the air gap between the speed sensor and tone ring teeth. Repeat in at least two more wheel positions to ensure that gap does not vary as the wheel is turned.

NOTE: Feeler gauges can be mounted to a welding rod and inserted between the vanes of the front disc brake hub and rotor to measure air gap precisely.

Is the gap consistent and less than 1.78mm (0.070 inch)?

Yes	No
REPLACE speed sensor. GO to **MM5** .	Gap is greater than 1.78mm (0.070 inch). Air gap is too large. REPLACE tone ring. GO to **MM5** . Gap is not consistent. Tone ring is not pressed on straight or axle end play is too great. GO to **MM6** .

MM5 RECHECK FRONT RIGHT SENSOR OUTPUT

- 4x2s ONLY, spin front right wheel and maintain a constant speed of 60 rpm (1 revolution per second).
- 4x4s ONLY, place in 4x4 low mode. Start engine and allow wheels to spin and stabilize at engine idle speed.
- Set the meter to the frequency counter (Hz) setting. Measure and record the frequency between the two pins of the speed sensor component connector.
- Change the meter to the A/C mV setting. Measure and record the voltage output between the two pins of the speed sensor component connector.
- Determine the speed sensor output in mV/Hz:
- Output — A/C Voltage/Frequency

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NOTE: Measurements of BOTH the frequency and the voltage output must be taken. The actual speed the wheels are turning is not important — the result of voltage output divided by the frequency will not change with wheel speed. However, it is crucial that both the frequency measurement and the voltage measurement be taken at the SAME wheel speed.

Is the sensor output greater than 5.8 mV/Hz (4x4)?

Yes	No
Output is now OK. Concern is most likely resolved. A drive test is recommended to VERIFY speed sensor output is OK for customer driving conditions.	VERIFY tone ring is pressed straight and fully onto the rotor hub. CORRECT as needed. REPEAT **MM5** . If no resolution, REPLACE speed sensor. DO NOT leave this test until output is OK.

MM6 RESOLVE INCONSISTENT AIR GAP CONCERN

- Remove the front disc brake hub and rotor and inspect the tone ring/hub mounting surface. Verify the tone ring is pressed straight and fully onto the hub. Correct before proceeding.
- Reinstall the front disc brake hub and rotor.
- Verify wheel end play is within allowable limits (refer to Section 04-01A or Section 04-01B). Correct as necessary.
- Measure the air gap between the speed sensor and tone ring teeth. Repeat in at least two more wheel positions to ensure that gap does not vary as the wheel is turned.

NOTE: Feeler gauges can be mounted to a welding rod and inserted between the vanes of the front disc brake hub and rotor to measure air gap precisely.

Is the gap consistent and less than 1.78mm (0.070 inch)?

Yes	No
GO to **MM5** to RECHECK speed sensor output.	Gap is greater than 1.78mm (0.070 inch). Air gap is too large. GO to **MM4** to resolve large air gap concern. Gap is not consistent. REPEAT **MM6** . DO NOT leave this step until a consistent air gap is obtained.

MM7 CHECK FOR WIRING INTERMITTENTS

NOTE: If the above steps have been completed, the MOST LIKELY cause of the concern is wiring related.

- Refer to Pinpoint Test ID , Intermittent Diagnosis Procedures and perform for Circuits 514 (Y/R) and 516 (Y/BK).

Is resolution obtained?

Yes	No
Concern is most likely resolved. A drive test is	

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recommended to VERIFY speed sensor output is OK during customer driving conditions.	GO to **MM8** .

MM8 CHECK IF ALL STEPS HAVE BEEN COMPLETED

- This step requires that a valid diagnostic trouble code has been obtained, ALL prior diagnostic steps have been completed, and the affected wiring integrity has been verified.

CAUTION: If the above is not complete, chances are that replacement of this or any other system component without specific direction will not, in most circumstances, resolve the concern and will consequently result in customer dissatisfaction.

Have all prior diagnostic steps been completed as described above?

Yes	No
REPLACE speed sensor. GO to **MM9** for drive test. If no resolution, REPLACE anti-lock brake control module. GO to **MM9** for drive test.	GO to last diagnostic step completed and CONTINUE.

MM9 SPEED SENSOR OUTPUT DRIVE TEST

- Reinstall all components and remove Rotunda Breakout Box 014-00322 or equivalent.
- Clear all codes.
- Key OFF.
- Key ON.
- Drive vehicles and perform the following:
  - Complete at least one hard left and one hard right turn.
  - Travel over stretch of rough road at normal vehicle speed.
  - Perform one hard acceleration from a stop.
- Retrieve code(s).

Is Code System Pass set?

Yes	No
STOP. Repair is complete.	Code being repaired still exists. GO to **MM8** . Different code is set (other than C1148, C1259 or C1234). GO to appropriate pinpoint test. Code being repaired still exists and anti-lock brake control module has been replaced. GO to **MM10** .

MM10 POSSIBLE CONDITIONS NOT CHECKED

At this point the following have been verified or are true if the above steps are complete:

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- Speed sensor strength is OK.
- Tone ring is intact with no damaged teeth and is correctly seated against the rotor hub.
- Air gap is within allowable limits and is consistent as the wheel rotates.
- Wiring between sensor and anti-lock brake control module is intact.
- The anti-lock brake control module has been replaced.
- The speed sensor has been replaced.
- The following are time consuming and should be performed only after all previous options have been exhausted.
- Verify Circuits 514 (Y/R) and 516 (Y/BK) are twisted throughout the wire loom. If the wires are not twisted, the anti-lock brake control module may be sensitive to any outside interference.
- Excessive axle vibration, especially over rough road can cause this issue. Verify front axle is not excessively noisy or otherwise performing abnormally.

NOTE: Blips or fallout indicate intermittent issue.

Does signal rise consistently and evenly?

Yes	No
STOP. Repair is complete.	GO to **MM8** .

PINPOINT TEST N: REAR AXLE SPEED SENSOR INPUT CIRCUIT FAILURE (STATIC) (CODE C1230)

Possible Code(s)

C1230 — Electrically shorted or open rear axle speed sensor circuit or coil.

Affected Circuit(s)/Electrical Component(s)

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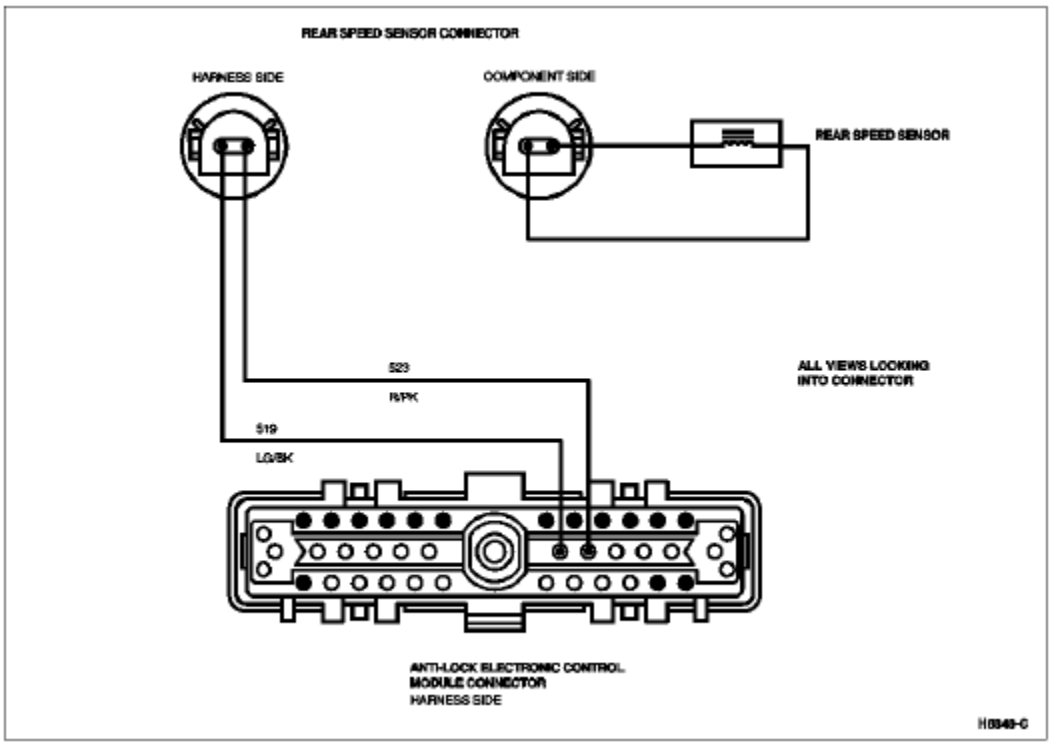

Description

Code C1230 is generated by the anti-lock electronic control module's detection of an open or shorted rear axle speed sensor coil or an open or shorted condition in Circuits 523 (R/PK) or 519 (LG/BK) between the wheel speed sensor and the anti-lock brake control module. If this fault is detected during the anti-lock electronic control module's self-check after key ON, the ABS warning lamp will come on immediately. This is generally an indication of a constant wiring or component fault. If the ABS warning lamp proves out normally and comes on later when the vehicle is driven, this is generally an indication of an intermittent wiring or component fault.

Possible Contributing Component/Vehicle Wiring Concerns

- Poor connection at rear axle speed sensor
- Terminal damage or backout in anti-lock brake control module connector Pins 21 or 22
- Terminal damage or backout in two-pin sensor connector
- Open or shorted rear axle speed sensor coil
- Open or shorted Circuit 523 (R/PK) or 519 (LG/BK)
- Improper rear axle speed sensor cable routing leading to above
- Defective rear axle speed sensor electrical test circuit in anti-lock brake control module

N1 DIAGNOSTIC TROUBLE CODE C1230: CHECK REAR AXLE SPEED SENSOR ELECTRICAL FAULT

- Ignition OFF.
- Install Rotunda Breakout Box 014-00322 or equivalent and Overlay.

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- Measure resistance between Pins 22 and 21.

Is reading between 800 and 1400 ohms?

Yes	No
GO to N7 .	GO to N2 .

N2 CHECK RESISTANCE AT REAR AXLE SPEED SENSOR

- Disconnect rear axle speed sensor connector.
- Measure resistance between the two pins on the speed sensor.

Is reading between 800 and 1400 ohms?

Yes	No
Speed sensor checks good. GO to N3 .	REPLACE speed sensor. GO to N11 .

N3 CHECK CIRCUIT 523 (R/PK) CONTINUITY

- Measure resistance between Pin 22 on the Rotunda Breakout Box 014-00322 or equivalent and wheel speed sensor harness connector pin for Circuit 523 (R/PK).

Is there continuity (zero or near zero ohms)?

Yes	No
Circuit 523 (R/PK) checks OK. GO to N4 .	REPAIR open or high resistance on Circuit 523 (R/PK). GO to N11 .

N4 CHECK CIRCUIT 519 (LG/BK) CONTINUITY

- Measure resistance between Pin 21 on the Rotunda Breakout Box 014-00322 or equivalent and wheel speed sensor harness connector pin for Circuit 519 (LG/BK).

Is there continuity (zero or near zero ohms)?

Yes	No
Circuit 519 (LG/BK) checks OK. GO to N5 .	REPAIR open or high resistance on Circuit 519 (LG/BK). GO to N11 .

N5 CHECK CIRCUIT 523 (R/PK) SHORT TO GROUND

- Measure resistance between Pins 1 and 22 on the Rotunda Breakout Box 014-00322 or equivalent.

Are there less than 10 ohms measured?

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Yes	No
REPAIR short to ground on Circuit 523 (R/PK). GO to **N11** .	Circuit 523 (R/PK) checks OK. GO to **N6** .

N6 CHECK CIRCUIT 519 (LG/BK) SHORT TO GROUND

- Measure resistance between Pins 1 and 21 on the Rotunda Breakout Box 014-00322 or equivalent.

Is there continuity (zero or near zero ohms)?

Yes	No
REPAIR short to ground on Circuit 519 (LG/BK). GO to **N11** .	Circuit 519 (LG/BK) checks OK. GO to **N8** .

N7 CHECK COIL CIRCUIT COMPONENT CONNECTOR RESISTANCE

- Remove speed sensor from rear axle housing.
- Measure resistance between speed sensor can and either coil circuit at component connector.

Is resistance less than 10 ohms?

Yes	No
Internal short in speed sensor detected. REPLACE speed sensor. GO to **N11** .	GO to **N8** .

N8 CHECK SPEED SENSOR CABLE ROUTING FOR DAMAGE

- Inspect the rear axle speed sensor cable from the rear axle housing to the frame for chafing or other wire damage.

Is damage found?

Yes	No
REPAIR damage. CORRECT any obvious routing issues. GO to **N11** .	GO to **N9** .

N9 CHECK FOR WIRING INTERMITTENTS

NOTE: If the above steps have been completed, the MOST LIKELY cause of the concern is wiring related.

- Refer to Pinpoint Test ID , Intermittent Diagnosis Procedure and perform for ALL affected circuits as shown on the pinpoint test mini-schematic.

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Is resolution obtained?

Yes	No
GO to **N11** for system verification.	Wiring system has been verified as intact. GO to **N10**.

N10 CHECK IF ALL STEPS HAVE BEEN COMPLETED

CAUTION: If the above is not complete, chances are that replacement of this or any other system component without specific direction will not, in most circumstances, resolve the concern and will consequently result in customer dissatisfaction.

- This step requires that a valid diagnostic trouble code has been obtained, ALL prior diagnostic steps have been completed, and the affected wiring integrity has been verified.

Have all prior diagnostic steps been completed as described above?

Yes	No
REPLACE sensor. GO to **N11** for system verification. If no resolution, REPLACE anti-lock brake control module. GO to **N11** for system verification.	GO to last diagnostic step completed and CONTINUE.

N11 CHECK FOR CODE REPEATABILITY

- Remove breakout box and reinstall all components.
- Clear all codes.
- Key OFF.
- Key ON.
- Retrieve code.

Is Code System Pass set?

Yes	No
STOP. Concern has been corrected.	Code being repaired still exists. Concern has NOT been corrected. RETURN to last diagnostic step completed and PROCEED. Different code is set. GO to appropriate pinpoint test. Code being repaired still exists and Test N9 is completed. **NOTE: The anti-lock system is disabled with the Rotunda Breakout Box 014-00322 or equivalent installed.** INSTALL breakout box with overlay. REPEAT

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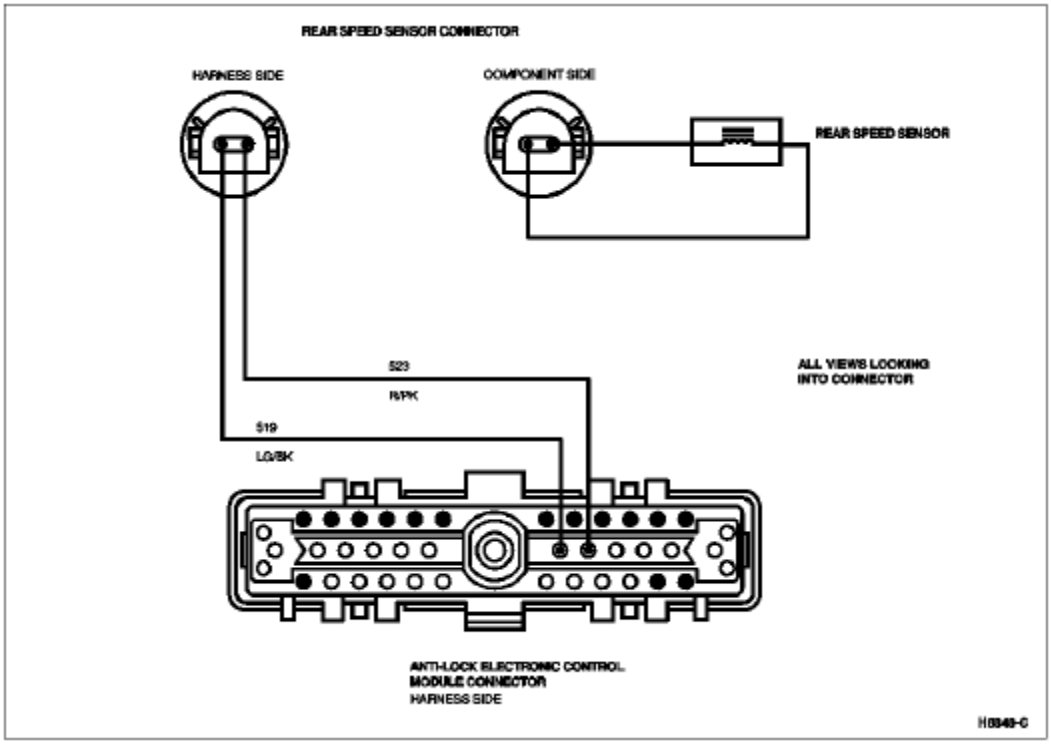
	Test Steps **N3** -N6 while driving vehicle. LOOK for any change in indicated continuity (turning on the DVOM beeper will help). INSPECT Circuits 523 (R/PK) and 519 (LG/BK) along their entire length from the speed sensor connector to the anti-lock brake control module harness connector for chafing or any other damage that could lead to an open or shorted condition. REPAIR as required.

PINPOINT TEST NN: REAR AXLE WHEEL SPEED SENSOR COHERENCY FAULT (DYNAMIC) (CODES C1229, C1260 and C1237)

Affected Circuit(s)/Electrical Component(s)



Description

Codes C1229, C1260, and C1237 are generated by the anti-lock electronic control module's detection of a missing, erratic, or otherwise improper wheel speed signal from the rear axle wheel speed sensor. The codes are set for specific faults at various vehicle speeds that are as follows:

Code C1229: Anti-lock brake control module detects that the rear axle wheel speed information is erratic. This code is only set at vehicle speeds greater than 40 km/h (25 mph).

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Code C1260: Anti-lock brake control module detects that the rear axle wheel speed information does not match the left front and right front wheel speed information.

Code 1237: Anti-lock brake control module detects that the rear axle wheel speed signal has dropped out when it was previously there. This code is not dependent upon vehicle speed.

Codes C1229, C1260 and C1237 CANNOT be set with the vehicle stationary. The vehicle should be driven when attempting to duplicate the concern. If Codes C1229, C1260 or C1237 are set, then the ABS warning lamp will come on and will remain on until the vehicle is shut off. However, if the condition is corrected, the ABS warning lamp will be turned off by the anti-lock brake control module and the system will again be operational.

Possible Contributing Component/Vehicle Wiring Concerns

- Damaged/missing tone ring teeth or missing tone ring
- Air gap too small or too large
- Excessive axle vibration
- Weak sensor
- Loose sensor
- INTERMITTENT short or open in Circuit 523 (R/PK) or 519 (LG/BK)

NOTE: If above codes are stored with C1155, check for intermittent short to ground or open. If above codes only are stored, the concern is output related and it is not necessary to check for intermittent open/short conditions.

- Disturbances caused by ignition or Radio Frequency Interference (RFI)
- Defective trigger circuit in anti-lock brake control module

NN1 DIAGNOSTIC TROUBLE CODES C1229, C1260 or C1237: INSPECT SPEED SENSOR MOUNTING/TONE RING

- Install Rotunda Breakout Box 014-00322 or equivalent and Overlay.
- Raise vehicle on hoist.
- Inspect the rear axle tone ring for damaged or missing teeth. Rotate ring to ensure all teeth are checked.
- Inspect the speed sensor for debris on the rear axle housing mounting boss or on speed sensor mounting flange. Clean as necessary.
- Reinstall speed sensor and tighten to specification.

CAUTION: Examine the ring carefully with good light. Failure to catch issues with the tone ring will lead to unnecessary component replacement and wasted diagnostic time.

Is tone ring intact or debris found at speed sensor mounting?

Yes	No
Debris is found. REMOVE debris and GO to NN6 .	Tone ring is not intact. REPLACE tone ring. GO to NN6 to DRIVE TEST vehicle. GO to NN2 .

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NN2 CHECK REAR AXLE SPEED SENSOR OUTPUT AT ANTI-LOCK ELECTRONIC CONTROL MODULE

- Lower vehicle so that wheels are just far enough off the ground to permit all wheels to turn.
- 4x4s ONLY, verify transfer case is in the 4x2 mode.
- Start engine and allow rear wheels to spin and stabilize at engine idle speed.

NOTE: Perform the following measurements with Rotunda 105-R0053 Digital/Analog Volt-Ohmmeter or equivalent. If not using Rotunda 105-R0053 or Fluke Frequency Meter, higher wheel speed may be required in order for the frequency meter to function correctly.

- Set the Rotunda Digital/Analog Volt-Ohmmeter 105-R0053 or equivalent, to the frequency counter (Hz) setting. Measure and record the frequency between Pins 21 and 22 on the Rotunda Breakout Box 014-00322 or equivalent.
- Change the meter to the A/C mV setting. Measure and record the voltage output between Pins 21 and 22 on the Rotunda Breakout Box 014-00322 or equivalent.
- Determine the speed sensor output in mV/Hz:
- Output — A/C Voltage/Frequency

NOTE: Measurements of BOTH the frequency and the voltage output must be taken. The actual speed the wheels are turning is not important — the result of voltage output divided by the frequency will not change with wheel speed. However, it is crucial that both the frequency measurement and the voltage measurement be taken at the SAME wheel speed.

Is the sensor output greater than 6.0 mV/Hz?

Yes	No
Output at anti-lock brake control module indicates that the air gap and sensor strength are OK. GO to **NN4** .	Sensor output at ECU is insufficient. GO to **NN3** .

NN3 CHECK REAR AXLE SENSOR OUTPUT AT SPEED SENSOR

- Disconnect the speed sensor connector at the rear axle housing.
- If vehicle is not running, key ON and allow rear wheels to spin and stabilize at engine idle speed.
- Set the Rotunda Digital/Analog Volt-Ohmmeter 105-R0053 or equivalent, to the frequency counter (Hz) setting. Measure and record the frequency between the two pins of the speed sensor component connector.
- Change the meter to the A/C mV setting. Measure and record the voltage output between the two pins of the speed sensor.
- Determine the speed sensor output in mV/Hz:
- Output — A/C Voltage/Frequency

NOTE: Measurements of BOTH the frequency and the voltage output must be taken. The actual speed the wheels are turning is not important — the result of voltage output divided by the frequency will not change with wheel speed. However, it is crucial that both the frequency measurement and the voltage measurement be taken at the SAME wheel speed.

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Is the sensor output greater than 6.0 mV/Hz?

Yes	No
Output indicates that air gap and speed sensor strength are OK at the sensor. GO to **NN4** .	REPLACE sensor. REPEAT **NN3** to RECHECK sensor output.

NN4 CHECK FOR WIRING INTERMITTENTS

NOTE: If the above steps have been completed, the MOST LIKELY cause of the concern is wiring related.

- Refer to Pinpoint Test ID , Intermittent Diagnosis Procedure and perform for Circuits 523 (R/PK) and 519 (LG/BK).

Is resolution obtained?

Yes	No
Concern is most likely resolved. A drive test is recommended to VERIFY speed sensor output is OK during customer driving conditions.	GO to **NN5** .

NN5 CHECK IF ALL STEPS HAVE BEEN COMPLETED

- This step requires that a valid diagnostic trouble code has been obtained, ALL prior diagnostic steps have been completed, and the affected wiring integrity has been verified.

CAUTION: If the above is not complete, chances are that replacement of this or any other system component without specific direction will not, in most circumstances, resolve the concern and will consequently result in customer dissatisfaction.

Have all prior diagnostic steps been completed as described above?

Yes	No
REPLACE speed sensor. GO to **NN6** for drive test. If no resolution, REPLACE anti-lock brake control module. GO to **NN6** for drive test.	GO to last diagnostic step completed and CONTINUE.

NN6 SENSOR OUTPUT DRIVE TEST

- Reinstall all components and remove Rotunda Breakout Box 014-00322 or equivalent.
- Clear all codes.
- Key OFF.
- Key ON.
- Drive vehicle and perform the following:
  - Complete at least one hard left and one hard right turn.
  - Travel over a stretch of rough road at normal vehicle speed.

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- Perform one hard acceleration from a stop.
- Retrieve code(s).

Is Code System Pass set?

Yes	No
STOP. Repair is complete.	Code being repaired still exists. GO to **NN5** . Different code is set (other than C1229, C1260 or C1237). GO to appropriate pinpoint test. Code being repaired still exists and anti-lock brake control module has been replaced. The following are time consuming and should be performed only after all previous options have been exhausted. Air gap between sensor and rear axle tone ring may be too large. VERIFY Circuits 523 (R/PK) and 519 (LG/BK) are twisted throughout the wire loom. If the wires are not twisted, the anti-lock brake control module may be sensitive to any outside interference. Excessive axle vibration, especially over rough road can cause this issue. VERIFY rear axle is not excessively noisy or otherwise performing abnormally. REPAIR as required.

PINPOINT TEST P: LF VALVE PAIR FUNCTION TEST

Affected Circuit(s)/Electrical Component(s)

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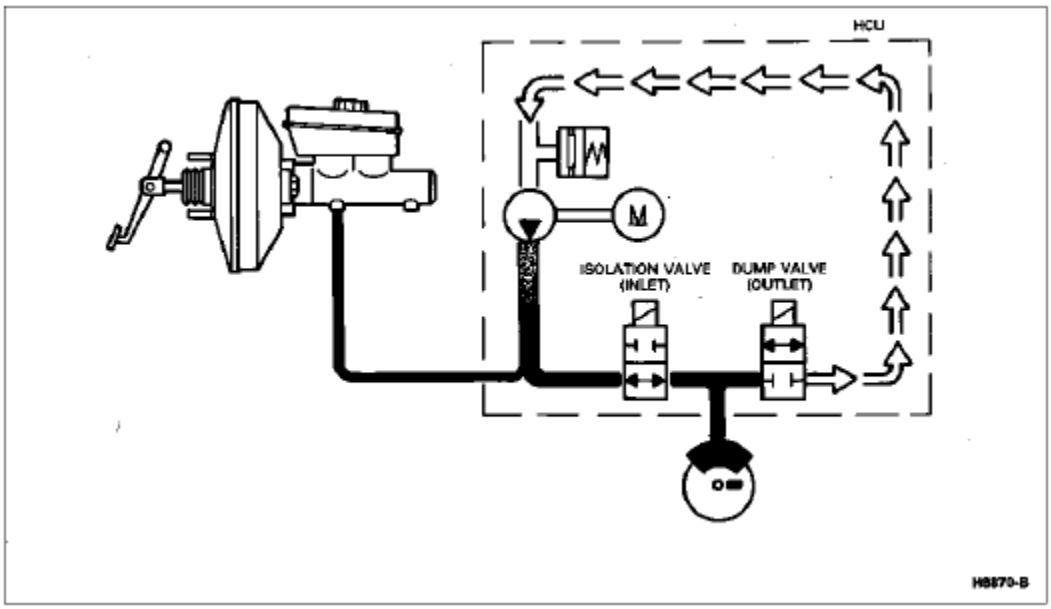

Possible Contributing Component/Vehicle Wiring Concerns

- Pinched or closed brake line or hose
- Worn or clogged front left outlet valve

P1 CHECK BRAKE LINES/HOSES

- Visually inspect brake lines from valve block to front left wheel.

Are they damaged?

Yes	No
REPLACE/REPAIR brake lines.	GO to **P2** .

P2 CHECK FRONT LEFT OUTLET VALVE

- Key OFF.
- Install Rotunda Breakout Box 014-00322 or equivalent and Overlay.
- Jumper Pins 19, 26, 40, and 1 together on the Rotunda Breakout Box 014-00322 or equivalent.
- Raise vehicle so front left wheel is just off the ground.
- Press hard on the brake pedal and have an assistant try to turn the LH front wheel.

  NOTE: This condition is similar to the master cylinder bypass condition. It is important that the brake pedal be quickly and forcefully applied to rule out master cylinder bypass as the cause if a hydraulic leak is detected. Typically, master cylinder bypass only occurs at low line pressures.

Does the wheel turn or the brake pedal drop slowly?

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Yes	No
REPLACE HCU. BLEED brake system. Refer to Section 06-06 .	GO to **P3** .

P3 CHECK FRONT LEFT OUTLET VALVE OPERATION

CAUTION: Do not leave ignition on for more than 30 seconds with the jumper installed.

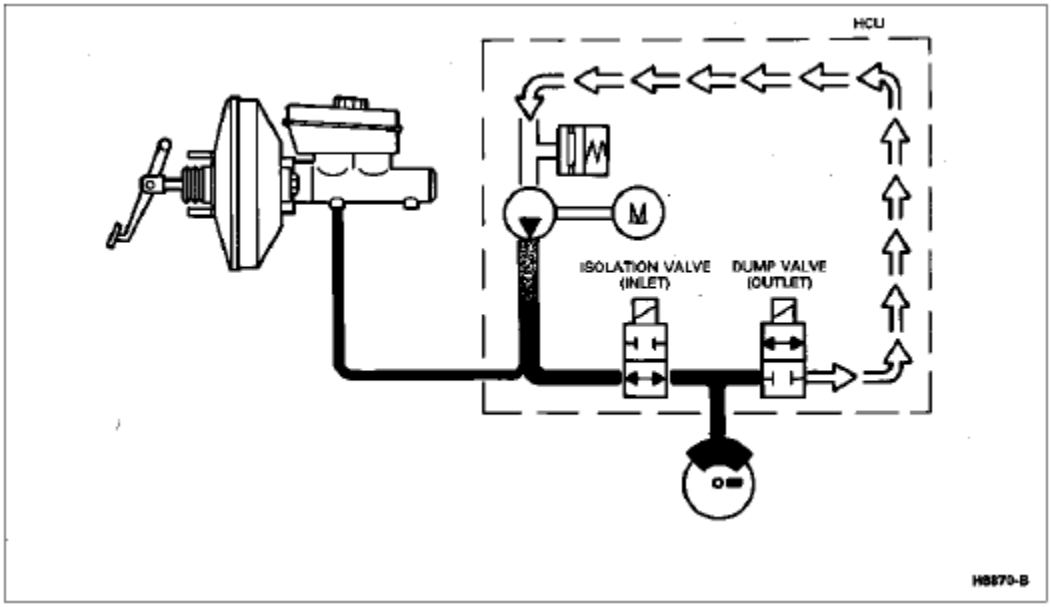
- Apply brake pedal force, turn ignition on and have assistant try to turn LH front wheel.

Does wheel turn now?

Yes	No
Valve is OK.	REPLACE HCU. BLEED brake system. REFER to Section 06-06 .

PINPOINT TEST Q: RF VALVE PAIR FUNCTION TEST

Affected Circuit(s)/Electrical Component(s)



Possible Contributing Component/Vehicle Wiring Concerns

- Pinched or closed brake line or hose
- Worn or clogged front right outlet valve

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Q1 CHECK BRAKE LINES/HOSES

- Visually inspect brake lines from valve block to right front wheel.

Are lines damaged?

Yes	No
REPAIR/REPLACE lines.	GO to **Q2** .

Q2 CHECK FRONT RIGHT OUTLET VALVE

- Key OFF.
- Install Rotunda Breakout Box 014-00322 or equivalent and Overlay.
- Jumper Pins 15, 19, 34, and 1 together on the Rotunda Breakout Box 014-00322 or equivalent.
- Raise vehicle so front right wheel is just off the ground.
- Press hard on the brake pedal and have an assistant try to turn the RH front wheel.

NOTE: This condition is similar to the master cylinder bypass condition. It is important that the brake pedal be quickly and forcefully applied to rule out master cylinder bypass as the cause if a hydraulic leak is detected. Typically, master cylinder bypass only occurs at low line pressures.

Does wheel turn or the pedal drop slowly?

Yes	No
REPLACE HCU. BLEED brake system. Refer to Section 06-06 .	GO to **Q3** .

Q3 CHECK FRONT RIGHT OUTLET VALVE OPERATION

CAUTION: Do not leave ignition on for more than 30 seconds with the jumper installed.

- Apply brake pedal force, turn ignition ON and have assistant try to turn wheel.

Does wheel turn now?

Yes	No
Valve is OK.	REPLACE HCU. BLEED brake system. REFER to Section 06-06 .

PINPOINT TEST R: REAR AXLE VALVE PAIR FUNCTION TEST

Affected Circuit(s)/Electrical Component(s)

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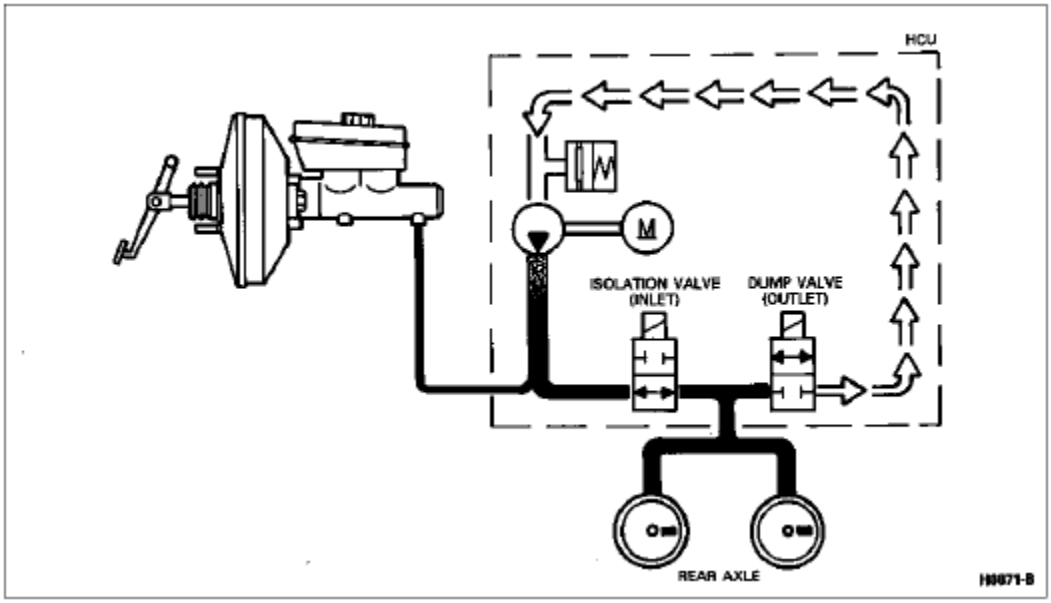

Possible Contributing Component/Vehicle Wiring Concerns

- Pinched or closed brake line or hose
- Worn or clogged rear axle outlet valve

R1 CHECK BRAKE LINES

- Visually inspect brake lines from valve block to rear wheel.

Are lines damaged?

Yes	No
REPAIR/REPLACE lines.	GO to **R2** .

R2 CHECK REAR AXLE OUTLET VALVE

- Key OFF.
- Install Rotunda Breakout Box 014-00322 or equivalent and Overlay.
- Jumper Pins 19, 27, 33, and 1 together on the Rotunda Breakout Box 014-00322 or equivalent.
- Raise vehicle so rear wheels are just off the ground.
- Press hard on the brake pedal and have an assistant try to turn a rear wheel.

  NOTE: This condition is similar to the master cylinder bypass condition. It is important that the pedal be quickly and forcefully applied to rule out master cylinder bypass as the cause if a hydraulic leak is detected. Typically, master cylinder bypass only occurs at low line pressures.

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Does the wheel turn or the brake pedal drop slowly?

Yes	No
REPLACE HCU. BLEED brake system. Refer to Section 06-06 .	GO to **R3** .

R3 CHECK REAR AXLE OUTLET VALVE OPERATION

CAUTION: Do not leave ignition on for more than 30 seconds with the jumper installed.

- Apply brake pedal force, turn ignition on and have assistant try to turn wheel.

Does wheel turn now?

Yes	No
Valve is OK.	REPLACE HCU. BLEED brake system. REFER to Section 06-06 .

PINPOINT TEST S: ABS HYDRAULIC PUMP MOTOR CIRCUIT OPEN (CODE C1096)

Possible Code(s)

C1096 — Open or intermittent connection to pump motor relay, damaged relay coil or contacts, damaged pump motor.

Affected Circuit(s)/Electrical Component(s)

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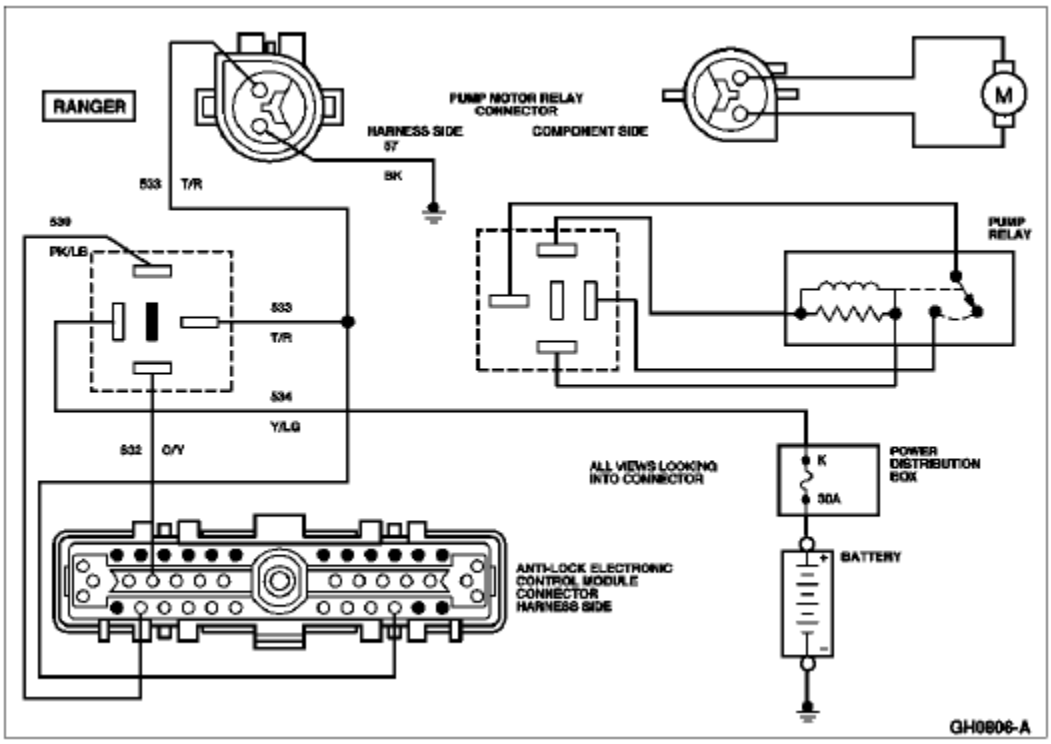

Description

Code C1096 is generated by the anti-lock brake control module.

Possible Contributing Component/Vehicle Wiring Concerns

- Damaged pump motor.
- Terminal backout in anti-lock brake control module harness connector Pins 29 and 37
- Open or shorted pump motor relay coil
- Open contacts in pump motor relay
- Terminal backout in pump motor 2-way, Pins 1 or 2

S1 VISUAL INSPECTION AND EQUIPMENT HOOK-UP

- Make sure the battery is OK. Refer to Section 14-01 .
- Inspect anti-lock brake control module pins, 30 amp pump motor feed fuse, battery and ground connections, relay connections and pump motor connections.
- Remove anti-lock brake control module, install Rotunda Breakout Box 014-00322 or equivalent and Overlay. Verify ground.
- Jumper Pins 1 and 19 together.
- Key ON (energize system relay).
- Jumper Pins 1 and 29 together (energize pump motor relay).

Is pump motor running?

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Yes	No
GO to S7 .	GO to S2 .

S2 VOLTAGE CHECK 1 AND 2

- Disconnect 2-way connector.
- Using battery positive lead connect B+ to Pin 2 (533) and ground to Pin 1 (57) on HCU side of 2-way connector.

Does pump motor run?

Yes	No
GO to S3 .	REPLACE HCU. GO to S9 .

S3 CHECK PIN 1 GROUND

- Check for continuity between Pin 1 on the harness side connector and a known good chassis ground.

Is there continuity?

Yes	No
GO to S4 .	REPAIR open in Circuit 57 (BK). GO to S9 .

S4 CONTINUITY CHECK, CIRCUIT 533 (T/R)

- Key OFF.
- Disconnect pump motor relay.
- Check continuity on Circuit 533 (T/R) to Pin 2.

Is there continuity?

Yes	No
GO to S5 .	REPAIR open in Circuit 533 (T/R). GO to S9 .

S5 CONTINUITY CHECK, PUMP MOTOR RELAY TO ABS POWER RELAY

- Remove ABS power relay.
- Check continuity between pump motor relay Circuit 532 (O/Y) and ABS power relay Circuit 532 (O/Y).

Is there continuity?

Yes	No
GO to S6 .	REPAIR Circuit 532 (O/Y). GO to S9 .

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S6 CONTINUITY CHECK, PUMP MOTOR RELAY CIRCUIT 534 (Y/LG)

- Disconnect battery negative cable.
- Check continuity from pump motor relay Circuit 534 (Y/LG) to battery (+) connection point.
- Reconnect battery negative cable when finished.

NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.

Is there continuity?

Yes	No
GO to S7.	REPAIR open in Circuit 534 (Y/LG) or REPLACE 30A fuse. GO to S9.

S7 CONTINUITY CHECK, PUMP MOTOR RELAY CIRCUIT 539 (PK/LB)

- Check continuity from pump motor relay Circuit 539 (PK/LB) to Pin 29 on the Rotunda Breakout Box 014-00322 or equivalent.

Is there continuity?

Yes	No
REPLACE pump motor relay. GO to S9.	REPAIR short to ground in Circuit 539 (PK/LB). GO to S9.

S8 CHECK IF ALL STEPS HAVE BEEN COMPLETED

- This step requires that a valid diagnostic trouble code has been obtained, ALL prior diagnostic steps have been completed, and the affected wiring integrity has been verified.

CAUTION: If the above is not complete, chances are that replacement of this or any other system component without specific direction will not, in most circumstances, resolve the concern and will consequently result in customer dissatisfaction.

Have all prior diagnostic steps been completed as described above?

Yes	No
REPLACE ECU. GO to S9.	GO to last diagnostic step completed and CONTINUE.

S9 CHECK FOR CODE REPEATABILITY

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- Clear all codes.
- Key OFF.
- Key ON.
- Retrieve code(s).

Is Code System Pass set?

Yes	No
STOP. Concern has been corrected.	Code C1096 still exists. Concern has NOT been corrected. RETURN to the last diagnostic step completed and PROCEED. Different code is set. GO to appropriate pinpoint test. Code C1096 still exists and Step S8 is complete. GO to **S10** .

S10 VERIFY INTEGRITY OF VEHICLE WIRING

NOTE: If the above steps have been completed, the MOST LIKELY cause of the concern is wiring related.

- Refer to Pinpoint Test ID , Intermittent Diagnosis Procedure and perform for ALL affected circuits as shown on the pinpoint test mini-schematic.

Is resolution achieved?

Yes	No
GO to **S9** for system OK verification.	GO to **S8** .

PINPOINT TEST T: ABS ACCELERATION SWITCH CIRCUIT FAILURE (CODE C1102)

Possible Code(s)

C1102 — Intermittent or open connection between anti-lock brake control module and G-switch, damaged G-switch or circuit in anti-lock brake control module.

Affected Circuit(s)/Electrical Component(s)

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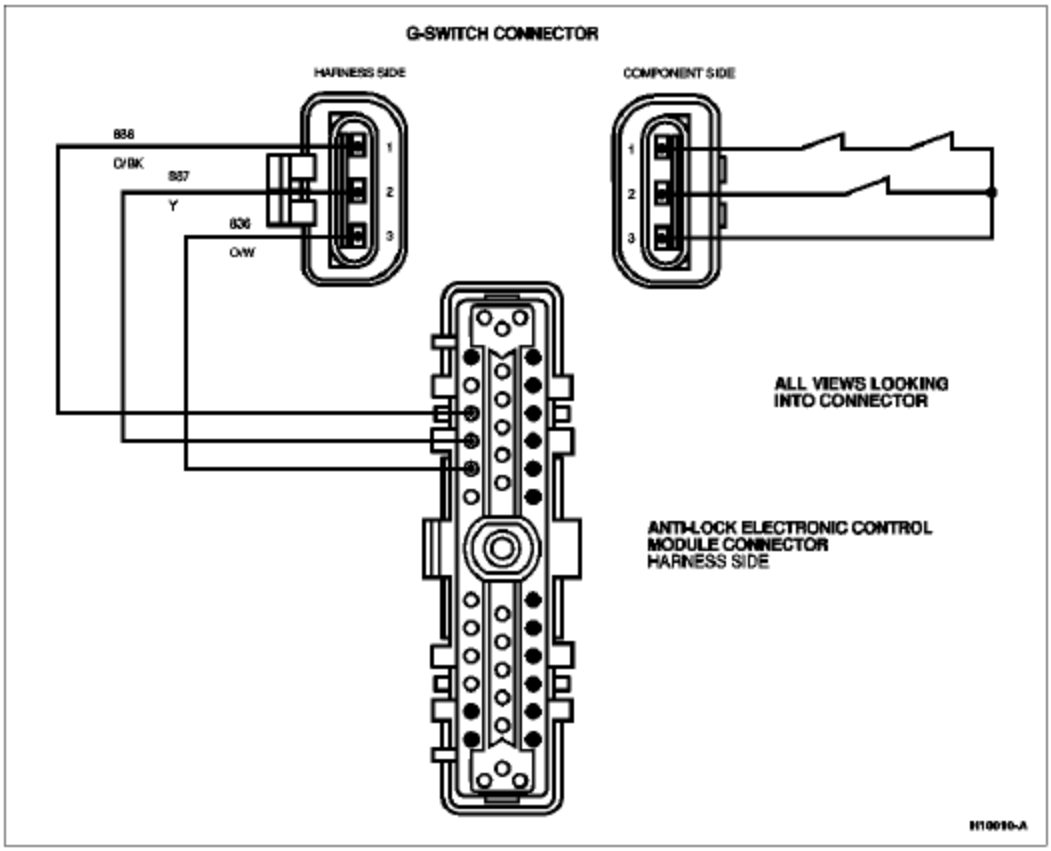

Description

Code C1102 is generated by the anti-lock electronic control module's detection of a circuit failure between the anti-lock brake control module and the G-switch and by a failed G-switch or internal anti-lock brake control module damage.

Possible Contributing Component/Vehicle Wiring Concerns

- Terminal backout in anti-lock brake control module wiring harness connector Pins 30, 31 and 32.
- Worn or damaged G-switch.
- Worn or damaged anti-lock brake control module.
- G-switch terminal backout, Pins 1, 2 and 3.
- Short to ground in Circuits 836 (O/W), 886 (O/BK) and 887 (Y).
- Module initialized on 4x4 vehicle then installed on 4x2 vehicle.

NOTE: The ECU can be reinitialized with the New Generation Star (NGS) Tester.

T1 SWITCH CHECK, DEFAULT G-SWITCH POSITION

- Disconnect G-switch harness connector.
- Remove the G-switch from the vehicle.
- Inspect harness connector and G-switch connector cavity for water or terminal corrosion.

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- Place the G-switch on a level surface.
- Measure the resistance between G-switch Pin 1 (Circuit 886) and Pin 3 (Circuit 836).
- Measure the resistance between G-switch Pin 2 (Circuit 887) and Pin 3 (Circuit 836).

Are both resistances measured less than 5 ohms?

Yes	No
GO to **T2** .	All switches should be closed. REPLACE G-switch. GO to **T11** .

T2 SWITCH CHECK, G-SWITCH RAISED 38.0MM

- Raise the front of the G-switch 38.0mm (1.5 in.). The arrow on the connector points toward the front.
- Measure the resistance between G-switch Pin 1 (Circuit 886) and Pin 3 (Circuit 836).

Is the resistance greater than 5 ohms?

Yes	No
GO to **T3** .	REPLACE G-switch. GO to **T11** .

T3 SWITCH CHECK, G-SWITCH RAISED 25.4MM

- Raise the rear of the G-switch 25.4mm (1.0 in.).
- Measure the resistance between G-switch Pin 2 (Circuit 887) and Pin 3 (Circuit 836).

Is the resistance greater than 5 ohms?

Yes	No
G-switch is OK. GO to **T4** .	REPLACE sensor. GO to **T11** .

T4 CONTINUITY CHECK, CIRCUIT 836 (O/W) BETWEEN ANTI-LOCK ELECTRONIC CONTROL MODULE AND G-SWITCH HARNESS CONNECTOR

- Install Rotunda Breakout Box 014-00322 or equivalent and Overlay.
- Measure the resistance between Pin 32 on the Rotunda Breakout Box 014-00322 or equivalent and G-switch harness connector Pin 3 (Circuit 836).

Is the resistance greater than 5 ohms?

Yes	No
REPAIR Circuit 836 (O/W) between anti-lock brake control module and G-switch. GO to **T11** .	GO to **T5** .

T5 SHORT TO GROUND CHECK, CIRCUIT 836 (O/W) BETWEEN ANTI-LOCK

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ELECTRONIC CONTROL MODULE AND G-SWITCH HARNESS CONNECTOR

- Measure the resistance between Pin 32 and Pin 1 or 14 on the Rotunda Breakout Box 014-00322 or equivalent.

Is the resistance greater than 5 ohms?

Yes	No
GO to **T6** .	REPAIR short to ground in Circuit 836 (O/W) between anti-lock brake control module and acceleration sensor. GO to **T11** .

T6 CONTINUITY CHECK, CIRCUIT 886 (O/BK) BETWEEN ANTI-LOCK ELECTRONIC CONTROL MODULE AND G-SWITCH HARNESS CONNECTOR

- Measure the resistance between Pin 30 on the Rotunda Breakout Box 014-00322 or equivalent and G-switch harness connector Pin 1 (Circuit 886).

Is the resistance greater than 5 ohms?

Yes	No
REPAIR Circuit 886 (O/BK) between anti-lock brake control module and acceleration sensor. GO to **T11** .	GO to **T7** .

T7 SHORT TO GROUND CHECK, CIRCUIT 886 (O/BK) BETWEEN ANTI-LOCK ELECTRONIC CONTROL MODULE AND G-SWITCH HARNESS CONNECTOR

- Measure the resistance between Pin 30 and Pin 1 or 14 on the Rotunda Breakout Box 014-00322 or equivalent.

Is the resistance greater than 5 ohms?

Yes	No
GO to **T8** .	REPAIR short to ground in Circuit 886 (O/BK) between anti-lock brake control module and acceleration G-switch. GO to **T11** .

T8 CONTINUITY CHECK, CIRCUIT 887 (Y) BETWEEN ANTI-LOCK ELECTRONIC CONTROL MODULE AND G-SWITCH HARNESS CONNECTOR

- Measure the resistance between Pin 31 on the Rotunda Breakout Box 014-00322 or equivalent and G-switch harness connector Pin 2 (Circuit 887).

Is the resistance greater than 5 ohms?

Yes	No

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REPAIR Circuit 887 (Y) between anti-lock brake control module and acceleration G-switch. GO to **T11** .	GO to **T9** .

T9 SHORT TO GROUND CHECK, CIRCUIT 887 (Y) BETWEEN ANTI-LOCK ELECTRONIC CONTROL MODULE AND G-SWITCH HARNESS CONNECTOR

- Measure the resistance between Pin 31 and Pin 1 or 14 on the Rotunda Breakout Box 014-00322 or equivalent .

Is the resistance greater than 5 ohms?

Yes	No
GO to **T11** .	REPAIR short to ground in Circuit 887 (Y) between anti-lock brake control module and G-switch. GO to **T11** .

T10 VERIFY ALL STEPS HAVE BEEN COMPLETED

- This step requires that a valid diagnostic trouble code has been obtained, ALL prior diagnostic steps have been completed, and the affected wiring integrity has been verified.

  CAUTION: If the above is not complete, chances are that replacement of this or any component without specific direction will not, in most circumstances, resolve the concern and will consequently result in customer dissatisfaction.

Have all prior diagnostic steps been completed as described above?

Yes	No
REPLACE G-switch. GO to **T11** . If no resolution, REPLACE anti-lock brake control module. GO to **T11** .	GO to last diagnostic step completed and CONTINUE.

T11 CHECK FOR CODE REPEATABILITY

- Remove Rotunda Breakout Box 014-00322 or equivalent and reinstall all components.
- Clear all codes.
- Key OFF.
- Key ON.
- Retrieve code(s).

Is Code System Pass set?

Yes	No
	Code C1102 still exists. Concern has NOT been corrected. RETURN to last diagnostic step

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STOP. Concern has been corrected.	completed and PROCEED. Different code is set. GO to appropriate pinpoint test. Code C1102 still exists and Step T9 is complete. GO to **T12** .

T12 VERIFY INTEGRITY OF VEHICLE WIRING

NOTE: If the above steps have been completed, the MOST LIKELY cause of the concern is wiring related.

- Refer to Pinpoint Test ID , Intermittent Diagnosis Procedure and perform for ALL affected circuits as shown on the pinpoint test mini-schematic.

Is resolution achieved?

Yes	No
GO to **T11** for system OK verification.	Go to **T10** .

PINPOINT TEST U: ABS HYDRAULIC PUMP MOTOR CIRCUIT FAILURE (CODE C1095)

Possible Code(s)

C1095 — Pump motor running but not triggered by ECU.

Affected Circuit(s)/Electrical Component(s)

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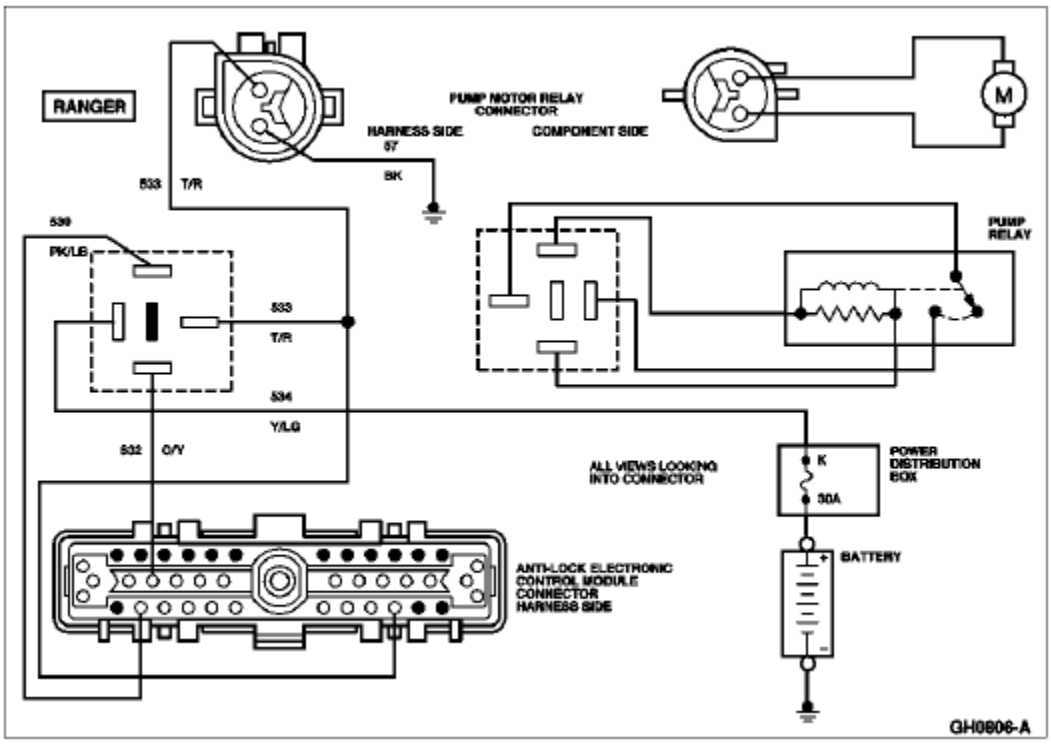

Description

Code C1095 is generated by the anti-lock brake control module when the pump motor is running but is not triggered.

Possible Contributing Component/Vehicle Wiring Concerns

- Damaged trigger circuit in anti-lock brake control module
- Welded relay contacts
- Ground short on Circuit 539 (PK/LB)

U1 PUMP MOTOR CHECK, KEY OFF

- Make sure the battery is OK. Refer to Section 14-01 .
- Key OFF.

Is the pump motor running?

Yes	No
REPLACE pump motor relay. GO to **U4** .	GO to **U2** .

U2 CHECK CIRCUIT 539 (PK/LB)

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- Remove anti-lock brake control module, install Rotunda Breakout Box 014-00322 or equivalent and Overlay. Verify Pin 1 is ground.
- Key ON.
- Jumper Pins 1 and 19 to energize main relay.
- Verify that contacts are not sticking or welded.

Is pump motor running?

Yes	No
REPAIR short to ground in Circuit 539 (PK/LB). GO to **U4** .	GO to **U4** .

U3 CHECK IF ALL STEPS HAVE BEEN COMPLETED

- This step requires that a valid diagnostic trouble code has been obtained, ALL prior diagnostic steps have been completed, and the affected wiring integrity has been verified.

CAUTION: If the above is not complete, chances are that replacement of this or any other system component without specific direction will not, in most circumstances, resolve the concern and will consequently result in customer dissatisfaction.

Have all prior diagnostic steps been completed as described above?

Yes	No
REPLACE anti-lock brake control module. GO to **U4** .	GO to last diagnostic step completed and CONTINUE.

U4 CHECK FOR CODE REPEATABILITY

- Clear all codes.
- Key OFF.
- Key ON.
- Retrieve code(s).

Is Code System Pass set?

Yes	No
STOP. Concern has been corrected.	Code C1095 still exists. Concern has NOT been corrected. RETURN to the last diagnostic step completed and PROCEED. Different code is set. GO to appropriate pinpoint test. Code C1095 still exists and Step U2 is complete. GO to **U5** .

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U5 VERIFY INTEGRITY OF VEHICLE WIRING

NOTE: If the above steps have been completed, the MOST LIKELY cause of the concern is wiring related.

- Refer to Pinpoint Test ID , Intermittent Diagnosis Procedure and perform for ALL affected circuits as shown on the pinpoint test mini-schematic.

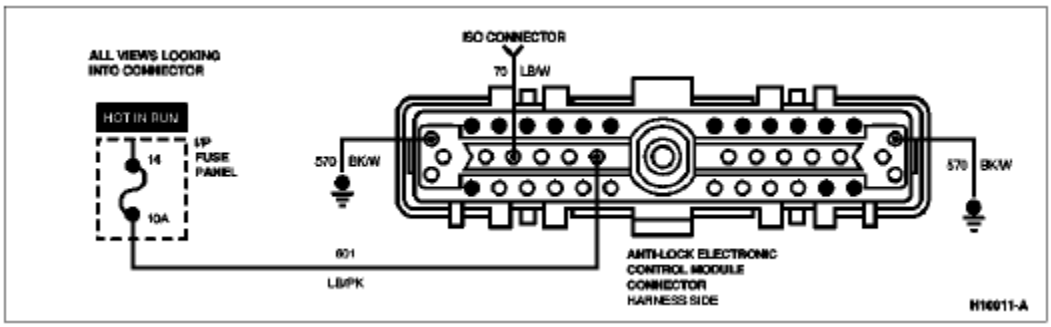
Is resolution achieved?

Yes	No
GO to **U4** for system OK verification.	GO to **U3** .

PINPOINT TEST V: NO COMMUNICATION

Hard Light — No Code

Affected Circuit(s)/Electrical Components:



Description

If no vehicle battery voltage is available to the anti-lock brake control module, or the voltage available is less than 9.5 volts, the anti-lock brake control module cannot initialize. As a result, the system relay cannot be energized and the ABS warning light remains on. No diagnostics are possible; therefore, no codes can be read.

Possible Contributing Base Brake Component/Vehicle Wiring Concerns

- Worn or damaged ignition switch
- Open ignition feed circuit to anti-lock brake control module
- Low battery voltage (less than 8V)
- Blown ignition fuse
- Open system ground
- Poor ground connection Circuit 570 (BK/W)
- B+ short on Circuit 70 (LB/W)
- Ground short on Circuit 601 (LB/PK) (fuse 14 blown).

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V1 INSTALL ROTUNDA BREAKOUT BOX 014-00322 OR EQUIVALENT

- Install Rotunda Breakout Box 014-00322 or equivalent and Overlay.
- Open power distribution box and locate ignition fuse 14 (10A).
- Check fuse for continuity.
- Verify both fuse terminals in the power network box are clean and secure.

Is there continuity and are terminals clean and secure?

Yes	No
REINSTALL fuse. GO to **V2** .	REPLACE fuse or SERVICE terminal as appropriate. GO to **PC3** .

V2 CHECK FOR B+ SHORT ON CIRCUIT 70 (LB/W)

- Key OFF.
- Measure voltage between Pins 1 and 16 at breakout box.

Is B+ present?

Yes	No
GO to **V3** .	REPAIR B+ short on Circuit 70 (LB/W). GO to **PC3** .

V3 VERIFY ECU GROUND

- Key OFF.
- Inspect ground eyelet at left radiator support for excessive dirt, corrosion, or looseness. Clean and tighten as necessary.
- Check for continuity between Pin 1 and the ground eyelet at left radiator support.
- Check for continuity between Pin 14 and the ground stud at left radiator support.

Is there continuity at both pins?

Yes	No
GO to **V4** .	REPAIR open circuit in ground between anti-lock brake control module harness connector and ground eyelet. GO to **PC3** .

V4 VERIFY DIAGNOSTIC LINE

- Key OFF.
- Measure resistance between NGS Tester Connector pin for Circuit 70 (LB/W) and Pin 16 on breakout

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box.

Is resistance measured less than 10 ohms?

Yes	No
GO to **V5** .	REPAIR or REPLACE open or high resistance issue in Circuit 70 (LB/W). GO to **PC3** .

V5 VERIFY DIAGNOSTIC GROUND

- Key OFF.
- Measure resistance between NGS Tester Connector pin for Circuit 57 (BK) and known good chassis ground.

Is resistance measured less than 10 ohms?

Yes	No
GO to **V6** .	REPAIR or REPLACE as necessary. GO to **PC3** .

V6 VERIFY PROPER VOLTAGE AT ANTI-LOCK ELECTRONIC CONTROL MODULE HARNESS CONNECTOR

- Key ON.
- Measure voltage between Pins 20 and 1.

Is there at least 9.5 volts?

Yes	No
REPLACE anti-lock brake control module. GO to **PC3** .	There is voltage greater than 0 volts but less than 9.5 volts. Anti-lock brake control module cannot initialize due to insufficient voltage. Problem is NOT in ABS system. REFER to Section 14-00 . There is 0 volts. REPAIR open circuit between fuse 14 and anti-lock brake control module harness connector in 601 (LB/PK). GO to **PC3** .

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Hydraulic Control Unit (HCU)

Removal

1. Remove the battery (10655) and battery tray (10732). Refer to Section 14-01 .
2. Raise and support the vehicle on a hoist.
3. From beneath the LH front fender apron (16055), remove the anti-lock hydraulic control unit bracket nut.
4. Lower the vehicle.
5. Disconnect the two anti-lock HCU electrical connectors.
6. **NOTE: To prevent contamination and brake fluid leakage after hydraulic tubes are disconnected, plug each tube and port.**

   Disconnect the five HCU hydraulic connectors.
7. Remove the HCU bracket-to-inner fender screw and stud and remove HCU.

Installation

To install, reverse the removal procedure.

Tighten the anti-lock HCU bracket-to-inner fender screw and stud to 11-13 Nm (91-122 lb-in).

Tighten the anti-lock HCU bracket nut to 11-13 Nm (91-122 lb-in).

Tighten the hydraulic brake tube to the HCU outlet port adapter nuts to 18-27 Nm (14-19 lb-ft).

Tighten the hydraulic brake tube to HCU inlet port nuts to 14-21 Nm (11-15 lb-ft).

Bleed the brake system. Refer to Section 06-06 .

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Control Module, Anti-Lock Brake, Ranger

Removal

1. Disconnect the battery cables and remove the battery.

2. Locate the anti-lock brake control module electrical connector in front and to the right of the battery tray (10732). Disconnect the connector.

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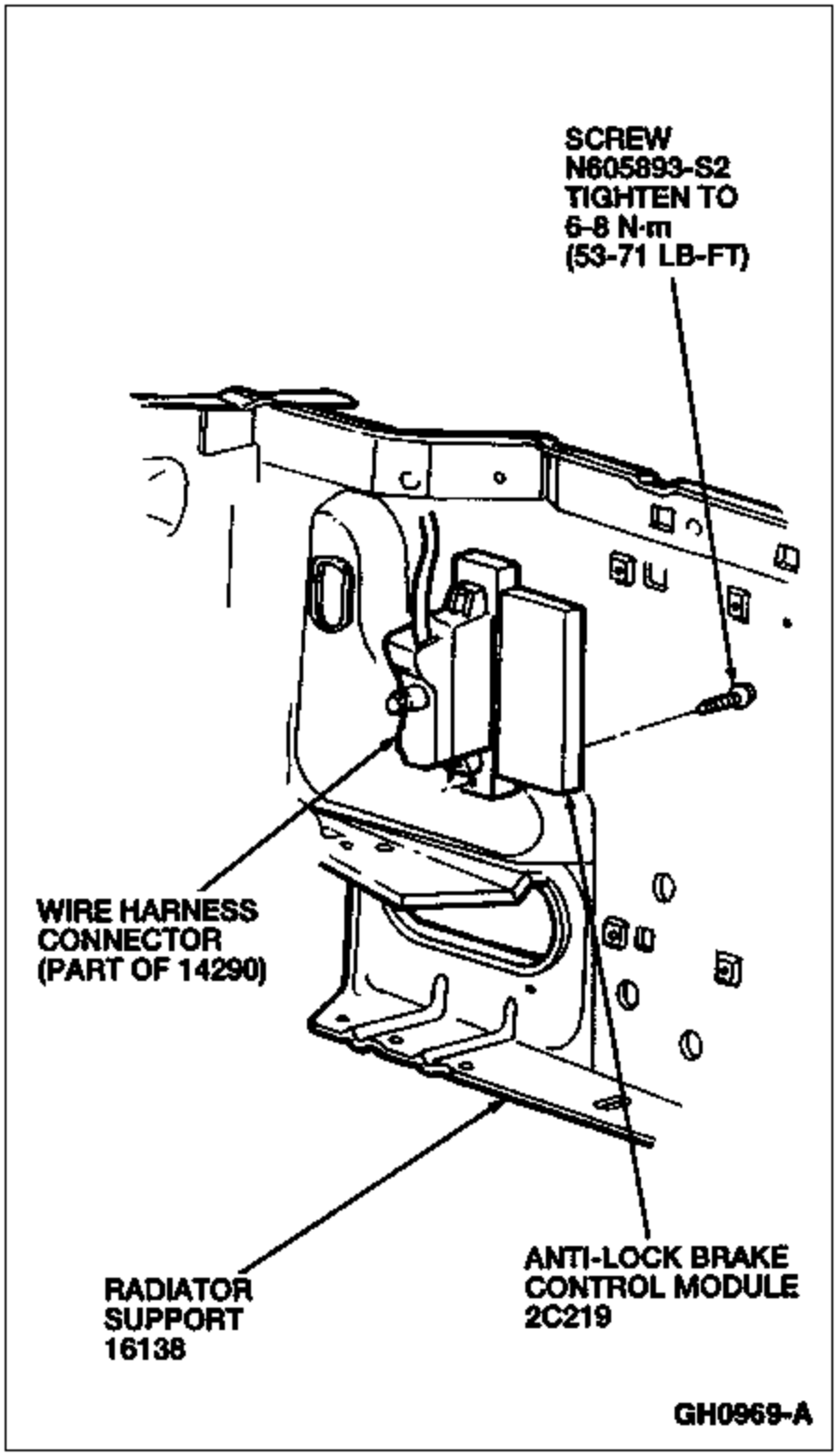

3. Remove the anti-lock brake control module-to-radiator support screw.

4. Slide the anti-lock brake control module to release the retaining tab and remove the module from the vehicle.

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Installation

To install, reverse the removal procedure. Tighten the module-to-radiator support screw to 6-8 Nm (53-71 lb-in).

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Relay, Anti-Lock Brake

Removal and Installation

The anti-lock brake relays are located in a relay box attached to the LH inner fender, behind the battery. The ABS power relay uses five terminal sockets and the pump motor relay uses four. The relay box must be removed from the LH inner fender to remove the relays. The relays are pulled from and pressed into their respective sockets.

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Brake Sensors

Front

Removal

1. From under the vehicle, disconnect the speed sensor assembly two-pin connector from wiring harness.
2. Separate the speed sensor cable from brake hose clips.
3. Remove the speed sensor retaining bolt from front spindle and slide sensor out of mounting hole.

Installation

For installation, follow removal procedures in reverse order. Tighten retaining bolt to 8-10 Nm (68-92 lb-in).

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Sensor Indicator, Anti-Lock Brake

Front

Removal and Installation

For removal and installation of the front speed sensor indicator (4x4 only), refer to Section 05-03A . Replace the rotor. Refer to Section 06-03 (4x2).

Rear

Removal and Installation

For removal and installation of the rear speed sensor indicator, refer to Section 05-02A or Section 05-02B .

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Brake Master Cylinder Reservoir Checking and Filling

Brake fluid level should not be more than 4mm (0.16 inch) below the MAX line on the side of the brake master cylinder reservoir (2K478). If brake fluid is low, the red BRAKE indicator will illuminate. To add brake fluid, clean and remove reservoir cap and pour clean brake fluid into the brake master cylinder reservoir. Fill to specification mentioned above. Use Ford High Performance DOT 3 Brake Fluid C6AZ-19542-AA or equivalent DOT 3 fluid meeting Ford specification ESA-M6C25-A, DOT3. If brake fluid has to be added often, check all hydraulic connections for leaks.

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SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Anti-Lock Brake Control Module Screw	6-8	—	53-71
Wheel Speed Sensor Bolt, Front	8-10	—	68-92
Anti-Lock Hydraulic Control Unit-to-Inner Fender Fasteners	11-13	—	91-122
Hydraulic Brake Tube Fittings	15-20	11-14	—
Speed Sensor Bolt, Rear	34-40	25-29	—
Wheel Lugnuts	135	100	—
HCU Bracket to Inner Fender Screw	11-13	—	91-122
HCU Bracket to Inner Fender Stud	11-13	—	91-122
HCU Bracket Nut	11-13	—	91-122
Hydraulic Brake Tube to HCU Outlet Port Nuts	18-27	14-19	—
Hydraulic Brake Tube to HCU Inlet Port Nuts	14-21	11-15	—

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Transmission Description

The 4R44E automatic transmissions are electronically controlled four-speed units.

The 4R44E transmission is used with the 2.3L and 3.0L engine applications.

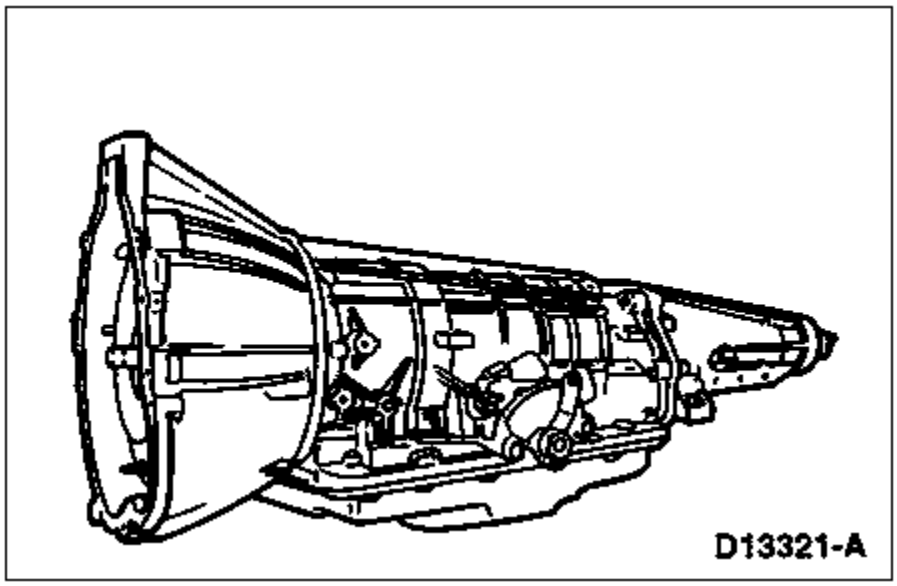
These transmissions feature a four element torque converter with a torque converter clutch (TCC). The geartrain includes:

- Three compound planetary gearsets
- Three bands
- Three multi-plate clutches
- Two one-way clutches

The hydraulic functions are directed by electronic solenoids to control:

- Engagement feel
- Shift feel
- Shift scheduling
- Modulated TCC applications
- Timing of the 3-2 T.D. and K.D. shifts
- Engine braking (with O/D canceled) utilizing the coast clutch
- Manual 1st timing

Transmission View



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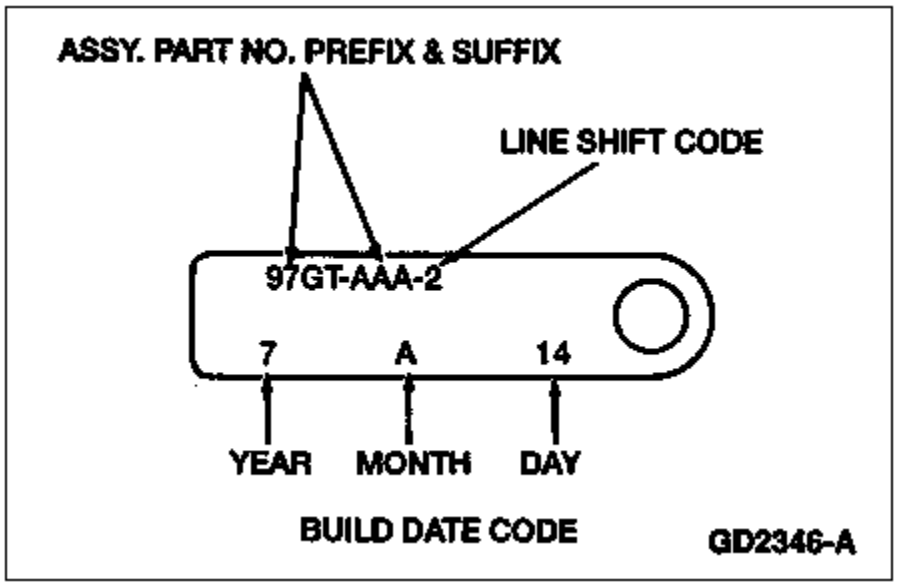
Identification Tags

Models are identified by a service identification tag affixed to the assembly. Typical service identification tags are shown below.

Located Under Extension Housing Bolt



Assembly Plant Bar Code I.D. Label Located on Fluid Pan

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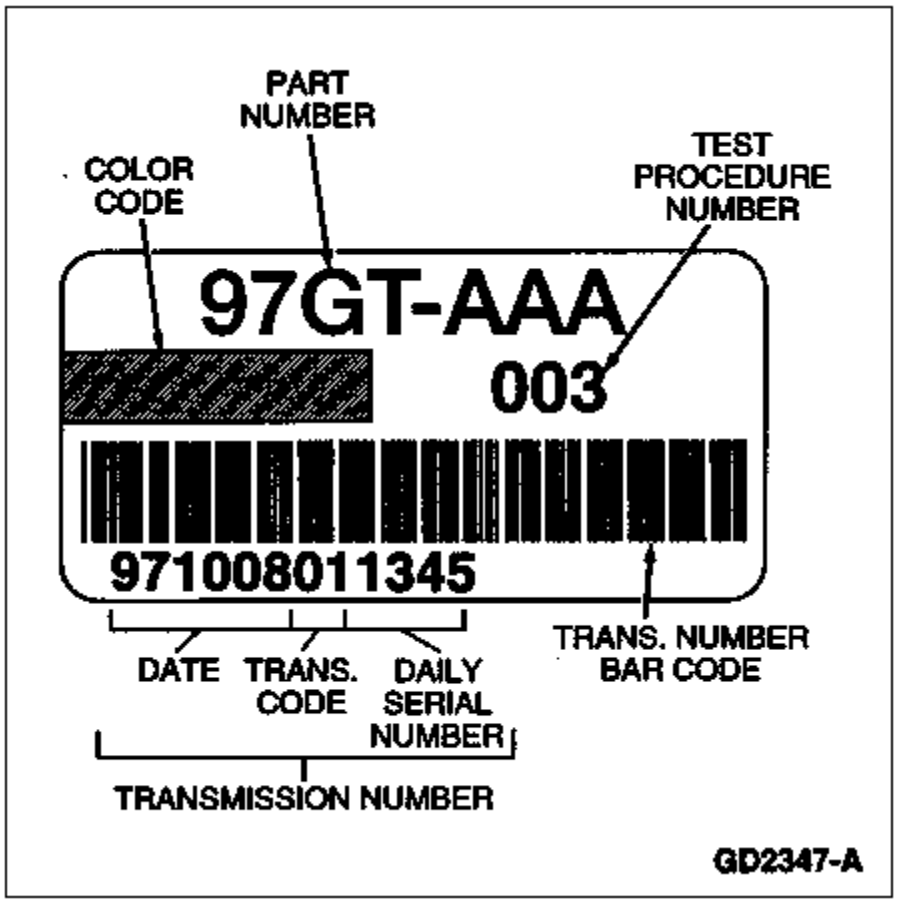

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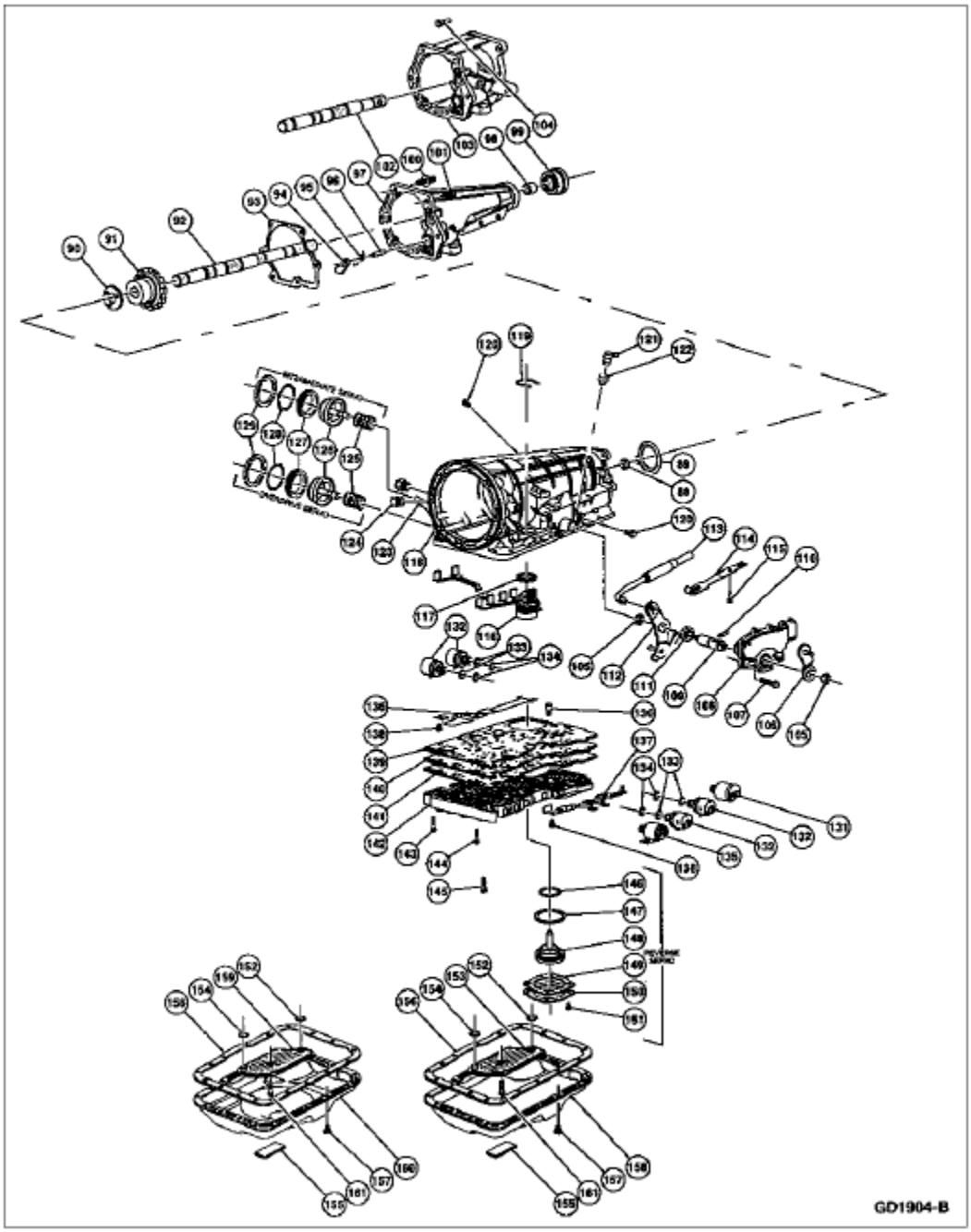
Exploded Views

Transmission, Exploded View — 4R44E (2.3L, 3.0L)



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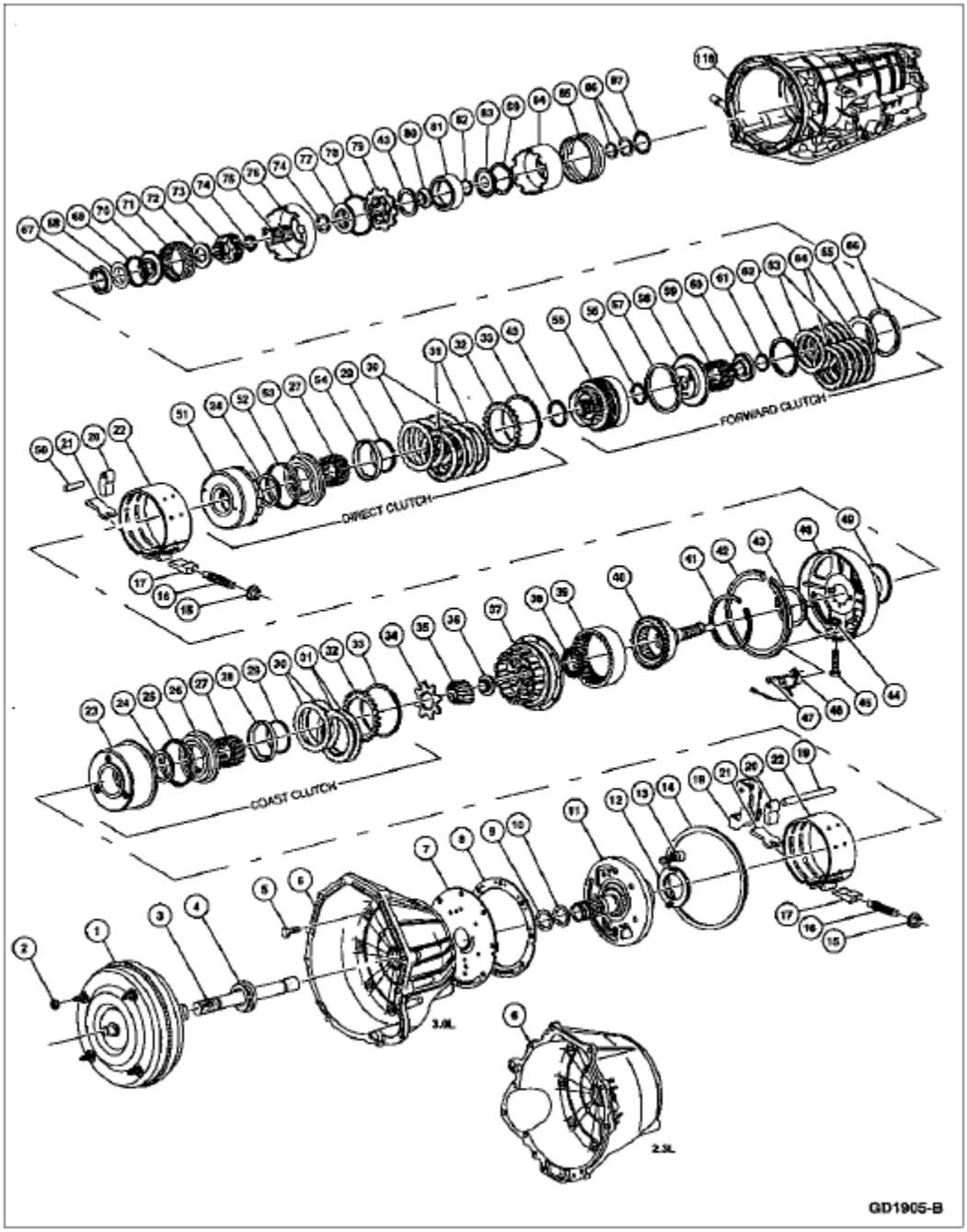

Item	Part Number	Description
1	7902	Converter Assembly — (Contains Piston Type Clutch) (Model Dependent)
2	379299-S2	Nut — (Att. Converter Assembly to Flex Plate) (4 Req'd)
3	7017	Shaft — Input

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4	7A248	Seal Assembly — Converter Hub to Converter Housing (Also in Converter Housing Assembly)
5	E804595-S300	Screw and Seal Assembly — M10 x 33 (Att. Converter Housing to Case) (8 Req'd)
6	7976	Housing Assembly — Converter (Model Dependent)
7	7B472	Plate — Fluid Pump Adapter
8	7A136	Gasket — Converter Housing to Case
9	7A248	Seal Ring — Fluid Pump Support
10	W701431-S300	O-Ring — Fluid Pump Shaft to Inner Gear (Also in Pump Assembly)
11	7A103	Support and Gear Assembly — Fluid Pump
12	7D014	Washer — Fluid Pump Input Thrust (Select Fit — 7 Variables) No. 1
13	W701429-S309M	Screw Flange Head — 8.8 Allen — M8 x 35 (Att. Pump Assembly Converter Housing) (6 Req'd)
14	7A248	Seal Ring — Fluid Pump
15	E825100-S100	Nut and Seal Assembly — Hex Intermediate and O/D Band Adjustment/Lock (2 Req'd)
16	7C492	Screw — Intermediate and O/D Band Adjuster/Lock (2 Req'd)
17	7D430	Strut — Intermediate and O/D Band Anchor (2 Req'd)
18	7A653	Bracket — O/D Band Lever to Case (Not Serviced Separately)
19	7D433	Shaft — O/D Actuating Lever
20	7330	Lever — Intermediate and O/D Band Servo (2 Req'd) (Model Dependent)
21	7D029	Strut — Intermediate and O/D Band Apply (2 Req'd)
22	7D034	Band Assembly — Intermediate and O/D (2 Req'd)
23	7L669	Drum Assembly — O/D Brake and Coast Clutch
24	7D404	Seal Ring — Coast Clutch and Direct Clutch Piston — Inner (2 Req'd)
25	7A548	Seal Ring — Coast Clutch Piston — Outer
26	7A262	Piston — Coast Clutch
27	7A480	Spring — Coast and Direct Clutch Piston (40 Req'd)
28	7A527	Retainer — Coast Clutch Piston Spring
29	E860125-S	Ring Retaining — 63 mm — Coast and Direct Clutch Piston in the Brake Drum (2 Req'd)
30	7B442	Plate — Coast (2 Req'd) and Direct (4 Req'd) Clutch External Steel
31	7B164	Plate Assembly — Coast (2 Req'd) and Direct (4 Req'd) Clutch Internal Friction
32	7B066	Plate — Coast and Direct Clutch Pressure (2 Req'd)

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33	E860126-S/129-S	Ring Retaining — Coast and Direct Clutch Plates (Select Fit) (2 Req'd)
34	7660	Adapter — Coast Clutch to O/D Carrier
35	7D063	Gear Assembly — Sun Overdrive
36	7D235	Race — Sun Gear Thrust Bearing — Rear (All) No. 12
37	7B446	Carrier Assembly — Planetary Gear O/D (With Trigger Wheel)
38	7L495	Bearing Assembly — O/D Planet Thrust No. 2
39	7653	Gear — Overdrive Ring
40	7A658	Shaft Assembly — Center Overdrive Ring (Includes O/D Overrunning Clutch 7C109)
41	W702037-S300	Ring Retaining — 110.1 mm O/D Center Shaft in O/D Ring Gear
42	W702465-S300	Ring Retaining — Center Support in Case
43	7M153	Bearing Assembly — Center Shaft Thrust No. 3-5 and No. 9 (3 Req'd)
44	E826160-S76	Nut and Cage Assembly — S/L Met. M6 (Att. Center Support to Case)
45	E804373-S	Screw Cap — 8.8 Allen M6 x 20 (Att. Center Support to Case)
46	7M101	Sensor — Turbine Shaft Speed With Wire to 16-Pin Connector
47	W702297-S300	Screw — Cap M6 x 15 (Att. Turbine Shaft Speed Sensor to Center Support)
48	7A130	Support Assembly — Center
49	7D014	Bearing Assembly — Intermediate Brake Drum Thrust (Select Fit — 4 Variables) No. 4
50	7D433	Shaft — Intermediate Band Actuating Lever
51	7D044	Drum Assembly — Intermediate Brake and Direct Clutch
52	7A548	Seal Ring — Direct Clutch Piston — Outer
53	7A262	Piston — Direct Clutch
54	7A527	Retainer — Direct Clutch Piston Spring
55	7A360	Cylinder Assembly — Forward Clutch
56	7A548	Seal Ring — Forward Clutch Piston — Inner
57	7A548	Seal Ring — Forward Clutch Piston — Outer
58	7A262	Piston Assembly — Forward Clutch
59	7A480	Spring — Forward Clutch Piston (15 Req'd)
60	7A527	Retainer — Forward Clutch Piston Spring
61	E860109-S	Ring Retaining 34 mm — Forward Clutch Piston and Spring in Forward Clutch Cylinder

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62	7B070	Spring — Forward Clutch Cushion
63	7B442	Plate — Forward Clutch External Steel (5 Req'd)
64	7B164	Plate Assembly — Forward Clutch Internal Friction (5 Req'd)
65	7B066	Plate — Forward Clutch Pressure
66	E860115-S/118-S	Ring Retaining — Forward Clutch Plates in Forward Clutch Cylinder (Select Fit)
67	7D234	Bearing Assembly — Forward Ring Gear Hub Thrust No. 6A
68	7D090	Washer — Forward Clutch Thrust No. 6B
69	E860122-S	Ring Retaining 87 mm — Forward and Output Shaft Ring Gears to Hubs (2 Req'd)
70	7B067	Hub — Forward Ring Gear
71	7D392	Gear — Forward Ring (72 External Teeth and 57 Internal Teeth)
72	7F374	Bearing Assembly — Forward Planet Thrust No. 7
73	7A398	Planetary Assembly — Forward (4 Pinion) (Serviced as 6-Pinion Only)
74	E860121-S	Ring Retaining 39 mm — Input Shell to Sun Gear Assembly (2 Req'd)
75	7D063	Gear Assembly — Sun (Forward)
76	7D064	Shell — Input
77	7M151	Bearing Assembly — Reverse Planet Carrier Thrust No. 8
78	W702037-S300	Snap Ring
79	7D006	Planet Assembly — Reverse (3 or 4 Pinion) (Serviced as 6 Pinion Only) (Model Dependent)
80	7B176	Sleeve — Output Shaft
81	7A153	Gear — Output Shaft Ring
82	E860527-S	Ring Retaining 25 x 2 mm — Output Shaft in Case
83	7D164	Hub — Output Shaft
84	7C498	Drum Assembly — Reverse Brake (Includes Low Overrunning Clutch)
85	7D095	Band Assembly — Reverse
86	7M150	Bearing Race (2 Pieces) — Output Shaft Hub Thrust No. 10A
87	7M150	Bearing Assembly — Output Shaft Hub Thrust No. 10B
88	7R205	Bearing Assembly — Output Shaft to Case (Part of Case Assembly)
89	7L339	Retainer — Splash Fluid
90	7B368	Washer — Output Shaft Thrust No. 11

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91	7M092	Gear — Transmission Parking (2.3L/3.0L)
92	7060	Shaft Assembly — Output (4x2)
93	7086	Gasket — Extension Housing
94	7A441	Pawl — Parking
95	7D070	Spring — Parking Pawl Return
96	7D071	Shaft — Parking Pawl
97	7A039	Housing Assembly — Extension (4x2)
98	7A034	Bushing — Extension Housing (4x2) (Also in Extension Housing)
99	7052	Seal Assembly — Extension Housing to Slip Yoke (Also in Extension Housing Assembly)
100	E804137-S72	Stud — (Att. Extension Housing to Case)
101	E800152-S72	Screw — M10 x 30 (Att. Extension Housing to Case) (5 Req'd)
102	7060	Shaft Assembly — Output (4x4)
103	7A039	Housing Assembly — Extension (4x4)
104	N605804-S100	Screw — M10 x 45 (Att. 4x4 Extension Housing to Transfer Case) (2 Req'd)
105	W701271-S309	Nut — (Att. Outer and Inner Manual Levers to Shaft) (2 Req'd)
106	7A256	Lever Assembly — Manual Control — Outer
107	N806933-S100	Screw — M6 x 25 (Att. Transmission Range Sensor to Case) (2 Req'd)
108	7F293	Sensor — Digital Transmission Range (DTR)
109	7A308	Shaft — Manual Valve Outer to Inner Lever
110	E840125-S	Pin — Spring (Retains Outer Manual Lever to Case)
111	7B498	Seal Assembly — Main Control Lever (Also in Case Assembly)
112	7A115-117	Lever — Manual Valve — Inner
113	7A232	Rod Assembly — Parking Pawl Actuating
114	7E332	Spring Assembly — Manual Valve Detent
115	E800185-S	Screw — M6 x 30 (Att. Detent Spring to Main Control)
116	7Z409	Connector Assembly (16-Pin with Wire Harness to 6 Solenoids)
117	W703015-S300	O-Ring — 16-Pin Connector Assembly to Case (2 Req'd)
118	7005	Case Assembly (Model Dependent)
119	84280020	Spring — Retains 16-Pin Connector in Case
120	E450102-S80	Plug — Pipe Line and EPC Pressure (Part of Case Assembly) (2 Req'd) (Not Serviced Separately)
121	7034	Vent Assembly — Also in Case Assembly (4x4)

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122	7034	Vent Assembly — Also in Case Assembly (4x2)
123	7A160	Tube — Lube Fluid Inlet — Short (Also in Case Assembly)
124	7D273	Connector Assembly — Fluid Tube (Also in Case Assembly) (2 Req'd)
125	7D028	Spring — Intermediate Servo Piston (Model Dependent)
126	7D021	Piston and Rod Assembly — Intermediate and O/D Servo (2 Req'd) (Model Dependent)
127	7D027	Cover and Seal Assembly — Intermediate and O/D Servo (2 Req'd) (Model Dependent)
128	7D040	O-Ring — Servo Cover to Case Intermediate and O/D Servo (2 Req'd)
129	E860343-S	Ring Retaining — 67 x 1.5 mm (Intermediate and O/D Servos in Case) (2 Req'd)
130	E804357-S76	Screw — Torx M6 x 21 (Att. Separating Plate to Main Control) (Also in Main Control Assembly)
131	7G383	Solenoid — (EPC) (Also in Main Control Assembly)
132	7G484	Solenoid Assembly (Shift) (Also in Main Control Assembly) (4 Req'd)
133	W702951-S300	O-Ring — Shift Solenoid to Main Control (Large) (15x1.5) (4 Req'd)
134	W702949-S300	O-Ring — Shift Solenoid to Main Control (Small) (13x1.5) (4 Req'd)
135	7G136	Solenoid Assembly — Converter Clutch with Clamp (Also in Main Control Assembly)
136	7L491	Clamp (SS1 and SS3) Solenoids (Also in Main Control) (Not Serviced Separately)
137	7L491	Clamp — Converter Clutch/SS4/SS2 and EPC Solenoids (Also in Main Control) (Not Serviced Separately)
138	E800155-S	Screw — M6 x 12 (Att. Solenoid Clamps to Main Control) (2 Req'd)
139	7C155	Gasket — Control Valve Body to Case
140	7A008	Plate — Valve Body Separating (Part of Main Control Assembly) (Not Serviced Separately)
141	7D100	Gasket — Control Valve Body Separating (Also in Main Control)
142	7A100	Control Assembly — Main (Model Dependent)
143	E800154-S	Screw — M6 x 45 (Att. Main Control to Case) (4 Req'd)
144	E800153-S	Screw — M6 x 40 (Att. Main Control to Case) (16 Req'd)
145	E800163-S	Screw — M6 x 35 (Att. Main Control to Case) (3 Req'd)
146	7423	Seal Ring — Reverse Servo Piston — Small (Also in

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		Piston Assembly)
147	7423	Seal Ring — Reverse Servo Piston — Large (Also in Piston Assembly)
148	7D189	Piston Assembly — With Rod and Retainer — Rear Band Servo (Select Fit)
149	7L173	Gasket — Reverse Servo Cover to Case
150	7D036	Cover — Reverse Servo
151	E800156-S	Screw — M6 x 20 (Att. Reverse Servo Cover to Case) (4 Req'd)
152	7A469	O-Ring — Fluid Filter Assembly — Small
153	7A098	Filter Assembly — Fluid Pan (4x2)
154	7A469	O-Ring — Fluid Filter Assembly — Large
155	7E290	Magnet — on Inner Bottom Surface (Not Serviced Separately)
156	7A191	Gasket — Fluid Pan
157	W701203-S309M	Screw — M8 x 16 (Att. Fluid Pan to Case) (18 Req'd)
158	7A194	Pan — Fluid (4x2)
159	7A098	Filter Assembly — Fluid Pan (4x4)
160	7A194	Pan — Fluid (4x4)
161	E800329-S	Screw — M6 x 55 (Att. Fluid Filter to Main Control)

Bushings, Bearing and Thrust Washer Locator — 4R44E

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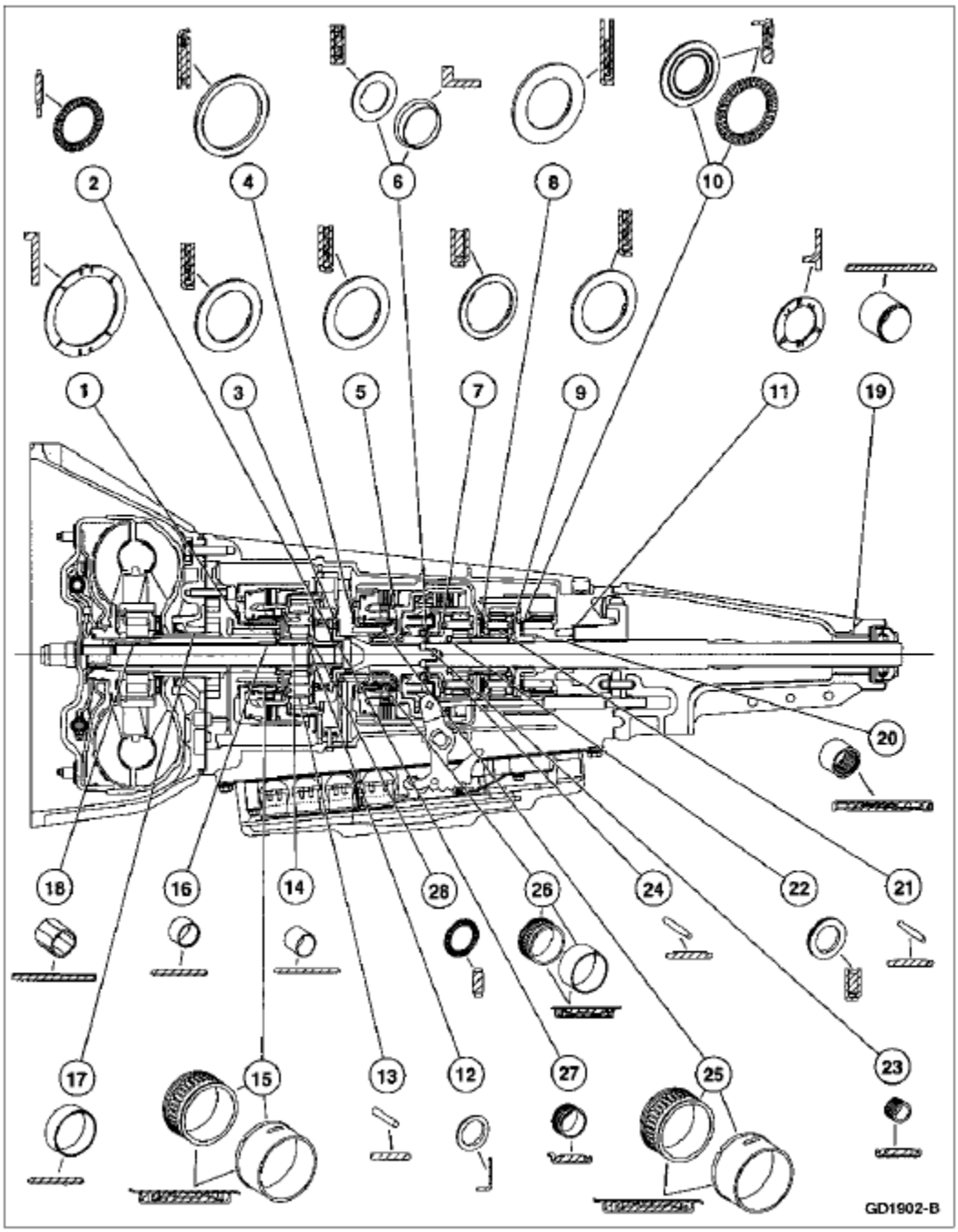

Item	Part Number	Description
1	7D014	No. 1 Selective Washer
2	7L495	No. 2 Needle Bearing
3	7M153	No. 3 Needle Bearing
4	7D014	No. 4 Selective Needle Bearing
5	7M153	No. 5 Needle Bearing
6	7D234,	No. 6A Needle Bearing and No. 6B Bushing

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	7D090	
7	7F374	No. 7 Needle Bearing
8	7M151	No. 8 Needle Bearing
9	7M153	No. 9 Needle Bearing
10	7M150	No. 10A Bearing Race and 10B Needle Bearing Assembly
11	7B368	No. 11 Washer
12	7D235	No. 12 Race
13	—	Needle Bearing (Part of 7B446 O/D Planetary Assembly) (Not Serviced Separately)
14	—	Bushing (Part of 7D063 O/D Sun Gear) (Not Serviced Separately)
15	—	Bearing, Seal Assembly and Sleeve (Not Serviced Separately)
16	—	Bushing (Part of 7L201 Pump Assembly) (Not Serviced Separately)
17	—	Bushing (Part of 7976 Converter Housing) (Not Serviced Separately)
18	—	Bushing (Part of 7L201 Pump Assembly) (Not Serviced Separately)
19	—	Bushing (Part of 7A039 and Serviced Separately)
20	7R205	Needle Bearing
21	—	Needle Bearing (Part of 7D006 Reverse Planetary Assembly) (Not Serviced Separately)
22	—	Needle Bearing (Part of 7A398 Forward Planetary Assembly) (Not Serviced Separately)
23	—	Needle Bearing (Part of 7060 Output Shaft) (Not Serviced Separately)
24	—	Needle Bearing (Part of 7A398 Forward Planetary Assembly) (Not Serviced Separately)
25	—	Bearing, Seal Assembly and Sleeve (Not Serviced Separately)
26	—	Bearing, Seal Assembly and Sleeve (Not Serviced Separately)
27	—	Needle Bearing (Part of 7B446 O/D Planetary Assembly) (Not Serviced Separately)
28	—	Needle Bearing (Part of 7B446 O/D Planetary Assembly) (Not Serviced Separately)

Seals, Rings and Gaskets Locator — 4R44E

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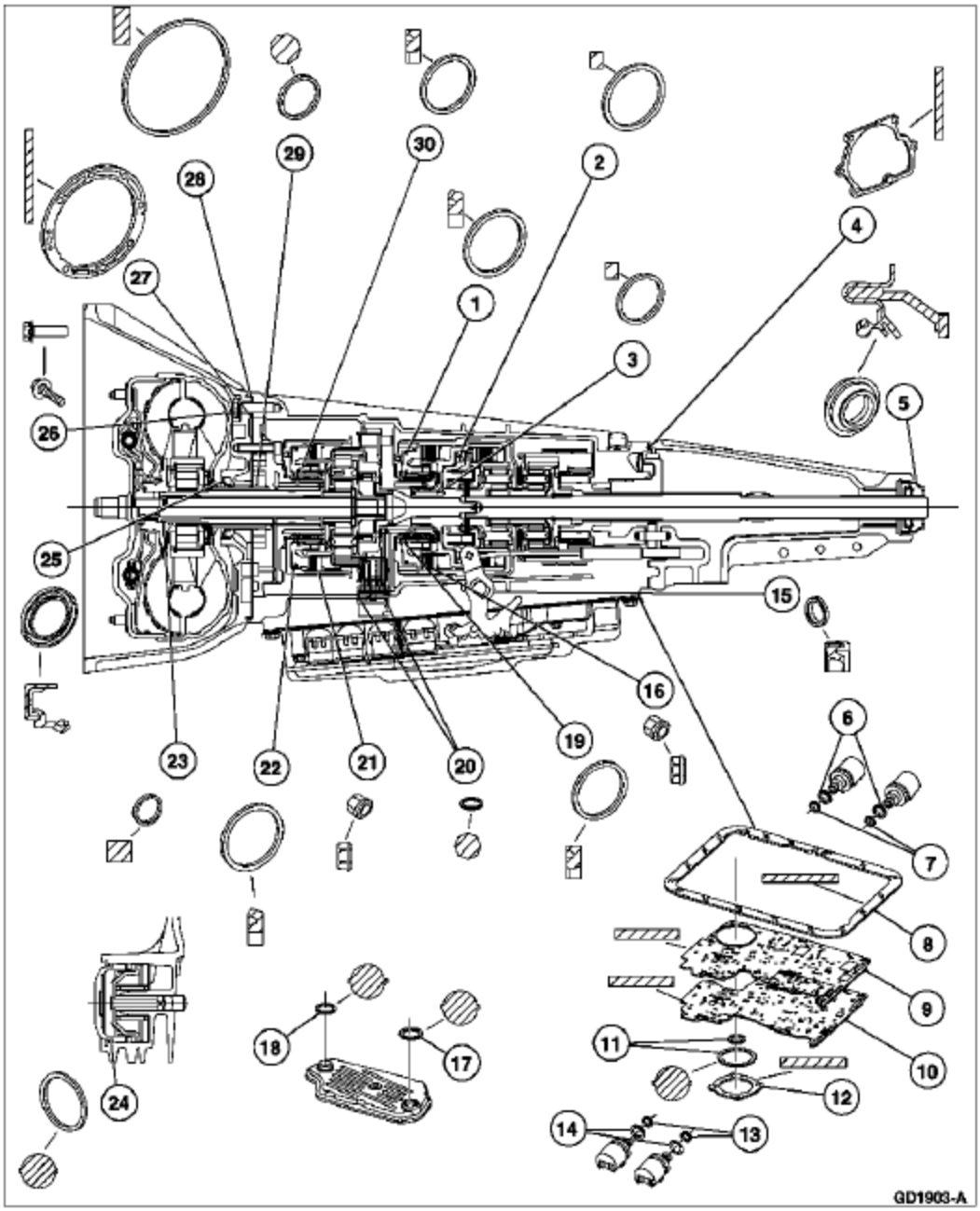

Item	Part Number	Description
1	7A548	Seal Ring
2	7A548	Seal Ring
3	7A548	Seal Ring
4	7086	Gasket (Transmission Extension)
5	7052	Seal Assembly (Extension Housing)
6	W702949-S300	O-Ring (Large)
7	W702951-S300	O-Ring (Small)
8	7A191	Gasket (Fluid Pan)

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9	7C155	Gasket (Valve Body Upper)
10	7D100	Gasket (Valve Body Lower)
11	7423	O-Ring (Reverse Servo Piston)
12	7L173	Gasket (Reverse Servo Plate Cover)
13	W702951-S300	O-Ring (Small)
14	W702949-S300	O-Ring (Large)
15	7B498	Seal Assembly (Manual Cover Lever)
16	E825100-S100	Nut and Seal
17	7A469	O-Ring (Large) (Fluid Filter Assembly)
18	7A469	O-Ring (Small) (Fluid Filter Assembly)
19	7D404	Seal Ring
20	W703015-S300	O-Ring
21	E825100-S100	Nut and Seal
22	7A548	Seal Ring
23	7L323	O-Ring
24	7D040	O-Ring (Intermediate/Overdrive Servos)
25	7A248	Seal Assembly (Converter Hub)
26	E804595-S200	Screw and Seal Assembly
27	7A136	Gasket (Fluid Pump)
28	7A248	Seal Ring (Fluid Pump)
29	W701431-S300	O-Ring
30	7D404	Seal Ring

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Transmission Range Operation

The 4R44E transmission range selector lever has six positions: P, R, N, D, 2, 1. The driver selects the required gear position by moving the selector lever to the various positions. Interlocking cables and linkages connect the selector lever to the transmission. This allows the selector lever to move internal linkages and the manual control valve, which signals the driver demand.

Park

No powerflow is transferred through the transmission in PARK. The manual lever shaft, which is connected to a park rod, presses the parking pawl into the park gear on the output shaft. This locks the output shaft and prevents the vehicle from rolling. However, for safety reasons, the parking brake should be applied whenever the vehicle is parked.

While the engine can be started in either P or N position, the ignition key can only be removed in PARK.

Reverse

Reverse gear allows the vehicle to be operated in a rearward direction, at a reduced gear ratio. When overdrive has been cancelled, engine braking is provided in the R position with the coast clutch applied.

Neutral

As in PARK, there is no power transferred through the transmission. However, the final drive is not locked by the parking pawl, so the wheels are free to rotate. The vehicle may be started in the N position, but the ignition key cannot be removed.

Overdrive

In the (D) position, the transmission will upshift or downshift 1-2-3-4 automatically.

When overdrive has been canceled by turning the transmission control switch on, the transmission will not upshift to 4th gear. Engine braking is provided in 1st, 2nd, 3rd and reverse gears with the coast clutch applied.

2nd Position

Selection of the 2 position provides a 2nd gear hold position from a manual upshift or downshift. When the 2 position is selected from a stop, the transmission will start in second gear. This allows for maximum traction on slippery surfaces. Engine braking is provided in the 2 position when the transmission control switch (TCS) is on or off.

1st Position

The 1 position provides a 1st gear hold after an automatic or manual downshift. The transmission is prevented from downshifting above a specific speed (approximately 48 km/h [30 mph]) to protect the powertrain from overspeeding. Engine braking is provided in the 1 position when the transmission control switch (TCS) is on or off.

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Transmission Shift Patterns

Upshifts

Transmission upshifting is controlled by the powertrain control module (PCM). The PCM receives inputs from various engine or vehicle sensors and driver demands to control shift scheduling, shift feel and torque converter clutch operation.

Downshifts

Under certain conditions the transmission will downshift automatically to a lower gear range (without moving the range selector lever). There are three categories of automatic downshifts: Coastdown, Torque Demand and Forced or Kickdown shifts.

Coastdown

The coastdown downshift occurs as the name indicates, when the vehicle is coasting down to a stop.

Torque Demand

The torque demand downshift occurs (automatically) during part throttle acceleration when the demand for torque is greater than the engine can provide at that gear ratio. The transmission will also disengage the torque converter clutch to provide added acceleration, if applied.

Kickdown

For maximum acceleration, the drive can force a downshift by pressing the accelerator pedal to the floor. A forced downshift into a lower gear (3rd, 2nd or 1st) is possible below calibrated speeds. For all shift speeds, specifications are subject to variations due to tire size, engine and transmission calibration requirements.

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Transmission Control Switch and Lamp Operation

The transmission control switch (TCS) is a driver-controlled momentary contact switch mounted on the end of the transmission range selector lever. When the TCS is activated, 4th gear operation (overdrive) is canceled, coast clutch is applied, and engine braking is provided in 1st, 2nd, 3rd and reverse gears.

The transmission control indicator lamp (TCIL) is located on the transmission range selector lever in the Aerostar and on the instrument panel in the Ranger. The TCIL indicates that the transmission control switch (TCS) has been depressed and 4th gear has been cancelled. The TCIL will flash if the powertrain control module (PCM) detects a concern in certain transmission related sensors or solenoids.

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Main Components and Functions

Torque Converter

The 4R44E uses a four element torque converter. The converter contains the standard internal components (turbine, impeller, and stator) for transfer of power and multiplication of torque. It also utilizes a disc type torque converter clutch (TCC) for maximum fuel economy.

The operation of the main torque converter components is as follows:

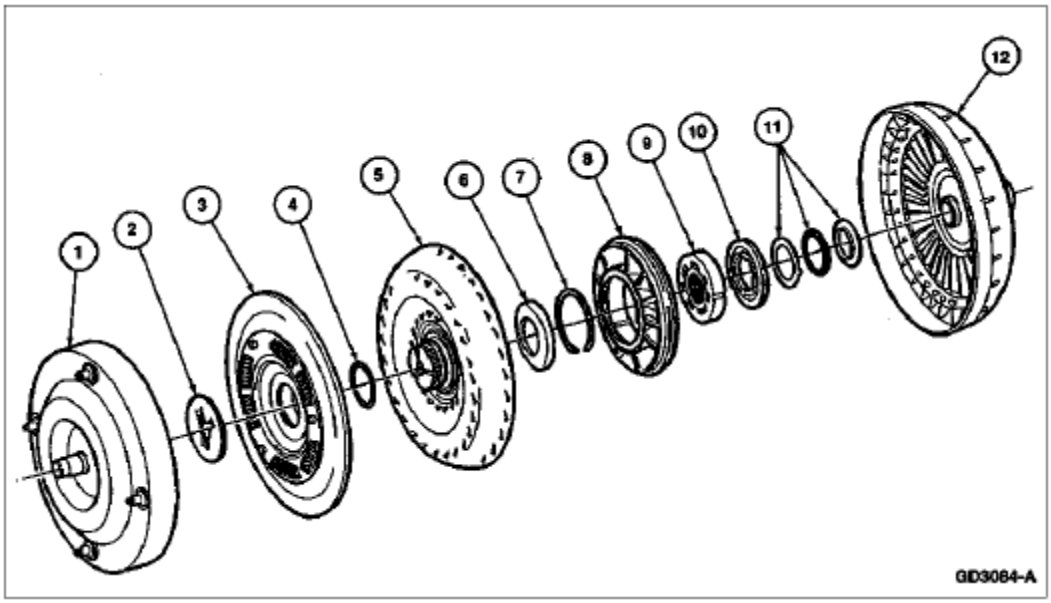
- The converter cover and impeller are connected to the engine crankshaft. Rotation of the cover and impeller by the engine crankshaft sets the fluid in motion.
- The turbine reacts to the fluid motion from the impeller, transferring rotation to the geartrain by way of the turbine shaft.
- The stator redirects the fluid going back to the impeller, from the turbine. By directing fluid back to the impeller in the same direction as engine rotation, the stator multiplies engine torque.

When applied, the TCC provides a mechanical link between the converter turbine and the engine, allowing for a direct mechanical power transfer from the engine to the transmission. The converter clutch pressure plate is applied and released by fluid pressure, which is controlled by the powertrain control module (PCM). The PCM controls the torque converter clutch using a pulse-width modulated TCC solenoid.

Torque Converter Clutch (TCC) Damper

The torque converter clutch damper assembly functions only when the torque converter clutch is applied.

Torque Converter Assembly



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Item	Part Number	Description
1	—	Cover (Part of 7902)
2	—	Thrust Washer (Part of 7902)
3	—	Converter Damper Plate (Part of 7902)
4	—	O-Ring (Part of 7902)
5	—	Turbine Assembly (Part of 7902)
6	—	Thrust Washer (Part of 7902)
7	—	Snap Ring (Part of 7902)
8	—	Reactor (Part of 7902)
9	—	One-Way Clutch Assembly (Part of 7902)
10	—	Thrust Washer (Part of 7902)
11	—	Thrust Bearing (Part of 7902)
12	—	Impeller Assembly (Part of 7902)

Impeller and Cover

The impeller sets the fluid in motion and directs it to the turbine. The impeller is welded to the converter cover.

Turbine

The turbine is the driven member of the converter. It is driven by fluid from the impeller and transfers the hydraulic power to the transmission. When the converter lockup clutch is engaged, the power is transferred mechanically.

Reactor

The reactor is equipped with heavily curved vanes and its center hub has an one-way clutch which prevents the stator from rotating opposite to the engine rotation. The reactor reverses the fluid and returns it to the impeller in the direction of impeller rotation. The one-way clutch prevents the force of this fluid from turning the stator against the impeller and turbine.

The reactor one-way clutch is built into the reactor (stator) and prevents it from rotating opposite to engine rotation.

Torque Converter Clutch

The clutch is joined to the turbine by means of the externally splined hub of the turbine and also internally splines within its own assembly.

When engaged the clutch friction plate bears against the inside of the converter cover, thereby producing a direct mechanical connection between the pump housing and the turbine.

Geartrain

Power is transmitted from the torque converter to the planetary gearsets through the input shaft.

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By holding and driving certain numbers of the gearsets, four forward ratios and one reverse ratio are obtained and transmitted to the output shaft and differential.

The ratios from the planetary gearsets are:

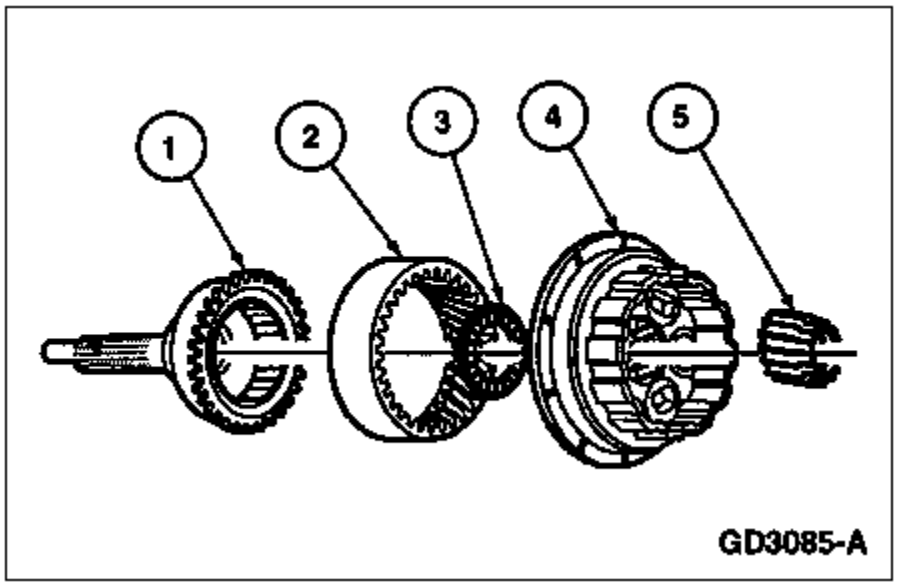
- 2.474:1 in 1st (Low)
- 1.474:1 in 2nd (Intermediate)
- 1.000:1 in 3rd (Drive)
- .75:1 in 4th (Overdrive)
- 2.1:1 in Reverse

Planetary Gearset — Overdrive

The planetary gear overdrive carrier is driven by the input shaft. The planetary gearset overdrive carrier drives the center shaft via the overdrive one-way clutch in 1st, 2nd and 3rd gears.

In overdrive, the overdrive sun gear is held, causing the pinion gear to rotate around the overdrive sun gear. The pinion gears in turn drive the overdrive ring gear resulting in an overdrive output ratio of 0.75:1.

The overdrive planetary gearset is also internally splined to the coast clutch for engine braking.



Item	Part Number	Description
1	7A658	Center Shaft Assembly
2	7653	Overdrive Ring Gear
3	7L495	No. 2 Overdrive Planetary Thrust Bearing
4	7B446	Overdrive Planetary Gear Carrier Assembly
5	7D063	Overdrive Sun Gear Assembly

Planetary Gearset — Forward

The forward planetary gearset is splined to the output shaft.

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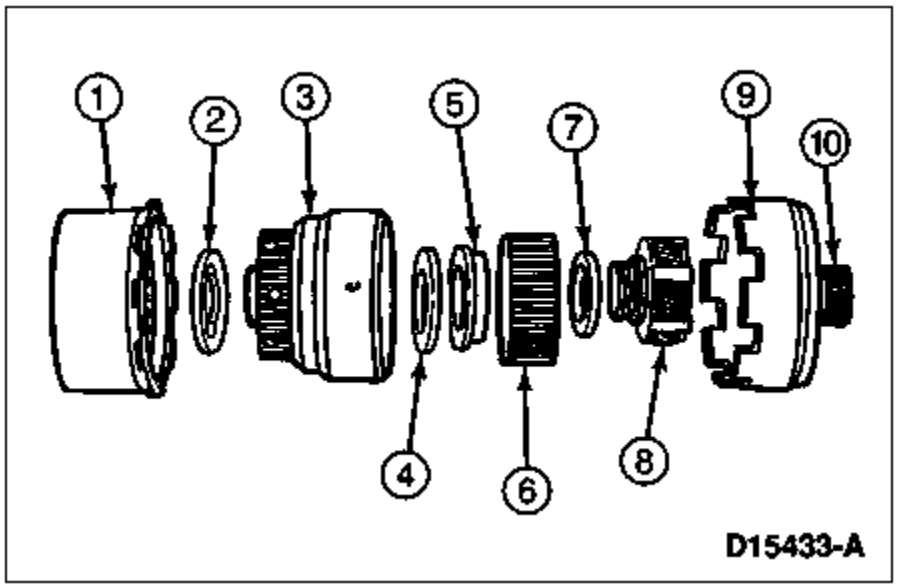
The forward planetary gearset is driven by the forward ring gear when the forward clutch is applied. The forward planetary gearset pinions drive the forward sun gear. The forward sun gear is splined to the input shell.



Item	Part Number	Description
1	7D044	Intermediate Brake and Direct Clutch Drum Assembly
2	7C096	No. 5 Forward Clutch Cylinder Thrust Bearing
3	7A360	Forward Clutch Cylinder Assembly
4	7D234	No. 6A Forward Ring Gear Hub Thrust Bearing
5	7D090	No. 6B Forward Clutch Thrust Washer
6	7D392	Forward Ring Gear
7	7F374	No. 7 Forward Planetary Thrust Bearing Assembly
8	7A398	Forward Planetary Assembly
9	7D064	Input Shell
10	7D063	Forward Sun Gear Assembly

Input Shaft

The input shaft is supported by two bushings in the stator support. End positioning of the input shaft is controlled by the splines in the converter turbine and the overdrive planetary carrier.

Output Shaft

The output shaft is supported by two bushings in the case and by the slip yoke bushing in the extension housing. End positioning is controlled by the parking pawl gear and snap ring or shoulder and by the reverse ring gear hub and snap ring.

Planetary Gearset — Low/Reverse

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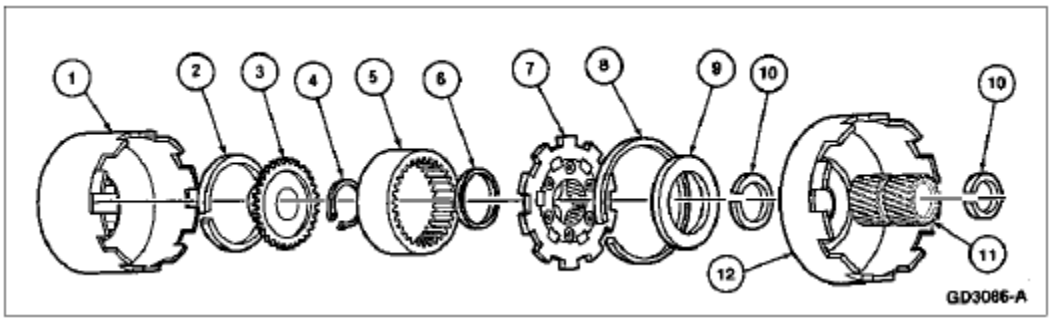
The low/reverse planetary gearset is connected to the low/reverse brake drum by lugs from the low/reverse brake drum to the lugs of the low/reverse planetary gearset.

The low/reverse planetary gearset is driven by the forward sun gear which is splined to the input shell.

The splines of the forward sun gear drive the pinions in the low/reverse planetary gearset. The pinions of the low/reverse planetary gearset drive the output shaft ring gear and output shaft hub which is splined to the output shaft.

The low/reverse planetary gearset is held via the low one-way clutch in the low/reverse brake drum assembly, when the low/reverse band is applied.



Item	Part Number	Description
1	7C498	Reverse Brake Drum Assembly
2	E860122-S	Retaining Ring
3	7D164	Output Shaft Hub
4	E860527-S	Retaining Ring
5	7A153	Output Shaft Ring Gear
6	7M153	No. 9 Reverse Planetary Carrier Thrust Bearing
7	7D006	Reverse Planetary Gearset
8	W702037-S300	Retaining Ring
9	7A166	No. 8 Reverse Planetary Carrier Thrust Bearing
10	E860121-S	Retaining Ring (2 Req'd)
11	7D063	Forward Sun Gear Assembly
12	7D064	Input Shell

Apply Components

Bands — Overdrive

Hydraulic pressure is applied to the front side of the overdrive servo. This pressure causes the servo to stroke and apply force to the band, causing the overdrive brake and coast clutch drum to be held.

The overdrive band holds the overdrive brake and coast clutch drum to the case in 4th gear. This causes the overdrive sun gear to be held stationary through the coast clutch adapter and the overdrive brake and coast clutch drum.

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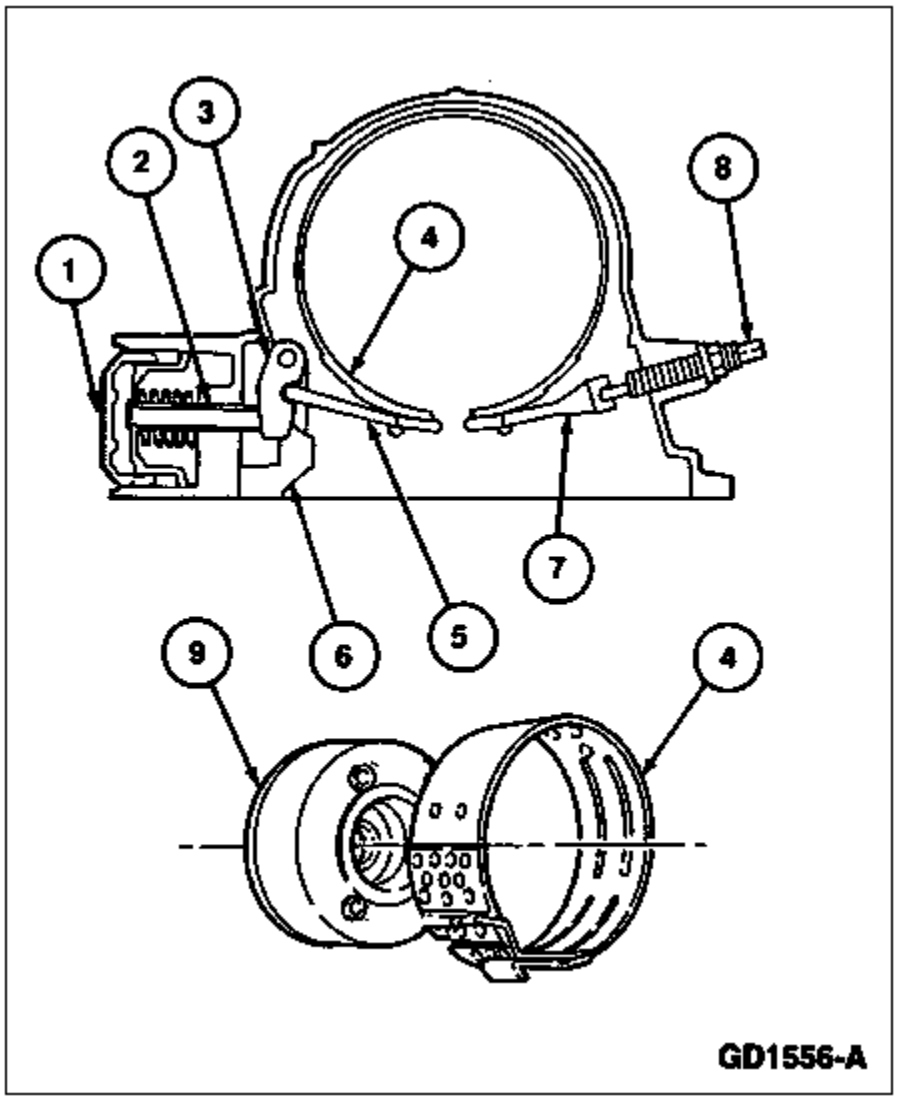

Item	Part Number	Description
1	7L493	Overdrive Servo Cover Assembly
2	7D021	Overdrive Servo Piston and Rod Assembly
3	7330	Overdrive Band Servo Lever
4	7D034	Overdrive Band Assembly
5	7D029	Overdrive Band Apply Strut
6	7A653	Overdrive Band Lever to Case Bracket
7	7D430	Overdrive Band Anchor Strut
8	7C492	Overdrive Band Adjuster/Lock Screw
9	7L669	Overdrive Brake and Coast Clutch Drum Assembly

Bands — Intermediate

Hydraulic pressure is applied to the front side of the intermediate servo. This pressure causes the servo to stroke and apply force to the intermediate band, causing the intermediate brake and direct clutch drum to be

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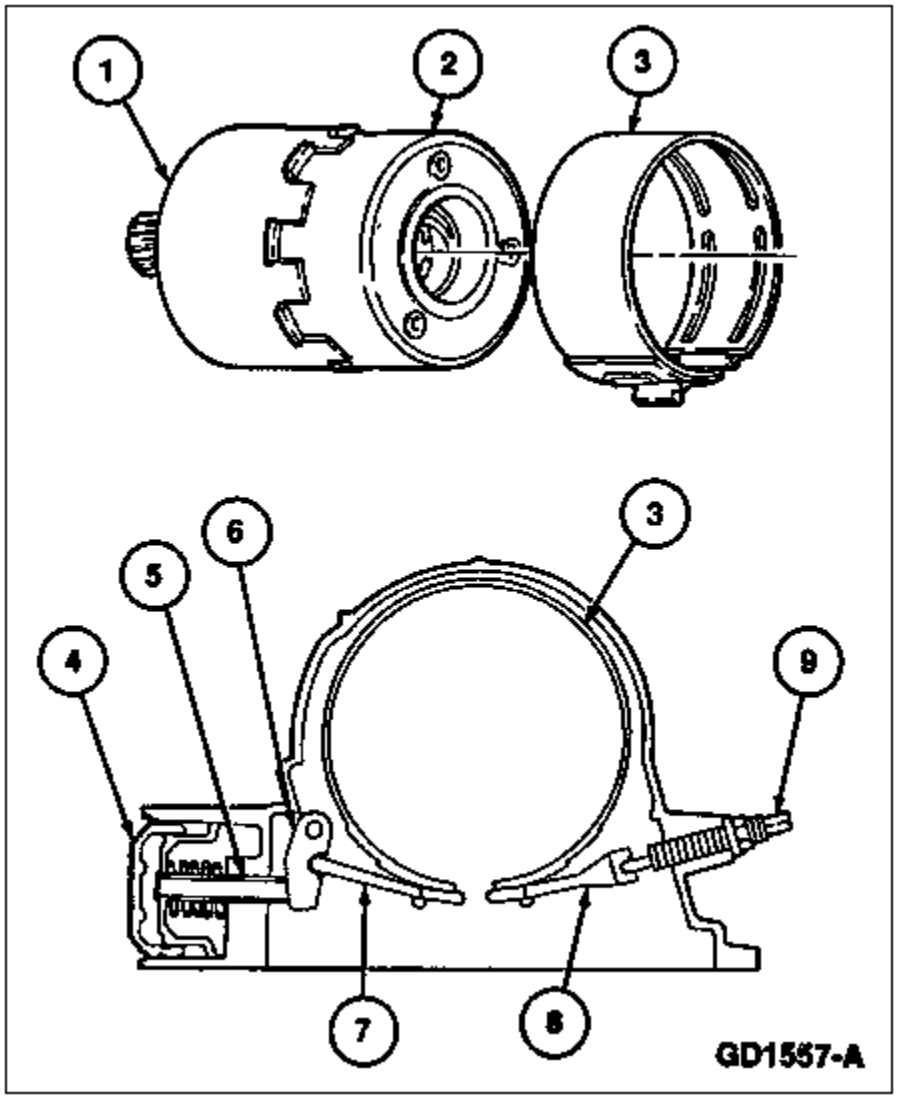
held.

The intermediate band holds the intermediate brake and direct clutch drum to the case in 2nd gear. This causes the input shell and the forward sun gear to be held stationary.



Item	Part Number	Description
1	7D064	Input Shell
2	7D044	Intermediate Brake and Coast Clutch Drum Assembly
3	7D034	Intermediate Band Assembly
4	7L493	Intermediate Servo Cover Assembly
5	7D021	Intermediate Servo Piston and Rod Assembly
6	7330	Intermediate Band Servo Lever
7	7D029	Intermediate Band Apply Strut
8	7D430	Intermediate Band Anchor Strut

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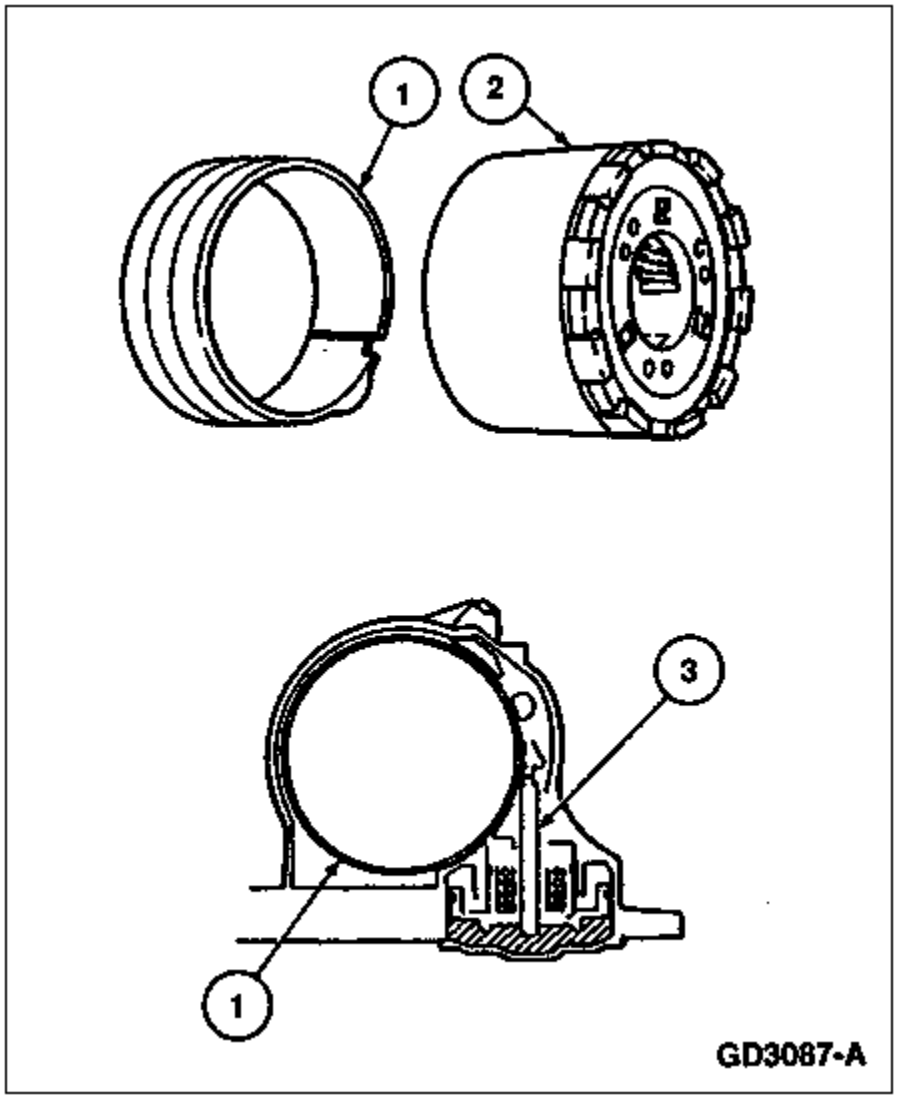
9	7C492	Intermediate Band Adjuster/Lock Screw

Bands — Low/Reverse

Hydraulic pressure is applied to the front side of the reverse servo. This pressure causes the servo to stroke and apply force to the reverse band, causing the reverse brake drum to be held.

The reverse band holds the reverse brake drum to the case in manual 1st and reverse gears. This causes the reverse planetary assembly to be held stationary.



Item	Part Number	Description
1	7D095	Low/Reverse Band Assembly
2	7C498	Low/Reverse Brake Drum Assembly
3	7D189	Low/Reverse Servo Piston Assembly

Clutches — Coast

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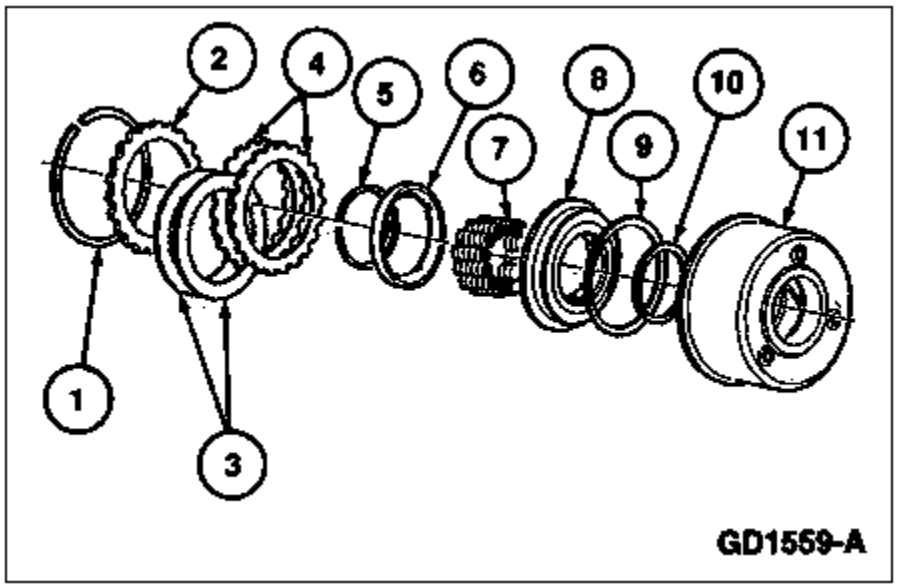
The coast clutch is a multi-disc clutch made up of steel and friction plates. The coast clutch is applied with hydraulic pressure and disengaged by return springs and exhaust of the hydraulic pressure. It is housed in the overdrive brake and coast clutch drum. The coast clutch is applied when the transmission control switch (TCS) is on and hydraulically applied in 2 and 1 positions. When the coast clutch is applied, it holds the planetary gear overdrive carrier and disengages the overdrive one-way clutch preventing overrunning. This uses engine compression to help slow the vehicle and provide engine braking.



Item	Part Number	Description
1	E860126-S/129-S	Retaining Ring (Select Fit)
2	7B066	Coast Clutch Pressure Plate
3	7B164	Coast Clutch Internal Plate — Friction (2 Req'd)
4	7B442	Coast Clutch External Plate — Steel (2 Req'd)
5	E860125-S	Retaining Ring
6	7A527	Coast Clutch Piston Spring Retainer
7	7A480	Coast Clutch Piston Spring (20 Req'd)
8	7A258	Coast Clutch Piston
9	7A548	Coast Clutch Piston Outer Seal Ring
10	7D404	Coast Clutch Piston Inner Seal Ring
11	7L669	Overdrive Brake and Coast Clutch Drum Assembly

Clutches — Direct

The direct clutch is a multi-disc clutch made up of steel and friction plates. The direct clutch is applied with hydraulic pressure and disengaged by return springs and exhaust of the hydraulic pressure. It is housed in the intermediate brake and direct clutch drum. The intermediate brake and direct clutch drum provides two functions. In drive, the direct clutch is applied and coupled to the forward clutch in 3rd and 4th gears. This drives the input shell and forward sun gear at a ratio of 1:1.

In reverse, the direct clutch is applied and coupled to the forward clutch and input shell. Since the forward

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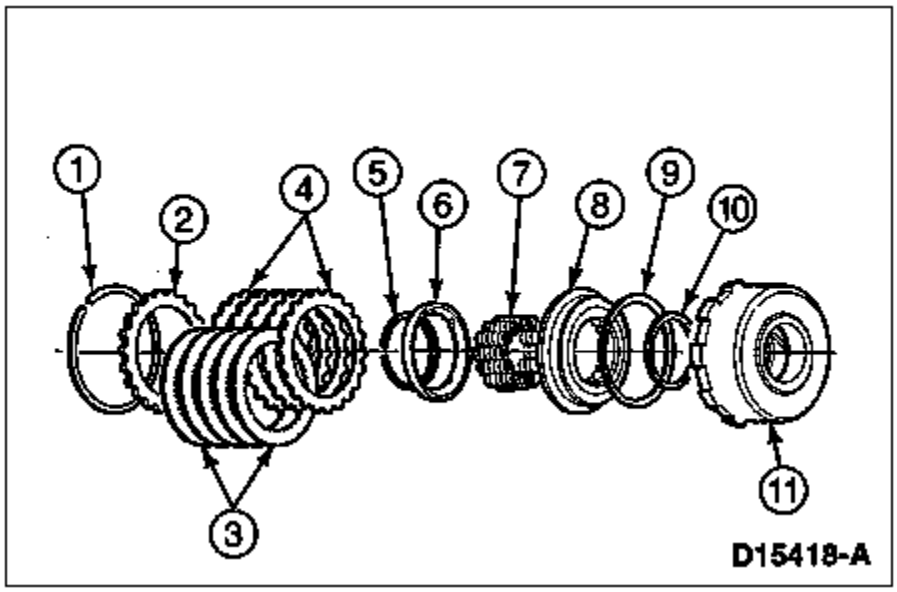
sun gear is splined to the input shell, this causes the forward sun gear to drive the pinions of the reverse planetary assembly that is being held by the reverse band in reverse rotation. This in turn drives the output shaft ring gear and hub at a ratio of 2.1:1.



Item	Part Number	Description
1	E860126-S/129-S	Retaining Ring (Select Fit)
2	7B066	Direct Clutch Pressure Plate
3	7B164	Direct Clutch Internal Plate — Friction (4 Req'd)
4	7B442	Direct Clutch External Plate — Steel (4 Req'd)
5	E860125-S	Retaining Ring
6	7A527	Direct Clutch Piston Springs Retainer (8 Tabs)
7	7A480	Direct Clutch Piston Spring (20 Req'd)
8	7A258	Direct Clutch Piston
9	7A548	Direct Clutch Piston Outer Seal Ring
10	7D404	Direct Clutch Piston Inner Seal Ring
11	7D044	Intermediate Brake and Direct Clutch Drum Assembly

Clutches — Forward

The forward clutch is a multi-disc clutch made up of steel and friction plates. The forward clutch is applied with hydraulic pressure and disengaged by return springs and exhaust of the hydraulic pressure. The forward clutch is applied in all forward gears and driven by the center shaft. The forward clutch also holds and drives the forward ring gear and hub when hydraulically applied.

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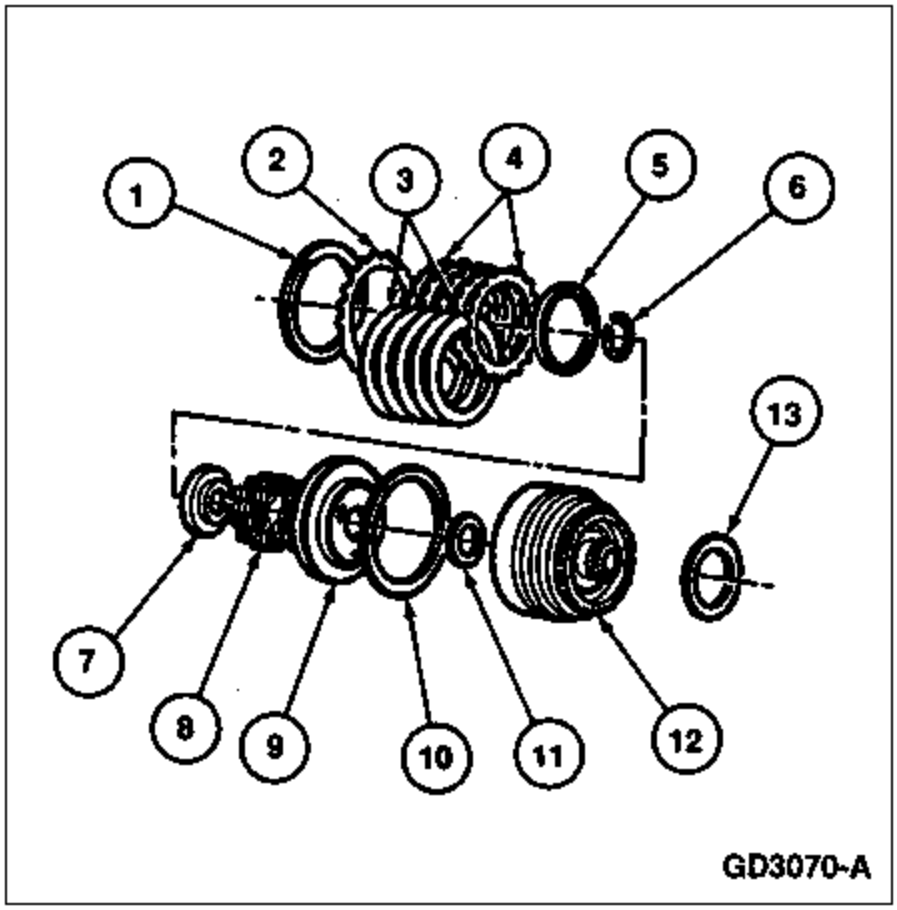

Item	Part Number	Description
1	E860115-S/118-S	Retaining Ring (Select Fit)
2	7B066	Forward Clutch Pressure Plate
3	7B164	Forward Clutch Internal Plate — Friction
4	7B442	Forward Clutch External Plate — Steel
5	7B070	Forward Clutch Cushion Spring
6	E860109-S	Retaining Ring
7	7A527	Forward Clutch Piston Spring Retainer
8	7A480	Forward Clutch Piston Spring (15 Req'd)
9	7A262	Forward Clutch Piston Assembly
10	7A548	Forward Clutch Piston Outer Seal Ring
11	7A548	Forward Clutch Piston Inner Seal Ring
12	7A360	Forward Clutch Cylinder Assembly
13	7M153	No. 5 Forward Clutch Cylinder Thrust Bearing

One-Way Clutches — Overdrive

The overdrive one-way clutch is a sprag-type one-way clutch that is pressed into the overdrive center shaft.

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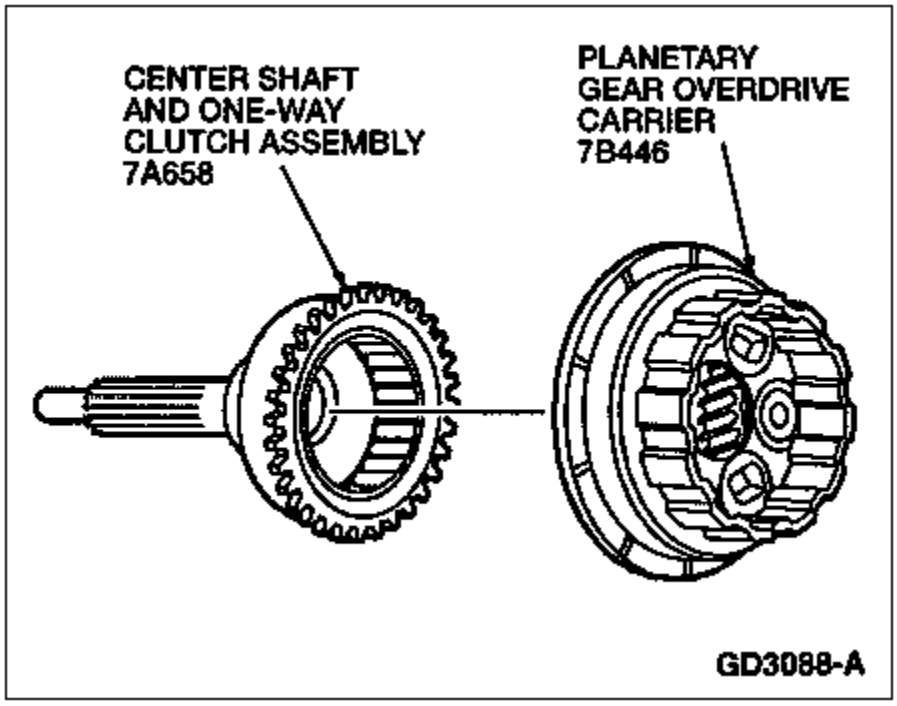
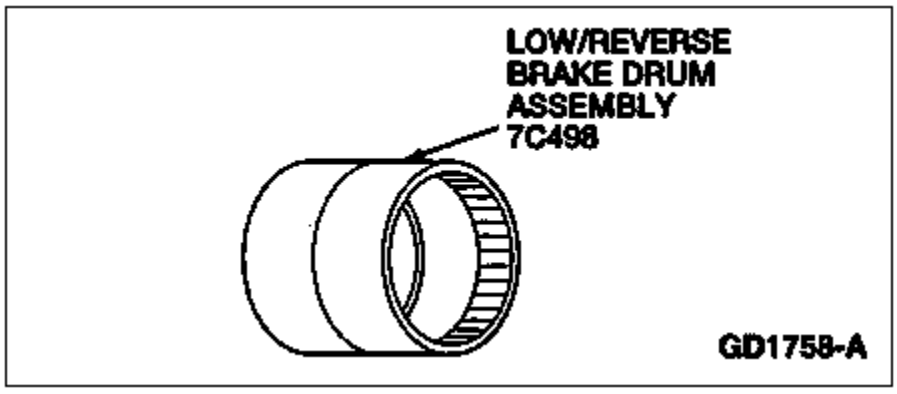
The overdrive one-way clutch is driven by the inner race of the overdrive planetary gear carrier. The overdrive one-way clutch holds and drives the outer race of the center shaft in 1st, 2nd, 3rd and reverse gears.

The overdrive one-way clutch overruns during all coast operations and is always overrunning in 4th gear.



One-Way Clutches — Low

The 2.3L and 3.0L use a spring and roller one-way clutch. The low one-way clutch holds the low/reverse brake drum and reverse planetary assembly to the case in 1st gear only and overruns in all other gears.



Hydraulic System

Pump

The fluid pump provides the fluid pressure required to charge the torque converter, main control assembly, transmission cooling system, lubrication system and apply devices.

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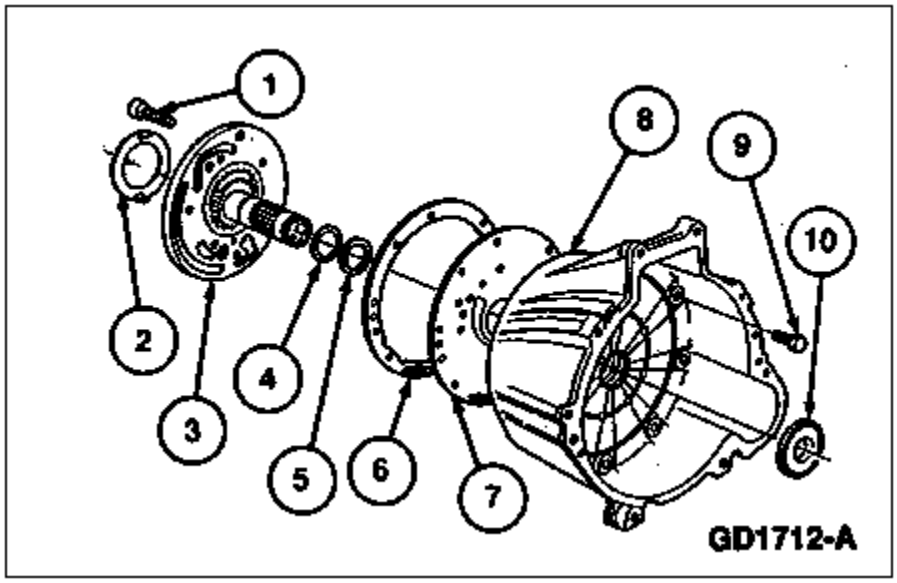
The 4R44E has a positive displacement gear and crescent-type pump which is shaft-driven by the torque converter cover.



Item	Part Number	Description
1	W701429-S309M	Fluid Pump-to-Converter Housing Screws (6 Req'd)
2	7D014	No. 1 Fluid Pump Input Thrust Washer (Nylon)
3	7A103	Fluid Pump Support and Gear Assembly
4	W701431-S300	Fluid Pump Shaft-to-Inner Gear O-Ring
5	7L323	Fluid Pump Support Seal Ring
6	7A136	Fluid Pump Gasket
7	7B472	Fluid Pump Adapter Plate
8	7976	Converter Housing Assembly
9	E804595-S200 (8 Req'd)	Converter Housing-to-Case Screw and Seal Assembly
10	7A248	Converter Hub-to-Converter Housing Seal Assembly

Filter

All fluid drawn from the pan passes through the fluid filter. The fluid filter and its accompanying seals are part of the fluid path to the fluid pump.

The fluid filter also has a bypass section. This allows the fluid which is vented at the main regulator valve to be recirculated to the pump without passing through the filtering element.

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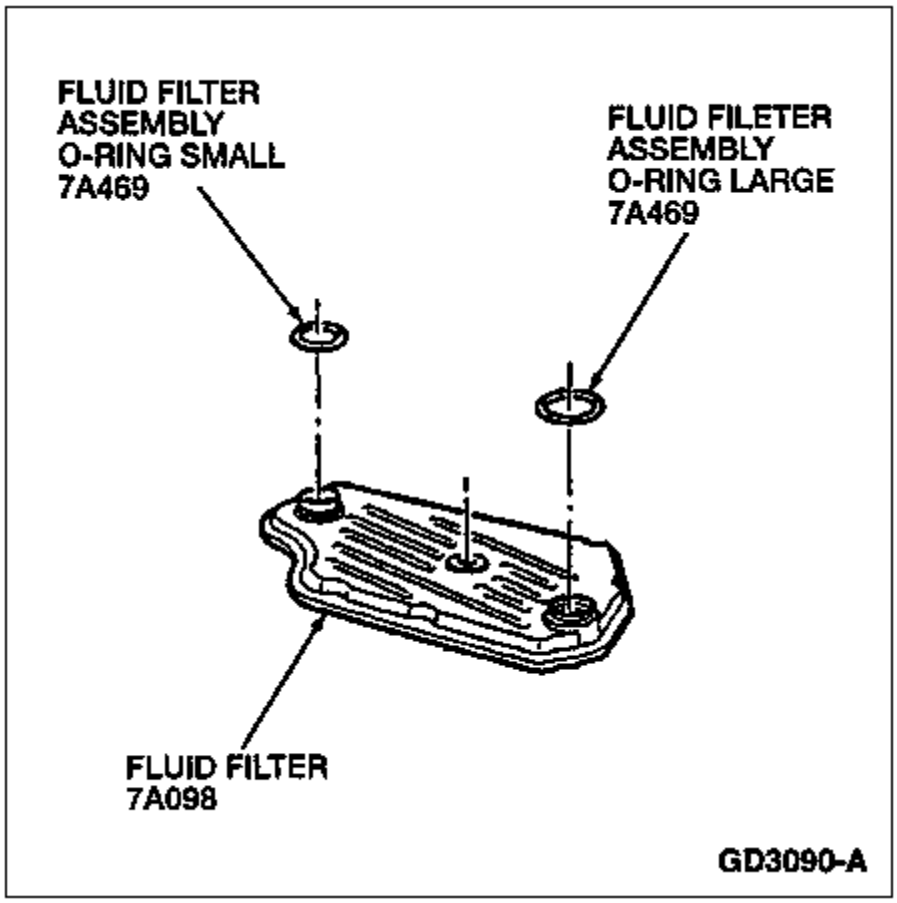

Main Control

The main control assembly and related components are part of the pressure side of the 4R44E hydraulic system. The main control assembly consists of the solenoids, the valve body assembly and the separator plate.

All valves inside the main control assembly are anodized aluminum. They cannot be sanded, filed or dressed in any way that may damage the valve surface. If the valves have any scratches, burrs or nicks that prevent free movement, the main control assembly must be replaced.

Main Control Assembly

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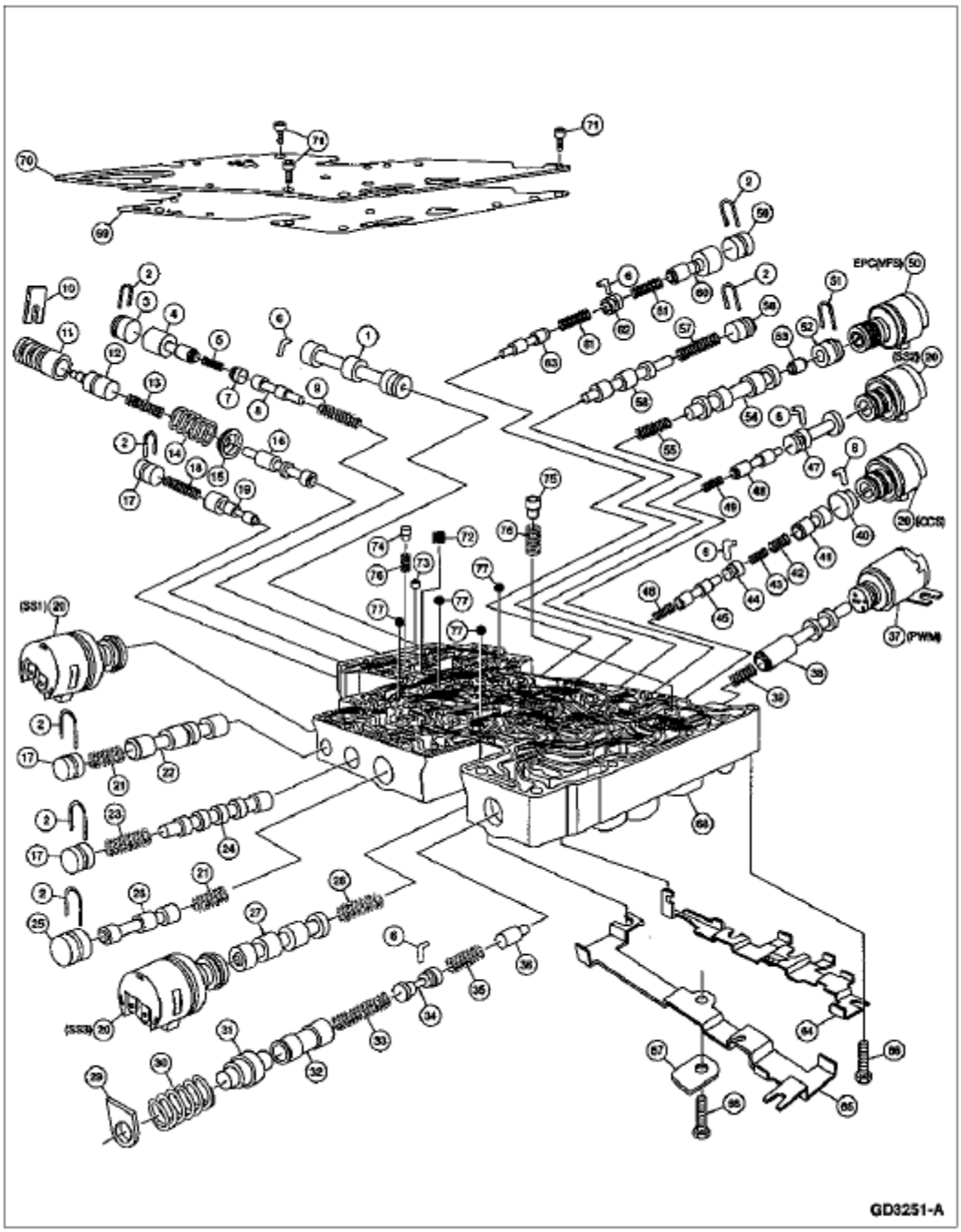

Item	Part Number	Description
1	—	Valve Manual
2	7E335	Retainer — Valve Plug (7 Req'd)
3	—	Plug — Valve Retainer
4	—	Valve — Forward Modulator
5	—	Spring — Forward Modulator
6	7E335	Retainer — Valve Plug (6 Req'd)
7	—	Plug — Valve Retainer

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8	—	Valve — EPC Boost
9	—	Spring — EPC Boost
10	7E336	Retainer — Valve Plug
11	—	Sleeve — Pressure Boost Valve
12	—	Valve — Pressure Boost
13	—	Spring — Pressure Boost
14	—	Spring — Oil Pressure Regulator
15	—	Retainer — Main Regulator Spring
16	—	Valve — Pressure Regulator
17	—	Plug — Valve Retainer (3 Req'd)
18	—	Spring — Forward Engagement
19	—	Valve — Forward Engagement Control
20	7G484	Solenoid — Shift (4 Req'd)
21	—	Spring — 3-2 (K.D./T.D.) (2 Req'd)
22	—	Valve — 3-2 (K.D.)
23	—	Spring — Manual Low (1)
24	—	Valve — Manual Low (1)
25	—	Plug — Valve Retainer
26	—	Valve — 3-2 (T.D.)
27	—	Valve — 3-4 Shift
28	—	Spring — 3-4 Shift
29	7E366	Retainer — Valve Plug
30	—	Spring — Thermostat Bypass
31	—	Valve — Thermostat Bypass
32	—	Valve — Thermostatic Bypass
33	—	Spring — Thermostat Bypass
34	—	Plug — Valve Retainer
35	—	Spring — Cooler Limit
36	—	Valve — Cooler Limit
37	7G136	Solenoid — Torque Converter Clutch (TCC)
38	—	Valve — Converter Clutch
39	—	Spring — Converter Clutch
40	—	Plug — Valve Retainer
41	—	Valve — Converter Clutch
42	—	Spring — Converter Clutch
43	—	Spring — Converter Clutch (3.0L and 4.0L Only)
44	—	Plug — Valve Retainer
45	—	Valve — Coast Clutch
46	—	Spring — Coast Clutch

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	—	Plug — Valve Retainer
48	—	Valve — 3-2 Downshifts
49	—	Spring — 3-2 Downshifts
50	7G383	Solenoid — EPC (VFS)
51	7E335	Retainer — Valve Plug
52	—	Plug — Valve Retainer
53	—	Valve — 1-2 Shift
54	—	Valve — 1-2 Shift
55	—	Spring — 1-2 Shift
56	—	Plug — Valve Retainer
57	—	Spring — 2-3 Shift
58	—	Valve — 2-3 Shift
59	—	Plug — Valve Retainer
60	—	Valve — Reverse Modulation
61	—	Spring — Reverse Modulation (2 Req'd)
62	—	Plug — Valve Retainer
63	—	Valve — Reverse Modulation
64	7L491	Clamp — SS1/SS2
65	7L491	Clamp — SS3/CCS/EPC/TCC
66	E800155-S72	Screw — Retain Solenoid Clamps (2 Req'd)
67	7D132	I.D. Plate
68	—	Body — Valve
69	7D100	Gasket — Separator Plate
70	7A008	Plate — Separator
71	E804357-S	Screw — Retain Separator Plate (3 Req'd)
72	7N113	Screen — EPC Limit Circuit
73	7D376	Extension Housing Lube Orifice
74	7E368	Valve EPC Limit (Metal)
75	7E368	Valve Converter Relief (Plastic)
76	7E340	Spring — EPC Limit/Converter Relief (2 Req'd)
77	7E195	Ball (4 Req'd)

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Transmission Electronic Control System

Electronic System Description

Shift scheduling, timing and feel (line pressure), as well as torque converter clutch (TCC) operation in the 4R44E are controlled electronically by the powertrain control module (PCM).

Input signals from various engine sensors give the PCM information about the engine's operating state. Other inputs are based on driver demands, such as the accelerator pedal position, which is monitored by the PCM using the throttle position (TP) sensor. Inputs are also supplied by the transmission itself. The turbine shaft speed (TSS) sensor and the transmission fluid temperature (TFT) sensor supply information to the PCM.

Using these input signals, the PCM can determine when the time and conditions are right for a shift or TCC application. The PCM controls six solenoids: three ON/OFF solenoids for upshifts and downshifts, one for pulse-width modulated control of the torque converter clutch, one for electronic line pressure control, and one ON/OFF solenoid for coast clutch application.

Component Locator

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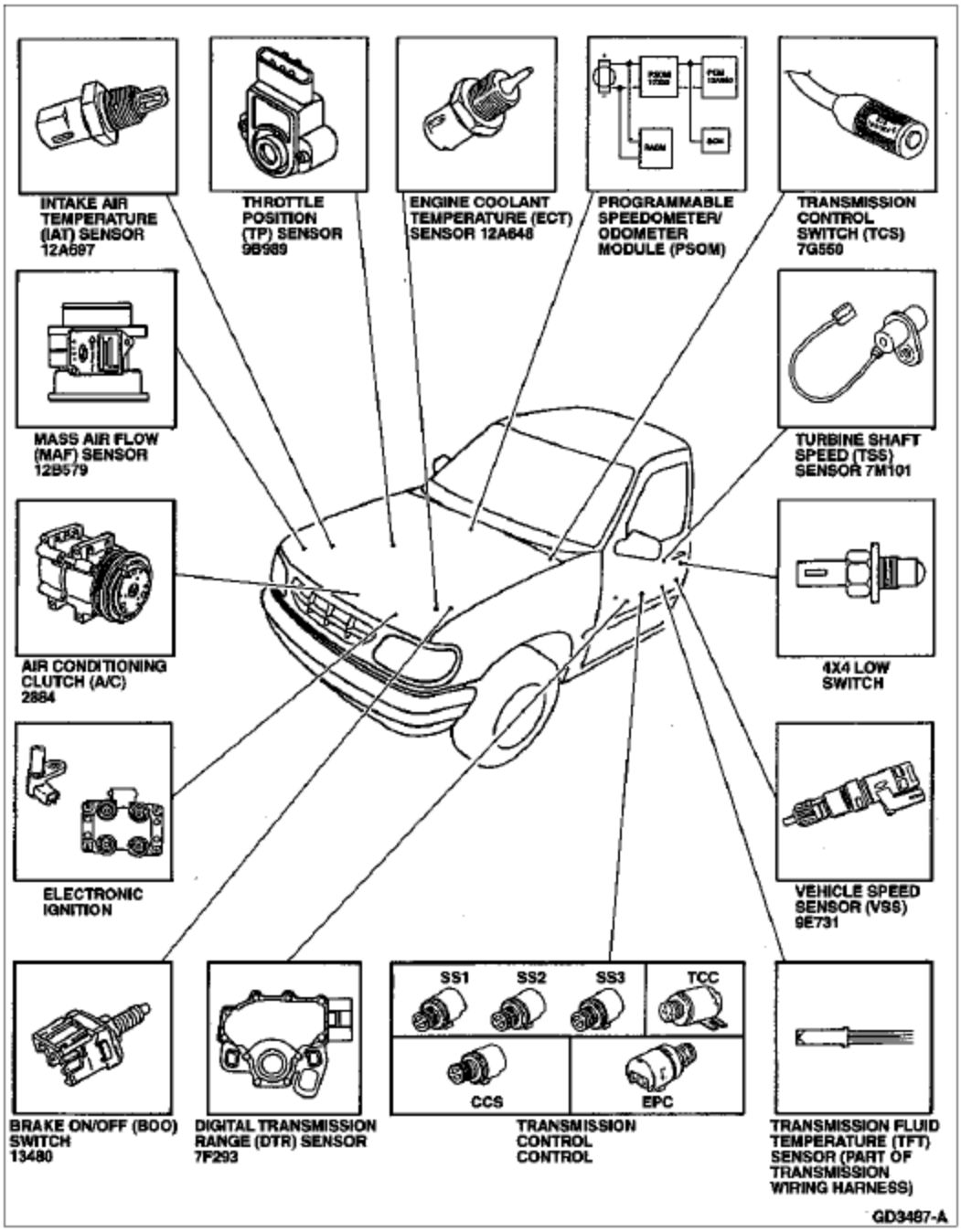

Powertrain Control Module (PCM) 12A650:

Description:
The powertrain control module (PCM) controls various engine functions and provides control of the 4R44E transmissions.
The PCM responds to inputs and operates solenoids for electro-hydraulic control of line pressure, shift scheduling, torque converter clutch (TCC) scheduling and coast clutch control for coast braking.
The PCM has the ability to:

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- Monitor its input and output devices for the presence of faults.
- Store diagnostic trouble codes (DTCs) related to detected faults.
- Alert the driver for some detected faults by turning on the malfunctioning indicator lamp (MIL) in the instrument cluster.
- Display information when a service technician connects diagnostic equipment.

Diagnostic Trouble Codes:

P0603, P0605.

Air Conditioning (A/C) Clutch 2884:

Description:

An electro-magnetic air conditioning (A/C) clutch is energized when the clutch cycling pressure switch closes. The switch is located on the suction accumulator-drier. The closing of the switch completes the circuit to the clutch and draws it into engagement with the compressor driveshaft.

When engaged, the A/C clutch is an input to the PCM to adjust electronic pressure control (EPC) pressure for the additional load on the engine. It is also used to adjust TCC modulation when the A/C clutch is engaged.

Symptoms:

Failed ON — EPC pressure slightly low with A/C off.
Failed OFF — EPC pressure slightly high with A/C on. If erratic A/C operation occurs, the customer may feel improper TCC apply and release.

Diagnostic Trouble Codes:

P1460.

Brake On/Off (BOO) Switch 13480:

Description:

The brake on/off (BOO) switch is connected to the brake pedal. When the brake pedal is pressed, the BOO switch has closed contacts allowing a voltage signal to the PCM.

The PCM may release TCC when the brakes are applied.

Symptoms:

Failed ON — converter clutch will not engage at less than 1/3 throttle.
Failed OFF or not connected — converter clutch will not disengage when brake is applied.

Diagnostic Trouble Codes:

P1703.

Engine Coolant Temperature (ECT) Sensor 12A648:

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Description:
The engine coolant temperature (ECT) sensor detects the temperature of engine coolant and supplies the information to the PCM.
The ECT sensor is threaded into the heater outlet fitting or cooling passage on the engine. For automatic transmission applications, the ECT is used to control TCC solenoid operation. For engine control applications, the ECT signal is used to modify ignition timing, exhaust gas recirculation (EGR) flow, and air-to-fuel ratio as a function of engine coolant temperature. On electronic instrument cluster applications, the ECT output is used to control a coolant temperature indicator.
Symptoms:
Torque converter clutch solenoid will always be "off," resulting in reduced fuel economy.
Diagnostic Trouble Codes:
P0117, P0118, P1116, P1117.

Electronic Ignition (EI) System:

Description:
The electronic ignition (EI) system has a crankshaft position (CKP) sensor and ignition coil packs. The CKP sensor sends crankshaft position information to the PCM. The rpm signal in the transmission strategy is then used for torque converter clutch control, EPC and shift scheduling.
Symptoms:
Engine malfunction, no torque converter clutch engagement.
Diagnostic Trouble Codes:
P0300-P0306, P0320, P0340, P1351-P1364.

4x4 Low (4x4L) Switch:

Description:
The low range switch is located on the transfer case cover. It provides an indication of when the 4x4 transfer case gear system is in the low range.
NOTE: Not all 4x4L switch concerns will set a DTC. Refer to Diagnosis by Symptom or pinpoint tests if shifts are delayed in 4x4L or shift early in normal mode.
Transmission Function:
Modifies shift schedule for 4x4L transfer case gear ratio.
Symptoms:
Failed on — Early shift schedule in 4x2 and 4x4H. Failed off — Shifts delayed in 4x4L. If the 4x4 low indicator light fuse is blown, the transmission will shift according to 4x4 low shift schedule regardless of transfer case position.
Diagnostic Trouble Codes:
P1781, P1729.

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Intake Air Temperature (IAT) Sensor 12A697:

Description:
The intake air temperature (IAT) sensor is used to determine the EPC pressure. It also provides the electronic fuel injection system with mixture (fuel and air) temperature information. The IAT is used both as a density corrector for airflow calculation and to proportion the cold enrichment fuel flow. This sensor is similar in construction to the engine coolant temperature (ECT) sensor, except it is packaged to improve sensor response time.
Symptoms:
Incorrect EPC pressure either high or low resulting in either harsh or soft shifts.
Diagnostic Trouble Codes:
P0112, P0113, P0114.

Mass Air Flow (MAF) Sensor 12B579:

Description:
The mass air flow (MAF) sensor directly measures the mass of the air flowing into the engine. The sensor output is a DC (analog) signal ranging from about 0.5 volts to 5.0 volts used by the processor to calculate the injector pulse width for stoichiometry. For transmission strategies, this sensor is used for EPC pressure control, shift, and torque converter clutch scheduling.
Symptoms:
Incorrect shift schedule, high/low EPC pressure. Incorrect torque converter engagement scheduling and symptoms similar to a throttle position (TP) sensor malfunction. Soft or firm shift based on EPC/line pressure. Soft shifts may be caused by a restricted air inlet.
Diagnostic Trouble Codes:
P0102, P0103, P1100, P1101.

Transmission Control Switch (TCS) 7G550:

Description:
The transmission control switch (TCS) is a momentary contact switch. When the driver presses the button of the TCS, a signal is sent to the PCM. At the same time, the PCM also causes the transmission control indicator lamp (TCIL) in the instrument panel to turn on or off.
When the TCS is initially pressed, the PCM disables transmission operation in D position/4th gear. At the same time, coast braking in 2nd gear and 3rd gear occurs because the coast clutch is applied.
When the button of the TCS is pressed again, the PCM enables 4th gear operation, releases the coast clutch and turns off the TCIL.
Symptoms:

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If the TCS fails with open contacts, no disabling of 4th gear and enabling of coast braking in 2nd and 3rd gear in D position is possible.
Diagnostic Trouble Codes:
P1780.

Transmission Control Indicator Lamp (TCIL):

Description:
The transmission control indicator lamp (TCIL) is located in the instrument panel for Ranger and on the end of the shift lever for Aerostar. It is labeled O/D OFF. The transmission control switch (TCS) and the PCM control the on/off operation of the TCIL.
When the driver initially presses the button of the TCS, the TCIL turns on to indicate that transmission operation in 4th gear is disabled. When the driver presses the TCS again, the TCIL turns off. The TCIL will flash if the EPC solenoid is shorted or a monitored sensor has failed.
Symptoms:
If the TCIL fails on or off, the driver may have an incorrect indication of transmission operation or monitored sensor malfunction.
Diagnostic Trouble Code:
N/A.

Throttle Position (TP) Sensor 9B989:

Description:
The throttle position (TP) sensor is a potentiometer mounted on the throttle body. The TP sensor detects the position of the throttle plate and sends this information to the processor assembly as varying voltage signal.
The PCM uses the monitored voltage level of the TP sensor for control of EPC pressure, torque converter clutch operation and shift scheduling.
If a malfunction occurs in the TP sensor circuit, the processor will recognize that the TP sensor signal is out of specification. The processor will then operate the transmission in a high capacity mode to prevent transmission damage.
Symptoms:
Harsh engagements, firm shift feel, abnormal shift schedule, torque converter clutch does not engage, or torque converter clutch cycling.
Diagnostic Trouble Codes:
P0121-P0123, P1120, P1121, P1124, P1125.

Programmable Speedometer/Odometer Module (PSOM):

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The programmable speedometer/odometer module (PSOM) receives input from the rear brake anti-lock sensor, which is mounted on the rear axle differential housing. The PSOM processes this input signal information and relays it to the powertrain control module and the speed control module. This signal tells the powertrain control module the vehicle speed in miles per hour (mph). The PSOM is also used as an input in determining shift scheduling and electronic pressure control.
Symptoms:
Harsh engagements, firm shift feel, abnormal shift schedule, unexpected downshifts may occur at closed throttle. Torque converter clutch will not engage, elevated EPC pressures.
NOTE: EPC shorted to ground or failed low may result in a false VSS code. Diagnose EPC concerns first. Then recheck VSS input and PSOM.
Diagnostic Trouble Codes:
P0500, P1500, P1501.

Vehicle Speed Sensor (VSS) 9E731:

Description:
The vehicle speed sensor (VSS) is a magnetic pickup that sends a signal to the processor assembly. This VSS signal tells the processor assembly the vehicle speed.
The PCM uses this information to control shift scheduling and EPC pressure.
Symptoms:
Harsh engagements, firm shift feel, abnormal shift schedule, unexpected downshifts may occur at closed throttle. Torque converter clutch will not engage, elevated EPC pressures.
NOTE: EPC shorted to ground or failed low may result in a false VSS code. Diagnose EPC concerns first. Then recheck VSS.
Diagnostic Trouble Codes:
P0500, P1500, P1501.

Transmission Fluid Temperature (TFT) Sensor:

Description:
The transmission fluid temperature (TFT) sensor is located on the transmission main control body wiring harness assembly. It is a temperature-sensitive device called a thermistor. The resistance value of the TFT will vary with temperature change. The processor monitors the voltage across the TFT to determine the temperature of the transmission fluid.
The processor assembly uses this initial signal to determine whether a cold start shift schedule is necessary. The cold start shift schedule allows quicker shifts when the transmission fluid temperature is cold. The processor also inhibits torque converter clutch operation at low transmission fluid temperatures and corrects EPC pressures for temperature.
Symptoms:
Torque converter clutch engagement and stabilized shift schedules happen too soon after a cold start.

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Harsh or soft shifts.
Diagnostic Trouble Codes:
P0712, P0713, P1711, P1783.

Digital Transmission Range (DTR) Sensor 7F293:

Description:
The digital transmission range (DTR) sensor is located on the outside of the transmission at the manual lever. The DTR sensor completes the start circuit in Park and Neutral, the back-up lamp circuit in Reverse and the neutral sense circuit (4x4 only) in Neutral. The DTR sensor also sends a digital output signal to the powertrain control module (PCM) indicating the position of the manual lever (P, R, N, D, 2, 1).
Symptoms:
Engagement concerns, wrong gear, no shifts, increase in EPC pressure.
Diagnostic Trouble Codes:
P0705, P0708, P1705, P1704.

Turbine Shaft Speed (TSS) Sensor 7M101:

Description:
A turbine shaft speed (TSS) sensor is a magnetic pickup that sends a signal to the processor assembly that indicates transmission turbine shaft input speed.
The TSS sensor provides torque converter turbine speed information for torque converter clutch control strategy. Also used in determining static EPC pressure settings.
Symptoms:
Increased engine rpm on engagements, harsh shifts (converter engaged), delayed shifts with hard apply (slip/bump feel).
Diagnostic Trouble Codes:
P0715.

Electronic Pressure Control (EPC) Solenoid 7H144:

Description:
The electronic pressure control (EPC) solenoid is a variable force style (VFS) solenoid. The VFS type solenoid is an electro-hydraulic actuator combining a solenoid and a regulating valve. It supplies EPC which regulates transmission line pressure and line modulator pressure. This is done by producing resisting forces to the main regulator and line modulator circuits. These two pressures control clutch application pressures.

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Symptoms:
Maximum EPC pressure, harsh shifts and engagements, **may set a false VSS code.** Zero EPC pressure — no 2nd and 4th gear, slips in 1st and 3rd with high input torque.
Diagnostic Trouble Codes:
P1746*, P1747*.
*Output circuit check, generated only by electrical conditions.

Torque Converter Clutch (TCC) Solenoid 7F037:

Description:
The torque converter clutch (TCC) solenoid is used in the transmission control system to control the application, modulation, and release of the torque converter clutch.
Symptoms:
Failed ON — engine runs rough/vehicle shudder, engine stalls in Drive at low idle speeds (1st, 2nd, 3rd, or 4th gear). Failed OFF — torque converter never engages.
Diagnostic Trouble Codes:
P0743*, P1744**.
*Output circuit check, generated only by electrical conditions.
**May also be generated by a non-electrical transmission hardware condition.

Coast Clutch Solenoid (CCS) 7G484:

Description: The coast clutch solenoid (CCS) is an on/off solenoid.
The PCM uses the coast clutch solenoid to control the apply and release of the coast clutch.
Symptoms:
If the coast clutch solenoid fails ON, coast braking occurs in all gears (except in 4th gear).
If the coast clutch solenoid fails OFF, no effect will be apparent.
Diagnostic Trouble Codes:
P1754*.

Shift Solenoid Assemblies (SS1, SS2, SS3) (7G484):

Description:
Three on/off solenoids are used for electronically controlled shift scheduling. The three solenoids are located on the main control assembly. The solenoids are two-way, normally open style.

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Solenoids SS1, SS2, and SS3 provide gear selection of 1st through 4th by controlling the pressure of the three shift valves.
SS1 Symptoms:
Improper gear selection depending on failure mode and manual lever position. Failed ON — 1st and 2nd. Failed OFF — 2nd, 3rd and 4th gears only.
Diagnostic Trouble Codes:
P0750*, P0751**, P0731**, P0732**, P0733**, P0734**.
SS2 Symptoms:
Improper gear selection depending on failure mode and manual lever position. Failed ON — 2nd gear only. Failed OFF — 1st, 3rd and 4th gears only.
Diagnostic Trouble Codes:
P0755*, P0756**, P0731**, P0732**, P0733**, P0734**.
SS3 Symptoms:
Improper gear selection depending on failure mode and manual lever position. Failed ON — No engine braking, 4th gear and incorrect gear ratios. Failed OFF — 1st, 2nd, 3rd only.
Diagnostic Trouble Codes:
P0760*, P0761**, P0733**, P0734**.
*Output circuit check, generated only by electrical conditions.
**May also be generated by a non-electrical transmission hardware condition.

SHIFT SOLENOID OPERATION CHART — 4R44E

Transmission Range Selector Lever Position	Powertrain Control Module (PCM) Gear Commanded	4R44E Solenoid States				
		Engine Braking	SS1	SS2	SS3	CCS
P/N	P/N	No	On	Off	Off	Off
R	R	Yes [1]	On	Off	Off	O/W [1]
(D) (Overdrive)	1 2 3 4	No No No No	On On Off Off	Off On Off Off	Off Off Off On	Off Off Off Off
(D) [1]	1 2 3	Yes Yes Yes	On On Off	Off On Off	Off Off Off	On On On
Manual 2	2	Yes	On	On	Off	On
Manual 1	1	Yes	On	Off	Off	On

[1] O/W=TCS "ON"

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Diagnostic Strategy

Troubleshooting an electronically controlled automatic transmission is simplified by using the proven method of diagnosis. One of the most important things to remember is that there is a definite procedure to follow.

NOTE: Do not take any short cuts or assume that critical checks or adjustments have already been made.

Follow the procedures as written to avoid missing critical components or steps.

To properly diagnose a concern the technician should have the following publications available:

- Service Manual
- Transmission Reference Manual
- Powertrain Control/Emissions Diagnosis (PC/ED) Manual
- OASIS Messages
- Technical Service Bulletins (TSBs)
- Electrical/Vacuum Troubleshooting Manual (EVTM)

These publications provide the information required when diagnosing transmission concerns.

Using the Diagnostic Flow Chart as a guide, follow the steps as indicated.

Preliminary Inspection

- Know and understand the customer's concern.
- Verify the concern by operating the vehicle.
- Check the fluid level and condition.
- Check for non-factory add-on items.
- Check shift linkages for proper adjustment.
- Check TSBs and OASIS messages for the concern.

Diagnostics

- Perform On-Board Diagnostic Procedures, key on engine off (KOEO), key on engine running (KOER).
- Record all diagnostic trouble codes (DTCs).
- Repair all non-transmission codes first.
- Repair all transmission codes second.
- Erase all continuous codes and attempt to repeat them.
- Repair all continuous codes.
- If only pass codes, proceed to Diagnosis By Symptom Charts for further information and diagnosis.

By following the diagnostic sequence the service technician will be able to diagnose and repair the concern the first time.

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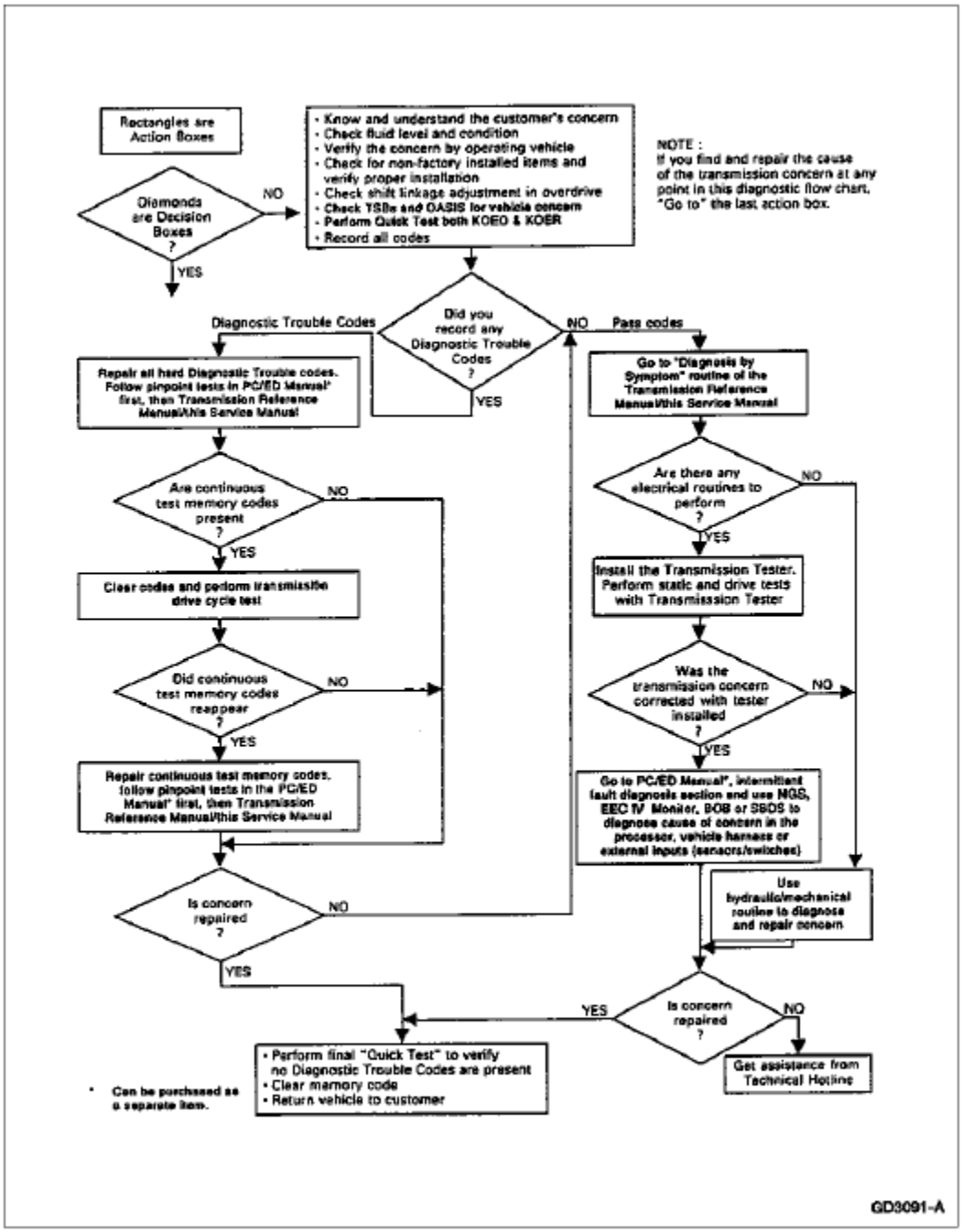
Diagnostic Flow Chart



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Preliminary Inspection

The following items must be checked before proceeding.

Know and Understand the Concern

This section provides information which must be used in determining the actual cause of customer concerns and performing the appropriate service procedures.

Verification of Condition

The following procedures must be used when verifying customer concerns for the transmission.

Required Equipment

Required equipment to diagnose the 4R44E transmission consists of:

- Rotunda Transmission Tester 007-00130, part of Rotunda Transmission Tester Kit, or equivalent.
- Rotunda New Generation STAR (NGS) Tester 007-00500 or equivalent.
- Rotunda EEC-V 104-pin Breakout Box 014-00950 or equivalent.
- Rotunda 73 Digital Multimeter 105-R0051 or equivalent.
- Rotunda Transmission Range (TR) Sensor Cable "E" 007-00111 or equivalent.
- Digital TR Sensor Overlay 007-00131, used with Rotunda Transmission Range (TR) Cable "E" 007-00111.
- Rotunda 4R44E/4R55E Overlay/Cable 007-00106, part of Transmission Tester Kit.

Determine Customer Concern

NOTE: If noise/vibration, check for dependencies: rpm, vehicle speed, shift, gear, range, or temperature.

NOTE: Some transmission conditions may cause engine concerns. The torque converter clutch not disengaging will stall the engine.

Determine customer concerns relative to vehicle usage and dependent driving conditions. Pay attention to the following items:

- Hot or cold vehicle operating temperature
- Hot or cold ambient temperatures
- Type of terrain
- Vehicle loaded/unloaded
- City/highway driving
- Upshift
- Downshift
- Coasting
- Engagement

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- Noise/vibration

Check Fluid Level and Condition

Fluid Level Check

NOTE: If the vehicle has been operating for an extended period at high speeds in city traffic during hot weather or pulling a trailer, the vehicle should be turned off for about 30 minutes to allow the oil to cool before checking.

Under normal circumstances, check the transmission fluid level during normal maintenance, it does not require a change. For severe duty only, change the fluid at 80,450 km (50,000 miles), since the vehicle does not use up transmission fluid. If the transmission is not working properly, or if there is some sign of fluid leakage, the fluid level should be checked.

It is preferable to check the transmission fluid level at normal operating temperature after approximately 32 km (20 miles) of driving. The fluid level can be checked without driving the vehicle if the outside temperature is above 10℃ (50℉).

With the vehicle on a level surface, start the engine and move the transmission range selector lever through all of the gear ranges, allowing sufficient time for each position to engage. Securely engage the transmission range selector lever in the Park position, fully set the parking brake control (2780) and leave the engine running.

Wipe off the fluid level indicator cap, pull thefluid level indicator (7A020) out and wipe the indicator end clean. Insert the fluid level indicator back into the oil filler tube (7A228) and make sure it is fully seated. Pull the fluid level indicator out and read the fluid level.

CAUTION: The vehicle should not be driven if the fluid level is below the bottom hole on the fluid level indicator and outside temperature is above 10°C (50℉).

When checking fluid at normal operating temperature, the fluid level should be within the crosshatched area on the fluid level indicator. When the vehicle has not been driven, and outside temperature is above 10°C (50℉), the fluid level should be between the holes in the fluid level indicator.

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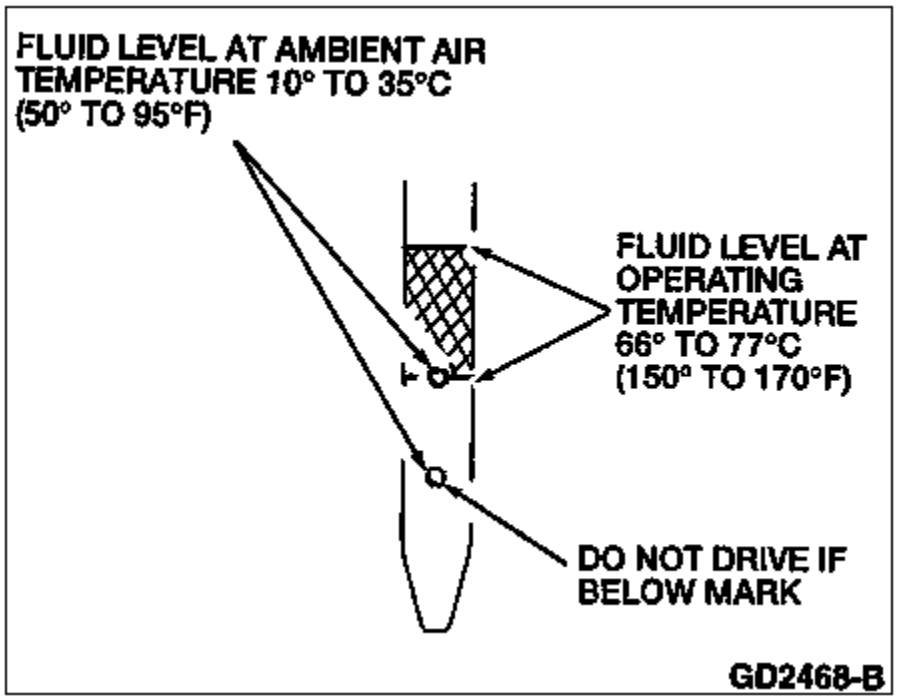

High or Low Fluid Level

CAUTION: If the fluid level is high, damage to the vehicle may occur. Excess fluid must be removed.

A fluid level that is too high may cause the fluid to become aerated due to the churning action of the rotating parts of the transmission. Aerated fluid will cause erratic line pressure, which may result in harsh/soft shifts or engagements, damage to the clutch materials, improper torque converter operation, and fluid coming out of the vent. Refer to Fluid Change — Drain/Refill in this section.

A fluid level that is too low will affect transmission operation, causing slipping, slow engagements, or damage to internal hardware. Low levels may also indicate that a leak is present in the fluid system. If the fluid level is low, add fluid using the procedures shown in Adding Fluid in this section.

Adding Fluid

CAUTION: Use of any fluid other than specified could result in transmission malfunction or failure.

Before adding any fluid, be sure that the correct type is used. MERCON V® XT-5-QM is stamped on the container.

Add fluid in 0.25L (1/2 pint) increments through the filler tube to bring the level to the correct area on the dipstick. If an overfill occurs, excess fluid must be removed.

Fluid Change — Drain/Refill

Normal maintenance and lubrication does not necessitate periodic automatic transmission fluid changes. For severe duty applications, change the fluid at 80,450 km (50,000 miles).

To remove excess fluid, disconnect the cooler feed line at the cooler. Attach a rubber hose to the line and

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insert the other end into a drain pan. Crank the engine for a short period of time (do not allow the engine to start) to remove a quantity of transmission fluid. Reattach the cooler line to the cooler. Start the engine. Move the transmission range selector lever through all gear ranges. Recheck the fluid for the proper level. Continue to add or subtract fluid until the proper level is reached. If a major service (e.g., clutch, band, bearing, etc.) is required, the unit will have to be removed. At this time, the torque converter (7902), transmission cooler, and cooler lines must be flushed to remove any contaminates. Refer to the Converter and Fluid Cooler Cleaning and Inspection procedure.

When used under severe duty conditions the transmission fluid filter/screen assembly should be replaced at 80,450 km (50,000 miles). The transmission fluid should be drained from the transmission and torque converter and refilled with MERCON V® XT-5-QM or equivalent MERCON® approved fluid as specified to the proper level.

When filling a dry transmission and torque converter, refer to Specifications for capacity. Check the fluid level as outlined.

Procedures for Drain and Refill

- Normal Maintenance
  - Not required with normal use.
- Severe Duty Maintenance
  - Change fluid at 80,450 km (50,000 miles) intervals using MERCON 5® XT-5-QM or equivalent.

CAUTION: Use only MERCON V® XT-5-QM transmission fluid. Use of any other fluids may result in a transmission malfunction or failure.

Maintenance Procedure

1. Loosen, then remove, the transmission fluid pan attaching screws to drain the fluid.
2. Remove and discard old pan gasket.
3. Thoroughly clean the pan and the transmission case pan rail surface.
4. Install new pan gasket onto pan and install pan to case with screws. Tighten screws to 13-15 Nm (115-133 lb-in).
5. Add 2.8 liters (3 quarts) of MERCON V® XT-5-QM or equivalent MERCON® approved fluid to transmission through the fill tube.
6. Start the engine. Move transmission range selector lever through all gear ranges, checking for engagements.
7. Check and adjust transmission fluid in 0.25 liter (1/2 pint) increments to proper level (cross-hatched area of fluid level indicator at normal operating temperature).

Major Service/Overhaul

1. Loosen, then remove, the transmission fluid pan attaching bolts to drain fluid.
2. Remove and discard old pan gasket.
3. Perform required internal repair and cleaning as required.

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4. Thoroughly flush torque converter, cooler lines and transmission in-tank radiator cooler and auxiliary cooler (if equipped).

5. Replace fluid filter and seal assembly.

6. Install cleaned pan and new pan gasket with screws. Tighten screws to 13-15 Nm (115-133 lb-in).

7. Add 3.7 liters (4 quarts) of MERCON V® XT-5-QM or equivalent MERCON® approved fluid to the transmission through the fill tube.

8. Start engine. Move the transmission range selector lever through all gear ranges, checking for engagements.

9. Check and adjust the transmission fluid level in 0.25 liter (1/2 pint) increments to the proper level (cross-hatched area of the fluid level indicator at normal operating temperature).

Fluid Condition Check

1. Check the fluid level. Refer to the Fluid Level Check for proper procedure.

2. Observe color and odor of the fluid. It should be red, not brown or black. Odor may indicate an overheating condition, clutch disc or band failure.

3. Use an absorbent white facial tissue and wipe the fluid level indicator. Examine the stain for evidence of solid particles and for engine coolant signs (gum or varnish on fluid level indicator) .

   If particles are present in the fluid or there is evidence of engine coolant or water, the transmission fluid pan (7A194) must be removed for further inspection.

   If fluid contamination or transmission failure is confirmed by further evidence of coolant or excessive particles in the transmission fluid pan, the transmission must be disassembled and completely cleaned and serviced. This includes cleaning and flushing the torque converter and transmission cooling system.

   During disassembly and assembly, all overhaul checks and adjustments of clearances and end play must be made.

   After the transmission has been serviced, all diagnostic tests and adjustments listed in the Diagnosis By Symptom Charts must be completed to make sure that the problem has been corrected.

Road Testing Vehicle

The Shift Point Road Test and Torque Converter Clutch Operation Test provide diagnostic information on transmission shift controls and torque converter operation.

Shift Point Road Test

This test verifies that the shift control system is operating properly.

1. Bring engine and transmission up to normal operating temperature.
2. Operate vehicle with transmission selector in (D) range.
3. Apply minimum throttle and observe speeds at which upshift occurs and torque converter engages. Refer to the following Shift Speeds chart. (Also refer to Automatic Transmission Specifications Issue

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FPS-12180-97.)

4. Stop the vehicle. Depress transmission control switch (TCS) to activate D range. Repeat Step 3. Transmission will make all upshifts except 3-4 and torque converter clutch apply should occur above 46 km/h (27 mph).
5. Press accelerator pedal to floor, wide open throttle (WOT). Transmission should shift from third to second, or third to first, depending on vehicle speed, and torque converter clutch should release.
6. With vehicle speed above 48 km/h (30 mph), move transmission range selector lever from D range to 1 range (LOW) and release accelerator pedal. Transmission should immediately downshift to second gear. When vehicle speed drops below 32 km/h (20 mph), transmission should downshift into first gear.
7. If transmission fails to upshift/downshift or torque converter clutch does not apply/release, refer to Diagnosis By Symptom Index for possible causes.

SHIFT SPEEDS — KM/H (MPH) [1]

Throttle Position	Range	Shift	KM/H (MPH) Range [1]
Closed Throttle	(D)	3-2	19-32 (12-20)
	(D)	2-1	10-23 (6-14)
Minimum Throttle	(D)	1-2	14-27 (9-17)
	(D)	2-3	26-43 (16-27)
	(D)	3-4	64-85 (40-53)
Part Throttle	(D)	1-2	29-47 (18-29)
	(D)	2-3	50-71 (31-44)
	(D)	3-4	89-116 (55-72)
	(D)	4-3	68-100 (43-62)
	(D)	3-2	40-61 (25-38)
Wide Open Throttle	(D)	1-2	53-72 (33-45)
	(D)	2-3	98-127 (61-79)
	(D)	3-2	93-119 (58-74)
	(D)	3-1, 2-1	47-66 (29-41)
Manual Pull-In	1	2-1	40-62 (25-38)

[1] Shift Speed Ranges are approximate for all applications. For specific applications (Engine, Axle Ratio and Application) refer to the Automatic Transmission Specification Issue FPS-12180-97.

Torque Converter Diagnosis

Prior to torque converter replacement all diagnostic procedures must be followed. This is to prevent the unnecessary replacement of good torque converters. Only after a complete diagnostic evaluation can the decision be made to replace the torque converter.

Begin with the normal diagnostic procedures as follows:

1. Preliminary inspection.
2. Know and understand the customer's concern.
3. Verify the concern.

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- Perform the Torque Converter Clutch Operation Test. Refer to the procedure in this section.

4. Perform diagnostic procedures.

    - Run on-board diagnostics. Refer to the procedure in this section.
        - Repair all non-transmission related DTCs first.
        - Repair all transmission DTCs.
        - Rerun on-board diagnostic to verify repair.
    - Perform Line Pressure Test . Refer to the procedure in this section.
    - Perform Stall Speed Test . Refer to the procedure in this section.
    - Diagnosis By Symptom Routines . Refer to the procedure in this section.
        - Use the index to locate the appropriate routine that best describes the symptom(s). The routine will list all possible components that may cause or contribute to the symptom. Check each component listed, diagnose and repair as required, before replacing the torque converter.

Torque Converter Operation Test

This test verifies that the torque converter clutch control system and the torque converter are operating properly.

1. Connect tachometer to engine.
2. Bring engine to normal operating temperature by driving vehicle at highway speeds for approximately 15 minutes in (D) range.
3. After normal operating temperature is reached, maintain constant vehicle speed of about 80 km/h (50 mph). Release throttle for about two seconds then reapply throttle to previous setting.
4. Engine rpm should increase when throttle is released and decrease in about five seconds (converter engagement) after throttle is reapplied. If this does not occur, refer to Torque Converter Clutch Operation Concerns in the Diagnosis By Symptom Index .

Visual Inspection

This inspection will identify malfunctions to the vehicle operating system that may affect diagnosis.

- Vehicle modification
- Electronic add-on items
    - Air conditioning
    - Generator (alternator)
    - Engine turbo
    - Cellular telephone
    - Cruise control
    - CB radio
    - Linear booster
    - Backup alarm signal
    - Computer
- Leaks — Refer to Leakage Inspection in this section.
- Proper linkage adjustments — Refer to Section 07-05 in this service manual.

These items, if not installed properly, will affect powertrain control module or transmission function. Pay particular attention to add-on wiring splices in the powertrain control module harness or transmission wiring harness, abnormal tire size, or axle ratio changes.

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After a road test, with the vehicle warm and before disturbing any connectors, perform the Quick Test using Rotunda New Generation STAR (NGS) Tester 007-00500 or equivalent. Refer to Section 4A in the Powertrain Control/Emissions Diagnosis Manual for diagnosis and testing of the automatic transmission.

Check TSBs and OASIS

Refer to all Technical Service Bulletins and OASIS messages which pertain to the transmission concern and follow the procedures as outlined.

Perform On-Board Diagnostics

After a road test, with the vehicle warm and before disturbing any connectors, perform Quick Test using Rotunda New Generation STAR (NGS) Tester 007-00500 or equivalent. Refer to Section 4A in the Powertrain Control/Emissions Diagnosis Manual for diagnosis and testing of the automatic transmission.

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Diagnostics

Diagnosing electronically controlled automatic transmissions is simplified using the following procedures. It is important to remember that there is a definite procedure to follow. Do not take short cuts or assume that critical checks or adjustments have already been made. Follow the procedures as written to avoid missing critical components or steps. By following the diagnostic sequence, the service technician will be able to diagnose and repair the concern the first time.

On-Board Diagnostics With NGS

NOTE: For detailed instructions and other diagnostic methods using the NGS, refer to the Powertrain Control/Emissions Diagnosis Manual or NGS instruction guide.

NOTE: If using a generic scan tool, refer to the Powertrain Control/Emissions Diagnosis Manual for instructions on performing OBD procedures.

The Quick Tests are in the Powertrain Control/Emissions Diagnosis Manual (PC/ED). These tests can be used to diagnose the powertrain control module (PCM) (12A650), sensors and actuators of the 4R44E transmission.

The following is a guide for using the On-Board Diagnostic (OBD) Quick Tests and the New Generation STAR (NGS) Tester.

Quick Test 1.0 — Visual Inspection

Perform the Visual Check and Vehicle Preparation procedures as outlined in the Powertrain Control/Emissions Diagnosis Manual.

Inspect the following:

- Air cleaner and inlet ducting.
- All engine vacuum hoses for damage, such as leaks, cracks, blockage, proper routing, etc.
- Powertrain control module (PCM) system wiring harnesses for proper connections, bent or broken pins, corrosion, loose wires, proper routing, etc.
- Sensors, actuators and powertrain control module (PCM) for physical damage.
- Engine coolant for proper level.
- Transmission fluid for proper level and condition.
- Any non-factory installed items wired into the transmission or PCM harnesses.

Perform all necessary servicing before continuing with Quick Tests.

Quick Test 2.0 — Set Up

Connect Rotunda New Generation STAR Tester 007-00500 or equivalent to Data Link Connector (refer to vehicle owner manual for connector location).

The following are steps to run OBD II procedures.

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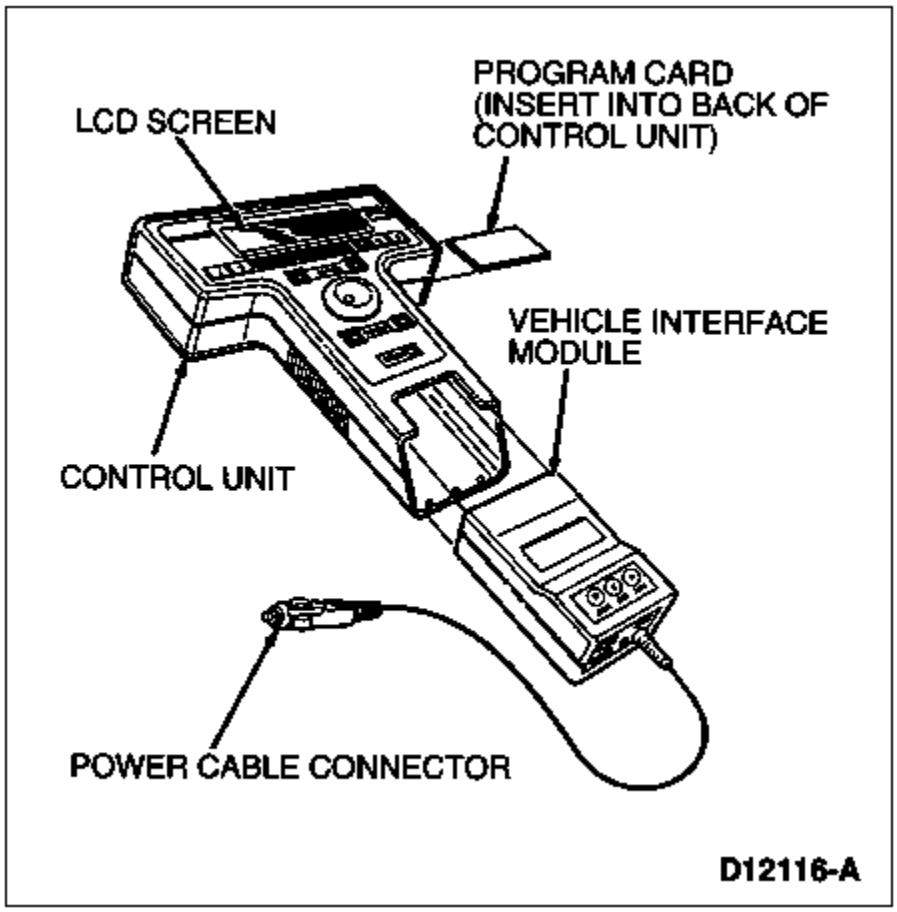
Vehicle and Tester Preparation

Prepare the vehicle as follows:

- Transmission range selector lever in PARK.
- Engine to operating temperature.
- Apply parking brake.
- Block wheels.
- Turn off all electrical loads including A/C and defroster. (If A/C is ON, DTC P1460 will set.)

Prepare the NGS as follows:



- Key OFF.
- Verify that the proper program card is inserted in the NGS.
- Connect J1962/16-way DCL cable adapter to the NGS.
- Connect NGS DCL cable adapter securely into the vehicle's DCL connector.
- Connect the NGS power supply cable to the vehicle battery power supply through cigarette lighter or at the battery with alligator clip adapter.
- Key ON or start vehicle if necessary.
- The NGS is now ready to communicate with the PCM.

Quick Test 3.0 — Key On, Engine Off (KOEO)

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CAUTION: Do not replace parts based on a code, perform Pinpoint Tests first.

- The key on engine off (KOEO) test provides "hard" diagnostic trouble codes (DTCs) present at the time of testing.
- Always service the "hard" DTCs first.

Performing KOEO

- Perform visual inspection and vehicle preparation as required.
- Select "Vehicle and Engine Selection" menu.
- Select year, engine, model with the appropriate qualifier if needed, for example, transmission or 49 state/Cal.
- Select "Diagnostic Data Link" menu.
- Select "Diagnostic Test Mode" menu.
- Select "KOEO On-Demand Self Test."
- Follow operating instructions from the NGS menu screen.
- Record all DTCs displayed.
- Service non-transmission DTCs first as they can directly affect the operation of the transmission. Road test the vehicle and repeat Quick Test to verify the repair.

Quick Test 4.0 — Continuous Memory Codes

Continuous DTCs are concerns which were detected during normal vehicle operation. These codes are retained for 40 warm-up cycles.

- The cause of some continuous DTCs may have been eliminated if KOEO and/or KOER DTCs were serviced. Always retest and service any DTCs that still remain.
- If DTCs are present, go to the On-Board Diagnostic Trouble Code Description Chart in this section for service information. Erase DTC, perform the Transmission Drive Cycle Test and repeat all Quick Test procedures after completing service on the DTCs.
- If the Continuous tests passes and a concern is still present, refer to the Diagnosis By Symptom Charts , OASIS and TSBs for concern diagnosis.

Performing Continuous DTC Tests

- Select "Vehicle and Engine Selection" menu
- Select year, engine, model with the appropriate qualifier if needed, for example, transmission or 49 state/Cal.
- Select "Diagnostic Data Link" menu.
- Select "Diagnostic Test Mode" menu.
- Select "Retrieve Continuous Codes."
- Follow operating instructions from the NGS menu screen.
- Record all DTCs displayed.
- Perform Transmission Drive Cycle Test.
- Rerun Continuous DTC Test. If DTCs have returned, service as required. Road test and rerun all DTC test procedures.

Quick Test 5.0 — Key On, Engine Running (KOER)

This test provides "hard" DTCs only.

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- Follow the menu screen instructions as they appear.
- If a DTC appears after the key on engine running (KOER) test, a malfunction is present. Refer to the DTC Code Chart for service information.

Performing KOER

- Perform visual inspection and vehicle preparation as required.
- Select "Vehicle and Engine Selection" menu.
- Select year, engine, model with the appropriate qualifier if needed, for example, transmission or 49 state/Cal.
- Select "Diagnostic Data Link" menu.
- Select "Diagnostic Test Mode" menu.
- Select "KOER On-Demand Self Test."
- Follow operating instructions from the NGS menu screen (example: turn key on, etc.) and perform brake on/off (BOO) and cycle the transmission control switch (TCS) on and off, if equipped, rotate steering wheel.
- Record all DTCs displayed.
- Service all non-transmission DTCs first as they can directly affect the operation of the transmission. Road test the vehicle and repeat Quick Test to verify the repair.

Special Test Modes

The following Special Test Modes may be used or required during diagnostics.

Output Test Mode

The diagnostic test mode aids is servicing output actuators associated with the PCM system. It allows the technician to energize and de-energize most of the system output actuators on command.

Performing Output Test Mode

Enter Output Test Mode with ignition key ON and the engine OFF.

- Perform visual inspection and vehicle preparation as required.
- Select "Vehicle and Engine Selection" menu.
- Select year, engine, model with the appropriate qualifier if needed, for example, transmission or 49 state/Cal.
- Select "Diagnostic Data Link" menu.
- Select "Diagnostic Test Mode" menu.
- Enter "Active Tests."
- Enter "Output Control."
- Follow operating instructions from the NGS menu screen.

PCM Reset Mode

The PCM reset mode provides a means for the NGS to command the powertrain control module to clear all DTCs. When resetting the PCM, a DTC P1000 will be set in the PCM until all OBD II system or components have been monitored during the OBDII Drive Cycle. When a PCM reset is performed the following occurs:

- DTCs cleared.

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- Freeze Frame Data cleared.
- Oxygen Sensor Test Data cleared.
- Status of the OBD II System Monitors reset.
- DTC P1000 set.

Performing PCM Reset

- Perform visual inspection and vehicle preparation as required.
- Select "Vehicle and Engine Selection" menu.
- Select year, engine, model with the appropriate qualifier if needed, for example, transmission or 49 state/Cal.
- Select "Generic OBD II Functions" menu.
- Select "Clearing ALL Codes."
- Follow operating instructions from the NGS menu screen.
- Perform OBD II Drive Cycle — Clear DTC P1000.

Clearing DTC P1000

In some localities it may become a legal requirement to pass an Inspection/Maintenance (I/M) test of the OBD II system. If the vehicle's powertrain system or its battery has just been serviced, the OBD II system is reset to a not ready for I/M testing condition. To prepare the vehicle for the test and to clear the DTC No. P1000, an OBD II Drive Cycle must be performed.

OBD II Drive Cycle

The following steps must be run in the order shown. If Steps 2, 3, or 4 are interrupted, repeat the step before proceeding. Any safe driving mode is acceptable between steps.

Always drive vehicle in a safe manner according to traffic conditions and obey all traffic laws.

1. Start engine and drive vehicle in typical city stop-and-go traffic for at least 10 minutes after it has reached normal operating temperature.

2. Idle vehicle for at least 45 seconds, then accelerate at part throttle to near 72 km/h (45 mph).

3. Cruise and maintain a select speed in the range of 48-64 km/h (30 to 40 mph) on a level road with throttle held steady for at least one minute.

4. Drive to accumulate at least four minutes in the range of 32-72 km/h (20 to 45 mph). If stop-and-go conditions occur, the accumulated time must be within the 32-72 km/h (20 to 45 mph) range. No wide open throttle (WOT) conditions should be encountered.

5. Decelerate and idle for at least 10 seconds.

6. Accelerate to approach 88 km/h (55 mph) at 1/2 throttle (elapsed time is about 10 seconds).

7. Cruise and maintain select speed in the range of 64-104 km/h (40 to 65 mph) on a level road with throttle held steady for at least one minute and 20 seconds.

8. OBDII Drive Cycle has been completed.

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Other NGS Features

For further information on other diagnostic testing features using the NGS or generic scan tool, refer to the Powertrain Control/Emissions Diagnosis Manual. Other diagnostic methods include the following:

- Parameter Identification (PID) Access Mode, used to monitor sensor and actuators.
- Freeze Frame Data Access Mode, used to view emissions related data values from specific PIDs.
- Oxygen Sensor Monitor Mode, used to monitor the O2 sensor.

Transmission Drive Cycle Test

NOTE: The Transmission Drive Cycle Test must be followed exactly. Malfunctions must occur four times consecutively for codes P0731, P0732, P0733 and P0734 to be set, and five times consecutively for continuous code P0743.

NOTE: When performing the Transmission Drive Cycle Test, refer to the Solenoid Application Chart for proper solenoid operation.

After performing the Quick Test, use the Transmission Drive Cycle Test for checking continuous codes.

1. Record and then erase Quick Test codes.
2. Warm engine to normal operating temperature.
3. Make sure transmission fluid level is correct.
4. With transmission in (D), moderately accelerate from stop to 80 km/h (50 mph). This allows the transmission to shift into fourth gear. Hold speed and throttle opening steady for a minimum of 15 seconds.
5. With transmission in fourth gear and maintaining steady speed and throttle opening, lightly apply and release brake pedal (2455) (to operate stoplamps). Then hold speed and throttle steady for an additional five seconds (minimum).
6. Brake to a stop and remain stopped for a minimum of 20 seconds.
7. Repeat Steps 4 through 6 at least five times.
8. Perform Quick Test and record continuous codes.
    - If DTCs are present, go to the On-Board Diagnostic Trouble Code Description Chart in this section for service information. Service all non-transmission DTCs first as they can directly affect the operation of the transmission. Repeat the Quick Test and Road Test to verify the correction. Erase DTCs, perform Drive Cycle and repeat the Quick Test after completing service on the DTCs.
    - If the continuous test passes and a concern is still present, refer to the Diagnosis By Symptom Charts , OASIS and TSBs for concern diagnostics.

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After On-Board Diagnostics

NOTE: The vehicle wiring harness, powertrain control module (PCM) (12A650) and non-transmission sensors may affect transmission operations. Service these concerns first.

After the On-Board Diagnostics procedures are completed, service all DTCs.

Begin with non-transmission related DTCs, then service any transmission related DTCs. Refer to the On-Board Diagnostic Trouble Code Description Chart for information on condition and symptoms. This chart will be helpful in referring to the proper manual(s) and to aid in diagnosing internal transmission concerns and external non-transmission inputs. The Pinpoint Tests are used in diagnosing electrical concerns of the transmission. Make sure that the vehicle wiring harness and the powertrain control module are diagnosed as well. The Powertrain Control/Emissions Diagnosis Manual will aid in diagnosing non-transmission electronic components.

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Before Pinpoint Tests

NOTE: Prior to entering Pinpoint Tests, refer to TSBs and OASIS messages for 4R44E concerns.

NOTE: Prior to entering Pinpoint Tests, the vehicle harness must be checked for continuity and shorts, and the powertrain control module (PCM) must be checked for any concerns. Refer to Section 4A in the Powertrain Control/Emissions Diagnosis Manual for diagnosis and testing of the PCM concerns.

NOTE: If any non-transmission service codes appear, service those codes first. They could affect the electrical operation of the transmission. Record and erase codes from continuous memory after repairs have been performed. After servicing any fault codes in the Quick Test, the Quick Test should be repeated.

NOTE: Check the EEC-V system wiring harness for proper connection, bent or broken pins, corrosion, loose wires, proper routing, proper seals and their condition. Check the powertrain control module (PCM) (12A650), sensors, and actuators for physical damage.

If codes appear while performing the Self Test, refer to the On-Board Diagnostic Trouble Code Description Chart for the appropriate service procedure.

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On-Board Diagnostic Trouble Code Description Chart

ON-BOARD DIAGNOSTIC TROUBLE CODE DESCRIPTION CHART

****May also be generated by some other non-electric transmission hardware system.**					
***Output circuit check, generated only by electrical symptoms.**					
Four-Digit DTC	**Component**	**Description**	**Condition**	**Symptom**	**Action**
P0112	IAT	IAT indicates 125°C (254°F) (grounded).	Voltage drop across IAT exceeds scale set for temperature 125°C (254°F).	Incorrect EPC pressure. Either high or low which will result in harsh or soft shifts.	Refer to PCED [1]
P0113	IAT	IAT indicates -40°C (-40°F) (open circuit).	Voltage drop across IAT exceeds scale set for temperature -40°C (-40°F).	Incorrect EPC pressure. Either high or low which will result in harsh or soft shifts.	Refer to PCED [1]
P0114	IAT	IAT out of on-board diagnostic range.	IAT temperature higher or lower than expected during KOEO and KOER.	Rerun on-board diagnostic at normal operating temperature.	Refer to PCED [1]
P1116	ECT	ECT out of on-board diagnostic range.	ECT temperature higher or lower than expected during KOEO and KOER.	Rerun on-board diagnostic at normal operating temperature.	Refer to PCED [1]
P0117	ECT	ECT indicates 125°C (254°F).	Voltage drop across ECT exceeds scale set for temperature 125°C (254°F) (grounded).	Torque converter clutch will always be off, resulting in reduced fuel economy.	Refer to PCED [1]
P0118	ECT	ECT indicates -40°C (-40°F).	Voltage drop across ECT exceeds scale set for temperature -40°C (-40°F) (open circuit).	Torque converter clutch will always be off, resulting in reduced fuel economy.	Refer to PCED [1]
P1124	TP	TP voltage high/low for on-board diagnostic.	TP was not in the correct position for on-board diagnostic.	Rerun at appropriate throttle position per application.	Refer to PCED [1]
P0121, P0122, P0123,	TP	TP concern.	PCM has detected an error. This error may cause a	Harsh engagements, firm shift feel, abnormal shift schedule, torque	Refer to PCED [1]

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P1120, P1121, P1125, P1124			transmission concern.	converter clutch does not engage. Torque converter clutch cycling.	
P0102, P0103, P1100, P1101	MAF	MAF concerns.	MAF system has a malfunction which may cause a transmission concern.	High/low EPC pressure, incorrect shift schedule. Incorrect torque converter clutch engagement scheduling. Symptoms similar to a TP failure.	Refer to PCED [1]
P0300-P0306, P0320, P0340, P1351-P1364	EI	EI concerns.	EI system has a malfunction which may cause a transmission concern.	Harsh engagements and shifts, late WOT shifts, no torque converter clutch engagement.	Refer to PCED [1]
P0500, P1500, P1501	VSS	Insufficient VSS input.	PCM detected a loss of vehicle speed signal during operation.	Torque converter clutch engages, shift engagement/ disengagement (hunting) on grades.	Refer to PCED [1]
P1705	DTR	DTR not in PARK or NEUTRAL.	On-board diagnostic not run in PARK.	Rerun on-board diagnostic in PARK.	Refer to Pinpoint Test D.
P1704	DTR	DTR sensor failure in transition state.	DTR sensor misaligned or failed electrically.	Increase in EPC pressure.	Refer to Pinpoint Test D.
P1703	BOO	Brake not actuated during on-board diagnostic KOER.	Brake not cycled during KOER.	Failed ON or not connected — torque converter clutch will not engage at less than 1/3 throttle. Failed OFF or not connected — torque converter clutch will not disengage when brake is applied.	Refer to PCED [1]
P1703	BOO	BOO switch circuit failed.	Brake ON circuit failure during KOEO.	Failed ON or not connected — torque converter clutch will not engage at less than 1/3 throttle. Failed OFF or not connected — torque converter clutch will not disengage when brake is applied.	Refer to PCED [1]
P1460	A/C	A/C clutch cycling pressure switch error.	A/C or Defrost ON condition may result from A/C clutch being ON during on-board diagnostic.	DTC set during on-board diagnostic — rerun with A/C OFF. Failed ON — EPC pressure slightly low with A/C OFF.	Refer to PCED [1]
P0731**	SS1, SS2, SS3 or	1st gear error.	No 1st gear.	Improper gear selection depending on failure or	Refer to Solenoid

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	internal parts			mode and manual lever position. Shift errors may also be due to other internal transmission concerns (stuck valves, damaged friction material).	On/Off Charts. Refer to Pinpoint Test A.
P0732**	SS1, SS2, SS3 or internal parts	2nd gear error.	No 2nd gear.	Improper gear selection depending on failure or mode and manual lever position. Shift errors may also be due to other internal transmission concerns (stuck valves, damaged friction material).	Refer to Solenoid On/Off Charts. Refer to Pinpoint Test A.
P0733**	SS1, SS2, SS3 or internal parts	3rd gear error.	No 3rd gear.	Improper gear selection depending on failure or mode and manual lever position. Shift errors may also be due to other internal transmission concerns (stuck valves, damaged friction material).	Refer to Solenoid On/Off Charts. Refer to Pinpoint Test A.
P0734**	SS1, SS2, SS3 or internal parts	4th gear error.	No 4th gear.	Improper gear selection depending on failure or mode and manual lever position. Shift errors may also be due to other internal transmission concerns (stuck valves, damaged friction material).	Refer to Solenoid On/Off Charts. Refer to Pinpoint Test A.
P0750*	SS1	SS1 solenoid circuit failure.	SS1 circuit failed to provide voltage drop across solenoid. Circuit open or shorted or PCM driver failure during on-board diagnostic.	Improper gear selection depending on condition mode and manual lever position. See Solenoid On/Off charts.	Refer to Pinpoint Test A.
P0755*	SS2	SS2 solenoid circuit failure.	SS2 circuit fails to provide voltage drop across solenoid. Circuit open or shorted or PCM driver failure during on-board diagnostic.	Improper gear selection depending on condition mode and manual lever position. See Solenoid On/Off charts.	Refer to Pinpoint Test A.
—	TCIL	TCIL circuit failure.	TCIL circuit open or shorted.	Failed ON — Overdrive cancel mode always ON. NO flashing TCIL for EPC failure or sensor. Failed OFF — Overdrive cancel mode	Refer to PCED [1]

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				never indicated. NO flashing TCIL for EPC sensor failure.	
P1747*	EPC	EPC solenoid circuit failure, shorted circuit.	Voltage through EPC solenoid is checked. An error will be noted if tolerance is exceeded.	Short Circuit — Causes minimum EPC pressure (minimum capacity) and limits engine torque (alternate firm). Zero EPC — no 2nd and 4th gear. Slips in 1st and 3rd with high torque input.	Refer to Pinpoint Test E.
P1744**	TCC	TCC slippage detected.	The PCM picked up an excessive amount of TCC slippage during normal vehicle operation.	TCC slippage/erratic or no torque converter clutch operation. Flash TCIL.	Refer to Diagnosis by Symptom Index.
P1780	TCS	TCS not changing states.	TCS not cycled during self test. TCS circuit open or shorted.	No (D) cancel when switch is cycled during KOER.	Rerun on-board diagnostic and cycle switch. Refer to PCED [1]
P1711	TFT	TFT out of on-board diagnostic range.	Transmission not at operating temperature during on-board diagnostic.	DTC set — Vehicle cold or overheated.	Warm or cool vehicle to normal operating temperature. Refer to Pinpoint Test B.
P0713	TFT	-40°C (-40°F) indicated TFT sensor circuit open.	Voltage drop across TFT sensor exceeds scale set for temperature -40°C (-40°F)	Firm shift feel.	Refer to Pinpoint Test B.
P0712	TFT	157°C (315°F) indicated TFT sensor circuit grounded.	Voltage drop across TFT sensor exceeds scale set for temperature of 157°C (315°F)	Firm shift feel.	Refer to Pinpoint Test B.
P0715	TSS	Insufficient input from Turbine Shaft Speed Sensor.	PCM detected a loss of TSS signal during operation.	Harsh shifts, abnormal shift schedule, no torque converter clutch activation.	Refer to Pinpoint Test F.
P0743*	TCC	TCC solenoid circuit failure during on-board diagnostic.	TCC solenoid circuit fails to provide voltage drop across solenoid. Circuit open or shorted or PCM drive failure during on-board diagnostic.	Short circuit — Engine stalls in second (OD, 2 range) at low idle speeds with brake applied. Open circuit — Torque converter clutch never engages.	Refer to Pinpoint Test C.
P1783	TFT	Transmission	Transmission fluid	Increase in EPC	Refer to

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		overtemp condition indicated.	temperature exceeded 127°C (270°F).	pressure.	Pinpoint Test B.
P0705	DTR	DTR circuit failure.	DTR sensor, circuit or PCM shorted or grounded.	Increase in EPC pressure.	Refer to Pinpoint Test D.
P0708	DTR	DTR circuit above maximum voltage — open.	DTR sensor, circuit or PCM indicates open.	Increase in EPC pressure.	Refer to Pinpoint Test D.
P0751 **	SS1	Shift solenoid No. 1 functional failure (California only).	Mechanical or hydraulic failure of the shift solenoid.	Improper gear selection depending on failure mode and manual lever position.	Refer to Solenoid On/Off Charts. Refer to Pinpoint Test A.
P0756 **	SS2	Shift solenoid No. 2 functional failure (California only).	Mechanical or hydraulic failure of the shift solenoid.	Improper gear selection depending on failure mode and manual lever position.	Refer to Solenoid On/Off Chart. Refer to Pinpoint Test A.
P1781	4x4L	4x4 low switch failure.	Switch closed or shorted during KOEO.	Early or delayed shifts.	Refer to Section 07-07A.
P1729	4x4L	4x4 low switch failure.	Circuit open/shorted.	Early or delayed shifts.	Refer to Section 07-07A.
P0761**	SS3	Shift solenoid No. 3 functional failure (California).	Mechanical or hydraulic failure of the shift solenoid.	Improper gear selection depending on failure mode and manual lever position.	Refer to Solenoid On/Off Charts. Refer to Pinpoint Test A.
P0760*	SS3	SS3 solenoid circuit failure.	SS3 circuit failed to provide voltage drop across solenoid. Circuit open or shorted or PCM driver failure during on-board diagnostic.	Improper gear selection depending on condition mode and manual lever position. See Solenoid On/Off chart.	Refer to Pinpoint Test A.
P1754*	CCS	CCS solenoid circuit failure.	CCS circuit failed to provide voltage drop across solenoid. Circuit open or shorted or PCM driver failure during on-board diagnostic.	Failed on — no coast braking except in 4th gear. Delayed 3-2 shifts. Failed off — coast braking 2nd, 3rd. Firm 3-2 and 4-3 shifts.	Refer to Pinpoint Test G.
P1746 *	EPC	EPC solenoid circuit open.	Voltage through EPC solenoid is checked. Error is	Open Circuit — Causes maximum EPC pressure, harsh	Refer to Pinpoint Test E.

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			noted if tolerance is exceeded.	engagements and shifts.	
P1701	Transmission	Reverse engagement error.	EPC pressure is low, no drop in TSS rpm, DTR indicates reverse	EPC pressure low, SS1 is off, engine lacks power.	Diagnosis by symptom.

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Rotunda Transmission Tester

Use Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit) with Rotunda 4R44E/4R55E Overlay/Cable 007-00106 in Transmission Tester Kit, Rotunda Transmission Range (TR) Sensor Cable "E" 007-00111 with Digital TR Sensor Overlay 007-00131 or equivalent to diagnose electronically controlled transmissions (7003). The following instructions outline the set up and use of this tester in the Pinpoint Tests for the 4R44E.

Transmission Tester

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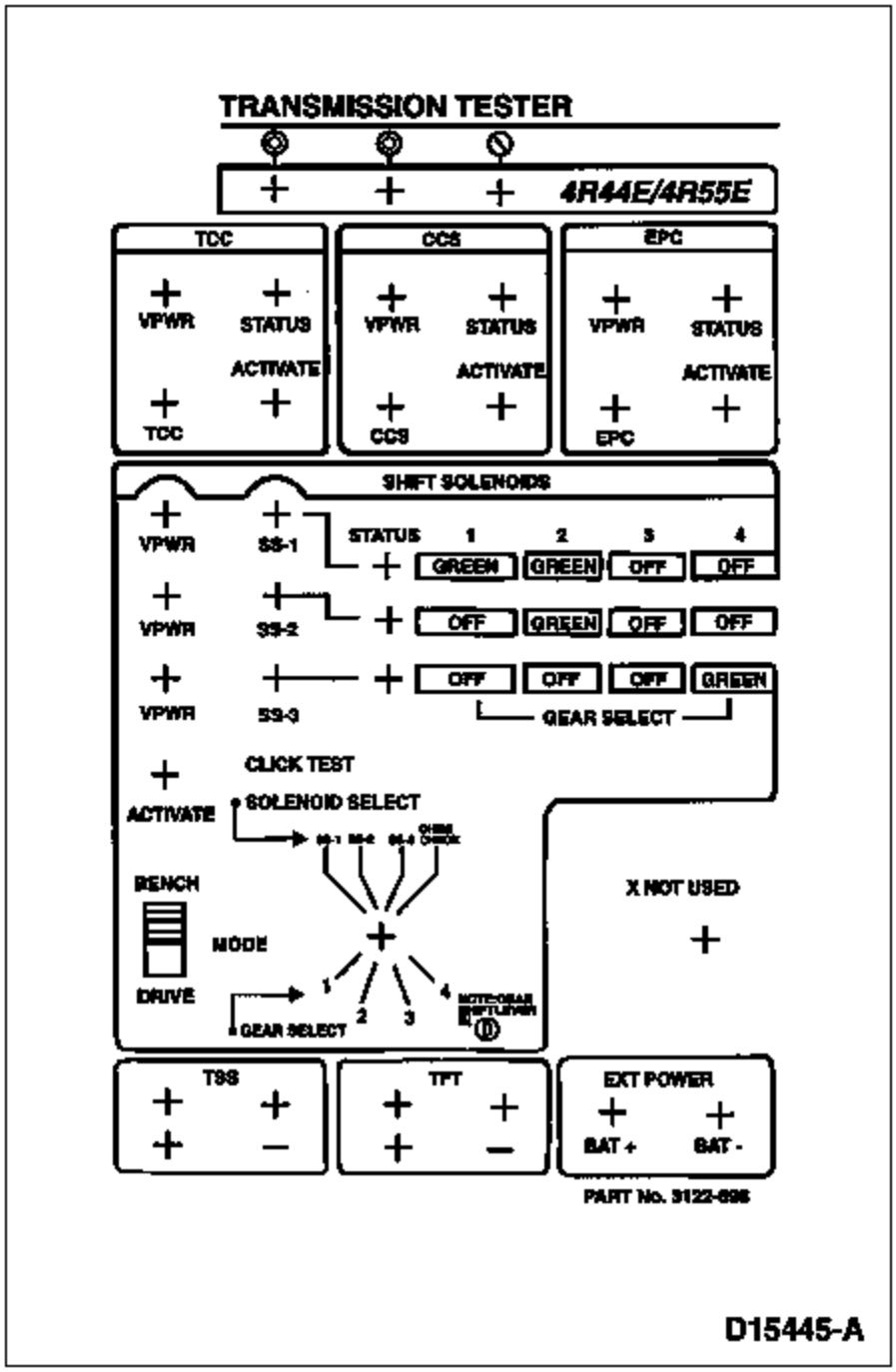

Overlays and Adapters

1. **Overlay and Cable Correctly Installed LEDs:** Only LEDs with the (O) symbol will light when the overlay and cable are correctly matched.

2. **Status LEDs:** LED OFF when not activated by tester (solenoid not activated, open circuit or signal line short to ground).

    - LED green when activated by tester and current draw is correct.

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- LED red when activated by tester and current draw is excessive (short at VPWR).
- All LEDs light orange during On-Board Diagnostics.

3. **Solenoid Activate Buttons:** Energize respective solenoids during click testing and activate selected circuits during DRIVE mode testing.

4. **Tester Mode Switch:** Selects operating mode, either BENCH or DRIVE.

5. **Solenoid Select/Gear Select Switch:** Has three functions:

   - BENCH MODE: acts as shift solenoid selector for click testing.
   - DRIVE MODE: acts as forward gear selector in place of vehicle's powertrain control module (PCM) (12A650) controlled shifting. Hydraulic safety mechanisms and overrides are built into the transmission.
   - OHMS CHECK: allows technician to measure ohms and to check for presence of diode on specific solenoids.

Tester Jacks

1. **VPWR Pin Jacks (red):** Vehicle Power (VPWR) test points for solenoid circuits.

2. **Solenoid Signal Line Pin Jacks (black):** Signal line test points for solenoid circuits.

3. **BAT + (red) and BAT - (black) Pin Jacks:** Battery reference points when measuring circuits for shorts.

4. **TFT Pin Jacks:** Test points for transmission fluid temperature sensor.

5. **TSS Jack:** Test points for TSS sensor.

LEDs and Controls

- LED turns **RED** when solenoid activates and **OFF** when solenoid deactivates.
- LED turns **GREEN** if an activated solenoid/harness is shorted.
- LED remains **OFF** if an activated solenoid/harness is shorted to ground or no continuity.

Instructions

The Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit) with Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in Transmission Tester Kit or equivalent allows a technician to operate the electrical portion of the transmission independent of the vehicle electronics to determine transmission concerns. The Transmission Tester usage is divided in six steps:

- Preliminary Testing and Diagnosis
- Installing the Transmission Tester
- Static Testing — Engine Off
- Dynamic Testing — Vehicle Running
- DTR Testing
- Removing Transmission Tester and Clearing DTCs

Preliminary Inspections

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1. Know and understand the customer's concern.

2. Verify the customer's concern:

    - Upshift
    - Downshift
    - Coasting
    - Engagement

If concern involves noise or vibration, does it relate to any of the following?

- Rpm
- Vehicle speed
- Shift
- Gear
- Range
- Temperature

3. Vehicle must be at normal operating temperature.

4. Check transmission fluid level and condition.

5. Check the following items:

    - Vehicle modifications
    - Electronic add-on items
    - Leaks
    - Linkage adjustments

6. Check TSBs and OASIS for related information.

7. Perform complete On-Board Diagnostics (OBD) for both KOEO and KOER.

8. Record all DTCs.

9. Repair all non-transmission DTCs.

Installation Procedures

Installing Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit) with Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in Transmission Tester Kit or equivalent at the transmission connector allows separation of the vehicle electronics from transmission electronics. Disconnecting normal vehicle electronics will cause firm shifts and defaults transmission to maximum line pressure.

During tester usage, additional DTCs may be set. Therefore, it is important that all codes are erased after service has been made. To verify elimination of all codes, rerun On-Board Diagnostics.

The following manuals will assist in diagnosis of electronically controlled transmissions:

- Powertrain Control/Emissions Diagnosis Manual.
- Transmission Reference Manual.

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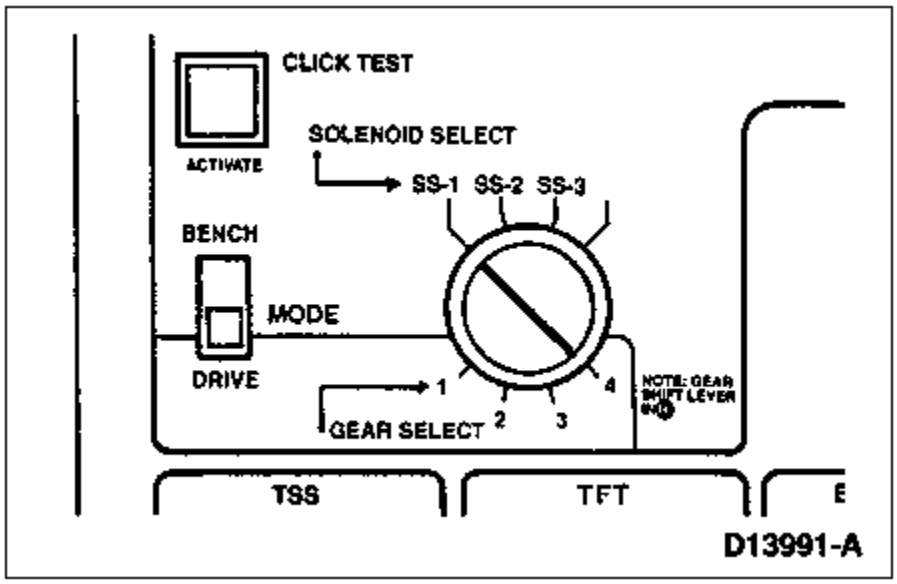
1. **CAUTION: Do not attempt to pry off connectors with a screwdriver. This will damage the connector and could result in transmission concerns.**

   Disconnect vehicle wiring harness at transmission connector.

2. Install appropriate overlay onto tester.

3. Turn tester solenoid select switch to the OHMS CHECK position.



4. **CAUTION: Route all cables away from heat sources.**

   Connect appropriate interface cable to transmission tester and then to the appropriate transmission connectors.

5. **CAUTION: Route gauge line away from heat sources.**

   Install a line pressure gauge into line pressure tap on transmission.

Static Testing — Engine Off

Static testing procedures allow for shop testing of the transmission in the vehicle or on the bench. Completion of these tests prove out transmission electronics.

- Refer to appropriate Pinpoint Test based on DTCs displayed.
- Use a digital volt-ohmmeter and the transmission tester to perform the Pinpoint Tests as indicated, based on the DTCs which were displayed.
- Perform repairs as indicated by the Pinpoint Tests. Always erase all codes, retest and road test vehicle after a repair.

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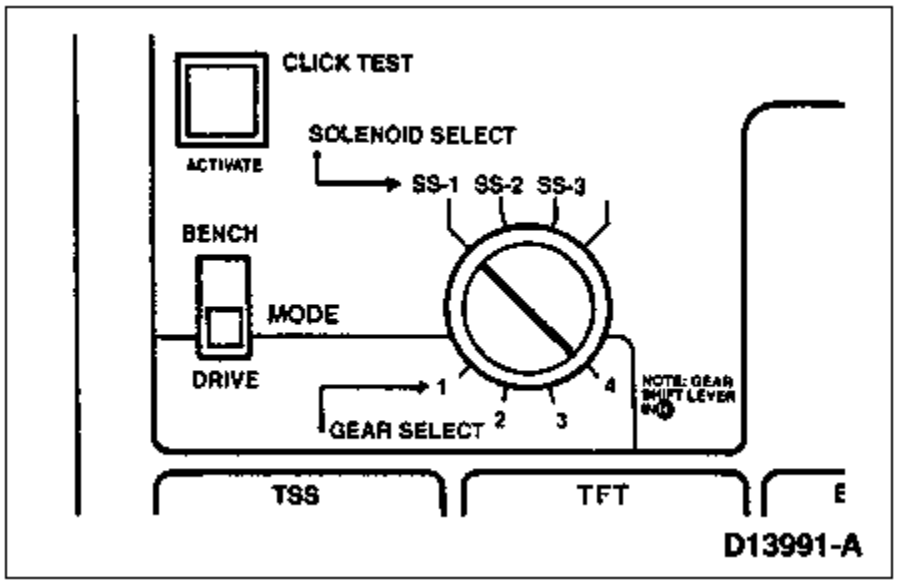

Resistance/Continuity Tests — EPC Solenoid

1. Set ohmmeter to 100-200 ohm range.
2. Connect COM lead to the EPC jack.
3. Connect ohmmeter POS lead to the VPWR jack.
4. Record resistance.
5. Refer to the chart for values.

If out of specification, refer to Pinpoint Test E in this section.

Solenoid	Resistance (Ohms)
S1	22-48
S2	22-48
S3	22-48
CCS	22-48
TCC	8.9-16.0
EPC	3.1-5.7

Resistance/Continuity Tests — Solenoids (SS1, SS2, SS3, TCC, CCS)

1. Set ohmmeter to 100-200 ohm range.
2. Connect ohmmeter COM lead to the appropriate solenoid (shift solenoid 1 [SS1], shift solenoid 2 [SS2], shift solenoid 3 [SS3], torque converter solenoid [TCC], coast clutch solenoid [CCS]) jack.
3. Connect ohmmeter POS lead to the appropriate VPWR jack for the solenoid being tested.

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4. Record resistance.
5. Refer to the chart for values.

If out of specification, refer to Pinpoint Test A (SS1, SS2, SS3); Pinpoint Test C (TCC), Pinpoint Test G (CCS).

Resistance/Continuity Tests — Transmission Fluid Temperature (TFT) Sensor

1. Set ohmmeter to 1000 ohm (k) scale.
2. Connect ohmmeter COM lead to TFT jack.
3. Connect ohmmeter POS lead to + TFT jack.
4. Record resistance. Resistance will vary with temperature.
5. Refer to the following chart.

If out of specification, refer to Pinpoint Test B in this section.

Temperature		Resistance
℃	℉	(Ohms)
-40 - -20	-40 - -4	967k-248k
-19 - -1	-3 - 31	248k-100k
0-20	32-68	100k-37k
21-40	69-104	37k-16k
41-70	105-158	16k-5k
71-90	159-194	5k-2.7k
91-110	195-230	2.7k-1.5k
110-130	231-266	1.5k-0.8k
131-150	267-302	0.8k-0.54k

Resistance/Continuity Tests — Turbine Shaft Speed (TSS) Sensor

1. Set Rotunda 73 Digital Multimeter 105-R0051 or equivalent to 200 ohms.
2. Connect multimeter COM lead to TSS jack.
3. Connect multimeter POS lead to (-) TSS jack.
4. Record resistance.

   Range:

   - TSS 64-120 ohms
5. If resistance is out of range, refer to Pinpoint Test F in this section.

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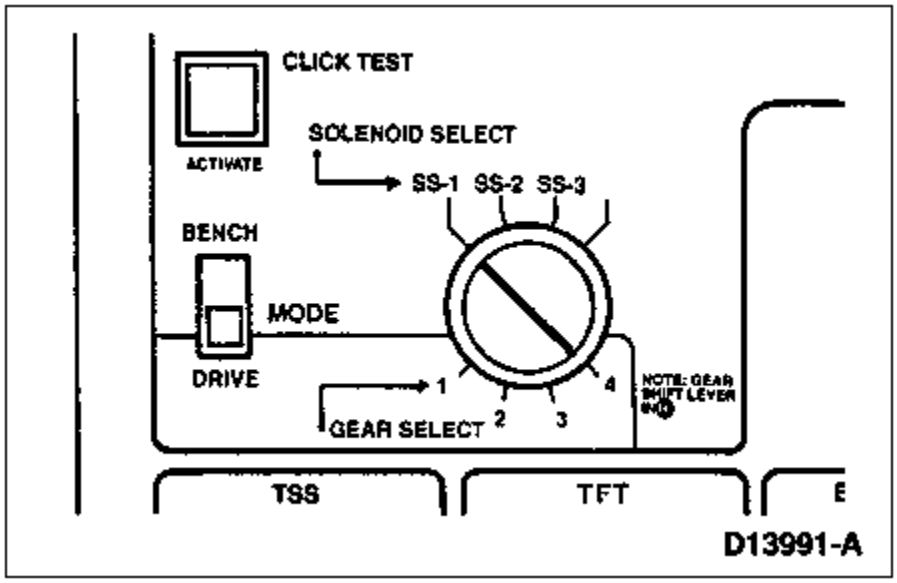
Solenoid Voltage Test

1. Slide MODE switch to BENCH position.
2. Set voltmeter to 20-volt DC range.
3. Determine solenoid to be tested and connect voltmeter leads as follows:
    - If testing SS1, SS2, or SS3 solenoid, turn the SOLENOID SELECT dial to SS1, SS2, or SS3 before hooking up leads.



    - Connect negative lead to solenoid jack.
    - Connect positive lead to VPWR jack.
4. Press solenoid activate/deactivate button and check voltage.

The LED should light, the voltage should change, and an audible click may be heard. See LED and Controls for reading LED status.

5. Observe and record values.

Dynamic Testing — Engine On

Preliminary Set Up

1. Slide MODE switch to DRIVE position.
2. Turn GEAR SELECT dial to 1.
3. Place vehicle in PARK with parking brake on.
4. Start engine.

EPC Solenoid

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CAUTION: Do not attempt to hold the electronic pressure control switch depressed (minimum line pressure) and stall the transmission (holding the vehicle with the brake while depressing the throttle with the transmission in gear). Transmission damage will result.

1. Observe line pressure. Record value. Line pressure should go to maximum. If not, refer to the Diagnosis By Symptom Index for diagnostic information or Pinpoint Test E concerning electronic pressure control solenoid.

2. Depress electronic pressure control switch. Record value. Line pressure should drop to a minimum value Record value. If not, refer to the Diagnosis by Symptom Index or Pinpoint Test E for the electronic pressure control solenoid.

Transmission Engagements

1. Verify that MODE switch is in DRIVE position.

2. Turn GEAR SELECT dial to 1.

3. Start engine.

4. Shift vehicle from PARK to REVERSE.

   - Did vehicle shift into REVERSE?
   - Was engagement firm?

5. Depress EPC switch. Line pressure should drop to idle pressure.

   While holding EPC switch down, shift vehicle from PARK to REVERSE.

   - Did vehicle shift into REVERSE?
   - Was engagement smooth?
   - Shift vehicle from REVERSE to PRK.
   - Release EPC switch. Line pressure should rise to MAX pressure.

6. Shift vehicle from PARK to DRIVE.

   - Did vehicle shift into DRIVE?
   - Was engagement firm?

7. Shift vehicle from DRIVE to PARK.

8. Depress EPC switch. Pressure should drop to idle pressure.

9. While holing EPC switch down, shift vehicle from PARK to DRIVE.

   - Did the vehicle shift from PARK to DRIVE?
   - Was the engagement smooth?

10. Release EPC Switch.

Upshifts/Downshits

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NOTE: Upshifts and downshifts will be firm during this procedure. Pressure gauges may be removed. These tests should be performed on the road. If performed on the hoist, shift feel during engagement may not be possible.

LED will turn green when solenoids are activated and turn off when deactivated. Refer to the appropriate overlay for the proper status shift sequence of the shift solenoids during upshifts and downshifts.

1. Move transmission range selector lever into (D) and accelerate to 24 km/h (15 mph). By moving transmission range selector lever, shift to second gear.

    - Did vehicle upshift to second gear?
    - Did appropriate shift solenoids activate/deactivate?

2. Accelerate to 40 km/h (25 mph) and select third gear by turning GEAR SELECT dial to 3.

    - Did vehicle upshift to third gear?
    - Did appropriate shift solenoids activate/deactivate?

3. Accelerate to 56-72 km/h (35/45 mph) and select fourth gear by turning GEAR SELECT dial to 3.

    - Did vehicle upshift to fourth gear?
    - Did appropriate shift solenoids activate/deactivate?

4. Reverse the order to downshift.

    - Did vehicle downshift from fourth to third, third to second, and second to first?

Torque Converter Clutch (TCC) Engagement

CAUTION: Do not depress torque converter clutch solenoid switch with transmission in gear and the vehicle at a stop. Damage to torque converter clutch may result.

NOTE: This test should be performed on the road. If performed on a hoist, torque converter clutch engagement feel may not be possible.

1. Accelerate and shift vehicle up into third gear. Hold speed steady and depress the torque converter clutch solenoid switch.

    - Did the torque converter engage?
    - Did the engine rpm drop?
    - Did torque converter clutch solenoid activate?
    - Did TCC solenoid deactivate when switch was reused?

Coast Clutch Engagement

NOTE: This test should be performed on the road. If performed on the hoist, coast clutch engagement feel may not be possible.

1. Accelerate and shift vehicle into third gear. Depress the coast clutch solenoid switch and immediately

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back off the throttle.

- Did the coast clutch engage? Did engine braking occur?
- Did the coast clutch solenoid activate?

2. Release the CCS switch.

- Did the CCS solenoid deactivate?

Turbine Shaft Speed (TSS) Sensor

NOTE: This test may be performed on the hoist or on the road.

1. Set voltmeter to 20 volts AC.
2. Connect voltmeter positive lead to +TSS.
3. Connect voltmeter negative lead to -TSS.
4. Slowly accelerate vehicle and monitor voltmeter.

- Did voltage increase with vehicle speed?

If testing of the DTR sensor is required, go to the following procedure. If testing of the DTR sensor is not required, go to the disconnecting the tester procedure in this section.

Digital Transmission Range (DTR) Sensor Testing

Introduction

The Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit), TR Testing Cable "E" 007-00111 and Digital TR Sensor Overlay 007-00131 or equivalent allows a technician to test the DTR sensor independent of vehicle electronics. DTR sensor testing is divided into four steps:

1. Preliminary diagnosis and testing.
2. Installing the Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit), TR Testing cable "E" (007-00111) and Digital TR Overlay or equivalent.
3. Testing the digital transmission range (DTR) sensor.
4. Testing the park/neutral, backup and optional circuits.

Preliminary Testing and Diagnosis

Before any diagnostic testing is done on a vehicle some preliminary checks must be performed. Be sure to write down any findings, especially any DTCs, for future reference.

1. Know and understand customer's concern.
2. Verify that DTR sensor is properly adjusted in NEUTRAL.

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3. Verify customer concern:

    - Upshift
    - Downshift
    - Coasting
    - Engagement

If concern involves noise or vibration, does it relate to any of the following?

- Rpm
- Vehicle speed
- Shift
- Gear
- Range
- Temperature

4. Vehicle must be at normal operating temperature.

5. Check transmission fluid level and condition.

6. Check for the following items:

    - Vehicle modifications
    - Electronic add-on items
    - Leaks
    - Linkage adjustments

7. Check TSBs and OASIS for related information.

8. Perform complete On-Board Diagnostics (OBD) for both KOEO and KOER.

9. Record all DTCs.

10. Repair all non-transmission DTCs.

Installation Procedures

Installing the Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit) and TR Testing Cable "E" 007-00111 and Digital TR Sensor Overlay 007-00131 at the transmission connector allows separation of the DTR sensor electronics from the vehicle electronics.

Testing may cause additional fault codes to be set. Therefore, it is important that all DTCs are erased whenever repairs are made. To verify elimination of all codes, rerun OBD test.

The following manuals will assist in diagnosis of electronically controlled transmissions:

- Powertrain Control/Emission Diagnosis (PC/ED) Manual
- Transmission Reference Manual

1. For proper DTR sensor diagnosis, follow Pinpoint Test D .

2. Disconnect vehicle harness at transmission DTR sensor.

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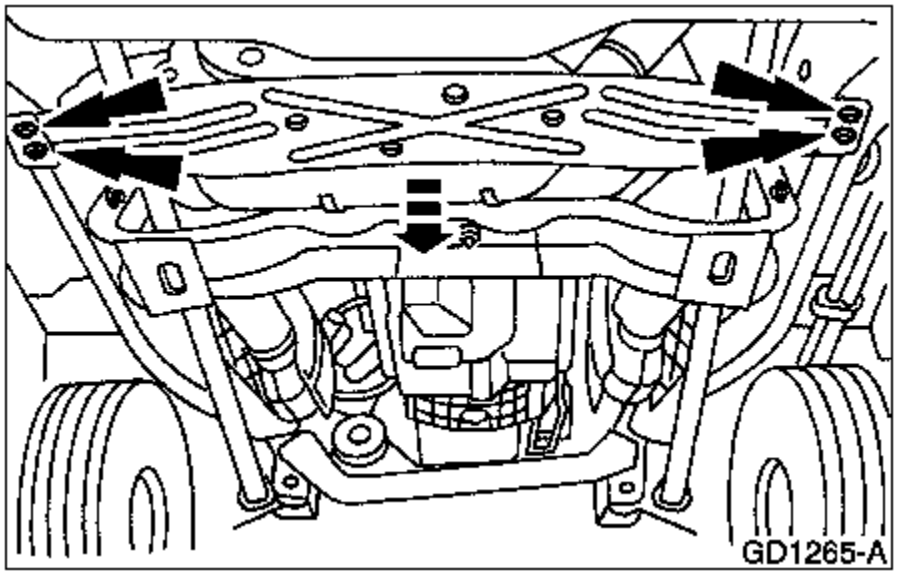
3. Set the two-way switch in the down position. (This switch will stay in the same position for all DTR sensor testing.)

4. Attach the Digital TR Sensor Overlay 007-00131 to the transmission tester.



Affixing the overlay will immobilize the two-way switch (set in Step 2) so it cannot be accidentally moved to an incorrect setting during testing.

5. Select and connect interface cable "E" 007-00111 to the tester and then black connector (digital) to DTR sensor.

Transmission	Model Year	Cable
4R44E	1997	E

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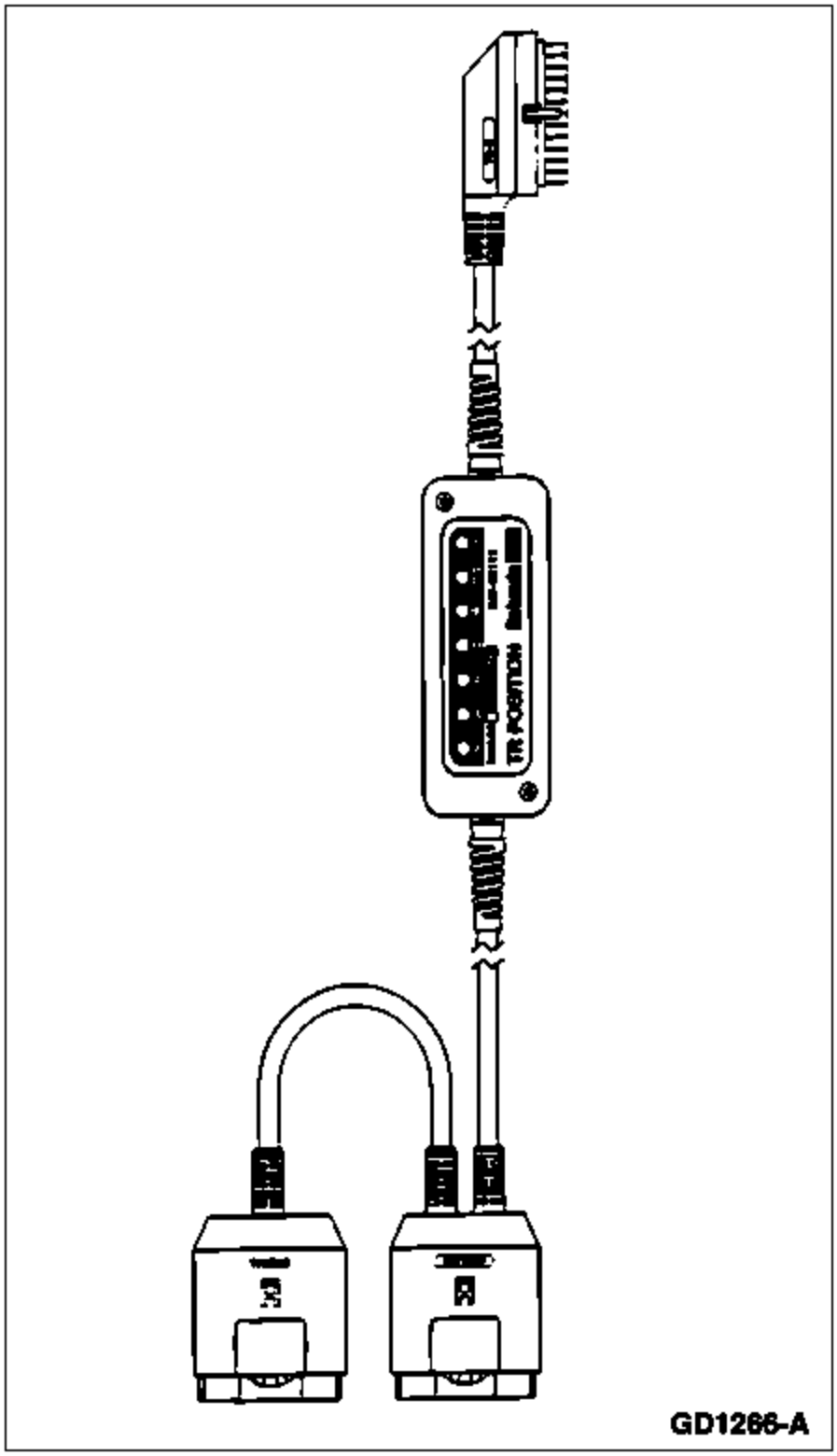

6. Set analog/digital switch on TR-E cable to digital.

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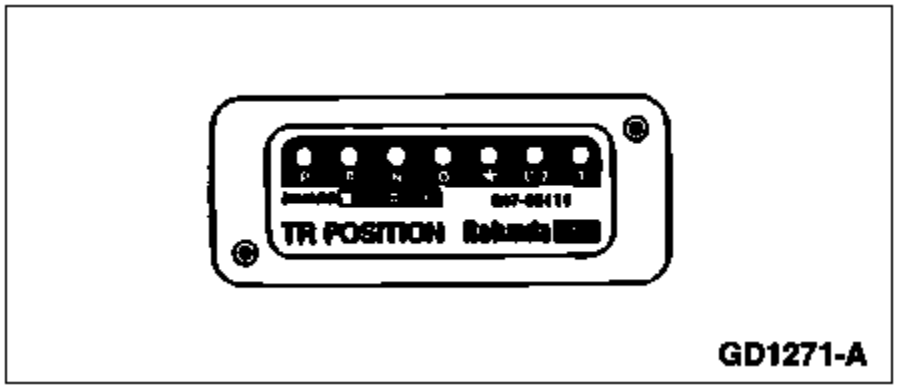
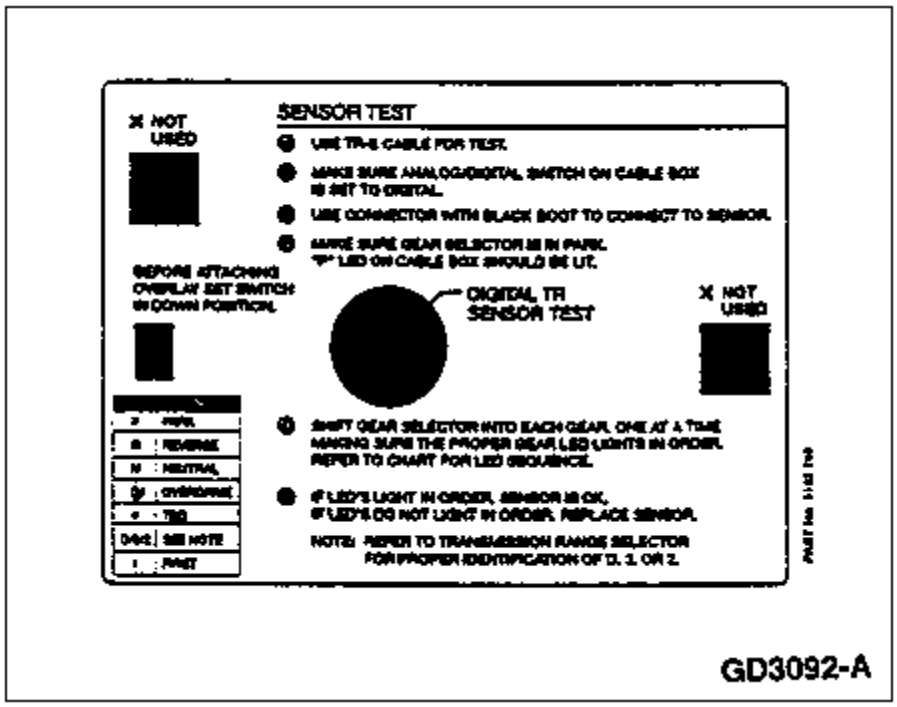


CAUTION: Route all cables away from heat sources to prevent damage to cables during testing.

Use the transmission tester extender cable when running tests with the transmission on the vehicle.

7. Turn large dial to DIGITAL TR SENSOR TEST.



8. Plug transmission tester power cable into cigar lighter socket.

All LEDs should light for a short period and then turn off. This is the Tester's internal circuit check.

CAUTION: For resistance checks, be sure that the tester selector switch is set to the TR SENSOR TEST position or damage to the ohmmeter may result.

Sensor Test

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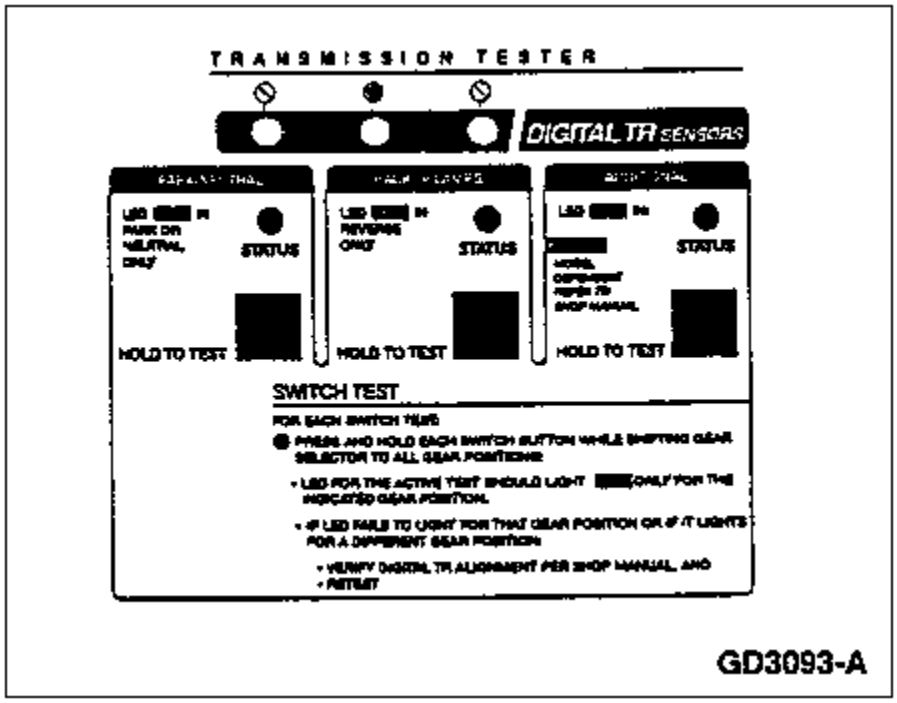
CAUTION: Be sure that the DIGITAL 12 pin sensor cable connector (black) is used. If the wrong connection is made or the slide switch is in the wrong position, the LEDs on the TR cable will give false or no response during testing. This will cause the replacement of good parts.

1. Place transmission range selector lever into PARK.
2. Ensure that the "E" cable ANALOG/DIGITAL switch is set to DIGITAL.
3. Move the transmission range selector lever through all ranges.
4. Monitor the LEDs, located on the "E" cable, in each gear position. The LED should illuminate RED for the appropriate range selected.
5. If the LED for the applicable gear range position fails to illuminate RED or if it lights for a position other than the gear selected:
    - Verify test cable connections at sensor and tester.
    - Verify transmission shift linkage for proper adjustment.
    - Verify DTR sensor for proper adjustment.
    - Retest.
6. If the sensor still fails to illuminate the LED RED for the selected gear range or indicates incorrect gear position, replace it.

Switch Tests — Park/Neutral, Backup Lamp and Optional Circuits

NOTE: LED lights red when circuit is closed.



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LED turns off when circuit is open.

1. Press and hold each test button while moving the transmission range selector lever to each gear position.

2. Monitor each STATUS LED:

   The LED in the appropriate gear position being testing should light red.

   If the LED for the applicable gear position fails to light red, or if it lights for a position other than the gear selected:

   - Verify DTR alignment. Refer to the assembly procedure in this section.
   - Retest.

3. If the DTR sensor fails, replace it.

   After testing is finished, follow the Disconnecting The Tester procedure in this section.

Disconnecting The Tester

1. **CAUTION: Do not attempt to pry off connectors with a screwdriver. This will damage the connector and could result in a transmission concern.**

   Disconnect transmission tester from the DTR sensor connector.

2. Reinstall vehicle wiring harness. Verify connection by pulling up on the harness.

3. Reinstall all heat shields that were previously removed.

4. Disconnect transmission tester power lead from vehicle.

5. Erase all DTCs using the procedures in the Powertrain Control/Emissions Diagnosis Manual.

6. Rerun On-Board Diagnostic Tests to receive a pass code.

7. Verify that the customer concern has been eliminated.

Digital Transmission Range (DTR) Sensor Connector

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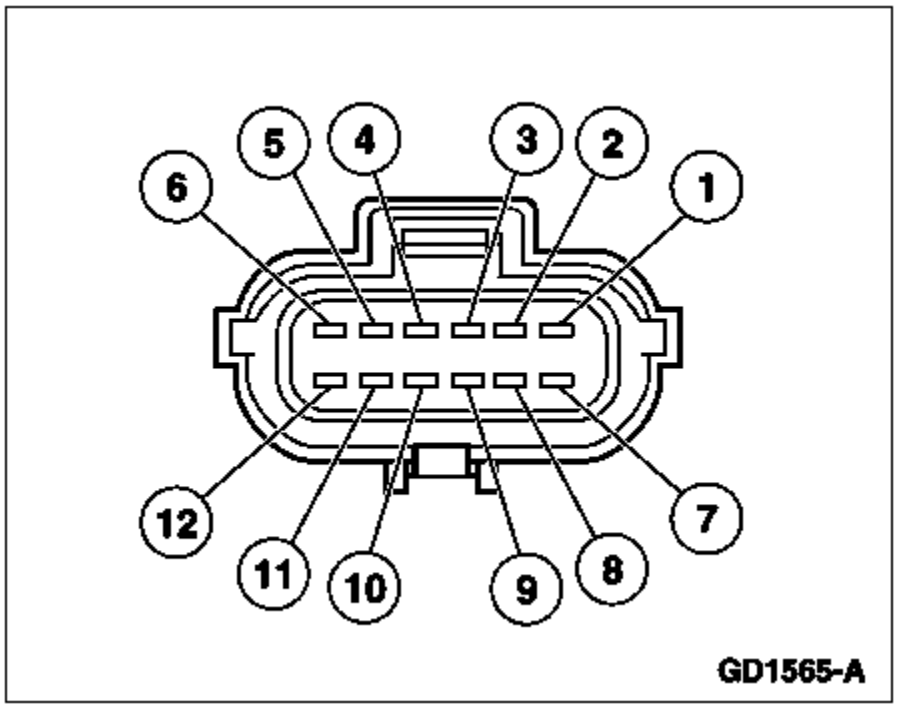

Pin Number	Circuit	EEC-V Pin Number	Circuit Function
1	—	—	NOT USED
2	359 (GY/R)	91	Signal Return
3	199 (LB/Y)	64	TR3A
4	1144 (Y/BK)	3	TR1
5	1145 (LB/BK)	49	TR2
6	1143 (W/BK)	50	TR4
7	57 (BK)	—	Ground
8	463 (R/W)	—	Neutral Sense
9	298 (P/O)	—	Fused Power Feed
10	32 (R/LB)	—	Starter Control
11	140 (BK/PK)	—	Back Up
12	33 (W/PK) * 329 (PK) **	—	Starter to Starter Interrupt Relay

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Transmission

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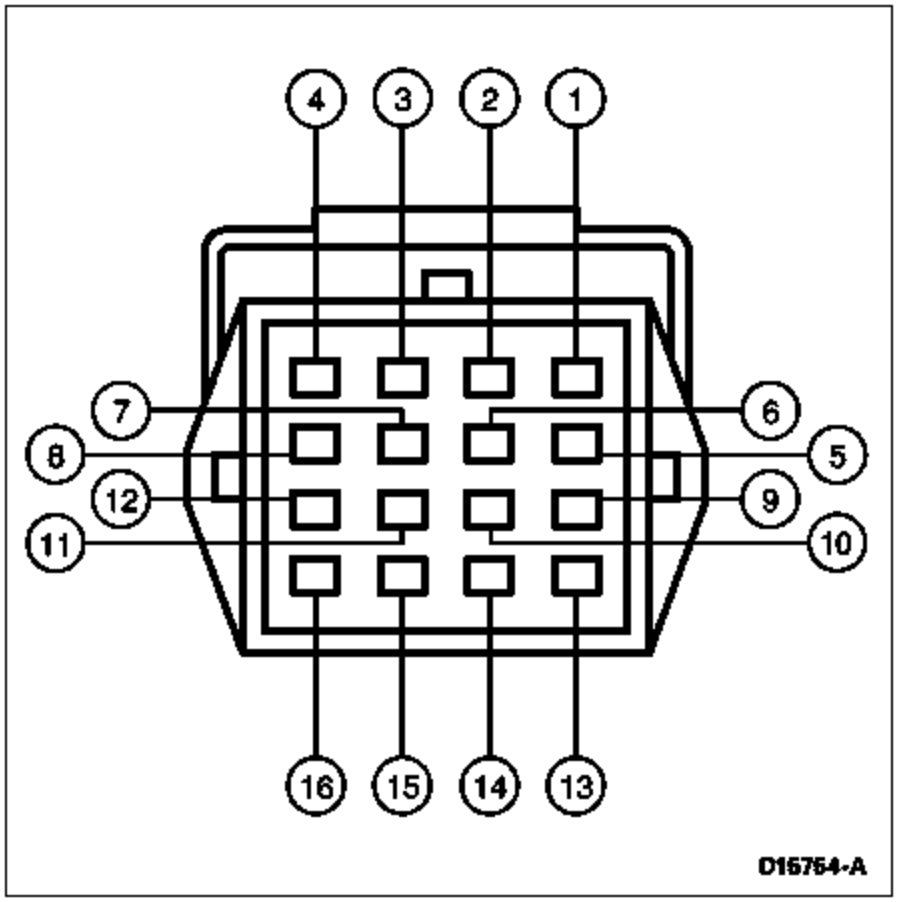

Pin Number	Circuit	Circuit Function
1	361 (R)	TCC Power
2	970 (GN/W)	Turbine Shaft Speed Sensor Signal
3	359 (GY/R)	Sensor Signal Return (TSS)
4	923 (O/BK)	Transmission Fluid Temperature Sensor
5	126 (P/Y) * 480 (P/Y) **	Torque Clutch Solenoid
6	—	NOT USED
7	971 (PK/BK)	Shift Solenoid No. 3
8	359 (GR/R)	Sensor Signal Return (TFT)
9	924 (BR/O)	Coast Clutch Solenoid
10	361 (R)	Shift Solenoid Power
11	361 (R)	EPC Power
12	925 (W/Y)	Electronic Pressure Control Solenoid
13	—	NOT USED
14	315 (P/O)	Shift Solenoid No. 2
15	—	NOT USED

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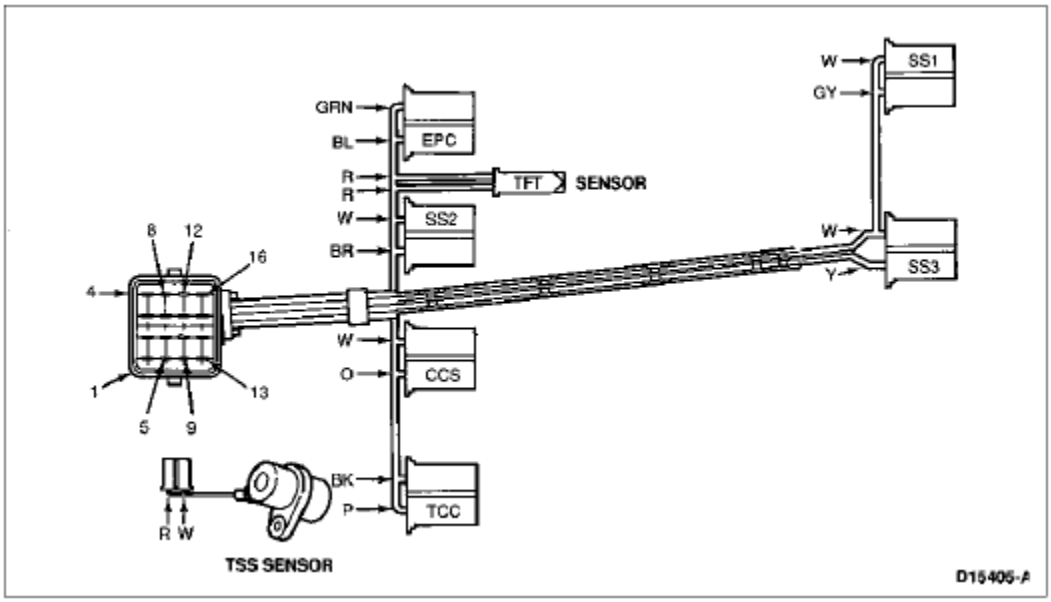
16	237 (O/Y)	Shift Solenoid No. 1

* Ranger
** Aerostar

Internal Harness Diagram



Pin Number	Circuit	Circuit Function
1	Black	TCC Power
2	Red	Turbine Shaft Speed Sensor Signal
3	White	Sensor Signal Return (TSS-)
4	Red	Transmission Fluid Temperature Sensor
5	Purple	Torque Converter Clutch Solenoid
6	—	NOT USED
7	Yellow	Shift Solenoid No. 3
8	Red	Sensor Signal Return (TFT-)
9	Orange	Coast Clutch Solenoid
10	White	Shift Solenoid Power
11	Green	EPC Power
12	Blue	Electronic Pressure Control Solenoid
13	—	NOT USED
14	Brown	Shift Solenoid No. 2
15	—	NOT USED
16	Gray	Shift Solenoid No. 1

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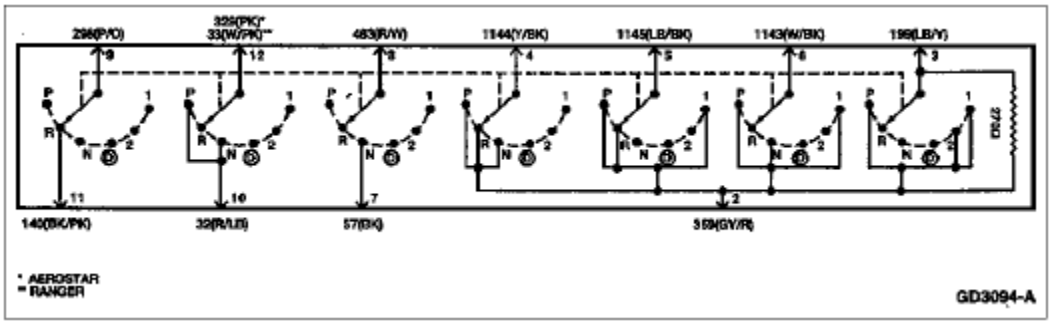
Transmission Range Sensor Internal Circuitry



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Pinpoint Tests

PINPOINT TEST A: SHIFT SOLENOIDS

Solenoid Operation Chart

The following chart shows normal solenoid operation for given operating modes.

SOLENOID OPERATION CHART — 4R44E

Transmission Range Selector Lever Position	Powertrain Control Module (PCM) Gear Commanded	4R44E Solenoid States				
		Engine Braking	SS1	SS2	SS3	CCS
P/N	P/N	No	On	Off	Off	Off
R	R	Yes [1]	On	Off	Off	O/W [1]
(D)(Overdrive)	1 2 3 4	No No No No	On On Off Off	Off On Off Off	Off Off Off On	Off Off Off Off
(D) [1]	1	Yes	On	Off	Off	On
	2 3	Yes Yes	On Off	On Off	Off Off	On On
Manual 2	2	Yes	On	On	Off	On
Manual 1	1	Yes	On	Off	Off	On

[1] O/W = TCS "ON"

Shift Solenoid Failure Mode Charts

NOTE: 2nd and 4th gear in O/D position can only be obtained with sufficient EPC pressure (i.e., no short in EPC circuit can be present).

Shift Solenoid Failure "Always Off"

Shift Solenoid failed in the OFF mode due to PCM and/or vehicle wiring concerns; solenoid electrically or mechanically stuck in the OFF mode.

SS1 Always OFF:	Transmission Range Selector Lever Position		
	OD	2	1

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PCM Gear Commanded	Actual Gear Obtained		
1	3	—	2
2	2	2	2 [1]
3	3	—	—
4	4	—	—

[1] When a manual pull-in occurs above a calibrated speed, the transmission will downshift from the higher gear until the vehicle speed drops below this calibrated speed.

SS2 Always OFF:	Transmission Range Selector Lever Position		
	OD	2	1
PCM Gear Commanded	Actual Gear Obtained		
1	1	—	1
2	1	2	1
3	3	—	—
4	4	—	—

SS3 Always OFF:	Transmission Range Selector Lever Position		
	OD	2	1
PCM Gear Commanded	Actual Gear Obtained		
1	1	—	1
2	2	2	2 [1]
3	3	—	—
4	3	—	—

[1] When a manual pull-in occurs above a calibrated speed, the transmission will downshift from the higher gear until the vehicle speed drops below this calibrated speed.

Shift Solenoid Failure "Always On"

Failed ON due to powertrain control module (PCM) (12A650) and/or vehicle wiring concerns; solenoid electrically or mechanically stuck ON.

SS1 Always ON:	Transmission Range Selector Lever Position		
	OD	2	1
PCM Gear Commanded	Actual Gear Obtained		
1	1	—	1
2	2	2	2 [1]
3	1	—	—
4	Ratio 1.86	—	—

[1] When a manual pull-in occurs above a calibrated speed, the transmission will downshift from the higher gear until the vehicle speed drops below this calibrated speed.

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SS2 Always ON:	Transmission Range Selector Lever Position		
	OD	2	1
PCM Gear Commanded	Actual Gear Obtained		
1	2	—	2
2	2	2	2
3	2	—	—
4	2	—	—

SS3 Always ON:	Transmission Range Selector Lever Position		
	OD	2	1
PCM Gear Commanded	Actual Gear Obtained		
1	Ratio 1.86	—	Ratio 1.86
2	Ratio 1.11	Ratio 1.11	Ratio 1.11 [1]
3	4	—	—
4	4	—	—

[1] When a manual pull-in occurs above a calibrated speed, the transmission will downshift from the higher gear until the vehicle speed drops below this calibrated speed.

NOTE: 2nd and 4th gear in O/D position can only be obtained with sufficient EPC pressure (i.e., no short in EPC circuit can be present).

A1 ELECTRONIC DIAGNOSTICS

- Check to make sure transmission harness connector is fully seated, terminals are fully engaged in connector and in good condition before proceeding.
- Connect New Generation STAR (NGS) Tester 007-00500 or equivalent.
- Perform KOEO test until continuous DTCs have been displayed.
- Enter output test mode (OTM). Refer to On-Board Diagnostics with NGS as outlined.
- Select the mode "ALL ON".
- Push START to turn outputs "ON".
- Push STOP to turn outputs "OFF".

Does vehicle enter OTM?

Yes	No
REMAIN in OTM. GO to **A2** .	PRESS START. If vehicle does not enter OTM, REFER to Powertrain Control/Emissions Diagnosis Manual for diagnosis and testing of the automatic transmission.

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A2 CHECK ELECTRICAL SIGNAL OPERATION

CAUTION: Do not pry up on connector, depress release button, then pull up on the connector.

NOTE: Refer to the schematic and chart preceding this pinpoint test.

- Disconnect transmission connector.
- Using a mirror, inspect both ends of connector for damaged or pushed out pins, corrosion, loose wires, and missing or damaged seals.
- Connect Rotunda 73 Digital Multimeter 105-R0051 or equivalent positive lead to VPWR and negative test lead to the solenoid circuit of the transmission vehicle harness connector.
- Place multimeter on 20-volt scale.
- While observing multimeter, press "start" and "stop" to cycle solenoid output ON and OFF.

Does the suspect solenoid output voltage change at least 0.5 volts?

Yes	No
GO to **A5**	GO to **A3** .

A3 CHECK CONTINUITY OF SOLENOID SIGNAL AND VPWR HARNESS CIRCUITS

NOTE: Refer to the schematic and chart preceding this pinpoint test.

- Key OFF.
- Ensure harness transmission connector is disconnected.
- Disconnect powertrain control module (PCM), inspect for damage or pushed out pins, corrosion, or loose wires.
- Install Rotunda Breakout Box 014-00950 or equivalent, leave PCM disconnected.
- Measure resistance between PCM test Pins 1, 27, 53 at the breakout box and the appropriate signal pin at transmission harness connector.
- Measure resistance between PCM test Pins 71/97 at the breakout box and the appropriate signal pins at the transmission harness connector.

Is each resistance less than 5.0 ohms?

Yes	No
GO to **A4** .	SERVICE open circuits. REMOVE breakout box. RECONNECT all components. REPEAT Quick Test.

A4 CHECK SOLENOID HARNESS FOR SHORTS TO POWER AND GROUND

NOTE: Refer to the schematic and chart preceding this pinpoint test.

- Ensure Rotunda Breakout Box 014-00950 or equivalent is installed and powertrain control module disconnected.

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- Ensure transmission harness connector is disconnected.
- Measure resistance between PCM signal test Pins 1, 27, 53 and the test Pins 71/97 at the breakout box.
- Measure resistance between PCM test Pins 1, 27, 53 and PCM test Pins 91 and test Pins 77, 103 at the breakout box and chassis ground.

Is each resistance greater than 10,000 ohms?

Yes	No
GO to **A5** .	SERVICE short circuit. REMOVE breakout box. RECONNECT all components. REPEAT Quick Test.

A5 TRANSMISSION FUNCTIONAL TEST

CAUTION: Do not pry connector. Pull transmission harness connector.

- Ensure that the vehicle harness is disconnected at transmission.
- Install tester to Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit) with Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in Transmission Tester Kit or equivalent.
- Use tests outlined in the Transmission Tester manual.
- Perform Solenoid Function Test.
- LED will turn green when solenoid activates and turn off when deactivated.
- LED will turn red if an activated solenoid/harness is shorted to BAT+ .
- LED will remain off if an activated solenoid/harness is shorted to ground or no continuity (open circuit).

Do the solenoids (LED) activate? (LED green)

Yes	No
GO to **A6** .	GO to **A7** .

A6 TRANSMISSION DRIVE TEST

- Reconnect PCM.
- Perform the Drive Test outlined in the Transmission Tester Manual.

Does the vehicle upshift when commanded by the tester?

Yes	No
REPLACE PCM. ERASE all codes and PERFORM the Transmission Drive Cycle Test as outlined in this manual. RERUN Quick Test. If the codes are still present, REFER to the Diagnosis By Symptom Routines .	GO to **A7** .

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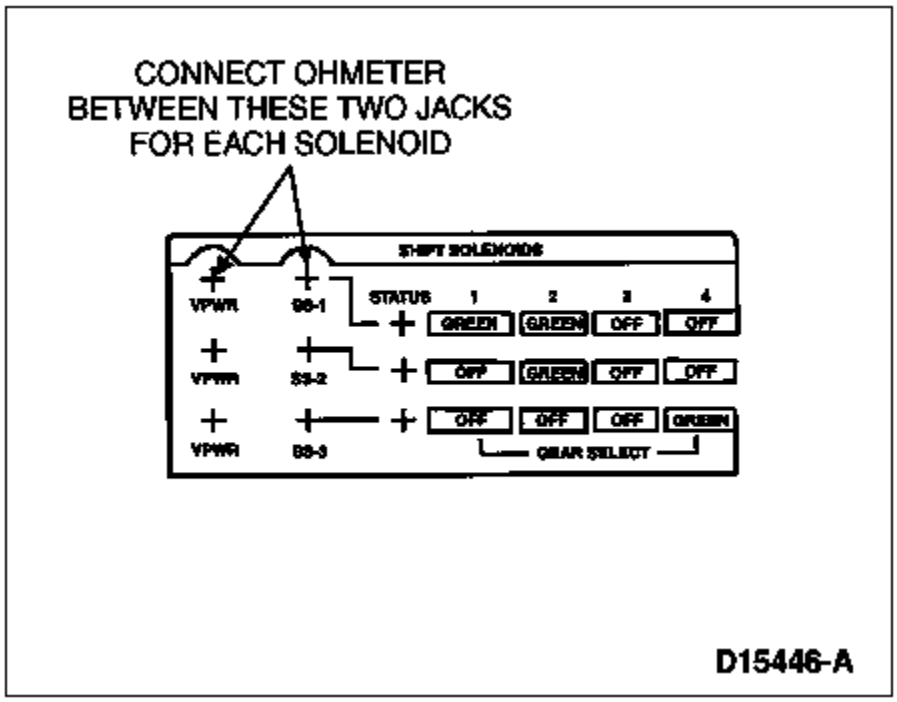
A7 CHECK RESISTANCE OF SOLENOID/HARNESS

NOTE: Refer to transmission tester for terminal locations.

- Set MODE switch to **BENCH** position.
- Rotate GEAR SELECTOR switch to **OHMS CHECK** position.
- Connect ohmmeter negative lead to SS1 jack and positive lead to VPWR jack on tester. This is to test SS1.
- Record resistance. Should be between 22-48 ohms.
- Connect ohmmeter negative lead to SS2 jack and positive lead to VPWR jack on tester. This is to test SS2.
- Record resistance. Should be between 22-48 ohms.
- Connect ohmmeter negative lead to SS3 jack and positive lead to VPWR jack on tester. This is to test SS3.
- Record resistance. Should be between 22-48 ohms.

Are all shift solenoid resistances within specifications?



Yes	No
GO to **A8** .	**NOTE: Out of specifications may be caused by internal harness or solenoid concerns.** GO to **A9** .

A8 CHECK SOLENOID/HARNESS FOR SHORT TO GROUND

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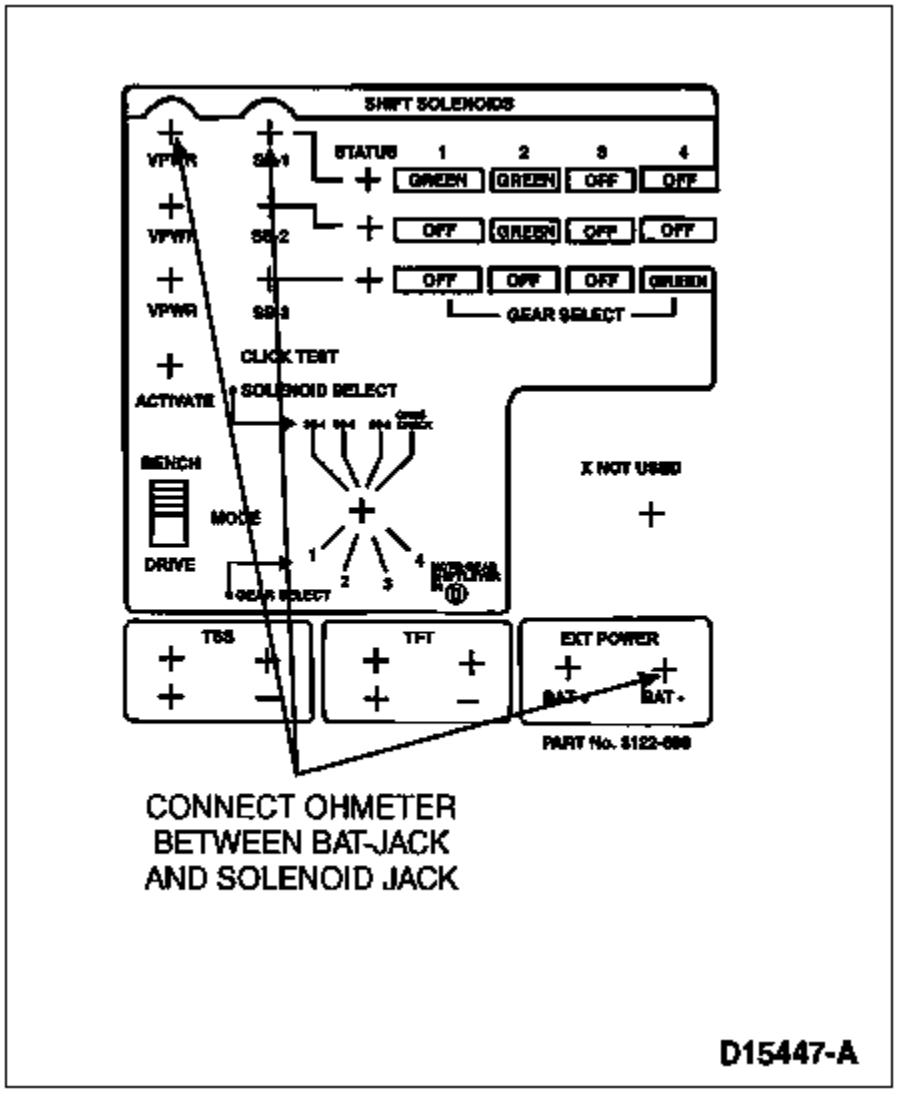
- Check for continuity between BAT- (engine ground) and appropriate jack with an ohmmeter or other low current tester (less than 200 milliamps).



Solenoid	Tester Jack
SS1	SS1 VPWR
SS2	SS2 VPWR
SS3	SS3 VPWR

- Connection should show infinite resistance (no continuity).

Is there continuity?

Yes	No

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GO to **A9** .	GO to the Shift Concerns in the Diagnosis By Symptom Index .

A9 INTERNAL ELECTRONIC DIAGNOSTICS

- Drain transmission fluid.
- Remove transmission fluid pan.
- Check that internal harness connector is fully engaged on shift solenoid assemblies.
- Check that internal harness connector terminals are fully seated in connector.
- Inspect connectors for damage.
- Inspect wires for insulation damage.

Were checks done and was everything OK?

Yes	No
GO to **A10** .	SERVICE as required.

A10 CHECK INTERNAL HARNESS (CONTINUITY)

CAUTION: Do not probe into connector terminals.

- Disconnect internal harness from solenoid assemblies.
- For SS1, connect positive lead from ohmmeter to tester jack SS1 and negative lead at appropriate signal wire of SS1 wire connector.
- Record resistance. Should be less than 0.5 ohms.
- For SS2, connect positive lead from ohmmeter to tester jack SS2 and negative lead at appropriate signal wire of the SS2 connector.
- Record resistance. Should be less than 0.5 ohms.
- For SS3, connect positive lead from ohmmeter to test jack SS3 and negative lead at appropriate signal wire of the SS3 wire connector.
- Record resistance. Should be less than 0.5 ohms.
- For SS1, SS2, and SS3 VPWR, connect positive lead from an ohmmeter to appropriate solenoid VPWR and negative lead to appropriate VPWR wire for SS1, SS2, or SS3.
- Record resistance. Should be less than 0.5 ohms.

Wire Colors					
SS1		SS2		SS3	
Signal	PWR	Signal	PWR	Signal	PWR
Gray	White	Brown	White	Yellow	White

Is resistance less than 0.5 ohms?

Yes	No
GO to **A11** .	REPLACE internal harness. GO to **A12** .

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A11 CHECK INTERNAL HARNESS (SHORTS TO GND)

- Check for continuity between BAT- (engine ground) and appropriate wire with ohmmeter or other low current tester (less than 200 milliamps).

Wire Colors					
SS1		SS2		SS3	
Signal	PWR	Signal	PWR	Signal	PWR
Gray	White	Brown	White	Yellow	White

- Connection should show infinite resistance (no continuity).

Is there continuity?

Yes	No
REPLACE internal harness. GO to **A12** .	GO to **A12** .

A12 CHECK SOLENOID RESISTANCE AT SOLENOID

- Check solenoid resistance by connecting ohmmeter at solenoid terminals.
- Measure and record resistance for each solenoid (SS1, SS2, SS3).

Is resistance between 22-48 ohms?

Yes	No
GO to **A13** .	REPLACE shift solenoid.

A13 CHECK SOLENOID FOR SHORT TO GROUND

- Check for continuity between engine ground and appropriate shift solenoid terminal with ohmmeter or other low current tester (less than 200 milliamps).

Solenoid	Terminal
SS1	+/-
SS2	+/-
SS3	+/-

- Connection should show infinite resistance (no continuity).

Is there continuity?

Yes	No
REPLACE shift solenoid.	REFER to the Diagnosis By Symptom Routines .

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PINPOINT TEST B: TRANSMISSION FLUID TEMPERATURE (TFT) SENSOR

B1 4R44E ELECTRICAL DIAGNOSIS

- Make sure transmission harness connector is fully seated and terminals are fully engaged in connector and in good condition before proceeding.

Have items been checked?

Yes	No
GO to **B2** .	PERFORM checks. ERASE codes. REPEAT Quick Test.

B2 CHECK ELECTRICAL SIGNAL OPERATION

CAUTION: Do not pry up on connector. Depress release button, then pull up on the vehicle harness.

NOTE: Refer to the schematic and chart preceding this pinpoint test.

- Key OFF.
- Disconnect transmission connector.
- Using a mirror, inspect both ends of the connector for damaged or pushed out pins, corrosion, or loose wires and missing or damaged seals.
- Connect Rotunda 73 Digital Multimeter 105-R0051 or equivalent positive test lead to TFT circuit and negative test lead to Signal Return (SIG RTN) circuit of transmission vehicle harness connector.
- Place multimeter on 20-volt scale.
- Turn key ON, engine OFF.

Is voltage between 4.75 and 5.25 volts?

Yes	No
GO to **B5** .	GO to **B3** .

B3 CHECK CONTINUITY OF TFT AND SIG RTN CIRCUITS

NOTE: Refer to the schematic and chart preceding this pinpoint test.

- Key OFF.
- Ensure that the vehicle harness is disconnected at the transmission connector.
- Disconnect powertrain control module (PCM). Inspect for damaged or pushed out pins, corrosion or loose wires.
- Install Rotunda Breakout Box 014-00950 or equivalent. Leave PCM disconnected.

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- Measure resistance between PCM test Pin 37 at the breakout box and the appropriate signal pin at transmission harness connector.
- Measure resistance between PCM test Pin 91 at the breakout box and the appropriate signal pins at the transmission harness connector.

Are both resistances less than 5.0 ohms?

Yes	No
GO to **B4** .	SERVICE open circuit(s). REMOVE breakout box. RECONNECT all components. ERASE all codes. REPEAT Quick Tests.

B4 CHECK TFT CIRCUIT FOR SHORT TO VPWR AND GROUND

NOTE: Refer to the schematic and chart preceding this pinpoint test.

- Key OFF.
- Ensure transmission harness connector is disconnected.
- Disconnect powertrain control module. Inspect for damaged or pushed out pins, corrosion or loose wires.
- Install Rotunda Breakout Box 014-00950 or equivalent. Leave powertrain control module disconnected.
- Measure resistance between PCM test signal Pin 37 and the test Pins 71/97 at the breakout box.
- Measure resistance between TFT test pin 37 and chassis ground, Pins 51, 76, 77, 103 and 91.

Is the resistance greater than 10,000 ohms?

Yes	No
GO to **B5** .	SERVICE short circuit. REMOVE breakout box. RECONNECT all components. ERASE codes. REPEAT Quick Tests.

B5 CHECK RESISTANCE OF TFT SENSOR

CAUTION: Do not pry up on connector. Depress release button, then pull up on vehicle harness connector.

NOTE: Be sure tester solenoid select switch is in the OHMS CHECK position or damage to ohmmeter may result.

- Vehicle at normal operating temperature.
- Disconnect vehicle harness at transmission.
- Install Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit) with Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in Transmission Tester Kit or equivalent to transmission connector.
- Set MODE switch to BENCH mode.
- Rotate solenoid select switch to OHMS CHECK mode.
- Connect ohmmeter negative lead to -TFT jack and positive lead to + TFT jack.

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NOTE: While performing tests 1 and 2 observe resistances. Code P0713 is set if resistance value exceeds 869K ohms (OPEN circuit). Code P0712 is set if resistance value falls below 597 ohms (SHORT circuit).

- Perform tests 1 and 2.
- Test 1: Record resistance. Should be approximately in following ranges:

Transmission Fluid Temperature

℃	℉	Resistance (Ohms)
-40 - -20	-40 - -4	967k-248k
-19 - -1	-3 - 31	248k-100k
0-20	32-68	100k-37k
21-40	69-104	37k-16k
41-70	105-158	16k-5k
71-90	159-194	5k-2.7k
91-110	195-230	2.7k-1.5k
111-130	231-266	1.5k-0.8k
131-150	267-302	0.8k-0.54k

- Test 2: Check for intermittent short or open.
- If resistance was between 0.8k and 100k ohms, perform following test. If transmission is cold, run transmission to warm it. If transmission is warm, allow transmission to cool. Check TFT sensor resistance again. Compare resistance with initial resistance. Resistance should decrease if transmission was heated and should increase if transmission was allowed to cool. If correct change in resistance occurs, repeat On-Board Diagnostics.

Is resistance within range?

Yes	No
GO to **B6** .	REPLACE internal transmission wiring harness. CLEAR codes. RERUN Quick Test.

B6 CHECK TFT SENSOR/HARNESS FOR SHORT TO GROUND

- Check for continuity between BAT- (engine ground) and appropriate jack (-TFT and +TFT), appropriate wire with ohmmeter, or other low current tester (less than 200 milliamps).
- Connection should show infinite resistance (no continuity).

Is there continuity?

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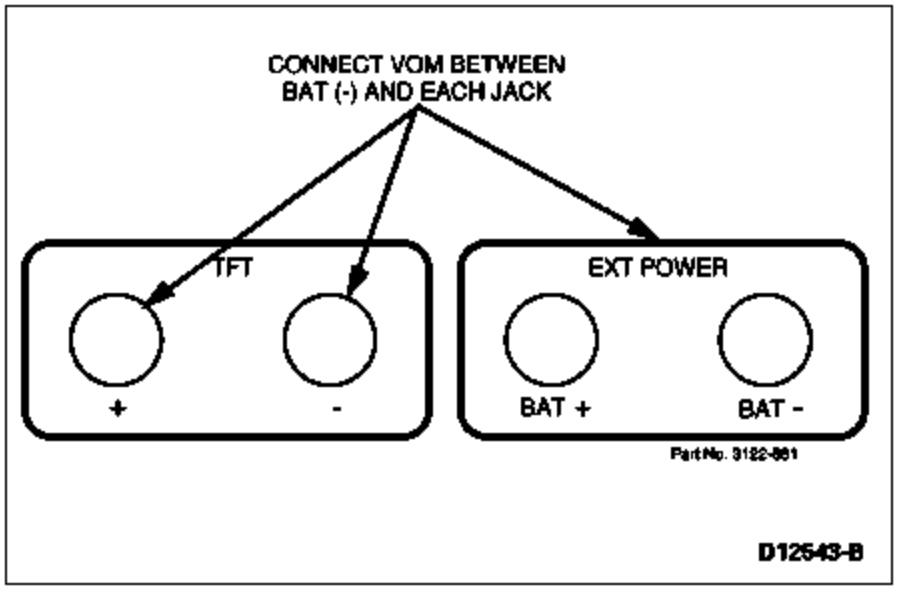

Yes	No
GO to **B7** .	REPLACE powertrain control module. CLEAR codes and RERUN Self Test.

B7 INTERNAL ELECTRONIC DIAGNOSTICS

- Drain transmission fluid.
- Remove transmission fluid pan.
- Check that internal harness connector is fully seated on TFT sensor.
- Check that internal harness connector terminals are fully engaged in connector.
- Inspect connector for damage.

Is everything in good condition?

Yes	No
REPEAT Quick Test. If codes are present and overtemp condition exists, CHECK fluid condition. CHECK overheat condition in the Diagnosis By Symptom Routine . SERVICE as required. REPEAT Quick Test.	SERVICE as required. REPLACE internal harness.

PINPOINT TEST C: TORQUE CONVERTER CLUTCH (TCC) SOLENOID

C1 ELECTRONIC DIAGNOSTICS

- Check to make sure transmission harness connector is fully seated, terminals are fully engaged in connector and in good condition before proceeding.

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- Connect New Generation STAR (NGS) Tester 007-00500 or equivalent.
- Perform KOEO test until continuous DTCs have been displayed.
- Enter output test mode (OTM). Refer to On-Board Diagnostics with NGS as outlined.
- Select the mode "ALL ON".
- Push START to turn outputs "ON".
- Push STOP to turn outputs "OFF".

Does vehicle enter OTM?

Yes	No
REMAIN in OTM. GO to C2.	PRESS START. If vehicle does not enter OTM, REFER to Powertrain Control/Emissions Diagnosis Manual for diagnosis and testing of the automatic transmission.

C2 CHECK ELECTRICAL SIGNAL OPERATION

CAUTION: Do not pry up on connector. Depress release button, then pull up on the vehicle harness.

NOTE: Refer to the schematic and chart preceding this pinpoint test.

- Disconnect transmission connector.
- Using a mirror, inspect both ends of the connector for damaged or pushed out pins, corrosion, loose wires and missing or damaged seals.
- Connect Rotunda 73 Digital Multimeter 105-R0051 or equivalent positive test lead to VPWR circuit and negative test lead to solenoid circuit of transmission vehicle harness connector.
- Place multimeter on 20-volt scale.
- While observing multimeter, press "start" and "stop" to cycle solenoid ON and OFF.

Does the suspected solenoid output voltage change at least 0.5 volts?

Yes	No
GO to C5.	GO to C3.

C3 CHECK CONTINUITY OF SOLENOID SIGNAL AND VPWR HARNESS CIRCUITS

NOTE: Refer to the schematic and chart preceding this pinpoint test.

- Turn key OFF.
- Ensure transmission harness connector is disconnected.
- Disconnect powertrain control module (PCM). Inspect for damaged or pushed out pins, corrosion or loose wires.
- Install Rotunda Breakout Box 014-00950 or equivalent. Leave powertrain control module disconnected.
- Measure resistance between PCM test Pin 54 at the breakout box and the appropriate signal pin at transmission harness connector.
- Measure resistance between PCM test Pins 71/97 at the breakout box and the VPWR pin at the

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transmission harness connector.

Is each resistance less than 5.0 ohms?

Yes	No
GO to C4 .	SERVICE the open circuit(s). REMOVE the breakout box. RECONNECT all components. REPEAT Quick Test.

C4 CHECK SOLENOID/HARNESS FOR SHORTS TO POWER AND GROUND

NOTE: Refer to the schematic and chart preceding this pinpoint test.

- Ensure Rotunda Breakout Box 014-00950 or equivalent is installed and powertrain control module is disconnected.
- Ensure transmission vehicle harness connector is disconnected.
- Measure resistance between PCM signal test Pin 54 and the test Pins 71/97 at the breakout box.
- Measure resistance between PCM signal test Pin 54 and test Pins 51, 76, 77, 91 and 103 at the breakout box and chassis ground.

Is the resistance greater than 10,000 ohms?

Yes	No
GO to C5 .	SERVICE the short circuit(s). REMOVE the breakout box. RECONNECT all components. REPEAT Quick Test.

C5 TRANSMISSION FUNCTIONAL TEST

CAUTION: Do not pry connector. Pull on transmission harness connector.

- Disconnect vehicle harness at transmission.
- Install Rotunda Tester 007-00130 (part of Rotunda Transmission Tester Kit) with Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in Transmission Tester Kit to transmission connector.
- Use tests outlined in the Transmission Tester manual.
- Perform TCC Solenoid Function Test.
- LED will turn green when solenoid activates and turn off when deactivated.
- LED will turn red if an activated solenoid/harness is shorted to BAT+ .
- LED will remain off if an activated solenoid/harness is shorted to ground or no continuity (open circuit).

Does the TCC (LED green) activate when the tester switch is depressed?

Yes	No
GO to C6 .	GO to C7 .

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C6 TRANSMISSION DRIVE TEST

- Reconnect PCM.
- Perform the Drive Test as outlined in Transmission Tester Manual.
- While in 3rd gear, depress the TCC switch.

Does the TCC activate (LED green)? Does the engine rpm drop?

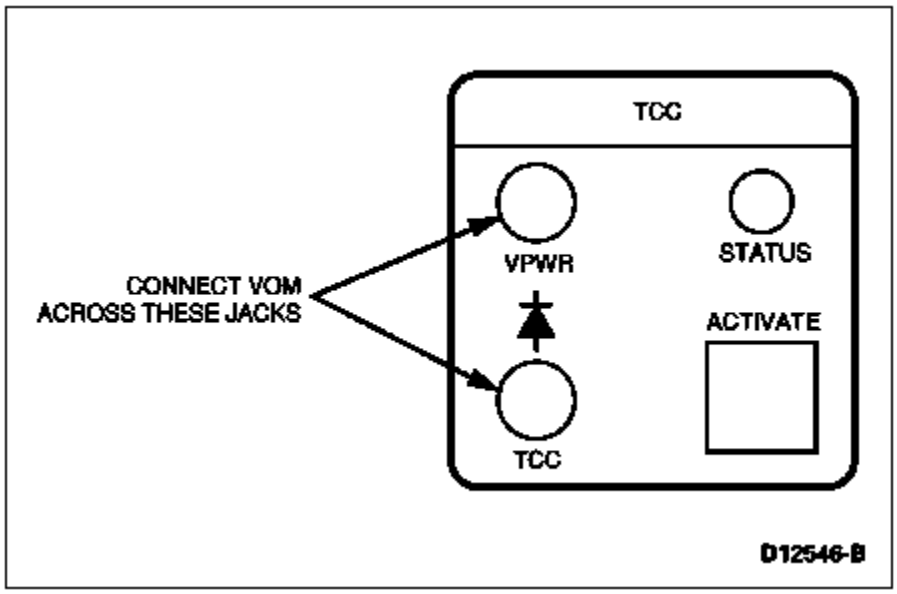
Yes	No
REPLACE PCM. ERASE all codes and PERFORM Transmission Drive Cycle Test and Torque Converter Engagement Test as outlined in this manual. RERUN Self Test. If codes are still present, REFER to the Diagnosis By Symptom Index — Torque Converter Concerns for continued diagnosis.	GO to **C7**.

C7 CHECK RESISTANCE OF SOLENOID/HARNESS

Refer to Transmission Tester for terminal locations.

- Set MODE switch to BENCH mode on tester.
- Rotate GEAR SELECTOR switch to OHMS CHECK position.
- Connect ohmmeter negative lead to TCC jack and positive lead to VPWR jack on tester. This is to test TCC.
- Record resistance. Should be between 8.9-16.0 ohms for TCC.

Is resistance within specifications?



Yes	No

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GO to **C8** .	**NOTE: Internal harness or solenoid may be damaged.** GO to **C9** .

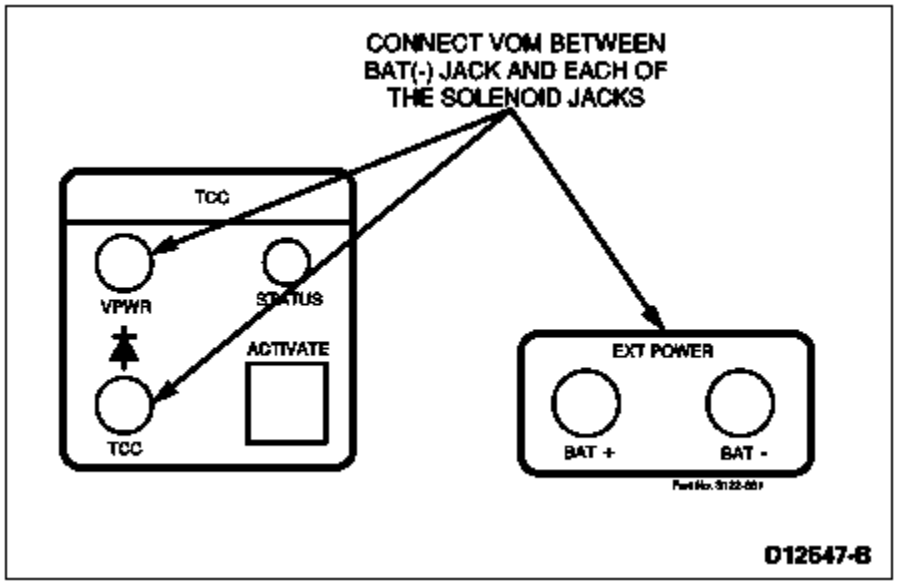
C8 CHECK SOLENOID/HARNESS FOR SHORT TO GROUND

- Check for continuity between BAT- (engine ground) and appropriate jack with ohmmeter or other low current tester (less than 200 milliamps).

Solenoid	Tester Jack
TCC	TCC VPWR

- Connection should show infinite resistance (no continuity).

Is there continuity?



Yes	No
GO to **C9** .	REFER to Diagnosis By Symptom Index in this manual to diagnose torque converter clutch concerns.

C9 INTERNAL ELECTRONIC DIAGNOSTICS

- Drain transmission fluid.
- Remove transmission fluid pan.
- Check that internal harness connector is fully seated on TCC solenoid.

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- Check that internal harness connector terminals are fully engaged in connector.
- Inspect connector for damage.

Is connector in good condition and seated properly?

Yes	No
GO to **C10** .	SERVICE as required.

C10 CHECK INTERNAL HARNESS (CONTINUITY)

NOTE: Do not probe into connector terminals.

- Disconnect internal harness from solenoid (TCC wire connector).
- Connect positive lead from ohmmeter to tester TCC jack and negative lead at purple wire at TCC connector.
- Record resistance. Should be less than 0.5 ohms.
- Next, connect positive lead from ohmmeter to tester VPWR jack and negative lead at black wire of TCC connector.

Record resistance. Is resistance less than 0.5 ohms?

Yes	No
GO to **C11** .	REPLACE internal harness. GO to **C12** .

C11 CHECK INTERNAL HARNESS

- Check for continuity between BAT- (engine ground) and the appropriate wire with an ohmmeter or other low current tester (less than 200 milliamps).

Solenoid	Wire Color
TCC	Purple
VPWR	Black

- Connection should not show continuity (infinite).

Is there continuity?

Yes	No
REPLACE internal harness. GO to **C12** .	GO to **C12** .

C12 CHECK SOLENOID RESISTANCE

- Check solenoid resistance by connecting ohmmeter at terminals of TCC solenoid.
- Record resistance. Should be between 8.9-16.0 ohms for TCC.

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Is resistance within specification?

Yes	No
GO to **C13** .	REPLACE TCC solenoid.

C13 CHECK SOLENOID FOR SHORT TO GROUND

- Check for continuity between BAT- (engine ground) and appropriate terminal with ohmmeter or other low current tester (less than 200 milliamps).

Solenoid	Terminal
TCC	+/-

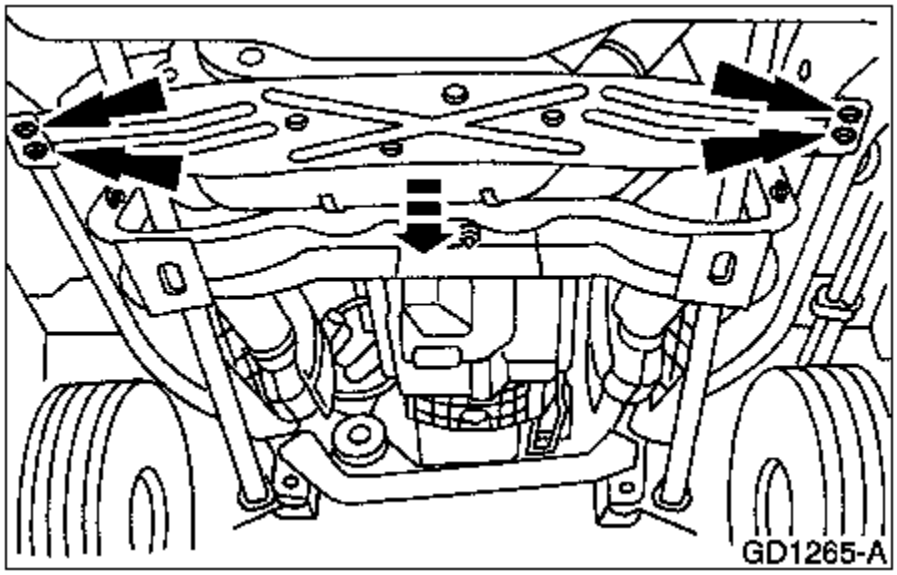
- Connection should show infinite resistance (no continuity).

Is there continuity?

Yes	No
REPLACE TCC solenoid.	REFER to Diagnosis By Symptom Index in this section for torque converter clutch concerns.

PINPOINT TEST D: DIGITAL TRANSMISSION RANGE (DTR) SENSOR

Digital TR Sensor Overlay



D1 VERIFY DIGITAL TRANSMISSION RANGE SENSOR ALIGNMENT

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- Turn ignition switch OFF.
- Place transmission range selector lever in PARK.
- Check to make sure the DTR sensor harness connector is fully seated, terminals are fully engaged in connector and in good condition before proceeding.
- Apply the parking brake.
- Place transmission range selector lever in OVERDRIVE.
- Verify the shift linkage is adjusted in the OVERDRIVE (O/D) position.
- Place transmission range selector lever in NEUTRAL.
- Verify that the Digital TR Sensor Alignment Tool (T97L-70010-A) fits in the appropriate slots.

Is the DTR sensor properly adjusted?

Yes	No
GO to **D2** .	ADJUST the DTR sensor as outlined under Assembly . PLACE transmission range selector lever into PARK and CLEAR DTCs. RERUN OBD tests.

D2 CHECK ELECTRICAL SIGNAL OPERATION

- Place transmission range selector lever in PARK.

CAUTION: Do not pry on connector. This will damage the connector and result in a transmission concern.

- Press button and pull out on DTR harness connector.
- Inspect both ends of the connector for damage or pushed out pins, corrosion, loose wires and missing or damaged seals.

Is there damage to the connector, pins or harness?

Yes	No
REPAIR as required. CLEAR DTCs and RERUN OBD tests.	If diagnosing a DTC, GO to **D3** . If diagnosing a starting concern, a backup lamp concern, or 4x4 low engagement concern, GO to **D8** .

D3 CHECK ELECTRICAL SYSTEM OPERATION (DTR AND PCM)

- Turn ignition switch OFF.
- Connect the New Generation STAR (NGS) tester.
- Reconnect DTR connector.
- Turn ignition switch ON.
- Select TR PIDs TR and TR_D on the NGS tester.
- Move transmission range selector lever into each gear and stop.
- Observe the PIDs, TR and TR_D, while wiggling harness and tapping on sensor.

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- Compare the PIDs to the chart below:

Selector Position	TR	TR_D
Park	P/N	0000
Reverse	REV	1100
Neutral	NTRL	0110
Drive	O/D *	1111
Man 2	MAN2	1001
Man 1	MAN1	0011

* Will read DRIVE if O/D cancel switch is ON.

Do the PIDs TR and TR_D match the above chart, and does the TR_D PID remain steady when the harness is wiggled or when the sensor is tapped upon?

Yes	No
The problem is not in the DTR sensor system. REFER to Diagnosis by Symptom for further diagnosis.	GO to **D4**. **NOTE: If TR_D changes when wiggling harness or tapping on the sensor, problem may be intermittent.**

D4 CHECK DIGITAL TRANSMISSION RANGE SENSOR OPERATION

- Disconnect DTR Sensor Connector.
- Connect TR-E Cable (007-00111) to Transmission Tester (007-00130).
- Connect TR-E Cable (007-00111) to DTR Sensor.
- Place the DIGITAL TR Overlay (007-00131) onto transmission tester (007-00130).
- Perform SENSOR TEST as instructed on the DTR overlay.

Does the status lamp on the tester TR-E cable match the selected gear positions?

Yes	No
Concern is not in the DTR sensor, GO to **D5**.	REPLACE the DTR sensor and ADJUST as outlined. REFER to Assembly for procedures. CLEAR DTCs and RERUN OBD tests.

D5 CHECK PCM HARNESS CIRCUITS FOR OPENS

NOTE: Refer to schematic diagram and illustration preceding the Pinpoint Tests.

- Turn ignition switch OFF.
- Disconnect powertrain control module (PCM) connector. Inspect for damaged or pushed out pins, corrosion or loose wires.

CAUTION: Do not pry connector. This will damage the connector and result in a

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transmission concern.

- Press button and pull out DTR connector.
- Install 104 Pin Breakout Box (014-00950).
- Measure resistance between PCM test pin 91 at the breakout box and signal return circuit pin at vehicle harness connector pin 2.
- Measure resistance between PCM test pin 3 at breakout box and TR1 circuit pin at vehicle harness connector pin 4.
- Measure resistance between PCM test pin 49 at breakout box and TR2 circuit pin at vehicle harness connector pin 5.
- Measure resistance between PCM test pin 50 at breakout box and TR4 circuit pin at vehicle harness connector pin 6.
- Measure resistance between PCM test pin 64 at breakout box and TR3A circuit pin at vehicle harness connector pin 3.

Are all resistances less than 5 ohms?

Yes	No
GO to **D6** .	REPAIR open circuit(s). RECONNECT all components. CLEAR DTCs. RERUN OBD tests.

D6 CHECK PCM HARNESS CIRCUITS FOR SHORT TO GROUND OR POWER

- Measure resistance between PCM test pin 91 and test pins 71/97 at breakout box.
- Measure resistance between PCM test pin 3 and power/ground test pins at breakout box.
- Measure resistance between PCM test pin 49 and power/ground test pins at breakout box.
- Measure resistance between PCM test pin 50 and power/ground test pins at breakout box.
- Measure resistance between PCM test pin 64 and power/ground test pins at breakout box.

Are all resistances greater than 10,000 ohms?

Yes	No
GO to **D7** .	REPAIR short circuit(s). RECONNECT all components. CLEAR DTCs. RERUN OBD tests.

D7 CHECK FOR SHORT BETWEEN TR/PCM INPUT SIGNAL CIRCUITS

- Measure resistance between test pin 3 and pins 49, 50 and 64 at the breakout box.
- Measure the resistance between test pin 49 and pins 3, 50 and 64 at the breakout box.
- Measure the resistance between test pin 50 and pins 3, 49 and 64 at the breakout box.
- Measure the resistance between test pin 64 and pins 3, 49 and 50 at the breakout box.

Are all resistances greater than 10,000 ohms?

Yes	No
REPLACE PCM. RECONNECT all components. CLEAR DTCs and RERUN OBD tests.	REPAIR shorts on circuits having less than 10,000 ohms between other TR/PCM input signal circuits. RECONNECT all components.

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	CLEAR DTCs and RERUN OBD tests.

D8 CHECK THE NON PCM INTERNAL CIRCUITS OF SENSOR

- Connect TR-E Cable (007-00111) to Transmission Tester (007-00130).
- Connect TR-E Cable (007-00111) to DTR sensor.
- Place the DIGITAL TR Overlay (007-00131) onto transmission tester (007-00130).
- Perform SWITCH TEST as instructed on the DTR overlay.

Does the status lamp on the tester indicate RED for the correct gear position?

Yes	No
Concern is not in the DTR sensor. For START SYSTEM concerns, GO to Section 03-06 . For Backup Lamp concerns, GO to Section 17-01 . For Optional Circuits: 4x4 Low Neutral Sense; REFER to Powertrain Control/Emissions Diagnosis Manual and Workshop Manual Section 07-07A for diagnosis.	REPLACE DTR sensor and ADJUST as outlined. REFER to Assembly for procedures. CLEAR DTCs and RERUN OBD tests.

PINPOINT TEST E: ELECTRICAL PRESSURE CONTROL (EPC) SOLENOID

E1 ELECTRONIC DIAGNOSTICS

- Check to make sure transmission harness connector is fully seated, terminals are fully engaged in connector and in good condition before proceeding.
- Connect New Generation STAR (NGS) Tester 007-00500 or equivalent.
- Perform KOEO test until continuous DTCs have been displayed.
- Enter output test mode (OTM). Refer to On-Board Diagnostics with NGS as outlined.
- Select the mode "ALL ON".
- Push START to turn outputs "ON".
- Push STOP to turn outputs "OFF".

Does vehicle enter OTM?

Yes	No
REMAIN in OTM. GO to **E2** .	PRESS START. If vehicle does not enter OTM, REFER to Powertrain Control/Emissions Diagnosis Manual for diagnosis and testing of the automatic transmission.

E2 CHECK ELECTRICAL SIGNAL OPERATION

CAUTION: Do not pry on connector. Pull up on the connector harness.

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NOTE: Refer to the schematic and chart preceding this pinpoint test.

- Disconnect transmission connector.
- Using a mirror, inspect both ends of connector for damage or pushed out pins, corrosion, loose wires, and missing or damaged seals.
- Connect a VOM positive lead to VPWR and the negative test lead to the solenoid circuit of the transmission vehicle harness connector.
- Place VOM on 20 volt scale.
- While observing VOM, press "start" and "stop" to cycle solenoid output ON and OFF.

Does the suspect solenoid output voltage change at least 0.5 volt?

Yes	No
GO to **E5** .	GO to **E3** .

E3 CHECK CONTINUITY OF SOLENOID SIGNAL AND VPWR HARNESS CIRCUITS

NOTE: Refer to the schematic and chart preceding this pinpoint test.

- Key OFF.
- Disconnect powertrain control module (PCM). Inspect for damaged or pushed out pins, corrosion, or loose wires.
- Install Rotunda Breakout Box 014-00950 or equivalent. Leave PCM disconnected.
- Measure resistance between PCM test Pin 81 at the breakout box and the appropriate signal pin at transmission harness connector.
- Measure resistance between PCM test Pins 71/97 at the breakout box and the appropriate signal pins at the transmission harness connector.

Is each resistance less than 5.0 ohms?

Yes	No
GO to **E4** .	SERVICE all open circuit(s). REMOVE the breakout box. RECONNECT all components. ERASE codes and REPEAT OBD Tests.

E4 CHECK HARNESS FOR SHORT TO GROUND OR POWER

NOTE: Refer to the schematic and chart preceding this pinpoint test.

- Key OFF.
- Ensure Rotunda Breakout Box 014-00950 or equivalent is installed and powertrain control module is disconnected.
- Ensure transmission connector is disconnected.
- Measure resistance between PCM signal test Pin 81 and the test Pins 71/97 at the breakout box.
- Measure resistance between PCM test Pin 81 and test Pins 77, 103, 76 and 91 at the breakout box and chassis ground.

Is each resistance greater than 10,000 ohms?

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Yes	No
GO to **E5** .	SERVICE all short circuit(s). REMOVE the breakout box. RECONNECT all components. ERASE codes and REPEAT OBD Tests.

E5 TRANSMISSION FUNCTIONAL TEST

- Ensure that the vehicle harness is disconnected at transmission connector.
- Reconnect PCM.
- Install line pressure gauge at line tap on case.
- Install Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit) with Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in Transmission Tester Kit or equivalent to transmission connector.
- Set MODE switch to DRIVE mode.
- Rotate GEAR SELECTOR switch to 1ST GEAR position.
- Use tests outlined in the Transmission Tester manual.
- Perform EPC Functional Test.
- LED will turn green when solenoid activates and turn off when deactivated.
- LED will turn red if activated solenoid/harness is shorted to BAT+ .
- LED will remain off if activated solenoid/harness is shorted to ground or no continuity (open circuit).
- Does EPC (LED green) activate when EPC switch is depressed?
- Observe line pressure on gauge while depressing EPC switch (vehicle must be running).

Does line pressure drop?

Yes	No
REPLACE powertrain control module, INSPECT power relay for damage, corrosion. SERVICE as required. REPEAT the OBD Tests.	GO to **E6** .

E6 CHECK RESISTANCE OF SOLENOID/HARNESS

- Set MODE switch to BENCH mode on tester.
- Rotate GEAR SELECTOR switch to OHMS CHECK position.
- Connect ohmmeter negative lead to EPC jack and positive lead to VPWR jack on tester. This is to test EPC solenoid and harness.

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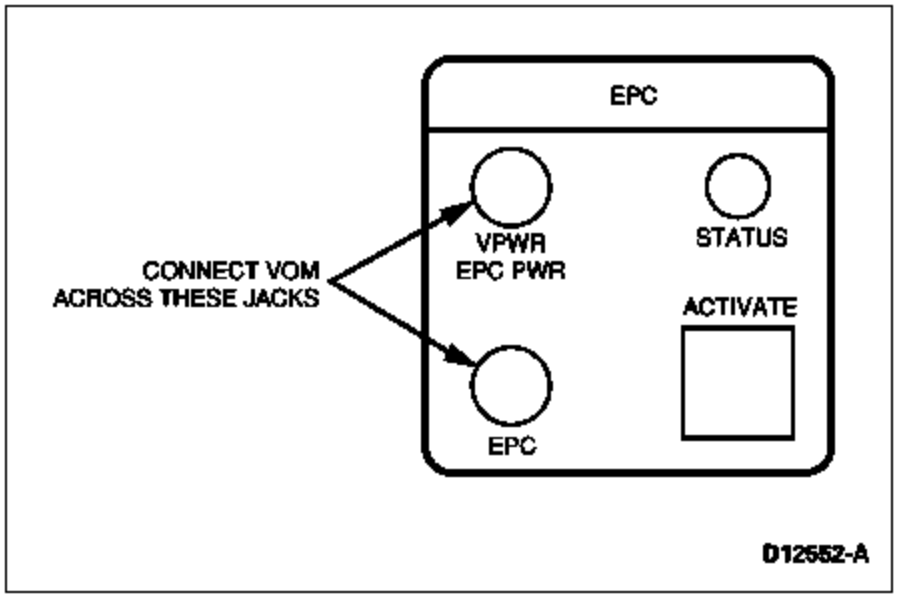

- Record resistance.

Is resistance between 3.10-5.7 ohms?

Yes	No
GO to **E7** .	**NOTE: Internal harness or solenoid may be damaged.** GO to **E8** .

E7 CHECK SOLENOID/HARNESS FOR SHORT TO GROUND

- Check for continuity between BAT- (engine ground) and appropriate jack with an ohmmeter or other low current tester (less than 200 milliamps).

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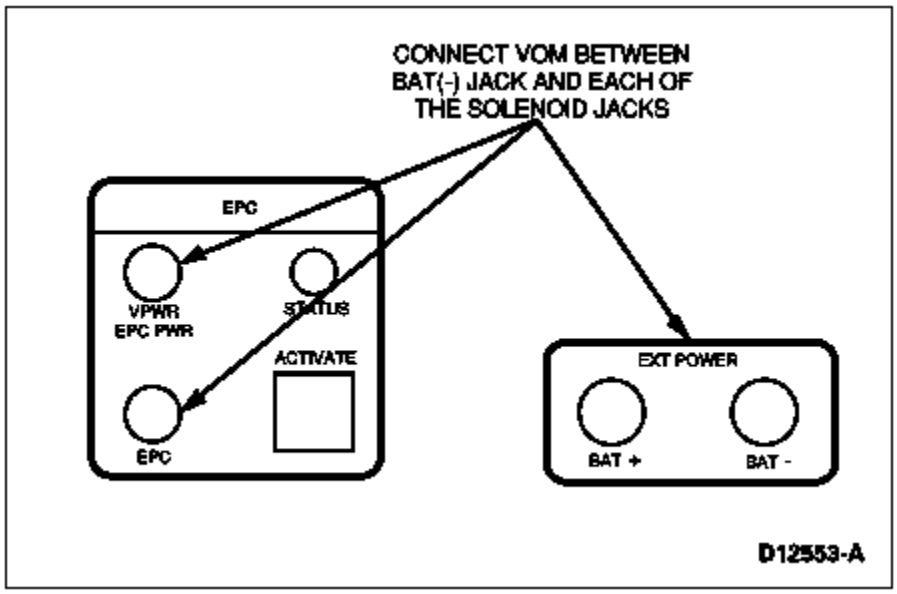

Solenoid	Tester Jack
EPC	EPC VPWR

- Connection should show infinite resistance (no continuity).

Is there continuity?

Yes	No
GO to **E8** .	REFER to Hydraulic/Mechanical Diagnosis charts in Diagnosis By Symptom Index .

E8 INTERNAL ELECTRONIC DIAGNOSTICS

- Drain transmission fluid.
- Remove transmission fluid pan.
- Check that internal harness connector is fully engaged on EPC solenoid.
- Check that internal harness connector terminals are fully seated in connector.
- Inspect connector for damage.

Is everything engaged and in good condition?

Yes	No
GO to **E9** .	SERVICE as required.

E9 CHECK INTERNAL HARNESS (CONTINUITY)

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- Disconnect internal harness from EPC solenoid assembly.
- Connect positive lead from an ohmmeter to tester EPC jack and negative lead at Blue wire at EPC connector.
- Record resistance. Should be less than 0.5 ohms.
- Next, connect positive lead from an ohmmeter to tester VPWR jack and negative lead at green wire at EPC connector.
- Record resistance.

Is resistance less than 0.5 ohms?

Yes	No
GO to **E10** .	REPLACE internal harness.

E10 CHECK INTERNAL HARNESS (SHORTS TO GND)

- Check for continuity between BAT- (engine ground) and appropriate wire with ohmmeter or other low current tester (less than 200 milliamps).

Solenoid	Wire Color
EPC	Blue - Green +

- Connection should show infinite resistance (no continuity).

Is there continuity?

Yes	No
REPLACE internal harness. GO to **E11** .	GO to **E11** .

E11 CHECK SOLENOID RESISTANCE

- Check solenoid resistance by connecting ohmmeter at EPC terminals of solenoid.
- Record resistance.

Is resistance between 3.10-5.7 ohms?

Yes	No
GO to **E12** .	REPLACE EPC solenoid.

E12 CHECK SOLENOID FOR SHORT TO GROUND

- Check for continuity between a good ground and each EPC terminal with ohmmeter or other low current tester (less than 200 milliamps).

Solenoid	Terminal

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EPC	+/-

- Connection should show infinite resistance (no continuity).

Is there continuity?

Yes	No
REPLACE EPC solenoid.	REFER to Hydraulic/Mechanical Diagnosis Charts in Diagnosis By Symptom Index for diagnosis of pressure concerns.

PINPOINT TEST F: TURBINE SHAFT SPEED (TSS) SENSOR

F1 4R44E/4R55E ELECTRONIC DIAGNOSTICS

- Check that the transmission vehicle harness connector is fully seated, terminals are fully engaged in connector and in good condition.

Have the items above been checked?

Yes	No
GO to **F2** .	PERFORM the checks. ERASE codes. RERUN OBD Tests.

F2 CHECK CONTINUITY OF TSS HARNESS CIRCUITS

CAUTION: Do not pry on connector. Use connector release and button.

NOTE: Refer to the schematic and chart preceding this pinpoint test.

- Key OFF.
- Disconnect transmission harness connector.
- Disconnect powertrain control module (PCM). Inspect for damaged or pushed out pins, corrosion, or loose wires.
- Install Rotunda Breakout Box 014-00950 or equivalent, leave powertrain control module disconnected.
- Measure resistance between PCM test Pin 84 at the breakout box and the appropriate signal pin at the transmission harness connector.
- Measure resistance between PCM test Pin 91 at the breakout box and the appropriate signal pin at the transmission harness connector.

Is each resistance less than 5.0 ohms?

Yes	No
	SERVICE open circuit(s). REMOVE breakout

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GO to **F3** .	box. RECONNECT all components. ERASE codes. RERUN OBD Tests.

F3 CHECK TSS CIRCUITS FOR SHORT TO POWER AND GROUND

- Key OFF.
- Ensure that the vehicle harness is disconnected.
- Breakout box installed, powertrain control module disconnected.
- Measure resistance between PCM test Pins 84, 91 and test Pins 71/97 at the breakout box.
- Measure resistance between PCM signal test Pins 84, and test Pins 91, 71/97, 77, 76 and 103 at the breakout box and chassis ground.

Is the resistance greater than 10,000 ohms?

Yes	No
GO to **F4** .	SERVICE short circuit(s). REMOVE breakout box. RECONNECT all components. ERASE codes and RERUN OBD Tests.

F4 TRANSMISSION FUNCTIONAL TEST

- Ensure that the vehicle harness is disconnected at the transmission.
- Reconnect PCM.
- Install Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit) with Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in the Transmission Tester Kit or equivalent.
- Connect voltmeter positive lead to +TSS and negative lead to -TSS. Set voltmeter to AC.
- Perform Drive Cycle Test . Monitor voltmeter.

Does the voltage increase with an increase in vehicle speed?

Yes	No
REPLACE powertrain control module.	GO to **F5** .

F5 CHECK RESISTANCE OF SOLENOID/HARNESS

NOTE: Refer to 4R44E Transmission Tester for terminal locations.

- Rotate GEAR SELECTOR switch to OFF position.
- Connect ohmmeter negative lead to TSS- jack and positive lead to TSS+ jack on tester.
- Record resistance.
- Resistance should be between 64-120 ohms.

Is the TSS resistance within specifications?

Yes	No

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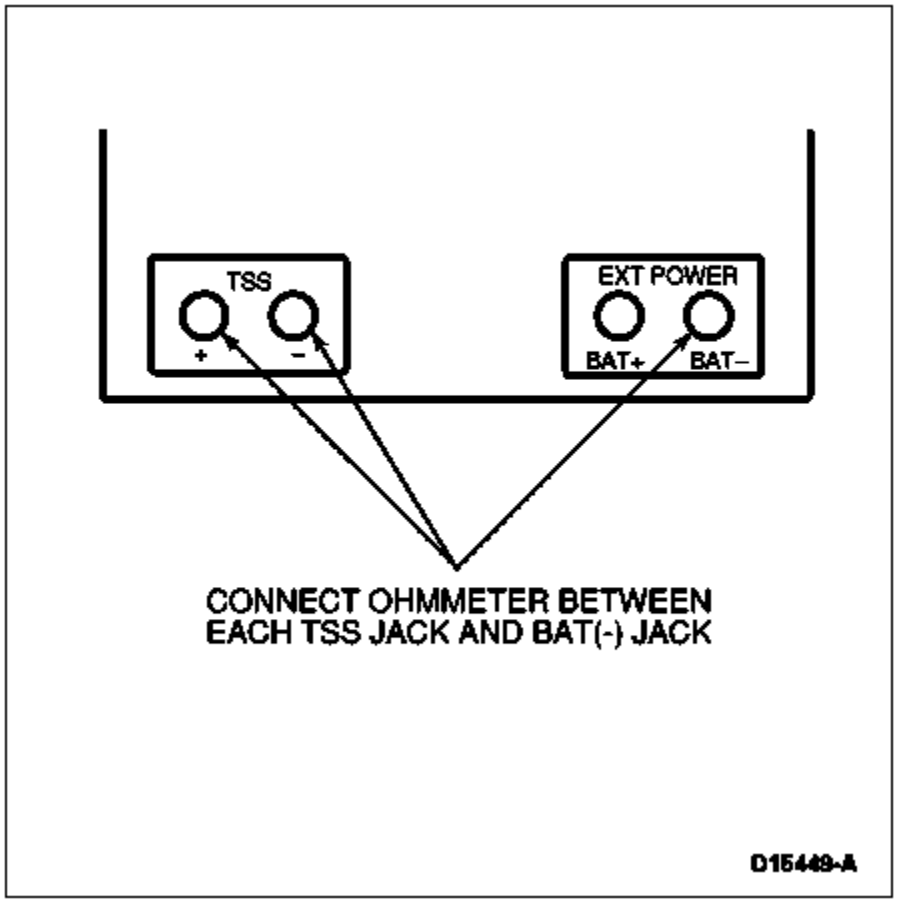
GO to **F6** .	**NOTE: Out of specification may be caused by internal harness or solenoid concerns.** GO to **F6** .

F6 CHECK SOLENOID/HARNESS FOR SHORT TO GROUND

- Check for continuity between BAT- (engine ground) and appropriate jack with an ohmmeter or other low current tester (less than 200 milliamps).



Solenoid	Tester Jack
TSS	TSS+ TSS-

- Connection should show infinite resistance (no continuity).

Is there continuity?

Yes	No
GO to Disassembly in this section for TSS	GO to Disassembly in this section for TSS

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service and hardware diagnosis.	service and hardware diagnosis.

PINPOINT TEST G: COAST CLUTCH SOLENOID

G1 ELECTRONIC DIAGNOSTICS

- Check to make sure transmission harness connector is fully seated, terminals are fully engaged in connector and in good condition before proceeding.
- Connect New Generation STAR (NGS) Tester 007-00500 or equivalent.
- Perform KOEO test until continuous DTCs have been displayed.
- Enter output test mode (OTM). Refer to On-Board Diagnostics with NGS as outlined.
- Select the mode "ALL ON".
- Push START to turn outputs "ON".
- Push STOP to turn outputs "OFF".

Does vehicle enter OTM?

Yes	No
REMAIN in OTM. GO to G2 .	PRESS START. If vehicle does not enter OTM, REFER to Powertrain Control/Emissions Diagnosis Manual for diagnosis and testing of the automatic transmission.

G2 CHECK ELECTRICAL SIGNAL OPERATION

CAUTION: Do not pry on connector. Depress release button, then pull on harness.

NOTE: Refer to the schematic and chart preceding this pinpoint test.

- Disconnect transmission connector.
- Using a mirror, inspect both ends of connector for damaged or pushed out pins, corrosion, loose wires, and missing or damaged seals.
- Connect Rotunda 73 Digital Multimeter 105-R0051 or equivalent positive test lead to vehicle power (VPWR) circuit and negative test lead to the solenoid circuit of the transmission vehicle harness connector.
- Place multimeter on 20-volt scale.
- While observing volt-ohmmeter, press "start" and "stop" several times to cycle solenoid output on and off.

Does the suspected solenoid output voltage change at least 0.5 volts?

Yes	No
GO to G5	GO to G3 .

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G3 CHECK CONTINUITY OF SOLENOID SIGNAL AND VEHICLE POWER HARNESS CIRCUITS

NOTE: Refer to the schematic and chart preceding this pinpoint test.

- Turn ignition switch off.
- Make sure transmission harness connector is disconnected.
- Disconnect powertrain control module. Inspect for damaged or pushed out pins, corrosion, or loose wires.
- Install Rotunda Breakout Box 014-00950 or equivalent, leave PCM disconnected.
- Measure resistance between PCM test Pin 28 at the breakout box and the appropriate signal pin at transmission harness connector.
- Measure resistance between PCM test Pins 71/97 at the breakout box and the appropriate signal pins at the transmission harness connector.

Is each resistance less than 5.0 ohms?

Yes	No
GO to **G4** .	SERVICE open circuit(s). REMOVE breakout box. RECONNECT all components. REPEAT Quick Test.

G4 CHECK SOLENOID HARNESS FOR SHORTS TO POWER AND GROUND

NOTE: Refer to the schematic and chart preceding this pinpoint test.

- Key OFF.
- Breakout box installed, powertrain control module disconnected.
- Transmission harness connector disconnected.
- Measure resistance between PCM signal test Pin 28 and test Pins 71/97 at the breakout box.
- Measure resistance between PCM test Pins 28 and test Pins 77, 76, 91, 51 and 103 at the breakout box and chassis ground.

Is each resistance greater than 10,000 ohms?

Yes	No
GO to **G5** .	SERVICE short circuit. REMOVE breakout box. RECONNECT all components. RERUN Self Test.

G5 TRANSMISSION FUNCTIONAL TEST

- Reconnect PCM.
- Disconnect vehicle harness at transmission.
- Install Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit) with Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in the Transmission Tester Kit or equivalent at the transmission connector.

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- Use tests outlined in the Transmission Tester manual.
- Perform the Solenoid Function Test.
- LED will turn green when solenoid activates and turn off when deactivated.
- LED will turn red if activated solenoid is shorted to BAT+ .
- LED will remain off if an activated solenoid is shorted to ground or no continuity.

Does the solenoid (LED) activate? (LED green)

Yes	No
GO to **G6** .	GO to **G7** .

G6 TRANSMISSION DRIVE TEST

- Perform the Drive Test as outlined in Transmission Tester Manual.
- **Does the CCS activate when commanded by the tester?**
- **Does engine braking occur?**

Does coast clutch engage?

Yes	No
REPLACE PCM. ERASE all codes and PERFORM the Transmission Drive Cycle as outlined in this section. RERUN Self Test. If symptom is still present, REFER to Diagnosis By Symptom Index to diagnose coast clutch concerns (no engine braking).	GO to **G7** .

G7 CHECK RESISTANCE OF SOLENOID/HARNESS

NOTE: Refer to the 4R44E/4R55E Transmission Tester for terminal locations.

- BENCH/DRIVE switch in BENCH mode.
- Rotate GEAR SELECTOR switch to Ohm position.
- Connect ohmmeter negative lead to CSS jack and positive lead to VPWR jack on tester. This is to test CCS.
- Record resistance.
- Resistance should be between 22-48 ohms.

Is the coast clutch solenoid resistance within specification?

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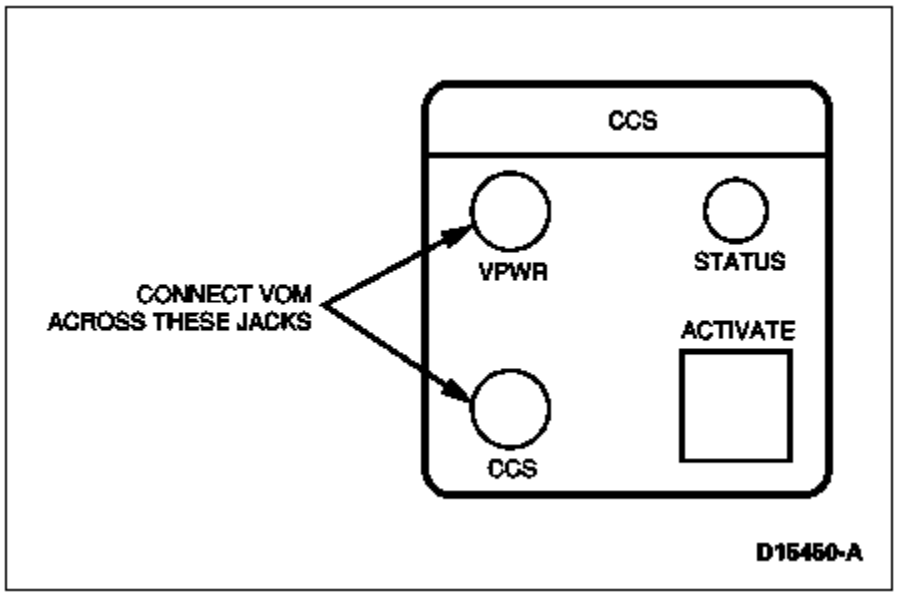

Yes	No
GO to G8 .	**NOTE: Out of specification may be caused by internal or solenoid concerns.** GO to G9 .

G8 CHECK SOLENOID/HARNESS FOR SHORT TO GROUND

- Check for continuity between BAT- (engine ground) and appropriate jack with an ohmmeter or other low current tester (less than 200 milliamps).

Solenoid	Tester Jack
CCS	CCS VPWR

- Connection should show infinite resistance (no continuity).

Is there continuity?

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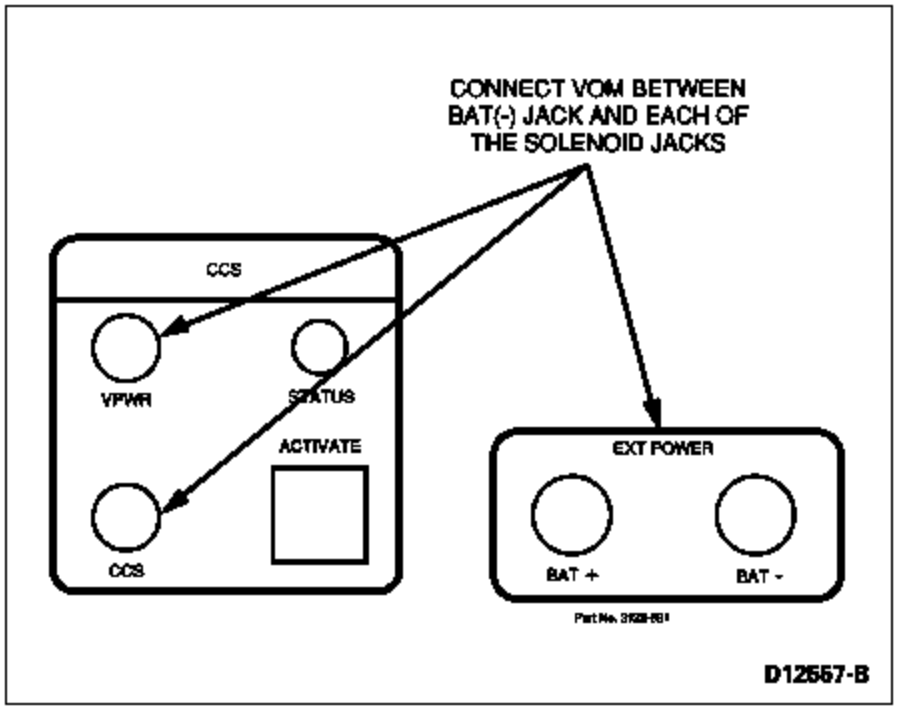

Yes	No
GO to **G9** .	GO to Service Manual Diagnosis By Symptom Index charts for diagnosis of coast clutch concerns.

G9 4R44E INTERNAL ELECTRONIC DIAGNOSTICS

- Drain transmission fluid.
- Remove transmission pan.
- Check that the internal harness connector is fully engaged on the coast clutch solenoid assembly.
- Check that the internal harness connector terminals are fully seated in the connector.
- Inspect the connector for damage.

Were the checks done and was everything OK?

Yes	No
GO to **G10** .	SERVICE as required.

G10 CHECK INTERNAL 4R44E HARNESS (CONTINUITY)

- Disconnect the internal harness from the solenoid assembly.
- For CCS, connect the positive lead from an ohmmeter to the tester jack CCS and the negative lead at the orange wire of the CCS wire connector.
- For CCS VPWR, connect the positive lead from an ohmmeter to the tester jack CCS VPWR and the negative lead at the white wire of the CCS wire connector.
- Record resistance. Should be less than 0.5 ohms.

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Are the resistances less than 0.5 ohms?

Yes	No
GO to **G11** .	REPLACE internal harness. GO to **G12** .

G11 CHECK INTERNAL HARNESS (SHORTS TO GND)

- Check for continuity between BAT- (engine ground) and appropriate wire with an ohmmeter or other low current tester (less than 200 milliamps).

Solenoid	Wire Color
CCS	Orange
VPWR	White

- Connection should show infinite resistance (no continuity).

Is there continuity?

Yes	No
REPLACE internal harness.	GO to **G12** .

G12 CHECK SOLENOID RESISTANCE AT SOLENOID

- Check solenoid resistance by connecting an ohmmeter at the terminals of the solenoid.
- Measure and record resistance for the solenoid. (CCS)
- Resistance should be between 22-48 ohms.

Is resistance between 22-48 ohms?

Yes	No
GO to **G13** .	REPLACE CCS solenoid.

G13 CHECK SOLENOID FOR SHORT TO GROUND

- Check for continuity between engine ground and appropriate solenoid terminal with ohmmeter or other low current tester (less than 200 milliamps).

Solenoid	Terminal
CCS	+/-

- Connection should show infinite resistance (no continuity).

Is there continuity?

Yes	No

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REPLACE CCS solenoid.	REFER to service manual for Hydraulic/Mechanical Diagnosis Charts under Diagnosis By Symptom Index (no engine braking).

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Special Testing Procedures

Engine Idle Speed Check

Refer to Section 4A in the Powertrain Control/Emissions Diagnosis Manual for diagnosis and testing of the engine idle speed.

Line Pressure Test

CAUTION: The Transmission Tester must be removed and the vehicle harness installed when verifying these pressures.

CAUTION: Perform Line Pressure Test prior to performing Stall Speed Test. If line pressure is low at stall, do not perform Stall Speed Test or further transmission damage will occur. Do not maintain wide open throttle in any gear range for more than five (5) seconds.

NOTE: Certain sensor failures may cause high EPC, FMEM (Failure Mode Effect Management) actions. Be sure that self test and electrical repairs have been performed, or test results may be incorrect.

This test verifies that the line pressure is within specifications.

1. Connect 0-2758 kPa (0-400 psi) pressure gauge to the line pressure tap.

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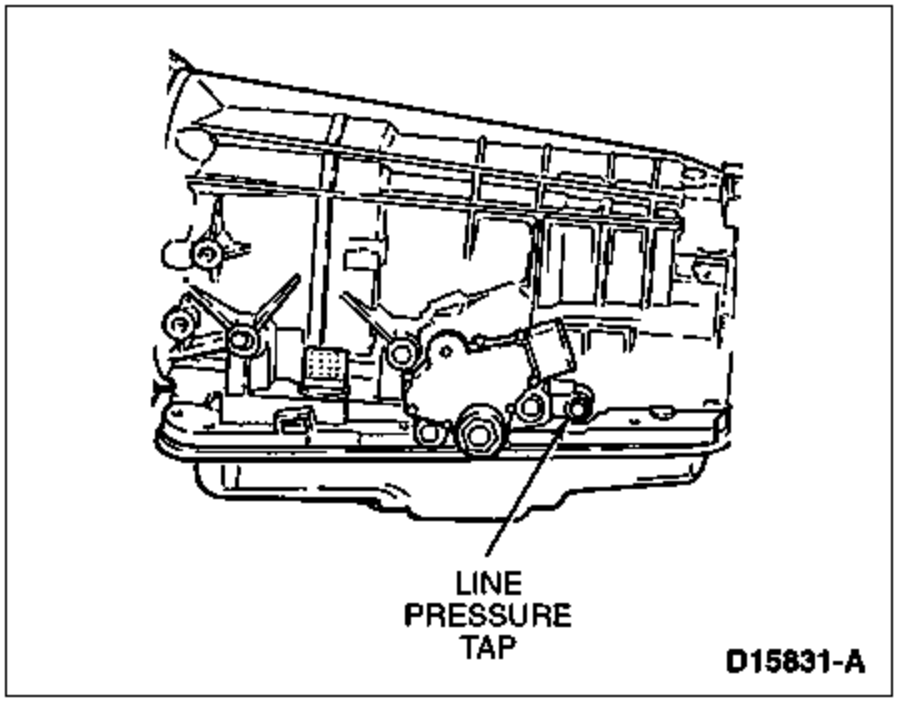

2. Start engine and check line pressures. Refer to the following Line Pressure Specifications No. 401 chart to determine if line pressure is within specifications.

CAUTION: Do not install Transmission Tester when verifying these pressures.

NOTE: Vehicle harness must be installed at transmission connector to verify these pressures.

REFERENCE: LINE PRESSURE SPECIFICATIONS No. 401

Trans.	Transmission Model/Application	Range	Idle		WOT Stall	
			EPC	Line	EPC	Line
4R44E	2.3L Ranger	R	37-47	115-145	112-134	282-350
	4x2	N	21-31	77-107		
		(D), 2, 1	20-30	77-107	112-134	228-263
4R44E	3.0L Ranger	R	46-56	143-173	112-134	282-350
	4x2, 4x4	N	31-41	94-124		
		(D), 2, 1	20-30	71-101	112-134	228-263
4R44E	3.0L Aerostar	R	47-57	153-183	112-134	282-350
	4x2	N	20-30	73-103		
		(D), 2, 1	40-50	105-135	112-134	228-263

3. If line pressure is not within specifications, check EPC pressure.

4. Connect Pressure Gauge to EPC pressure tap.

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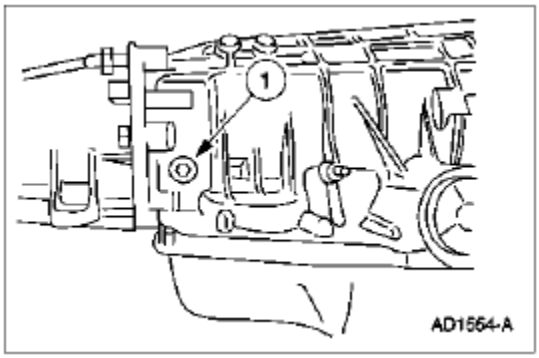
5. Start engine and check EPC pressure. Refer to Reference: Line Pressure Chart in this section for specification.

6. If EPC pressure is not within specification, perform Pinpoint Test E to diagnose EPC operation. If EPC operation is OK, refer to Line Pressure Diagnosis Chart in this section for line pressure concern causes.



Item	Part Number	Description
1	—	Electronic Pressure Control (EPC)

LINE PRESSURE DIAGNOSIS CHART

Test Results	Possible Source
High at Idle — All Ranges	• Wiring Harnesses • EPC Boost Valve • EPC Solenoid • Main Regulator Valve
Low at Idle — All Ranges	• Low Fluid Level • Fluid Inlet Filter/Seal • Main Control Body • Cross Leaks • Gaskets • Pump • Separator Plate
Low — All Forward Ranges	• Forward Clutch • Main Control • O/D Servo
Low in Park Only	• Valve Body
Low in Reverse Only	• Separator Plate • Rear Servo Piston, Cover Seal • Reverse Clutch • O/D Servo • Valve Body • Forward Clutch
Low in Neutral Only	• Valve Body • O/D Servo

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Low in Overdrive Only	• Forward Clutch • O/D Servo • Valve Body
Low in Drive Only (O/D Cancelled)	• Forward Clutch • O/D Servo • Valve Body
Low in 1st Position Only	• Forward Clutch • Valve Body
Low in 2nd Position Only	• Intermediate Servo • O/D Servo • Forward Clutch

Stall Speed Test

This test checks operation of the following items:

- Torque converter clutch
- Forward clutch
- Low one way clutch (OWC) assembly
- Engine performance

WARNING: APPLY THE PARKING BRAKE FIRMLY WHILE PERFORMING EACH STALL TEST.

CAUTION: Always perform Line Pressure Test procedures prior to performing the Stall Speed Test. If line pressure is low at stall, do not perform Stall Speed Test or further transmission damage will occur.

NOTE: The Stall Speed Test should be performed with the engine and transmission at normal operating temperatures.

1. Connect tachometer to the engine.
2. **CAUTION: After testing each of the following ranges (D), 2, 1, and R, move the transmission range selector lever to N (NEUTRAL) and run engine at 1000 rpm for about 15 seconds to allow the torque converter to cool before testing the next range.**

   CAUTION: Do not maintain wide open throttle in any range for more than five (5) seconds.

   CAUTION: If the engine rpm recorded by the tachometer exceeds maximum specified rpm, release the accelerator pedal immediately. Clutch or band slippage is indicated.

   NOTE: Prolonged use of this procedure may set Diagnostic Trouble Code P0712, P1783. After performing Stall Speed Test run OBD Test and clear DTCs from memory.

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Press accelerator pedal to floor (WOT) in each range. Record rpm reached in each range. Stall speeds should be as follows:

Vehicle	Engine	Rpm
Ranger	2.3	2610-3035
Ranger	3.0	2870-3338
Aerostar	3.0	2762-3230

If stall speeds were too high, refer to the following Stall Speed Diagnosis Chart. If stall speeds were too low, first check the engine idle speed. If engine idle is OK, remove torque converter and check the torque converter clutch for slippage.

STALL SPEED DIAGNOSIS CHART

Transmission Range Selector Lever Position	Stall Speeds High	Stall Speeds Low
(D)Overdrive, D, and 1	Overdrive One-Way Clutch, Rear One-Way Clutch	—
D, 2 and 1	Forward Clutch, O/D One-Way Clutch	—
(D)Overdrive	Forward Clutch, O/D One-Way Clutch	—
(D)Overdrive, D, 2, 1 and R	General Pressure Concerns, Forward Clutch, O/D One-Way Clutch	Converter One-Way Clutch or Engine Performance
R Only	High/Reverse and High Clutch and Low and Reverse Band/Servo	—
2 Only	Intermediate Band/Servo	—
1 Only	Low/Reverse Band/Servo	—

Air Pressure Tests

A no drive condition can exist, even with correct transmission fluid pressure, because of inoperative clutches or bands. An erratic shift can be located through a series of checks by substituting air pressure for fluid pressure to determine the location of the malfunction.

When the transmission range selector lever is in a forward gear range ((D) , 2, 1), a no drive condition may be caused by an inoperative forward clutch, or an overrunning one-way clutch.

Failure to drive in R (REVERSE) could be caused by a malfunctioning reverse clutch, reverse servo, or band.

Follow the procedure to determine the location of the inoperative clutch or band by introducing air pressure into the various test plate passages.

Test Procedures

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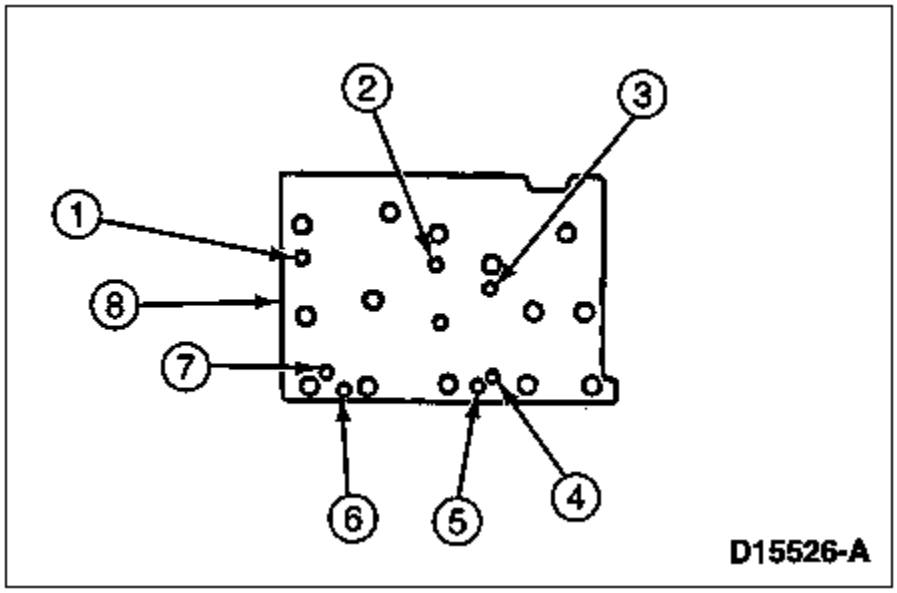
NOTE: Cover vent in test plate with a clean, lint-free shop towel to prevent spray when air is applied. Plugging vent hole during testing will result in inaccurate results.

NOTE: Use only dry regulated air pressure 276kPa (40 psi) max. A dull thud should be heard when the clutch or band applies. There should be no hissing sound when band or clutch applies.

1. Drain transmission fluid and remove transmission oil pan.
2. Remove filter and seal assembly and main control valve body.
3. Install 4R44E/4R55E Transmission Test Plate T95L-77000-AH and Transmission Test Plate Gasket T95L-77000-AH1.
4. **CAUTION: Do not apply air to test the vent.**

   Apply air pressure to appropriate clutch port (refer to diagram). A dull thud may be heard or movement felt when clutch is applied or released. If clutch seals or check balls are leaking a hissing sound may be heard.



Item	Part Number	Description
1	—	Coast Clutch Apply
2	—	Direct Clutch Apply
3	—	Forward Clutch Apply
4	—	Intermediate Servo Release
5	—	Intermediate Servo Apply
6	—	Overdrive Servo Release
7	—	Overdrive Servo Apply
8	T95L-77000-AH	4R44E/4R55E Transmission Test Plate

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—	T95L-77000-AH1	Transmission Test Plate Gasket

Test Results

If test results find that the servos do not operate, disassemble, clean and inspect them to locate the source of the concern.

If air pressure applied to the clutch passages fails to operate a clutch, or operates another clutch simultaneously, disassemble and use air pressure to check the fluid passages in the center support and clutches to detect obstructions.

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Leakage Inspection

CAUTION: Do not try to stop the fluid leak by increasing the torque beyond specifications. This may cause damage to the case threads.

Check the vehicle speed sensor (VSS) and the speedometer cable connection at the transmission. Replace rubber seal if necessary.

Leakage at the transmission fluid pan to case gasket often can be stopped by tightening the attaching bolts to 13-15 Nm (115-133 lb-ft). If necessary, replace the oil pan case gasket.

Check the fluid filler tube connection at the transmission case. If leakage is found here, install a new grommet.

Check fluid lines and fittings between the transmission and the cooler in the radiator tank for looseness, wear, or damage. If leakage cannot be stopped by tightening a fluid tube nut, replace the damaged parts. When fluid is found leaking between the case and cooler line fitting, check for missing or damaged O-ring, then tighten the fitting to maximum specification.

If the leak continues, replace cooler line fitting and tighten to specification. The same procedure should be followed for fluid leaks between the radiator cooler and the cooler line fittings in this section. Refer to Transmission Cooler Line Replacement for procedures.

Check the engine coolant in the radiator. If transmission fluid is present in the coolant, the cooler in the radiator is probably leaking.

The cooler can be further checked for leaks by disconnecting the lines for the cooler fittings and applying no more than 345 kPa (50 psi) air pressure to the fittings. Remove the radiator cap to relieve the pressure buildup at the exterior of the oil cooler tank. If the cooler is leaking and/or will not hold pressure, replace the cooler.

If leakage is found at the transmission range selector lever, replace the seal.

If leakage is found at the transmission internal harness connector, replace O-ring.

External Sealing

The 4R44E transmission has the following parts to prevent external fluid leakage:

- Gaskets
- Lip-type seals
- O-ring seals
- Seal rings
- Seal grommets
- Thread sealant

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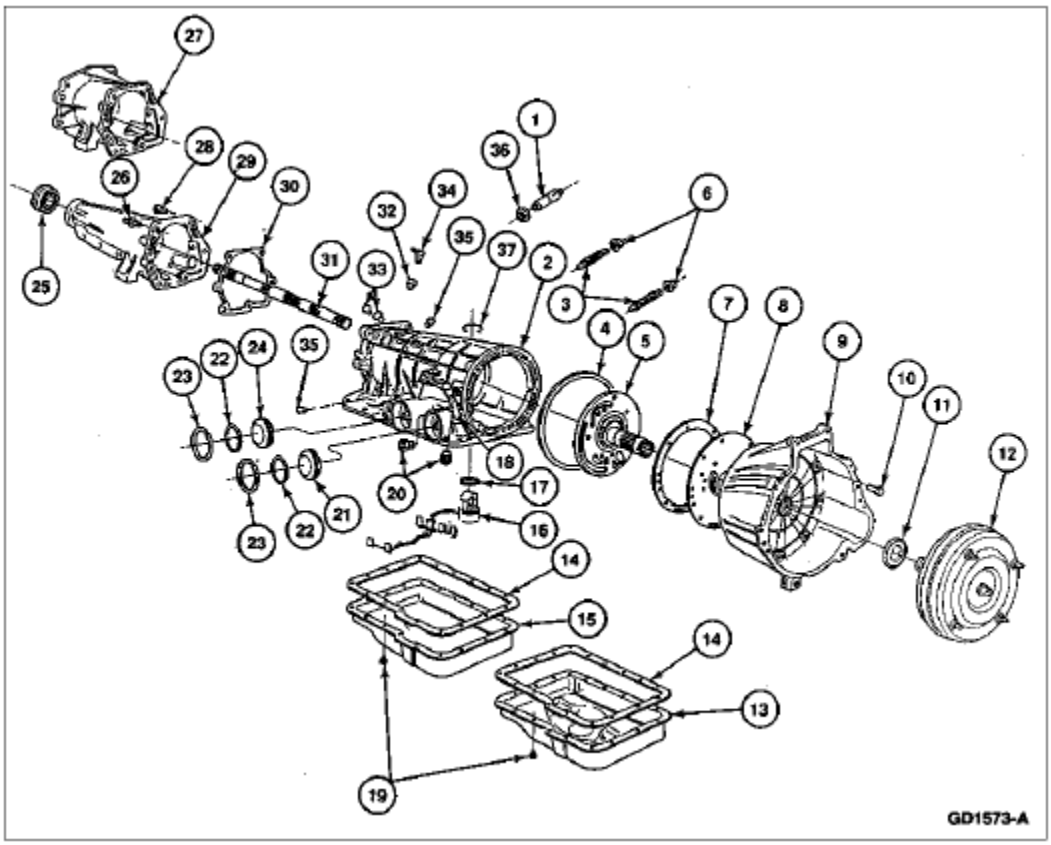
External Sealing



Item	Part Number	Description
1	7A308	Shaft (Manual Valve Outer to Inner Levers)
2	7005	Case Assembly
3	7C492	Screw (Intermediate and O/D Band) Adjuster/Lock (2 Req'd)
4	7A248	Seal Ring (Fluid Pump)
5	7A103	Support and Gear Assembly (Fluid Pump)
6	E825100-S100	Nut and Seal — Hex (Intermediate and O/D Bands) Adjuster/Lock (2 Req'd)
7	7A136	Gasket (Fluid Pump)
8	7B472	Plate (Fluid Pump Adaptor)
9	7976	Housing Assembly (Converter)
10	E804595-S200	Screw and Seal Assembly, M10x33 (Attach Converter Housing to Case) (8 Req'd)
11	7A248	Seal Assembly (Converter Hub to Converter Housing) (Also in Converter Housing Assembly)

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12	7902	Converter Assembly (Contains Piston Type Clutch)
13	7A194	Pan (4x4 Fluid)
14	7A191	Gasket Assembly (Fluid Pan)
15	7A194	Pan (4x2 Fluid)
16	14A624	Connector Assembly (16-Pin) (with Harness to 6 Solenoids)
17	W703015-S300	O-Ring (16-Pin Connector to Case)
18	7A160	Tube (Lube Fluid Inlet) Short (Also in Case Assembly)
19	W701203-S309M	Screw, M8x14 (Att. Fluid Pan to Case) (18 Req'd)
20	7D273	Connector Assembly — Fluid Tube (2 Req'd) (Also in Case)
21	7L493	Cover and Seal Assembly (O/D Servo)
22	E853170-S	O-Ring (Servo Cover to Case) (Intermediate and O/D Servos) (2 Req'd)
23	E860343-S	Ring, Retaining, 67x1.5 mm (Intermediate and O/D Servos in Case) (2 Req'd)
24	7L493	Cover and Seal Assembly (Intermediate Servo)
25	7052	Seal Assembly (Extension Housing to Slip Yoke) (Also in Extension Housing Assembly)
26	E804137-S72	Stud (Att. Extension Housing to Case)
27	7A039	Housing Assembly (4x4 Extension)
28	E800152-S72	Screw, M10x30 (Att. Extension to Case) (5 Req'd)
29	7A039	Housing Assembly (4x2 Extension)
30	7086	Gasket (Extension Housing)
31	7060	Shaft Assembly (4x2 Output)
32	7034	Vent Assembly (4x2) (Also Contained in Case Assembly)
33	E840171-S2	Pin (Reverse Band — Anchor) (2 Req'd) (Part of Case Assembly)
34	7034	Vent Assembly (4x4 Case) (Also Contained in Case Assembly)
35	E450102-S80	Plug — Pipe (Line and EPC Pressure) (Part of Case Assembly) (2 Req'd)
36	7B498	Seal Assembly (Main Control Lever) (Also in Case Assembly)
37	84280020	Spring (Retains 16-Pin Connector in Case)

Fluid Leakage in Torque Converter Area

In diagnosing and correcting fluid leaks in the torque converter (7902) area, use the following procedures to locate the exact cause of the leakage. Leakage at the front of the transmission, as evidenced by fluid around the converter housing, may have several sources. By careful observation it is possible to pinpoint the source

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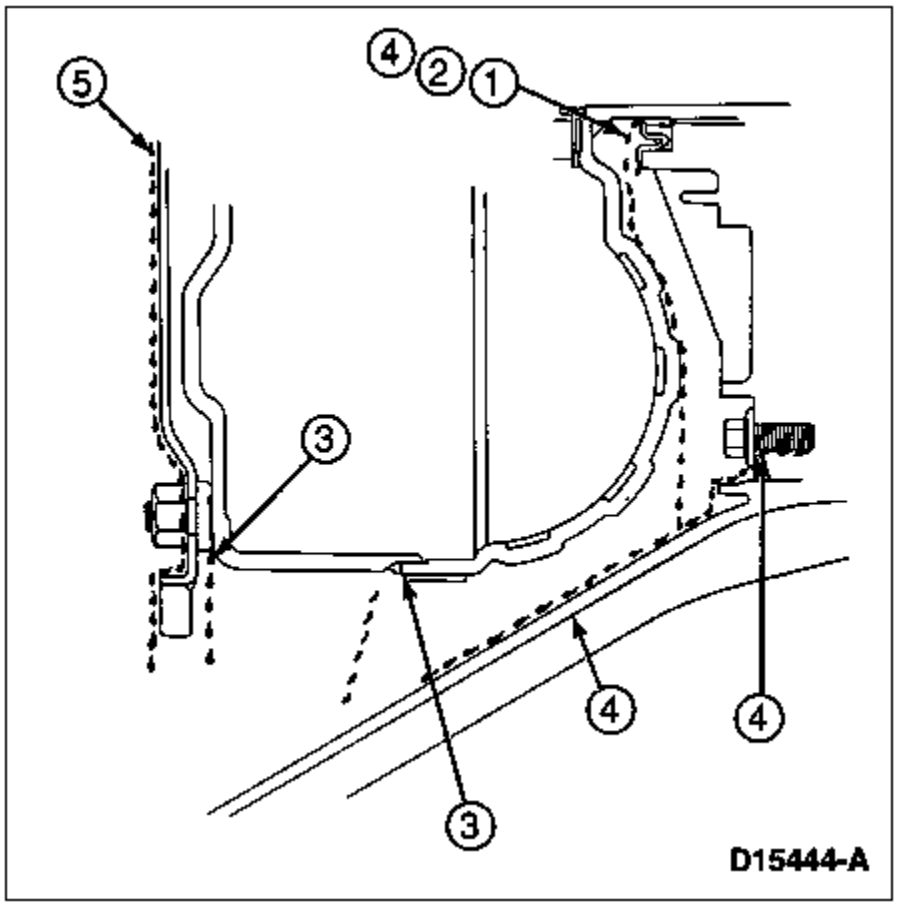
of the leak before removing the transmission from the vehicle. The paths which the fluid can take to reach the bottom of the converter housing are as follows:

Torque Converter Area Leak Points



1. Fluid leaking by the torque converter impeller hub seal lip will tend to move along the converter impeller hub and onto the back of the impeller housing. Except in the case of a total seal failure, fluid leakage by the lip of the seal will be deposited on the inside of the converter housing only, near the outside diameter of the converter housing.

2. Fluid leakage by the outside diameter of the converter hub seal and the case will follow the same path which the leaks by the inside diameter of the seal follow.

3. Fluid leakage from the torque converter to the flywheel stud weld will appear at the outer diameter of the torque converter on the back face of the flywheel (6375), and in the converter housing only near theflywheel. If a converter-to-flywheel stud leak is suspected, remove torque converter and pressure check.

4. Fluid leakage from the pump will flow down the back of the converter housing. Leakage may be from loose or missing pump bolts, torn or damaged pump-to-case gasket and/or a worn pump bushing.

5. Engine oil leaks are sometimes improperly diagnosed as transmission pump seal leaks. The following areas of possible leakage should also be checked.

    a. Leakage at the valve cover may allow engine oil to flow over the converter housing or seep down between the converter housing and block, causing oil to be present in or at the bottom of

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the converter housing.
b. Oil plug leaks will allow oil to flow down the rear face of the block to the converter housing.
c. Leakage at the crankshaft seal will work back to the flywheel, and then into the converter housing.

Leak Check Test

The following procedures should be used to determine the cause of the leakage before service is made.

1. Remove the fluid level indicator (7A020) and note the color of the fluid. Original factory fill fluid is dyed red to aid in determining if leakage is from the engine or transmission. Unless a considerable amount of makeup fluid has been added or the fluid has been changed, the red color should assist in pinpointing the leak.

2. Remove the converter housing access cover. Clean off any fluid from the top and bottom of the converter housing, front of the transmission case, and rear face of the engine and pan. Clean the converter area by washing with suitable nonflammable solvent, and blow dry with compressed air.

3. Wash out converter housing and the front of the flywheel. The converter housing may be washed out using clean solvent and a squirt-type fluid can. Blow dry all washed areas with compressed air.

4. Start and run the engine until the transmission reaches its normal operating temperature. Observe the back of the block and top of the converter housing for evidence of fluid leakage. Raise the vehicle on a hoist and position suitable safety stands under vehicle. Run the engine at fast idle, then at engine idle, occasionally shifting to the drive and reverse ranges to increase pressure within the transmission. Observe the front of the flywheel, back of the block (in as far as possible), and inside the converter housing and front of the transmission case. Run the engine until fluid leakage is evident and the probable source of leakage can be determined.

Leak Check Test With Black Light

Fluid soluble aniline or fluorescent dyes premixed at the rate of 2.5ml (1/2 teaspoon) of dye powder to 0.24L (1/2 pint) of automatic transmission fluid have proven helpful in locating the source of fluid leakage. Such dyes may be used to determine whether an engine fluid or transmission fluid leak is present, or if the fluid in the transmission fluid cooler hose leaks into the engine coolant system. An ultraviolet light must be used to detect the fluorescent dye solution.

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Transmission Fluid Cooler

The following procedures will assist in diagnosing the transmission cooling system. Refer to Section 07-02 for specific transmission cooling system diagnosis and testing procedures.

Transmission Fluid Cooler Flow Test

NOTE: The transmission linkage/cable adjustment, fluid level, and line pressure must be within specification before performing this test.

1. Remove fluid level indicator (7A020) from fluid filler tube.
2. Place funnel in fluid filler tube.
3. Raise vehicle on hoist and position suitable safety stands under vehicle.
4. Remove cooler return line (rear fitting) from fitting on transmission case. Refer to removal and installation of the transmission fluid cooler line in Section 07-02 .
5. Connect one end of a hose to the cooler return line and route the other end of the hose to a point where it can be inserted into the funnel at the fluid filler tube.
6. Remove safety stands and lower vehicle. Insert end of hose into funnel.
7. Start engine and run at idle with transmission in neutral range.
8. When fluid flowing from hose is all liquid, an adequate amount of fluid should be observed (approximately 1 liter [1 quart] delivered in 30 seconds). If adequate flow is observed, test is completed.
9. If the flow is not adequate, stop engine. Disconnect hose from cooler return line and connect it to converter out line fitting (front fitting) on transmission case.
10. Repeat Steps 7 and 8. If flow is now adequate, refer to Section 07-02 for diagnosis of transmission fluid cooler (7A095). If flow is not adequate, service pump and/or converter assembly, and main control.

Transmission Fluid Cooler — Backflush/Cleaning

CAUTION: Whenever a transmission has been disassembled to replace worn or damaged parts or because the valve body sticks from foreign material, the transmission fluid cooler must be cleaned using the Rotunda Torque Converter/Fluid Cooler Cleaner 014-00028 or equivalent. Under no circumstances should torque converters be cleaned by hand agitation with solvent.

When internal wear or damage has occurred in the transmission, metal particles, clutch plate material, or band material may have been carried into the transmission cooler. These contaminants are a major cause of reoccurring transmission concerns and must be removed from the system before the transmission is put back into service.

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1. Conduct backflushing with a Rotunda Torque Converter/Transmission Fluid Cooler Cleaner 014-00028 or equivalent. Test the equipment to make sure that a vigorous fluid flow is present before proceeding. Replace the system filter if flow is weak or contaminated.

2. To aid in attaching the cleaner to the transmission steel cooler lines, connect two additional rubber hoses to the transmission end of the steel transmission cooler lines as described.

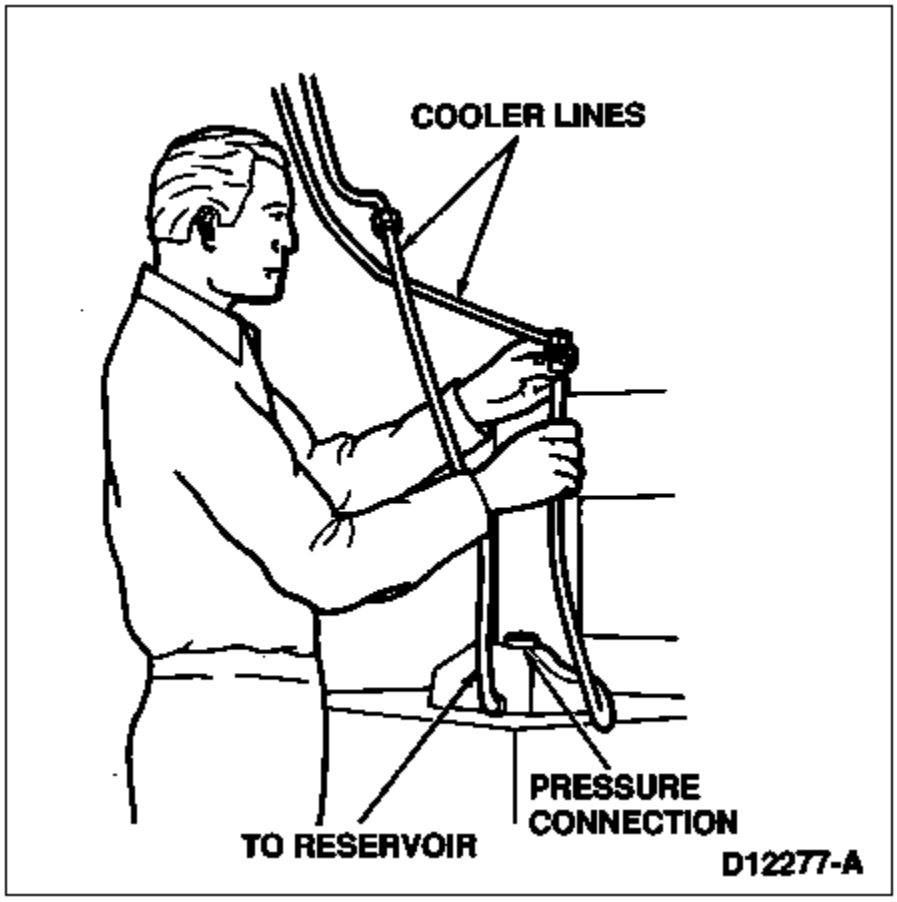
    - Connect the cleaner tank pressure line to the steel transmission cooler return line (longest line).
    - Connect a tank return hose to the steel transmission cooler pressure line (shorter line). Place the outlet end of this hose in the solvent tank reservoir.

3. Turn on solvent pump and allow the solvent to circulate a minimum of 5 minutes (cycling switch on and off will help dislodge contaminants in cooler system).

4. Switch off the solvent pump and disconnect the solvent pressure hose from the transmission cooler return line.

5. Use compressed air to blow out the cooler(s) and lines (blow air into the transmission cooler return line) until all solvent is removed.

6. Remove the rubber return hose from the remaining steel cooler line.



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Transmission Fluid Cooler Tube Replacement

When fluid leakage is found at the transmission fluid cooler, the transmission fluid cooler must be replaced. Refer to Section 03-03 .

When transmission fluid cooler steel lines must be replaced, each replacement line must be fabricated from the same size inside diameter and length steel line as the original line.

Using the old line as a guide, bend the new line as required. Add the necessary fittings, and install the line.

After the fittings have been tightened, check and add fluid as necessary. Check for fluid leaks.

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Diagnosis by Symptom

The Diagnosis by Symptom Index gives the technician diagnostic information, direction and suggests possible components, using a symptom as a starting point.

The Diagnosis by Symptom Index is divided into two categories: Electrical Routines, indicated by 200 series numbers, and Hydraulic/Mechanical Routines, indicated by 300 series numbers. The Electrical Routines list the possible electrical components that could cause or contribute to the symptom described. The Hydraulic/Mechanical Routines list the possible hydraulic or mechanical components that could cause or contribute to the symptom described.

Diagnosis by Symptom Chart — Directions

1. Using the Diagnosis by Symptom Index, select the Symptom/Concern that best describes the condition.

2. Turn to the Routine indicated in the Diagnosis by Symptom Index.

3. Always begin diagnosis of a symptom by using the following:

    a. Preliminary inspections
    b. Verification of condition
    c. Check the fluid level
    d. Perform other test procedures as directed

4. Then begin with the Electrical Routine, if indicated. Follow the reference or action required statements. Always perform the On-Board Diagnostic Tests as required. Never skip steps. Service as required. If the concern is still present after electrical diagnosis then proceed to the Hydraulic/Mechanical Routine listed.

CAUTION: Not all concerns and conditions with electrical components will set a Diagnostic Trouble Code (DTC). Be aware that the components listed may still be the cause. Verify proper function of those components prior to proceeding to the Hydraulic/Mechanical Routine listed.

5. The Hydraulic/Mechanical Routines list possible hydraulic or mechanical components that could cause the concern. These components are listed in the removal sequence and by most likely concern. All components listed must be inspected to ensure proper repair.

Diagnosis by Symptom Index

Diagnosis By Symptom Index

4R44E	Routines	
	Electrical [1]	Mechanical/ Hydraulic

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Engagement Concerns:		
• No Forward Only	201	301
• No Reverse Only	202	302
• Harsh Reverse Only	203	303
• Harsh Forward Only	204	304
• Delayed/Soft Reverse Only	205	305
• Delayed/Soft Forward Only	206	306
• No Forward and No Reverse	207A	307A
• No Forward in (D) Position and No Reverse	207B	307B
• Harsh Forward and Harsh Reverse	208	308
• Delayed Forward and Delayed Reverse	209	309
Shift Concerns:		
• Some/All Shifts Missing	210	310
• Timing Concern		
Early/Late (Some/All)	211	311
Erratic/Hunting (Some/All)	212	312
• Feel Concerns		
Soft/Slipping (Some/All)	213	313
Harsh (Some/All)	214	314
• No First Gear in Drive, Engages in a Higher Gear	215	315
• No First Gear in Manual 1st	216	316
• No Manual Second Gear	217	317
Torque Converter Clutch Operation Concerns:		
• Does Not Apply	240	340
• Always Applied/Stalls Vehicle	241	341
• Cycling/Shudder/Chatter	242	342
Other Concerns:		
• Shift Lever Efforts High	251	351
• External Leaks	252	352
• Poor Vehicle Performance	253A	353A
• Poor Performance — Wrong Gear Ratio in (D) Manual 2 or Manual 1 Position	253B 254	353B 354
• Noise/Vibration — Forward or Reverse	255	355
• Engine Will Not Crank	256	356
• No Park Range	257	357
• Overheating	258	358
• No Engine Braking in Manual 2	259	359
• No Engine Braking in Manual 1	260	360
• No Engine Braking with (D) Canceled (2nd and 3rd Gears)	261	361
• Fluid Venting or Foaming	263	363
• Slips/Chatters in Manual 1st Gear	264	364
• Slips/Chatters in Manual 2nd Gear	265	365
• FMEM — Harsh Engagements and Shifts		
Reference:		
• Pressure Charts	—	401
• Check Ball Locations	—	501
• Band/Clutch Application Chart	—	601

[1] Perform electrical routine first.

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Diagnostic Routines

Engagement Concerns: No Forward Only

Possible Component	Reference/Action
201 — ELECTRICAL ROUTINE	
No Electrical Concerns	
301 — HYDRAULIC/MECHANICAL ROUTINE	
Fluid	
• Improper level	• Adjust to proper level.
Shift Linkage (Internal/External)	
• Transmission shift cable and bracket damaged or misadjusted. TR sensor out of adjustment	• Inspect for damage. Readjust as required. Service all damaged components. After servicing linkage, readjust DTR sensor.
Improper Pressures	
• Improper band/clutch application pressure, line pressure low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is low, check the following possible components: main control, filter/seal, pump assembly.
Filter and Seal Assembly	
• Filter damaged, plugged; seal damaged, cut or missing	• Inspect for damage and replace.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gaskets damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• Forward modulator valve/EPC boost valve (207), forward engagement control valve (209), spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.
Pump Assembly	
• Pump damaged, leaking	• Inspect for damage. Service or replace as required.
• Screws out of torque specification	• Tighten screws to specification.
Center Support Assembly	
• Forward clutch support seal rings leaking	• Perform air pressure check. If OK, go to forward clutch assembly. Service as required.
Forward Clutch Assembly	
• Forward clutch assembly burnt/damaged/leaking. Check ball in cylinder/leaking piston seal rings	• Perform air pressure check. Service as required.
Rear One-Way Clutch Assembly	

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• Rear one-way clutch damaged, worn	• Replace rear one-way clutch and case.

Engagement Concerns: No Reverse Only

Possible Component	Reference/Action
202 — ELECTRICAL ROUTINE	
No Electrical Concerns	
302 — HYDRAULIC/MECHANICAL ROUTINE	
Fluid	
• Improper level	• Adjust to proper level.
Shift Linkages (Internal/External)	
• Transmission shift cable and bracket damaged or misadjusted. DTR sensor out of adjustment	• Inspect for damage. Readjust as required. Service all damaged components. After servicing linkages, readjust DTR sensor.
Improper Pressures	
• Improper band/clutch application pressures, line pressure low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is low, check the following possible components: reverse clutch.
Filter and Seal Assembly	
• Filter damaged, plugged; seal damaged, cut or missing	• Inspect for damage and replace.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• 1-2 shift valve (203), 2-3 shift valve (204), reverse modulator valve (205), spring damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.
Pump Assembly	
• Screws out of torque specification • Pump damaged, leaking	• Tighten screws to specifications. • Inspect for damage. Service as required.
Direct/Reverse Clutch/Reverse Band	
• Reverse clutch assembly burnt/worn/leaking check ball in clutch piston/leaking piston seal rings, cover gasket damaged	• Perform air pressure test. • Inspect for damage. Service as required.
• Direct/reverse servo piston seal cut/leaking	• Check and replace piston seal. Check and replace low/reverse band.

Engagement Concerns: Harsh Reverse Only

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Possible Component	Reference/Action
203 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harness, PCM, TP, VSS, RPM, EPC, SS1 (off)	• Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit) and Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in the Transmission Tester Kit to perform transmission static and dynamic tests. Perform the following Pinpoint Tests: A, E. Service as required. Clear codes, road test and rerun on-board diagnostics.
303 — HYDRAULIC/MECHANICAL ROUTINE	
Improper Pressures • Improper band/clutch application pressures, line pressure high	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is high, check the following possible components: main control.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• EPC, SS1, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Service as required.
• Reverse modulator valves (205), pressure boost valve/main regulator valve (208), check ball B, springs, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong components used in rebuild	• Verify that proper components were used.
Direct/Reverse Clutch Assembly • Assembly • Seals damaged, missing • Center support hub/seal ring damaged • Check ball damaged • Friction elements damaged or missing	• Air check clutch assembly as outlined in this manual. • Inspect direct clutch assembly for damage. Service as required.

[1] Can be purchased as a separate item.

Engagement Concerns: Harsh Forward Only

Possible Component	Reference/Action
204 — ELECTRICAL ROUTINE	
Powertrain Control System	

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• Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harness, PCM, TP, RPM, VSS, EPC	• Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit) and Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in the Transmission Tester Kit to perform transmission static and dynamic tests. Perform the following Pinpoint Test: E. Service as required. Clear codes, road test and rerun on-board diagnostics.
304 — HYDRAULIC/MECHANICAL ROUTINE	
Improper Pressures • Improper band/clutch application pressures, line pressure high	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is high check the following possible components: main control.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Service as required.
• Reverse modulator valves (205), forward modulator valve/EPC boost valve (207), forward engagement control valve (209), spring, damaged, missing, misassembled, stuck bore damage	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.
Forward Clutch Assembly	
• Assembly	• Air check clutch assembly as outlined in this manual.
• Plates burnt, missing; check ball missing, damaged; hub damaged	• Inspect for damage. Service as required.

[1] Can be purchased as a separate item.

Engagement Concerns: Delay/Soft Reverse

Possible Component	Reference/Action
205 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harness, PCM, TP, RPM, VSS, EPC	• Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit) and Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in the Transmission Tester Kit to perform transmission static and dynamic tests. Perform the following Pinpoint Test: E. Service as required. Clear codes, road test and rerun on-board diagnostics.

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305 — HYDRAULIC/MECHANICAL ROUTINE	
Engine Driveline	
• Looseness in the driveshaft, U-joints or engine mounts	• Service as required.
• Contamination blockage in cooler lines, in-tank radiator or auxiliary transmission oil cooler	• Perform transmission fluid cooler flow check.
Fluid	
• Improper level	• Adjust to proper level.
• Fluid contaminated	• Inspect fluid for contamination. If contaminated, locate source of contamination. If burnt, inspect mechanical band, clutches. Service as required.
Shift Linkages (Internal/External)	
• Transmission shift cable and bracket damaged or misadjusted. DTR sensor out of adjustment	• Inspect for damage. Readjust as required. Service all damaged components. After servicing linkages, readjust DTR sensor.
Improper Pressures	
• Improper band/clutch application pressures, line pressure low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is low, check the following possible components: main control.
Filter and Seal Assembly	
• Filter damaged, plugged; seal damaged, cut or missing	• Inspect for damage and replace.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Service as required.
• Reverse modulator valves (205), forward modulator valve/EPC boost valve (207), forward engagement control valve (209), spring damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.
Overdrive One-Way Clutch Assembly	
• One-way clutch damaged	• Determine cause of condition. Service as required.
Center Support Assembly	
• Direct/reverse clutch center support seal rings/ring grooves worn/damaged	• Determine cause of condition. Service as required.

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Reverse Clutch Drum • Rear reverse clutch drum bushing, one-way clutch damaged	• Air pressure test. Determine cause of condition. Visually inspect seal rings and pistons. Service as required.
Reverse Clutch Assembly	
• Assembly	• Perform air pressure check.
• Reverse clutch piston seals cut/worn	• Inspect for damage. Service as required.
• Reverse servo piston damaged/worn	• Inspect for damage. Service as required.
Reverse Band Assembly	
• Reverse band out of adjustment or damaged	• Inspect and readjust per procedures.
• Reverse band servo piston and rod damaged	• Inspect for damage. Service as required.
• Servo band cover gasket damaged	• Inspect gasket and replace.

[1] Can be purchased as a separate item.

Engagement Concerns: Delayed/Soft Forward

Possible Component	Reference/Action
206 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harness, PCM, TP, RPM, VSS, EPC	• Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit) and Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in the Transmission Tester Kit to perform transmission static and dynamic tests. Perform the following Pinpoint Test: E. Service as required. Clear codes, road test and rerun on-board diagnostics.
306 — HYDRAULIC/MECHANICAL ROUTINE	
Fluid • Improper level	• Adjust to proper level.
Shift Linkages (Internal/External) • Transmission shift cable and bracket damaged or misadjusted. DTR sensor out of adjustment	• Inspect for damage. Readjust as required. Service all damaged components. After servicing linkages, readjust DTR sensor.
Improper Pressures • Improper band/clutch application pressures, line pressure low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is low, check the following possible components: main control.
Filter and Seal Assembly • Filter damaged, plugged; seal damaged, cut or missing	• Inspect for damage and replace.

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Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Service as required.
• Forward modulator valve/EPC boost valve (207), forward engagement control valve (209), valve, spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Extension housing lube orifice plugged, missing • Wrong component used in rebuild	• Inspect for damage. Service as required. • Verify that proper components were used.
Overdrive One-Way Clutch Assembly • Overdrive one-way clutch damaged	• Replace as required.
Forward Clutch Assembly	
• Forward clutch piston check ball not seating/leaking	• Replace forward clutch piston. Service transmission as required.
• Forward hub seal rings damaged • Forward clutch piston seals cut/worn	• Inspect for damage. Service as required. • Replace seal and service as required.
Rear One-Way Clutch • Rear one-way clutch damaged/worn	• Determine cause of condition. Service as required.

[1] Can be purchased as a separate item.

Engagement Concerns: No Forward And No Reverse

Possible Component	Reference/Action
207A — ELECTRICAL ROUTINE	
No Electrical Concerns	
307A — HYDRAULIC/MECHANICAL ROUTINE	
Fluid • Improper level	• Adjust to proper level.
Improper Pressures • Improper band/clutch application pressures, line pressure low, EPC	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is high/low, check the following possible

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pressure low	components: main control.
Filter and Seal Assembly • Filter damaged, plugged; seal damaged, cut or missing	• Inspect for damage and replace.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Service as required.
• EPC blow-off valve, spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.
Pump Assembly	
• Screws out of torque specification	• Tighten screws to specification.
• Pump gears damaged, cracked	• Inspect for damage. If damaged, replace pump.
Overdrive One-Way Clutch Assembly • Overdrive one-way clutch damaged	• Inspect for damage. Service as required.

Engagement Concerns: No Forward In (D) Position And No Reverse

Possible Component	Reference/Action
207B — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harness, PCM, TP, RPM, VSS, EPC	• Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit) and Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in the Transmission Tester Kit to perform transmission static and dynamic tests. Perform the following Pinpoint Test: E. Service as required. Clear codes, road test and rerun on-board diagnostics.
307B — HYDRAULIC/MECHANICAL ROUTINE	
Fluid • Improper level	• Adjust to proper level.

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Improper Pressures • Improper band/clutch application pressures, line pressure low, EPC pressure low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is high/low, check the following possible components: main control, pump assembly.
Filter and Seal Assembly • Filter damaged, plugged; seal damaged, cut or missing	• Inspect for damage and replace.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Service as required.
• Forward modulator valve/EPC boost valve (207), pressure boost valve (208), EPC blow off valve, spring, damaged, missing, misassembled, stuck bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.
Pump Assembly	
• Screws out of torque specification	• Tighten screws to specification.
• Gears damaged, cracked	• Inspect for damage. If damaged, replace pump.
Overdrive One-Way Clutch Assembly • Overdrive one-way clutch damaged	• Determine cause of condition. Service as required.
Mechanical • Mechanical damage	• Check splines on turbine input shaft and overdrive carrier, overdrive one-way clutch, center shaft, forward clutch, forward carrier and output shaft.

[1] Can be purchased as a separate item.

Engagement Concerns: Harsh Forward And Reverse

Possible Component	Reference/Action
208 — ELECTRICAL ROUTINE	
Powertrain Control System	
• Electrical inputs/outputs, vehicle wiring harness, internal transmission wiring harness, PCM, EPC, TSS, TFT, VSS, DTR, TCC, TP	• Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use Rotunda Transmission Tester 007-00130, Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in the Transmission Tester Kit, Transmission Range (TR) Sensor Cable "E" (007-00111)

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and MAF NOTE: Refer to FMEM — Routine 265 for additional information.	and Digital TR Sensor Overlay (007-00131) or equivalents to perform transmission static and dynamic tests. Perform the following Pinpoint Tests: B, C, D, E, F. Service as required, clear codes, road test and rerun on-board diagnostics.
308 — HYDRAULIC/MECHANICAL ROUTINE	
Engine/Driveline	
• Loose in the driveshaft, U-joints or engine mounts	• Service as required.
• Engine idle speed too high	• Check engine idle speed. Refer to the Powertrain Control/Emissions Diagnosis Manual [a] .
Fluid	
• Improper level	• Adjust to proper level.
Improper Pressures	
• Improper band/clutch application pressures, line pressure high	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is high, check the following possible components: main control.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• TCC, EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Service as required.
• Forward modulator valve/EPC boost valve (207), pressure boost valve/main regulator or valve (208), spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.

[1] Can be purchased as a separate item.

Engagement Concerns: Delayed Soft Forward And Reverse

Possible Component	Reference/Action
209 — ELECTRICAL ROUTINE	
No Electrical Concerns	
309 — HYDRAULIC/MECHANICAL ROUTINE	
Fluid	
• Improper level	• Adjust to proper level.

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• Fluid contaminated	• Inspect fluid for contamination. If contaminated, locate source of contamination. If burnt, inspect mechanical band, clutches. Service as required.
Improper Pressures • Improper band/clutch application pressures, line pressure low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is low, check the following possible components: main control, pump assembly.
Filter and Seal Assembly • Filter damaged, plugged; seal damaged, cut or missing	• Inspect for damage and replace.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• Forward modulator valve/EPC boost valve (207), pressure boost valve/main regulator valve (208), EPC blow-off valve, spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.
Pump Assembly	
• Screws out of torque specification	• Tighten screws to specification.
• Inner gears damaged, cracked	• Inspect for damage. Service as required.

Shift Concerns: Some Or All Shifts Missing

Possible Component	Reference/Action
210 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harness, PCM, TP, RPM, DTR, VSS, SS1, SS2, SS3, TCS, TSS, EPC (no 4th or 2nd when EPC is low)	• Perform shift point test. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit), Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in the Transmission Tester Kit, Transmission Range (TR) Sensor Cable "E" (007-00111) and Digital TR Sensor Overlay (007-00131) or equivalents to perform transmission static and dynamic tests. Perform the following Pinpoint Tests: A, D, E, F. Service as required. Clear codes, road test and rerun on-board diagnostics.
310 — HYDRAULIC/MECHANICAL ROUTINE	
Fluid	
• Improper level	• Adjust to proper level.
• Fluid contaminated	• Inspect fluid for contamination. If contaminated, locate

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	source of contamination. If burnt, inspect mechanical band, clutches. Service as required.
Shift Linkages (Internal/External)	
• Transmission shift cable and bracket damaged or misadjusted. DTR sensor out of adjustment	• Inspect for damage. Readjust as required. Service all damaged components. After servicing linkages, readjust DTR sensor.
Improper Pressures	
• Improper band/clutch application pressures, line pressure low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is low, check the following possible components: main control, pump, EPC solenoid.
Filter and Seal Assembly	
• Filter damaged, plugged; seal damaged, cut or missing	• Inspect for damage and replace.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• SS1, SS2, SS3, EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Service as required.
• Forward modulator valve/EPC boost valve (207), pressure boost valve/main regulator valve (208), extension housing lube orifice, check ball C damaged, spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong components used in rebuild	• Verify that proper components were used.
Overdrive Band	
• Not adjusted properly	• Readjust to proper specification.
• Piston seals damaged	• Inspect for damage. Service as required.
Intermediate Band	
• Not adjusted properly	• Readjust to proper specification.
• Servo, piston and seals damaged	• Inspect for damage. Service as required.
For diagnosis related to a specific shift, refer to Reference/Action.	• To diagnose specific No Shift, refer to the appropriate shift routine. **No Shift** 1-2, **Routine** 220/320 **No Shift** 2-3, **Routine** 221/321 **No Shift** 3-4, **Routine** 222/322

[1] Can be purchased as a separate item.

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Shift Concerns: Timing — Early/Late (Some/All)

Possible Component	Reference/Action
211 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harness, PCM, TP, TFT, EPC, VSS, SS1, SS2, SS3, RPM	• Perform shift point test. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit) and Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in the Transmission Tester Kit to perform transmission static and dynamic tests. Perform the following Pinpoint Tests: A, B, E. Service as required, clear codes, road test and rerun on-board diagnostics.
Other Electrical Concerns • No power to PCM, Keep Alive Memory erased from PCM	• Inspect EEC power relay. Service as required. • Restore memory by performing drive cycle test.
311 — HYDRAULIC/MECHANICAL ROUTINE	
Power/Engine Performance • Poor vehicle performance	• Refer to Routine No. 253A, 253B, 353A, 353B.
Other • Tire size change • Axle ratio change • Speedometer gear change	• Refer to the specifications decal on door panel and verify that vehicle has original equipment. Changes in tire size or axle ratio will affect shift timing.
Improper Pressures • Improper band/clutch application pressures, line pressure low (late shifts)	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is low, check the following possible components: main control.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• SS1, SS2, SS3, EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Service as required.
• Wrong component used in rebuild	• Verify that proper components were used.
For diagnosis related to a specific shift or if all above are OK, refer to Reference/Action.	• To diagnose specific shift-timing concern, refer to the appropriate shift routine. **Soft/Slipping Shift** 1-2, **Routine** 226/326 **Soft/Slipping Shift** 2-3, **Routine** 227/327 **Soft/Slipping Shift** 3-4, **Routine** 228/328 **Soft/Slipping Shift** 4-3, **Routine** 229/329

[1] Can be purchased as a separate item.

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Shift Concerns: Timing — Erratic Hunting (Some/All)

Possible Component	Reference/Action
212 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harness, internal transmission wiring harness, PCM, TP, RPM, EPC, TFT, SS1, SS2, SS3, DTR, TCC, CCS	• Perform shift point and TCC tests. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1]. Use Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit), Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in the Transmission Tester Kit and Transmission Range (TR) Sensor Adapter or equivalents to perform transmission static and dynamic tests. Perform the following Pinpoint Tests: A, B, C, D, E, G. Service as required. Clear codes, road test and rerun on-board diagnostics.
312 — HYDRAULIC/MECHANICAL ROUTINE	
Fluid	
• Improper level • Fluid contaminated	• Adjust to proper level. • Inspect fluid for contamination. If contaminated, locate source of contamination. If burnt, inspect mechanical band, clutches. Service as required.
Filter and Seal Assembly • Filter damaged, plugged; seal damaged, cut or missing	• Inspect for damage and replace.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• SS1, SS2, SS3, EPC, CCS, solenoid stuck, damaged, O-ring damaged or out of bore • Wrong component used in rebuild	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Service as required. • Verify that proper components were used.
Torque Converter Clutch Assembly	• Refer to converter cycling routine No. 342.
Further Diagnosis	
• For further diagnosis for timing issues, refer to Reference/Action.	• For specific shift diagnosis, refer to the following application chart.

[1] Can be purchased as a separate item.

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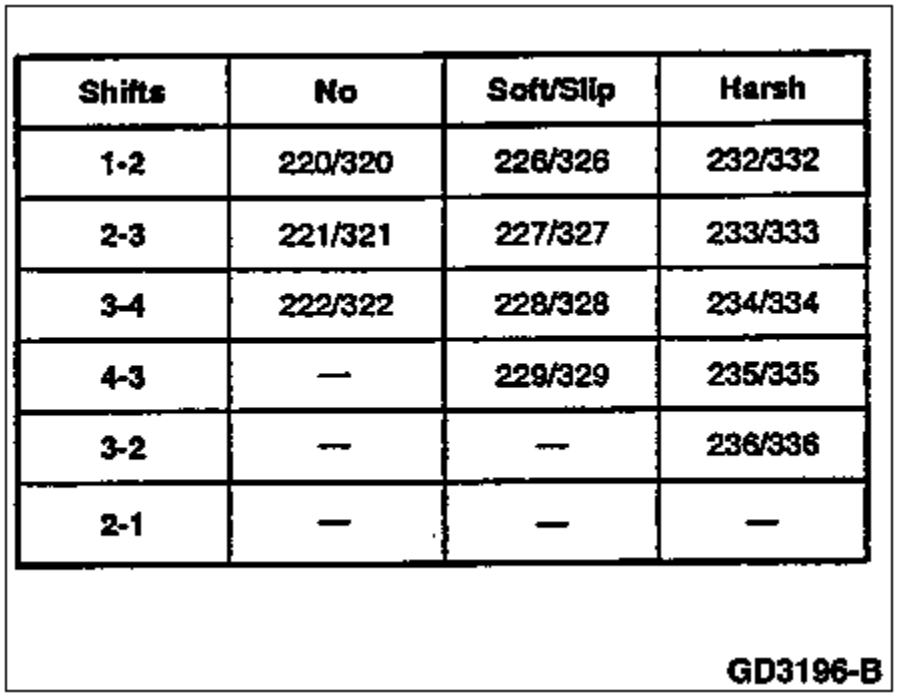

Shifts	No	Soft/Slip	Harsh
1-2	220/320	226/326	232/332
2-3	221/321	227/327	233/333
3-4	222/322	228/328	234/334
4-3	—	229/329	235/335
3-2	—	—	236/336
2-1	—	—	—

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Shift Concerns: Feel — Soft/Slipping (Some/All)

Possible Component	Reference/Action
213 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harness, PCM, TP, RPM, EPC, TFT, MAF • Engine — restricted air inlet	• Perform shift point test. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit) and Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in the Transmission Tester Kit to perform transmission static and dynamic tests. Perform the following Pinpoint Tests: B, E. Service as required. Clear codes, road test and rerun on-board diagnostics.
313 — HYDRAULIC/MECHANICAL ROUTINE	
Fluid	
• Improper level • Fluid contaminated	• Adjust to proper level. • Inspect fluid for contamination. If contaminated, locate source of contamination. If burnt, inspect mechanical band, clutches. Service as required.
Improper Pressures • Improper band/clutch application pressures, line pressure low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is low check the following possible components: main control, filter/seal, pump assembly.
Filter and Seal Assembly	

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• Filter damaged, plugged; seal damaged, cut or missing	• Inspect for damage and replace.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Service as required.
• Pressure boost valve/main regulator valve (208), EPC blow-off valve, extension housing lube orifice, check ball C missing, valve spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.
Pump Assembly • Screws out of torque specification	• Tighten screws to specification.
Overdrive Band	
• Not adjusted properly	• Readjust to proper specification.
• Piston seals damaged	• Inspect for damage. Service as required.
Intermediate Band	
• Not adjusted properly	• Readjust to proper specification.
• Servo, piston and seals damaged	• Inspect for damage. Service as required.
For diagnosis related to a specific shift see Reference/Action.	• To diagnose a specific shift concern, refer to the appropriate shift routine. **Soft/Slipping Shift** 1-2, **Routine** 226/326 **Soft/Slipping Shift** 2-3, **Routine** 227/327 **Soft/Slipping Shift** 3-4, **Routine** 228/328 **Soft/Slipping Shift** 4-3, **Routine** 229/329

[1] Can be purchased as a separate item.

Shift Concerns: Feel — Harsh (Some/All)

Possible Component	Reference/Action
214 — ELECTRICAL ROUTINE	
Powertrain Control System	
• Electrical inputs/outputs, vehicle wiring harness, internal transmission wiring harness, PCM, EPC, TFT, RPM, DTR, VSS, TP*, MAF*	• Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit), Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in the Transmission Tester Kit and Transmission Range (TR) Sensor Adapter or equivalents to perform

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* Also see Routine 265	transmission static and dynamic tests. Perform the following Pinpoint Tests: B, D, E. Service as required. Clear codes, road test and rerun on-board diagnostics.
314 — HYDRAULIC/MECHANICAL ROUTINE	
Fluid • Improper level	• Adjust to proper level.
Improper Pressures • Improper band/clutch application pressures, line pressure high	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is high check the following possible components: main control.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Service as required.
• Forward modulator valve/EPC boost valve (207), pressure boost valve/main regulator valve (208), spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.
Overdrive Band • Misadjusted (tight)	• Readjust to specification.
Intermediate Band • Misadjusted (tight)	• Readjust to specification.
For diagnosis related to a specific shift, refer to Reference/Action.	• For diagnosis of a specific harsh shift, refer to the appropriate shift routine. **Harsh Shift** 1-2, **Routine** 232/332 **Harsh Shift** 2-3, **Routine** 233/333 **Harsh Shift** 3-4, **Routine** 234/334 **Harsh Shift** 4-3, **Routine** 235/335 **Harsh Shift** 3-2, **Routine** 236/336

[1] Can be purchased as a separate item.

Shift Concerns: No 1st Gear In Drive, Engages In High-Gear

Possible Component	Reference/Action
215 — ELECTRICAL ROUTINE	
Powertrain Control System	

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• Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, SS1, SS2, SS3, DTR, EPC	• Perform shift point and TCC tests. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit) and Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in the Transmission Tester Kit and Transmission Range (TR) Sensor Adapter or equivalents to perform transmission static and dynamic tests. Perform the following Pinpoint Tests: A, D, E. Service as required. Clear codes, road test and rerun on-board diagnostics.
315 — HYDRAULIC/MECHANICAL ROUTINE	
Shift Linkages (Internal/External)	
• Transmission shift cable and bracket damaged or misadjusted. DTR sensor out of adjustment	• Inspect for damage. Readjust as required. Service all damaged components. After servicing linkage, readjust DTR sensor.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• SS1, SS2, SS3, EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Service as required.
• Wrong components used in rebuild	• Verify that proper components were used.
Mechanical	
• Clutches damaged	• Refer to disassembly and assembly of transmission in this section.
For diagnosis related to a specific gear, use transmission tester to determine gear	• Refer to the following routines: **Shift** 1-2, **Routine** 220/320 **Shift** 2-3, **Routine** 221/321 **Shift** 3-4, **Routine** 222/322

[1] Can be purchased as a separate item.

Shift Concerns: No Manual 1st Gear

Possible Component	Reference/Action
216 — ELECTRICAL ROUTINE	
Powertrain Control System	
• Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, SS1	• Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit) and Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in the Transmission Tester Kit to perform transmission static and dynamic tests. Perform the following Pinpoint Test: A. Service as

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	required. Clear codes, road test and rerun on-board diagnostics.
316 — HYDRAULIC/MECHANICAL ROUTINE	
Improper Pressures • Improper band/clutch application (no engine braking), pressures, line pressure low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is low check the following possible components: main control.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• SS1, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Service as required.
• Check ball A damaged	• Inspect for damage. Service as required.
Low/Reverse One-Way Clutch Assembly	
• Rear one-way clutch damaged	• Service as required.

[1] Can be purchased as a separate item.

Shift Concerns: No Manual 2nd Gear

Possible Component	Reference/Action
217 — ELECTRICAL ROUTINE	
No Electrical Concerns	
317 — HYDRAULIC/MECHANICAL ROUTINE	
Improper Pressures • Improper band/clutch application pressures, line pressure high/low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is high/low check the following possible components: main control.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• Check ball A damaged • Wrong component used in rebuild	• Inspect for damage. Service as required. • Verify that proper components were used.
Intermediate Band	
• Intermediate band out of	• Adjust intermediate band.

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adjustment	
• Damaged or worn intermediate servo piston, lever, strut or internal leaks	• Perform air pressure test.
• Polished, glazed intermediate band or drum	• Replace or service as required.

Shift Concerns: No 1-2 Shift (Automatic)

Possible Component	Reference/Action
220 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, TP, VSS, SS1, SS2, EPC	• Perform shift point test. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit) and Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in the Transmission Tester Kit to perform transmission static and dynamic tests. Perform the following Pinpoint Tests: A, E. Service as required, clear codes, road test and rerun on-board diagnostics.
320 — HYDRAULIC/MECHANICAL ROUTINE	
Shift Linkage (Internal/External) • Transmission shift cable and bracket damaged or misadjusted. DTR sensor out of adjustment	• Inspect for damage. Readjust as required. Service all damaged components. After servicing linkages, readjust DTR sensor.
Improper Pressures • Improper band/clutch application pressures, line pressure low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is low check the following possible components: main control.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• SS1, SS2, EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Service as required.
• 1-2 shift valve (203), forward modulator valve/EPC boost valve (207), spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.

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Intermediate Band Assembly	
• Band adjustment incorrect	• Inspect and readjust as required.
• Seals, piston, cover damaged	• Inspect for damage. Service as required.
• Friction elements worn, missing, damaged, misassembled	• Inspect for damage. Service as required.
• Return spring damaged • Case bore damaged, leaking	• Inspect for damage. Service as required. • Inspect for damage. Service as required.

[1] Can be purchased as a separate item.

Shift Concerns: No 2-3 Shift (Automatic)

Possible Component	Reference/Action
221 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, TP, VSS, SS1, SS2	• Perform shift point test. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit) and Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in the Transmission Tester Kit to perform transmission static and dynamic tests. Perform the following Pinpoint Test: A. Service as required, clear codes, road test and rerun on-board diagnostics.
321 — HYDRAULIC/MECHANICAL ROUTINE	
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• SS1, SS2, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Service as required.
• 1-2 shift valve (203), 2-3 shift valve (204), spring, damaged, missing, misassembled, stuck, bore damaged • Wrong components used in rebuild	• Inspect for damage, If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage. • Verify that proper components were used.
Center Support Assembly	
• Screws not tightened to specification	• Inspect, install new and retighten to specification.
• Seal rings damaged • Outside diameter of casebore or center	• Inspect for damage. Service as required. • Inspect for damage. Service as required.

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support damaged or leaking	
Direct Clutch Assembly	
• Assembly	• Air check assembly as outlined in this manual.
• Seals, piston, cylinder damaged	• Inspect for damage. Service as required.
• Friction elements mission or damaged	• Inspect for damage. Service as required.
• Check ball missing, damaged	• Inspect for damage. Service as required.

[1] Can be purchased as a separate item.

Shift Concerns: No 3-4 Shift (Automatic)

Possible Component	Reference/Action
222 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, TP, VSS, SS3, CCS, EPC, TCS	• Perform shift point test. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit) and Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in the Transmission Tester Kit to perform transmission static and dynamic tests. Perform the following Pinpoint Tests: A, E, G. Service as required, clear codes, road test and rerun on-board diagnostics.
322 — HYDRAULIC/MECHANICAL ROUTINE	
Improper Pressures • Improper band/clutch application pressures, line pressure high/low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is high/low, check the following possible components: main control.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• SS3, CCS, EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Service as required.
• Forward modulator valve/EPC boost valve (207), pressure boost valve/main regulator valve (208), SS3 solenoid/3-4 shift valve (215), spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong components used in	• Verify that proper components were used.

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rebuild	
Overdrive Band Assembly	
• Band adjustment incorrect	• Inspect and readjust as required.
• Band friction plates burnt, missing	• Inspect for damage. Service as required.
• Cylinder damaged, leaking seals damaged	• Inspect for damage. Service as required.
• Piston cover seal, strut, lever damaged	• Inspect for damage. Service as required.
Overdrive Planetary Assembly	
• Damaged	• Inspect for damage. Service as required.

[1] Can be purchased as a separate item.

Shift Concerns: Soft/Slipping 1-2 Only (Automatic)

Possible Component	Reference/Action
226 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, TP, MAF, EPC	• Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit) and Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in the Transmission Tester Kit to perform transmission static and dynamic tests. Perform the following Pinpoint Test: E. Service as required, clear codes, road test and rerun on-board diagnostics.
326 — HYDRAULIC/MECHANICAL ROUTINE	
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Service as required.
• EPC solenoid/1-2 shift valve (203), 2-3 shift valve (204), forward modulator valve/EPC boost valve (207), pressure boost valve/main regulator valve (208), EPC blow-off valve, extension housing lube orifice, spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.
Intermediate Band Assembly	
• Band adjustment incorrect	• Inspect and adjust as required.
• Seals or piston, strut, lever, damaged	• Inspect for damage. Service as required.

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• Friction elements worn, damaged, misassembled	• Inspect for damage. Service as required.
• Return spring wrong, damaged	• Inspect for damage. Service as required.
• Case bore damaged, leaking	• Inspect for damage. Service as required.

[1] Can be purchased as a separate item.

Shift Concerns: Soft/Slipping 2-3 Only (Automatic)

Possible Component	Reference/Action
227 — ELECTRICAL ROUTINE	
Powertrain Control System	
• Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, EPC, TP, SS1	• Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit) and Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in the Transmission Tester Kit to perform transmission static and dynamic tests. Perform the following Pinpoint Tests: A, E. Service as required. Clear codes, road test and rerun on-board diagnostics.
327 — HYDRAULIC/MECHANICAL ROUTINE	
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• EPC, SS1, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Service as required.
• 2-3 shift valve (204), forward modulator valve/EPC boost valve (207), pressure boost valve/main regulator valve (208), extension housing tube orifice, EPC blow-off valve, spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.
Center Support Assembly	
• Screw not tightened to specification	• Inspect, retighten to specification.
• Seal rings, groove damaged	• Inspect for damage. Service as required.
• Outside diameter or case bore, center support, damaged or leaking	• Inspect for damage. Service as required.
Direct Clutch Assembly	
• Assembly	• Air check clutch assembly as outlined in this section.
• Seals, piston, cylinder damaged	• Inspect for damage. Service as required.
• Friction elements burnt, missing	• Inspect for damage. Service as required.

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• Improper quantity of plates installed	• Inspect for proper quantity. Service as required.
• Check ball missing, not seating • Brake drum, intermediate band, damaged, misadjusted or incorrect	• Inspect for damage. Service as required. • Inspect for damage, readjust. Service as required.
Intermediate Servo	
• Piston, strut, lever, cover, damaged	• Inspect for damage. Service as required.
• Seal leaking	• Inspect for damage. Service as required.
• Piston rod lever incorrect, damaged	• Inspect for correct rod, damaged. Service as required.
• Case bore damaged • Spring damaged	• Inspect bore. Service as required. • Inspect for damage. Service as required.

[1] Can be purchased as a separate item.

Shift Concerns: Soft/Slipping 3-4 Only (Automatic)

Possible Component	Reference/Action
228 — ELECTRICAL ROUTINE	
Powertrain Control System	
• Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, TP, EPC	• Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit) and Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in the Transmission Tester Kit to perform transmission static and dynamic tests. Perform the following Pinpoint Test: E. Service as required, clear codes, road test and rerun on-board diagnostics.
328 — HYDRAULIC/MECHANICAL ROUTINE	
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Service as required.
• Forward modulator valve/EPC boost valve (207) pressure boost valve/main regulator valve (208), 3-4 shift valve (215), extension housing lube orifice, EPC blow-off valve, spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.
Overdrive Band Assembly	
• Assembly band adjustment incorrect	• Inspect and readjust as required.

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• Friction elements burnt	• Inspect for damage. Service as required.
• Cylinder damaged	• Inspect for damage. Service as required.
• Piston rod, lever, strut, missing or damaged	• Inspect for damage. Service as required.
• Cover, piston seals leaking	• Inspect for damage. Service as required.
• Case bore damage, leaks	• Leak test.

[1] Can be purchased as a separate item.

Shift Concerns: Soft/Slipping 4-3 Downshifts

Possible Component	Reference/Action
229 — ELECTRICAL ROUTINE	
No Electrical Components	
329 — HYDRAULIC/MECHANICAL ROUTINE	
Overdrive One-Way Clutch	
• Damaged	• Inspect for damage. Service as required.
• Sprags missing, damaged, or worn	• Inspect for damage. Service as required.

Shift Concerns: Harsh 1-2 Only (Automatic)

Possible Component	Reference/Action
232 — ELECTRICAL ROUTINE	
Powertrain Control System	
• Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM	• Run on-board diagnostics. Refer to Section 4A in the Powertrain Control/Emissions Diagnosis Manual [1] for diagnosis and testing of the automatic transmission. Service as required. Clear codes, road test and rerun on-board diagnostics.
332 — HYDRAULIC/MECHANICAL ROUTINE	
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• 1-2 shift valve (203), spring, damaged, missing misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.
Intermediate Band Assembly	
• Band adjustment incorrect	• Inspect and readjust as required.
• Seal or piston damaged	• Inspect for damage. Service as required.

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• Friction element, lever rod, damaged or misassembled return spring	• Inspect for damage. Service as required.
Direct Clutch • Drum damaged, outer diameter out of specification	• Inspect for damage. Service as required.

[1] Can be purchased as a separate item.

Shift Concerns: Harsh 2-3 Shift Only (Automatic)

Possible Component	Reference/Action
233 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, EPC, TCC, TP	• Perform TCC tests. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit) and Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in the Transmission Tester Kit to perform transmission static and dynamic tests. Perform the following Pinpoint Tests: C, E. Service as required. Clear codes, road test and rerun on-board diagnostics.
333 — HYDRAULIC/MECHANICAL ROUTINE	
Improper Pressures • Improper band/clutch application pressures, line pressure low, EPC pressure low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is low, check the following possible components: main control.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• EPC, TCC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Service as required.
• Torque converter clutch (200), forward modulator valve/EPC boost valve (207), pressure boost valve/main regulator valve (208), thermostat bypass valve/cooler limit valve (216), spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.
Center Support Assembly	
• Seal rings damaged	• Inspect for damage. Service as required.
• Outside diameter or case bore damaged or leaking	• Inspect for damage. Service as required.
Direct Clutch Assembly	

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• Assembly	• Air check assembly as outlined in this section.
• Seals, piston or cylinder damaged	• Inspect for damage. Service as required.
• Friction elements damaged, missing or improper quantity of plates were installed	• Inspect for damage. Service as required.
• Check ball missing, not seating • Intermediate brake band damaged or worn	• Inspect for damage. Service as required. • Inspect for damage, readjust. Service as required.
Intermediate Servo Assembly • Piston, spring, lever, strut wrong, damaged	• Inspect for damage. Service as required.
Torque Converter Clutch Assembly	• Refer to routines 241/341.

[1] Can be purchased as a separate item.

Shift Concerns: Harsh 3-4 Only (Automatic)

Possible Component	Reference/Action
234 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, EPC, TCC, TP	• Perform TCC tests. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit) and Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in the Transmission Tester Kit to perform transmission static and dynamic tests. Perform the following Pinpoint Tests: C, E. Service as required. Clear codes, road test and rerun on-board diagnostics.
334 — HYDRAULIC/MECHANICAL ROUTINE	
Improper Pressures • Improper band/clutch application pressures, line pressure high/low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is high/low, check the following possible components: main control.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• TCC, EPC, SS3, O-ring, solenoid struck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Service as required.
• Torque converter clutch (200), forward modulator valve/EPC boost valve (207), pressure boost valve/main regulator valve (208), thermostat bypass valve/cooler limit valve (216), spring, damaged,	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.

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missing, misassembled, stuck, bore damaged • Wrong component used in rebuild	• Verify that proper components were used.
Overdrive Band Assembly	
• Band adjustment incorrect	• Air check servo band assembly as outlined in this section.
• Friction elements burnt, missing	• Inspect for damage. Service as required.
• Cylinder damaged, seals damaged • Lever, strut, piston, rod wrong	• Inspect for damage. Service as required.
Torque Converter Clutch Assembly	• Refer to routines 241/341.

[1] Can be purchased as a separate item.

Shift Concerns: Harsh 4-3 Only (Automatic)

Possible Component	Reference/Action
235 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, TCC	• Perform TCC Tests. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit) and Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in the Transmission Tester Kit to perform transmission static and dynamic tests. Perform the following Pinpoint Test: C. Service as required. Clear codes, road test and rerun on-board diagnostics.
335 — HYDRAULIC/MECHANICAL ROUTINE	
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• TCC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Service as required.
• TCC valve (200), thermostat bypass valve/cooler limit valve (216), spring, damaged, missing misassembled, stuck, bore damage	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.
Torque Converter Assembly	• Refer to routines 241/341.

[1] Can be purchased as a separate item.

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Shift Concerns: Harsh 3-2 Only (Automatic)

Possible Component	Reference/Action
236 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, SS3, TCC, EPC	• Perform shift point and TCC tests. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit) and Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in the Transmission Tester Kit to perform transmission static and dynamic tests. Perform the following Pinpoint Tests: A, C, E. Service as required. Clear codes, road test and rerun on-board diagnostics.
336 — HYDRAULIC/MECHANICAL ROUTINE	
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• TCC, EPC, SS3, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Service as required.
• Torque converter clutch (200), forward modulator valve/EPC boost valve (207), pressure boost valve/main regulator valve (208), manual low valve (212), 3-2 torque demand valve (213), thermostat bypass valve/cooler limit valve (216), spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
Direct Clutch Drum • Damaged	• Inspect for damage. Service as required.
Intermediate Band • Misadjusted	• Readjust band to proper specification.
Intermediate Servo Assembly • Piston, servo, spring, damage, wrong part used in rebuild	• Inspect for damage. Service as required.
Torque Converter Clutch Assembly	• Refer to routines 241/341.

[1] Can be purchased as a separate item.

Torque Converter Clutch Operation Concerns: No Clutch Apply

Possible Component	Reference/Action
240 — ELECTRICAL ROUTINE	
Powertrain Control System	

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• Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, ECT, TSS, TCC NOTE: Also refer to Routine No. 265.	• Perform TCC tests. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit) and Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in the Transmission Tester Kit to perform transmission static and dynamic tests. Perform the following Pinpoint Tests: C, F. Service as required. Clear codes, road test and rerun on-board diagnostics.
340 — HYDRAULIC/MECHANICAL ROUTINE	
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• Converter clutch control valve (201), thermostat bypass valve/cooler limit valve (216), spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• TCC solenoid and valve (200), stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Service as required.
• Wrong component used in rebuild	• Verify that proper components were used.
Pump Assembly	
• Front pump seal worn or damaged	• Inspect for damage. Service as required.
• Screws out of torque specification	• Retorque screws to specification.
Torque Converter Clutch Assembly	
• Torque converter internal malfunction preventing lockup, piston application	• Remove transmission. Inspect for damage. Replace torque converter if required.

[1] Can be purchased as a separate item.

Torque Converter Clutch Operation Concerns: Clutch Always Applies/Stalls Vehicle

Possible Component	Reference/Action
241 — ELECTRICAL ROUTINE	
Powertrain Control System	
• Low engine idle	• Verify engine idle speed is within specification.
• Electrical inputs/outputs, vehicle wiring harnesses,	• Perform TCC tests. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] Use Rotunda Transmission

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internal transmission wiring harnesses, PCM, TCC	Tester 007-00130 (part of Rotunda Transmission Tester Kit), Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in the Transmission Tester Kit and Transmission Range (TR) Sensor Adapter or equivalents to perform transmission static and dynamic tests. Perform the following Pinpoint Test C . Service as required. Clear codes, road test and rerun on-board diagnostics.
341 — HYDRAULIC/MECHANICAL ROUTINE	
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• TCC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Service as required.
• TCC solenoid and valve (200), TCC control valve (201), spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control, If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and result in further main control or transmission damage.
• Wrong components used in rebuild	• Verify that proper components were used.
Torque Converter Clutch Assembly	
• Torque converter internal malfunction preventing lockup piston application	• Remove transmission. Inspect for damage. Replace torque converter if required.

[1] Can be purchased as a separate item.

Torque Converter Clutch Operation Concerns: Cycling/Shudder/Chatter

Possible Component	Reference/Action
242 — ELECTRICAL ROUTINE	
Powertrain Control System	
• Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, TCC, DTR, BOO, TP, RPM	• Perform TCC tests. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit), Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in the Transmission Tester Kit and Transmission Range (TR) Sensor Cable "E" (007-00111) or equivalents to perform transmission static and dynamic tests. Perform the following Pinpoint Tests: C, D. Service as required. Clear codes, road test and rerun on-board diagnostics.
• Speed control equipped vehicles	• Evaluate with speed control off.
342 — HYDRAULIC/MECHANICAL ROUTINE	
Fluid	

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• Fluid contaminated	• Inspect fluid for contamination. If contaminated, locate source of contamination. If burnt, inspect mechanical band, clutches. Service as required.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• TCC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Service as required.
• TCC solenoid and valve (200), converter clutch control valve (201), thermostat bypass valve/cooler limit valve (216), spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
Pump Assembly	
• Screws out of torque specification	• Tighten screws to specification.
• Cross leaks	• Inspect for damage. Service as required.
• Front pump seal damage	• Inspect for damage. Service as required.
• Seal on inner pump gear damaged	• Inspect for damage. Service as required.
Torque Converter Clutch Assembly • End clearance (excessive), internal leakage, clutch material damage	• Perform end play check. Inspect and service as required.

[1] Can be purchased as a separate item.

Other Concerns: Shift Level Efforts High

Possible Component	Reference/Action
251 — ELECTRICAL ROUTINE	
No Electrical Concerns	
351 — HYDRAULIC/MECHANICAL ROUTINE	
Brake Shift Interlock • System, solenoid damaged	• Refer to brake section or steering column section in the service manual.
Shift Linkages (Internal/External) • Transmission shift cable and bracket damaged or misadjusted. DTR sensor out of adjustment	• Inspect for damage. Readjust as required. Service all damaged components. After servicing linkages, readjust DTR sensor.
Case	

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• Manual control outer lever damaged. Manual valve inner lever pin bent, damaged. Manual valve inner lever, spring rod damaged • Manual valve lever shaft retaining pin damaged	• Adjust linkage and install manual valve lever shaft retaining pin.

Other Concerns: External Leaks

Possible Component	Reference/Action
252 — ELECTRICAL ROUTINE	
No Electrical Concerns	
352 — HYDRAULIC/MECHANICAL ROUTINE	
Case • Case vent	• Check the vent for free breathing. Service as required.
Seals/Gaskets • Leakage at gaskets, seals, etc. Refer to leakage diagram for potential leak locations	• Remove all traces of lubricant on exposed surfaces of transmission. Check the vent for free breathing. Operate transmission at normal temperatures and perform fluid leakage check. Service as required.

Other Concerns: Poor Vehicle Performance

Possible Component	Reference/Action
253A — ELECTRICAL ROUTINE	
Powertrain Control System	
• Poor engine performance	• Check engine tune-up. Refer to Section 4A in the Powertrain Control/Emissions Diagnosis Manual [1] for diagnosis and testing of the automatic transmission.
• Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, SS3, TCC	• Perform shift point tests on O/D with the TCS off. Refer to shift point specification if out of specifications. Run on-board diagnostic and check for shift error codes. Perform shift point and TCC tests. Re-run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit), Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in the Transmission Tester Kit and Transmission Range (TR) Sensor Cable "E" (007-00111) or equivalents to perform transmission static and dynamic tests. Perform the following Pinpoint Tests: A, C. Service as required. Clear codes, road test and rerun on-board diagnostics.
353A — HYDRAULIC/MECHANICAL ROUTINE	
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.

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• Separator plate damaged	• Inspect for damage. Service as required.
• SS3, TCC solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Service as required.
• SS3 and 3-4 shift valve (215), spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used
Torque Converter Clutch Assembly	
• Torque converter one-way clutch slipping	• Inspect one-way clutch. Replace torque converter.
• Incorrect TCC used in rebuild	• Inspect for correct TCC assembly. Replace as required.

[1] Can be purchased as a separate item.

Other Concerns: Poor Vehicle Performance/Wrong Gear Ratio In D, M2, M1

Possible Component	Reference/Action
253B — ELECTRICAL ROUTINE	
Powertrain Control System	
• Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, SS3 (on)	• Perform shift point and TCC tests. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1]. Use Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit), Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in the Transmission Tester Kit and Transmission Range (TR) Sensor Cable "E" (007-00111) or equivalents to perform transmission static and dynamic tests. Perform the following Pinpoint Test: A. Service as required. Clear codes, road test and rerun on-board diagnostics.
353B — HYDRAULIC/MECHANICAL ROUTINE	
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• SS3, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Service as required.
• SS3 solenoid and valve (215), spring, damaged, missing,	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will

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misassembled, stuck, bore damaged • Wrong component used in rebuild	remove the anodized finish and result in further main control or transmission damage. • Verify that proper components were used.

[1] Can be purchased as a separate item.

Other Concerns: Noise/Vibration — Forward Or Reverse

Possible Component	Reference/Action
254 — ELECTRICAL ROUTINE	
No Electrical Concerns	
354 — HYDRAULIC/MECHANICAL ROUTINE	
Fluid • Improper level	• Adjust to proper level.
Shift Linkages (Internal/External) • Transmission shift cable and bracket damaged or misadjusted. DTR sensor out of adjustment	• Inspect for damage. Readjust as required. Service all damaged components. After servicing linkages, readjust DTR sensor.
Improper Pressures • Improper band/clutch application pressures, line pressure high/low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is high/low, check the following possible components: pump assembly.
Pump Assembly	
• Internal leakage, cavitation • Screws out of torque specification	• Inspect and service as required. • Tighten screws to specification.
Overdrive One-Way Clutch Assembly • One-way clutch damaged, worn, misassembled	• Service one-way clutch.
Rear One-Way Clutch Assembly • One-way clutch damaged, worn, misassembled	• Service one-way clutch.
Other • Transmission oil cooler lines, fill tube grounding	• Relocate transmission oil cooler lines or fill tube properly.
Gear • Gear noise	• Service planetary gear assemblies.
Torque Converter Clutch Assembly	• Refer to routines 242/342.

Other Concerns: Engine Will Not Crank

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Possible Component	Reference/Action
255 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, DTR sensor	• Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] for diagnosis. Use Rotunda Transmission Tester 007-00130 and Transmission Range (TR) Sensor Cable "E" 007-00111 or equivalents to perform transmission static and dynamic tests. Perform the following Pinpoint Test: D. Service as required. Clear codes, road test and rerun on-board diagnostics.
355 — HYDRAULIC/MECHANICAL ROUTINE	
Shift Linkages (Internal/External) • Transmission shift cable and bracket damaged or misadjusted. DTR sensor out of adjustment	• Inspect for damage. Readjust as required. Service all damaged components. After servicing linkages, readjust DTR sensor.
Pump Assembly • Seized	• Refer to disassembly of transmission. Inspect for damage. Service or replace as required.
Flywheel • Damaged	• Inspect for damage. Service as required.

[1] Can be purchased as a separate item.

Other Concerns: No Park Range

Possible Component	Reference/Action
256 — ELECTRICAL ROUTINE	
No Electrical Concerns	
356 — HYDRAULIC/MECHANICAL ROUTINE	
Shift Linkages (Internal/External) • Transmission shift cable and bracket damaged or misadjusted. DTR sensor out of adjustment	• Inspect for damage. Readjust as required. Service all damaged components. After servicing linkages, readjust DTR sensor.
Park Mechanism	
• Park gear, parking pawl, parking pawl return spring, park or guide plate, parking pawl shaft, parking pawl actuating rod, manual lever, manual lever detent spring damaged, misassembled	• Inspect for damage. Service as required.
• Transfer case and linkages damaged	• Refer to service manual for transfer case and linkage diagnosis.
4x4 Applications • Transfer case and linkage damaged	• Refer to service manual for transfer case and linkage diagnosis.

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Other Concerns: Transmission Overheating

Possible Component	Reference/Action
257 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, TFT, TCC	• Perform shift point and TCC test. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit), Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in the Transmission Tester Kit and Transmission Range (TR) Sensor Cable "E" (007-00111) or equivalents to perform transmission static and dynamic tests. Perform the following Pinpoint Tests: B, C. Service as required. Clear codes, road test and rerun on-board diagnostics.
357 — HYDRAULIC/MECHANICAL ROUTINE	
Fluid • Improper level	• Adjust to proper level.
Improper Pressures • Improper band/clutch application pressures, line pressure high/low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is high/low, check the following possible components: main control, TCC.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• TCC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Service as required.
• Thermostat bypass valve/cooler limit valve (216), spring, damaged, missing misassembled, stuck, bore damaged • Wrong component used in rebuild	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage. • Verify that proper components were used.
Torque Converter Clutch Assembly	
• Seized torque converter one-way clutch • Excessive slip detected	• Refer to routines 240/340. • Inspect torque converter one-way clutch. • Replace torque converter as required. • Run on-board diagnostics.
Other • Restriction in transmission oil cooler or tubes	• Service transmission oil cooler or tubes.

[1] Can be purchased as a separate item.

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Other Concerns: No Engine Braking In Manual 2 Position

Possible Component	Reference/Action
258 — ELECTRICAL ROUTINE	
No Electrical Concerns	
358 — HYDRAULIC/MECHANICAL ROUTINE	
Improper Pressures • Improper band/clutch application pressures, line pressure high/low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is high/low, check the following possible components: main control, coast clutch assembly.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• Extension housing lube orifice, check ball A and C not seating or damaged, spring, damaged, missing misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong part used in rebuild	• Service as required.
Coast Clutch Assembly	
• Coast clutch damaged	• Replace as required.
• Seal ring damaged	• Inspect for damage. Service as required.
Intermediate Band	
• Intermediate band out of adjustment	• Adjust intermediate band.
• Intermediate servo leaking	• Perform air pressure test to determine if intermediate servo is leaking. Service as required.
• Glazed intermediate band	• Service or replace as required.

Other Concerns: No Engine Braking In Manual 1 Position

Possible Component	Reference/Action
259 — ELECTRICAL ROUTINE	
No Electrical Concerns	
359 — HYDRAULIC/MECHANICAL ROUTINE	
Fluid • Improper level	• Adjust to proper level.
Shift Linkages (Internal/External) • Transmission shift cable and	• Inspect for damage. Readjust as required. Service all

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bracket damaged or misadjusted. DTR sensor out of adjustment	damaged components. After servicing linkages, readjust DTR sensor.
Improper Pressures	
• Improper band/clutch application pressures, line pressure high/low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is high/low, check the following possible components: main control.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• Manual low valve (212), check ball E not seating properly, spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong part used in rebuild	• Inspect for correct part. Service as required.
Coast Clutch Assembly	
• Wrong part used in rebuild	• Inspect parts. Service as required.
• Overdrive clutch damaged • Seal rings damaged	• Replace as required.
Reverse Clutch/Band	
• Reverse servo or piston or gasket seal leaking	• Perform air pressure test. Check and replace piston seal as required.
• Reverse band burnt, worn or damaged	• Replace as required.
• Polished or glazed low reverse clutch band or drum	• Service or replace as required.
Rear One-Way Clutch Assembly	
• Rear one-way clutch damaged	• Replace as required.

Other Concerns: No Engine Braking With Overdrive Cancelled(In 2nd And 3rd)

Possible Component	Reference/Action
260 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, SS3 (also no 3rd gear), CCS	• Perform shift point tests. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use Rotunda Transmission Tester to perform transmission static and dynamic tests. Perform the following Pinpoint Tests: A, G. Service as required. Clear codes, road test and rerun on-board diagnostics. Also check for engine braking in manual 1 and manual 2. NOTE: No engine braking in O/D position with the TCS off, 1st

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	gear is a normal function.
360 — HYDRAULIC/MECHANICAL ROUTINE	
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• SS3, CCS, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Service as required.
• Coast clutch solenoid and valve/converter clutch control valve (201), SS3 solenoid/3-4 shift solenoid (215), spring, damaged, missing misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.
Coast Clutch Assembly	
• Wrong part used in rebuild	• Verify that proper components were used.
• Overdrive clutch damaged	• Replace as required.
• Seal rings damaged	• Inspect for damage. Service as required.

[1] Can be purchased as a separate item.

Other Concerns: Fluid Venting/Foaming

Possible Component	Reference/Action
261 — ELECTRICAL ROUTINE	
No Electrical Concerns	
361 — HYDRAULIC/MECHANICAL ROUTINE	
• Vent blocked or damaged	• Check vent for damage or blockage. Service as required.
• Overfilled transmission	• Check level and adjust as required.
• Fluid contaminated (antifreeze, water)	• Check for contamination, locate source of contamination. Service as required.
• Overheating	• Refer to routines 257/357.
• Filter and seal assembly damaged or misassembled	• Inspect filter and seal assembly for damage. Service as required.

Other Concerns: Slips/Chatters In Manual 1 Position

Possible Component	Reference/Action
263 — ELECTRICAL ROUTINE	
No Electrical Concerns	
363 — HYDRAULIC/MECHANICAL ROUTINE	

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Improper Pressures • Improper band/clutch application pressures, line pressure high/low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is high/low, check the following possible components: main control.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• Wrong components used in rebuild	• Verify that proper components were used.
• Dirty or sticking main control valve body	• Clean, service or replace main control valve body.
Rear One-Way Clutch Assembly • Low/reverse one-way clutch damaged	• Replace rear one-way clutch and case.

Other Concerns: Slips/Chatters In Manual 2 Position

Possible Component	Reference/Action
264 — ELECTRICAL ROUTINE	
No Electrical Concerns	
364 — HYDRAULIC/MECHANICAL ROUTINE	
Improper Pressures • Improper band/clutch application pressures, line pressure high/low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is high/low, check the following possible components: main control.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Service as required.
• Wrong components used in rebuild	• Verify that proper components were used.
• Dirty or sticking main control valve body	• Clean, service or replace main control valve body.
Intermediate Band	
• Intermediate band out of adjustment	• Adjust intermediate band.
• Damaged or worn intermediate servo piston,	• Perform air pressure test. Inspect for damage. Service as required.

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lever, strut, or internal leaks • Polished, glazed low and intermediate band or drum	• Replace or service as required.

Other Concerns: FMEM — Harsh Engagements And Shifts

Possible Component	Reference/Action
265 — ELECTRICAL ROUTINE	
Powertrain Control System • Operating in FMEM strategy. Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, EPC, VSS, DTR, TCC, transmission overtemp (TFT), TP and MAF, shift error detected (shift solenoid, TSS, VSS and internal hardware)	• Run on-board diagnostics. Service as required. Clear codes, road test and rerun self test. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit), Rotunda 4R44E/4R55E Overlay/Cable 007-00106 included in the Transmission Tester Kit and Transmission Range (TR) Sensor Cable "E" (007-00111) or equivalent, perform Transmission Static and Dynamic Test. Perform the following Pinpoint Test B , C, D, E, F. Service as required, clear codes, road test and rerun on-board diagnostics.
365 — HYDRAULIC/MECHANICAL ROUTINE	
No Hydraulic/Mechanical Concerns	

[1] Can be purchased as a separate item.

Pressure Chart No. 401

Trans.	Transmission Model/Application	Range	Idle		WOT Stall	
			EPC	Line	EPC	Line
4R44E	2.3L Ranger	R	37-47	115-145	112-134	282-350
	4x2	N	21-31	77-107		
		(D), 2, 1	20-30	77-107	112-134	228-263
4R44E	3.0L Ranger	R	46-56	143-173	112-134	282-350
	4x2, 4x4	N	31-41	94-124		
		(D), 2, 1	20-30	71-101	112-134	228-263
4R44E	3.0L Aerostar	R	47-57	153-183	112-134	282-350
	4x2	N	20-30	73-103		
		(D), 2, 1	40-50	105-135	112-134	228-263

Main Control Body Check Ball Location No. 501

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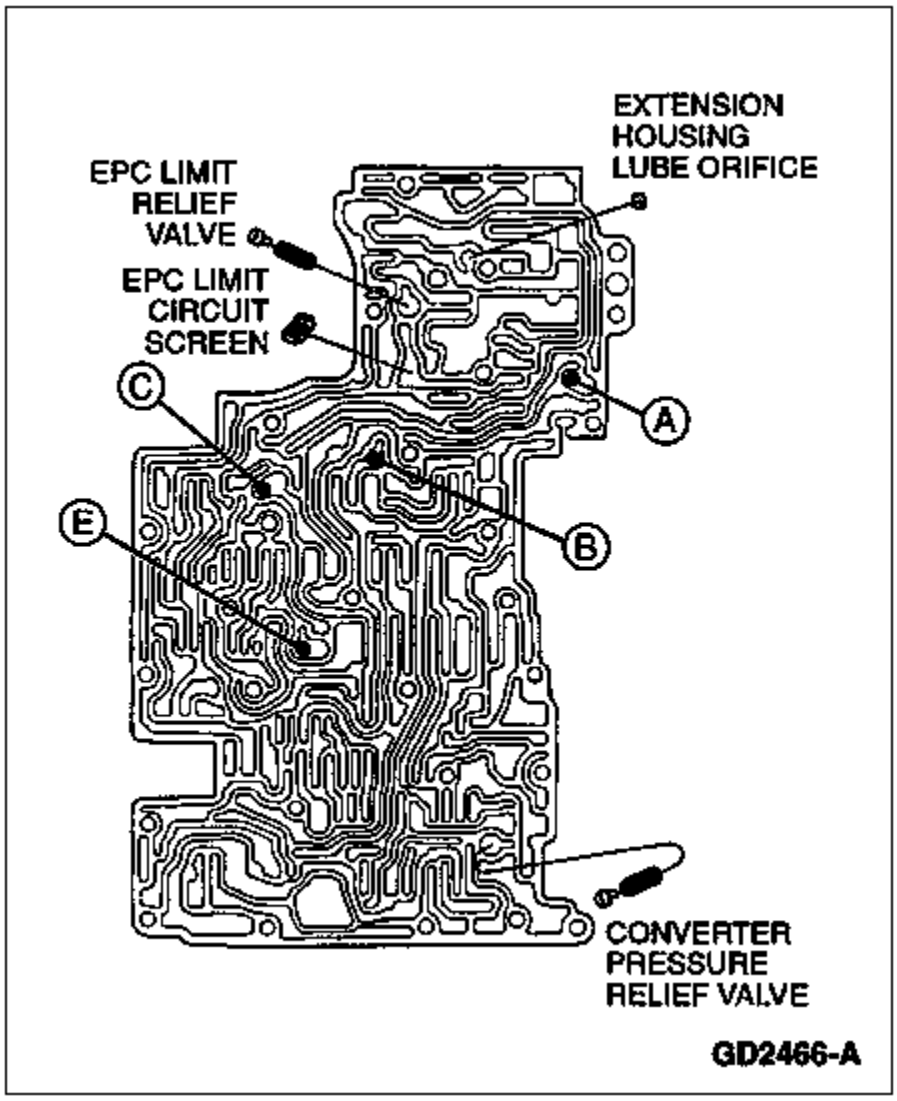

Band/Clutch Application Chart No. 601 (4R44E)

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	OVERDRIVE BAND	INTERMEDIATE BAND	LOW/REVERSE BAND	FORWARD CLUTCH	DIRECT CLUTCH	COAST CLUTCH	O/D ONE-WAY CLUTCH		REAR ONE-WAY CLUTCH		SHIFT SOLENOID 1 (SS1)	SHIFT SOLENOID 2 (SS2)	SHIFT SOLENOID 3 (SS3)	COAST CLUTCH SOLENOID (CCS)	ENGINE BRAKING	TCIL
							DRIVE	COAST	DRIVE	COAST						
PARK											ON	OFF	OFF	OFF	NE	NE
REVERSE			A		A		H	OR			ON	OFF	OFF	OFF	NO	OFF
REVERSE*			A		A	A	H	H			ON	OFF	OFF	ON	YES	ON
NEUTRAL											ON	OFF	OFF	OFF	NE	NE
1ST				A			H	OR	H	OR	ON	OFF	OFF	OFF	NO	OFF
1ST*				A		A	H	H	H	OR	ON	OFF	OFF	ON	YES	ON
2ND		A		A			H	OR	OR	OR	ON	ON	OFF	OFF	NO	OFF
2ND*		A		A		A	H	H	OR	OR	ON	ON	OFF	ON	YES	ON
3RD				A	A		H	OR	OR	OR	OFF	OFF	OFF	OFF	NO	OFF
3RD*				A	A	A	H	H	OR	OR	OFF	OFF	OFF	ON	YES	ON
4TH	A			A	A		OR	OR	OR	OR	OFF	OFF	ON	OFF	NO	OFF
MAN. 1ST			A	A		A	H	H	H	H	ON	OFF	OFF	ON	YES	NE
MAN. 2ND		A		A		A	H	H	OR	OR	ON	ON	OFF	ON	YES	NE

A = APPLIED H = HOLD OR = OVERRUNNING * = OVERDRIVE CANCELLED NE = NO EFFECT

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Transmission Fluid Drain and Refill

Intervals for drain and refill, due to in-vehicle service or major service operation, are as follows:

- Normal Maintenance
  - Not required with normal use.
- Severe Duty Maintenance
  - Change fluid at 80,450 km (50,000 mile) intervals using MERCON 5® XT-5-QM or equivalent.

CAUTION: Use only MERCON V® XT-5-QM Service Fluid as the use of any other fluids may result in a transmission malfunction or failure.

Maintenance Procedure

1. Loosen, then remove the transmission fluid pan-to-case screws to drain the fluid.
2. Remove and discard old pan gasket.
3. Thoroughly clean the fluid pan and the transmission case fluid pan rail surface.
4. Install new pan gasket onto pan and install fluid pan to case with screws. Tighten screws to 13-15 Nm (115-133 lb-in).
5. Add 2.8 liters (3 quarts) of MERCON V® XT-5-QM or equivalent MERCON® approved fluid into fluid filler tube.
6. Start engine. Move transmission range selector lever through all gear ranges, checking for engagements.
7. Check and adjust transmission fluid in 0.25 liter (1/2 pint) increments to proper level (cross-hatched area of fluid level indicator at normal operating temperatures).

Major Service/Overhaul

1. Loosen, then remove the transmission fluid pan screws to drain fluid.
2. Remove and discard old pan gasket.
3. Perform required internal repair and cleaning as required.
4. Thoroughly flush torque converter, cooler lines and transmission in-tank radiator cooler and auxiliary cooler (if equipped).
5. Replace with new fluid filter and O-rings assembly.

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6. Install cleaned fluid pan and new pan gasket with fluid pan-to-case screws. Tighten fluid pan-to-case screws to 13-15 Nm (115-133 lb-in).

7. Add 3.7 liters (4 quarts) of MERCON V® XT-5-QM or equivalent MERCON® approved fluid into fluid filler tube.

8. Start engine. Move the transmission range selector lever through all gear ranges, checking for engagements.

9. Check and adjust the transmission fluid level in 0.25 liter (1/2 pint) increments to the proper level (cross-hatched area of the fluid level indicator at normal operating temperatures).

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Extension Housing Seal and Bushing

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Impact Slide Hammer	T50T-100-A
Extension Housing Bushing Remover	T77L-7697-E
Extension Housing Bushing Replacer	T77L-7697-F
Extension Housing Seal Replacer	T74P-77052-A

SPECIAL SERVICE TOOLS DESIRED

Tool Number	Description
Seal Remover	T94P-77001-BH

Removal

1. Raise vehicle on a hoist and position suitable safety stands under vehicle.
2. Remove rear driveshaft. Refer to Section 05-01 .
3. Remove output shaft and extension housing seal using Seal Remover T94P-77001-BH and Impact Slide Hammer T50T-100-A.

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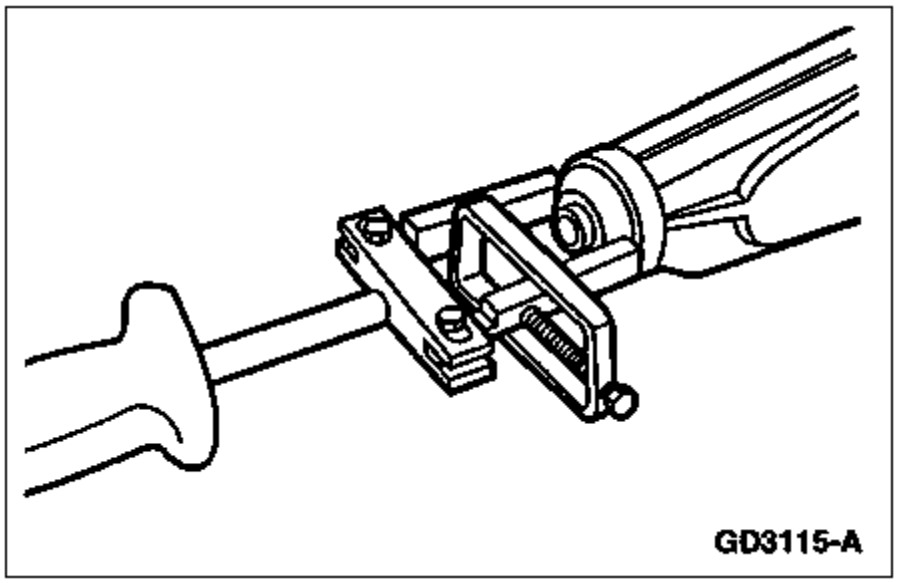

4. **CAUTION: Use the extension housing bushing remover carefully so that the seal area is not damaged.**

   Remove the bushing using Extension Housing Bushing Remover T77L-7697-E.

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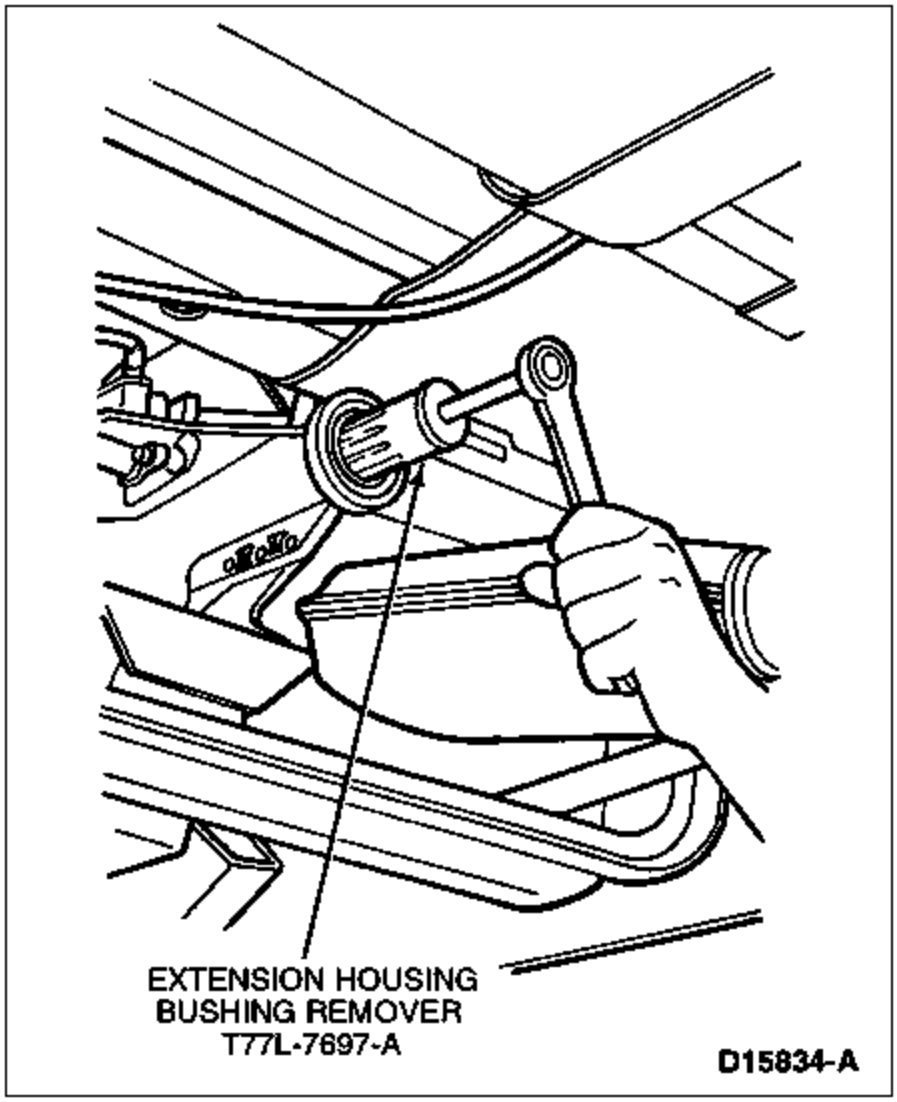

Installation

1. Inspect the counterbore of the extension housing for burrs. If necessary, remove burrs with an oil stone.

2. **CAUTION: The lube hole in the bushing must be aligned with the lube groove in the extension housing, located 90°(3 o'clock position) from top when viewed from rear.**

   CAUTION: Tool will bottom when bushing is in the proper position.

   NOTE: Install the extension housing bushing if it was removed.

   Install the extension housing bushing using Extension Housing Bushing Replacer T77L-7697-F.

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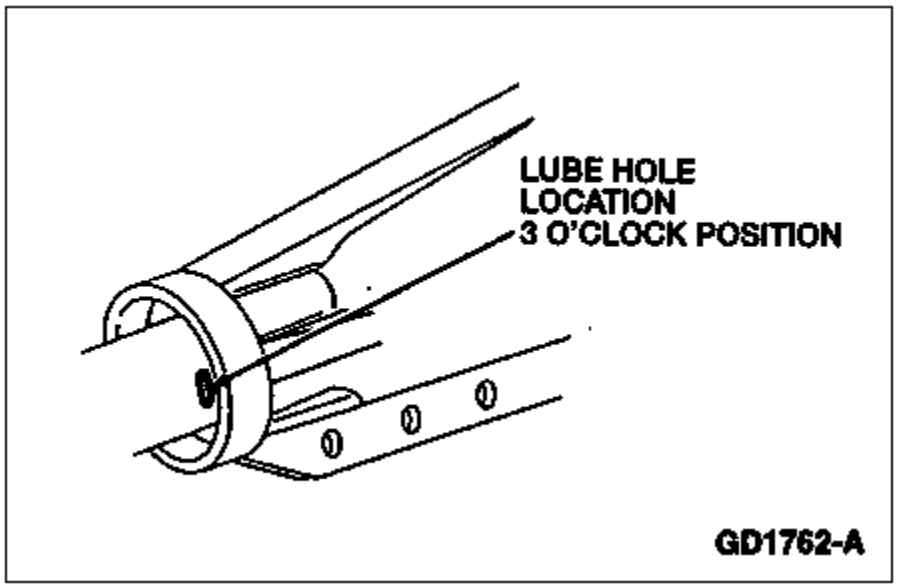

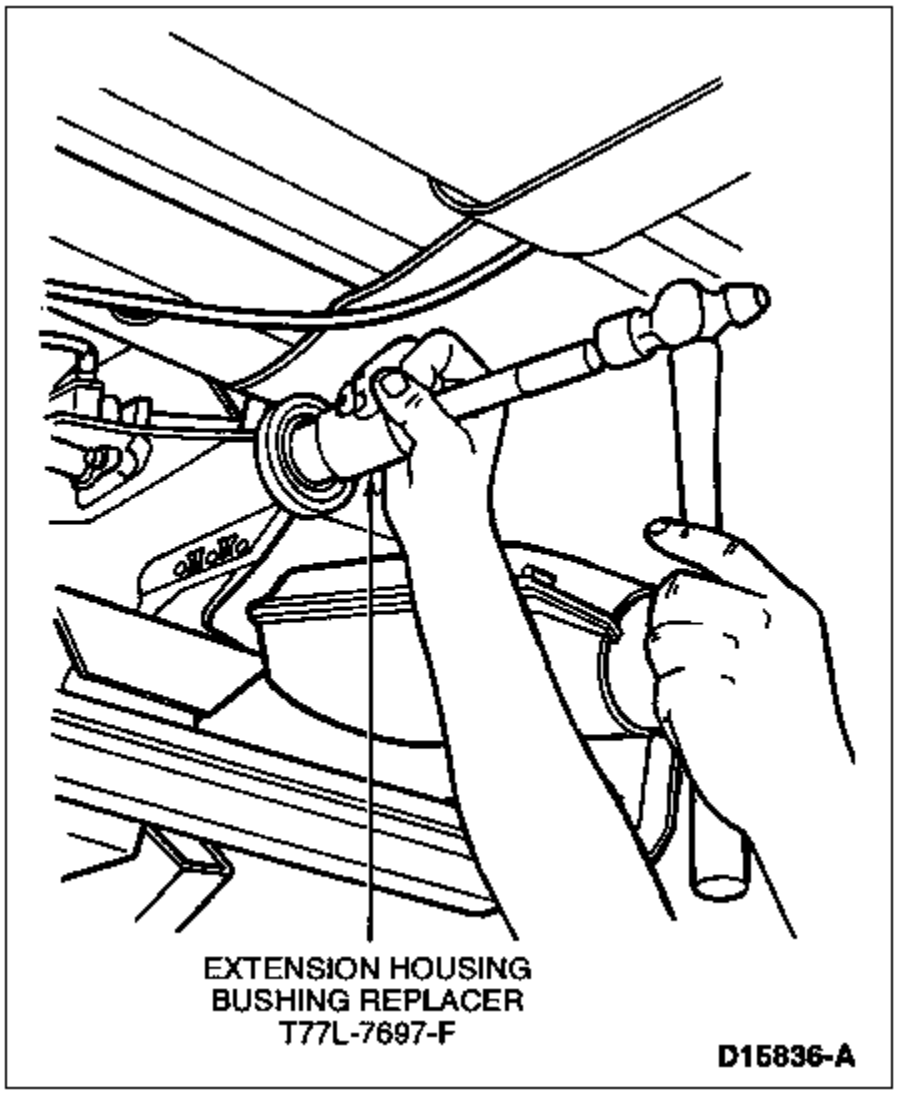

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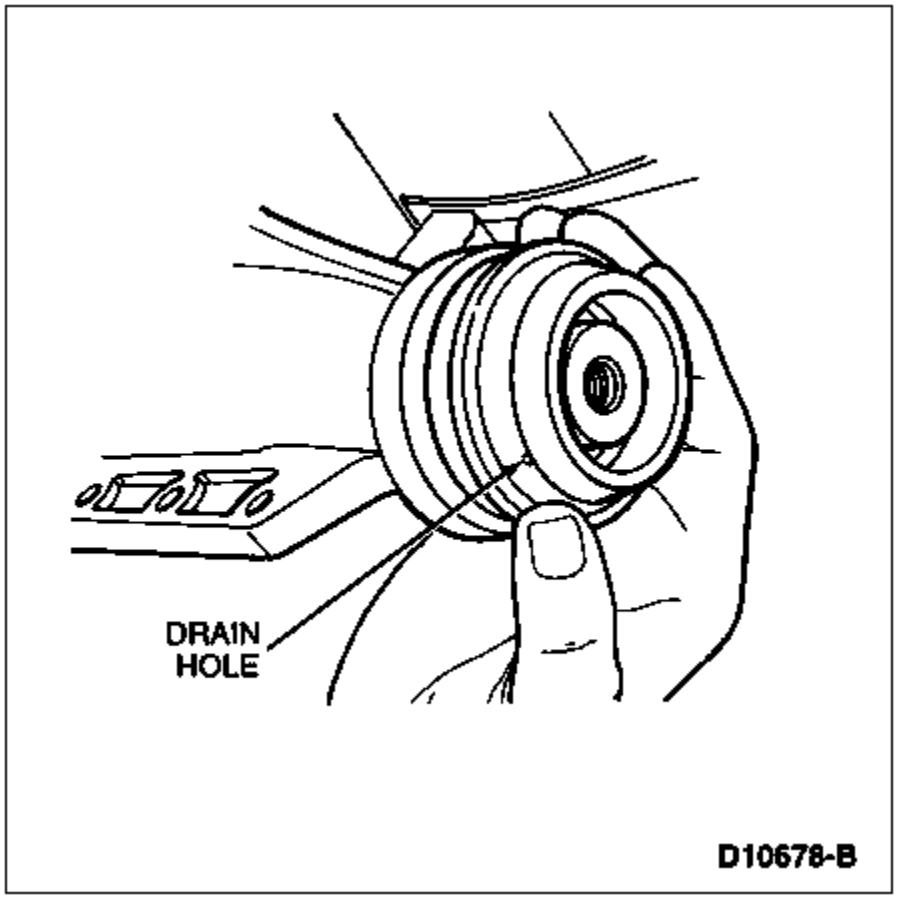
3. Position new output shaft and extension housing seal with drain hole positioned facing downward (6 o'clock position).



4. Seat seal using Extension Housing Seal Replacer T74P-77052-A.

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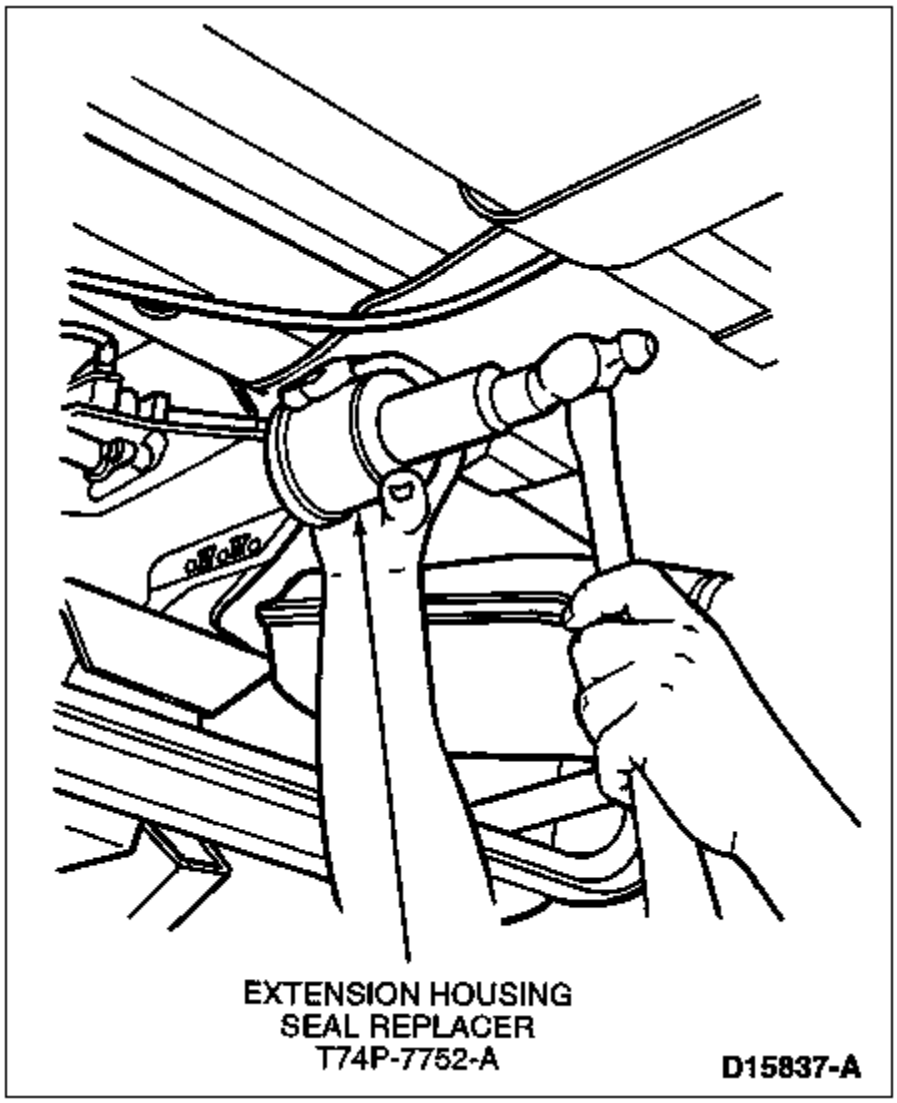

5. Inspect driveshaft slip-yoke. Replace if damaged or worn.
6. Install driveshaft. Refer to Section 05-01 .
7. Remove safety stands and lower vehicle.
8. Fill the transmission to the proper level. Refer to Specifications at the end of this section.

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Extension Housing Gasket

Removal

1. Raise vehicle on hoist and position suitable safety stands under vehicle.
2. Remove front (4x4 only) and rear driveshaft. Refer to Section 05-01 .
3. Remove transfer case assembly (4x4 only). Refer to Section 07-07A or Section 07-07B .
4. Remove transmission mounting pad nuts and bolts. Refer to the transmission removal procedures in this section.
5. Carefully remove wire harness locators from extension housing wire bracket.
6. Position jack under transmission and raise transmission.
7. Remove five extension housing screws, one stud and wiring bracket using a 17 mm socket.

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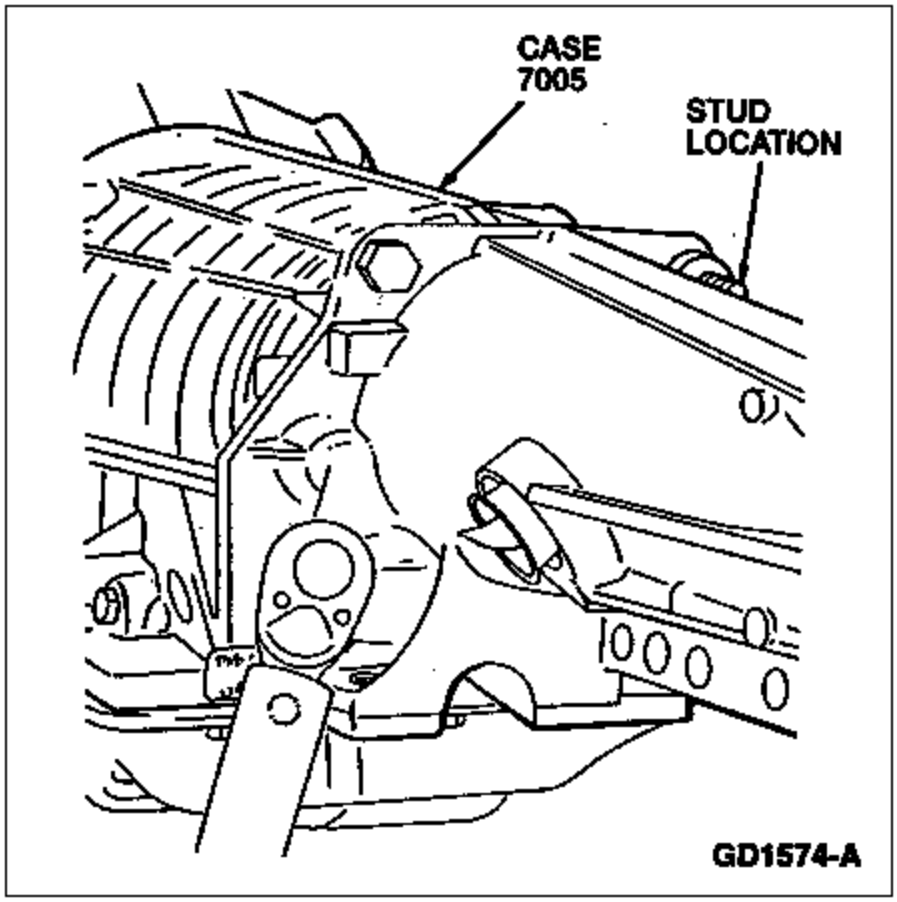

8. **CAUTION: The parking pawl, parking pawl return spring and parking pawl shaft could fall out during removal of the extension housing.**

   Carefully remove extension housing.

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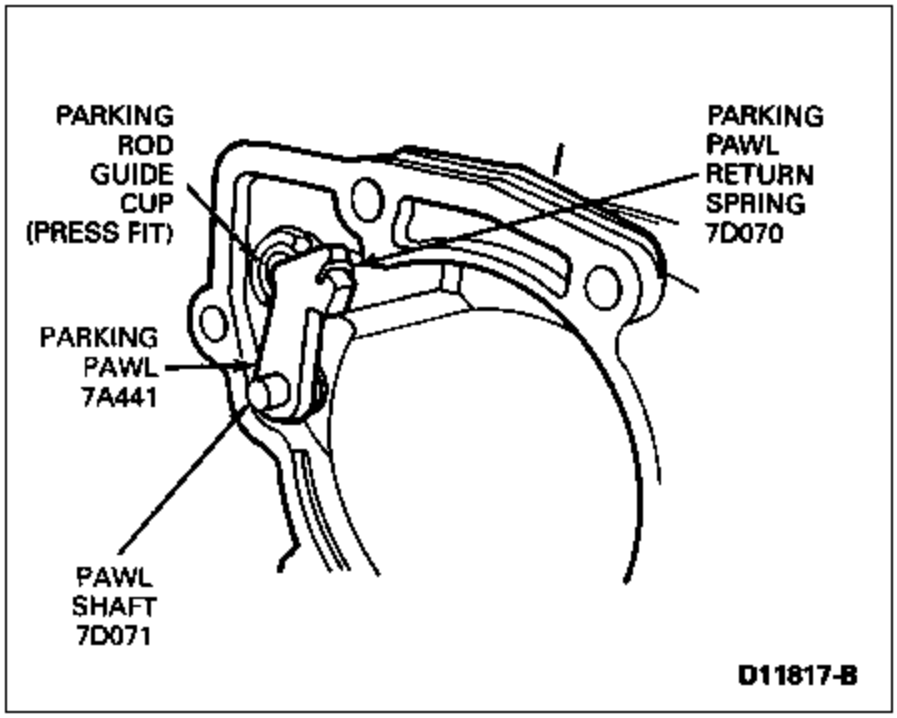

9. Remove and discard extension housing gasket (7086) from extension housing and mating surfaces.

Installation

1. Clean extension housing and transmission mating surfaces. Place a light film of petroleum jelly on the extension housing gasket and position gasket on the transmission case.

2. **NOTE: The guide cup is press-fit into the extension housing and is not serviced separately.**

   Install the parking pawl, pawl return spring and pawl shaft into the extension housing.

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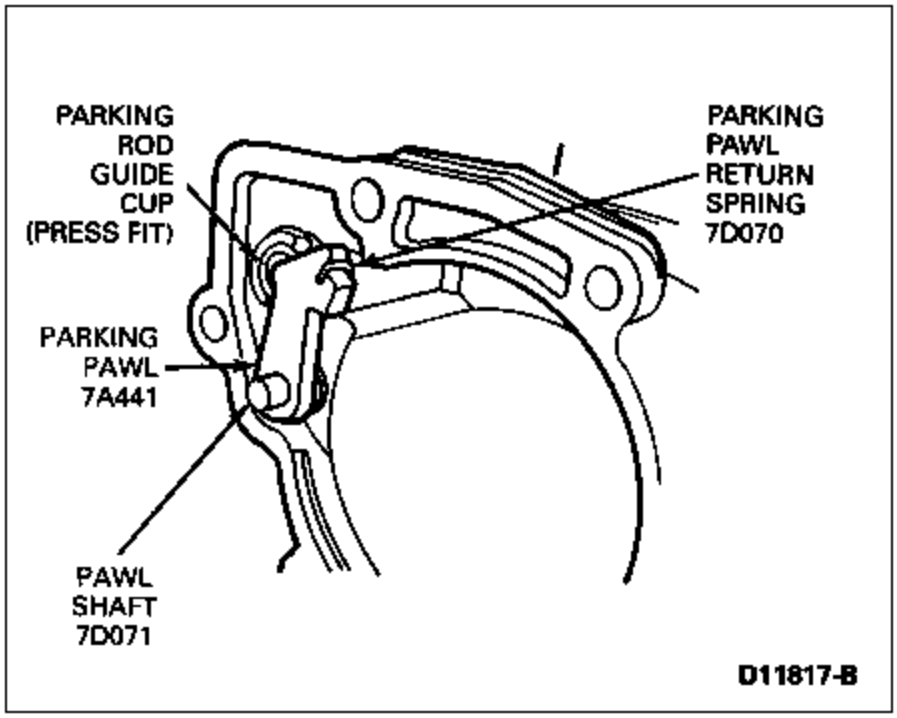

3. **CAUTION: Make sure the parking lever actuating rod is correctly seated into the case parking rod guide cup.**

   Install the extension housing. Install the five M10 x 30 mm extension housing screws and one stud. Tighten the extension housing-to-case stud and screws to 36-52 Nm (27-39 lb-ft).

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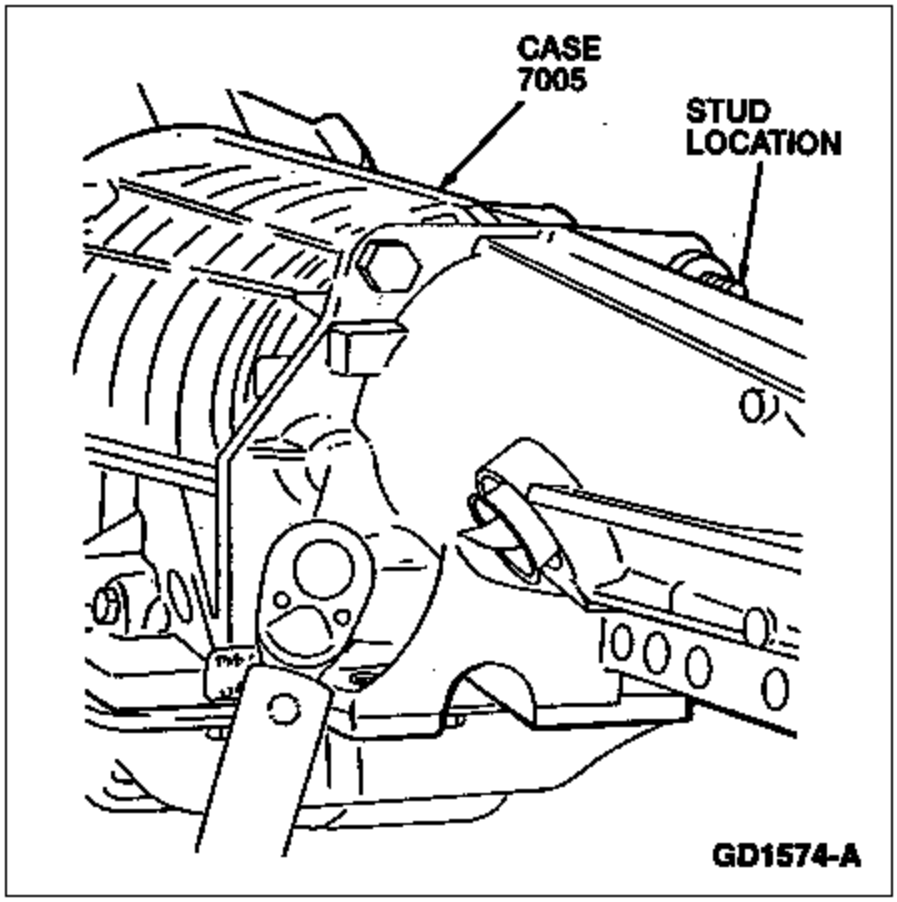

4. On 4x4 models only, install transfer case. Refer to Section 07-07A or Section 07-07B .
5. On 4x4 models only, attach transfer case vent hose to attaching plate. Refer to Section 07-07A or Section 07-07B .
6. Install four-wheel drive connector, if equipped.
7. Install new wire harness locator into extension housing wire bracket.
8. Install transmission mounting pad nuts and bolts and tighten to 68-95 Nm (50-70 lb-ft).
9. On Ranger vehicles, install the two crossmember-to-frame through bolts and nuts and tighten to 88-115 Nm (65-85 lb-ft).
10. On Aerostar vehicles, install the two crossmember-to-frame through bolts and nuts and tighten to 37-52 Nm (28-38 lb-ft).
11. Remove universal high lift transmission jack.
12. Install front (4x4 only) and rear driveshaft. Refer to Section 05-01 .
13. Fill the transmission to the proper level. Refer to Preliminary Testing procedure in this section.

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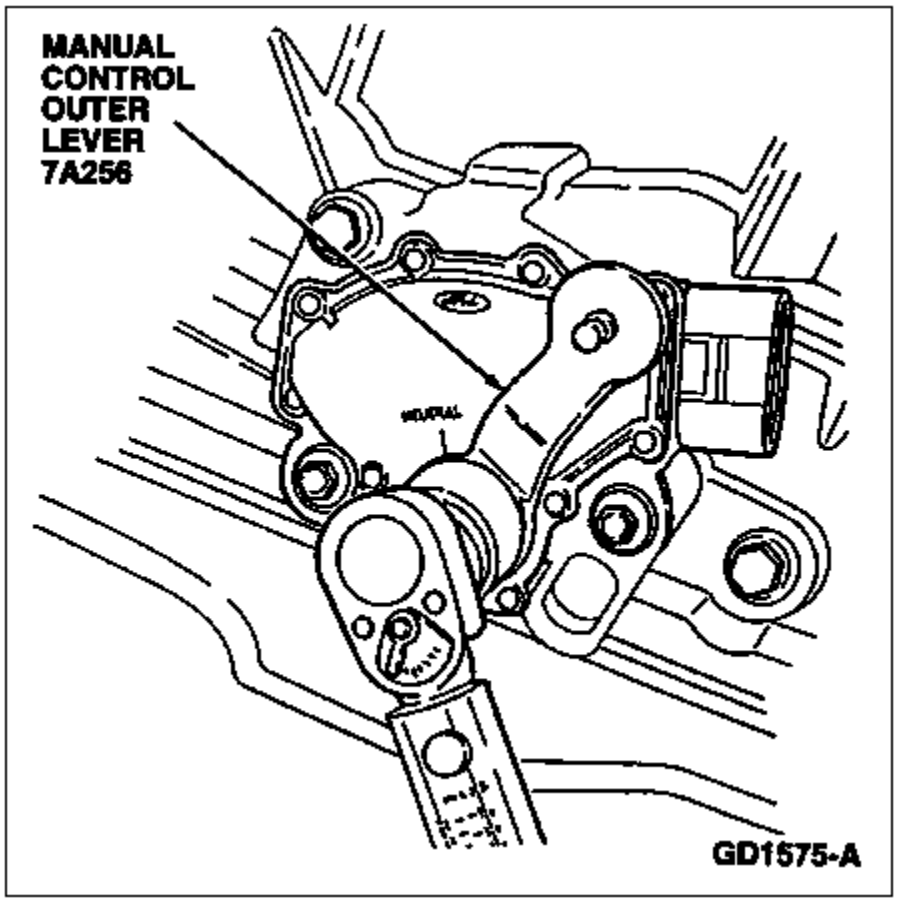
Digital Transmission Range (DTR) Sensor

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Digital TR Sensor Alignment Tool	T97L-70010-A

Removal

1. Use a screwdriver to remove the shift cable and fitting from the transmission lever ball stud.
2. Disconnect vehicle harness connector from digital transmission range (DTR) sensor by depressing tab.
3. Remove the manual control outer lever nut and manual control outer lever.



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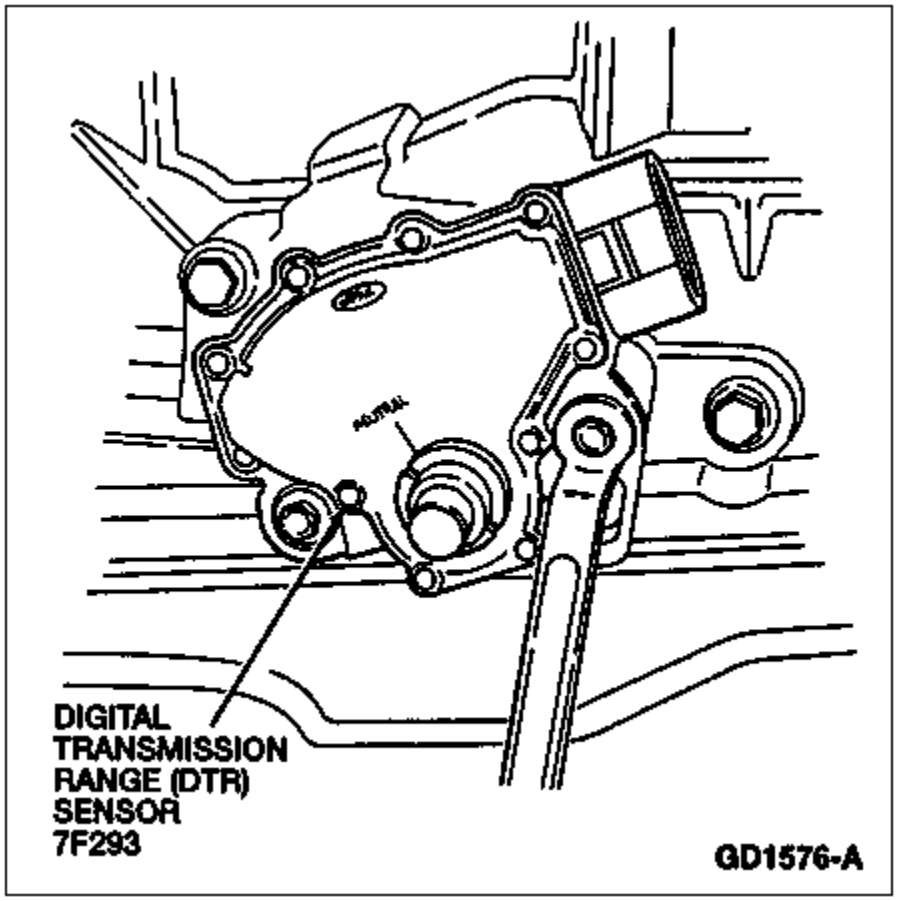
4. Remove the two M6 x 25 TR sensor screws and remove the DTR sensor.



Installation

1. Install the DTR sensor on the manual lever. Install the two TR sensor screws and finger tighten. Rotate the manual lever to the neutral position (two detents rearward).

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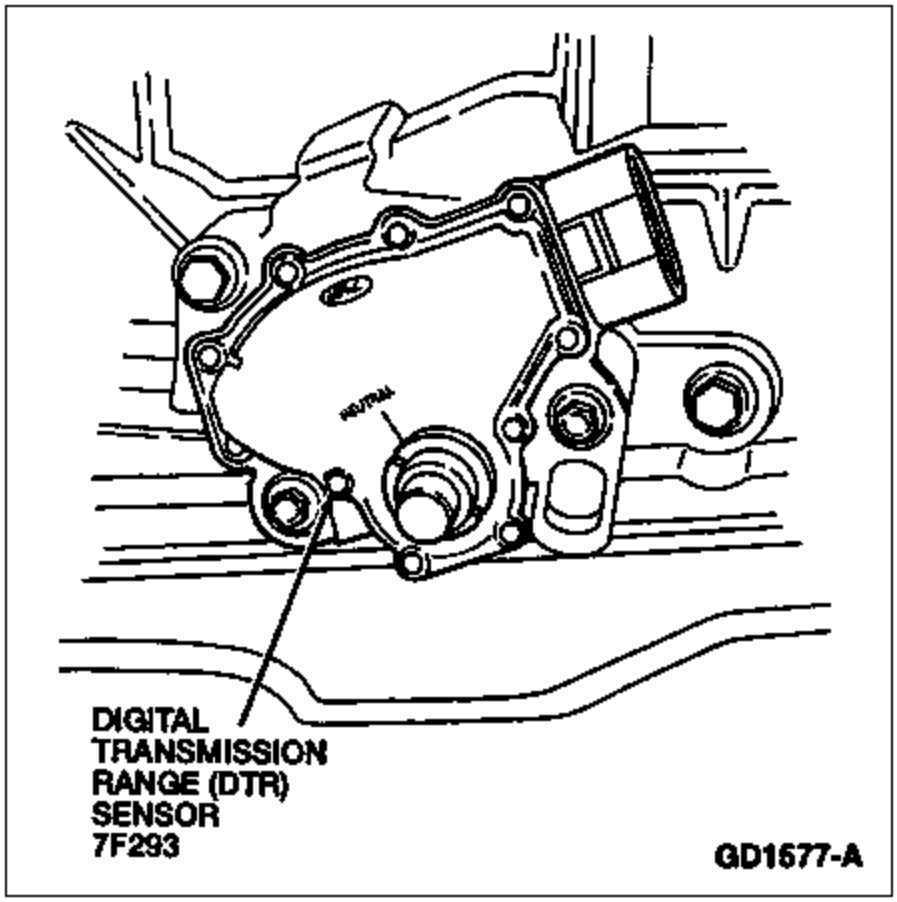

2. Install Digital TR Sensor Alignment Tool T97L-70010-A into the three slots on the DTR sensor. Tighten the TR sensor-to-case screws to 8-11 Nm (71-97 lb-in). Remove the alignment tool.

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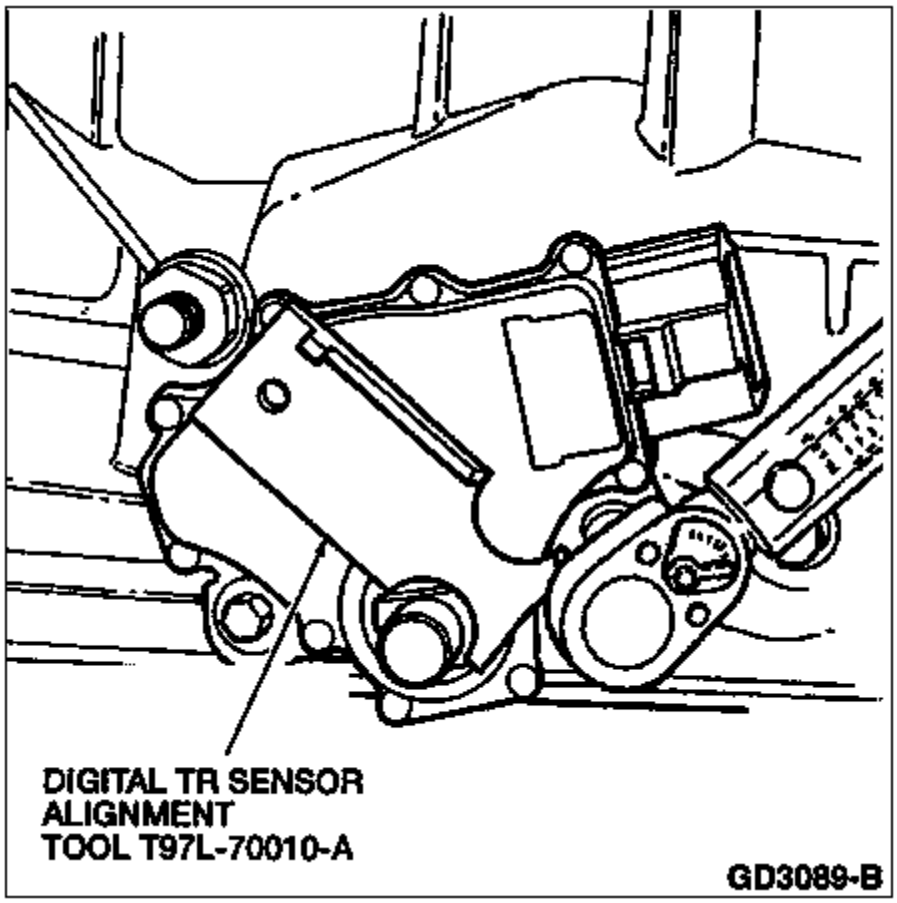

3. Install the manual control outer lever and manual control outer lever nut. Tighten the manual control outer lever nut to 41-54 Nm (30-40 lb-ft).

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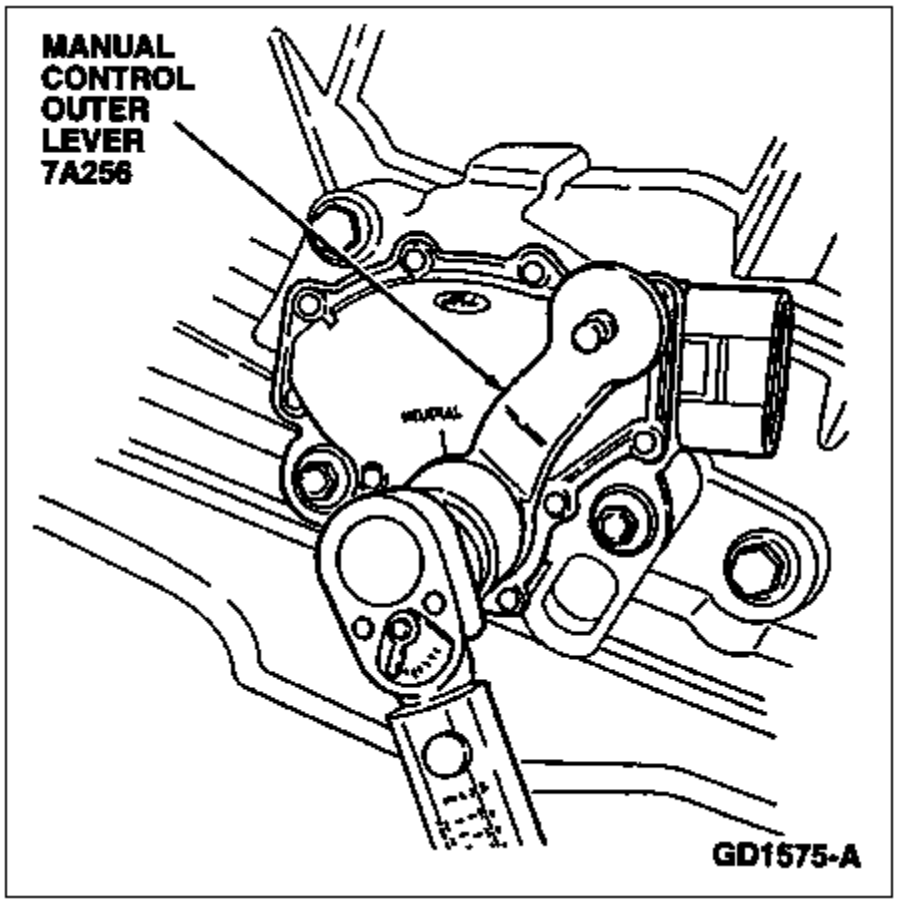

4. Install shift cable or linkage from manual control lever (7A256). Use a screwdriver to remove the cable and fitting from the transmission lever ball stud.

5. Adjust shift cable. Refer to adjustments in Section 07-05 .

6. Reconnect vehicle harness connector to DTR sensor.

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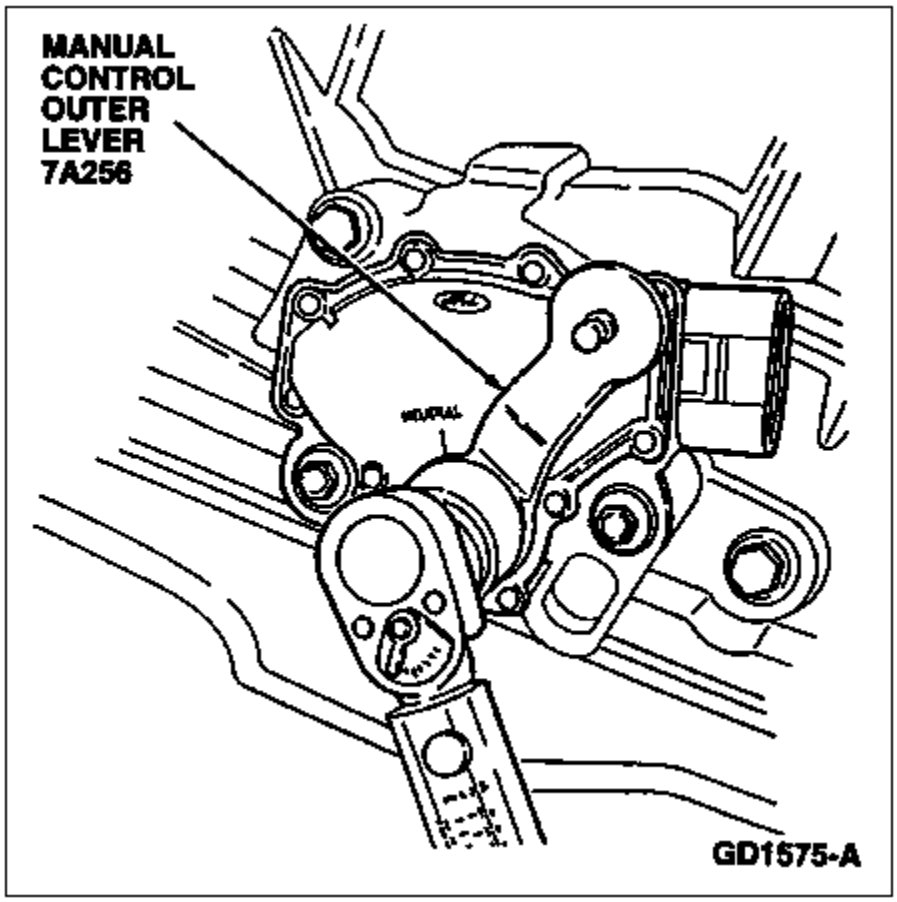
Digital Transmission Range (DTR) Sensor Adjustment

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Digital TR Sensor Alignment Tool	T97L-70010-A

1. Use a screwdriver to remove the shift cable and fitting from the transmission lever ball stud.
2. Disconnect vehicle harness connector from digital transmission range (DTR) sensor by depressing tab.
3. Remove the manual control outer lever nut and manual control outer lever.



4. Loosen the two M6 x 25 TR sensor screws.
5. Install Digital TR Sensor Alignment Tool T97L-70010-A into the three slots on the DTR sensor. Tighten the TR sensor-to-case screws to 8-11 Nm (71-97 lb-in). Remove the alignment tool.

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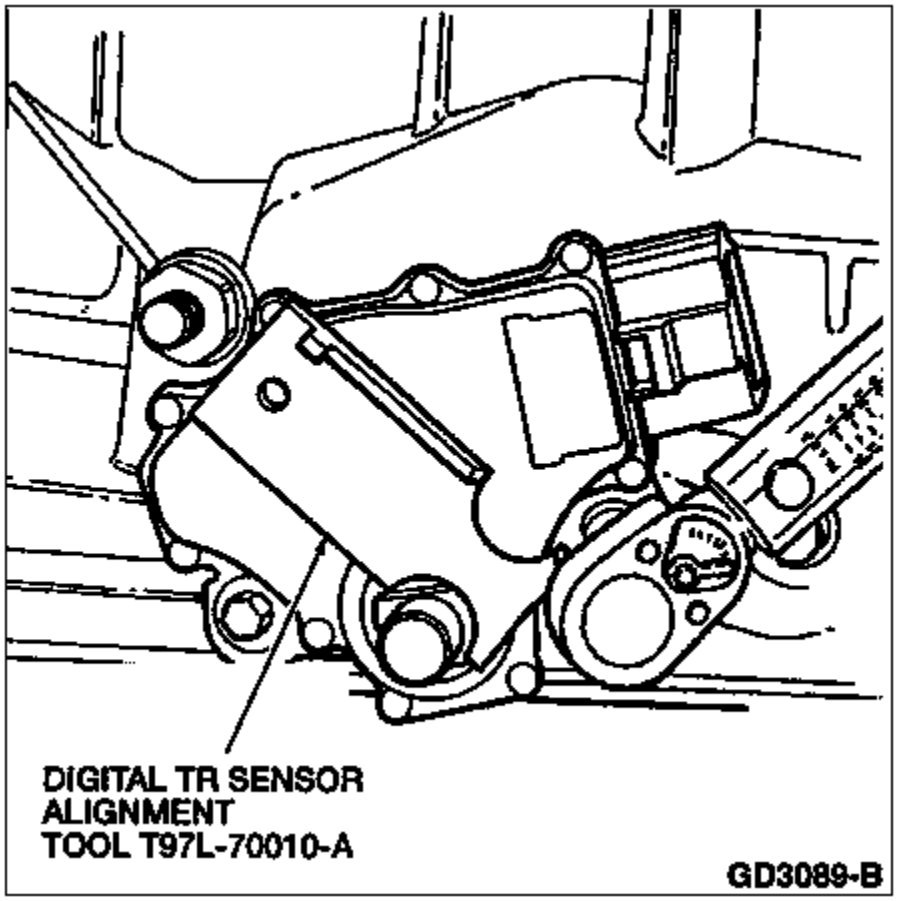

6. Install the manual control outer lever and manual control outer lever nut. Tighten the manual control outer lever nut to 41-54 Nm (30-40 lb-ft).

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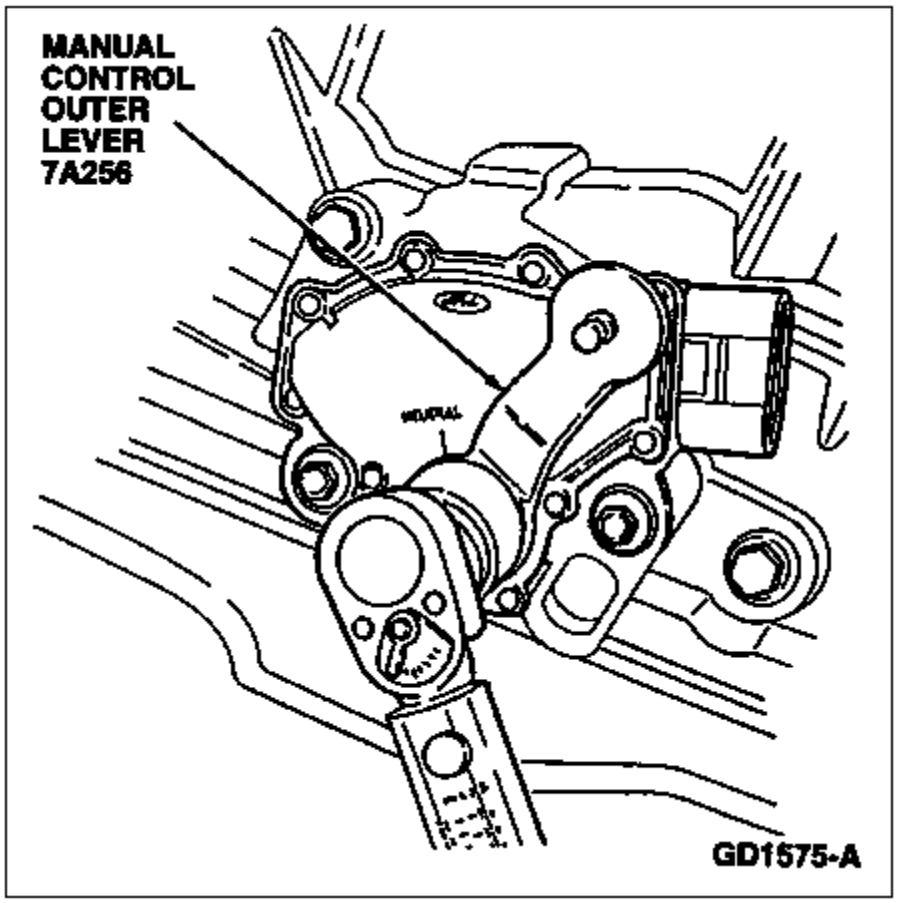

7. Install shift cable or linkage from manual control lever (7A256). Use a screwdriver to remove the cable and fitting from the transmission lever ball stud.

8. Adjust shift cable. Refer to adjustments in Section 07-05 .

9. Reconnect vehicle harness connector to DTR sensor.

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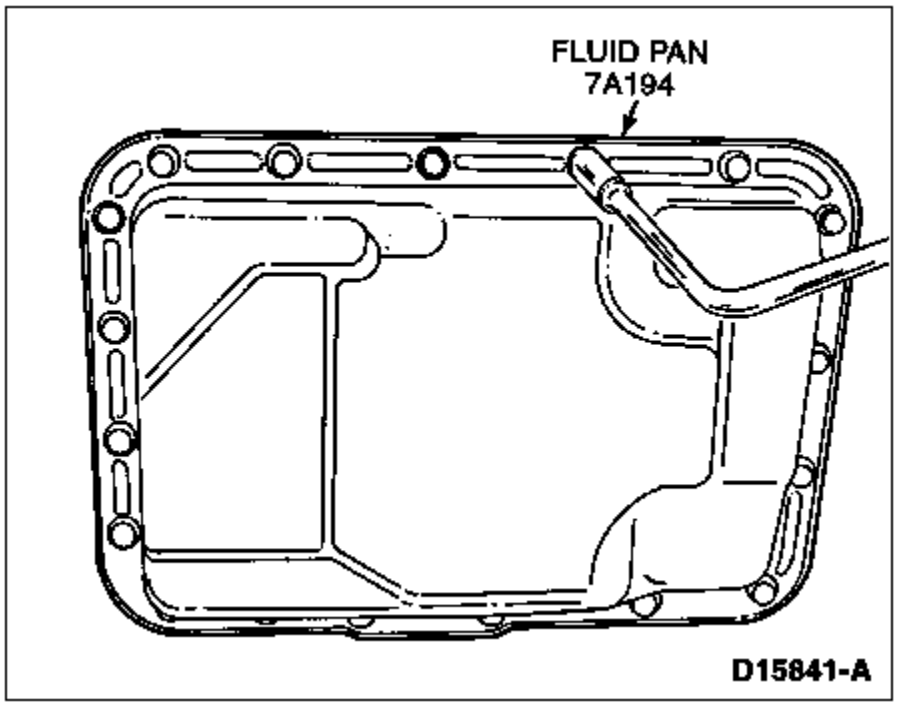
Fluid Pan, Gasket and Filter

Removal

1. Using a 13 mm socket, remove all M8 x 16 mm fluid pan screws, except for two in the front. Loosen two front screws only.



2. Pry the rear of the pan down and allow fluid to drain.
3. Support fluid pan and remove two remaining screws.
4. Remove fluid pan and discard old gasket.
5. Use a 10 mm socket to remove the M6 x 55 mm fluid filter assembly screw. Remove the fluid filter assembly and discard.

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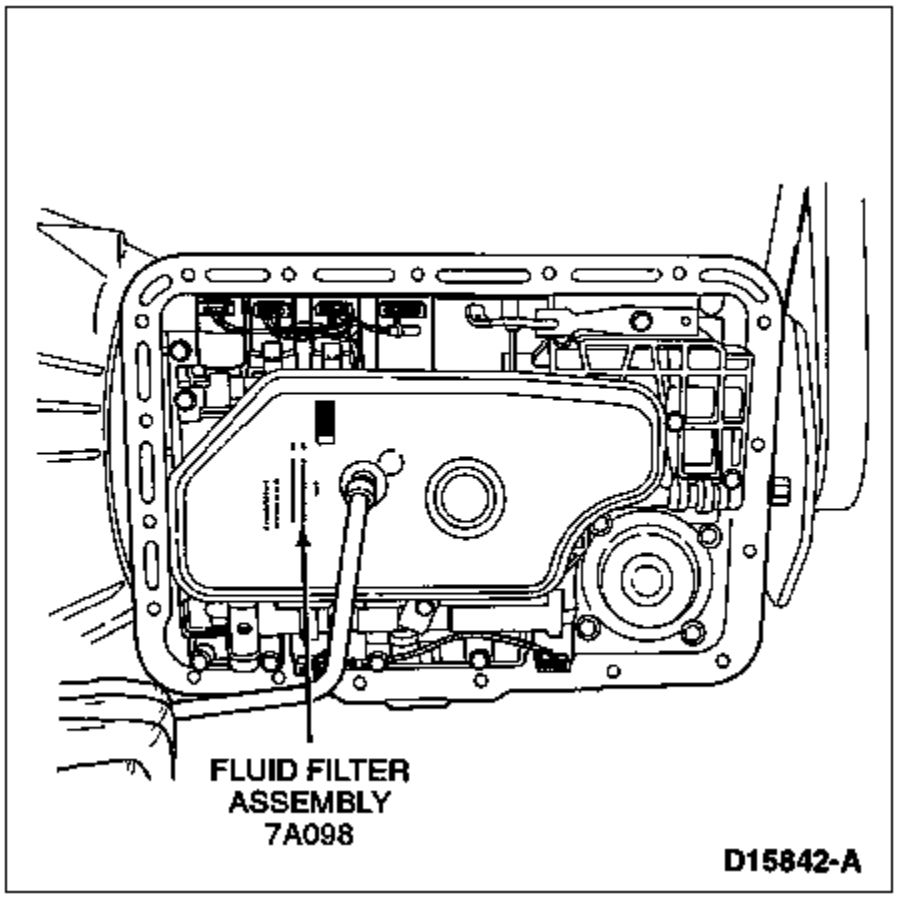

Installation

1. Clean all mating surfaces, making sure they are free from debris and oil.
2. Install new fluid pan gasket on fluid pan and align holes.
3. Lube and install new O-rings onto filter assembly.
4. Install new filter onto main control assembly.
5. Make sure that both O-rings are properly installed on filter prior to installation.

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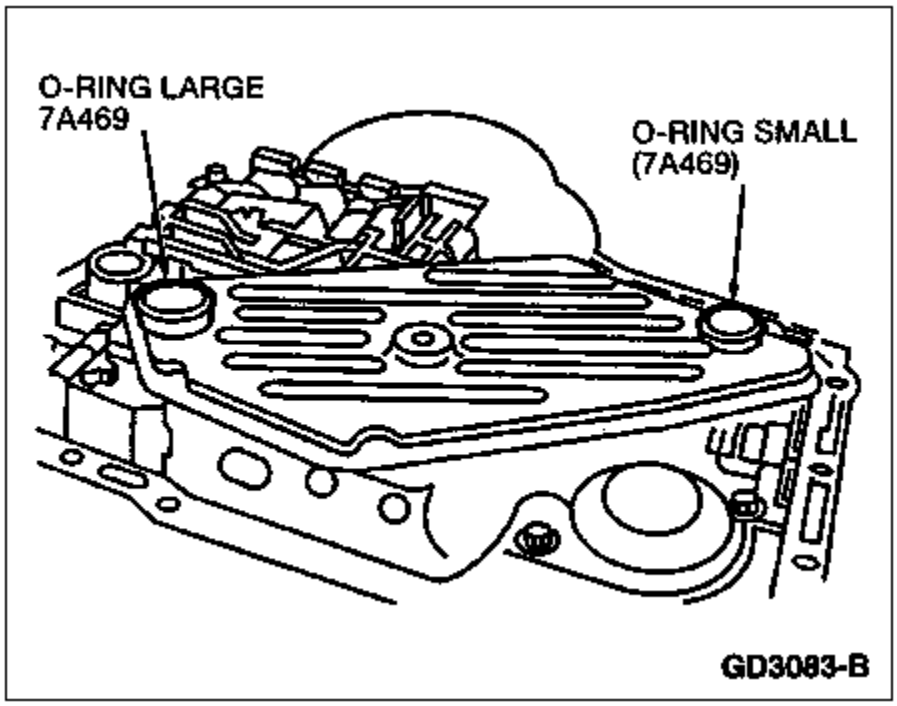

6. **CAUTION: Make sure wire harness is not pinched under filter.**

   Install one M6 x 55 mm fluid filter assembly-to-main control assembly screw using a 10 mm socket as shown. Tighten to 8-11 Nm (71-97 lb-in).

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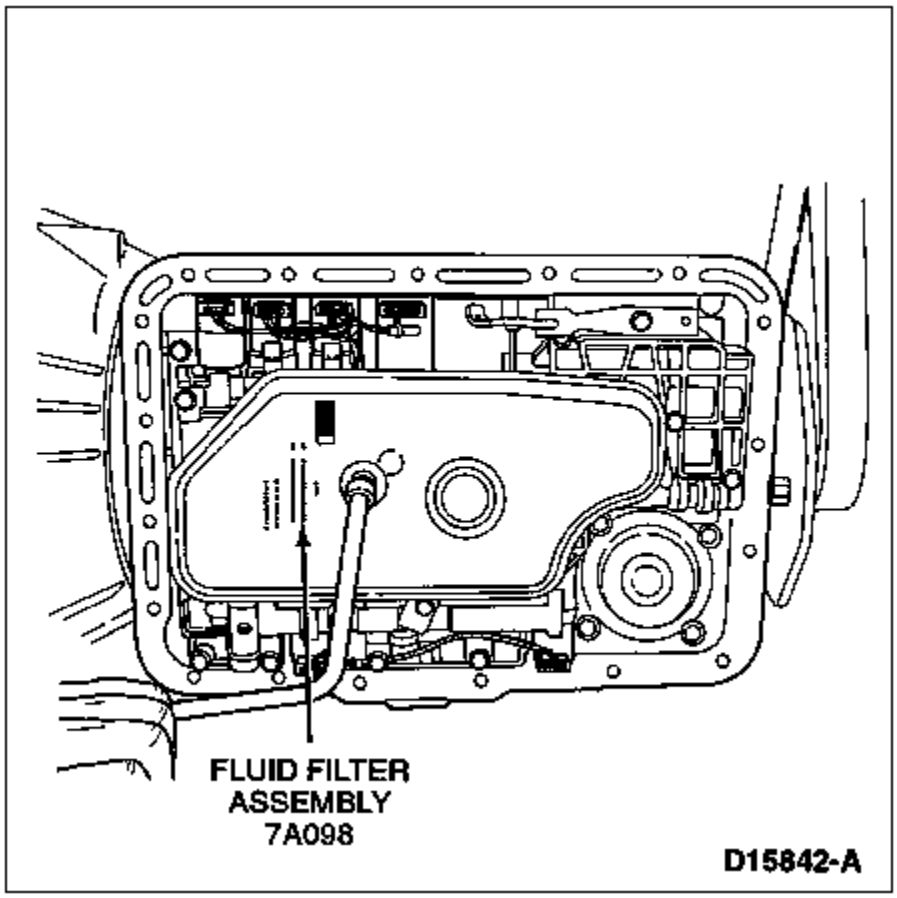

7. Install fluid pan and gasket onto transmission and install eighteen M8 x 16 mm fluid pan-to-case screws. Tighten to 13-15 Nm (115-133 lb-in) using a crisscross sequence.

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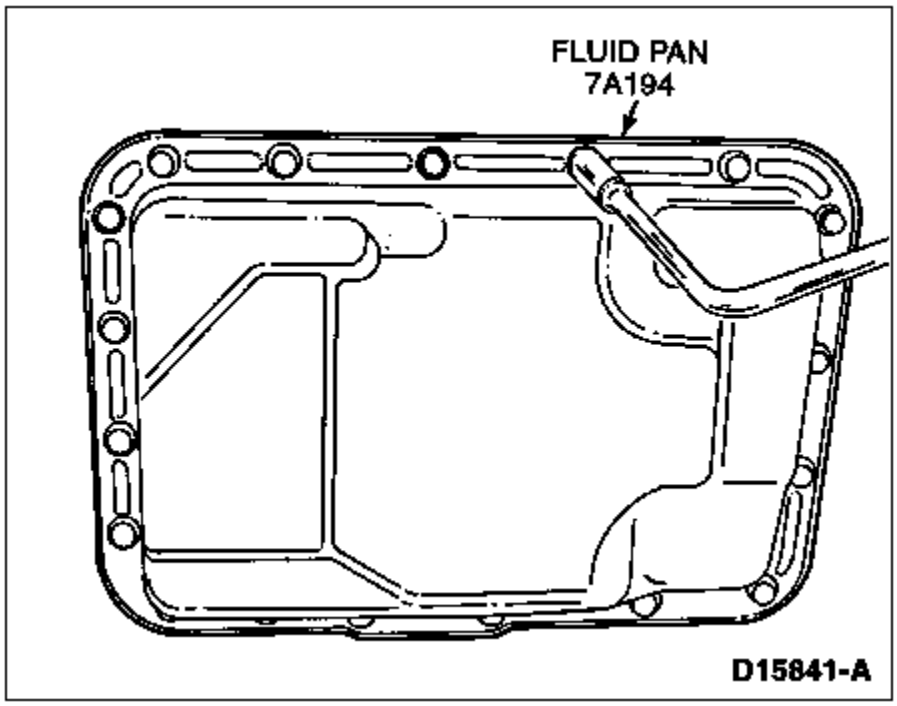

8. Fill the transmission to the proper level. Refer to the procedure in this section.

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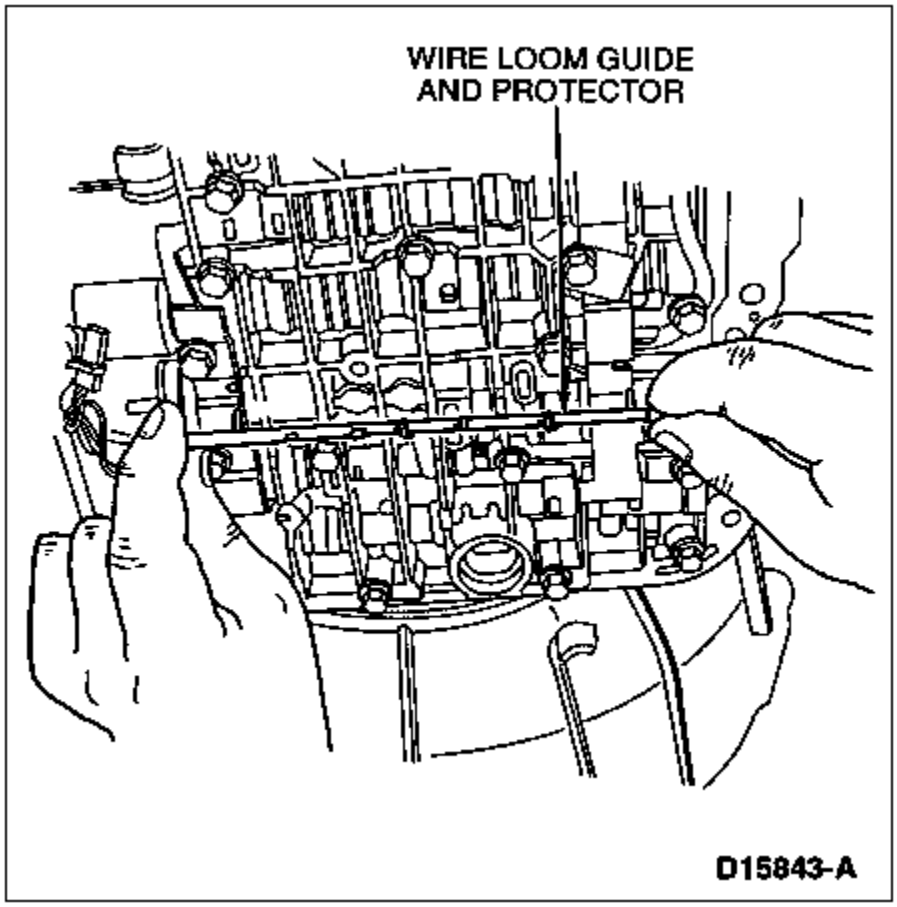
Solenoid Service

Removal

NOTE: Main control assembly does not need to be removed for solenoid service.

1. Remove fluid pan gasket and filter as described in this section.
2. Carefully lift up on the wire loom guide and protector. Disengage the retaining pins from the solenoid brackets.



3. Disconnect the appropriate solenoid connector(s) from the solenoid(s) by carefully pulling downward and wiggling side to side.

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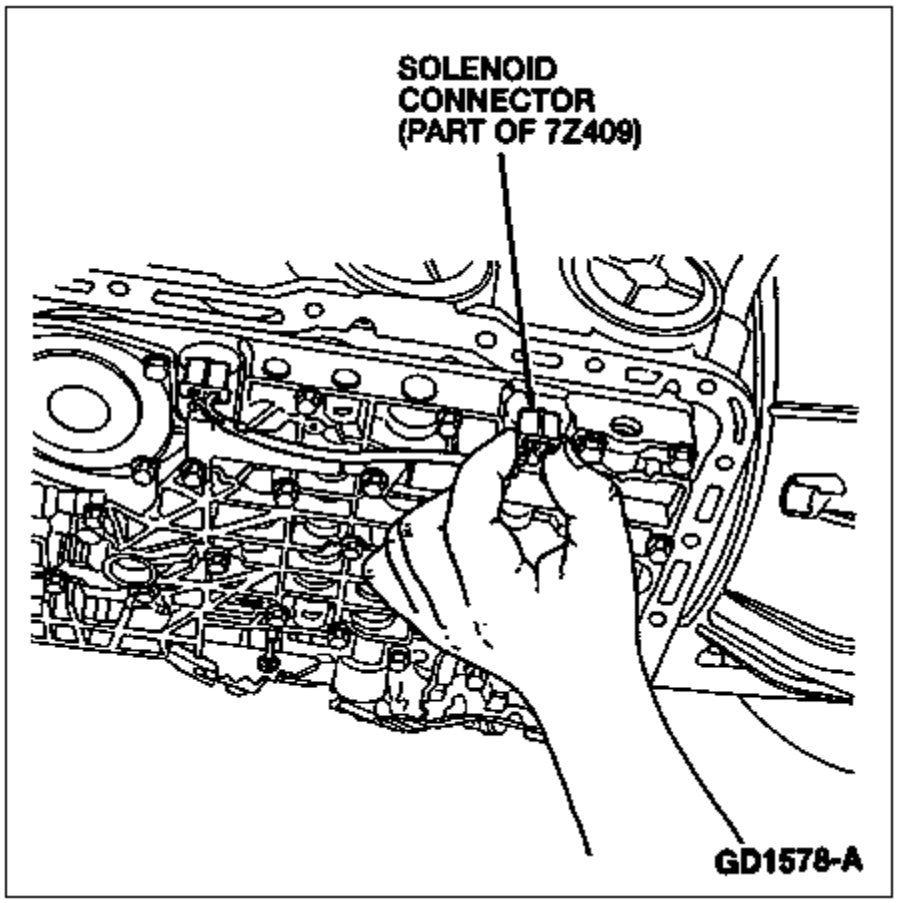

4. **CAUTION: SS3 may pop out of its bore. This may damage the solenoid.**

   NOTE: Steps 4, 5 and 6 refer to SS1 and SS3 solenoids only.

   Use a 10 mm socket to remove the SS1 and SS3 solenoid clamp screws. Remove the solenoid clamp.

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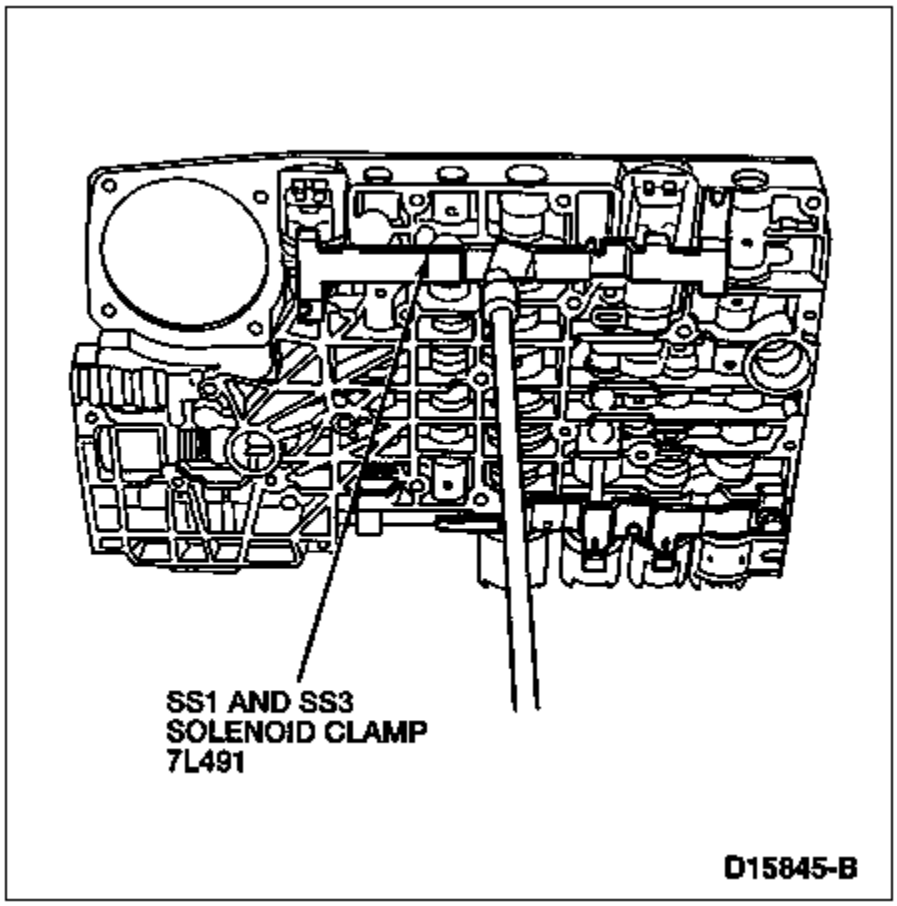

5. Remove SS1 and SS3 and service as required.

6. **CAUTION: The TCC solenoid may pop out of its bore. The converter modulator valve may come out after the TCC solenoid has been removed. This may damage the solenoid or converter modulator valve.**

   NOTE: Steps 6-8 refer to TCC, CCS, SS2 and EPC solenoids only.

   Remove the TCC, CCS, SS2 and EPC solenoid clamp screws.

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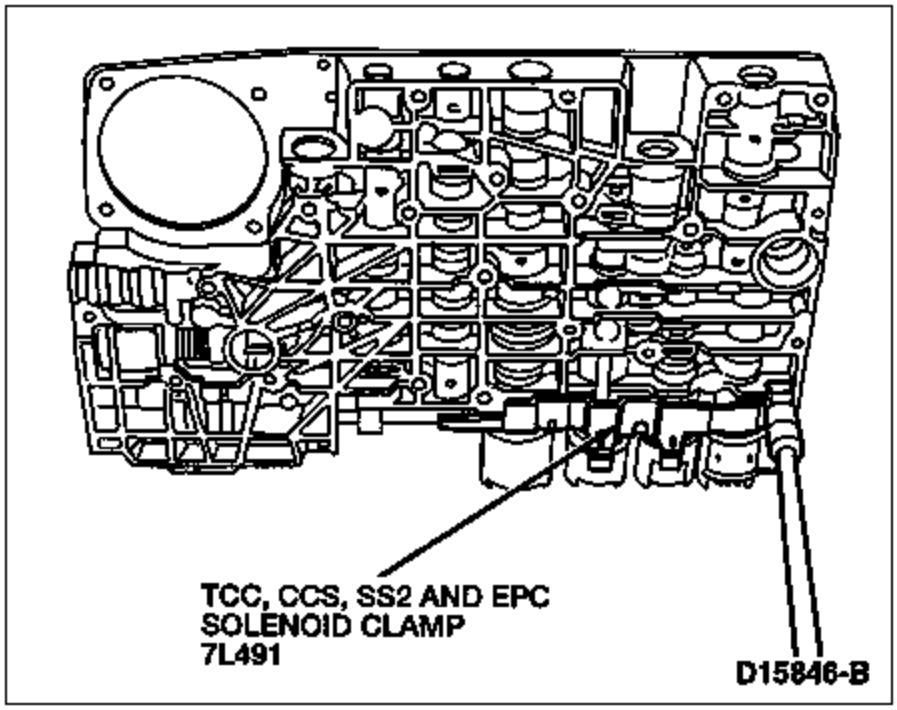
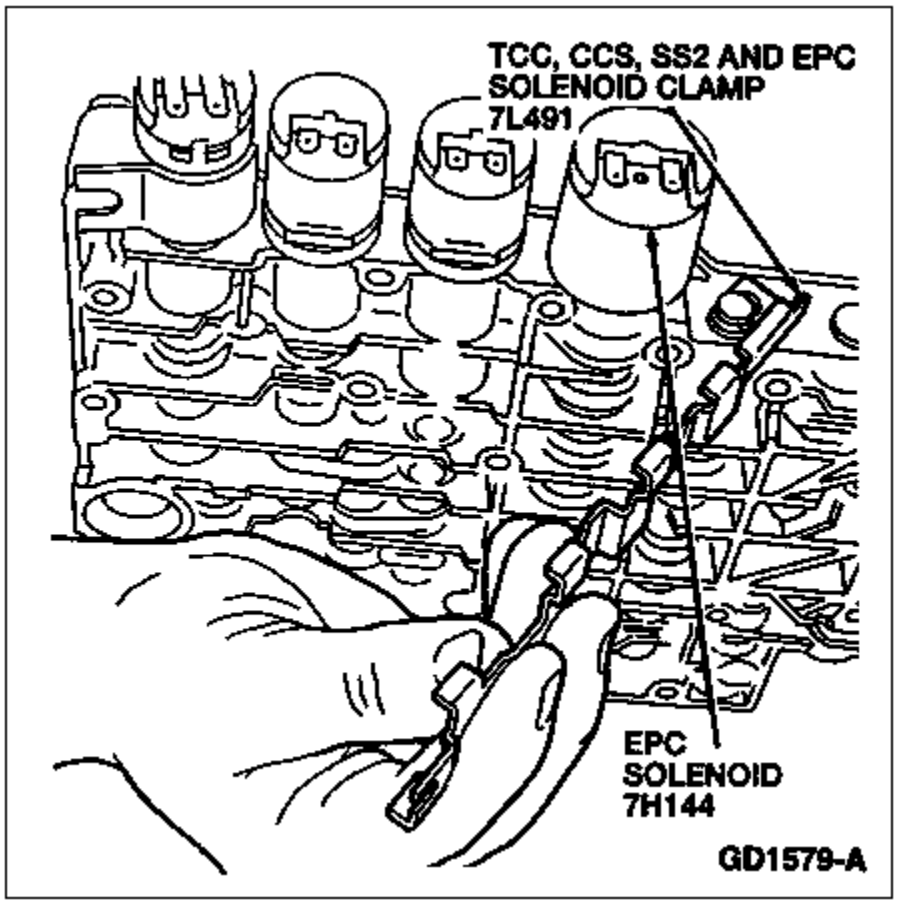


7. Remove the solenoid clamp.



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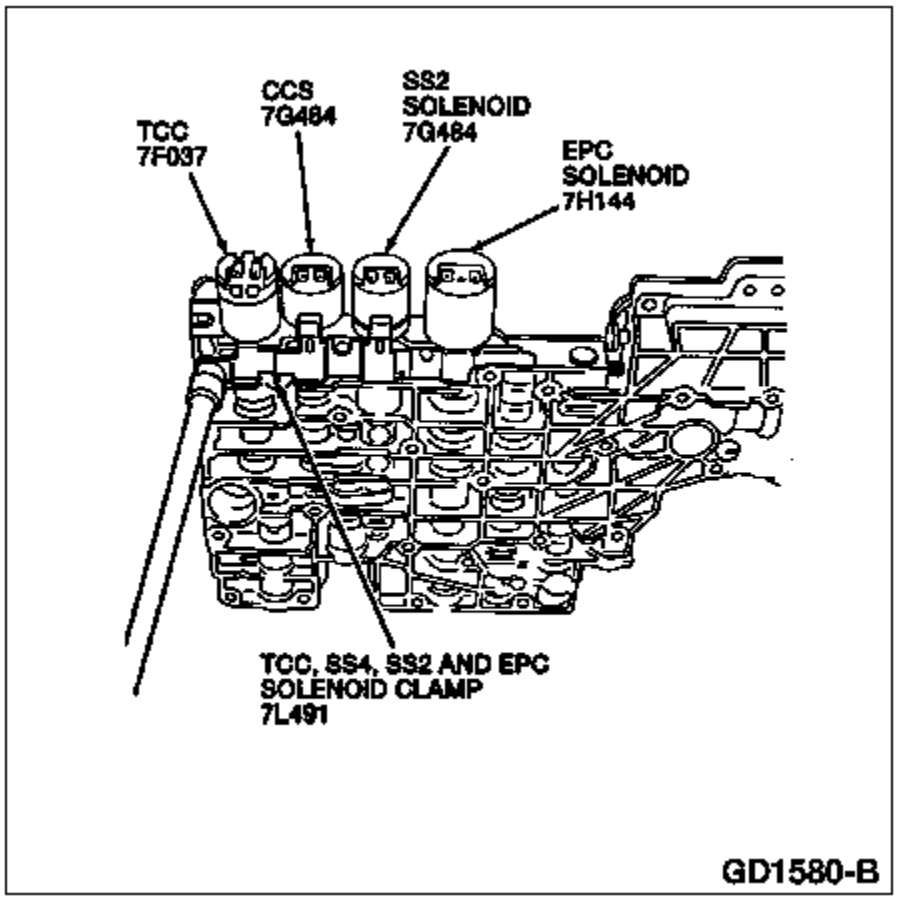
8. Remove solenoids and service as required.

Installation

1. **CAUTION: The solenoid clamp must be installed in the TCC and EPC solenoid grooves, shift solenoid pockets and the No. 204 plug.**

   Install the TCC, CCS, SS2, EPC solenoids, solenoid bracket and screws. Tighten to 6-8 Nm (53-71 lb-in).



2. Install the SS1 and SS3 solenoids, solenoid bracket and screws. Tighten to 6-8 Nm (53-71 lb-in).

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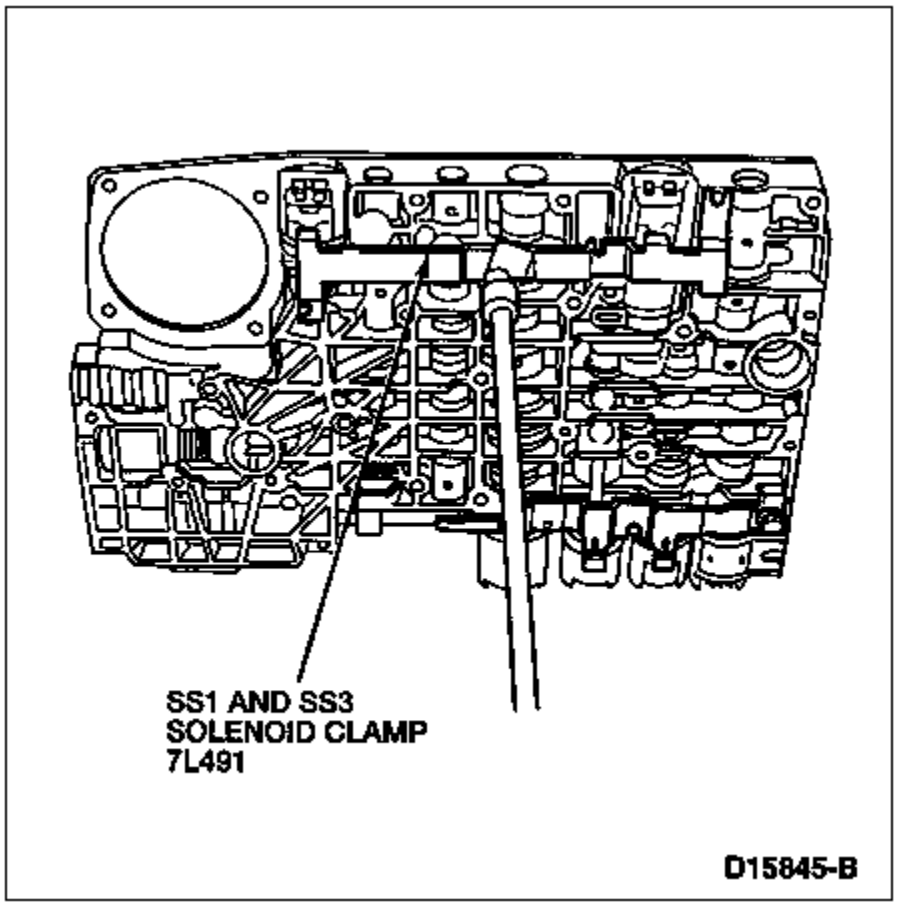

3. Carefully press down to install the solenoid connectors on the solenoids as shown.

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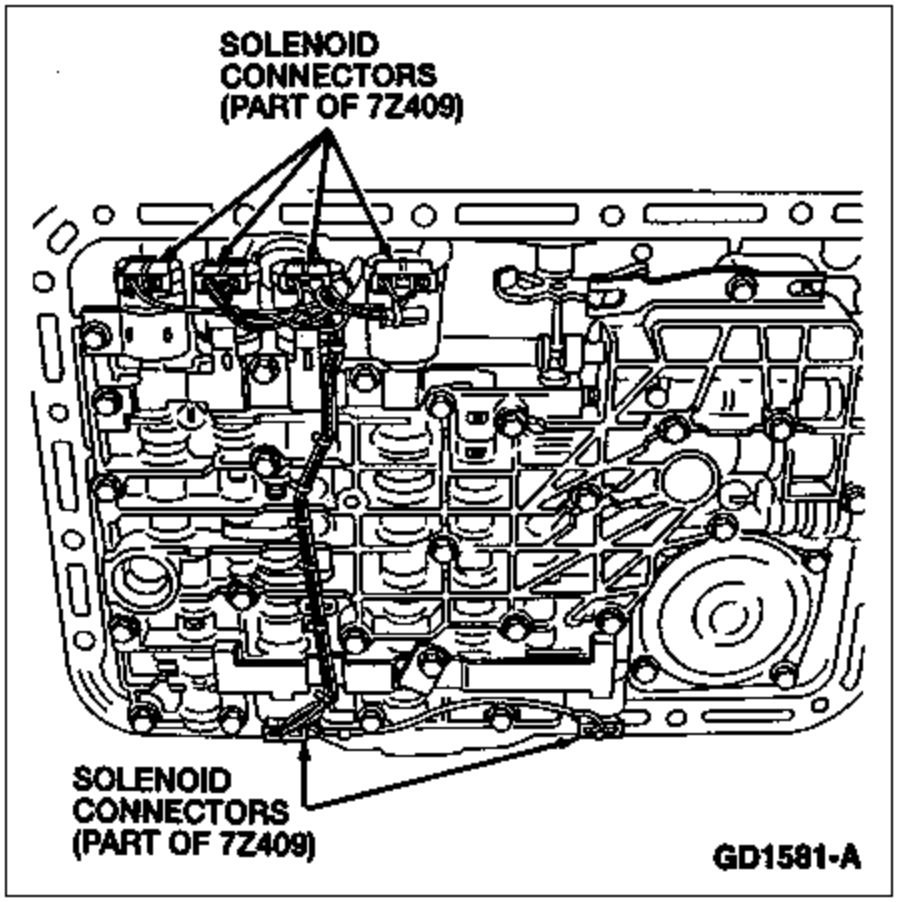

4. **CAUTION: Excessive pressure may break the locating pins.**

   Install the wiring loom protector and guide. Align the pins in the holes of the solenoid clamps and gently push down.

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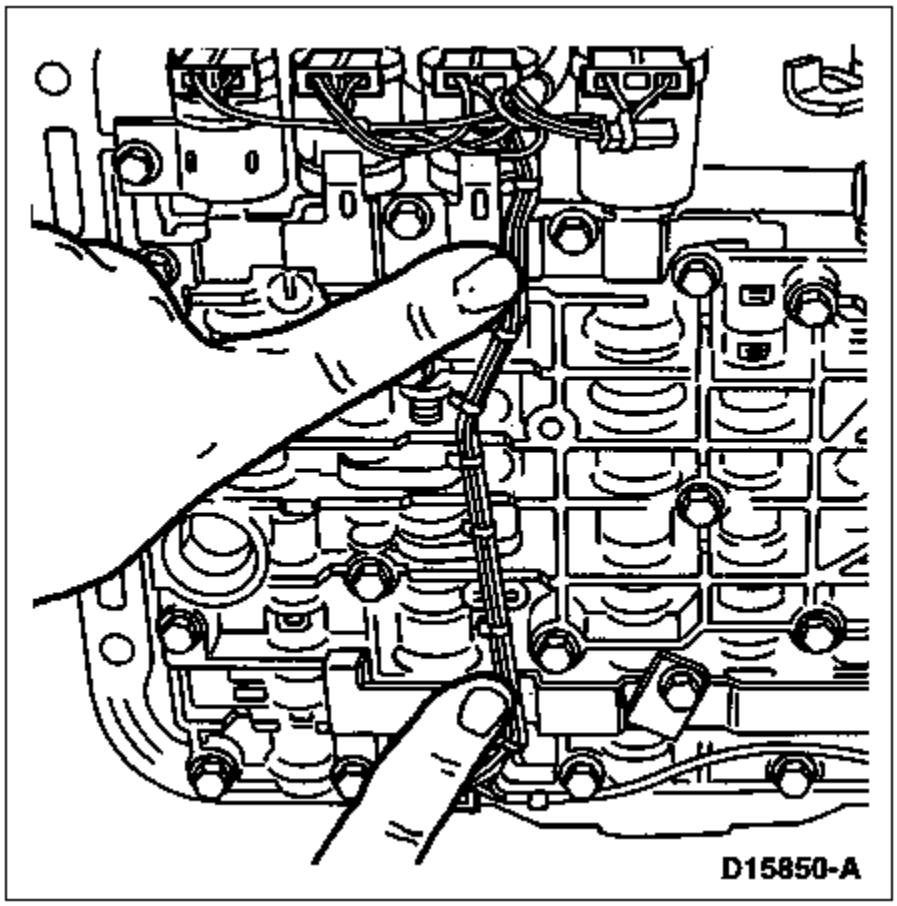

5. Install new fluid pan gasket and filter as described in this section.
6. Fill the transmission to the proper level. Refer to the procedure in this section.

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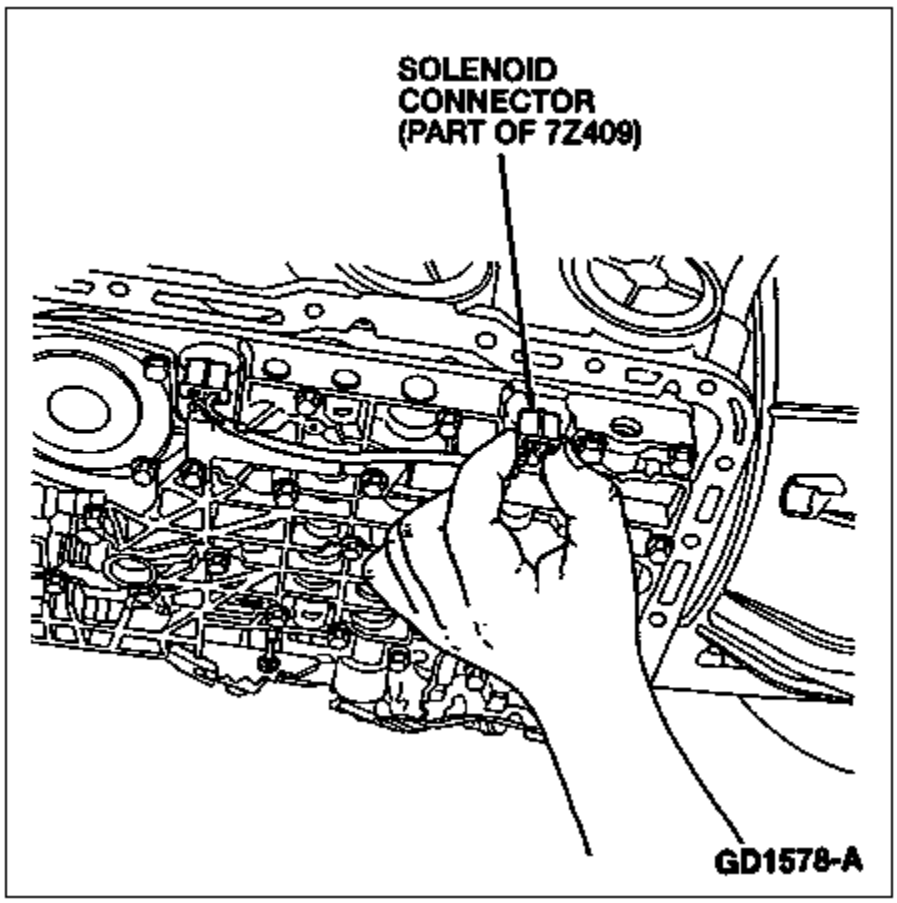
Internal Harness Service

16-Pin Connectors

Removal

NOTE: The main control assembly does not need to be removed.

1. Remove fluid, pan, gasket and filter as described in this section. Discard gasket.
2. Disconnect the solenoid connectors from the solenoids by carefully pulling downward and wiggling side to side.



3. **CAUTION: The TCC solenoid may pop out of its bore. The converter modulator valve may come out after the TCC solenoid clamp has been removed. This may damage the solenoid or converter modulator valve.**

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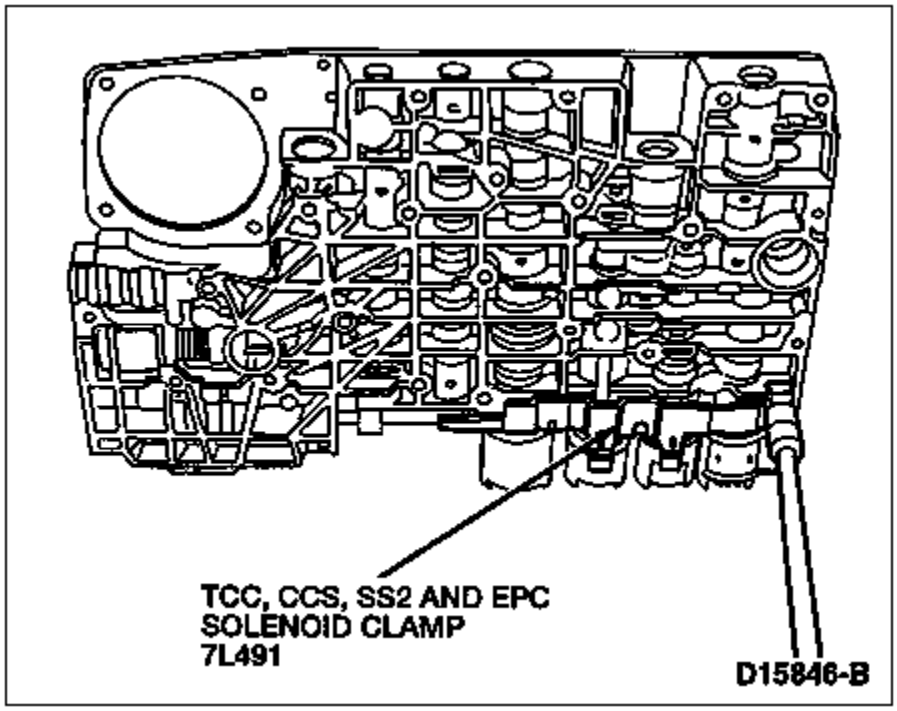
Remove the TCC, CCS, SS2 and EPC solenoid clamp screws.



4. Remove the solenoid clamp and EPC and SS2 solenoids.

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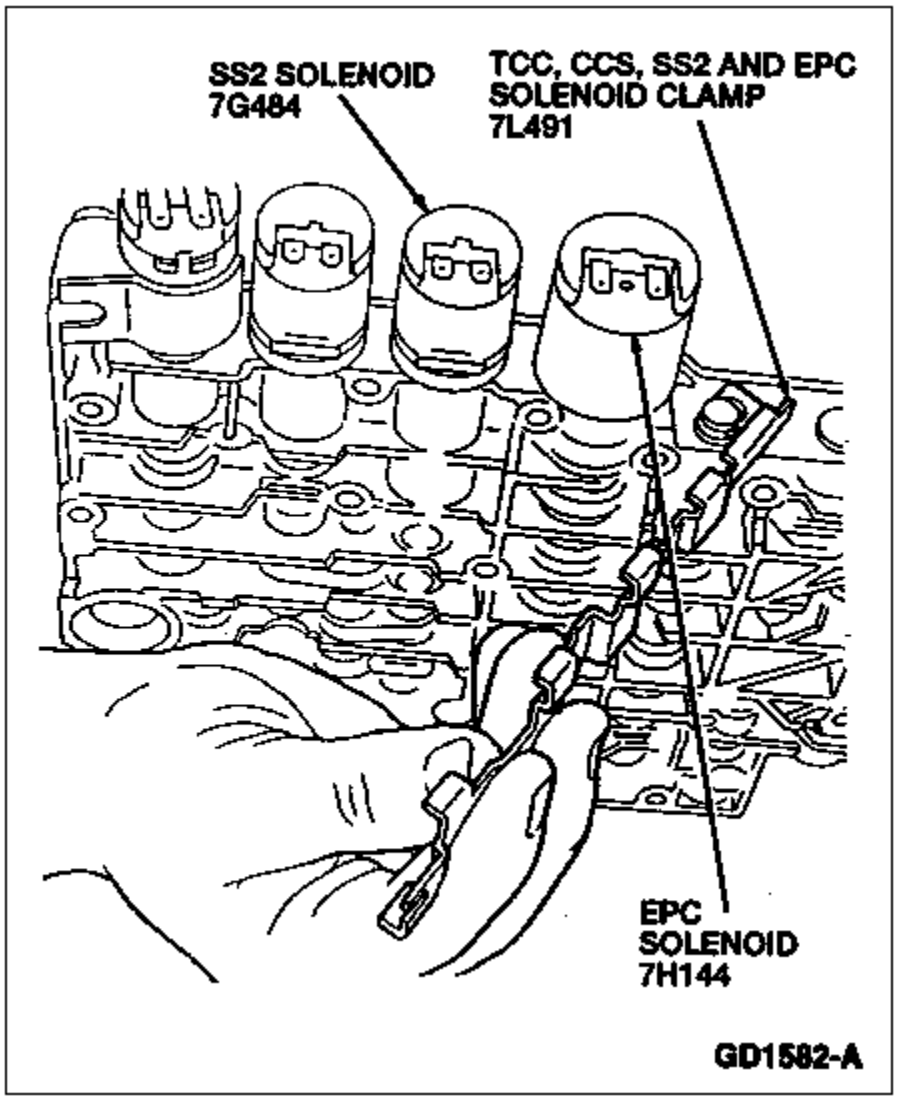

5. **CAUTION: Do not pry on other wires or damage the connector case surface.**

   Carefully disconnect the turbine shaft speed (TSS) sensor connector from the 16-pin case connector.

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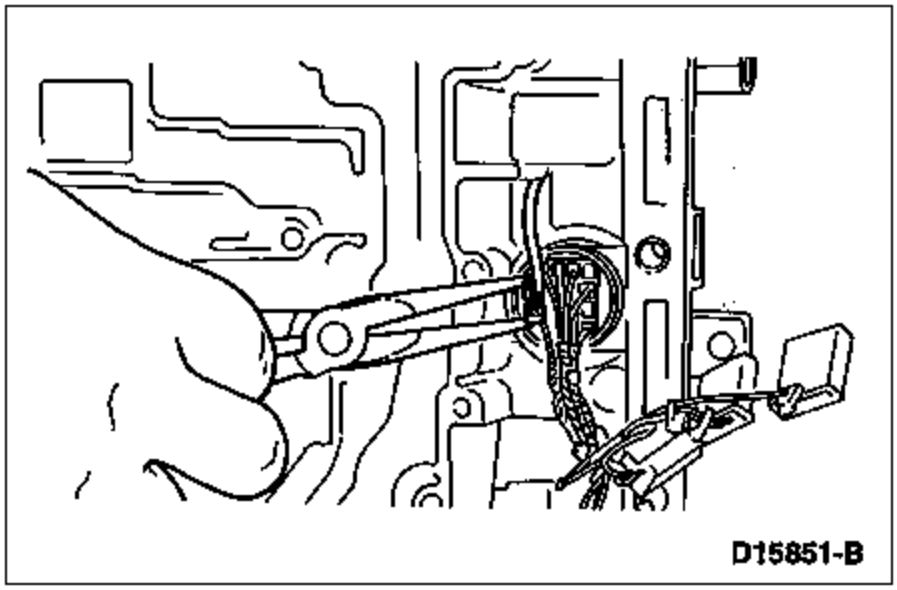
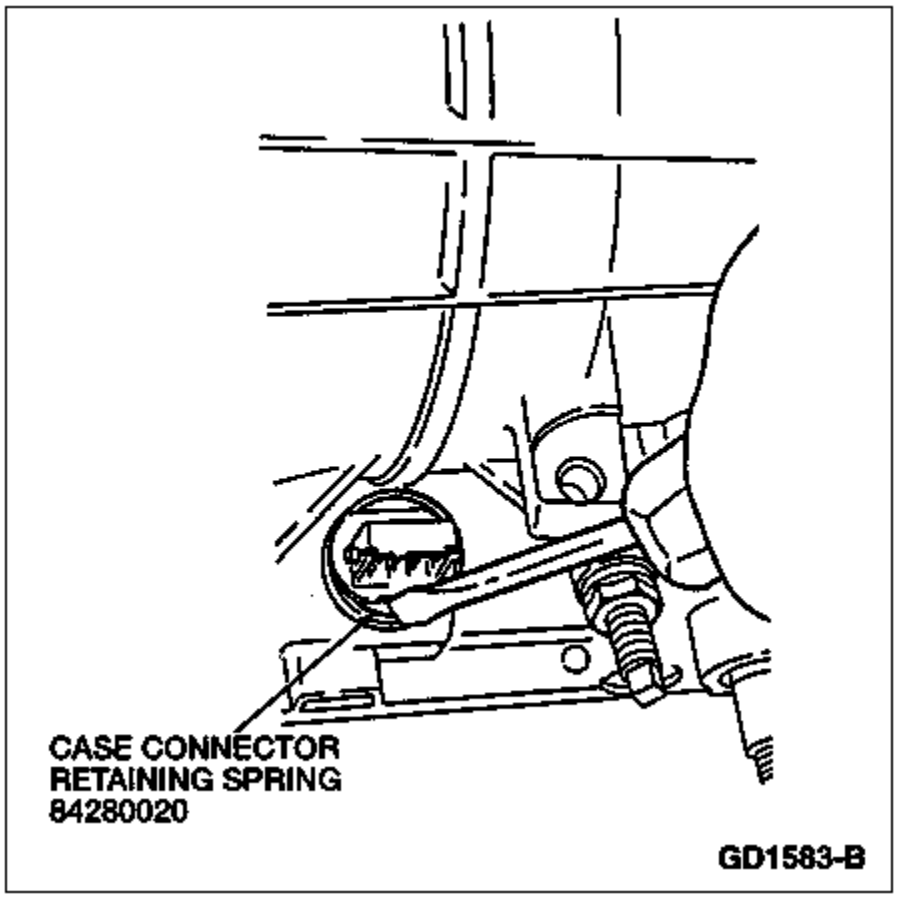


6. **CAUTION: Do not overstretch the case connector retaining spring.**

   Use a screwdriver to carefully remove the case connector retaining spring.



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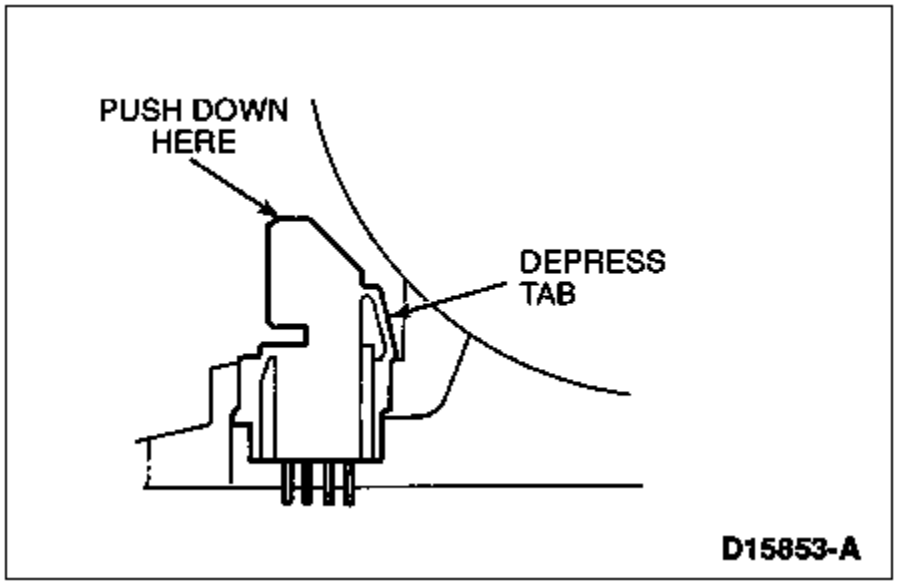
7. **CAUTION: Do not damage the connector or harness.**

   Carefully push down on the top of the connector until it stops. Depress the tab on the back side of the connector and push down on the connector.



8. Remove the connector and harness through the bottom of the case.

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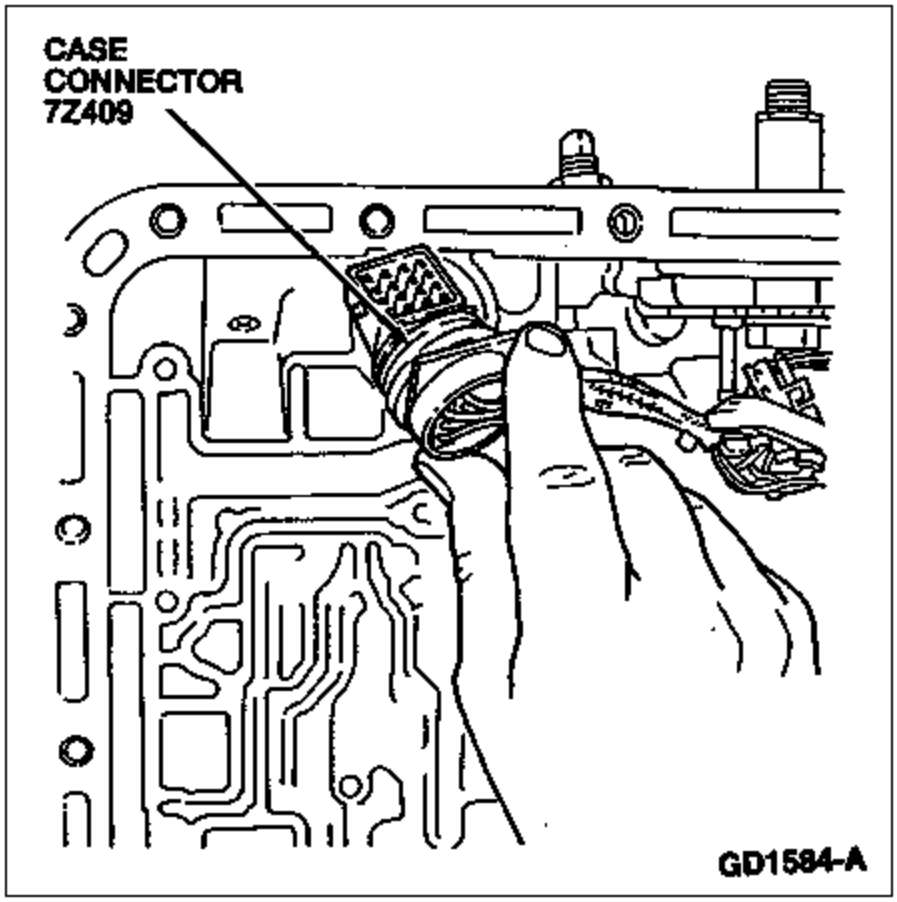

Installation

1. Replace O-rings (W703015-S300) on connector.
2. **NOTE: Make sure the tab is in the lock position.**

   Install the case 16-pin connector through the case until a click is heard.

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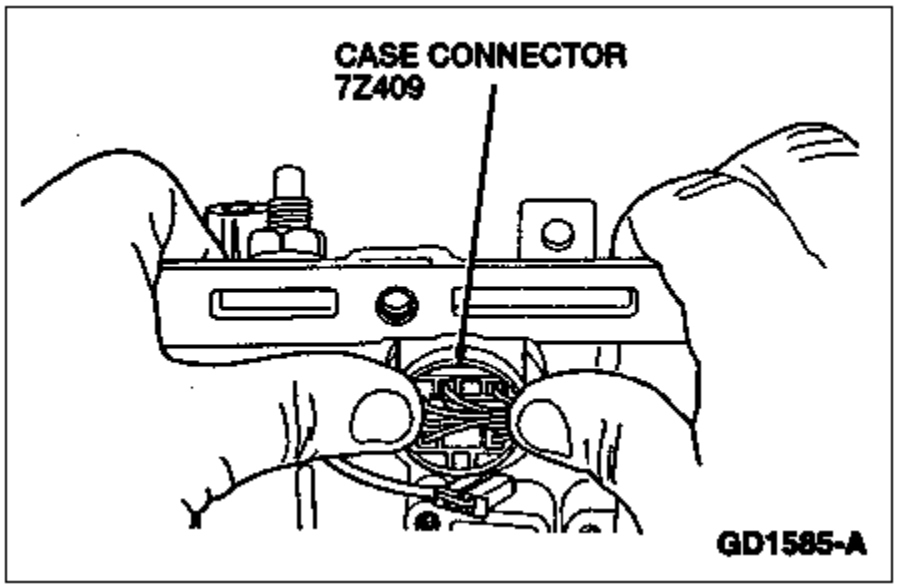
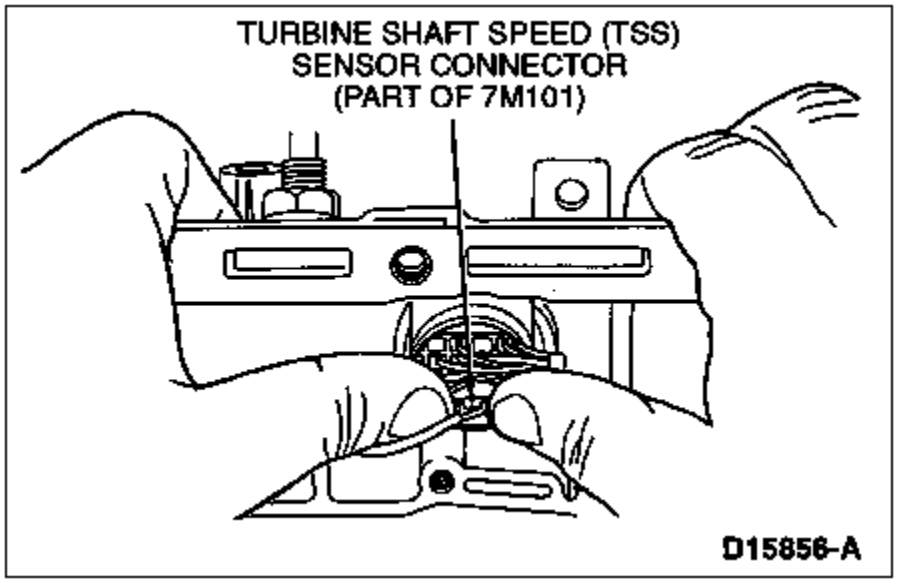


3. **NOTE: Align the slot on the TSS connector with the slot on the 16-pin case connector.**

   Carefully install the TSS connector into the 16-pin case connector.



4. **CAUTION: Do not overstretch the retaining spring.**

   Install the case connector retaining spring.

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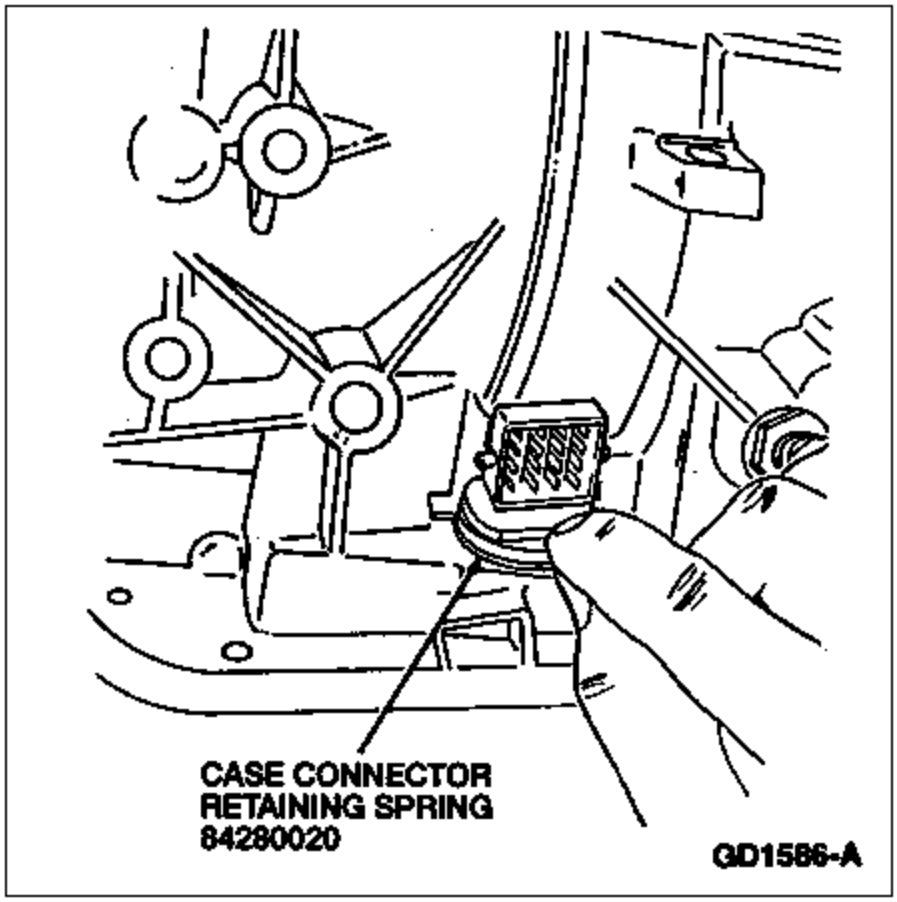

5. Install SS2 and EPC solenoids.

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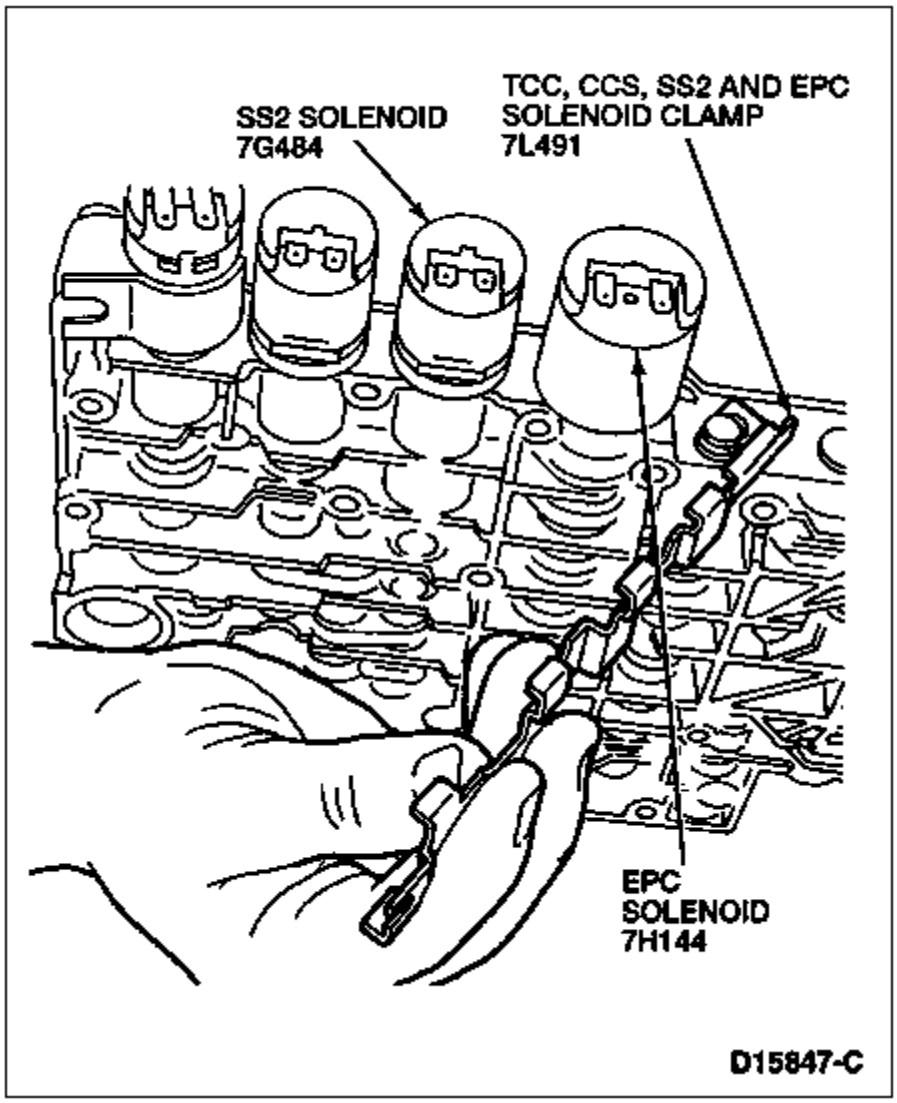

6. **CAUTION: The solenoid bracket must be installed in the TCC and EPC solenoid grooves, shift solenoid pockets and the No. 204 plug.**

   Install the solenoid clamp with solenoid clamps-to-main control screws. Tighten to 6-8 Nm (53-71 lb-in).

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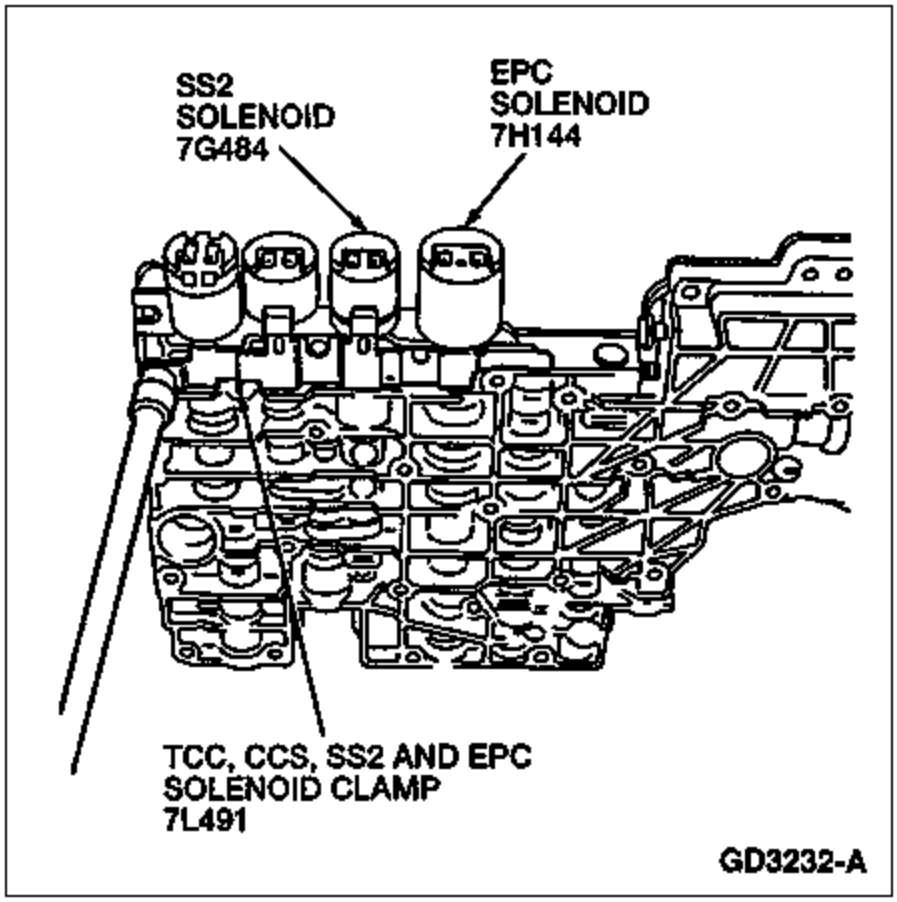

7. Install connectors on solenoids.
8. Install filter.
9. Install new fluid pan gasket onto pan.
10. Install pan.
11. Fill the transmission to the proper level. Refer to the procedure in this section.

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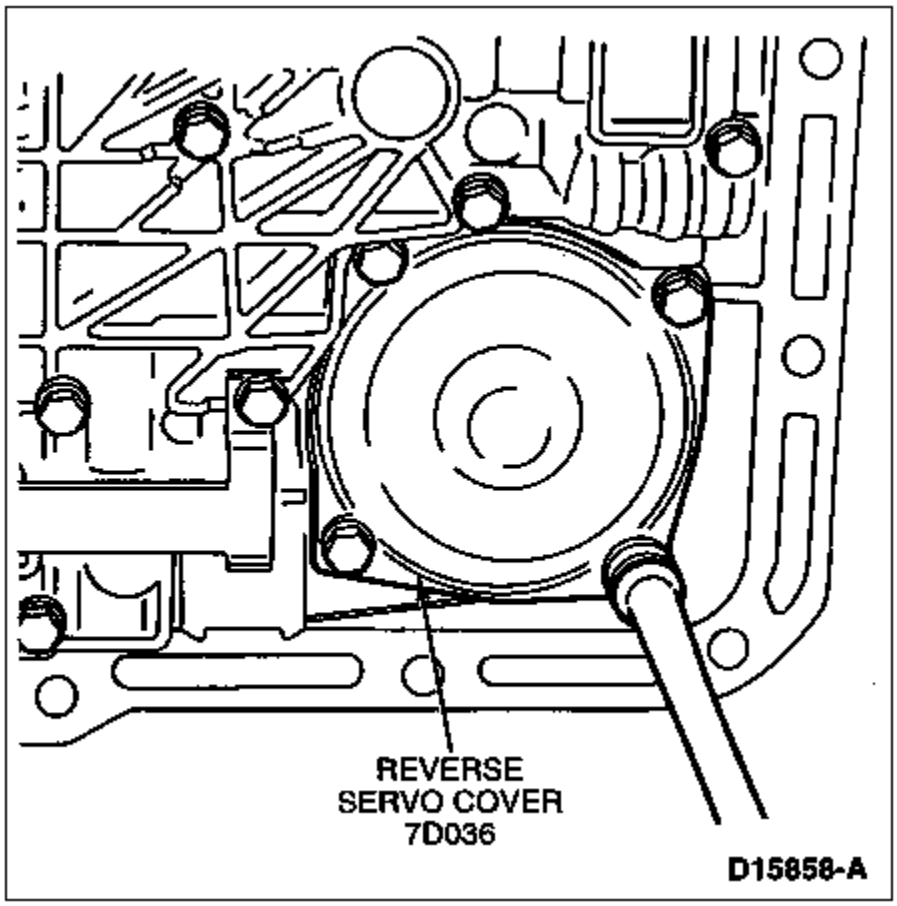
Rear Servo Assembly

Removal

1. Remove fluid pan and filter as described in this section.

2. Use a 10 mm socket to remove the four M6 x 20 mm reverse servo cover screws. Remove the reverse servo cover, gasket and the reverse servo piston and rod assembly.



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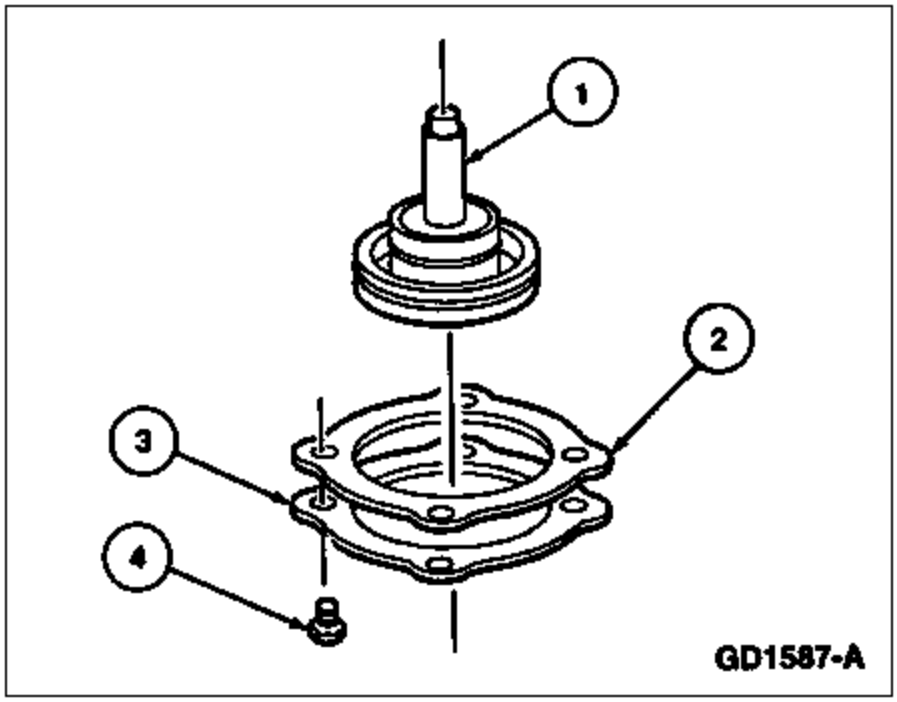

Item	Part Number	Description
1	7D189	Piston Assembly with Rod and Retainer (Rear Band Servo)
2	7L173	Reverse Servo Cover-to-Case Gasket
3	7D036	Reverse Servo Cover
4	E800156-S	Low/Reverse Servo Cover-to-Case Screw (4 Req'd)

3. Clean and inspect servo bore, piston and rod assembly. Service as required.

Installation

1. Install the reverse servo and rod assembly into the case.
2. Install the reverse servo cover, new gasket and the four reverse servo cover-to-case screws. Tighten cover-to-case screws in sequence as shown to 12-14 Nm (106-124 lb-in).

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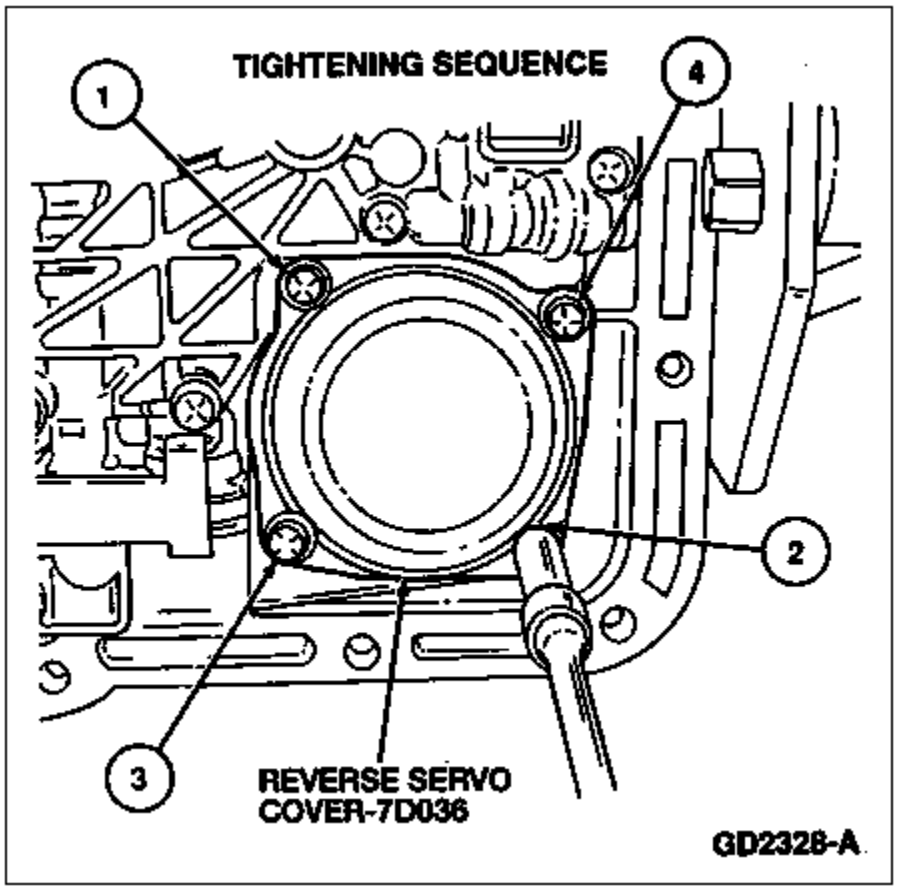

3. Install pan, new gasket and filter as described in this section.
4. Refill transmission.

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Manual Control Lever Shaft Seal

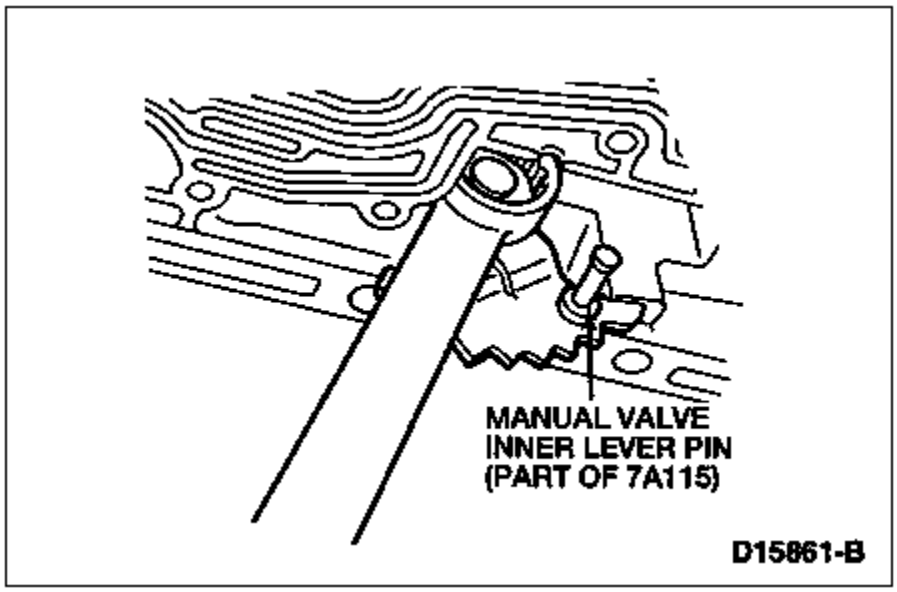
SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Shift Lever Seal Replacer	T74P-77498-A

Removal

1. Remove linkage and digital transmission range (DTR) sensor as described in this section.
2. Remove fluid pan. Filter does not need to be removed.
3. **CAUTION: Do not damage the manual valve inner lever pin.**

   Remove the manual valve inner lever nut. Support inner manual valve lever and park rod assembly.



4. **CAUTION: Do not damage the case fluid pan rail.**

   Use a small hammer and drift punch to tap lightly on each side of the manual control lever shaft spring pin (two or three times). This will loosen the pin prior to removal.

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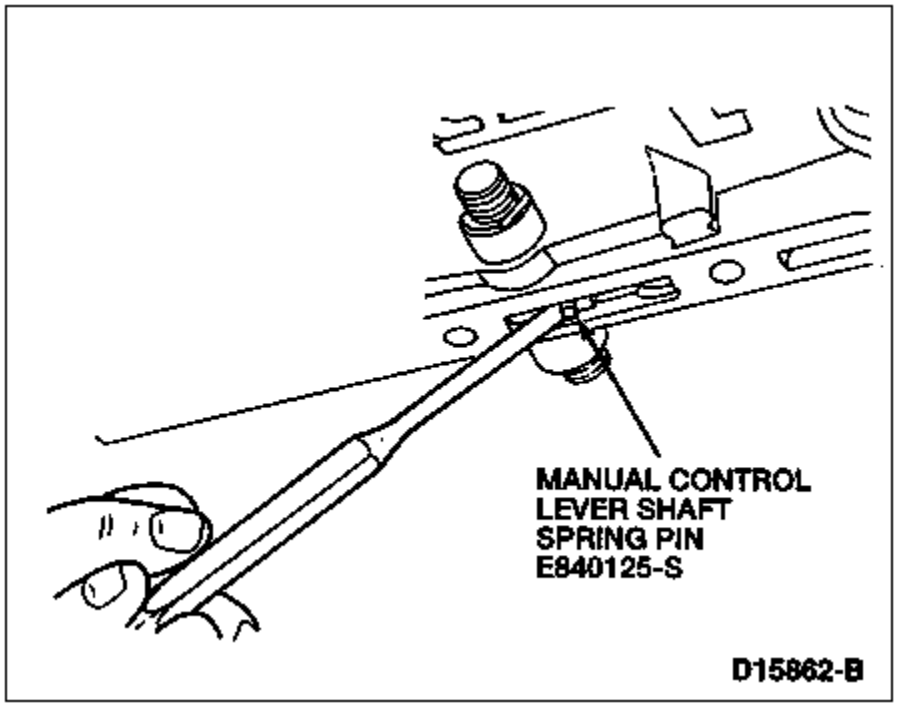
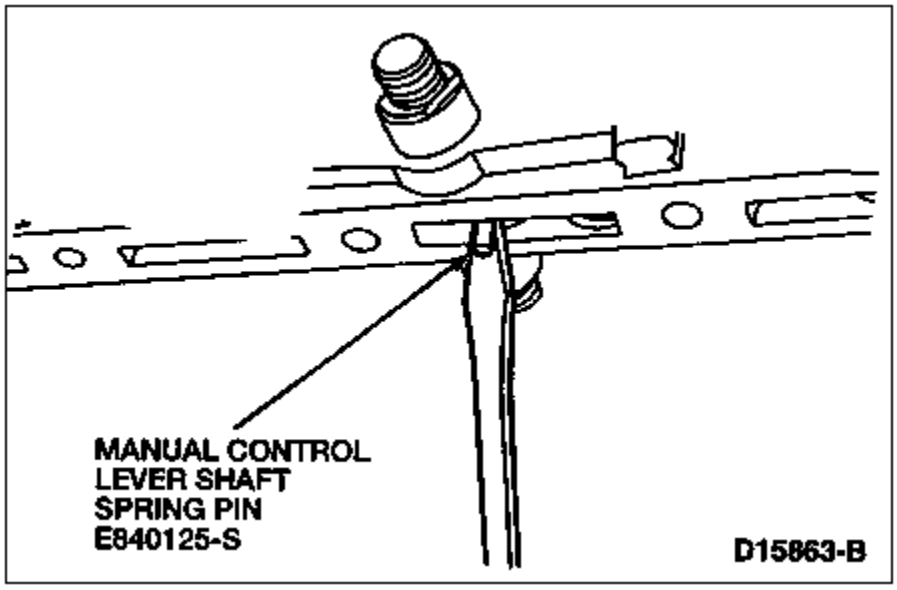


5. **CAUTION: Do not damage the case fluid pan rail.**

   Remove the manual control lever shaft spring pin with a narrow, sharp-edged screwdriver from the side as shown.



6. Remove the manual control lever shaft.

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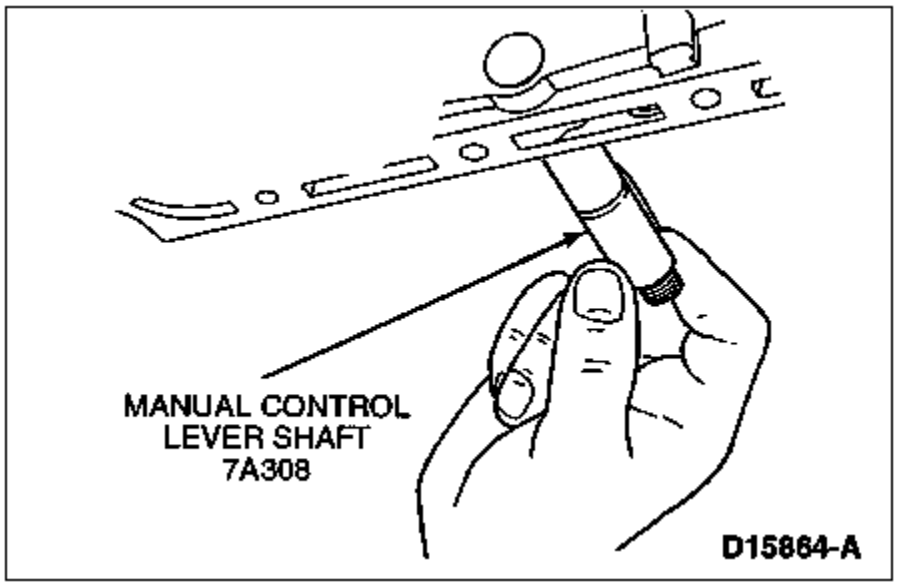
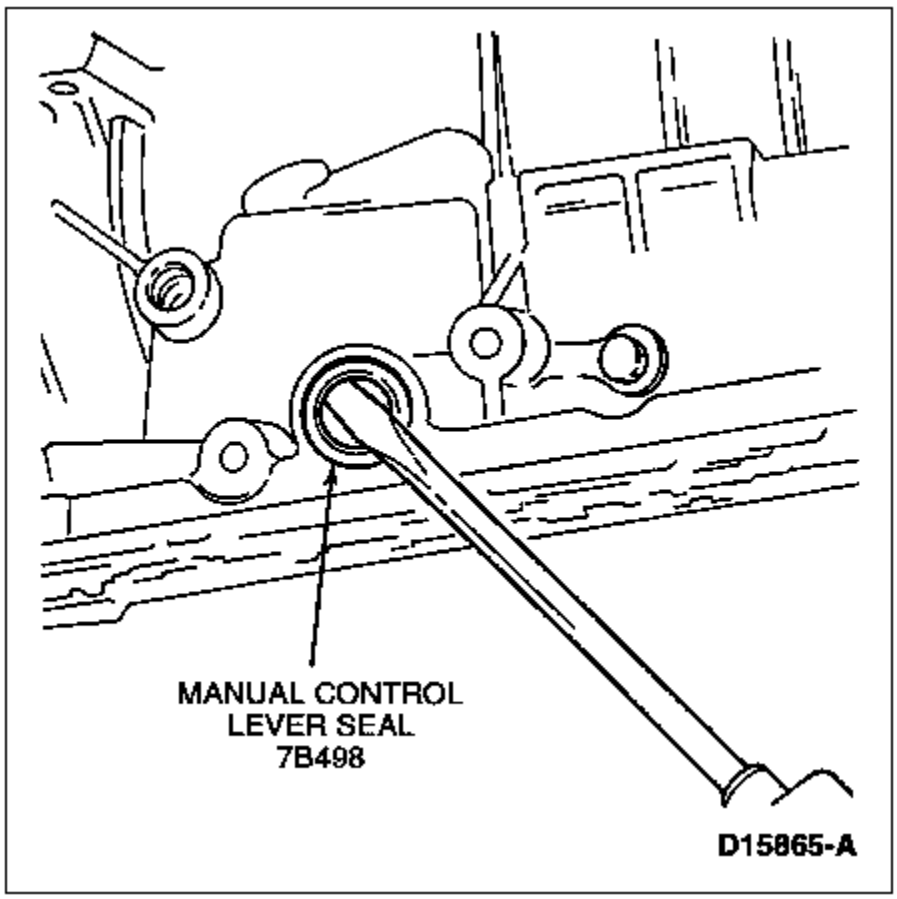


7. **CAUTION: Do not damage the bore.**

   Remove the manual control lever seal.



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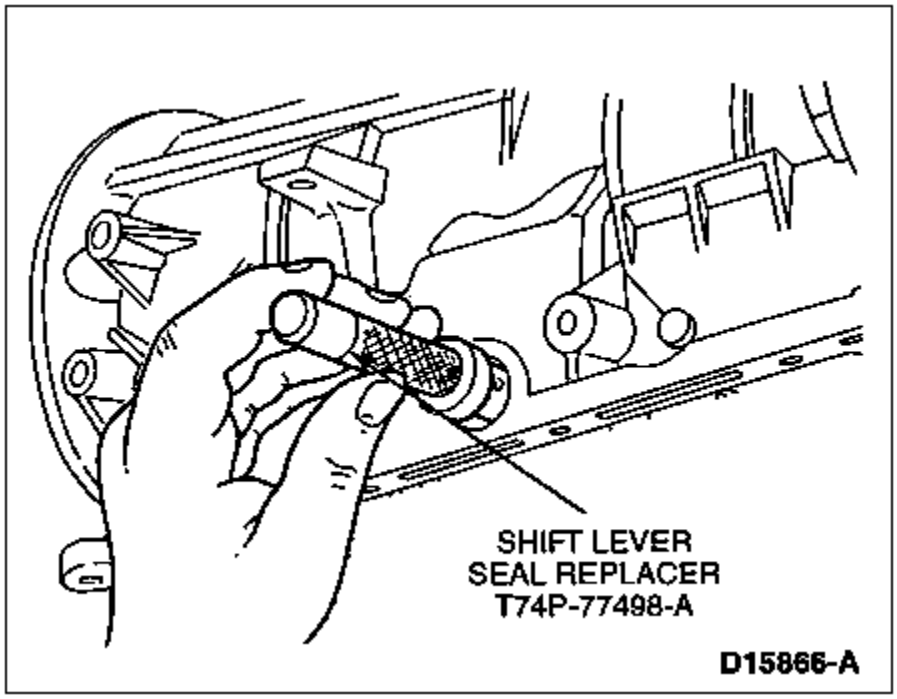
Installation

1. Lubricate and install the main control lever seal using Shift Lever Seal Replacer T74P-77498-A.



2. Install the manual control lever shaft into the case.

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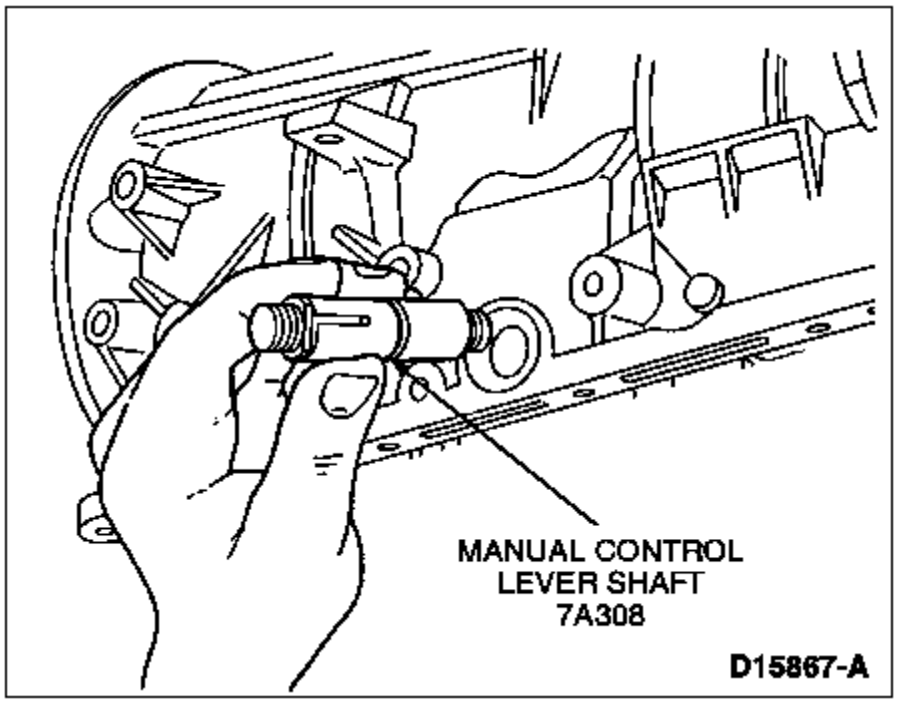

3. **CAUTION: Use care not to damage the fluid pan rail surface when installing the retaining pin.**

   Align the manual control lever shaft with the manual control lever shaft spring pin. Install the retaining pin.

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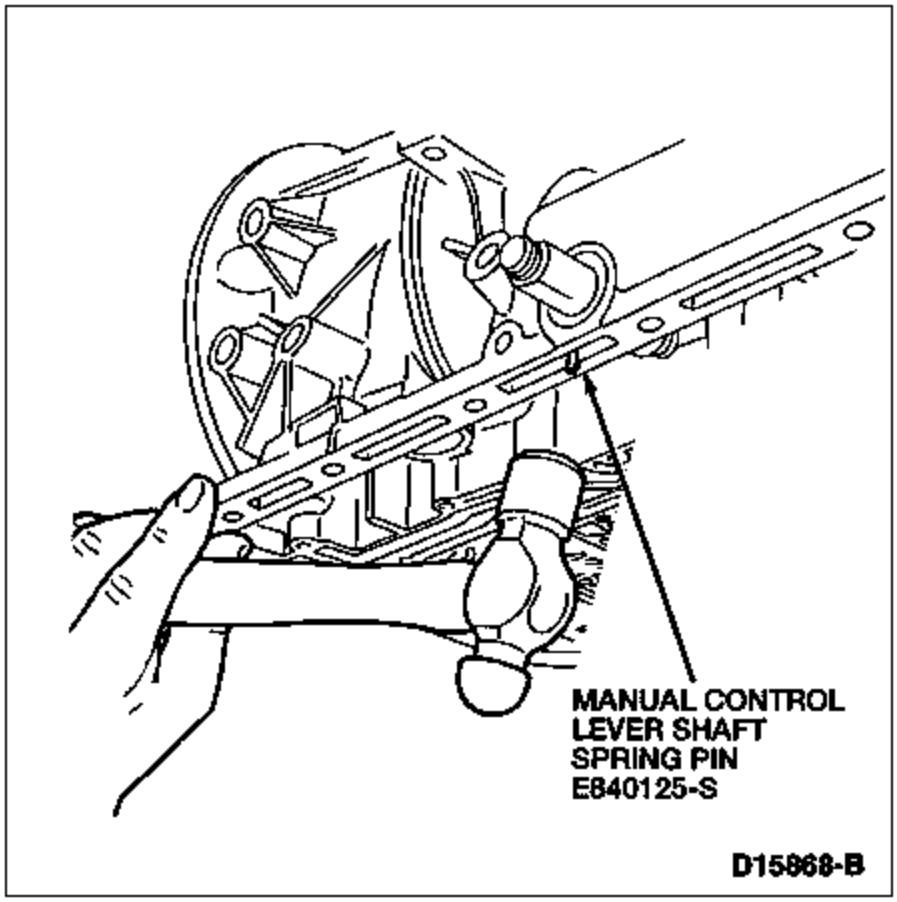

4. Align the flats of the manual valve inner lever with the flats on the manual control lever shaft.

5. **CAUTION: Do not bend the manual valve inner lever pin.**

   Install manual valve inner lever nut and tighten to 41-54 Nm (30-44 lb-ft).

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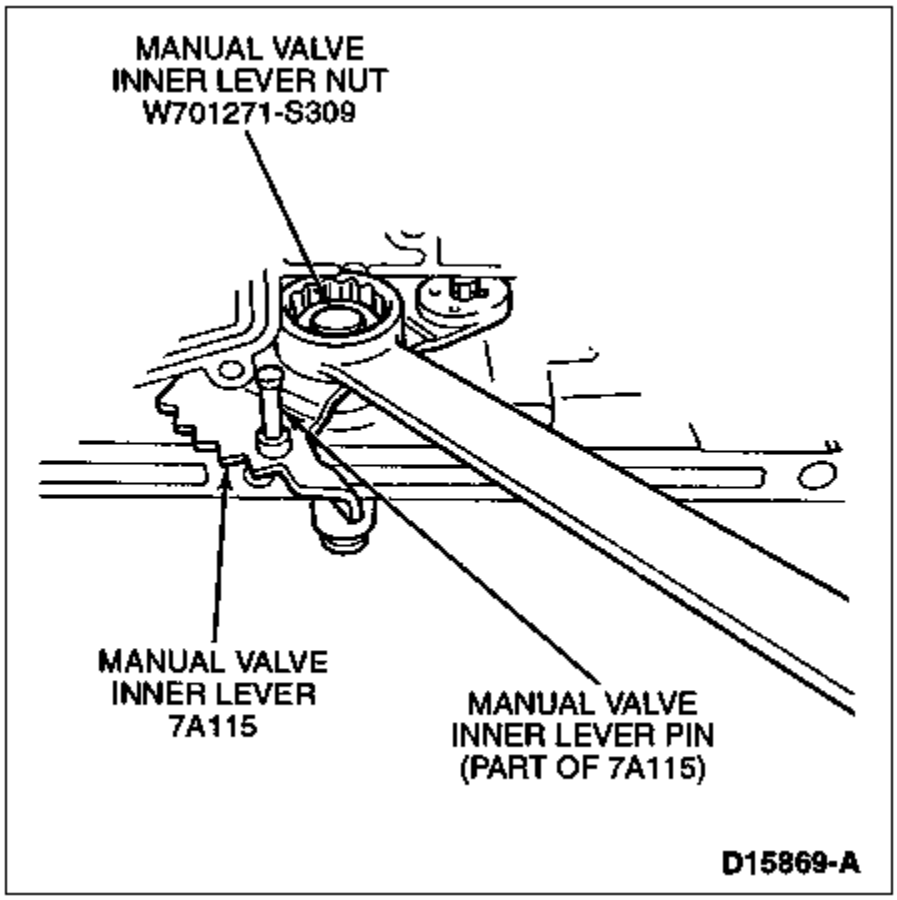

6. **CAUTION: Park pawl actuating rod must be properly installed into parking pawl and guide cup located in extension housing. Verify park linkage function.**

   Verify that the output shaft is locked in the PARK position.

7. Install new gasket and install pan.

8. Install DTR sensor and linkage.

9. Fill the transmission to the proper level. Refer to the procedure in this section.

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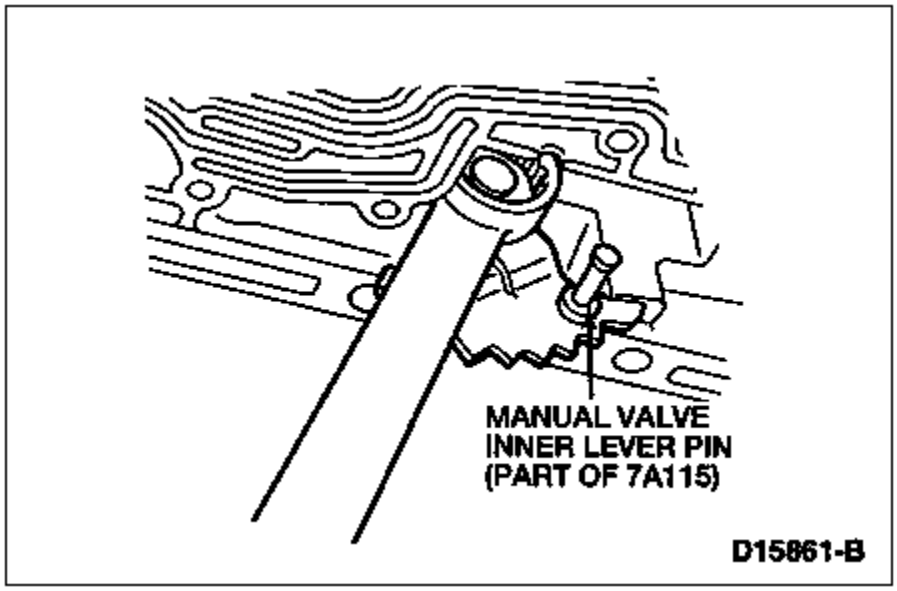
Park System

Removal

1. Remove fluid pan. Remove fluid filter.
2. Remove EPC, SS2 and CCS solenoids. Remove case connector as described in this section.
3. **CAUTION: To avoid damage, make sure the wrench does not strike the manual valve inner lever pin.**

   Remove the manual valve inner lever nut.



4. Remove the manual valve inner lever and parking pawl actuating rod assembly.

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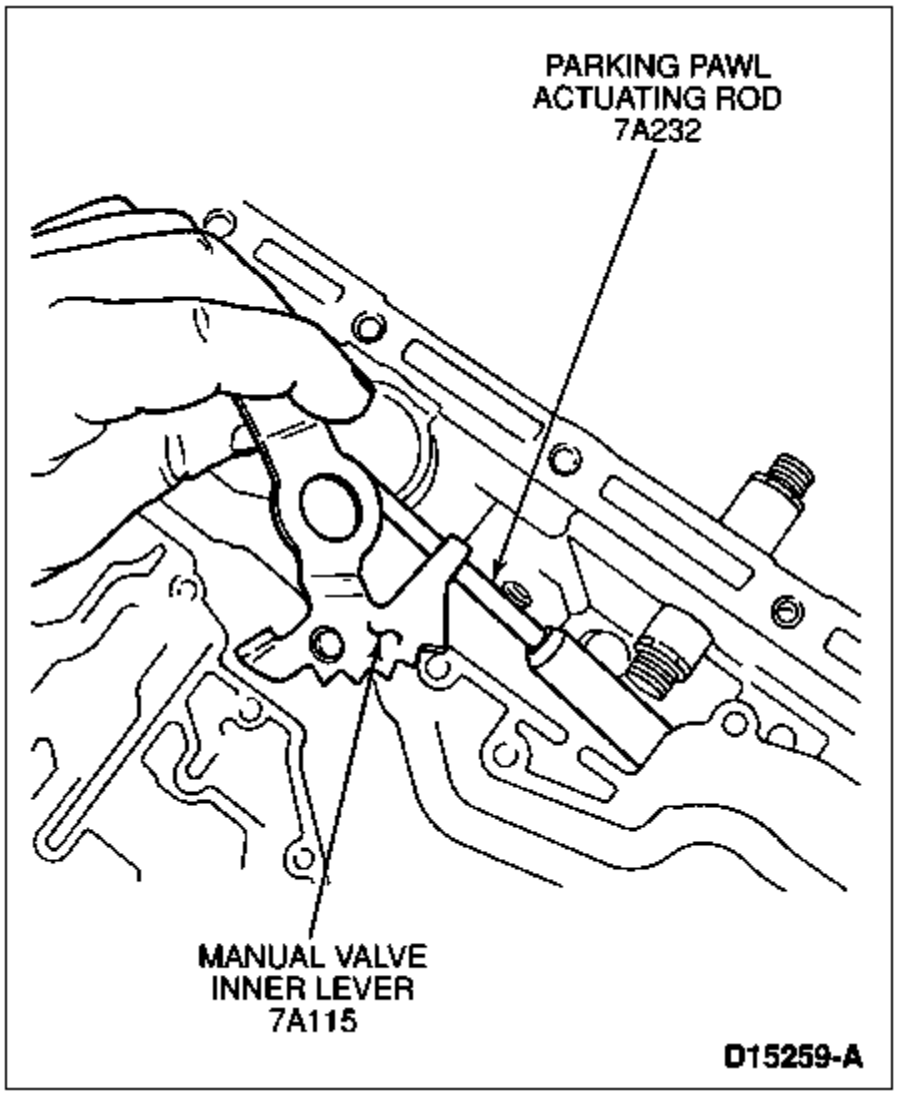

5. Remove extension housing as described in this section.

6. Inspect park pawl spring and shaft. Inspect park pawl actuating rod. Service as required.

Installation

1. Install the manual valve inner lever and parking pawl actuating rod into the case. Align the flats of the manual valve inner lever with the flats on the manual control lever shaft.

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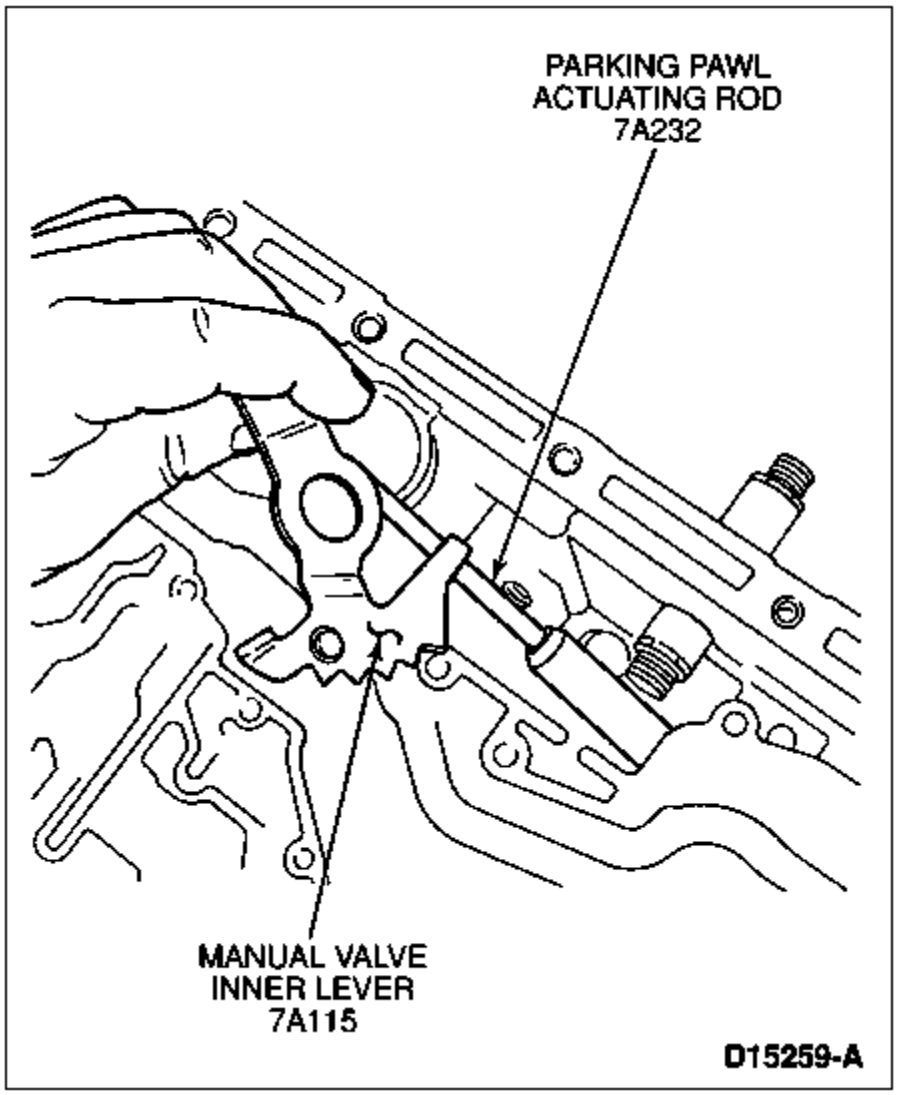

2. **CAUTION: Do not bend the manual valve inner lever pin.**

   Install manual valve inner lever nut and tighten to 41-54 Nm (30-40 lb-ft).

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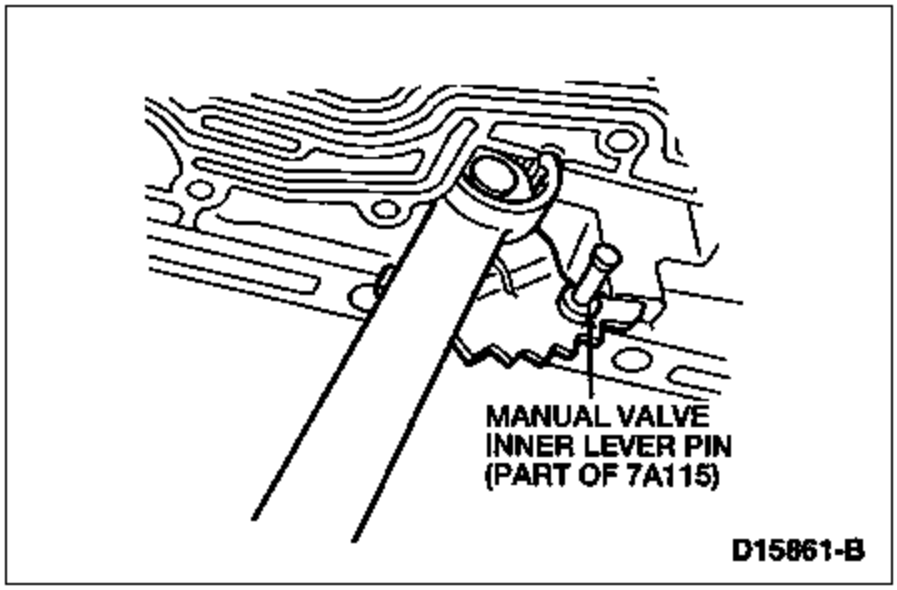

3. Install extension housing as described in this section, noting all cautions and notes.
4. Install EPC, SS2 and CCS solenoids and 16-pin case connector as described in this section.
5. Install fluid filter, fluid pan and new pan gasket with fluid pan-to-case screws. Tighten fluid pan-to-case screws to 13-15 Nm (115-133 lb-in).

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Main Control Valve Body

NOTE: If a transmission has been disassembled to replace worn or damaged parts and the valves in the main control valve body (7A100) stick repeatedly from foreign material, the torque converter must be removed and cleaned by using a mechanically agitated cleaner, such as Rotunda Torque Converter/Fluid Cooler Cleaner 014-00028 or equivalent.

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Valve Body Guide Pin (.235)	T95L-70010-B
Valve Body Guide Pin (.248)	T95L-70010-C

Removal

1. Remove fluid pan.
2. Carefully lift up on the wire loom guide and protector. Disengage the retaining pins from the solenoid clamps.

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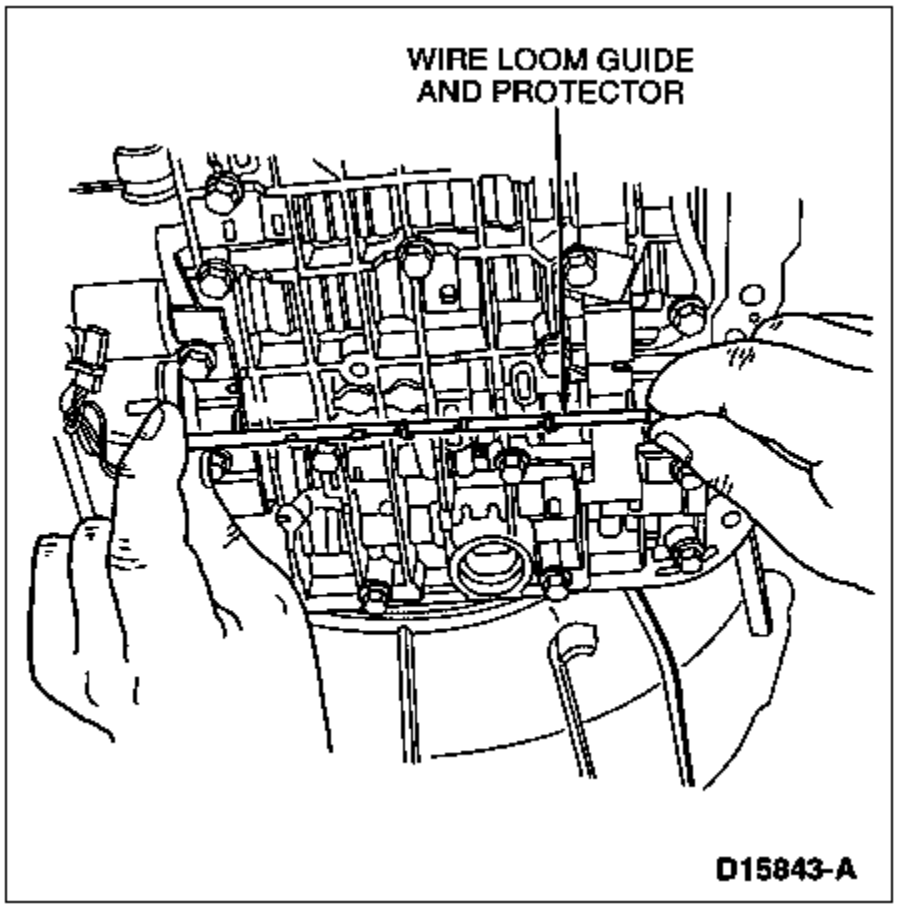

3. Disconnect the six solenoid connectors from the solenoids by carefully pulling downward and wiggling side to side.

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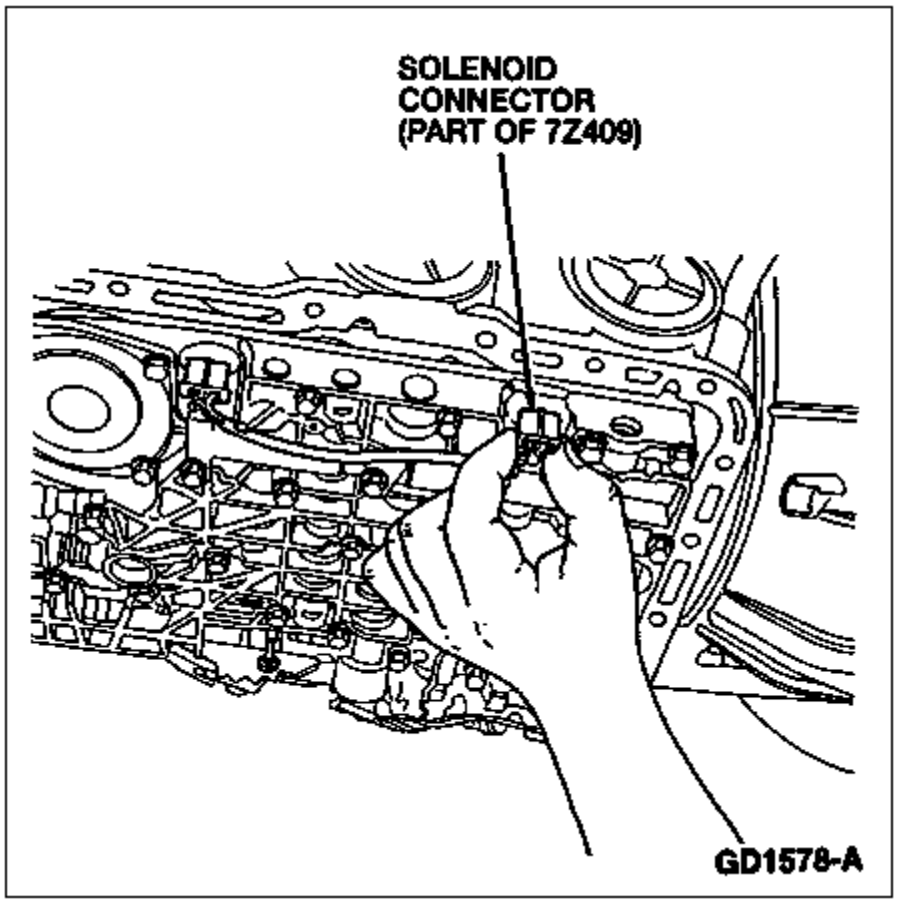

4. Use a 10 mm socket to remove the M6 x 30 mm manual valve detent spring screw. Remove the manual valve detent spring.

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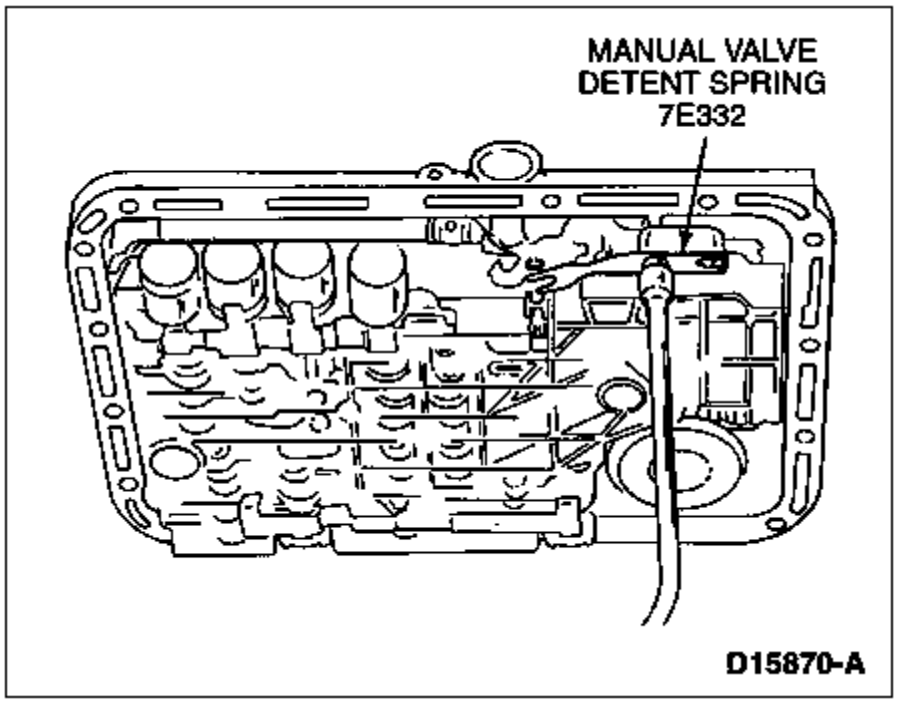

5. Use a 10 mm socket to remove the four M6 x 20 mm reverse servo cover screws. Remove the reverse servo cover, gasket and the servo piston and rod assembly.

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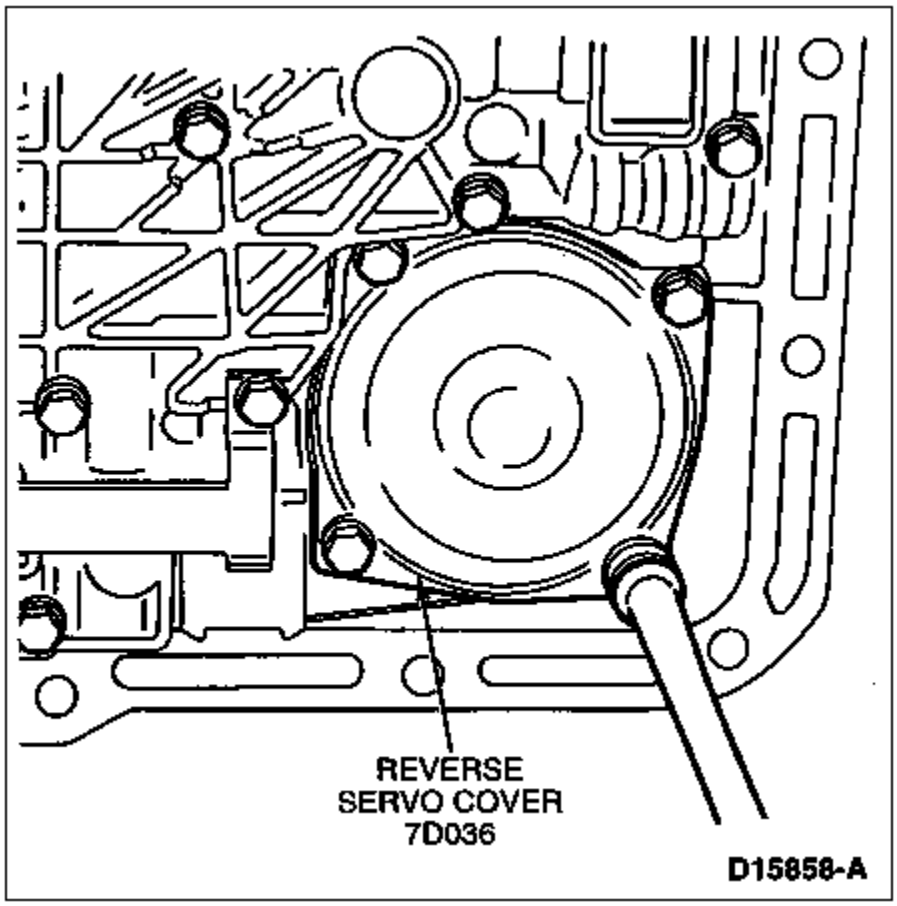

6. **CAUTION: Support main control valve body.**

   Use a 10 mm socket to remove the sixteen M6 x 40 mm, four M6 x 45 mm, two M6 x 35 mm and one M6 x 30 mm main control valve body screws.

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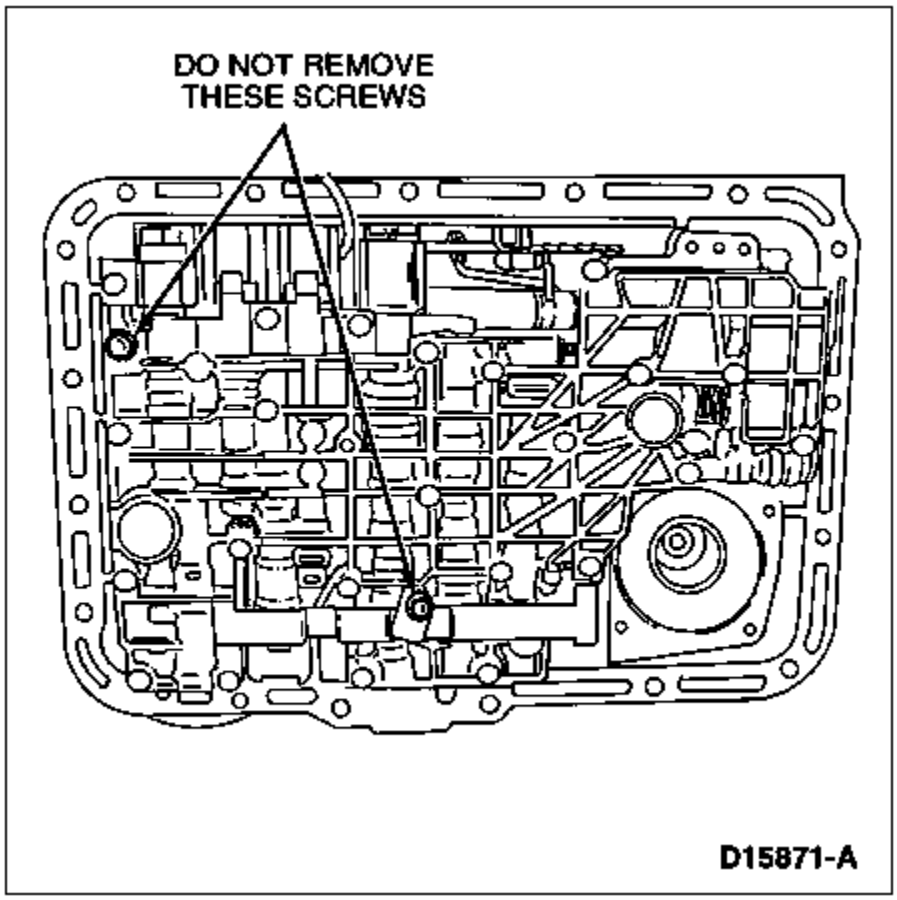
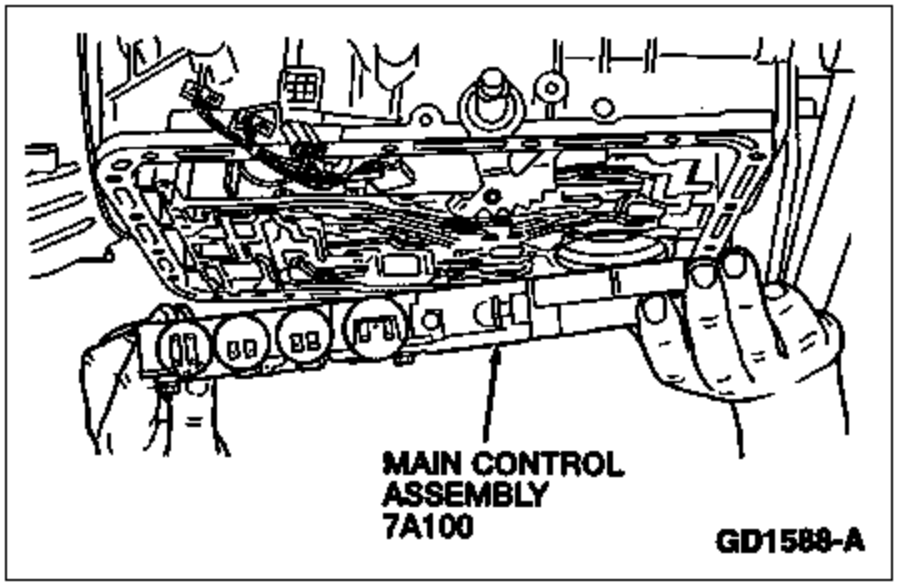


7. Remove the main control assembly.



8. Install the guide pins into the case in the positions shown.

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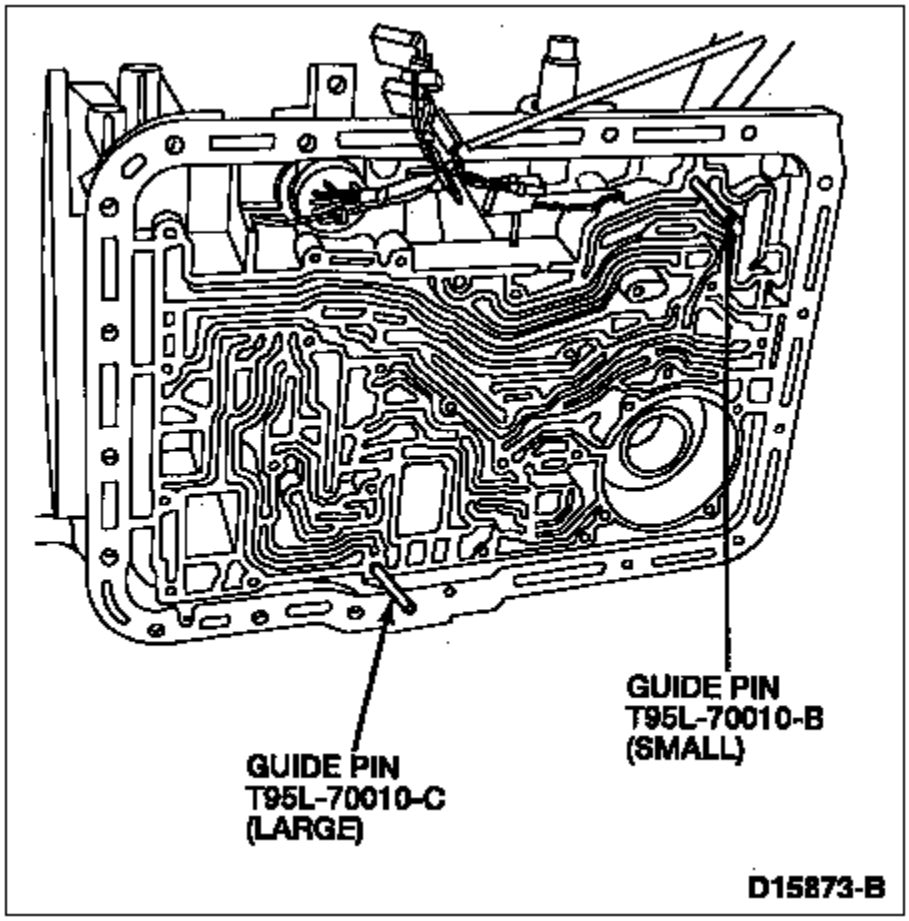

9. Install new separator to case gasket.

10. **NOTE: Make sure main control assembly gasket is properly aligned.**

    Install the main control assembly on the case. Align the manual valve with the manual valve inner lever pin as shown.

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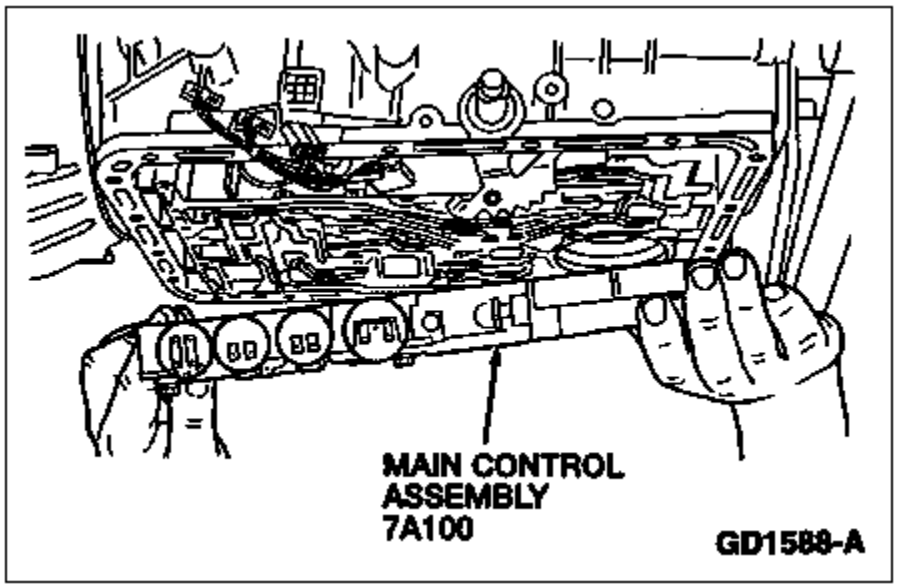

11. Install four M6 x 45 mm screws in locations A. Finger tighten.
12. Install two M6 x 35 mm main control assembly-to-case screws in locations B. Finger tighten.
13. Install one M6 x 30 mm main control assembly-to-case screws in location C. Finger tighten.
14. Remove both valve body guide pins T95L-70010-B and T95L-70010-C.
15. Install sixteen M6 x 40 mm main control assembly-to-case screws in locations D. Finger tighten.
16. Tighten all main control assembly-to-case screws to 8-11 Nm (71-97 lb-in) in sequence shown, using a 10 mm socket.

Main Control Assembly Screws and Locations

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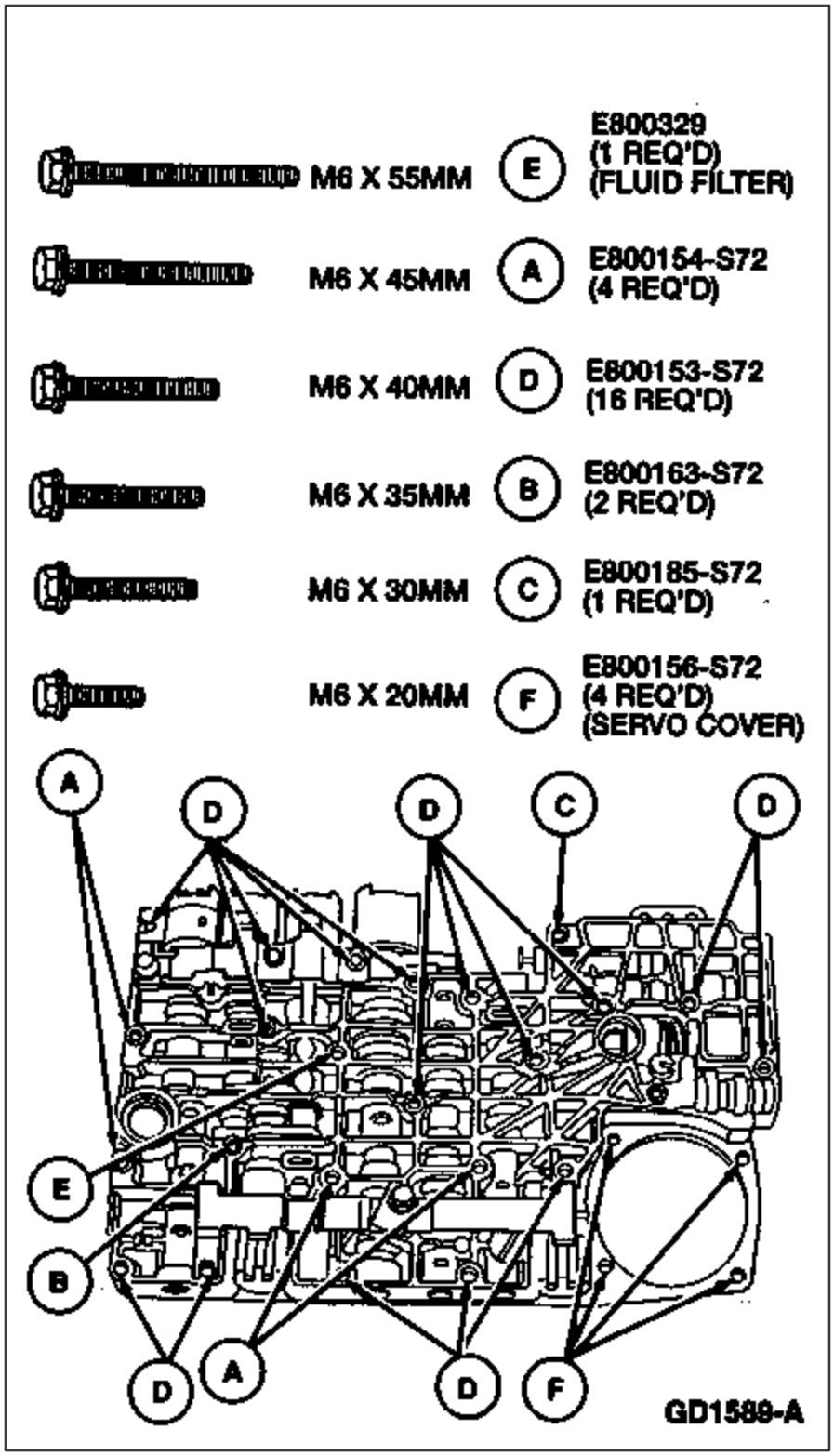

Refer to the tightening sequence (1R, 2R, 3R, 4R) for reverse servo cover installation also.

Tightening Sequence

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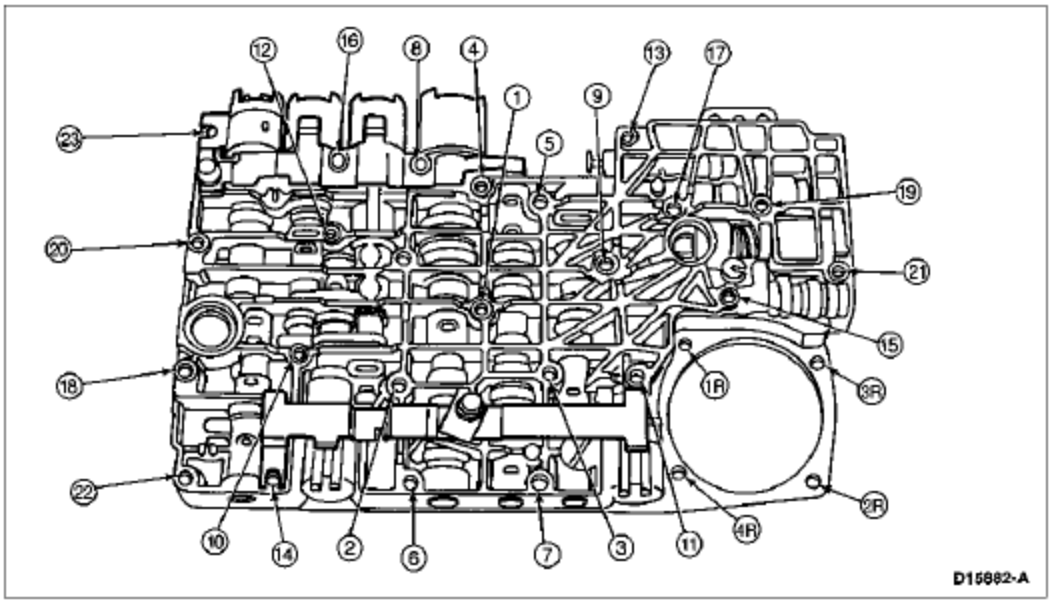
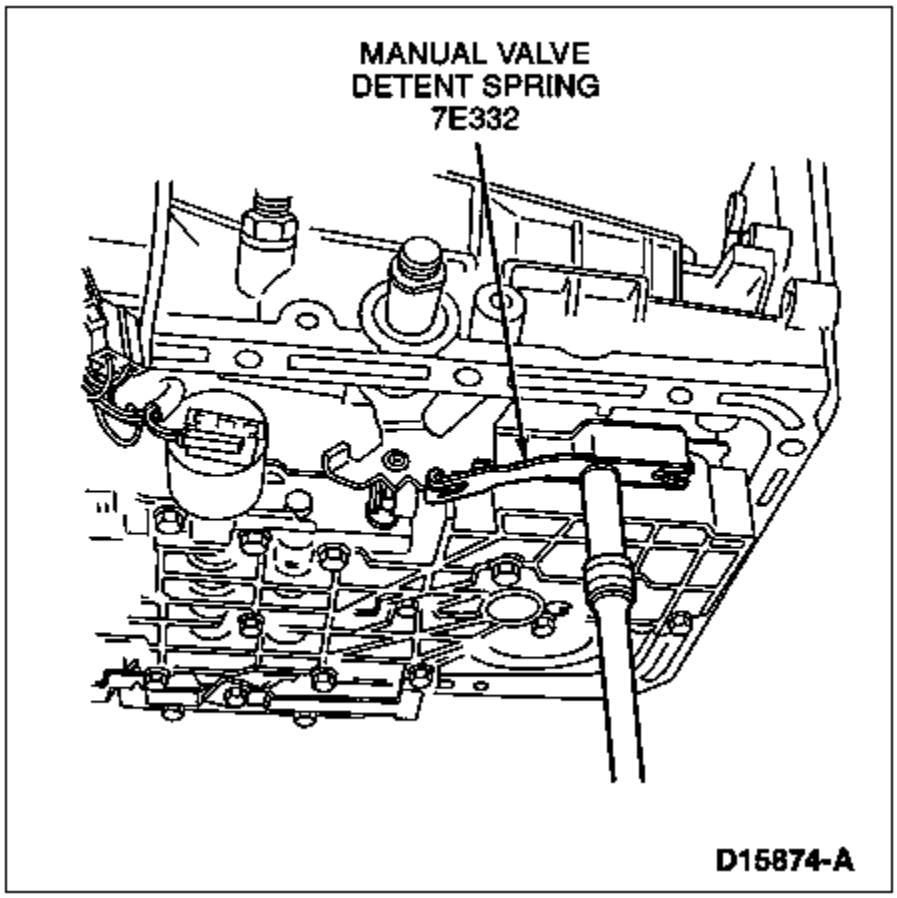


17. Install the manual valve detent spring. Install the manual valve detent spring screw and tighten to 8-11 Nm (71-97 lb-in).



18. Install the reverse servo assembly into the case.

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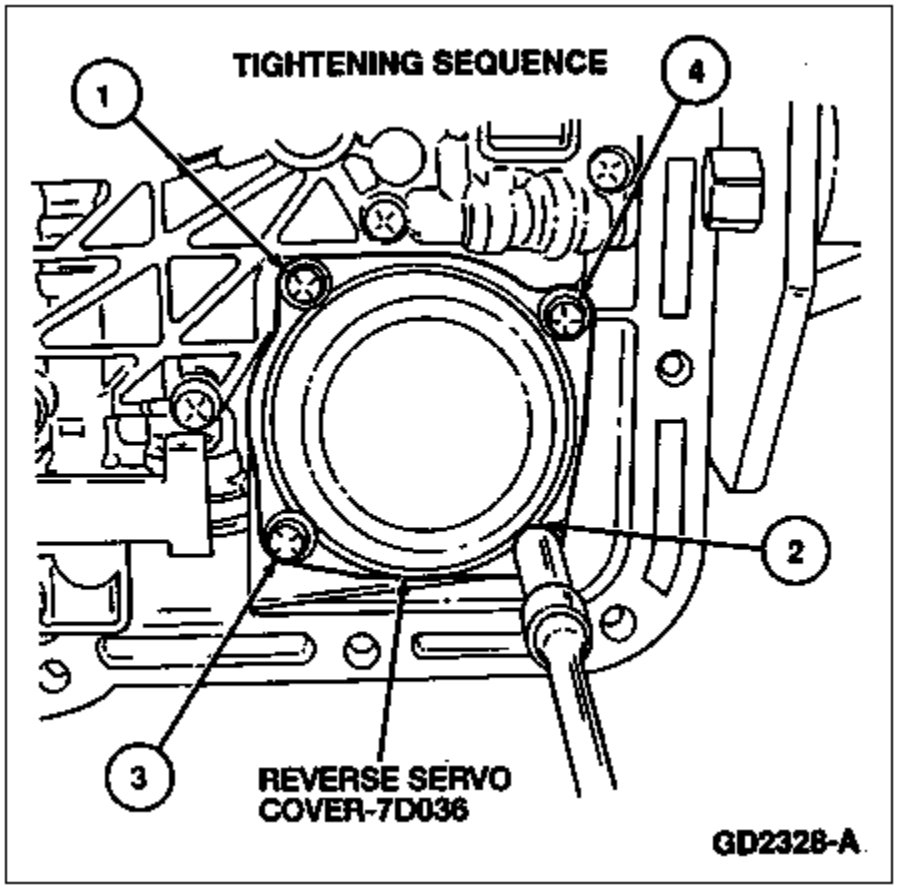
19. Install the reverse servo and rod assembly cover, new gasket and the four servo cover-to-case screws. Tighten the screws in sequence as shown to 12-14 Nm (106-124 lb-in).



20. Carefully press down to install the solenoid connectors on the solenoid.

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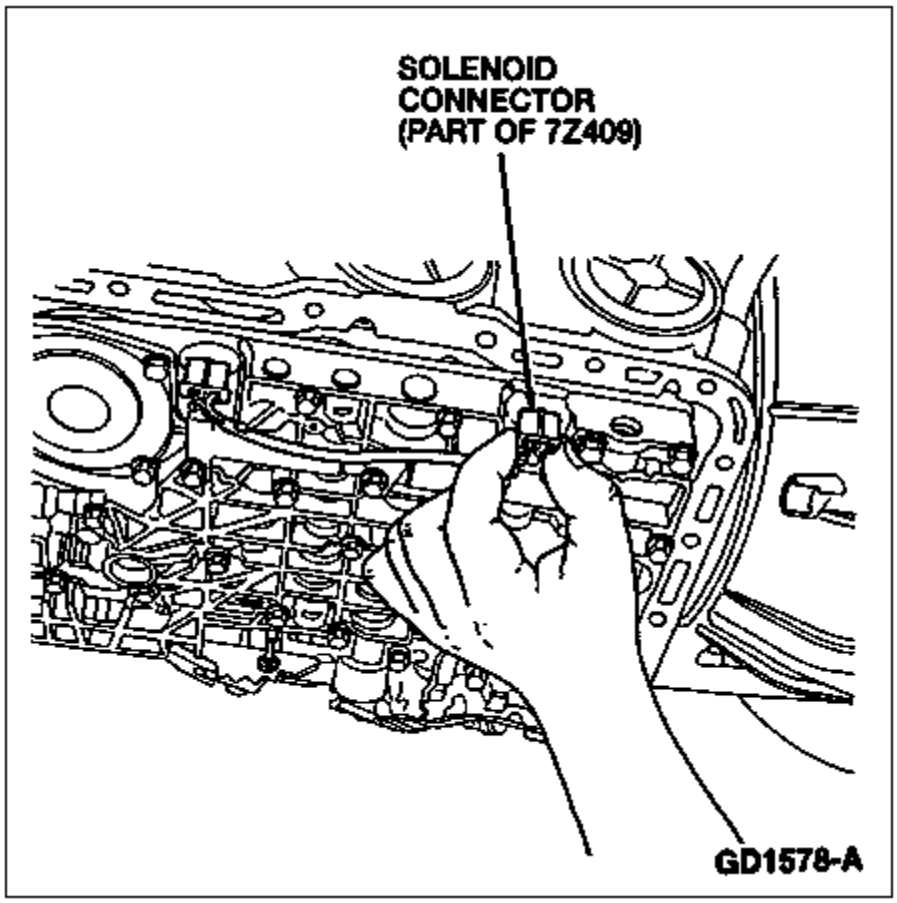

21. **CAUTION: Excessive pressure may break the locating pins.**

Install the wiring loom protector and guide. Align the pins in the holes of the solenoid clamps and gently push down.

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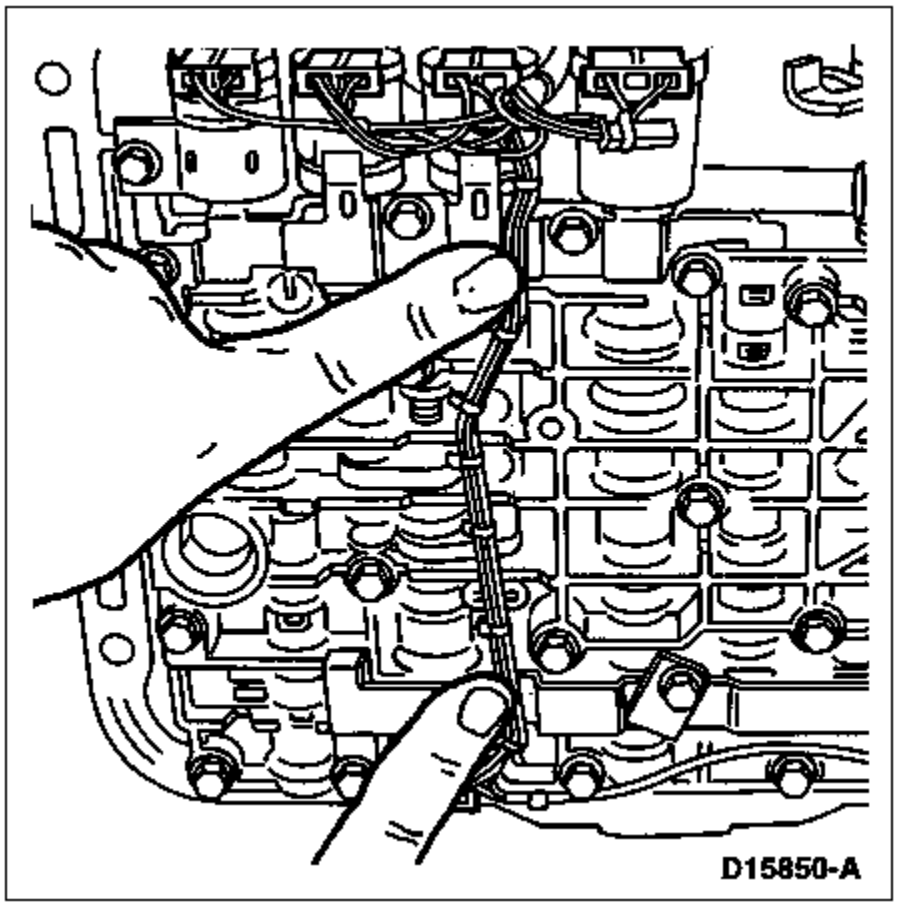

22. Install filter, new gasket and fluid pan.

23. Fill the transmission to the proper level. Refer to the procedure in this section.

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Intermediate and Overdrive Servos

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Servo Cover Compressor	T95L-77028-A
Servo Removal Tool	T97T-7D021-A

Removal

NOTE: Procedures are the same for both O/D and intermediate servos.

1. **NOTE: Catalytic converter(s) may have to be removed.**

   Remove heat shield, if equipped.

2. **CAUTION: Servo is under spring tension. Use caution when removing.**

   NOTE: The J-hook must be in the appropriate hole for the servo being removed.

   Install Servo Cover Compressor T95L-77028-A over the intermediate servo cover at the fluid pan rail with tool stamping facing up. Tighten the screws.

3. Using a 1/2-inch wrench, tighten the nut on the J-hook until there is a gap between the servo cover and the snap ring.

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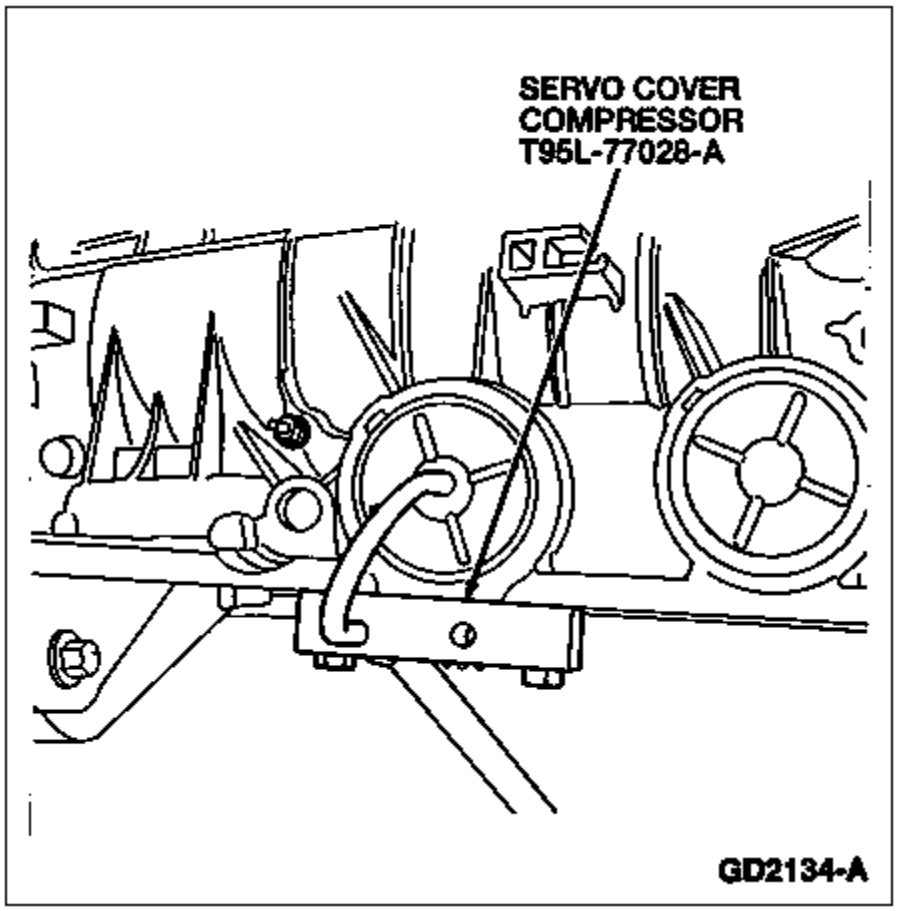

4. Carefully remove the servo cover retaining ring.

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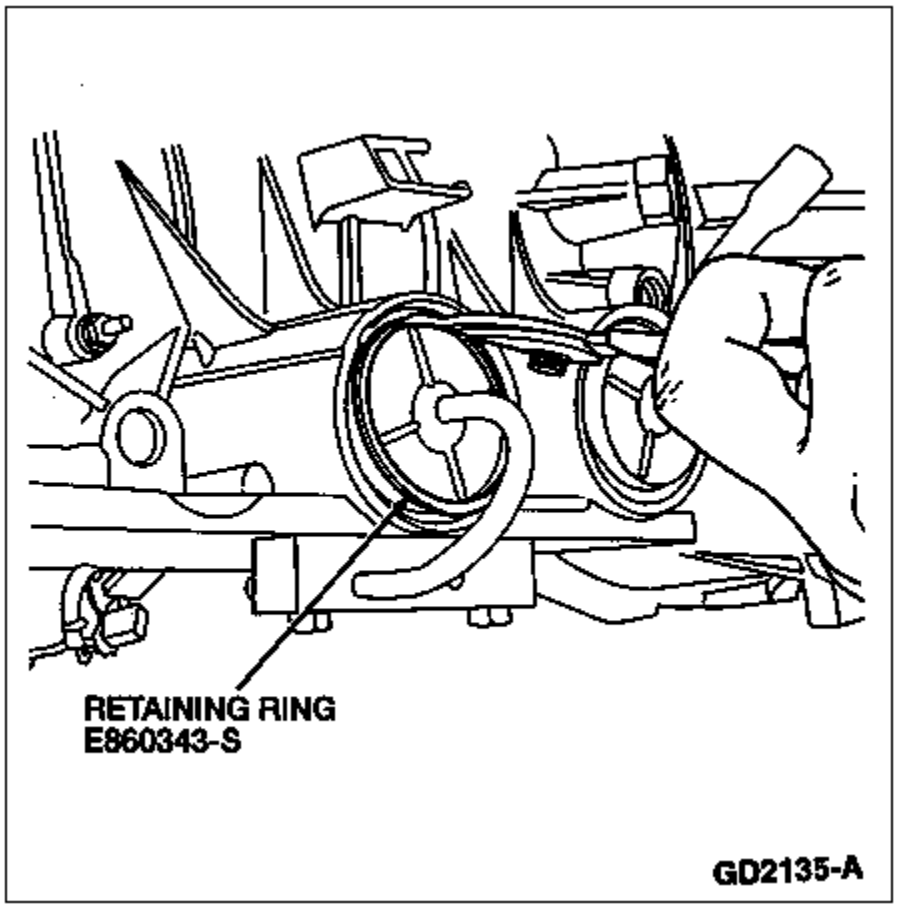

5. **CAUTION: The servo cover is under spring tension.**

   Carefully back off the nut on the J-hook until the servo spring is unloaded.

6. Insert Servo Removal Tool T97T-7D021-A into case and locate on servo rod.

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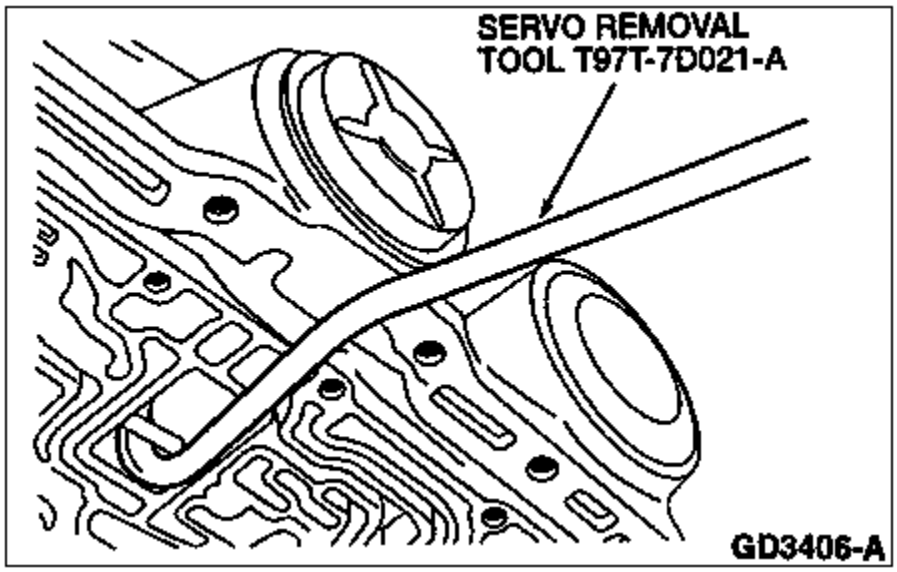
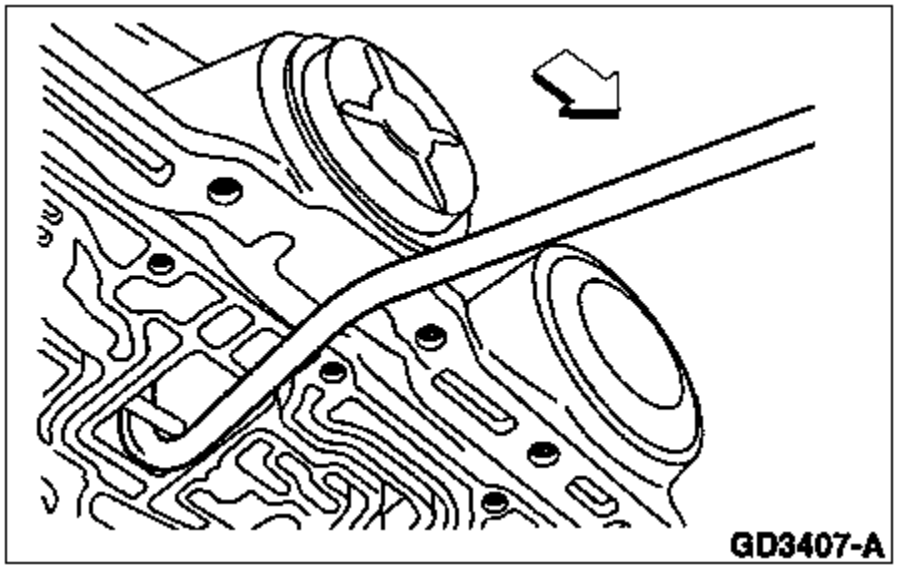


7. Gently push on Servo Removal Tool T97T-7D021-A to remove front servo cover, piston and spring.



8. **NOTE: Tag the spring, piston and cover assembly. Label accordingly for assembly. The covers have letters cast on the outer surface for identification.**

   Remove the intermediate servo cover, piston and spring.

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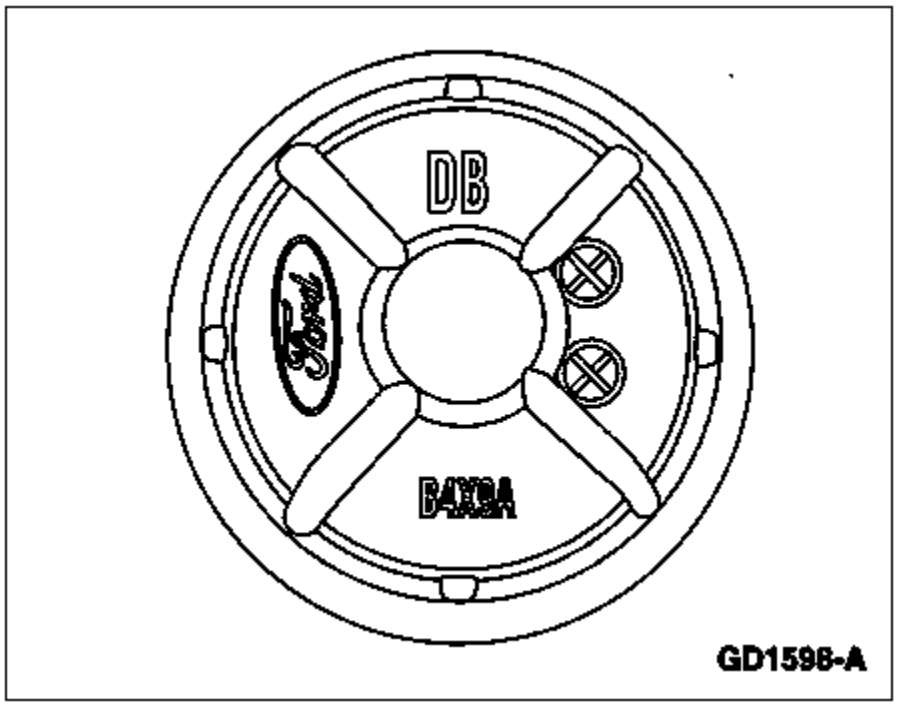

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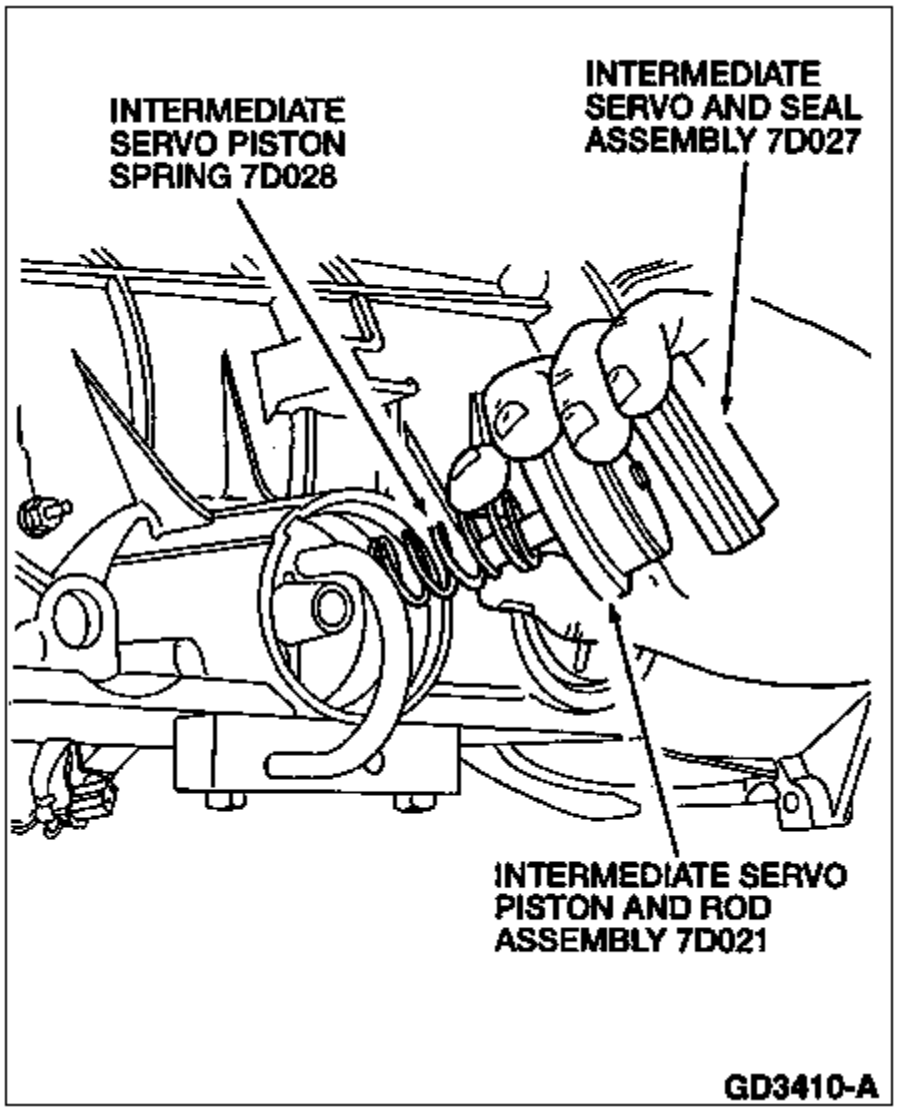

9. Remove Servo Cover Compressor T95L-77028-A.

10. **NOTE: The J-hook must be in the appropriate hole for the servo being removed.**

    Install Servo Cover Compressor T95L-77028-A over the overdrive servo cover at the fluid pan rail. Tighten the screws.

11. Using a 1/2-inch wrench, tighten the nut on the J-hook until there is a gap between the servo cover and the retaining ring.

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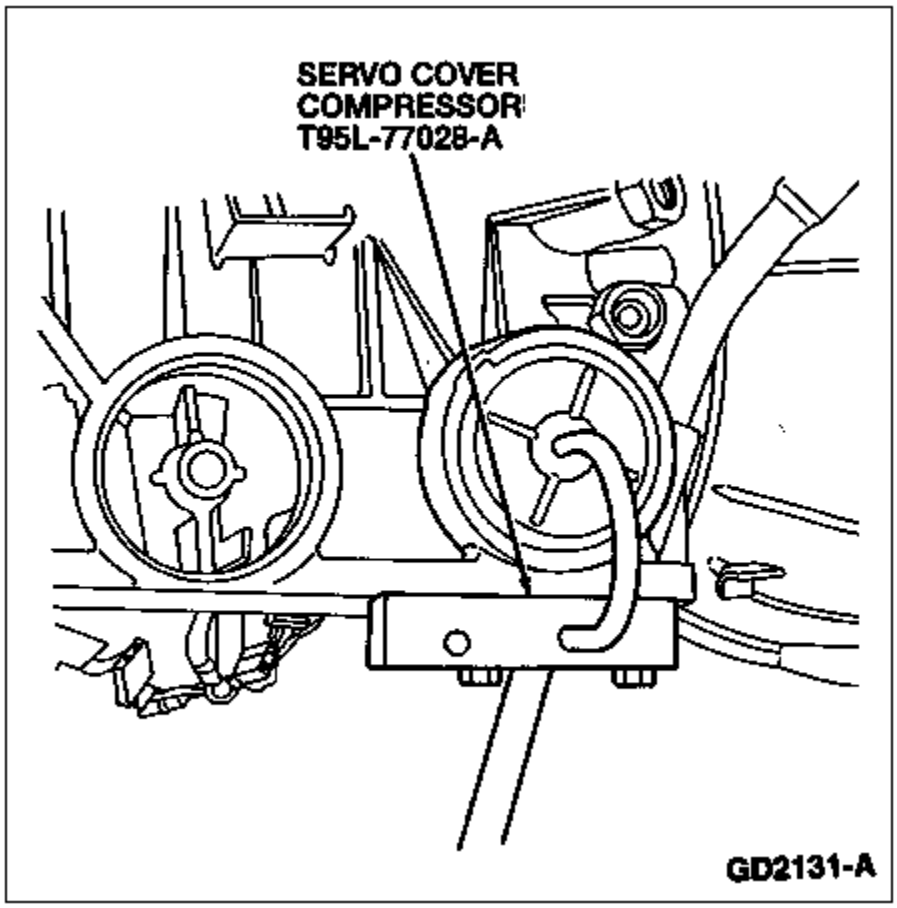

12. Carefully remove the servo cover retaining ring.

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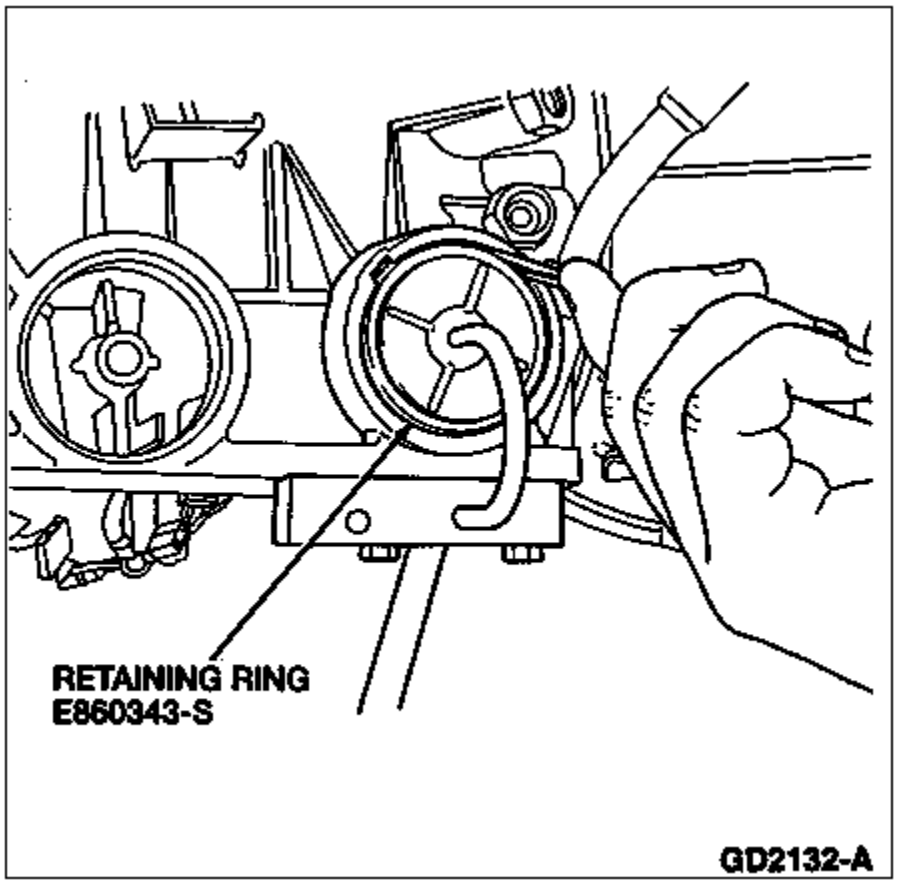
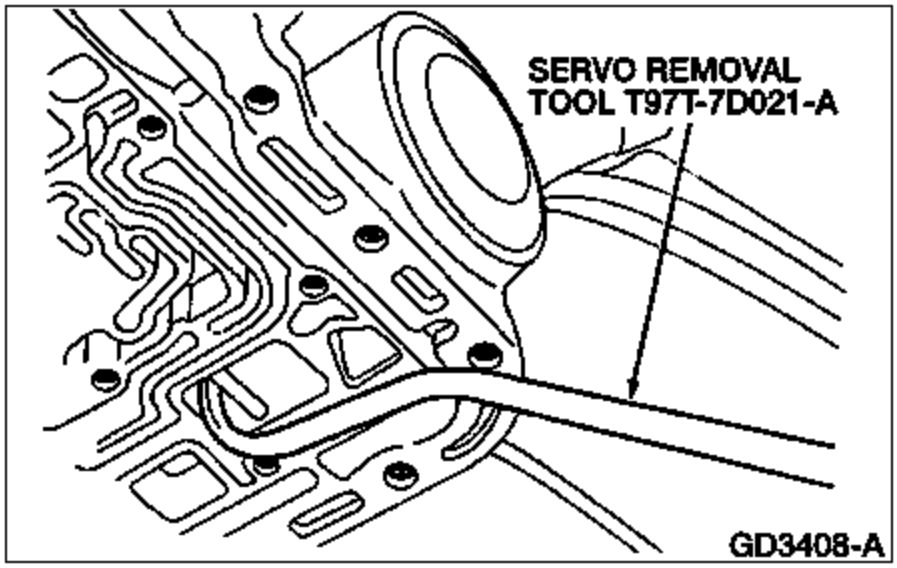


13. **CAUTION: The servo cover is under spring tension.**

    Carefully back off the nut on the J-hook until the servo spring is unloaded.

14. Insert Servo Removal Tool T97T-7D021-A into case and locate on servo rod.



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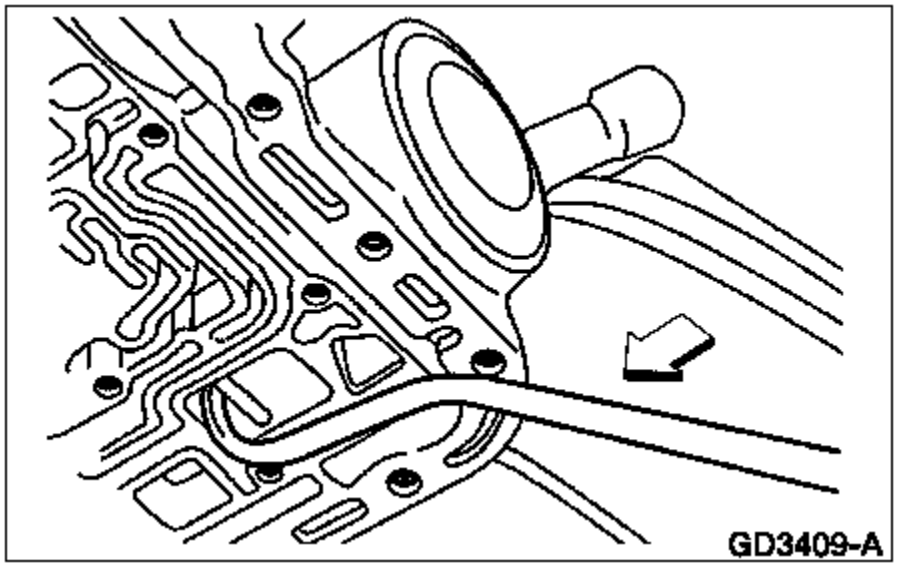
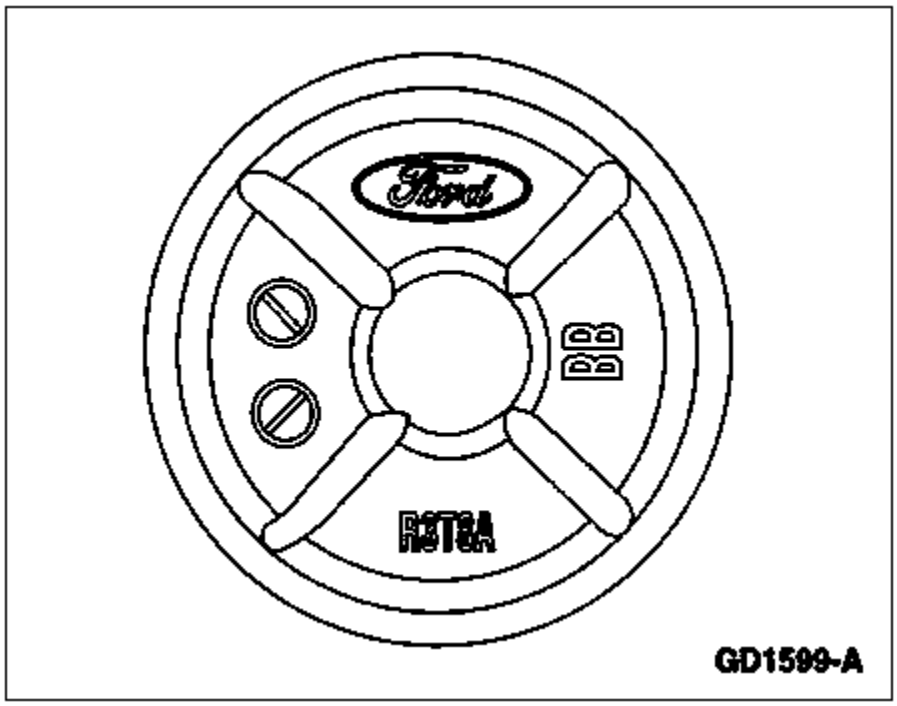
15. Gently push on Servo Removal Tool T97T-7D021-A to remove front servo cover, piston and spring.



16. **NOTE: Tag the spring, piston and cover assembly. Label accordingly for assembly. The covers have letters cast on the outer surface for identification.**

    Remove the overdrive servo cover, piston and spring.



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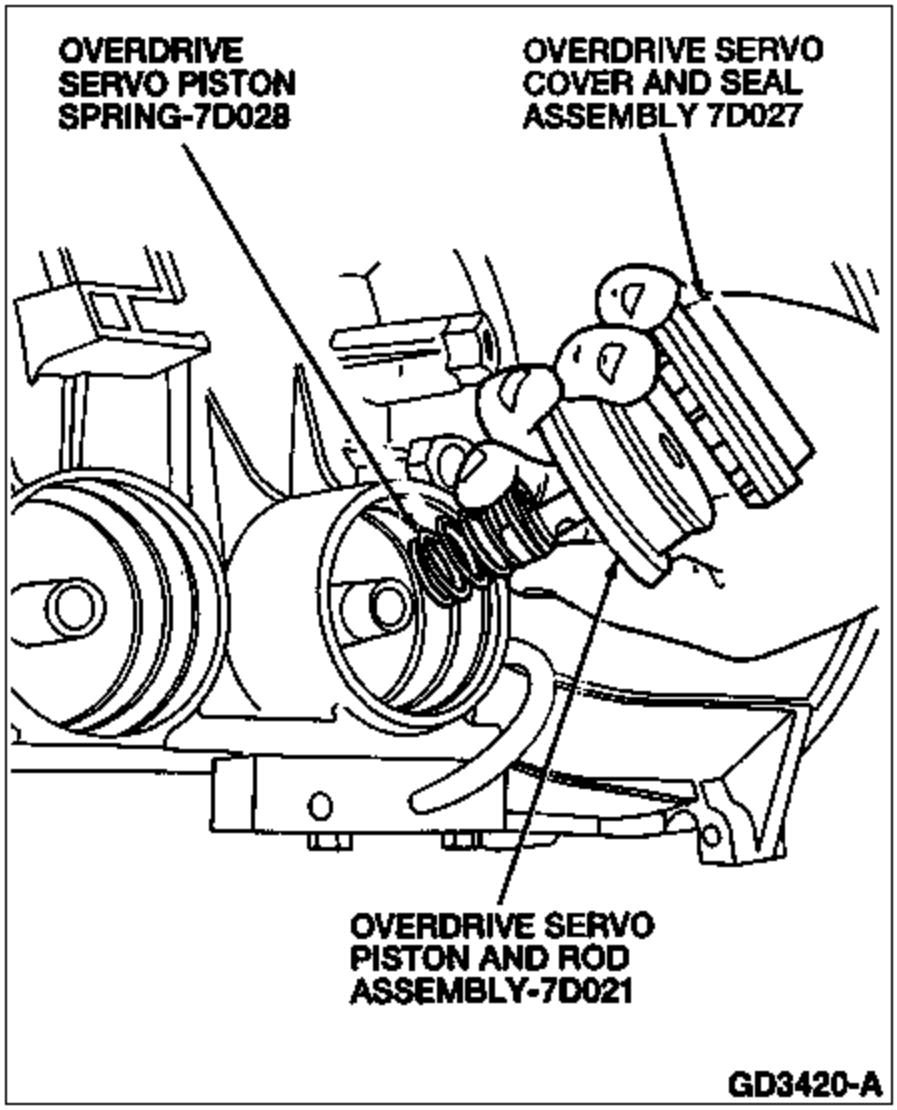

17. Remove Servo Cover Compressor T95L-77028-A.

18. Service as required.

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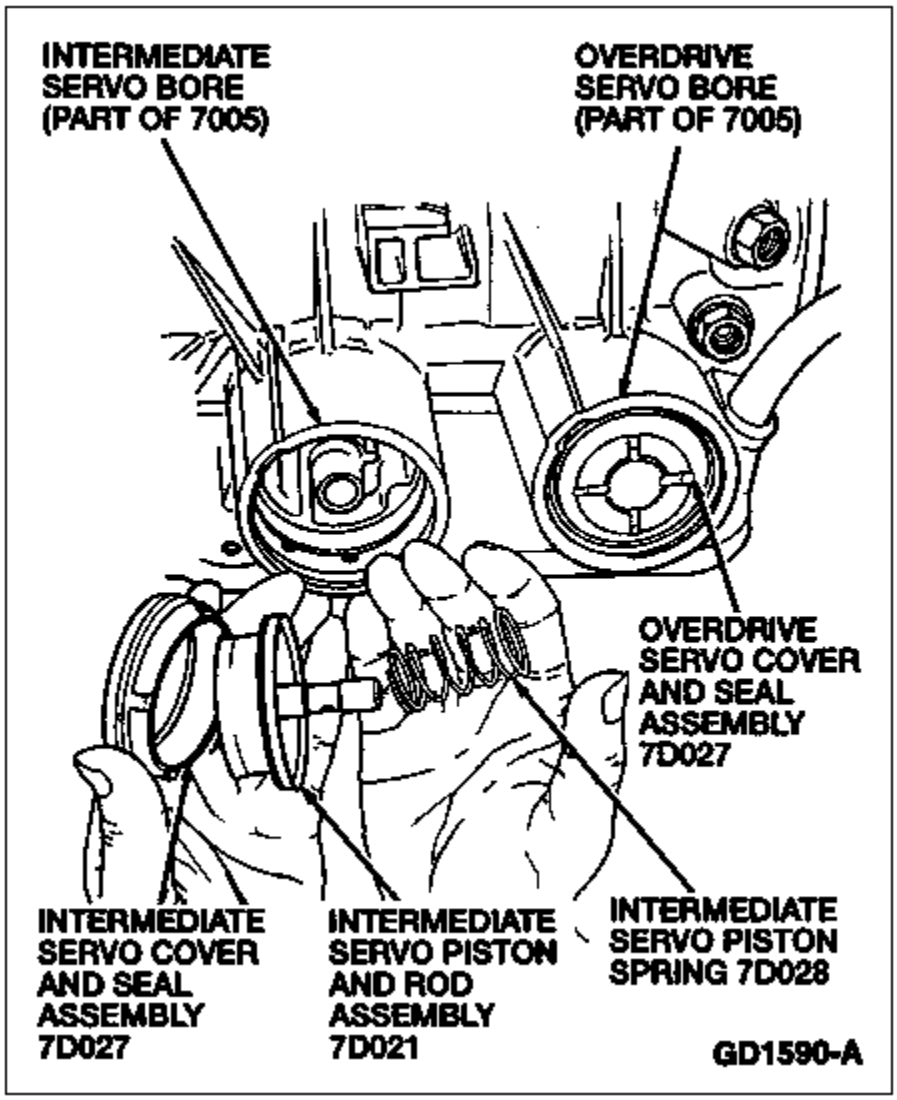

Installation

1. **CAUTION: Do not damage O-ring during installation. Do not press servo cover and O-ring past relief hole in case, or O-ring damage may occur.**

   Install servo assembly.

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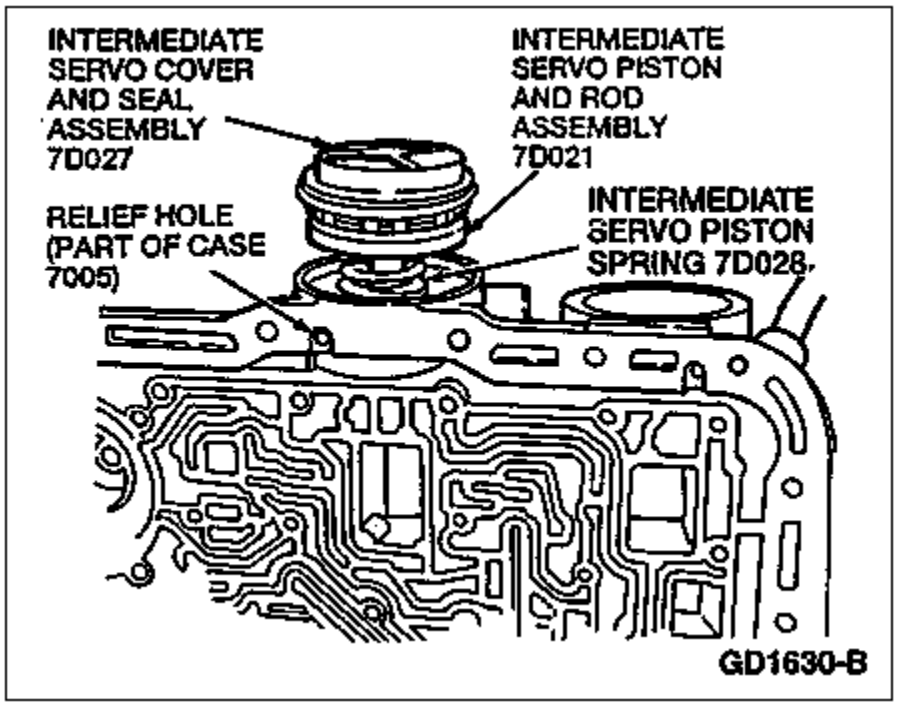

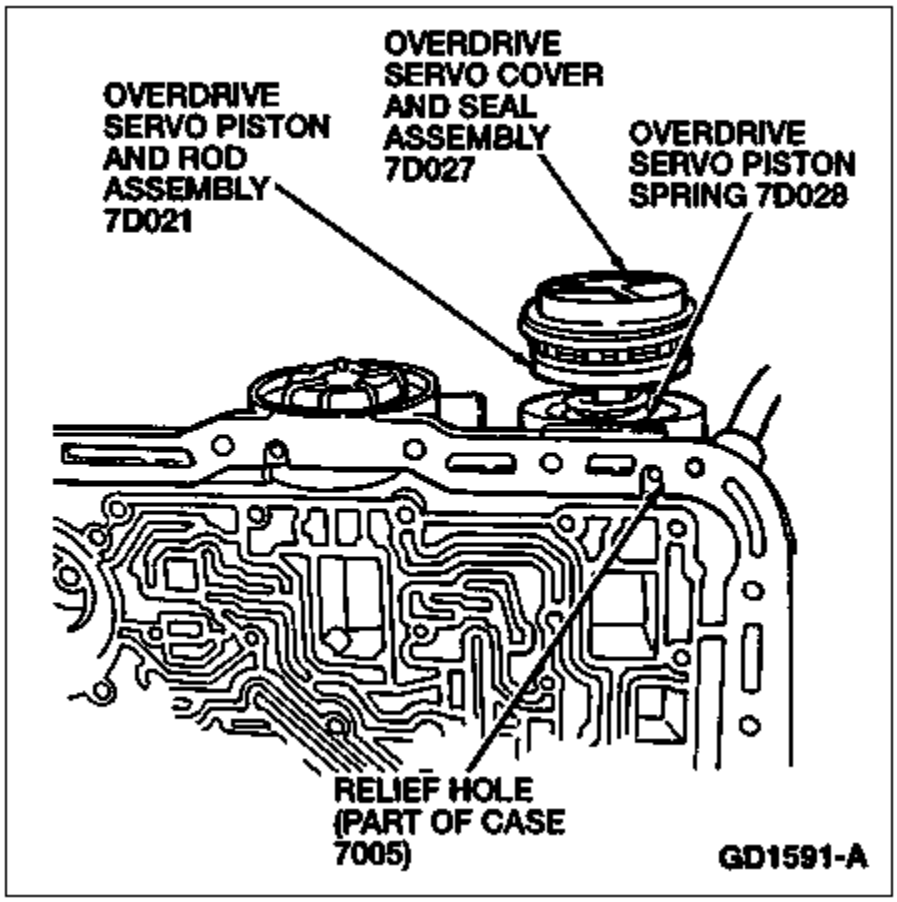

2. Carefully compress servo cover and install retaining ring.

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3. Install heat shield, if equipped.
4. Install catalytic converter if removed.

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Band Adjustments

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Band Adjustment Torque Wrench Set	T71P-77370-A

1. **CAUTION: Do not allow adjustment screw to back out. Band strut could fall in transmission assembly.**

   CAUTION: Throw the locknuts away. The locknuts are not reusable for assembly.

   Remove the overdrive and intermediate band locknuts and discard, then back off the band adjusting screws.

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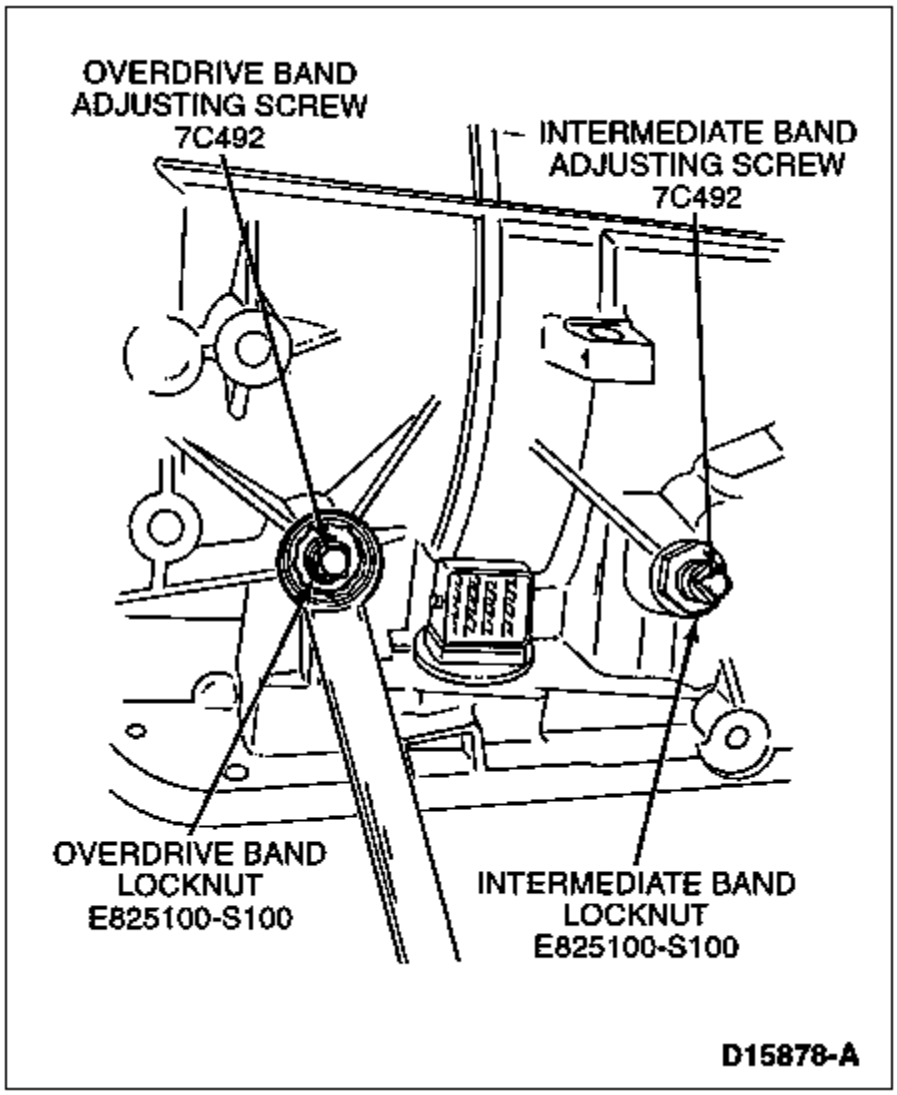

2. **CAUTION: Install, but do not tighten, a new locknut on the band adjusting screw. Apply petroleum jelly to the locknut seal.**

CAUTION: Servos must be installed prior to band adjustment.

Install two new locknuts. Tighten the band adjusting screws using Band Adjustment Torque Wrench Set T71P-77370-A. The wrench will click at 14 Nm (10 lb-ft). Back off the band adjusting screw exactly two and one-half (2 1/2) turns for the intermediate band and two turns for the overdrive band and hold that position. Tighten the overdrive and intermediate band locknut-to-case adjusting screws to 47-61 Nm (35-45 lb-ft) using a 19 mm wrench.

Intermediate Band Adjustment

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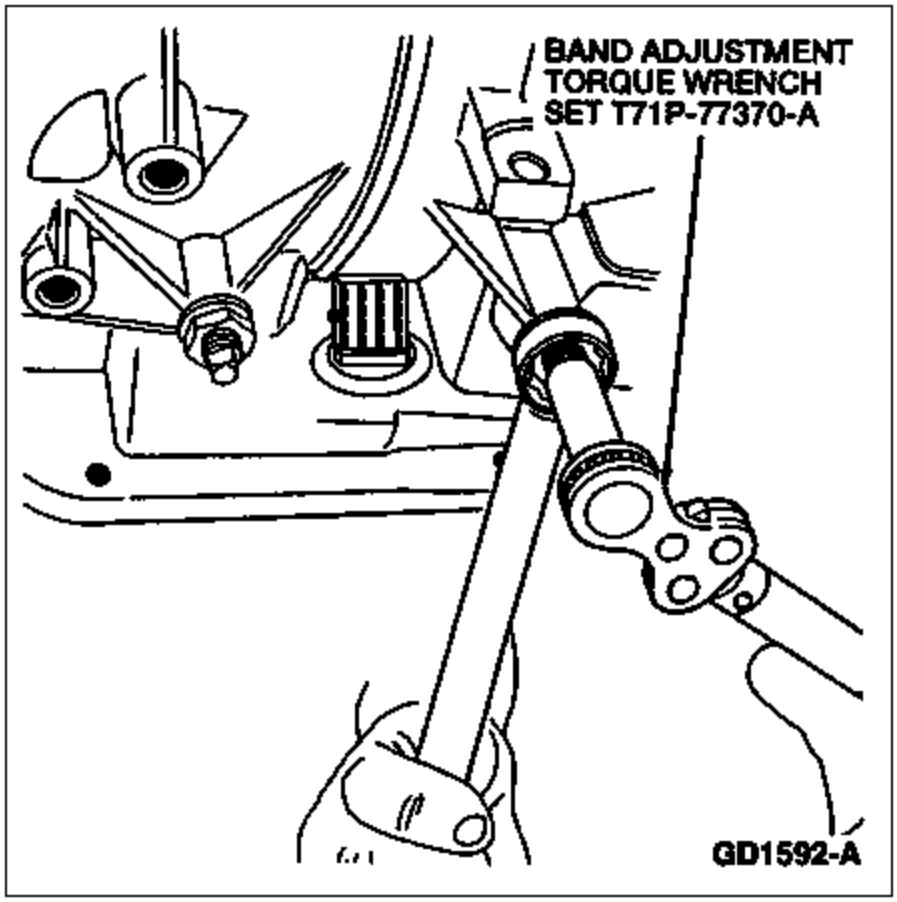
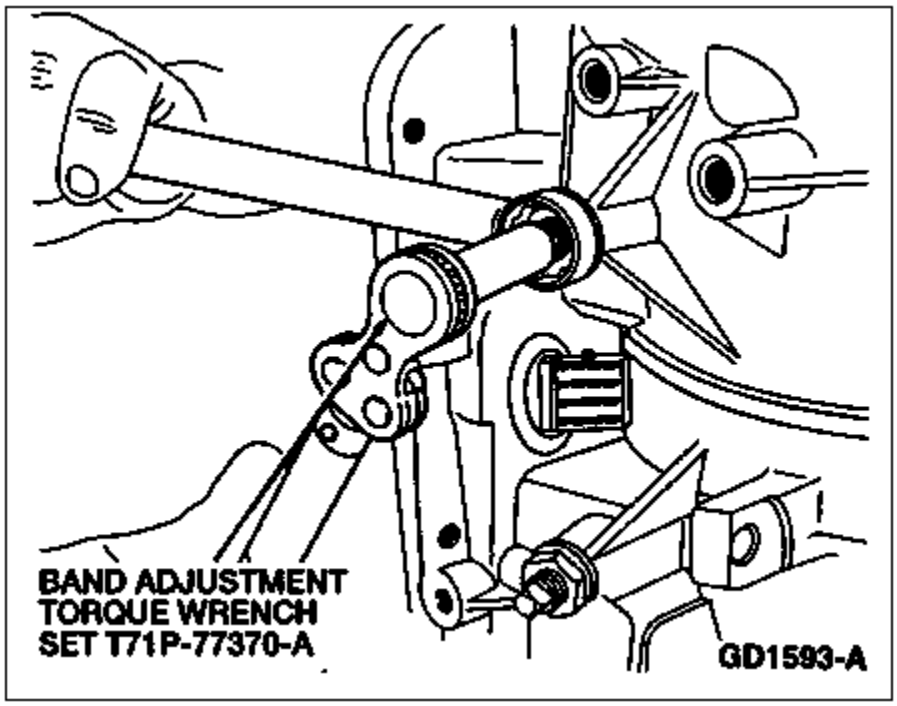


Overdrive Band Adjustment



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Transmission — 4x2 Aerostar

1. Disconnect the negative battery cable. Remove the transmission fluid level indicator.
2. Raise the vehicle and position safety stands under the vehicle.
3. Mark the relationship of the driveshaft centering flange and the rear axle companion flange.
4. Remove the four bolts retaining the driveshaft centering flange to the rear axle companion flange and disconnect the driveshaft from the rear axle. Remove the driveshaft from the vehicle.
5. Install a transmission plug in the output shaft seal.
6. Remove the transmission pan bolts and drain the transmission. Install the transmission pan, using the original gasket.
7. Disconnect the shift cable from the shift lever and from the shift cable bracket.
8. **NOTE: Note the position of the ground cable at the starter bolt for installation.**

   Remove three starter motor bolts and position the starter aside, using mechanics wire.
9. Remove two transmission access cover bolts and the access cover from the converter housing.
10. **NOTE: Mark and index one converter stud to the flexplate. The flexplate-to-converter nuts are not reuseable.**

    Rotate the torque converter and remove four converter-to-flexplate nuts. Discard the nuts.
11. **NOTE: The transmission harness is removed from the transmission after the transmission is removed.**

    Disconnect the 8-pin and 16-pin connectors (for transmission sensors) at the left rear cylinder head. Disconnect the rear HO2S connector at the rear extension housing. Disconnect the right HO2S connector.
12. Remove two transmission mount nuts.
13. Support the engine.
14. Place Rotunda E4OD Transmission Jack Adapter 014-00763 or equivalent on the Transmission Jack 014-00942. Raise and secure the adapter to the transmission. Secure a safety strap to the transmission.
15. Remove the left and right crossmember bolts and nuts. Remove the crossmember. Remove the exhaust hanger bolt.
16. Remove the left and right bolts retaining the Three Way Catalytic (TWC) converters to the exhaust manifolds. Position the exhaust aside using mechanics wire.

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17. **NOTE: The case connector fittings must be held in place to prevent them from moving while loosening the tube nuts.**

    Remove the transmission fluid cooler lines from the transmission case. Cap the transmission lines and plug the fittings at the transmission.

18. Slightly lower the transmission and remove six transmission-to-engine bolts.

19. **CAUTION: Make sure the torque converter separates from the flexplate, remains seated in the transmission, and does not tip forward (so it will not fall out while lowering the transmission).**

    Separate transmission from the engine and flexplate. While carefully lowering the transmission and watching for obstructions, disconnect the fill tube.

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Transmission — 4x2 Ranger

Removal

1. Disconnect the negative battery cable and remove the transmission fluid level indicator.
2. Remove two bolts retaining the fan shroud to the radiator.
3. Raise the vehicle and position suitable jack stands under the vehicle.
4. Mark the relationship of the driveshaft flange and the rear axle companion flange, so the driveshaft can be installed in the original position.
5. Remove two bolts and clips retaining the mid-ship bearing to the rear crossmember. Remove four bolts retaining the driveshaft flange to the rear axle companion flange. Disconnect and remove the driveshaft from the vehicle and install a plug into the extension housing.
6. Position a drain pan, remove the transmission pan bolts, and drain the fluid. Install the transmission pan, with the original gasket. Remove the drain pan.
7. Disconnect the shift cable from the transmission manual control lever and remove the cable from the cable bracket.
8. Remove the oil filter drain funnel retainers. Remove three starter motor bolts and position the starter aside, using mechanics wire. Remove the funnel.
9. Remove two torque converter access cover bolts and the access cover from the converter housing.
10. **NOTE: Mark the converter stud to the flexplate. The flexplate-to-converter nuts are not reusable.**

    Rotate the torque converter and remove four converter-to-flexplate nuts. Discard the nuts.
11. Support the engine.
12. Install a transmission jack under the transmission. Secure the transmission to the jack.
13. Remove the transmission mount nuts. Remove the left and right crossmember bolts and nuts. Remove the crossmember.
14. Disconnect three HO2S connectors from the catalytic converter assembly.
15. Remove the bolts retaining the Y-pipe to the exhaust manifolds. Remove the converter-to-tailpipe retainers. Secure the tailpipe. Remove the converter hanger bolt and the converter assembly.
16. **NOTE: The case connector fittings must be held in place while loosening the tube nuts from the cooler lines.**

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Slightly lower the transmission. Remove the bolt retaining the cooler lines to the right side of the engine block. Disconnect the transmission fluid cooler lines. Cap the cooler lines and plug the fittings at the transmission.

17. Disconnect both transmission 16-pin connectors at the left rear cylinder head. Remove the transmission-to-engine bolts. Remove the fluid level indicator tube.

18. **CAUTION: Make sure the torque converter separates from the flexplate and remains seated in the transmission. Do not allow the transmission to tip forward, as the converter could fall out while lowering the transmission.**

    Separate the transmission from the engine and carefully lower the transmission from the vehicle.

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Transmission

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Torque Converter Handles	T81P-7902-C
Impact Slide Hammer	T50T-100-A
Extension Housing Bushing Remover	T77L-7697-E
A4LD Holding Fixture Adapter	T93T-77002-AH
Bench-Mounted Holding Fixture	T57L-500-B
Servo Cover Compressor	T95L-77028-A
4R44E/4R55E Transmission Test Plate	T95L-77000-AH
Servo Removal Tool	T97T-7D021-A

SPECIAL SERVICE TOOLS DESIRED

Tool Number	Description
T94P-77001-BH	Seal Remover

Disassembly

1. **WARNING: DO NOT REMOVE THE TORQUE CONVERTER OR TRANSFER CASE FROM THE TRANSMISSION WHILE STILL ON THE JACK. DOING SO COULD CAUSE THE TRANSMISSION TO FALL OFF THE JACK.**

   Relocate the transmission to the top of a flat workbench.

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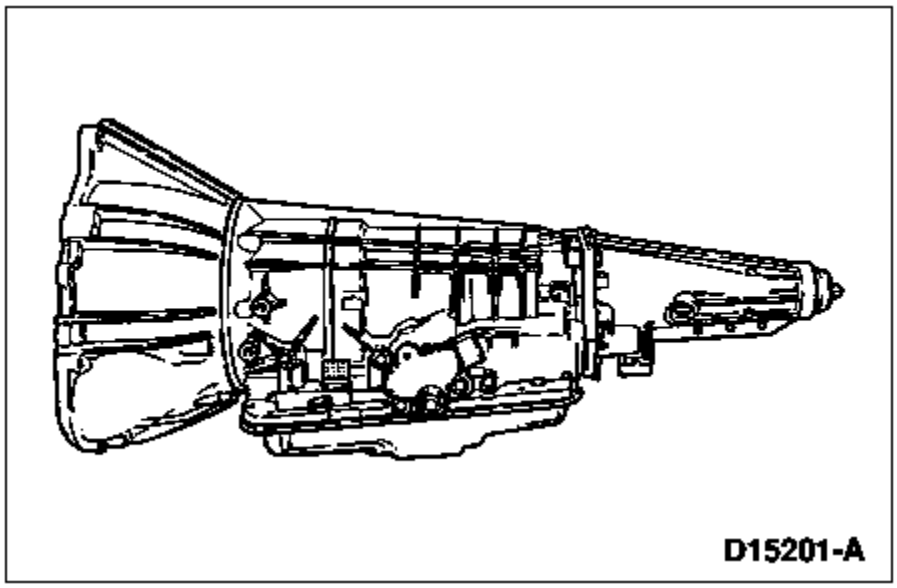
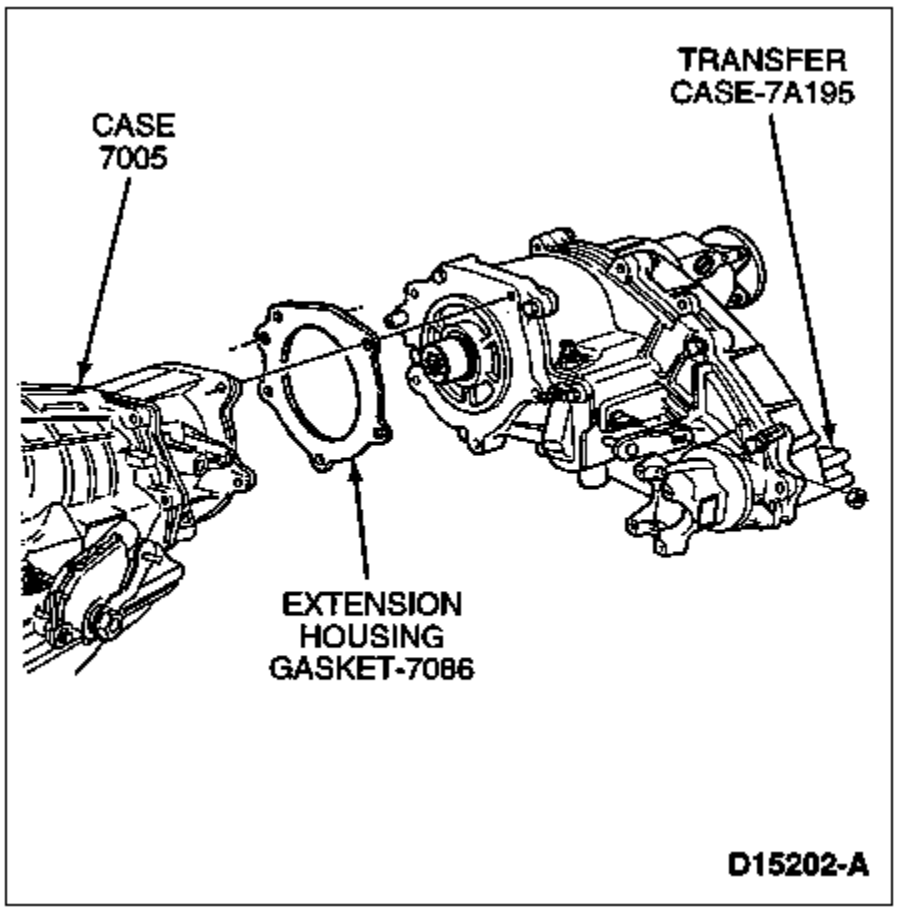


2. **NOTE: Refer to Section 07-07A , Section 07-07B , Section 07-07C or Section 07-07D for transfer case service.**

   If the vehicle has a transfer case, use a 13 mm socket to remove the five transfer case-to-extension housing screws. Remove the transfer case and set aside for assembly.



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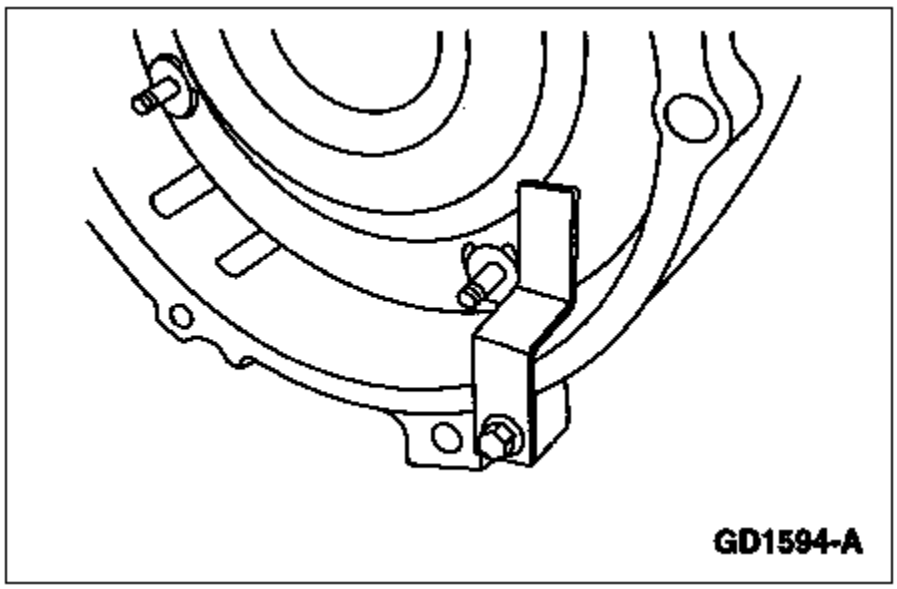
3. Remove Torque Converter Holding Tool T97T-7902-A from transmission.



4. **WARNING: THE TORQUE CONVERTER IS HEAVY, ESPECIALLY WHEN FULL OF FLUID.**

   Remove the torque converter using Torque Converter Handles T81P-7902-C.

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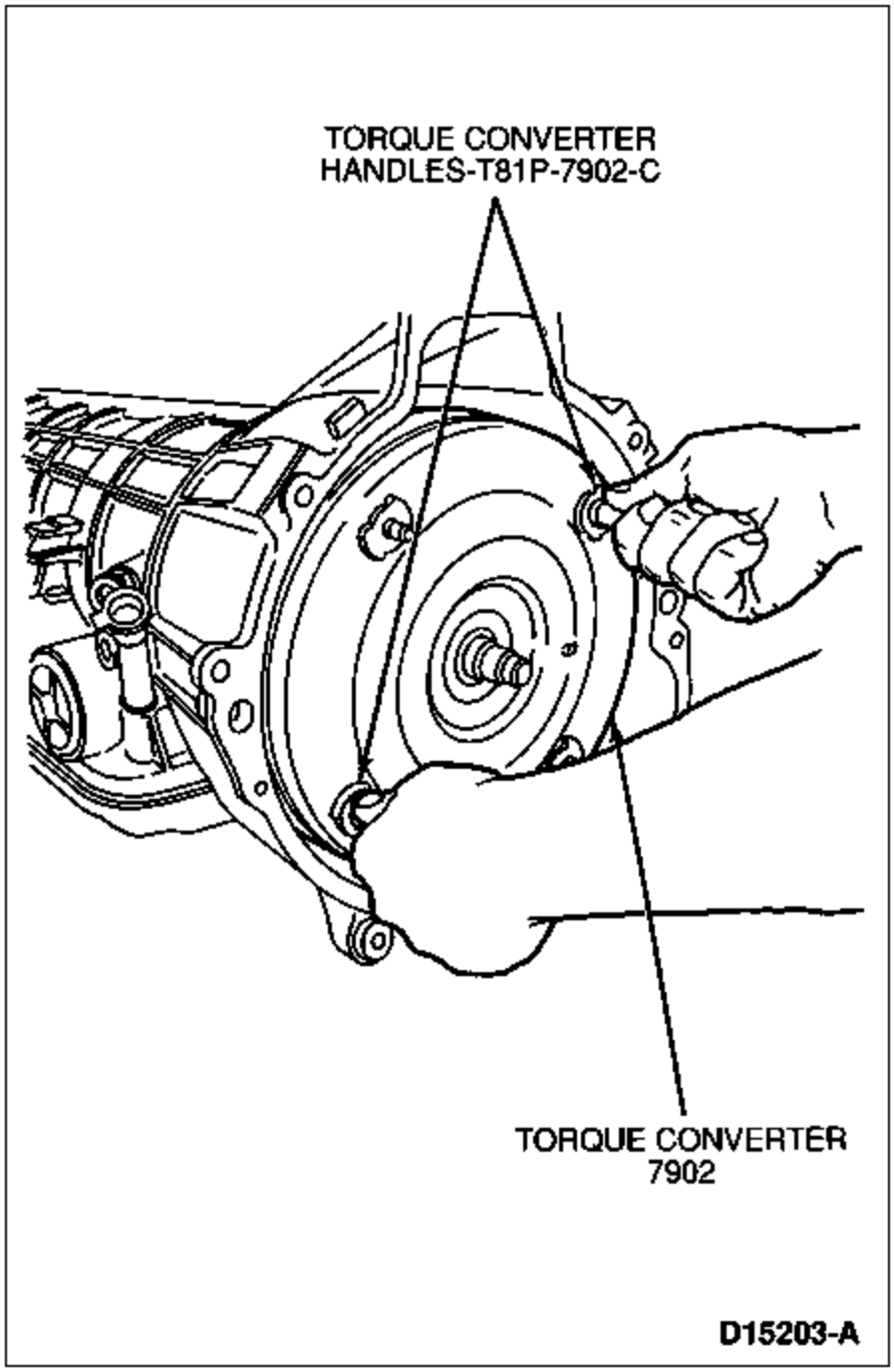

5. **NOTE: The splines on the input shaft are not the same on both ends. The end with the shorter spline goes into the assembly.**

   Remove the input shaft.

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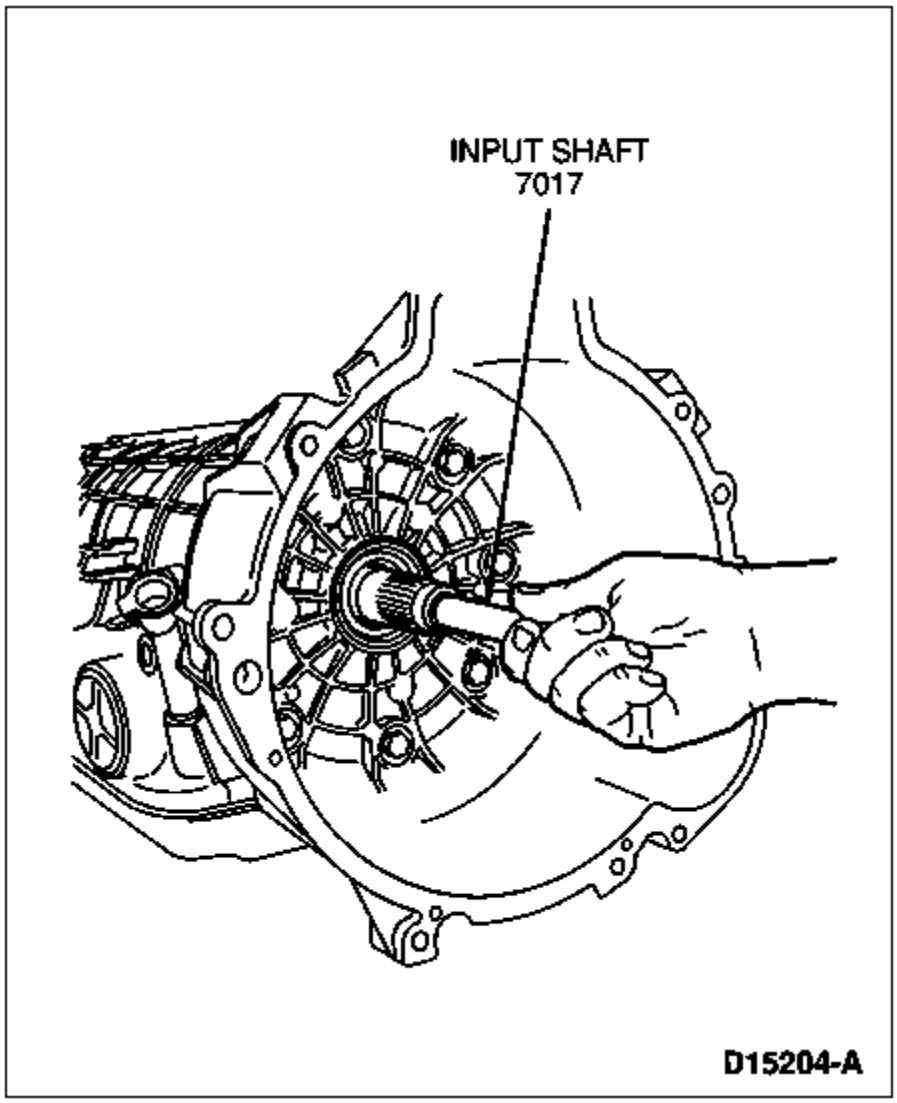

6. Remove the manual control outer lever nut and manual control outer lever.

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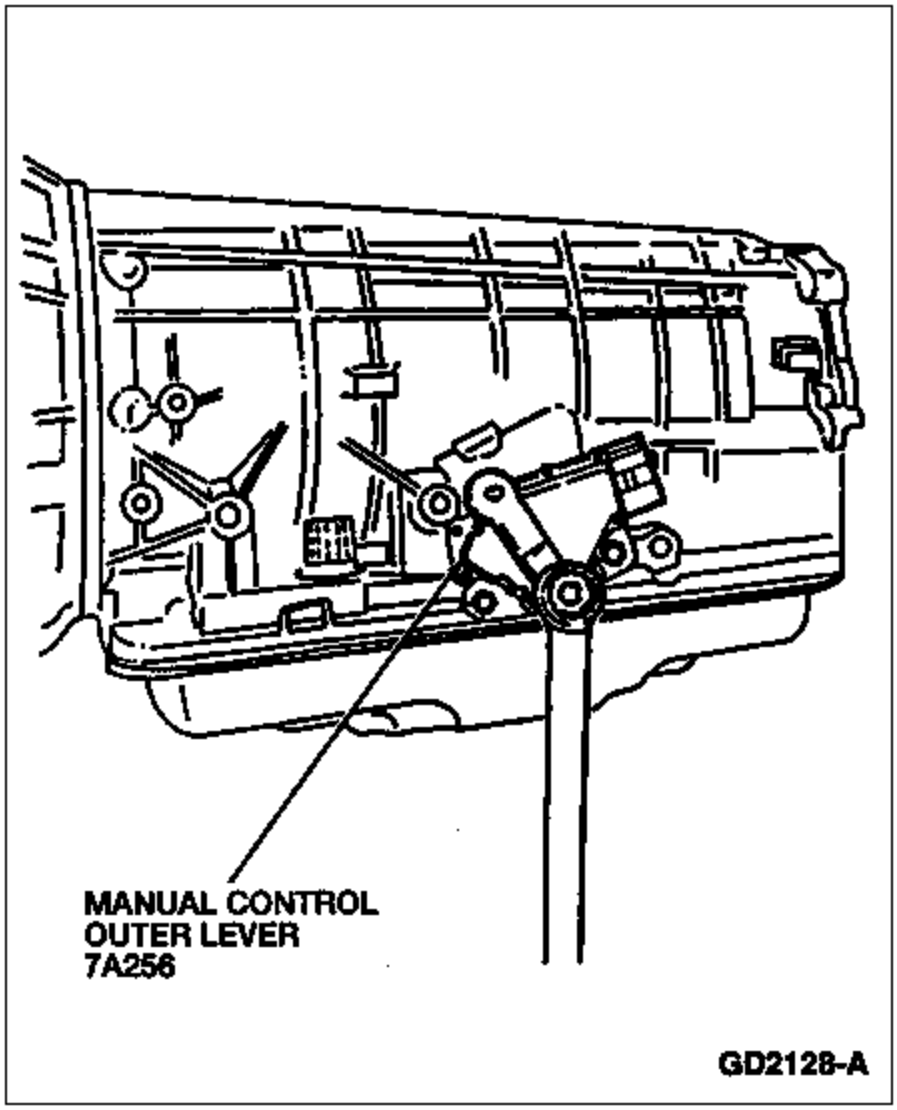

7. Remove the two M6 x 25 digital transmission range (DTR) sensor screws and remove the DTR sensor.

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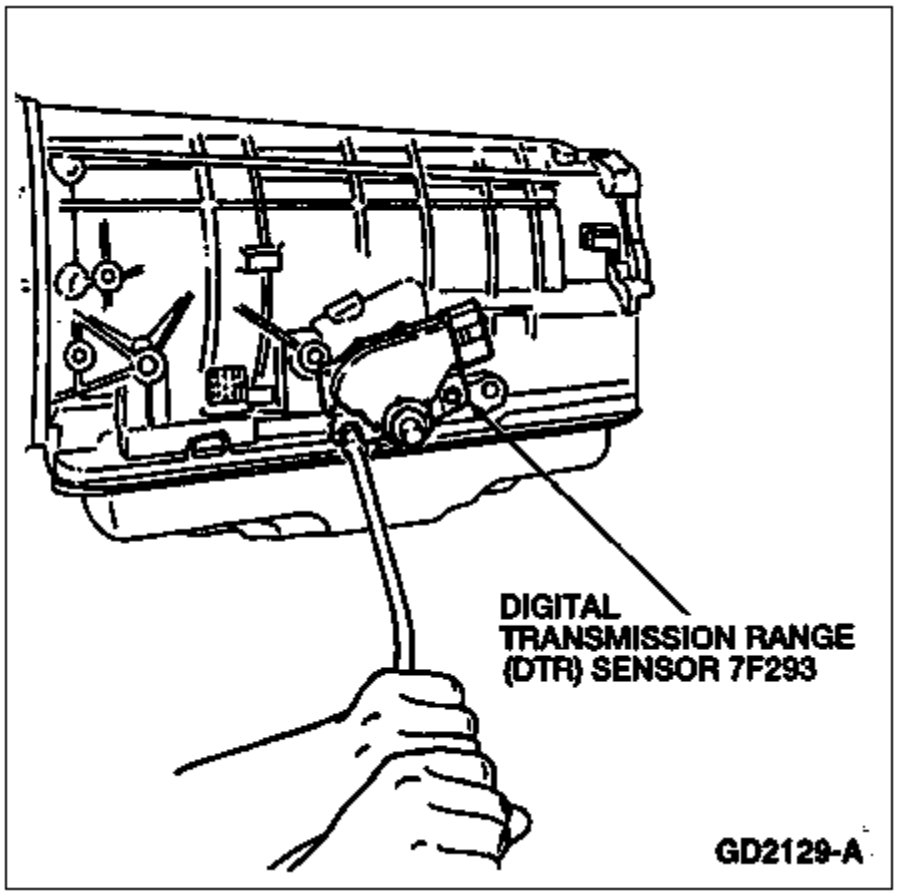
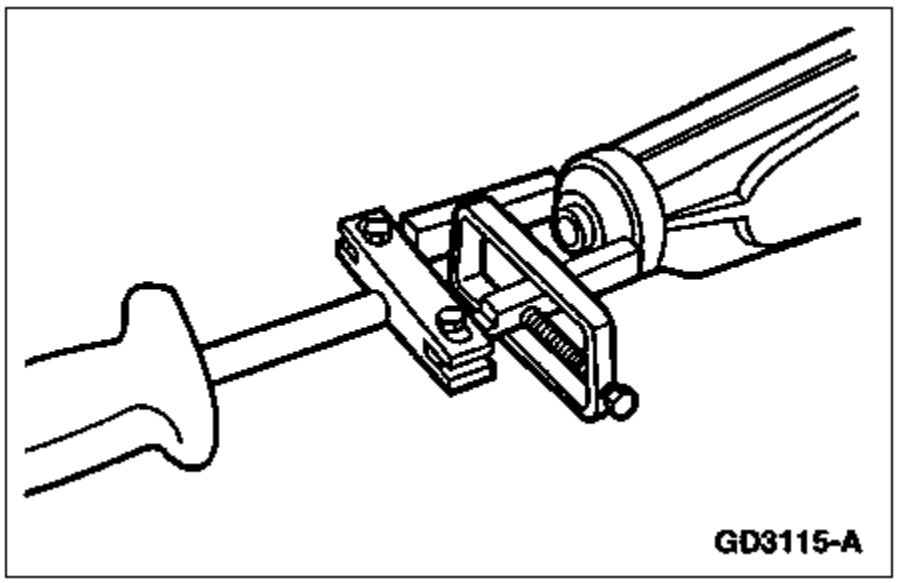


8. Remove the extension housing seal using Seal Remover T94P-77001-BH and Impact Slide Hammer T50T-100-A.



9. **NOTE: Remove the extension housing bushing only if service is required.**

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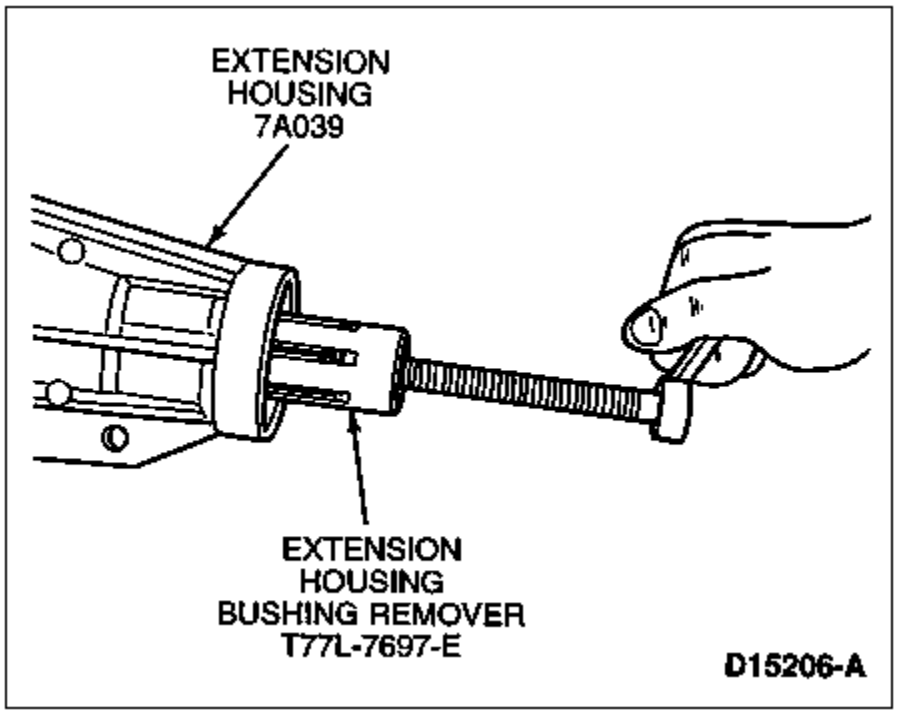
Inspect the extension housing bushing and driveshaft slip-yoke for nicks, gouges, scoring and wear.

Remove the extension housing bushing using Extension Housing Bushing Remover T77L-7697-E.



10. **CAUTION: The parking pawl, parking pawl return spring and parking pawl shaft could fall out during removal of the extension housing.**

    Use a 17 mm socket to remove the five M10 x 30 mm extension housing-to-transmission case screws and one (1) stud.

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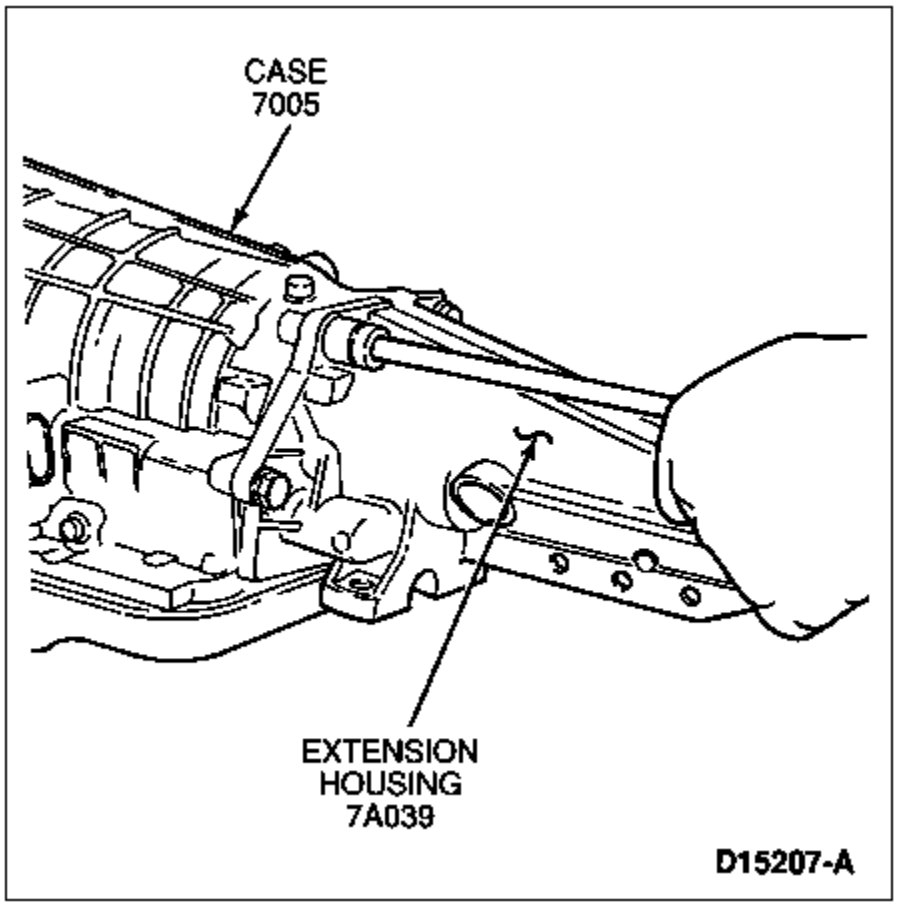

11. Remove the parking pawl, parking pawl return spring and parking pawl shaft.

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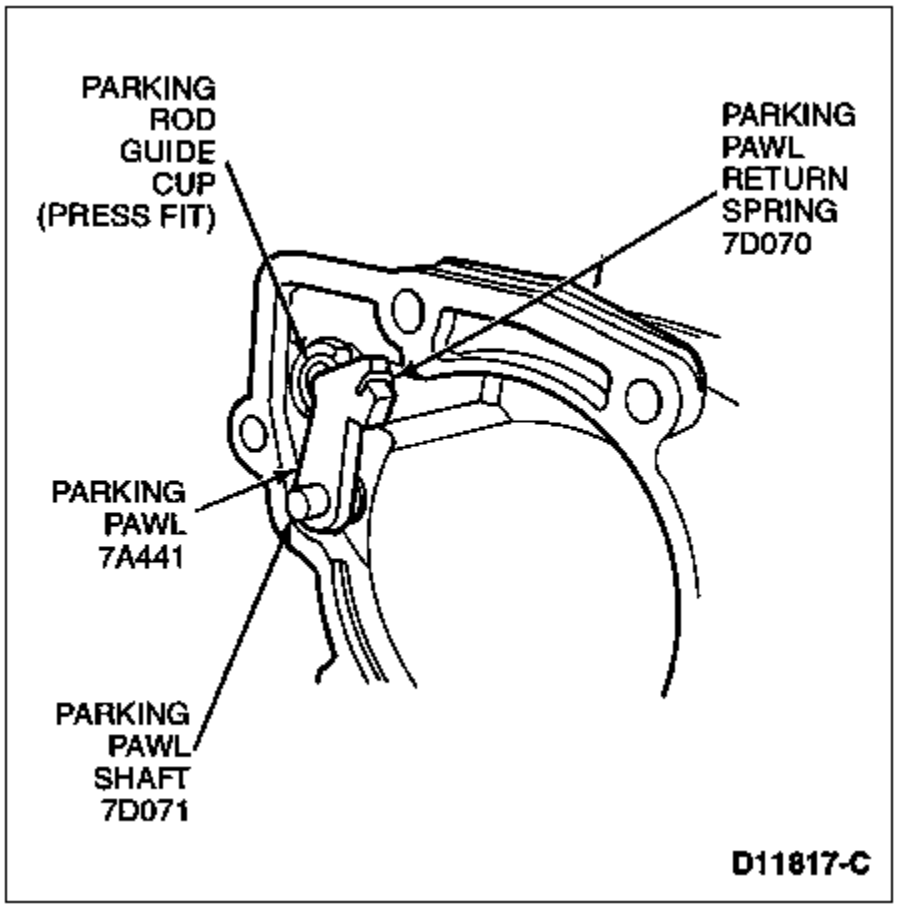

12. **CAUTION: The parking pawl actuating rod must slip freely into the clearance hole in the adapter plate.**

    NOTE: See the special service tool section for a drawing of this optional adapter plate.

    Use four M10 x 30 mm extension housing to transmission case screws to attach the adapter plate to the transmission.

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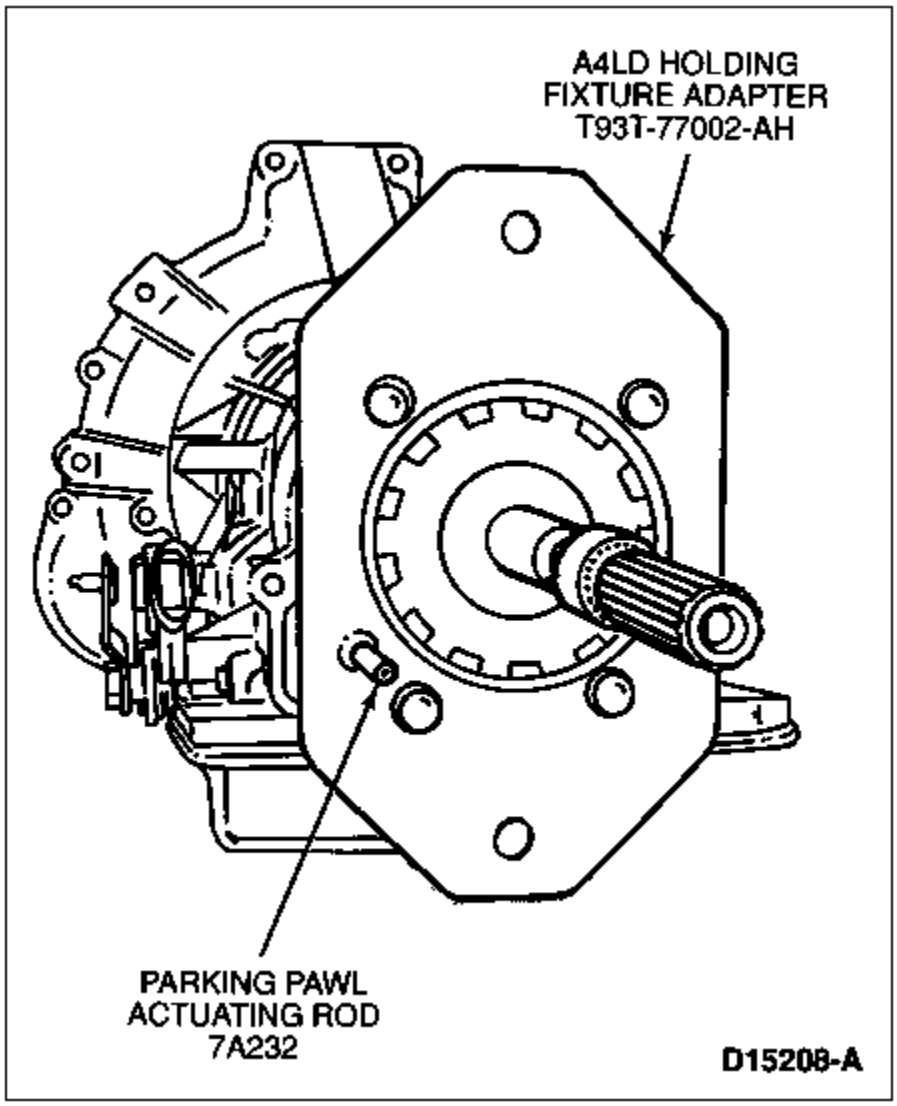

13. Attach the fixture arm assembly (part of T57L-500-B) with two 7/16 x 2-inch bolts and nuts.

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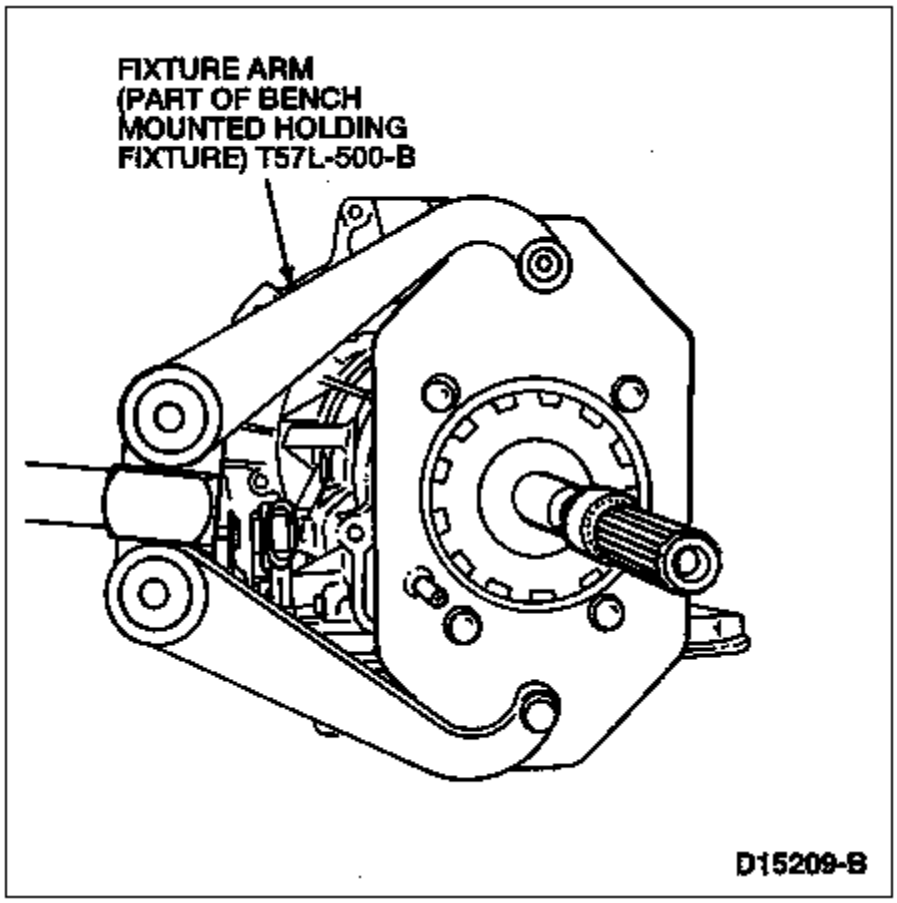

14. **WARNING: MAKE SURE THE LOCK PIN ON BENCH-MOUNTED HOLDING FIXTURE T57L-500-B IS SECURE.**

    Install the transmission assembly to Bench-Mounted Holding Fixture T57L-500-B. Rotate to the position shown. Place a drain pan under the assembly.

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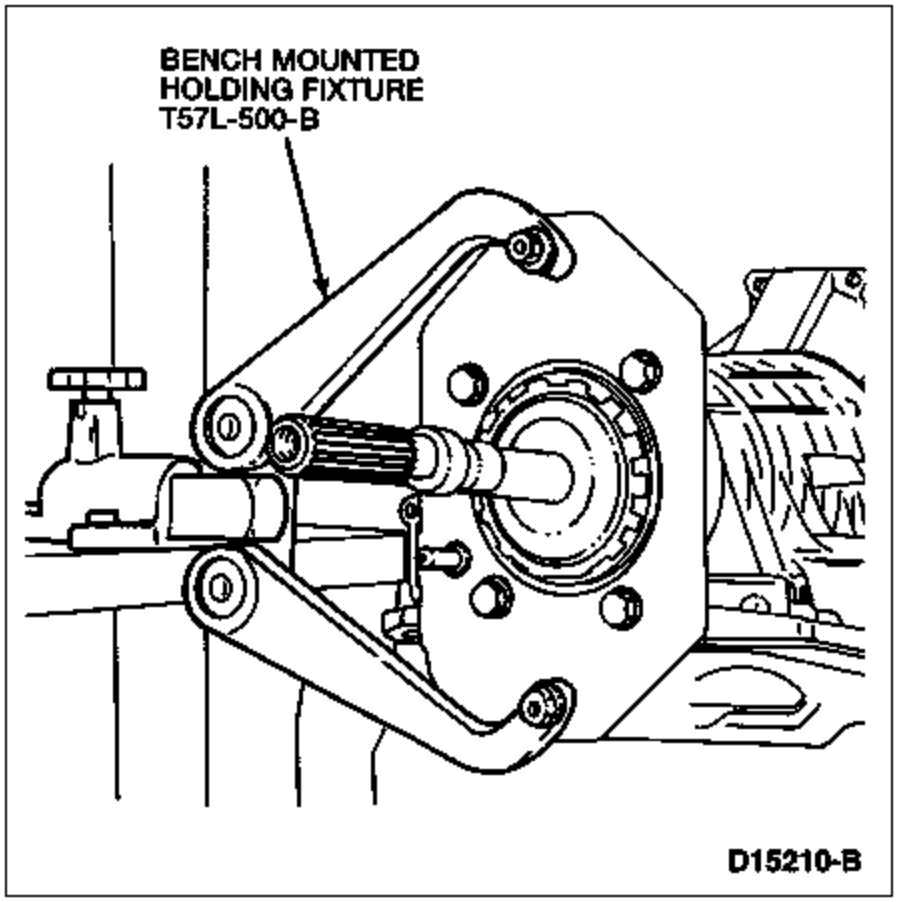

15. **WARNING: MAKE SURE THE LOCK PIN ON BENCH-MOUNTED HOLDING FIXTURE T57L-500-B IS SECURE.**

    Rotate transmission assembly so that the fluid pan is facing up.

16. **CAUTION: Do not reuse the fluid pan gasket.**

    Use a 13 mm socket to remove the eighteen M8 x 16 mm fluid pan screws. Remove the fluid pan and fluid pan gasket. Discard the fluid pan gasket.

Fluid Pan Removal

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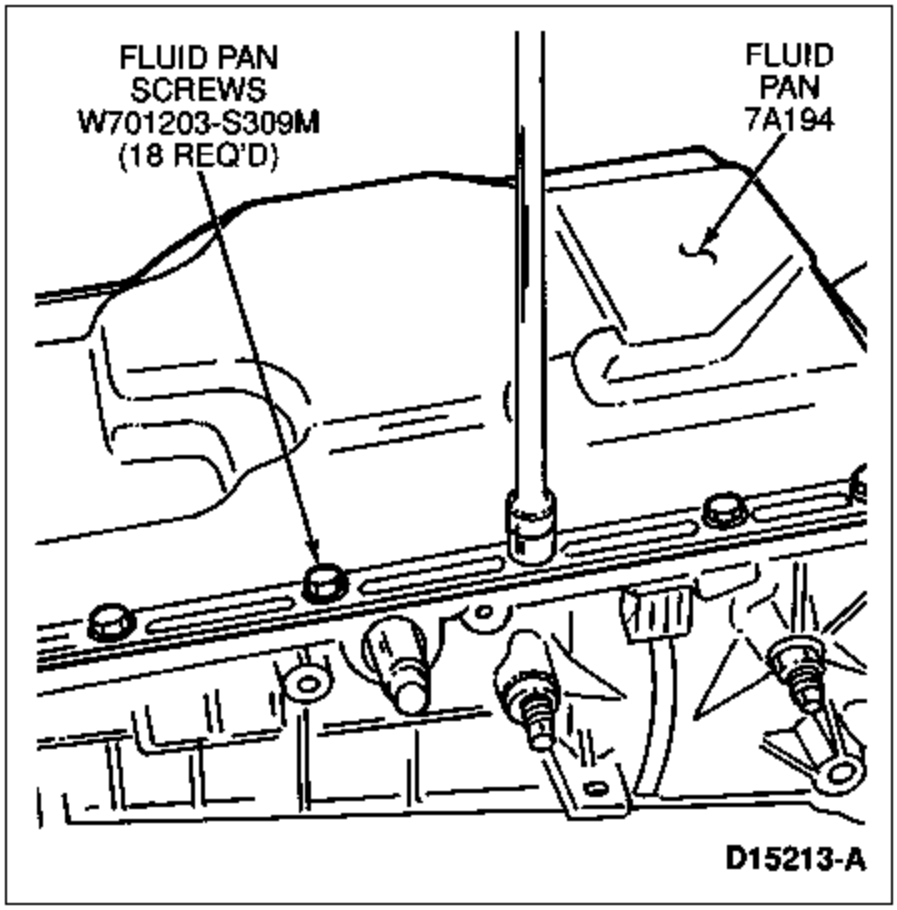

17. Use a 10 mm socket to remove the M6 x 55 mm fluid pan filter assembly screw. Remove and discard the fluid pan filter assembly.

Fluid Pan Filter Removal

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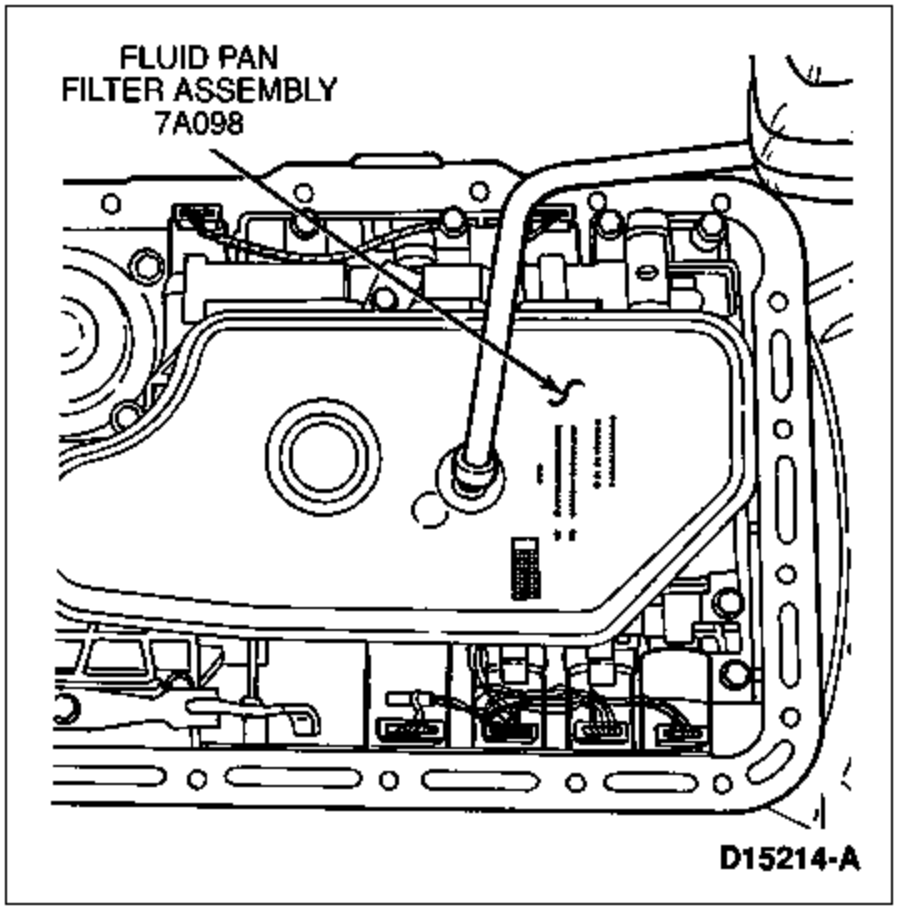

18. Carefully lift up on the wire loom guide and protector. Disengage the retaining pins from the solenoid clamps.

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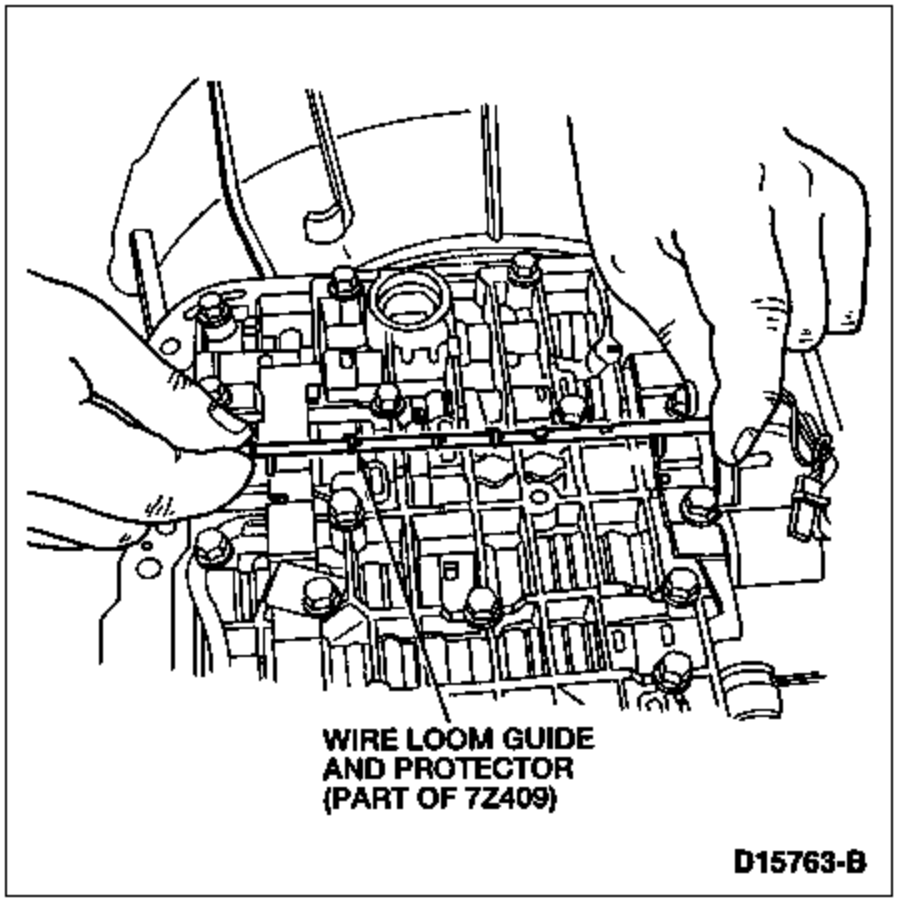

19. Disconnect the six solenoid connectors from the solenoids by carefully pulling upward and wiggling side to side.

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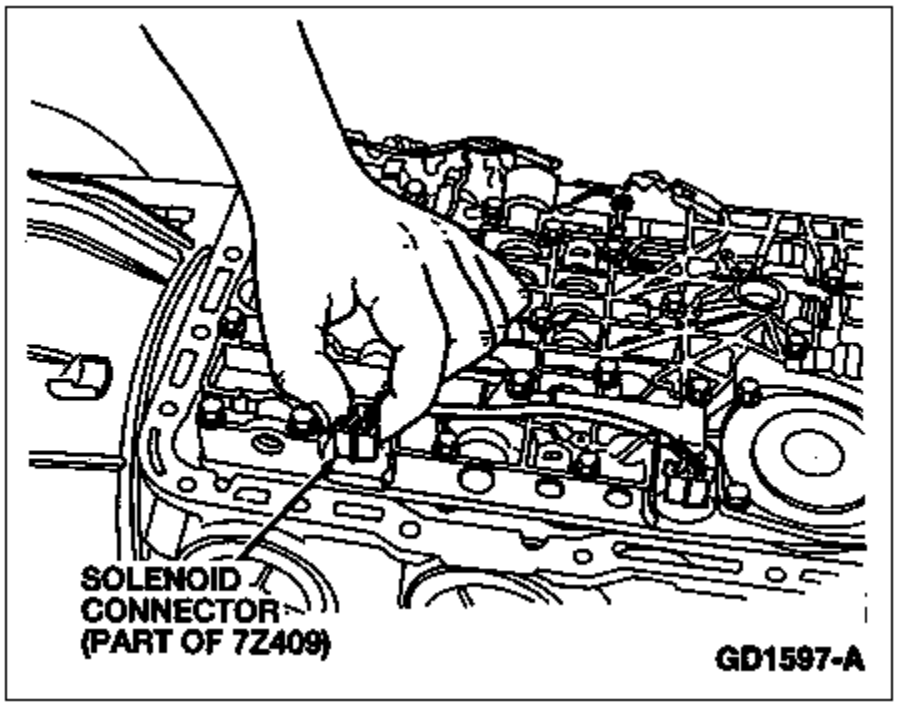

20. Use a 10 mm socket to remove the M6 x 30 mm manual valve detent spring screw. Remove the manual valve detent spring.

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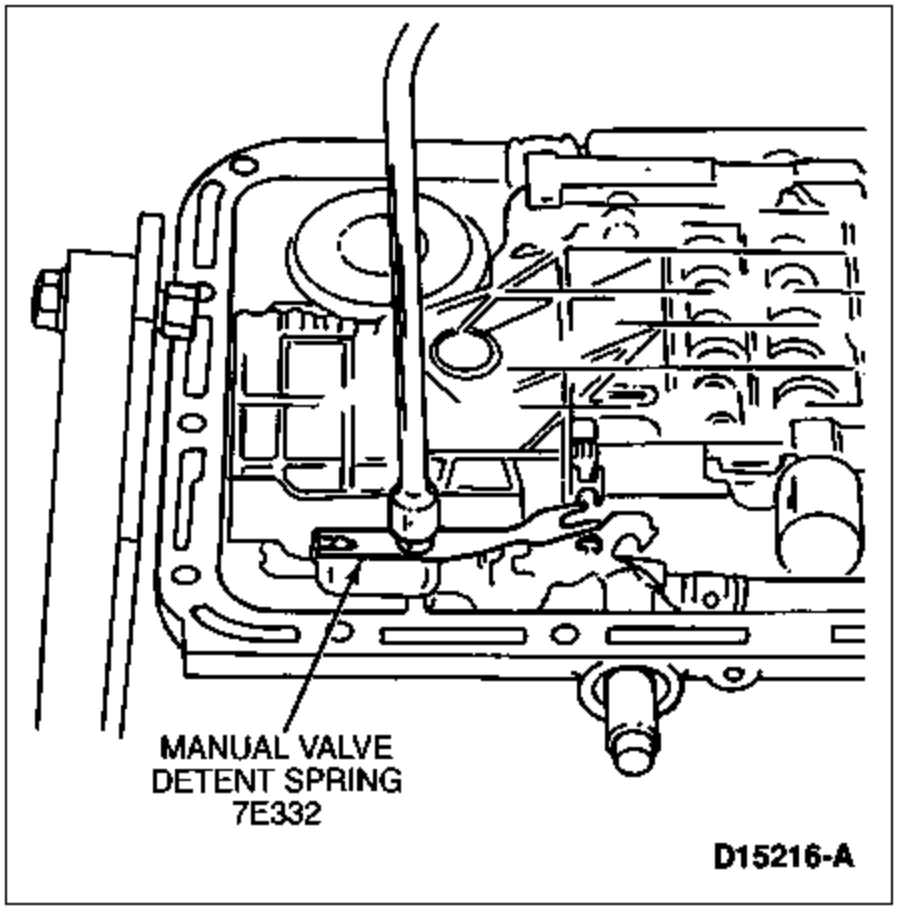

21. Use a 10 mm socket to remove the four M6 x 20 mm reverse servo cover screws. Remove the low/reverse servo cover, gasket and piston and rod assembly.

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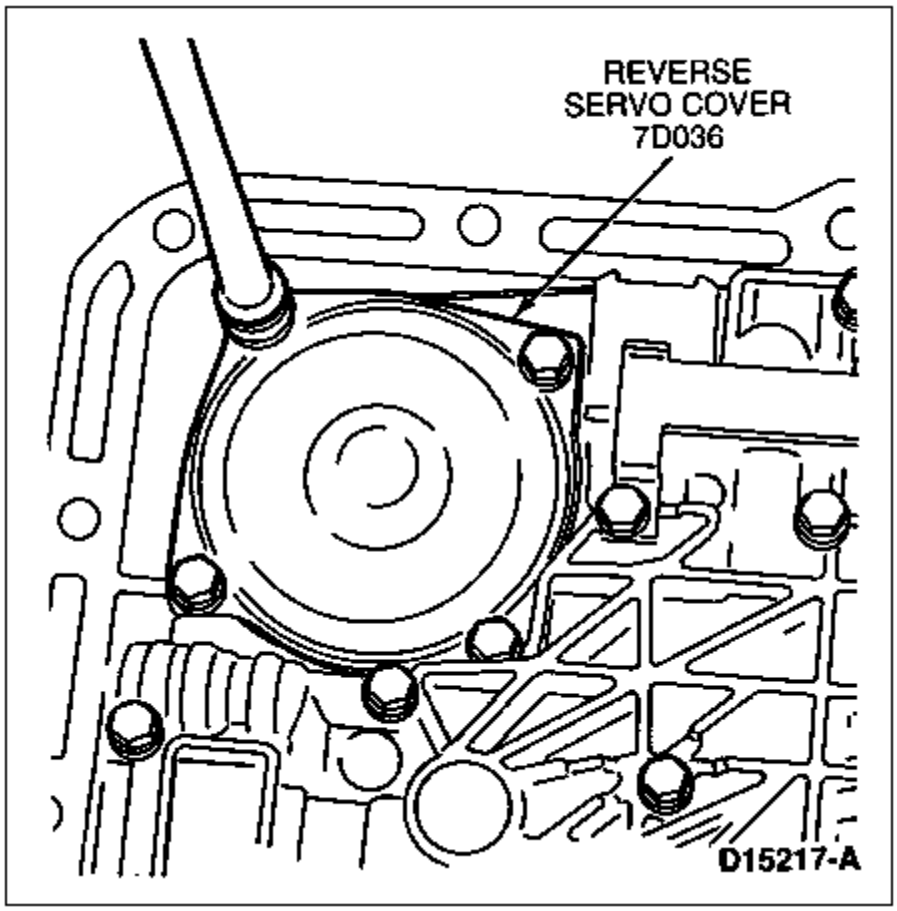

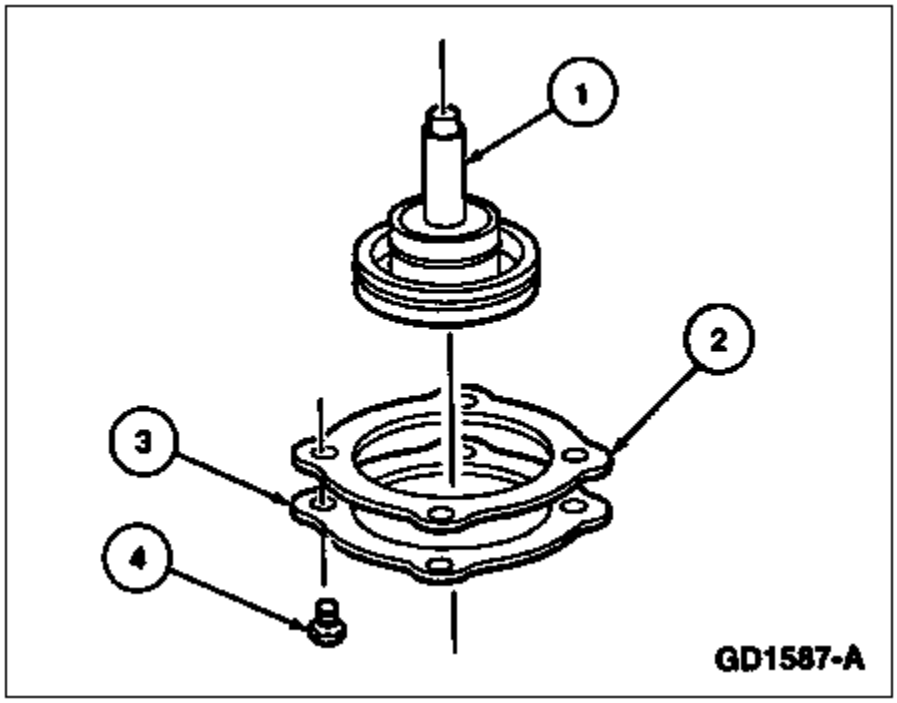

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Item	Part Number	Description
1	7D189	Piston Assembly with Rod and Retainer (Rear Band Servo) (Select Fit)
2	7L173	Reverse Servo-to-Case Gasket
3	7D036	Reverse Servo Cover
4	E800156-S	Low/Reverse Servo Cover-to-Case Screw (4 Req'd)

22. **CAUTION: To prevent solenoid valves from falling out, do not remove the two screws shown below.**

    NOTE: Refer to the main control disassembly and assembly in this section.

    Use a 10 mm socket to remove the sixteen M6 x 40 mm, four M6 x 45 mm, two M6 x 35 mm and one M6 x 30 mm main control valve body screws.

23. Remove the main control assembly, separator plate and gaskets. Discard gaskets.

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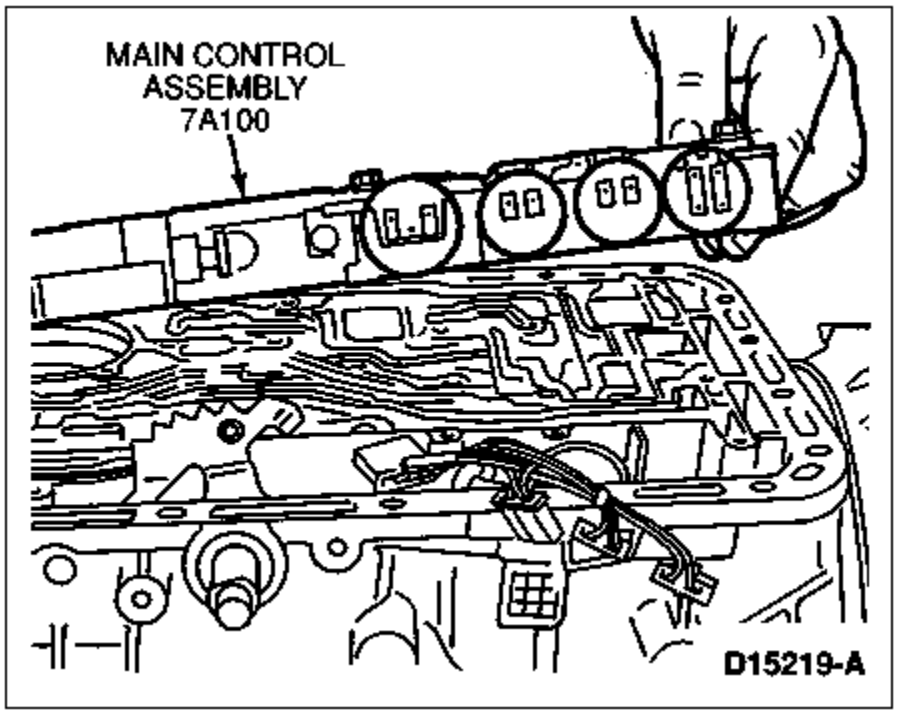

24. **CAUTION: Throw the locknuts away. The locknuts are not reusable for assembly.**

Remove the overdrive and intermediate band locknuts and discard. Back off the band adjusting screws.

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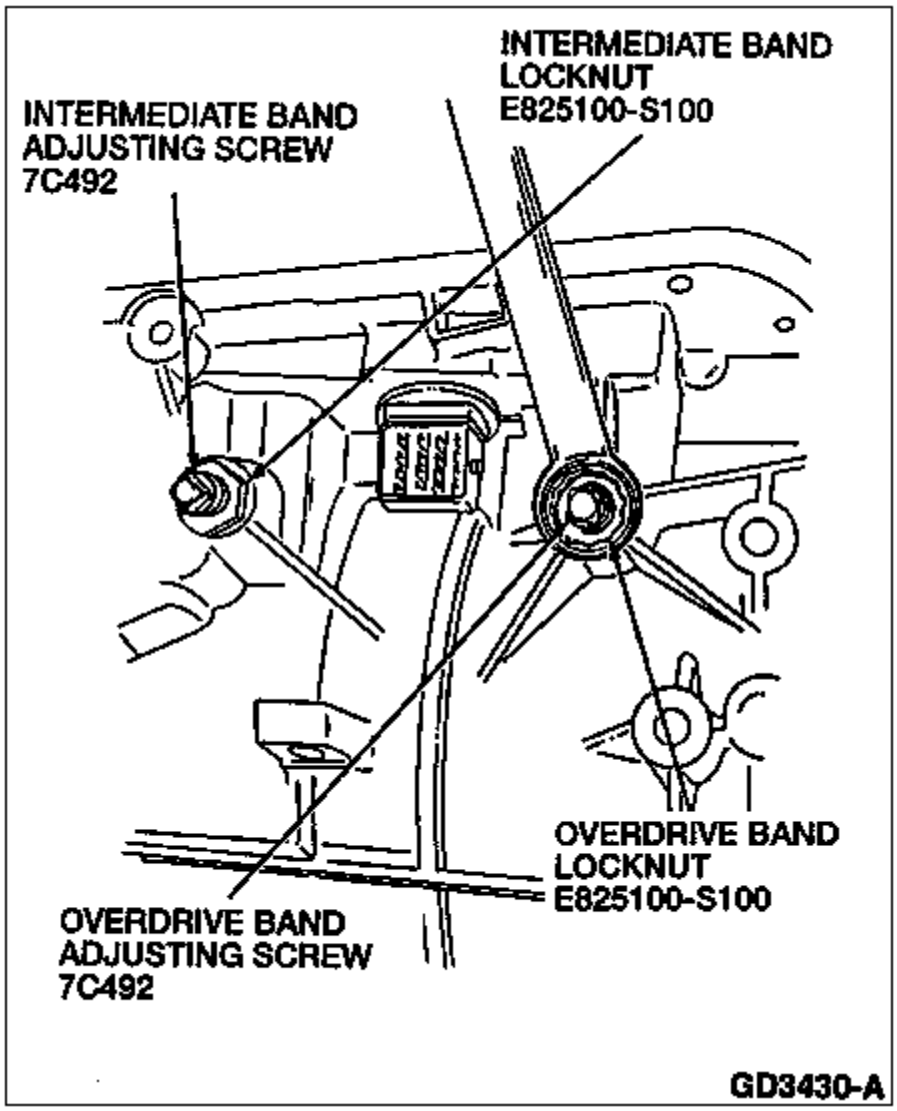

25. **NOTE: The J-hook must be in the appropriate hole for the servo being removed.**

    Install Servo Cover Compressor T95L-77028-A over the intermediate servo cover at the fluid pan rail with tool stamping facing up. Tighten the screws.

26. Using a 1/2-inch wrench, tighten the nut on the J-hook until there is a gap between the servo cover and the snap ring.

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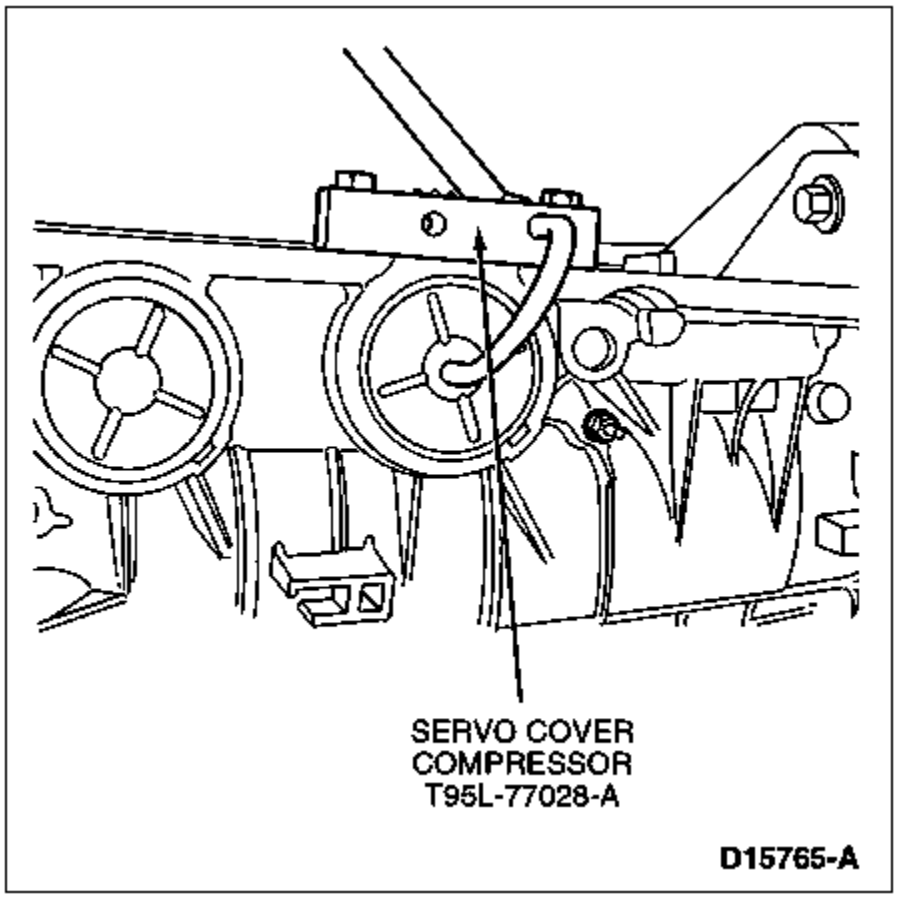

27. Carefully remove the servo cover retaining ring.

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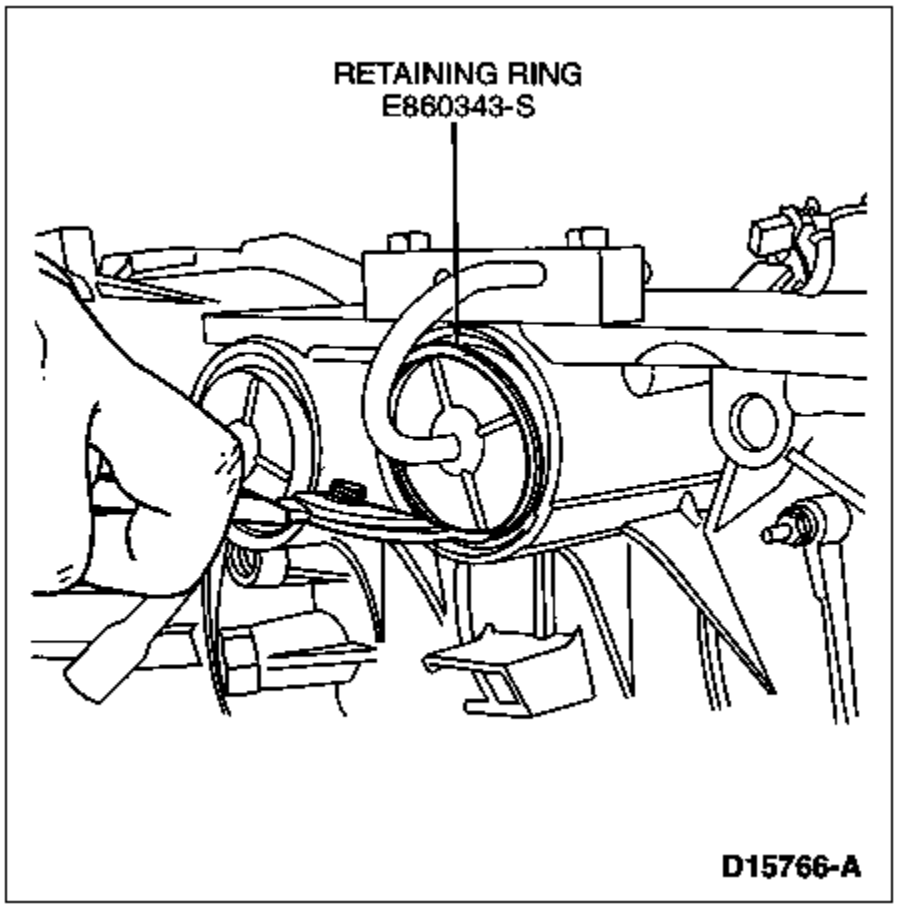

28. **CAUTION: The servo cover is under spring tension.**

    Carefully back off the nut on the J-hook until the servo spring is unloaded.

29. Insert Servo Removal Tool T97T-7D021-A into case and locate on servo rod.

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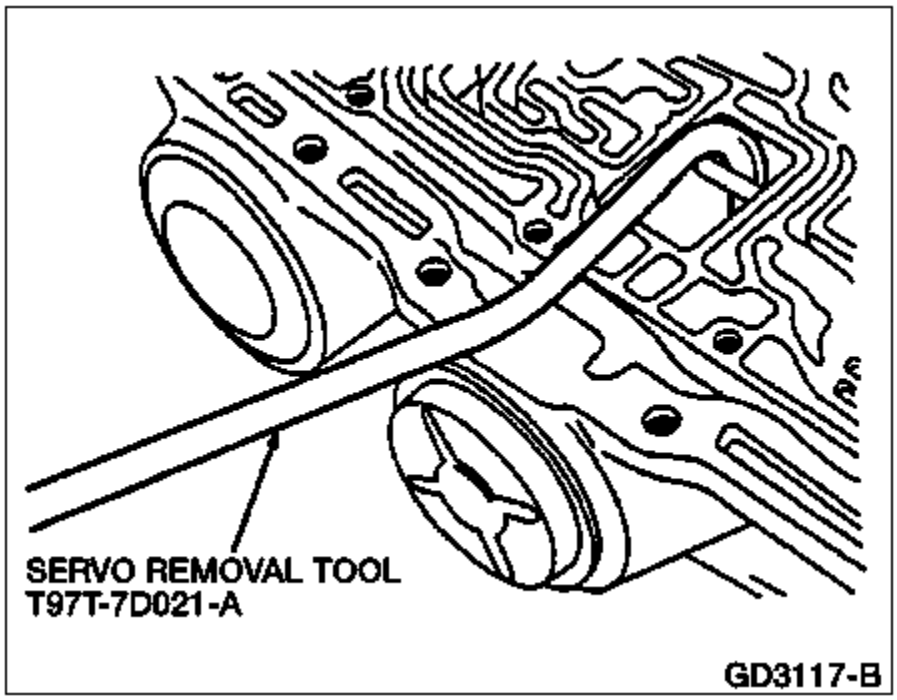
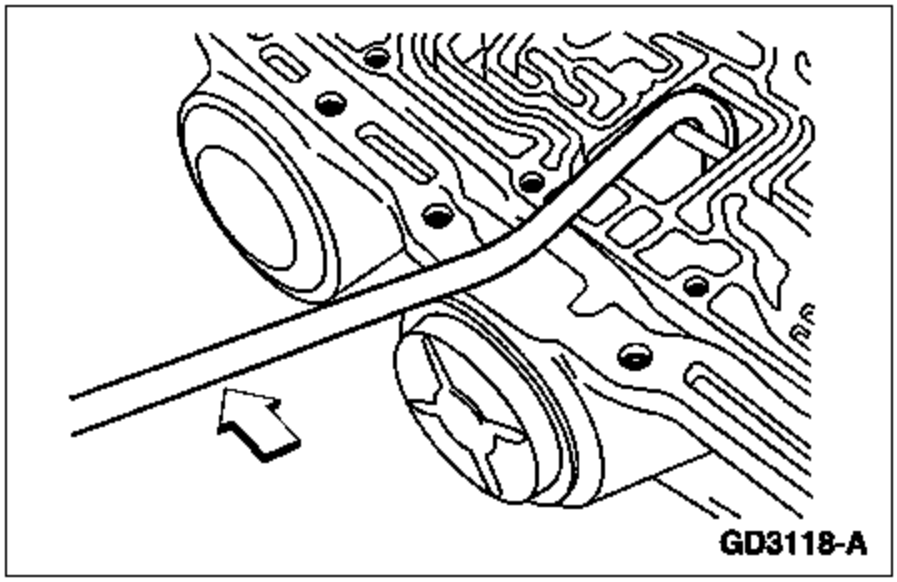


30. Gently push on Servo Removal Tool T97T-7D021-A to remove front servo cover, piston and spring.



31. **NOTE: Tag the spring, piston and cover assembly. Label accordingly for assembly. The covers have letters cast on the outer surface for identification.**

    Remove the intermediate servo cover, piston and spring.

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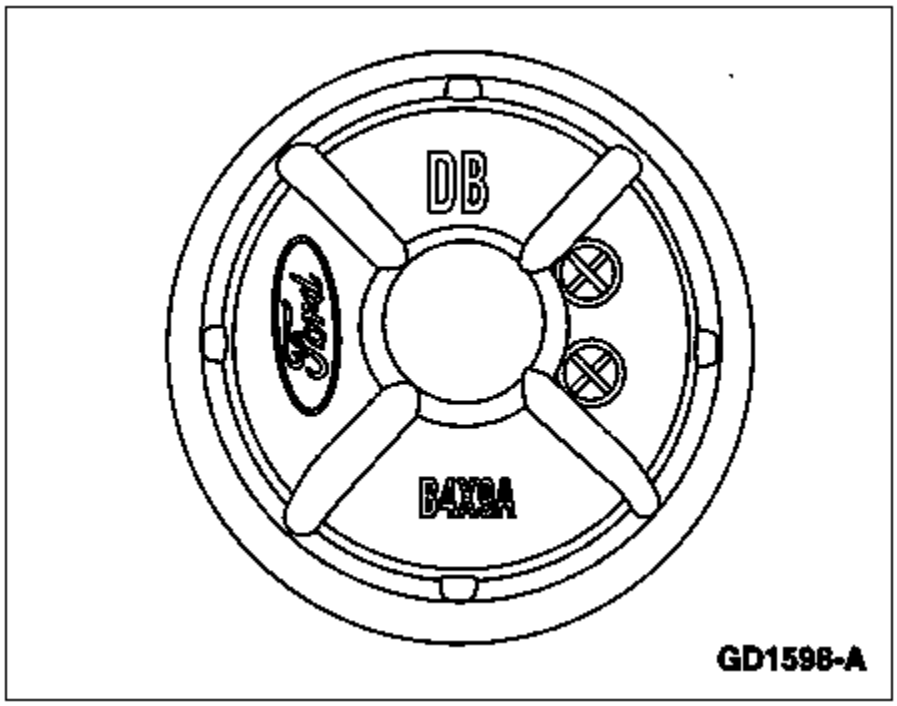

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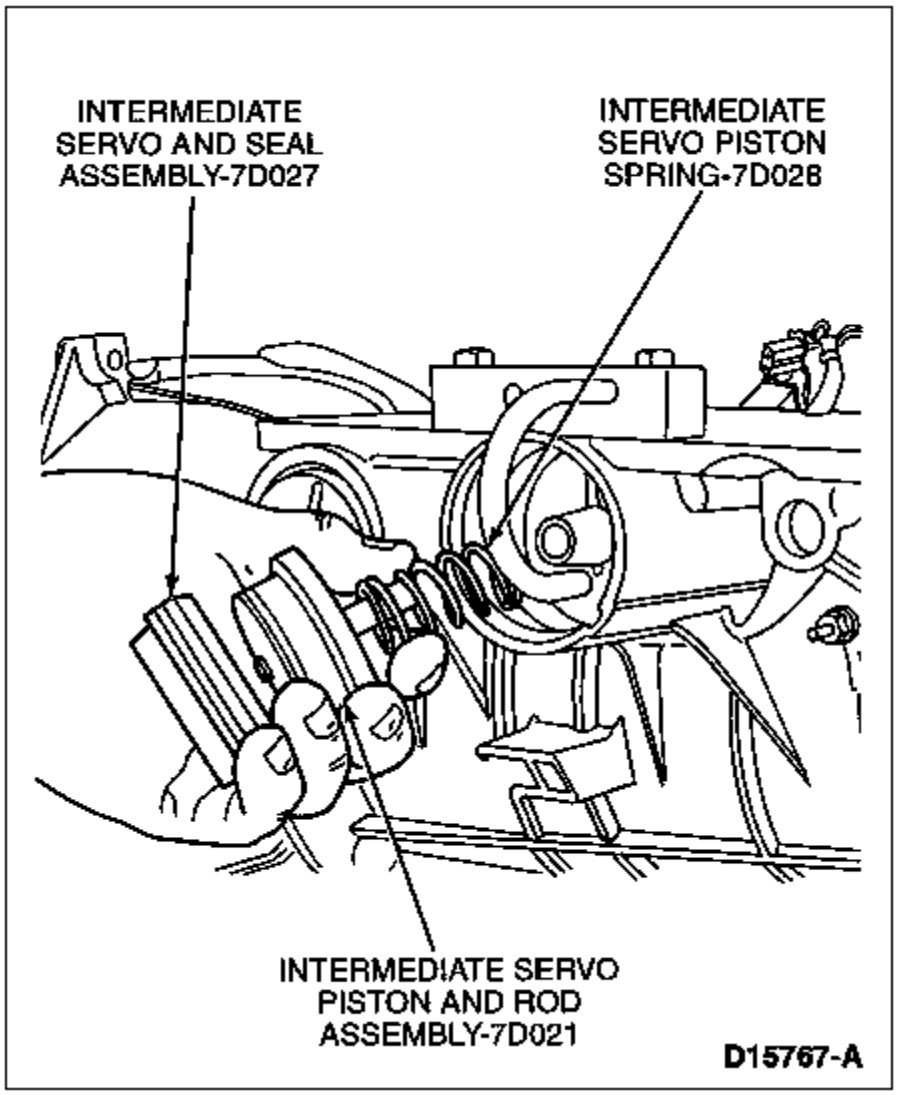

32. Remove Servo Cover Compressor T95L-77028-A.

33. **NOTE: The J-hook must be in the appropriate hole for the servo being removed.**

    Install Servo Cover Compressor T95L-77028-A over the overdrive servo cover at the fluid pan rail. Tighten the screws.

34. Using a 1/2-inch wrench, tighten the nut on the J-hook until there is a gap between the servo cover and the retaining ring.

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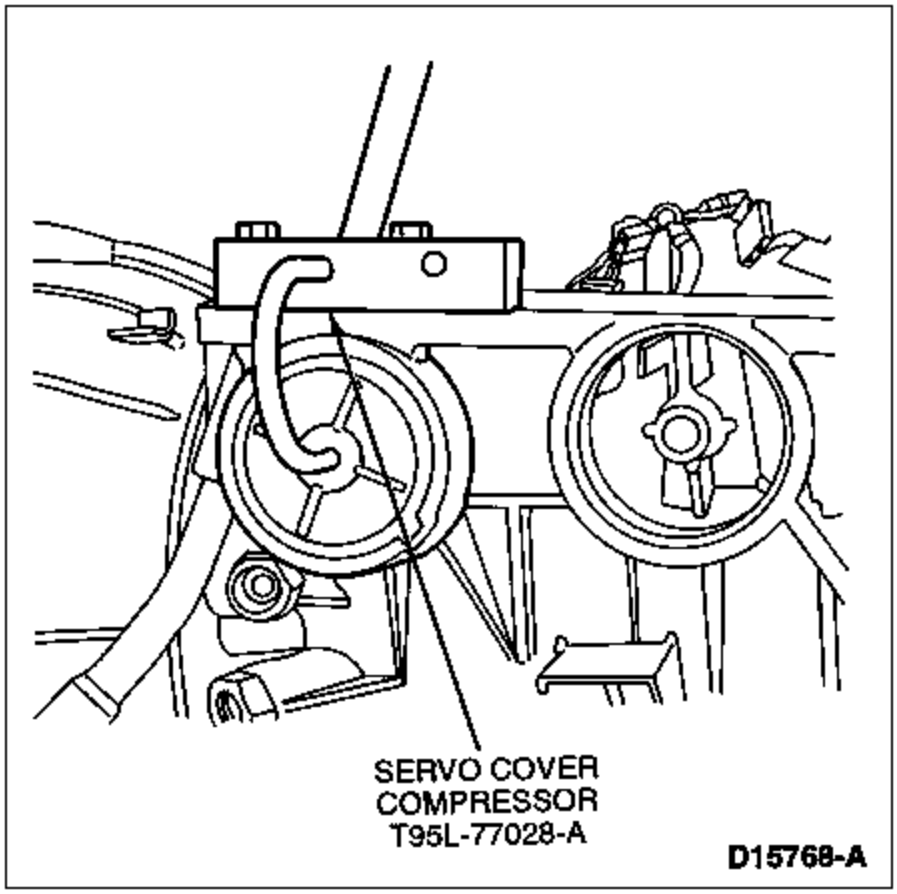

35. Carefully remove the servo cover retaining ring.

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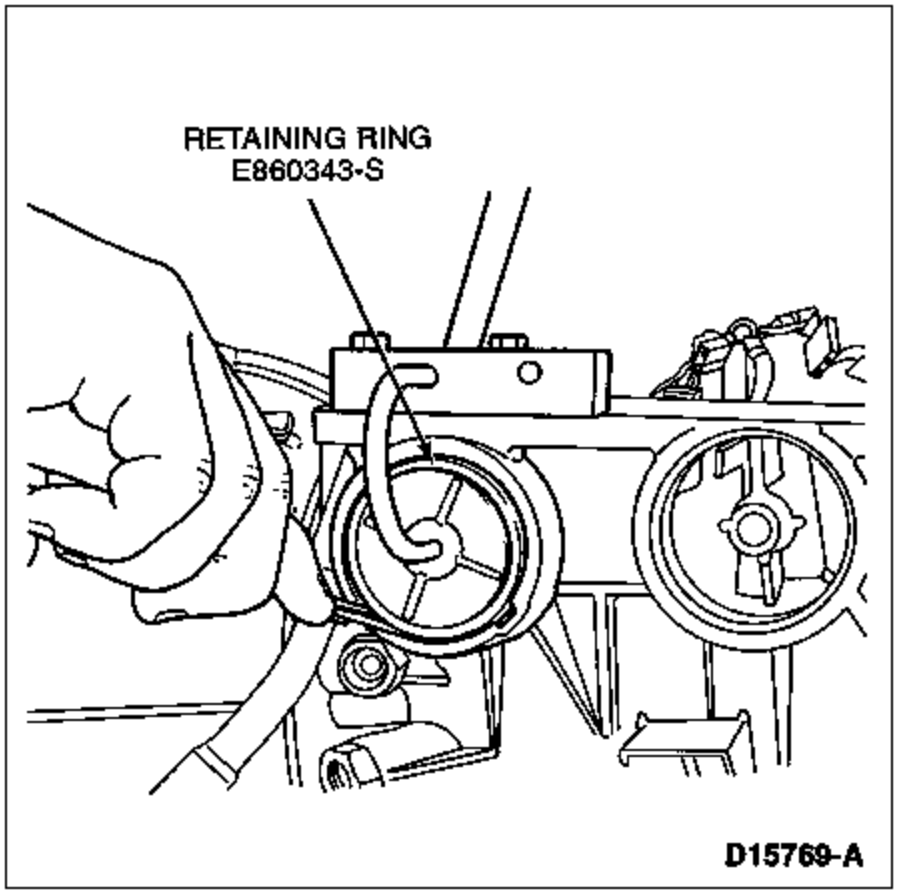

36. **CAUTION: The servo cover is under spring tension.**

    Carefully back off the nut on the J-hook until the servo spring is unloaded.

37. Insert Servo Removal Tool T97T-7D021-A into case and locate on servo rod.

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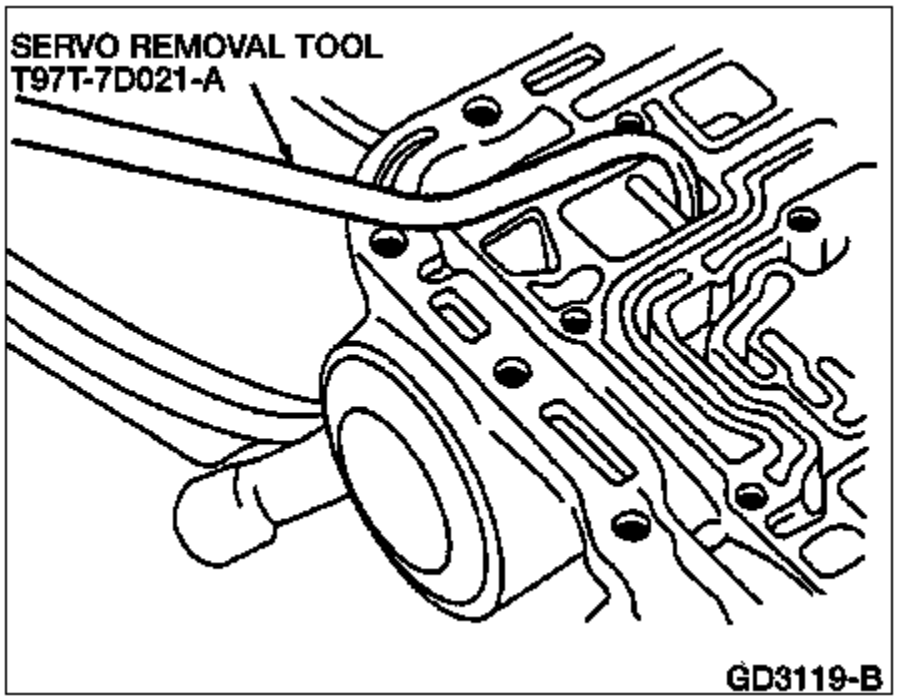
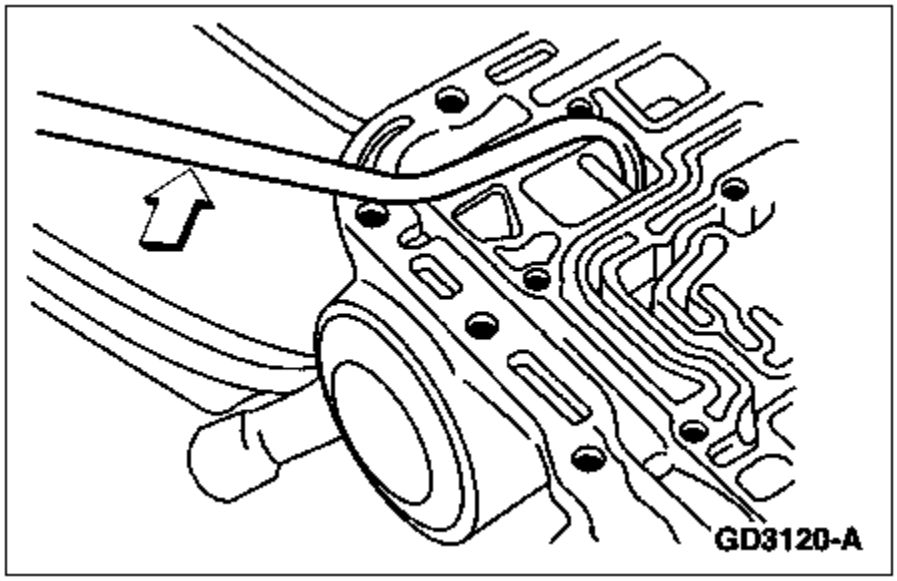


38. Gently push on Servo Removal Tool T97T-7D021-A to remove front servo cover, piston and spring.



39. **NOTE: Tag the spring, piston and cover assembly. Label accordingly for assembly. The covers have letters cast on the outer surface for identification.**

    Remove the overdrive servo cover, piston and spring.

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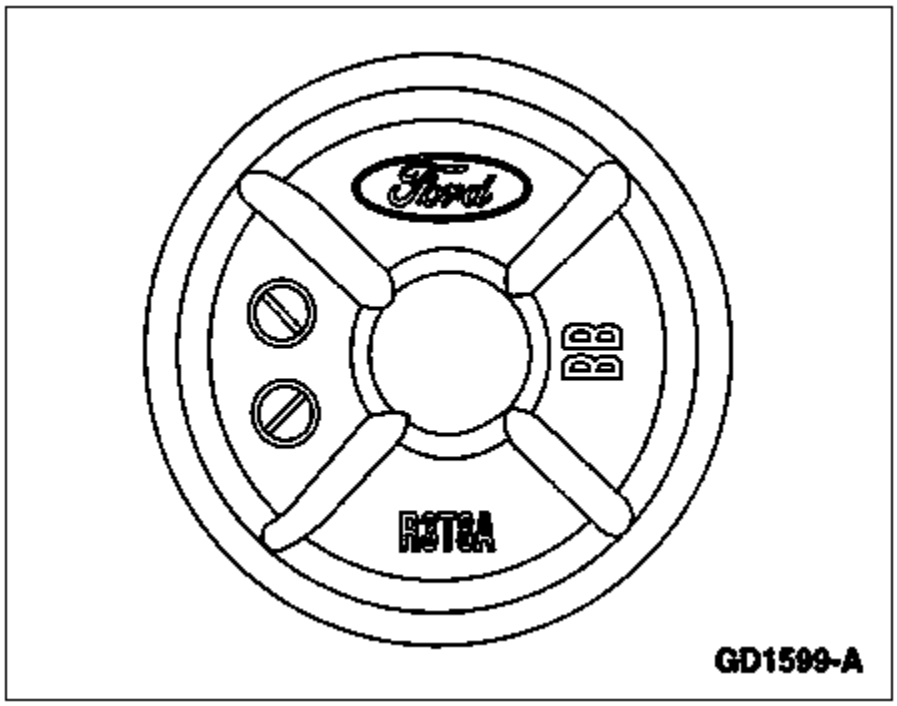

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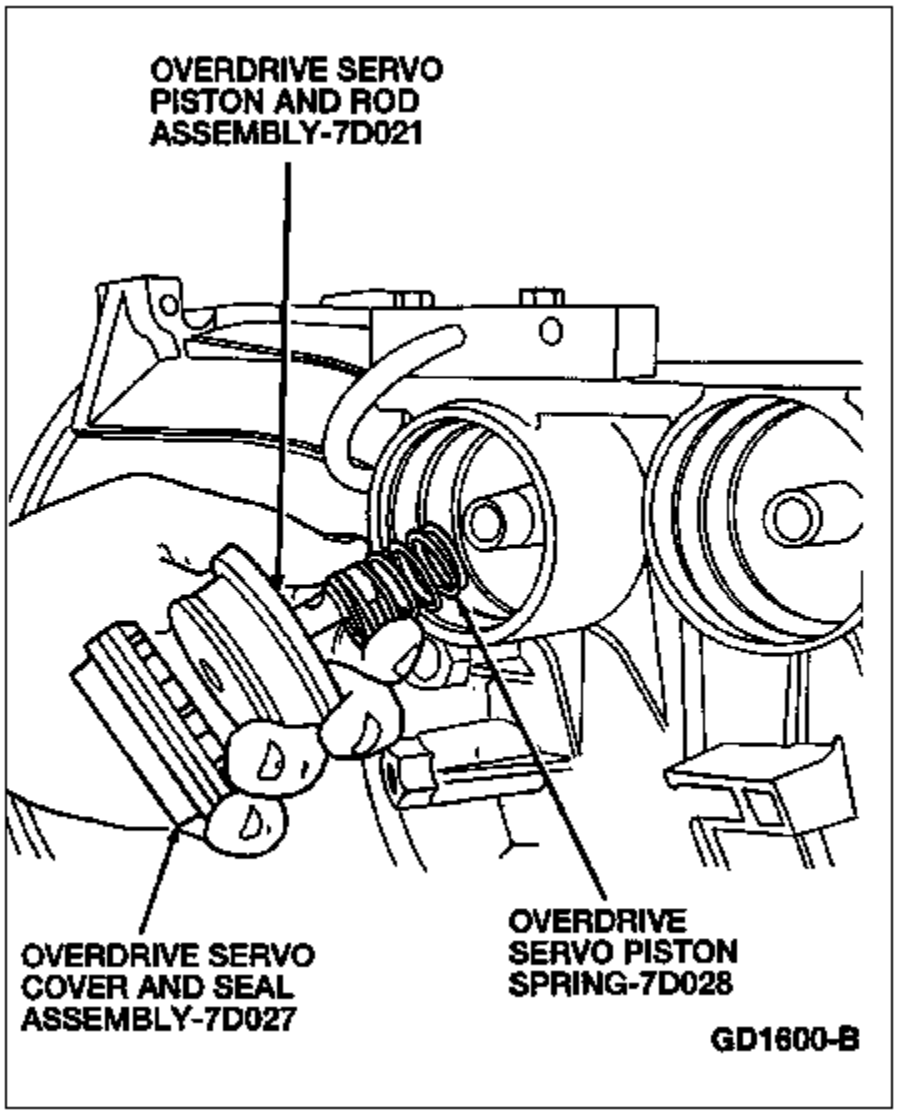

40. Remove Servo Cover Compressor T95L-77028-A.

41. **WARNING: MAKE SURE THE LOCK PIN ON BENCH-MOUNTED HOLDING FIXTURE T57L-500-B IS SECURE.**

    Rotate the transmission assembly with the converter housing facing up.

42. **CAUTION: Throw the screws away. The screws are not reusable for assembly.**

    Use a 17 mm socket to remove the eight M10 x 33 mm converter housing-to-case screws. Discard the screws.

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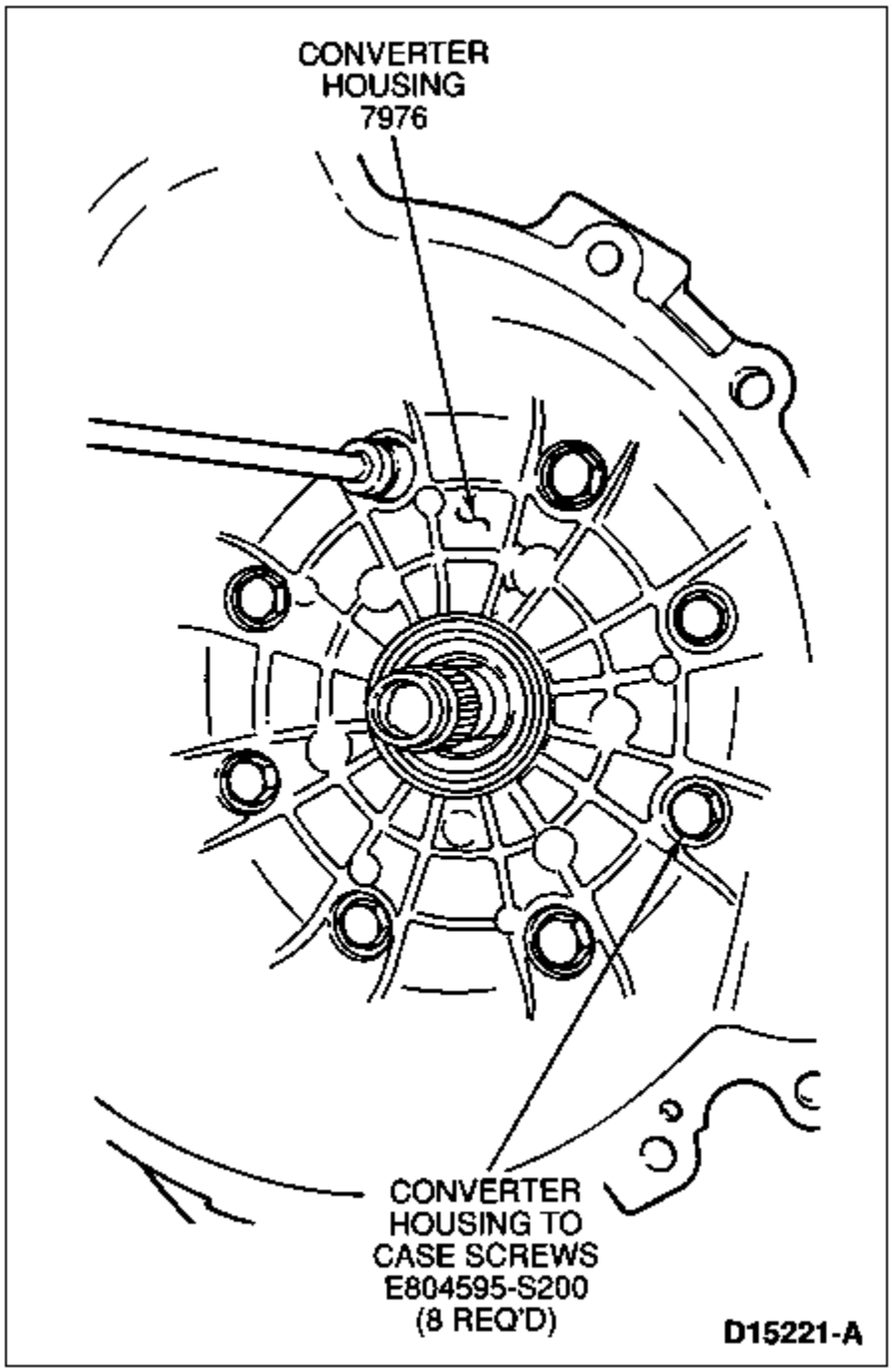

43. **NOTE: Rotate and lift the converter housing so that the clutch assemblies will stay in place.**

    Remove the converter housing and fluid pump support and gear assembly.

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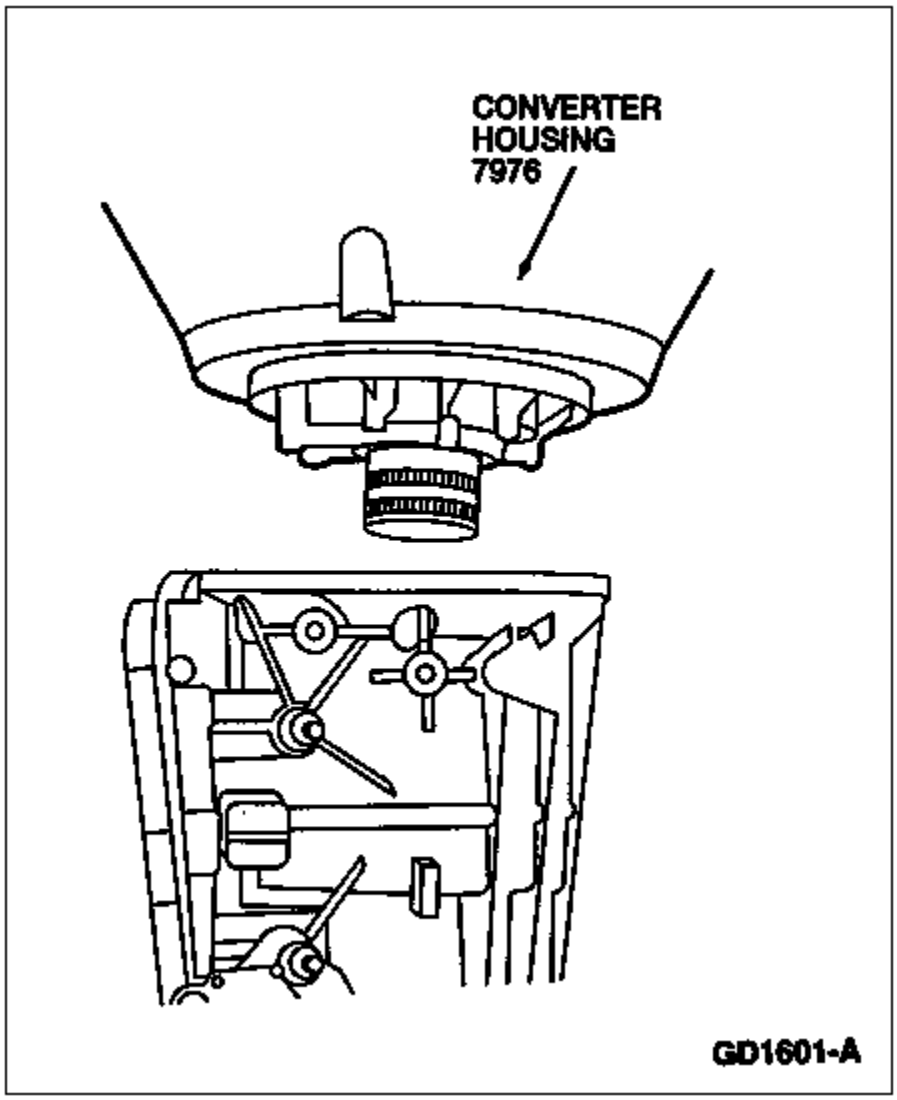

44. **NOTE: Refer to Converter Housing And Pump Assembly under subassemblies for service information.**

Remove the No. 1 fluid pump thrust washer. Tag the No. 1 fluid pump thrust washer for identification.

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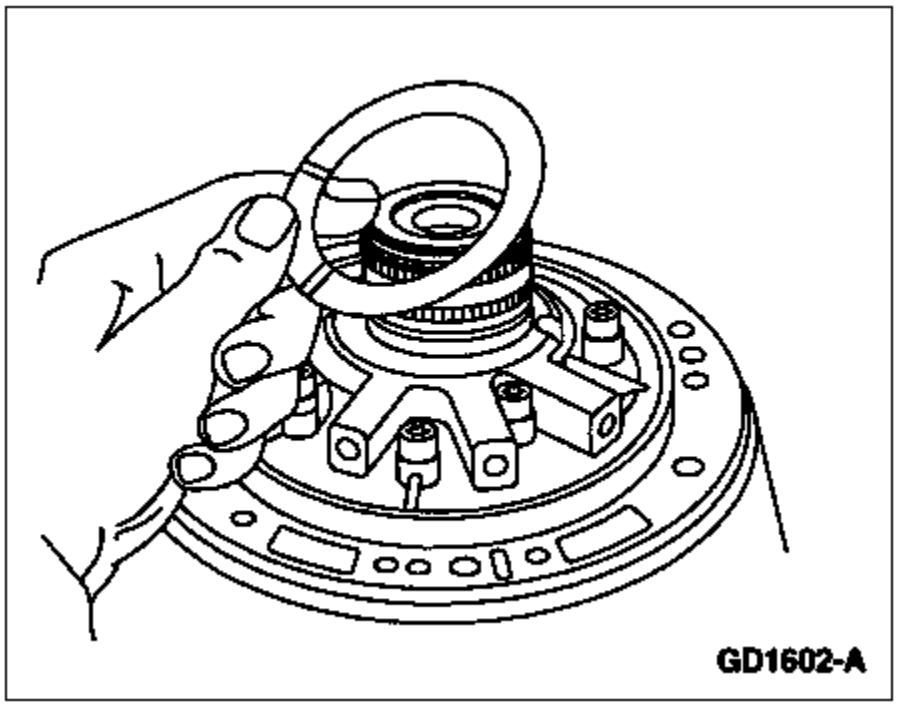

45. Remove overdrive band adjusting screw. Compress the overdrive band around the overdrive brake and coast clutch drum. Remove the overdrive band anchor strut.

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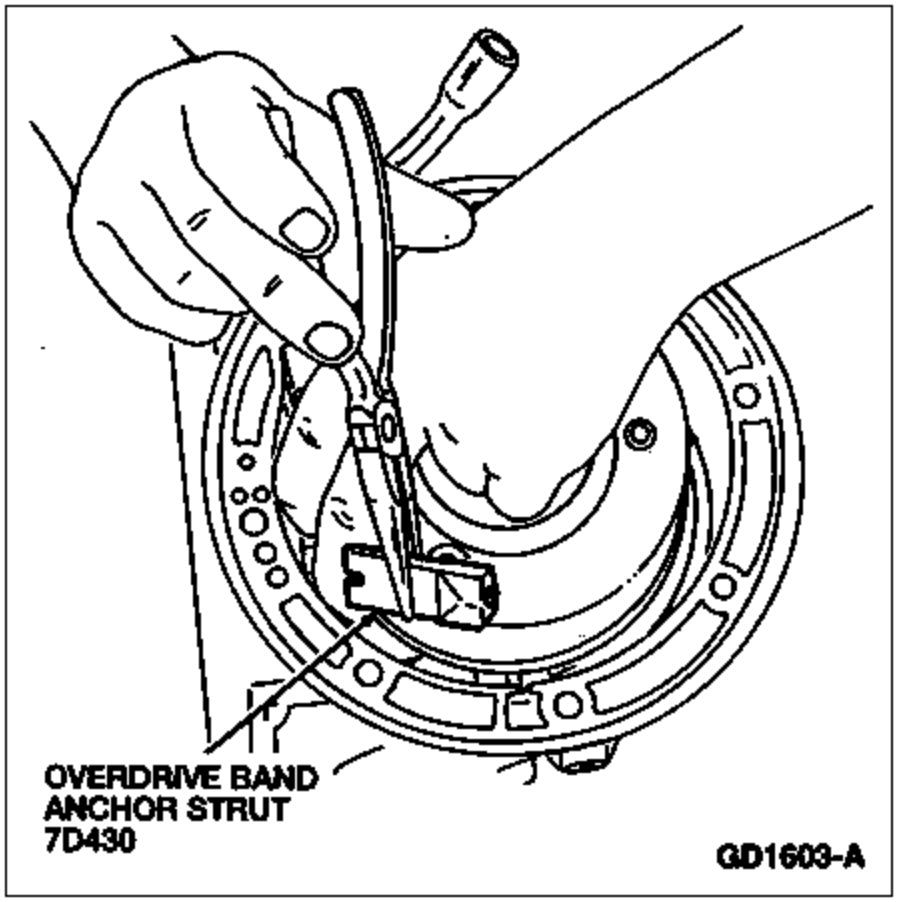

46. **CAUTION: Identify which end of the overdrive band is the anchor side or the apply side.**

Remove the overdrive band.

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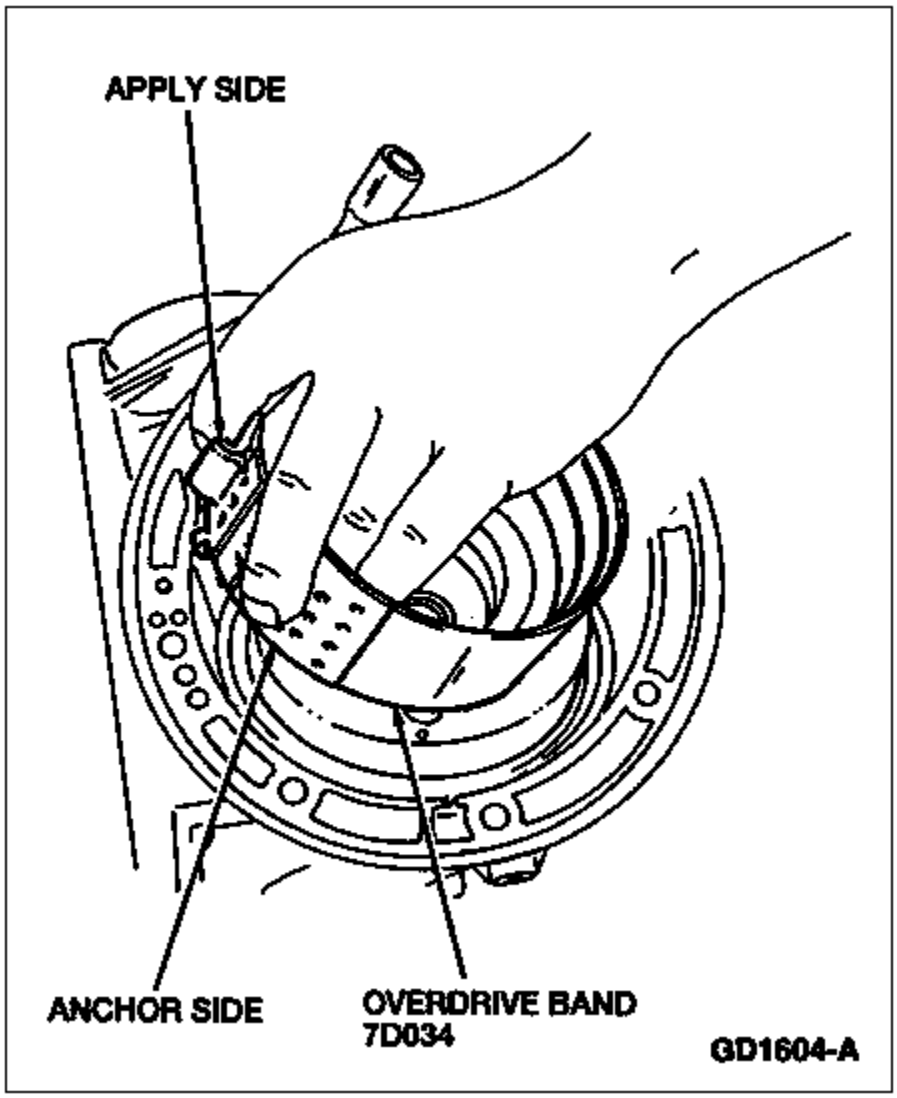

47. Remove the overdrive brake and coast clutch drum.

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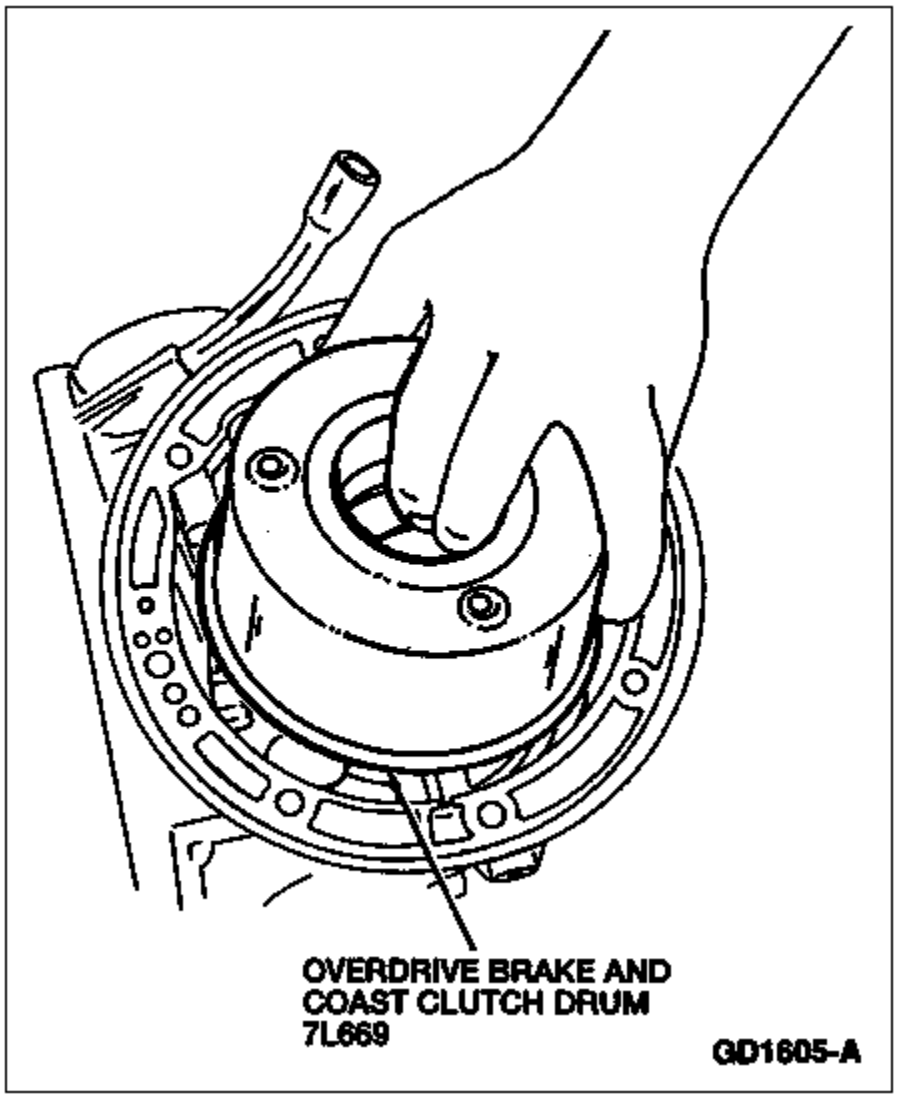

48. Remove the overdrive band apply strut.

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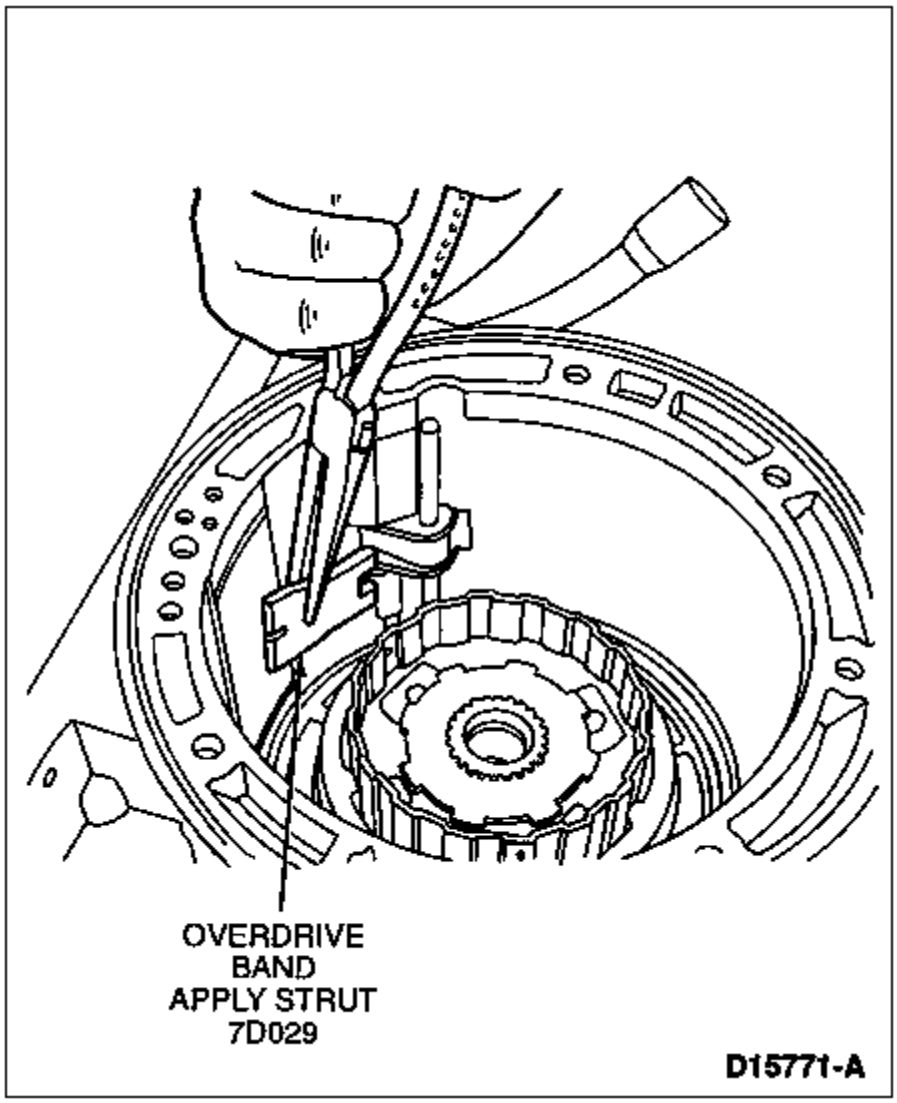

49. **NOTE: Tag and identify the overdrive lever for assembly. The overdrive lever has a letter stamped into its side.**

    NOTE: The overdrive band actuating lever shaft is longer than the intermediate shaft.

    Remove the overdrive band actuating lever shaft.

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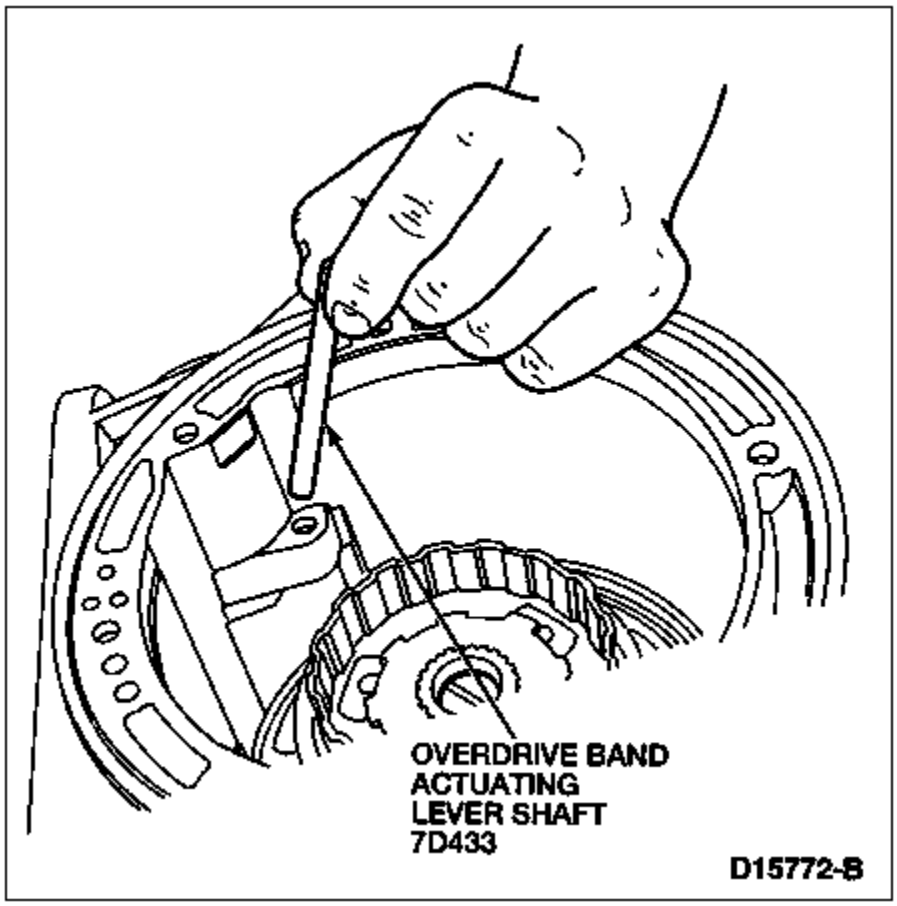

50. **CAUTION: Do not bend the exciter wheel.**

NOTE: No. 12 thrust bearing is in this assembly.

Remove the planetary gear overdrive carrier.

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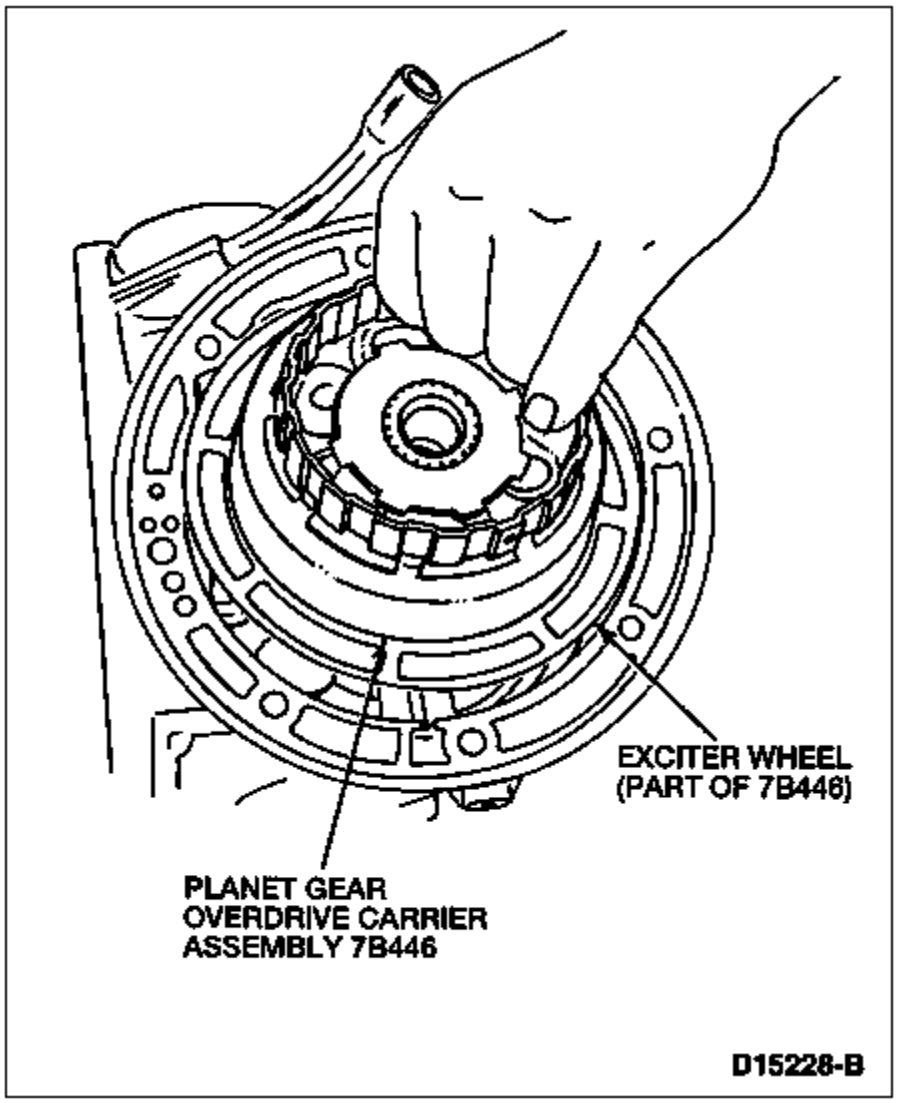

51. Remove the servo band lever and overdrive control bracket.

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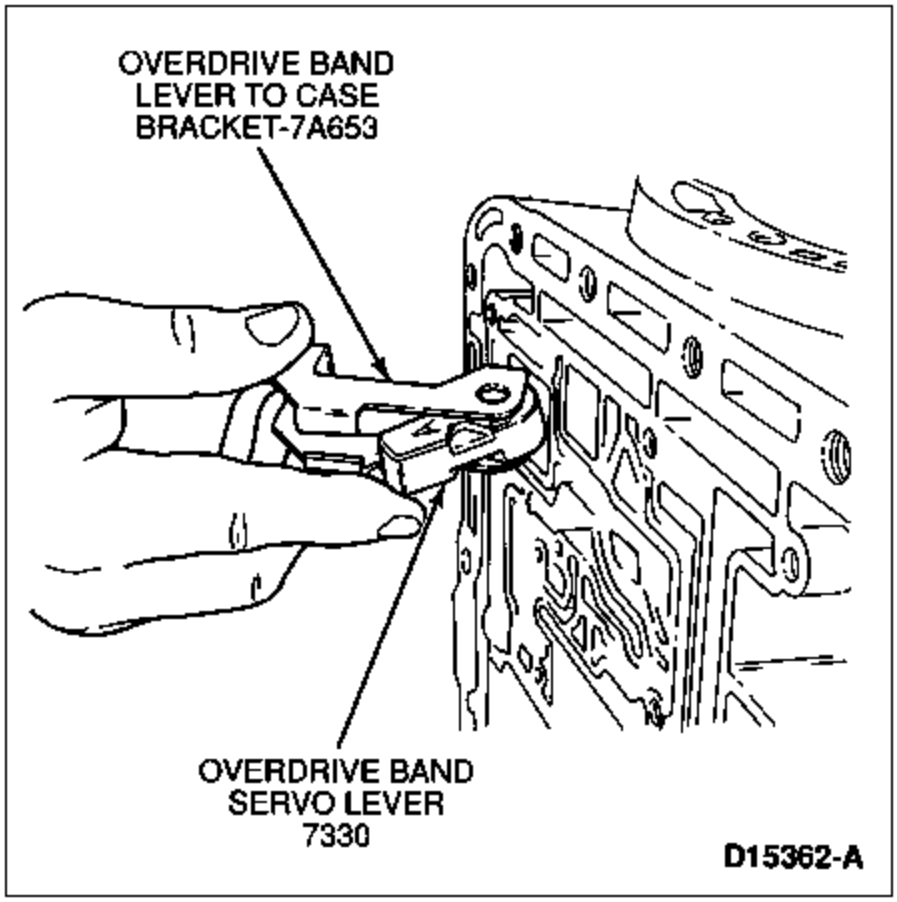
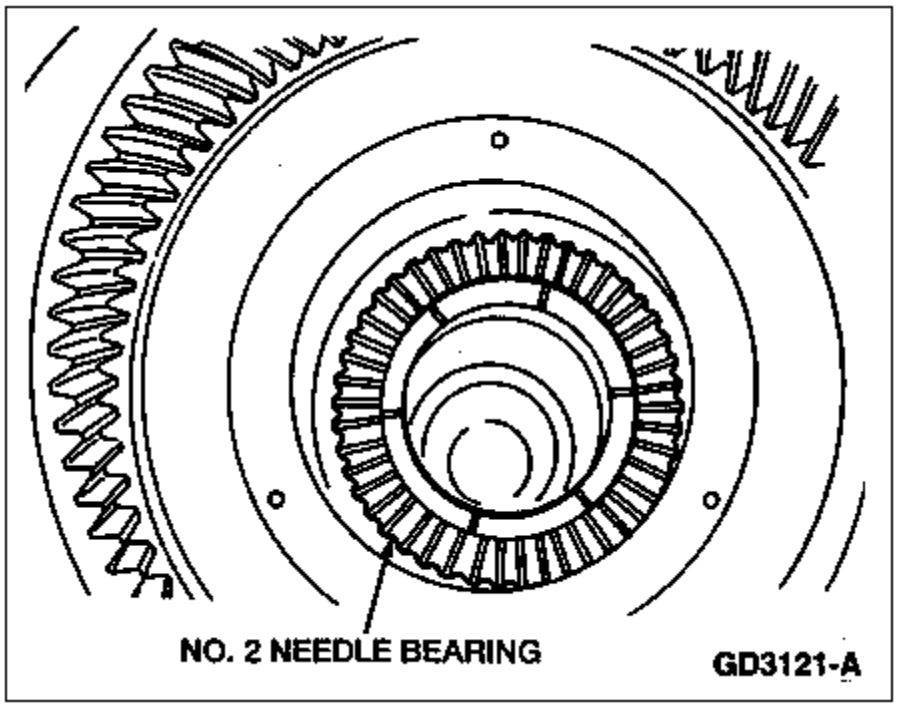


52. Remove the No. 2 needle bearing if not already removed with planetary gear overdrive carrier.



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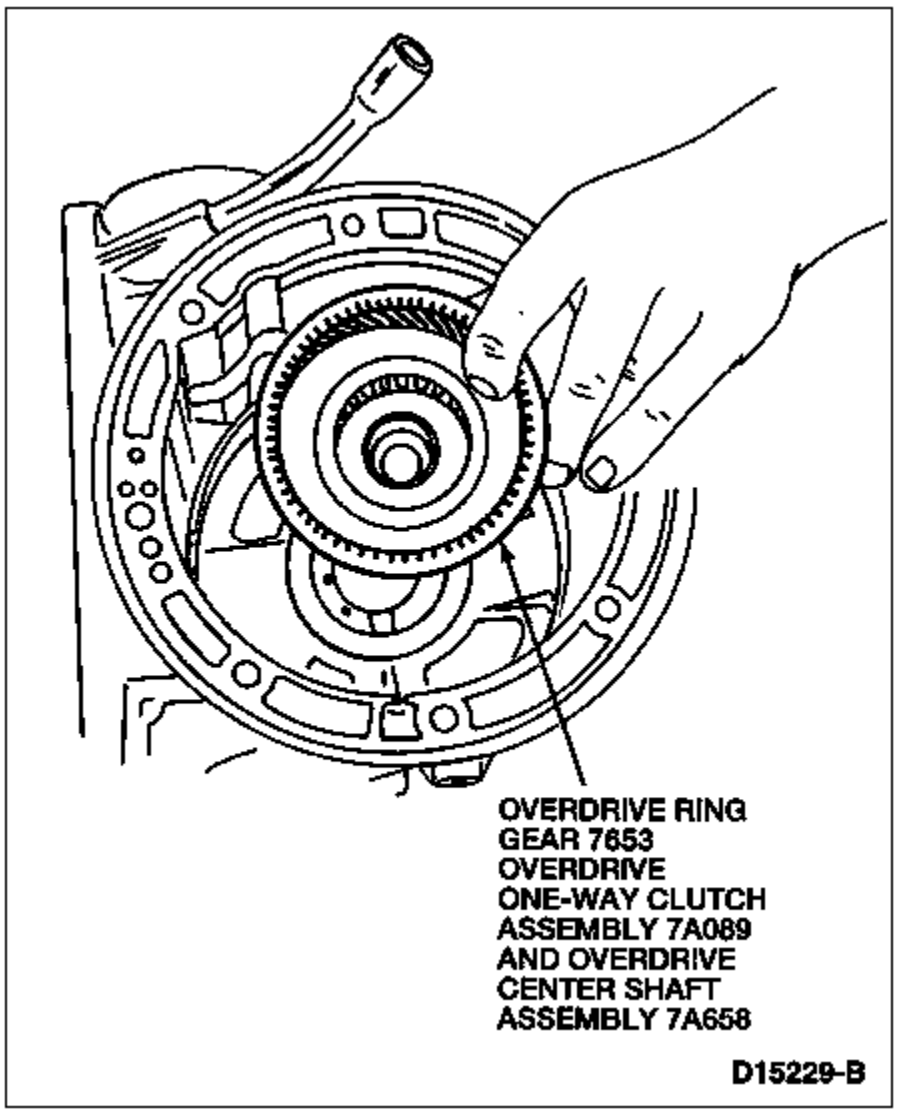
53. Remove the overdrive ring gear, overdrive one-way clutch and overdrive center shaft assembly.



54. **NOTE: Tag and identify the No. 3 center shaft thrust bearing assembly for assembly.**

Remove the No. 3 center shaft thrust bearing assembly.

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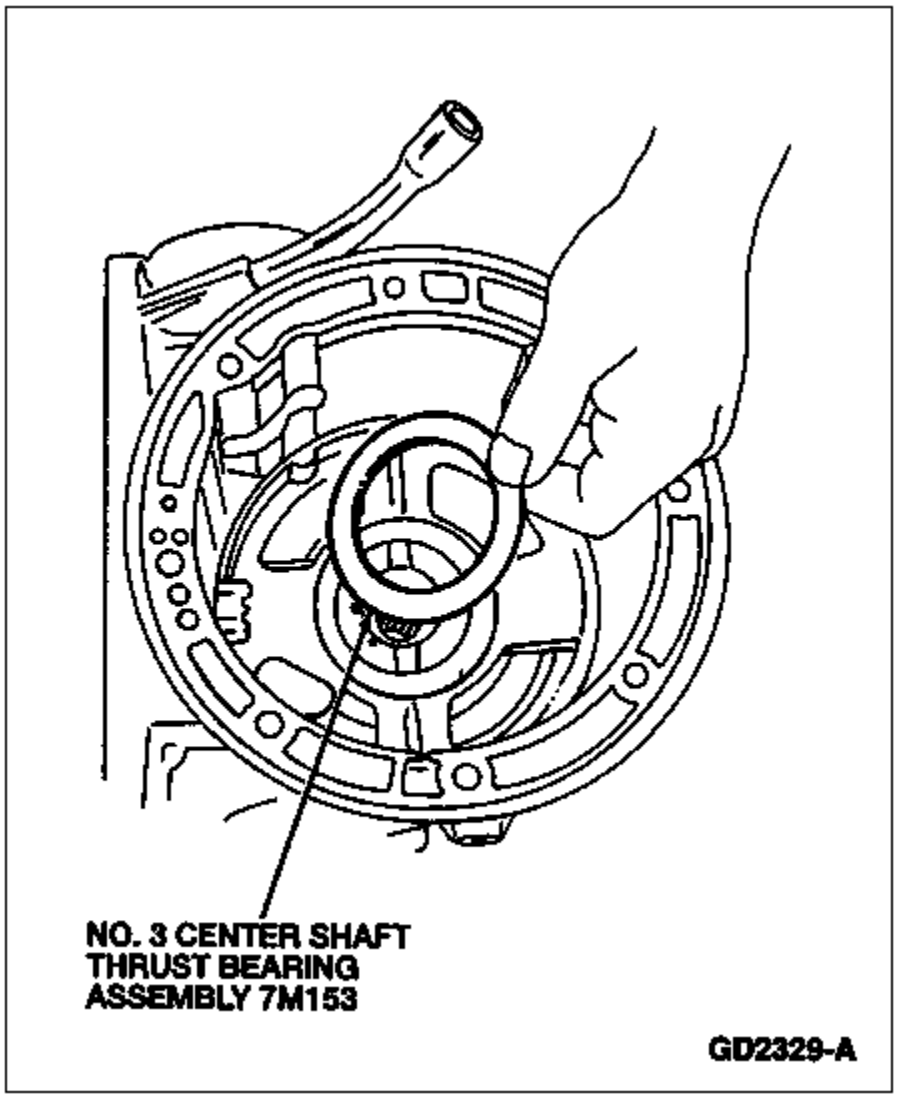

55. **CAUTION: The center support locking nut could fall into the remaining assembly if not removed.**

Use a 5 mm Allen wrench to remove the M6 x 20 mm center support capscrew.

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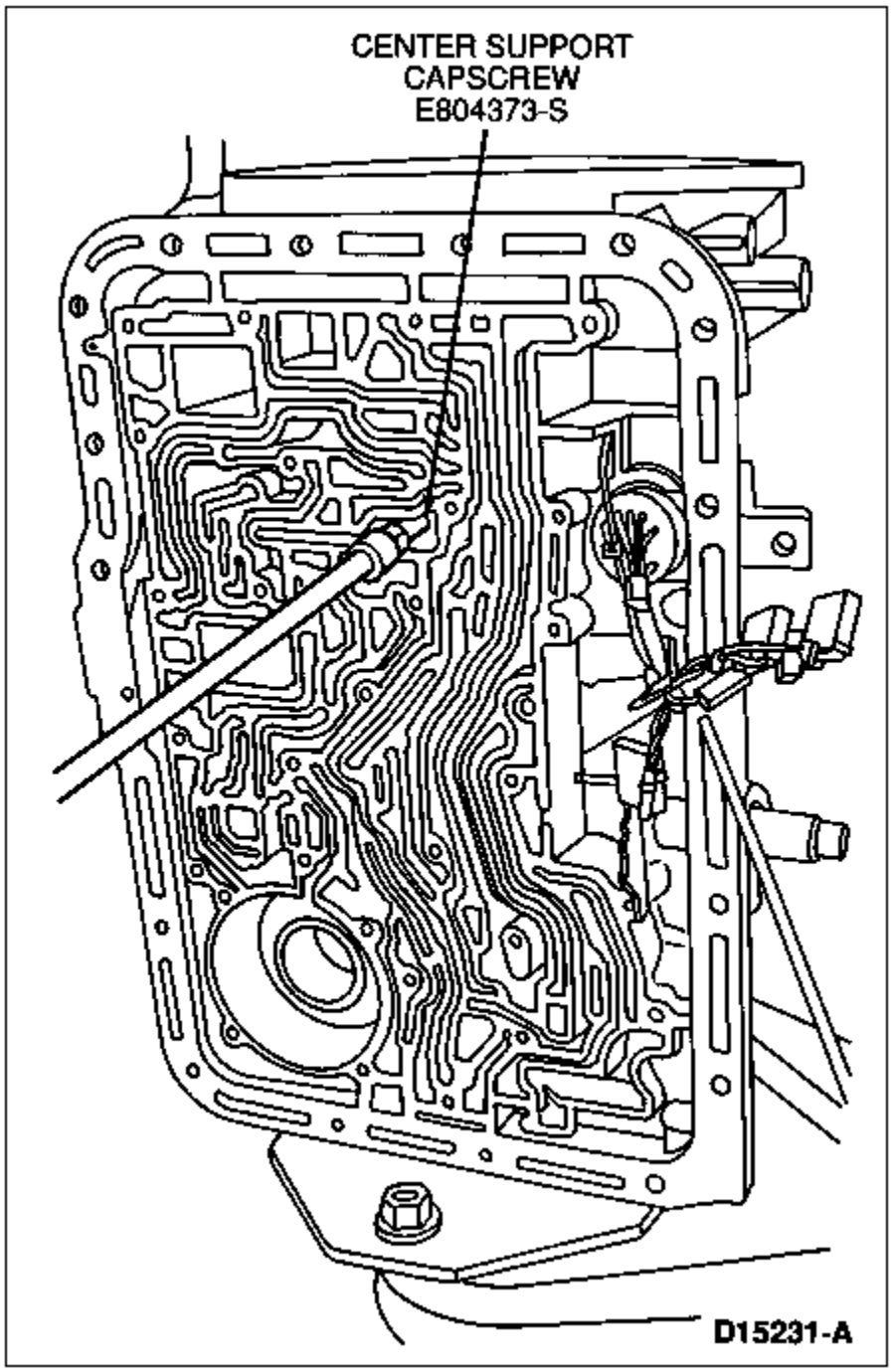

56. Remove the locking nut and cage from center support.

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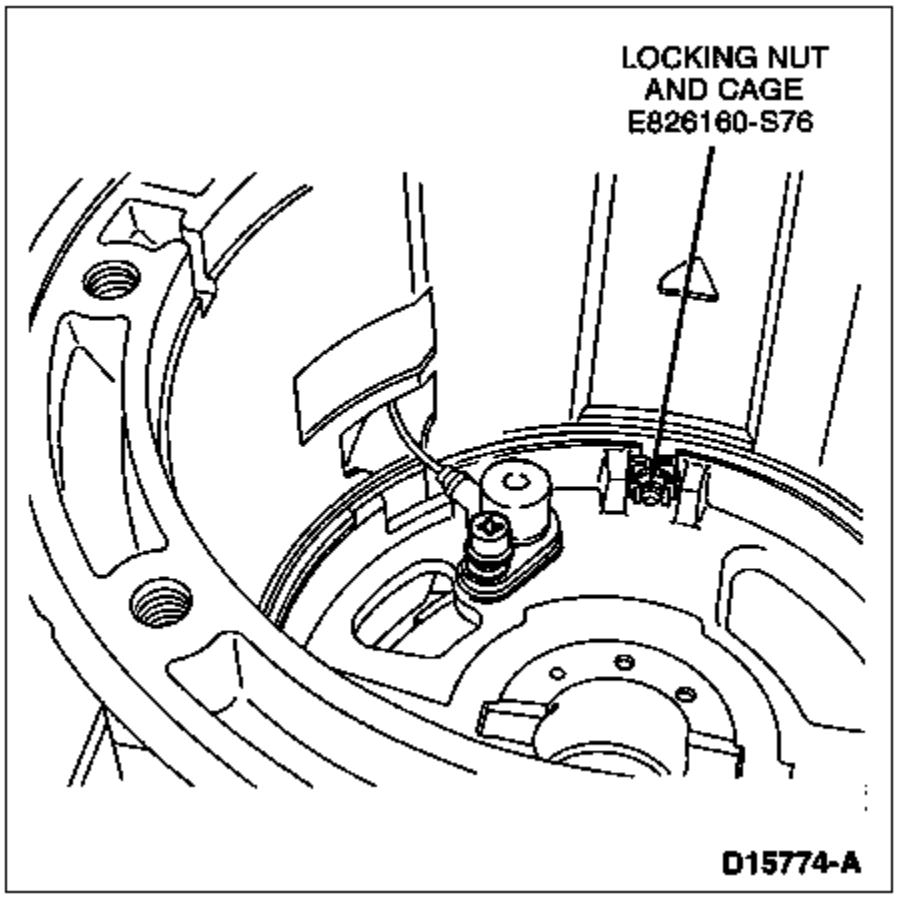

57. **CAUTION: Do not pry on other wires or damage the connector or case surface.**

Carefully disconnect the turbine shaft speed (TSS) sensor connector from the 16-pin case connector.

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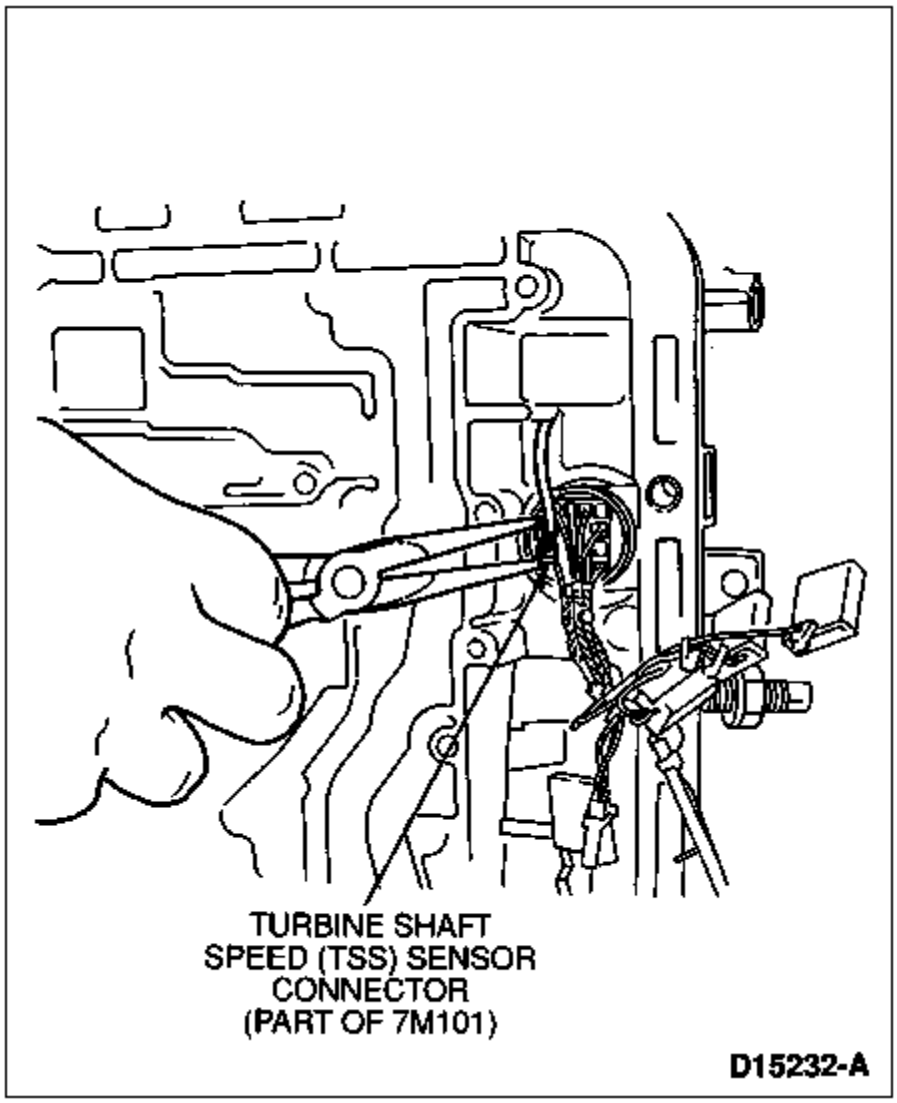

58. Carefully remove TSS sensor connector wires from the retaining slot on the 16-pin case connector.

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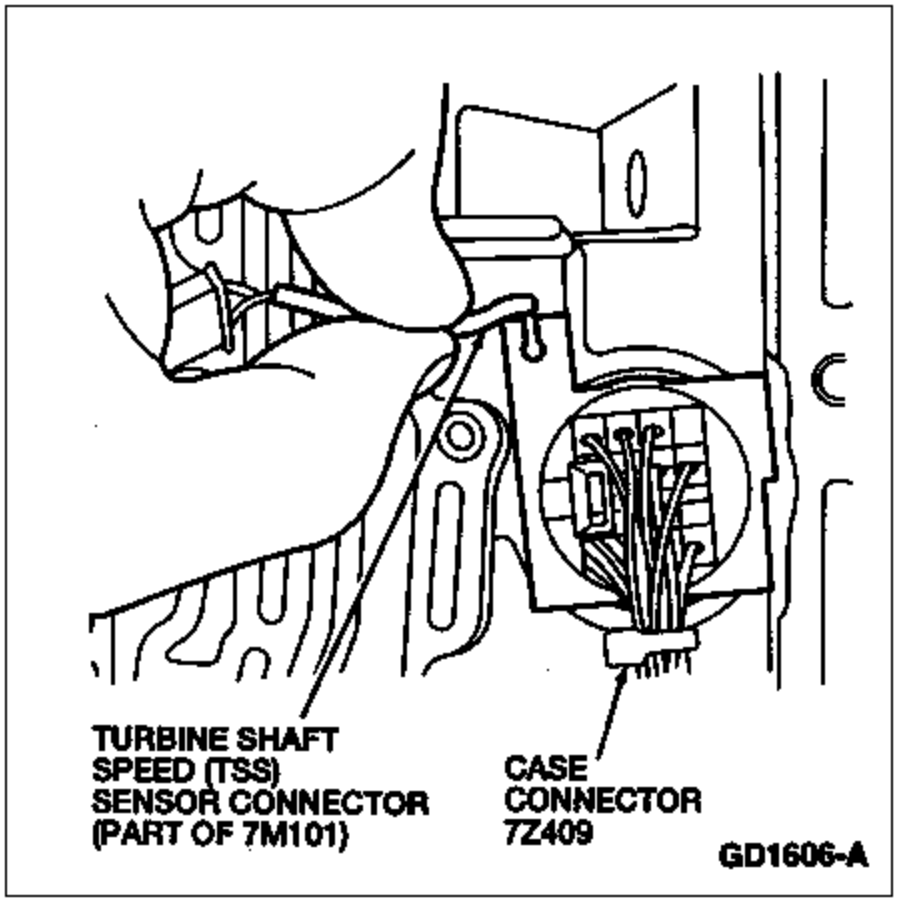

59. Use a T30 Torx® bit to remove the TSS screw.

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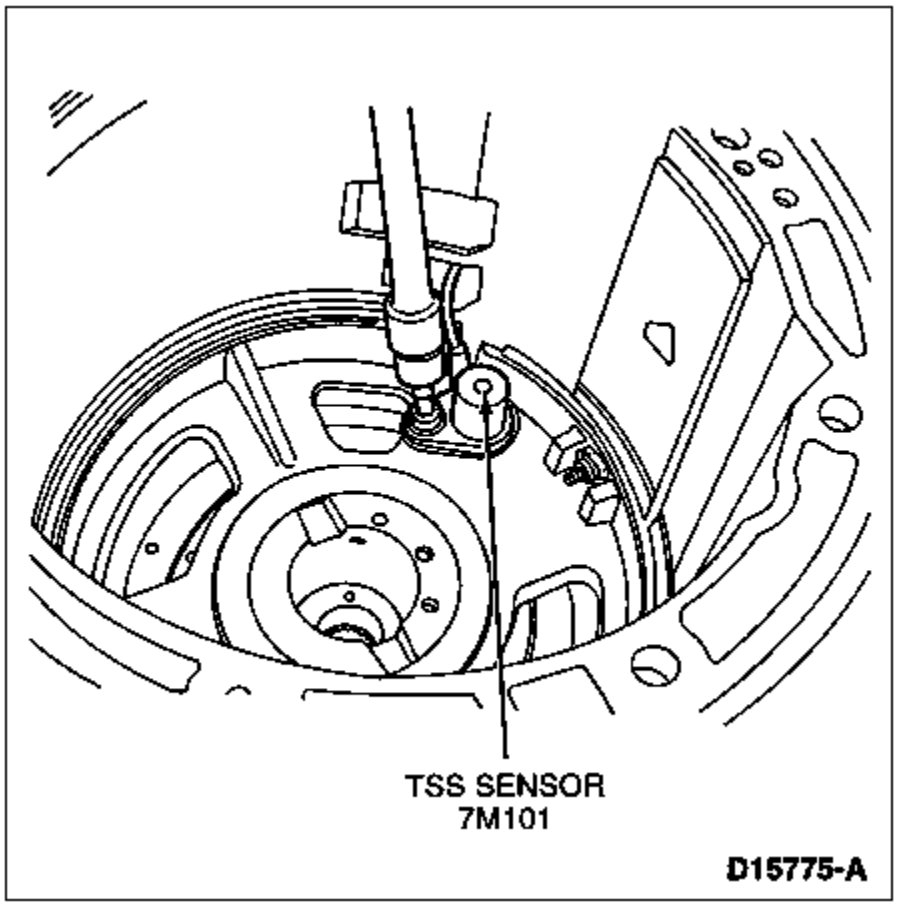

60. Carefully route the TSS connector and wiring into the transmission through the opening in the case. Remove the TSS.

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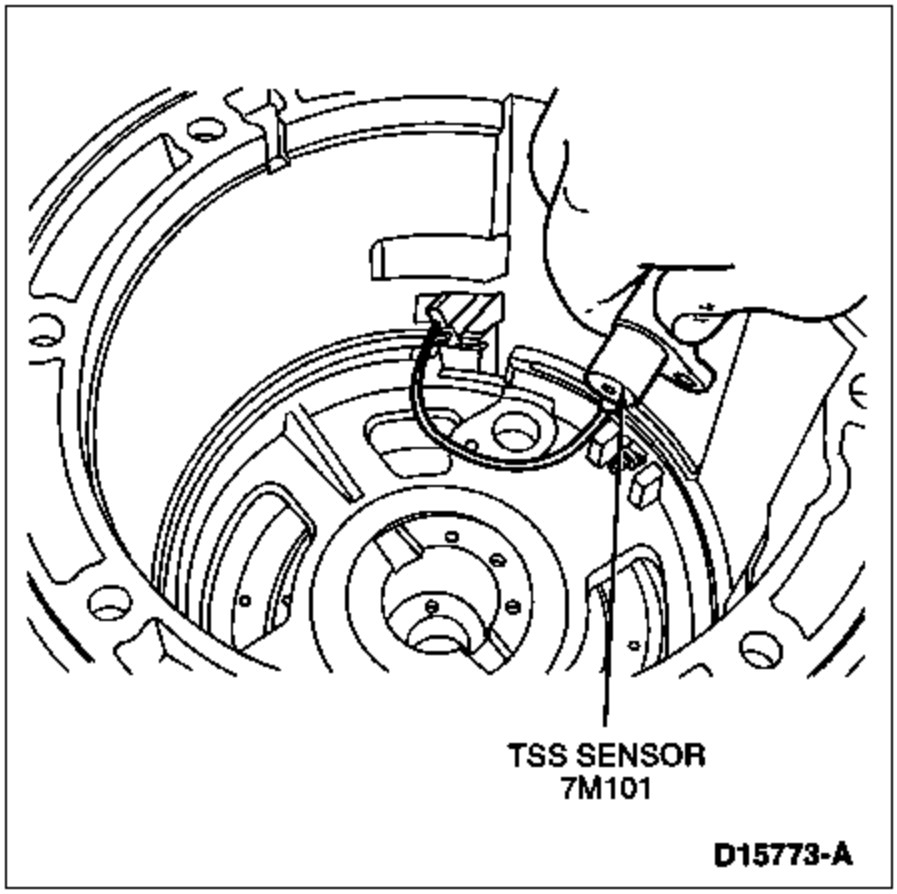

61. **CAUTION: Do not overstretch the case connector retaining spring.**

Use a screwdriver to carefully remove the case connector retaining spring.

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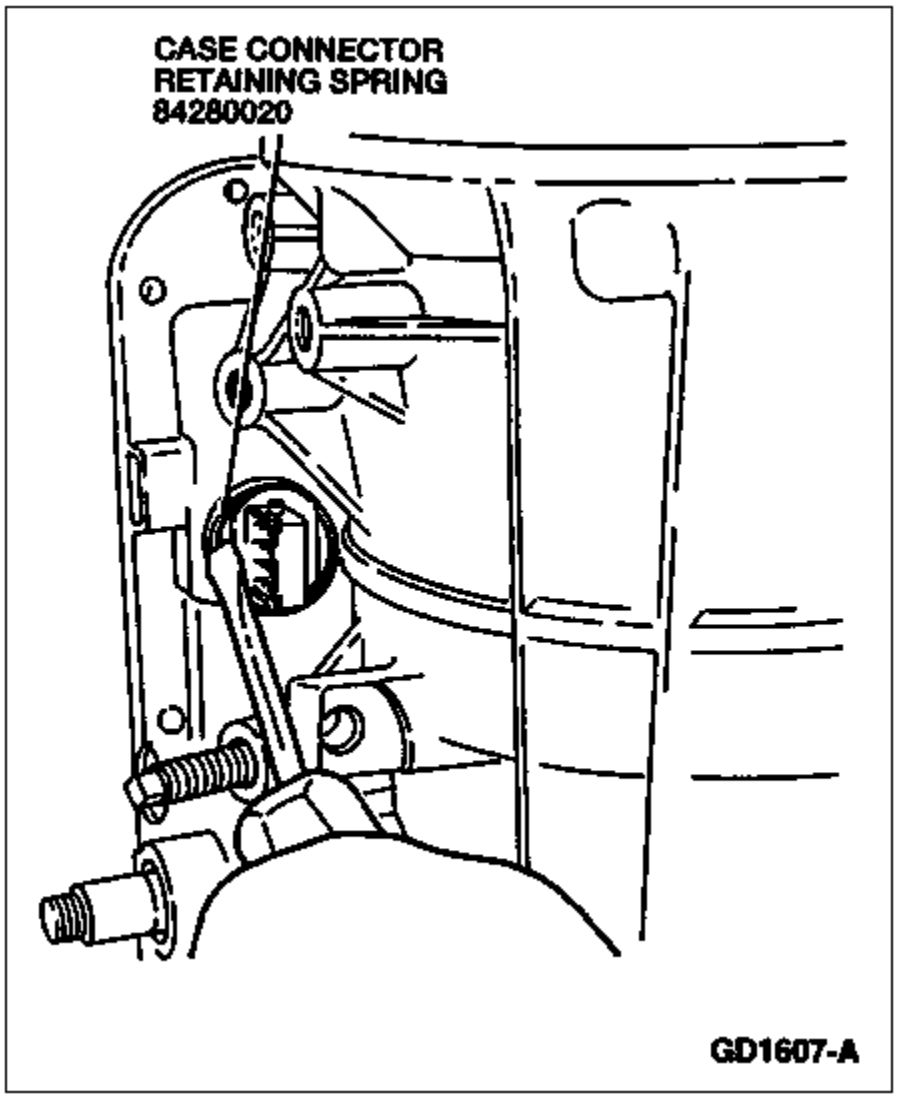

62. **CAUTION: Do not damage the connector or harness.**

Carefully push down on the top of the connector until it stops. Depress the tab on the back side of the connector and push down on the connector. Remove the connector and harness through the bottom of the case.

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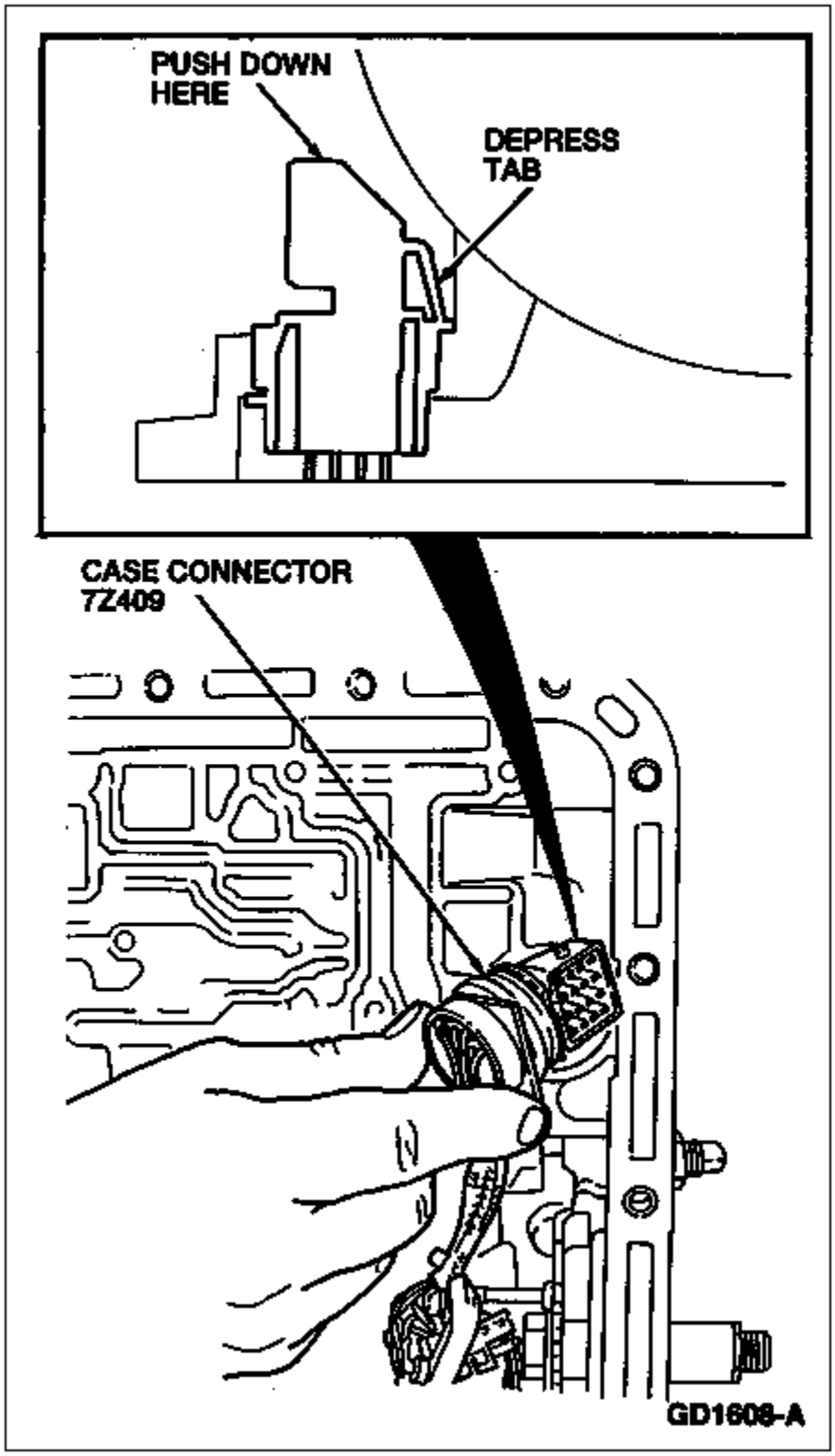

63. Remove the center support retaining ring.

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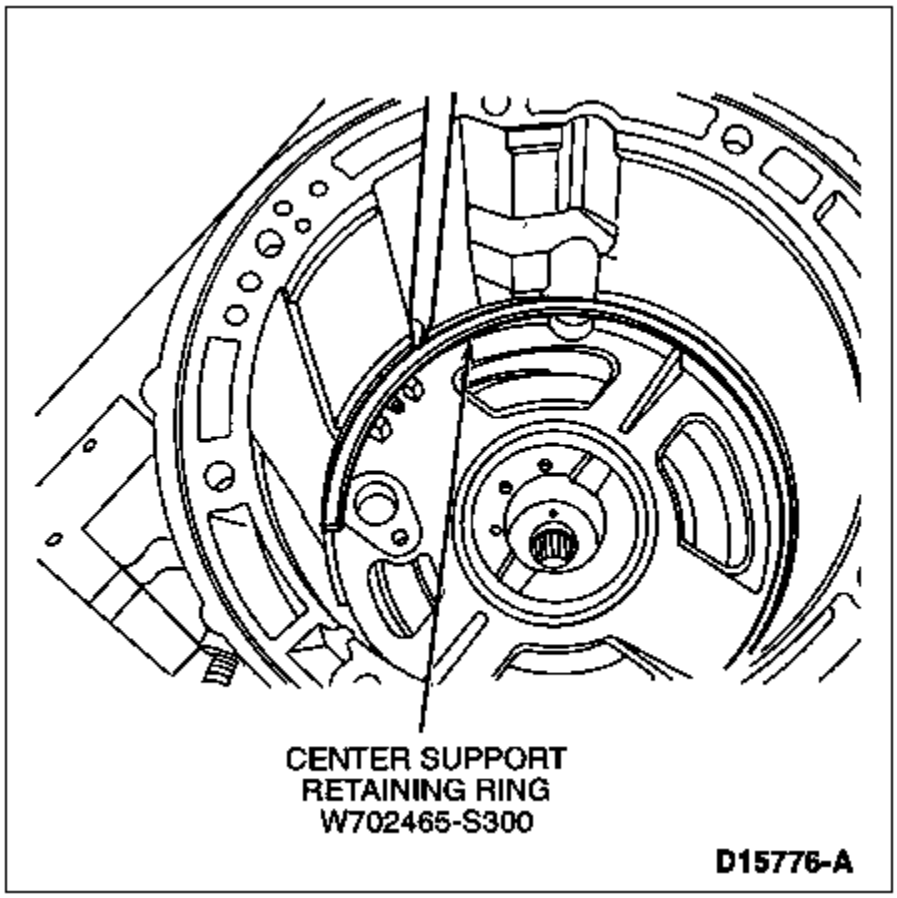

64. Remove the center support by pulling evenly around the center support web.

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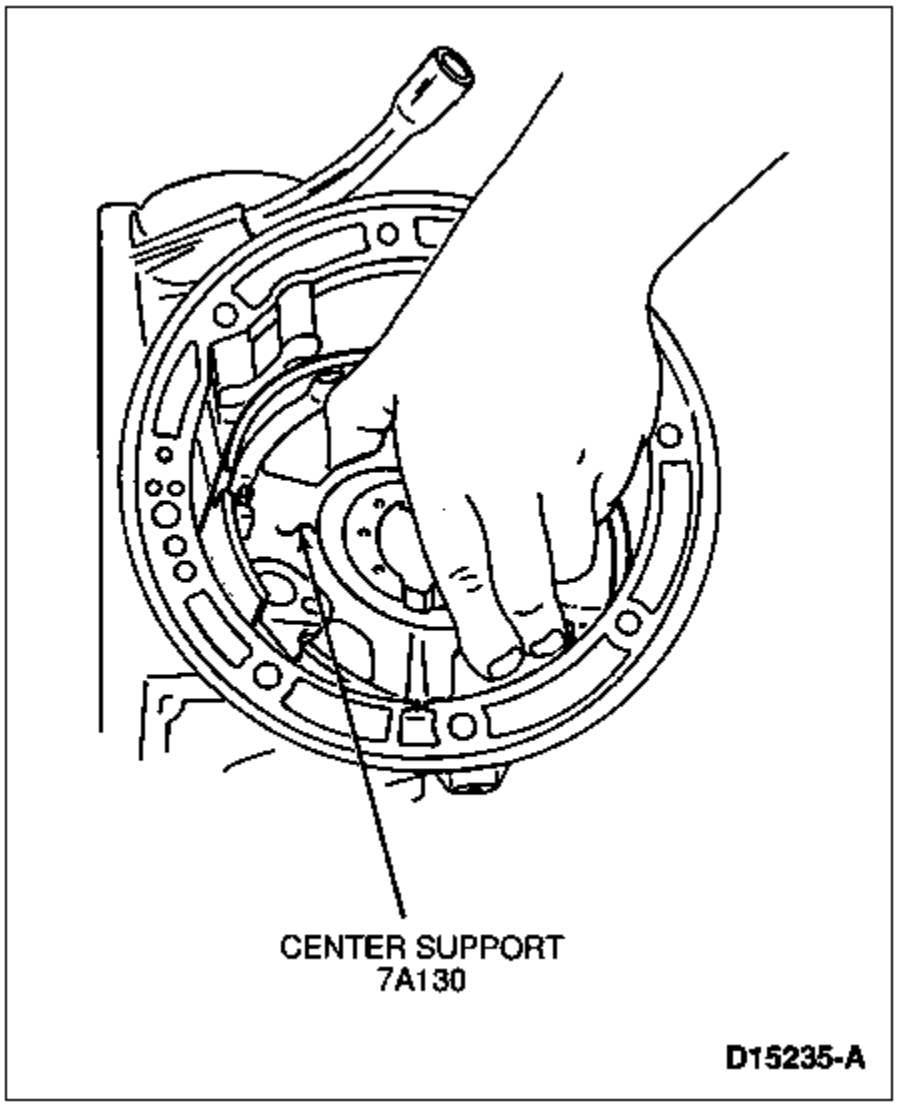
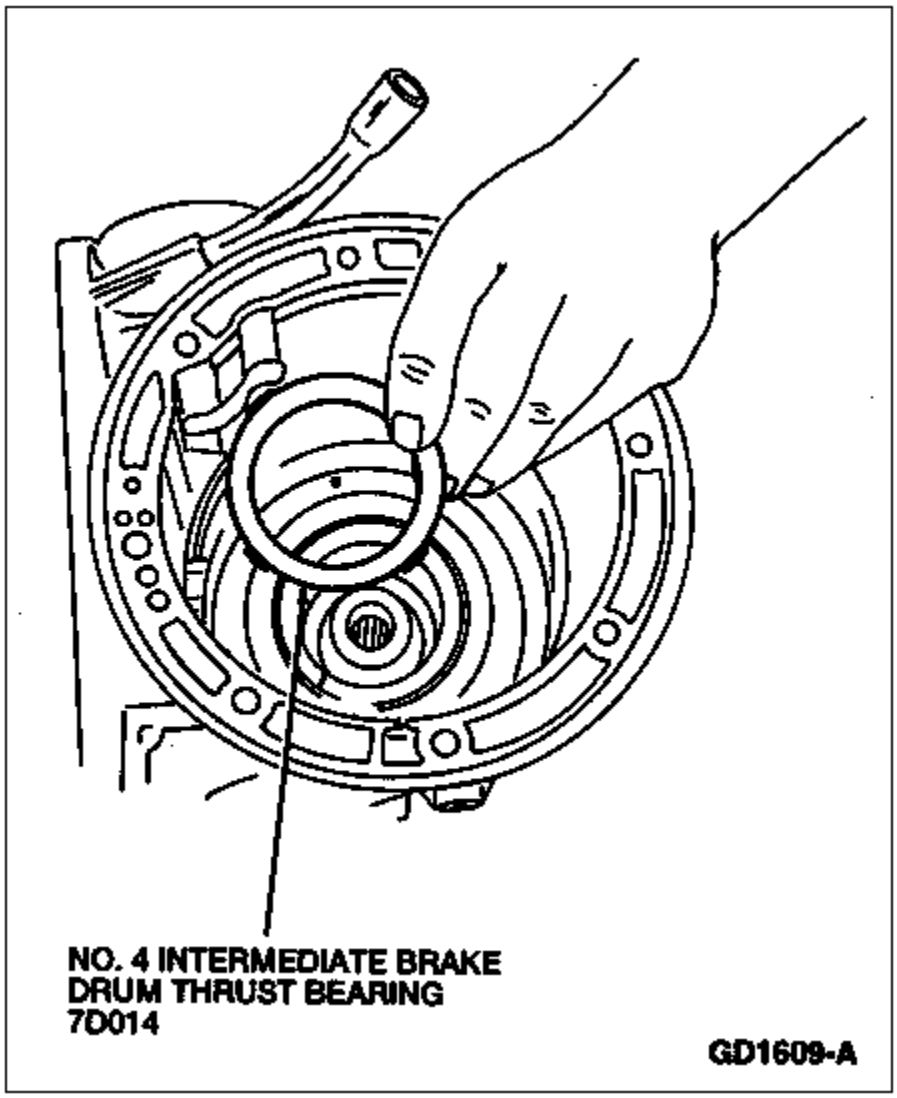


65. **NOTE: Tag and identify the No. 4 intermediate brake drum thrust bearing for assembly.**

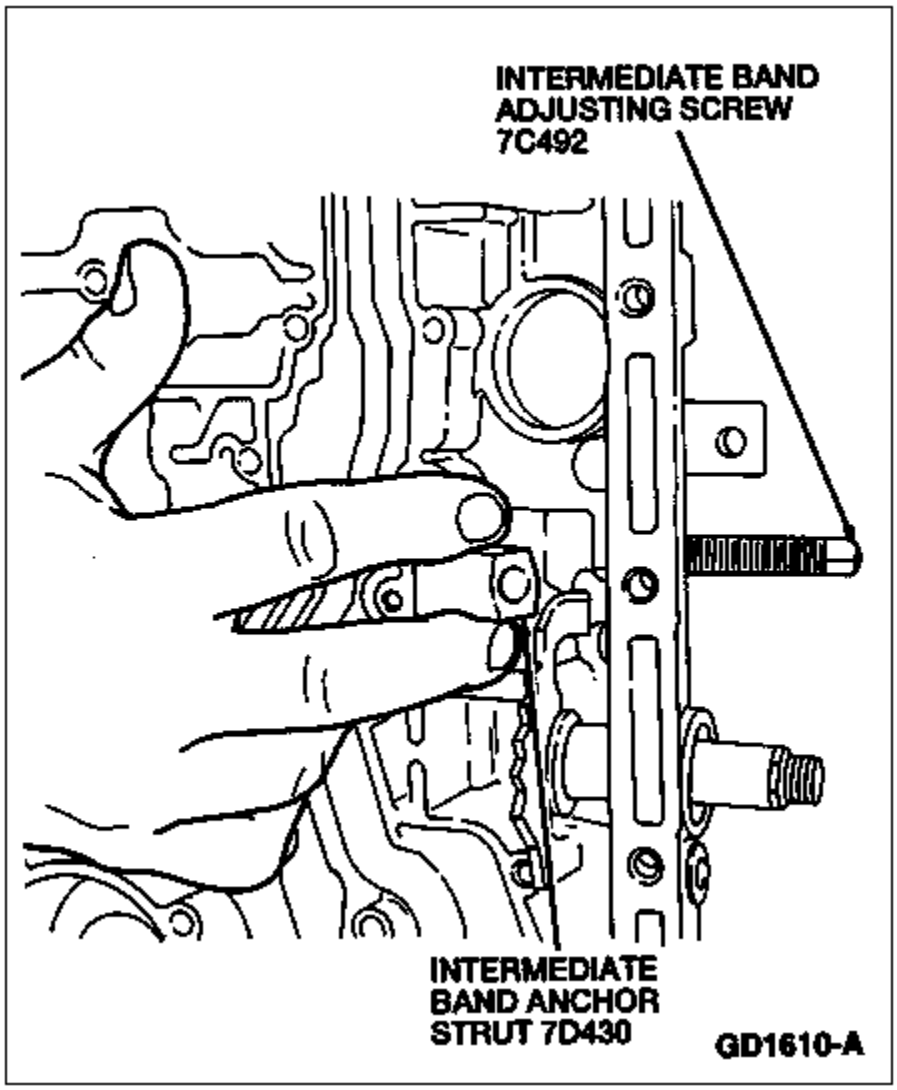
Remove the No. 4 intermediate brake drum thrust bearing.

tomsn048@gmail.com



66. Remove the intermediate band anchor strut through the bottom of the case. Remove intermediate band adjusting screw.

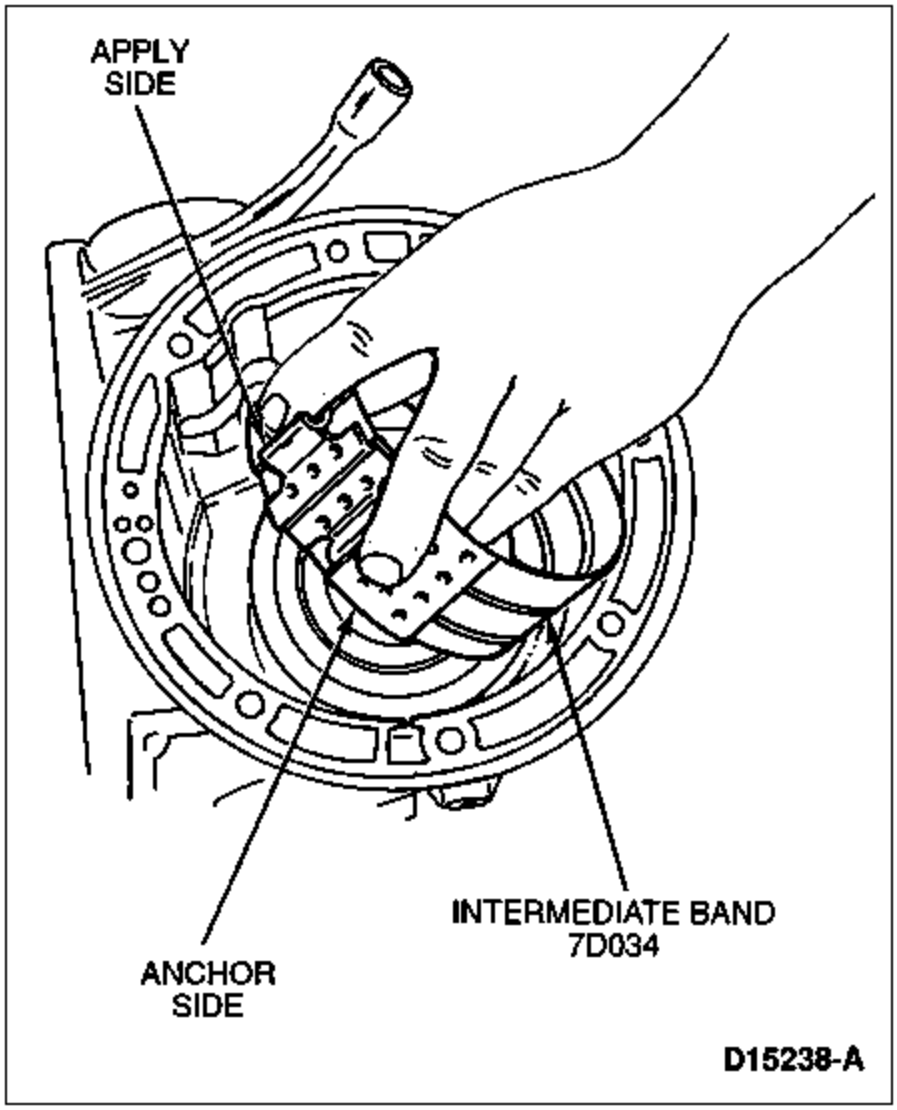
tomsn048@gmail.com



67. **CAUTION: Identify which end of the intermediate band is the anchor side or the apply side.**

Remove the intermediate band.

tomsn048@gmail.com



68. Remove the intermediate band apply strut.

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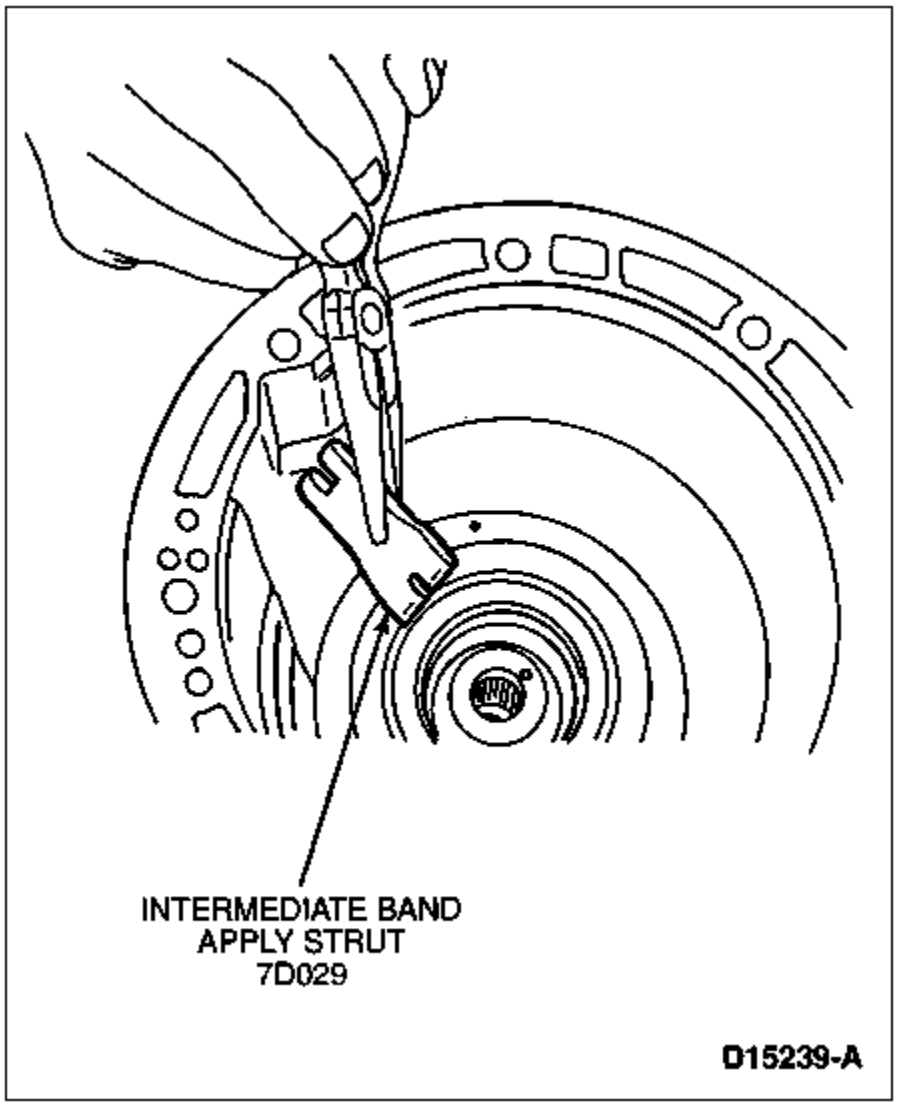

69. **NOTE: The intermediate band actuating lever shaft is shorter than the overdrive band actuating lever shaft.**

    Remove the intermediate band actuating lever shaft.

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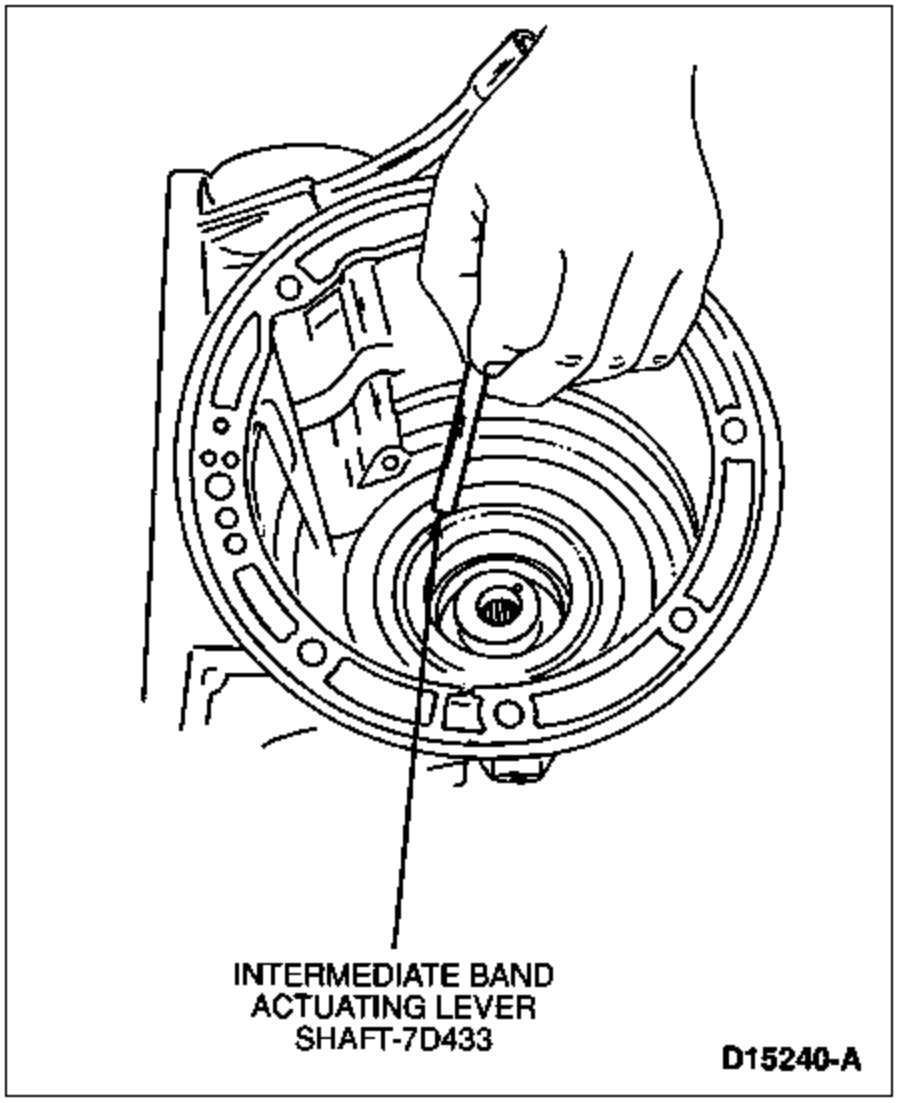

70. **NOTE: Tag and identify the intermediate band servo lever for assembly. The intermediate band servo lever has a letter stamped on its side for identification.**

    Remove the intermediate band servo lever.

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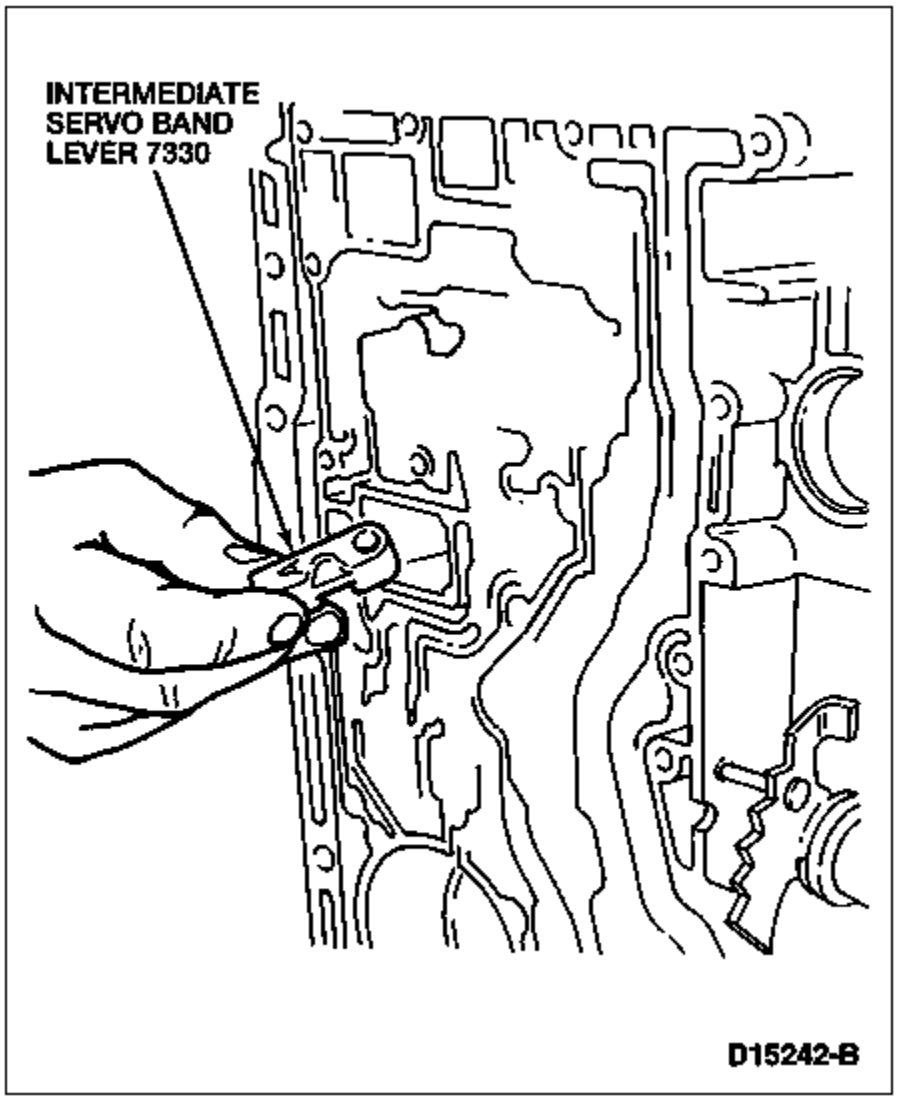

71. **CAUTION: Make sure the lock pin on Bench-Mounted Holding Fixture T57L-500-B is secure.**

Rotate the transmission so the fluid pan surface is facing up.

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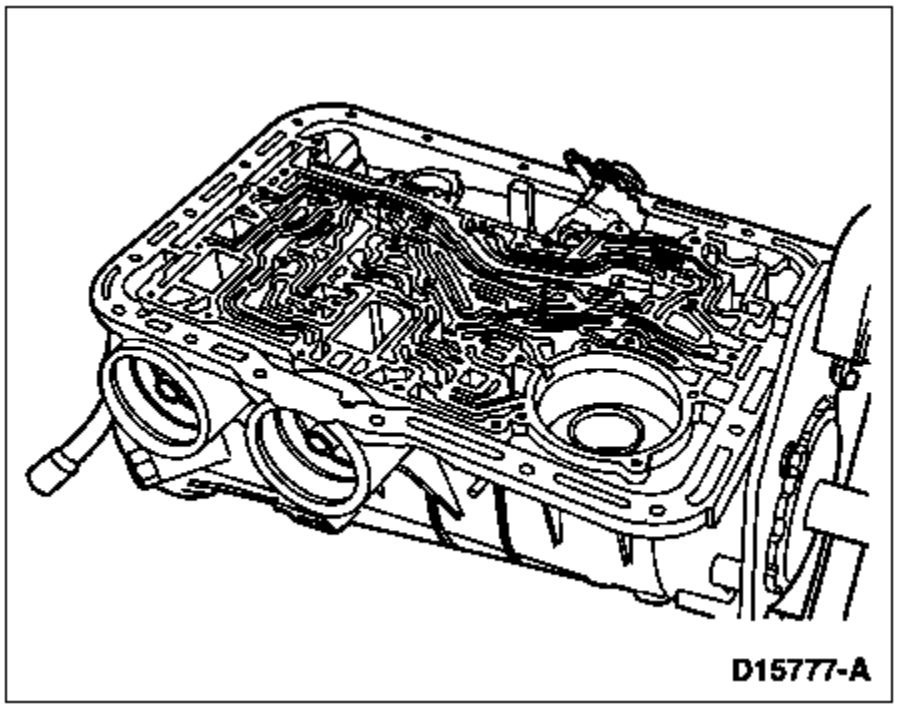

72. **NOTE: The No. 5 forward clutch cylinder thrust bearing may come out with the intermediate brake and direct clutch drum.**

    Remove the intermediate brake and direct clutch drum.

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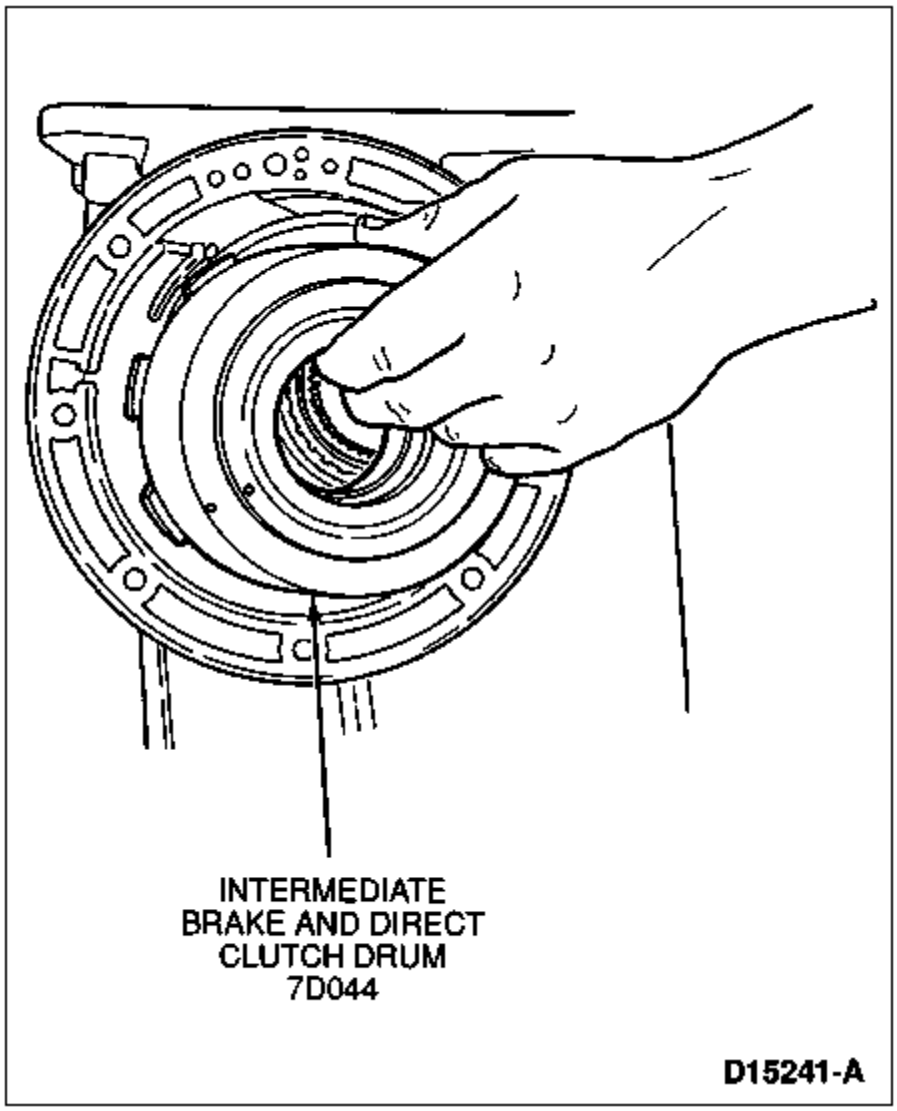

73. **NOTE: Tag and identity the No. 5 forward clutch cylinder thrust bearing for assembly.**

Remove the No. 5 forward clutch cylinder thrust bearing.

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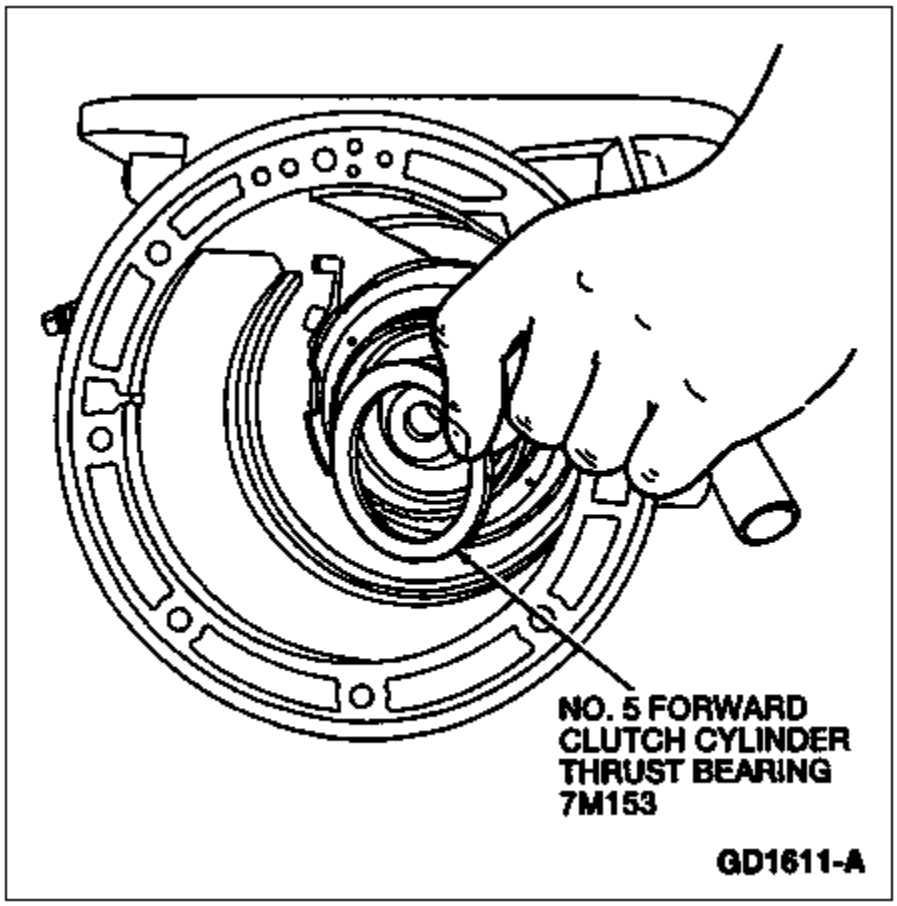

74. **NOTE: The No. 5 forward clutch cylinder thrust bearing may come out with the forward clutch cylinder.**

    Remove the forward clutch cylinder.

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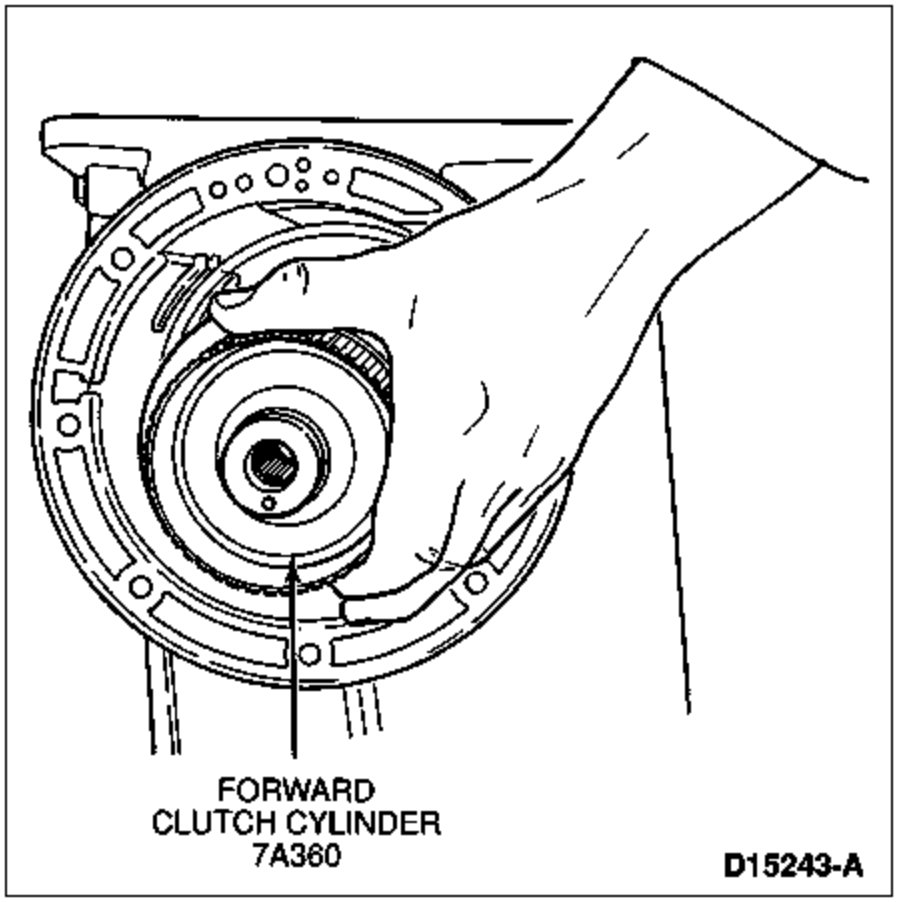

75. Remove No. 6A forward ring gear hub thrust bearing assembly.

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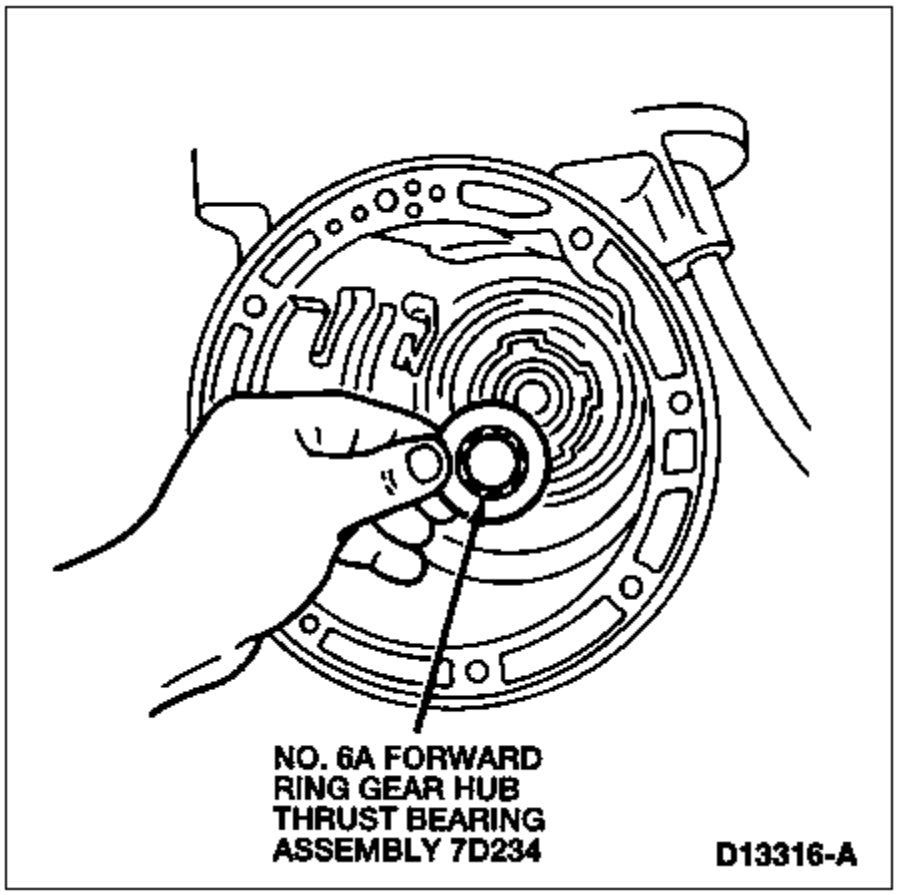

76. Remove the forward ring gear and forward ring gear hub.

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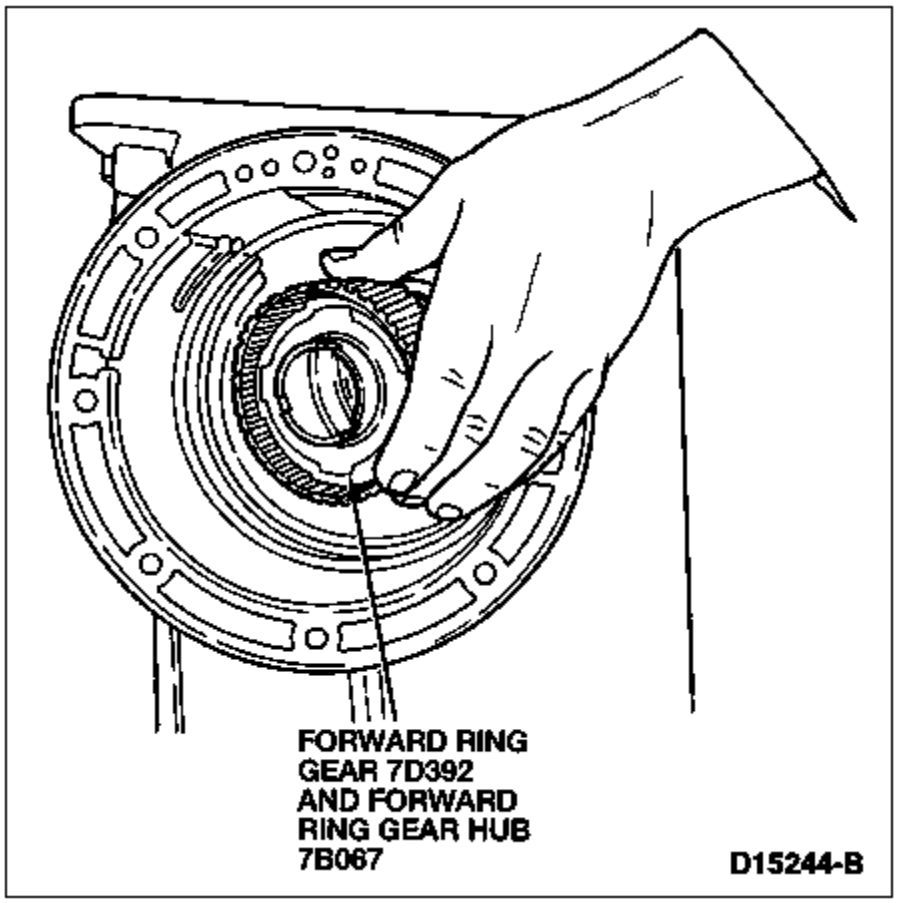
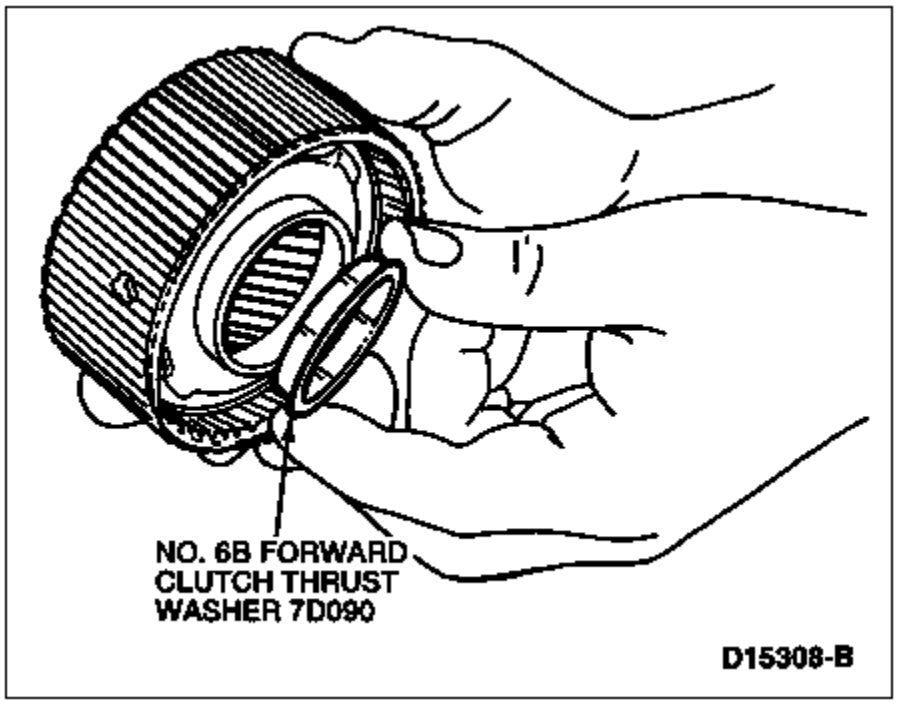


77. Remove No. 6B forward clutch thrust washer.



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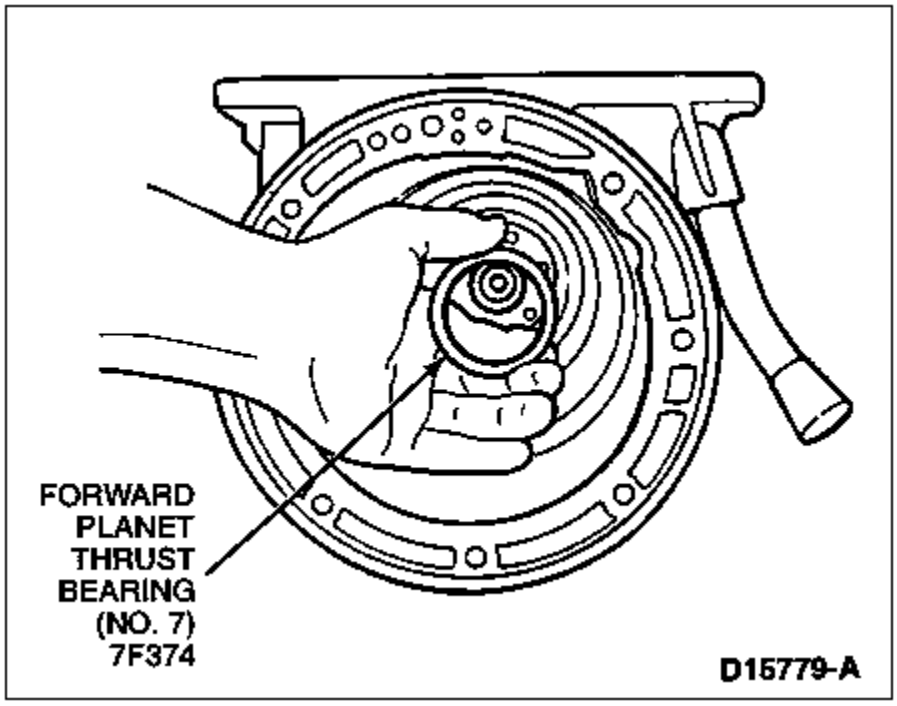
78. **NOTE: Check black oxidized side during removal to ensure correct placement during reassembly. Black oxidized side must be toward planetary assembly. The uncoated side must face up.**

    Remove the No. 7 forward planetary thrust bearing.



79. Remove the forward planetary assembly.

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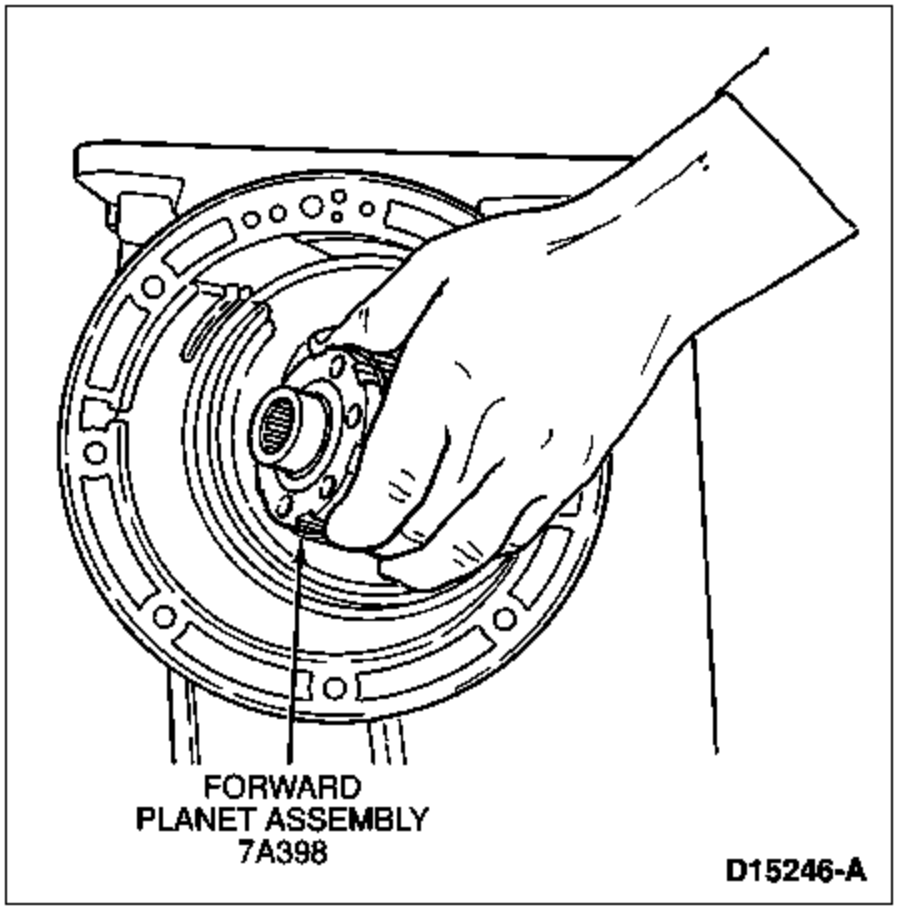
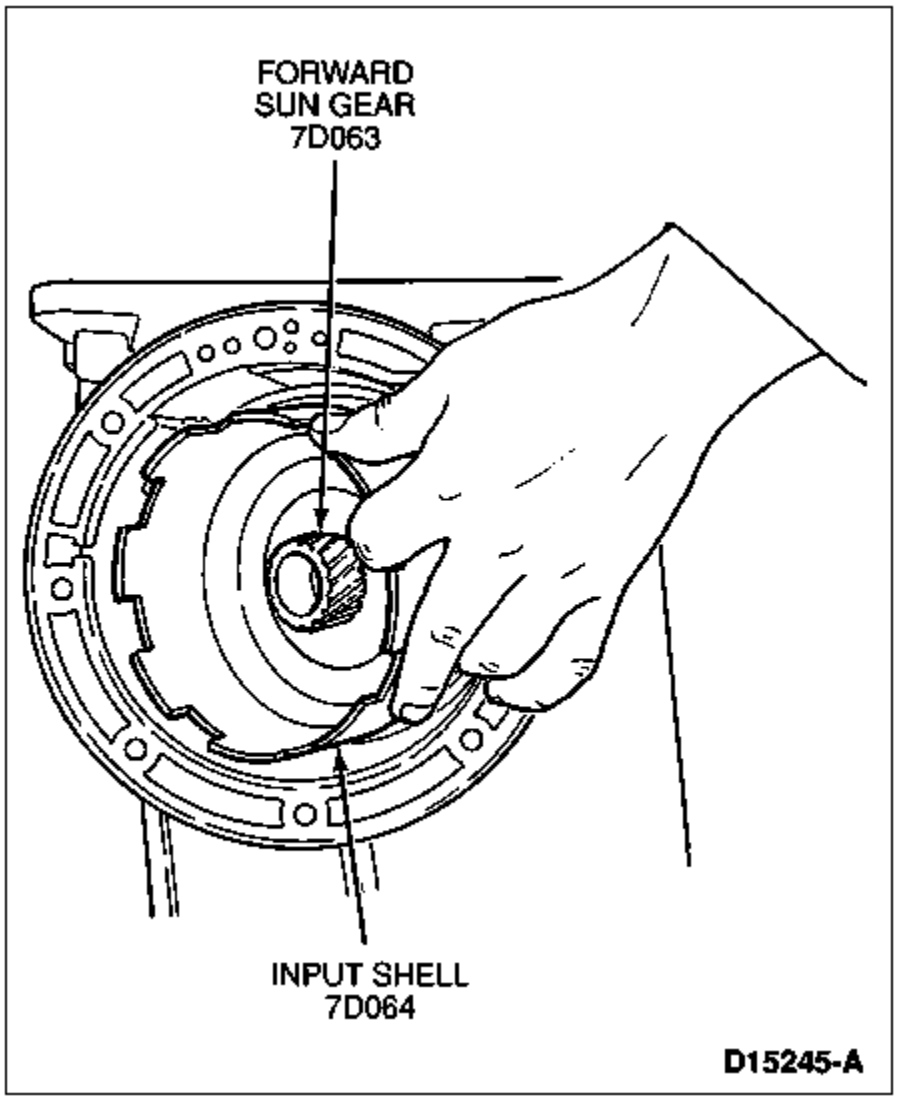


80. Remove the input shell with forward sun gear.

tomsn048@gmail.com



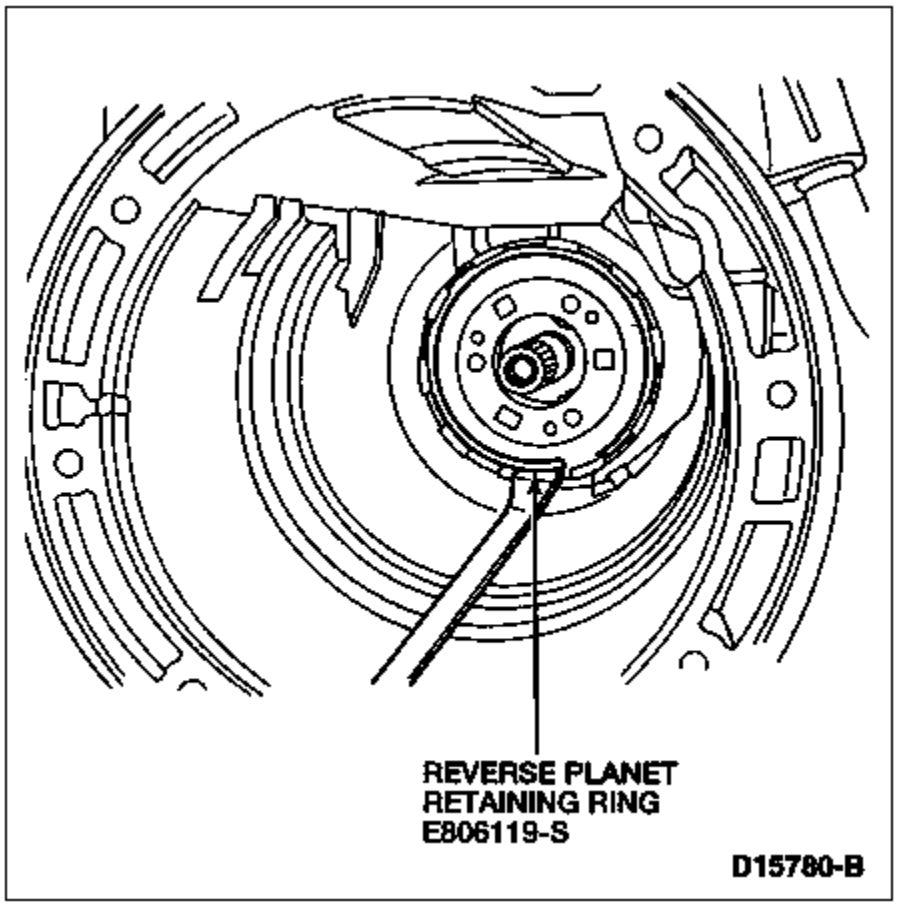
81. **NOTE: Tag and identify the No. 8 thrust bearing for assembly.**

Remove the No. 8 thrust bearing from the reverse planetary assembly.

tomsn048@gmail.com

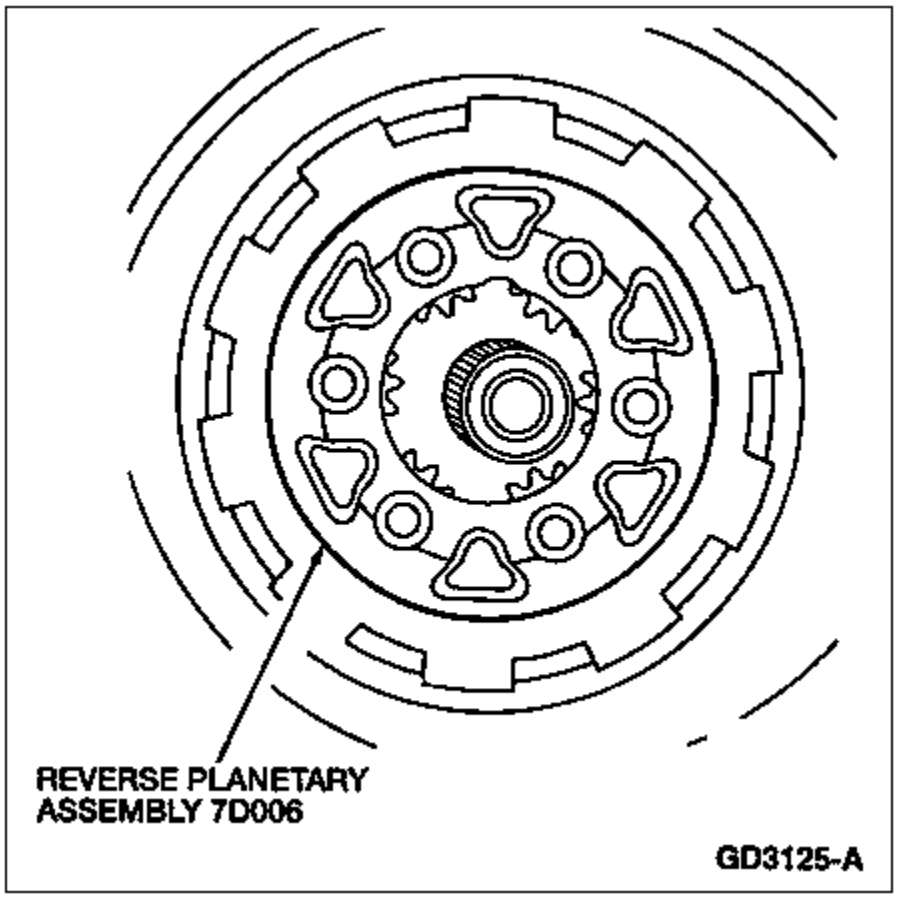
82. Remove the reverse planetary retaining ring.

tomsn048@gmail.com



83. Remove the reverse planetary assembly.

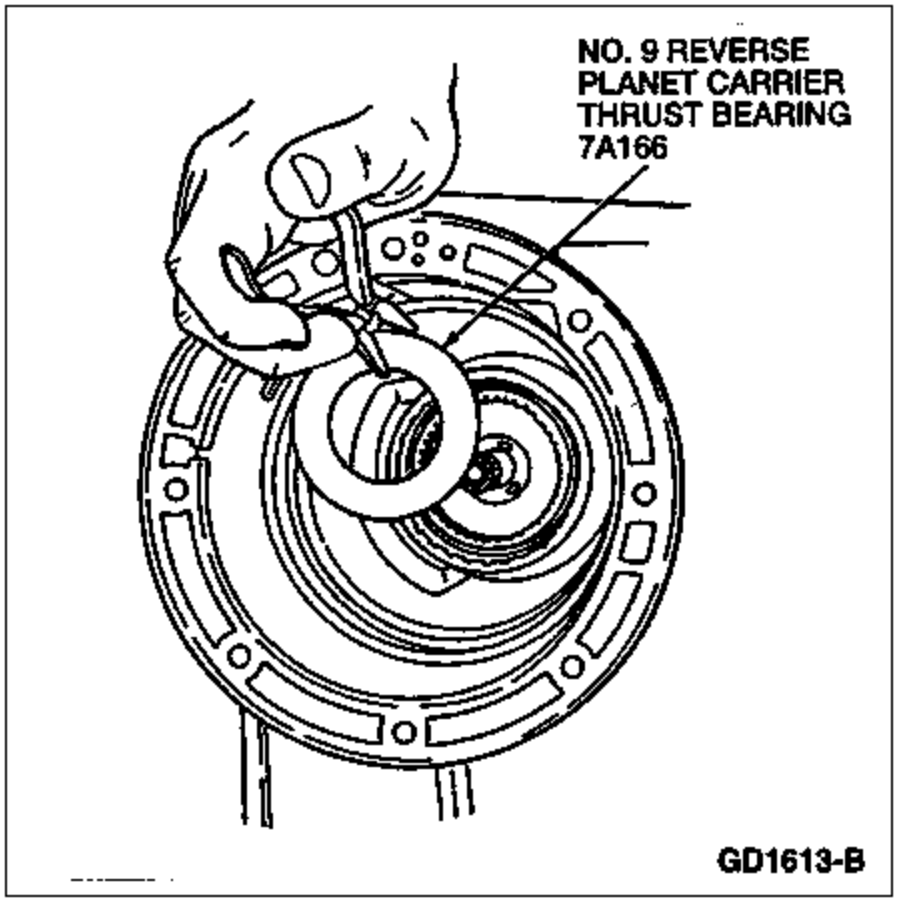
tomsn048@gmail.com



84. **NOTE: Tag and identify for reassembly.**

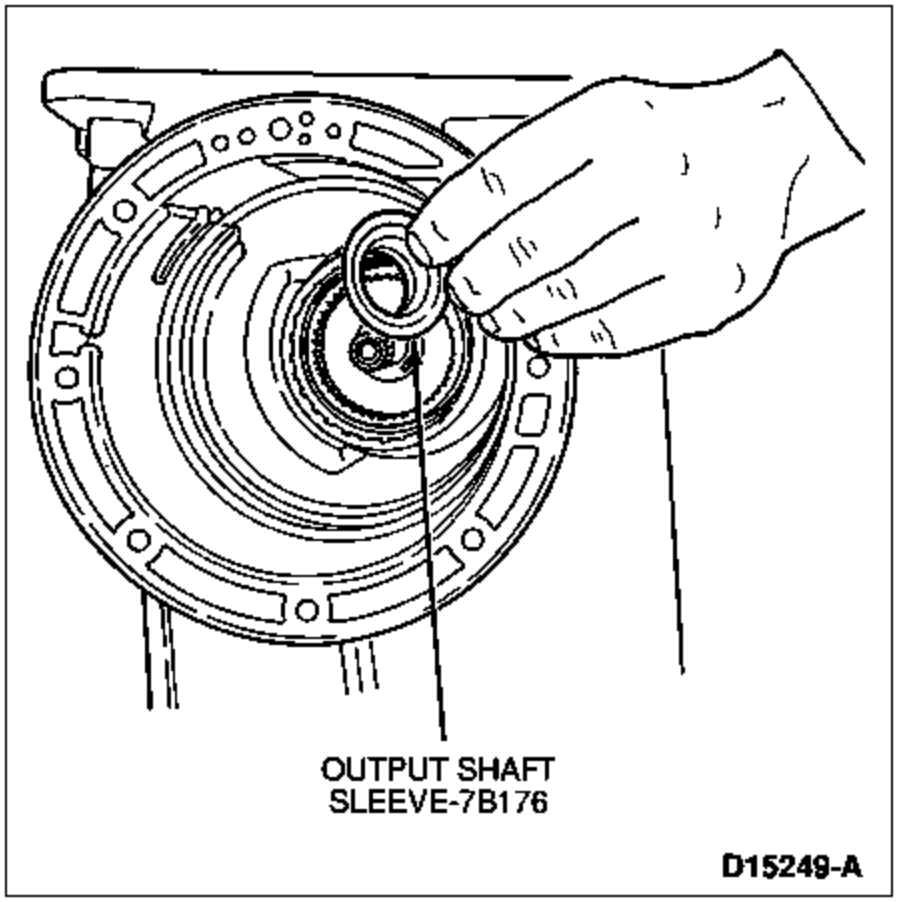
Remove the No. 9 reverse planetary carrier thrust bearing.

tomsn048@gmail.com



85. Remove the output shaft sleeve.

tomsn048@gmail.com



86. **CAUTION: Discard the output shaft retaining ring. A new retaining ring must be used for assembly.**

Remove the output shaft retaining ring from inside the case on the output shaft.

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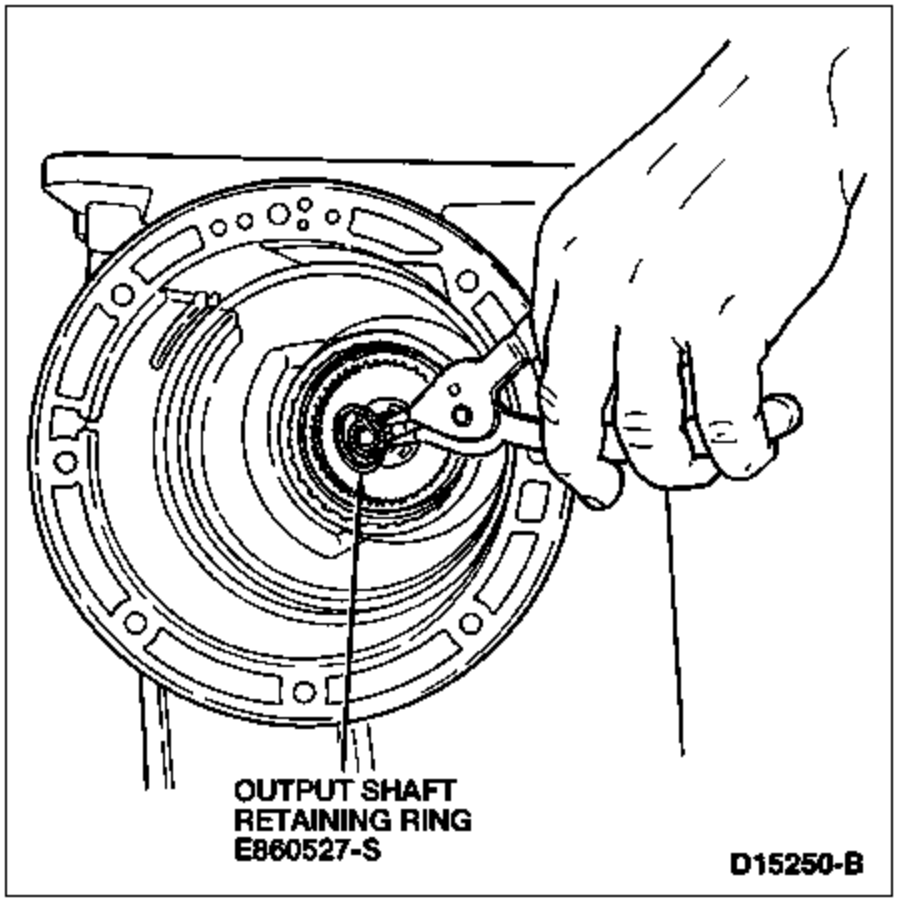

87. Remove the output shaft ring gear and output shaft hub.

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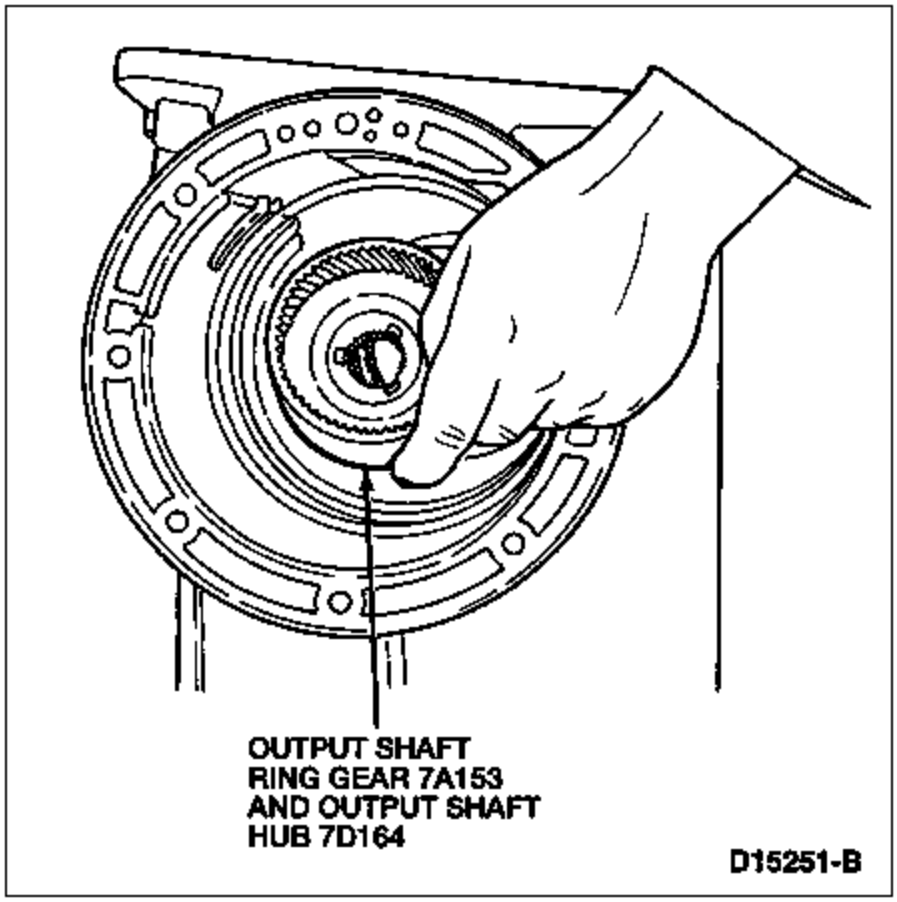

88. **NOTE: Tag and identify the No. 10B output shaft hub thrust bearing for assembly.**

Remove the No. 10B output shaft hub thrust bearing.

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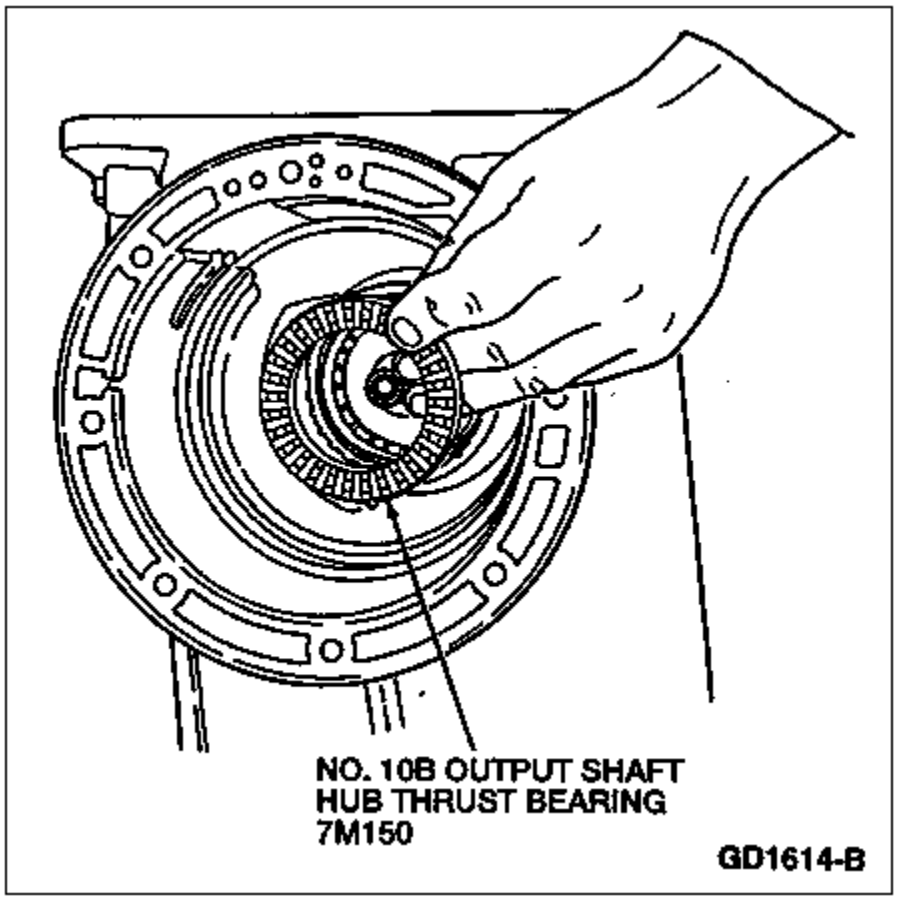

89. **NOTE: The inner race of the rear one-way clutch is not removable. It is serviced in the case.**

Remove the reverse brake drum and the one-way clutch assembly.

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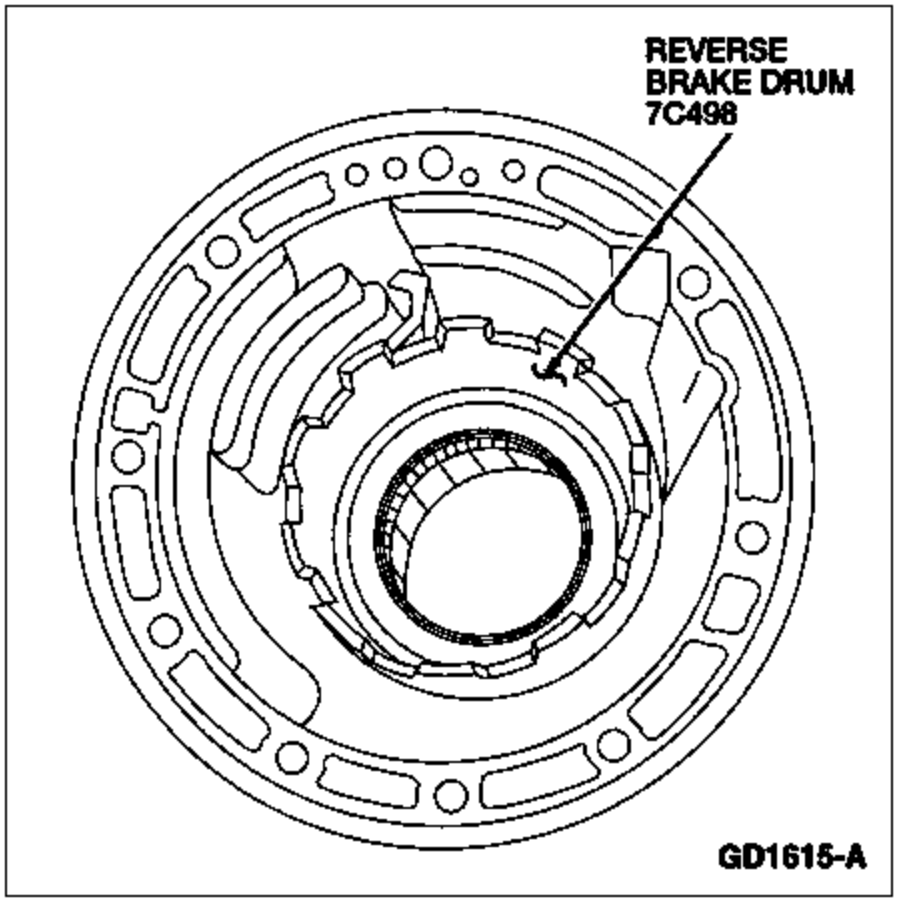

90. Remove the reverse band.

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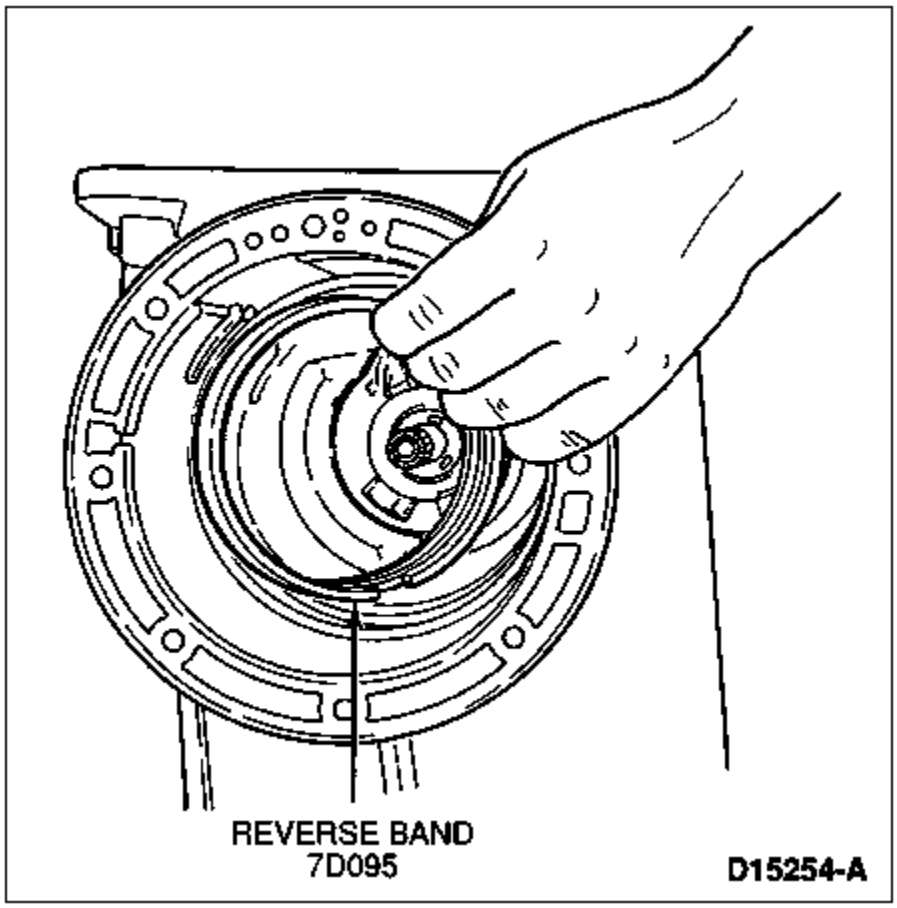

91. Remove the output shaft.

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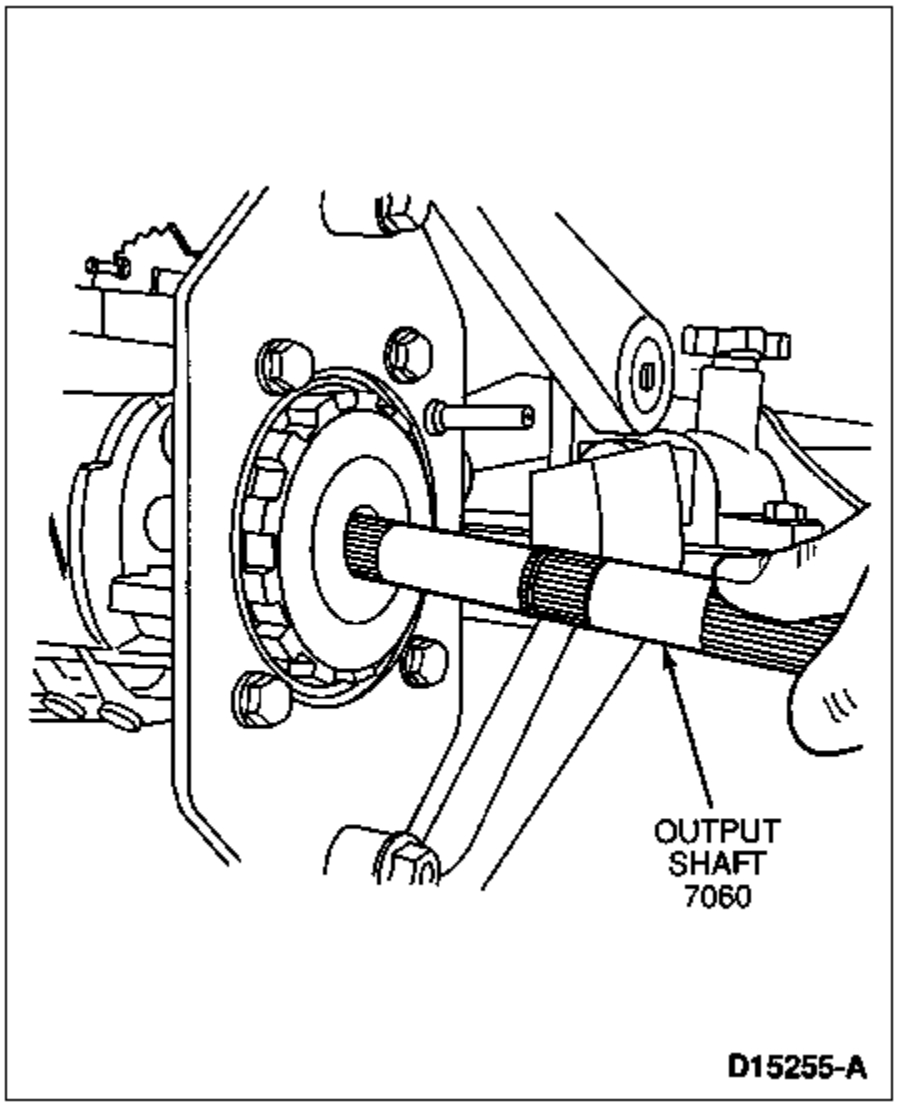
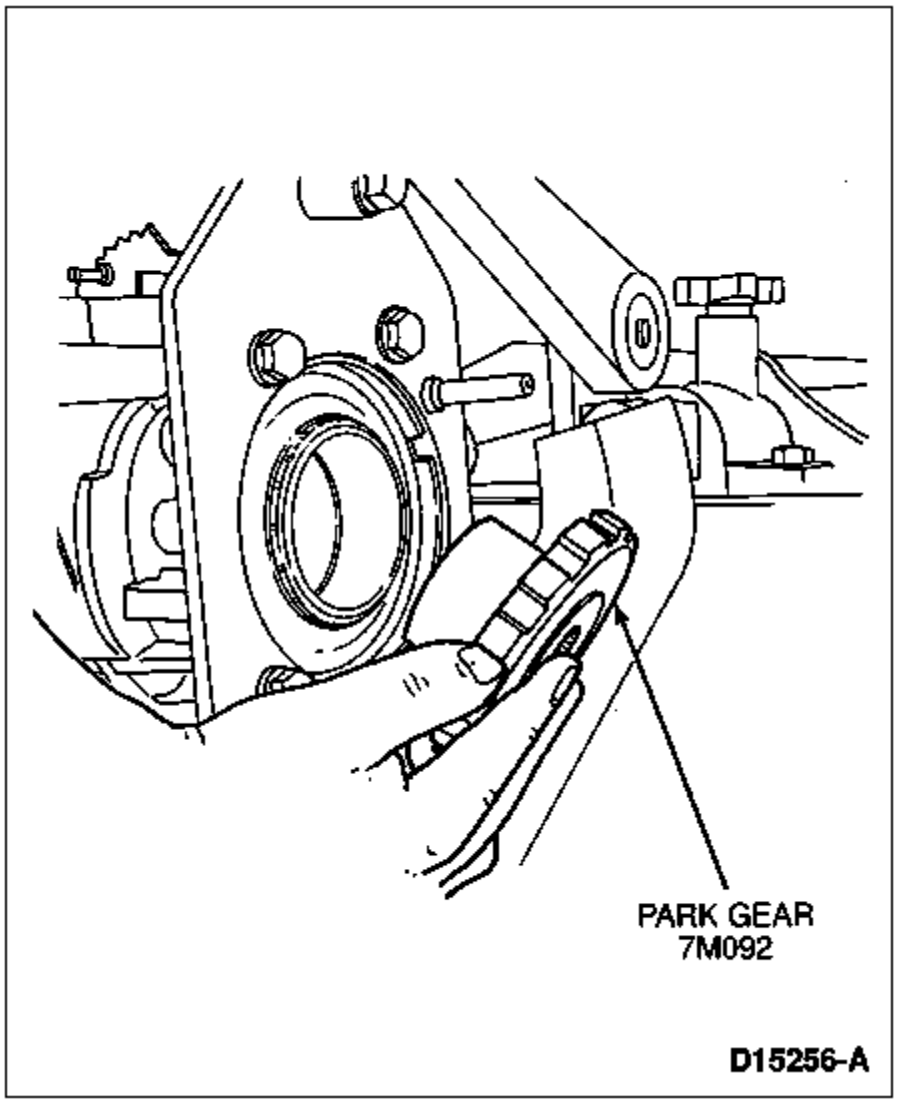


92. Remove the park gear.

tomsn048@gmail.com



93. **NOTE: Tag and identify the No. 11 output shaft thrust washer for assembly.**

Remove the No. 11 output shaft thrust washer.

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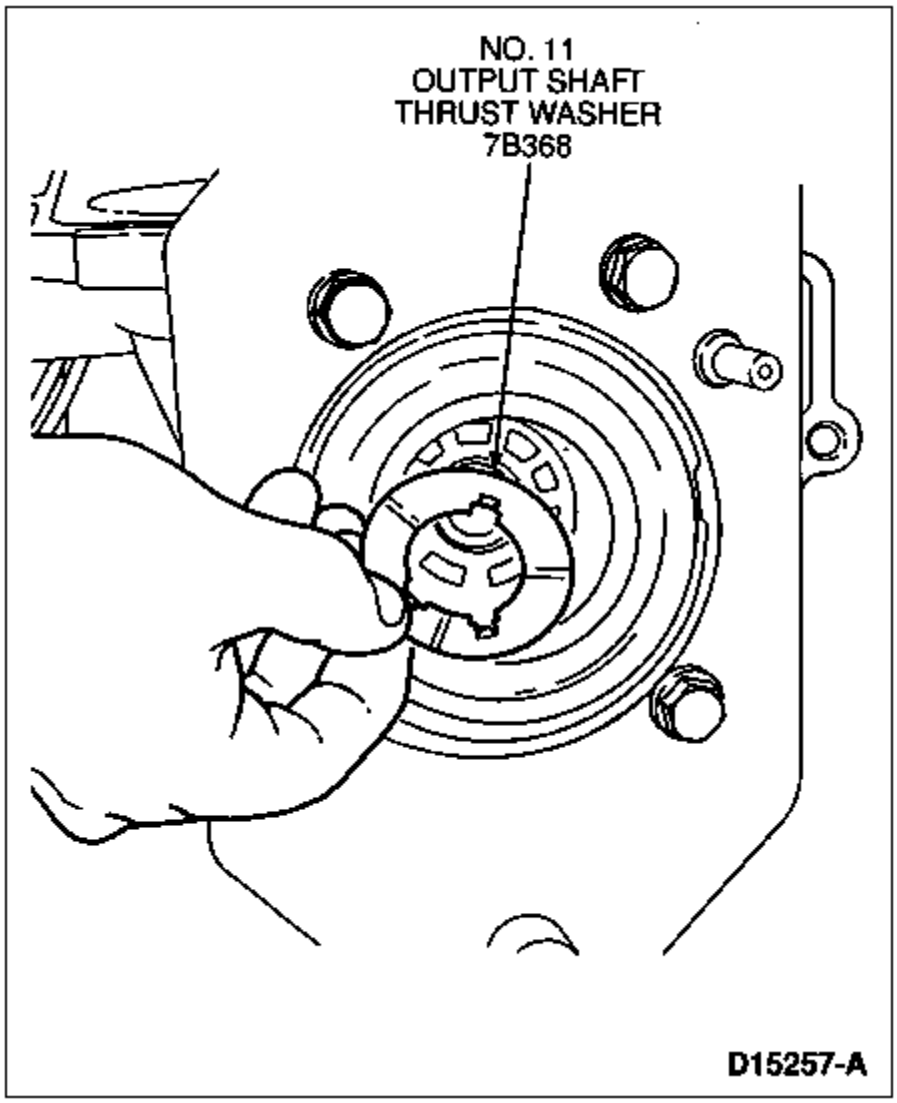
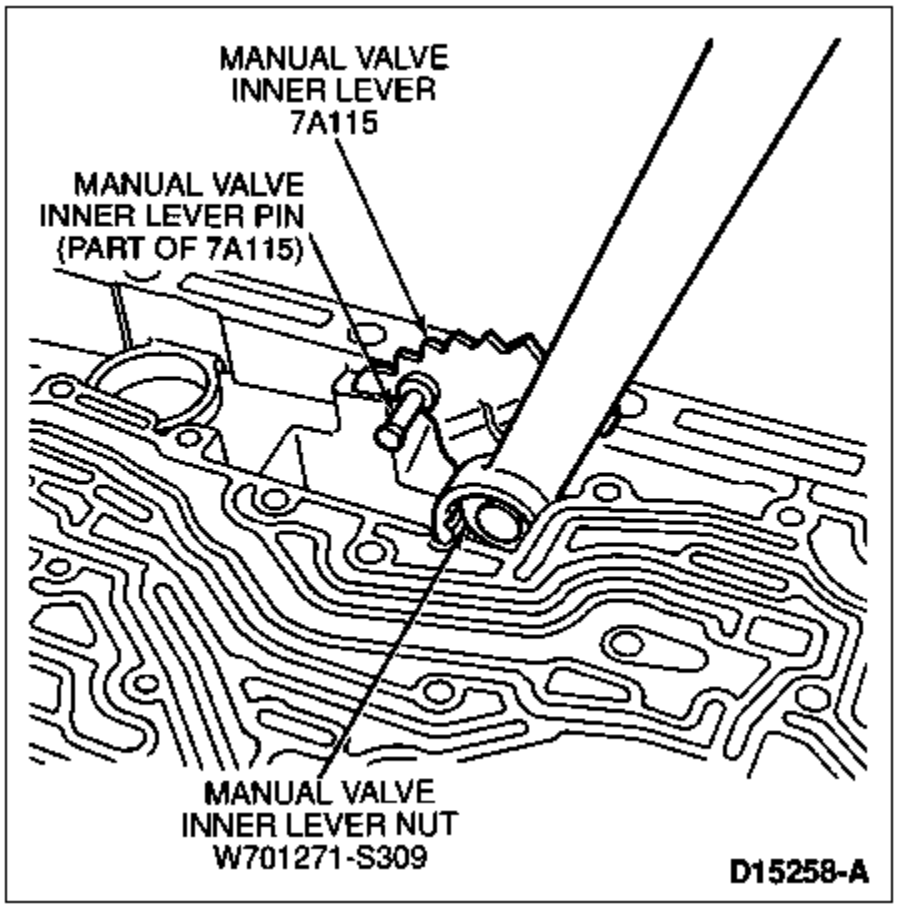


94. **CAUTION: To avoid damage, make sure wrench does not strike the manual valve inner lever pin.**

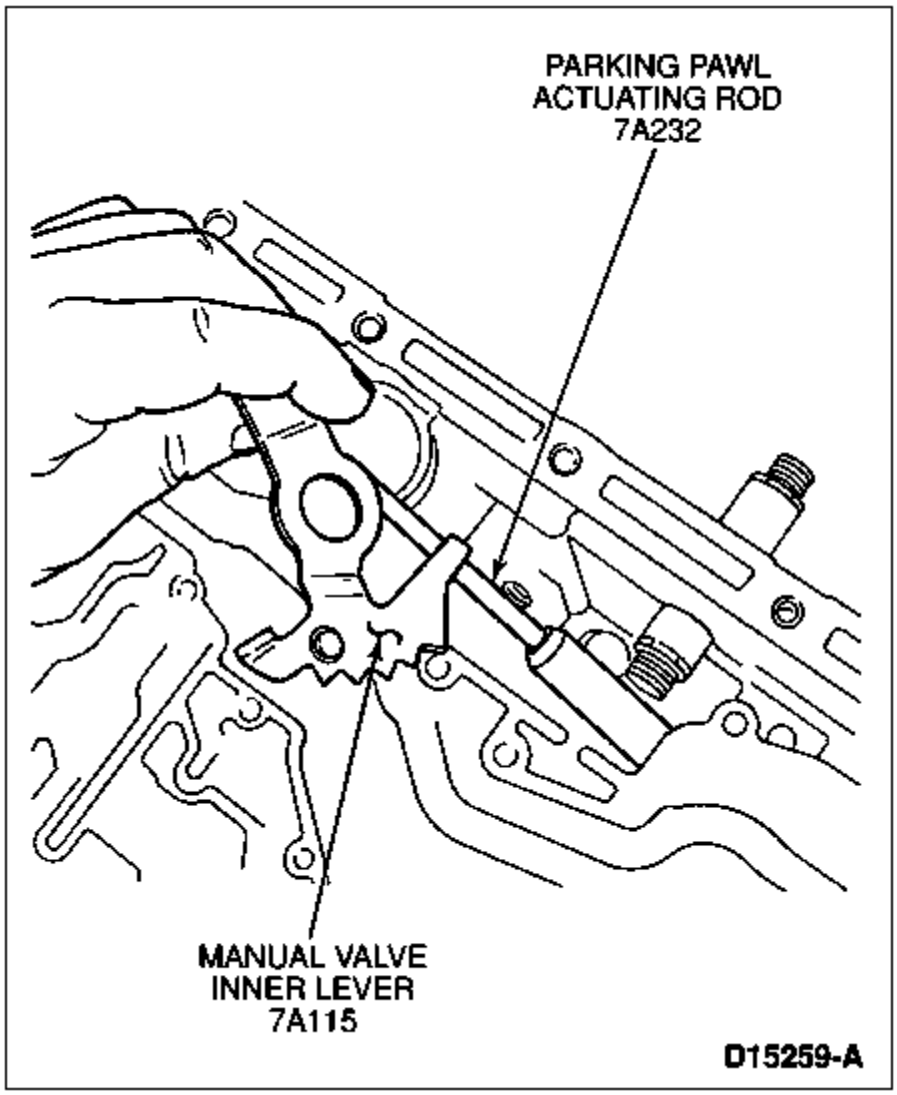
Remove the manual valve inner lever nut.

tomsn048@gmail.com



95. Remove the manual valve inner lever and parking pawl actuating rod assembly.

tomsn048@gmail.com



96. **CAUTION: Do not damage the case fluid pan rail.**

Using a small hammer and drift, tap lightly on each side of the manual control lever shaft retaining pin (two or three times). This will loosen the pin prior to removal.

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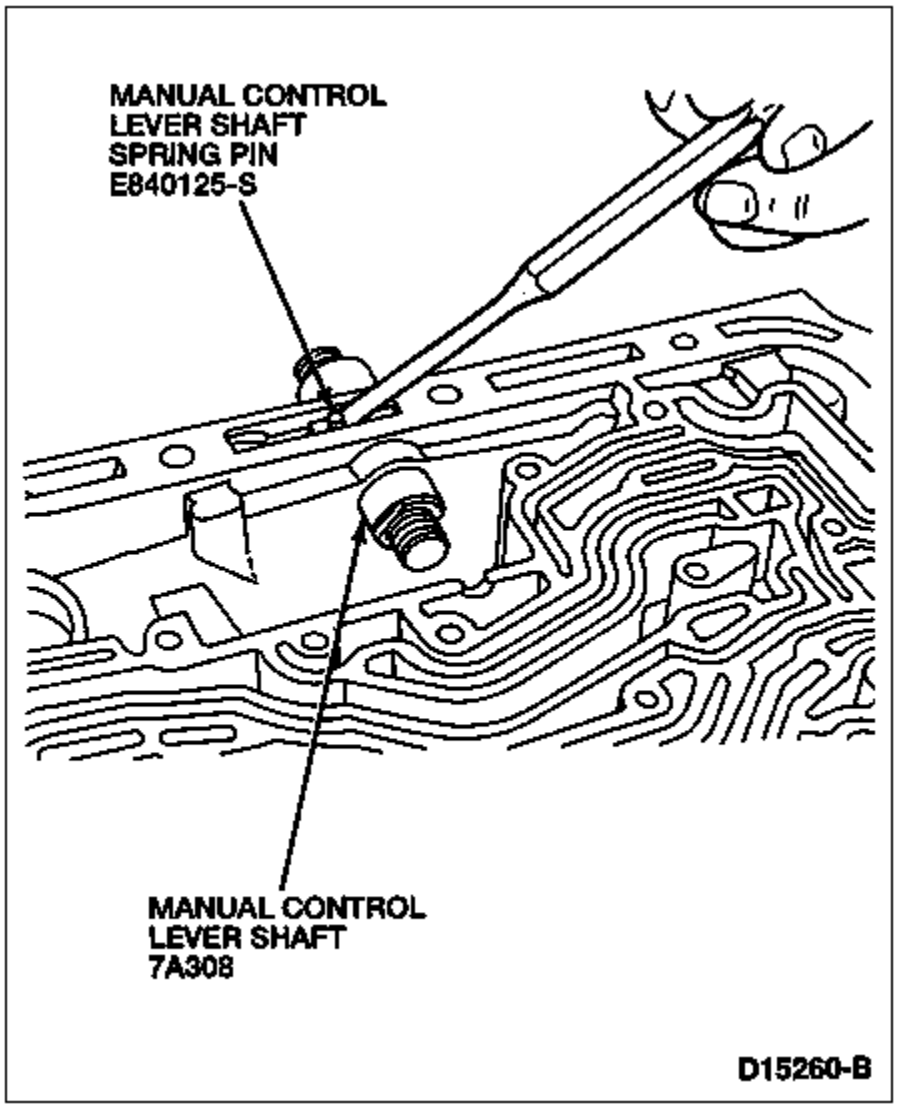

97. **CAUTION: Do not damage the case fluid pan rail.**

Remove the manual control lever shaft retaining pin with a narrow, sharp edged screwdriver from the side as shown.

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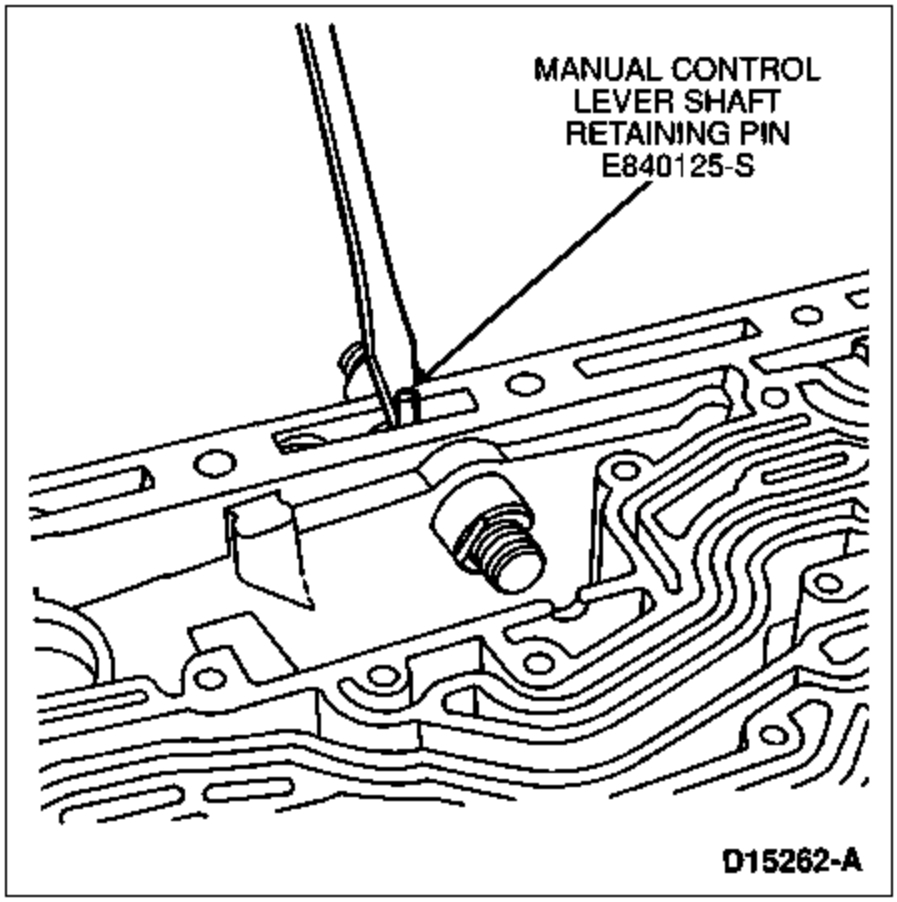

98. Remove the manual control lever shaft.

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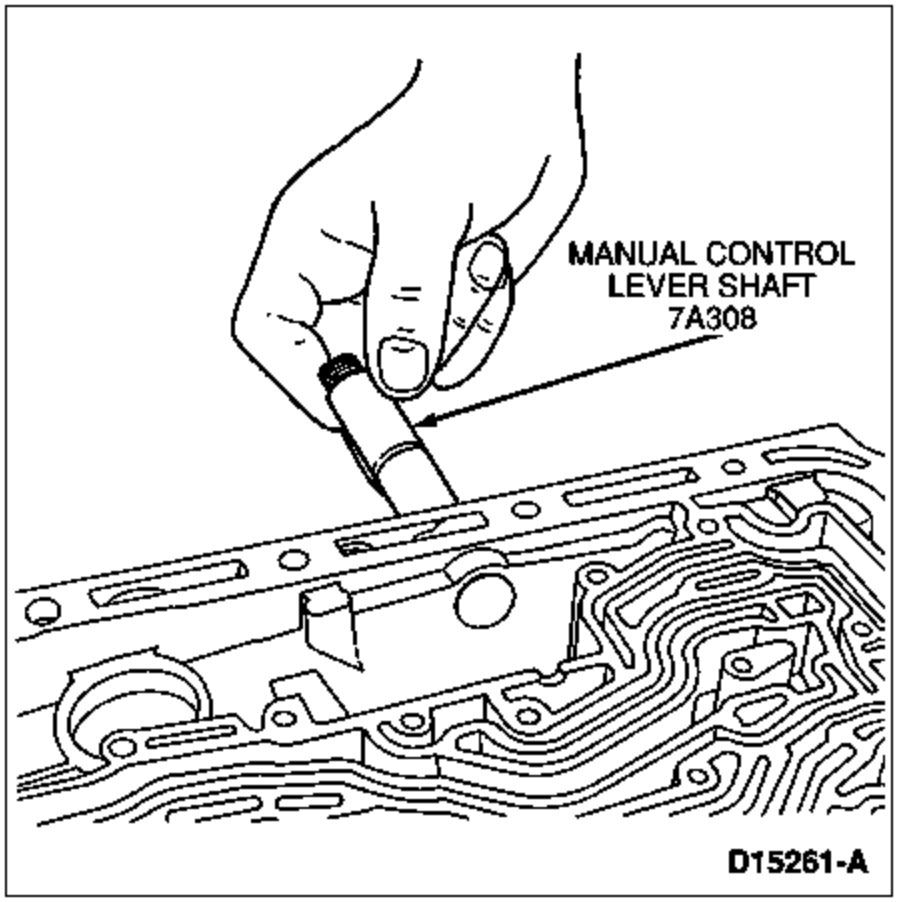

99. **CAUTION: Do not damage the bore.**

Remove the manual control lever seal.

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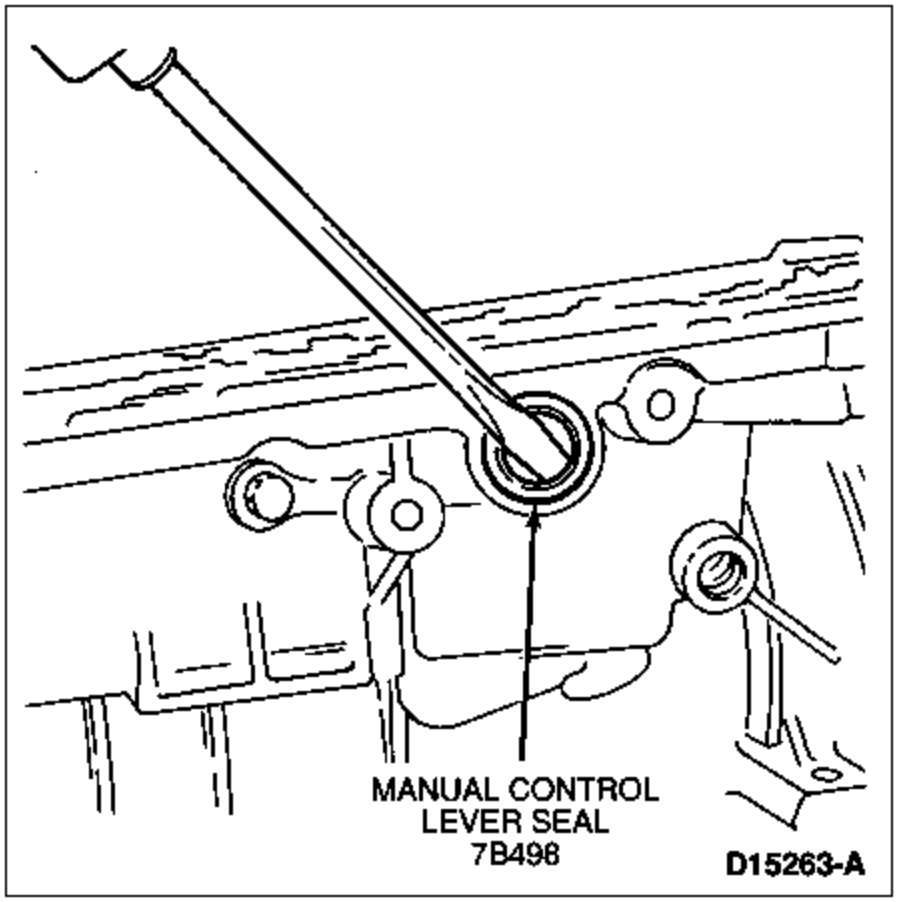

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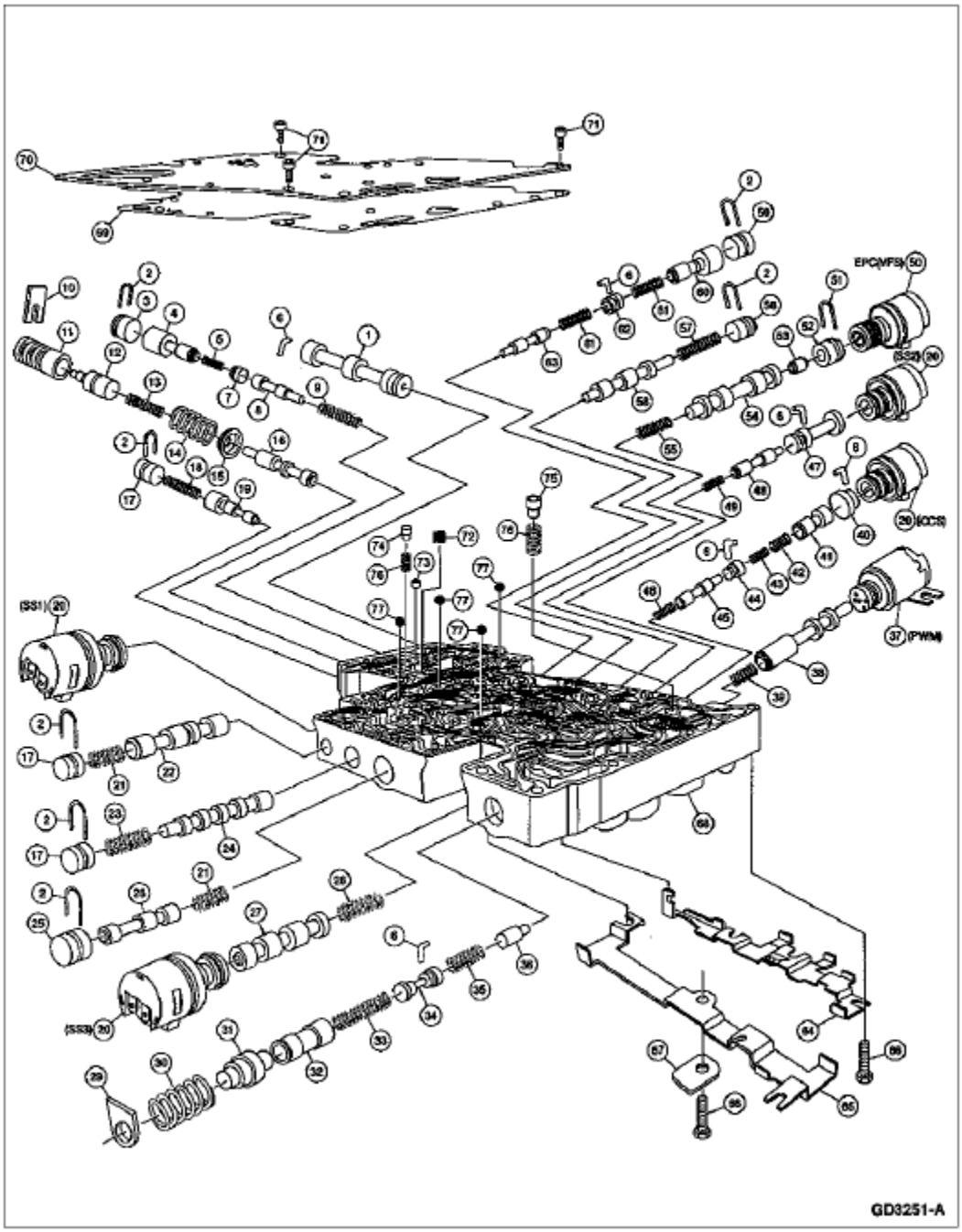
Main Control Valve Body

Main Control Valve Body



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Item	Part Number	Description
1	—	Valve Manual
2	7E335	Retainer — Valve Plug (7 Req'd)
3	—	Plug — Valve Retainer
4	—	Valve — Forward Modulator
5	—	Spring — Forward Modulator
6	7E335	Retainer — Valve Plug (6 Req'd)
7	—	Plug — Valve Retainer
8	—	Valve — EPC Boost
9	—	Spring — EPC Boost
10	7E336	Retainer — Valve Plug
11	—	Sleeve — Pressure Boost Valve
12	—	Valve — Pressure Boost
13	—	Spring — Pressure Boost
14	—	Spring — Oil Pressure Regulator
15	—	Retainer — Main Regulator Spring
16	—	Valve — Pressure Regulator
17	—	Plug — Valve Retainer (3 Req'd)
18	—	Spring — Forward Engagement
19	—	Valve — Forward Engagement Control
20	7G484	Solenoid — Shift (4 Req'd)
21	—	Spring — 3-2 (K.D./T.D.) (2 Req'd)
22	—	Valve — 3-2 (K.D.)
23	—	Spring — Manual Low (1)
24	—	Valve — Manual Low (1)
25	—	Plug — Valve Retainer
26	—	Valve — 3-2 (T.D.)
27	—	Valve — 3-4 Shift
28	—	Spring — 3-4 Shift
29	7E366	Retainer — Valve Plug
30	—	Spring — Thermostat Bypass
31	—	Valve — Thermostat Bypass
32	—	Valve — Thermostatic Bypass
33	—	Spring — Thermostat Bypass
34	—	Plug — Valve Retainer
35	—	Spring — Cooler Limit
36	—	Valve — Cooler Limit
37	7G136	Solenoid — Converter Clutch (PWM)

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38	—	Valve — Converter Clutch
39	—	Spring — Converter Clutch
40	—	Plug — Valve Retainer
41	—	Valve — Converter Clutch
42	—	Spring — Converter Clutch
43	—	Spring — Converter Clutch (3.0L and 4.0L Only)
44	—	Plug — Valve Retainer
45	—	Valve — Coast Clutch
46	—	Spring — Coast Clutch
47	—	Plug — Valve Retainer
48	—	Valve — 3-2 Downshifts
49	—	Spring — 3-2 Downshifts
50	7G383	Solenoid — EPC (VFS)
51	7E335	Retainer — Valve Plug
52	—	Plug — Valve Retainer
53	—	Valve — 1-2 Shift
54	—	Valve — 1-2 Shift
55	—	Spring — 1-2 Shift
56	—	Plug — Valve Retainer
57	—	Spring — 2-3 Shift
58	—	Valve — 2-3 Shift
59	—	Plug — Valve Retainer
60	—	Valve — Reverse Modulation
61	—	Spring — Reverse Modulation (2 Req'd)
62	—	Plug — Valve Retainer
63	—	Valve — Reverse Modulation
64	7L491	Clamp — SS1/SS2
65	7L491	Clamp — SS3/CCS/EPC/TCC
66	E800155-S72	Screw — Retain Solenoid Clamps (2 Req'd)
67	7D132	I.D. Plate
68	—	Body — Valve
69	7D100	Gasket — Separator Plate
70	7A008	Plate — Separator
71	E804357-S	Screw — Retain Separator Plate (3 Req'd)
72	7N113	Screen — EPC Limit Circuit
73	7D376	Extension Housing Lube Orifice
74	7E368	Valve EPC Limit (Metal)
75	7E368	Valve Converter Relief (Plastic)
76	7E340	Spring — EPC Limit/Converter Relief (2 Req'd)

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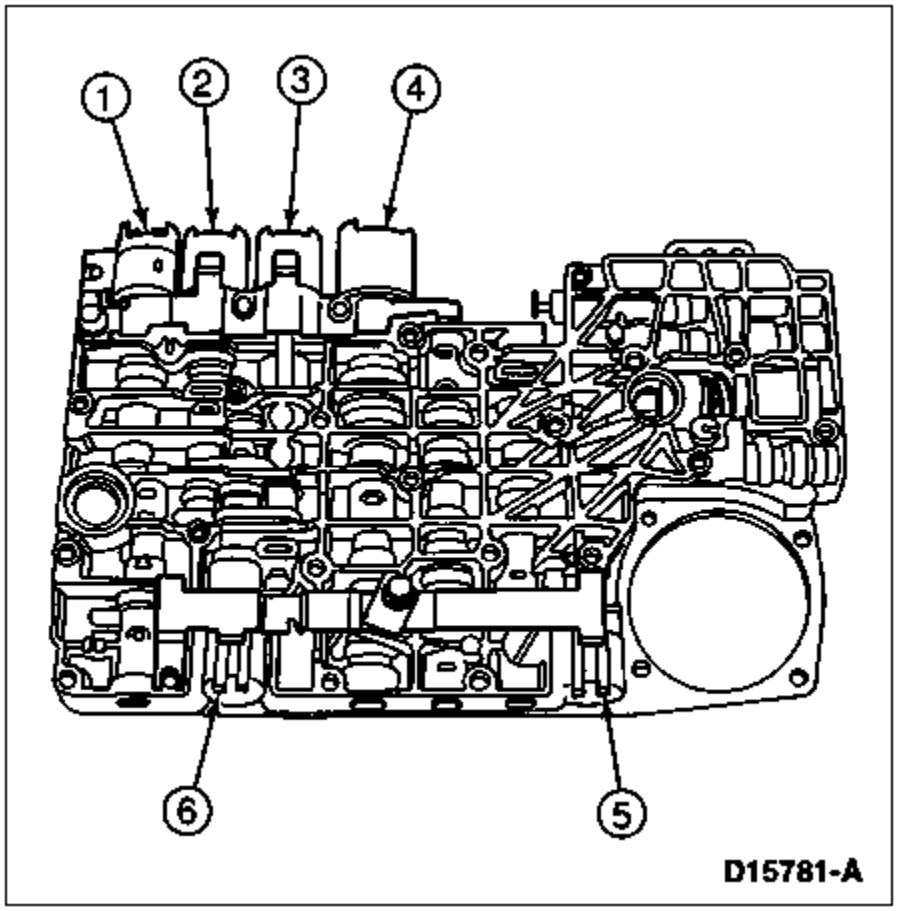
	7E195	Ball (4 Req'd)

Disassembly



Item	Part Number	Description
1	7F037	Torque Converter Clutch Solenoid Assembly
2	7G484	Coast Clutch Solenoid Assembly
3	7G484	Shift Solenoid 2 Assembly
4	7H144	EPC Solenoid Assembly
5	7G484	Shift Solenoid 1 Assembly
6	7G484	Shift Solenoid 3 Assembly

1. **CAUTION: SS3 may pop out of its bore. This may damage the solenoid.**

   Use a 10 mm socket to remove the SS1 and SS3 solenoid clamp screws. Remove the solenoid clamp and the solenoids.

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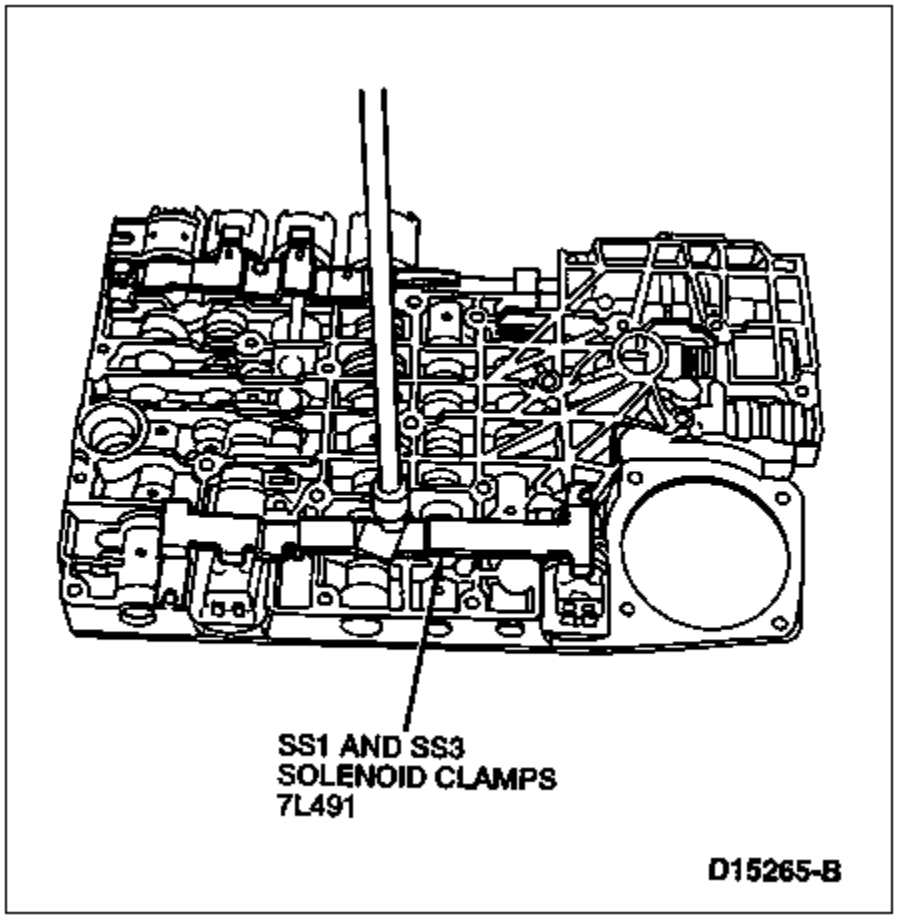

2. **NOTE: The TCC solenoid may pop out of its bore.**

   The converter modulator valve may come out after the TCC solenoid has been removed. This may damage the solenoid or converter modulator valve.

   Remove the TCC, CCS, SS2 and EPC solenoid clamp screw.

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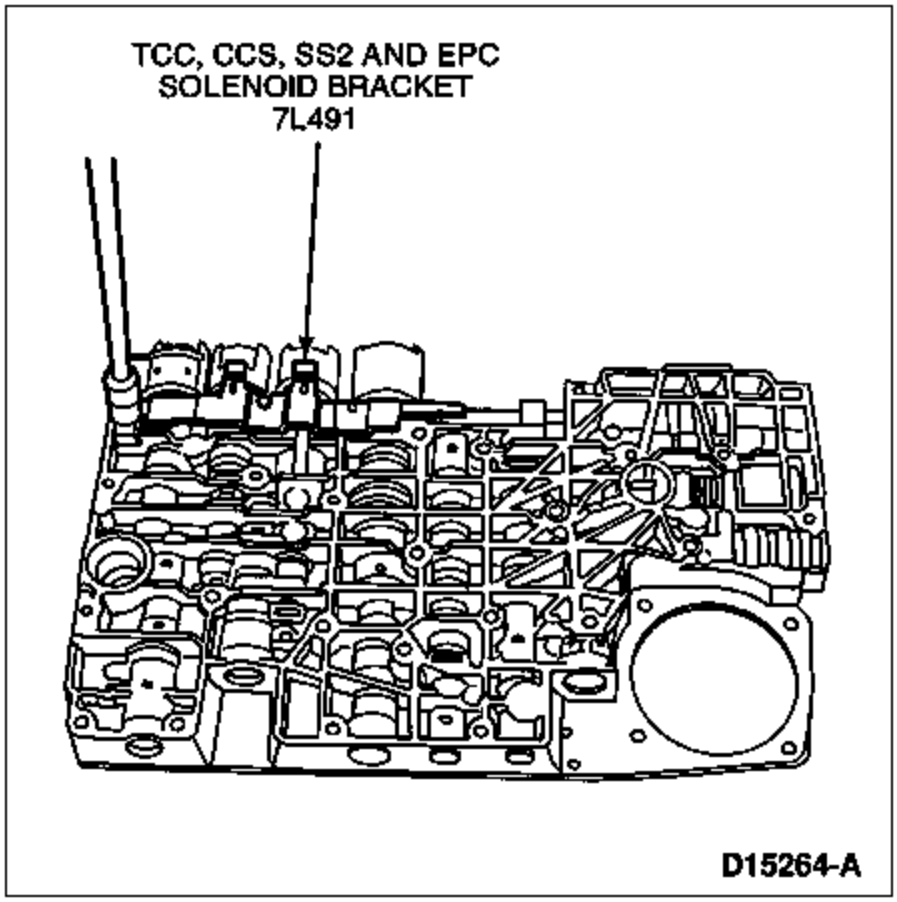

3. Remove the solenoid clamp and the solenoids.

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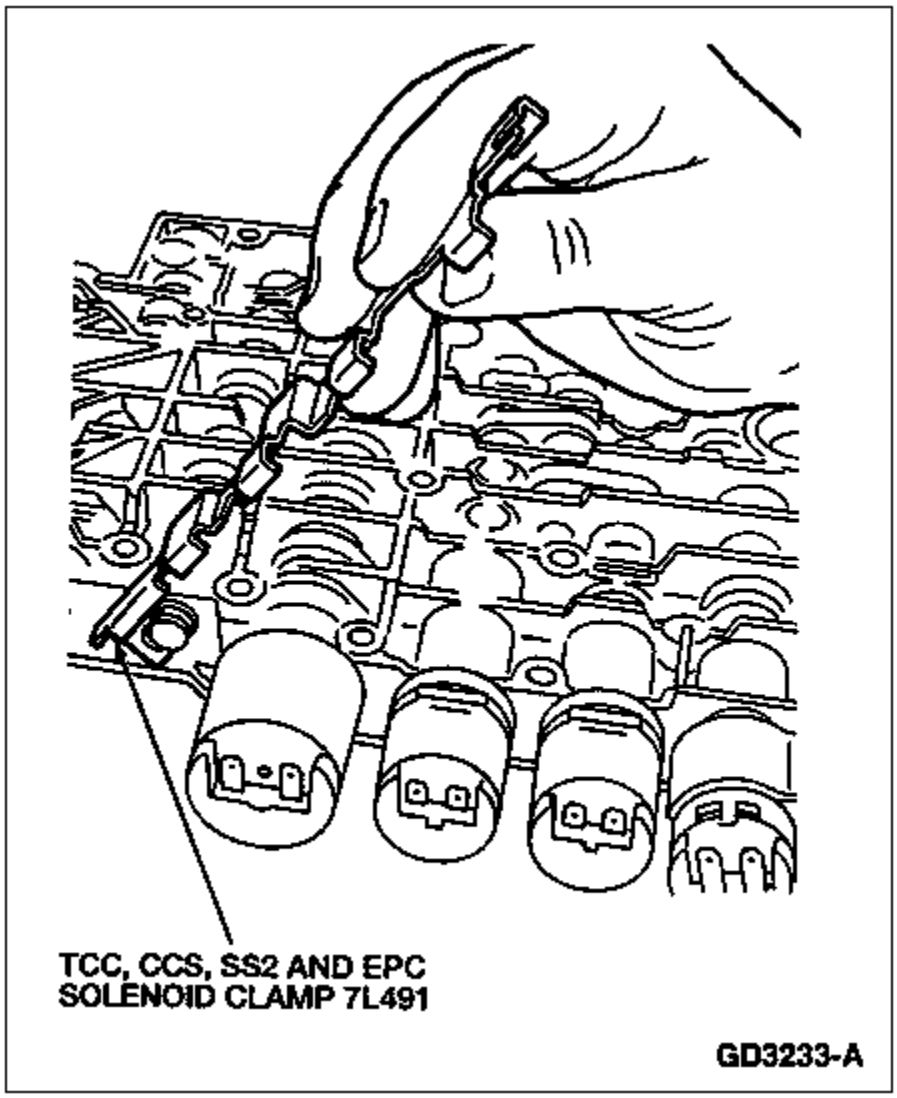

4. **CAUTION: Valves may come out when rotating the main control.**

   Carefully rotate the main control assembly so that the control valve body-to-case gasket is facing up. Remove and discard the control valve body-to-case gasket.

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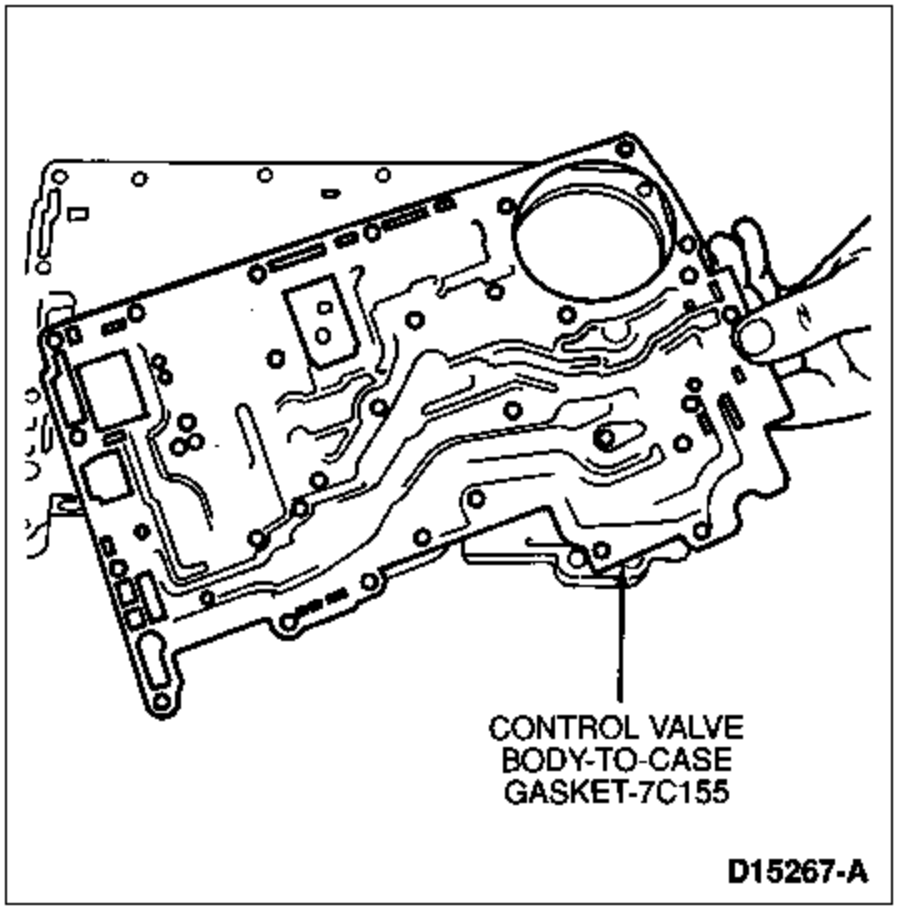
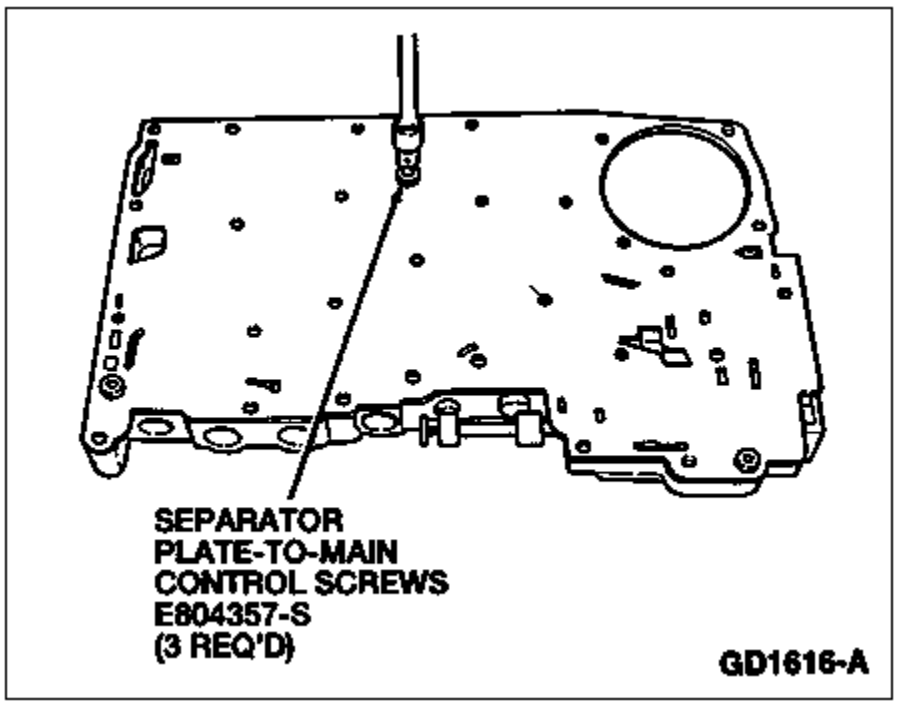


5. Use a T30 Torx® bit to remove the three separator plate-to-main control screws.



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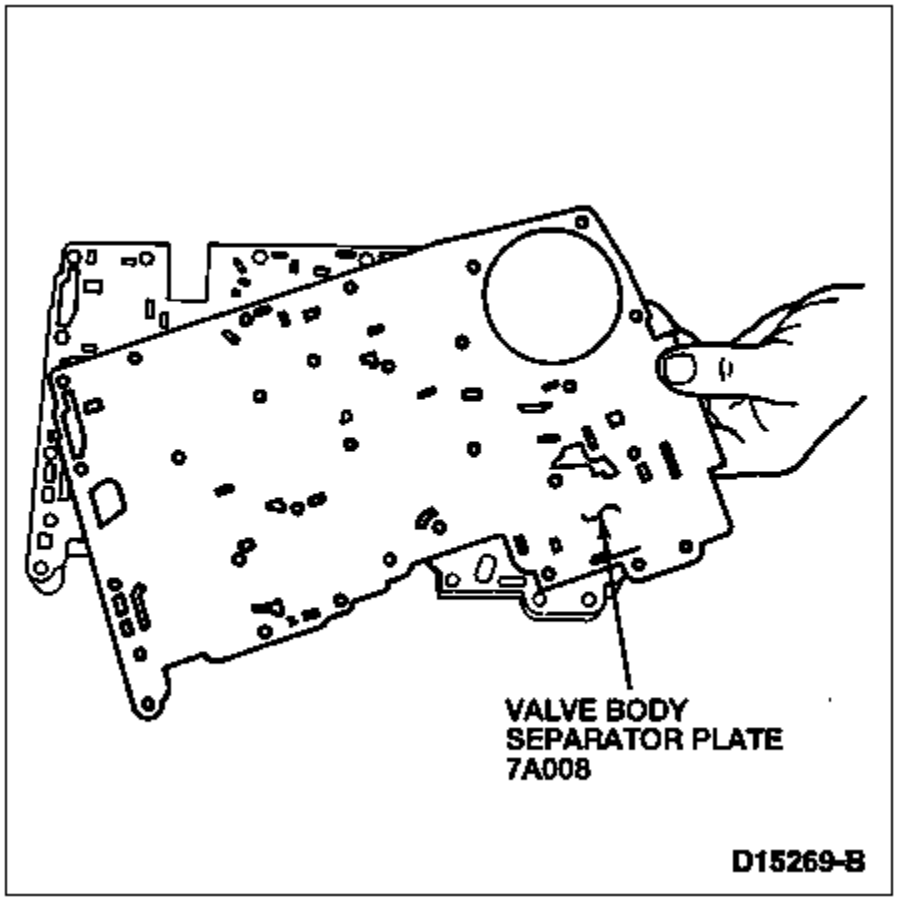
6. **CAUTION: The extension housing lube orifice and relief valves may stick to the separator plate.**

   Remove the valve body separator plate.



7. Remove and discard the control valve body separator gasket.

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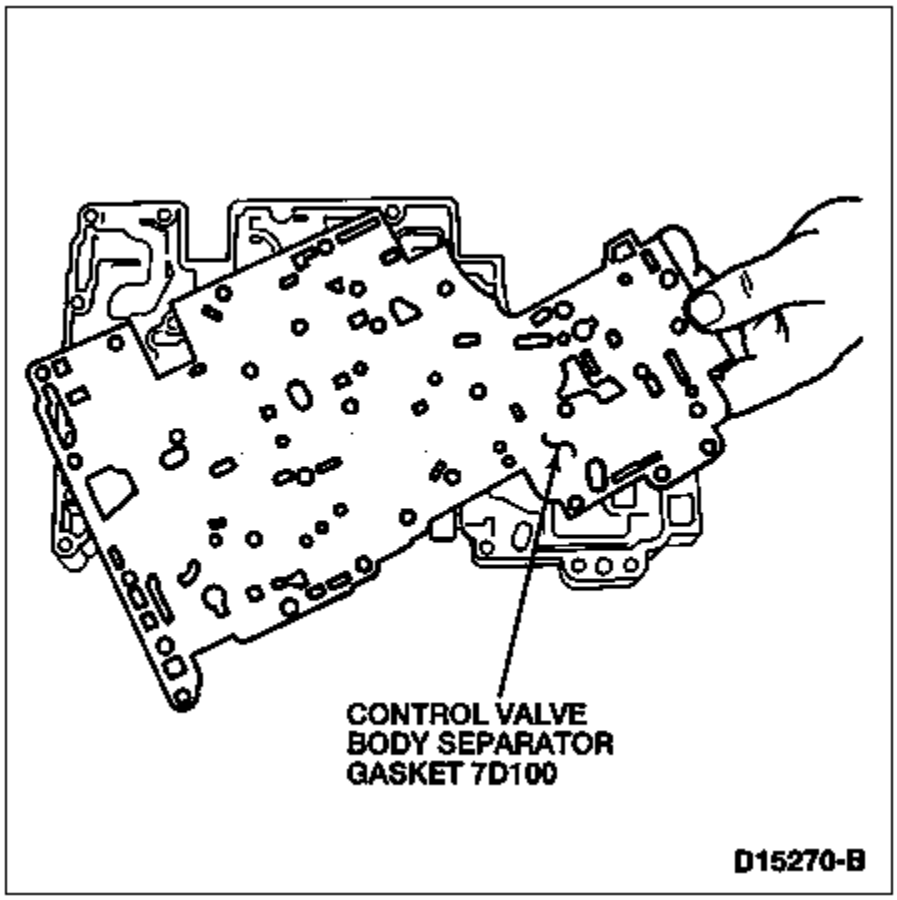

8. Carefully remove the extension housing lube orifice.

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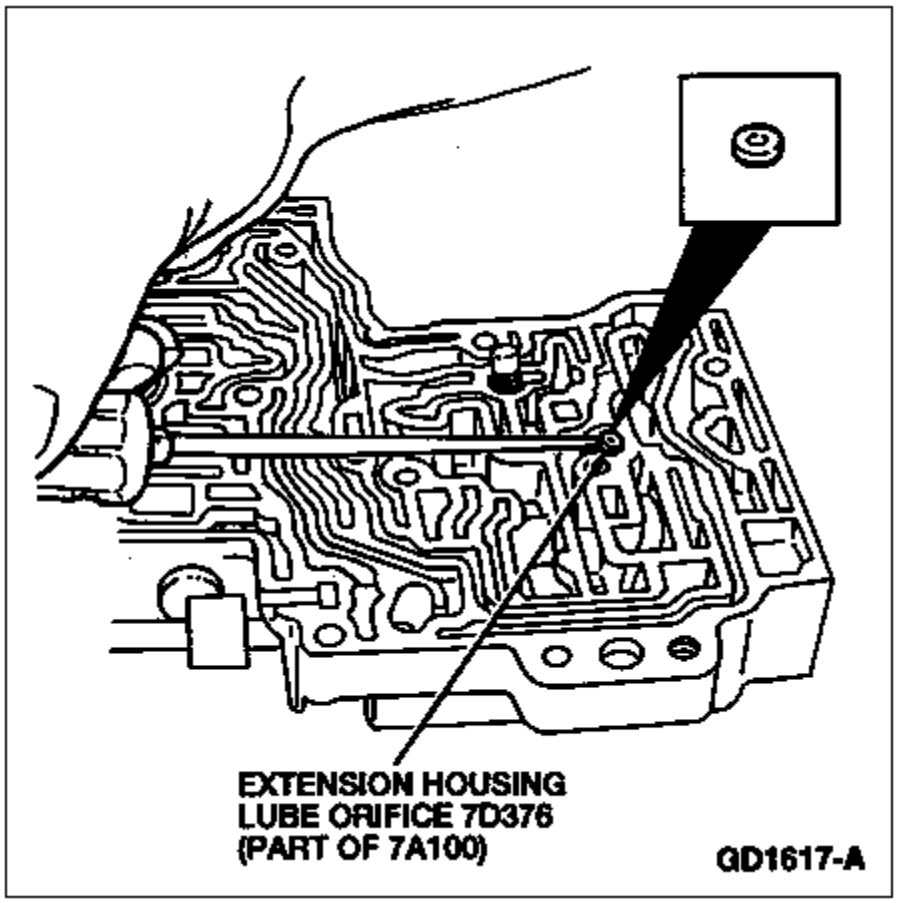
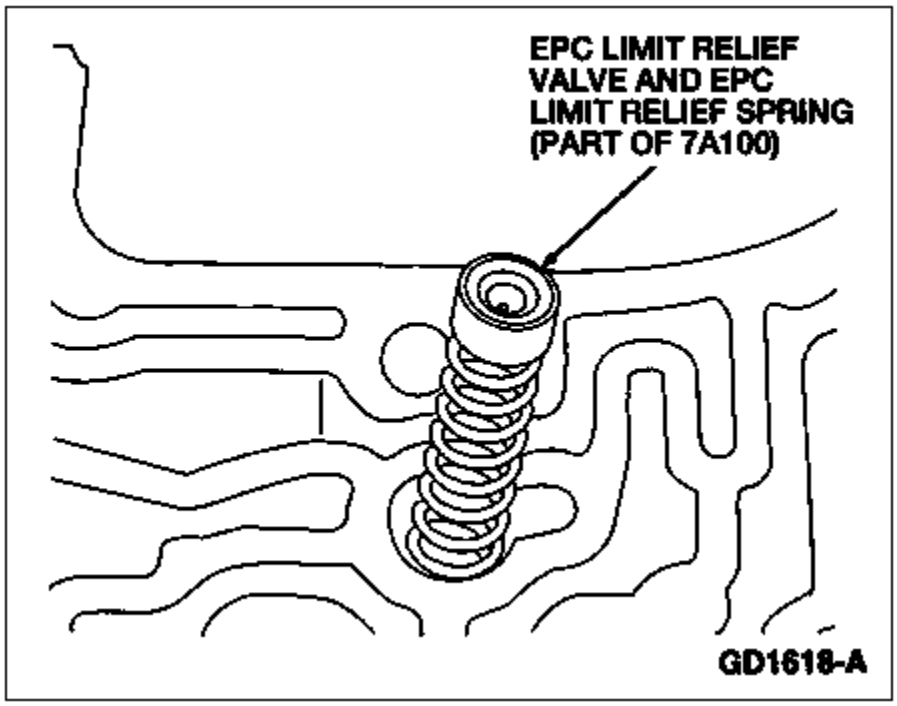


9. Remove the electronic pressure control (EPC) limit relief valve (metal-silver color) and spring.



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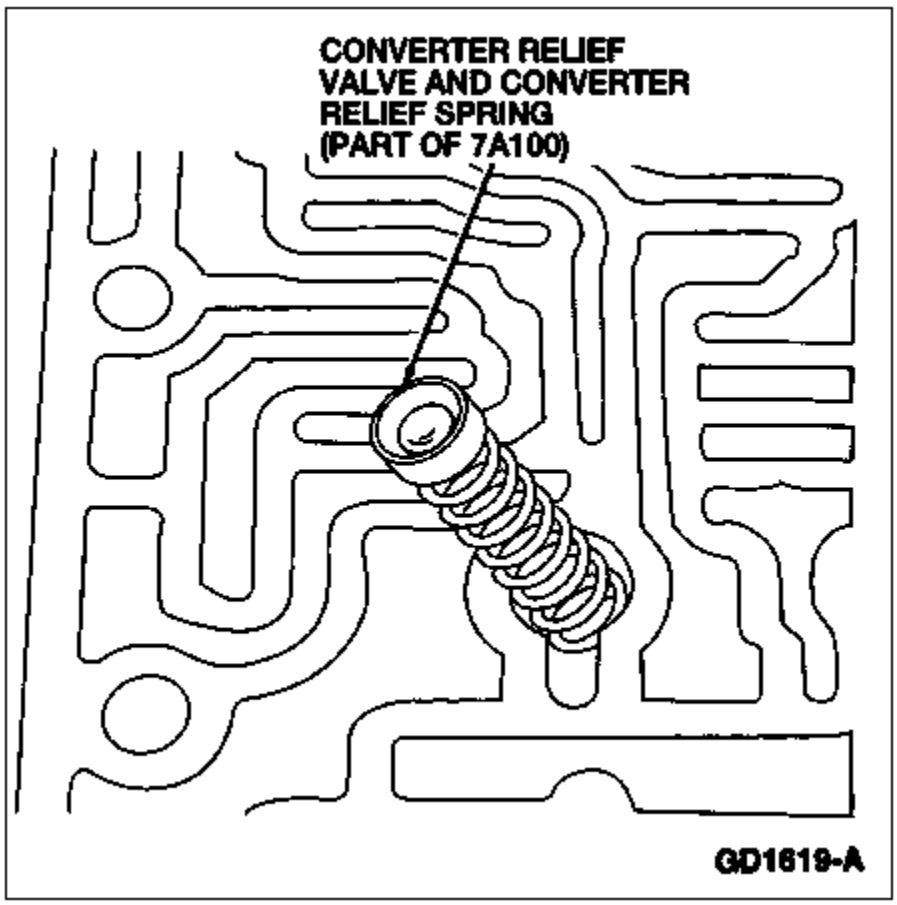
10. Remove the converter relief valve (plastic-dark color) and spring.



11. Remove the EPC limit circuit screen.

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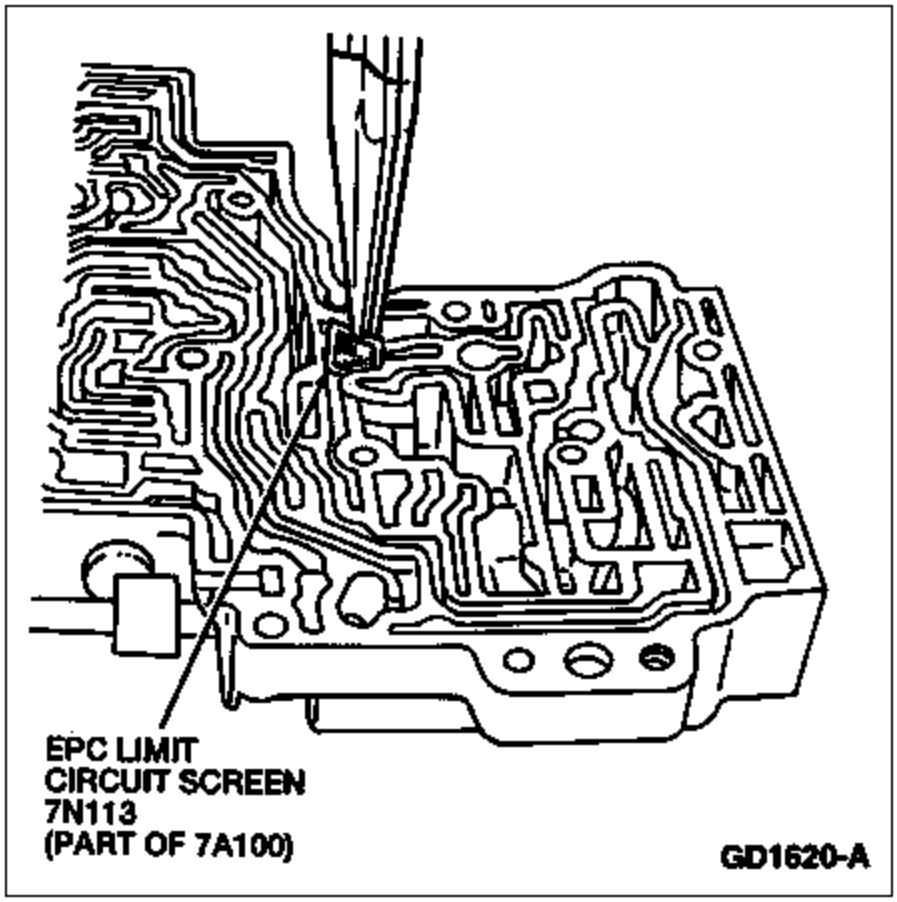

12. Remove the four check balls.

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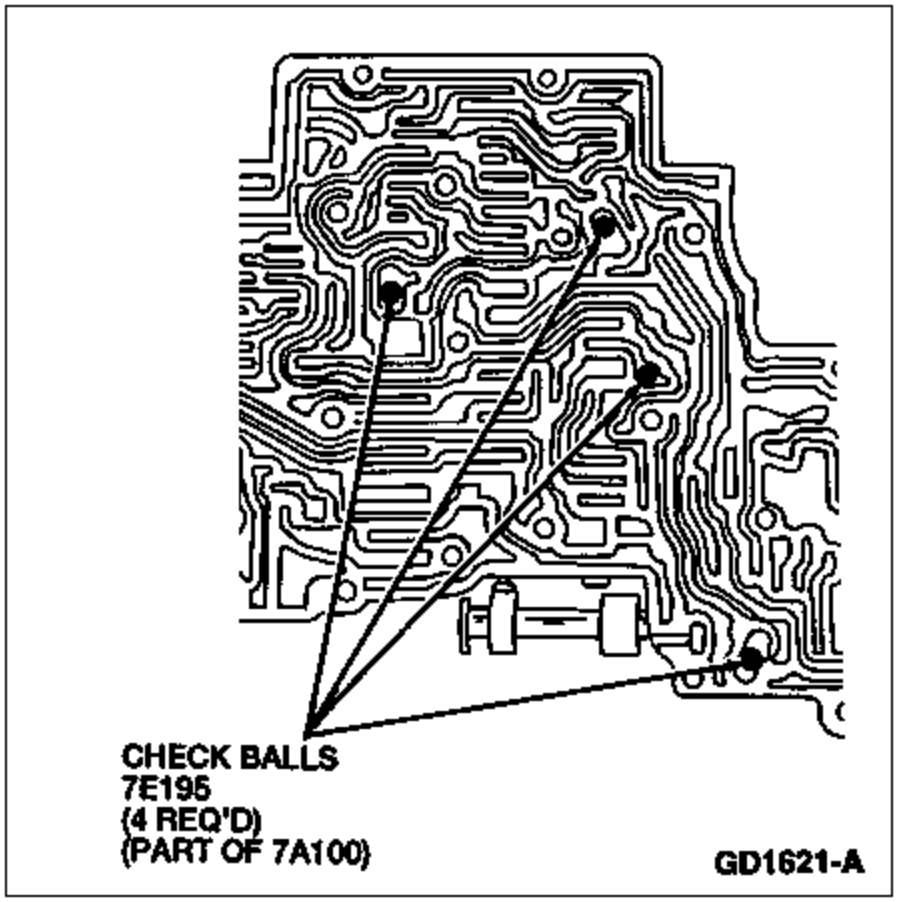

13. **CAUTION: Do not lose parts when cleaning or servicing.**

    Thoroughly clean all parts in solvent and blow dry with moisture-free compressed air.

14. Inspect all valve and plug bores for scores. Check all fluid passages for obstructions. Inspect the check valve for free movement. Inspect all mating surfaces for burrs or distortion. Inspect all plugs and valves for burrs or scores. Replace the control valve body if the bores are scored or if the valves are scored beyond the point of being able to be cleaned.

15. Inspect all springs for distortion. Check all valves and plugs for free movement in their respective bores. Valves and plugs, when dry, must fall from their own weight in their respective bores.

16. Roll the manual valve on a flat surface to check for a bent condition.

17. Clean and inspect the EPC limit circuit screen.

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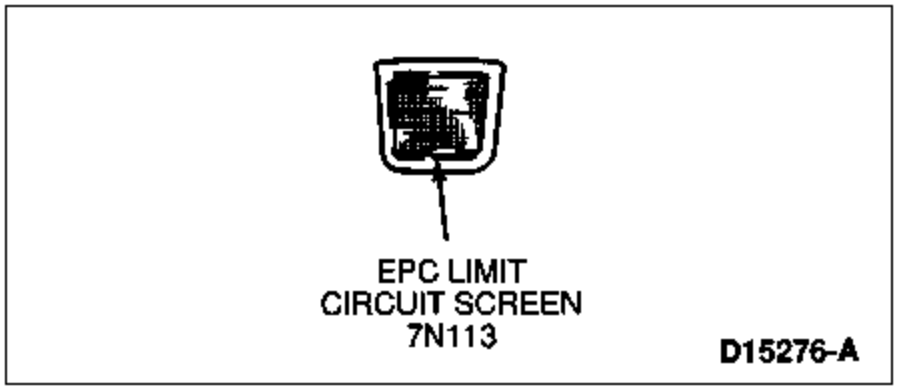
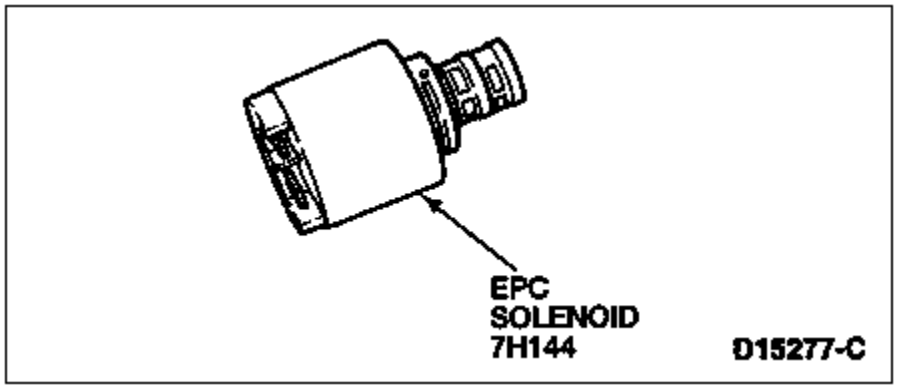
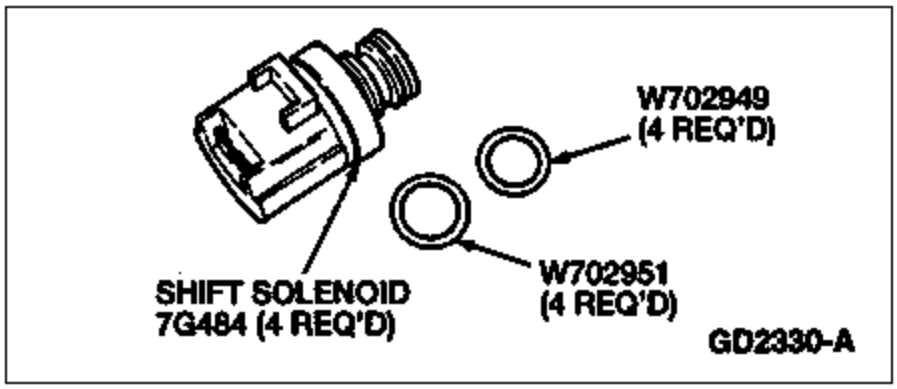


18. Clean and inspect the EPC solenoid screens.



19. Remove and replace all shift and coast clutch solenoid O-rings.



20. Clean and inspect the torque converter clutch (TCC) solenoid.

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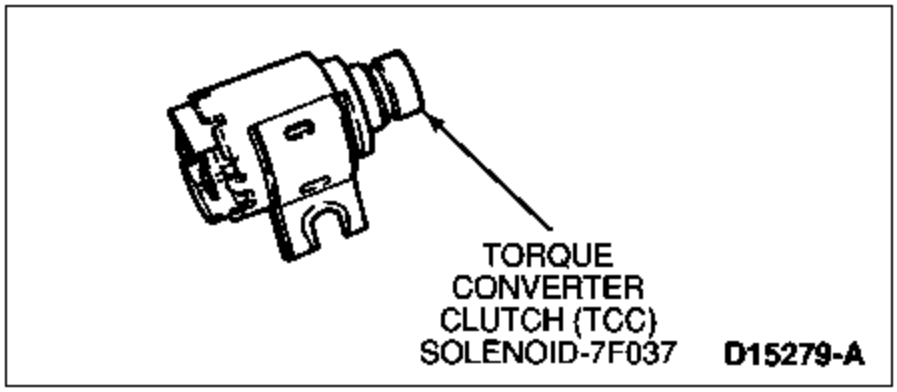
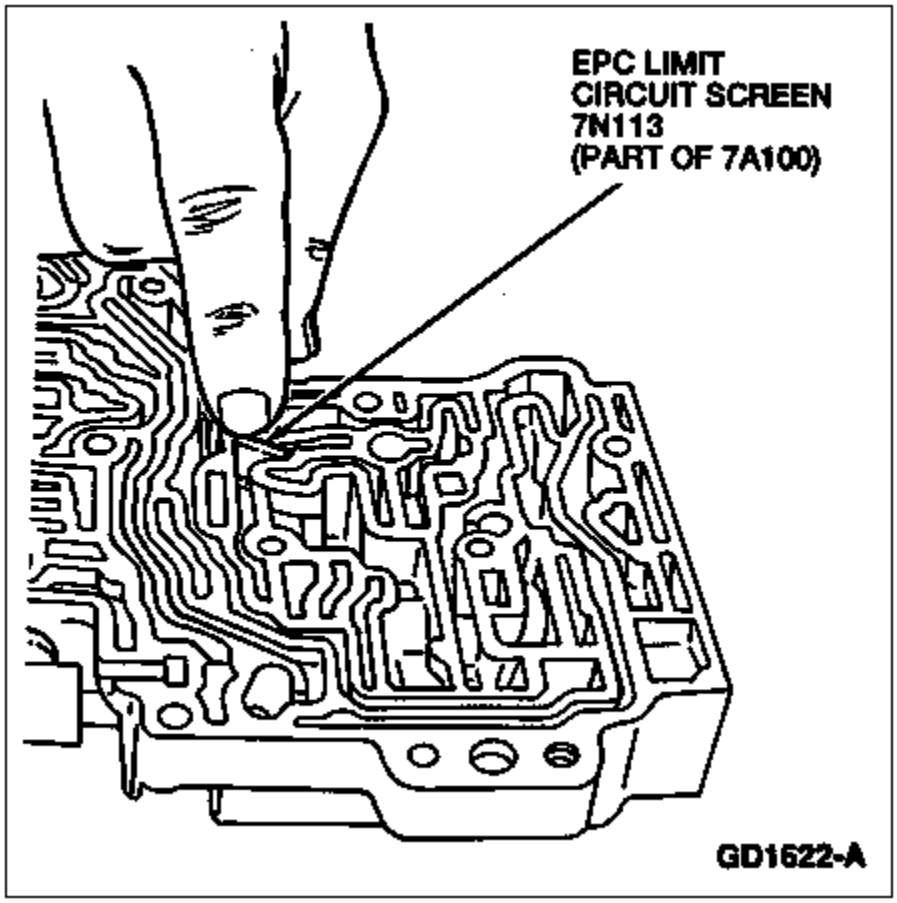


Assembly

1. **CAUTION: Make sure that the screen is properly located.**

   Install the EPC limit circuit screen. Push down on the EPC limit circuit screen to make sure it is fully seated.



2. Install the four check balls in proper locations as shown.

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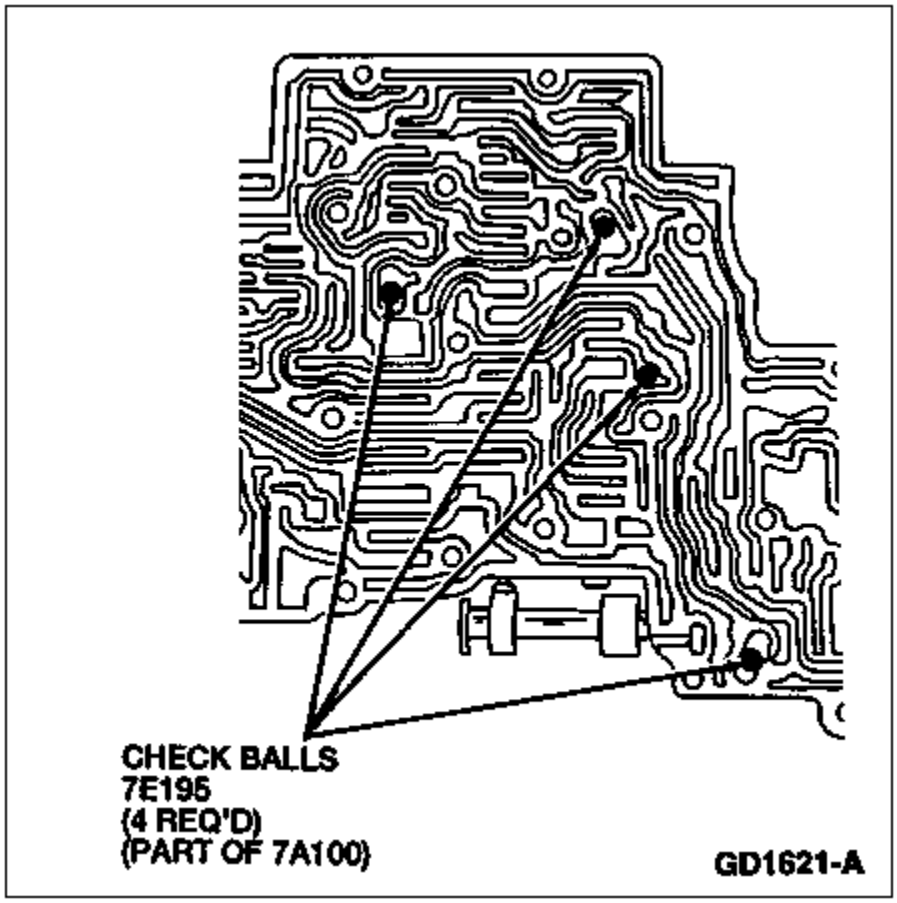
Check Ball Installation



3. **CAUTION: The springs and valves are not interchangeable.**

   Install the converter relief valve (plastic-dark color) and spring.

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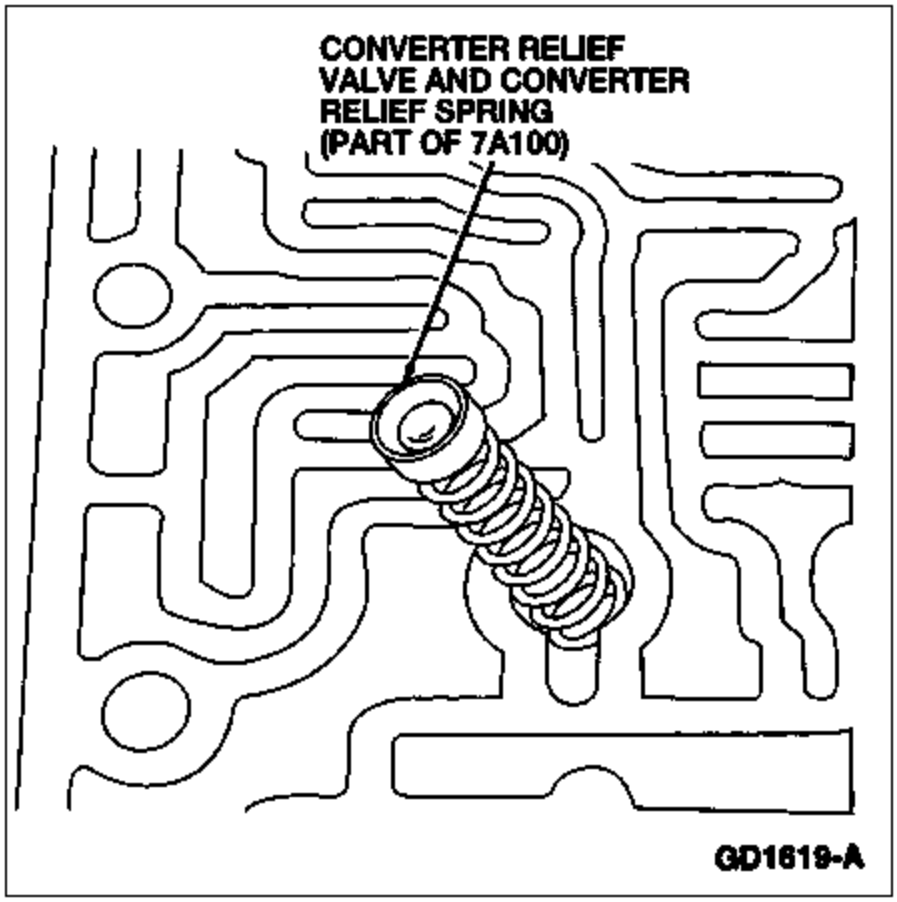

4. **CAUTION: The springs and valves are not interchangeable.**

   Install the EPC limit relief valve (metal-silver color) and spring.

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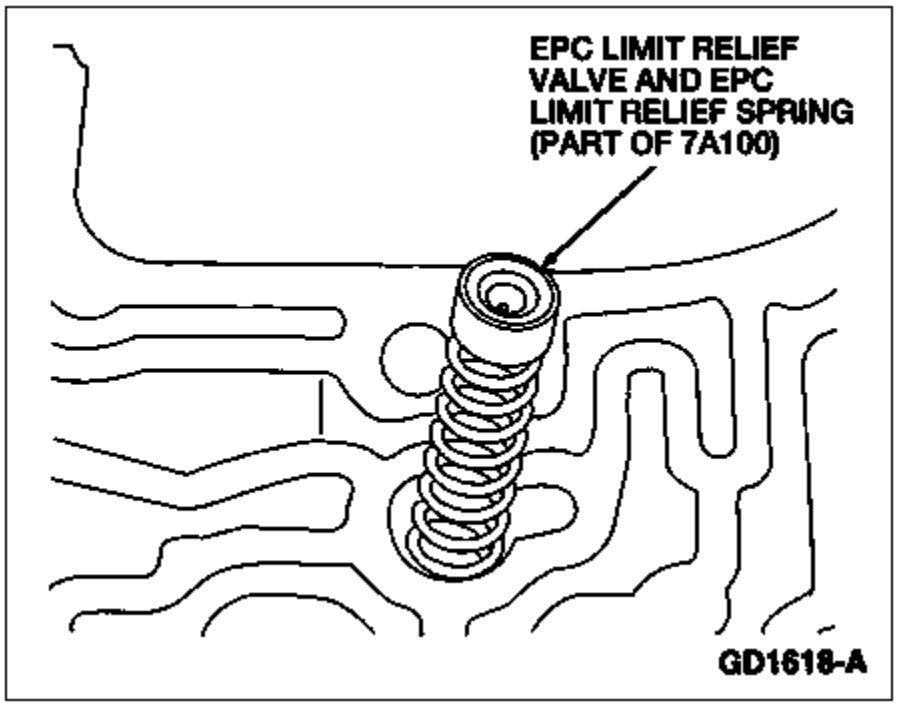
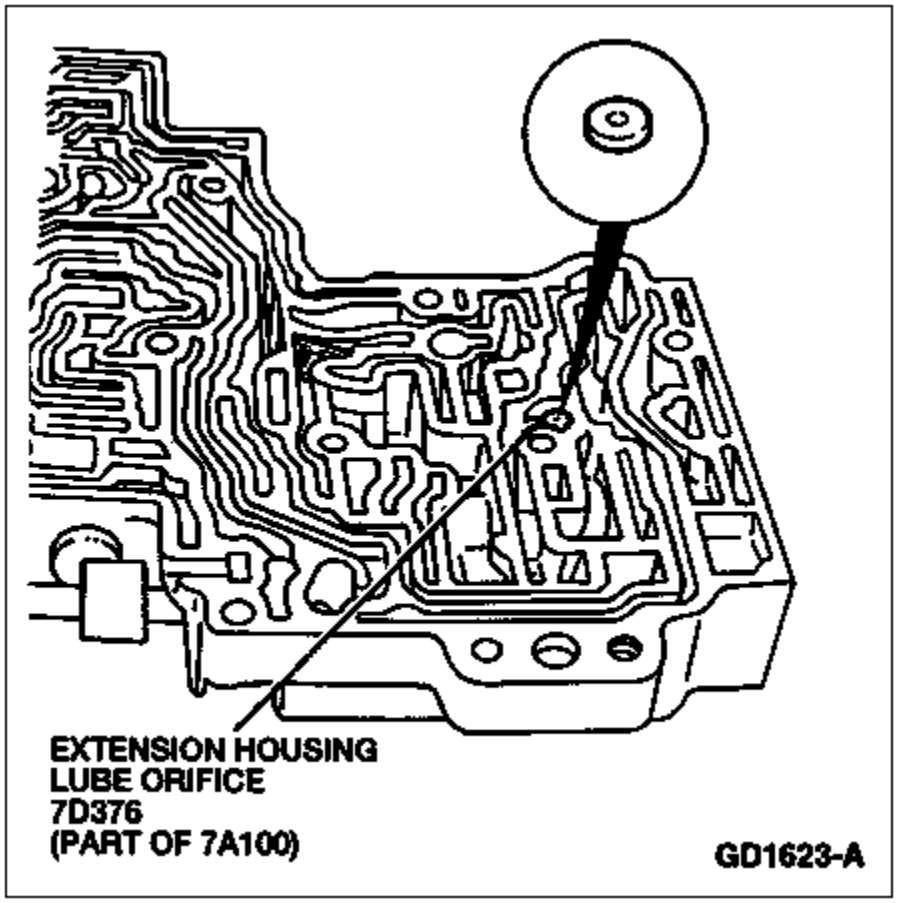


5. Install the extension housing lube orifice.



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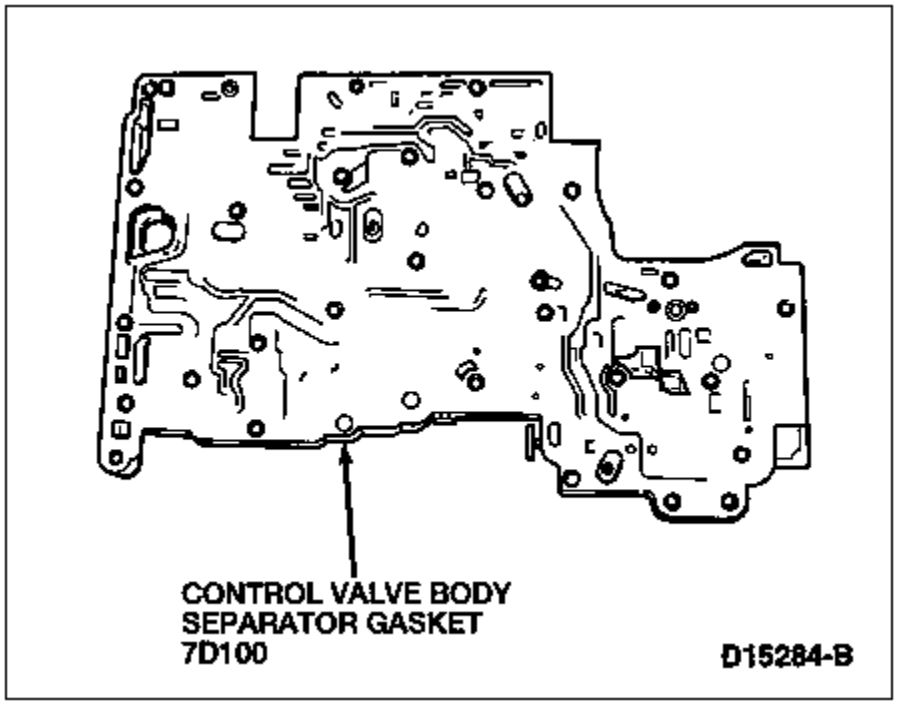
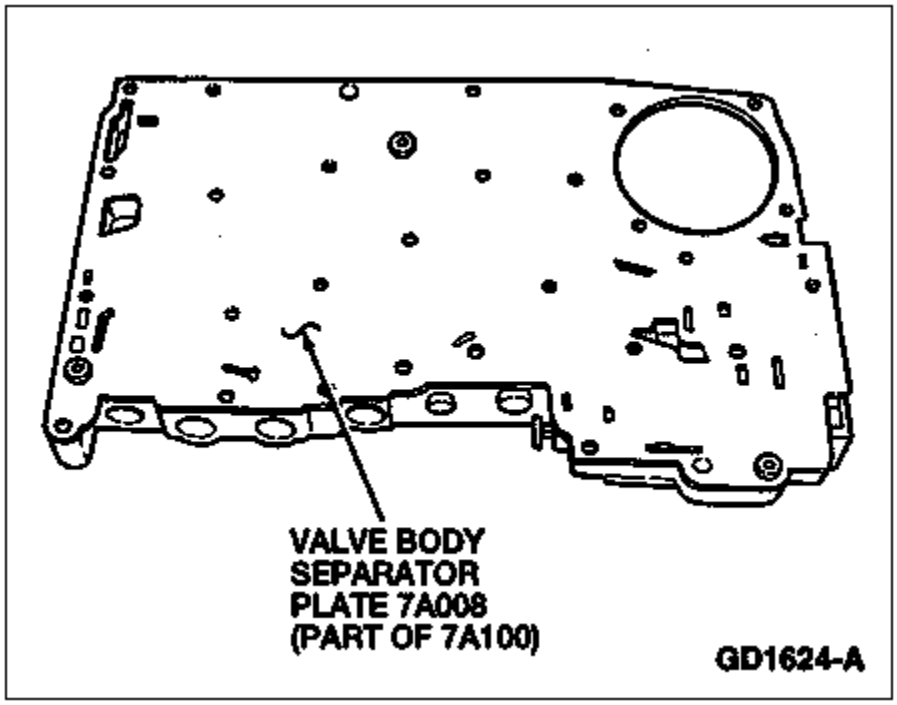
6. Install and align the control valve body separator gasket.



7. Install the valve body separator plate. Install the three (3) separating plate-to-main control screws fingertight.



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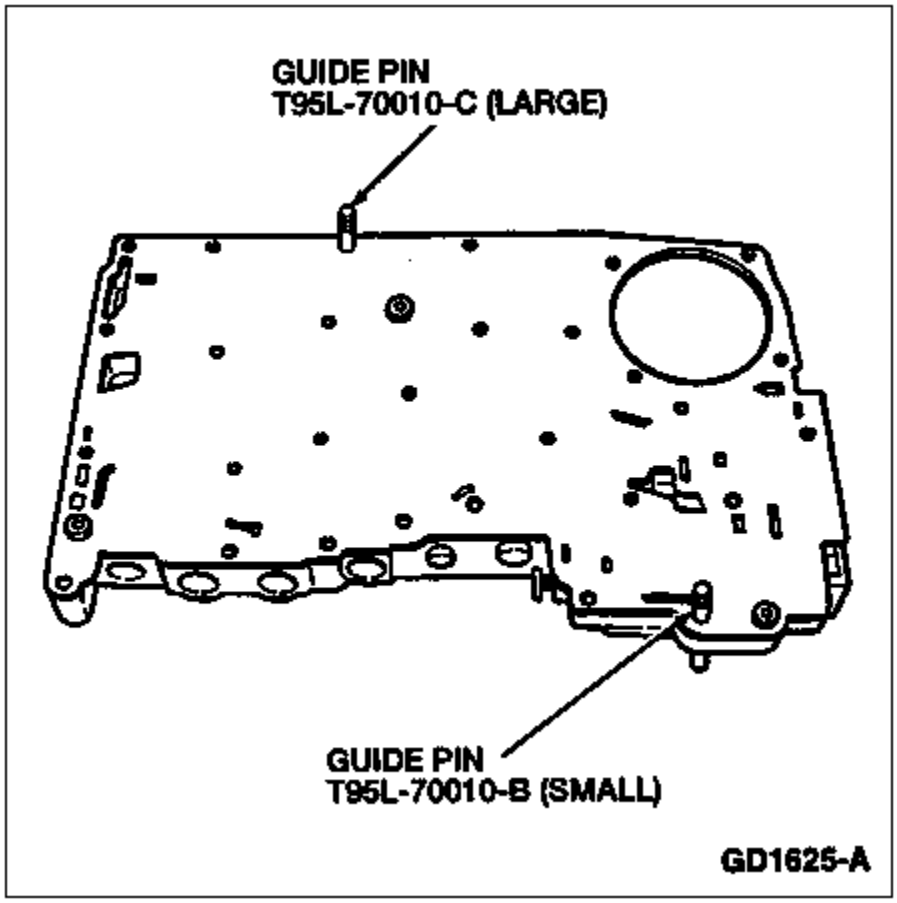
8. Install the alignment pins in the locations shown.



9. Tighten the separator plate-to-main control screws to 6-8 Nm (53-71 lb-in).

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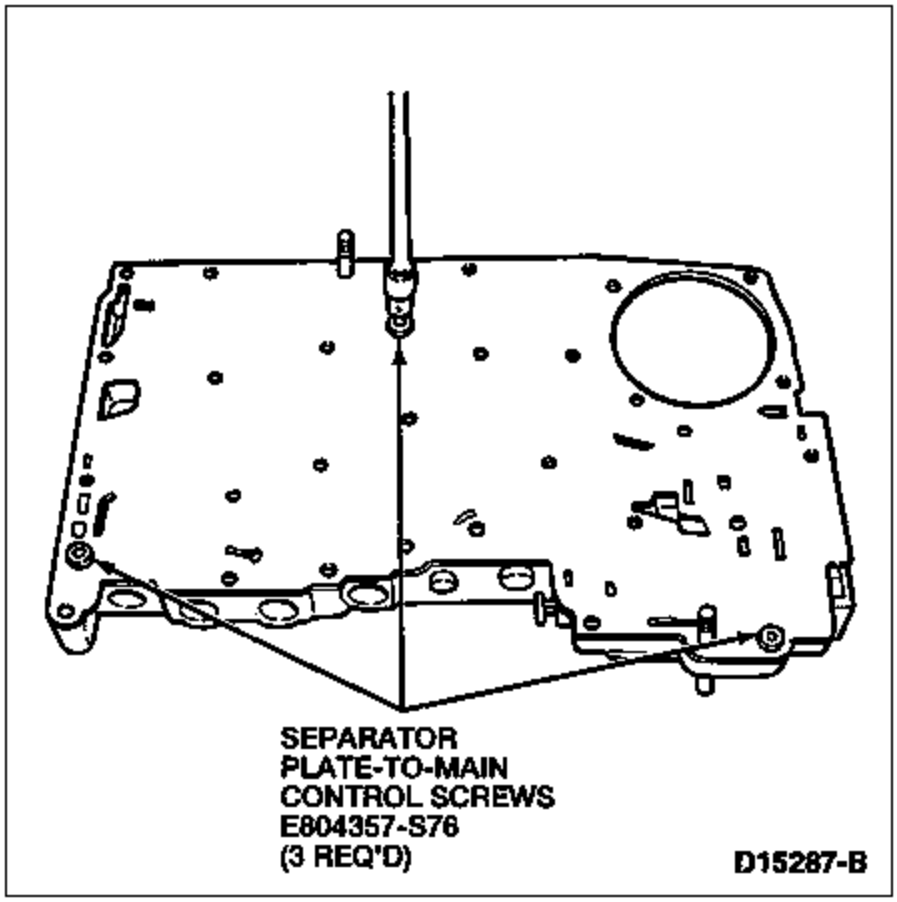

10. **NOTE: Apply petroleum jelly on the separator surface to hold the gasket in place.**

    Install the control valve body-to-case gasket.

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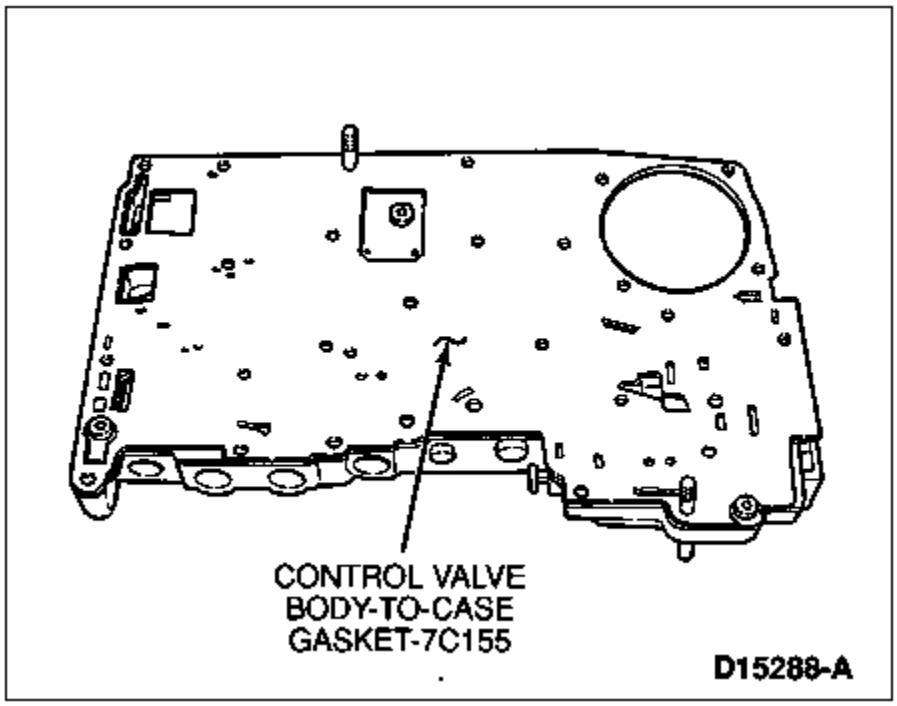

11. Remove the alignment pins.
12. Rotate the main control so that the separator plate is facing down.
13. **CAUTION: The shift and coast clutch solenoid terminals must face upward.**

    NOTE: The shift and CCS solenoids are interchangeable.

    NOTE: If the TCC valve came out, use caution when installing the TCC solenoid.

    Install the solenoids.

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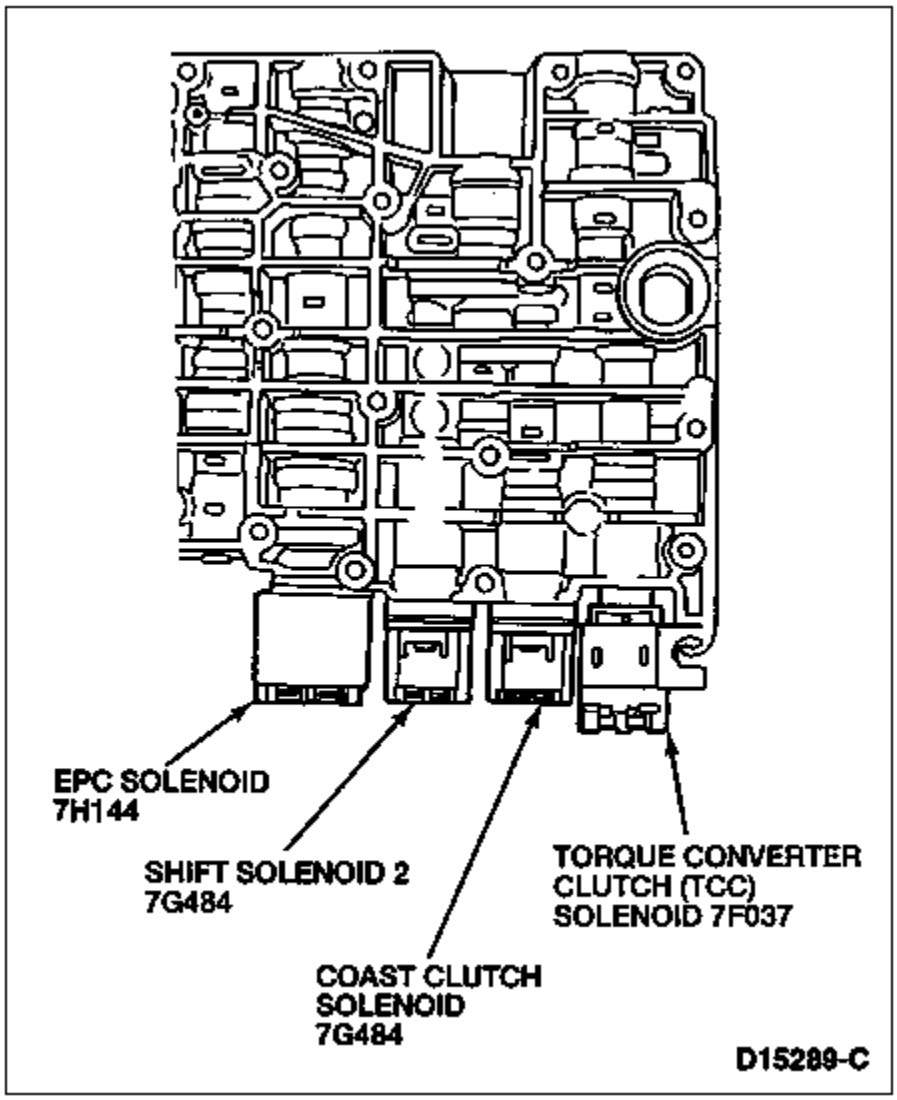

14. **CAUTION: The solenoid clamp must be installed in the TCC and EPC solenoid grooves, shift solenoid pockets and the No. 204 plug.**

    Install the solenoid clamp. Tighten the solenoid clamp screw to 6-8 Nm (53-71 lb-in).

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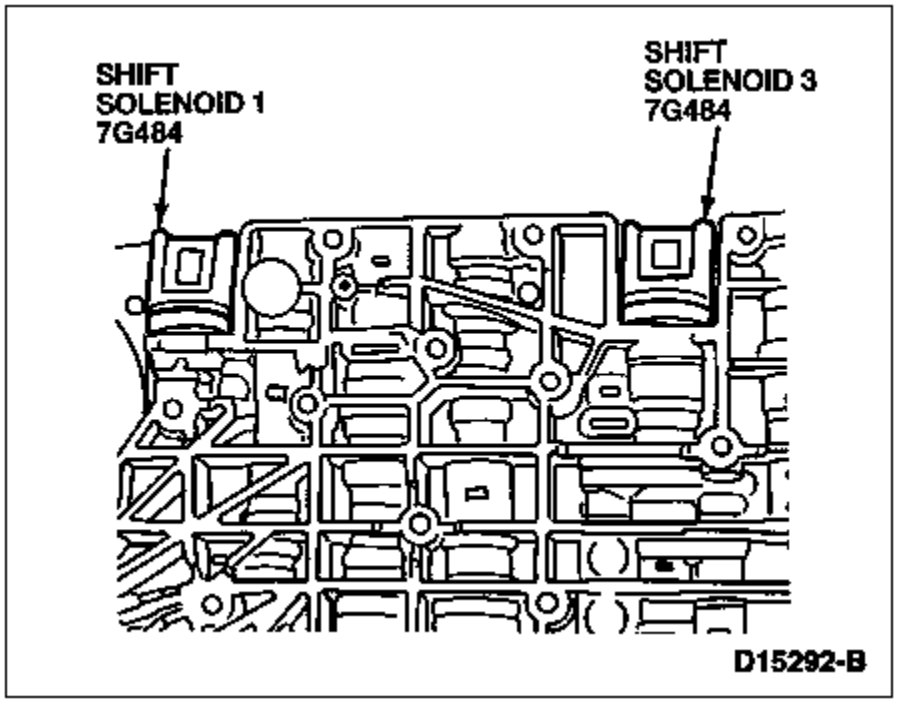
15. Install shift solenoids 1 and 3.



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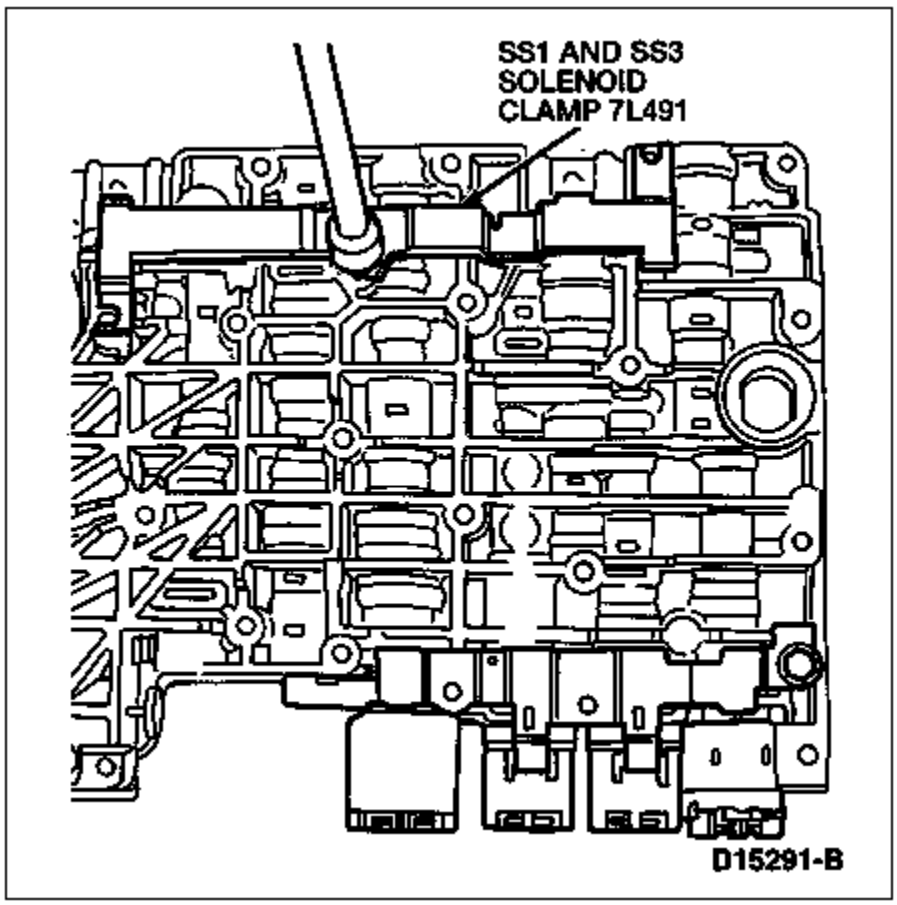
16. Install the solenoid clamp. Tighten the clamp screw to 6-8 Nm (53-71 lb-in).



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Converter Housing and Fluid Pump

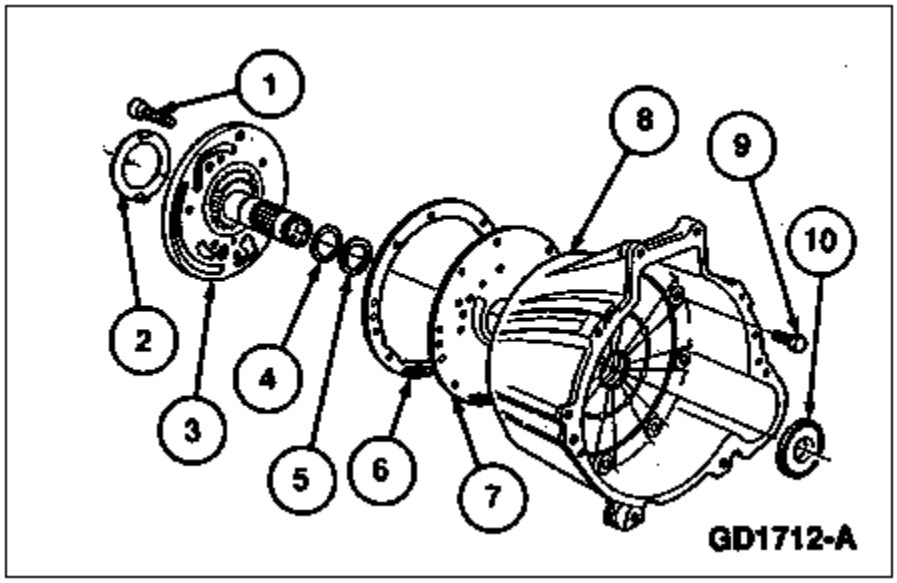
SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Converter Housing Seal Replacer	T97T-77000-A

SPECIAL SERVICE TOOLS DESIRED

Tool Number	Description
TOOL-1175-AC	Seal Remover

Converter Housing and Fluid Pump



Item	Part Number	Description
1	W701429-S309M	Fluid Pump-to-Converter Housing Screws (6 Req'd)
2	7D014	No. 1 Fluid Pump Input Thrust Washer
3	7A103	Fluid Pump Support and Gear Assembly

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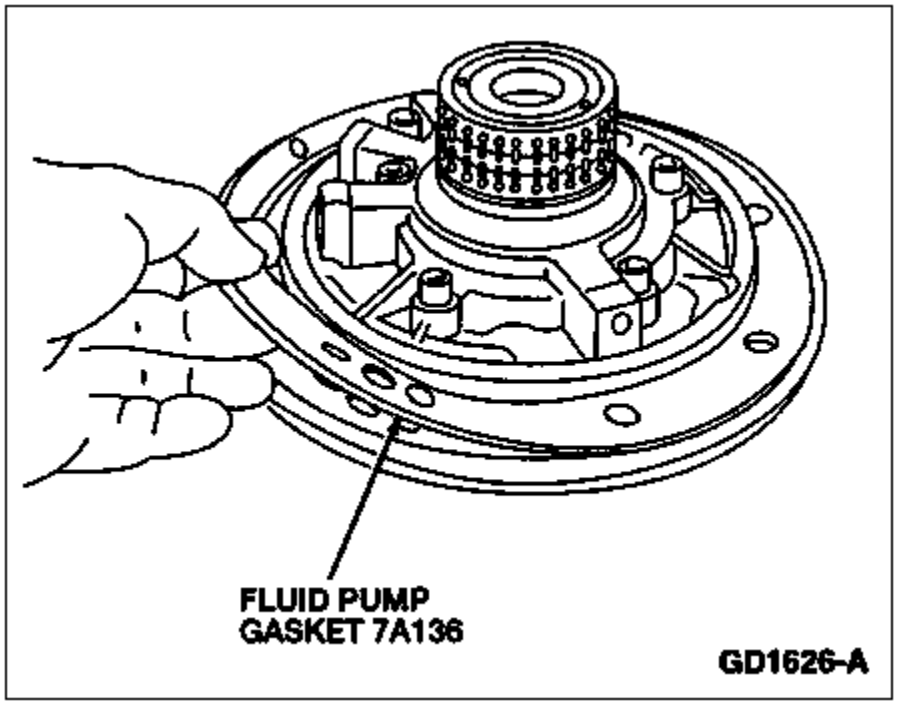
4	W701431-S300	Fluid Pump Shaft-to-Inner Gear O-Ring
5	7L323	Fluid Pump Support Seal Ring
6	7A136	Fluid Pump Gasket
7	7B472	Fluid Pump Adapter Plate
8	7976	Converter Housing Assembly
9	E804595-S200	Converter Housing-to-Case Screw and Seal Assembly (8 Req'd)
10	7A248	Converter Hub-to-Converter Housing Seal Assembly

Disassembly

1. Remove and discard the fluid pump gasket.



2. Remove and discard the fluid pump square cut seal ring.

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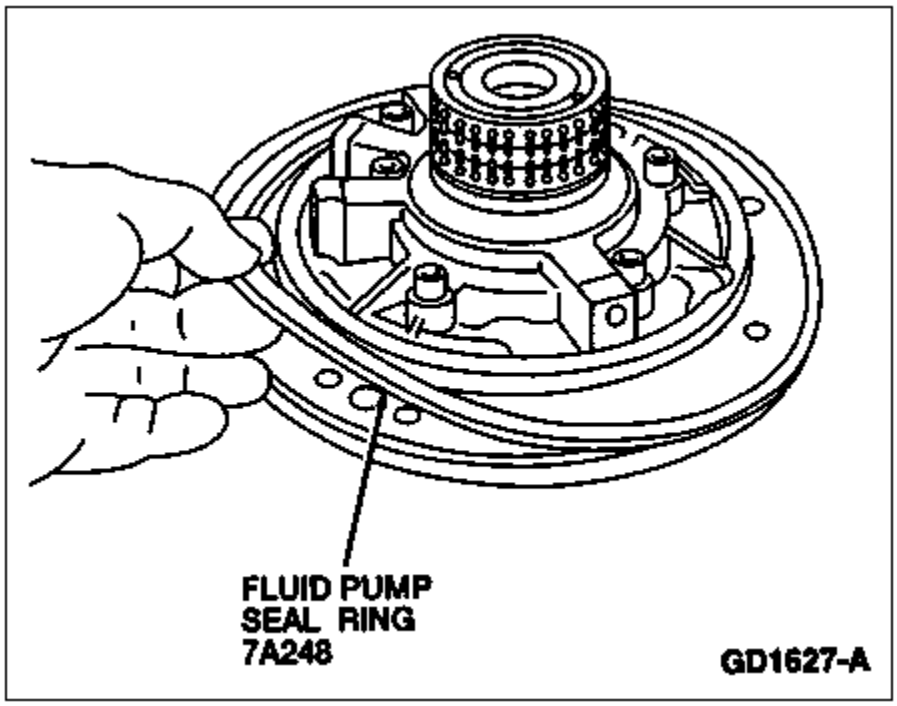
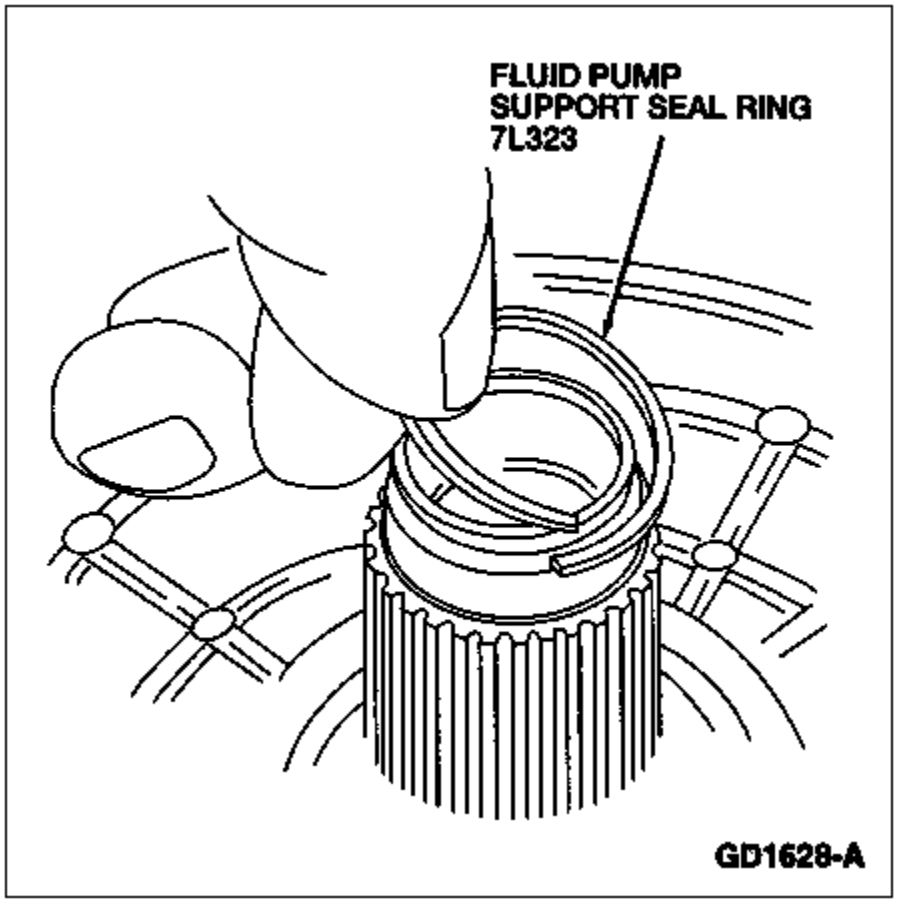


3. Remove the fluid pump support seal ring.



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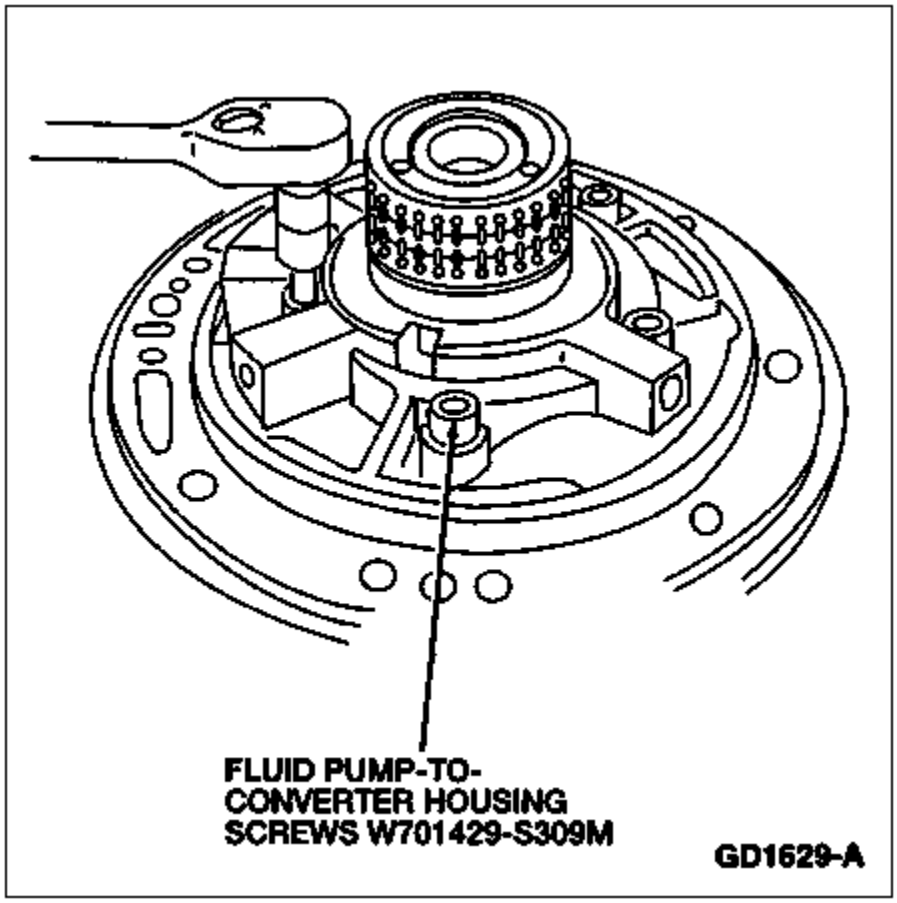
4. Use a Torx® 40 wrench to remove the six M8 x 35 mm front pump-to-converter housing screws. Remove the fluid pump support and gear and the fluid pump adapter plate.



5. **NOTE: The pump gears are part of the pump assembly and are not serviced separately.**

   NOTE: A rough casting on the pump surface crescent is not a flaw.

   Remove the pump gears.

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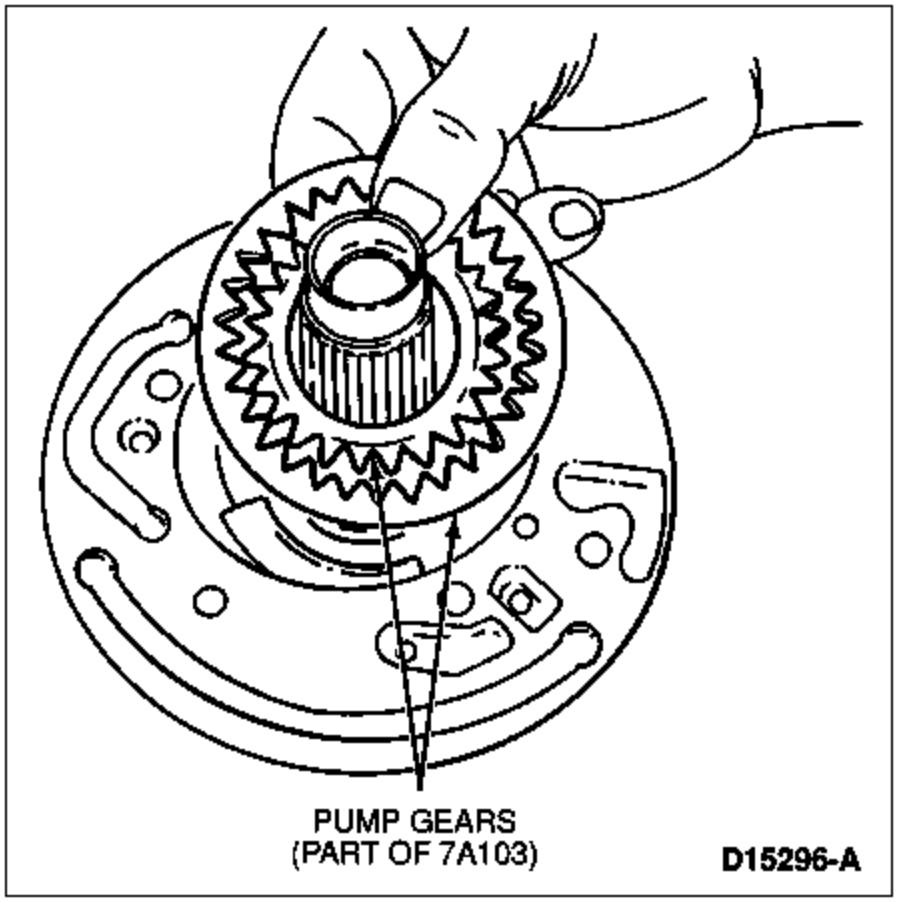
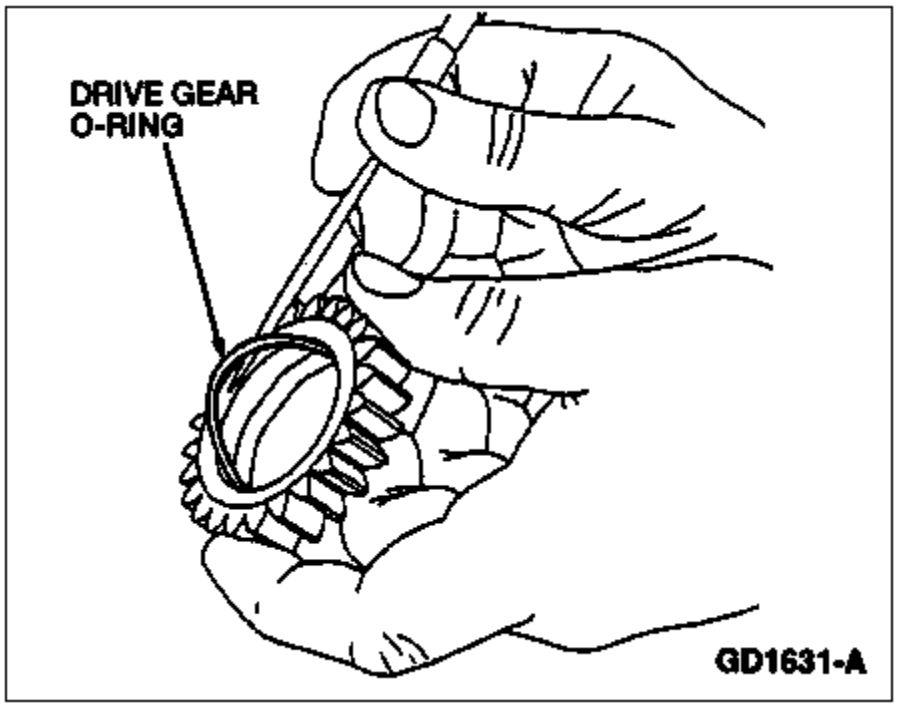


6. Remove the drive gear O-ring and discard.



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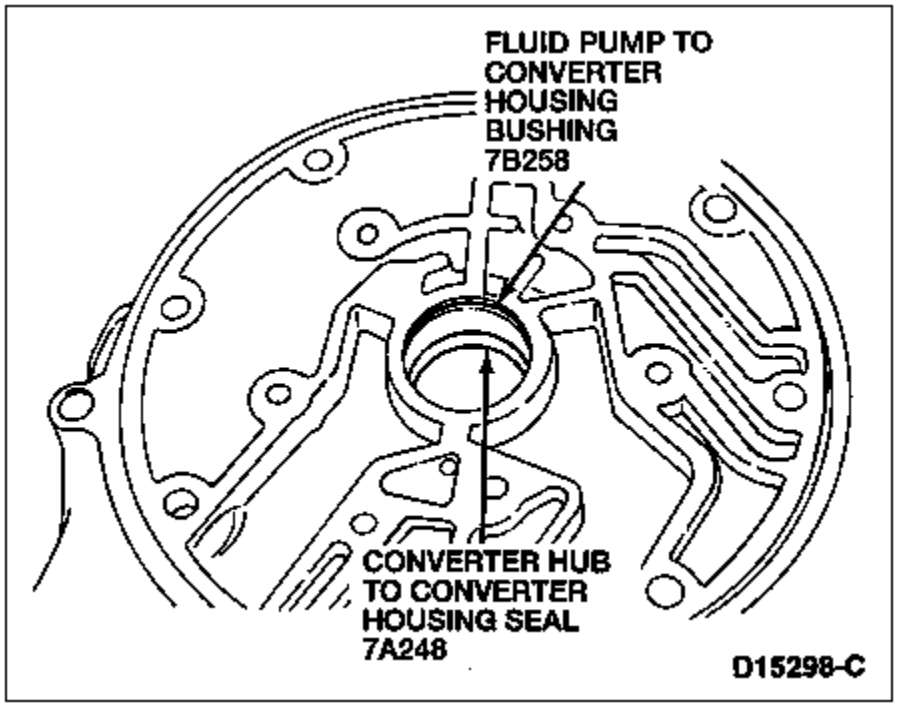
7. Inspect the pump gears for scoring and cracks. Replace pump assembly if damaged.

8. **NOTE: Fluid pump-to-converter housing bushing is not serviced separately. If service is required, the converter housing assembly must be replaced.**

   Inspect the fluid pump to converter housing bushing and converter hub to converter housing seal. Replace converter housing assembly if necessary.



9. Remove and discard the converter hub-to-converter housing seal using Seal Remover TOOL-1175-AC or equivalent from the converter housing as shown.

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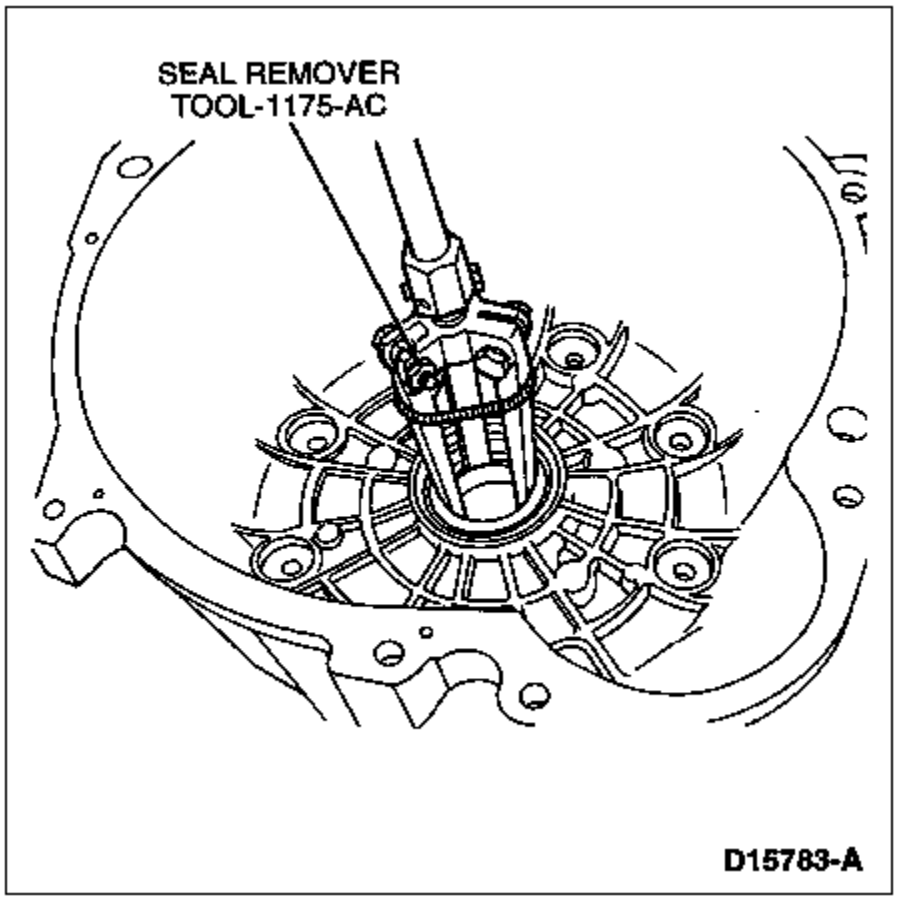

10. Clean and inspect the front and rear input shaft support bushings. If bushings are worn, scored or damaged, replace the fluid pump support and gear assembly. Inspect the pump gear pockets for scoring and wear. Replace if necessary.

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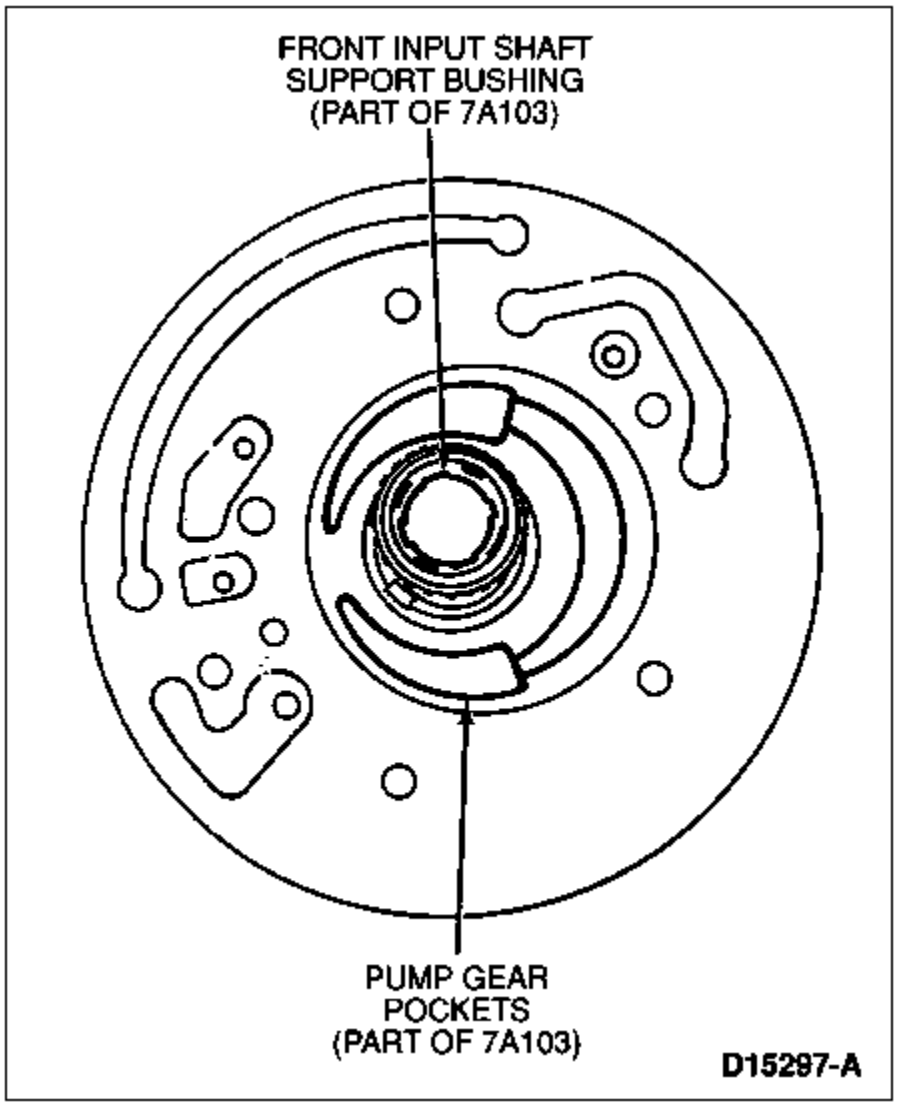

11. Inspect the mating surfaces of the pump body and case for burrs.

    Inspect the drive and driven gear bearing surface for scores and check the gear teeth for burrs.

    Inspect the fluid pump seal for cuts or nicks. Inspect the pump bushing for scoring.

    Check the fluid passages for obstruction.

    If any parts are found to be damaged or worn, replace the pump as an assembly. Minor burrs and scores may be removed with a crocus cloth.

Assembly

1. **NOTE: Check and make sure that the garter spring has not popped off of the converter hub-to-converter housing seal.**

   Install new converter hub to housing seal onto Converter Housing Seal Replacer T97T-77000-A.

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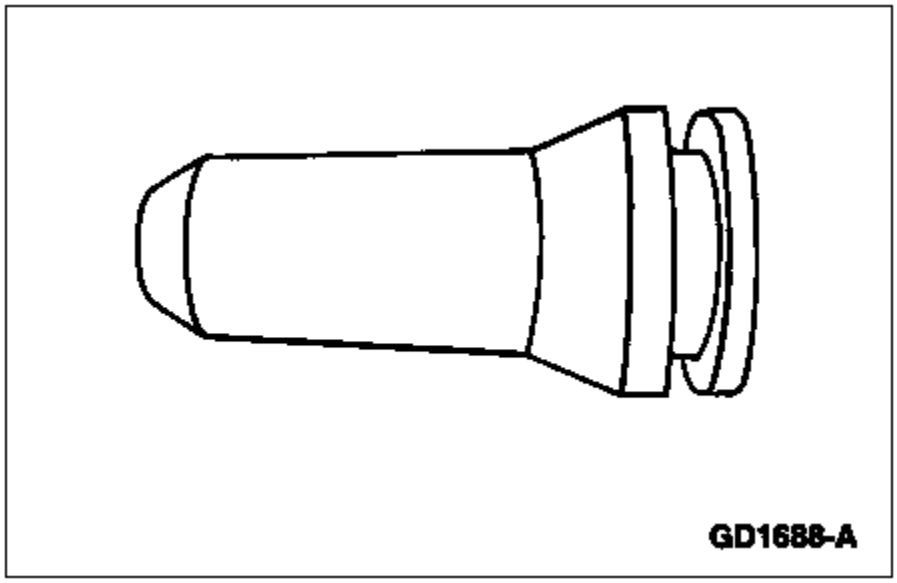
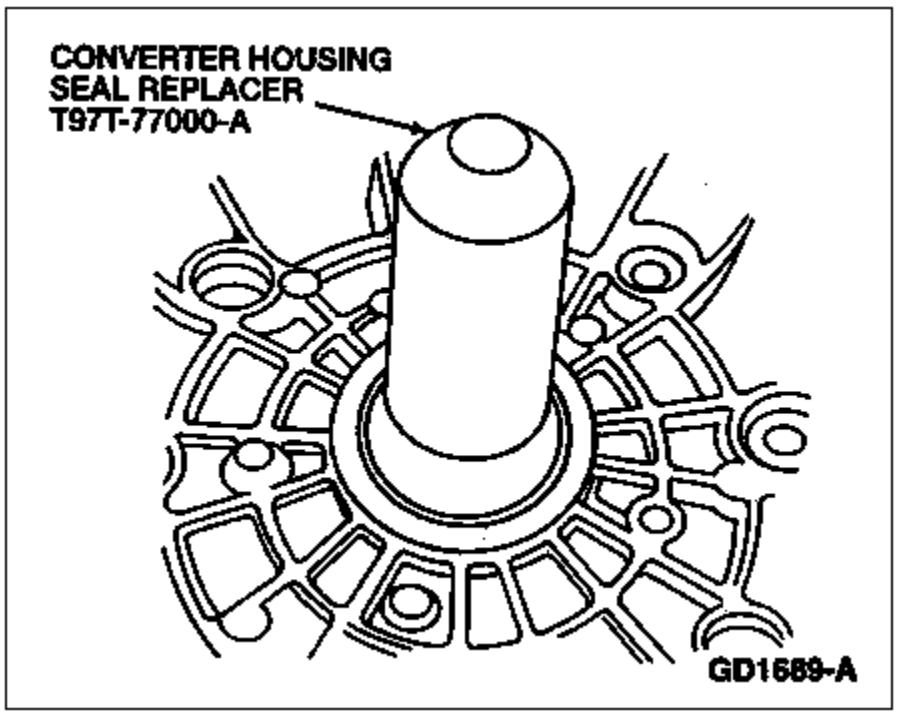


2. **CAUTION: Place the converter housing on a block of wood or equivalent to protect the converter hydraulic passages on the back side.**

   Install a new converter hub-to-converter housing seal until it bottoms in housing using Converter Housing Seal Replacer T97T-77000-A.



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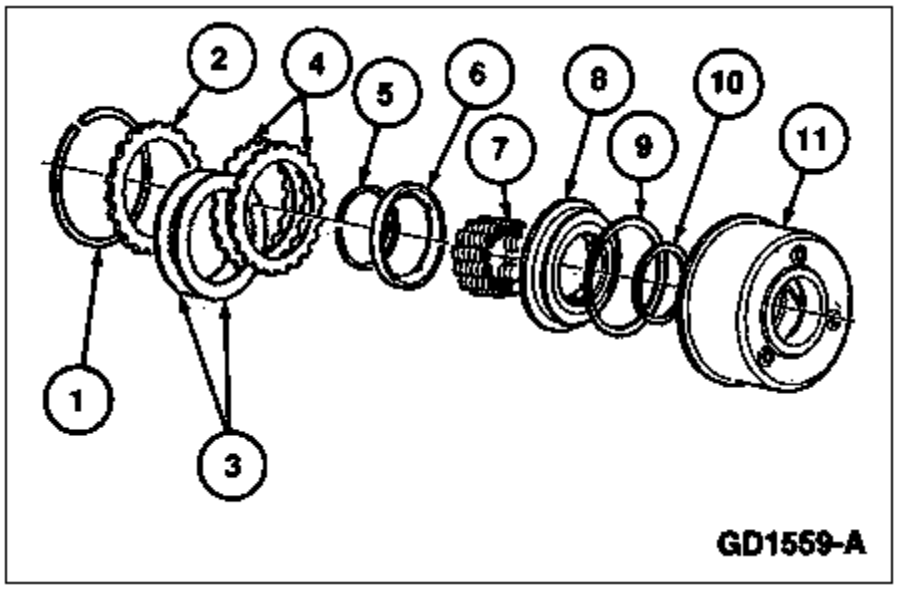
Coast Clutch

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Clutch Spring Compressor	T65L-77515-A
Coast Clutch Outer Seal Sizing Tool	T95L-70010-D

Overdrive Brake and Coast Clutch Drum Assembly



Item	Part Number	Description
1	E860126-S/129-S	Retaining Ring (Select Fit)
2	7B066	Coast Clutch Pressure Plate
3	7B164	Coast Clutch Internal Plate — Friction (2 Req'd)
4	7B442	Coast Clutch External Plate — Steel (2 Req'd)
5	E860125-S	Retaining Ring
6	7A527	Coast Clutch Piston Spring Retainer
7	7A480	Coast Clutch Piston Springs (20 Req'd)
8	7A258	Coast Clutch Piston
9	7D548	Coast Clutch Piston Outer Seal Ring

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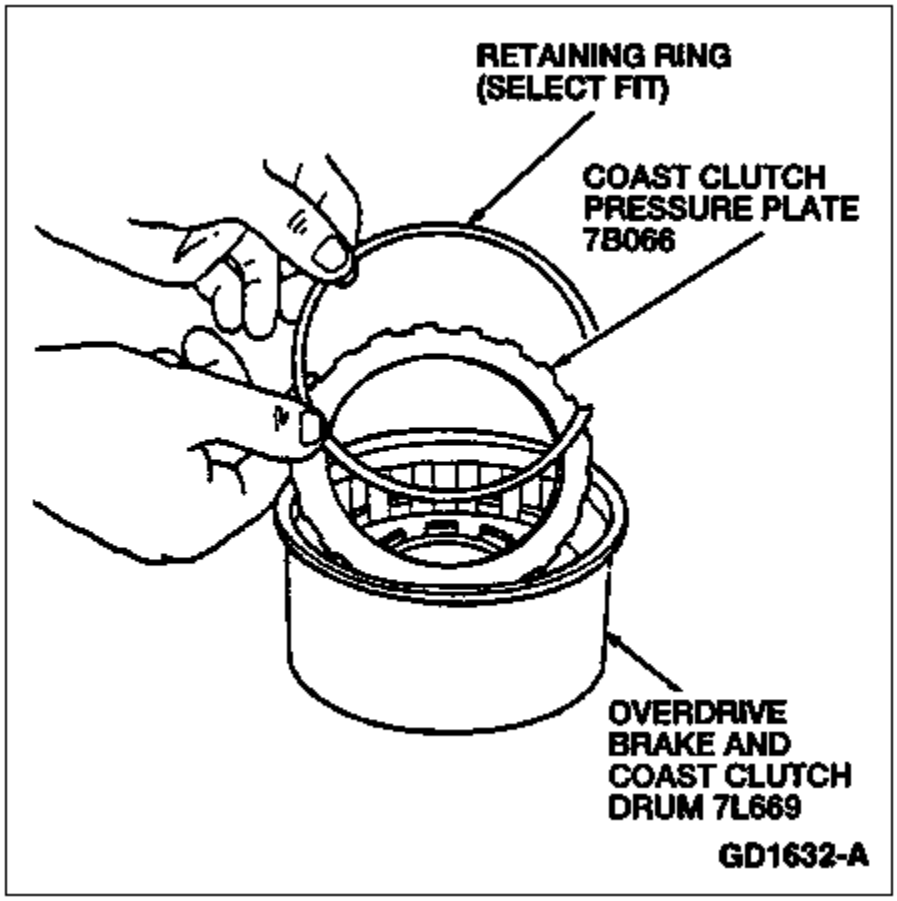
10	7D404	Coast Clutch Piston Inner Seal Ring
11	7L669	Overdrive Brake and Coast Clutch Drum Assembly

Disassembly

1. **CAUTION: This is a select fit ring. See assembly procedure if the ring or clutch plate pack is replaced.**

   Remove the retaining ring and coast clutch pressure plate from the overdrive brake and coast clutch drum.

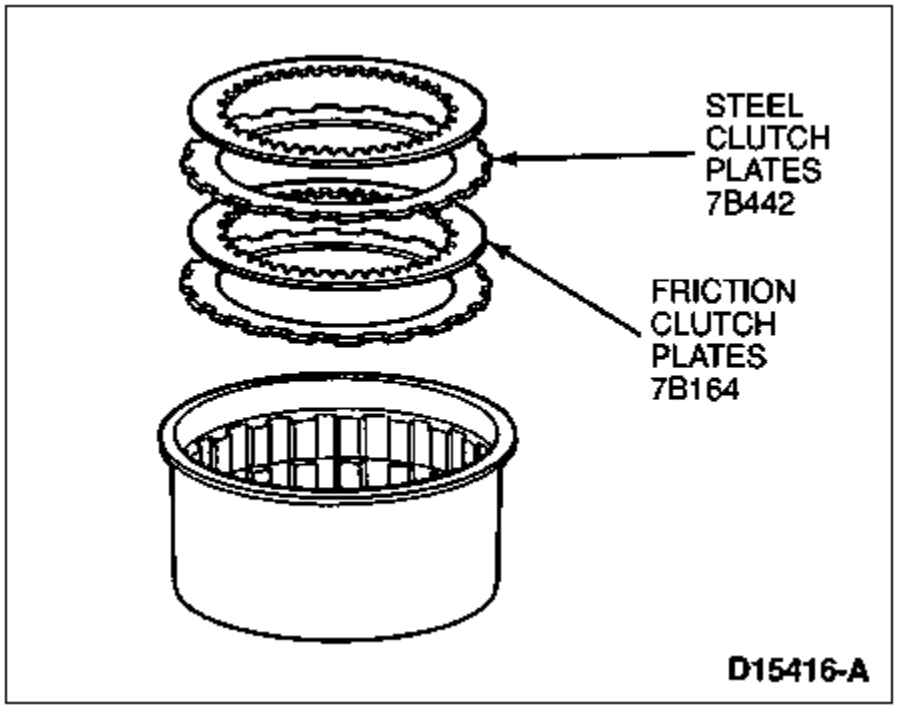


2. **CAUTION: Coast clutch friction plates are directional. Note direction of grooves for installation.**

   CAUTION: If new clutch plates are being used, they should be soaked in clean transmission fluid for at least 30 minutes before assembly.

   Remove the coast clutch pack. Inspect for wear, damage or overheating. Replace as necessary.

tomsn048@gmail.com



3. **WARNING: USE CAUTION WHEN RELEASING TOOL PRESSURE ON THE REAR CLUTCH PISTON SPRINGS.**

   CAUTION: Do not fully compress the clutch spring compressor or damage to the spring retainer may occur.

   Compress the clutch piston springs with Clutch Spring Compressor T65L-77515-A. Remove the retaining ring.

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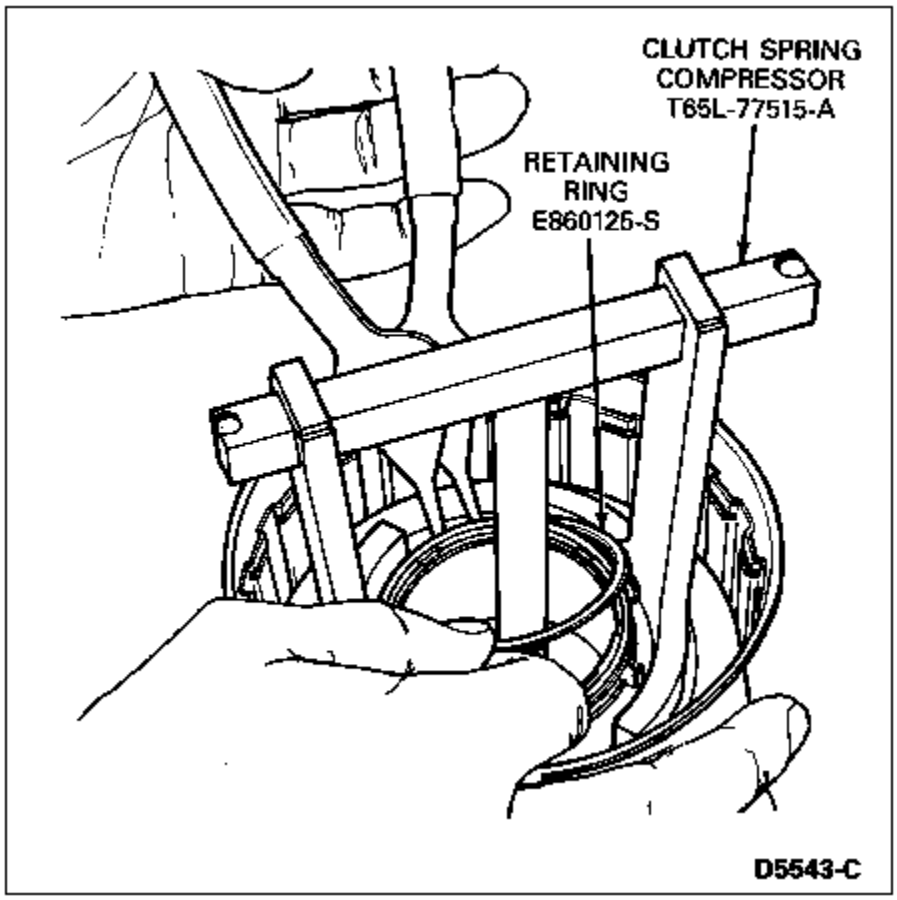

4. Remove the clutch piston spring retainer and 20 clutch piston springs.

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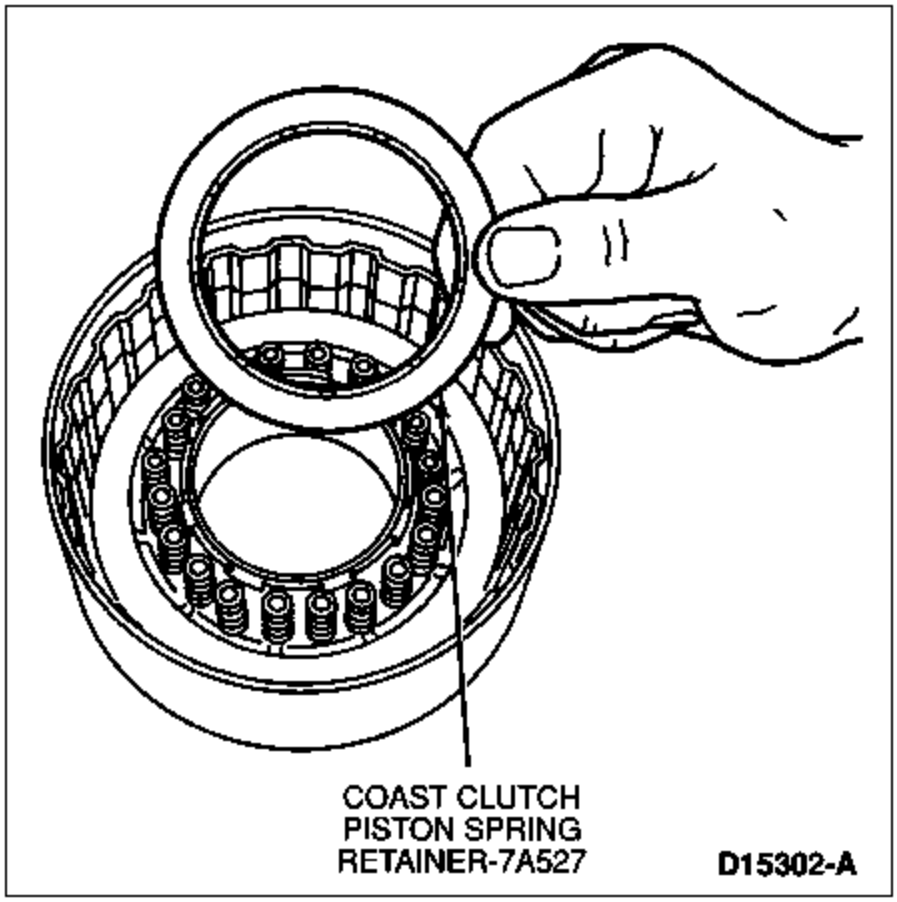

5. **WARNING: AIR PRESSURE MUST NOT EXCEED 138 KPA (20 PSI). WEAR SAFETY GLASSES WHEN USING COMPRESSED AIR, AND MAKE SURE DRUM IS FACING DOWN AS SHOWN.**

   Remove the coast clutch piston by using air pressure. Apply air pressure to one hole on the inside diameter of the overdrive brake and coast clutch drum while blocking the other hole with a finger.

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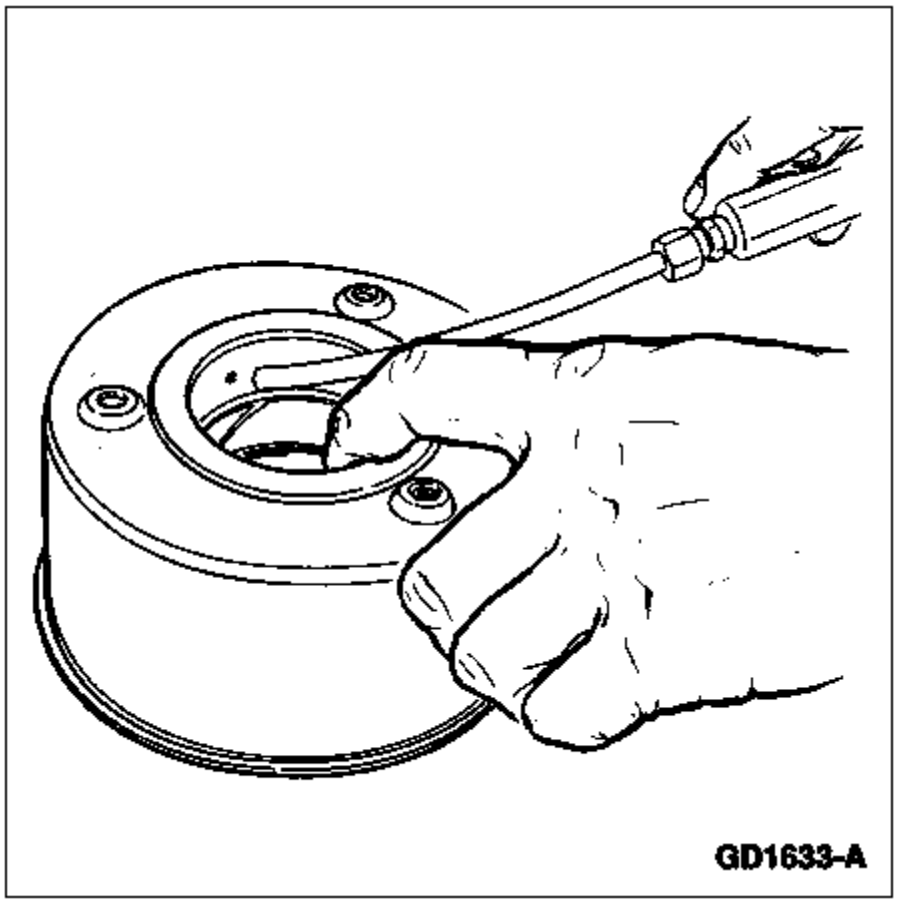

6. Remove the coast clutch piston inner and outer seal. Clean and replace as necessary.

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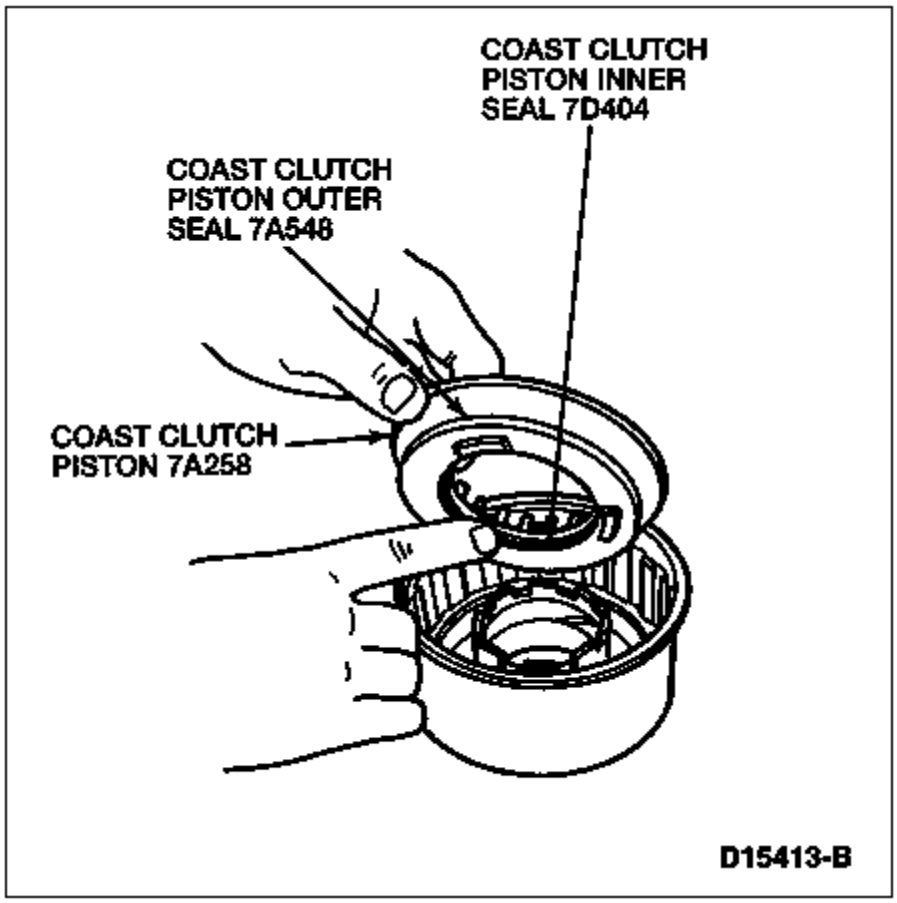

Assembly

1. **CAUTION: The lip seals must be positioned as shown. Care must be taken to prevent roll over of the lip seal.**

   Install new coast clutch piston inner and outer seal on the coast clutch piston.

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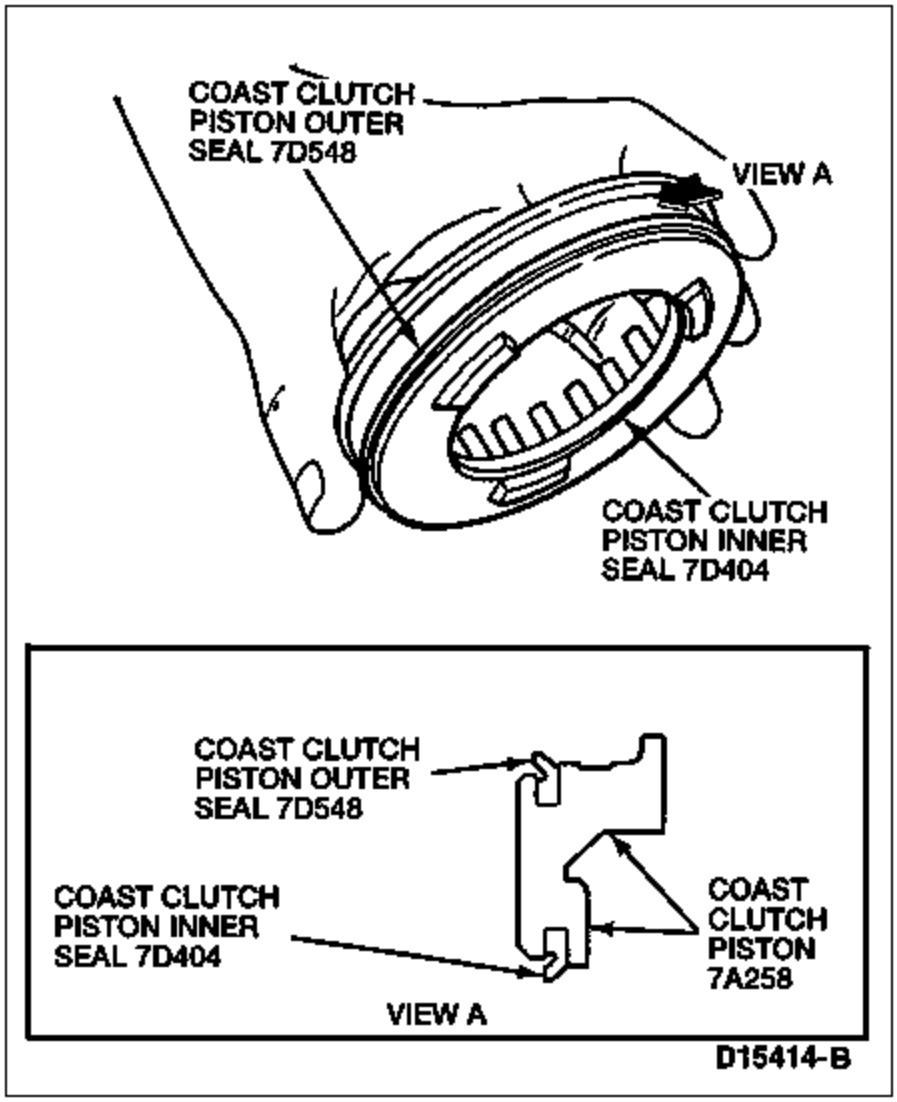

2. **CAUTION: Lubricate the coast clutch piston inner and outer seal.**

   Carefully press the coast clutch piston into Coast Clutch Outer Seal Sizing Tool T95L-70010-D.

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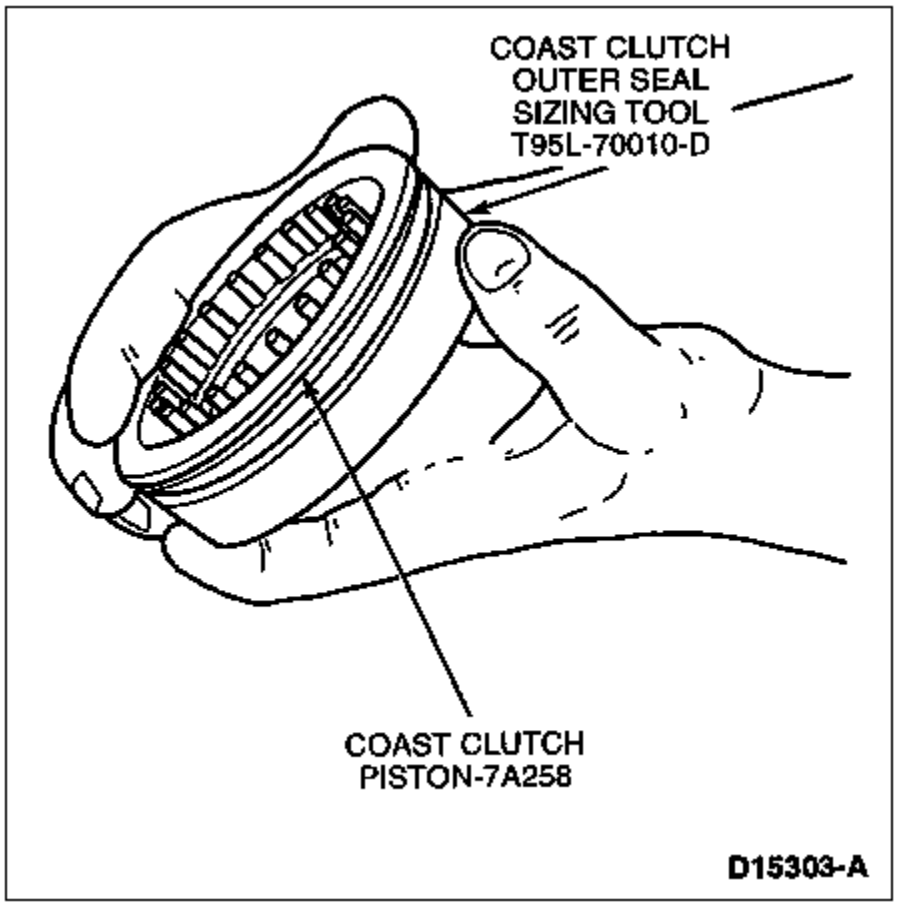

3. Inspect the drum band surface, bushing, and thrust surfaces for scores. Minor scores may be removed with a crocus cloth. Badly scored parts must be replaced.

4. Inspect the clutch piston bore and the piston and the piston inner and outer bearing surfaces for scores.

5. Check the fluid passages for obstructions. All fluid passages must be clean and free of obstructions.

6. Inspect the clutch plates for wear, scoring and fit on the clutch hub serrations. Replace all plates that are badly scored, worn or do not fit freely in the hub serrations.

7. Inspect the clutch pressure plate for scores on the clutch plate surface. Check the clutch release spring(s) for distortion.

8. Make sure the check ball is free and clear of debris prior to installing piston. The check ball is located in the overdrive brake and coast clutch drum.

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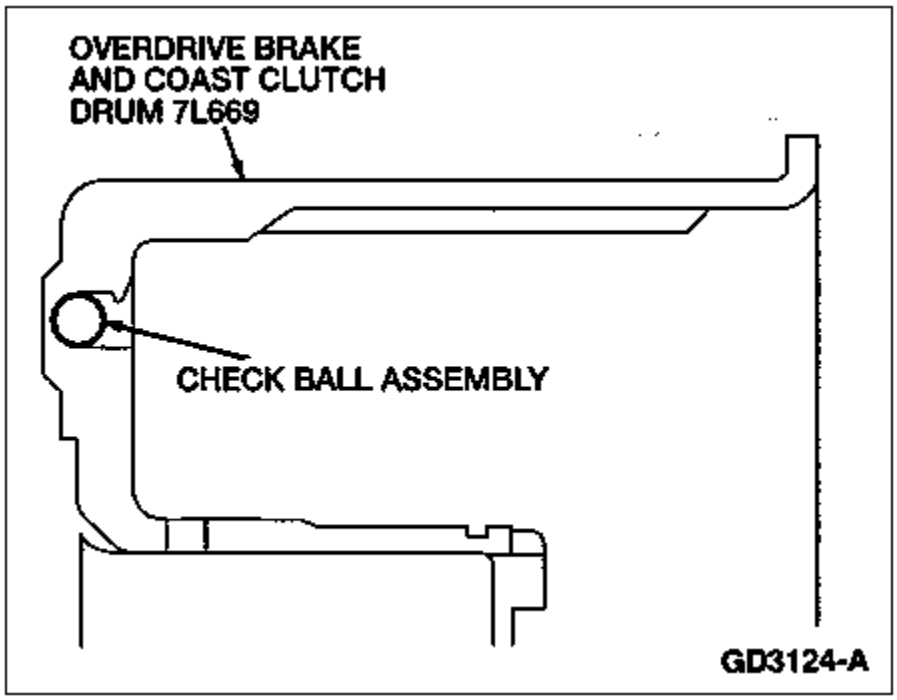
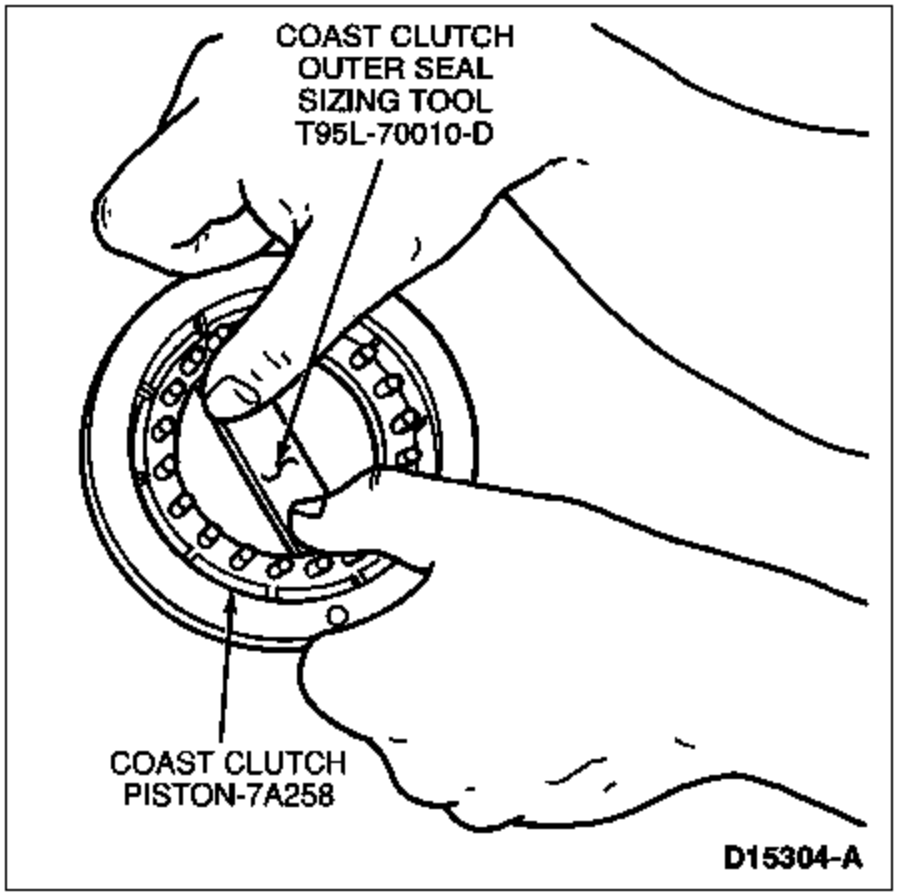


9. Carefully remove the coast clutch piston from Coast Clutch Outer Seal Sizing Tool T95L-70010-D.



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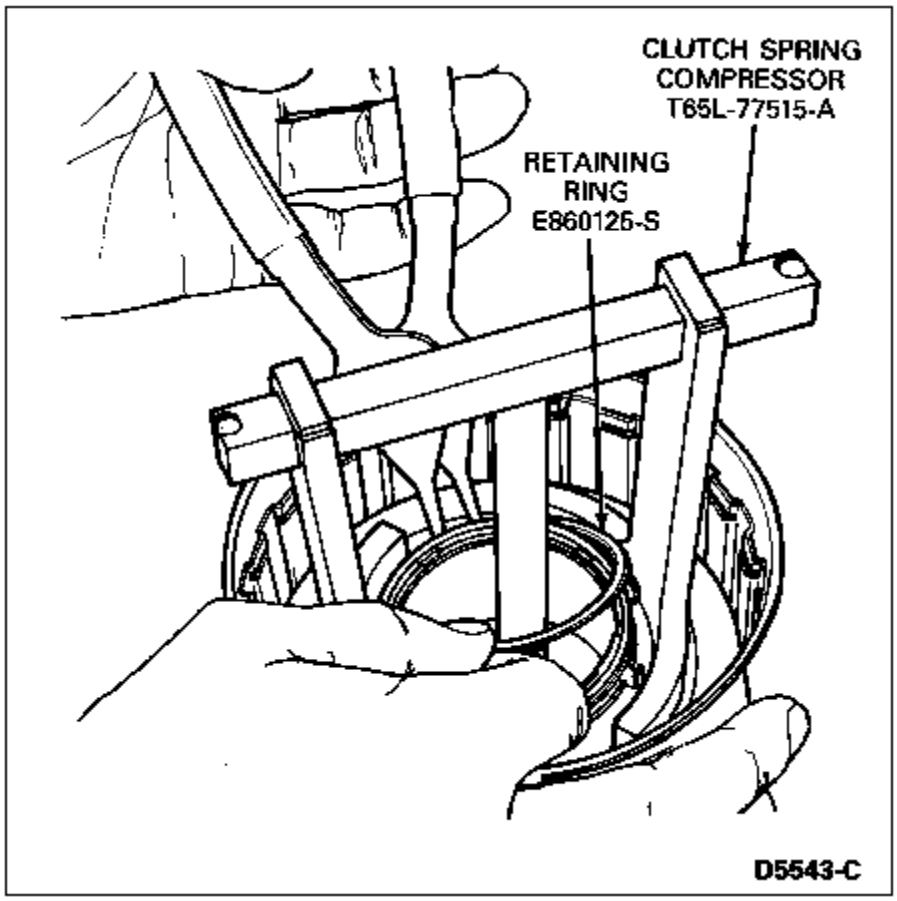
10. **CAUTION: Care must be taken to prevent damage to the seals during installation.**

    Carefully install the coast clutch piston into the overdrive brake and coast clutch drum.

11. Install the 20 coast clutch piston springs and coast clutch piston spring retainer onto the coast clutch piston.

12. **CAUTION: Do not fully compress the clutch spring compressor or damage to the coast clutch piston spring retainer may occur.**

    Compress the coast clutch piston springs with Clutch Spring Compressor T65L-77515-A. Install the retaining ring. Release the load on the springs applied by the tool. Remove the tool.



13. **CAUTION: Friction plates are directional and must be installed with grooves clockwise (I.D. to O.D.). The word "TOP" should face up.**

    CAUTION: If new clutch plates are being used, they should be soaked in clean transmission fluid for at least 30 minutes before assembly.

    NOTE: When installing friction plate, the word "TOP" should face up. If reusing plates, grooves must be installed clockwise.

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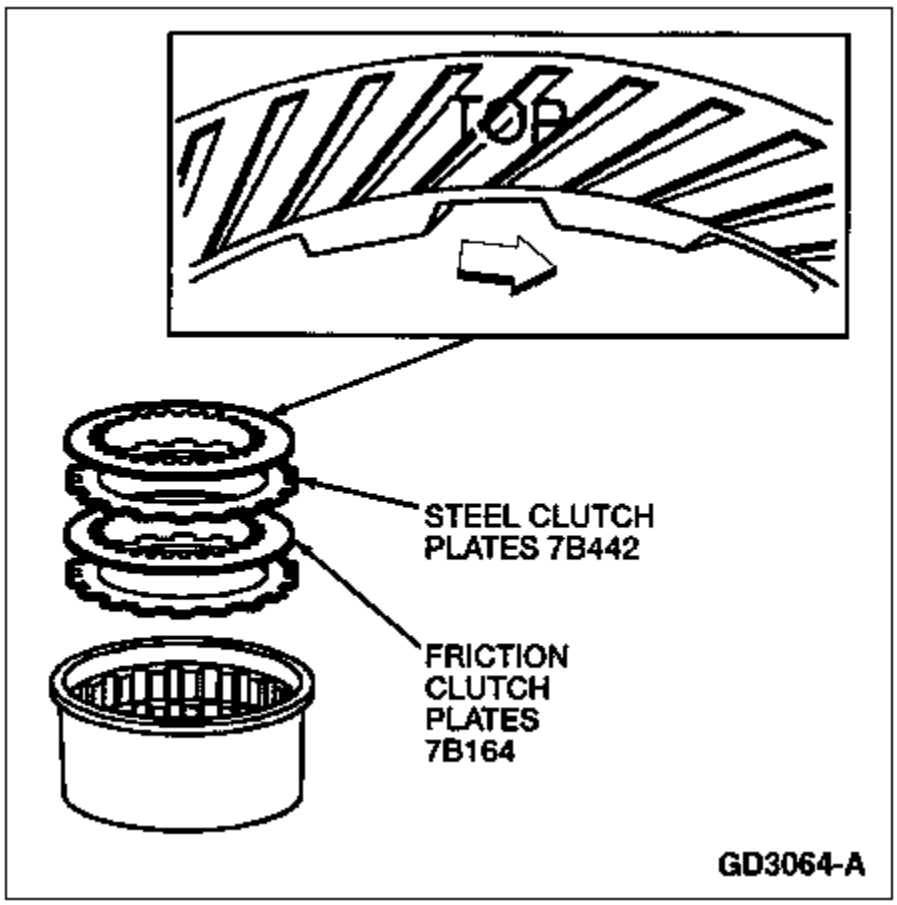
Install the two steel clutch plates and two friction clutch plates in alternating order, starting with a steel plate first.



14. **CAUTION: The retaining ring is select fit.**

Install the coast clutch pressure plate. Install the original retaining ring on top of the clutch pressure plate.

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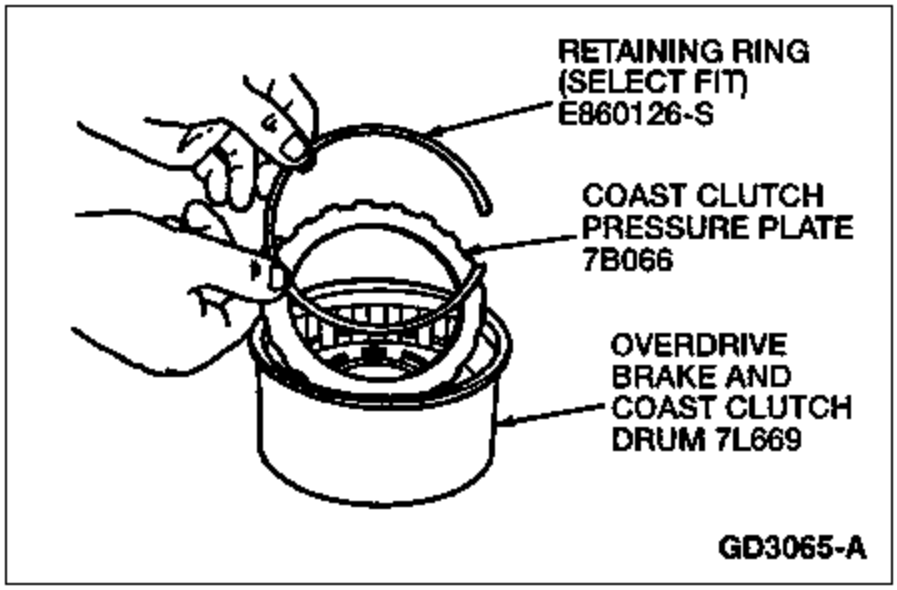

15. **WARNING: AIR PRESSURE MUST NOT EXCEED 138 KPA (20 PSI). WEAR SAFETY GLASSES WHEN USING COMPRESSED AIR. MAKE SURE DRUM IS FACING DOWN AS SHOWN.**

    NOTE: The coast clutch piston must apply with air pressure and release when the air is removed.

    Air check the assembly. Apply air to one hole on the inside diameter of the overdrive brake and coast clutch drum while blocking the other hole with a finger.

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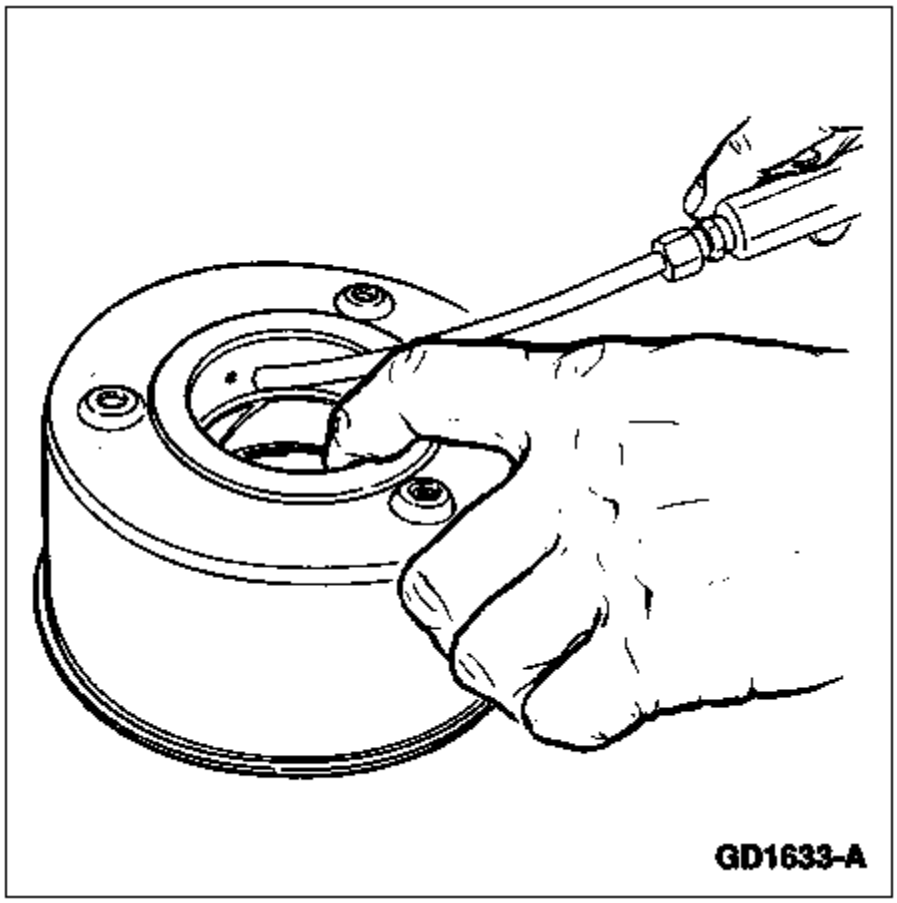

16. Check the free play of the clutch pack. Push down on the clutch pack. Use a feeler gauge to check the gap between the retaining ring and the pressure plate. Specification: 1.3 to 2.0 mm (.051 to .079 inch).

    If the reading is not within specification, remove the retaining ring and check the thickness. Replace it with a ring that will correct free play. Verify with a feeler gauge.

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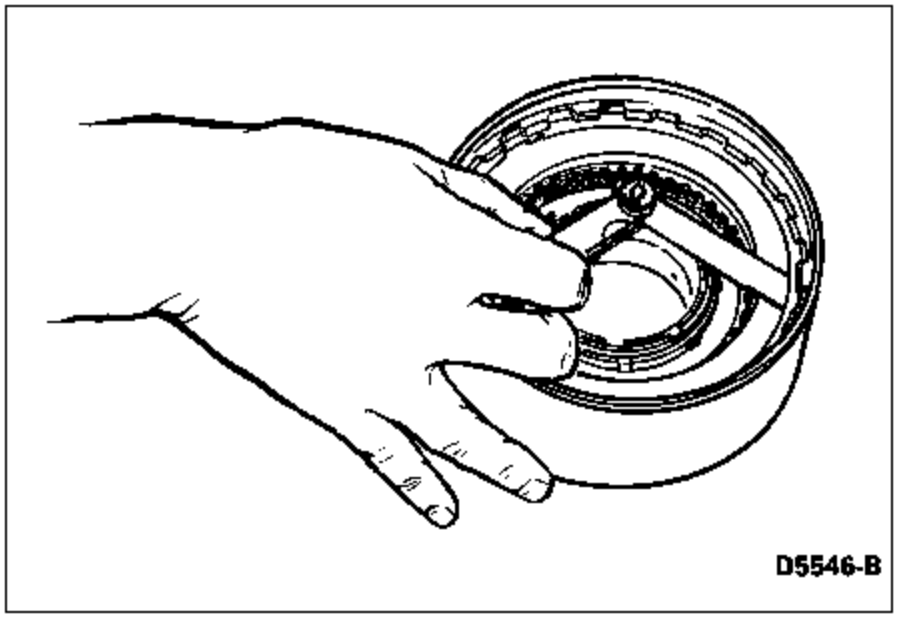

COAST CLUTCH

	Thickness		Diameter	
Part Number	mm	Inches	mm	Inches
E860126-S	1.37	.0539	130.1	5.122
E860127-S	1.73	.0681	130.1	5.122
E860128-S	2.08	.0819	130.1	5.122
E860129-S	2.44	.0961	130.1	5.122

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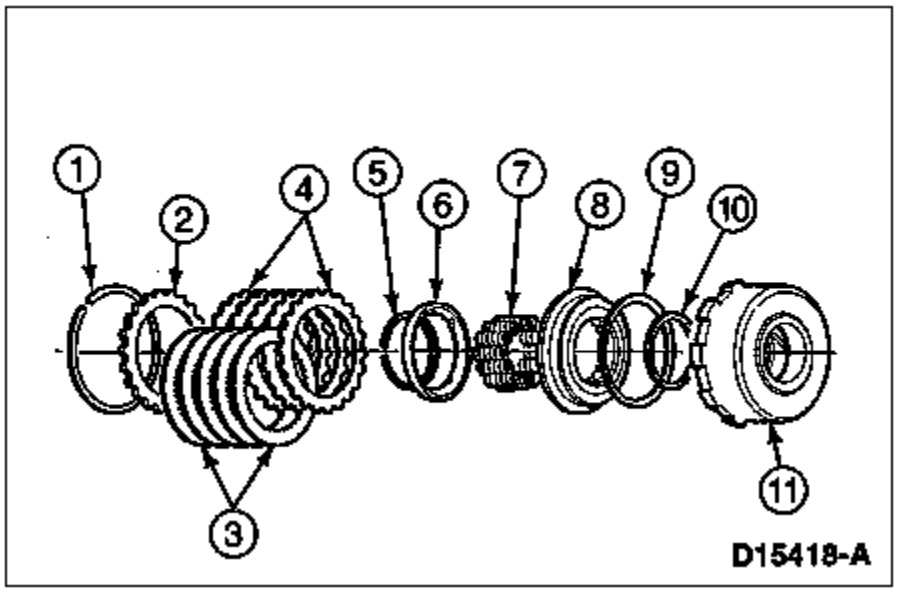
Intermediate Brake and Direct Clutch Drum Assembly

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Clutch Spring Compressor	T65L-77515-A
Direct Clutch Outer Seal Sizing Tool	T95L-70010-E

Intermediate Brake and Direct Clutch Drum Assembly



Item	Part Number	Description
1	E860126-S/129-S	Retaining Ring (Select Fit)
2	7B066	Direct Clutch Pressure Plate
3	7B164	Direct Clutch Internal Plate — Friction
4	7B442	Direct Clutch External Plate — Steel
5	E860125-S	Retaining Ring
6	7A527	Direct Clutch Piston Spring Retainer (8 Tabs)
7	7A480	Direct Clutch Piston Springs (20 Req'd)
8	7A258	Direct Clutch Piston
9	7A548	Direct Clutch Piston Outer Seal Ring

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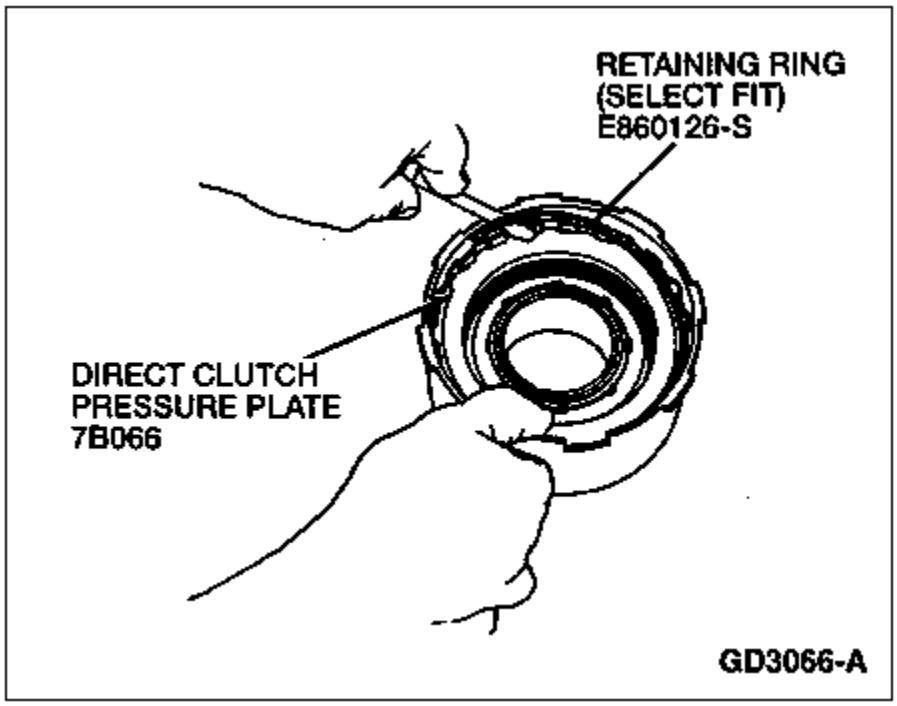
10	7D404	Direct Clutch Piston Inner Seal Ring
11	7D044	Intermediate Brake and Direct Clutch Drum Assembly

Disassembly

1. **CAUTION: The retaining ring is a select fit ring. See assembly procedure if the ring or clutch pack is replaced.**

   Remove the retaining ring and direct clutch pressure plate.



2. **CAUTION: Friction plates are directional and must be installed with grooves clockwise (I.D. to O.D.). The word "TOP" should face up.**

   CAUTION: If new clutch plates are being used, they should be soaked in clean transmission fluid for at least 30 minutes before assembly.

   Remove the direct clutch pack. Inspect for wear, damage or overheating. Replace the steel or friction plates as necessary.

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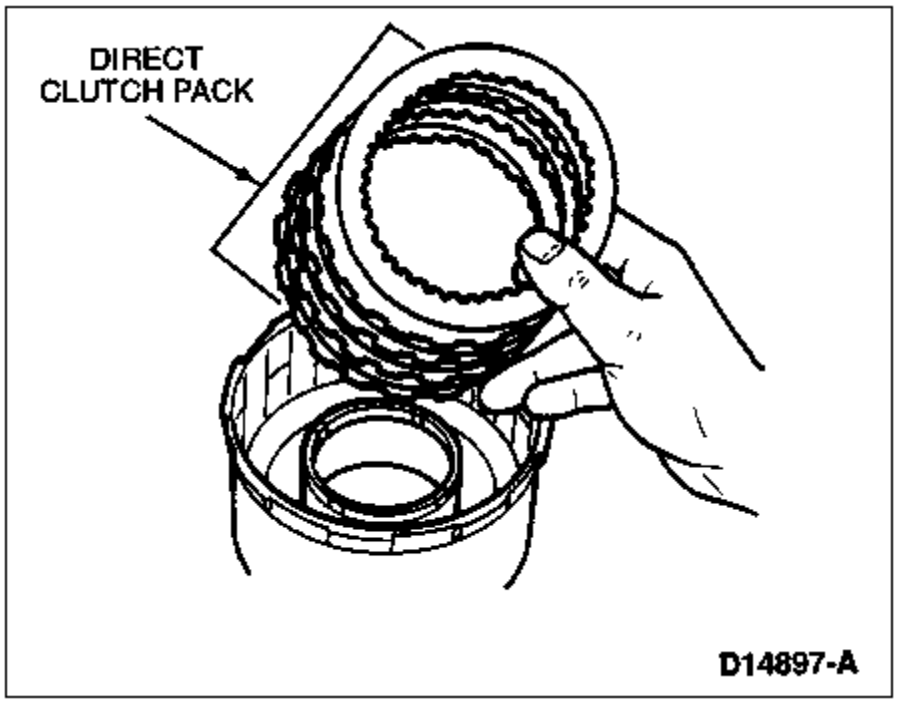

3. **WARNING: AFTER REMOVING THE RETAINING RING, USE CARE WHEN RELEASING THE PRESSURE ON THE SPRINGS.**

   CAUTION: Do not fully compress the clutch spring compressor or damage to the spring retainer may occur.

   Compress the direct clutch piston springs with Clutch Spring Compressor T65L-77515-A. Remove the retaining ring. Remove the tool.

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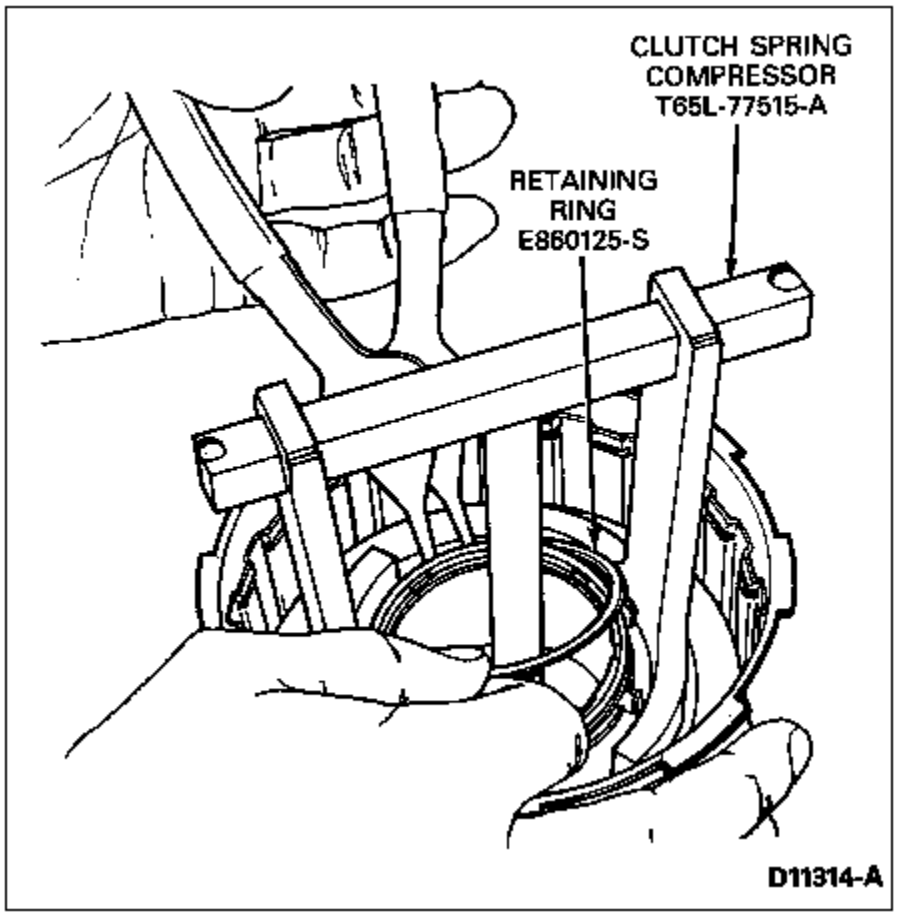
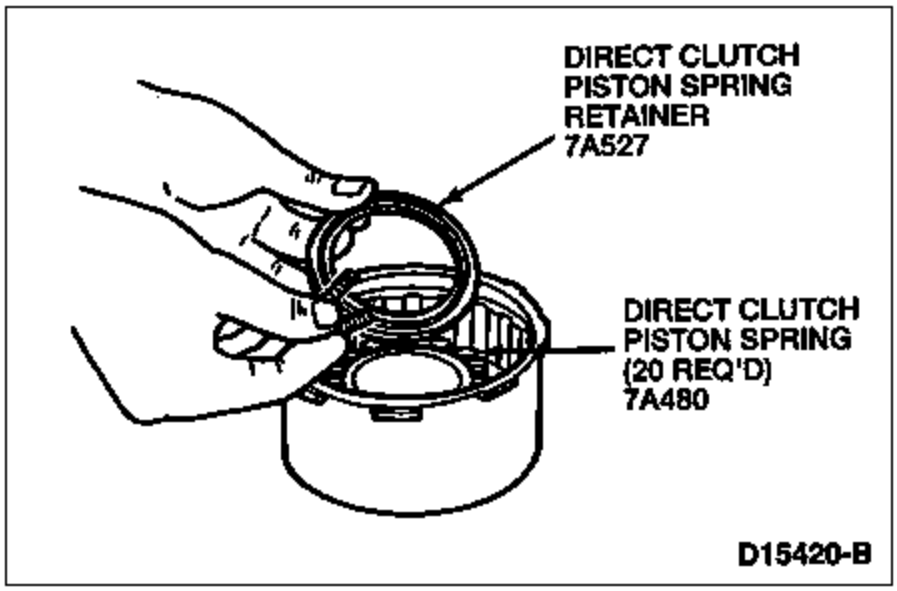


4. Remove the direct clutch piston spring retainer and 20 direct clutch piston springs.



5. **WARNING: DO NOT EXCEED 138 KPA (20 PSI). WEAR SAFETY GLASSES WHEN USING**

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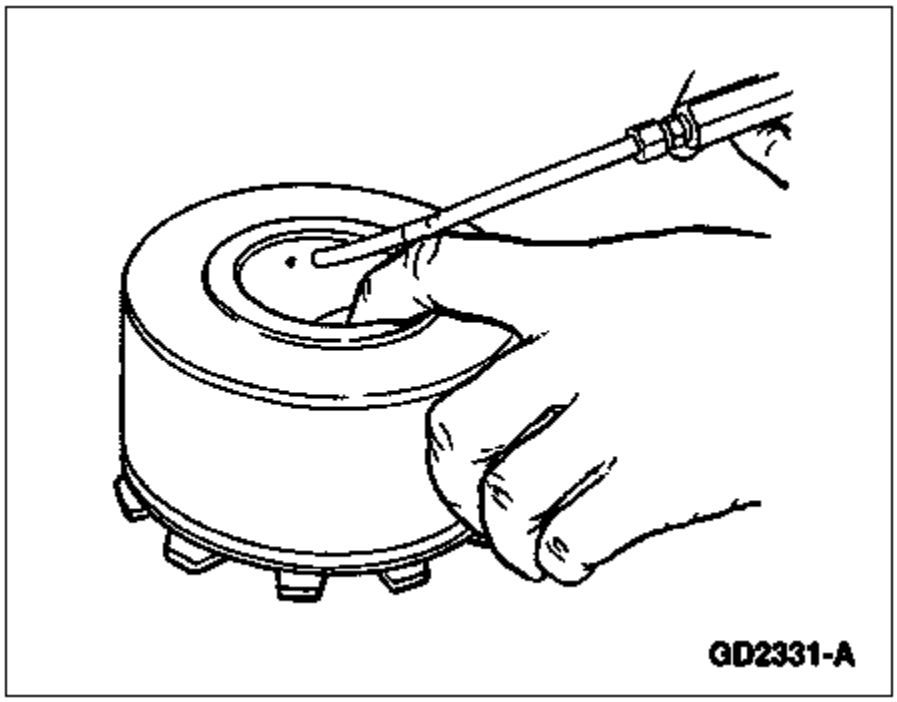
COMPRESSED AIR. MAKE SURE DRUM IS FACING DOWN AS SHOWN.

Remove the direct clutch piston using compressed air. Apply air pressure to one hole on the inside diameter of the intermediate brake and direct clutch drum while blocking the other hole with a finger.



6. Remove the direct clutch piston inner and outer seals. Clean and replace as necessary.

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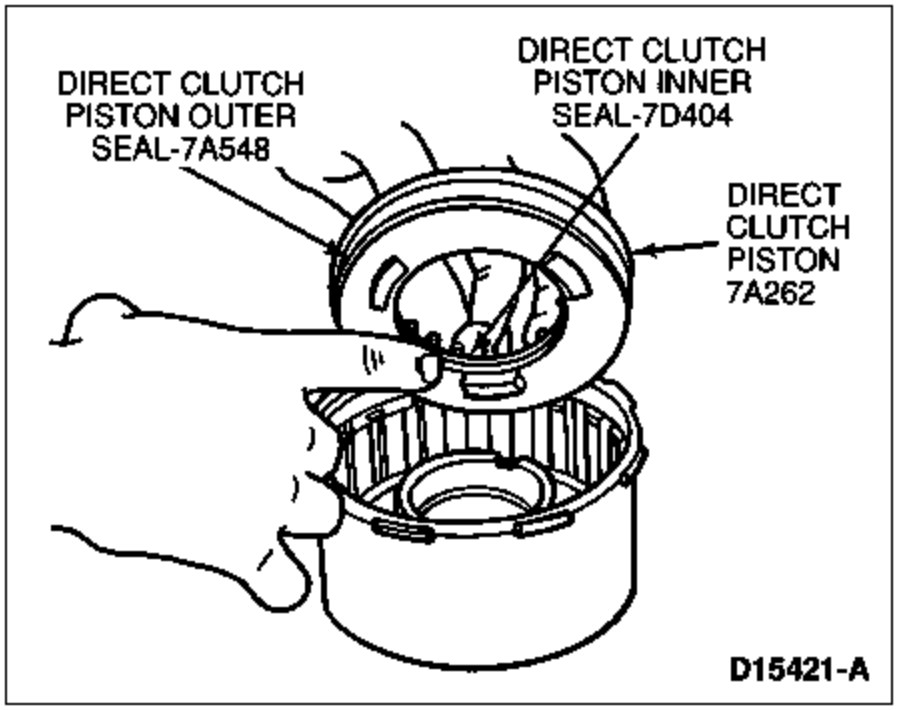

Assembly

1. **CAUTION: The lip seals must be positioned as shown. Care must be taken to prevent rollover of the lip seal.**

   Install new direct clutch piston inner and outer seals on the direct clutch piston.

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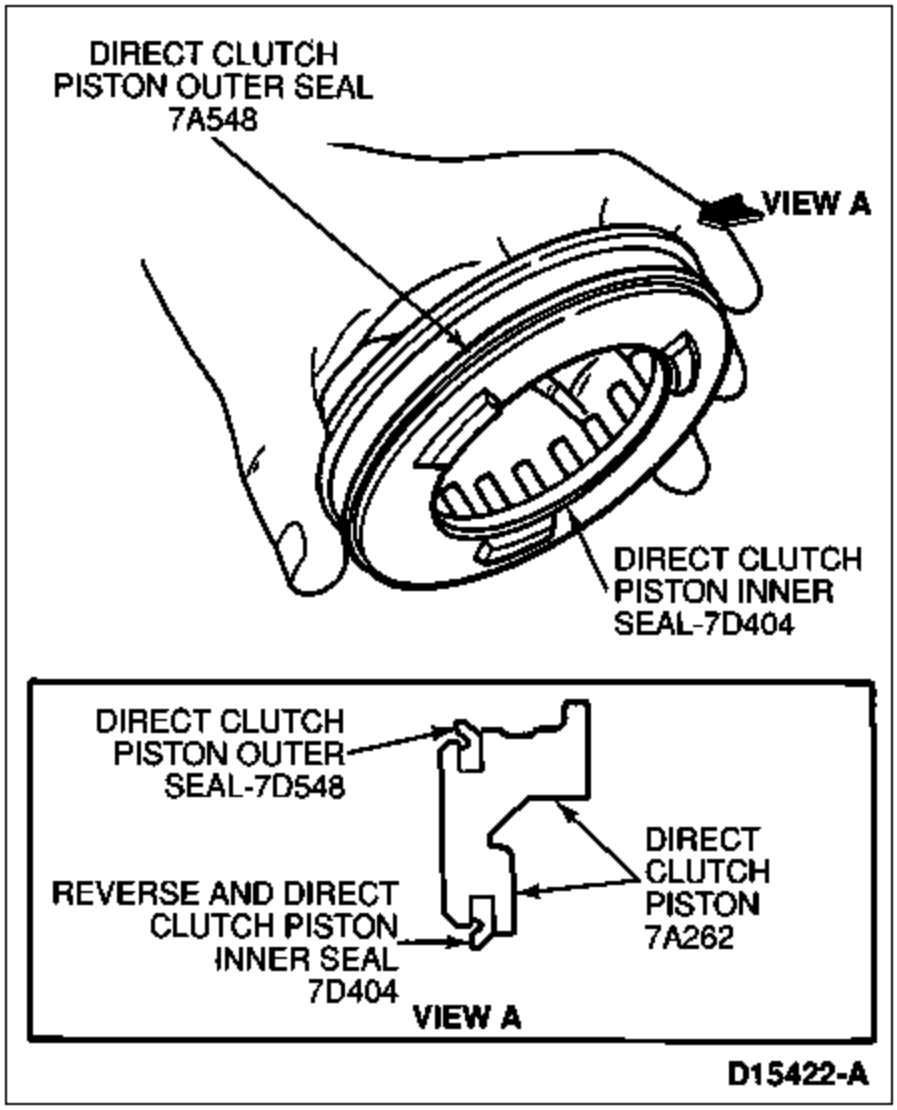

2. **CAUTION: Lubricate the direct clutch piston inner and outer seals with MERCON V® XT-5-QM transmission fluid.**

   Carefully press the direct clutch piston into Direct Clutch Outer Seal Sizing Tool T95L-70010-E.

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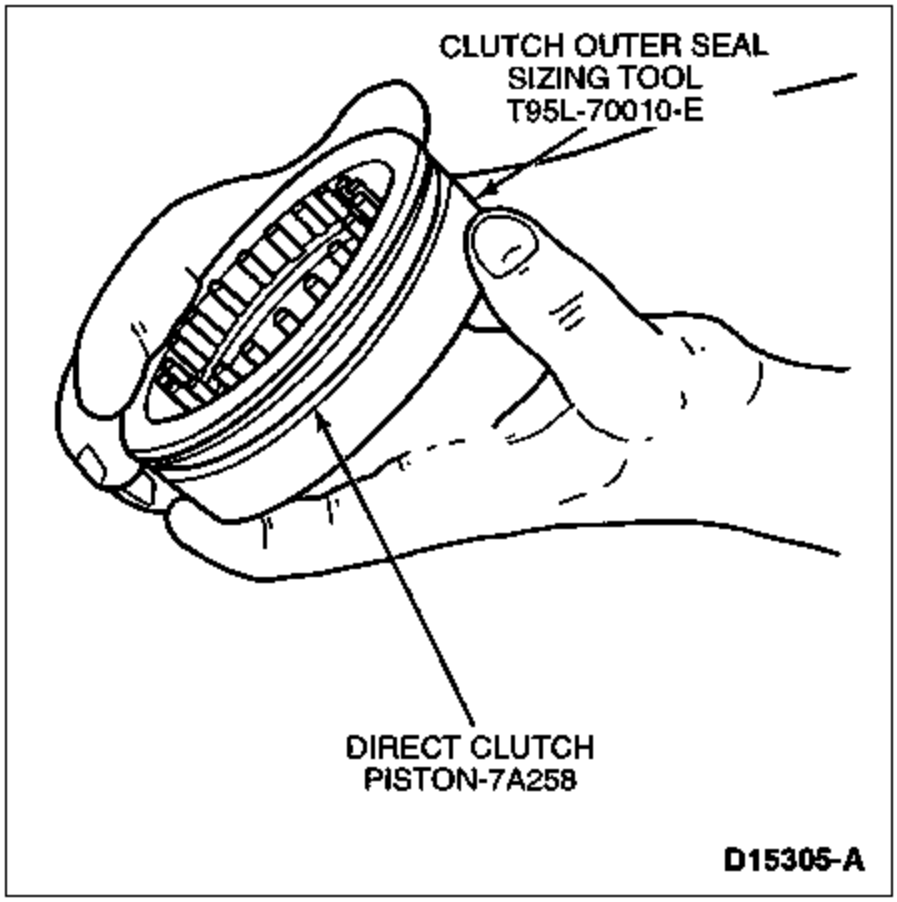

3. Inspect the drum band surface, bushing and thrust surfaces for scores. Minor scores may be removed with a crocus cloth. Badly scored parts must be replaced.

4. Inspect the clutch piston bore and the piston and the piston inner and outer bearing surfaces for scores.

5. Check the fluid passages for obstructions. All fluid passages must be clean and free of obstructions.

6. Inspect the clutch plates for wear, scoring and fit on the clutch hub serrations. Replace all plates that are badly scored, worn or do not fit freely in the hub serrations.

7. Inspect the direct clutch pressure plate for scores on the clutch plate bearing surface. Check the clutch release springs for distortion.

8. Make sure the check ball is free and clear of debris prior to installing piston. The check ball is located in the intermediate brake and direct clutch drum assembly.

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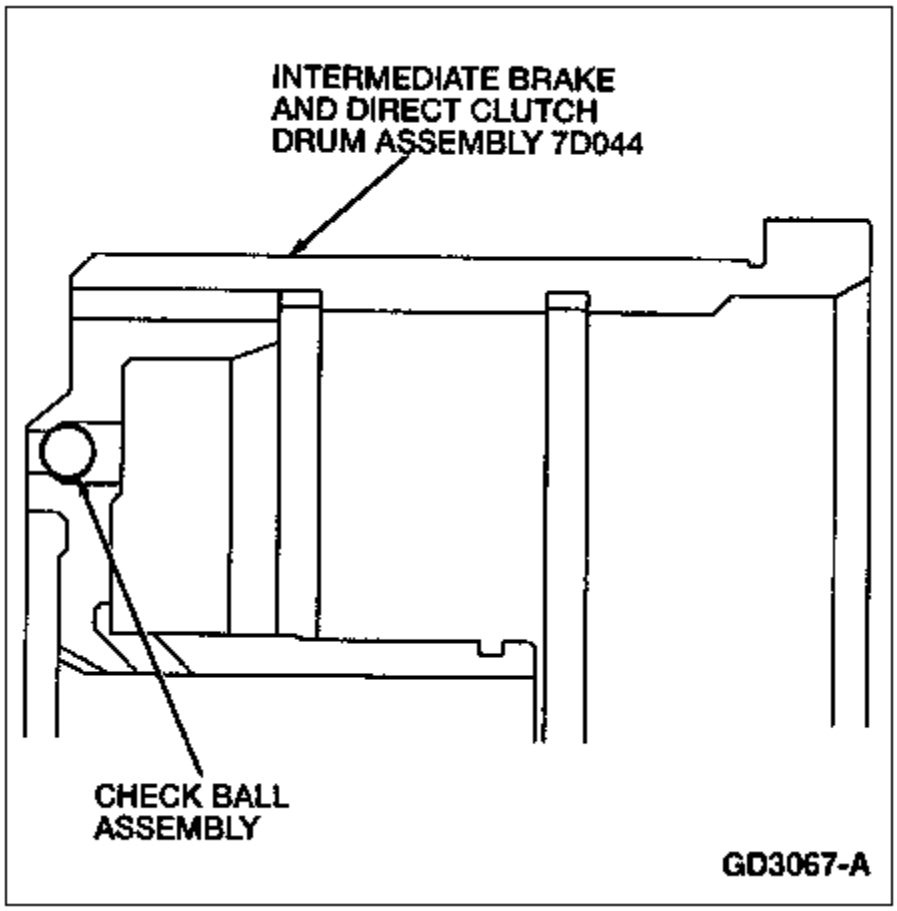

9. Carefully remove the direct clutch piston from Direct Clutch Outer Seal Sizing Tool T95L-70010-E.

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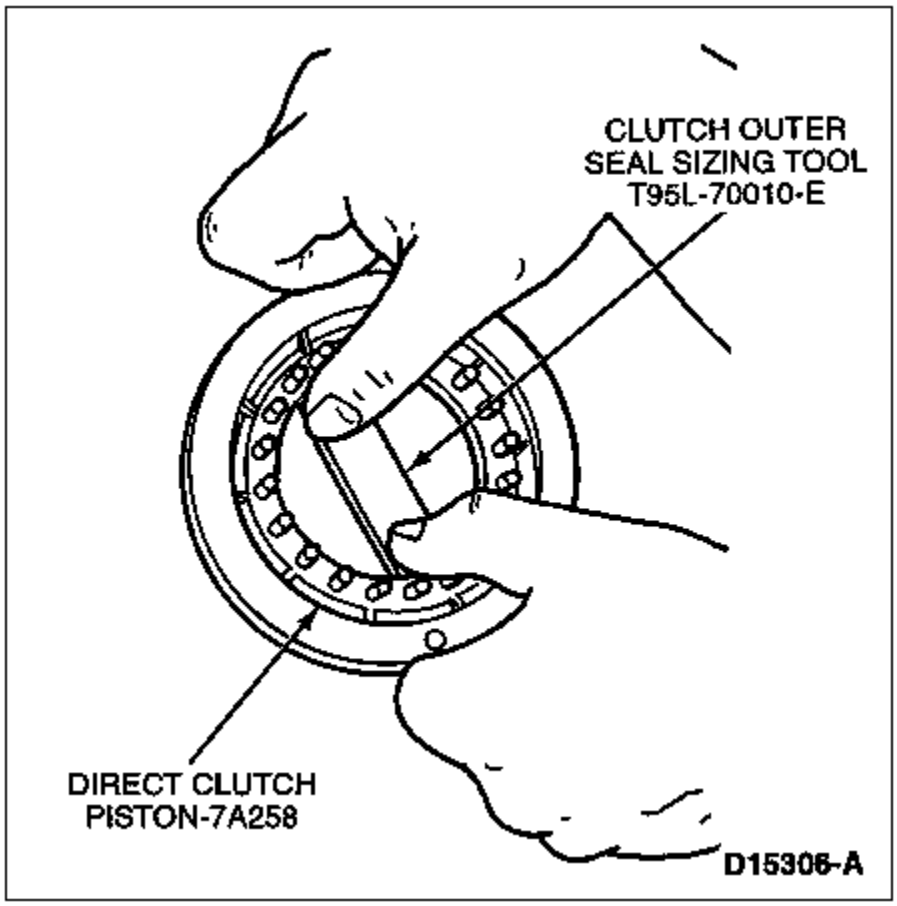

10. **CAUTION: Care must be taken to prevent damage to the seals during installation.**

Carefully install the clutch piston into the intermediate brake and direct clutch drum.

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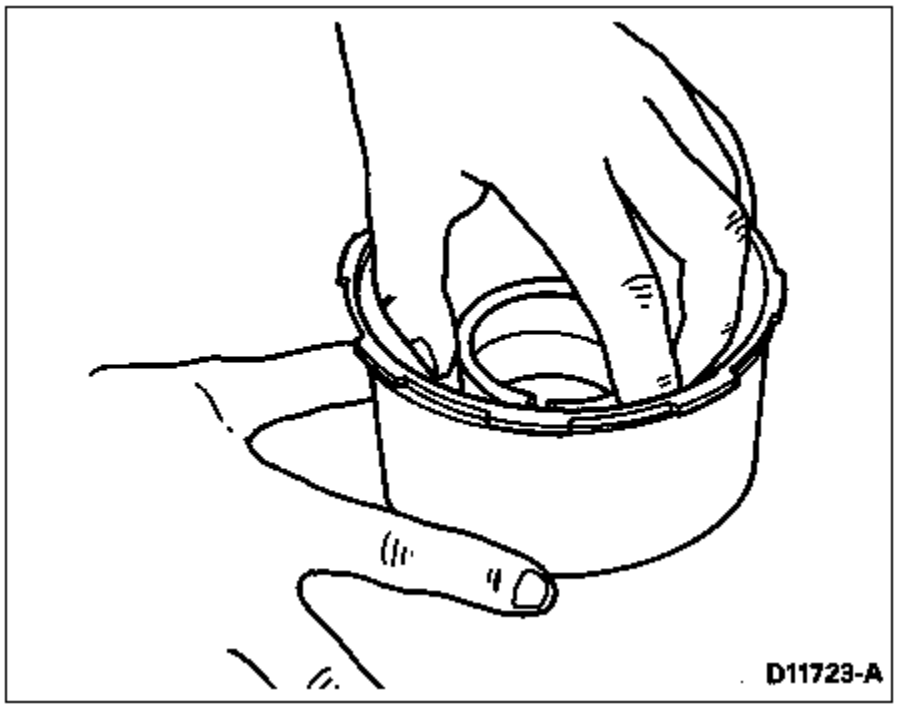
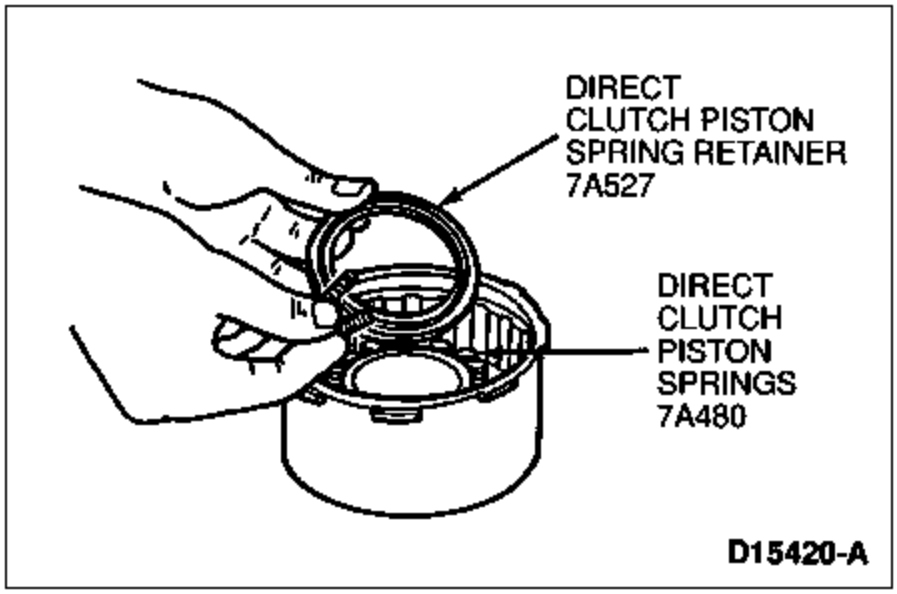


11. Install the direct clutch piston spring retainer and 20 direct clutch piston springs.



12. **CAUTION: Do not fully compress the clutch spring compressor damage to the spring retainer may occur.**

Compress the direct clutch piston springs with Clutch Spring Compressor T65L-77515-A. Install the retaining ring. Remove the tool.

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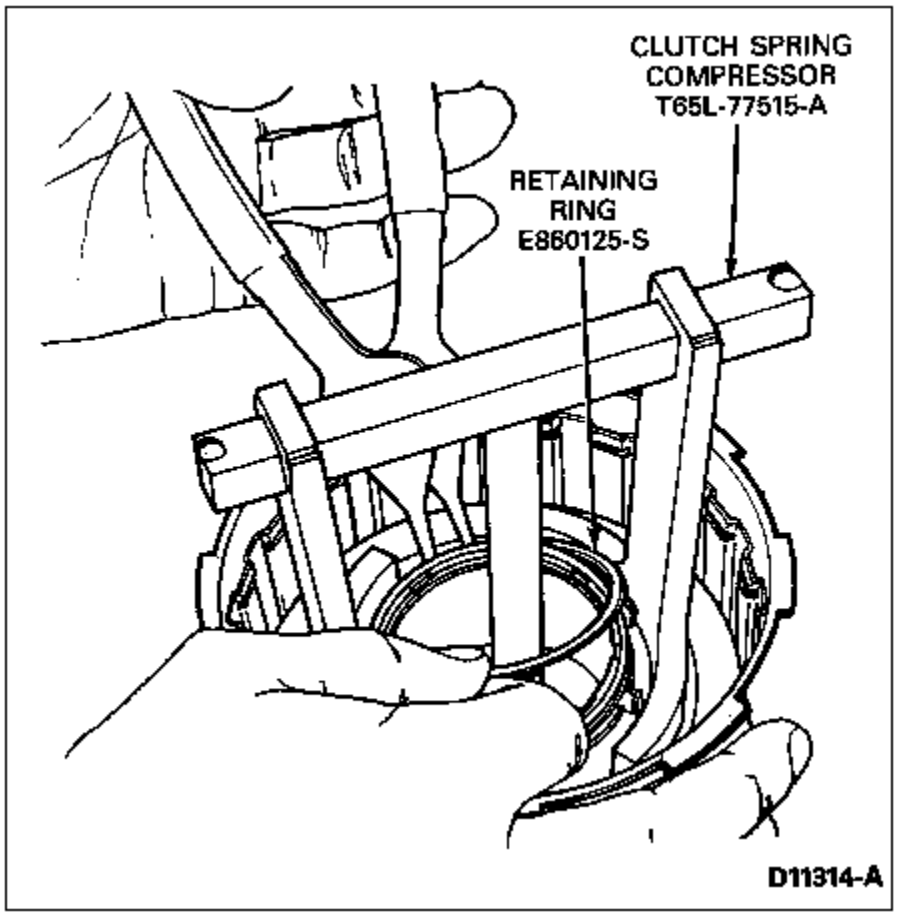

13. **CAUTION: Friction plates are directional and must be installed with grooves clockwise (I.D. to O.D.). The word "TOP" should face up.**

CAUTION: The number of plates is model dependent. See Specifications at the end of this section. If new plates are being used, they should be soaked in clean transmission fluid for at least 30 minutes before assembly.

NOTE: When installing friction plates, the word "TOP" should face up. If reusing plates, grooves must be installed clockwise.

Install the steel clutch plates and friction clutch plates in alternating order, starting with a steel plate and finishing with a friction plate.

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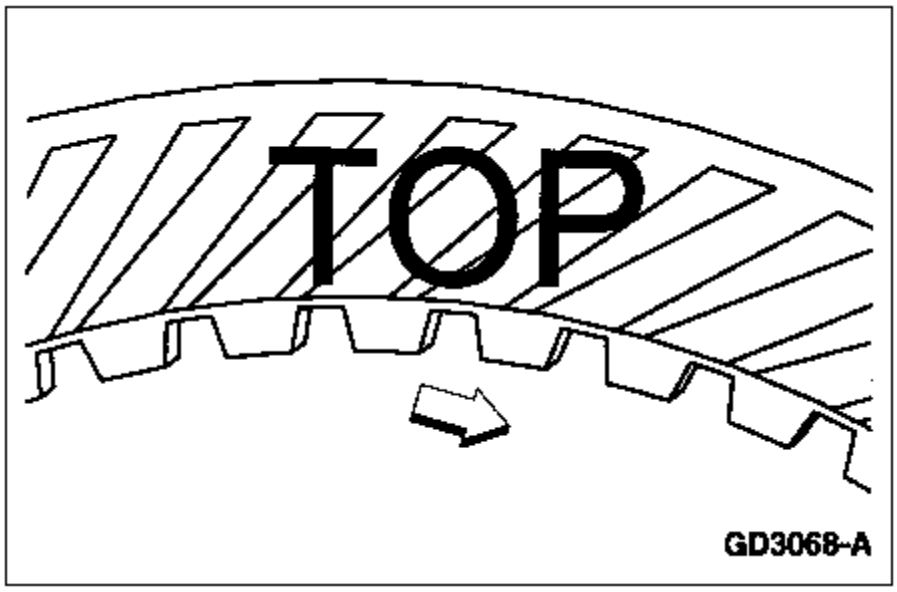

CLUTCH PACK

Steel	Friction
4	4

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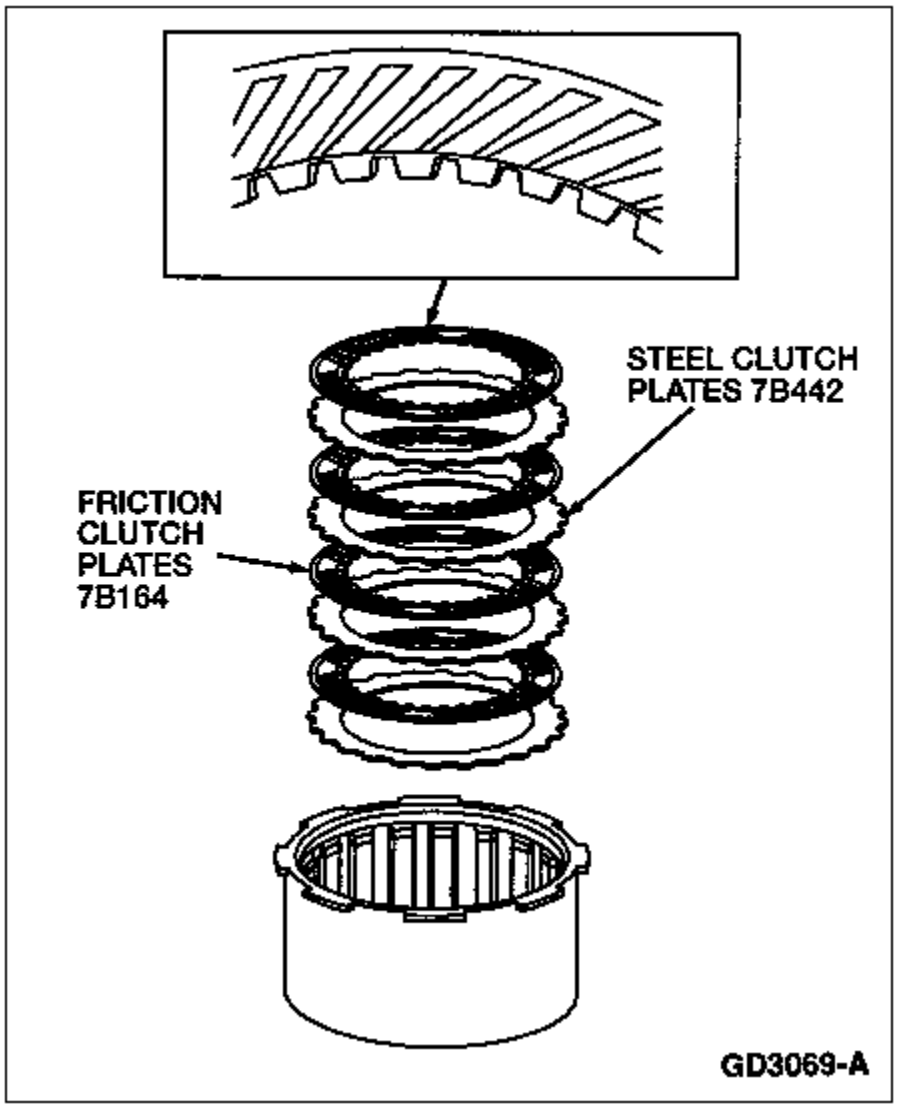

14. **CAUTION: The retaining ring is a select fit.**

Install the direct clutch pressure plate and original retaining ring on the clutch stack.

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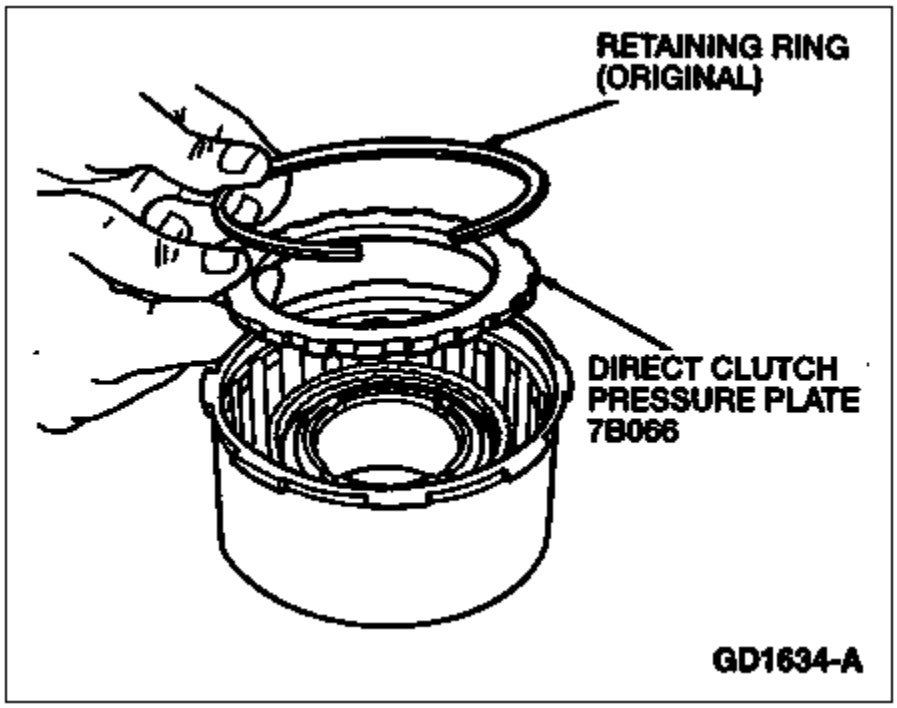

15. **WARNING: AIR PRESSURE MUST NOT EXCEED 138 KPA (20 PSI). WEAR SAFETY GLASSES WHEN USING COMPRESSED AIR. MAKE SURE THE DRUM IS FACING DOWN AS SHOWN.**

    NOTE: The direct clutch piston must apply with air pressure and release when the air is removed.

    Air check the assembly. Apply air to one hole on the inside diameter of the intermediate brake and direct clutch drum while blocking the other hole with a finger.

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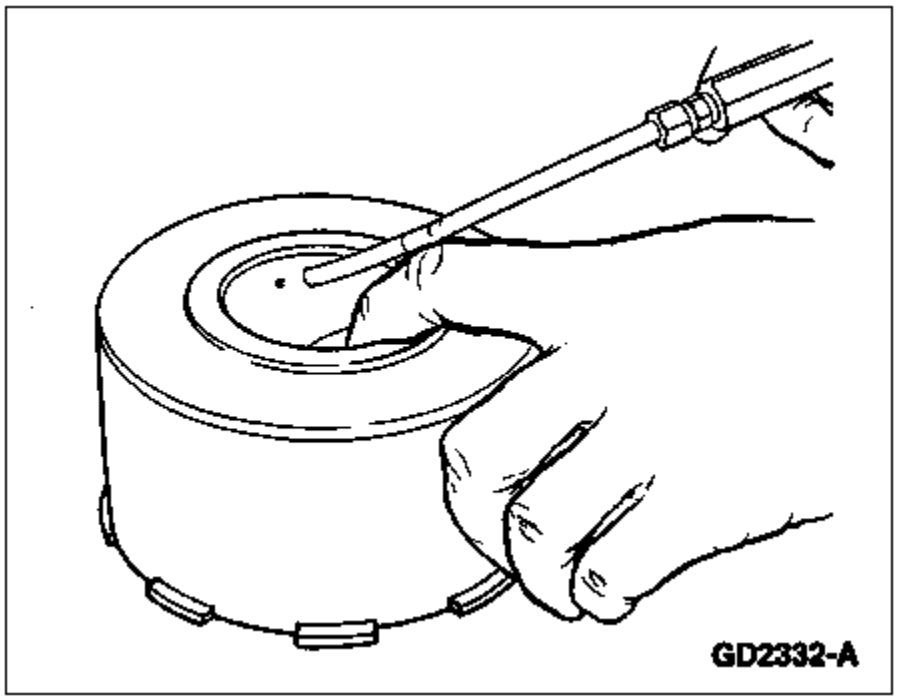
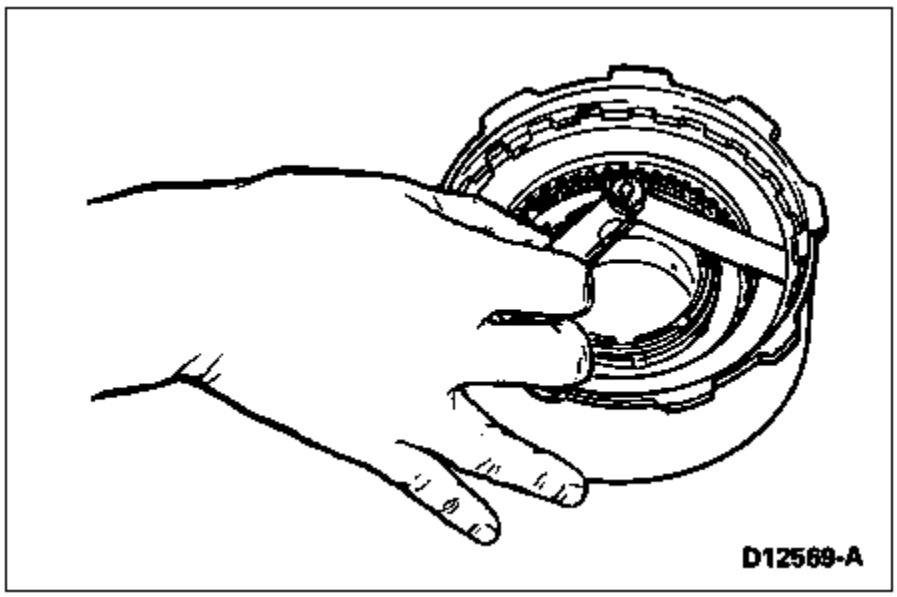


16. Push down on the clutch pack. Use a feeler gauge to check the gap between the retaining ring and the clutch pressure plate. Specification: 1.3 to 2.0 mm (0.051 to 0.079 inch).

    If the reading is not within specification, remove the retaining ring and check thickness. Replace with a ring that will correct free play, and verify with a feeler gauge.



DIRECT CLUTCH

	Thickness		Diameter	

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Part Number	mm	Inches	mm	Inches
E860126-S	1.37	.0539	130.1	5.122
E860127-S	1.73	.0681	130.1	5.122
E860128-S	2.08	.0819	130.1	5.122
E860129-S	2.44	.0961	130.1	5.122

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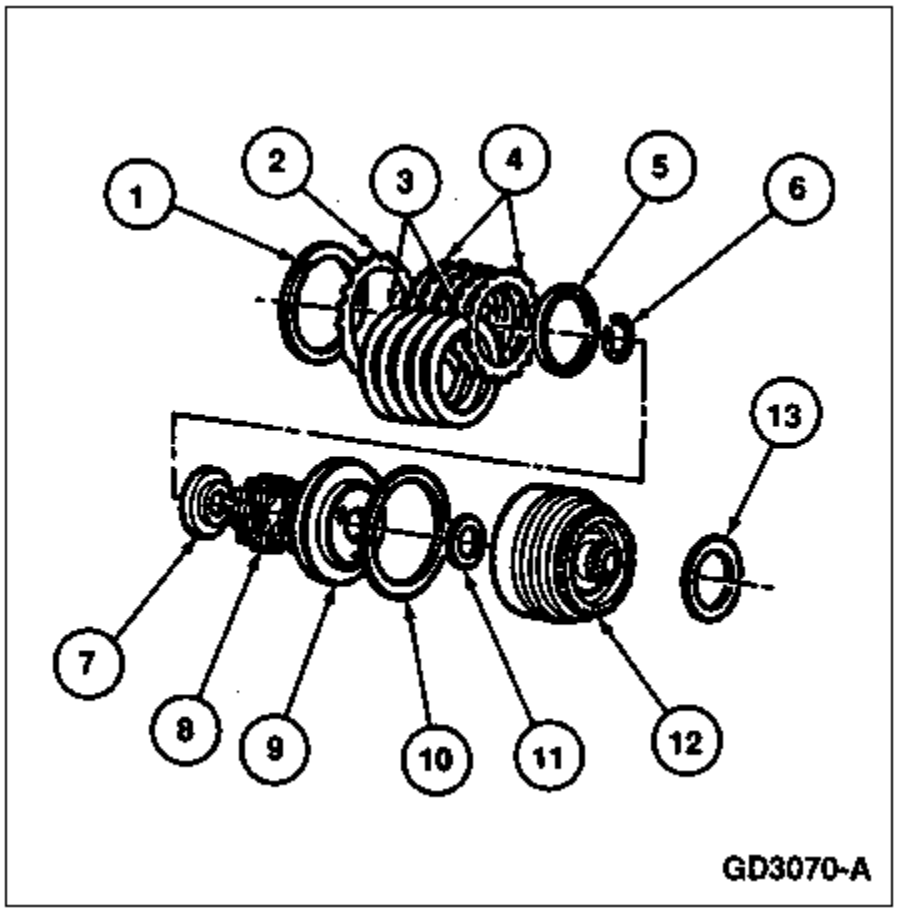
Forward Clutch

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Clutch Spring Compressor	T65L-77515-A
Lip Seal Protector	T74P-77548-A
Lip Seal Protector	T74P-77548-B

Forward Clutch Assembly



Item	Part Number	Description
1	E860115-S/118-S	Retaining Ring (Select Fit)

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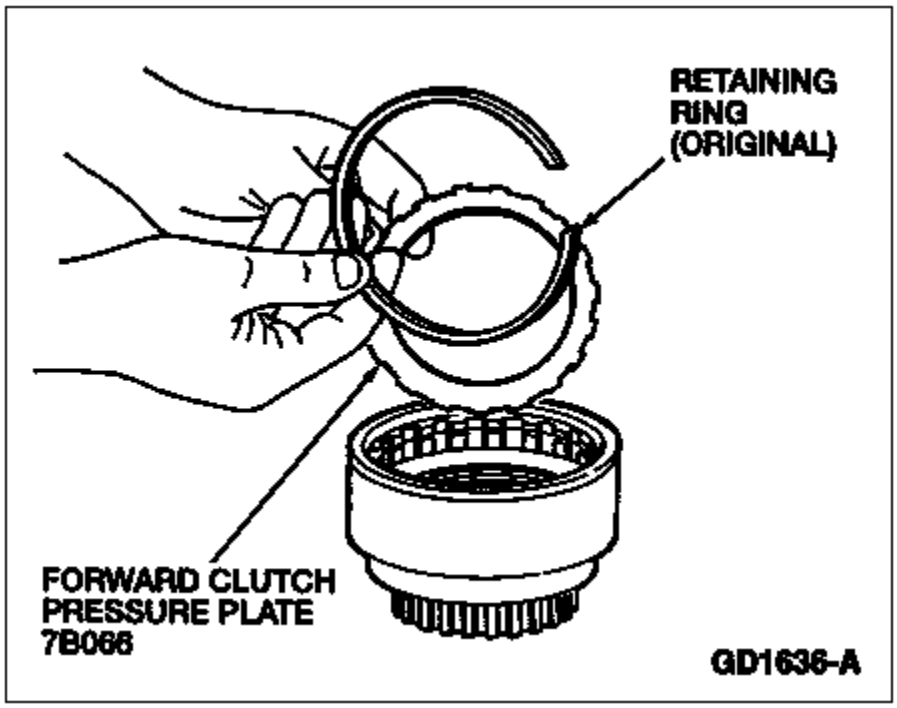
2	7B066	Forward Clutch Pressure Plate
3	7B164	Forward Clutch Internal Plate — Friction
4	7B442	Forward Clutch External Plate — Steel
5	7B070	Forward Clutch Cushion Spring
6	E860109-S	Retaining Ring
7	7A527	Forward Clutch Piston Spring Retainer
8	7A480	Forward Clutch Piston Springs (15 Req'd)
9	7A262	Forward Clutch Piston Assembly
10	7A548	Forward Clutch Piston Outer Seal Ring
11	7A548	Forward Clutch Piston Inner Seal Ring
12	7A360	Forward Clutch Cylinder Assembly
13	7M153	No. 5 Forward Clutch Cylinder Thrust Bearing

Disassembly

1. **CAUTION: The retaining ring is a select fit ring. See assembly procedure if the retaining ring or clutch pack is replaced.**

   CAUTION: If new plates are being used, they should be soaked in clean transmission fluid for at least 30 minutes before assembly.

   Remove the retaining ring and forward clutch pressure plate.



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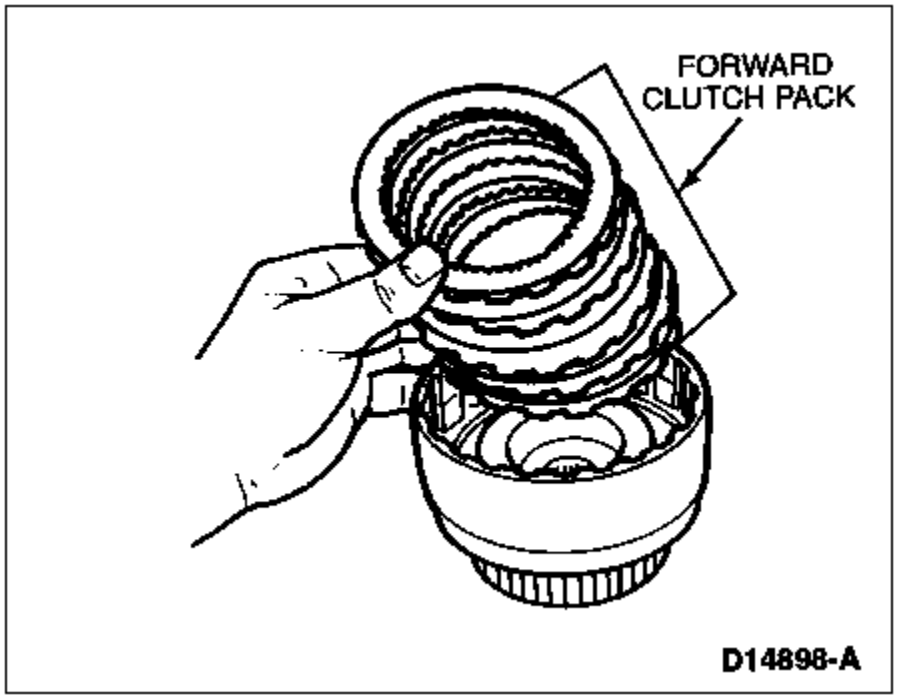
2. **CAUTION: Friction plates are directional and must be installed with grooves counterclockwise (I.D. to O.D.). The word "TOP" should face up.**

   Remove the forward clutch pack. Inspect for wear, damage or overheating. Replace as necessary.



3. **CAUTION: Do not fully compress the clutch spring compressor or damage to the spring retainer may occur.**

   Compress the forward clutch piston springs with Clutch Spring Compressor T65L-77515-A. Remove the retaining ring.

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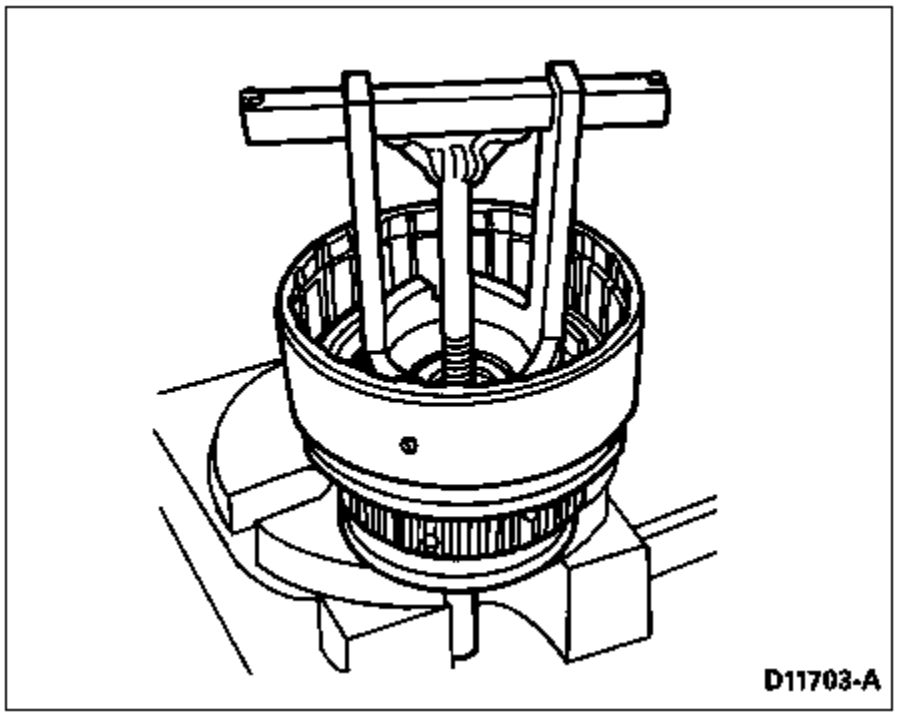

4. **WARNING: CAREFULLY RELEASE THE TOOL PRESSURE ON THE FORWARD CLUTCH PISTON SPRINGS AND REMOVE THE TOOL.**

   Remove the clutch spring compressor from the forward clutch cylinder.

5. Remove the forward clutch piston spring retainer and 15 forward clutch piston springs. Remove the rubber forward clutch cushion spring. Replace as necessary.

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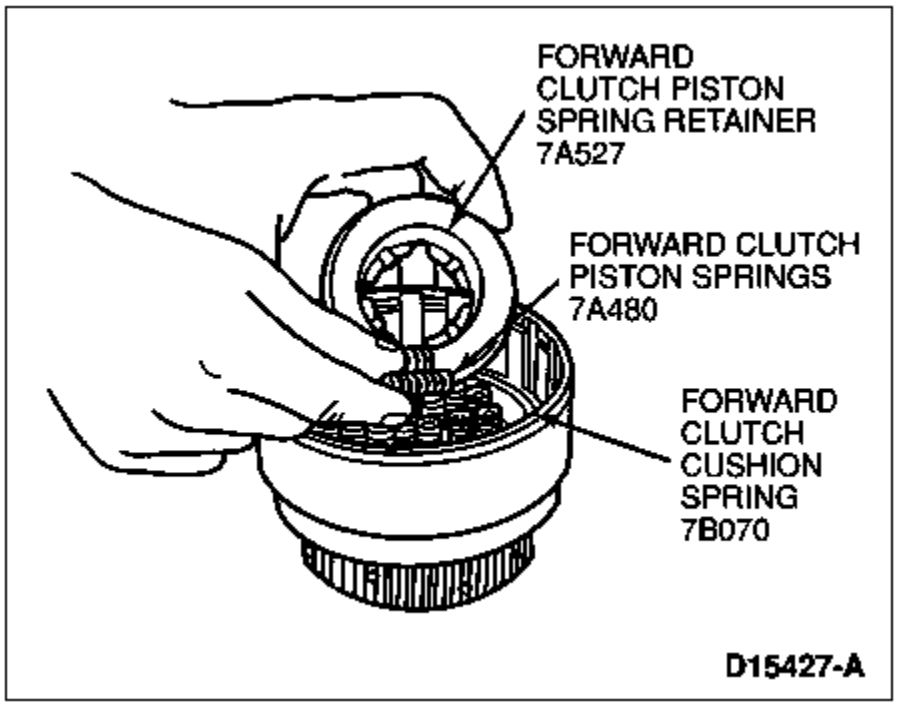

6. **WARNING: AIR PRESSURE MUST NOT EXCEED 138 KPA (20 PSI). WEAR SAFETY GLASSES WHEN USING COMPRESSED AIR. MAKE SURE THE CYLINDER IS FACING DOWN AS SHOWN.**

   NOTE: This is the middle-sized port.

   Use the center support to remove the forward clutch piston. Install the center support on the forward clutch cylinder. Apply air pressure to the far left port in the center support as shown.

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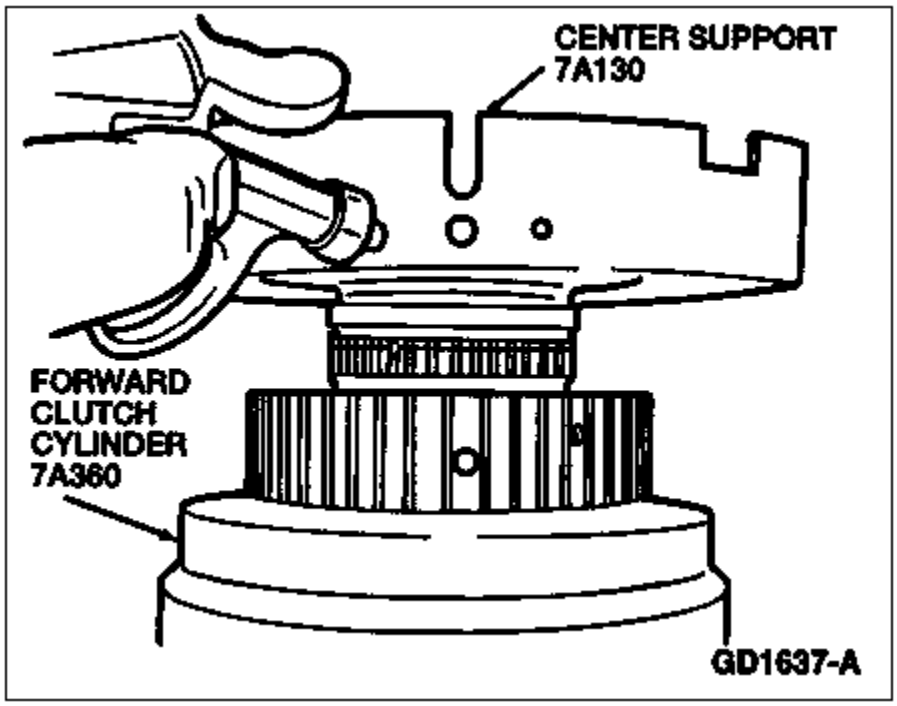
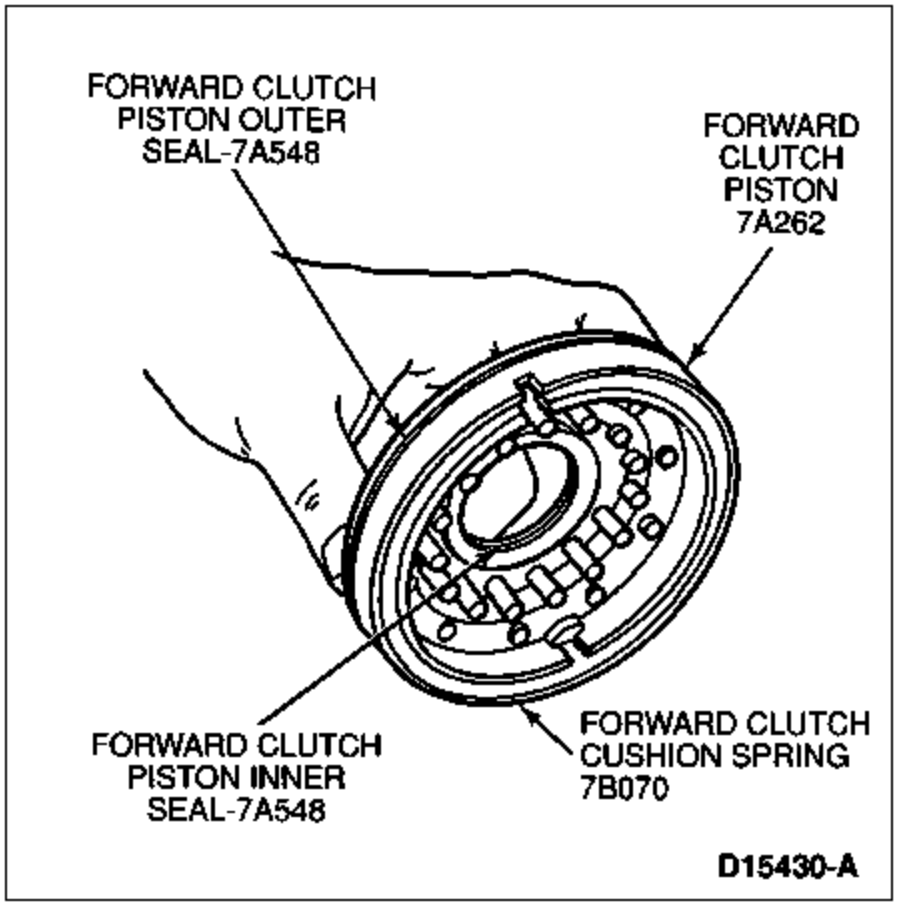


7. Remove the forward clutch piston inner and outer seals. Clean and replace as necessary.



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8. Inspect the forward clutch cylinder thrust surfaces, piston bore and clutch plate serration for scores or burrs. Minor scores or burrs may be removed with a crocus cloth. Replace the forward clutch cylinder if it is badly scored or damaged.

9. Check the fluid passages in the forward clutch cylinder for obstructions. Clean out all passages. Inspect the forward clutch piston for scores and replace if necessary. Inspect the piston check ball for freedom of movement and proper seating.

10. Check the clutch release springs for distortion and cracks. Replace the springs if they are distorted or cracked.

11. Inspect the friction clutch plates, steel clutch plates and clutch pressure plate for worn or scored bearing surface. Replace all parts that are deeply scored.

12. Check clutch plates for flatness and fit on the clutch hub serrations. Discard any plate that does not slide freely on the serrations or that is not flat.

13. Check clutch hub thrust surfaces for scores and clutch hub splines for wear.

14. **NOTE: The check ball is located in the piston.**

    Make sure the check ball is free and clear of debris prior to installing the forward clutch piston.

15. Inspect bearing and seal rings for damage.

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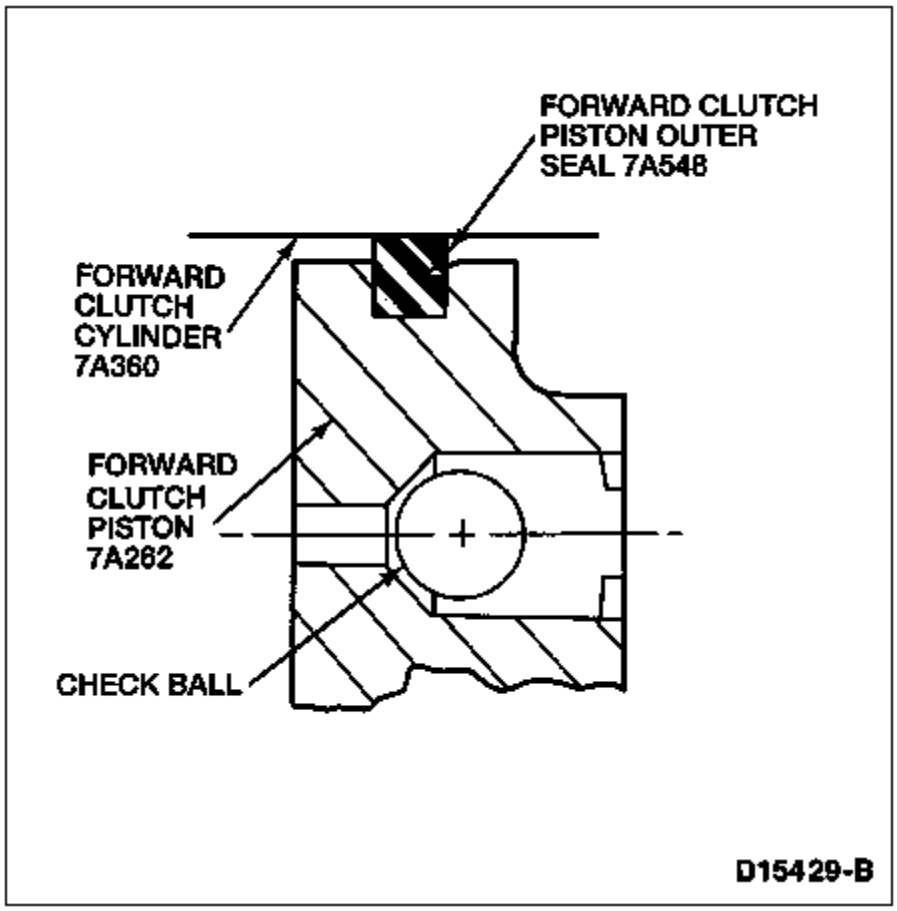

Assembly

1. **CAUTION: If there is evidence of clutch plate burning, replace the forward clutch cushion spring.**

   Install new forward clutch piston inner and outer seals on the forward clutch piston. Install the forward clutch cushion spring.

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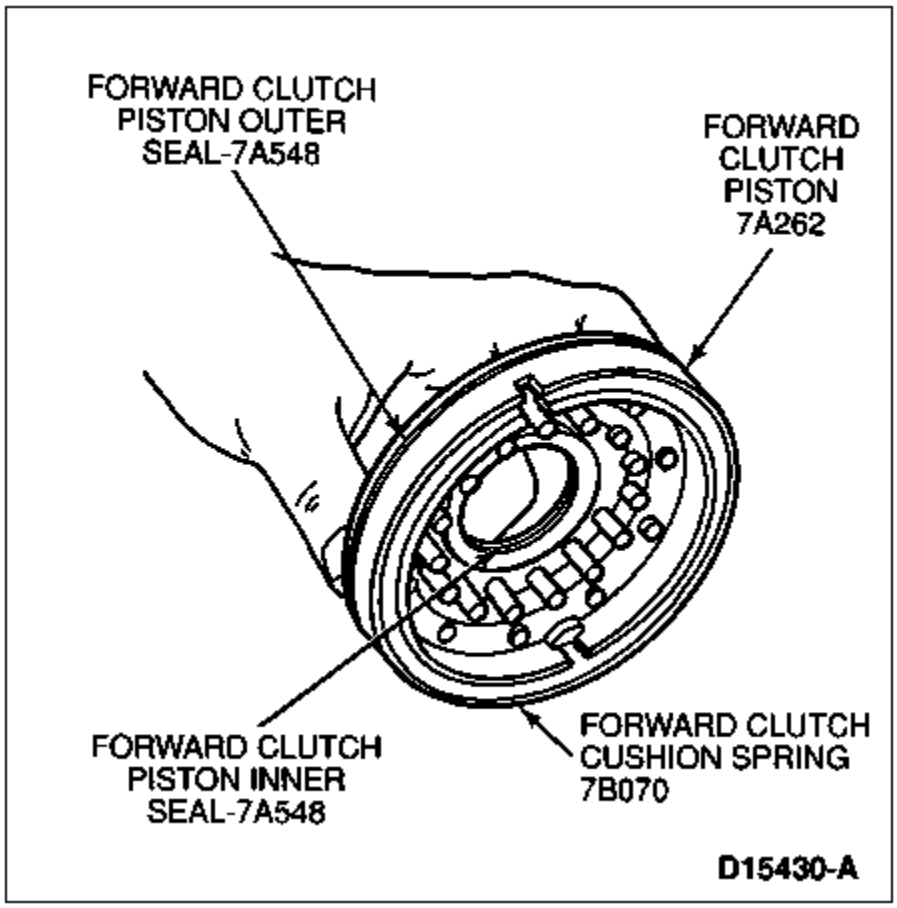

2. To prevent damage to the forward clutch piston outer seal, install Lip Seal Protector T74P-77548-B. To prevent damage to the forward clutch piston inner seal install Lip Seal Protector T74P-77548-A into forward clutch cylinder.

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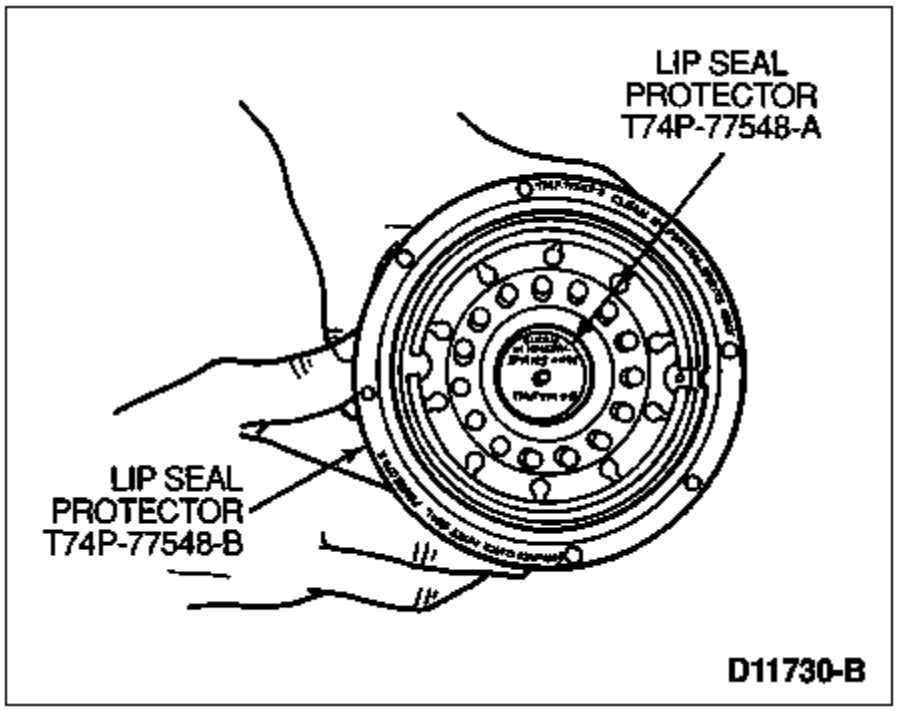

3. **CAUTION: Care must be taken to prevent damage to the seals.**

   NOTE: Apply petroleum jelly to the inner and outer seals.

   Carefully install the forward clutch piston into the forward clutch cylinder.

4. Carefully remove Lip Seal Protector T74P-77548-A and Lip Seal Protector T74P-77548-B from the forward clutch cylinder.

5. Install the 15 forward clutch piston springs and forward clutch piston spring retainer.

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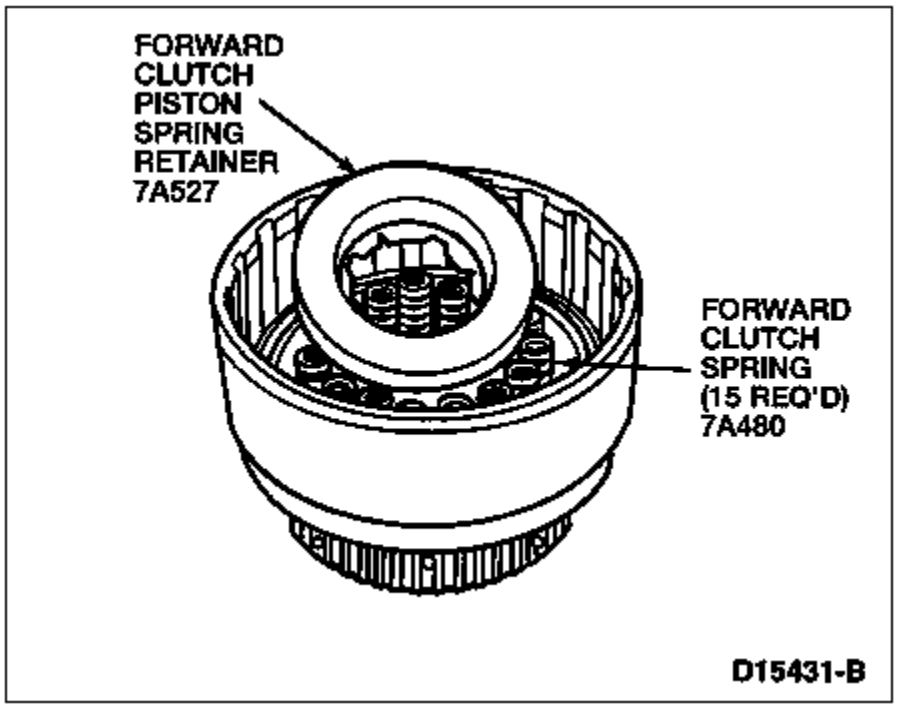
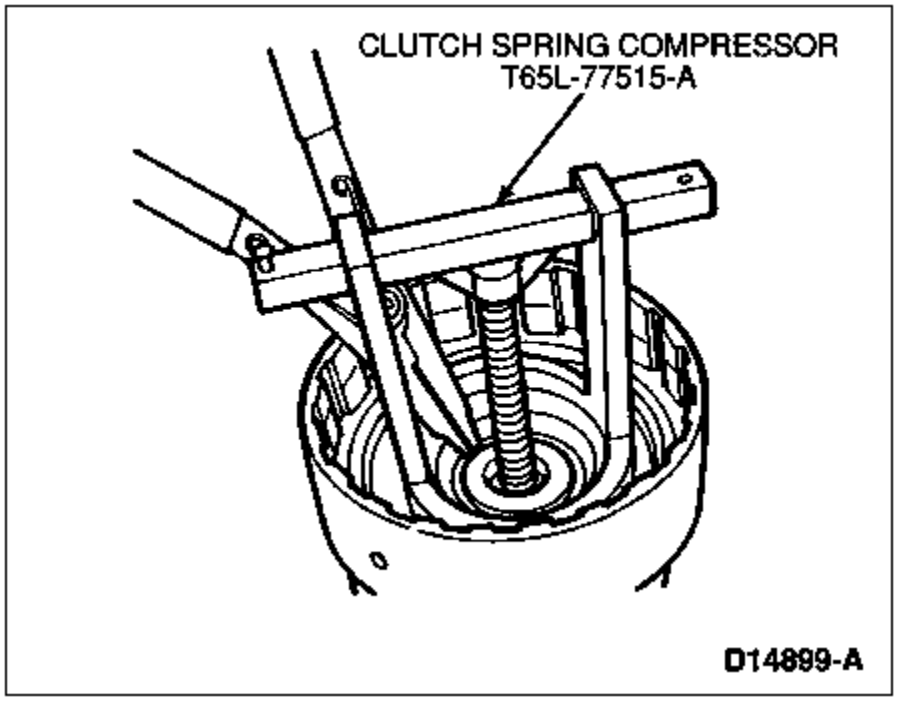


6. **CAUTION: Do not fully compress the clutch spring compressor or damage to the forward clutch piston spring retainer may occur.**

   Compress the clutch piston springs with Clutch Spring Compressor T65L-77515-A and install the retaining ring. Release the load on the forward clutch piston springs and remove the tool.



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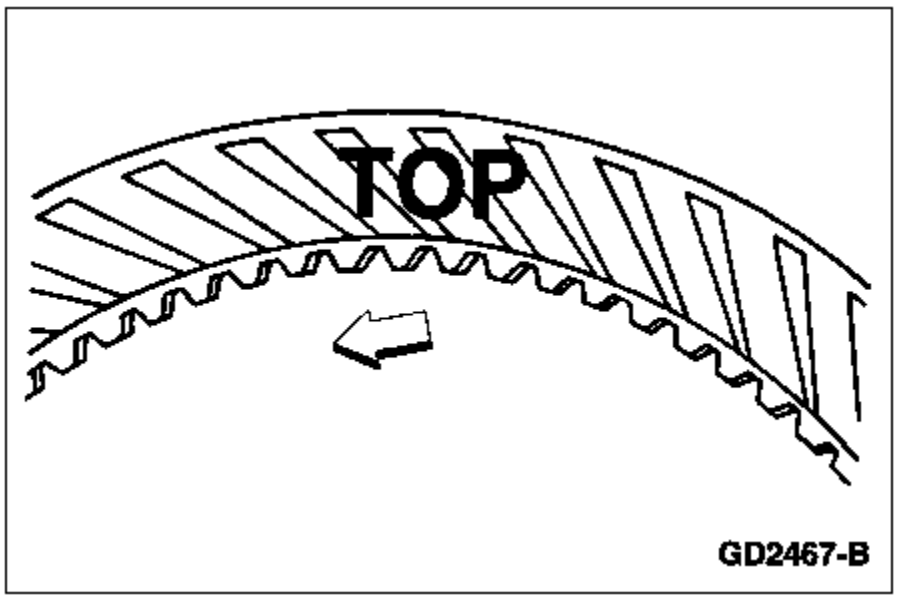
7. **CAUTION: Friction plates are directional and must be installed with grooves counterclockwise (I.D. to O.D.). The word "TOP" should face up.**

   CAUTION: If new plates are being used, they should be soaked in clean transmission fluid for at least 30 minutes before assembly.

   NOTE: When installing friction plates, the word "TOP" should face up. If reusing plates, grooves must be installed counterclockwise.

   Install the steel clutch plates and friction clutch plates in alternating order, starting with a steel plate and finishing with a friction plate.



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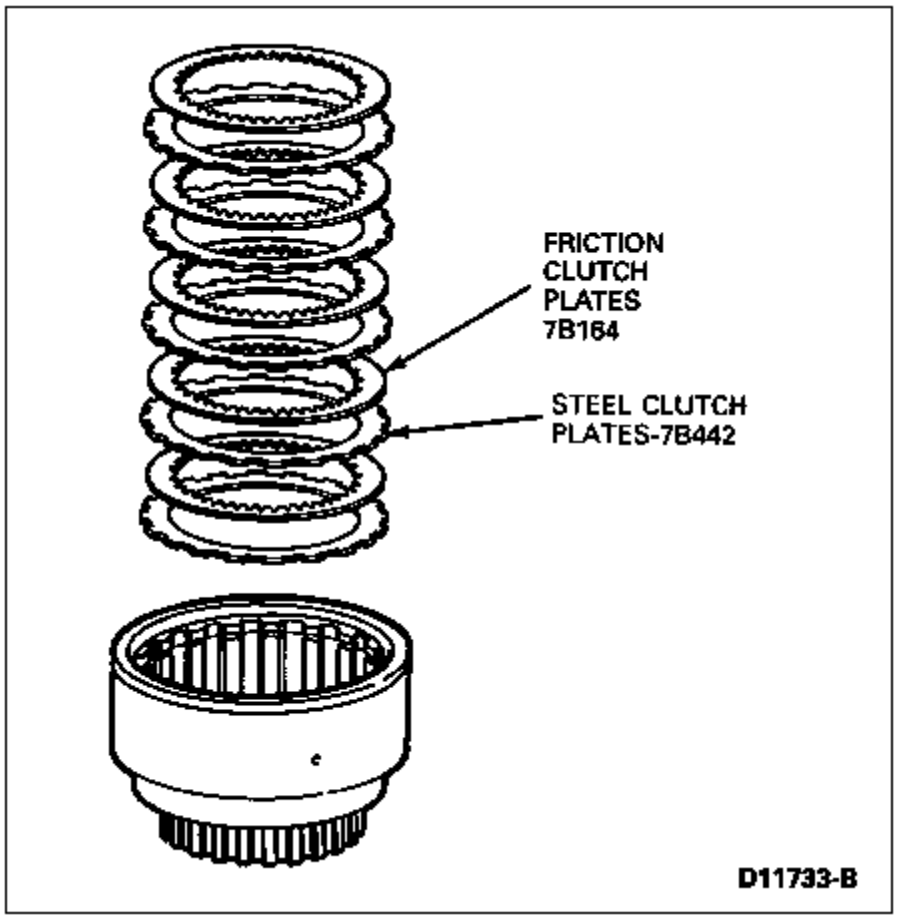

CLUTCH PACK

Steel	Friction
5	5

8. **CAUTION: The retaining ring is a select fit.**

   Install the forward clutch pressure plate on the clutch pack. Install the original retaining ring.

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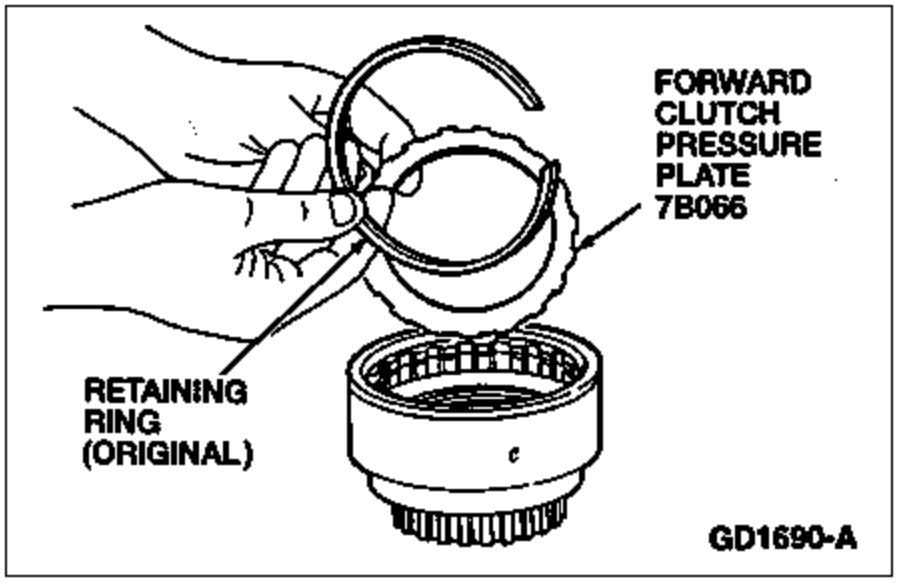
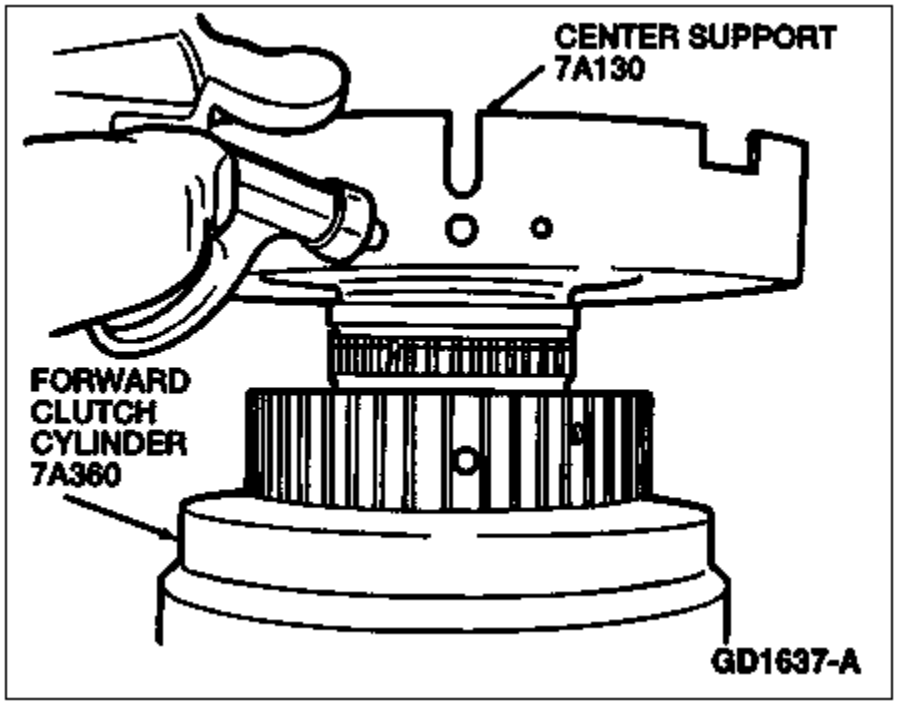


9. **WARNING: DO NOT EXCEED 138 KPA (20 PSI). WEAR SAFETY GLASSES WHEN USING COMPRESSED AIR. MAKE SURE THE DRUM IS FACING DOWN AS SHOWN.**

   NOTE: The forward clutch piston must apply with air pressure and release when the air is removed.

   Install the center support on the forward clutch cylinder. Apply air pressure to the far left port in the center support as shown.



10. Push down on the clutch pack. Use a feeler gauge to check the gap between the retaining ring and

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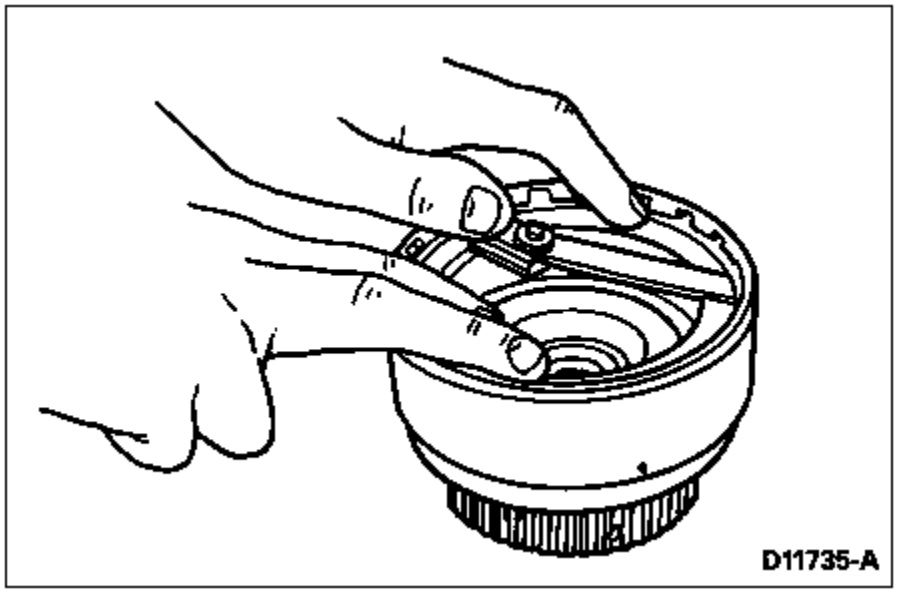
the clutch pressure plate. Specification: 1.4 to 2.1 mm (.055 to .083 inch). If the reading is not within specifications, remove the retaining ring and check the thickness. Replace the retaining ring with one that will provide correct free play. Verify free play with a feeler gauge.



FORWARD CLUTCH CYLINDER

	Thickness		Diameter	
Part Number	mm	Inches	mm	Inches
E860115-S	1.37	.0539	125.1	4.925
E860116-S	1.73	.0681	125.1	4.925
E860117-S	2.08	.0819	125.1	4.925
E860118-S	2.44	.0961	125.1	4.925

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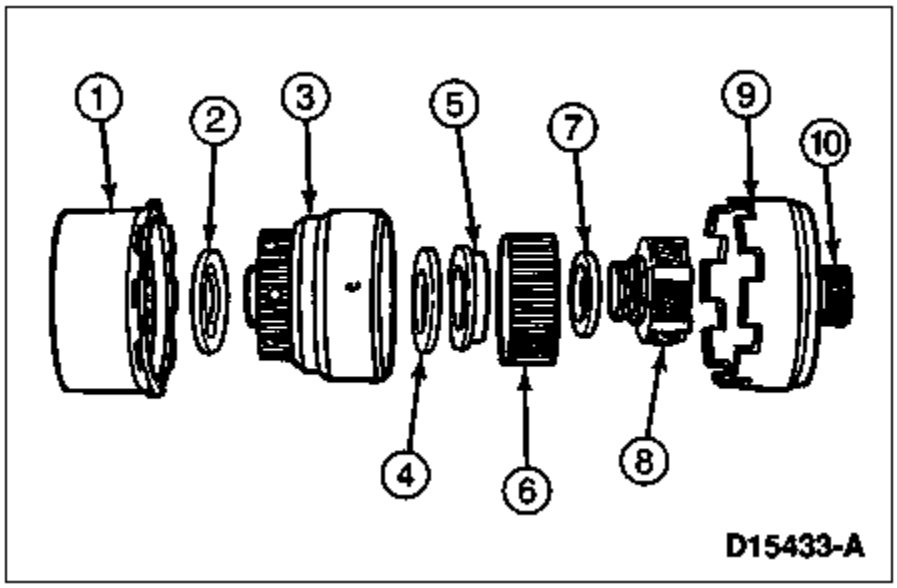
Forward Geartrain Assembly

Assembly



Item	Part Number	Description
1	—	Intermediate Brake and Direct Clutch Drum Assembly
2	7M153	No. 5 Forward Clutch Cylinder Thrust Bearing
3	—	Forward Clutch Cylinder Assembly
4	7D234	No. 6A Forward Ring Gear Hub Thrust Bearing Assembly
5	7D090	No. 6B Forward Clutch Thrust Washer
6	7D392	Forward Ring Gear
7	7F374	No. 7 Forward Planetary Thrust Bearing Assembly
8	7A398	Forward Planetary Assembly
9	7D064	Input Shell
10	7D063	Forward Sun Gear Assembly

1. Install the No. 5 forward clutch cylinder thrust bearing on the forward clutch cylinder assembly. Use petroleum jelly to hold the bearing in place.

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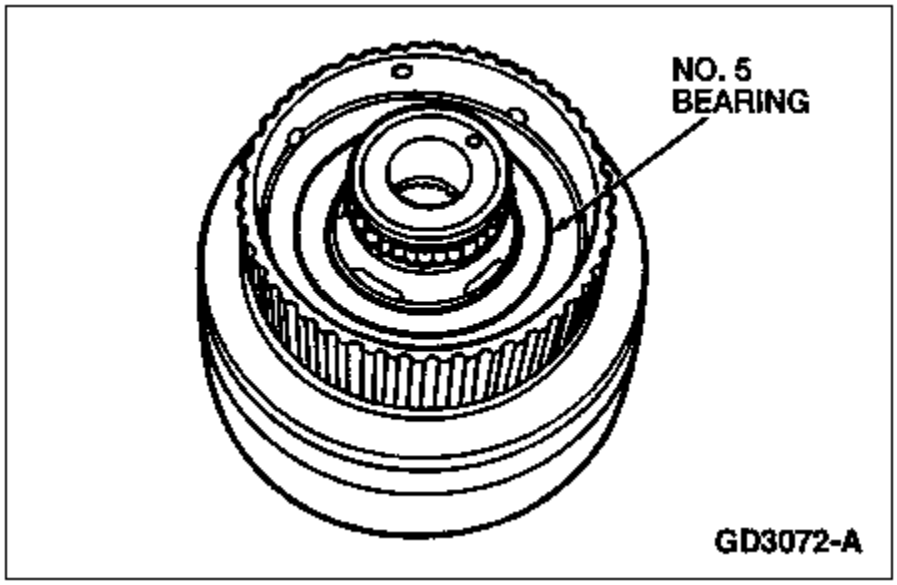
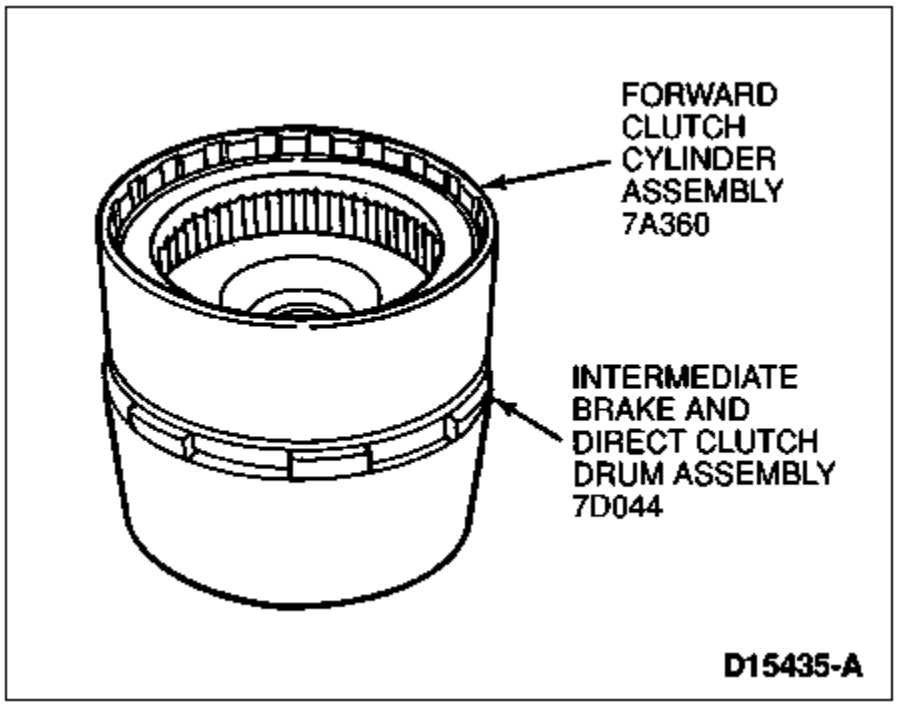


2. Install the forward clutch cylinder assembly into the intermediate brake and direct clutch drum assembly as shown.



3. Install the No. 6A forward ring gear hub thrust bearing into the forward clutch cylinder with tabs facing up as shown.

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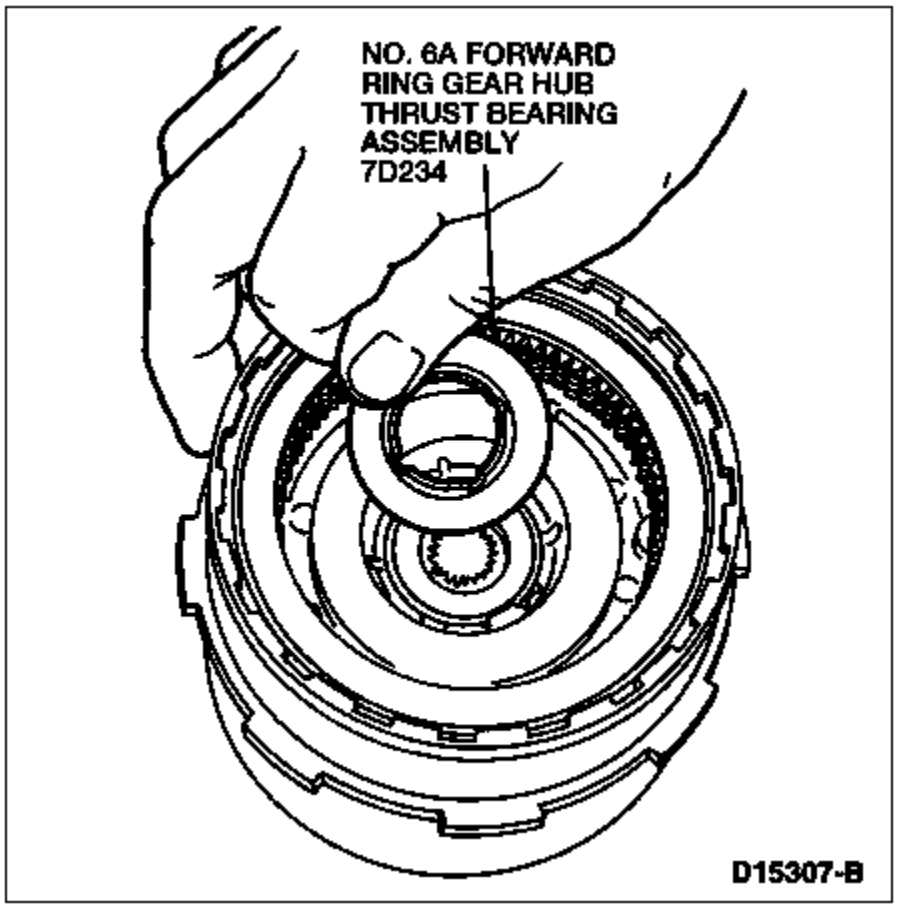

4. **NOTE: Use petroleum jelly to hold the washer in place.**

   Install the No. 6B forward clutch thrust washer into the forward ring gear hub.

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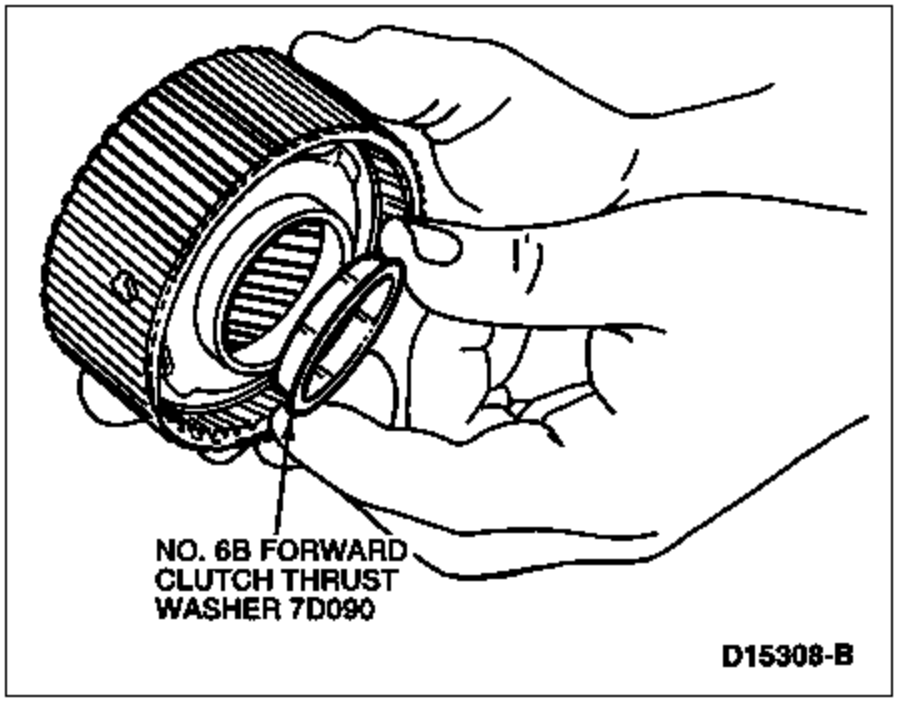

5. **NOTE: Make sure the No. 6A bearing and No. 6B forward clutch thrust washer assembly are inside the forward ring gear.**

   Install the forward ring gear and forward clutch thrust washer into the forward clutch cylinder assembly as shown.

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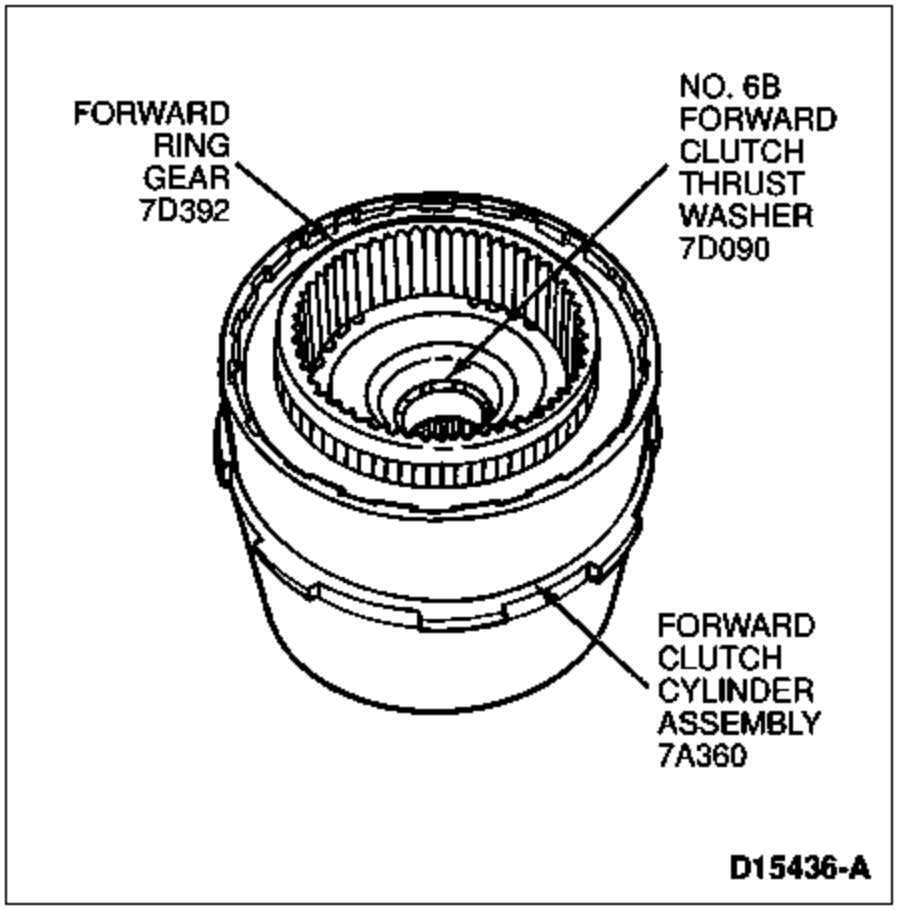

6. **CAUTION: Black oxidized color of thrust bearing must face up toward planetary assembly.**

   Install the No. 7 forward planetary thrust bearing into the forward ring gear as shown.

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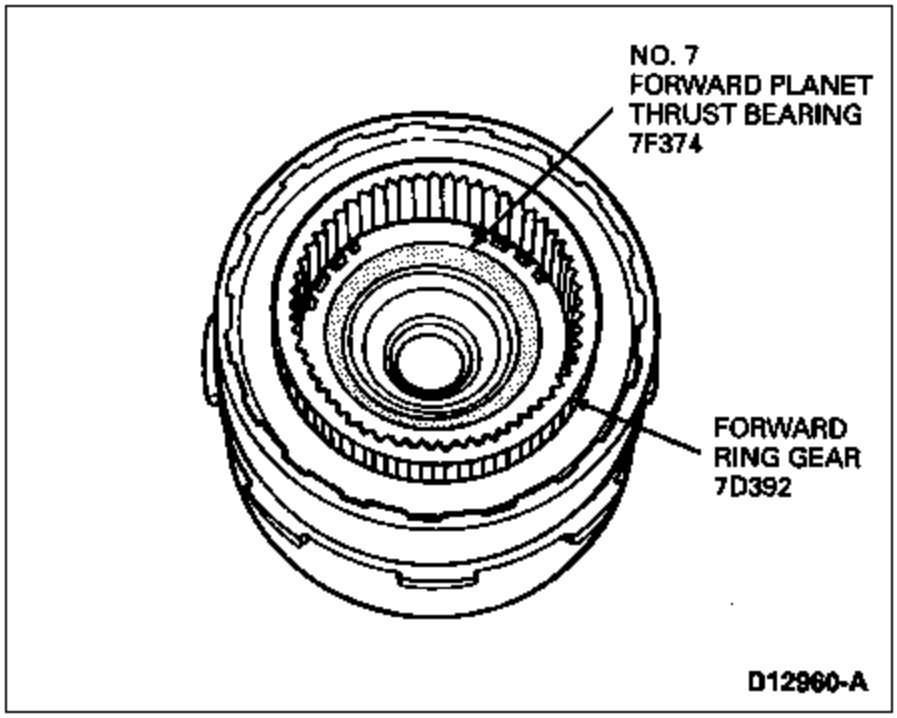
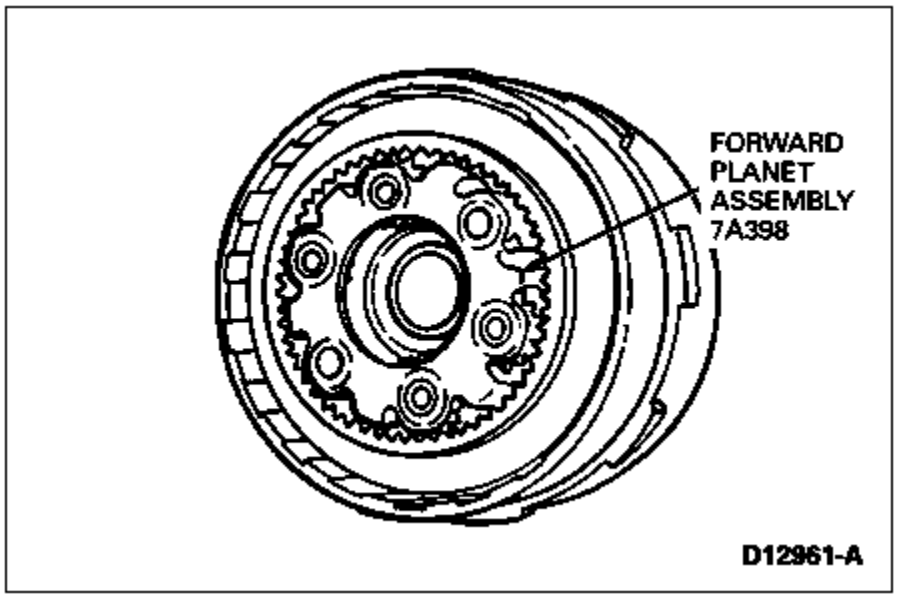


7. **NOTE: All service replacements are 6 pinion only.**

   Install the forward planetary assembly into the forward ring gear as shown.



8. **NOTE: If sun gear, retaining rings or input shell require service, perform steps a-e.**

   Inspect the drum gear, bushing and washer for scoring, wear or damage. Replace as required.

   a. Remove rear retaining ring and sun gear from input shell.

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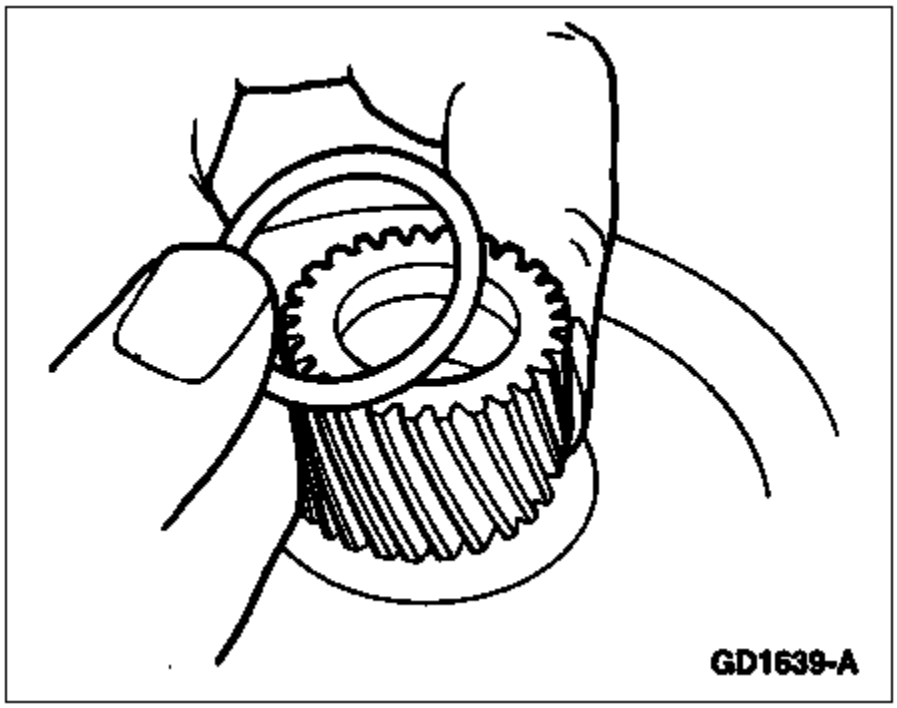
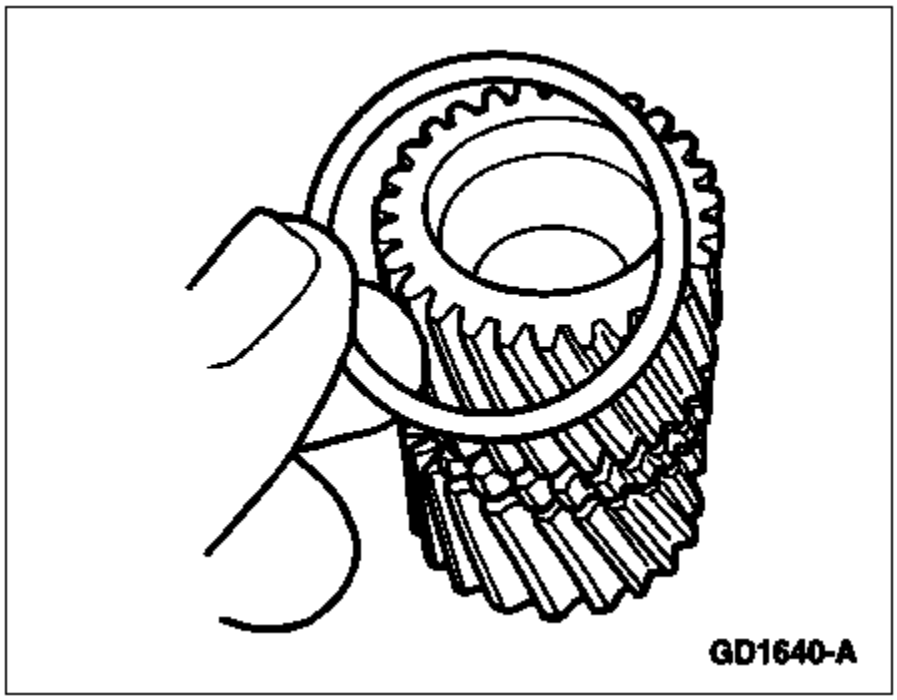


b. Remove front retaining ring from sun gear.



c. Install new retaining ring onto sun gear.

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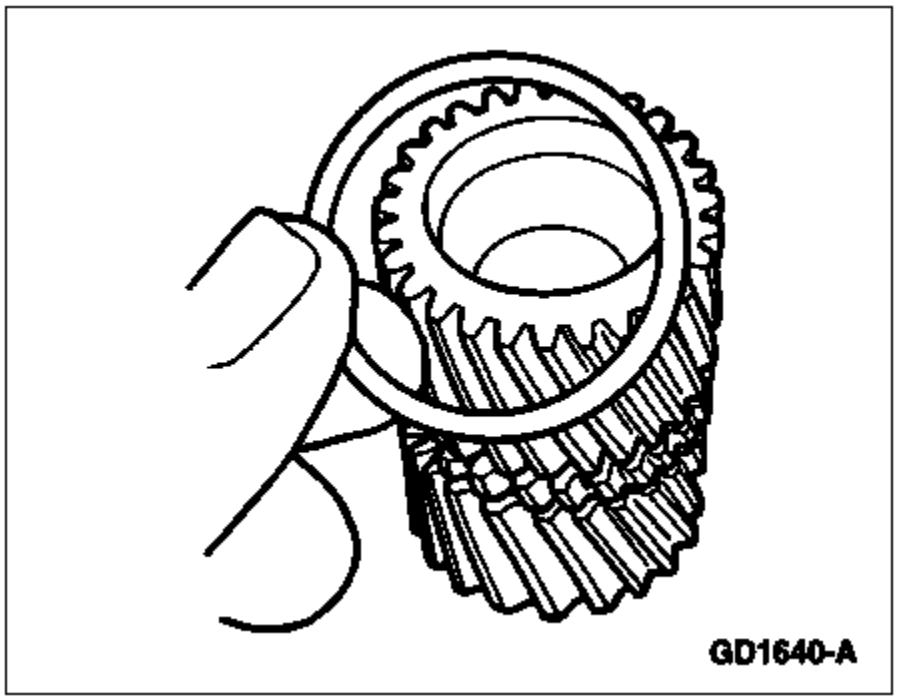
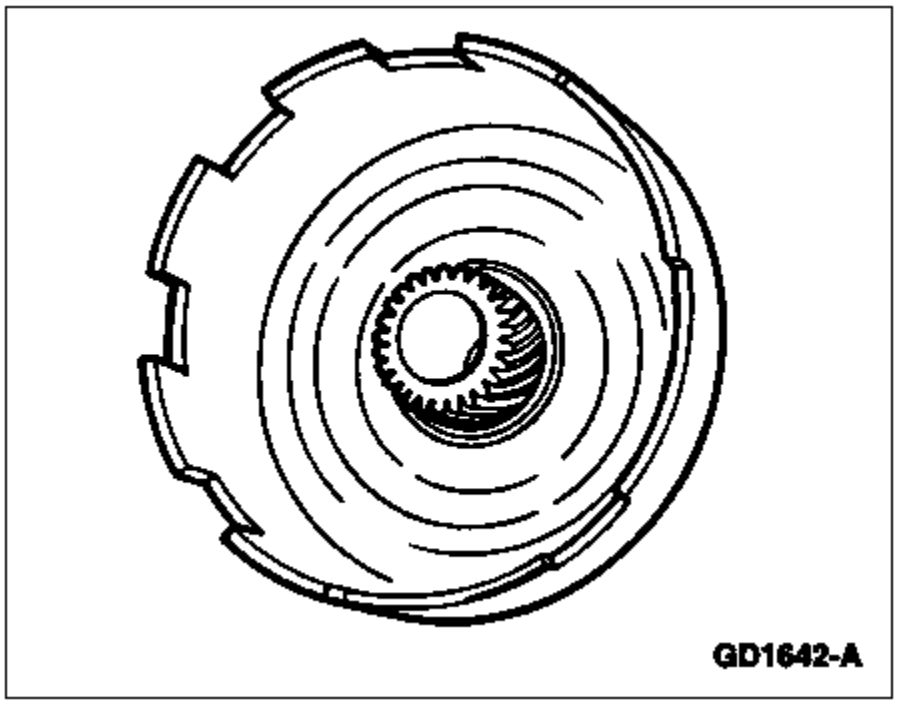


d. Install forward sun gear into input shell.



e. Install new rear retaining ring onto sun gear.

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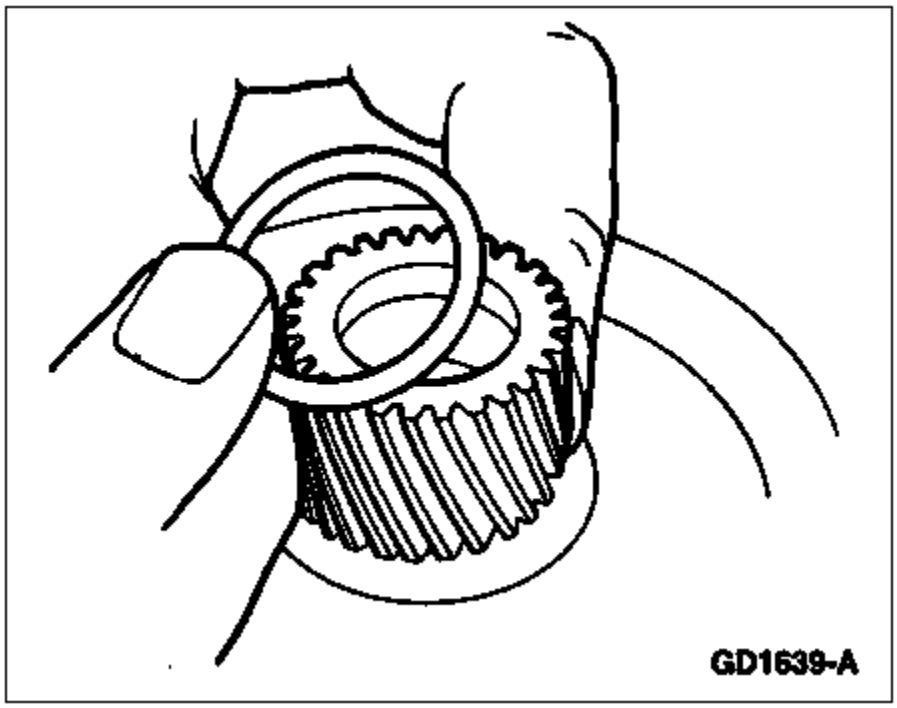
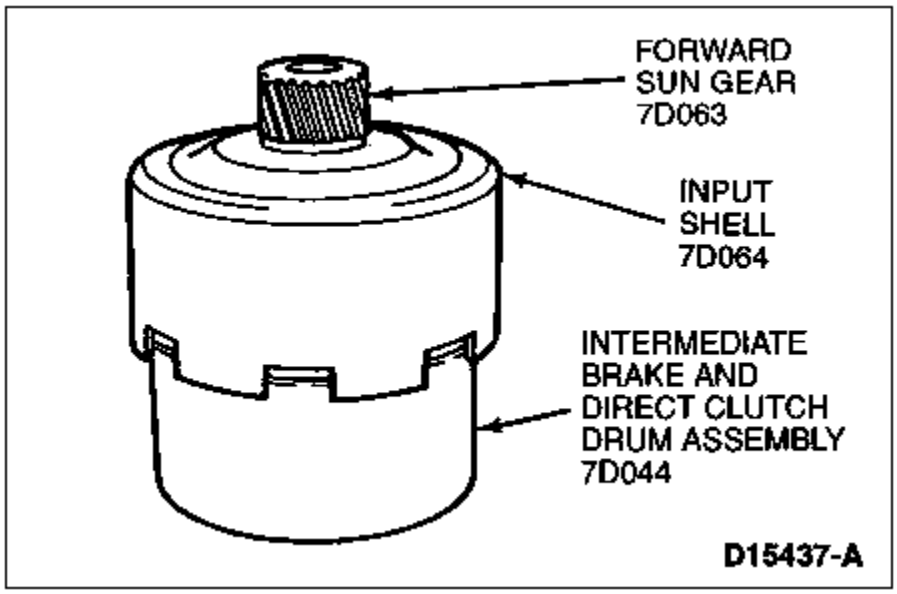


9. **NOTE: Make sure the forward sun gear aligns with the forward planetary assembly. Make sure the input shell aligns with the intermediate brake and direct clutch drum assembly as shown.**

   Install the input shell with forward sun gear assembly as shown.



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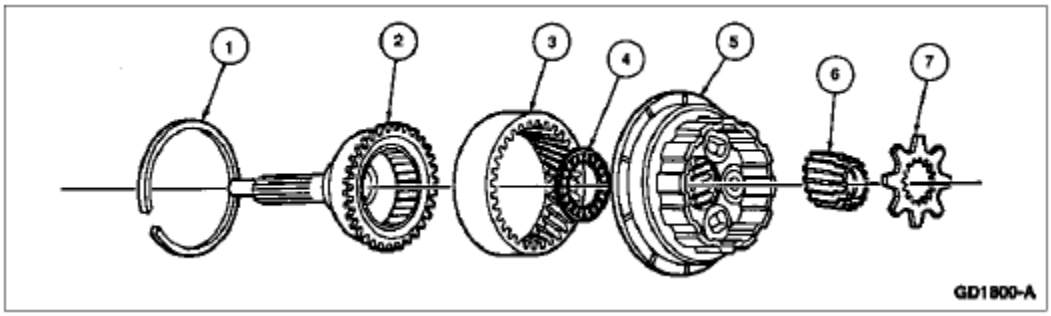
Overdrive Planetary and One-Way Clutch Assembly

Overdrive Planetary and One-Way Clutch Assembly



Item	Part Number	Description
1	W702037-S	Retaining Ring
2	7A658	Overdrive Center Shaft Assembly
3	7653	Overdrive Ring Gear
4	7L495	No. 2 Overdrive Planetary Thrust Bearing
5	7B446	Overdrive Planetary Gear Carrier Assembly
6	7D063	Overdrive Sun Gear Assembly
7	7660	Coast Clutch Adapter

Disassembly

1. Remove the overdrive center shaft retaining ring from the overdrive ring gear.

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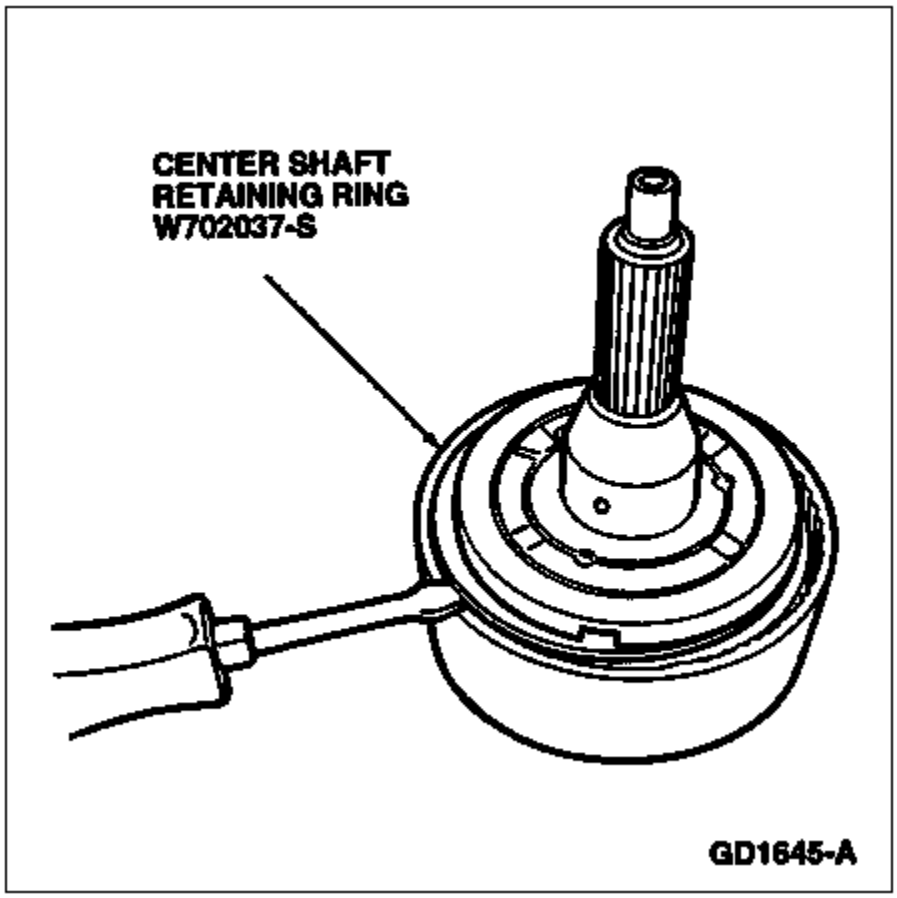
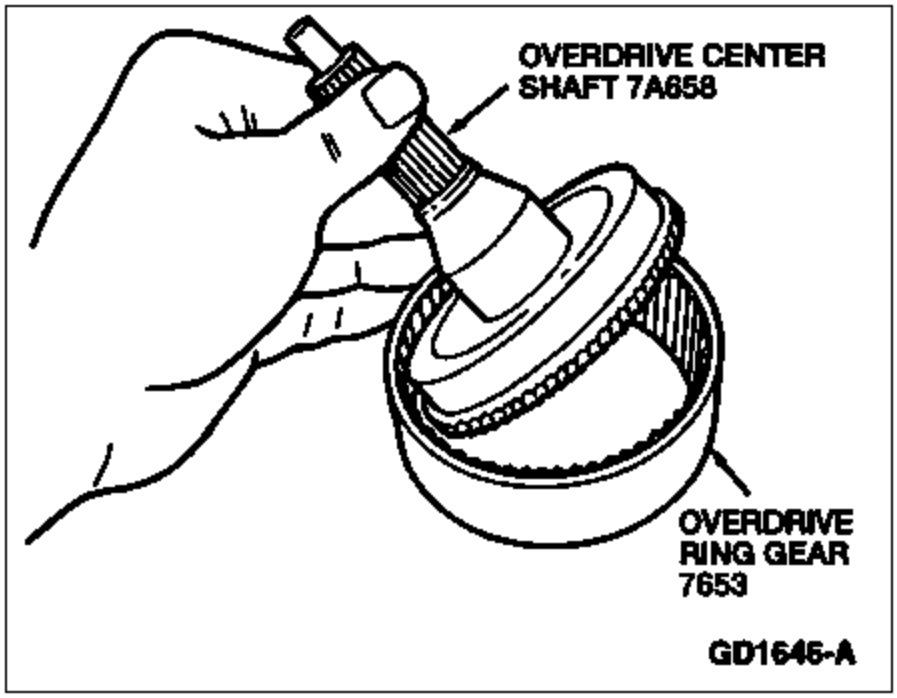


2. Remove the overdrive center shaft from the overdrive ring gear.



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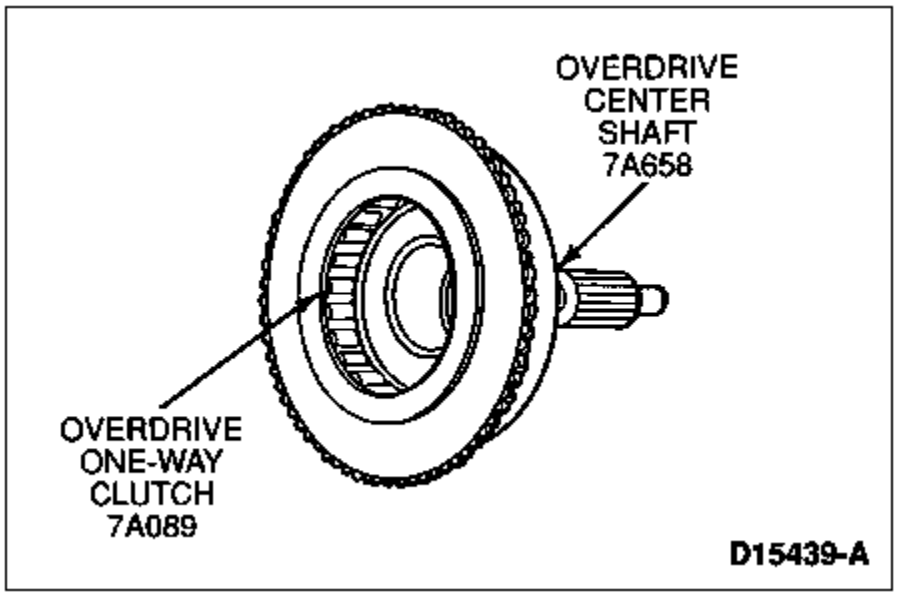
3. **CAUTION: Do not remove the overdrive one-way clutch. Damage to the clutch may occur if it is removed.**

   NOTE: The overdrive one-way clutch is serviced with the overdrive center shaft.

   Clean and inspect the overdrive one-way clutch and overdrive center shaft assembly. Check for cracks in the roller cage and wear on the roller clutch. Inspect the press fit of the one-way roller clutch to the overdrive center shaft.

   Inspect the rollers and springs for excessive wear or damage.

   Inspect the spring and roller cage for bent or damaged spring retainers.



4. Temporarily insert the overdrive planetary gear carrier assembly into the one-way clutch rollers for verification of the one-way clutch. The planetary must rotate counterclockwise and hold clockwise as shown. Remove the overdrive planetary gear carrier assembly.

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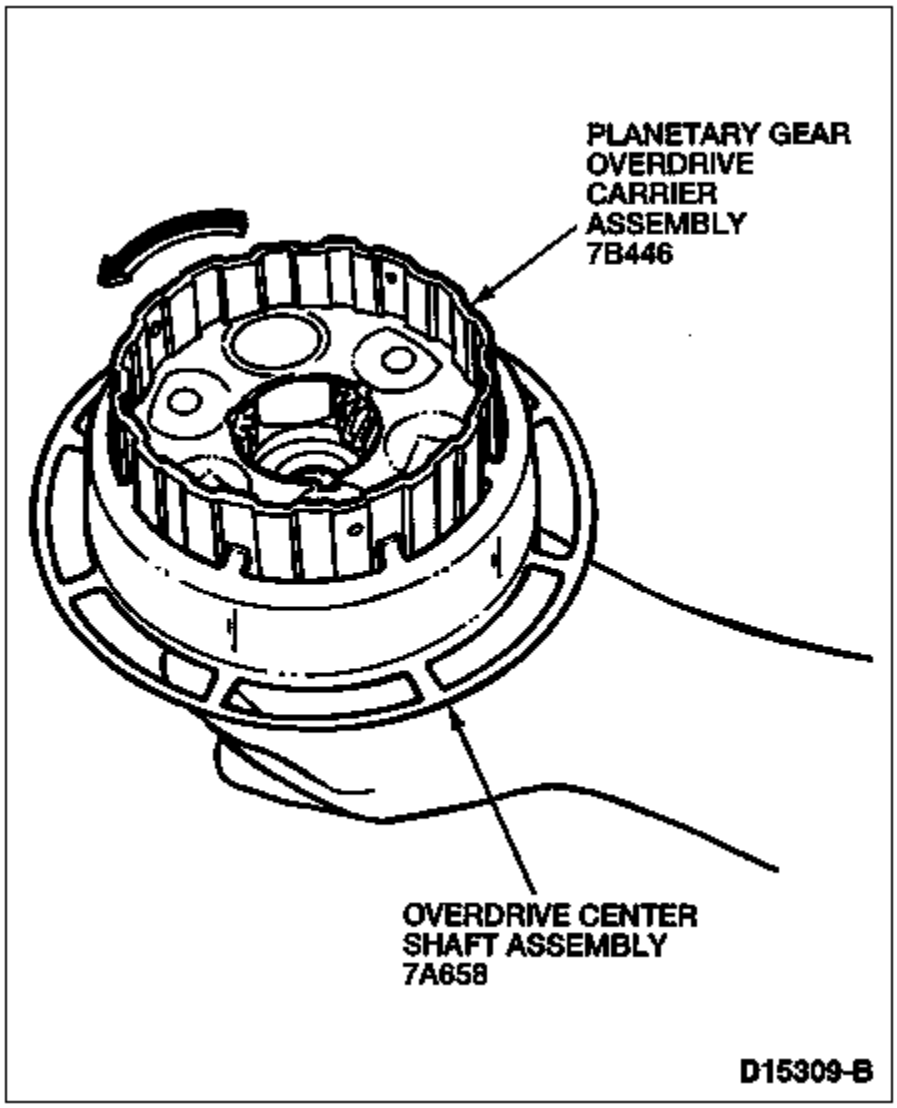

Assembly

1. Install the overdrive center shaft and overdrive one-way clutch into the overdrive ring gear.

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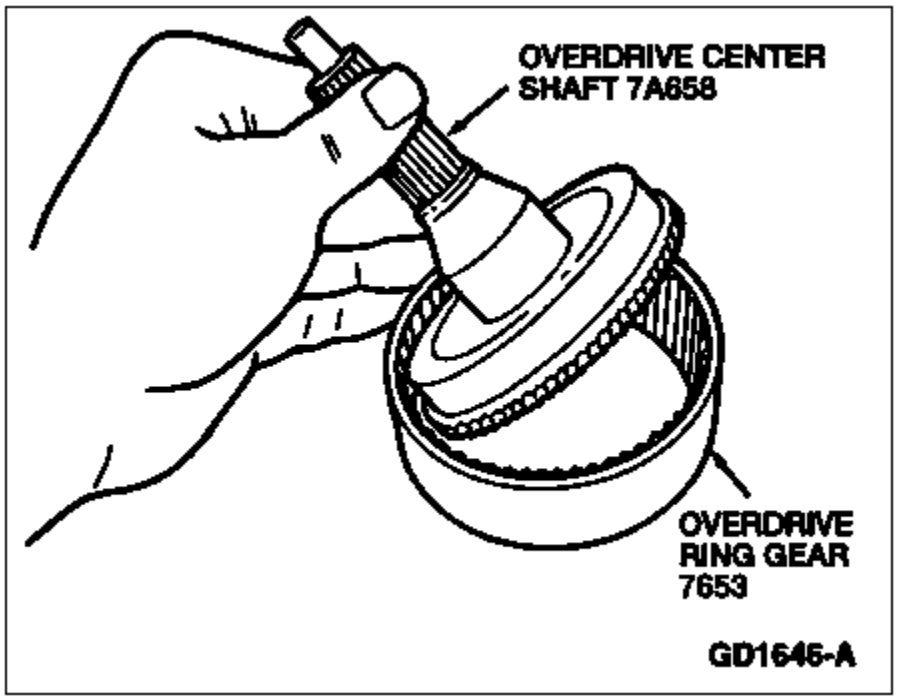
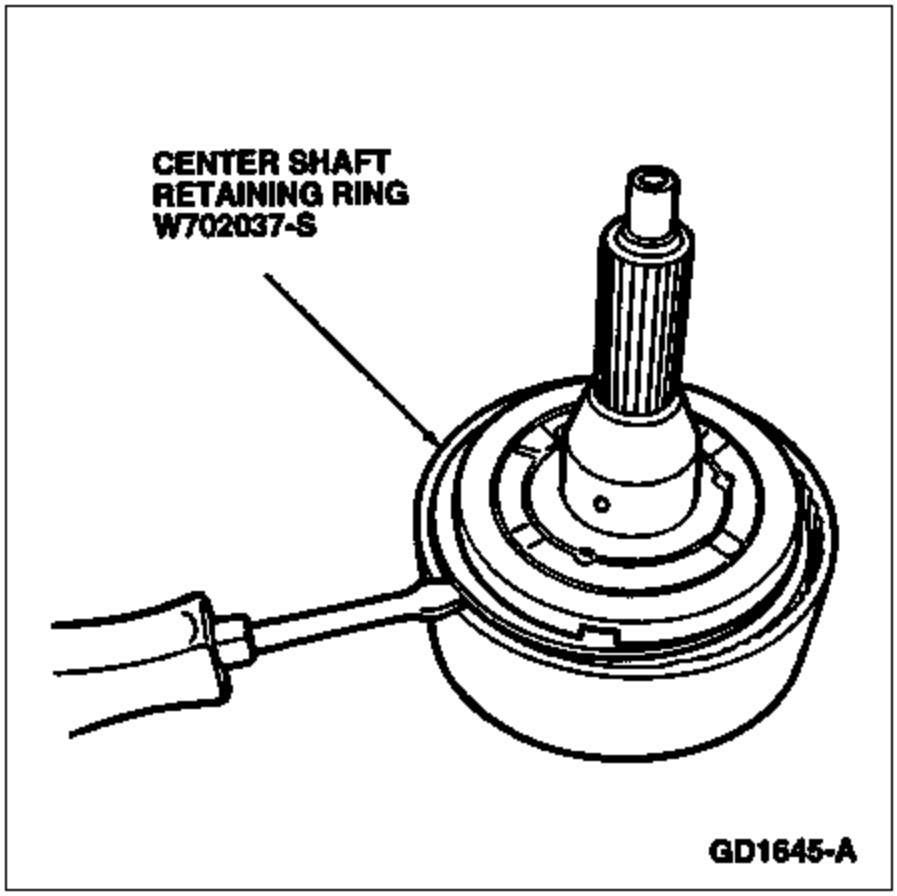


2. Install the center shaft retaining ring.



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3. **CAUTION: Planetary's must be replaced. Do not restake.**

   NOTE: Individual parts of the planetary carriers are not serviceable.

   Check the pins and shafts in the planetary assemblies for loose fit and/or complete disengagement. Use a new planetary assembly if either condition exists. Before installing a planetary assembly, the shaft retaining pins should be checked for adequate staking.

   Inspect the pinion gears for damaged or excessively worn teeth.

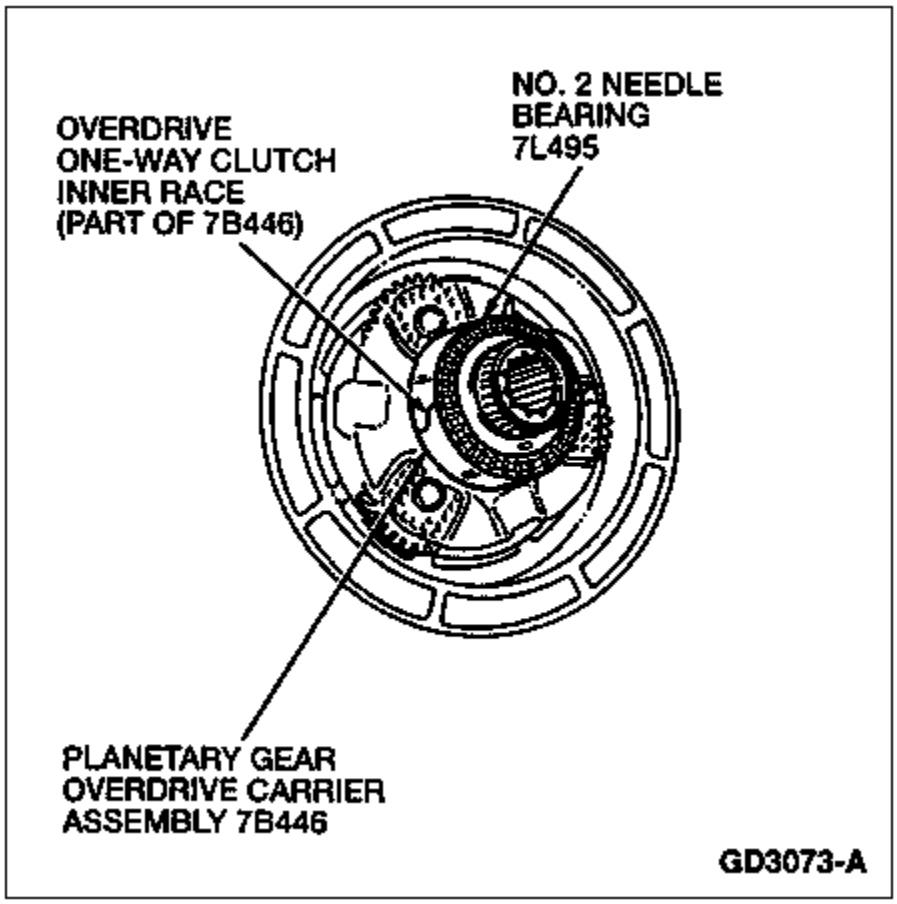
   Check for free rotation of the pinion gears.

   Inspect the overdrive one-way clutch inner race for scoring.

   Check pinion bearing and gears.

   Inspect the inner and outer races for scored or damaged surface areas where the rollers contact the races.

   Inspect the needle bearing on the nose of the overdrive planetary gear carrier assembly.



4. Remove and inspect the No.2 planetary thrust bearing.

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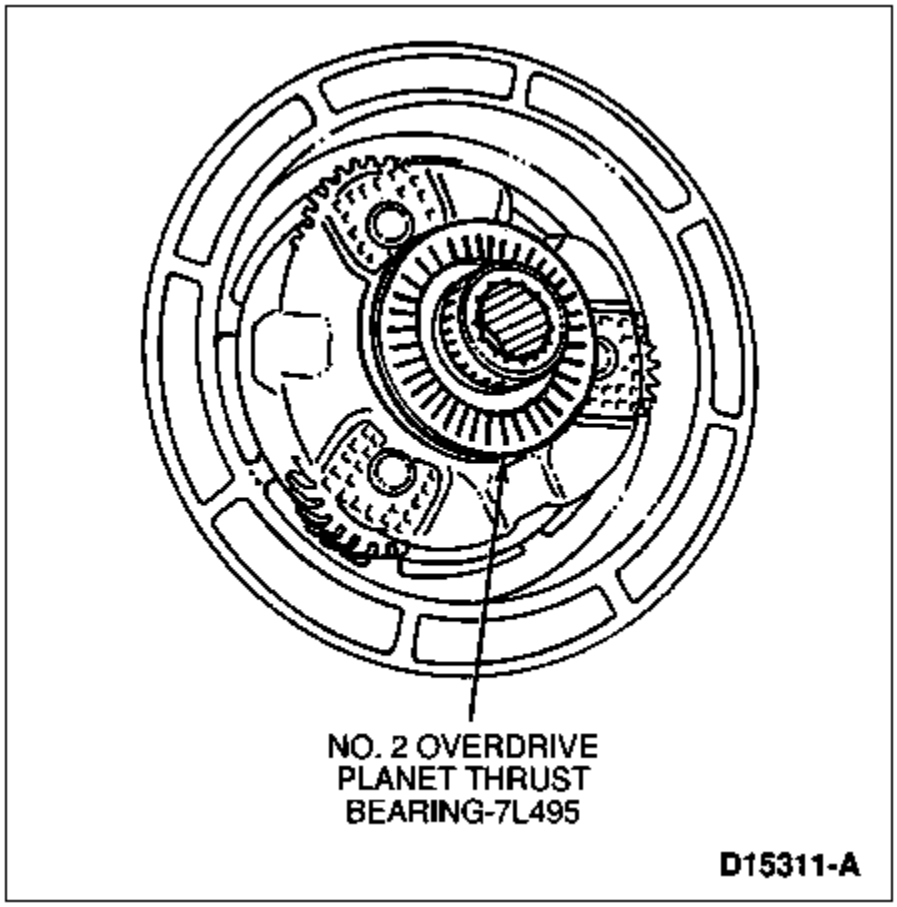

5. Remove coast clutch to O/D carrier adapter and O/D sun gear.

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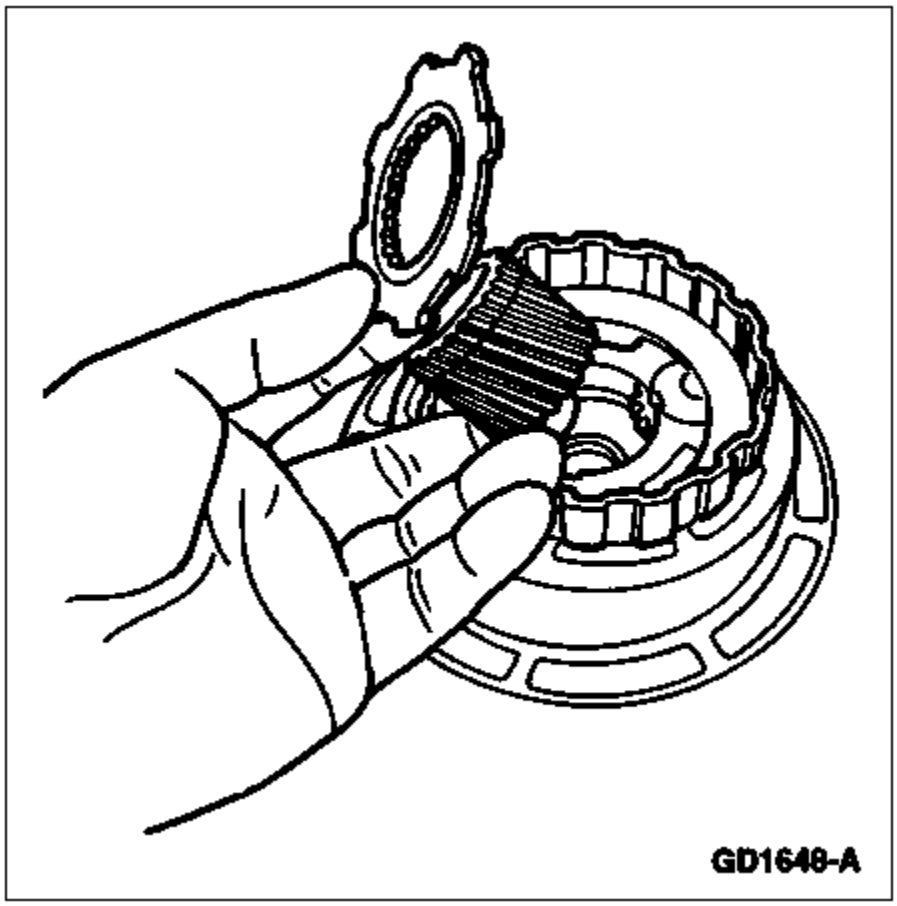

6. Inspect the No. 12 needle bearing inside the overdrive planetary gear carrier.

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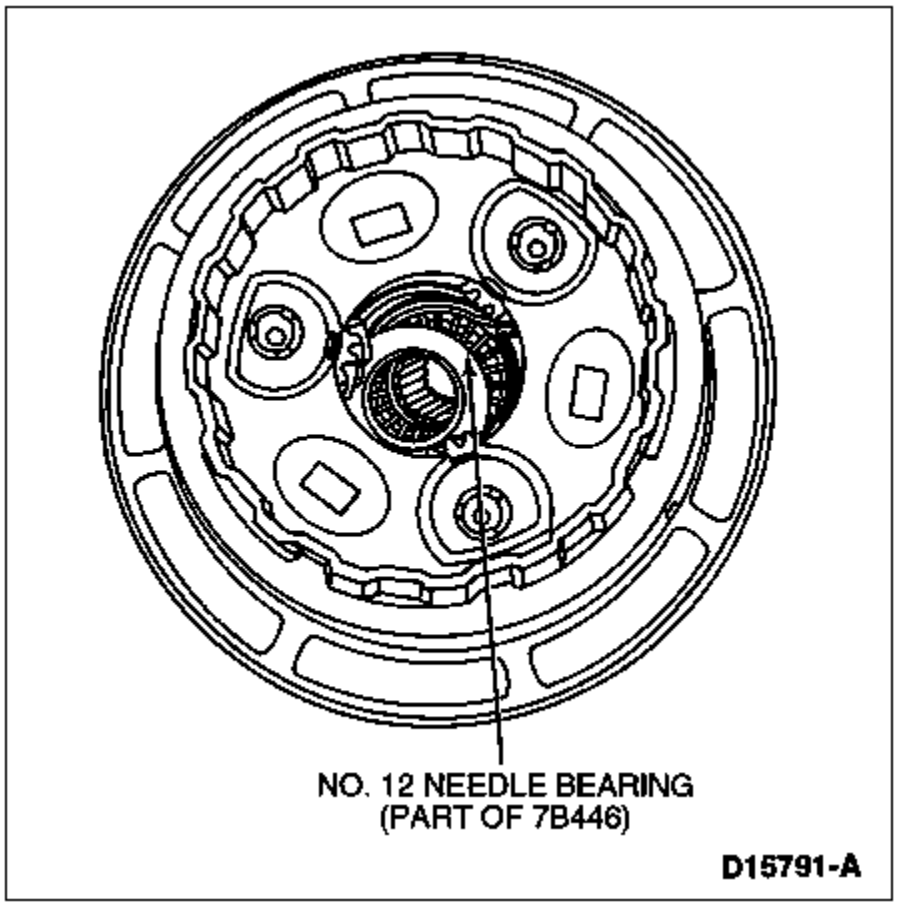

7. **NOTE: Use petroleum jelly to hold the No. 2 overdrive planetary thrust bearing in place.**

   Install the No. 2 overdrive planetary thrust bearing between the overdrive center shaft face and the overdrive planetary gear carrier assembly.

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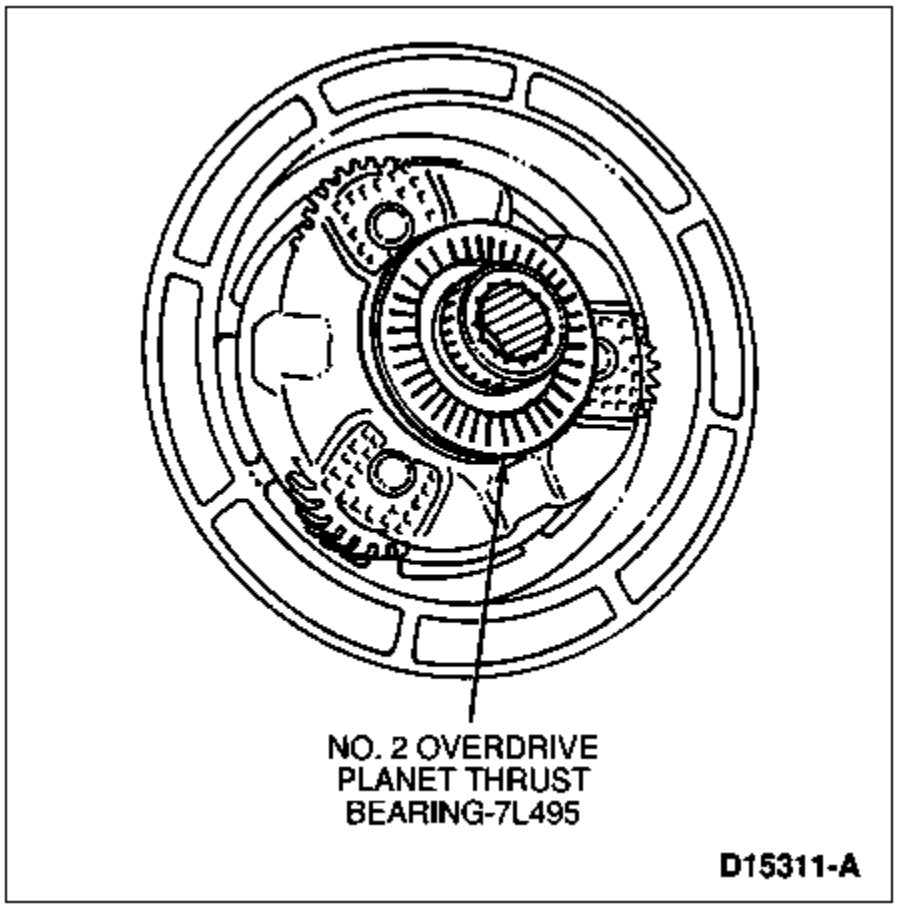

8. Install the overdrive planetary gear carrier into the overdrive center shaft and overdrive ring gear.

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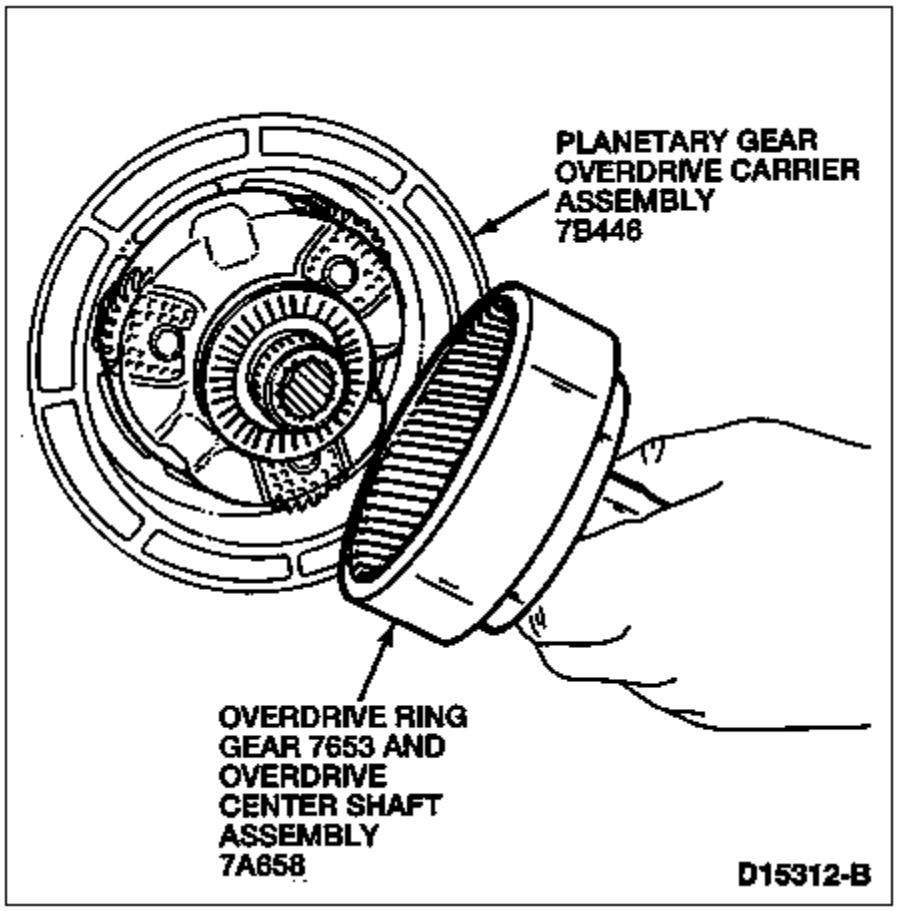

9. **CAUTION: Use care not to bend or damage the exciter wheel.**

CAUTION: Before installing the overdrive sun gear into the overdrive planetary gear carrier, make sure the No. 12 sun gear thrust bearing race is aligned with the needle bearing inside the overdrive planetary gear carrier. The overdrive sun gear will not seat properly if the No. 12 sun gear thrust bearing race is not aligned in the center of the overdrive sun gear.

Install the overdrive sun gear into the overdrive planetary gear carrier.

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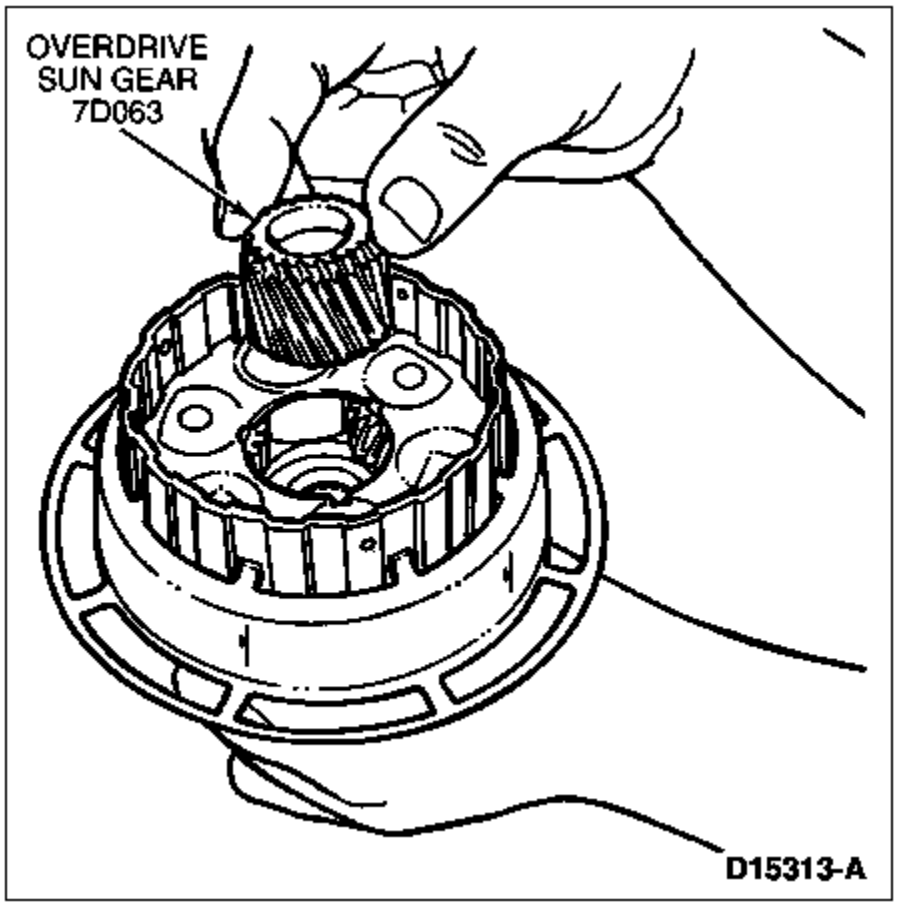

10. Install the coast clutch adapter on the overdrive sun gear.

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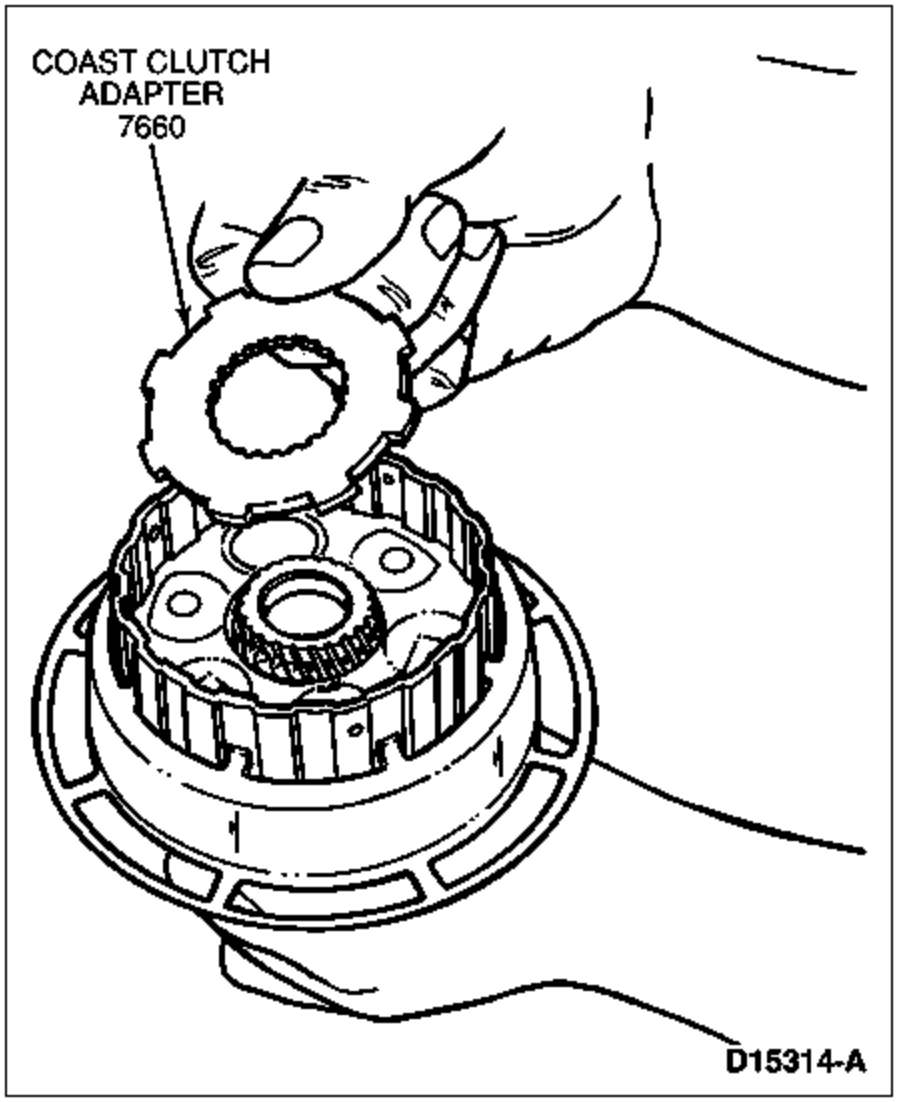

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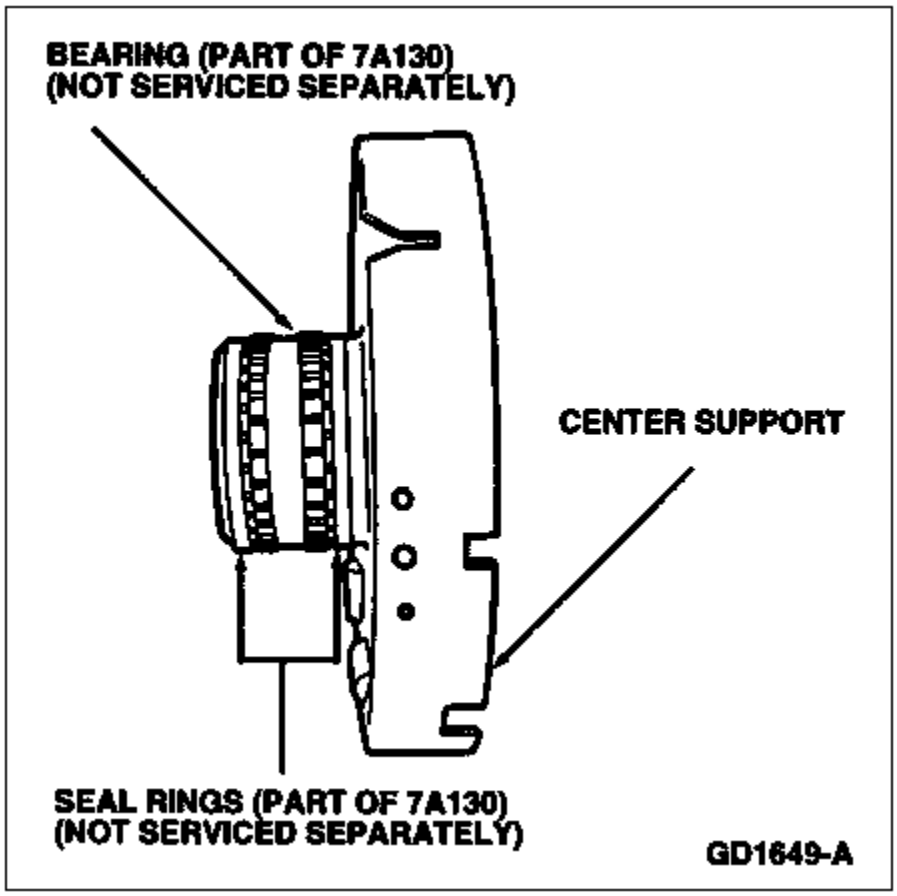
Center Support

Inspection



1. Inspect center support for damage. If damaged, replace center support assembly.

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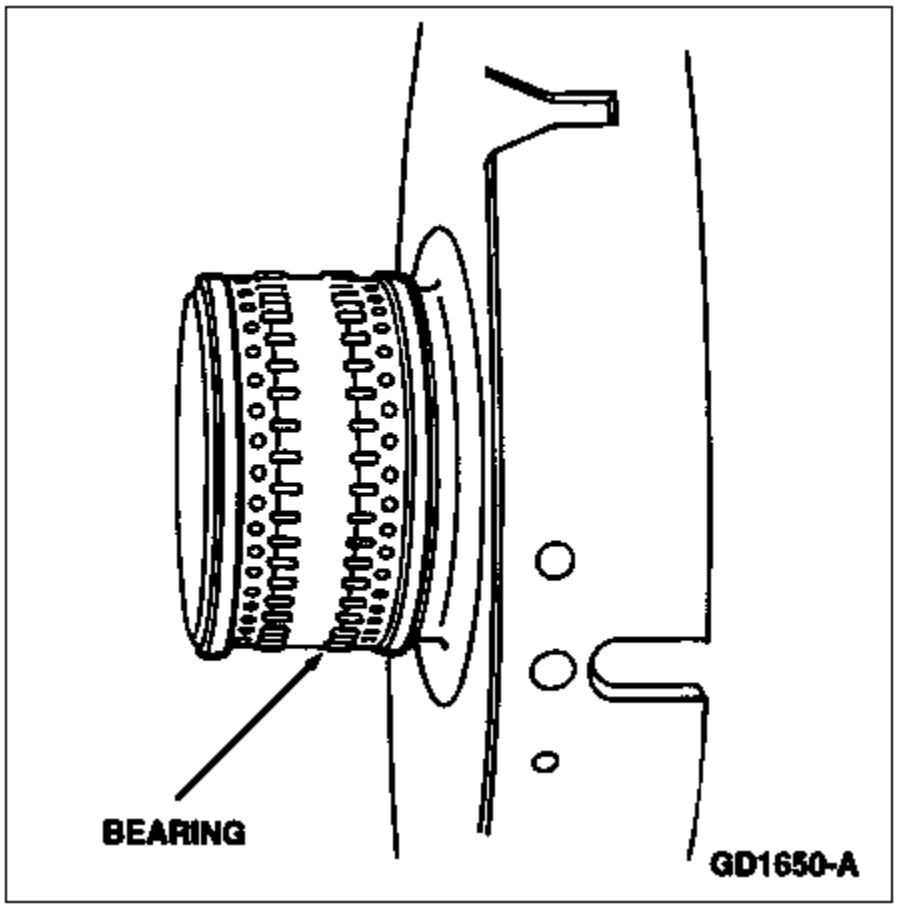
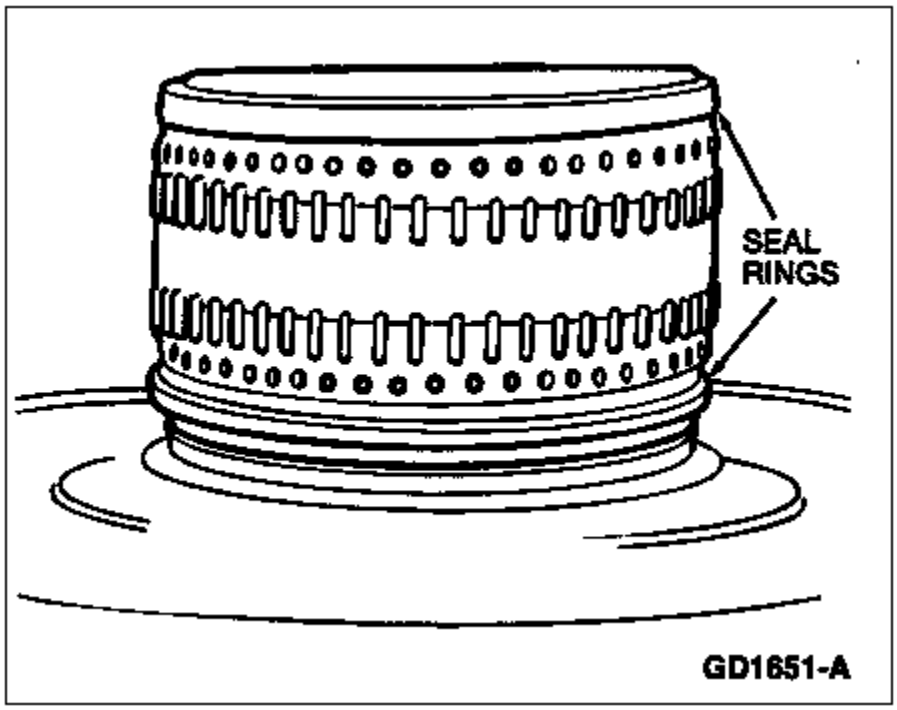


2. Inspect seal rings for damage. If damaged, replace center support.



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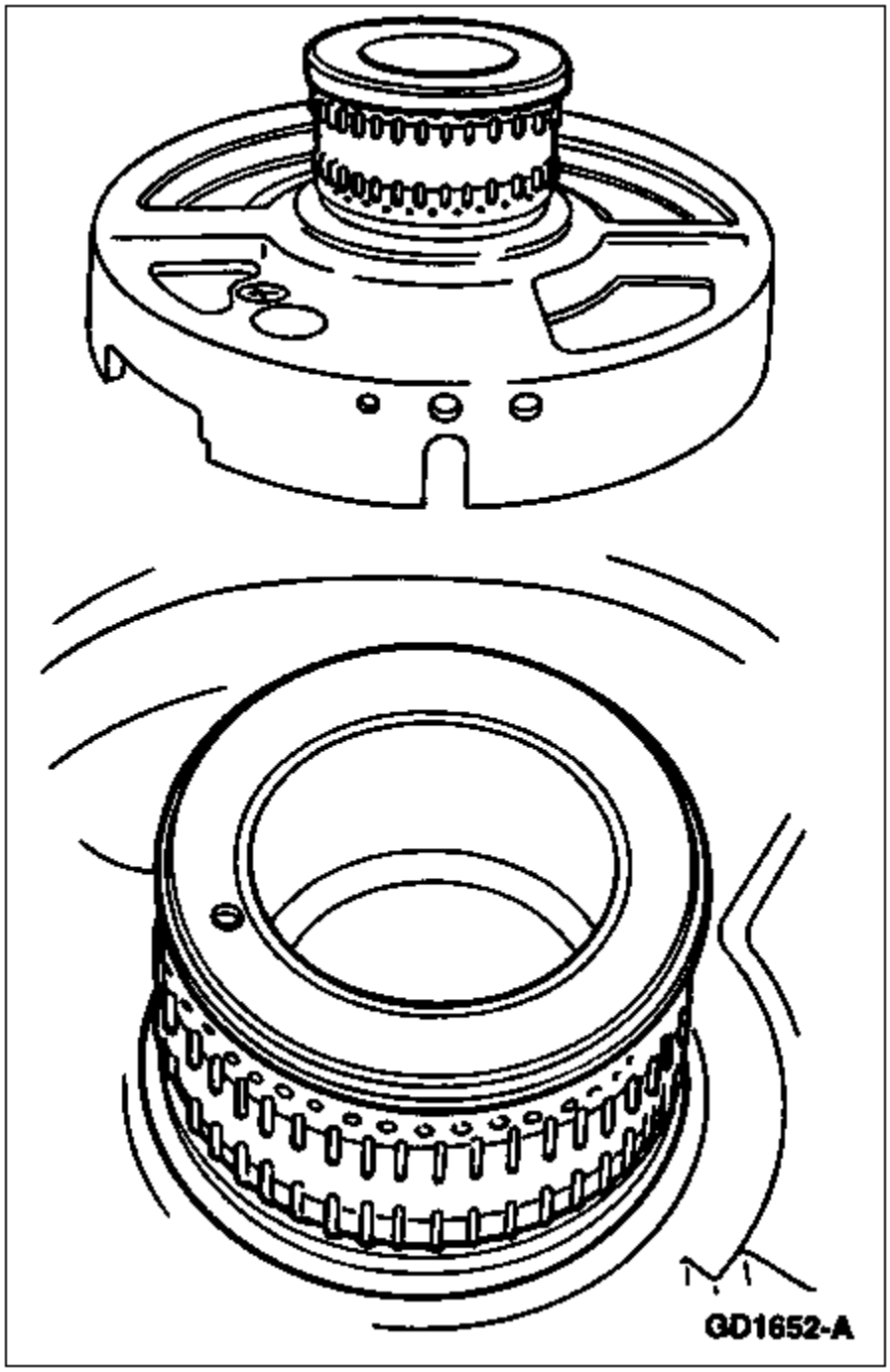
3. Inspect thrust surface for wear, scoring or damage. Inspect forward clutch sealing surface for scoring or damage. Inspect hydraulic passages for damage or restrictions.



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Low/Reverse Brake Drum

Low/Reverse Brake Drum Assembly

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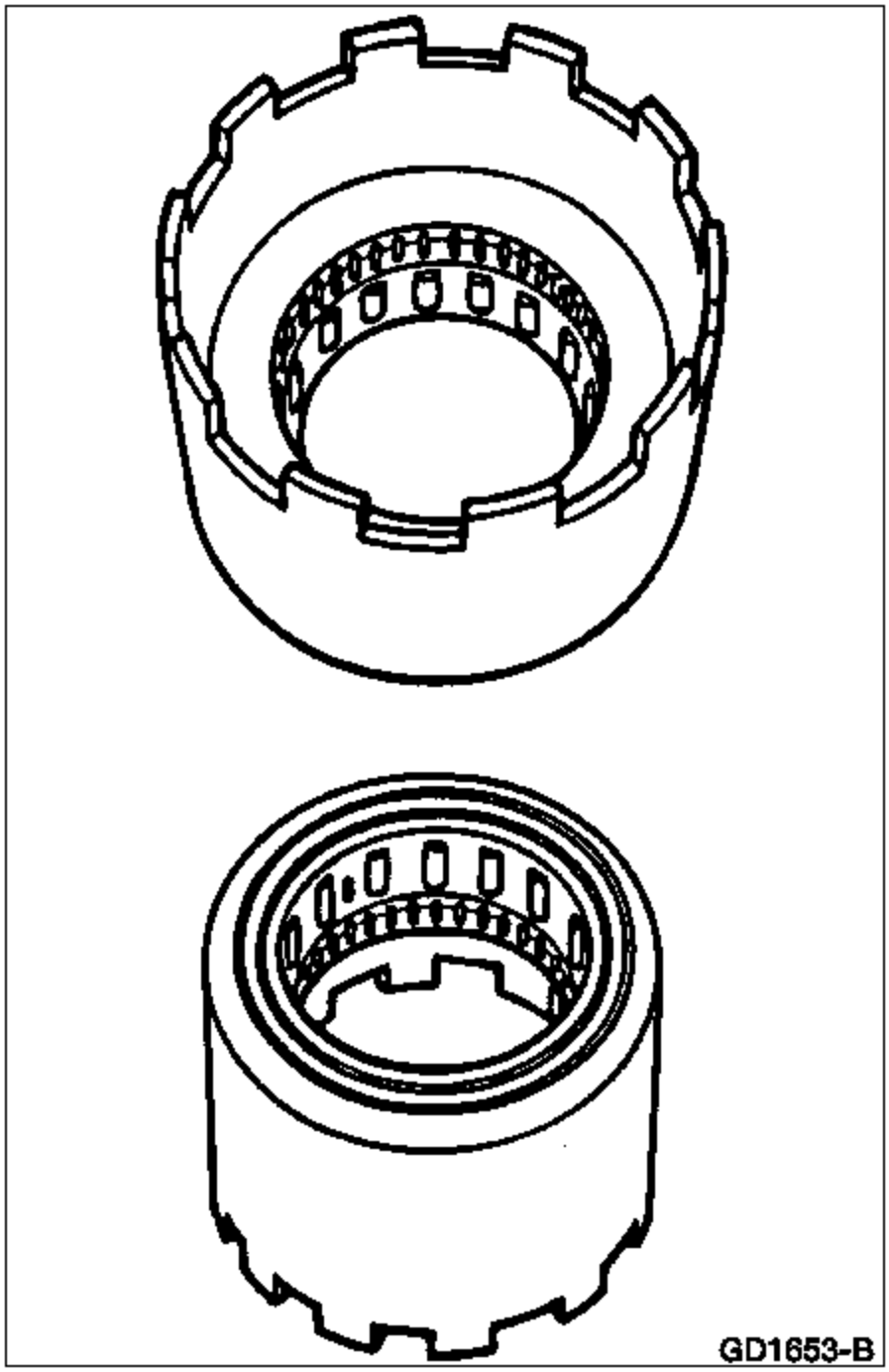

Inspection

1. **NOTE: The rear one-way clutch is part of the low/reverse drum assembly.**

   Inspect rollers, sprags, and reverse drum for damage. If damaged, replace drum assembly.

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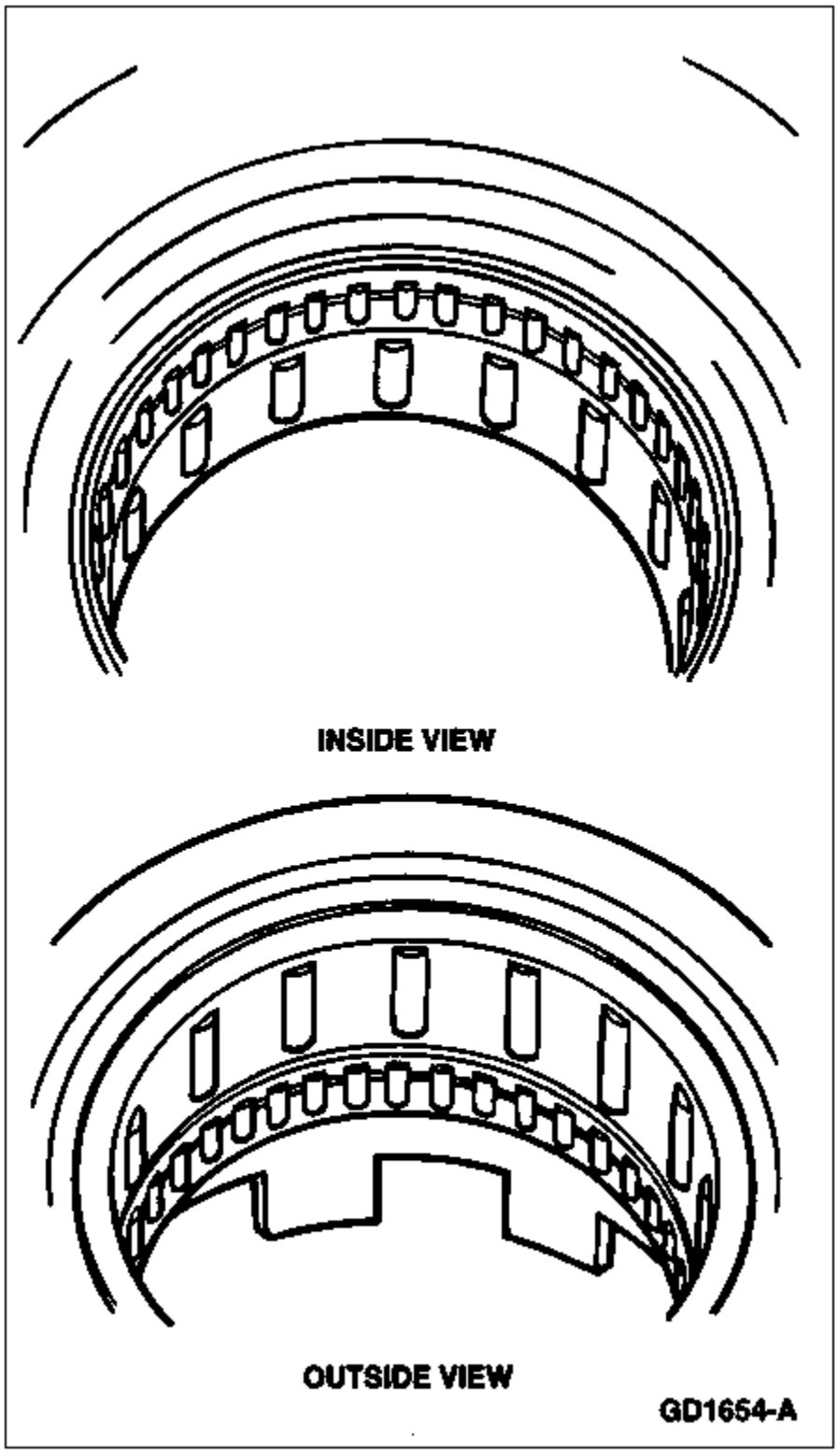

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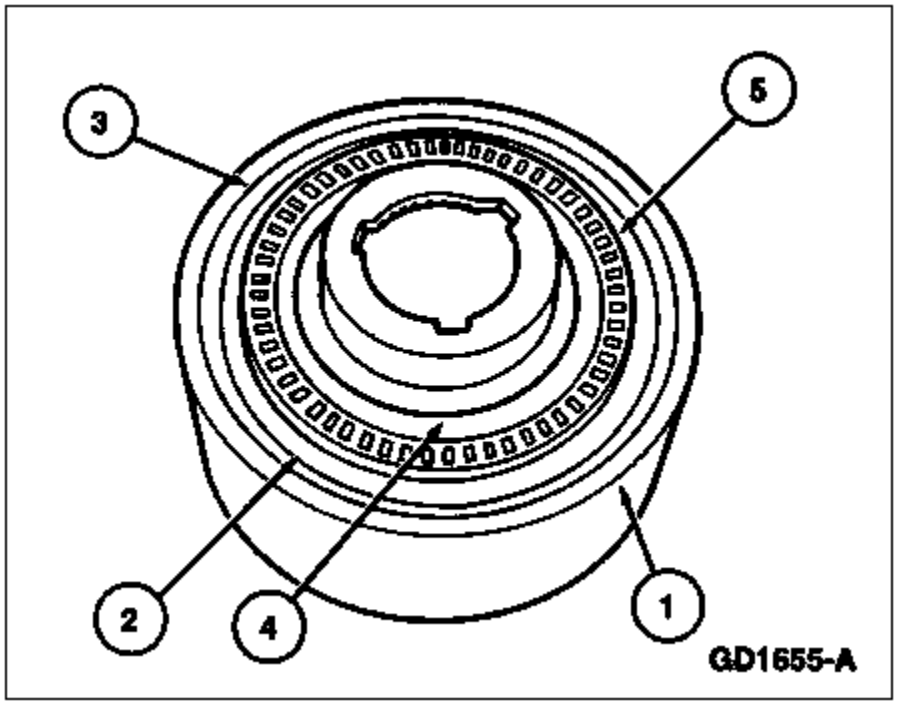
tomsn048@gmail.com

Output Shaft Ring Gear and Hub Assembly

Output Shaft Ring Gear and Hub Assembly



Item	Part Number	Description
1	7A153	Output Shaft Ring Gear
2	7D164	Output Shaft Hub
3	E860122-S	Retaining Ring
4	7M150	No. 10A Bearing Race Assembly
5	7M150	No. 10B Needle Bearing

Disassembly

1. Inspect the ring gear, hub, No. 10B needle bearing and No. 10A bearing race assembly for damage. If service is required, use the following procedures.

2. Remove No. 10B needle bearing, if not already removed.

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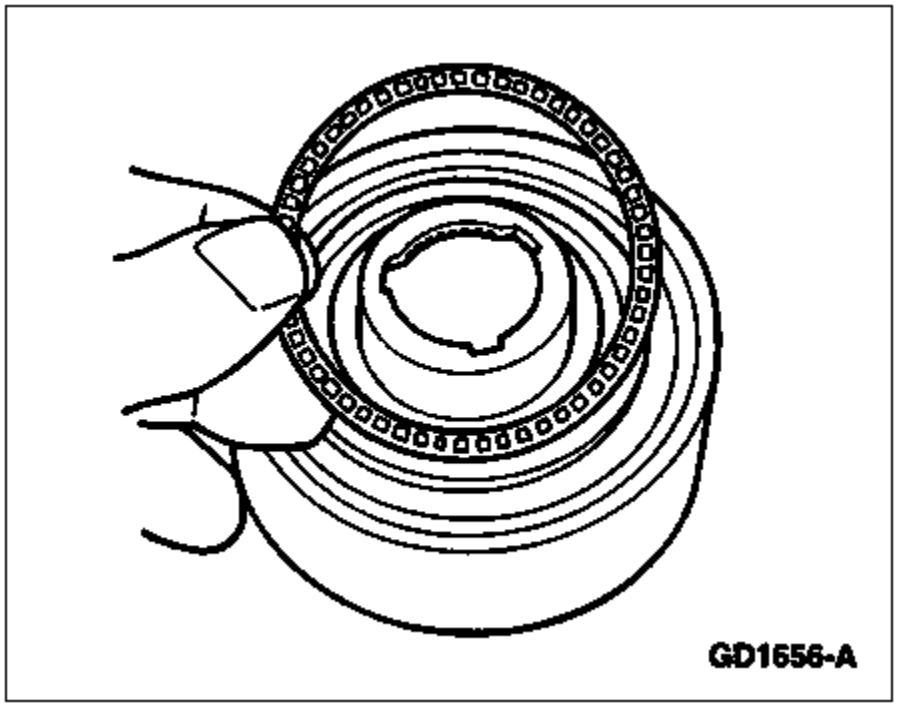
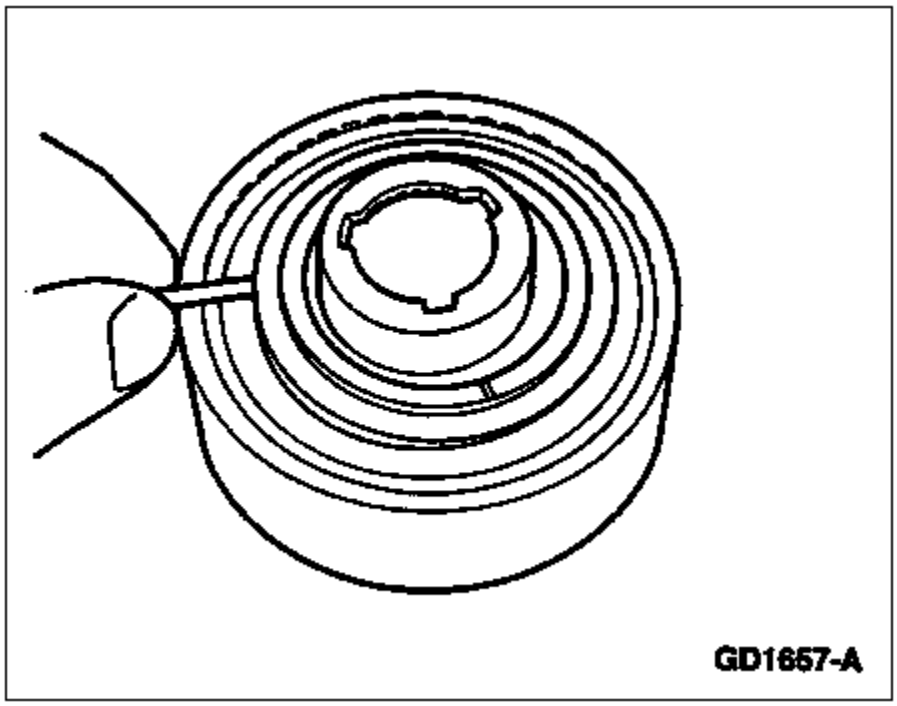


3. Remove No. 10A bearing race assembly.



4. Separate ring gear from hub by removing retaining ring.

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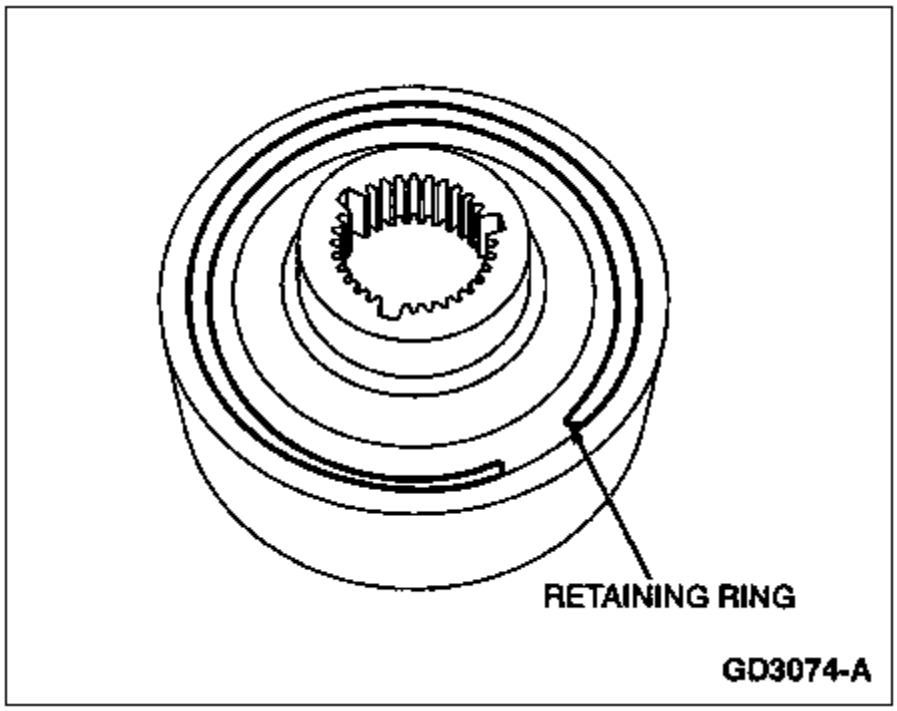
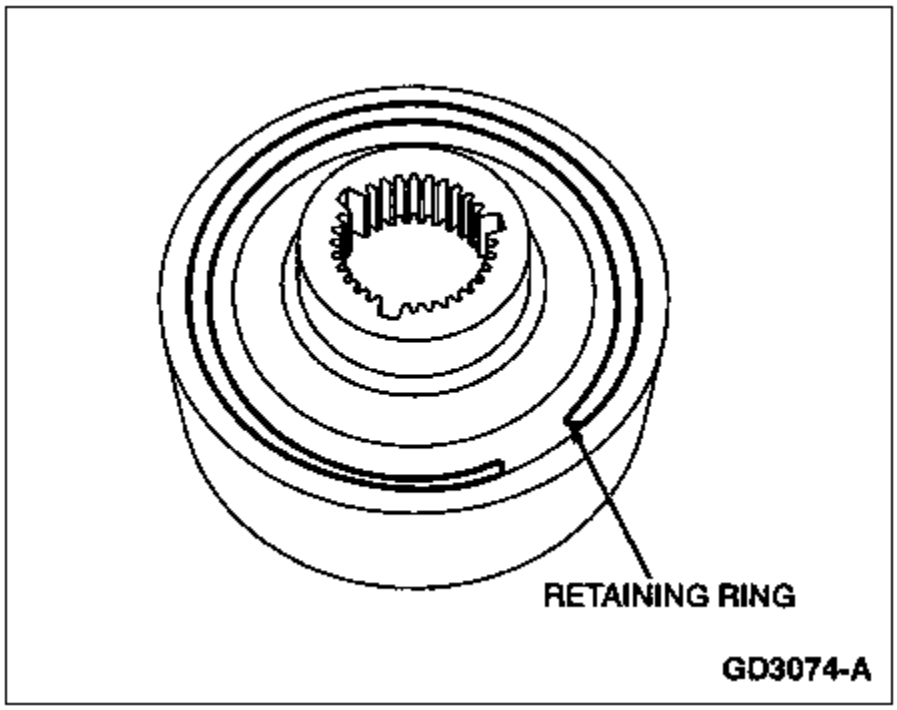


Assembly

1. Install output shaft hub into ring. Install retaining ring.



2. Install No. 10A bearing race assembly onto outshaft hub. Press on-snap fit.

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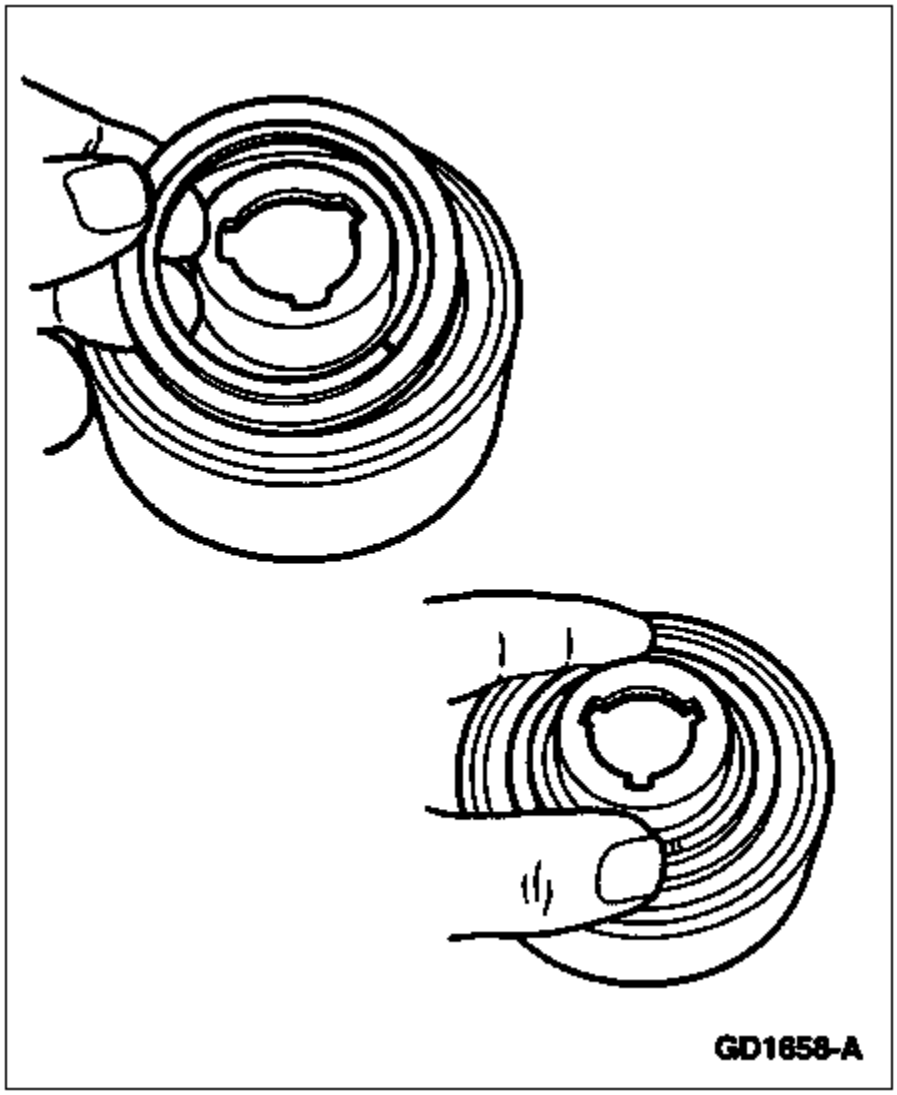

3. Use petroleum jelly and install No. 10B needle bearing onto output shaft ring gear and hub assembly.

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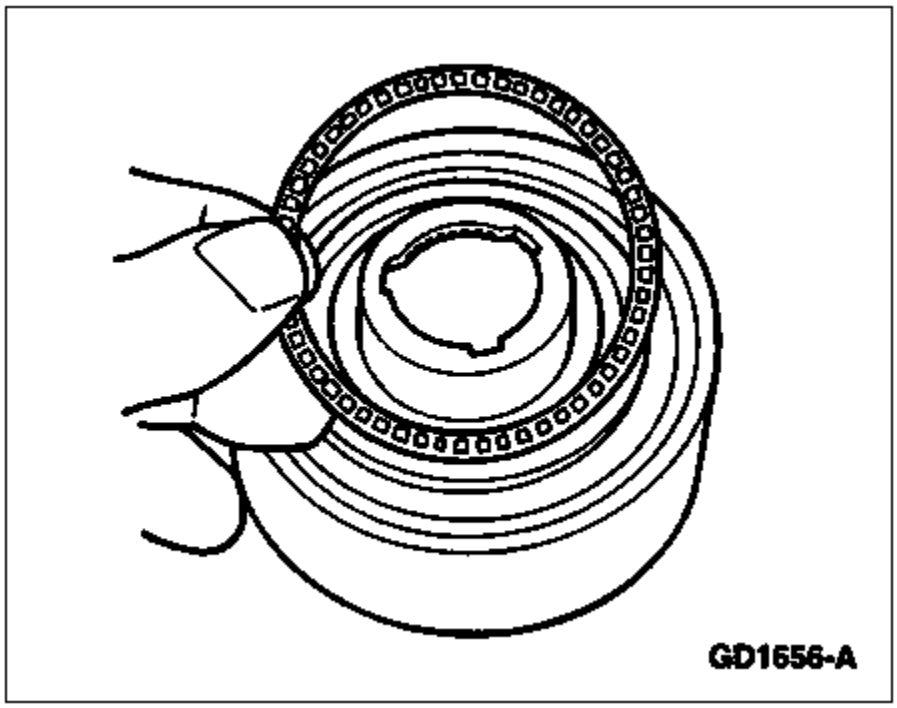

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Torque Converter Service Procedures

Cleaning/Inspection

When internal wear or damage has occurred in the transmission, metal particles, clutch plate material, or band material may have been carried into the torque converter. These contaminates are a major cause of recurring transmission troubles and MUST be removed from the system before the transmission is put back into the vehicle.

Whenever a transmission has been disassembled to replace worn or damaged parts, or because the valve body sticks repeatedly from foreign material, the torque converter MUST be cleaned using a mechanical agitated cleaner, such as Rotunda Torque Converter/Transmission Oil Cooler Cleaner 014-00028 or equivalent.

Torque Converter Flushing

NOTE: Mineral spirits used to clean the torque converter must be fresh, non-chlorinated and non-halogenated.

Following the instructions included with the Torque Converter/Transmission Oil Cooler Cleaner 014-00028, flush out the converter.

After flushing the torque converter, follow these steps:

- Thoroughly drain the remaining solvent through the impeller hub.
- Add 1.9L (2.0 quarts) of clean MERCON V® Automatic Transmission Fluid into fluid filler tube.
- Agitate the solution inside the torque converter by hand.
- Thoroughly drain the torque converter through the impeller hub.

Torque Converter Leak Check

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Torque Converter Leak Check Tool and Gasket	014-R1075

1. Clean the outside surface of the torque converter.

2. Install Torque Converter Leak Check Tool and Gasket 014-R1075 into converter hub.

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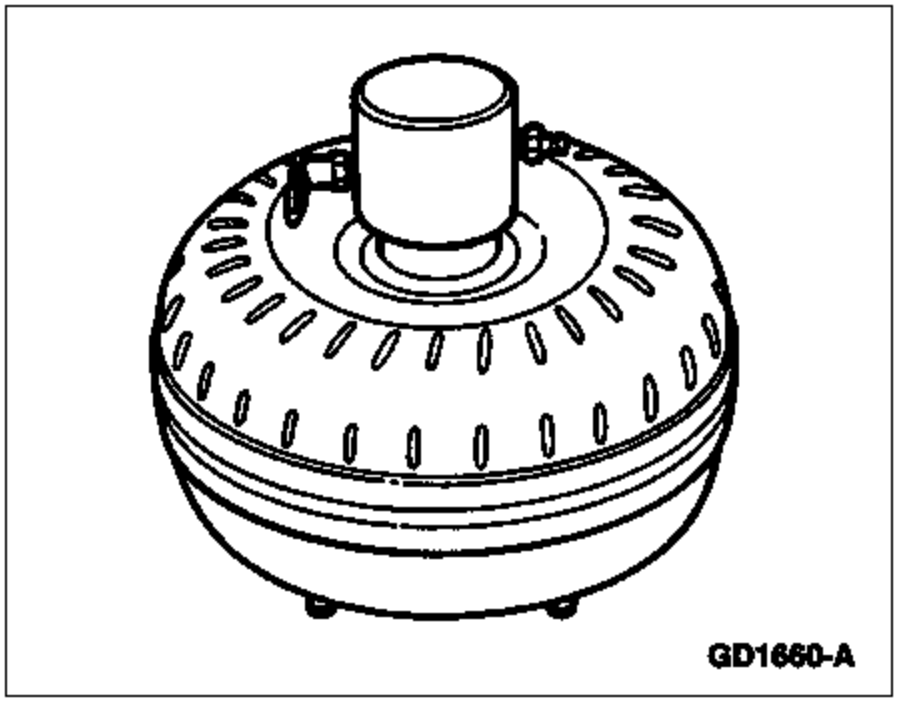

3. Install torque converter with installed Torque Converter Leak Check Tool and Gasket 014-R1075 into press.

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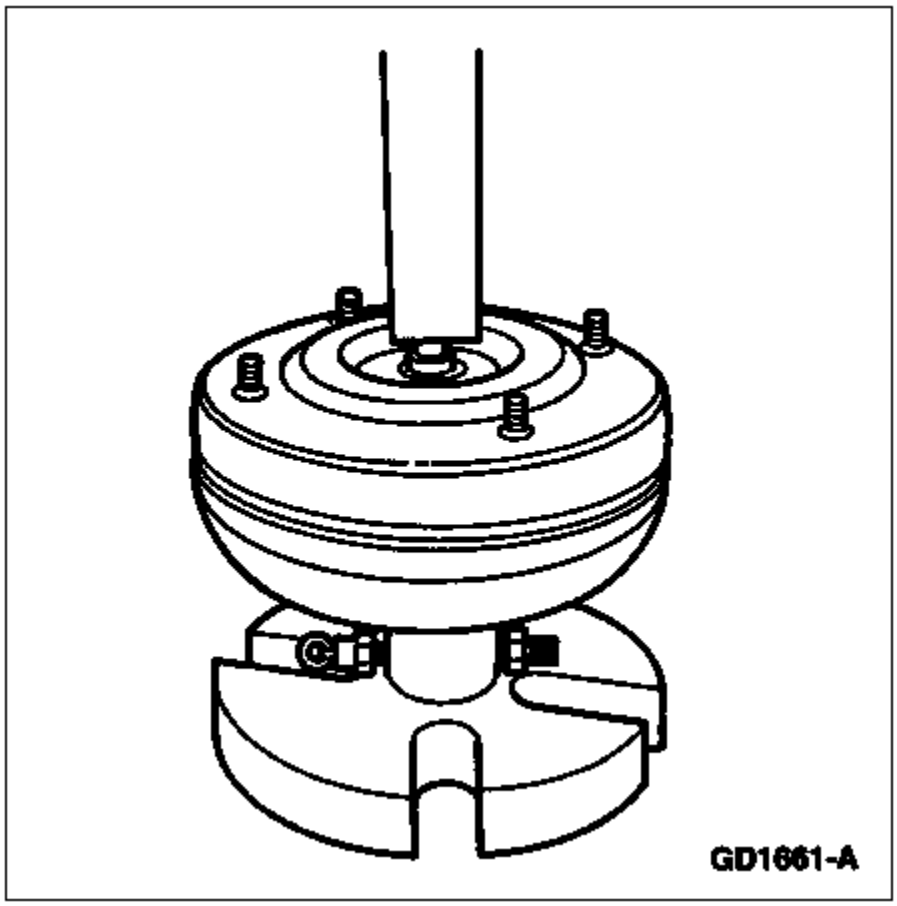

4. **WARNING: ALWAYS FOLLOW PROPER SAFETY PROCEDURES WHILE USING PRESS.**

   Secure press. Apply enough force from press to seal tool into torque converter.

5. **NOTE: Use clean dry shop air.**

   Apply air pressure 80 psi (MAX) to valve on Torque Converter Leak Check Tool and Gasket 014-R1075.

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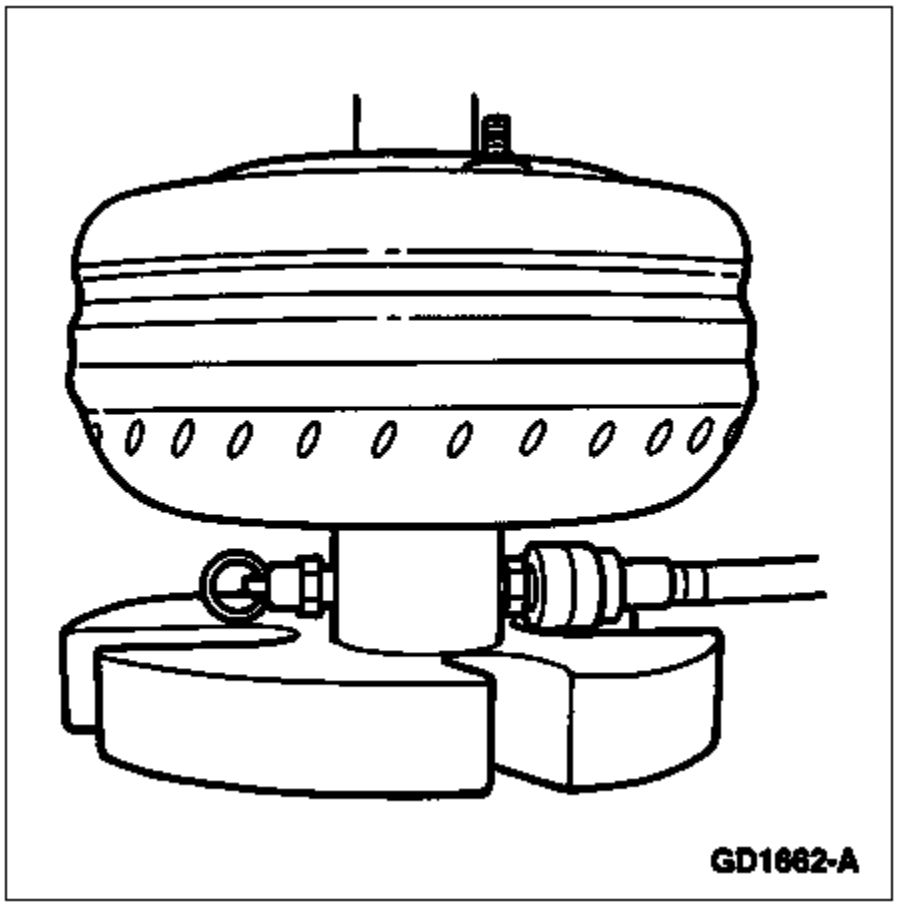

6. With air pressure applied to valve, inspect for leaks at studs, seams and pilot hub. A soap bubble solution may be applied around those areas to aid in diagnosis. If leaks are present, replace converter.

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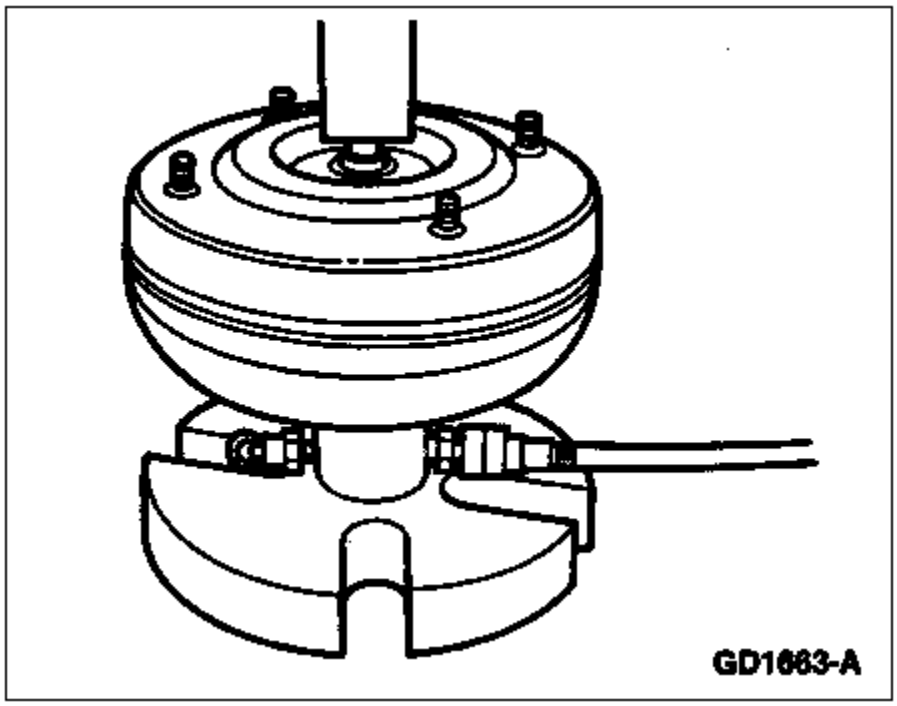

7. Release pressure and then slowly release press. Remove air hose.

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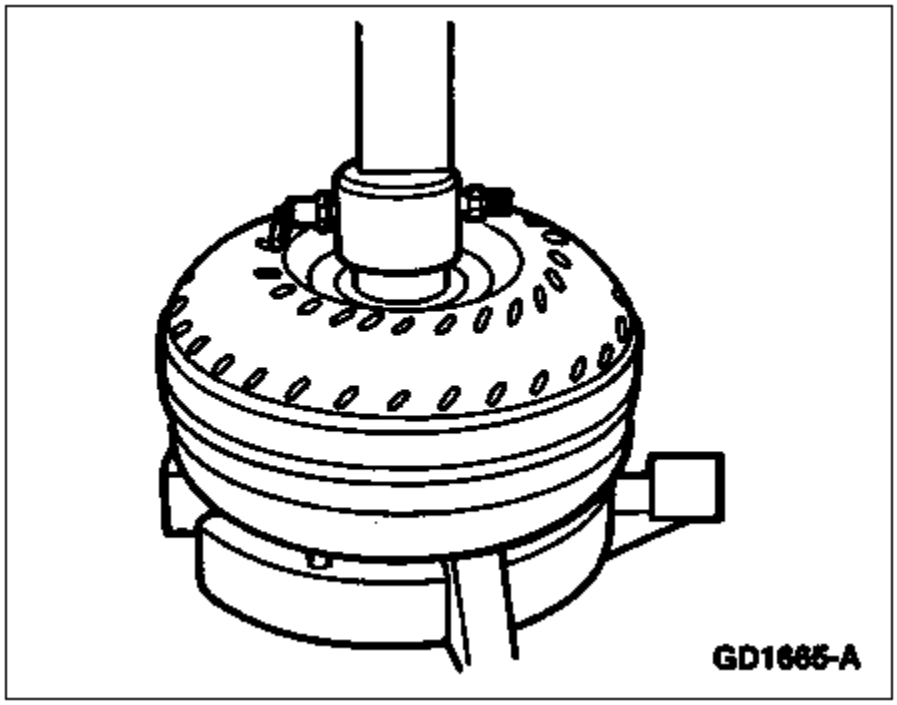
8. Rotate torque converter and tool then reinstall into press with tool up.



9. **WARNING: ALWAYS FOLLOW PROPER SAFETY PROCEDURES WHILE USING PRESS.**

   Secure press. Apply enough force from press to seal tool into torque converter.

10. **NOTE: Use clean dry shop air.**

    Apply air pressure 80 psi (MAX) to valve on leak check tool.

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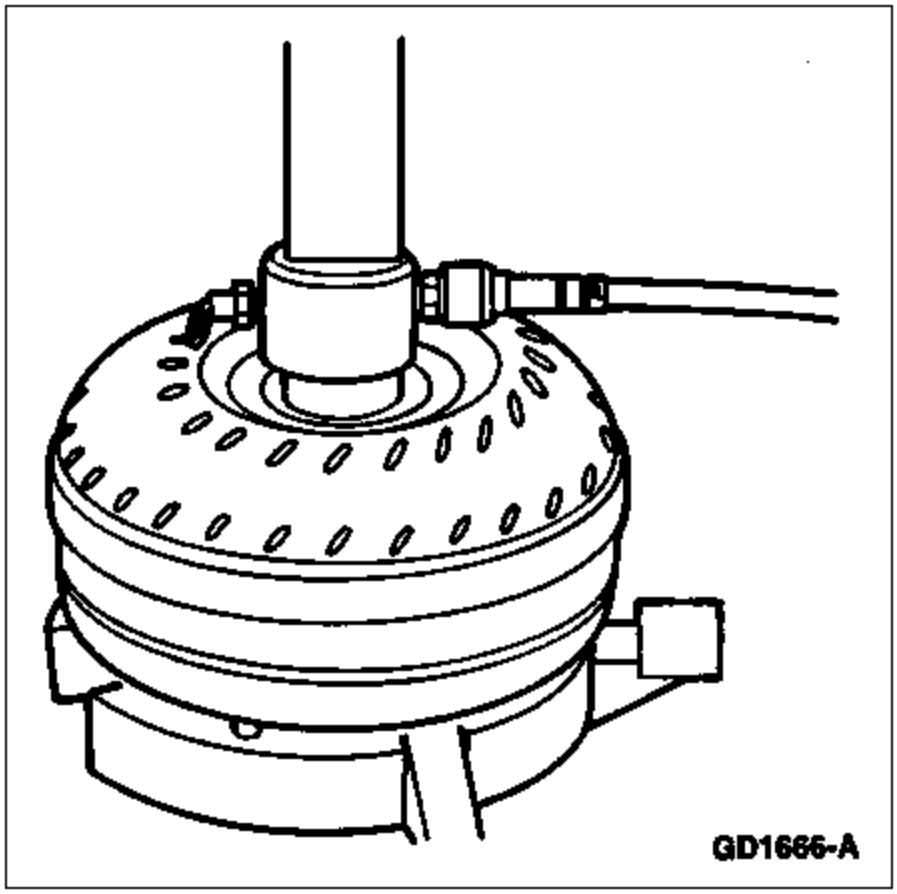

11. With air pressure applied to valve, inspect for leaks at converter hub, seams and studs. A soap bubble solution may be applied around those areas to aid in diagnosis. If leaks are present, replace converter.

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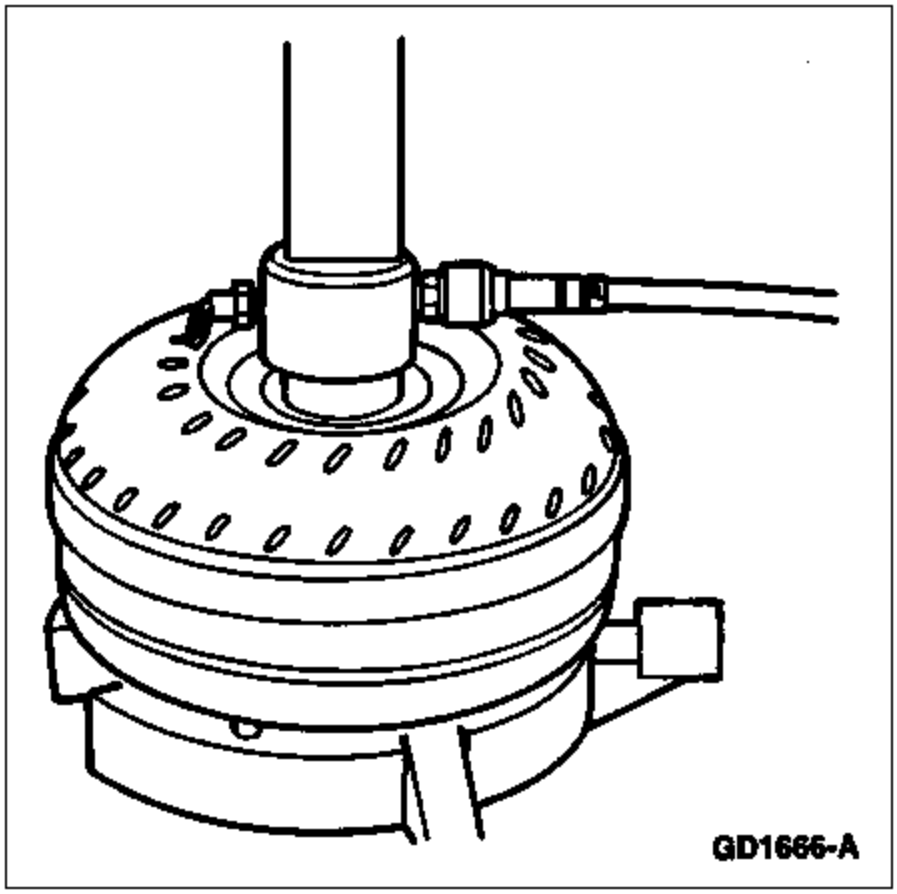

12. Remove air hose. Release pressure and then slowly release press. Remove the converter. Remove the tool.

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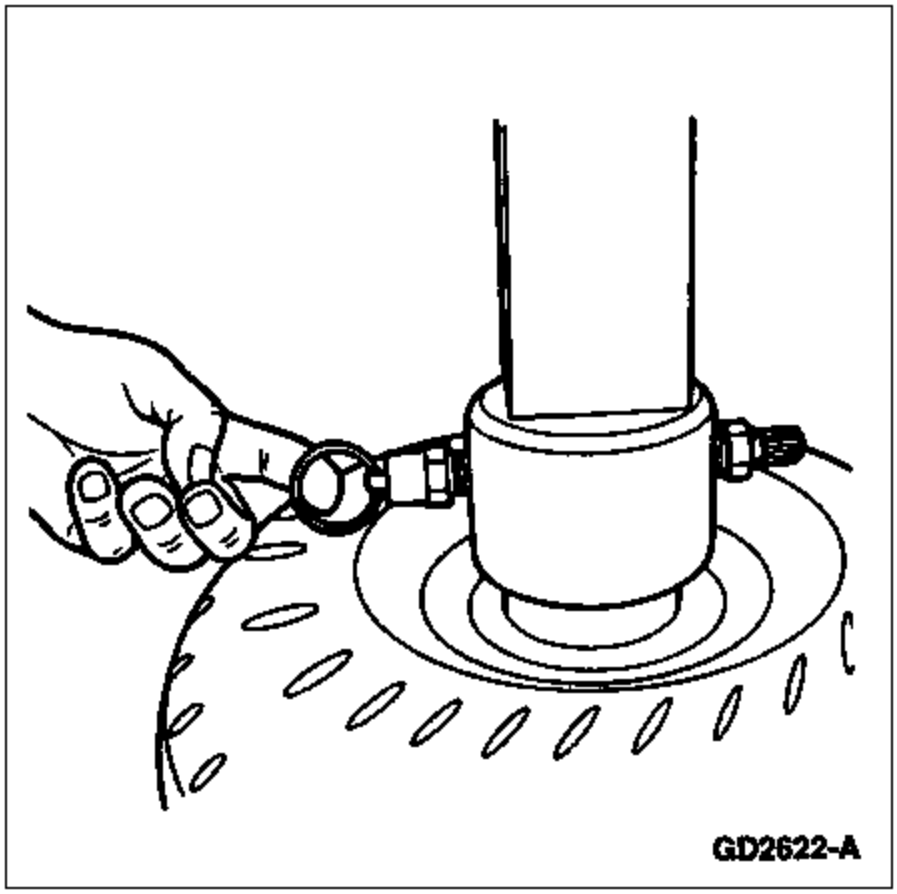

Stator to Impeller Interference Check

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
End Play Checking Tool	T80L-7902-A

1. Install the fluid pump support into torque converter. Engage the splines of the one-way clutch inner race with the mating splines of the stator support.

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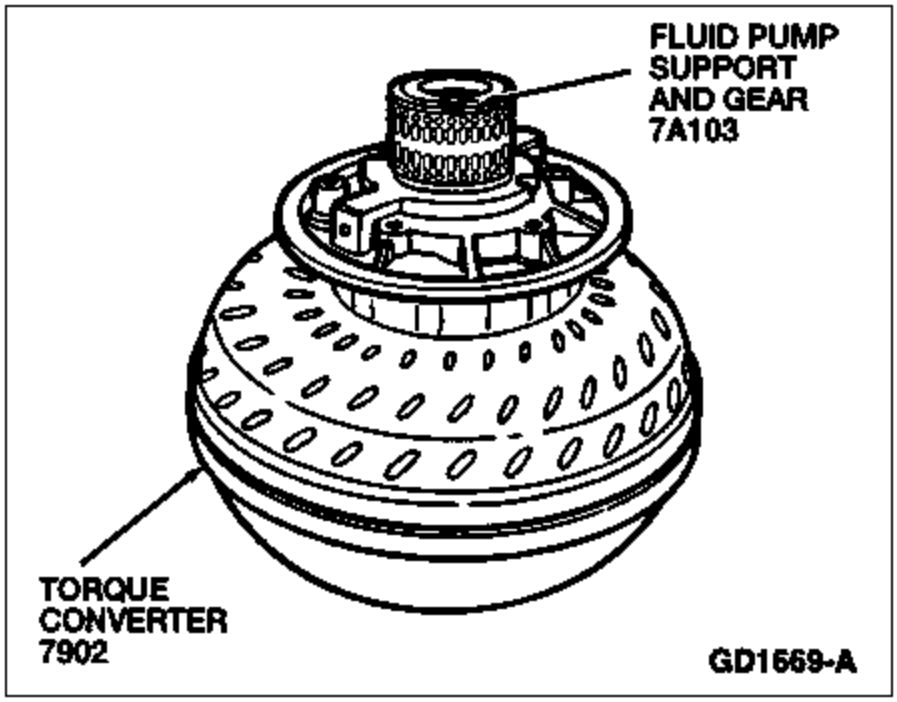
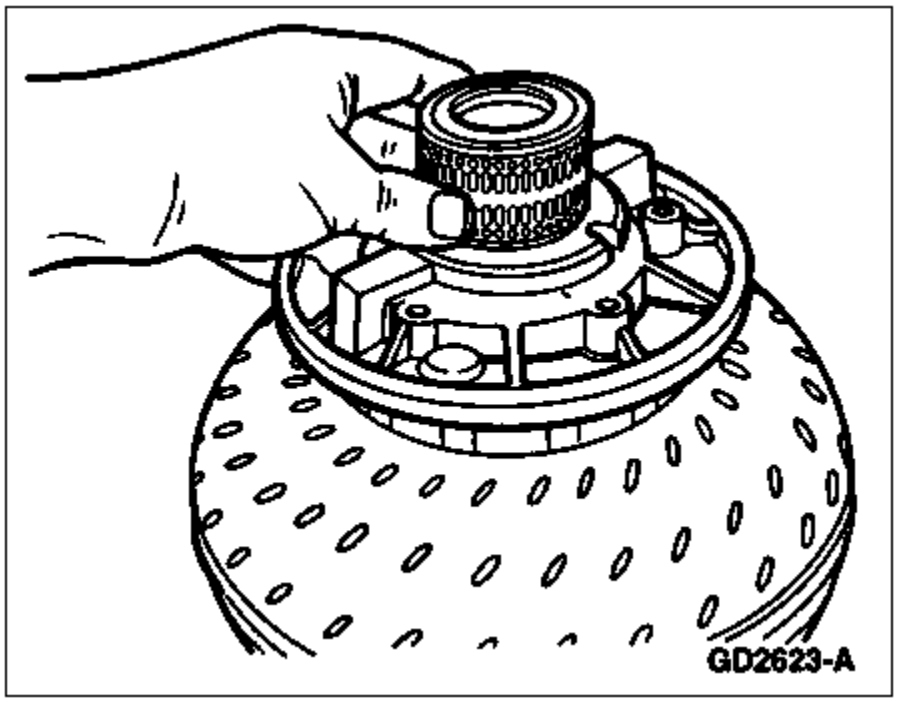


2. Rotate the torque converter both clockwise and counterclockwise. The fluid pump support should rotate freely without any signs of interference or scraping within the torque converter.

   If there is an indication of scraping, the trailing edges of the stator blades may be interfering with the leading edges of the impeller blades. In such cases, replace the torque converter.



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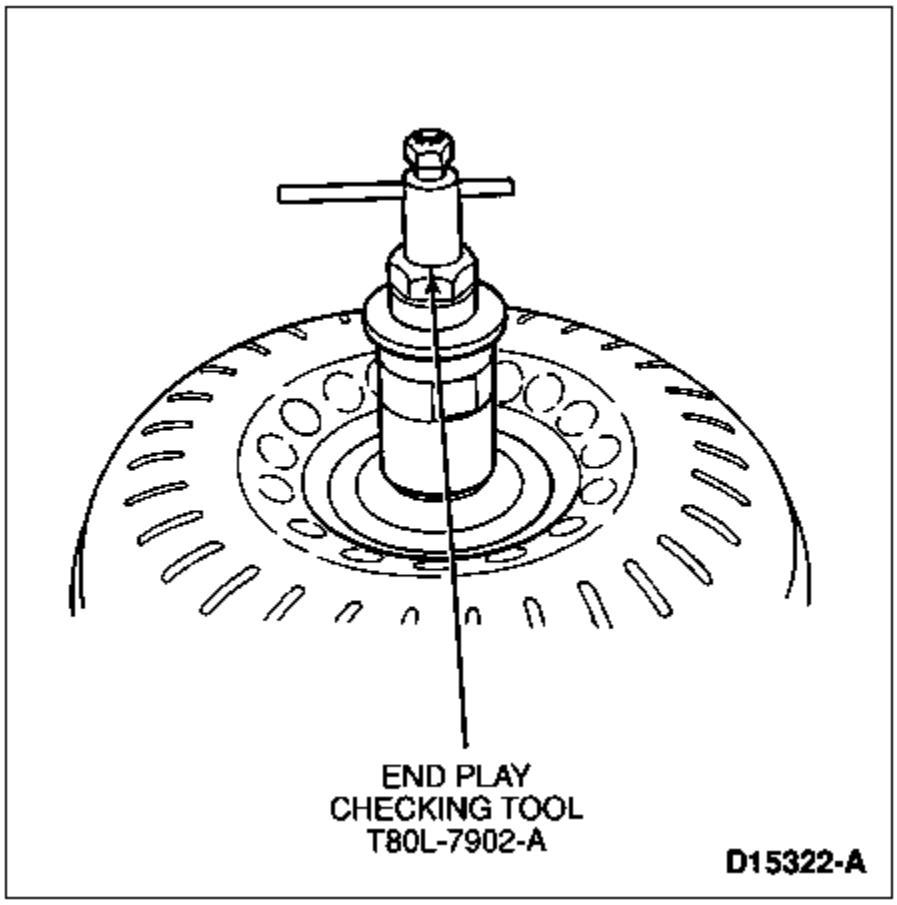
Torque Converter End Play Check

1. Install End Play Checking Tool T80L-7902-A into the converter turbine hub until it bottoms.



2. Expand the sleeve in the turbine spline by tightening the threaded inner post until the tool is securely locked in the spline.

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3. Attach Dial Indicator with Bracketry TOOL-4201-C or equivalent to End Play Checking Tool T80L-7902-A. Position the indicator button on the converter impeller housing and set the dial face to zero (0).

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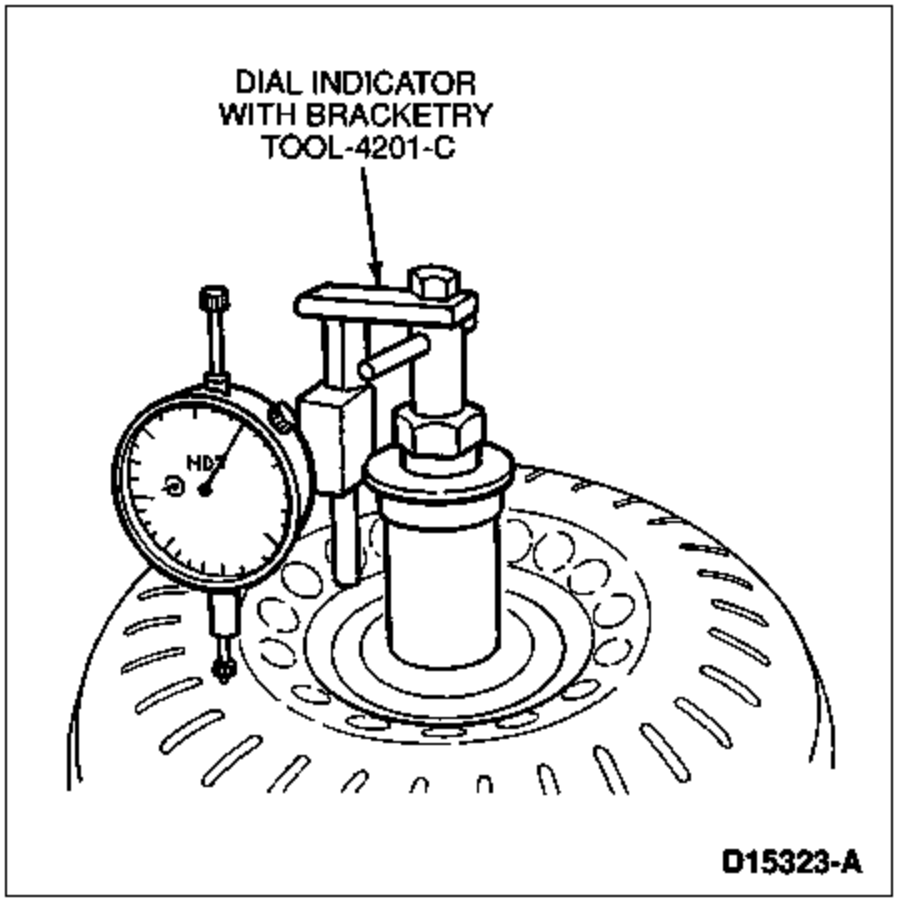

4. Lift the tool upwards as far as it will go and note the indicator reading. The indicator reading is the total end play which the turbine and stator share. Replace the torque converter if the total end play exceeds the specifications.

CONVERTER END PLAY

New or Rebuilt Converter		Used Converter	
mm	Inch	mm	Inch
0.58 Max.	0.023 Max.	1.27 Max.	0.050 Max.

5. Loosen the threaded inner post to remove the tool from the torque converter (7902).

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Transmission

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Bench-Mounted Holding Fixture	T57L-500-B
Shift Lever Seal Replacer	T74P-77498-A
Gauge Bar	T93T-77003-AH
Front Pump Alignment Set	T74P-77103-X
Band Adjustment Torque Wrench Set	T71P-77370-A
Servo Rod Selecting Gauge	T74P-77190-A
Extension Housing Bushing Replacer	T77L-7697-F
Extension Housing Seal Replacer	T74P-77052-A
TR Sensor Alignment Tool	T97L-70010-A
Drive Handle	T80T-4000-W
Case Bearing Installation Tool	T97T-77110-A
Bearing Cup Puller	T77F-1102-A
Impact Slide Hammer	T50T-100-A
Turbine Shaft Speed Sensor Gauge	T95L-70010-F
Valve Body Guide Pin (.235)	T95L-70010-B
Valve Body Guide Pin (.248)	T95L-70010-C
Torque Converter Handles	T81P-7902-C
Servo Cover Compressor	T95L-77028-A
Converter Guide Pins	T95L-7902-A

1. Inspect the case for cracks and stripped threads. Inspect the gasket surfaces and mating surfaces for burrs. Check the vent for obstructions and check all fluid passages for obstructions and leakage.

2. Inspect case bearing for damage. If damaged, replace bearing. Refer to steps a-d.

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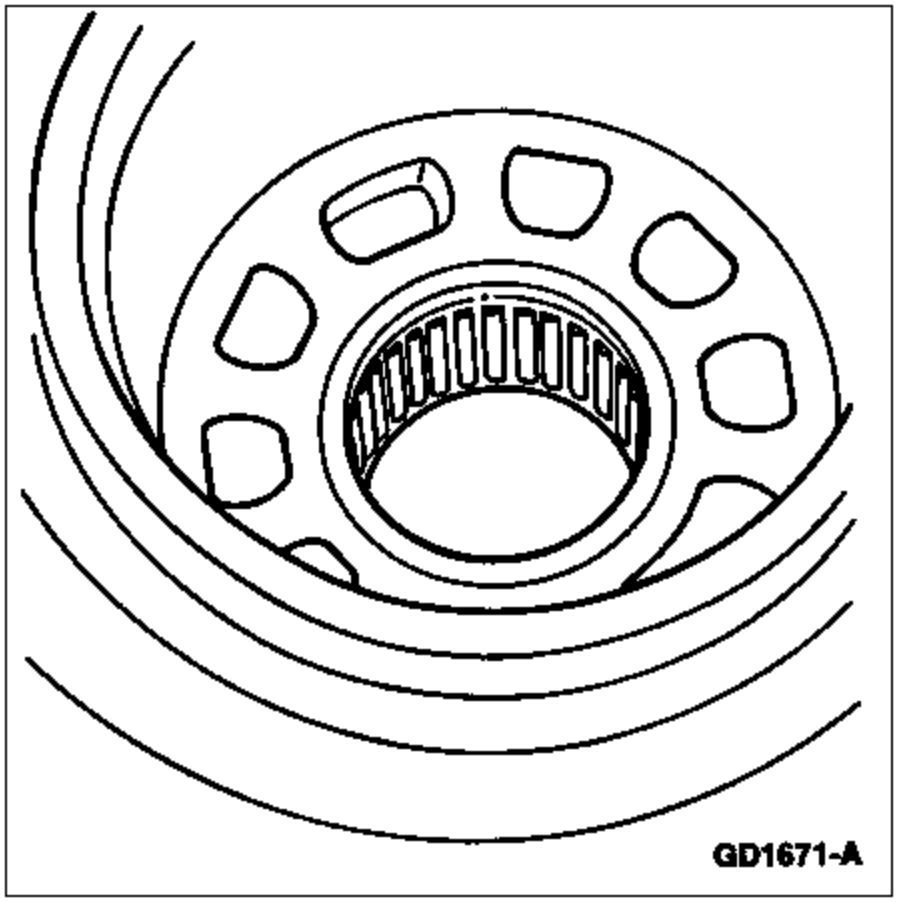

a. Install Bearing Cup Puller T77F-1102-A with Impact Slide Hammer T50T-100-A onto case bearing. Remove bearing.

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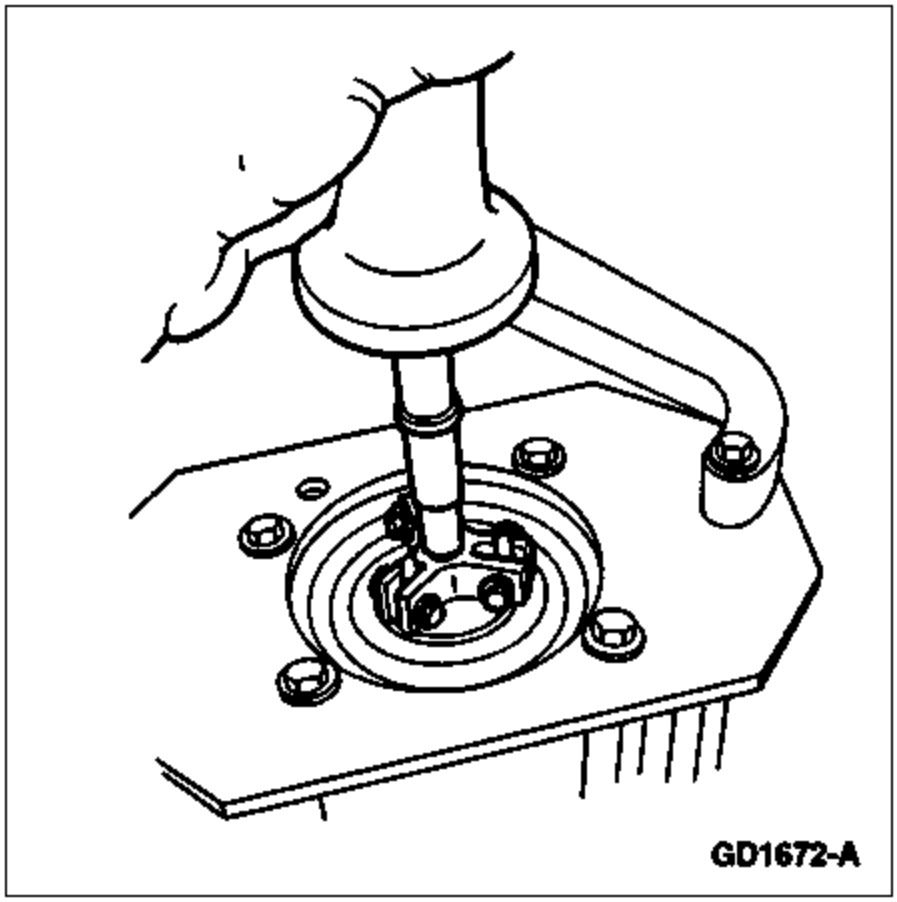
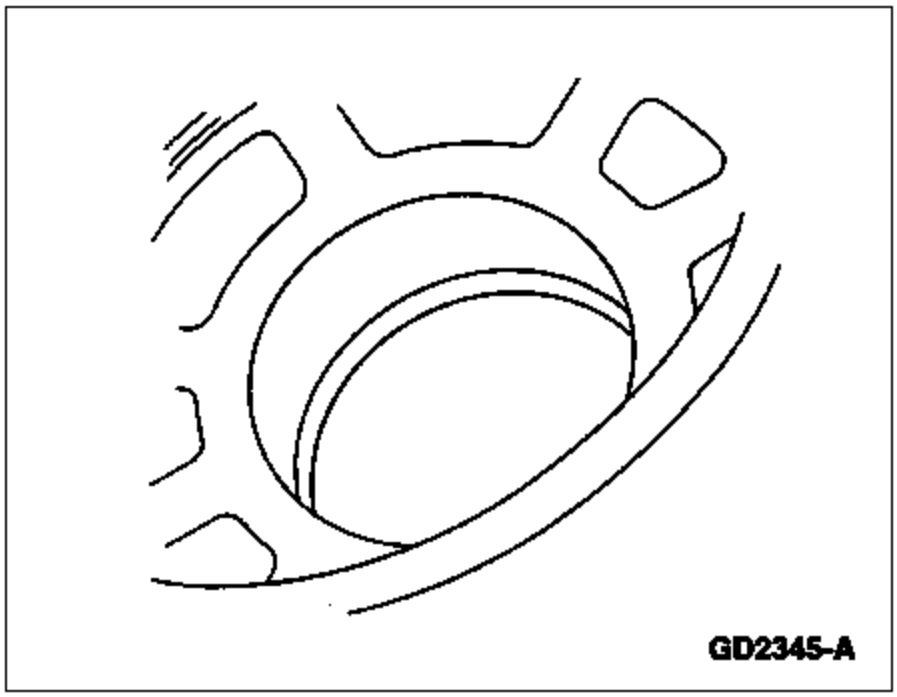


b. Inspect case bore for nicks and burrs. Remove with oil stone prior to installation of new bearing.



c. Install Drive Handle T80T-4000-W into Case Bearing Installation Tool T97T-77110-A. Install

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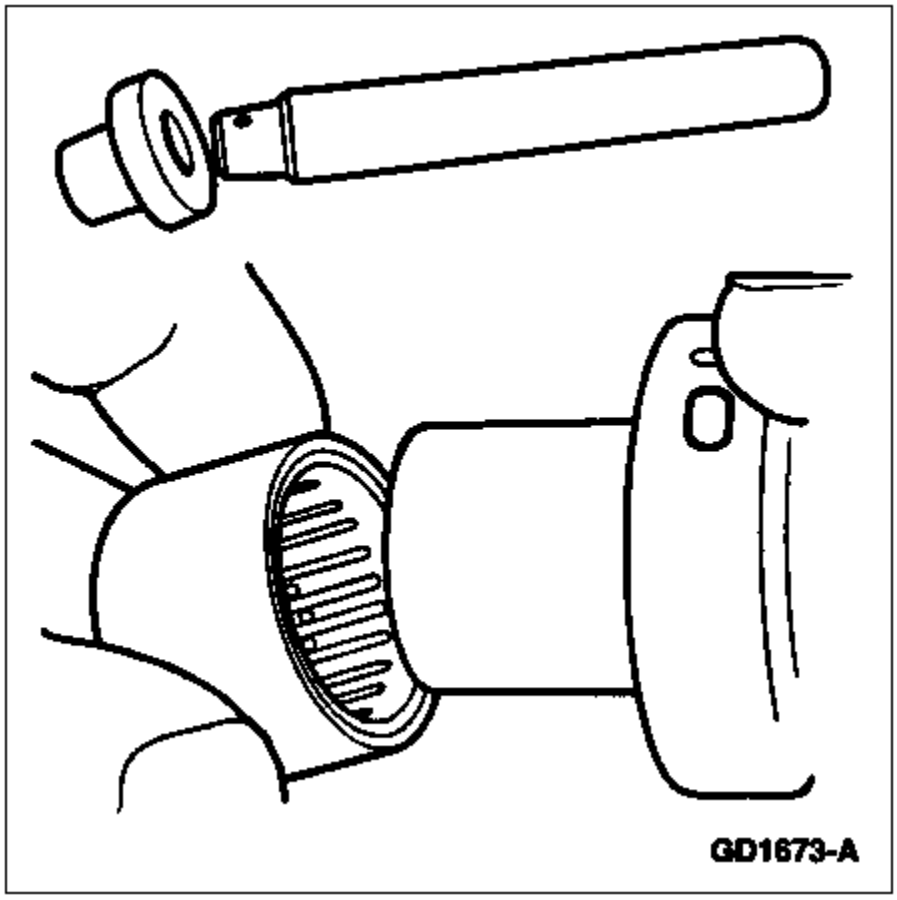
new bearing on Case Bearing Installation Tool T97T-77110-A. Make sure bearing seal ring is facing Drive Handle T80T-4000-W.



d. Using a hammer, tap bearing into place with Case Bearing Installation Tool T97T-77110-A.

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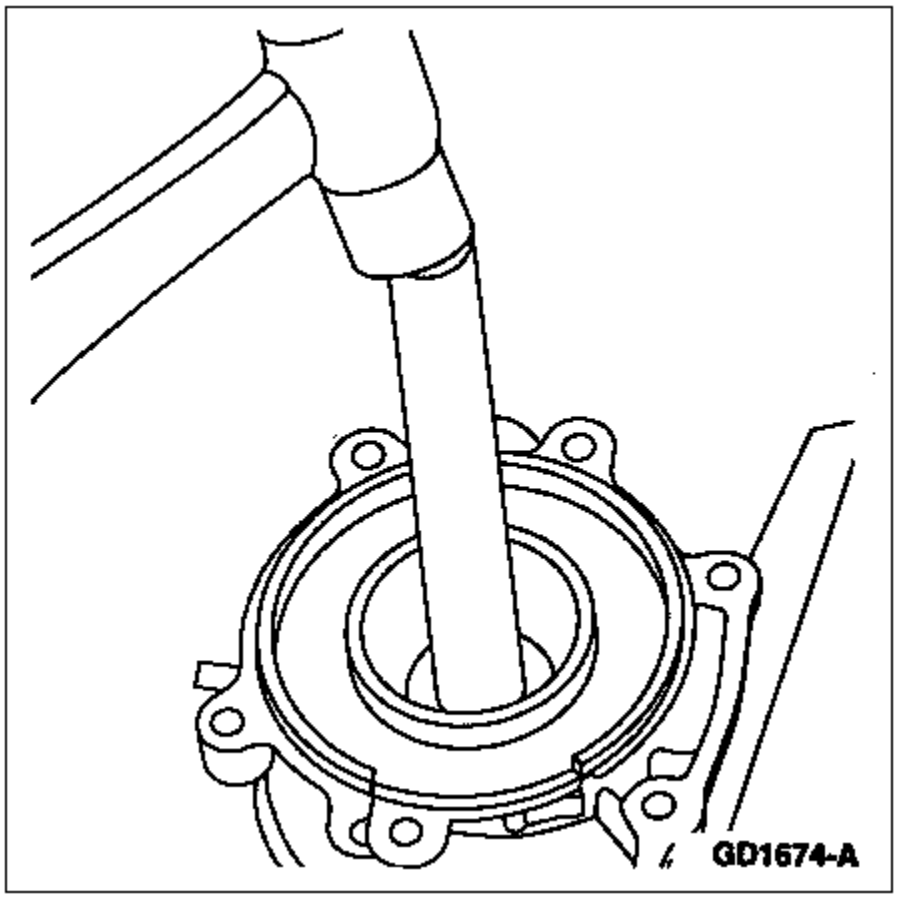

3. Check all parking linkage for wear or damage.
4. Inspect all case threads for damage.

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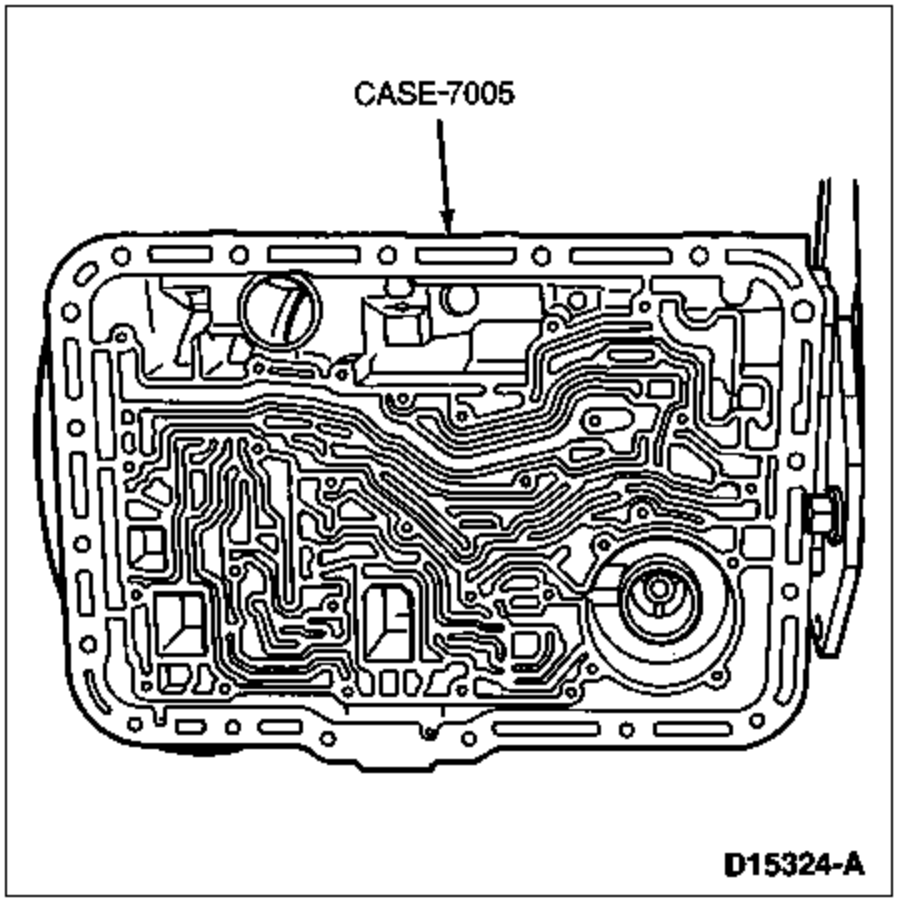
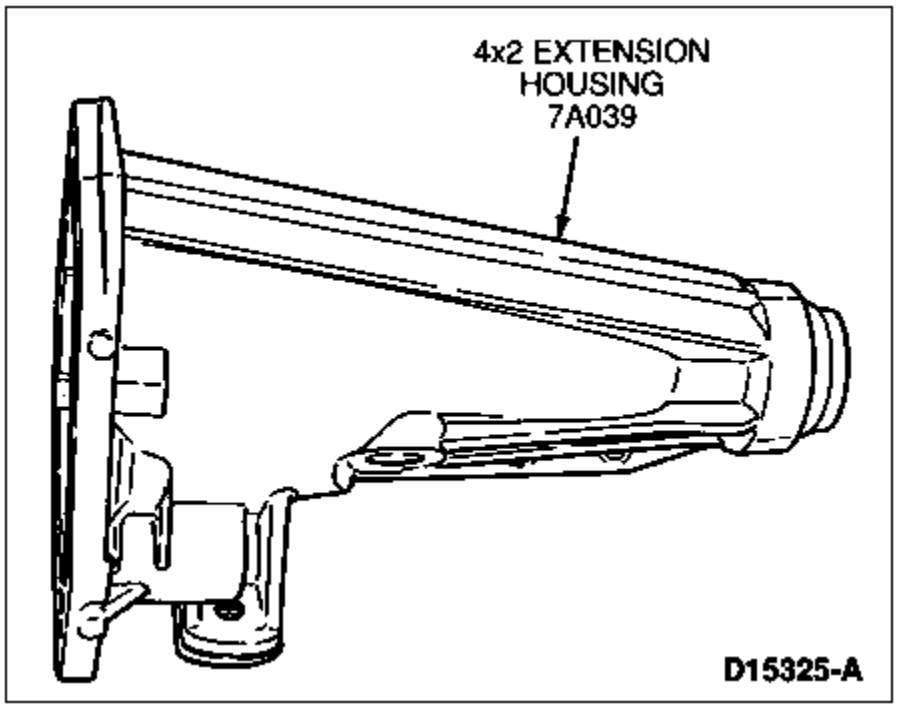


5. Inspect the extension housing for cracks. Inspect the gasket surfaces for burrs or warpage.



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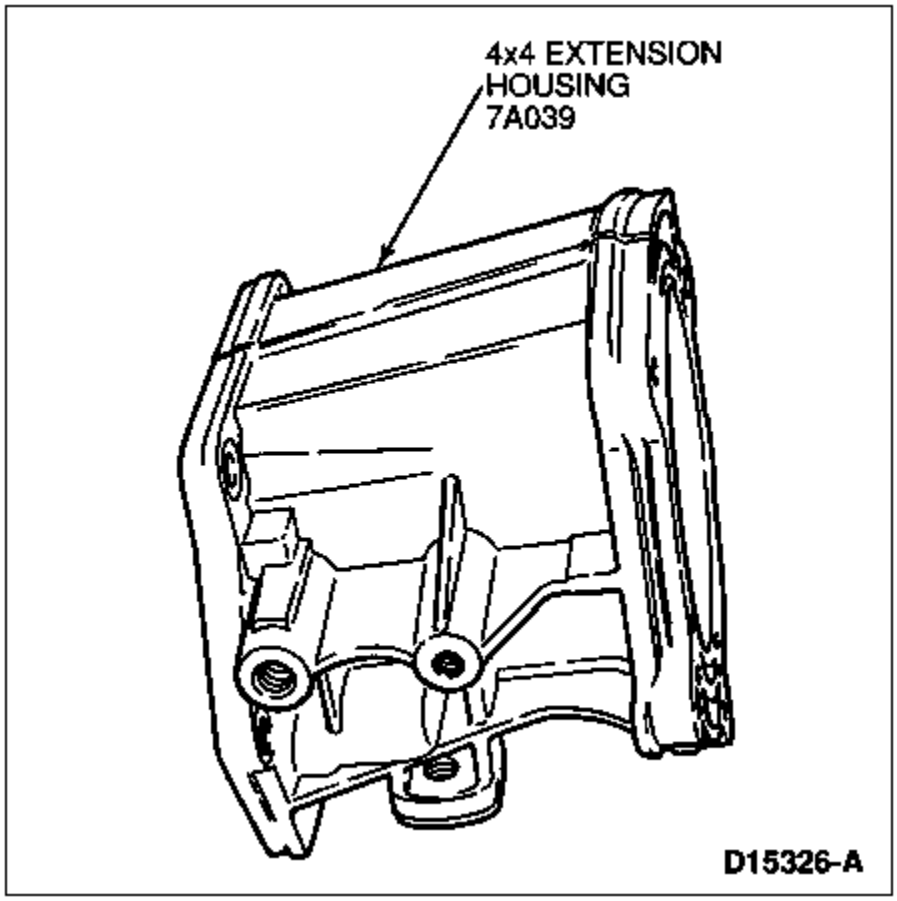

6. Inspect the bushing for scores or wear. Replace if required.

7. Inspect the rear seal for hardness, cracks or wear. If the seal shows wear or deterioration, replace the seal.

8. Inspect the seal counterbore and remove all burrs and scores with a crocus cloth.

9. **NOTE: Bench-Mounted Holding Fixture T57L-500-B should still be attached to the adapter plate. If it is not, reattach the fixture arm at this time.**

   Reattach the adapter plate to the extension housing face using four M10 x 30 mm screws.

10. **WARNING: MAKE SURE THE LOCK PIN ON BENCH-MOUNTED HOLDING FIXTURE T57L-500-B IS SECURE.**

    Install the transmission case in the Bench-Mounted Holding Fixture T57L-500-B and rotate so the transmission fluid pan rail is facing up.

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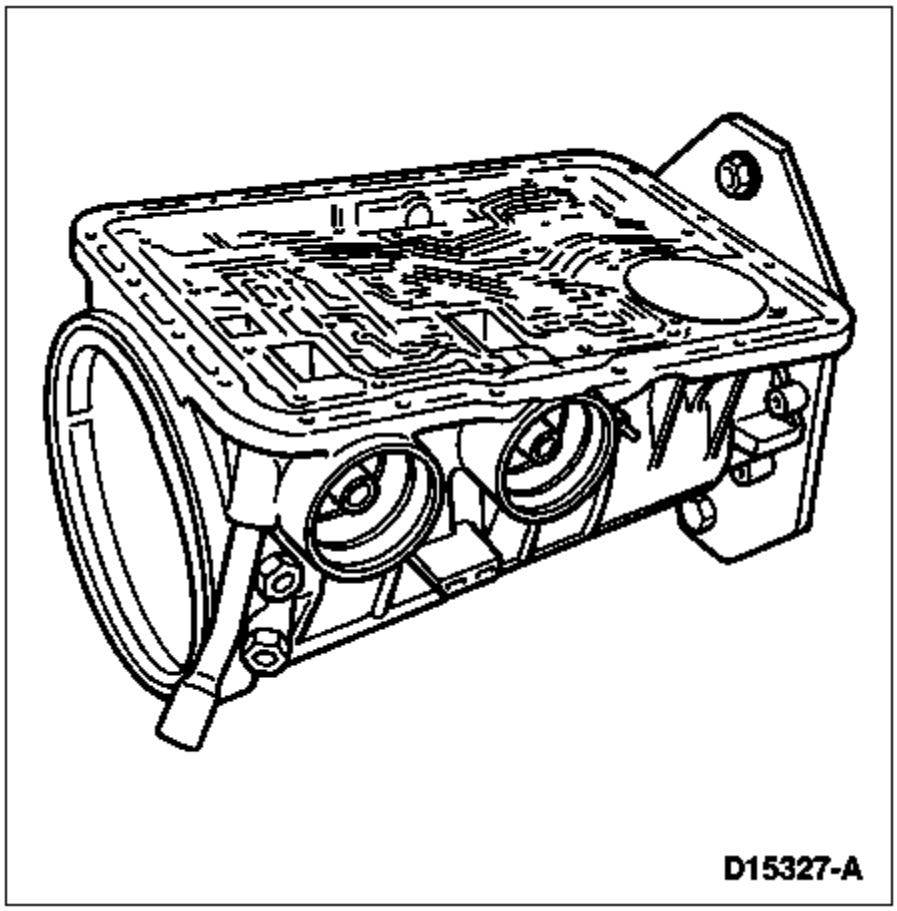
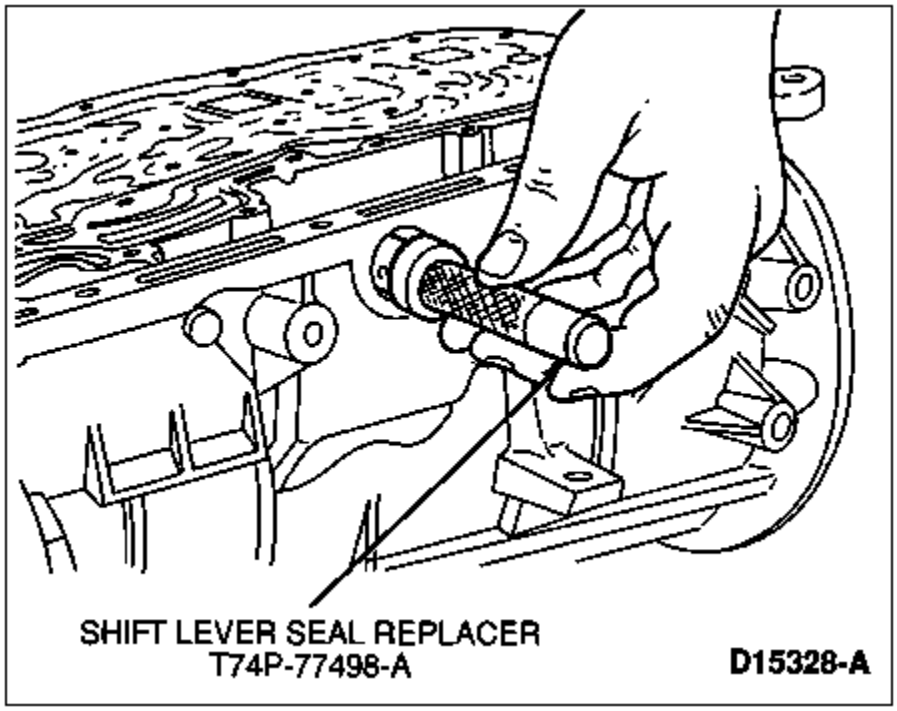


11. Lubricate and install the main control lever seal using Shift Lever Seal Replacer T74P-77498-A.



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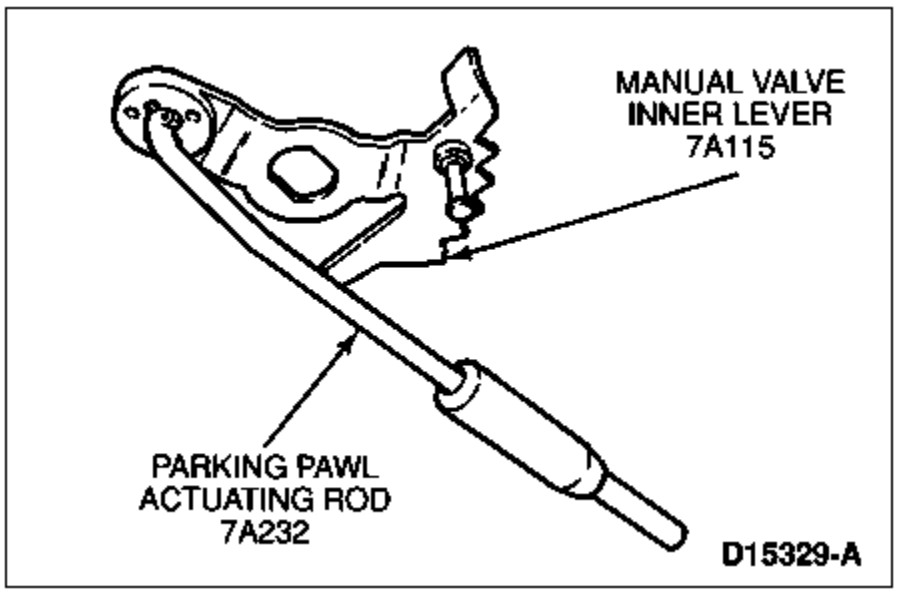
12. Assemble the manual valve inner lever and parking pawl actuating rod as shown.



13. Install the manual control lever shaft into the case.

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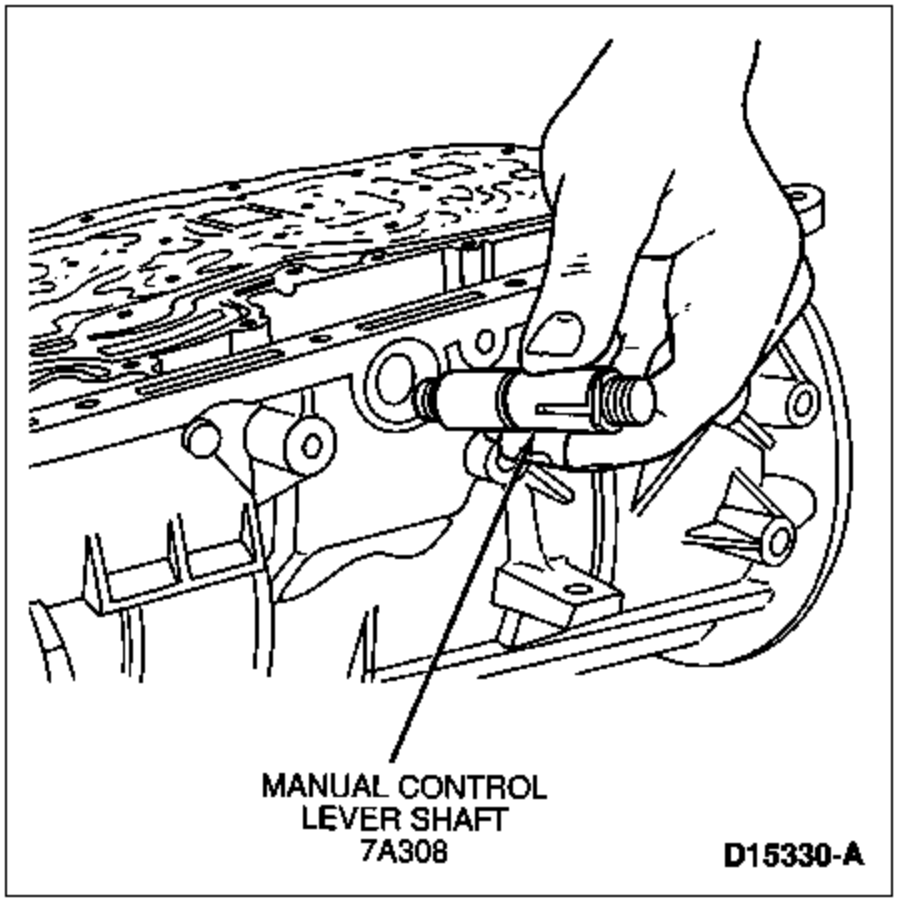

14. **CAUTION: Use care not to damage the fluid pan rail surface when installing the retaining pin.**

    Align the manual control lever shaft with the manual control lever shaft retaining pin. Install the retaining pin.

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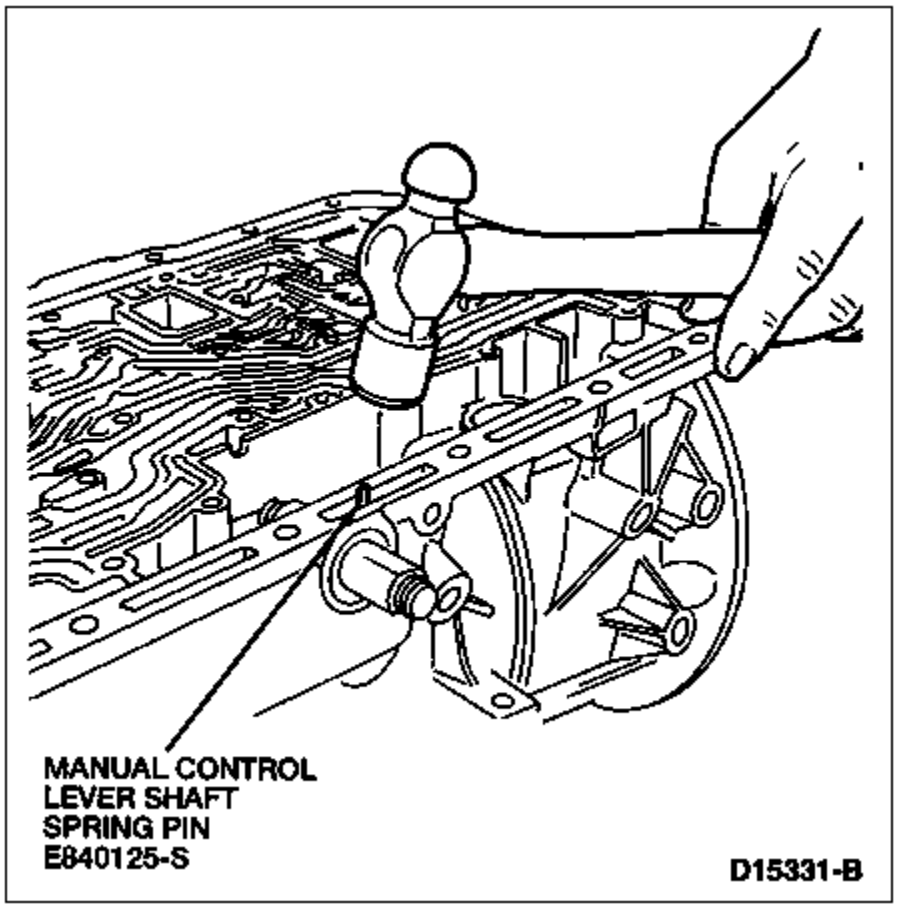

15. Install the manual valve inner lever and parking pawl actuating rod into the case. Align the flats of the manual valve inner lever with the flats on the manual control lever shaft.

16. **CAUTION: To avoid damage, do not allow wrench to strike the manual valve inner lever pin.**

    Install manual valve inner lever nut and tighten to 41-54 Nm (30-40 lb-ft).

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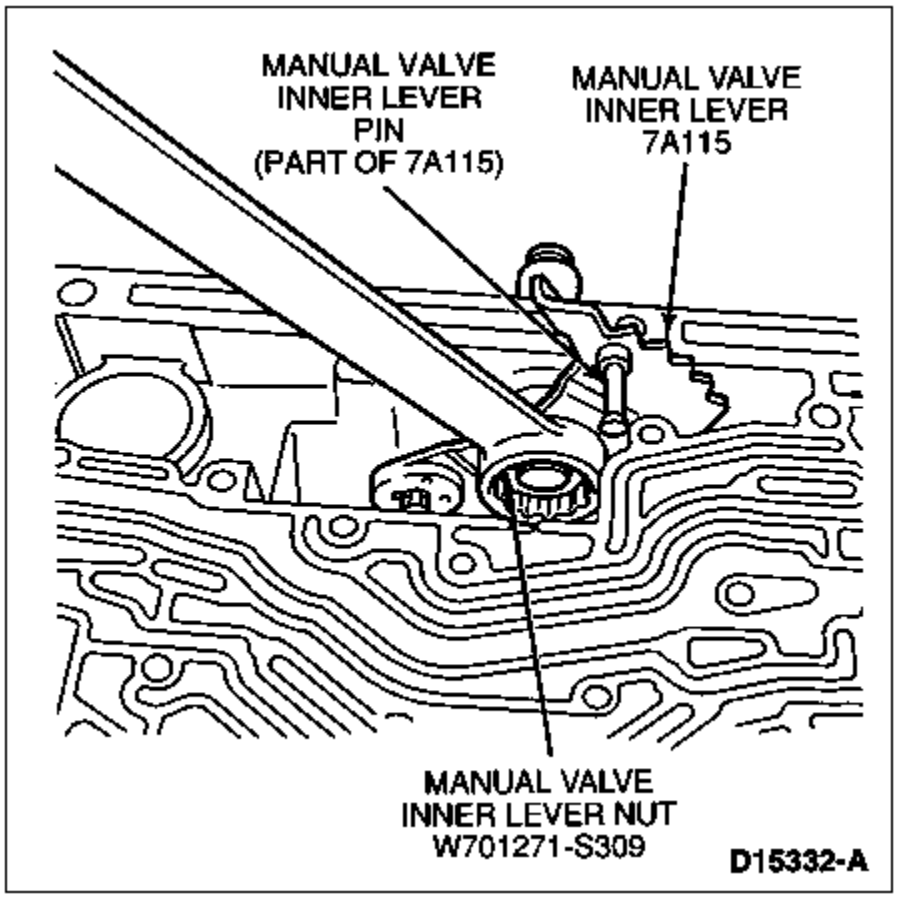

17. **CAUTION: The tabs on the No. 11 output shaft thrust washer point into the case. Ensure that the thrust washer is properly seated.**

    Apply petroleum jelly to the No. 11 output shaft thrust washer and install into the rear of the case bore.

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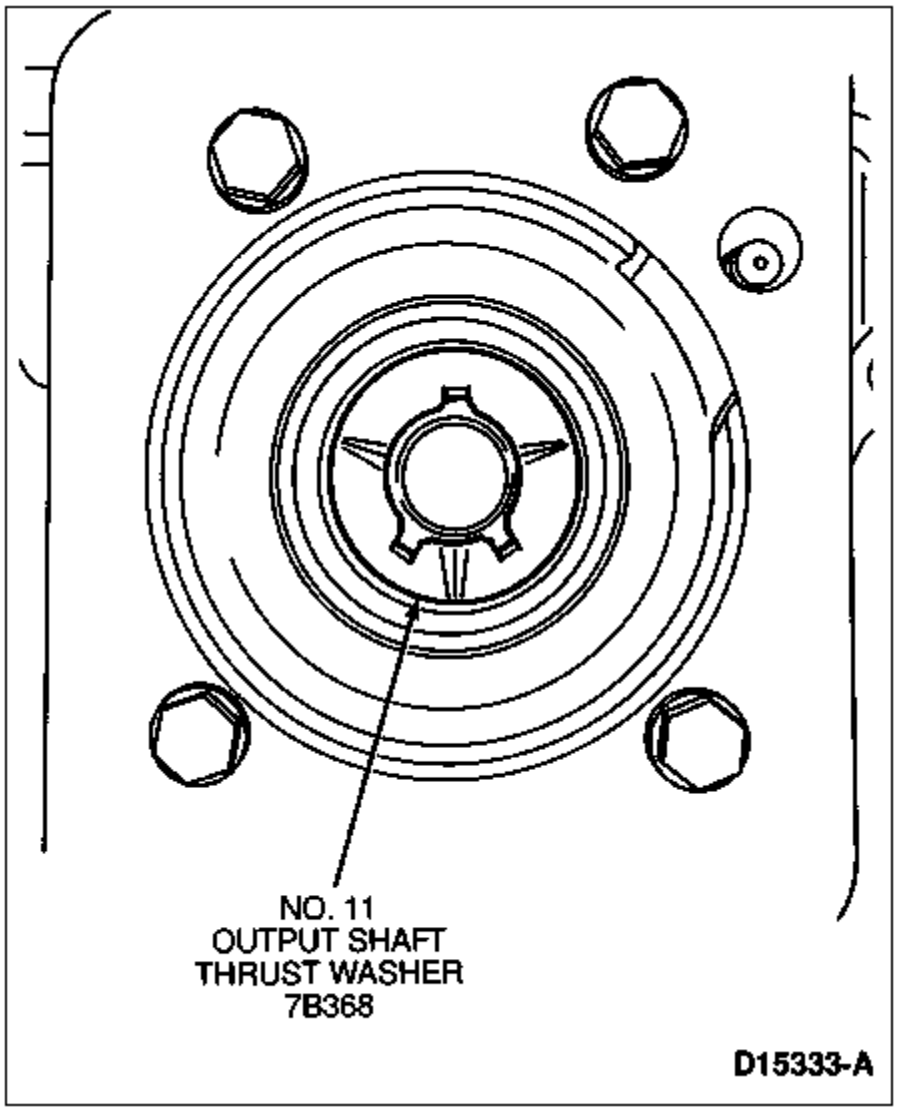

18. Install the park gear into the rear case bore.

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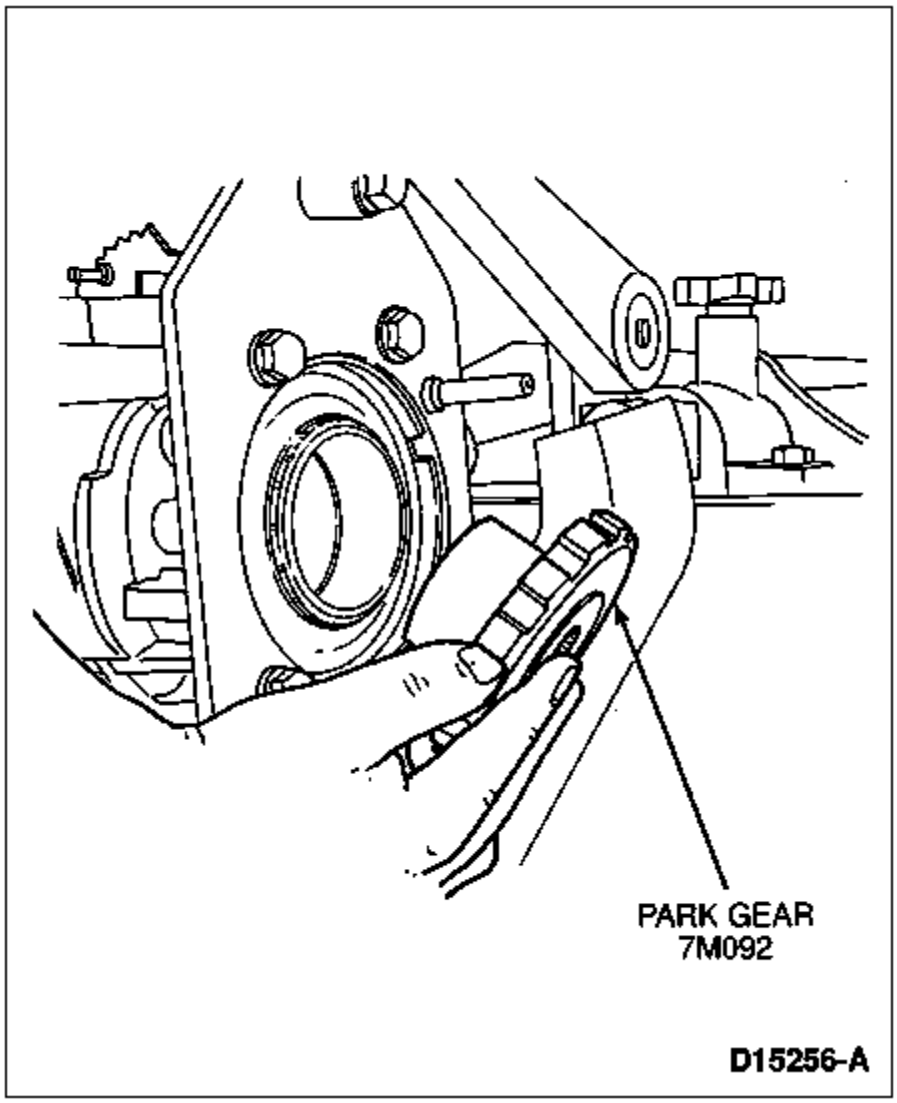

19. Rotating the reverse brake drum assembly clockwise and install into case.

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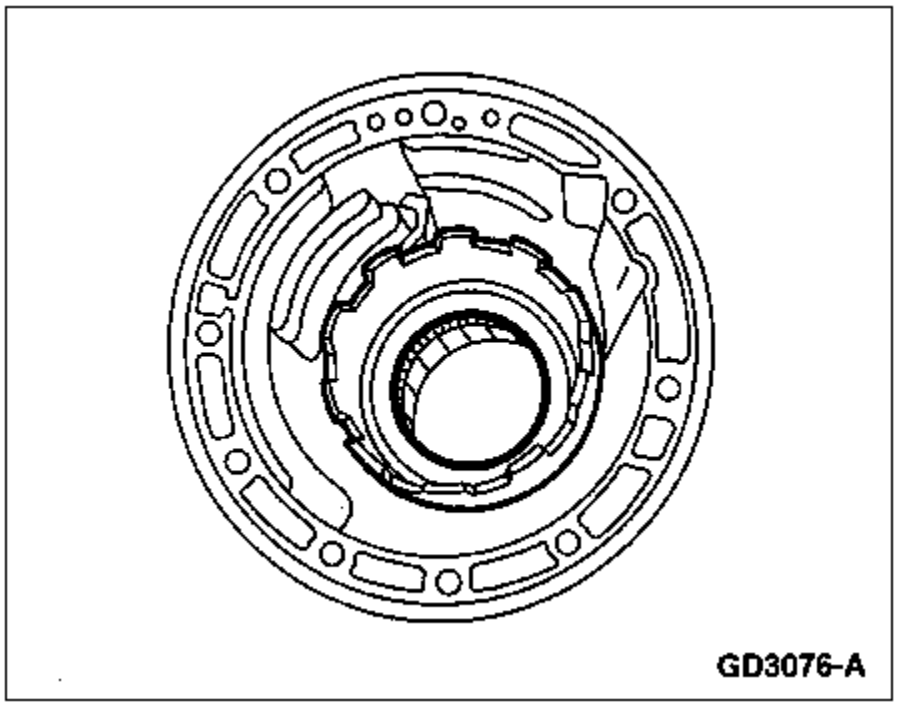
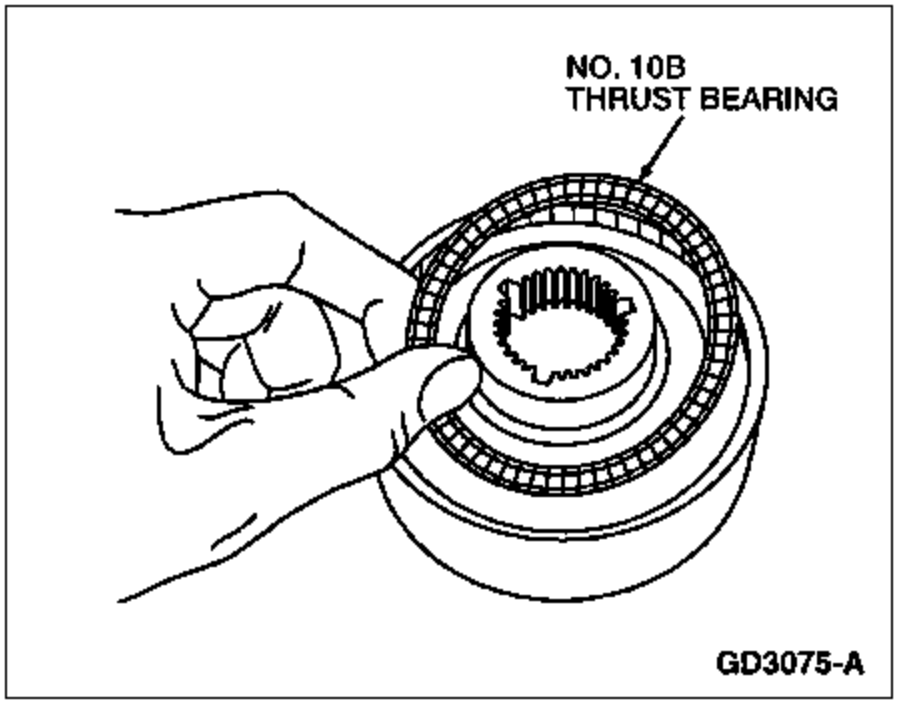


20. If not already installed, use petroleum jelly to install No. 10B thrust bearing onto output shaft hub.



21. Install the output shaft through the output shaft park gear.

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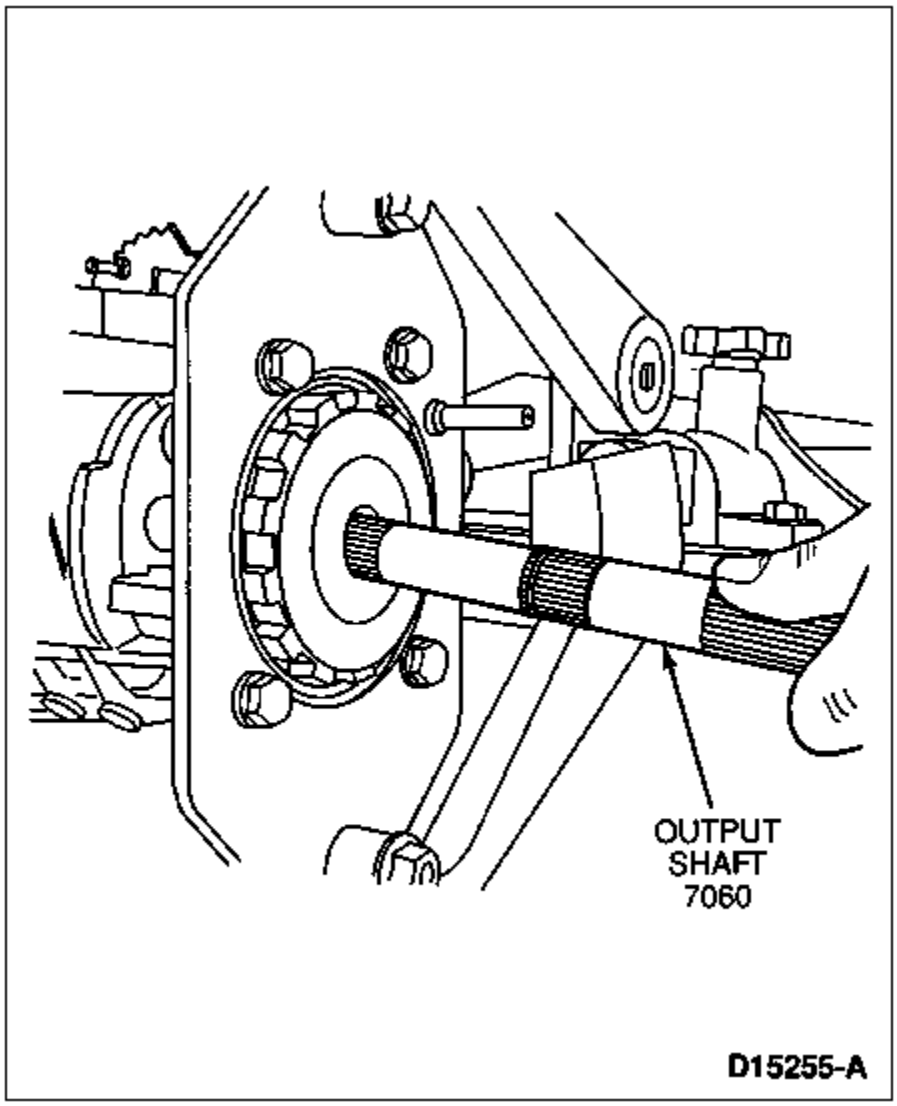

22. Install the output shaft ring gear and output shaft hub assembly.

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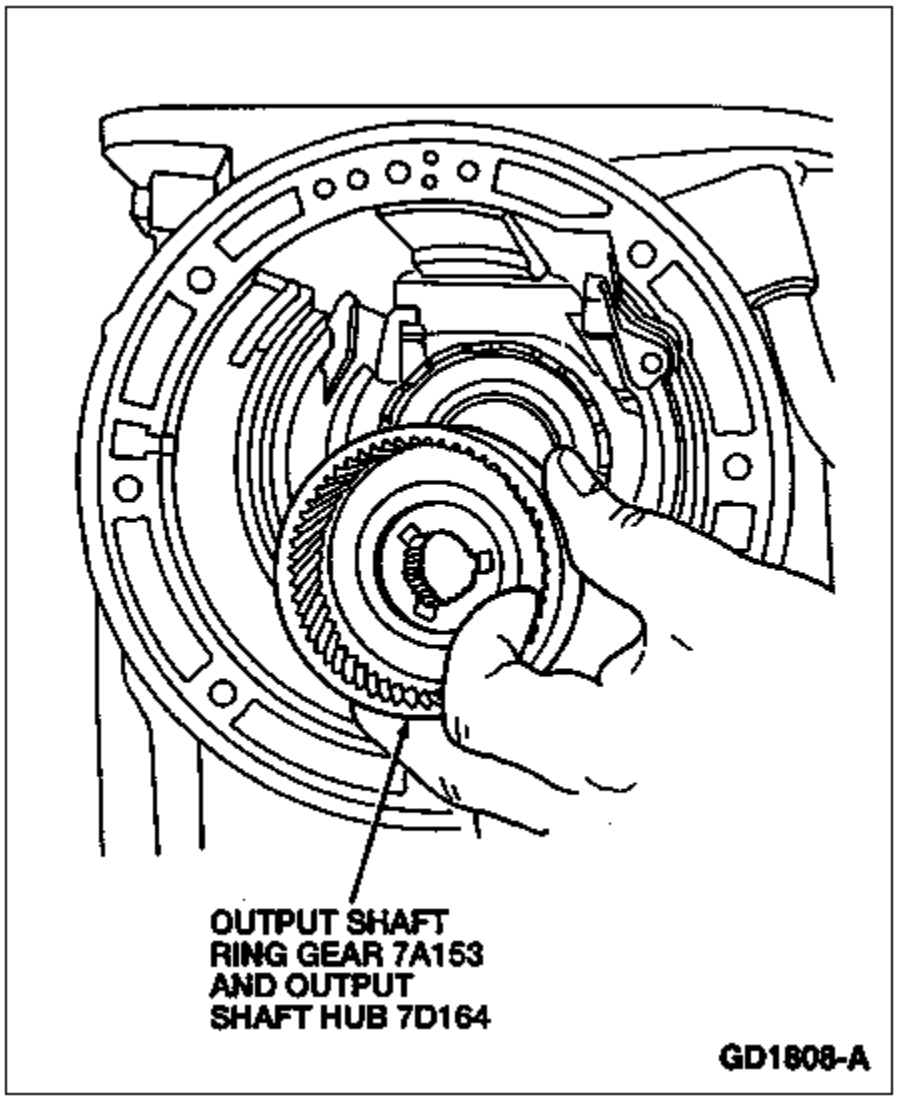

23. **CAUTION: Always use a new retaining ring.**

Install a new output shaft retaining ring in the output shaft retaining ring groove.

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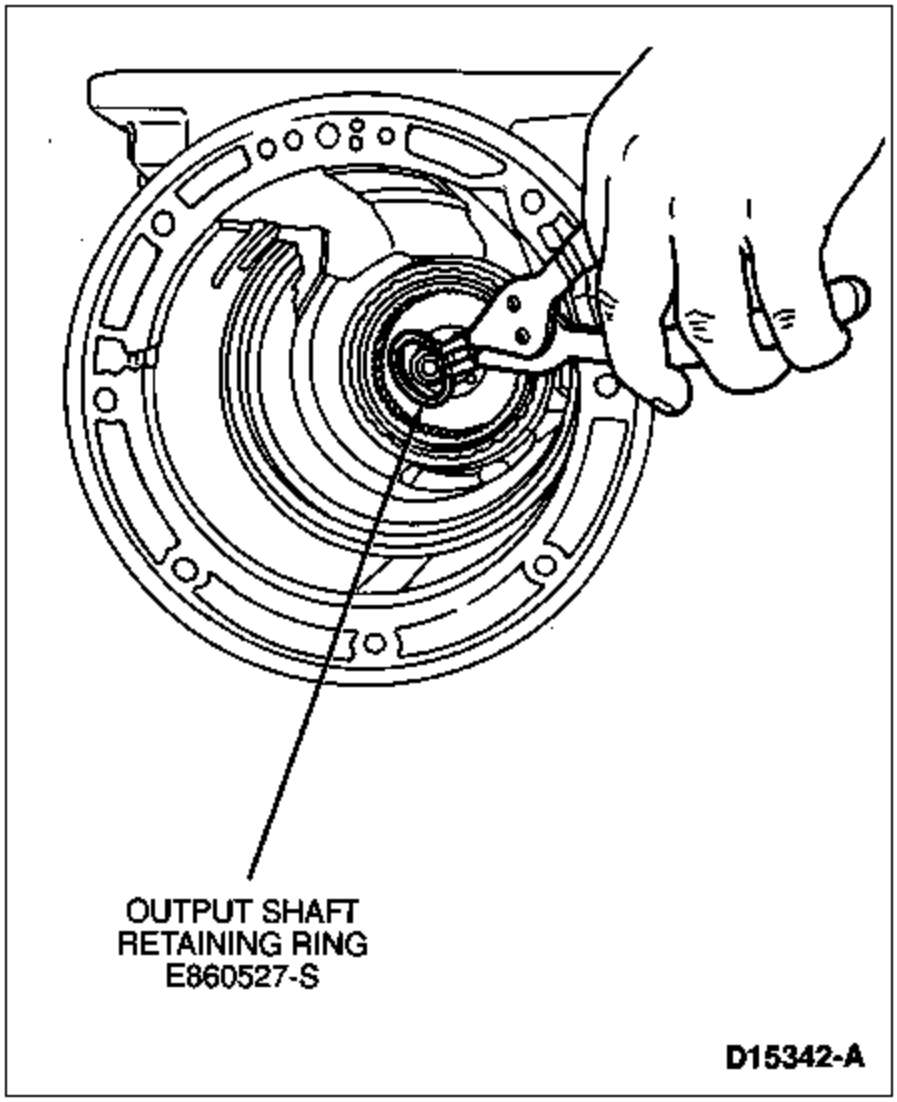

24. **NOTE: Use petroleum jelly to hold the sleeve in place.**

    Install the output shaft sleeve with cone facing up.

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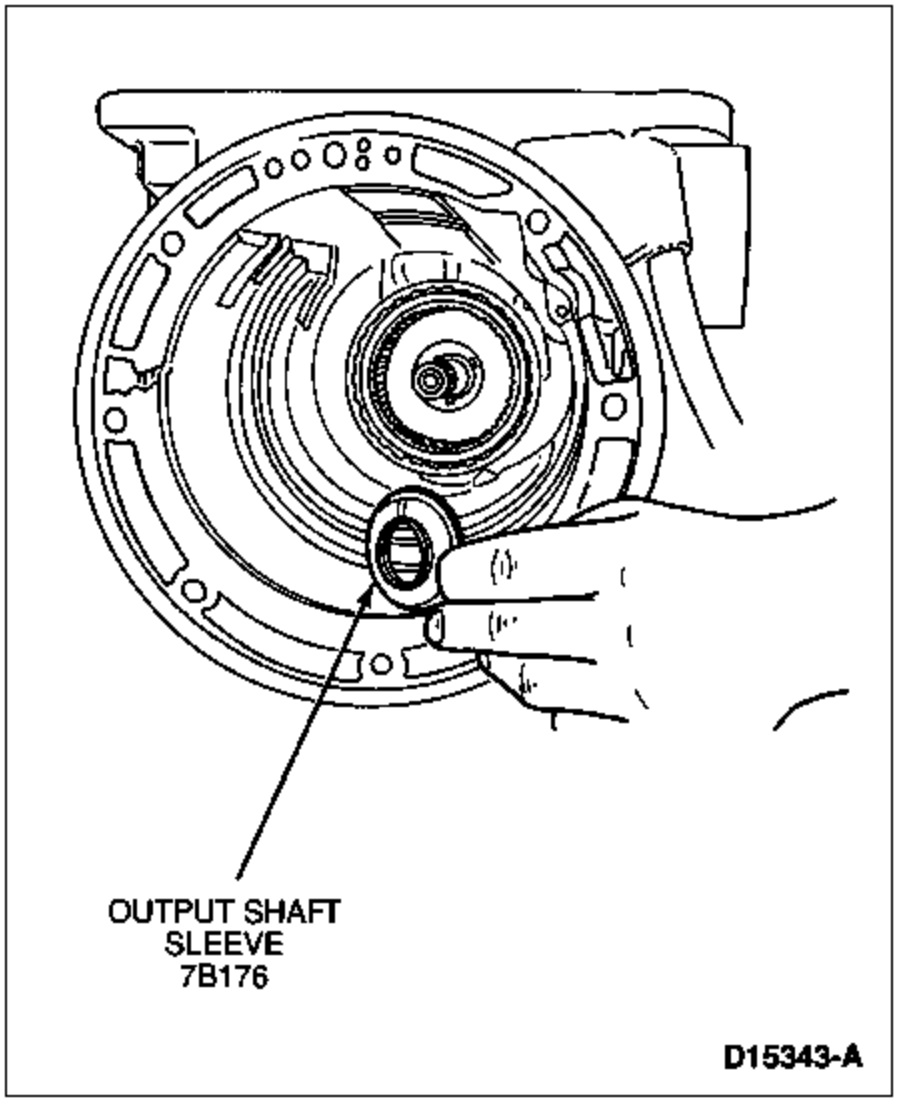

25. **NOTE: Use petroleum jelly to hold the needle bearings in place.**

Position the No. 8 reverse planetary carrier needle bearing on the front face of the reverse planetary.
Position the No. 9 reverse planetary carrier needle bearing on the rear face of the reverse planetary.

No. 8 and 9 Reverse Planetary Carrier Needle Bearing Position

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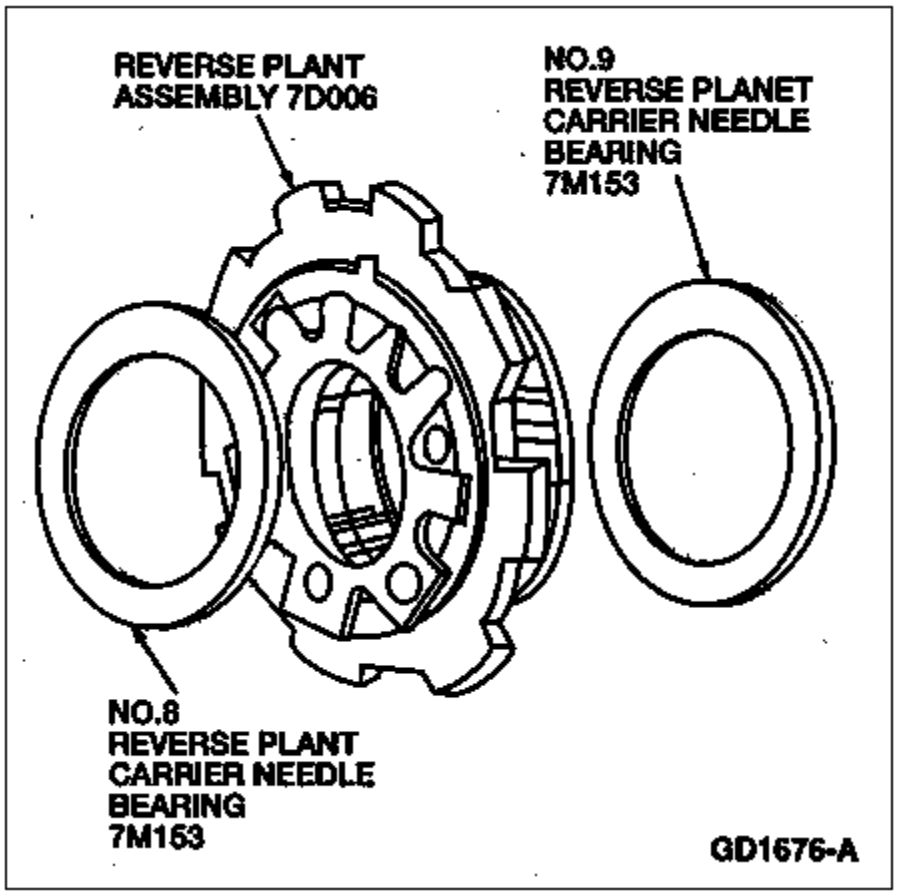

26. **CAUTION: Make sure the needle bearings stay in place.**

Install the reverse planetary assembly, with No. 8 and No. 9 reverse planetary carrier needle bearings, into the output shaft ring gear.

Reverse Planetary Assembly Installation

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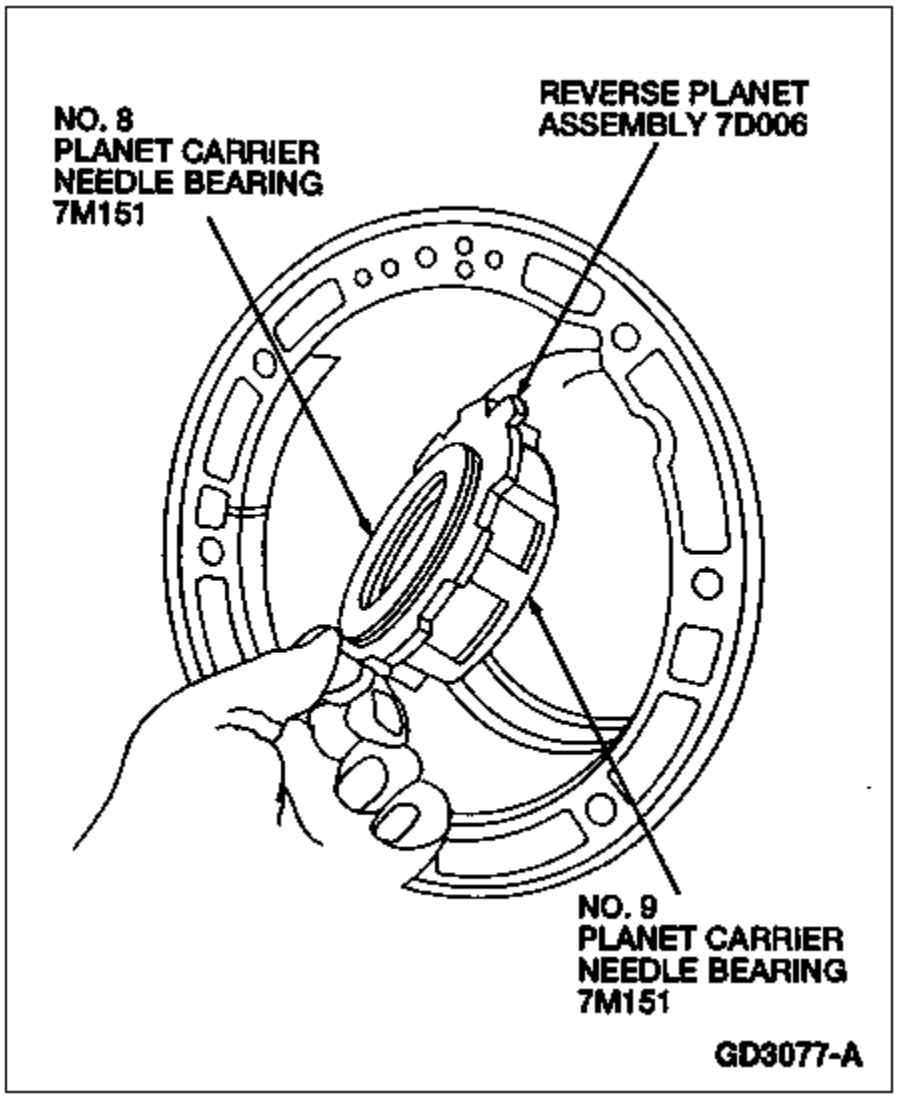

27. PULL THE REVERSE BRAKE DRUM FORWARD and install the retaining ring into reverse brake drum groove. This will hold the reverse planetary assembly in place.

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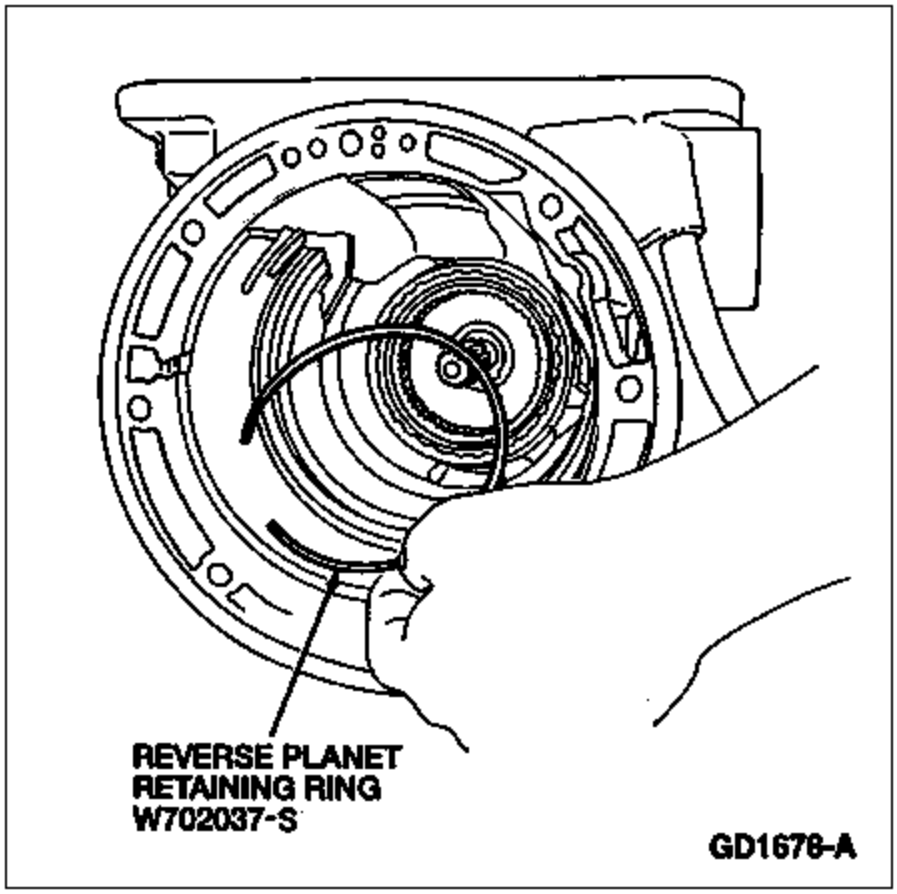

28. **CAUTION: Make sure band is resting on the two anchor pins in the case.**

Install the reverse band over the reverse brake drum.

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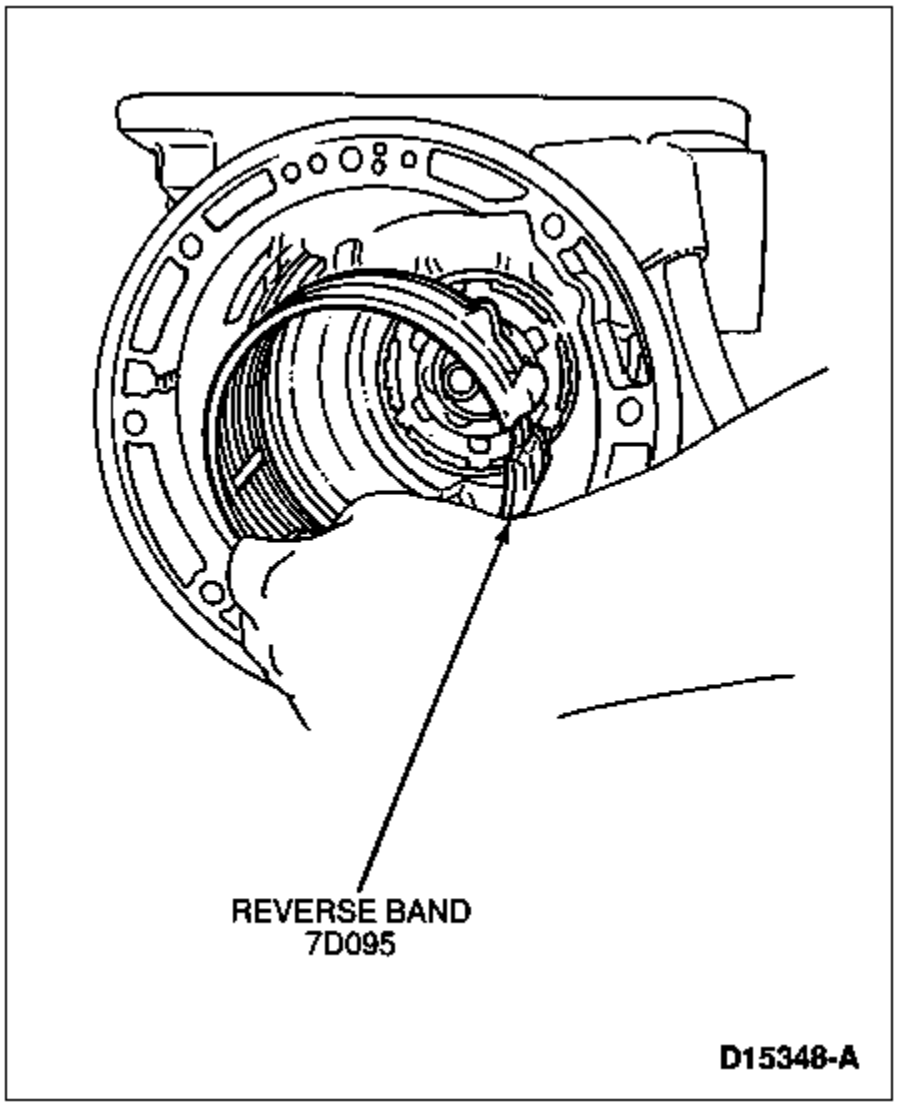

29. Install the reverse band servo piston and rod temporarily to hold the reverse clutch band in position.

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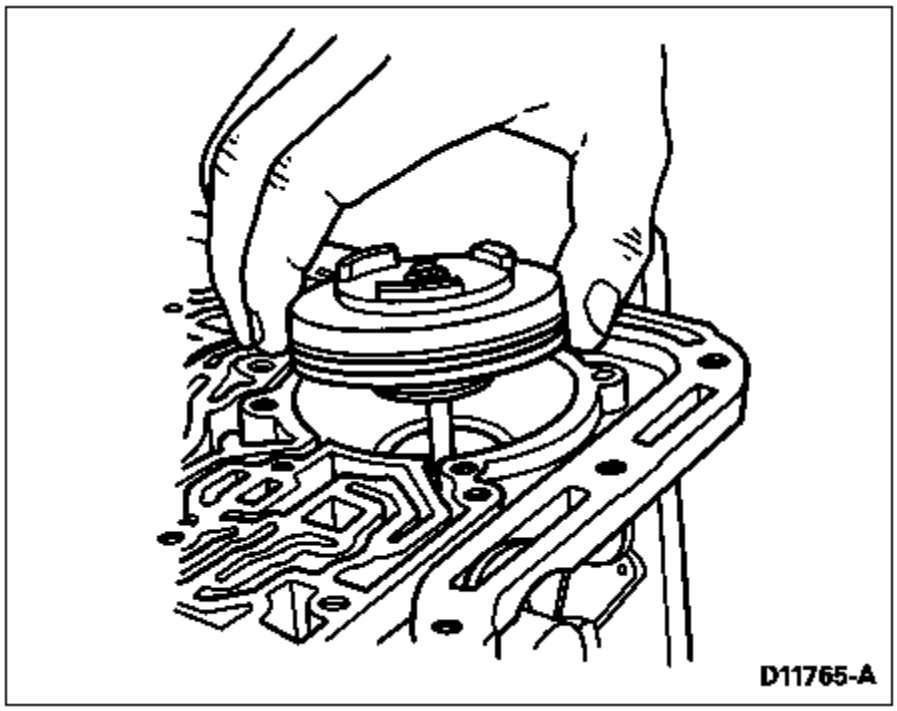
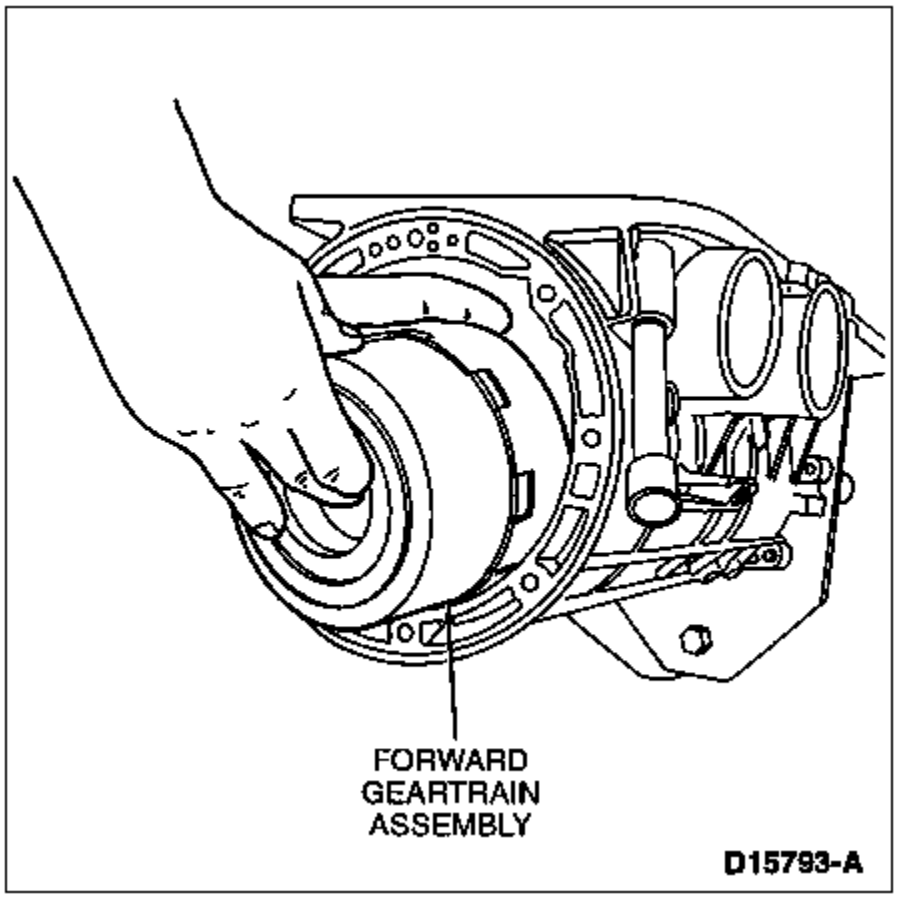


30. Install the previously assembled forward geartrain assembly.



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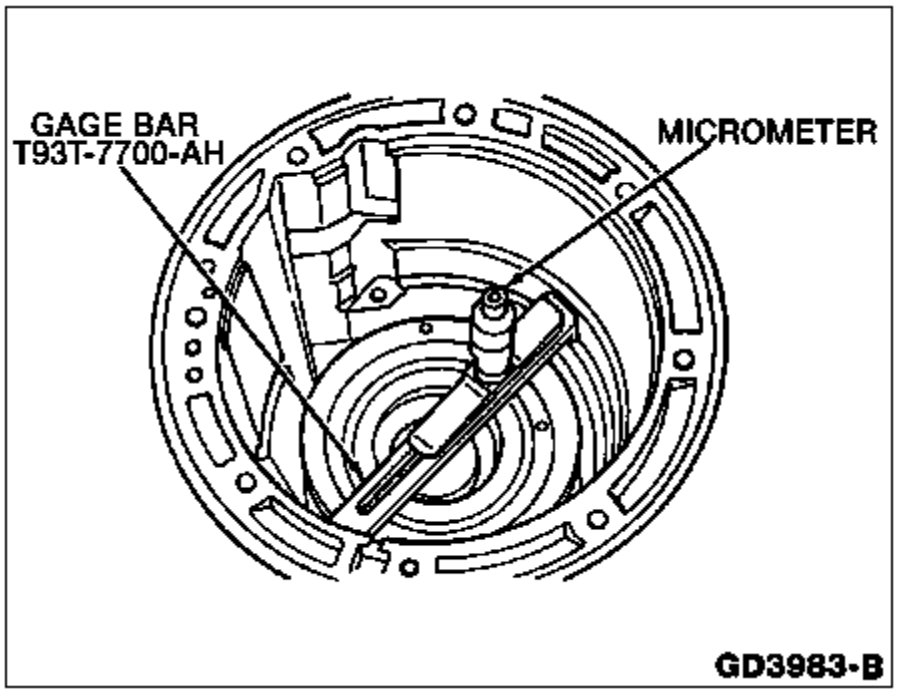
31. **WARNING: MAKE SURE THE LOCK PIN ON BENCH-MOUNTED HOLDING FIXTURE T57L-500-B IS SECURE.**

    Rotate the transmission assembly so that the converter housing gasket surface is facing up.

32. Place Gage Bar T93T-77003-AH on the case shoulder of the number four intermediate brake drum thrust surface. Set the mircometer on top of the gage bar as shown.



33. Extend the micrometer probe until it contacts the intermediate brake drum thrust bearing surface. Record the reading as dimension "A."

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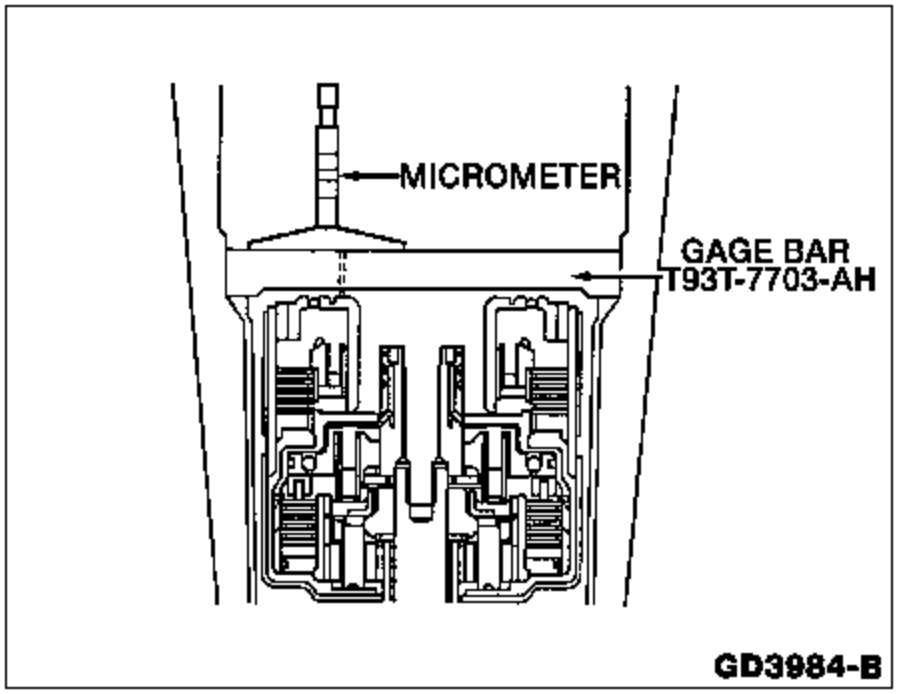
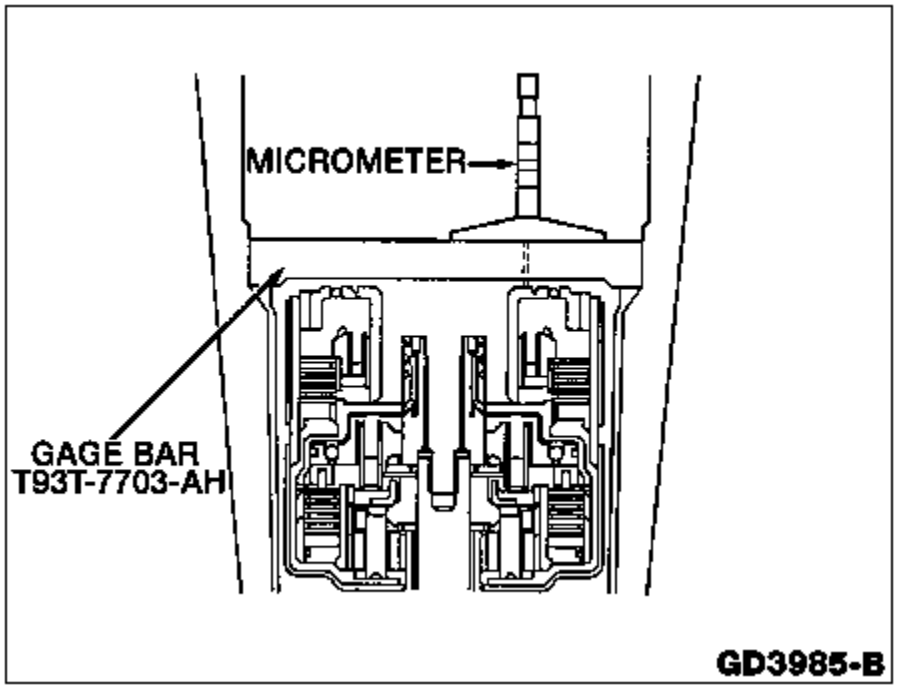


34. Place the micrometer on the opposite side and extend the mircometer probe until it contacts the intermediate brake drum thrust surface. Record the reading as dimension "B."



35. Add the dimensions "A" and "B," divide the total of "A" and "B" by two. Subtract the gage bar thickness (17.18 mm [0.700 in]). This is dimension "C."

36. Place Gage Bar T93T-77003-AH across the center support. Place micrometer on top of the gage bar as shown. Extend the micrometer probe until it contacts the center support thrust bearing surface.

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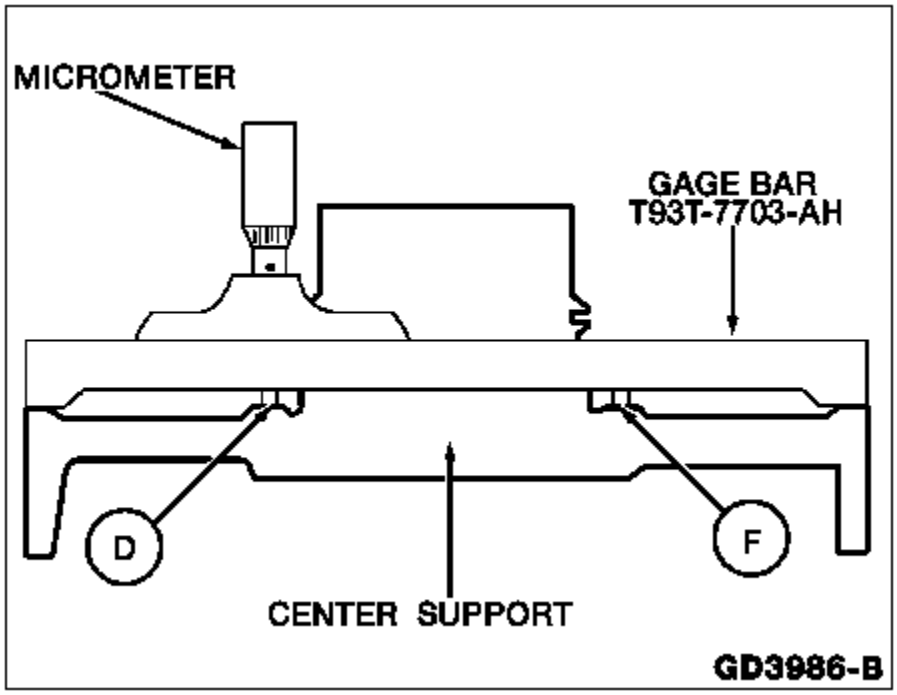
Record the reading as dimension "D."



37. Place the micrometer on the opposite side of Gage Bar T93T-77003-AH and extend the micrometer until it contacts the center support thrust bearing surface. Record the dimension as "F."

38. Add dimensions "D" and "F" and divide the total of "D" and "F" by two, then subtract the Gage Bar thickness (17.18 mm [0.700 in]). The resulting dimension is "G."

39. Add dimensions "G" and "C." This total is dimension "J." Use the chart below and dimension "J" to choose the proper number four thrust bearing. Reference end play is 0.21-0.51 mm (0.008-0.020 in).

Dimension "J"	Service Part Number	Bearing Thickness	Identification Notches
3.01-3.15 mm (0.119-0.124 in)	F77Z-7D014-GA	2.65-2.80 mm (0.104-0.110 in)	None
3.17-3.34 mm (0.125-0.132 in)	F77Z-7D014-HA	2.80-2.95 mm (0.110-0.116 in)	One
3.36-3.54 mm (0.133-0.140 in)	F77Z-7D014-KA	3.00-3.15 mm (0.118-0.124 in)	Two
3.57-3.71 mm (0.141-0.147 in)	F77Z-7D014-LA	3.20-3.35 mm (0.126-0.132 in)	Three

40. Install the intermediate servo actuating lever as shown.

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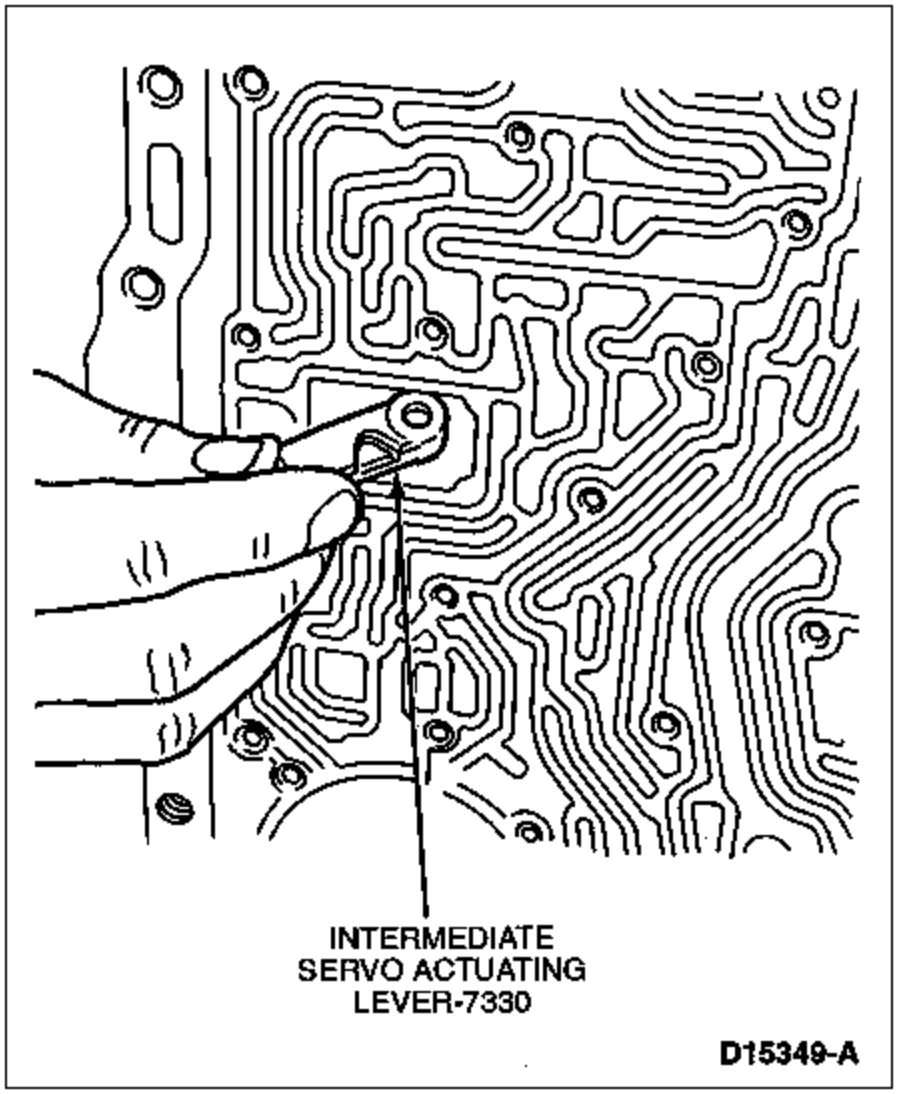

41. **NOTE: The intermediate band actuating lever shaft is shorter than the overdrive shaft.**

    Install the intermediate band actuating lever shaft through the intermediate servo lever.

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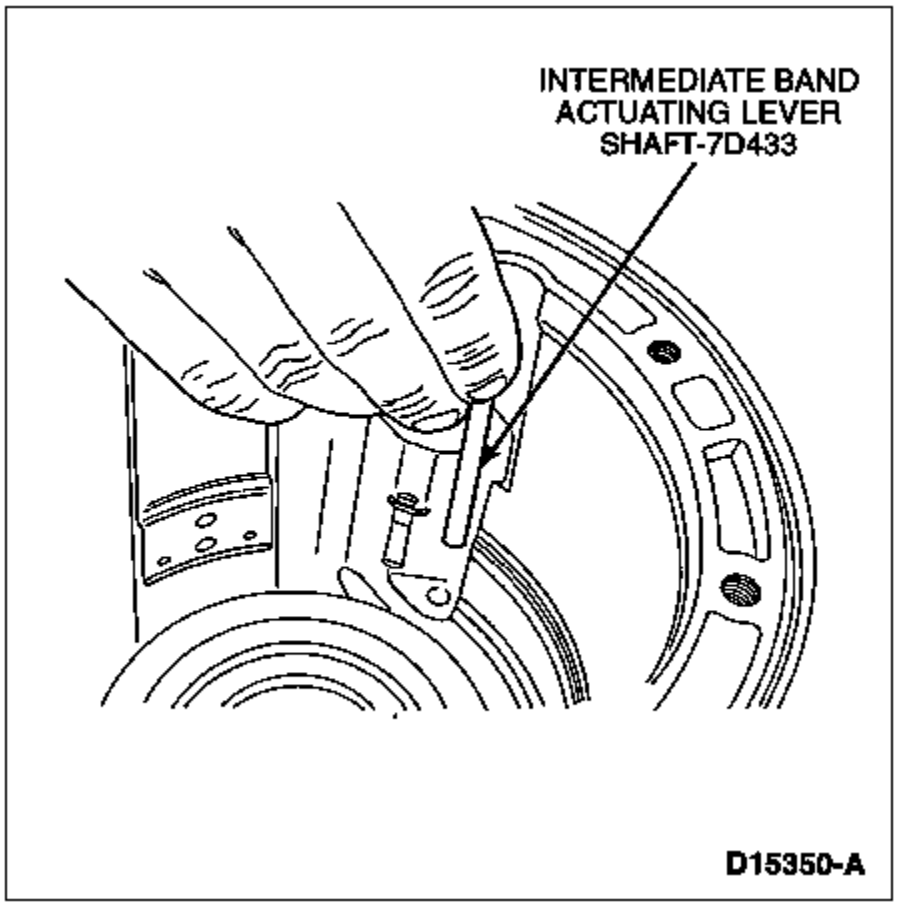

42. Install the intermediate band apply strut on the intermediate servo lever.

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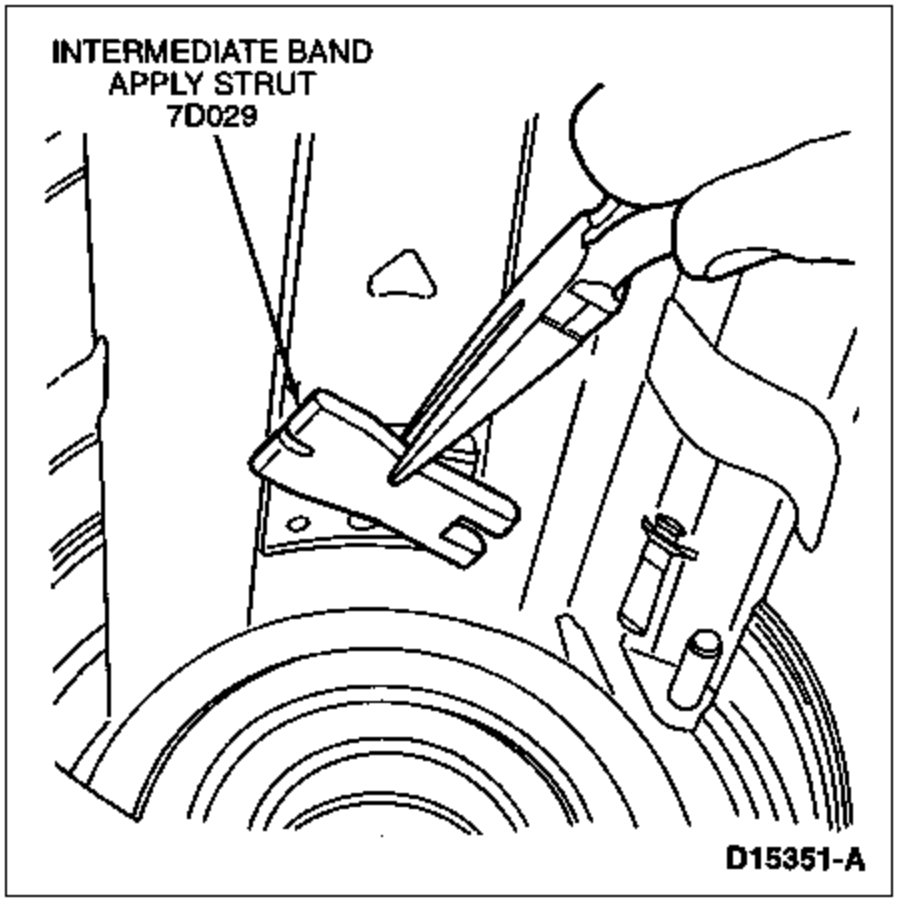

43. **NOTE: Make sure the apply strut is aligned with the band notch.**

    Install the intermediate band.

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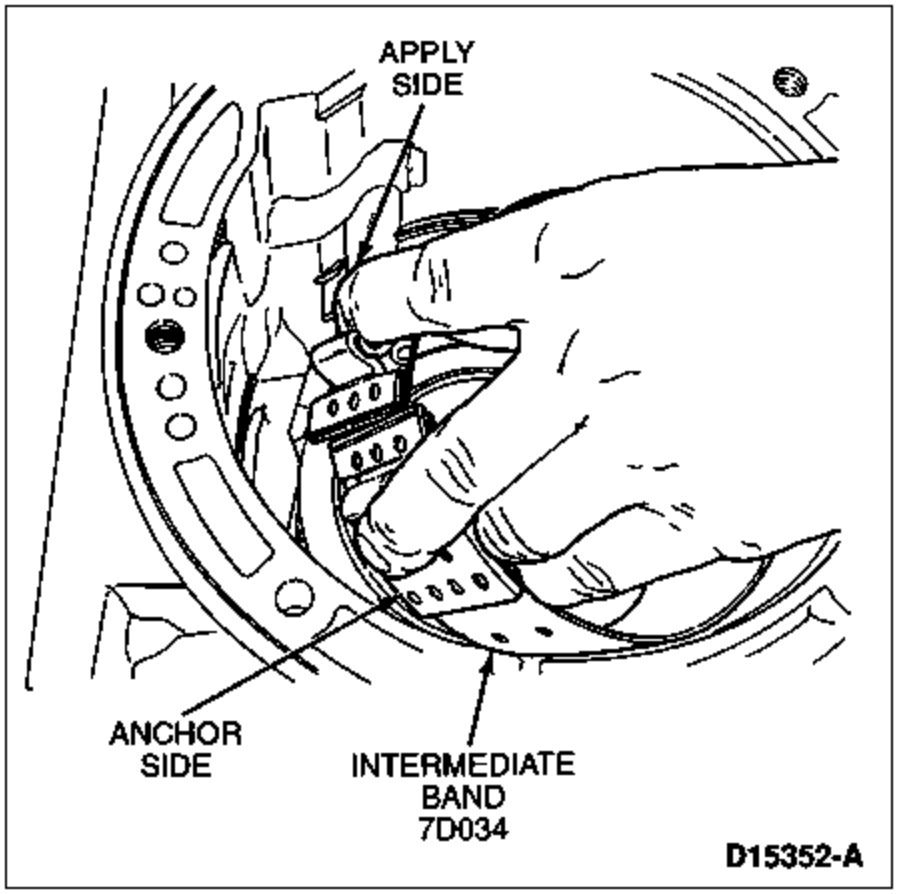

44. **NOTE: Use the intermediate band adjusting screw as a temporary alignment guide.**

    NOTE: The overdrive and intermediate band anchor struts are the same.

    Install the intermediate band anchor strut and intermediate band adjusting screw.

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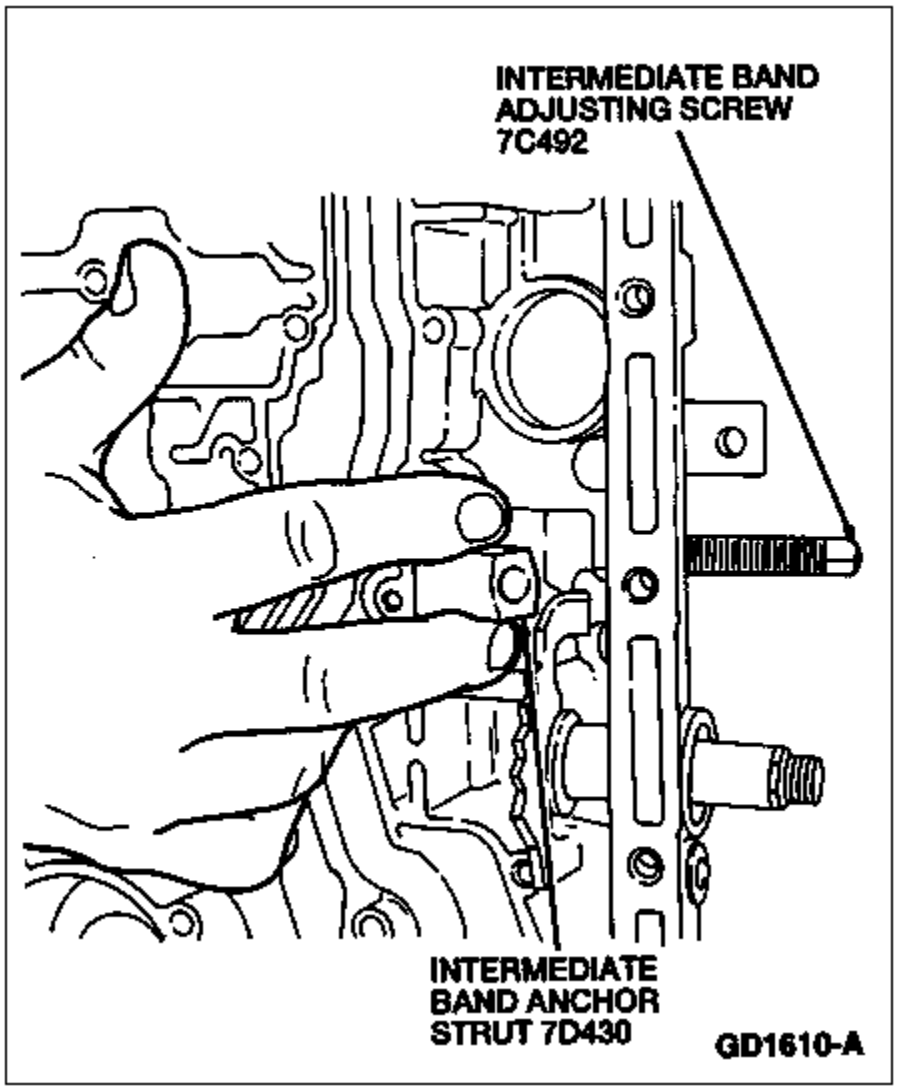

45. **NOTE: Use petroleum jelly to hold the No. 4 intermediate brake drum thrust bearing in place.**

Install the correctly selected No. 4 intermediate brake drum thrust bearing over the center support as shown.

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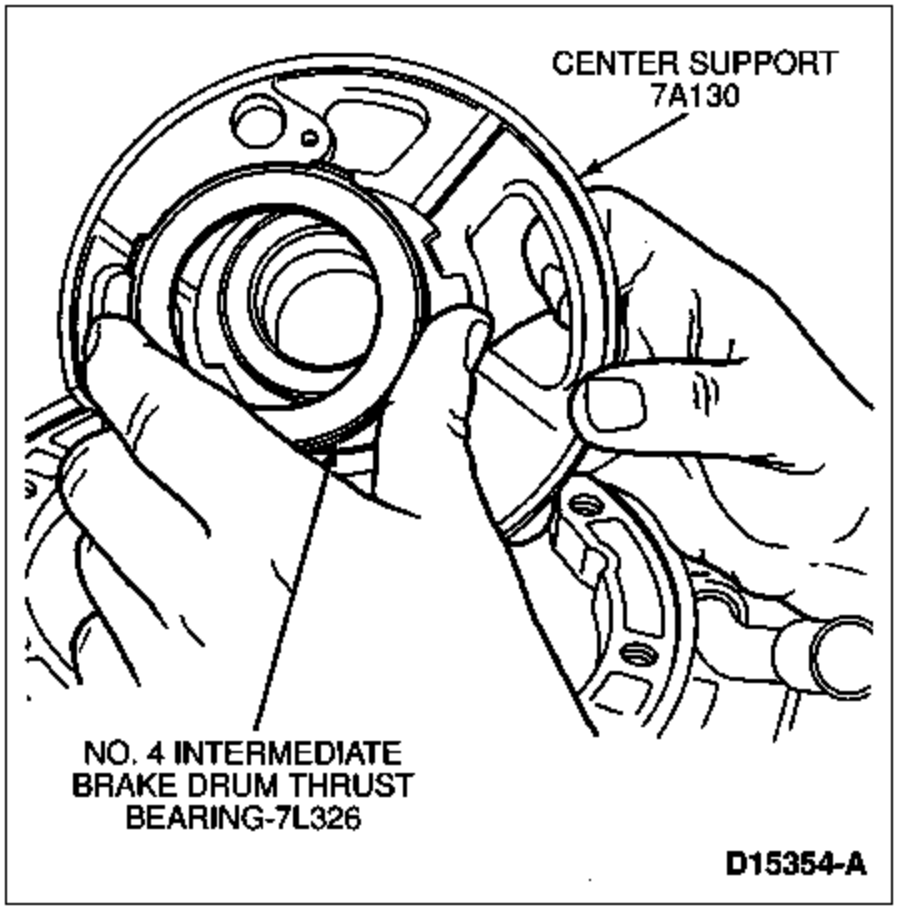

46. **CAUTION: Do not apply pressure to the rear planetary support while installing. Damage to the sealing rings may result. Make sure the rear planetary support is seated.**

Position the center support into the reverse clutch drum. Use the input shaft as an aid to seat the center support. Gently wiggle the input shaft from side to side until the center support is seated against the case shoulder. Remove the input shaft.

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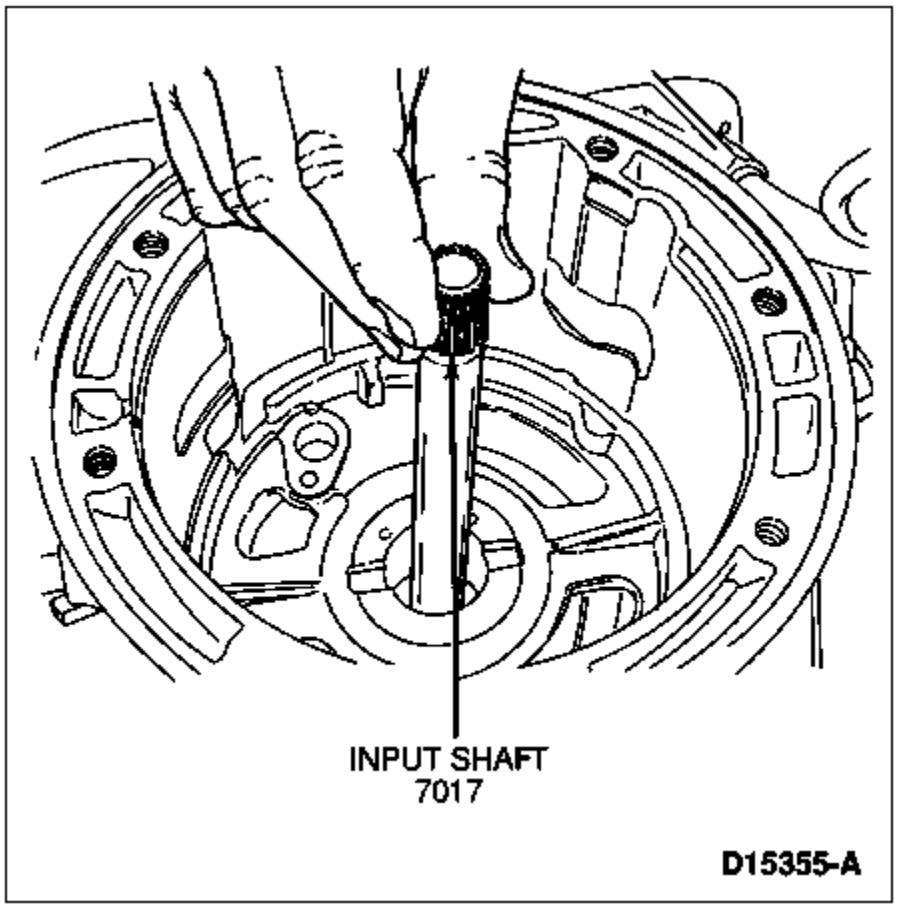

47. **CAUTION: Install the retaining ring in the transmission case groove with the tapered side facing up.**

CAUTION: The retaining ring must be installed so the notch opening is not obstructed by the center support retaining ring. This will prevent damage to the turbine shaft speed (TSS) sensor wires.

Install the center support retaining ring in the transmission case groove.

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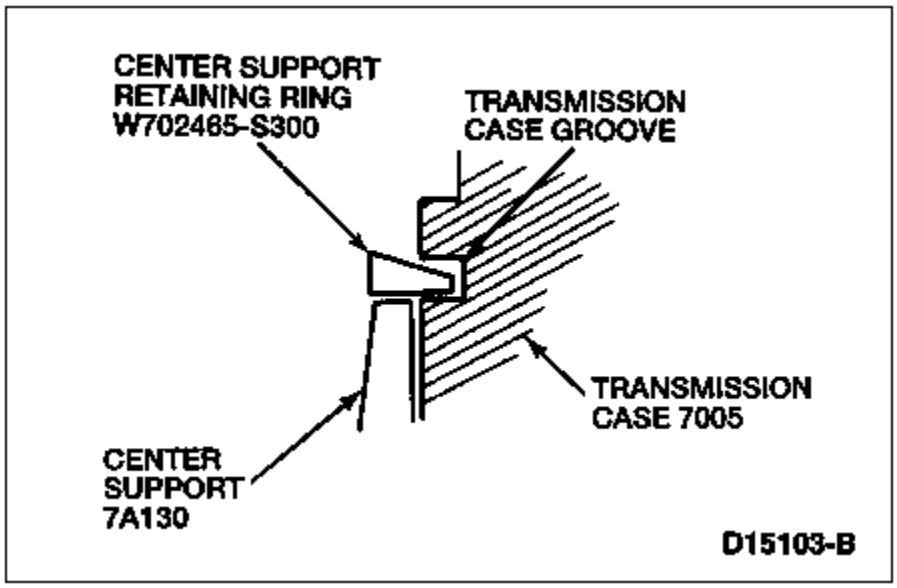

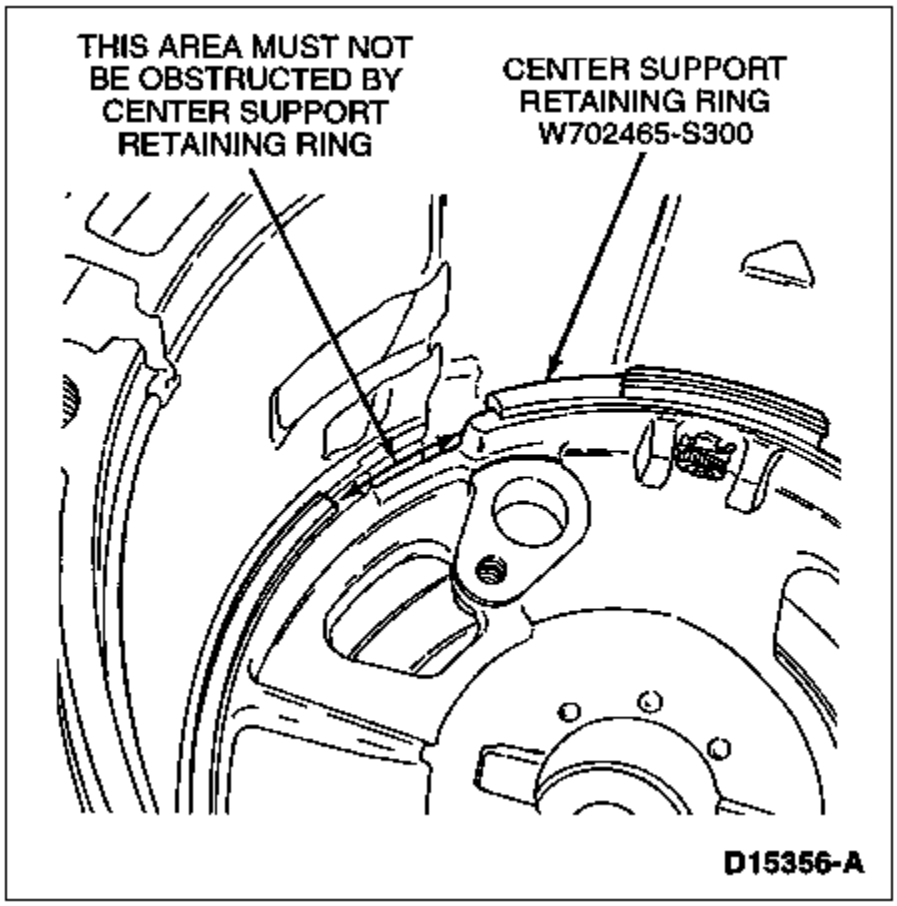

48. Ensure that the nut and cage assembly is in place.

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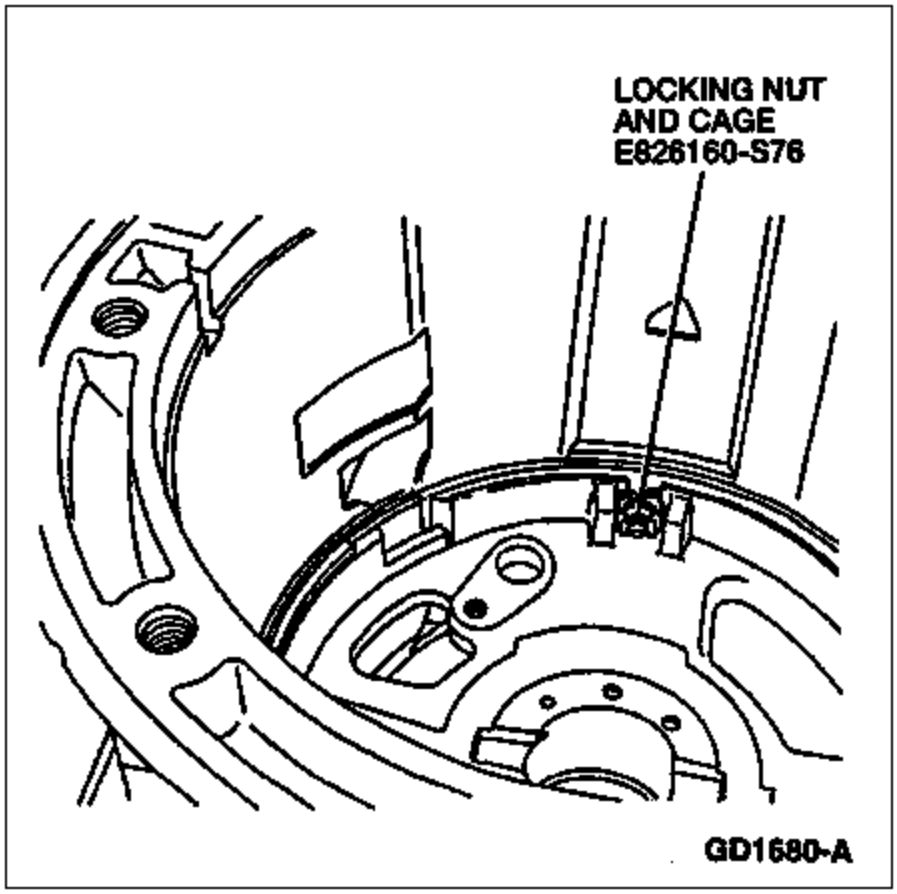

49. Use a 5 mm Allen wrench to install the M6 x 20 mm center support-to-case capscrew into the nut and cage assembly as shown. Tighten the center support-to-case capscrew to 9-13 Nm (80-115 lb-in).

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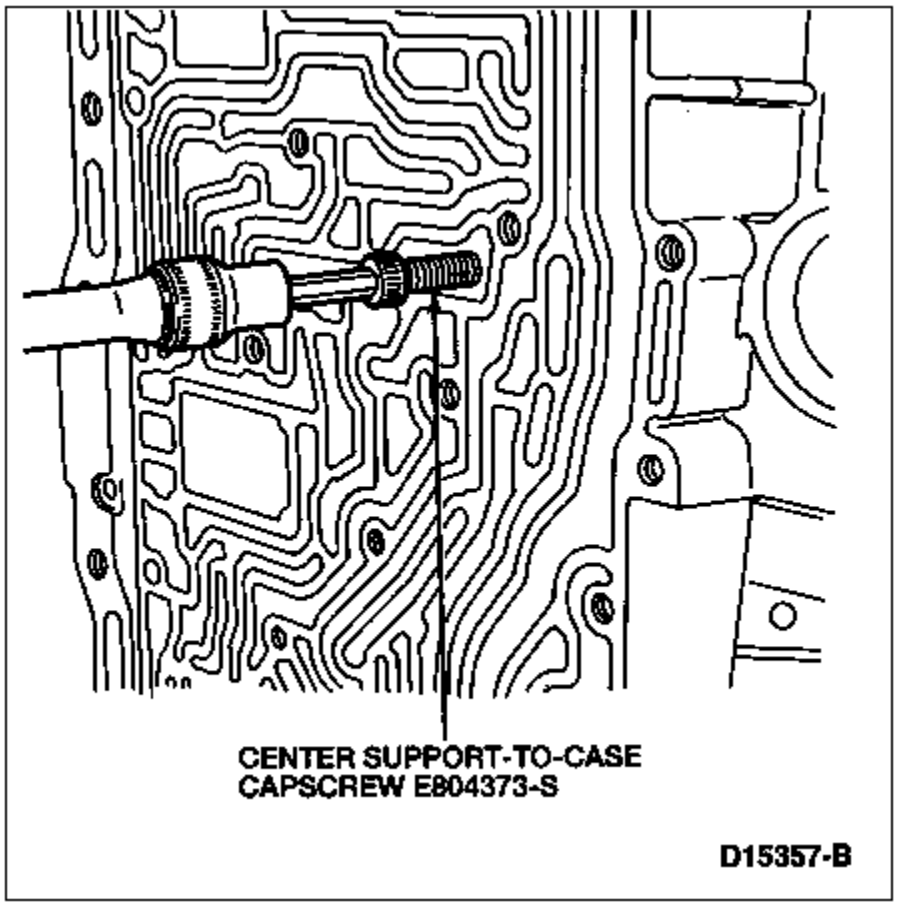

50. **CAUTION: Carefully route the turbine shaft speed (TSS) sensor connector and wiring harness through the opening in the case. Do not damage the wiring.**

Route the TSS sensor connector and wiring harness through the opening in the case.

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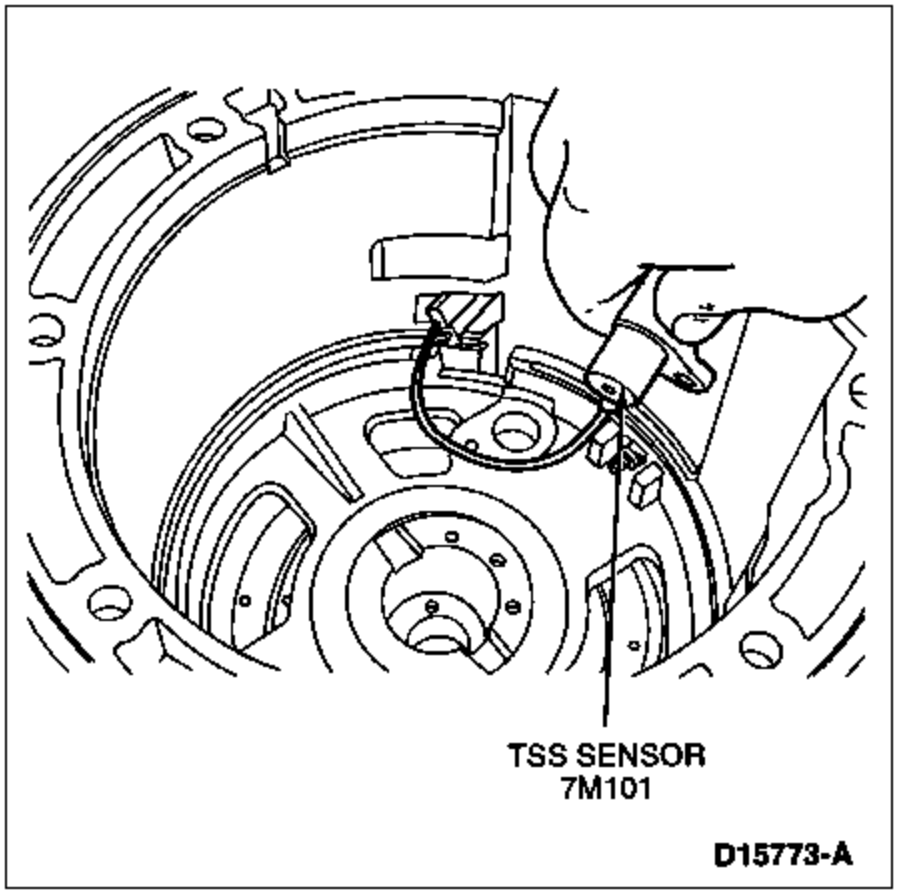

51. Install the turbine shaft speed (TSS) sensor on the center support. Use a T30 Torx® Socket to install the TSS screw. Tighten the TSS sensor-to-center support screw to 8-11 Nm (71-97 lb-in).

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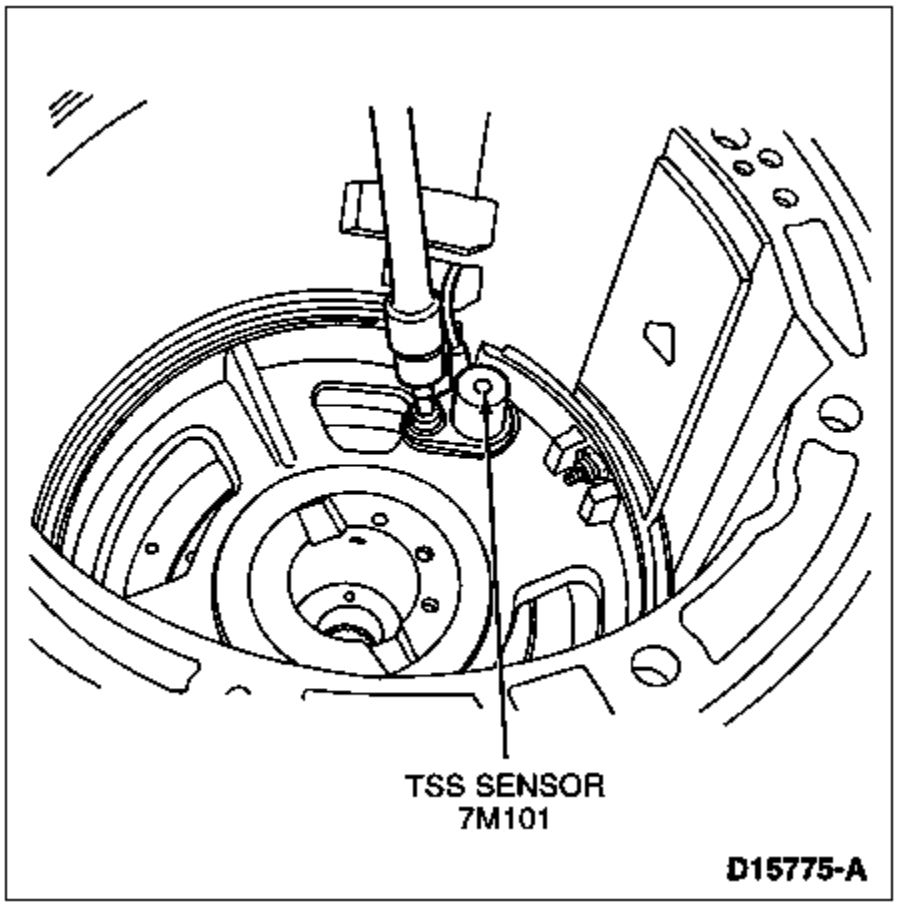

52. **CAUTION: Use only the No. 3 center shaft thrust bearing assembly.**

NOTE: No. 3 center shaft thrust bearing assembly has no notches on the outer race.

Install the No. 3 center shaft thrust bearing assembly.

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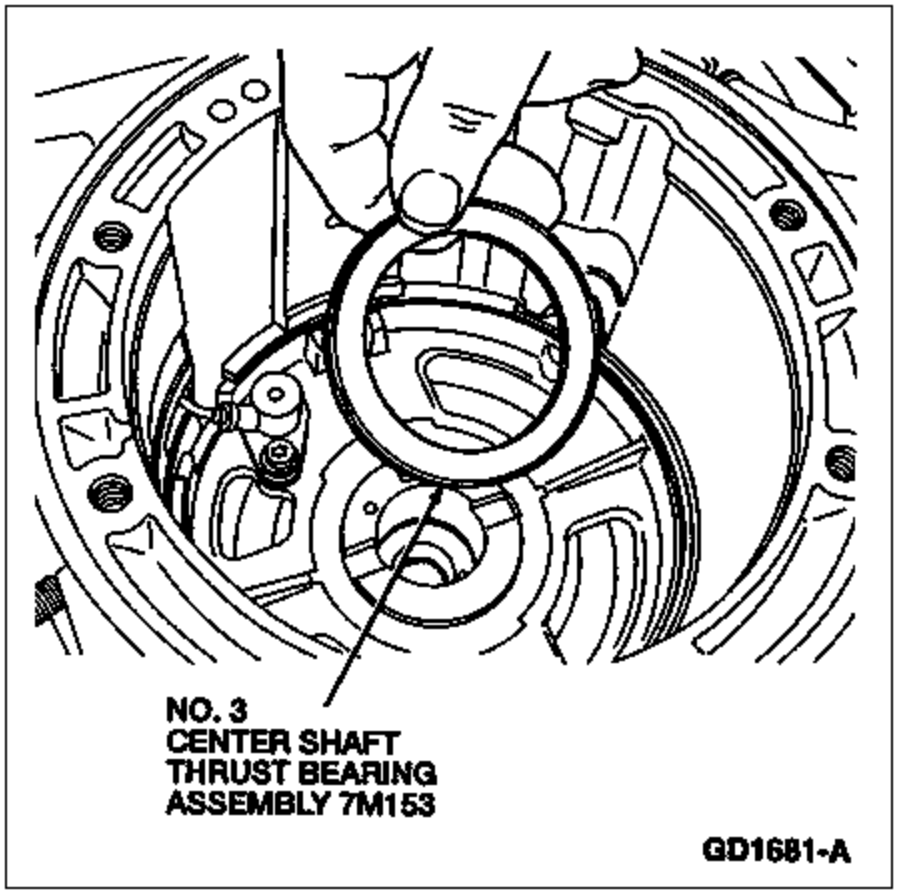

53. **CAUTION: Do not bend the trigger wheel.**

Install the planetary gear overdrive carrier, overdrive ring gear, overdrive one-way clutch and overdrive center shaft assembly.

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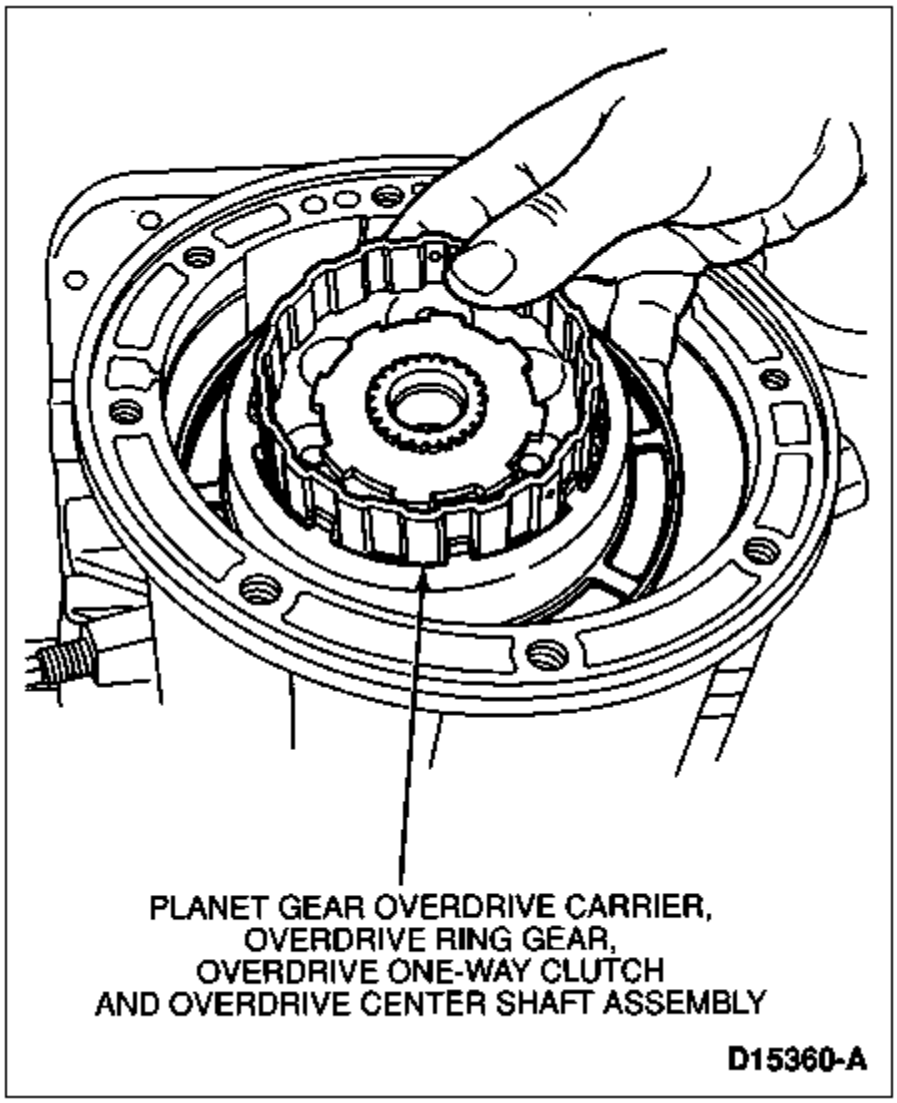

54. **NOTE: Perform TSS air gap clearance check.** This step and the next two steps describe the procedures for checking the turbine shaft speed (TSS) sensor air gap clearance.

    Place the thin blade of Turbine Shaft Speed Sensor Gauge T95L-70010-F over the turbine shaft speed (TSS) sensor as shown. Rotate the trigger wheel. The trigger wheel window should pass over the thin blade of the TSS gauge. If it doesn't, the planetary gear overdrive carrier and trigger wheel must be replaced.

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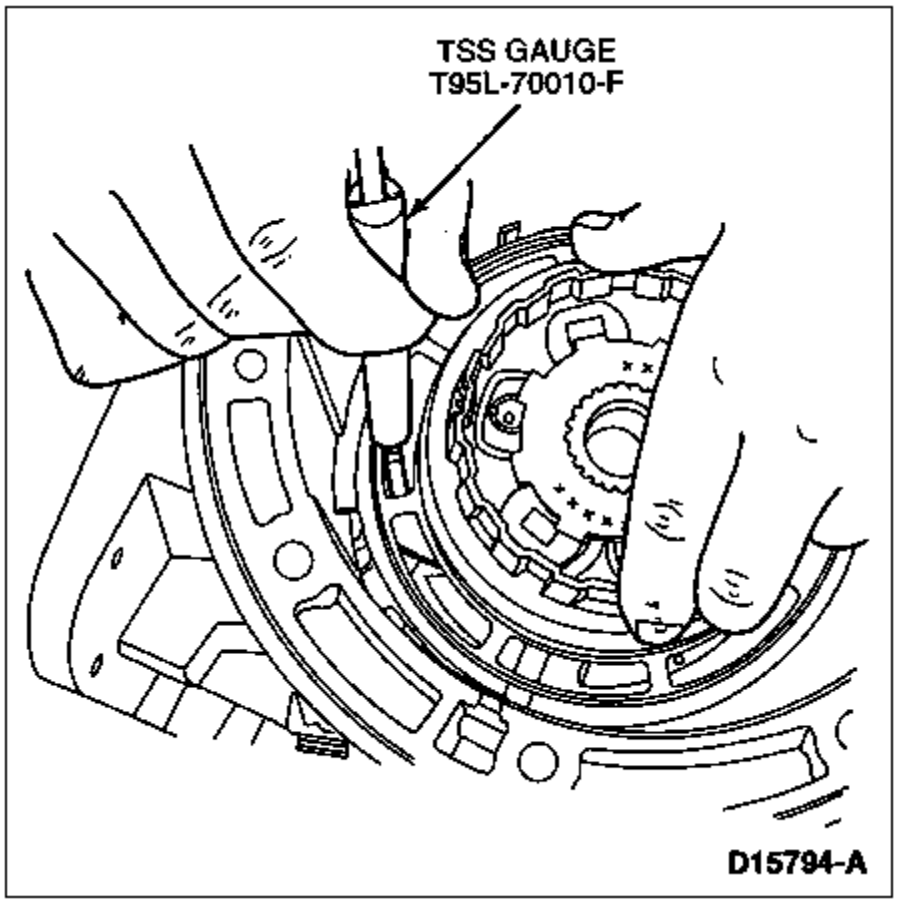

55. Place the thick blade of Turbine Shaft Speed Sensor Gauge over the turbine shaft speed (TSS) sensor as shown. Rotate the trigger wheel. The trigger wheel window should not pass over the thick blade of the TSS gauge. If it does, the planetary gear overdrive carrier and trigger wheel must be replaced.

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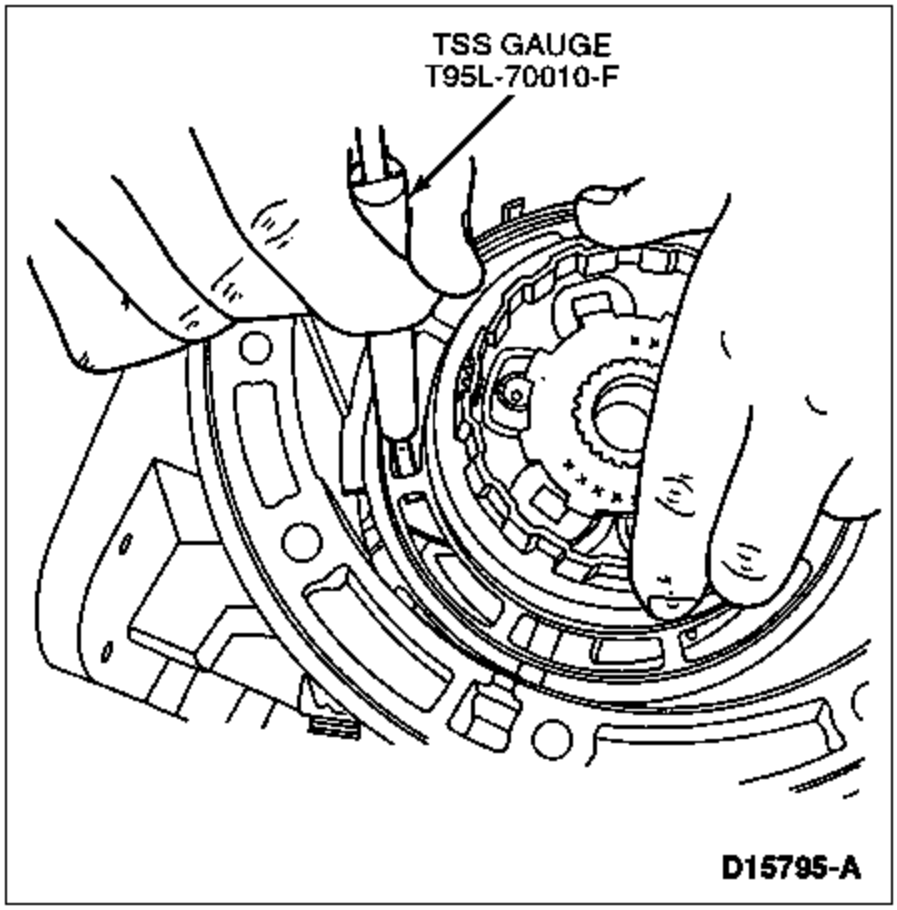

56. Repeat the previous two steps for the remaining trigger wheel windows.

57. Align the clutch plates and front adapter gear and install the overdrive brake and coast clutch drum assembly.

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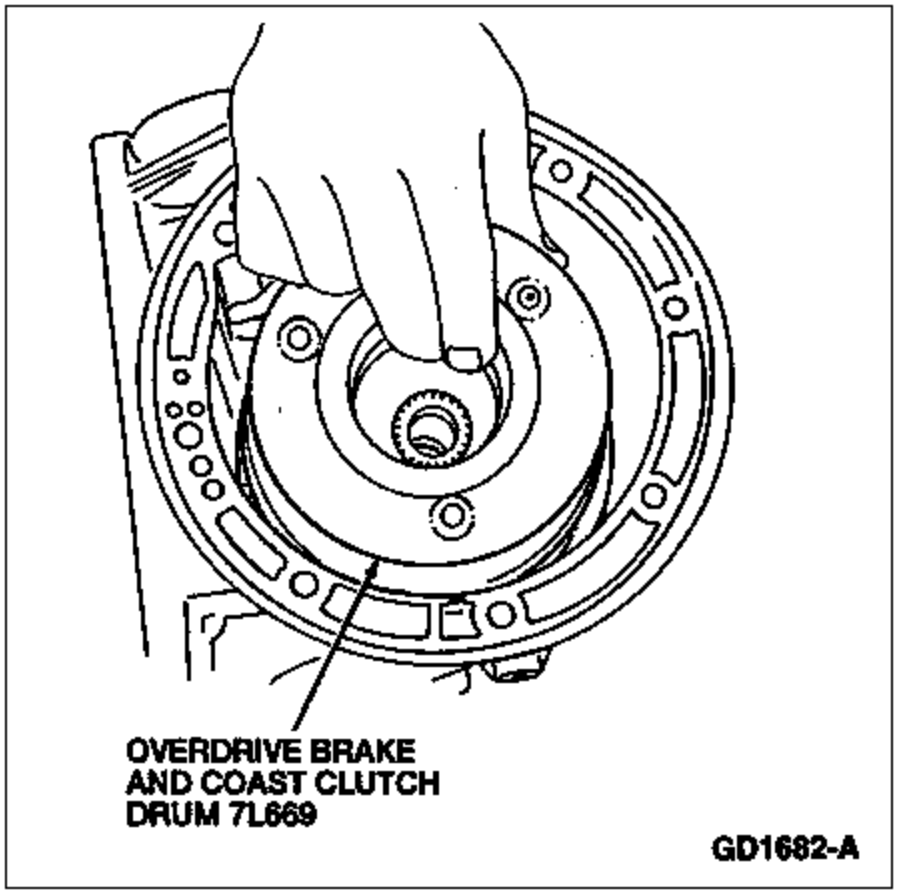

58. Install the overdrive band lever-to-case bracket and overdrive band servo lever as shown.

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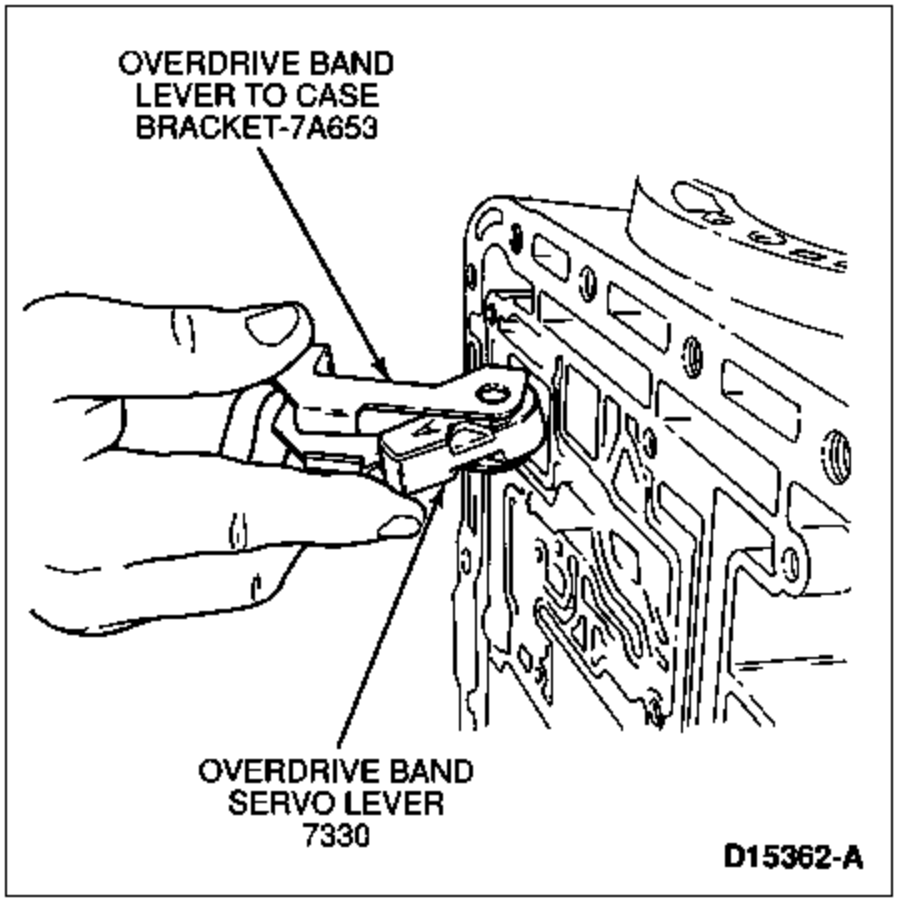

59. **NOTE: The overdrive band actuating lever shaft is longer than the intermediate band actuating lever shaft.**

    Install the overdrive band actuating lever shaft through the overdrive band lever to case bracket and overdrive band servo actuating lever.

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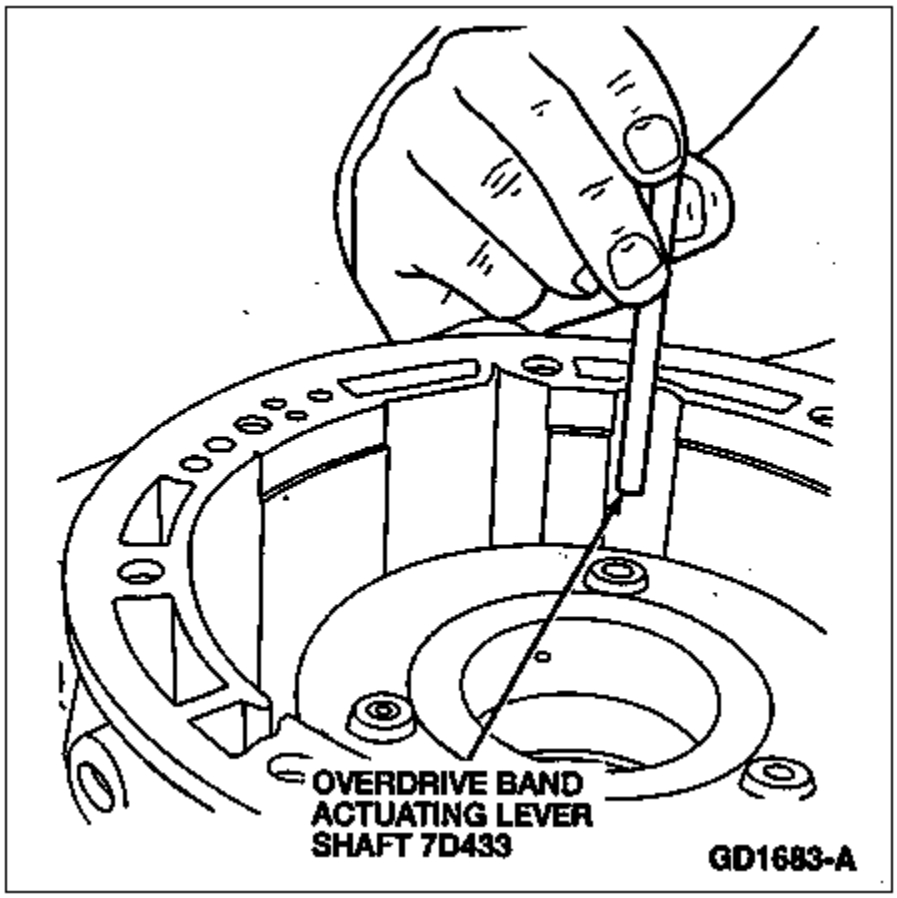

60. Install the overdrive band apply strut.

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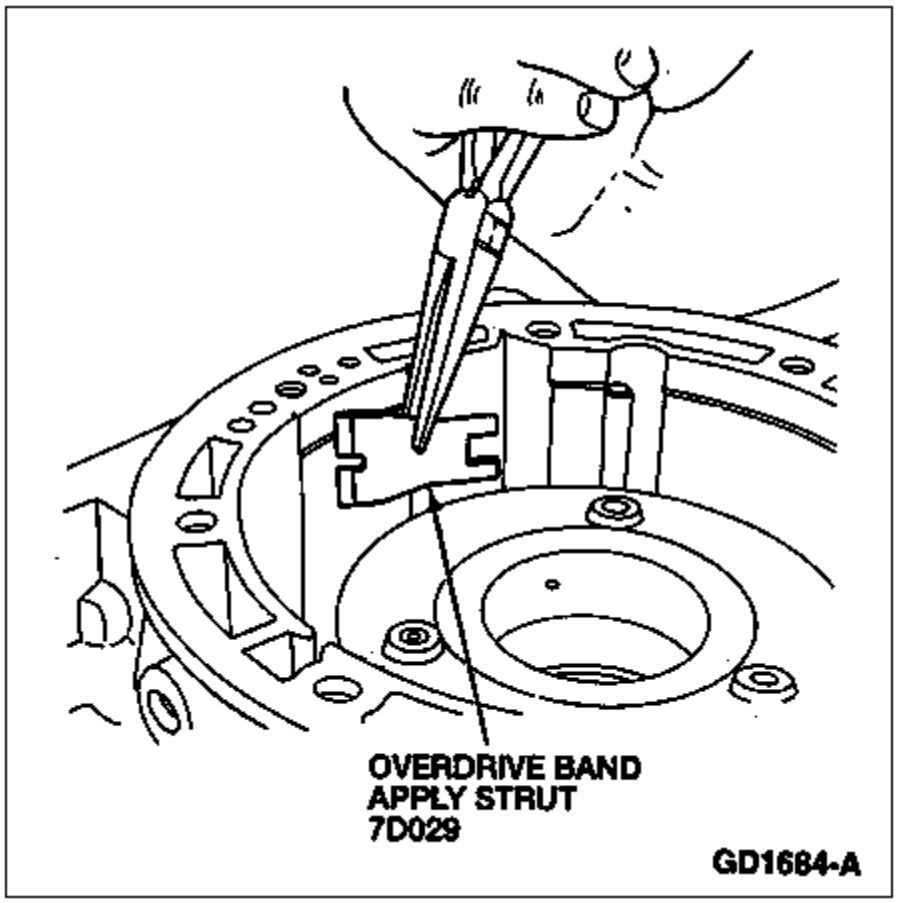

61. **NOTE: If the overdrive band is reused, it must be installed in the same position as when removed.**

    Install the overdrive band assembly over the overdrive brake and coast clutch drum.

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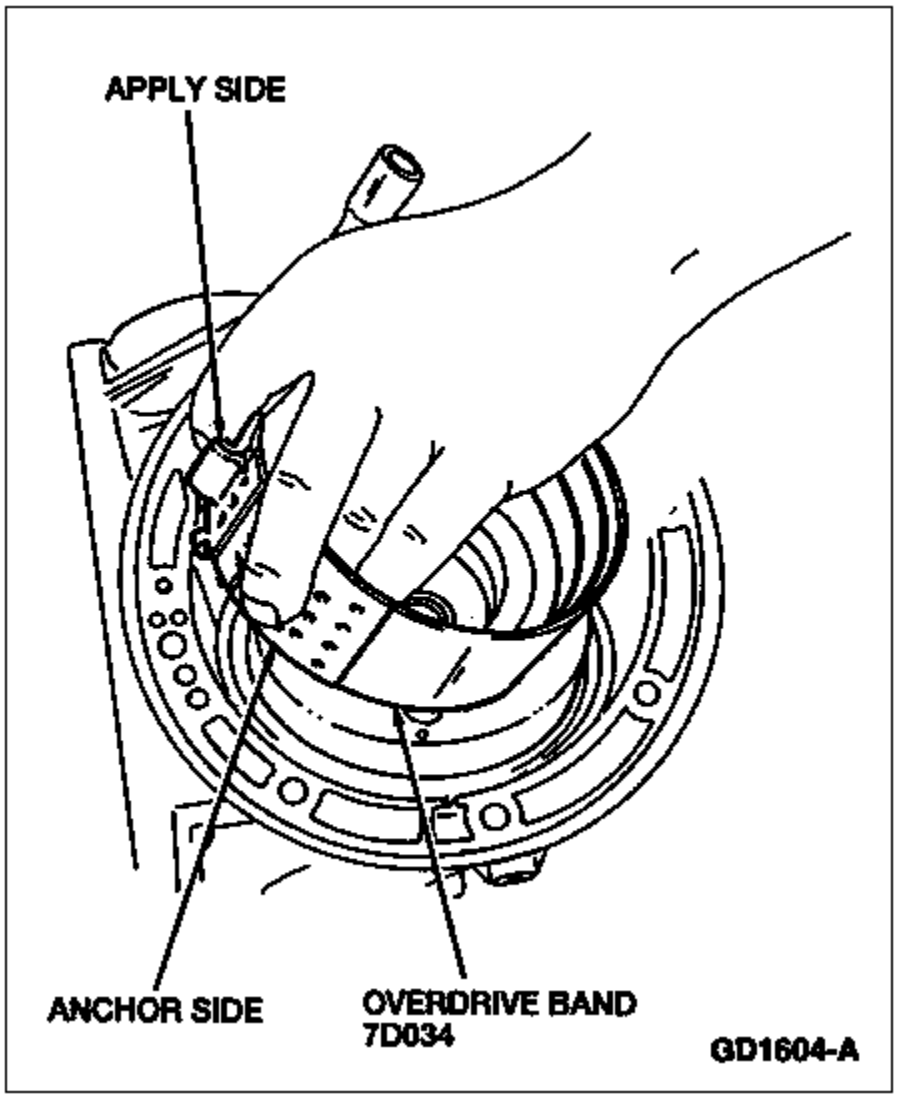

62. **NOTE: Use the band adjusting screw as a temporary alignment guide.**

    Install the overdrive band anchor strut.

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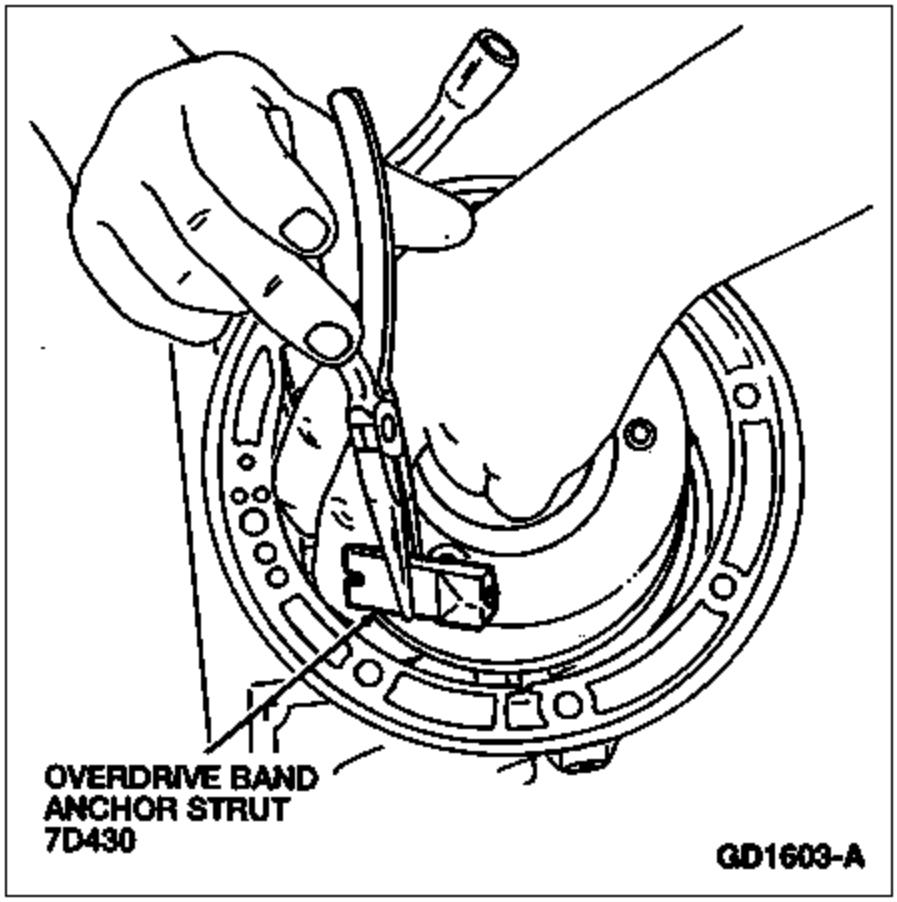

63. Install the overdrive band adjusting screw.

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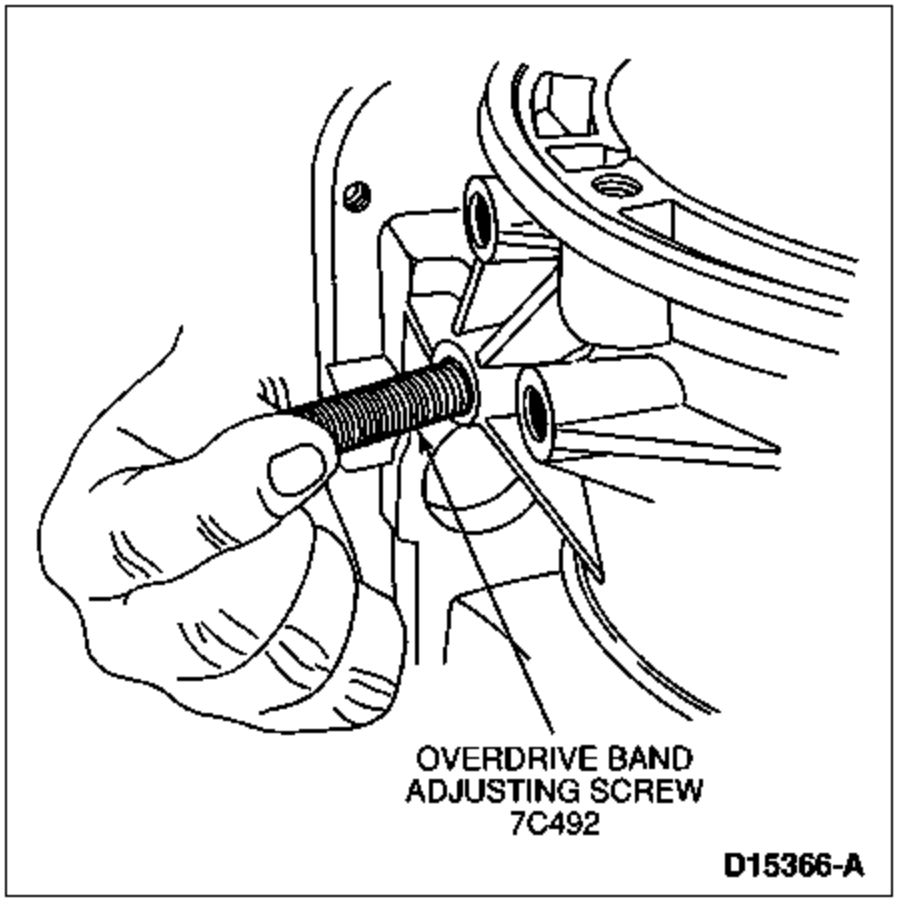

64. Perform the front end play check procedure as follows:

    a. **CAUTION: Be sure the pump body is seated against the washer and overdrive brake and coast clutch drum. The pump body must be below the level of the case gasket surface.**

    Use petroleum jelly to hold any No. 1 fluid pump thrust washer on the rear of the pump. The washer tabs go into the pump face. Place the pump into position in the case.

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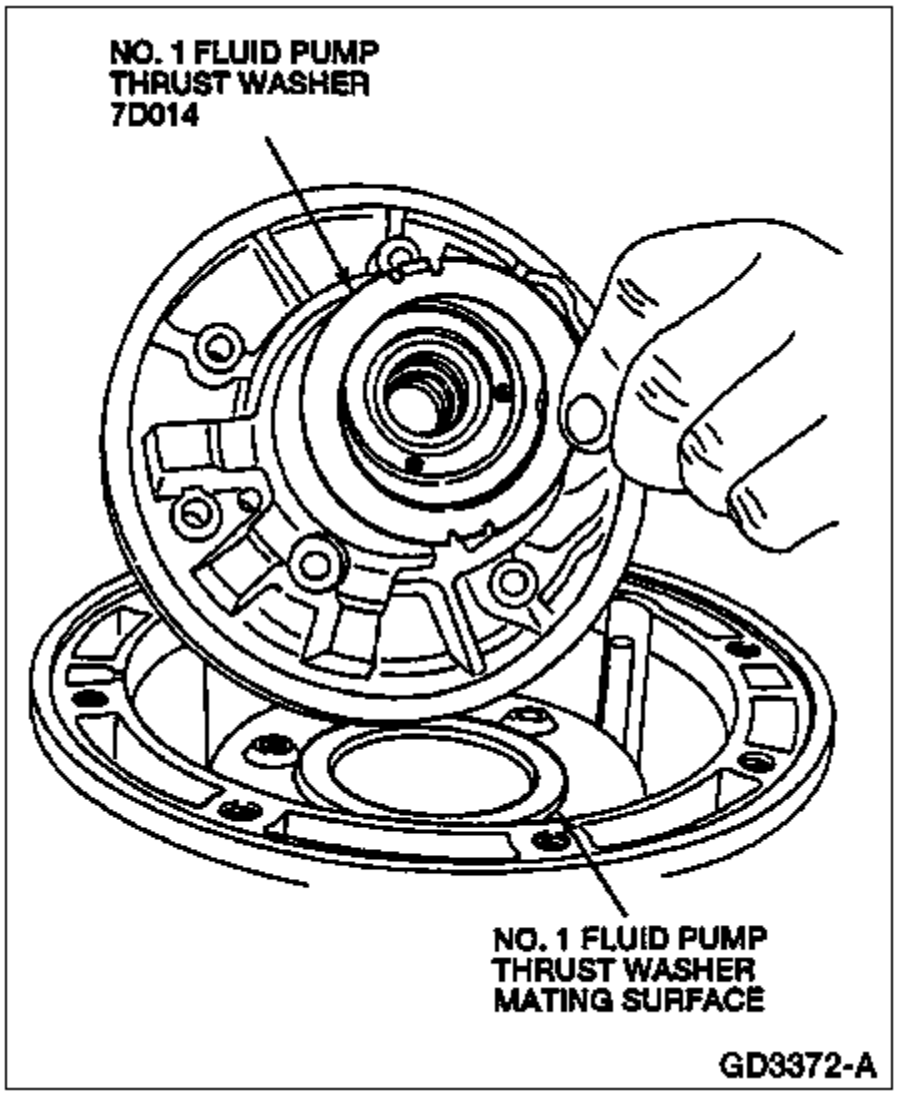

b. **CAUTION: The gauge bar must rest on the gasket surface.**

   Place Gauge Bar T93T-77003-AH across the case as shown.
c. Place a micrometer on the gauge bar and extend the probe until it contacts the pump surface.
d. Read the micrometer and subtract the thickness of the gauge bar (17.78 mm [0.700 inch]). Record this as dimension "A."
e. Move the gauge bar to the opposite side of the case.
f. Repeat Steps c and d and record this measurement as dimension "B."
g. Add dimensions "A" and "B" together and divide by 2. This is the front end clearance, dimension "C."

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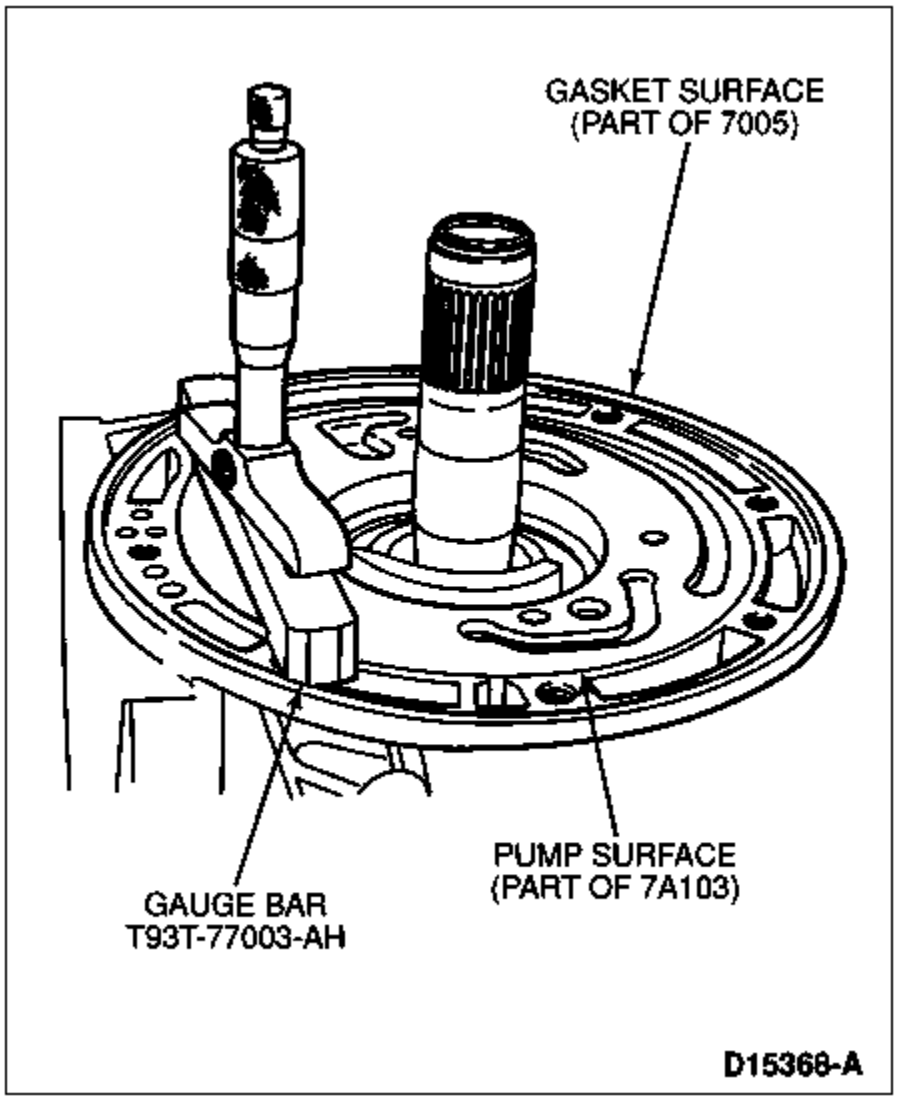

h. **CAUTION: If the average is below the specification, choose a thinner washer. If the average is above the specification, choose a thicker washer.**

NOTE: The front end play specification is 0.18-0.70 mm (0.007-0.028 in).

NOTE: The tabs on the washer go into the pump face.

Remove the pump and install the correct No. 1 thrust washer. Use petroleum jelly to hold the washer in place.

TRANSMISSION END CLEARANCE

Dimension "C"	Identification: Color	Service Part Number	Washer Thickness
Front No. 1 (All Engines) 0.18-0.70 mm (0.007-0.028 in.) Without Gasket	White Green Red Beige Black Yellow	97GT-7D014-TA 97GT-7D014-MA 97GT-7D014-NA 97GT-7D014-PA 97GT-7D014-RA 97GT-7D014-SA	1.55-1.60 mm (0.061-0.063 in.) 1.75-1.80 mm (0.069-0.071 in.) 1.85-1.90 mm (0.073-0.075 in.)

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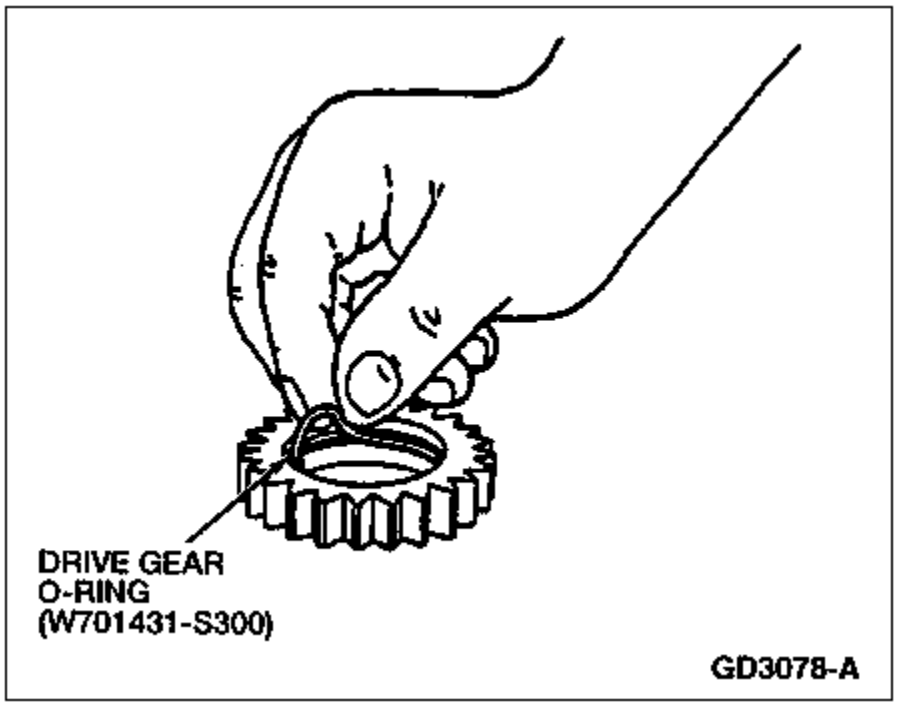
			1.95-2.00 mm (0.077-0.079 in.) 2.05-2.10 mm (0.081-0.083 in.) 2.15-2.20 mm (0.085-0.087 in.)

i. **NOTE: Front end clearance specification is 0.18-0.70 mm (0.007-0.028 in).**

Verify front end clearance is correct; repeat steps a-g.

65. Install a new drive gear O-ring.



66. Lubricate Fluid Pump Seal Sizing Tool T95L-70010-G to seat drive gear O-ring.

67. Install Fluid Pump Seal Sizing Tool into pump drive gear to seat drive gear O-ring into groove.

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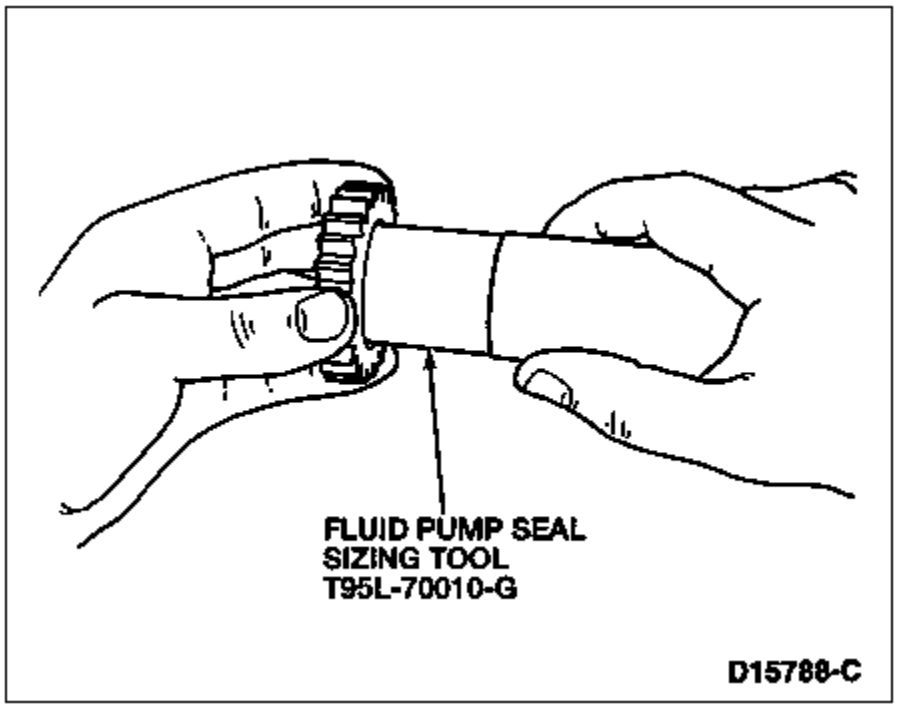

68. Remove Fluid Pump Seal Sizing Tool.

69. **CAUTION: The chamber on the inside edge of the small gear must be up when in the pump housing gear pocket. The dimple on the larger gear must be down when in the pump housing gear pocket.**

    Position the two pump gears into the pump housing. Apply a lubricant to the pump gears to prevent scoring at initial start-up.

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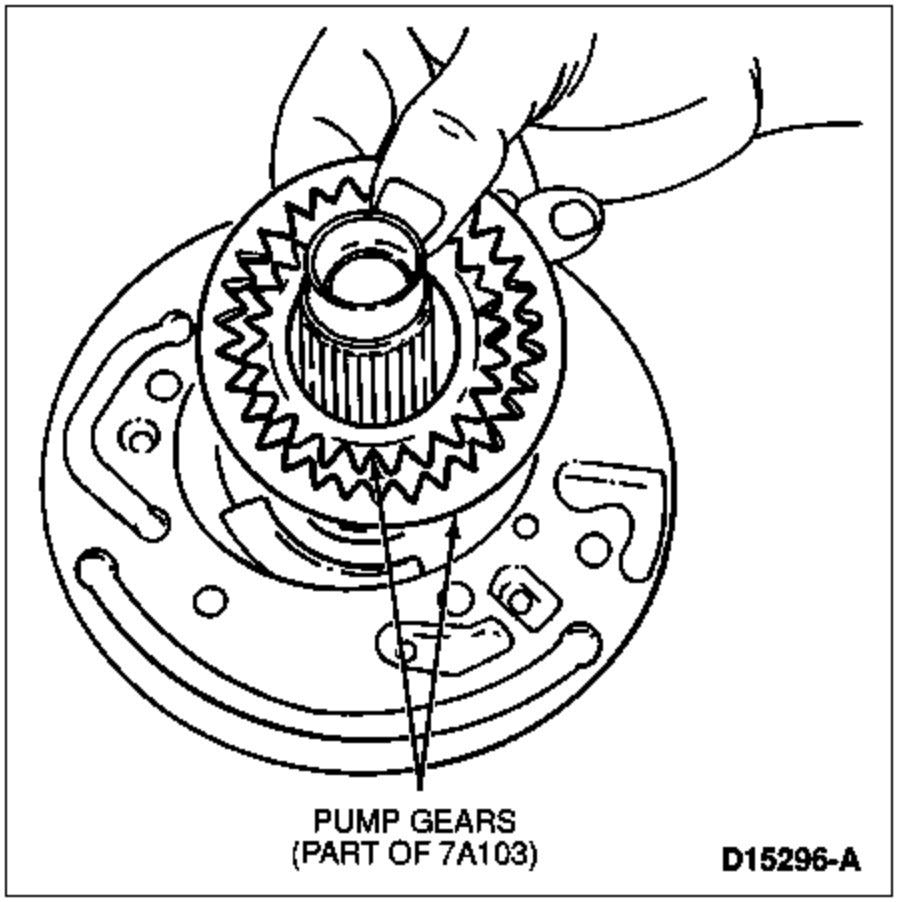

70. **CAUTION: Make sure the holes in the plate line up with the holes in the pump.**

Install the fluid pump adapter plate.

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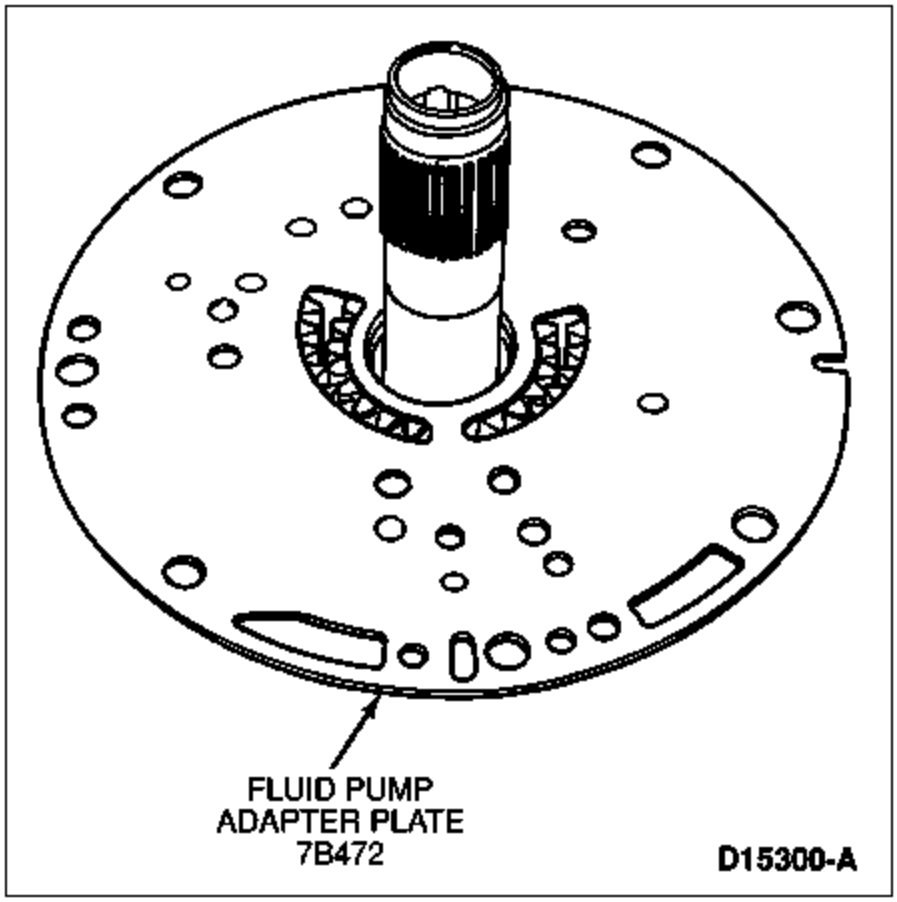

71. **CAUTION: Do not allow the pump gears to come out of the pump housing pocket.**

NOTE: The notch on the outside of the fluid pump adapter plate will be at the nine o'clock position, relative to the converter housing.

Turn the converter housing face down on the bench. Hold the fluid pump adapter plate against the front pump support and gear to keep the pump gears in place. Turn the pump and adapter plate over and place on the converter housing.

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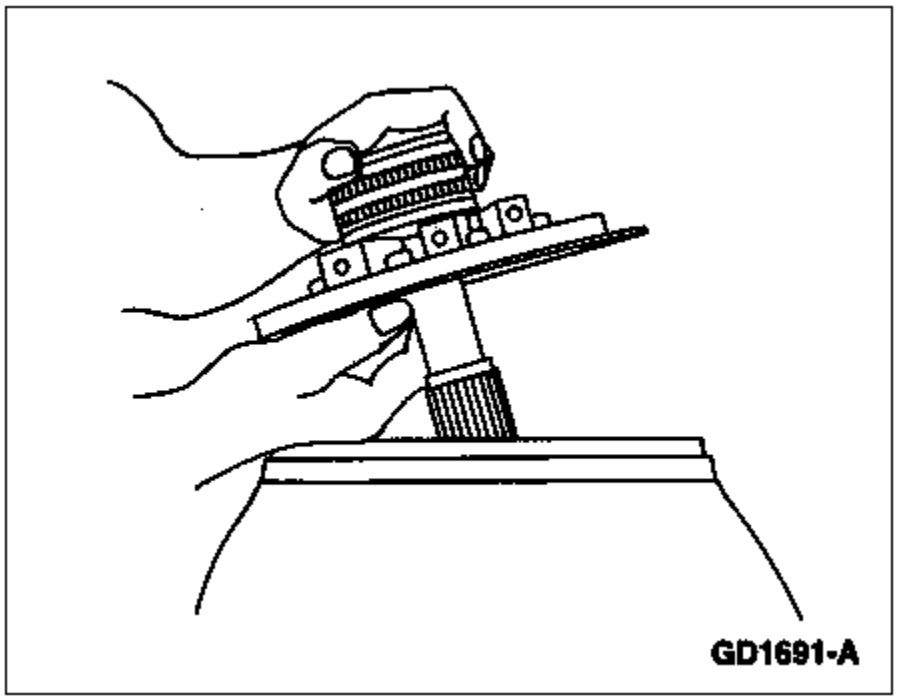
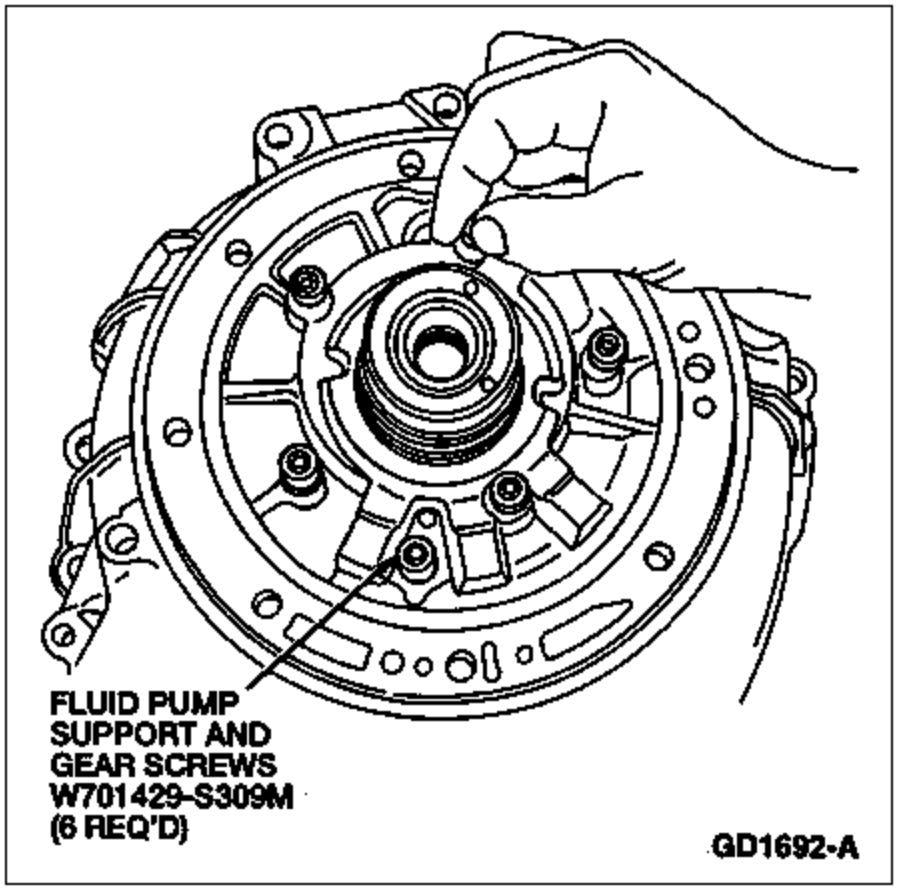


72. Install the six M8 x 35 mm Torx® head front pump support and gear screws fingertight only.



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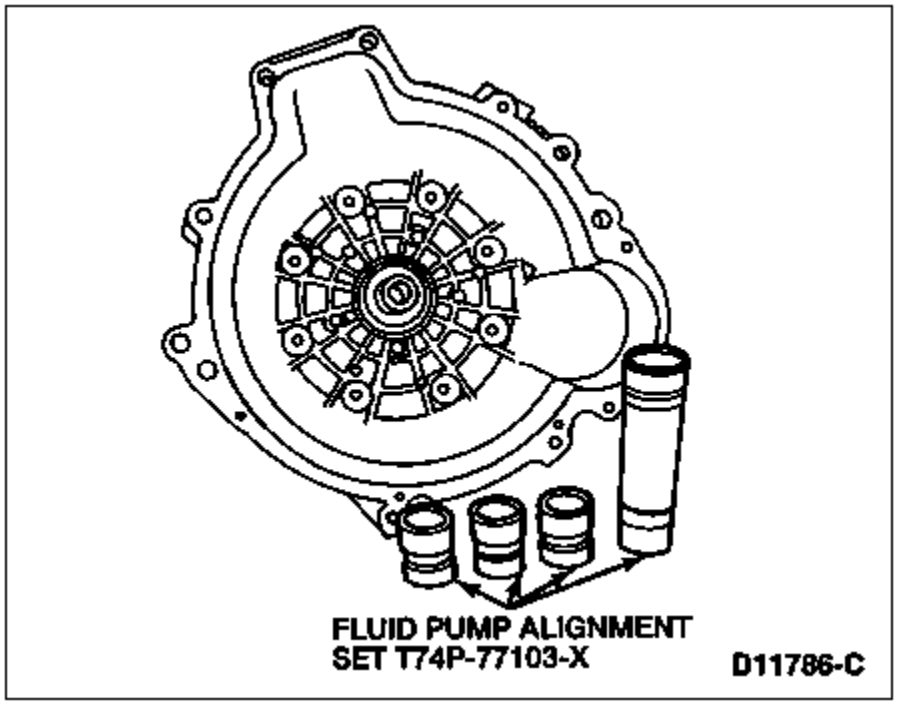
73. **CAUTION: Fluid Pump Alignment Set T74P-77103-X must be used to properly align the front pump support and gear to the fluid pump adapter plate. This will prevent seal leakage, gear noise, broken gears and bushing failure.**

    Select the gauge that will be the snuggest fit when placed over the fluid pump support and gear.



74. Thread the gauge into Pump Alignment Handle T74P-77103-H (Part of T74P-77103-X, Fluid Pump Alignment Set). Slide the tool over the front pump support and gear until it bottoms out in the pump gear pocket. This centers the pump to the converter housing.

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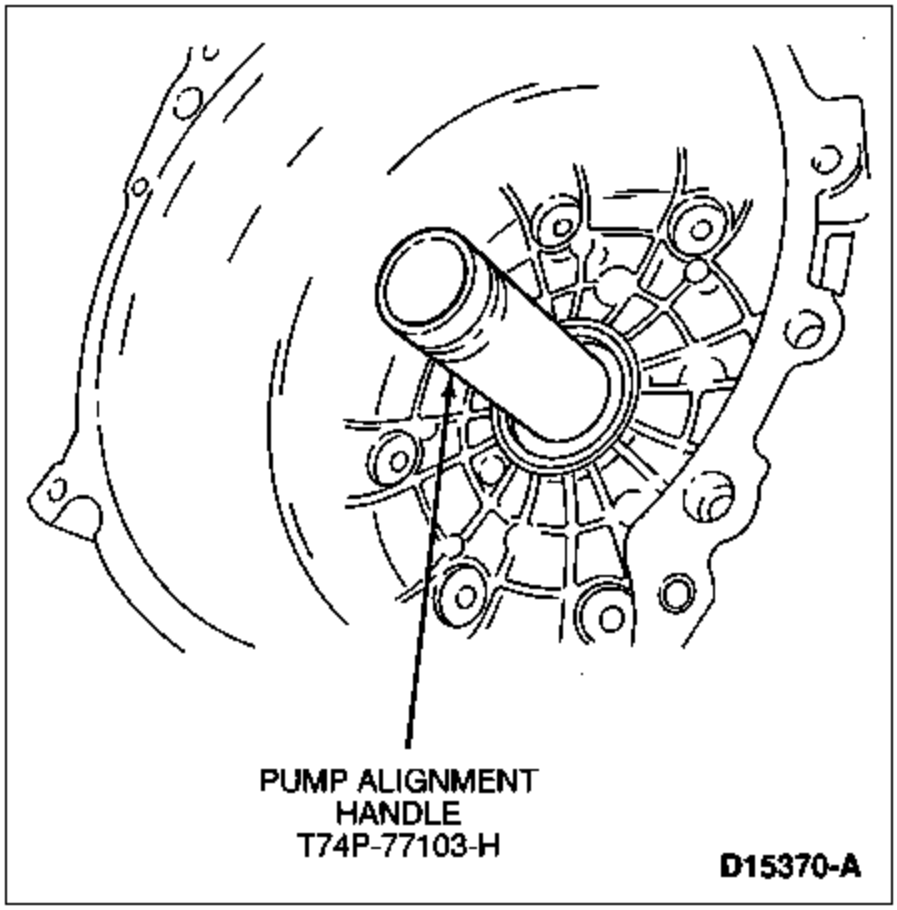

75. Use a Torx® 40 socket wrench to tighten the six M8 x 35 mm fluid pump support and gear-to-converter housing screws. Tighten the fluid pump support and gear-to-converter housing screws in a star pattern to 22-28 Nm (16-21 lb-ft). Remove the Pump Alignment Handle.

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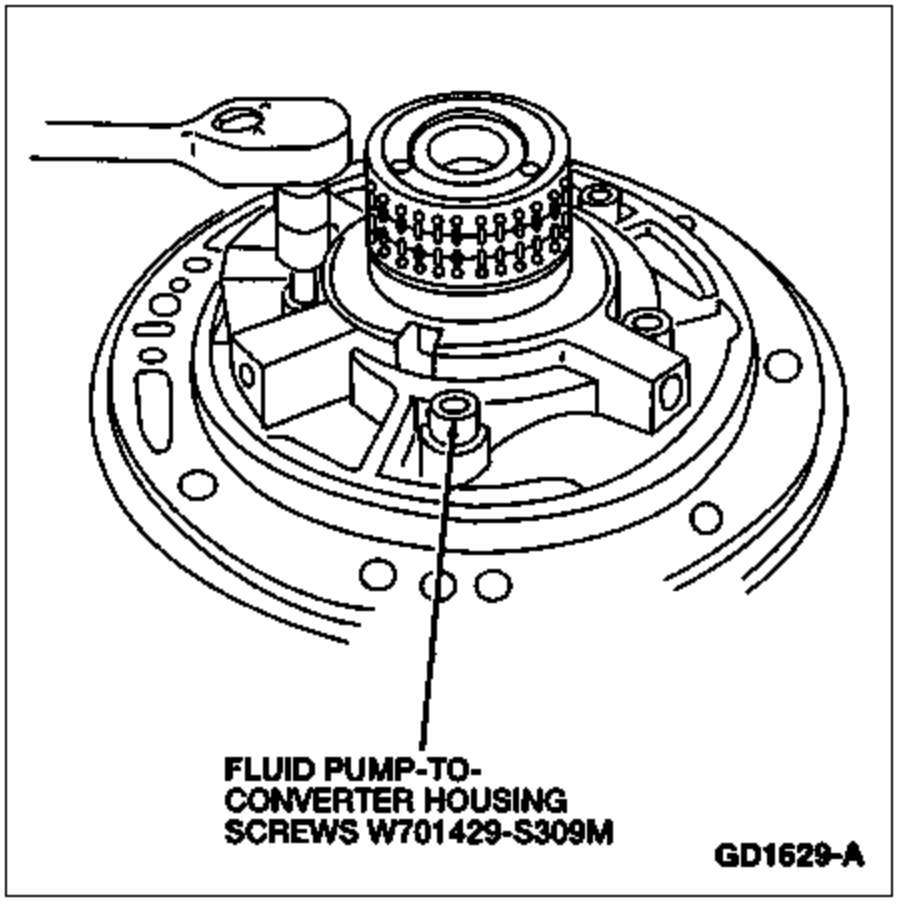

76. Install a new fluid pump seal ring.

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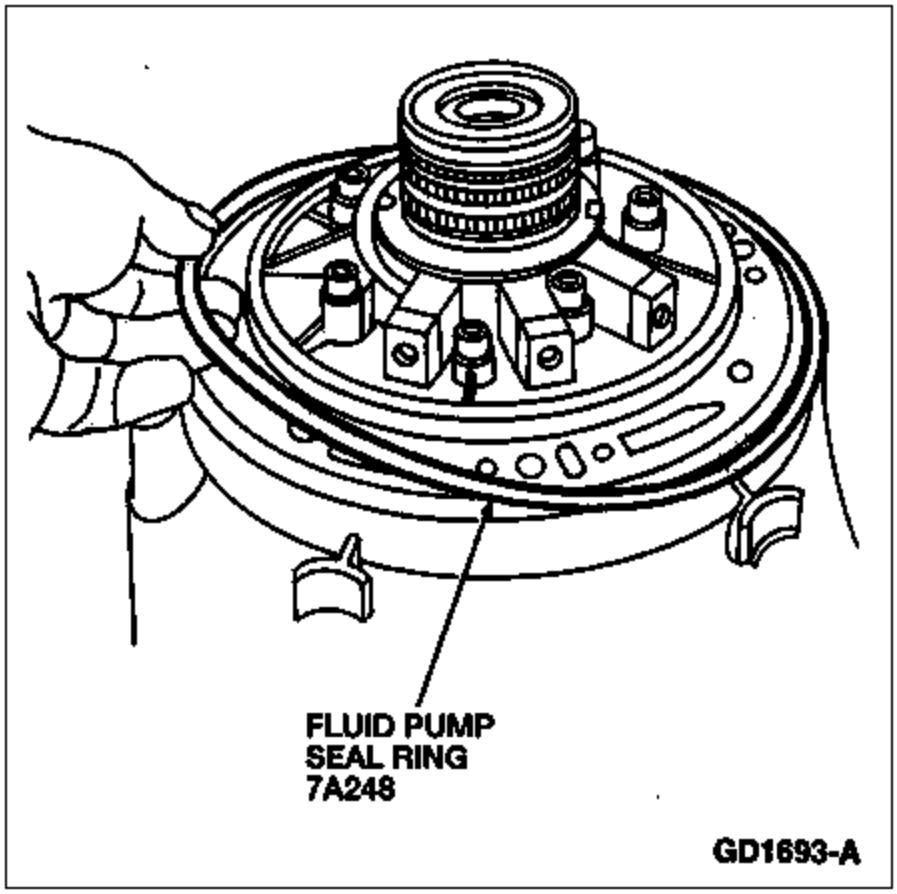

77. **NOTE: Make sure the fluid pump seal ring is installed on the converter housing and pump assembly.**

    Place a new fluid pump gasket on the fluid pump adapter plate as shown. Use petroleum jelly to hold the fluid pump gasket in place.

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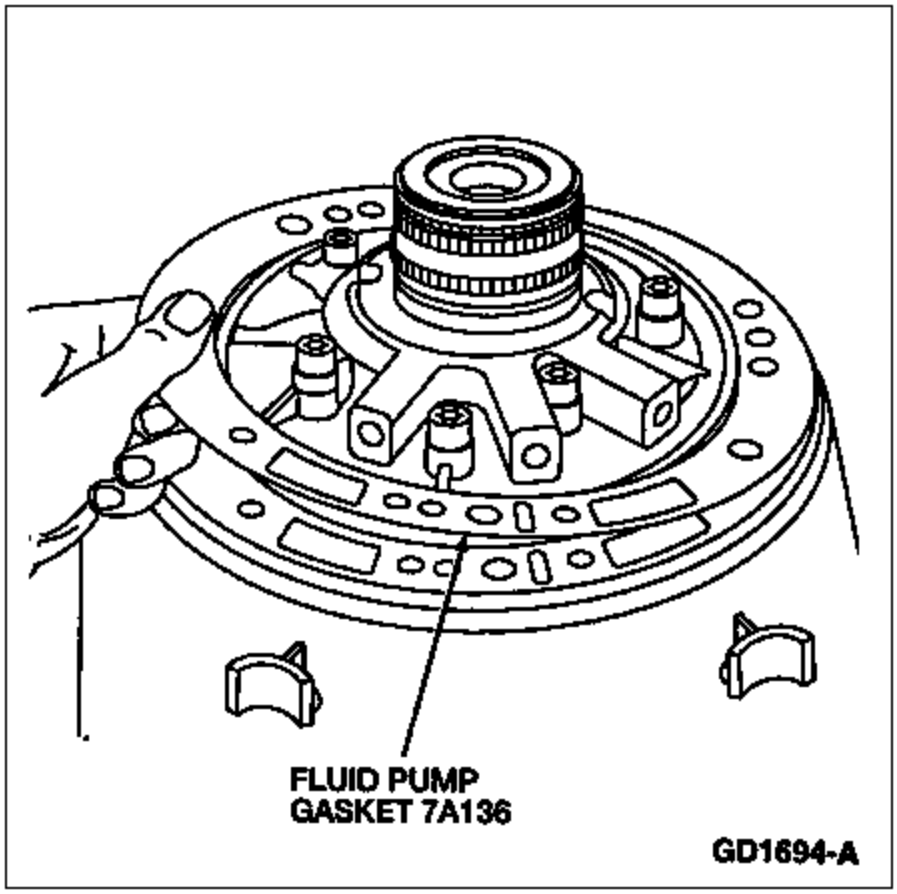

78. Install the correct No. 1 fluid pump thrust washer on the fluid pump support and gear. Use petroleum jelly to hold the washer in place.

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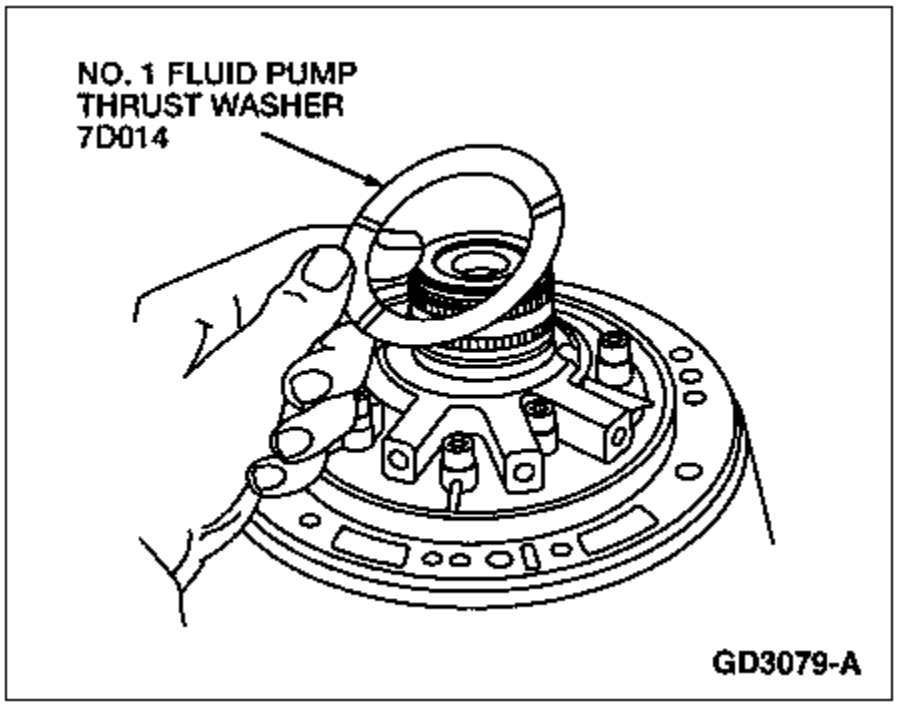
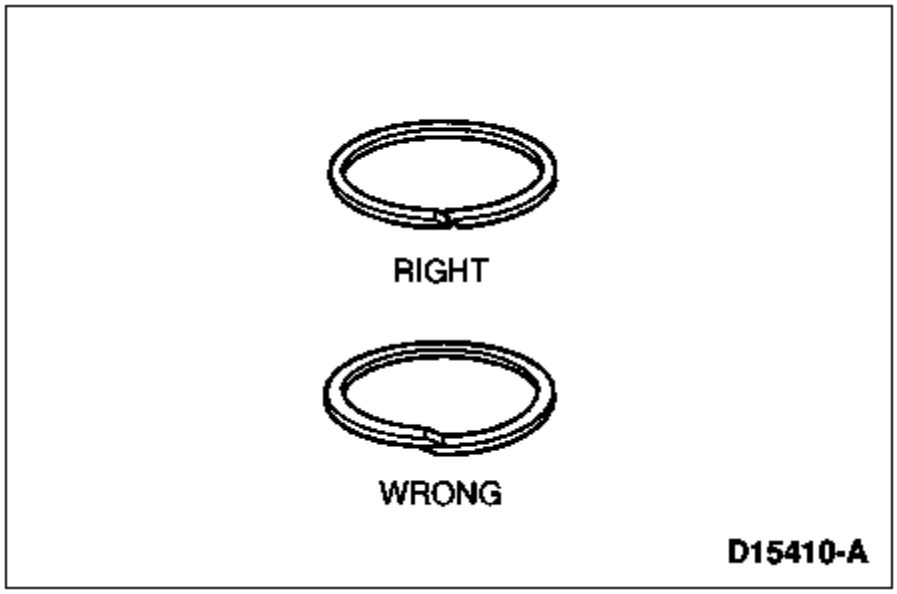


79. **NOTE: Verify correct seal installation. Be sure seal grooves are clean and free of burrs.**

Turn the converter housing over and install the front pump support seal ring.



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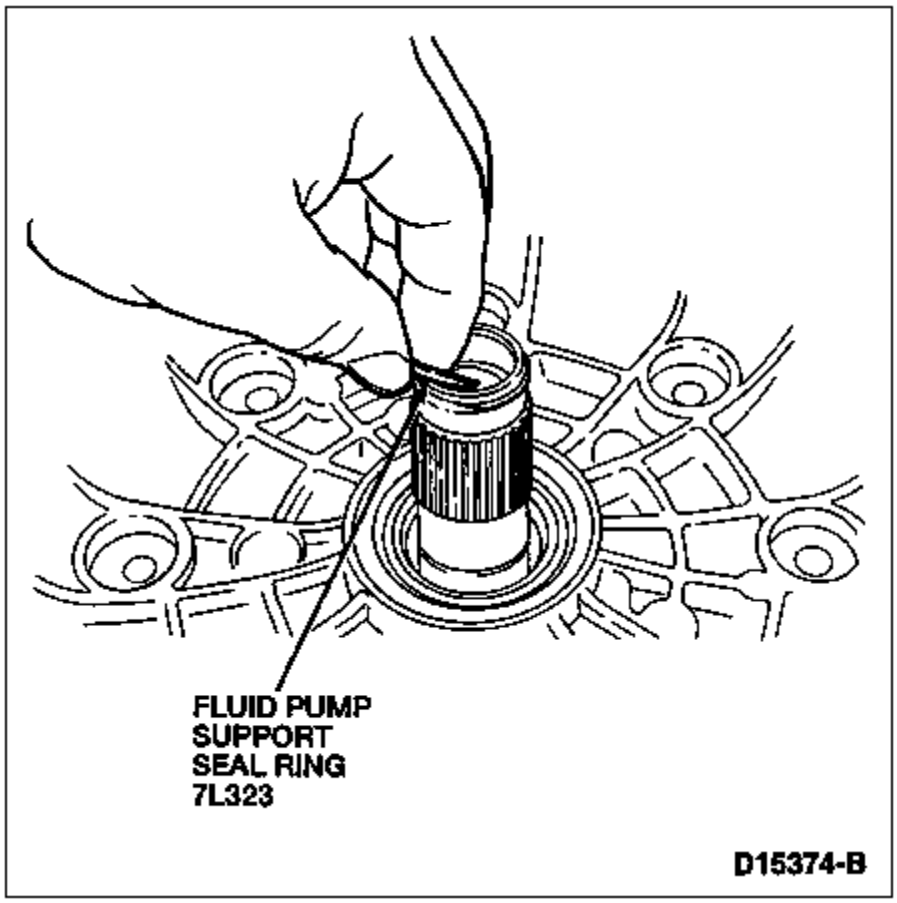

80. **NOTE: The splines on the input shaft are not the same length. The shorter splines go into the assembly.**

Install the input shaft as a guide for the converter housing and fluid pump support and gear assembly. Install the Converter Guide Pins T95L-7902-A as shown.

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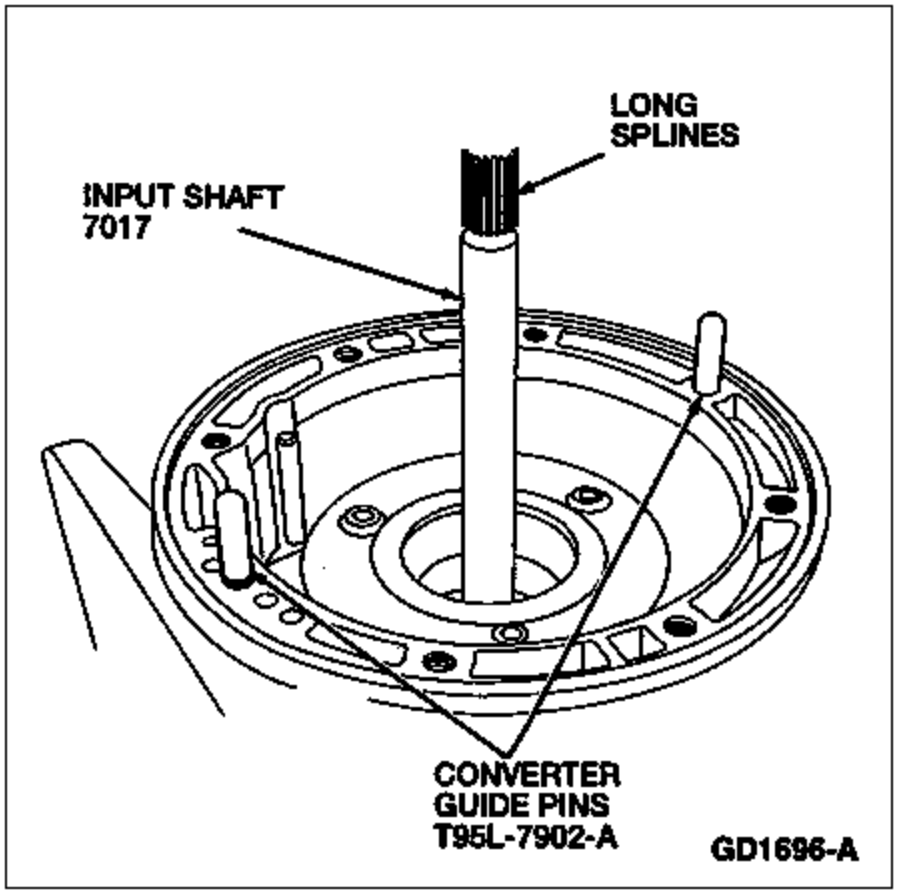

81. Install the converter housing and fluid pump support and gear assembly (with the fluid pump gasket) and the No. 1 fluid pump thrust washer to the case.

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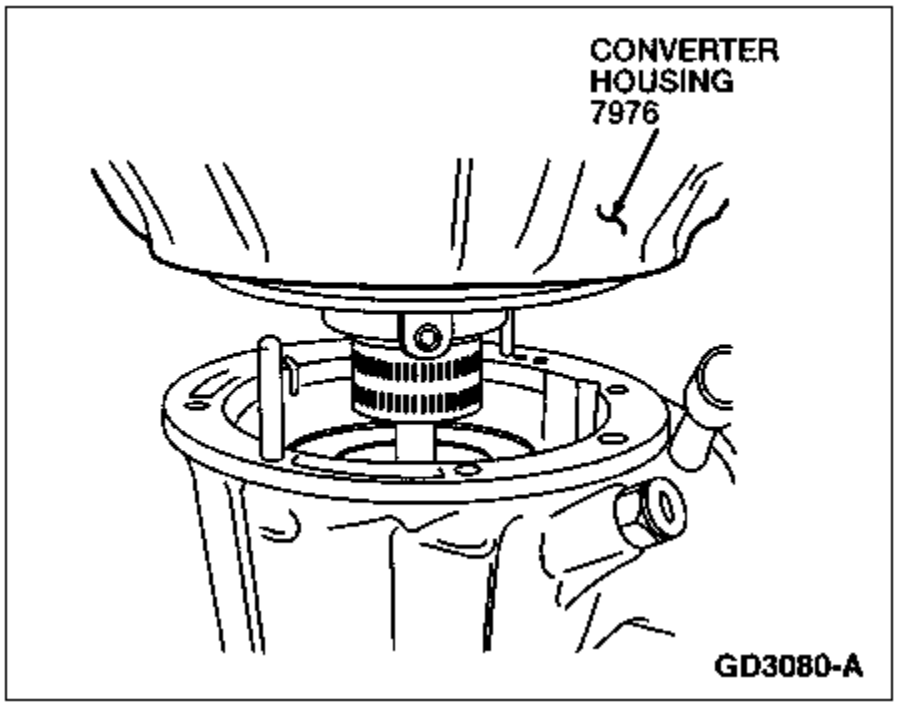

82. **NOTE: Lubricate O-rings on converter housing screws.**

Remove Converter Guide Pins and use a 17 mm socket wrench to install the eight new M10 x 33 mm converter housing-to-case screws. Tighten the converter housing-to-case screws in a star pattern to 36-52 Nm (27-39 lb-ft).

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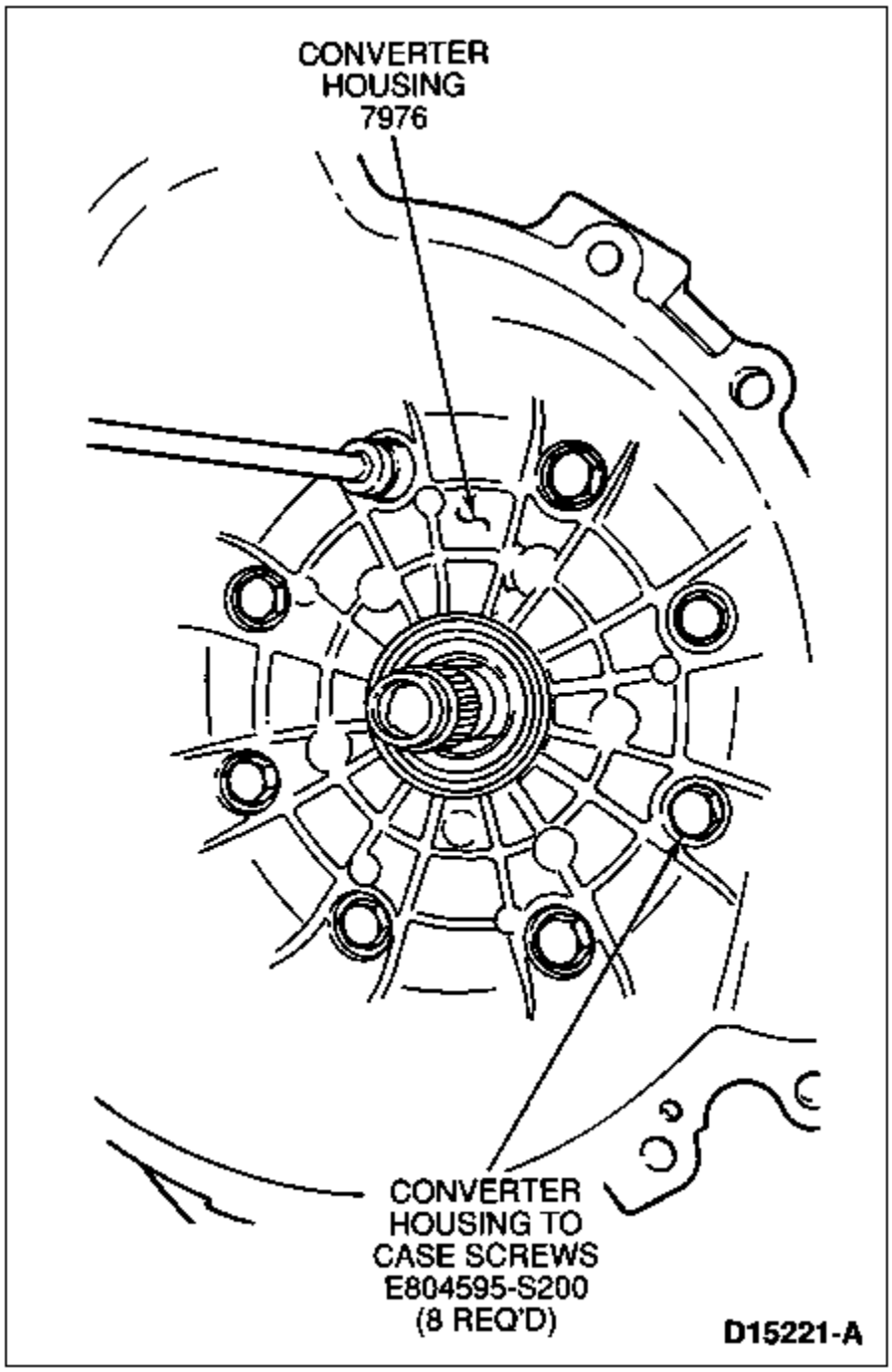

83. Remove input shaft.

84. **WARNING: MAKE SURE THE LOCK PIN ON BENCH-MOUNTED HOLDING FIXTURE T57L-500-B IS SECURE.**

    Rotate the transmission assembly so the fluid pan rail is facing up.

85. **CAUTION: Do not damage the overdrive servo cover to case O-ring during installation. Do not press the overdrive servo cover and O-ring past the relief hole in the case. O-ring damage may occur.**

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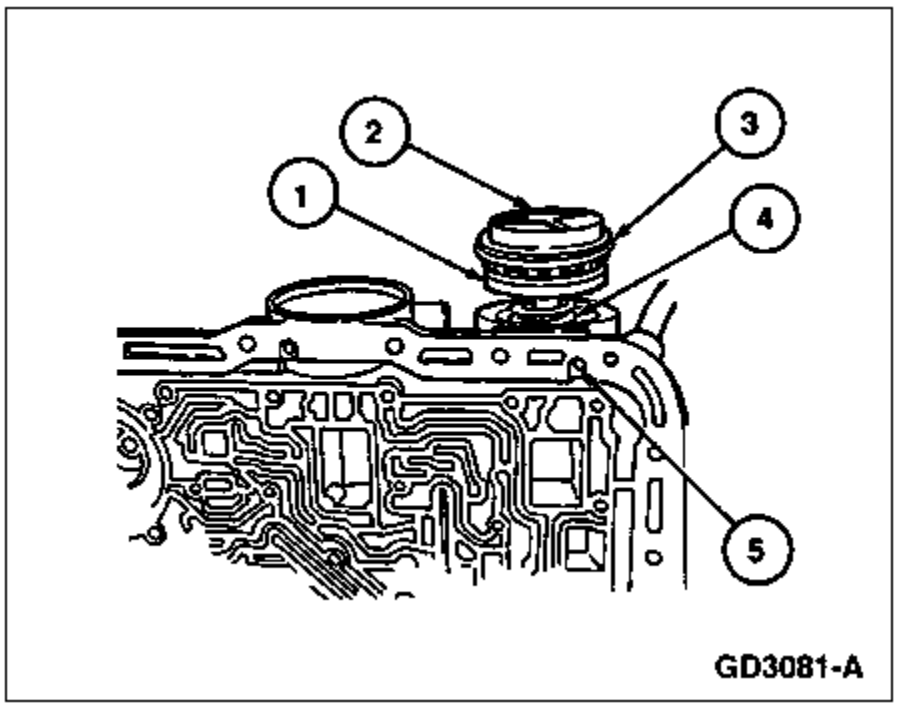
Install the overdrive servo piston spring, servo piston and rod assembly, servo cover to case O-ring with servo cover.



Item	Part Number	Description
1	7D021	Overdrive Servo Piston and Rod Assembly
2	7D027	Overdrive Servo Cover and Seal Assembly
3	7D040	Overdrive Servo O-Ring
4	7D028	Overdrive Servo Piston Spring
5	—	Relief Hole (Part of 7005)

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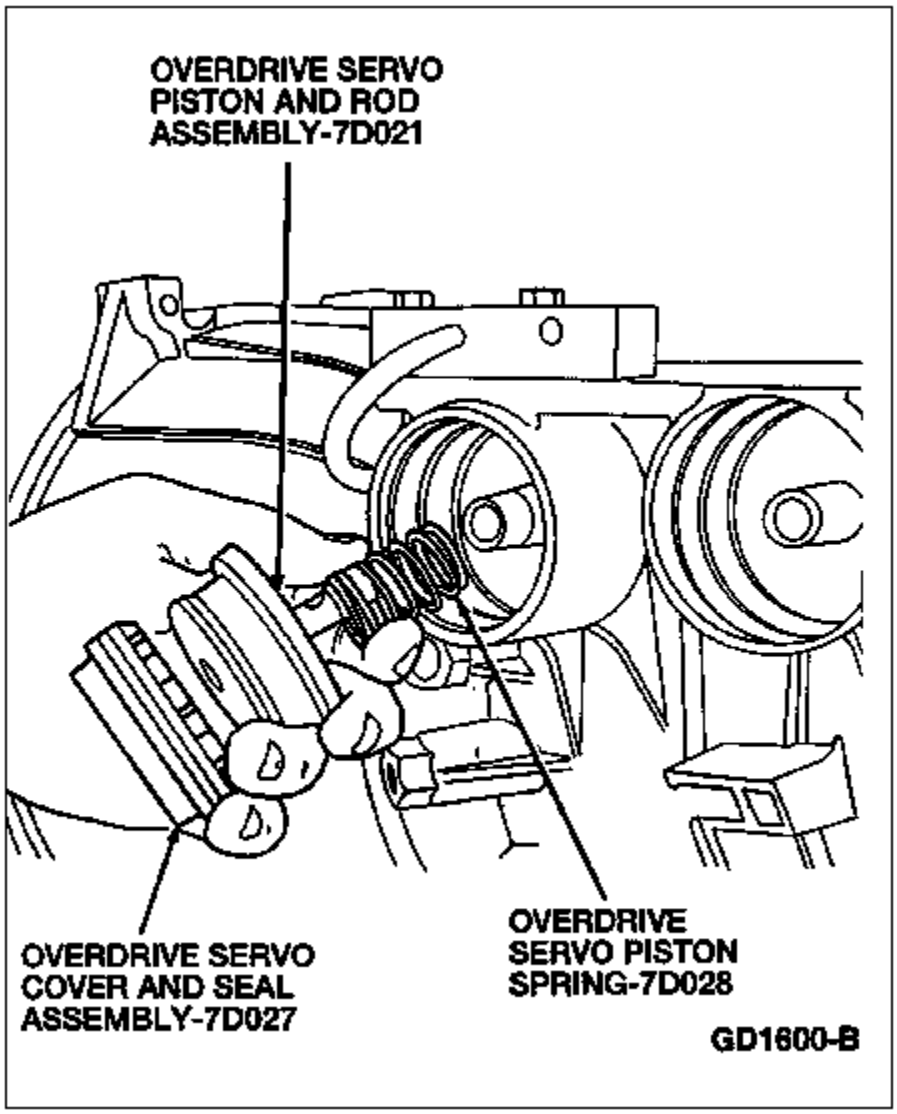

86. **NOTE: The J-hook must be in the appropriate hole for the servo being removed, and tool number should be facing up.**

    Install Servo Cover Compressor T95L-77028-A over the overdrive servo cover at the fluid pan rail. Tighten the screws.

87. Use a 1/2-inch wrench to tighten the nut on the J-hook until there is a gap between the servo cover and the snap ring.

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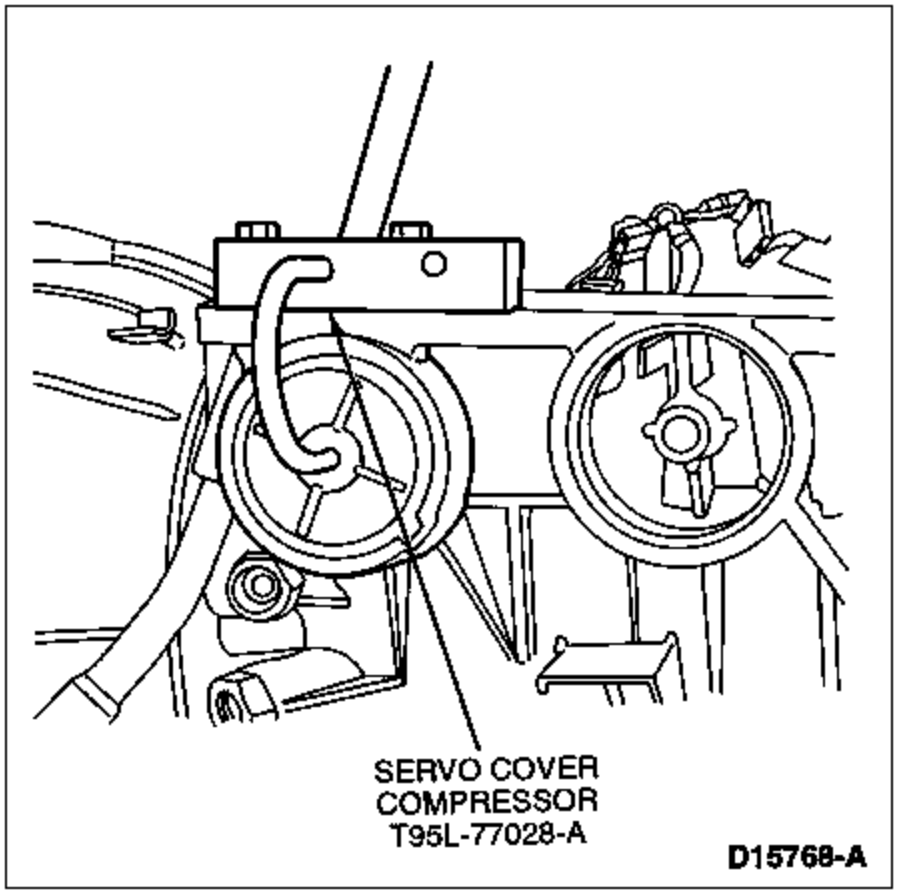

88. Carefully install the servo cover retaining ring.

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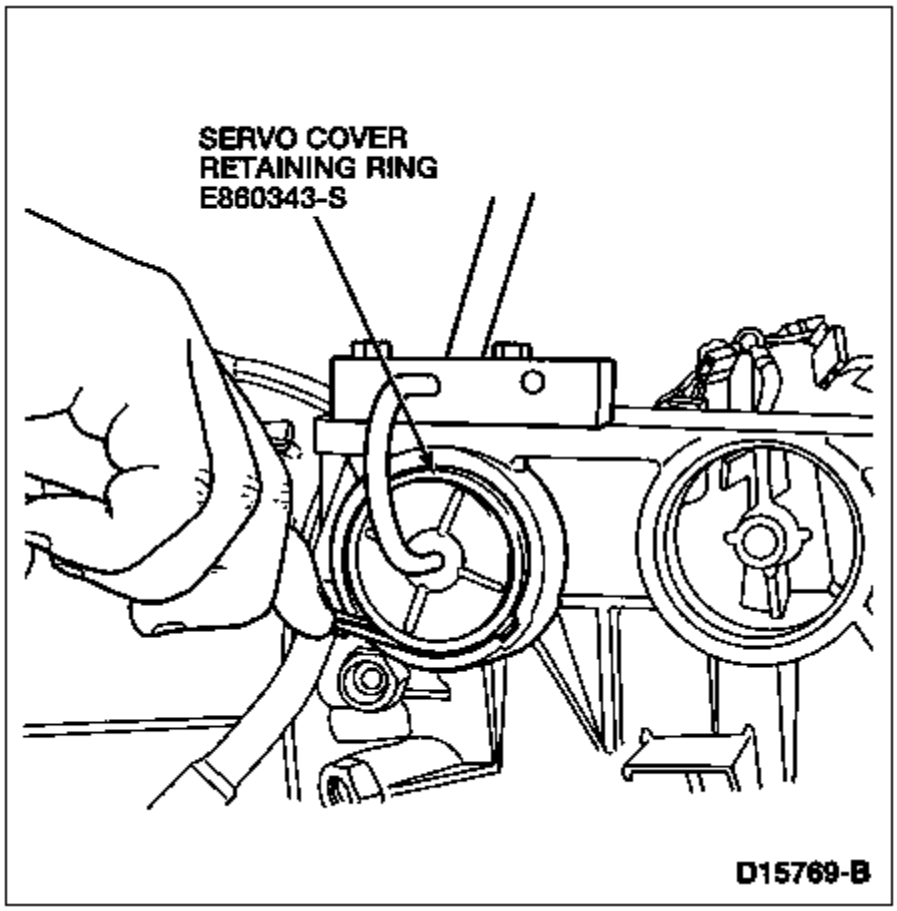

89. **CAUTION: The servo cover is under spring tension.**

    Carefully back off the nut on the J-hook until the servo spring is unloaded.

90. Remove Servo Cover Compressor T95L-77028-A.

91. **CAUTION: Do not damage the intermediate servo cover to case O-ring during installation. Do not press the intermediate servo cover and seal assembly and O-ring past the relief hole in the case. O-ring damage may occur.**

    Install the intermediate servo piston spring, servo piston and rod assembly, servo cover to case O-ring with servo cover assembly with O-ring.

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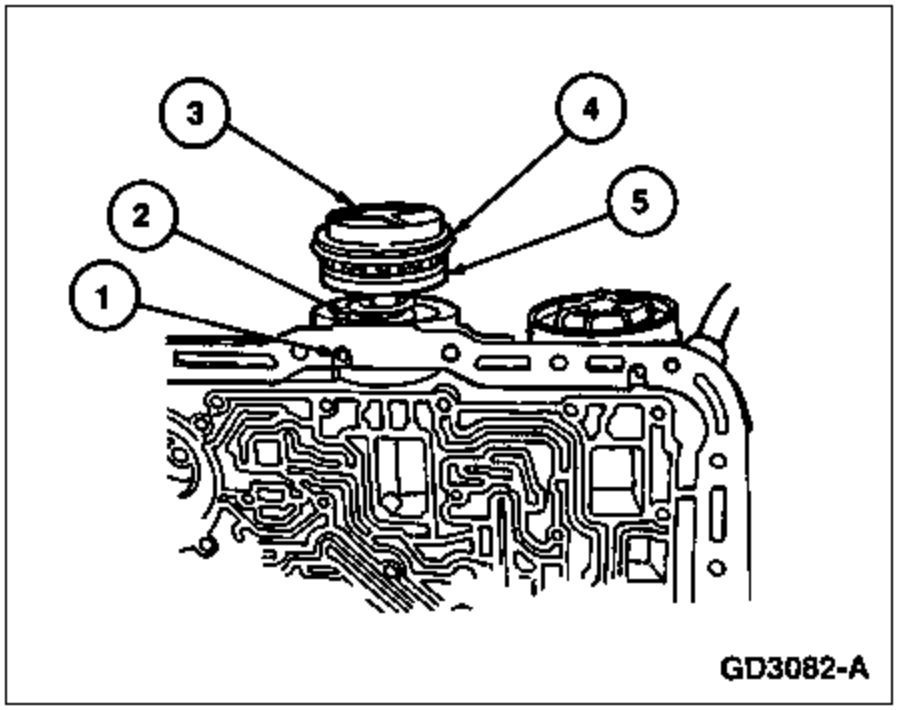

Item	Part Number	Description
1	—	Relief Hole (Part of 7005)
2	7D028	Intermediate Servo Piston Spring
3	7D027	Intermediate Servo Cover and Seal Assembly
4	7D040	Intermediate Servo O-Ring
5	7D021	Intermediate Servo Piston and Rod Assembly

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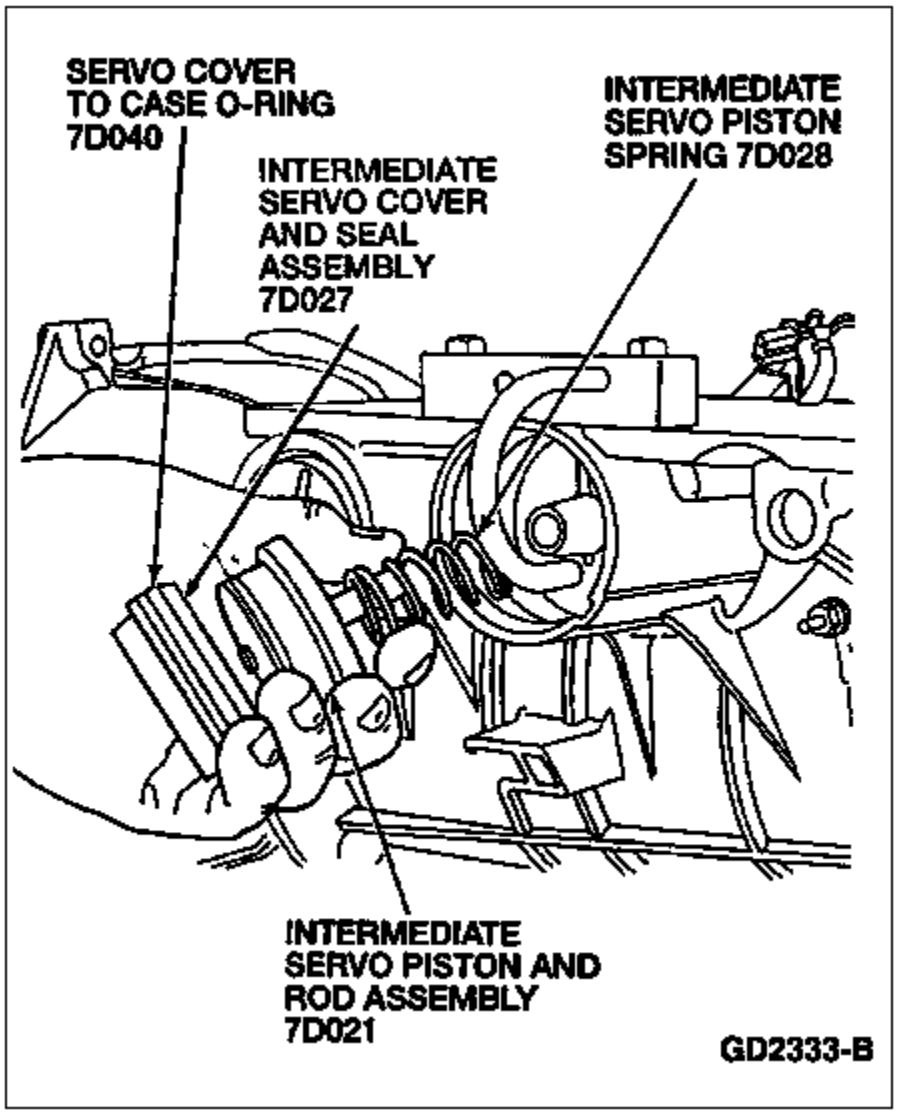

92. **NOTE: The J-hook must be in the appropriate hole for the servo being removed, and tool number should be facing up.**

    Install Servo Cover Compressor T95L-77028-A over the intermediate servo cover at the fluid pan rail. Tighten the screws.

93. Use a 1/2-inch wrench to tighten the nut on the J-hook until there is a gap between the servo cover and the snap ring.

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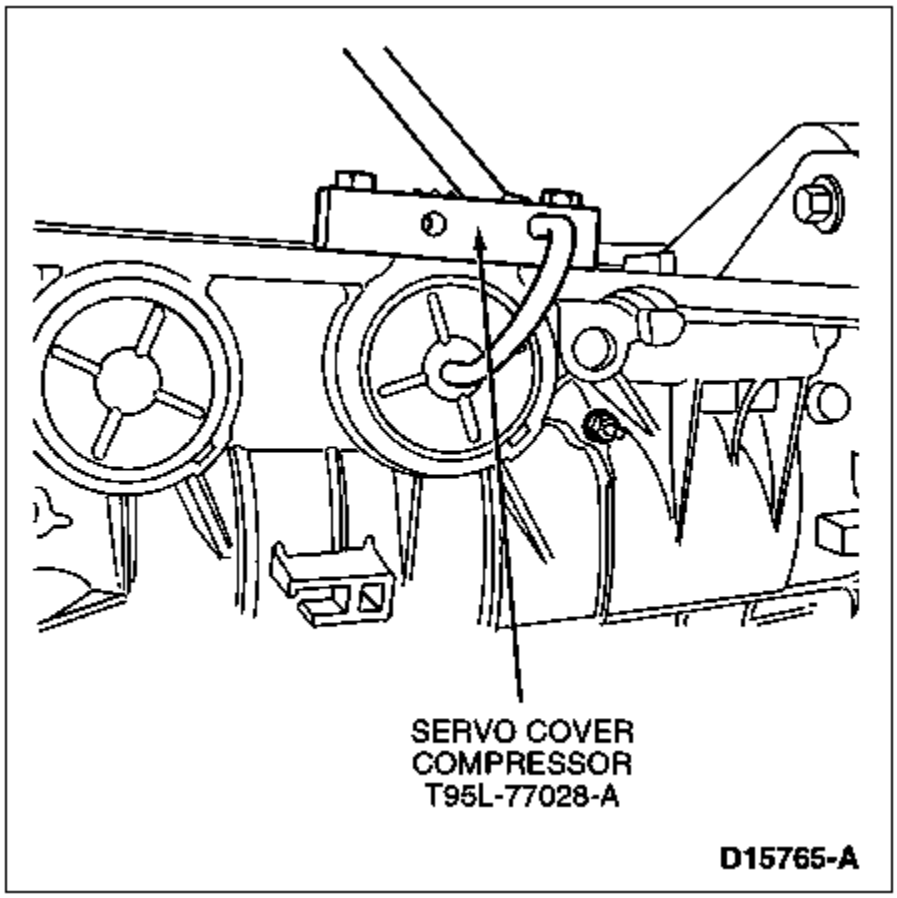

94. Carefully install the intermediate servo cover retaining ring.

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95. **CAUTION: The servo cover is under spring tension.**

    Carefully back off the nut on the J-hook until the servo piston spring is unloaded.

96. Remove Servo Cover Compressor T95L-77028-A.

97. **CAUTION: Install, but do not tighten, a new locknut on the band adjusting screw. Apply petroleum jelly to the locknut seal.**

    CAUTION: The overdrive servo must be installed prior to band adjustment.

    Install new locknut. Tighten the overdrive band adjusting screw using Band Adjustment Torque Wrench Set T71P-77370-A. The wrench will click at 14 Nm (10 lb-ft). Back off the band adjusting screw exactly two (2) turns and hold that position. Tighten the overdrive band locknut to 47-61 Nm (35-45 lb-ft) using a 19 mm wrench.

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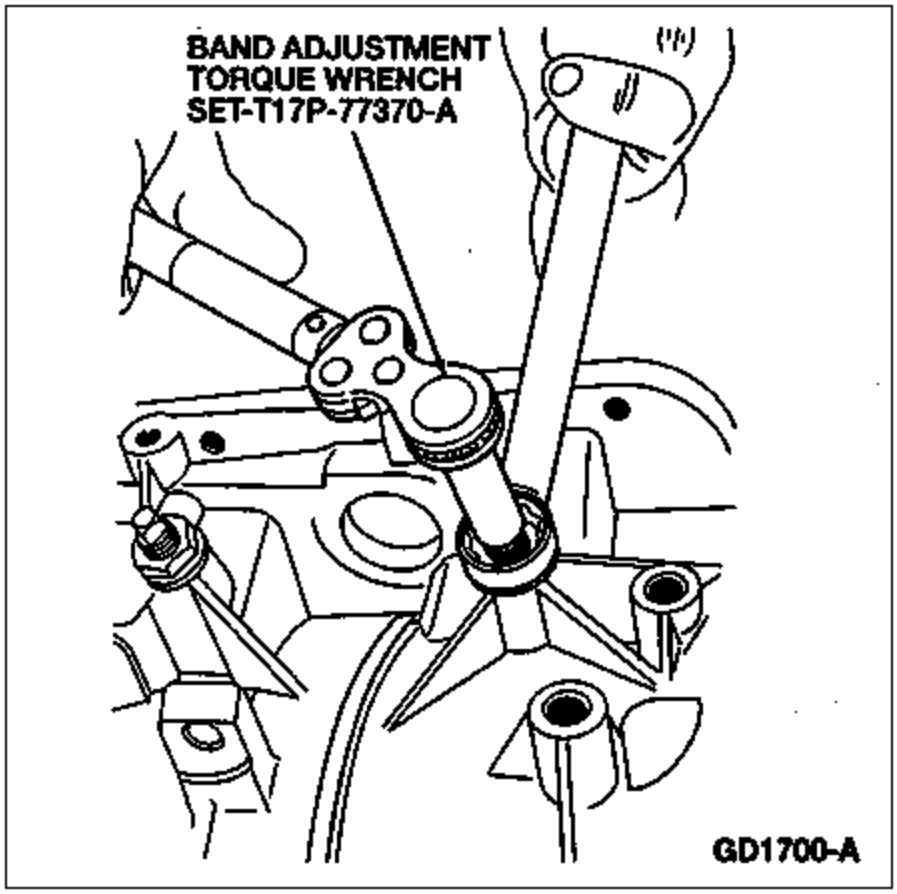

98. **CAUTION: Install, but do not tighten, a new locknut on the band adjusting screw. Apply petroleum jelly to the locknut seal.**

CAUTION: Intermediate servo must be installed prior to band adjustment.

Install new locknut. Tighten the intermediate band adjusting screw using Band Adjustment Torque Wrench Set T71P-77370-A. The wrench will click at 14 Nm (10 lb-ft). Back off the band adjusting screw exactly two and one-half (2 1/2) turns and hold that position. Tighten the intermediate band locknut to 47-61 Nm (35-45 lb-ft) using a 19 mm wrench.

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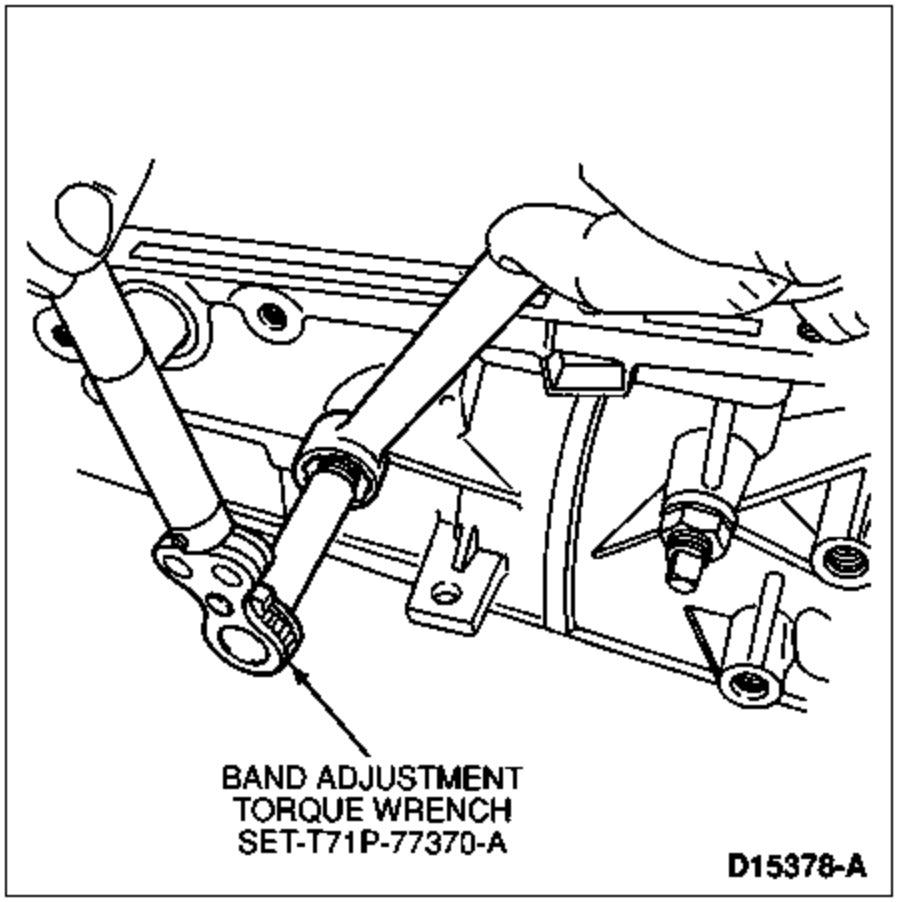

99. **NOTE: Make sure the tab is in the lock position.**

Inspect O-rings (W703015-S300) for damage. Replace if damaged. Lubricate and install the 16-pin connector assembly through the case until a click is heard.

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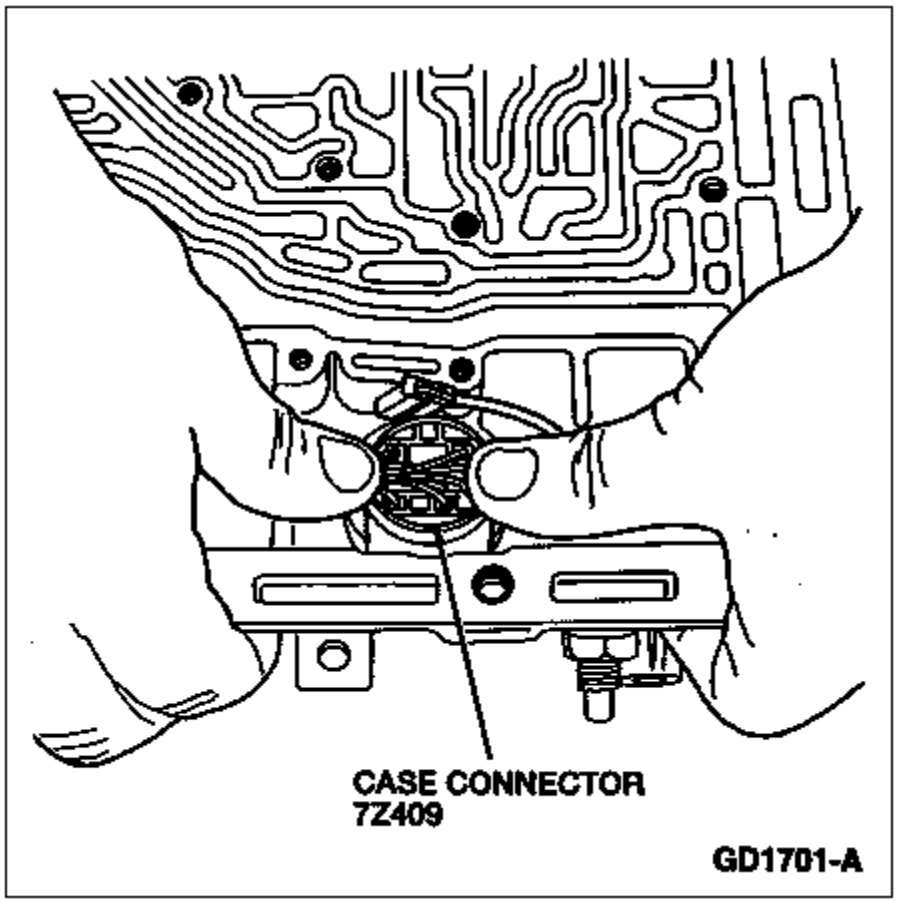

100. **CAUTION: Do not overstretch the 16-pin connector assembly retaining spring.**

Install the 16-pin connector assembly retaining spring.

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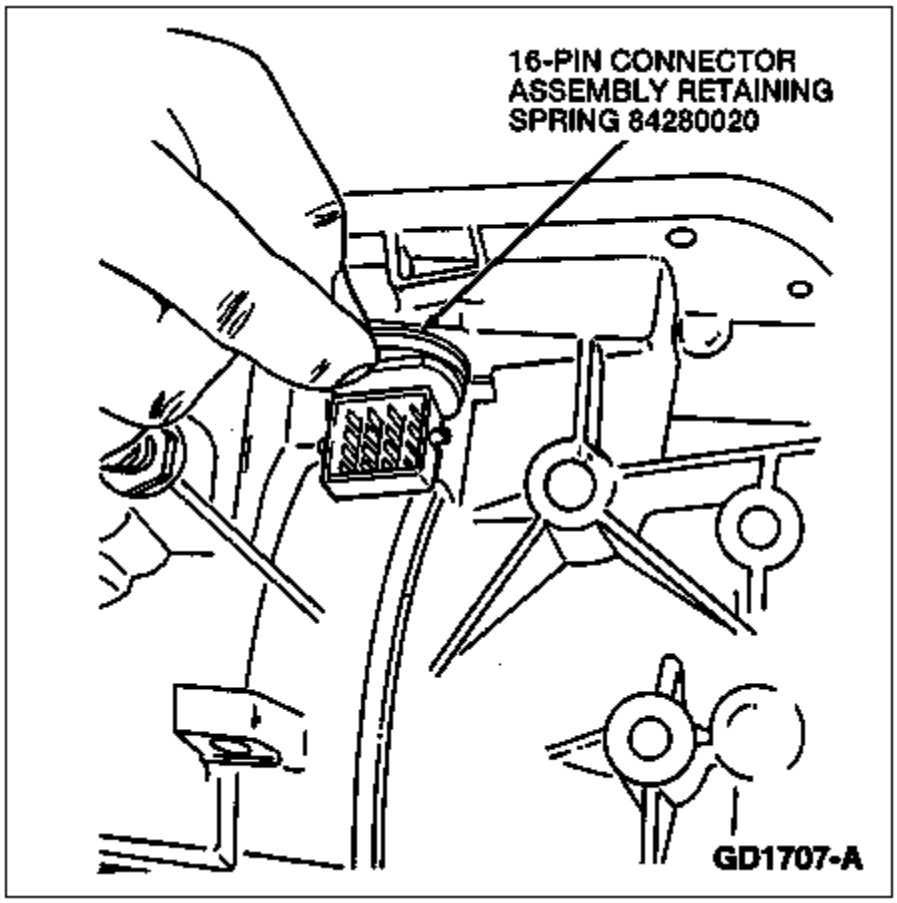

101. **NOTE: Align the slot on the turbine shaft speed (TSS) sensor connector with the slot on the 16-pin connector assembly.**

Carefully install the TSS sensor connector into the 16-pin connector assembly.

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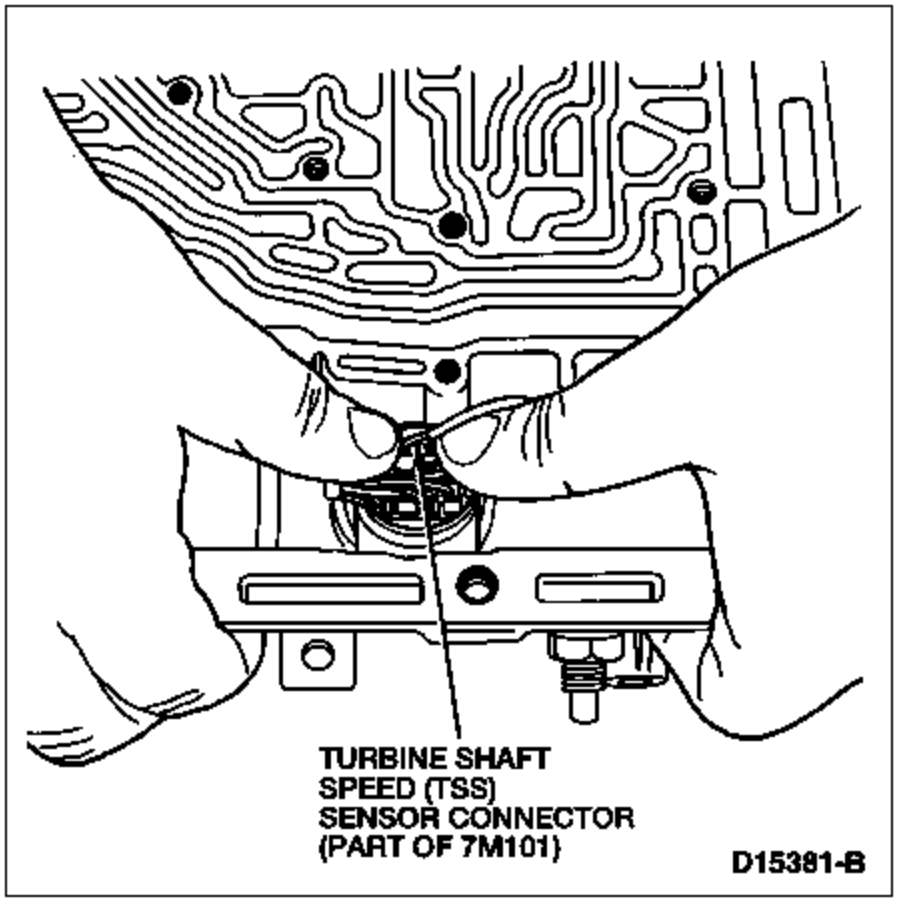

102. Carefully insert TSS sensor connector wires into the retaining slot on the 16-pin case connector.

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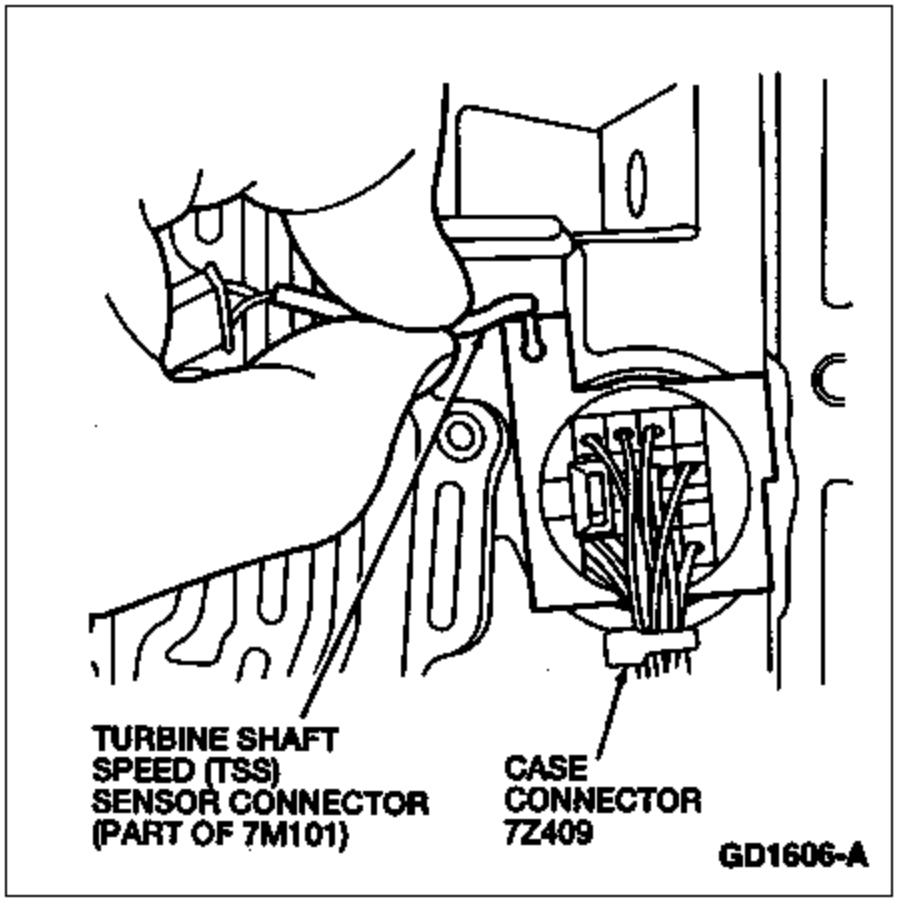

103. Install the valve body guide pins into the case in the positions shown.

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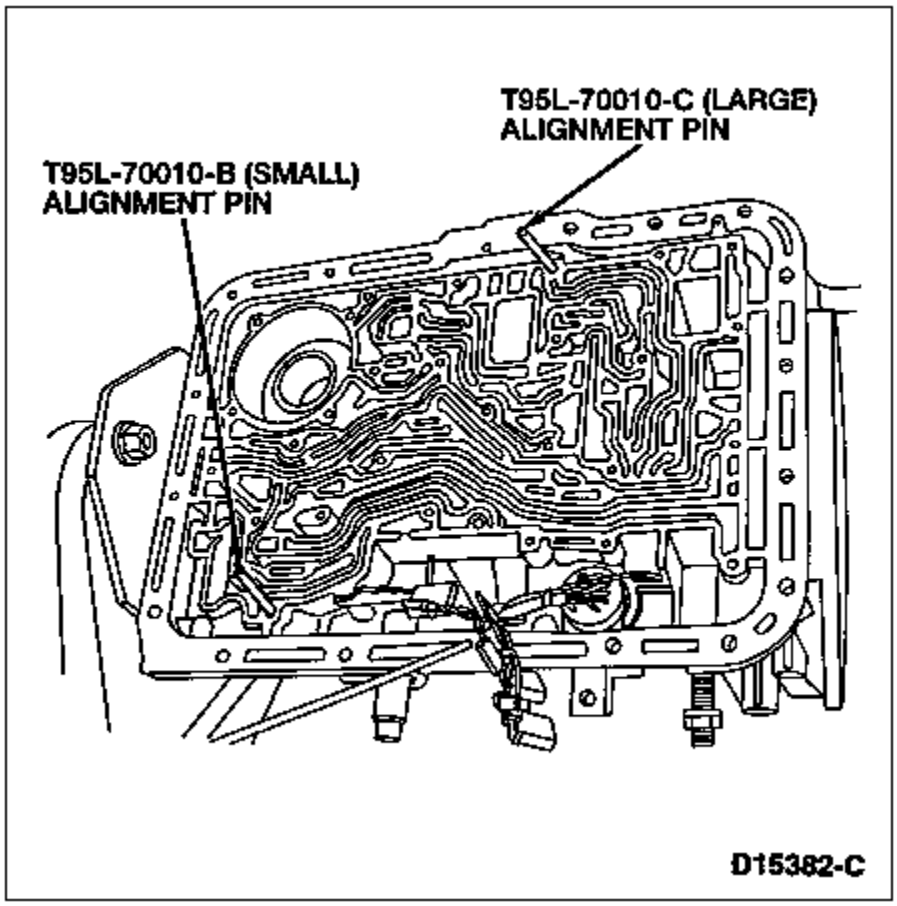

104. **NOTE: Ensure main control assembly gasket is properly aligned.**

Install the main control assembly on the case. Align the manual valve with the manual valve inner lever pin as shown.

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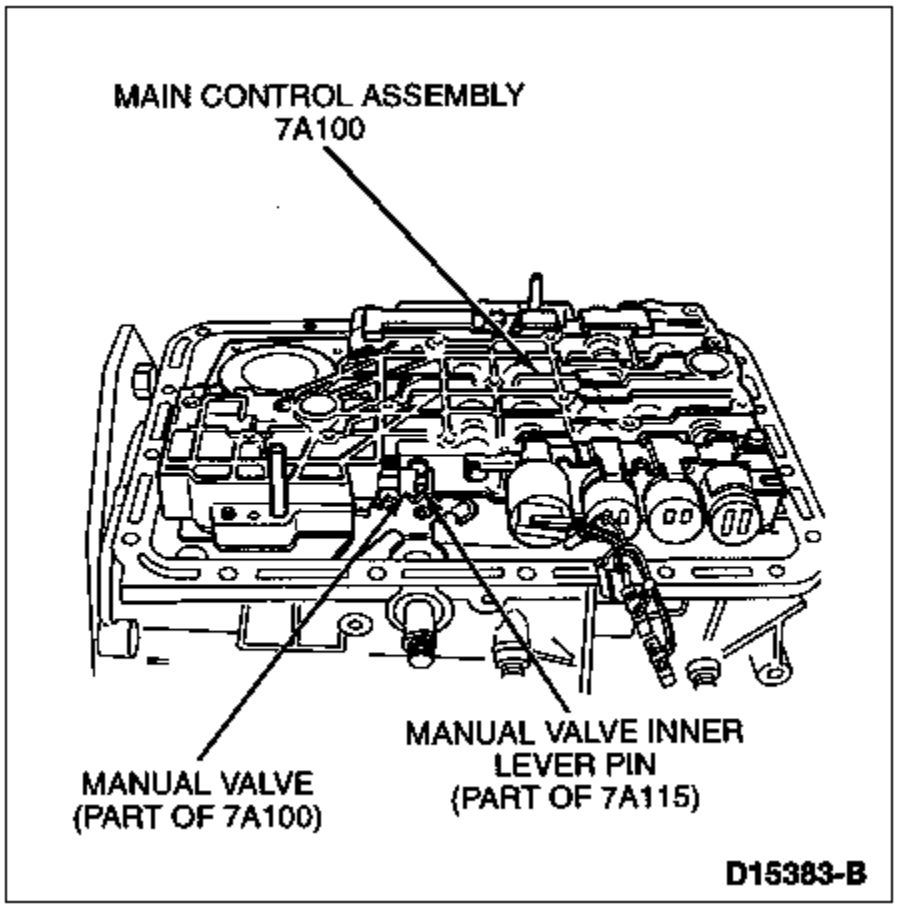

105. Install four M6 x 45 mm main control assembly-to-case screws in location A. Fingertighten.

Main Control Assembly Screws and Locations

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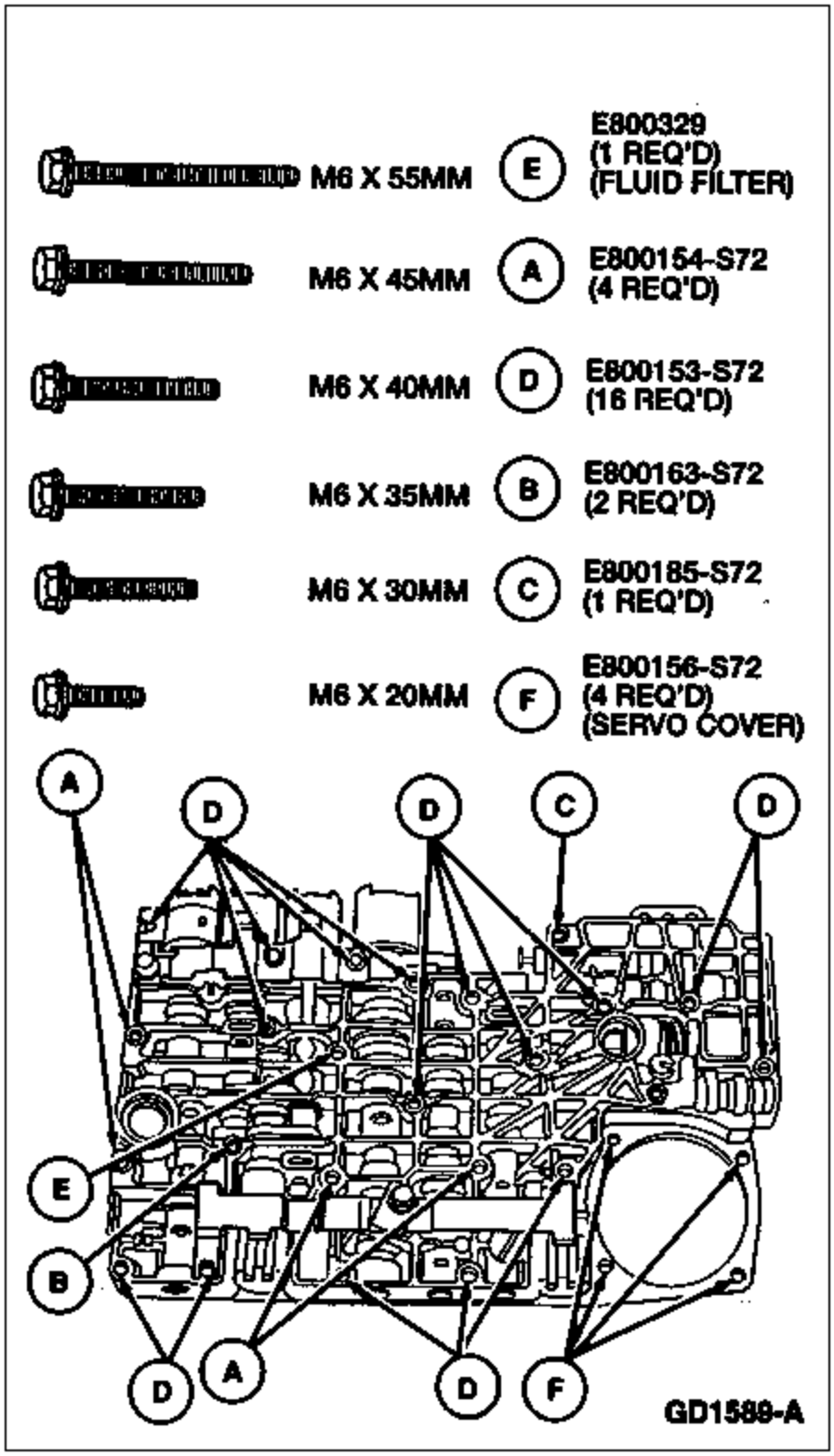

106. Install two M6 x 35 mm main control assembly-to-case screws in location B. Fingertighten.

107. Install one M6 x 30 mm main control assembly-to-case screw in location C. Fingertighten.

108. Remove both Valve Body Guide pins T95L-70010-B and T95L-70010-C.

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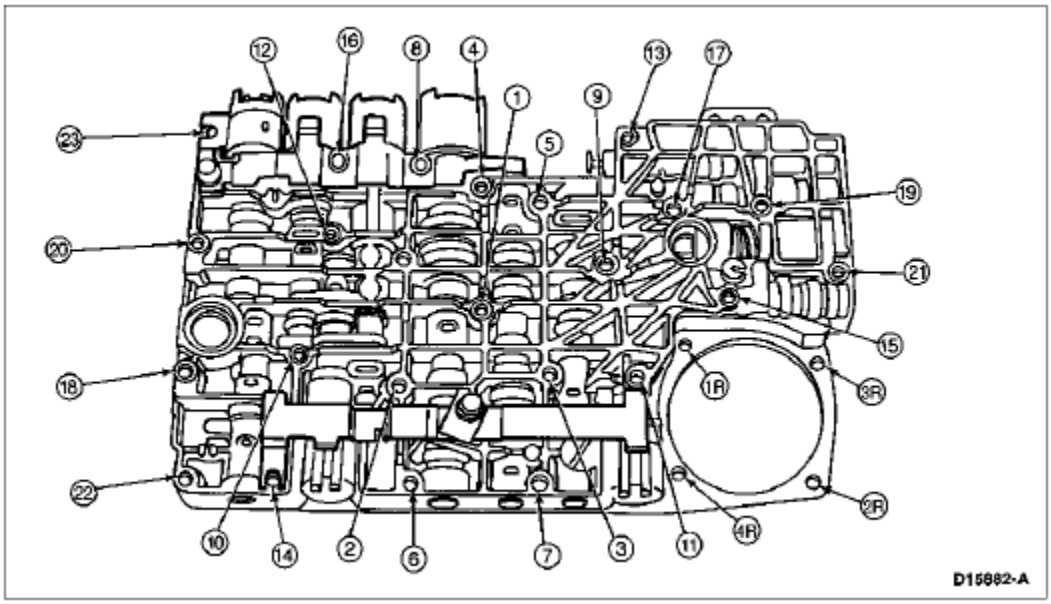
109. Install sixteen M6 x 40 mm main control assembly-to-case screws in location D. Fingertighten.

110. Tighten all main control assembly-to-case screws including reverse servo cover sequence (1R, 2R, 3R and 4R), to 8-11 Nm (71-97 lb-in) in sequence shown, using a 10 mm socket wrench.

Tightening Sequence



111. Install the manual valve detent spring. Install the manual valve detent spring screw in location A. Tighten the manual valve detent spring screw to 8-11 Nm (71-97 lb-in).

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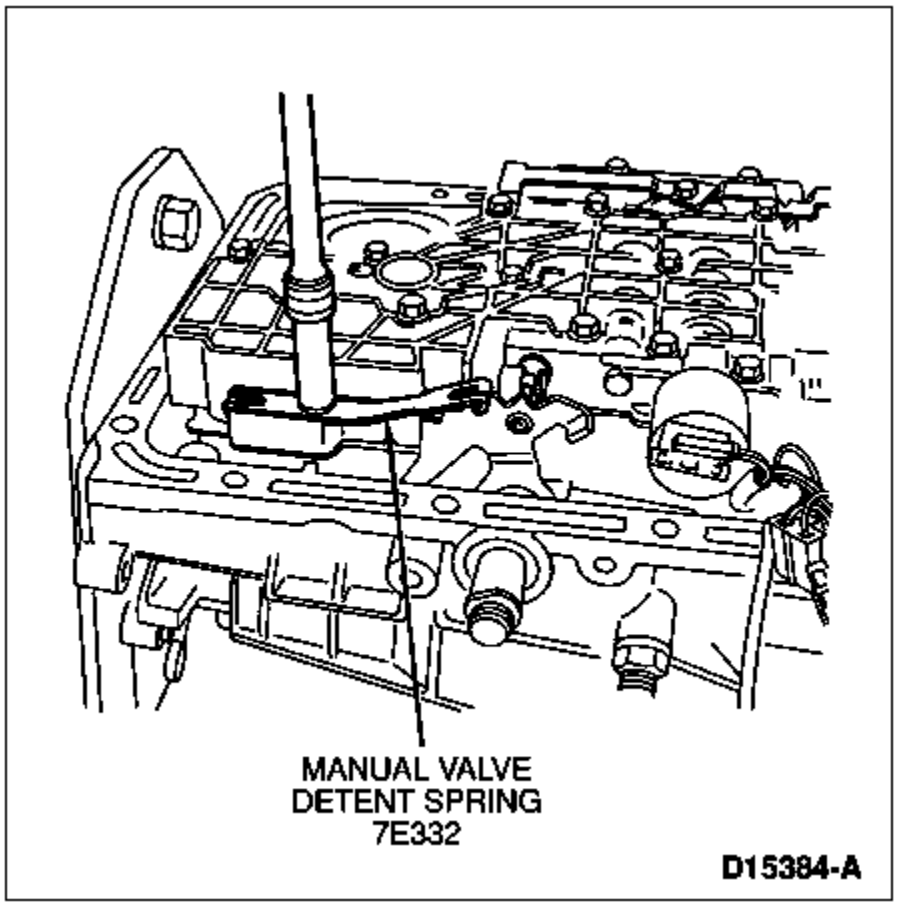

112. **NOTE: Perform Steps 105 through 112 only if rear reverse servo piston and rod is to be checked.**

Remove the reverse servo piston and rod from the case.

113. **NOTE: An A4LD Reverse Servo Return Spring D4ZZ-7D031-A is to be used only as a test spring.**

Install the reverse servo piston and rod into the servo bore along with a D4ZZ-7D031-A reverse servo return spring.

114. Install a new reverse servo separator plate cover gasket. Install Servo Rod Selecting Gauge T74P-77190-A and tighten with the three screws.

115. Tighten the servo gauge adjusting screw to 4 Nm (35.5 lb-in).

116. Install Dial Indicator with Bracketry TOOL-4201-C or equivalent on the transmission case. Position the indicator on the piston pad. Set the dial indicator to zero.

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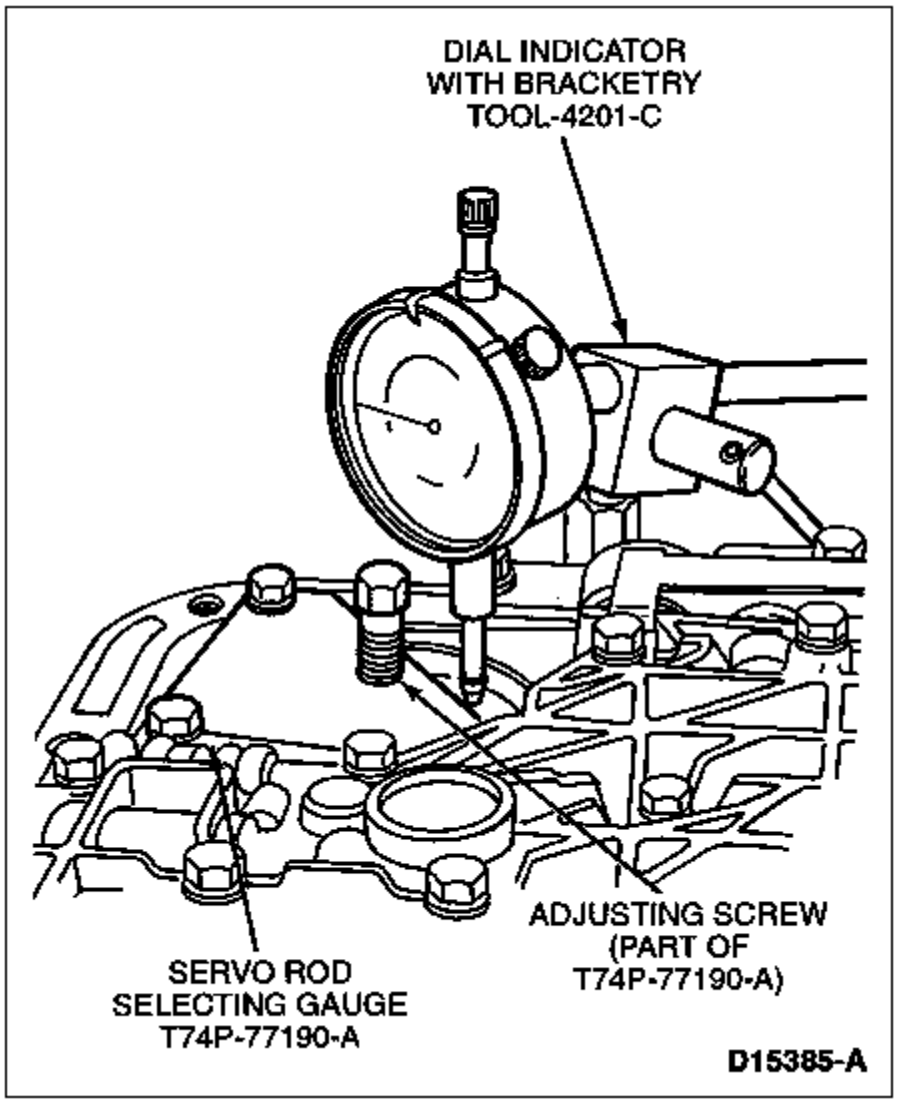

117. **NOTE: If the piston travel in this step is 3-5.6 mm (0.120-0.220 inch), it is within specification. If the piston travel is greater than 5.6 mm (0.220 inch), use the next longer piston and rod. If the piston travel is less than 3 mm (0.120 inch), use the next shorter piston and rod.**

Back out the servo gauge adjusting screw until it bottoms out on the tool. Record the distance the servo piston traveled.

118. **CAUTION: Make sure the test spring is removed after this step.**

Use the above procedure to check the piston travel with the newly selected reverse band servo piston and rod (if required) to make sure that the piston travel is 3-5.6 mm (0.120-0.220 inch).

Remove the servo gauge and the reverse band servo return spring.

NOTE: Grooves are located on reverse servo rod.

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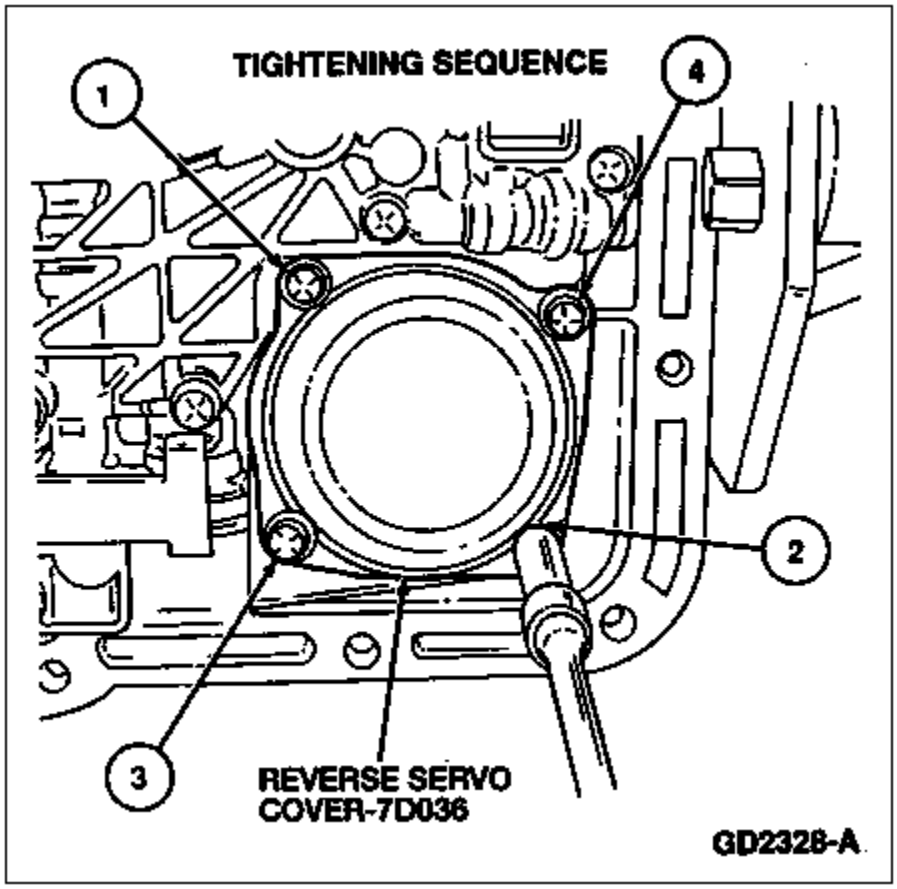
Length — mm	Length — Inches	I.D.
54/53	2.112/2.085	1 Groove
51/50	2.014/1.986	No Groove
49/48	1.915/1.888	2 Grooves

119. **CAUTION: The reverse servo test spring must be removed.**

Install the reverse servo cover and the four reverse servo cover-to-case screws. Tighten the reverse servo cover-to-case screws to 12-14 Nm (106-124 lb-in) in the sequence shown.



120. Carefully press down to install the solenoid connectors on the solenoids as shown.

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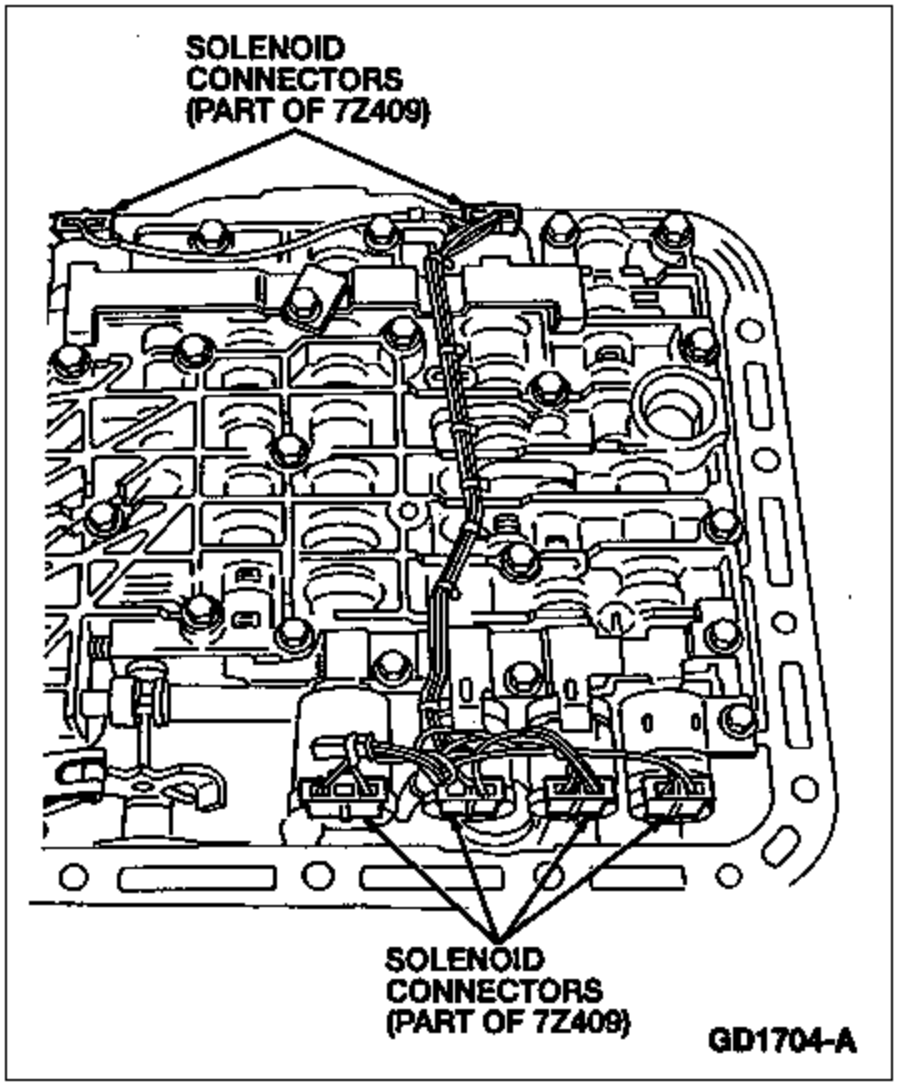

121. **CAUTION: Excessive pressure may break the locating pins.**

Install the wiring loom protector and guide. Align the pins in the holes of the solenoid clamps and gently push down.

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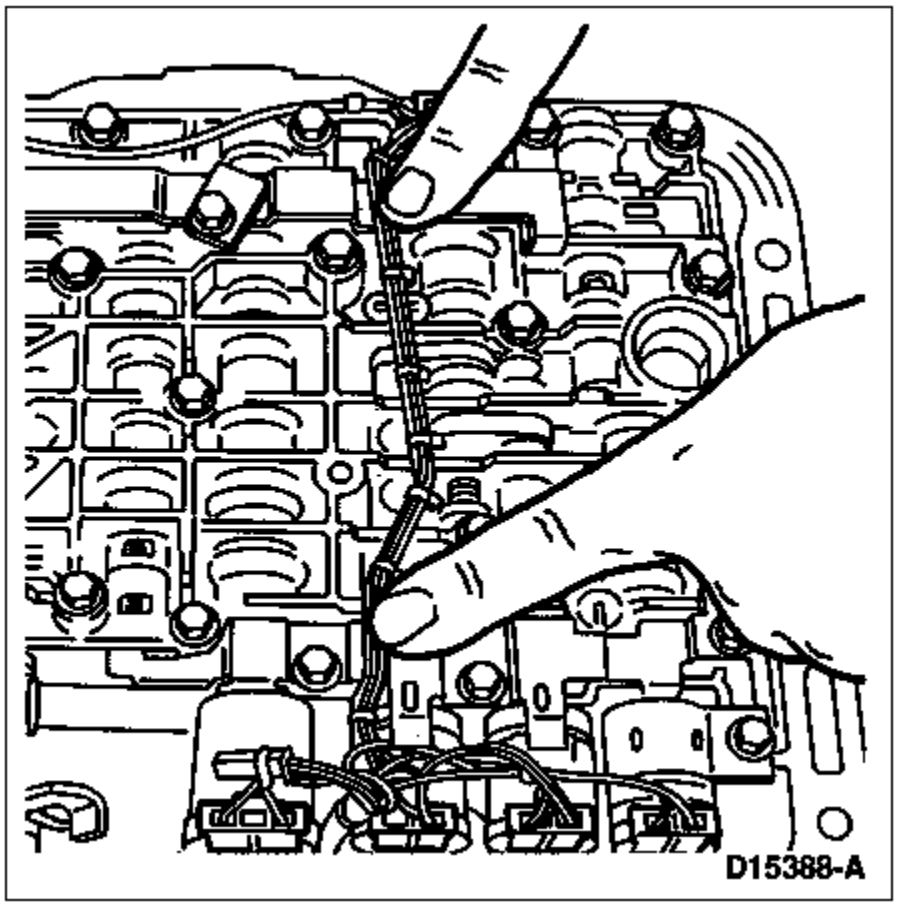
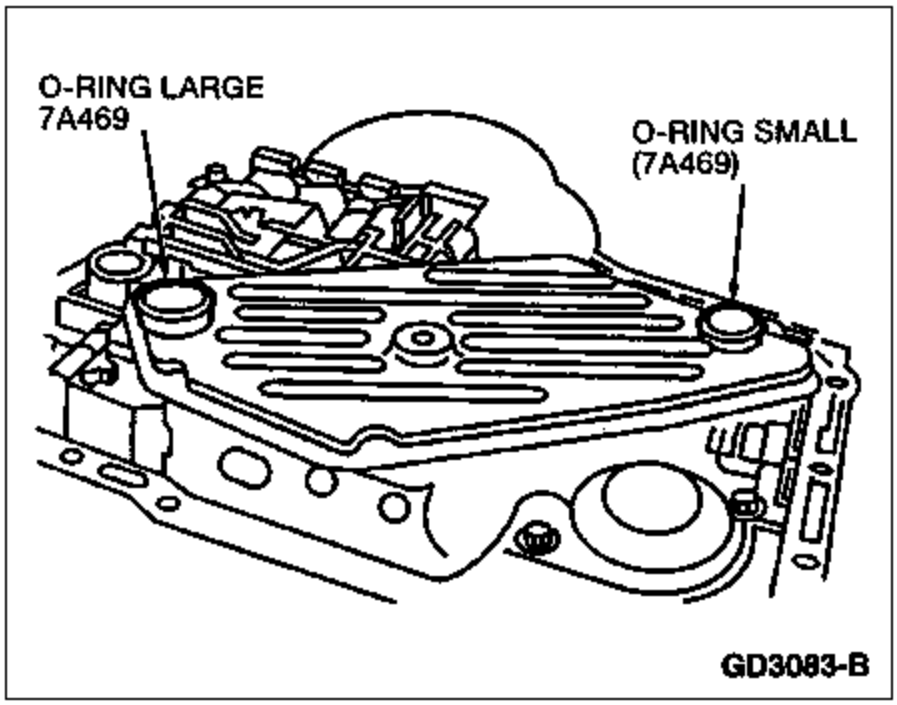


122. Ensure that both O-rings are properly installed onto filter prior to installation.



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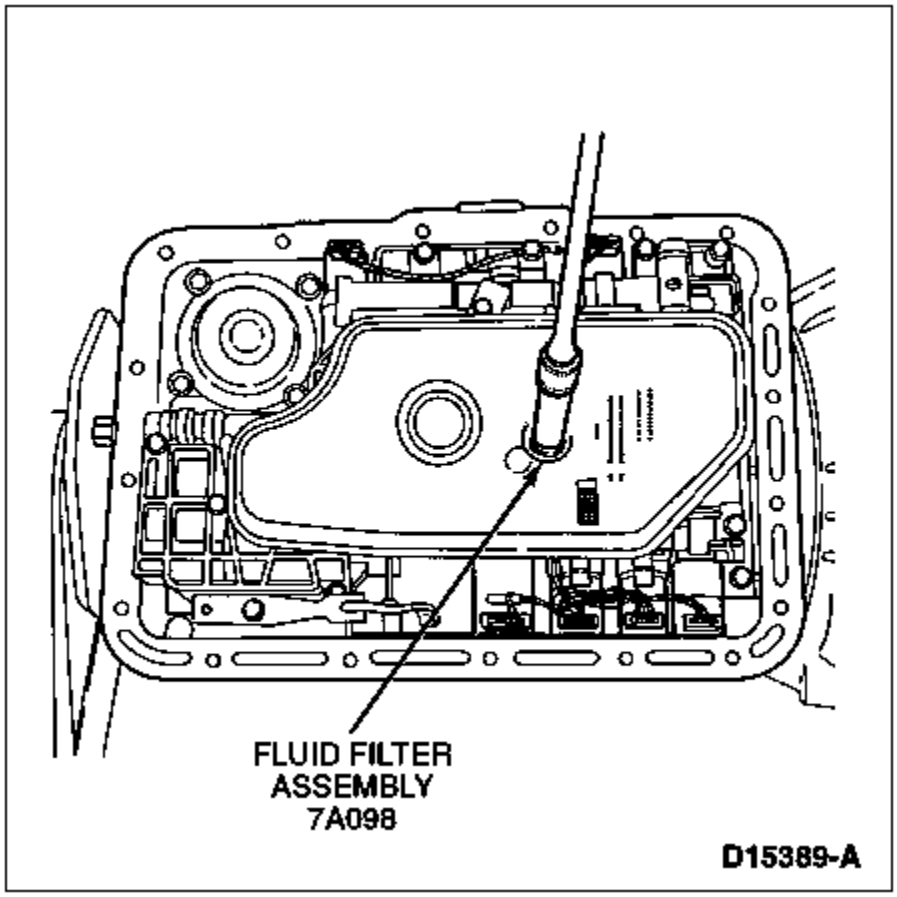
123. **CAUTION: Lubricate the fluid filter O-rings with MERCON V® XT-5-QM approved fluid, or they may be damaged.**

Lubricate and install new O-rings onto filter assembly. Install a new fluid filter assembly into the main control assembly. Install one "E" length M6 x 55 fluid filter assembly-to-main control assembly screw and tighten to 8-11 Nm (71-97 lb-in).



124. Install Rotunda Transmission Tester 007-00130 on the transmission 16-pin case connector.

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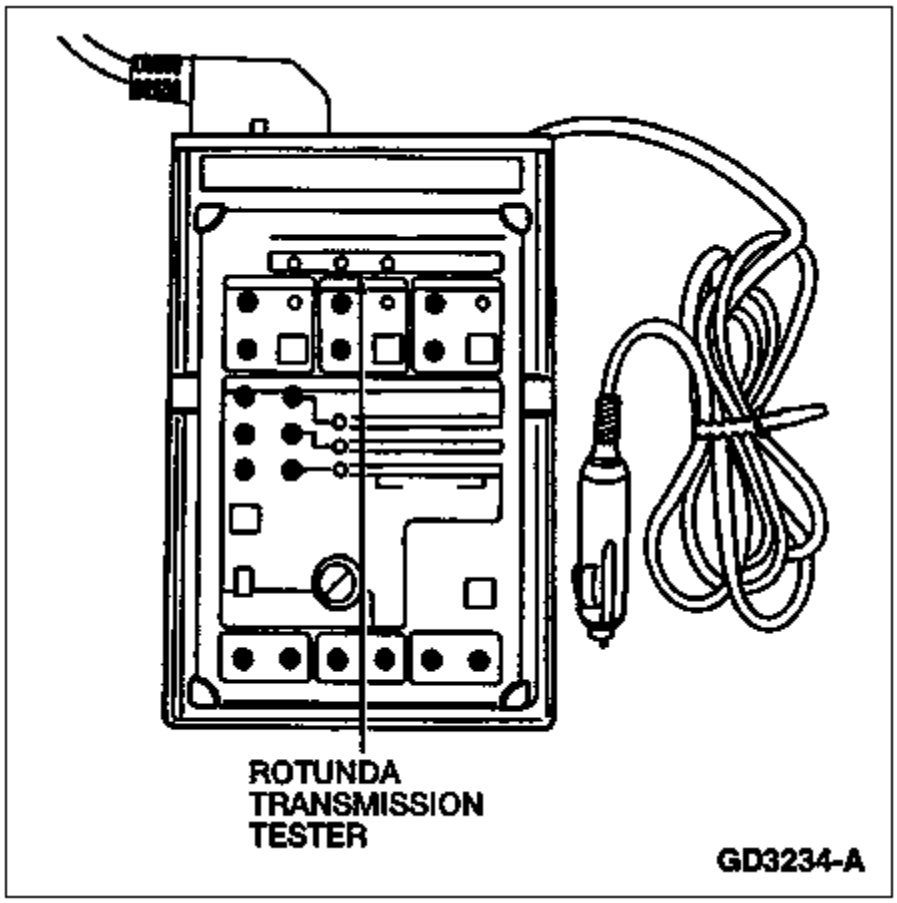

125. Use Rotunda Transmission Tester 007-00130 and the 4R44E/4R55E Cable/Overlay 007-00106 to perform the solenoid static function check bench testing procedures. Refer to Diagnosis and Testing in this section. This procedure will verify the electrical function of all solenoids prior to installing the fluid pan.

126. Depress the lock tab and remove the transmission tester.

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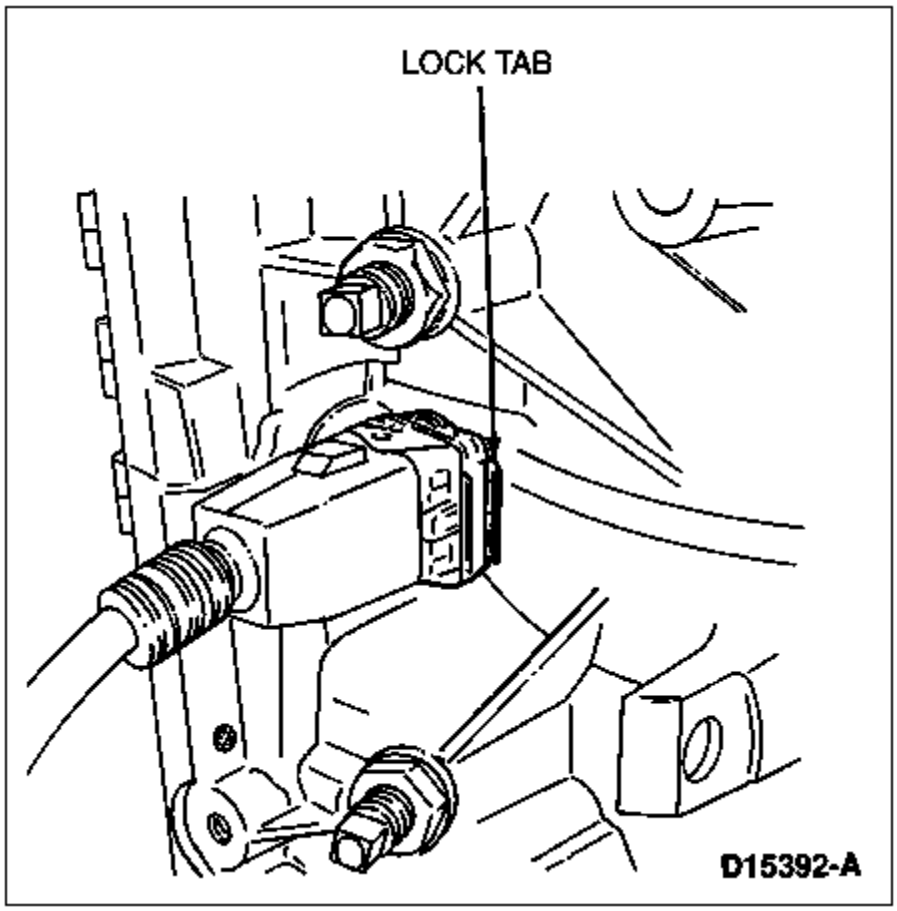

127. Position a new fluid pan gasket on the case fluid pan rail.

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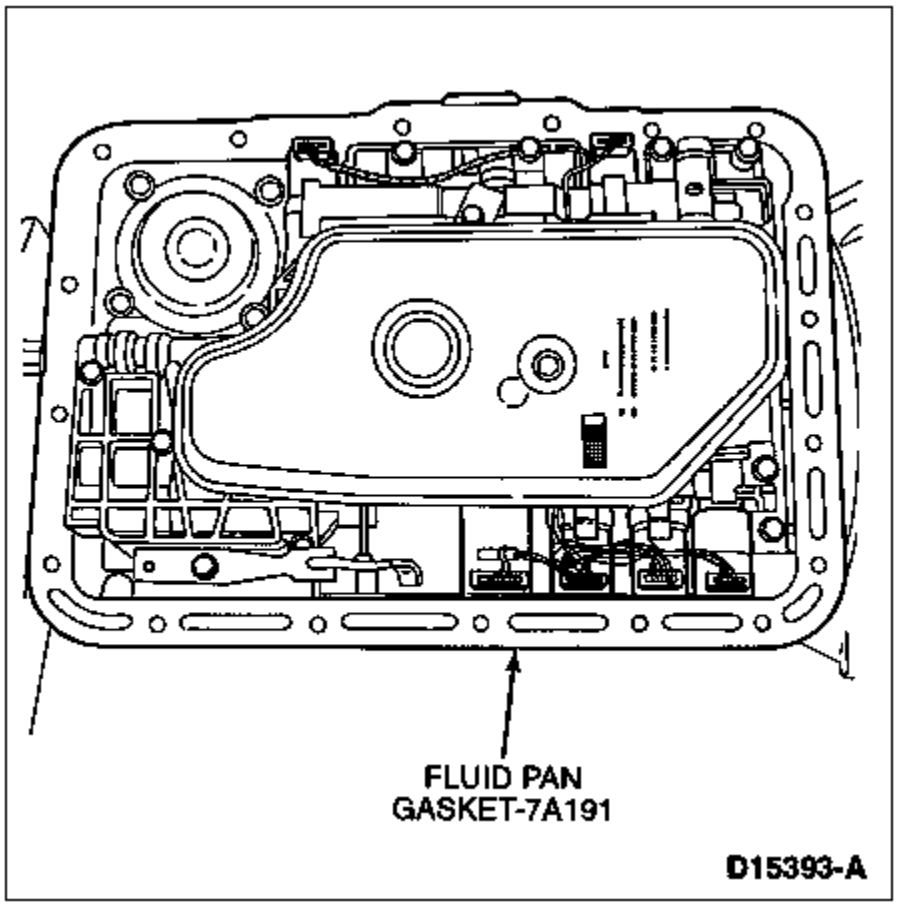

128. Install the fluid pan on top of the gasket. Use a 13 mm socket wrench to install the eighteen M8 x 16 mm fluid pan-to-case screws. Tighten the fluid pan-to-case screws to 13-15 Nm (115-133 lb-in).

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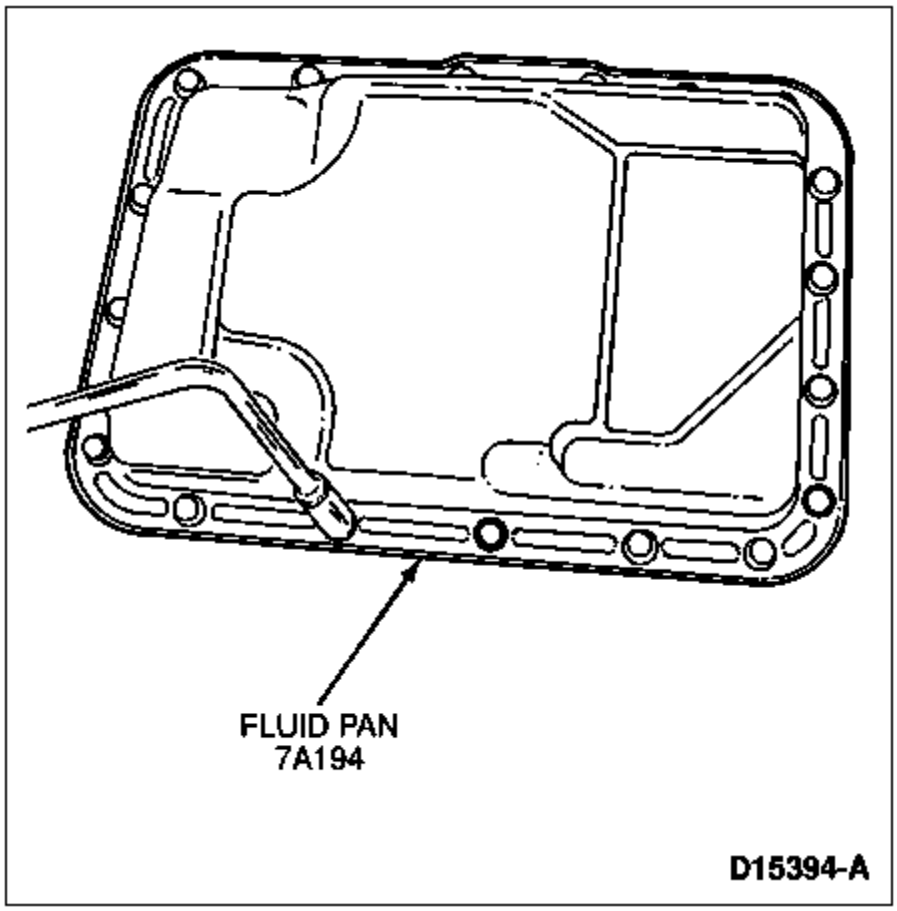

129. Remove the transmission from the bench fixture pivot. Place the transmission on a flat surface. Remove the fixture and adapter plate.

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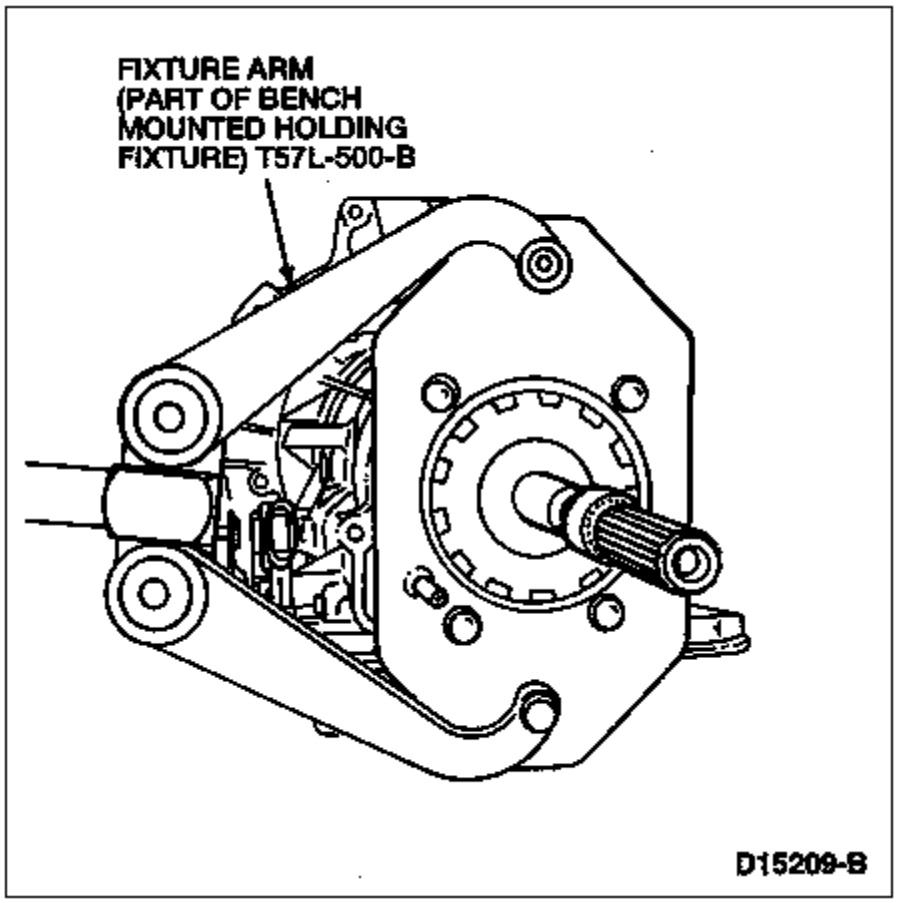

130. **CAUTION: Make sure the parking lever actuating rod is correctly seated into the case parking rod guide cup.**

NOTE: Use petroleum jelly to hold the gasket in place.

NOTE: The guide cup is press-fit into the extension housing and is not serviced separately.

Install a new extension housing gasket on the case.

131. Install the parking pawl, pawl return spring and pawl shaft into the extension housing.

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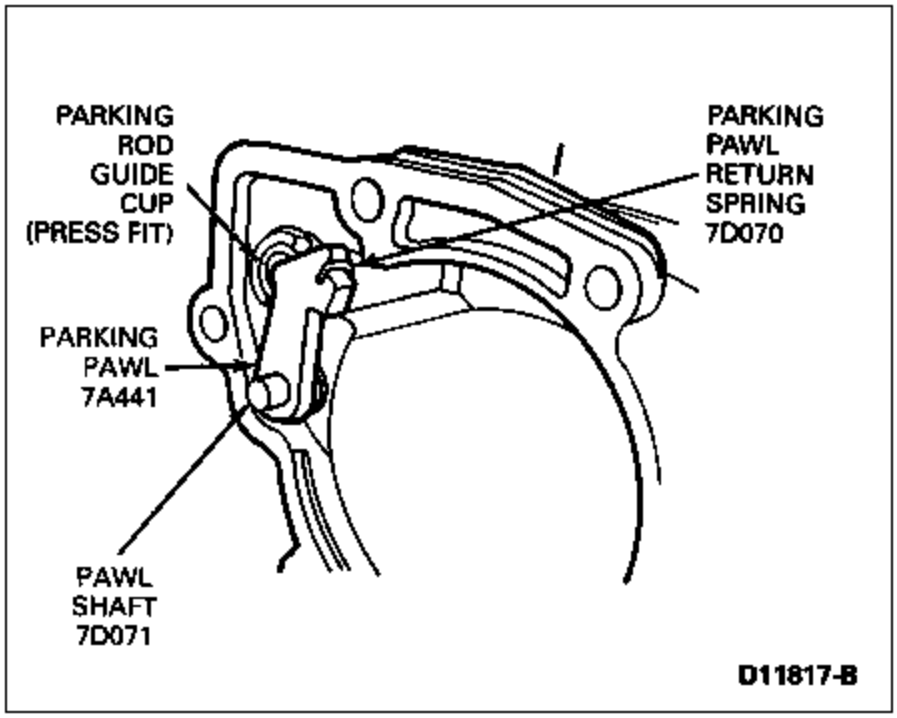

132. Install the extension housing. Install the five M10 x 30 mm extension housing-to-case screws and one stud. Tighten the extension housing-to-case screws and stud to 36-52 Nm (27-39 lb-ft).

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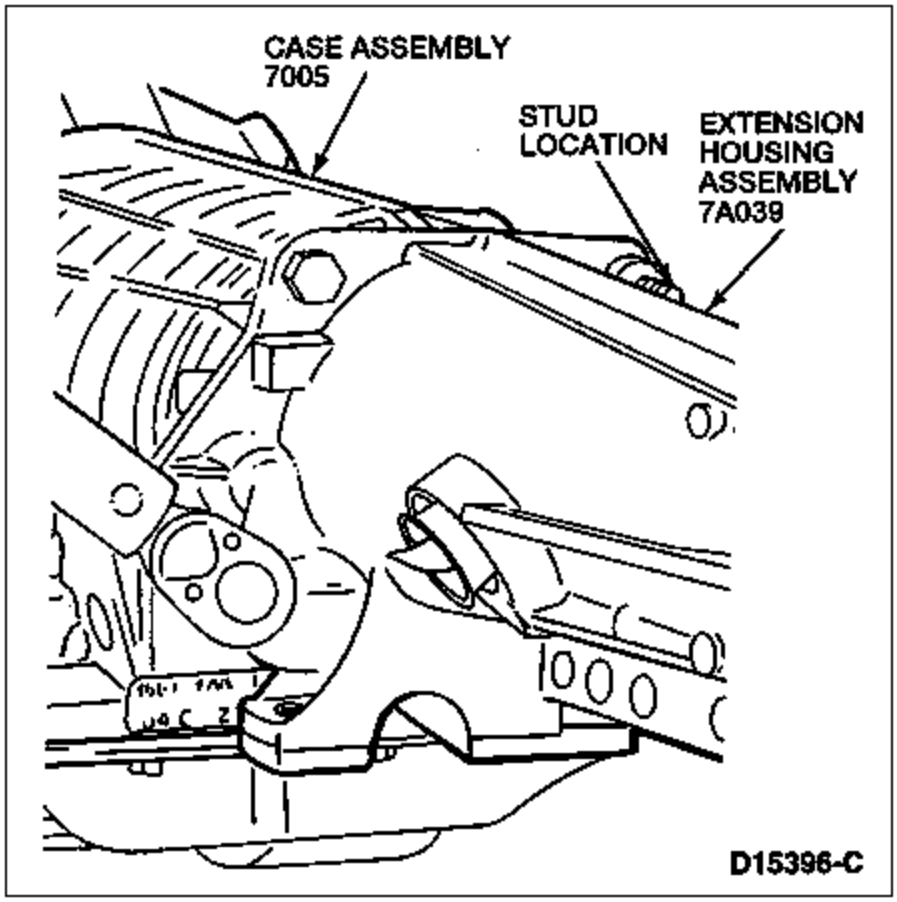

133. **CAUTION: The lube hole in the bushing must be aligned with the lube groove in the extension housing.**

CAUTION: Tool will bottom when bushing is in the proper position.

NOTE: The lube hole should be located at the 3 o'clock position with view extension from the rear.

NOTE: Install the extension housing bushing only if it was removed in disassembly.

Install the extension housing bushing using Extension Housing Bushing Replacer T77L-7697-F.

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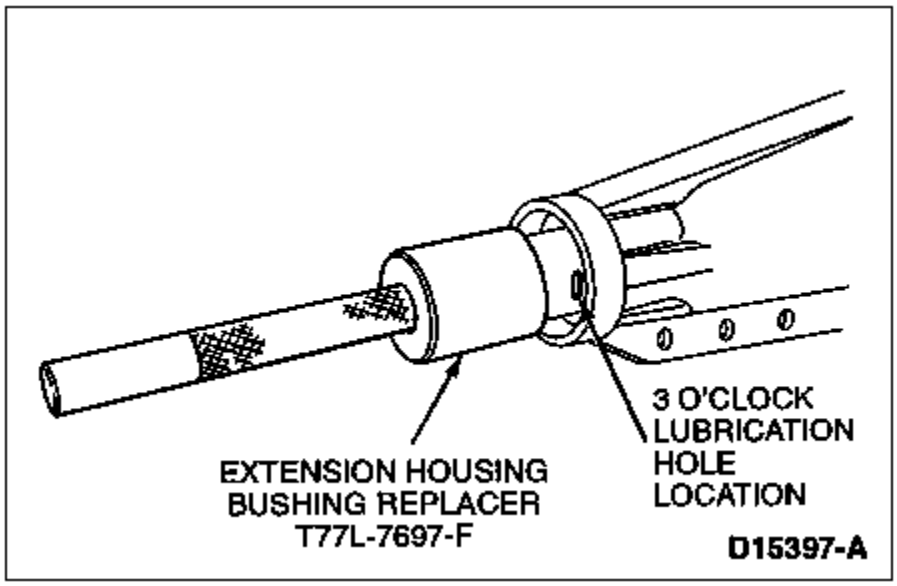
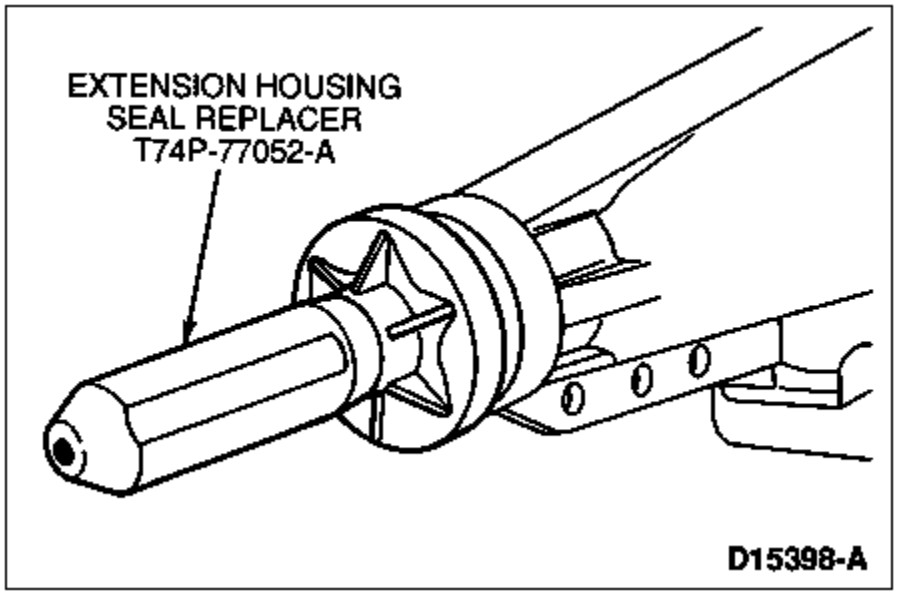


134. Position the extension housing seal drain hole at the 6 o'clock (down) position and install the extension housing seal using Extension Housing Seal Replacer T74P-77052-A.



135. Install the digital transmission range (DTR) sensor on the manual lever. Install the two TR sensor screws and finger tighten. Rotate the manual lever to the neutral position (two detents rearward).

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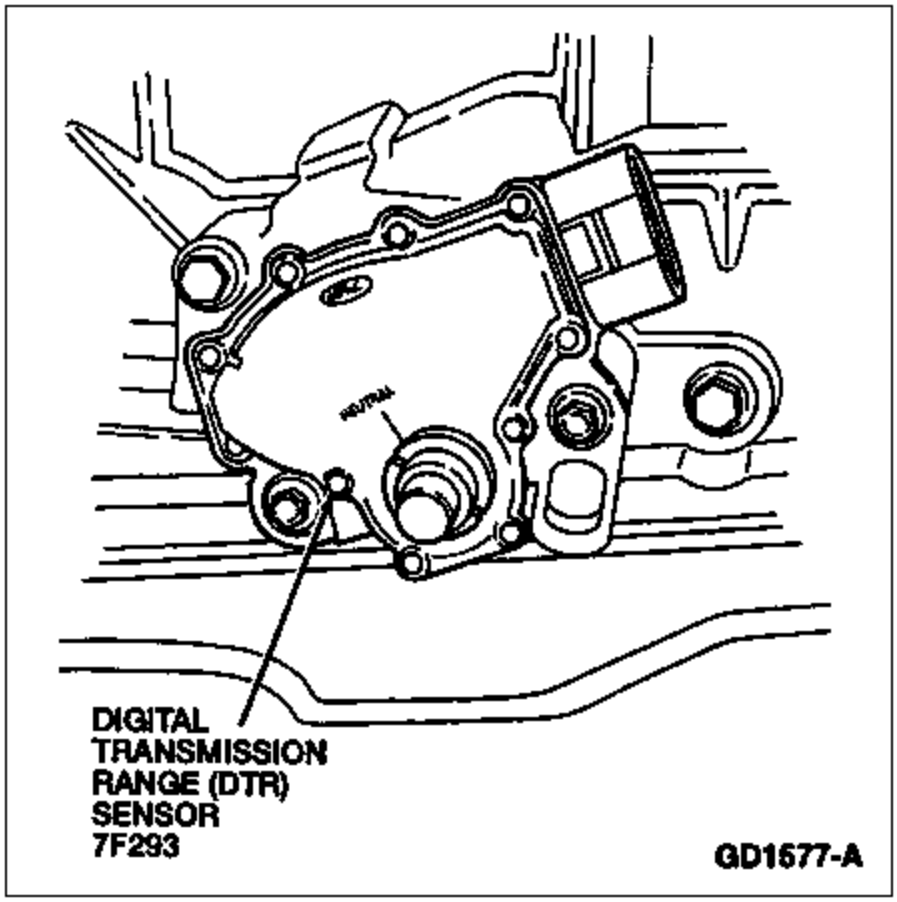

136. Install Digital TR Sensor Alignment Tool T97L-70010-A into the three slots on the DTR sensor. Tighten the TR sensor-to-case screws to 8-11 Nm (71-97 lb-in). Remove the alignment tool.

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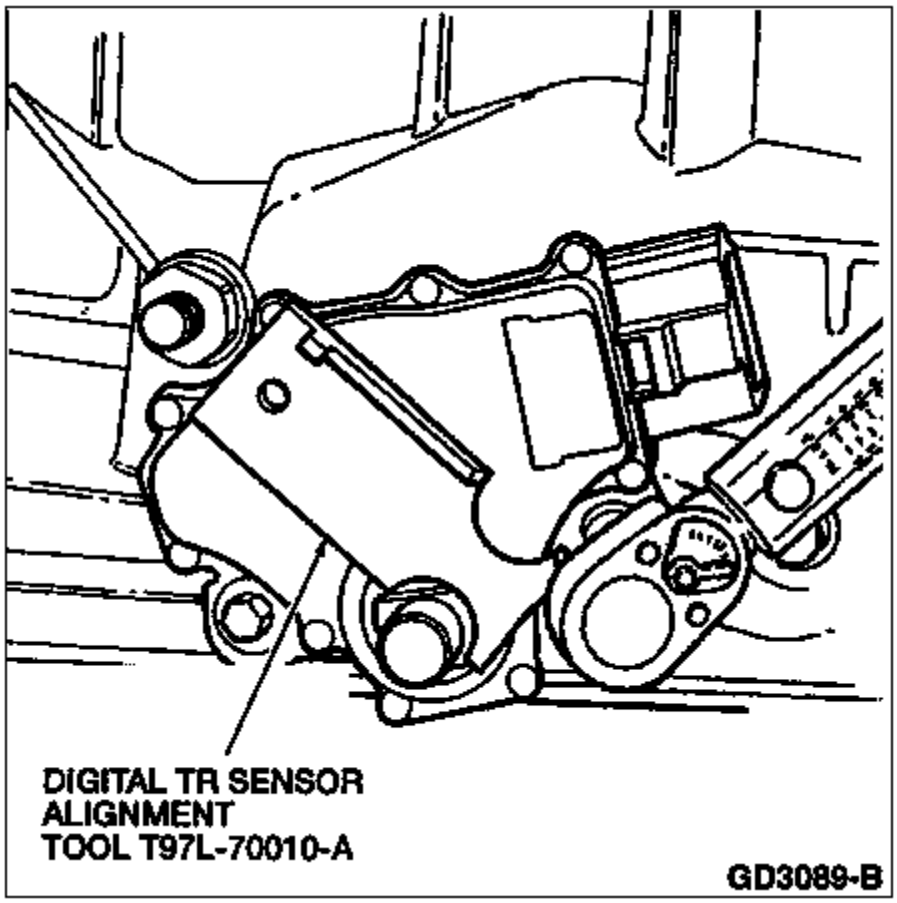

137. Install the manual control outer lever and manual control outer lever nut. Tighten the manual control outer lever nut to 41-54 Nm (30-40 lb-ft).

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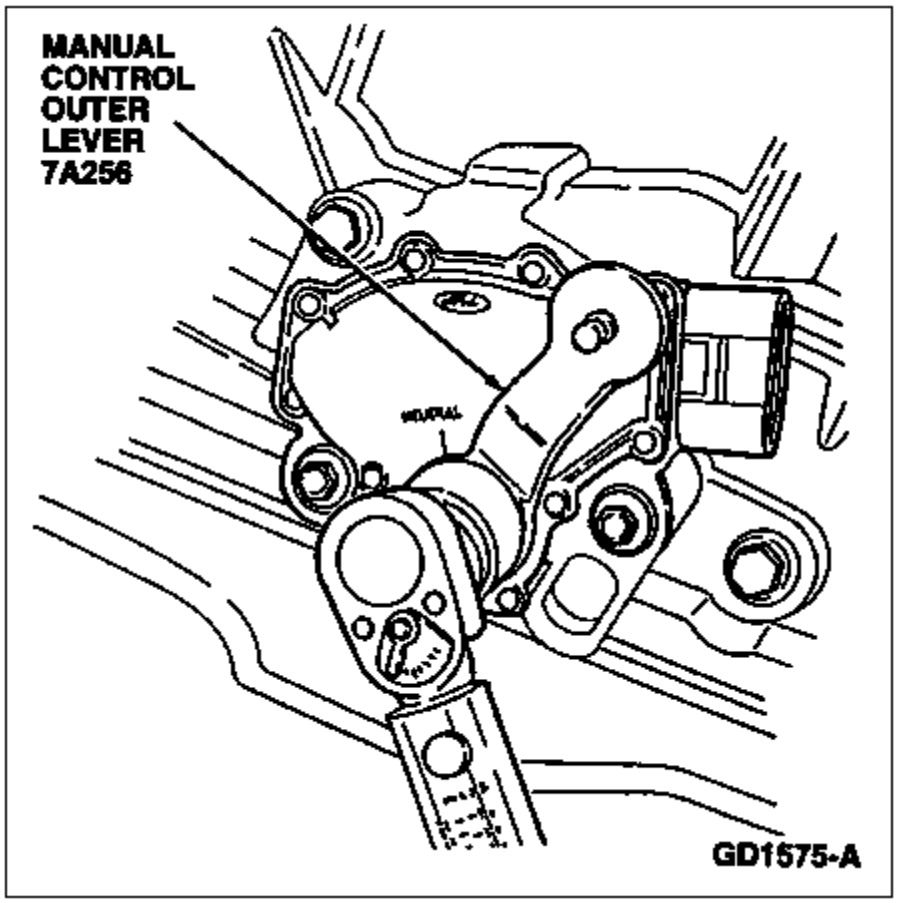

138. **CAUTION: The splines are not the same on both ends. The shaft end with the shorter splines goes into the front pump support and gear.**

Install the input shaft into the front pump support and gear.

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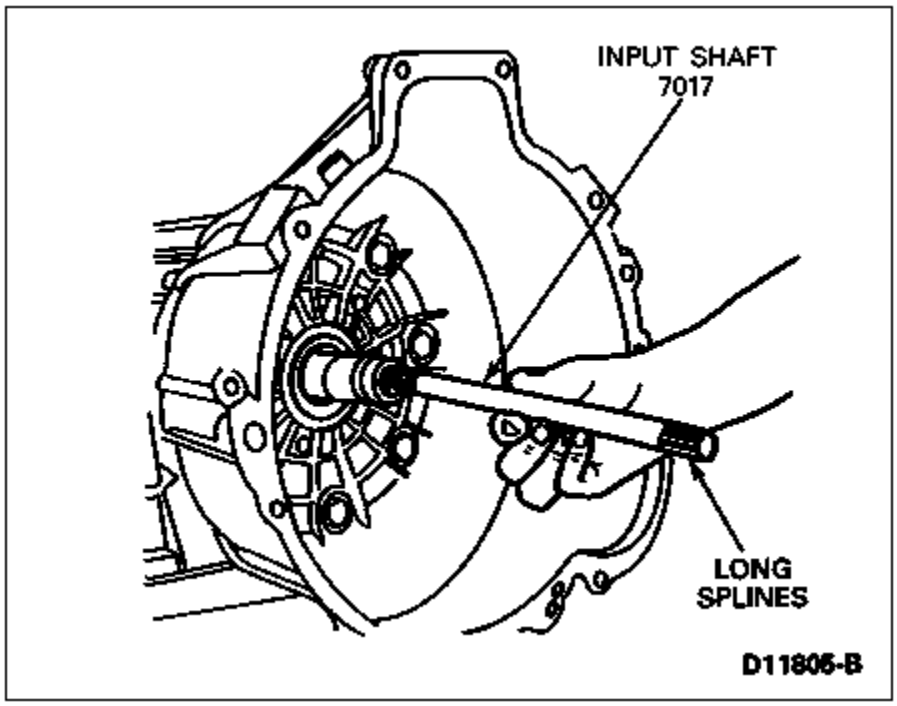

139. Insert Fluid Pump Seal Sizing Tool T95L-70010-G into pump drive gear to make sure the drive gear O-ring is properly seated prior to installing the torque converter. Remove tool.

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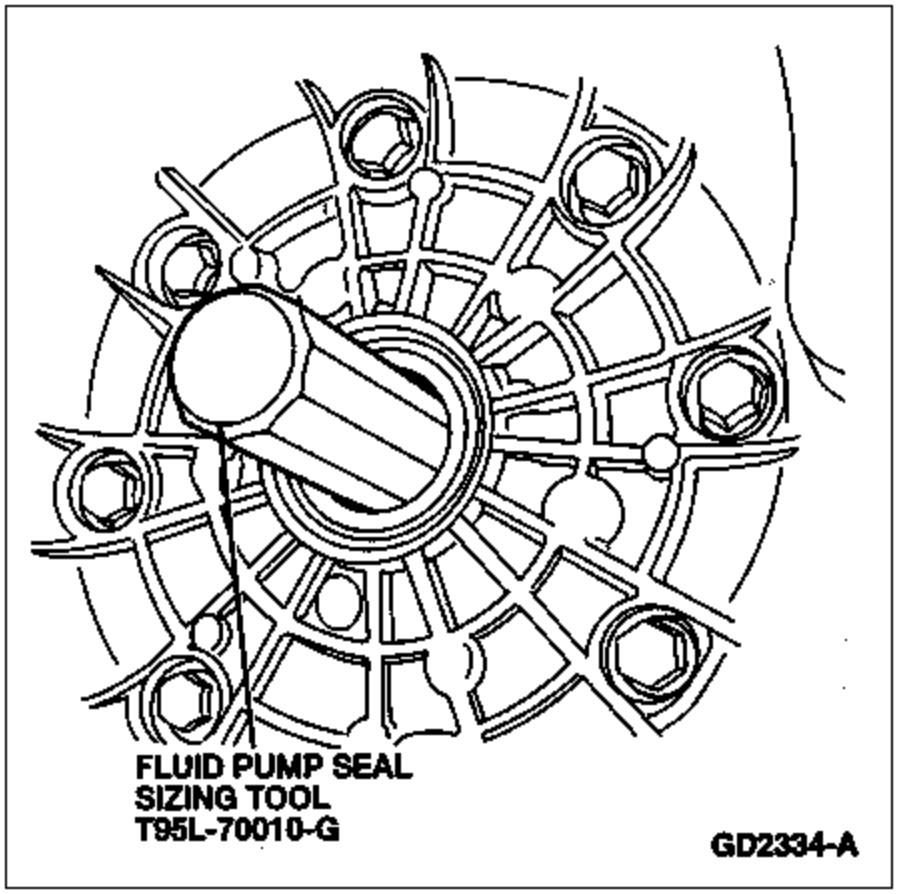

140. **WARNING: THE TORQUE CONVERTER CAN FALL OUT IF THE TRANSMISSION IS TIPPED.**

CAUTION: Do not damage the pump drive gear O-ring when installing the torque converter.

CAUTION: Make sure the converter hub is fully engaged in the front pump support and gear and rotates freely. Do not damage the hub seal.

CAUTION: If the torque converter slides out, the hub seal may be damaged.

Lightly lubricate the converter hub with MERCON V® XT-5-QM transmission fluid.

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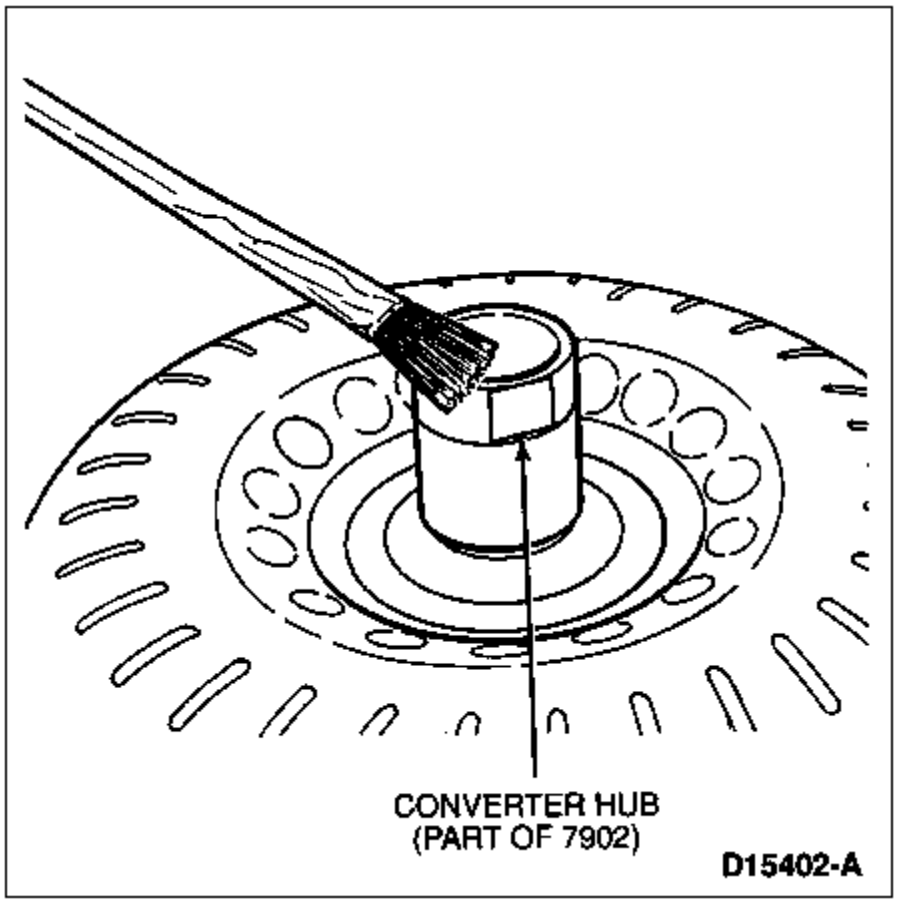

141. **WARNING: THE TORQUE CONVERTER IS HEAVY, ESPECIALLY WHEN FULL OF FLUID.**

Use Torque Converter Handles T81P-7902-C to install the torque converter by pushing and rotating.

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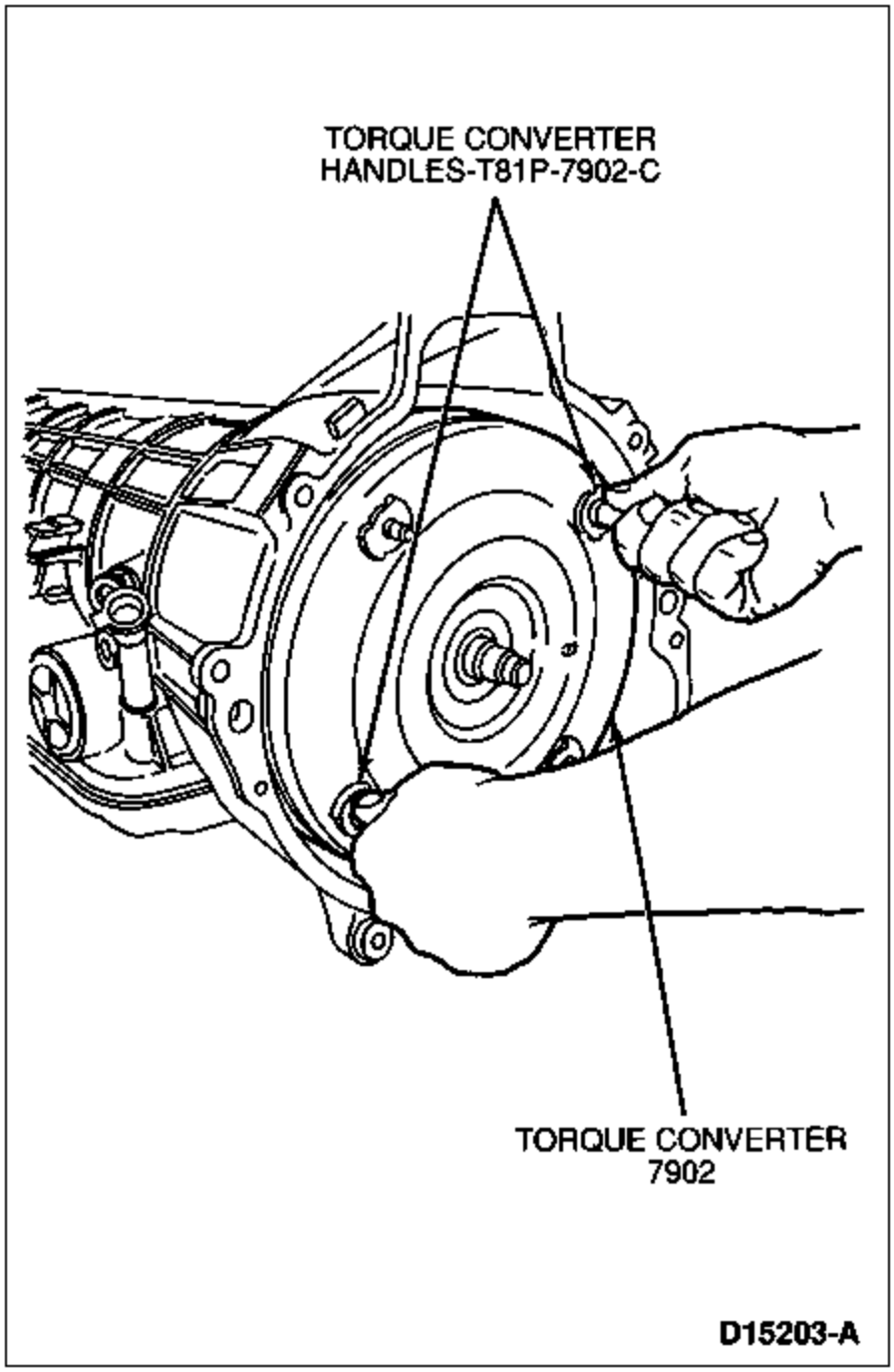

142. **NOTE: dimension "A" should be 10.23-14.43 mm (0.43-0.56 inch).**

Check dimension "A."

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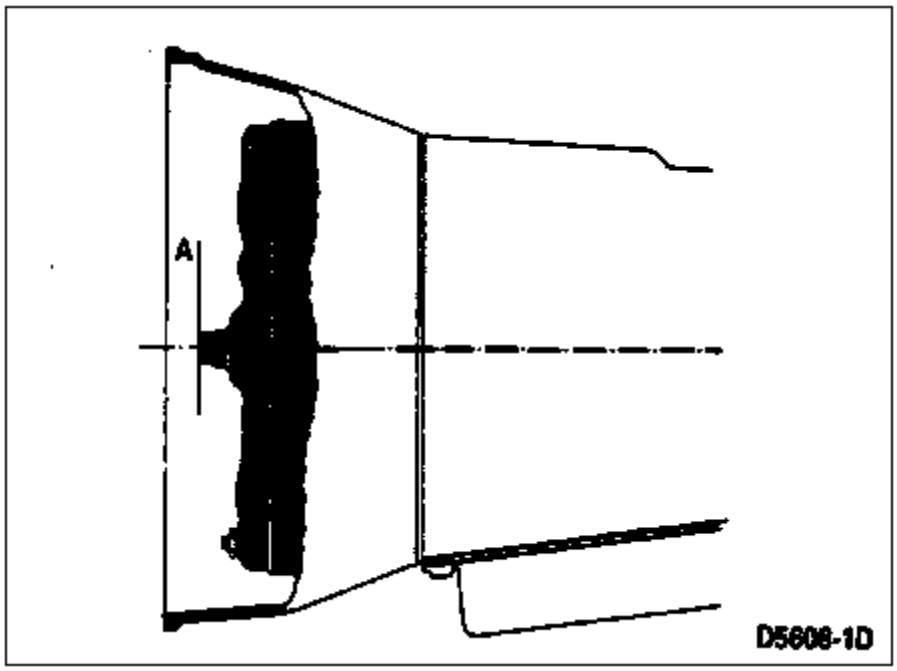
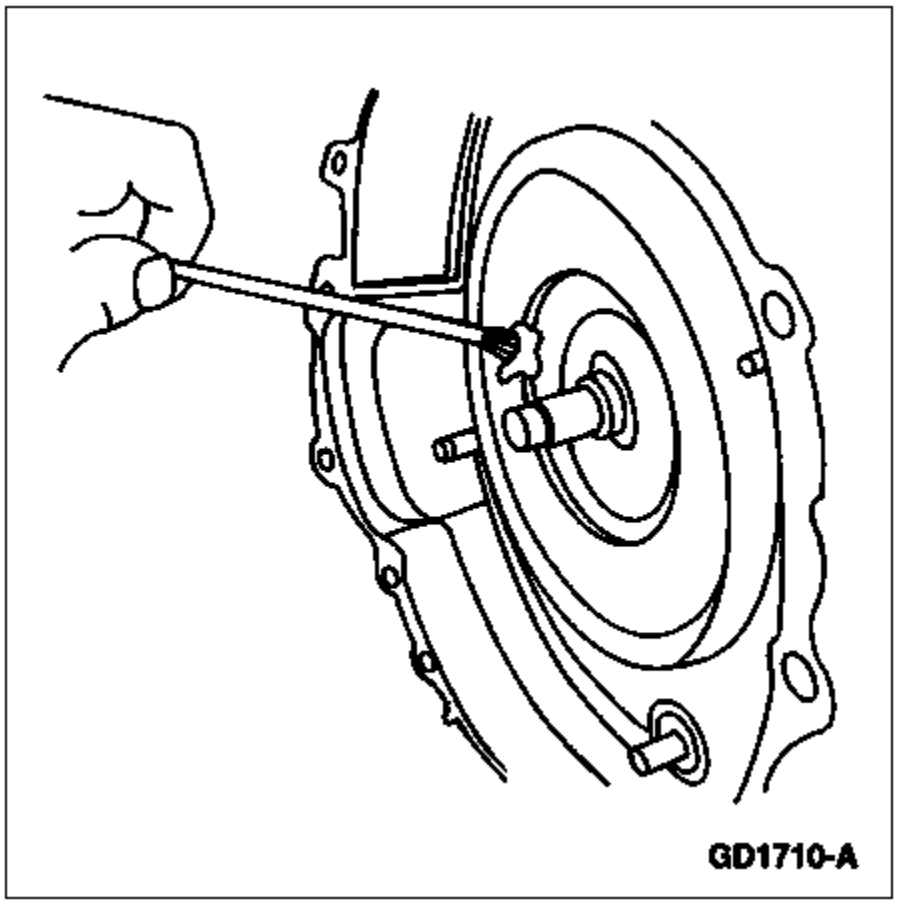


143. Prior to installation of the transmission assembly, the torque converter pilot hub must be properly lubricated. Use Ford Multi Purpose Grease (D0AZ-19584-AA, specification ESA-M1C45-A).



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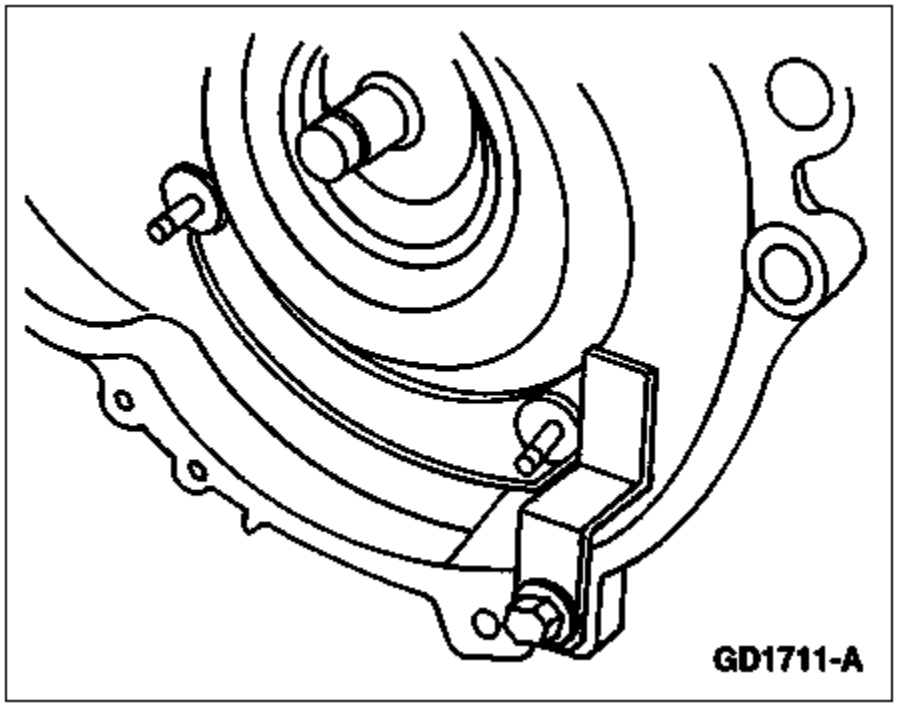
144. Before installing transmission, make sure that the transmission cooling system (line and cooler[s]) have been thoroughly flushed. Use the procedure found in this section. If contamination cannot be removed, or proper flow cannot be obtained, replace cooler and/or lines.

145. Install Torque Converter Holding Tool T97T-7902-A onto the case using standard bolt and nut to prevent converter from falling forward when moving to jackstand and to vehicle.



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Transmission — 4x2 Aerostar

1. Install transmission and tighten bolts to 44-60 N-m (32-44 lb-ft).

2. **CAUTION: Use care not to bend or otherwise damage the cooler lines.**

   NOTE: The case connector fitting must be held in place to prevent it from moving while tightening the tube nut.

   Remove the caps from the lines and fittings. Securely install the transmission cooler lines to the transmission fittings.

3. Install new torque converter nuts and tighten them to 34-46 Nm (25-34 lb-ft).

4. Position the dual TWC converter assembly to the exhaust manifolds. Install four bolts and tighten them to 34-46 Nm (25-34 lb-ft).

5. Install the exhaust hanger to the transmission mount. Tighten the retainer to 20-27 Nm (15-20 lb-ft).

6. Raise the transmission, position the crossmember, and install through bolts and nuts. Tighten the retainers to 37-52 Nm (27-38 lb-ft).

7. Lower the transmission onto the crossmember. Remove the transmission jack adapter plate from the transmission. Lower and remove the jack.

8. Install the nuts to the transmission support insulator. Tighten the nuts to 85-118 Nm (63-87 lb-ft).

9. Reconnect the 8-pin and 16-pin connectors at the left rear cylinder head, reconnect the HO2S, and install the shift indicator cable to the bracket and lever.

10. Position the transmission access cover and install the two transmission access cover screws. Tighten them to 16-22 Nm (12-16 lb-ft).

11. Position the starter motor and ground wire. Install the bolts and tighten them to 22-28 Nm (16-21 lb-ft).

12. Lightly coat the slip yoke with High Temperature 4x4 Front Axle and Wheel Bearing Grease E8TZ-19590-A or equivalent.

13. Remove the plug and install the driveshaft. Rotate the driveshaft and align it with the index mark made during removal. Install the bolts and tighten them to 83-118 Nm (61-87 lb-ft).

14. Remove the safety stands.

15. Lower the vehicle.

16. Connect the negative battery cable.

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17. Fill the transmission to the proper level with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or equivalent and install the indicator.

18. **NOTE: A weight of 1.4kg (3 lb) must be hung on the gearshift lever to verify the lever is located firmly on the DRIVE or the OVERDRIVE detent.**

    From inside the vehicle, place the gearshift lever in the DRIVE or the OVERDRIVE position.

19. Raise the vehicle.

20. Remove the shift cable from the transmission lever ball stud. Pull the lock tab down on the shift cable body. Position the gearshift lever in the DRIVE position (three detents from the front-most lever position, with the first position counted as one). Connect the cable end fitting to the transmission lever ball stud. Push up on the lock tab to lock the cable in the correctly adjusted position.

21. Lower the vehicle.

22. Remove the 1.4kg (3 lb) weight from the gearshift lever. After making the adjustment, check for park engagement. Check the gearshift lever in all detent positions with the engine running to verify correct detent/transmission actions. Readjust if necessary.

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Transmission—4x2 Ranger

Installation

1. Position the torque converter to the transmission. Align the converter to the front pump by rotating the converter and pushing it inward until full engagement is made. Lightly lubricate the converter pilot hub using Ford Multi-Purpose Grease D0AZ-19584-AA or equivalent meeting Ford specification ESB-M1C93-B.

2. **NOTE: The torque converter must rest squarely against the flexplate. This indicates that the converter pilot is not binding in the crankshaft.**

   Position the transmission under the vehicle. Raise the transmission into position. Do not allow the torque converter drive flats to disengage the pump gear. Rotate the converter to align the studs with the flexplate mounting holes. Position the transmission to the engine.

3. **NOTE: The top right transmission-to-engine bolt, retaining the fluid level indicator tube and harness bracket, must be installed after the other transmission-to-engine bolts have been installed and tightend.**

   Install the connector bracket, fluid level indicator tube, and six transmission-to-engine bolts. Tighten the bolts to 44-60 Nm (32-44 lb-ft). Connect the 16-pin harness connectors.

4. Remove the engine support.

5. **CAUTION: Use care not to bend or otherwise damage the cooler lines. The case connector fitting must be held in place to prevent it from moving while tightening the tube nut.**

   Remove the caps from the lines and fittings. Install the transmission cooler lines. Tighten the fittings to 35-43 Nm (26-32 lb-ft). Securely install the bolt retaining the cooler line bracket to the engine block.

6. Install new torque converter nuts. Tighten the nuts to 34-46 Nm (25-34 lb-ft).

7. Install the torque converter access cover. Securely install two access cover bolts.

8. Raise the transmission and position the Y-pipe to the exhaust manifolds. Loosely install the hanger bracket bolt. Install the converter-to-tailpipe flange bolts and the Y-pipe-to-manifold bolts. Tighten the bolts to 34-46 Nm (25-34 lb-ft).

9. Install the exhaust hanger at the transmission support insulator. Tighten the retainer to 20-27 Nm (15-20 lb-ft).

10. Position the crossmember. Install the bolts and nuts. Tighten the retainers to 37-52 Nm (27-38 lb-ft).

11. Lower the transmission guiding support insulator studs into the crossmember. Install the transmission support insulator nuts. Tighten the nuts to 85-118 Nm (63-87 lb-ft).

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12. Lower and remove the transmission jack from under the vehicle.

13. Connect the HO2S connectors and install the shift cable to the shift cable bracket. Connect the shift cable to the manual control lever.

14. Install the oil filter funnel and the starter motor. Install the bolts and tighten them to 22-28 Nm (16-21 lb-ft). Securely install the oil filter funnel bolt and nut.

15. Lightly coat the slip yoke with Premium Long-life Grease XG-1-C (or -K, or equivalent meeting Ford specification ESA-M1C75-B).

16. Remove the extension housing plug and install the driveshaft. Rotate the driveshaft and align it to the index mark made during removal. Install the bolts and tighten them to 83-118 Nm (61-87 lb-ft). Install two midship bearing clips and bolts. Tighten the retainers to 37-50 Nm (27-37 lb-ft).

17. Remove the jack stands.

18. Lower the vehicle.

19. From inside the vehicle, place the gearshift lever in the DRIVE or OVERDRIVE position. Hang a weight of 1.4 kg (3 lb) on the gearshift lever to verify the lever is located firmly on the D or OVERDRIVE detent.

20. Raise the vehicle.

21. Remove the shift cable from the transmission lever ball stud. Pull down on the lock tab on the shift cable body. Position the gearshift lever in the DRIVE position. (This is three detents from the frontmost lever position, with the first position counted as one). Connect the cable end fitting to the transmission lever ball stud. Push up on the lock tab and lock the cable in the correctly adjusted position.

22. Lower the vehicle.

23. Install the fan shroud-to-radiator bolts. Tighten the bolts to 6-8 Nm (53-71 lb-in).

24. Connect the negative battery cable.

25. Fill the transmission to the proper level with Mercon® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or equivalent meeting MERCON® specification and install the fluid level indicator.

26. Check the operation of the transmission.

27. Remove the three-pound weight from the gearshift lever. After making the adjustment, check for park engagement. Check the gearshift lever in all detent positions with the engine running, to verify correct detent/transmission actions. Readjust if necessary.

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Transmission — 4x4

1. **WARNING: SECURE THE TRANSMISSION TO THE TRANSMISSION JACK WITH A SAFETY CHAIN.**

   Position the transmission on a transmission jack.

2. Raise the transmission jack and position the transmission to engine.

3. Remove Torque Converter Holding Tool T97T-7902-A.

4. Position the transmission to the engine and align the converter stud-to-flex plate index mark made at removal.

5. Install the four converter housing-to-engine screws. Tighten to 40-55 Nm (30-41 lb-ft) on the 2.3L. On the 3.0L, tighten to 40-55 Nm (30-41 lb-ft).

6. **CAUTION: Use care not to bend or otherwise damage the cooler lines.**

   Remove the plugs and install the transmission cooler lines. Tighten the transmission cooler lines tube nuts to 24-31 Nm (18-23 lb-ft).

7. Install the two lower converter housing-to-engine screws. Tighten to 40-55 Nm (30-41 lb-ft) on the 2.3L. On the 3.0L, tighten to 40-55 Nm (30-41 lb-ft).

8. Install the fluid filler tube into the lube fluid inlet short tube.

9. Install the two upper converter housing-to-engine screws. Tighten to 40-55 Nm (30-41 lb-ft) on the 2.3L. Tighten to 40-55 Nm (30-41 lb-ft) on the 3.0L.

10. Install the transfer case. Refer to Section 07-07A , Section 07-07B , Section 07-07C or Section 07-07D .

11. Install the transfer case vent bracket. Tighten the transfer case vent bracket screws to 34-46 Nm (25-34 lb-ft).

12. Install the five transfer case-to-extension housing bolts. Tighten to 34-48 Nm (25-35 lb-ft).

13. On 3.0L, install the catalytic converter and crossover pipe nuts using 15 mm socket wrench. Tighten the nuts to 24-34 Nm (18-25 lb-ft).

14. On 3.0L, install the catalytic converter-to-exhaust bolts. Tighten to 24-34 Nm (18-25 lb-ft).

15. Install the rear engine mount. Refer to Section 02-03 .

16. On Aerostar vehicles, install the two crossmember-to-frame through nuts and bolts. Tighten to 37-52 Nm (28-38 lb-ft).

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17. On Aerostar vehicles, install the engine support-to-crossmember screws. Tighten to 98-132 Nm (73-97 lb-ft).

18. On Ranger vehicles, install the two crossmember-to-frame through nuts and bolts. Tighten to 88-115 Nm (65-85 lb-ft).

19. On Ranger vehicles, install the engine support-to-crossmember nuts. Tighten to 88-115 Nm (65-85 lb-ft).

20. Install the two rear engine support-to-crossmember nuts. Tighten to 85-118 Nm (63-87 lb-ft).

21. Connect the transfer case electrical connectors.

22. Install the front axle driveshaft. Refer to Section 05-03A , Section 05-03B or Section 05-03C .

23. Install the transfer case skid plate. Tighten the skid plate screws to 22-28 Nm (16-21 lb-ft).

24. Connect the 16-pin transmission electrical connector and the digital transmission range (DTR) sensor connector.

25. Install the transmission shift cable into the cable bracket.

26. Install the transmission shift bellcrank on the ball stud lever.

27. Connect the transmission shift cable to the transmission manual control lever.

28. Adjust shift cable; refer to cable adjustment.

29. Install the vehicle speed sensor (VSS) (if equipped) into the transfer case.

30. Align the index mark made at removal and install the rear driveshaft. Refer to Section 05-01 .

31. **CAUTION: Never turn the engine counterclockwise (as viewed from the front).**

    CAUTION: Use new flexplate-to-converter nuts.

    Install the four new flexplate-to-converter nuts, using a 22 mm socket wrench and breaker bar on the crankshaft pulley to turn the engine into position. Tighten the flexplate-to-converter nuts to 30-40 Nm (22-30 lb-ft).

32. Install the starter motor. Refer to Section 03-06 .

33. For 3.0L, install the transmission access cover and screws. Tighten the bolts to 16-22 Nm (12-16 lb-ft).

34. Lower the vehicle.

35. Fill the transmission fluid with MERCON V® XT-5-QM to the proper level. Refer to procedure in this section.

36. Install the fluid level indicator.

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37. Install the battery ground cable.

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Transmission Fluid Lines

When one or more of the fluid cooler steel tubes must be replaced, each replacement tube must be fabricated from the same size steel tubing as the original line.

Using the old tube as a guide, bend the new tube as required. Add the necessary fittings and install the tube. Make sure the tube has adequate clearance to the other components, especially the exhaust system and parts having sharp edges.

After the fittings have been tightened, add fluid as needed and check for fluid leaks.

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Transmission

It is important to completely clean all transmission components including the converter, fluid cooler, cooler lines, main control valve body, all clutches and check balls after any transmission servicing that generates contamination. These contaminants are a major cause for recurring transmission troubles and must be removed from the system before the transmission is put back into service. The cleaning of debris from the coast, direct/reverse, and the forward clutch check balls is often omitted. This omission can lead to a repeat servicing of the transmission.

Clean the parts with a suitable solvent and use moisture-free air to dry off all the parts and clean out fluid passages.

CAUTION: Do not use mineral spirits or oil based solvent.

The composition clutch plates, bands, and synthetic seals should not be cleaned in a vapor degreaser or any type of detergent solution.

To clean these parts, wipe them off with a lint-free cloth. New clutch plates or bands should be soaked in transmission fluid specified for that transmission type for 30 minutes before being assembled.

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Main Control Valve Body

1. Clean all parts thoroughly in clean solvent and blow dry with moisture-free compressed air.

2. Inspect all valve and plug bores for scores. Check all fluid passages for obstructions. Inspect the check valve for free movement. Inspect all mating surfaces for burrs or distortion. Inspect all plugs and valves for burrs or scores. Replace the control valve body if the bores or valve are scored beyond the point of being cleanable.

3. **CAUTION: Do not sand, stone or polish valves and bores. This removes the anodizing treatment and destroys them.**

   Inspect all springs for distortion. Check all valves and plugs for free movement in their respective bores. Valves and plugs, when dry, must fall from their own weight into their respective bores.

4. Roll the manual valve on a flat surface to check for a bent condition.

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Overdrive and Intermediate Servos

NOTE: Identify servo covers, pistons, and springs with a tag.

1. Inspect the servo bore for cracks and the servo piston for damage (the rubber sealing surfaces should be pliable). Inspect the piston bore, servo piston bore and servo piston stem for scores. Check the fluid passages for obstructions. Replace damaged seals.

2. Check the servo springs, servo band strut(s) and apply levers for distortion and wear.

3. Inspect the cover seal and gasket cover sealing surface for damage.

4. Inspect the band lining for excessive wear and for proper bonding to the metal band.

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Low-Reverse Servo and Band

1. Inspect the bore for scores.
2. Check the fluid passages for obstructions.
3. Inspect the band for distortion. Inspect the band ends for cracks.
4. Inspect the servo for distortion.
5. Inspect the band lining for excessive wear and for proper bonding to the metal band.
6. Replace the cover seal if damaged.
7. Replace the piston seals if damaged.

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Extension Housing

1. Inspect the housing for cracks. Inspect the gasket surface for burrs or warpage.
2. Inspect the bushing for scores or wear. Inspect slip yoke for damage. Replace if required.
3. Inspect the rear seal for hardness, cracks or wear. Replace if required.
4. Inspect the seal counterbore and remove all burrs and scores with a crocus cloth.

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Pump

1. Inspect the mating surfaces of the pump body and case for burrs.
2. Inspect the drive and driven gear bearing surfaces for scores. Check the gear teeth for burrs.
3. Inspect the inner pump gear O-ring for damage.
4. Inspect the front pump seal for cuts or nicks. Inspect the pump bushing for scoring.
5. Check all fluid passages for obstruction.
6. If any parts are found damaged or worn, replace the pump as an assembly. Minor burrs and scores may be removed with a crocus cloth.

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Direct/Reverse and Coast Clutches

1. Inspect the drum band surface, bushing and thrust surfaces for scores. Minor scores may be removed with a crocus cloth. Badly scored parts must be replaced.

2. Inspect the clutch piston bore and piston inner and outer bearing surfaces for scores.

3. Check the fluid passages for obstructions. All fluid passages must be clean and free of obstruction.

4. Inspect the clutch plates for wear, scoring and fit on the clutch hub serrations. Replace all plates that are badly scored, worn or do not fit freely in the hub serrations.

5. Inspect the clutch pressure plate for scoring and binding on the clutch plate surface. Check the clutch release spring for distortion pressure.

6. The clutch cylinders have check balls. Inspect the check balls for freedom of movement and proper seating.

7. Inspect the friction plates for proper installation (direction).

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Forward Clutch

1. Inspect the clutch cylinder thrust surfaces, piston bore and clutch plate serration for scores or burrs. Minor scores and burrs may be removed with a crocus cloth. Replace the clutch cylinder if it is badly scored or damaged.

2. Check the fluid passages in the clutch cylinder for obstructions. Clean out all fluid passages. Inspect the clutch piston for scores and replace if necessary. Inspect the piston check ball for freedom of movement and proper seating.

3. Check the clutch release springs for distortion and cracks. Replace the springs if they are distorted or cracked.

4. Inspect the composition clutch plates, steel clutch plates and clutch pressure plate for worn or scored surfaces. Replace all parts that are deeply scored.

5. Check all clutch plates for flatness and fit on the clutch hub serrations. Discard any plate that does not slide freely on the serrations or that is not flat.

6. Check the clutch hub thrust surfaces for scores. Check the clutch hub splines for wear.

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Input Shaft

Check the input shaft for damaged or worn splines. Replace the shaft if the splines are excessively worn. Inspect the bushings in the stator support for scores.

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Overdrive One-Way Clutch and Rear One-Way Clutch

1. Inspect the outer and inner races for scores or damaged surface areas where the rollers contact the races.

2. Inspect the rollers and springs for excessive wear or damage.

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Converter and Fluid Cooler

When wear or internal damage has occurred in the transmission, metal particles, clutch plate material, or band material may have been carried into the converter and fluid cooler. These contaminants are a major cause of recurring transmission troubles and must be removed from the system before the transmission is put back into service.

Whenever a transmission has been disassembled to replace worn or damaged parts, or because the valve body sticks from foreign material, the converter, fluid cooler and cooler lines must be cleaned and flushed. Rotunda Torque Converter/Transmission Oil Cooler Cleaner 014-00028 or equivalent can be used. Under no circumstances should an attempt be made to clean the torque converter by hand agitation with solvent.

The lack of a drain plug in the torque converter increases the amount of residual flushing solvent in the torque converter after cleaning. This retained solvent is not acceptable and a method of diluting is required. The following procedure is to be used after the removal of the torque converter from the cleaning equipment.

1. Thoroughly drain the remaining solvent through the converter hub.
2. Add 1.9L (2.0 quarts) of clean MERCON V® XT-5-QM transmission fluid to the converter. Agitate by hand.
3. Thoroughly drain the solution through the converter hub.

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Pinion Carriers

Individual parts of the planetary carriers are not serviceable.

1. Check the pins and shafts in the planetary assemblies for loose fit and/or complete disengagement. Use a new planetary assembly if either condition exists. Before installing a planetary assembly, the shaft retaining pins should be checked for adequate staking. Do not restake the planetary pinion. If necessary, replace the planetary assembly.

2. Inspect the pinion gears for damaged or excessively worn teeth.

3. Check for free rotation of the pinion gears.

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Stator Support

1. Inspect the stator support splines for burrs and wear.
2. Check the oil ring grooves in the stator support for nicks, burrs or damaged edges.
3. Check the front and rear bushings of the stator support for wear or scoring.
4. Check front pump support seal and groove.
5. Check the seal rings for damage.
6. Check bearings for damage.

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Case

Inspect the case for cracks and stripped threads. Inspect the gasket surfaces and mating surfaces for burrs. Check the vent for obstructions, and check all fluid passages for obstructions and leakage.

Inspect the case bearing for scores. Check all parking linkage parts for wear or damage.

Inspect the case threads for damage.

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Case Thread Repair Procedures

If a transmission case thread is damaged, service kits may be purchased from local jobbers. To service a damaged thread, the following procedure should be carefully followed.

1. Drill out the damaged threads, using the same drill size as the thread outside diameter. For example, use a 5/16-inch drill for a 5/16-18-inch thread.

2. Select the proper special tap and tap the drilled hole. The tap is marked for the size of the thread being repaired. The special tap marked 5/16-18 inch will not cut the same thread as a standard 5/16-18-inch tap. It does cut a thread large enough to accommodate the insert, and after the insert is installed, the original thread size is restored.

3. Select the proper coil inserting tool. These tools are marked with the thread size being repaired. Place the insert on the tool and adjust the sleeve to the length of the insert being used. Press the insert against the face of the tapped hole. Turn the tool clockwise and wind the insert into the hole until the insert is one-half turn below the face.

4. Working through the insert, bend the insert tang straight up and down until it breaks off at the notch.

5. Improperly installed inserts can be removed with the extractor tool. Place the extractor tool in the insert with the blade resting against the top coil one-quarter to one-half turn away from the end of the coil. Tap the tool sharply with a hammer until the blade cuts into the insert. Exert downward pressure on the tool and turn it counterclockwise until the insert is removed.

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SPECIFICATIONS

Fluid Capacity

Vehicle	Engine	Approximate Refill Capacity [1]	
		Liters	U.S. Quarts
Aerostar, Ranger — 4R44E (4x2)	2.3L, 3.0L	9.0	9.5
Aerostar, Ranger — 4R44E (4x4)	2.3L, 3.0L	9.3	9.8

[1] Approximate dry capacity, includes cooler and lines. Fluid level indicator should be used to determine actual fluid requirements and fluid specification. Check level at normal operating temperature. DO NOT OVERFILL.

If it is necessary to add or replace fluid, use only fluid which has been certified by the supplier as meeting one of the Ford Motor Company specifications shown.

Note: Use Motorcraft MERCON V® or fluid meeting Ford specification XT-5-QM.

Torque Specifications

Description	Nm	Lb-Ft	Lb-In
Extension Housing-to-Case Screws and Stud	36-52	27-39	—
Transmission Mounting Pad Nuts and Bolts	68-95	50-70	—
Transmission Range Sensor-to-Case	8-11	—	71-97
Manual Control Outer Lever Nut	41-54	30-40	—
Fluid Pan-to-Case Screws	13-15	—	115-133
Solenoid Clamps-to-Main Control Screws	6-8	—	53-71
Reverse Servo Cover-to-Case Bolts	12-14	—	106-124
Manual Valve Inner Lever Nut	41-54	30-40	—
Main Control Assembly-to-Case Screws	8-11	—	71-97
Manual Valve Detent Spring Screw	8-11	—	71-97
Overdrive Band Locknut-to-Case Adjusting Screw	47-61	35-45	—
Intermediate Band Locknut-to-Case Adjusting Screw	47-61	35-45	—
Center Support-to-Case Capscrew	9-13	—	80-115
Turbine Shaft Speed (TSS) Sensor-to-Center Support Screw	8-11	—	71-97
Fluid Pump Support and Gear-to-Converter Housing Bolts	22-28	16-21	—
Converter Housing-to-Case Screw	36-52	27-39	—
Fluid Filter Assembly-to-Main Control Assembly Screw	8-11	—	71-97
Converter Housing-to-Engine Bolts (2.3L)	40-55	30-41	—

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Converter Housing-to-Engine Bolts (3.0L)	40-55	30-41	—
Converter Housing Access Cover to Engine Oil Pan (2.3L)	2.3-3.3	—	20-29
Catalytic Converter-to-Crossover Pipe Nuts	34-46	25-34	—
Catalytic Converter-to-Exhaust Pipe Nuts and Bolts	34-46	25-34	—
Engine Support-to-Crossmember Bolts (Aerostar)	98-132	73-97	—
Engine Support-to-Crossmember Nuts (Ranger)	88-115	65-85	—
Rear Engine Support-to-Crossmember Nuts	85-118	63-87	—
Crossmember-to-Frame Through Bolts and Nuts (Aerostar)	37-52	28-38	—
Crossmember-to-Frame Through Bolts and Nuts (Ranger)	88-115	65-85	—
Transmission Cooler Lines Case Connectors	35-43	26-32	—
Transmission Fluid Cooler Line Nut to Case Converter	24-31	18-23	—
Flexplate-to-Converter Nuts	30-40	22-30	—
Transmission Access Cover Screws (3.0L)	16-22	12-16	—
Transfer Case Vent Bracket Bolts	34-46	25-34	—
Transfer Case-to-Extension Housing Bolts	34-48	25-35	—
Catalytic Converter and Crossover Pipe Nuts (3.0L)	24-34	18-25	—
Catalytic Converter-to-Exhaust Bolts (3.0L)	24-34	18-25	—
Transfer Case Skid Plate Bolts	22-28	16-21	—
Separator Plate-to-Main Control Screws	6-8	—	53-71
Pressure Plug-to-Case	10-15	—	89-133
Servo Gauge Adjusting Screw	4	—	35.5

End Play Specifications — Selective Thrust Washer (Nylon)

Transmission End Play Dimension "C"	Selective Thrust Washer (Nylon)		Identification: Color
	Part Number	Thickness	
Front No. 1 (All Engines) 0.18-0.70 mm (0.007-0.028 In.) Without Gasket	97GT-7D014-TA 97GT-7D014-MA 97GT-7D014-NA 97GT-7D014-PA 97GT-7D014-RA 97GT-7D014-SA	1.55-1.60 mm (0.061-0.063 In.) 1.75-1.80 mm (0.069-0.071 In.) 1.85-1.90 mm (0.073-0.075 In.) 1.95-2.00 mm (0.077-0.079 In.) 2.05-2.10 mm (0.081-0.083 In.) 2.15-2.20 mm (0.085-0.087 In.)	White Green Red Beige Black Yellow

End Play Specifications — Selective Needle Bearings

Transmission End Play Dimension "C"	Selective Needle Bearings		Identification: Notches
	Part Number	Thickness	

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1.67-1.85 mm (0.066-0.073 In.) 1.86-2.04 mm (0.073-0.080 In.) 2.05-2.23 mm (0.081-0.088 In.) 2.25-2.43 mm (0.089-0.096 In.) Rear No. 4 Reference End Play 0.21-0.51 mm (0.008-0.020 In.)	97GT-7D014-GA 97GT-7D014-HA 97GT-7D014-KA 97GT-7D014-LA	2.65-2.80 mm (0.104-0.110 In.) 2.80-2.95 mm (0.110-0.116 In.) 3.00-3.15 mm (0.118-0.124 In.) 3.20-3.35 mm (0.126-0.132 In.)	0 1 2 3

Torque Converter End Play

	Converter End Play			
	New or Rebuilt Converter		Used Converter	
Transmission Model	mm	Inch	mm	Inch
4R44E	0.58 Max.	0.023 Max.	1.27 Max.	0.050 Max.

Selective Snap Rings

Coast and Reverse Clutch Drum					Forward Clutch Cylinder				
	Thickness		Diameter			Thickness		Diameter	
Part Number	mm	Inches	mm	Inches	Part Number	mm	Inches	mm	Inches
E 860126-S	1.37	.0539	130.1	5.122	E 860115-S	1.37	.0539	125.1	4.925
E 860127-S	1.73	.0681	130.1	5.122	E 860116-S	1.73	.0681	125.1	4.925
E 860128-S	2.08	.0819	130.1	5.122	E 860117-S	2.08	.0819	125.1	4.925
E 860129-S	2.44	.0961	130.1	5.122	E 860118-S	2.44	.0961	125.1	4.925

Band Adjustment And Torque Chart

		Locknut		Screw	
Description	Number of Turns to Back Off	Nm	Lb-Ft	Nm	Lb-Ft
Intermediate Band	2.5	47-61	35-45	14	10
Overdrive Band	2.0	47-61	35-45	14	10

Clutch Plate Usage And Clearance Specifications

				Selective Snap Rings	
Clutch	Steel	Friction	Clearance	Part Number	Thickness
Forward Clutch					
2.3L/3.0L	5	5	0.055-0.083	E 860115-S E 860116-S E 860117-S E 860118-S	1.37 mm (0.0539 In.) 1.73 mm (0.0681 In.) 2.08 mm (0.0819 In.)

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					2.44 mm (0.0961 In.)
Direct/Reverse Clutch					
2.3L/3.0L	4	4	0.051-0.079	E 860126-S E 860127-S E 860128-S E 860129-S	1.37 mm (0.0539 In.) 1.73 mm (0.0681 In.) 2.08 mm (0.0819 In.) 2.44 mm (0.0961 In.)
Coast Clutch					
All Engines	2	2	0.051-0.079	E 860126-S E 860127-S E 860128-S E 860129-S	1.37 mm (0.0539 In.) 1.73 mm (0.0681 In.) 2.08 mm (0.0819 In.) 2.44 mm (0.0961 In.)

4R44E Service Identification Model Chart

7000 Prefix and Suffix	Speedo Drive Teeth	C=Column F=Floor	Engine Displacement	Vehicle Application
Vehicle Applications (600 Nm)				
97GT-EBA	6T	C	3.0L	Ranger (4x2)
97GT-GBA	6T	C	2.3L	Ranger (4x2)
97GT-MBA	6T	C	3.0L	Aerostar (4x2) Van
97GT-NBA	6T	C	3.0L	Aerostar (4x4) Wagon
97GT-FBA	—	C	3.0L	Ranger (4x4)

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Transmission Description

The 5R55E automatic transmission is an electronically controlled five-speed unit.

The 5R55E transmission is used with the 4.0L engine applications.

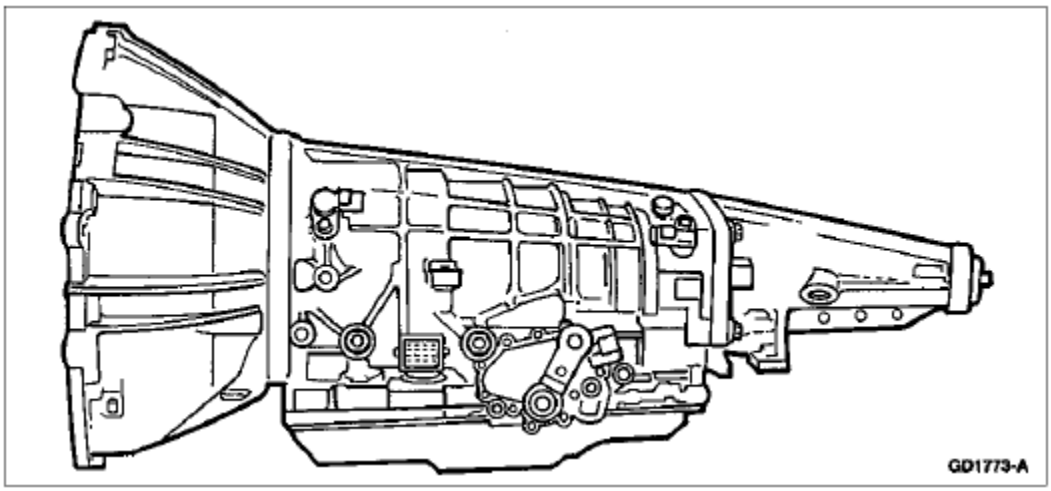
This transmission features a four element torque converter with a torque converter clutch (TCC). The geartrain includes:

- Three compound planetary gearsets
- Three bands
- Three multi-plate clutches
- Two one-way clutches

The hydraulic functions are directed by electronic solenoids to control:

- Engagement feel
- Shift feel
- Shift scheduling
- Modulated TCC applications
- Timing of the 3-2 T.D. and K.D. shifts
- Engine braking (with O/D canceled) utilizing the coast clutch
- Manual 1st timing

Transmission View



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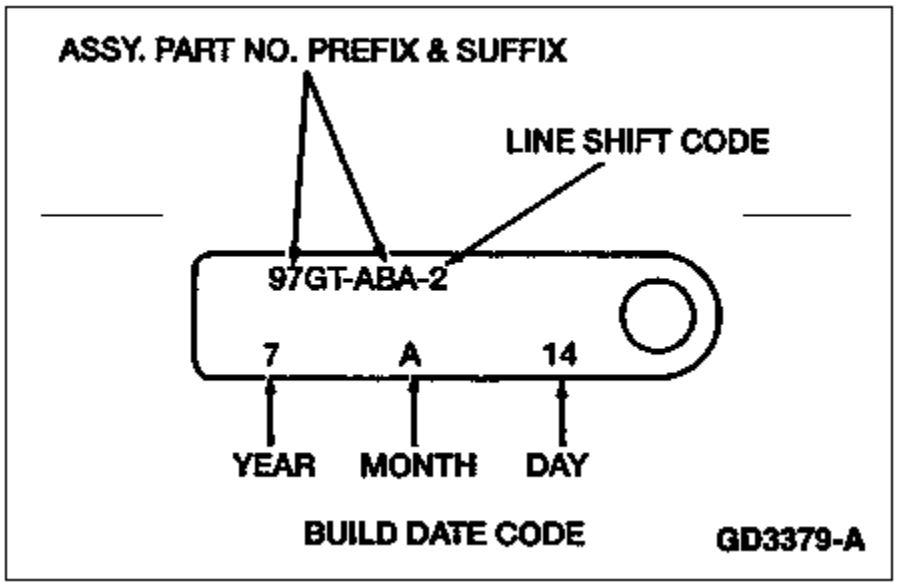
Identification Tags

Models are identified by a service identification tag affixed to the assembly. Typical service identification tags are shown below.

Located Under Extension Housing Bolt



Assembly Plant Bar Code I.D. Label Located on Fluid Pan

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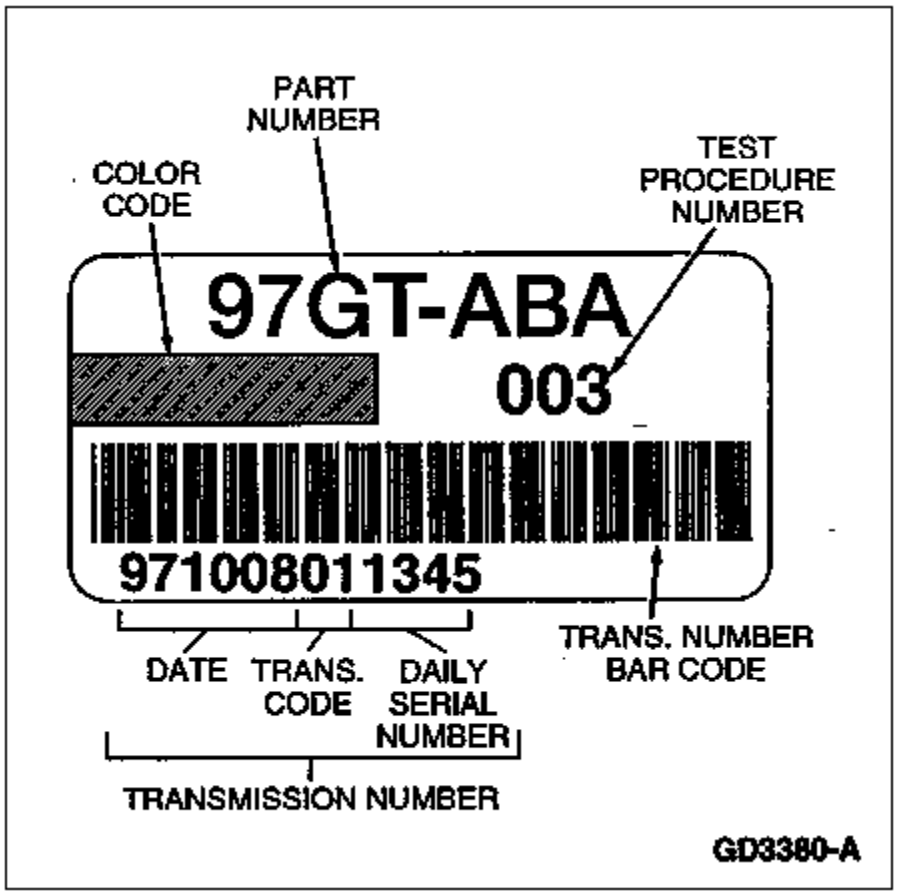

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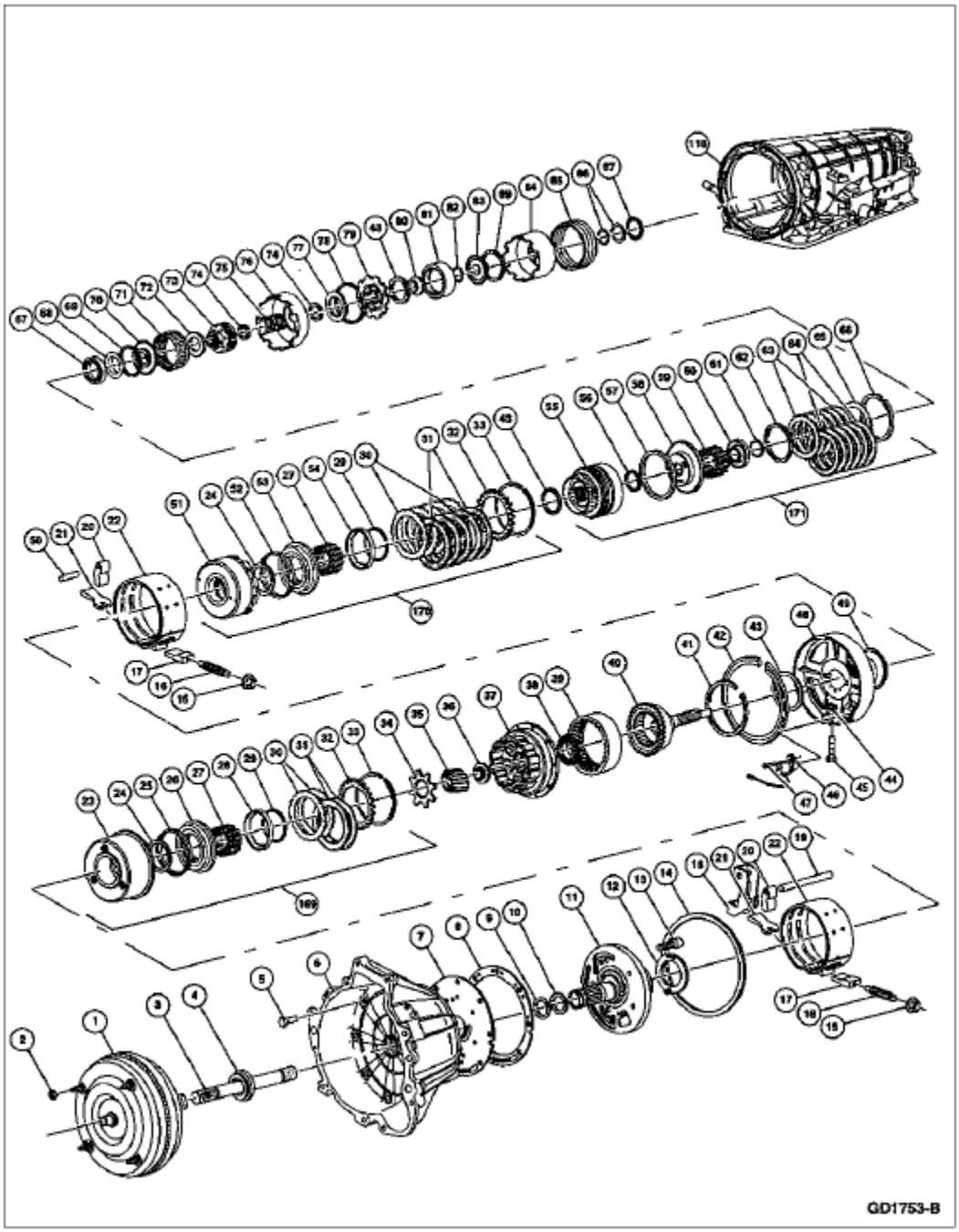
Exploded Views

Transmission, Exploded View — 5R55E (4.0L)



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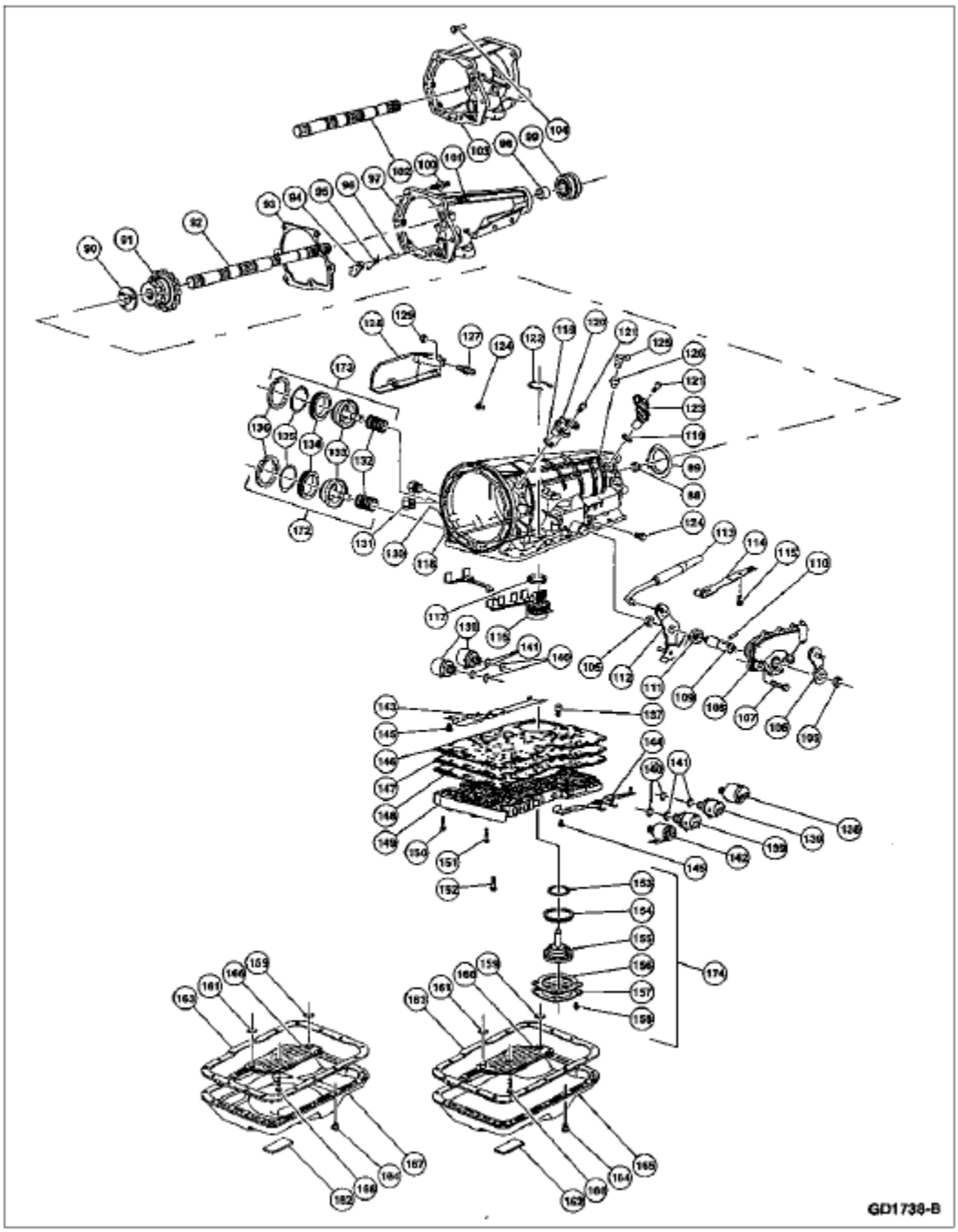
Transmission, Exploded View — 5R55E (4.0L) (continued)



Item	Part Number	Description
1	7902	Converter Assembly — (Contains Piston Type Clutch)
2	379299-S2	Nut — (Att. Converter Assembly to Flex Plate) (4

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		Req'd)
3	7017	Shaft — Input
4	7A248	Seal Assembly — Converter Hub to Converter Housing (Also in Converter Housing Assembly)
5	E804595-S300	Screw and Seal Assembly — M10 x 33 (Att. Converter Housing to Case) (8 Req'd)
6	7976	Housing Assembly — Converter
7	7B472	Plate — Fluid Pump Adapter
9	7L323	Seal Ring — Fluid Pump Support
10	W701431-S300	O-Ring — Fluid Pump Shaft to Inner Gear (Also in Pump Assembly)
11	7A103	Support and Gear Assembly — Fluid Pump
12	7D014	Washer — Fluid Pump Input Thrust (Select Fit — 7 Variables) No. 1
13	W701429-S309M	Screw Flange Head — 8.8 Allen, M8 x 35 (Att. Pump Assembly Converter Housing) (6 Req'd)
14	7A248	Seal Ring — Fluid Pump
15	E825100-S100	Nut and Seal Assembly — Hex Intermediate and Front Band Adjustment/Lock (2 Req'd)
16	7C492	Screw — Intermediate and Front Band Adjuster/Lock (2 Req'd)
17	7D430	Strut — Intermediate and Front Band Anchor (2 Req'd)
18	7A653	Bracket — Front Band Lever to Case (Not Serviced Separately)
19	7D433	Shaft — Front Actuating Lever
20	7330	Lever — Intermediate and Front Band Servo (2 Req'd)
21	7D029	Strut — Intermediate and Front Band Apply (2 Req'd)
22	7D034	Band Assembly — Intermediate and Front (2 Req'd)
23	7L669	Drum Assembly — Front Brake and Coast Clutch
24	7D404	Seal Ring — Coast Clutch and Direct Clutch Piston — Inner (2 Req'd)
25	7A548	Seal Ring — Coast Clutch Piston — Outer
26	7A262	Piston — Coast Clutch
27	7A480	Spring — Coast and Direct Clutch Piston (40 Req'd)
28	7A527	Retainer — Coast Clutch Piston Springs
29	E860125-S	Ring Retaining — 63 mm — Coast and Direct Clutch Piston in The Brake Drum (2 Req'd)
30	7B442	Plate — Coast (2 Req'd) and Direct (4 or 5 Req'd) Clutch External Steel
31	7B164	Plate Assembly — Coast (2 Req'd) and Direct (4 or 5 Req'd) Clutch Internal Friction

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32	7B066	Plate — Coast and Direct Clutch Pressure (2 Req'd)
33	E860126-S/129-S	Ring Retaining — Coast and Direct Clutch Plates (Select Fit)
34	7660	Adapter — Coast Clutch to Front Carrier
35	7D063	Gear Assembly — Sun Overdrive
36	7D235	Race — Sun Gear Thrust Bearing — Rear (All) No. 12
37	7B446	Carrier Assembly — Planetary Gear Front (With Trigger Wheel)
38	7L495	Bearing Assembly — Front Planet Thrust No. 2
39	7653	Gear — Overdrive Ring
40	7A658	Shaft Assembly — Center Overdrive Ring (Includes Front Overrunning Clutch 7C109)
41	W702037-S300	Ring Retaining — 110.1mm Center Shaft in Front Ring Gear
42	W702465-S300	Ring Retaining — Center Support in Case
43	7M153	Bearing Assembly — Center Shaft Thrust No. 3, No. 5 and No. 9 (3 Req'd)
44	E826160-S76	Nut and Cage Assembly — S/L Met. M6 (Att. Center Support to Case)
45	E804373-S	Screw Cap — 8.8 Allen M6 x 20 (Att. Center Support to Case)
46	7M101	Sensor — Trans Turbine Shaft Speed (TSS) With Wire to 16-Pin Connector
47	W702297-S300	Screw — Cap M6 x 15 (Att Turbine Shaft Speed Sensor to Center Support)
48	7A130	Support Assembly — Center
49	7D014	Bearing Assembly — Intermediate Brake Drum Thrust (Select Fit — 4 Variables) No. 4
50	7D433	Shaft — Intermediate Band Actuating Lever
51	7D044	Drum Assembly — Intermediate Brake and Direct Clutch (Model Dependent)
52	7A548	Seal Ring — Direct Clutch Piston — Outer
53	7A262	Piston — Direct Clutch
54	7A527	Retainer — Direct Clutch Piston Spring
55	7A360	Cylinder Assembly — Forward Clutch
56	7A548	Seal Ring — Forward Clutch Piston — Inner
57	7A548	Seal Ring — Forward Clutch Piston — Outer
58	7A262	Piston Assembly — Forward Clutch
59	7A480	Spring — Forward Clutch Piston (15 Req'd)
60	7A527	Retainer — Forward Clutch Piston Spring
61	E860109-S	Ring Retaining 34mm — Forward Clutch Piston and

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		Spring in Forward Clutch Cylinder
62	7B070	Spring — Forward Clutch Cushion
63	7B442	Plate — Forward Clutch External Steel (6 Req'd)
64	7B164	Plate Assembly — Forward Clutch Internal Friction (6 Req'd)
65	7B066	Plate — Forward Clutch Pressure
66	E860115-S/118-S	Ring Retaining — Forward Clutch Plates in Forward Clutch Cylinder (Select Fit)
67	7D234	Bearing Assembly — Forward Ring Gear Hub Thrust No. 6A
68	7D090	Washer — Forward Clutch Thrust No. 6B
69	E860122-S	Ring Retaining 87mm — Forward and Output Shaft Ring Gears to Hubs (2 Req'd)
70	7B067	Hub — Forward Ring Gear
71	7D392	Gear — Forward Ring (72 External Teeth and 57 Internal Teeth)
72	7F374	Bearing Assembly — Forward Planet Thrust No. 7
73	7A398	Planetary Assembly — Forward (6 Pinion) (Model Dependent)
74	E860121-S	Ring Retaining 39mm — Input Shell to Sun Gear Assembly (2 Req'd)
75	7D063	Gear Assembly — Sun (Forward)
76	7D064	Shell — Input
77	7M151	Bearing Assembly — Low/Reverse Planet Carrier Thrust No. 8
78	W702037-S300	Snap Ring
79	7D006	Planet Assembly — Low/Reverse (6 Pinion)
80	7B176	Sleeve — Output
81	7A153	Gear — Output Shaft Ring
82	E860527-S	Ring Retaining 25 x 2 mm — Output Shaft in Case
83	7D164	Hub — Output Shaft
84	7C498	Drum Assembly — Low/Reverse Brake (Includes Overrunning Clutch)
85	7D095	Band Assembly — Low/Reverse
86	7M150	Bearing Race (2 Pieces) — Output Shaft Hub Thrust No. 10A
87	7M150	Bearing Assembly — Output Shaft Hub Thrust No. 10B
88	7R205	Bearing Assembly — Output Shaft to Case (Part of Case Assembly)
89	7L339	Retainer — Splash Fluid
90	7B368	Washer — Output Shaft Thrust No. 11

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91	7M167	Gear Assembly — Transmission Parking (4.0L)
92	7060	Shaft Assembly — Output (4x2)
93	7086	Gasket — Extension Housing
94	7A441	Pawl — Parking
95	7D070	Spring — Parking Pawl Return
96	7D071	Shaft — Parking Pawl
97	7A039	Housing Assembly — Extension (4x2)
98	7A034	Bushing — Extension Housing (4x2) (Also in Extension Housing)
99	7052	Seal Assembly — Extension Housing to Slip Yoke (Also in Extension Housing)
100	E804137-S72	Stud — (Att. Extension Housing to Case)
101	E800152-S72	Screw — M10 x 30 (Att. Extension Housing to Case) (5 Req'd)
102	7060	Shaft Assembly — Output (4x4)
103	7A039	Housing Assembly — Extension (4x4)
104	N605804-S100	Screw — M10 x 45 (Att. 4x4 Extension Housing to Transfer Case) (5 Req'd)
105	W701271-S309	Nut — (Att. Outer and Inner Manual Valves to Shaft) (2 Req'd)
106	7A256	Lever Assembly — Manual Control — Outer
107	N806933-S100	Screw — M6 x 25 (Att. Transmission Range Sensor to Case) (2 Req'd)
108	7F293	Sensor — Digital Transmission Range (DTR)
109	7A308	Shaft — Manual Valve Outer to Inner Lever
110	E840125-S	Pin — Spring (Retains Outer Manual Lever to Case)
111	7B498	Seal Assembly — Main Control Lever (Also in Case Assembly)
112	7A115	Lever — Manual Valve — Inner
113	7A232	Rod Assembly — Parking Pawl Actuating
114	7E332	Spring Assembly — Manual Valve Detent
115	E800185-S	Screw — M6 x 30 (Att Detent Spring to Main Control)
116	7Z409	Connector Assembly (16-Pin With Wire Harness to 6 Solenoids)
117	W703015-S300	O-Ring — 16-Pin Connector in Case
118	7005	Case Assembly (Model Dependent)
119	W702981-S300	O-Ring — Speed Sensor to Case (2 Req'd)
120	7M183	Sensor Assembly — Transmission Overdrive Drum Speed (ODS)
121	W702297-	Screw — Cap M6x15 (Att O.D. and Output Shaft

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	S300	Speed Sensors to Case) (4.0L Only)
122	84280020	Spring — Retains 16-Pin Connector in Case
123	7H103	Sensor Assembly — Transmission Output Shaft Speed (OSS)
124	E450102-S80	Plug — Pipe Line and EPC Pressure (Part of Case Assembly) (2 Req'd) (Not Serviced Separately)
125	7034	Vent Assembly — Also in Case Assembly (4x4)
126	7034	Vent Assembly — Also in Case Assembly (4x2)
127	E804533-S201	Stud — M6x12 (Att Heat Shield to Case) (All 4.0L and 4x4)
128	7F103	Shield — Transmission Heat (4.0L Only)
129	N620040-S36	Nut — Hex (Retains Heat Shield to Stud) (4.0L Only)
130	7A160	Tube — Lube Fluid Inlet — Short (Also in Case Assembly)
131	7D273	Connector Assembly — Fluid Tube (Also in Case Assembly)
132	7D028	Spring — Intermediate Servo Piston)
133	7D021	Piston and Rod Assembly — Intermediate and Front Servo (2 Req'd)
134	7D027	Cover and Seal Assembly — Intermediate Front Servo Assembly (2 Req'd)
135	7D040	O-Ring — Servo Cover to Case Intermediate and Front Servo (2 Req'd)
136	E860343-S	Ring Retaining — 67 x 1.5mm (Intermediate and Front Servos in Case) (2 Req'd)
137	E804357-S76	Screw — Torx M6 x 21 (Att. Separating Plate to Main Control) (Also in Main Control Assembly)
138	7G383	Solenoid Assembly — Electronic Pressure Control (EPC)
139	7G484	Solenoid Assembly — Trans Shift (SS) (Also in Main Control Assembly) (4 Req'd)
140	W702951-S300	O-Ring — Shift Solenoid to Main Control (Small) (13x1.5) (4 Req'd)
141	W702949-S300	O-Ring — Shift Solenoid to Main Control (Large) (15x1.5) (4 Req'd)
142	7G136	Solenoid Assembly — Trans Torque Converter Clutch (TCC) PWM With Clamp (Also in Main Control Assembly)
143	7L491	Clamp (SS1 and SS3) Solenoids (Also in Main Control Assembly) (Not Serviced Separately)
144	7L491	Clamp — Converter Clutch/SS4/SS2 and EPC Solenoids (Also in Main Control) (Not Serviced Separately)
145	E800155-S	Screw — M6 x 12 (Att. Solenoid Clamps to Main Control) (2 Req'd)

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146	7C155	Gasket — Control Valve Body to Case
147	7A008	Plate — Valve Body Separating (Part of Main Control Assembly) (Not Serviced Separately)
148	7D100	Gasket — Control Valve Body Separating (Also in Main Control Assembly)
149	7A100	Control Assembly — Main (Model Dependent)
150	E800154-S	Screw — M6 x 45 (Att. Main Control to Case) (4 Req'd)
151	E800153-S	Screw — M6 x 40 (Att. Main Control to Case) (16 Req'd)
152	E800163-S	Screw — M6 x 35 (Att. Main Control to Case) (3 Req'd)
153	7423	Seal Ring — Low/Reverse Servo Piston — Small (Also in Piston Assembly)
154	7423	Seal Ring — Low/Reverse Servo Piston — Large (Also in Piston Assembly)
155	7D189	Piston Assembly — With Rod and Retainer — Low/Reverse Band Servo (Select Fit)
156	7L173	Gasket — Low/Reverse Servo Cover to Case
157	7D036	Cover — Low/Reverse Servo
158	E800156-S	Screw — M6 x 20 (Att. Low/Reverse Servo Cover to Case) (4 Req'd)
159	7A469	O-Ring — Fluid Filter Assembly — Small
160	7A098	Filter Assembly — Fluid Pan (4x2)
161	7A469	O-Ring — Fluid Filter Assembly — Large
162	7E290	Magnet — on Inner Bottom Surface
163	7A191	Gasket — Fluid Pan
164	W701203-S309M	Screw — M8 x 14 (Att. Fluid Pan to Case) (18 Req'd)
165	7A194	Pan — Fluid (4x2)
166	7A098	Filter Assembly — Fluid Pan (4x4)
167	7A194	Pan — Fluid (4x4)
168	E800329-S	Screw — M6 x 55 (Att. Fluid Filter to Main Control)
169	—	Coast Clutch
170	—	Direct Clutch
171	—	Forward Clutch
172	—	Overdrive Servo
173	—	Intermediate Servo
174	—	Reverse Servo

Bushings, Bearing and Thrust Washer Locator — 5R55E

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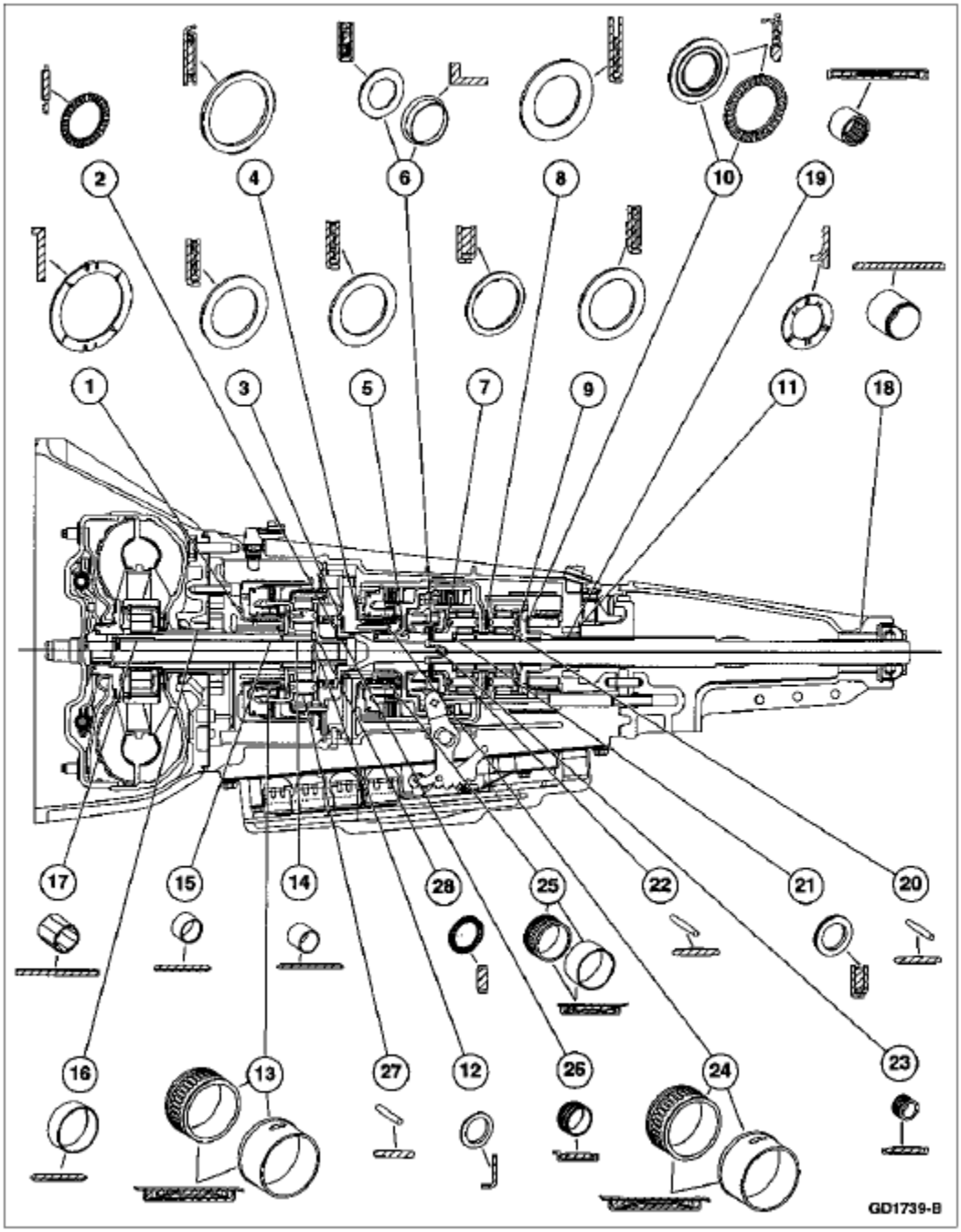

Item	Part Number	Description
1	7D014	No. 1 Selective Washer
2	7L495	No. 2 Needle Bearing
3	7M153	No. 3 Needle Bearing
4	7D014	No. 4 Selective Needle Bearing
5	7M153	No. 5 Needle Bearing

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6	7D234, 7D090	No. 6A Needle Bearing and No. 6B Bushing
7	7F374	No. 7 Needle Bearing
8	7M151	No. 8 Needle Bearing
9	7M153	No. 9 Needle Bearing
10	7M150	No. 10A Bearing Race and No. 10B Needle Bearing Assembly
11	7B368	No. 11 Washer
12	7D235	No. 12 Race
13	—	Bearing, Seal Assembly and Sleeve (Not Serviced Separately)
14	—	Bushing (Part of 7D063 O.D. Sun Gear) (Not Serviced Separately)
15	—	Bushing (Part of 7L201 Pump Assembly) (Not Serviced Separately)
16	—	Bushing (Part of 7976 Converter Housing) (Not Serviced Separately)
17	—	Bushing (Part of 7L201 Pump Assembly) (Not Serviced Separately)
18	—	Bushing (Part of 7A039 Extension Housing and Available Separately)
19	7R205	Needle Bearing
20	—	Needle Bearing (Part of 7D006 Low/Reverse Planetary Assembly) (Not Serviced Separately)
21	—	Needle Bearing (Part of 7A398 Forward Planetary Assembly) (Not Serviced Separately)
22	—	Needle Bearing (Part of 7060 Output Shaft) (Not Serviced Separately)
23	—	Needle Bearing (Part of 7A398 Forward Planetary Assembly) (Not Serviced Separately)
24	—	Bearing, Seal Assembly and Sleeve (Not Serviced Separately)
25	—	Bearing, Seal Assembly and Sleeve (Not Serviced Separately)
26	—	Needle Bearing (Part of 7B446 Front Planetary Assembly) (Not Serviced Separately)
27	—	Needle Bearing (Part of 7B446 Front Planetary Assembly) (Not Serviced Separately)
28	—	Needle Bearing (Part of 7B446 Front Planetary Assembly) (Not Serviced Separately)

Seals, Rings and Gaskets Locator — 5R55E

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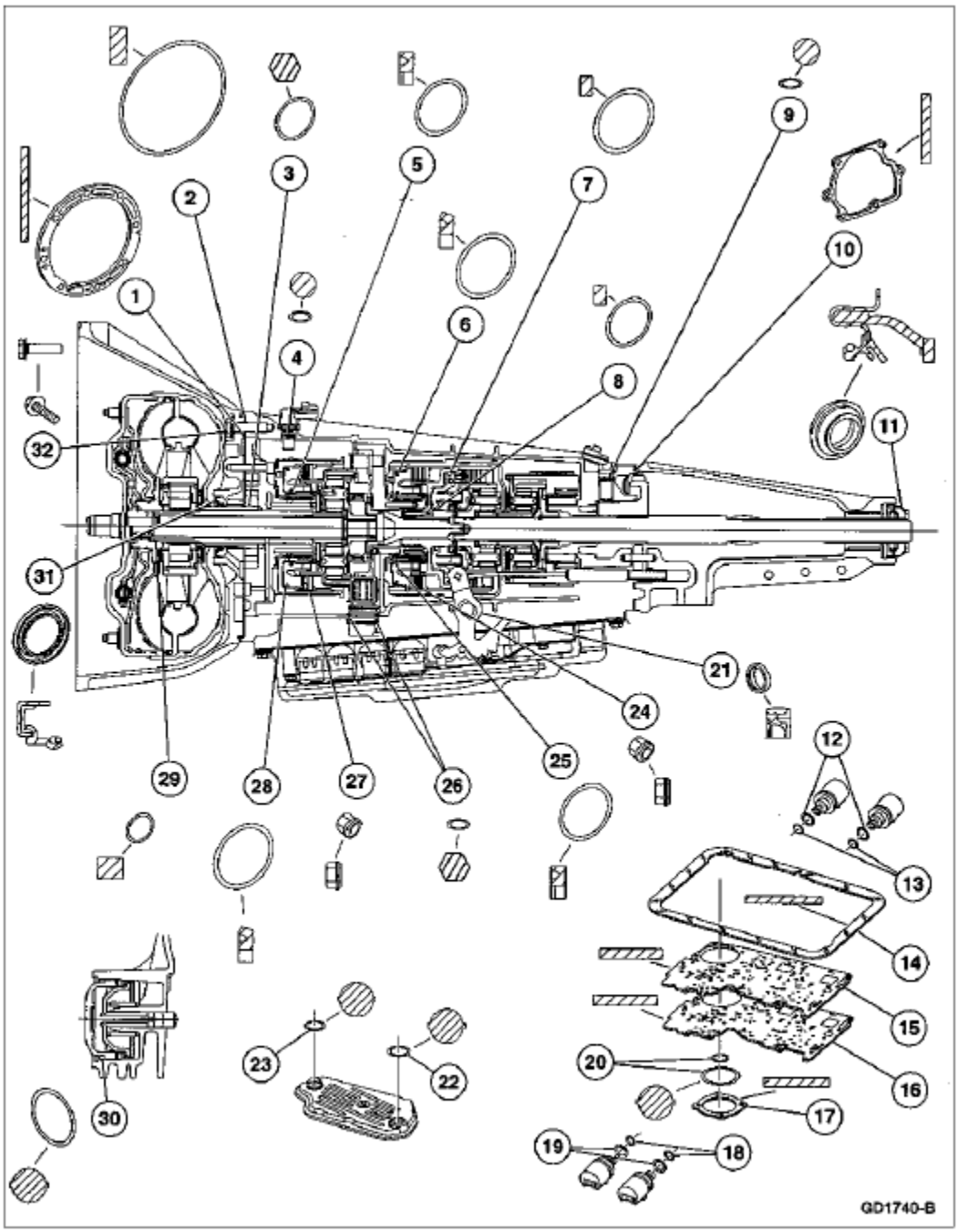

Item	Part Number	Description
1	7A136	Gasket (Fluid Pump)
2	7A248	Seal Ring (Fluid Pump)
3	W701431-S300	O-Ring
4	W7022981-S300	O-Ring
5	7D404	Seal Ring
6	7A548	Seal Ring

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7	7A548	Seal Ring
8	7A548	Seal Ring
9	W702981-S300	O-Ring
10	7086	Gasket (Transmission Extension)
11	7052	Seal Assembly (Extension Housing)
12	W702949-S300	O-Ring (Large)
13	W702951-S300	O-Ring (Small)
14	7A191	Gasket (Fluid Pan)
15	7C155	Gasket (Main Control, Upper)
16	7D100	Gasket (Main Control, Lower)
17	7L173	Gasket (Low/Reverse Servo Plate Cover)
18	W702951-S300	O-Ring (Small)
19	W702949-S300	O-Ring (Large)
20	7423	O-Ring (Low/Reverse Servo Piston)
21	7B498	Seal Assembly (Manual Lever)
22	E825100-S100	Nut and Seal (Intermediate Band Adjustment/Lock)
23	E853164	O-Ring (Large) (Fluid Filter Assembly)
24	E853163	O-Ring (Small) (Fluid Filter Assembly)
25	7D404	Seal Ring
26	84400120	O-Ring
27	E825100-S100	Nut and Seal
28	7A548	Seal Ring
29	7L323	O-Ring
30	7D040	O-Ring (Intermediate/Front Servo Covers)
31	7A248	Seal Assembly (Converter Hub)
32	E804595-S200	Screw and Seal Assembly

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Transmission Range Operation

The 5R55E transmission range selector lever has six positions: P, R, N, D, 2, 1. The driver selects the required gear position by moving the selector lever to the various positions. Interlocking cables and linkages connect the selector lever to the transmission. This allows the selector lever to move internal linkages and the manual control valve, which signals the driver demand.

Park

No powerflow is transferred through the transmission in PARK. The manual lever shaft, which is connected to a park rod, presses the parking pawl into the park gear on the output shaft. This locks the output shaft and prevents the vehicle from rolling. However, for safety reasons, the parking brake should be applied whenever the vehicle is parked.

While the engine can be started in either P or N position, the ignition key can only be removed in PARK.

Reverse

Reverse gear allows the vehicle to be operated in a rearward direction, at a reduced gear ratio. When overdrive has been cancelled, engine braking is provided in the R position with the coast clutch applied.

Neutral

As in PARK, there is no power transferred through the transmission. However, the final drive is not locked by the parking pawl, so the wheels are free to rotate. The vehicle may be started in the N position, but the ignition key cannot be removed.

Overdrive

In the (D) position, the transmission will upshift or downshift 1-2-3-4-5 automatically.

When overdrive has been canceled by turning the transmission control switch on, the transmission will not upshift to 5th gear. Engine braking is provided in 1st, 2nd, 3rd, 4th and reverse gears with the coast clutch applied.

2nd Position

Selection of the 2 position provides a 3rd gear hold position from a manual upshift or downshift. When the 2 position is selected from a stop, the transmission will start in 3rd gear. This allows for maximum traction on slippery surfaces. Engine braking is provided in the 2 position when the transmission control switch (TCS) is on or off.

1st Position

The 1 position provides a 1st gear hold after an automatic or manual downshift. The transmission is prevented from downshifting above a specific speed (approximately 48 km/h [30 mph]) to protect the powertrain from overspeeding. Engine braking is provided in the 1 position when the transmission control switch (TCS) is on or off.

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Transmission Shift Patterns

Upshifts

Transmission upshifting is controlled by the powertrain control module (PCM). The PCM receives inputs from various engine or vehicle sensors and driver demands to control shift scheduling, shift feel and torque converter clutch operation.

Downshifts

Under certain conditions the transmission will downshift automatically to a lower gear range (without moving the range selector lever). There are three categories of automatic downshifts: Coastdown, Torque Demand and Forced or Kickdown shifts.

Coastdown

The coastdown downshift occurs as the name indicates, when the vehicle is coasting down to a stop.

Torque Demand

The torque demand downshift occurs (automatically) during part throttle acceleration when the demand for torque is greater than the engine can provide at that gear ratio. The transmission will also disengage the torque converter clutch to provide added acceleration, if applied.

Kickdown

For maximum acceleration, the driver can force a downshift by pressing the accelerator pedal to the floor. A forced downshift into a lower gear (4th, 3rd, 2nd or 1st) is possible below calibrated speeds. For all shift speeds, specifications are subject to variations due to tire size, engine and transmission calibration requirements.

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Transmission Control Switch and Lamp Operation

The transmission control switch (TCS) is a driver-controlled momentary contact switch mounted on the end of the transmission range selector lever. When the TCS is activated, 5th gear operation (overdrive) is canceled, coast clutch is applied, and engine braking is provided in 1st, 2nd, 3rd, 4th and reverse gears.

The transmission control indicator lamp (TCIL) is located on the transmission range selector lever in the Aerostar and on the instrument panel in the Ranger. The TCIL indicates that the transmission control switch (TCS) has been depressed and 5th gear has been cancelled. The TCIL will flash if the powertrain control module (PCM) detects a concern in certain transmission related sensors or solenoids.

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Main Components and Functions

Torque Converter

The 5R55E uses a four element torque converter. The converter contains the standard internal components (turbine, impeller, and stator) for transfer of power and multiplication of torque. It also utilizes a disc type torque converter clutch (TCC) for maximum fuel economy.

The operation of the main torque converter components is as follows:

- The converter cover and impeller are connected to the engine crankshaft. Rotation of the cover and impeller by the engine crankshaft sets the fluid in motion.
- The turbine reacts to the fluid motion from the impeller, transferring rotation to the geartrain by way of the turbine shaft.
- The stator redirects the fluid going back to the impeller, from the turbine. By directing fluid back to the impeller in the same direction as engine rotation, the stator multiplies engine torque.

When applied, the TCC provides a mechanical link between the converter turbine and the engine, allowing for a direct mechanical power transfer from the engine to the transmission. The converter clutch pressure plate is applied and released by fluid pressure, which is controlled by the powertrain control module (PCM). The PCM controls the torque converter clutch using a pulse-width modulated TCC solenoid.

Torque Converter Clutch (TCC) Damper

The torque converter clutch damper assembly functions 100% of the time regardless of position of the torque converter clutch. With this design you have total dampening of the powertrain, similar to a manual transmission clutch disc assembly.

Torque Converter Assembly

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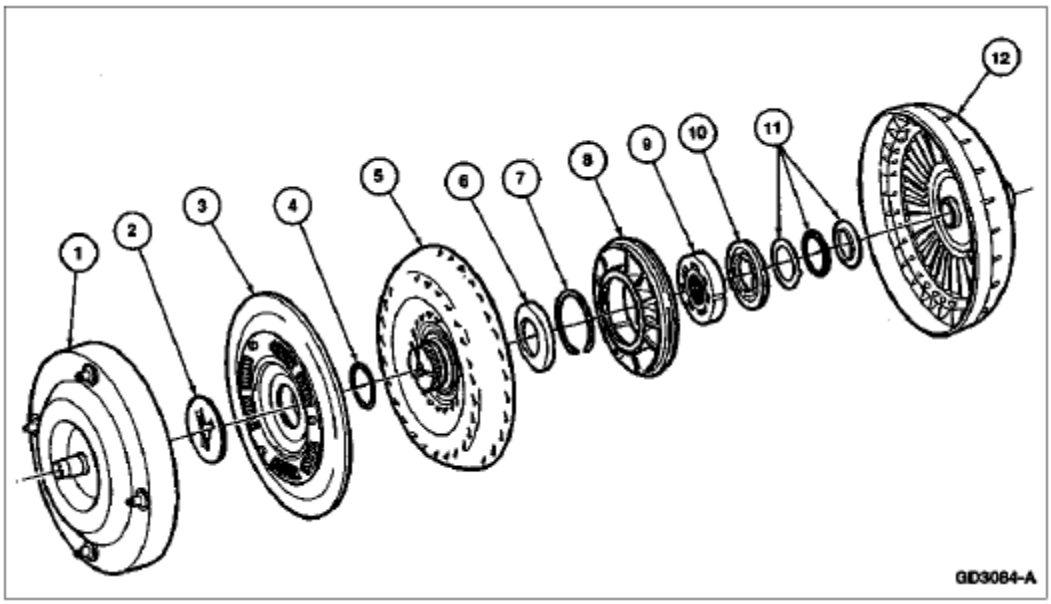

Item	Part Number	Description
1	—	Cover (Part of 7902)
2	—	Thrust Washer (Part of 7902)
3	—	Converter Damper Plate (Part of 7902)
4	—	O-Ring (Part of 7902)
5	—	Turbine Assembly (Part of 7902)
6	—	Thrust Washer (Part of 7902)
7	—	Snap Ring (Part of 7902)
8	—	Reactor (Part of 7902)
9	—	One-Way Clutch Assembly (Part of 7902)
10	—	Thrust Washer (Part of 7902)
11	—	Thrust Bearing (Part of 7902)
12	—	Impeller Assembly (Part of 7902)

Impeller and Cover

The impeller sets the fluid in motion and directs it to the turbine. The impeller is welded to the converter cover.

Turbine

The turbine is the driven member of the converter. It is driven by fluid from the impeller and transfers the hydraulic power to the transmission. When the converter lockup clutch is engaged, the power is transferred mechanically.

Reactor

The reactor is equipped with heavily curved vanes and its center hub has an one-way clutch which prevents the stator from rotating opposite to the engine rotation. The reactor reverses the fluid and returns it to the

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impeller in the direction of impeller rotation. The one-way clutch prevents the force of this fluid from turning the stator against the impeller and turbine.

The reactor one-way clutch is built into the reactor (stator) and prevents it from rotating opposite to engine rotation.

Torque Converter Clutch

The clutch is joined to the turbine by means of the externally splined hub of the turbine and also internally splines within its own assembly.

When engaged the clutch friction plate bears against the inside of the converter cover, thereby producing a direct mechanical connection between the pump housing and the turbine.

Geartrain

Power is transmitted from the torque converter to the planetary gearsets through the input shaft.

By holding and driving certain numbers of the gearsets, four forward ratios and one reverse ratio are obtained and transmitted to the output shaft and differential.

The gear ratios are:

- 1st — 2.47
- 2nd — 1.87
- 3rd — 1.47
- 4th — 1.00
- 5th — 0.75
- Reverse — 2.1

Planetary Gearset — Front

The planetary gear front carrier is driven by the input shaft. The planetary gearset front carrier drives the center shaft via the front one-way clutch in 1st, 2nd, 3rd and 4th gears.

In overdrive, the front sun gear is held, causing the pinion gear to rotate around the front sun gear. The pinion gears in turn drive the front ring gear resulting in an overdrive output ratio of 0.75:1.

The front planetary gearset is also internally splined to the coast clutch for engine braking.

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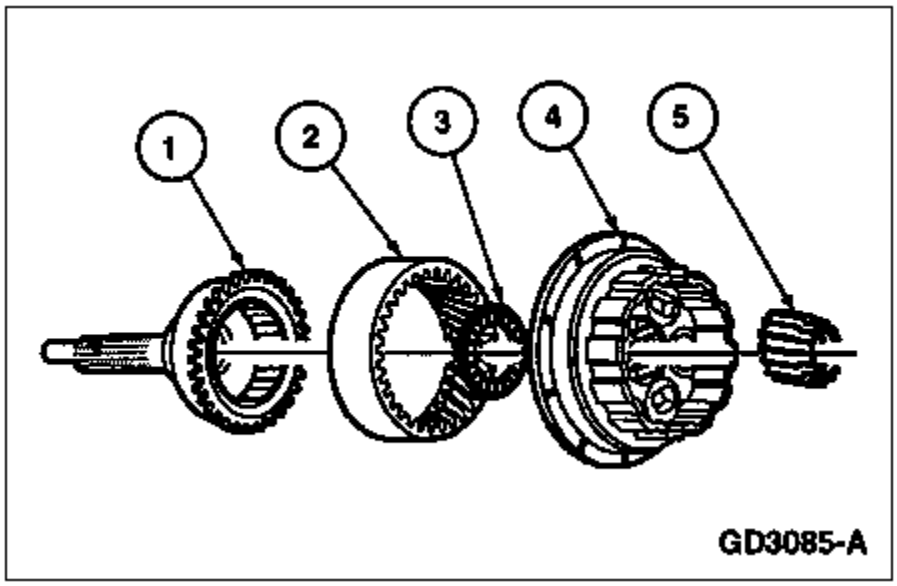

Item	Part Number	Description
1	7A658	Center Shaft Assembly
2	7653	Front Ring Gear
3	7L495	No. 2 Front Planetary Thrust Bearing
4	7B446	Front Planetary Gear Carrier Assembly
5	7D063	Front Sun Gear Assembly

Planetary Gearset — Forward

The forward planetary gearset is splined to the output shaft.

The forward planetary gearset is driven by the forward ring gear when the forward clutch is applied. The forward planetary gearset pinions drive the forward sun gear. The forward sun gear is splined to the input shell.

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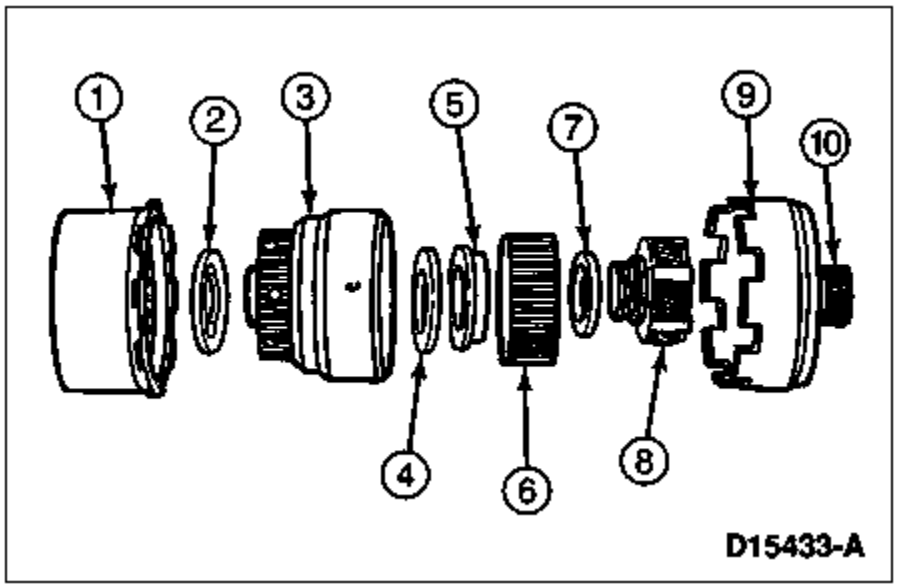

Item	Part Number	Description
1	7D044	Intermediate Brake and Direct Clutch Drum Assembly
2	7M153	No. 5 Forward Clutch Thrust Bearing
3	7A360	Forward Clutch Cylinder Assembly
4	7D234	No. 6A Forward Ring Gear Hub Thrust Bearing
5	7D090	No. 6B Forward Clutch Thrust Washer
6	7D392	Forward Ring Gear
7	7F374	No. 7 Forward Planetary Thrust Bearing Assembly
8	7A398	Forward Planetary Assembly
9	7D064	Input Shell
10	7D063	Forward Sun Gear Assembly

Input Shaft

The input shaft is supported by two bushings in the stator support. End positioning of the input shaft is controlled by the splines in the converter turbine and the front planetary carrier.

Output Shaft

The output shaft is supported by two bushings in the case and by the slip yoke bushing in the extension housing. End positioning is controlled by the parking pawl gear and snap ring or shoulder and by the reverse ring gear hub and snap ring.

Planetary Gearset — Low/Reverse

The low/reverse planetary gearset is connected to the low/reverse brake drum by lugs from the low/reverse brake drum to the lugs of the low/reverse planetary gearset.

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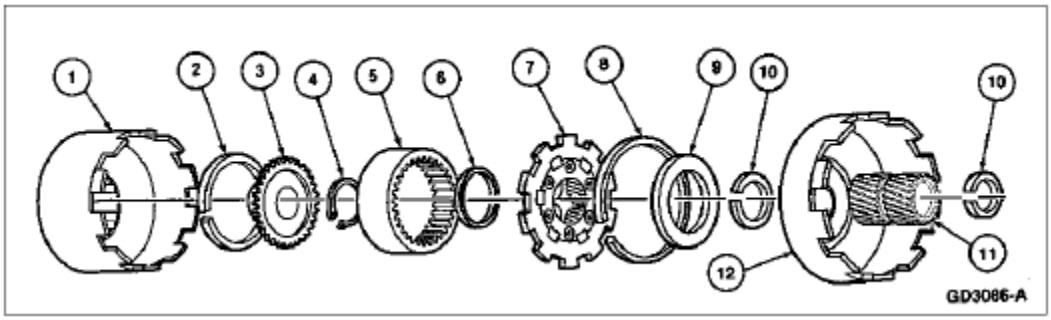
The low/reverse planetary gearset is driven by the forward sun gear which is splined to the input shell.

The splines of the forward sun gear drive the pinions in the low/reverse planetary gearset. The pinions of the low/reverse planetary gearset drive the output shaft ring gear and output shaft hub which is splined to the output shaft.

The low/reverse planetary gearset is held via the rear one-way clutch in the low/reverse brake drum assembly, when the low/reverse band is applied.



Item	Part Number	Description
1	7C498	Low/Reverse Brake Drum Assembly
2	E860122-S	Retaining Ring
3	7D164	Output Shaft Hub
4	E860527-S	Retaining Ring
5	7A153	Output Shaft Ring Gear
6	7M153	No. 9 Reverse Planetary Carrier Thrust Bearing
7	7D006	Low/Reverse Planetary Gearset
8	W702037-S300	Retaining Ring
9	7M153	No. 8 Reverse Planetary Carrier Thrust Bearing
10	E860121-S	Retaining Ring (2 Req'd)
11	7D063	Forward Sun Gear Assembly
12	7D064	Input Shell

Apply Components

Bands — Front

Hydraulic pressure is applied to the front side of the front servo. This pressure causes the servo to stroke and apply force to the band, causing the front brake and coast clutch drum to be held.

The front band holds the front brake and coast clutch drum to the case in 2nd and 5th gears. This causes the front sun gear to be held stationary through the coast clutch adapter and the front brake and coast clutch drum.

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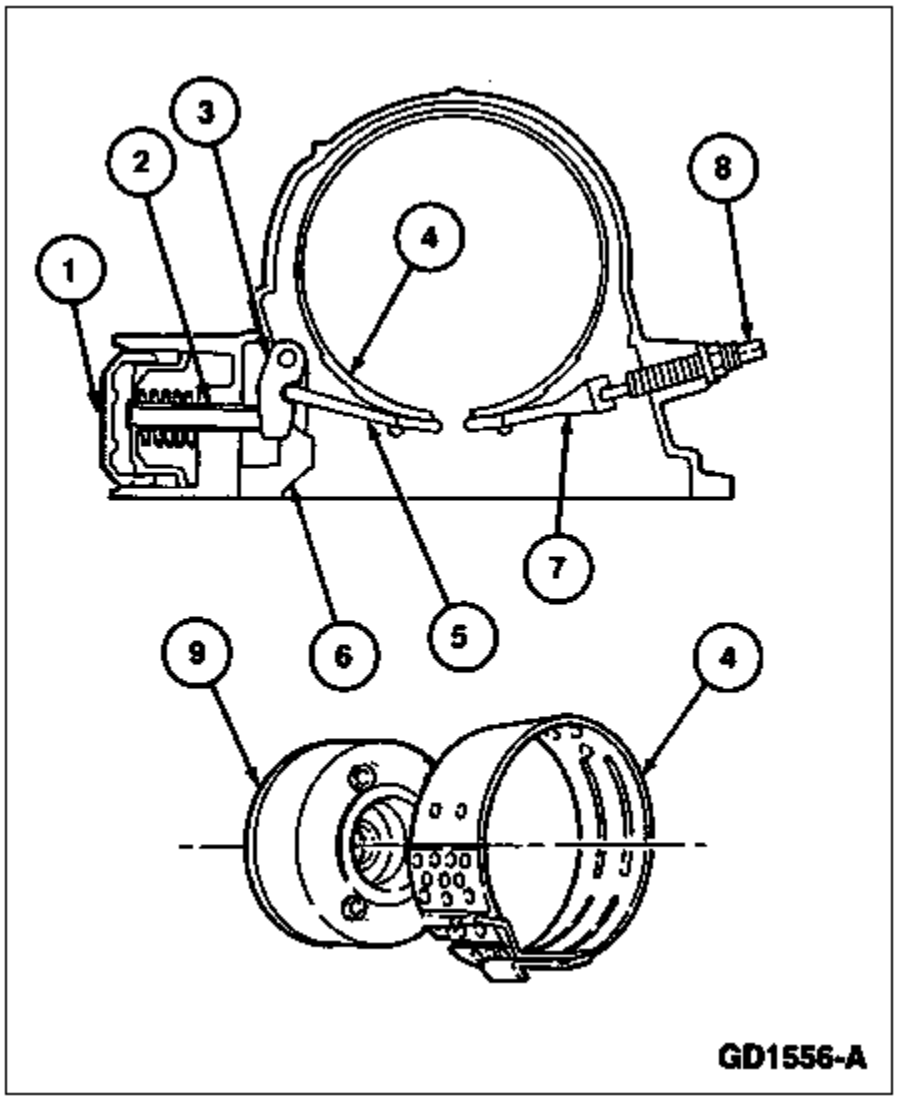

Item	Part Number	Description
1	7L493	Front Servo Cover Assembly
2	7D021	Front Servo Piston and Rod Assembly
3	7330	Front Band Servo Lever
4	7D034	Front Band Assembly
5	7D029	Front Band Apply Strut
6	7A653	Front Band Lever to Case Bracket
7	7D430	Front Band Anchor Strut
8	7C492	Front Band Adjuster/Lock Screw
9	7L669	Front Brake and Coast Clutch Drum Assembly

Bands — Intermediate

Hydraulic pressure is applied to the front side of the intermediate servo. This pressure causes the servo to stroke and apply force to the intermediate band, causing the intermediate brake and direct clutch drum to be

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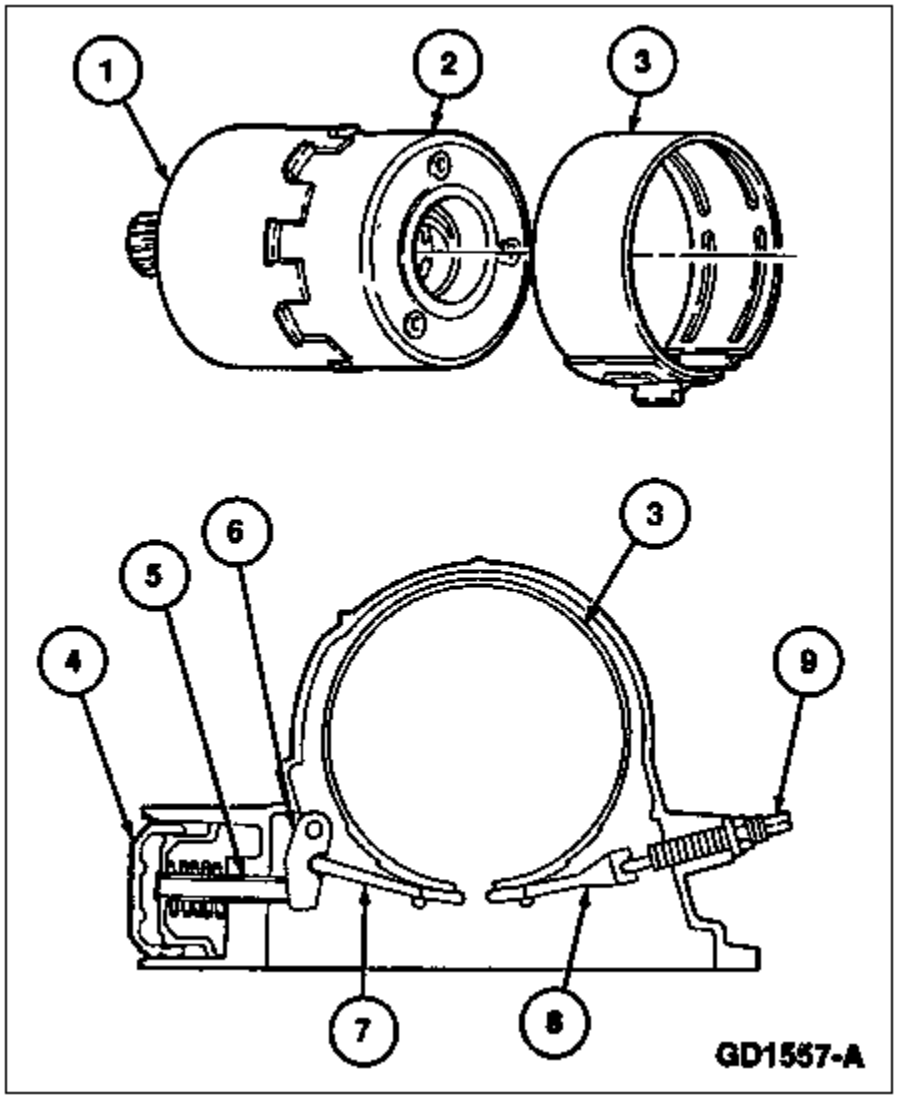
held.

The intermediate band holds the intermediate brake and direct clutch drum to the case in 3rd gear. This causes the input shell and the forward sun gear to be held stationary.



Item	Part Number	Description
1	7D064	Input Shell
2	7D044	Intermediate Brake and Coast Clutch Drum Assembly
3	7D034	Intermediate Band Assembly
4	7L493	Intermediate Servo Cover Assembly
5	7D021	Intermediate Servo Piston and Rod Assembly
6	7330	Intermediate Band Servo Lever
7	7D029	Intermediate Band Apply Strut
8	7D430	Intermediate Band Anchor Strut

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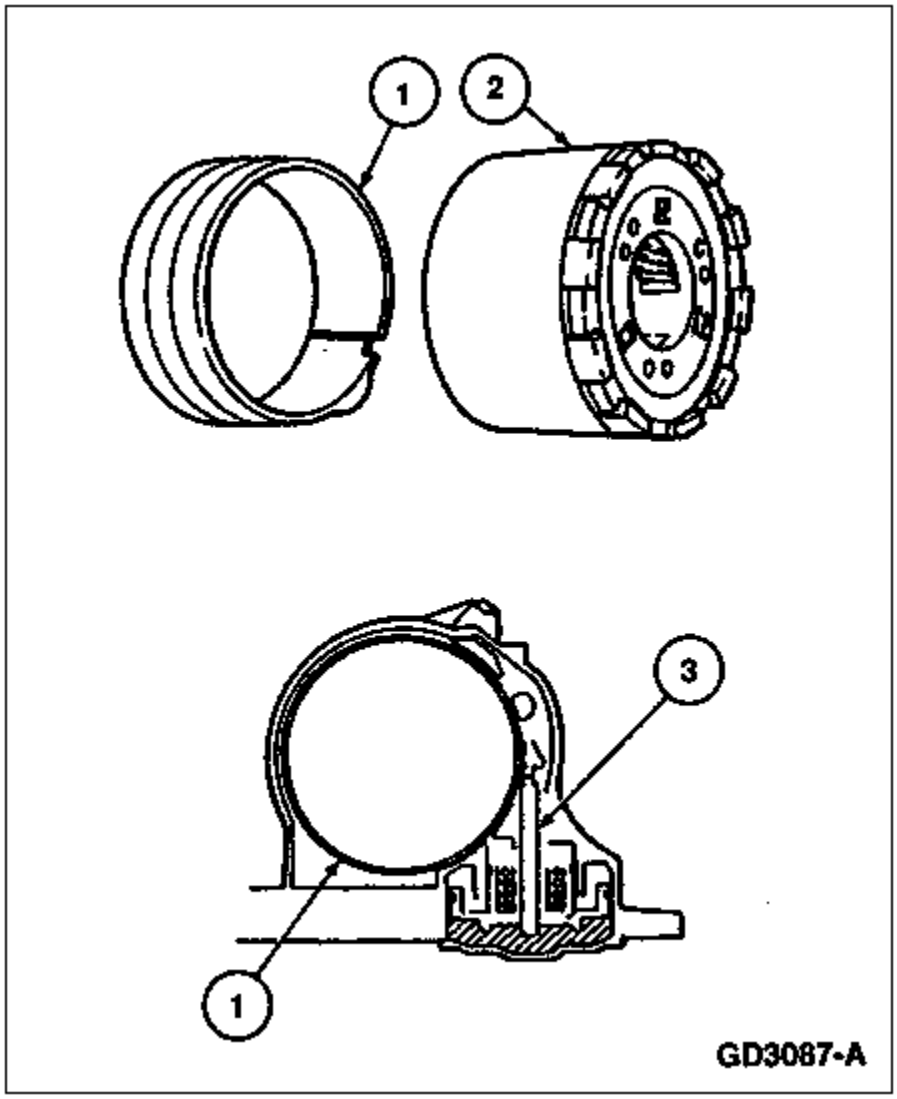
9	7C492	Intermediate Band Adjuster/Lock Screw

Bands — Low/Reverse

Hydraulic pressure is applied to the front side of the low/reverse servo. This pressure causes the servo to stroke and apply force to the low/reverse band, causing the low/reverse brake drum to be held.

The low/reverse band holds the low/reverse brake drum to the case in manual 1st and reverse gears. This causes the low/reverse planetary assembly to be held stationary.



Item	Part Number	Description
1	7D095	Low/Reverse Band Assembly
2	7C498	Low/Reverse Brake Drum Assembly
3	7D189	Low/Reverse Servo Piston Assembly

Clutches — Coast

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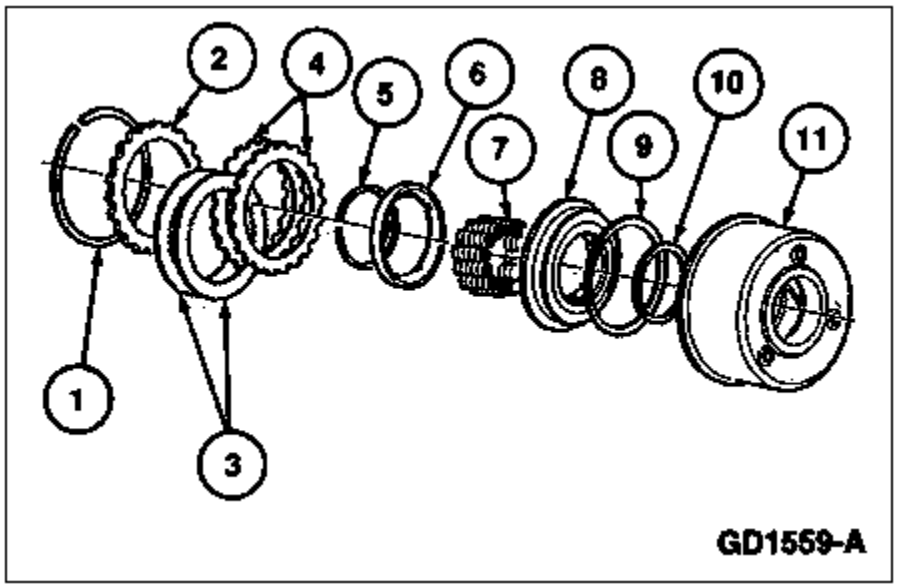
The coast clutch is a multi-disc clutch made up of steel and friction plates. The coast clutch is applied with hydraulic pressure and disengaged by return springs and exhaust of the hydraulic pressure. It is housed in the front brake and coast clutch drum. The coast clutch is applied when the transmission control switch (TCS) is on and hydraulically applied in 2 and 1 positions. When the coast clutch is applied, it holds the planetary gear front carrier and disengages the front one-way clutch preventing overrunning. This uses engine compression to help slow the vehicle and provide engine braking.



Item	Part Number	Description
1	E860126-S/129S	Retaining Ring (Select Fit)
2	7B066	Coast Clutch Pressure Plate
3	7B164	Coast Clutch Internal Plate — Friction
4	7B442	Coast Clutch External Plate — Steel
5	E860125-S	Retaining Ring
6	7A527	Coast Clutch Piston Spring Retainer
7	7A480	Coast Clutch Piston Spring (20 req'd)
8	7A258	Coast Clutch Piston
9	7A548	Coast Clutch Piston Outer Seal Ring
10	7D404	Coast Clutch Piston Inner Seal Ring
11	7L669	Front Brake and Coast Clutch Drum Assembly

Clutches — Direct

The direct clutch is a multi-disc clutch made up of steel and friction plates. The direct clutch is applied with hydraulic pressure and disengaged by return springs and exhaust of the hydraulic pressure. It is housed in the intermediate brake and direct clutch drum. The intermediate brake and direct clutch drum provides two functions. In drive, the direct clutch is applied and coupled to the forward clutch in 4th and 5th gears. This drives the input shell and forward sun gear at a ratio of 1:1.

In reverse, the direct clutch is applied and coupled to the forward clutch and input shell. Since the forward sun gear is splined to the input shell, this causes the forward sun gear to drive the pinions of the low/reverse planetary assembly that is being held by the low/reverse band in reverse rotation. This in turn drives the

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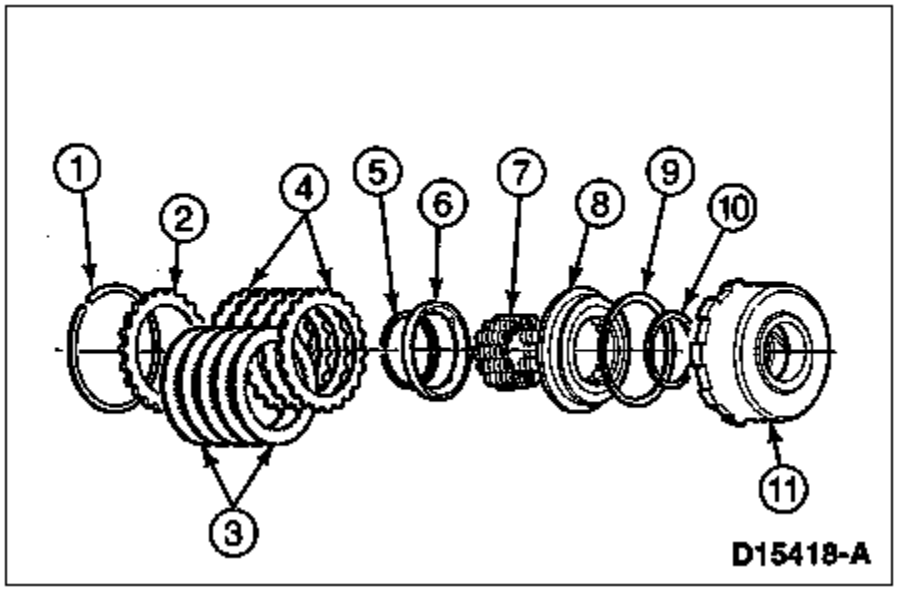
output shaft ring gear and hub at a ratio of 2.1:1.



Item	Part Number	Description
1	E860126-S/129S	Retaining Ring (Select Fit)
2	7B066	Direct Clutch Pressure Plate
3	7B164	Direct Clutch Internal Plate — Friction
4	7B442	Direct Clutch External Plate — Steel
5	E860125-S	Retaining Ring
6	7A527	Direct Clutch Piston Springs Retainer (8 Tabs)
7	7A480	Direct Clutch Piston Spring (20 Req'd)
8	7A258	Direct Clutch Piston
9	7A548	Direct Clutch Piston Outer Seal Ring
10	7D404	Direct Clutch Piston Inner Seal Ring
11	7D044	Intermediate Brake and Direct Clutch Drum Assembly

Clutches — Forward

The forward clutch is a multi-disc clutch made up of steel and friction plates. The forward clutch is applied with hydraulic pressure and disengaged by return springs and exhaust of the hydraulic pressure. The forward clutch is applied in all forward gears and driven by the center shaft. The forward clutch also holds and drives the forward ring gear and hub when hydraulically applied.

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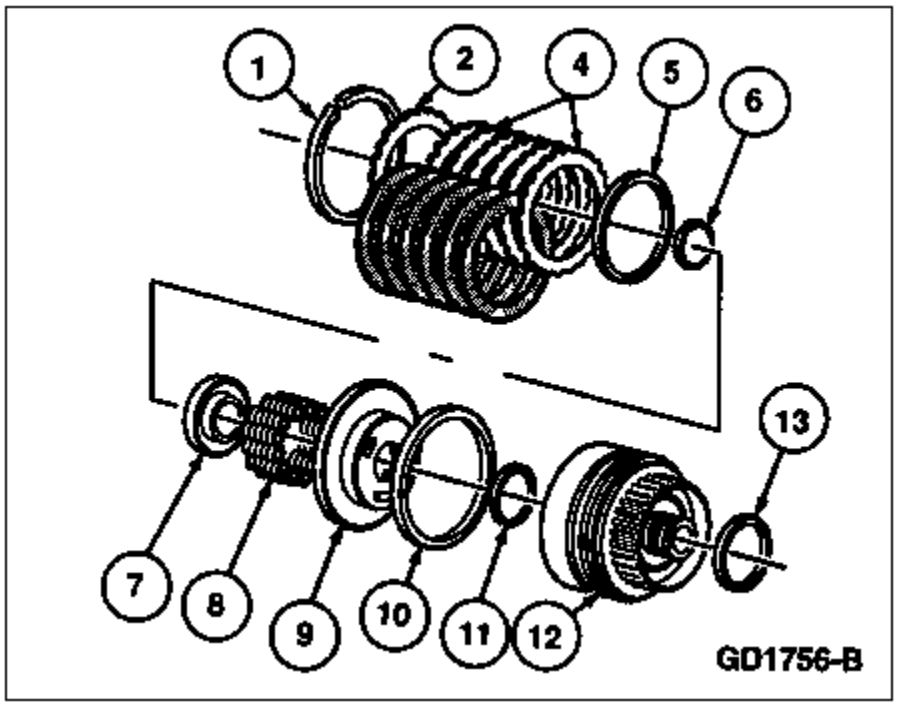

Item	Part Number	Description
1	E860115-S/118S	Retaining Ring (Select Fit)
2	7B066	Forward Clutch Pressure Plate
3	7B164	Forward Clutch Internal Plate — Friction
4	7B442	Forward Clutch External Plate — Steel
5	7B070	Forward Clutch Cushion Spring
6	E860109-S	Retaining Ring
7	7A527	Forward Clutch Piston Spring Retainer
8	7A480	Forward Clutch Piston Spring (15 Req'd)
9	7A262	Forward Clutch Piston Assembly
10	7A548	Forward Clutch Piston Outer Seal Ring
11	7A548	Forward Clutch Piston Inner Seal Ring
12	7A360	Forward Clutch Cylinder Assembly
13	7M153	No. 5 Forward Clutch Cylinder Thrust Bearing

One-Way Clutches — Overdrive

The front one-way clutch is a sprag-type one-way clutch that is pressed into the center shaft.

The front one-way clutch is driven by the inner race of the front planetary gear carrier. The front one-way clutch holds and drives the outer race of the center shaft in 1st, 2nd, 3rd, 4th and reverse gears.

The front one-way clutch overruns during all coast operations and is always overrunning in 5th gear.

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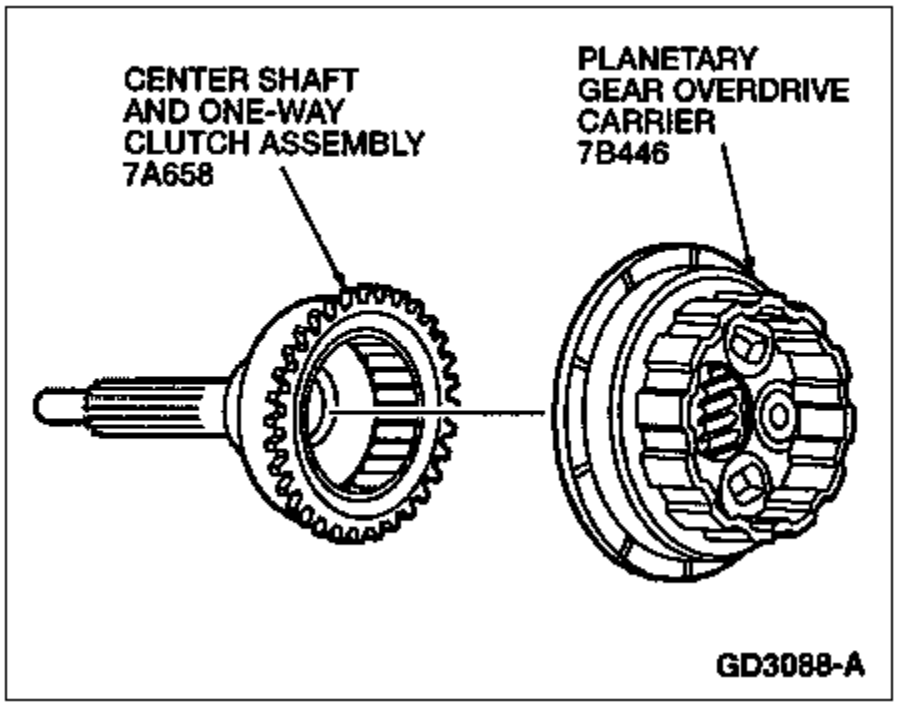
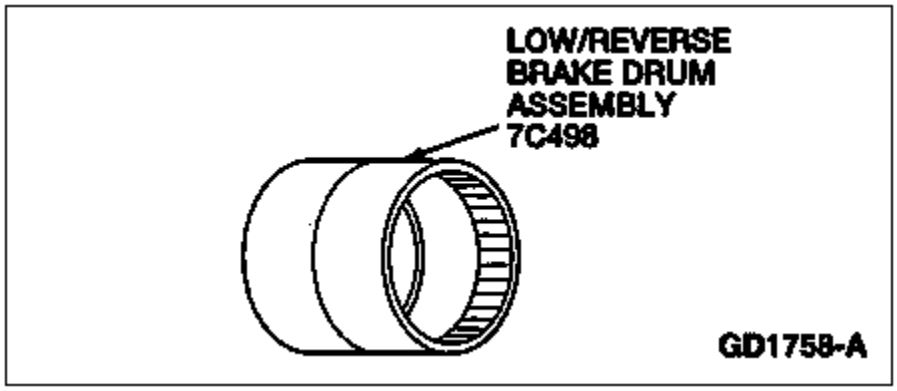


One-Way Clutches — Low

The 4.0L uses a sprag-type one-way clutch. The low/reverse one-way clutch holds the low/reverse brake drum and low/reverse planetary assembly to the gear case in 1st gear only and overruns in all other gears.



Hydraulic System

Pump

The fluid pump provides the fluid pressure required to charge the torque converter, main control assembly, transmission cooling system, lubrication system and apply devices.

The 5R55E has a positive displacement gear and crescent-type pump which is shaft-driven by the torque converter cover.

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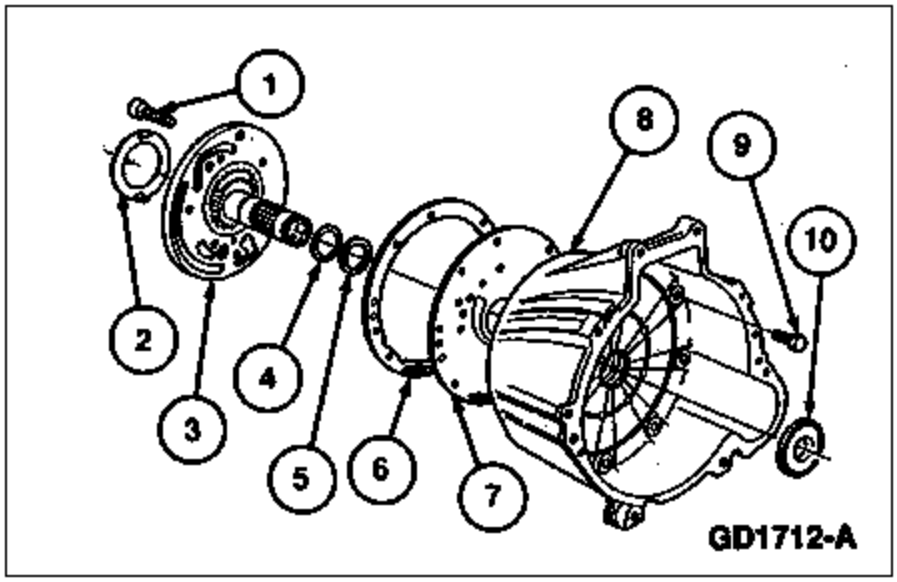

Item	Part Number	Description
1	W701429-S309M	Fluid Pump-to-Converter Housing Screws (6 Req'd)
2	7D014	No. 1 Fluid Pump Input Thrust Washer (Nylon)
3	7A103	Fluid Pump Support and Gear Assembly
4	W701431-S300	Fluid Pump Shaft-to-Inner Gear O-Ring
5	7L323	Fluid Pump Support Seal Ring
6	7A136	Fluid Pump Gasket
7	7B472	Fluid Pump Adapter Plate
8	7976	Converter Housing Assembly
9	E804595-S200 (8 Req'd)	Converter Housing-to-Case Screw and Seal Assembly
10	7A248	Converter Hub-to-Converter Housing Seal Assembly

Filter

All fluid drawn from the pan passes through the fluid filter. The fluid filter and its accompanying seals are part of the fluid path to the fluid pump.

The fluid filter also has a bypass section. This allows the fluid which is vented at the main regulator valve to be recirculated to the pump without passing through the filtering element.

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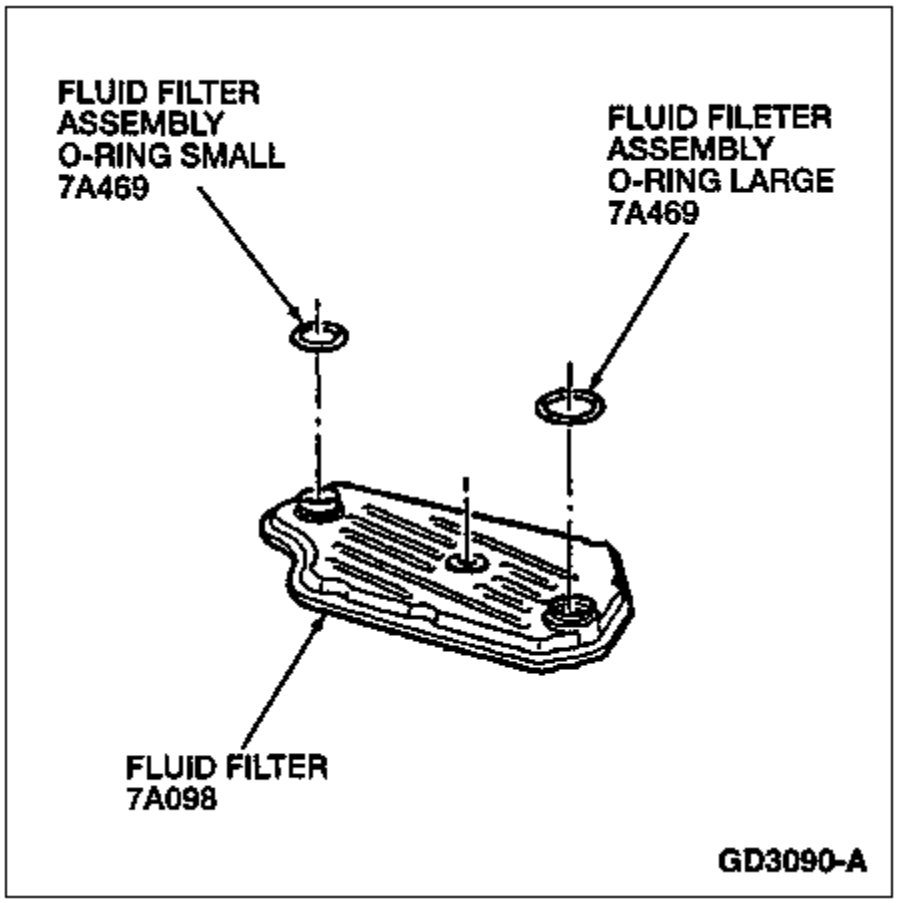

Main Control

The main control assembly and related components are part of the pressure side of the 5R55E hydraulic system. The main control assembly consists of the solenoids, the valve body assembly and the separator plate.

All valves inside the main control assembly are anodized aluminum. They cannot be sanded, filed or dressed in any way that may damage the valve surface. If the valves have any scratches, burrs or nicks that prevent free movement, the main control assembly must be replaced.

Main Control Assembly

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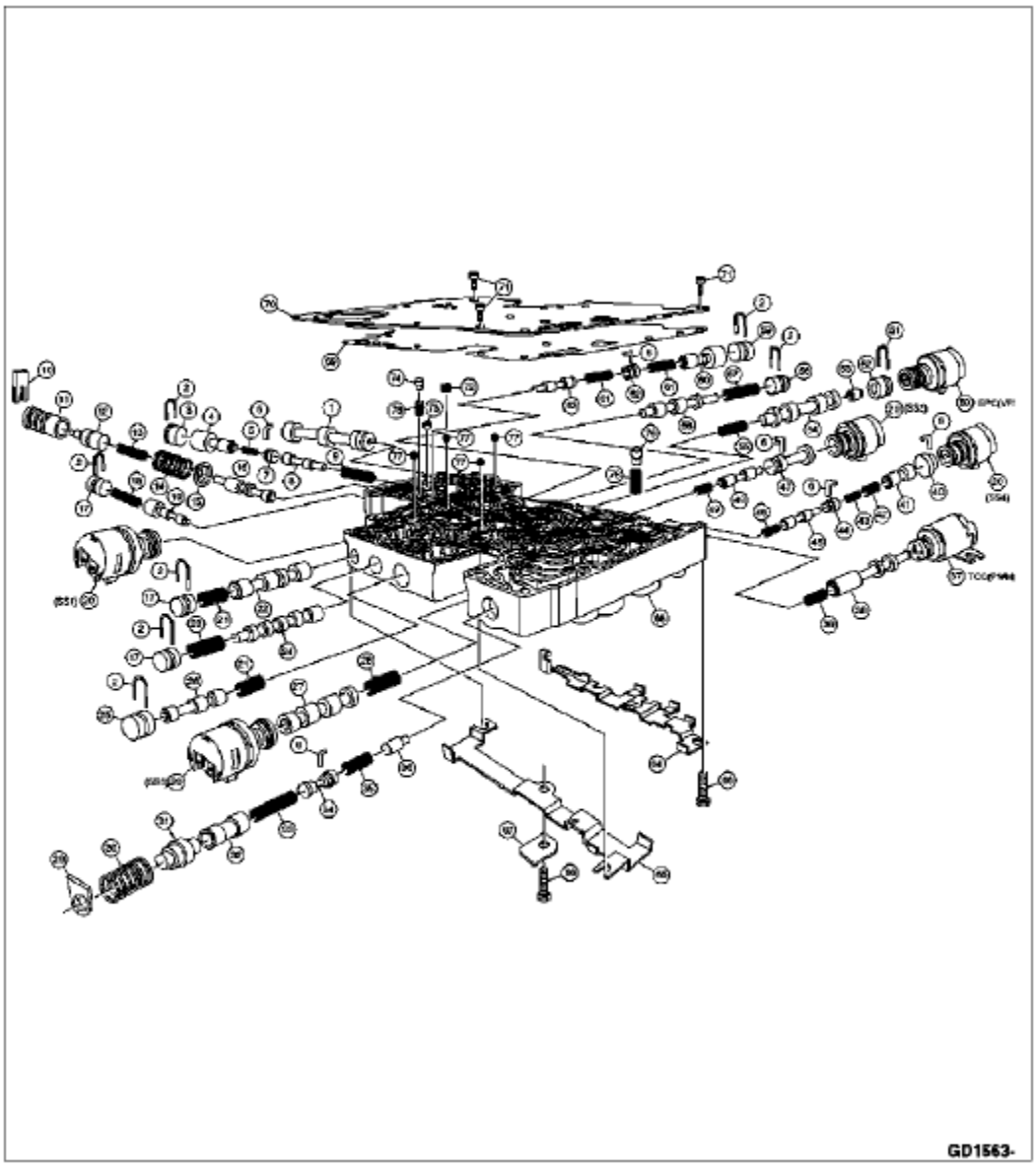

Item	Part Number	Description
1	—	Valve — Manual
2	7E335	Retainer — Valve Plug (7 Req'd)
3	—	Plug — Valve Retainer
4	—	Valve — Forward Modulator
5	—	Spring — Forward Modulator
6	7E335	Retainer — Valve Plug (6 Req'd)
7	—	Plug — Valve Retainer
8	—	Valve — EPC Boost
9	—	Spring — EPC Boost
10	7E336	Retainer — Valve Plug
11	—	Sleeve — Pressure Boost

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12	—	Valve — Pressure Boost Valve
13	—	Spring — Pressure Boost
14	—	Spring — Oil Pressure Regulator
15	—	Retainer — Main Regulator Spring
16	—	Valve — Pressure Regulator
17	—	Plug — Valve Retainer (3 Req'd)
18	—	Spring — Forward Engagement
19	—	Valve — Forward Engagement Control
20	7G484	Solenoid — Shift (4 Req'd)
21	—	Spring — 4-3 (K.D./T.D.) (2 Req'd)
22	—	Valve — 4-3 (K.D.)
23	—	Spring — Manual Low (1)
24	—	Valve — Manual Low (1)
25	—	Plug — Valve Retainer
26	—	Valve — 4-3 (T.D.)
27	—	Valve — 1 and 2 4-5 Shift
28	—	Spring — 1-2 and 4-5 Shift
29	7E366	Retainer — Valve Plug
30	—	Spring — Thermostat Bypass
31	—	Valve — Thermostat Bypass
32	—	Valve — Thermostatic Bypass
33	—	Spring — Thermostat Bypass
34	—	Plug — Valve Retainer
35	—	Spring — Cooler Limit
36	—	Valve — Cooler Limit
37	7G136	Solenoid — Torque Converter Clutch (TCC)
38	—	Valve — Converter Clutch
39	—	Spring — Converter Clutch
40	—	Plug — Valve Retainer
41	—	Valve — Converter Clutch
42	—	Spring — Converter Clutch
43	—	Spring — Converter Clutch
44	—	Plug — Valve Retainer
45	—	Valve — Coast Clutch
46	—	Spring — Coast Clutch
47	—	Plug — Valve Retainer
48	—	Valve — 4-3 Downshifts
49	—	Spring — 4-3 Downshifts
50	7G383	Solenoid — EPC (VFS)

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	7E335	Retainer — Valve Plug
52	—	Plug — Valve Retainer
53	—	Valve — 2-3 Shift
54	—	Valve — 2-3 Shift
55	—	Spring — 2-3 Shift
56	—	Plug — Valve Retainer
57	—	Spring — 3-4 Shift
58	—	Valve — 3-4 Shift
59	—	Plug — Valve Retainer
60	—	Valve — Reverse Modulation
61	—	Spring — Reverse Modulation (2 Req'd)
62	—	Plug — Valve Retainer
63	—	Valve — Reverse Modulation
64	7L491	Clamp — SS1/SS2
65	7L491	Clamp — SS3/SS4/EPC/TCC
66	E800155-S72	Screw — Retain Solenoid Clamps (2 Req'd)
67	7D132	I.D. Plate
68	—	Body — Valve
69	7D100	Gasket — Separator Plate
70	7A008	Plate — Separator
71	E804357-S76	Screw — Retain Separator Plate (3 Req'd)
72	7N113	Screen — EPC Limit Circuit
73	7D376	Extension Housing Lube Orifice
74	7E368	Valve — EPC Limit (Metal)
75	7E368	Valve — Converter Relief (Plastic)
76	7E340	Spring — EPC Limit/Converter Relief (2 Req'd)
77	7E195	Ball (4 Req'd)

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Transmission Electronic Control System

Electronic System Description

Shift scheduling, timing and feel (line pressure), as well as torque converter clutch (TCC) operation in the 5R55E is controlled electronically by the powertrain control module (PCM).

Input signals from various engine sensors give the PCM information about the engine's operating state. Other inputs are based on driver demands, such as the accelerator pedal position, which is monitored by the PCM using the throttle position (TP) sensor. Inputs are also supplied by the transmission itself. The turbine shaft speed (TSS) sensor, the output shaft speed (OSS) sensor and the transmission fluid temperature (TFT) sensor supply information to the PCM.

Using these input signals, the PCM can determine when the time and conditions are right for a shift or TCC application. The PCM controls six solenoids: four ON/OFF solenoids for upshifts, downshifts, and coast clutch application, one for pulse-width modulated control of the torque converter clutch and one for electronic line pressure control.

Component Locator

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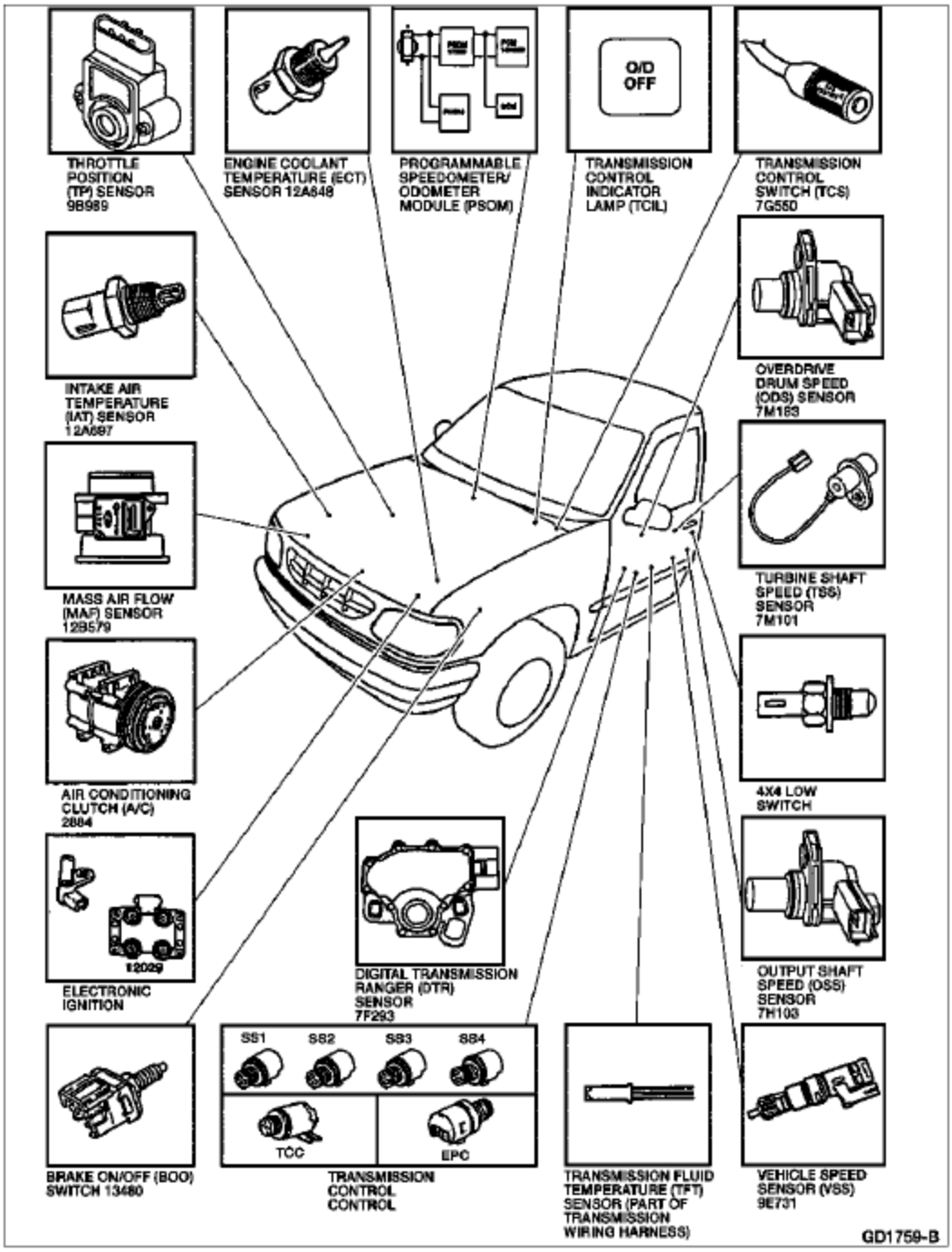

Powertrain Control Module (PCM) 12A650:

Description:
The powertrain control module (PCM) controls various engine functions and provides control of the 5R55E transmission.
The PCM responds to inputs and operates solenoids for electro-hydraulic control of line pressure, shift scheduling, torque converter clutch (TCC) scheduling and coast clutch control for coast braking.

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The PCM has the ability to:

- Monitor its input and output devices for the presence of faults.
- Store diagnostic trouble codes (DTCs) related to detected faults.
- Alert the driver for some detected faults by turning on the malfunctioning indicator lamp (MIL) in the instrument cluster.
- Display information when a service technician connects diagnostic equipment.

Diagnostic Trouble Codes:

P0603, P0605.

Air Conditioning (A/C) Clutch 2884:

Description:

An electro-magnetic air conditioning (A/C) clutch is energized when the clutch cycling pressure switch closes. The switch is located on the suction accumulator-drier. The closing of the switch completes the circuit to the clutch and draws it into engagement with the compressor driveshaft.

When engaged, the A/C clutch is an input to the PCM to adjust electronic pressure control (EPC) pressure for the additional load on the engine. It is also used to adjust TCC modulation when the A/C clutch is engaged.

Symptoms:

Failed ON — EPC pressure slightly low with A/C off.
Failed OFF — EPC pressure slightly high with A/C on. If erratic A/C operation occurs, the customer may feel improper TCC apply and release.

Diagnostic Trouble Codes:

P1460.

Brake On/Off (BOO) Switch 13480:

Description:

The brake on/off (BOO) switch is connected to the brake pedal. When the brake pedal is pressed, the BOO switch has closed contacts allowing a voltage signal to the PCM.

The PCM may release TCC when the brakes are applied.

Symptoms:

Failed ON — converter clutch will not engage at less than 1/3 throttle.
Failed OFF or not connected — converter clutch will not disengage when brake is applied.

Diagnostic Trouble Codes:

P1703.

Engine Coolant Temperature (ECT) Sensor 12A648:

Description:

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The engine coolant temperature (ECT) sensor detects the temperature of engine coolant and supplies the information to the PCM.
The ECT sensor is threaded into the heater outlet fitting or cooling passage on the engine. For automatic transmission applications, the ECT is used to control TCC solenoid operation. For engine control applications, the ECT signal is used to modify ignition timing, exhaust gas recirculation (EGR) flow, and air-to-fuel ratio as a function of engine coolant temperature. On electronic instrument cluster applications, the ECT output is used to control a coolant temperature indicator.
Symptoms:
Torque converter clutch solenoid will always be "off," resulting in reduced fuel economy.
Diagnostic Trouble Codes:
P0117, P0118, P1116.

Electronic Ignition (EI) System:

Description:
The electronic ignition (EI) system has a crankshaft position (CKP) sensor and ignition coil packs. The CKP sensor sends crankshaft position information to the PCM. The rpm signal in the transmission strategy is then used for torque converter clutch control, EPC and shift scheduling.
Symptoms:
Engine malfunction, no torque converter clutch engagement.
Diagnostic Trouble Codes:
P0300-P0306, P0320, P0340, P1351-P1364.

4x4 Low (4x4L) Switch:

Description:
The low range switch is located on the transfer case cover. It provides an indication of when the 4x4 transfer case gear system is in the low range.
NOTE: Not all 4x4L switch concerns will set a DTC. Refer to Diagnosis by Symptom or pinpoint tests if shifts are delayed in 4x4L or shift early in normal mode.
Transmission Function:
Modifies shift schedule for 4x4L transfer case gear ratio.
Symptoms:
Failed on — Early shift schedule in 4x2 and 4x4H. Failed off — Shifts delayed in 4x4L. If the 4x4 low indicator light fuse is blown, the transmission will shift according to 4x4 low shift schedule regardless of transfer case position.
Diagnostic Trouble Codes:
P1781, P1729.

Overdrive Drum Speed (ODS) Sensor 7M183:

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Description:
The overdrive drum speed (ODS) sensor is a magnetic pickup that sends a signal to the powertrain control module (PCM) assembly that indicates overdrive drum speed. The ODS sensor signal is used in the transmission control strategy to determine EPC pressure, shift and torque converter scheduling. The ODS sensor is mounted externally on the transmission.
Diagnostic Trouble Codes:
P1719.

Output Shaft Speed Sensor (OSS) 7H103:

Description:
The output shaft speed (OSS) sensor is a magnetic pickup that sends a signal to the powertrain control module (PCM) assembly that indicates output shaft speed. The OSS sensor signal is used in the transmission control strategy to determine EPC pressure, shift and torque converter scheduling. The OSS sensor is mounted externally on the transmission.
Symptoms:
Harsh shifts, abnormal shift schedule, no torque converter engagements.
Diagnostic Trouble Codes:
P0720, P0721.

Intake Air Temperature (IAT) Sensor 12A697:

Description:
The intake air temperature (IAT) sensor is used to determine the EPC pressure. It also provides the electronic fuel injection system with mixture (fuel and air) temperature information. The IAT is used both as a density corrector for airflow calculation and to proportion the cold enrichment fuel flow. This sensor is similar in construction to the engine coolant temperature (ECT) sensor, except it is packaged to improve sensor response time.
Symptoms:
Incorrect EPC pressure either high or low resulting in either harsh or soft shifts.
Diagnostic Trouble Codes:
P0112, P0113, P0114.

Mass Air Flow (MAF) Sensor 12B579:

Description:
The mass air flow (MAF) sensor directly measures the mass of the air flowing into the engine. The sensor output is a DC (analog) signal ranging from about 0.5 volts to 5.0 volts used by the processor to calculate the injector pulse width for stoichiometry. For transmission strategies, this sensor is used for EPC pressure control, shift, and torque converter clutch scheduling.
Symptoms:

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Incorrect shift schedule, high/low EPC pressure. Incorrect torque converter engagement scheduling and symptoms similar to a throttle position (TP) sensor malfunction. Soft or firm shift based on EPC/line pressure. Soft shifts may be caused by a restricted air inlet.
Diagnostic Trouble Codes:
P0102, P0103, P1100, P1101.

Transmission Control Switch (TCS) 7G550:

Description:
The transmission control switch (TCS) is a momentary contact switch. When the driver presses the button of the TCS, a signal is sent to the PCM. At the same time, the PCM also causes the transmission control indicator lamp (TCIL) in the instrument panel to turn on or off.
When the TCS is initially pressed, the PCM disables transmission operation in D position/5th gear. At the same time, coast braking in 1st, 2nd, 3rd, and 4th gears occurs because the coast clutch is applied.
When the button of the TCS is pressed again, the PCM enables 5th gear operation, releases the coast clutch and turns off the TCIL.
Symptoms:
If the TCS fails with open contacts, no disabling of 5th gear and enabling of coast braking in 1st, 2nd, 3rd, and 4th gears in D position is possible.
Diagnostic Trouble Codes:
P1780.

Transmission Control Indicator Lamp (TCIL):

Description:
The transmission control indicator lamp (TCIL) is located in the instrument panel for Ranger and on the shift lever for Aerostar. It is labeled O/D OFF. The transmission control switch (TCS) and the PCM control the on/off operation of the TCIL.
When the driver initially presses the button of the TCS, the TCIL turns on to indicate that transmission operation in 4th gear is disabled. When the driver presses the TCS again, the TCIL turns off. The TCIL will flash if EPC solenoid is shorted or a monitored sensor has failed.
Symptoms:
If the TCIL fails on or off, the driver may have an incorrect indication of transmission operation or monitored sensor malfunction.
Diagnostic Trouble Code:
N/A.

Throttle Position (TP) Sensor 9B989:

Description:
The throttle position (TP) sensor is a potentiometer mounted on the throttle body. The TP sensor detects

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the position of the throttle plate and sends this information to the processor assembly as varying voltage signal.
The PCM uses the monitored voltage level of the TP sensor for control of EPC pressure, torque converter clutch operation and shift scheduling.
If a malfunction occurs in the TP sensor circuit, the processor will recognize that the TP sensor signal is out of specification. The processor will then operate the transmission in a high capacity mode to prevent transmission damage.
Symptoms:
Harsh engagements, firm shift feel, abnormal shift schedule, torque converter clutch does not engage, or torque converter clutch cycling.
Diagnostic Trouble Codes:
P0121-P0123, P1120, P1121, P1124, P1125.

Programmable Speedometer/Odometer Module (PSOM):

The programmable speedometer/odometer module (PSOM) receives input from the rear brake anti-lock sensor, which is mounted on the rear axle differential housing. The PSOM processes this input signal information and relays it to the powertrain control module and the speed control module. This signal tells the powertrain control module the vehicle speed in miles per hour (mph). The PSOM is also used as an input in determining shift scheduling and electronic pressure control.
Symptoms:
Harsh engagements, firm shift feel, abnormal shift schedule, unexpected downshifts may occur at closed throttle. Torque converter clutch will not engage, elevated EPC pressures.
NOTE: EPC shorted to ground or failed low may result in a false VSS code. Diagnose EPC concerns first. Then recheck VSS input and PSOM.
Diagnostic Trouble Codes:
P0500, P0501, P0503, P1500, P1501.

Vehicle Speed Sensor (VSS) 9E731:

Description:
The vehicle speed sensor (VSS) is a magnetic pickup that sends a signal to the processor assembly. This VSS signal tells the processor assembly the vehicle speed.
The PCM uses this information to control shift scheduling and EPC pressure.
Symptoms:
Harsh engagements, firm shift feel, abnormal shift schedule, unexpected downshifts may occur at closed throttle. Torque converter clutch will not engage, elevated EPC pressures.
NOTE: EPC shorted to ground or failed low may result in a false VSS code. Diagnose EPC concerns first. Then recheck VSS.
Diagnostic Trouble Codes:
P0500, P0501, P0503, P1500, P1501.

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Transmission Fluid Temperature (TFT) Sensor:

Description:
The transmission fluid temperature (TFT) sensor is located on the transmission main control body wiring harness assembly. It is a temperature-sensitive device called a thermistor. The resistance value of the TFT will vary with temperature change. The processor monitors the voltage across the TFT to determine the temperature of the transmission fluid.
The processor assembly uses this initial signal to determine whether a cold start shift schedule is necessary. The cold start shift schedule allows quicker shifts when the transmission fluid temperature is cold. The processor also inhibits torque converter clutch operation at low transmission fluid temperatures and corrects EPC pressures for temperature.
Symptoms:
Torque converter clutch engagement and stabilized shift schedules happen too soon after a cold start. Harsh or soft shifts.
Diagnostic Trouble Codes:
P0712, P0713, P1711, P1783.

Digital Transmission Range (DTR) Sensor 7F293:

Description:
The digital transmission range (DTR) sensor is located on the outside of the transmission at the manual lever. The DTR sensor completes the start circuit in Park and Neutral, the back-up lamp circuit in Reverse and the Neutral sense circuit (4x4 only) in Neutral. The DTR sensor also sends a digital output signal to the powertrain control module (PCM) indicating the position of the manual lever (P, R, N, D, 2, 1).
Symptoms:
Engagement concerns, wrong gear, no shifts, increase in EPC pressure.
Diagnostic Trouble Codes:
P0705, P0708, P1705, P1704.

Turbine Shaft Speed (TSS) Sensor 7M101:

Description:
A turbine shaft speed (TSS) sensor is a magnetic pickup that sends a signal to the processor assembly that indicates transmission turbine shaft input speed.
The TSS sensor provides torque converter turbine speed information for torque converter clutch control strategy. Also used in determining static EPC pressure settings.
Symptoms:
Increased engine rpm on engagements, harsh shifts (converter engaged), delayed shifts with hard apply (slip/bump feel).
Diagnostic Trouble Codes:
P0715.

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Electronic Pressure Control (EPC) Solenoid 7H144:

Description:
The electronic pressure control (EPC) solenoid is a variable force style (VFS) solenoid. The VFS type solenoid is an electro-hydraulic actuator combining a solenoid and a regulating valve. It supplies EPC which regulates transmission line pressure and line modulator pressure. This is done by producing resisting forces to the main regulator and line modulator circuits. These two pressures control clutch application pressures.
Symptoms:
Maximum EPC pressure, harsh shifts and engagements, **may set a false VSS code.** Zero EPC pressure — no 2nd and 4th gear, slips in 1st and 3rd with high input torque.
Diagnostic Trouble Codes:
P1746*, P1747*. *Output circuit check, generated only by electrical conditions.

Torque Converter Clutch (TCC) Solenoid 7F037:

Description:
The torque converter clutch (TCC) solenoid is used in the transmission control system to control the application, modulation, and release of the torque converter clutch.
Symptoms:
Failed ON — engine runs rough/vehicle shudder, engine stalls in Drive at low idle speeds (1st, 2nd, 3rd, 4th, or 5th gear). Failed OFF — torque converter never engages.
Diagnostic Trouble Codes:
P0741**, P0743*, P1740, P1744**.
*Output circuit check, generated only by electrical conditions. **May also be generated by a non-electrical transmission hardware condition.

Shift Solenoid Assemblies (SS1, SS2, SS3, SS4) (7G484):

Description:
Four on/off solenoids are used for electronically controlled shift scheduling. The four shift solenoids are two-way, normally open style. Solenoids SS1, SS2, SS3, and SS4 provide gear selection of 1st through 5th by controlling the pressure of the shift valves. SS4 is also used to apply and release the coast clutch.
SS1 Symptoms:
Improper gear selection depending on failure mode and manual lever position. Failed ON: No 4th and 5th gears. Failed OFF: No 1st and 2nd gears.
Diagnostic Trouble Codes:
P0750*, P0751**, P0731**, P0732**, P0734**, P0735**, P1714**.

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SS2 Symptoms:
Improper gear selection depending on failure mode and manual lever position. Failed ON: No 1st, 2nd, 4th, and 5th gears. Failed OFF: No 3rd gear.
Diagnostic Trouble Codes:
P0755*, P0756**, P0731**, P0732**, P0733**, P0734**, P0735**, P1715**.
SS3 Symptoms:
Improper gear selection depending on failure mode and manual lever position. Failed ON: No 1st, 3rd, and 4th gears. Failed OFF: No 2nd and 5th gears.
Diagnostic Trouble Codes:
P0760*, P0761**, P0731**, P0732**, P0733**, P0734**, P0735**, P1716***, P7162.
SS4 Symptoms:
Improper gear selection depending on failure mode and manual lever position. Failed On: No 2nd and 5th gears. Failed Off: No engine braking.
Diagnostic Trouble Codes:
P0765*, P0732**, P0735**, P1717***, P1762.
*Output circuit check, generated only by electrical conditions.
**May also be generated by some other non-electrical transmission hardware condition.
***Solenoid mechanically or hydraulically stuck.

SOLENOID APPLICATION CHART — 5R55E

Transmission Range Selector Lever Position	Powertrain Control Module (PCM) Commanded Gear	5R55E Solenoid States				
		SS1	SS2	SS3	SS4	Engine Braking
P/N	P/N	On	Off	Off	Off	No
R	R	On	Off	Off	O/W [1]	Yes
(D) (Overdrive)	1	On	Off	Off	Off	No
(D)	2 [G]	On	Off	On	Off	No
(D)	3	On	On	Off	Off	No
(D)	4	Off	Off	Off	Off	No
(D)	5	Off	Off	On	Off	Yes
(D) Off [1]	1	On	Off	Off	Off	No
	2 [G]	On	Off	On	Off	No
	3	On	On	Off	On	Yes
	4	Off	Off	Off	On	Yes
2	2	On	On	Off	On	Yes
1	1	On	Off	Off	On	Yes

[1] O/W=TCS "ON"
[G] Shift scheduled by PCM calibration.

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Diagnostic Strategy

Troubleshooting an electronically controlled automatic transmission is simplified by using the proven method of diagnosis. One of the most important things to remember is that there is a definite procedure to follow.

NOTE: Do not take any short cuts or assume that critical checks or adjustments have already been made.

Follow the procedures as written to avoid missing critical components or steps.

To properly diagnose a concern the technician should have the following publications available:

- Workshop Manual
- Powertrain Control/Emissions Diagnosis (PC/ED) Manual
- OASIS Messages
- Technical Service Bulletins (TSBs)
- Electrical/Vacuum Troubleshooting Manual (EVTM)

These publications provide the information required when diagnosing transmission concerns.

Using the Diagnostic Flow Chart as a guide, follow the steps as indicated.

Preliminary Inspection

- Know and understand the customer's concern.
- Verify the concern by operating the vehicle.
- Check the fluid level and condition.
- Check for non-factory add-on items.
- Check shift linkages for proper adjustment.
- Check TSBs and OASIS messages for the concern.

Diagnostics

- Perform On-Board Diagnostic Procedures, key on engine off (KOEO), key on engine running (KOER).
- Record all diagnostic trouble codes (DTCs).
- Repair all non-transmission codes first.
- Repair all transmission codes second.
- Erase all continuous codes and attempt to repeat them.
- Repair all continuous codes.
- If only pass codes, proceed to Diagnosis by Symptom Charts for further information and diagnosis.

By following the diagnostic sequence the service technician will be able to diagnose and repair the concern the first time.

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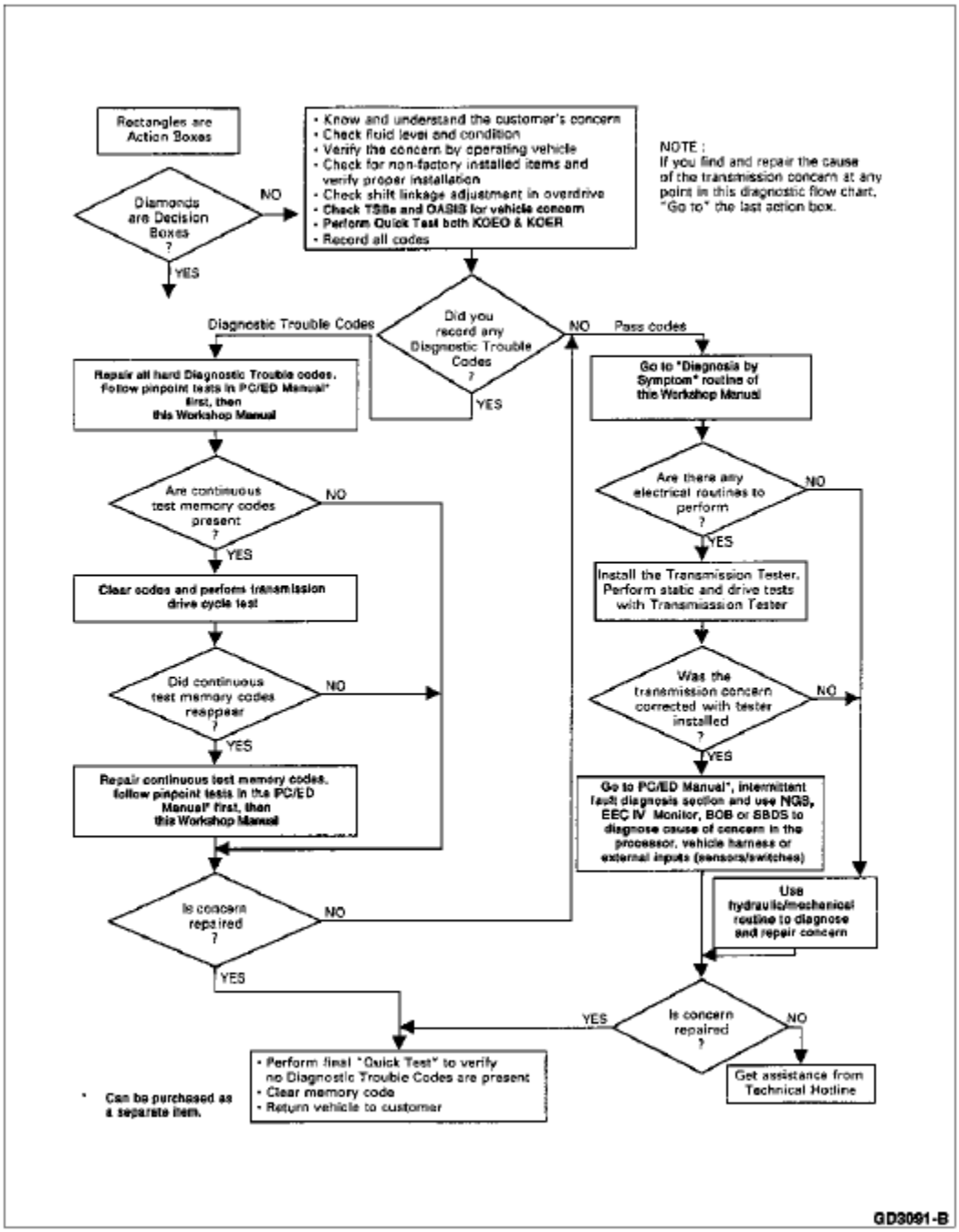
Diagnostic Flow Chart



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Preliminary Inspection

The following items must be checked before proceeding.

Know and Understand the Concern

This section provides information which must be used in determining the actual cause of customer concerns and performing the appropriate repair procedures.

Verification of Condition

The following procedures must be used when verifying customer concerns for the transmission.

Required Equipment

Required equipment to diagnose the 5R55E transmission consists of:

- Rotunda Transmission Tester 007-00130, part of Rotunda Transmission Tester Kit, or equivalent.
- Rotunda New Generation STAR (NGS) Tester 007-00500 or equivalent.
- Rotunda EEC-V 104-pin Breakout Box 014-00950 or equivalent.
- Rotunda 73 Digital Multimeter 105-R0051 or equivalent.
- Digital TR Sensor Overlay 007-00131, used with Rotunda Transmission Range (TR) Cable "E" 007-00111.
- Rotunda Transmission Range (TR) Sensor Cable "E" 007-00111 or equivalent.

Determine Customer Concern

NOTE: If noise/vibration, check for dependencies: rpm, vehicle speed, shift, gear, range, or temperature.

NOTE: Some transmission conditions may cause engine concerns. The torque converter clutch not disengaging will stall the engine.

Determine customer concerns relative to vehicle usage and dependent driving conditions. Pay attention to the following items:

- Hot or cold vehicle operating temperature
- Hot or cold ambient temperatures
- Type of terrain
- Vehicle loaded/unloaded
- City/highway driving
- Upshift
- Downshift
- Coasting
- Engagement
- Noise/vibration

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Check Fluid Level and Condition

Fluid Level Check

NOTE: If the vehicle has been operating for an extended period at high speeds in city traffic during hot weather or pulling a trailer, the vehicle should be turned off for about 30 minutes to allow the oil to cool before checking.

Under normal circumstances, check the transmission fluid level during normal maintenance and does not require a change. For severe duty only, change the fluid at 80,000 km (50,000 miles), since the vehicle does not use up transmission fluid. If the transmission is not working properly, or if there is some sign of fluid leakage, the fluid level should be checked.

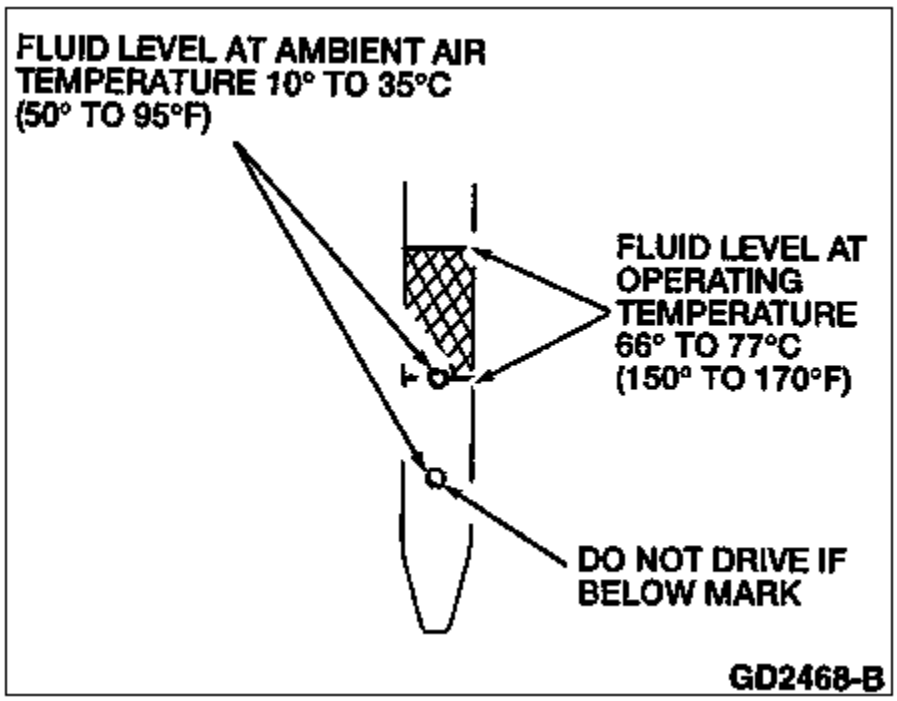
It is preferable to check the transmission fluid level at normal operating temperature after approximately 32 km (20 miles) of driving. The fluid level can be checked without driving the vehicle if the outside temperature is above 10℃ (50℉).

With the vehicle on a level surface, start the engine and move the transmission range selector lever through all of the gear ranges, allowing sufficient time for each position to engage. Securely engage the transmission range selector lever in the Park position, fully set the parking brake control (2780) and leave the engine running.

Wipe off the fluid level indicator cap, pull thefluid level indicator (7A020) out and wipe the indicator end clean. Insert the fluid level indicator back into the oil filler tube (7A228) and make sure it is fully seated. Pull the fluid level indicator out and read the fluid level.

CAUTION: The vehicle should not be driven if the fluid level is below the bottom hole on the fluid level indicator and outside temperature is above 10°C (50℉).

When checking fluid at normal operating temperature, the fluid level should be within the crosshatched area on the fluid level indicator. When the vehicle has not been driven, and outside temperature is above 10°C (50℉), the fluid level should be between the holes in the fluid level indicator.



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High or Low Fluid Level

CAUTION: If the fluid level is high, damage to the vehicle may occur. Excess fluid must be removed.

A fluid level that is too high may cause the fluid to become aerated due to the churning action of the rotating parts of the transmission. Aerated fluid will cause erratic line pressure, which may result in harsh/soft shifts or engagements, damage to the clutch materials, improper torque converter operation, and fluid coming out of the vent. Refer to Fluid Change — Drain/Refill in this section.

A fluid level that is too low will affect transmission operation, causing slipping, slow engagements, or damage to internal hardware. Low levels may also indicate that a leak is present in the fluid system. If the fluid level is low, add fluid using the procedures shown in Adding Fluid in this section.

Adding Fluid

CAUTION: Use of any fluid other than specified could result in transmission malfunction or failure.

Before adding any fluid, be sure that the correct type is used. MERCON V® XT-5-QM is stamped on the container.

Add fluid in 0.25L (1/2 pint) increments through the filler tube to bring the level to the correct area on the dipstick. If an overfill occurs, excess fluid must be removed.

Fluid Change — Drain/Refill

Normal maintenance and lubrication does not necessitate periodic automatic transmission fluid changes. For severe duty applications change the fluid at 80,000 km (50,000 miles).

To remove excess fluid, disconnect the cooler feed line at the cooler. Attach a rubber hose to the line and insert the other end into a drain pan. Crank the engine for a short period of time (do not allow the engine to start) to remove a quantity of transmission fluid. Reattach the cooler line to the cooler. Start the engine. Move the transmission range selector lever through all gear ranges. Recheck the fluid for the proper level. Continue to add or subtract fluid until the proper level is reached. If a major repair (e.g., clutch, band, bearing, etc.) is required, the unit will have to be removed. At this time, the torque converter (7902), transmission cooler, and cooler lines must be flushed to remove any contaminates. Refer to the Converter and Fluid Cooler Cleaning and Inspection procedure.

When used under severe duty conditions the transmission fluid filter/screen assembly should be replaced at 80,000 km (50,000 miles). The transmission fluid should be drained from the transmission and torque converter and refilled with MERCON V® XT-5-QM or equivalent MERCON V® approved fluid as specified to the proper level.

When filling a dry transmission and torque converter, refer to Specifications for capacity. Check the fluid level as outlined.

Procedures for Drain and Refill

- Normal Maintenance
  - Not required. Filled for life.
- Severe Duty Maintenance
  - Change fluid at 80,000 km (50,000 miles) intervals. Use MERCON V® XT-5-QM.

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CAUTION: Use only MERCON V® XT-5-QM transmission fluid. Use of any other fluids may result in a transmission malfunction or failure.

Maintenance Procedure

1. Loosen, then remove, the transmission fluid pan attaching screws to drain the fluid.
2. Remove and discard old pan gasket.
3. Thoroughly clean the pan and the transmission case pan rail surface.
4. Install new pan gasket onto pan and install pan to case with screws. Tighten screws to 13-15 Nm (115-133 lb-in).
5. Add 2.8 liters (3 quarts) of MERCON V® XT-5-QM or equivalent MERCON V® approved fluid to transmission through the fill tube.
6. Start the engine. Move transmission range selector lever through all gear ranges, checking for engagements.
7. Check and adjust transmission fluid in 0.25 liter (1/2 pint) increments to proper level (cross-hatched area of fluid level indicator at normal operating temperature).

Major Service/Overhaul

1. Loosen, then remove, the transmission fluid pan attaching bolts to drain fluid.
2. Remove and discard old pan gasket.
3. Perform required internal repair and cleaning.
4. Thoroughly flush torque converter, cooler lines and transmission in-tank radiator cooler and auxiliary cooler (if equipped).
5. Replace fluid filter and seal assembly.
6. Install cleaned pan and new pan gasket with screws. Tighten screws to 13-15 Nm (115-133 lb-in).
7. Add 3.7 liters (4 quarts) of MERCON V® XT-5-QM or equivalent MERCON V® approved fluid to the transmission through the fill tube.
8. Start engine. Move the transmission range selector lever through all gear ranges, checking for engagements.
9. Check and adjust the transmission fluid level in 0.25 liter (1/2 pint) increments to the proper level (cross-hatched area of the fluid level indicator at normal operating temperature).

Fluid Condition Check

1. Check the fluid level. Refer to the Fluid Level Check for proper procedure.
2. Observe color and odor of the fluid. It should be red, not brown or black. Odor may indicate an overheating condition, clutch disc or band failure.

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3. Use an absorbent white facial tissue and wipe the fluid level indicator. Examine the stain for evidence of solid particles and for engine coolant signs (gum or varnish on fluid level indicator) .

   If particles are present in the fluid or there is evidence of engine coolant or water, the transmission fluid pan (7A194) must be removed for further inspection.

   If fluid contamination or transmission failure is confirmed by further evidence of coolant or excessive particles in the transmission fluid pan, the transmission must be disassembled and completely cleaned and serviced. This includes cleaning and flushing the torque converter and transmission cooling system.

   During disassembly and assembly, all overhaul checks and adjustments of clearances and end play must be made.

   After the transmission has been repaired, all diagnostic tests and adjustments listed in the Diagnosis by Symptom charts must be completed to make sure that the problem has been corrected.

Road Testing Vehicle

The Shift Point Road Test and Torque Converter Clutch Operation Test provide diagnostic information on transmission shift controls and torque converter operation.

Shift Point Road Test

This test verifies that the shift control system is operating properly.

1. Bring engine and transmission up to normal operating temperature.
2. Operate vehicle with transmission selector in (D) range.
3. Apply minimum throttle and observe speeds at which upshift occurs and torque converter engages. Refer to the following Shift Speeds chart. (Also refer to Automatic Transmission Specifications Issue FPS-12180-97.)
4. Stop the vehicle. Depress transmission control switch (TCS) to activate D range. Repeat Step 3. Transmission will make all upshifts except 4-5 and torque converter clutch apply should occur above 46 km/h (27 mph).
5. Press accelerator pedal to floor, wide open throttle (WOT). Transmission should shift from third to second, or third to first, depending on vehicle speed, and torque converter clutch should release.
6. With vehicle speed above 48 km/h (30 mph), move transmission range selector lever from D range to 1 range (LOW) and release accelerator pedal. Transmission should immediately downshift to third gear. When vehicle speed drops below 32 km/h (20 mph), transmission should downshift into first gear.
7. If transmission fails to upshift/downshift or torque converter clutch does not apply/release, refer to Diagnosis by Symptom Index for possible causes.

SHIFT SPEEDS — KM/H (MPH) [1]

Throttle Position	Range	Shift	KM/H (MPH) Range [1]
Closed Throttle	(D)	3-2	12-37 (8-23)
	(D)	2-1	12-32 (8-20)
Minimum Throttle	(D)	1-2	16-32 (10-20)
	(D)	2-3	25-48 (16-30)

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	(D)	3-4	63-89 (39-55)
		4-5	93-117 (58-73)
Part Throttle	(D)	1-2	27-53 (17-33)
	(D)	2-3	46-79 (29-49)
	(D)	3-4	72-110 (45-69)
	(D)	4-5	82-117 (51-73)
	(D)	5-4	74-104 (46-65)
	(D)	4-3	64-100 (40-62)
	(D)	3-2	40-68 (25-42)
Wide Open Throttle	(D)	1-2	53-77 (33-48)
	(D)	2-3	96-131 (60-82)
	(D)	3-2	80-123 (50-77)
	(D)	3-1, 2-1	38-68 (24-42)
Manual Pull-In	1	2-1	48-56 (30-35)

[1] Shift Speed Ranges are approximate for all applications. For specific applications (Engine, Axle Ratio and Application) refer to the Automatic Transmission Specification Issue FPS-12180-97.

Torque Converter Diagnosis

Prior to torque converter replacement, all diagnostic procedures must be followed. This is to prevent the unnecessary replacement of good torque converters. Only after a complete diagnostic evaluation can the decision be made to replace the torque converter.

Begin with the normal diagnostic procedures as follows:

1. Preliminary inspection.
2. Know and understand the customer's concern.
3. Verify the concern.
    - Perform the Torque Converter Clutch Operation Test. Refer to the procedure in this section.
4. Perform diagnostic procedures.
    - Run on-board diagnostics. Refer to the procedure in this section.
        - Repair all non-transmission related DTCs first.
        - Repair all transmission DTCs.
        - Rerun on-board diagnostic to verify repair.
    - Perform Line Pressure Test . Refer to the procedure in this section.
    - Perform Stall Speed Test . Refer to the procedure in this section.
    - Diagnosis by Symptom Routines . Refer to the procedure in this section.
        - Use the index to locate the appropriate routine that best describes the symptom(s). The routine will list all possible components that may cause or contribute to the symptom. Check each component listed, diagnose and repair as required before repairing the torque converter.

Torque Converter Operation Test

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This test verifies that the torque converter clutch control system and the torque converter are operating properly.

1. Connect tachometer to engine.
2. Bring engine to normal operating temperature by driving vehicle at highway speeds for approximately 15 minutes in (D) range.
3. After normal operating temperature is reached, maintain constant vehicle speed of about 80 km/h (50 mph). Release throttle for about two seconds then reapply throttle to previous setting.
4. Engine rpm should increase when throttle is released and decrease in about five seconds (converter engagement) after throttle is reapplied. If this does not occur, refer to Torque Converter Clutch Operation Concerns in the Diagnosis by Symptom Index .

Visual Inspection

This inspection will identify malfunctions to the vehicle operating system that may affect diagnosis.

- Vehicle modification
- Electronic add-on items
  - Air conditioning
  - Generator (alternator)
  - Engine turbo
  - Cellular telephone
  - Cruise control
  - CB radio
  - Linear booster
  - Backup alarm signal
  - Computer
- Leaks — Refer to Leakage Inspection in this section.
- Proper linkage adjustments — Refer to Section 07-05 in this workshop manual.

These items, if not installed properly, will affect powertrain control module or transmission function. Pay particular attention to add-on wiring splices in the powertrain control module harness or transmission wiring harness, abnormal tire size, or axle ratio changes.

After a road test, with the vehicle warm and before disturbing any connectors, perform the Quick Test using Rotunda New Generation STAR (NGS) Tester 007-00500 or equivalent. Refer to Section 4A in the Powertrain Control/Emissions Diagnosis Manual for diagnosis and testing of the automatic transmission.

Check TSBs and OASIS

Refer to all Technical Service Bulletins and OASIS messages which pertain to the transmission concern and follow the procedures as outlined.

Perform On-Board Diagnostics

After a road test, with the vehicle warm and before disturbing any connectors, perform Quick Test using Rotunda New Generation STAR (NGS) Tester 007-00500 or equivalent. Refer to Section 4A in the Powertrain Control/Emissions Diagnosis Manual for diagnosis and testing of the automatic transmission.

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Diagnostics

Diagnosing electronically controlled automatic transmissions is simplified using the following procedures. It is important to remember that there is a definite procedure to follow. Do not take short cuts or assume that critical checks or adjustments have already been made. Follow the procedures as written to avoid missing critical components or steps. By following the diagnostic sequence, the technician will be able to diagnose and repair the concern the first time.

On-Board Diagnostics With NGS

NOTE: For detailed instructions and other diagnostic methods using the NGS, refer to the Powertrain Control/Emissions Diagnosis Manual or NGS instruction guide.

NOTE: If using a generic scan tool, refer to the Powertrain Control/Emissions Diagnosis Manual for instructions on performing OBD procedures.

The Quick Tests are in the Powertrain Control/Emissions Diagnosis Manual (PC/ED). These tests can be used to diagnose the powertrain control module (PCM) (12A650), sensors and actuators of the 5R55E transmission.

The following is a guide for using the On-Board Diagnostic (OBD) Quick Tests and the New Generation STAR (NGS) Tester.

Quick Test 1.0 — Visual Inspection

Perform the Visual Check and Vehicle Preparation procedures as outlined in the Powertrain Control/Emissions Diagnosis Manual.

Inspect the following:

- Air cleaner and inlet ducting.
- All engine vacuum hoses for damage, such as leaks, cracks, blockage, proper routing, etc.
- Powertrain control module (PCM) system wiring harnesses for proper connections, bent or broken pins, corrosion, loose wires, proper routing, etc.
- Sensors, actuators and powertrain control module (PCM) for physical damage.
- Engine coolant for proper level.
- Transmission fluid for proper level and condition.
- Any non-factory installed items wired into the transmission or PCM harnesses.

Perform all necessary repairs before continuing with Quick Tests.

Quick Test 2.0 — Set Up

Connect Rotunda New Generation STAR (NGS) Tester 007-00500 or equivalent to Data Link Connector (refer to vehicle owner manual for connector location).

The following are steps to run OBD II procedures.

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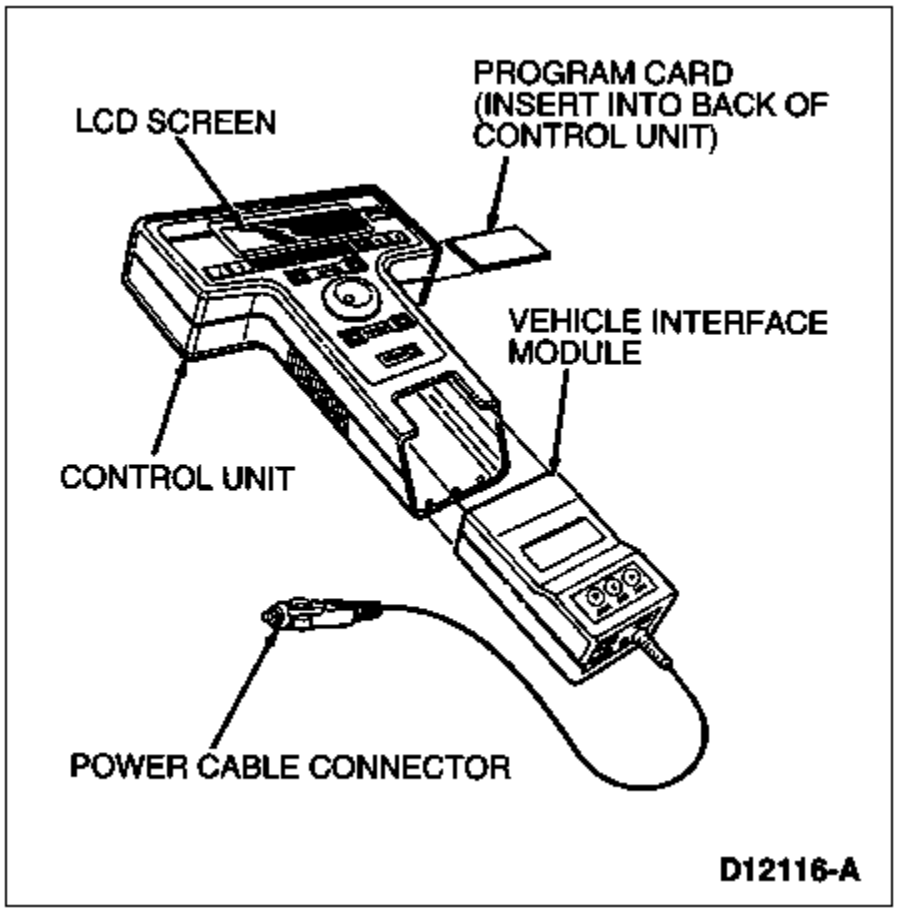
Vehicle and Tester Preparation

Prepare the vehicle as follows:

- Transmission range selector lever in PARK.
- Engine to operating temperature.
- Apply parking brake.
- Block wheels.
- Turn off all electrical loads including A/C and defroster. (If A/C is ON, DTC P1460 will set.)

Prepare the NGS as follows:



- Key OFF.
- Verify that the proper program card is inserted in the NGS.
- Connect J1962/16-way DCL cable adapter to the NGS.
- Connect NGS DCL cable adapter securely into the vehicle's DCL connector.
- Connect the NGS power supply cable to the vehicle battery power supply through cigarette lighter or at the battery with alligator clip adapter.
- Key ON or start vehicle if necessary.
- The NGS is now ready to communicate with the PCM.

Quick Test 3.0 — Key On, Engine Off (KOEO)

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CAUTION: Do not replace parts based on a code, perform Pinpoint Tests first.

- The key on engine off (KOEO) test provides "hard" diagnostic trouble codes (DTCs) present at the time of testing.
- Always repair the "hard" DTCs first.

Performing KOEO

- Perform visual inspection and vehicle preparation as required.
- Select "Vehicle and Engine Selection" menu.
- Select year, engine, model with the appropriate qualifier if needed, for example, transmission or 49 state/Cal.
- Select "Diagnostic Data Link" menu.
- Select "Diagnostic Test Mode" menu.
- Select "KOEO On-Demand Self Test."
- Follow operating instructions from the NGS menu screen.
- Record all DTCs displayed.
- Repair non-transmission DTCs first as they can directly affect the operation of the transmission. Road test the vehicle and repeat Quick Test to verify the repair.

Quick Test 4.0 — Continuous Memory Codes

Continuous DTCs are concerns which were detected during normal vehicle operation. These codes are retained for 40 warm-up cycles.

- The cause of some continuous DTCs may have been eliminated if KOEO and/or KOER DTCs were repaired. Always retest and repair any DTCs that still remain.
- If DTCs are present, go to the On-Board Diagnostic Trouble Code Description Chart in this section for service information. Erase DTC, perform the Transmission Drive Cycle Test and repeat all Quick Test procedures after completing repair on the DTCs.
- If the Continuous tests passes and a concern is still present, refer to the Diagnosis by Symptom charts, OASIS and TSBs for concern diagnosis.

Performing Continuous DTC Tests

- Select "Vehicle and Engine Selection" menu
- Select year, engine, model with the appropriate qualifier if needed, for example, transmission or 49 state/Cal.
- Select "Diagnostic Data Link" menu.
- Select "Diagnostic Test Mode" menu.
- Select "Retrieve Continuous Codes."
- Follow operating instructions from the NGS menu screen.
- Record all DTCs displayed.
- Perform Transmission Drive Cycle Test .
- Rerun Continuous DTC Test. If DTCs have returned, repair as required. Road test and rerun all DTC test procedures.

Quick Test 5.0 — Key On, Engine Running (KOER)

This test provides "hard" DTCs only.

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- Follow the menu screen instructions as they appear.
- If a DTC appears after the key on engine running (KOER) test, a malfunction is present. Refer to the DTC Code Chart for service information.

Performing KOER

- Perform visual inspection and vehicle preparation as required.
- Select "Vehicle and Engine Selection" menu.
- Select year, engine, model with the appropriate qualifier if needed, for example, transmission or 49 state/Cal.
- Select "Diagnostic Data Link" menu.
- Select "Diagnostic Test Mode" menu.
- Select "KOER On-Demand Self Test."
- Follow operating instructions from the NGS menu screen (example: turn key on, etc.) and perform brake on/off (BOO) and cycle the transmission control switch (TCS) on and off, if equipped, rotate steering wheel.
- Record all DTCs displayed.
- Repair all non-transmission DTCs first as they can directly affect the operation of the transmission. Road test the vehicle and repeat Quick Test to verify the repair.

Special Test Modes

The following Special Test Modes may be used or required during diagnostics.

Output Test Mode

The diagnostic test mode aids is servicing output actuators associated with the PCM system. It allows the technician to energize and de-energize most of the system output actuators on command.

Performing Output Test Mode

Enter Output Test Mode with ignition key ON and the engine OFF.

- Perform visual inspection and vehicle preparation as required.
- Select "Vehicle and Engine Selection" menu.
- Select year, engine, model with the appropriate qualifier if needed, for example, transmission or 49 state/Cal.
- Select "Diagnostic Data Link" menu.
- Select "Diagnostic Test Mode" menu.
- Enter "Active Tests."
- Enter "Output Control."
- Follow operating instructions from the NGS menu screen.

Output State Control (OSC) Mode

Output State Control (OSC) allows the technician to take control of certain parameters to function the transmission. For example, OSC allows the technician to shift the transmission only when he/she commands a gear change. If the technician commands 1st gear in OSC, the transmission will remain in 1st gear until the technician commands the next gear. Another example, the technician can command a shift solenoid to turn on or off when performing an electrical circuit check. OSC has two modes of operation for transmission, the BENCH MODE and the DRIVE MODE. Each mode/parameter has a unique set of vehicle operating

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requirements that the technician is required to meet before being allowed to operate OSC.

NOTE: To operate OSC the Digital Transmission Range (DTR) Sensor and the Vehicle Speed Sensor (VSS) must be operational. No Diagnostic Trouble Codes (DTCs) related to the DTR sensor or the VSS sensor can be present.

- The vehicle requirements MUST BE MET when SENDING the OSC value.
- If the vehicle requirements are NOT MET when SENDING the OSC value, and ERROR MESSAGE will appear. When the ERROR MESSAGE is received, OSC is aborted and must be restarted.
- If AFTER SENDING an OSC value, and the vehicle requirements are no longer met, the PCM will cancel the OSC value and NO ERROR message will appear.
- The OSC value [XXX] may be sent anytime to cancel OSC.

Output State Control (OSC) Procedures

- Perform visual inspection and vehicle preparation as required.
- Select "Vehicle and Engine Selection" menu.
- Select appropriate vehicle and engine.
- Select "Diagnostic Data Link".
- Select "Powertrain Control Module".
- Select "Diagnostic Test Mode".
- Select "KOEO On-Demand Self Test and KOER On-Demand Self Tests".
- Perform test and record DTCs.
- Repair all NON-Transmission DTCs.
- Repair all VSS and DTR Sensor DTCs.
- Ensure that VSS/DTR Sensors are functional.
- Select "Active Command Modes".
- Select "Output State Control".
- Select "Trans - Bench Mode or Trans - Drive Mode".

OSC — Transmission Bench Modes

The following OSC — Transmission Bench Modes may be used or required during diagnostics.

SS1, SS2, SS3, SS4 and TCC in BENCH MODE

The BENCH MODE allows the technician to perform electrical circuit checks on the following components:

- SS1 - Activates SS#1 OFF or ON
- SS2 - Activates SS#2 OFF or ON
- SS3 - Activates SS#3 OFF or ON
- SS4 - Activates SS#4 OFF or ON
- TCC - Activates TCC OFF or ON

OSC "SS1, SS2, SS3, SS4, TCC" BENCH Mode Operates ONLY when:

- VSS and DTR Sensor are operational.
- No VSS and DTR Sensor DTCs.
- Transmission Range Selector Lever in P.
- Key ON.
- Engine OFF.

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OSC COMMAND VALUES

- [OFF] - turns solenoid OFF
- [ON] - turns solenoid ON
- [XXX] - cancels OSC value sent
- [SEND] - sends the values to PCM

Bench Mode Procedure for SS1, SS2, SS3, SS4, and TCC

Follow operating instructions from the NGS menu screen:

- Select "Output State Control".
- Select "Trans - Bench Mode".
- Select "PIDs" to be monitored.
- Monitor all selected PIDs during test.
- Select "Parameters - SS1, SS2, SS3, SS4, or TCC".
- Select "ON" to turn solenoid ON.
- Press "SEND" to send command ON.
- Select "OFF" to turn solenoid OFF.
- Press "SEND" to send command OFF.
- Select "XXX" to cancel at any time.
- Press "SEND".

EPC in BENCH MODE

The BENCH MODE is also used to test the functionality of the transmission's electronic pressure control. During BENCH MODE, the EPC solenoid can ramp in increments of 15 PSI from zero to 90 PSI and 90 to zero PSI.

The OSC functions for the parameter EPC allows the technician to choose the following options:

- EPC - Activates EPC to selected values
- [00] - sets EPC pressure to 00 PSI
- [15] - sets EPC pressure to 15 PSI
- [30] - sets EPC pressure to 30 PSI
- [45] - sets EPC pressure to 45 PSI
- [60] - sets EPC pressure to 60 PSI
- [75] - sets EPC pressure to 75 PSI
- [90] - sets EPC pressure to 90 PSI

OSC "EPC" BENCH Mode Operates ONLY when:

- VSS and DTR Sensor are operational.
- No VSS and DTR Sensor DTCs.
- Transmission Range Selector Lever in P.
- Pressure gauge installed.
- Key ON.
- Engine ON.
- Engine RPM at 1500.

OSC COMMAND VALUES

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- [00] - sets EPC pressure to 00 PSI
- [15] - sets EPC pressure to 15 PSI
- [30] - sets EPC pressure to 30 PSI
- [45] - sets EPC pressure to 45 PSI
- [60] - sets EPC pressure to 60 PSI
- [75] - sets EPC pressure to 75 PSI
- [90] - sets EPC pressure to 90 PSI
- [OFF] - turns solenoid off
- [ON] - turns solenoid on
- [XXX] - cancels OSC value sent
- [SEND] - sends the values to PCM

Bench Mode Procedure for EPC

Following operating instructions from the NGS menu screen.

- Select "Output State Control".
- Select "Trans - Bench Mode".
- Select "PIDs" to be monitored.
- Monitor all selected PIDs during test.
- Select "Parameters - EPC".
- Select Value "0 - 90 psi".
- Press "SEND" to send command.
- Select "XXX" to cancel at any time.
- Press "SEND".

OSC — Transmission Drive Modes

The DRIVE MODE allows control of three transmission parameters. Each mode/parameter has a unique set of vehicle operating requirements that the technician is required to meet before being allowed to operate OSC. The recommended procedure, when using the DRIVE MODE, is to control one parameter at a time.

The DRIVE MODE allows the technician to perform the following functions on the transmission:

- GR_CM - allows upshifts or downshifts
- TCC - engages or disengages the torque converter clutch
- EPC - increases/decreases EPC pressure

GR_CM in DRIVE MODE

This OSC function is used to test the transmission shift functions.

The OSC functions for the GR_CM parameter allows the technician to choose the following options:

- [1] - PCM selects 1st gear
- [2] - PCM selects 2nd gear
- [3] - PCM selects 3rd gear
- [4] - PCM selects 4th gear
- [5] - PCM selects 5th gear

OSC "GR_CM" Mode Operates ONLY when:

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- VSS and DTR Sensor are operational.
- No VSS and DTR Sensor DTCs.
- Engine "ON".
- TCC "OFF".
- Transmission Range Selector Lever on O/D.
- Vehicle Speed is greater than 2 mph.

OSC COMMAND VALUES

- [1] - PCM selects 1st gear
- [2] - PCM selects 2nd gear
- [3] - PCM selects 3rd gear
- [4] - PCM selects 4th gear
- [5] - PCM selects 5th gear
- [OFF] - turns solenoid off
- [ON] - turns solenoid on
- [XXX] - cancels OSC value sent
- [SEND] - sends the values to PCM

Drive Mode Procedure for GR_CM

Follow operating instructions from the NGS menu screen.

- Select "Output State Control".
- Select "Trans - Drive Mode".
- Select "PIDs" to be monitored.
- Monitor all selected PIDs during test.
- Select "Parameters - GR_CM".
- Select Value "1-5".
- Press "SEND" to send command.
- Re-Select Value "1-5".
- Press "SEND" to send command.
- Select "XXX" to cancel at any time.
- Press "SEND".

TCC in DRIVE MODE

This OSC function is used to test whether the torque converter clutch is engaging and disengaging correctly.

The OSC functions for the TCC parameter allows the technician to choose the following:

- TCC - activates TCC OFF and ON
- [ON] - turns TCC solenoid ON
- [OFF] - turns TCC solenoid OFF

OSC "TCC OFF" DRIVE Mode Operates ONLY when:

- VSS and DTR Sensors are operational.
- No VSS and DTR Sensor DTCs present.
- Engine ON.

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- Transmission Range Selector Lever in O/D.
- Vehicle speed is greater than 2 mph.

OSC "TCC ON" DRIVE Mode Operates ONLY when:

- VSS and DTR Sensors are operational.
- No VSS and DTR Sensor DTCs present.
- Engine ON.
- Transmission Range Selector Lever in O/D.
- Vehicle speed is greater than 2 mph.
- Transmission in 2nd gear or higher.
- TFT is between 60 and 275 degrees F.
- Brake not applied "OFF" below 20 mph.
- (Not an excessive load on engine (engine lugging).

OSC COMMAND VALUES

- [OFF] - turns TCC OFF
- [ON] - turns TCC ON
- [XXX] - cancels OSC value sent
- [SEND] - sends the values to PCM

Drive Mode Procedures for TCC

Follow operating instructions from the NGS menu screen.

- Select "Output State Control".
- Select "Trans - Drive Mode".
- Select "PIDs" to be monitored.
- Monitor all selected PIDs during test.
- Select "Parameters - TCC".
- Select "ON" to turn solenoid ON.
- Press "SEND" to send command ON.
- Select "OFF" to turn solenoid OFF.
- Press "SEND" to send command OFF.
- Select "XXX" to cancel at any time.
- Press "SEND".

EPC in DRIVE MODE

This OSC functions is used to increase the EPC pressure while testing the transmission shift functions. This OSC functions can only increase the EPC pressure greater than what the PCM normally commands. If an OSC value, such as [75] or [90] PSI is sent, the upshifts and downshifts should exhibit a harsher shift. Harsher shifts would indicate that the EPC pressure control works at higher pressures. The best test for the EPC is to use the BENCH MODE and a hydraulic pressure gauge. Using EPC in the BENCH MODE will confirm that the EPC works at both the higher and lower pressures.

The OSC functions for the parameter EPC allows the technician to choose the following options:

- EPC - Activates EPC to selected
    - [00] - sets EPC pressure to 00 PSI

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- [15] - sets EPC pressure to 15 PSI
- [30] - sets EPC pressure to 30 PSI
- [45] - sets EPC pressure to 45 PSI
- [60] - sets EPC pressure to 60 PSI
- [75] - sets EPC pressure to 75 PSI
- [90] - sets EPC pressure to 90 PSI

OSC "EPC" DRIVE Mode Operates ONLY when:

- VSS and DTR Sensor are operational.
- No VSS and DTR Sensor DTCs.
- Transmission Range Selector Lever in O/D.
- Pressure gauge installed.
- Key ON.
- Engine ON.
- Vehicle speed greater than 2 mph.
- OSC value for EPC must be greater than what the PCM commands (see EPC PID).

OSC COMMAND VALUES

- [00] - sets EPC pressure to 00 PSI
- [15] - sets EPC pressure to 15 PSI
- [30] - sets EPC pressure to 30 PSI
- [45] - sets EPC pressure to 45 PSI
- [60] - sets EPC pressure to 60 PSI
- [75] - sets EPC pressure to 75 PSI
- [90] - sets EPC pressure to 90 PSI
- [OFF] -" turns solenoid off
- [ON] - turns solenoid on
- [XXX] - cancels OSC value sent
- [SEND] - sends the values to PCM

Drive Mode Procedure for EPC

Follow operating instructions from the NGS menu screen.

- Select "Output State Control".
- Select "Trans - Drive Mode".
- Select "PIDs" to be monitored.
- Monitor all selected PIDs during test.
- Select "Parameters - EPC".
- Select Value "0-90 psi".
- Press "SEND" to send command.
- Re-Select Value "0-90 psi".
- Press "SEND" to send command.
- Select "XXX" to cancel at any time.
- Press "SEND".

Using Output State Control (OSC) and Accessing PIDs

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To confirm that the OSC value was sent by the NGS and the EEC has accepted the OSC substitution, a corresponding PID for each OSC parameter must be monitored. Additional PIDs should be monitored to help the technician adequately diagnose the transmission.

The following is a list of OSC parameters and their corresponding PID:

OSC Parameter	Corresponding PID	Additional PIDs
SS1	SS1	SS1F
SS2	SS2	SS2F
SS3	SS3	SS3F
SS4	CCSF	—
TCC	TCC	TCCF, TCCMACT (do not use PID TCCMCMD during OSC)
EPC	EPC	—
GR_CM	GEAR	TRANRAT

To confirm that the OSC substitution occurred, SEND the OSC value and monitor the corresponding PID value. If no ERROR MESSAGE was received and the value of the corresponding PID remains the same as the value sent from OSC, then the OSC substitution was successful.

PCM Reset Mode

The PCM reset mode provides a means for the NGS to command the powertrain control module to clear all DTCs. When resetting the PCM, a DTC P1000 will be set in the PCM until all OBD II system or components have been monitored during the OBDII Drive Cycle. When a PCM reset is performed the following occurs:

- DTCs cleared.
- Freeze Frame Data cleared.
- Oxygen Sensor Test Data cleared.
- Status of the OBD II System Monitors reset.
- DTC P1000 set.

Performing PCM Reset

- Perform visual inspection and vehicle preparation as required.
- Select "Vehicle and Engine Selection" menu.
- Select year, engine, model with the appropriate qualifier if needed, for example, transmission or 49 state/Cal.
- Select "Generic OBD II Functions" menu.
- Select "Clearing ALL Codes."
- Follow operating instructions from the NGS menu screen.
- Perform OBD II Drive Cycle — Clear DTC P1000.

Clearing DTC P1000

In some localities it may become a legal requirement to pass an Inspection/Maintenance (I/M) test of the OBD II system. If the vehicle's powertrain system or its battery has just been repaired or replaced, the OBD II system is reset to a not ready for I/M testing condition. To prepare the vehicle for the test and to clear the DTC No. P1000, an OBD II Drive Cycle must be performed.

OBD II Drive Cycle

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The following steps must be run in the order shown. If Steps 2, 3, or 4 are interrupted, repeat the step before proceeding. Any safe driving mode is acceptable between steps.

Always drive vehicle in a safe manner according to traffic conditions and obey all traffic laws.

1. Start engine and drive vehicle in typical city stop-and-go traffic for at least 10 minutes after it has reached normal operating temperature.

2. Idle vehicle for at least 45 seconds, then accelerate at part throttle to near 72 km/h (45 mph).

3. Cruise and maintain a select speed in the range of 48-64 km/h (30 to 40 mph) on a level road with throttle held steady for at least one minute.

4. Drive to accumulate at least four minutes in the range of 32-72 km/h (20 to 45 mph). If stop-and-go conditions occur, the accumulated time must be within the 32-72 km/h (20 to 45 mph) range. No wide open throttle (WOT) conditions should be encountered.

5. Decelerate and idle for at least 10 seconds.

6. Accelerate to approach 88 km/h (55 mph) at 1/2 throttle (elapsed time is about 10 seconds).

7. Cruise and maintain select speed in the range of 64-104 km/h (40 to 65 mph) on a level road with throttle held steady for at least one minute and 20 seconds.

8. OBD II Drive Cycle has been completed.

Other NGS Features

For further information on other diagnostic testing features using the NGS or generic scan tool, refer to the Powertrain Control/Emissions Diagnosis Manual. Other diagnostic methods include the following:

- Parameter Identification (PID) Access Mode, used to monitor sensor and actuators.
- Freeze Frame Data Access Mode, used to view emissions related data values from specific PIDs.
- Oxygen Sensor Monitor Mode, used to monitor the O2 sensor.

Transmission Drive Cycle Test

NOTE: The Transmission Drive Cycle Test must be followed exactly. Malfunctions must occur four times consecutively for codes P0731, P0732, P0733, P0734 and P0735 to be set, and five times consecutively for continuous code P0743.

NOTE: When performing the Transmission Drive Cycle Test, refer to the Solenoid Application Chart for proper solenoid operation.

After performing the Quick Test, use the Transmission Drive Cycle Test for checking continuous codes.

1. Record and then erase Quick Test codes.

2. Warm engine to normal operating temperature.

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3. Make sure transmission fluid level is correct.

4. With transmission in (D), moderately accelerate from stop to 80 km/h (50 mph). This allows the transmission to shift into fifth gear. Hold speed and throttle opening steady for a minimum of 15 seconds.

5. With transmission in fifth gear and maintaining steady speed and throttle opening, lightly apply and release brake pedal (2455) (to operate stoplamps). Then hold speed and throttle steady for an additional five seconds (minimum).

6. Brake to a stop and remain stopped for a minimum of 20 seconds.

7. Repeat Steps 4 through 6 at least five times.

8. Perform Quick Test and record continuous codes.

    - If DTCs are present, go to the On-Board Diagnostic Trouble Code Description Chart in this section for service information. Repair all non-transmission DTCs first as they can directly affect the operation of the transmission. Repeat the Quick Test and Road Test to verify the correction. Erase DTCs, perform Drive Cycle and repeat the Quick Test after completing repair on the DTCs.
    - If the continuous test passes and a concern is still present, refer to the Diagnosis by Symptom charts, OASIS and TSBs for concern diagnostics.

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After On-Board Diagnostics

NOTE: The vehicle wiring harness, powertrain control module (PCM) (12A650) and non-transmission sensors may affect transmission operations. Repair these concerns first.

After the On-Board Diagnostics procedures are completed, repair all DTCs.

Begin with non-transmission related DTCs, then service any transmission related DTCs. Refer to the On-Board Diagnostic Trouble Code Description Chart for information on condition and symptoms. This chart will be helpful in referring to the proper manual(s) and to aid in diagnosing internal transmission concerns and external non-transmission inputs. The Pinpoint Tests are used in diagnosing electrical concerns of the transmission. Make sure that the vehicle wiring harness and the powertrain control module are diagnosed as well. The Powertrain Control/Emissions Diagnosis Manual will aid in diagnosing non-transmission electronic components.

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Before Pinpoint Tests

NOTE: Prior to entering Pinpoint Tests, refer to TSBs and OASIS messages for 5R55E concerns.

NOTE: Prior to entering Pinpoint Tests, the vehicle harness must be checked for continuity and shorts, and the powertrain control module (PCM) must be checked for any concerns. Refer to Section 4A in the Powertrain Control/Emissions Diagnosis Manual for diagnosis and testing of the PCM concerns.

NOTE: If any non-transmission repair codes appear, repair those codes first. They could affect the electrical operation of the transmission. Record and erase codes from continuous memory after repairs have been performed. After repairing any fault codes in the Quick Test, the Quick Test should be repeated.

NOTE: Check the EEC-V system wiring harness for proper connection, bent or broken pins, corrosion, loose wires, proper routing, proper seals and their condition. Check the powertrain control module (PCM) (12A650), sensors, and actuators for physical damage.

If codes appear while performing the Self Test, refer to the On-Board Diagnostic Trouble Code Description Chart for the appropriate repair procedure.

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On-Board Diagnostic Trouble Code Description Chart

ON-BOARD DIAGNOSTIC TROUBLE CODE DESCRIPTION CHART

****May also be generated by some other non-electric transmission hardware system.**					
***Output circuit check, generated only by electrical symptoms.**					
Four-Digit DTC	**Component**	**Description**	**Condition**	**Symptom**	**Action**
P0112	IAT	IAT indicates 125°C (254°F) (grounded).	Voltage drop across IAT exceeds scale set for temperature 125°C (254°F).	Incorrect EPC pressure. Either high or low which will result in harsh or soft shifts.	Refer to PCED [1]
P0113	IAT	IAT indicates -40°C (-40°F) (open circuit).	Voltage drop across IAT exceeds scale set for temperature -40°C (-40°F).	Incorrect EPC pressure. Either high or low which will result in harsh or soft shifts.	Refer to PCED [1]
P0114	IAT	IAT out of on-board diagnostic range.	IAT temperature higher or lower than expected during KOEO and KOER.	Rerun on-board diagnostic at normal operating temperature.	Refer to PCED [1]
P1116	ECT	ECT out of on-board diagnostic range.	ECT temperature higher or lower than expected during KOEO and KOER.	Rerun on-board diagnostic at normal operating temperature.	Refer to PCED [1]
P0117	ECT	ECT indicates 125°C (254°F).	Voltage drop across ECT exceeds scale set for temperature 125°C (254°F) (grounded).	Torque converter clutch will always be off, resulting in reduced fuel economy.	Refer to PCED [1]
P0118	ECT	ECT indicates -40°C (-40°F).	Voltage drop across ECT exceeds scale set for temperature -40°C (-40°F) (open circuit).	Torque converter clutch will always be off, resulting in reduced fuel economy.	Refer to PCED [1]
P1124	TP	TP voltage high/low for on-board diagnostic.	TP was not in the correct position for on-board diagnostic.	Rerun at appropriate throttle position per application.	Refer to PCED [1]
P0121, P0122, P0123,	TP	TP concern.	PCM has detected an error. This error may cause a	Harsh engagements, firm shift feel, abnormal shift schedule, torque	Refer to PCED [1]

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P1120, P1121, P1125, P1124			transmission concern.	converter clutch does not engage. Torque converter clutch cycling.	
P0102, P0103, P1100, P1101	MAF	MAF concerns.	MAF system has a malfunction which may cause a transmission concern.	High/low EPC pressure, incorrect shift schedule. Incorrect torque converter clutch engagement scheduling. Symptoms similar to a TP failure.	Refer to PCED [1]
P0300-P0308, P0320, P0340, P1351-P1364	EI	EI concerns.	EI system has a malfunction which may cause a transmission concern.	Harsh engagements and shifts, late WOT shifts, no torque converter clutch engagement.	Refer to PCED [1]
P0500, P0501, P0503, P1500, P1501	VSS	Insufficient VSS input.	PCM detected a loss of vehicle speed signal during operation.	Torque converter clutch engages, shift engagement/ disengagement (hunting) on grades.	Refer to PCED [1]
P1705	DTR	DTR not in PARK or NEUTRAL.	On-board diagnostic not run in PARK.	Rerun on-board diagnostic in PARK.	Refer to Pinpoint Test D.
P1704	DTR	DTR sensor failure in transition state.	DTR sensor misaligned or failed electrically.	Increase in EPC pressure.	Refer to Pinpoint Test D.
P1703	BOO	Brake not actuated during on-board diagnostic KOER.	Brake not cycled during KOER.	Failed ON or not connected — torque converter clutch will not engage at less than 1/3 throttle. Failed OFF or not connected — torque converter clutch will not disengage when brake is applied.	Refer to PCED [1]
P1703	BOO	BOO switch circuit failed.	Brake ON circuit failure during KOEO.	Failed ON or not connected — torque converter clutch will not engage at less than 1/3 throttle. Failed OFF or not connected — torque converter clutch will not disengage when brake is applied.	Refer to PCED [1]
P1460	A/C	A/C clutch cycling pressure switch error.	A/C or Defrost ON condition may result from A/C clutch being ON during on-board diagnostic.	DTC set during on-board diagnostic — rerun with A/C OFF. Failed ON — EPC pressure slightly low with A/C OFF.	Refer to PCED [1]
P0731**	SS1, SS2, SS3 or	1st gear error.	No 1st gear.	Improper gear selection depending on	Refer to Solenoid

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	internal parts			failure or mode and manual lever position. Shift errors may also be due to other internal transmission concerns (stuck valves, damaged friction material).	On/Off Charts. Refer to Pinpoint Test A.
P0732**	SS1, SS2, SS3 or internal parts	2nd gear error.	No 2nd gear.	Improper gear selection depending on failure or mode and manual lever position. Shift errors may also be due to other internal transmission concerns (stuck valves, damaged friction material).	Refer to Solenoid On/Off Charts. Refer to Pinpoint Test A.
P0733**	SS1, SS2, SS3 or internal parts	3rd gear error.	No 3rd gear.	Improper gear selection depending on failure or mode and manual lever position. Shift errors may also be due to other internal transmission concerns (stuck valves, damaged friction material).	Refer to Solenoid On/Off Charts. Refer to Pinpoint Test A.
P0734**	SS1, SS2, SS3 or internal parts	4th gear error.	No 4th gear.	Improper gear selection depending on failure or mode and manual lever position. Shift errors may also be due to other internal transmission concerns (stuck valves, damaged friction material).	Refer to Solenoid On/Off Charts. Refer to Pinpoint Test A.
P0750*	SS1	SS1 solenoid circuit failure.	SS1 circuit failed to provide voltage drop across solenoid. Circuit open or shorted or PCM driver failure during on-board diagnostic.	Improper gear selection depending on condition mode and manual lever position. See Solenoid On/Off charts.	Refer to Pinpoint Test A.
P0755*	SS2	SS2 solenoid circuit failure.	SS2 circuit fails to provide voltage drop across solenoid. Circuit open or shorted or PCM driver failure during on-board diagnostic.	Improper gear selection depending on condition mode and manual lever position. See Solenoid On/Off charts.	Refer to Pinpoint Test A.
—	TCIL	TCIL circuit failure	TCIL circuit open or shorted.	Failed ON — Overdrive cancel mode always	Refer to PCED [1]

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				ON. NO flashing TCIL for EPC failure or sensor. Failed OFF — Overdrive cancel mode never indicated. NO flashing TCIL for EPC sensor failure.	
P1747**	EPC	EPC solenoid circuit failure, shorted circuit.	Voltage through EPC solenoid is checked. An error will be noted if tolerance is exceeded.	Short Circuit — Causes minimum EPC pressure (minimum capacity) and limits engine torque (alternate firm). Zero EPC — no 2nd and 4th gear. Slips in 1st and 3rd with high torque input.	Refer to Pinpoint Test E.
P0741**, P1744**	TCC	TCC slippage detected.	The PCM picked up an excessive amount of TCC slippage during normal vehicle operation.	TCC slippage/erratic or no torque converter clutch operation. Flash TCIL.	Refer to Diagnosis by Symptom Index.
P1780	TCS	TCS not changing states.	TCS not cycled during self test. TCS circuit open or shorted.	No (D) cancel when switch is cycled during KOER.	Rerun on-board diagnostic and cycle switch. Refer to PCED [1]
P1711	TFT	TFT out of on-board diagnostic range.	Transmission not at operating temperature during on-board diagnostic.	DTC set — Vehicle cold or overheated.	Warm or cool vehicle to normal operating temperature. Refer to Pinpoint Test B.
P0713	TFT	-40°C (-40°F) indicated TFT sensor circuit open.	Voltage drop across TFT sensor exceeds scale set for temperature -40°C (-40°F)	Firm shift feel.	Refer to Pinpoint Test B.
P0712	TFT	157°C (315°F) indicated TFT sensor circuit grounded.	Voltage drop across TFT sensor exceeds scale set for temperature of 157°C (315°F)	Firm shift feel.	Refer to Pinpoint Test B.
P0715	TSS	Insufficient input from Turbine Shaft Speed Sensor.	PCM detected a loss of TSS signal during operation.	Harsh shifts, abnormal shift schedule, no torque converter clutch activation.	Refer to Pinpoint Test F.
P0743*	TCC	TCC solenoid circuit failure during on-board diagnostic.	TCC solenoid circuit fails to provide voltage drop across solenoid. Circuit	Short circuit — Engine stalls in second (OD, 2 range) at low idle speeds with brake applied. Open circuit —	Refer to Pinpoint Test A.

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			open or shorted or PCM drive failure during on-board diagnostic.	Torque converter clutch never engages.	
P1783	TFT	Transmission overtemp condition indicated.	Transmission fluid temperature exceeded 127℃ (270°F).	Increase in EPC pressure.	Refer to Pinpoint Test B.
P0705	DTR	DTR circuit failure.	DTR sensor, circuit or PCM shorted or grounded.	Increase in EPC pressure.	Refer to Pinpoint Test D.
P0708	DTR	DTR circuit above maximum voltage — open.	DTR sensor, circuit or PCM indicates open.	Increase in EPC pressure.	Refer to Pinpoint Test D.
P0751**	SS1	Shift solenoid No. 1 functional failure.	Mechanical or hydraulic failure of the shift solenoid.	Improper gear selection depending on failure mode and manual lever position.	Refer to Solenoid On/Off Charts. Refer to Pinpoint Test A.
P0756**	SS2	Shift solenoid No. 2 functional failure.	Mechanical or hydraulic failure of the shift solenoid.	Improper gear selection depending on failure mode and manual lever position.	Refer to Solenoid On/Off Chart. Refer to Pinpoint Test A.
P1781	4x4L	4x4 low switch failure.	Switch closed or shorted during KOEO.	Early or delayed shifts.	Refer to Section 07-07A.
P1729	4x4L	4x4 low switch failure.	Circuit open/shorted.	Early or delayed shifts.	Refer to Section 07-07A.
P0761**	SS3	Shift solenoid No. 3 functional failure.	Mechanical or hydraulic failure of the shift solenoid.	Improper gear selection depending on failure mode and manual lever position.	Refer to Solenoid On/Off Charts. Refer to Pinpoint Test A.
P0760*	SS3	SS3 solenoid circuit failure.	SS3 circuit failed to provide voltage drop across solenoid. Circuit open or shorted or PCM driver failure during on-board diagnostic.	Improper gear selection depending on condition mode and manual lever position. See Solenoid On/Off chart.	Refer to Pinpoint Test A.
P1746**	EPC	EPC solenoid circuit open.	Voltage through EPC solenoid is checked. Error is noted if tolerance is exceeded.	Open Circuit — Causes maximum EPC pressure, harsh engagements and shifts.	Refer to Pinpoint Test E.

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P1701	Transmission	Reverse engagement error.	EPC pressure is low, no drop in TSS rpm, DTR indicates reverse	EPC pressure low, SS1 is off, engine lacks power.	Diagnosis by symptom.
P1714	SS1	SS1 malfunction.	Mechanical failure of the solenoid detected.	Improper gear selection depending on condition, mode and manual lever position. See Solenoid Operation Chart.	Pinpoint Test H.
P1715	SS2	SS2 malfunction.	Mechanical failure of the solenoid detected.	Improper gear selection depending on condition, mode and manual lever position. See Solenoid Operation Chart.	Pinpoint Test H.
P1716	SS3	SS3 malfunction.	Mechanical failure of the solenoid detected.	Improper gear selection depending on condition, mode and manual lever position. See Solenoid Operation Chart.	Pinpoint Test H.
P1717	SS4	SS4 malfunction.	Mechanical failure of the solenoid detected.	Improper gear selection depending on condition, mode and manual lever position. See Solenoid Operation Chart.	Pinpoint Test H.
P0735	SS1, SS2, SS3, SS4 or internal parts	5th gear error	No 5th gear.	Improper gear selection depending on failure mode or manual lever position. Shift errors may also be due to other internal transmission concerns (stuck valves, damaged friction material etc.).	Refer to Solenoid On/Off Charts. Refer to Pinpoint Test A.
P1719	ODS	Insufficient input from ODS sensor.	PCM detected a loss of ODS signal during operation.	Harsh or flairing 2-1, 2-3 or 5-4 shift.	Refer to Pinpoint Test F.
P0765	SS4	SS4 solenoid circuit failure.	SS4 circuit failed to provide voltage drop across solenoid. Circuit open, shorted or PCM driver circuit failure during on-board diagnostics.	Improper gear selection depending on condition, mode and manual lever position. See Solenoid On/Off charts.	Refer to Pinpoint Test A.
P1762	Transmission	SS3/SS4/OD band failure.	Failure or SS3, SS4 or the front band.	No 2nd or 5th gear.	Diagnosis by symptom.
P0743	TCC	TCC solenoid circuit failure	TCC solenoid circuit fails to	Short circuit: engine stalls in O/D or 2	Pinpoint Test A.

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		during OBD Test.	provide voltage drop across solenoid. Circuit open, shorted or PCM driver failure during OBD Test.	position at low idle with brake applied. Open circuit: torque converter never engages.	
P1740	TCC	TCC Malfunction.	Mechanical failure of the solenoid detected.	Failed ON — Engine stalls in 2nd (O/D, Manual 2 ranges) at low idle speeds with brake applied. Failed OFF — Torque converter never applies.	Pinpoint Test H.
P0720	OSS	Insufficient input from OSS sensor.	PCM detected a loss of OSS signal during operation.	Harsh shifts, abnormal shift schedule, no torque converter clutch engagement.	Refer to Pinpoint Test F.
P0721	OSS	Output shaft speed sensor signal noisy.	PCM has detected an erratic OSS signal.	Harsh shifts, abnormal shift schedule, no torque converter clutch engagement.	Pinpoint Test F.

[1] Can be purchased as a separate item.

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Rotunda Transmission Tester

Use Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit), Rotunda Transmission Range (TR) Sensor Cable "E" 007-00111 with Digital TR Overlay 007-00131 or equivalent to diagnose electronically controlled transmissions (7003). The following instructions outline the set up and use of this tester in the Pinpoint Tests for the 5R55E.

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Transmission Tester

- BENCH MODE: acts as shift solenoid selector for click testing.
- DRIVE MODE: acts as forward gear selector in place of vehicle's powertrain control module (PCM) (12A650) controlled shifting. Hydraulic safety mechanisms and overrides are built into the transmission (7003).
- OHMS CHECK: allows technician to measure ohms and to check for presence of diode on specific solenoids.

Tester Jacks

1. **VPWR Pin Jacks (red):** Vehicle Power (VPWR) test points for solenoid circuits.
2. **Solenoid Signal Line Pin Jacks (black):** Signal line test points for solenoid circuits.
3. **BAT + (red) and BAT - (black) Pin Jacks:** Battery reference points when measuring circuits for shorts.
4. **TFT Pin Jacks:** Test points for transmission fluid temperature sensor.
5. **TSS Jack:** Test points for TSS sensor.

LEDs and Controls

- LED turns **RED** when solenoid activates and **OFF** when solenoid deactivates.
- LED turns **GREEN** if an activated solenoid/harness is shorted.
- LED remains **OFF** if an activated solenoid/harness is shorted to ground or no continuity.

Digital Transmission Range (DTR) Sensor Testing

Introduction

The Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit) and TR Testing Cable "E" 007-00111 with Digital TR Sensor Overlay 007-00131 or equivalent allows a technician to test the DTR sensor independent of vehicle electronics. DTR sensor testing is divided into four steps:

1. Preliminary diagnosis and testing.
2. Installing the Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit) and TR Testing Cable "E" 007-00111 with Digital TR Sensor Overlay 007-00131 or equivalent.
3. Testing the digital transmission range (DTR) sensor.
4. Testing the park/neutral, backup and optional circuits.

Preliminary Testing and Diagnosis

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Before any diagnostic testing is done on a vehicle some preliminary checks must be performed. Be sure to write down any findings, especially any DTCs, for future reference.

1. Know and understand customer's concern.
2. Verify that DTR sensor is properly adjusted in NEUTRAL.
3. Verify customer concern:
    - Upshift
    - Downshift
    - Coasting
    - Engagement

If concern involves noise or vibration, does it relate to any of the following?

- Rpm
- Vehicle speed
- Shift
- Gear
- Range
- Temperature

4. Vehicle must be at normal operating temperature.
5. Check transmission fluid level and condition.
6. Check for the following items:
    - Vehicle modifications
    - Electronic add-on items
    - Leaks
    - Linkage adjustments
7. Check TSBs and OASIS for related information.
8. Perform complete On-Board Diagnostics (OBD) for both KOEO and KOER.
9. Record all DTCs.
10. Repair all non-transmission DTCs.

Installation Procedures

Installing the Rotunda Transmission Tester 007-00130 (part of Rotunda Transmission Tester Kit) and TR Testing Cable "E" 007-00111 with Digital TR Sensor Overlay 007-00131 at the transmission connector allows separation of the DTR sensor electronics from the vehicle electronics.

Testing may cause additional fault codes to be set. Therefore, it is important that all DTCs are erased whenever repairs are made. To verify elimination of all codes, rerun OBD test.

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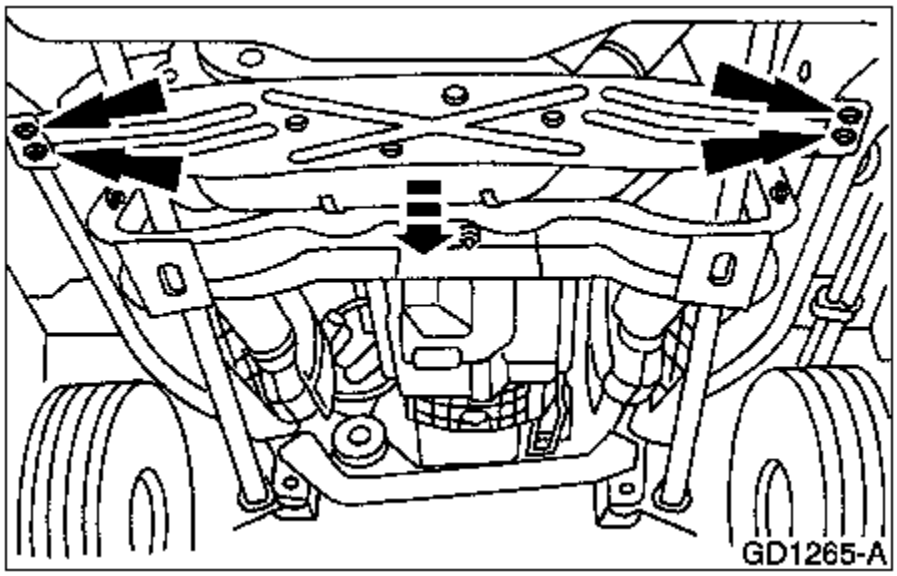
The following manuals will assist in diagnosis of electronically controlled transmissions:

- Powertrain Control/Emissions Diagnosis Manual

1. For proper Digital TR Sensor Diagnosis follow Pinpoint Test D .
2. Disconnect vehicle harness at digital transmission DTR sensor.
3. Set the two-way switch in the down position. (This switch will stay in the same position for all DTR sensor testing.)
4. Attach the Digital TR Sensor Overlay 007-00131 to the transmission tester.



Affixing the overlay will immobilize the two-way switch (set in Step 2) so it cannot be accidentally moved to an incorrect setting during testing.

5. Select and connect interface cable "E" 007-00111 to the tester and then black connector (digital) to DTR sensor.

Transmission	Model Year	Cable
5R55E	1997-Up	E

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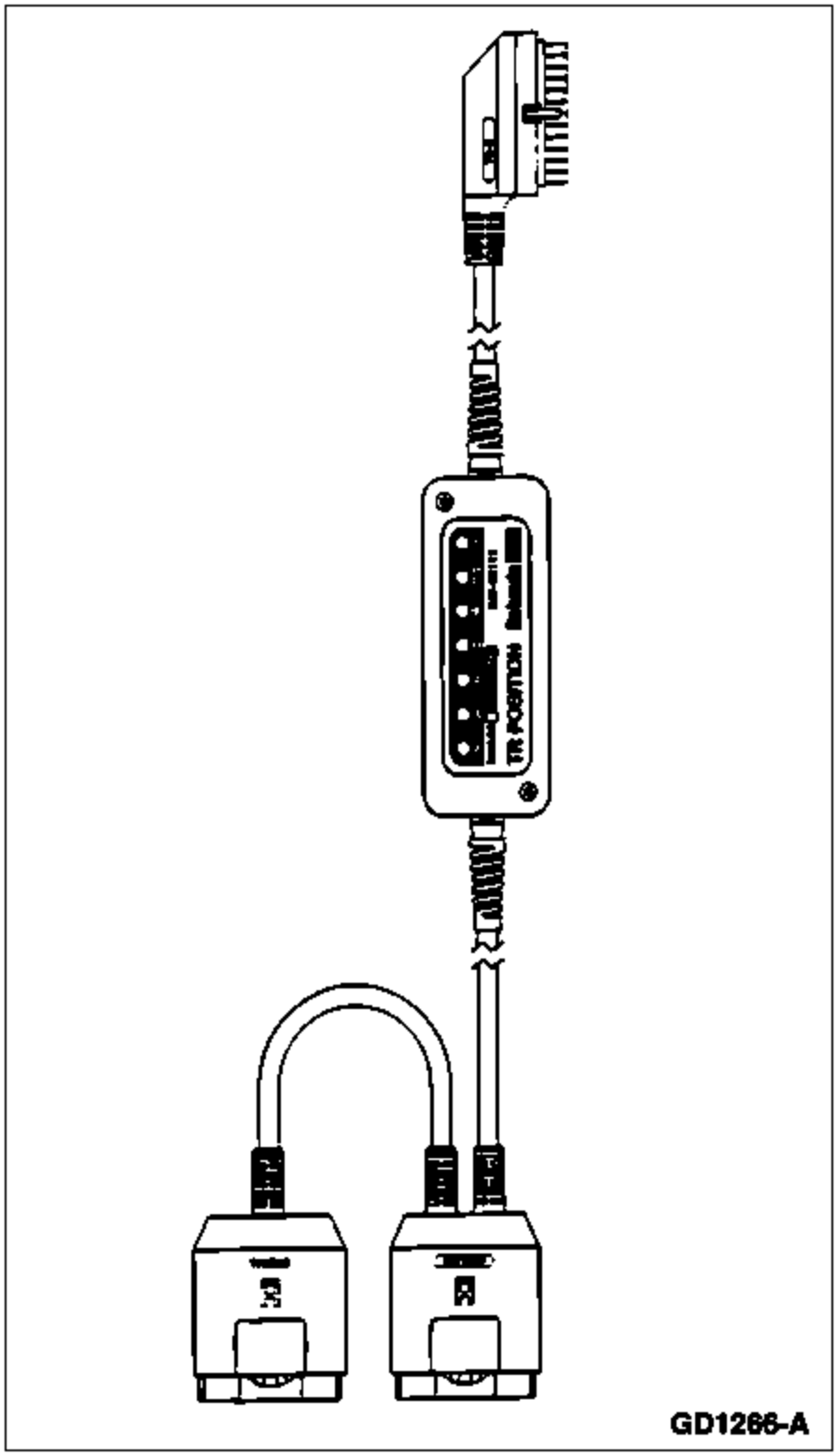

6. Set Analog/Digital Switch on TR-E Cable to Digital.

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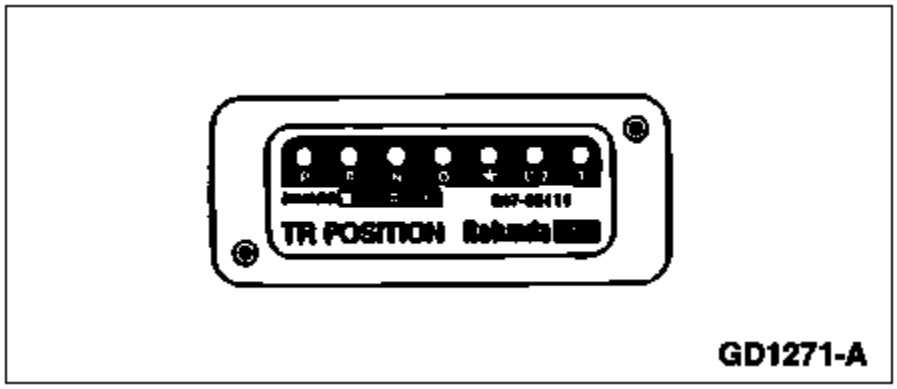
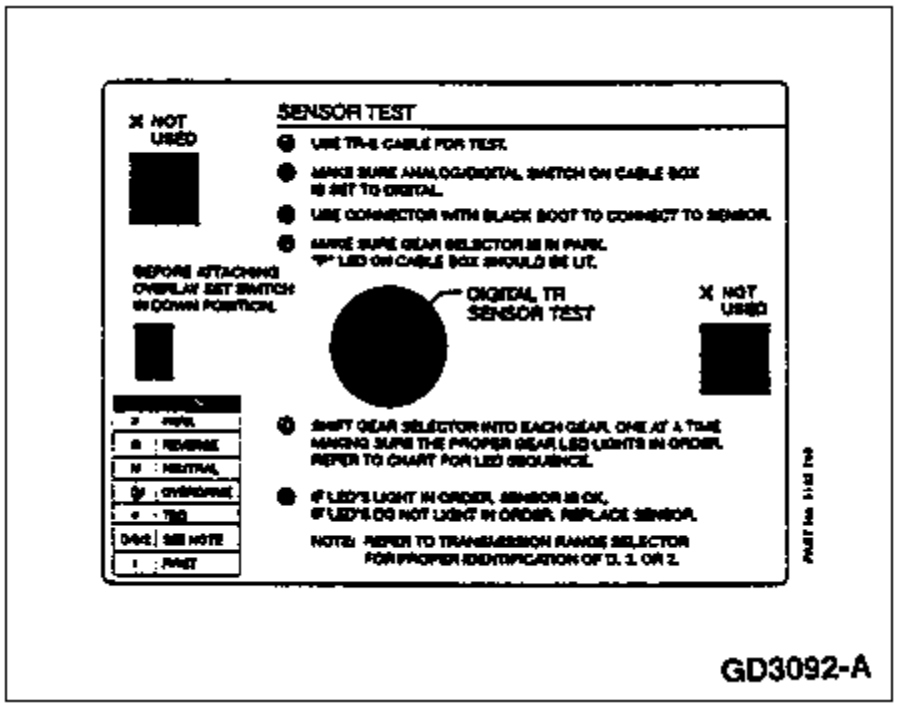


CAUTION: Route all cables away from heat sources to prevent damage to cables during testing.

Use the transmission tester extender cable when running tests with the transmission on the vehicle.

7. Turn large dial to DIGITAL TR SENSOR TEST.



8. Plug transmission tester power cable into cigar lighter socket.

All LEDs should light for a short period and then turn off. This is the Tester's internal circuit check.

CAUTION: For resistance checks, be sure that the tester selector switch is set to the TR SENSOR TEST position or damage to the ohmmeter may result.

Sensor Test

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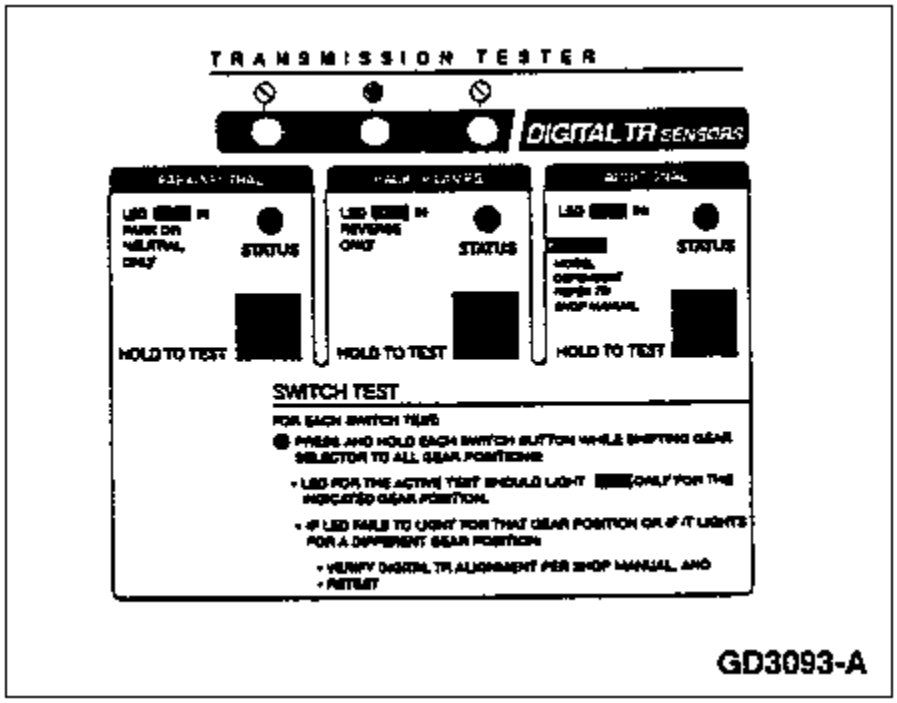
CAUTION: Be sure that the DIGITAL 12 pin sensor cable connector (black) is used. If the wrong connection is made or the slide switch is in the wrong position, the LEDs on the TR cable will give false or no response during testing. This will cause the replacement of good parts.

1. Place transmission range selector lever into PARK.
2. Ensure that the "E" cable ANALOG/DIGITAL switch is set to DIGITAL.
3. Move the transmission range selector lever through all ranges.
4. Monitor the LEDs, located on the "E" cable, in each gear position. The LED should illuminate RED for the appropriate range selected.
5. If the LED for the applicable gear range position fails to illuminate RED or if it lights for a position other than the gear selected:
    - Verify test cable connections at sensor and tester.
    - Verify transmission shift linkage for proper adjustment.
    - Verify DTR sensor for proper adjustment.
    - Retest.
6. If the sensor still fails to illuminate the LED RED for the selected gear range or indicates incorrect gear position, replace it.

Switch Tests — Park/Neutral, Backup Lamp and Optional Circuits

NOTE: LED lights red when circuit is closed.



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LED turns off when circuit is open.

1. Press and hold each test button while moving the transmission range selector lever to each gear position.
2. Monitor each STATUS LED:

   The LED in the appropriate gear position being testing should light red.

   If the LED for the applicable gear position fails to light red, or if it lights for a position other than the gear selected:

   - Verify DTR alignment. Refer to the Assembly procedure in this section.
   - Retest.
3. If the DTR sensor fails, replace it.

   After testing is finished, follow the Disconnecting The Tester procedure in this section.

Disconnecting The Tester

1. **CAUTION: Do not attempt to pry off connectors with a screwdriver. This will damage the connector and could result in a transmission concern.**

   Disconnect transmission tester from the DTR sensor connector.
2. Reinstall vehicle wiring harness. Verify connection by pulling up on the harness.
3. Reinstall all heat shields that were previously removed.
4. Disconnect transmission tester power lead from vehicle.
5. Erase all DTCs using the procedures in the Powertrain Control/Emissions Diagnosis Manual.
6. Rerun On-Board Diagnostic Tests to receive a pass code.
7. Verify that the customer concern has been eliminated.

Digital Transmission Range (DTR) Sensor Vehicle Harness Connector

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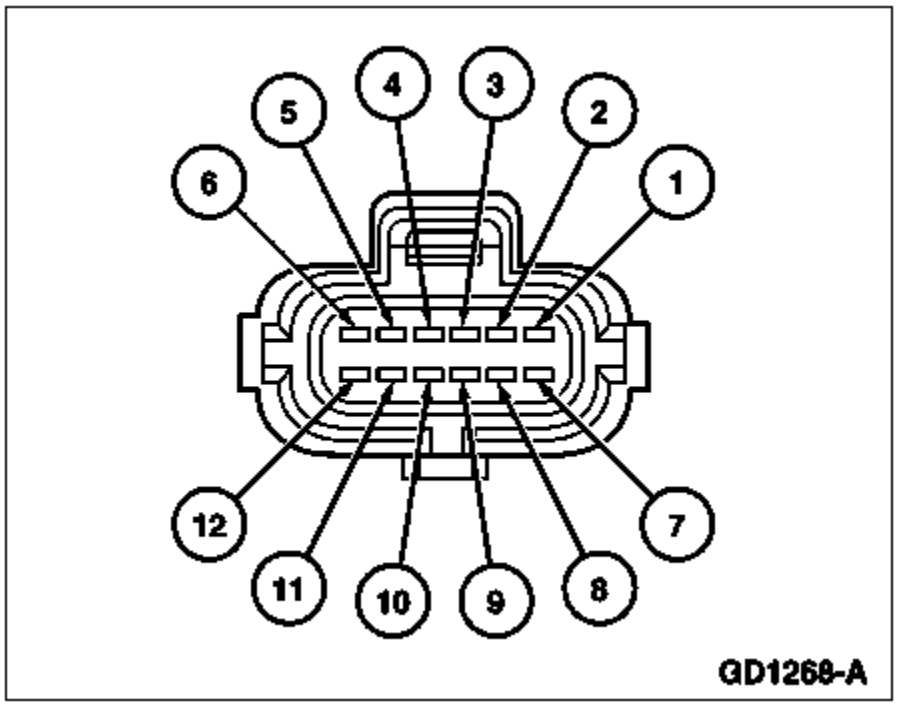

Pin Number	Circuit	EEC-V Pin Number	Circuit Function
1	—	—	NOT USED
2	359 (GY/R)	91	Signal Return
3	199 (LB/Y)	64	TR3A
4	1144 (Y/BK)	3	TR1
5	1145 (LB/BK)	49	TR2
6	1143 (W/BK)	50	TR4
7	57 (BK)	—	Ground
8	463 (R/W)	—	Neutral Sense
9	298 (P/O)	—	Fused Power Feed
10	32 (R/LB)	—	Starter Control
11	140 (BK/PK)	—	Back Up
12	33 (W/PK) * 329 (PK) **	—	Starter to Starter Interrupt Relay

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Transmission External Harness

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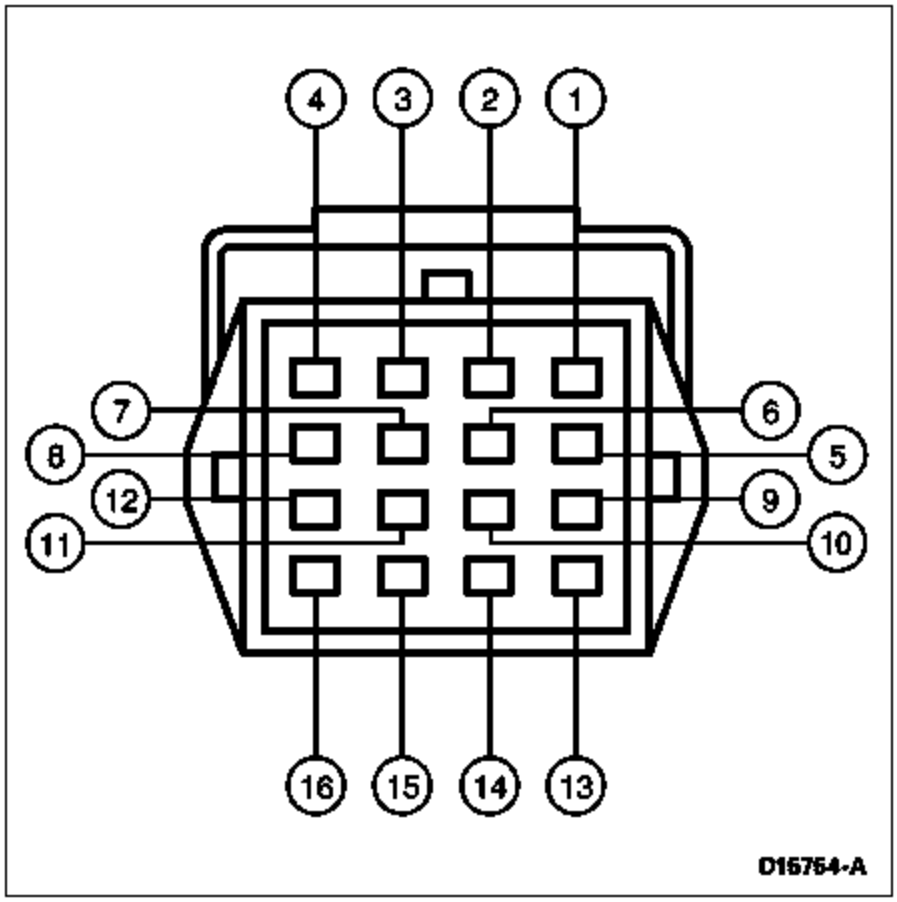

Pin Number	Circuit	Circuit Function
1	361 (R)	TCC Power
2	970 (GN/W)	Turbine Shaft Speed Sensor Signal
3	359 (GY/R)	Sensor Signal Return (TSS)
4	923 (O/BK)	Transmission Fluid Temperature Sensor
5	126 (P/Y) * 480 (P/Y) **	Torque Clutch Solenoid
6	—	NOT USED
7	971 (PK/BK)	Shift Solenoid No. 3
8	359 (GR/R)	Sensor Signal Return (TFT)
9	924 (BR/O)	Shift Solenoid No. 4
10	361 (R)	Shift Solenoid Power
11	361 (R)	EPC Power
12	925 (W/Y)	Electronic Pressure Control Solenoid
13	—	NOT USED
14	315 (P/O)	Shift Solenoid No. 2
15	—	NOT USED

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16	237 (O/Y)	Shift Solenoid No. 1

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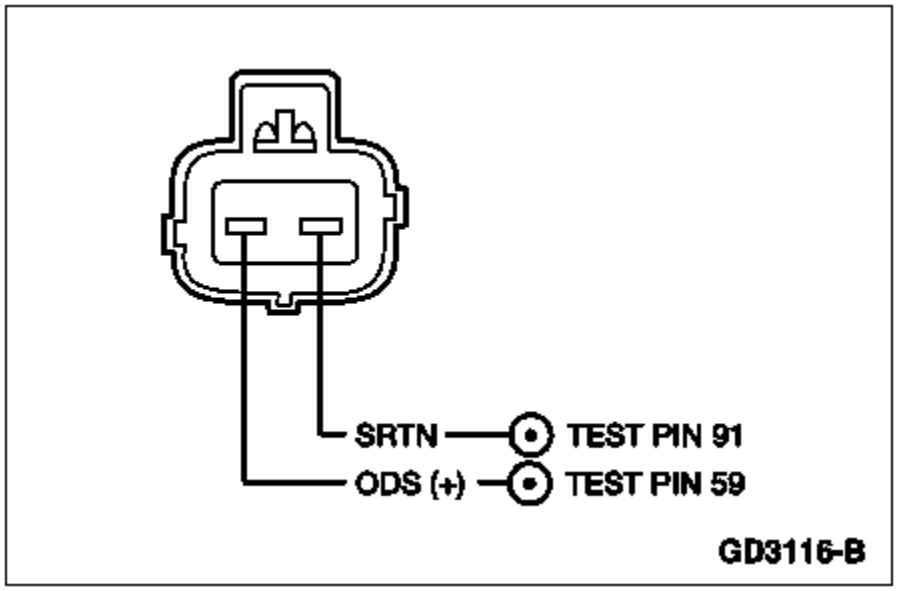
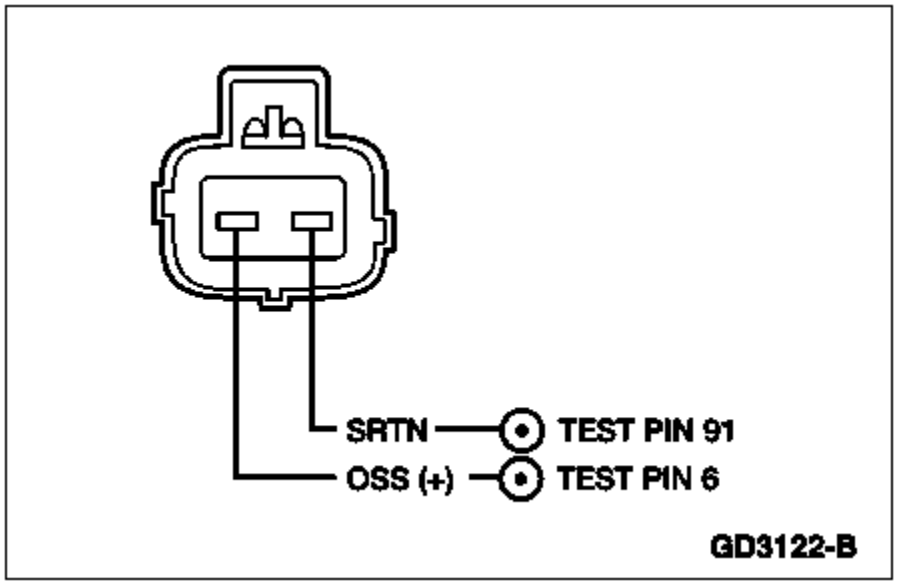
Overdrive Drum Speed (ODS) Sensor Connector



Output Shaft Speed (OSS) Sensor Connector



Internal Harness Diagram

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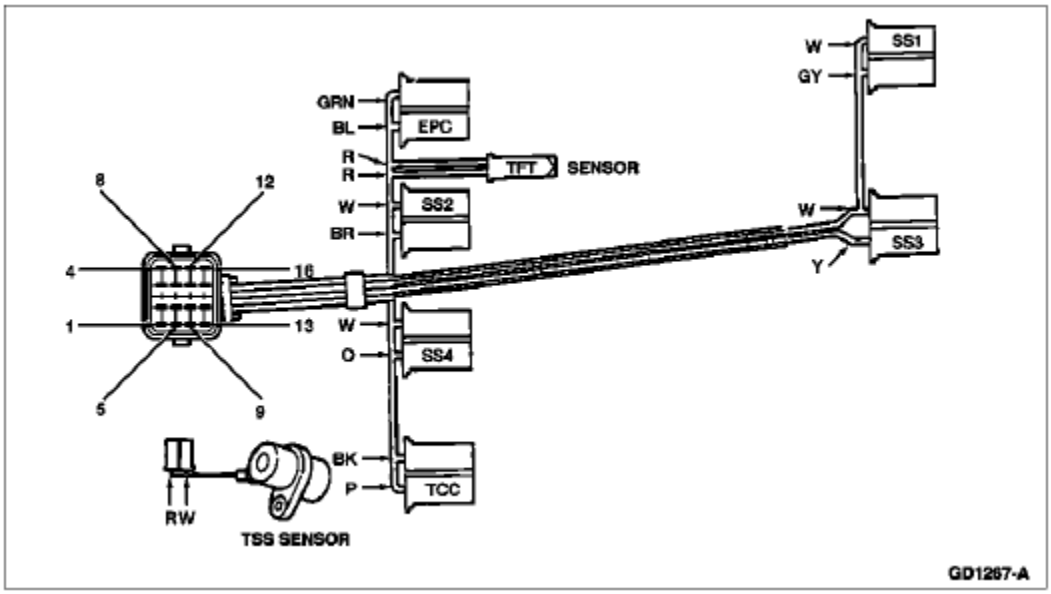

Pin Number	Circuit	Circuit Function
1	Black	TCC Power
2	Red	Turbine Shaft Speed Sensor Signal
3	White	Sensor Signal Return (TSS-)
4	Red	Transmission Fluid Temperature Sensor
5	Purple	Torque Converter Clutch Solenoid
6	—	NOT USED
7	Yellow	Shift Solenoid No. 3
8	Red	Sensor Signal Return (TFT-)
9	Orange	Shift Solenoid No. 4
10	White	Shift Solenoid Power
11	Green	EPC Power
12	Blue	Electronic Pressure Control Solenoid
13	—	NOT USED
14	Brown	Shift Solenoid No. 2
15	—	NOT USED
16	Gray	Shift Solenoid No. 1

Digital Transmission Range Sensor Internal Circuitry

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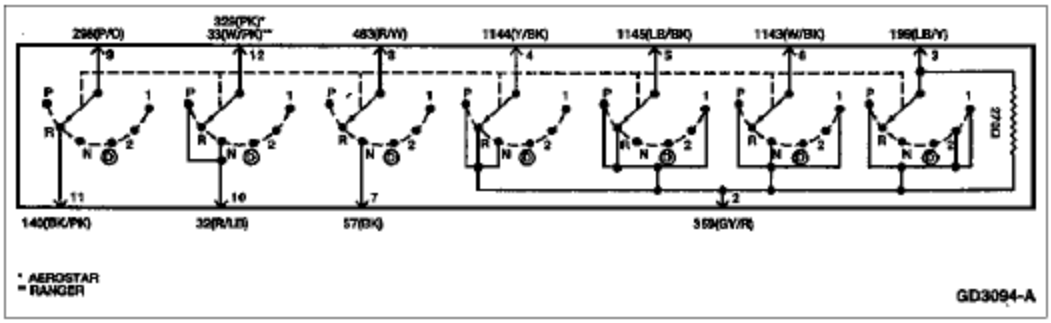

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Pinpoint Tests

PINPOINT TEST A: SHIFT SOLENOIDS (SS1, SS2, SS3, SS4) AND TORQUE CONVERTER CLUTCH (TCC) SOLENOID

Solenoid Operation Chart

The following chart shows normal solenoid operation for given operating modes.

SOLENOID APPLICATION CHART — 5R55E

Transmission Range Selector Lever Position	Powertrain Control Module (PCM) Commanded Gear	5R55E Solenoid States				
		SS1	SS2	SS3	SS4	Engine Braking
P/N	P/N	On	Off	Off	Off	No
R	R	On	Off	Off	O/W [1]	Yes
(D) (Overdrive)	1	On	Off	Off	Off	No
(D)	2 [G]	On	Off	On	Off	No
(D)	3	On	On	Off	Off	No
(D)	4	Off	Off	Off	Off	No
(D)	5	Off	Off	On	Off	Yes
(D) Off [1]	1	On	Off	Off	Off	No
	2 [G]	On	Off	On	Off	No
	3	On	On	Off	On	Yes
	4	Off	Off	Off	On	Yes
2	2	On	On	Off	On	Yes
1	1	On	Off	Off	On	Yes

[1] O/W=TCS "ON"
[G] Shift scheduled by PCM calibration.

Shift Solenoid Failure Mode Charts

NOTE: 2nd and 4th gear in O/D position can only be obtained with sufficient EPC pressure (i.e., no short in EPC circuit can be present).

Shift Solenoid Failure "Always On"

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Shift Solenoid failed in the OFF mode due to PCM and/or vehicle wiring concerns; solenoid electrically or mechanically stuck in the ON mode.

	Transmission Range Selector Lever Position		
SS1 Always "ON":	**OD**	**2**	**1**
PCM Gear Commanded	**Actual Gear Obtained**		
1	1	3	1
2	2	Ratio 1.1	2
3	3	3	3
4	1	3	1
5	2	Ratio 1.1	2

	Transmission Range Selector Lever Position		
SS2 Always "ON":	**OD**	**2**	**1**
PCM Gear Commanded	**Actual Gear Obtained**		
1	3	3	3
2	Ratio 1.1	Ratio 1.1	Ratio 1.1
3	3	3	3
4	3	3	3
5	Ratio 1.1	Ratio 1.1	Ratio 1.1

	Transmission Range Selector Lever Position		
SS3 Always "ON":	**OD**	**2**	**1**
PCM Gear Commanded	**Actual Gear Obtained**		
1	2	3	1
2	2	Ratio 1.1	2
3	Ratio 1.1	3	3
4	5	3	3
5	5	Ratio 1.1	Ratio 1.1

	Transmission Range Selector Lever Position		
SS4 Always "ON":	**OD**	**2**	**1**
PCM Gear Commanded	**Actual Gear Obtained**		
1	1	3	1
2	1	3	1
3	3	3	3
4	4	3	3

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5	4	3	3

Shift Solenoid Failure "Always OFF"

Failed ON due to powertrain control module and/or vehicle wiring concerns, solenoid electrically or mechanically stuck OFF.

	Transmission Range Selector Lever Position		
SS1 Always "OFF":	**OD**	**2**	**1**
PCM Gear Commanded	**Actual Gear Obtained**		
1	4	3	3
2	5	Ratio 1.1	Ratio 1.1
3	3	3	3
4	4	3	3
5	5	Ratio 1.1	Ratio 1.1

	Transmission Range Selector Lever Position		
SS2 Always "OFF":	**OD**	**2**	**1**
PCM Gear Commanded	**Actual Gear Obtained**		
1	1	3	1
2	2	Ratio 1.1	2
3	1 [a] (2 [b])	3	1
4	4	3	3
5	5	Ratio 1.1	Ratio 1.1

[a] During downshift only
[b] During upshift only

	Transmission Range Selector Lever Position		
SS3 Always "OFF":	**OD**	**2**	**1**
PCM Gear Commanded	**Actual Gear Obtained**		
1	1	3	1
2	1	3	1
3	3	3	3
4	4	3	3
5	4	3	3

	Transmission Range Selector Lever Position		
SS4 Always "OFF":	**OD**	**2**	**1**

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PCM Gear Commanded	Actual Gear Obtained		
1	1	3	1
2	2	Ratio 1.1	2
3	3	3	3
4	4	3	3
5	5	Ratio 1.1	Ratio 1.1

NOTE: Read and record all DTCs. All DTR sensor and VSS DTCs must be repaired before entering Output State Control (OCS).

A1 ELECTRONIC DIAGNOSTICS

- Turn the ignition switch to the OFF position.
- Place the transmission range selector lever in PARK.
- Check to make sure the transmission harness connector is fully seated, terminals are fully engaged in connector and in good condition before proceeding.
- Connect New Generation STAR (NGS) 007-00500 Tester.
- Turn the ignition switch to the ON position.
- Select Diagnostic Data Link.
- Select PCM.
- Select Active Command Modes.
- Select Output State Control (OSC).
- Select Trans — Bench Mode.

Does vehicle enter Trans — Bench Mode?

Yes	No
REMAIN in Trans — Bench Mode. GO to **A2** .	REPEAT procedure to enter Trans — Bench Mode. If vehicle did not enter Trans — Bench Mode, REFER to Powertrain Control/Emissions Diagnosis Manual for diagnosis of PCM or NGS.

A2 WIGGLE TEST

- Remain in Trans — Bench Mode.
- Select PIDS to be monitored:

PID Command	PID Actual
SSA	SS1F
SSB	SS2F
SSC	SS3F
SSD	CCSF
TCC	TCCF

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- Select "ON" to turn suspect solenoid ON.
- Press "SEND".
- Wiggle all wiring and connectors to the transmission. Monitor the Solenoid State for changes.
- Select "OFF" to turn solenoid OFF.
- Press "SEND".

Does the suspect solenoid(s) fault state change?

Yes	No
REPAIR open or short in the vehicle harness or connector.	GO to **A3** .

A3 SOLENOID FUNCTIONAL CHECK

- Monitor each solenoid state.
- Turn each solenoid "ON" and "OFF".

Does the solenoid turn "ON" and "OFF" when commanded and can solenoid activation be heard?

Yes	No
GO to **A4** .	GO to **A5** .

A4 OSC TRANS — DRIVE MODE (GR_CM OR TCC)

- Perform OSC Trans — Drive Mode.
- Select GR_CM for shift solenoids. Follow procedures for GR_CM as listed in this section.
- Select TCC for torque converter clutch solenoids. Follow procedures for TCC in drive mode as listed in this section.

Does the transmission upshift and downshift or torque converter engage/disengage when commanded?

Yes	No
CLEAR all DTCs. Road test to verify if concern is still present. If concern is still present, REFER to Diagnosis by Symptom to diagnosis shift or torque converter concern.	GO to **A5** .

A5 CHECK FOR BATTERY VOLTAGE

- Remove transmission fluid pan.
- Visually inspect all wires and connectors for damage.
- Turn the ignition switch to the ON position.
- Connect DVOM positive lead to VPWR solenoid terminal and negative lead to a good ground.

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Is the battery voltage present?

Yes	No
GO to **A6** .	CHECK for open or short circuit in harness or solenoid.

A6 ELECTRICAL SIGNAL CHECK

- Leave positive lead connected to VPWR solenoid terminal and connect negative lead to the signal terminal of the appropriate solenoid.
- Select Trans — Bench Mode.
- Select parameter SS1, SS2, SS3, SS4, or TCC.
- Select "ON".
- Press "SEND".
- Turn the solenoids "ON" and "OFF" while monitoring the voltage reading on the DVOM, solenoid state on the NGS (ON and OFF), listen for the solenoid to activate (click).
- Select "OFF".
- Press "SEND".

Does the voltage and solenoid state change?

Yes	No
GO to **A7** .	CHECK for open or short circuit in harness, solenoid or a PCM concern.

A7 CHECK SOLENOID RESISTANCE AT SOLENOID

- Disconnect the appropriate solenoid connector at the solenoid.
- Check solenoid resistance by connecting an ohmmeter at the terminals of the solenoid.
- Measure and record the resistance for each solenoid. (SS1, SS2,SS3,SS4 or TCC).

Solenoid	Resistance (ohms)
SS1	22-48
SS2	22-48
SS3	22-48
SS4	22-48
TCC	8.9-16

Is the resistance within specification?

Yes	No
GO to **A8** .	REPLACE the solenoid.

A8 CHECK SOLENOID FOR SHORT TO GROUND

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- Check for continuity between engine ground and appropriate shift solenoid terminal with ohmmeter or other low current tester (less than 200 milliamps).

Solenoid	Terminal
SS1	+/-
SS2	+/-
SS3	+/-
SS4	+/-
TCC	+/-

- Connection should show infinite resistance (no continuity).

Is there continuity?

Yes	No
REPLACE the solenoid.	REFER to Diagnosis by Symptom Charts for diagnosis of shift or torque converter concerns.

PINPOINT TEST B: TRANSMISSION FLUID TEMPERATURE (TFT) SENSOR

B1 ELECTRONIC DIAGNOSTICS

- Check to make sure the transmission harness connector is fully seated, terminals are fully engaged in connector and in good condition before proceeding.
- Connect NGS (007-00500) tester.
- Turn the ignition switch to the ON position.
- Select Diagnostic Data Link.
- Select PCM.
- Select PID/Data Monitor and Record.
- Select the following PIDs:
  - TFT.
  - TFTV.

Does vehicle enter PID/Data Monitor and Record?

Yes	No
REMAIN in PID/Data Control. GO to **B2** .	REPEAT procedure to enter PID. If vehicle did not enter PID, REFER to Powertrain Control/Emissions Diagnosis Manual for diagnosis of PCM or NGS.

B2 WARM-UP/COOL-DOWN CYCLE

- While monitoring the TFT PIDs, perform the following test: If transmission is cold, run transmission to

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warm it up. If transmission is warm, allow transmission to cool down.

Do the TFT PIDs increase as the transmission is warmed or decrease as the transmission is cooled or does the TFT or TFTV drop in and out of range?

Yes	No
If the TFT PIDs increase as the transmission is warmed or decrease as the transmission is cooled, CLEAR all DTCs. Road test to verify if concern is still present. If concern is still present, REFER to Diagnosis by Symptom to diagnose transmission overheating. If the TFT or TFTV drop in and out of range, INSPECT for intermittent concern in the internal/external harness, sensor or connector.	GO to **B3** .

B3 ELECTRICAL SIGNAL CHECK

- Remove transmission fluid pan.
- Visually inspect all wires and connectors for damage.
- Connect DVOM positive lead to +TFT at sensor terminal and negative lead to a good ground.

Is voltage present?

Yes	No
GO to **B4** .	CHECK for open or short circuit in vehicle harness, internal harness or a PCM concern.

B4 CHECK RESISTANCE OF TFT SENSOR

- Disconnect vehicle harness from transmission.
- Connect DVOM across +TFT and -TFT terminals at transmission connector.
- Record the resistance.
- Resistance should be approximately in the following ranges:

Transmission Fluid Temperature

℃	℉	Resistance (Ohms)
-40 to -20	-40 to -4	967k-284k
-19 - -1	-3-31	248k-100k
0-20	32-68	100k-37k
21-40	69-104	37k-16k
41-70	105-158	16k-5k
71-90	159-194	5k-2.7k
91-110	195-230	2.7k-1.5k
111-130	231-266	1.5k-0.8k

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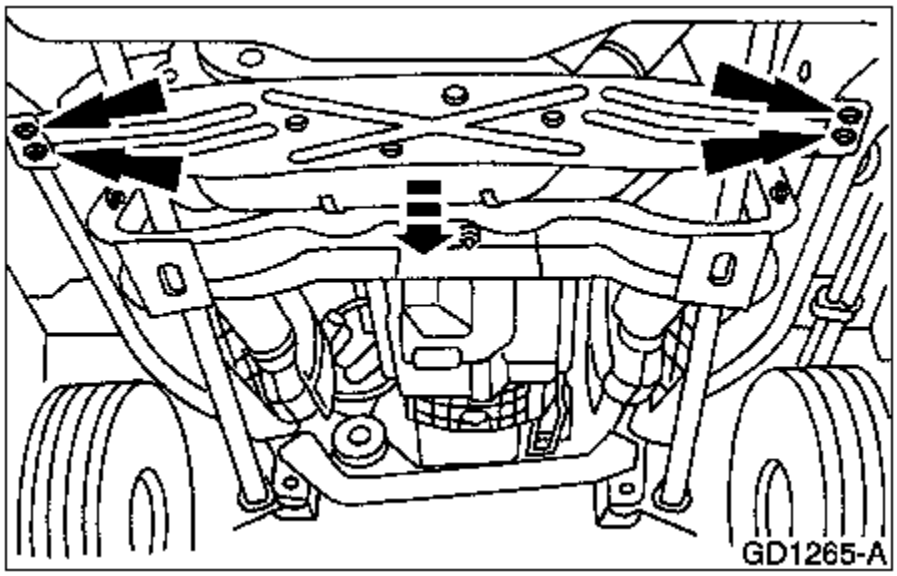
131-150	267-302	0.8k-0.54k

Is the resistance in range?

Yes	No
REFER to Diagnosis by Symptom chart to diagnose an overheating concern.	REPLACE internal harness (sensor is part of harness).

PINPOINT TEST D: DIGITAL TRANSMISSION RANGE (DTR) SENSOR

Digital TR Sensor Overlay



D1 VERIFY DIGITAL TRANSMISSION RANGE SENSOR ALIGNMENT

- Turn ignition switch OFF.
- Place transmission range selector lever in PARK.
- Check to make sure the DTR sensor harness connector is fully seated, terminals are fully engaged in connector and in good condition before proceeding.
- Apply the parking brake.
- Place transmission range selector lever in OVERDRIVE.
- Verify the shift linkage is adjusted in the OVERDRIVE (O/D) position.
- Place transmission range selector lever in NEUTRAL.
- Verify that the Digital TR Sensor Alignment Tool (T97L-70010-A) fits in the appropriate slots.

Is the DTR sensor properly adjusted?

Yes	No

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GO to **D2** .	ADJUST the DTR sensor as outlined under Assembly . PLACE transmission range selector lever into PARK and CLEAR DTCs. RERUN OBD tests.

D2 CHECK ELECTRICAL SIGNAL OPERATION

- Place transmission range selector lever in PARK.

CAUTION: Do not pry on connector. This will damage the connector and result in a transmission concern.

- Press button and pull out on DTR harness connector.
- Inspect both ends of the connector for damage or pushed out pins, corrosion, loose wires and missing or damaged seals.

Is there damage to the connector, pins or harness?

Yes	No
REPAIR as required. CLEAR DTCs and RERUN OBD tests.	If diagnosing a DTC, GO to **D3** . If diagnosing a starting concern, a backup lamp concern, or 4x4 low engagement concern, GO to **D8** .

D3 CHECK ELECTRICAL SYSTEM OPERATION (DTR AND PCM)

- Turn ignition switch OFF.
- Connect the New Generation STAR (NGS) tester.
- Reconnect DTR connector.
- Turn ignition switch ON.
- Select TR PIDs TR and TR_D on the NGS tester.
- Move transmission range selector lever into each gear and stop.
- Observe the PIDs, TR and TR_D, while wiggling harness and tapping on sensor.
- Compare the PIDs to the chart below:

Selector Position	TR	TR_D
Park	P/N	0000
Reverse	REV	1100
Neutral	NTRL	0110
Drive	O/D *	1111
Man 2	MAN2	1001
Man 1	MAN1	0011

* Will read DRIVE if O/D cancel switch is ON.

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Do the PIDs TR and TR_D match the above chart, and does the TR_D PID remain steady when the harness is wiggled or when the sensor is tapped upon?

Yes	No
The problem is not in the DTR sensor system. REFER to Diagnosis by Symptom for further diagnosis.	GO to **D4**. **NOTE: If TR_D changes when wiggling harness or tapping on the sensor, problem may be intermittent.**

D4 CHECK DIGITAL TRANSMISSION RANGE SENSOR OPERATION

- Disconnect DTR Sensor Connector.
- Connect TR-E Cable (007-00111) to Transmission Tester (007-00130).
- Connect TR-E Cable (007-00111) to DTR Sensor.
- Place the DIGITAL TR Overlay (007-00131) onto transmission tester (007-00130).
- Perform SENSOR TEST as instructed on the DTR overlay.

Does the status lamp on the tester TR-E cable match the selected gear positions?

Yes	No
Concern is not in the DTR sensor, GO to **D5**.	REPLACE the DTR sensor and ADJUST as outlined. REFER to Assembly for procedures. CLEAR DTCs and RERUN OBD tests.

D5 CHECK PCM HARNESS CIRCUITS FOR OPENS

NOTE: Refer to schematic diagram and illustration preceding the Pinpoint Tests.

- Turn ignition switch OFF.
- Disconnect powertrain control module (PCM) connector. Inspect for damaged or pushed out pins, corrosion or loose wires.

CAUTION: Do not pry connector. This will damage the connector and result in a transmission concern.

- Press button and pull out DTR connector.
- Install 104 Pin Breakout Box (014-00950).
- Measure resistance between PCM test pin 91 at the breakout box and signal return circuit pin at vehicle harness connector pin 2.
- Measure resistance between PCM test pin 3 at breakout box and TR1 circuit pin at vehicle harness connector pin 4.
- Measure resistance between PCM test pin 49 at breakout box and TR2 circuit pin at vehicle harness connector pin 5.
- Measure resistance between PCM test pin 50 at breakout box and TR4 circuit pin at vehicle harness connector pin 6.
- Measure resistance between PCM test pin 64 at breakout box and TR3A circuit pin at vehicle harness connector pin 3.

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Are all resistances less than 5 ohms?

Yes	No
GO to **D6** .	REPAIR open circuit(s). RECONNECT all components. CLEAR DTCs. RERUN OBD tests.

D6 CHECK PCM HARNESS CIRCUITS FOR SHORT TO GROUND OR POWER

- Measure resistance between PCM test pin 91 and test pins 71/97 at breakout box.
- Measure resistance between PCM test pin 3 and test pins 77, 97, 51, 76, 77, 103, and 91 at breakout box.
- Measure resistance between PCM test pin 49 and test pins 77, 97, 51, 76, 77, 103, and 91 at breakout box.
- Measure resistance between PCM test pin 50 and test pins 77, 97, 51, 76, 77, 103, and 91 at breakout box.
- Measure resistance between PCM test pin 64 and test pins 77, 97, 51, 76, 77, 103, and 91 at breakout box.

Are all resistances greater than 10,000 ohms?

Yes	No
GO to **D7** .	REPAIR short circuit(s). RECONNECT all components. CLEAR DTCs. RERUN OBD tests.

D7 CHECK FOR SHORT BETWEEN TR/PCM INPUT SIGNAL CIRCUITS

- Measure resistance between test pin 3 and pins 49, 50 and 64 at the breakout box.
- Measure the resistance between test pin 49 and pins 3, 50 and 64 at the breakout box.
- Measure the resistance between test pin 50 and pins 3, 49 and 64 at the breakout box.
- Measure the resistance between test pin 64 and pins 3, 49 and 50 at the breakout box.

Are all resistances greater than 10,000 ohms?

Yes	No
REPLACE PCM. RECONNECT all components. CLEAR DTCs and RERUN OBD tests.	REPAIR shorts on circuits having less than 10,000 ohms between other TR/PCM input signal circuits. RECONNECT all components. CLEAR DTCs and RERUN OBD tests.

D8 CHECK THE NON PCM INTERNAL CIRCUITS OF SENSOR

- Connect TR-E Cable (007-00111) to Transmission Tester (007-00130).
- Connect TR-E Cable (007-00111) to DTR sensor.
- Place the DIGITAL TR Overlay (007-00131) onto transmission tester (007-00130).
- Perform SWITCH TEST as instructed on the DTR overlay.

Does the status lamp on the tester indicate RED for the correct gear position?

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Yes	No
Concern is not in the DTR sensor. For START SYSTEM concerns, GO to Section 03-06 . For Backup Lamp concerns, GO to Section 17-01 . For Optional Circuits: 4x4 Low Neutral Sense; REFER to Powertrain Control/Emissions Diagnosis Manual and Workshop Manual Section 07-07A for diagnosis.	REPLACE DTR sensor and ADJUST as outlined. REFER to Assembly for procedures. CLEAR DTCs and RERUN OBD tests.

PINPOINT TEST E: ELECTRICAL PRESSURE CONTROL (EPC) SOLENOID

NOTE: Read and record all DTCs. All DTR sensor and VSS DTCs must be repaired before entering Output State Control (OCS).

E1 ELECTRONIC DIAGNOSTICS

- Turn the ignition switch to the OFF position.
- Place the transmission range selector lever in PARK.
- Check to make sure transmission harness connector is fully seated, terminals are fully engaged in connector and in good condition before proceeding.
- Connect NGS (007-00500) tester.
- Turn the ignition switch to the ON position.
- Select Diagnostic Data Link.
- Select PCM.
- Select Active Command Modes.
- Select Output State Control (OSC).
- Select Trans — Bench Mode.

Does vehicle enter Trans — Bench Mode.?

Yes	No
REMAIN in Trans — Bench Mode, GO to **E2** .	REPEAT procedure to enter Trans — Bench Mode. If vehicle did not enter Trans — Bench Mode, REFER to Powertrain Control/Emissions Diagnosis Manual for diagnosis of PCM or NGS.

E2 SOLENOID FUNCTIONAL CHECK

- Install 300 psi pressure gauge into EPC tap.
- Monitor pressure gauge.
- Select parameter — EPC.
- Select value 15, 30, 45, 60, 70, or 90 PSI.
- Press "SEND".
- Select another value "0-90 psi".

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- Press "SEND".
- Select "XXX".
- Press "SEND".

Does the pressure reading match the commanded pressure?

Yes	No
CLEAR DTCs.	GO to **E3** .

E3 CHECK FOR BATTERY VOLTAGE

- Remove transmission fluid pan.
- Visually inspect all wires and connectors for damage.
- Turn the ignition switch to the ON position.
- Connect DVOM positive lead to VPWR solenoid terminal and negative lead to a good ground.

Is the battery voltage present?

Yes	No
GO to **E4** .	CHECK for open or short circuit in harness.

E4 ELECTRICAL SIGNAL CHECK

- Leave positive lead connected to VPWR solenoid terminal and connect negative lead to the signal terminal of the EPC solenoid.
- Turn the solenoids ON and OFF while monitoring the voltage reading on the DVOM, solenoid state on the NGS (ON and OFF), listen for the solenoid to activate (click).
- Select Trans — Bench Mode.
- Select parameter — EPC.
- Select a value "0-90 psi".
- Press "SEND".
- Select another value "0-90 psi".
- Press "SEND".
- Select "XXX".
- Press "SEND".

Does the voltage and solenoid state change?

Yes	No
GO to **E5** .	CHECK for open or short circuit in harness or PCM.

E5 CHECK SOLENOID RESISTANCE AT SOLENOID

- Disconnect vehicle harness from transmission.

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- Check solenoid resistance by connecting an ohmmeter at the terminals of the solenoid.
- Measure and record the resistance of the EPC solenoid.
- Resistance should be between 3.10-5.7 ohms.

Is the resistance within specification?

Yes	No
GO to **E6** .	REPLACE the solenoid.

E6 CHECK SOLENOID FOR SHORT TO GROUND

- Check for continuity between engine ground and the EPC solenoid terminals with ohmmeter or other low current tester (less than 200 milliamps).

Solenoid	Terminal
EPC	+/-

- Connection should show infinite resistance (no continuity).

Is there continuity?

Yes	No
REPLACE the solenoid.	REFER to Diagnosis by Symptom Charts for diagnosis of pressure concerns.

PINPOINT TEST F: TURBINE SHAFT SPEED (TSS), AND OUTPUT SHAFT SPEED (OSS) SENSORS

F1 ELECTRONIC DIAGNOSTICS

- Check to make sure transmission harness connector is fully seated, terminals are fully engaged in connector and in good condition before proceeding.
- Connect NGS (007-00500) tester.
- Turn the ignition switch to the ON position.
- Select Diagnostic Data Link.
- Select PCM.
- Select PID/Data Monitor and Record.
- Select the following PIDs:
  - TSS.
  - ODS.
  - OSS.

Does vehicle enter PID/Data Monitor and Record?

Yes	No

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REMAIN in PID/Data, GO to **F2** .	REPEAT procedure to enter PID. If vehicle did not enter PID, REFER to Powertrain Control/Emissions Diagnosis Manual for diagnosis of PCM or NGS.

F2 DRIVE CYCLE TEST

- While monitoring the appropriate sensor PID, drive the vehicle so that the transmission upshifts and downshifts through all gears.

Does the TSS or OSS Speed PID increase and decrease with engine and vehicle speed or is the sensor signal erratic (drop to zero or near zero and return to normal operation)?

Yes	No
If the TSS or OSS Speed PID increase and decrease with engine and vehicle speed, CLEAR all DTCs. Road test to verify if concern is still present. If concern is still present, REFER to Diagnosis by Symptom charts for diagnosis. If the sensor signal is erratic, INSPECT for intermittent concern in the internal/external harness, sensor, or connector.	If the TSS or OSS Speed PID does not increase and decrease with engine and vehicle speed, INSPECT for open or short in vehicle harness, sensor, a PCM concern, or internal hardware concern. If the sensor signal is steady, GO to **F3** .

F3 CHECK RESISTANCE OF TSS OR OSS SENSOR

- Disconnect the appropriate vehicle harness connector from the OSS sensor. For the TSS sensor disconnect the vehicle harness connector from the transmission.
- For OSS: connect ohmmeter negative lead to one pin of the sensor and the positive lead to the other pin on the sensor.
- For TSS: connect ohmmeter negative lead to the signal return pin and the positive lead to the TSS signal at the transmission connector.
- Record resistance.
- Resistance should be as follows:

Sensor	Resistance (Ohms)
TSS	64-126
OSS	305-735

Is the resistance within specification for the appropriate sensor?

Yes	No
REFER to Diagnosis by Symptom charts for concern diagnosis.	For OSS, REPLACE sensor. For TSS, GO to Workshop Manual for repair and hardware diagnosis.

PINPOINT TEST H: SOLENOID MECHANICAL FAILURE

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NOTE: Repair all other DTCs before repairing the following DTCs: P1714, P1715, P1716, P1717, P1740.

H1 ELECTRONIC DIAGNOSTICS

- Connect the New Generation STAR (NGS) 007-00500 Tester.
- Place the transmission range selector lever in PARK.
- Turn the ignition switch to the ON position.
- Perform KOEO test until continuous DTCs have been displayed.
- If any of the following DTCs are present continue with test: P1714, P1715, P1716, P1717, P1740.

Are other DTCs present for TFT or shift solenoids?

Yes	No
REPAIR the DTCs for TFT or shift solenoids first. CLEAR DTCs and PERFORM Transmission Drive Cycle Test . RERUN Quick Test.	REPLACE the appropriate solenoid and/or body. REFER to the DTC Chart for code description. GO to **H2** .

H2 TRANSMISSION DRIVE CYCLE TEST

- Perform Transmission Drive Cycle Test as listed in this section.

Does the vehicle upshift and/or downshift OK?

Yes	No
GO to **H3** .	REFER to Diagnosis by Symptom to diagnose shift concerns.

H3 RETRIEVE DTCs

- Connect the New Generation STAR (NGS) 007-00500 Tester.
- Place transmission range selector lever in PARK.
- Turn the ignition switch to the ON position.
- Perform KOEO test until continuous DTCs have been displayed.

Are DTCs P1714, P1715, P1716, P1717, P1740 still present?

Yes	No
REPLACE PCM. Road test and RERUN Quick test.	Testing completed. If a concern still exists, REFER to the Diagnosis by Symptom chart for concern diagnosis.

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Special Testing Procedures

Engine Idle Speed Check

Refer to Section 4A in the Powertrain Control/Emissions Diagnosis Manual for diagnosis and testing of the engine idle speed.

Line Pressure Test

CAUTION: The Transmission Tester must be removed and the vehicle harness installed when verifying these pressures.

CAUTION: Perform Line Pressure Test prior to performing Stall Speed Test. If line pressure is low at stall, do not perform Stall Speed Test or further transmission damage will occur. Do not maintain wide open throttle in any gear range for more than five (5) seconds.

NOTE: Certain sensor failures may cause high EPC, FMEM (Failure Mode Effect Management) actions. Be sure that self test and electrical repairs have been performed, or test results may be incorrect.

This test verifies that the line pressure is within specifications.

1. Connect 0-2758 kPa (0-400 psi) pressure gauge to the line pressure tap.

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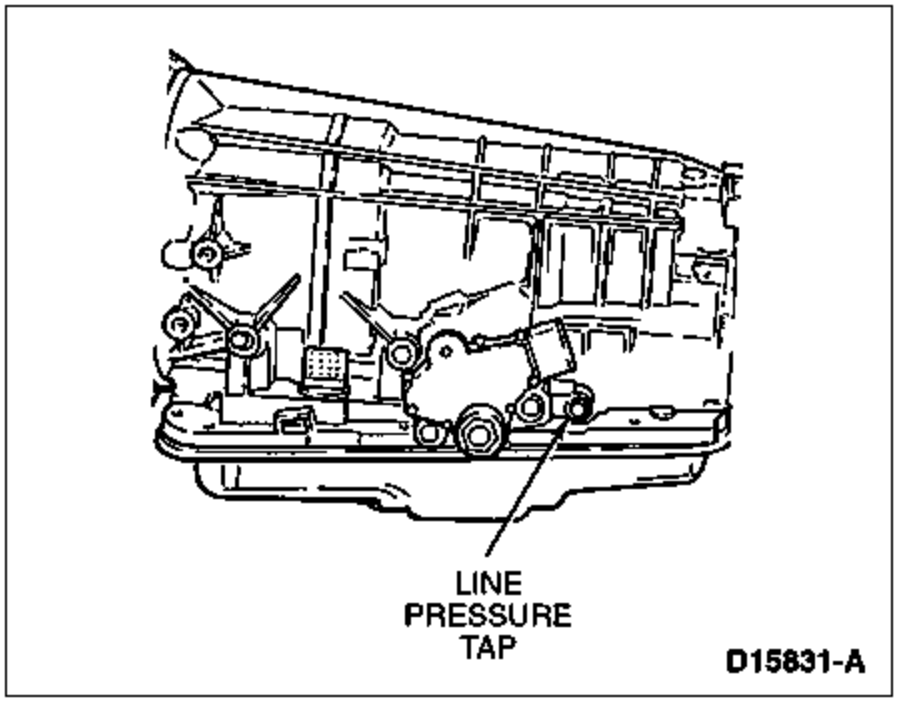

2. Start engine and check line pressures. Refer to the following Line Pressure Specifications No. 401 chart to determine if line pressure is within specifications.

CAUTION: Do not install Transmission Tester when verifying these pressures.

NOTE: Vehicle harness must be installed at transmission connector to verify these pressures.

REFERENCE: LINE PRESSURE SPECIFICATIONS No. 401

Trans.	Transmission Model/Application	Range	Idle		WOT Stall	
			EPC	Line	EPC	Line
	4.0L Aerostar	R	57-67	100-130	112-134	282-350
	4x2, AWD	N	26-36	82-112		
5R55E		(D), 2, 1	25-35	80-110	112-134	228-263
	4.0L Ranger	R	52-62	138-168	112-134	282-350
5R55E	4x2, 4x4	N	32-42	95-125		
		(D), 2, 1	25-35	80-110	112-134	228-263

3. If line pressure is not within specifications, perform On-Board Diagnostics, Pinpoint Test E . Perform Air Pressure Test and repair main control or pump assembly as required.

4. If line pressure is not within specifications after mechanical checks and there are no DTCs, electronic pressure control (EPC) solenoid may be mechanically malfunctioning. Refer to the Line Pressure Diagnosis Chart for symptom diagnosis.

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LINE PRESSURE DIAGNOSIS CHART

Test Results	Possible Source
High at Idle — All Ranges	• Wiring Harnesses • EPC Boost Valve • EPC Solenoid • Main Regulator Valve
Low at Idle — All Ranges	• Low Fluid Level • Fluid Inlet Filter/Seal • Main Control Body • Cross Leaks • Gaskets • Pump • Separator Plate
Low — All Forward Ranges	• Forward Clutch • Main Control • O/D Servo
Low in Park Only	• Valve Body
Low in Reverse Only	• Separator Plate • Rear Servo Piston, Cover Seal • Reverse Clutch • O/D Servo • Valve Body • Forward Clutch
Low in Neutral Only	• Valve Body • O/D Servo
Low in Overdrive Only	• Forward Clutch • O/D Servo • Valve Body
Low in Drive Only (O/D Cancelled)	• Forward Clutch • O/D Servo • Valve Body
Low in 1st Position Only	• Forward Clutch • Valve Body
Low in 2nd Position Only	• Intermediate Servo • O/D Servo • Forward Clutch

Stall Speed Test

This test checks operation of the following items:

- Torque converter clutch
- Forward clutch
- Low one way clutch (OWC) assembly
- Engine performance

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WARNING: APPLY THE PARKING BRAKE FIRMLY WHILE PERFORMING EACH STALL TEST.

CAUTION: Always perform Line Pressure Test procedures prior to performing the Stall Speed Test. If line pressure is low at stall, do not perform Stall Speed Test or further transmission damage will occur.

NOTE: The Stall Speed Test should be performed with the engine and transmission at normal operating temperatures.

1. Connect tachometer to the engine.

2. **CAUTION: After testing each of the following ranges (D), 2, 1, and R, move the transmission range selector lever to N (NEUTRAL) and run engine at 1000 rpm for about 15 seconds to allow the torque converter to cool before testing the next range.**

   CAUTION: Do not maintain wide open throttle in any range for more than five (5) seconds.

   CAUTION: If the engine rpm recorded by the tachometer exceeds maximum specified rpm, release the accelerator pedal immediately. Clutch or band slippage is indicated.

   NOTE: Prolonged use of this procedure may set Diagnostic Trouble Code P0712, P1783. After performing Stall Speed Test run OBD Test and clear DTCs from memory.

   Press accelerator pedal to floor (WOT) in each range. Record rpm reached in each range. Stall speeds should be as follows:

Vehicle	Engine	Rpm
Ranger	4.0	2405-2800
Aerostar	4.0	2454-2833

If stall speeds were too high, refer to the following Stall Speed Diagnosis Chart. If stall speeds were too low, first check the engine idle speed. If engine idle is OK, remove torque converter and check the torque converter clutch for slippage.

STALL SPEED DIAGNOSIS CHART

Transmission Range Selector Lever Position	Stall Speeds High	Stall Speeds Low
(D)Overdrive, D, and 1	Overdrive One-Way Clutch, Rear One-Way Clutch	—
D, 2 and 1	Forward Clutch, O/D One-Way Clutch	—
(D)Overdrive	Forward Clutch, O/D One-Way Clutch	—

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(D)Overdrive, D, 2, 1 and R	General Pressure Concerns, Forward Clutch, O/D One-Way Clutch	Converter One-Way Clutch or Engine Performance
R Only	High/Reverse and High Clutch and Low and Reverse Band/Servo	—
2 Only	Intermediate Band/Servo	—
1 Only	Low/Reverse Band/Servo	—

Air Pressure Tests

A no drive condition can exist, even with correct transmission fluid pressure, because of inoperative clutches or bands. An erratic shift can be located through a series of checks by substituting air pressure for fluid pressure to determine the location of the malfunction.

When the transmission range selector lever is in a forward gear range ((D) , 2, 1), a no drive condition may be caused by an inoperative forward clutch, or an overrunning one-way clutch.

Failure to drive in R (REVERSE) could be caused by a malfunctioning reverse clutch, reverse servo, or band.

Follow the procedure to determine the location of the inoperative clutch or band by introducing air pressure into the various test plate passages.

Test Procedures

NOTE: Cover vent in test plate with a clean, lint-free shop towel to prevent spray when air is applied. Plugging vent hole during testing will result in inaccurate results.

NOTE: Use only dry regulated air pressure 276kPa (40 psi) max. A dull thud should be heard when the clutch or band applies. There should be no hissing sound when band or clutch applies.

1. Drain transmission fluid and remove transmission oil pan.
2. Remove filter and seal assembly and main control valve body.
3. Install 4R44E/5R55E Transmission Test Plate T95L-77000-AH and Transmission Test Plate Gasket T95L-77000-AH1.
4. **CAUTION: Do not apply air to test the vent.**

   Apply air pressure to appropriate clutch port (refer to diagram). A dull thud may be heard or movement felt when clutch is applied or released. If clutch seals or check balls are leaking a hissing sound may be heard.

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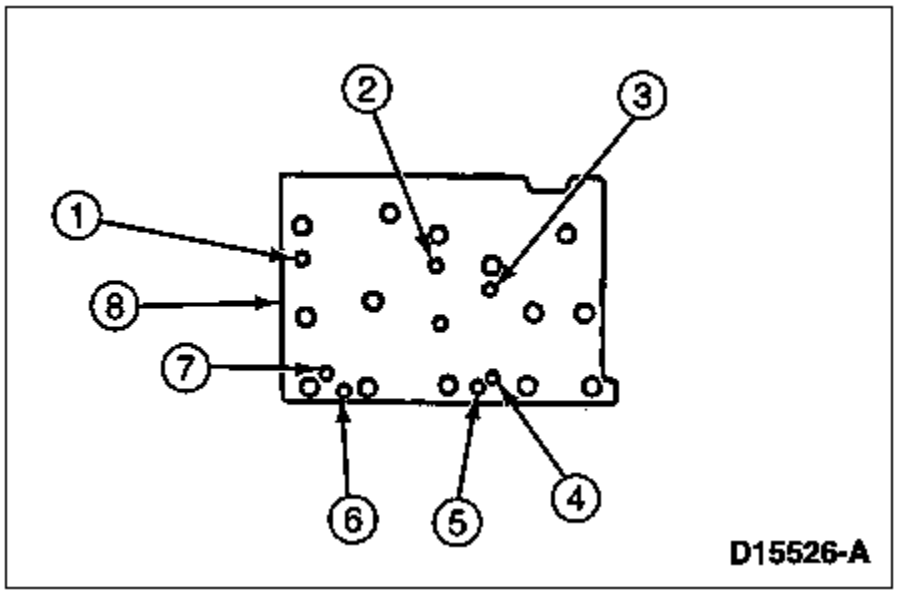

Item	Part Number	Description
1	—	Coast Clutch Apply
2	—	Direct Clutch Apply
3	—	Forward Clutch Apply
4	—	Intermediate Servo Release
5	—	Intermediate Servo Apply
6	—	Front Servo Release
7	—	Front Servo Apply
8	T95L-77000-AH	4R44E/5R55E Transmission Test Plate
—	T95L-77000-AH1	Transmission Test Plate Gasket

Test Results

If test results find that the servos do not operate, disassemble, clean and inspect them to locate the source of the concern.

If air pressure applied to the clutch passages fails to operate a clutch, or operates another clutch simultaneously, disassemble and use air pressure to check the fluid passages in the center support and clutches to detect obstructions.

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Leakage Inspection

CAUTION: Do not try to stop the fluid leak by increasing the torque beyond specifications. This may cause damage to the case threads.

Check the vehicle speed sensor (VSS) and the speedometer cable connection at the transmission. Replace rubber seal if necessary.

Leakage at the transmission fluid pan to case gasket often can be stopped by tightening the attaching bolts to 13-15 Nm (115-133 lb-in). If necessary, replace the oil pan case gasket.

Check the fluid filler tube connection at the transmission case. If leakage is found here, install a new grommet.

Check fluid lines and fittings between the transmission and the cooler in the radiator tank for looseness, wear, or damage. If leakage cannot be stopped by tightening a fluid tube nut, replace the damaged parts. When fluid is found leaking between the case and cooler line fitting, check for missing or damaged O-ring, then tighten the fitting to maximum specification.

If the leak continues, replace cooler line fitting and tighten to specification. The same procedure should be followed for fluid leaks between the radiator cooler and the cooler line fittings in this section. Refer to Transmission Cooler Line Replacement for procedures.

Check the engine coolant in the radiator. If transmission fluid is present in the coolant, the cooler in the radiator is probably leaking.

The cooler can be further checked for leaks by disconnecting the lines for the cooler fittings and applying no more than 345 kPa (50 psi) air pressure to the fittings. Remove the radiator cap to relieve the pressure buildup at the exterior of the oil cooler tank. If the cooler is leaking and/or will not hold pressure, replace the cooler.

If leakage is found at the transmission range selector lever, replace the seal.

If leakage is found at the transmission internal harness connector, replace O-ring.

External Sealing

The 5R55E transmission has the following parts to prevent external fluid leakage:

- Gaskets
- Lip-type seals
- O-ring seals
- Seal rings
- Seal grommets
- Thread sealant

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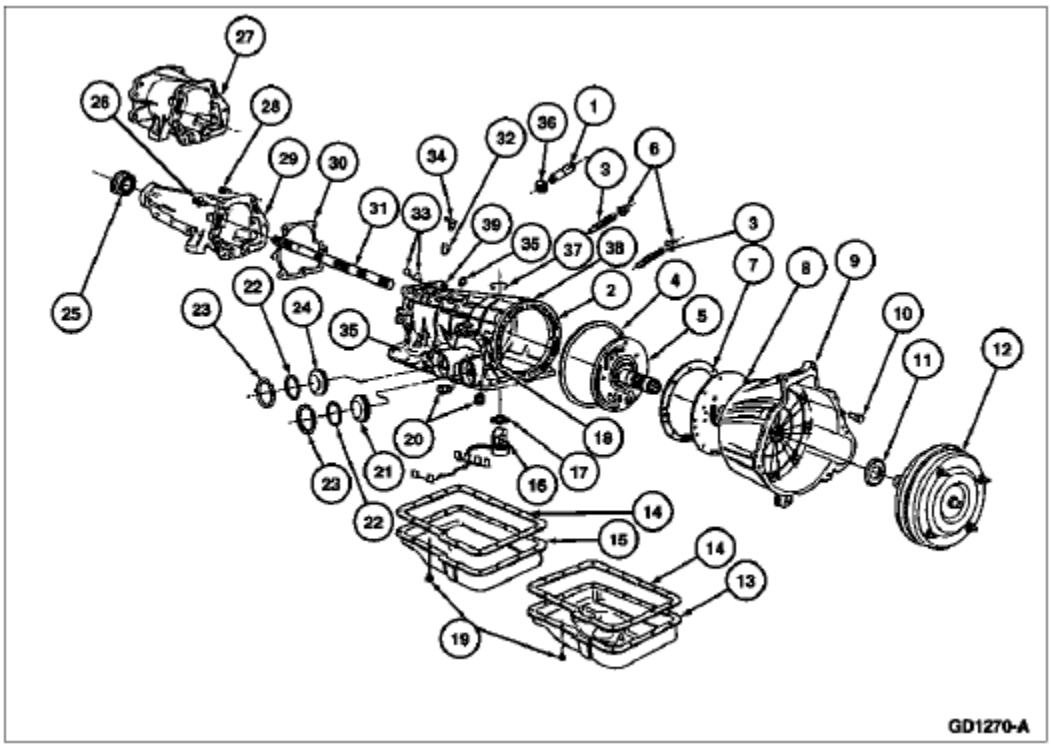
External Sealing



Item	Part Number	Description
1	7A308	Shaft (Manual Valve Outer to Inner Levers)
2	7005	Case Assembly
3	7C492	Screw (Intermediate and O/D Band) Adjuster/Lock (2 Req'd)
4	7A248	Seal Ring (Fluid Pump)
5	7A103	Support and Gear Assembly (Fluid Pump)
6	E825100-S100	Nut and Seal — Hex (Intermediate and O/D Bands) Adjuster/Lock (2 Req'd)
7	7A136	Gasket (Fluid Pump)
8	7B472	Plate (Fluid Pump Adaptor)
9	7976	Housing Assembly (Converter)
10	E804595-S200	Screw and Seal Assembly, M10x33 (Attach Converter Housing to Case) (8 Req'd)
11	7A248	Seal Assembly (Converter Hub to Converter Housing) (Also in Converter Housing Assembly)
12	7902	Converter Assembly (Contains Piston Type Clutch)
13	7A194	Pan (4x4 Fluid)

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14	7A191	Gasket Assembly (Fluid Pan)
15	7A194	Pan (4x2 Fluid)
16	14A624	Connector Assembly (16-Pin) (with Harness to 6 Solenoids)
17	W703015-S300	O-Ring (16 Pin Connector to Case)
18	7A160	Tube (Lube Fluid Inlet) Short (Also in Case Assembly)
19	W701203-S309M	Screw, M8x14 (Att. Fluid Pan to Case) (18 Req'd)
20	7D273	Connector Assembly — Fluid Tube (2 Req'd) (Also in Case)
21	7L493	Cover and Seal Assembly (O/D Servo)
22	E853170-S	O-Ring (Servo Cover to Case) (Intermediate and O/D Servos) (2 Req'd)
23	E860343-S	Ring, Retaining, 67x1.5mm (Intermediate and O/D Servos in Case) (2 Req'd)
24	7L493	Cover and Seal Assembly (Intermediate Servo)
25	7052	Seal Assembly (Extension Housing to Slip Yoke) (Also in Extension Housing Assembly)
26	E804137-S72	Stud (Att. Extension Housing to Case)
27	7A039	Housing Assembly (4x4 Extension)
28	E800152-S72	Screw, M10x30 (Att. Extension to Case) (5 Req'd)
29	7A039	Housing Assembly (4x2 Extension)
30	7086	Gasket (Extension Housing)
31	7060	Shaft Assembly (4x2 Output)
32	7034	Vent Assembly (4x2) (Also Contained in Case Assembly)
33	E840171-S2	Pin (Reverse Band — Anchor) (2 Req'd) (Part of Case Assembly)
34	7034	Vent Assembly (4x4 Case) (Also Contained in Case Assembly)
35	E450102-S80	Plug — Pipe (Line and EPC Pressure) (Part of Case Assembly)
36	7B498	Seal Assembly (Main Control Lever) (Also in Case Assembly)
37	84280020	Spring (Retains 16-Pin Connector in Case)
38	W702981-S300	O-Ring (Overdrive Drum Speed Sensor to Case)
39	W702981-S300	O-Ring (Output Shaft Speed Sensor to Case)

Fluid Leakage in Torque Converter Area

In diagnosing and correcting fluid leaks in the torque converter (7902) area, use the following procedures to

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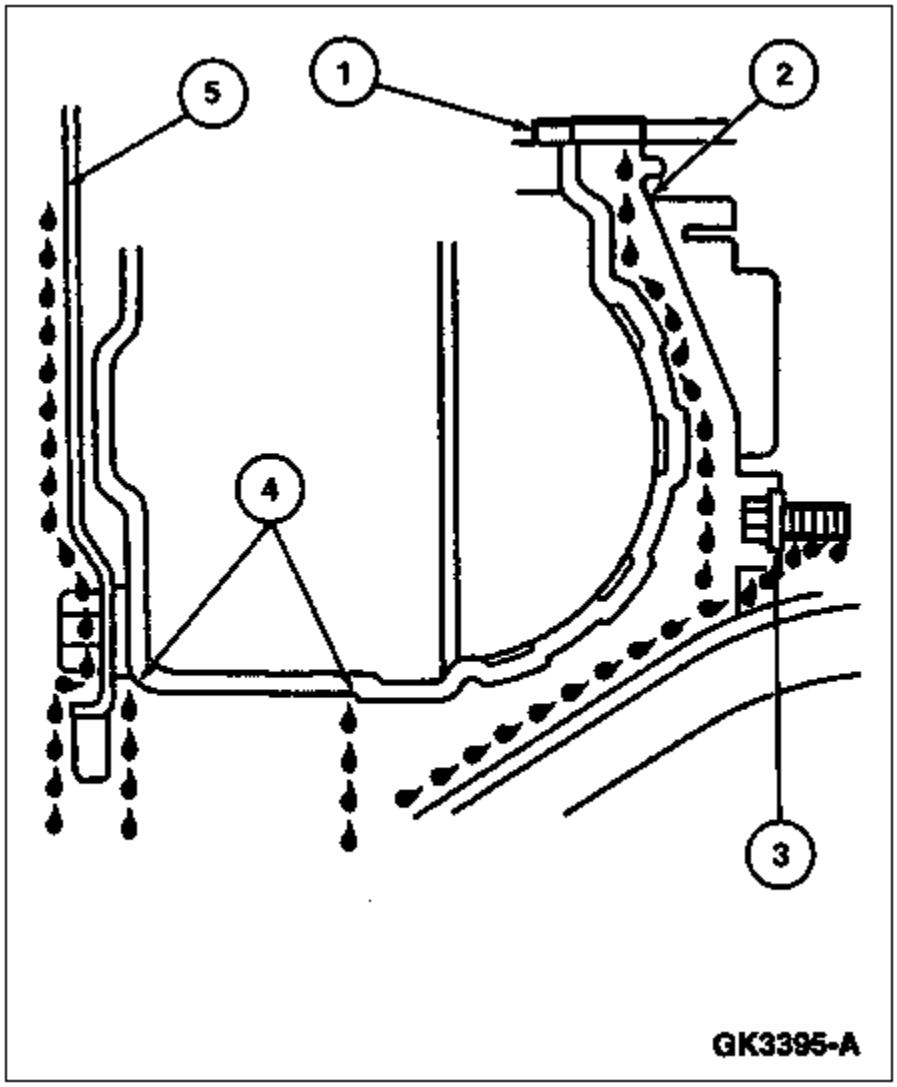
locate the exact cause of the leakage. Leakage at the front of the transmission, as evidenced by fluid around the converter housing, may have several sources. By careful observation it is possible to pinpoint the source of the leak before removing the transmission from the vehicle. The paths which the fluid can take to reach the bottom of the converter housing are as follows:

Torque Converter Area Leak Points



1. Fluid leaking by the front pump seal lip will tend to move along the impeller hub and onto the back of the impeller housing. Except in case of a total seal failure, fluid leakage by the lip of the seal will be deposited on the inside of the torque converter housing only, near the outside diameter of the housing.

2. Fluid leakage by the outside diameter of the front pump seal and front pump body will follow the same path that leaks by the inside diameter of the front pump seal follow.

3. Fluid that leaks by a front pump to case bolt or pump gasket will be deposited on the inside of the torque converter housing only. Fluid will not be deposited on the back of the torque converter.

4. Fluid leakage from the converter seal weld or converter to flywheel stud weld will appear at the outside diameter of the torque converter on the back face of the flywheel (6375), and in the converter

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housing only near the flywheel. Fluid leaks from the torque converter will leave a ring of fluid around the inside of the torque converter housing.

5. **NOTE: White facial tissue paper may aid in determining the color (red is transmission fluid) and source of the leakage fluid.**

   Engine oil leaks are sometimes improperly diagnosed as transmission pump gasket leaks. The following areas of possible leakage should also be checked to determine if engine oil leakage is causing the concern.

   a. Leakage at the valve cover gasket (6584) may allow oil to flow over the torque converter housing or seep down between the torque converter housing and cylinder blocks (6010) causing oil to be present in or at the bottom of the torque converter housing.
   b. Oil galley plug leaks will allow oil to flow down the rear face of the cylinder blocks to the bottom of the torque converter housing.
   c. Leakage at the crankshaft rear oil seal (6701) will work back to the flywheel, and then into the torque converter housing.
   d. Leakage at oil pressure sensor (9278).

Leak Check Test

The following procedures should be used to determine the cause of the leakage before service is made.

1. Remove the fluid level indicator (7A020) and note the color of the fluid. Original factory fill fluid is dyed red to aid in determining if leakage is from the engine or transmission. Unless a considerable amount of makeup fluid has been added or the fluid has been changed, the red color should assist in pinpointing the leak.

2. Remove the converter housing access cover. Clean off any fluid from the top and bottom of the converter housing, front of the transmission case, and rear face of the engine and pan. Clean the converter area by washing with suitable nonflammable solvent, and blow dry with compressed air.

3. Wash out converter housing and the front of the flywheel. The converter housing may be washed out using clean solvent and a squirt-type fluid can. Blow dry all washed areas with compressed air.

4. Start and run the engine until the transmission reaches its normal operating temperature. Observe the back of the block and top of the converter housing for evidence of fluid leakage. Raise the vehicle on a hoist and position suitable safety stands under vehicle. Run the engine at fast idle, then at engine idle, occasionally shifting to the drive and reverse ranges to increase pressure within the transmission. Observe the front of the flywheel, back of the block (in as far as possible), and inside the converter housing and front of the transmission case. Run the engine until fluid leakage is evident and the probable source of leakage can be determined.

Leak Check Test With Black Light

Fluid soluble aniline or fluorescent dyes premixed at the rate of 2.5ml (1/2 teaspoon) of dye powder to 0.24L (1/2 pint) of automatic transmission fluid have proven helpful in locating the source of fluid leakage. Such dyes may be used to determine whether an engine fluid or transmission fluid leak is present, or if the fluid in the transmission fluid cooler hose leaks into the engine coolant system. An ultraviolet light must be used to detect the fluorescent dye solution.

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Transmission Fluid Cooler

The following procedures will assist in diagnosing the transmission cooling system. Refer to Section 07-02 for specific transmission cooling system diagnosis and testing procedures.

Transmission Fluid Cooler Flow Test

NOTE: The transmission linkage/cable adjustment, fluid level, and line pressure must be within specification before performing this test. Refer to repair procedures in this section.

1. Remove fluid level indicator (7A020) from fluid filler tube.
2. Place funnel in fluid filler tube.
3. Raise vehicle on hoist and position suitable safety stands under vehicle.
4. Remove cooler return line (rear fitting) from fitting on transmission case. Refer to removal and installation of the transmission fluid cooler line in Section 07-02 .
5. Connect one end of a hose to the cooler return line and route the other end of the hose to a point where it can be inserted into the funnel at the fluid filler tube.
6. Remove safety stands and lower vehicle. Insert end of hose into funnel.
7. Start engine and run at idle with transmission in neutral range.
8. When fluid flowing from hose is all liquid, an adequate amount of fluid should be observed (approximately 1.0 liter [1.05 quart] delivered in 30 seconds). If adequate flow is observed, test is completed.
9. If the flow is not adequate, stop engine. Disconnect hose from cooler return line and connect it to converter out line fitting (front fitting) on transmission case.
10. Repeat Steps 7 and 8. If flow is now adequate, refer to Section 07-02 for diagnosis of transmission fluid cooler (7A095). If flow is not adequate, repair pump and/or converter assembly, and main control.

Transmission Fluid Cooler — Backflush/Cleaning

CAUTION: Whenever a transmission has been disassembled to replace worn or damaged parts or because the valve body sticks from foreign material, the transmission fluid cooler must be cleaned using the Torque Converter/Fluid Cooler Cleaner 014-00028 or equivalent. Under no circumstances should torque converters be cleaned by hand agitation with solvent.

When internal wear or damage has occurred in the transmission, metal particles, clutch plate material, or band material may have been carried into the transmission cooler. These contaminants

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are a major cause of reoccurring transmission concerns and must be removed from the system before the transmission is put back into service.

1. Conduct backflushing with a Torque Converter/Transmission Fluid Cooler Cleaner 014-00028 or equivalent. Test the equipment to make sure that a vigorous fluid flow is present before proceeding. Replace the system filter if flow is weak or contaminated.

2. To aid in attaching the cleaner to the transmission steel cooler lines, connect two additional rubber hoses to the transmission end of the steel transmission cooler lines as described.

    - Connect the cleaner tank pressure line to the steel transmission cooler return line (longest line).
    - Connect a tank return hose to the steel transmission cooler pressure line (shorter line). Place the outlet end of this hose in the solvent tank reservoir.

3. Turn on solvent pump and allow the solvent to circulate a minimum of 5 minutes (cycling switch on and off will help dislodge contaminants in cooler system).

4. Switch off the solvent pump and disconnect the solvent pressure hose from the transmission cooler return line.

5. Use compressed air to blow out the cooler(s) and lines (blow air into the transmission cooler return line) until all solvent is removed.

6. Remove the rubber return hose from the remaining steel cooler line.

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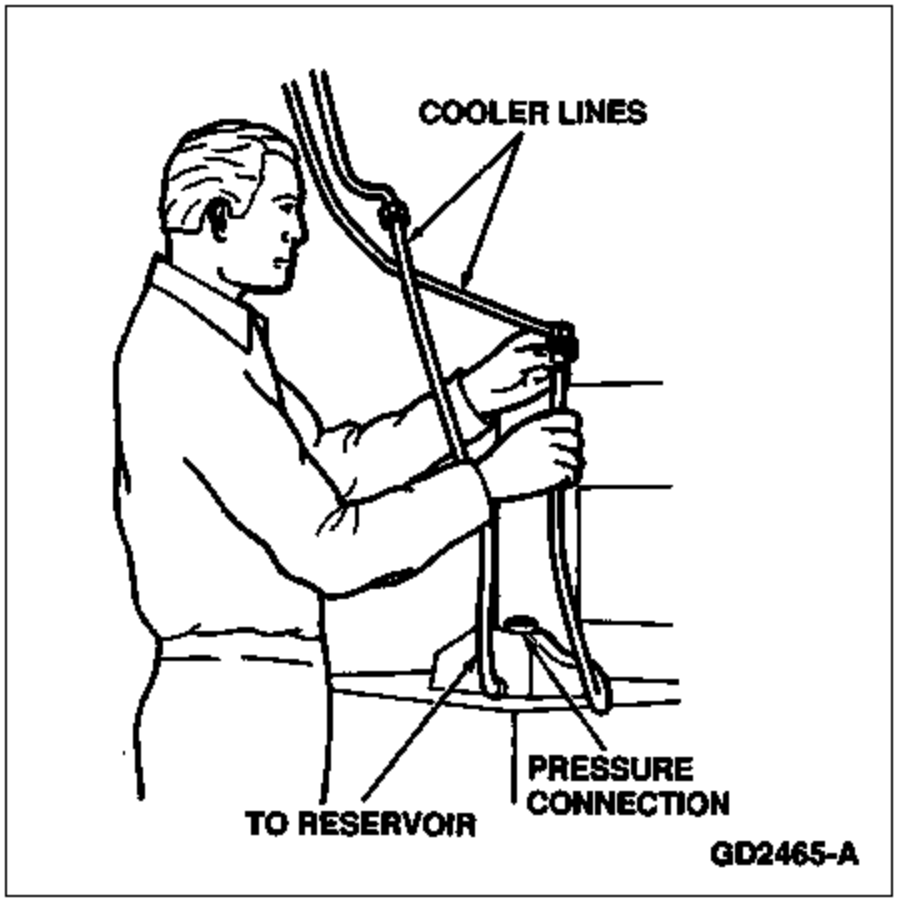

Transmission Fluid Cooler Tube Replacement

When fluid leakage is found at the transmission fluid cooler, the transmission fluid cooler must be replaced. Refer to Section 03-03 .

When transmission fluid cooler steel lines must be replaced, each replacement line must be fabricated from the same size inside diameter and length steel line as the original line.

Using the old line as a guide, bend the new line as required. Add the necessary fittings, and install the line.

After the fittings have been tightened, check and add fluid as necessary. Check for fluid leaks.

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Diagnosis by Symptom

The Diagnosis by Symptom Index gives the technician diagnostic information, direction and suggests possible components, using a symptom as a starting point.

The Diagnosis by Symptom Index is divided into two categories: Electrical Routines, indicated by 200 series numbers, and Hydraulic/Mechanical Routines, indicated by 300 series numbers. The Electrical Routines list the possible electrical components that could cause or contribute to the symptom described. The Hydraulic/Mechanical Routines list the possible hydraulic or mechanical components that could cause or contribute to the symptom described.

Diagnosis by Symptom Chart — Directions

1. Using the Diagnosis by Symptom Index, select the Symptom/Concern that best describes the condition.

2. Turn to the Routine indicated in the Diagnosis by Symptom Index.

3. Always begin diagnosis of a symptom by using the following:

    a. Preliminary inspections
    b. Verification of condition
    c. Check the fluid level
    d. Perform other test procedures as directed

4. Then begin with the Electrical Routine, if indicated. Follow the reference or action required statements. Always perform the On-Board Diagnostic Tests as required. Never skip steps. Service as required. If the concern is still present after electrical diagnosis then proceed to the Hydraulic/Mechanical Routine listed.

CAUTION: Not all concerns and conditions with electrical components will set a Diagnostic Trouble Code (DTC). Be aware that the components listed may still be the cause. Verify proper function of those components prior to proceeding to the Hydraulic/Mechanical Routine listed.

5. The Hydraulic/Mechanical Routines list possible hydraulic or mechanical components that could cause the concern. These components are listed in the removal sequence and by most likely concern. All components listed must be inspected to ensure proper repair.

Diagnosis by Symptom Index

DIAGNOSIS BY SYMPTOM INDEX

5R55E	Routines	
	Electrical [1]	Mechanical/ Hydraulic

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Engagement Concerns:		
• No Forward Only	201	301
• No Reverse Only	202	302
• Harsh Reverse Only	203	303
• Harsh Forward Only	204	304
• Delayed/Soft Reverse Only	205	305
• Delayed/Soft Forward Only	206	306
• No Forward and No Reverse	207A	307A
• No Forward in (D) Position and No Reverse	207B	307B
• Harsh Forward and Harsh Reverse	208	308
• Delayed Forward and Delayed Reverse	209	309
Shift Concerns:		
• Some/All Shifts Missing	210	310
• Timing Concern		
Early/Late (Some/All)	211	311
Erratic/Hunting (Some/All)	212	312
• Feel Concerns		
Soft/Slipping (Some/All)	213	313
Harsh (Some/All)	214	314
• No First Gear in Drive, Engages in a Higher Gear	215	315
• No First Gear in Manual 1st Position	216	316
• No Manual Third Gear in 2nd Position	217	317
Torque Converter Clutch Operation Concerns:		
• Does Not Apply	240	340
• Always Applied/Stalls Vehicle	241	341
• Cycling/Shudder/Chatter	242	342
Other Concerns:		
• Shift Lever Efforts High	251	351
• External Leaks	252	352
• Poor Vehicle Performance	253A	353A
• Poor Performance — Wrong Gear Ratio in (D) , 2 or 1 Positions.	253B 254	353B 354
• Noise/Vibration — Forward or Reverse	255	355
• Engine Will Not Crank	256	356
• No Park Range	257	357
• Overheating	258	358
• No Engine Braking in Manual 2	259	359
• No Engine Braking in Manual 1	260	360
• No Engine Braking with (D) Canceled (3rd and 4th Gears)	261	361
• Fluid Venting or Foaming	263	363
• Slips/Chatters in 1st Position	264	364
• Slips/Chatters in Manual 2nd Position	265	365
• FMEM — Harsh Engagements and Shifts		
Reference:		
• Pressure Charts	—	401
• Check Ball Locations	—	501
• Band/Clutch Application Chart	—	601

[1] Perform electrical routine first.

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Diagnostic Routines

Engagement Concerns: No Forward Only

Possible Component	Reference/Action
201 — ELECTRICAL ROUTINE	
No Electrical Concerns	
301 — HYDRAULIC/MECHANICAL ROUTINE	
Fluid	
• Improper level	• Adjust to proper level.
Shift Linkage (Internal/External)	
• Transmission shift cable and bracket damaged or misadjusted. DTR sensor out of adjustment	• Inspect for damage. Readjust as required. Repair all damaged components. After repairing linkage, readjust DTR sensor.
Improper Pressures	
• Improper band/clutch application pressure, line pressure low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is low, check the following possible components: main control, filter/seal, pump assembly.
Filter and Seal Assembly	
• Filter damaged, plugged; seal damaged, cut or missing	• Inspect for damage and replace.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gaskets damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• Forward modulator valve/EPC boost valve (207), forward engagement control valve (209), spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.
Pump Assembly	
• Pump damaged, leaking	• Inspect for damage. Repair or replace as required.
• Screws out of torque specification	• Tighten screws to specification.
Center Support Assembly	
• Forward clutch support seal rings leaking	• Perform air pressure check. If OK, go to forward clutch assembly. Repair as required.
Forward Clutch Assembly	
• Forward clutch assembly burnt/damaged/leaking. Check ball in cylinder/leaking piston seal rings	• Perform air pressure check. Repair as required.
Rear One-Way Clutch Assembly	
• Rear one-way clutch damaged, worn	• Replace rear one-way clutch and case.

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Engagement Concerns: No Reverse Only

Possible Component	Reference/Action
202 — ELECTRICAL ROUTINE	
No Electrical Concerns	
302 — HYDRAULIC/MECHANICAL ROUTINE	
Fluid	
• Improper level	• Adjust to proper level.
Shift Linkages (Internal/External)	
• Transmission shift cable and bracket damaged or misadjusted. DTR sensor out of adjustment	• Inspect for damage. Readjust as required. Repair all damaged components. After repairing linkages, readjust DTR sensor.
Improper Pressures	
• Improper band/clutch application pressures, line pressure low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is low, check the following possible components: reverse clutch.
Filter and Seal Assembly	
• Filter damaged, plugged; seal damaged, cut or missing	• Inspect for damage and replace.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• 2-3 shift valve (203), 3-4 shift valve (204), reverse modulator valve (205), spring damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.
Pump Assembly	
• Screws out of torque specification • Pump damaged, leaking	• Tighten screws to specifications. • Inspect for damage. Repair as required.
Direct/Reverse Clutch/Reverse Band	
• Reverse clutch assembly burnt/worn/leaking check ball in clutch piston/leaking piston seal rings, cover gasket damaged	• Perform air pressure test. • Inspect for damage. Repair as required.
• Direct/reverse servo piston seal cut/leaking	• Check and replace piston seal. Check and replace low/reverse band.

Engagement Concerns: Harsh Reverse Only

Possible Component	Reference/Action

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203 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harness, PCM, TP, VSS, RPM, EPC, SS1 (off)	• Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use NGS to perform the following Pinpoint Tests: A, E. Repair as required. Clear codes, road test and rerun on-board diagnostics.
303 — HYDRAULIC/MECHANICAL ROUTINE	
Improper Pressures • Improper band/clutch application pressures, line pressure high	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is high, check the following possible components: main control.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• EPC, SS1, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Repair as required.
• Reverse modulator valves (205), pressure boost valve/main regulator valve (208), check ball B, springs, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong components used in rebuild	• Verify that proper components were used.
Direct/Reverse Clutch Assembly • Assembly • Seals damaged, missing • Center support hub/seal ring damaged • Check ball damaged • Friction elements damaged or missing	• Air check clutch assembly as outlined in this manual. • Inspect direct clutch assembly for damage. Repair as required.

[1] Can be purchased as a separate item.

Engagement Concerns: Harsh Forward Only

Possible Component	Reference/Action
204 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harness, PCM, TP, RPM, VSS, EPC	• Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use NGS to perform the following Pinpoint Test: E. Repair as required. Clear codes, road test and rerun on-board diagnostics.
304 — HYDRAULIC/MECHANICAL ROUTINE	
Improper Pressures	

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• Improper band/clutch application pressures, line pressure high	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is high check the following possible components: main control.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Repair as required.
• Reverse modulator valves (205), forward modulator valve/EPC boost valve (207), forward engagement control valve (209), spring, damaged, missing, misassembled, stuck bore damage	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.
Forward Clutch Assembly	
• Assembly	• Air check clutch assembly as outlined in this manual.
• Plates burnt, missing; check ball missing, damaged; hub damaged	• Inspect for damage. Repair as required.

[1] Can be purchased as a separate item.

Engagement Concerns: Delay/Soft Reverse

Possible Component	Reference/Action
205 — ELECTRICAL ROUTINE	
Powertrain Control System	
• Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harness, PCM, TP, RPM, VSS, EPC	• Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use NGS to perform the following Pinpoint Test: E. Repair as required. Clear codes, road test and rerun on-board diagnostics.
305 — HYDRAULIC/MECHANICAL ROUTINE	
Engine Driveline	
• Looseness in the driveshaft, U-joints or engine mounts	• Repair as required.
• Contamination blockage in cooler lines, in-tank radiator or auxiliary transmission oil cooler	• Perform transmission fluid cooler flow check.
Fluid	
• Improper level	• Adjust to proper level.
• Fluid contaminated	• Inspect fluid for contamination. If contaminated, locate source of contamination. If burnt, inspect mechanical band, clutches. Repair as required.
Shift Linkages (Internal/External)	
• Transmission shift cable and bracket	• Inspect for damage. Readjust as required. Repair all

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damaged or misadjusted. DTR sensor out of adjustment	damaged components. After repairing linkages, readjust DTR sensor.
Improper Pressures	
• Improper band/clutch application pressures, line pressure low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is low, check the following possible components: main control.
Filter and Seal Assembly	
• Filter damaged, plugged; seal damaged, cut or missing	• Inspect for damage and replace.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Repair as required.
• Reverse modulator valves (205), forward modulator valve/EPC boost valve (207), forward engagement control valve (209), spring damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.
Front One-Way Clutch Assembly	
• One-way clutch damaged	• Determine cause of condition. Repair as required.
Center Support Assembly	
• Direct/reverse clutch center support seal rings/ring grooves worn/damaged	• Determine cause of condition. Repair as required.
Reverse Clutch Drum	
• Rear reverse clutch drum bushing, one-way clutch damaged	• Air pressure test. Determine cause of condition. Visually inspect seal rings and pistons. Repair as required.
Reverse Clutch Assembly	
• Assembly	• Perform air pressure check.
• Reverse clutch piston seals cut/worn	• Inspect for damage. Repair as required.
• Reverse servo piston damaged/worn	• Inspect for damage. Repair as required.
Reverse Band Assembly	
• Reverse band out of adjustment or damaged	• Inspect and readjust per procedures.
• Reverse band servo piston and rod damaged	• Inspect for damage. Repair as required.
• Servo band cover gasket damaged	• Inspect gasket and replace.

[1] Can be purchased as a separate item.

Engagement Concerns: Delayed/Soft Forward

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Possible Component	Reference/Action
206 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harness, PCM, TP, RPM, VSS, EPC	• Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use NGS to perform the following Pinpoint Test: E. Repair as required. Clear codes, road test and rerun on-board diagnostics.
306 — HYDRAULIC/MECHANICAL ROUTINE	
Fluid • Improper level	• Adjust to proper level.
Shift Linkages (Internal/External) • Transmission shift cable and bracket damaged or misadjusted. DTR sensor out of adjustment	• Inspect for damage. Readjust as required. Repair all damaged components. After repairing linkages, readjust DTR sensor.
Improper Pressures • Improper band/clutch application pressures, line pressure low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is low, check the following possible components: main control.
Filter and Seal Assembly • Filter damaged, plugged; seal damaged, cut or missing	• Inspect for damage and replace.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Repair as required.
• Forward modulator valve/EPC boost valve (207), forward engagement control valve (209), valve, spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Extension housing lube orifice plugged, missing	• Inspect for damage. Repair as required.
• Wrong component used in rebuild	• Verify that proper components were used.
Front One-Way Clutch Assembly • Overdrive one-way clutch damaged	• Replace as required.
Forward Clutch Assembly	
• Forward clutch piston check ball not seating/leaking	• Replace forward clutch piston. Repair transmission as required.
• Forward hub seal rings damaged	• Inspect for damage. Repair as required.
• Forward clutch piston seals cut/worn	• Replace seal and repair as required.

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Rear One-Way Clutch • Rear one-way clutch damaged/worn	• Determine cause of condition. Repair as required.

[1] Can be purchased as a separate item.

Engagement Concerns: No Forward And No Reverse

Possible Component	Reference/Action
207A — ELECTRICAL ROUTINE	
No Electrical Concerns	
307A — HYDRAULIC/MECHANICAL ROUTINE	
Fluid • Improper level	• Adjust to proper level.
Improper Pressures • Improper band/clutch application pressures, line pressure low, EPC pressure low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is high/low, check the following possible components: main control.
Filter and Seal Assembly • Filter damaged, plugged; seal damaged, cut or missing	• Inspect for damage and replace.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Repair as required.
• EPC blow-off valve, spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.
Pump Assembly	
• Screws out of torque specification	• Tighten screws to specification.
• Pump gears damaged, cracked	• Inspect for damage. If damaged, replace pump.
Front One-Way Clutch Assembly • Overdrive one-way clutch damaged	• Inspect for damage. Repair as required.

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Engagement Concerns: No Forward In (D) Position And No Reverse

Possible Component	Reference/Action
207B — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harness, PCM, TP, RPM, VSS, EPC	• Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use NGS to perform the following Pinpoint Test: E. Repair as required. Clear codes, road test and rerun on-board diagnostics.
307B — HYDRAULIC/MECHANICAL ROUTINE	
Fluid • Improper level	• Adjust to proper level.
Improper Pressures • Improper band/clutch application pressures, line pressure low, EPC pressure low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is high/low, check the following possible components: main control, pump assembly.
Filter and Seal Assembly • Filter damaged, plugged; seal damaged, cut or missing	• Inspect for damage and replace.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Repair as required.
• Forward modulator valve/EPC boost valve (207), pressure boost valve (208), EPC blow off valve, spring, damaged, missing, misassembled, stuck bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.
Pump Assembly	
• Screws out of torque specification	• Tighten screws to specification.
• Gears damaged, cracked	• Inspect for damage. If damaged, replace pump.
Front One-Way Clutch Assembly • Front one-way clutch damaged	• Determine cause of condition. Repair as required.
Mechanical • Mechanical damage	• Check splines on turbine input shaft and overdrive carrier, overdrive one-way clutch, center shaft, forward clutch, forward carrier and output shaft.

[1] Can be purchased as a separate item.

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Engagement Concerns: Harsh Forward And Reverse

Possible Component	Reference/Action
208 — ELECTRICAL ROUTINE	
Powertrain Control System	
• Electrical inputs/outputs, vehicle wiring harness, internal transmission wiring harness, PCM, EPC, TSS, TFT, VSS, DTR, TCC, TP and MAF NOTE: Refer to FMEM — Routine 265 for additional information.	• Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use NGS to perform the following Pinpoint Tests: A, B, D, E, F. Repair as required, clear codes, road test and rerun on-board diagnostics.
308 — HYDRAULIC/MECHANICAL ROUTINE	
Engine/Driveline	
• Loose in the driveshaft, U-joints or engine mounts	• Repair as required.
• Engine idle speed too high	• Check engine idle speed. Refer to the Powertrain Control/Emissions Diagnosis Manual [a] .
Fluid	
• Improper level	• Adjust to proper level.
Improper Pressures	
• Improper band/clutch application pressures, line pressure high	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is high, check the following possible components: main control.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• TCC, EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Repair as required.
• Forward modulator valve/EPC boost valve (207), pressure boost valve/main regulator or valve (208), spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.

[1] Can be purchased as a separate item.

Engagement Concerns: Delayed/Soft Forward And Reverse

Possible Component	Reference/Action
209 — ELECTRICAL ROUTINE	
No Electrical Concerns	

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309 — HYDRAULIC/MECHANICAL ROUTINE	
Fluid	
• Improper level • Fluid contaminated	• Adjust to proper level. • Inspect fluid for contamination. If contaminated, locate source of contamination. If burnt, inspect mechanical band, clutches. Repair as required.
Improper Pressures • Improper band/clutch application pressures, line pressure low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is low, check the following possible components: main control, pump assembly.
Filter and Seal Assembly • Filter damaged, plugged; seal damaged, cut or missing	• Inspect for damage and replace.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• Forward modulator valve/EPC boost valve (207), pressure boost valve/main regulator valve (208), EPC blow-off valve, spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.
Pump Assembly	
• Screws out of torque specification	• Tighten screws to specification.
• Inner gears damaged, cracked	• Inspect for damage. Repair as required.

Shift Concerns: Some Or All Shifts Missing

Possible Component	Reference/Action
210 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harness, PCM, TP, RPM, DTR, OSS, SS1, SS2, SS3, SS4, TCS, TSS, EPC	• Perform shift point test. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use NGS to perform the following Pinpoint Tests: A, D, E, F. Repair as required. Clear codes, road test and rerun on-board diagnostics.
310 — HYDRAULIC/MECHANICAL ROUTINE	
Fluid	
• Improper level • Fluid contaminated	• Adjust to proper level. • Inspect fluid for contamination. If contaminated, locate source of contamination. If burnt, inspect

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	mechanical band, clutches. Repair as required.
Shift Linkages (Internal/External) • Transmission shift cable and bracket damaged or misadjusted. DTR sensor out of adjustment	• Inspect for damage. Readjust as required. Repair all damaged components. After repairing linkages, readjust DTR sensor.
Improper Pressures • Improper band/clutch application pressures, line pressure low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is low, check the following possible components: main control, pump, EPC solenoid.
Filter and Seal Assembly • Filter damaged, plugged; seal damaged, cut or missing	• Inspect for damage and replace.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• SS1, SS2, SS3, SS4, EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Repair as required.
• Forward modulator valve/EPC boost valve (207), pressure boost valve/main regulator valve (208), extension housing lube orifice, check ball C damaged, spring, damaged, missing, misassembled, stuck, bore damaged • Wrong components used in rebuild	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage. • Verify that proper components were used.
Front Band	
• Not adjusted properly • Piston seals damaged	• Readjust to proper specification. • Inspect for damage. Repair as required.
Intermediate Band	
• Not adjusted properly • Servo, piston and seals damaged	• Readjust to proper specification. • Inspect for damage. Repair as required.
For diagnosis related to a specific shift, refer to Reference/Action.	• To diagnose specific No Shift, refer to the appropriate shift routine. **No Shift** 1-2, **Routine** 220/320 **No Shift** 2-3, **Routine** 221/321 **No Shift** 3-4, **Routine** 222/322 **No Shift** 4-5, **Routine** 270/370 **No Shift** 5-4, **Routine** 271/371

[1] Can be purchased as a separate item.

Shift Concerns: Timing — Early/Late (Some/All)

Possible Component	Reference/Action
211 — ELECTRICAL ROUTINE	

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Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harness, PCM, TP, TFT, EPC, OSS, SS1, SS2, SS3, SS4, RPM	• Perform shift point test. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use NGS to perform the following Pinpoint Tests: A, B, E. Repair as required, clear codes, road test and rerun on-board diagnostics.
Other Electrical Concerns • No power to PCM, Keep Alive Memory erased from PCM	• Inspect EEC power relay. Repair as required. • Restore memory by performing drive cycle test.
311 — HYDRAULIC/MECHANICAL ROUTINE	
Power/Engine Performance • Poor vehicle performance	• Refer to Routine No. 253A, 253B, 353A, 353B.
Other • Tire size change • Axle ratio change • Speedometer gear change	• Refer to the specifications decal on door panel and verify that vehicle has original equipment. Changes in tire size or axle ratio will affect shift timing.
Improper Pressures • Improper band/clutch application pressures, line pressure low (late shifts)	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is low, check the following possible components: main control.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• SS1, SS2, SS3, SS4, EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Repair as required.
• Wrong component used in rebuild	• Verify that proper components were used.
For diagnosis related to a specific shift or if all above are OK, refer to Reference/Action.	• To diagnose specific shift-timing concern, refer to the appropriate shift routine. **Soft/Slipping Shift** 1-2, **Routine** 226/326 **Soft/Slipping Shift** 2-3, **Routine** 227/327 **Soft/Slipping Shift** 3-4, **Routine** 228/328 **Soft/Slipping Shift** 4-5, **Routine** 272/372 **Soft/Slipping Shift** 5-4, **Routine** 273/373 **Soft/Slipping Shift** 4-3, **Routine** 229/329

[1] Can be purchased as a separate item.

Shift Concerns: Timing — Erratic/Hunting (Some/All)

Possible Component	Reference/Action
212 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harness, internal transmission wiring harness, PCM, TP, RPM, EPC,	• Perform shift point and TCC tests. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use NGS to perform the

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TFT, SS1, SS2, SS3, SS4, DTR, TCC, OSS	following Pinpoint Tests: A, B, D, E, F. Repair as required. Clear codes, road test and rerun on-board diagnostics.
312 — HYDRAULIC/MECHANICAL ROUTINE	
Fluid	
• Improper level • Fluid contaminated	• Adjust to proper level. • Inspect fluid for contamination. If contaminated, locate source of contamination. If burnt, inspect mechanical band, clutches. Repair as required.
Filter and Seal Assembly • Filter damaged, plugged; seal damaged, cut or missing	• Inspect for damage and replace.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• SS1, SS2, SS3, SS4, EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Repair as required.
• Wrong component used in rebuild	• Verify that proper components were used.
Torque Converter Clutch Assembly	• Refer to converter cycling routine No. 342.
Further Diagnosis	
• For further diagnosis for timing issues, refer to Reference/Action.	• For specific shift diagnosis, refer to the following application chart.

[1] Can be purchased as a separate item.

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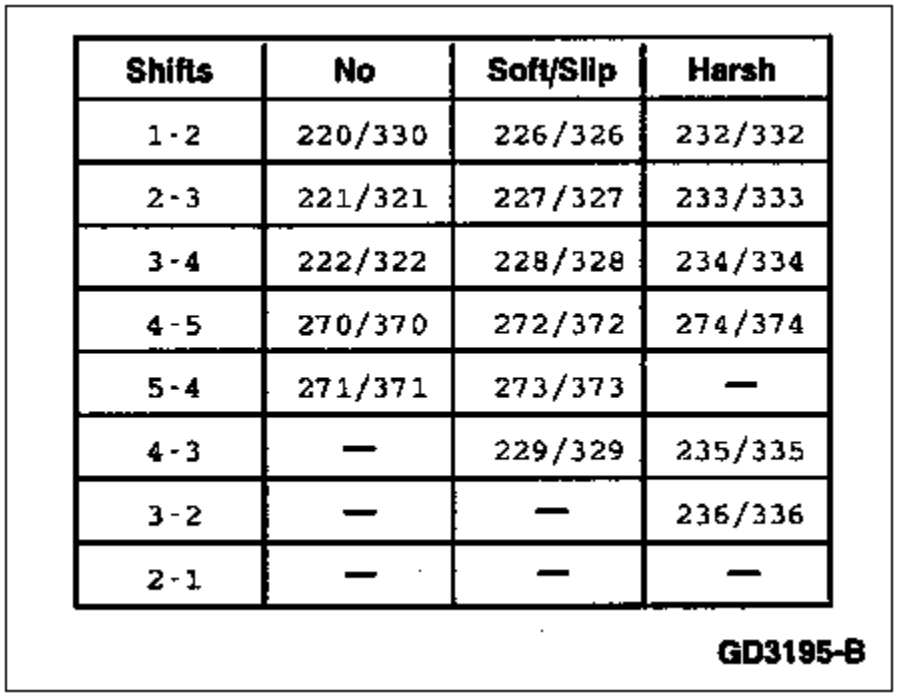

Shifts	No	Soft/Slip	Harsh
1-2	220/330	226/326	232/332
2-3	221/321	227/327	233/333
3-4	222/322	228/328	234/334
4-5	270/370	272/372	274/374
5-4	271/371	273/373	—
4-3	—	229/329	235/335
3-2	—	—	236/336
2-1	—	—	—

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Shift Concerns: Feel — Soft/Slipping (Some/All)

Possible Component	Reference/Action
213 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harness, PCM, TP, RPM, EPC, TFT, MAF • Engine — restricted air inlet	• Perform shift point test. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use NGS to perform the following Pinpoint Tests: B, E. Repair as required. Clear codes, road test and rerun on-board diagnostics.
313 — HYDRAULIC/MECHANICAL ROUTINE	
Fluid	
• Improper level • Fluid contaminated	• Adjust to proper level. • Inspect fluid for contamination. If contaminated, locate source of contamination. If burnt, inspect mechanical band, clutches. Repair as required.
Improper Pressures • Improper band/clutch application pressures, line pressure low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is low check the following possible components: main control, filter/seal, pump assembly.
Filter and Seal Assembly • Filter damaged, plugged; seal damaged, cut or missing	• Inspect for damage and replace.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.

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• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Repair as required.
• Pressure boost valve/main regulator valve (208), EPC blow-off valve, extension housing lube orifice, check ball C missing, valve spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.
Pump Assembly	
• Screws out of torque specification	• Tighten screws to specification.
Front Band	
• Not adjusted properly	• Readjust to proper specification.
• Servo, piston, and seals damaged	• Inspect for damage. Repair as required.
Intermediate Band	
• Not adjusted properly	• Readjust to proper specification.
• Servo, piston, and seals damaged	• Inspect for damage. Repair as required.
For diagnosis related to a specific shift see Reference/Action.	• To diagnose a specific shift concern, refer to the appropriate shift routine. **Soft/Slipping Shift** 1-2, **Routine** 226/326 **Soft/Slipping Shift** 2-3, **Routine** 227/327 **Soft/Slipping Shift** 3-4, **Routine** 228/328 **Soft/Slipping Shift** 4-5, **Routine** 272/372 **Soft/Slipping Shift** 5-4, **Routine** 273/373 **Soft/Slipping Shift** 4-3, **Routine** 229/329

[1] Can be purchased as a separate item.

Shift Concerns: Feel — Harsh (Some/All)

Possible Component	Reference/Action
214 — ELECTRICAL ROUTINE	
Powertrain Control System	
• Electrical inputs/outputs, vehicle wiring harness, internal transmission wiring harness, PCM, EPC, TFT, RPM, DTR, OSS, TP*, MAF* * Also see Routine 265	• Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use NGS to perform the following Pinpoint Tests: B, D, E. Repair as required. Clear codes, road test and rerun on-board diagnostics.
314 — HYDRAULIC/MECHANICAL ROUTINE	
Fluid	
• Improper level	• Adjust to proper level.
Improper Pressures	
• Improper band/clutch application pressures, line pressure high	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is high check the following

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	possible components: main control.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Repair as required.
• Forward modulator valve/EPC boost valve (207), pressure boost valve/main regulator valve (208), spring, damaged, missing, misassembled, stuck, bore damaged • Wrong component used in rebuild	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage. • Verify that proper components were used.
Front Band • Misadjusted (tight)	• Readjust to specification.
Intermediate Band • Misadjusted (tight)	• Readjust to specification.
For diagnosis related to a specific shift, refer to Reference/Action.	• For diagnosis of a specific harsh shift, refer to the appropriate shift routine. **Harsh Shift** 1-2, **Routine** 232/332 **Harsh Shift** 2-3, **Routine** 233/333 **Harsh Shift** 3-4, **Routine** 234/334 **Harsh Shift** 4-5, **Routine** 274/374 **Harsh Shift** 4-3, **Routine** 235/335 **Harsh Shift** 3-2, **Routine** 236/336

[1] Can be purchased as a separate item.

Shift Concerns: No 1st Gear In Drive, Engages In High-Gear

Possible Component	Reference/Action
215 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, SS1, SS2, SS3, SS4, DTR, EPC	• Perform shift point and TCC tests. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use NGS to perform the following Pinpoint Tests: A, D, E. Repair as required. Clear codes, road test and rerun on-board diagnostics.
315 — HYDRAULIC/MECHANICAL ROUTINE	
Shift Linkages (Internal/External) • Transmission shift cable and bracket damaged or misadjusted. DTR sensor out of adjustment	• Inspect for damage. Readjust as required. Repair all damaged components. After repairing linkage, readjust DTR sensor.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.

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• SS1, SS2, SS3, SS4, EPC, solenoid stuck, damaged, O-ring damaged or out of bore • Wrong components used in rebuild	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Repair as required. • Verify that proper components were used.
Mechanical • Clutches damaged	• Refer to disassembly and assembly of transmission in this section.
For diagnosis related to a specific gear, use transmission tester to determine gear	• Refer to the following routines: **Shift** 1-2, **Routine** 220/320 **Shift** 2-3, **Routine** 221/321 **Shift** 3-4, **Routine** 222/322 **Shift** 4-5, **Routine** 270/370

[1] Can be purchased as a separate item.

Shift Concerns: No First Gear In Man 1st Position

Possible Component	Reference/Action
216 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, SS1, SS2	• Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use NGS to perform the following Pinpoint Test: A. Repair as required. Clear codes, road test and rerun on-board diagnostics.
316 — HYDRAULIC/MECHANICAL ROUTINE	
Improper Pressures • Improper band/clutch application (no engine braking), pressures, line pressure low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is low check the following possible components: main control.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• SS1, SS2, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Repair as required.
• Check ball A damaged	• Inspect for damage. Repair as required.
Low/Reverse One-Way Clutch Assembly • Rear one-way clutch damaged	• Repair as required.

[1] Can be purchased as a separate item.

Shift Concerns: No Manual 3rd Gear In 2nd Position

Possible Component	Reference/Action

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217 — ELECTRICAL ROUTINE	
No Electrical Concerns	
317 — HYDRAULIC/MECHANICAL ROUTINE	
Improper Pressures • Improper band/clutch application pressures, line pressure high/low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is high/low check the following possible components: main control.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• Check ball A damaged • Wrong component used in rebuild	• Inspect for damage. Repair as required. • Verify that proper components were used.
Intermediate Band	
• Intermediate band out of adjustment	• Adjust intermediate band.
• Damaged or worn intermediate servo piston, lever, strut or internal leaks • Polished, glazed intermediate band or drum	• Perform air pressure test. • Replace or repair as required.

Shift Concerns: No 1-2 Shift (Automatic)

Possible Component	Reference/Action
220 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, TP, OSS, SS1, SS2, EPC, SS3, SS4, DTR	• Perform shift point test. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use NGS to perform the following Pinpoint Tests: A, E, D, Repair as required, clear codes, road test and rerun on-board diagnostics.
320 — HYDRAULIC/MECHANICAL ROUTINE	
Shift Linkage (Internal/External) • Transmission shift cable and bracket damaged or misadjusted. DTR sensor out of adjustment	• Inspect for damage. Readjust as required. Repair all damaged components. After repairing linkages, readjust DTR sensor.
Improper Pressures • Improper band/clutch application pressures, line pressure low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is low check the following possible components: main control.

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Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• SS1, SS2, SS3, SS4, EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Repair as required.
• 1-2 shift valve (215), forward modulator valve/EPC boost valve (207), spring, damaged, missing, misassembled, stuck, bore damaged • Wrong component used in rebuild	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage. • Verify that proper components were used.
Front Band Assembly	
• Band adjustment incorrect	• Inspect and readjust as required.
• Seals, piston, cover damaged	• Inspect for damage. Repair as required.
• Friction elements worn, missing, damaged, misassembled	• Inspect for damage. Repair as required.
• Return spring damaged	• Inspect for damage. Repair as required.
• Case bore damaged, leaking	• Inspect for damage. Repair as required.

[1] Can be purchased as a separate item.

Shift Concerns: No 2-3 Shift (Automatic)

Possible Component	Reference/Action
221 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, TP, OSS, SS1, SS2, EPC, SS3, SS4, DTR	• Perform shift point test. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use NGS to perform the following Pinpoint Tests: A, D, E. Repair as required, clear codes, road test and rerun on-board diagnostics.
321 — HYDRAULIC/MECHANICAL ROUTINE	
Improper Pressures • Improper band/clutch application pressures, line pressure low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is low, check the following possible components: main control.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damages, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• SS1, SS2, SS3, SS4, EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Repair as required.

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• 1-2 shift valve (203), forward modulator valve/EPC boost valve (207), spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file, or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.
Intermediate Band Assembly	
• Band adjustment incorrect	• Inspect and readjust as required.
• Seals, piston, cover damaged	• Inspect for damage. Repair as required.
• Friction elements worn, missing, damaged, misassembled	• Inspect for damage. Repair as required.
• Return spring damaged	• Inspect for damage. Repair as required.
• Case bore damaged, leaking	• Inspect for damage. Repair as required.

Shift Concerns: No 3-4 Shift (Automatic)

Possible Component	Reference/Action
222 — ELECTRICAL ROUTINE	
Powertrain Control System	
• Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, TP, OSS, SS1, SS2, SS3, SS4	• Perform shift point test. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use NGS to perform the following Pinpoint Test: A. Repair as required, clear codes, road test and rerun on-board diagnostics.
322 — HYDRAULIC/MECHANICAL ROUTINE	
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• SS1, SS2, SS3, SS4 solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Repair as required.
• 1-2 shift valve (203), 3-4 shift valve (204), spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage, If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong components used in rebuild	• Verify that proper components were used.
Center Support Assembly	
• Screws not tightened to specification	• Inspect, install new and retighten to specification.
• Seal rings and bearings damaged	• Inspect for damage. Repair as required.

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• Outside diameter of casebore or center support damaged or leaking	• Inspect for damage. Repair as required.
Direct Clutch Assembly	
• Assembly	• Air check assembly as outlined in this manual.
• Seals, piston, cylinder damaged	• Inspect for damage. Repair as required.
• Friction elements missing or damaged	• Inspect for damage. Repair as required.
• Check ball missing, damaged	• Inspect for damage. Repair as required.

[1] Can be purchased as a separate item.

Shift Concerns: No 4-5 Shift (Automatic)

Possible Component	Reference/Action
270 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, TP, OSS, SS3, SS4, EPC, TCS	• Perform shift point test. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use NGS to perform the following Pinpoint Tests: A, E, F. Repair as required, clear codes, road test and rerun on-board diagnostics.
370 — HYDRAULIC/MECHANICAL ROUTINE	
Improper Pressures • Improper band/clutch application pressures, line pressure high/low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is high/low, check the following possible components: main control.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• SS3, SS4, EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Repair as required.
• Forward modulator valve/EPC boost valve (207), pressure boost valve/main regulator valve (208), SS3 solenoid/4-5 shift valve (215), spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong components used in rebuild	• Verify that proper components were used.
Front Band Assembly	
• Band adjustment incorrect	• Inspect and readjust as required.
• Band friction plates burnt, missing	• Inspect for damage. Repair as required.
• Cylinder damaged, leaking seals damaged	• Inspect for damage. Repair as required.
• Piston cover seal, strut, lever	• Inspect for damage. Repair as required.

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damaged	
Front Planetary Assembly • Damaged	• Inspect for damage. Repair as required.

[1] Can be purchased as a separate item.

Shift Concerns: No 5-4 Shift (Manual)

Possible Component	Reference/Action
271 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, TP, OSS, TCS	• Perform shift point test. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use Transmission Tester to perform transmission static and dynamic tests. Perform the following Pinpoint Test: A. Repair as required, clear codes, road test and rerun on-board diagnostics.
371 — HYDRAULIC/MECHANICAL ROUTINE	
No hydraulic/mechanical components	

[1] Can be purchased as a separate item.

Shift Concerns: Soft/Slipping 1-2 Only (Automatic)

Possible Component	Reference/Action
226 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, TP, MAF, EPC	• Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use NGS to perform the following Pinpoint Test: E. Repair as required, clear codes, road test and rerun on-board diagnostics.
326 — HYDRAULIC/MECHANICAL ROUTINE	
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Repair as required.
• EPC solenoid/1-2 shift valve (215), 2-3 shift valve (203), forward modulator valve/EPC boost valve (207), pressure boost valve/main regulator valve (208), EPC blow-off valve, extension housing lube orifice, spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.

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Front Band Assembly	
• Band adjustment incorrect	• Inspect and adjust as required.
• Seals or piston, strut, lever, damaged	• Inspect for damage. Repair as required.
• Friction elements worn, damaged, misassembled	• Inspect for damage. Repair as required.
• Return spring wrong, damaged	• Inspect for damage. Repair as required.
• Case bore damaged, leaking	• Inspect for damage. Repair as required.

[1] Can be purchased as a separate item.

Shift Concerns: Soft/Slipping 2-3 Only (Automatic)

Possible Component	Reference/Action
227 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, TP, MAF, EPC, SS4	• Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [24] . Use NGS to perform the following Pinpoint Test: A, E. Repair as required, clear codes, road test and rerun on-board diagnostics.
327 — HYDRAULIC/MECHANICAL ROUTINE	
Improper Pressures • Improper band/clutch application pressures, line pressure low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is low check the following possible components: main control.
Main Control Assembly	
• Screw out of torque specification	• Tighten and replace gasket
• Gasket damaged, off location	• Inspect and replace gasket
• Separator plate damaged	• Inspect for damage. Repair as required.
• SS1, SS2, SS3, SS4, EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Repair as required
• 1-2 shift valve (203), forward modulator valve/EPC boost valve (207), spring, damaged, missing, misassembled, stuck bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.
Intermediate Band Assembly	
• Band adjustment incorrect	• Inspect and readjust as required.
• Seals, piston, cover damaged	• Inspect for damage. Repair as required.
• Friction elements worn, missing, damaged, misassembled	• Inspect for damage. Repair as required.
• Return spring damaged	• Inspect for damage. Repair as required.
• Case bore damaged, leaking	• Inspect for damage. Repair as required.

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[24] Can be purchased as a separate item.

Shift Concerns: Soft/Slipping 3-4 Only (Automatic)

Possible Component	Reference/Action
228 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, EPC, TP	• Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use NGS to perform the following Pinpoint Tests: A, E. Repair as required. Clear codes, road test and rerun on-board diagnostics.
328 — HYDRAULIC/MECHANICAL ROUTINE	
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Repair as required.
• 3-4 shift valve (204), forward modulator valve/EPC boost valve (207), pressure boost valve/main regulator valve (208), extension housing tube orifice, EPC blow-off valve, spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.
Center Support Assembly	
• Screw not tightened to specification	• Inspect, retighten to specification.
• Seal rings and bearings groove damaged	• Inspect for damage. Repair as required.
• Outside diameter or case bore, center support, damaged or leaking	• Inspect for damage. Repair as required.
Direct Clutch Assembly	
• Assembly	• Air check clutch assembly as outlined in this section.
• Seals, piston, cylinder damaged	• Inspect for damage. Repair as required.
• Friction elements burnt, missing	• Inspect for damage. Repair as required.
• Improper quantity of plates installed	• Inspect for proper quantity. Repair as required.
• Check ball missing, not seating	• Inspect for damage. Repair as required.
• Brake drum, intermediate band, damaged, misadjusted or incorrect	• Inspect for damage, readjust. Repair as required.
Intermediate Servo	
• Piston, strut, lever, cover, damaged	• Inspect for damage. Repair as required.
• Seal leaking	• Inspect for damage. Repair as required.
• Piston rod lever incorrect, damaged	• Inspect for correct rod, damaged. Repair as required.

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• Case bore damaged	• Inspect bore. Repair as required.
• Spring damaged	• Inspect for damage. Repair as required.

[1] Can be purchased as a separate item.

Shift Concerns: Soft/Slipping 4-5 Only (Automatic)

Possible Component	Reference/Action
272 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, TP, EPC, MAF	• Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use NGS to perform the following Pinpoint Test: E. Repair as required, clear codes, road test and rerun on-board diagnostics.
372 — HYDRAULIC/MECHANICAL ROUTINE	
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Repair as required.
• Forward modulator valve/EPC boost valve (207) pressure boost valve/main regulator valve (208), 4-5 shift valve (215), extension housing lube orifice, EPC blow-off valve, spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.
Front Band Assembly	
• Band adjustment incorrect	• Inspect and readjust as required.
• Friction elements burnt	• Inspect for damage. Repair as required.
• Cylinder damaged	• Inspect for damage. Repair as required.
• Piston rod, lever, strut, missing or damaged	• Inspect for damage. Repair as required.
• Cover, piston seals leaking	• Inspect for damage. Repair as required.
• Case bore damage, leaks	• Leak test.

[1] Can be purchased as a separate item.

Shift Concerns: Soft/Slipping 4-3 Downshifts (Automatic)

Possible Component	Reference/Action
229 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring	• Run on-board diagnostics. Refer to

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harnesses, internal transmission wiring harnesses, PCM, EPC, TP, SS2, SS3	Powertrain Control/Emissions Diagnosis Manual [1] . Use NGS to perform the following Pinpoint Tests: A, E. Repair as required. Clear codes, road test and rerun on-board diagnostics.
329 — HYDRAULIC/MECHANICAL ROUTINE	
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged, openings No. 100, 170 blocked	• Inspect for damage. Repair as required.
• SS2, SS3, EPC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Repair as required.
• 3-4 shift valve (204), forward modulator valve/EPC boost valve (207), pressure boost valve/main regulator valve (208), 4-3 kickdown valve (211), manual low valve (212), 4-3 torque demand valve (213), extension housing lube orifice, EPC blow-off valve, spring, damaged, missing misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.
Center Support Assembly	
• Screw not tightened to specification	• Inspect, retighten to specification.
• Seal rings and bearings groove damaged	• Inspect for damage. Repair as required.
• Outside diameter or case bore, center support, damaged or leaking	• Inspect for damage. Repair as required.
Direct Clutch Assembly	
• Assembly	• Air check clutch assembly as outlined in this section.
• Seals, piston, cylinder damaged	• Inspect for damage. Repair as required.
• Friction elements burnt, missing	• Inspect for damage. Repair as required.
• Improper quantity of plates installed	• Inspect for proper quantity. Repair as required.
• Check ball missing, not seating	• Inspect for damage. Repair as required.
• Brake drum, intermediate band, damaged, misadjusted or incorrect	• Inspect for damage, readjust. Repair as required.
Intermediate Servo	
• Piston, strut, lever, cover, damaged	• Inspect for damage. Repair as required.
• Seal leaking	• Inspect for damage. Repair as required.
• Spring damaged	• Inspect for damage. Repair as required.
• Piston rod lever incorrect, damaged case bore	• Leak test.

[1] Can be purchased as a separate item.

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Shift Concerns: Harsh 1-2 Only (Automatic)

Possible Component	Reference/Action
232 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM	• Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Repair as required. Clear codes, road test and rerun on-board diagnostics.
332 — HYDRAULIC/MECHANICAL ROUTINE	
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• 1-2 shift valve (215), spring, damaged, missing misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.
Front Band Assembly	
• Band adjustment incorrect	• Inspect and readjust as required.
• Seal or piston damaged	• Inspect for damage. Repair as required.
• Friction element, lever rod, damaged or misassembled return spring	• Inspect for damage. Repair as required.
Direct Clutch • Drum damaged, outer diameter out of specification	• Inspect for damage. Repair as required.

[1] Can be purchased as a separate item.

Shift Concerns: Harsh 2-3 Only (Automatic)

Possible Component	Reference/Action
233 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, SS4	• Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [27] . Use NGS to perform Pinpoint Test A . Repair as required. Clear codes, road test and rerun on-board diagnostics.
333 — HYDRAULIC/MECHANICAL ROUTINE	
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.

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• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• 1-2 shift valve (203), spring, damaged, missing misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.
Intermediate Band Assembly	
• Band adjustment incorrect	• Inspect and readjust as required.
• Seal or piston damaged	• Inspect for damage. Repair as required.
• Friction element, lever rod, damaged or misassembled return spring	• Inspect for damage. Repair as required.
Direct Clutch	
• Drum damaged, outer diameter out of specification	• Inspect for damage. Repair as required.

[27] Can be purchased as a separate item.

Shift Concerns: Harsh 3-4 Shift Only (Automatic)

Possible Component	Reference/Action
234 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, TCC, TP	• Perform TCC tests. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use NGS to perform the following Pinpoint Tests: A. Repair as required. Clear codes, road test and rerun on-board diagnostics.
334 — HYDRAULIC/MECHANICAL ROUTINE	
Improper Pressures • Improper band/clutch application pressures, line pressure low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is low, check the following possible components: main control.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• TCC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Repair as required.
• 3-4 shift valve (204) torque converter clutch (200), forward modulator valve/EPC	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing

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boost valve (207), pressure boost valve/main regulator valve (208), thermostat bypass valve/cooler limit valve (216), spring, damaged, missing, misassembled, stuck, bore damaged	parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.
Center Support Assembly	
• Seal rings and bearings damaged	• Inspect for damage. Repair as required.
• Outside diameter or case bore damaged or leaking	• Inspect for damage. Repair as required.
Direct Clutch Assembly	
• Assembly	• Air check assembly as outlined in this section.
• Seals, piston or cylinder damaged	• Inspect for damage. Repair as required.
• Friction elements damaged, missing or improper quantity of plates were installed	• Inspect for damage. Repair as required.
• Check ball missing, not seating	• Inspect for damage. Repair as required.
• Intermediate brake band damaged or worn	• Inspect for damage, readjust. Repair as required.
Intermediate Servo Assembly	
• Piston, spring, lever, strut wrong, damaged	• Inspect for damage. Repair as required.
Torque Converter Clutch Assembly	• Refer to routines 241/341.

[1] Can be purchased as a separate item.

Shift Concerns: Harsh 4-5 Only (Automatic)

Possible Component	Reference/Action
274 — ELECTRICAL ROUTINE	
Powertrain Control System	
• Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, TCC, TP	• Perform TCC tests. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use NGS to perform the following Pinpoint Tests: A. Repair as required. Clear codes, road test and rerun on-board diagnostics.
374 — HYDRAULIC/MECHANICAL ROUTINE	
Improper Pressures	
• Improper band/clutch application pressures, line pressure high/low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is high/low, check the following possible components: main control.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.

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• TCC, O-ring, solenoid struck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Repair as required.
• Torque converter clutch (200), 4-5 shift valve (215), forward modulator valve/EPC boost valve (207), pressure boost valve/main regulator valve (208), thermostat bypass valve/cooler limit valve (216), spring, damaged, missing, misassembled, stuck, bore damaged • Wrong component used in rebuild	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage. • Verify that proper components were used.
Front Band Assembly	
• Band adjustment incorrect	• Air check servo band assembly as outlined in this section.
• Friction elements burnt, missing	• Inspect for damage. Repair as required.
• Cylinder damaged, seals damaged • Lever, strut, piston, rod wrong	• Inspect for damage. Repair as required.
Torque Converter Clutch Assembly	• Refer to routines 241/341.

[1] Can be purchased as a separate item.

Shift Concerns: Harsh 4-3 Only (Automatic)

Possible Component	Reference/Action
235 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, TCC,	• Perform shift point and TCC tests. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use NGS to perform the following Pinpoint Tests: E. Repair as required. Clear codes, road test and rerun on-board diagnostics.
335 — HYDRAULIC/MECHANICAL ROUTINE	
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• TCC, EPC, SS3, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Repair as required.
• Torque converter clutch (200), forward modulator valve/EPC boost valve (207), pressure boost valve/main regulator valve (208), 4-3 kickdown valve (211), manual low valve (212), 4-3 torque demand valve (213), thermostat bypass valve/cooler limit valve (216), spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.

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Direct Clutch Drum • Damaged	• Inspect for damage. Repair as required.
Intermediate Band • Misadjusted	• Readjust band to proper specification.
Intermediate Servo Assembly • Piston, servo, spring, damage, wrong part used in rebuild	• Inspect for damage. Repair as required.
Torque Converter Clutch Assembly	• Refer to routines 241/341.

[1] Can be purchased as a separate item.

Shift Concerns: Harsh 3-2 Only (Automatic)

Possible Component	Reference/Action
235 — ELECTRICAL ROUTINE	
Powertrain Control System • No electrical concerns	
335 — HYDRAULIC/MECHANICAL ROUTINE	
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• 1-2 shift valve (203), spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild.	• Verify that proper components were used.
Intermediate Band Assembly	
• Band adjustment incorrect	• Inspect and readjust as required.
• Seal or piston damaged	• Inspect for damage. Repair as required.
• Friction element, lever rod, damaged or misassembled return to spring	• Inspect for damage. Repair as required.
Direct Clutch • Drum damaged, outer diameter out of specification	• Inspect for damage. Repair as required.

Torque Converter Clutch Operation Concerns: No Clutch Apply

Possible Component	Reference/Action

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240 — ELECTRICAL ROUTINE	
Powertrain Control System	
• Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, ECT, TSS, TCC NOTE: Also refer to Routine No. 265.	• Perform TCC tests. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use NGS to perform the following Pinpoint Tests: A, F. Repair as required. Clear codes, road test and rerun on-board diagnostics.
340 — HYDRAULIC/MECHANICAL ROUTINE	
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• Converter clutch control valve (201), thermostat bypass valve/cooler limit valve (216), spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• TCC solenoid and valve (200), stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Repair as required.
• Wrong component used in rebuild	• Verify that proper components were used.
Pump Assembly	
• Front pump seal worn or damaged	• Inspect for damage. Repair as required.
• Screws out of torque specification	• Retorque screws to specification.
Torque Converter Clutch Assembly • Torque converter internal malfunction preventing lockup, piston application	• Remove transmission. Inspect for damage. Replace torque converter if required.

[1] Can be purchased as a separate item.

Torque Converter Clutch Operation Concerns: Clutch Always Applies/Stalls Vehicle

Possible Component	Reference/Action
241 — ELECTRICAL ROUTINE	
Powertrain Control System	
• Low engine idle	• Verify engine idle speed is within specification.
• Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, TCC	• Perform TCC tests. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] for diagnosis. Use NGS to perform the following Pinpoint Test: A. Repair as required, clear codes, road test and rerun on-board diagnostics.
341 — HYDRAULIC/MECHANICAL ROUTINE	
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.

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• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• TCC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Repair as required.
• TCC solenoid and valve (200), TCC control valve (201), spring, damaged, missing, misassembled, stuck, bore damaged • Wrong components used in rebuild	• Inspect for damage. If damaged, replace main control, If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and result in further main control or transmission damage. • Verify that proper components were used.
Torque Converter Clutch Assembly • Torque converter internal malfunction preventing lockup piston application	• Remove transmission. Inspect for damage. Replace torque converter if required.

[1] Can be purchased as a separate item.

Torque Converter Clutch Operation Concerns: Cycling/Shudder/Chatter

Possible Component	Reference/Action
242 — ELECTRICAL ROUTINE	
Powertrain Control System	
• Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, TCC, BOO, TP, RPM, TSS, OSS	• Perform TCC tests. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use NGS to perform the following Pinpoint Tests: A. Repair as required. Clear codes, road test and rerun on-board diagnostics.
• Speed control equipped vehicles	• Evaluate with speed control off.
342 — HYDRAULIC/MECHANICAL ROUTINE	
Fluid • Fluid contaminated	• Inspect fluid for contamination. If contaminated, locate source of contamination. If burnt, inspect mechanical band, clutches. Repair as required.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• TCC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Repair as required.
• TCC solenoid and valve (200), converter clutch control valve (201), thermostat bypass valve/cooler limit valve (216), spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
Pump Assembly	
• Screws out of torque specification	• Tighten screws to specification.

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• Cross leaks	• Inspect for damage. Repair as required.
• Front pump seal damage • Seal on inner pump gear damaged	• Inspect for damage. Repair as required. • Inspect for damage. Repair as required.
Torque Converter Clutch Assembly • End clearance (excessive), internal leakage, clutch material damage	• Perform end play check. Inspect and repair as required.

[1] Can be purchased as a separate item.

Other Concerns: Shift Lever Efforts High

Possible Component	Reference/Action
251 — ELECTRICAL ROUTINE	
No Electrical Concerns	
351 — HYDRAULIC/MECHANICAL ROUTINE	
Brake Shift Interlock • System, solenoid damaged	• Refer to brake section or steering column section in the Workshop Manual.
Shift Linkages (Internal/External) • Transmission shift cable and bracket damaged or misadjusted. DTR sensor out of adjustment	• Inspect for damage. Readjust as required. Repair all damaged components. After repairing linkages, readjust DTR sensor.
Case	
• Manual control outer lever damaged. Manual valve inner lever pin bent, damaged. Manual valve inner lever, spring rod damaged • Manual valve lever shaft retaining pin damaged	• Adjust linkage and install manual valve lever shaft retaining pin.

Other Concerns: External Leaks

Possible Component	Reference/Action
252 — ELECTRICAL ROUTINE	
No Electrical Concerns	
352 — HYDRAULIC/MECHANICAL ROUTINE	
Case • Case vent	• Check the vent for free breathing. Repair as required.
Seals/Gaskets • Leakage at gaskets, seals, etc. Refer to leakage diagram for potential leak locations	• Remove all traces of lubricant on exposed surfaces of transmission. Check the vent for free breathing. Operate transmission at normal temperatures and perform fluid leakage check. Repair as required.

Other Concerns: Poor Vehicle Performance

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Possible Component	Reference/Action
253A — ELECTRICAL ROUTINE	
Powertrain Control System	
• Poor engine performance	• Check engine tune-up. Refer to Section 4A in the Powertrain Control/Emissions Diagnosis Manual [1] for diagnosis and testing of the automatic transmission.
• Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, TCC	• Perform shift point tests in O/D with the TCS off. Refer to shift point specification if out of specifications. Run on-board diagnostic and check for shift error codes. Perform shift point and TCC tests. Re-run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use NGS to perform the following Pinpoint Tests: A. Repair as required. Clear codes, road test and rerun on-board diagnostics.
353A — HYDRAULIC/MECHANICAL ROUTINE	
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• TCC solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Repair as required.
• 3-4 shift valve (215), spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used
Torque Converter Clutch Assembly	
• Torque converter one-way clutch slipping	• Inspect one-way clutch. Replace torque converter.
• Incorrect TCC used in rebuild	• Inspect for correct TCC assembly. Replace as required.

[1] Can be purchased as a separate item.

Other Concerns: Poor Vehicle Performance/Wrong Gear Ratio In D, 2nd, And 1st Positions

Possible Component	Reference/Action
253B — ELECTRICAL ROUTINE	
Powertrain Control System	
• Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, SS1, SS2, SS3, SS4	• Perform shift point and TCC tests. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use NGS to perform the following Pinpoint Test: A. Repair as required. Clear codes, road test and rerun on-board diagnostics.

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353B — HYDRAULIC/MECHANICAL ROUTINE	
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• SS1, SS2, SS3, SS4, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Repair as required.
• SS3 solenoid and valve (215), spring, damaged, missing, misassembled, stuck, bore damaged SS1 (210), SS2 (202), SS4 (201) • Wrong component used in rebuild	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and result in further main control or transmission damage. • Verify that proper components were used.

[1] Can be purchased as a separate item.

Other Concerns: Noise/Vibration — Forward Or Reverse

Possible Component	Reference/Action
254 — ELECTRICAL ROUTINE	
No Electrical Concerns	
354 — HYDRAULIC/MECHANICAL ROUTINE	
Fluid • Improper level	• Adjust to proper level.
Shift Linkages (Internal/External) • Transmission shift cable and bracket damaged or misadjusted. DTR sensor out of adjustment	• Inspect for damage. Readjust as required. Repair all damaged components. After repairing linkages, readjust DTR sensor.
Improper Pressures • Improper band/clutch application pressures, line pressure high/low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is high/low, check the following possible components: pump assembly.
Pump Assembly	
• Internal leakage, cavitation • Screws out of torque specification	• Inspect and repair as required. • Tighten screws to specification.
Front One-Way Clutch Assembly • One-way clutch damaged, worn, misassembled	• Repair one-way clutch.
Rear One-Way Clutch Assembly • One-way clutch damaged, worn, misassembled	• Repair one-way clutch.
Other	

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• Transmission oil cooler lines, fill tube grounding	• Relocate transmission oil cooler lines or fill tube properly.
Gear • Gear noise	• Repair planetary gear assemblies.
Torque Converter Clutch Assembly	• Refer to routines 242/342.

Other Concerns: Engine Will Not Crank

Possible Component	Reference/Action
255 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, DTR sensor	• Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] for diagnosis. Use NGS to perform the following Pinpoint Test: D. Repair as required. Clear codes, road test and rerun on-board diagnostics.
355 — HYDRAULIC/MECHANICAL ROUTINE	
Shift Linkages (Internal/External) • Transmission shift cable and bracket damaged or misadjusted. DTR sensor out of adjustment	• Inspect for damage. Readjust as required. Repair all damaged components. After repairing linkages, readjust DTR sensor.
Pump Assembly • Seized	• Refer to disassembly of transmission. Inspect for damage. Repair or replace as required.
Flywheel • Damaged	• Inspect for damage. Repair as required.

[1] Can be purchased as a separate item.

Other Concerns: No Park Range

Possible Component	Reference/Action
256 — ELECTRICAL ROUTINE	
No Electrical Concerns	
356 — HYDRAULIC/MECHANICAL ROUTINE	
Shift Linkages (Internal/External) • Transmission shift cable and bracket damaged or misadjusted. DTR sensor out of adjustment	• Inspect for damage. Readjust as required. Repair all damaged components. After repairing linkages, readjust DTR sensor.
Park Mechanism	
• Park gear, parking pawl, parking pawl return spring, park or guide plate, parking pawl shaft, parking pawl actuating rod, manual lever, manual lever detent spring damaged, misassembled	• Inspect for damage. Repair as required.

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• Transfer case and linkages damaged	• Refer to Workshop Manual for transfer case and linkage diagnosis.
4x4 Applications • Transfer case and linkage damaged	• Refer to Workshop Manual for transfer case and linkage diagnosis.

Other Concerns: Transmission Overheating

Possible Component	Reference/Action
257 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, TFT, TCC	• Perform shift point and TCC test. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1]. Use NGS to perform the following Pinpoint Tests: A, B. Repair as required. Clear codes, road test and rerun on-board diagnostics.
357 — HYDRAULIC/MECHANICAL ROUTINE	
Fluid • Improper level	• Adjust to proper level.
Improper Pressures • Improper band/clutch application pressures, line pressure high/low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is high/low, check the following possible components: main control, TCC.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• TCC, solenoid stuck, damaged, O-ring damaged or out of bore	• Inspect for damage. Perform solenoid function test as listed in electrical routine. Repair as required.
• Thermostat bypass valve/cooler limit valve (216), spring, damaged, missing misassembled, stuck, bore damaged • Wrong component used in rebuild	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage. • Verify that proper components were used.
Torque Converter Clutch Assembly	
• Seized torque converter one-way clutch • Excessive slip detected	• Refer to routines 240/340. • Inspect torque converter one-way clutch. • Replace torque converter as required. • Run on-board diagnostics.
Other	

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• Restriction in transmission oil cooler or tubes	• Repair transmission oil cooler or tubes.

[1] Can be purchased as a separate item.

Other Concerns: No Engine Braking In 2nd Position

Possible Component	Reference/Action
258 — ELECTRICAL ROUTINE	
No Electrical Concerns	
358 — HYDRAULIC/MECHANICAL ROUTINE	
Improper Pressures • Improper band/clutch application pressures, line pressure high/low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is high/low, check the following possible components: main control, coast clutch assembly.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• Extension housing lube orifice, check ball A and C not seating or damaged, spring, damaged, missing misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong part used in rebuild	• Repair as required.
Coast Clutch Assembly	
• Coast clutch damaged	• Replace as required.
• Seal ring damaged	• Inspect for damage. Repair as required.
Intermediate Band	
• Intermediate band out of adjustment	• Adjust intermediate band.
• Intermediate servo leaking	• Perform air pressure test to determine if intermediate servo is leaking. Repair as required.
• Glazed intermediate band	• Repair or replace as required.

Other Concerns: No Engine Braking In 1st Position

Possible Component	Reference/Action
259 — ELECTRICAL ROUTINE	
No Electrical Concerns	
359 — HYDRAULIC/MECHANICAL ROUTINE	
Fluid • Improper level	• Adjust to proper level.

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Shift Linkages (Internal/External)	
• Transmission shift cable and bracket damaged or misadjusted. DTR sensor out of adjustment	• Inspect for damage. Readjust as required. Repair all damaged components. After repairing linkages, readjust DTR sensor.
Improper Pressures	
• Improper band/clutch application pressures, line pressure high/low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is high/low, check the following possible components: main control.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• Manual low valve (212), check ball E not seating properly, spring, damaged, missing, misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong part used in rebuild	• Inspect for correct part. Repair as required.
Coast Clutch Assembly	
• Wrong part used in rebuild	• Inspect parts. Repair as required.
• Overdrive clutch damaged • Seal rings damaged	• Replace as required.
Reverse Clutch/Band	
• Reverse servo or piston or gasket seal leaking	• Perform air pressure test. Check and replace piston seal as required.
• Reverse band burnt, worn or damaged	• Replace as required.
• Polished or glazed low reverse clutch band or drum	• Repair or replace as required.
Rear One-Way Clutch Assembly	
• Rear one-way clutch damaged	• Replace as required.

Other Concerns: No Engine Braking With Overdrive Cancelled In 3rd And 4th)

Possible Component	Reference/Action
260 — ELECTRICAL ROUTINE	
Powertrain Control System • Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, SS3, SS4	• Perform shift point tests. Run on-board diagnostics. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use NGS to perform the following Pinpoint Tests: A. Repair as required. Clear codes, road test and rerun on-board diagnostics. Also check for engine braking in 1 and 2 positions.

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	NOTE: No engine braking in O/D position with the TCS off, 1st gear is a normal function.
360 — HYDRAULIC/MECHANICAL ROUTINE	
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• Coast clutch solenoid and valve/converter clutch control valve (201), SS3 solenoid/3-4 shift solenoid (215), spring, damaged, missing misassembled, stuck, bore damaged	• Inspect for damage. If damaged, replace main control. If parts are missing, replace missing parts or main control. If misassembled, reassemble properly. Do not stone, file or sand valves. This will remove the anodized finish and may result in further main control or transmission damage.
• Wrong component used in rebuild	• Verify that proper components were used.
Coast Clutch Assembly	
• Wrong part used in rebuild	• Verify that proper components were used.
• Overdrive clutch damaged	• Replace as required.
• Seal rings damaged	• Inspect for damage. Repair as required.

[1] Can be purchased as a separate item.

Other Concerns: Fluid Venting/Foaming

Possible Component	Reference/Action
261 — ELECTRICAL ROUTINE	
No Electrical Concerns	
361 — HYDRAULIC/MECHANICAL ROUTINE	
• Vent blocked or damaged	• Check vent for damage or blockage. Repair as required.
• Overfilled transmission	• Check level and adjust as required.
• Fluid contaminated (antifreeze, water)	• Check for contamination, locate source of contamination. Repair as required.
• Overheating	• Refer to routines 257/357.
• Filter and seal assembly damaged or misassembled	• Inspect filter and seal assembly for damage. Repair as required.

Other Concerns: Slips/Chatters In 1st Position

Possible Component	Reference/Action
263 — ELECTRICAL ROUTINE	
No Electrical Concerns	
363 — HYDRAULIC/MECHANICAL ROUTINE	
Improper Pressures	
• Improper band/clutch application pressures, line	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If

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pressure high/low	pressure is high/low, check the following possible components: main control.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• Wrong components used in rebuild	• Verify that proper components were used.
• Dirty or sticking main control valve body	• Clean, repair or replace main control valve body.
Rear One-Way Clutch Assembly	
• Low/reverse one-way clutch damaged	• Replace rear one-way clutch and case.

Other Concerns: Slips/Chatters In 2nd Position

Possible Component	Reference/Action
264 — ELECTRICAL ROUTINE	
No Electrical Concerns	
364 — HYDRAULIC/MECHANICAL ROUTINE	
Improper Pressures	
• Improper band/clutch application pressures, line pressure high/low	• Check line pressure at tap. Perform line pressure and stall speed tests. Refer to pressure chart No. 401 for specifications. If pressure is high/low, check the following possible components: main control.
Main Control Assembly	
• Screw out of torque specification	• Tighten to specification.
• Gasket damaged, off location	• Inspect and replace gasket.
• Separator plate damaged	• Inspect for damage. Repair as required.
• Wrong components used in rebuild	• Verify that proper components were used.
• Dirty or sticking main control valve body	• Clean, repair or replace main control valve body.
Intermediate Band	
• Intermediate band out of adjustment	• Adjust intermediate band [1] .
• Damaged or worn intermediate servo piston, lever, strut, or internal leaks	• Perform air pressure test. Inspect for damage. Repair as required.
• Polished, glazed low and intermediate band or drum	• Replace or repair as required.

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[1] See also 2-3 slip.

Other Concerns: FMEM — Harsh Engagements And Shifts

Possible Component	Reference/Action
265 — ELECTRICAL ROUTINE	
Powertrain Control System • Operating in FMEM strategy. Electrical inputs/outputs, vehicle wiring harnesses, internal transmission wiring harnesses, PCM, EPC, OSS, DTR, TCC, transmission overtemp (TFT), TP and MAF, shift error detected (shift solenoid, TSS, OSS and internal hardware)	• Run on-board diagnostics. Repair as required. Clear codes, road test and rerun self test. Refer to Powertrain Control/Emissions Diagnosis Manual [1] . Use NGS to perform the following Pinpoint Test A , B, D, E, F. Repair as required, clear codes, road test and rerun on-board diagnostics.
365 — HYDRAULIC/MECHANICAL ROUTINE	
No Hydraulic/Mechanical Concerns	

[1] Can be purchased as a separate item.

Pressure Chart No. 401

Trans.	Transmission Model/Application	Range	Idle		WOT Stall	
			EPC	Line	EPC	Line
	4.0L Aerostar	R	57-67	100-130	112-134	282-350
	4x2, AWD	N	26-36	82-112		
5R55E		(D), 2, 1	25-35	80-110	112-134	228-263
	4.0L Ranger	R	52-62	138-168	112-134	282-350
5R55E	4x2, 4x4	N	32-42	95-125		
		(D), 2, 1	25-35	80-110	112-134	228-263

Main Control Body Check Ball Location No. 501

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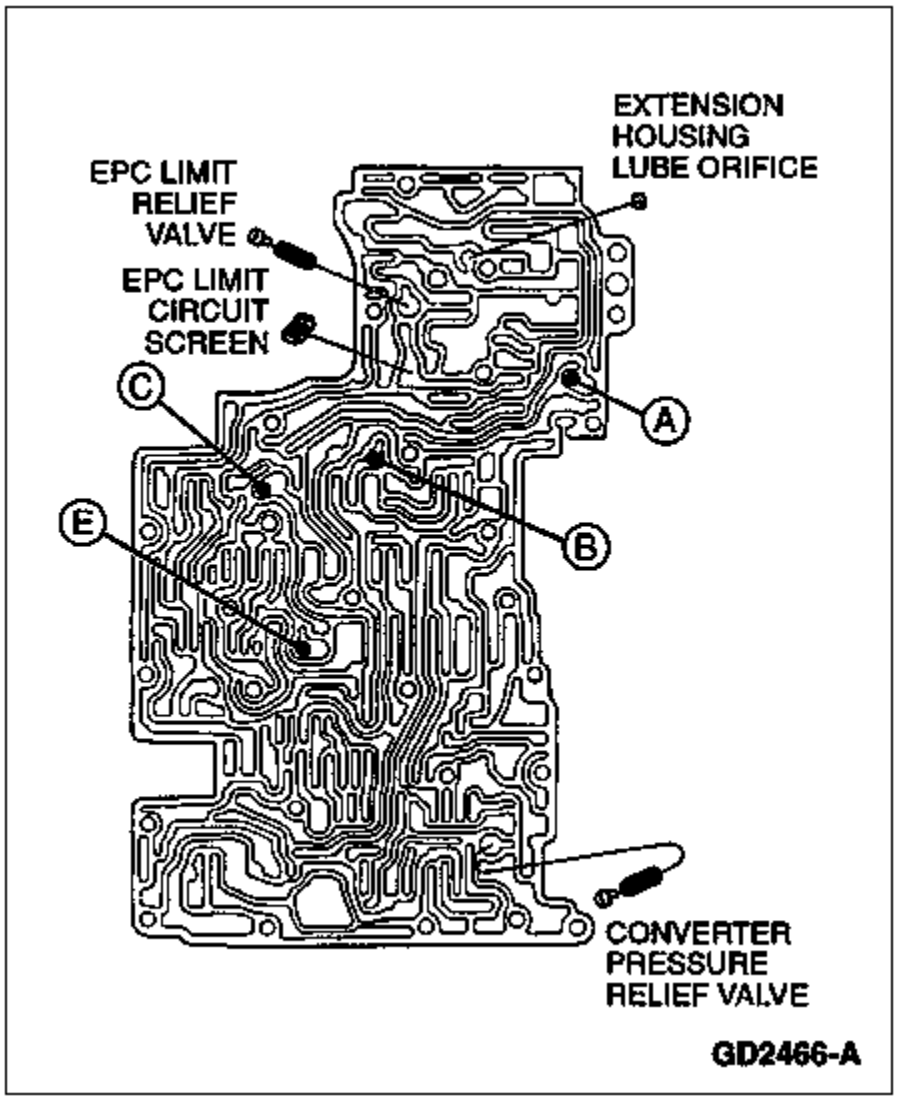

Band/Clutch Application Chart No. 601 (5R55E)

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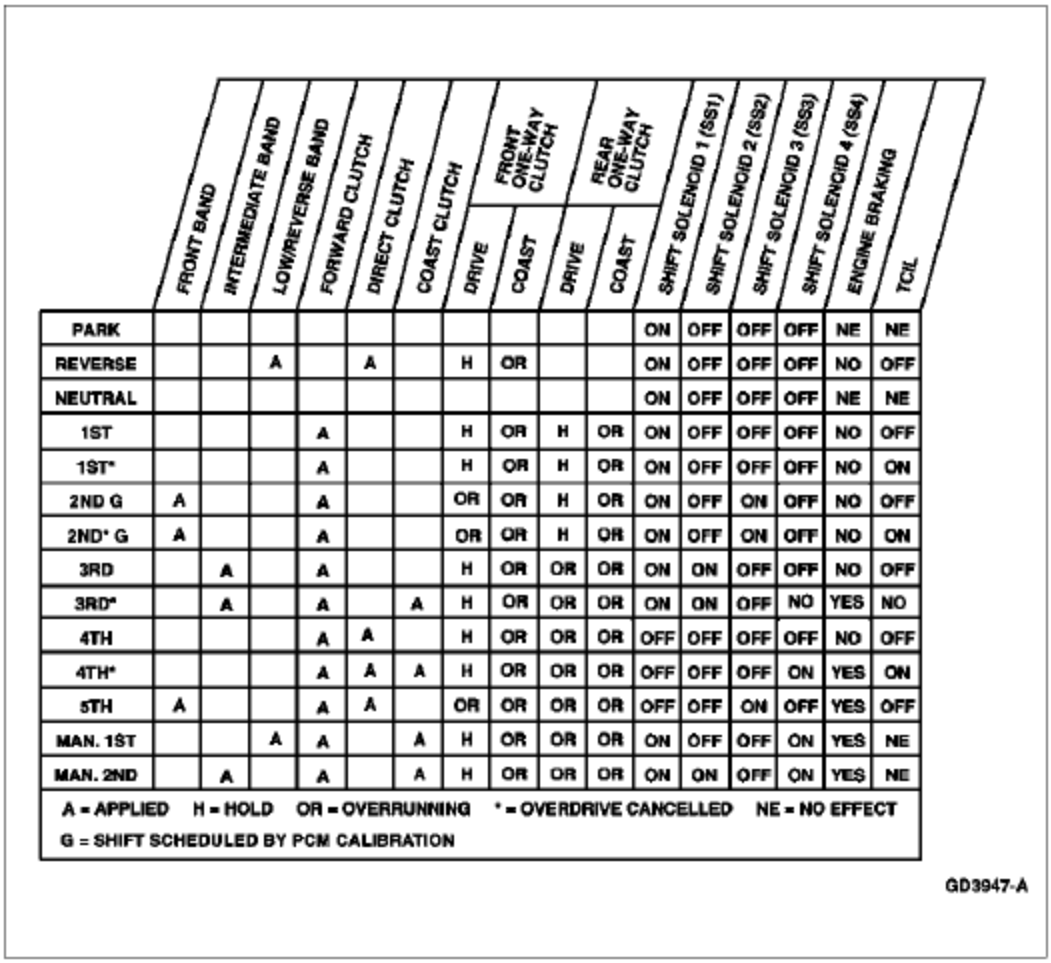

	FRONT BAND	INTERMEDIATE BAND	LOW/REVERSE BAND	FORWARD CLUTCH	DIRECT CLUTCH	COAST CLUTCH	FRONT ONE-WAY CLUTCH		REAR ONE-WAY CLUTCH		SHIFT SOLENOID 1 (SS1)	SHIFT SOLENOID 2 (SS2)	SHIFT SOLENOID 3 (SS3)	SHIFT SOLENOID 4 (SS4)	ENGINE BRAKING	TCIL
							DRIVE	COAST	DRIVE	COAST						
PARK											ON	OFF	OFF	OFF	NE	NE
REVERSE			A		A		H	OR			ON	OFF	OFF	OFF	NO	OFF
NEUTRAL											ON	OFF	OFF	OFF	NE	NE
1ST				A			H	OR	H	OR	ON	OFF	OFF	OFF	NO	OFF
1ST*				A			H	OR	H	OR	ON	OFF	OFF	OFF	NO	ON
2ND G	A			A			OR	OR	H	OR	ON	OFF	ON	OFF	NO	OFF
2ND* G	A			A			OR	OR	H	OR	ON	OFF	ON	OFF	NO	ON
3RD		A		A			H	OR	OR	OR	ON	ON	OFF	OFF	NO	OFF
3RD*		A		A		A	H	OR	OR	OR	ON	ON	OFF	NO	YES	NO
4TH				A	A		H	OR	OR	OR	OFF	OFF	OFF	OFF	NO	OFF
4TH*				A	A	A	H	OR	OR	OR	OFF	OFF	OFF	ON	YES	ON
5TH	A			A	A		OR	OR	OR	OR	OFF	OFF	ON	OFF	YES	OFF
MAN. 1ST			A	A		A	H	OR	OR	OR	ON	OFF	OFF	ON	YES	NE
MAN. 2ND		A		A		A	H	OR	OR	OR	ON	ON	OFF	ON	YES	NE

A = APPLIED H = HOLD OR = OVERRUNNING * = OVERDRIVE CANCELLED NE = NO EFFECT
G = SHIFT SCHEDULED BY PCM CALIBRATION

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Transmission Fluid Drain and Refill

Intervals for drain and refill, due to in-vehicle service or major service operation, are as follows:

- Normal Maintenance
  - Not required with normal use.
- Severe Duty Maintenance
  - Change fluid at 80,450 km (50,000 mile) intervals using MERCON V® XT-5-QM or equivalent.

CAUTION: Use only MERCON V® XT-5-QM Service Fluid as the use of any other fluids may result in a transmission malfunction or failure.

Maintenance Procedure

1. Loosen, then remove the transmission fluid pan-to-case screws to drain the fluid.
2. Remove and discard old pan gasket.
3. Thoroughly clean the fluid pan and the transmission case fluid pan rail surface.
4. Install new pan gasket onto pan and install fluid pan to case with screws. Tighten screws to 13-15 Nm (115-133 lb-in).
5. Add 2.8 liters (3 quarts) of MERCON V® XT-5-QM.
6. Start engine. Move transmission range selector lever through all gear ranges, checking for engagements.
7. Check and adjust transmission fluid in 0.25 liter (1/2 pint) increments to proper level (cross-hatched area of fluid level indicator at normal operating temperatures).

Major Service/Overhaul

1. Loosen, then remove the transmission fluid pan screws to drain fluid.
2. Remove and discard old pan gasket.
3. Perform required internal repair and cleaning as required.
4. Thoroughly flush torque converter, cooler lines and transmission in-tank radiator cooler and auxiliary cooler (if equipped).
5. Replace with new fluid filter and O-rings assembly.

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6. Install cleaned fluid pan and new pan gasket with fluid pan-to-case screws. Tighten fluid pan-to-case screws to 13-15 Nm (115-133 lb-in).

7. Add 3.7 liters (4 quarts) of MERCON V® XT-5-QM or equivalent MERCON® approved fluid into fluid filler tube.

8. Start engine. Move the transmission range selector lever through all gear ranges, checking for engagements.

9. Check and adjust the transmission fluid level in 0.25 liter (1/2 pint) increments to the proper level (cross-hatched area of the fluid level indicator at normal operating temperatures).

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Extension Housing Seal and Bushing

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Impact Slide Hammer	T50T-100-A
Extension Housing Bushing Remover	T77L-7697-E
Extension Housing Bushing Replacer	T77L-7697-F
Extension Housing Seal Replacer	T74P-77052-A

SPECIAL SERVICE TOOLS DESIRED

Tool Number	Description
Seal Remover	T94P-77001-BH

Removal

1. Raise vehicle on a hoist and position suitable safety stands under vehicle.
2. Remove rear driveshaft. Refer to Section 05-01 .
3. Remove output shaft and extension housing seal using Seal Remover T94P-77001-BH and Impact Slide Hammer T50T-100-A.

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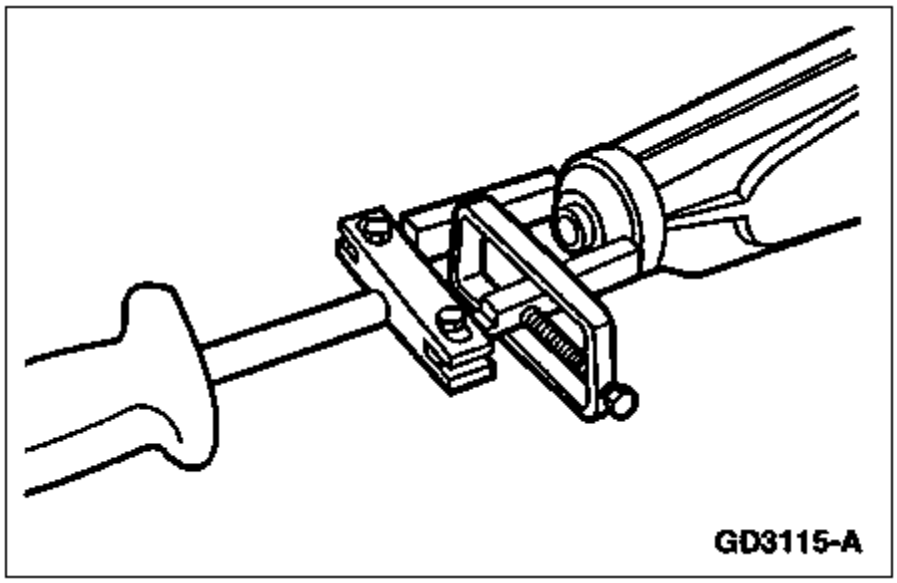

4. **CAUTION: Use the extension housing bushing remover carefully so that the seal area is not damaged.**

   Remove the bushing using Extension Housing Bushing Remover T77L-7697-E.

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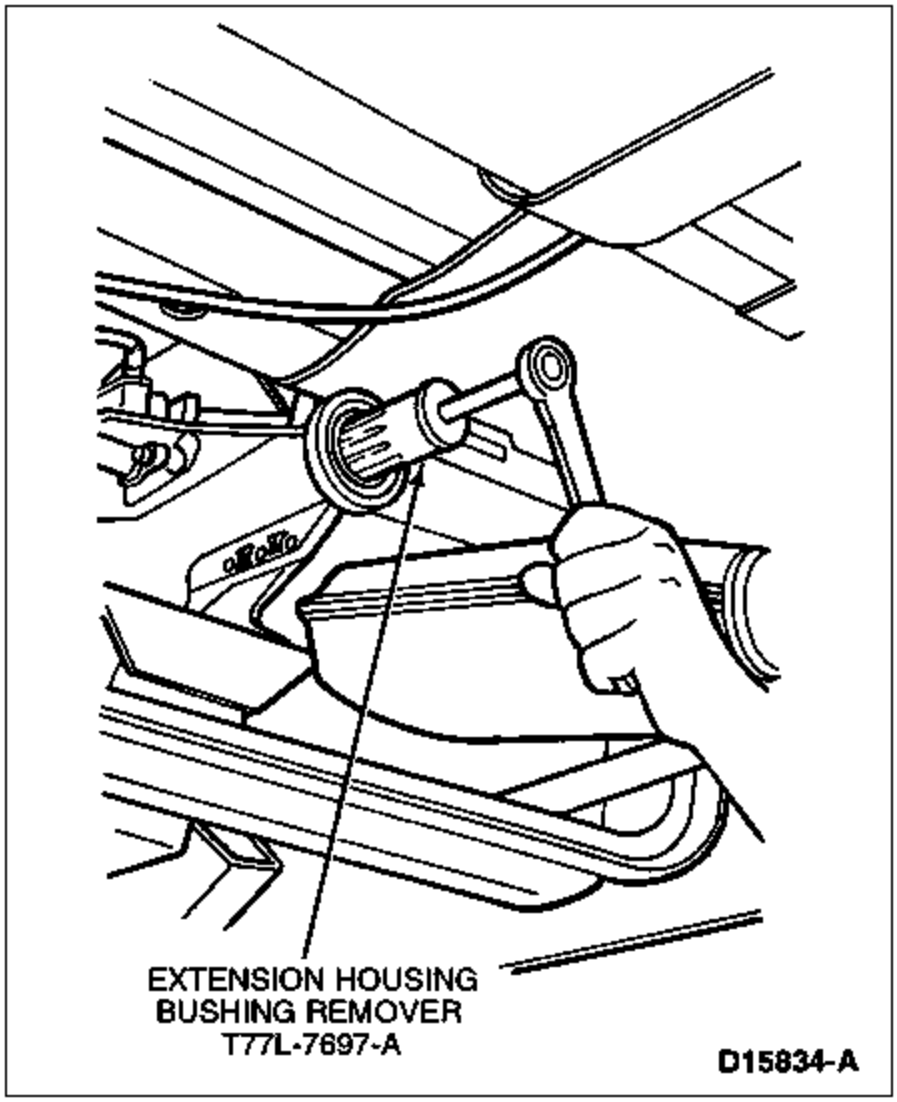

Installation

1. Inspect the counterbore of the extension housing for burrs. If necessary, remove burrs with an oil stone.

2. **CAUTION: The lube hole in the bushing must be aligned with the lube groove in the extension housing, located 90°(3 o'clock position) from top when viewed from rear.**

   CAUTION: Tool will bottom when bushing is in the proper position.

   NOTE: Install the extension housing bushing if it was removed.

   Install the extension housing bushing using Extension Housing Bushing Replacer T77L-7697-F.

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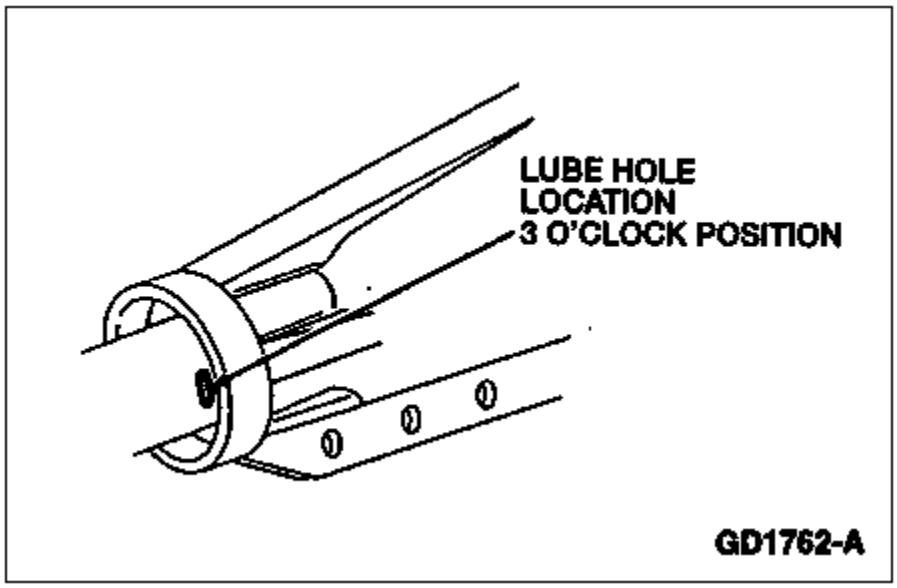

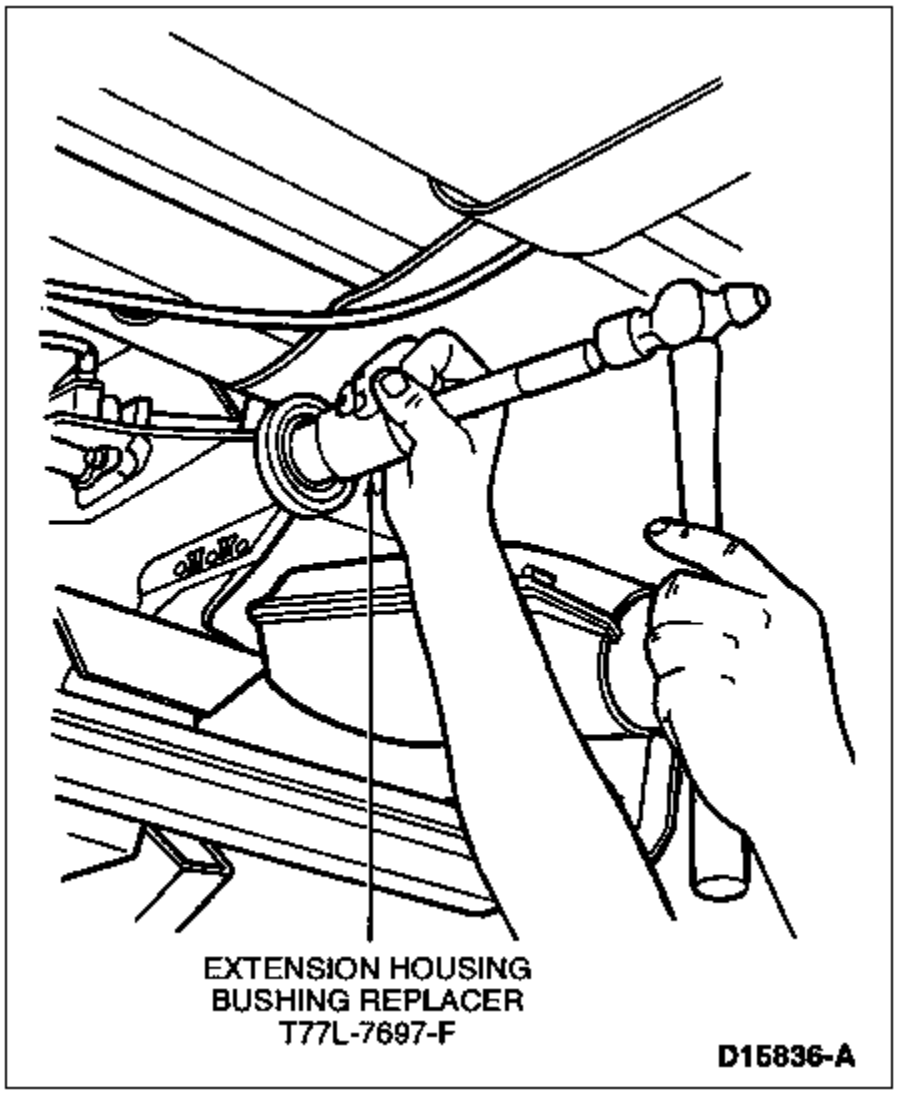

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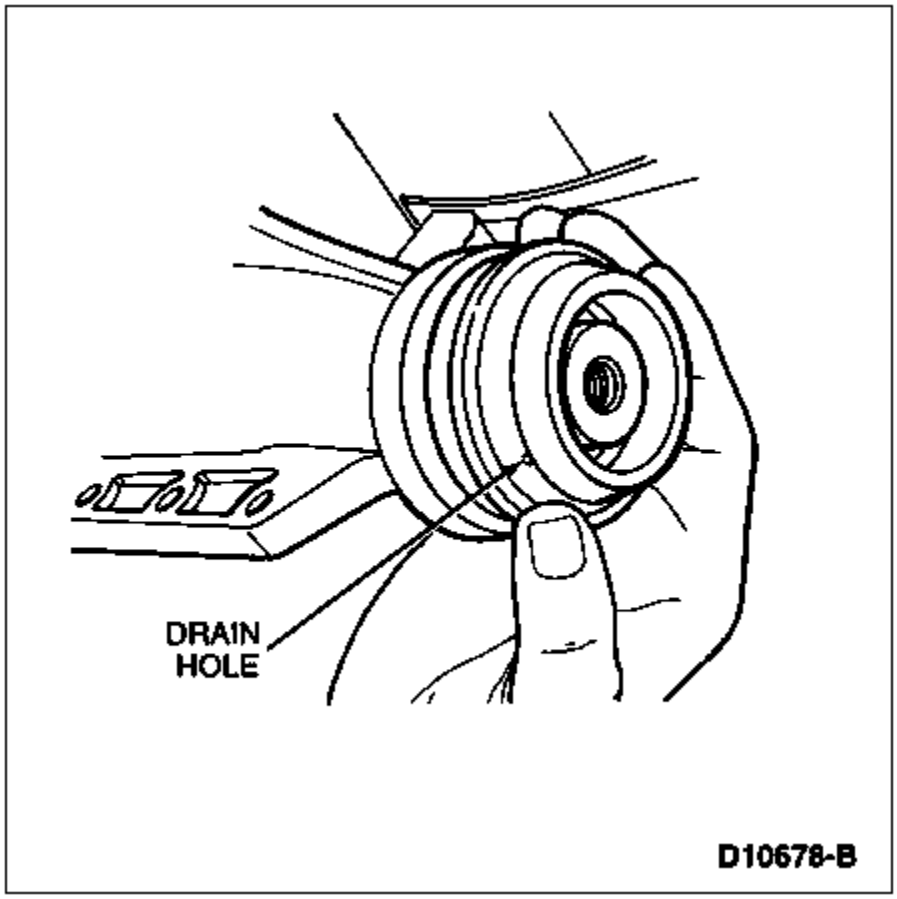
3. Position new output shaft and extension housing seal with drain hole positioned facing downward (6 o'clock position).



4. Seat seal using Extension Housing Seal Replacer T74P-77052-A.

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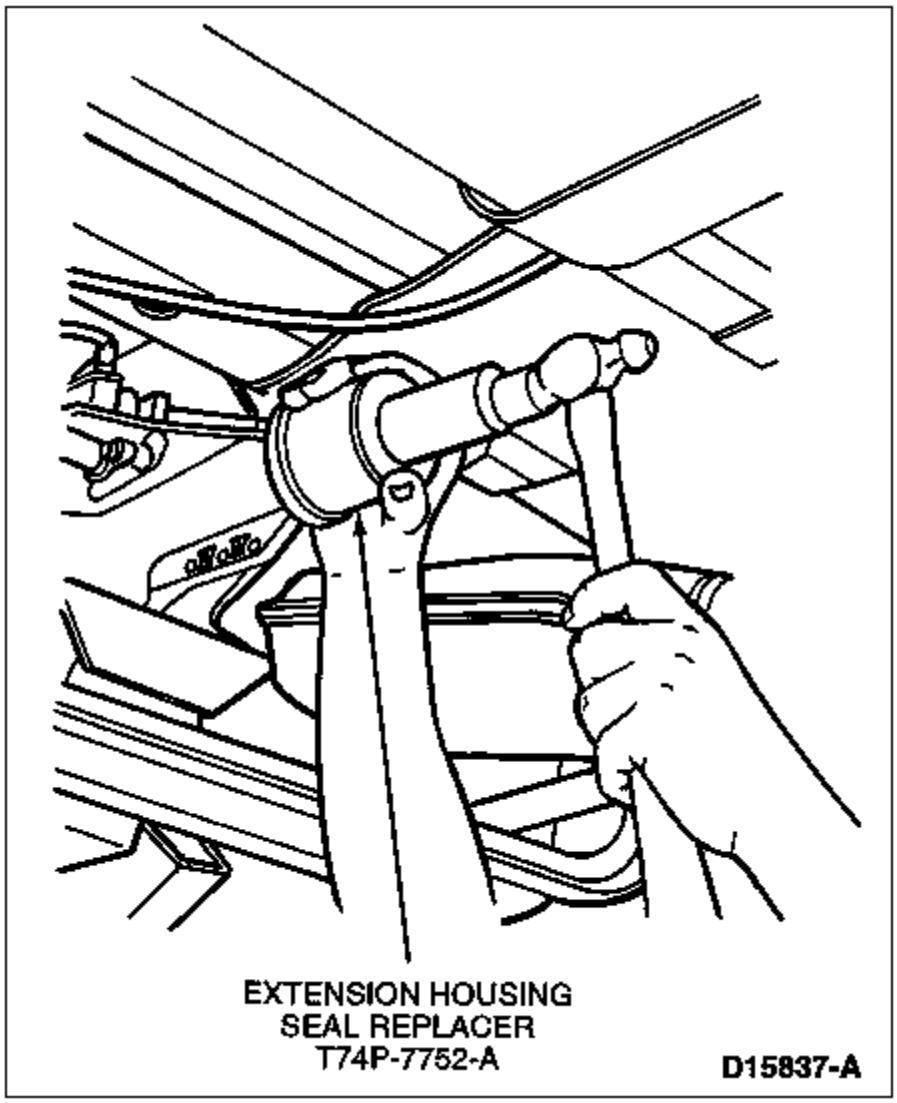

5. Inspect driveshaft slip-yoke. Replace if damaged or worn.
6. Install driveshaft. Refer to Section 05-01 .
7. Remove safety stands and lower vehicle.
8. Fill the transmission to the proper level. Refer to specifications at the end of this section.

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Extension Housing Gasket

Removal

1. Raise vehicle on hoist and position suitable safety stands under vehicle.
2. Remove front (4x4 only) and rear driveshaft. Refer to Section 05-01 .
3. Remove transfer case assembly (4x4 only). Refer to Section 07-07A or Section 07-07B .
4. Remove transmission mounting pad nuts and bolts. Refer to the Transmission Removal procedures in this section.
5. Carefully remove wire harness locators from extension housing wire bracket.
6. Position jack under transmission and raise transmission.
7. Remove five extension housing screws, one stud and wiring bracket using a 17mm socket.

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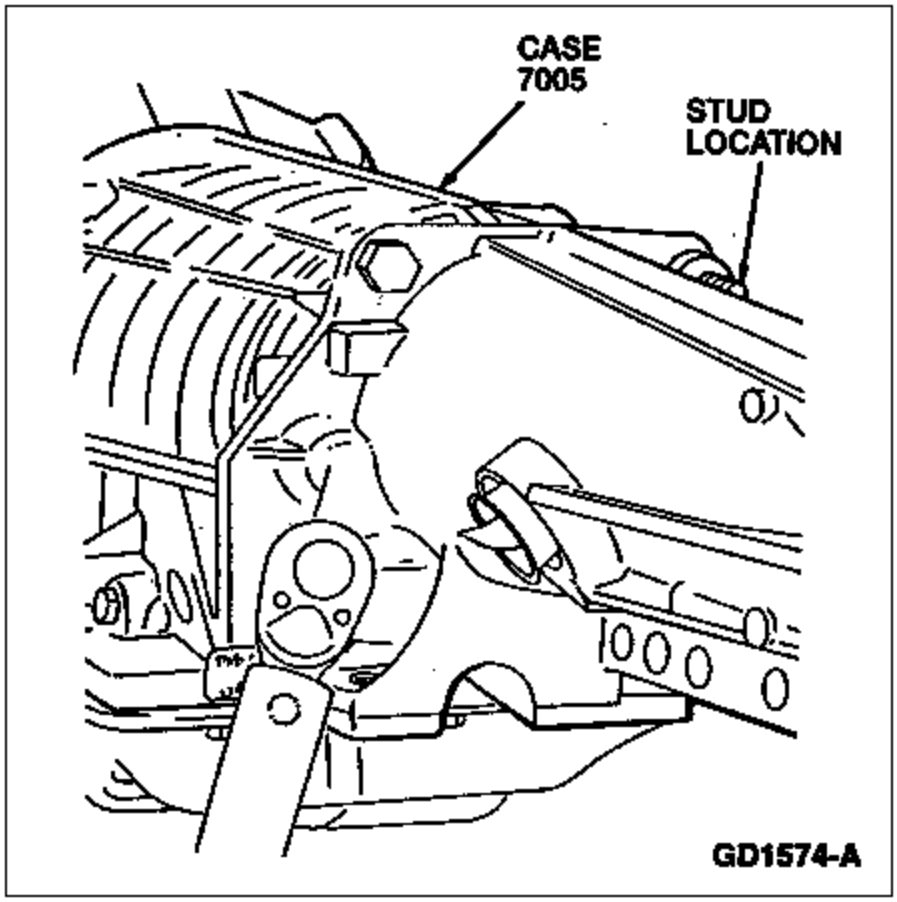

8. **CAUTION: The parking pawl, parking pawl return spring and parking pawl shaft could fall out during removal of the extension housing.**

   Carefully remove extension housing.

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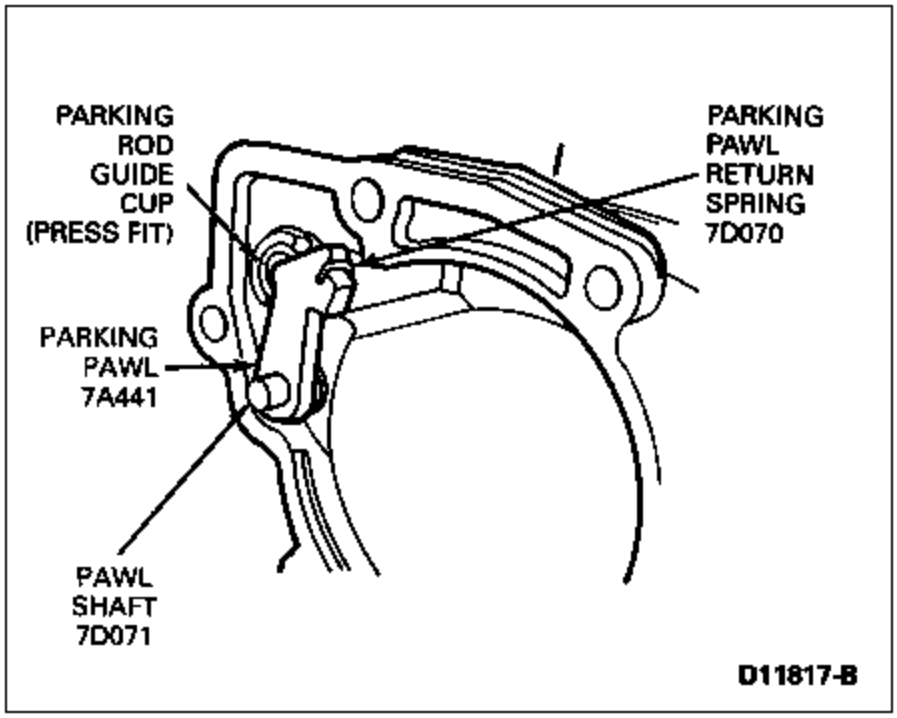

9. Remove and discard extension housing gasket (7086) from extension housing and mating surfaces.

Installation

1. Clean extension housing and transmission mating surfaces. Place a light film of petroleum jelly on the extension housing gasket and position gasket on the transmission case.

2. **NOTE: The guide cup is press-fit into the extension housing and is not serviced separately.**

   Install the parking pawl, pawl return spring and pawl shaft into the extension housing.

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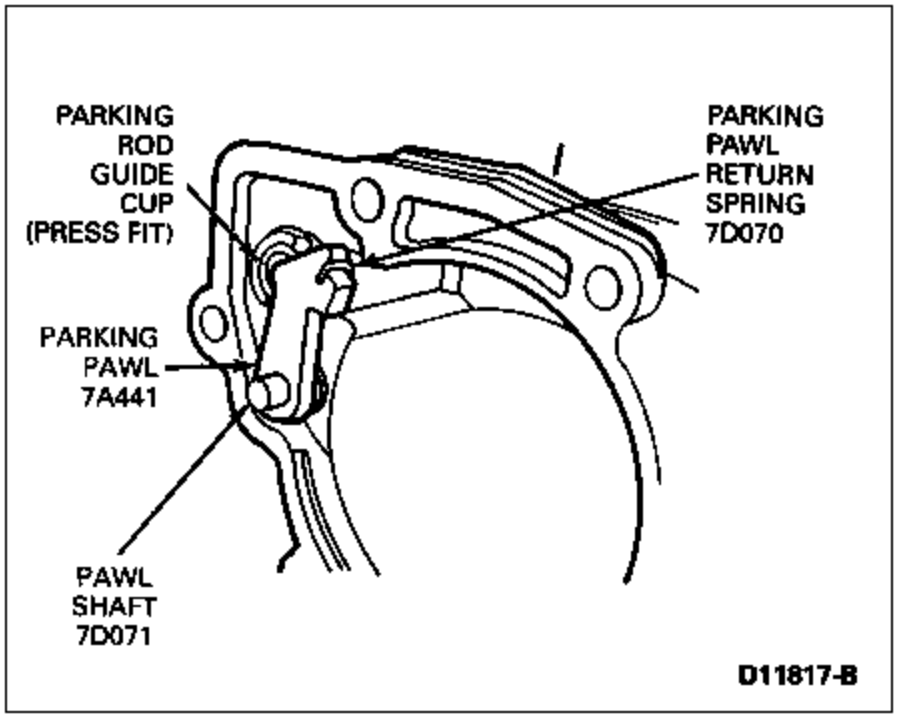

3. **CAUTION: Make sure the parking lever actuating rod is correctly seated into the case parking rod guide cup.**

   Install the extension housing. Install the five M10 x 30mm extension housing screws and one stud. Tighten the extension housing-to-case stud and screws to 36-52 Nm (27-39 lb-ft).

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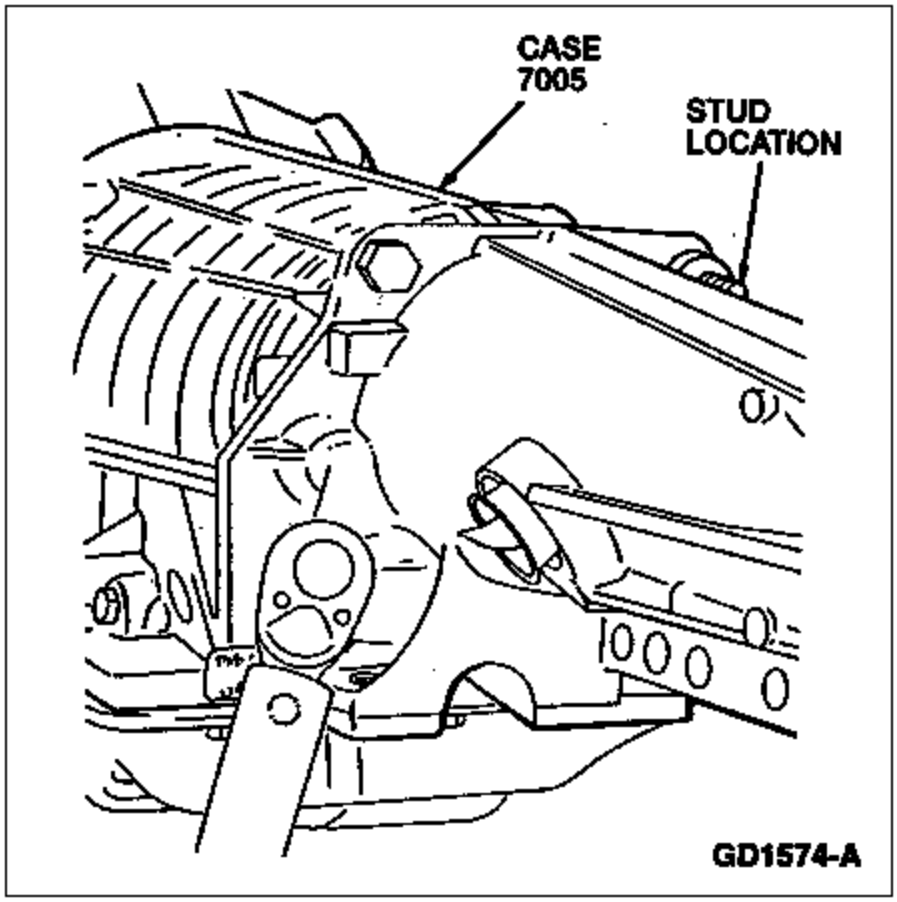

4. On 4x4 models only, install transfer case. Refer to Section 07-07A or Section 07-07B .
5. On 4x4 models only, attach transfer case vent hose to attaching plate. Refer to Section 07-07A or Section 07-07B .
6. Install four-wheel drive connector, if equipped.
7. Install new wire harness locator into extension housing wire bracket.
8. Install transmission mounting pad nuts and bolts and tighten to 68-95 Nm (50-70 lb-ft).
9. On Ranger vehicles, install the two crossmember-to-frame through bolts and nuts and tighten to 88-115 Nm (65-85 lb-ft).
10. On Aerostar vehicles, install the two crossmember-to-frame through bolts and nuts and tighten to 37-52 Nm (28-38 lb-ft).
11. Remove universal high lift transmission jack.
12. Install front (4x4 only) and rear driveshaft. Refer to Section 05-01 .
13. Fill the transmission to the proper level. Refer to Preliminary Testing procedure in this section.

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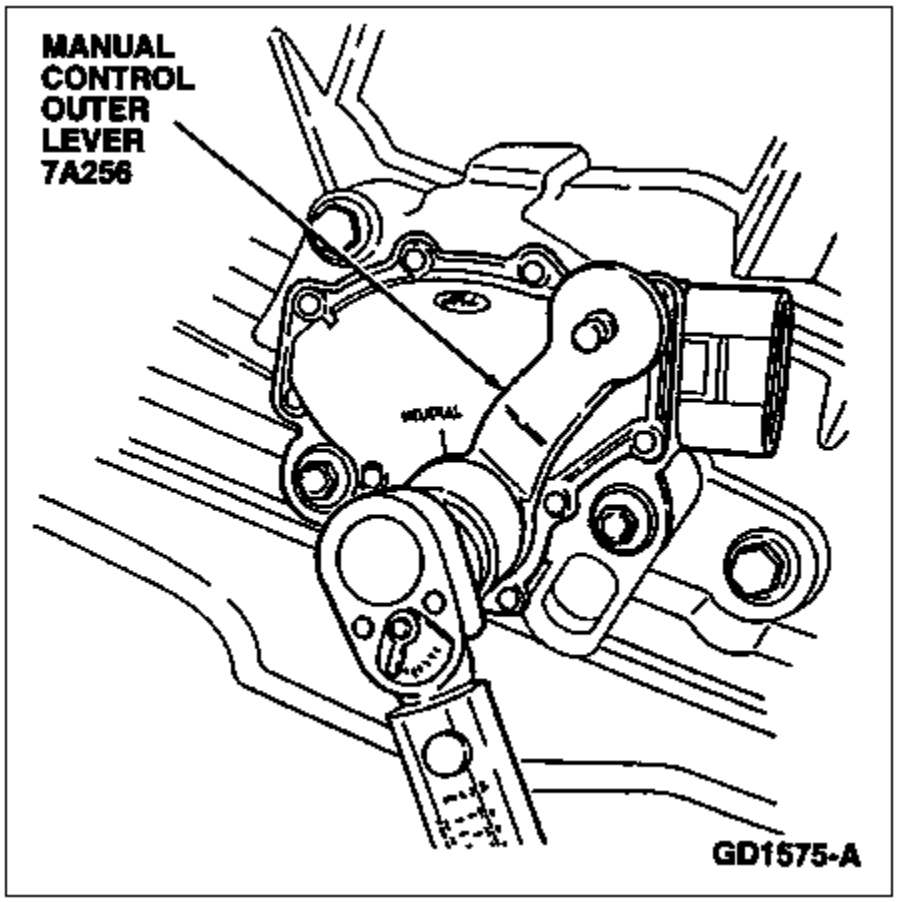
Digital Transmission Range (DTR) Sensor

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Digital TR Sensor Alignment Tool	T97L-70010-A

Removal

1. Use a screwdriver to remove the shift cable and fitting from the transmission lever ball stud.
2. Disconnect vehicle harness connector from digital transmission range (DTR) sensor by depressing tab.
3. Remove the manual control outer lever nut and manual control outer lever.



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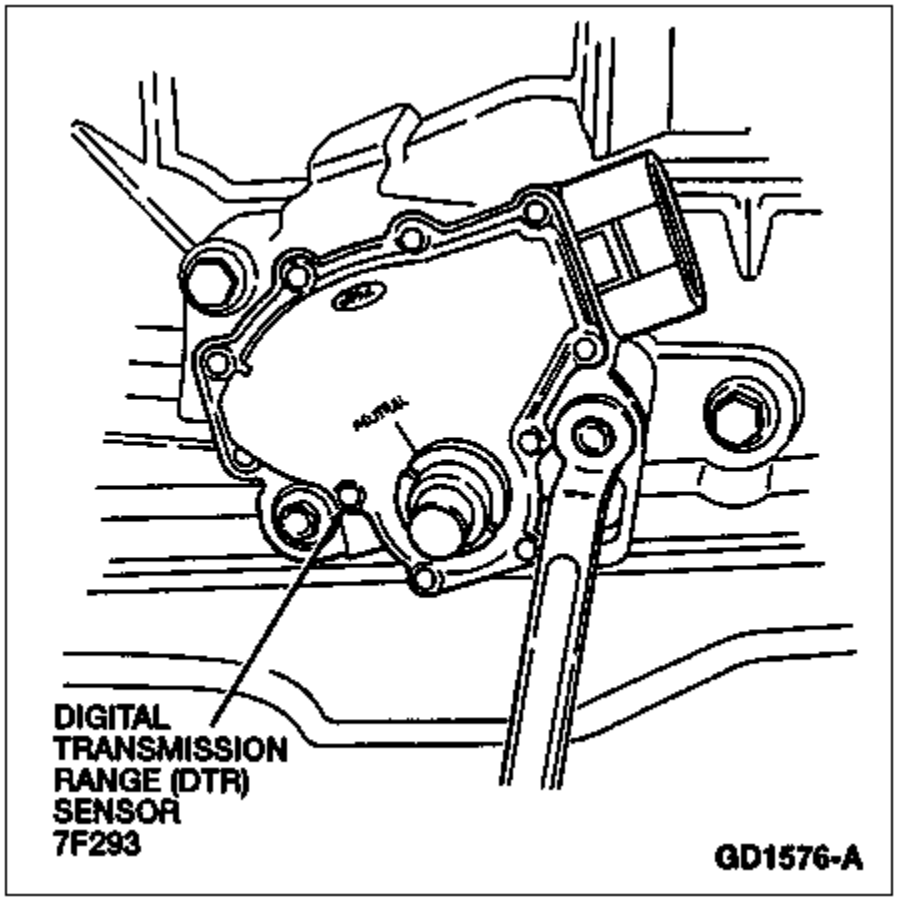
4. Remove the two M6 x 25 TR sensor screws and remove the DTR sensor.



Installation

1. Install the DTR sensor on the manual lever. Install the two TR sensor screws and finger tighten. Rotate the manual lever to the neutral position (two detents rearward).

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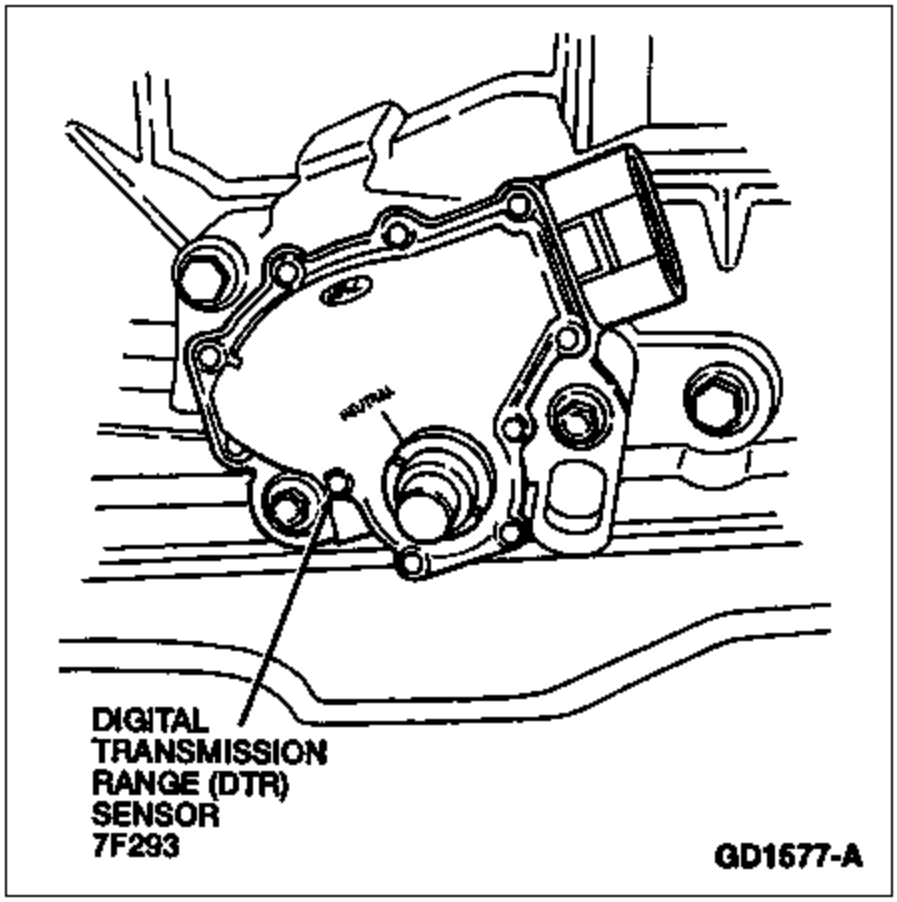

2. Install Digital TR Sensor Alignment Tool T97L-70010-A into the three slots on the DTR sensor. Tighten the TR sensor-to-case screws to 8-11 Nm (71-97 lb-in). Remove the alignment tool.

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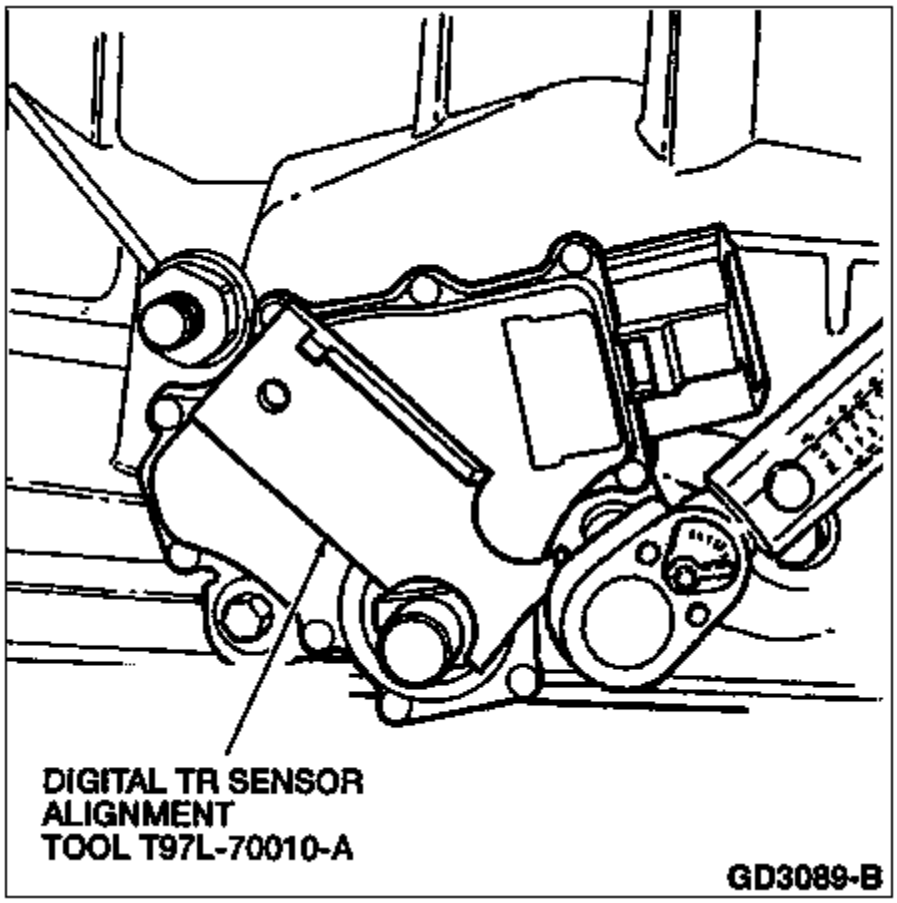

3. Install the manual control outer lever and manual control outer lever nut. Tighten the manual control outer lever nut to 41-54 Nm (30-40 lb-ft).

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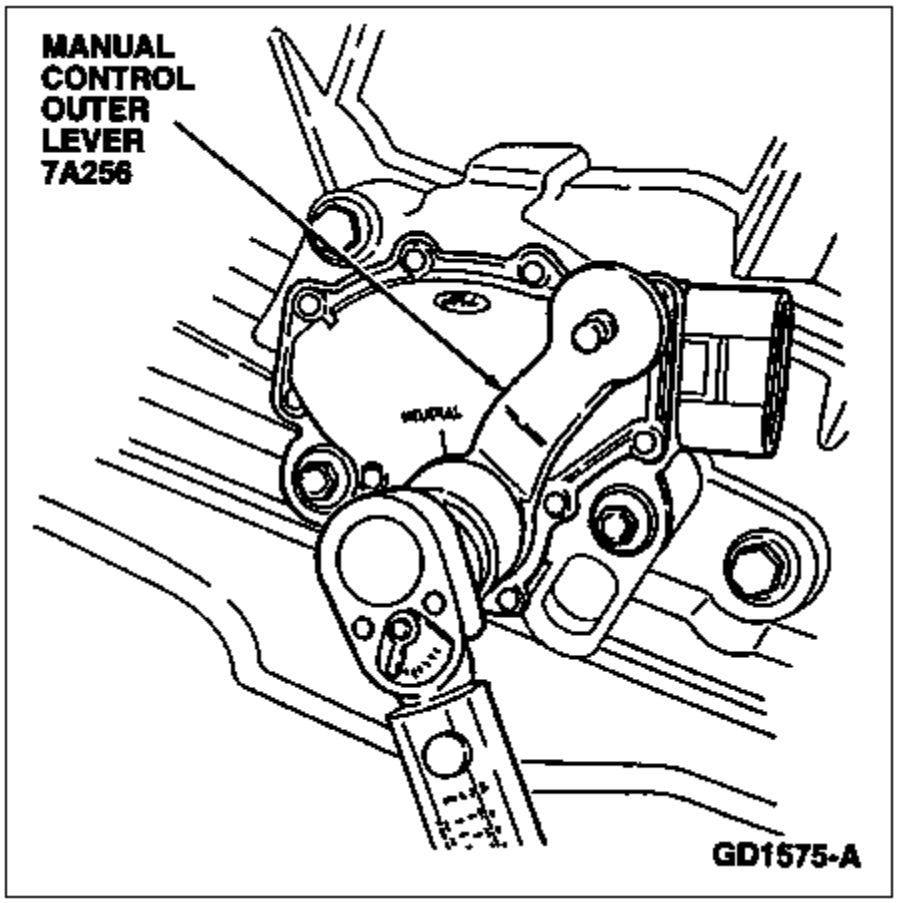

4. Install shift cable or linkage from manual control lever (7A256). Use a screwdriver to remove the cable and fitting from the transmission lever ball stud.

5. Adjust shift cable. Refer to adjustments in Section 07-05 .

6. Reconnect vehicle harness connector to DTR sensor.

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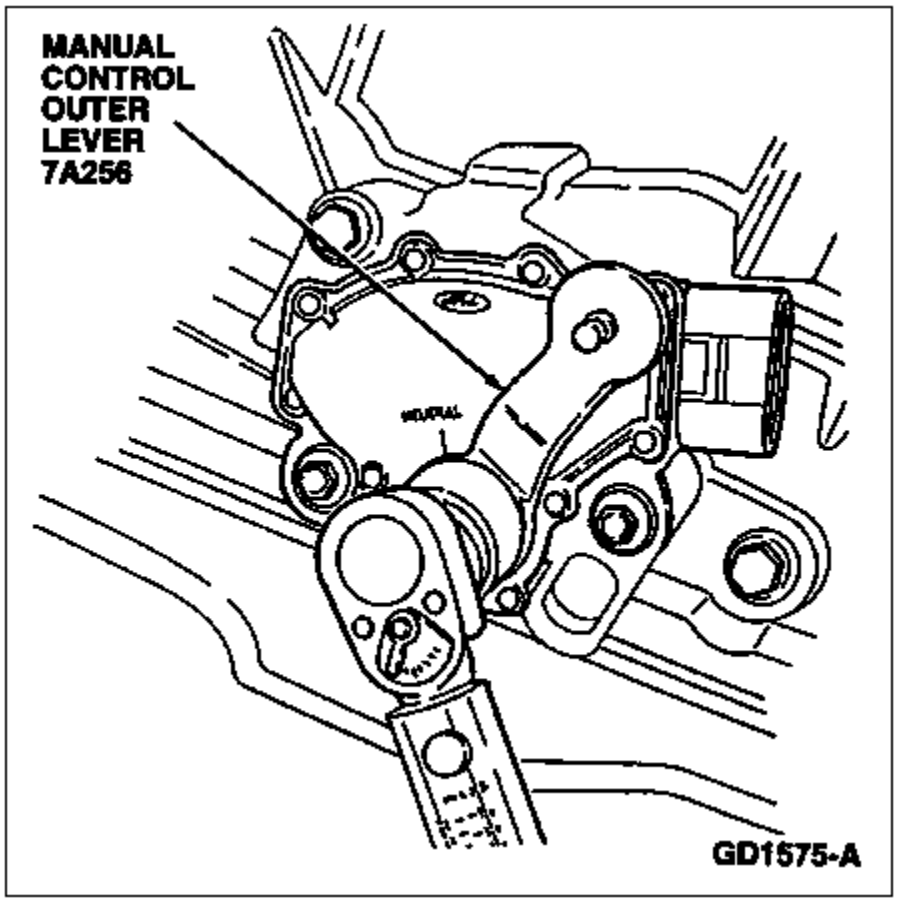
Digital Transmission Range (DTR) Sensor Adjustment

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Digital TR Sensor Alignment Tool	T97L-70010-A

1. Use a screwdriver to remove the shift cable and fitting from the transmission lever ball stud.
2. Disconnect vehicle harness connector from digital transmission range (DTR) sensor by depressing tab.
3. Remove the manual control outer lever nut and manual control outer lever.



4. Loosen the two M6 x 25 TR sensor screws.
5. Install Digital TR Sensor Alignment Tool T97L-70010-A into the three slots on the DTR sensor. Tighten the TR sensor-to-case screws to 8-11 Nm (71-97 lb-in). Remove the alignment tool.

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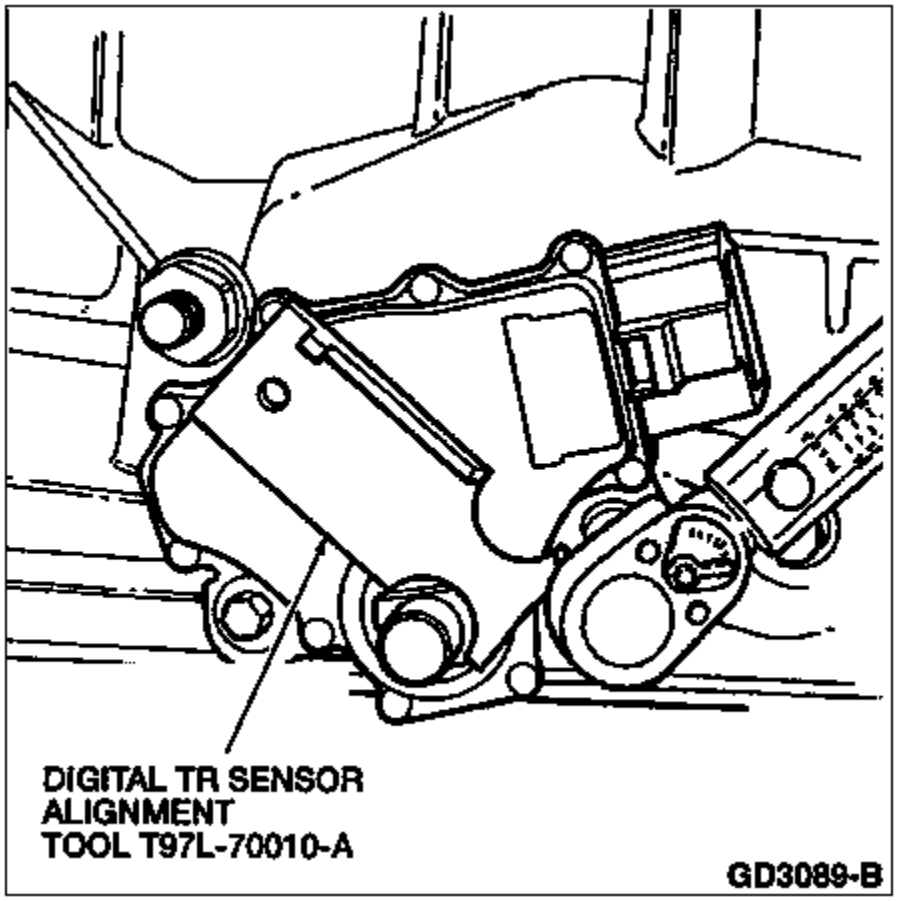

6. Install the manual control outer lever and manual control outer lever nut. Tighten the manual control outer lever nut to 41-54 Nm (30-40 lb-ft).

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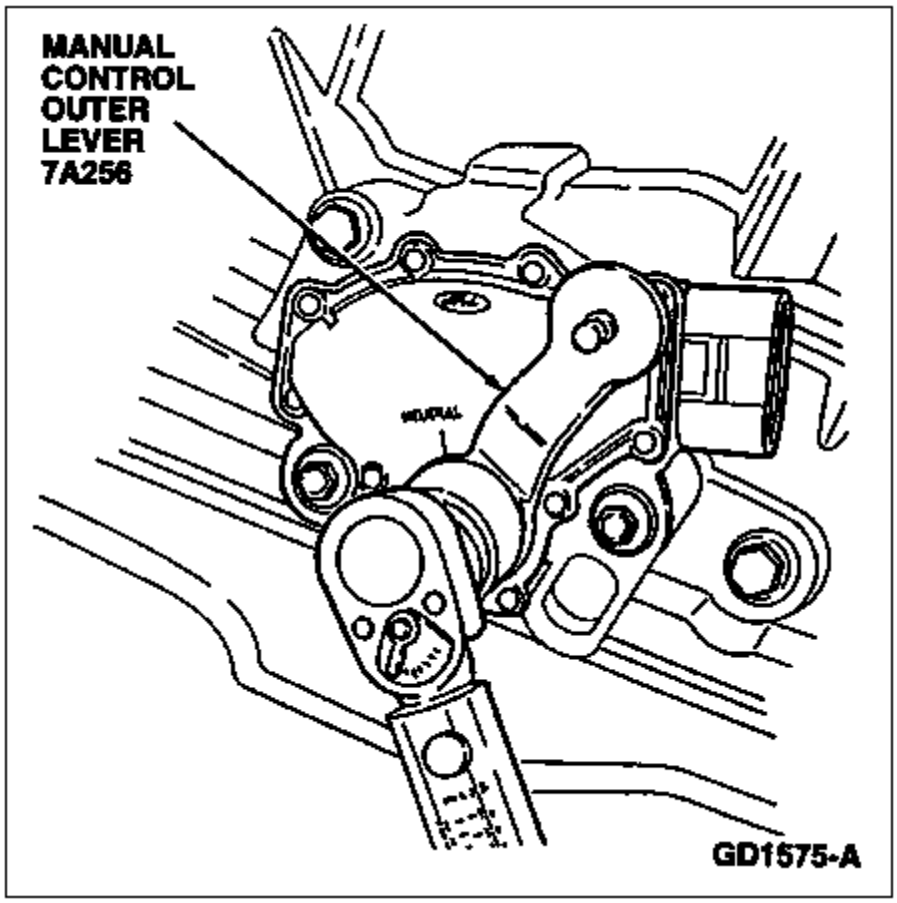

7. Install shift cable or linkage from manual control lever (7A256). Use a screwdriver to remove the cable and fitting from the transmission lever ball stud.

8. Adjust shift cable. Refer to adjustments in Section 07-05 .

9. Reconnect vehicle harness connector to DTR sensor.

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Heat Shield

Removal

1. **NOTE: A transmission heat shield is on all 4.0L vehicles.**

   Remove the M6 x 1.0 transmission heat shield nut from the studded screw.

2. Carefully pry the transmission heat shield off the fluid pan rail.

Installation

1. **NOTE: A heat shield is on all 4.0L vehicles.**

   Align heat shield retaining clips over fluid pan rail and install the heat shield on the fluid pan rail.

2. Install the heat shield nut. Tighten the heat shield nut to 8-11 Nm (71-97 lb-in).

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Fluid Pan, Gasket and Filter

Removal

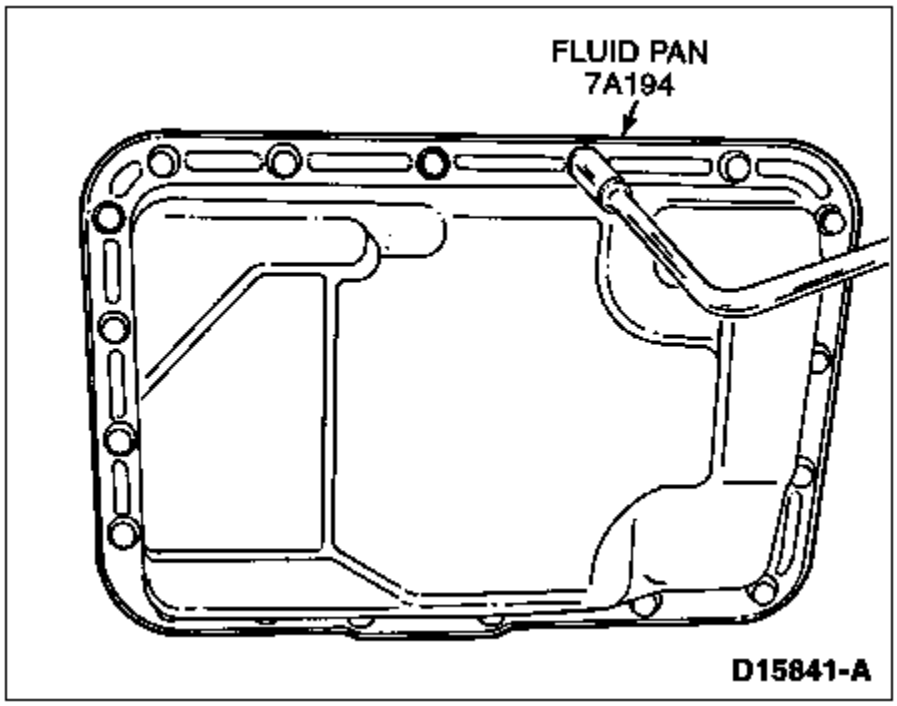
1. **NOTE: A transmission heat shield is on all 4.0L vehicles.**

   Remove the M6 x 1.0 transmission heat shield nut from the studded screw.

2. Carefully pry the transmission heat shield off the fluid pan rail.

3. **NOTE: Heat shield does not have to be removed from vehicle for fluid pan removal.**

   Using a 13mm socket, remove all M8 x 16mm fluid pan screws, except for two in the front. Loosen two front screws only.



4. Pry the rear of the pan down and allow fluid to drain.

5. Support fluid pan and remove two remaining screws.

6. Remove fluid pan and discard old gasket.

7. Use a 10mm socket to remove the M6 x 55mm fluid filter assembly screw. Remove the fluid filter

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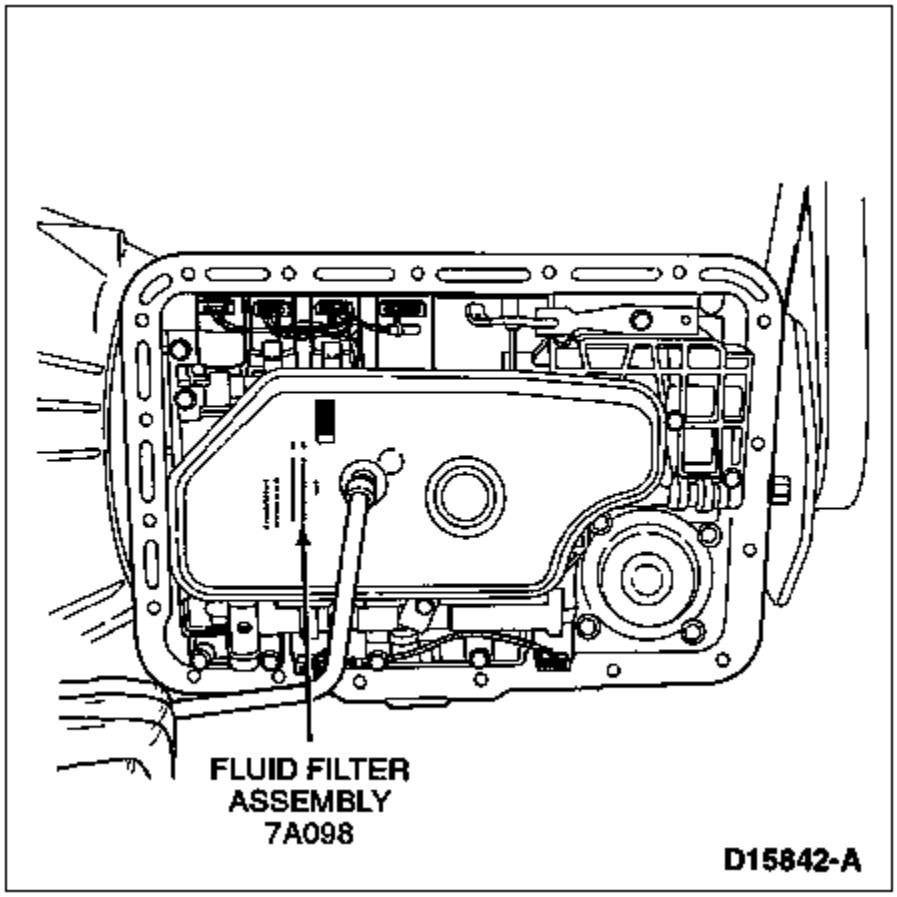
assembly and discard.



Installation

1. Clean all mating surfaces, making sure they are free from debris and oil.
2. Install new fluid pan gasket on fluid pan and align holes.
3. Lube and install new O-rings onto filter assembly.
4. Install new filter onto main control assembly.
5. Make sure that both O-rings are properly installed on filter prior to installation.

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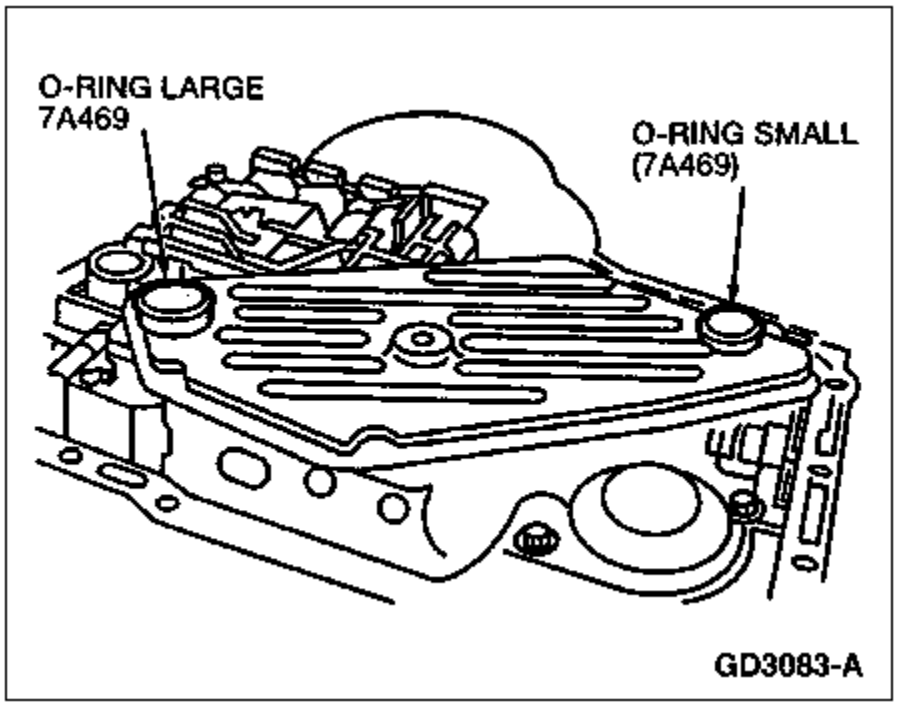

6. **CAUTION: Make sure wire harness is not pinched under filter.**

   Install one M6 x 55mm fluid filter assembly-to-main control assembly screw using a 10mm socket as shown. Tighten to 8-11 Nm (71-97 lb-in).

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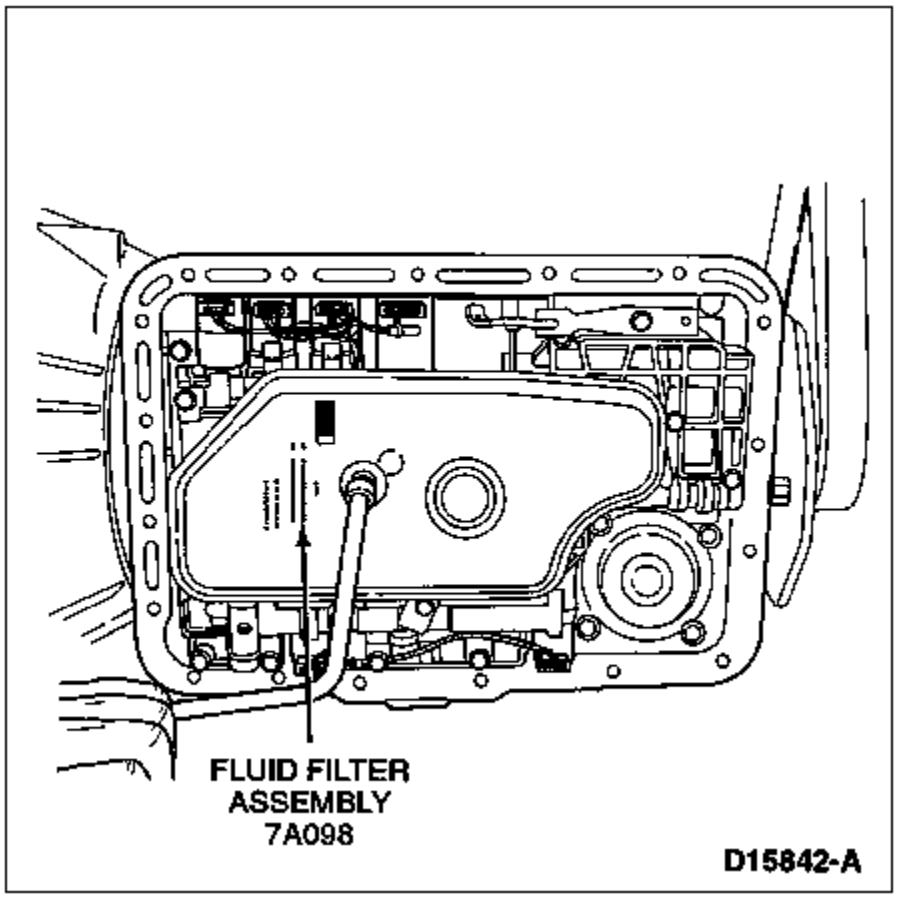

7. Install fluid pan and gasket onto transmission and install eighteen M8 x 16mm fluid pan-to-case screws. Tighten to 13-15 Nm (115-133 lb-in) using a crisscross sequence.

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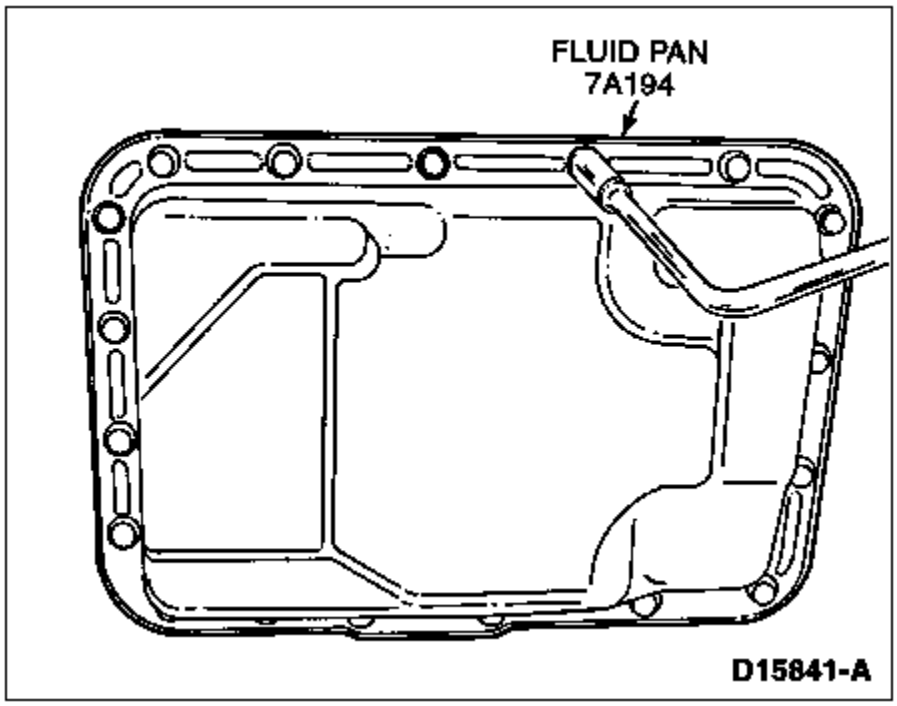

8. **NOTE: A heat shield is on all 4.0L vehicles.**

   Align heat shield retaining clips over fluid pan rail and install the heat shield on the fluid pan rail. Install the heat shield nut. Tighten the heat shield nut to 8-11 Nm (71-97 lb-in).

9. Fill the transmission to the proper level. Refer to the procedure in this section.

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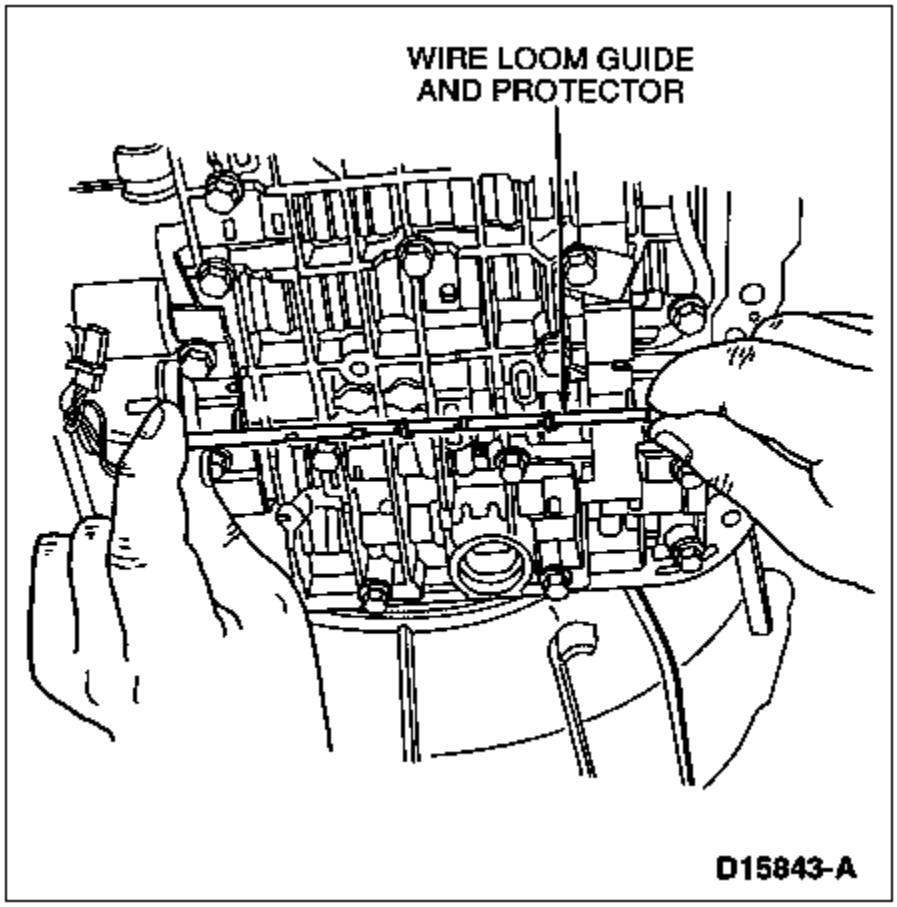
Solenoid Service

Removal

NOTE: Main control assembly does not need to be removed for solenoid service.

1. Remove fluid pan gasket and filter as described in this section.
2. Carefully lift up on the wire loom guide and protector. Disengage the retaining pins from the solenoid brackets.



3. Disconnect the appropriate solenoid connector(s) from the solenoid(s) by carefully pulling downward and wiggling side to side.

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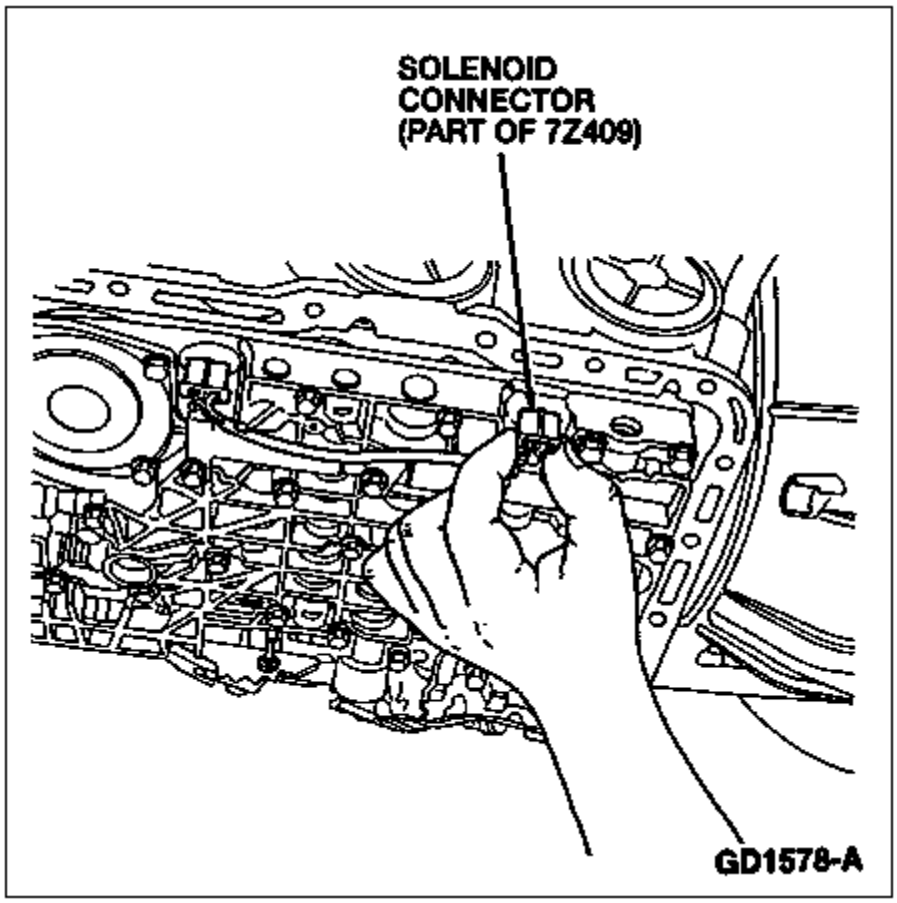

4. **CAUTION: SS3 may pop out of its bore. This may damage the solenoid.**

   NOTE: Steps 4, 5 and 6 refer to SS1 and SS3 solenoids only.

   Use a 10mm socket to remove the SS1 and SS3 solenoid clamp screws. Remove the solenoid clamp.

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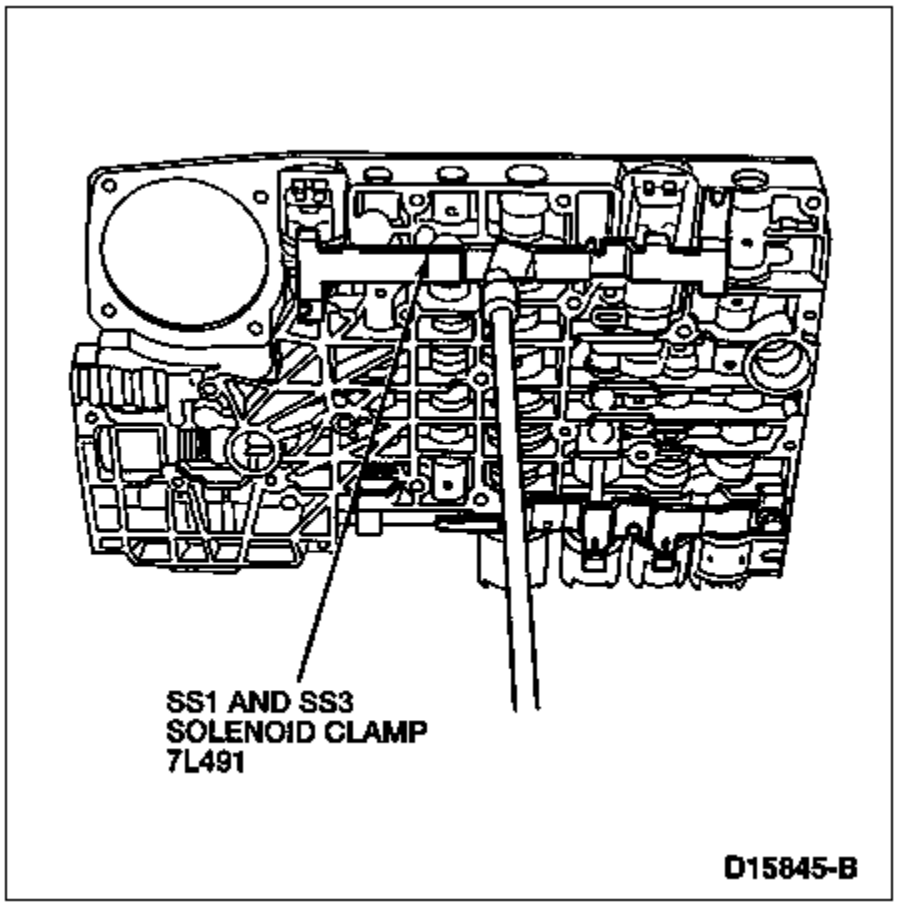

5. Remove SS1 and SS3 and service as required.

6. **CAUTION: The TCC solenoid may pop out of its bore. The converter modulator valve may come out after the TCC solenoid has been removed. This may damage the solenoid or converter modulator valve.**

   NOTE: Steps 6-8 refer to TCC, SS4, SS2 and EPC solenoids only.

   Remove the TCC, SS4, SS2 and EPC solenoid clamp screws.

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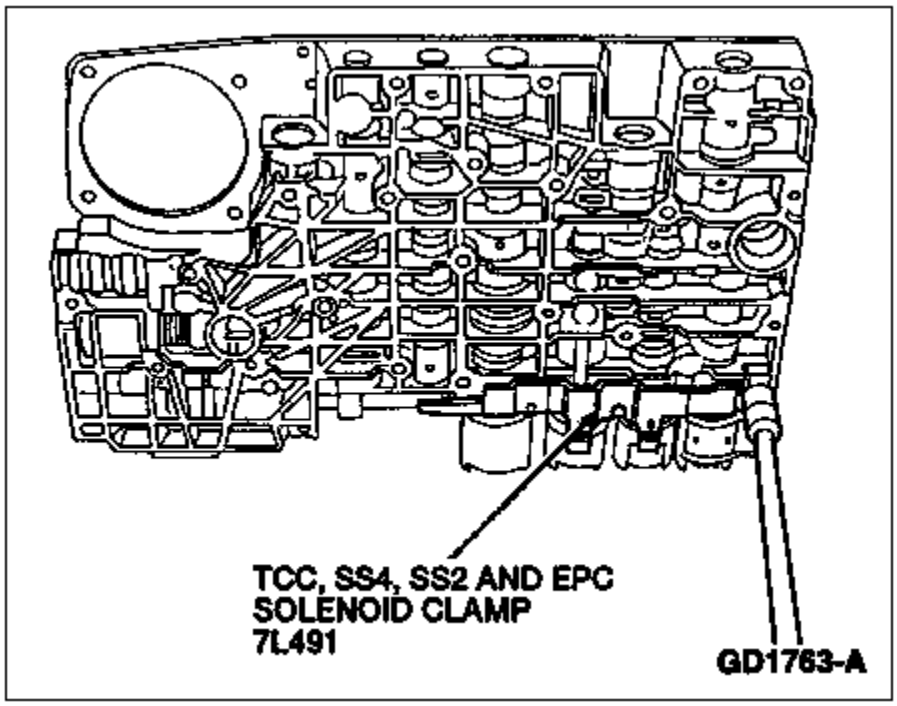

7. Remove the solenoid clamp.

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8. Remove solenoids and service as required.

Installation

1. **CAUTION: The solenoid clamp must be installed in the TCC and EPC solenoid grooves, shift solenoid pockets and the No. 204 plug.**

   Install the TCC, SS4, SS2, EPC solenoids, solenoid clamp and screws. Tighten to 6-8 Nm (53-71 lb-in).

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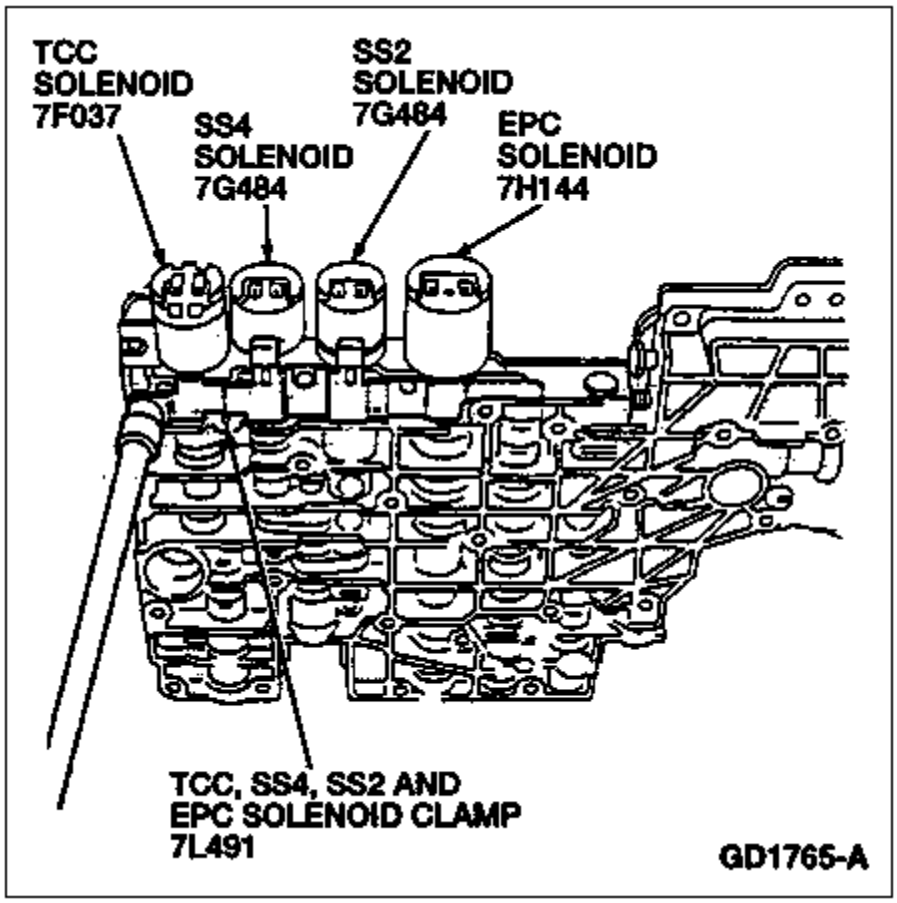

2. Install the SS1 and SS3 solenoids, solenoid clamp and screws. Tighten to 8-11 Nm (71-97 lb-in).

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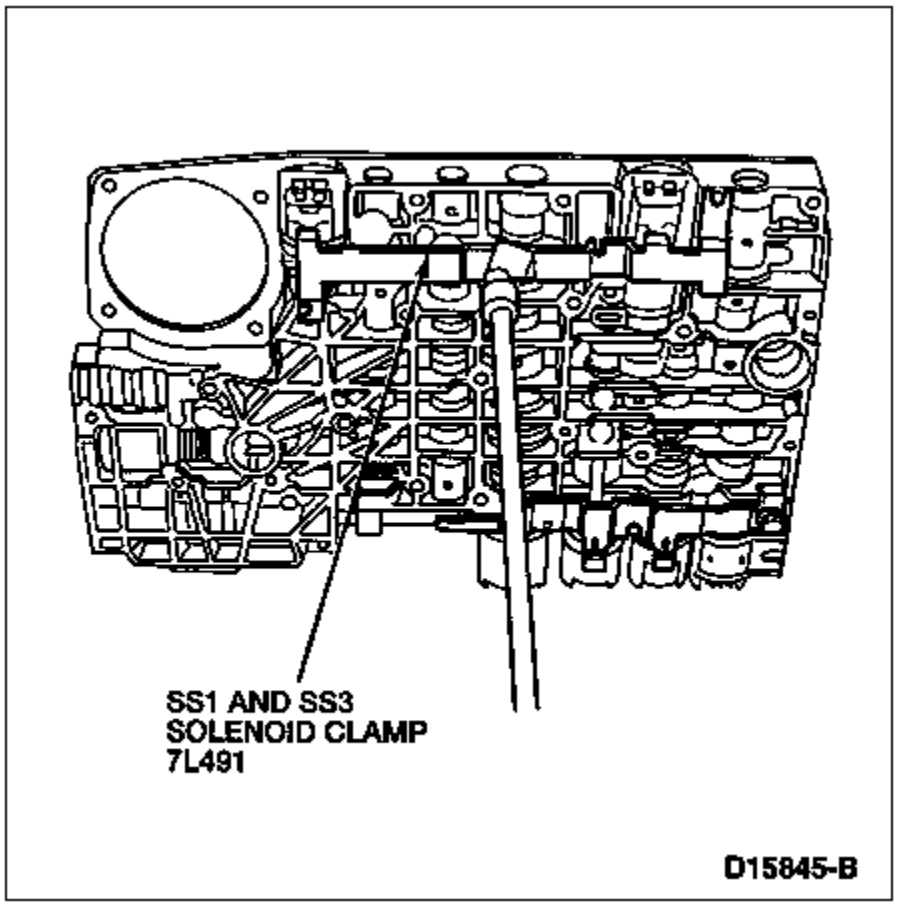

3. Carefully press down to install the solenoid connectors on the solenoids as shown.

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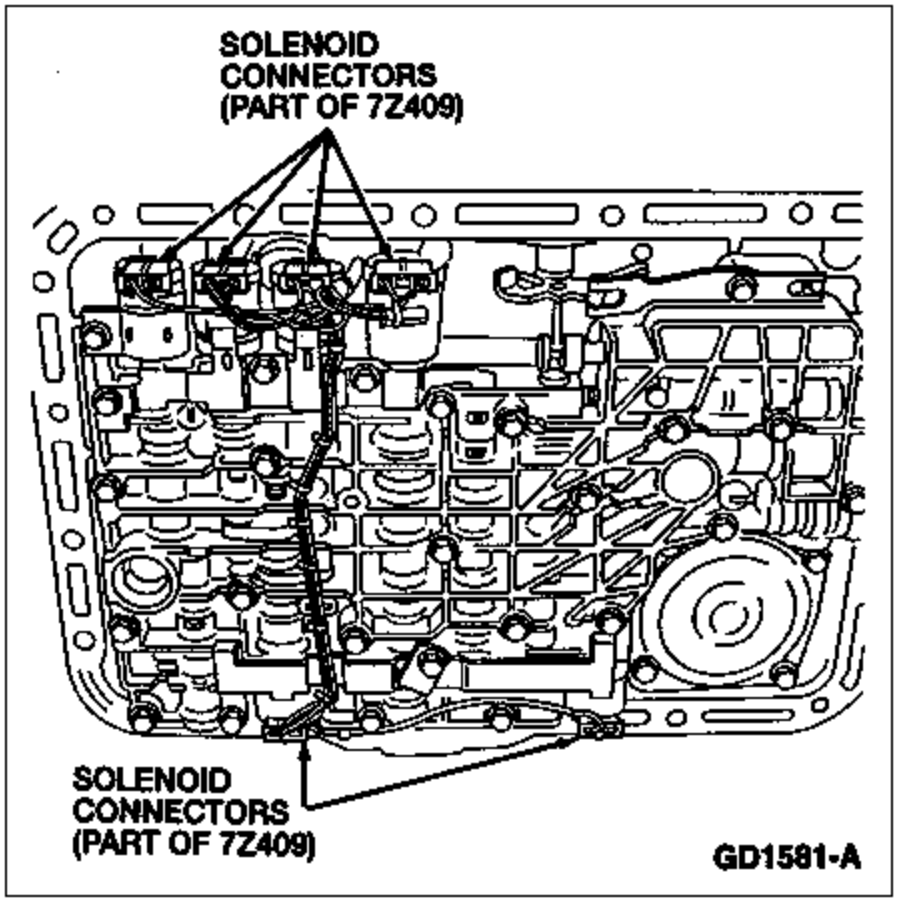

4. **CAUTION: Excessive pressure may break the locating pins.**

   Install the wiring loom protector and guide. Align the pins in the holes of the solenoid clamps and gently push down.

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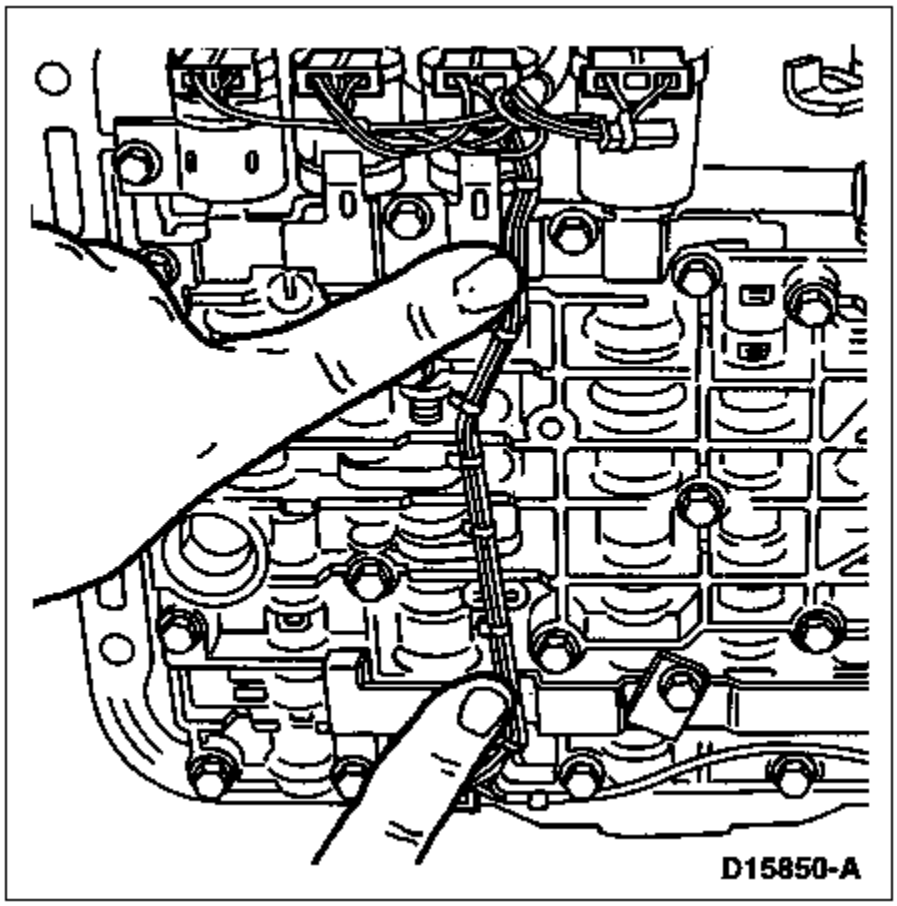

5. Install new fluid pan gasket and filter as described in this section.
6. Fill the transmission to the proper level. Refer to the procedure in this section.

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Internal Harness Service

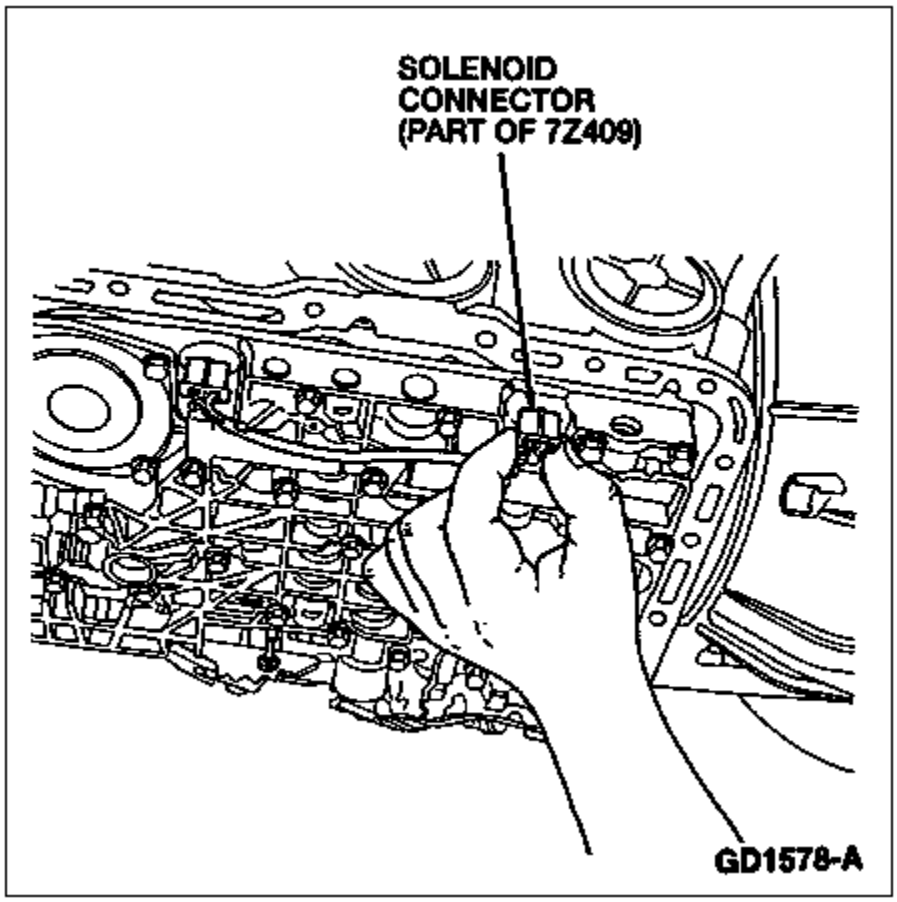
16-Pin Connectors

Removal

NOTE: The main control assembly does not need to be removed.

1. Remove fluid, pan, gasket and filter as described in this section. Discard filter.
2. **NOTE: Only EPC and SS2 solenoid connectors need to be removed.**

   Disconnect the solenoid connectors from the solenoids by carefully pulling downward and wiggling side to side.



3. **CAUTION: The TCC solenoid may pop out of its bore. The converter modulator valve may**

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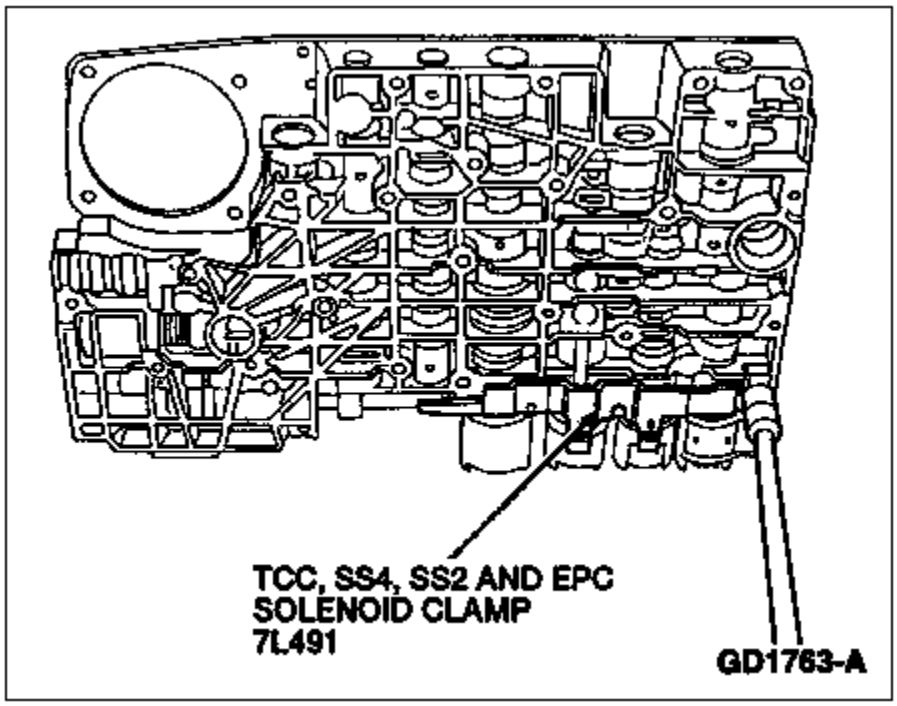
come out after the TCC solenoid clamp has been removed. This may damage the solenoid or converter modulator valve.

Remove the TCC, SS4, SS2 and EPC solenoid clamp screws.



4. Remove the solenoid clamp and EPC and SS2 solenoids.

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5. **CAUTION: Do not pry on other wires or damage the connector case surface.**

   Carefully disconnect the turbine shaft speed (TSS) sensor connector from the 16-pin case connector.

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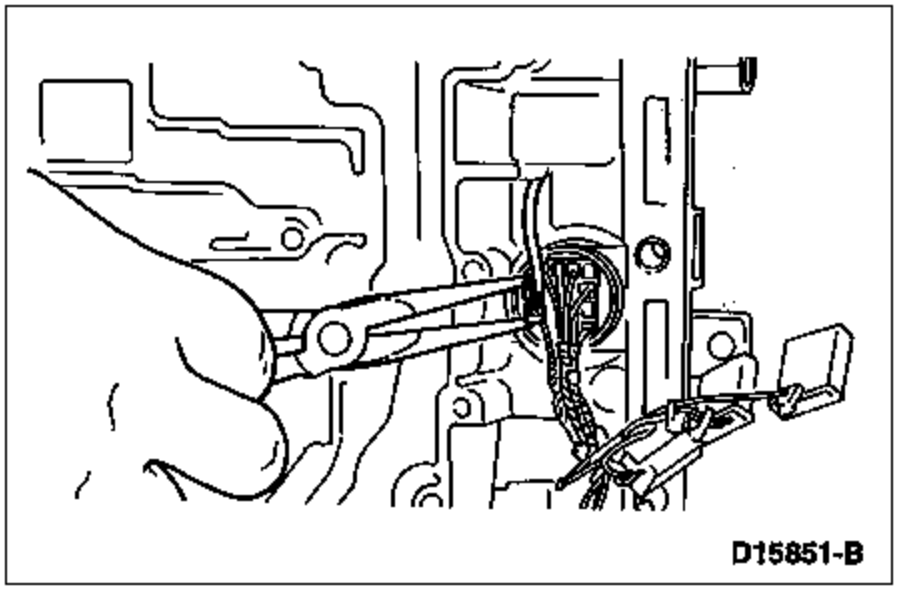
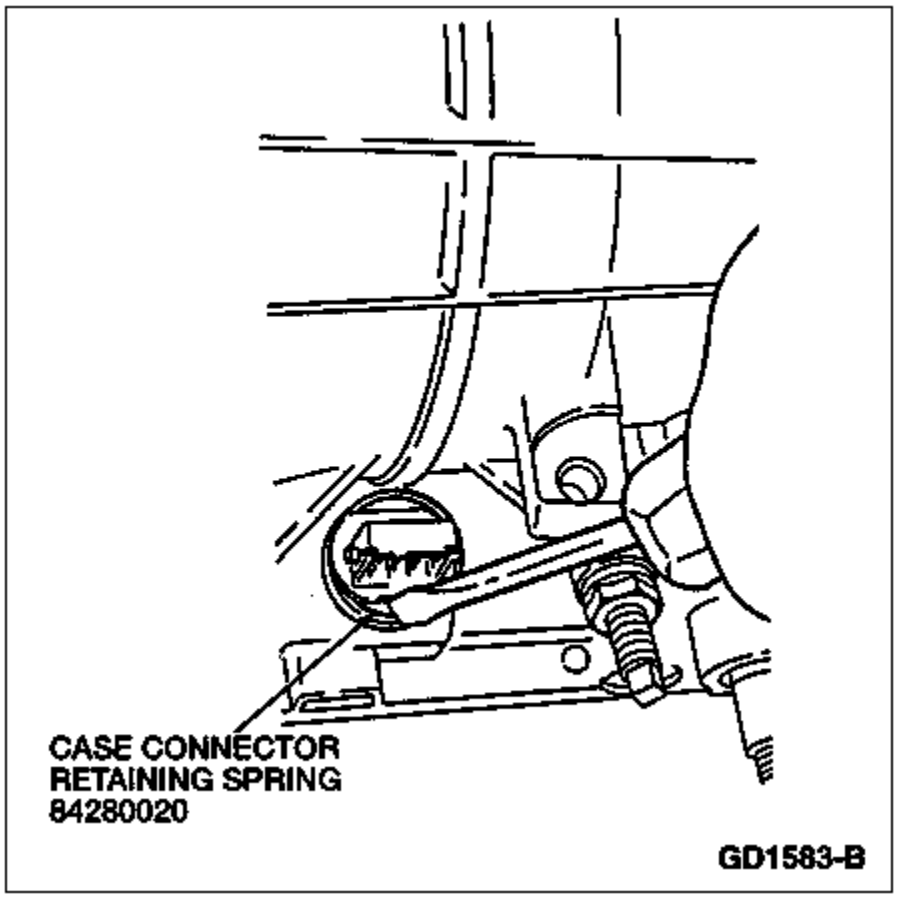


6. **CAUTION: Do not overstretch the case connector retaining ring.**

Use a screwdriver to carefully remove the case connector retaining spring.



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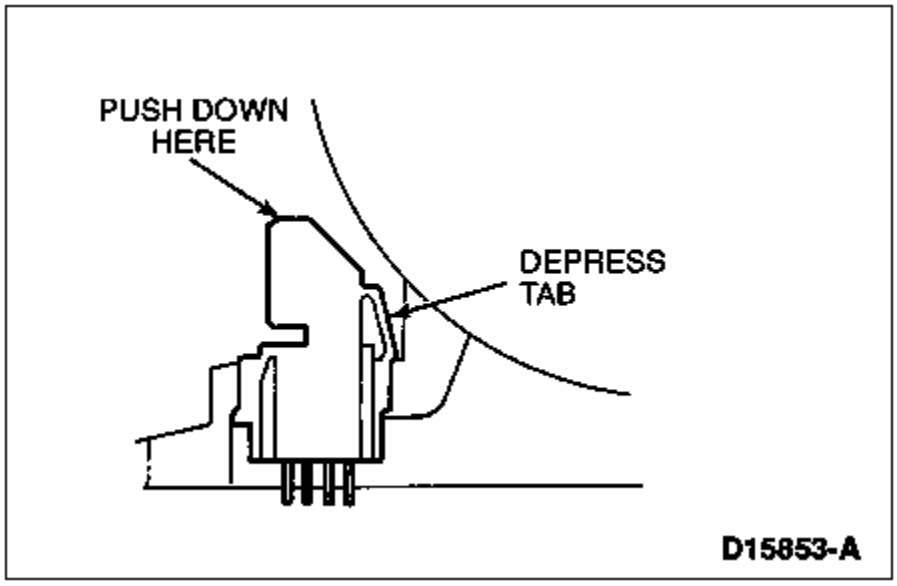
7. **CAUTION: Do not damage the connector or harness.**

   Carefully push down on the top of the connector until it stops. Depress the tab on the back side of the connector and push down on the connector.



8. Remove the connector and harness through the bottom of the case.

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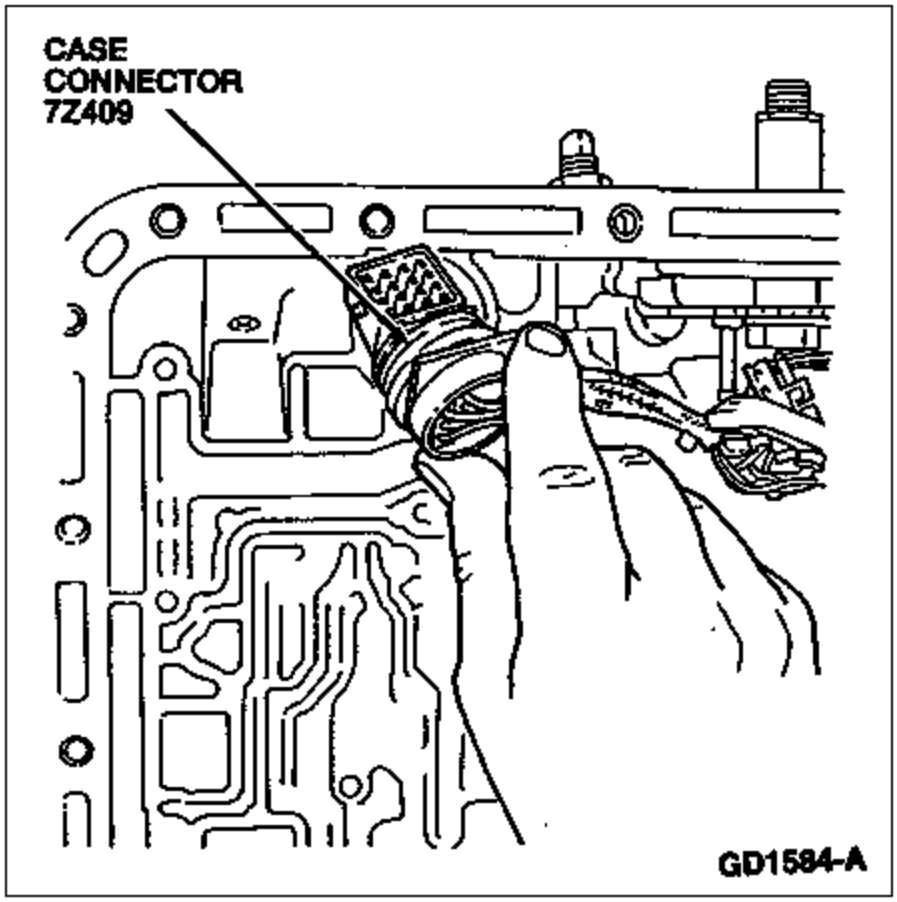

Installation

1. Replace O-rings (W703015-S300) on connector.
2. **NOTE: Make sure the tab is in the lock position.**

   Install the case 16-pin connector through the case until a click is heard.

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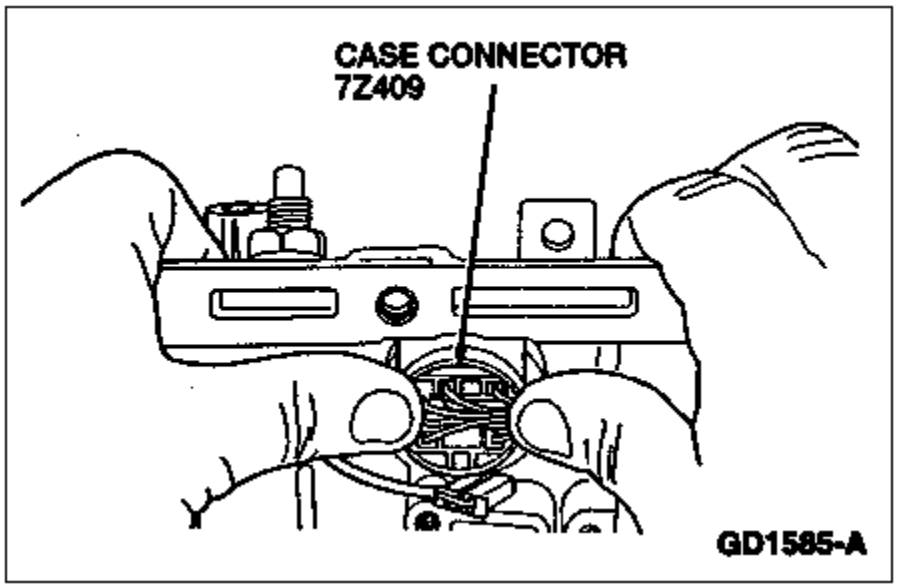
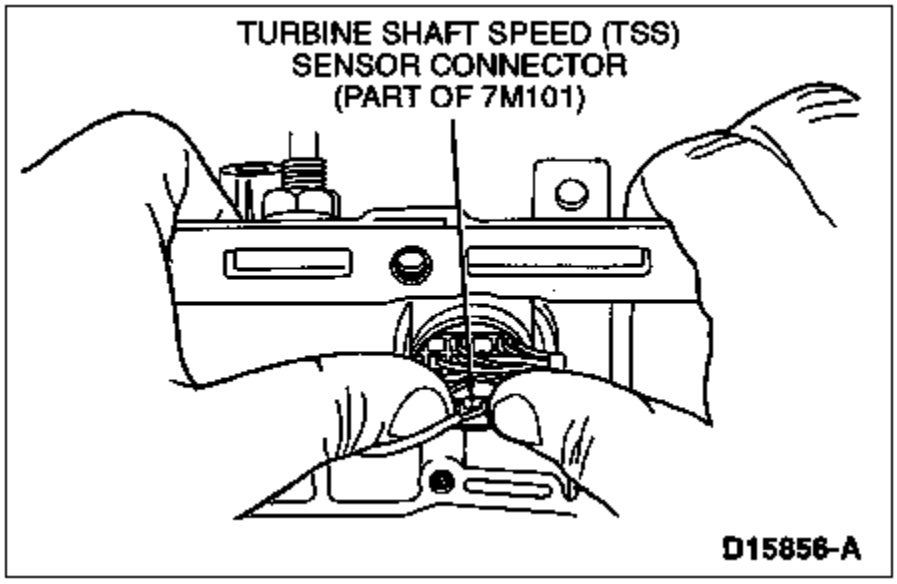


3. **NOTE: Align the slot on the TSS connector with the slot on the 16-pin case connector.**

   Carefully install the TSS connector into the 16-pin case connector.



4. **CAUTION: Do not overstretch the retaining spring.**

   Install the case connector retaining spring.

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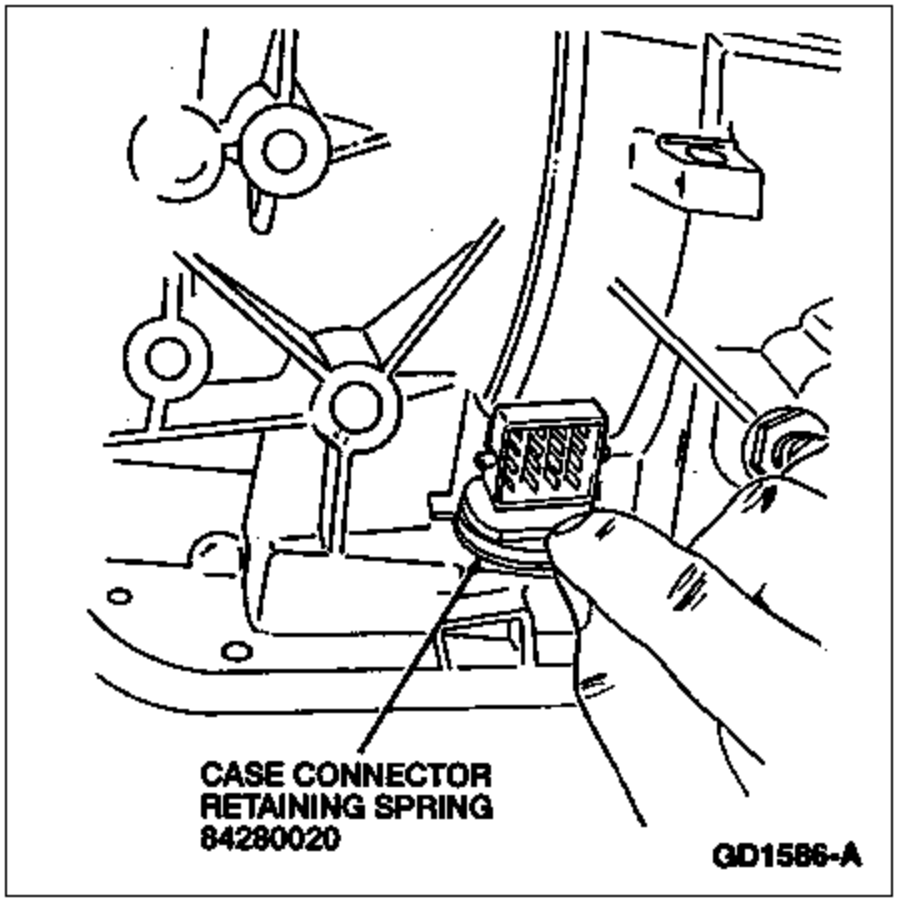

5. Install SS2 and EPC solenoids.

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6. **CAUTION: The solenoid bracket must be installed in the TCC and EPC solenoid grooves, shift solenoid pockets and the No. 204 plug.**

   Install the solenoid clamp with solenoid clamps-to-main control screws. Tighten to 6-8 Nm (53-71 lb-in).

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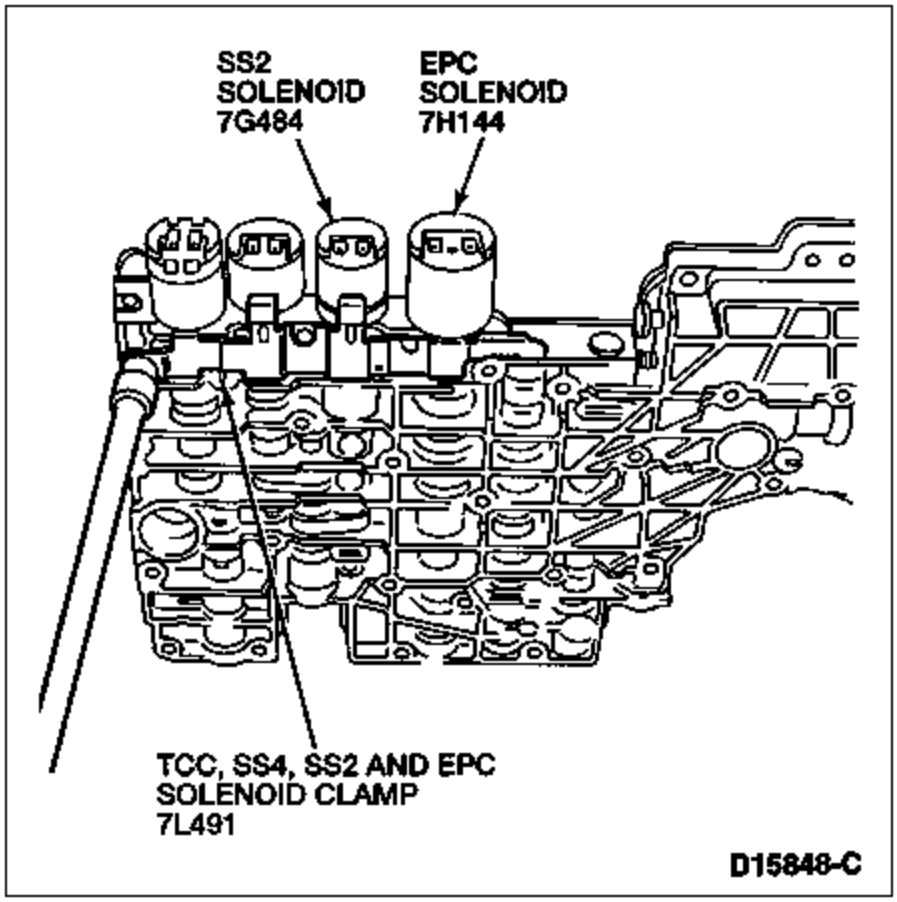

7. Install connectors on solenoids.
8. Install filter.
9. Install new fluid pan gasket onto pan.
10. Install pan.
11. Fill the transmission to the proper level. Refer to the procedure in this section.

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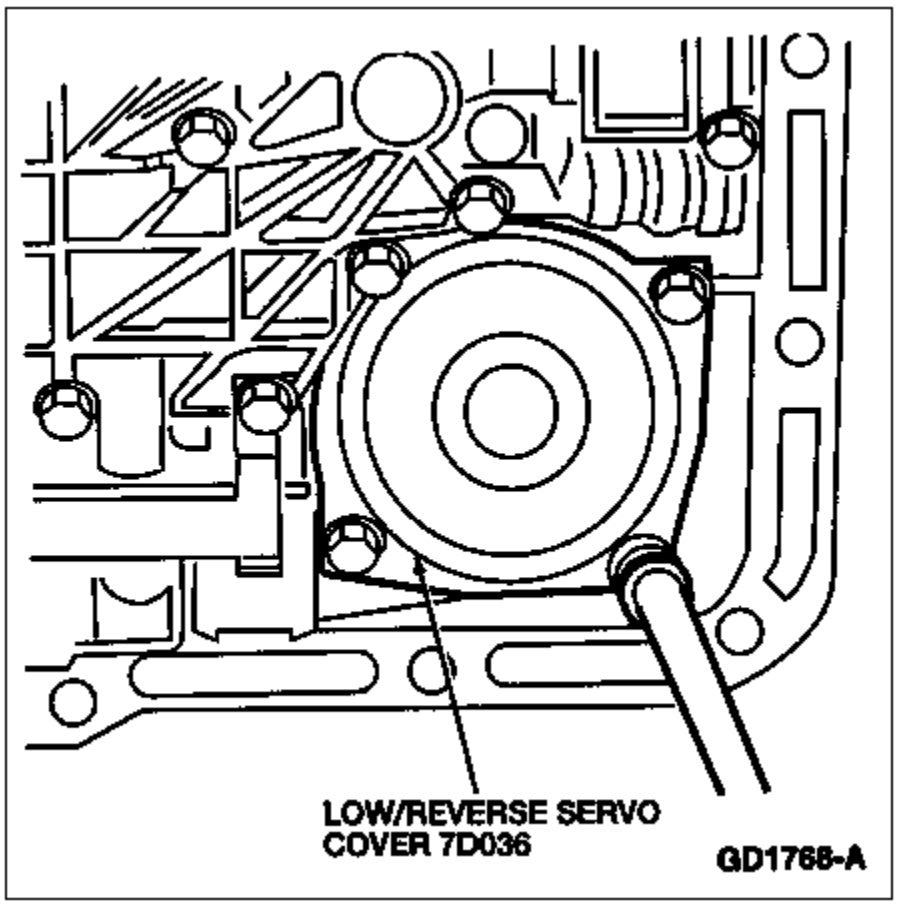
Low/Reverse Servo Assembly

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Servo Red Selecting Gauge	T74P-77190-A

Removal

1. Remove fluid pan and filter as described in this section.
2. Use a 10mm socket to remove the four M6 x 20mm low/reverse servo cover screws. Remove the low/reverse servo cover, gasket and the servo piston and rod assembly.



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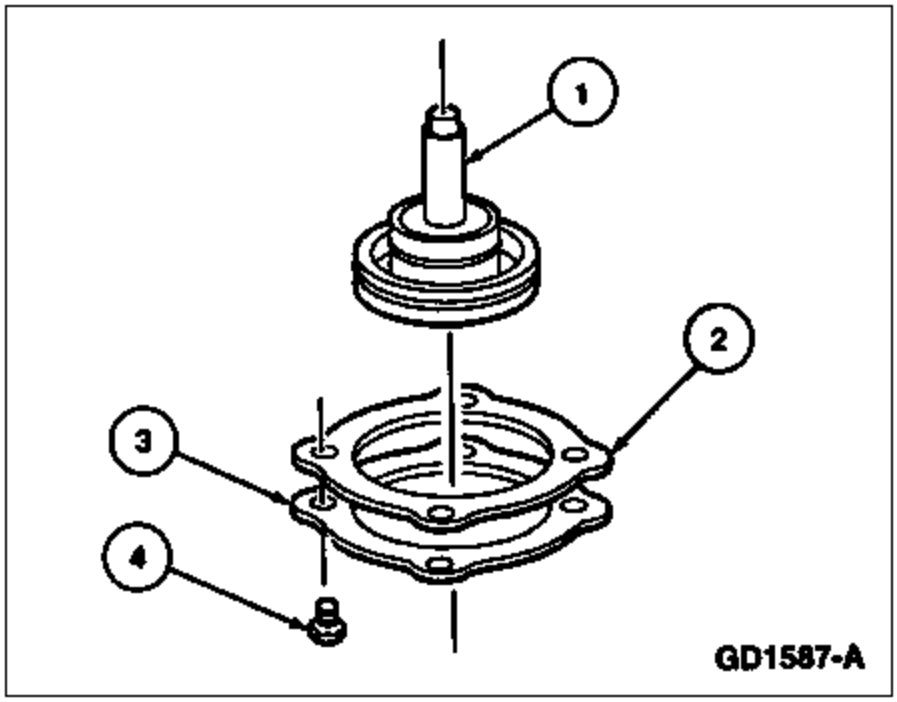

Item	Part Number	Description
1	7D189	Low/Reverse Servo and Rod Assembly
2	7L173	Low/Reverse Servo Cover-to-Case Gasket
3	7D036	Low/Reverse Servo Cover
4	E800156-S	Low/Reverse Servo Cover-to-Case Screw (4 Req'd)

3. Clean and inspect servo bore, piston and rod assembly. Service as required.

Installation

1. **NOTE: An A4LD Reverse Servo Return Spring D4ZZ-7D031-A is to be used only as a test spring.**

   Install the low/reverse servo piston and rod into the servo bore along with a D4ZZ-7D031-A reverse servo return spring.

2. Install a new low/reverse servo separator plate cover gasket. Install Servo Rod Selecting Gauge T74P-77190-A and tighten with the three screws.

3. Tighten the servo gauge adjusting screw to 4 Nm (35.5 lb-in).

4. Install Dial Indicator with Bracketry TOOL-4201-C or equivalent on the transmission case. Position the indicator on the piston pad. Set the dial indicator to zero.

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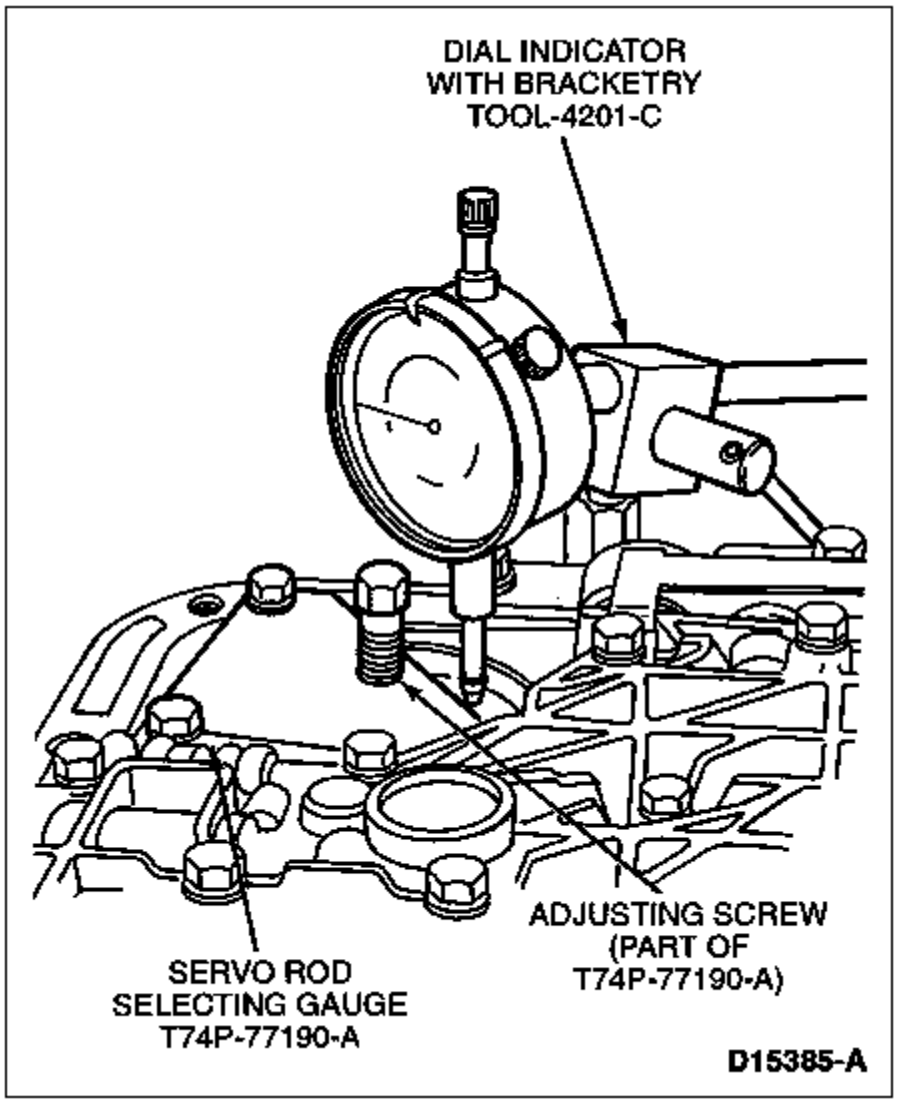

5. **NOTE: If the piston travel in this step is 3-5.6mm (0.120-0.220 inch), it is within specification. If the piston travel is greater than 5.6mm (0.220 inch), use the next longer piston and rod. If the piston travel is less than 3mm (0.120 inch), use the next shorter piston and rod.**

   Back out the servo gauge adjusting screw until it bottoms out on the tool. Record the distance the servo piston traveled.

6. **CAUTION: Make sure the test spring is removed after this step.**

   Use the above procedure to check the piston travel with the newly selected reverse band servo piston and rod (if required) to make sure that the piston travel is 3-5.6mm (0.120-0.220 inch).

   Remove the servo gauge and the reverse band servo return spring.

NOTE: Grooves are located on reverse servo rod.

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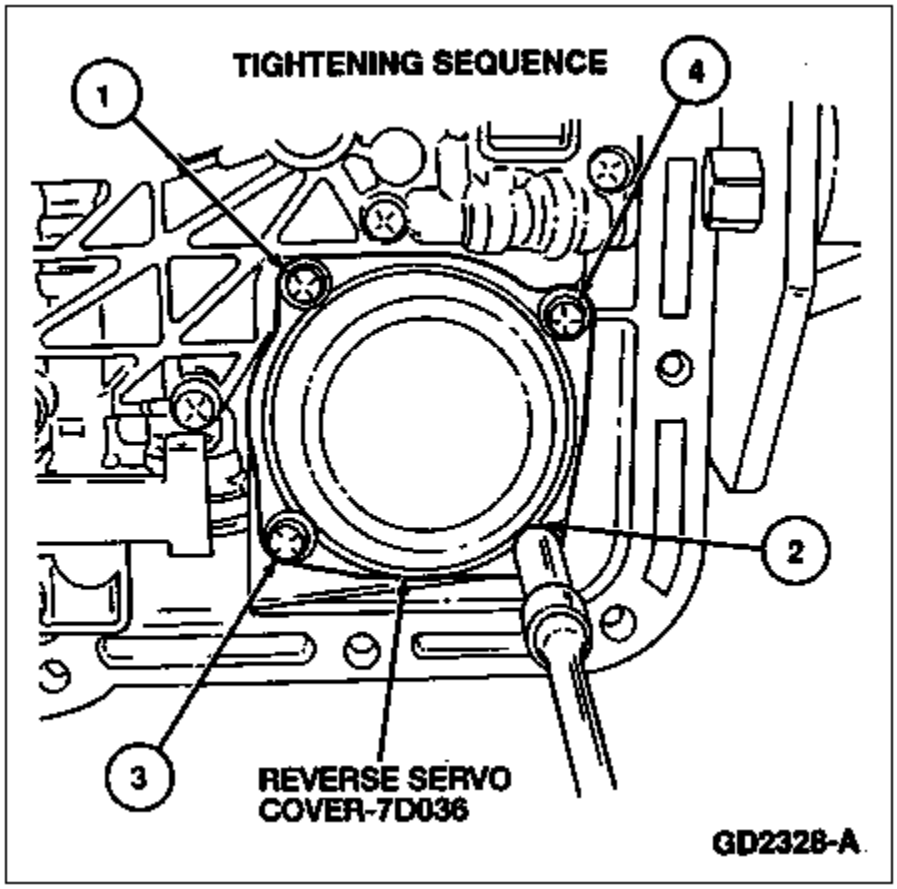
Length — mm	Length — Inches	I.D.
54/53	2.112/2.085	1 Groove
51/50	2.014/1.986	No Groove
49/48	1.915/1.888	2 Grooves

7. Install the low/reverse servo and rod assembly into the case.

8. Install the low/reverse servo cover, new gasket and the four low/reverse servo cover-to-case screws. Tighten cover-to-case screws in sequence as shown to 12-14 Nm (106-124 lb-in).



9. Install pan, new gasket and filter as described in this section.

10. Refill transmission.

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Manual Control Lever Shaft Seal

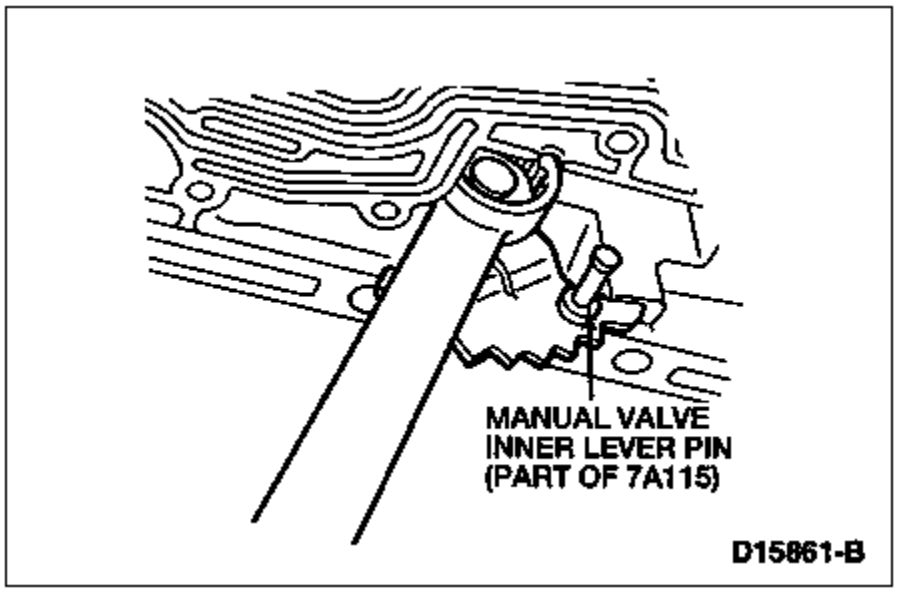
SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Shift Lever Seal Replacer	T74P-77498-A

Removal

1. Remove linkage and digital transmission range (DTR) sensor as described in this section.
2. Remove fluid pan. Filter does not need to be removed.
3. **CAUTION: Do not damage the manual valve inner lever pin.**

   Remove the manual valve inner lever nut. Support inner manual valve lever and park rod assembly.



4. **CAUTION: Do not damage the case fluid pan rail.**

   Use a small hammer and drift punch to tap lightly on each side of the manual control lever shaft spring pin (two or three times). This will loosen the pin prior to removal.

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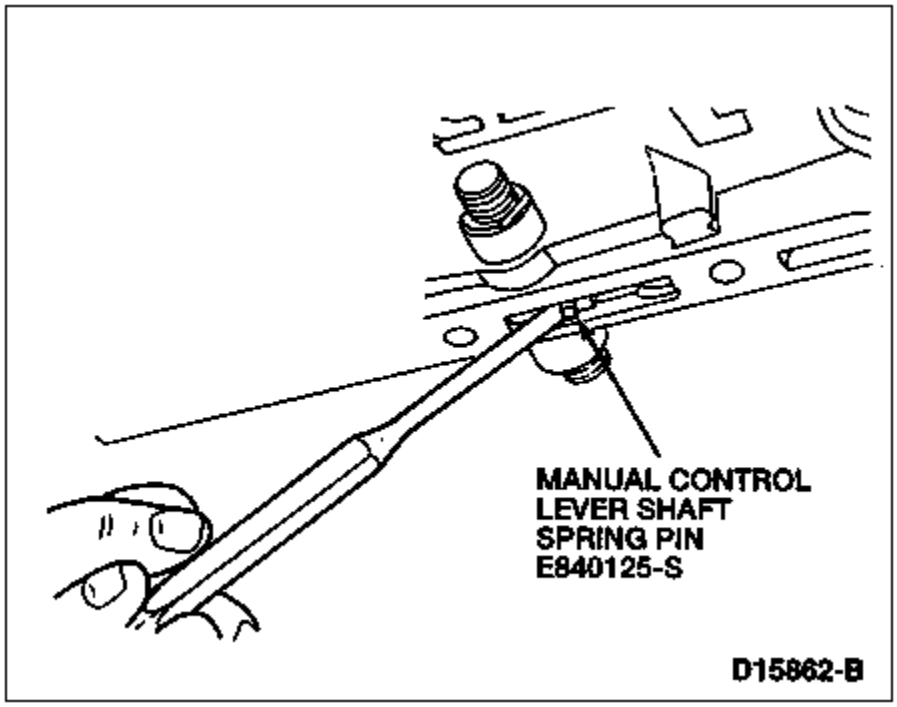
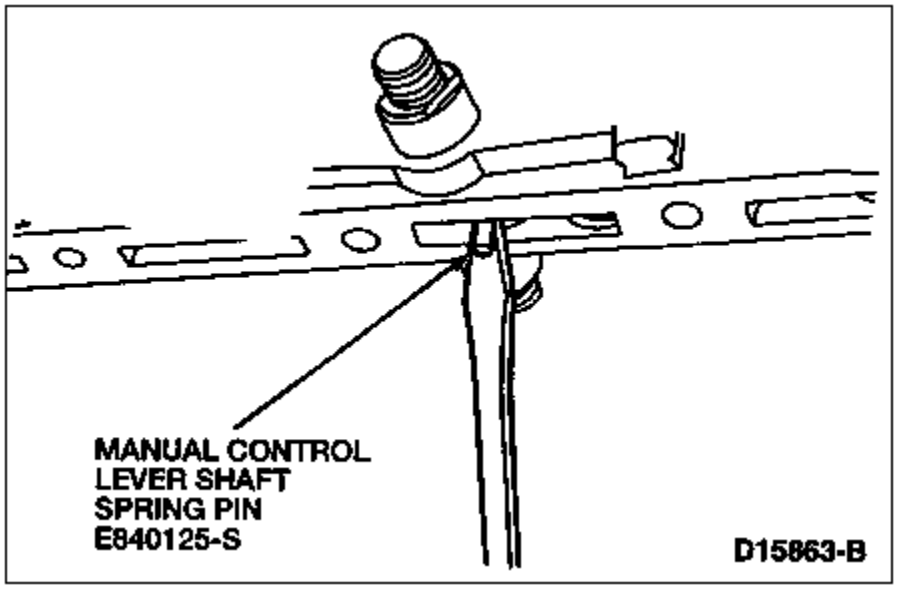


5. **CAUTION: Do not damage the case fluid pan rail.**

   Remove the manual control lever shaft spring pin with a narrow, sharp-edged screwdriver from the side as shown.



6. Remove the manual control lever shaft.

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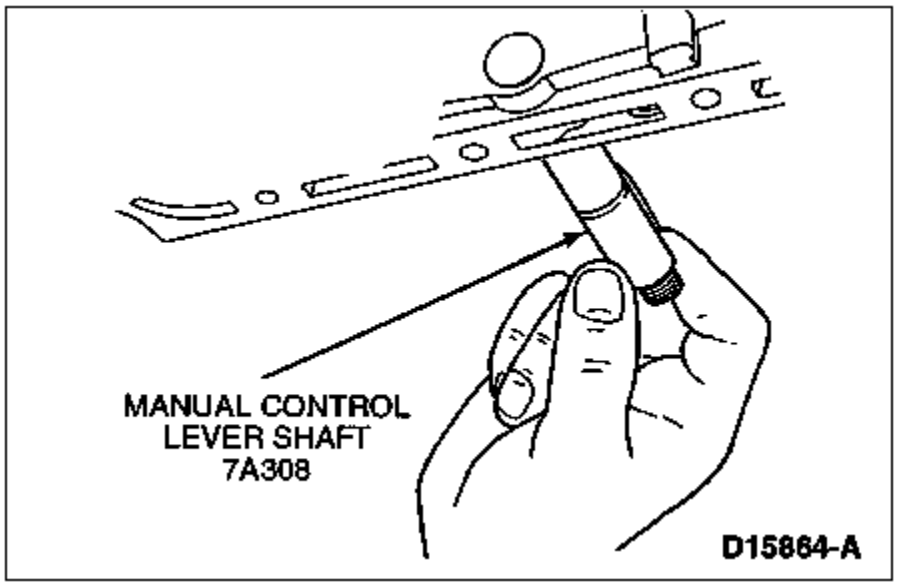
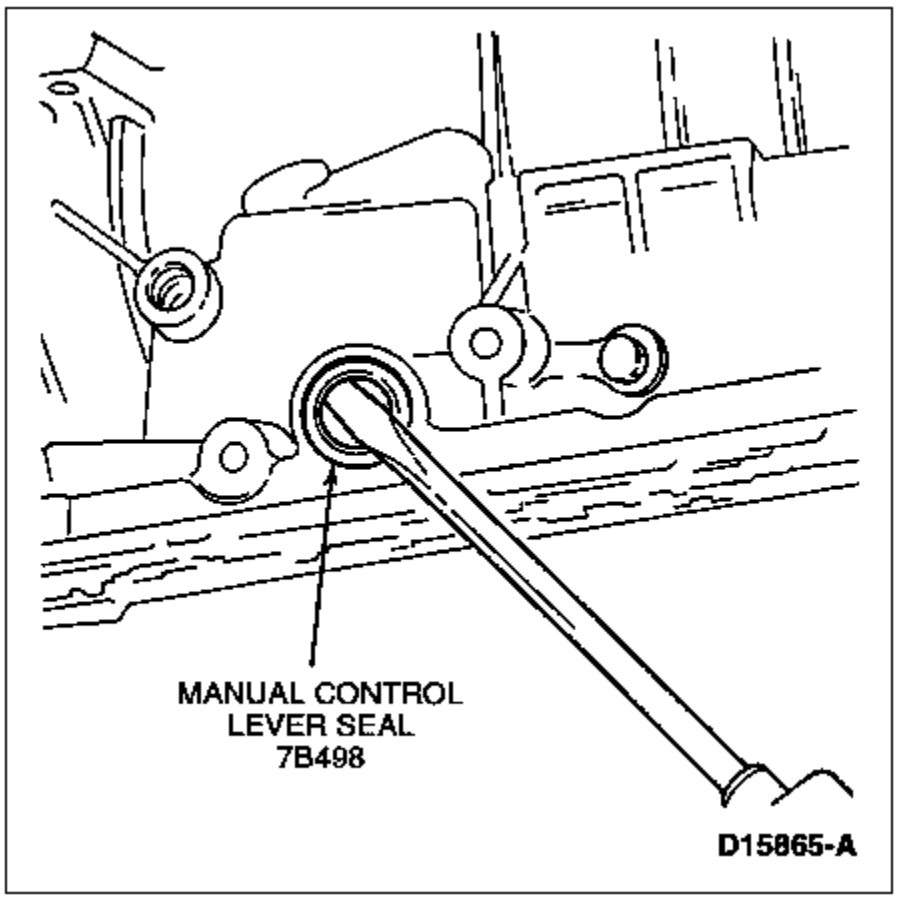


7. **CAUTION: Do not damage the bore.**

   Remove the manual control lever seal.



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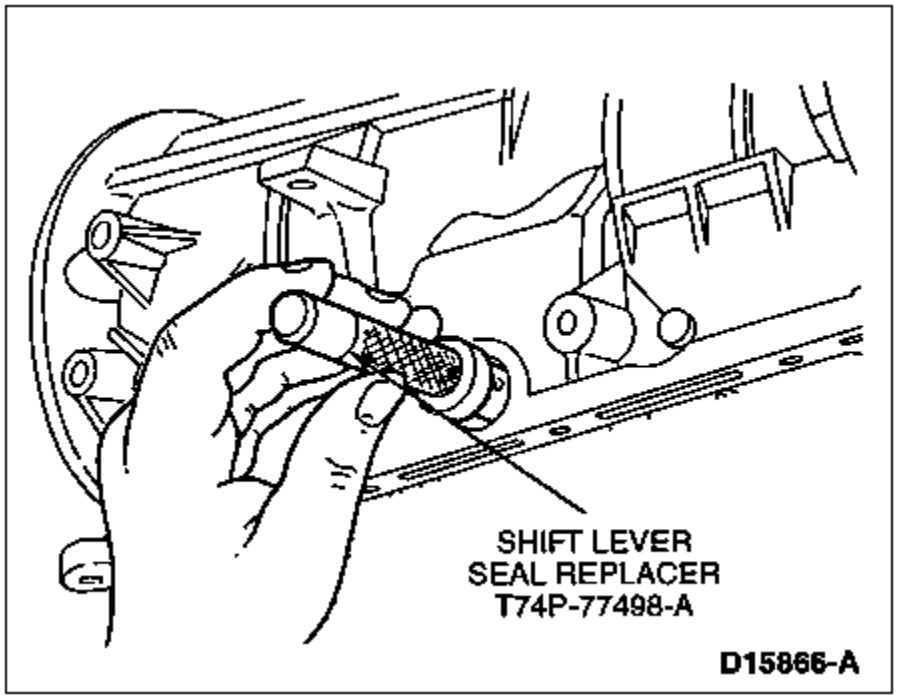
Installation

1. Lubricate and install the main control lever seal using Shift Lever Seal Replacer T74P-77498-A.



2. Install the manual control lever shaft into the case.

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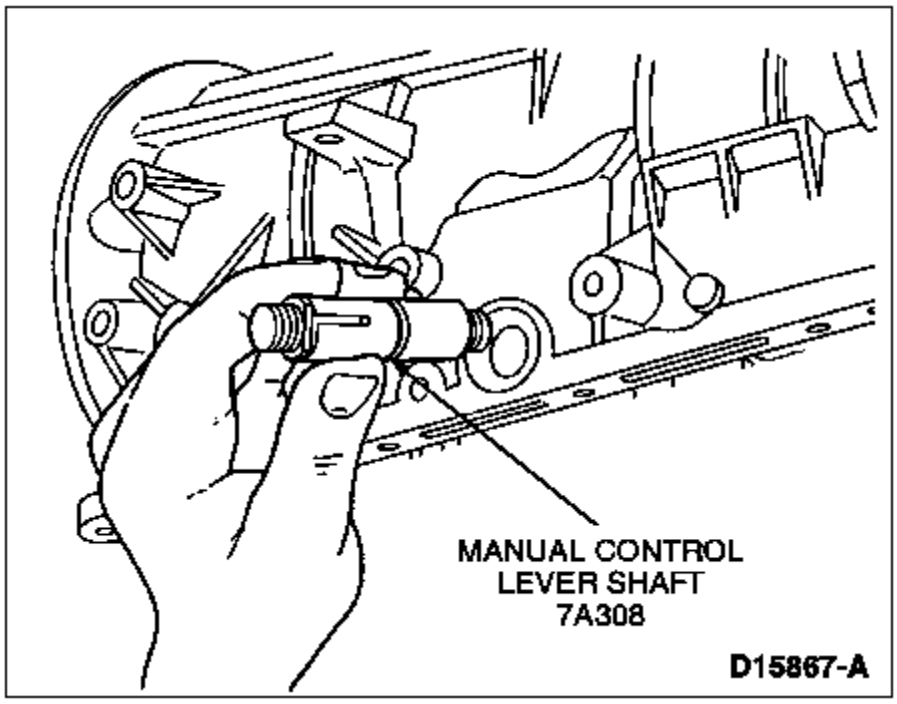

3. **CAUTION: Use care not to damage the fluid pan rail surface when installing the retaining pin.**

   Align the manual control lever shaft with the manual control lever shaft spring pin. Install the retaining pin.

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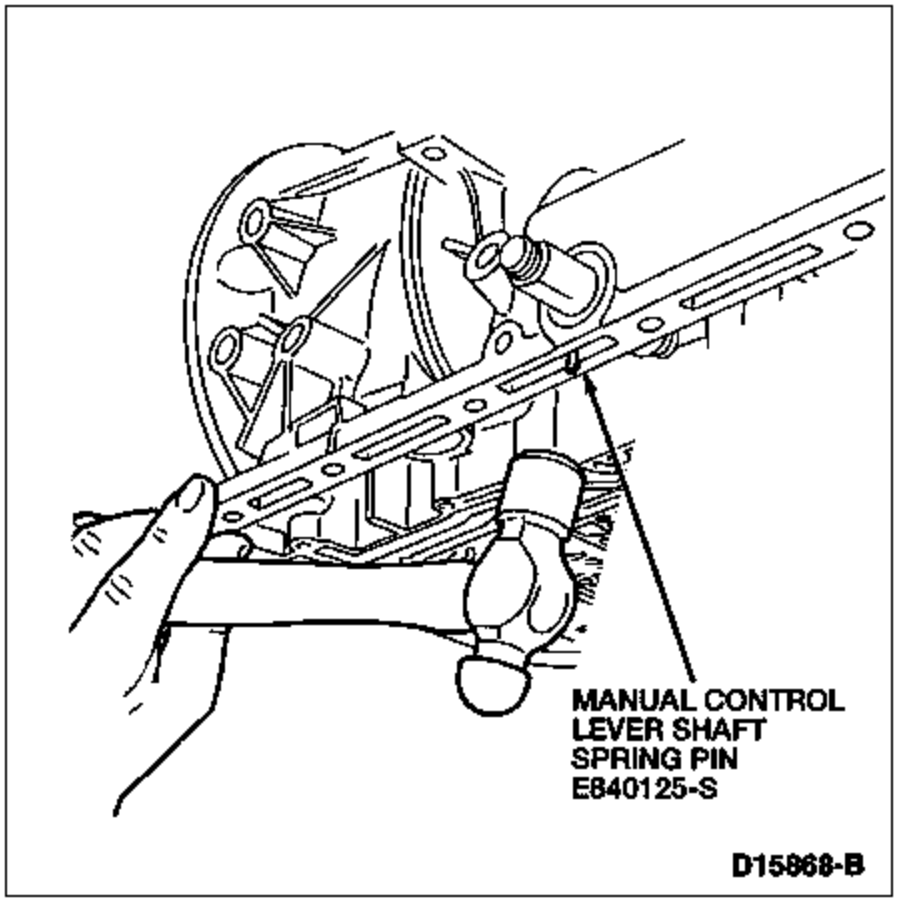

4. Align the flats of the manual valve inner lever with the flats on the manual control lever shaft.

5. **CAUTION: Do not bend the manual valve inner lever pin.**

   Install manual valve inner lever nut and tighten to 41-54 Nm (30-44 lb-ft).

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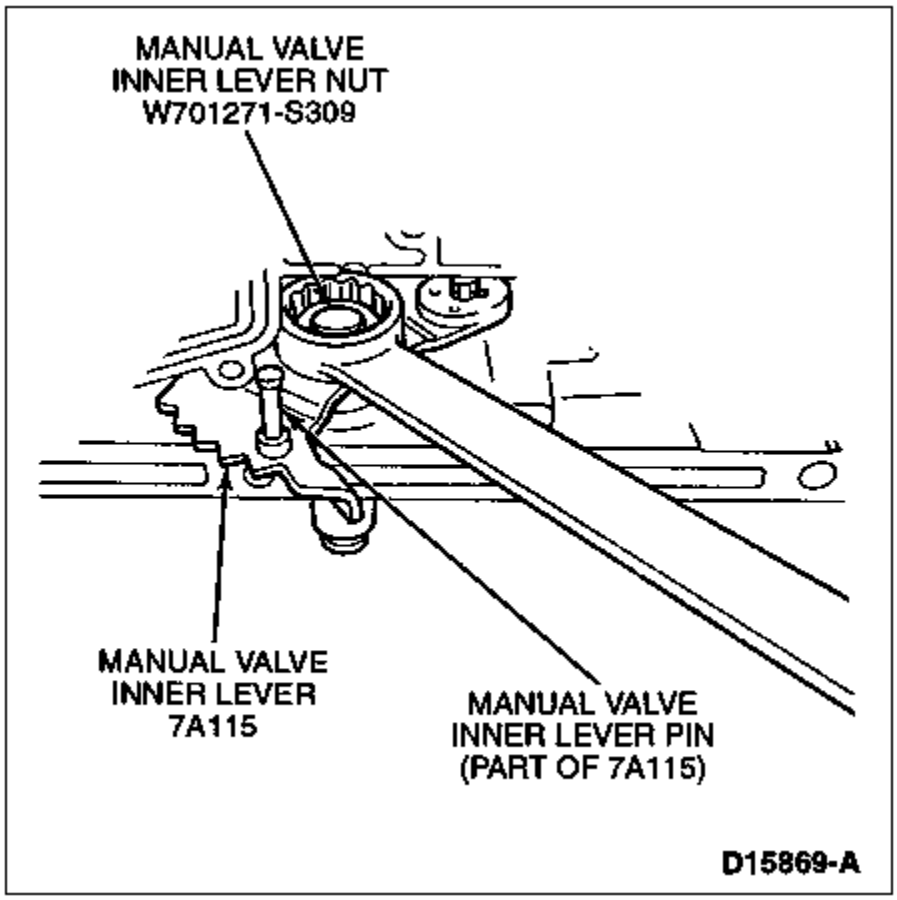

6. **CAUTION: Park pawl actuating rod must be properly installed into parking pawl and guide cup located in extension housing. Verify park linkage function.**

   Verify that the output shaft is locked in the PARK position.

7. Install new gasket and install pan.

8. Install DTR sensor and linkage.

9. Fill the transmission to the proper level. Refer to the procedure in this section.

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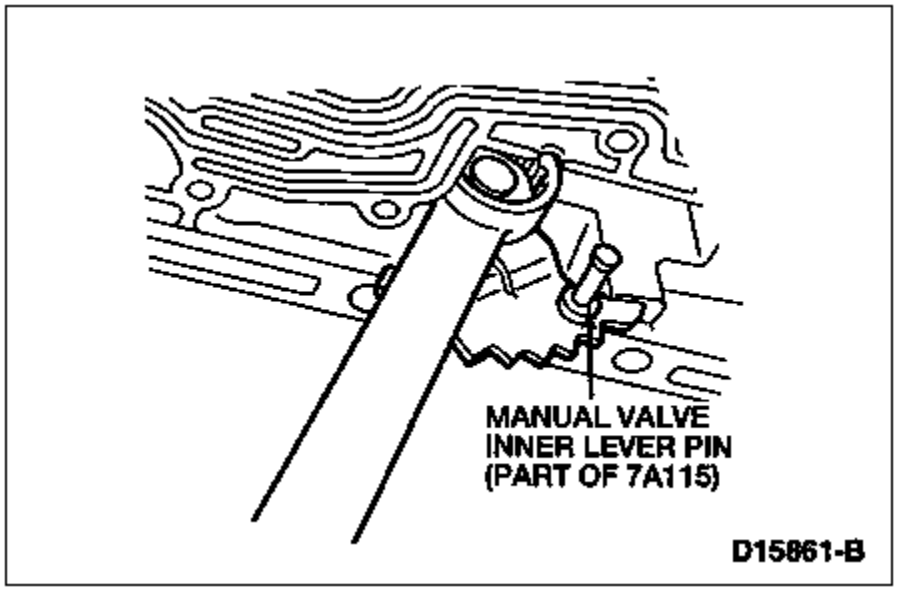
Park System

Removal

1. Remove fluid pan. Remove fluid filter.
2. Remove EPC, SS2 and SS4 solenoids. Remove case connector as described in this section.
3. **CAUTION: To avoid damage, make sure the wrench does not strike the manual valve inner lever pin.**

   Remove the manual valve inner lever nut.



4. Remove the manual valve inner lever and parking pawl actuating rod assembly.

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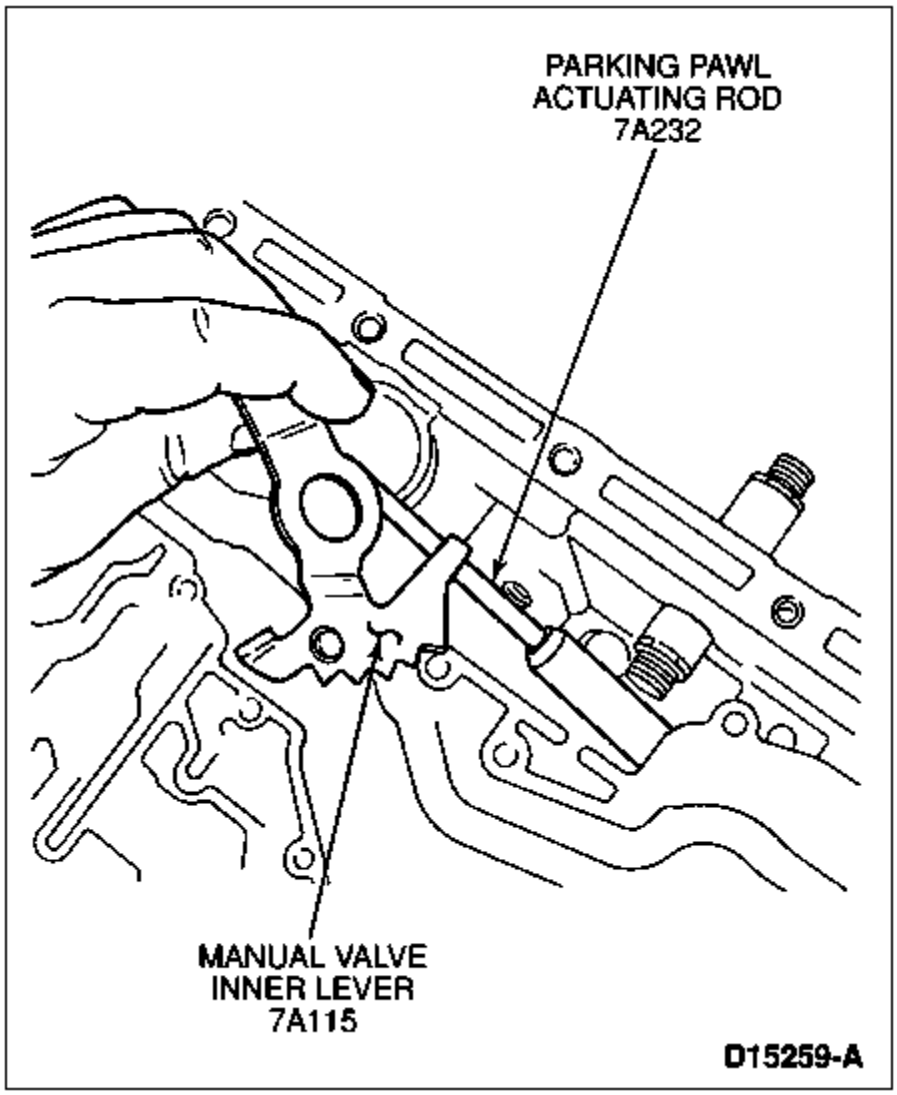

5. Remove extension housing as described in this section.

6. Inspect park pawl spring and shaft. Inspect park pawl actuating rod. Service as required.

Installation

1. Install the manual valve inner lever and parking pawl actuating rod into the case. Align the flats of the manual valve inner lever with the flats on the manual control lever shaft.

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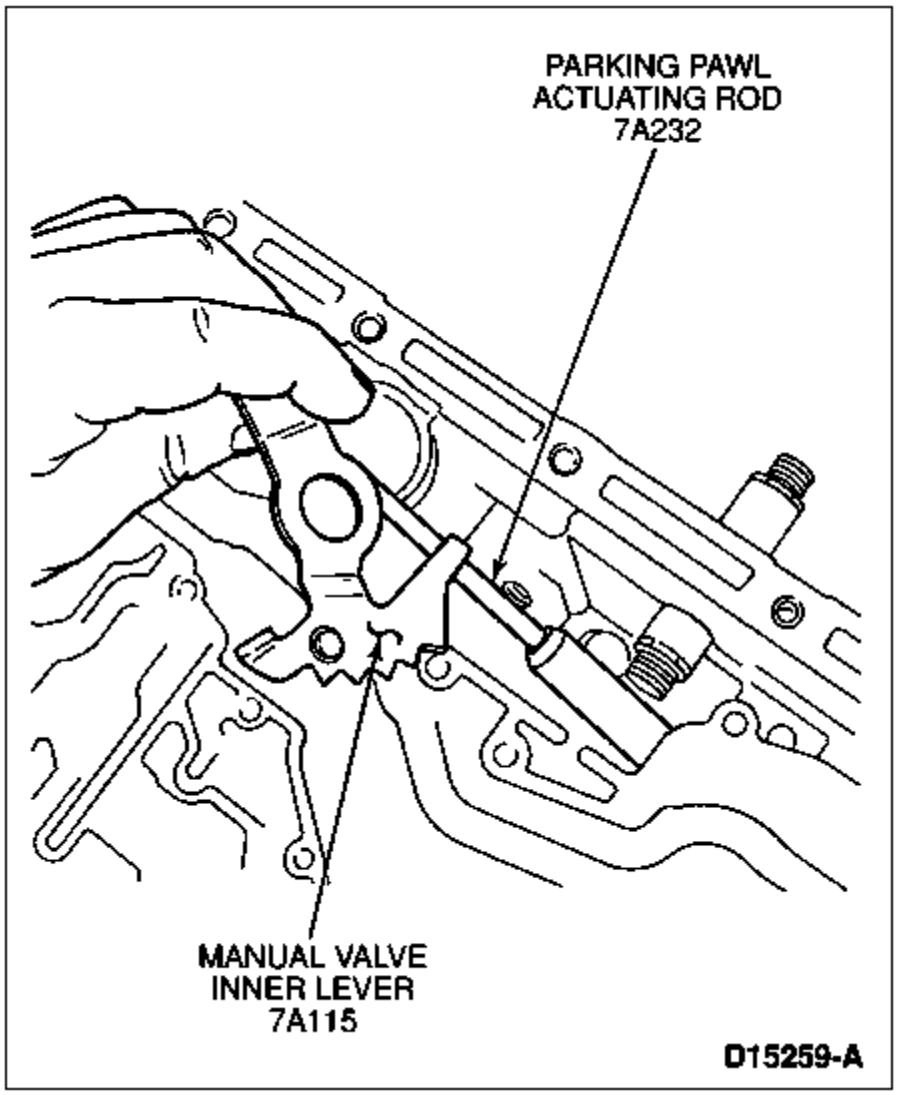

2. **CAUTION: Do not bend the manual valve inner lever pin.**

   Install manual valve inner lever nut and tighten to 41-54 Nm (30-44 lb-ft).

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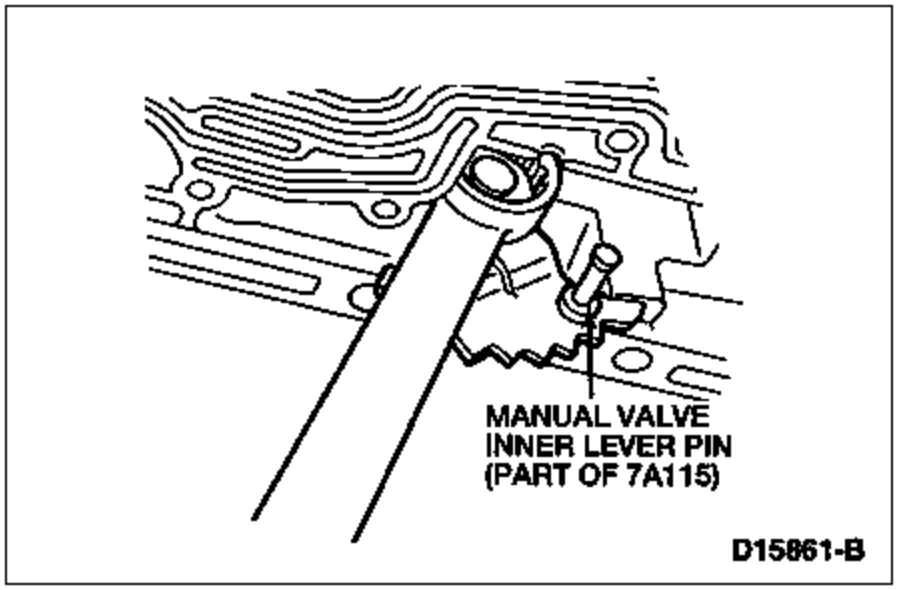

3. Install extension housing as described in this section, noting all cautions and notes.
4. Install EPC, SS2 and SS4 solenoids and 16-pin case connector as described in this section.
5. Install fluid filter, fluid pan and new pan gasket with fluid pan-to-case screws. Tighten fluid pan-to-case screws to 13-15 Nm (115-133 lb-in).

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Main Control Valve Body

NOTE: If a transmission has been disassembled to replace worn or damaged parts and the valves in the main control valve body (7A100) stick repeatedly from foreign material, the torque converter must be removed and cleaned by using a mechanically agitated cleaner, such as Rotunda Torque Converter/Fluid Cooler Cleaner 014-00028 or equivalent.

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Valve Body Guide Pin (.235)	T95L-70010-B
Valve Body Guide Pin (.248)	T95L-70010-C

Removal

1. Remove fluid pan.
2. Carefully lift up on the wire loom guide and protector. Disengage the retaining pins from the solenoid clamps.

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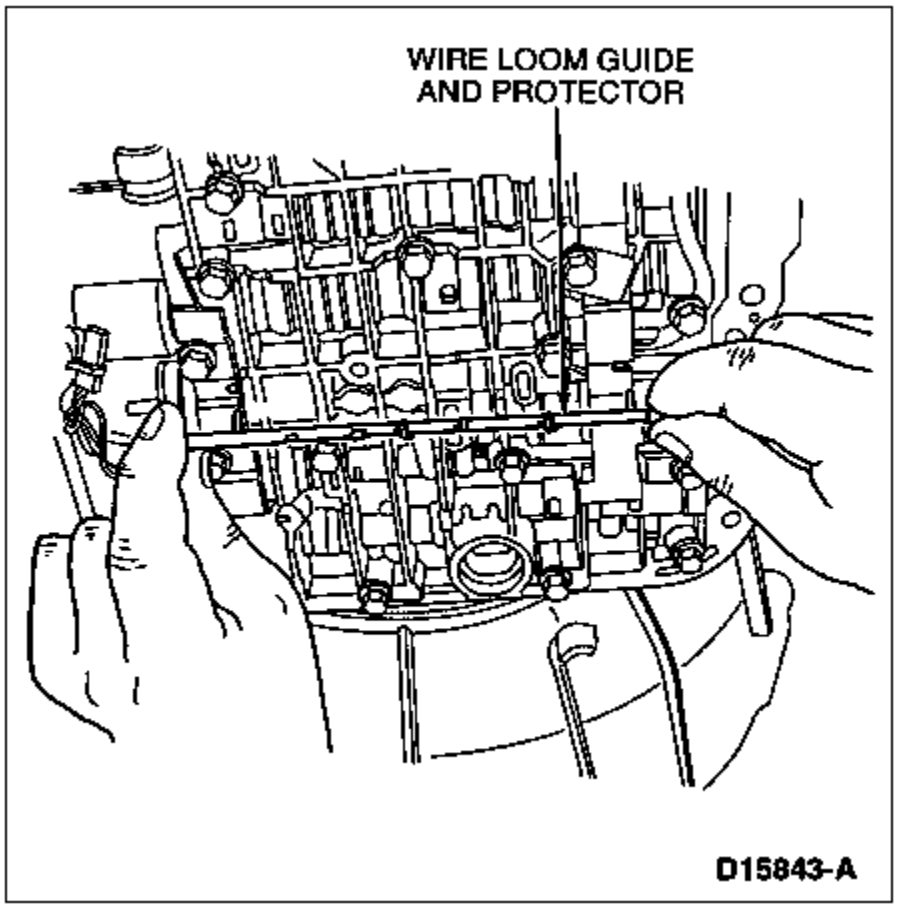

3. Disconnect the six solenoid connectors from the solenoids by carefully pulling downward and wiggling side to side.

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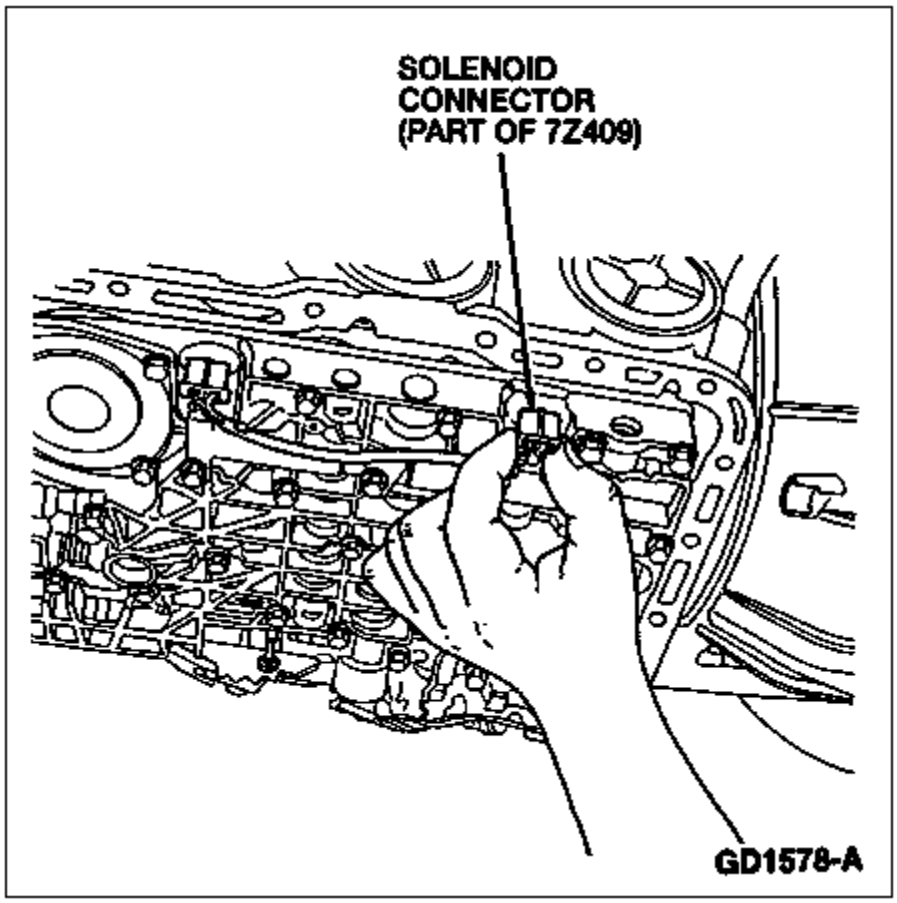

4. Use a 10mm socket to remove the M6 x 30mm manual valve detent spring screw. Remove the manual valve detent spring.

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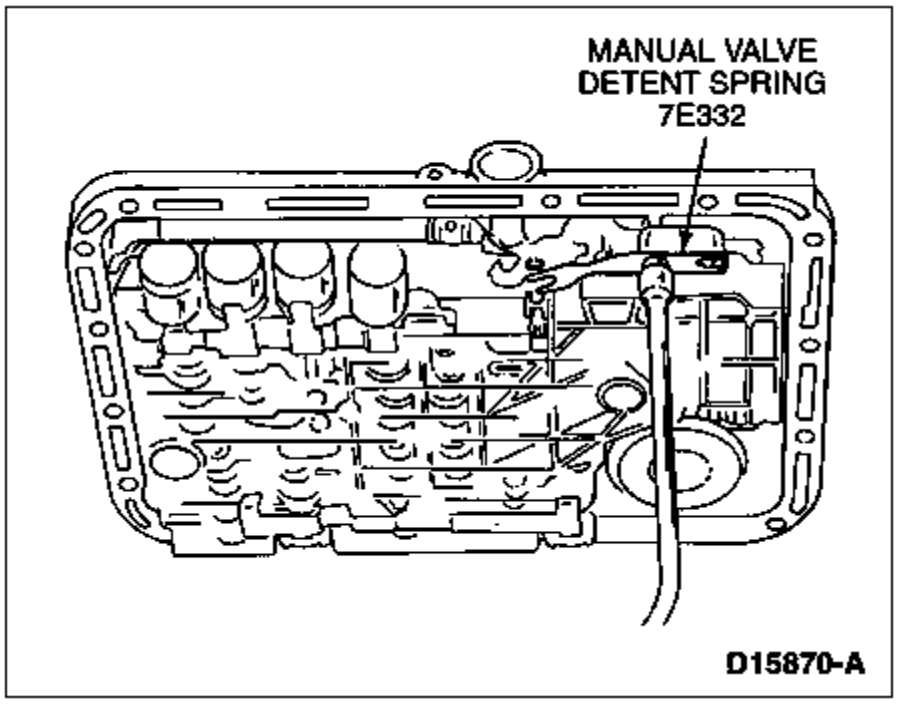

5. Use a 10mm socket to remove the four M6 x 20mm low/reverse servo cover screws. Remove the low/reverse servo cover, gasket and the servo piston and rod assembly.

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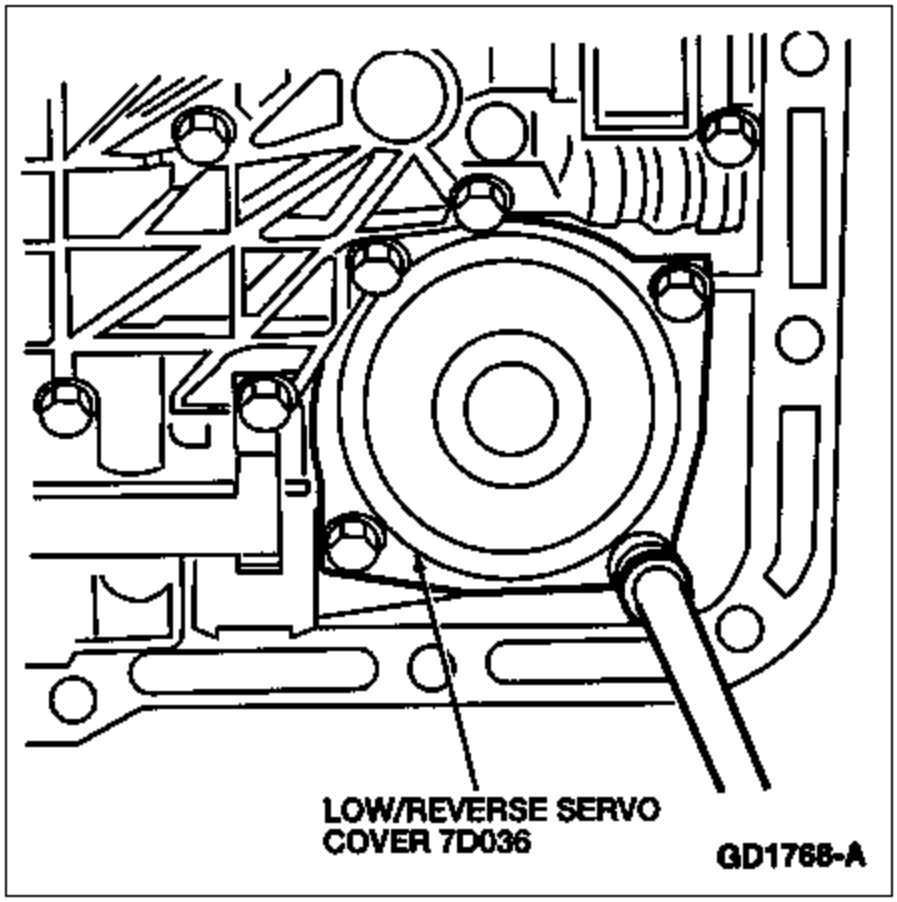

6. **CAUTION: Support main control valve body.**

   Use a 10mm socket to remove the sixteen M6 x 40mm, four M6 x 45mm, two M6 x 35mm and one M6 x 30mm main control valve body screws.

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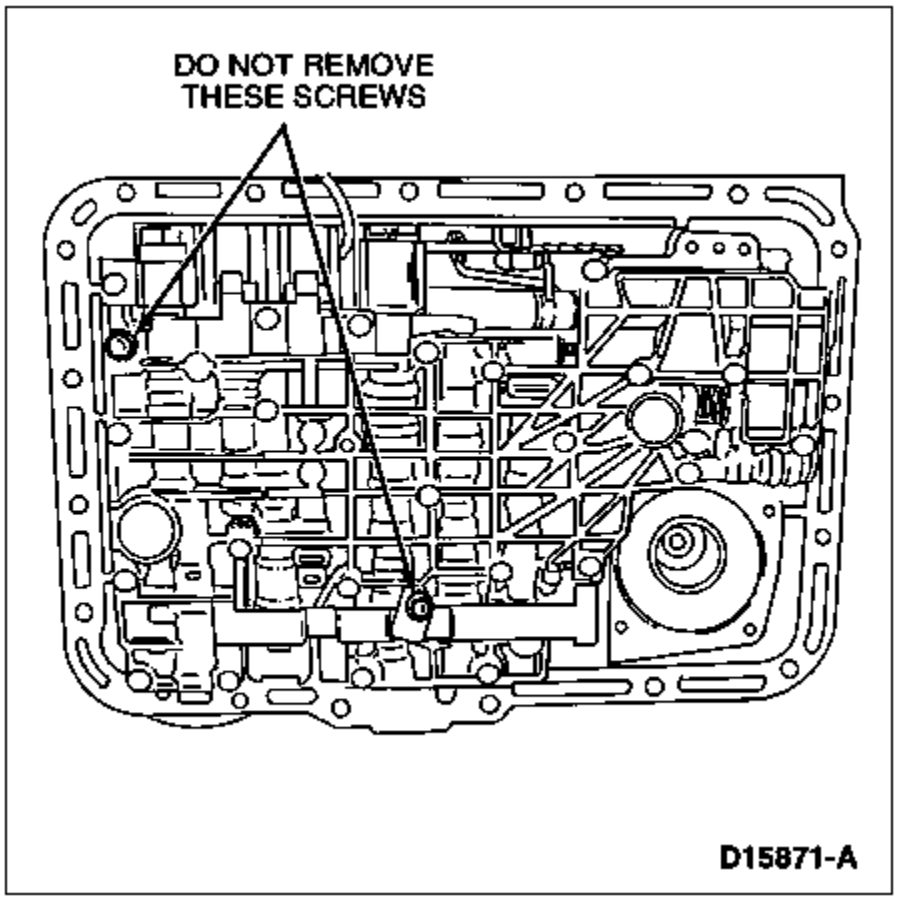
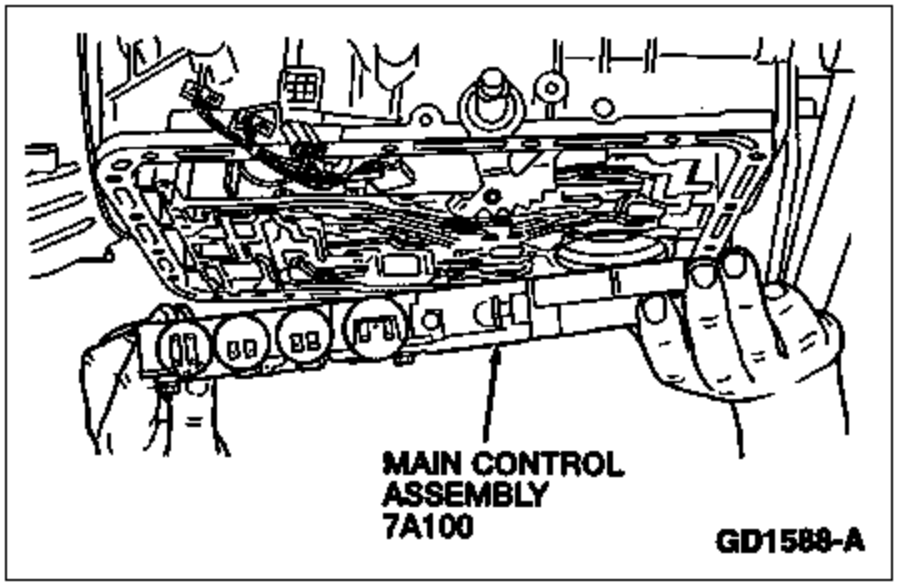


7. Remove the main control assembly.



8. Install the guide pins into the case in the positions shown.

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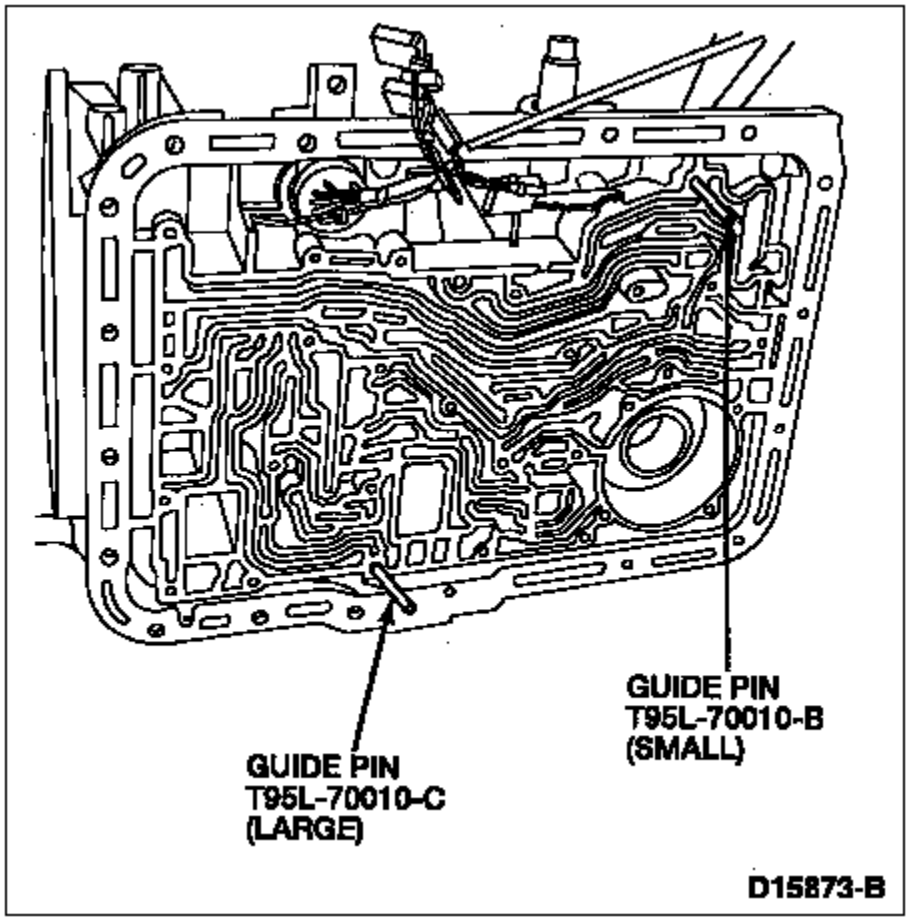

9. Install new separator to case gasket.

10. **NOTE: Make sure main control assembly gasket is properly aligned.**

    Install the main control assembly on the case. Align the manual valve with the manual valve inner lever pin as shown.

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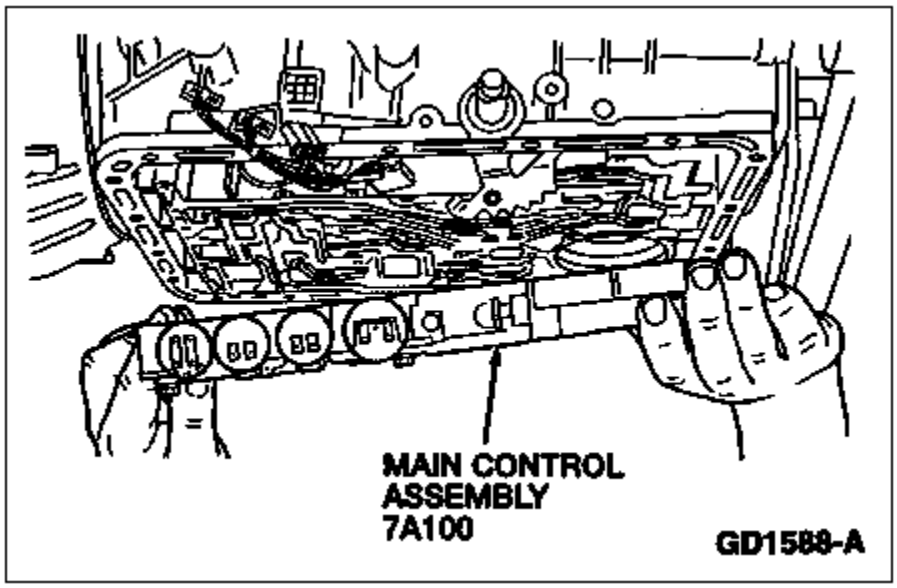

11. Install four M6 x 45mm screws in locations A. Finger tighten.
12. Install two M6 x 35mm main control assembly-to-case screws in locations B. Finger tighten.
13. Install one M6 x 30mm main control assembly-to-case screws in location C. Finger tighten.
14. Remove both valve body guide pins T95L-70010-B and T95L-70010-C.
15. Install sixteen M6 x 40mm main control assembly-to-case screws in locations D. Finger tighten.
16. Tighten all main control assembly-to-case screws to 8-11 Nm (71-97 lb-in) in sequence shown, using a 10mm socket.

Main Control Assembly Screws and Locations

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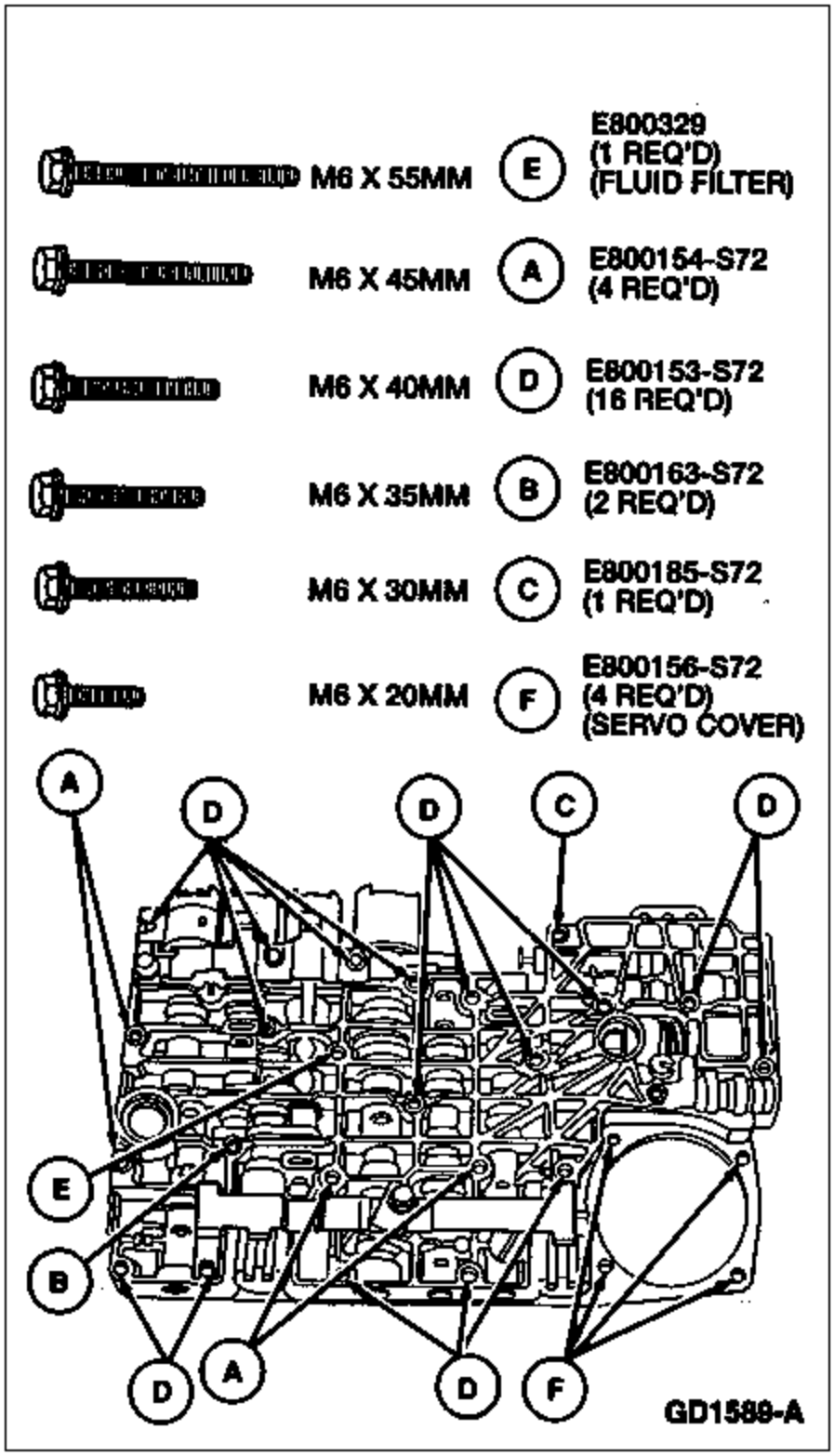

Refer to the tightening sequence (1R, 2R, 3R, 4R) for reverse servo cover installation also.

Tightening Sequence

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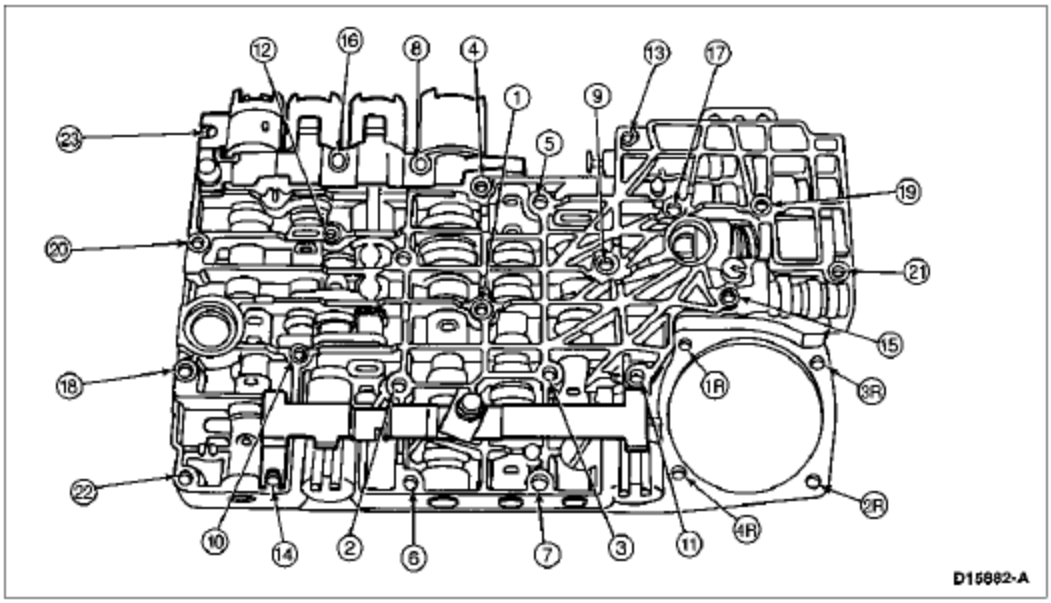
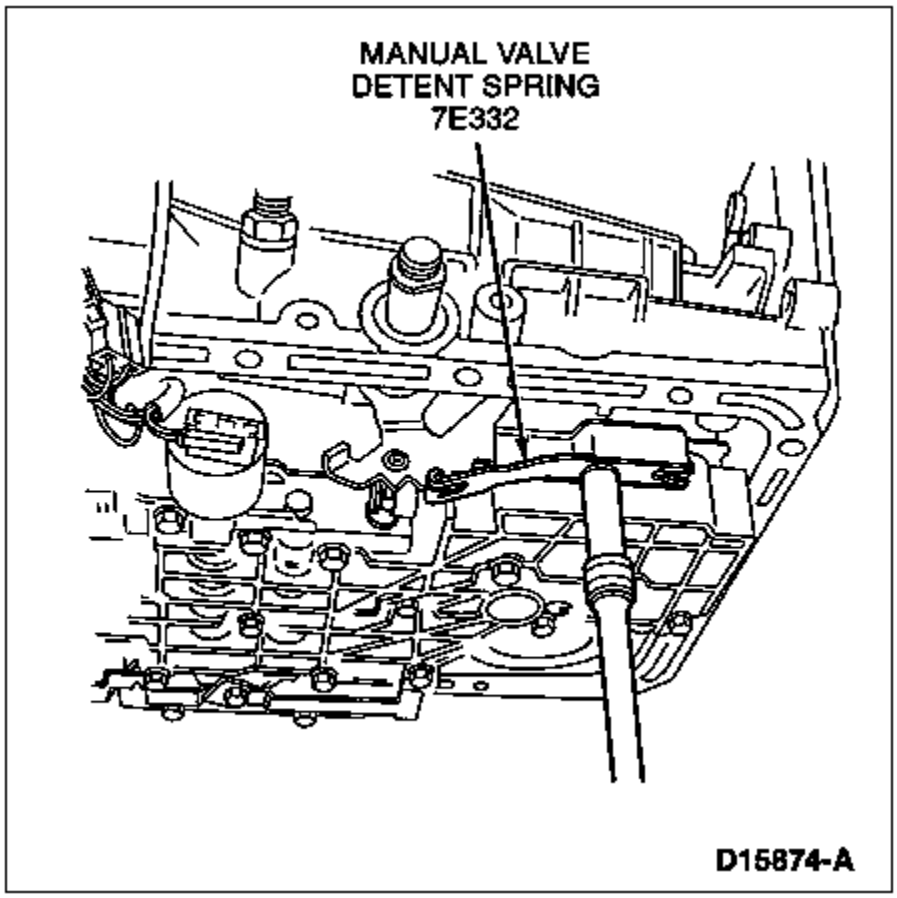


17. Install the manual valve detent spring. Install the manual valve detent spring screw and tighten to 8-11 Nm (71-97 lb-in).



18. Install the low/reverse servo assembly into the case.

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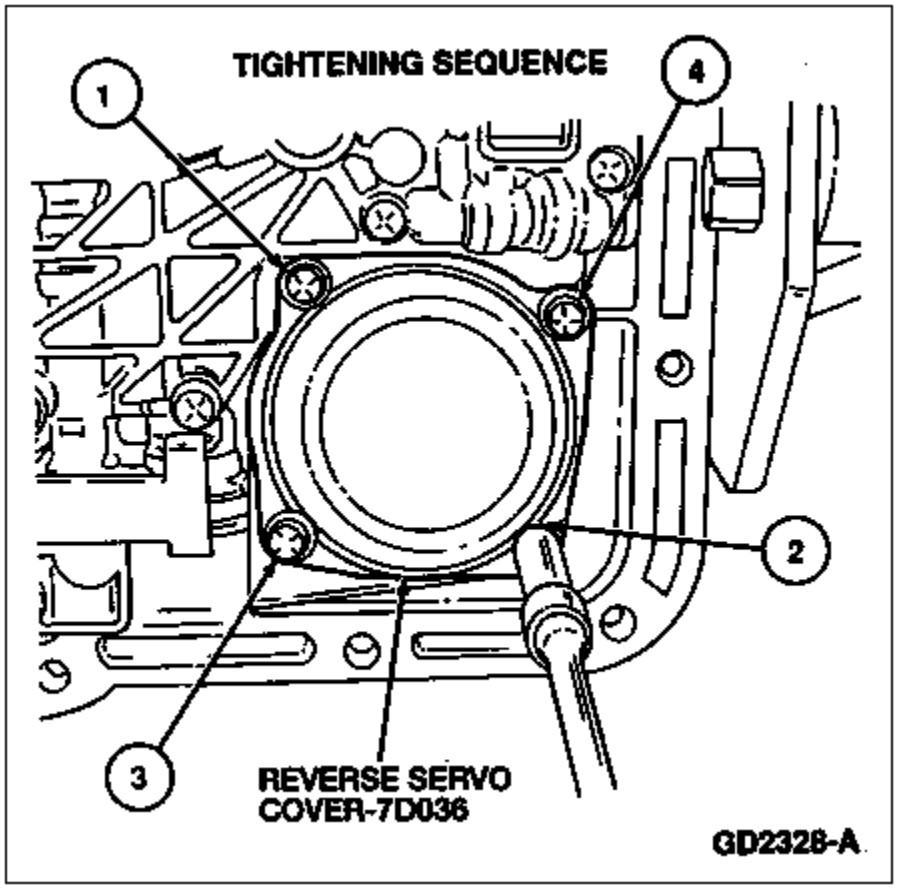
19. Install the low/reverse servo and rod assembly cover, new gasket and the four servo cover-to-case screws. Tighten the screws in sequence as shown to 12-14 Nm (106-124 lb-in).



20. Carefully press down to install the solenoid connectors on the solenoid.

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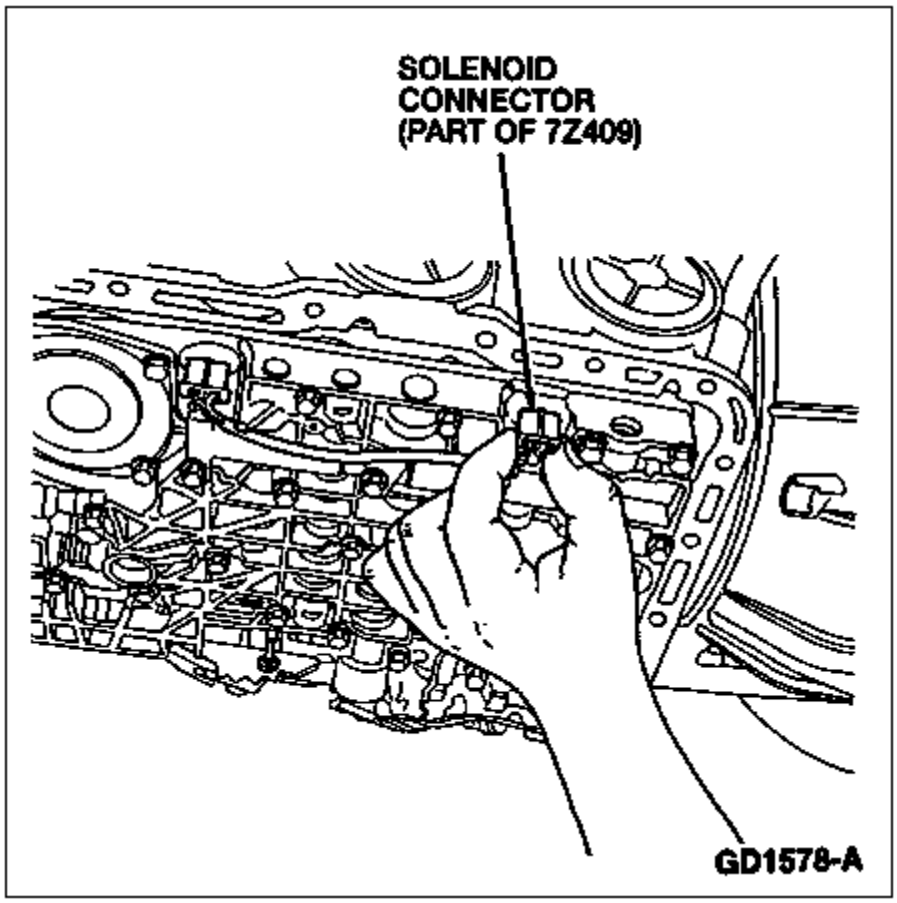

21. **CAUTION: Excessive pressure may break the locating pins.**

Install the wiring loom protector and guide. Align the pins in the holes of the solenoid clamps and gently push down.

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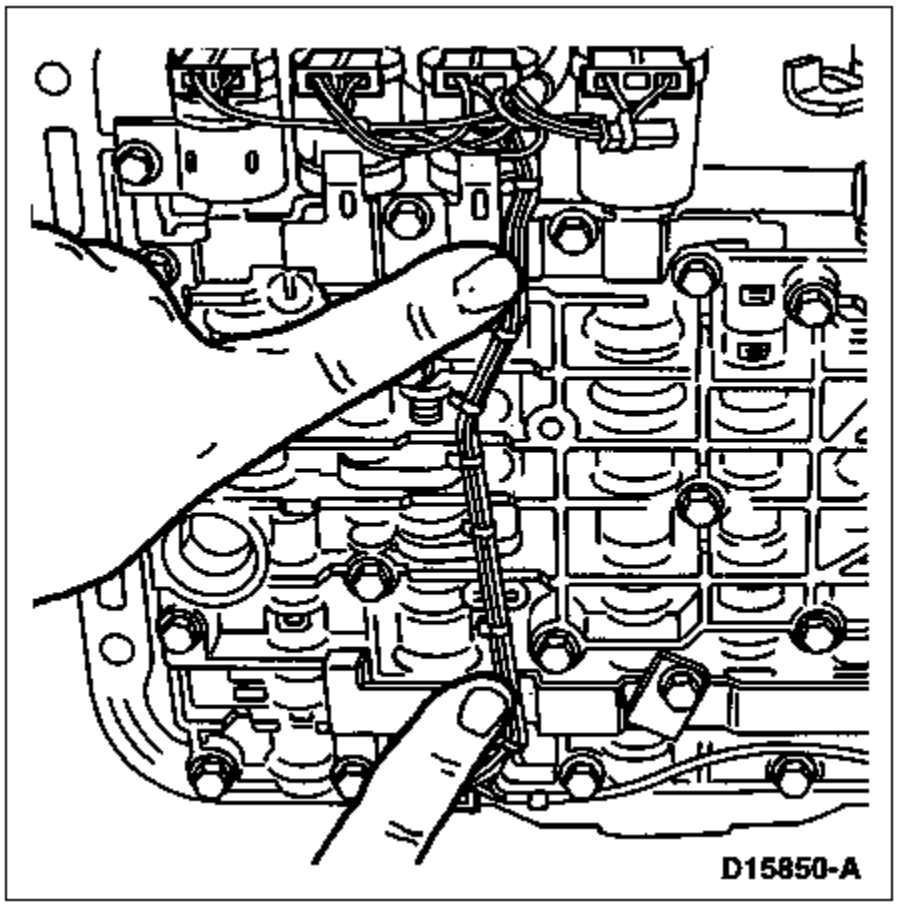

22. Install filter, new gasket and fluid pan.

23. Fill the transmission to the proper level. Refer to the procedure in this section.

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Intermediate and Front Servos

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Servo Cover Compressor	T95L-77028-A
Servo Removal Tool	T97T-7D021

Removal

NOTE: Procedures are the same for both front and intermediate servos.

1. **NOTE: Catalytic converter(s) may have to be removed.**

   Remove heat shield, if equipped.

2. **CAUTION: Servo is under spring tension. Use caution when removing.**

   NOTE: The J-hook must be in the appropriate hole for the servo being removed.

   Install Servo Cover Compressor T95L-77028-A over the intermediate servo cover at the fluid pan rail with tool stamping facing up. Tighten the screws.

3. Using a 1/2-inch wrench, tighten the nut on the J-hook until there is a gap between the servo cover and the snap ring.

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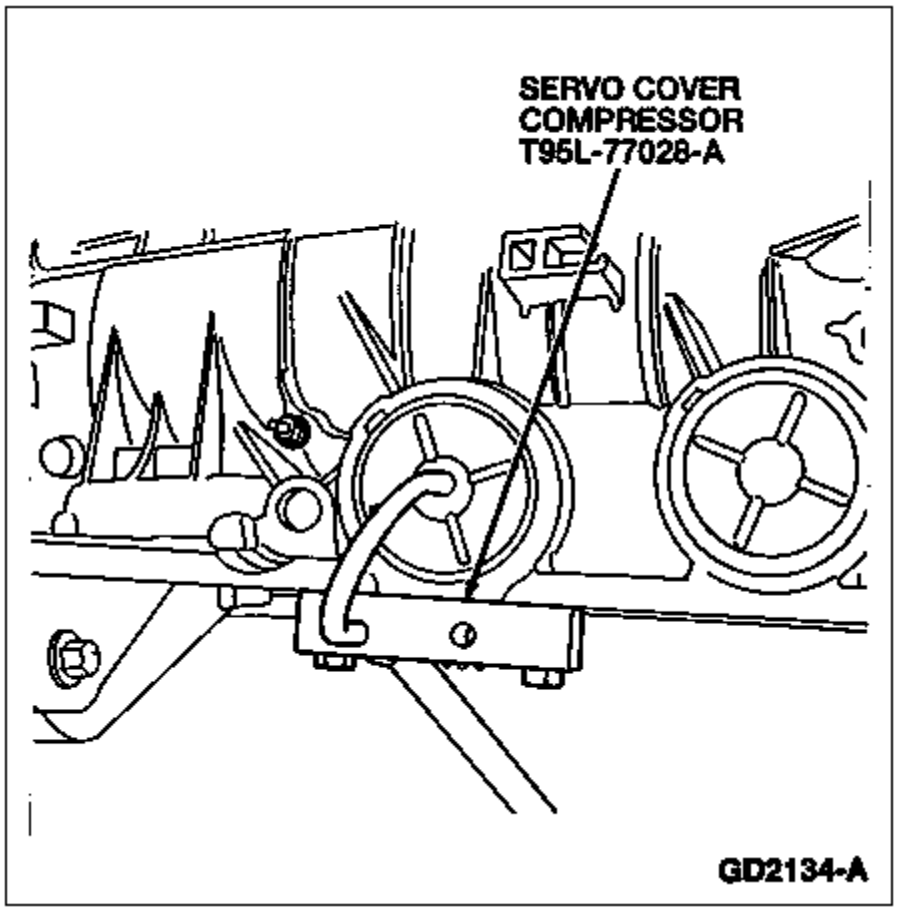

4. Carefully remove the servo cover retaining ring.

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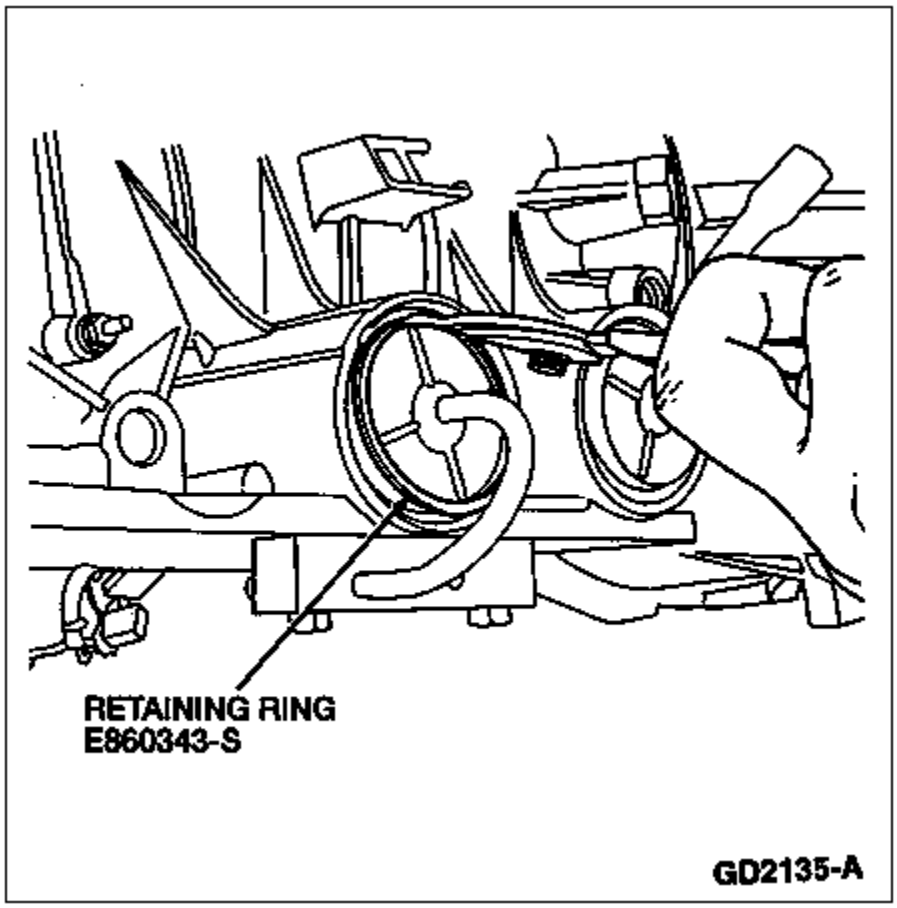

5. **CAUTION: The servo cover is under spring tension.**

   Carefully back off the nut on the J-hook until the servo spring is unloaded.

6. Insert Servo Removal Tool T97T-7D021-A into case and locate on servo rod.

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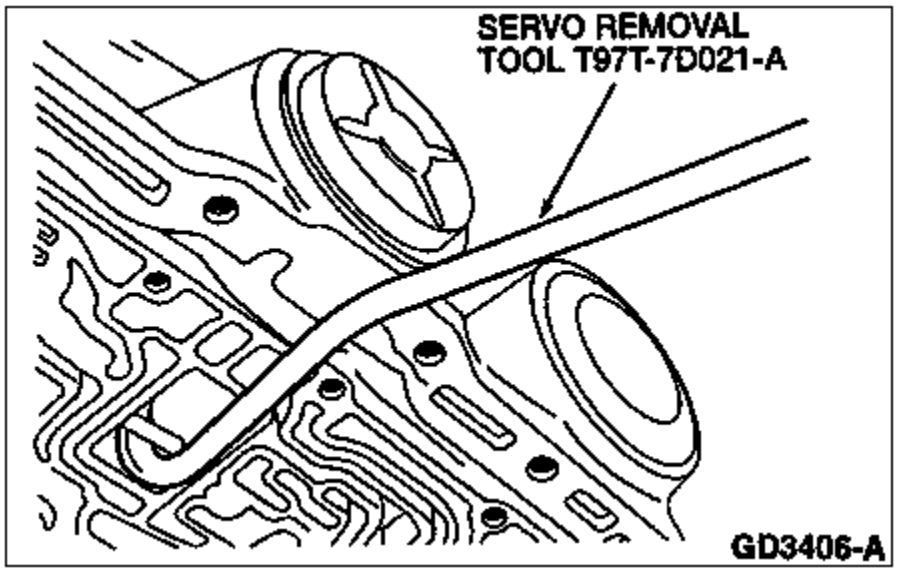
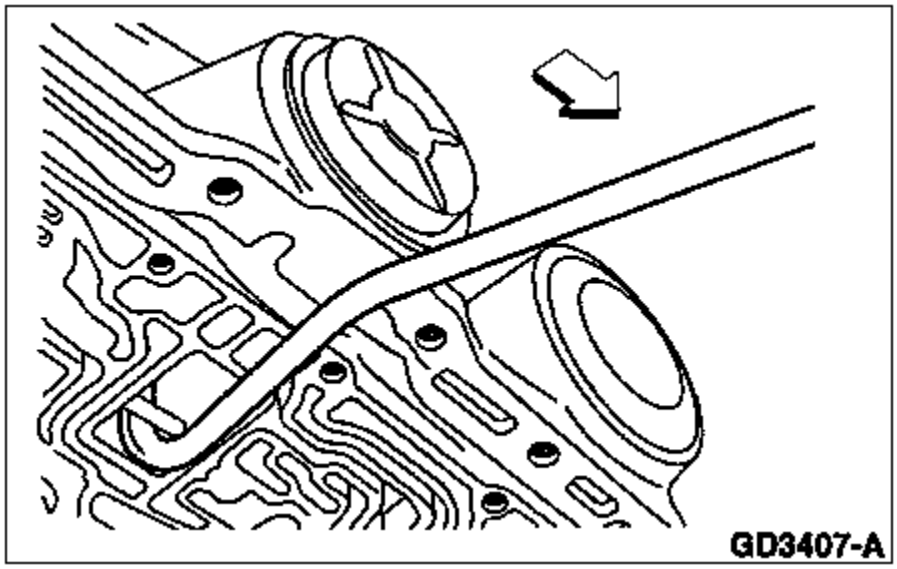


7. Gently push on Servo Removal Tool T97T-7D021-A to remove front servo cover, piston and spring.



8. **NOTE: Tag the spring, piston and cover assembly. Label accordingly for assembly. The covers have letters cast on the outer surface for identification.**

   Remove the intermediate servo cover, piston and spring.

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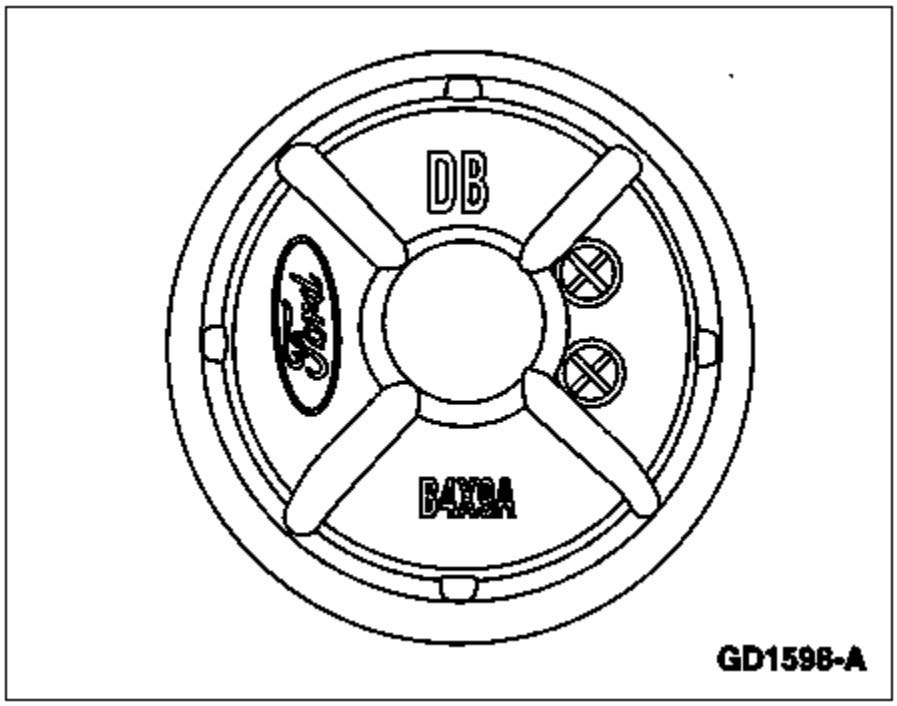

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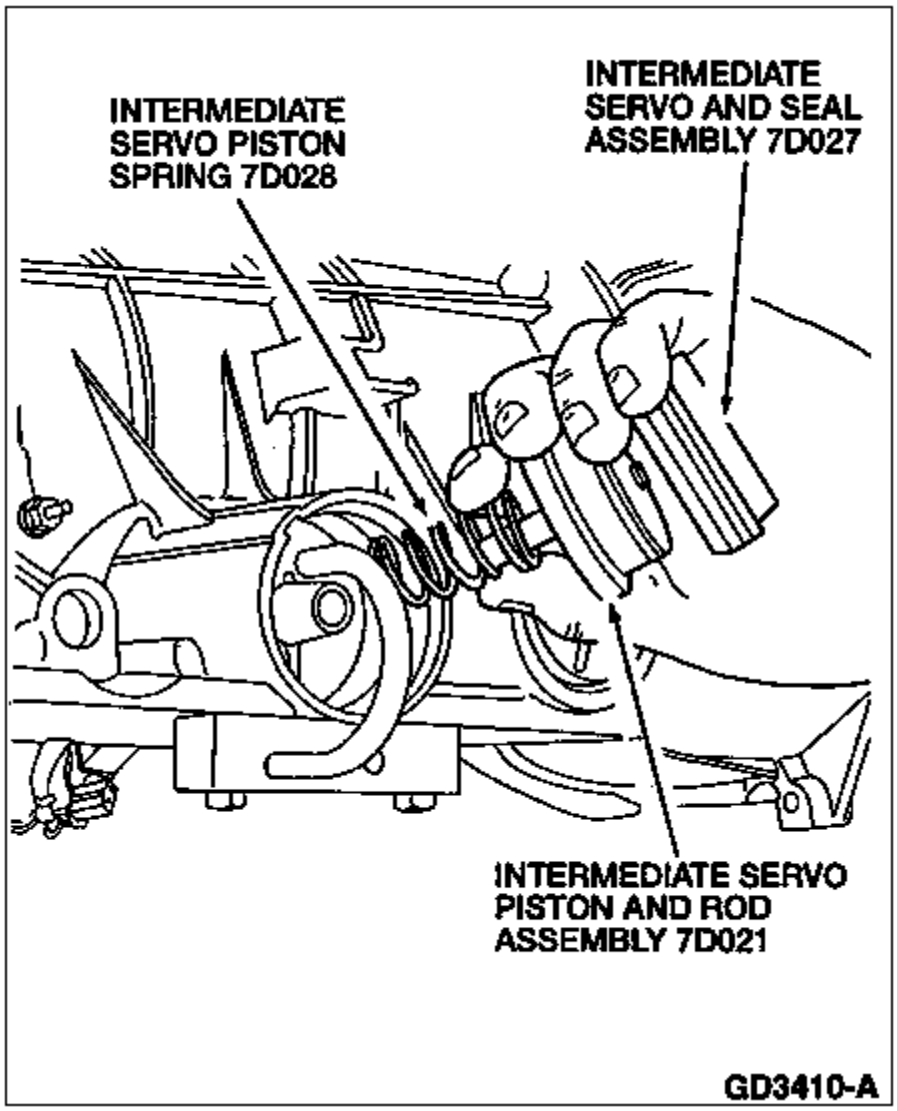

9. Remove Servo Cover Compressor T95L-77028-A.

10. **NOTE: The J-hook must be in the appropriate hole for the servo being removed.**

    Install Servo Cover Compressor T95L-77028-A over the front servo cover at the fluid pan rail. Tighten the screws.

11. Using a 1/2-inch wrench, tighten the nut on the J-hook until there is a gap between the servo cover and the retaining ring.

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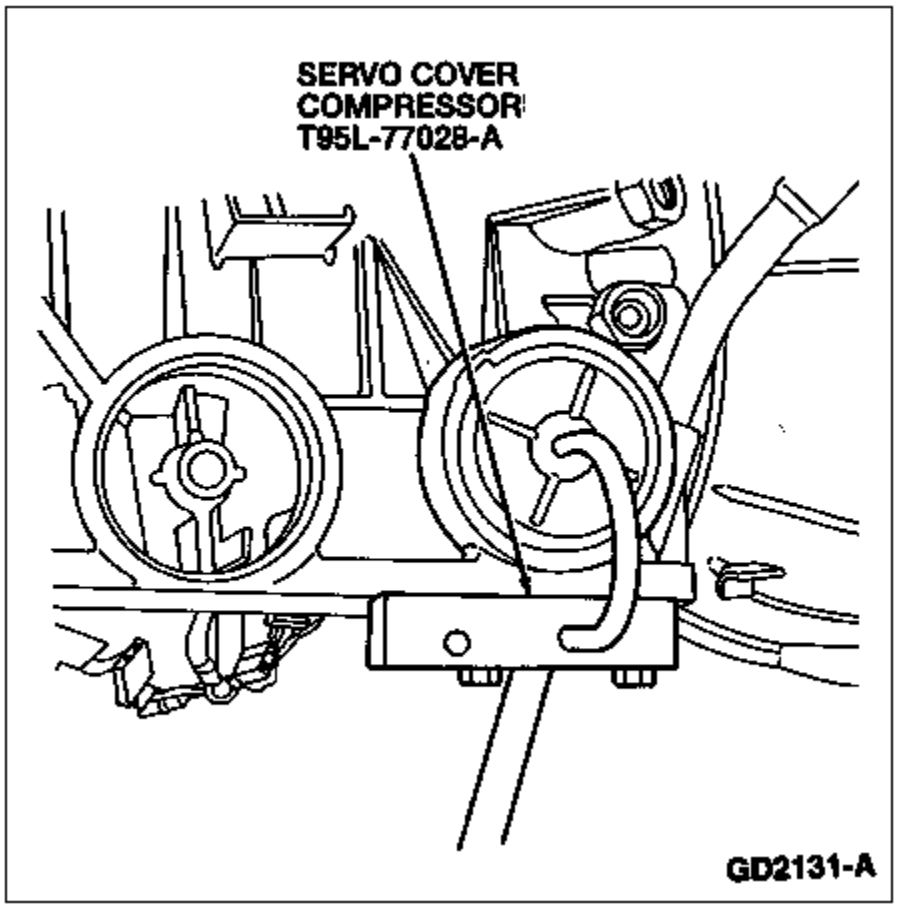

12. Carefully remove the servo cover retaining ring.

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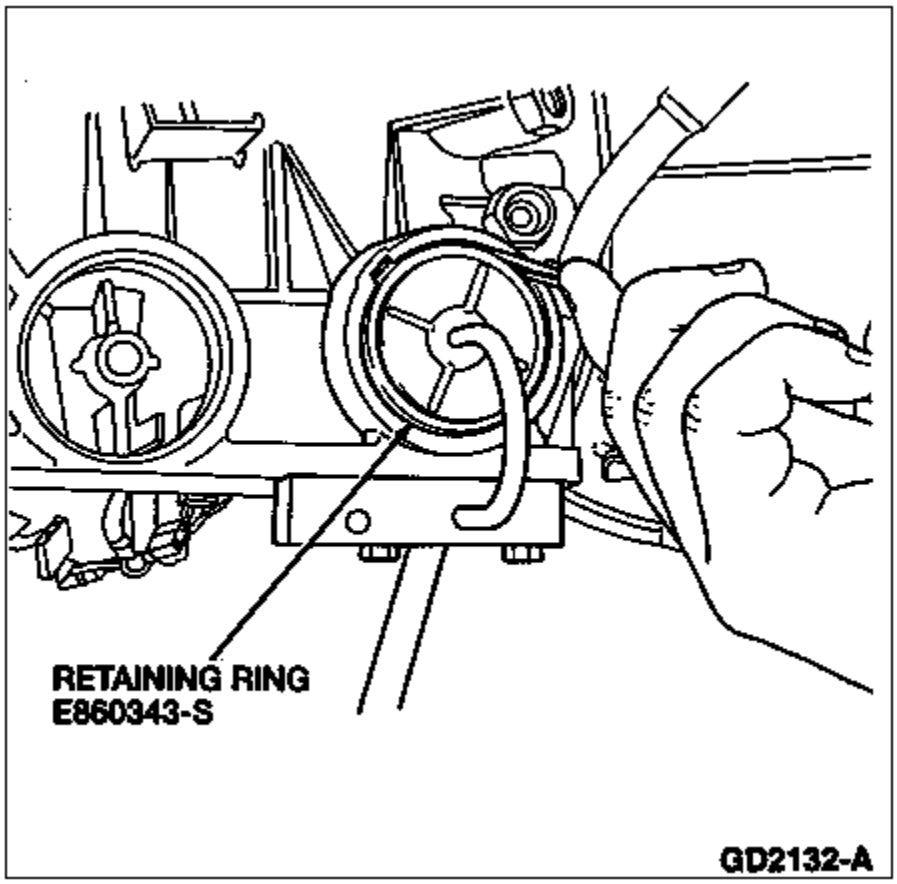
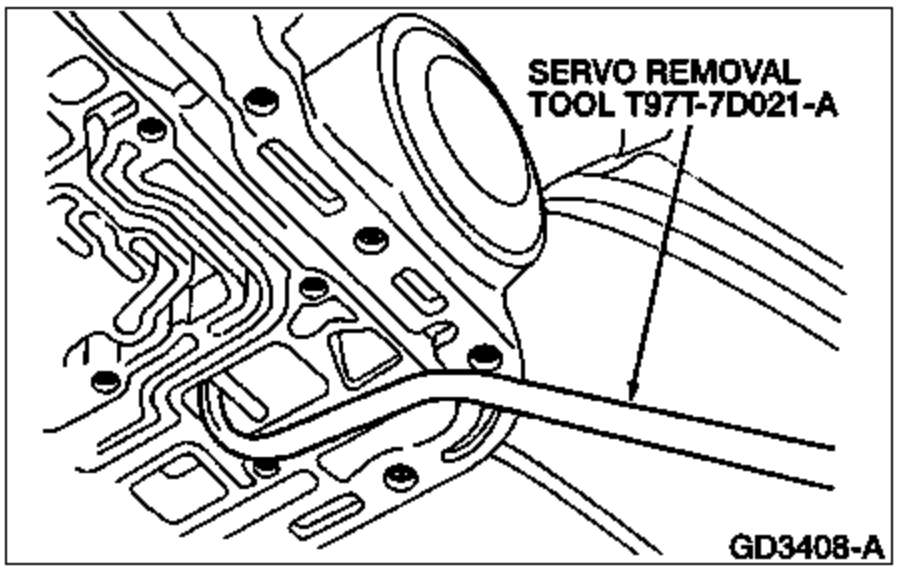


13. **CAUTION: The servo cover is under spring tension.**

    Carefully back off the nut on the J-hook until the servo spring is unloaded.

14. Insert Servo Removal Tool T97T-7D021-A into case and locate on servo rod.



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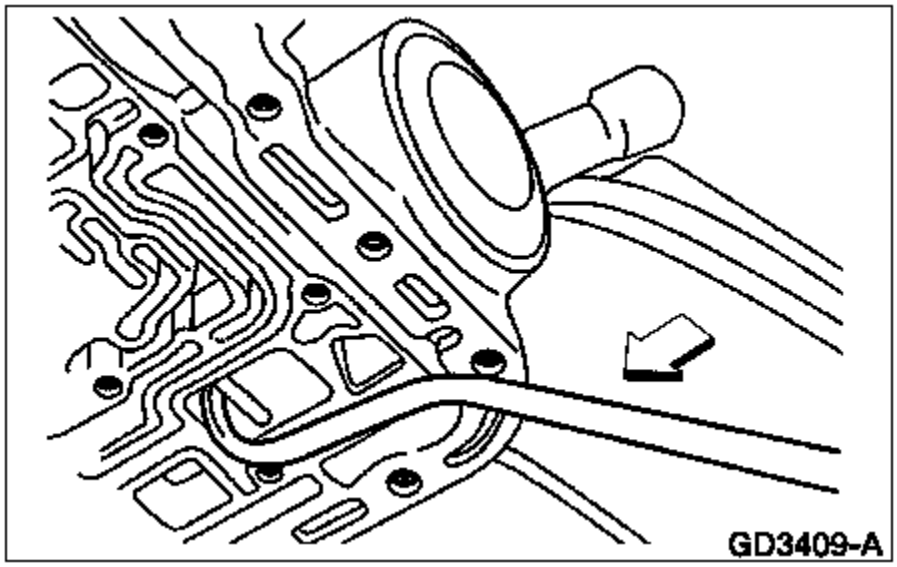
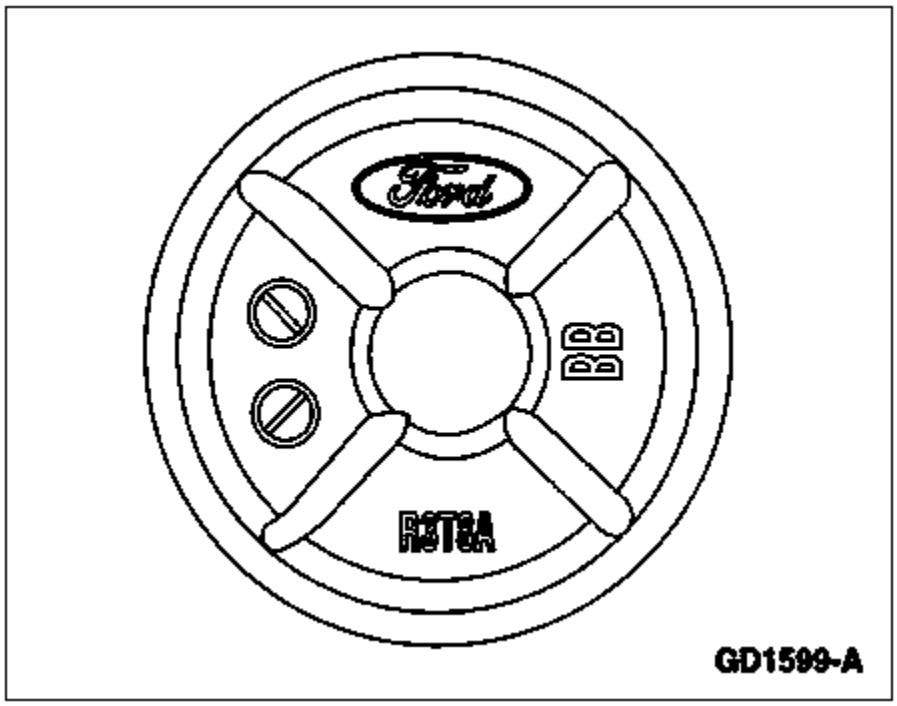
15. Gently push on Servo Removal Tool T97T-7D021-A to remove front servo cover piston and spring.



16. **NOTE: Tag the spring, piston and cover assembly. Label accordingly for assembly. The covers have letters cast on the outer surface for identification.**

    Remove the front servo cover, piston and spring.



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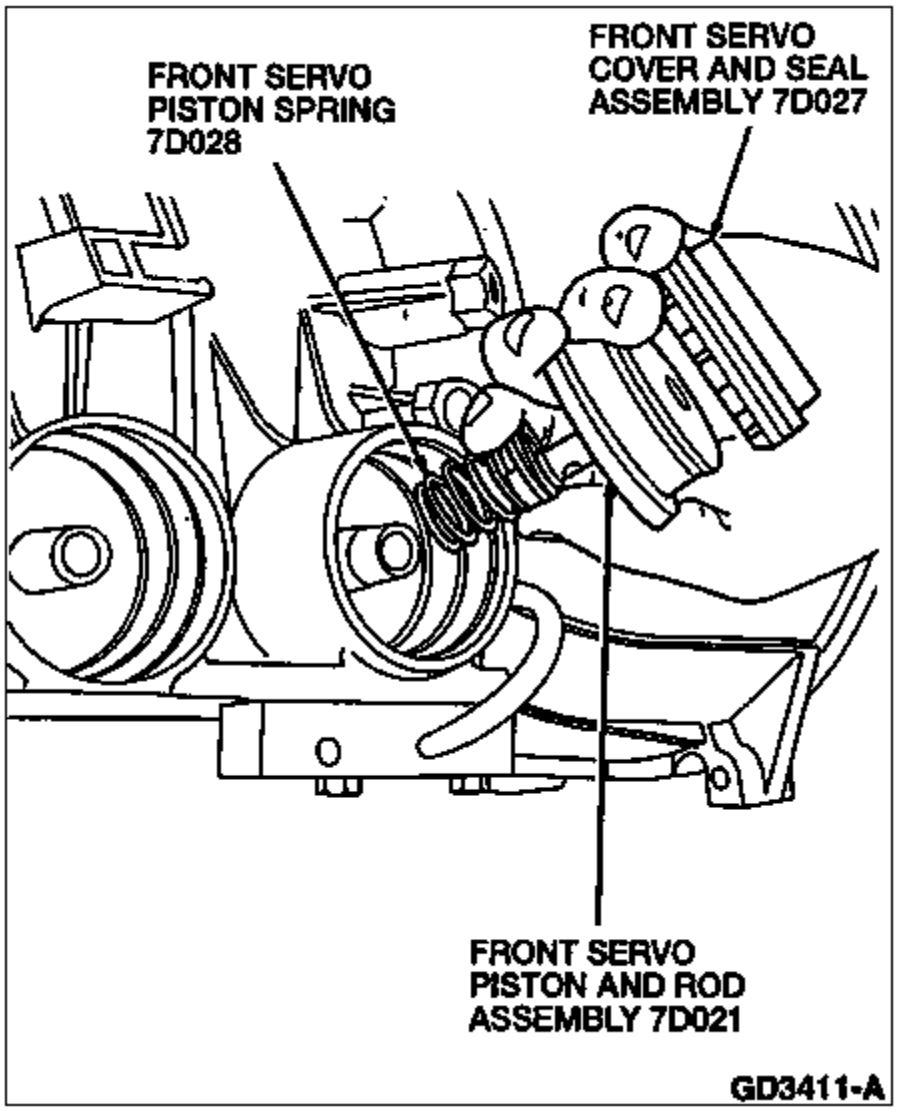

17. Remove Servo Cover Compressor T95L-77028-A.

18. Service as required.

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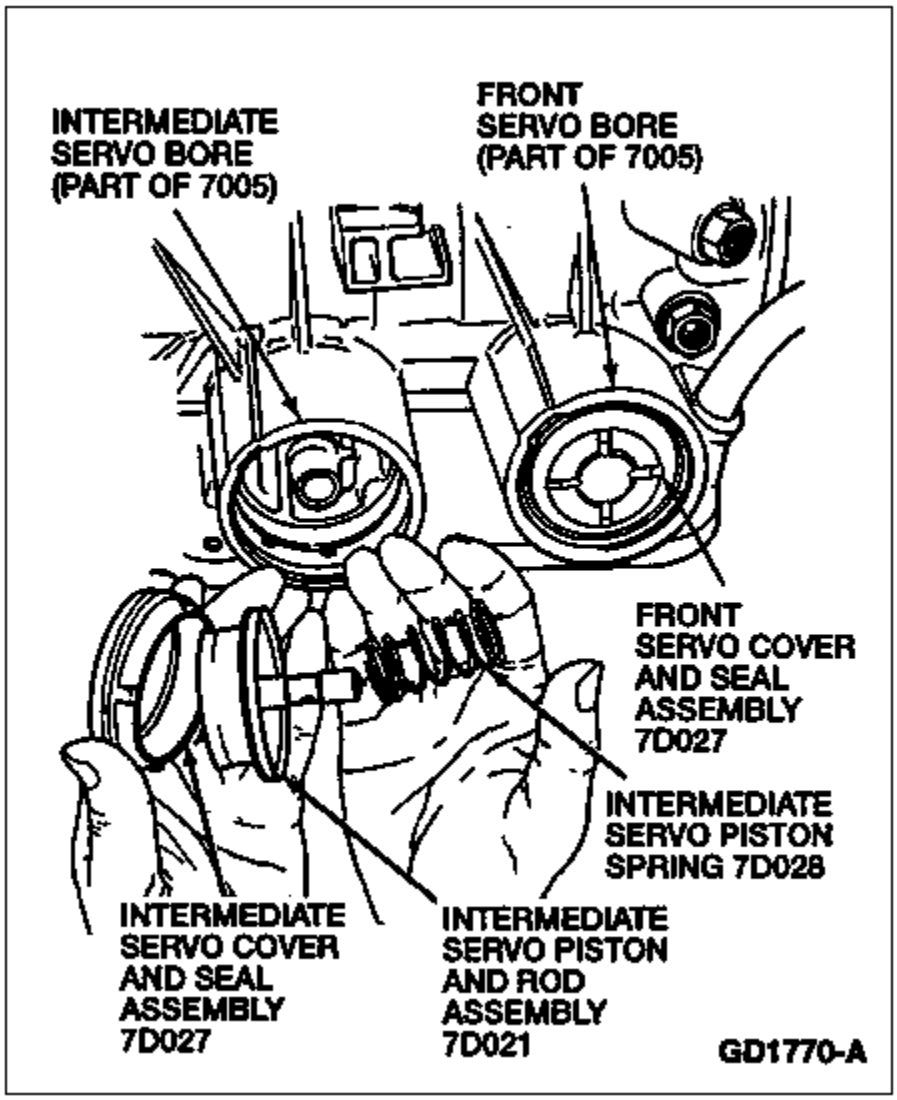

Installation

1. **CAUTION: Do not damage O-ring during installation. Do not press servo cover and O-ring past relief hole in case, or O-ring damage may occur.**

   Install servo assembly.

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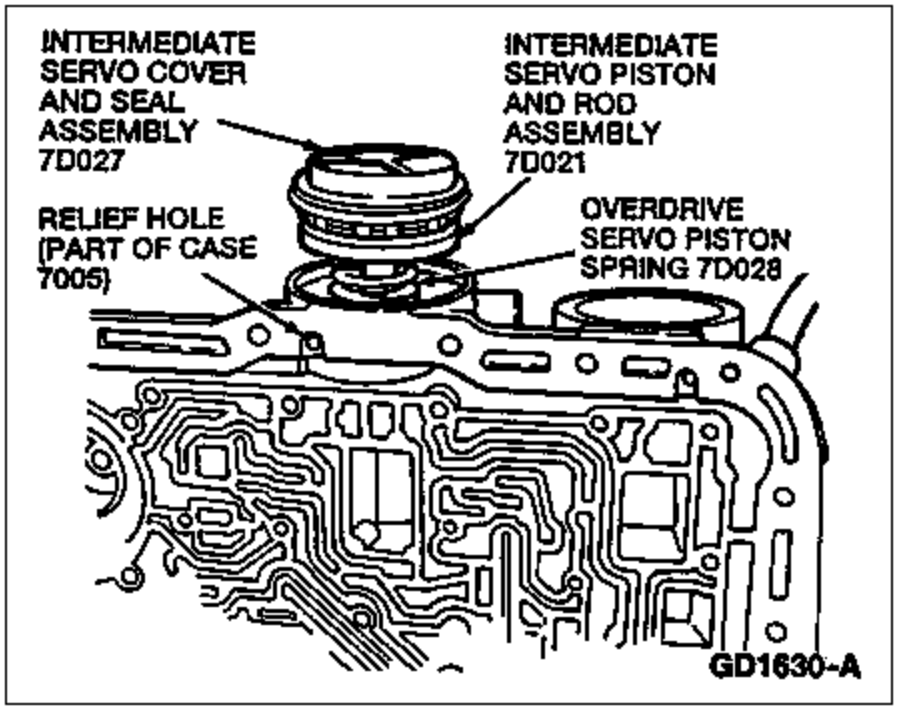

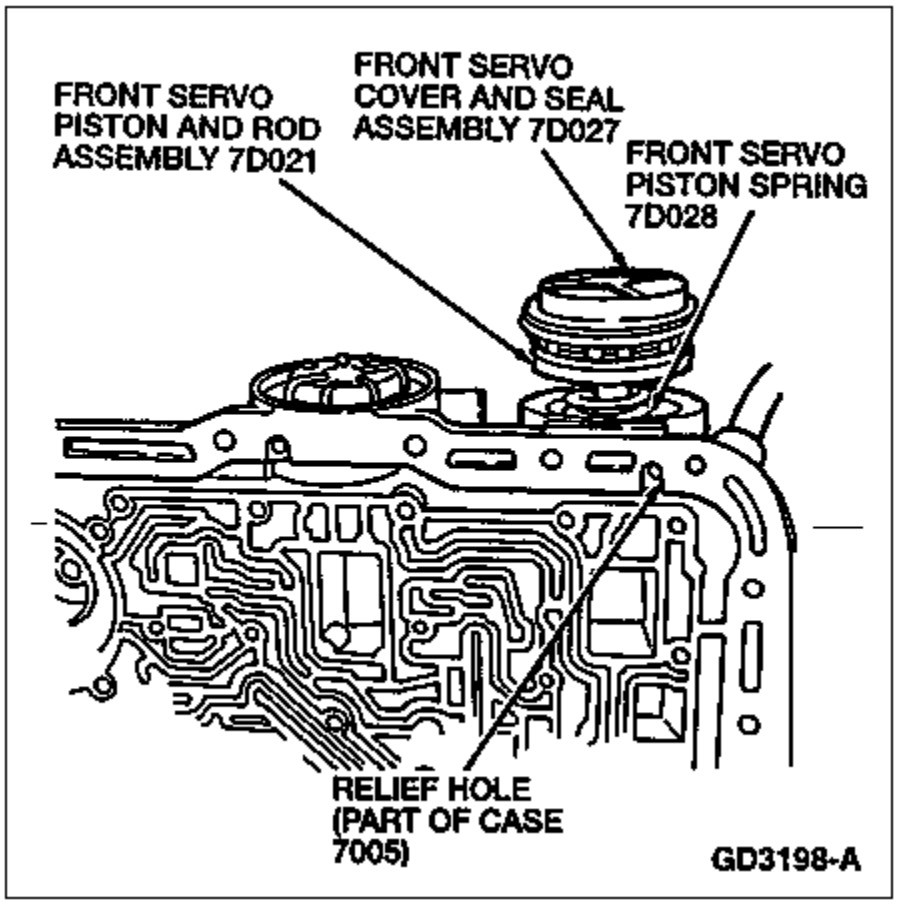

2. Carefully compress servo cover and install retaining ring.

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3. Install heat shield, if equipped.
4. Install catalytic converter if removed.

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Band Adjustments

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Band Adjustment Torque Wrench Set	T71P-77370-A

1. **CAUTION: Do not allow adjustment screw to back out. Band strut could fall in transmission assembly.**

   CAUTION: Throw the locknuts away. The locknuts are not reusable for assembly.

   Remove the front and intermediate band locknuts and discard, then back off the band adjusting screws.

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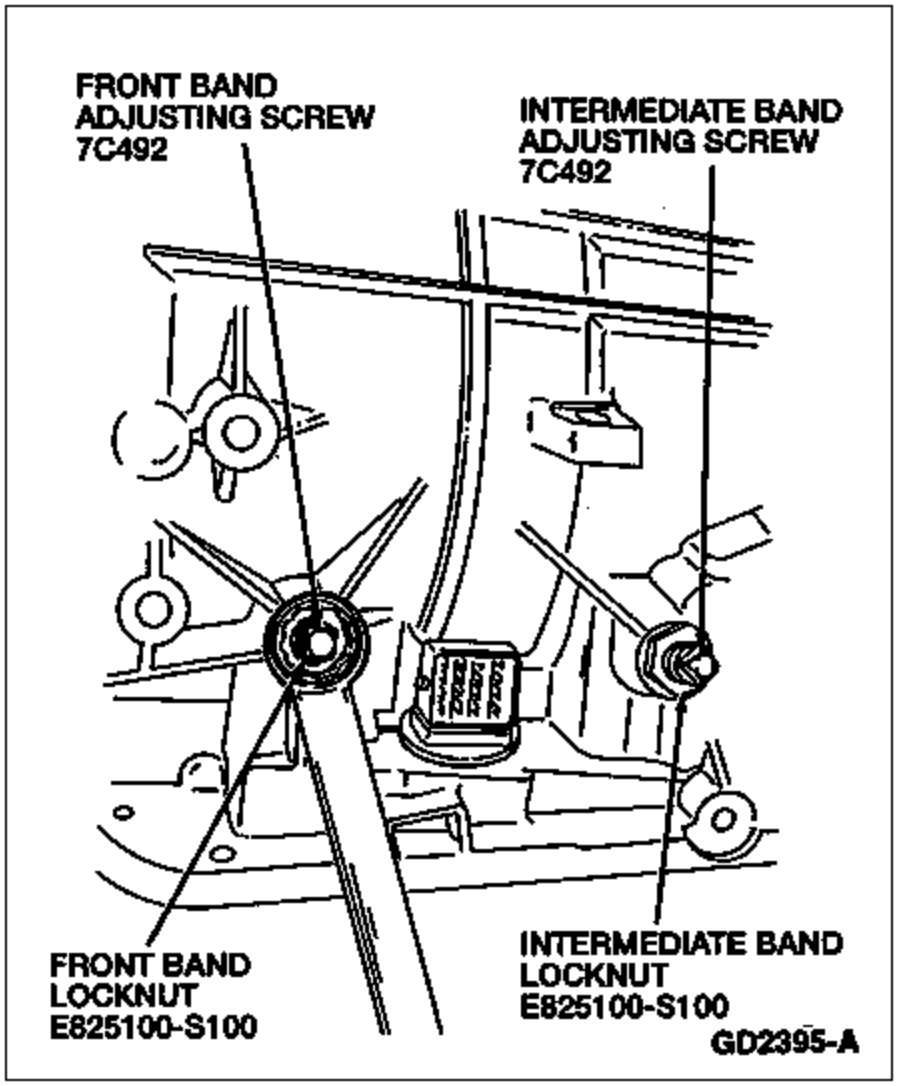

2. **CAUTION: Install, but do not tighten, a new locknut on the band adjusting screw. Apply petroleum jelly to the locknut seal.**

   CAUTION: Servos must be installed prior to band adjustment.

   Install two (2) new locknuts.

   Tighten the band adjusting screws using Band Adjustment Torque Wrench Set T71P-77370-A. The wrench will click at 14 Nm (10 lb-ft). Back off the band adjusting screw exactly two and one-half (2 1/2) turns for the intermediate band and two (2) turns for the front band and hold that position. Tighten the front and intermediate band locknut-to-case adjusting screws to 47-61 Nm (35-45 lb-ft) using a 19mm wrench.

Intermediate Band Adjustment

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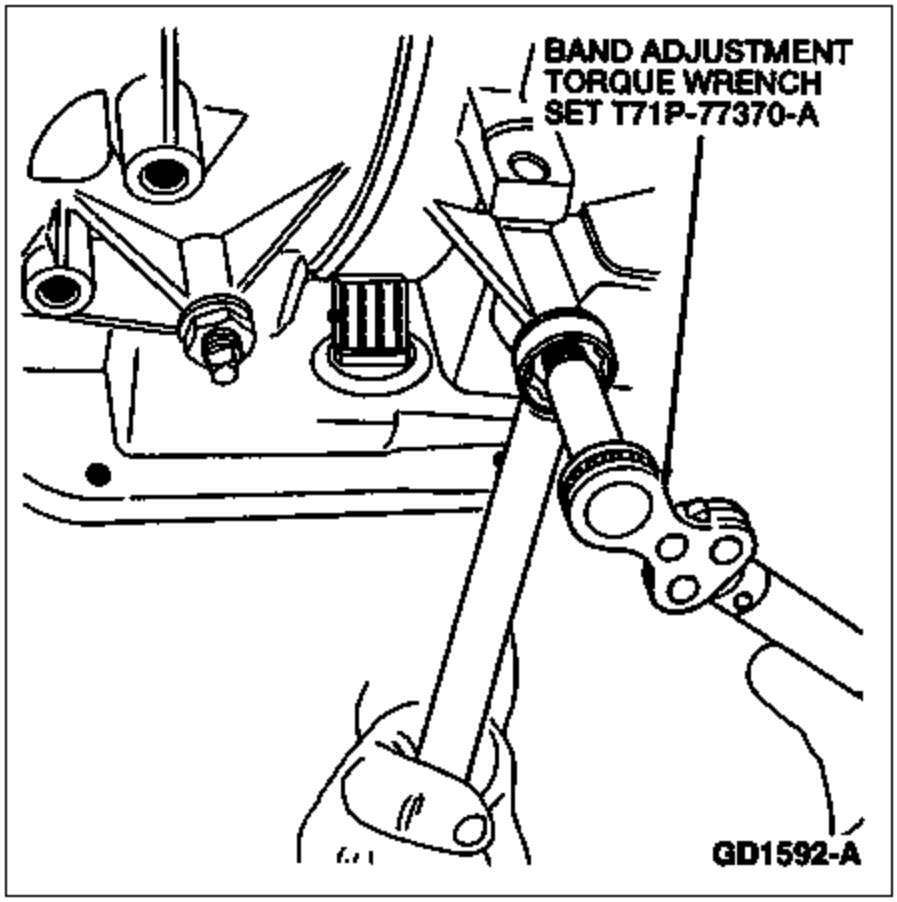
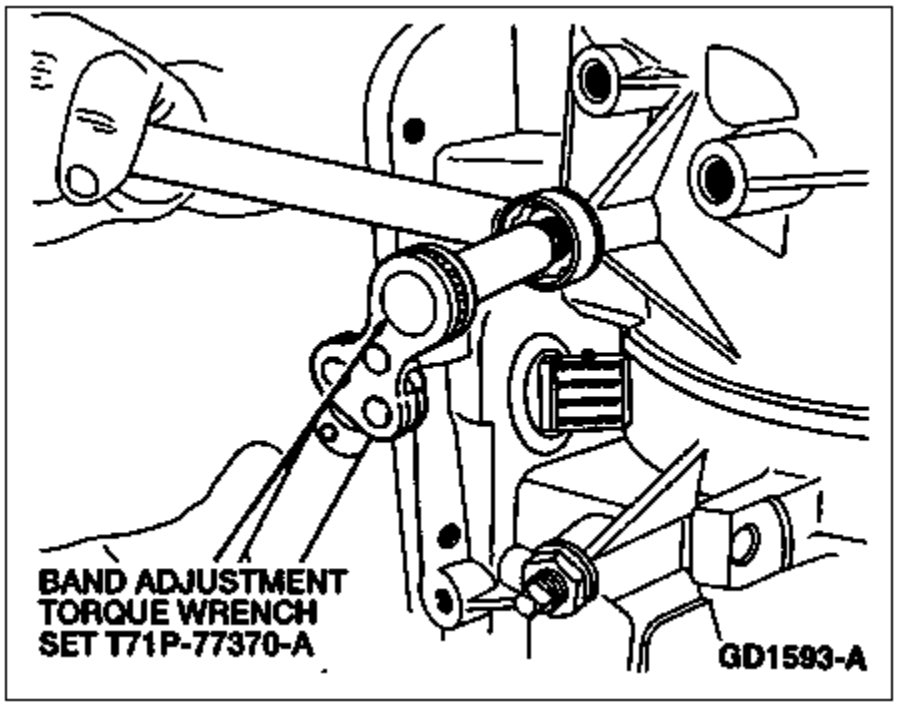


Front Band Adjustment



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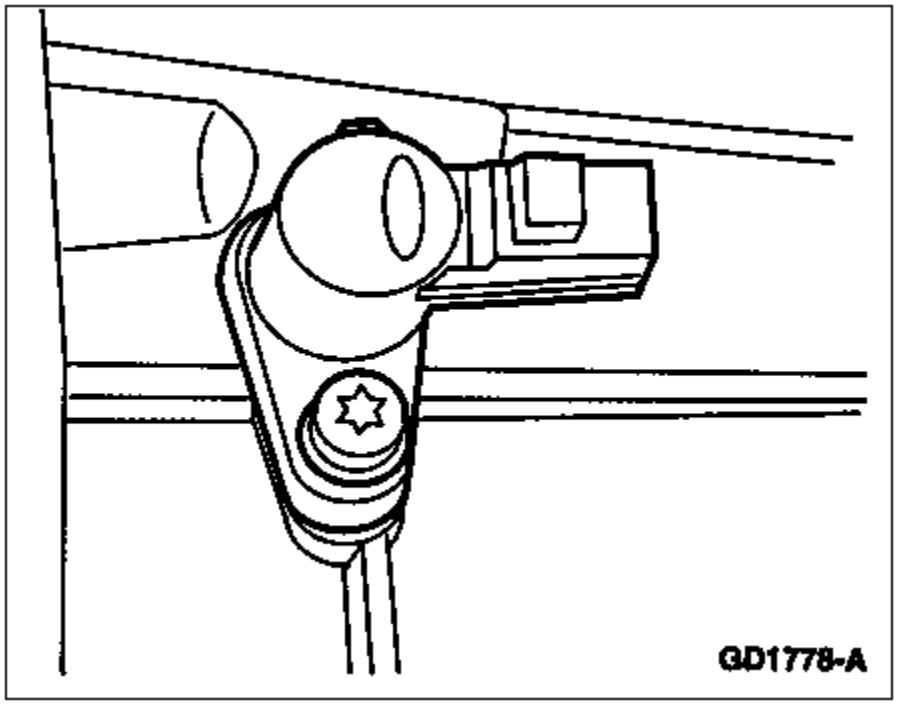
Overdrive Drum Speed Sensor

Removal

1. Disconnect vehicle harness from overdrive drum speed (ODS) (7M183) sensor.
2. Use a T30 torx socket to remove attaching bolt.
3. Remove ODS sensor from case.



Installation

1. Inspect the O-ring for damage.
2. Lubricate the O-ring on the sensor with petroleum jelly.
3. Install overdrive drum speed sensor (7M183) into case.
4. Install attaching bolt and tighten to 8-11 Nm (71-97 lb-in).

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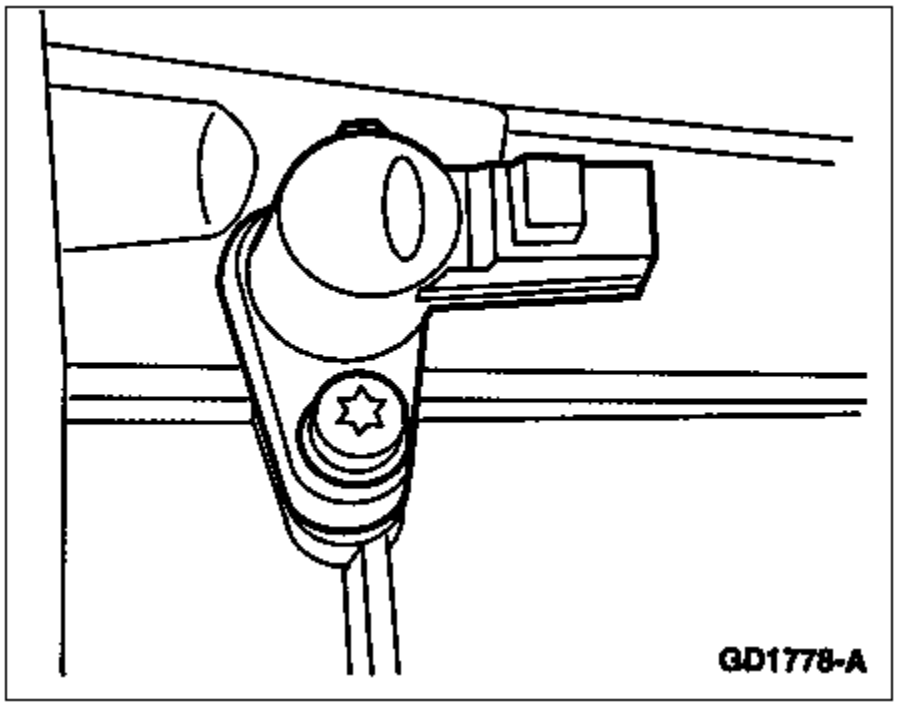
5. Connect vehicle harness to sensor.



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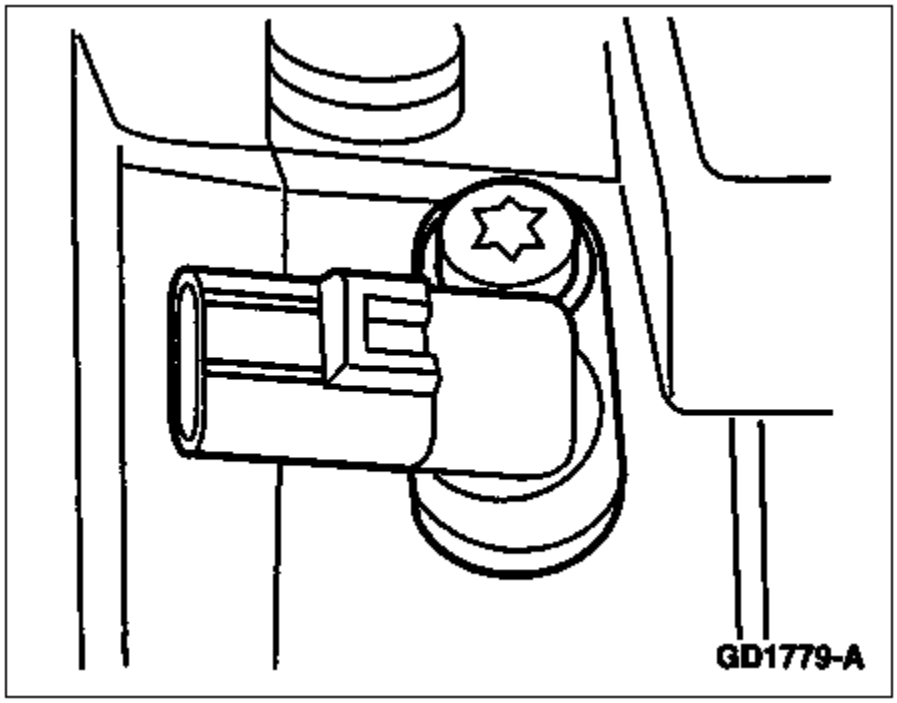
Output Shaft Speed Sensor

Removal

1. Disconnect vehicle harness from output shaft speed (OSS) (7H103) sensor.
2. Use a T30 torx socket to remove attaching bolt.
3. Remove OSS sensor from case.



Installation

1. Inspect the O-ring for damage.
2. Lubricate the O-ring on the sensor with petroleum jelly.
3. Install output shaft speed (7H103) sensor into case.
4. Install attaching bolt and tighten to 8-11 Nm (71-97 lb-in).

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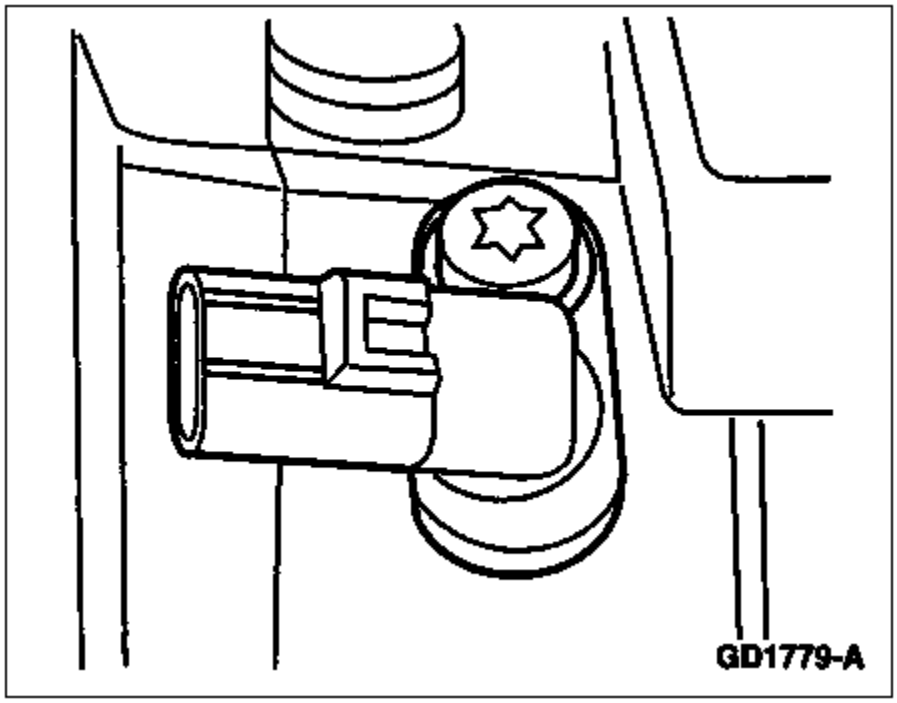
5. Connect vehicle harness to sensor.



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Transmission — 4x2

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Extension Housing Seal Replacer	T74P-77052-A
Torque Converter Holding Tool	T97T-7902-A

CAUTION: Disconnect the battery ground cable.

1. **NOTE: If the transmission is to be removed for a period of time, support the engine with a safety stand and a wood block.**

   Remove the transmission fluid level indicator.

2. Raise the vehicle on a hoist.

3. Drain the transmission. Refer to the procedure in this section.

4. **NOTE: On 4.0L engines, the converter-to-flexplate attaching nuts are accessed through the starter motor mounting hole.**

   Remove the starter-to-converter housing screws and position the starter motor out of the way.

5. Mark and index the converter stud to flexplate.

6. **NOTE: Flexplate-to-converter attaching nuts are not reusable.**

   Remove the four flexplate-to-converter nuts by placing a 22mm socket and breaker bar on the crankshaft pulley bolt. Rotate the pulley clockwise (as viewed from the front) to gain access to each of the nuts. Remove and discard nuts.

7. Scribe a mark indexing the driveshaft to the rear axle flange. Remove the shaft (refer to Section 05-00) and install a spare slip-yoke or Extension Housing Seal Plug in the extension housing.

8. Remove the speed control speedometer cable and/or VSS (if equipped) from the extension housing and plug the hole.

9. Disconnect the transmission shift cable at the transmission manual control lever. Remove the transmission shift bellcrank from the ball and stud lever. Depress the tab on the cable and remove the cable from the bracket.

10. Disconnect the digital transmission range (DTR) sensor, overdrive drum speed (ODS) sensor, output shaft speed (OSS) sensor, and the 16-pin transmission connectors.

11. Remove the two rear engine mount-to-crossmember nuts.

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12. **CAUTION: Do not allow the transmission to hang freely.**

    Place Transmission Jack 014-00210 under the transmission and raise the transmission slightly.

13. On Ranger and Aerostar vehicles, remove the two crossmember-to-frame sidemember support nuts and bolts. Remove the crossmember.

14. Remove the two rear engine mount-to-extension housing bolts. Remove the rear engine mount. Refer to Section 02-03 .

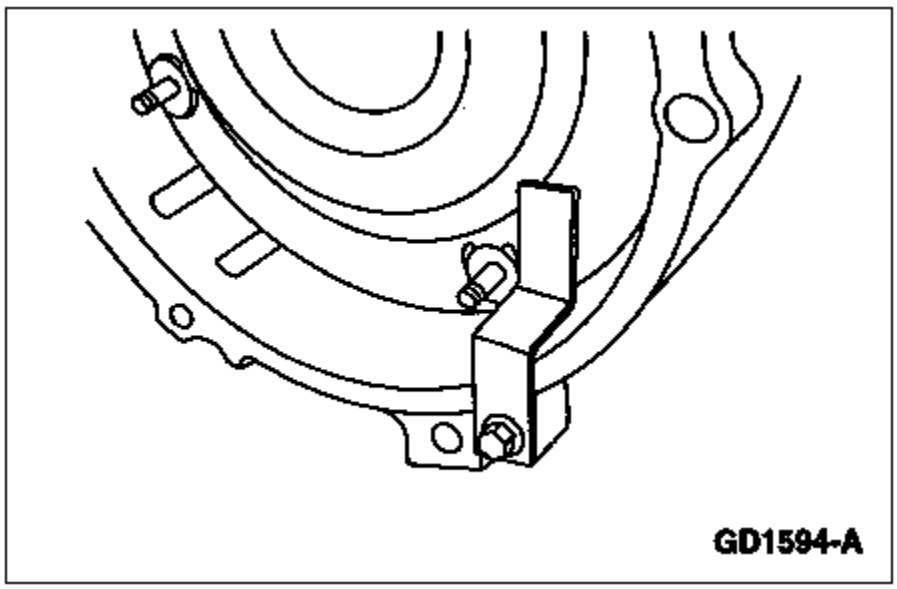
15. On 4.0L vehicles, remove the two catalytic converter-to-exhaust nuts and bolts.

16. On 4.0L vehicles, remove the three catalytic converter-to-crossover pipe nuts using a 15mm socket. Remove the catalytic converter assembly.

17. **CAUTION: Do not allow the transmission to hang freely.**

    Lower the jack under the transmission slightly.

18. Install Torque Converter Holding Tool T97T-7902-A with standard bolt into case.



19. Remove the two upper converter housing-to-engine screws.

20. Remove the fluid filler tube from the lube fluid inlet short tube.

21. Remove the two lower converter housing-to-engine screws.

22. **CAUTION: Care should be taken not to damage the cooler lines.**

    Disconnect the fluid cooler lines at the transmission. Plug all openings to keep out contamination. Refer to Section 07-02 .

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23. Remove the four side converter housing-to-engine screws.

24. Route all wire harnesses and hardware out of the way.

25. **WARNING: SECURE THE TRANSMISSION TO THE TRANSMISSION JACK WITH A SAFETY CHAIN.**

    Remove the transmission.

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Transmission — 4x4

CAUTION: Disconnect the battery ground cable.

NOTE: If the transmission is to be removed for a period of time, support the engine with a safety stand and a wood block.

1. Remove the transmission fluid level indicator.
2. Raise the vehicle on a hoist.
3. Drain the transmission. Refer to the procedure in this section.
4. **NOTE: On 4.0L engines, the converter-to-flexplate attaching nuts are accessed through the starter motor mounting hole.**

   Remove the starter-to-converter housing screws and position the starter motor out of the way.
5. Mark and index the converter stud to flexplate.
6. **NOTE: Flexplate-to-converter attaching nuts are not reusable.**

   Remove the four flexplate-to-converter attaching nuts by placing a 22mm socket and breaker bar on the crankshaft pulley attaching bolt. Rotate the pulley clockwise (as viewed from the front) to gain access to each of the nuts. Remove and discard nuts.
7. Scribe a mark on both the transfer case flange and the rear axle flange. Remove the rear drive shaft. Refer to Section 05-00 .
8. **CAUTION: The vehicle speed sensor (VSS) may be broken if not removed prior to transfer case removal.**

   Remove the VSS from the transfer case.
9. Disconnect the transmission shift cable at the transmission manual control lever. Remove the transmission shift bellcrank from the ball stud lever. Depress the tab on the cable and remove the cable from the bracket.
10. Disconnect the digital transmission range (DTR) sensor, overdrive drum speed (ODS) sensor, output shaft speed (OSS) sensor, and the 16-pin transmission connectors.
11. Remove the four transfer case skid plate screws and remove the transfer case skid plate.
12. Remove the four screws attaching the front axle driveshaft to the transfer case flange.
13. **CAUTION: Wire-tie the front axle driveshaft out of the way of the frame.**

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Remove the front axle driveshaft from the transfer case flange.

14. Disconnect the transfer case electrical connectors.

15. Remove the two rear engine mount-to-crossmember nuts.

16. **CAUTION: Do not allow the transmission to hang freely.**

    Place Transmission Jack 014-00210 under the transmission and raise the transmission slightly.

17. On Ranger and Aerostar vehicles, remove the two crossmember-to-frame through bolts and nuts. Remove the crossmember.

18. Remove the two rear engine mount-to-extension housing screws. Remove the rear engine mount. Refer to Section 02-03 .

19. On 4.0L vehicles, remove the two catalytic converter-to-exhaust nuts and bolts.

20. On 4.0L vehicles, remove the three catalytic converter-to-crossover pipe nuts. Remove the catalytic converter assembly.

21. Support the transfer case.

22. Remove the five transfer case-to-extension housing screws.

23. Remove the transfer case vent bracket screws and remove the transfer case vent bracket.

24. Carefully remove the transfer case and discard the transfer case-to-extension housing gasket.

25. **CAUTION: Do not allow the transmission to hang freely.**

    Lower the jack under the transmission slightly.

26. Install Torque Converter Holding Tool T97T-7902-A with standard bolt into case.

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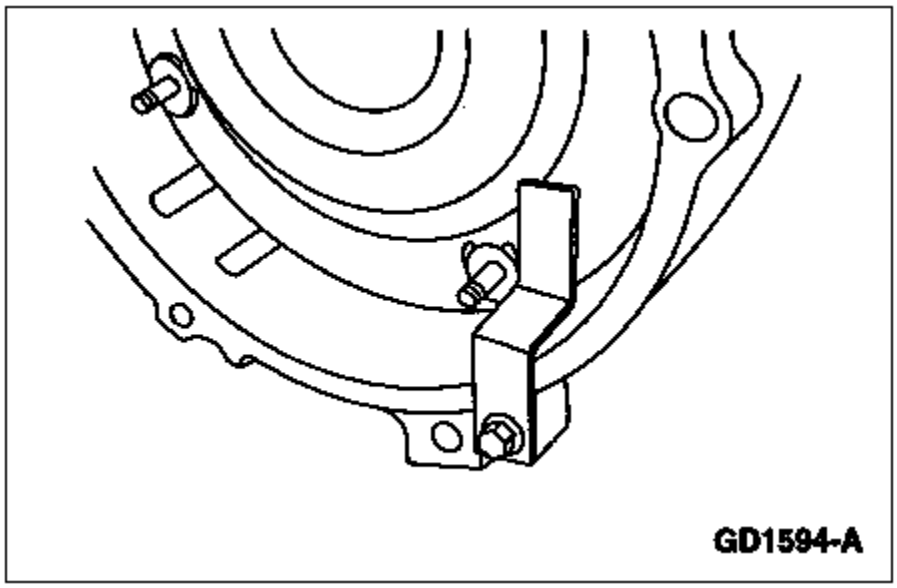

27. Remove the two upper converter housing-to-engine attaching screws.

28. Remove the fluid filler tube from the lube fluid inlet short tube.

29. Remove the two lower converter housing-to-engine attaching screws.

30. **CAUTION: Care should be taken not to damage the fluid cooler lines.**

    Disconnect the fluid cooler lines at the transmission. Plug all openings to keep out contamination. Refer to Section 07-02 .

31. Remove the four side converter housing-to-engine attaching screws.

32. Route all wire harnesses and hardware out of the way.

33. **WARNING: SECURE THE TRANSMISSION TO THE TRANSMISSION JACK WITH A SAFETY CHAIN.**

    Remove the transmission.

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Transmission

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Torque Converter Handles	T81P-7902-C
Impact Slide Hammer	T50T-100-A
Extension Housing Bushing Remover	T77L-7697-E
A4LD Holding Fixture Adapter	T93T-77002-AH
Bench-Mounted Holding Fixture	T57L-500-B
Servo Cover Compressor	T95L-77028-A
4R44E/4R55E Transmission Test Plate	T95L-77000-AH
Servo Removal Tool	T97T-7D021-A

SPECIAL SERVICE TOOLS DESIRED

Tool Number	Description
T94P-77001-BH	Seal Remover

Disassembly

1. **WARNING: DO NOT REMOVE THE TORQUE CONVERTER OR TRANSFER CASE FROM THE TRANSMISSION WHILE STILL ON THE JACK. DOING SO COULD CAUSE THE TRANSMISSION TO FALL OFF THE JACK.**

   Relocate the transmission to the top of a flat workbench.

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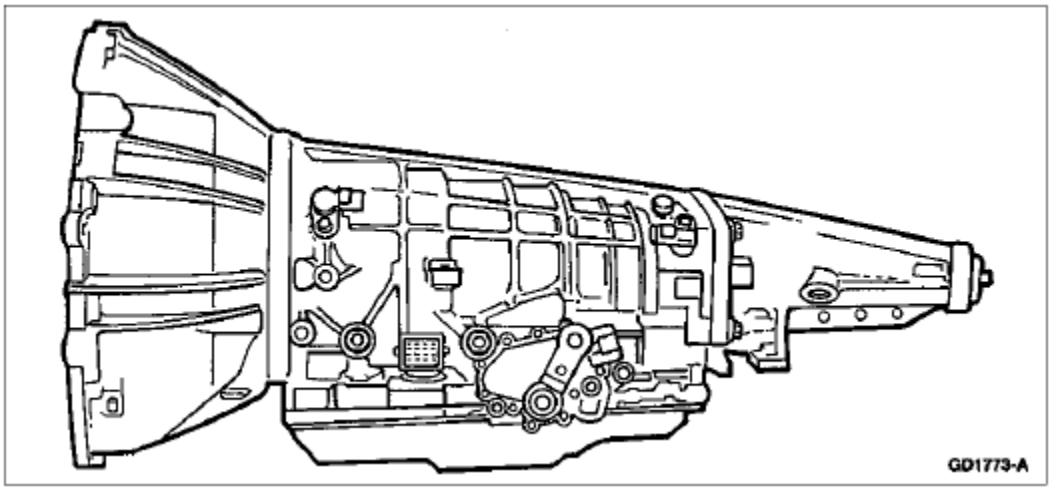
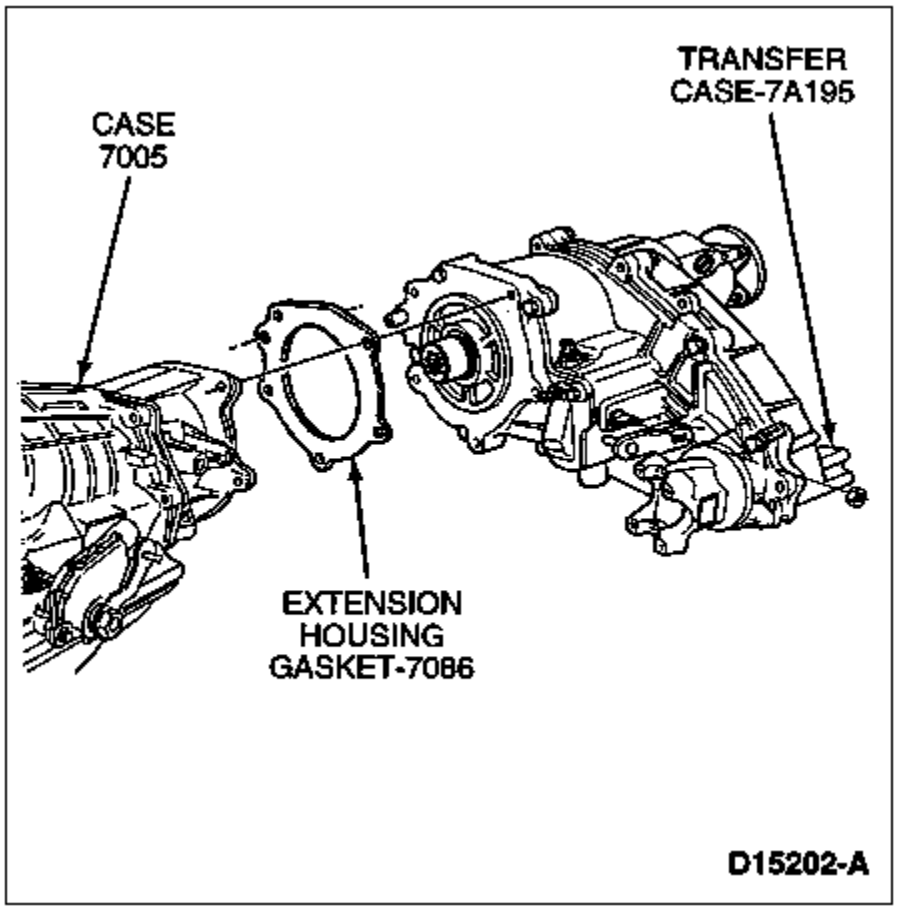


2. **NOTE: Refer to Section 07-07A , Section 07-07B , Section 07-07C , Section 07-07D for transfer case service.**

   If the vehicle has a transfer case, use a 13mm socket to remove the five transfer case-to-extension housing screws. Remove the transfer case and set aside for assembly.



3. Remove Torque converter Holding Tool T97T-7902-A form transmission.

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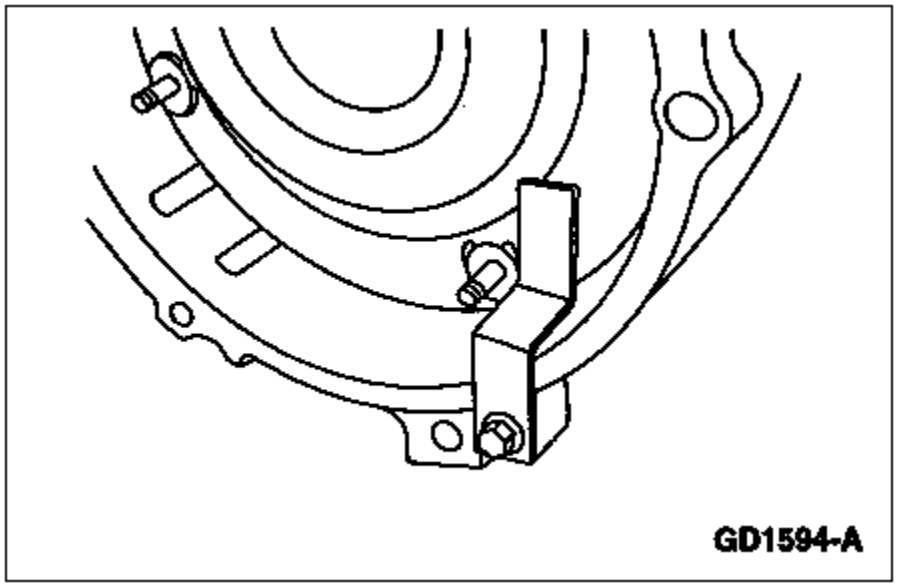

4. **WARNING: THE TORQUE CONVERTER IS HEAVY, ESPECIALLY WHEN FULL OF FLUID.**

   Remove the torque converter using Torque Converter Handles T81P-7902-C.

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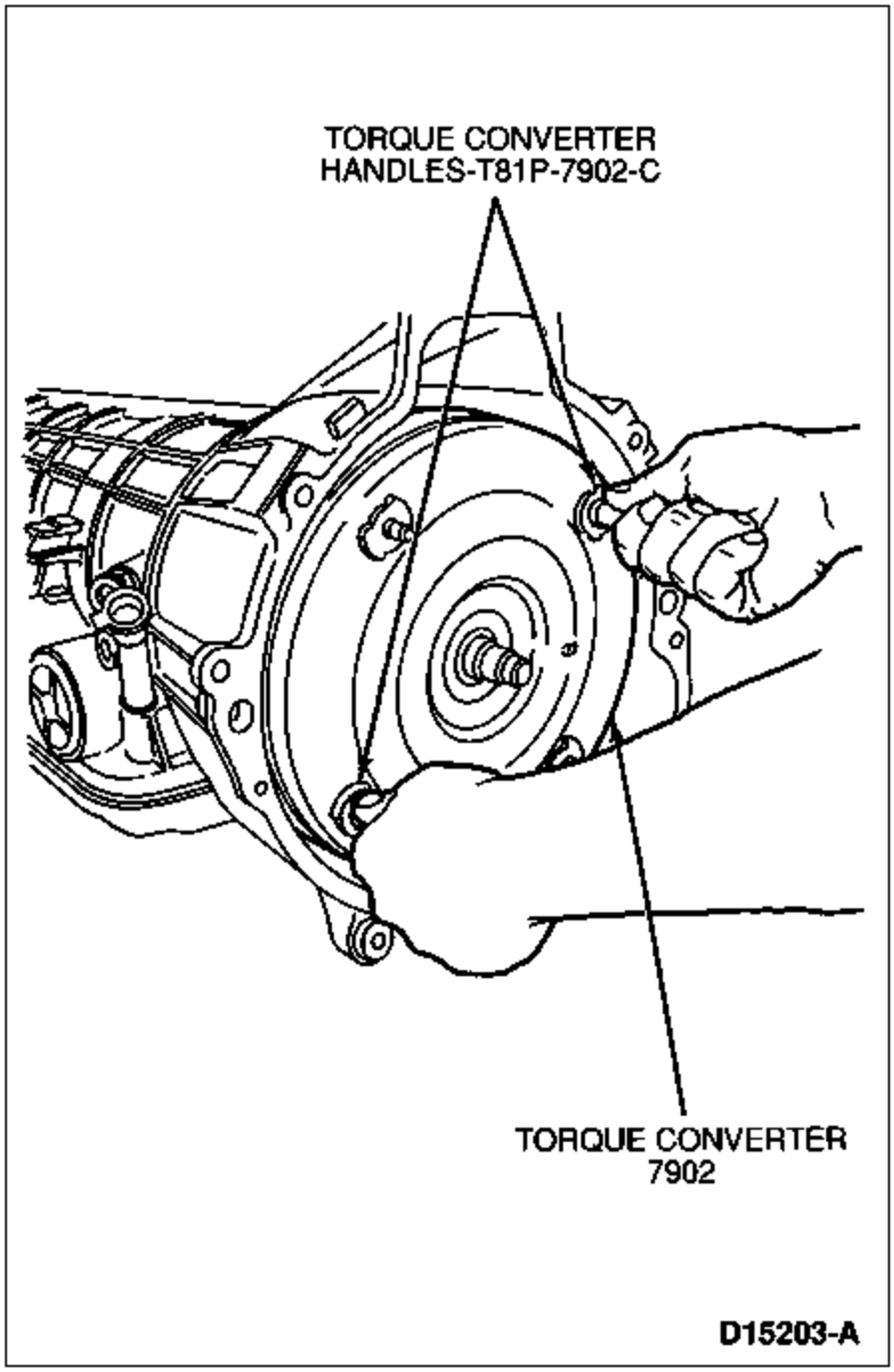

5. **NOTE: The splines on the input shaft are not the same on both ends. The end with the shorter spline goes into the assembly.**

   Remove the input shaft.

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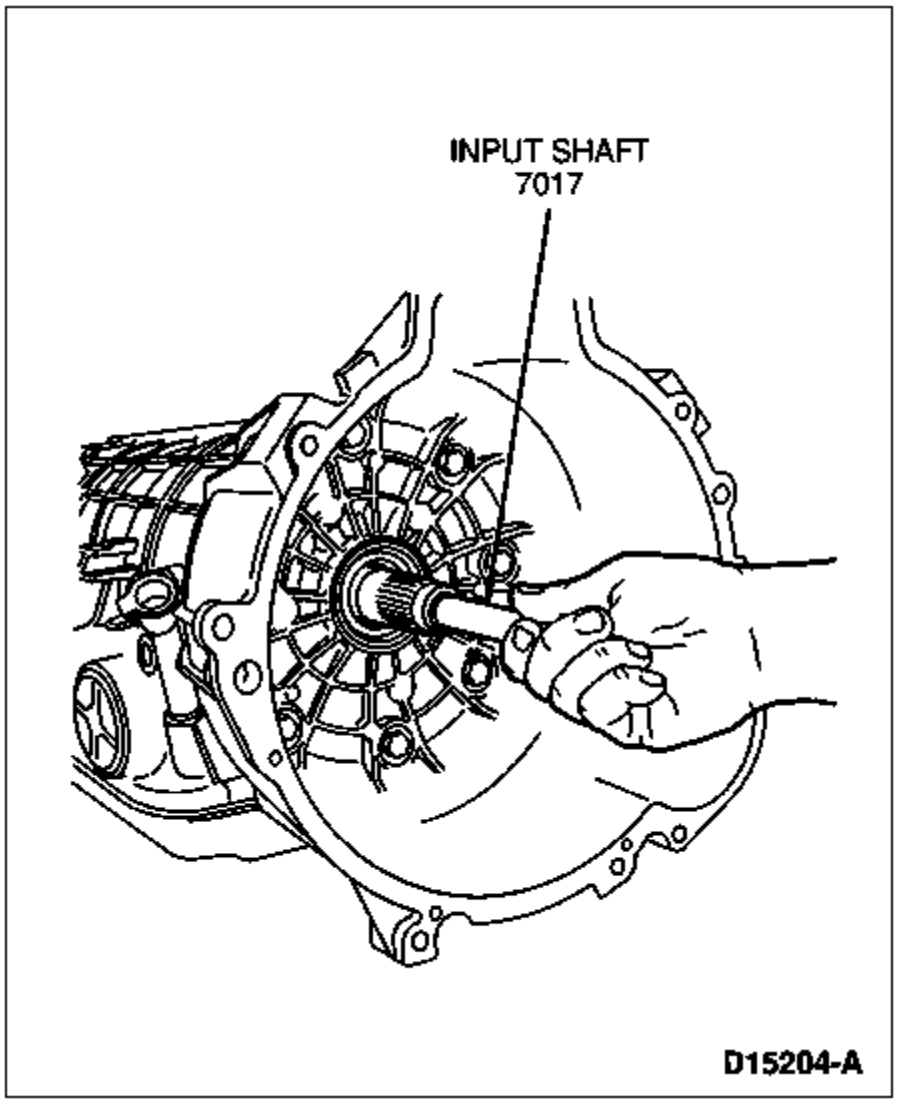

6. Use a T30 torx socket to remove overdrive drum speed sensor attaching bolt, then remove sensor.

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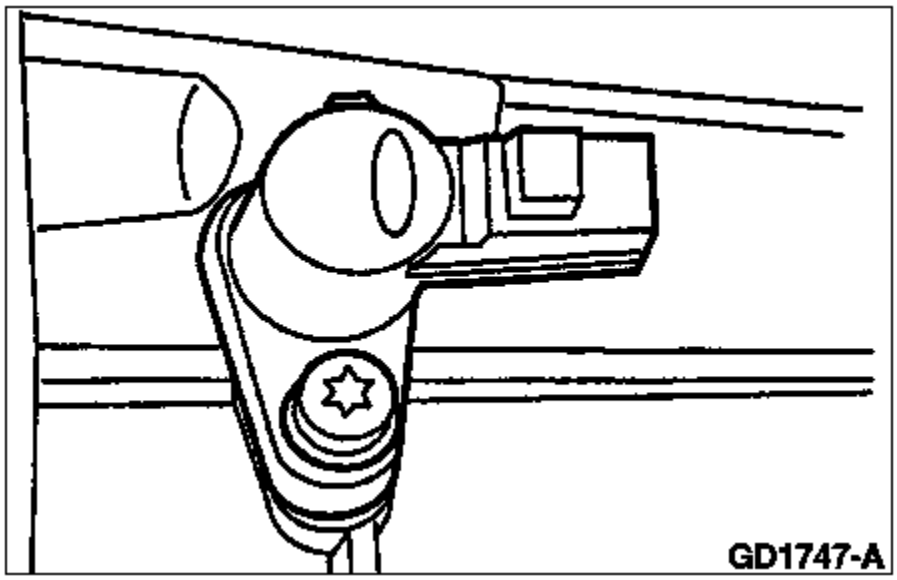
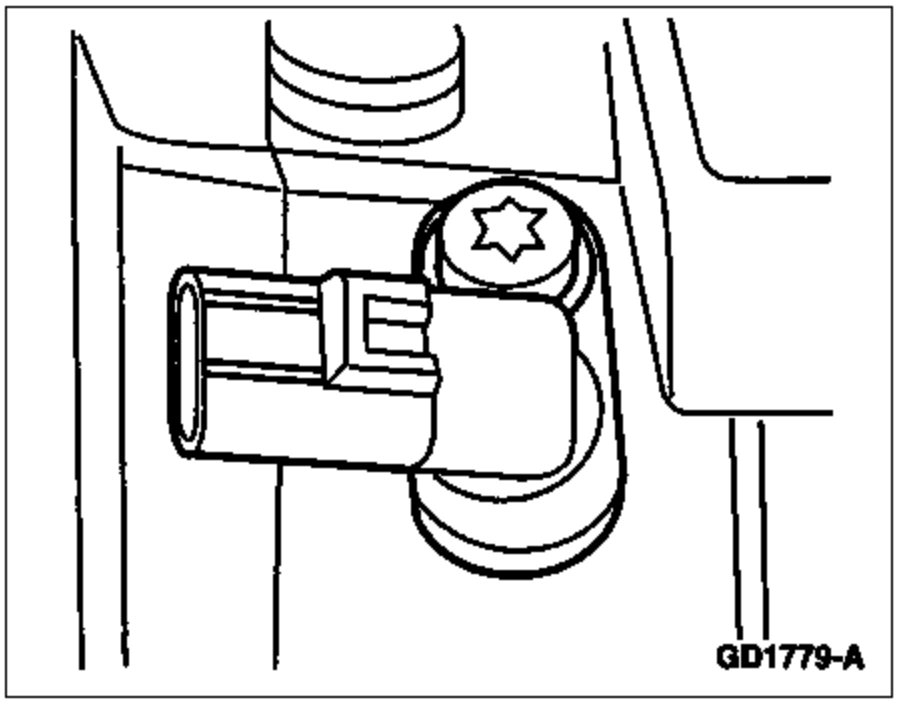


7. Use a T30 torx socket to remove output shaft speed sensor attaching bolt, then remove sensor.



8. Remove the M6 x 1.0 transmission heat shield nut from the studded screw.

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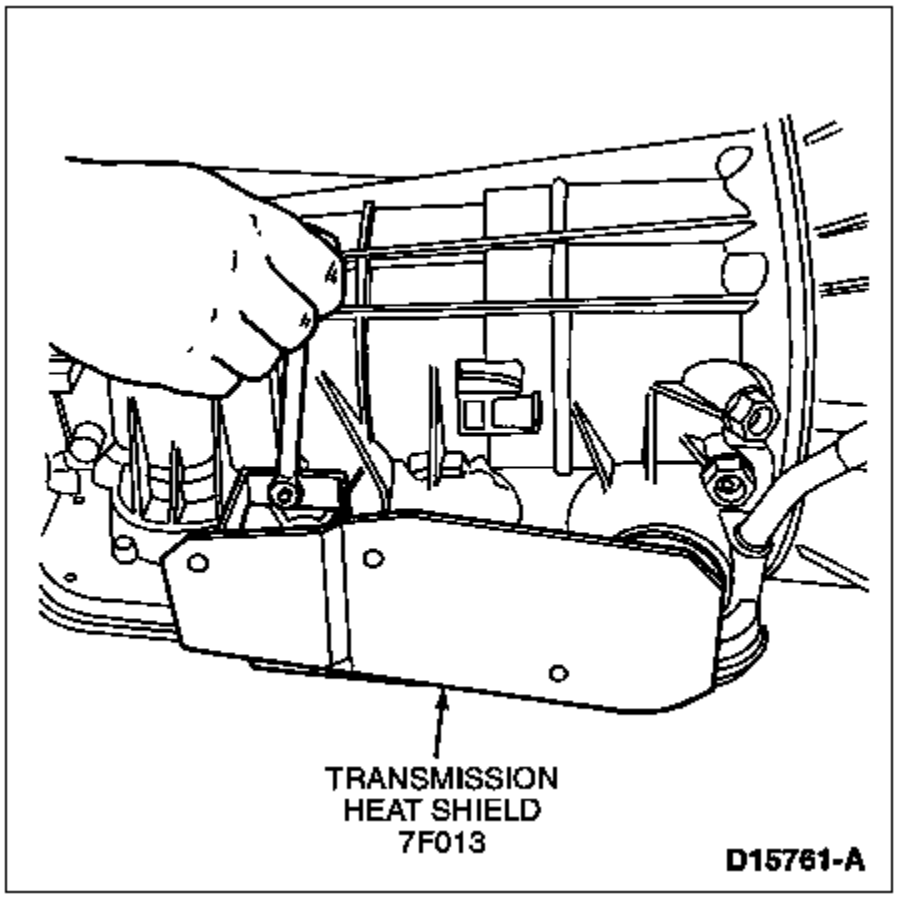

9. Carefully pry the transmission heat shield off of the fluid pan rail near the retaining clips.

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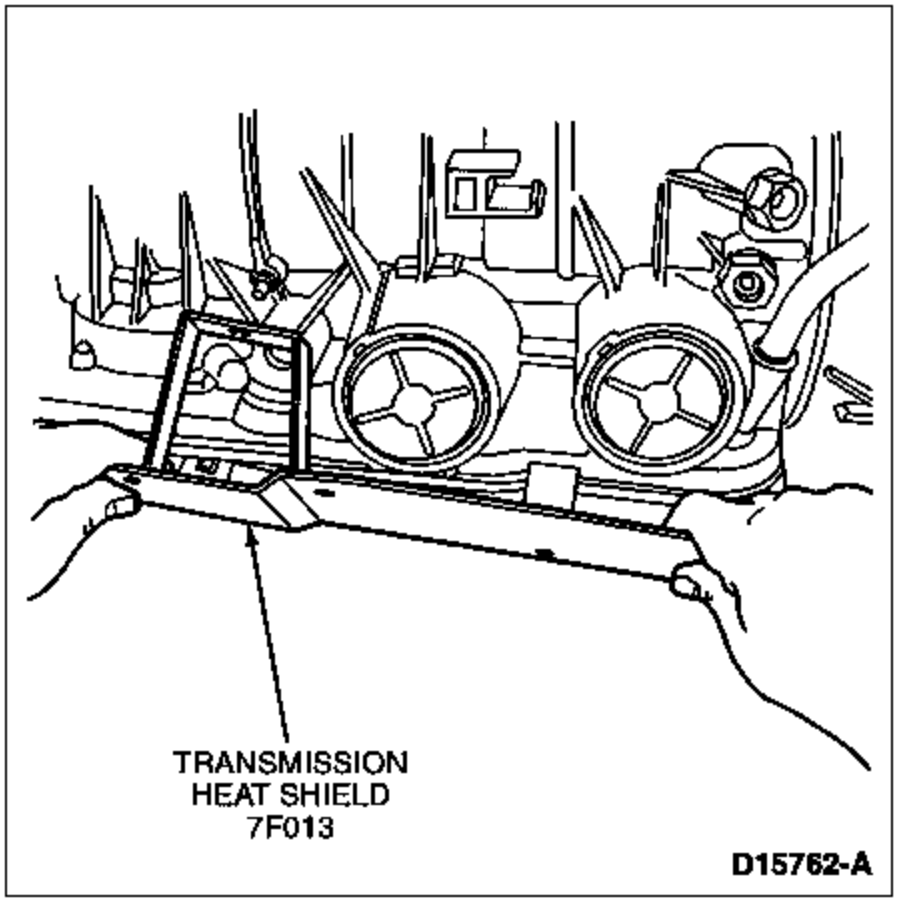

10. Remove the manual control outer lever nut and manual control outer lever.

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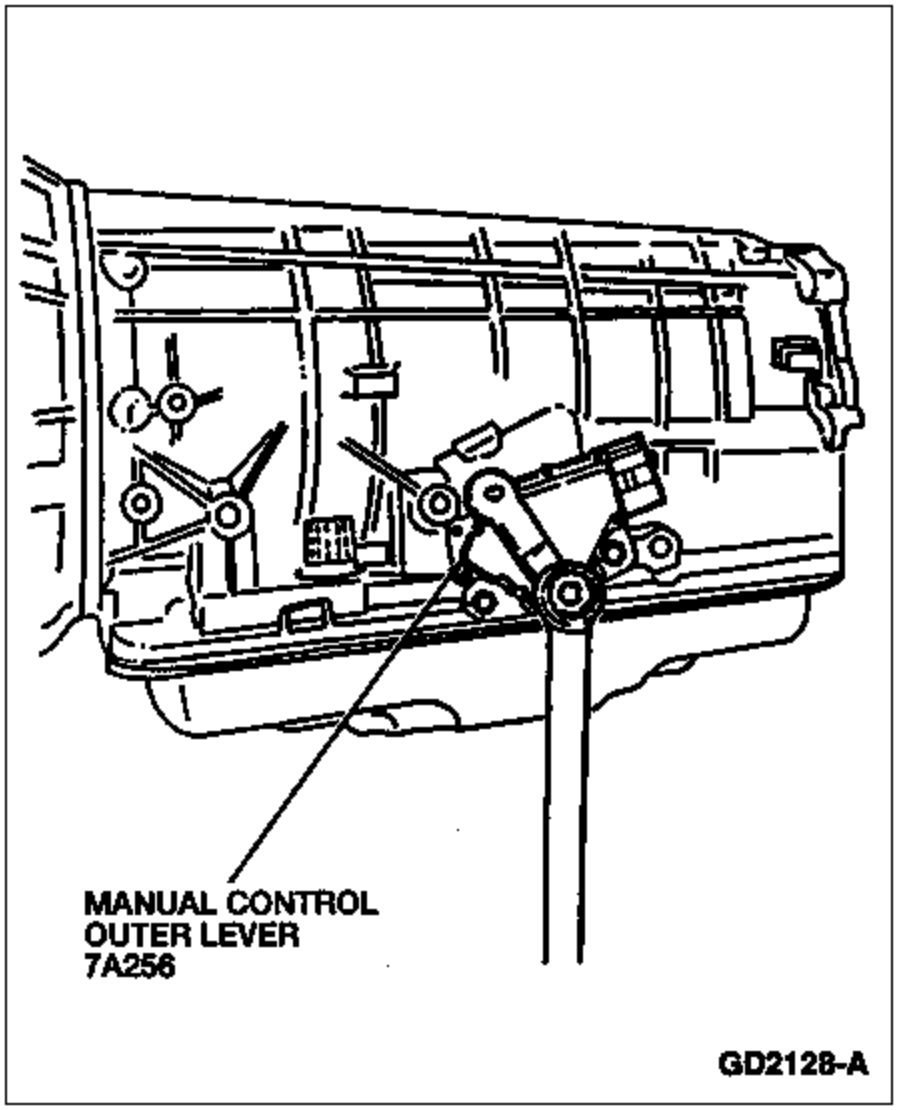

11. Remove the two M6 x 25 digital transmission range (DTR) sensor screws and remove the DTR sensor.

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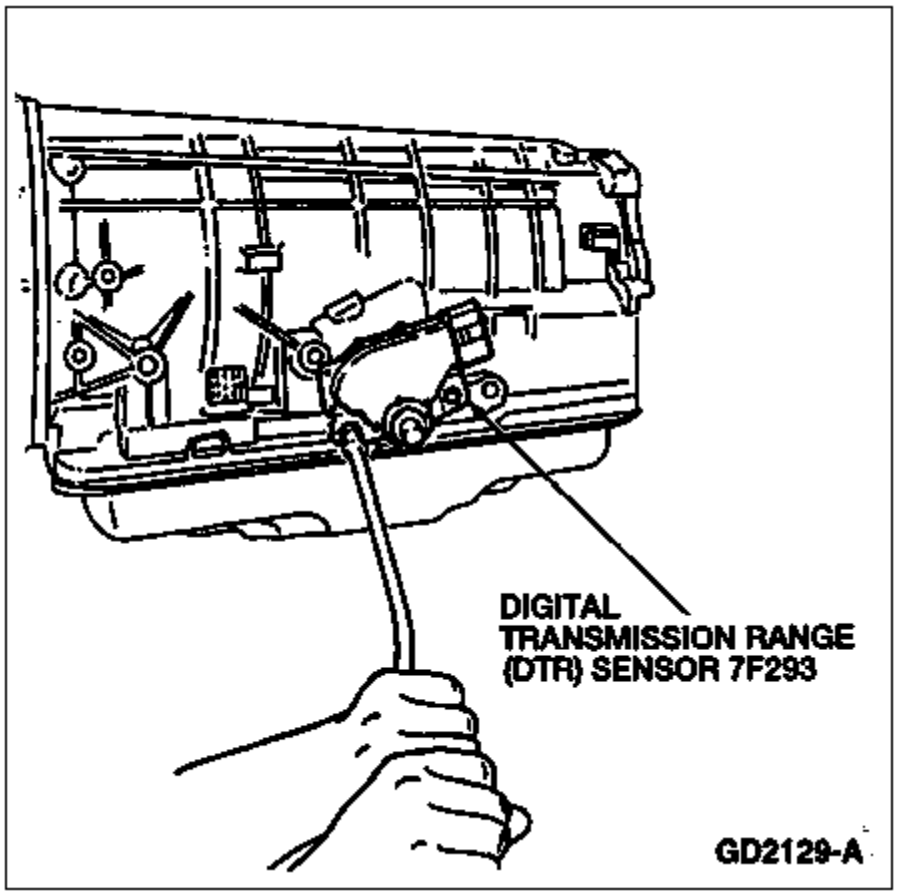
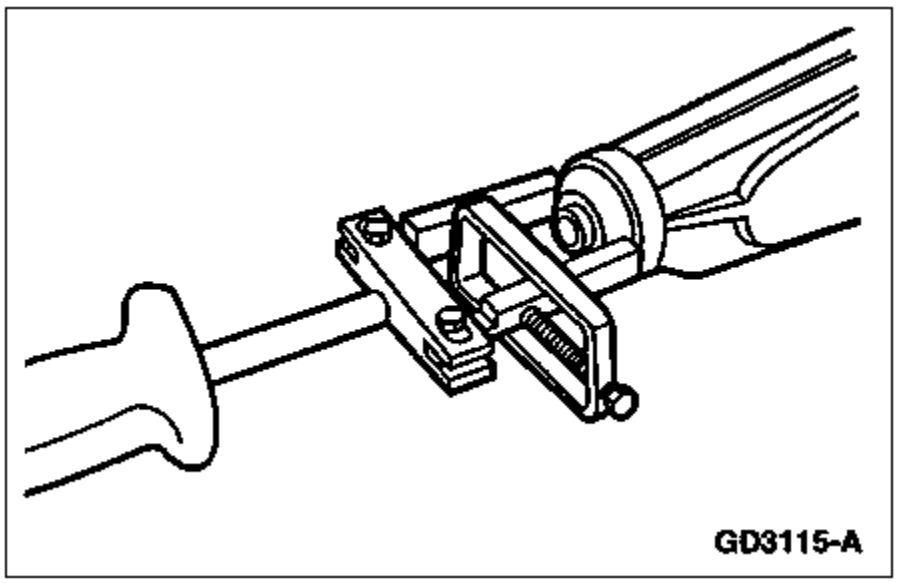


12. Remove the extension housing seal using Seal Remover T94P-77001-BH and Impact Slide Hammer T50T-100-A.



13. **NOTE: Remove the extension housing bushing only if service is required.**

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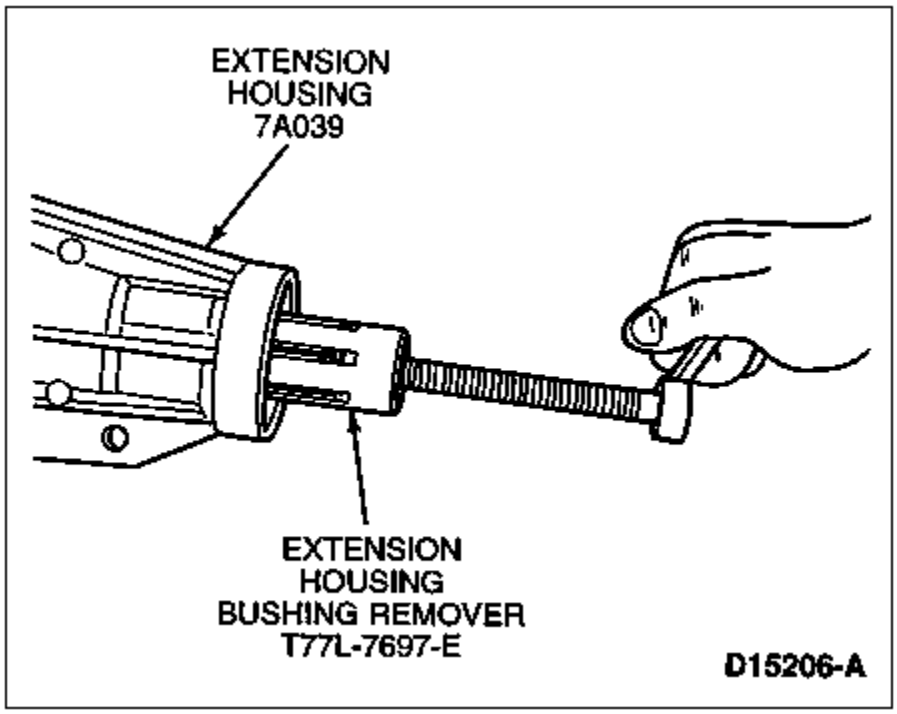
Inspect the extension housing bushing and driveshaft slip-yoke for nicks, gouges, scoring and wear.

Remove the extension housing bushing using Extension Housing Bushing Remover T77L-7697-E.



14. **CAUTION: The parking pawl, parking pawl return spring and parking pawl shaft could fall out during removal of the extension housing.**

Use a 17mm socket to remove the five M10 x 30mm extension housing-to-transmission case screws, one stud and gasket. Discard gasket.

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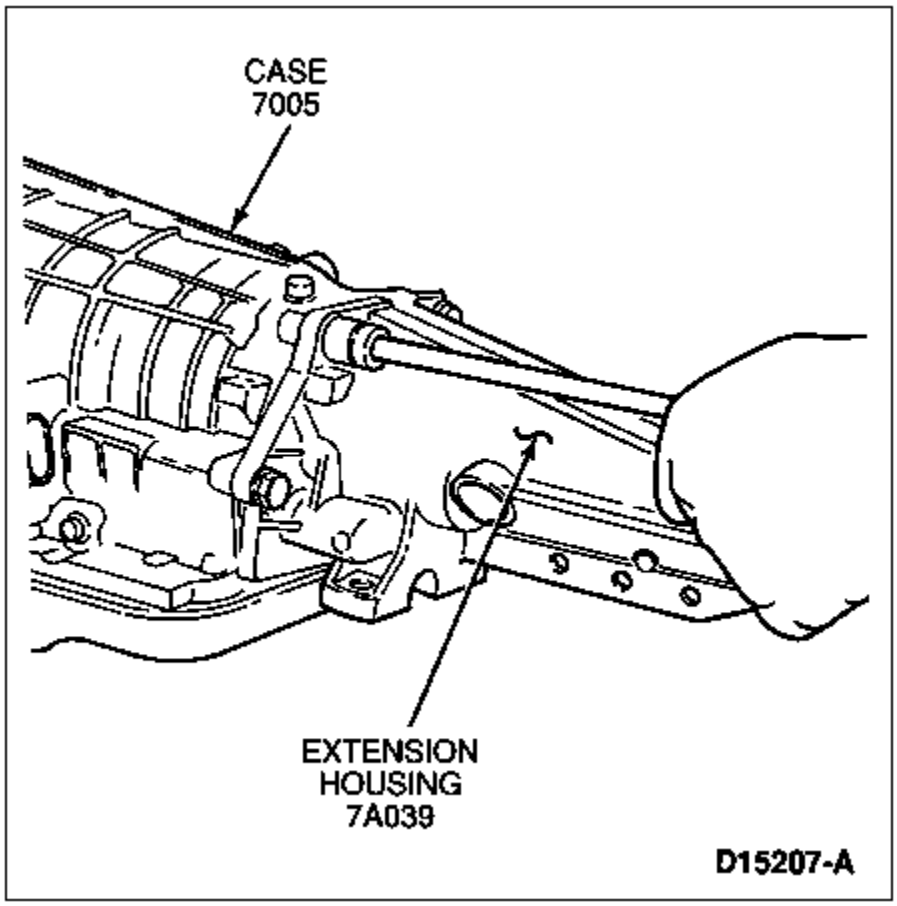

15. Remove the parking pawl, parking pawl return spring and parking pawl shaft.

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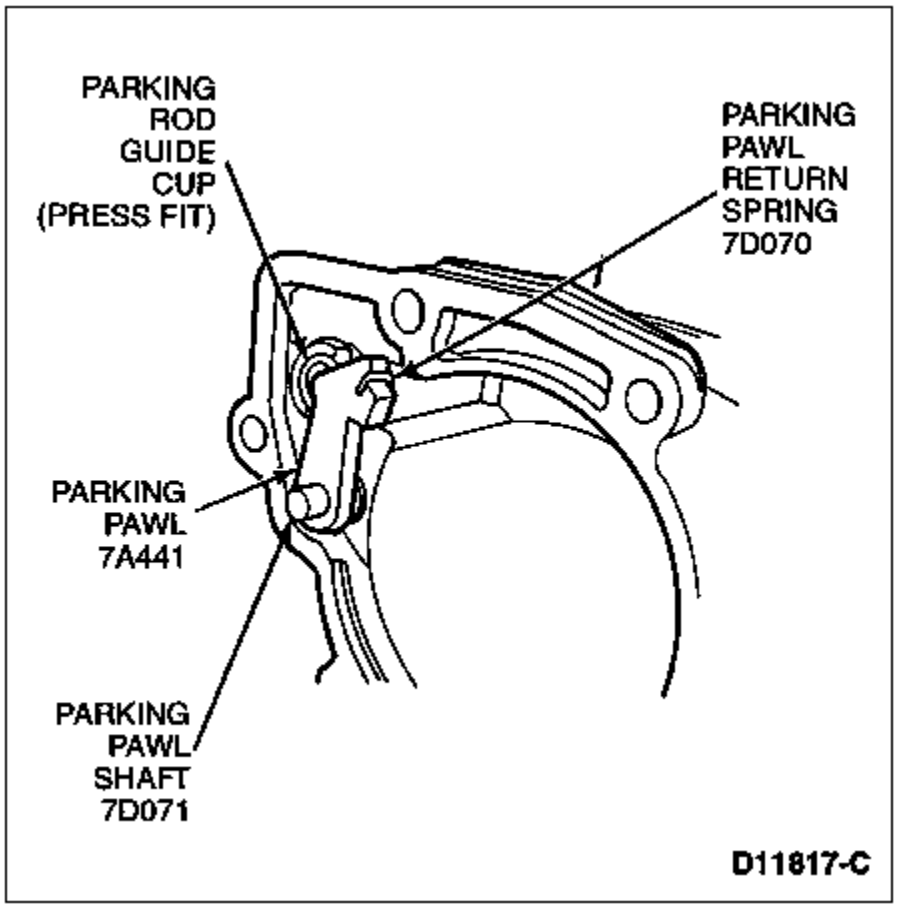

16. **CAUTION: The parking pawl actuating rod must slip freely into the clearance hole in the adapter plate.**

NOTE: See the special service tool section for a drawing of this optional adapter plate.

Use the four M10 x 30mm extension housing to transmission case screws to attach the adapter plate to the transmission.

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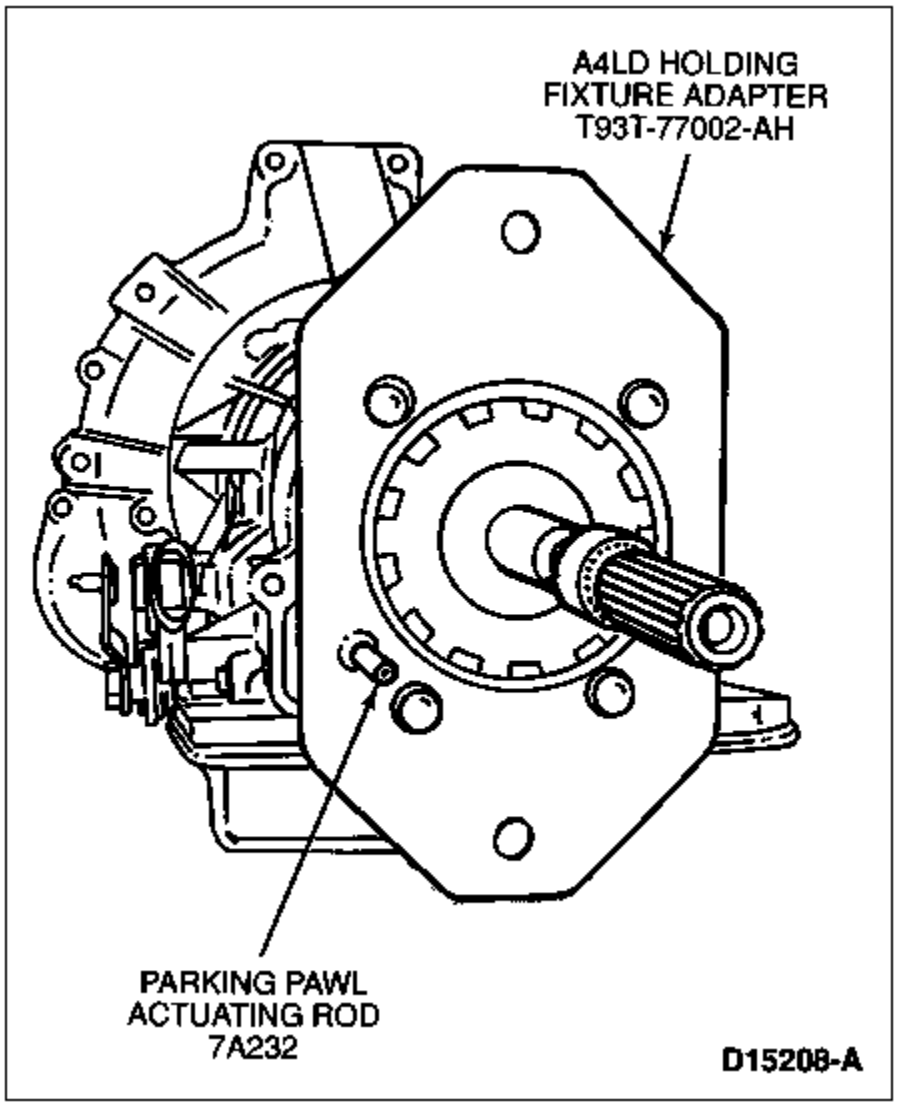

17. Attach the fixture arm assembly (part of T57L-500-B) with two 7/16 x 2-inch bolts and nuts.

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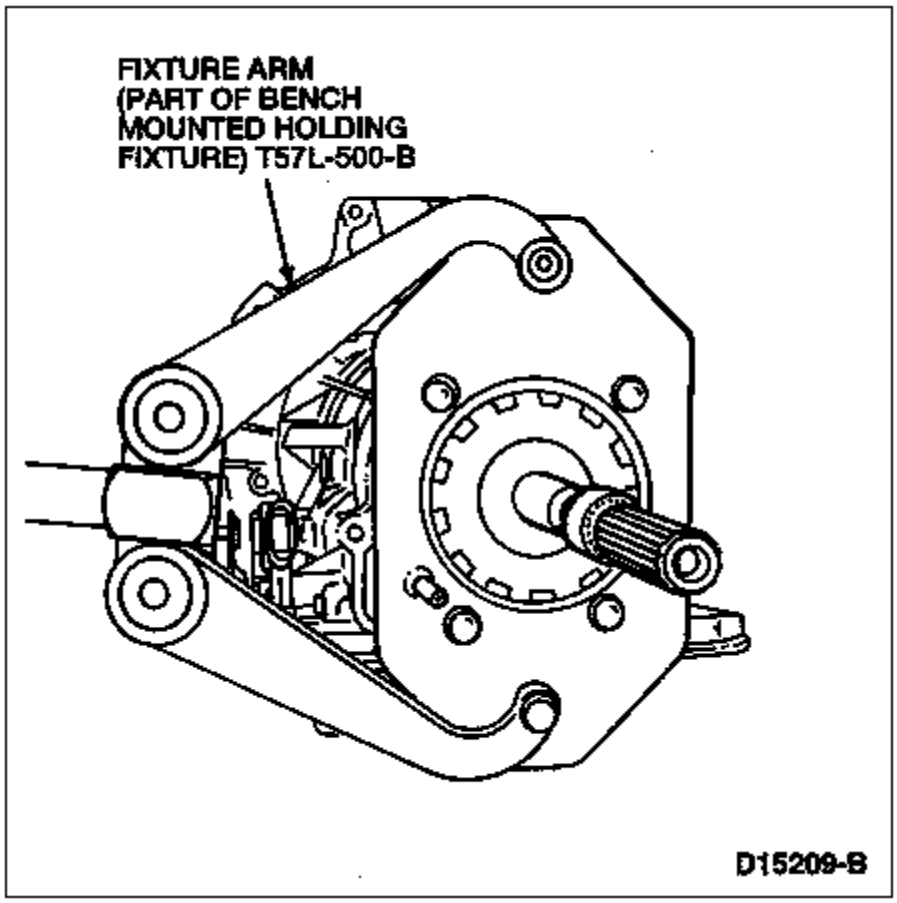

18. **WARNING: MAKE SURE THE LOCK PIN ON BENCH-MOUNTED HOLDING FIXTURE T57L-500-B IS SECURE.**

    Install the transmission assembly to Bench-Mounted Holding Fixture T57L-500-B. Rotate to the position shown. Place a drain pan under the assembly.

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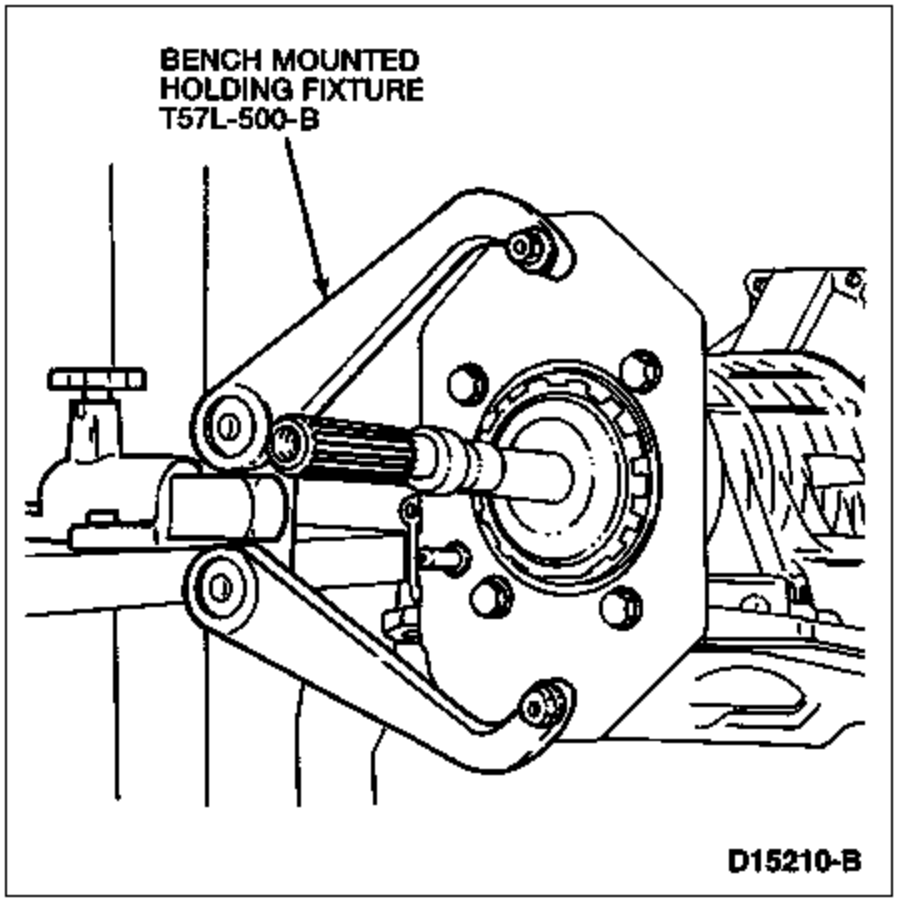

19. **WARNING: MAKE SURE THE LOCK PIN ON BENCH-MOUNTED HOLDING FIXTURE T57L-500-B IS SECURE.**

    Rotate transmission assembly so that the fluid pan is facing up.

20. **CAUTION: Do not reuse the fluid pan gasket.**

    Use a 13mm socket to remove the eighteen M8 x 16mm fluid pan screws. Remove the fluid pan and fluid pan gasket. Discard the fluid pan gasket.

Fluid Pan Removal

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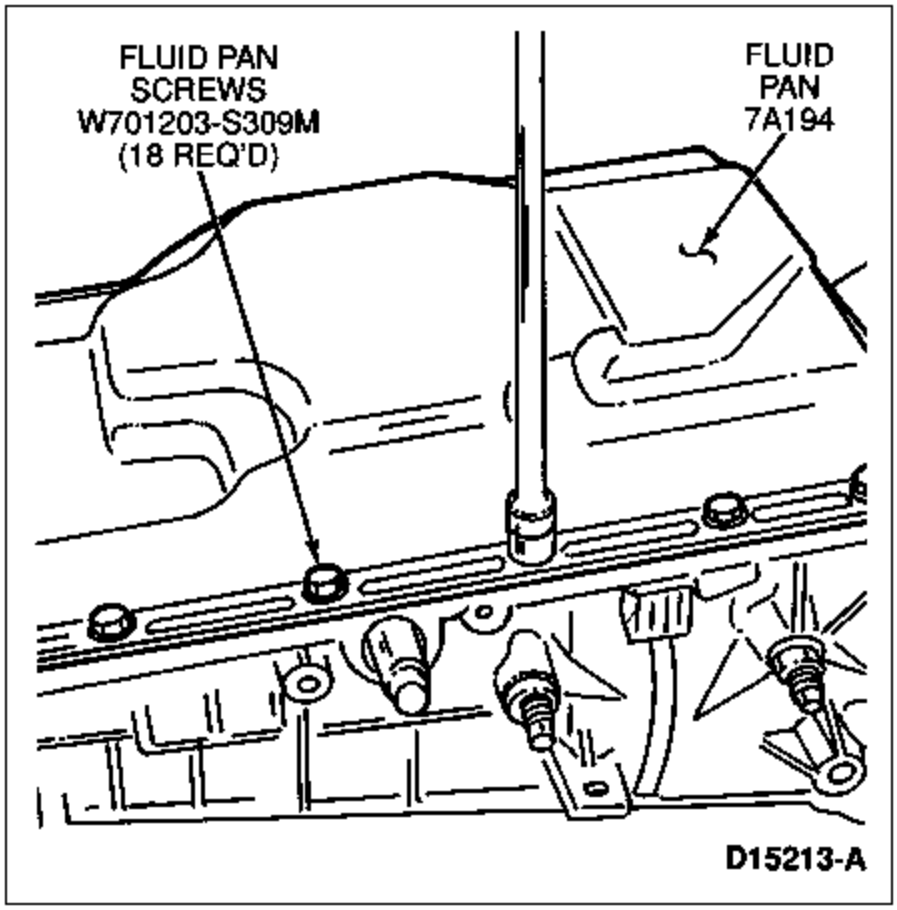

21. Use a 10mm socket to remove the M6 x 55mm fluid pan filter assembly screw. Remove and discard the fluid pan filter assembly.

Fluid Pan Filter Removal

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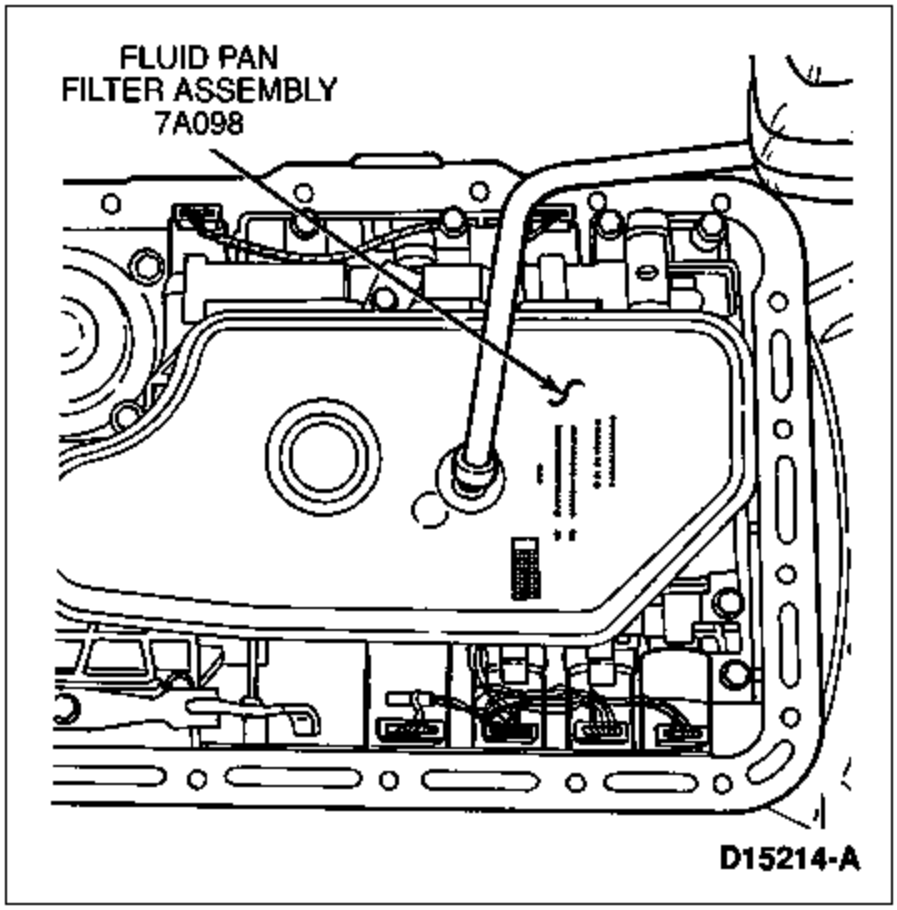

22. Carefully lift up on the wire loom guide and protector. Disengage the retaining pins from the solenoid clamps.

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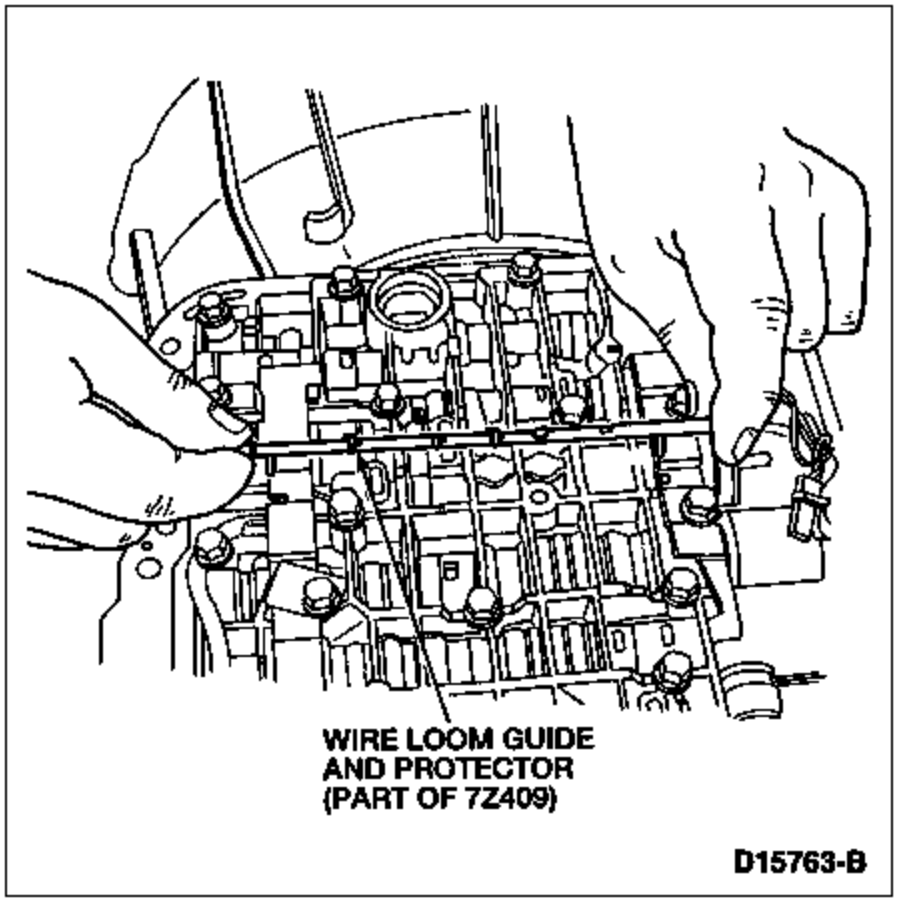

23. Disconnect the six solenoid connectors from the solenoids by carefully pulling upward and wiggling side to side.

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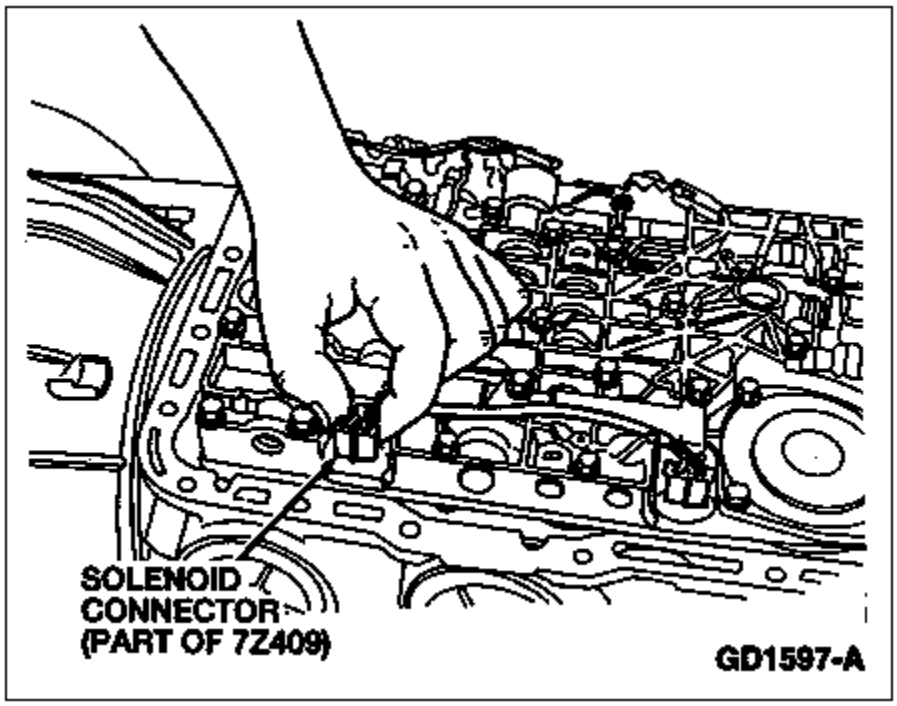

24. Use a 10mm socket to remove the M6 x 30mm manual valve detent spring screw. Remove the manual valve detent spring.

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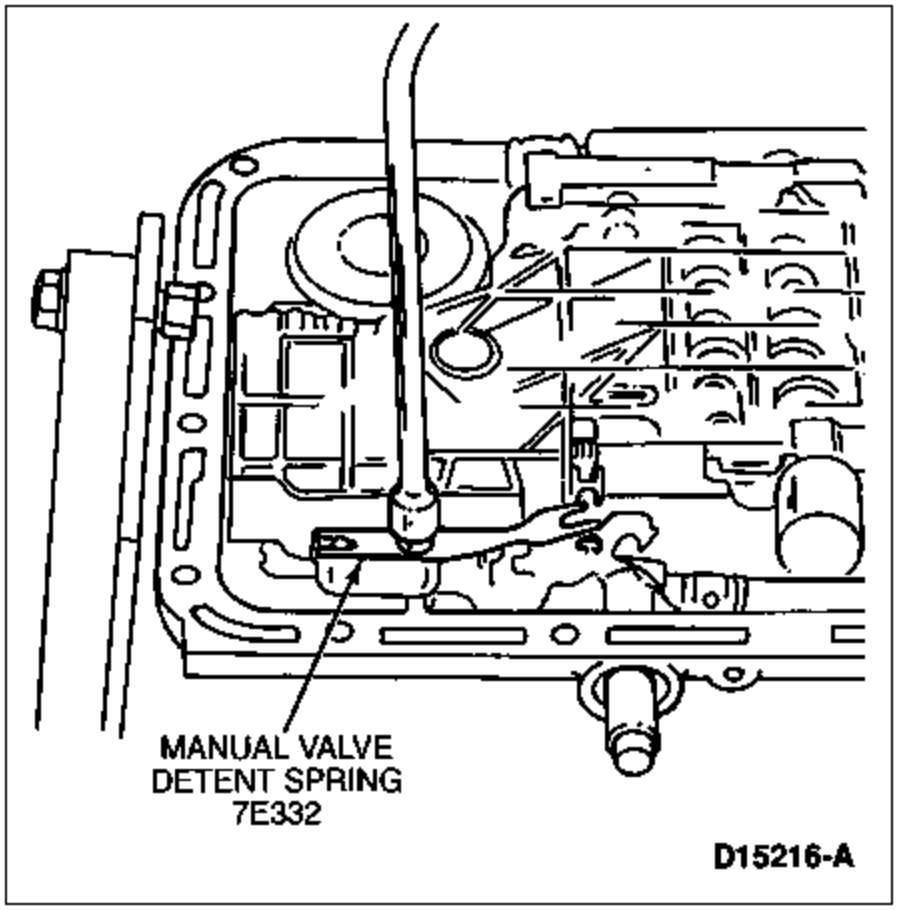

25. Use a 10mm socket to remove the four M6 x 20mm low/reverse servo cover screws. Remove the low/reverse servo cover, gasket and piston and rod assembly.

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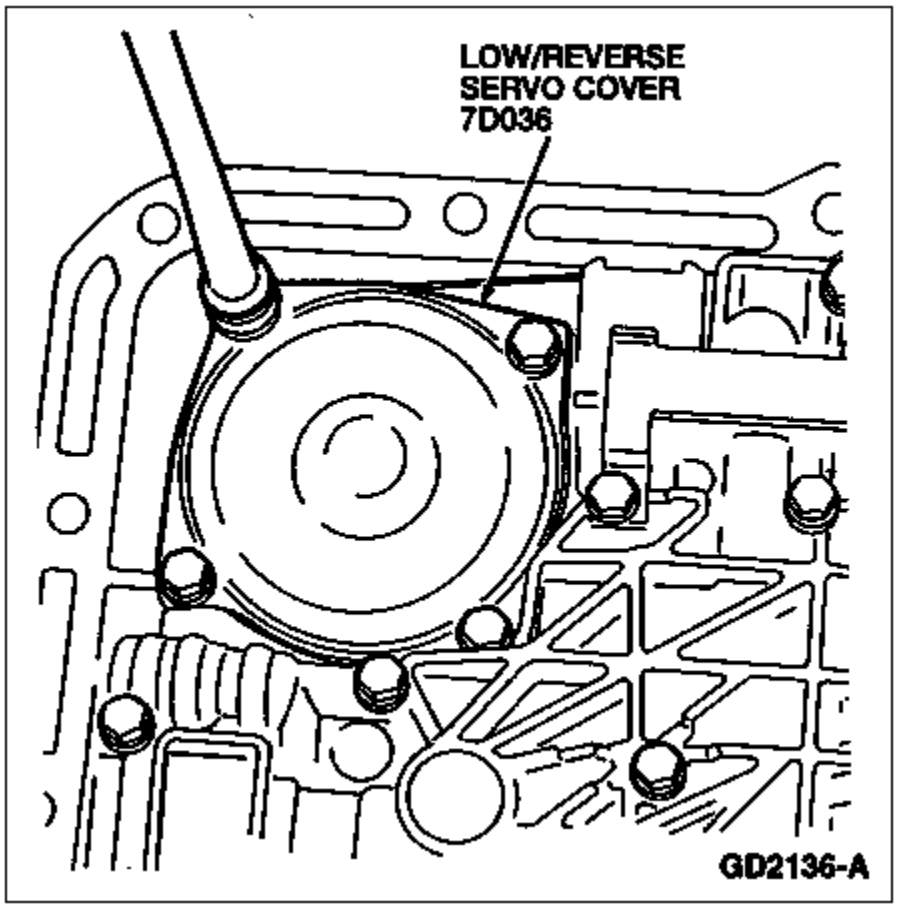

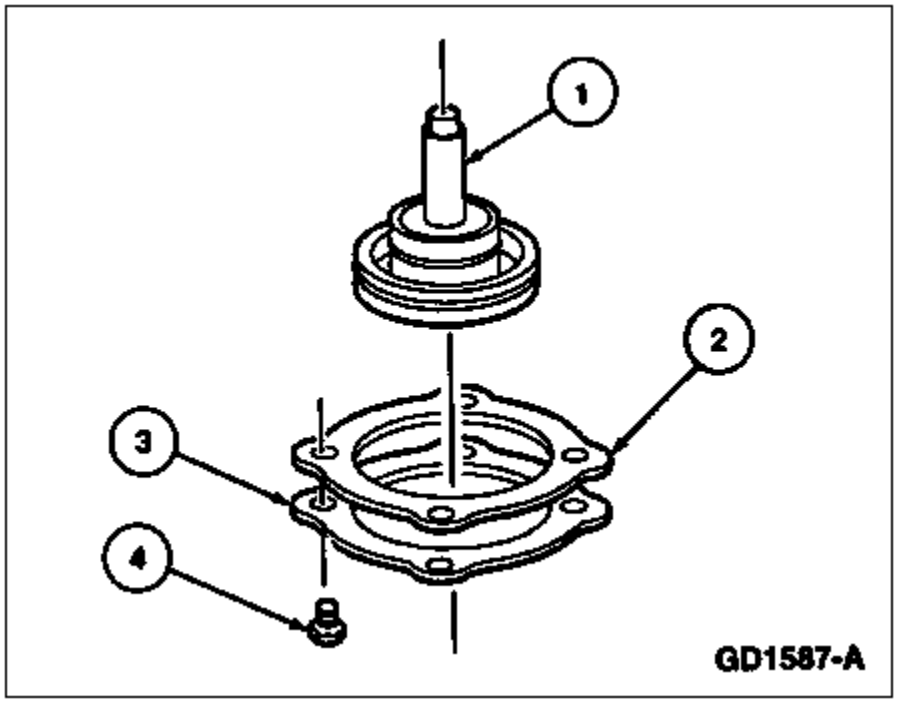

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Item	Part Number	Description
1	7D189	Low/Reverse Servo and Rod Assembly
2	7L173	Low/Reverse Servo-to-Case Gasket
3	7D036	Low/Reverse Servo Cover
4	E800156-S	Low/Reverse Servo Cover-to-Case Screw (4 Req'd)

26. **CAUTION: To prevent solenoid valves from falling out, do not remove the two screws shown below.**

    NOTE: Refer to the Main Control disassembly and assembly in this section.

    Use a 10mm socket to remove the sixteen M6 x 40mm, four M6 x 45mm, two M6 x 35mm and one M6 x 30mm main control valve body screws.

27. Remove the main control assembly, separator plate and gasket. Discard gasket.

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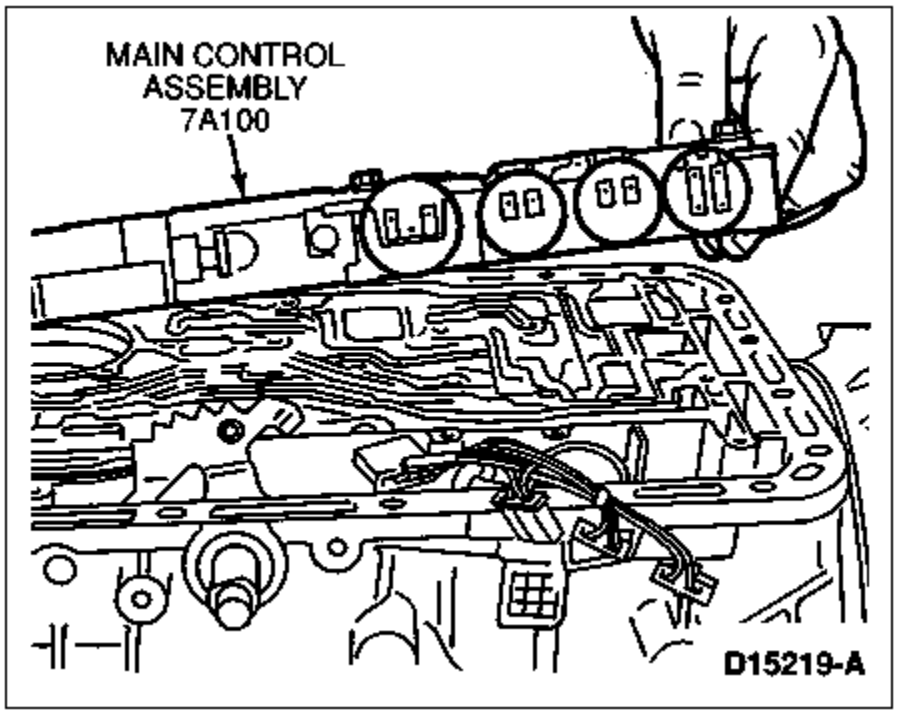

28. **CAUTION: Throw the locknuts away. The locknuts are not reusable for assembly.**

Remove the front and intermediate band locknuts and discard. Back off the band adjusting screws.

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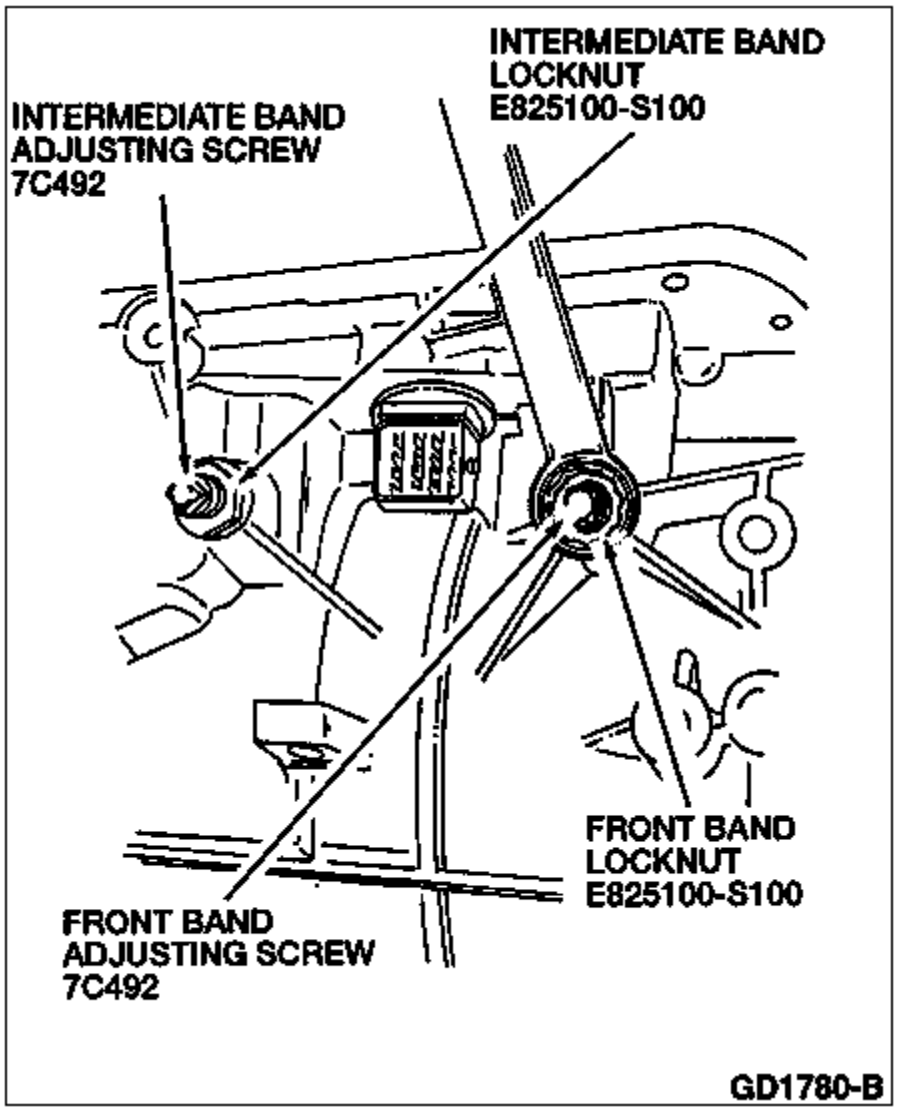

29. **NOTE: The J-hook must be in the appropriate hole for the servo being removed.**

    Install Servo Cover Compressor T95L-77028-A over the intermediate servo cover at the fluid pan rail with tool stamping facing up. Tighten the screws.

30. Using a 1/2-inch wrench, tighten the nut on the J-hook until there is a gap between the servo cover and the snap ring.

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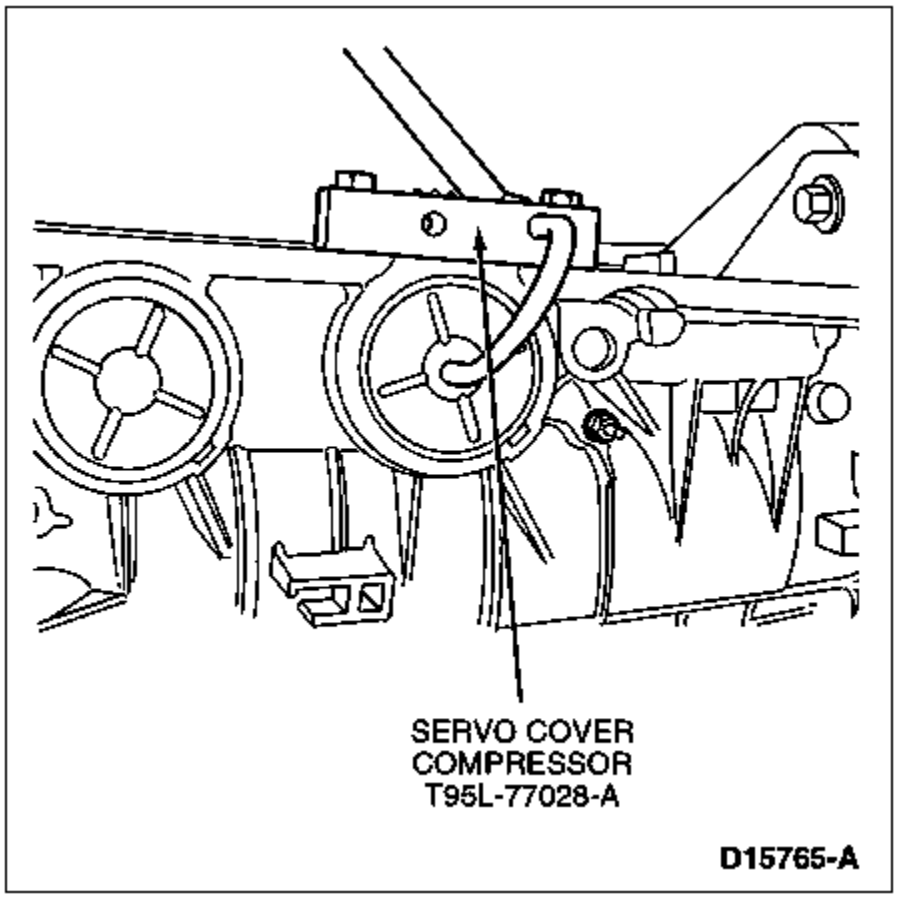

31. Carefully remove the servo cover retaining ring.

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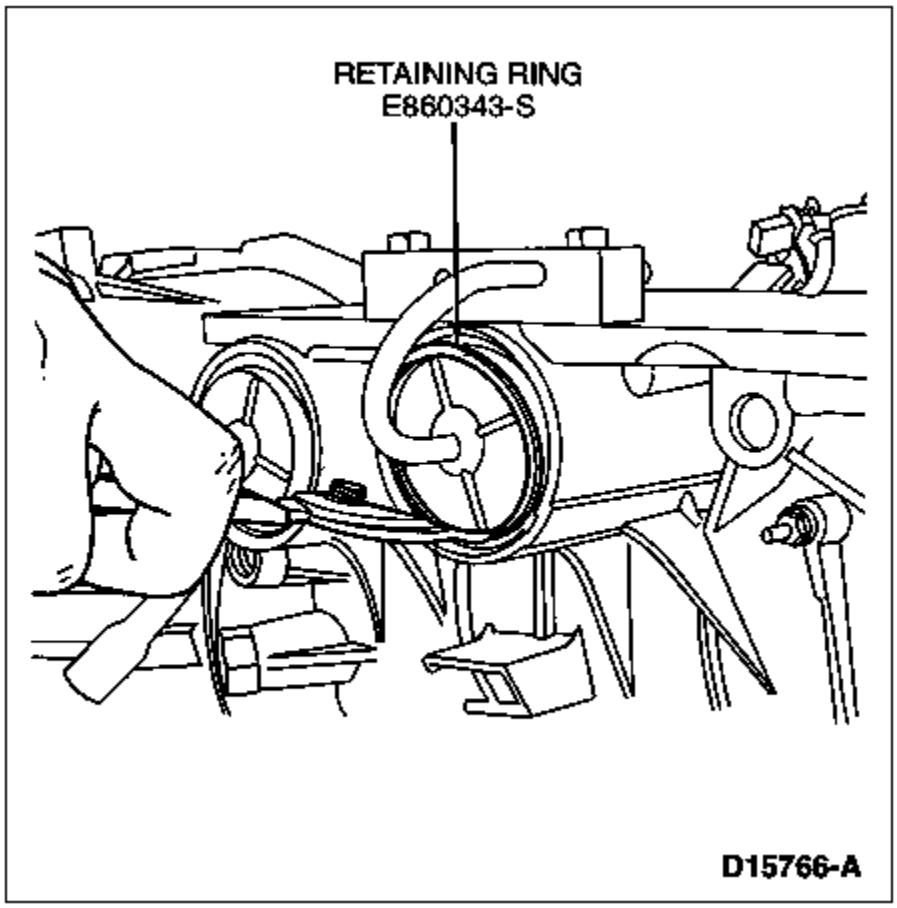

32. **CAUTION: The servo cover is under spring tension.**

    Carefully back off the nut on the J-hook until the servo spring is unloaded.

33. Insert Servo Removal Tool T97T-7D021-A into case and locate on servo rod.

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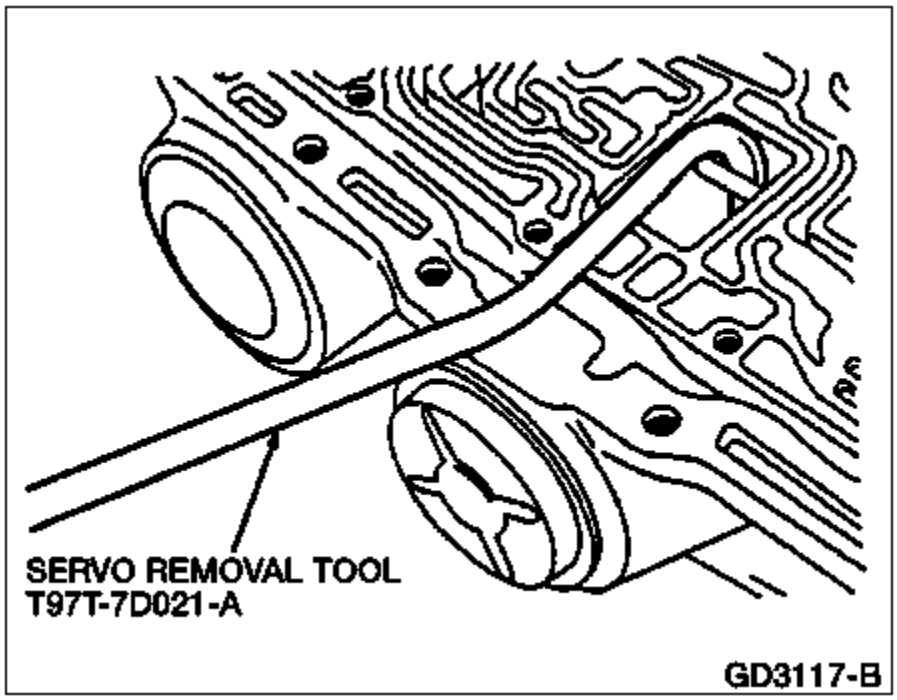
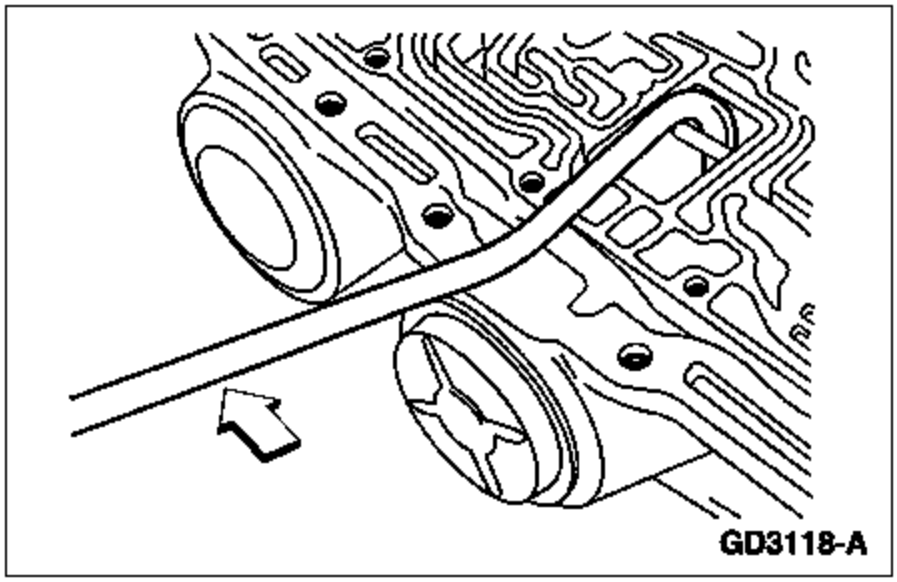


34. Gently push on Servo Removal Tool T97T-7D021-A to remove front servo cover, piston and spring.



35. **NOTE: Tag the spring, piston and cover assembly. Label accordingly for assembly. The covers have letters cast on the outer surface for identification.**

    Remove the intermediate servo cover, piston and spring.

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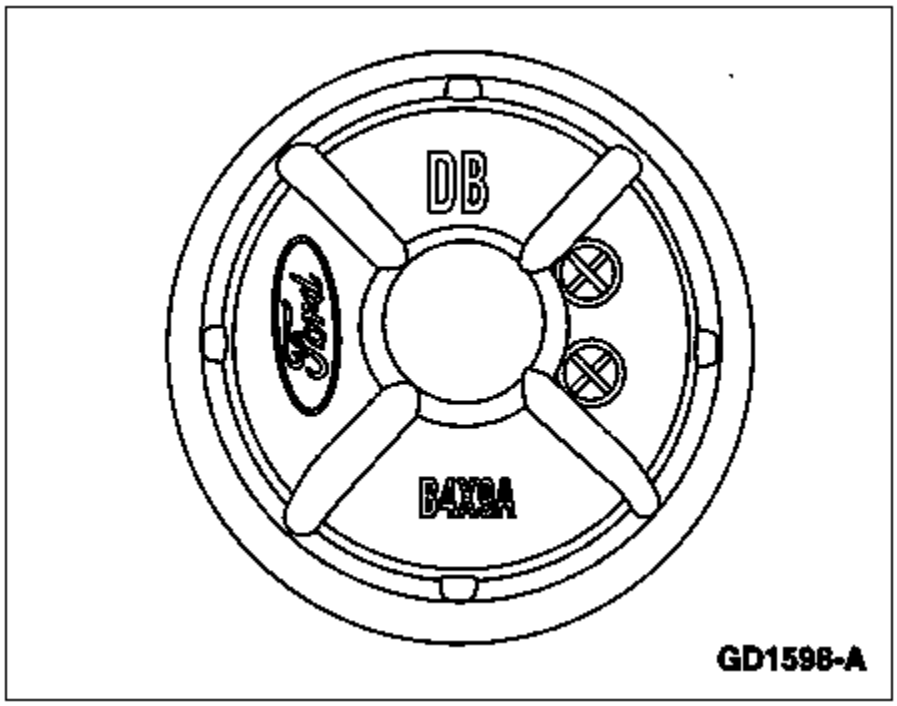

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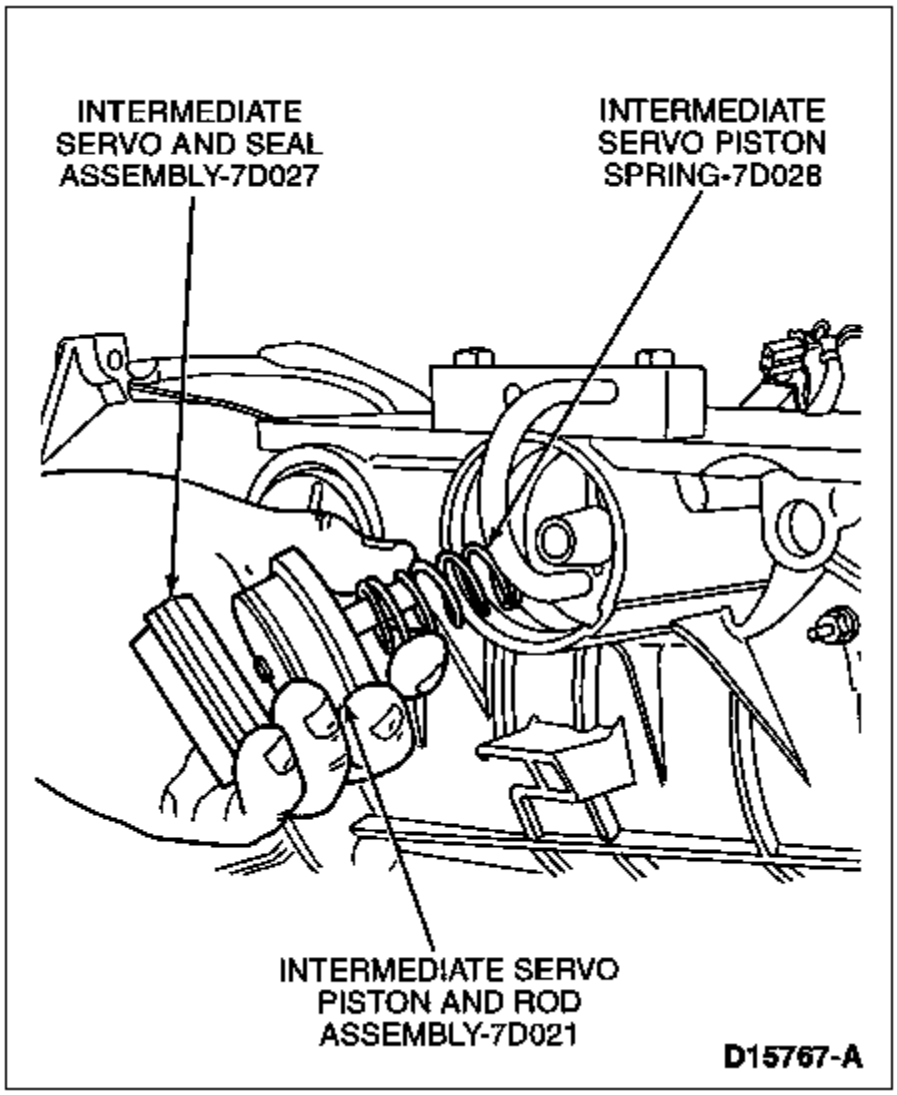

36. Remove Servo Cover Compressor T95L-77028-A.

37. **NOTE: The J-hook must be in the appropriate hole for the servo being removed.**

    Install Servo Cover Compressor T95L-77028-A over the front servo cover at the fluid pan rail. Tighten the screws.

38. Using a 1/2-inch wrench, tighten the nut on the J-hook until there is a gap between the servo cover and the retaining ring.

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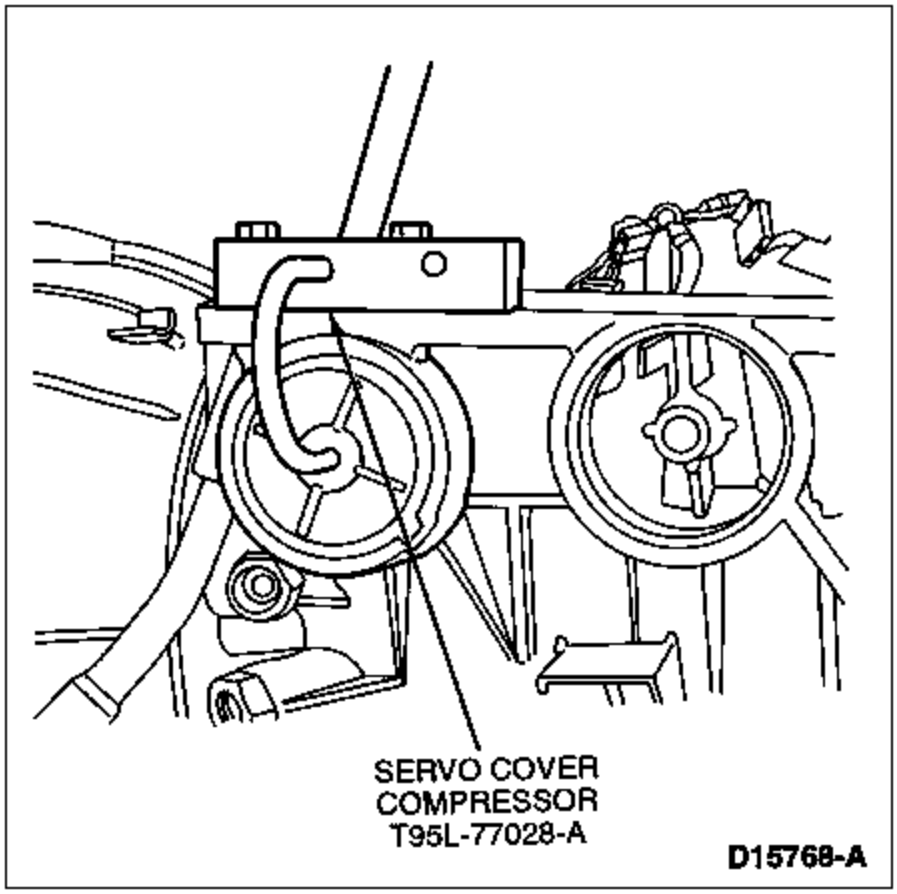

39. Carefully remove the servo cover retaining ring.

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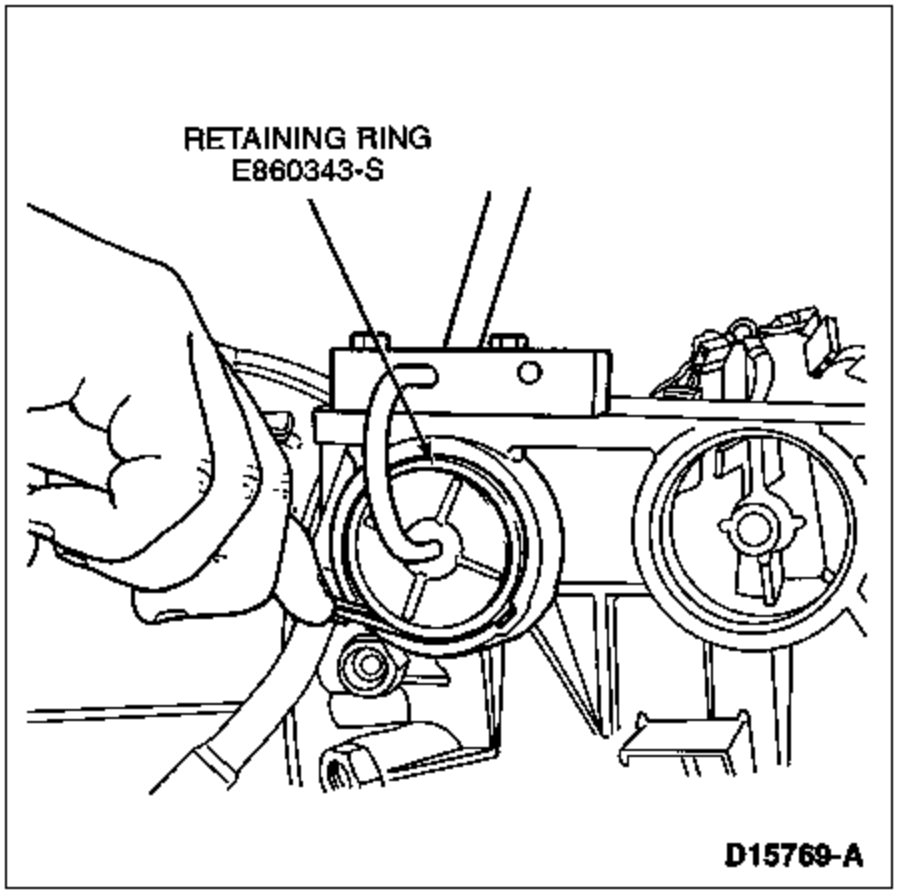

40. **CAUTION: The servo cover is under spring tension.**

    Carefully back off the nut on the J-hook until the servo spring is unloaded.

41. Insert Servo Removal Tool T97T-7D021-A into case and locate on servo rod.

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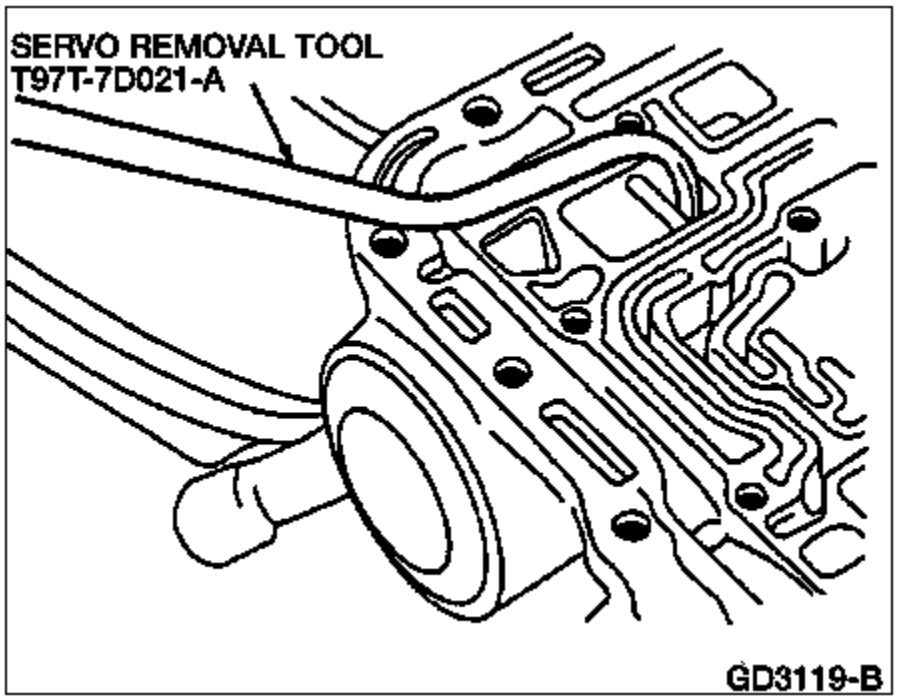
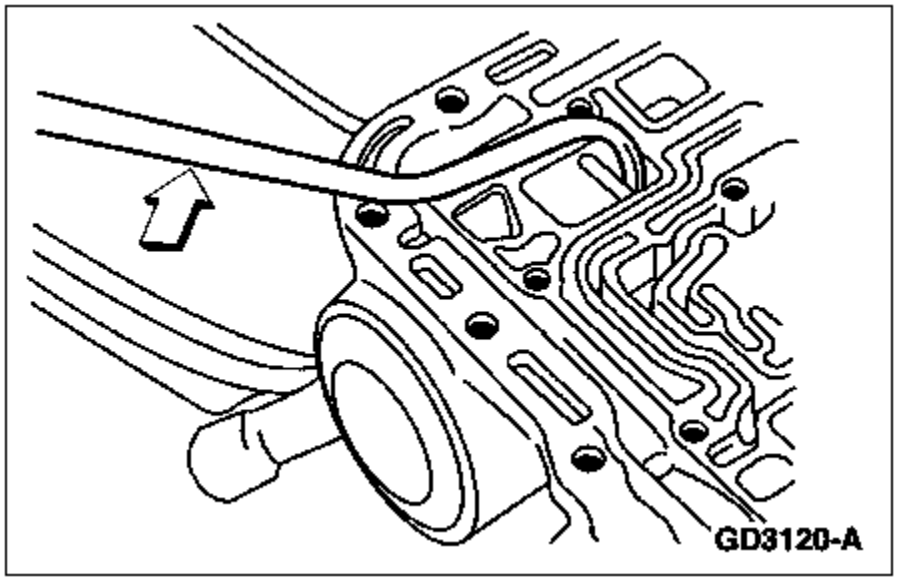


42. Gently push on Servo Removal Tool T97T-7D021-A to remove front servo cover, piston and spring.



43. **NOTE: Tag the spring, piston and cover assembly. Label accordingly for assembly. The covers have letters cast on the outer surface for identification.**

Remove the front servo cover, piston and spring.

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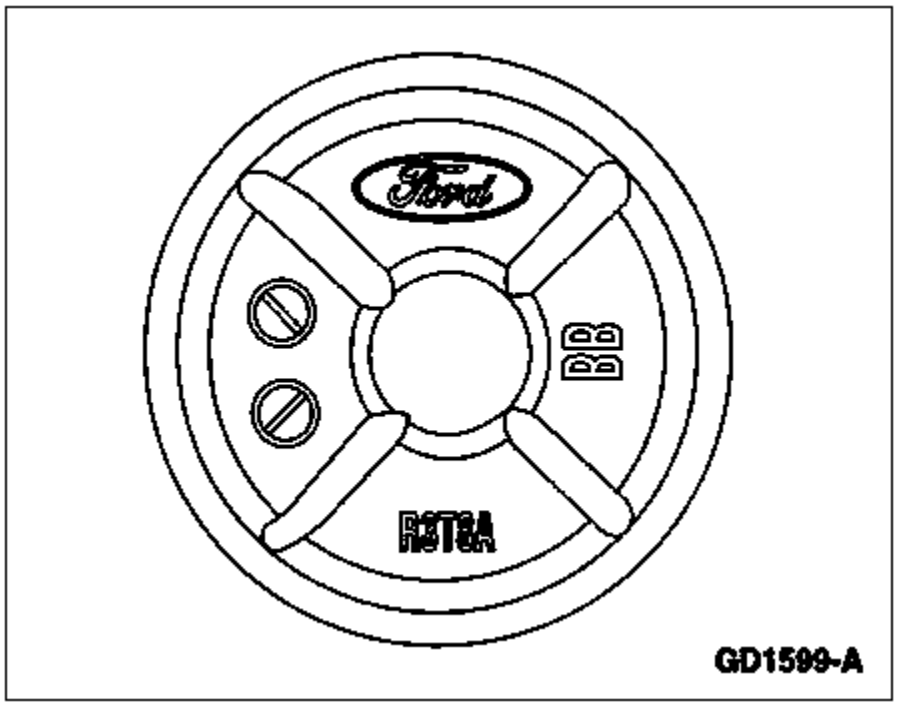
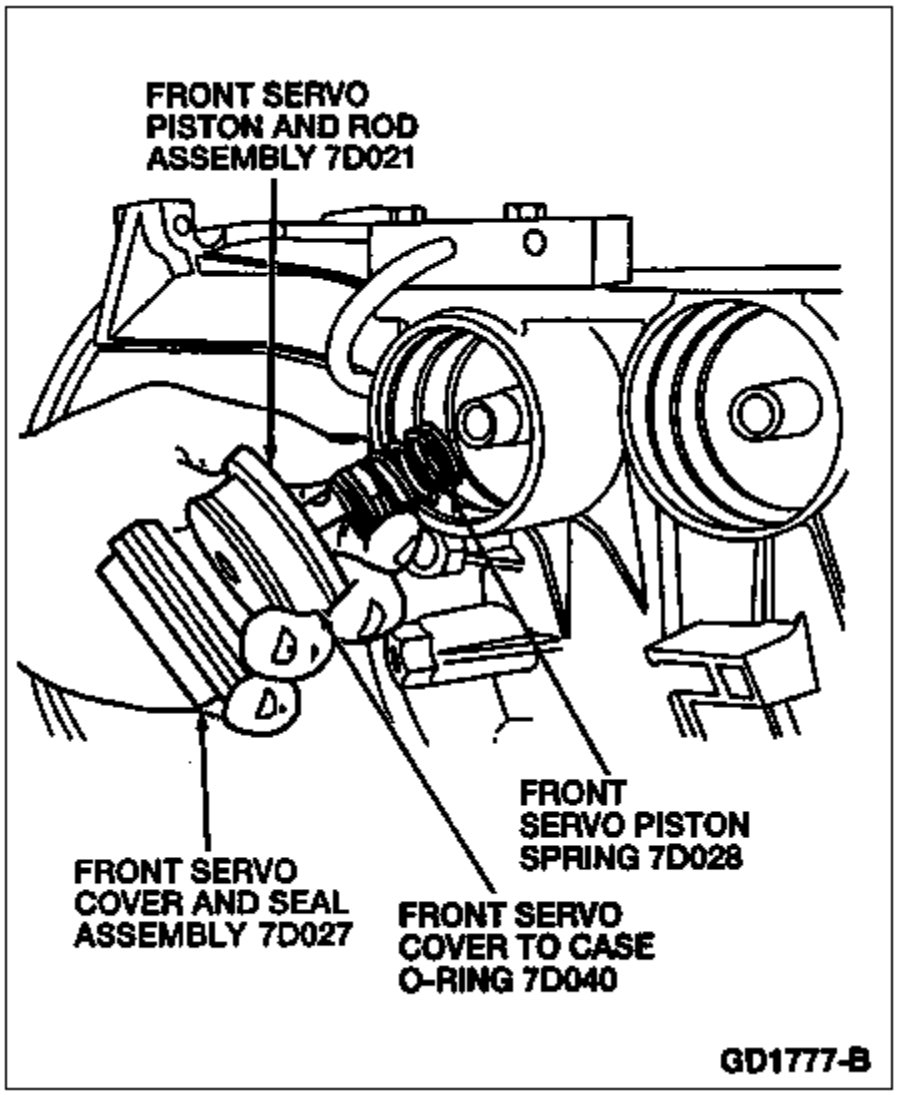


tomsn048@gmail.com



44. Remove Servo Cover Compressor T95L-77028-A.

45. **WARNING: MAKE SURE THE LOCK PIN ON BENCH-MOUNTED HOLDING FIXTURE T57L-500-B IS SECURE.**

    Rotate the transmission assembly with the converter housing facing up.

46. **CAUTION: Throw the screws away. The screws are not reusable for assembly.**

    Use a 17mm socket to remove the eight M10 x 33mm converter housing-to-case screws. Discard the screws.

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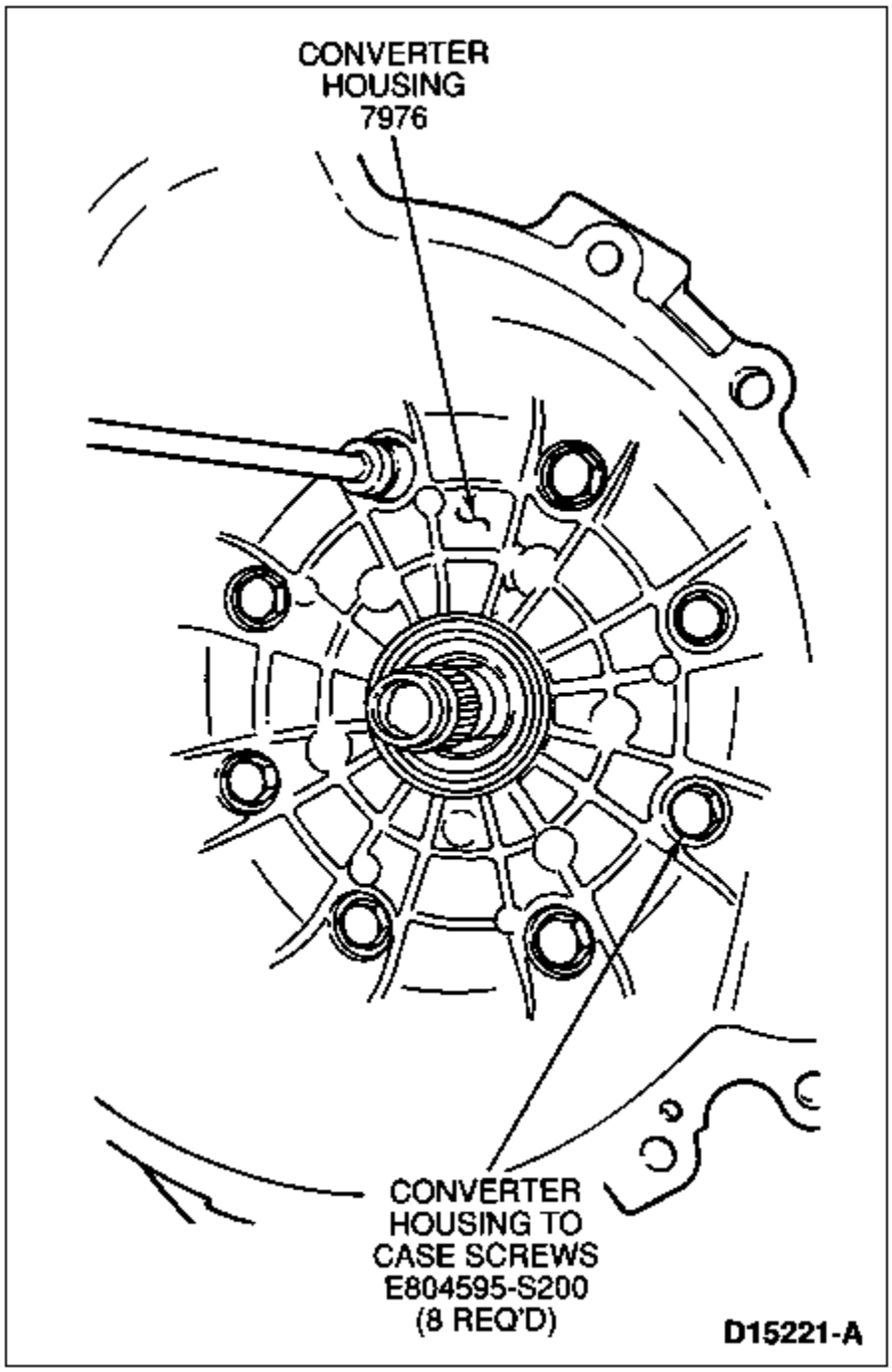

47. **NOTE: Rotate and lift the converter housing so that the clutch assemblies will stay in place.**

    Remove the converter housing and fluid pump support and gear assembly.

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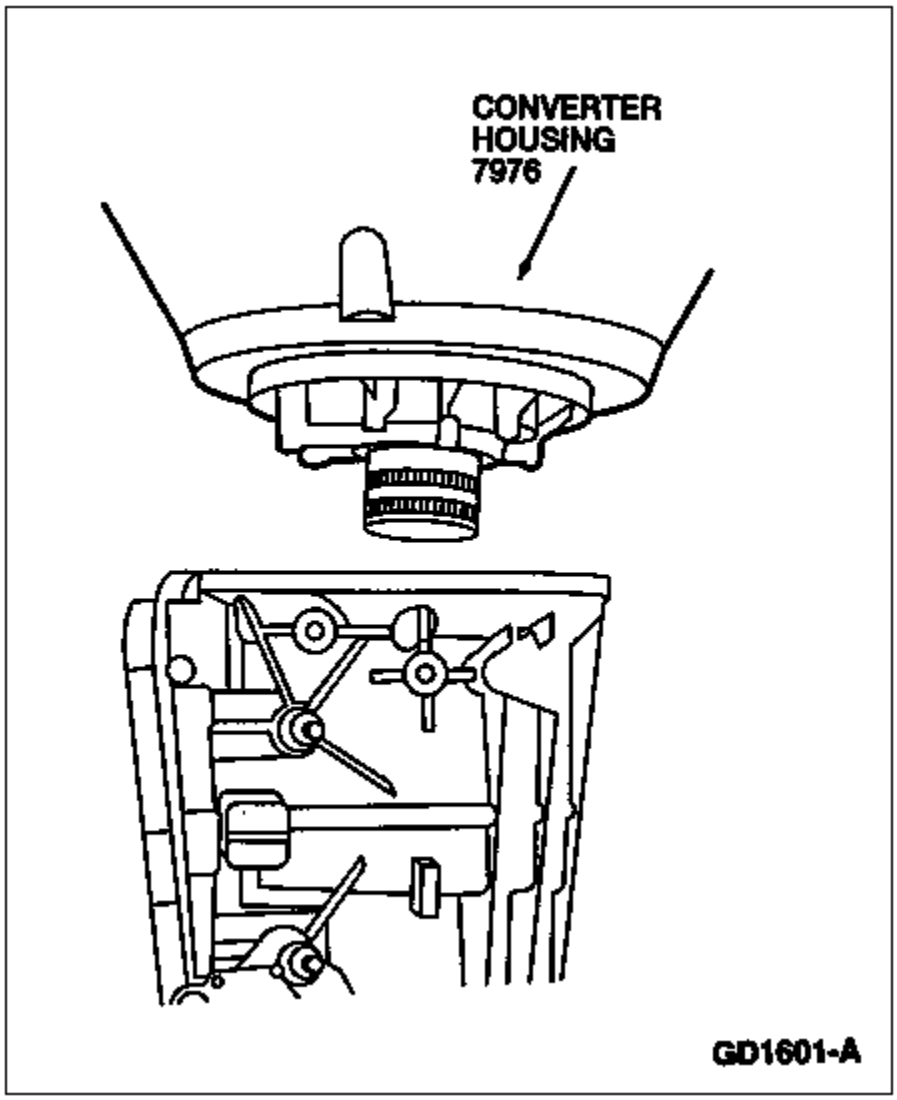

48. **NOTE: Refer to Converter Housing And Pump Assembly under subassemblies for service information.**

    Remove the No. 1 fluid pump thrust washer. Tag the No. 1 fluid pump thrust washer for identification.

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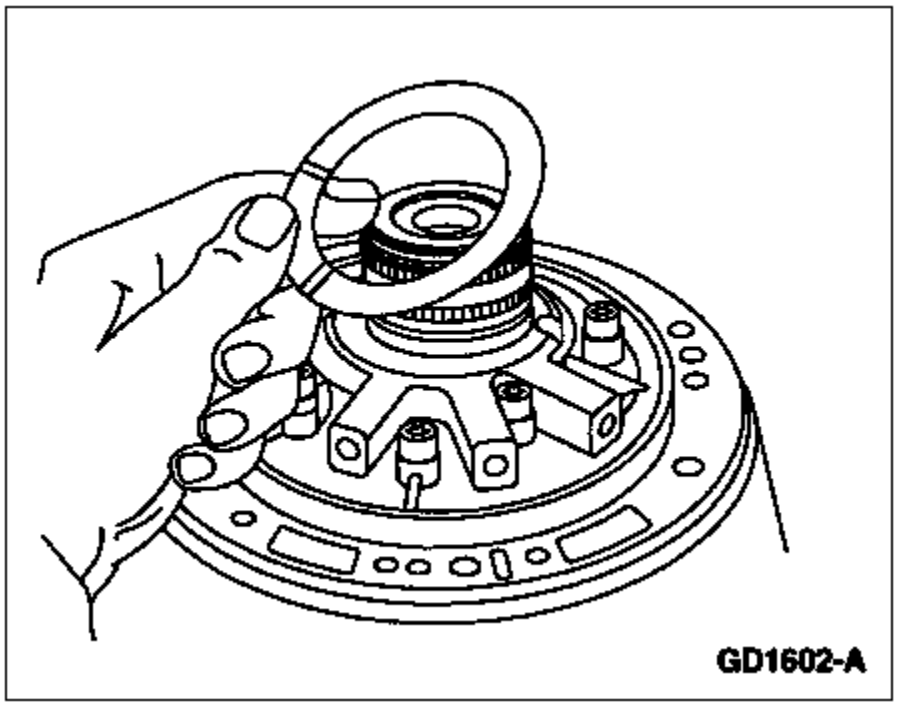

49. Remove front band adjusting screw. Compress the front band around the front brake and coast clutch drum. Remove the front band anchor strut.

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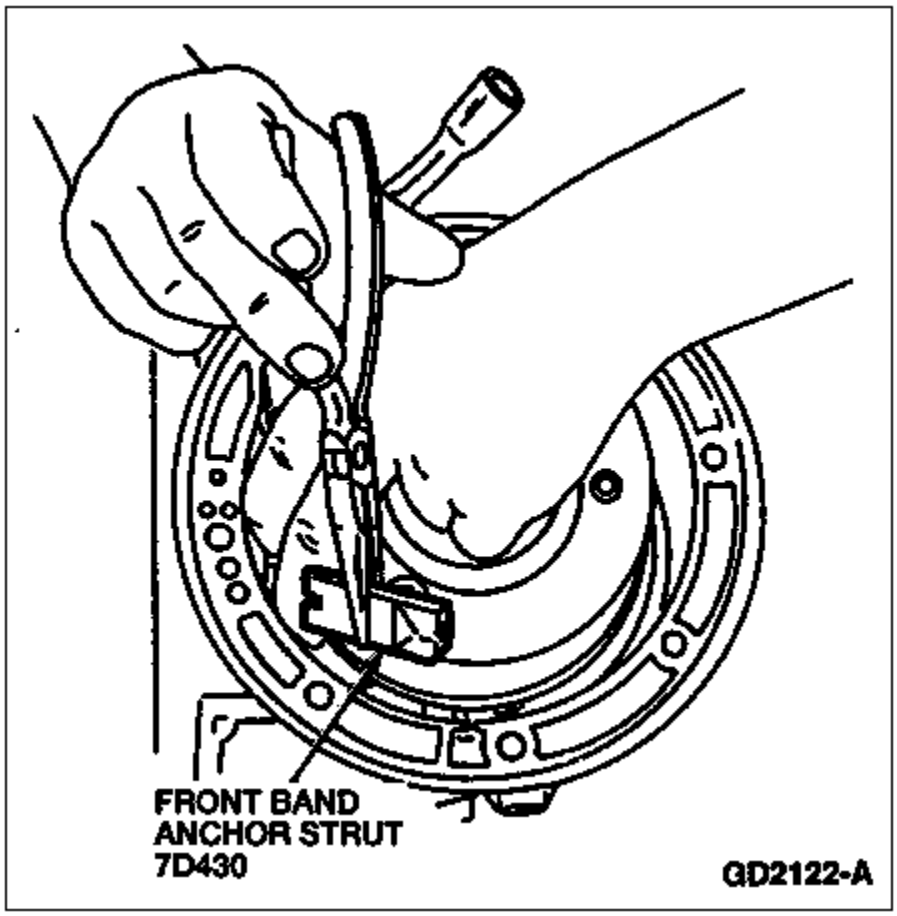

50. **CAUTION: Identify which end of the overdrive band is the anchor side or the apply side.**

Remove the front band.

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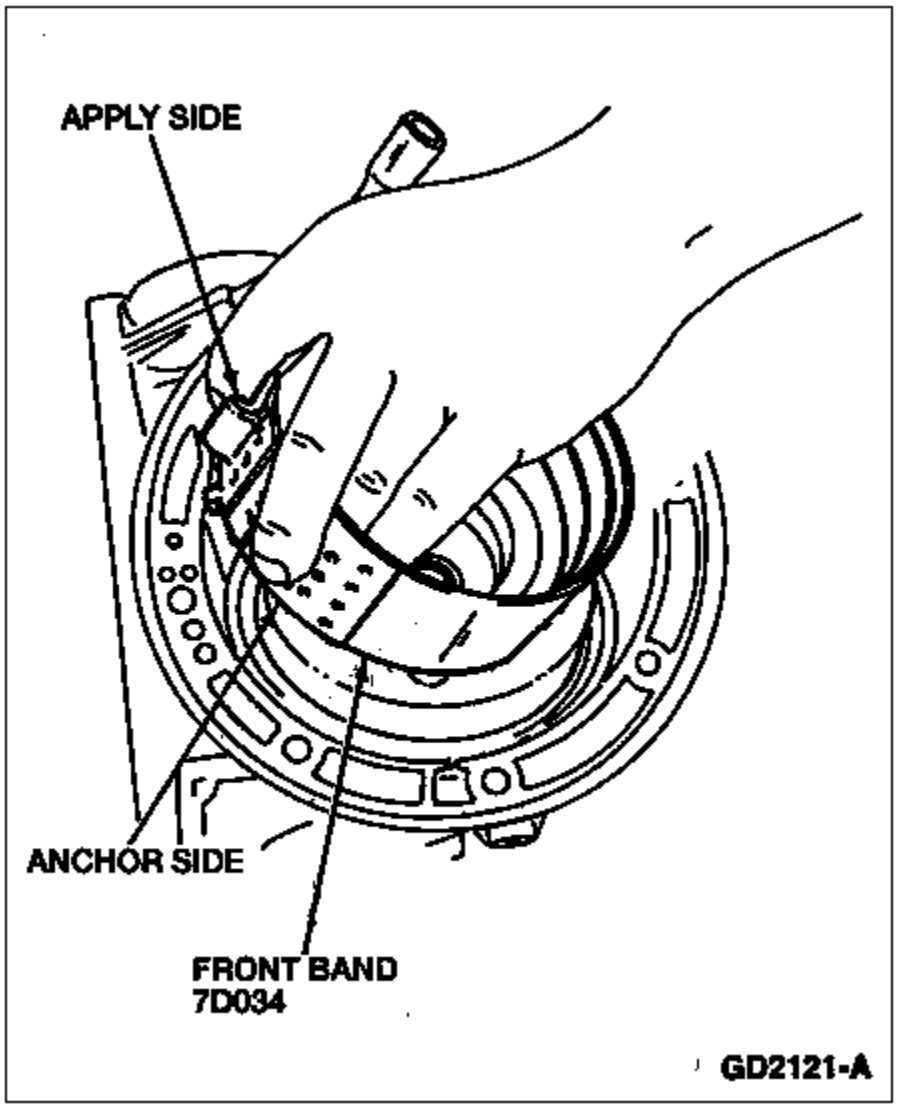
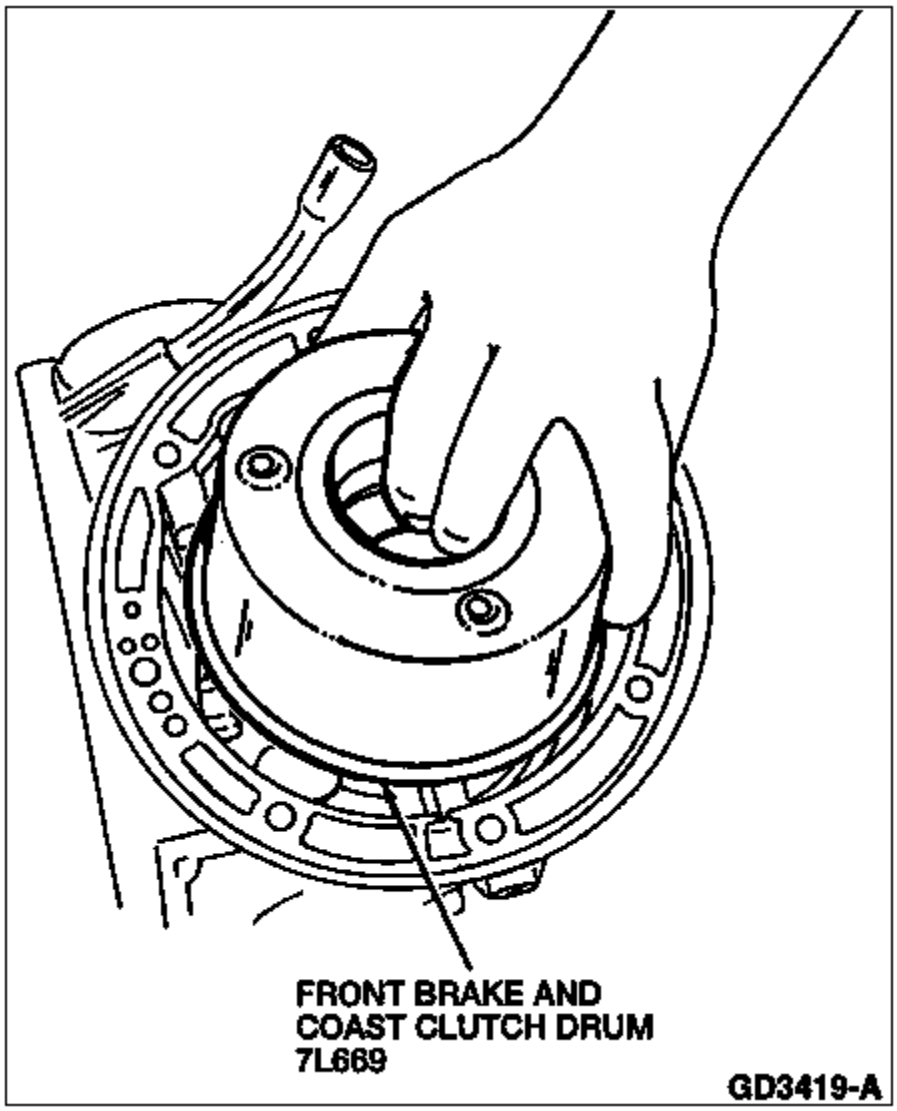


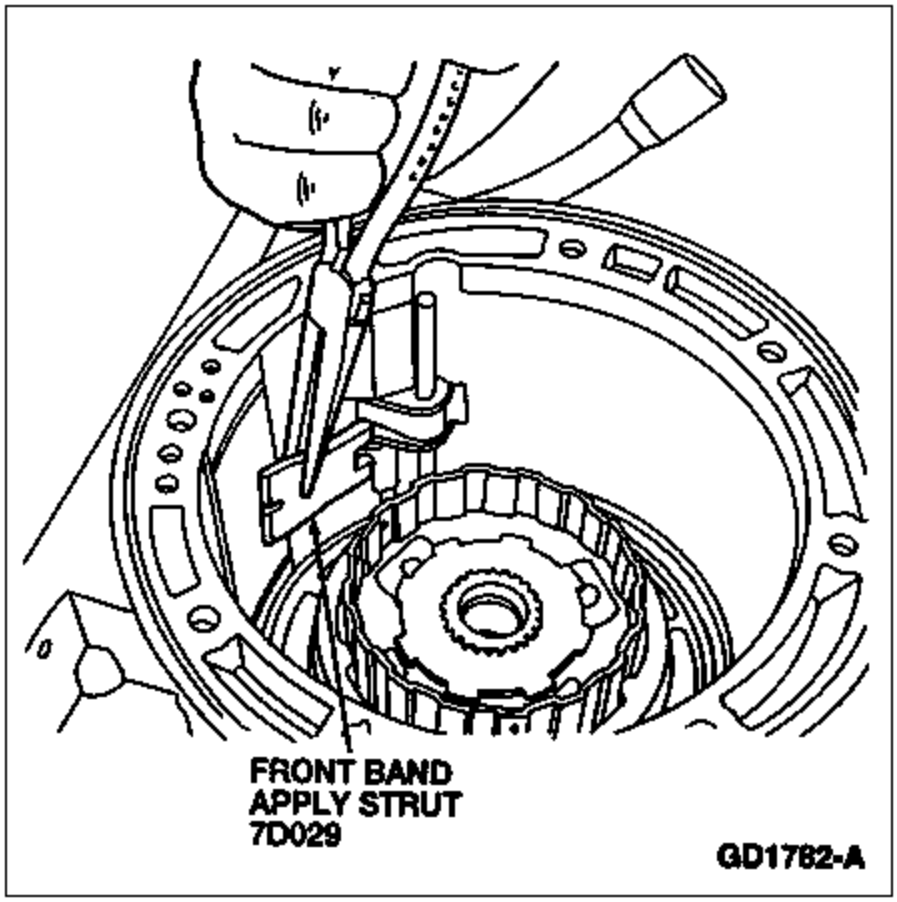
51. Remove the front brake and coast clutch drum.

tomsn048@gmail.com



52. Remove the front band apply strut.

tomsn048@gmail.com



53. **NOTE: Tag and identify the front lever for assembly. The front lever has a letter stamped into its side.**

    NOTE: The front band actuating lever shaft is longer than the intermediate shaft.

    Remove the front band actuating lever shaft.

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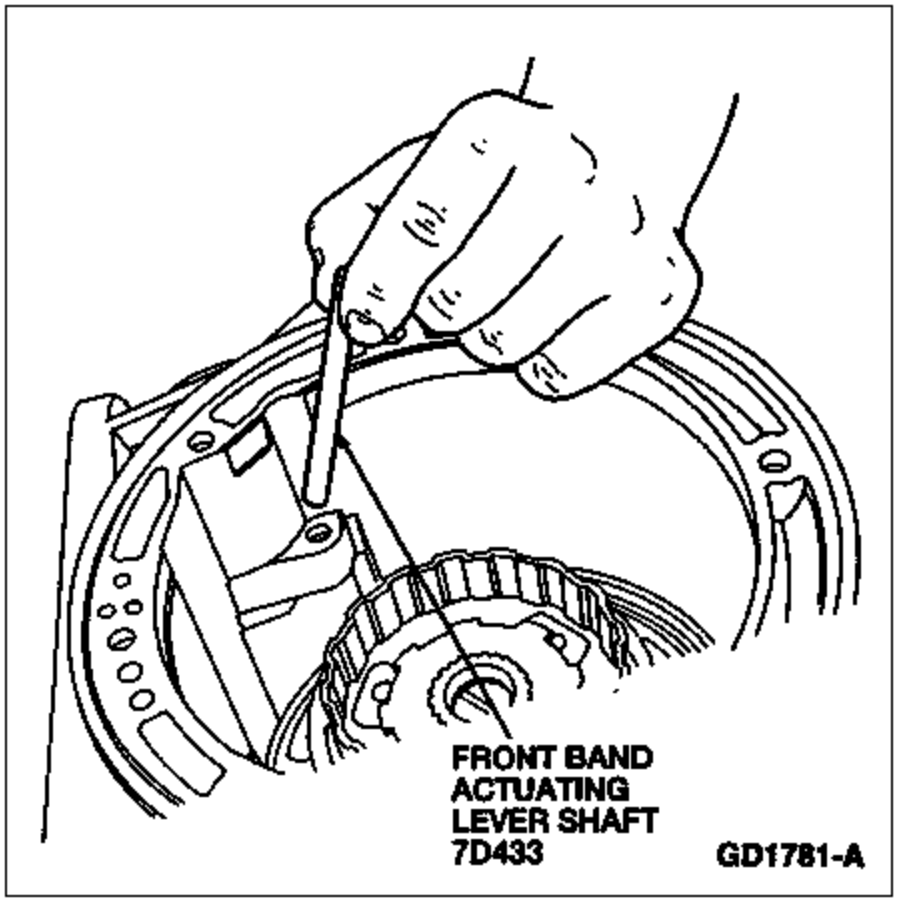
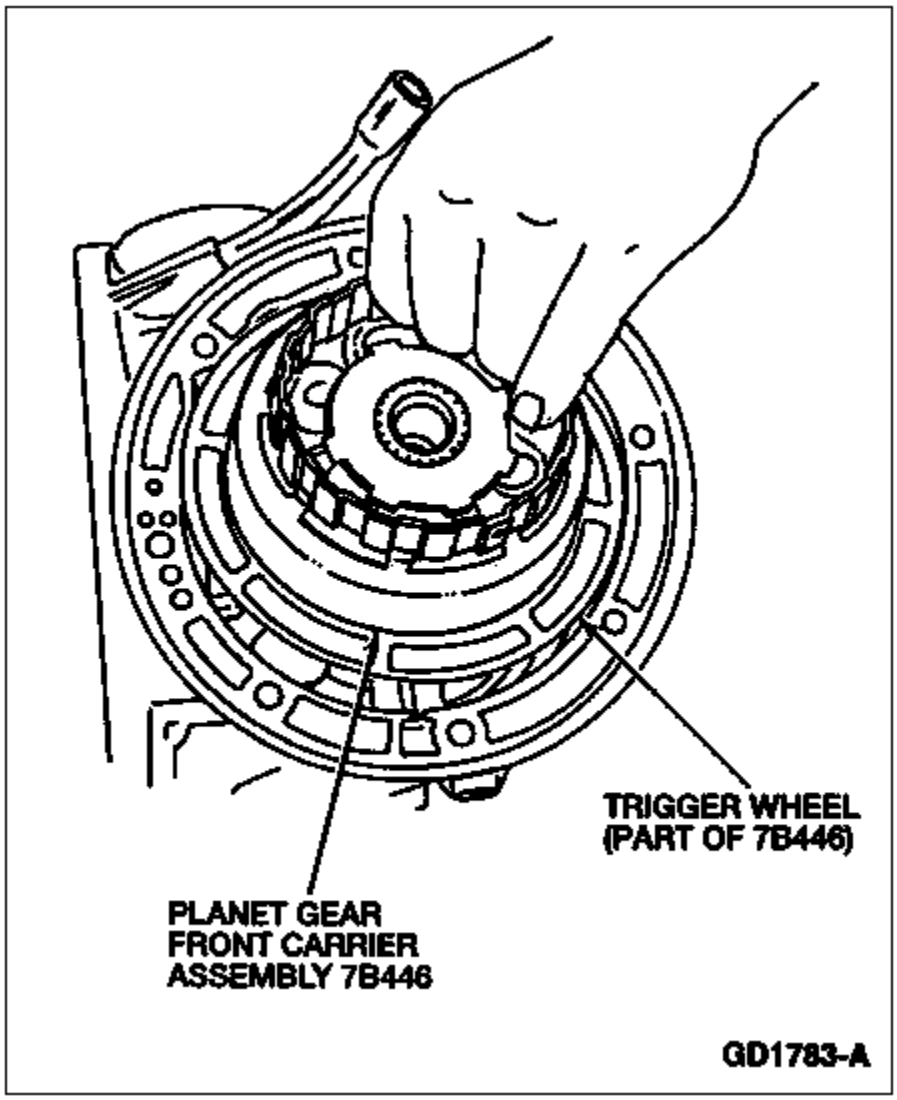


54. **CAUTION: Do not bend the trigger wheel.**

NOTE: No. 2 thrust bearing is in this assembly.

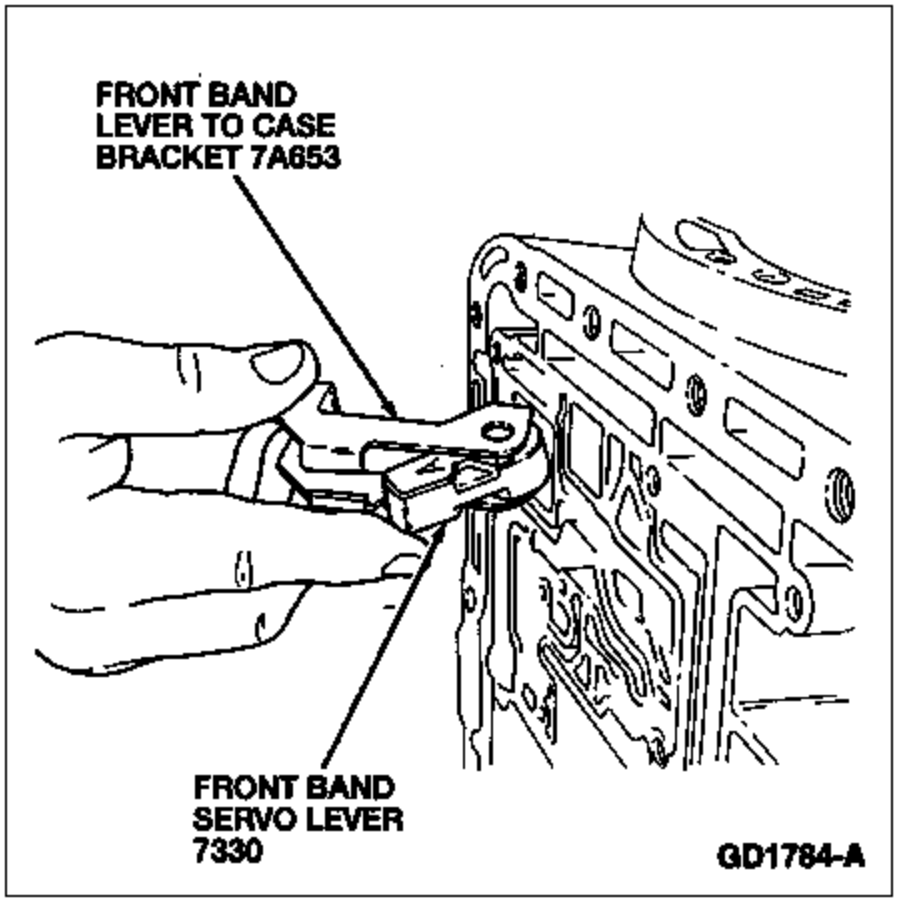
Remove the planetary gear front carrier.

tomsn048@gmail.com



55. Remove the servo band lever and front control bracket.

tomsn048@gmail.com



56. Remove the No. 2 needle bearing if not already removed with planetary gear front carrier.

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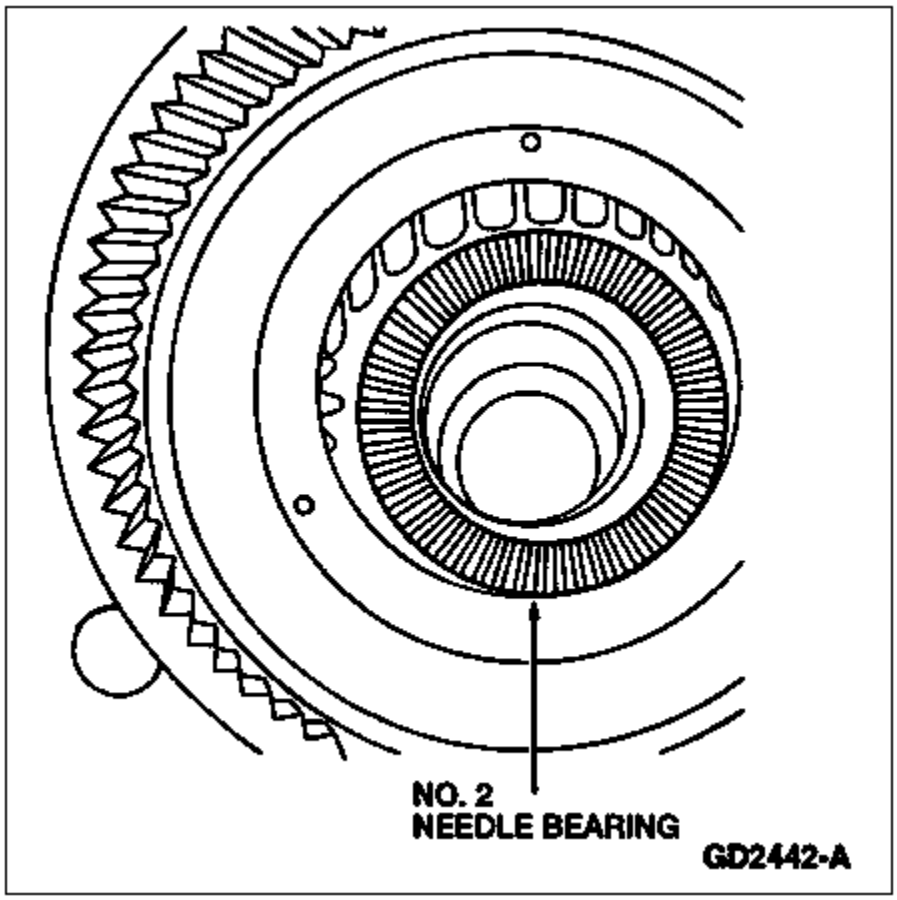
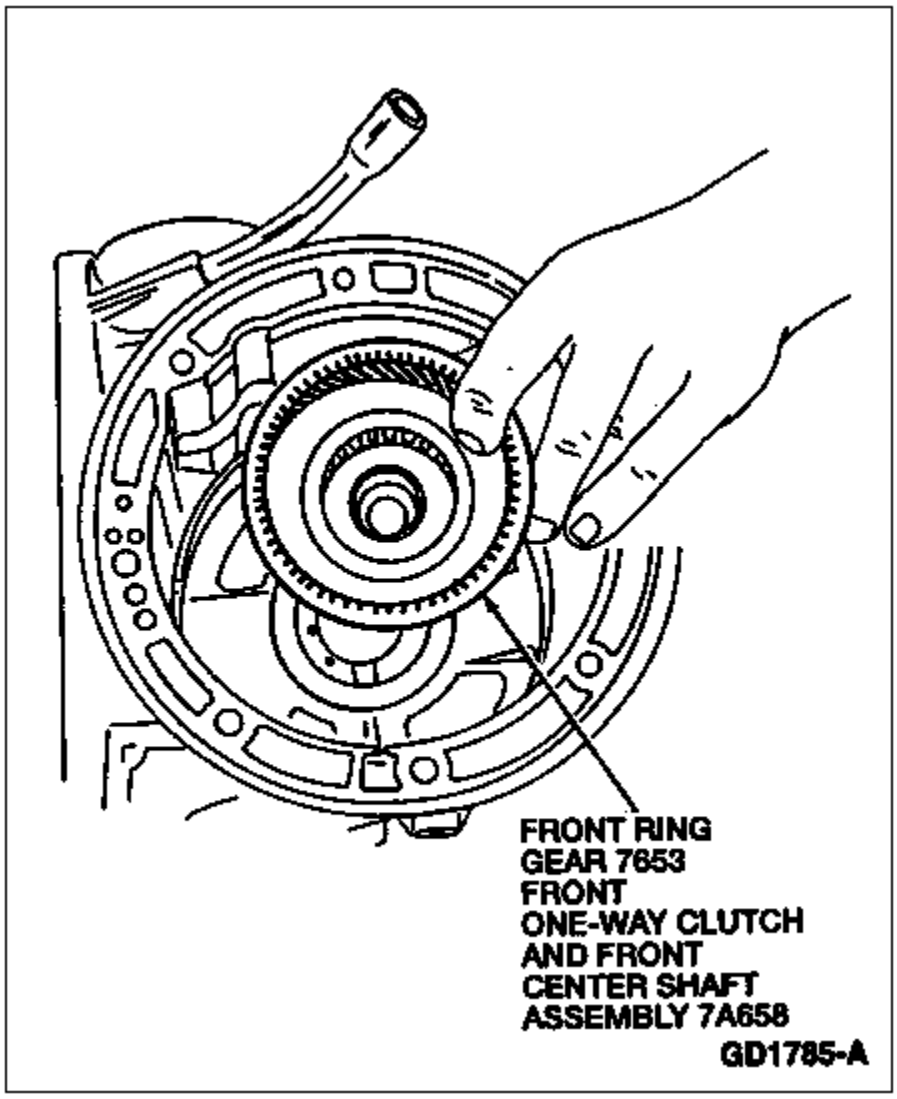


57. Remove the front ring gear, front one-way clutch and front center shaft assembly.

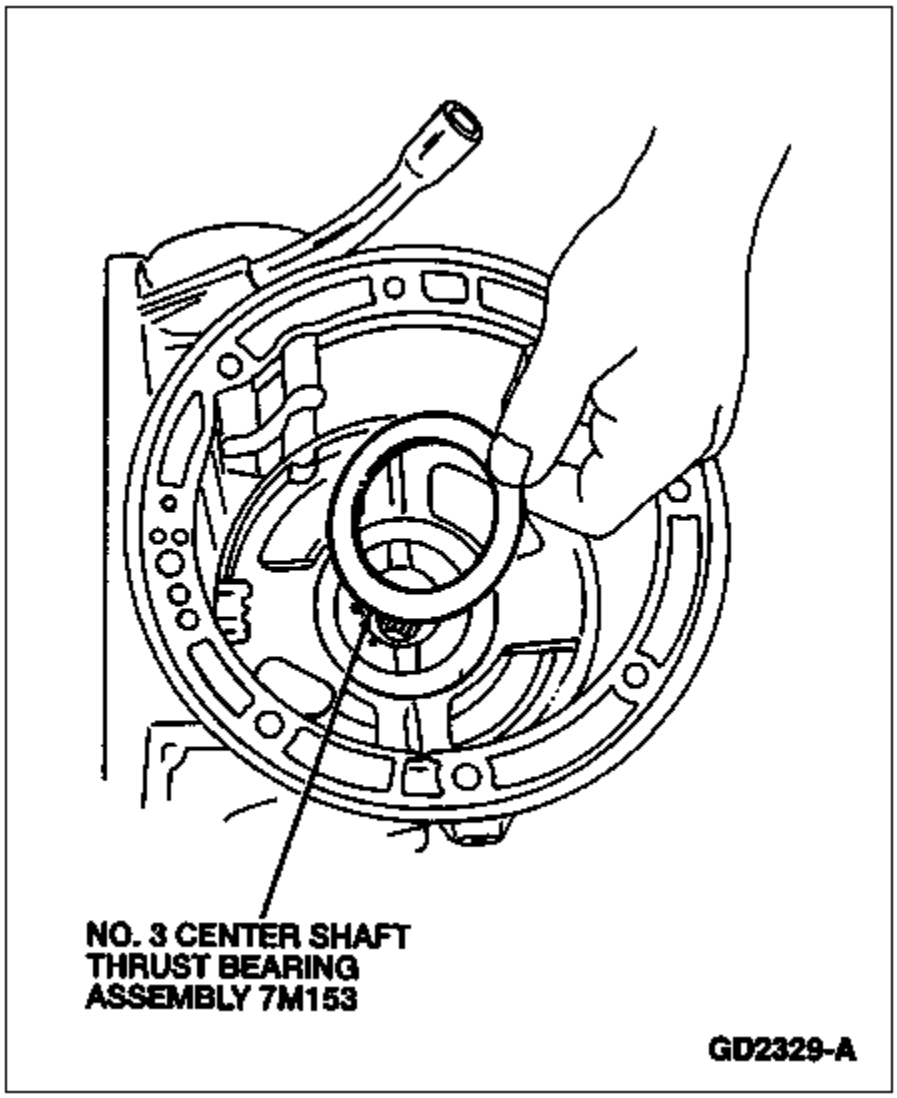
tomsn048@gmail.com



58. **NOTE: Tag and identify the No. 3 center shaft thrust bearing assembly for assembly.**

Remove the No. 3 center shaft thrust bearing assembly.

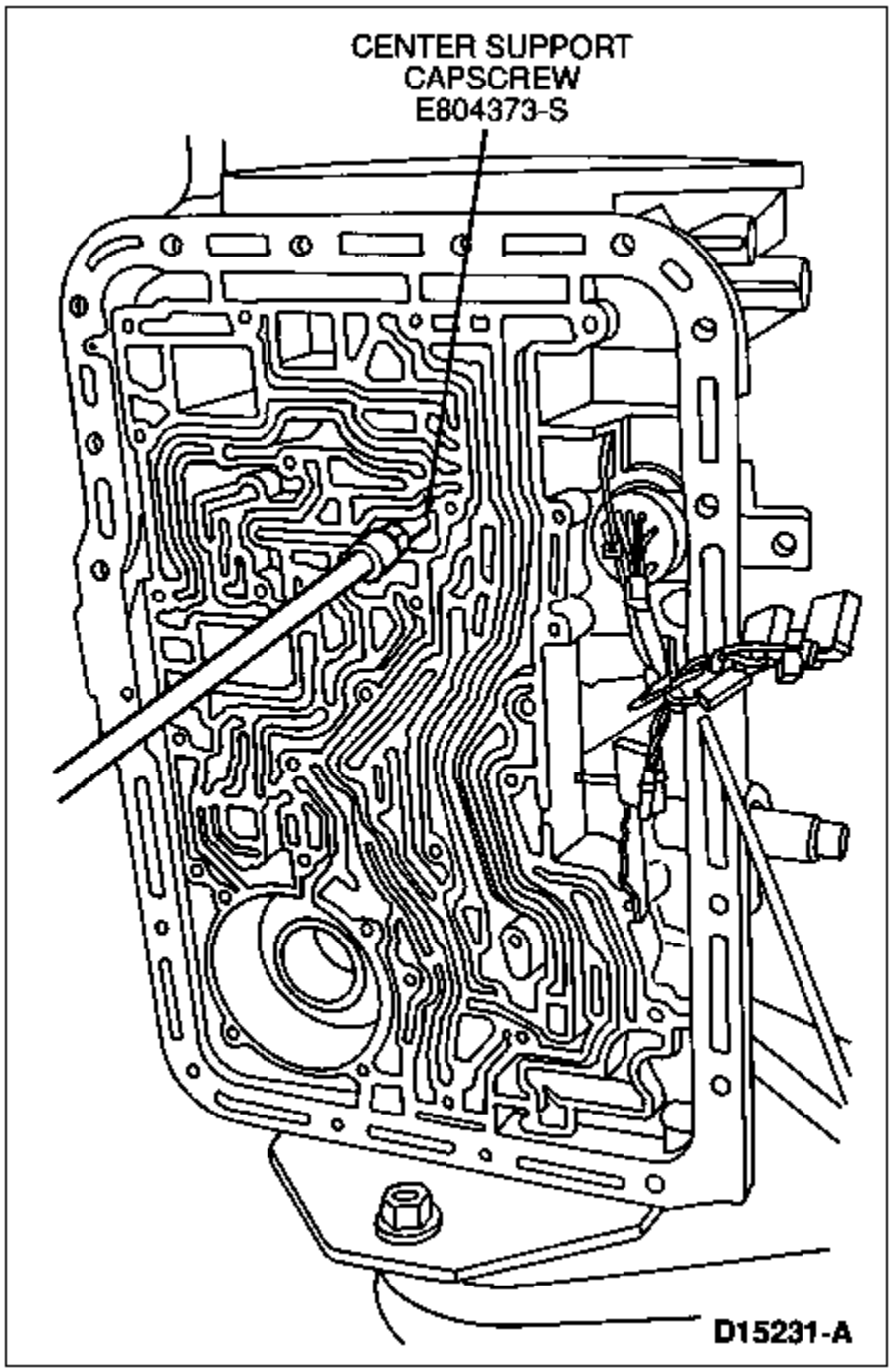
tomsn048@gmail.com



59. **CAUTION: The center support locking nut could fall into the remaining assembly if not removed.**

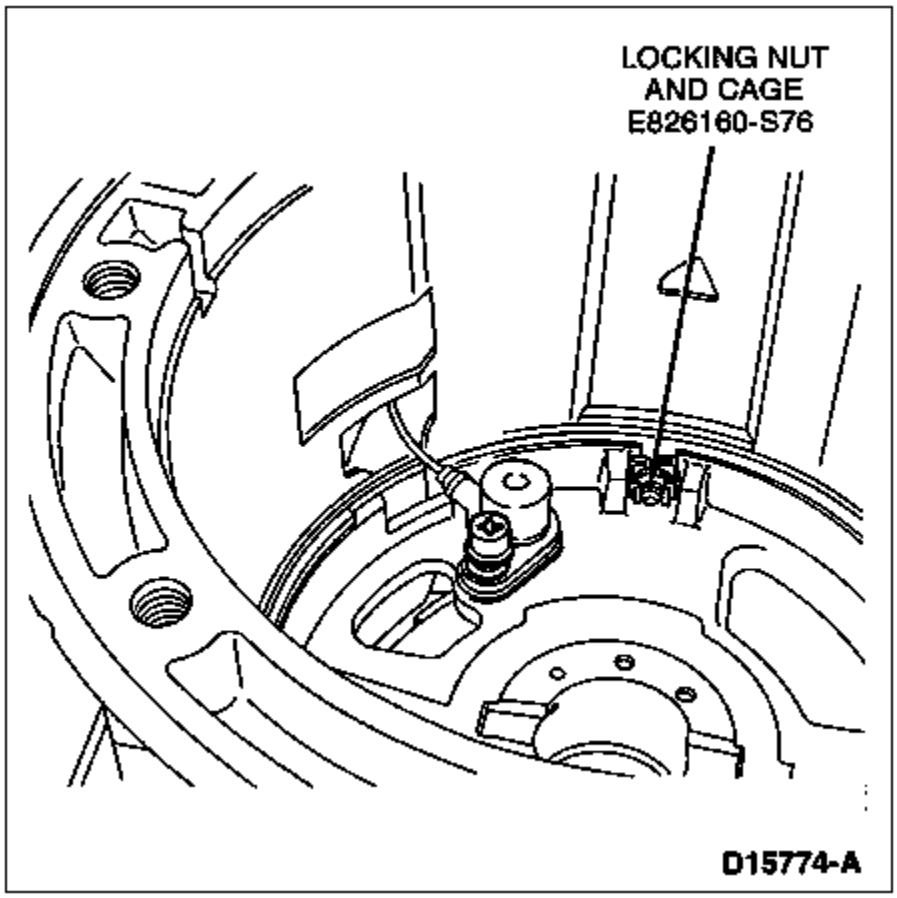
Use a 5mm Allen wrench to remove the M6 x 20mm center support capscrew.

tomsn048@gmail.com



60. Remove the locking nut and cage from center support.

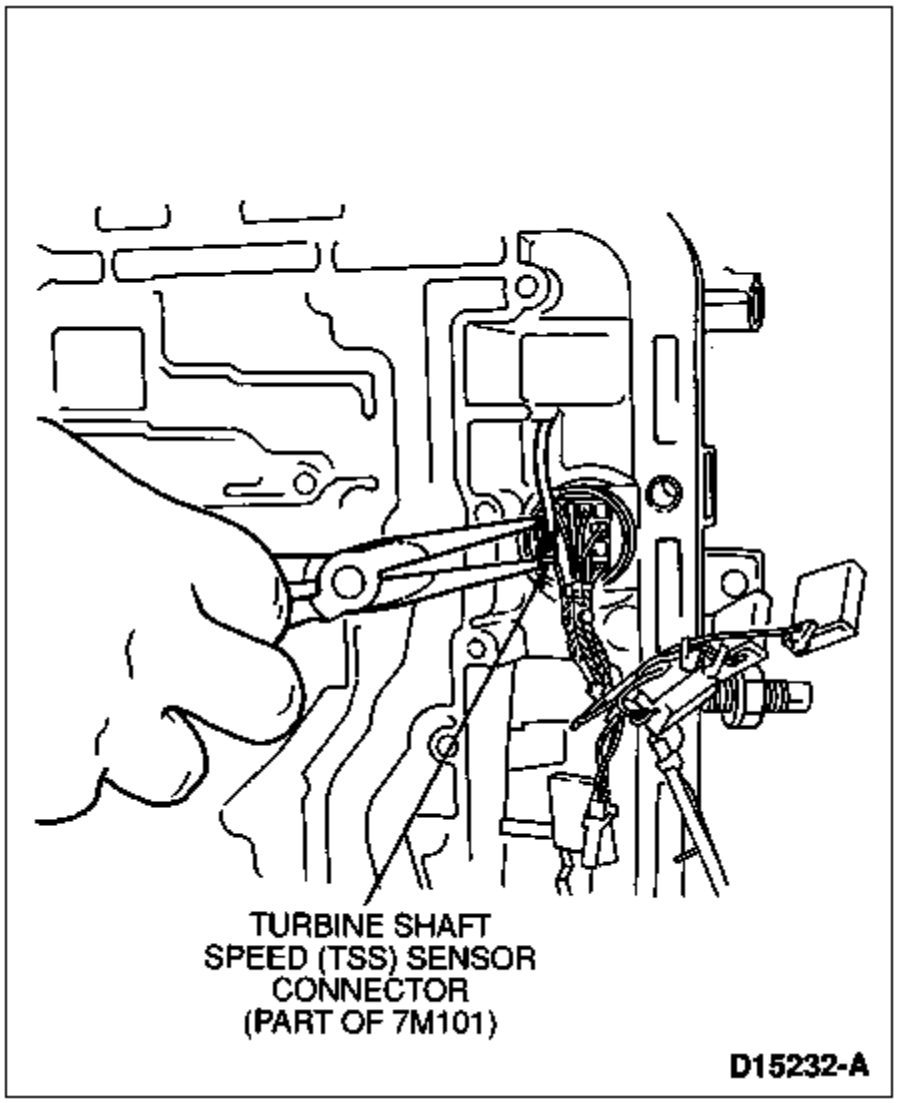
tomsn048@gmail.com



61. **CAUTION: Do not pry on other wires or damage the connector or case surface.**

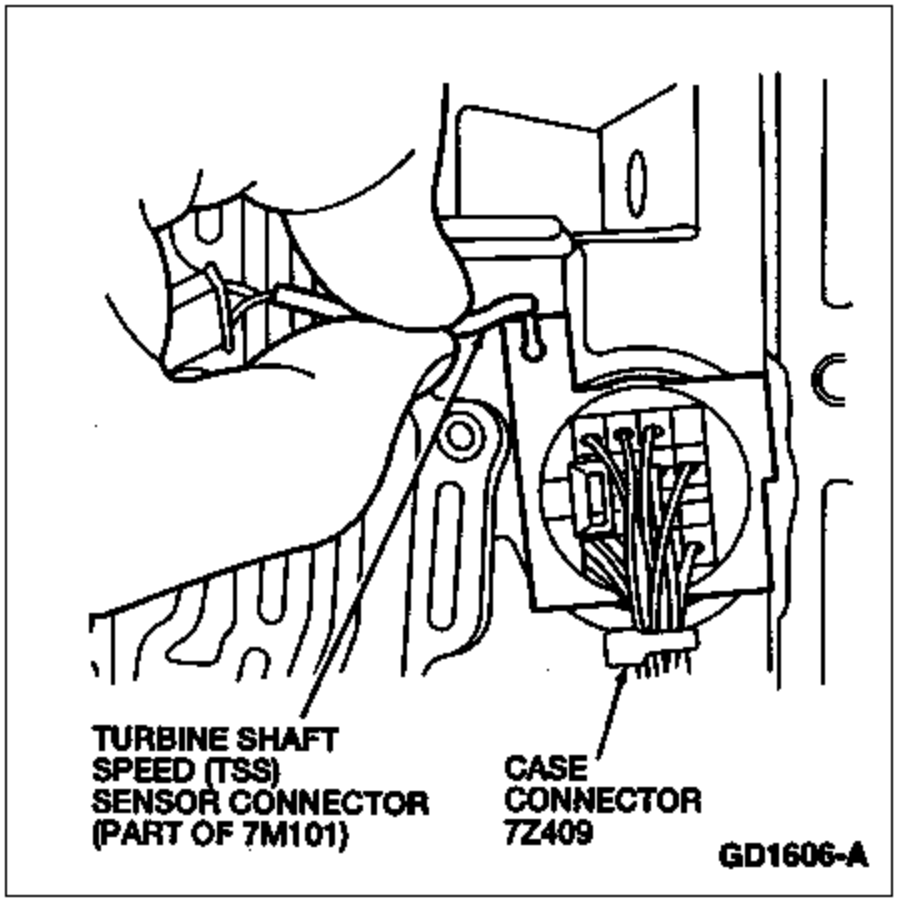
Carefully disconnect the turbine shaft speed (TSS) sensor connector from the 16-pin case connector.

tomsn048@gmail.com



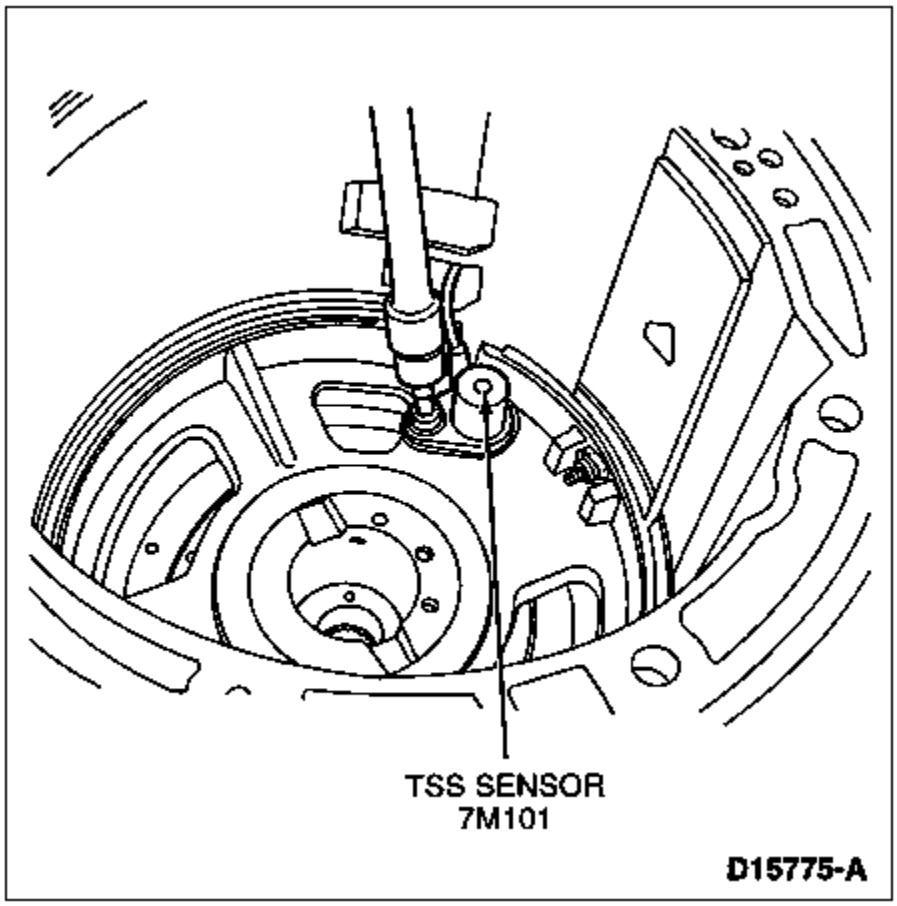
62. Carefully remove TSS sensor connector wires from the retaining slot on the 16-pin case connector.

tomsn048@gmail.com



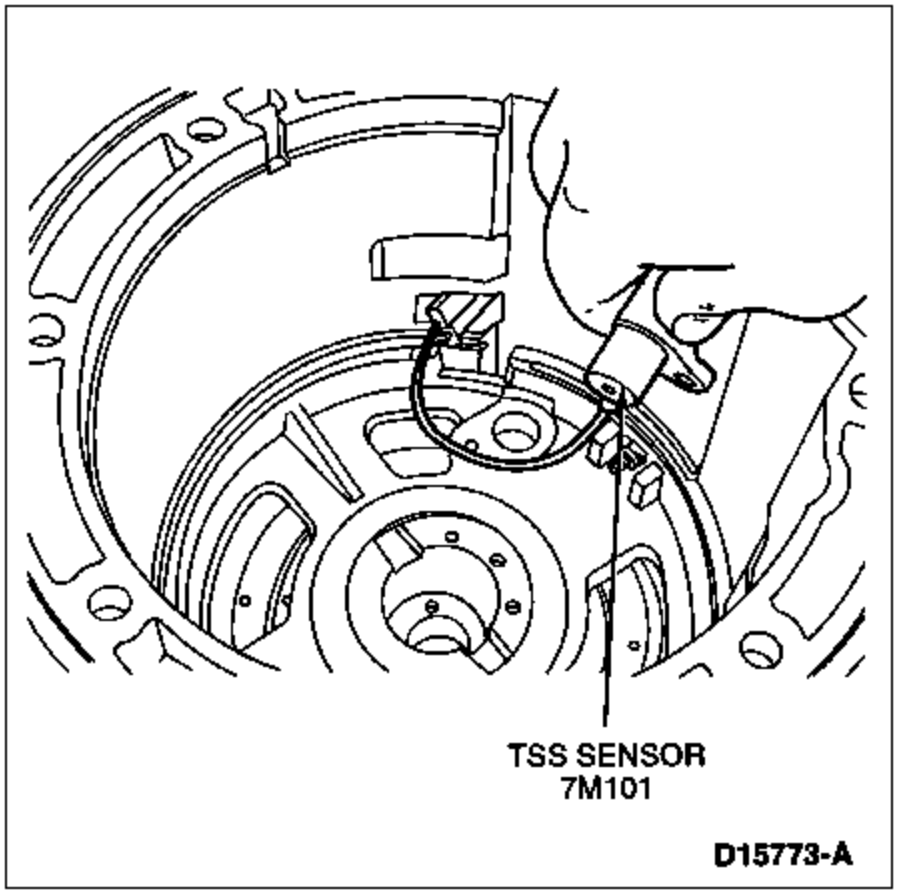
63. Use a T30 Torx® bit to remove the TSS screw.

tomsn048@gmail.com



64. Carefully route the TSS connector and wiring into the transmission through the opening in the case. Remove the TSS.

tomsn048@gmail.com



65. **CAUTION: Do not overstretch the case connector retaining spring.**

Use a screwdriver to carefully remove the case connector retaining spring.

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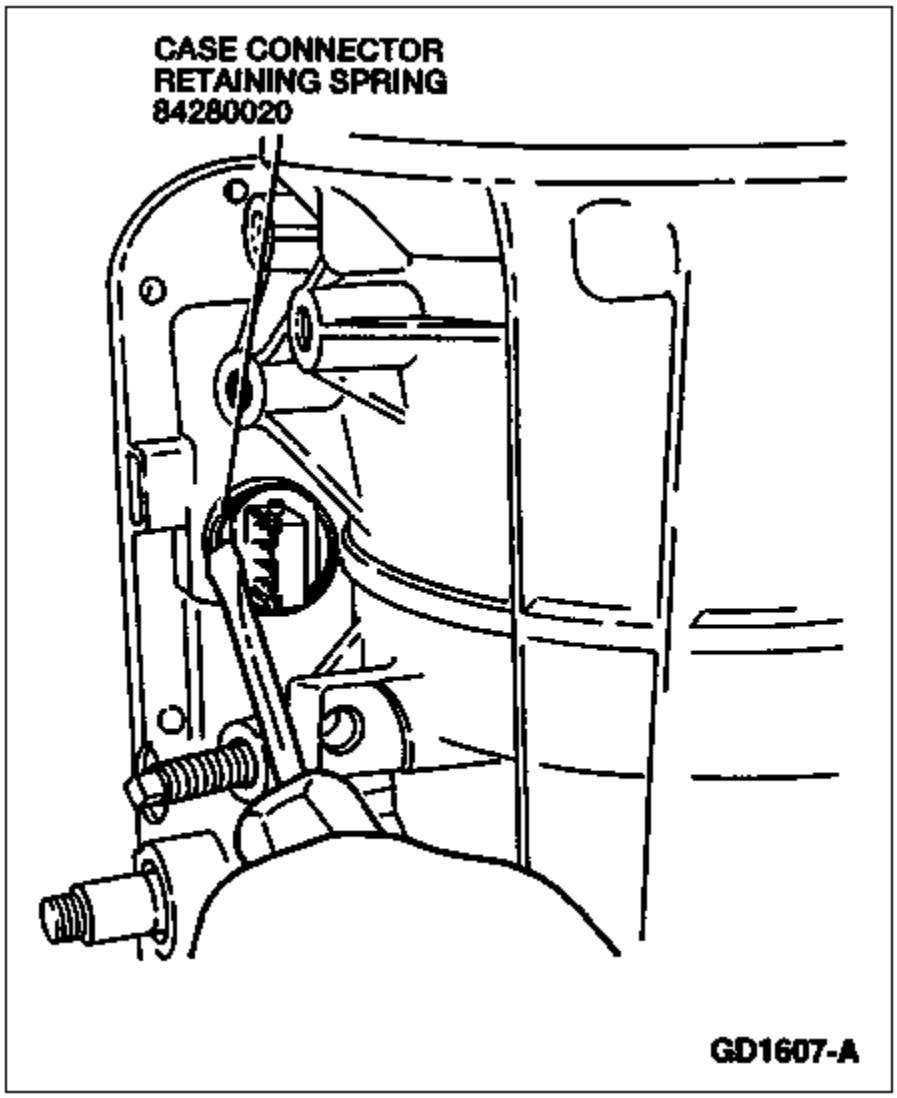

66. **CAUTION: Do not damage the connector or harness.**

Carefully push down on the top of the connector until it stops. Depress the tab on the back side of the connector and push down on the connector. Remove the connector and harness through the bottom of the case.

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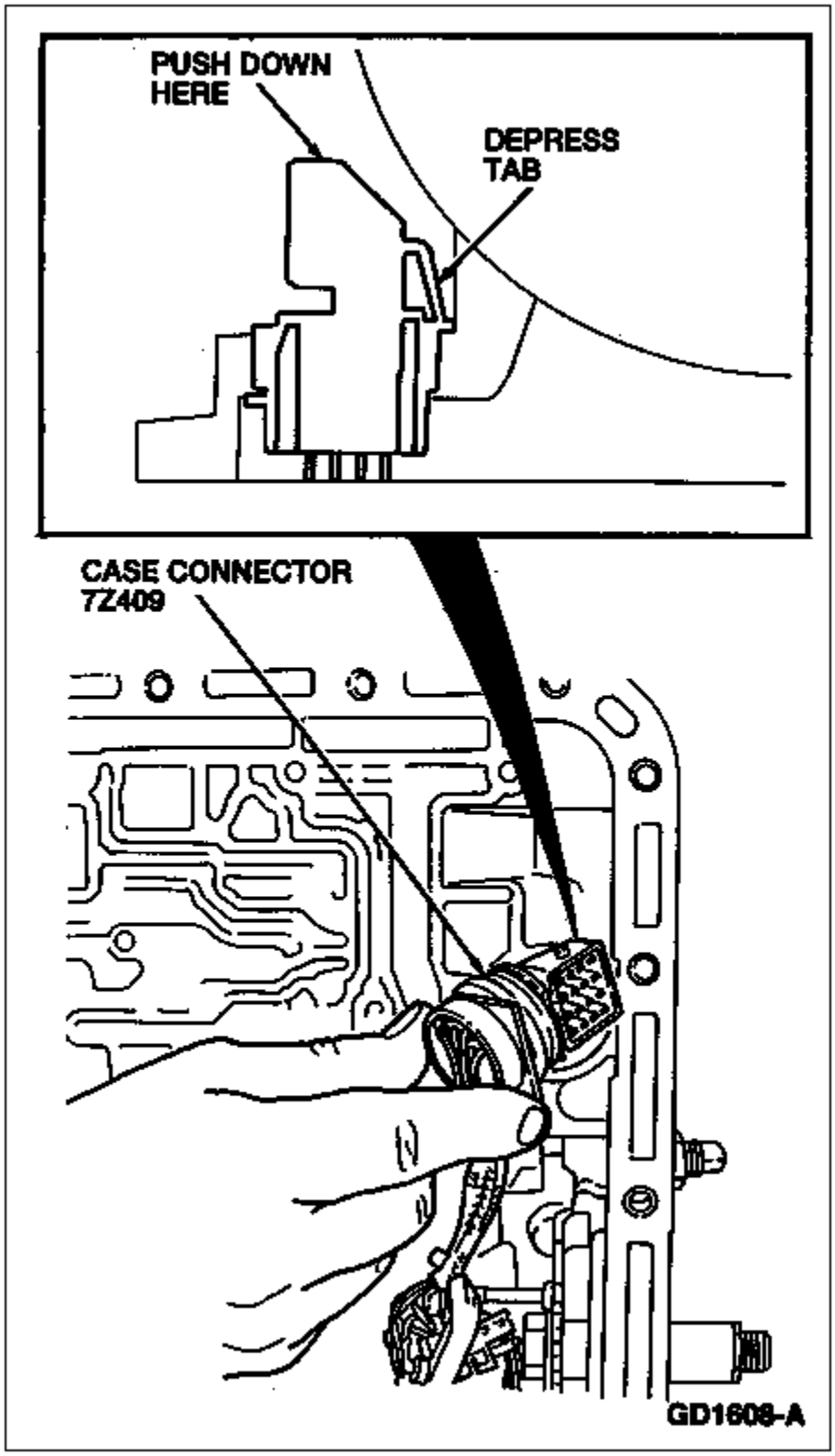
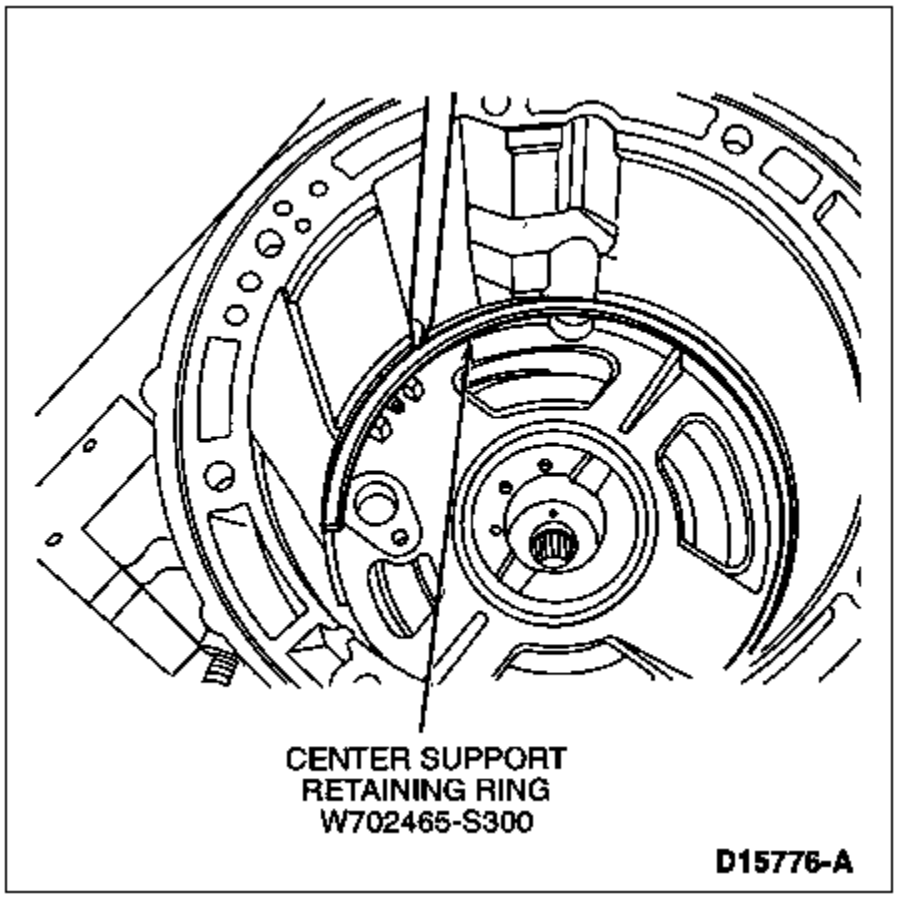


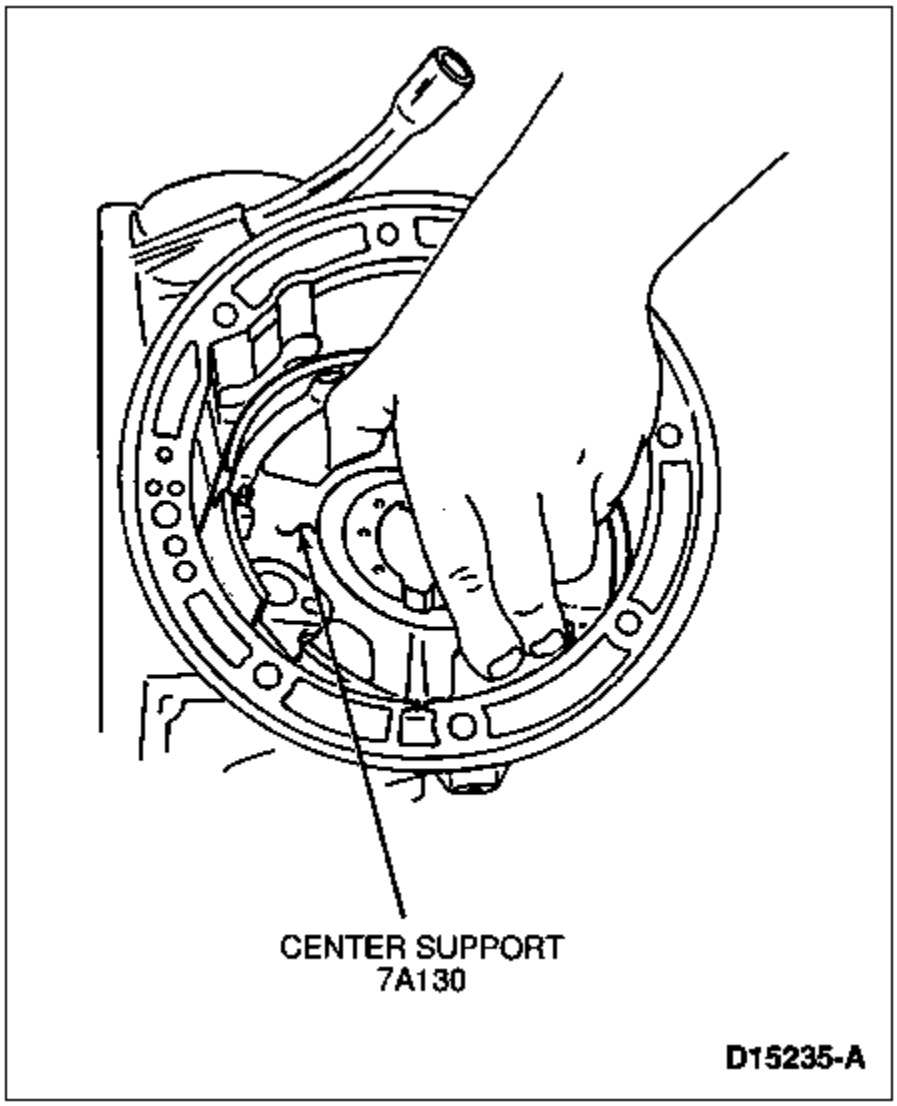
67. Remove the center support retaining ring.

tomsn048@gmail.com



68. Remove the center support by pulling evenly around the center support web.

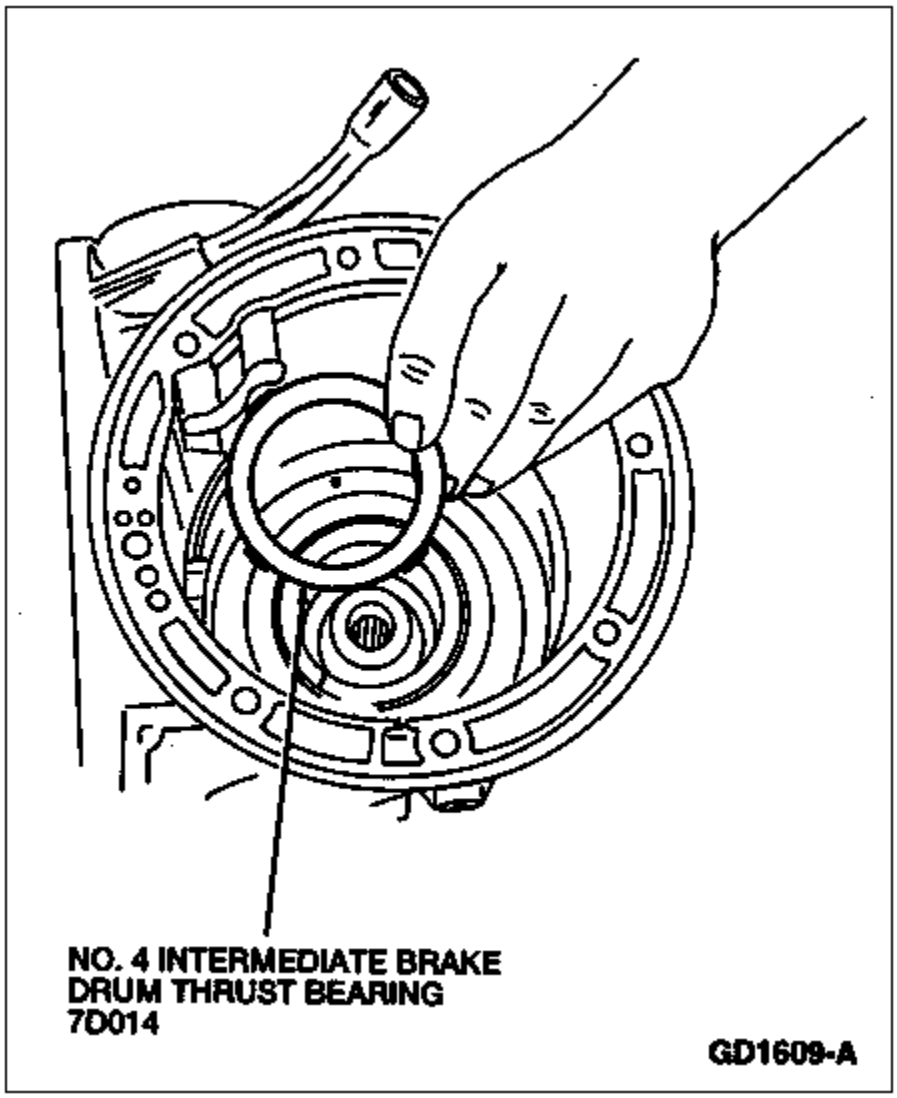
tomsn048@gmail.com



69. **NOTE: Tag and identify the No. 4 intermediate brake drum thrust bearing for assembly.**

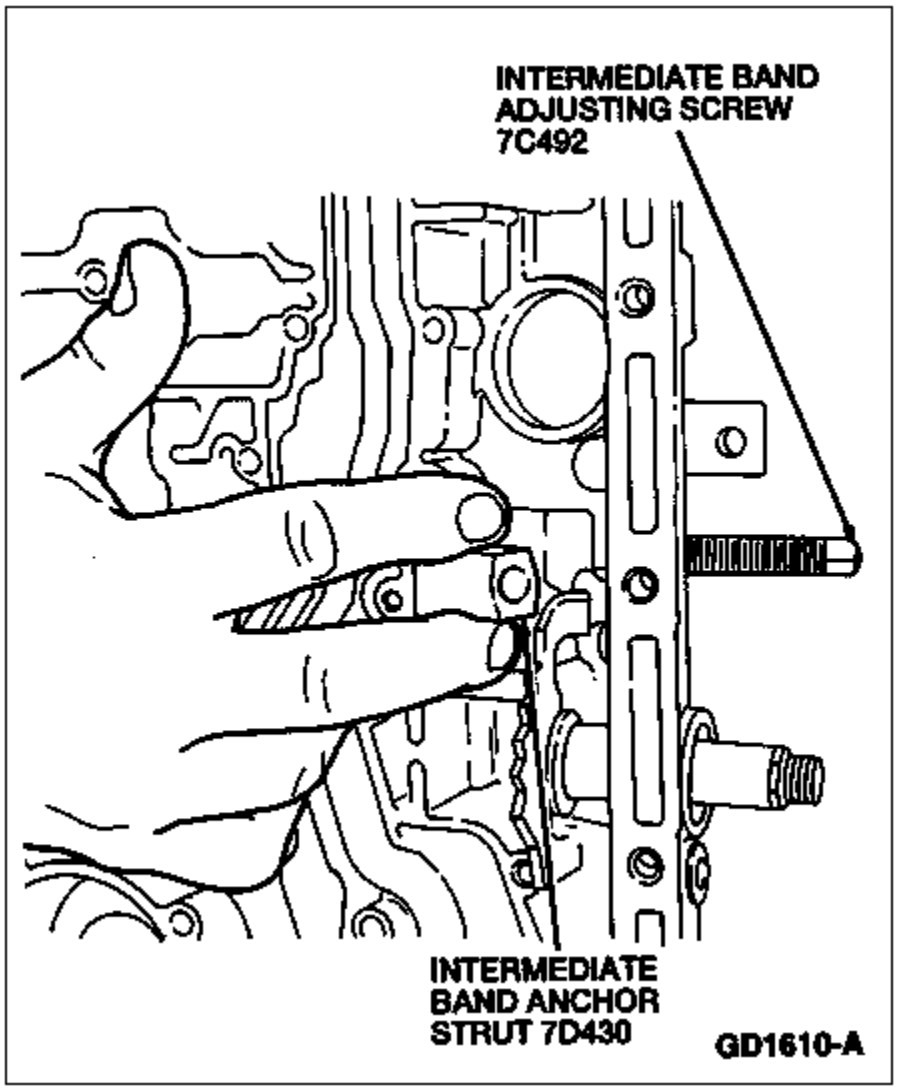
Remove the No. 4 intermediate brake drum thrust bearing.

tomsn048@gmail.com



70. Remove the intermediate band anchor strut through the bottom of the case. Remove intermediate band adjusting screw.

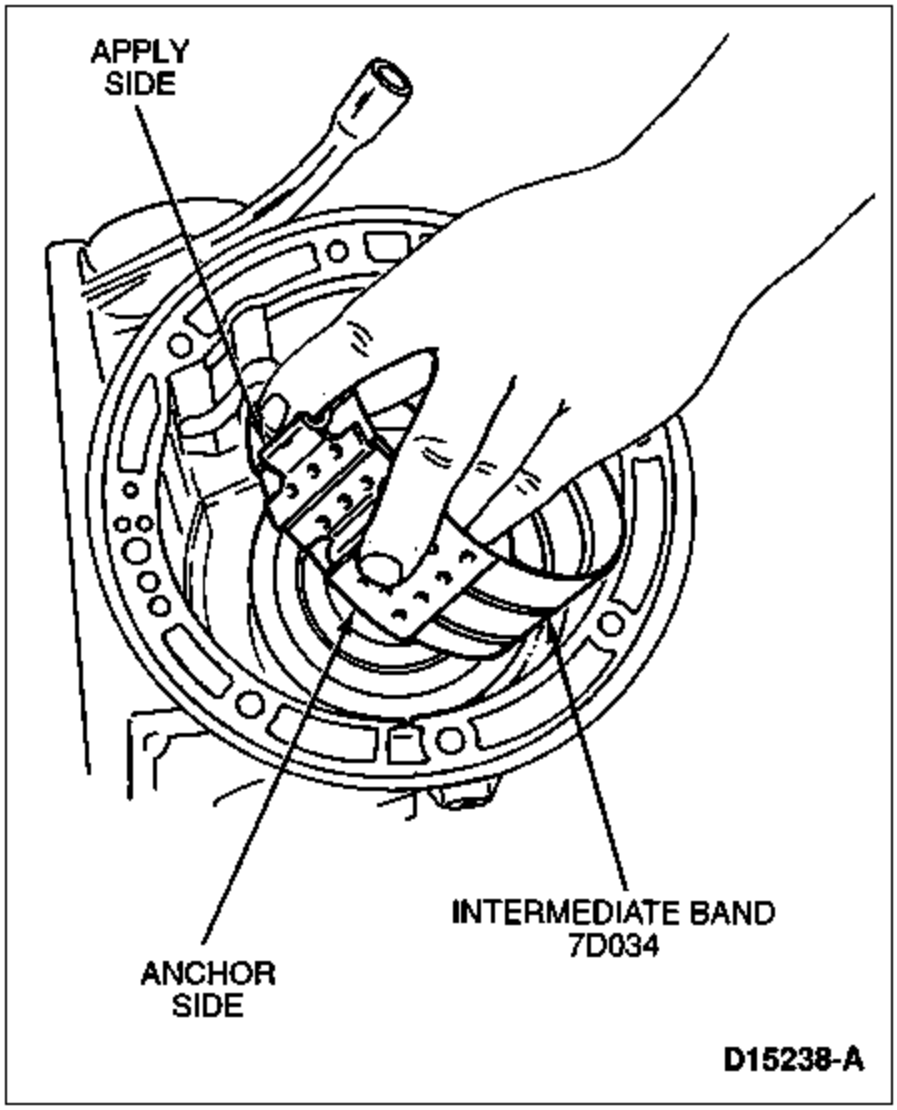
tomsn048@gmail.com



71. **CAUTION: Identify which end of the intermediate band is the anchor side or the apply side.**

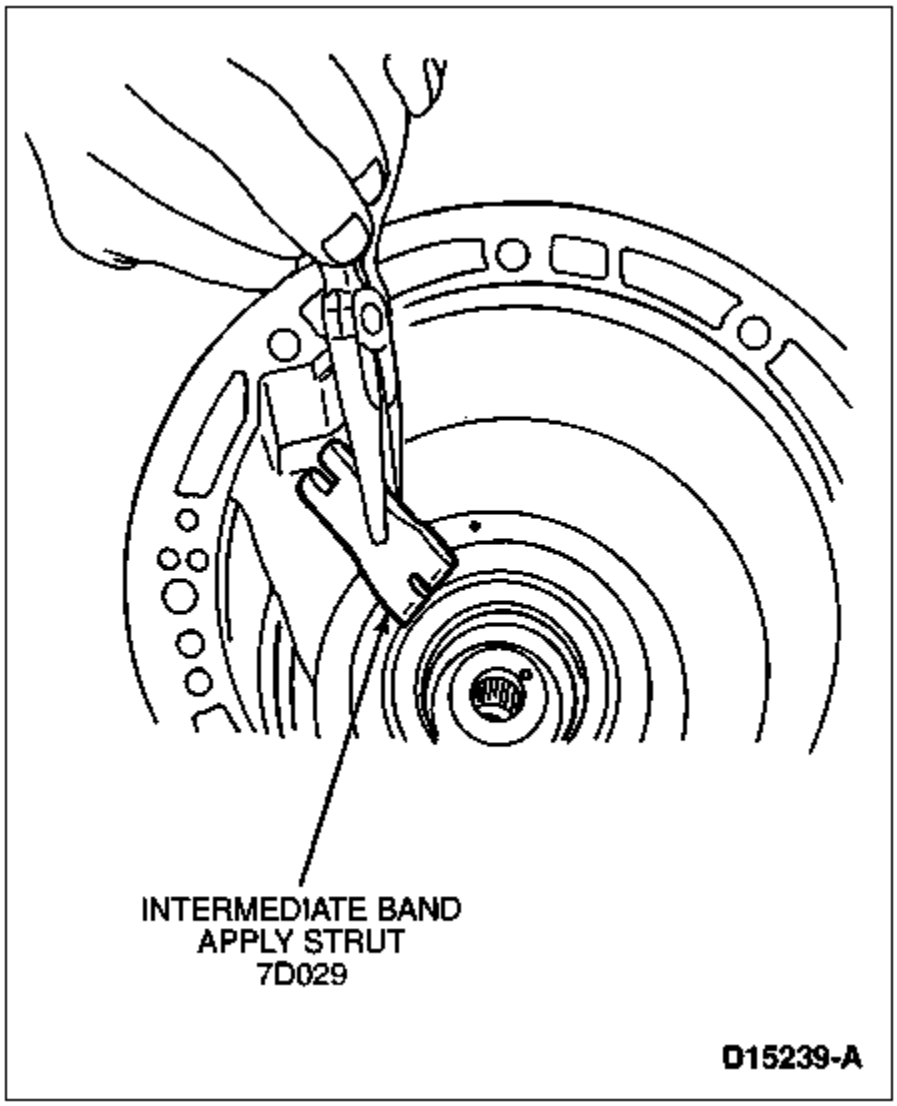
Remove the intermediate band.

tomsn048@gmail.com



72. Remove the intermediate band apply strut.

tomsn048@gmail.com



73. **NOTE: The intermediate band actuating lever shaft is shorter than the overdrive band actuating lever shaft.**

    Remove the intermediate band actuating lever shaft.

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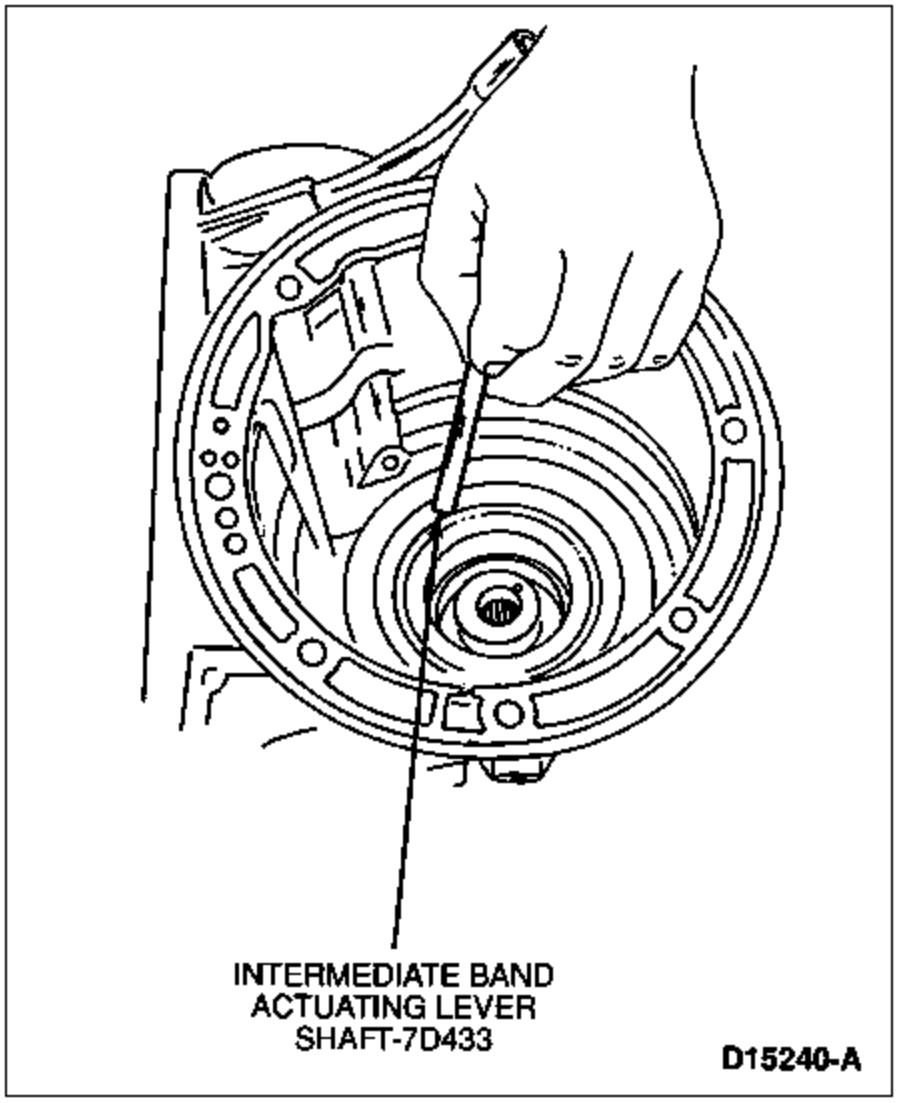
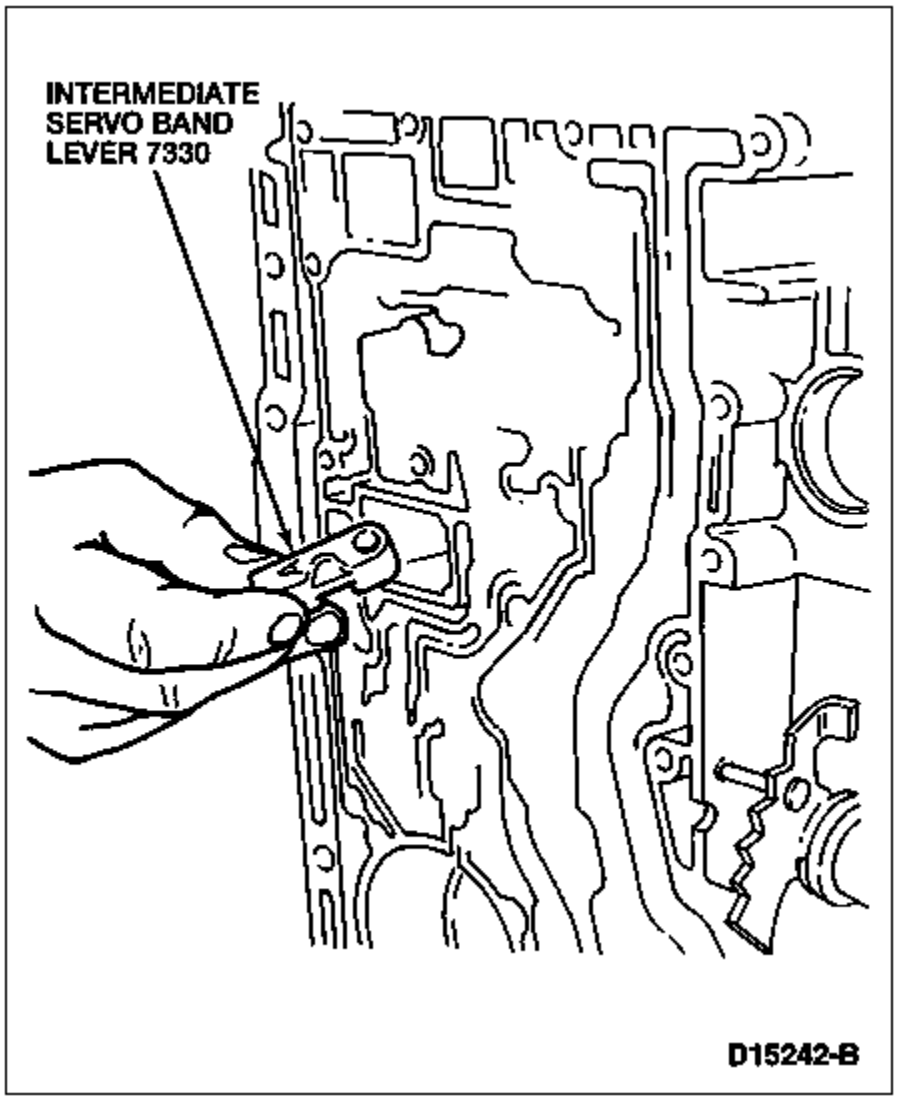


74. **NOTE: Tag and identify the intermediate band servo lever for assembly. The intermediate band servo lever has a letter stamped on its side for identification.**

    Remove the intermediate band servo lever.

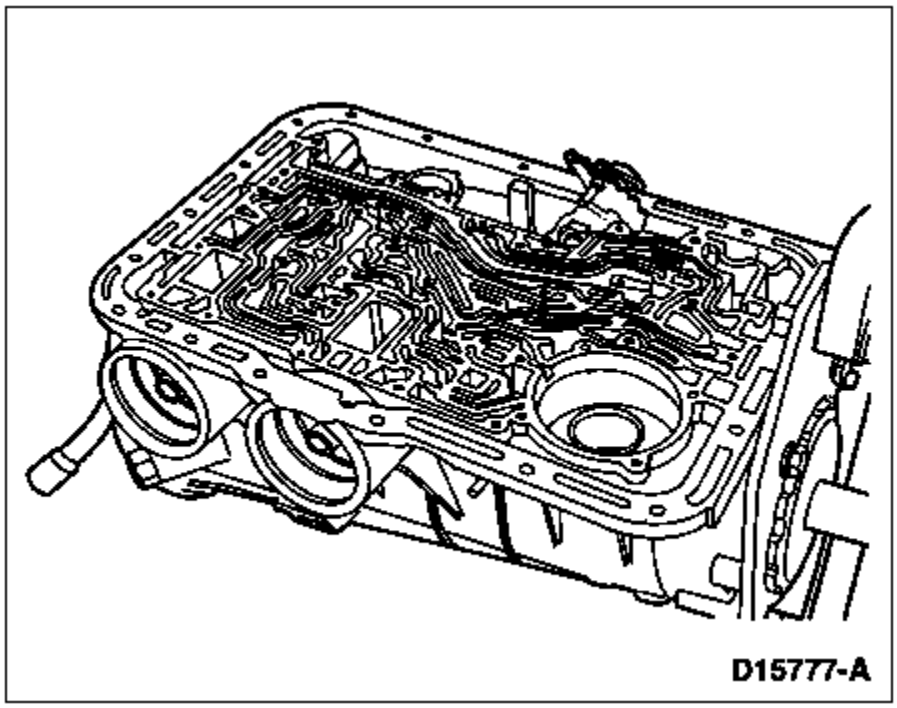
tomsn048@gmail.com



75. **CAUTION: Make sure the lock pin on Bench-Mounted Holding Fixture T57L-500-B is secure.**

Rotate the transmission so the fluid pan surface is facing up.

tomsn048@gmail.com



76. **NOTE: The No. 5 forward clutch cylinder thrust bearing may come out with the intermediate brake and direct clutch drum.**

Remove the intermediate brake and direct clutch drum.

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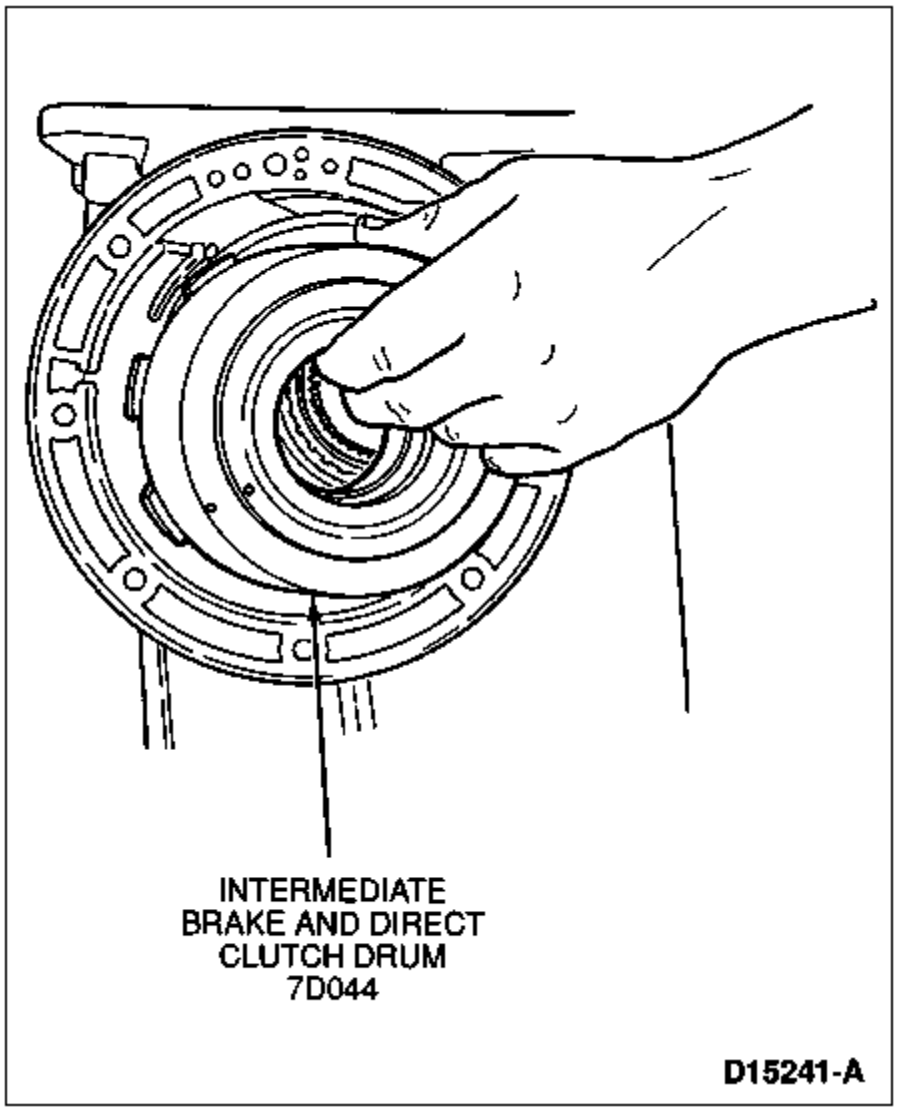
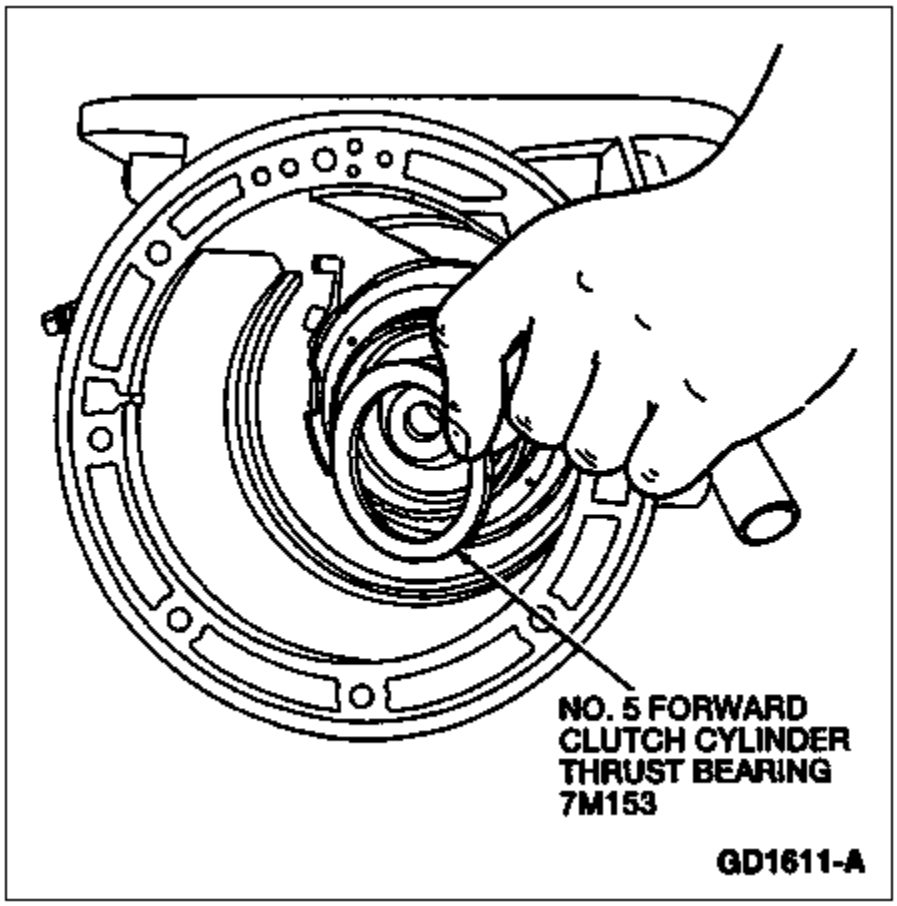


77. **NOTE: Tag and identify the No. 5 forward clutch cylinder thrust bearing for assembly.**

Remove the No. 5 forward clutch cylinder thrust bearing.

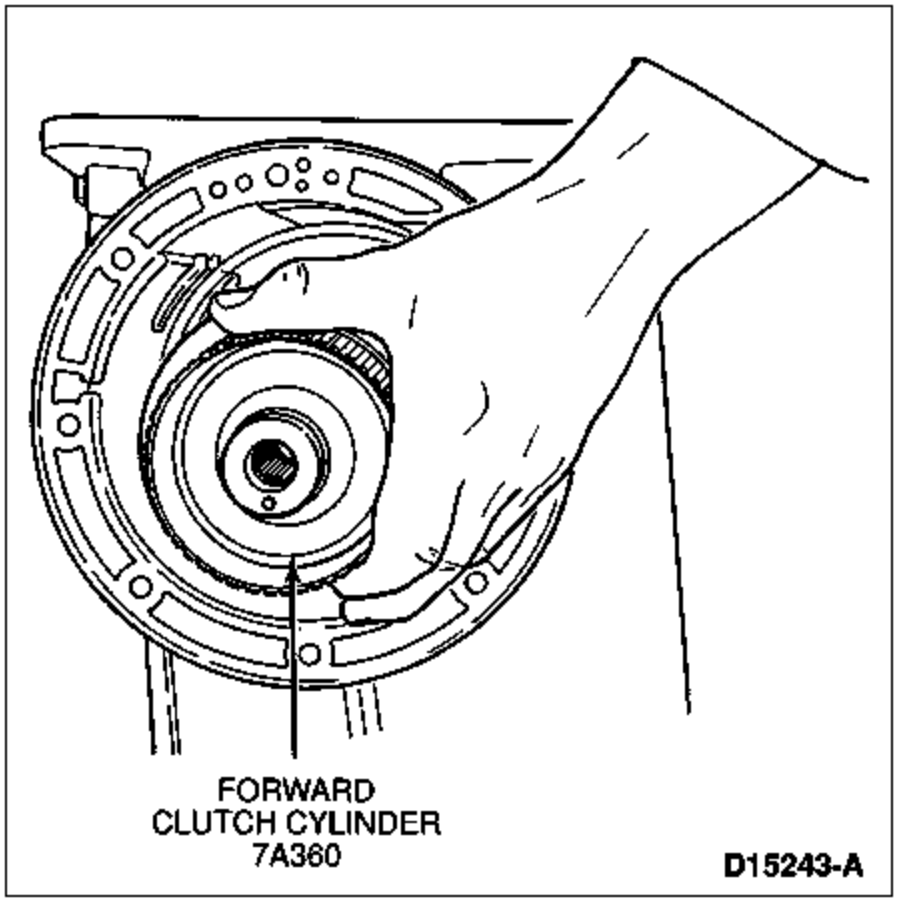
tomsn048@gmail.com



78. **NOTE: The No. 5 forward clutch cylinder thrust bearing may come out with the forward clutch cylinder.**

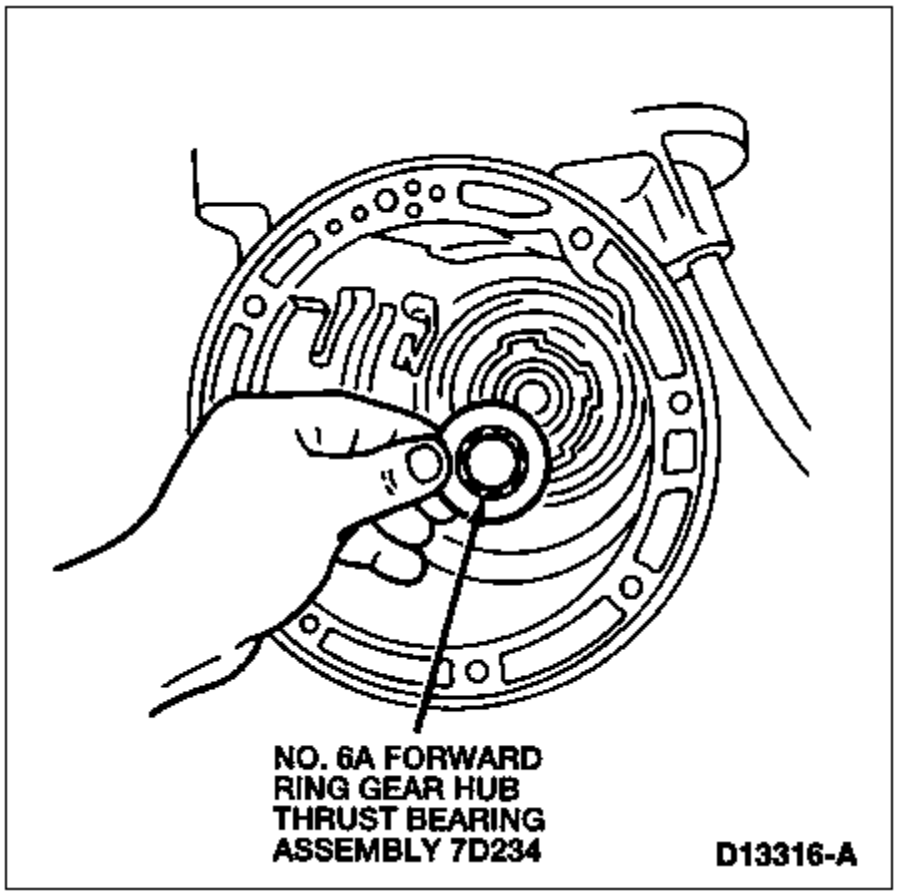
    Remove the forward clutch cylinder.

tomsn048@gmail.com



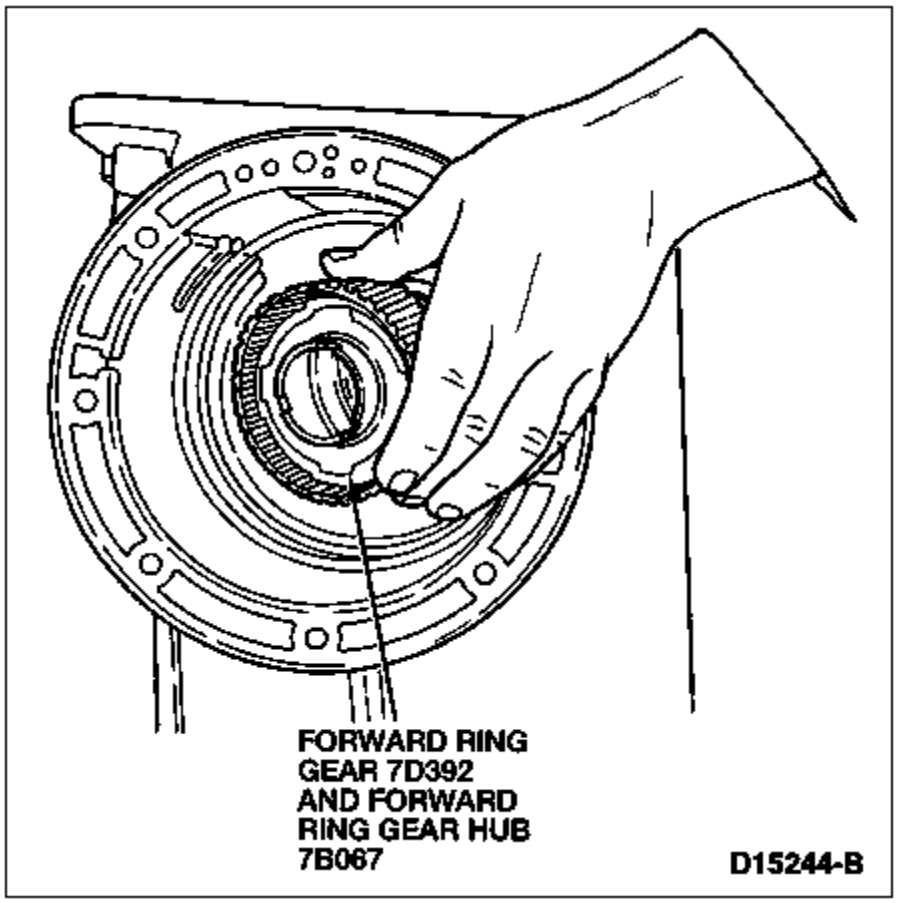
79. Remove No. 6A forward ring gear hub thrust bearing assembly.

tomsn048@gmail.com

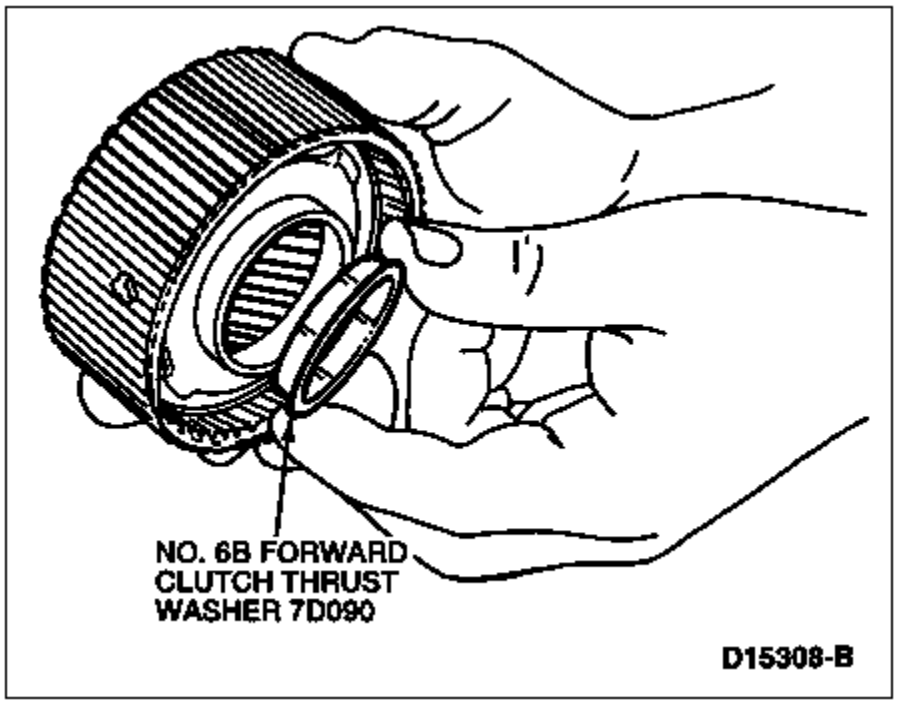


80. Remove the forward ring gear and forward ring gear hub.

tomsn048@gmail.com



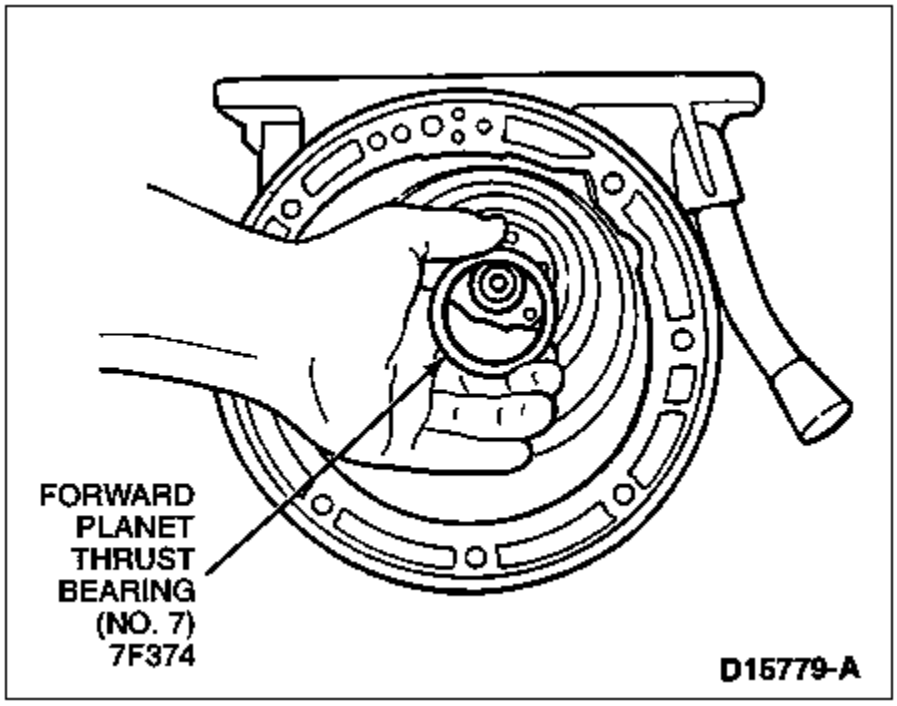
81. Remove No.6B forward clutch thrust washer.



tomsn048@gmail.com

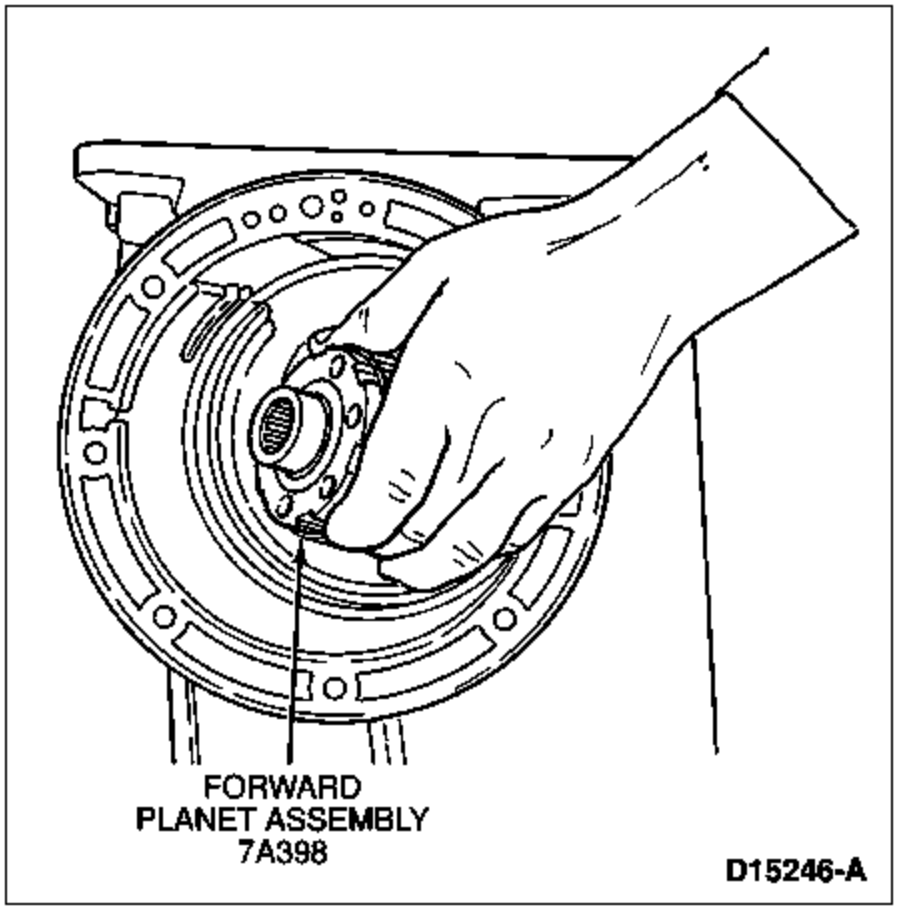
82. **NOTE: Check black oxidized side during removal to ensure correct placement during reassembly. Black oxidized side must be toward planetary assembly. The uncoated side must face up.**

    Remove the No. 7 forward planetary thrust bearing.



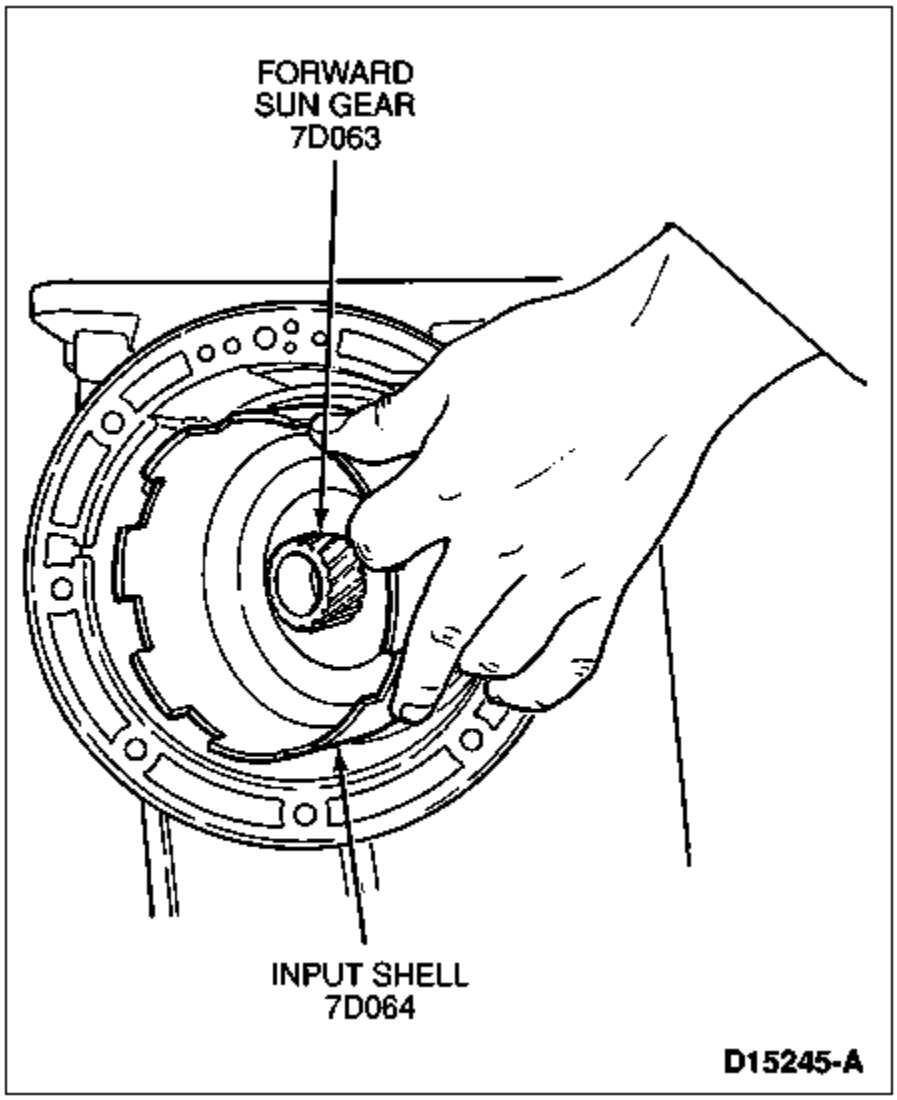
83. Remove the forward planetary assembly.

tomsn048@gmail.com



84. Remove the input shell with forward sun gear.

tomsn048@gmail.com



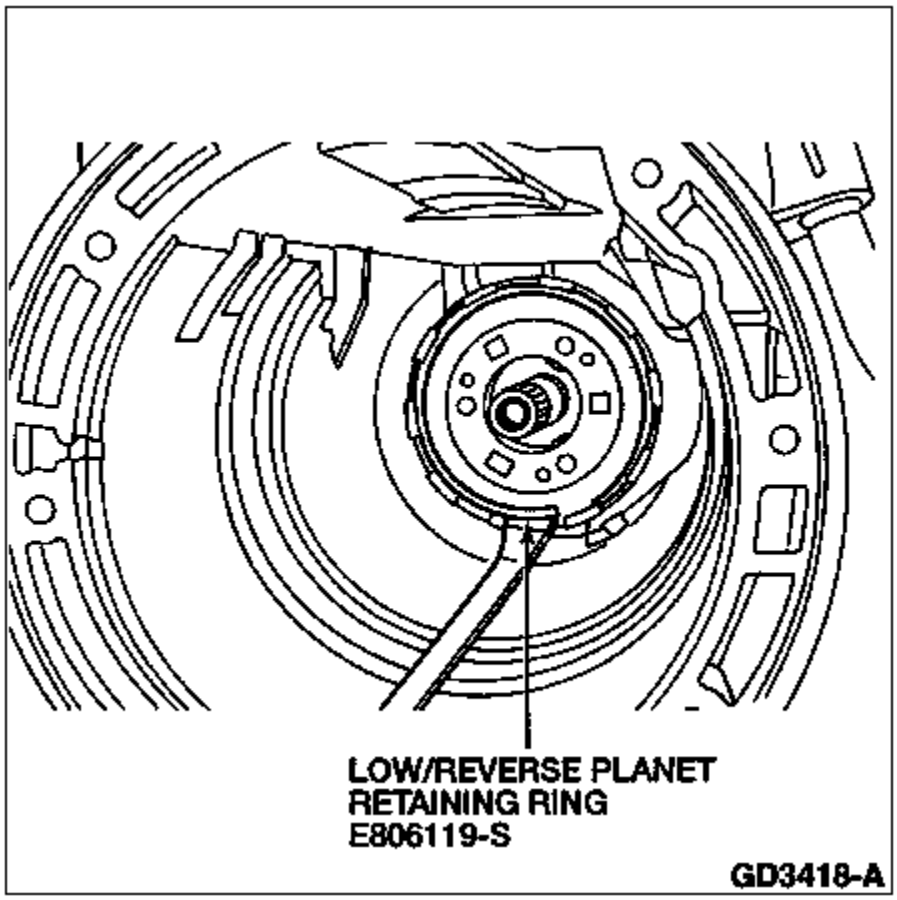
85. **NOTE: Tag and identify the No. 8 reverse planetary carrier thrust bearing for assembly.**

Remove the No. 8 low/reverse planetary carrier thrust bearing from the reverse planetary assembly.

tomsn048@gmail.com

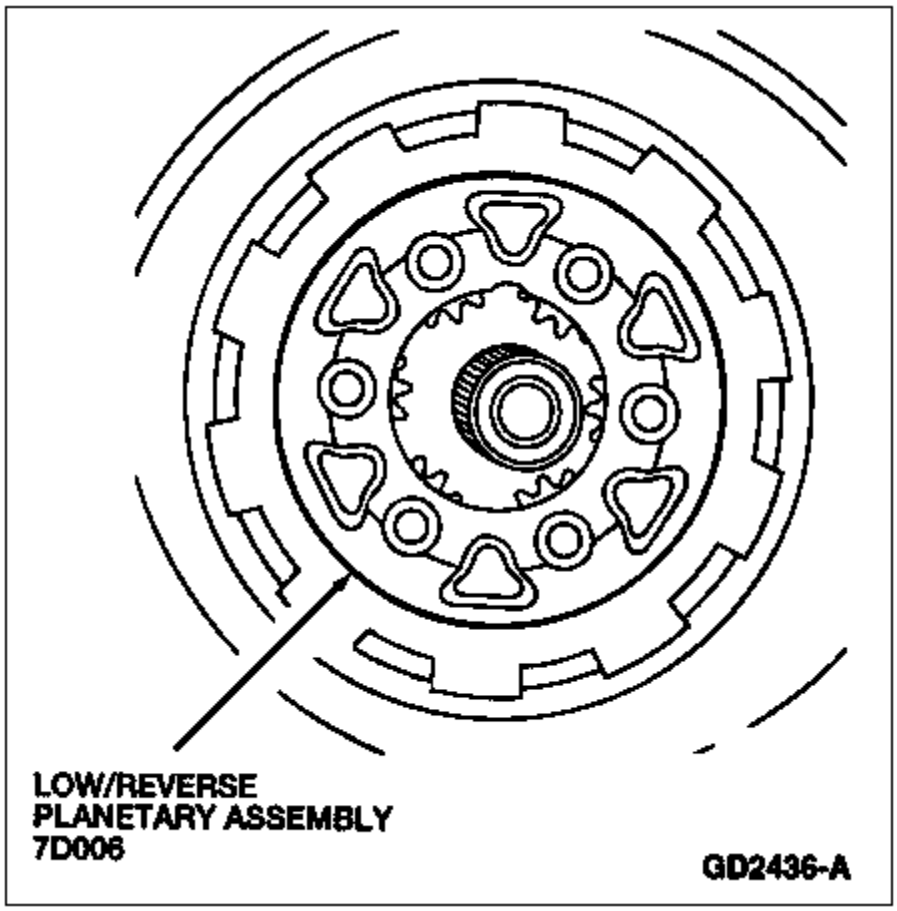
86. Remove the low/reverse planetary retaining ring.

tomsn048@gmail.com



87. Remove low/reverse planetary assembly.

tomsn048@gmail.com



88. **NOTE: Tag and identify the No. 9 low/reverse planetary carrier thrust bearing for reassembly.**

Remove the No. 9 low/reverse planetary carrier thrust bearing.

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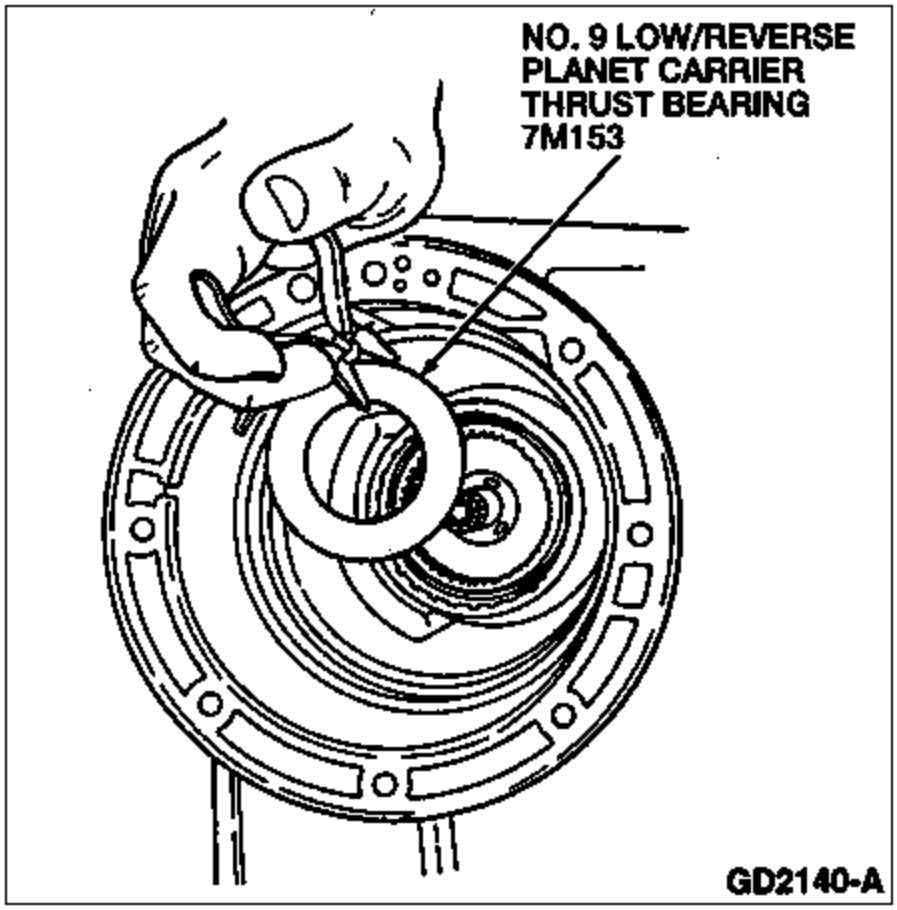

89. Remove the output shaft sleeve.

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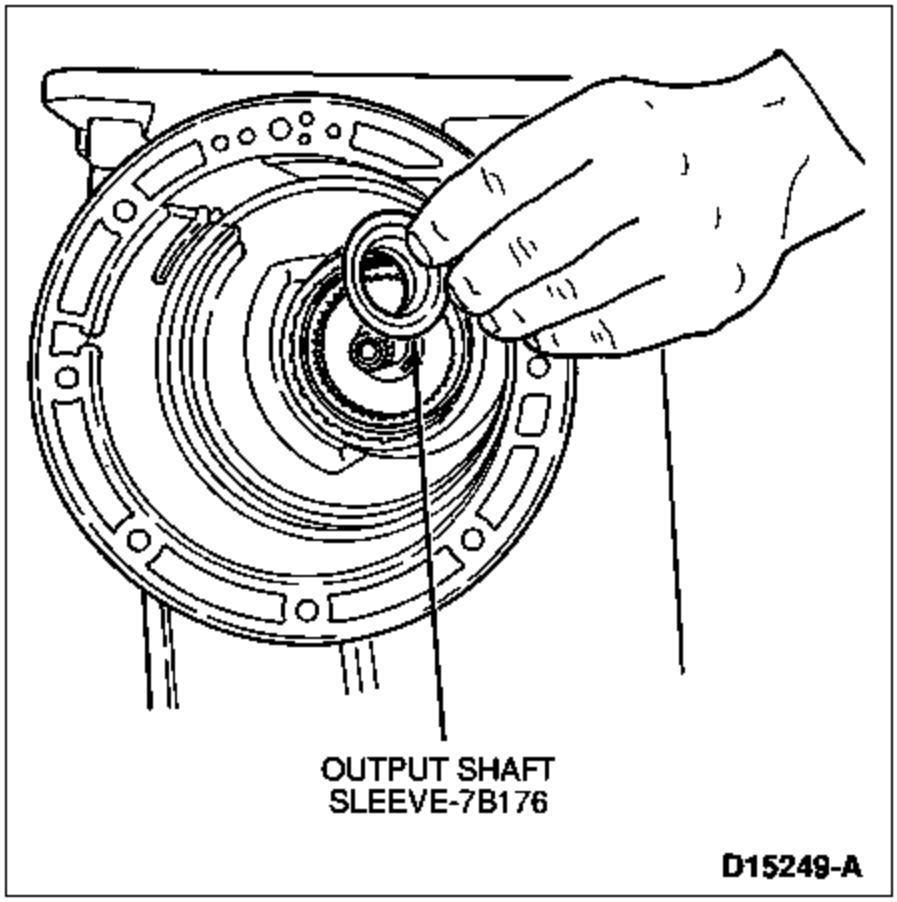

90. **CAUTION: Discard the output shaft retaining ring. A new retaining ring must be used for assembly.**

Remove the output shaft retaining ring from inside the case on the output shaft.

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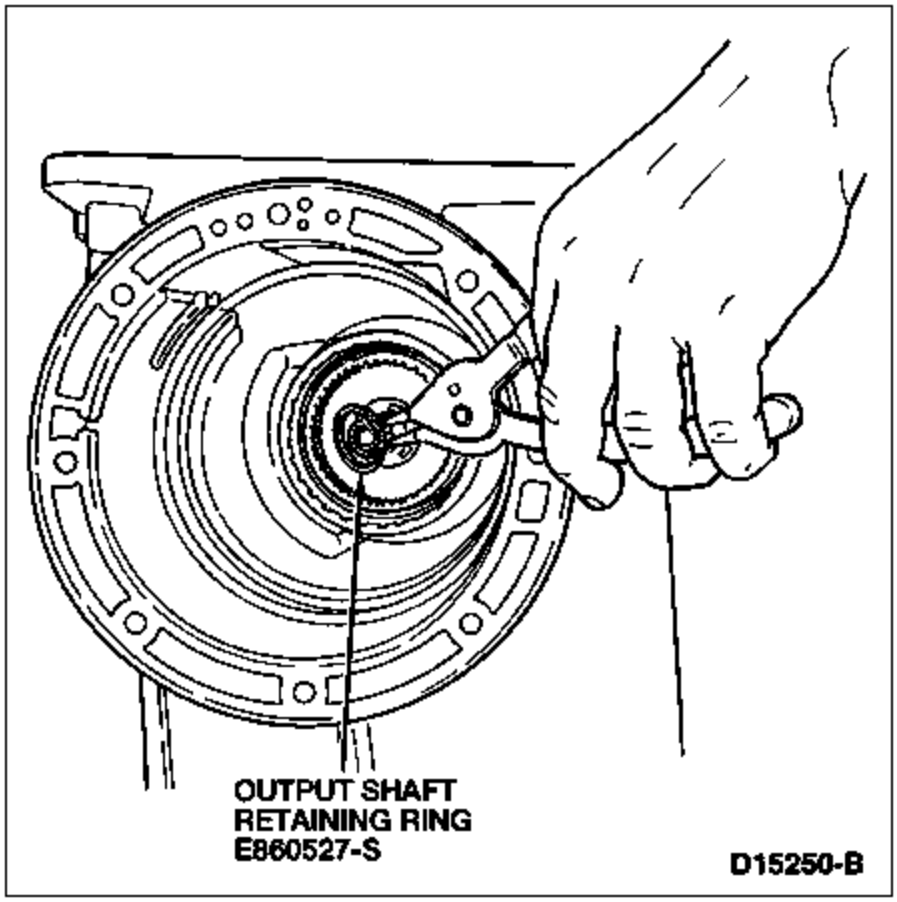

91. Remove the output shaft ring gear and output shaft hub.

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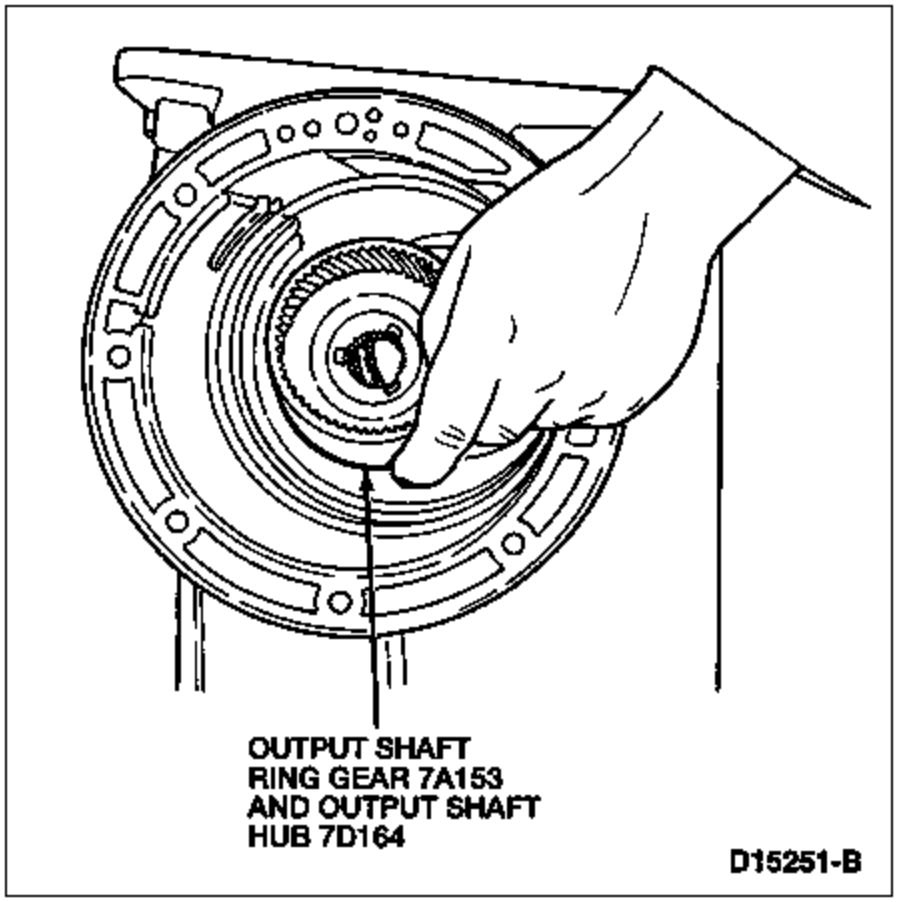

92. **NOTE: Tag and identify the No. 10B output shaft hub thrust bearing for assembly.**

Remove the No. 10B output shaft hub thrust bearing.

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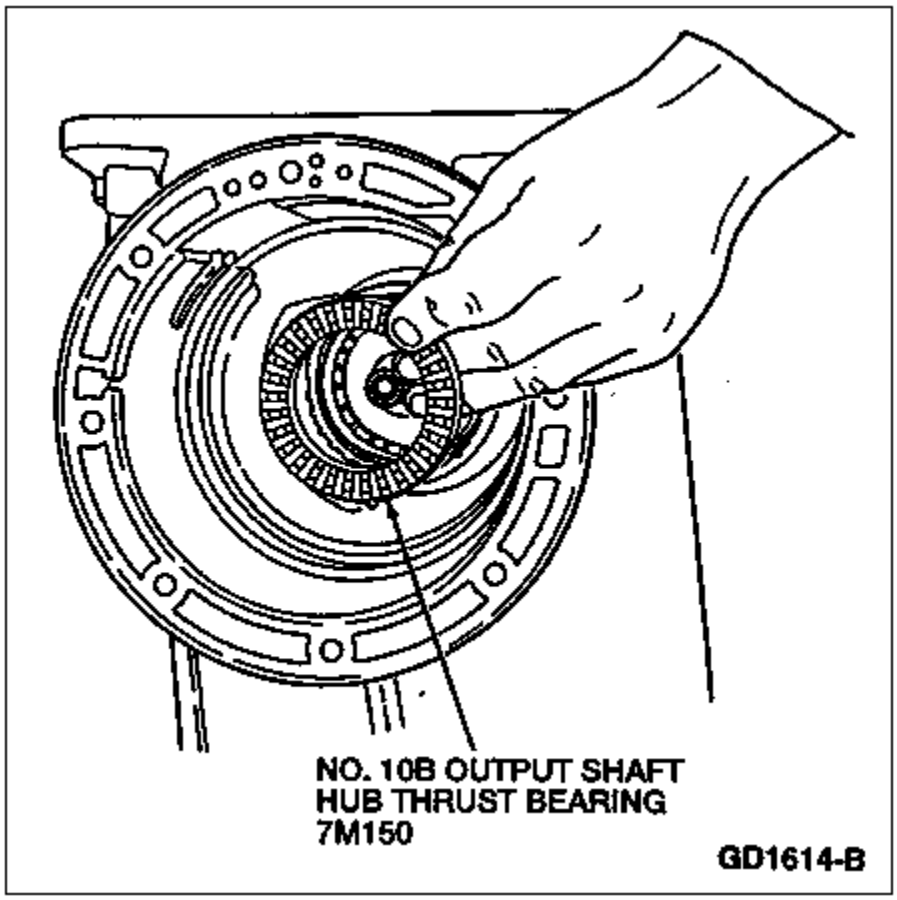

93. **NOTE: The inner race of the rear one-way clutch is not removable. It is serviced in the case.**

Remove the low/reverse brake drum and the one-way clutch assembly.

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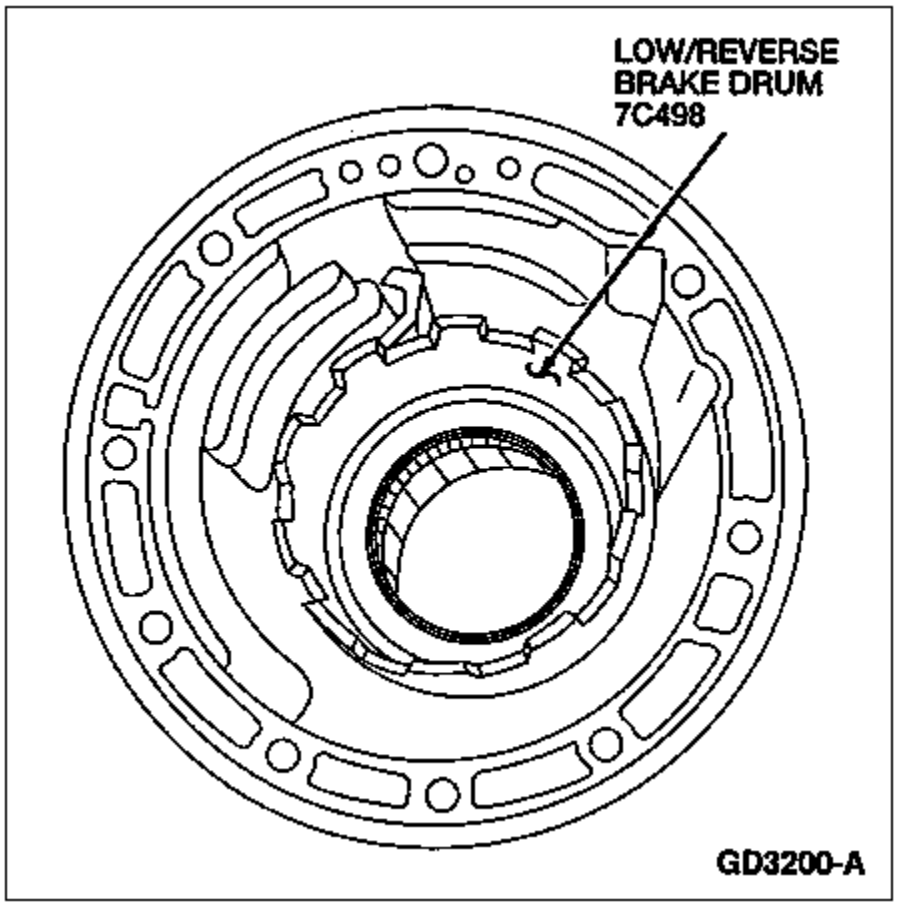

94. Remove the reverse band.

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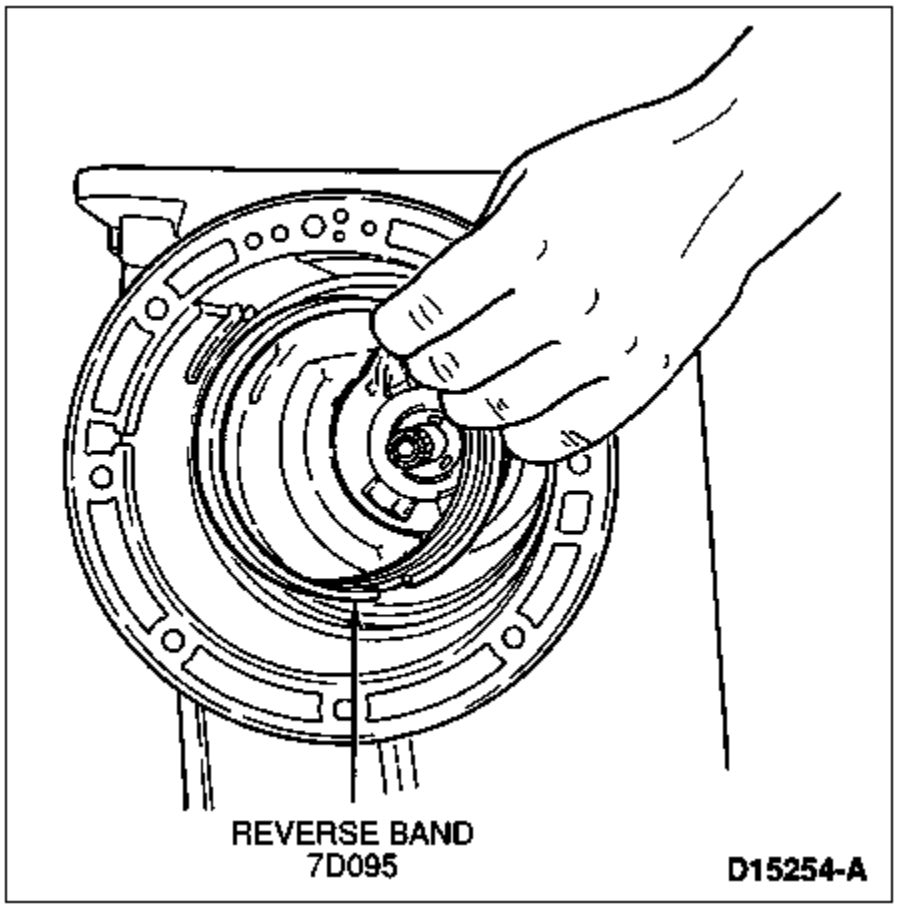

95. Remove the output shaft.

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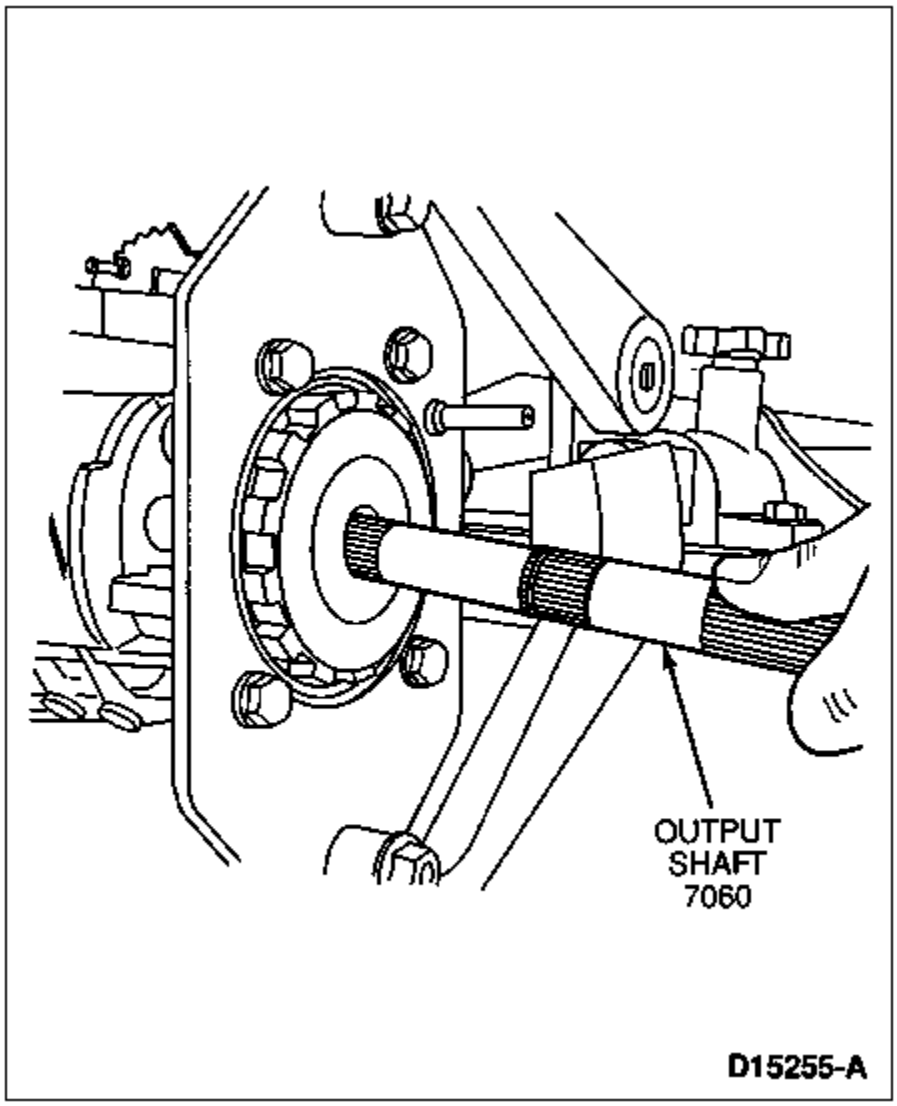

96. Remove the park gear.

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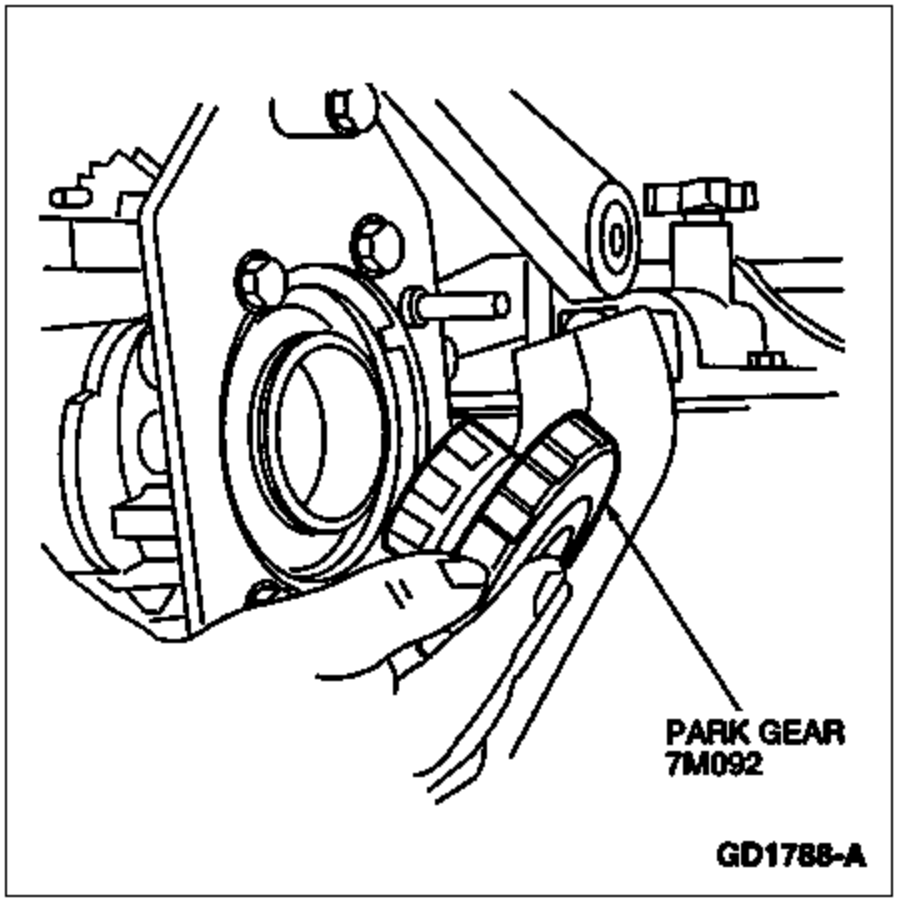

97. **NOTE: Tag and identify the No. 11 output shaft thrust washer for assembly.**

Remove the No. 11 output shaft thrust washer.

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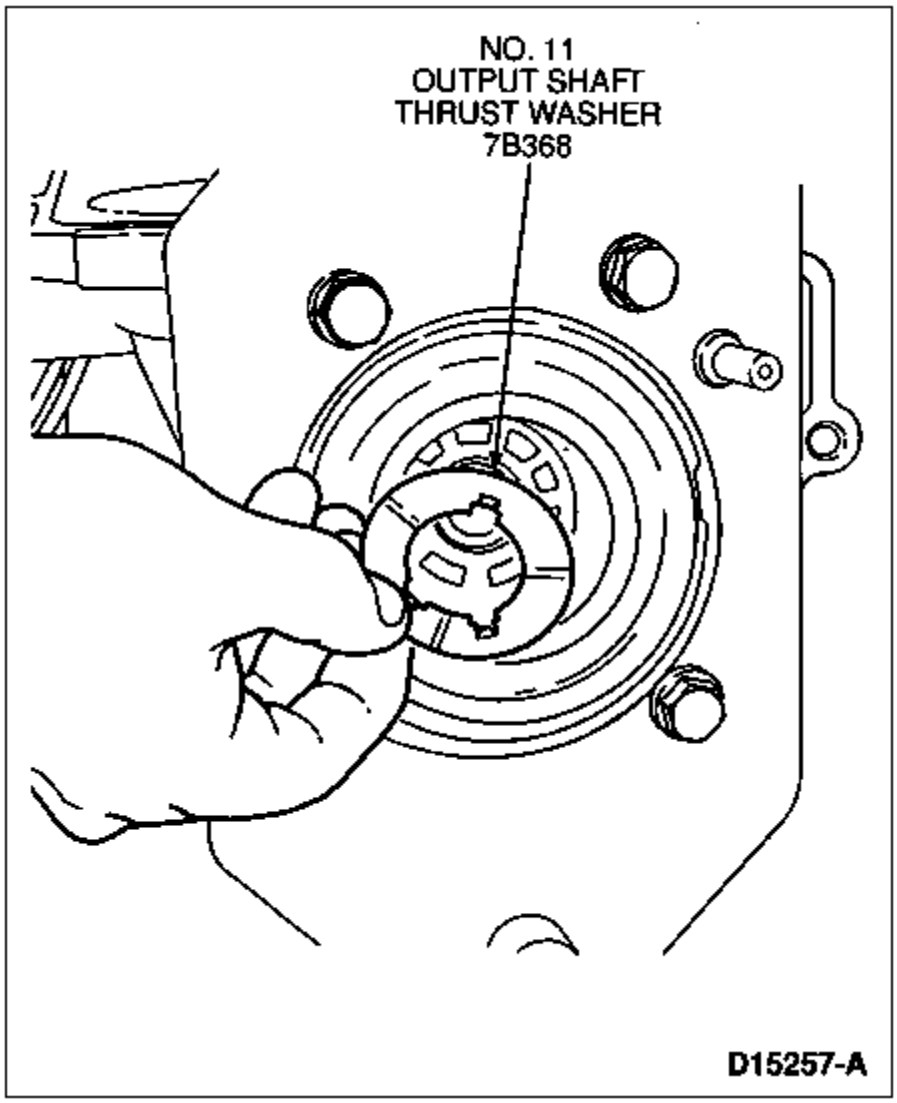
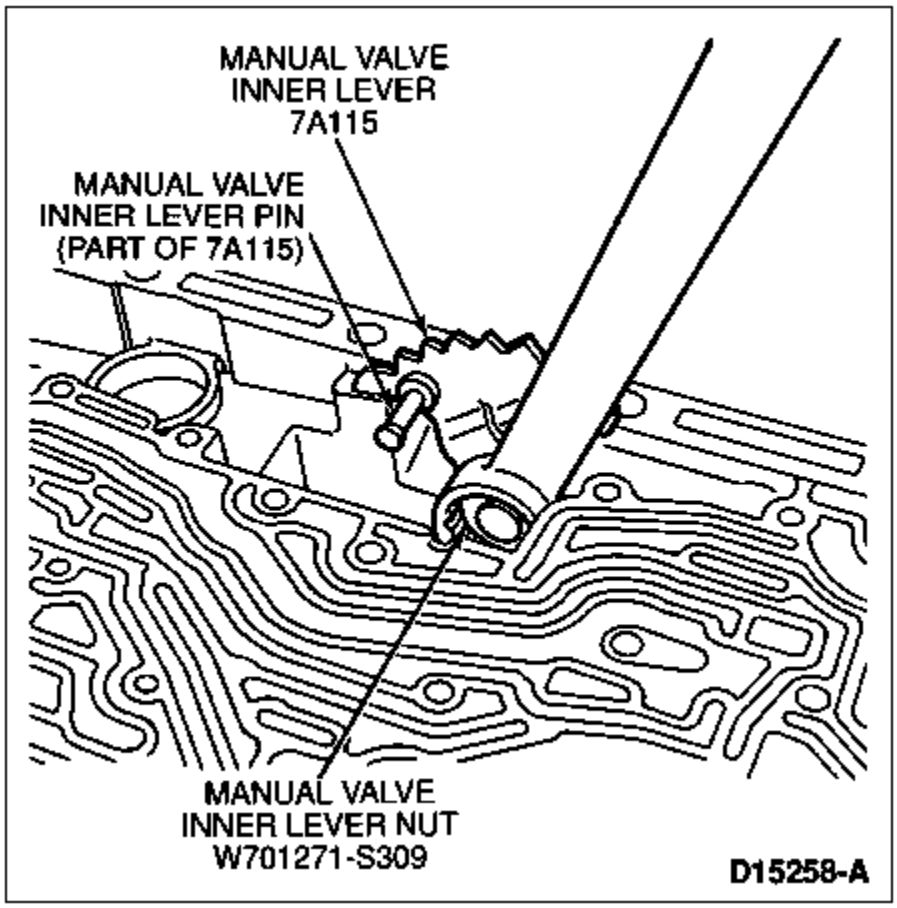


98. **CAUTION: To avoid damage, make sure wrench does not strike the manual valve inner lever pin.**

Remove the manual valve inner lever nut.

tomsn048@gmail.com



99. Remove the manual valve inner lever and parking pawl actuating rod assembly.

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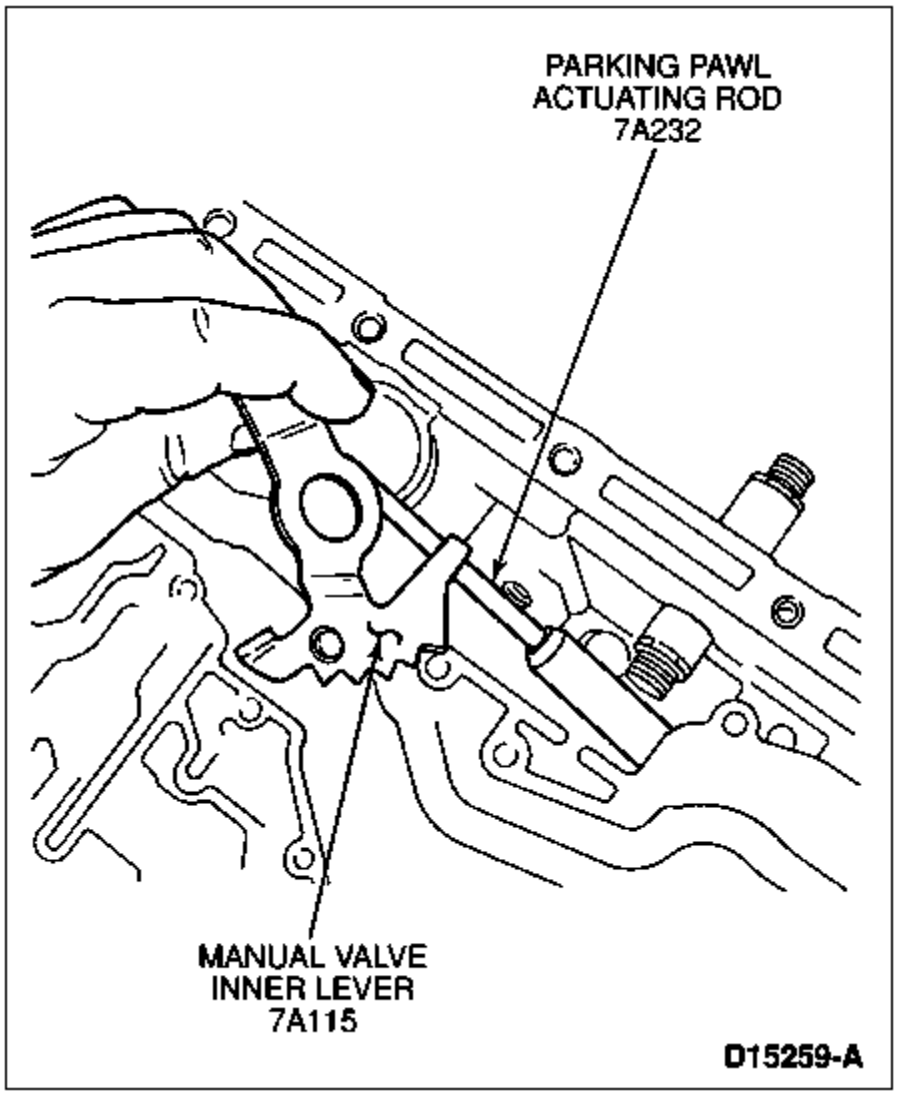

100. **CAUTION: Do not damage the case fluid pan rail.**

Using a small hammer and drift, tap lightly on each side of the manual control lever shaft retaining pin (two or three times). This will loosen the pin prior to removal.

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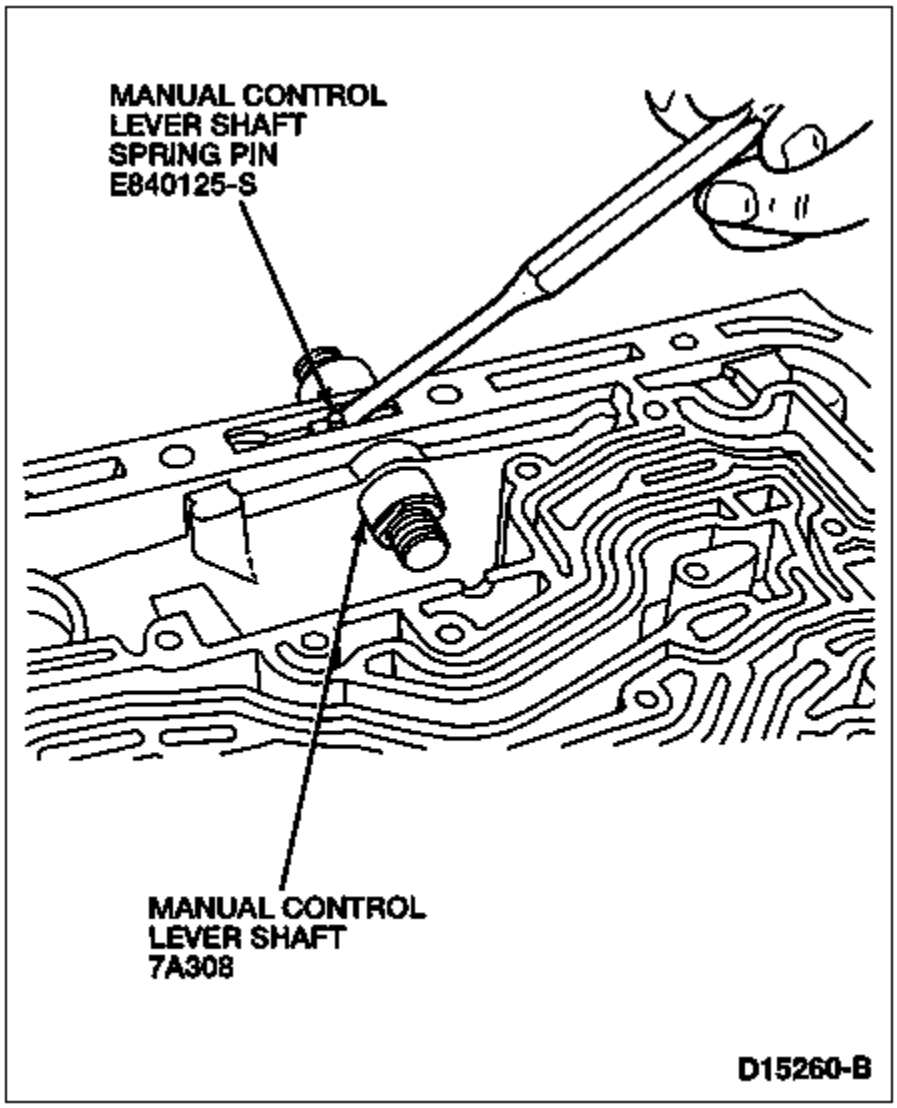

101. **CAUTION: Do not damage the case fluid pan rail.**

Remove the manual control lever shaft retaining pin with a narrow, sharp edged screwdriver from the side as shown.

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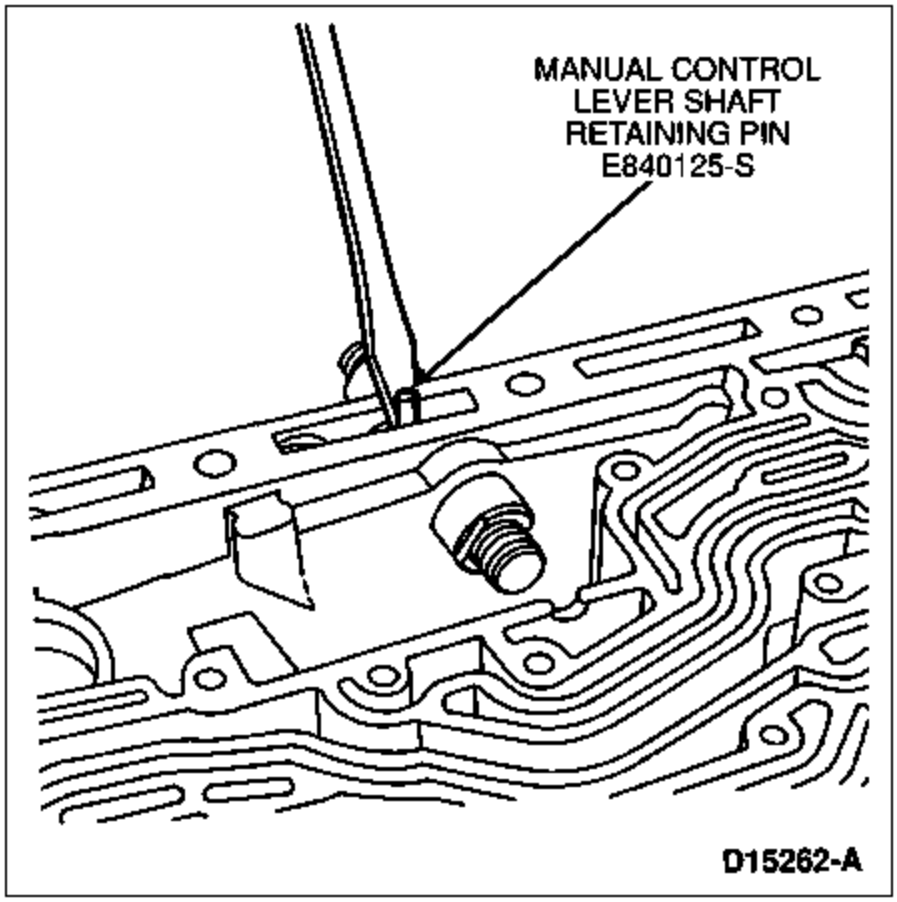

102. Remove the manual control lever shaft.

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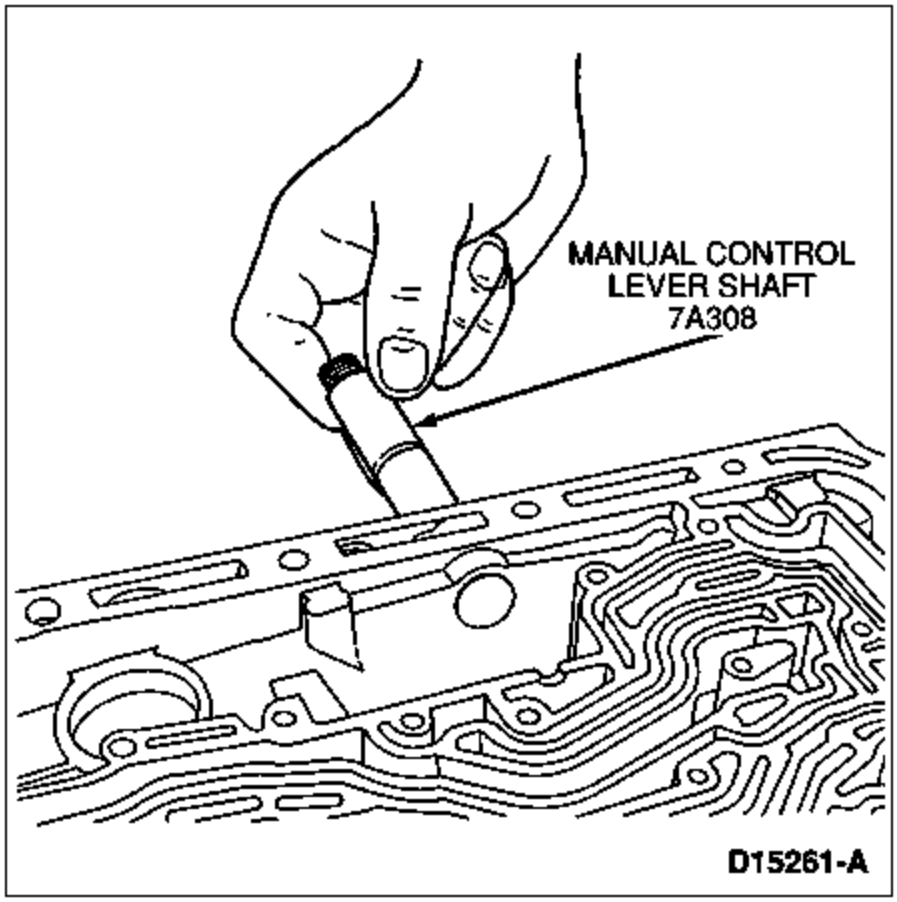

103. **CAUTION: Do not damage the bore.**

Remove the manual control lever seal.

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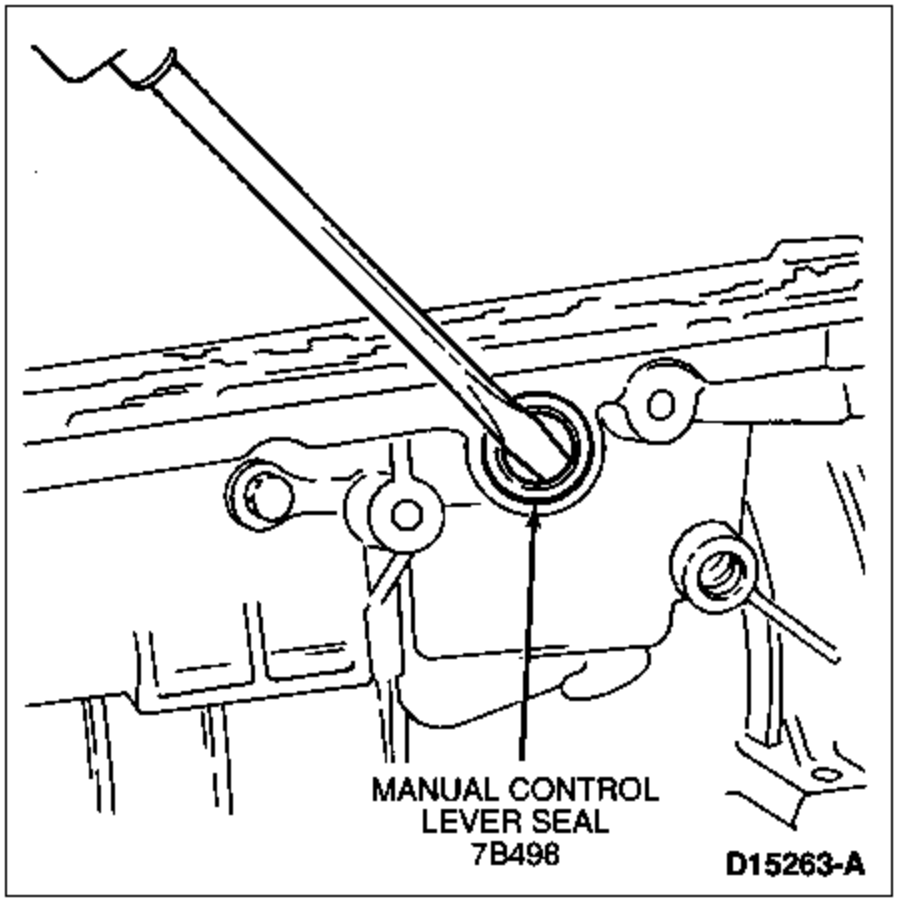

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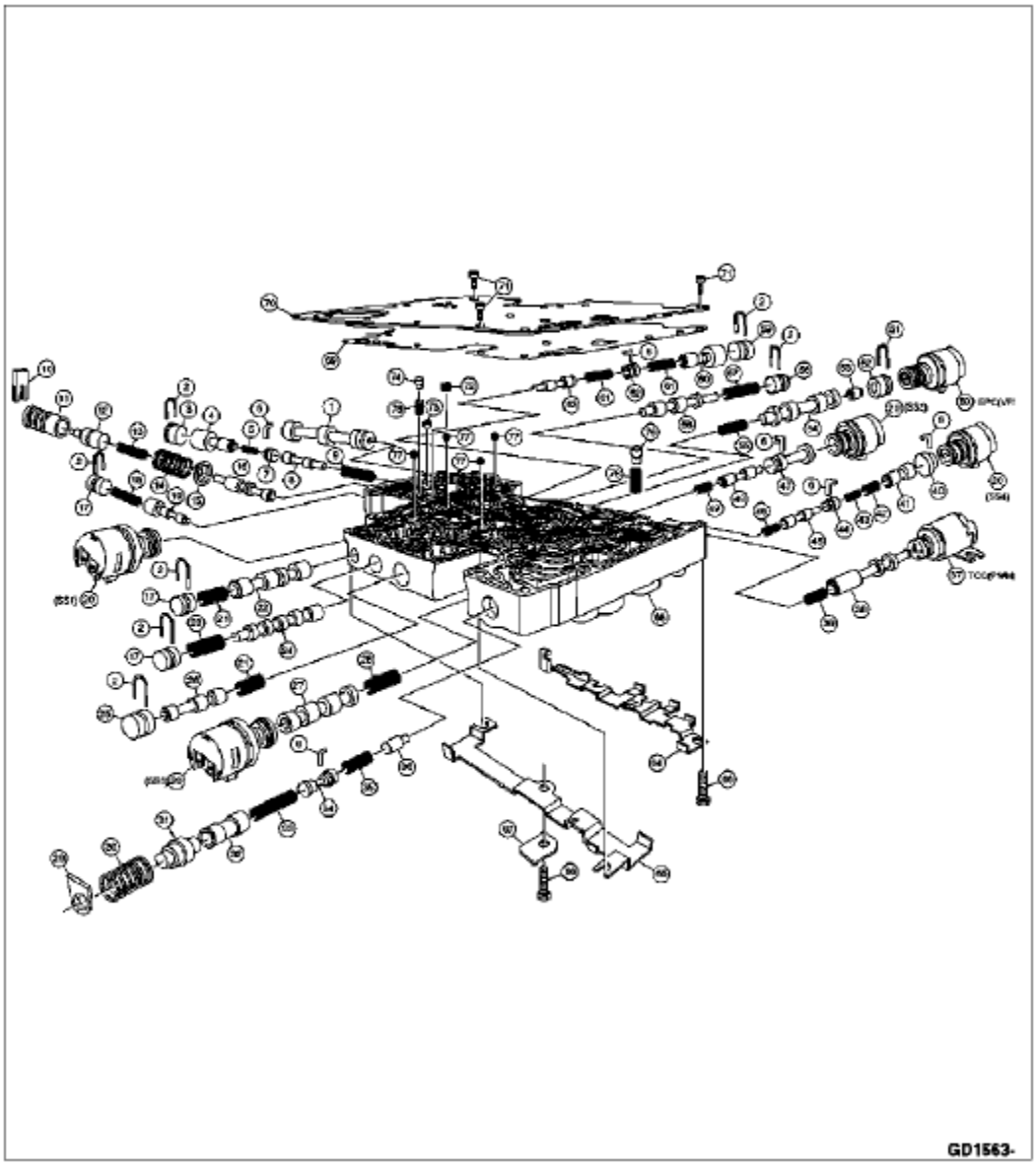
Main Control Valve Body

Main Control Valve Body



Item	Part Number	Description
1	—	Valve — Manual

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2	7E335	Retainer — Valve Plug (7 Req'd)
3	—	Plug — Valve Retainer
4	—	Valve — Forward Modulator
5	—	Spring — Forward Modulator
6	7E355	Retainer — Valve Plug (6 Req'd)
7	—	Plug — Valve Retainer
8	—	Valve — EPC Boost
9	—	Spring — EPC Boost
10	7E336	Retainer — Valve Plug
11	—	Sleeve — Pressure Boost Valve
12	—	Valve — Pressure Boost
13	—	Spring — Pressure Boost
14	—	Spring — Oil Pressure Regulator
15	—	Retainer — Main Regulator Spring
16	—	Valve — Pressure Regulator
17	—	Plug — Valve Retainer (3 Req'd)
18	—	Spring — Forward Engagement
19	—	Valve — Forward Engagement Control
20	7G484	Solenoid — Shift (4 Req'd)
21	—	Spring — 4-3 (K.D./T.D.) (2 Req'd)
22	—	Valve — 4-3 (K.D.)
23	—	Spring — Manual Low (1)
24	—	Valve — Manual Low (1)
25	—	Plug — Valve Retainer
26	—	Valve — 4-3 (T.D.)
27	—	Valve — 1-2 and 4-5 Shift
28	—	Spring — 1-2 and 4-5 Shift
29	7E366	Retainer — Valve Plug
30	—	Spring — Thermostat Bypass
31	—	Valve — Thermostat Bypass
32	—	Valve — Thermostatic Bypass
33	—	Spring — Thermostat Bypass
34	—	Plug — Valve Retainer
35	—	Spring — Cooler Limit
36	—	Valve — Cooler Limit
37	7G136	solenoid — Torque Converter Clutch (TCC)
38	—	Valve — Converter Clutch
39	—	Spring — Converter Clutch
40	—	Plug — Valve Retainer

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	—	Valve — Converter Clutch
42	—	Spring — Converter Clutch
43	—	Spring — Converter Clutch
44	—	Plug — Valve Retainer
45	—	Valve — Coast Clutch
46	—	Spring — Coast Clutch
47	—	Plug — Valve Retainer
48	—	Valve — 4-3 Downshifts
49	—	Spring — 4-3 Downshifts
50	7G383	Solenoid — EPC (VFS)
51	7E335	Retainer — Valve Plug
52	—	Plug — Valve Retainer
53	—	Valve — 2-3 Shift
54	—	Valve — 2-3 Shift
55	—	Spring — 2-3 Shift
56	—	Plug — Valve Retainer
57	—	Spring — 3-4 Shift
58	—	Valve — 3-4 Shift
59	—	Plug — Valve Retainer
60	—	Valve — Reverse Modulation
61	—	Spring — Reverse Modulation (2 Req'd)
62	—	Plug — Valve Retainer
63	—	Valve — Reverse Modulation
64	7L491	Clamp — SS1/SS2
65	7L491	Clamp — SS3/SS4/EPC/TCC
66	E800155	Screw — Retain Solenoid Clamps (2 Req'd)
67	7D132	I.D. Plate
68	—	Body — Valve
69	7D100	Gasket — Separator Plate
70	7A008	Plate — Separator
71	E804357	Screw — Retain Separating Plate (3 Req'd)
72	7N113	Screen — EPC Limit Circuit
73	7D376	Extension Housing Lube Orifice
74	7E368	Valve — EPC Limit (Metal)
75	7E368	Valve — Converter Relief (Plastic)
76	7E340	Spring — EPC Limit/Converter Relief (2 Req'd)
77	7E195	Ball (4 Req'd)

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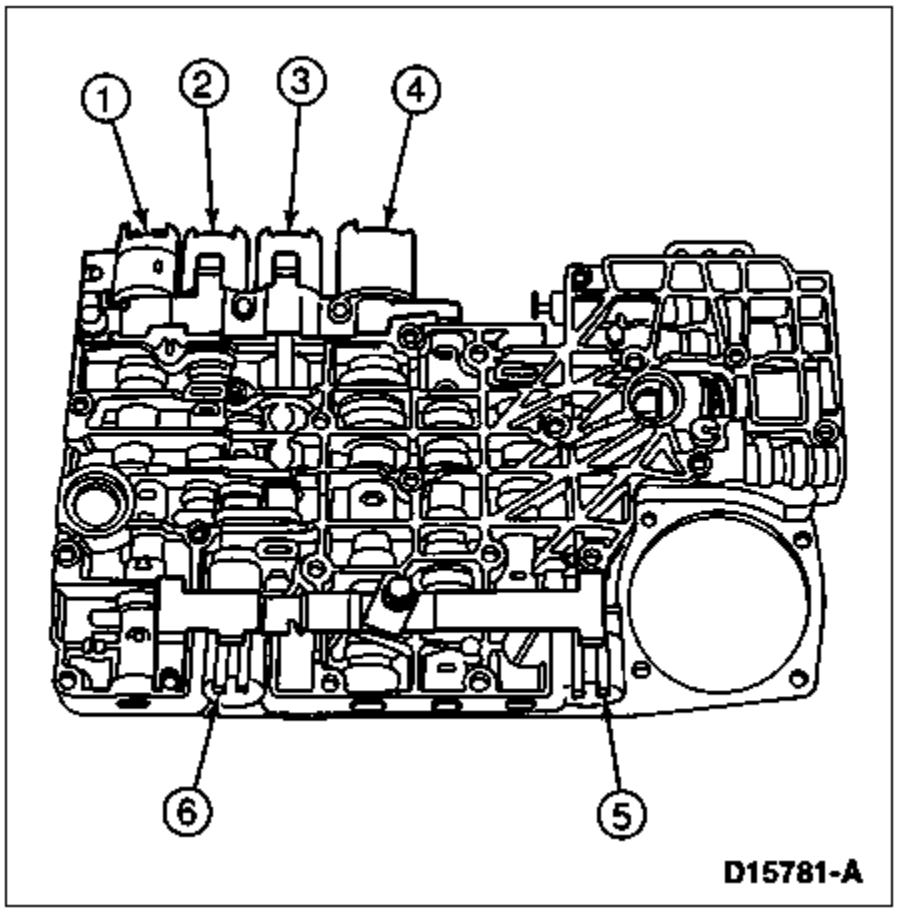
Disassembly



Item	Part Number	Description
1	7F037	Torque Converter Clutch Solenoid Assembly
2	7G484	Shift Solenoid 4 Assembly
3	7G484	Shift Solenoid 2 Assembly
4	7H144	EPC Solenoid Assembly
5	7G484	Shift Solenoid 1 Assembly
6	7G484	Shift Solenoid 3 Assembly

1. **CAUTION: SS3 may pop out of its bore. This may damage the solenoid.**

   Use a 10mm socket to remove the SS1 and SS3 solenoid clamp screws. Remove the solenoid clamp and the solenoids.

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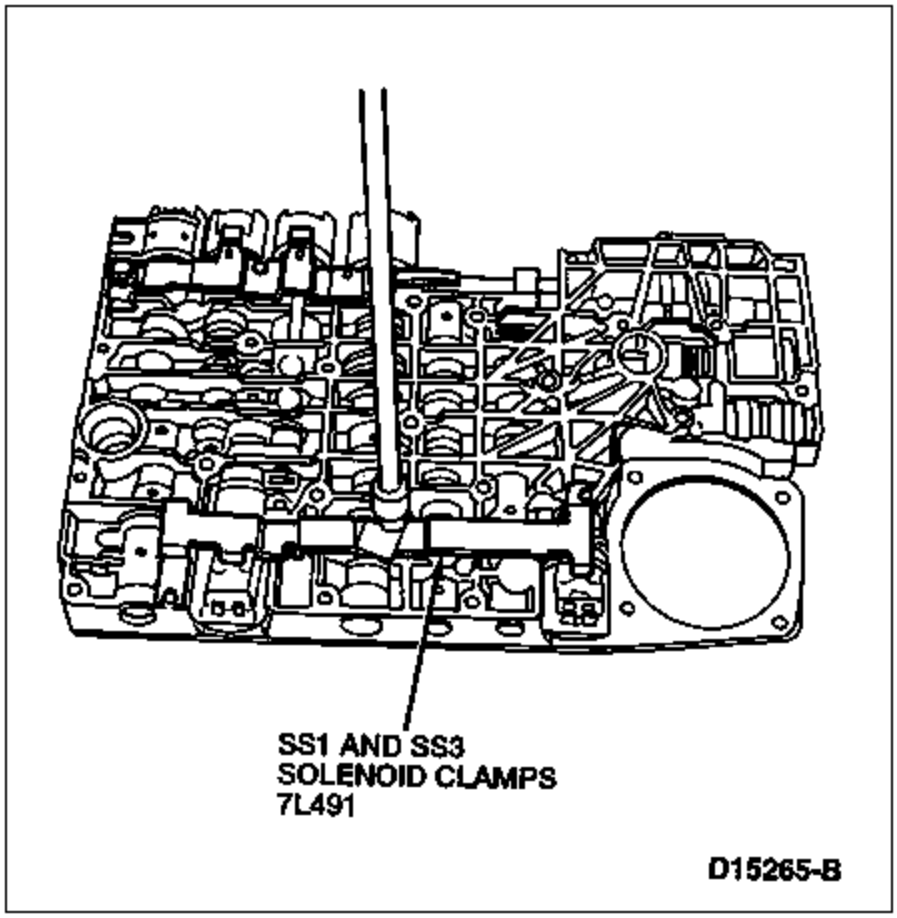

2. **NOTE: The TCC solenoid may pop out of its bore.**

   The converter modulator valve may come out after the TCC solenoid has been removed. This may damage the solenoid or converter modulator valve.

   Remove the TCC, SS4, SS2 and EPC solenoid clamp screw.

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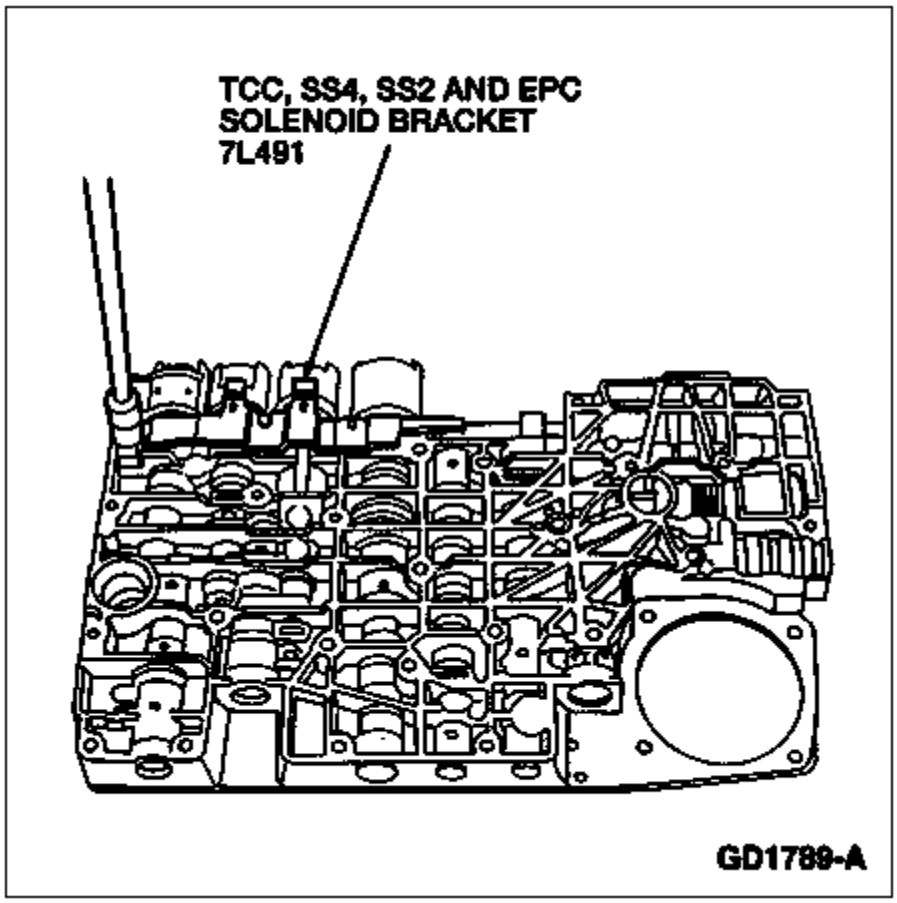

3. Remove the solenoid clamp and the solenoids.

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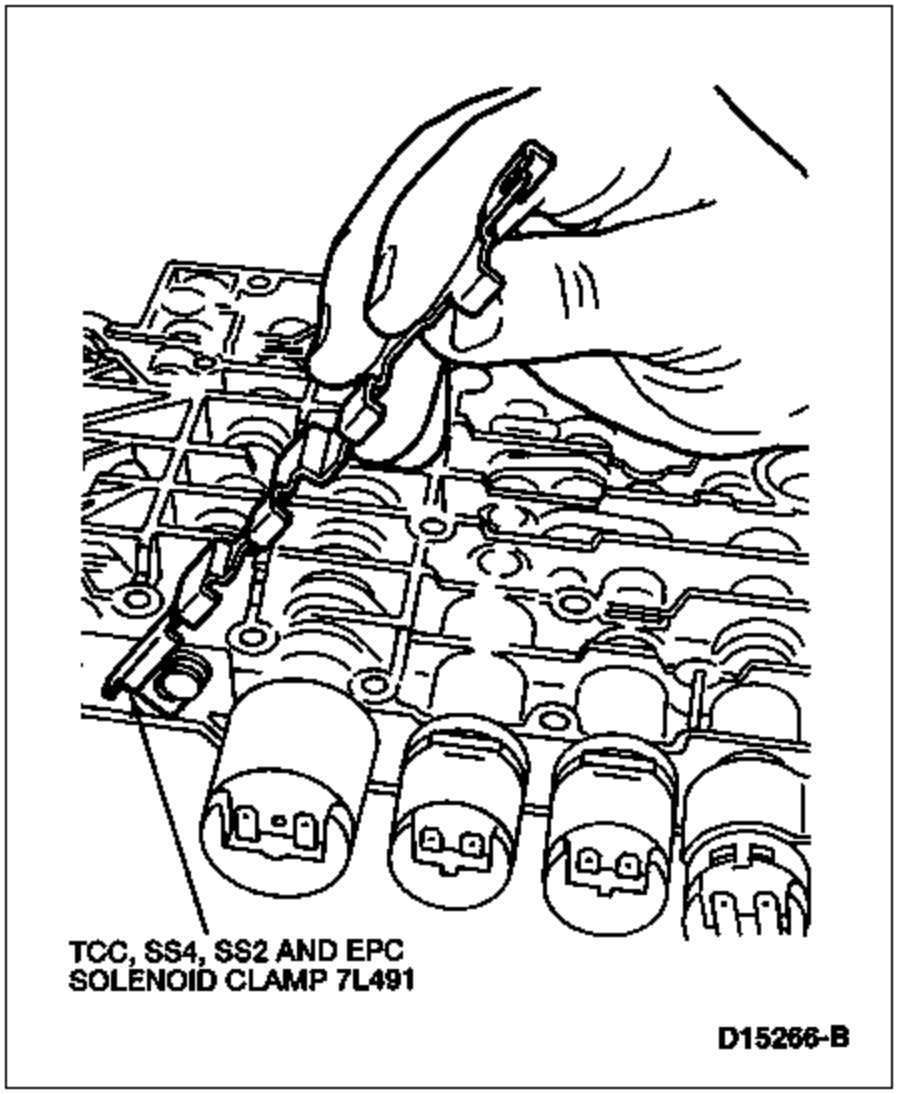

4. **CAUTION: Valves may come out when rotating the main control.**

   Carefully rotate the main control assembly so that the control valve body-to-case gasket is facing up. Remove and discard the control valve body-to-case gasket.

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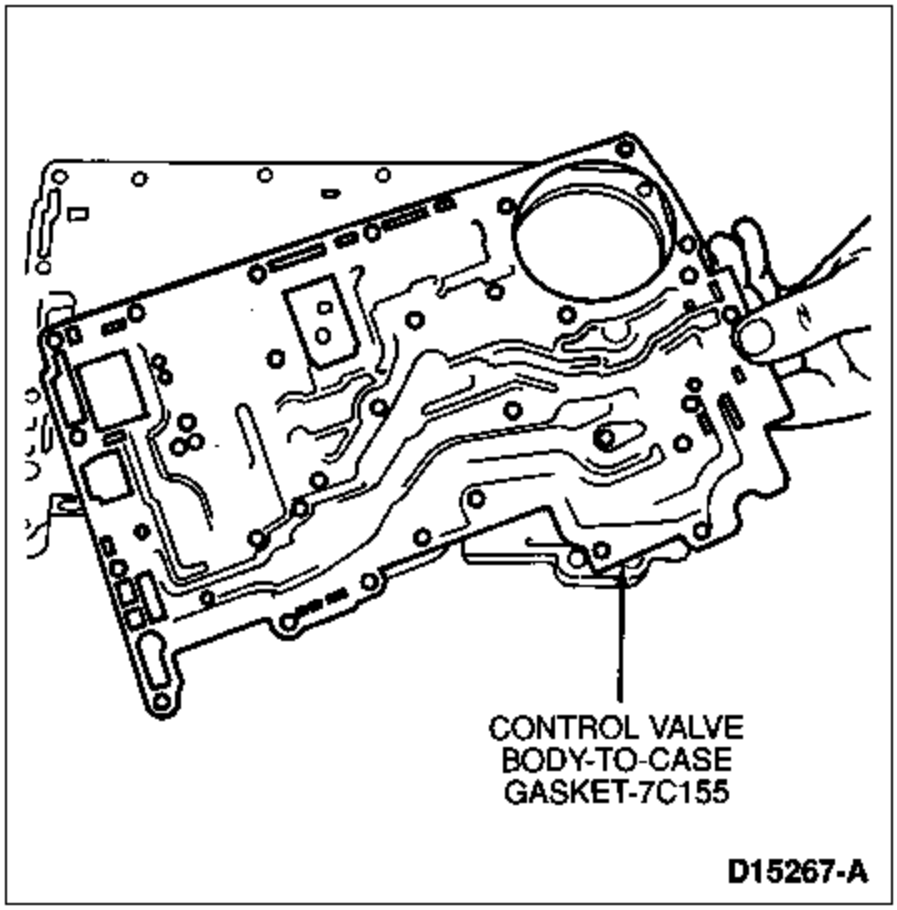
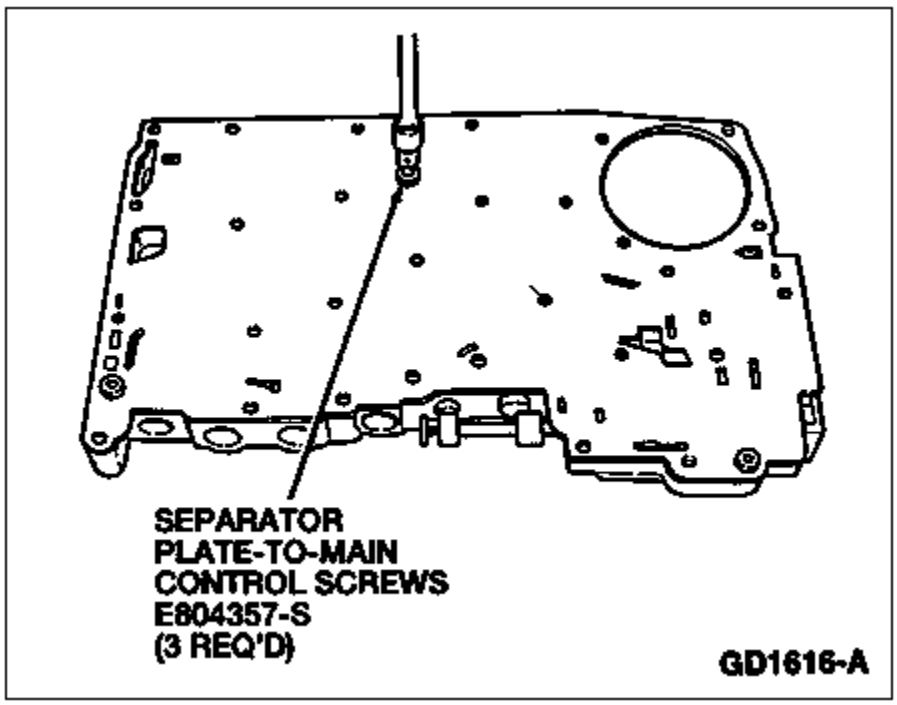


5. Use a T30 Torx® bit to remove the three separator plate-to-main control screws.



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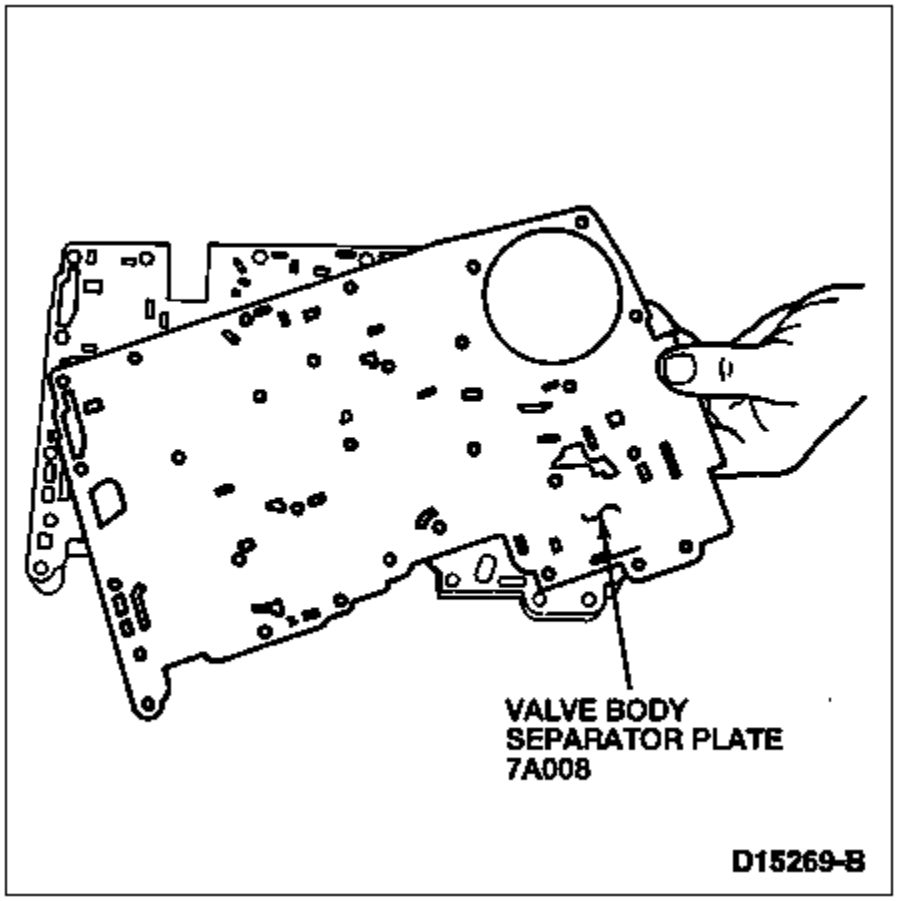
6. **CAUTION: The extension housing lube orifice and relief valves may stick to the separator plate.**

   Remove the valve body separator plate.



7. Remove and discard the control valve body separator gasket.

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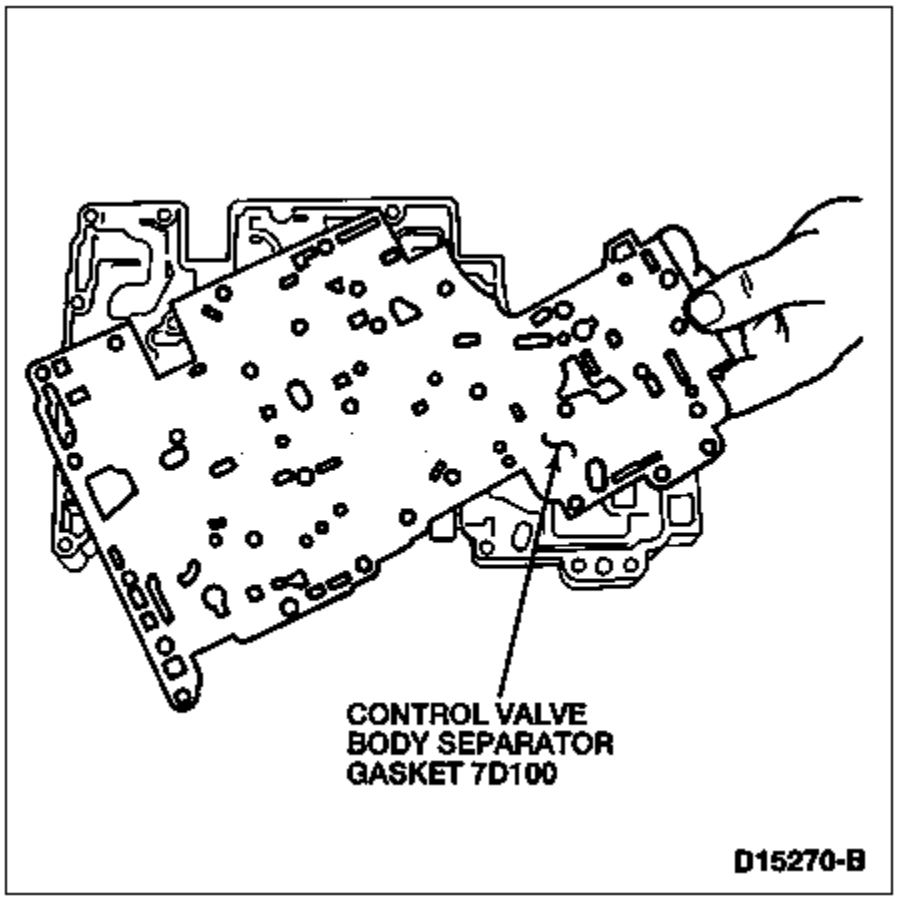

8. Carefully remove the extension housing lube orifice.

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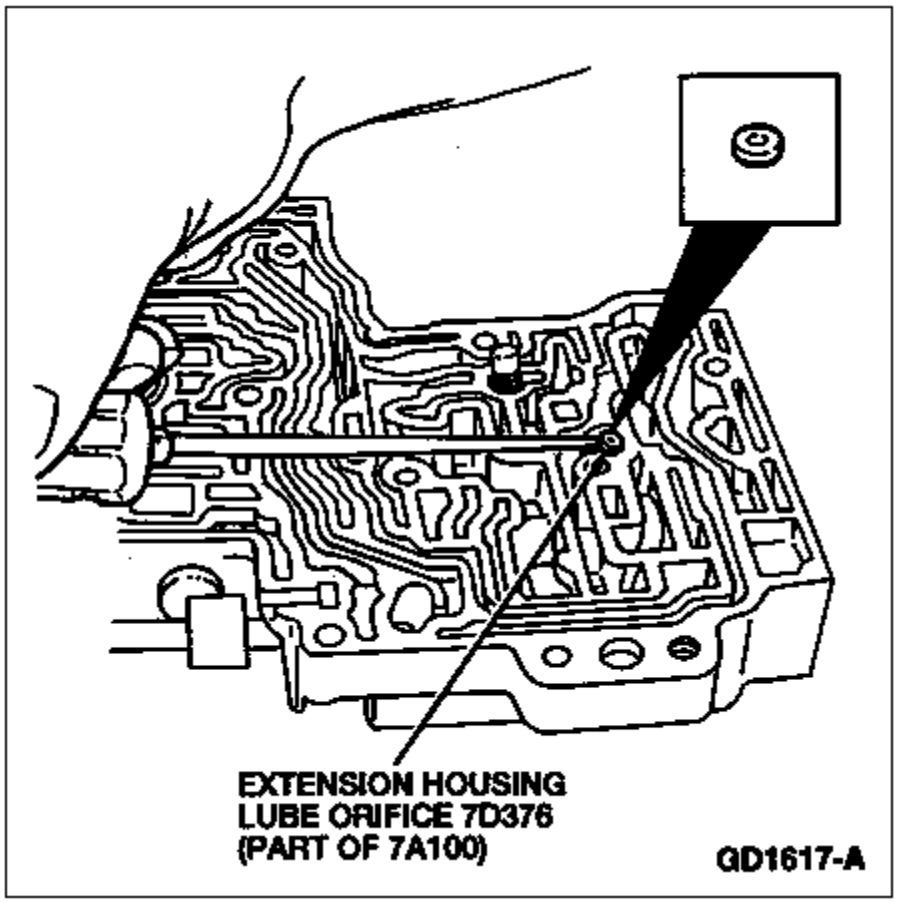
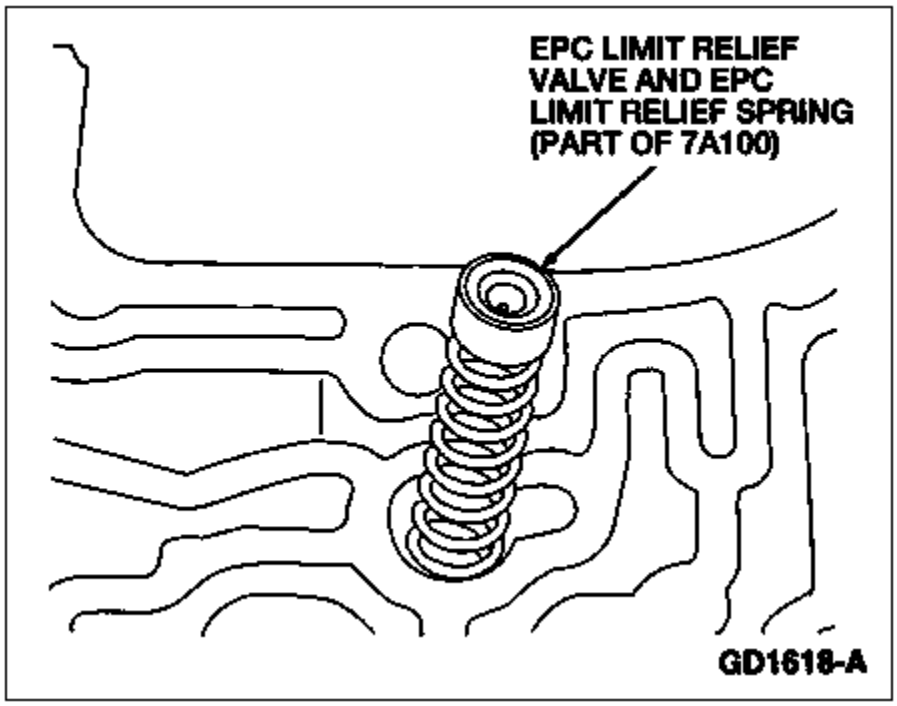


9. Remove the electronic pressure control (EPC) limit relief valve (metal-silver color) and spring.



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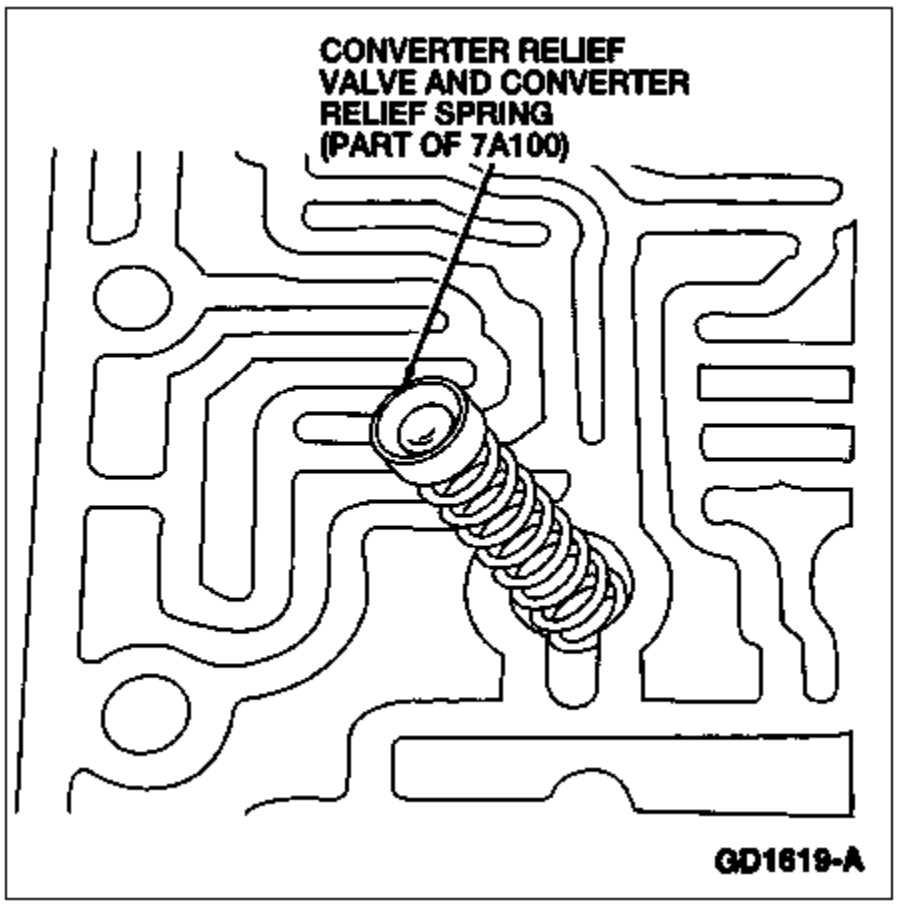
10. Remove the converter relief valve (plastic-dark color) and spring.



11. Remove the EPC limit circuit screen.

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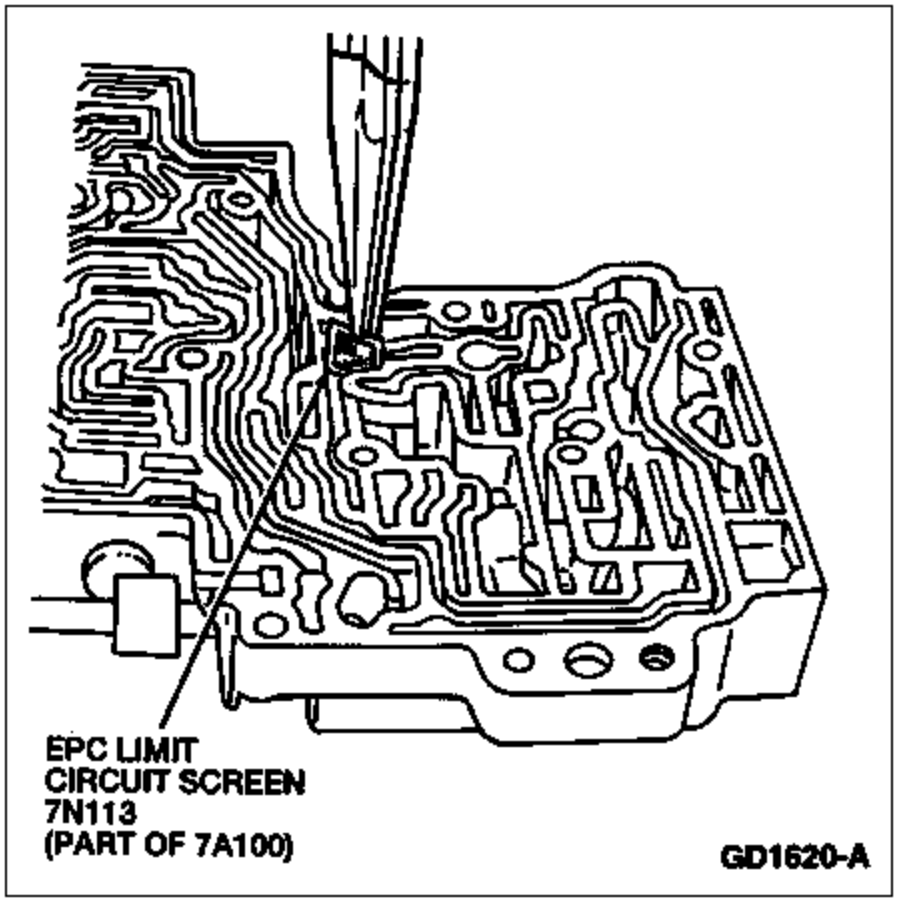
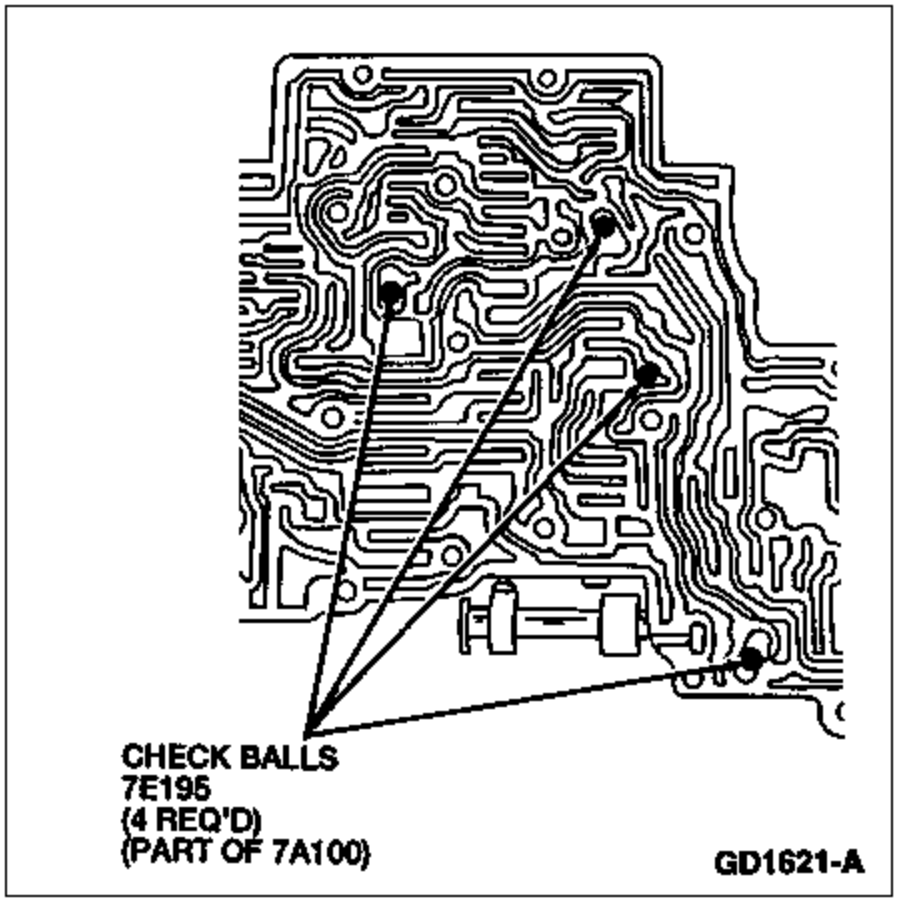


12. Remove the four check balls.

tomsn048@gmail.com



13. **CAUTION: Do not lose parts when cleaning or servicing.**

    Thoroughly clean all parts in solvent and blow dry with moisture-free compressed air.

14. Inspect all valve and plug bores for scores. Check all fluid passages for obstructions. Inspect the check valve for free movement. Inspect all mating surfaces for burrs or distortion. Inspect all plugs and valves for burrs or scores. Replace the control valve body if the bores are scored or if the valves are scored beyond the point of being able to be cleaned.

15. Inspect all springs for distortion. Check all valves and plugs for free movement in their respective bores. Valves and plugs, when dry, must fall from their own weight in their respective bores.

16. Roll the manual valve on a flat surface to check for a bent condition.

17. Clean and inspect the EPC limit circuit screen.

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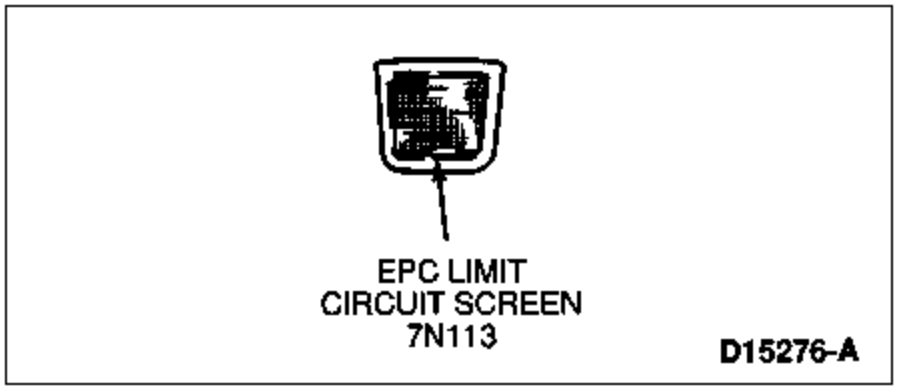
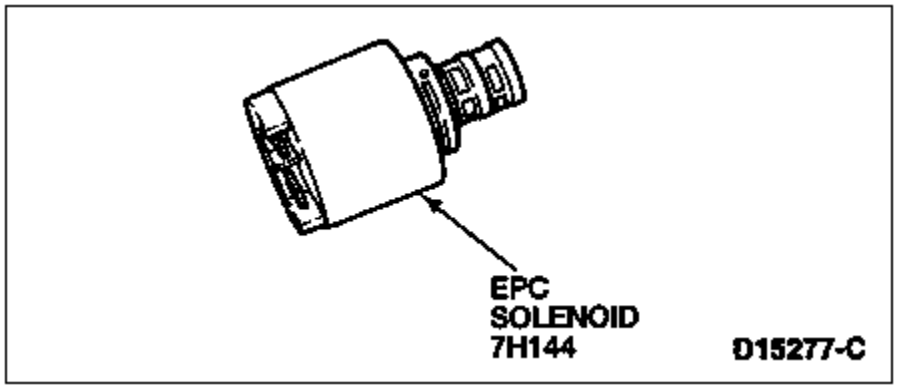
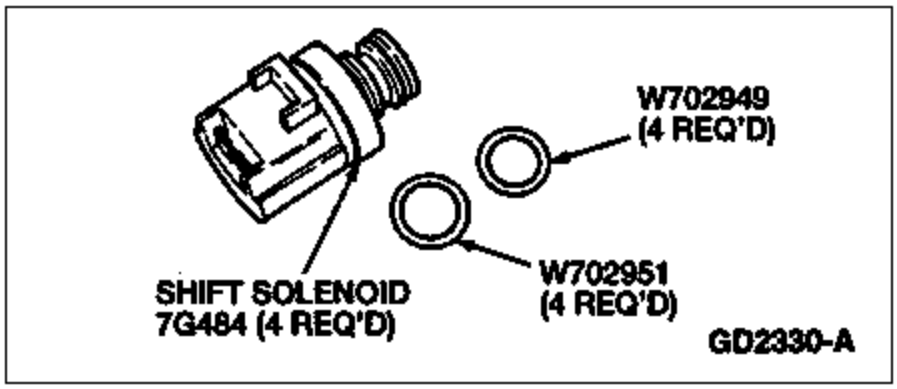


18. Clean and inspect the EPC solenoid screens.



19. Remove and replace all shift solenoid O-rings.



20. Clean and inspect the torque converter clutch (TCC) solenoid.

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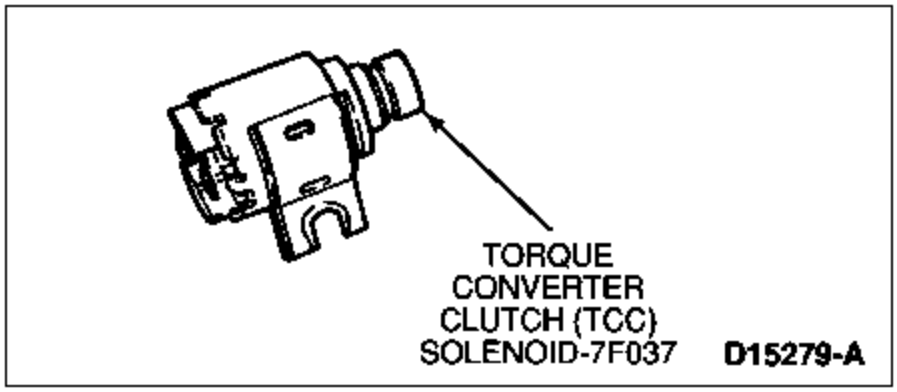
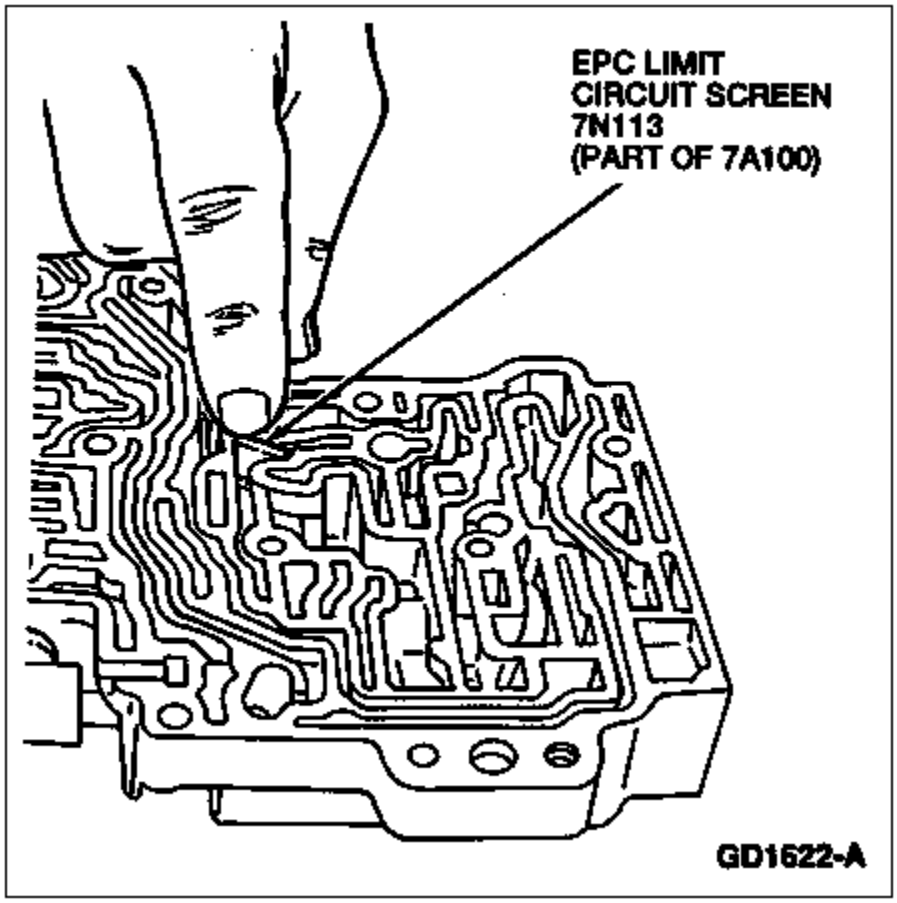


Assembly

1. **CAUTION: Make sure that the screen is properly located.**

   Install the EPC limit circuit screen. Push down on the EPC limit circuit screen to make sure it is fully seated.



2. Install the four check balls in proper locations as shown.

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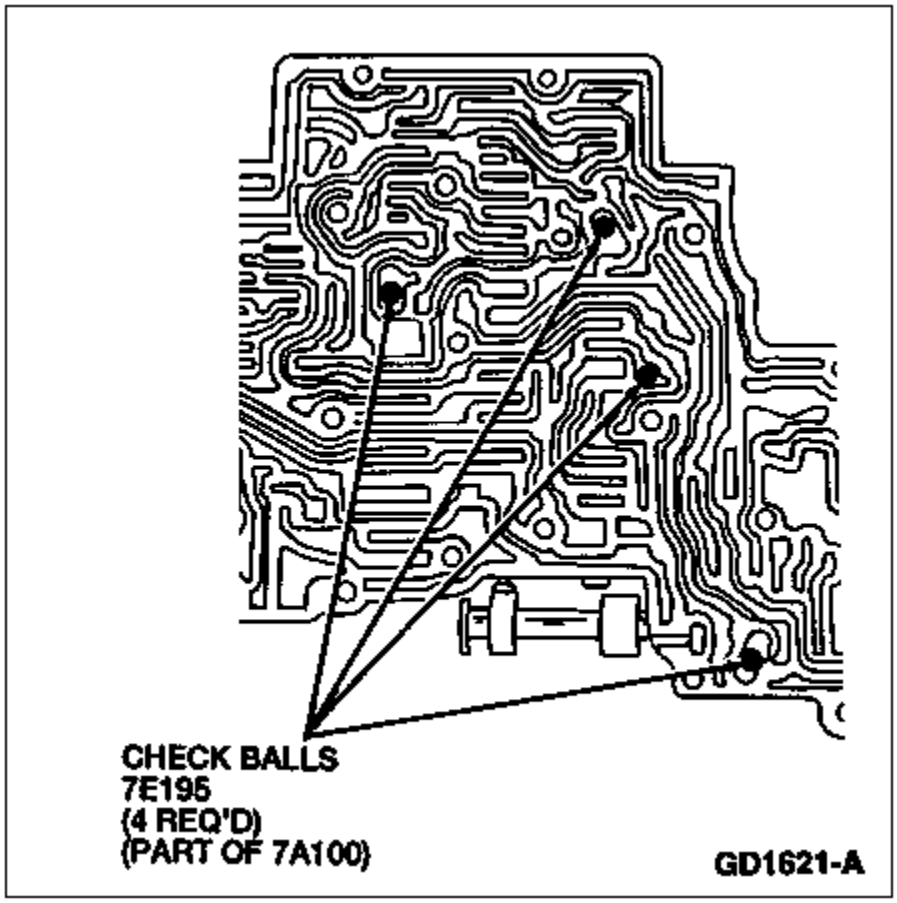
Check Ball Installation



3. **CAUTION: The springs and valves are not interchangeable.**

   Install the converter relief valve (plastic-dark color) and spring.

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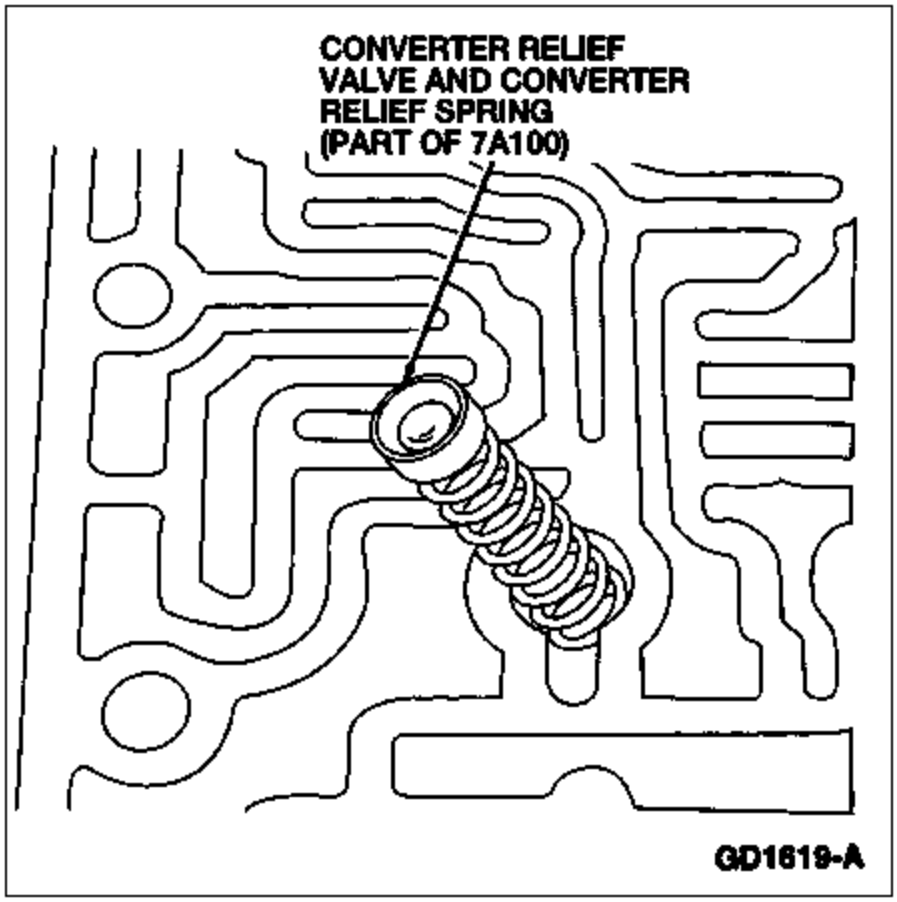

4. **CAUTION: The springs and valves are not interchangeable.**

   Install the EPC limit relief valve (metal-silver color) and spring.

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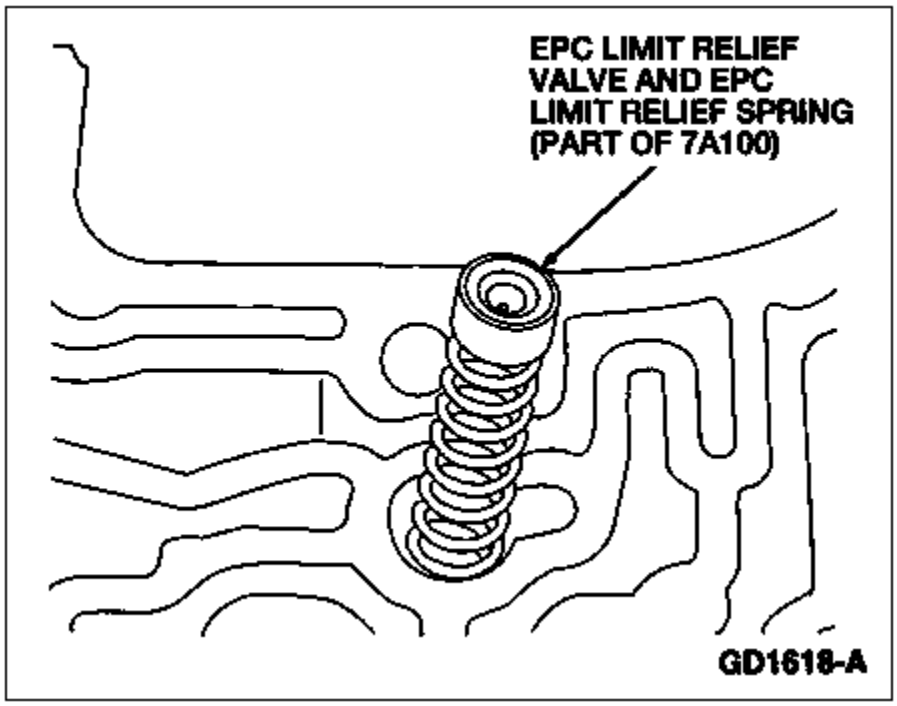
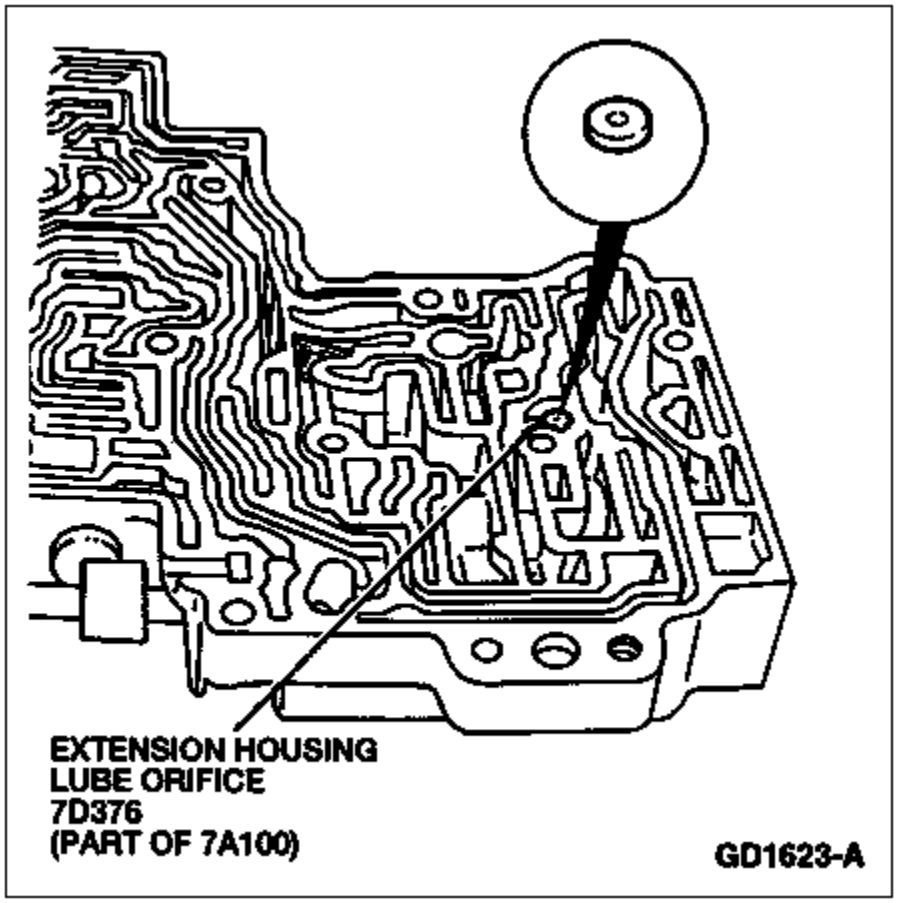


5. Install the extension housing lube orifice.



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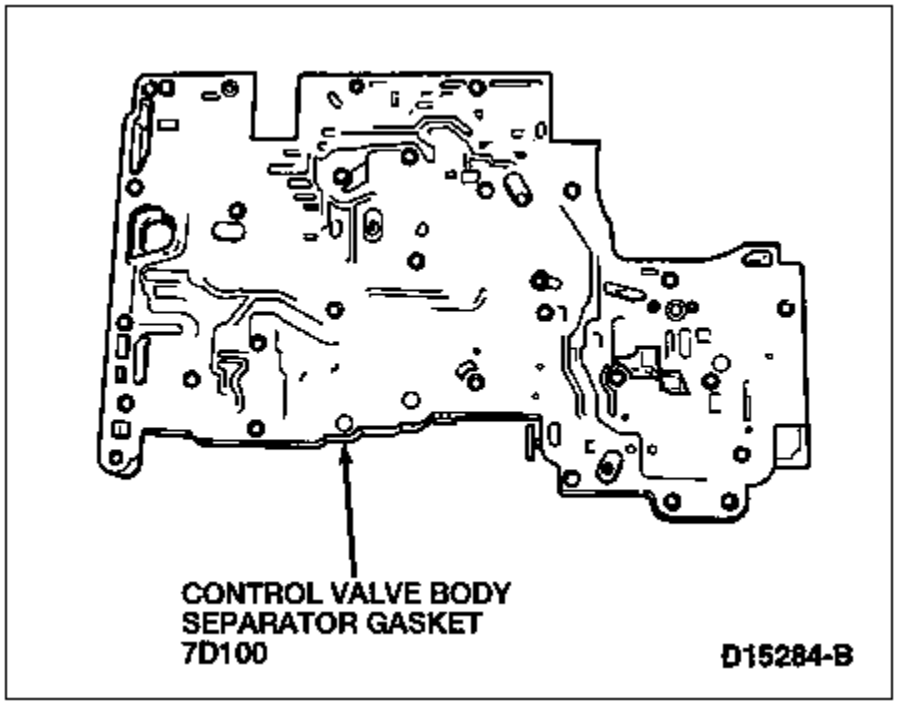
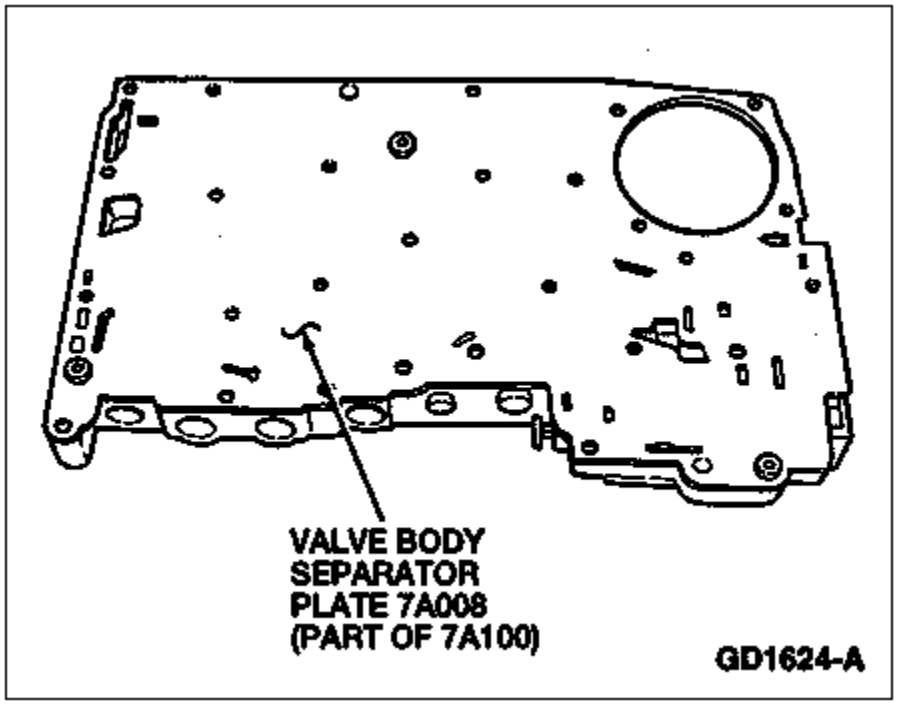
6. Install and align the control valve body separator gasket.



7. Install the valve body separator plate. Install the three (3) separating plate-to-main control screws fingertight.



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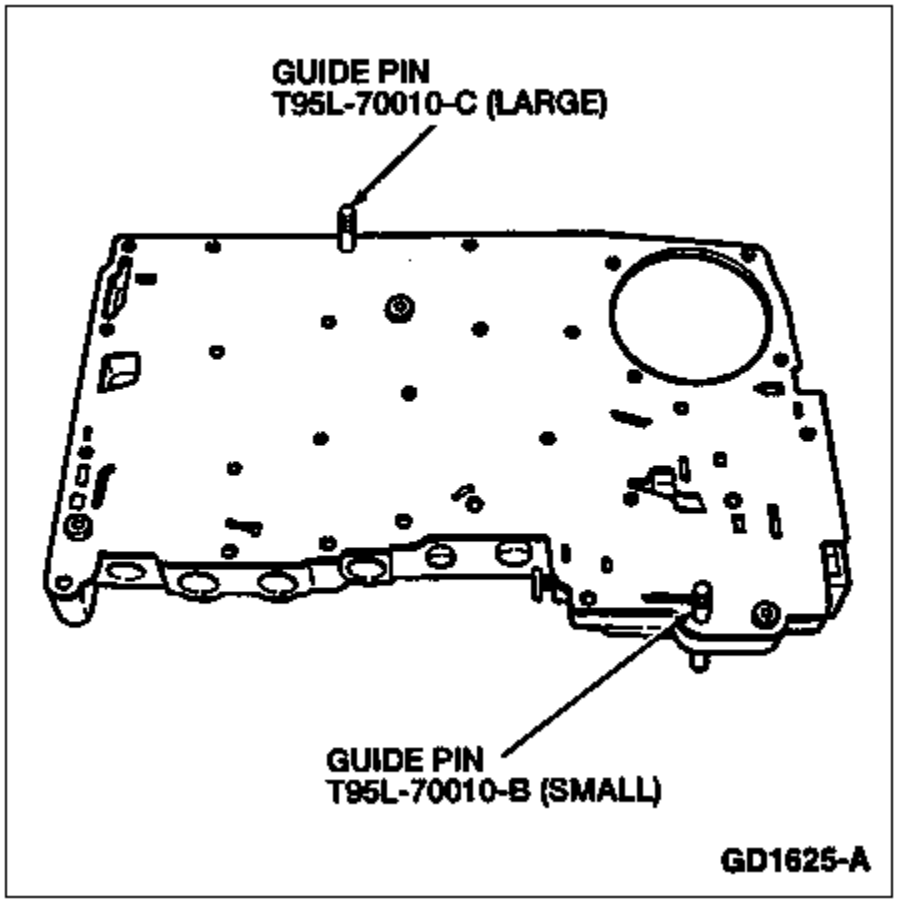
8. Install the alignment pins in the locations shown.



9. Tighten the separator plate-to-main control screws to 6-8 Nm (53-71 lb-in).

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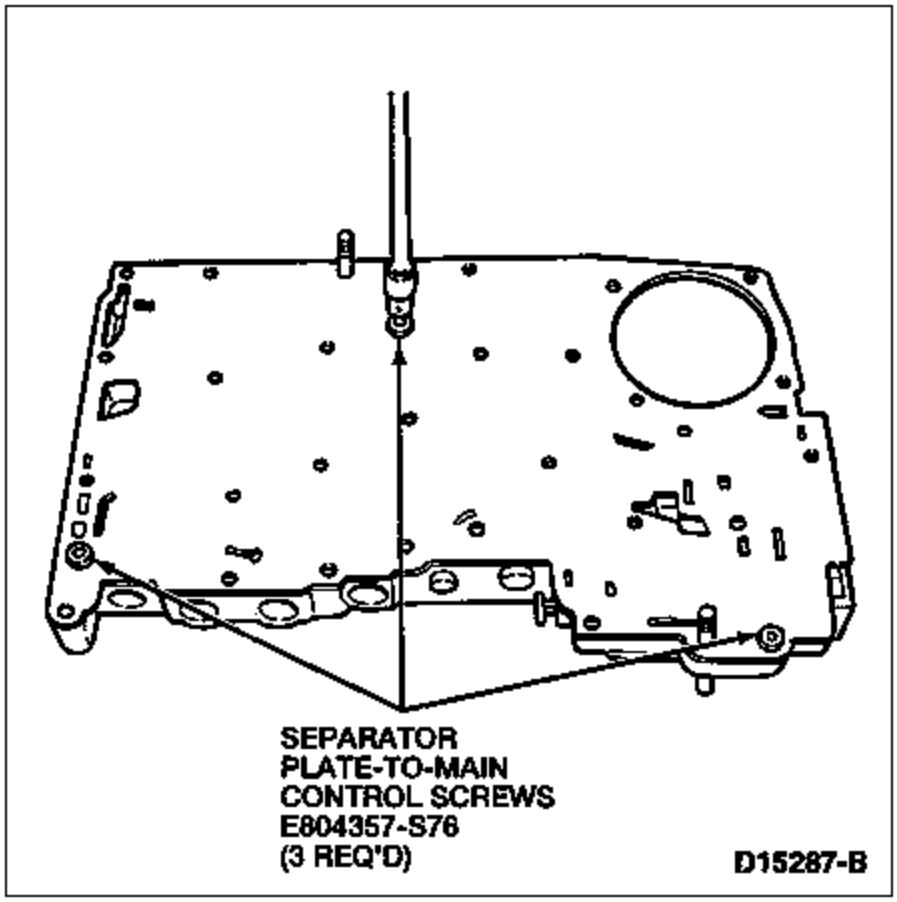

10. **NOTE: Apply petroleum jelly on the separator surface to hold the gasket in place.**

    Install the control valve body-to-case gasket.

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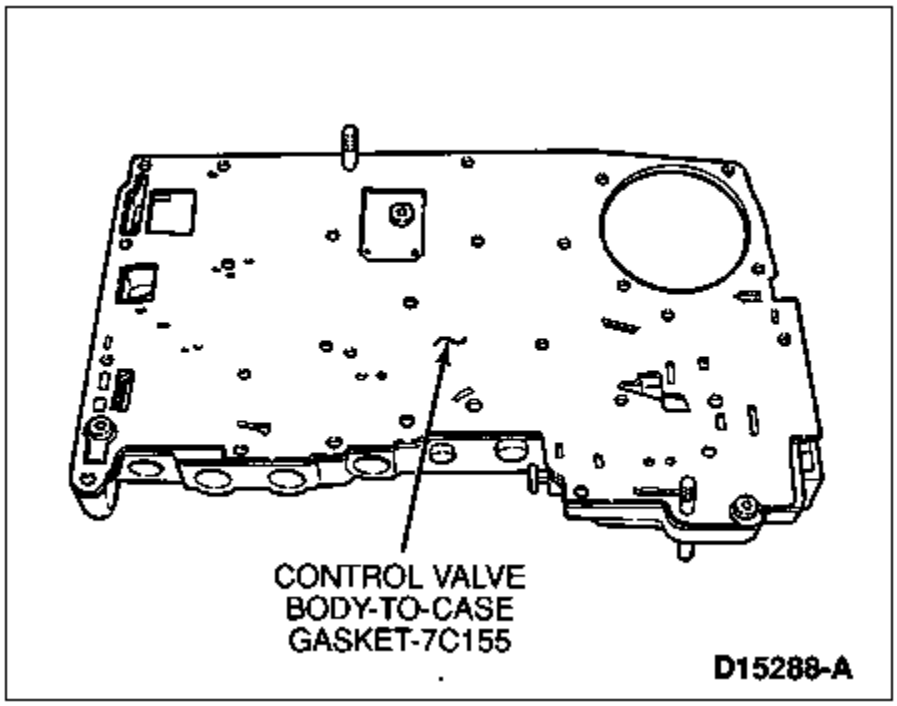

11. Remove the alignment pins.
12. Rotate the main control so that the separator plate is facing down.
13. **CAUTION: The shift solenoid terminals must face upward.**

    NOTE: All the shift solenoids are interchangeable.

    NOTE: If the TCC valve came out, use caution when installing the TCC solenoid.

    Install the solenoids.

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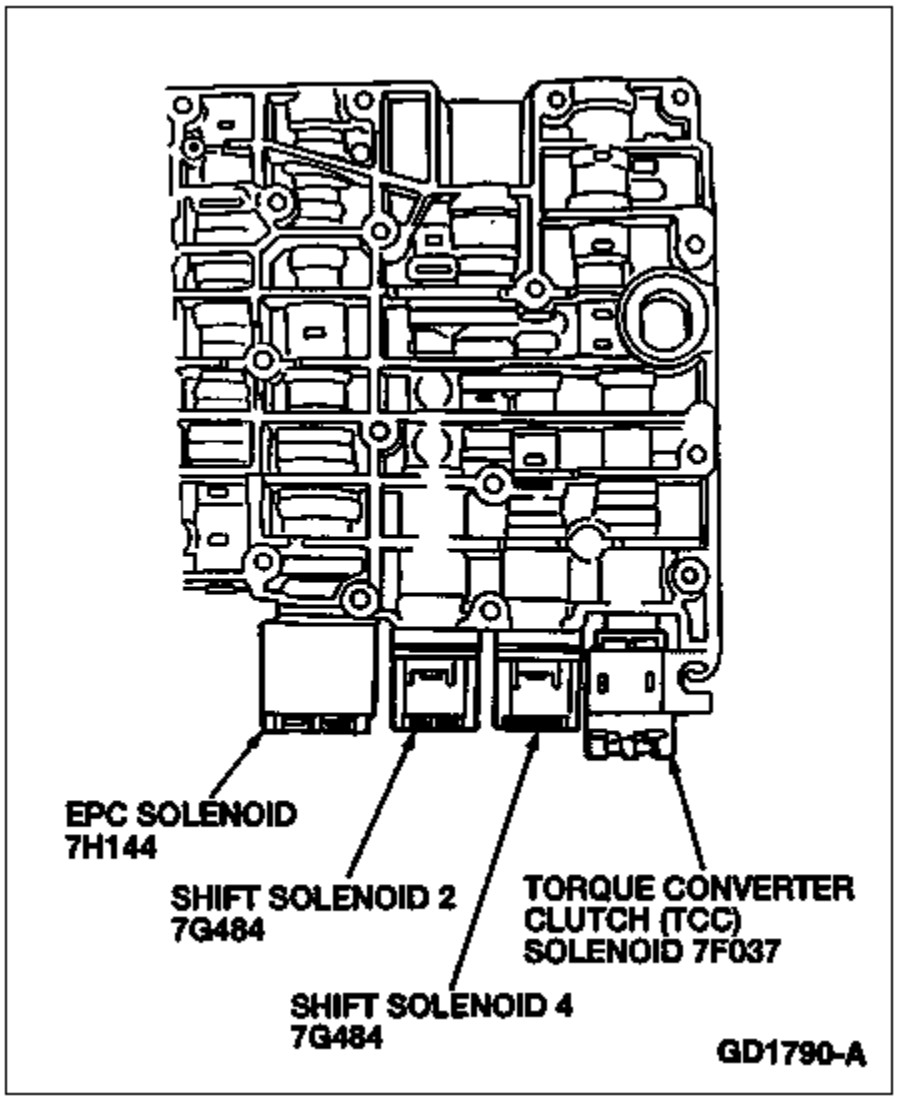

14. **CAUTION: The solenoid clamp must be installed in the TCC and EPC solenoid grooves, shift solenoid pockets and the No. 204 plug.**

    Install the solenoid clamp. Tighten the solenoid clamp screw to 6-8 Nm (53-71 lb-in).

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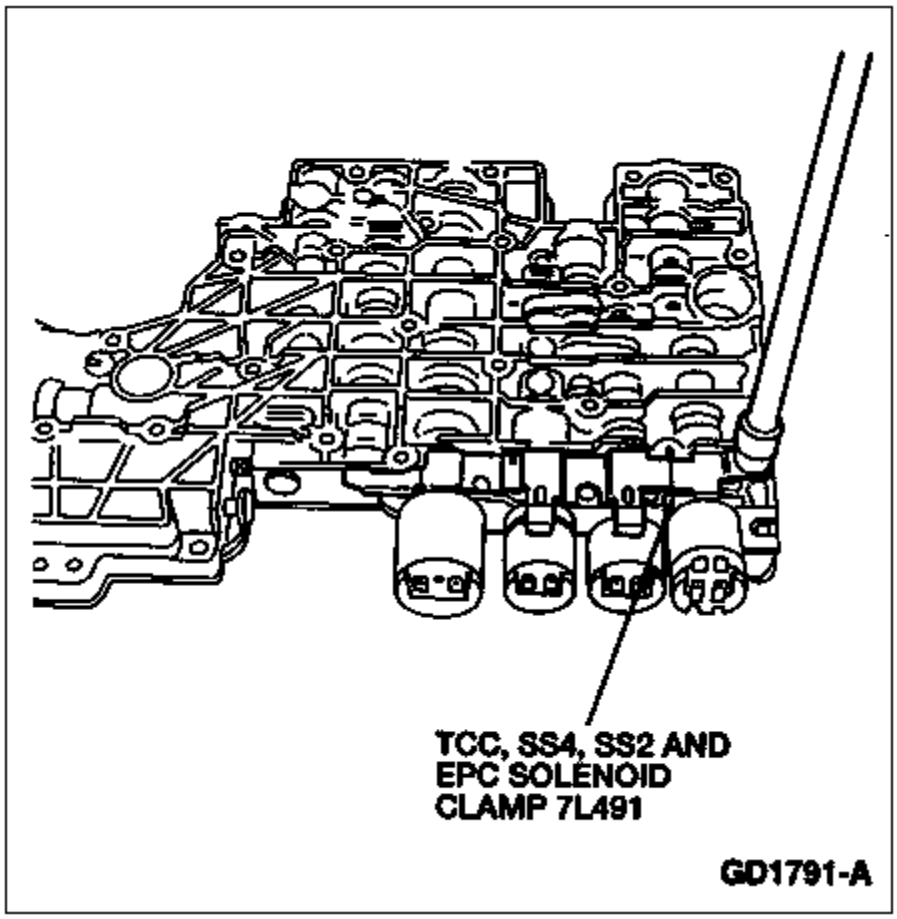
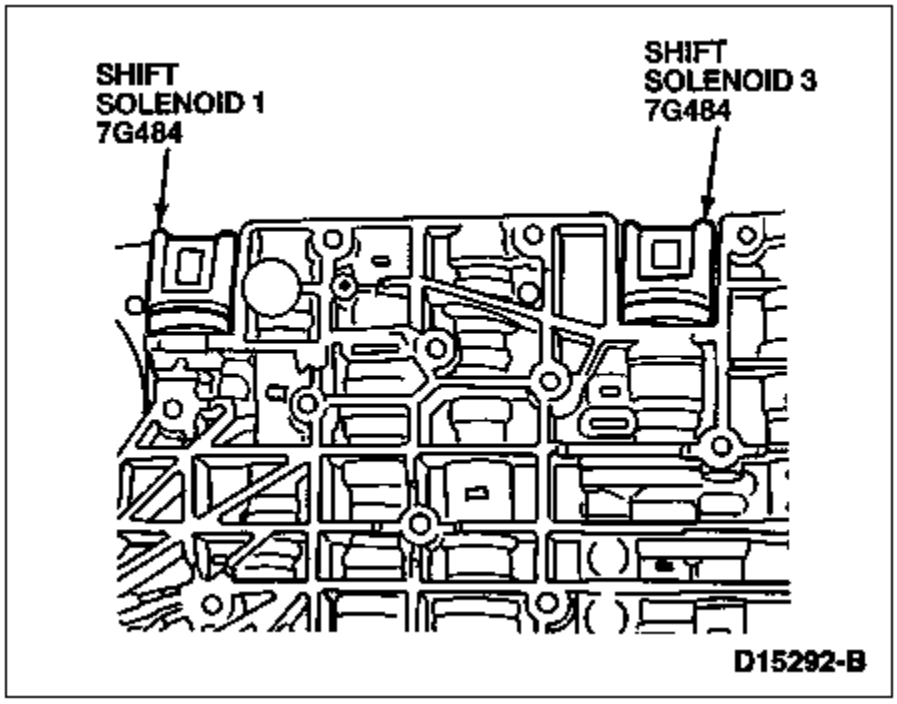


15. Install shift solenoids 1 and 3.



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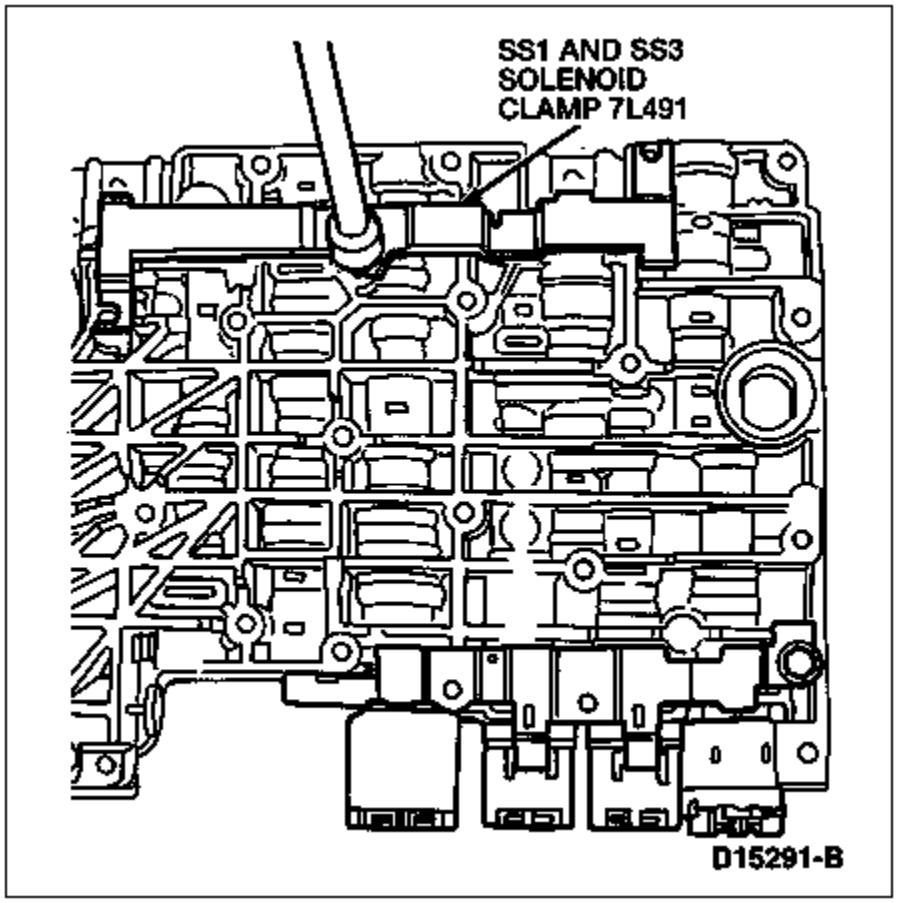
16. Install the solenoid clamp. Tighten the clamp screw to 6-8 Nm (53-71 lb-in).



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Converter Housing and Fluid Pump

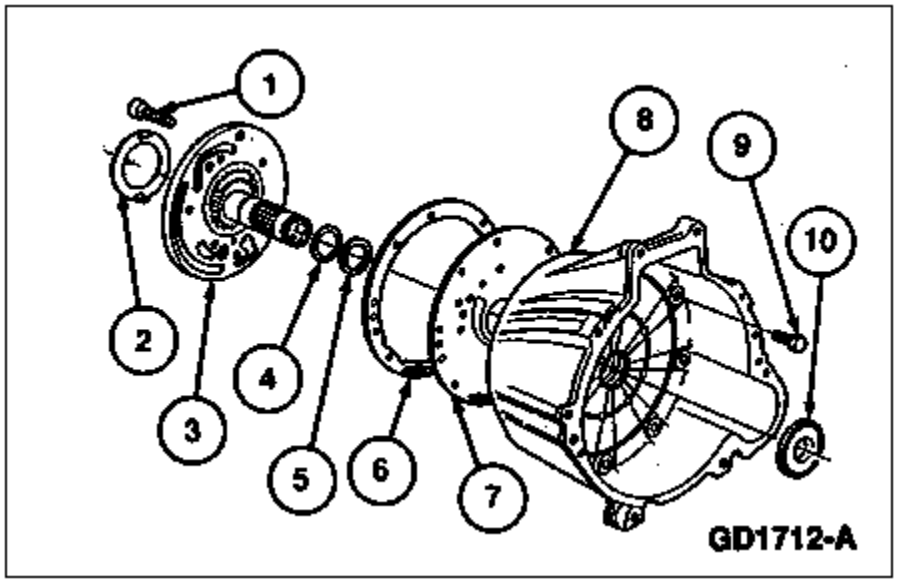
SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Converter Housing Seal Replacer	T97T-77000-A

SPECIAL SERVICE TOOLS DESIRED

Tool Number	Description
TOOL-1175-AC	Seal Remover

Converter Housing and Fluid Pump



Item	Part Number	Description
1	W701429-S309M	Fluid Pump-to-Converter Housing Screws (6 Req'd)
2	7D014	No. 1 Fluid Pump Input Thrust Washer
3	7A103	Fluid Pump Support and Gear Assembly

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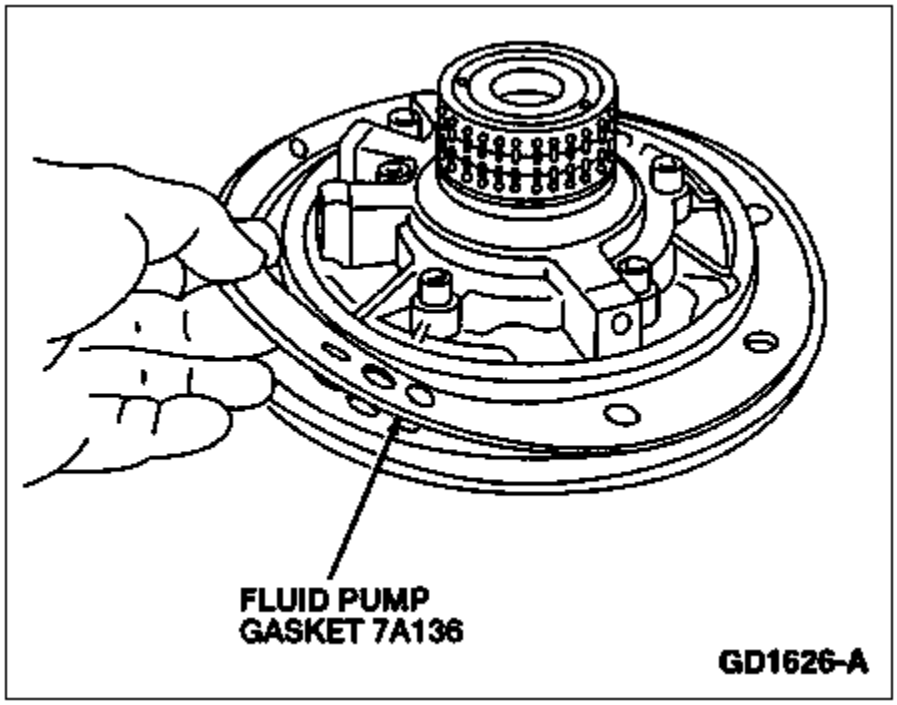
4	W701431-S300	Fluid Pump Shaft-to-Inner Gear O-Ring
5	7L323	Fluid Pump Support Seal Ring
6	7A136	Fluid Pump Gasket
7	7B472	Fluid Pump Adapter Plate
8	7976	Converter Housing Assembly
9	E804595-S200	Converter Housing-to-Case Screw and Seal Assembly (8 Req'd)
10	7A248	Converter Hub-to-Converter Housing Seal Assembly

Disassembly

1. Remove and discard the fluid pump gasket.



2. Remove and discard the fluid pump square cut seal ring.

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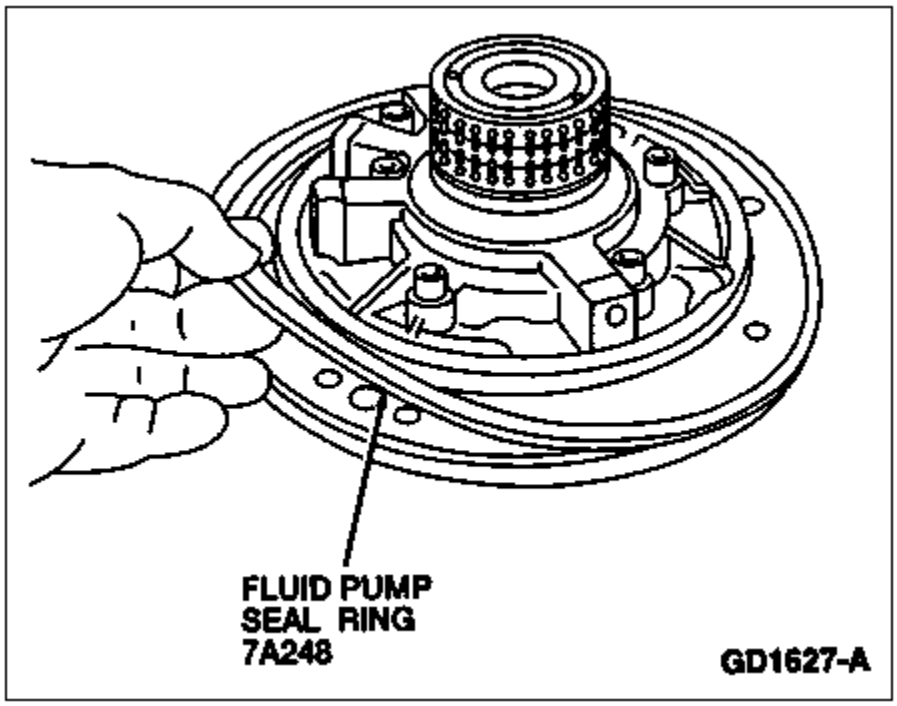
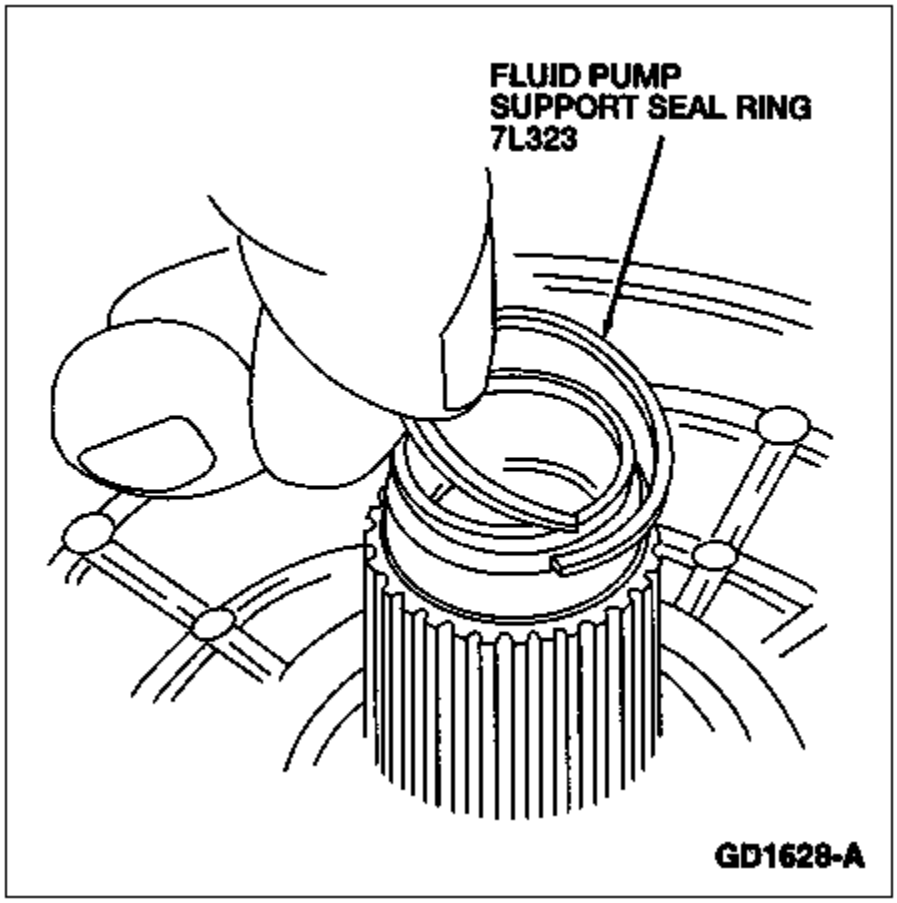


3. Remove the fluid pump support seal ring.



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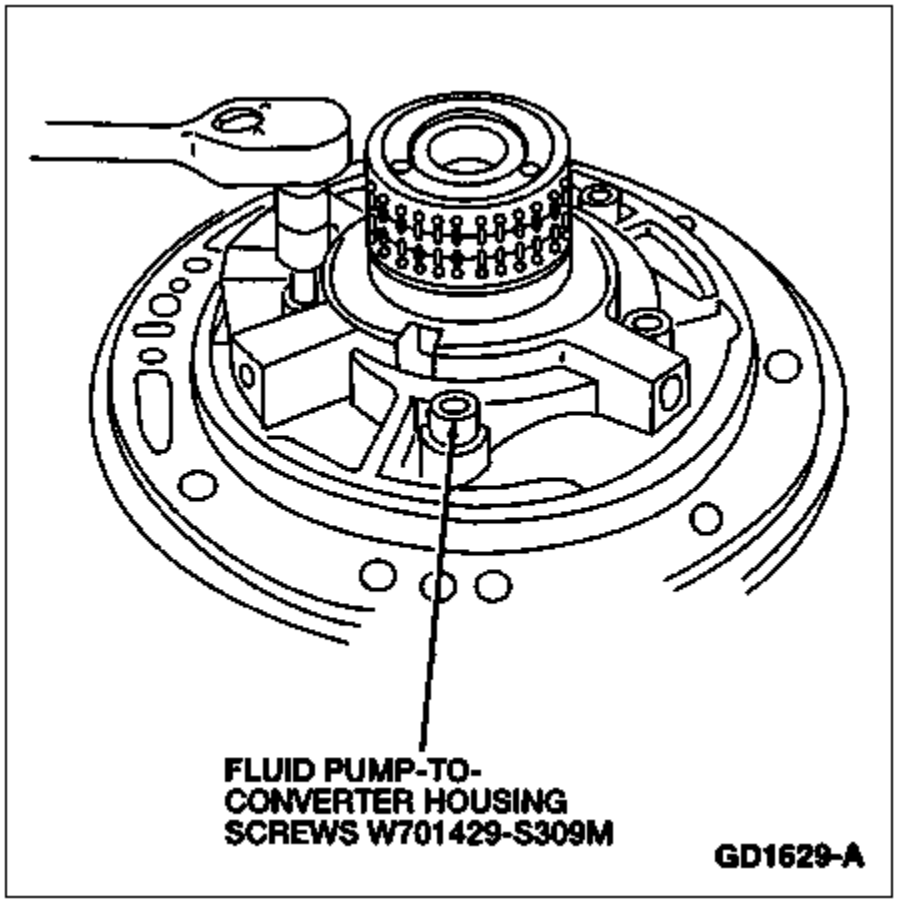
4. Use a Torx® 40 wrench to remove the six M8 x 35mm front pump-to-converter housing screws. Remove the fluid pump support and gear and the fluid pump adapter plate.



5. **NOTE: The pump gears are part of the pump assembly and are not serviced separately.**

   NOTE: A rough casting on the pump surface crescent is not a flaw.

   Remove the pump gears.

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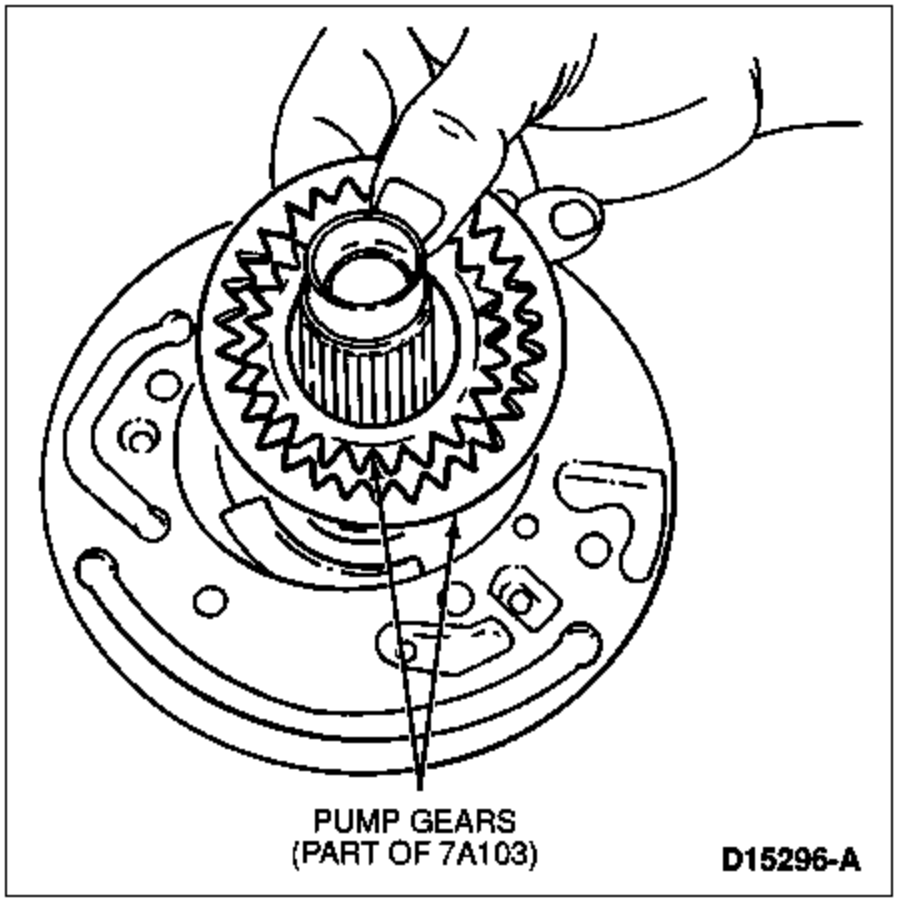
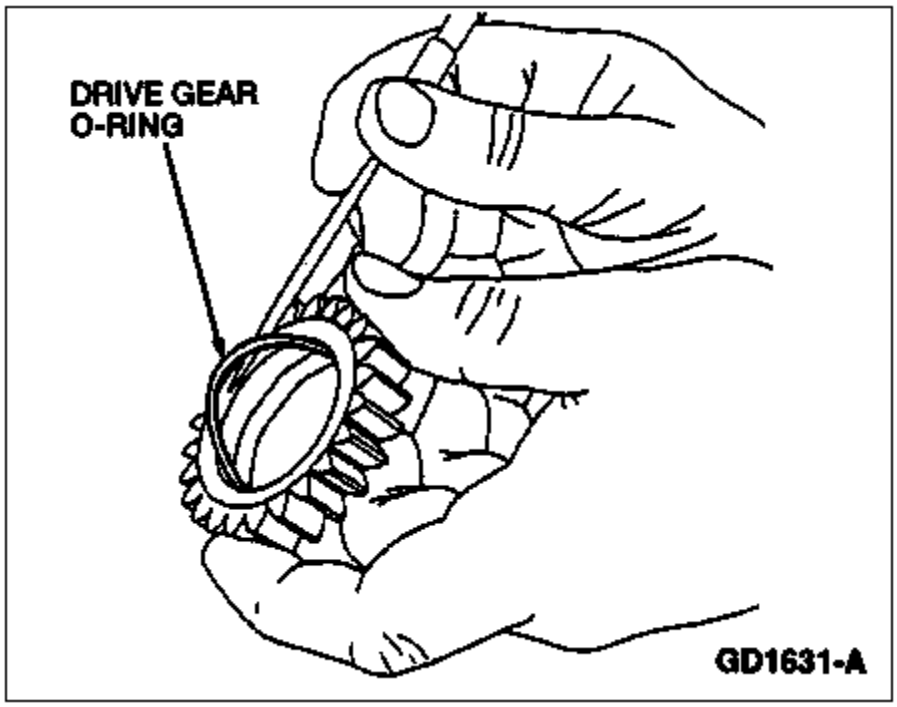


6. Remove the drive gear O-ring and discard.



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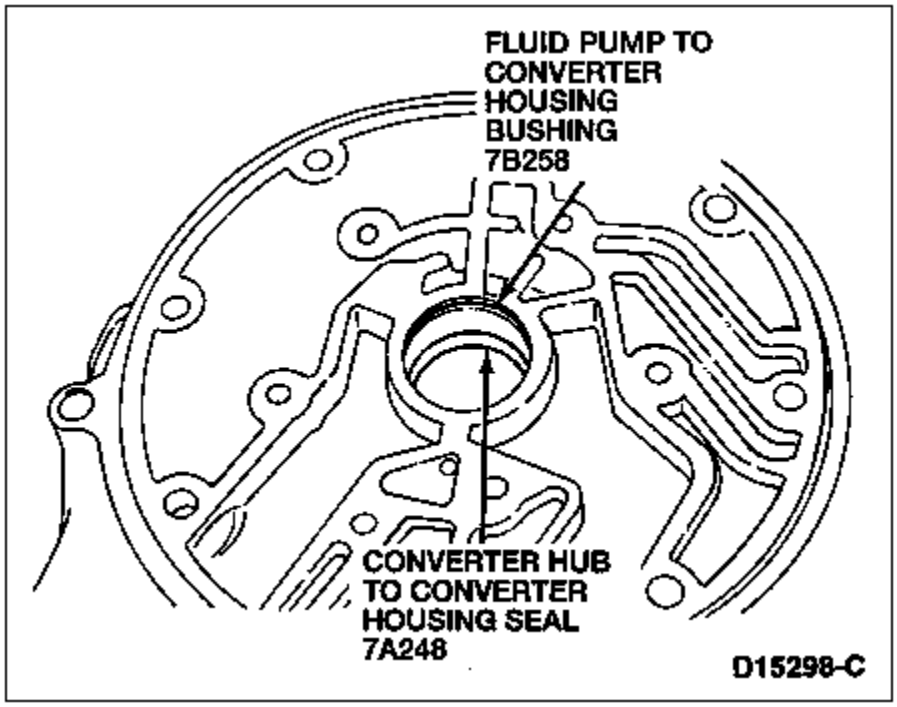
7. Inspect the pump gears for scoring and cracks. Replace pump assembly if damaged.

8. **NOTE: Fluid pump-to-converter housing bushing is not serviced separately. If service is required, the converter housing assembly must be replaced.**

   Inspect the fluid pump to converter housing bushing and converter hub to converter housing seal. Replace converter housing assembly if necessary.



9. Remove and discard the converter hub-to-converter housing seal using Seal Remover TOOL-1175-AC or equivalent from the converter housing as shown.

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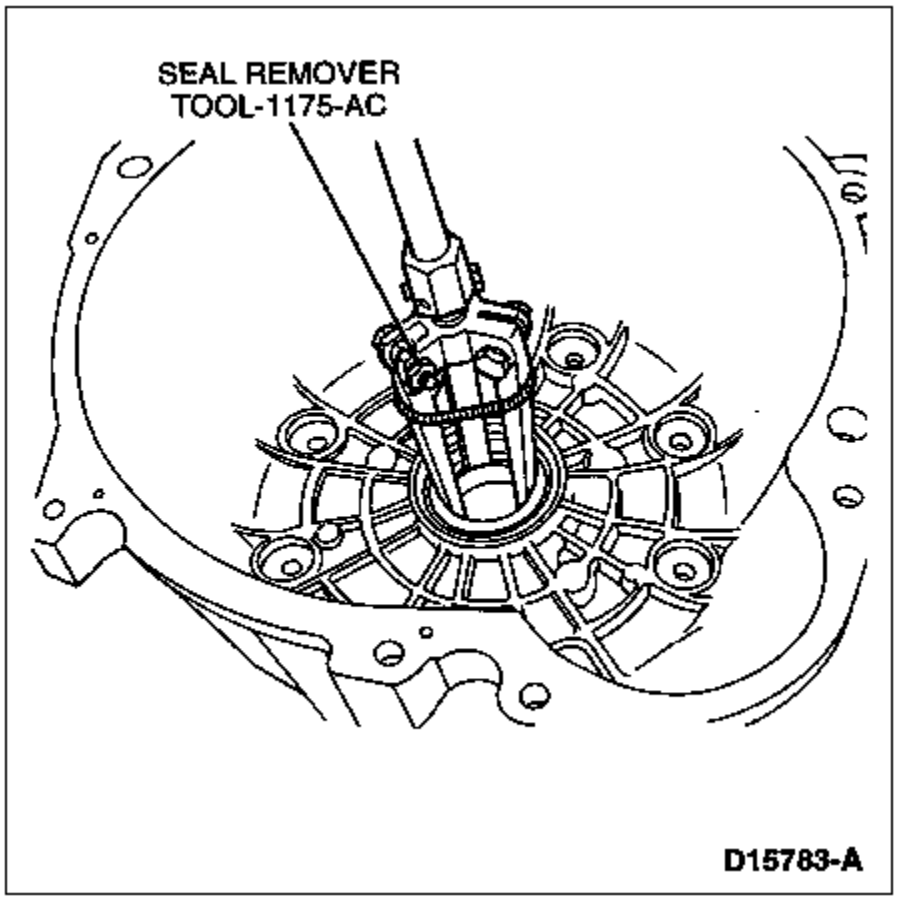

10. Clean and inspect the front and rear input shaft support bushings. If bushings are worn, scored or damaged, replace the fluid pump support and gear assembly. Inspect the pump gear pockets for scoring and wear. Replace if necessary.

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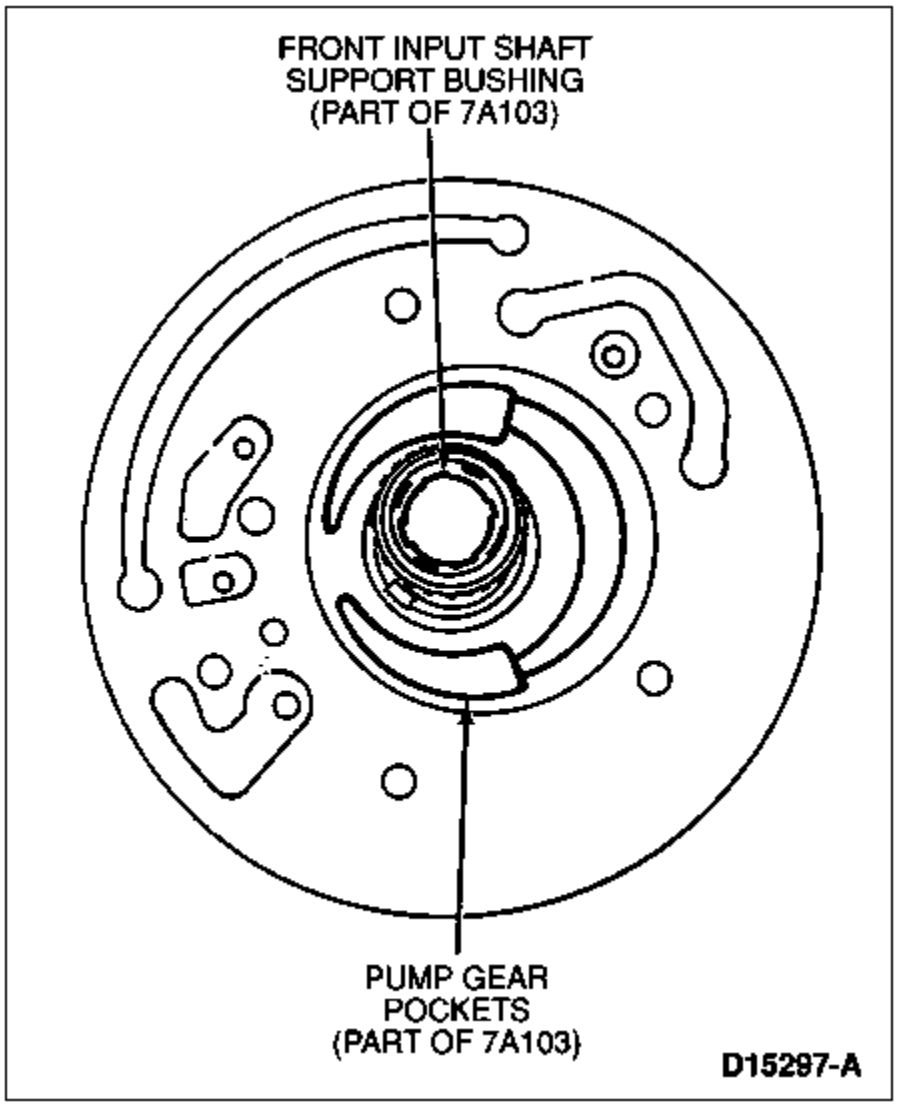

11. Inspect the mating surfaces of the pump body and case for burrs.

    Inspect the drive and driven gear bearing surface for scores and check the gear teeth for burrs.

    Inspect the fluid pump seal for cuts or nicks. Inspect the pump bushing for scoring.

    Check the fluid passages for obstruction.

    If any parts are found to be damaged or worn, replace the pump as an assembly. Minor burrs and scores may be removed with a crocus cloth.

Assembly

1. **NOTE: Check and make sure that the garter spring has not popped off of the converter hub-to-converter housing seal.**

   Install new converter hub to housing seal onto Converter Housing Seal Replacer T97T-77000-A.

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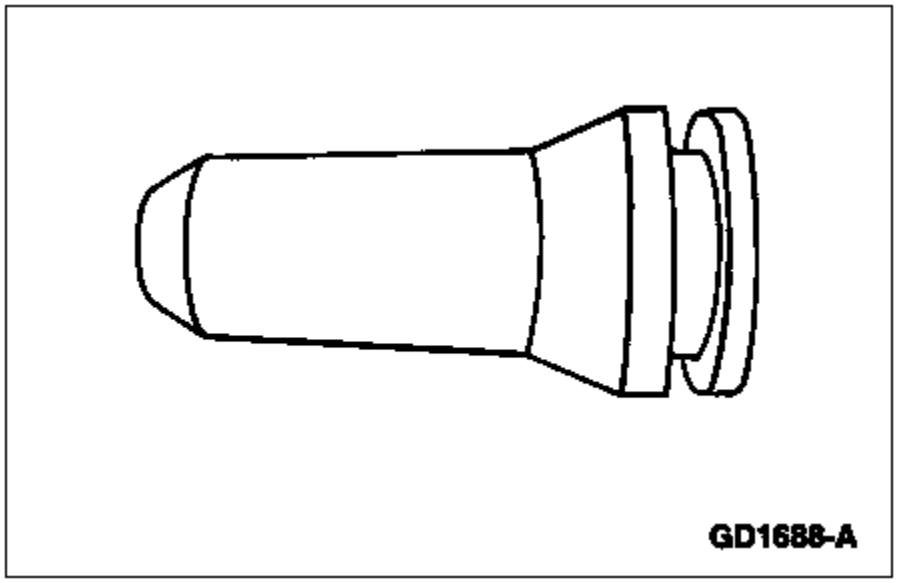
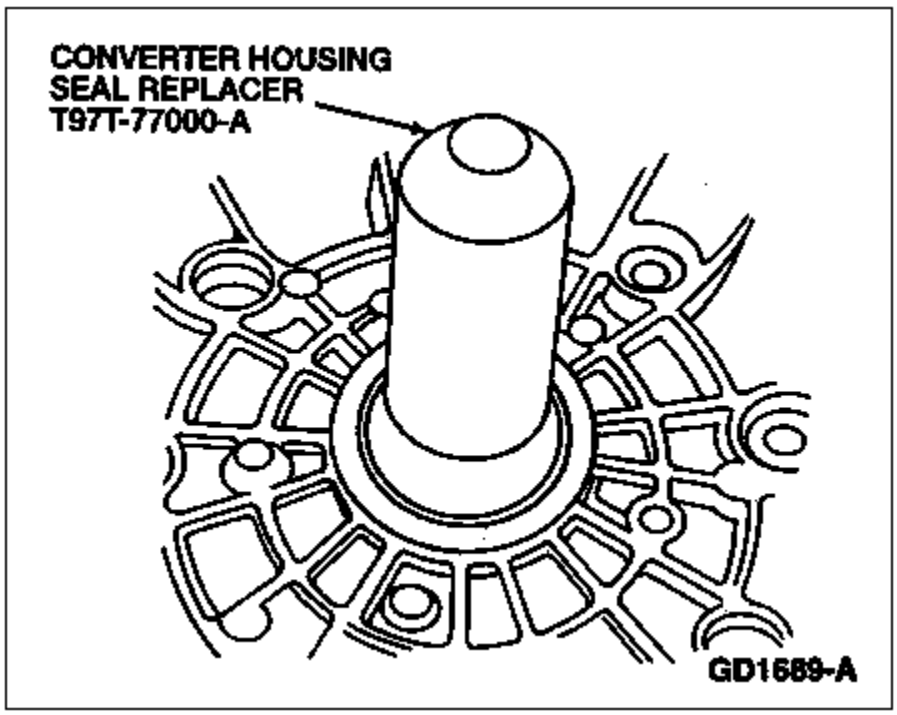


2. **CAUTION: Place the converter housing on a block of wood or equivalent to protect the converter hydraulic passages on the back side.**

   Install a new converter hub-to-converter housing seal until it bottoms in housing using Converter Housing Seal Replacer T97T-77000-A.



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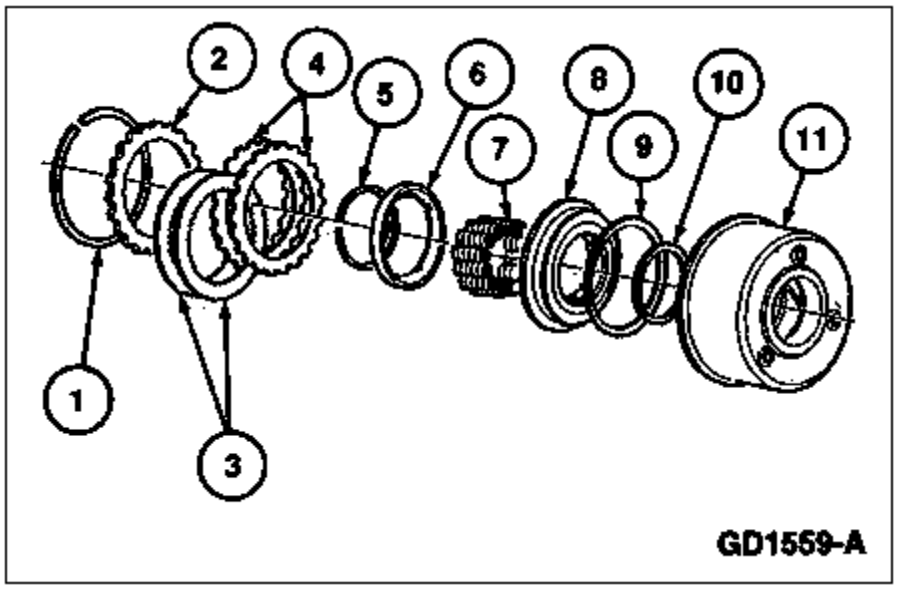
Coast Clutch

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Clutch Spring Compressor	T65L-77515-A
Coast Clutch Outer Seal Sizing Tool	T95L-70010-D

Front Brake and Coast Clutch Drum Assembly



Item	Part Number	Description
1	E860126-S/129S	Retaining Ring (Select Fit)
2	7B066	Coast Clutch Pressure Plate
3	7B164	Coast Clutch Internal Plate — Friction
4	7B442	Coast Clutch External Plate — Steel
5	E860125-S	Retaining Ring
6	7A527	Coast Clutch Piston Spring Retainer
7	7A480	Coast Clutch Piston Springs (20 Req'd)
8	7A258	Coast Clutch Piston
9	7D548	Coast Clutch Piston Outer Seal Ring
10	7D404	Coast Clutch Piston Inner Seal Ring

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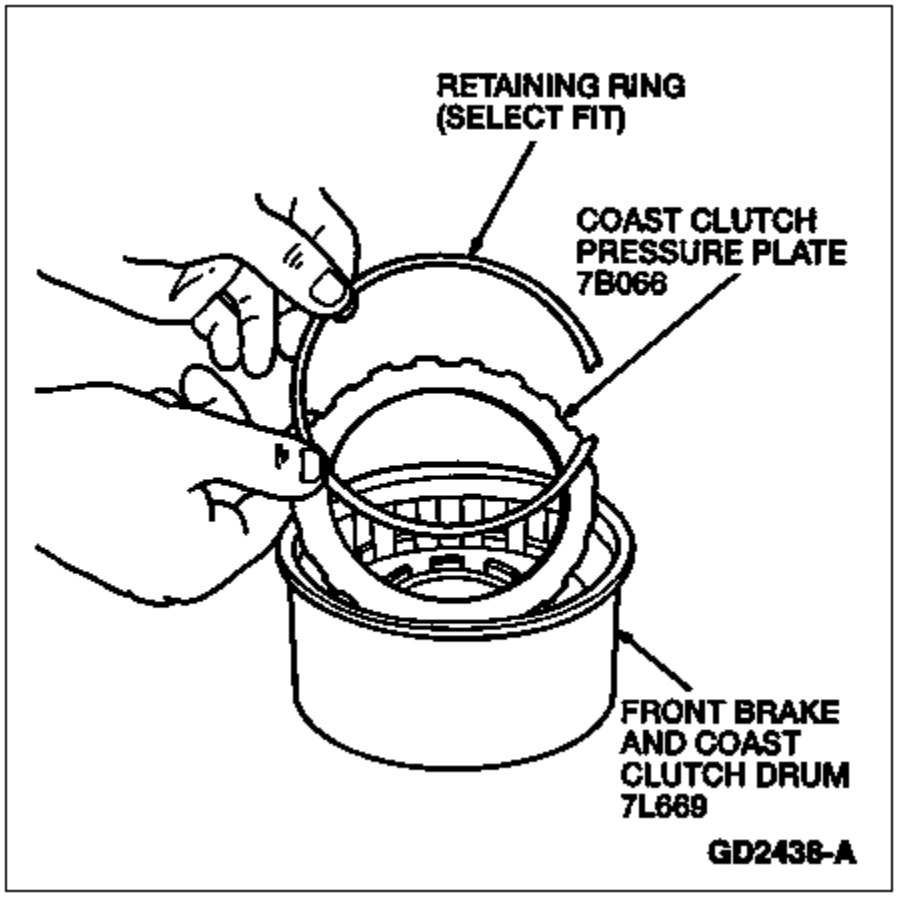
11	7L669	Front Brake and Coast Clutch Drum Assembly

Disassembly

1. **CAUTION: This is a select fit ring. See Assembly procedure if the ring or clutch plate pack is replaced.**

   Remove the retaining ring and coast clutch pressure plate from the front brake and coast clutch drum.



2. **CAUTION: Friction plates are directional. Note direction of grooves for installation.**

   CAUTION: If new clutch plates are being used, they should be soaked in clean transmission fluid for at least 30 minutes before assembly.

   Remove the coast clutch pack. Inspect for wear, damage or overheating. Replace as necessary.

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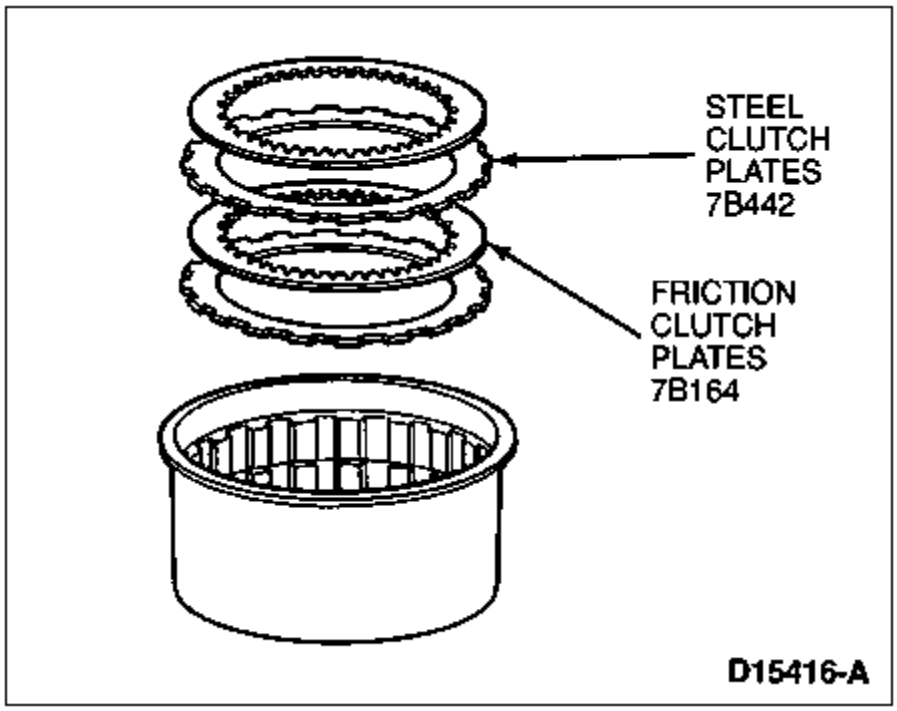

3. **WARNING: USE CAUTION WHEN RELEASING TOOL PRESSURE ON THE REAR CLUTCH PISTON SPRINGS.**

   CAUTION: Do not fully compress the clutch spring compressor or damage to the spring retainer may occur.

   Compress the clutch piston springs with Clutch Spring Compressor T65L-77515-A. Remove the retaining ring.

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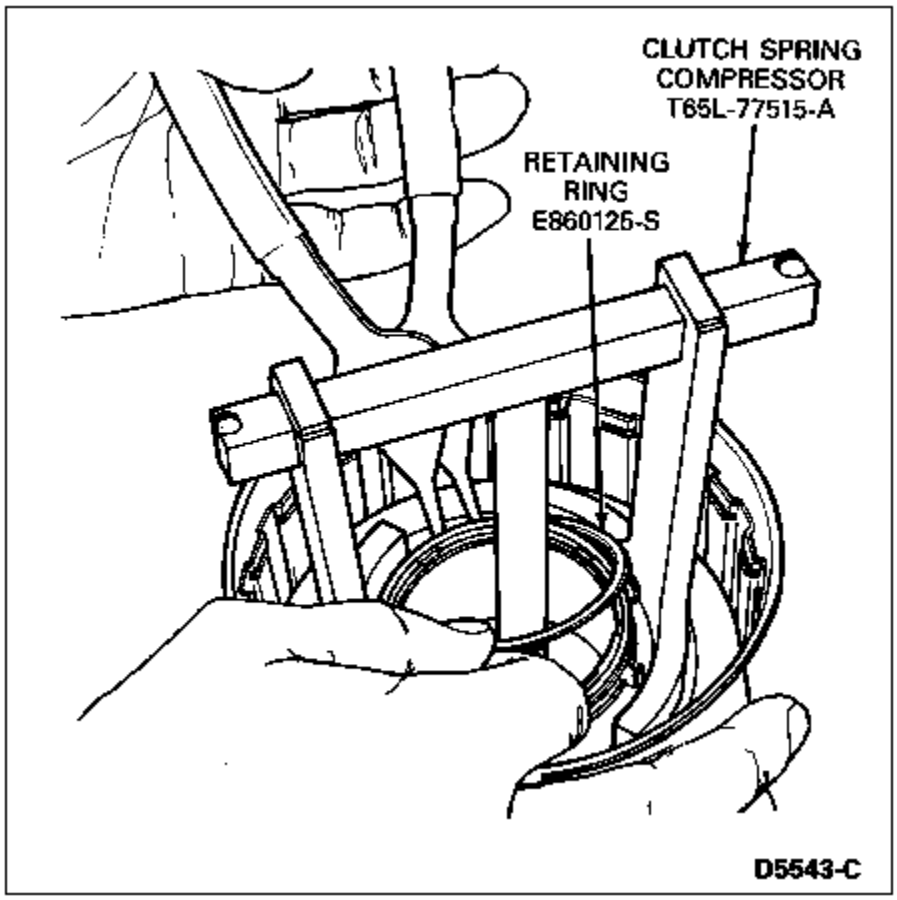

4. Remove the clutch piston spring retainer and 20 clutch piston springs.

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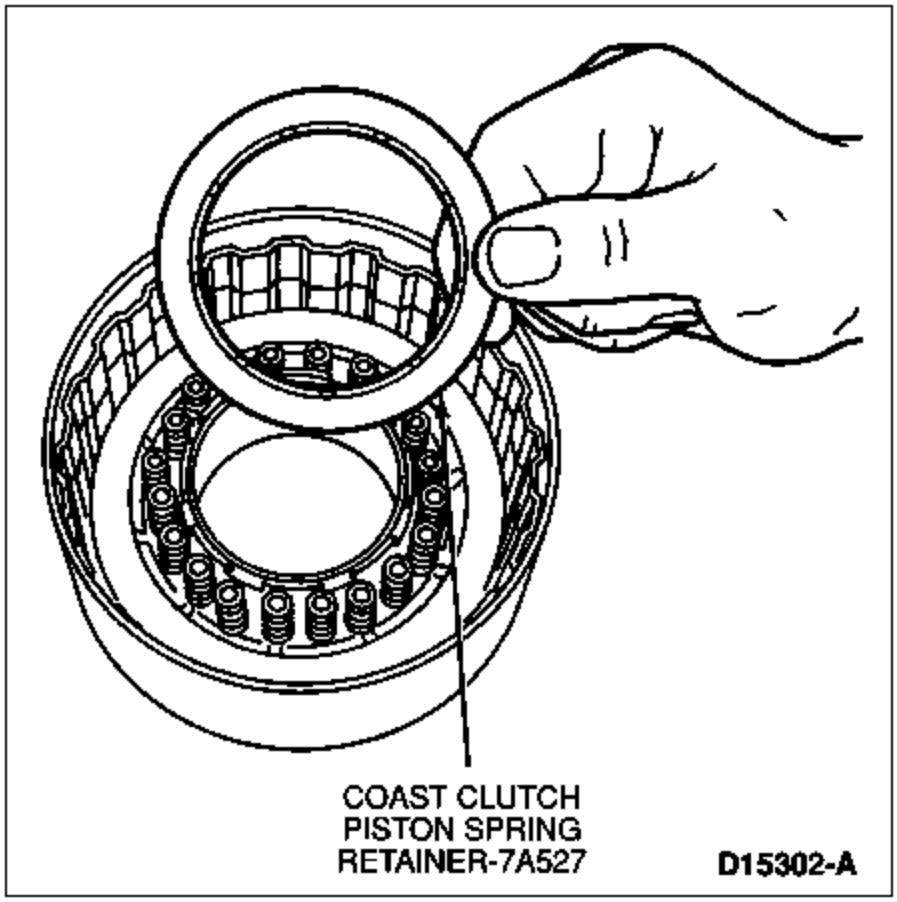

5. **WARNING: AIR PRESSURE MUST NOT EXCEED 138 KPA (20 PSI). WEAR SAFETY GLASSES WHEN USING COMPRESSED AIR, AND MAKE SURE DRUM IS FACING DOWN AS SHOWN.**

   Remove the coast clutch piston by using air pressure. Apply air pressure to one hole on the inside diameter of the front brake and coast clutch drum while blocking the other hole with a finger.

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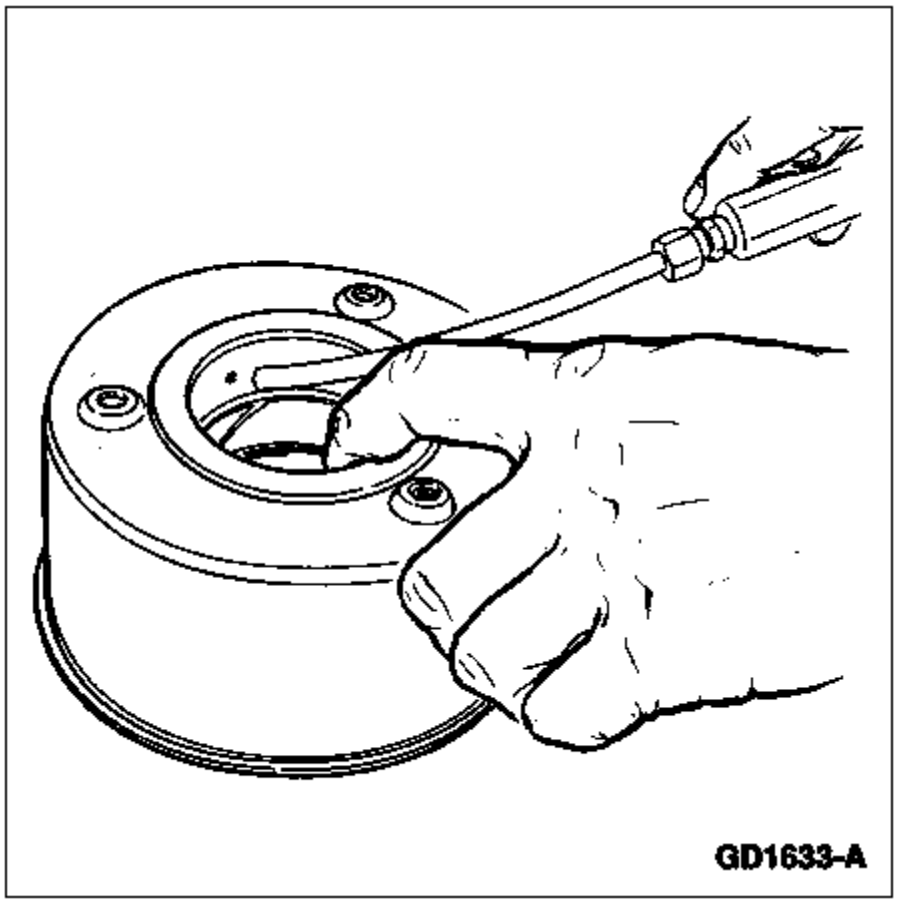

6. Remove the coast clutch piston inner and outer seal. Clean and replace as necessary.

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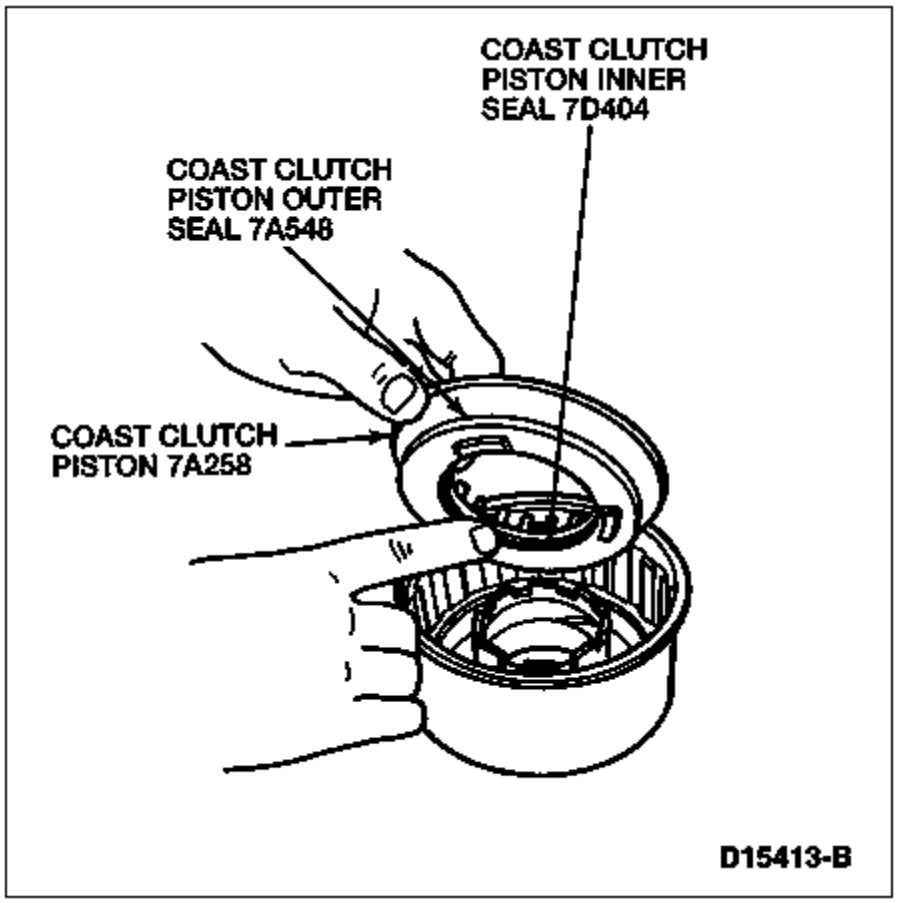

Assembly

1. **CAUTION: The lip seals must be positioned as shown. Care must be taken to prevent roll over of the lip seal.**

   Install new coast clutch piston inner and outer seal on the coast clutch piston.

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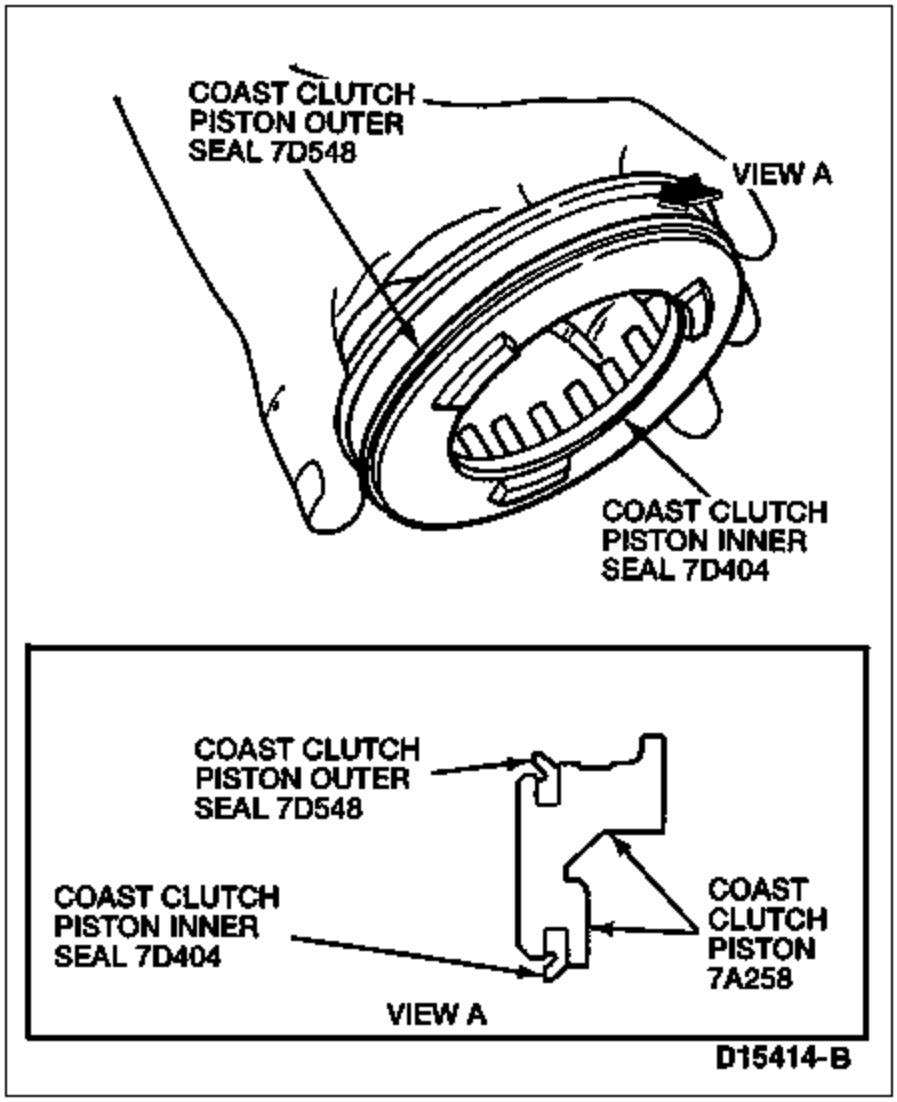

2. **CAUTION: Lubricate the coast clutch piston inner and outer seal.**

   Carefully press the coast clutch piston into Coast Clutch Outer Seal Sizing Tool T95L-70010-D.

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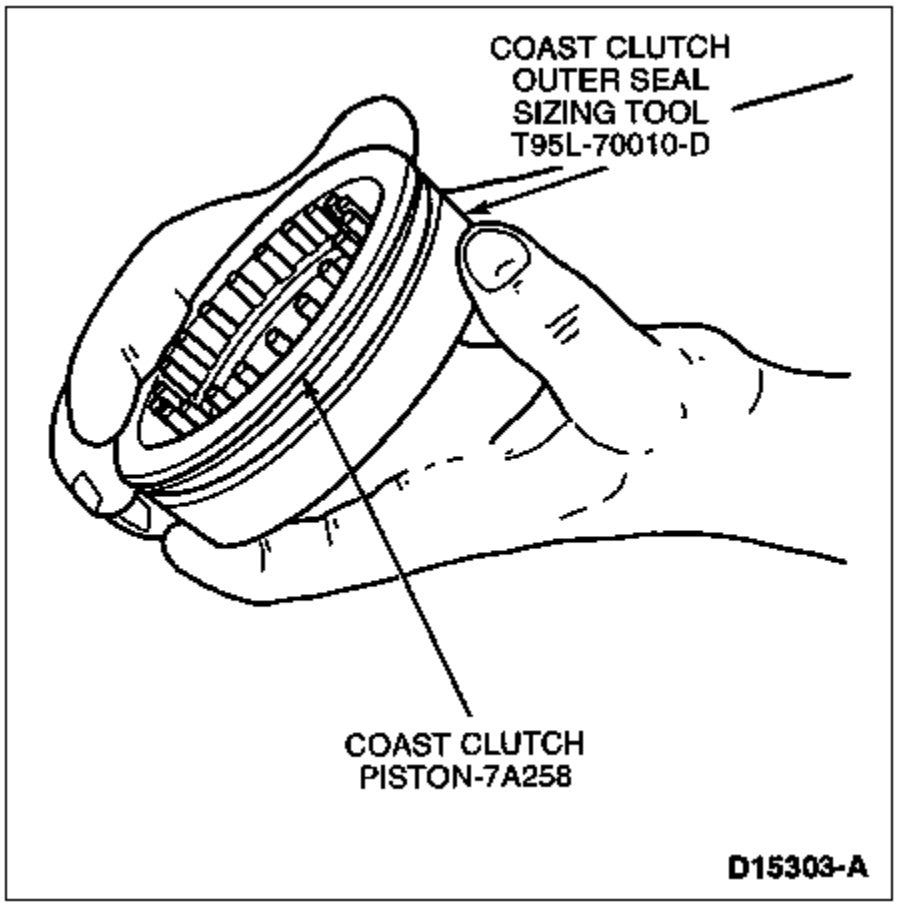

3. Inspect the drum band surface, bushing, and thrust surfaces for scores. Minor scores may be removed with a crocus cloth. Badly scored parts must be replaced.

4. Inspect the clutch piston bore and the piston and the piston inner and outer bearing surfaces for scores.

5. Check the fluid passages for obstructions. All fluid passages must be clean and free of obstructions.

6. Inspect the clutch plates for wear, scoring and fit on the clutch hub serrations. Replace all plates that are badly scored, worn or do not fit freely in the hub serrations.

7. Inspect the clutch pressure plate for scores on the clutch plate surface. Check the clutch release spring(s) for distortion.

8. Make sure the check ball is free and clear of debris prior to installing piston. The check ball is located in the front brake and coast clutch drum.

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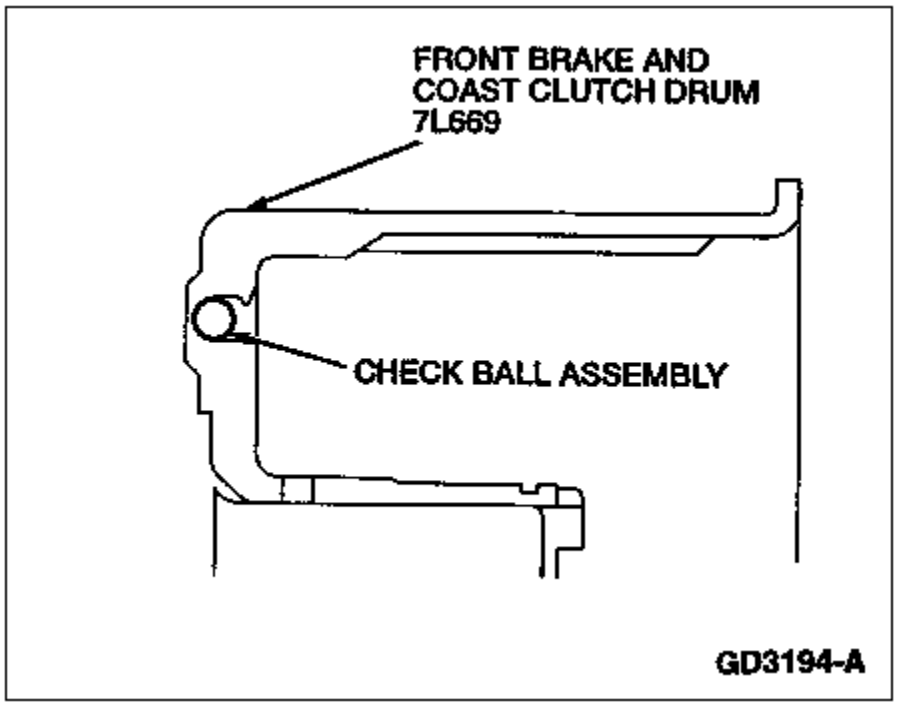
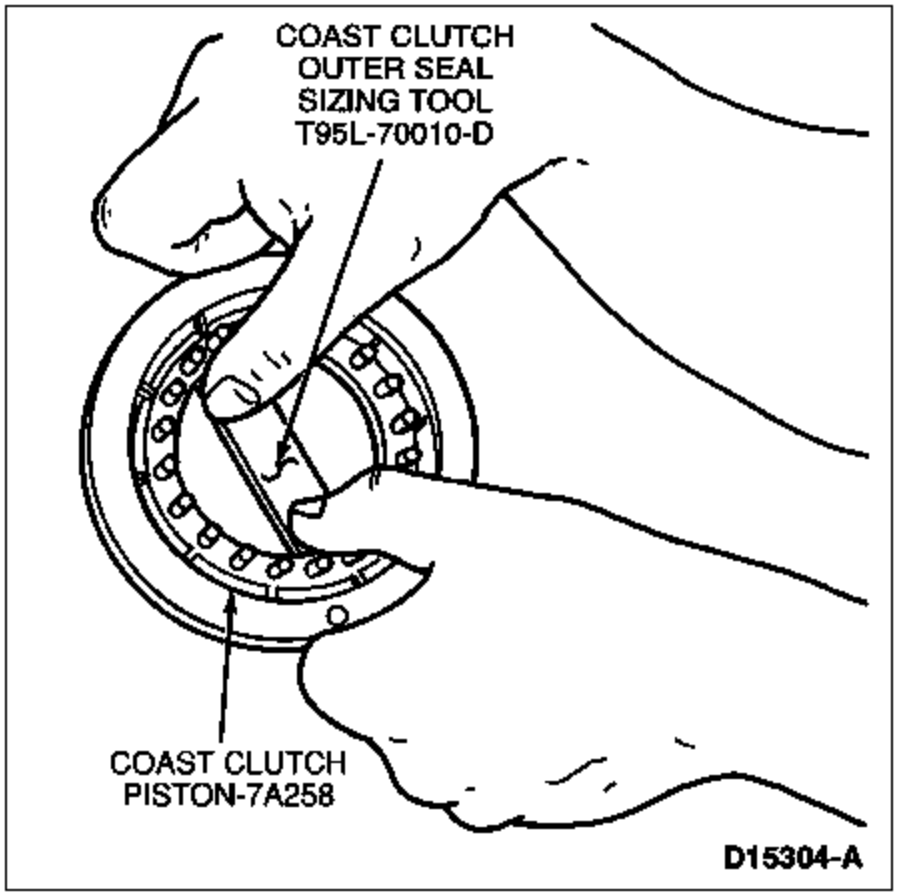


9. Carefully remove the coast clutch piston from Coast Clutch Outer Seal Sizing Tool T95L-70010-D.



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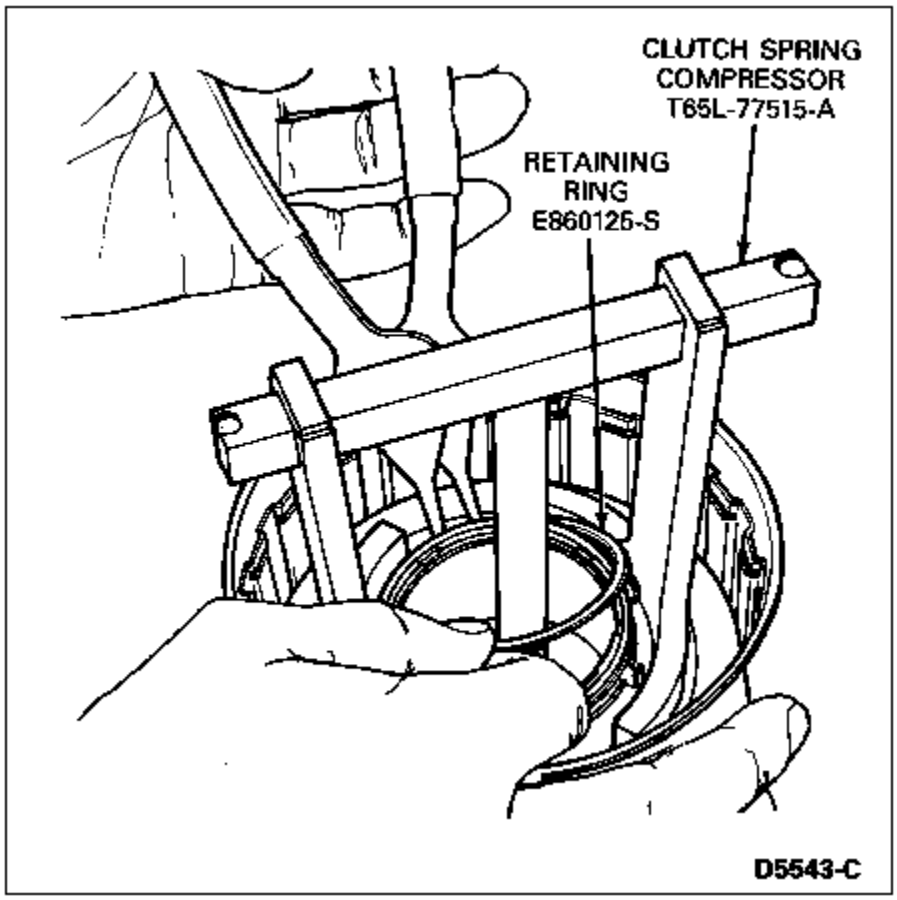
10. **CAUTION: Care must be taken to prevent damage to the seals during installation.**

    Carefully install the coast clutch piston into the front brake and coast clutch drum.

11. Install the 20 coast clutch piston springs and coast clutch piston spring retainer onto the coast clutch piston.

12. **CAUTION: Do not fully compress the clutch spring compressor or damage to the coast clutch piston spring retainer may occur.**

    Compress the coast clutch piston springs with Clutch Spring Compressor T65L-77515-A. Install the retaining ring. Release the load on the springs applied by the tool. Remove the tool.



13. **CAUTION: Coast clutch friction plates are directional and must be installed with grooves clockwise (I.D. to O.D.). The word "TOP" should face up.**

    CAUTION: If new clutch plates are being used, they should be soaked in clean transmission fluid for at least 30 minutes before assembly.

    NOTE: When installing friction plates, the word "TOP" should face up. If reusing plates,

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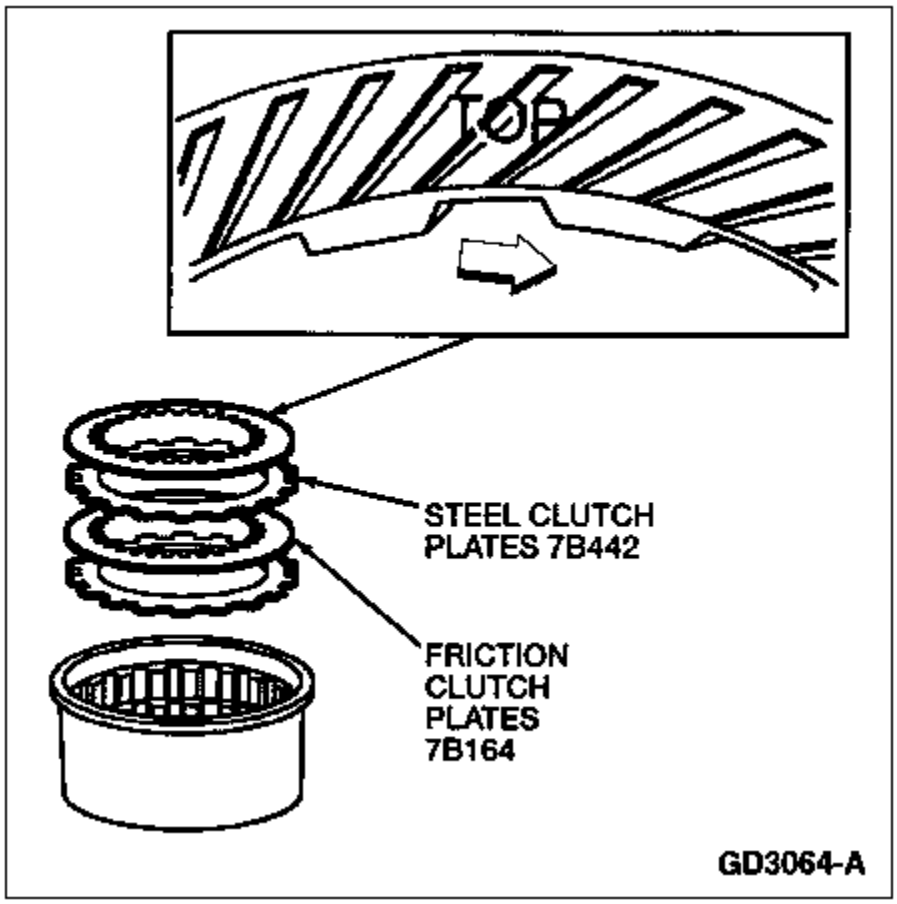
grooves must be installed clockwise.

Install the two steel clutch plates and two friction clutch plates in alternating order, starting with a steel plate first.



14. **CAUTION: The retaining ring is select fit.**

Install the coast clutch pressure plate. Install the original retaining ring on top of the clutch pressure plate.

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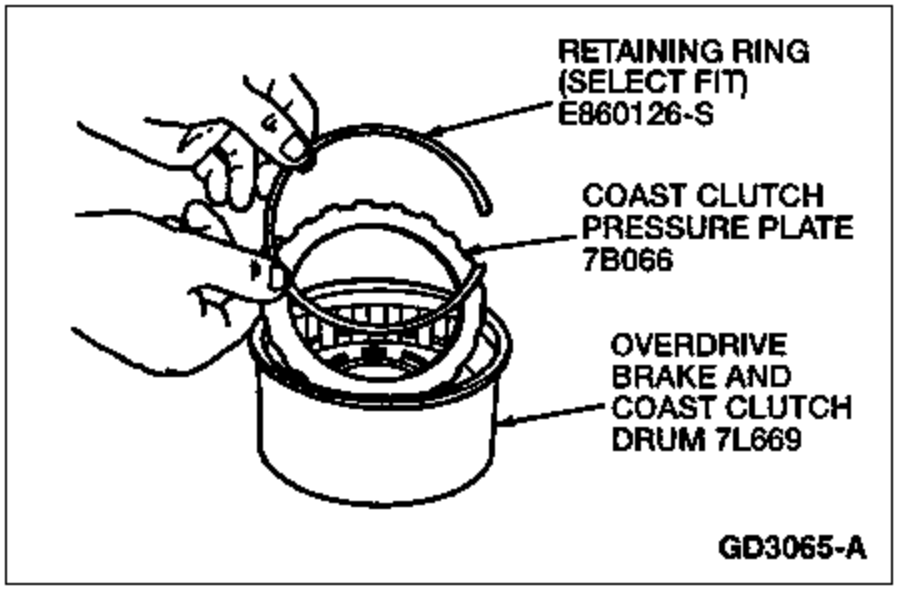

15. **WARNING: AIR PRESSURE MUST NOT EXCEED 138 KPA (20 PSI). WEAR SAFETY GLASSES WHEN USING COMPRESSED AIR. MAKE SURE DRUM IS FACING DOWN AS SHOWN.**

    NOTE: The coast clutch piston must apply with air pressure and release when the air is removed.

    Air check the assembly. Apply air to one hole on the inside diameter of the front brake and coast clutch drum while blocking the other hole with a finger.

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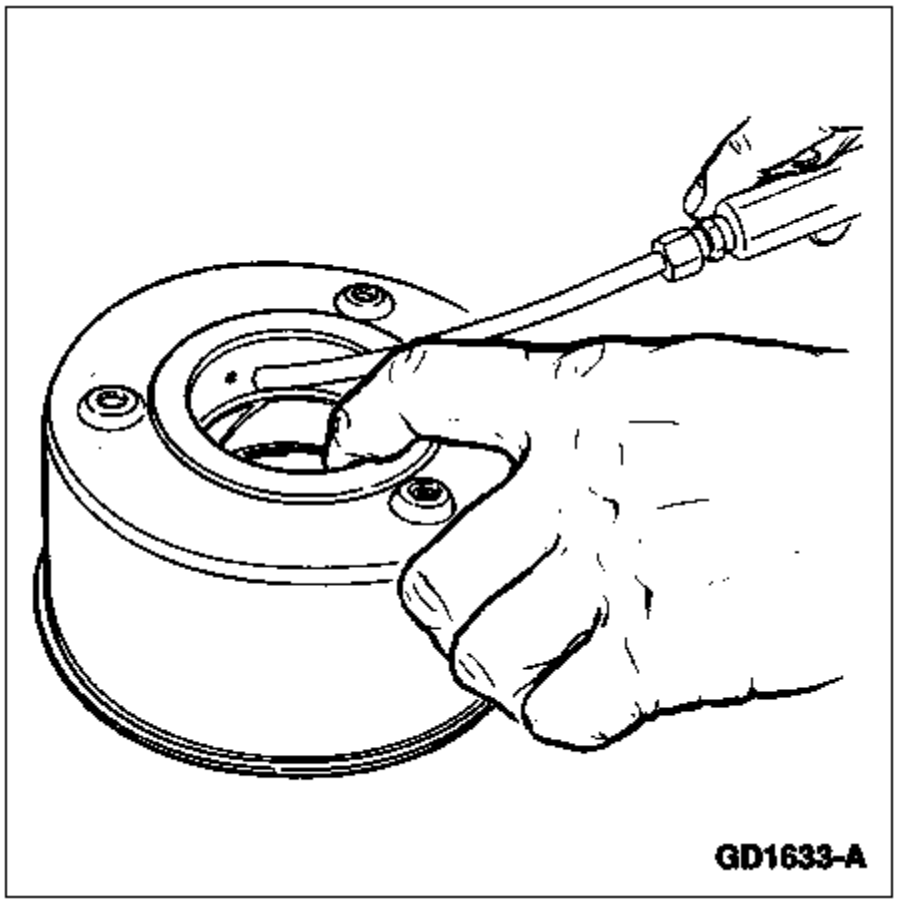

16. Check the free play of the clutch pack. Push down on the clutch pack. Use a feeler gauge to check the gap between the retaining ring and the pressure plate. Specification: 1.3 to 2.0mm (.051 to .079 inch).

    If the reading is not within specification, remove the retaining ring and check the thickness. Replace it with a ring that will correct free play. Verify with a feeler gauge.

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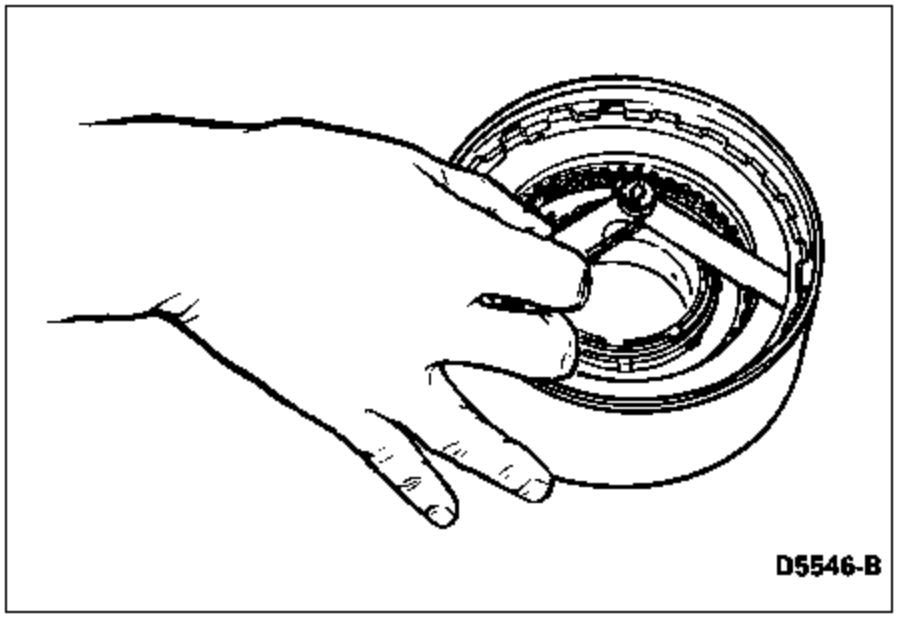

COAST CLUTCH

	Thickness		Diameter	
Part Number	mm	Inches	mm	Inches
E860126-S	1.37	.0539	130.1	5.122
E860127-S	1.73	.0681	130.1	5.122
E860128-S	2.08	.0819	130.1	5.122
E860129-S	2.44	.0961	130.1	5.122

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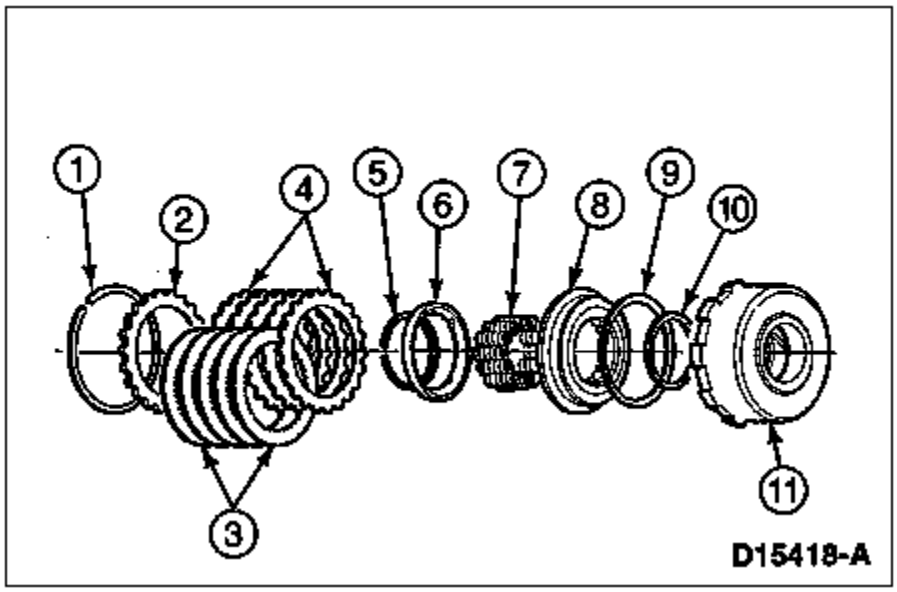
Intermediate Brake and Direct Clutch Drum Assembly

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Clutch Spring Compressor	T65L-77515-A
Direct Clutch Outer Seal Sizing Tool	T95L-70010-E

Intermediate Brake and Direct Clutch Drum Assembly



Item	Part Number	Description
1	E860126-S/129S	Retaining Ring (Select Fit)
2	7B066	Direct Clutch Pressure Plate
3	7B164	Direct Clutch Internal Plate — Friction
4	7B442	Direct Clutch External Plate — Steel
5	E860125-S	Retaining Ring
6	7A527	Direct Clutch Piston Spring Retainer (8 Tabs)
7	7A480	Direct Clutch Piston Springs (20 Req'd)
8	7A258	Direct Clutch Piston
9	7A548	Direct Clutch Piston Outer Seal Ring

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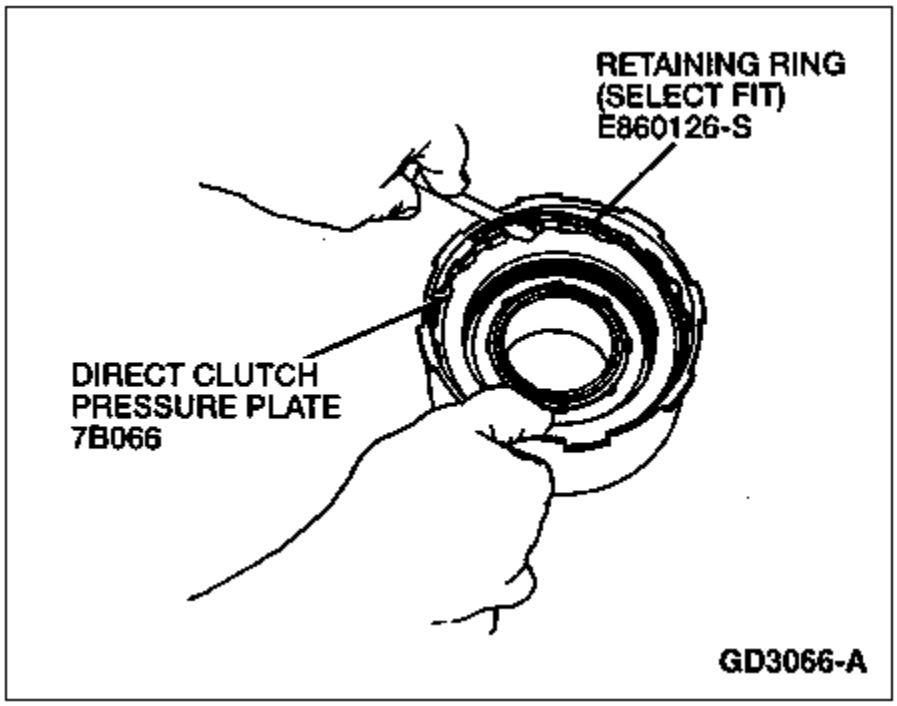
10	7D404	Direct Clutch Piston Inner Seal Ring
11	7D044	Intermediate Brake and Direct Clutch Drum Assembly

Disassembly

1. **CAUTION: The retaining ring is a select fit ring. See assembly procedure if the ring or clutch pack is replaced.**

   Remove the retaining ring and direct clutch pressure plate.



2. **CAUTION: Friction plates are directional and must be installed with grooves clockwise (I.D. to O.D.). The word "TOP" should face up.**

   CAUTION: If new clutch plates are being used, they should be soaked in clean transmission fluid for at least 30 minutes before assembly.

   Remove the direct clutch pack. Inspect for wear, damage or overheating. Replace the steel or friction plates as necessary.

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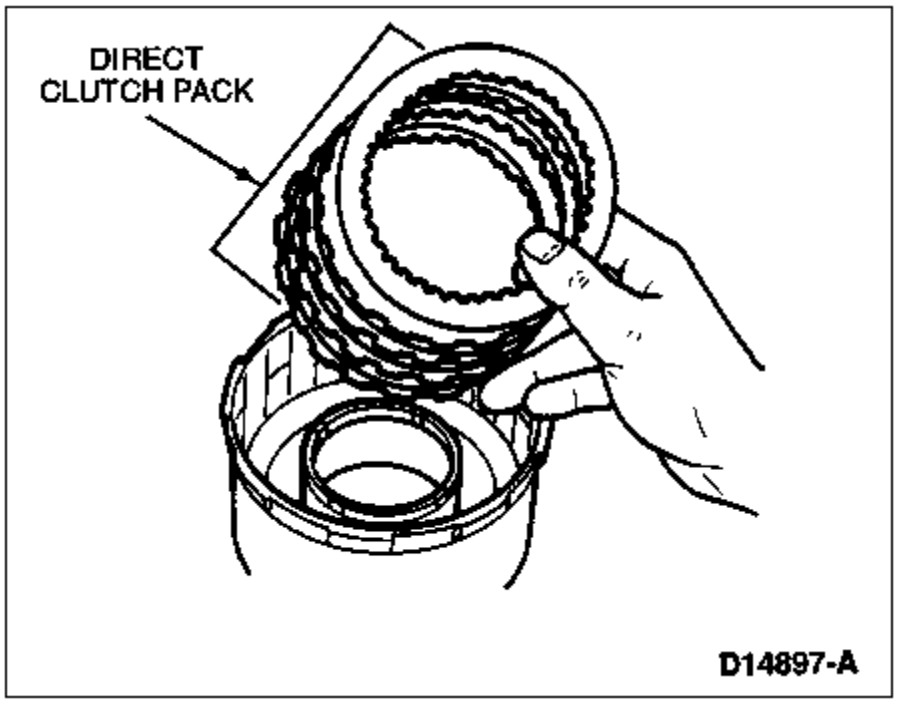

3. **WARNING: AFTER REMOVING THE RETAINING RING, USE CARE WHEN RELEASING THE PRESSURE ON THE SPRINGS.**

   CAUTION: Do not fully compress the clutch spring compressor or damage to the spring retainer may occur.

   Compress the direct clutch piston springs with Clutch Spring Compressor T65L-77515-A. Remove the retaining ring. Remove the tool.

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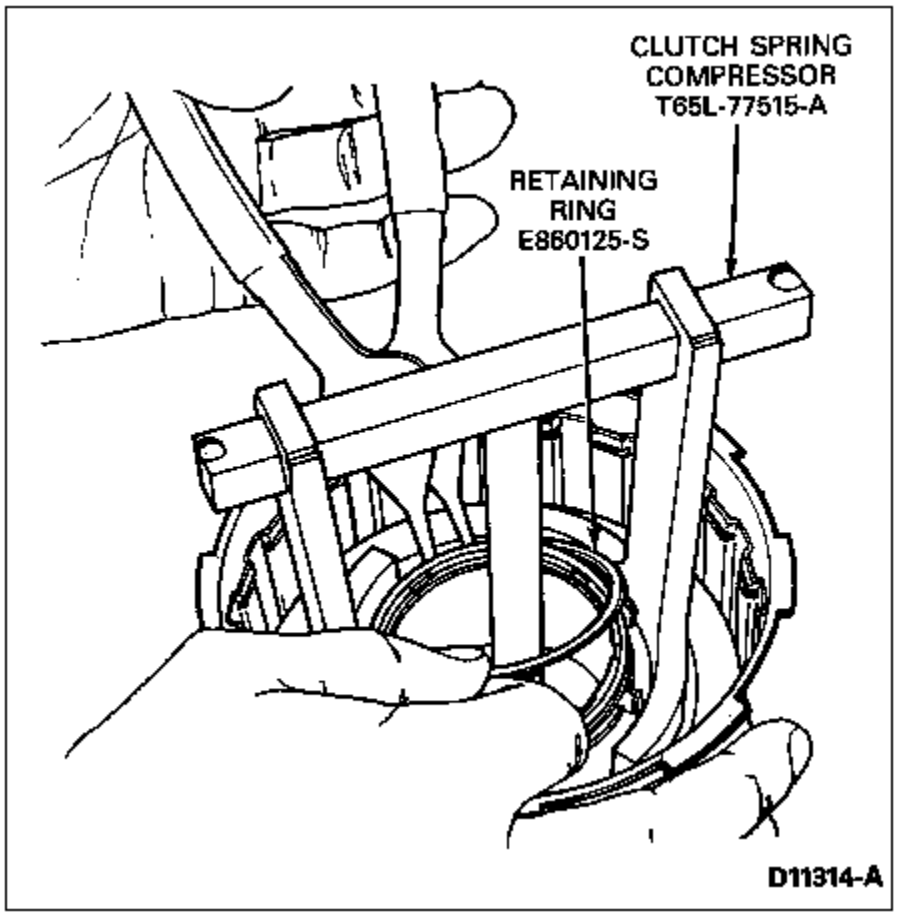
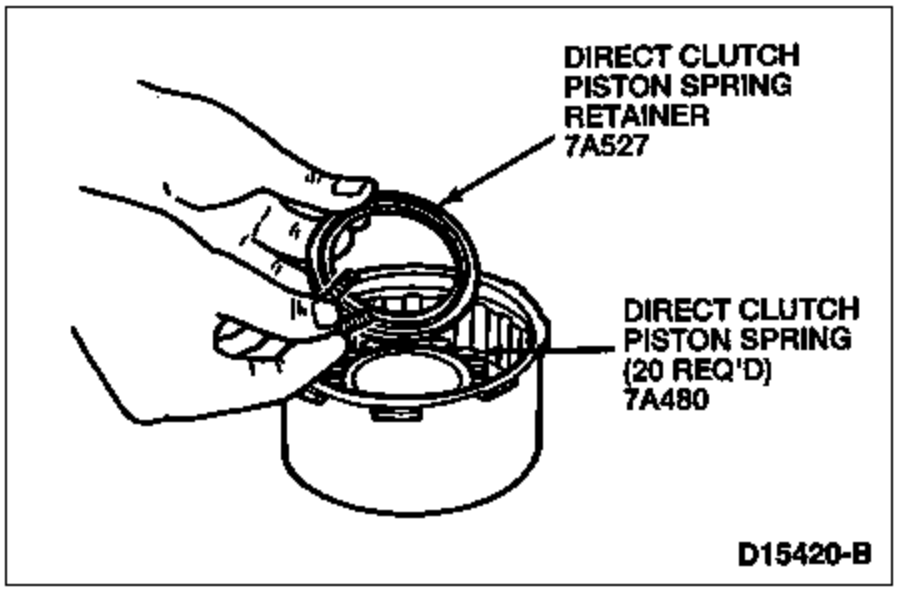


4. Remove the direct clutch piston spring retainer and 20 direct clutch piston springs.



5. **WARNING: DO NOT EXCEED 138 KPA (20 PSI). WEAR SAFETY GLASSES WHEN USING**

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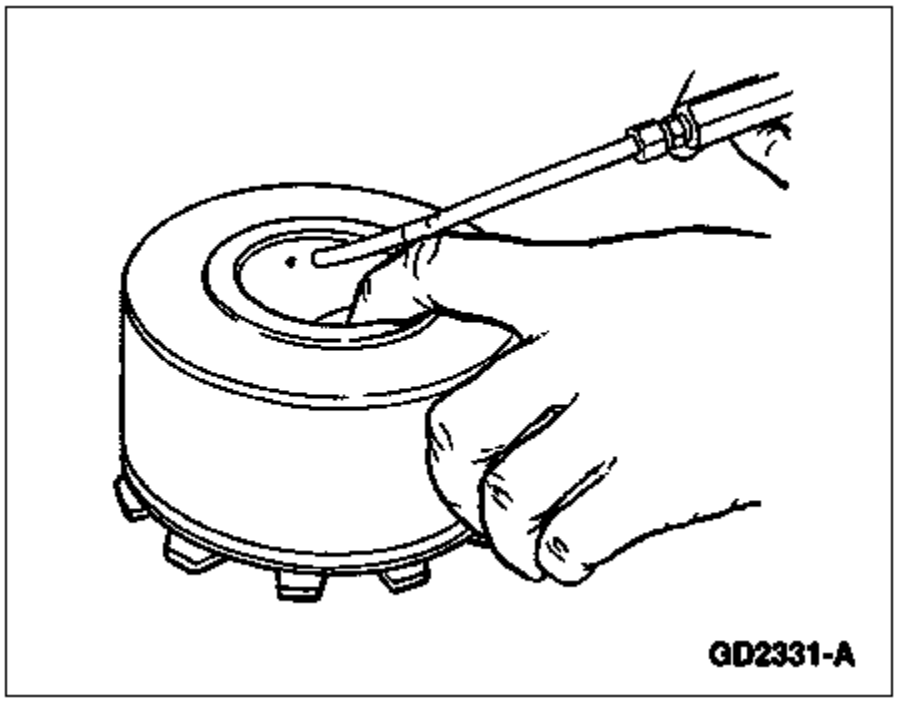
COMPRESSED AIR. MAKE SURE DRUM IS FACING DOWN AS SHOWN.

Remove the direct clutch piston using compressed air. Apply air pressure to one hole on the inside diameter of the intermediate brake and direct clutch drum while blocking the other hole with a finger.



6. Remove the direct clutch piston inner and outer seals. Clean and replace as necessary.

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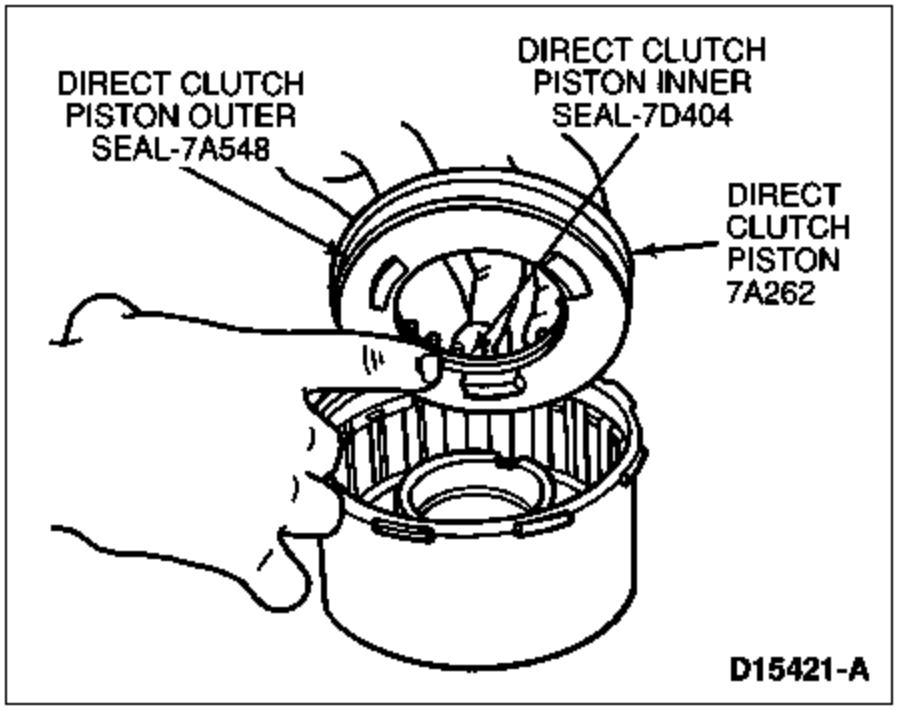

Assembly

1. **CAUTION: The lip seals must be positioned as shown. Care must be taken to prevent rollover of the lip seal.**

   Install new direct clutch piston inner and outer seals on the direct clutch piston.

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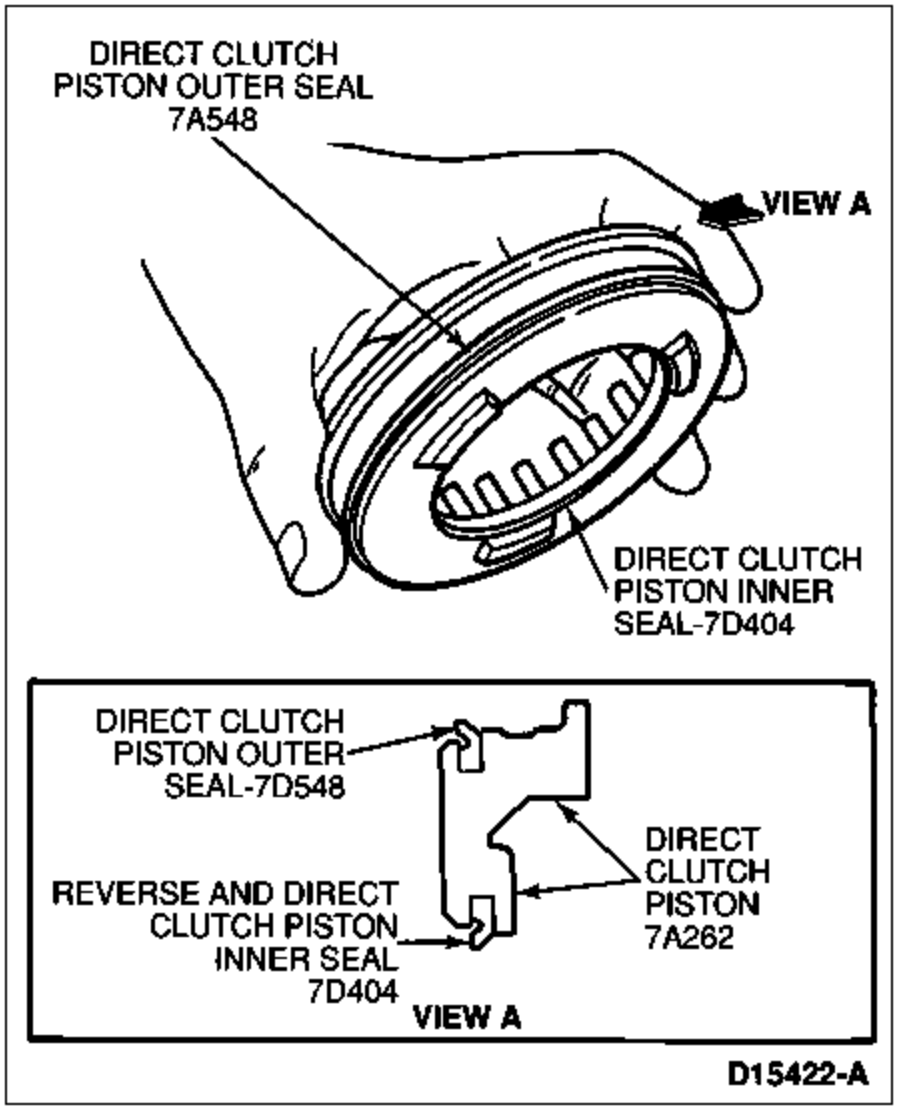

2. **CAUTION: Lubricate the direct clutch piston inner and outer seals with MERCON V® XT-5-QM transmission fluid.**

   Carefully press the direct clutch piston into Direct Clutch Outer Seal Sizing Tool T95L-70010-E.

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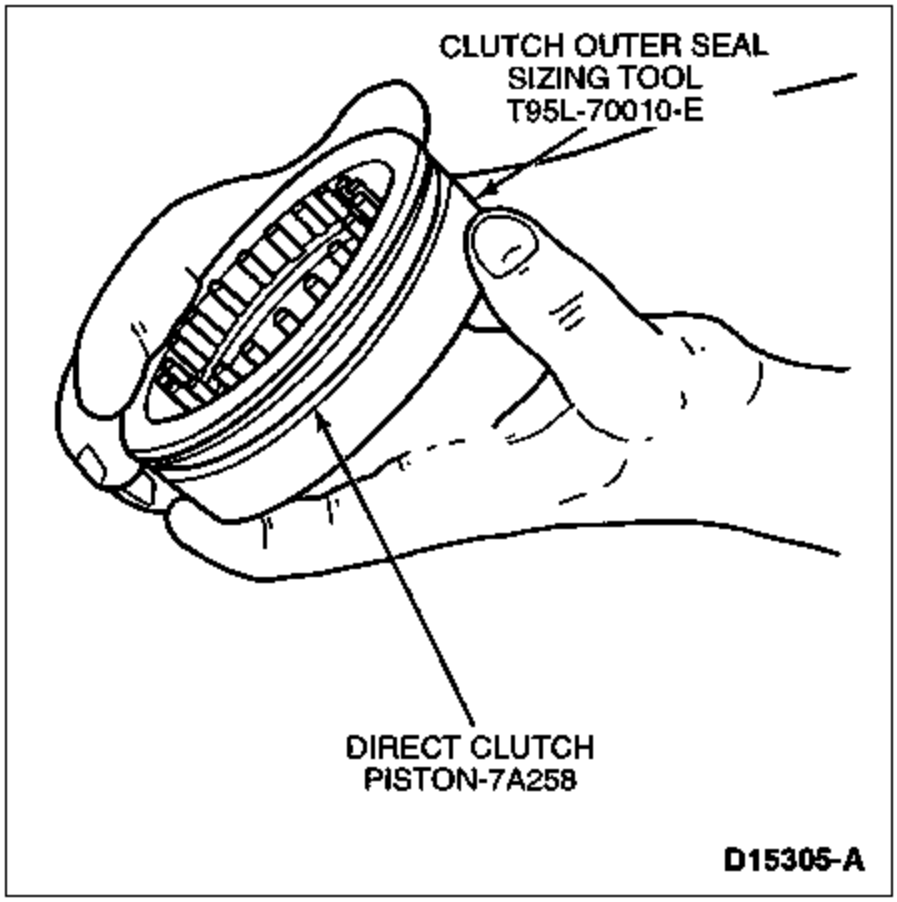

3. Inspect the drum band surface, bushing and thrust surfaces for scores. Minor scores may be removed with a crocus cloth. Badly scored parts must be replaced.

4. Inspect the clutch piston bore and the piston and the piston inner and outer bearing surfaces for scores.

5. Check the fluid passages for obstructions. All fluid passages must be clean and free of obstructions.

6. Inspect the clutch plates for wear, scoring and fit on the clutch hub serrations. Replace all plates that are badly scored, worn or do not fit freely in the hub serrations.

7. Inspect the direct clutch pressure plate for scores on the clutch plate bearing surface. Check the clutch release springs for distortion.

8. Make sure the check ball is free and clear of debris prior to installing piston. The check ball is located in the intermediate brake and direct clutch drum assembly.

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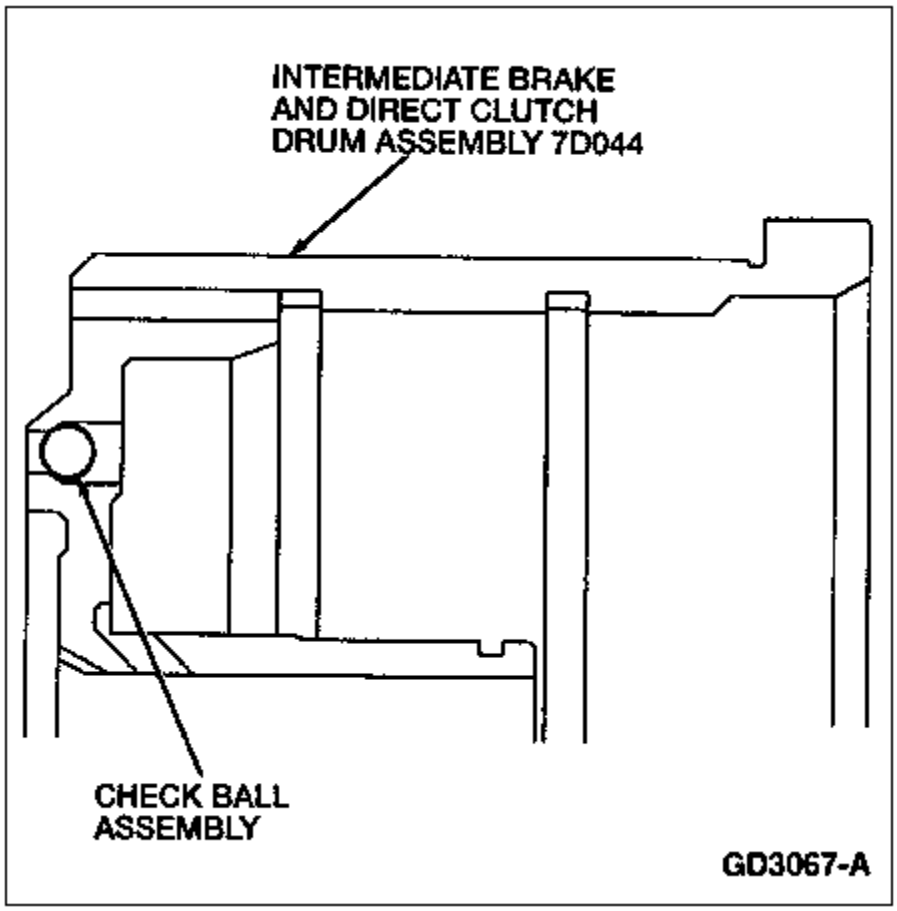

9. Carefully remove the direct clutch piston from Direct Clutch Outer Seal Sizing Tool T95L-70010-E.

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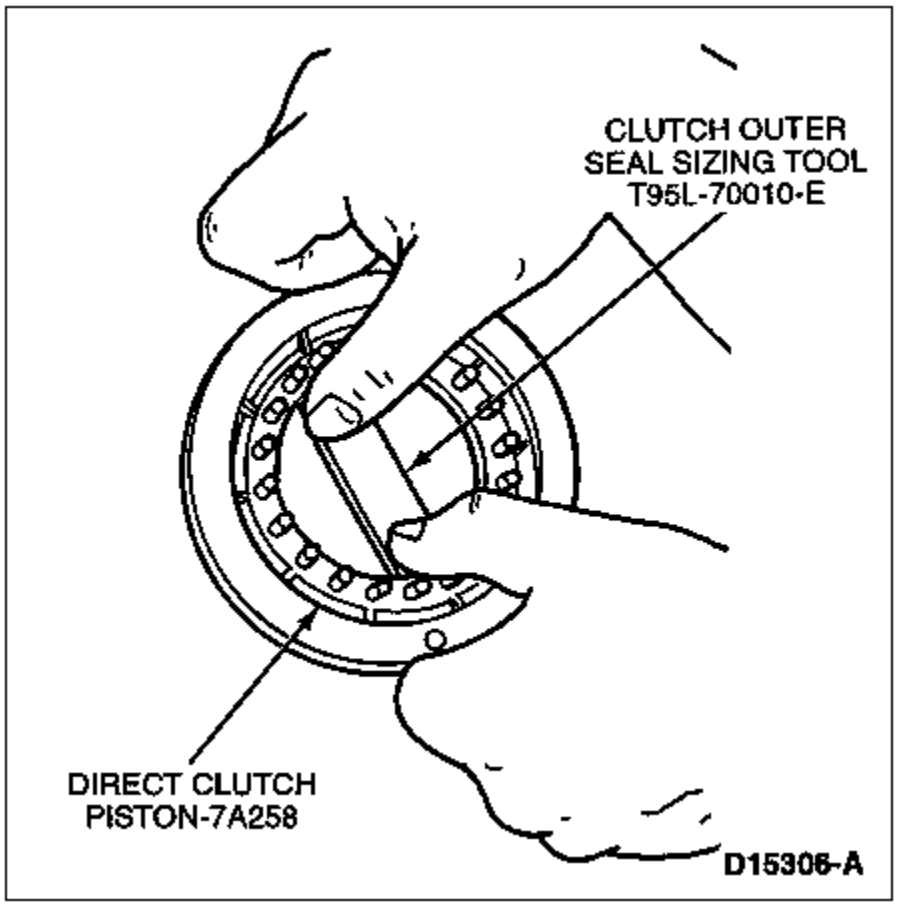

10. **CAUTION: Care must be taken to prevent damage to the seals during installation.**

Carefully install the clutch piston into the intermediate brake and direct clutch drum.

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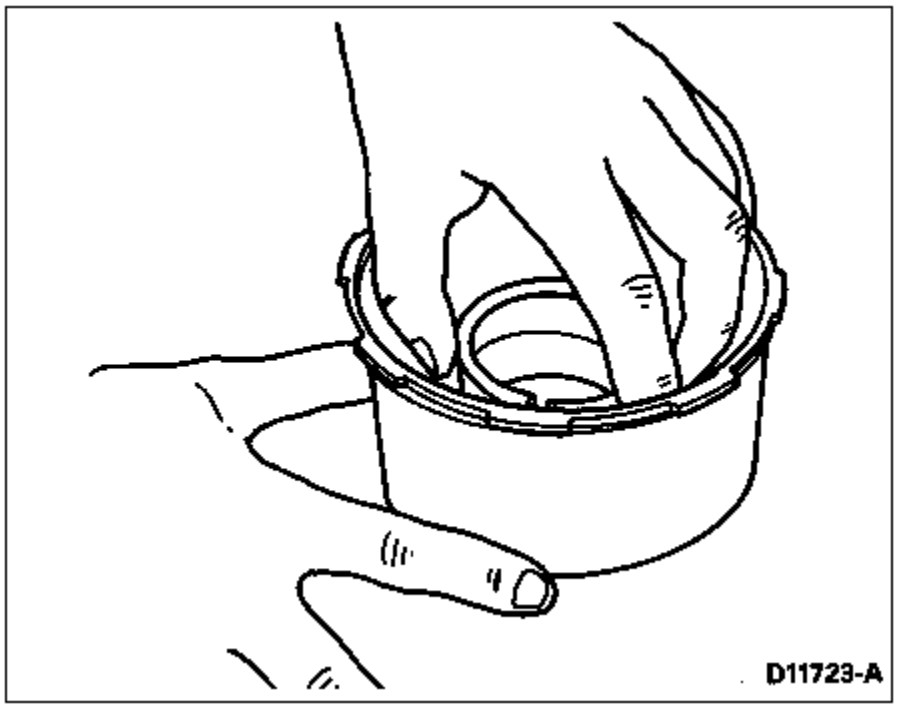
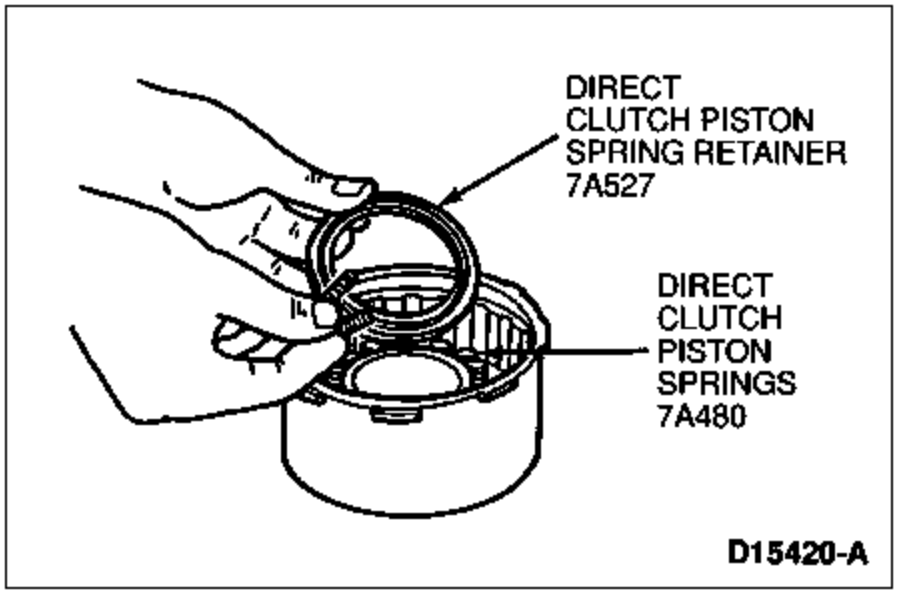


11. Install the direct clutch piston spring retainer and 20 direct clutch piston springs.



12. **CAUTION: Do not fully compress the clutch spring compressor damage to the spring retainer may occur.**

Compress the direct clutch piston springs with Clutch Spring Compressor T65L-77515-A. Install the retaining ring. Remove the tool.

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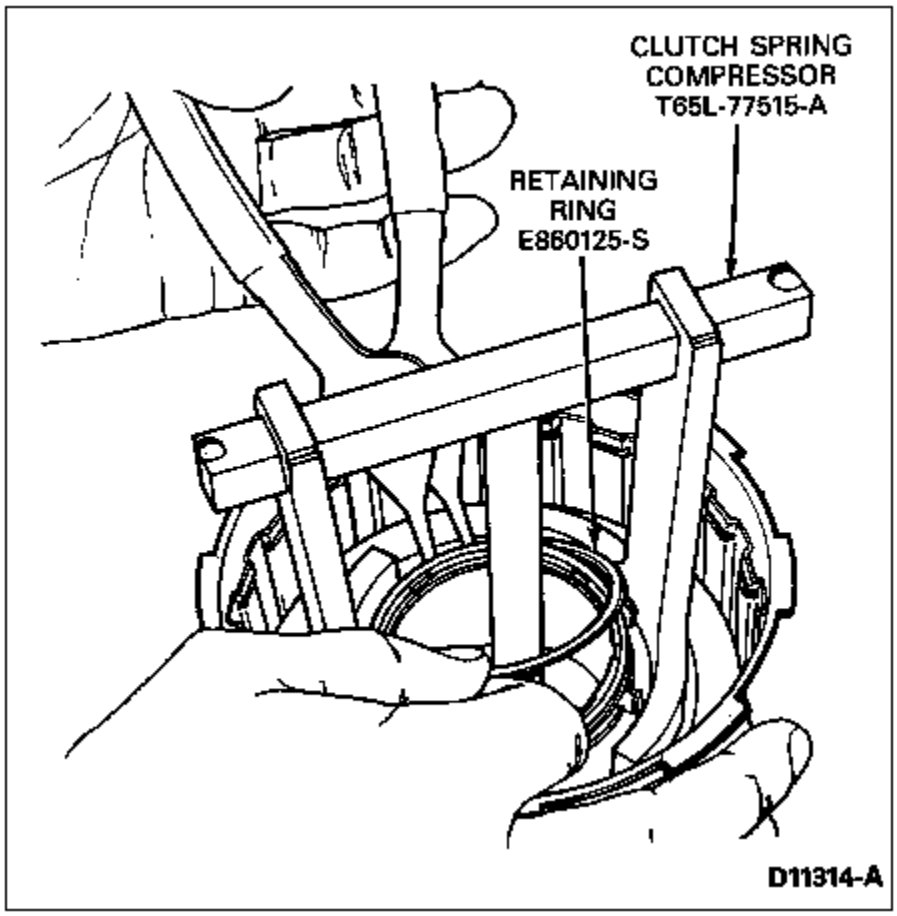

13. **CAUTION: Friction plates are directional and must be installed with grooves clockwise (I.D. to O.D.). The word "TOP" should be face up.**

CAUTION: The number of plates is model dependent. See Specifications at the end of this section. If new plates are being used, they should be soaked in clean transmission fluid for at least 30 minutes before assembly.

When installing friction plates, the word "TOP" should face up. If reusing plates, grooves must be installed clockwise.

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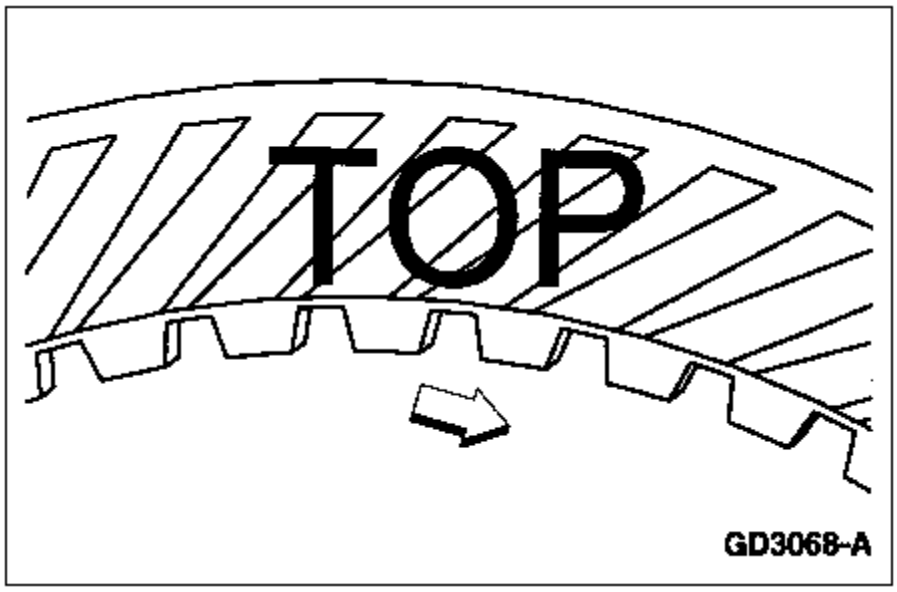

Install the steel clutch plates and friction clutch plates in alternating order, starting with a steel plate and finishing with a friction plate.

CLUTCH PACK

Engine	Steel	Friction
4.0L-EFI	4	4
4.0L-SOHC	5	5

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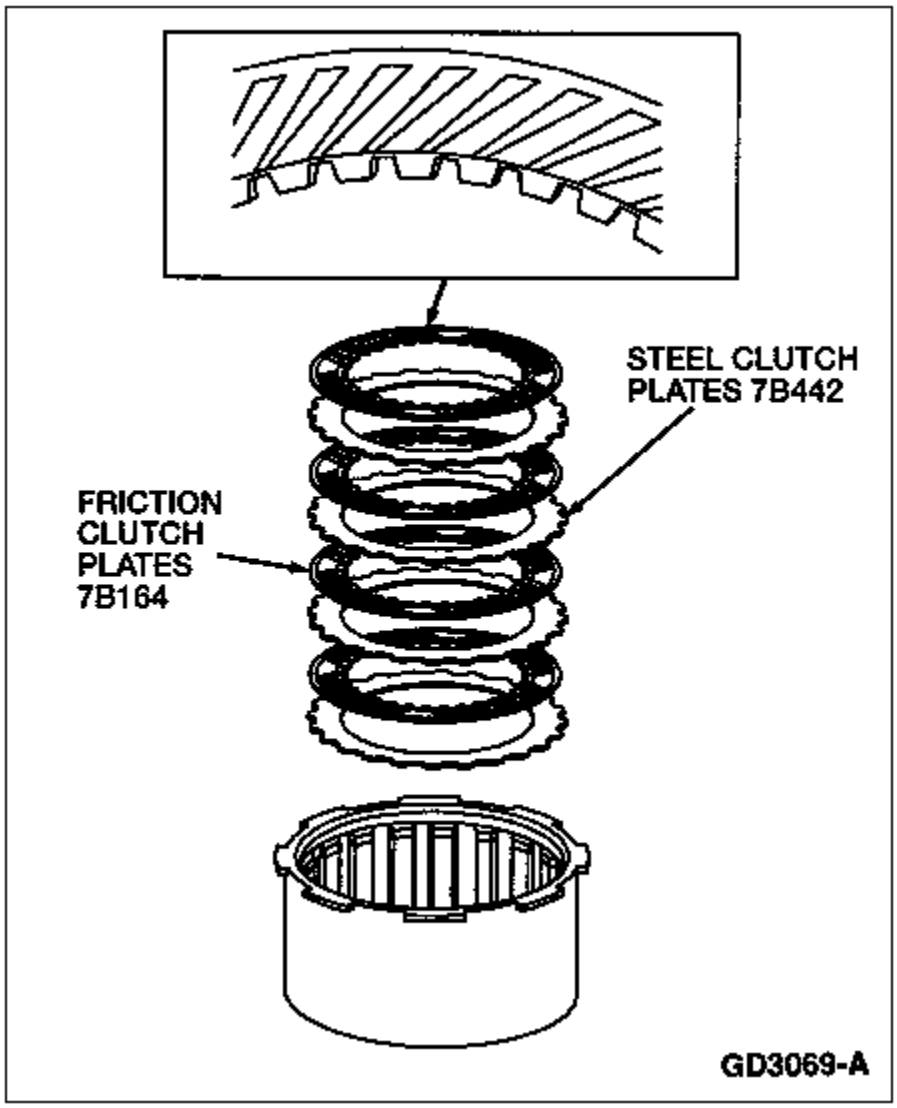

14. **CAUTION: The retaining ring is a select fit.**

Install the direct clutch pressure plate and original retaining ring on the clutch stack.

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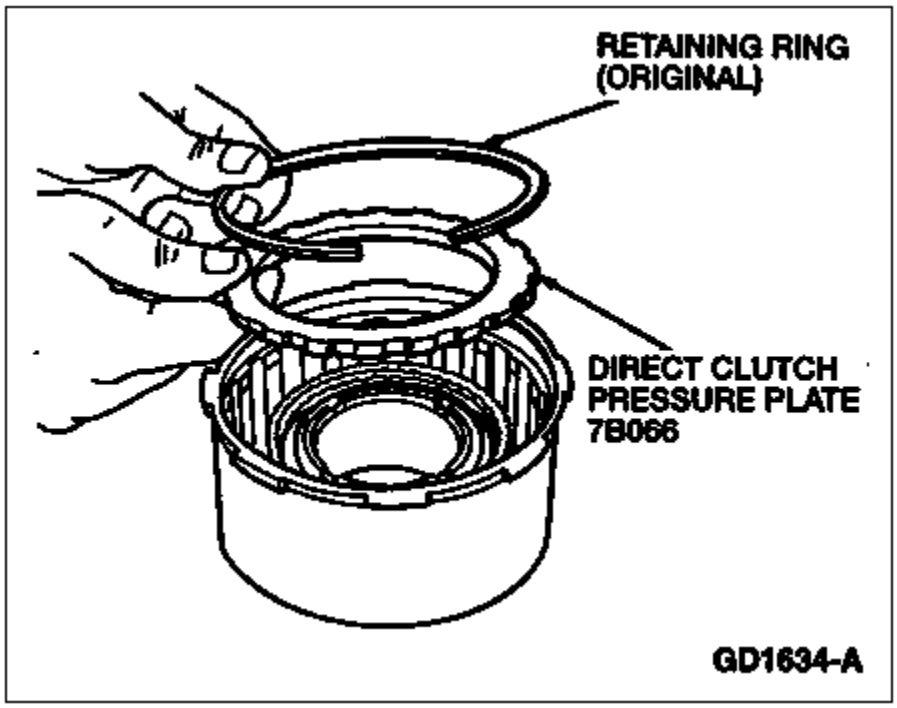

15. **WARNING: AIR PRESSURE MUST NOT EXCEED 138 KPA (20 PSI). WEAR SAFETY GLASSES WHEN USING COMPRESSED AIR. MAKE SURE THE DRUM IS FACING DOWN AS SHOWN.**

    NOTE: The direct clutch piston must apply with air pressure and release when the air is removed.

    Air check the assembly. Apply air to one hole on the inside diameter of the intermediate brake and direct clutch drum while blocking the other hole with a finger.

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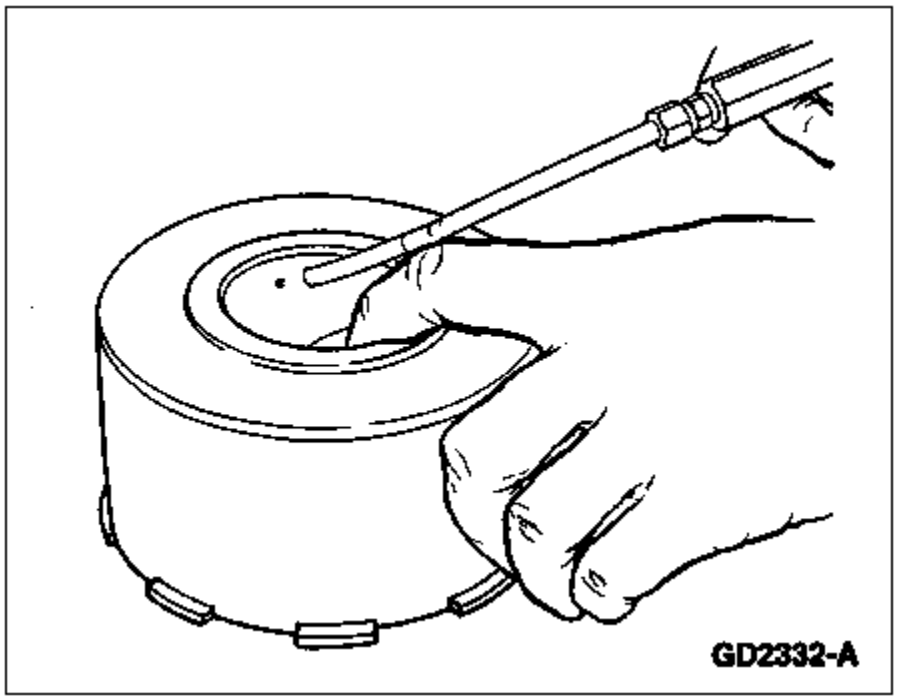
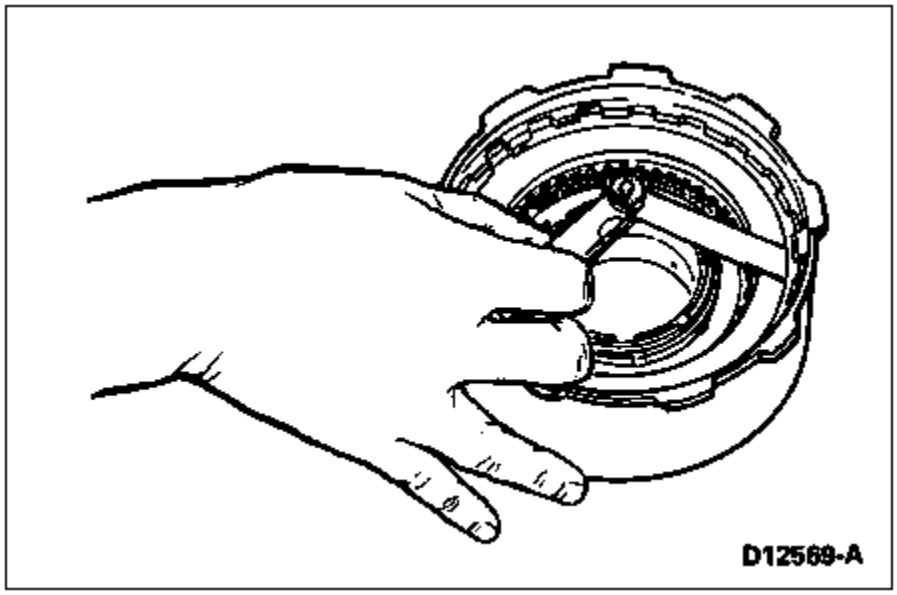


16. Push down on the clutch pack. Use a feeler gauge to check the gap between the retaining ring and the clutch pressure plate. Specification: 1.3 to 2.0mm (0.051 to 0.079 inch).

    If the reading is not within specification, remove the retaining ring and check thickness. Replace with a ring that will correct free play, and verify with a feeler gauge.



DIRECT CLUTCH

	Thickness		Diameter	

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Part Number	mm	Inches	mm	Inches
E860126-S	1.37	.0539	130.1	5.122
E860127-S	1.73	.0681	130.1	5.122
E860128-S	2.08	.0819	130.1	5.122
E860129-S	2.44	.0961	130.1	5.122

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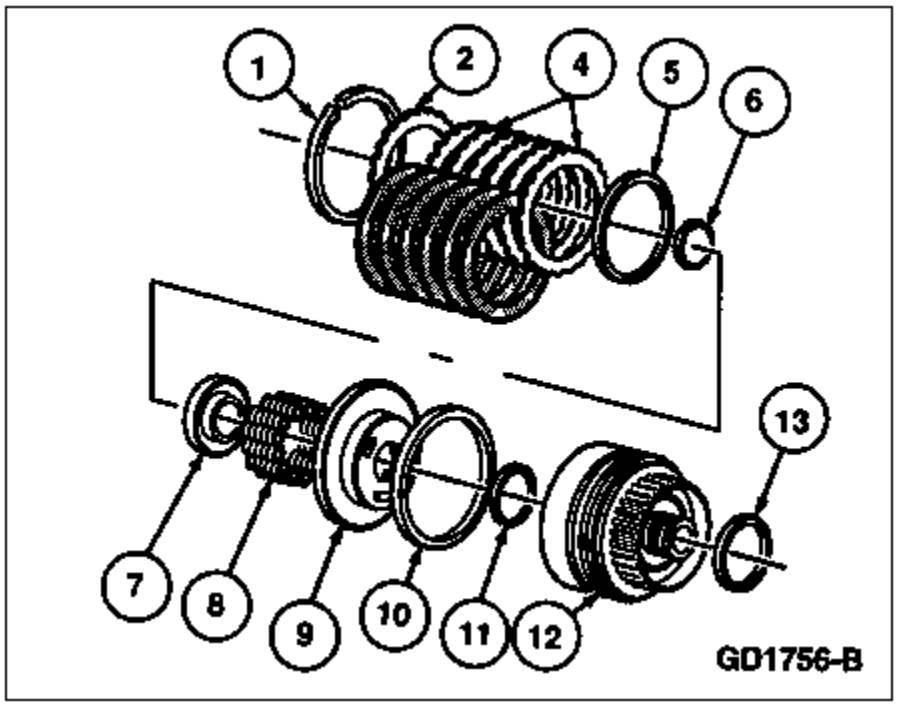
Forward Clutch

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Clutch Spring Compressor	T65L-77515-A
Lip Seal Protector	T74P-77548-A
Lip Seal Protector	T74P-77548-B

Forward Clutch Assembly



Item	Part Number	Description
1	E860115-S/118S	Retaining Ring
2	7B066	Forward Clutch Pressure Plate
3	7B164	Forward Clutch Internal Plate — Friction
4	7B442	Forward Clutch External Plate — Steel
5	7B070	Forward Clutch Cushion Spring
6	E860109-S	Retaining Ring

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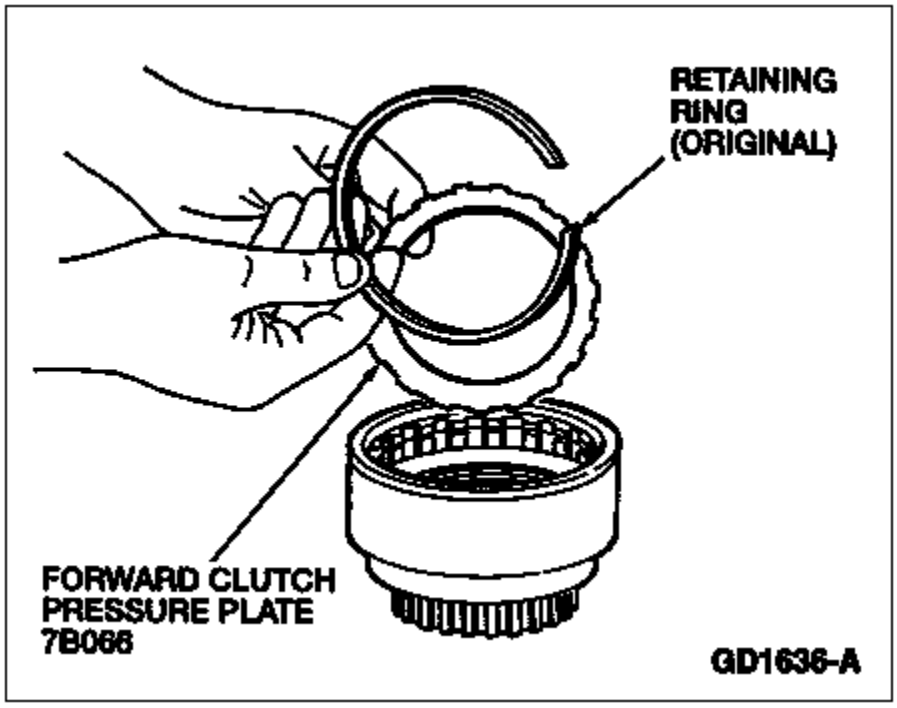
7	7A527	Forward Clutch Piston Spring Retainer
8	7A480	Forward Clutch Piston Springs (15 Req'd)
9	7A262	Forward Clutch Piston Assembly
10	7A548	Forward Clutch Piston Outer Seal Ring
11	7A548	Forward Clutch Piston Inner Seal Ring
12	7A360	Forward Clutch Cylinder Assembly
13	7M153	No. 5 Forward Clutch Cylinder Thrust Bearing

Disassembly

1. **CAUTION: The retaining ring is a select fit ring. See assembly procedure if the retaining ring or clutch pack is replaced.**

   CAUTION: If new plates are being used, they should be soaked in clean transmission fluid for at least 30 minutes before assembly.

   Remove the retaining ring and forward clutch pressure plate.



2. **CAUTION: Friction plates are directional and must be installed with grooves counterclockwise (I.D. to O.D.). The word "TOP" should face up.**

   NOTE: The number of clutch plates is engine dependent.

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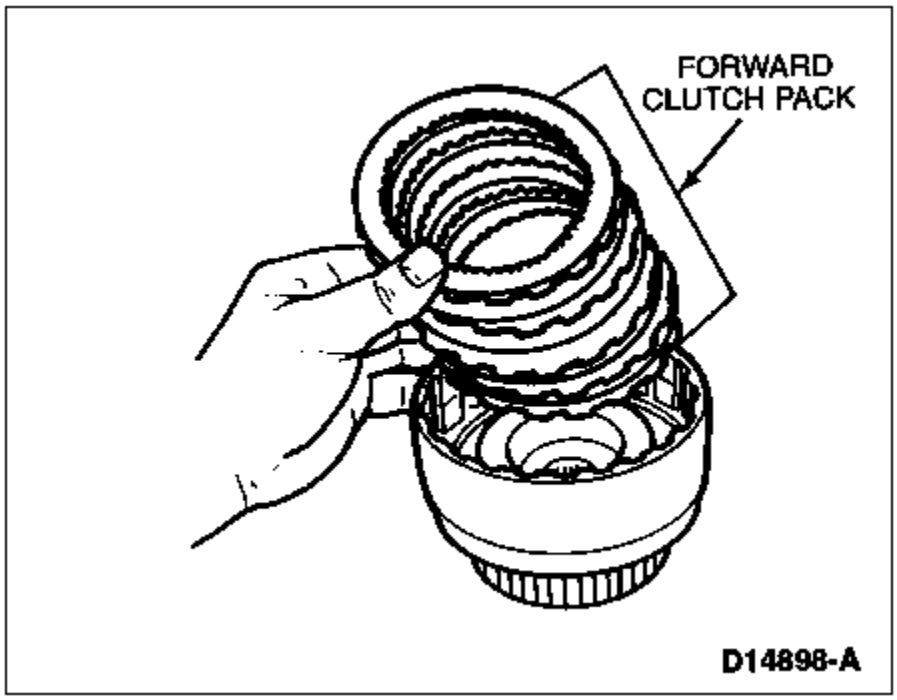
Remove the forward clutch pack. Inspect for wear, damage or overheating. Replace as necessary.



3. **CAUTION: Do not fully compress the clutch spring compressor or damage to the spring retainer may occur.**

   Compress the forward clutch piston springs with Clutch Spring Compressor T65L-77515-A. Remove the retaining ring.

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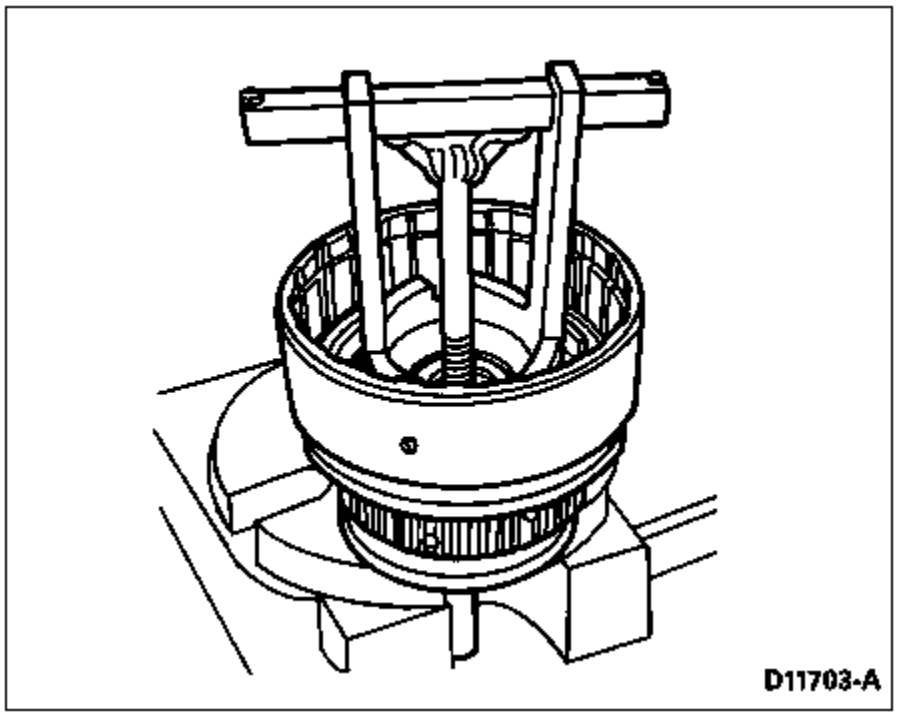

4. **WARNING: CAREFULLY RELEASE THE TOOL PRESSURE ON THE FORWARD CLUTCH PISTON SPRINGS AND REMOVE THE TOOL.**

   Remove the clutch spring compressor from the forward clutch cylinder.

5. **CAUTION: The forward clutch cushion spring is model dependent.**

   Remove the forward clutch piston spring retainer and 15 forward clutch piston springs. Remove the rubber forward clutch cushion spring. Replace as necessary.

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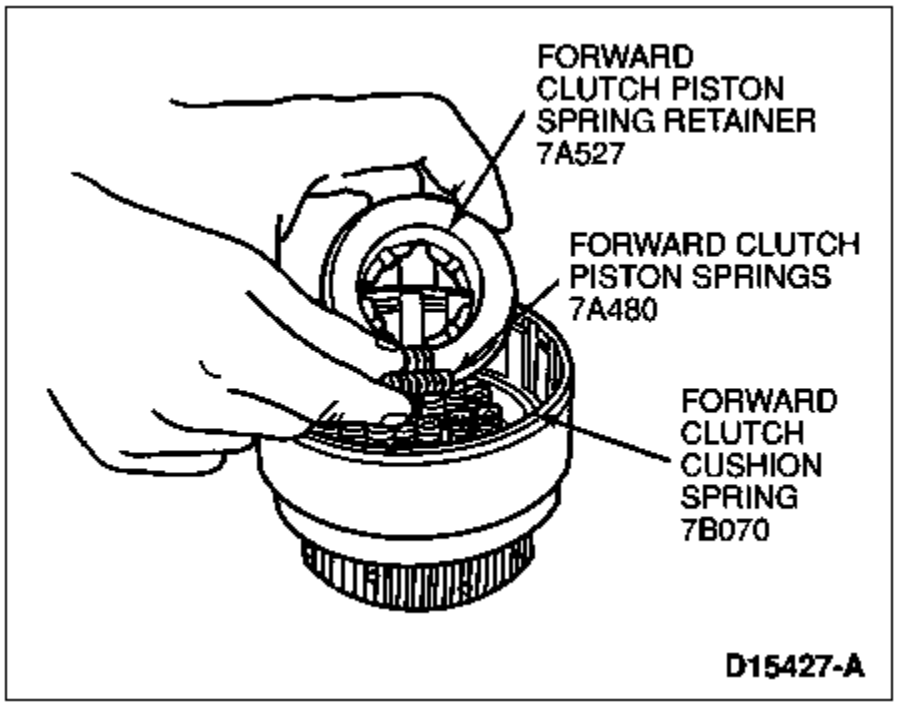

6. **WARNING: AIR PRESSURE MUST NOT EXCEED 138 KPA (20 PSI). WEAR SAFETY GLASSES WHEN USING COMPRESSED AIR. MAKE SURE THE CYLINDER IS FACING DOWN AS SHOWN.**

   NOTE: This is the middle-sized port.

   Use the center support to remove the forward clutch piston. Install the center support on the forward clutch cylinder. Apply air pressure to the far left port in the center support as shown.

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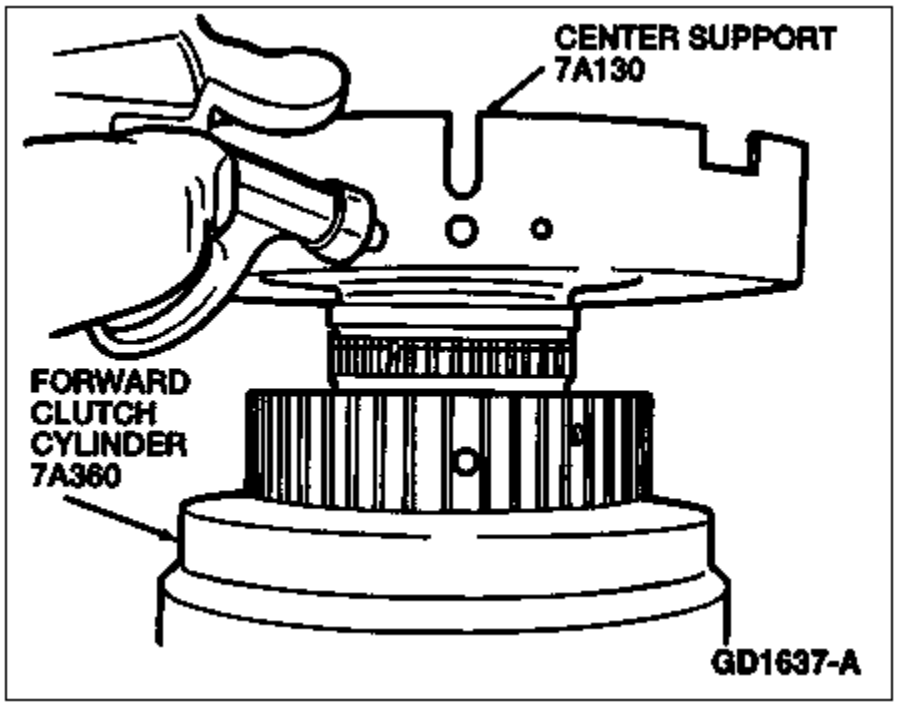
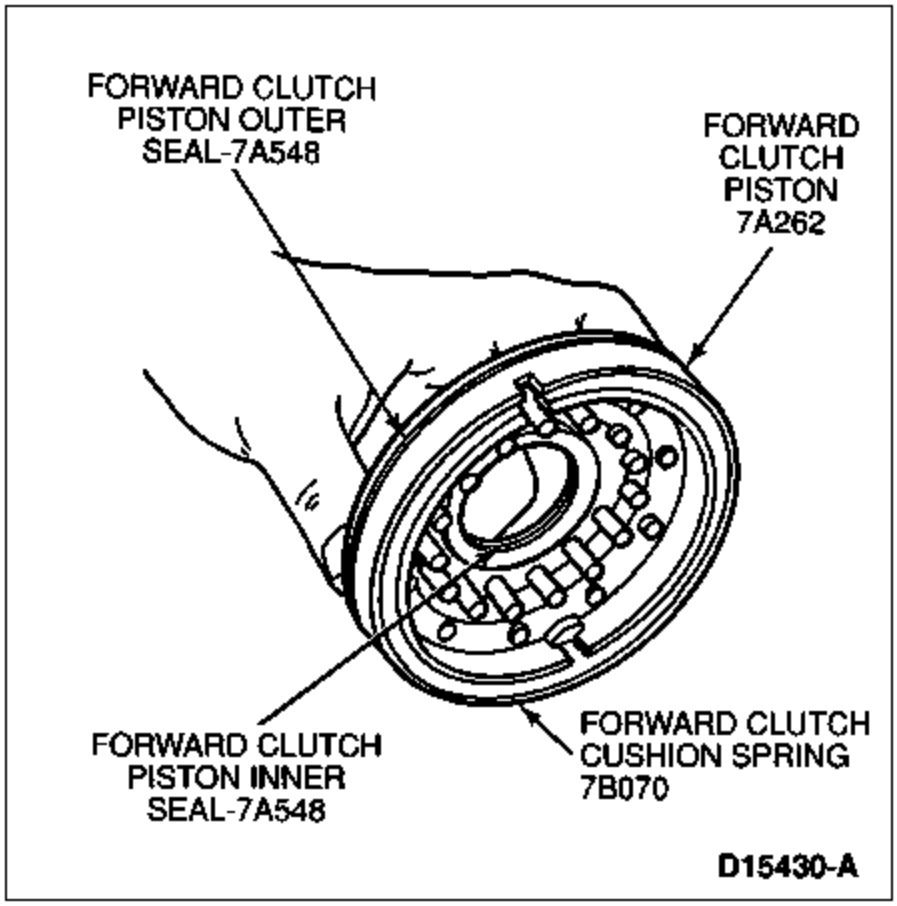


7. Remove the forward clutch piston inner and outer seals. Clean and replace as necessary.



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8. Inspect the forward clutch cylinder thrust surfaces, piston bore and clutch plate serration for scores or burrs. Minor scores or burrs may be removed with a crocus cloth. Replace the forward clutch cylinder if it is badly scored or damaged.

9. Check the fluid passages in the forward clutch cylinder for obstructions. Clean out all passages. Inspect the forward clutch piston for scores and replace if necessary. Inspect the piston check ball for freedom of movement and proper seating.

10. Check the clutch release springs for distortion and cracks. Replace the springs if they are distorted or cracked.

11. Inspect the friction clutch plates, steel clutch plates and clutch pressure plate for worn or scored bearing surface. Replace all parts that are deeply scored.

12. Check clutch plates for flatness and fit on the clutch hub serrations. Discard any plate that does not slide freely on the serrations or that is not flat.

13. Check clutch hub thrust surfaces for scores and clutch hub splines for wear.

14. **NOTE: The check ball is located in the piston.**

    Make sure the check ball is free and clear of debris prior to installing the forward clutch piston.

15. Inspect bearing and seal rings for damage.

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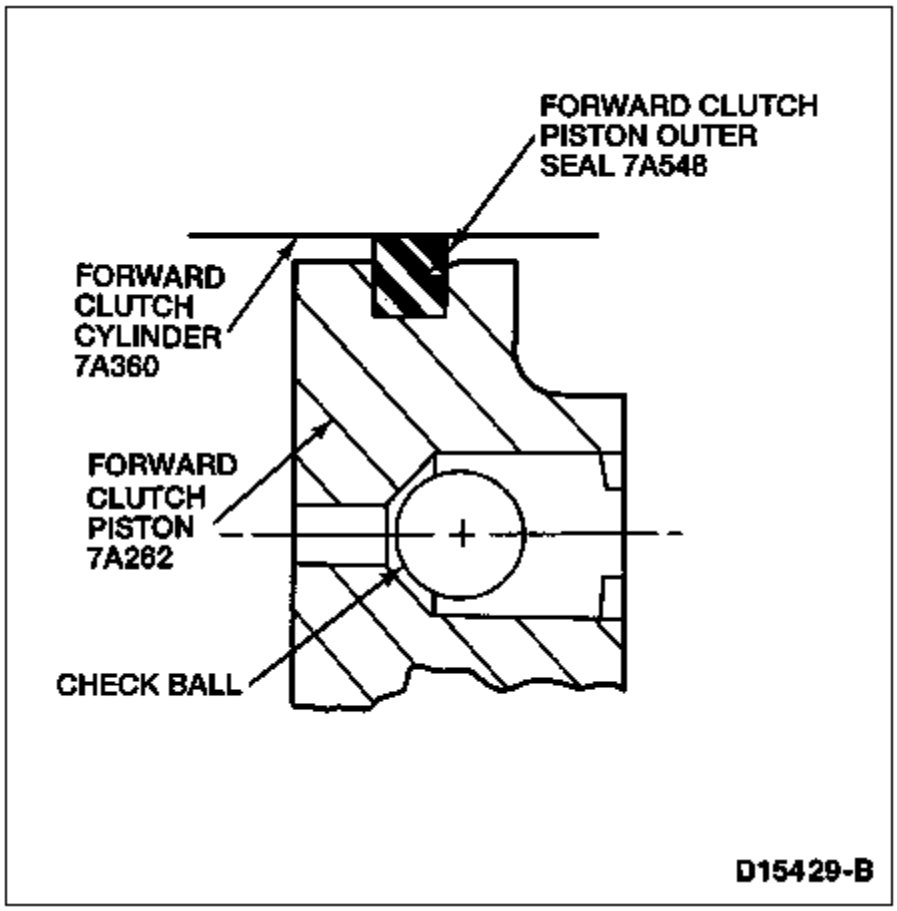

Assembly

1. **CAUTION: If there is evidence of clutch plate burning, replace the forward clutch cushion spring.**

   Install new forward clutch piston inner and outer seals on the forward clutch piston. Install the forward clutch cushion spring.

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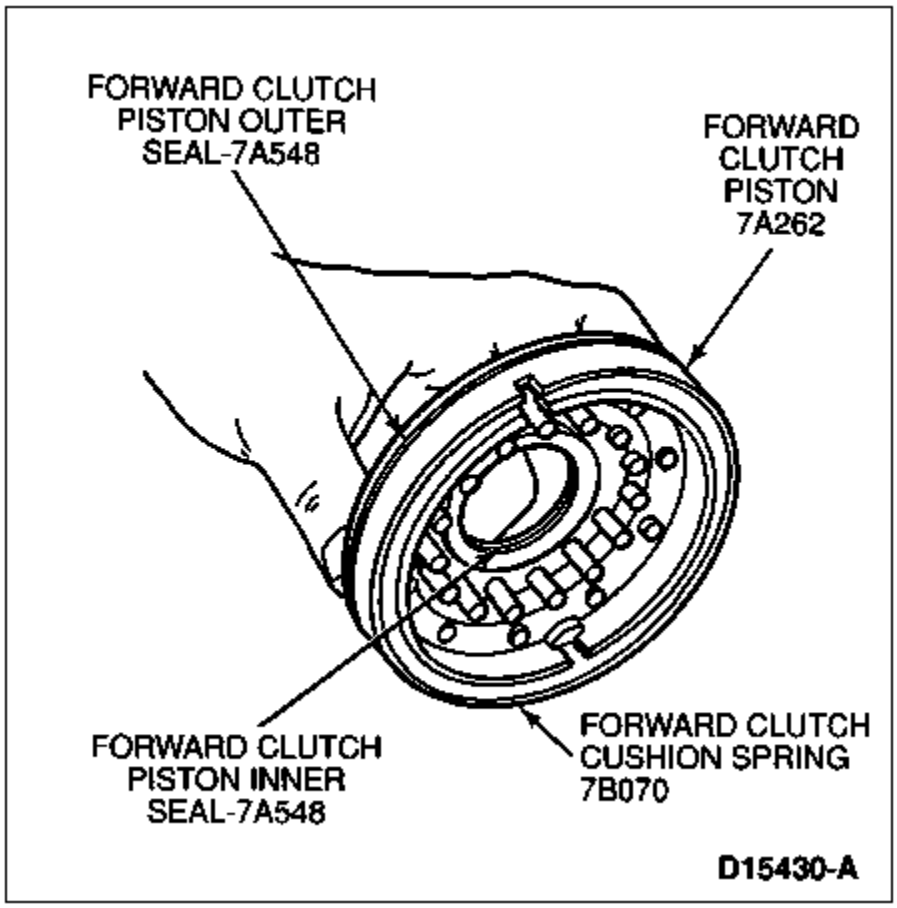

2. To prevent damage to the forward clutch piston outer seal, install Lip Seal Protector T74P-77548-B. To prevent damage to the forward clutch piston inner seal install Lip Seal Protector T74P-77548-A into forward clutch cylinder.

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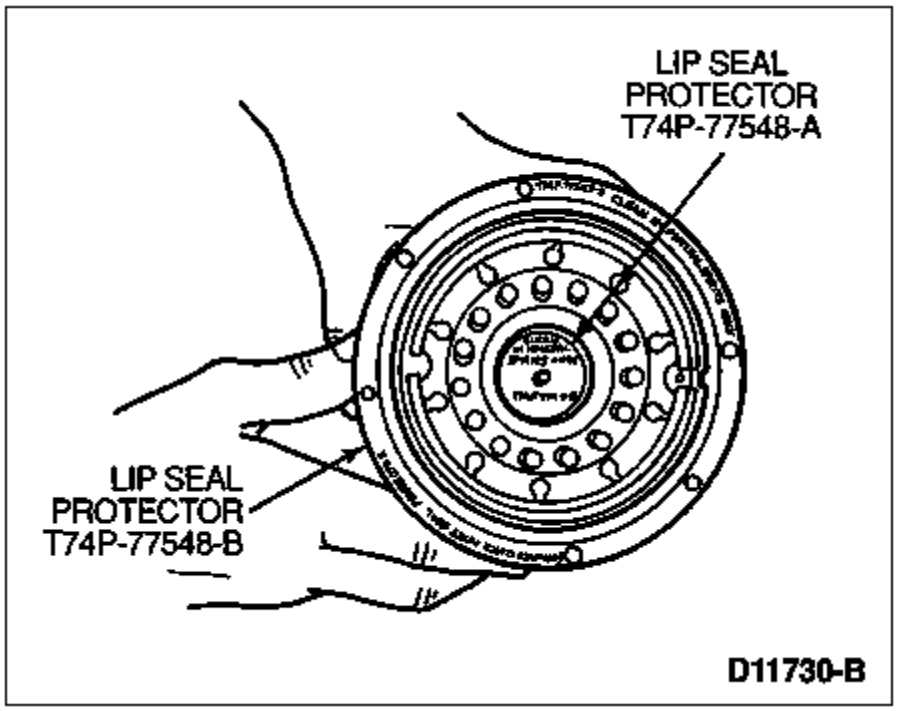

3. **CAUTION: Care must be taken to prevent damage to the seals.**

   NOTE: Apply petroleum jelly to the inner and outer seals.

   Carefully install the forward clutch piston into the forward clutch cylinder.

4. Carefully remove Lip Seal Protector T74P-77548-A and Lip Seal Protector T74P-77548-B from the forward clutch cylinder.

5. Install the 15 forward clutch piston springs and forward clutch piston spring retainer.

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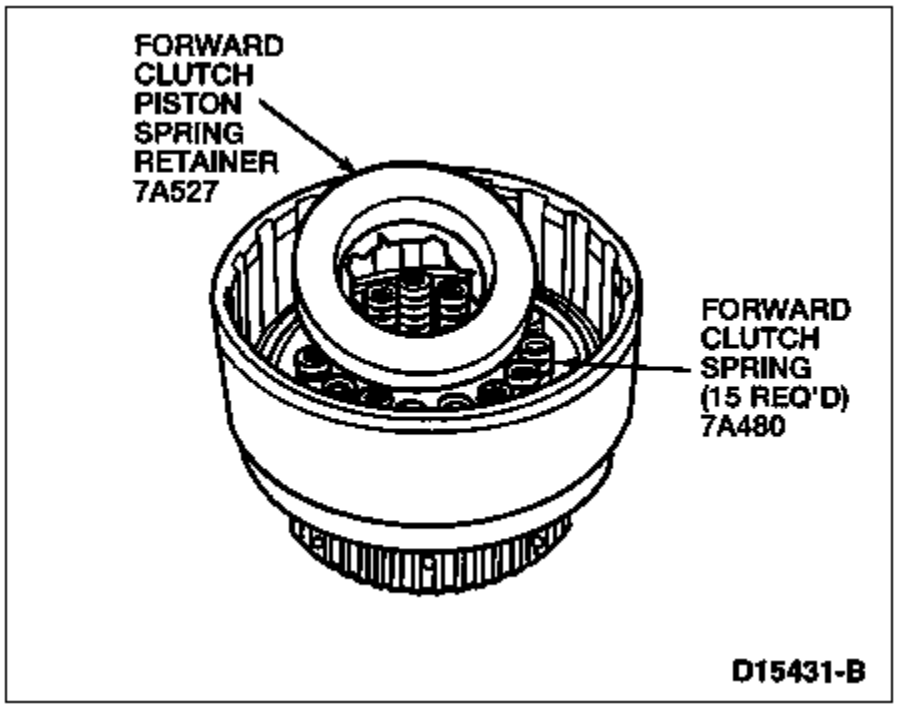
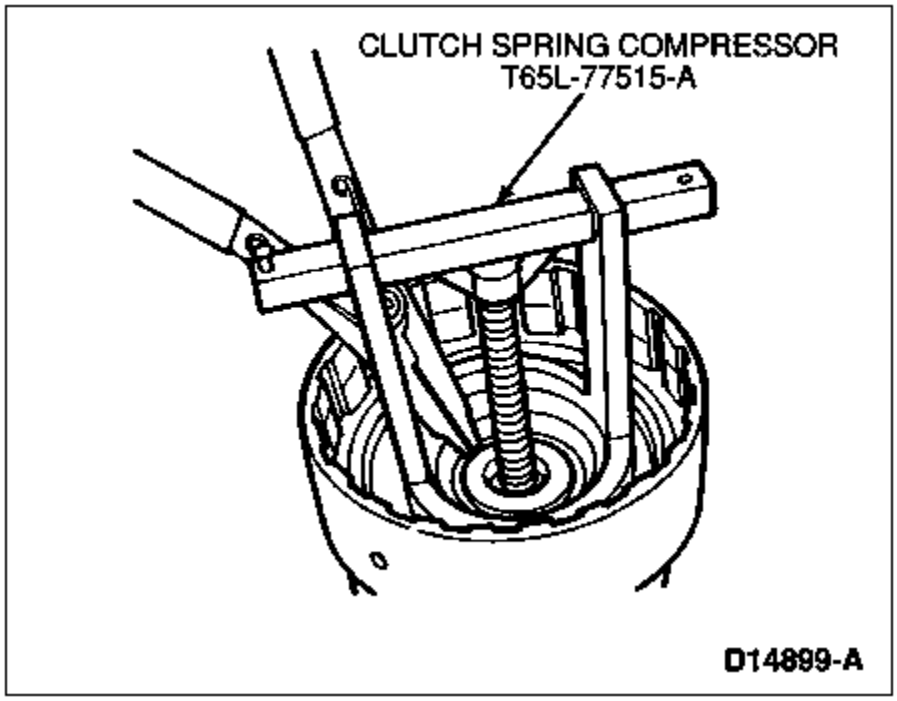


6. **CAUTION: Do not fully compress the clutch spring compressor or damage to the forward clutch piston spring retainer may occur.**

   Compress the clutch piston springs with Clutch Spring Compressor T65L-77515-A and install the retaining ring. Release the load on the forward clutch piston springs and remove the tool.



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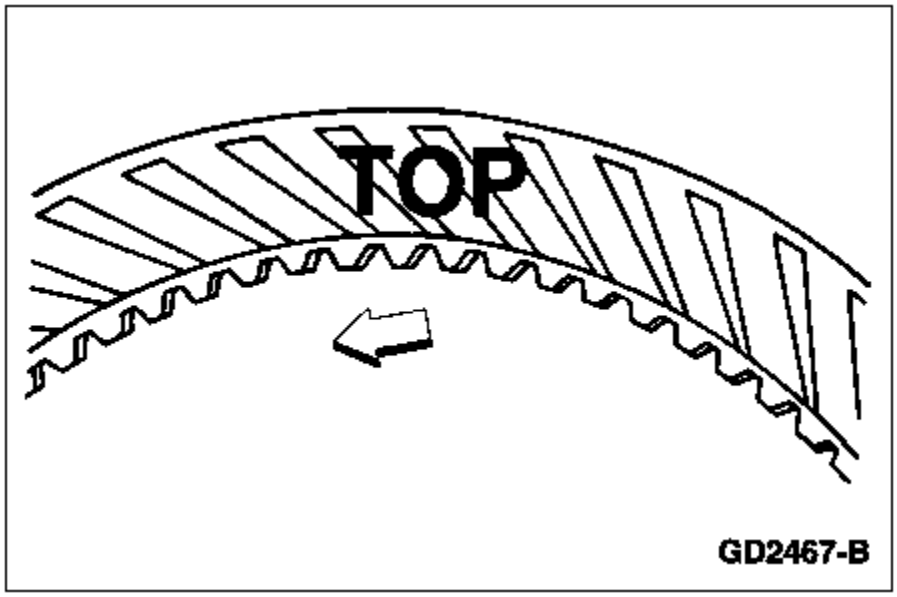
7. **CAUTION: Friction plates are directional and must be installed with groove counterclockwise (I.D. to O.D.). The word "TOP" should face up.**

   CAUTION: If new plates are being used, they should be soaked in clean transmission fluid for at least 30 minutes before assembly.

   When installing friction plates, the word "TOP" should face up. If reusing plates, grooves must be installed counterclockwise.



   Install the steel clutch plates and friction clutch plates in alternating order, starting with a steel plate and finishing with a friction plate.

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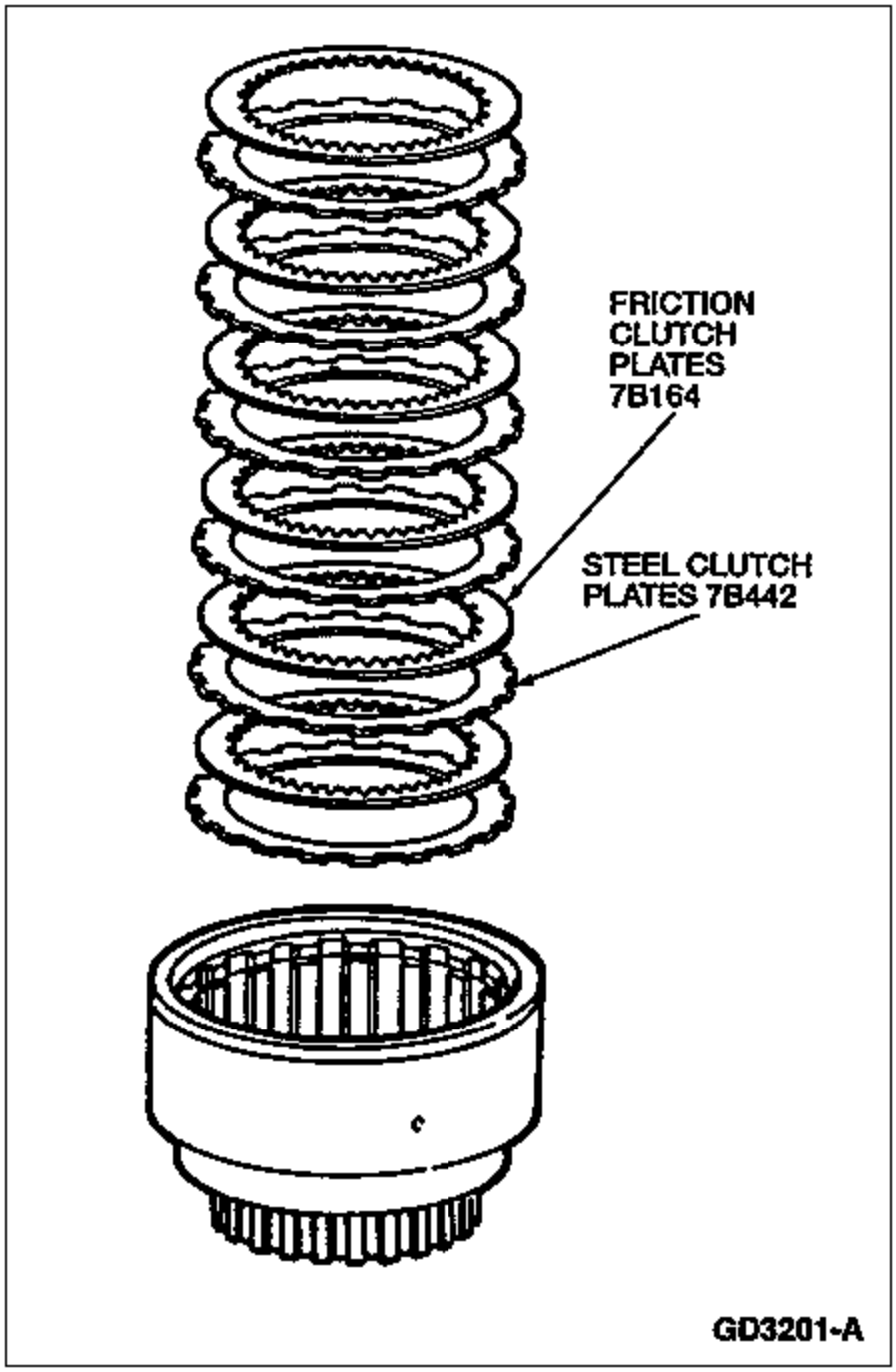

CLUTCH PACK

Engine	Steel	Friction
4.0L-EFI	6	6
4.0L-SOHC	6	6

8. **CAUTION: The retaining ring is a select fit.**

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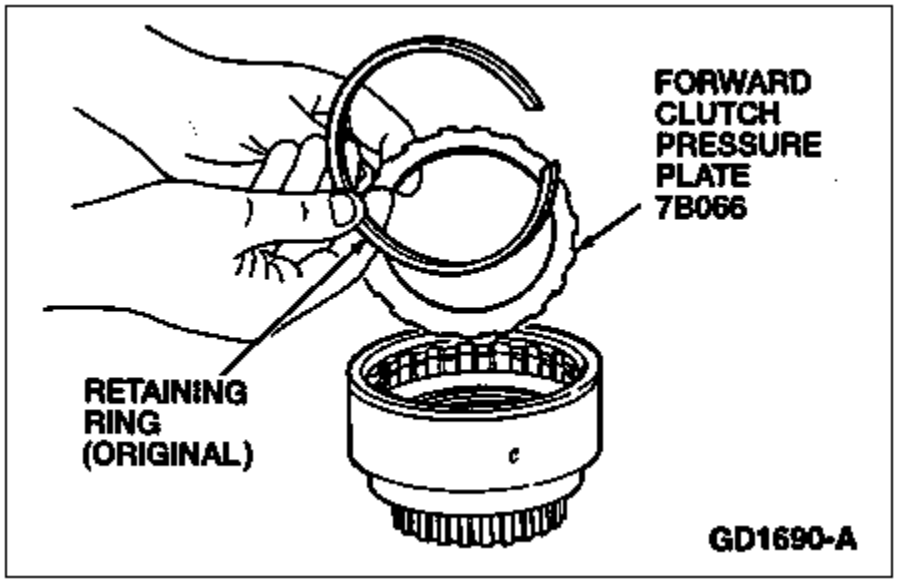
Install the forward clutch pressure plate on the clutch pack. Install the original retaining ring.



9. **WARNING: DO NOT EXCEED 138 KPA (20 PSI). WEAR SAFETY GLASSES WHEN USING COMPRESSED AIR. MAKE SURE THE DRUM IS FACING DOWN AS SHOWN.**

   NOTE: The forward clutch piston must apply with air pressure and release when the air is removed.

   Install the center support on the forward clutch cylinder. Apply air pressure to the far left port in the center support as shown.

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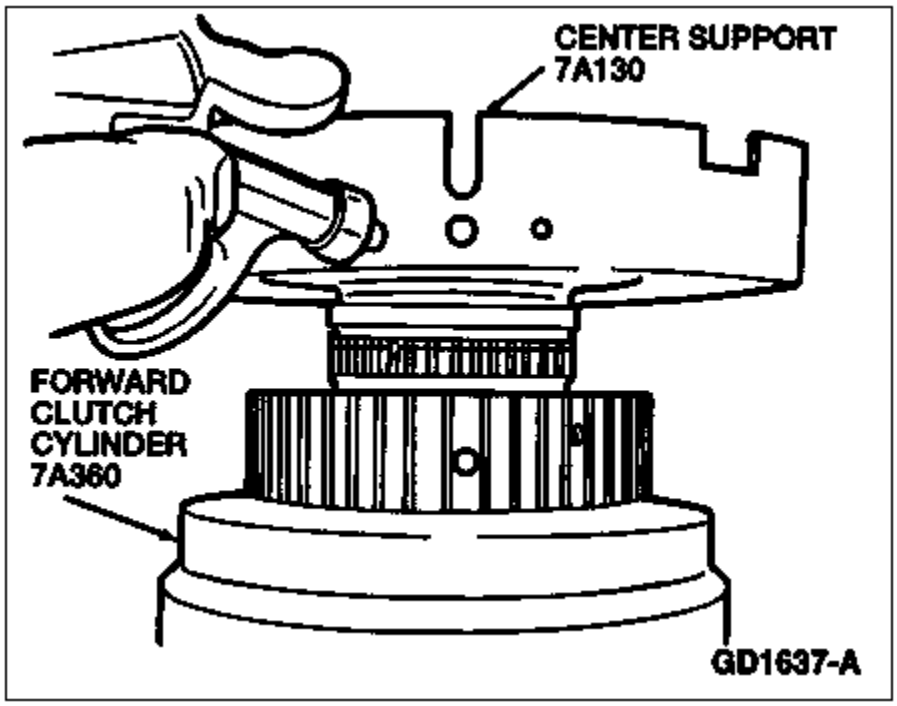
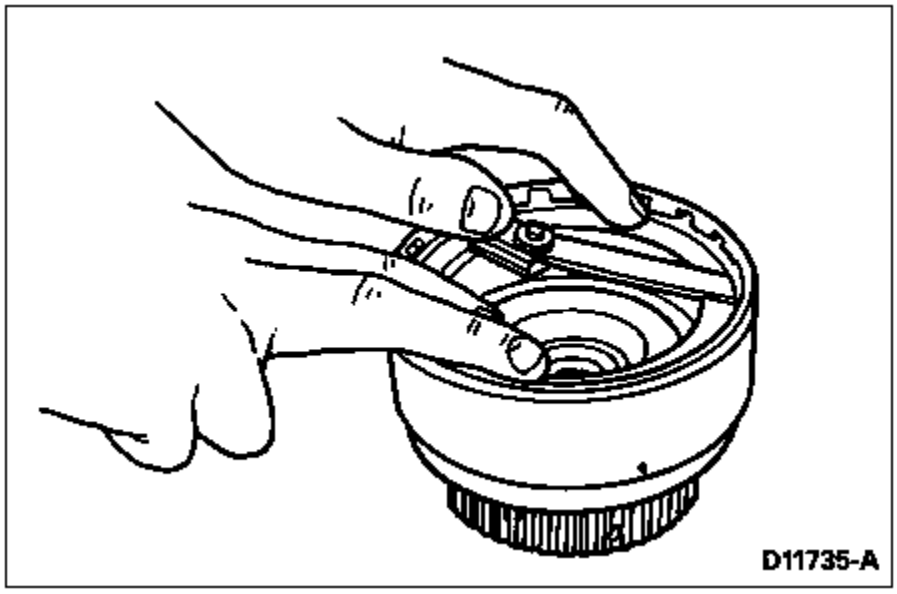


10. Push down on the clutch pack. Use a feeler gauge to check the gap between the retaining ring and the clutch pressure plate. Specification: 1.4 to 2.1mm (.055 to .083 inch). If the reading is not within specifications, remove the retaining ring and check the thickness. Replace the retaining ring with one that will provide correct free play. Verify free play with a feeler gauge.



FORWARD CLUTCH CYLINDER

	Thickness		Diameter	
Part Number	mm	Inches	mm	Inches

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E860115-S	1.37	.0539	125.1	4.925
E860116-S	1.73	.0681	125.1	4.925
E860117-S	2.08	.0819	125.1	4.925
E860118-S	2.44	.0961	125.1	4.925

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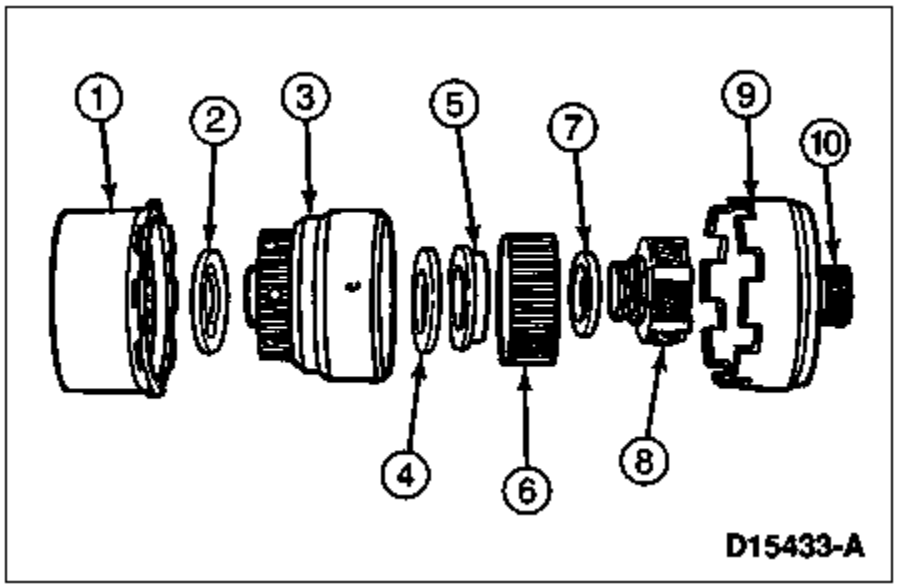
Forward Geartrain Assembly

Assembly



Item	Part Number	Description
1	—	Intermediate Brake and Direct Clutch Drum Assembly
2	7M153	No. 5 Forward Clutch Cylinder Thrust Bearing
3	—	Forward Clutch Cylinder Assembly
4	7D234	No. 6A Forward Ring Gear Hub Thrust Bearing Assembly
5	7D090	No. 6B Forward Clutch Thrust Washer
6	7D392	Forward Ring Gear
7	7F374	No. 7 Forward Planetary Thrust Bearing Assembly
8	7A398	Forward Planetary Assembly
9	7D064	Input Shell
10	7D063	Forward Sun Gear Assembly

1. Install the No. 5 forward clutch cylinder thrust bearing on the forward clutch cylinder assembly. Use petroleum jelly to hold the washer in place.

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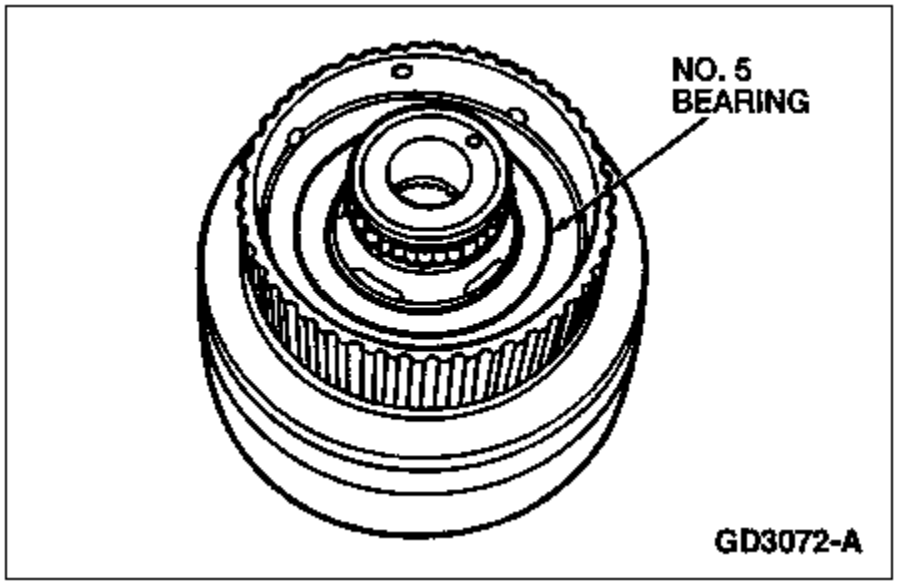
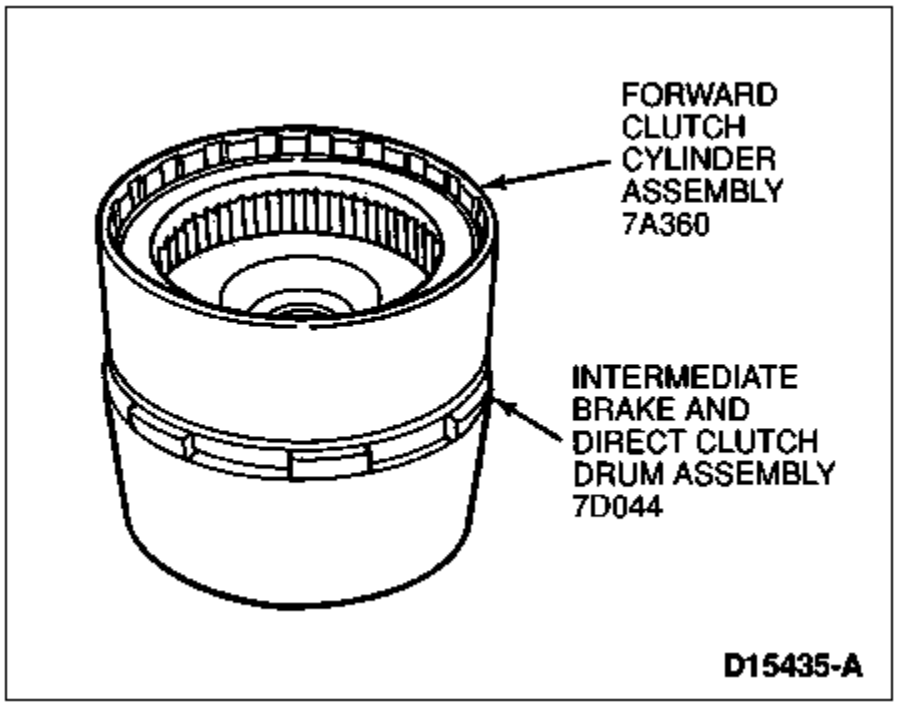


2. Install the forward clutch cylinder assembly into the intermediate brake and direct clutch drum assembly as shown.



3. Install the No. 6A forward ring gear hub thrust bearing into the forward clutch cylinder with the tabs facing up as shown.

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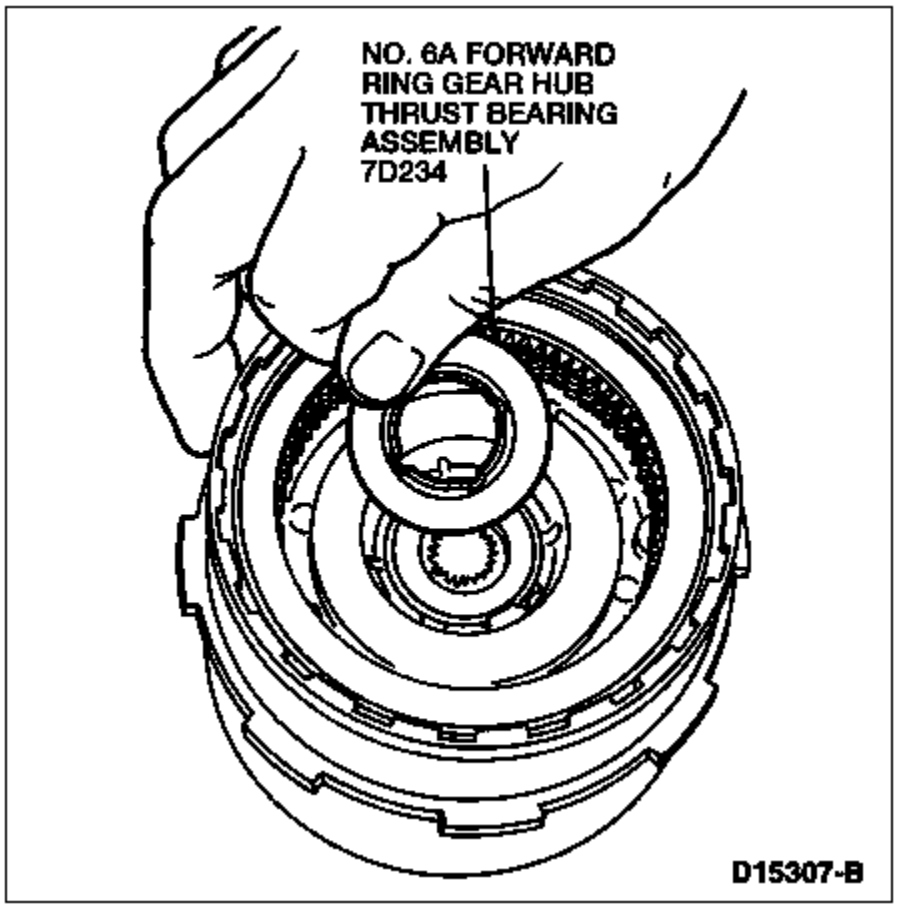

4. **NOTE: Use petroleum jelly to hold the washer in place.**

   Install the No. 6B forward clutch thrust washer into the forward ring gear hub.

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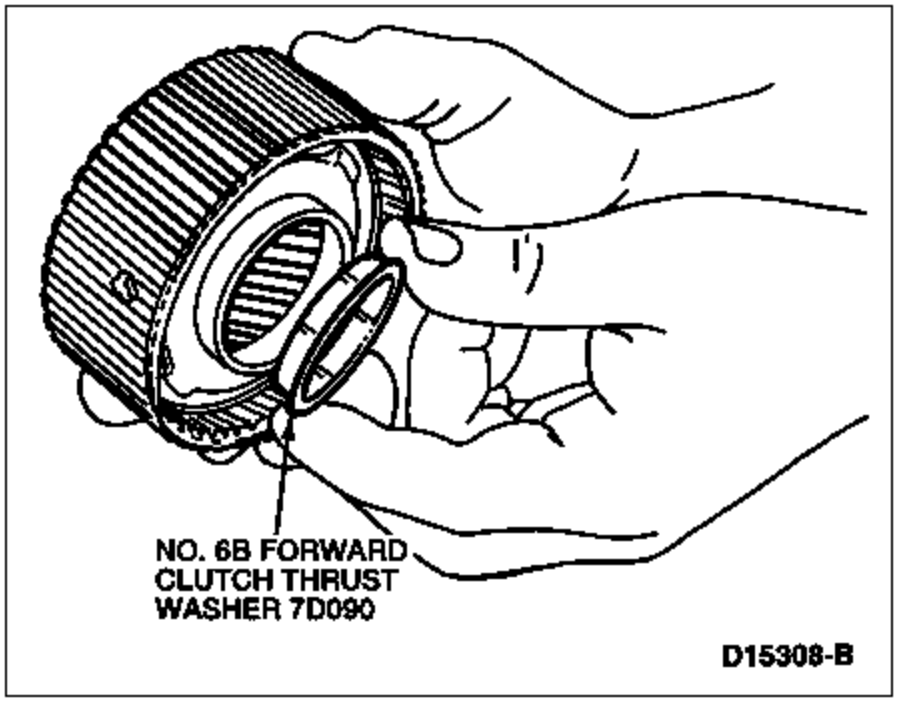

5. **NOTE: Make sure the No. 6A bearing and No. 6B forward clutch thrust washer assembly are inside the forward ring gear.**

   Install the forward ring gear and forward clutch thrust washer into the forward clutch cylinder assembly as shown.

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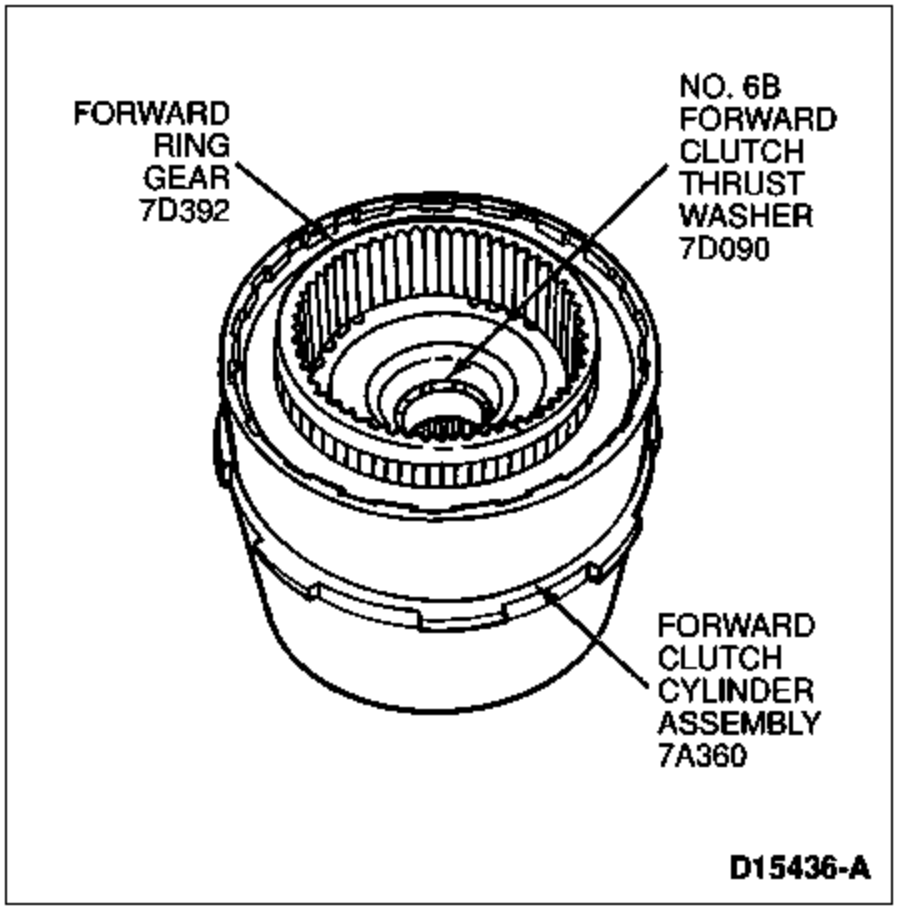

6. **CAUTION: Black oxidized color of thrust bearing must face up toward planetary assembly.**

   Install the No. 7 forward planetary thrust bearing into the forward ring gear as shown.

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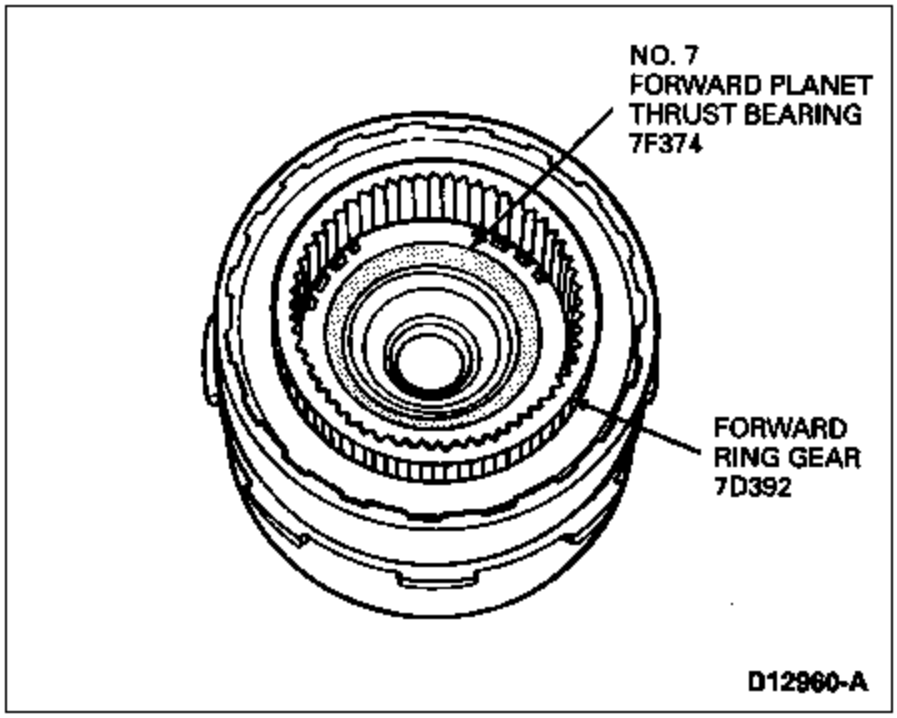
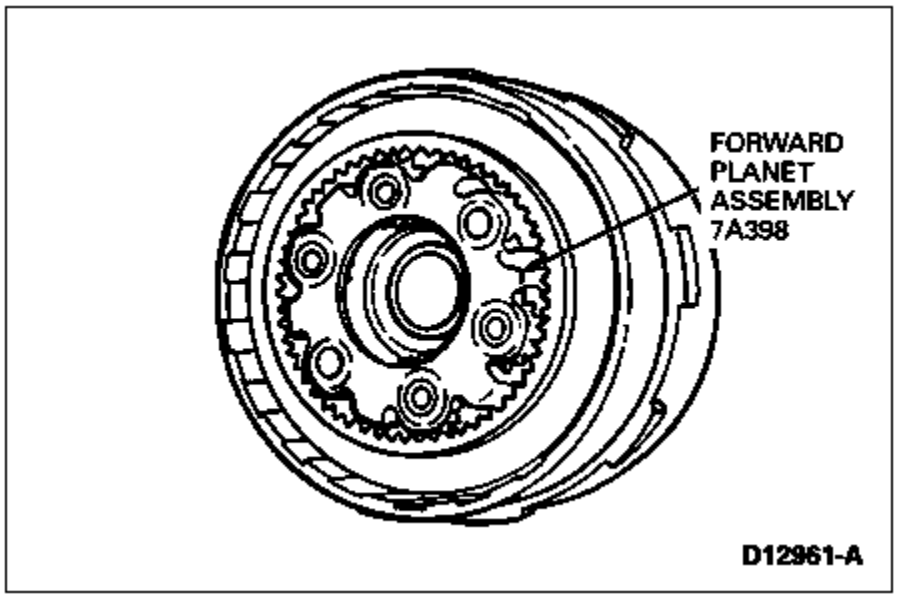


7. **NOTE: All service replacements are 6 pinion only.**

   Install the forward planetary assembly into the forward ring gear as shown.



8. **NOTE: If sun gear, retaining rings or input shell require service; perform steps a-e.**

   Inspect the drum gear, bushing and washer for scoring, wear or damage. Replace as required.

   a. Remove rear retaining ring and sun gear from input shell.

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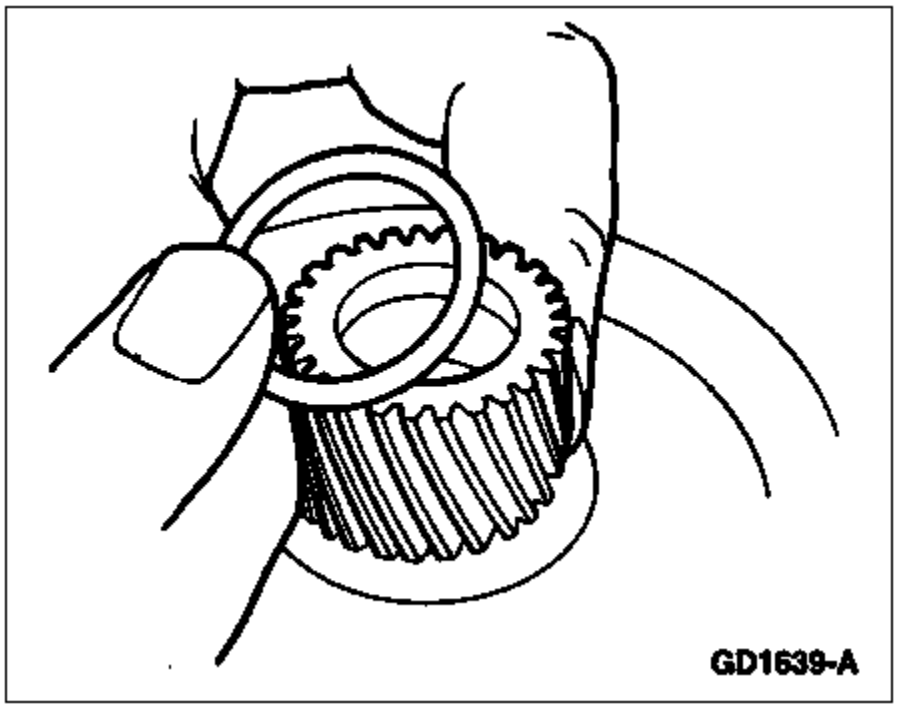
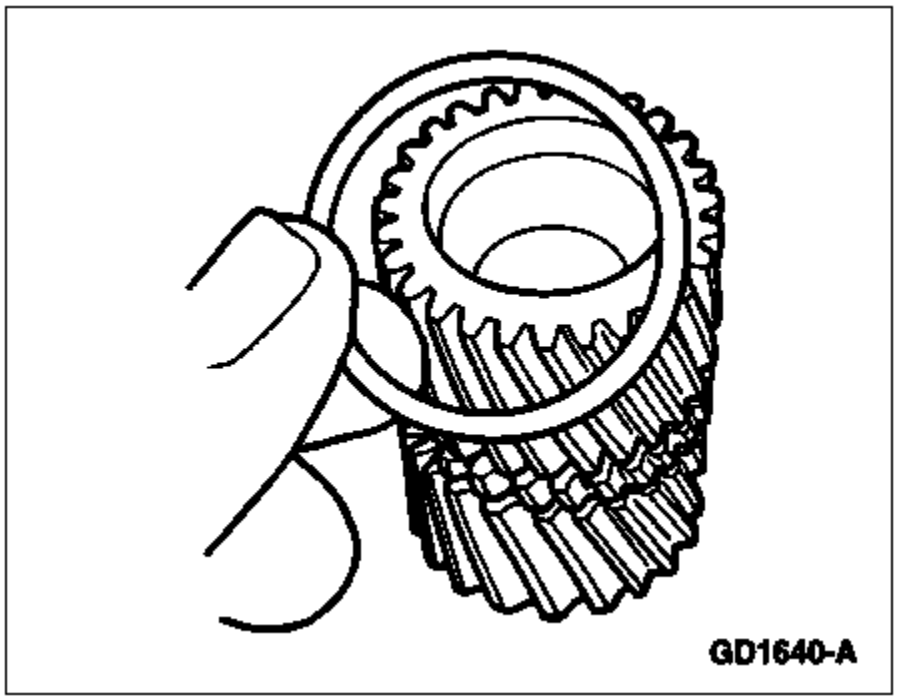


b. Remove front retaining ring from sun gear.



c. Install new retaining ring onto sun gear.

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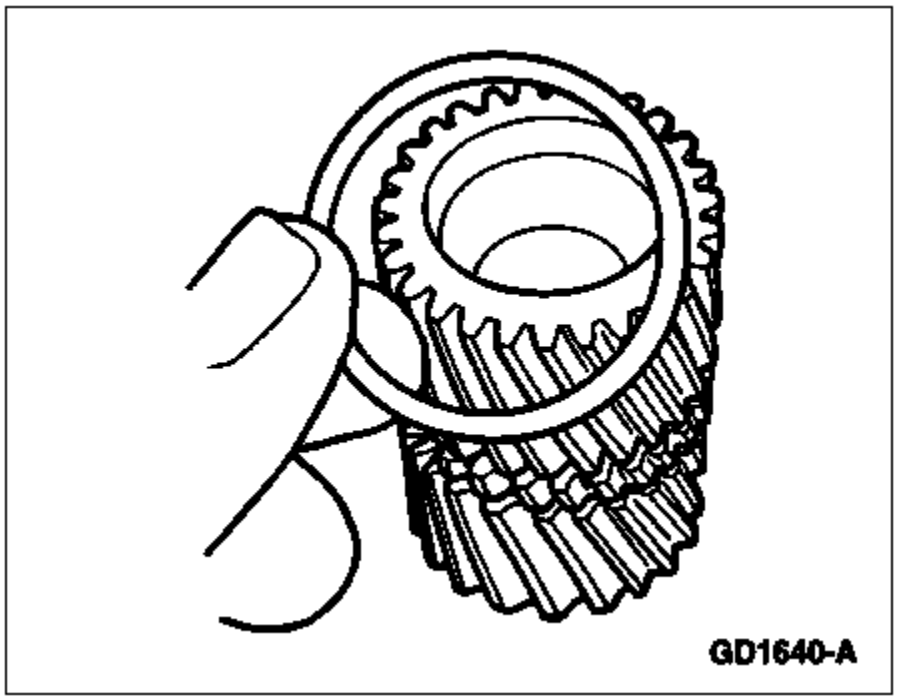
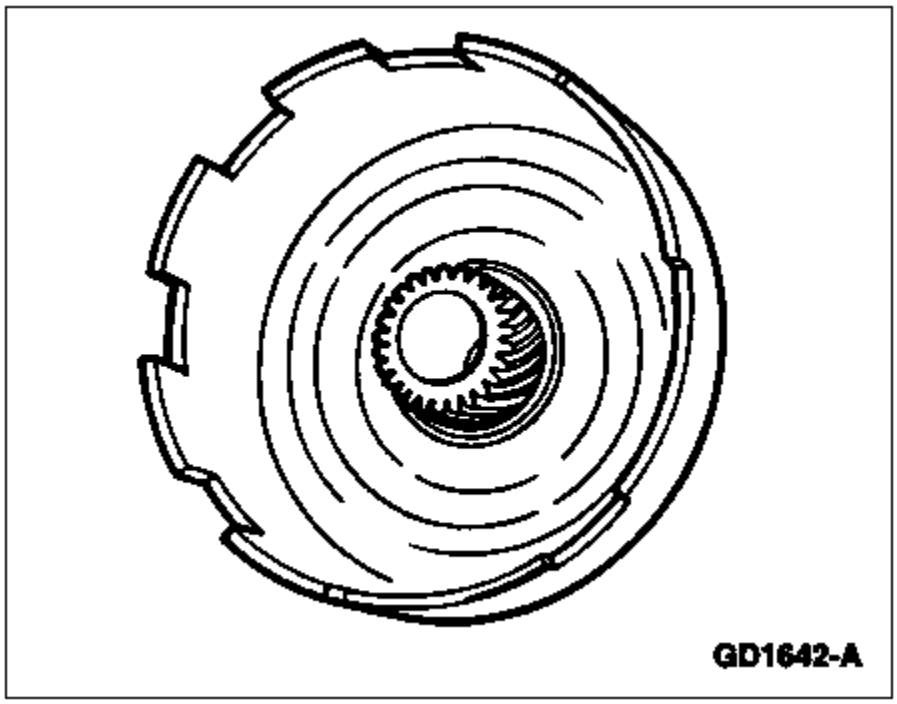


d. Install forward sun gear into input shell.



e. Install new rear retaining ring onto sun gear.

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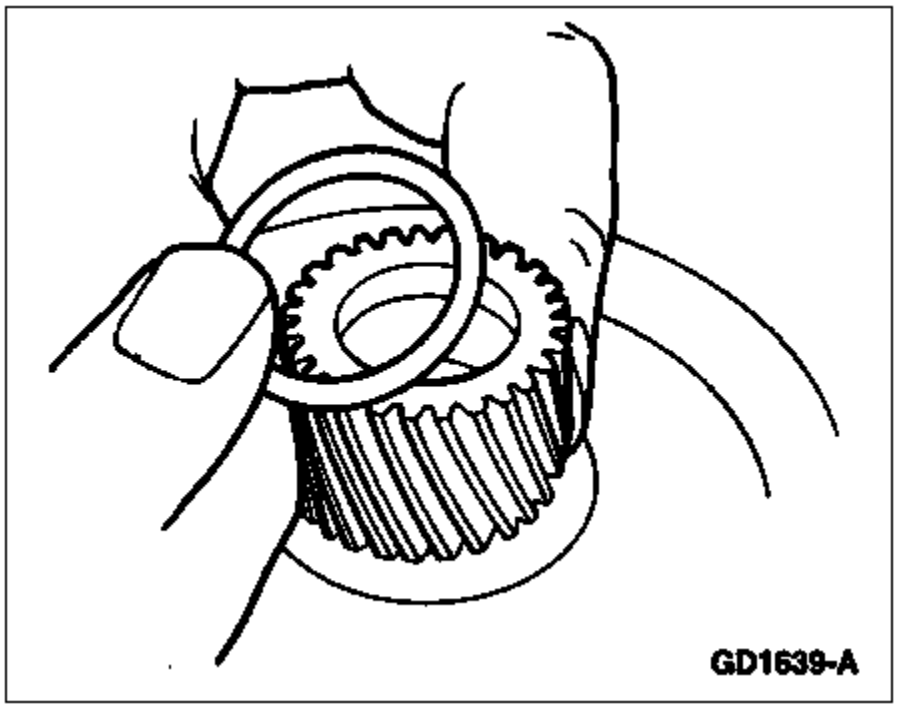
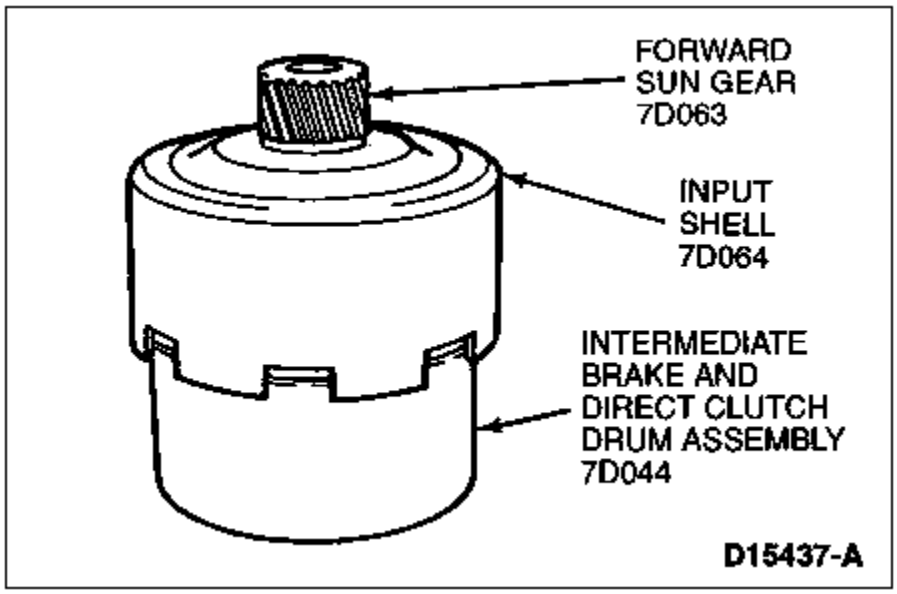


9. **NOTE: Make sure the forward sun gear aligns with the forward planetary assembly. Make sure the input shell aligns with the intermediate brake and direct clutch drum assembly as shown.**

   Install the input shell with forward sun gear assembly as shown.



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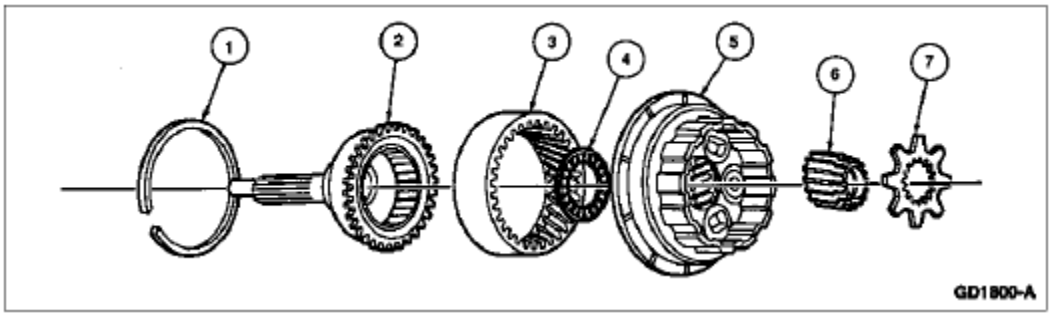
Overdrive Planetary and One-Way Clutch Assembly

Overdrive Planetary and One-Way Clutch Assembly



Item	Part Number	Description
1	W702037-S	Retaining Ring
2	7A658	Center Shaft Assembly
3	7653	Front Ring Gear
4	7L495	No. 2 Front Planetary Thrust Bearing
5	7B446	Front Planetary Gear Carrier Assembly
6	7D063	Front Sun Gear Assembly
7	7660	Coast Clutch Adapter

Disassembly

1. Remove the center shaft retaining ring from the front ring gear.

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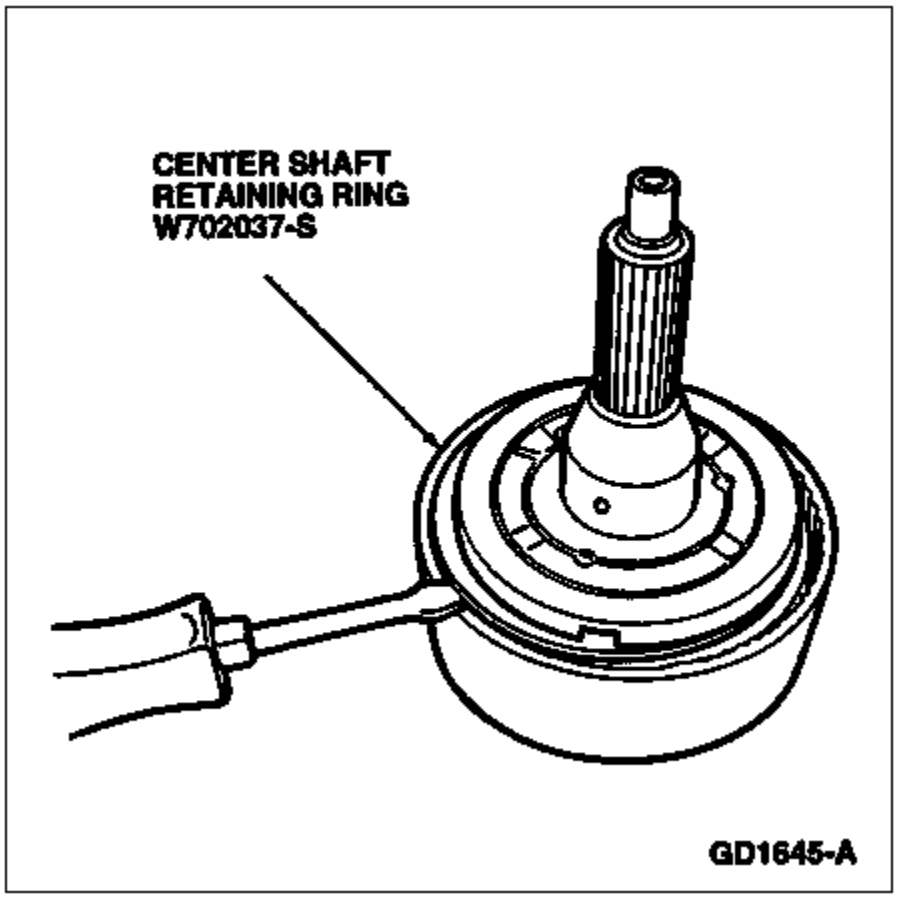
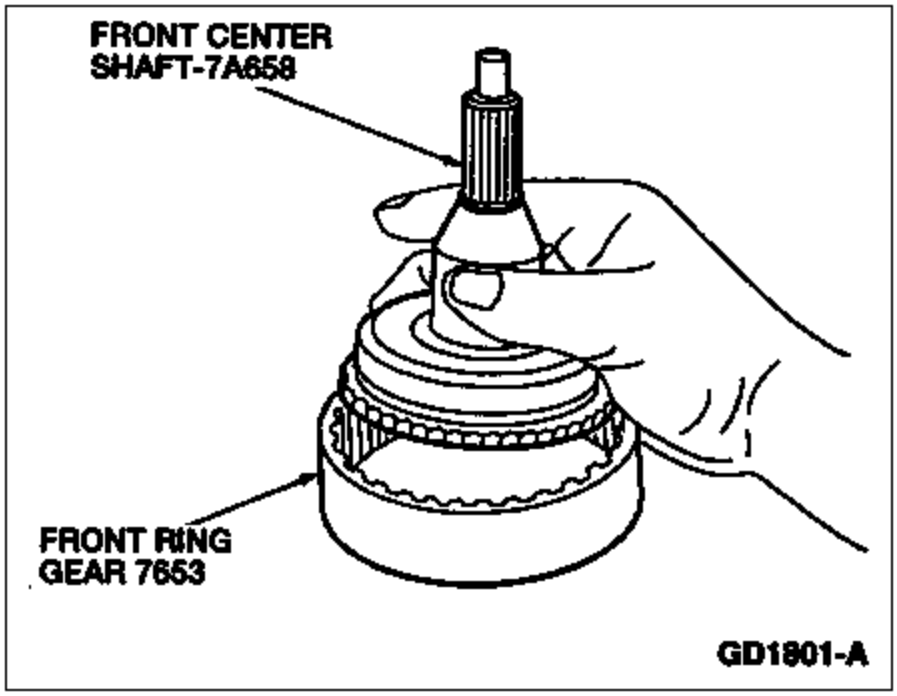


2. Remove the center shaft from the front ring gear.



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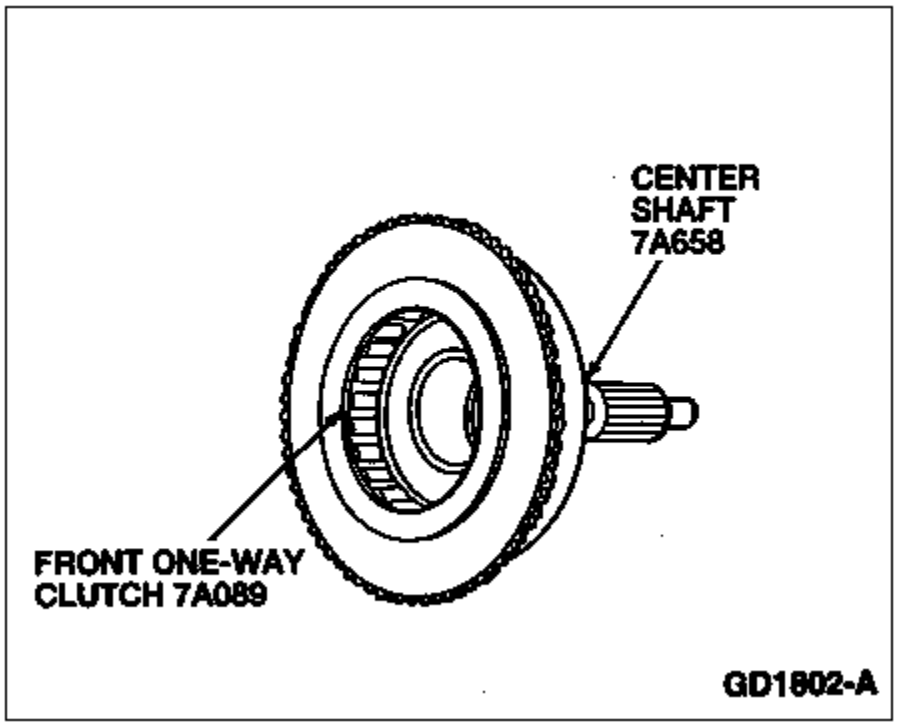
3. **CAUTION: Do not remove the front one-way clutch. Damage to the clutch may occur if it is removed.**

   NOTE: The front one-way clutch is serviced with the front center shaft.

   Clean and inspect the front one-way clutch and front center shaft assembly. Check for cracks in the roller cage and wear on the roller clutch. Inspect the press fit of the one-way roller clutch to the overdrive center shaft.

   Inspect the rollers and springs for excessive wear or damage.

   Inspect the spring and roller cage for bent or damaged spring retainers.



4. Temporarily insert the front planetary gear carrier assembly into the one-way clutch rollers for verification of the one-way clutch. The planetary must rotate counterclockwise and hold clockwise as shown. Remove the front planetary gear carrier assembly.

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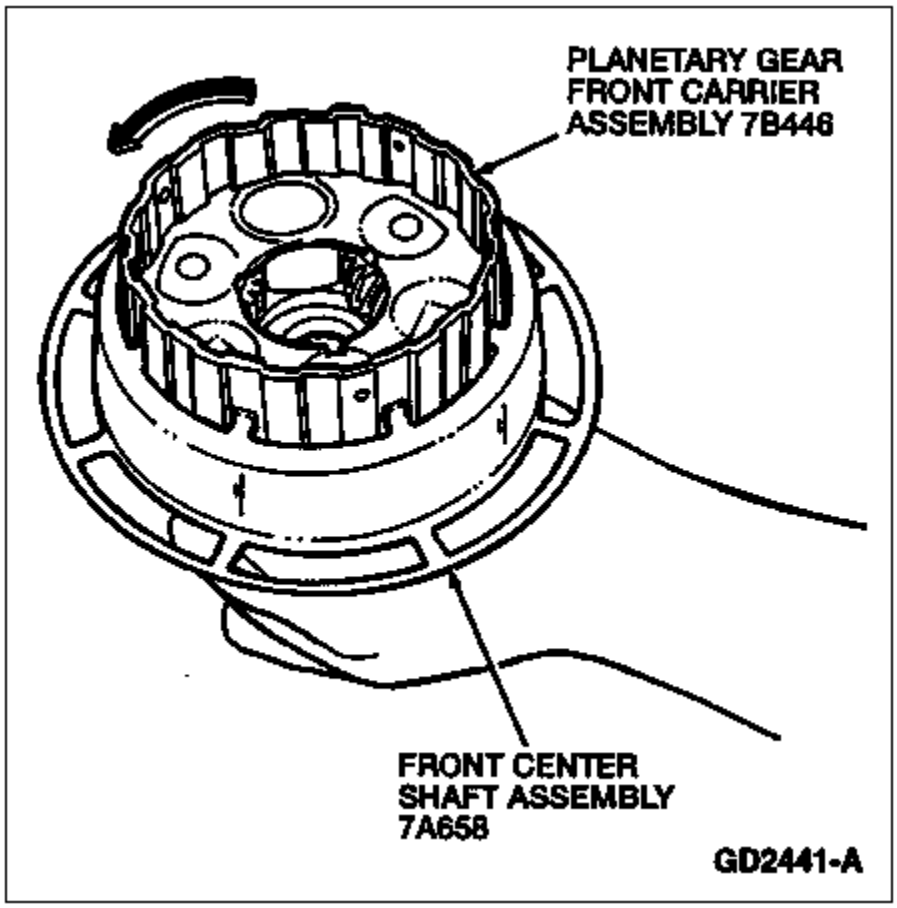

Assembly

1. Install the center shaft and front one-way clutch into the front ring gear.

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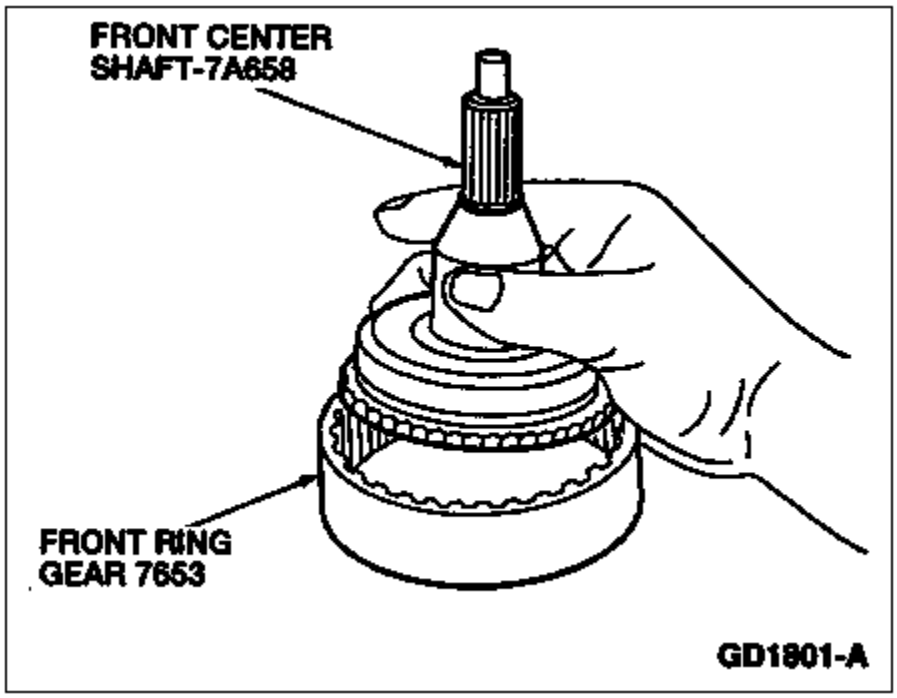
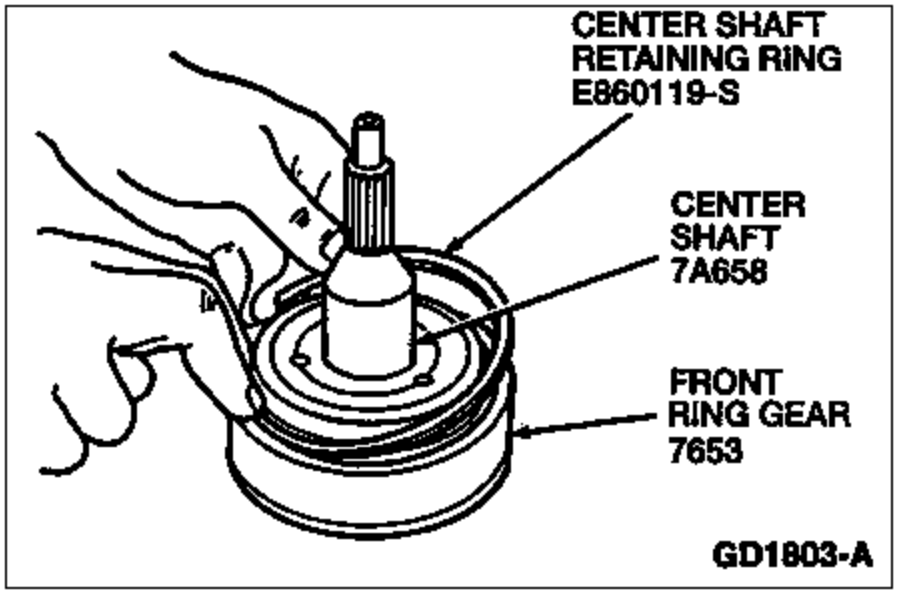


2. Install the center shaft retaining ring.



3. **CAUTION: Planetarys must be replaced. Do not restake.**

   NOTE: Individual parts of the planetary carriers are not serviceable.

   Check the pins and shafts in the planetary assemblies for loose fit and/or complete disengagement. Use a new planetary assembly if either condition exists. Before installing a planetary assembly, the shaft retaining pins should be checked for adequate staking.

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Inspect the pinion gears for damaged or excessively worn teeth.

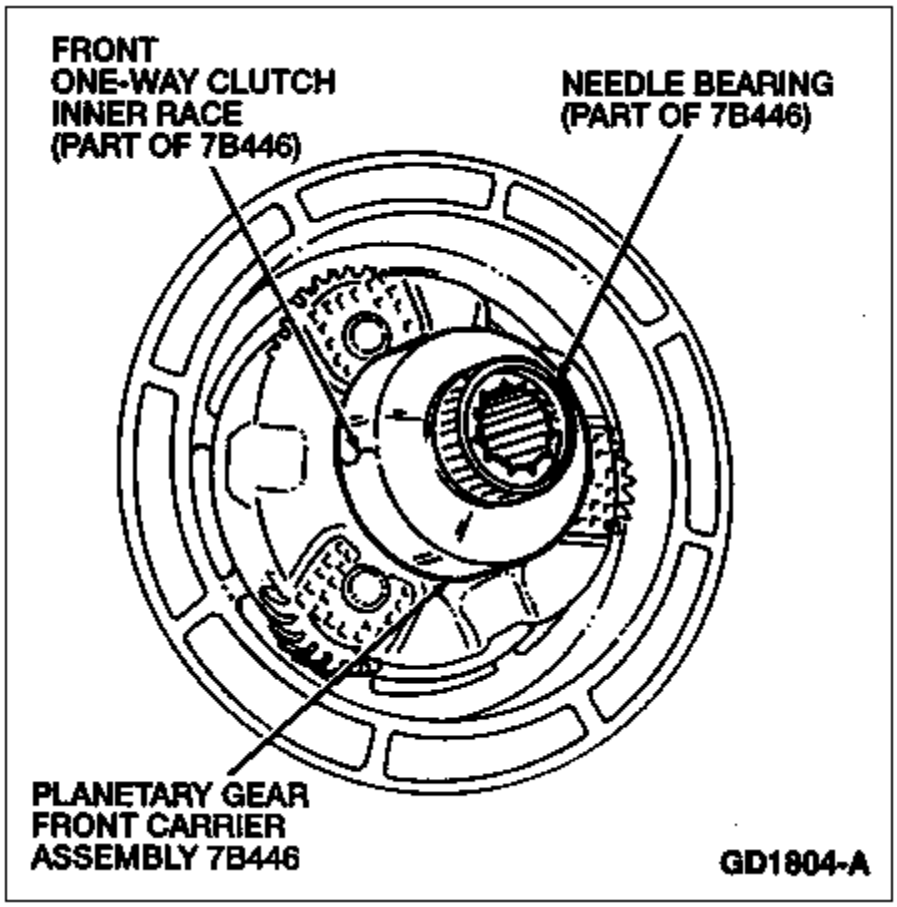
Check for free rotation of the pinion gears.

Inspect the overdrive one-way clutch inner race for scoring.

Check pinion bearing and gears.

Inspect the inner and outer races for scored or damaged surface areas where the rollers contact the races.

Inspect the needle bearing on the nose of the front planetary gear carrier assembly.



4. Remove and inspect the No. 2 planetary thrust bearing.

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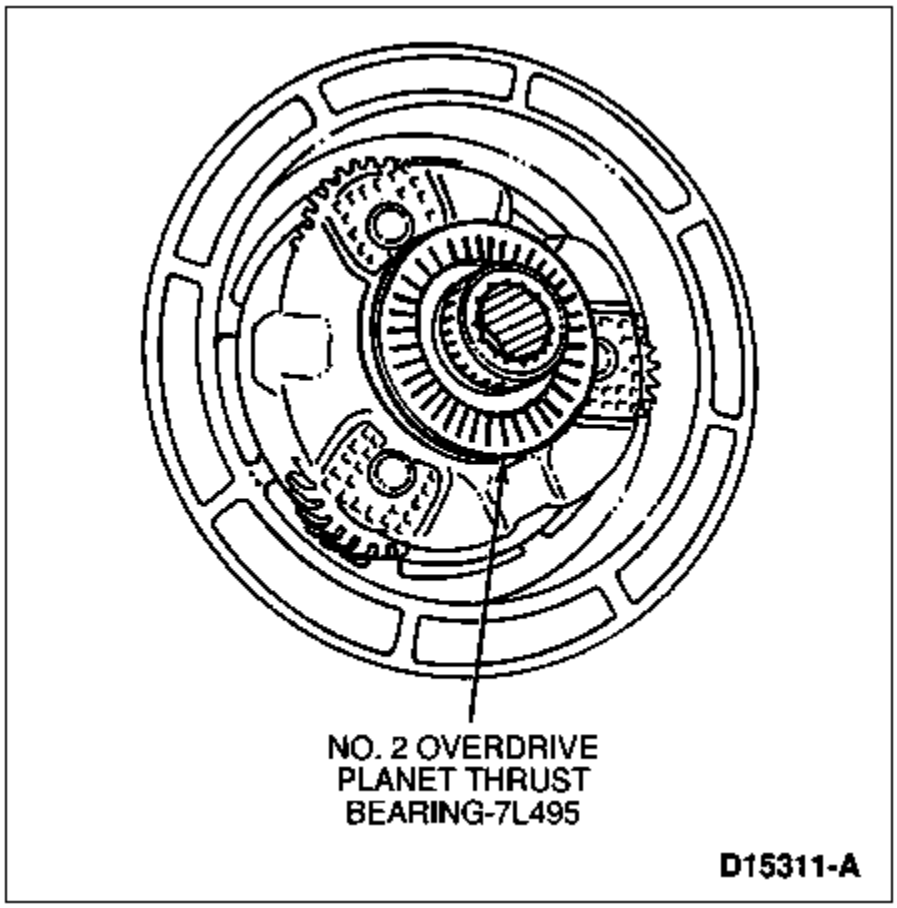

5. Remove coast clutch to front carrier adapter and front sun gear.

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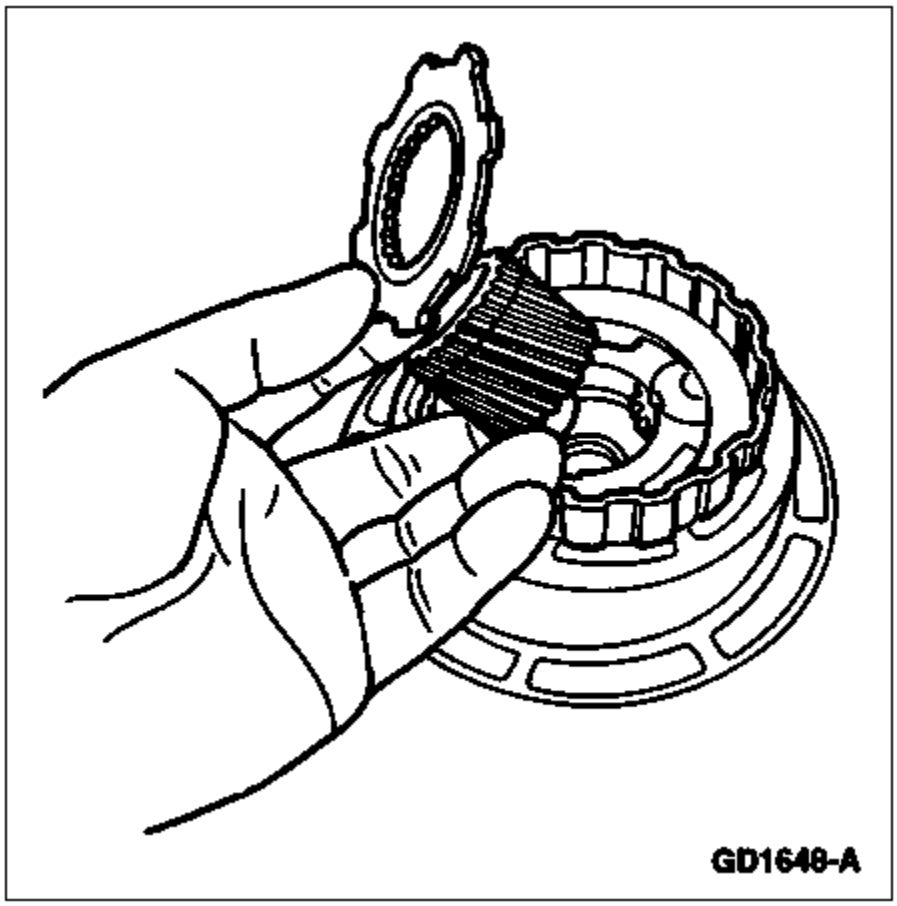

6. Inspect the No. 12 needle bearing inside the front planetary gear carrier.

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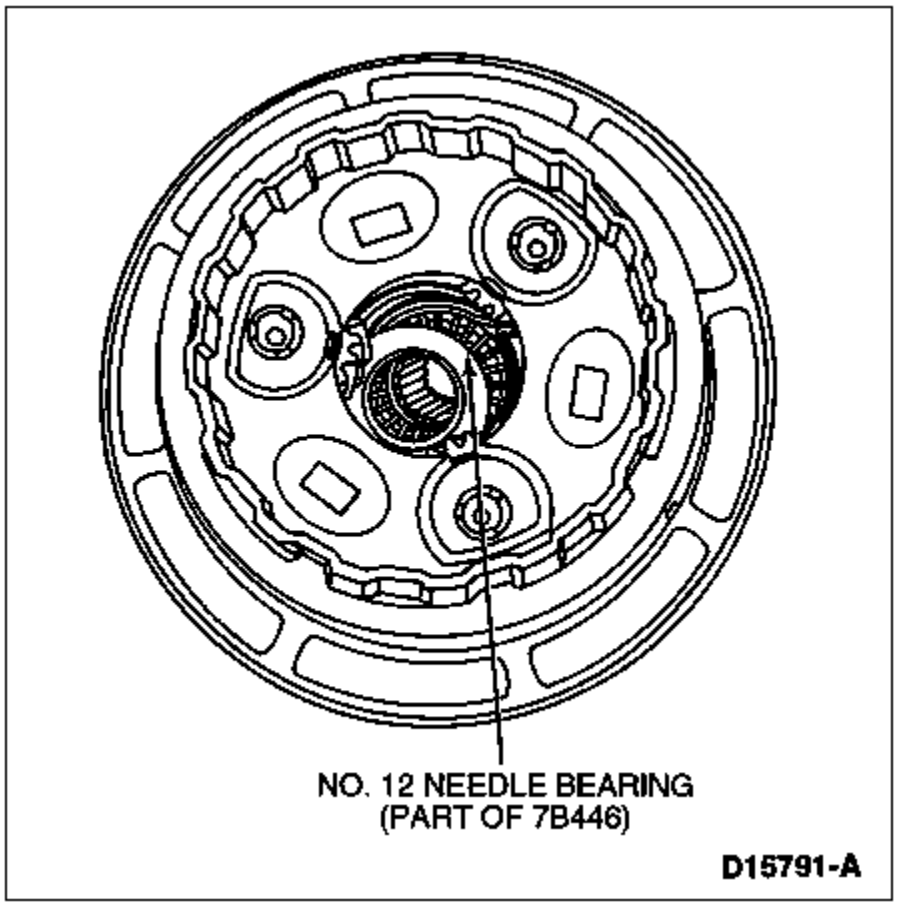

7. **NOTE: Use petroleum jelly to hold the No. 2 front planetary thrust bearing in place.**

   Install the No. 2 front planetary thrust bearing between the front center shaft face and the front planetary gear carrier assembly.

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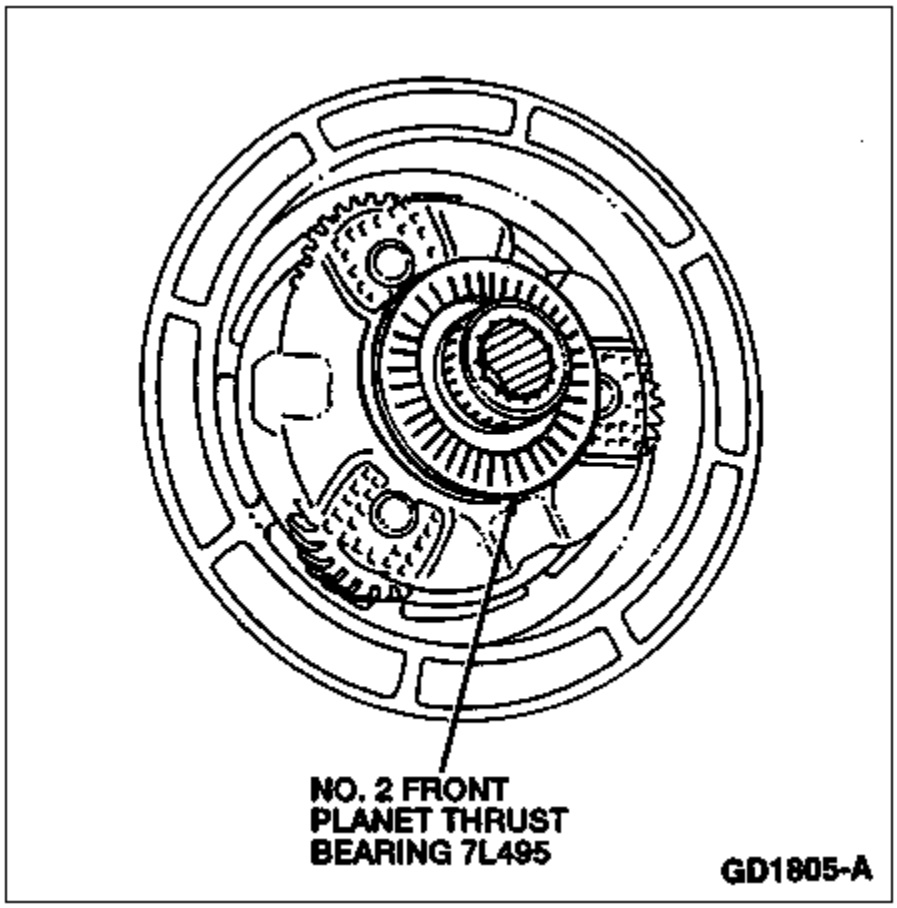

8. Install the front planetary gear carrier into the center shaft and front ring gear.

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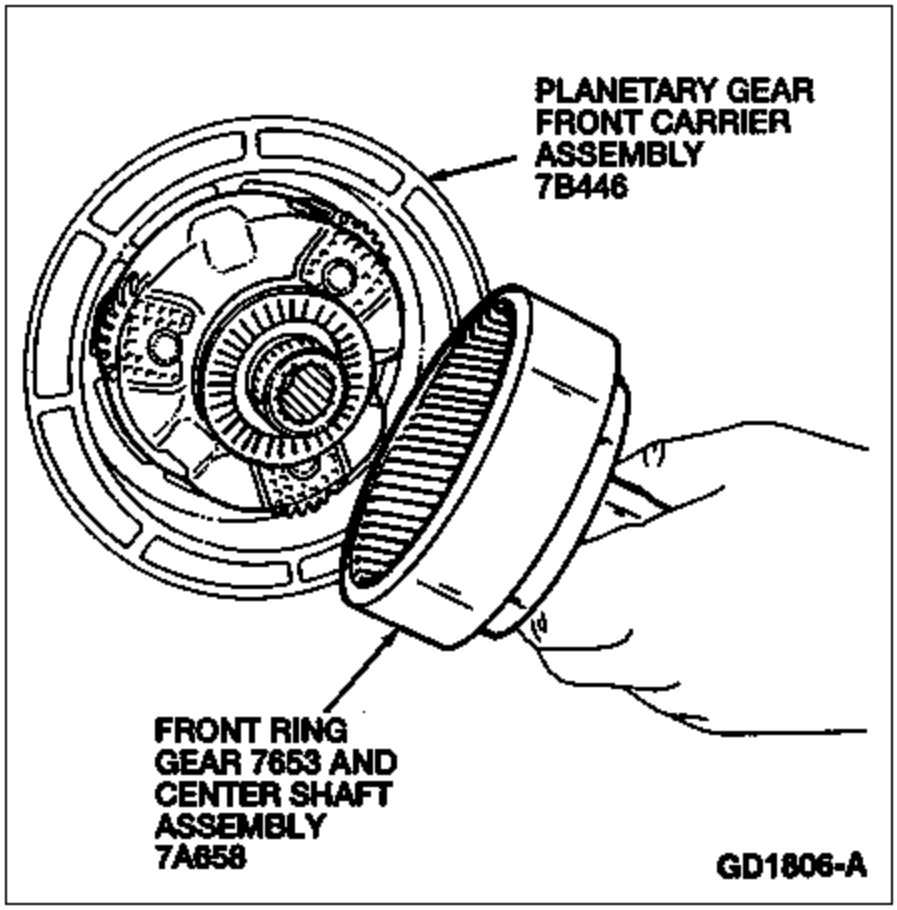

9. **CAUTION: Use care not to bend or damage the exciter wheel.**

   CAUTION: Before installing the front sun gear into the front planetary gear carrier, make sure the No. 12 sun gear thrust bearing race is aligned with the needle bearing inside the front planetary gear carrier. The front sun gear will not seat properly if the No.12 sun gear thrust bearing race is not aligned in the center of the front sun gear.

   Install the front sun gear into the front planetary gear carrier.

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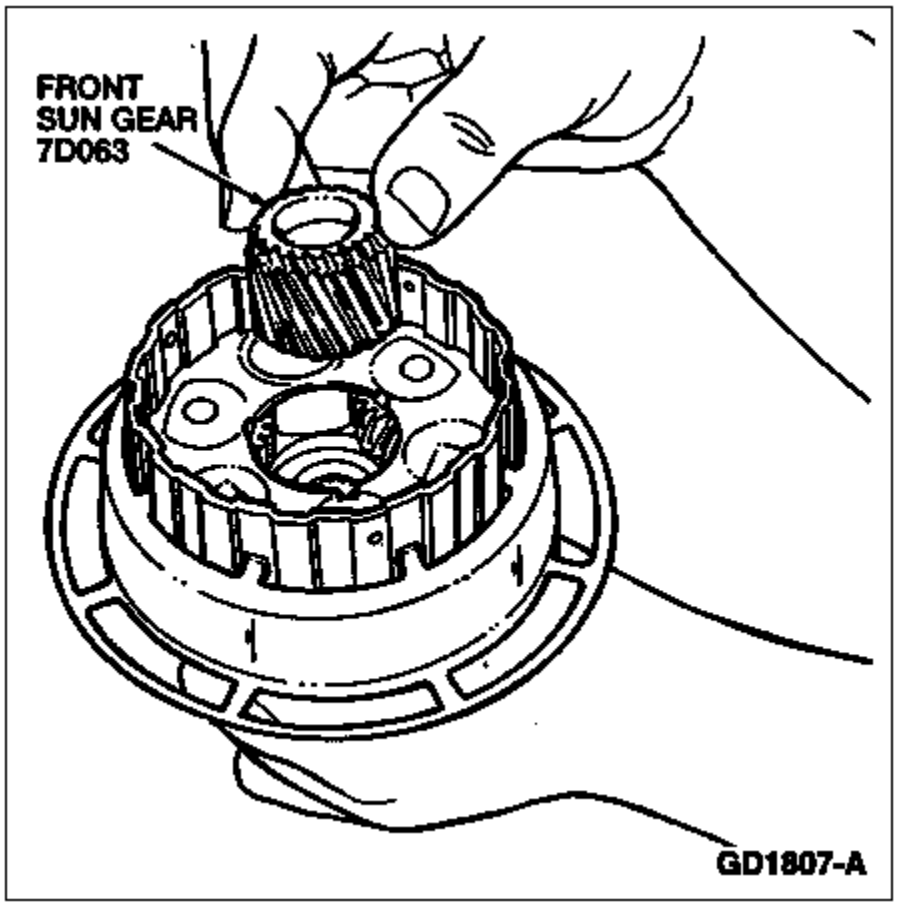

10. Install the coast clutch adapter on the front sun gear.

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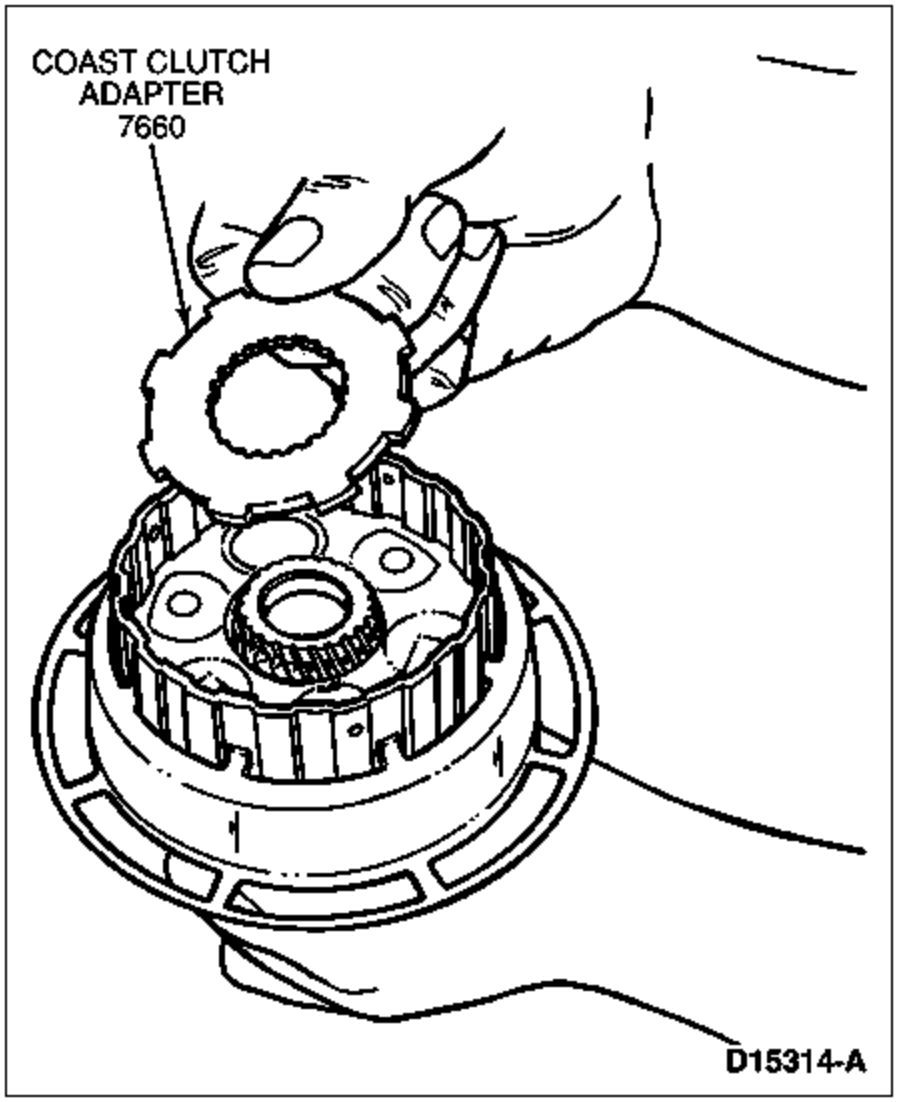

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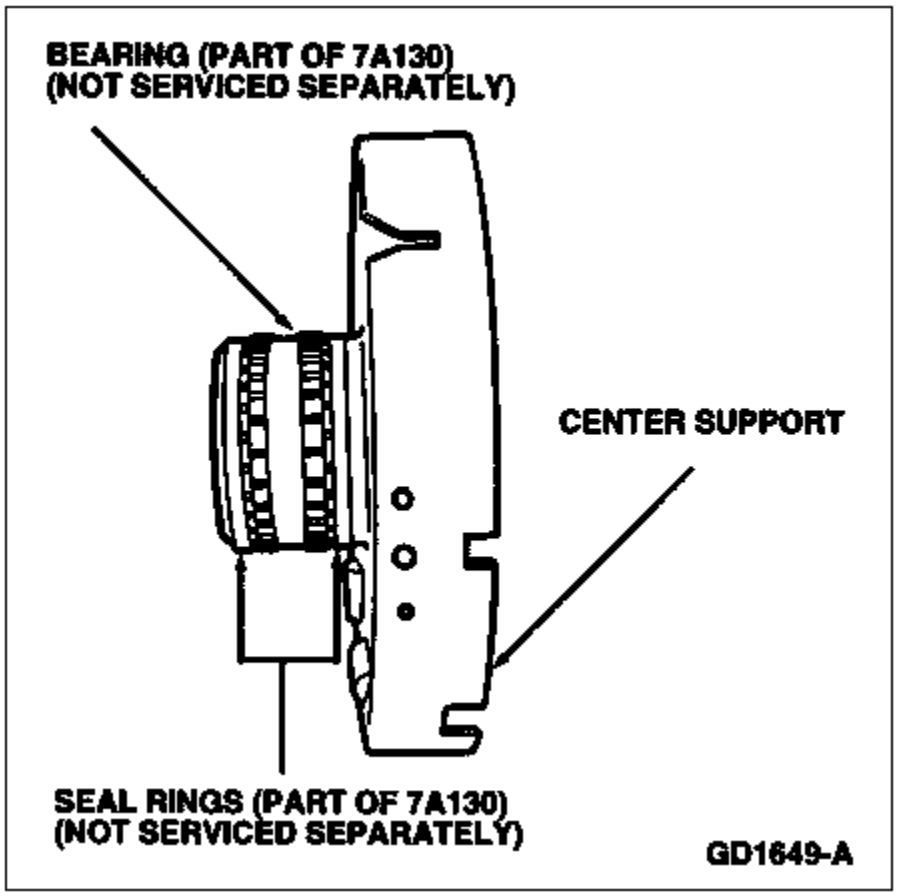
Center Support

Inspection



1. Inspect center support for damage. If damaged, replace center support assembly.

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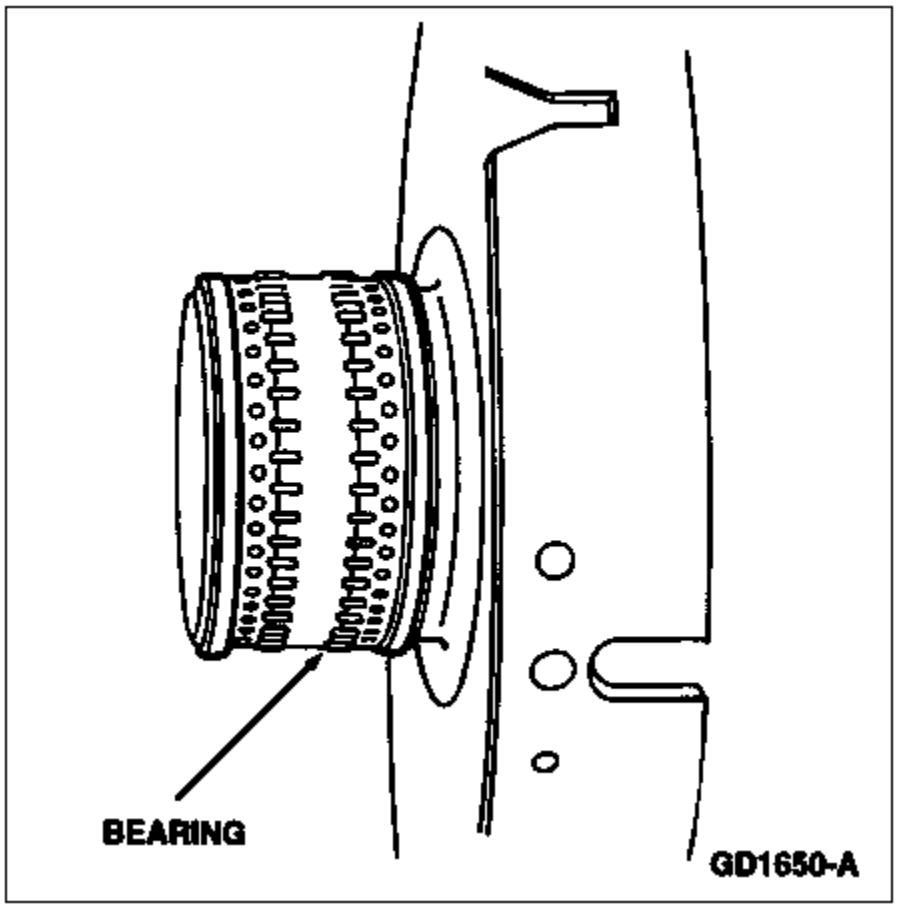
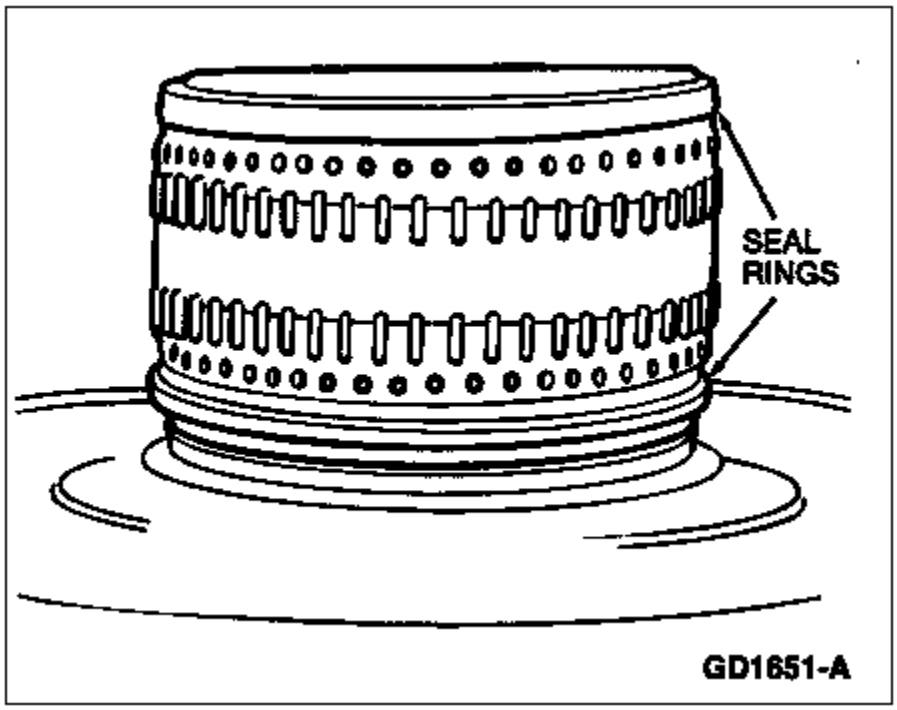


2. Inspect seal rings for damage. If damaged, replace center support.



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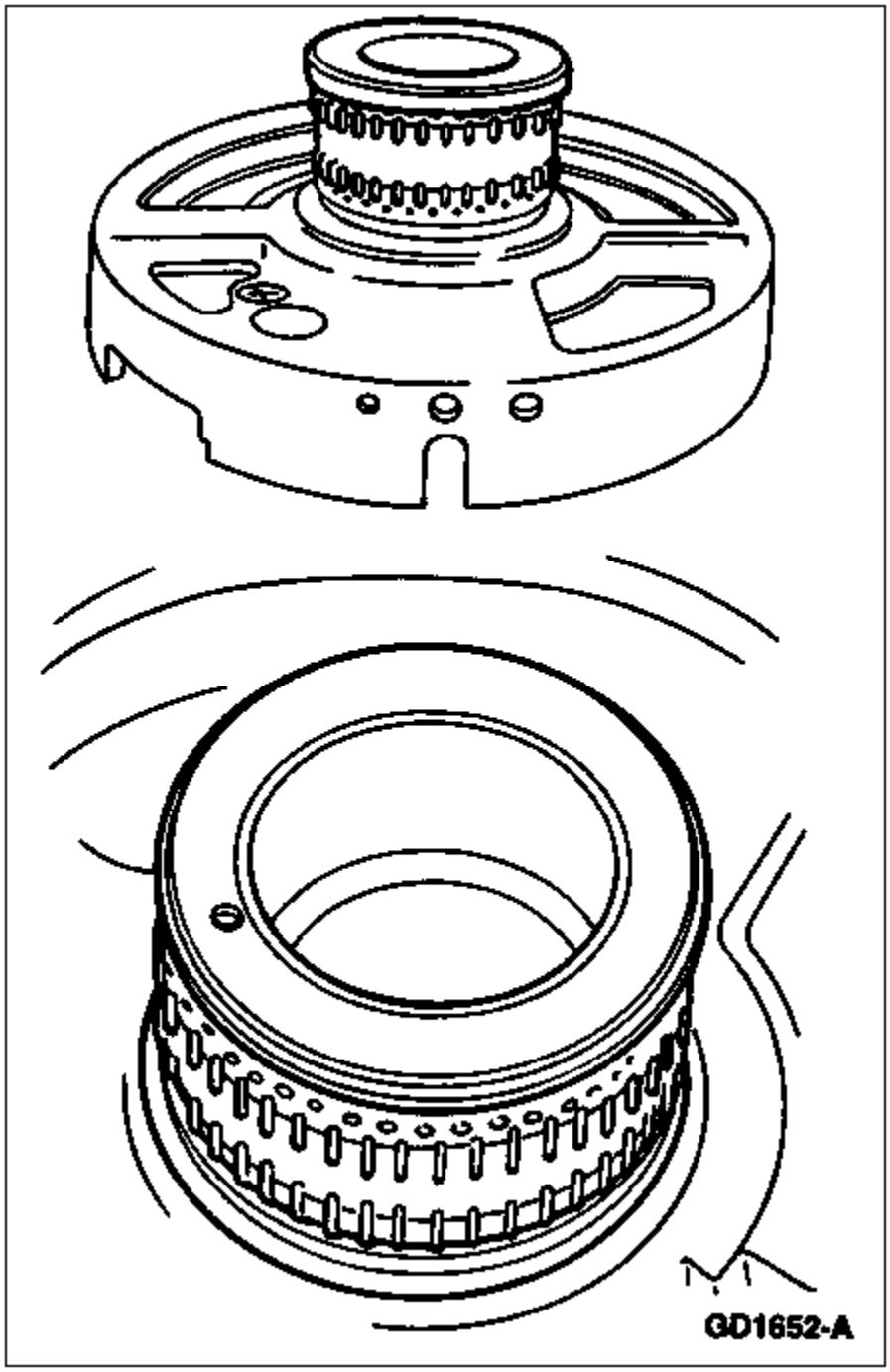
3. Inspect thrust surface for wear, scoring or damage. Inspect forward clutch sealing surface for scoring or damage. Inspect hydraulic passages for damage or restrictions.



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Low/Reverse Brake Drum

Low/Reverse Brake Drum Assembly

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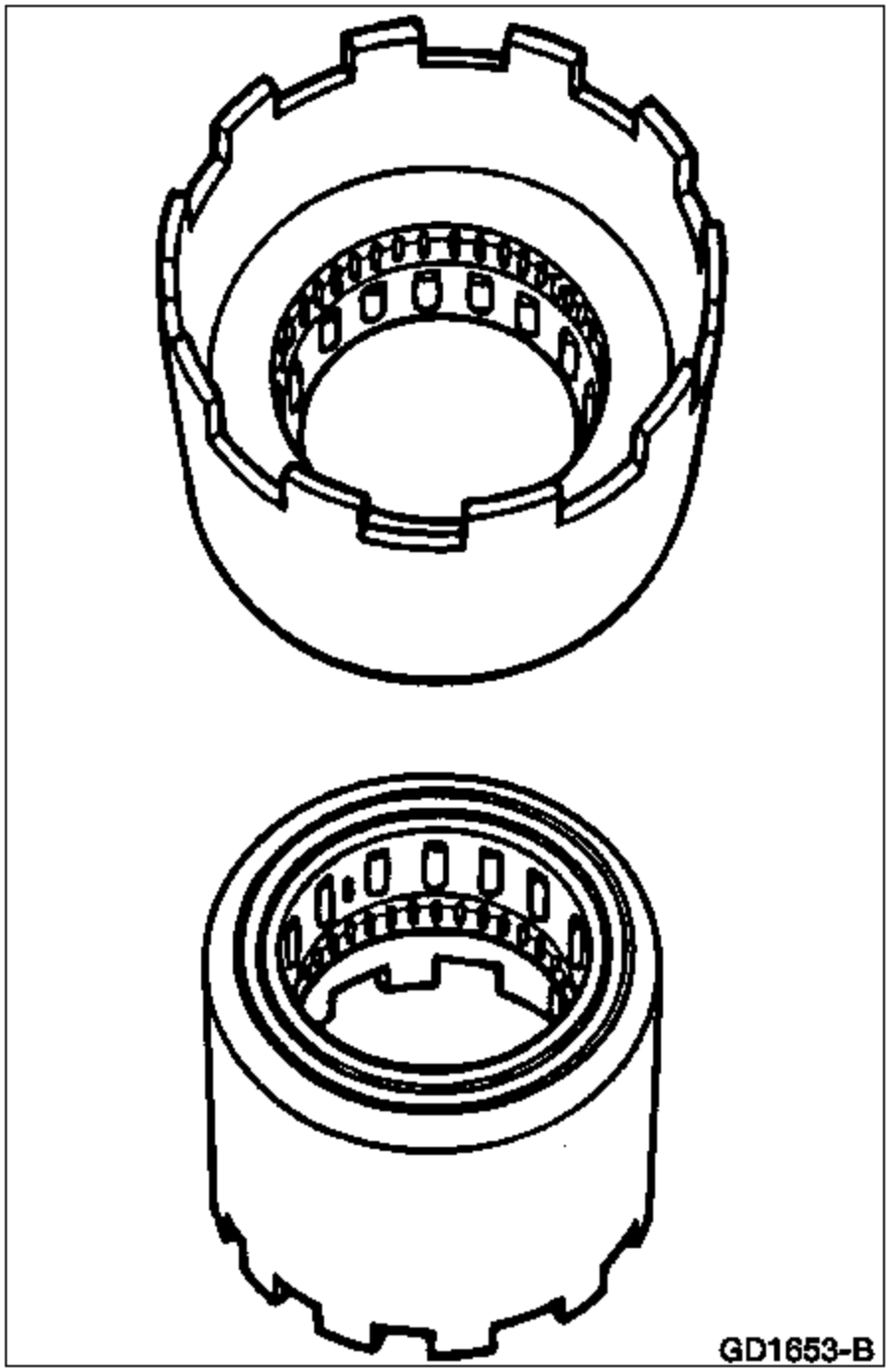

Inspection

1. **NOTE: The rear one-way clutch is part of the reverse drum assembly.**

   Inspect rollers, sprags, and low/reverse drum for damage. If damaged, replace drum assembly.

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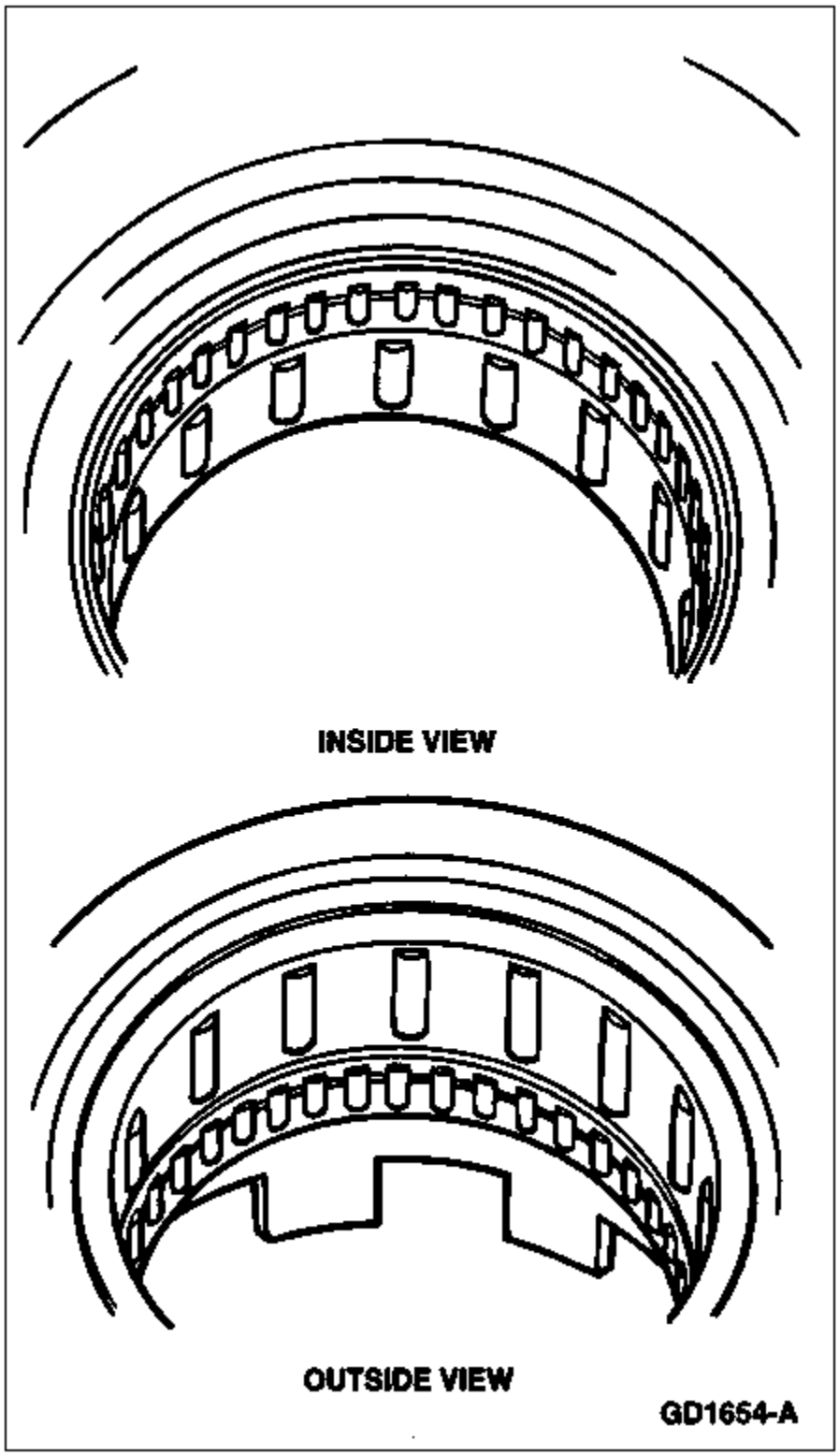

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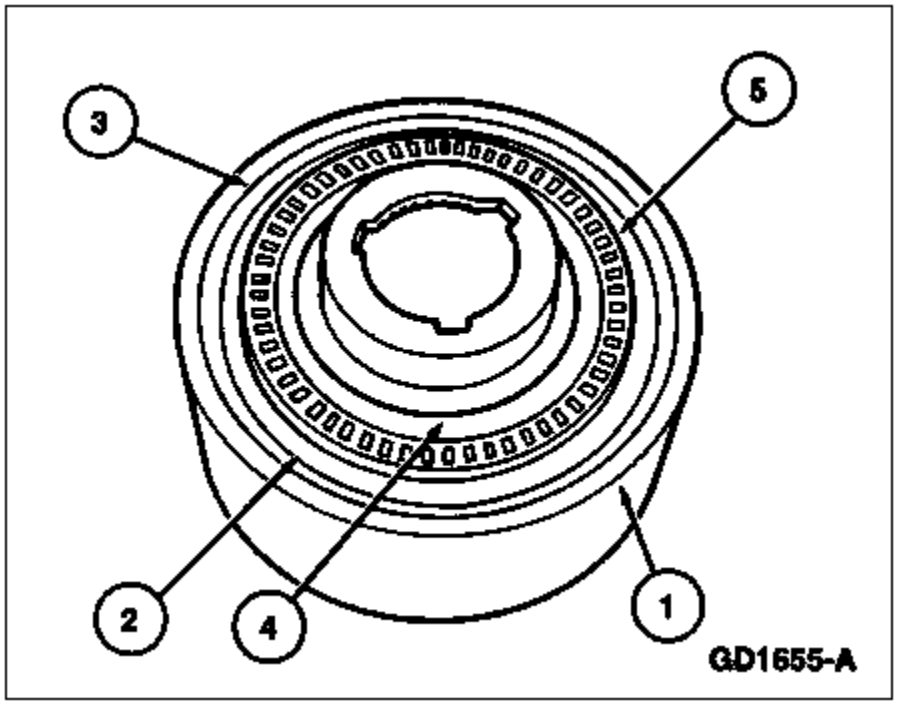
tomsn048@gmail.com

Output Shaft Ring Gear and Hub Assembly

Output Shaft Ring Gear and Hub Assembly



Item	Part Number	Description
1	7A153	Output Shaft Ring Gear
2	7D164	Output Shaft Hub
3	E860122-S	Retaining Ring
4	7M150	No. 10A Bearing Race Assembly
5	7M150	No. 10B Needle Bearing

Disassembly

1. Inspect the ring gear, hub, No.10B needle bearing and No. 10A bearing race assembly for damage. If service is required, use the following procedures.

2. Remove No. 10B needle bearing, if not already removed.

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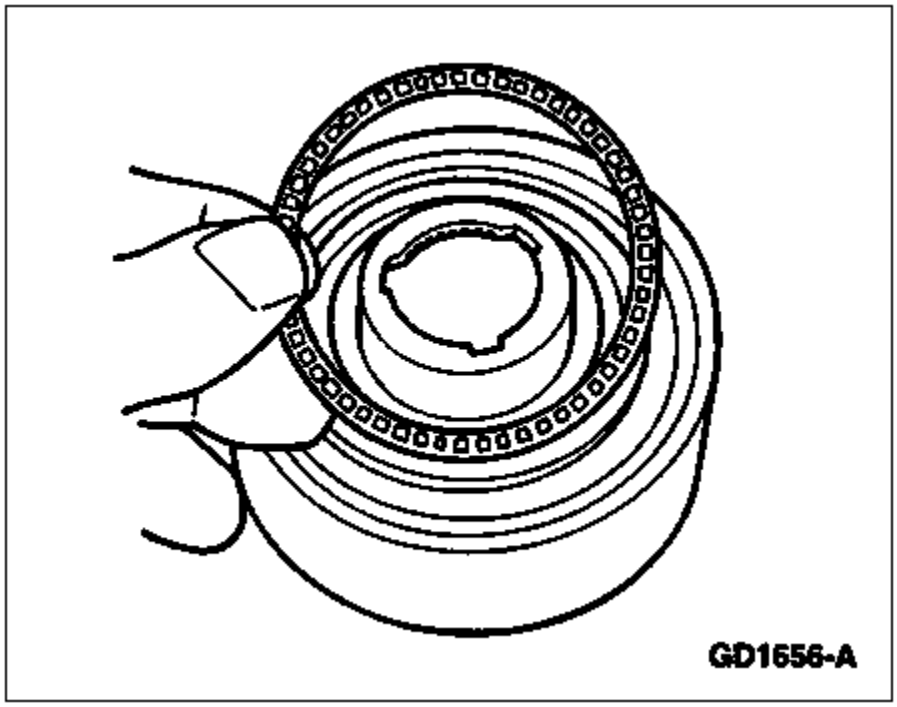
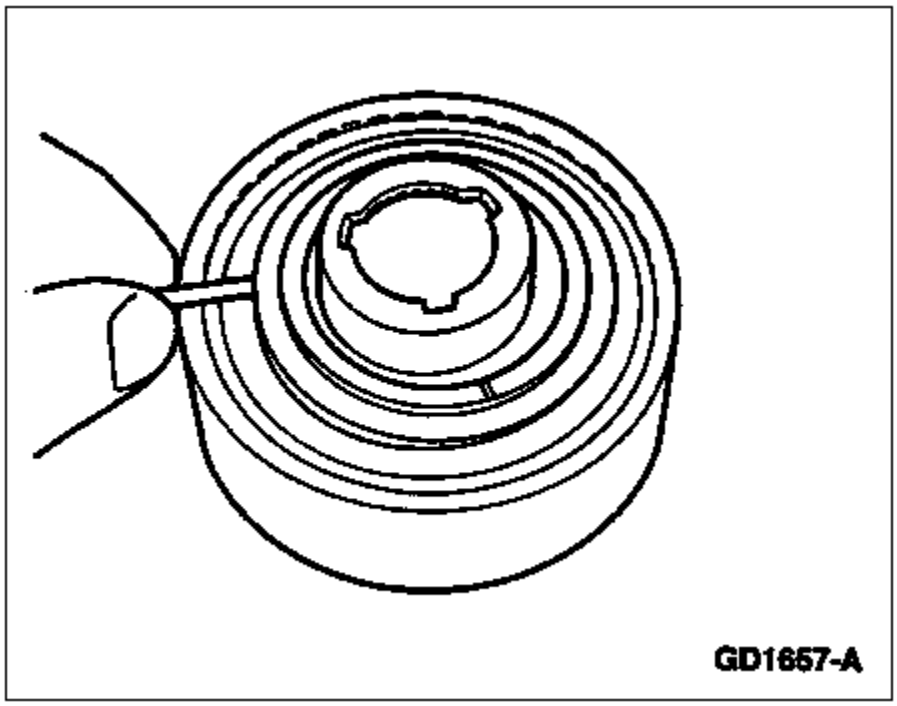


3. Remove No. 10A bearing race assembly.



4. Separate ring gear from hub by removing retaining ring.

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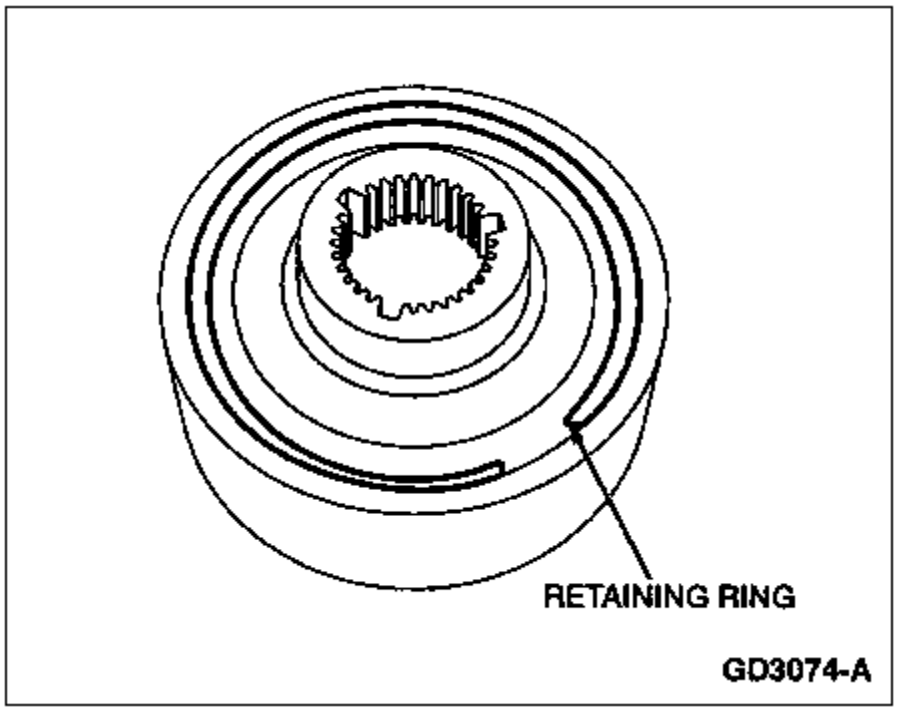
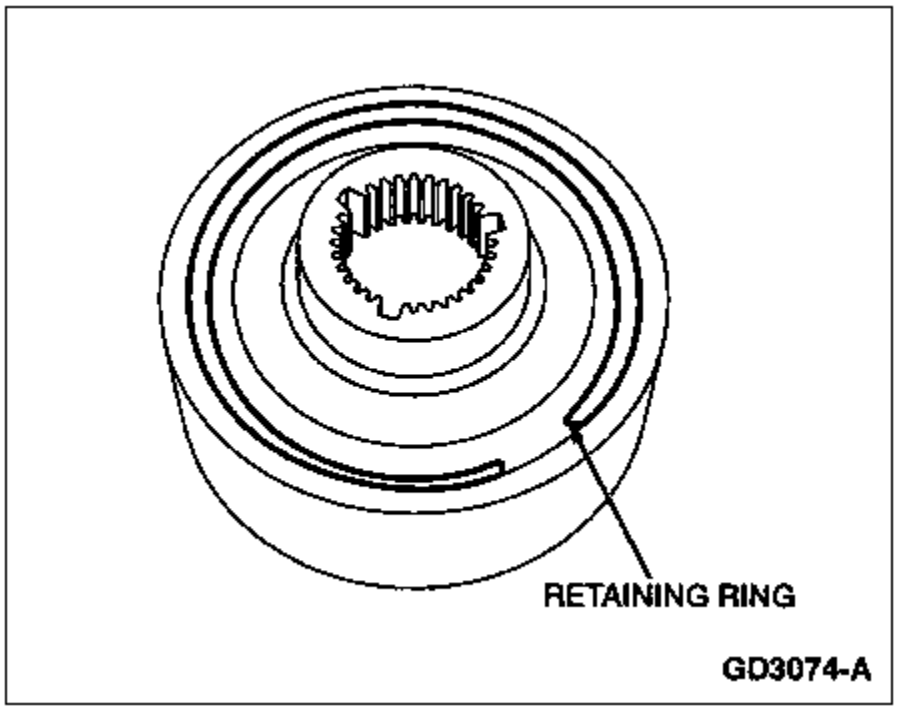


Assembly

1. Install output shaft hub into ring gear. Install retaining ring.



2. Install No. 10A bearing race assembly onto outshaft hub. Press on - snap fit.

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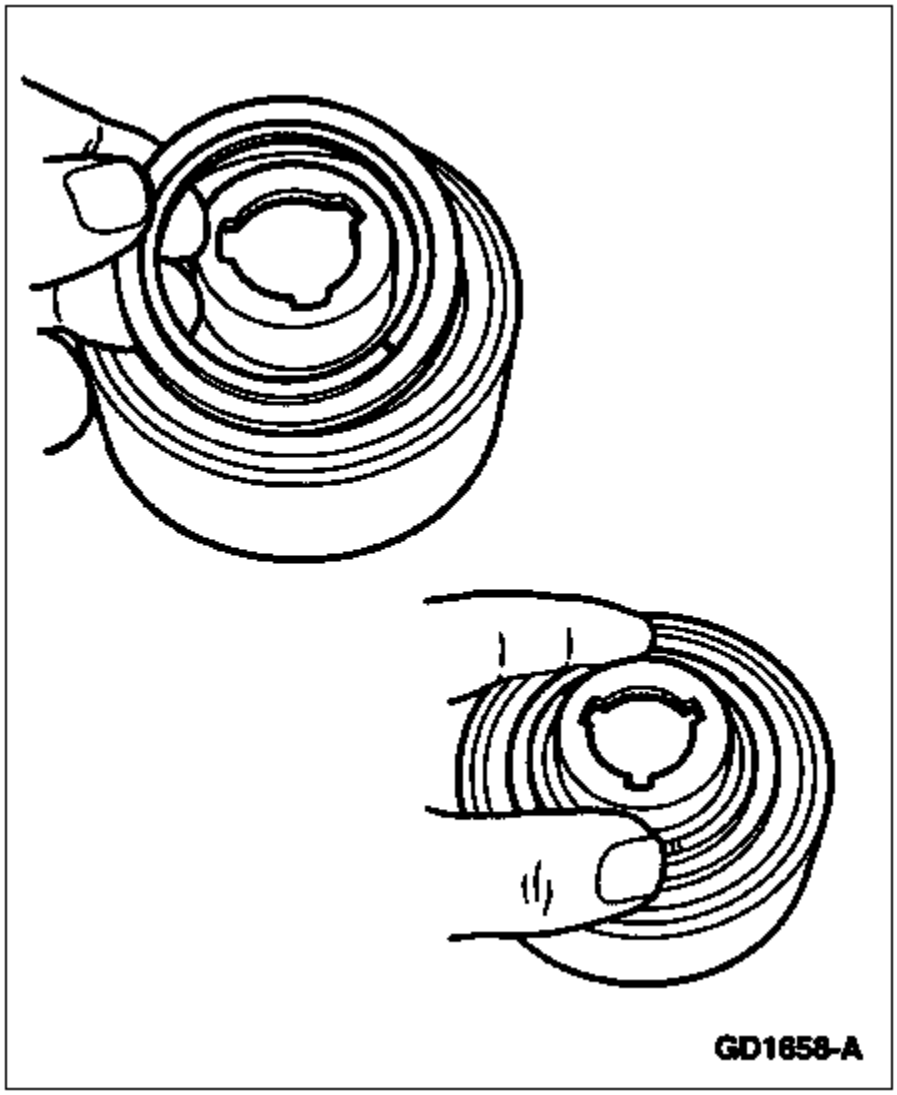

3. Using petroleum jelly, install No. 10B needle bearing onto output shaft ring gear and hub assembly.

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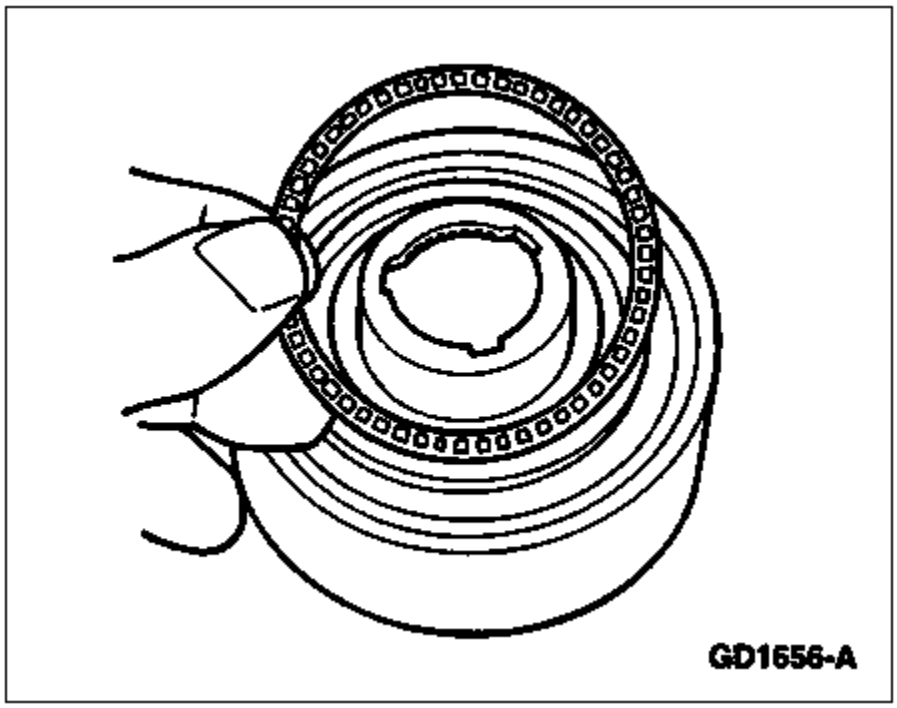

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Torque Converter Service Procedures

Cleaning/Inspection

When internal wear or damage has occurred in the transmission, metal particles, clutch plate material, or band material may have been carried into the torque converter. These contaminates are a major cause of recurring transmission troubles and MUST be removed from the system before the transmission is put back into the vehicle.

Whenever a transmission has been disassembled to replace worn or damaged parts, or because the valve body sticks repeatedly from foreign material, the torque converter MUST be cleaned using a mechanical agitated cleaner, such as Rotunda Torque Converter/Transmission Oil Cooler Cleaner 014-00028 or equivalent.

Torque Converter Flushing

NOTE: Mineral spirits used to clean the torque converter must be fresh, non-chlorinated and non-halogenated.

Following the instructions included with the Torque Converter/Transmission Oil Cooler Cleaner 014-00028, flush out the converter.

After flushing the torque converter, follow these steps:

- Thoroughly drain the remaining solvent through the impeller hub.
- Add 1.9L (2.0 quarts) of clean MERCON V® XT-5-QM Automatic Transmission Fluid into fluid filler tube.
- Agitate the solution inside the torque converter by hand.
- Thoroughly drain the torque converter through the impeller hub.

Torque Converter Leak Check

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Torque Converter Leak Check Tool and Gasket	014-R1075

1. Clean the outside surface at the torque converter.

2. Install Torque Converter Leak Check Tool and Gasket 014-R1075 into converter hub.

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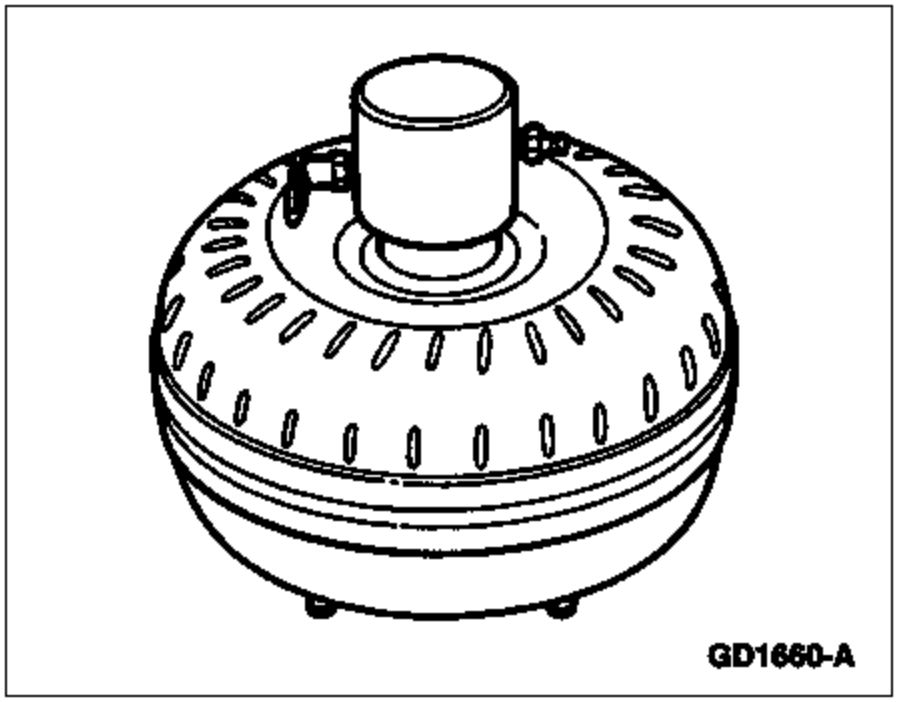

3. Install torque converter with installed Torque Converter Leak Check Tool and Gasket 014-R1075 into press.

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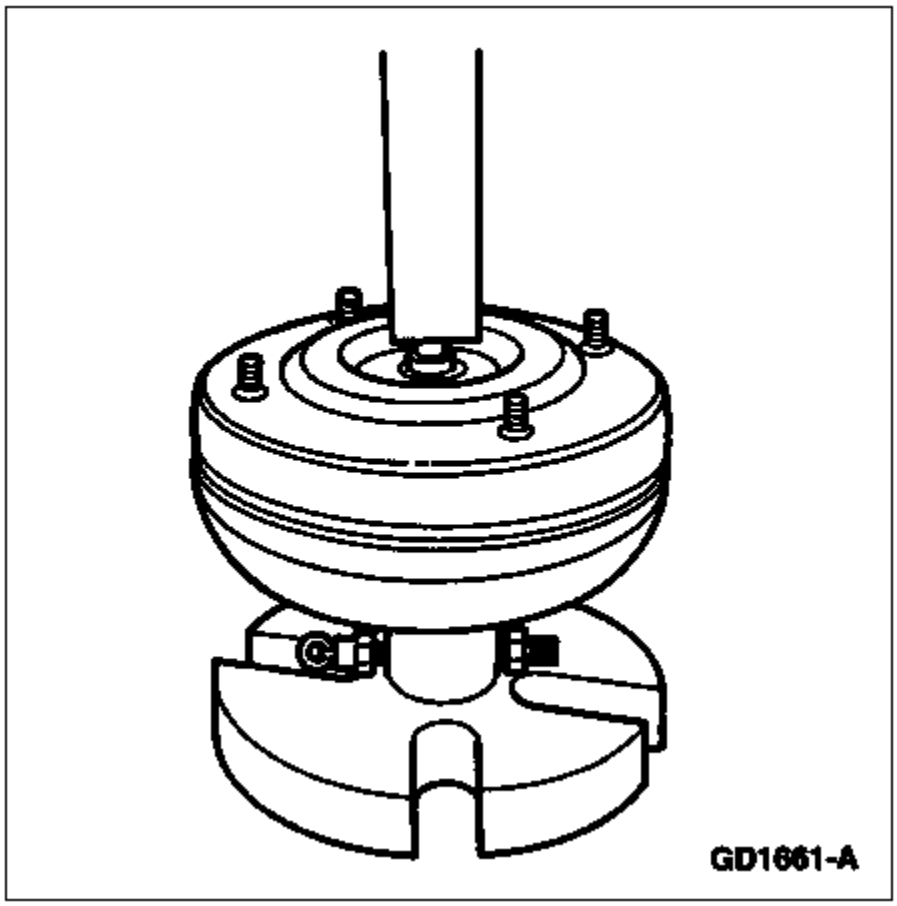

4. **WARNING: ALWAYS FOLLOW PROPER SAFETY PROCEDURES WHILE USING PRESS.**

   Secure press. Apply enough force from press to seal tool into torque converter.

5. **NOTE: Use clean dry shop air.**

   Apply air pressure 80 psi (MAX) to valve on Torque Converter Leak Check Tool and Gasket 014-R1075.

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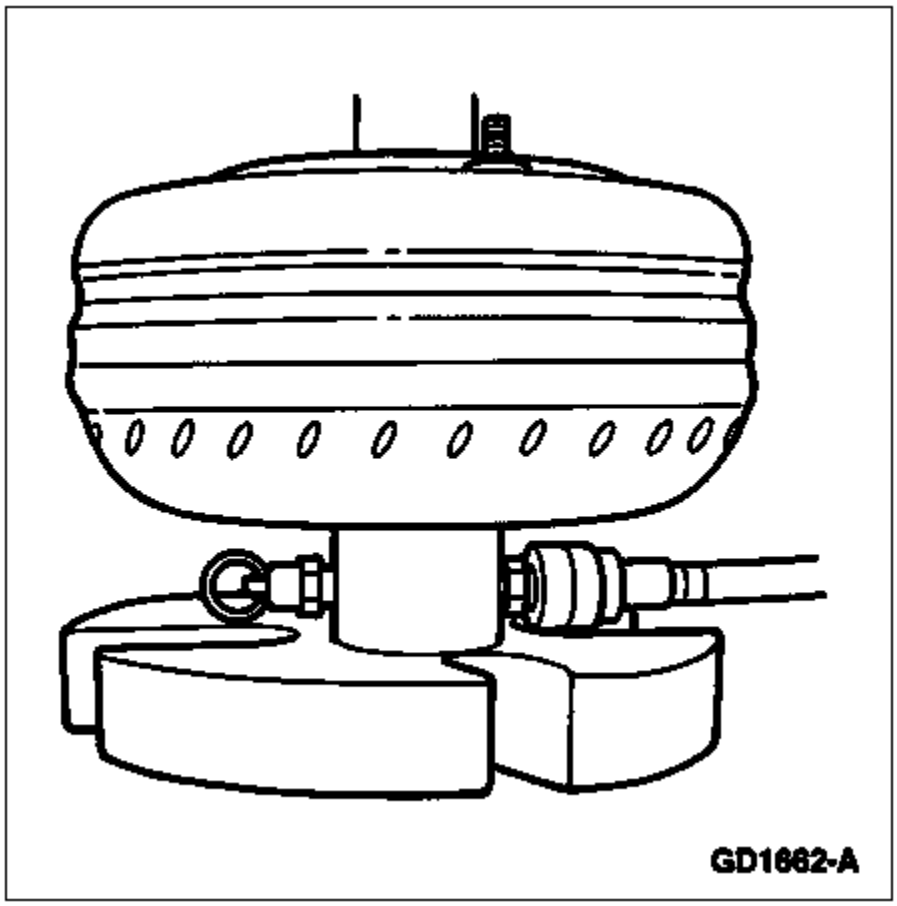

6. With air pressure applied to valve, inspect for leaks at studs, seams and pilot hub. A soap bubble solution may be applied around those areas to aid in diagnosis. If leaks are present, replace converter.

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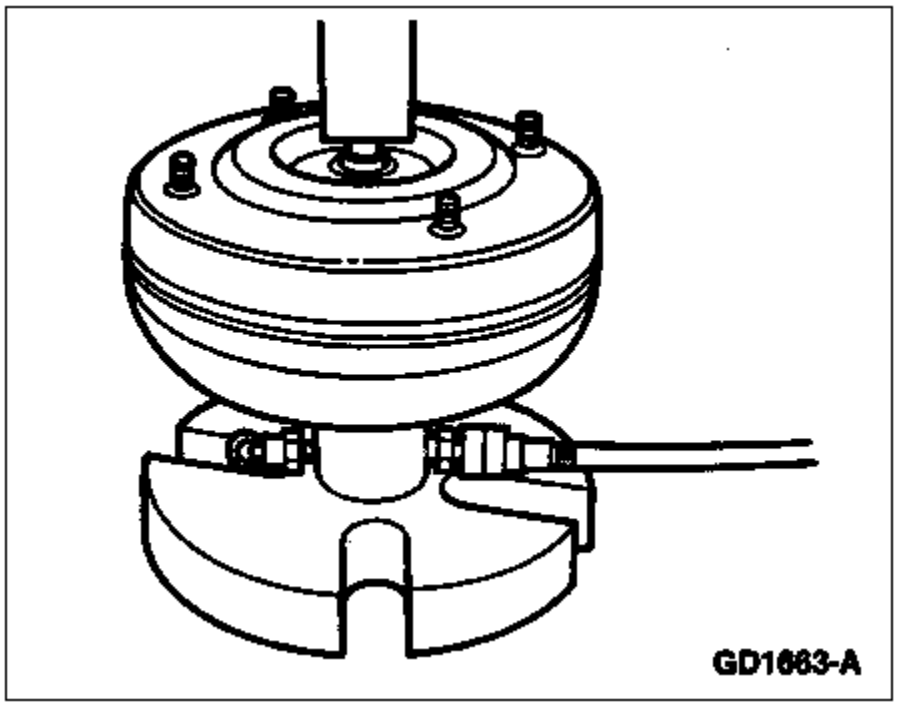

7. Release pressure and then slowly release press. Remove air hose.

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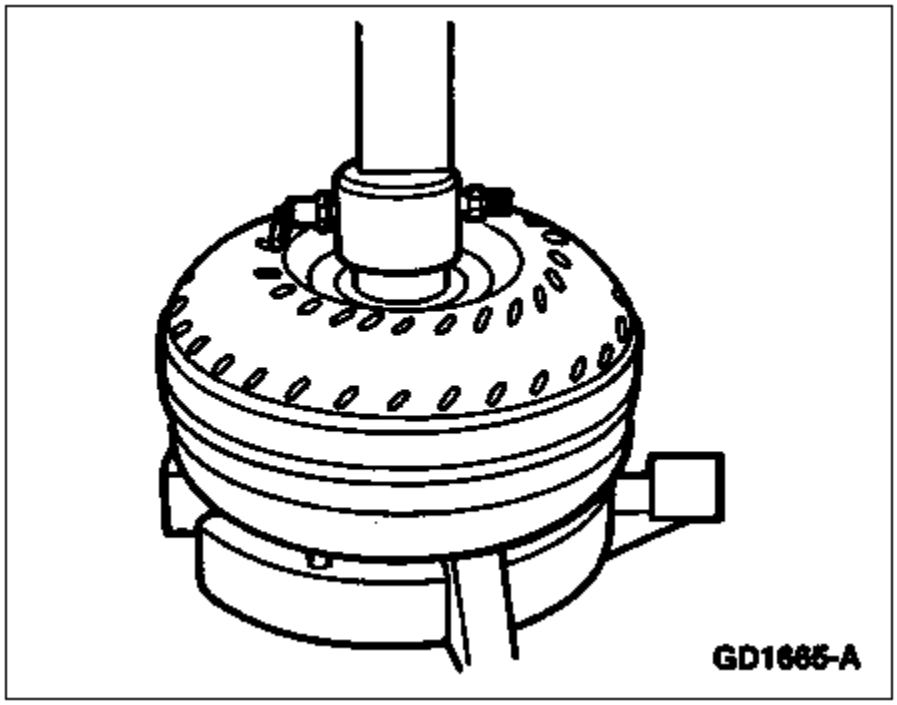
8. Rotate torque converter and tool then reinstall into press with tool up.



9. **WARNING: ALWAYS FOLLOW PROPER SAFETY PROCEDURES WHILE USING PRESS.**

   Secure press. Apply enough force from press to seal tool into torque converter.

10. **NOTE: Use clean dry shop air.**

    Apply air pressure 80 psi (MAX) to valve on leak check tool.

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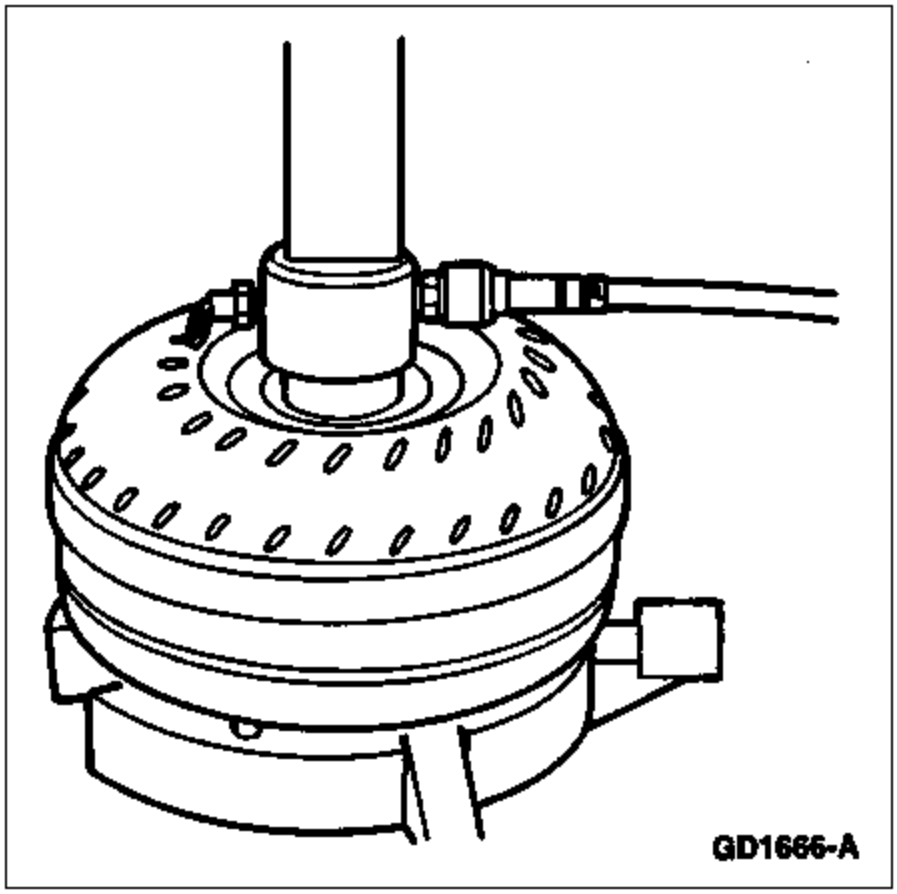

11. With air pressure applied to valve, inspect for leaks at converter hub, seams and studs. A soap bubble solution may be applied around those areas to aid in diagnosis. If leaks are present, replace converter.

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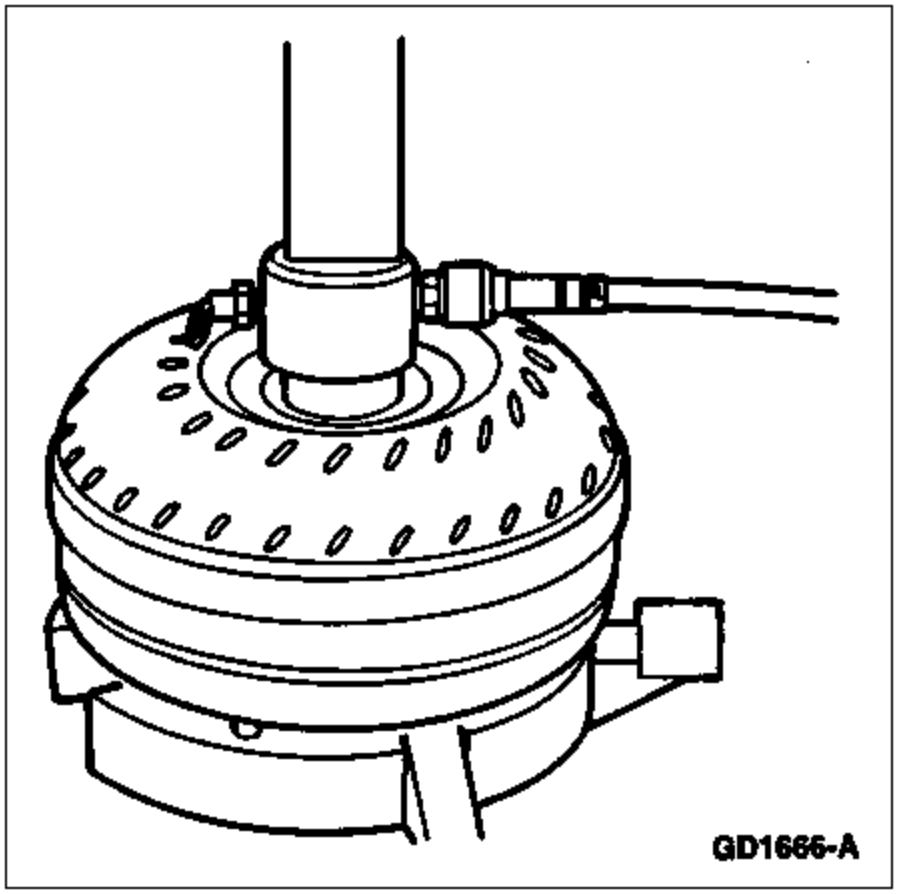

12. Remove air hose. Release pressure and then slowly release press. Remove converter. Remove tool.

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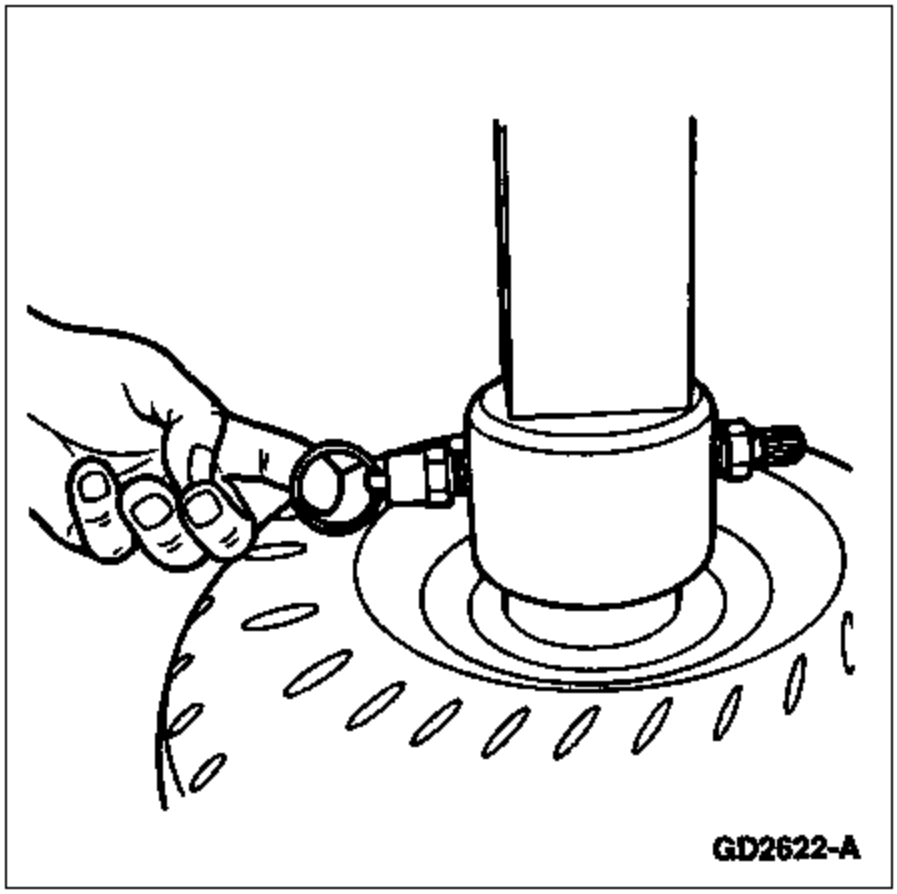

Stator to Impeller Interference Check

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
End Play Checking Tool	T80L-7902-A

1. Install the fluid pump support into torque converter. Engage the splines of the one-way clutch inner race with the mating splines of the stator support.

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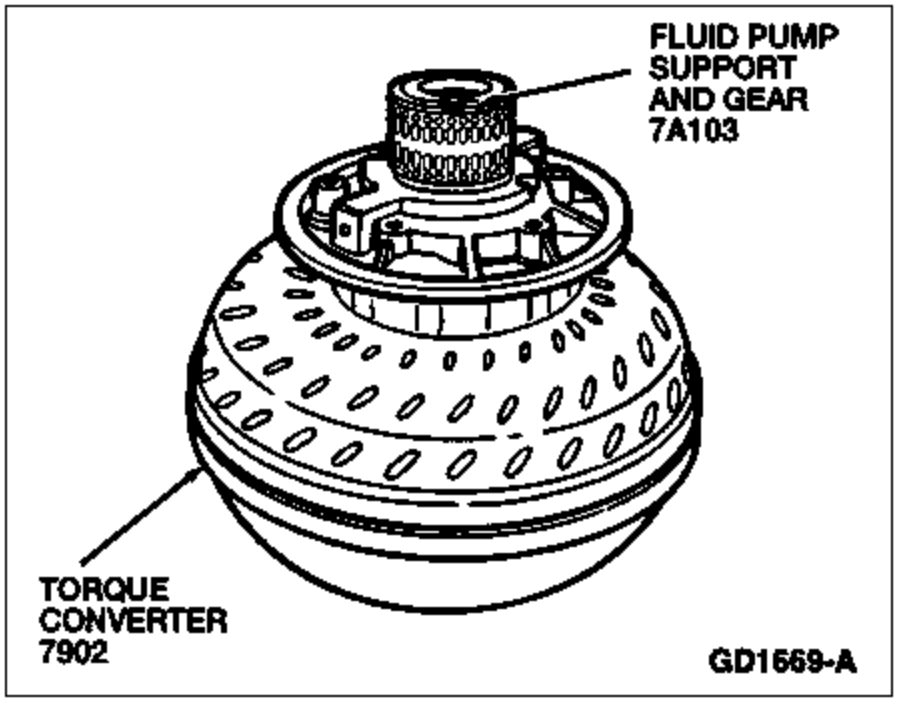
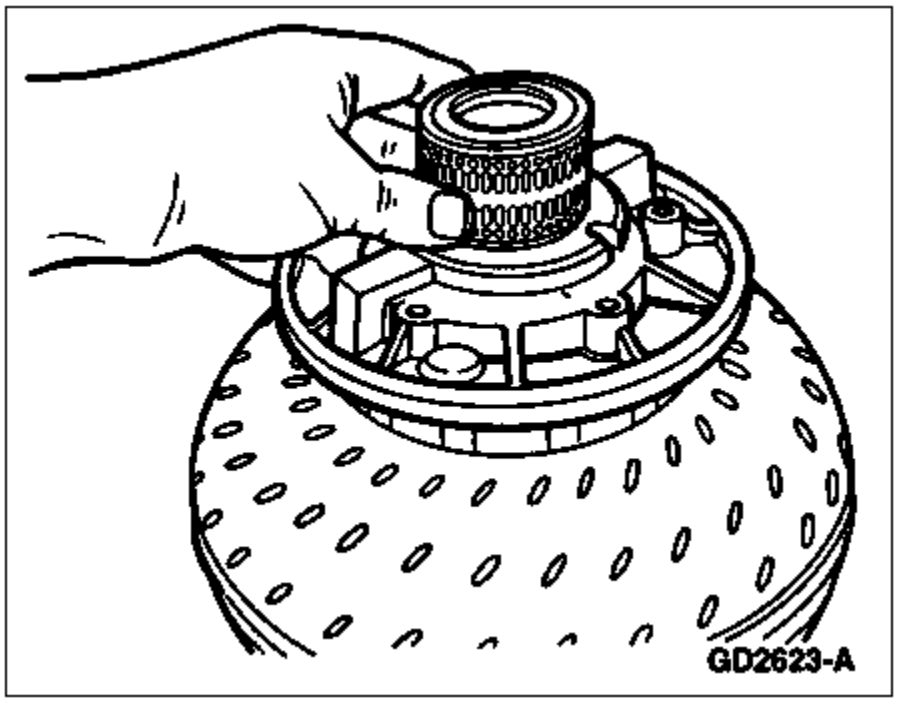


2. Rotate the torque converter both clockwise and counterclockwise. The fluid pump support should rotate freely without any signs of interference or scraping within the torque converter.

   If there is an indication of scraping, the trailing edges of the stator blades may be interfering with the leading edges of the impeller blades. In such cases, replace the torque converter.



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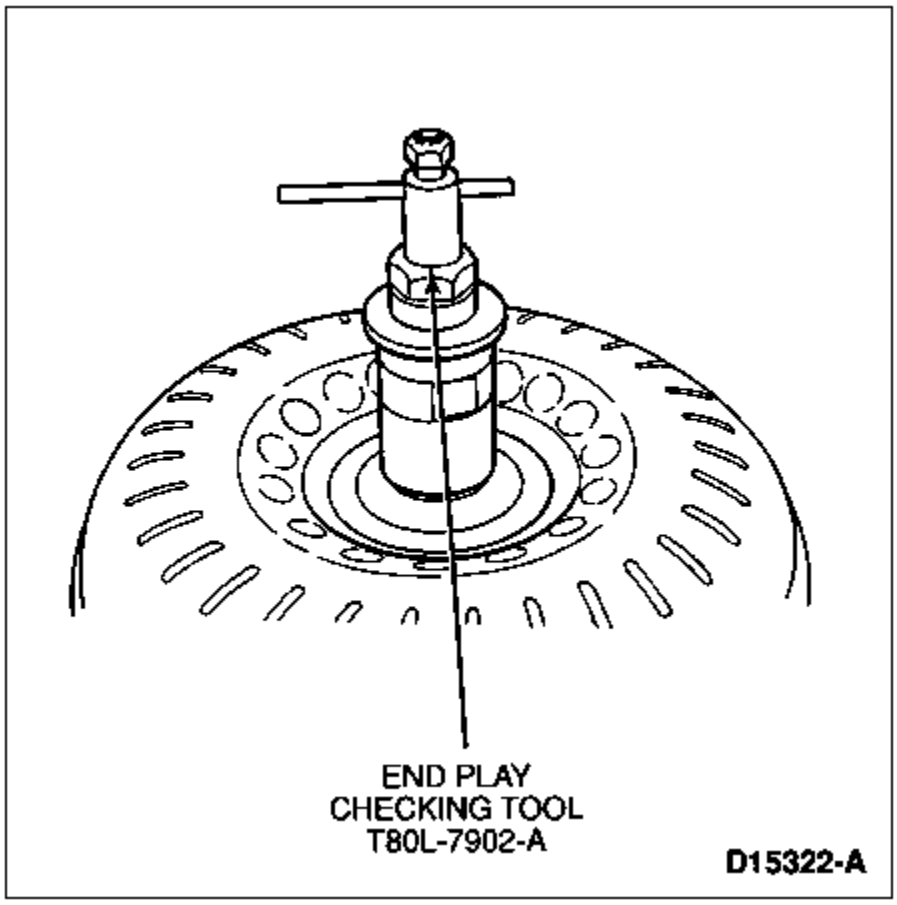
Torque Converter End Play Check

1. Install End Play Checking Tool T80L-7902-A into the converter turbine hub until it bottoms.



2. Expand the sleeve in the turbine spline by tightening the threaded inner post until the tool is securely locked in the spline.

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3. Attach Dial Indicator with Bracketry TOOL-4201-C or equivalent to End Play Checking Tool T80L-7902-A. Position the indicator button on the converter impeller housing and set the dial face to zero (0).

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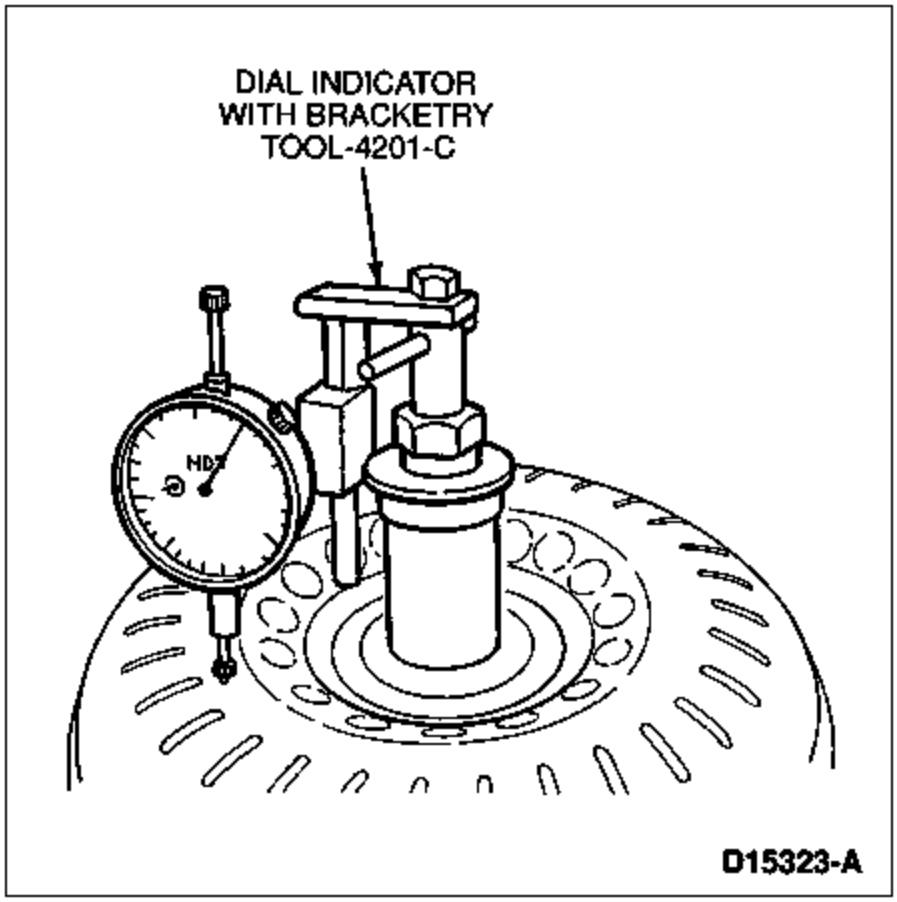

4. Lift the tool upwards as far as it will go and note the indicator reading. The indicator reading is the total end play which the turbine and stator share. Replace the torque converter if the total end play exceeds the specifications.

CONVERTER END PLAY

New or Rebuilt Converter		Used Converter	
mm	Inch	mm	Inch
0.58 Max.	0.023 Max.	1.27 Max.	0.050 Max.

5. Loosen the threaded inner post to remove the tool from the torque converter (7902).

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Transmission

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Bench-Mounted Holding Fixture	T57L-500-B
Shift Lever Seal Replacer	T74P-77498-A
Gauge Bar	T93T-77003-AH
Front Pump Alignment Set	T74P-77103-X
Band Adjustment Torque Wrench Set	T71P-77370-A
Servo Rod Selecting Gauge	T74P-77190-A
Extension Housing Bushing Replacer	T77L-7697-F
Extension Housing Seal Replacer	T74P-77052-A
Digital TR Sensor Alignment Tool	T97L-70010-A
Drive Handle	T80T-4000-W
Case Bearing Installation Tool	T97T-77110-A
Bearing Cup Puller	T77F-1102-A
Impact Slide Hammer	T50T-100-A
Turbine Shaft Speed Sensor Gauge	T95L-70010-F
Valve Body Guide Pin (.235)	T95L-70010-B
Valve Body Guide Pin (.248)	T95L-70010-C
Torque Converter Handles	T81P-7902-C
Servo Cover Compressor	T95L-77028A
Converter Guide Pins	T95L-7902A

1. Inspect the case for cracks and stripped threads. Inspect the gasket surfaces and mating surfaces for burrs. Check the vent for obstructions and check all fluid passages for obstructions and leakage.

2. Inspect case bearing for damage. If damaged, replace bearing. Refer to steps a-d.

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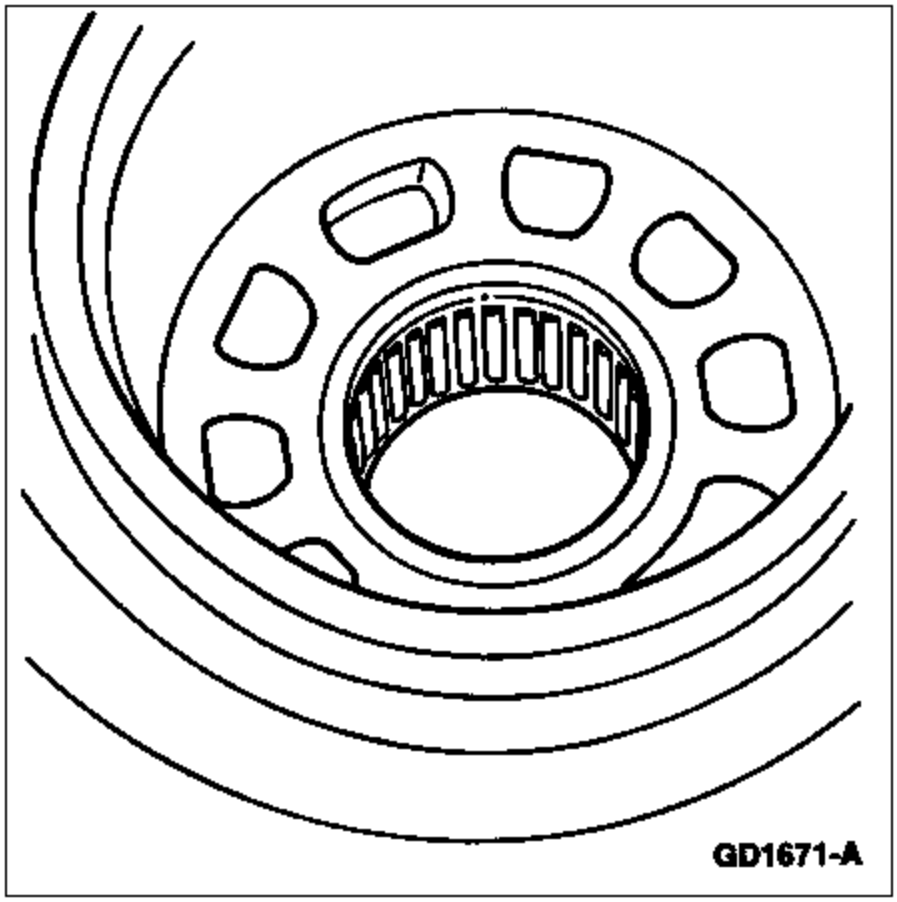

a. Install Bearing Cup Puller T77F-1102-A with Impact Slide Hammer T50T-100-A onto case bearing. Remove bearing.

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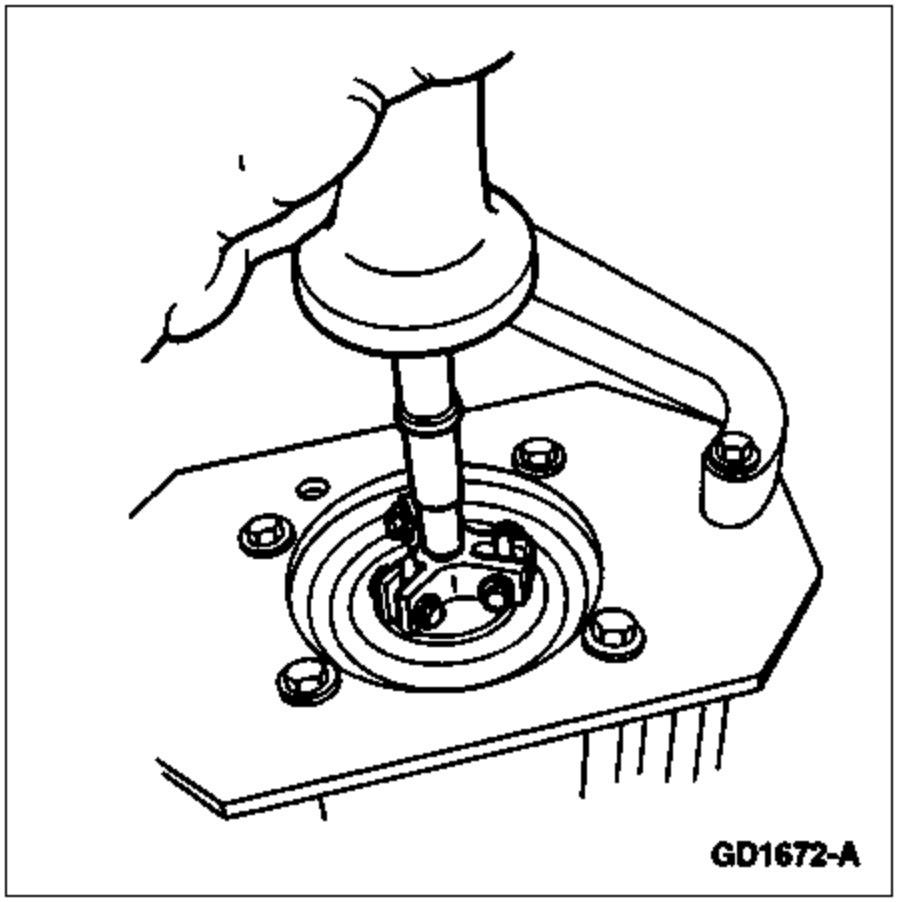
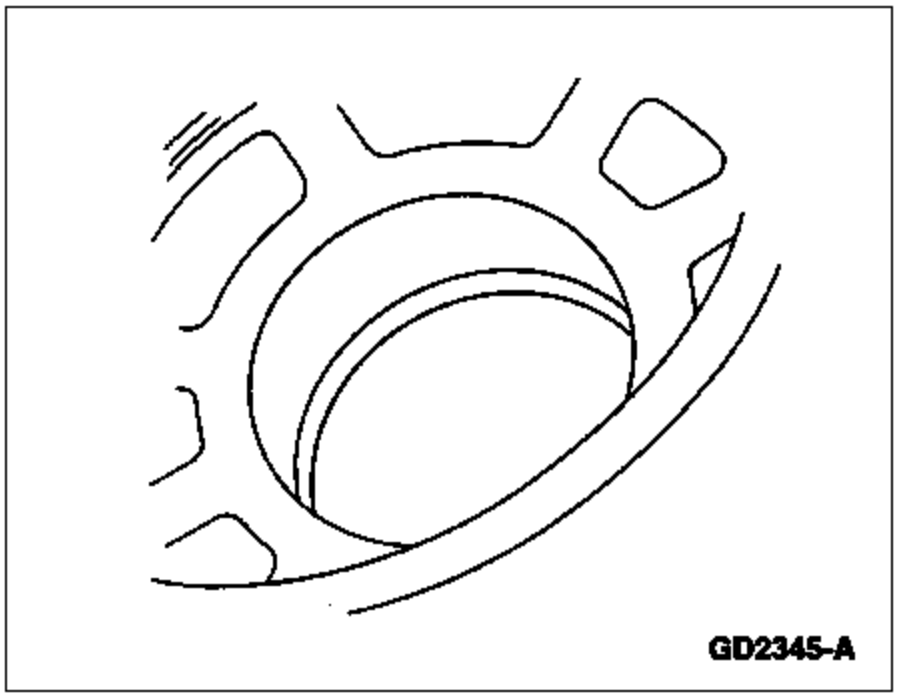


b. Inspect case bore for nicks and burrs. Remove with oil stone prior to installation of new bearing.



c. Install Drive Handle T80T-4000-W into Case Bearing Installation Tool T97T-77110-A. Install

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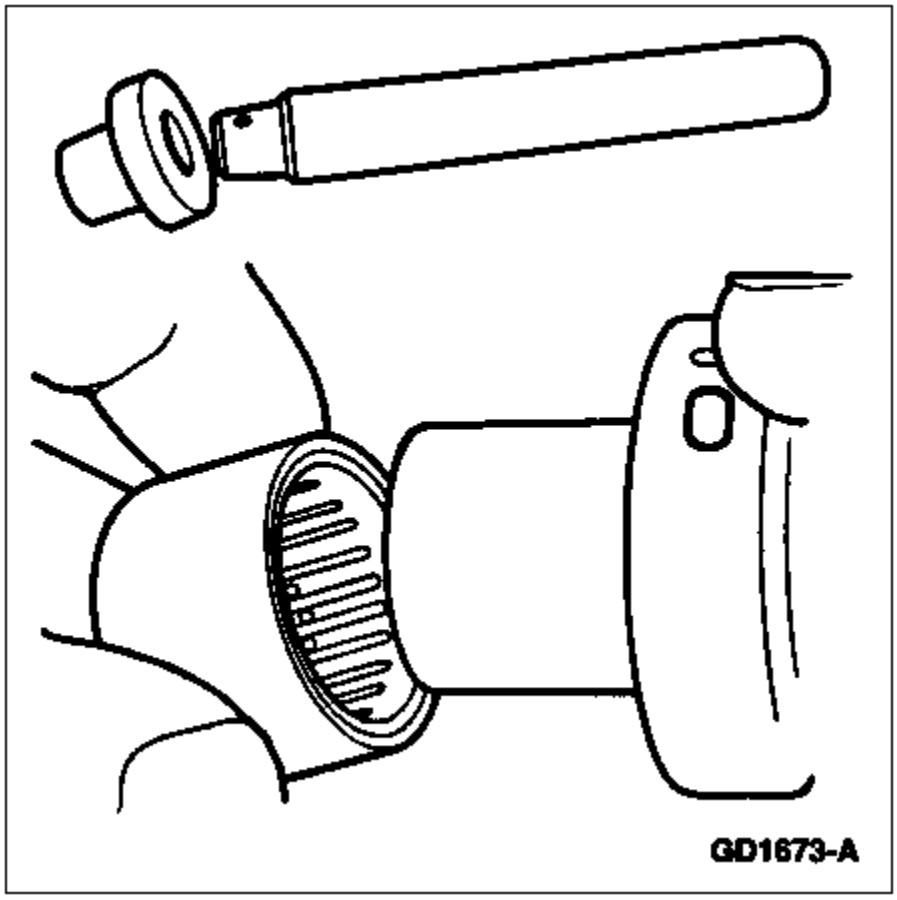
new bearing on Case Bearing Installation Tool T97T-77110-A. Make sure bearing seal ring is facing Drive Handle T80T-4000-W.



d. Using a hammer, tap bearing into place with Case Bearing Installation Tool T97T-77110-A.

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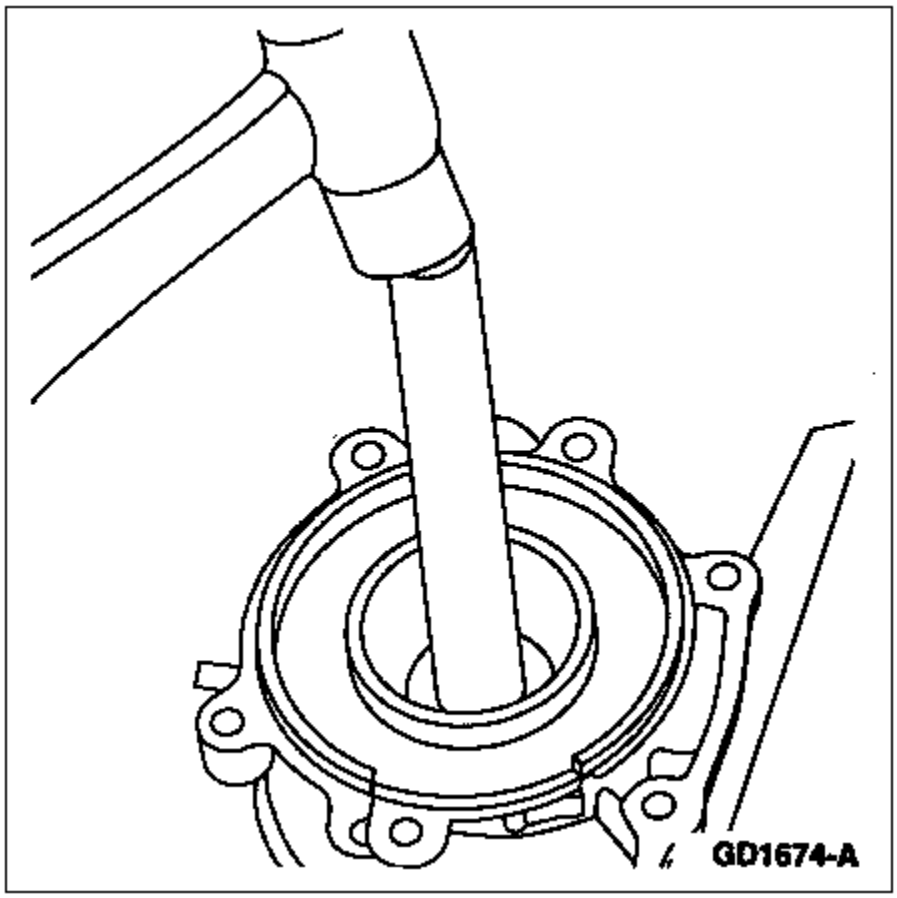

3. Check all parking linkage for wear or damage.
4. Inspect all case threads for damage.

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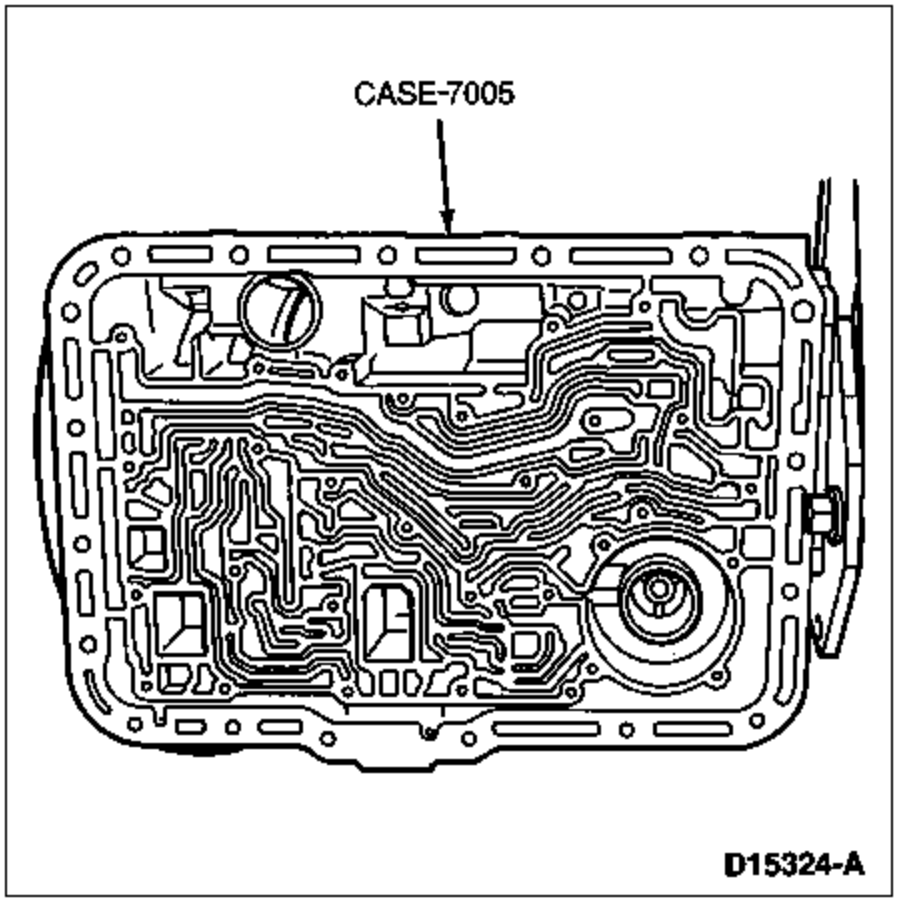
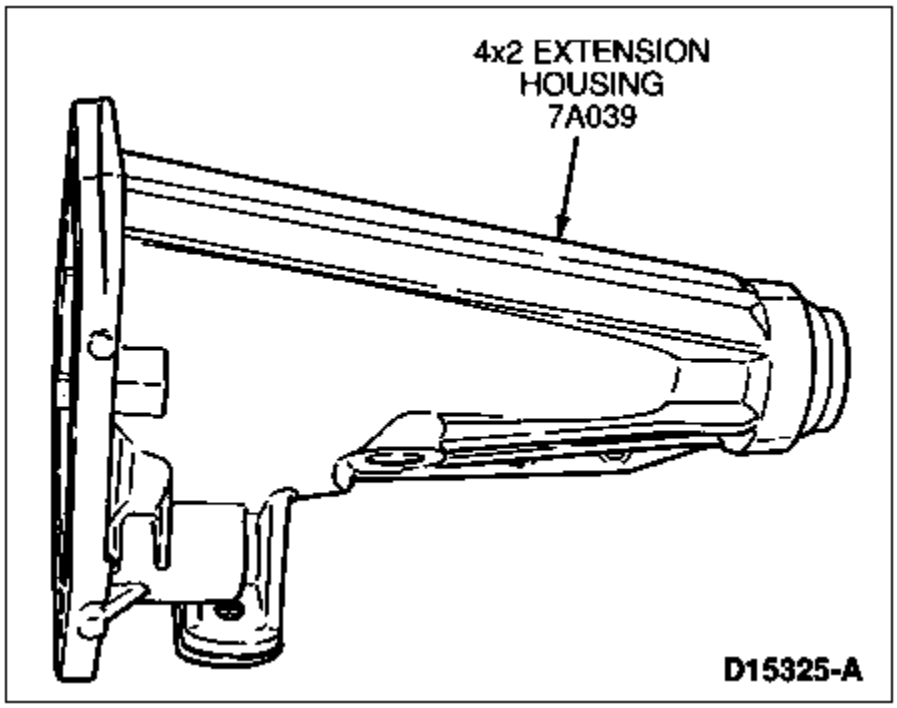


5. Inspect the extension housing for cracks. Inspect the gasket surfaces for burrs or warpage.



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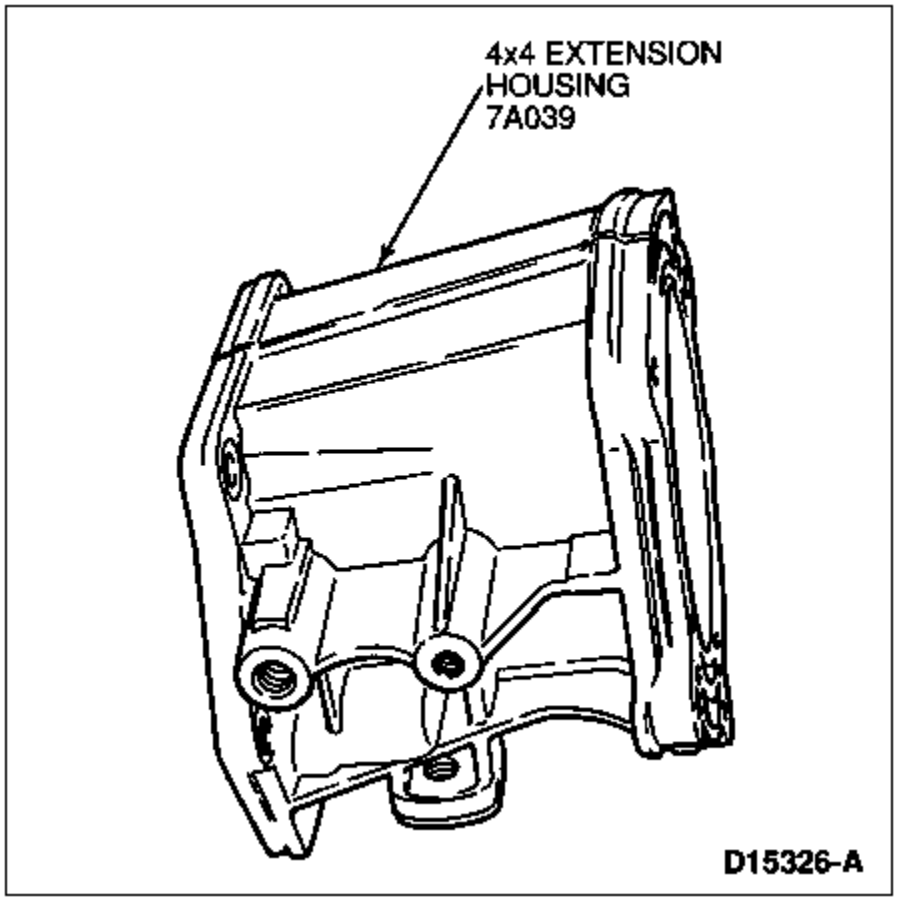

6. Inspect the bushing for scores or wear. Replace if required.

7. Inspect the rear seal for hardness, cracks or wear. If the seal shows wear or deterioration, replace the seal.

8. Inspect the seal counterbore and remove all burrs and scores with a crocus cloth.

9. **NOTE: Bench-Mounted Holding Fixture T57L-500-B should still be attached to the adapter plate. If it is not, reattach the fixture arm at this time.**

   Reattach the adapter plate to the extension housing face using four M10 x 30 mm screws.

10. **WARNING: MAKE SURE THE LOCK PIN ON BENCH-MOUNTED HOLDING FIXTURE T57L-500-B IS SECURE.**

    Install the transmission case in the Bench-Mounted Holding Fixture T57L-500-B and rotate so the transmission fluid pan rail is facing up.

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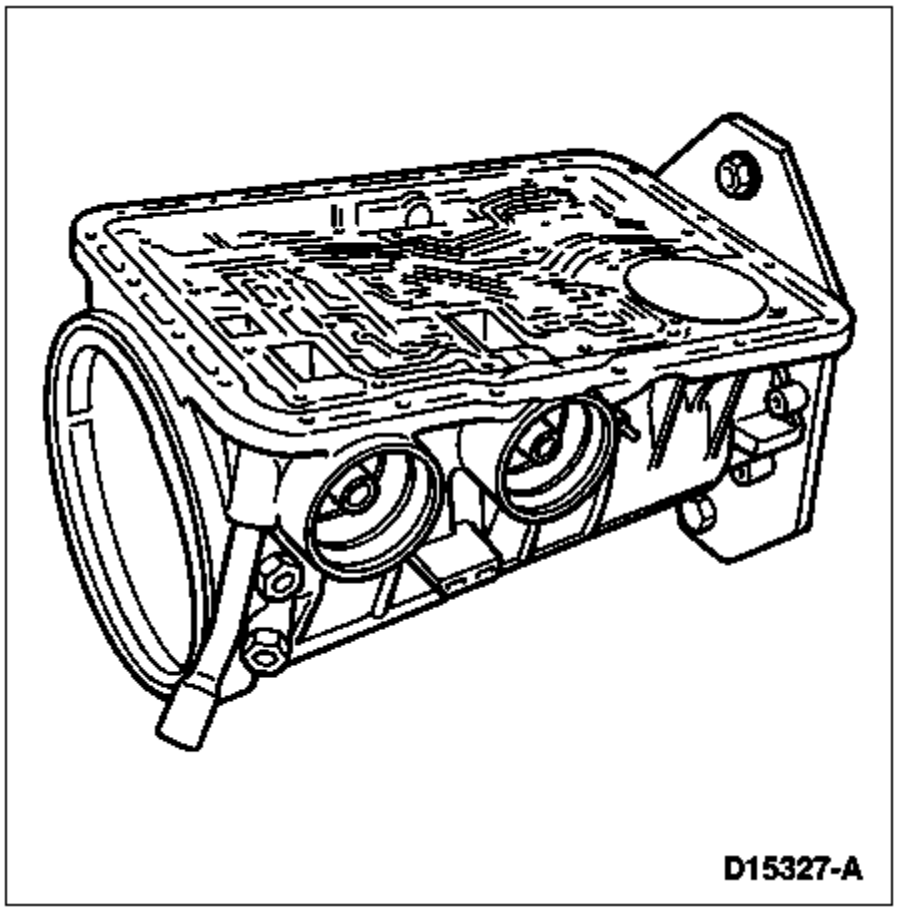
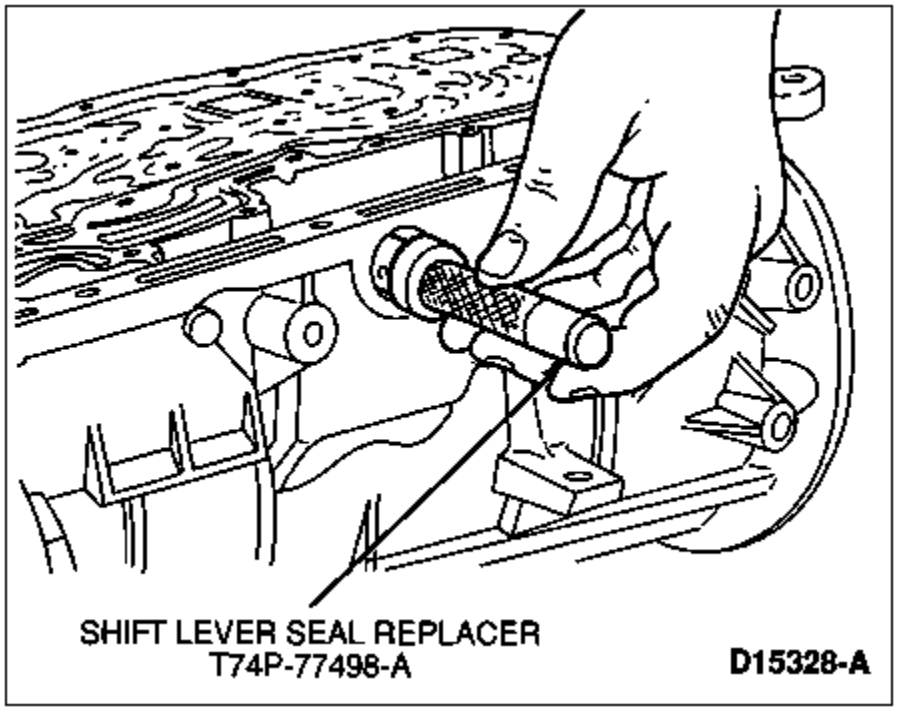


11. Lubricate and install the main control lever seal using Shift Lever Seal Replacer T74P-77498-A.



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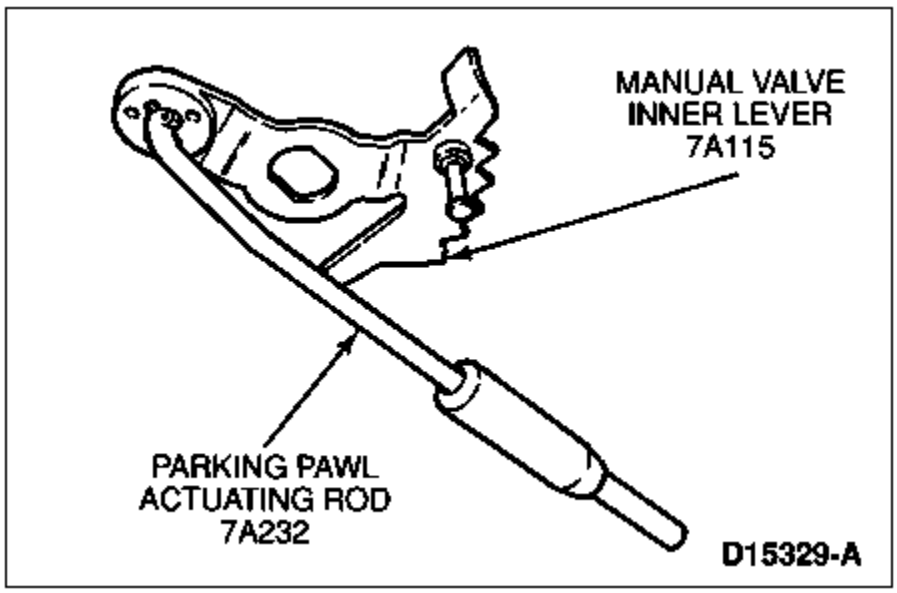
12. Assemble the manual valve inner lever and parking pawl actuating rod as shown.



13. Install the manual control lever shaft into the case.

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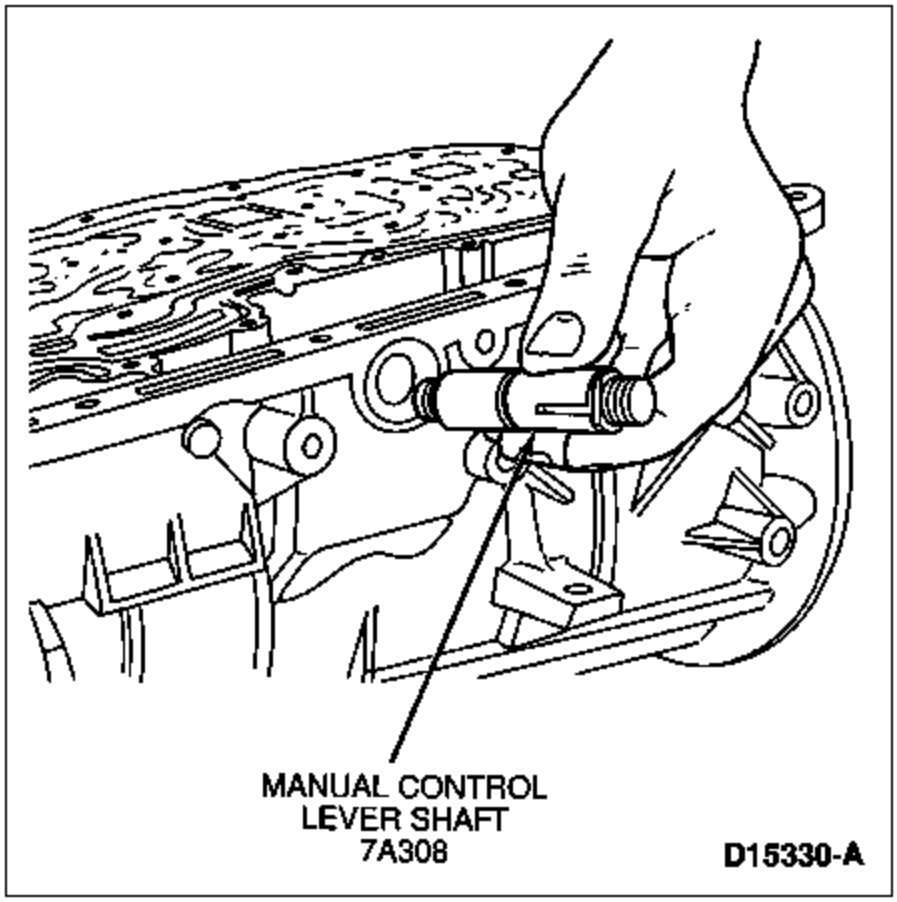

14. **CAUTION: Use care not to damage the fluid pan rail surface when installing the retaining pin.**

    Align the manual control lever shaft with the manual control lever shaft retaining pin. Install the retaining pin.

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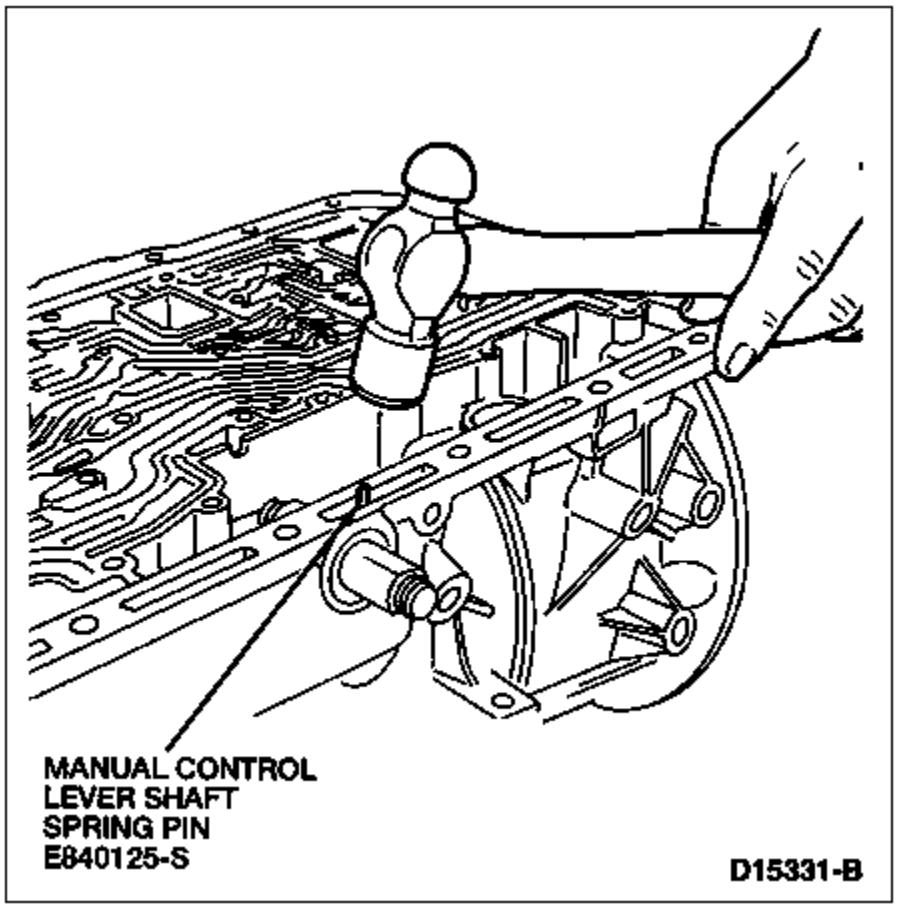

15. Install the manual valve inner lever and parking pawl actuating rod into the case. Align the flats of the manual valve inner lever with the flats on the manual control lever shaft.

16. **CAUTION: To avoid damage, do not allow wrench to strike the manual valve inner lever pin.**

    Install manual valve inner lever nut and tighten to 41-54 Nm (30-40 lb-ft).

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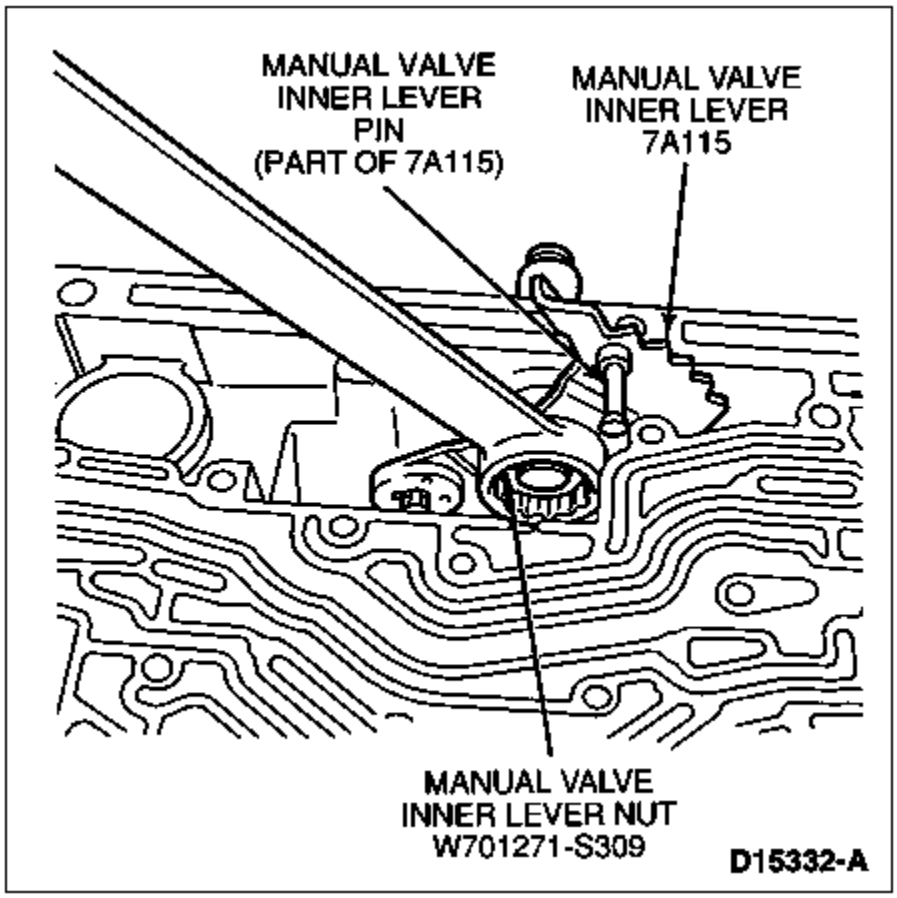

17. **CAUTION: The tabs on the No. 11 output shaft thrust washer point into the case. Ensure that the thrust washer is properly seated.**

    Apply petroleum jelly to the No. 11 output shaft thrust washer and install into the rear of the case bore.

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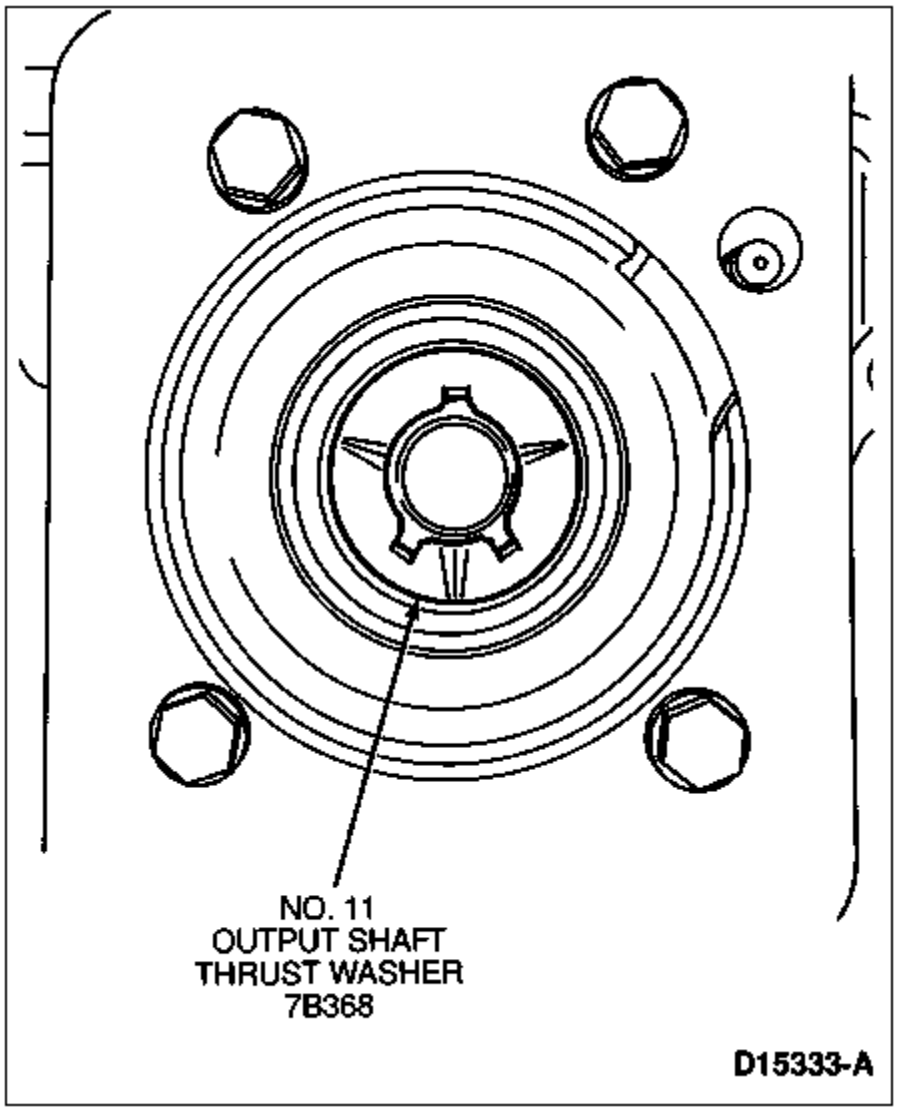

18. Install the park gear into the rear case bore.

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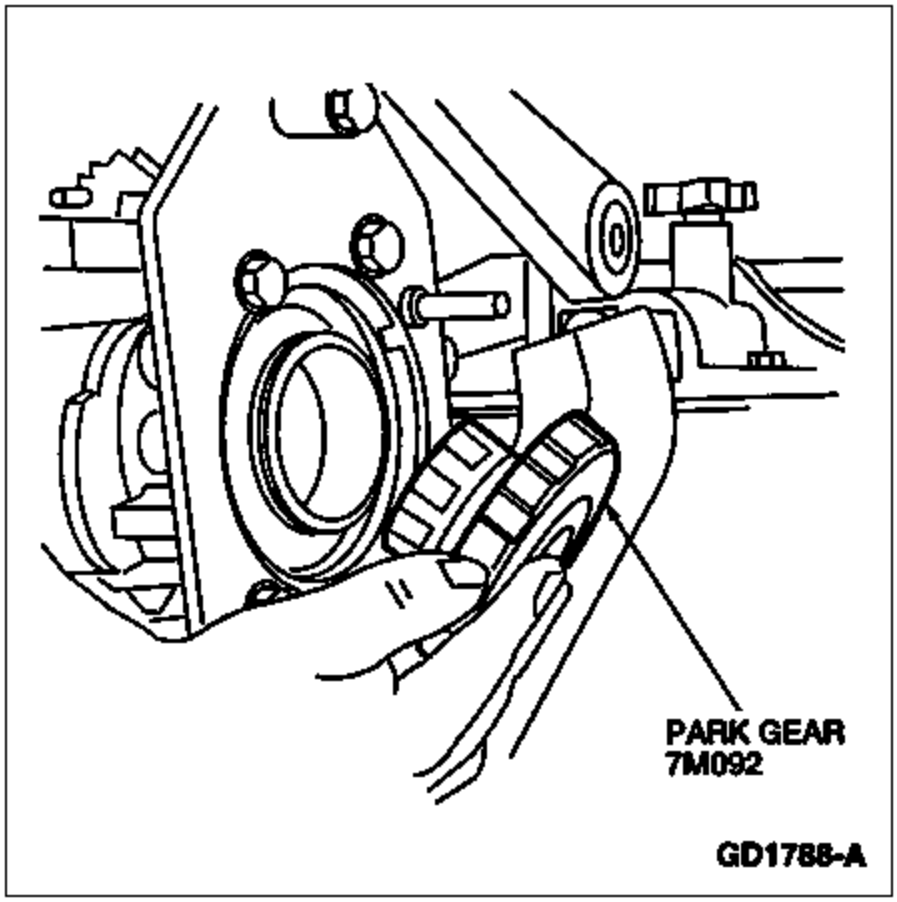
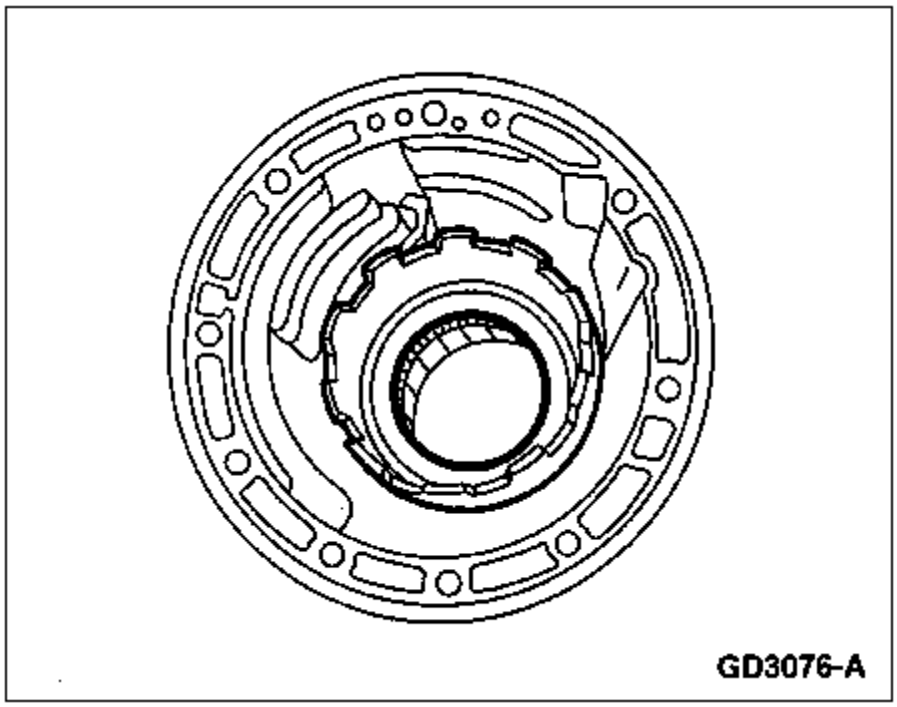


19. Rotating the reverse brake drum assembly clockwise, install into case.



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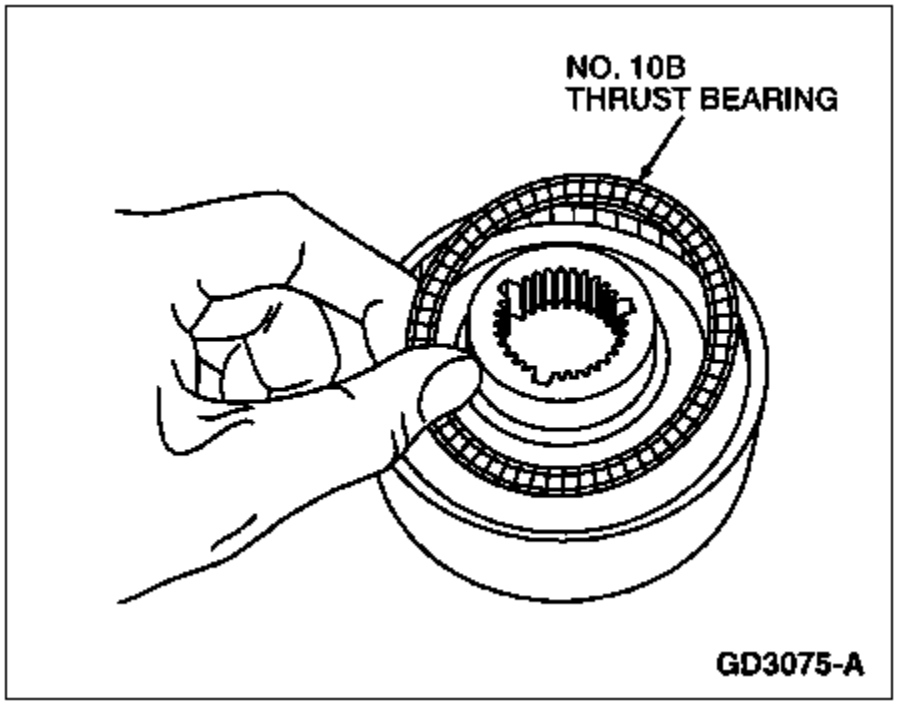
20. If not already installed, use petroleum jelly to install No. 10B thrust bearing onto output shaft ring gear and hub assembly.



21. Install the output shaft through the output shaft park gear.

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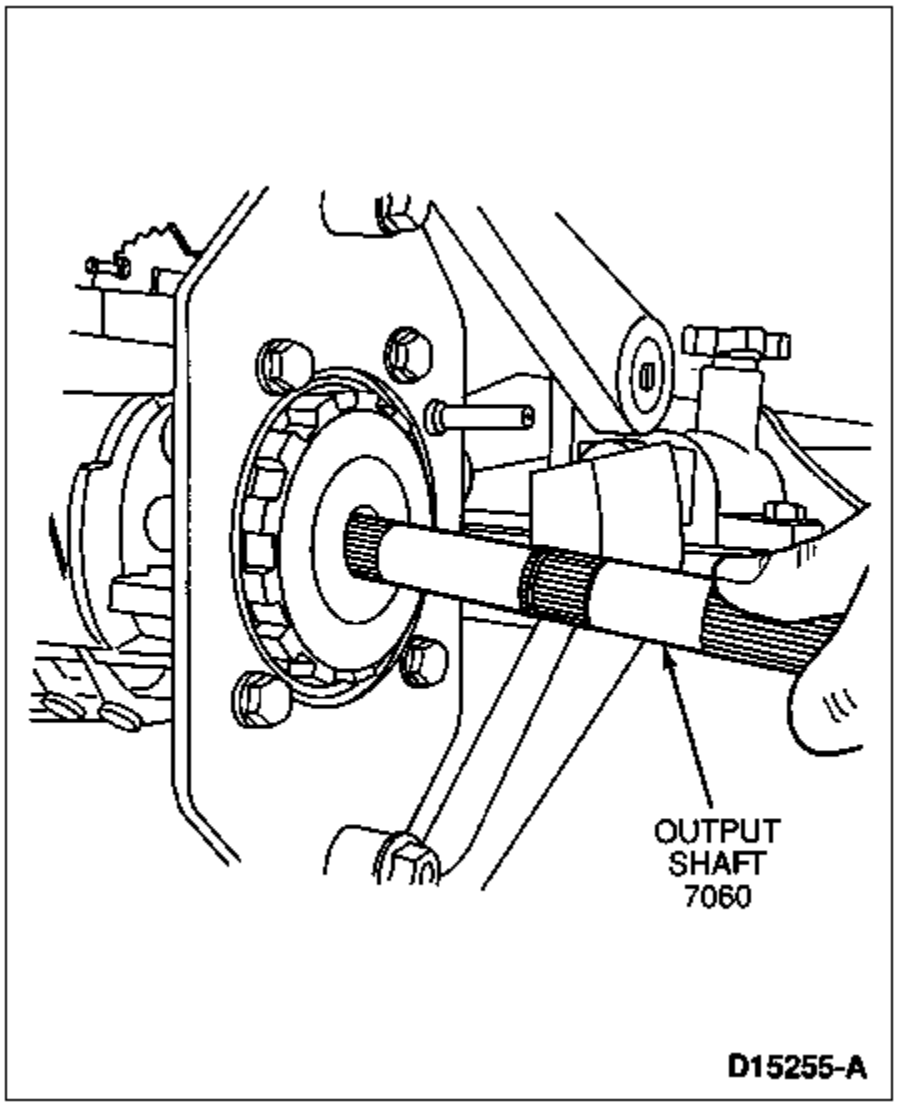

22. Install the output shaft ring gear and output shaft hub assembly.

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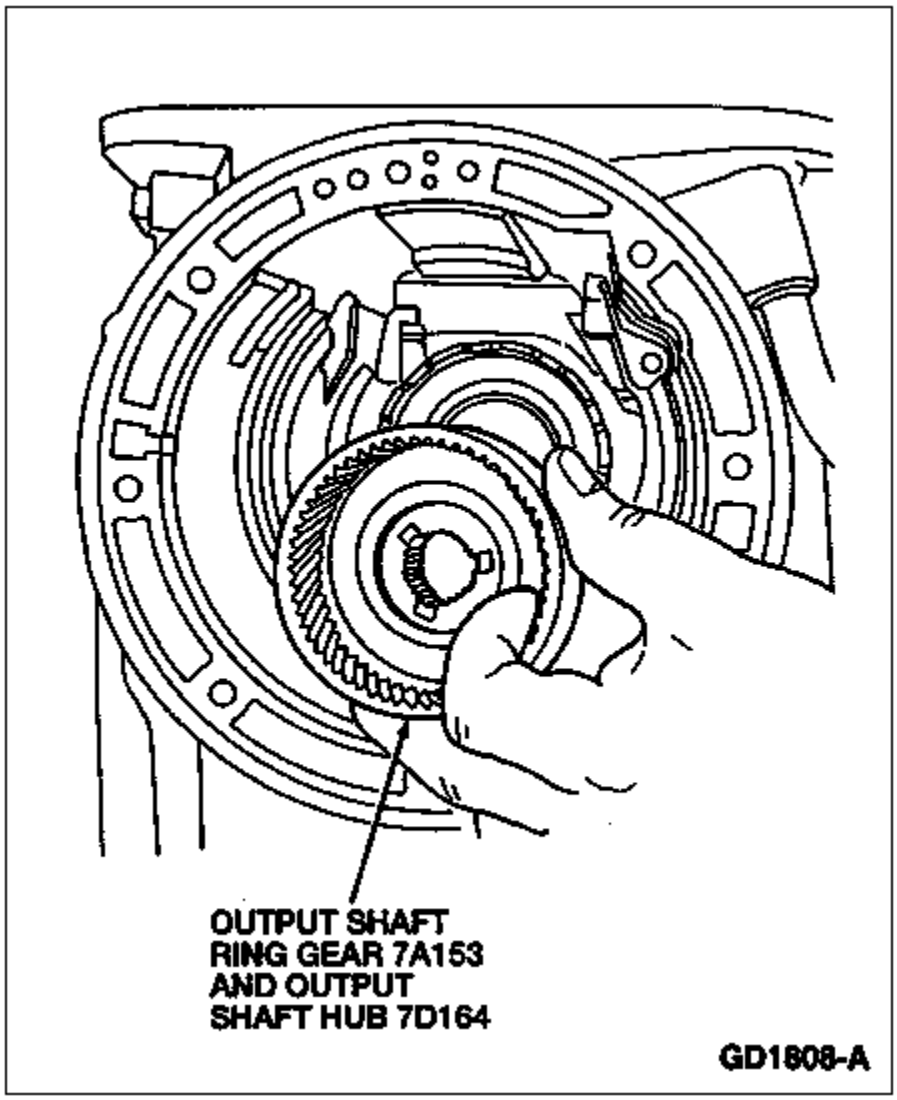

23. **CAUTION: Always use a new retaining ring.**

Install a new output shaft retaining ring in the output shaft retaining ring groove.

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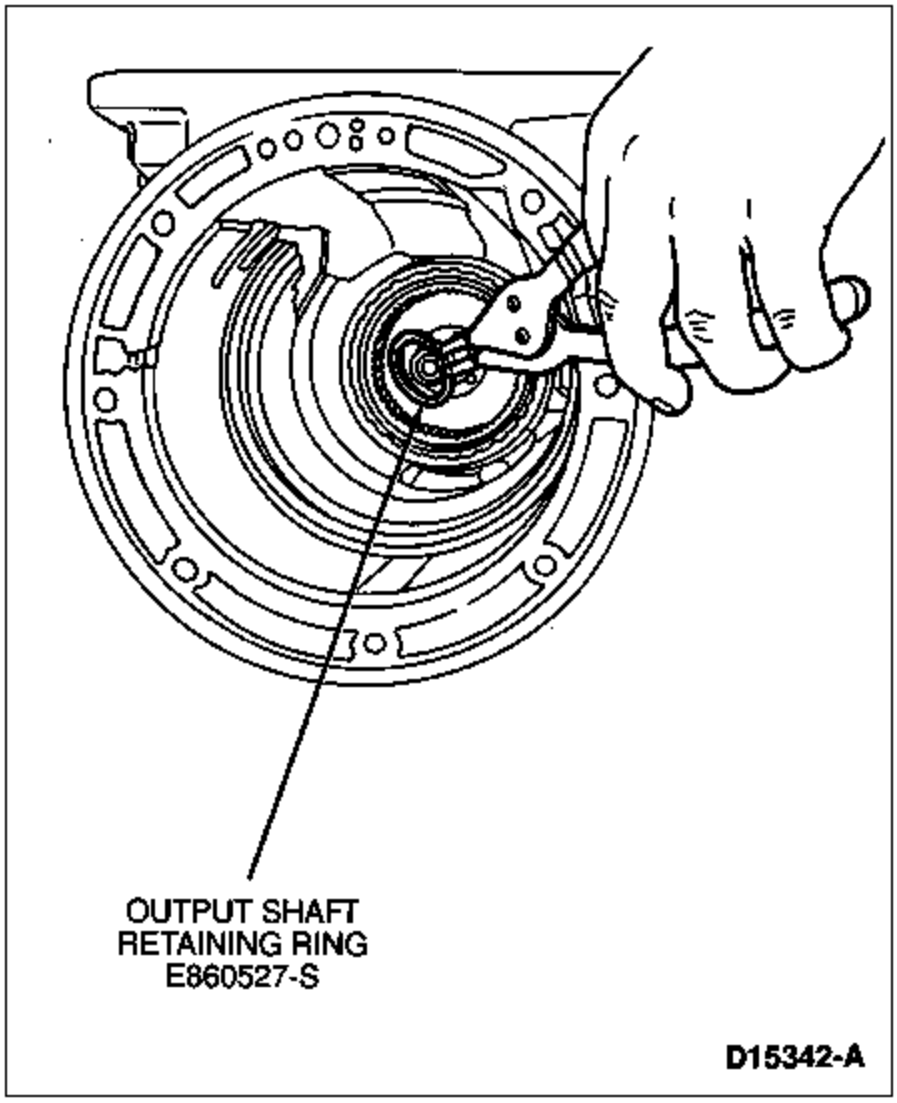

24. **NOTE: Use petroleum jelly to hold the sleeve in place.**

    Install the output shaft sleeve with cone facing up.

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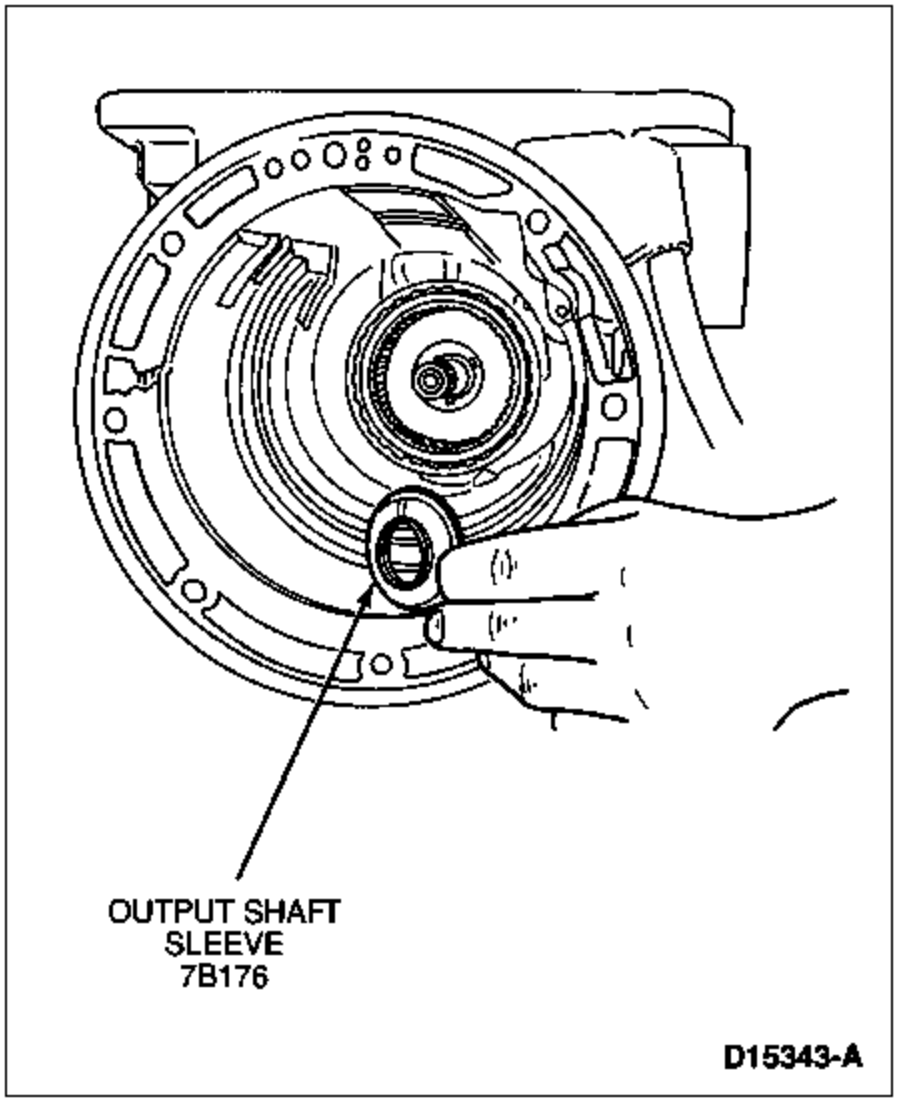

25. **NOTE: Use petroleum jelly to hold the needle bearings in place.**

    Position the No. 8 low/reverse planetary carrier needle bearing on the front face of the low/reverse planetary. Position the No. 9 low/reverse planetary carrier needle bearing on the rear face of the low/reverse planetary.

    No. 8 and 9 Low/Reverse Planetary Carrier Needle Bearing Position

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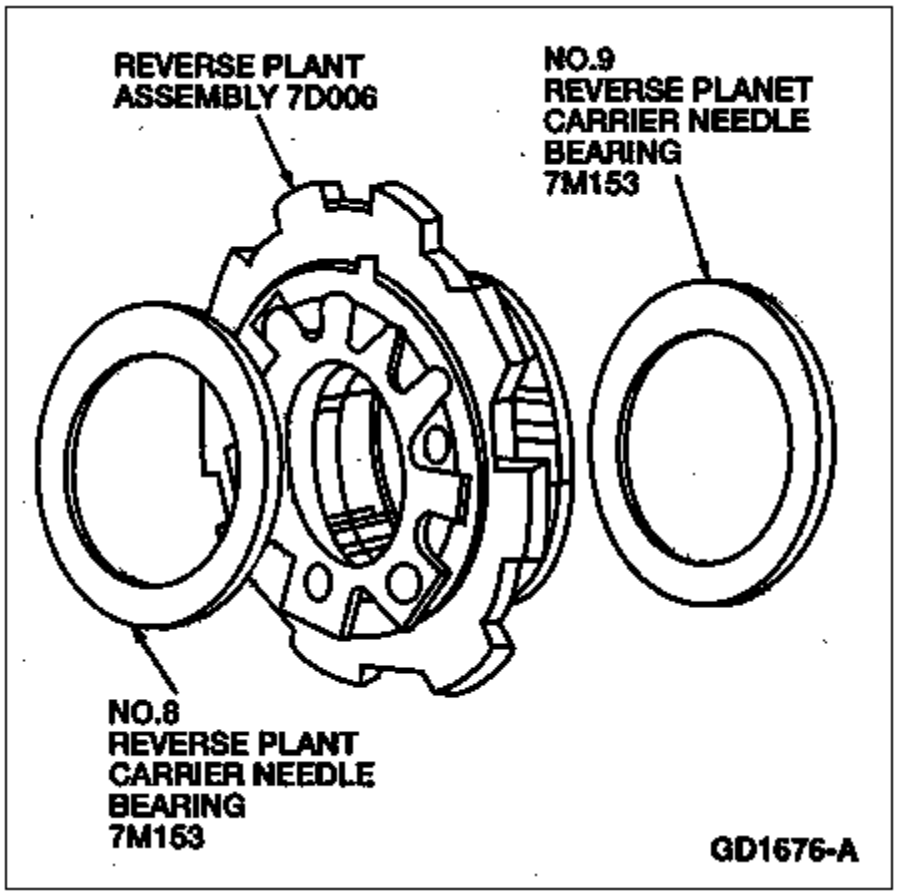

26. **CAUTION: Make sure the needle bearings stay in place.**

Install the low/reverse planetary assembly, with No. 8 and No. 9 low/reverse planetary carrier needle bearings, into the output shaft ring gear.

Reverse Planetary Assembly Installation

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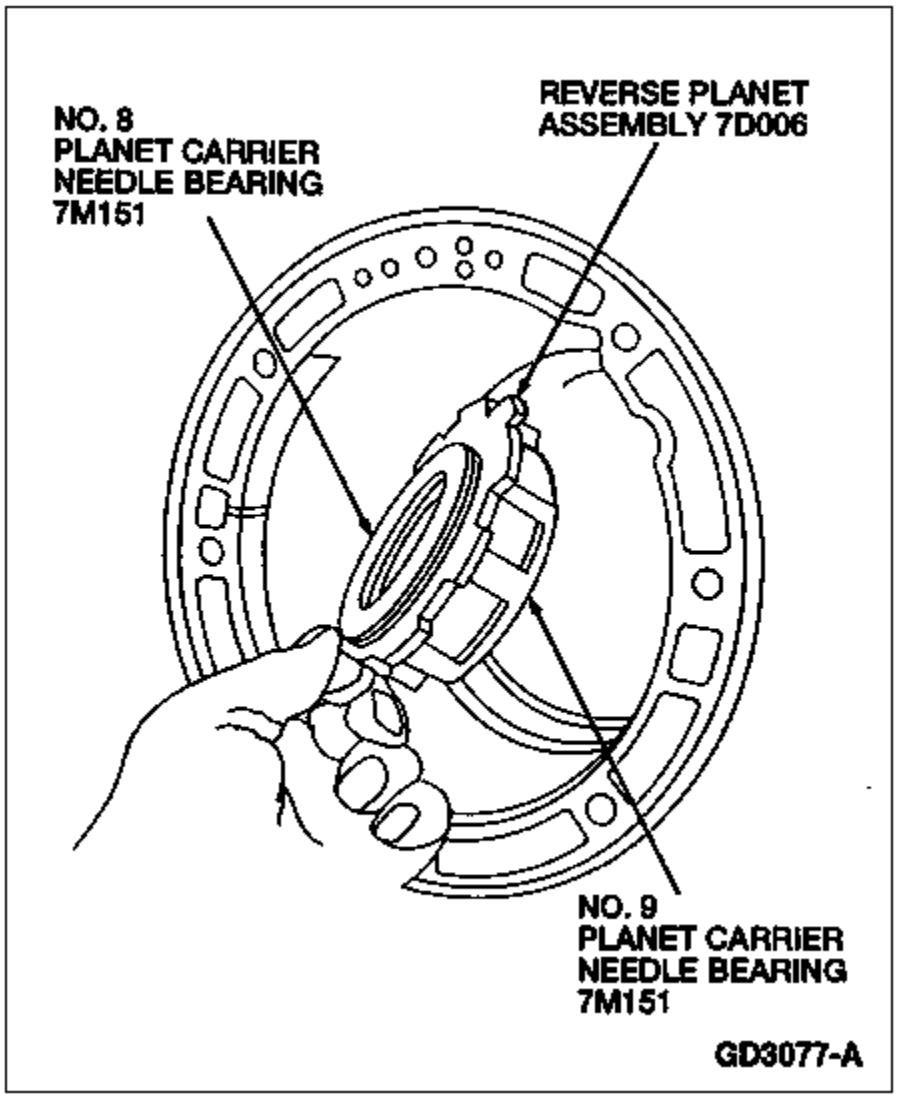

27. Pull the low/reverse brake drum forward and install the retaining ring into the low/reverse brake drum groove. This will hold the low/reverse planetary assembly in place.

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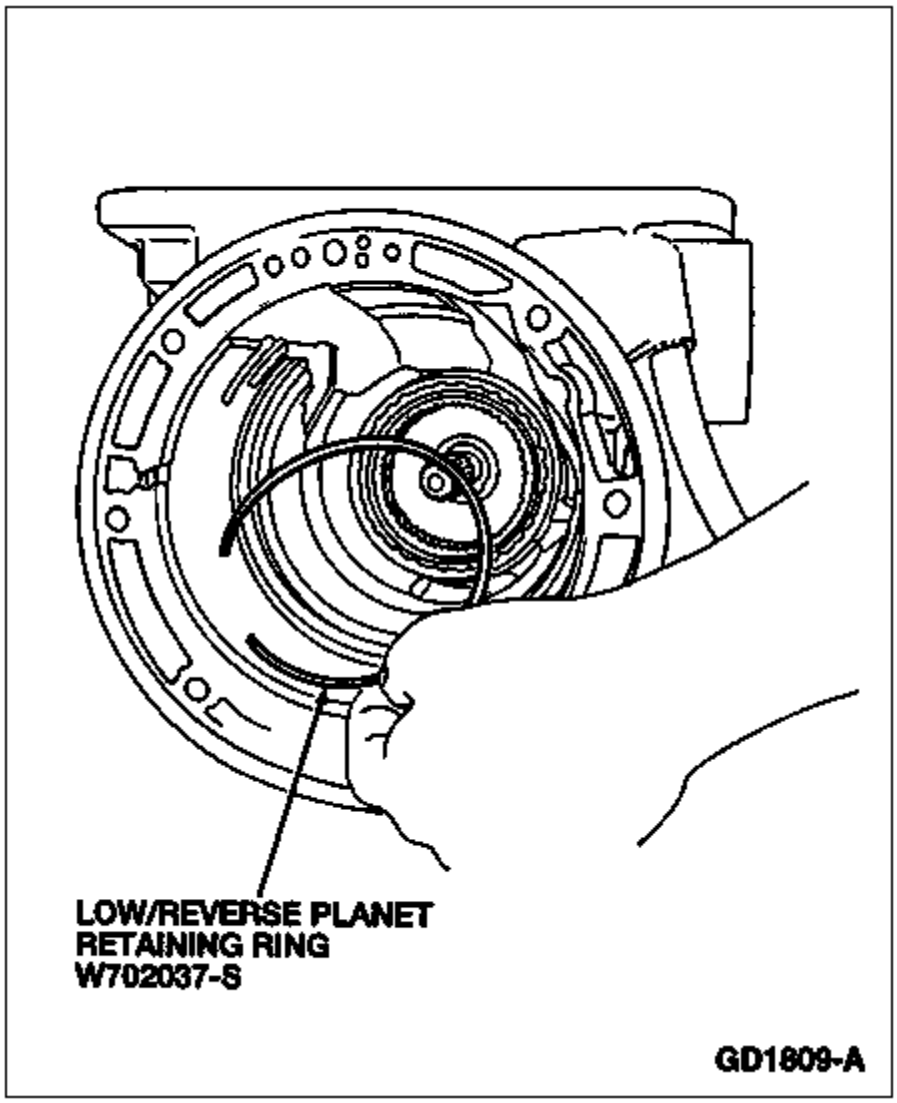

28. **CAUTION: Make sure band is resting on the two anchor pins in the case.**

Install the low/reverse band over the low/reverse brake drum.

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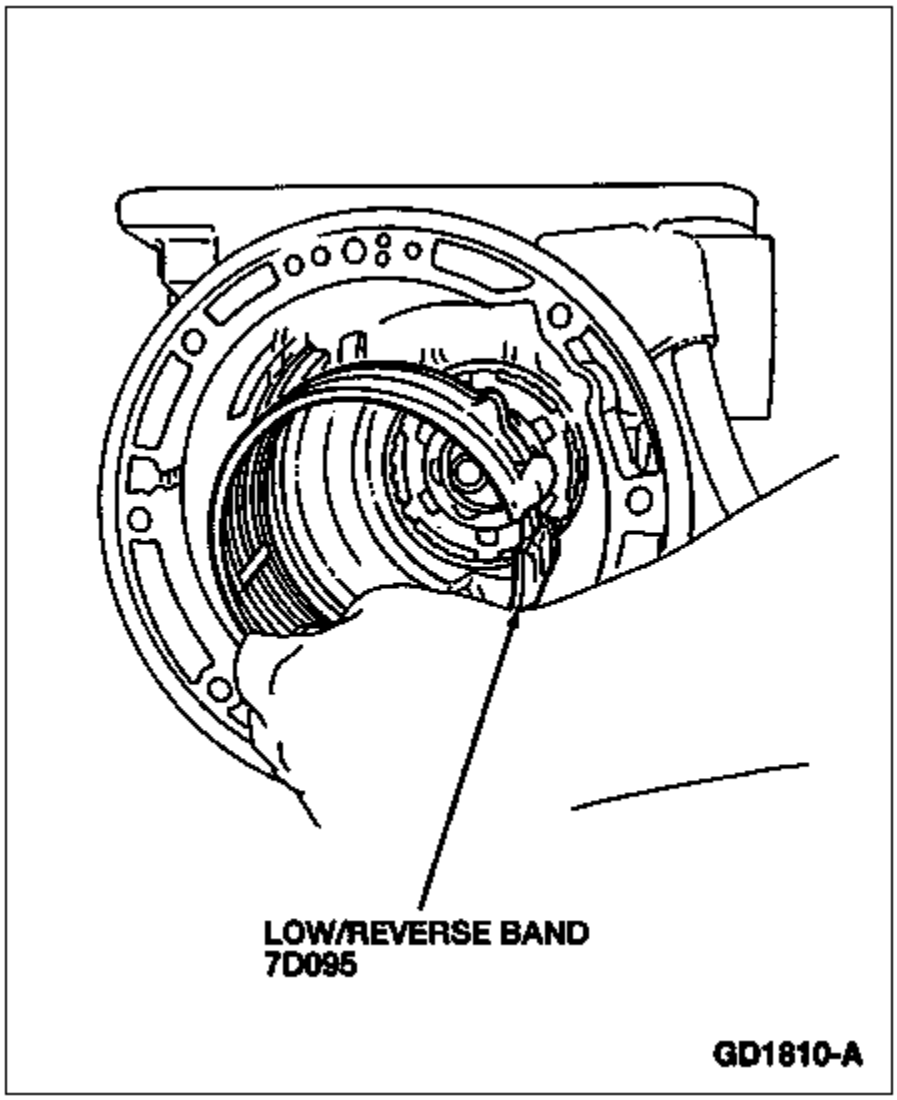

29. Install the low/reverse band servo piston and rod temporarily to hold the low/reverse clutch band in position.

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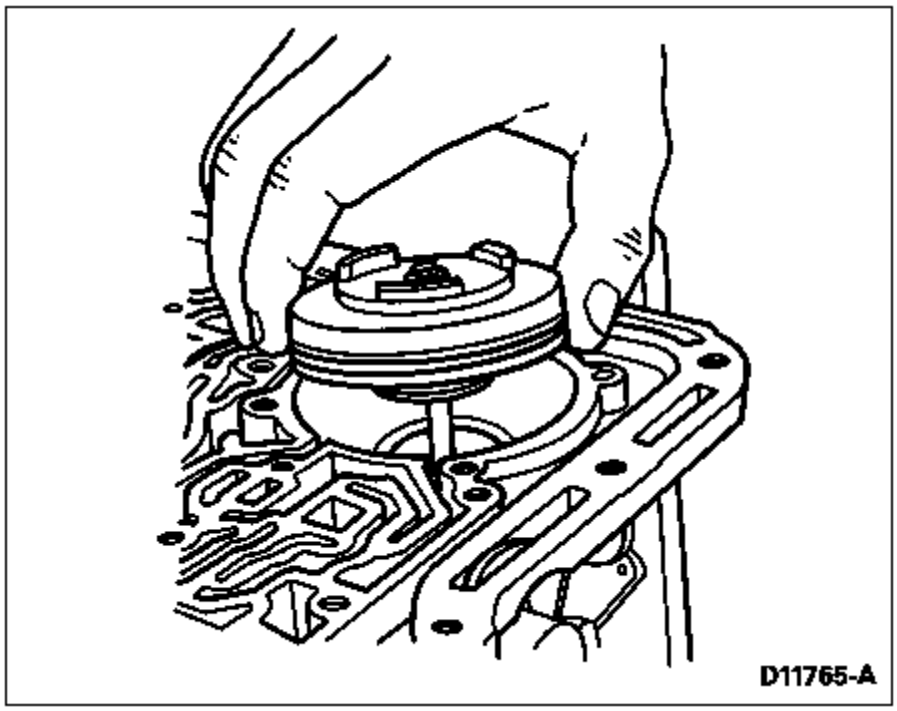
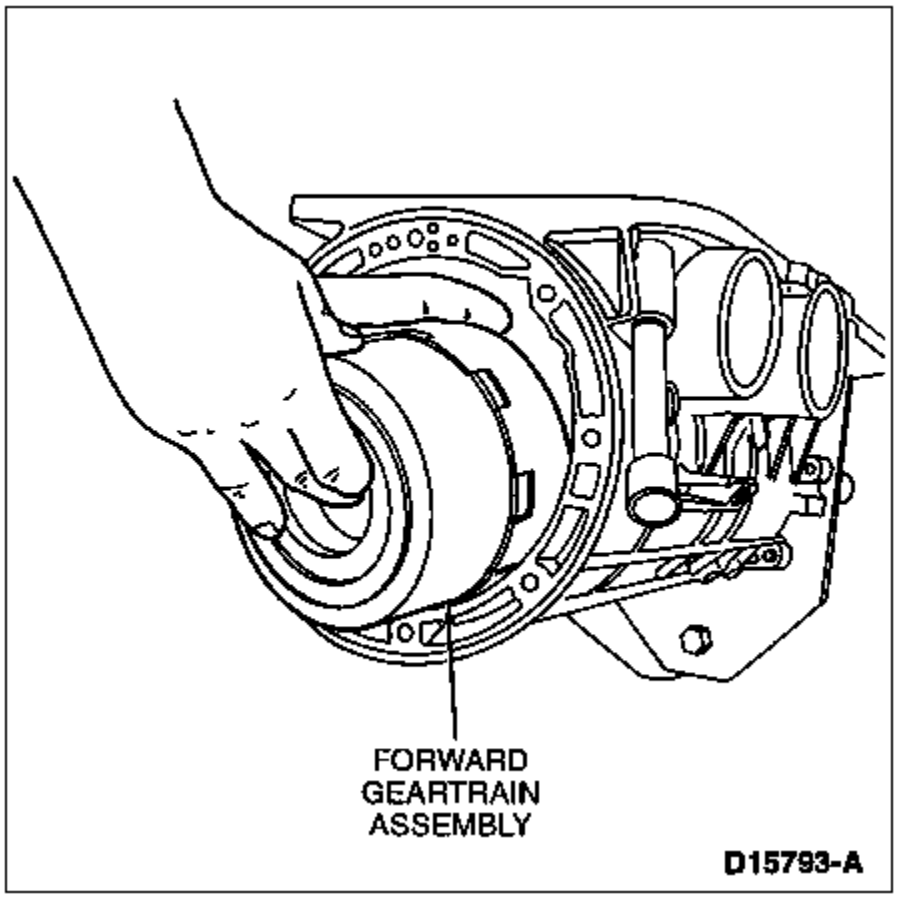


30. Install the previously assembled forward geartrain assembly.



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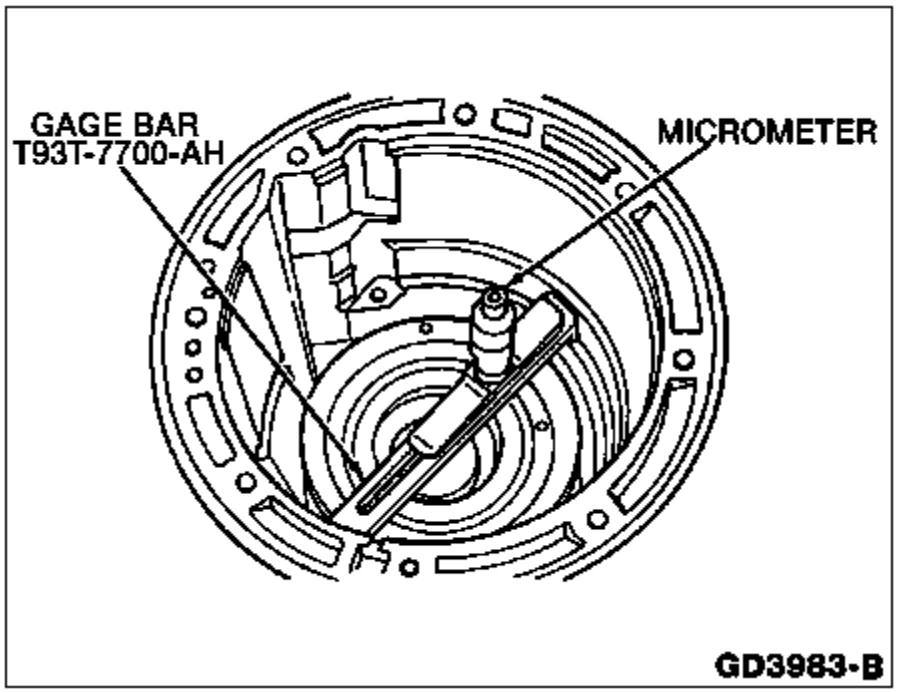
31. **WARNING: MAKE SURE THE LOCK PIN ON BENCH-MOUNTED HOLDING FIXTURE T57L-500-B IS SECURE.**

    Rotate the transmission assembly so that the converter housing gasket surface is facing up.

32. Place Gage Bar T93T-77003-AH on the case shoulder of the number four intermediate brake drum thrust surface. Set the mircometer on top of the gage bar as shown.



33. Extend the micrometer probe until it contacts the intermediate brake drum thrust bearing surface. Record the reading as dimension "A."

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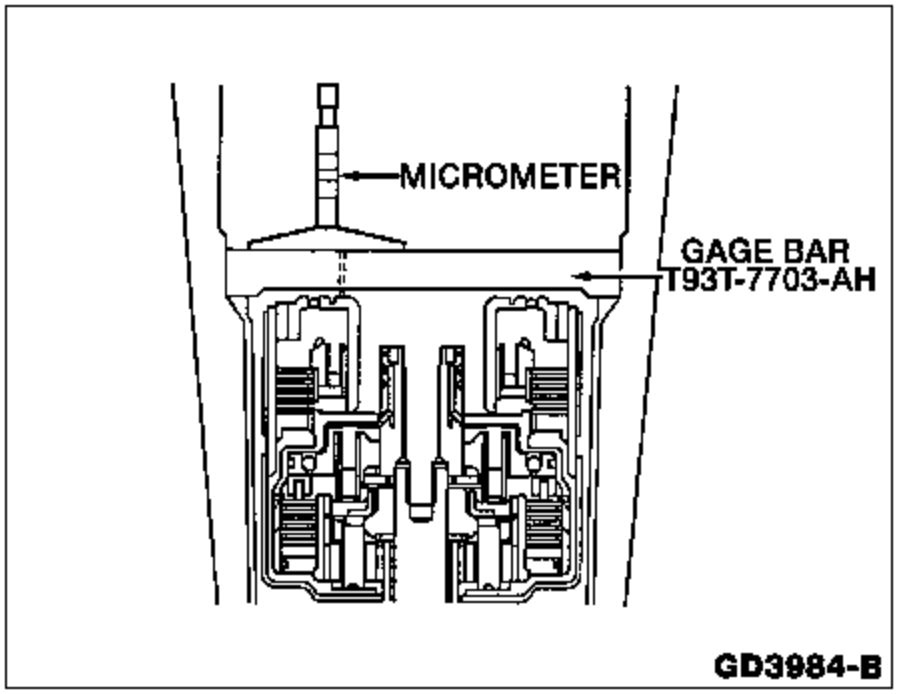
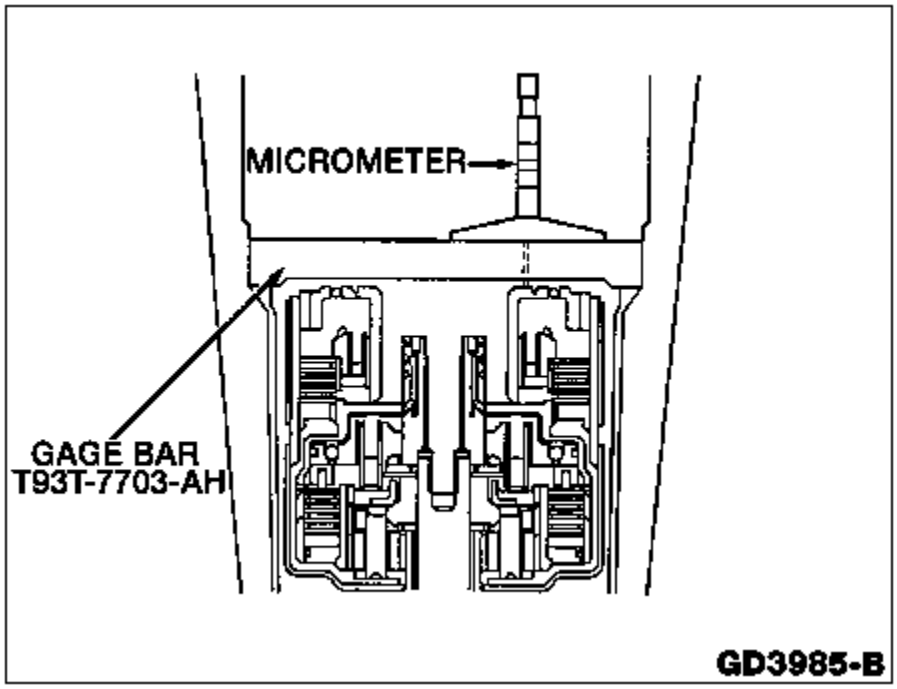


34. Place the micrometer on the opposite side and extend the mircometer probe until it contacts the intermediate brake drum thrust surface. Record the reading as dimension "B."



35. Add the dimensions "A" and "B," divide the total of "A" and "B" by two. Subtract the gage bar thickness (17.78 mm [0.700 in]). This is dimension "C."

36. Place Gage Bar T93T-77003-AH across the center support. Place micrometer on top of the gage bar as shown. Extend the micrometer probe until it contacts the center support thrust bearing surface.

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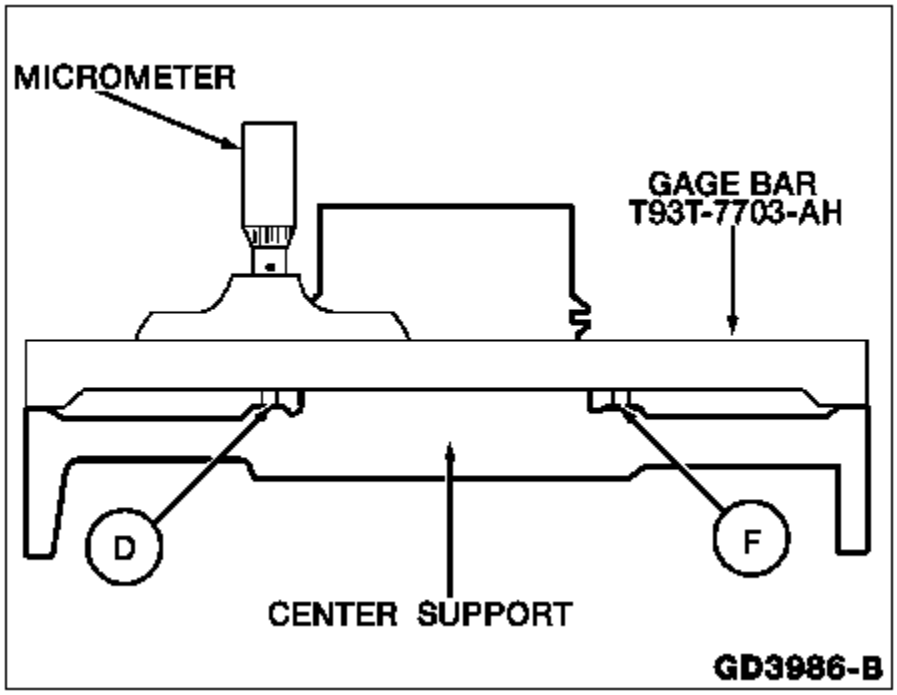
Record the reading as dimension "D."



37. Place the micrometer on the opposite side of Gage Bar T93T-77003-AH and extend the micrometer until it contacts the center support thrust bearing surface. Record the dimension as "F."

38. Add dimensions "D" and "F" and divide the total of "D" and "F" by two, then subtract the Gage Bar thickness (17.78 mm [0.700 in]). The resulting dimension is "G."

39. Add dimensions "G" and "C." This total is dimension "J." Use the chart below and dimension "J" to choose the proper number four thrust bearing. Reference end play is 0.21-0.51 mm (0.008-0.020 in).

Dimension "J"	Service Part Number	Bearing Thickness	Identification Notches
3.01-3.15 mm (0.119-0.124 in)	F77Z-7D014-GA	2.65-2.80 mm (0.104-0.110 in)	None
3.17-3.34 mm (0.125-0.132 in)	F77Z-7D014-HA	2.80-2.95 mm (0.110-0.116 in)	One
3.36-3.54 mm (0.133-0.140 in)	F77Z-7D014-KA	3.00-3.15 mm (0.1118-0.124 in)	Two
3.57-3.71 mm (0.141-0.147 in)	F77Z-7D014-LA	3.20-3.35 mm (0.126-0.132 in)	Three

40. Install the intermediate servo actuating lever as shown.

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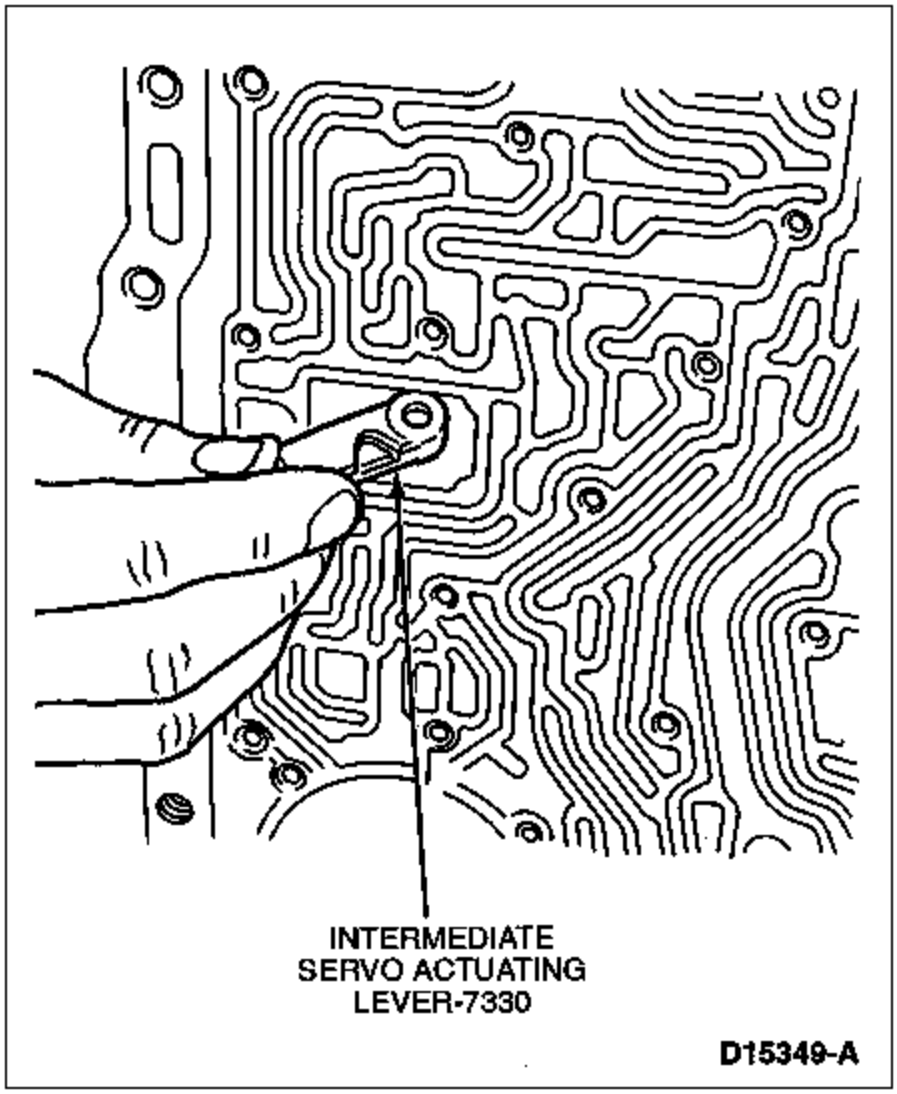

41. **NOTE: The intermediate band actuating lever shaft is shorter than the overdrive shaft.**

    Install the intermediate band actuating lever shaft through the intermediate servo lever.

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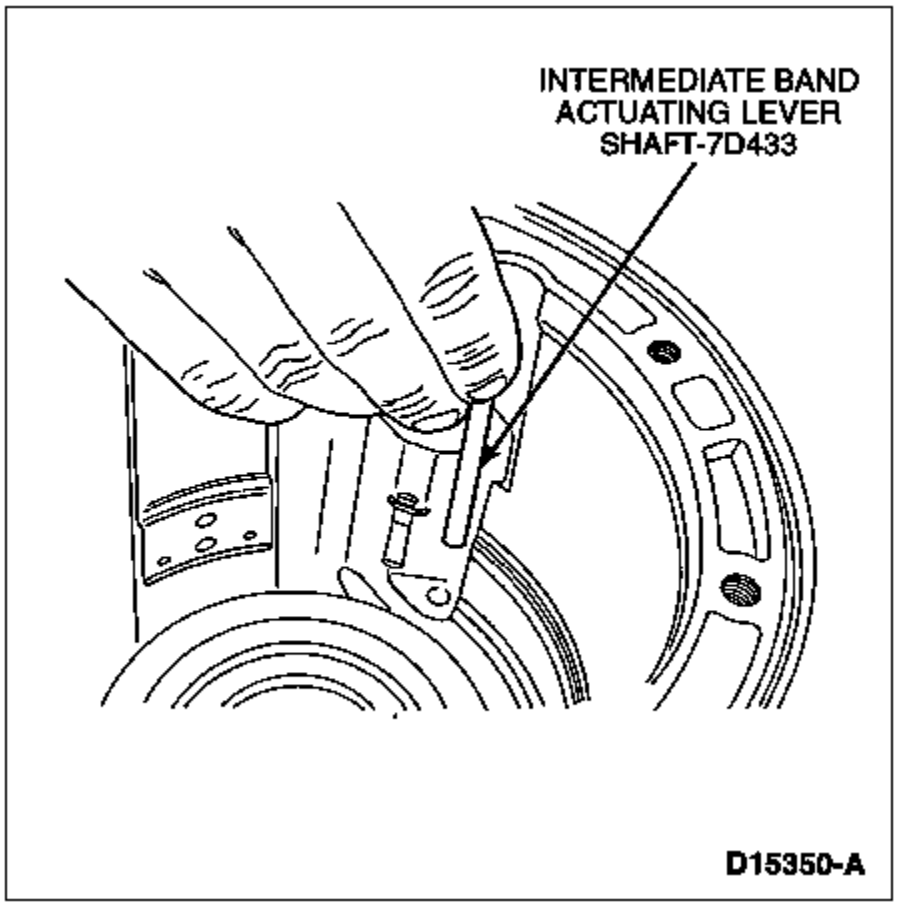

42. Install the intermediate band apply strut on the intermediate servo lever.

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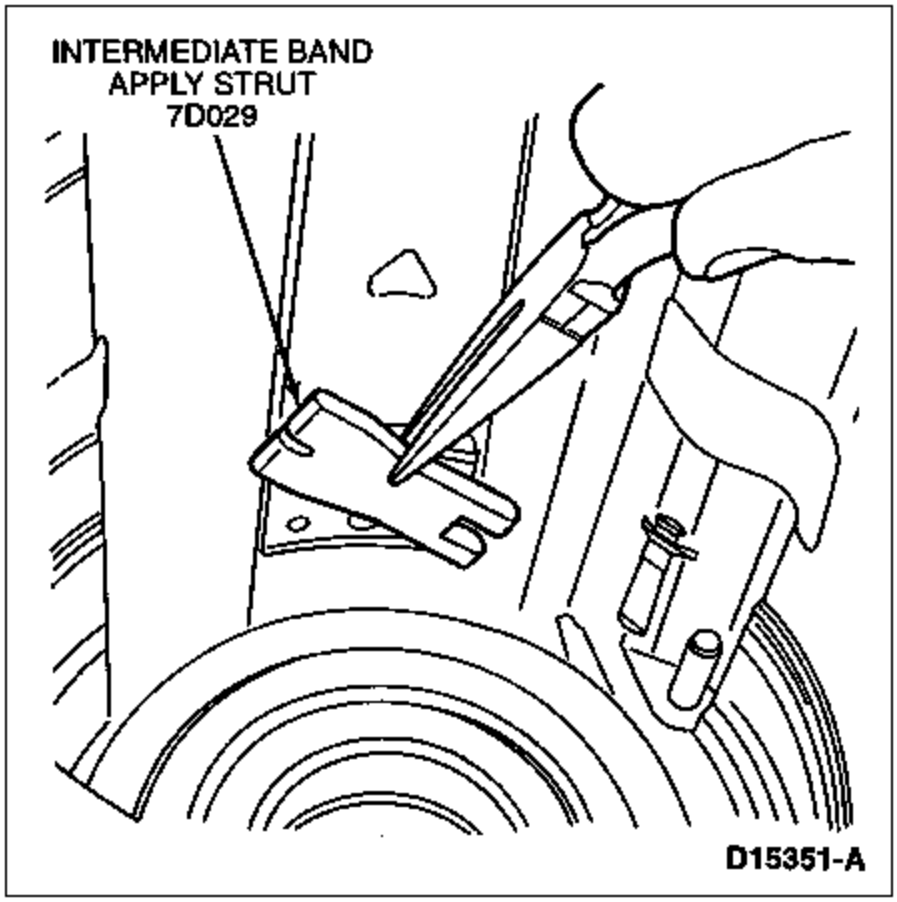

43. **NOTE: Make sure the apply strut is aligned with the band notch.**

    Install the intermediate band.

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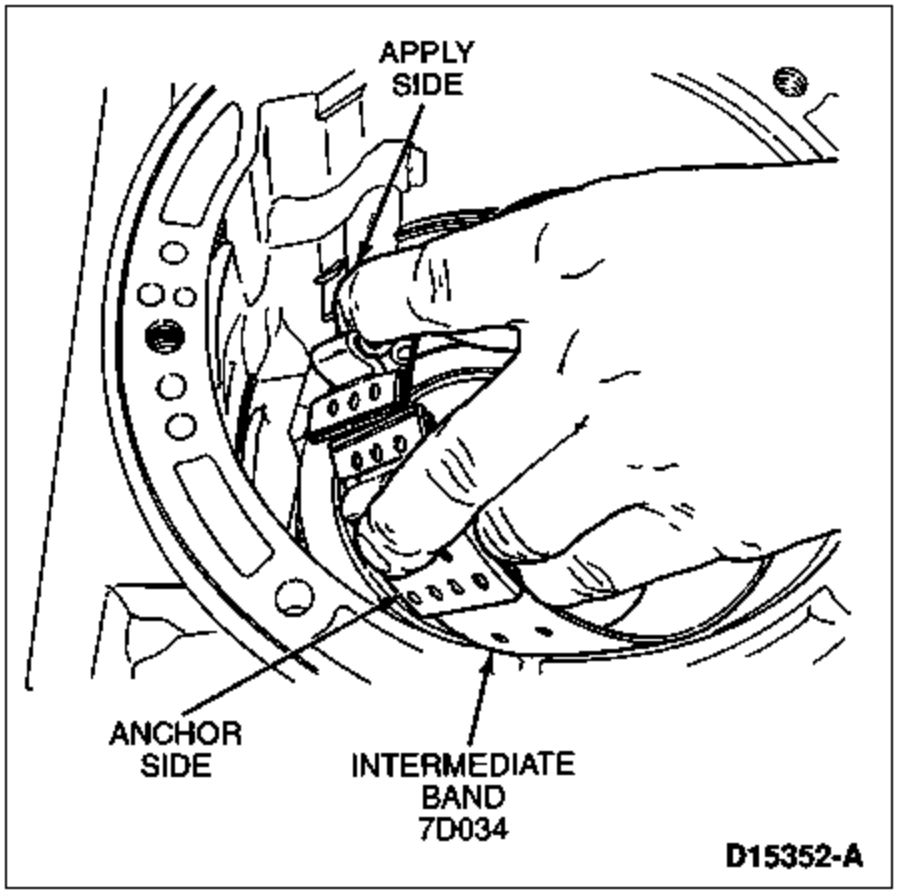

44. **NOTE: Use the intermediate band adjusting screw as a temporary alignment guide.**

    NOTE: The front and intermediate band anchor struts are the same.

    Install the intermediate band anchor strut and intermediate band adjusting screw.

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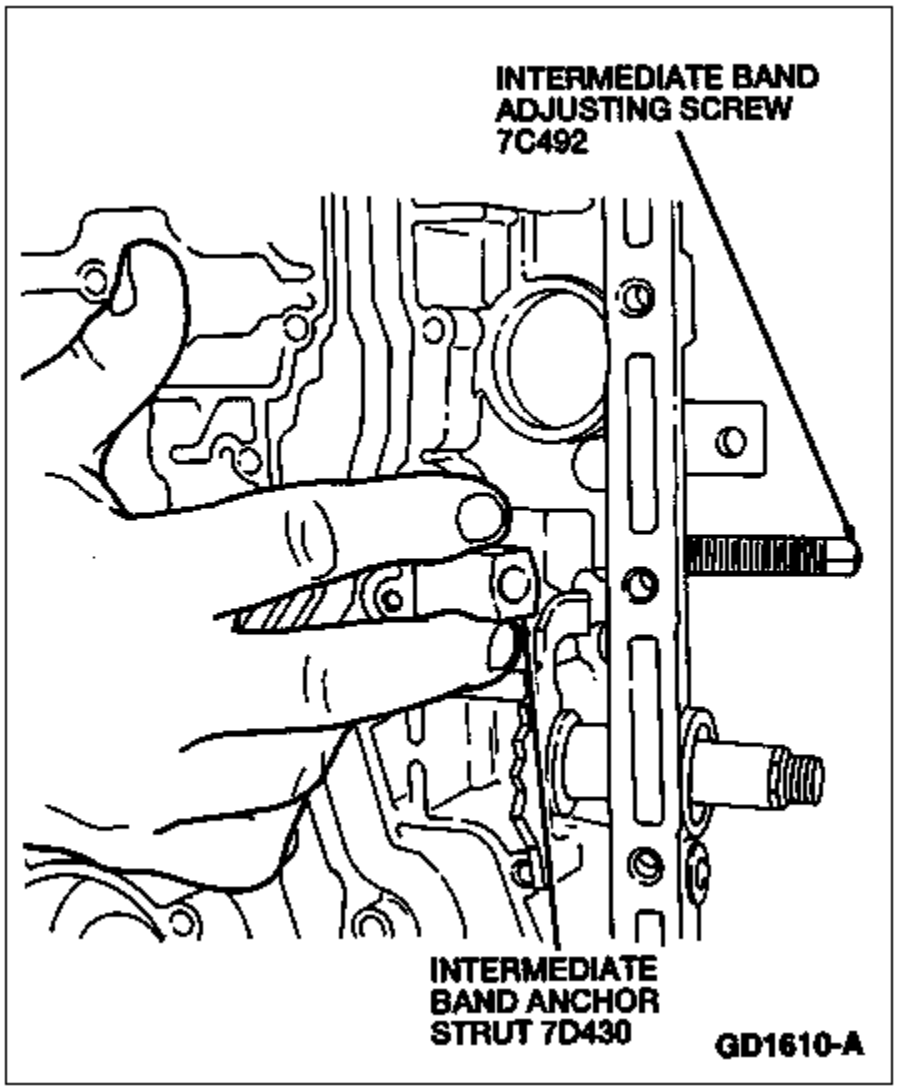

45. **NOTE: Use petroleum jelly to hold the No. 4 intermediate brake drum thrust bearing in place.**

Install the correctly selected No. 4 intermediate brake drum thrust bearing over the center support as shown.

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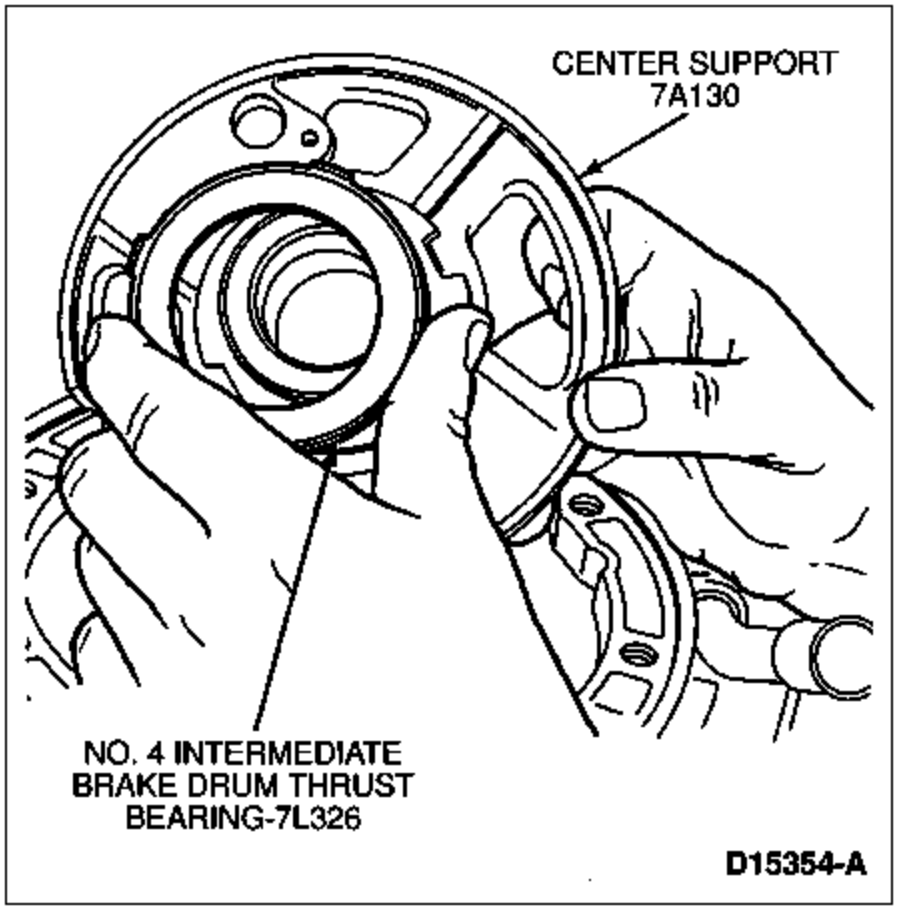

46. **CAUTION: Do not apply pressure to the rear planetary support while installing. Damage to the sealing rings may result. Make sure the rear planetary support is seated.**

Position the center support into the reverse clutch drum. Use the input shaft as an aid to seat the center support. Gently wiggle the input shaft from side to side until the center support is seated against the case shoulder. Remove the input shaft.

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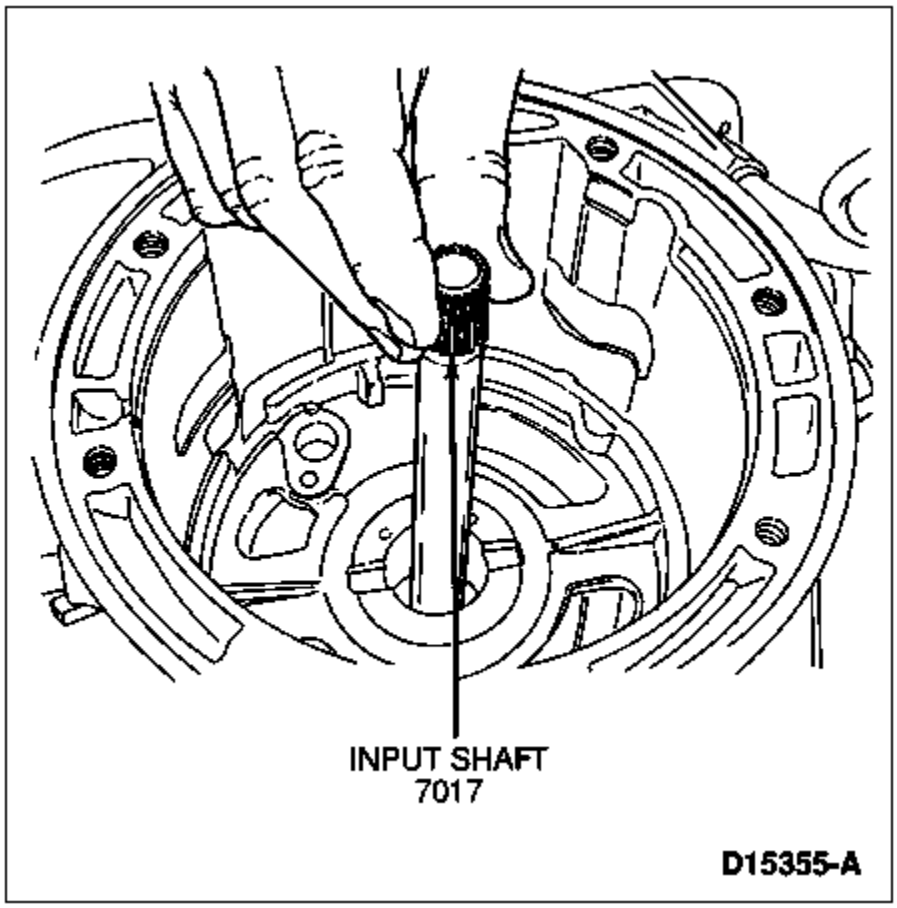

47. **CAUTION: Install the retaining ring in the transmission case groove with the tapered side facing up.**

CAUTION: The retaining ring must be installed so the notch opening is not obstructed by the center support retaining ring. This will prevent damage to the turbine shaft speed (TSS) sensor wires.

Install the center support retaining ring in the transmission case groove.

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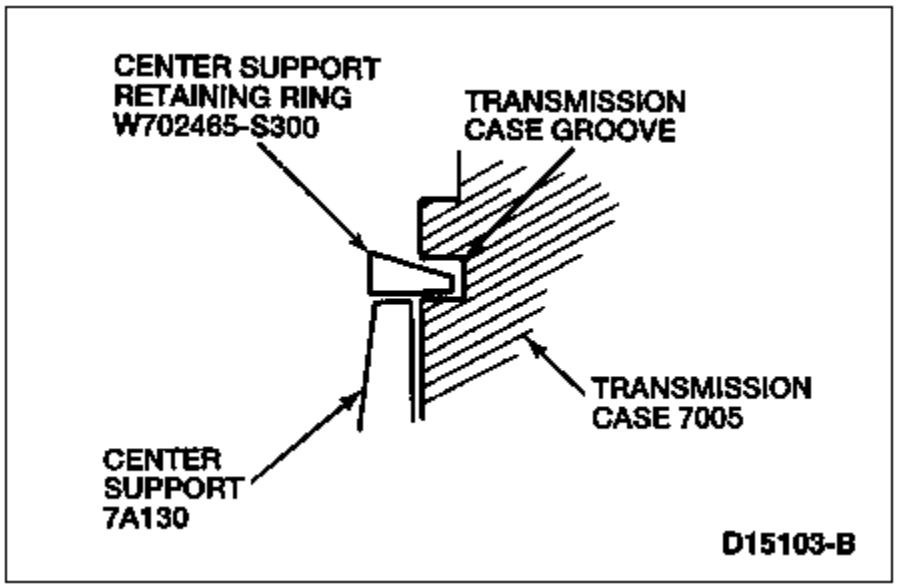

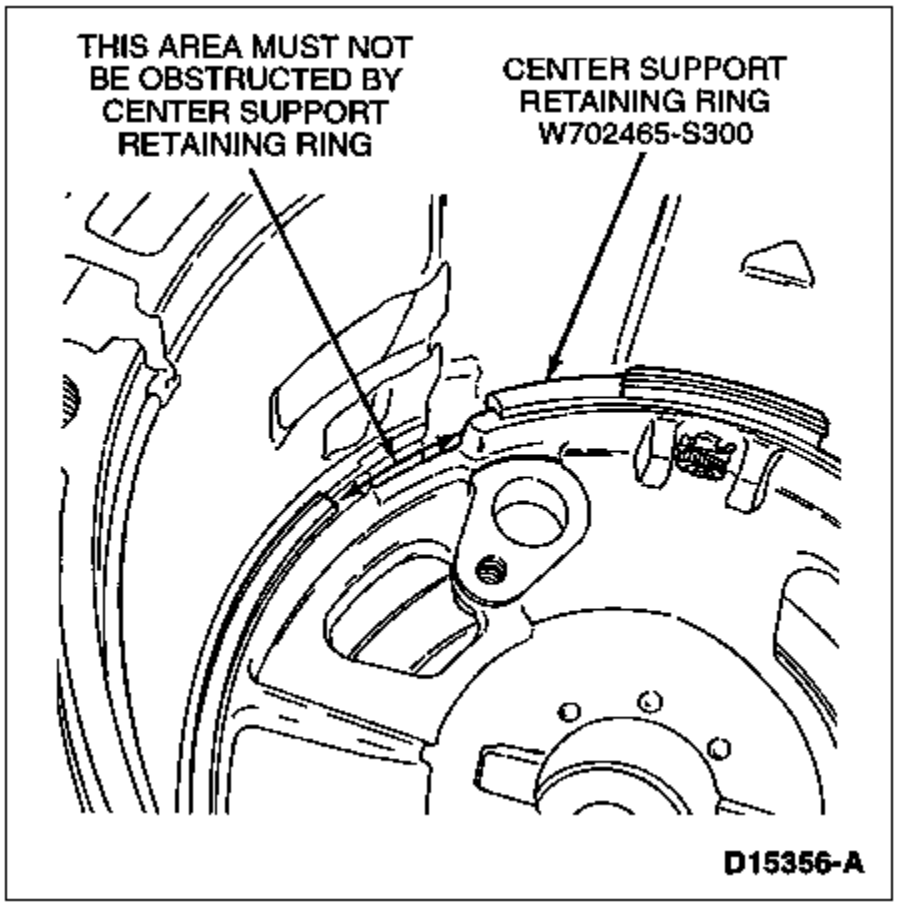

48. Ensure that the nut and cage assembly is in place.

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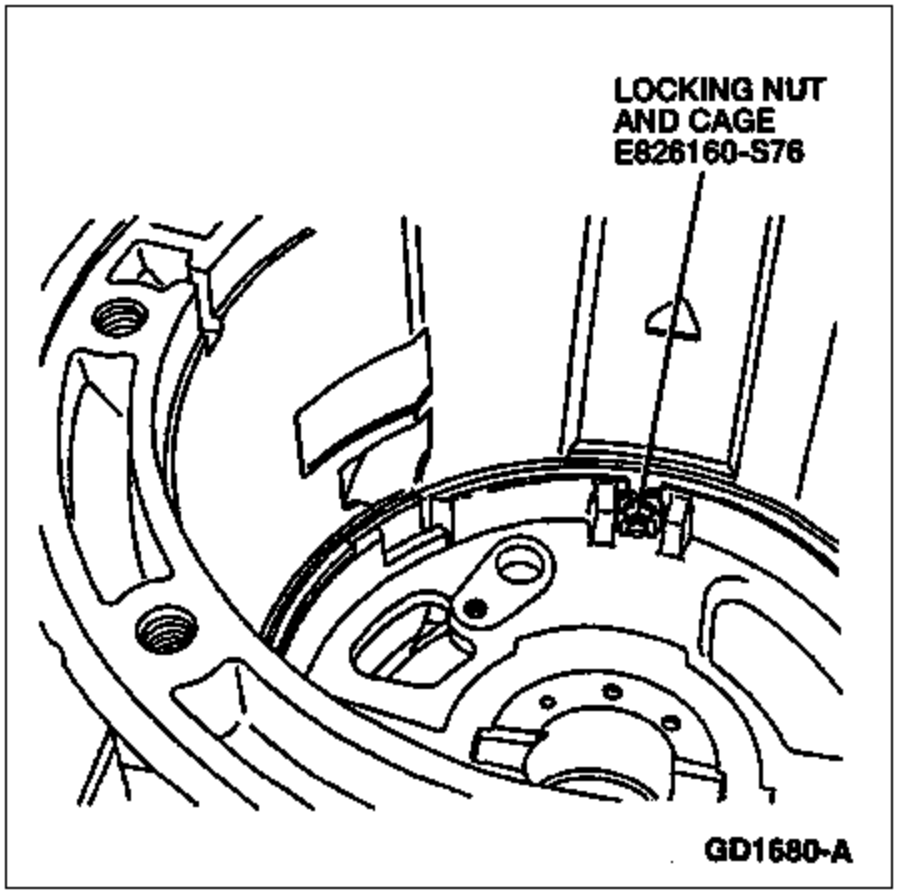

49. Use a 5 mm Allen wrench to install the M6 x 20 mm center support-to-case capscrew into the nut and cage assembly as shown. Tighten the center support-to-case capscrew to 9-13 Nm (80-115 lb-in).

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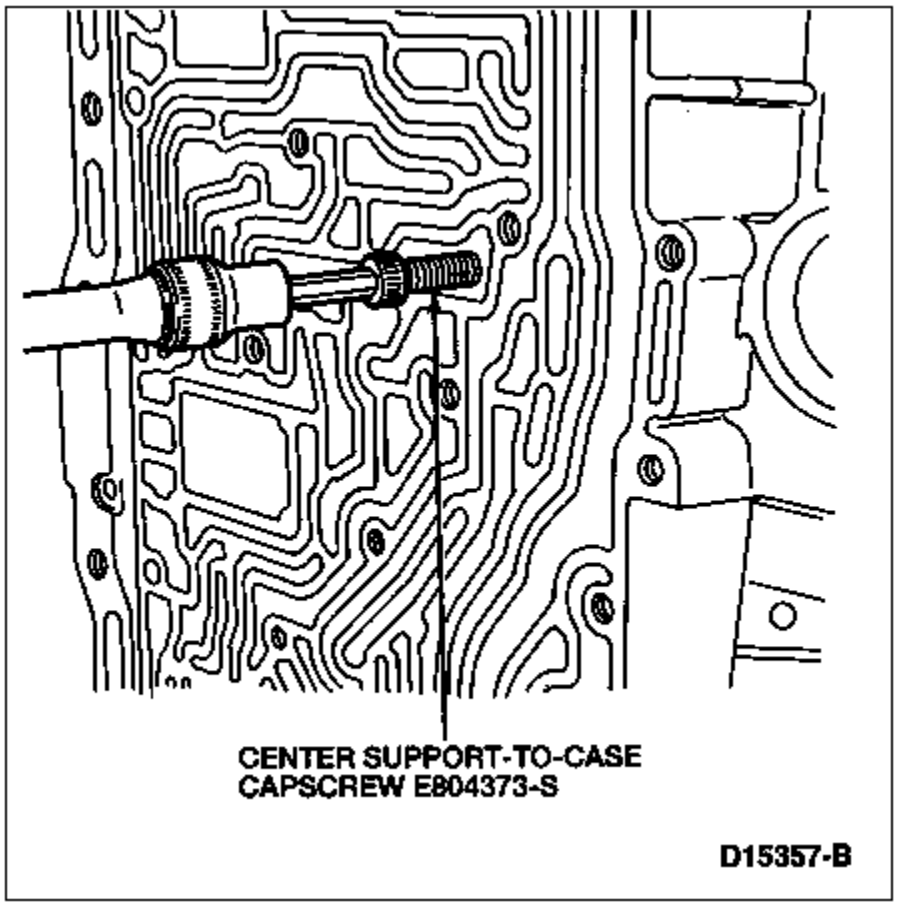

50. **CAUTION: Carefully route the turbine shaft speed (TSS) sensor connector and wiring harness through the opening in the case. Do not damage the wiring.**

Route the TSS sensor connector and wiring harness through the opening in the case.

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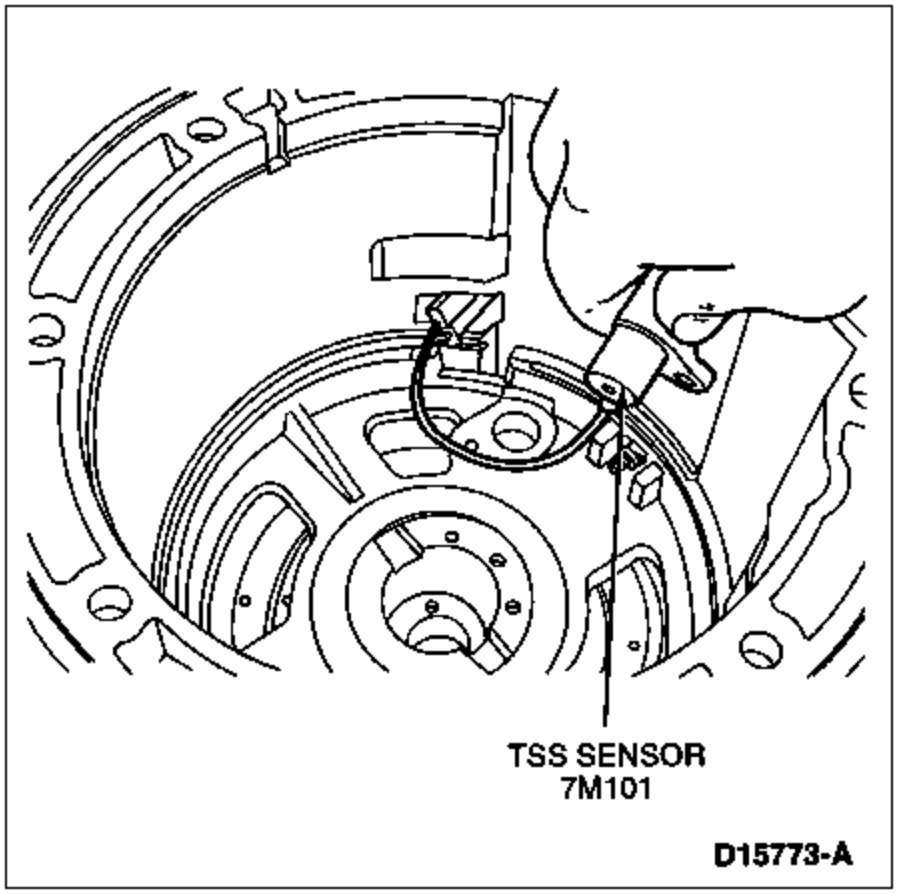

51. Install the turbine shaft speed (TSS) sensor on the center support. Use a T30 torx socket to install the TSS screw. Tighten the TSS sensor-to-center support screw to 8-11 Nm (71-97 lb-in).

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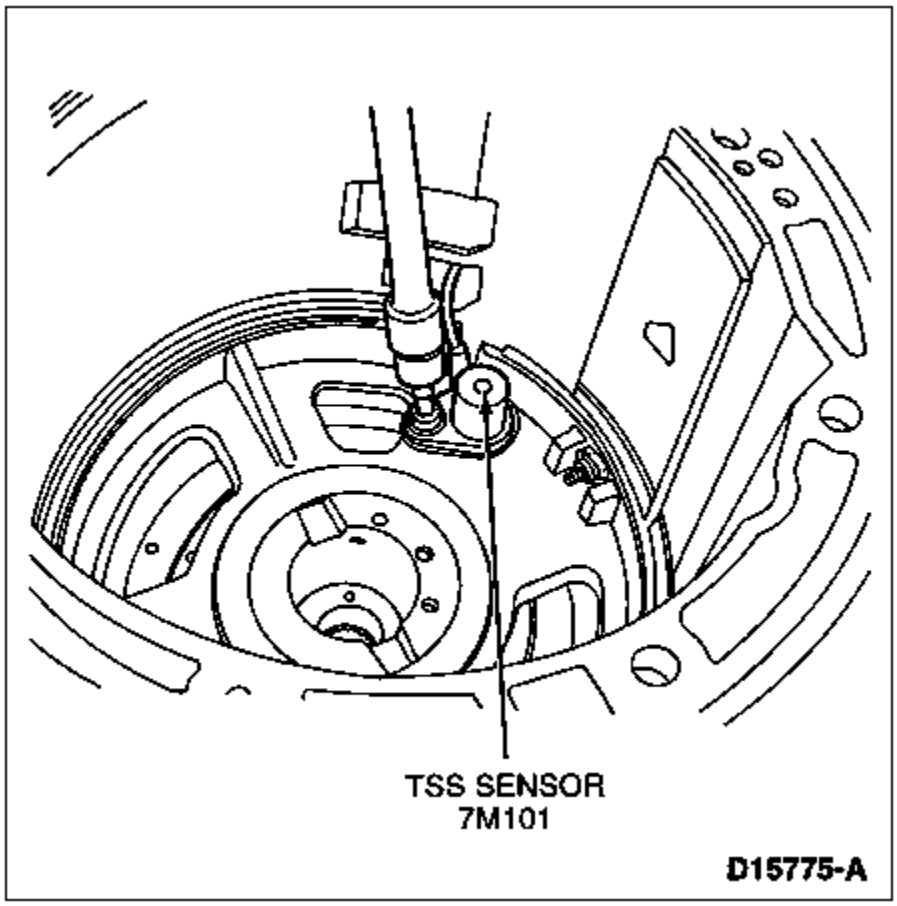

52. **CAUTION: Use only the No. 3 center shaft thrust bearing assembly.**

NOTE: No. 3 center shaft thrust bearing assembly has no notches on the outer race.

Install the No. 3 center shaft thrust bearing assembly.

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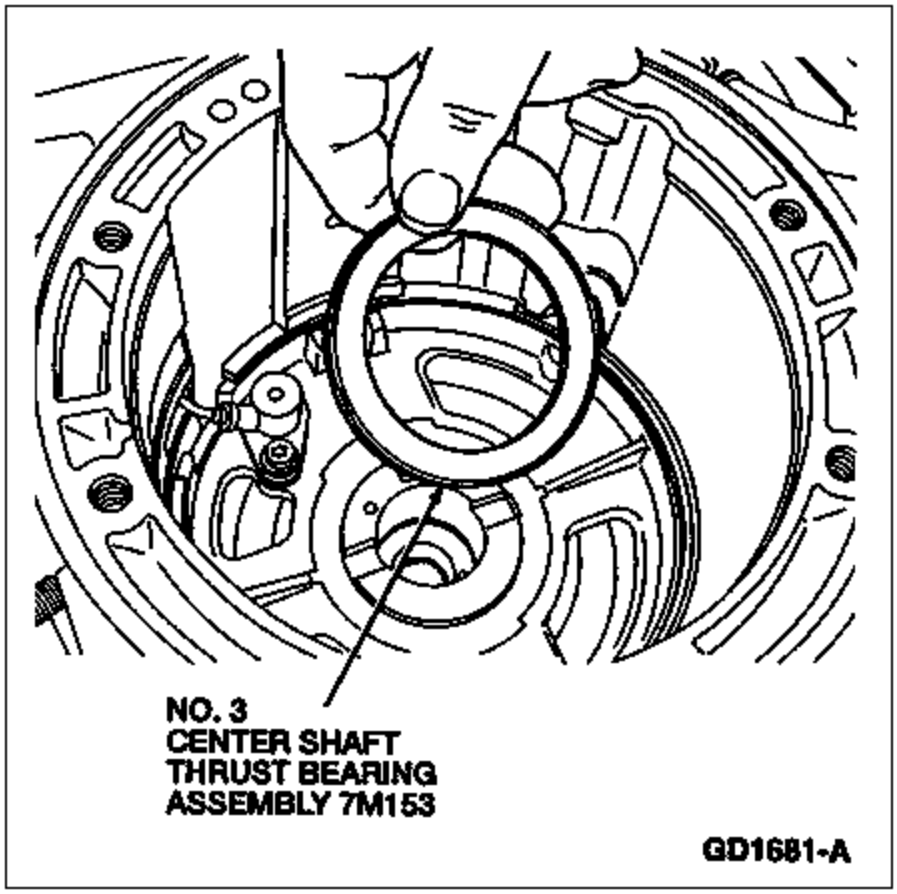

53. **CAUTION: Do not bend the trigger wheel.**

Install the planetary gear front carrier, front ring gear, front one-way clutch and center shaft assembly.

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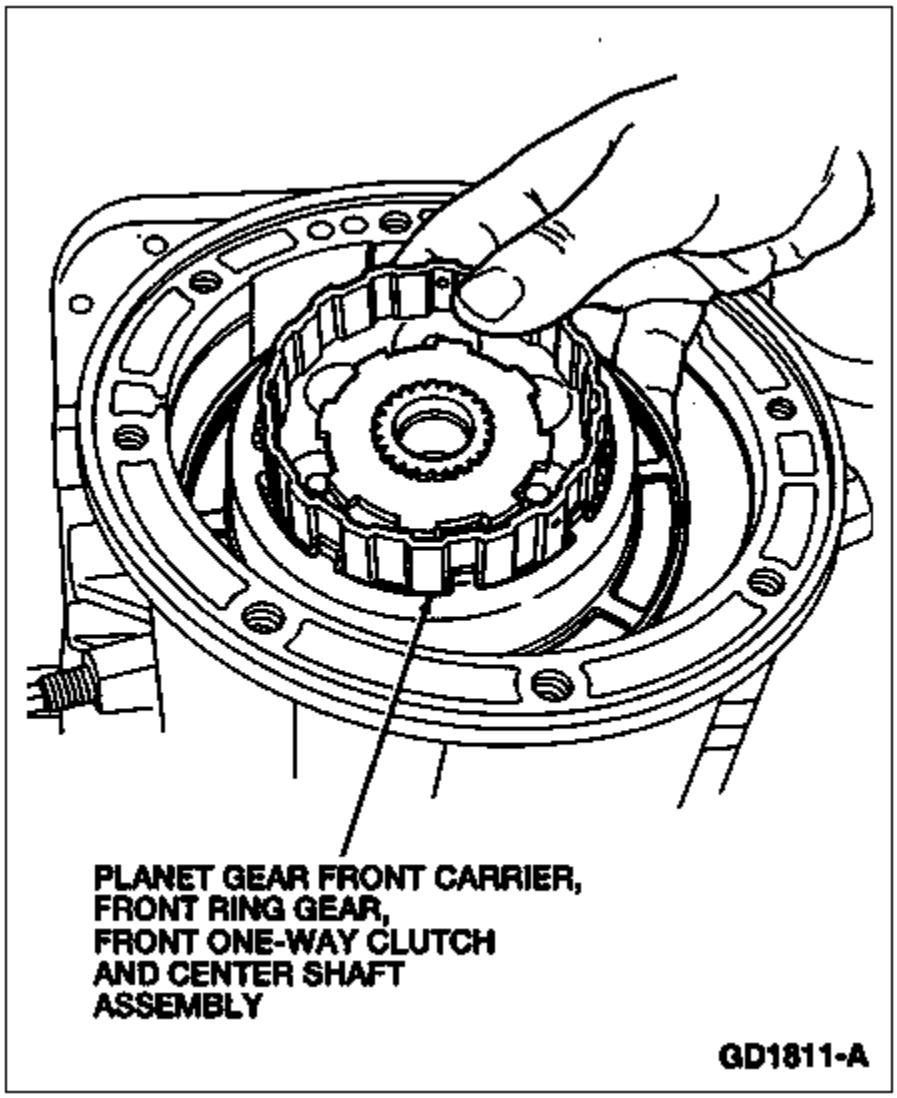

54. **NOTE: Perform TSS air gap clearance check . This step and the next two steps describe the procedures for checking the turbine shaft speed (TSS) sensor air gap clearance.**

Place the thin blade of Turbine Shaft Speed Sensor Gauge T95L-70010-F over the turbine shaft speed (TSS) sensor as shown. Rotate the trigger wheel. The trigger wheel window should pass over the thin blade of the TSS gauge. If it doesn't, the planetary gear overdrive carrier and trigger wheel must be replaced.

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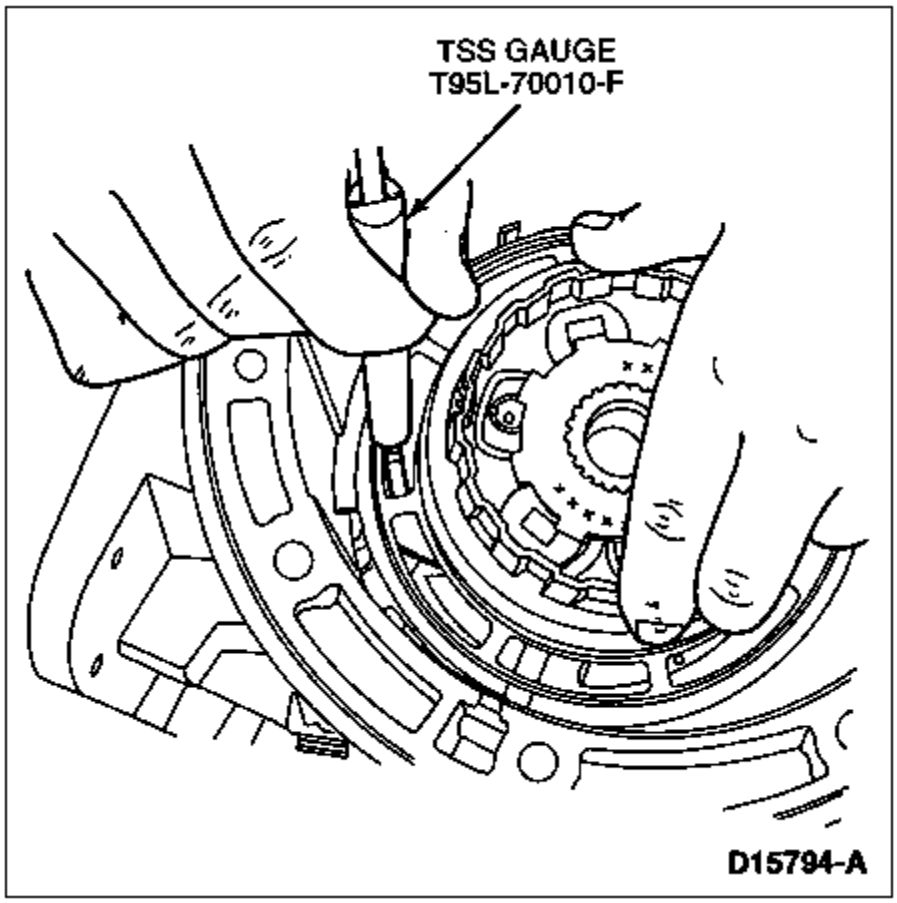

55. Place the thick blade of Turbine Shaft Speed Sensor Gauge over the turbine shaft speed (TSS) sensor as shown. Rotate the trigger wheel. The trigger wheel window should not pass over the thick blade of the TSS gauge. If it does, the planetary gear overdrive carrier and trigger wheel must be replaced.

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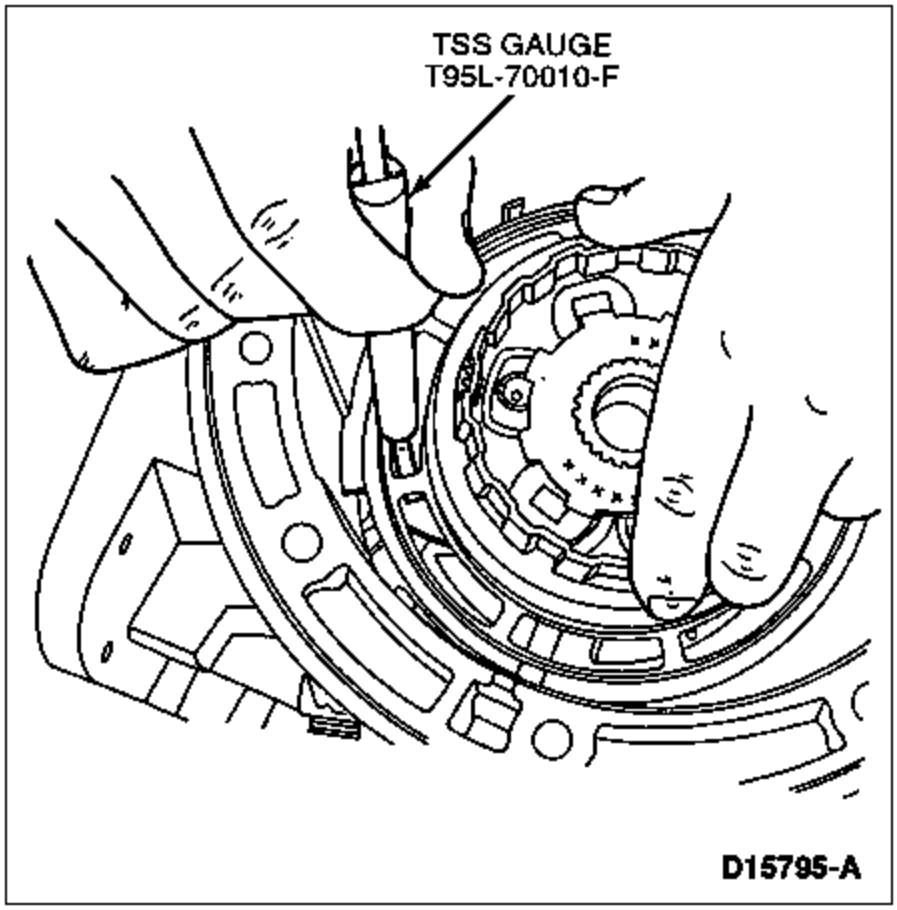

56. Repeat the previous two steps for the remaining trigger wheel windows.

57. Align the clutch plates and front adapter gear and install the front brake and coast clutch drum assembly.

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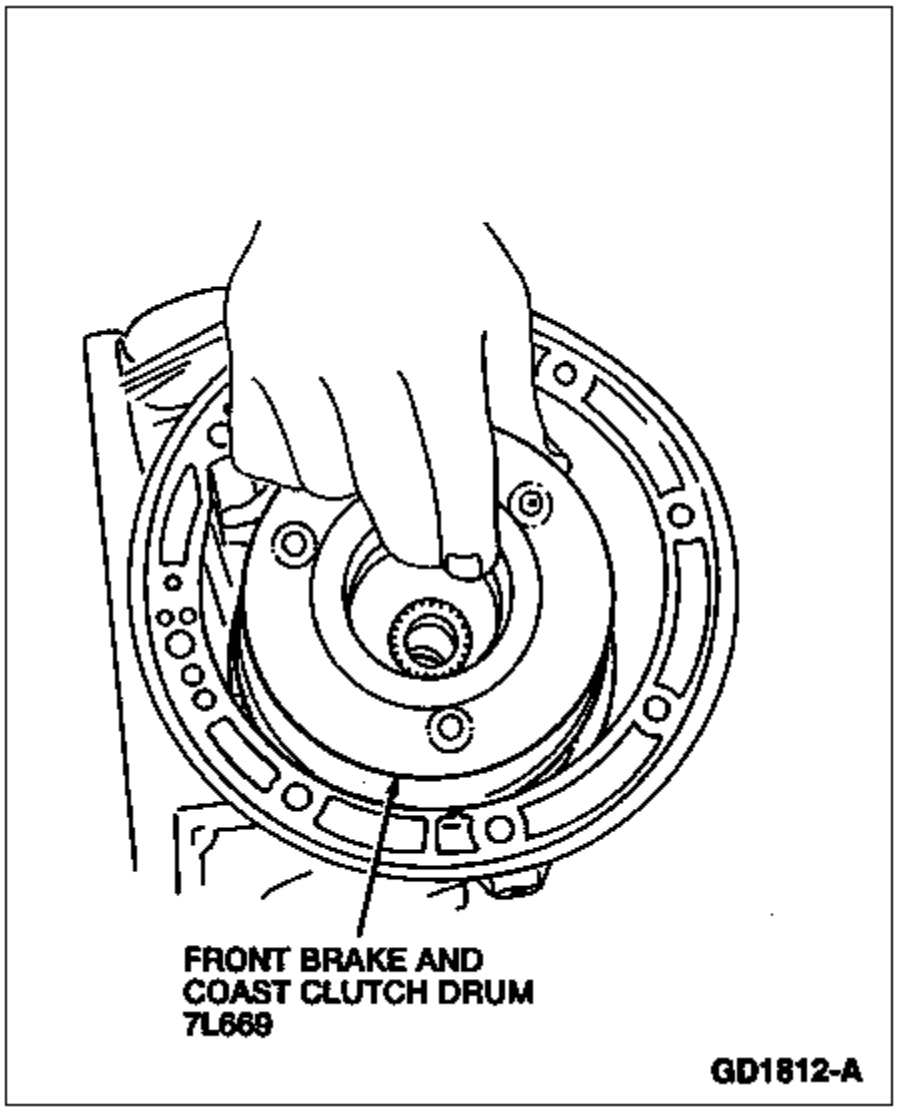

58. Install the front band lever-to-case bracket and front band servo lever as shown.

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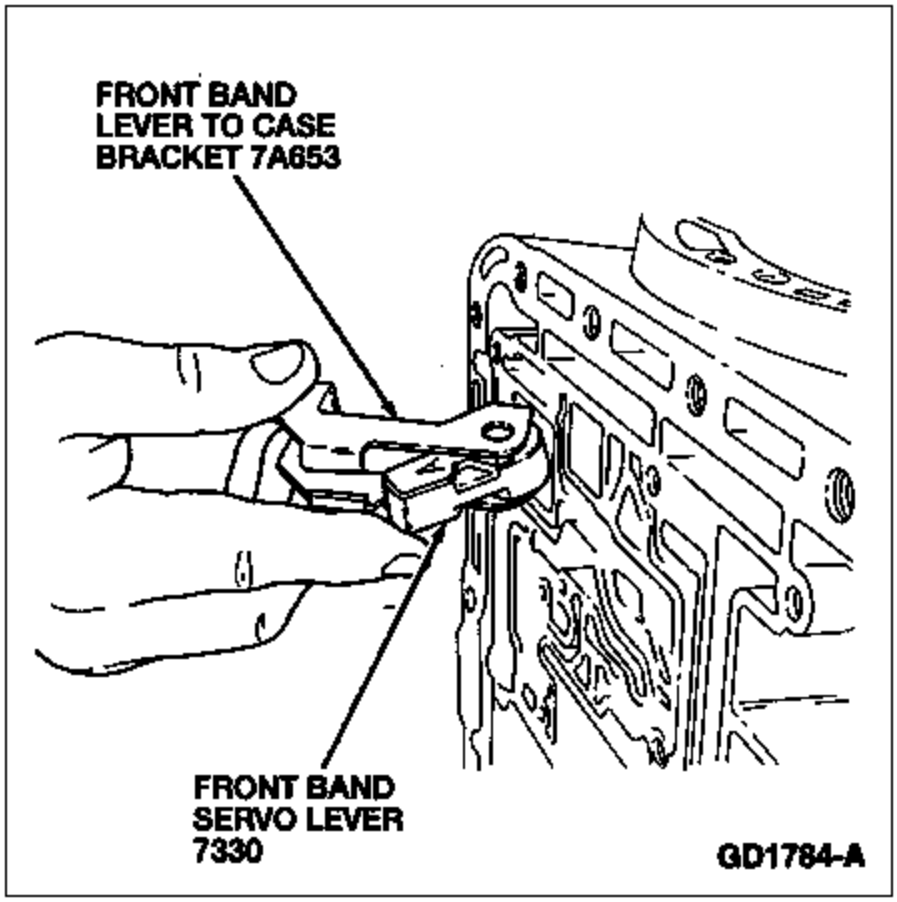

59. **NOTE: The front band actuating lever shaft is longer than the intermediate band actuating lever shaft.**

    Install the front band actuating lever shaft through the front band lever to case bracket and front band servo actuating lever.

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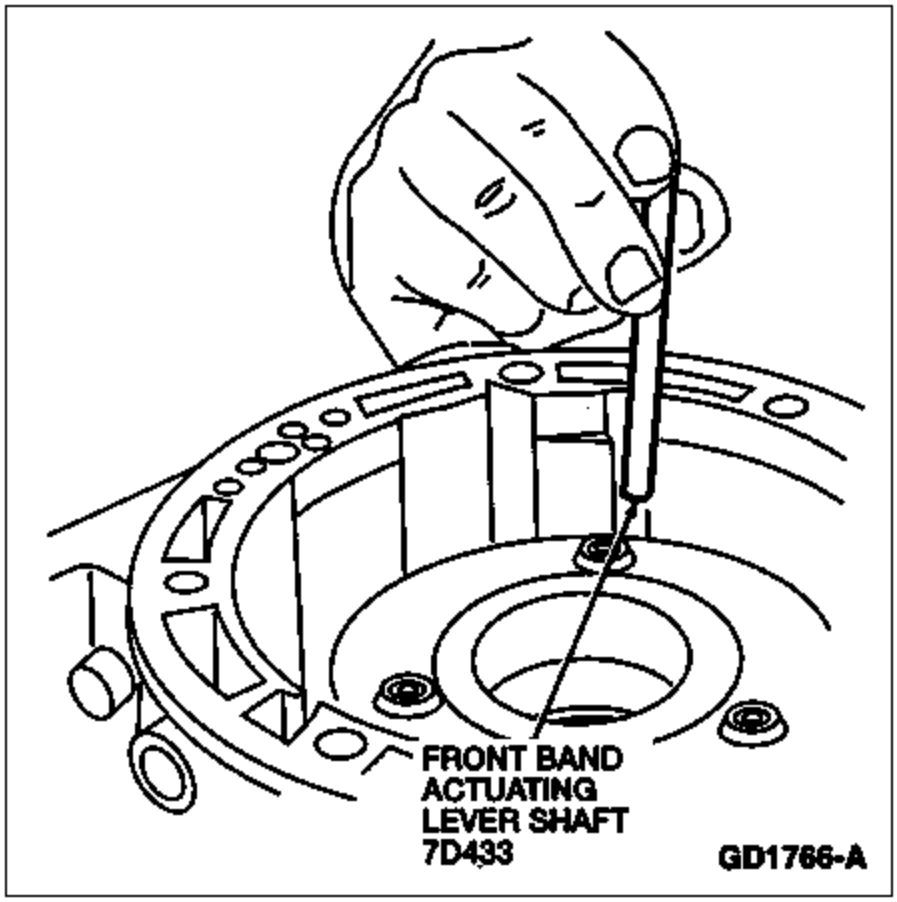

60. Install the front band apply strut.

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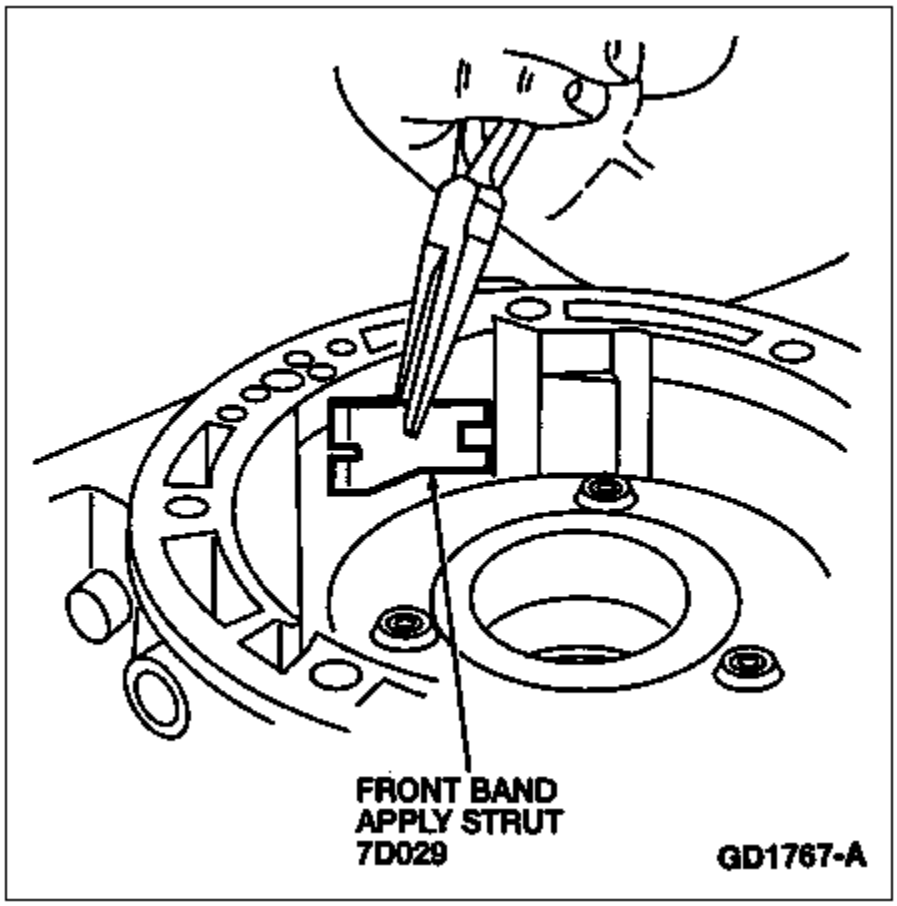

61. **NOTE: If the front band is reused, it must be installed in the same position as when removed.**

    Install the front band assembly over the front brake and coast clutch drum.

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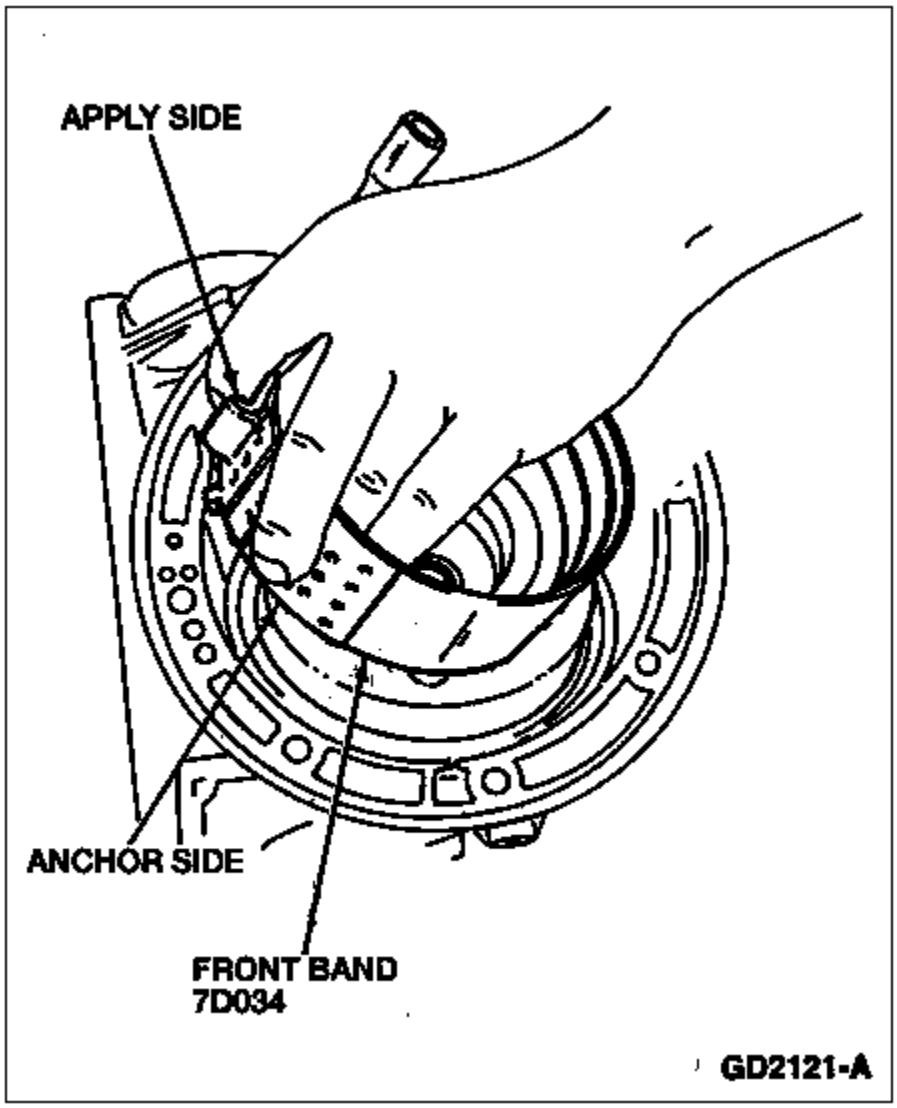

62. **NOTE: Use the band adjusting screw as a temporary alignment guide.**

    Install the front band anchor strut.

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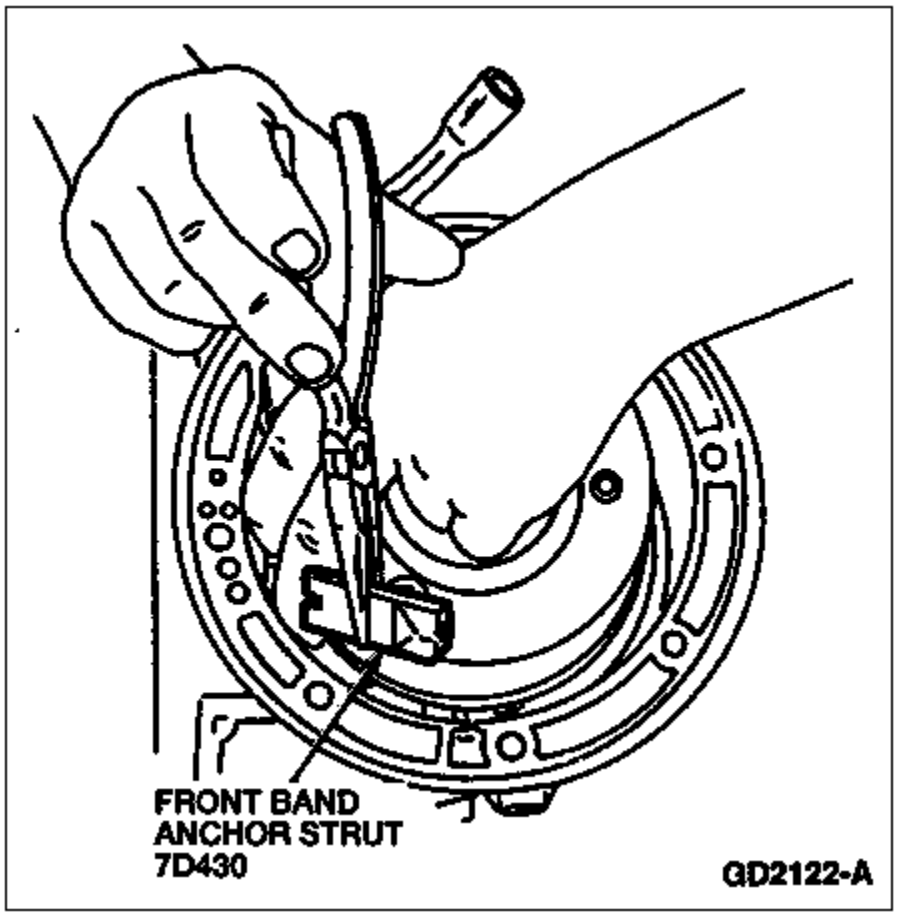

63. Install the front band adjusting screw.

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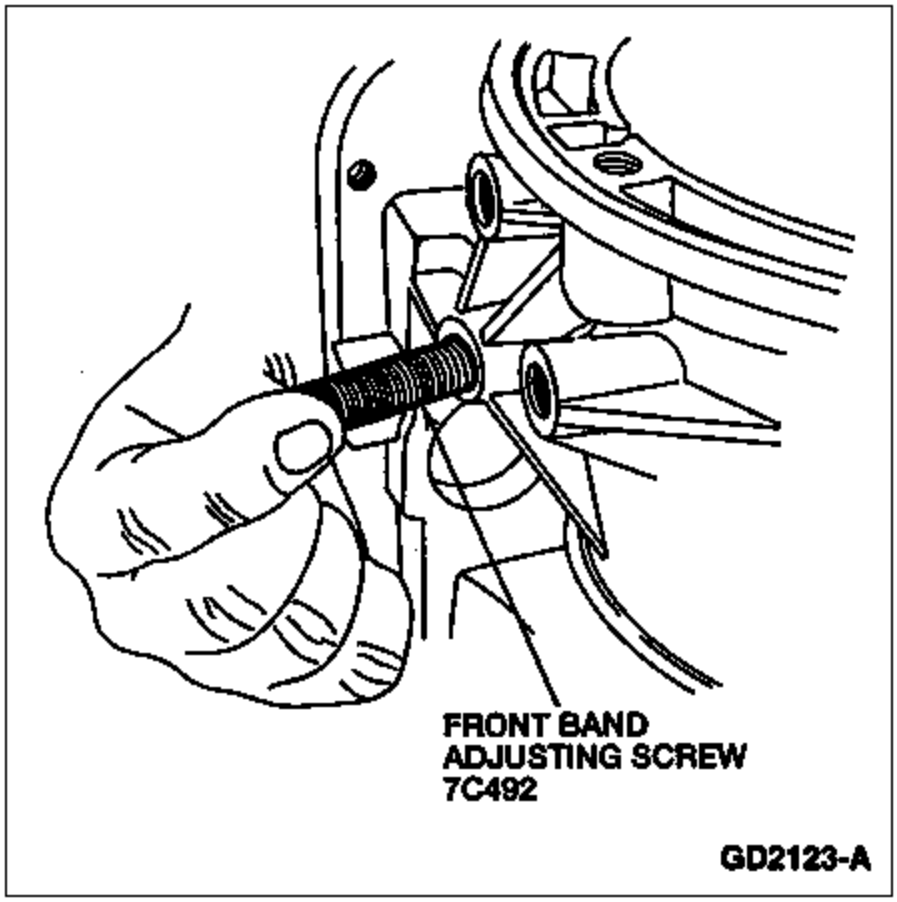

64. Perform the front end play check procedure as follows:

    a. **CAUTION: Be sure the pump body is seated against the washer and front brake and coast clutch drum. The pump body must be below the level of the case gasket surface.**

    Use petroleum jelly to hold any No. 1 fluid pump thrust washer on the rear of the pump. The washer tabs go into the pump face. Place the pump into position in the case.

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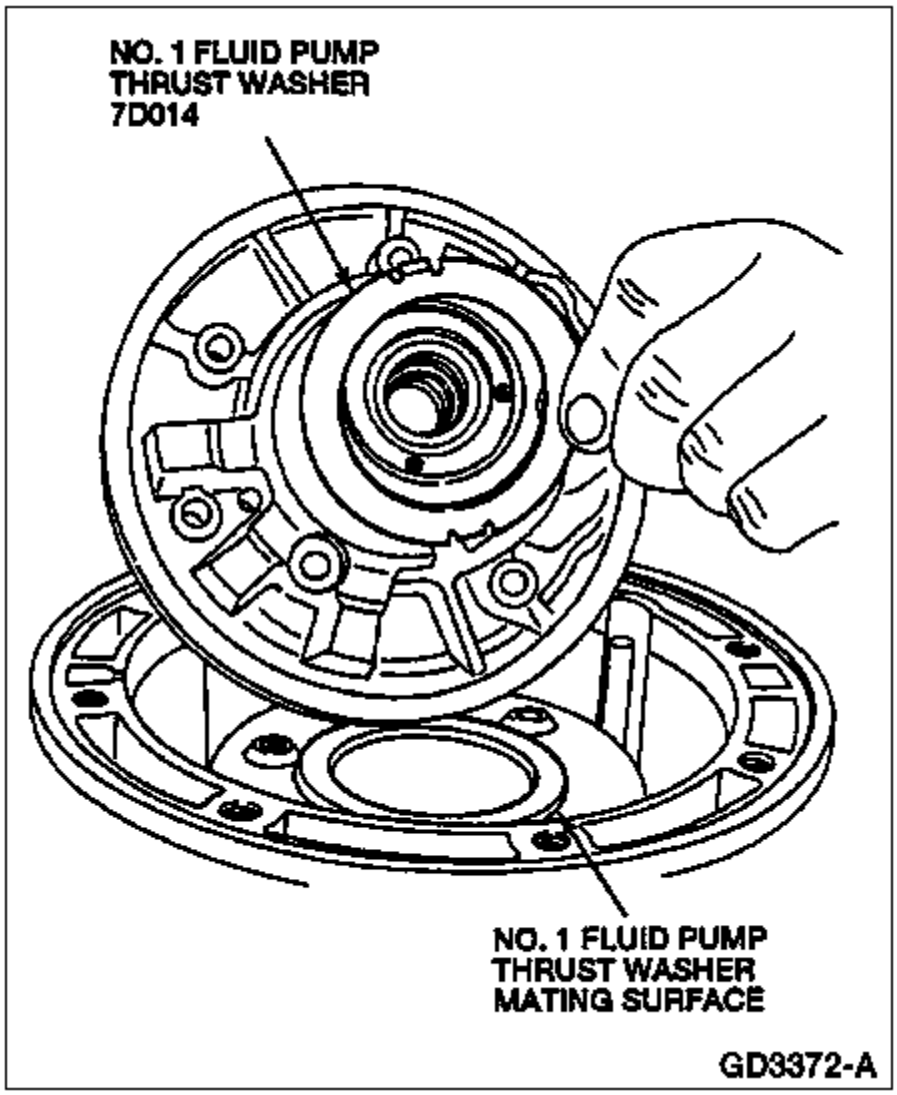

b. **CAUTION: The gauge bar must rest on the gasket surface.**

   Place Gauge Bar T93T-77003-AH across the case as shown.
c. Place a micrometer on the gauge bar and extend the probe until it contacts the pump surface.
d. Read the micrometer and subtract the thickness of the gauge bar (17.78 mm [0.700 inch]). Record this as dimension "A."
e. Move the gauge bar to the opposite side of the case.
f. Repeat Steps c and d and record this measurement as dimension "B."
g. Add dimensions "A" and "B" together and divide by 2. This is the front end clearance, dimension "C."

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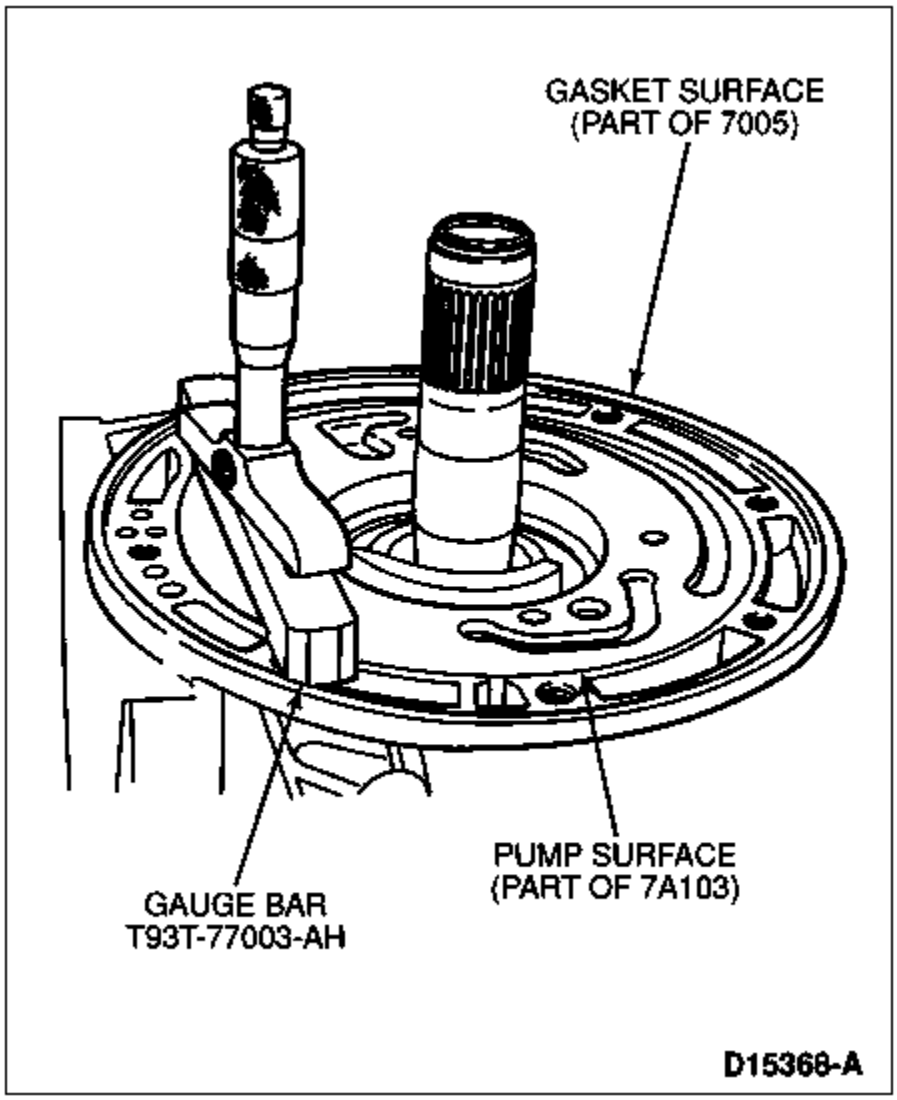

h. **CAUTION: If the average is below the specification, choose a thinner washer. If the average is above the specification, choose a thicker washer.**

NOTE: The front end play specification is 0.18-0.70 mm (0.007-0.028 in).

NOTE: The tabs on the washer go into the pump face.

Remove the pump and install the correct No. 1 thrust washer. Use petroleum jelly to hold the washer in place.

TRANSMISSION END CLEARANCE

Dimension "C"	Identification: Color	Service Part Number	Washer Thickness
Front No. 1 (All Engines) 0.18-0.70 mm (0.007-0.028 in.) Without Gasket	White Green Red Beige Black Yellow	97GT-7D014-TA 97GT-7D014-MA 97GT-7D014-NA 97GT-7D014-PA 97GT-7D014-RA 97GT-7D014-SA	1.55-1.60 mm (0.061-0.063 in.) 1.75-1.80 mm (0.069-0.071 in.) 1.85-1.90 mm (0.073-0.075 in.)

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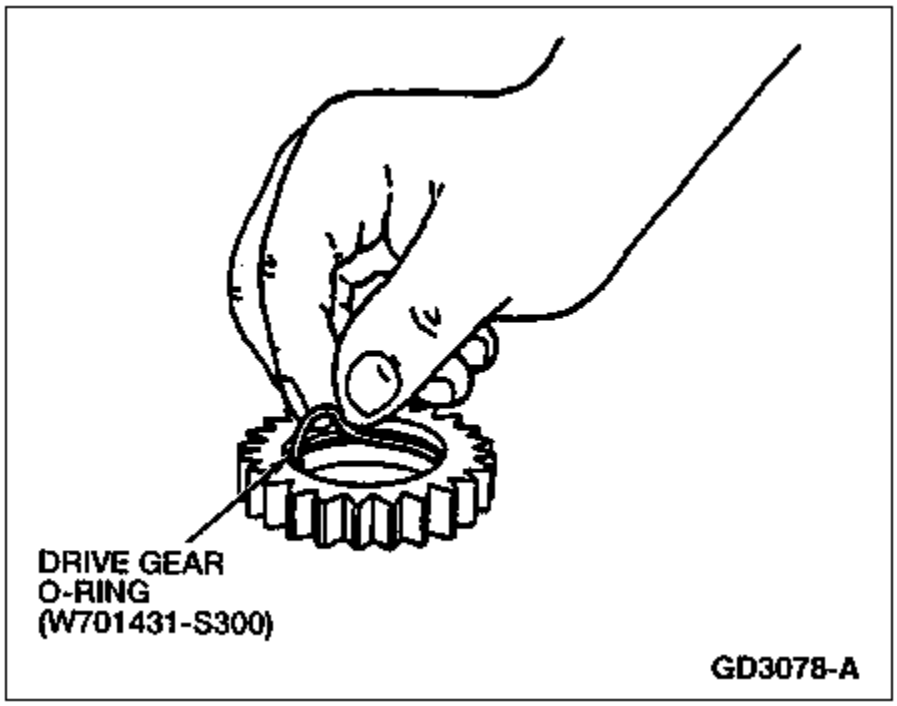
			1.95-2.00 mm (0.077-0.079 in.) 2.05-2.10 mm (0.081-0.083 in.) 2.15-2.20 mm (0.085-0.087 in.)

i. **NOTE: Front end clearance specification is 0.18-0.70mm (0.007-0.028 in).**

Verify front and clearance is correct, repeat steps a-g.

65. Install a new drive gear O-ring.



66. Lubricate Fluid Pump Seal Sizing Tool T95L-70010-G to seat drive gear O-ring.

67. Install Fluid Pump Seal Sizing Tool into pump drive gear to seat drive gear O-ring into groove.

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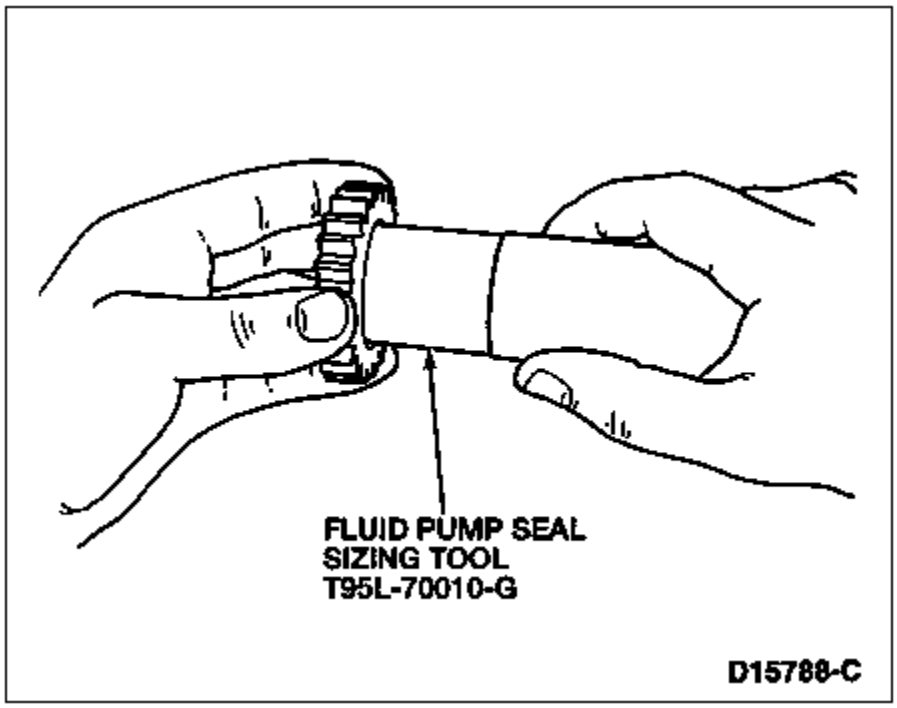

68. Remove Fluid Pump Seal Sizing Tool.

69. **CAUTION: The chamber on the inside edge of the small gear must be up when in the pump housing gear pocket. The dimple on the larger gear must be down when in the pump housing gear pocket.**

    Position the two pump gears into the pump housing. Apply a lubricant to the pump gears to prevent scoring at initial start-up.

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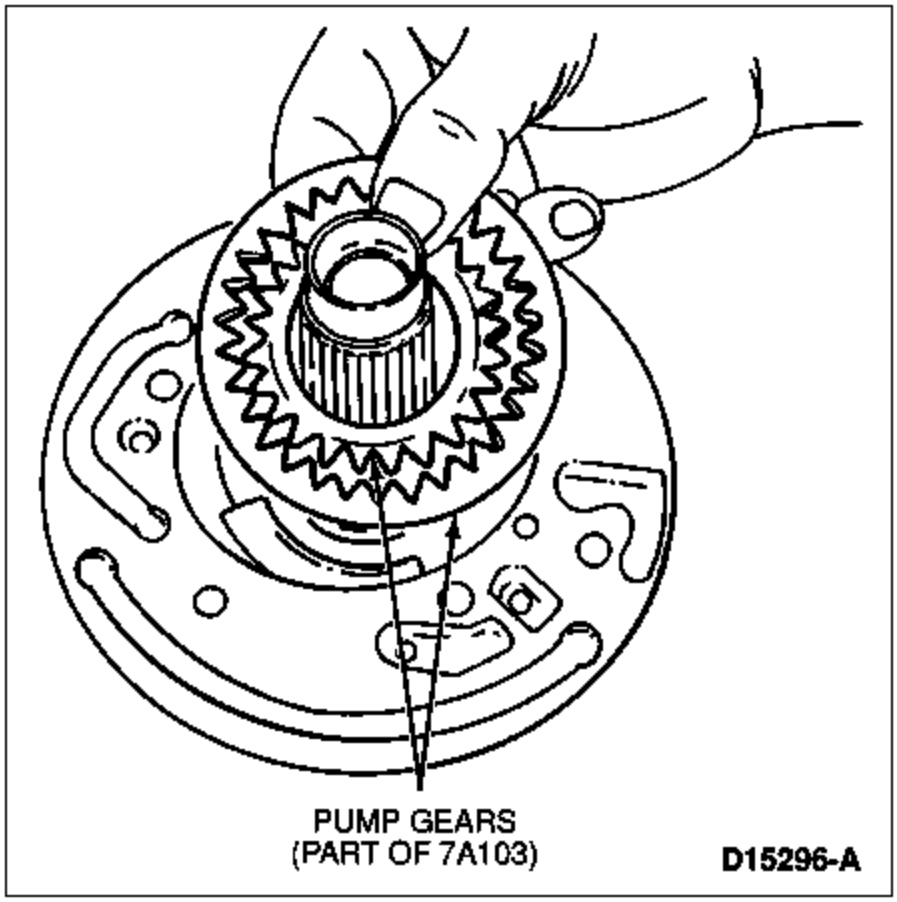

70. **CAUTION: Make sure the holes in the plate line up with the holes in the pump.**

Install the fluid pump adapter plate.

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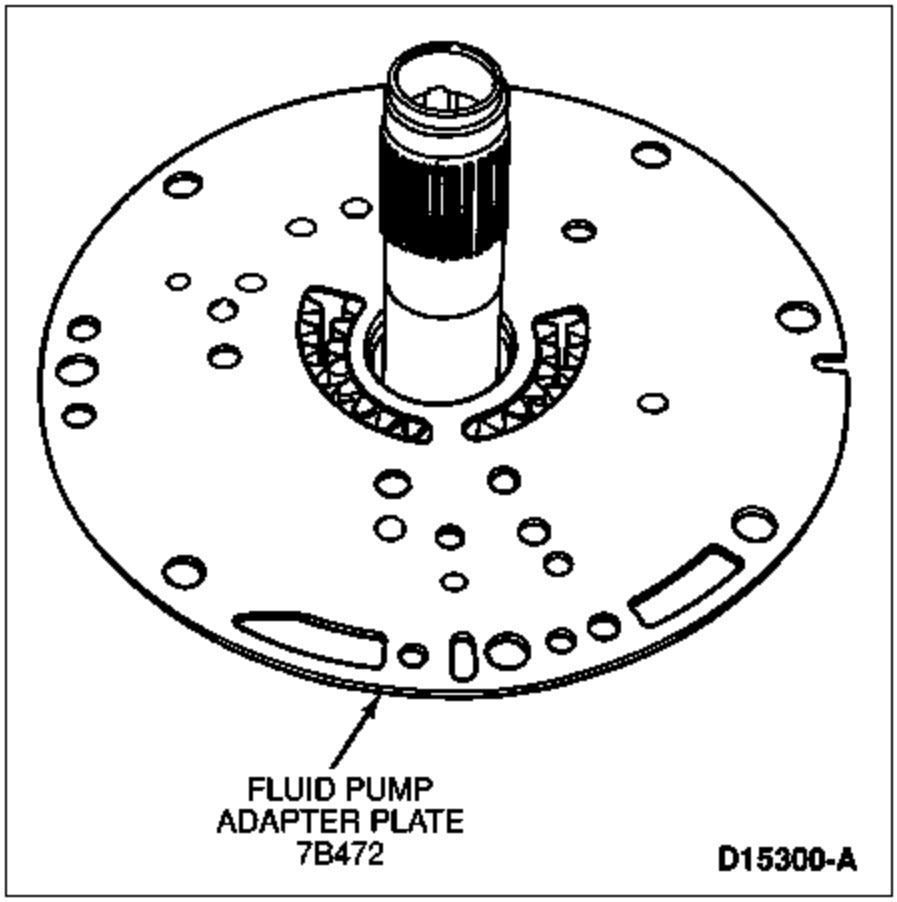

71. **CAUTION: Do not allow the pump gears to come out of the pump housing pocket.**

NOTE: The notch on the outside of the fluid pump adapter plate will be at the nine o'clock position, relative to the converter housing.

Turn the converter housing face down on the bench. Hold the fluid pump adapter plate against the front pump support and gear to keep the pump gears in place. Turn the pump and adapter plate over and place on the converter housing.

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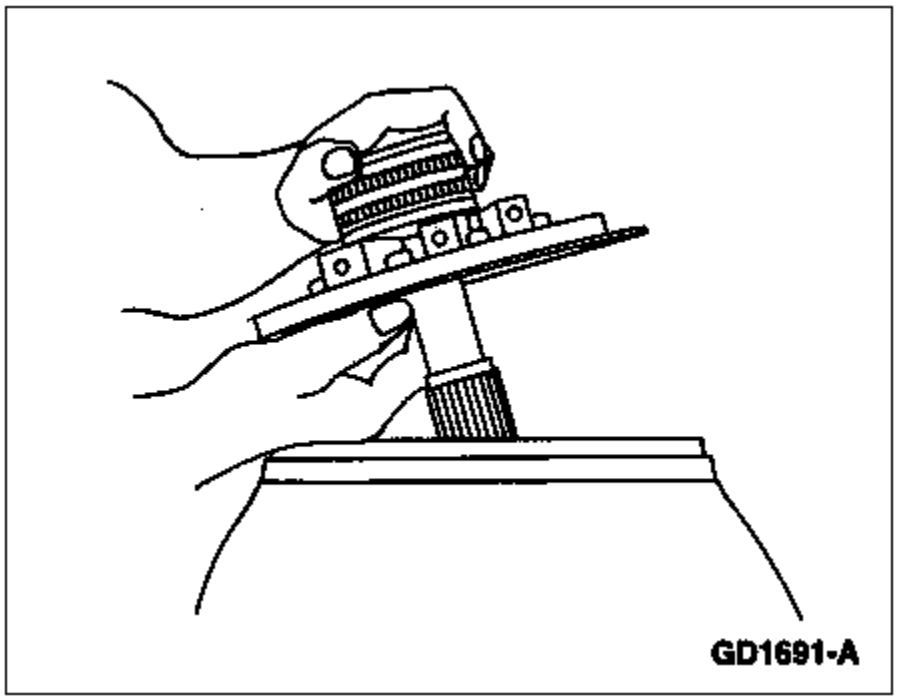
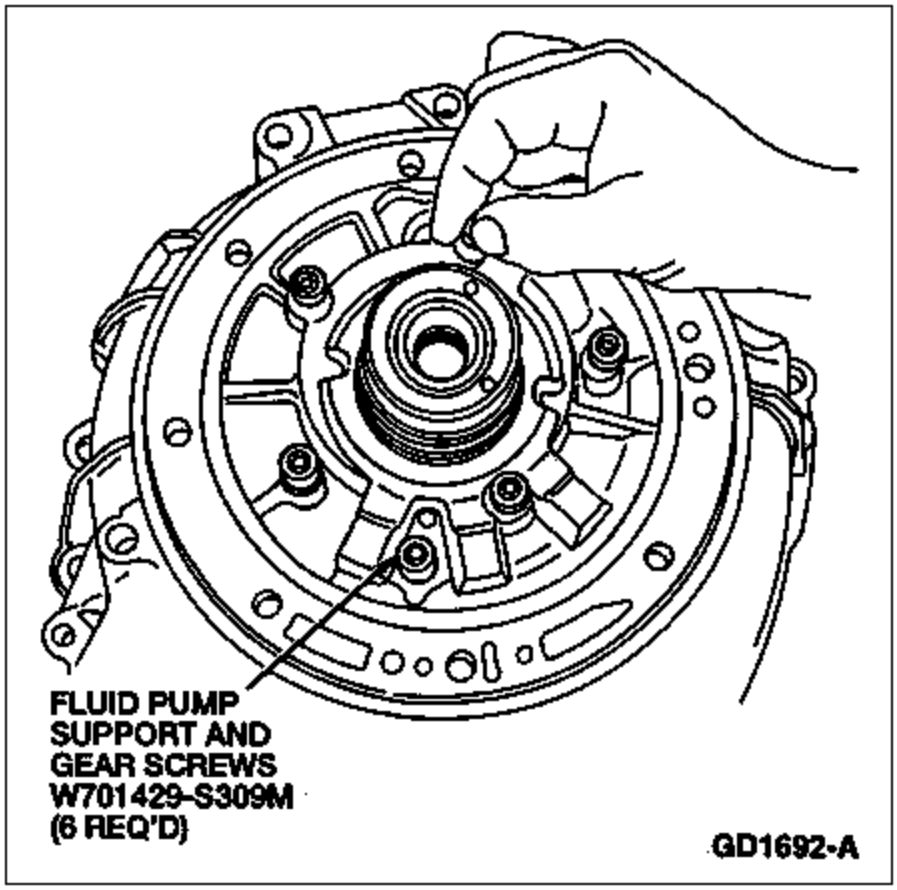


72. Install the six M8 x 35 mm Torx® head front pump support and gear screws fingertight only.



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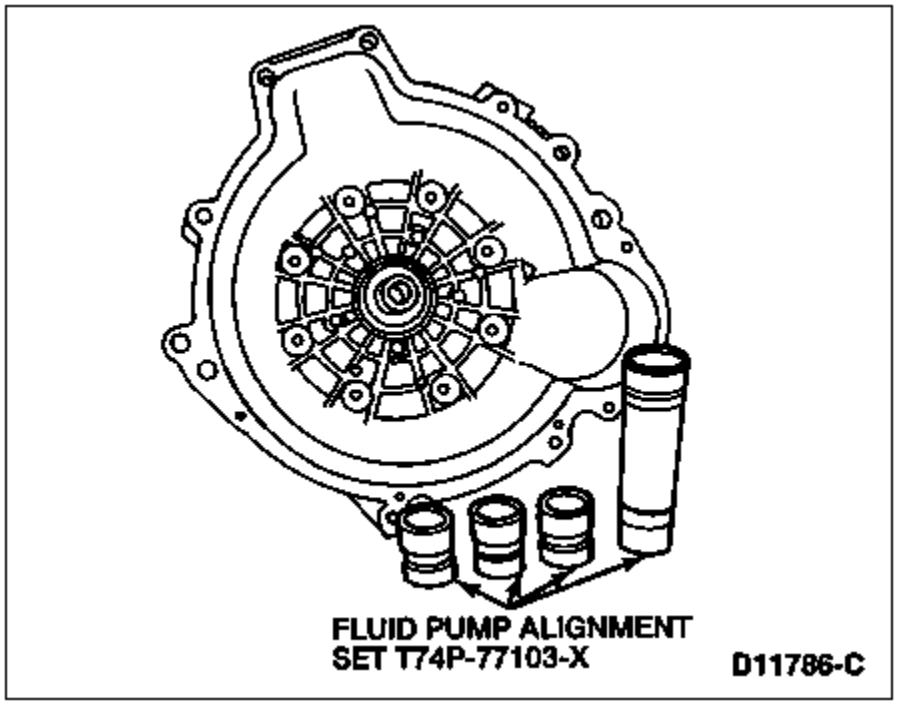
73. **CAUTION: Fluid Pump Alignment Set T74P-77103-X must be used to properly align the front pump support and gear to the fluid pump adapter plate. This will prevent seal leakage, gear noise, broken gears and bushing failure.**

    Select the gauge that will be the snuggest fit when placed over the fluid pump support and gear.



74. Thread the gauge into Pump Alignment Handle T74P-77103-H (Part of T74P-77103-X, Fluid Pump Alignment Set). Slide the tool over the front pump support and gear until it bottoms out in the pump gear pocket. This centers the pump to the converter housing.

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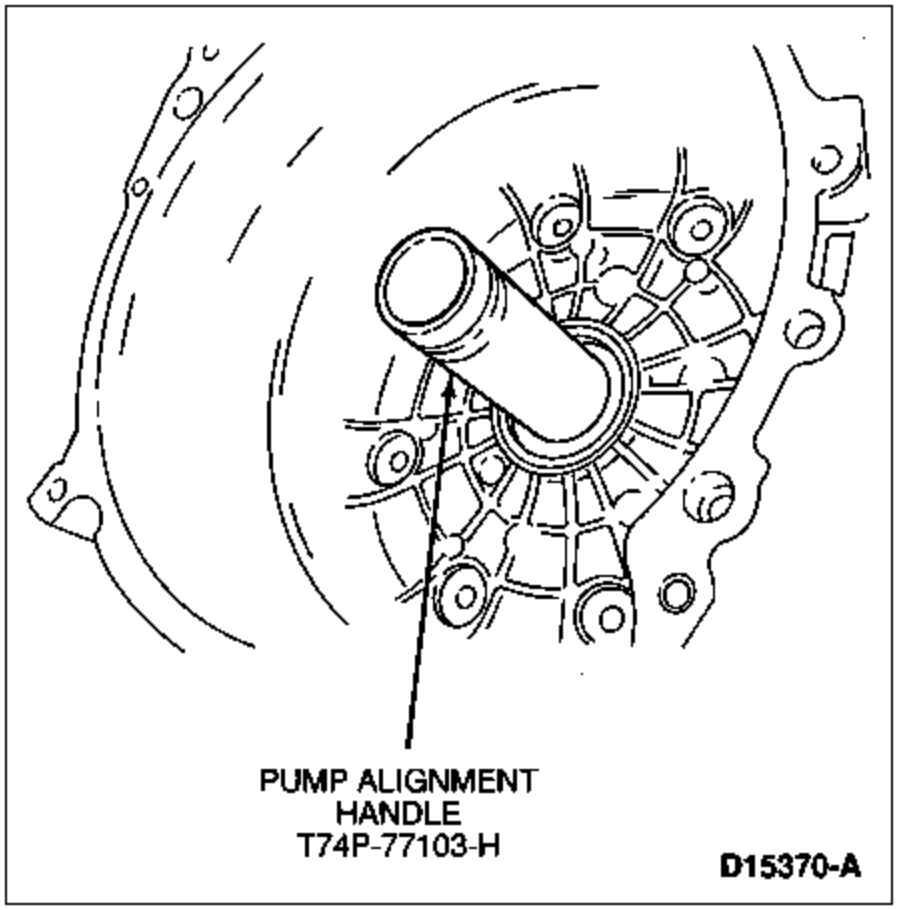

75. Use a Torx® 40 socket wrench to tighten the six M8 x 35 mm fluid pump support and gear-to-converter housing screws. Tighten the fluid pump support and gear-to-converter housing screws in a star pattern to 22-28 Nm (16-21 lb-ft). Remove the Pump Alignment Handle.

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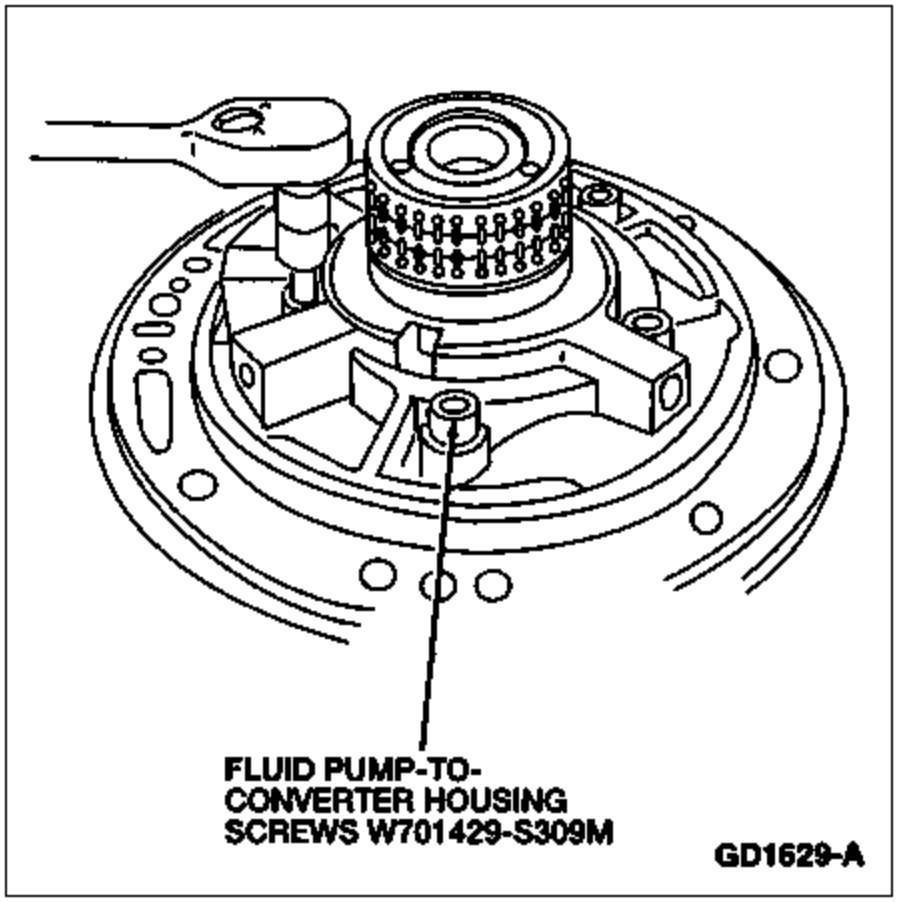

76. Install a new fluid pump seal ring.

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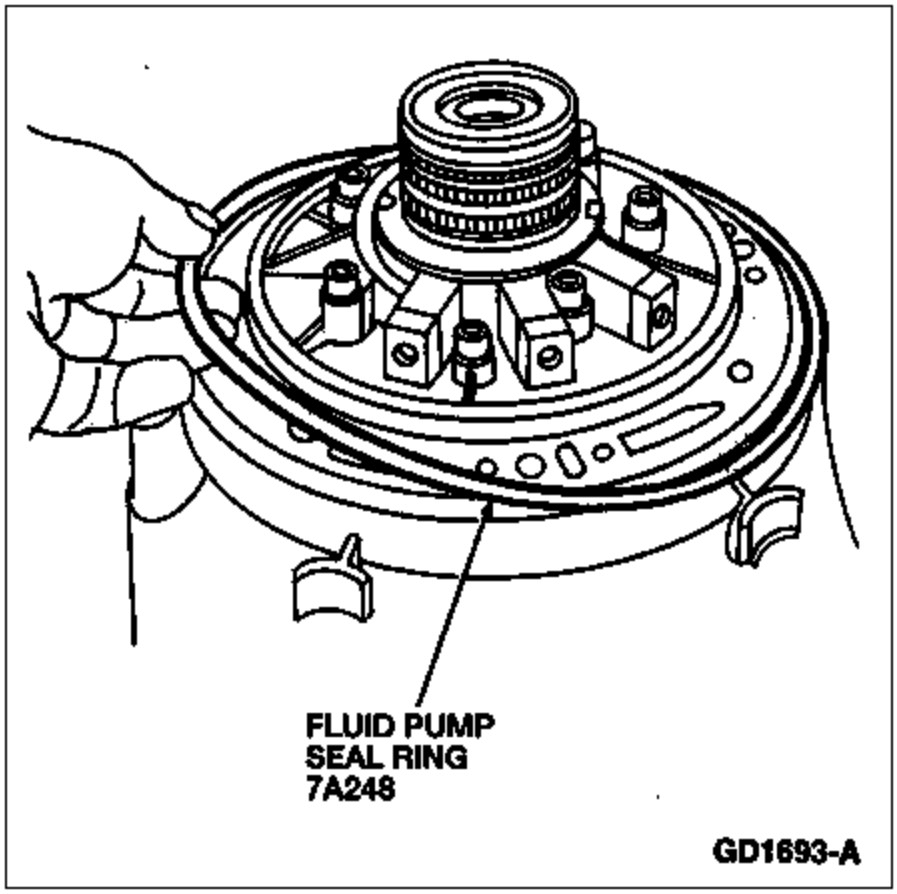

77. **NOTE: Make sure the fluid pump seal ring is installed on the converter housing and pump assembly.**

    Place a new fluid pump gasket on the fluid pump adapter plate as shown. Use petroleum jelly to hold the fluid pump gasket in place.

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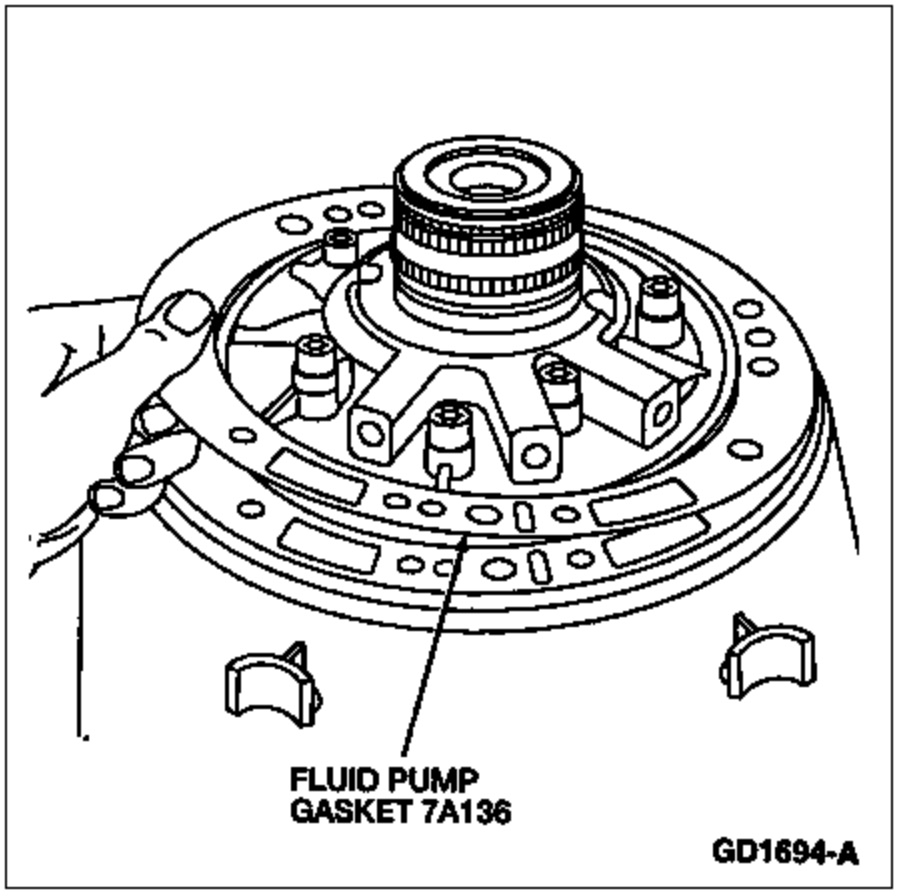

78. Install the correct No. 1 fluid pump thrust washer on the fluid pump support and gear. Use petroleum jelly to hold the washer in place.

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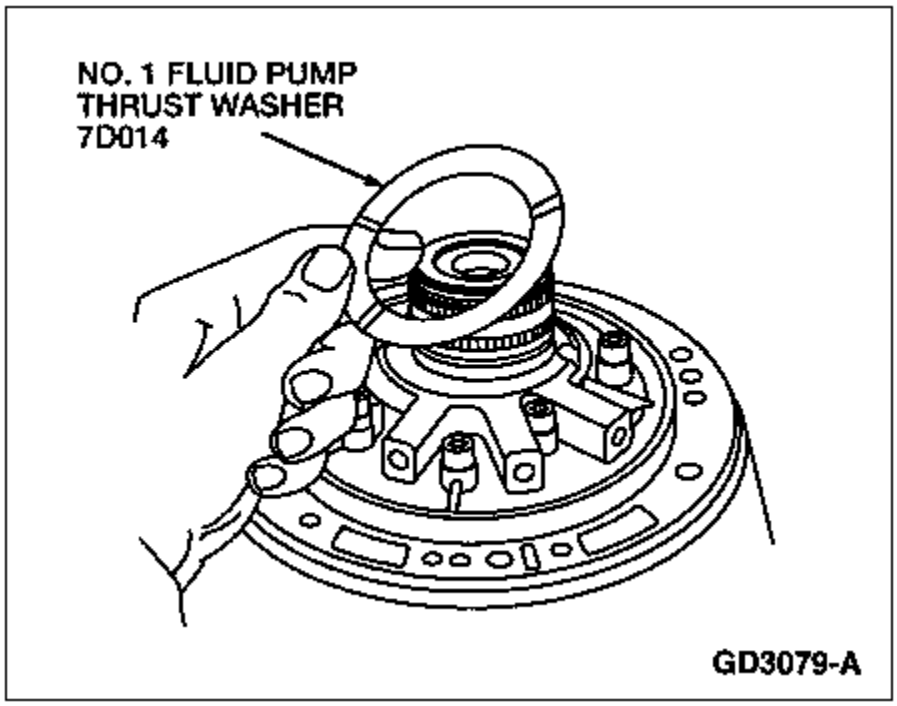
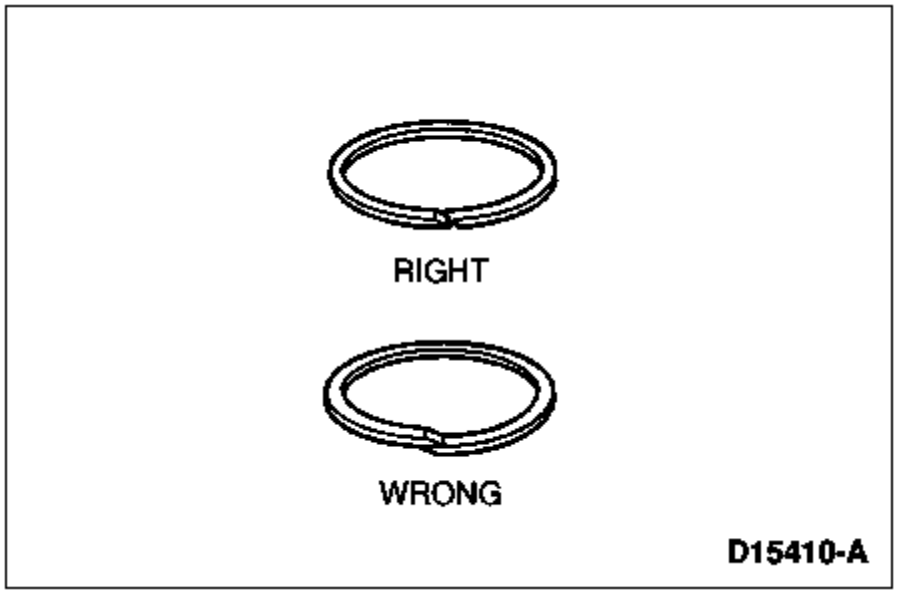


79. **NOTE: Verify correct seal installation. Be sure seal grooves are clean and free of burrs.**

Turn the converter housing over and install the front pump support seal ring.



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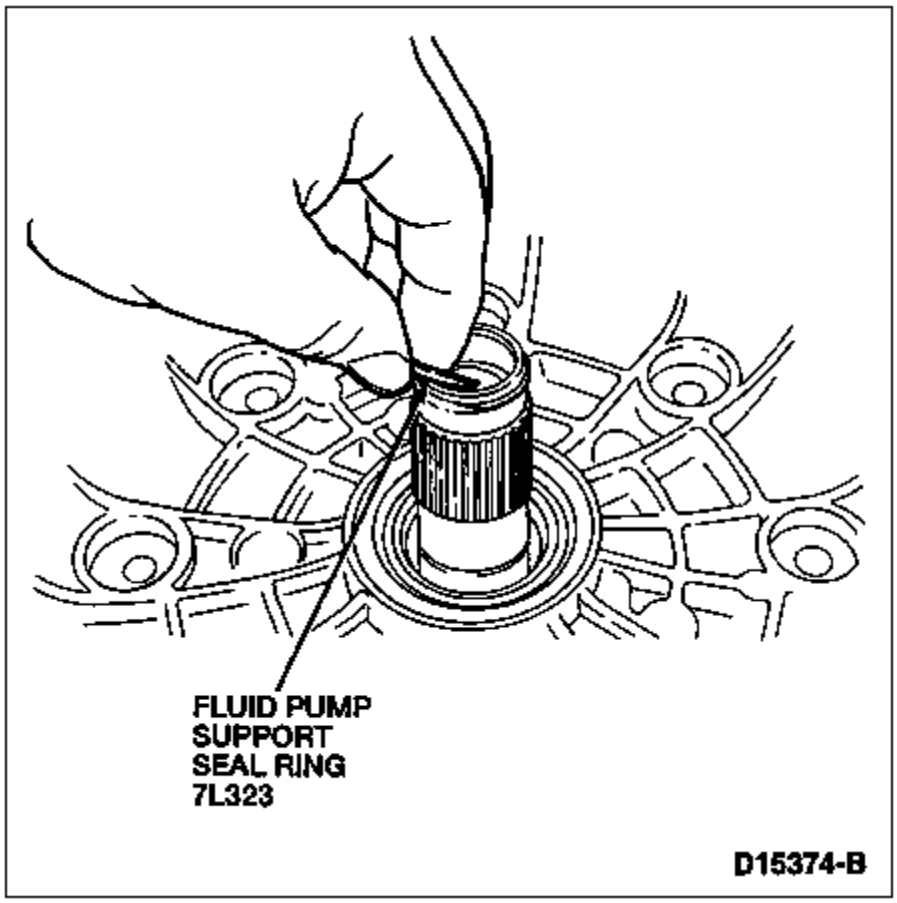

80. **NOTE: The splines on the input shaft are not the same length. The shorter splines go into the assembly.**

Install the input shaft as a guide for the converter housing and fluid pump support and gear assembly. Install the Converter Guide Pins T95L-7902-A as shown.

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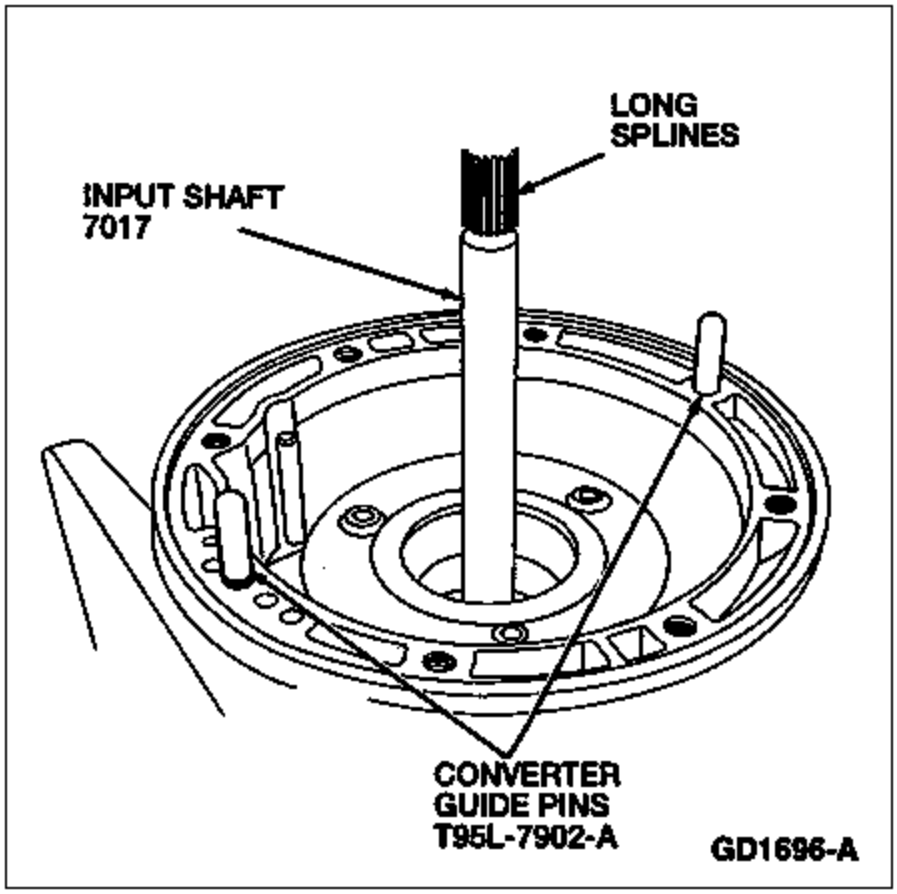

81. Install the converter housing and fluid pump support and gear assembly (with the fluid pump gasket) and the No. 1 fluid pump thrust washer to the case.

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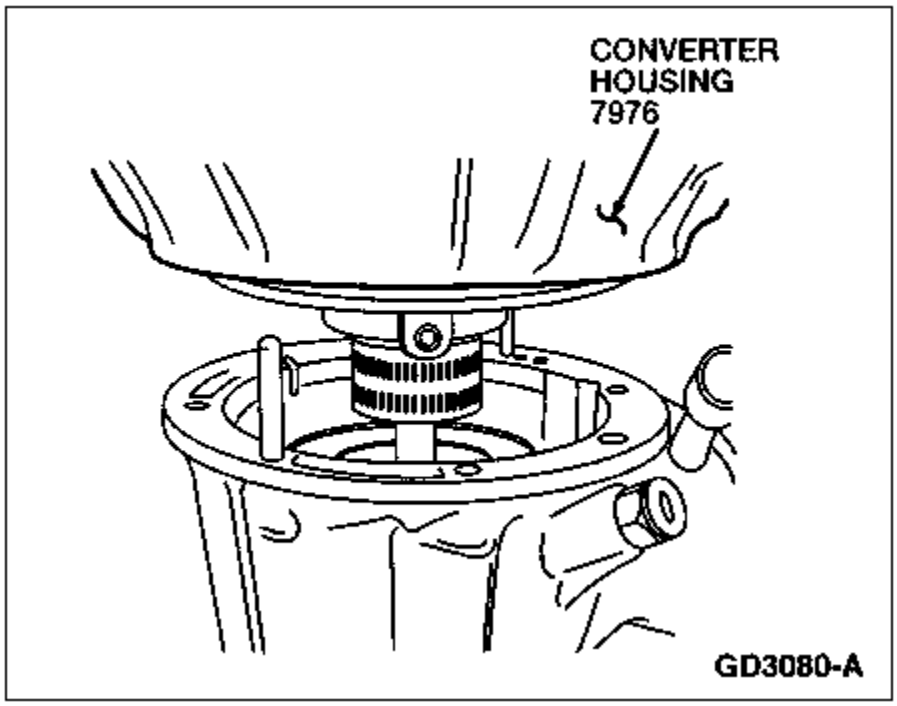

82. **NOTE: Lubricate O-rings on converter housing screws.**

Remove Converter Guide Pins and use a 17 mm socket wrench to install the eight new M10 x 33 mm converter housing-to-case screws. Tighten the converter housing-to-case screws in a star pattern to 36-52 Nm (27-39 lb-ft).

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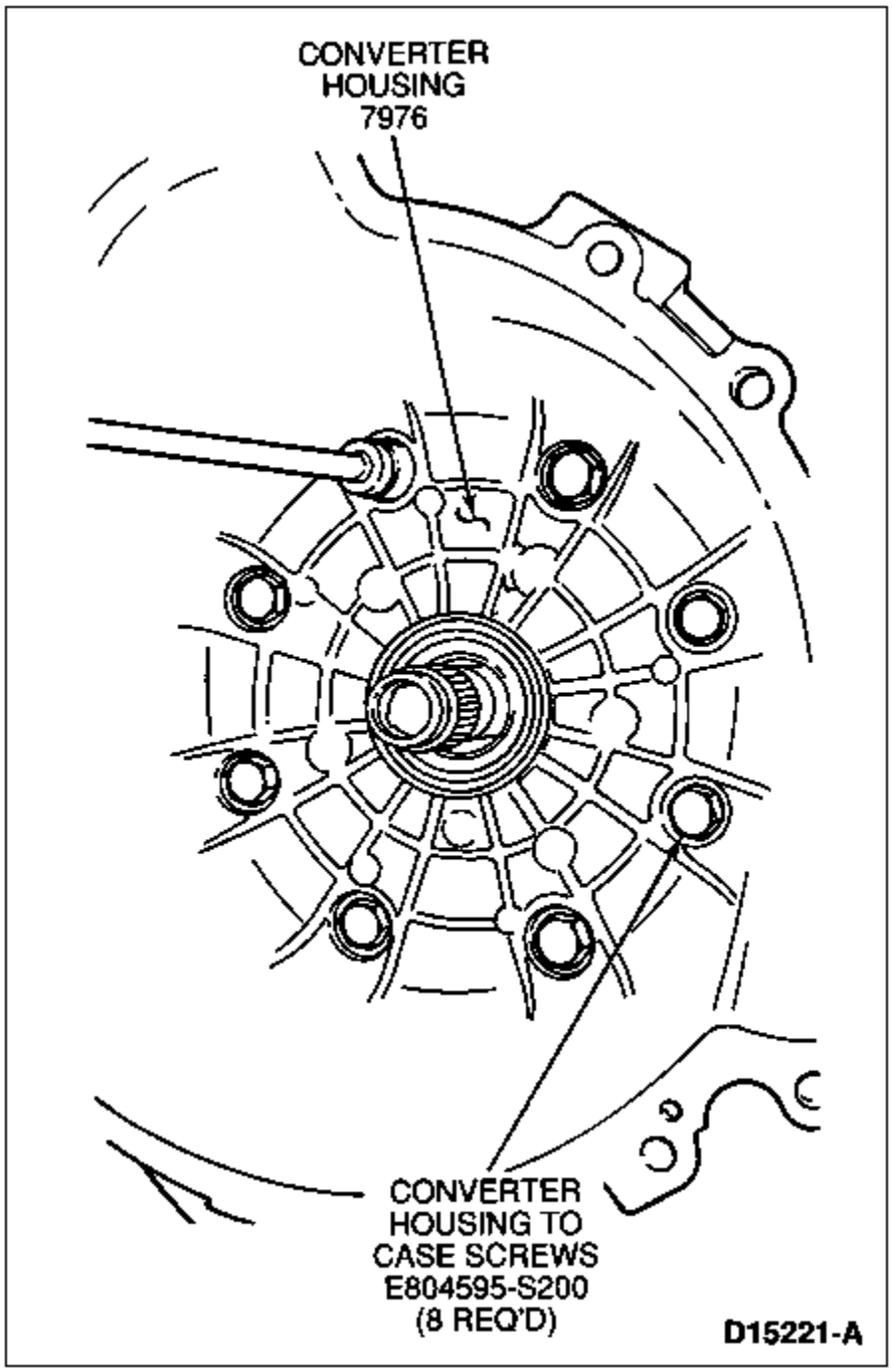

83. Remove the input shaft.

84. **WARNING: MAKE SURE THE LOCK PIN ON BENCH-MOUNTED HOLDING FIXTURE T57L-500-B IS SECURE.**

    Rotate the transmission assembly so the fluid pan rail is facing up.

85. **CAUTION: Do not damage the front servo cover to case O-ring during installation. Do not press the front servo cover and O-ring past the relief hole in the case. O-ring damage may occur.**

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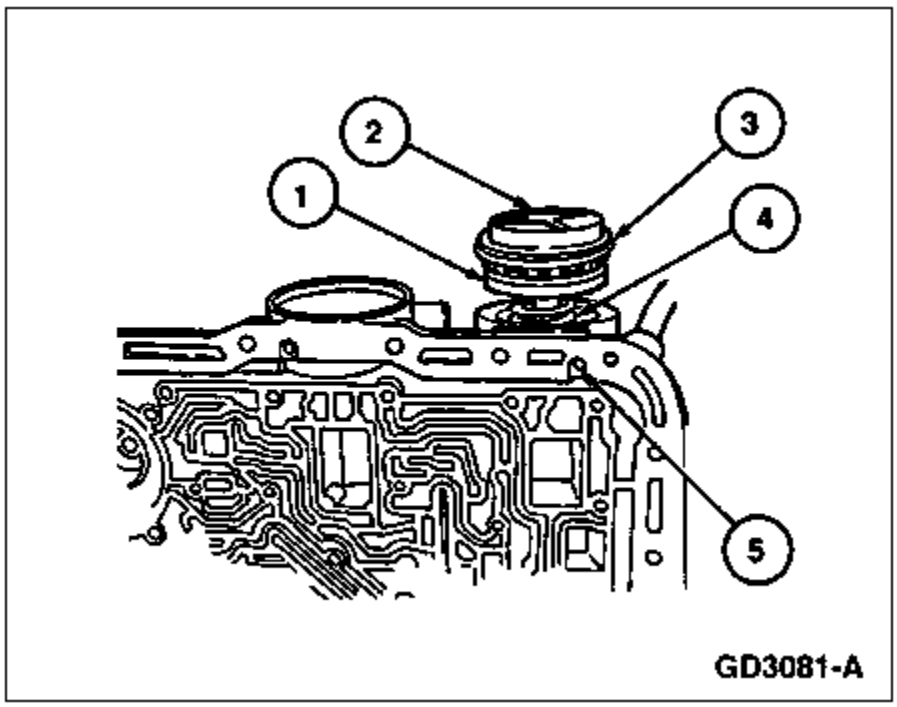
Install the front servo piston spring, servo piston and rod assembly, servo cover to case O-ring with servo cover.



Item	Part Number	Description
1	7D021	Front Servo Piston and Rod Assembly
2	7D027	Front Servo Cover and Seal Assembly
3	7D040	Front Servo O-Ring
4	7D028	Front Servo Piston Spring
5	—	Relief Hole (Part of 7005)

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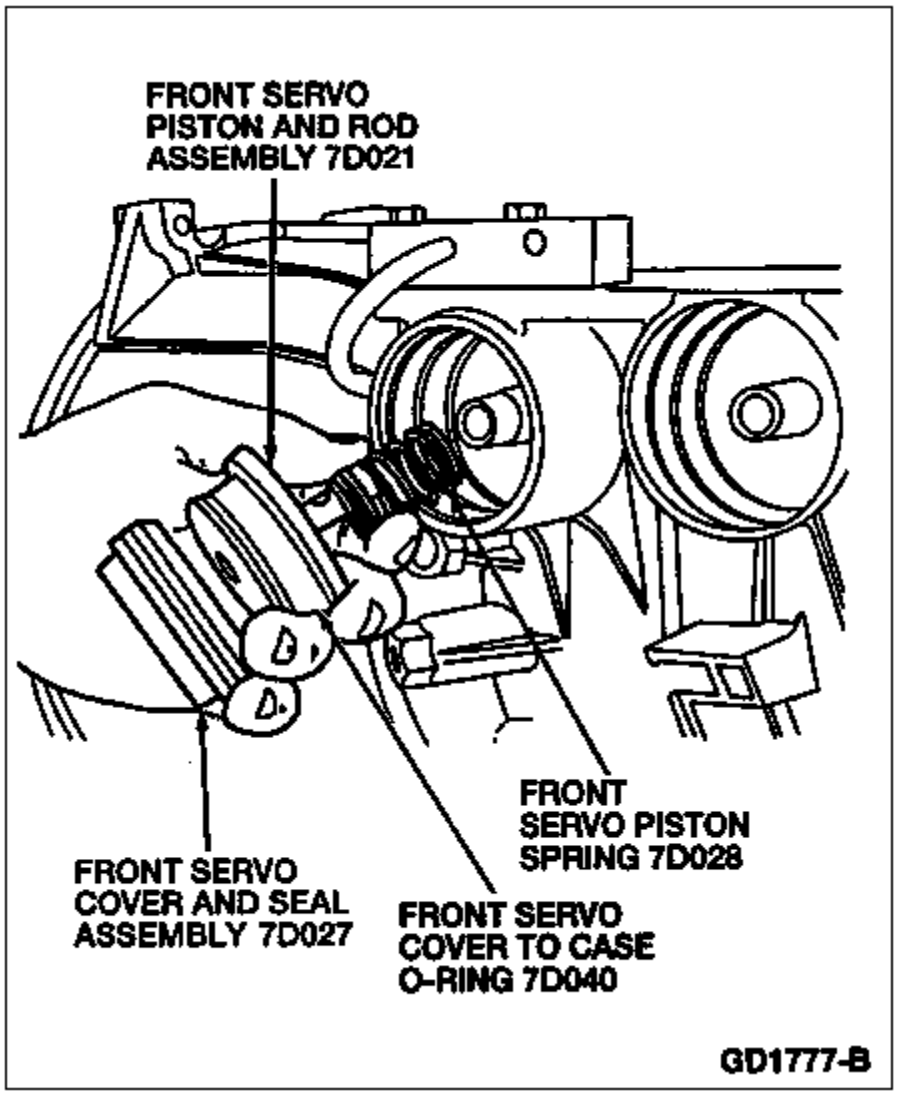

86. **NOTE: The J-hook must be in the appropriate hole for the servo being removed, and tool number should be facing up.**

    Install Servo Cover Compressor T95L-77028-A over the front servo cover at the fluid pan rail. Tighten the screws.

87. Use a 1/2-inch wrench to tighten the nut on the J-hook until there is a gap between the servo cover and the snap ring.

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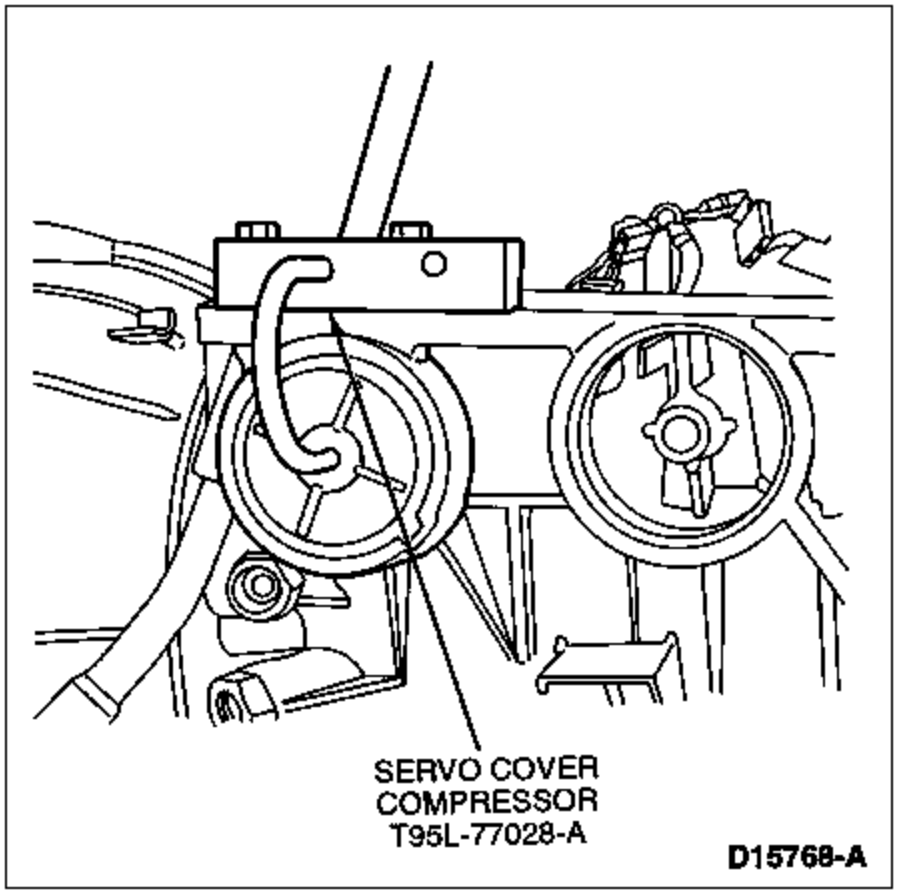

88. Carefully install the servo cover retaining ring.

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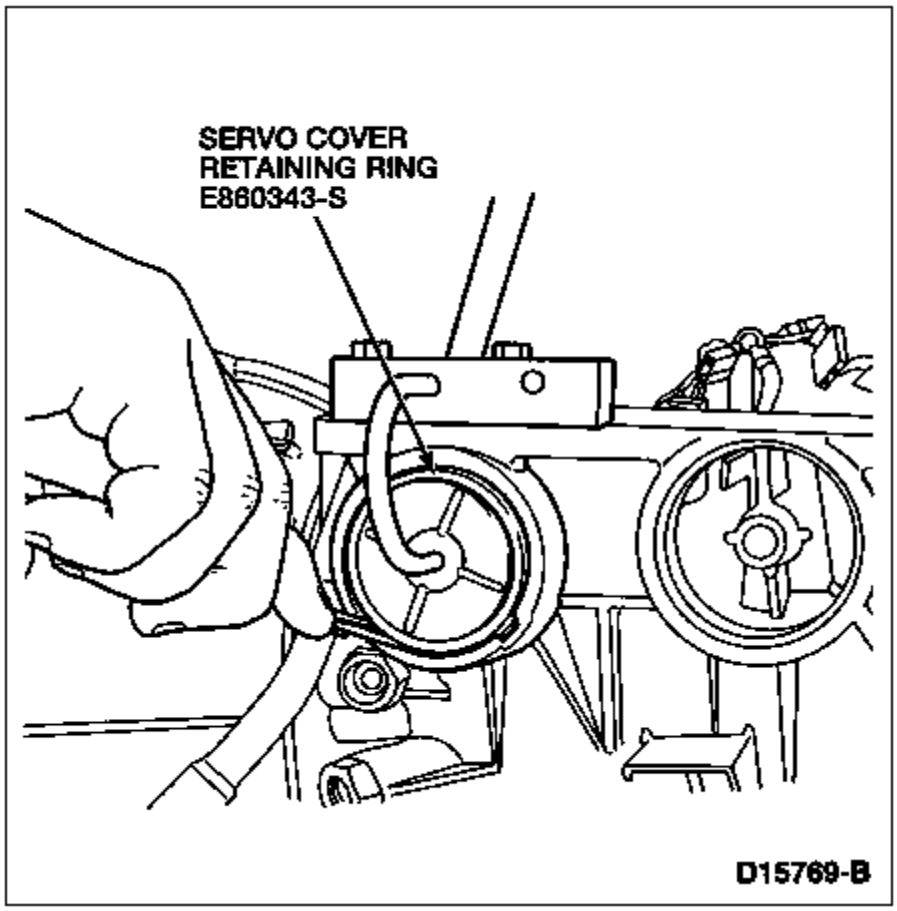

89. **CAUTION: The servo cover is under spring tension.**

    Carefully back off the nut on the J-hook until the servo spring is unloaded.

90. Remove Servo Cover Compressor T95L-77028-A.

91. **CAUTION: Do not damage the intermediate servo cover to case O-ring during installation. Do not press the intermediate servo cover and seal assembly and O-ring past the relief hole in the case. O-ring damage may occur.**

    Install the intermediate servo piston spring, servo piston and rod assembly, servo cover to case O-ring with servo cover assembly with O-ring.

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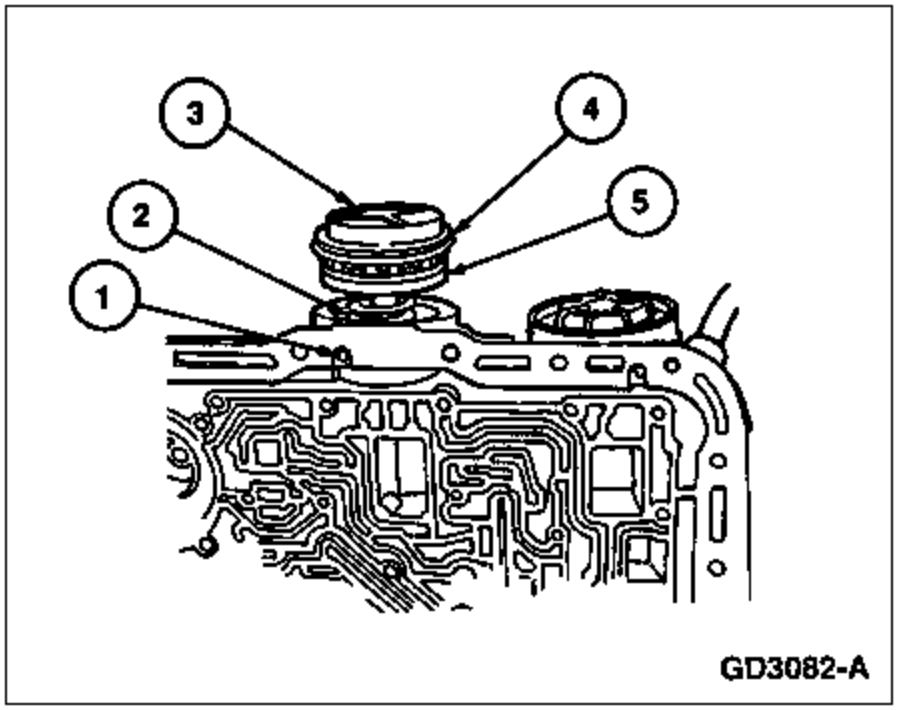

Item	Part Number	Description
1	—	Relief Hole (Part of 7005)
2	7D028	Intermediate Servo Piston Spring
3	7D027	Intermediate Servo Cover and Seal Assembly
4	7D040	Intermediate Servo O-Ring
5	7D021	Intermediate Servo Piston and Rod Assembly

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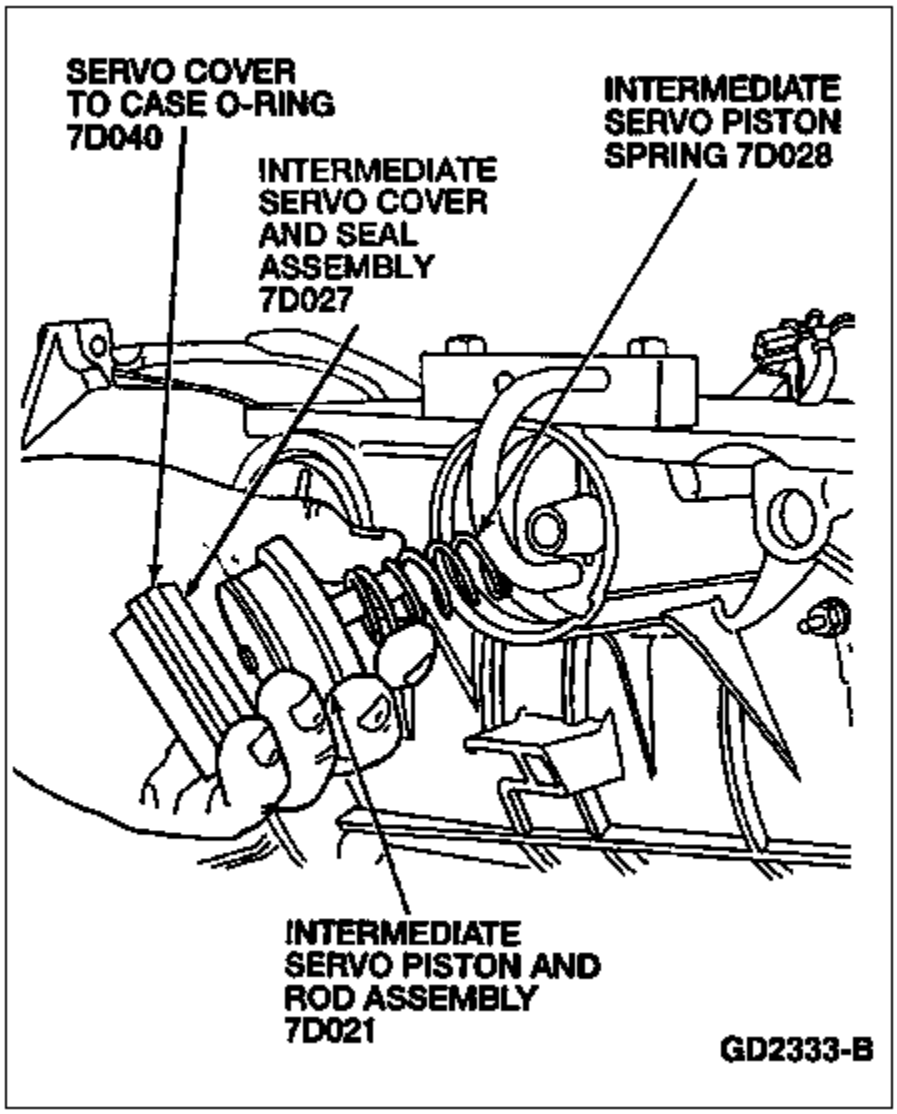

92. **NOTE: The J-hook must be in the appropriate hole for the servo being removed, and tool number should be facing up.**

    Install Servo Cover Compressor T95L-77028-A over the intermediate servo cover at the fluid pan rail. Tighten the screws.

93. Use a 1/2-inch wrench to tighten the nut on the J-hook until there is a gap between the servo cover and the snap ring.

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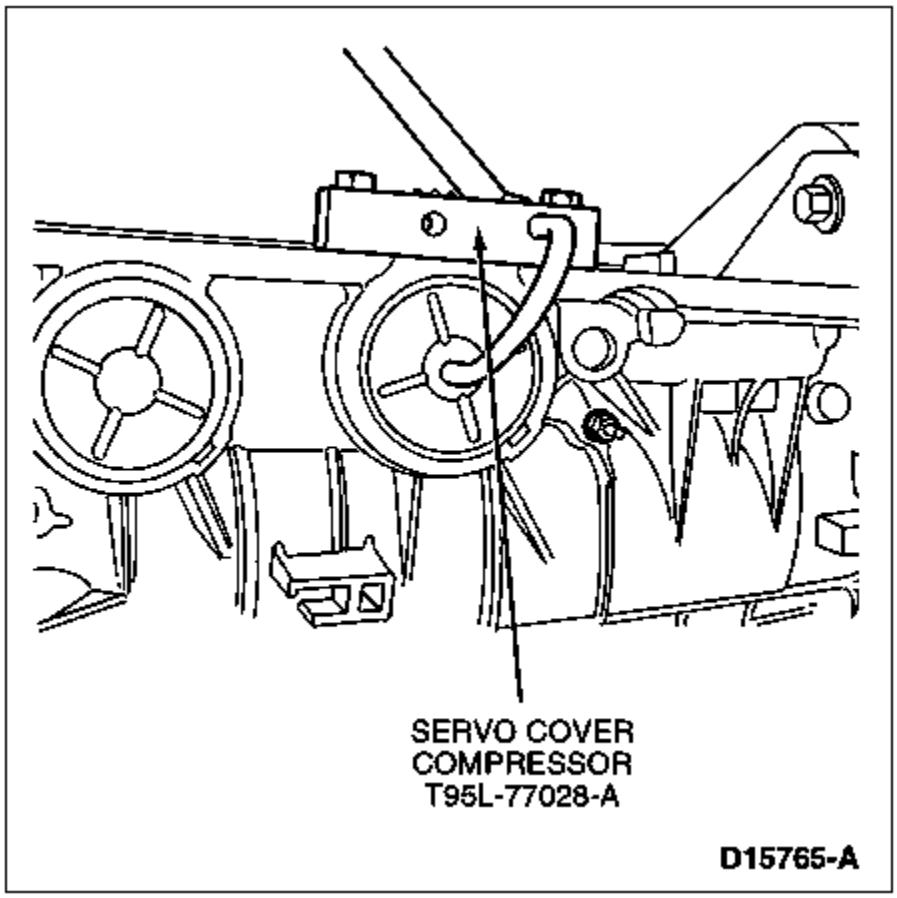

94. Carefully install the intermediate servo cover retaining ring.

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95. **CAUTION: The servo cover is under spring tension.**

    Carefully back off the nut on the J-hook until the servo piston spring is unloaded.

96. Remove Servo Cover Compressor T95L-77028-A.

97. **CAUTION: Install, but do not tighten, a new locknut on the band adjusting screw. Apply petroleum jelly to the locknut seal.**

    CAUTION: The front servo must be installed prior to band adjustment.

    Install a new locknut.

    Tighten the front band adjusting screw using Band Adjustment Torque Wrench Set T71P-77370-A. The wrench will click at 14 Nm (10 lb-ft). Back off the band adjusting screw exactly two (2) turns and hold that position. Tighten the front band locknut to 47-61 Nm (35-45 lb-ft) using a 19 mm wrench.

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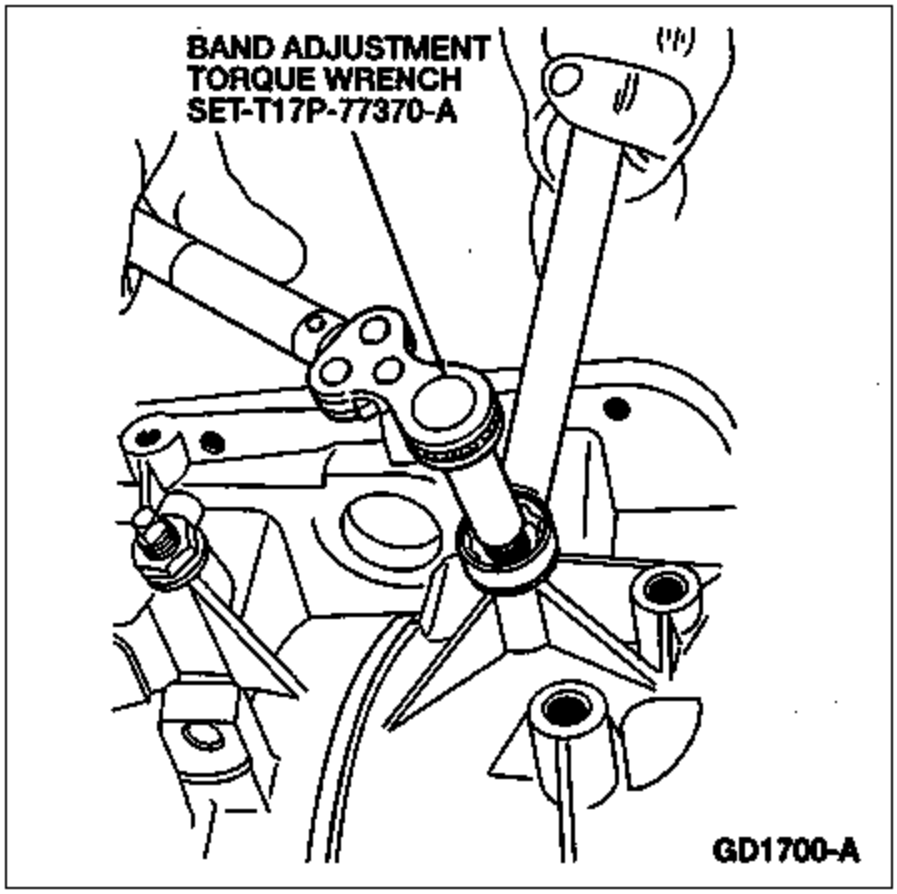

98. **CAUTION: Install, but do not tighten, a new locknut on the band adjusting screw. Apply petroleum jelly to the locknut seal.**

CAUTION: Intermediate servo must be installed prior to band adjustment.

Install a new locknut.

Tighten the intermediate band adjusting screw using Band Adjustment Torque Wrench Set T71P-77370-A. The wrench will click at 14 Nm (10 lb-ft). Back off the band adjusting screw exactly two and one-half (2 1/2) turns and hold that position. Tighten the intermediate band locknut to 47-61 Nm (35-45 lb-ft) using a 19 mm wrench.

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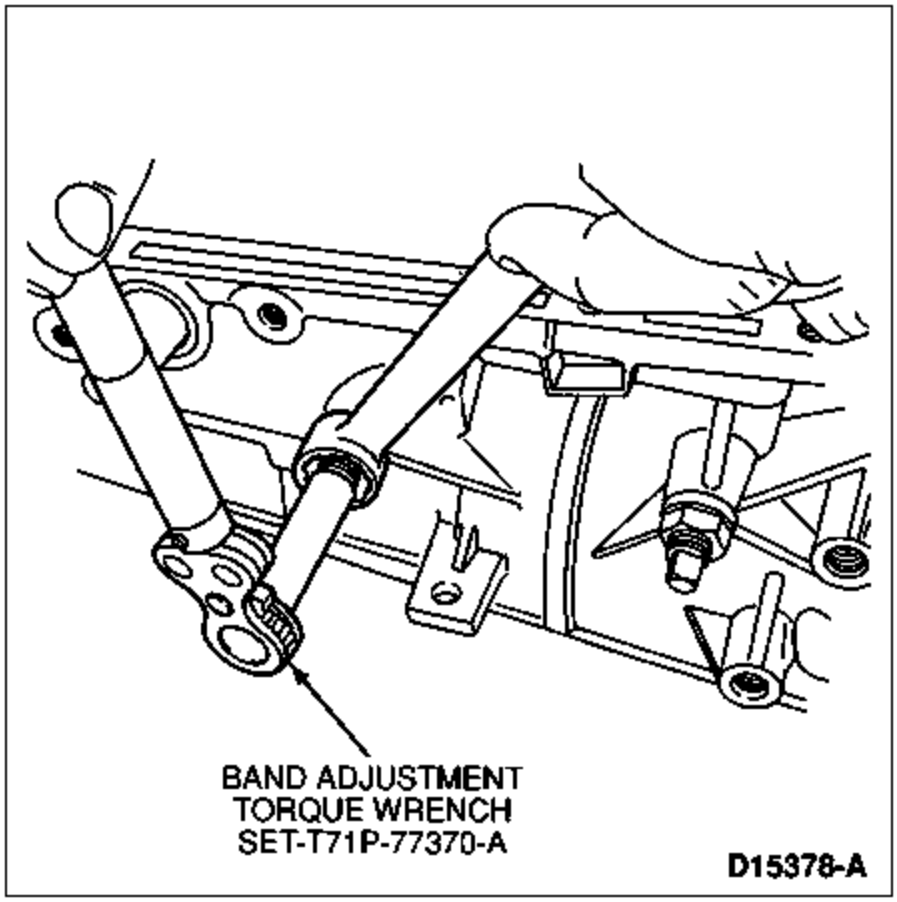

99. **NOTE: Make sure the tab is in the lock position.**

Inspect O-rings (W703015-S300) for damage. Replace if damaged. Lubricate and install the 16-pin connector assembly through the case until a click is heard.

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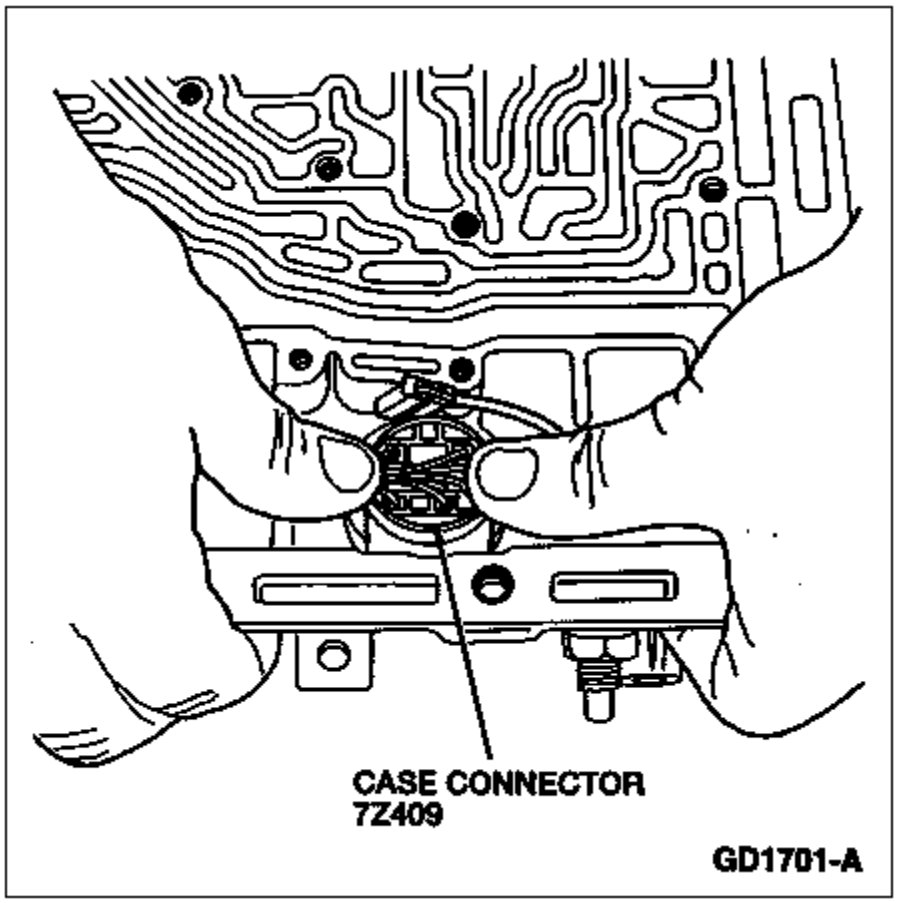

100. **CAUTION: Do not overstretch the 16-pin connector assembly retaining spring.**

Install the 16-pin connector assembly retaining spring.

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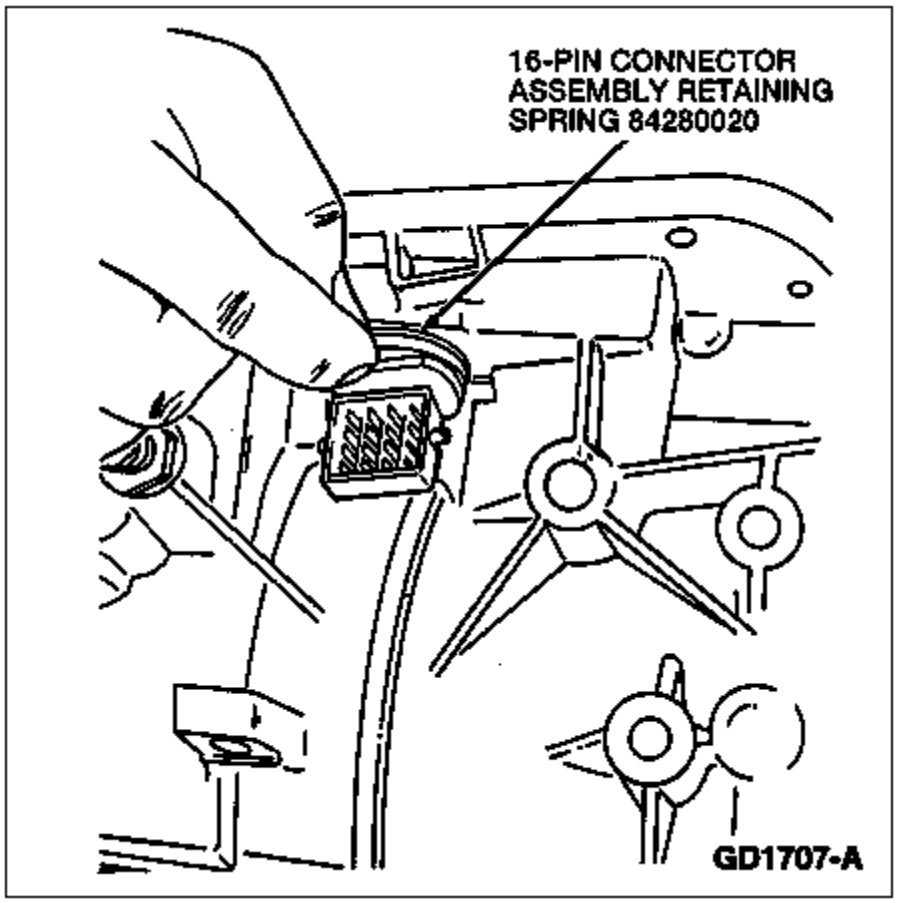

101. **NOTE: Align the slot on the turbine shaft speed (TSS) sensor connector with the slot on the 16-pin connector assembly.**

Carefully install the TSS sensor connector into the 16-pin connector assembly.

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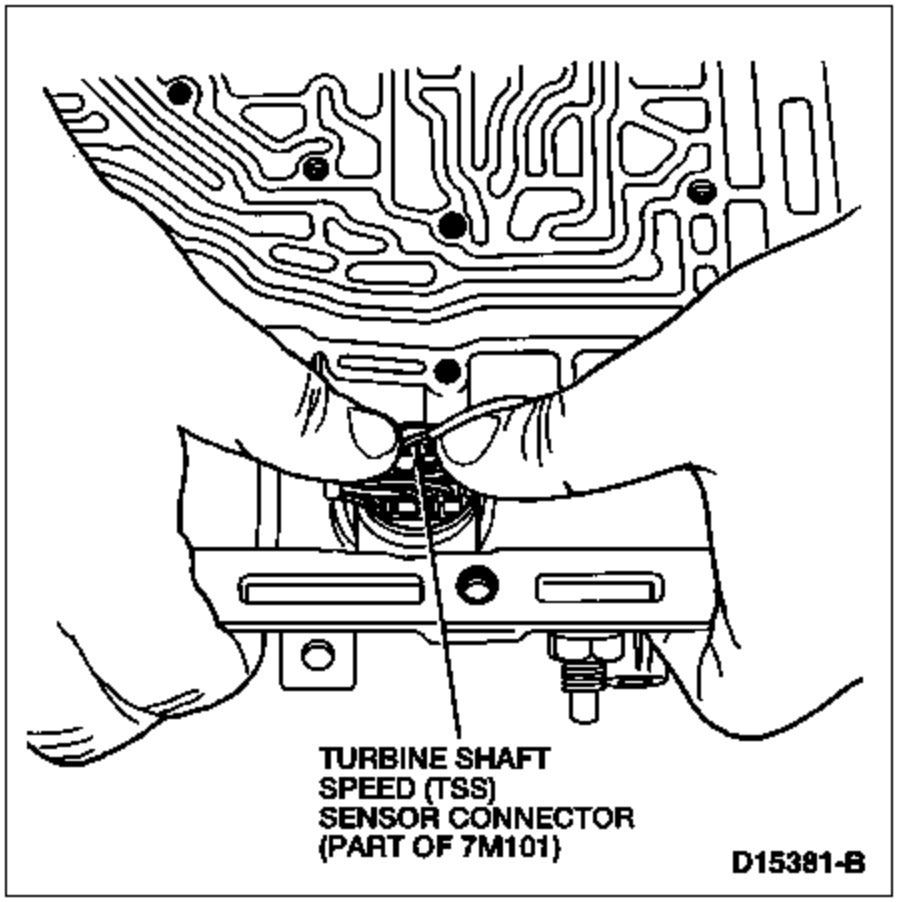

102. Carefully insert TSS sensor connector wires into the retaining slot on the 16-pin case connector.

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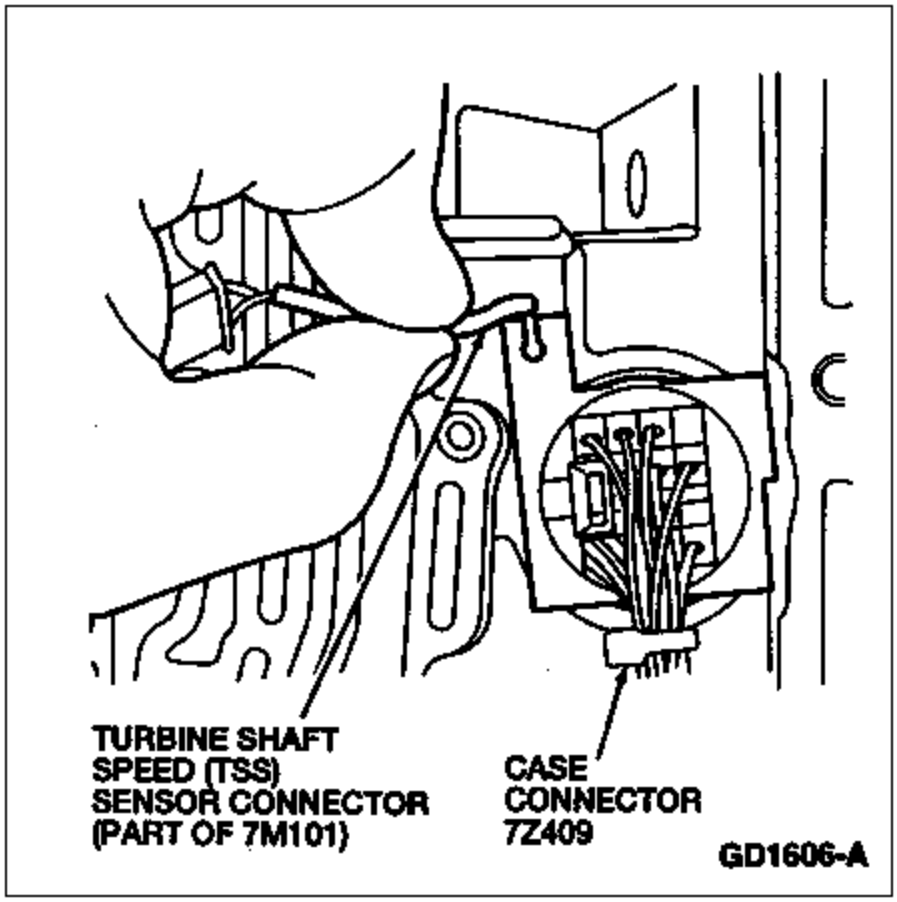

103. Install the valve body guide pins into the case in the positions shown.

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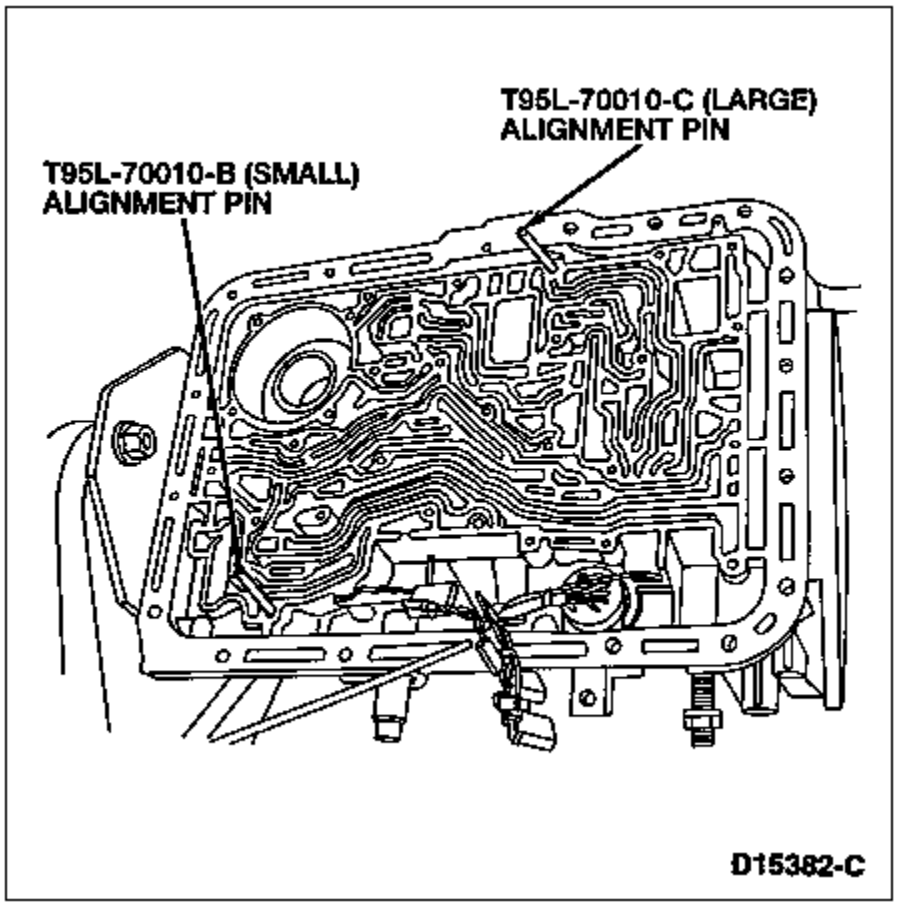

104. **NOTE: Ensure main control assembly gasket is properly aligned.**

Install the main control assembly on the case. Align the manual valve with the manual valve inner lever pin as shown.

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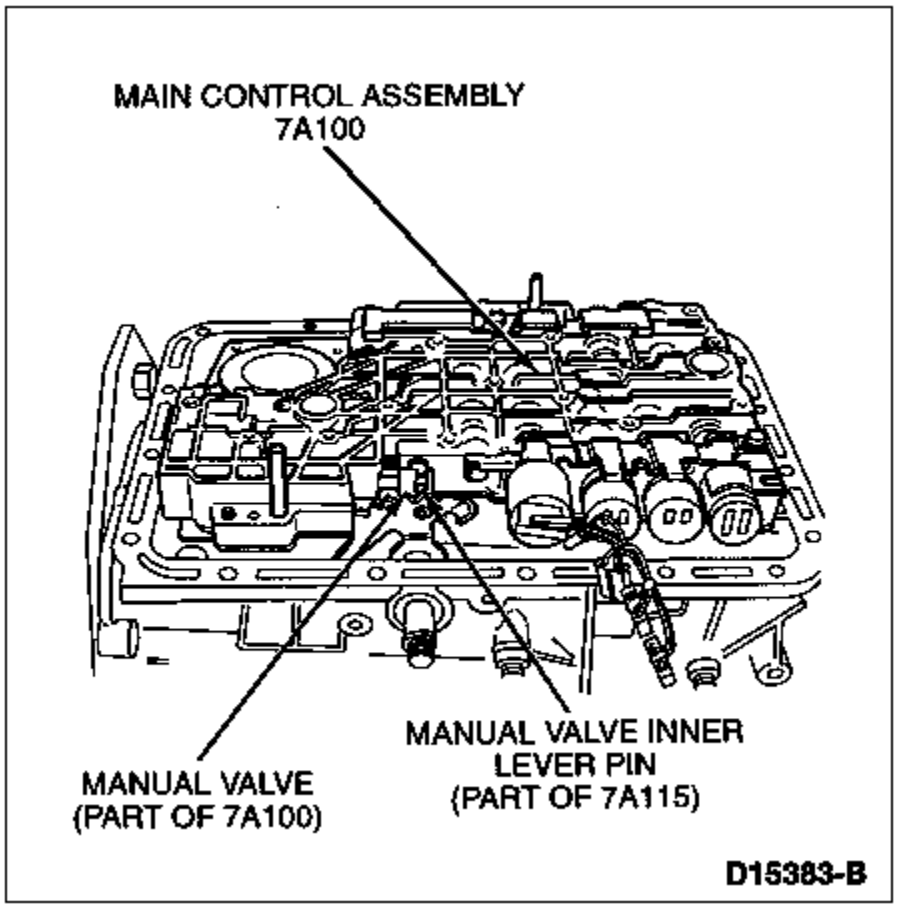

105. Install four M6 x 45 mm main control assembly-to-case screws in location A. Fingertighten.

Main Control Assembly Screws and Locations

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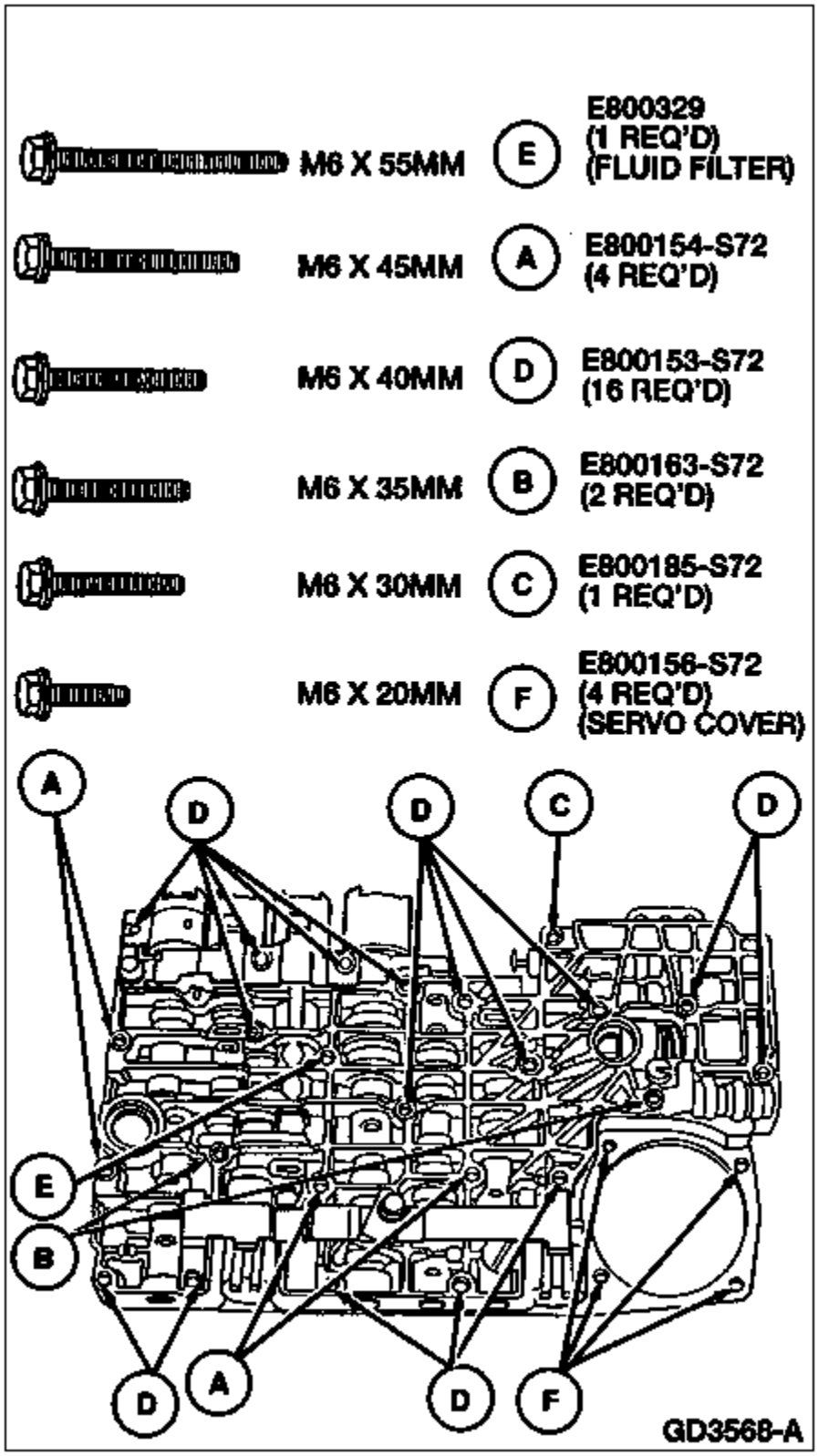

106. Install two M6 x 35 mm main control assembly-to-case screws in location B. Fingertighten.

107. Install one M6 x 30 mm main control assembly-to-case screw in location C. Fingertighten.

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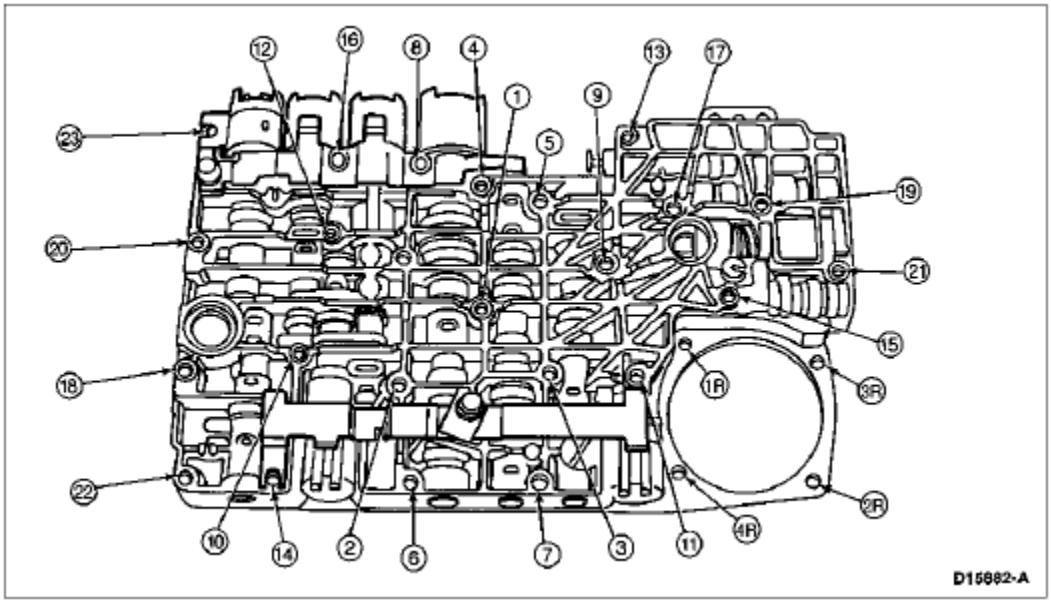
108. Remove both Valve Body Guide pins T95L-70010-B and T95L-70010-C.

109. Install sixteen M6 x 40 mm main control assembly-to-case screws in location D. Fingertighten.

110. Tighten all main control assembly-to-case screws including reverse servo cover sequence (1R, 2R, 3R and 4R), to 8-11 Nm (71-97 lb-in) in sequence shown, using a 10mm socket wrench.

Tightening Sequence



111. Install the manual valve detent spring. Install the manual valve detent spring screw in location A. Tighten the manual valve detent spring screw to 8-11 Nm (71-97 lb-in).

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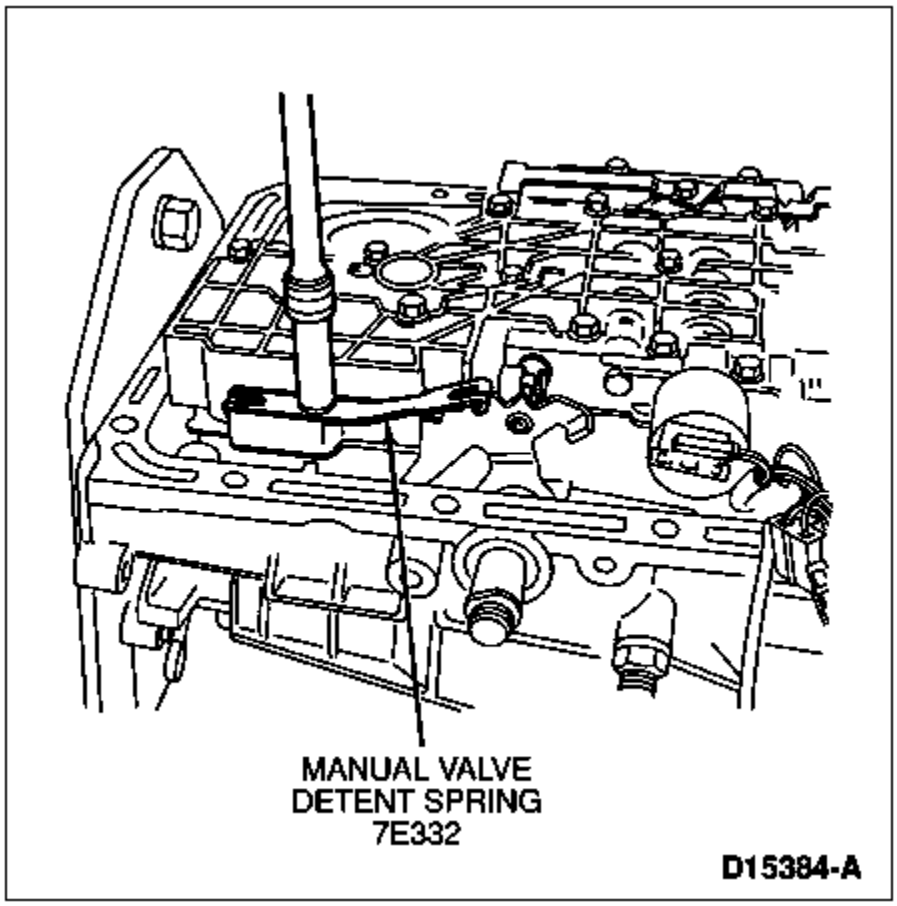

112. **NOTE: Perform Steps 105 through 112 only if low/rear reverse servo piston and rod is to be checked.**

Remove the low/reverse servo piston and rod from the case.

113. **NOTE: An A4LD Reverse Servo Return Spring D4ZZ-7D031-A is to be used only as a test spring.**

Install the low/reverse servo piston and rod into the servo bore along with a D4ZZ-7D031-A reverse servo return spring.

114. Install a new low/reverse servo separator plate cover gasket. Install Servo Rod Selecting Gauge T74P-77190-A and tighten with the three screws.

115. Tighten the servo gauge adjusting screw to 4 Nm (35.5 lb-in).

116. Install Dial Indicator with Bracketry TOOL-4201-C or equivalent on the transmission case. Position the indicator on the piston pad. Set the dial indicator to zero.

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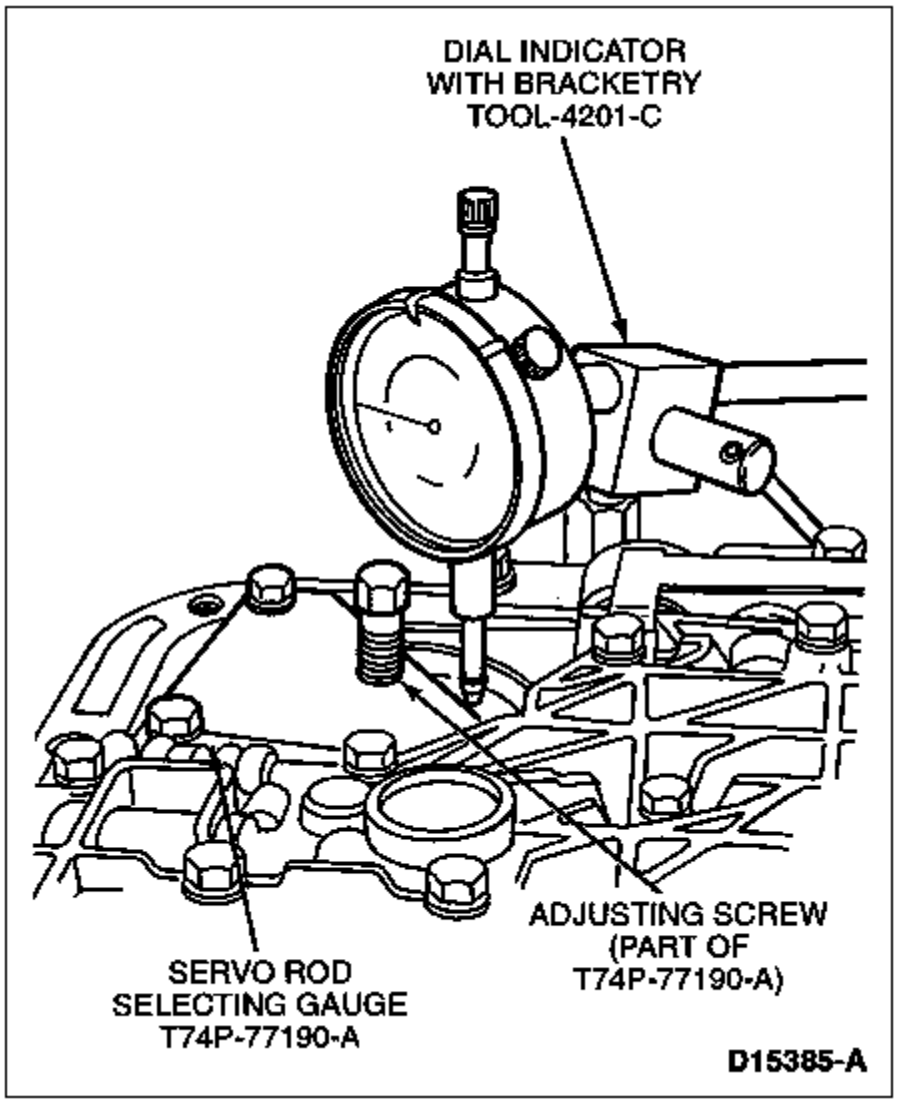

117. **NOTE: If the piston travel in this step is 3-5.6 mm (0.120-0.220 inch), it is within specification. If the piston travel is greater than 5.6mm (0.220 inch), use the next longer piston and rod. If the piston travel is less than 3 mm (0.120 inch), use the next shorter piston and rod.**

Back out the servo gauge adjusting screw until it bottoms out on the tool. Record the distance the servo piston traveled.

118. **CAUTION: Make sure the test spring is removed after this step.**

Use the above procedure to check the piston travel with the newly selected reverse band servo piston and rod (if required) to make sure that the piston travel is 3-5.6 mm (0.120-0.220 inch).

Remove the servo gauge and the reverse band servo return spring.

NOTE: Grooves are located on reverse servo rod.

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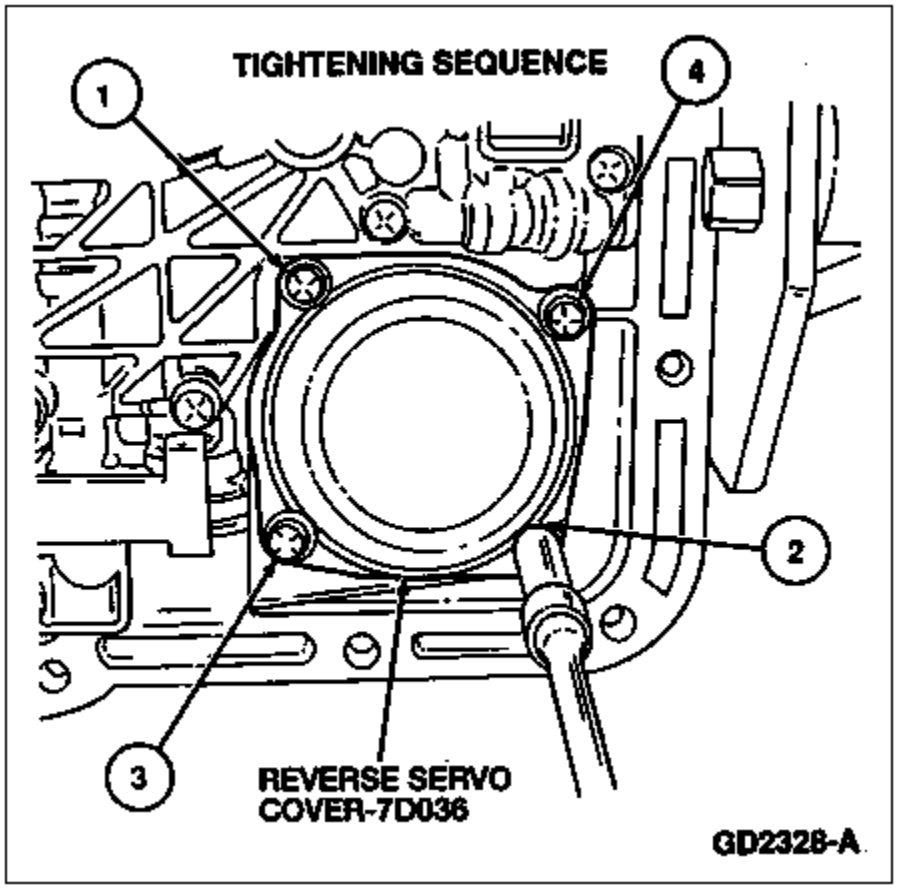
Length — mm	Length — Inches	I.D.
54/53	2.112/2.085	1 Groove
51/50	2.014/1.986	No Groove
49/48	1.915/1.888	2 Grooves

119. **CAUTION: The reverse servo test spring must be removed.**

Install the low/reverse servo cover and the four low/reverse servo cover-to-case screws. Tighten the low/reverse servo cover-to-case screws to 12-14 Nm (106-124 lb-in) in the sequence shown.



120. Carefully press down to install the solenoid connectors on the solenoids as shown.

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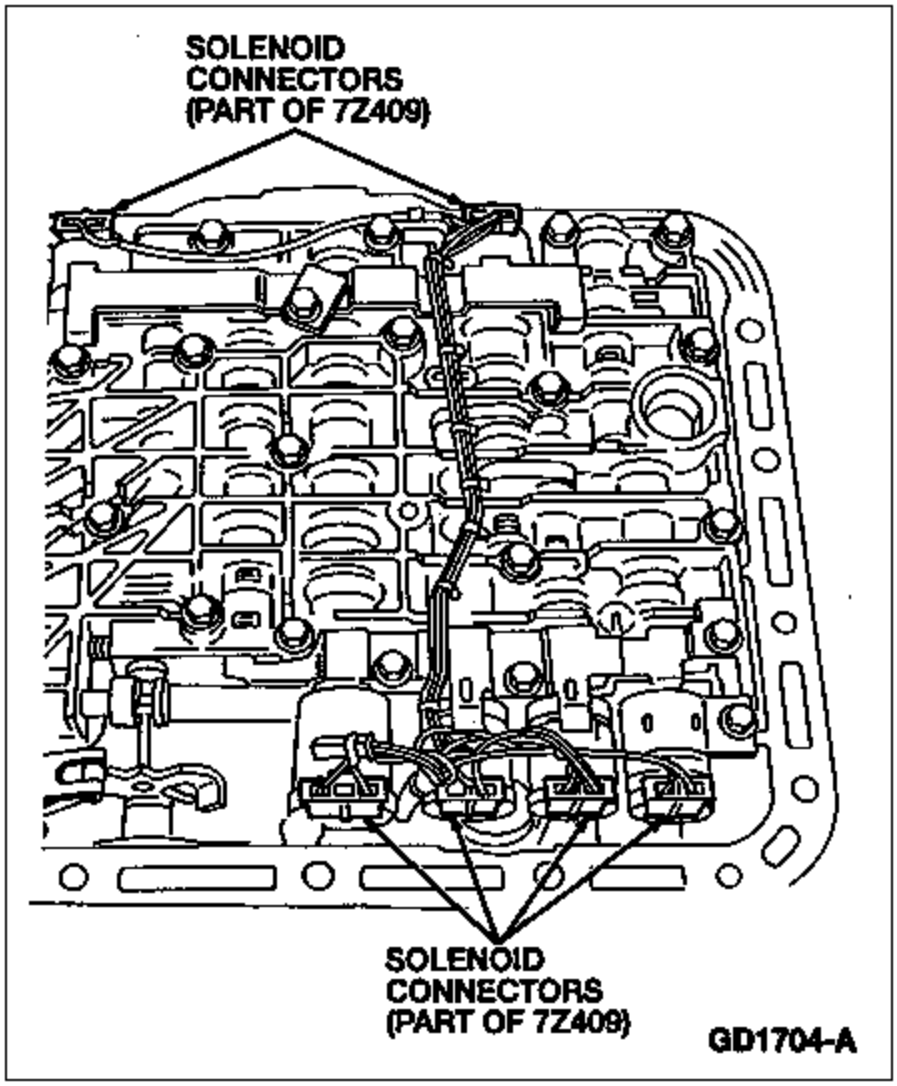

121. **CAUTION: Excessive pressure may break the locating pins.**

Install the wiring loom protector and guide. Align the pins in the holes of the solenoid clamps and gently push down.

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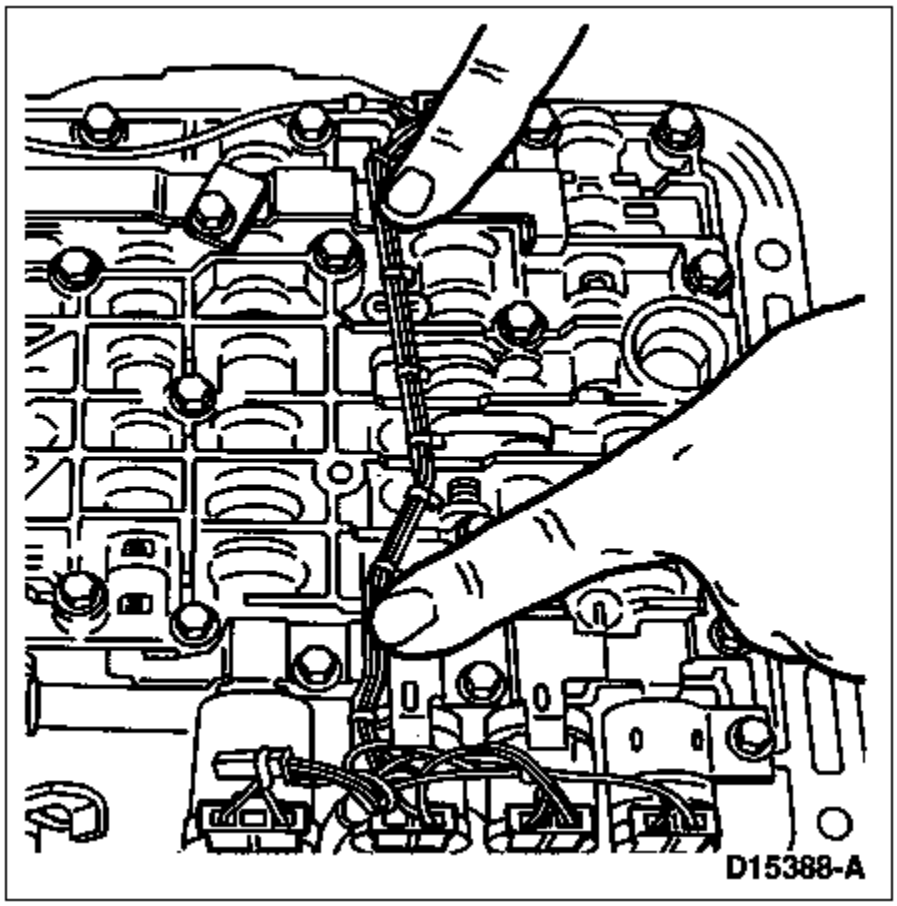
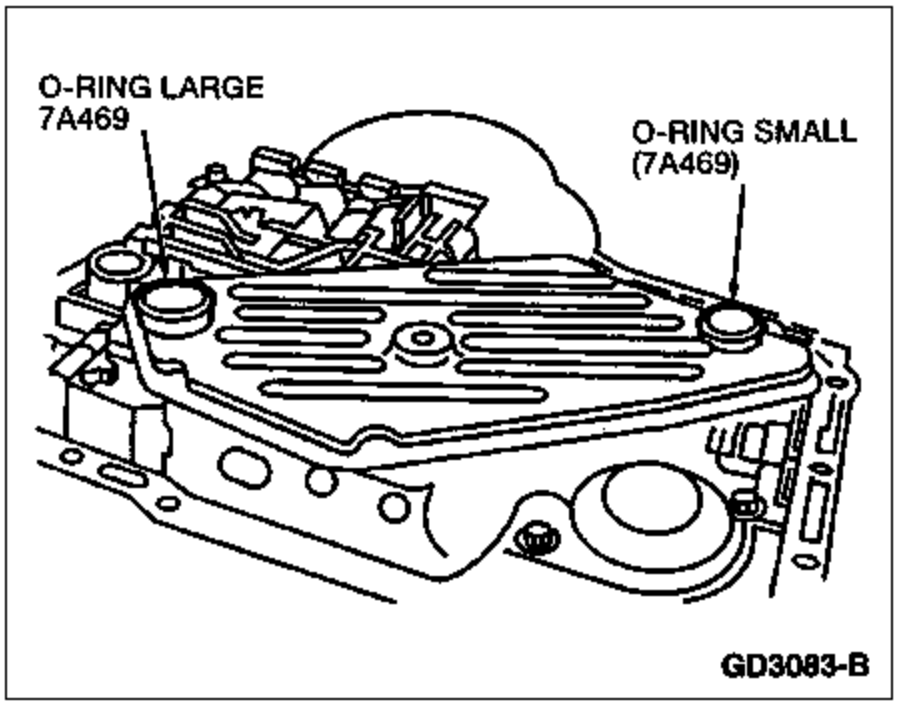


122. Ensure that both O-rings are properly installed on filter prior to installation.



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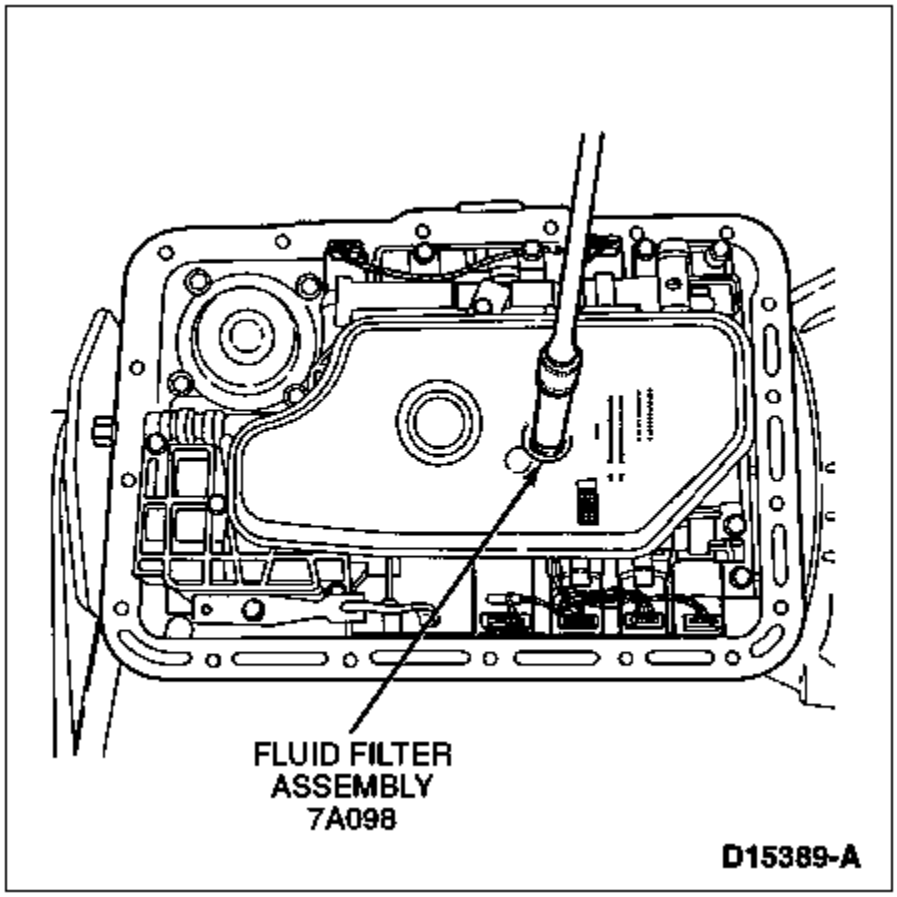
123. **CAUTION: Lubricate the fluid filter O-rings with MERCON V® XT-5-QM or equivalent approved fluid, or they may be damaged.**

Lubricate and install new O-rings onto filter assembly. Install a new fluid filter assembly into the main control assembly. Install one "E" length M6 x 55 fluid filter assembly-to-main control assembly screw and tighten to 8-11 Nm (71-97 lb-in).



124. Position a new fluid pan gasket on the case fluid pan rail.

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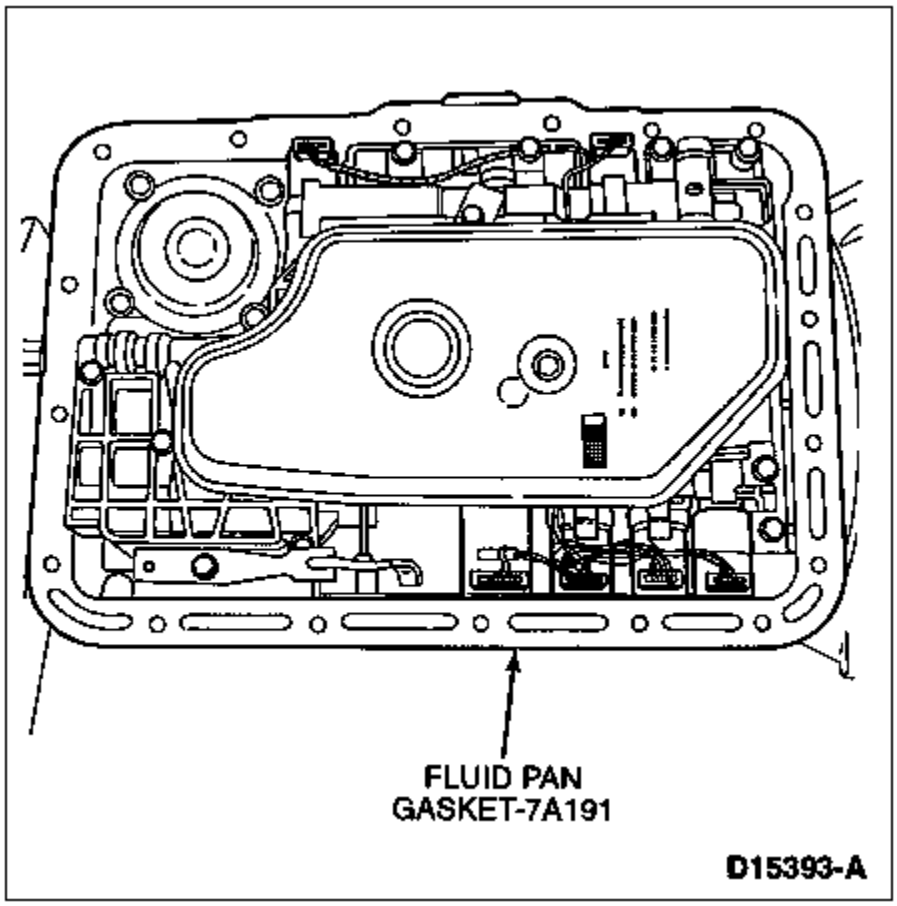

125. Install the fluid pan on top of the gasket. Use a 13 mm socket wrench to install the eighteen M8 x 16 mm fluid pan-to-case screws. Tighten the fluid pan-to-case screws to 13-15 Nm (115-133 lb-in).

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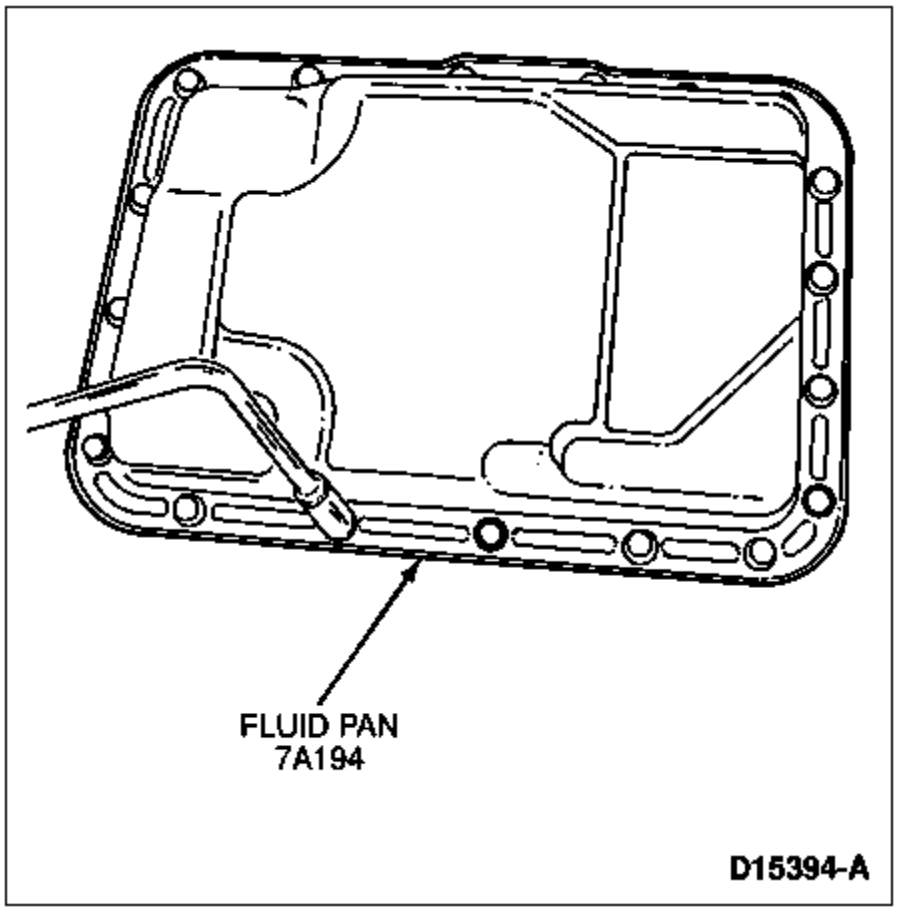

126. Remove the transmission from the bench fixture pivot. Place the transmission on a flat surface. Remove the fixture and adapter plate.

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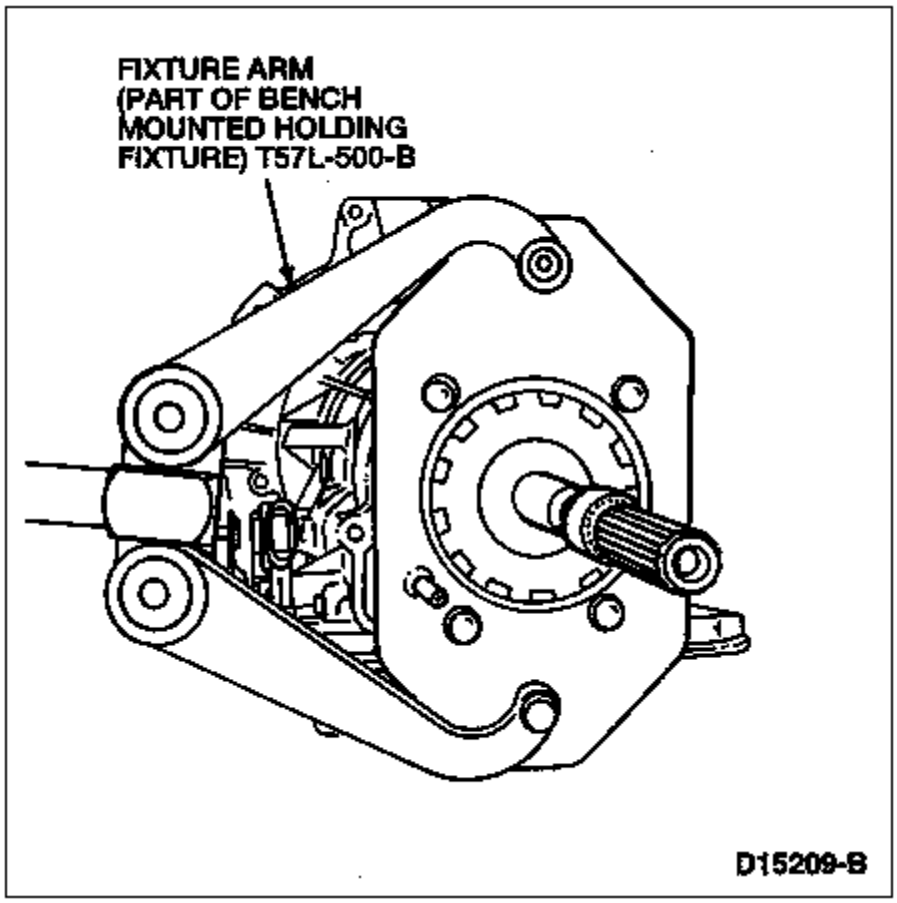

127. **CAUTION: Make sure the parking lever actuating rod is correctly seated into the case parking rod guide cup.**

NOTE: Use petroleum jelly to hold the gasket in place.

NOTE: The guide cup is press-fit into the extension housing and is not serviced separately.

Install a new extension housing gasket on the case.

128. Install the parking pawl, pawl return spring and pawl shaft into the extension housing.

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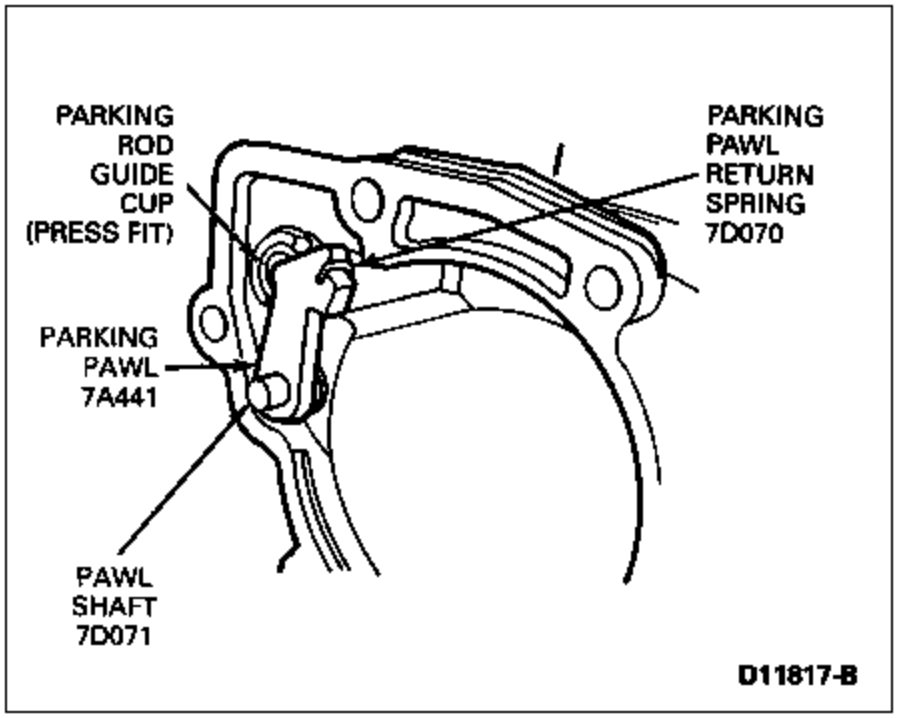

129. Install the extension housing. Install the five M10 x 30 mm extension housing-to-case screws and one stud. Tighten the extension housing-to-case screws and stud to 36-52 Nm (27-39 lb-ft).

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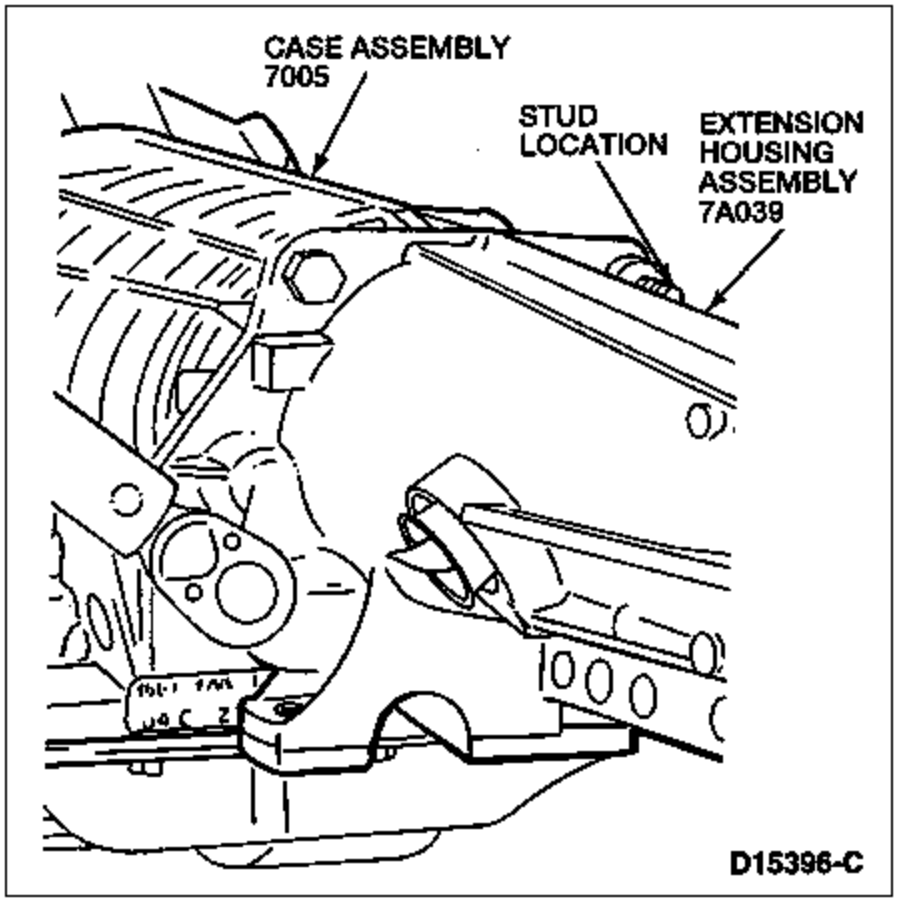

130. **CAUTION: The lube hole in the bushing must be aligned with the lube groove in the extension housing.**

CAUTION: Tool will bottom when bushing is in the proper position.

NOTE: The lube hole should be located at the 3 o'clock position with view extension from the rear.

NOTE: Install the extension housing bushing only if it was removed in disassembly.

Install the extension housing bushing using Extension Housing Bushing Replacer T77L-7697-F.

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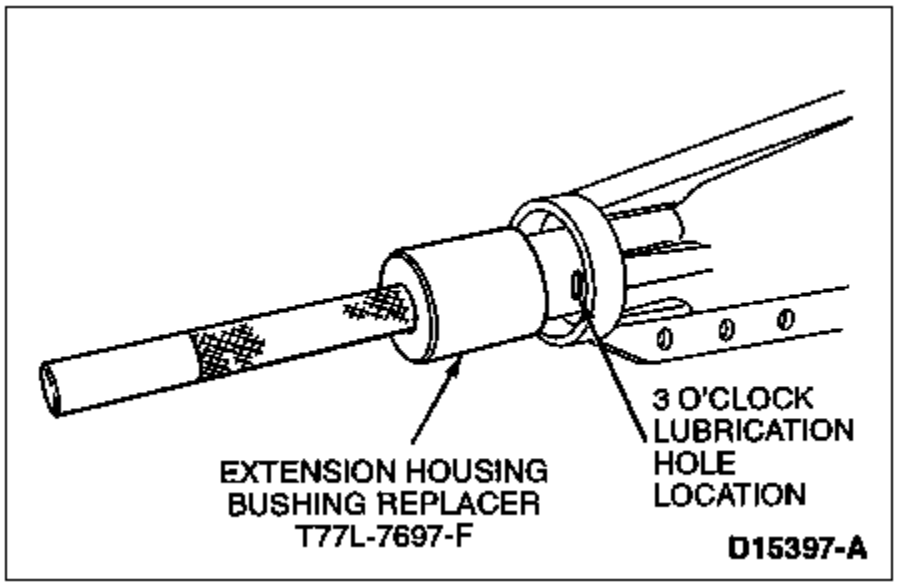
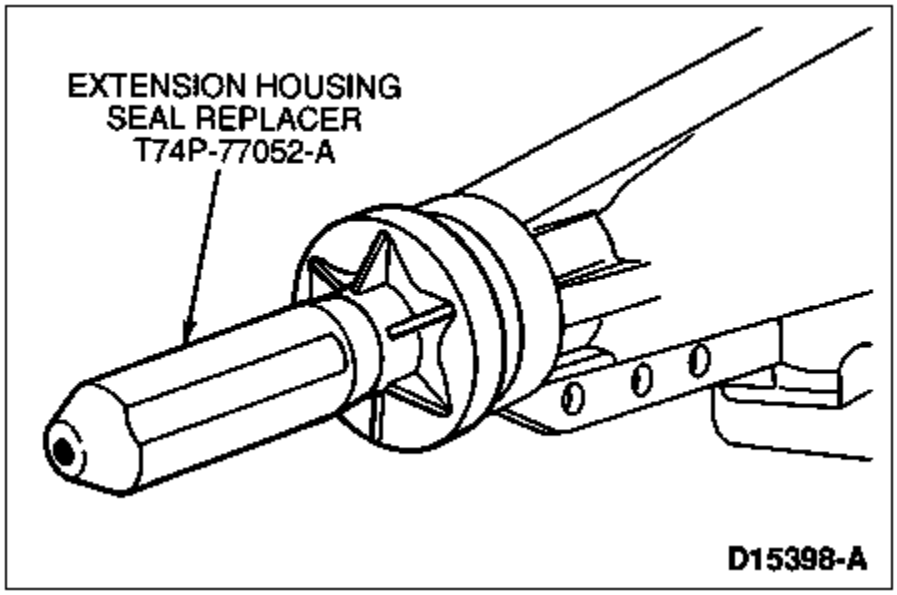


131. Position the extension housing seal drain hole at the 6 o'clock (down) position and install the extension housing seal using Extension Housing Seal Replacer T74P-77052-A.



132. Install the digital transmission range (DTR) sensor on the manual lever. Install the two TR sensor screws and finger tighten. Rotate the manual lever to the neutral position (two detents rearward).

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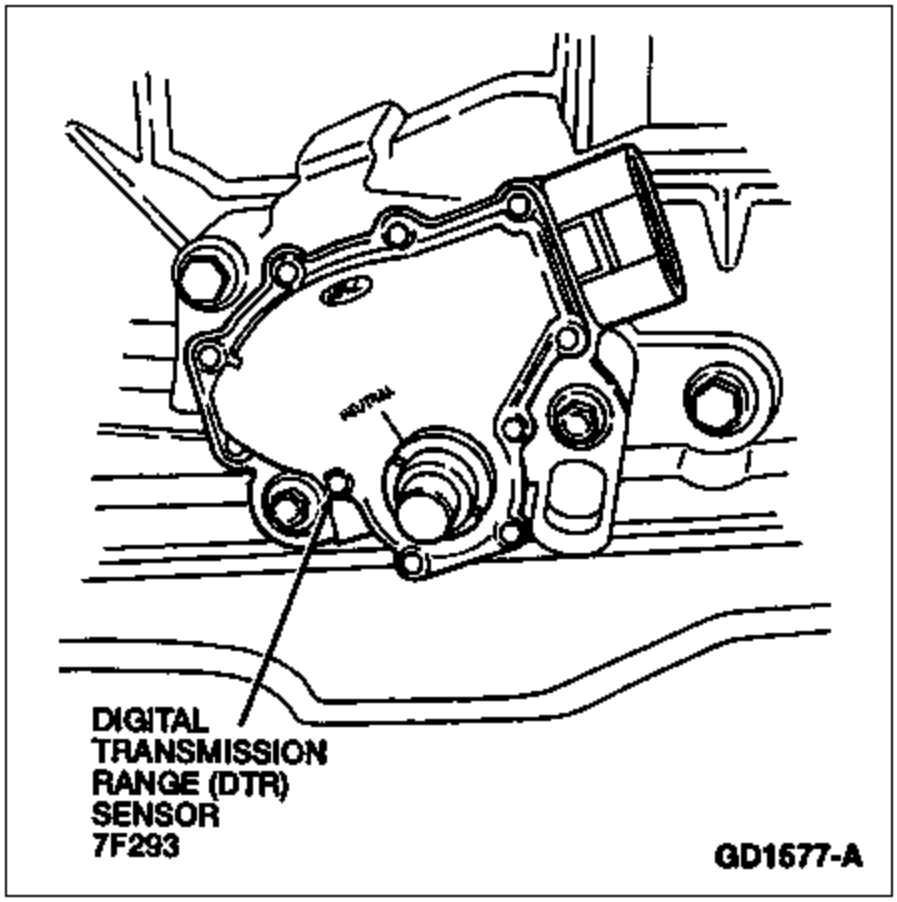

133. Install Digital TR Sensor Alignment Tool T97L-70010-A into the three slots on the DTR sensor. Tighten the TR sensor-to-case screws to 8-11 Nm (71-97 lb-in). Remove the alignment tool.

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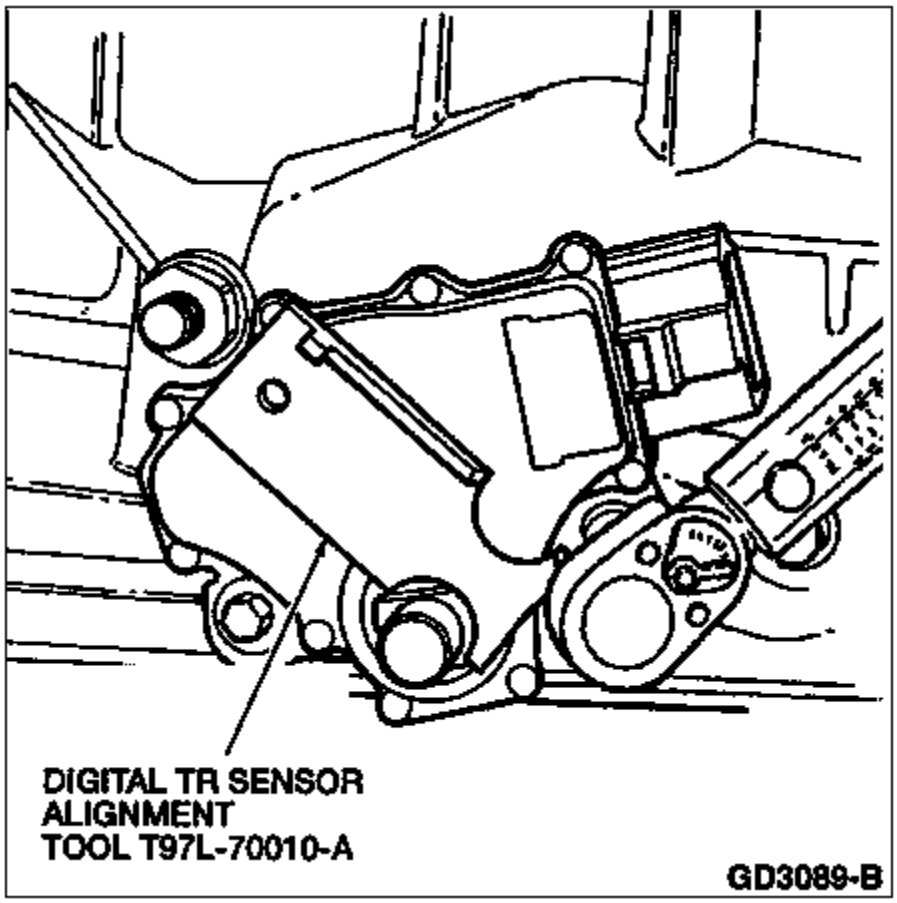

134. Install the manual control outer lever and manual control outer lever nut. Tighten the manual control outer lever nut to 41-54 Nm (30-40 lb-ft).

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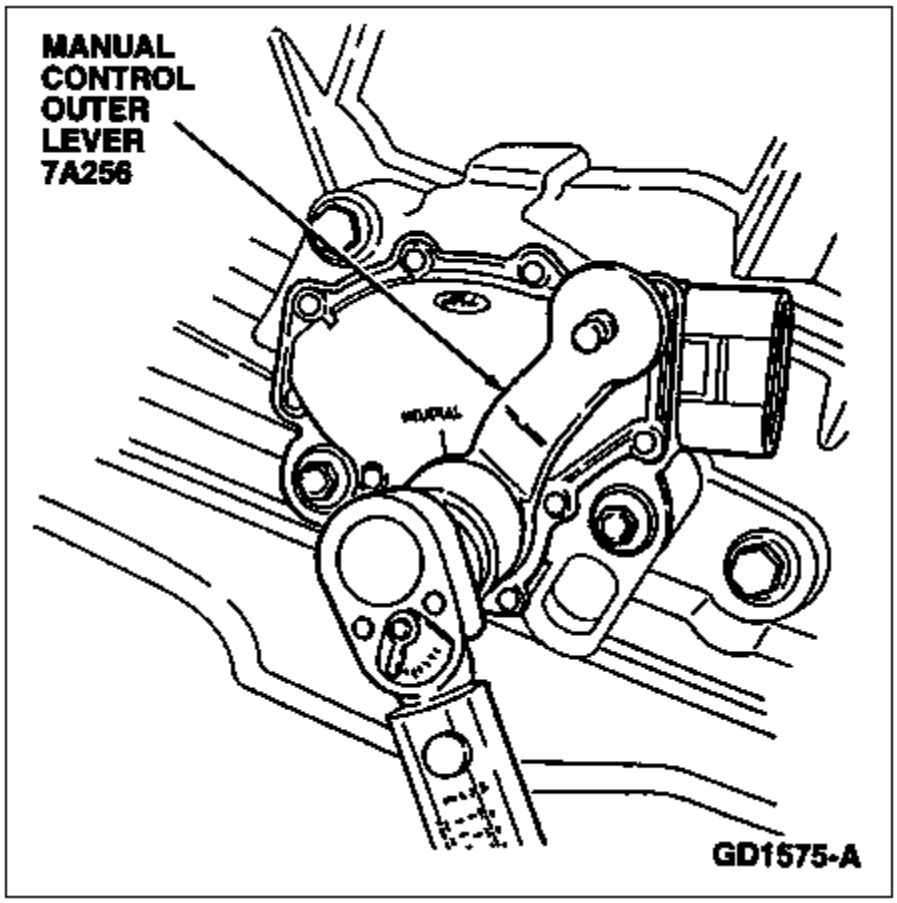

135. Align transmission heat shield retaining clips over fluid pan rail and install the heat shield on the fluid pan rail.

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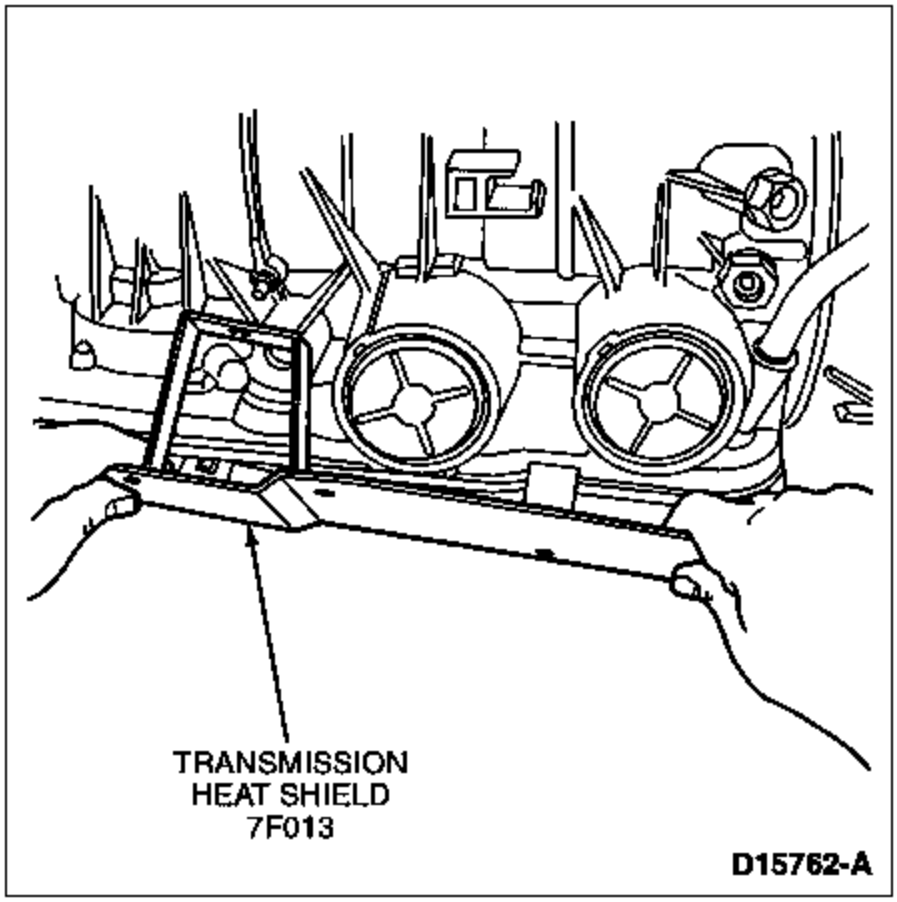

136. Install the transmission heat shield nut. Tighten the transmission heat shield nut to 8-11 Nm (71-97 lb-in).

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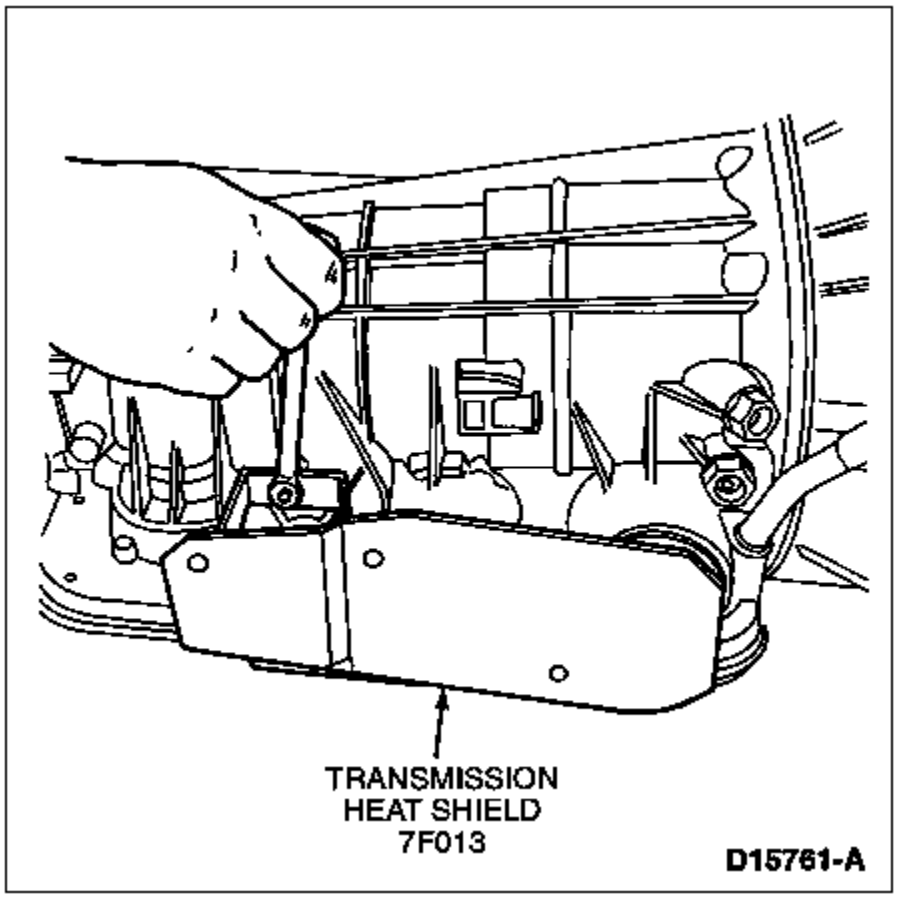
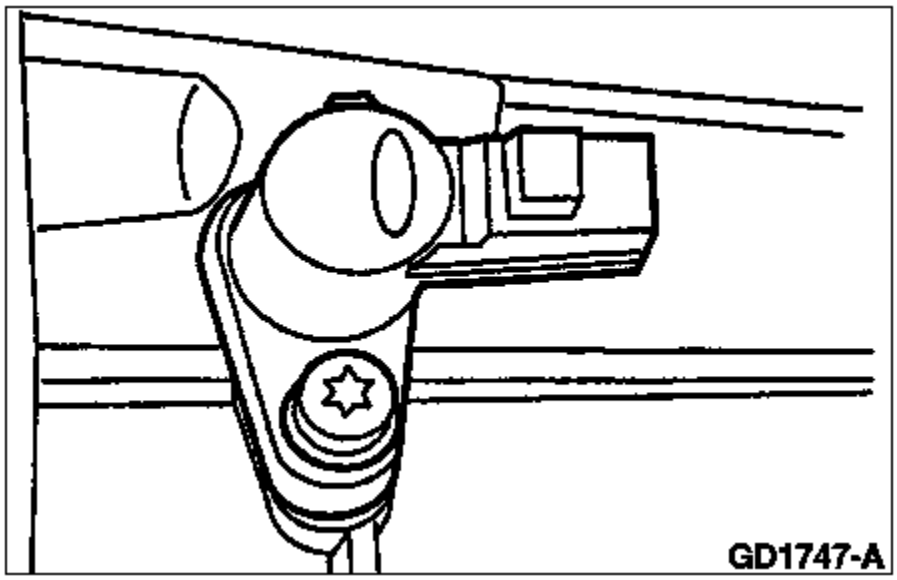


137. Inspect O-ring (W702981) for damage. If damaged, replace O-ring.

138. Install overdrive drum speed (7M183) sensor into case. Install attaching bolt and tighten to 8-11 Nm (71-97 lb-in).



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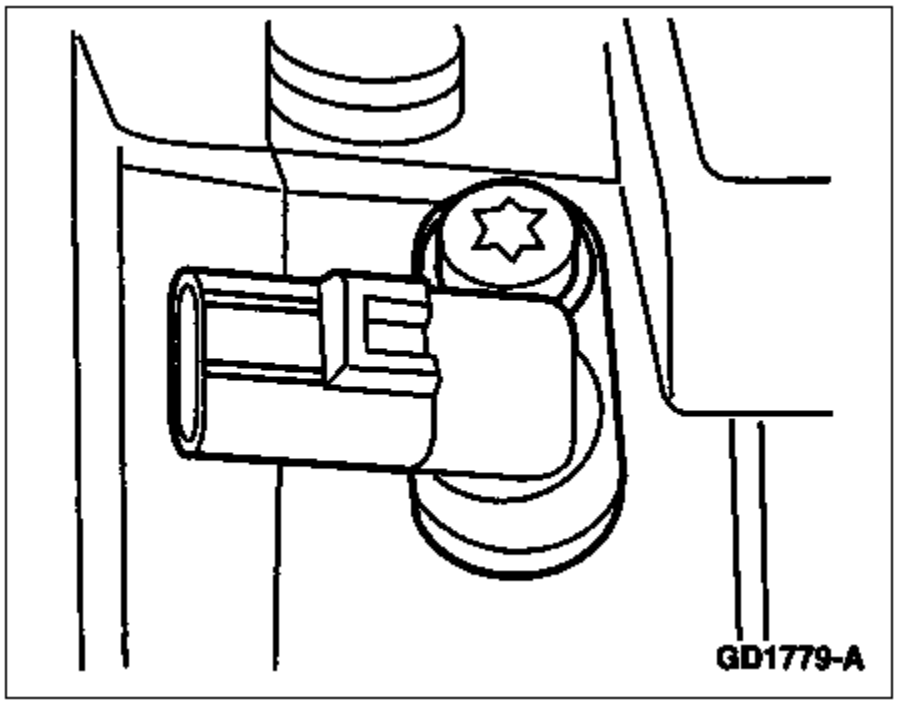
139. Inspect O-ring (W702981) for damage. If damaged, replace O-ring.

140. Install output shaft speed (7H103) sensor into case. Install attaching bolt and tighten to 8-11 Nm (71-97 lb-in).



141. **CAUTION: The splines are not the same on both ends. The shaft end with the shorter splines goes into the front pump support and gear.**

Install the input shaft into the front pump support and gear.

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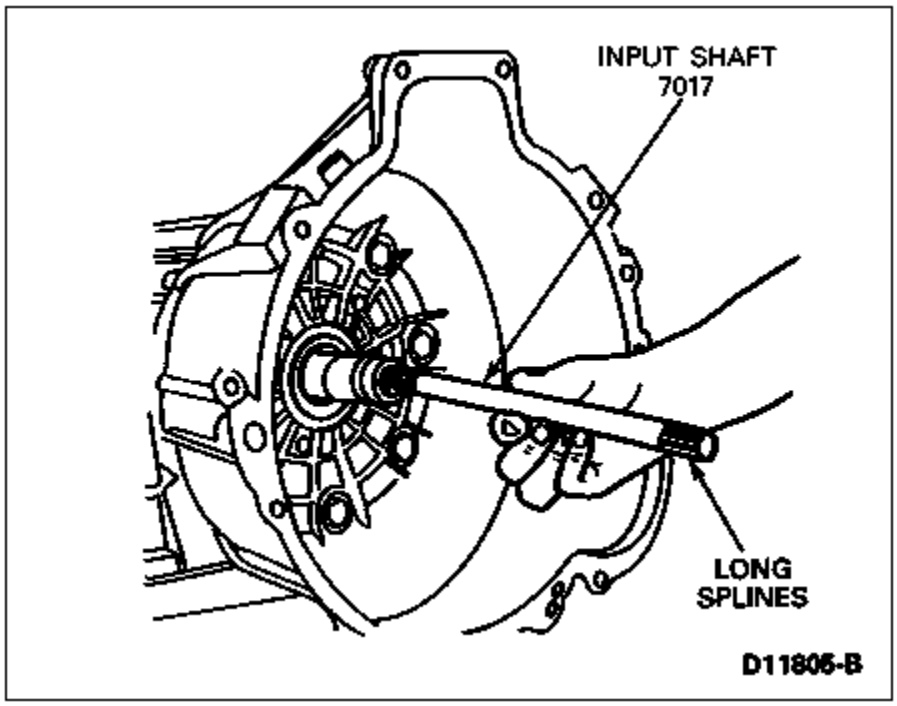

142. Insert Fluid Pump Seal Sizing Tool T95L-70010-G into pump drive gear to make sure the drive gear O-ring is properly seated prior to installing the torque converter. Remove tool.

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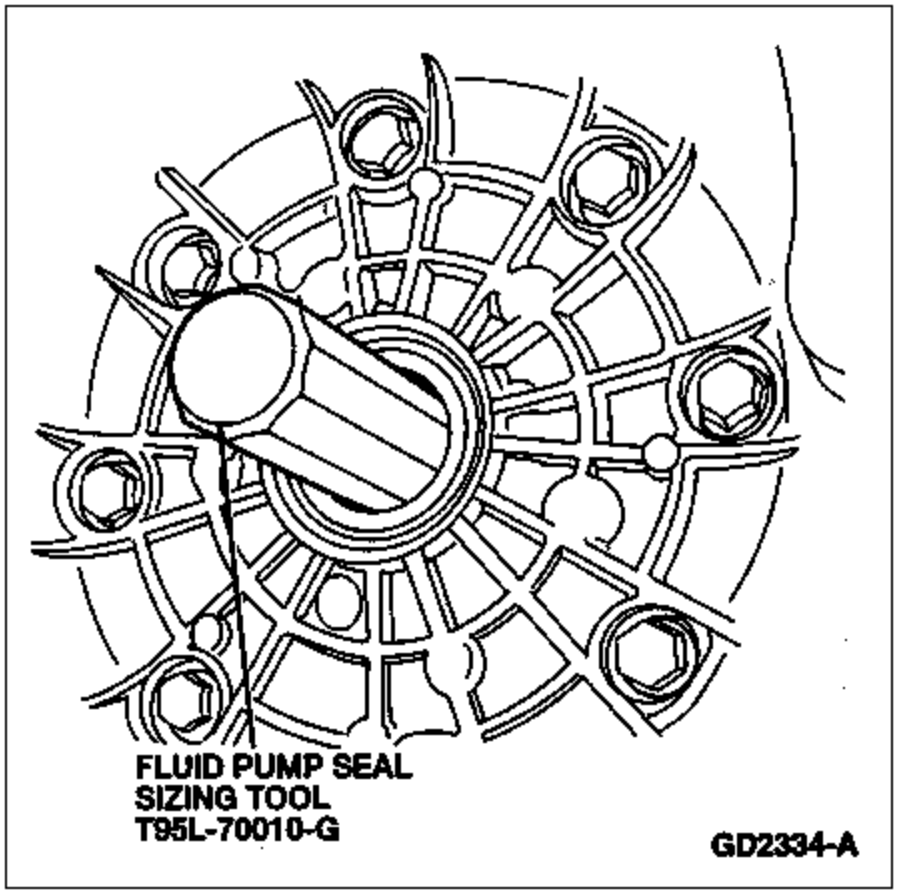

143. **WARNING: THE TORQUE CONVERTER CAN FALL OUT IF THE TRANSMISSION IS TIPPED.**

CAUTION: Do not damage the pump drive gear O-ring when installing the torque converter.

CAUTION: Make sure the converter hub is fully engaged in the front pump support and gear and rotates freely. Do not damage the hub seal.

CAUTION: If the torque converter slides out, the hub seal may be damaged.

Lightly lubricate the converter hub with MERCON V® XT-5-QM transmission fluid.

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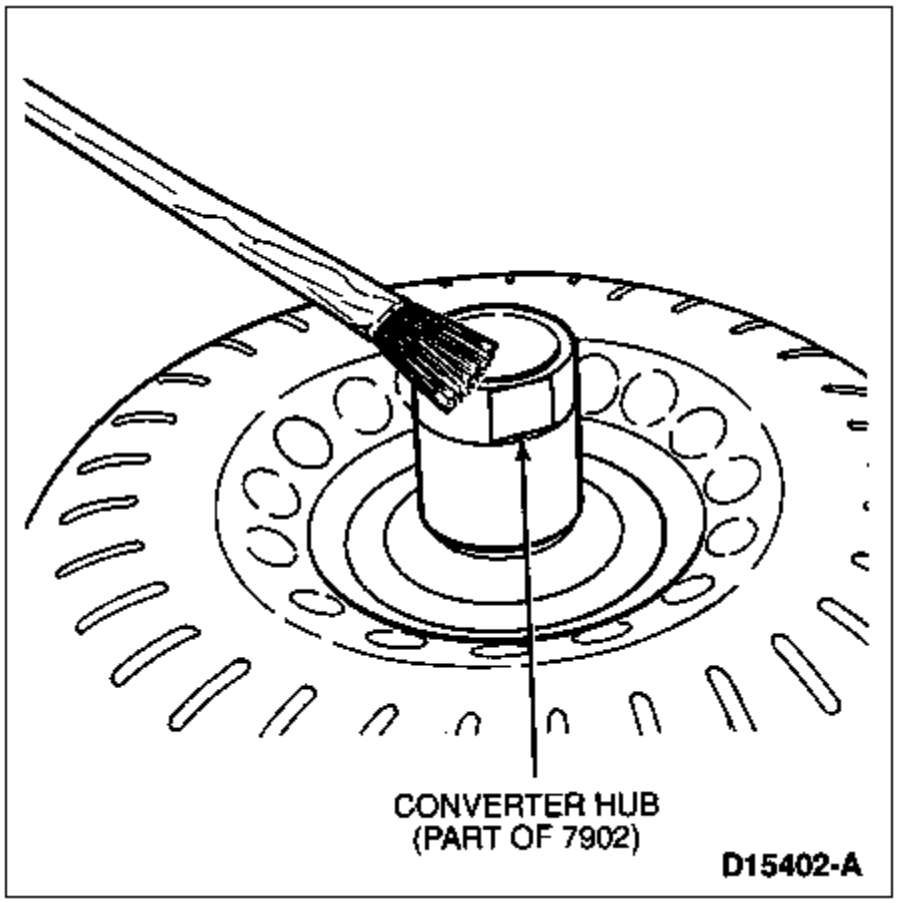

144. **WARNING: THE TORQUE CONVERTER IS HEAVY, ESPECIALLY WHEN FULL OF FLUID.**

Use Torque Converter Handles T81P-7902-C to install the torque converter by pushing and rotating.

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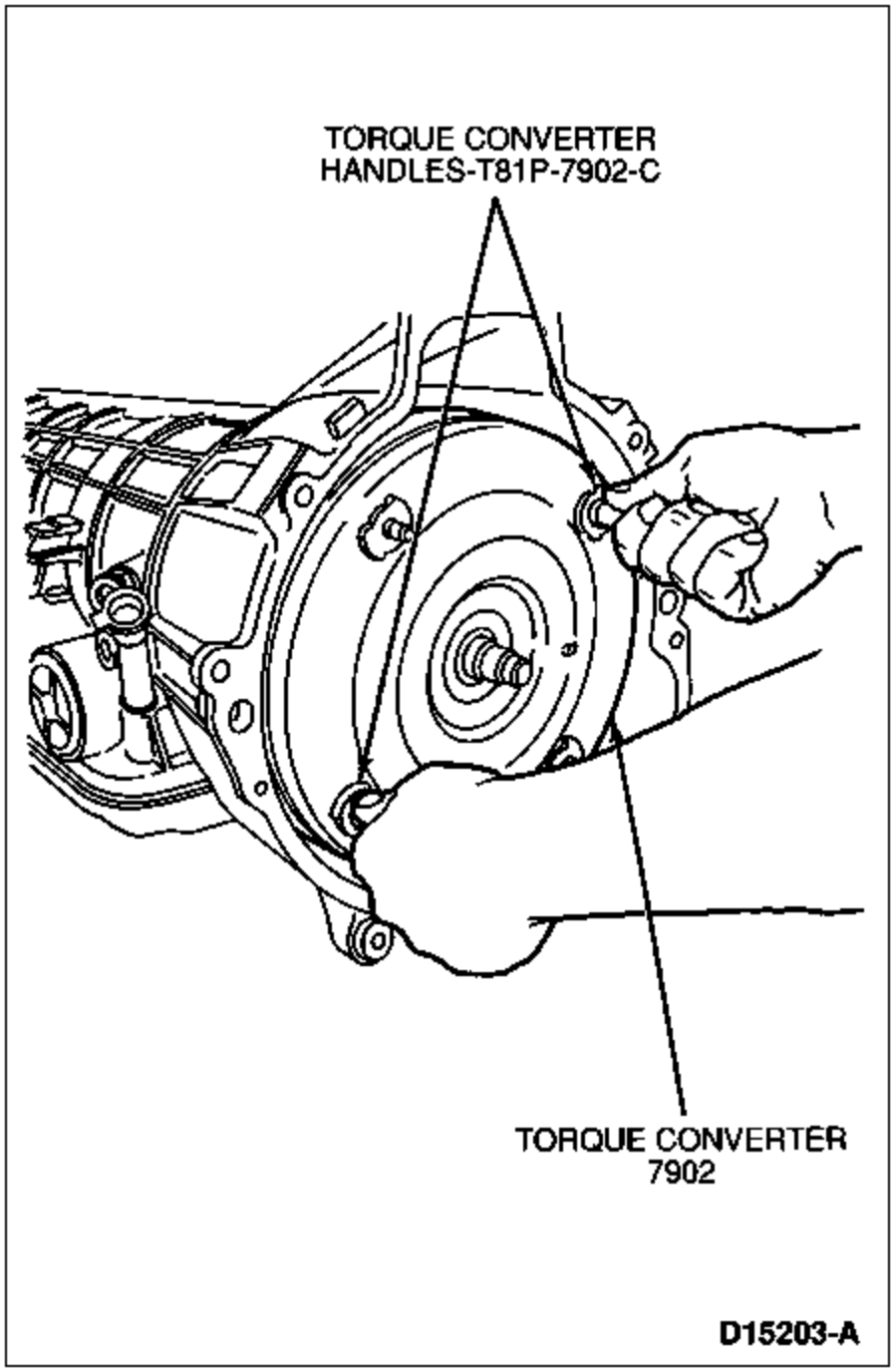

145. **NOTE: dimension "A" should be 10.23-14.43 mm (0.43-0.56 inch).**

Check dimension "A."

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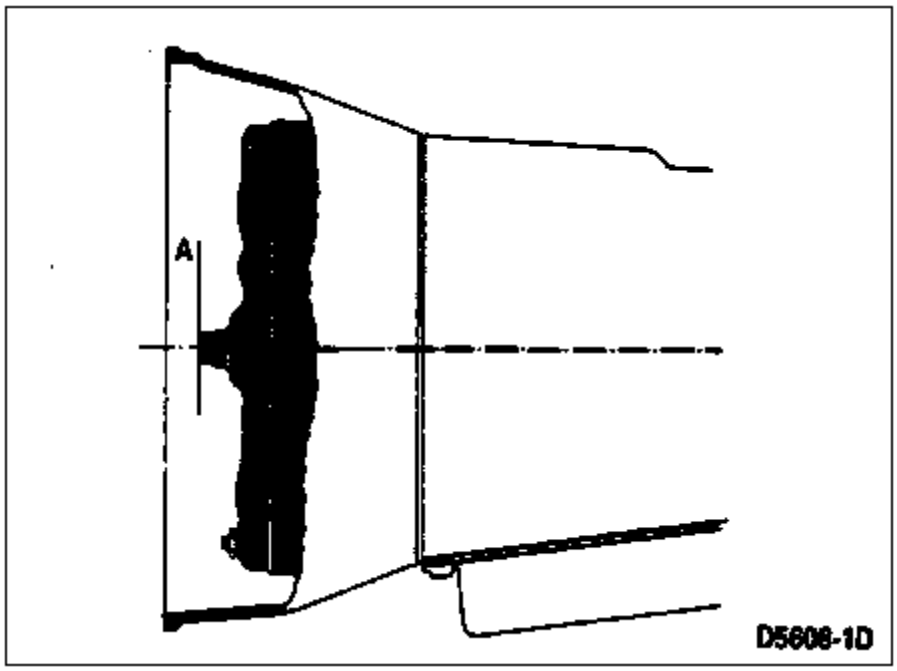
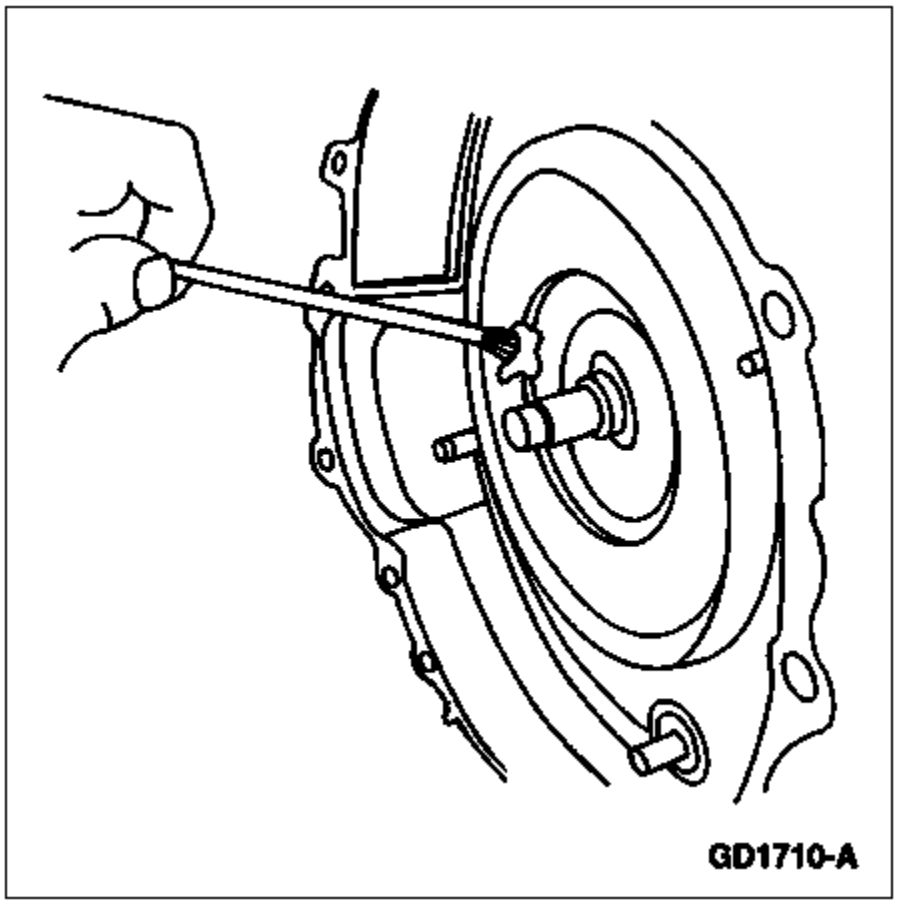


146. Prior to vehicle installation, lubricate the converter pilot hub with Ford Multi-Purpose Grease (D0AZ-19584-A, specification ESA-M1C45-A).



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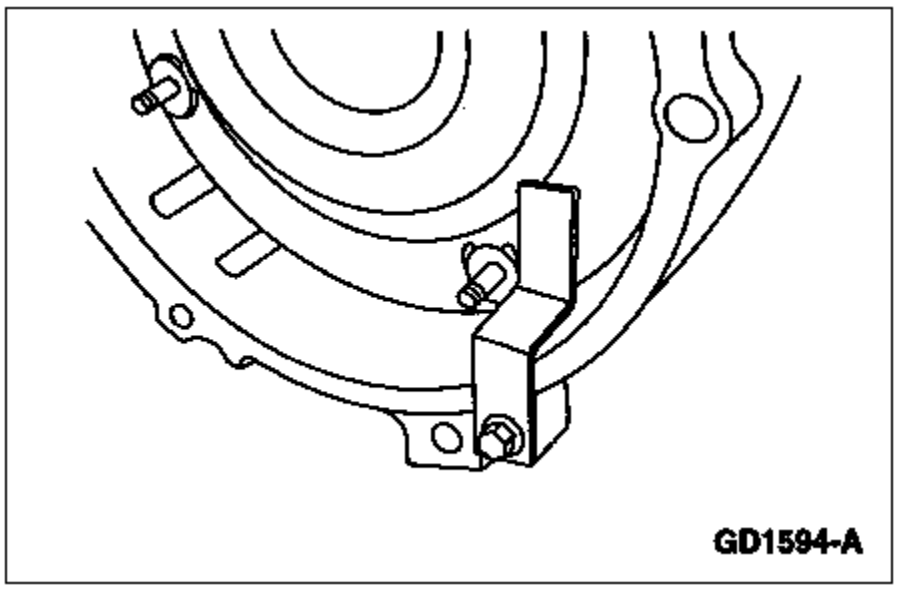
147. Before installing transmission, make sure that the transmission cooling system (line and cooler[s]) have been thoroughly flushed. Use procedures found in this section. If contamination cannot be removed or proper flow cannot be obtained, replace cooler(s) and/or lines.

148. Install Torque Converter Holding Tool T97T-7902-A on case using a standard bolt and nut to prevent converter from falling forward when moving to jackstand and to vehicle.



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Transmission — 4x2

1. **WARNING: SECURE THE TRANSMISSION TO THE TRANSMISSION JACK WITH A SAFETY CHAIN.**

   Position the transmission on a transmission jack.

2. Raise the transmission jack and position the transmission near the engine.

3. Remove the Torque Converter Holding Tool T97T-7902-A.

4. Align the flex plate-to-converter index mark made at removal.

5. Align the mating holes and install the four converter housing-to-engine screws. Tighten to 40-55 Nm (30-41 lb-ft).

6. **CAUTION: Use care not to bend or otherwise damage the cooler lines.**

   Remove the plugs and connect the transmission cooler lines-to-case connectors. Tighten the cooler tube nuts to 24-31 Nm (18-23 lb-ft).

7. Install the two lower converter housing-to-engine screws. Tighten to 40-55 Nm (30-41 lb-ft).

8. Install the fluid filler tube into the fluid inlet short tube.

9. Install the two upper converter housing-to-engine screws. Tighten to 40-55 Nm (30-41 lb-ft).

10. Install the catalytic converter assembly. Install the catalytic converter-to-crossover pipe nuts and tighten to 34-46 Nm (25-34 lb-ft).

11. Position the catalytic converter to the exhaust pipe. Install the catalytic converter-to-exhaust pipe nuts and bolts and tighten to 34-46 Nm (25-34 lb-ft).

12. Install the rear engine mount. Refer to Section 02-03 .

13. On Aerostar vehicles, install the two crossmember-to-frame through nuts and bolts. Tighten to 37-52 Nm (28-38 lb-ft).

14. On Aerostar vehicles, install the engine support-to-crossmember screws. Tighten to 98-132 Nm (73-97 lb-ft).

15. On Ranger vehicles, position the crossmember and install the two crossmember-to-frame sidemember through nuts and bolts. Tighten to 88-115 Nm (65-85 lb-ft).

16. On Ranger vehicles, install the engine support-to-crossmember nuts. Tighten to 88-115 Nm (65-85 lb-ft).

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17. Remove the transmission jack.

18. Install the two rear engine support-to-crossmember nuts. Tighten to 85-118 Nm (63-87 lb-ft).

19. Connect the vehicle harness connectors to the 16-pin transmission connector the overdrive drum speed (ODS) sensor, the output shaft speed (OSS) sensor and the digital transmission range (DTR) sensor.

20. Install the transmission shift cable into the transmission shift cable bracket.

21. Install the transmission shift bellcrank onto the ball and stud lever. Connect the transmission shift cable to the transmission manual control lever.

22. Install the speed control/speedometer cable and/or VSS (if equipped) into the extension housing.

23. Remove plug from the extension housing.

24. Install the driveshaft. Refer to Section 05-01 .

25. **CAUTION: Use new flexplate-to-converter nuts.**

    Install the four new flexplate-to-converter nuts using a breaker bar and a 22mm socket wrench on the crankshaft pulley bolt to rotate each stud into position. Rotate the crankshaft pulley clockwise (as viewed from the front) of the vehicle. Tighten the flexplate-to-converter nuts to 30-40 Nm (22-30 lb-ft).

26. Install the starter motor. Refer to Section 03-06 .

27. Lower the vehicle.

28. Fill the transmission with MERCON V® XT-5-QM fluid to the proper level. Refer to the procedure in this section.

29. Install the fluid level indicator.

30. Connect the battery ground cable.

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Transmission — 4x4

1. **WARNING: SECURE THE TRANSMISSION TO THE TRANSMISSION JACK WITH A SAFETY CHAIN.**

   Position the transmission on a transmission jack.

2. Raise the transmission jack and position the transmission near the engine.

3. Remove Torque Converter Holding Tool T97T-7902-A.

4. Position the transmission to the engine and align the converter stud-to-flex plate index mark made at removal.

5. Install the four converter housing-to-engine screws. Tighten to 40-55 Nm (30-41 lb-ft).

6. **CAUTION: Use care not to bend or otherwise damage the cooler lines.**

   Remove the plugs and install the transmission cooler lines. Tighten the transmission cooler lines tube nuts to 24-31 Nm (18-23 lb-ft).

7. Install the two lower converter housing-to-engine screws. Tighten to 40-55 Nm (30-41 lb-ft).

8. Install the fluid filler tube into the lube fluid inlet short tube.

9. Install the two upper converter housing-to-engine screws. Tighten to 40-55 Nm (30-41 lb-ft).

10. Install the transfer case. Refer to Section 07-07A , Section 07-07B , Section 07-07C or Section 07-07D .

11. Install the transfer case vent bracket. Tighten the transfer case vent bracket screws to 34-46 Nm (25-34 lb-ft).

12. Install the five transfer case-to-extension housing bolts. Tighten to 34-48 Nm (25-35 lb-ft).

13. Install the catalytic converter and crossover pipe nuts using 15mm socket wrench. Tighten the nuts to 24-34 Nm (18-25 lb-ft).

14. Install the catalytic converter-to-exhaust bolts. Tighten to 24-34 Nm (18-25 lb-ft).

15. Install the rear engine mount. Refer to Section 02-03 .

16. On Aerostar vehicles, install the two crossmember-to-frame through nuts and bolts. Tighten to 37-52 Nm (28-38 lb-ft).

17. On Aerostar vehicles, install the engine support-to-crossmember screws. Tighten to 98-132 Nm (73-97 lb-ft).

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18. On Ranger vehicles, install the two crossmember-to-frame through nuts and bolts. Tighten to 88-115 Nm (65-85 lb-ft).

19. On Ranger vehicles, install the engine support-to-crossmember nuts. Tighten to 88-115 Nm (65-85 lb-ft).

20. Install the two rear engine support-to-crossmember nuts. Tighten to 85-118 Nm (63-87 lb-ft).

21. Connect the transfer case electrical connectors.

22. Install the front axle driveshaft. Refer to Section 05-03A , Section 05-03B or Section 05-03C .

23. Install the transfer case skid plate. Tighten the skid plate screws to 22-28 Nm (16-21 lb-ft).

24. Connect the vehicle harness connectors to the 16-pin transmission connector, the overdrive drum speed (ODS) sensor, the output shaft speed (OSS) sensor and the digital transmission range (DTR) sensor connector.

25. Install the transmission shift cable into the cable bracket.

26. Install the transmission shift bellcrank on the ball stud lever.

27. Connect the transmission shift cable to the transmission manual control lever.

28. Adjust shift cable; refer to cable adjustment.

29. Install the vehicle speed sensor (VSS) (if equipped) into the transfer case.

30. Align the index mark made at removal and install the rear driveshaft. Refer to Section 05-01 .

31. **CAUTION: Never turn the engine counterclockwise (as viewed from the front).**

    CAUTION: Use new flexplate-to-converter nuts.

    Install the four new flexplate-to-converter nuts, using a 22mm socket wrench and breaker bar on the crankshaft pulley to turn the engine into position. Tighten the flexplate-to-converter nuts to 30-40 Nm (22-30 lb-ft).

32. Install the starter motor. Refer to Section 03-06 .

33. Lower the vehicle.

34. Fill the transmission with MERCON V® XT-5-QM fluid to the proper level. Refer to procedure in this section.

35. Install the fluid level indicator.

36. Install the battery ground cable.

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Transmission Fluid Lines

When one or more of the fluid cooler steel tubes must be replaced, each replacement tube must be fabricated from the same size steel tubing as the original line.

Using the old tube as a guide, bend the new tube as required. Add the necessary fittings and install the tube. Make sure the tube has adequate clearance to the other components, especially the exhaust system and parts having sharp edges.

After the fittings have been tightened, add fluid as needed and check for fluid leaks.

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Transmission

It is important to completely clean all transmission components including the converter, fluid cooler, cooler lines, main control valve body, all clutches and check balls after any transmission servicing that generates contamination. These contaminants are a major cause for recurring transmission troubles and must be removed from the system before the transmission is put back into service. The cleaning of debris from the coast, direct/reverse, and the forward clutch check balls is often omitted. This omission can lead to a repeat servicing of the transmission.

Clean the parts with a suitable solvent and use moisture-free air to dry off all the parts and clean out fluid passages.

CAUTION: Do not use mineral spirits or oil based solvent.

The composition clutch plates, bands, and synthetic seals should not be cleaned in a vapor degreaser or any type of detergent solution.

To clean these parts, wipe them off with a lint-free cloth. New clutch plates or bands should be soaked in transmission fluid specified for that transmission type for 30 minutes before being assembled.

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Main Control Valve Body

1. Clean all parts thoroughly in clean solvent and blow dry with moisture-free compressed air.

2. Inspect all valve and plug bores for scores. Check all fluid passages for obstructions. Inspect the check valve for free movement. Inspect all mating surfaces for burrs or distortion. Inspect all plugs and valves for burrs or scores. Replace the control valve body if the bores or valve are scored beyond the point of being cleanable.

3. **CAUTION: Do not sand, stone or polish valves and bores. This removes the anodizing treatment and destroys them.**

   Inspect all springs for distortion. Check all valves and plugs for free movement in their respective bores. Valves and plugs, when dry, must fall from their own weight into their respective bores.

4. Roll the manual valve on a flat surface to check for a bent condition.

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Front and Intermediate Servos

NOTE: Identify servo covers, pistons, and springs with a tag.

1. Inspect the servo bore for cracks and the servo piston for damage (the rubber sealing surfaces should be pliable). Inspect the piston bore, servo piston bore and servo piston stem for scores. Check the fluid passages for obstructions. Replace damaged seals.
2. Check the servo springs, servo band strut(s) and apply levers for distortion and wear.
3. Inspect the cover seal and gasket cover sealing surface for damage.
4. Inspect the band lining for excessive wear and for proper bonding to the metal band.

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Low-Reverse Servo and Band

1. Inspect the bore for scores.
2. Check the fluid passages for obstructions.
3. Inspect the band for distortion. Inspect the band ends for cracks.
4. Inspect the servo for distortion.
5. Inspect the band lining for excessive wear and for proper bonding to the metal band.
6. Replace the cover seal if damaged.
7. Replace the piston seals if damaged.

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Extension Housing

1. Inspect the housing for cracks. Inspect the gasket surface for burrs or warpage.
2. Inspect the bushing for scores or wear. Inspect slip yoke for damage. Replace if required.
3. Inspect the rear seal for hardness, cracks or wear. Replace if required.
4. Inspect the seal counterbore and remove all burrs and scores with a crocus cloth.

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Pump

1. Inspect the mating surfaces of the pump body and case for burrs.
2. Inspect the drive and driven gear bearing surfaces for scores. Check the gear teeth for burrs.
3. Inspect the inner pump gear O-ring for damage.
4. Inspect the front pump seal for cuts or nicks. Inspect the pump bushing for scoring.
5. Check all fluid passages for obstruction.
6. If any parts are found damaged or worn, replace the pump as an assembly. Minor burrs and scores may be removed with a crocus cloth.

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Direct, Low/Reverse and Coast Clutches

1. Inspect the drum band surface, bushing and thrust surfaces for scores. Minor scores may be removed with a crocus cloth. Badly scored parts must be replaced.

2. Inspect the clutch piston bore and piston inner and outer bearing surfaces for scores.

3. Check the fluid passages for obstructions. All fluid passages must be clean and free of obstruction.

4. Inspect the clutch plates for wear, scoring and fit on the clutch hub serrations. Replace all plates that are badly scored, worn or do not fit freely in the hub serrations.

5. Inspect the clutch pressure plate for scoring and binding on the clutch plate surface. Check the clutch release spring for distortion pressure.

6. The clutch cylinders have check balls. Inspect the check balls for freedom of movement and proper seating.

7. Inspect the friction plates for proper installation (direction).

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Forward Clutch

1. Inspect the clutch cylinder thrust surfaces, piston bore and clutch plate serration for scores or burrs. Minor scores and burrs may be removed with a crocus cloth. Replace the clutch cylinder if it is badly scored or damaged.

2. Check the fluid passages in the clutch cylinder for obstructions. Clean out all fluid passages. Inspect the clutch piston for scores and replace if necessary. Inspect the piston check ball for freedom of movement and proper seating.

3. Check the clutch release springs for distortion and cracks. Replace the springs if they are distorted or cracked.

4. Inspect the composition clutch plates, steel clutch plates and clutch pressure plate for worn or scored surfaces. Replace all parts that are deeply scored.

5. Check all clutch plates for flatness and fit on the clutch hub serrations. Discard any plate that does not slide freely on the serrations or that is not flat.

6. Check the clutch hub thrust surfaces for scores. Check the clutch hub splines for wear.

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Input Shaft

Check the input shaft for damaged or worn splines. Replace the shaft if the splines are excessively worn. Inspect the bushings in the stator support for scores.

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Front One-Way Clutch and Rear One-Way Clutch

1. Inspect the outer and inner races for scores or damaged surface areas where the sprags contact the races.

2. Inspect the sprags for excessive wear or damage.

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Converter and Fluid Cooler

When wear or internal damage has occurred in the transmission, metal particles, clutch plate material, or band material may have been carried into the converter and fluid cooler. These contaminants are a major cause of recurring transmission troubles and must be removed from the system before the transmission is put back into service.

Whenever a transmission has been disassembled to replace worn or damaged parts, or because the valve body sticks from foreign material, the converter, fluid cooler and cooler lines must be cleaned and flushed. Rotunda Torque Converter/Transmission Oil Cooler Cleaner 014-00028 or equivalent can be used. Under no circumstances should an attempt be made to clean the torque converter by hand agitation with solvent.

The lack of a drain plug in the torque converter increases the amount of residual flushing solvent in the torque converter after cleaning. This retained solvent is not acceptable and a method of diluting is required. The following procedure is to be used after the removal of the torque converter from the cleaning equipment.

1. Thoroughly drain the remaining solvent through the converter hub.
2. Add 1.9L (2.0 quarts) of clean MERCON V® XT-5-QM transmission fluid to the converter. Agitate by hand.
3. Thoroughly drain the solution through the converter hub.

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Pinion Carriers

Individual parts of the planetary carriers are not serviceable.

1. Check the pins and shafts in the planetary assemblies for loose fit and/or complete disengagement. Use a new planetary assembly if either condition exists. Before installing a planetary assembly, the shaft retaining pins should be checked for adequate staking. Do not restake the planetary pinion. If necessary, replace the planetary assembly.

2. Inspect the pinion gears for damaged or excessively worn teeth.

3. Check for free rotation of the pinion gears.

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Stator Support

1. Inspect the stator support splines for burrs and wear.
2. Check the oil ring grooves in the stator support for nicks, burrs or damaged edges.
3. Check the front and rear bushings of the stator support for wear or scoring.
4. Check front pump support seal and groove.
5. Check the seal rings for damage.
6. Check bearings for damage.

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Case

Inspect the case for cracks and stripped threads. Inspect the gasket surfaces and mating surfaces for burrs. Check the vent for obstructions, and check all fluid passages for obstructions and leakage.

Inspect the case bearing for scores. Check all parking linkage parts for wear or damage.

Inspect the case threads for damage.

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Case Thread Repair Procedures

If a transmission case thread is damaged, service kits may be purchased from local jobbers. To service a damaged thread, the following procedure should be carefully followed.

1. Drill out the damaged threads, using the same drill size as the thread outside diameter. For example, use a 5/16-inch drill for a 5/16-18-inch thread.

2. Select the proper special tap and tap the drilled hole. The tap is marked for the size of the thread being repaired. The special tap marked 5/16-18 inch will not cut the same thread as a standard 5/16-18-inch tap. It does cut a thread large enough to accommodate the insert, and after the insert is installed, the original thread size is restored.

3. Select the proper coil inserting tool. These tools are marked with the thread size being repaired. Place the insert on the tool and adjust the sleeve to the length of the insert being used. Press the insert against the face of the tapped hole. Turn the tool clockwise and wind the insert into the hole until the insert is one-half turn below the face.

4. Working through the insert, bend the insert tang straight up and down until it breaks off in the notch.

5. Improperly installed inserts can be removed with the extractor tool. Place the extractor tool in the insert with the blade resting against the top coil one-quarter to one-half turn away from the end of the coil. Tap the tool sharply with a hammer until the blade cuts into the insert. Exert downward pressure on the tool and turn it counterclockwise until the insert is removed.

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SPECIFICATIONS

Fluid Capacity

Vehicle	Engine	Approximate Refill Capacity [1]	
		Liters	U.S. Quarts
Aerostar, Ranger — 5R55E (4x2)	4.0L	9.0	9.5
Aerostar, Ranger — 5R55E (4x4)	4.0L	9.3	9.8

[1] Approximate dry capacity, includes cooler and lines. Fluid level indicator should be used to determine actual fluid requirements and fluid specification. Check level at normal operating temperature. DO NOT OVERFILL.

If it is necessary to add or replace fluid, use only fluid which has been certified by the supplier as meeting one of the Ford Motor Company specifications shown.

Note: Use Motorcraft MERCON V® or fluid meeting Ford specification XT-5-QM.

Torque Specifications

Description	Nm	Lb-Ft	Lb-In
Extension Housing-to-Case Screws and Stud	36-52	27-39	—
Transmission Mounting Pad Nuts and Bolts	68-95	50-70	—
Transmission Range Sensor-to-Case	8-11	—	71-97
Manual Control Outer Lever Nut	41-54	30-40	—
Heat Shield Nut	8-11	—	71-97
Fluid Pan-to-Case Screws	13-15	—	115-133
Solenoid Clamps-to-Main Control Screws	8-11	—	53-71
Reverse Servo Cover-to-Case Bolts	12-14	—	106-124
Manual Valve Inner Lever Nut	41-54	30-40	—
Main Control Assembly-to-Case Screws	8-11	—	71-97
Manual Valve Detent Spring Screw	8-11	—	71-97
Front Band Locknut-to-Case Adjusting Screw	47-61	35-45	—
Intermediate Band Locknut-to-Case Adjusting Screw	47-61	35-45	—
Center Support-to-Case Capscrew	9-13	—	80-115
Turbine Shaft Speed (TSS) Sensor-to-Center Support Screw	8-11	—	71-97
Fluid Pump Support and Gear-to-Converter Housing Bolts	22-28	16-21	—
Converter Housing-to-Case Screw	36-52	27-39	—
Fluid Filter Assembly-to-Main Control Assembly Screw	8-11	—	71-97

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Heat Shield-to-Case Stud	12-16	—	106-142
Converter Housing-to-Engine Bolts	40-55	30-41	—
Catalytic Converter-to-Crossover Pipe Nuts	34-46	25-34	—
Catalytic Converter-to-Exhaust Pipe Nuts and Bolts	34-46	25-34	—
Engine Support-to-Crossmember Bolts (Aerostar)	98-132	73-97	—
Engine Support-to-Crossmember Nuts (Ranger)	88-115	65-85	—
Rear Engine Support-to-Crossmember Nuts	85-118	63-87	—
Crossmember-to-Frame Through Bolts and Nuts (Aerostar)	37-52	28-38	—
Crossmember-to-Frame Through Bolts and Nuts (Ranger)	88-115	65-85	—
Transmission Cooler Lines Case Connectors	35-43	26-32	—
Transmission Fluid Cooler Line Nuts-to-Case Connector	24-31	18-23	—
Overdrive Drum Speed (ODS) Sensor Attaching Screw	8-11	—	71-97
Output Shaft Speed (OSS) Sensor Attaching Screw	8-11	—	71-97
Flexplate-to-Converter Nuts	30-40	22-30	—
Transfer Case Vent Bracket Bolts	34-46	25-34	—
Transfer Case-to-Extension Housing Bolts	34-48	25-35	—
Catalytic Converter and Crossover Pipe Nuts	24-34	18-25	—
Catalytic Converter-to-Exhaust Bolts	24-34	18-25	—
Transfer Case Skid Plate Bolts	22-28	16-21	—
Separator Plate-to-Main Control Screws	6-8	—	53-71
Pressure Plug-to-Case	10-15	—	89-133
Servo Gauge Adjusting Screw	4	—	35.5

End Play Specifications — Selective Thrust Washer (Nylon)

Transmission End Play Dimension "C"	Selective Thrust Washer (Nylon)		Identification: Color
	Part Number	Thickness	
Front No. 1 0.18-0.70mm (0.007-0.028 In.) Without Gasket	97GT-7D014-TA 97GT-7D014-MA 97GT-7D014-NA 97GT-7D014-PA 97GT-7D014-RA 97GT-7D014-SA	1.55-1.60mm (0.061-0.063 In.) 1.75-1.80mm (0.069-0.071 In.) 1.85-1.90mm (0.073-0.075 In.) 1.95-2.00mm (0.077-0.079 In.) 2.05-2.10mm (0.081-0.083 In.) 2.15-2.20mm (0.085-0.087 In.)	White Green Red Beige Black Yellow

End Play Specifications — Selective Needle Bearings

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Transmission End Play Dimension "C"	Selective Needle Bearings		Identification: Notches
	Part Number	Thickness	
1.67-1.85mm (0.066-0.073 In.) 1.86-2.04mm (0.073-0.080 In.) 2.05-2.23mm (0.081-0.088 In.) 2.25-2.43mm (0.089-0.096 In.) Rear No. 4 Reference End Play 0.21-0.51mm (0.008-0.020 In.)	97GT-7D014-GA 97GT-7D014-HA 97GT-7D014-KA 97GT-7D014-LA	2.65-2.80mm (0.104-0.110 In.) 2.80-2.95mm (0.110-0.116 In.) 3.00-3.15mm (0.118-0.124 In.) 3.20-3.35mm (0.126-0.132 In.)	0 1 2 3

Torque Converter End Play

Transmission Model	Converter End Play			
	New or Rebuilt Converter		Used Converter	
	mm	Inch	mm	Inch
5R55E	0.58 Max.	0.023 Max.	1.27 Max.	0.050 Max.

Selective Snap Rings

Coast and Reverse Clutch Drum					Forward Clutch Cylinder				
	Thickness		Diameter			Thickness		Diameter	
Part Number	mm	Inches	mm	Inches	Part Number	mm	Inches	mm	Inches
E 860126-S	1.37	.0539	130.1	5.122	E 860115-S	1.37	.0539	125.1	4.925
E 860127-S	1.73	.0681	130.1	5.122	E 860116-S	1.73	.0681	125.1	4.925
E 860128-S	2.08	.0819	130.1	5.122	E 860117-S	2.08	.0819	125.1	4.925
E 860129-S	2.44	.0961	130.1	5.122	E 860118-S	2.44	.0961	125.1	4.925

Band Adjustment And Torque Chart

Description	Number of Turns to Back Off	Locknut		Screw	
		Nm	Lb-Ft	Nm	Lb-Ft
Intermediate Band	2.5	47-61	35-45	14	10
Front Band	2.0	47-61	35-45	14	10

Clutch Plate Usage And Clearance Specifications

Clutch	Steel	Friction	Clearance	Selective Snap Rings	
				Part Number	Thickness

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Forward Clutch					
4.0L	6	6	0.055-0.083	E 860115-S E 860116-S E 860117-S E 860118-S	1.37mm (0.0539 In.) 1.73mm (0.0681 In.) 2.08mm (0.0819 In.) 2.44mm (0.0961 In.)
Direct, Low/Reverse Clutch					
4.0L	5	5	0.051-0.079	E 860126-S E 860127-S E 860128-S E 860129-S	1.37mm (0.0539 In.) 1.73mm (0.0681 In.) 2.08mm (0.0819 In.) 2.44mm (0.0961 In.)
Coast Clutch					
All Engines	2	2	0.051-0.079	E 860126-S E 860127-S E 860128-S E 860129-S	1.37mm (0.0539 In.) 1.73mm (0.0681 In.) 2.08mm (0.0819 In.) 2.44mm (0.0961 In.)

5R55E Service Identification Model Chart

7000 Prefix and Suffix	Speedo Drive Teeth	C=Column F=Floor	Engine Displacement	Vehicle Application
Vehicle Application (750 Nm)				
97GT-KAA	7T	C	4.0L-EFI	Ranger (4x2)
97GT-LAA	7T	C	4.0L-EFI	Ranger (4x4)
97GT-RAA	7T	C	4.0L-EFI	Aerostar (4x2) Wagon
97GT-SAA	7T	C	4.0L-EFI	Aerostar (AWD) Wagon

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Inspection and Verification

CAUTION: Do not repair the radiator (8005) . Aluminum tabs securing radiator outlet tank (8054) are permanently damaged during disassembly.

When transmission fluid leakage is found at the auxiliary transmission fluid cooler (7A095), the Auxiliary Cooler must be replaced. Refer to the procedure in this section.

When transmission fluid leakage is found at the radiator, the radiator must be replaced. Refer to Section 03-03 .

Symptom Chart — Transmission Overheating

TRANSMISSION OVERHEATING

Condition	Possible Source	Action
• Transmission Overheating	• Low transmission fluid.	• REFER to Section 07-01A or Section 07-01B for adding fluid procedure.
	• Clogged radiator or auxiliary transmission fluid cooler.	• Refer to the Transmission Fluid Flow in the Component Tests.
	• Leaking auxiliary transmission fluid cooler.	• INSPECT auxiliary transmission fluid cooler for leaks. Service as required.
	• Leaking radiator transmission fluid cooler.	**WARNING: NEVER REMOVE THE RADIATOR CAP UNDER ANY CONDITIONS WHILE THE ENGINE IS OPERATING. FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN PERSONAL INJURY AND/OR DAMAGE TO THE COOLING SYSTEM OR ENGINE. TO AVOID HAVING SCALDING HOT COOLANT OR STEAM BLOW OUT OF THE RADIATOR, USE EXTREME CARE WHEN REMOVING THE RADIATOR CAP FROM A HOT RADIATOR. WAIT UNTIL THE ENGINE HAS COOLED, THEN WRAP A THICK CLOTH AROUND THE RADIATOR CAP AND TURN IT SLOWLY TO THE FIRST STOP. STEP BACK WHILE THE PRESSURE IS RELEASED FROM THE COOLING SYSTEM. WHEN YOU ARE CERTAIN ALL THE PRESSURE HAS BEEN RELEASED, PRESS DOWN ON THE RADIATOR CAP (WITH A CLOTH), TURN AND REMOVE.**

	• Clogged or leaking fluid tubes, hoses or connections.	• INSPECT engine coolant for signs of transmission fluid. REPLACE radiator as required. • INSPECT fluid tubes, hoses, and connections for leaks. SERVICE as required.

Component Tests

Transmission Fluid Cooler Flow Test

NOTE: The transmission linkage/cable adjustment, fluid level, and line pressure must be within specification before performing this test. Refer to service procedures in Section 07-01A or Section 07-01B .

1. Remove fluid level indicator (7A020) from fluid filler tube.
2. Place funnel in fluid filler tube.
3. Raise vehicle on hoist and position suitable safety stands under vehicle.
4. Remove cooler return line (rear fitting) from fitting on transmission case.
5. Connect one end of a hose to the cooler return line and route the other end of the hose to a point where it can be inserted into the funnel at the fluid filler tube.
6. Remove safety stands and lower vehicle. Insert end of hose into funnel.
7. Start engine and run at idle with transmission in neutral range.
8. When fluid flowing from hose is all liquid, an adequate amount of fluid should be observed (approximately 1 liter [1 quart] delivered in 30 seconds). If adequate flow is observed, test is completed.
9. If the flow is not adequate, stop engine. Disconnect hose from cooler return line and connect it to converter out line fitting (front fitting) on transmission case.
10. Repeat Steps 7 and 8. If flow is now adequate, refer to the Symptom Chart . If flow is not adequate, service pump and/or converter assembly, and main control.

Transmission Fluid Cooler — Auxiliary

Removal

1. Place a drain pan under the transmission fluid cooler (7A095).
2. Disconnect all transmission fluid cooler tubes and hoses at the transmission fluid cooler. Plug all port openings.
3. Remove nuts and bolts and remove the transmission fluid cooler from the vehicle.

Installation

CAUTION: Make sure all plugs are removed from port openings before installing tubes.

To install, reverse the removal procedure.

Refill transmission fluid to proper operating levels. Start engine and check for leaks.

Fluid Cooler Tube(s)

Removal and Installation

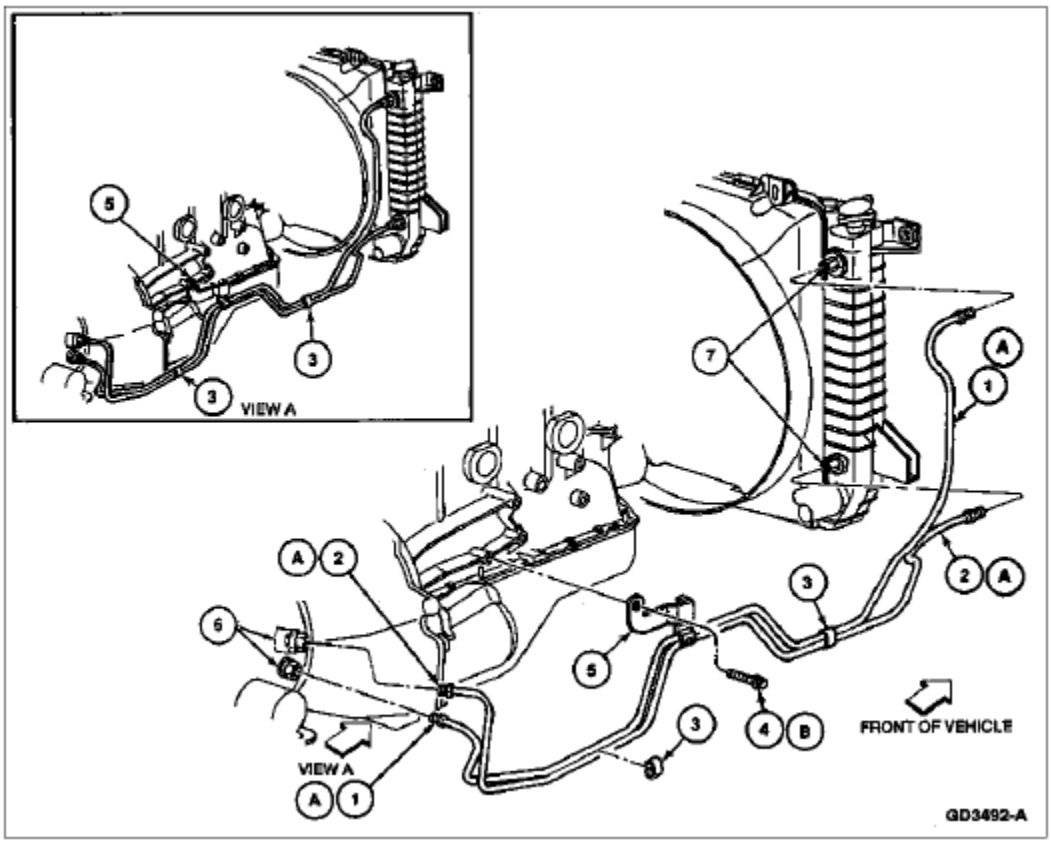
CAUTION: To prevent cross threading, all tube nuts must be hand started before being torqued to specifications.

When one or more of the transmission fluid cooler steel tubes must be replaced, each replacement tube must be fabricated from the same size steel tubing as the original line.

Using the original transmission fluid tube as a guide, bend the new tube as required. Add the necessary fittings and install the tube. Make sure that the replacement tube has adequate clearance to other components, especially the exhaust system and parts having sharp edges.

After the fittings have been tightened, add fluid as needed, and check for fluid leaks.

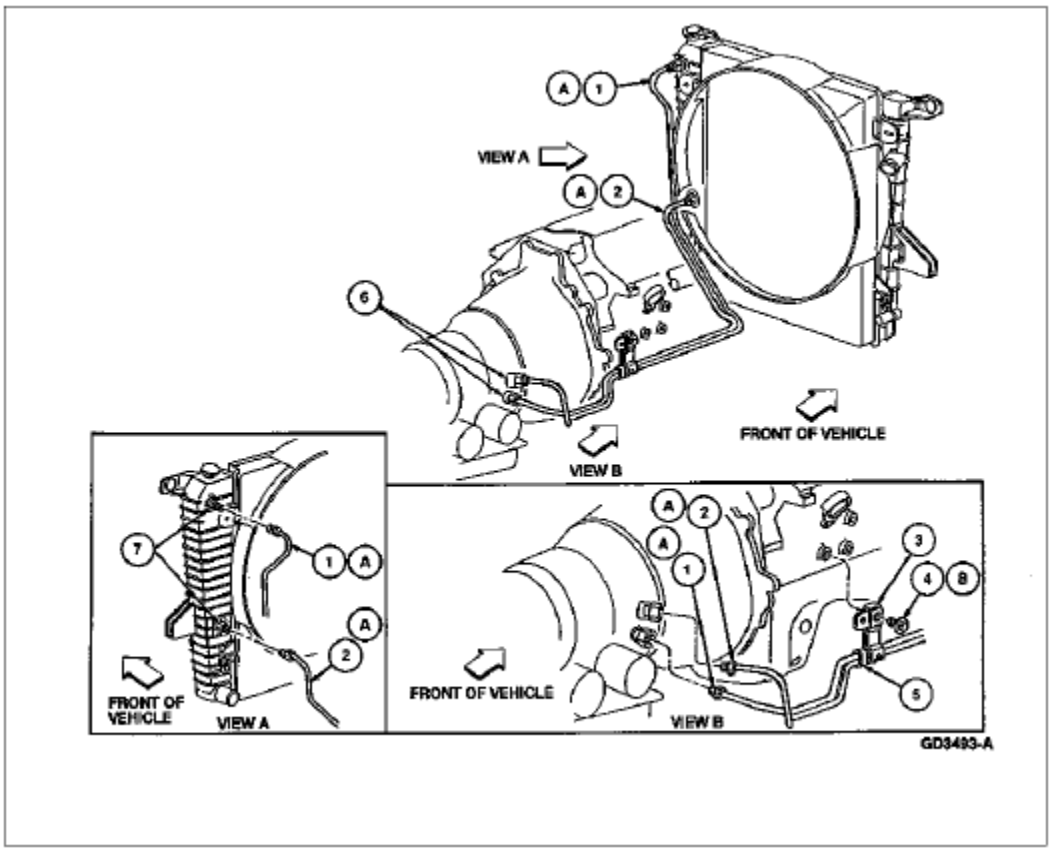
Ranger — 2.3L



Item	Part Number	Description

1	—	Fluid Cooler Outlet Tube
2	7A030	Fluid Cooler Inlet Tube
3	388160-S101	C-Clip
4	N802653-S100	Tube Clip Screw and Washer
5	7N291	Transmission Fluid Cooler Line Clip
6	7D273	Fluid Tube Connector - Transmission
7	7D273	Fluid Tube Connector - Radiator
A	—	Tighten to 24-31 Nm (18-23 Lb-Ft)
B	—	Tighten to 17-23 Nm (13-17 Lb-Ft)

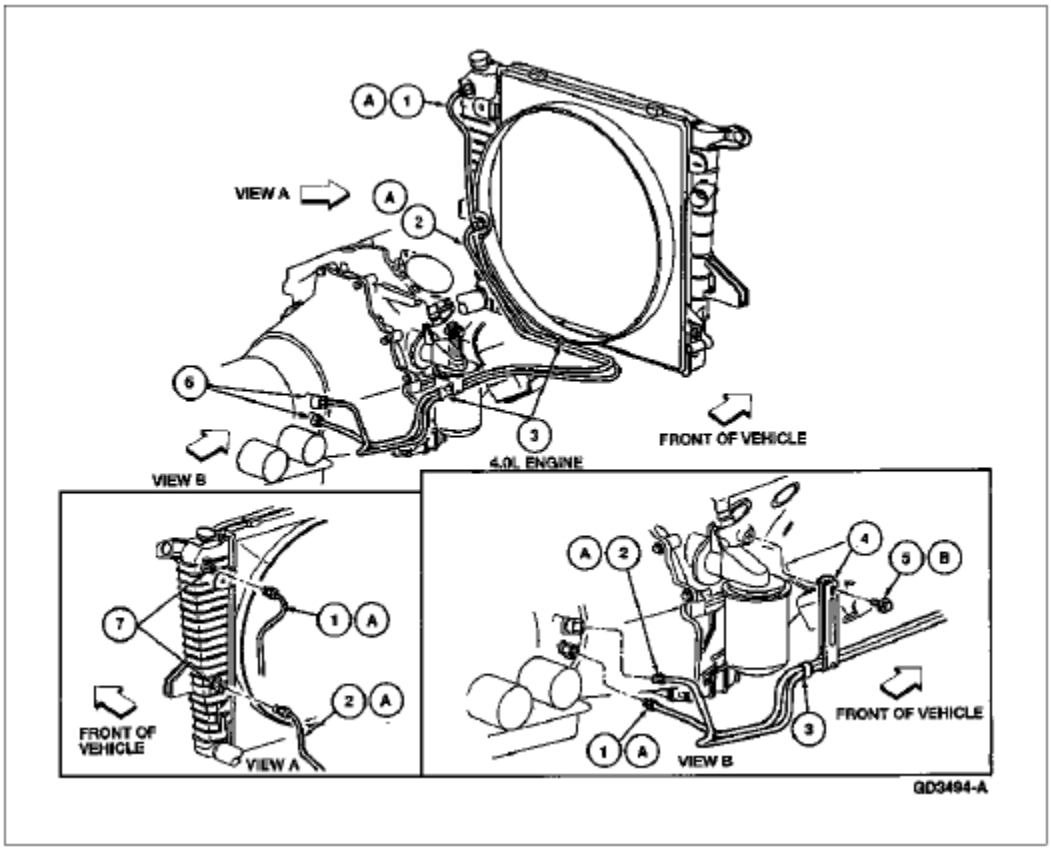
Ranger — 3.0L



Item	Part Number	Description
1	—	Fluid Cooler Outlet Tube
2	7A030	Fluid Cooler Inlet Tube
3	7N291	Transmission Fluid Cooler Line Clip
4	N802653-S100	Tube Clip Screw and Washer

5	388160-S101	C-Clip
6	7D273	Fluid Tube Connector - Transmission
7	7D273	Fluid Tube Connector - Radiator
A	—	Tighten to 24-31 Nm (18-23 Lb-Ft)
B	—	Tighten to 17-23 Nm (13-17 Lb-Ft)

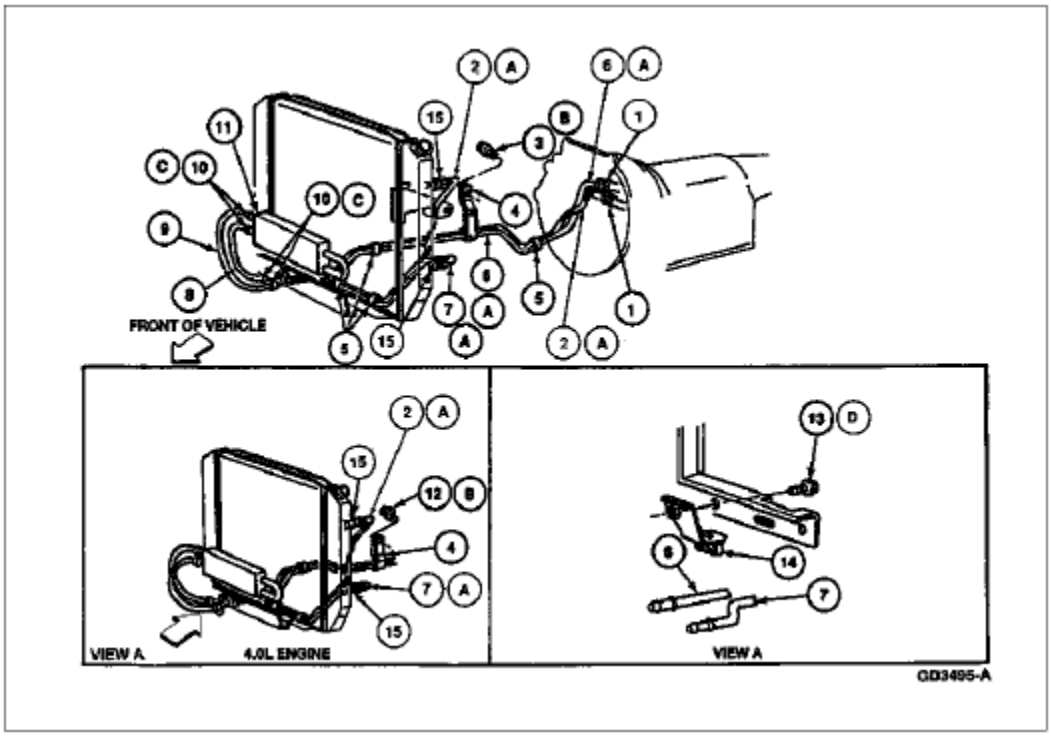
Ranger — 4.0L



Item	Part Number	Description
1	—	Fluid Cooler Outlet Tube
2	7A030	Fluid Cooler Inlet Tube
3	388160-S101	C-Clip
4	7N291	Transmission Fluid Cooler Line Clip
5	N802653-S100	Tube Clip Screw and Washer
6	7D273	Fluid Tube Connector - Transmission
7	7D273	Fluid Tube Connector - Radiator
A	—	Tighten to 24-31 Nm

		(18-23 Lb-Ft)
B	—	Tighten to 17-23 Nm (13-17 Lb-Ft)

Aerostar



Item	Part Number	Description
1	7D273	Fluid Tube Connector - Transmission
2	—	Fluid Cooler Outlet Tube
3	N802653-S100	Tube Clip Screw and Washer
4	7N291	Transmission Fluid Cooler Line Clip
5	388160-S56	C-Clip (4 Req'd)
6	7A030	Fluid Cooler Inlet Tube
7	7F113	Auxiliary Inlet Tube
8	F69A-74256-AA	Fluid Cooler Hose - Outlet
9	N809641-5400A	Fluid Cooler Hose - Inlet
10	376240-S	Hose Clamp (4 Req'd)
11	—	Transmission Fluid Auxilliary Cooler
12	N802827-S2	Nut
13	N606674-S56	Screw and Washer Assembly
14	7N150	Bracket Assembly

15	7D273	Fluid Tube Connector - Radiator
A	—	Tighten to 24-31 Nm (18-23 Lb-Ft)
B	—	Tighten to 17-23 Nm (13-17 Lb-Ft)
C	—	Tighten to 3.1-4.3 Nm (28-38 Lb-In)
	—	Tighten to 9-12 Nm (7-9 Lb-Ft)

Transmission Fluid Cooler

When internal wear or damage has occurred in the automatic transmission/transaxle (A/T) (7000), metal particles, clutch plate material, or band material may have been carried into the torque converter (7902) and transmission fluid cooler (7A095). These contaminants are a major cause of recurring transmission troubles and must be removed from the system before the automatic transmission/transaxle is put back into service.

Whenever a automatic transmission/transaxle has been disassembled to replace worn or damaged parts or because the valve body sticks due to foreign material, the torque converter and transmission fluid cooler must be cleaned by using a mechanically agitated cleaner, such as Rotunda Torque Converter/Oil Cooler Cleaner 014-00028 or equivalent.

Transmission Fluid Cooler Tube(s)/Hose(s)

1. Loosen hose clamps and remove each auxiliary cooler hose.
2. Disassemble and remove the clip attaching the cooler tubes to the engine and C-clips holding the tubes together.
3. Disassemble all cooler tube connections at the transmission and radiator and remove the cooler tubes, taking care not to bend them.
4. Flush out all the cooler tubes and hoses to remove all foreign materials by using Rotunda Torque Converter/Oil Cooler Cleaner 014-00028 or equivalent. Each tube can be connected to the fluid source by a piece of commercially available flexible hose if required. Hoses must not be soaked in the fluid.
5. Blow out each tube and hose with air to remove any remaining degreasing fluid.
6. Reinstall parts on vehicle without bending the tubes. Make sure that all clips, brackets, and connections are properly secured.
7. Verify tube clearances to other components, especially the exhaust system are free from interference. Also, check that hoses are not kinked before starting vehicle.

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Hose Clamp	3.1-4.3	—	28-38
Cooler Tubes Hold Down Bracket	17-23	13-17	—
Fluid Cooler Inlet Tube Fittings (Nuts)	24-31	18-23	—
Fluid Cooler Tube Fittings (Nuts)	24-31	18-23	—
Auxiliary Inlet Tube Fittings (Nuts)	24-31	18-23	—

Description

The M5OD is a top-shift, fully-synchronized, five-speed manual transmission (7003), equipped with an overdrive fifth gear ratio. All gear changes (including reverse) are accomplished with synchronizer sleeves.

The case (7005), case cover (7222), and extension housing (7A039) are constructed of aluminum alloy. Steel bearing race inserts provide durability in appropriate areas.

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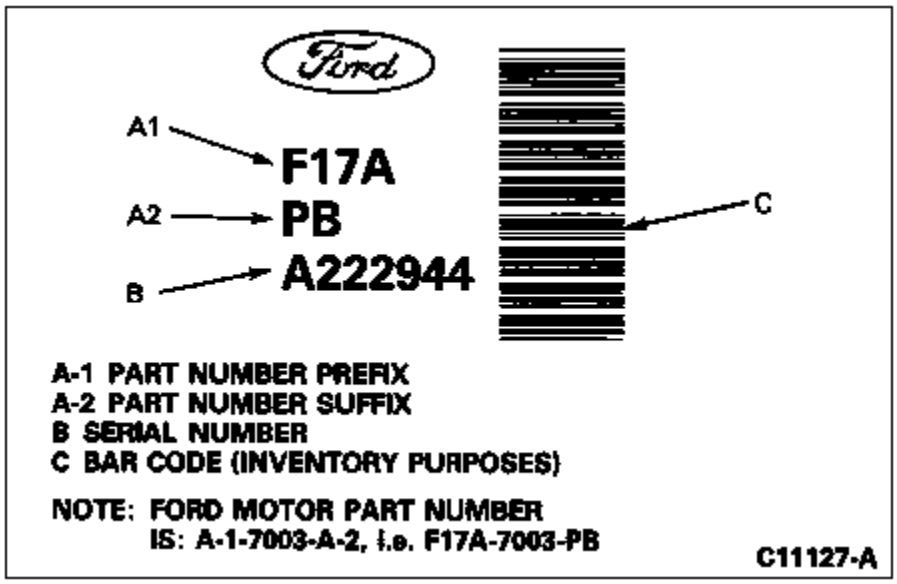
Transmission Identification

The Vehicle Safety Compliance Certification Label (located on the driver's door lock pillar) lists applicable transmission identification codes. For identification of the label codes, refer to Section 00-01 .

Manual transmissions (7003) are equipped with service identification tags. The M5OD transmission service tag is located on the driver's side of the transmission.



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Powerflow

Powerflow is accomplished with a series of gears and synchronizers as follows:

Neutral

The synchronizer sleeves are centered. The input gear drives the countershaft (7111). Since no gears are locked to the output shaft, it is not driven.

First Gear

The first/second synchronizer is splined to the output shaft. The first/second synchronizer sleeve locks the first gear (1GR) (7100) to the output shaft through the synchronizer. The input gear drives the countershaft. First gear on the countershaft drives the first gear on the output shaft, which is driven in reduction at 3.72:1.

Second Gear

The synchronizer is splined to the output shaft. The synchronizer sleeve locks second gear (2GR) (7102) to the output shaft through the synchronizer. The input gear drives the countershaft. Second gear on the countershaft drives second gear on the output shaft. The output shaft is driven in reduction at 2.20:1.

Third Gear

The third/fourth synchronizer is splined to the output shaft. The synchronizer sleeve locks third gear to the output shaft through the synchronizer. The input gear drives the countershaft. Third gear on the countershaft drives third gear on the output shaft. The output shaft is driven in reduction at 1.50:1.

Fourth Gear

The third/fourth synchronizer is splined to the output shaft. The synchronizer locks the input shaft (7017) to the output shaft. The input shaft and output shaft turn at the same speed (1:1 ratio).

Fifth Gear (Overdrive)

The fifth/reverse gear synchronizer is splined to the countershaft. The synchronizer sleeve locks fifth gear to the countershaft. The input gear drives the countershaft. Fifth gear on the countershaft drives fifth gear which is splined to the output shaft. The output shaft is overdriven at a ratio of 0.79:1.

Reverse Gear

A reverse idler gear produces rotation in the opposite direction of output shaft rotation. The fifth/reverse synchronizer is splined to the countershaft. The synchronizer sleeve locks reverse gear to the countershaft. The input gear drives the countershaft. The countershaft reverse gear drives the reverse idler gear. The reverse idler gear drives reverse gear (which is splined to the output shaft) at a reduction ratio of 3.40:1.

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Symptom Chart — Transmission, Manual

TRANSMISSION, MANUAL

Condition	Possible Source	Action
• Transmission Shifts Hard	• Transmission oil low or improper type.	• ADD lubricant or CHANGE lubricant as required.
	• Shift lever binding or worn.	• REMOVE cap from shift tower. ELIMINATE binding condition or REPLACE components as required.
	• Worn or damaged internal shift mechanism.	• REMOVE transmission cover. CHECK internal shift mechanism by shifting into and out of all gears. REPAIR or REPLACE as required.
	• Binding of sliding gears and/or synchronizers.	• CHECK for free movement of gears and synchronizers. REPAIR or REPLACE as required.
	• Housings and/or shafts out of alignment.	• REMOVE transmission and CHECK for binding condition between input shaft and engine crankshaft pilot bearing or bushing. CHECK flywheel housing alignment. REPAIR or REPLACE as required.
	• Incomplete clutch disengagement.	• SEE Section 08-00 , Clutch General Service for reserve measurement test.
• Noisy in Forward Gears **NOTE: While verifying the condition, determine whether the noise is gear rollover noise, release bearing rub or some other transmission related noise. Gear rollover noise, inherent in manual transmissions, is caused by the constant mesh gears turning at engine idle speed, while the clutch is engaged and the transmission is in neutral; and release bearing rub is sometimes mistaken for mainshaft bearing noise. Gear rollover noise will**	• Lubricant level low, or improper type.	• ADD lubricant, or REFILL with specified lubricant.

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disappear when the clutch is disengaged or when the transmission is engaged in gear. Release bearing rub will disappear when the clutch is engaged. In the event that a bearing is damaged, the noise is more pronounced while engaged in gear under load or coast than in neutral.		
	• Components grinding on transmission.	• CHECK for screws, bolts, etc., of cab or other components grinding. CORRECT as required.
	• Component housing bolts loose.	• CHECK torque on transmission-to-flywheel housing bolts, output shaft flange nut and flywheel housing-to-engine block bolts. TIGHTEN bolts to specification.
	• Flywheel housing-to-engine crankshaft alignment.	• CHECK and ALIGN flywheel housing to engine crankshaft.
	• Noisy bearings or gears.	• REMOVE and DISASSEMBLE transmission. INSPECT input, output and countershaft bearings. INSPECT speedometer gear and gear teeth for wear or damage. REPLACE as required.
• Gears Clash when Shifting from One Forward Gear to Another	• Incomplete clutch disengagement.	• REFER to Section 08-00 for clutch reserve measurement test.
	• Pilot bearing binding.	• REMOVE transmission and CHECK for binding condition between input shaft and engine crankshaft pilot bearing. REPLACE as required.
	• Damaged gear teeth and/or synchronizer.	• DISASSEMBLE transmission, REPAIR or REPLACE as required.
	• Engine idle speed too high.	• ADJUST engine idle speed.
	• Improper manual shift linkage.	• ADJUST and REPAIR manual shift linkage as required.
• Transmission Jumps Out of Gear	• Loose transmission-to-engine block	• TIGHTEN transmission-to-engine block bolts to specifications. LOOSEN all

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	bolts, or loose levers.	bolts and RESEAT flywheel housing. TIGHTEN all bolts. TIGHTEN levers if necessary.
	• Crankshaft pilot bearing worn.	• REPLACE bearing.
	• Interior components damage.	• DISASSEMBLE transmission. INSPECT the synchronizer sleeves for free movement on their hubs. INSPECT the synchronizer blocking rings for widened index slots, rounded clutch teeth and smooth internal surface. CHECK countershaft cluster gear for excessive end play. CHECK shift forks for loose mounting on shift rails. INSPECT synchronizer sliding sleeve and gear clutch teeth for wear or damage. REPAIR or REPLACE as required.
	• Worn gear teeth due to partial engagement.	• REPLACE worn or damaged gears.
• Transmission Will Not Shift into One Gear — All Others OK	• Backup switch ball frozen.	• If reverse is problem, CHECK backup switch for ball frozen in extended position (if so equipped).
	• Internal components.	• REMOVE transmission. If transmission will not shift into reverse, CHECK for damaged reverse gear train, in single rail shift transmission. Also, CHECK for misaligned reverse relay lever. INSPECT shift rail and fork system synchronizer system and gear clutch teeth for restricted travel. REPAIR or REPLACE as required.
• Transmission Is Locked in One Gear. It Cannot Be Shifted Out of That Gear	• Internal components.	• REMOVE transmission. INSPECT problem gears, shift rails and forks and synchronizer for wear or damage. REPAIR as required. CHECK for broken fork slot tabs on single rail transmissions.
	• Loose fork on rail.	• On single rail shift, CHECK for broken selector arm pin or selector plate. REPAIR or REPLACE as necessary.
• Transmission Leaks	• Improper amount or type of lubricant.	• CHECK level and type. FILL to bottom of filler plug hole.

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	• Other component leaking.	• IDENTIFY leaking fluid as from engine, power steering or transmission. REPAIR as required.
	• False report.	• REMOVE all traces of lube on exposed transmission surfaces. CHECK vent for free breathing. OPERATE transmission and INSPECT for new leakage. REPAIR as required.
	• Internal components.	• REMOVE transmission. INSPECT for leaks at the input shaft bearing retainer seal and gasket and shift rail expansion plug. INSPECT for leaks at the top cover gasket. INSPECT case for sand holes or cracks. REPAIR or REPLACE as required.
	• Improper installation torque.	• TIGHTEN to specified torque value.
• Shift Lever Loose	• Retaining bolts loose.	• TIGHTEN to specified torque.
• Shift Lever Tight	• Worn or damaged shift lever lower bushing.	• INSPECT shift lever assembly. REMOVE and REPLACE parts as required.
• Noise from Transfer Case	• Incorrect tire inflation pressures and/or incorrect size tires and wheels.	• MAKE sure that all tires and wheels are the same size, and that inflation pressures are correct.
	• Excessive tire tread wear.	• CHECK tire tread wear to see if there is more than .06 inch difference in tread wear between front and rear. INTERCHANGE one front and one rear wheel. REINFLATE tires to specifications.
	• Internal components.	• OPERATE vehicle in all transmission gears with transfer case in 2HI, or HI range. If there is noise in transmission in neutral gear, or in some gears and not in others, REMOVE and REPAIR transmission.If there is noise in all gears, OPERATE vehicle in all transfer case ranges. If

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		noisy in all ranges, DISASSEMBLE transfer case. CHECK input gear, planetary gear assembly, sprockets, chain and single cardan U-joint for damage. REPLACE as necessary.
• Transfer Case Jumps Out of Gear	• Incomplete shift linkage travel. • Loose mounting bolts. • Front and rear driveshaft slip-yokes dry or loose. • Internal components.	• CHECK for interference to shift boot or body. • TIGHTEN mounting bolts. • LUBRICATE and REPAIR slip-yokes as required. TIGHTEN flange yoke attaching nut to specifications. • DISASSEMBLE transfer case. INSPECT input gear, planetary gear assembly, sliding shift collar hubs and detent spring for damage. REPLACE as required.

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Transmission

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Clutch Coupling Tool	T88T-70522-A
Seal Remover	T74P-77248-A

Removal

1. Shift the transmission (7003) into neutral position.
2. Remove the retainer screws and slide the gearshift lever boot (7277) up the shaft of gearshift lever (7210).
3. Remove the retaining bolt and remove the gearshift lever. Remove the stub shaft through the floor opening.
4. Disconnect the battery ground cable (14301) from the battery terminal.
5. Raise the vehicle on hoist and position suitable safety stands under vehicle.
6. **NOTE: Drain transmission only if disassembly is required.**

   Place drain pan under transmission. Using a 24mm wrench, remove case plug (7A010) and drain transmission.
7. Disconnect the driveshaft (4602) at the rear axle. On Ranger SuperCab, remove the driveshaft center bearing bracket (4A499).
8. Pull the driveshaft rearward and disconnect from the transmission. Install a suitable plug in the extension housing (7A039) to prevent lubricant leakage if transmission was not drained. On 4x4 models, unbolt driveshaft from rear case yoke (7B214) at the case (7005). Remove driveshaft.
9. Disconnect the hydraulic clutch hose (7T504) at the case using Clutch Coupling Tool T88T-70522-A. Plug both ends of the hydraulic clutch hose to prevent fluid leakage and entry of contaminants.
10. Remove the speedometer cable (17260) from the extension housing or driveshaft center bearing bracket.
11. Disconnect starter motor (11001) wires and backup lamp switch (15520).
12. Remove exhaust system components for adequate clearance (V-6 engines only). Refer to Section 09-00 .
13. Place a jack under the engine (6007), protecting theoil pan (6675) with a wood block.
14. On 4x4 vehicles, remove the transfer case (7A195), as described in Section 07-07A , Section 07-

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07B , Section 07-07C or Section 07-07D .

15. Remove the starter motor. Position Hi-Lift Transmission Jack 014-00942 or equivalent under the transmission.

16. Remove the bolts, lockwashers and flatwashers attaching thetransmission to the rear plate of engine.

17. Remove the nuts and bolts attaching the transmission support insulator (6068) to the crossmember.

18. Remove the nuts attaching the crossmember to the frame side rails and remove the crossmember. Refer to Section 02-03 .

19. Work the transmission off the locating dowels and slide the transmission rearward until the spline on input shaft (7017) clears the clutch disc (7550). Lower the transmission from the vehicle.

Transmission Assembly, Typical

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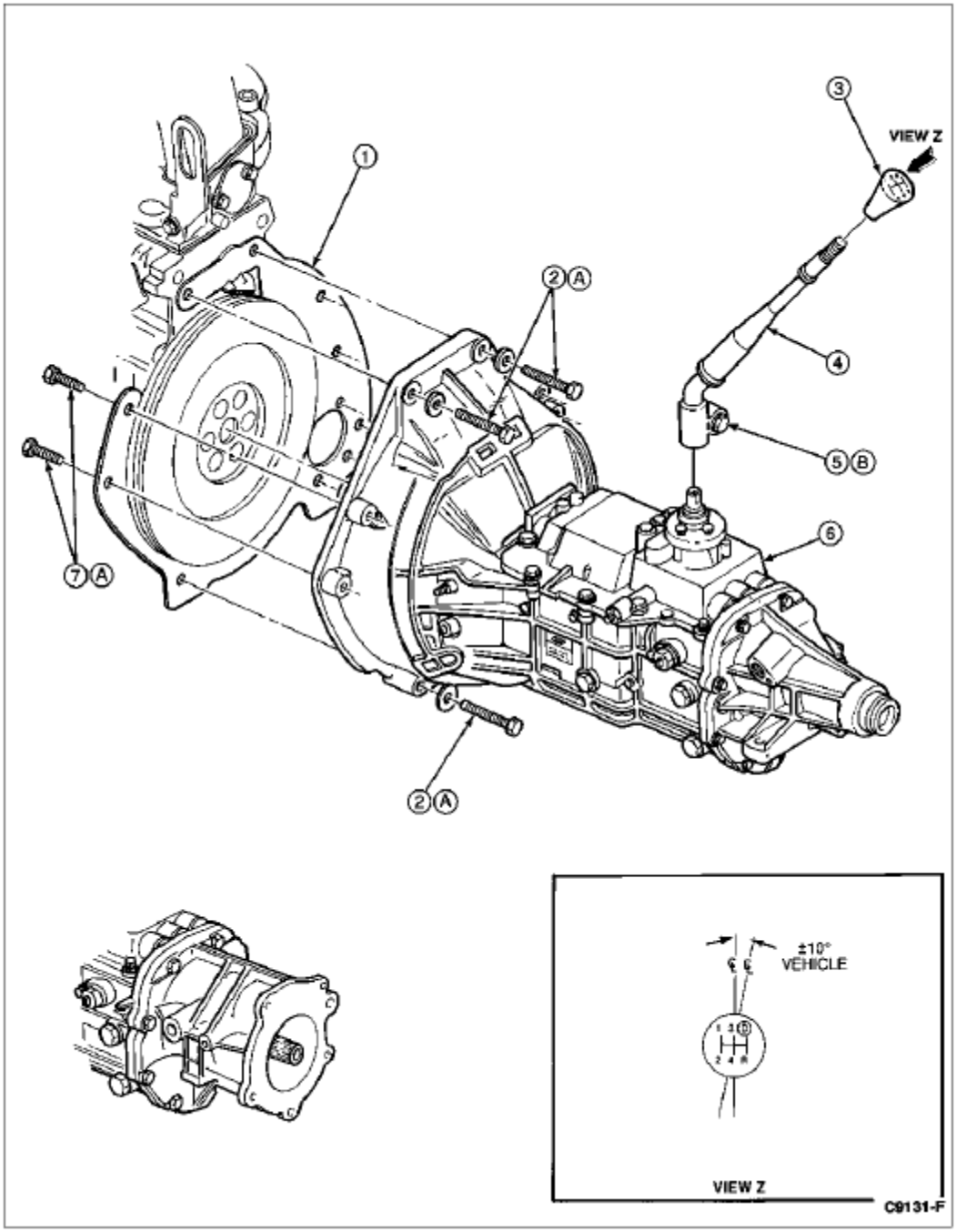

Item	Part Number	Description
1	7007	Engine Rear Plate
2	N802244-S100	Bolt
3	7213	Gearshift Lever Knob
4	7210	Gearshift Lever
5	N605906-S100	Bolt
6	7003	Transmission
7	N8023281-S100	Bolt

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A	—	Tighten to 38-51 Nm (28-38 Lb-Ft)
B	—	Tighten to 27-40 Nm (20-30 Lb-Ft)

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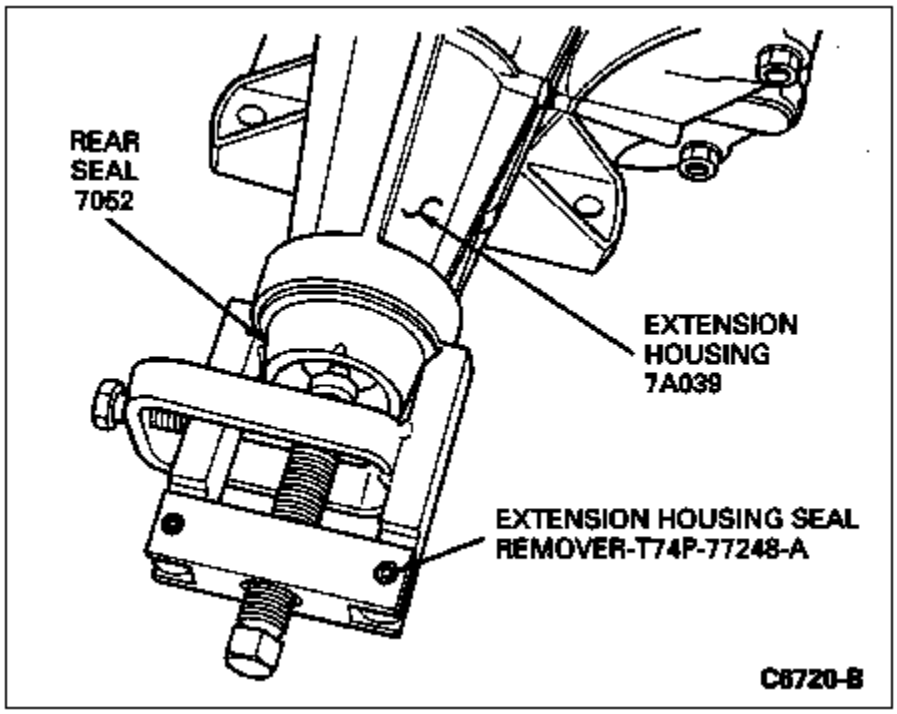
Extension Housing

1. **NOTE: On 4x2 vehicles, if it is necessary to remove oil seal (7052), the extension housing (7A039) must be installed to case (7005). Remove oil seal using extension housing Seal Remover T74P-77248-A.**

   Using a 14mm wrench, remove eight retaining bolts from extension housing. Pry gently at locations provided on extension housing and case. Remove extension housing from case.



2. If necessary, remove rear oil bypass tube (7A174) from extension housing using a 10mm socket (4x2 vehicles only).

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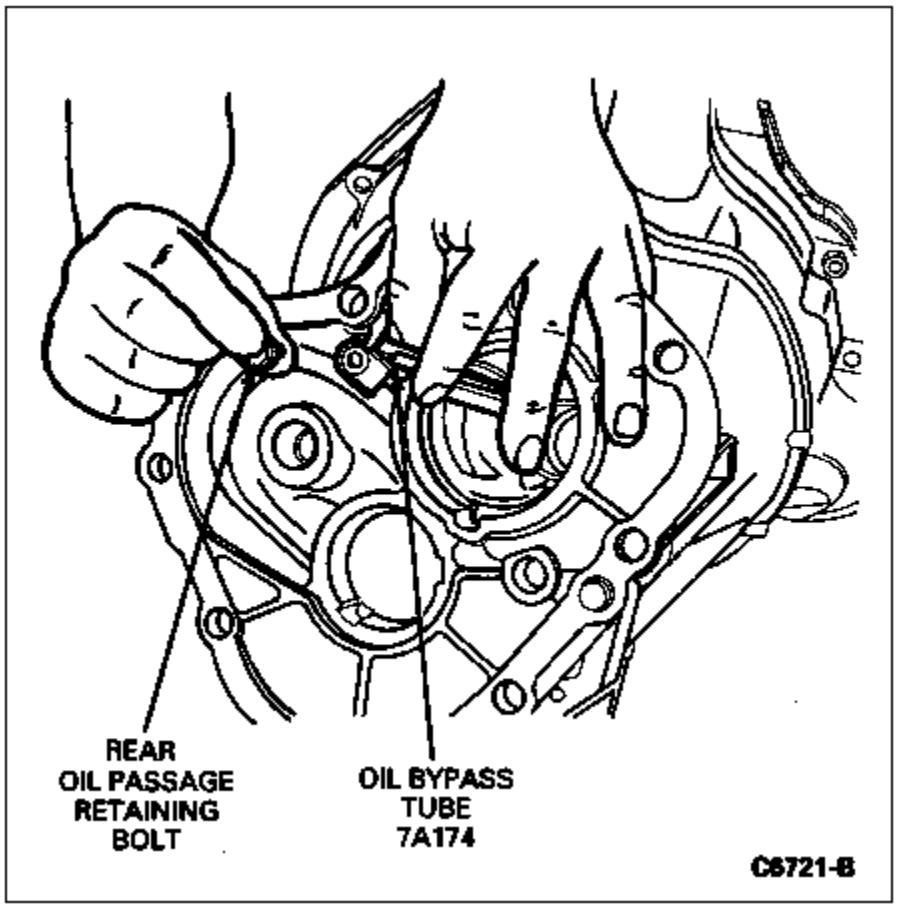

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Shift Lever and Boot

1. Place gearshift in neutral position.
2. Remove the retaining screws and slide gearshift lever boot up the shift lever shaft.
3. Remove retaining bolt and remove shift lever shaft.

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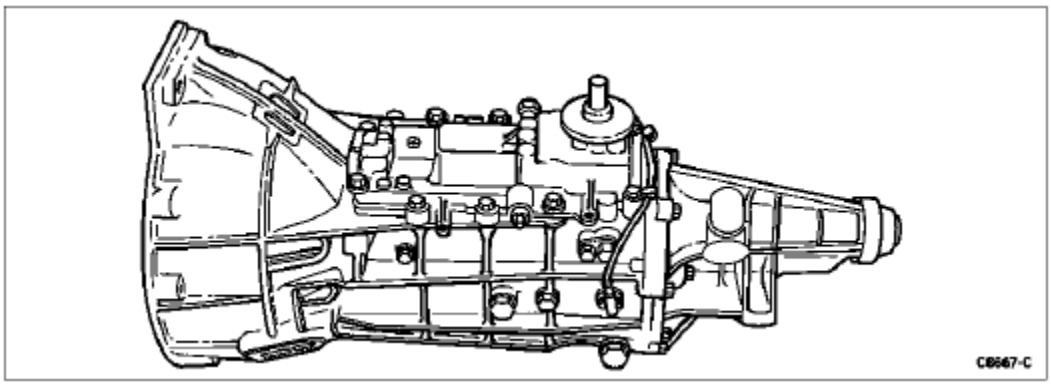
Transmission

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Remover/Replacer Tube	T75L-7025-B
TOD Forcing Screw	T84T-7025-B
Bearing Puller	T77J-7025-H

1. Remove transmission (7003) from vehicle as outlined in Removal, Transmission in this section. Set transmission on workbench.

M5OD Transmission Assembly



2. Remove gearshift lever (7210) and gearshift lever boot (7277) if necessary.
3. Using a 12mm wrench, remove 10 retaining bolts and remove case cover (7222).
4. Remove output shaft seal from output shaft (4x2 vehicles only).
5. Remove the speedometer drive gear and steel ball (4x2 vehicles only).

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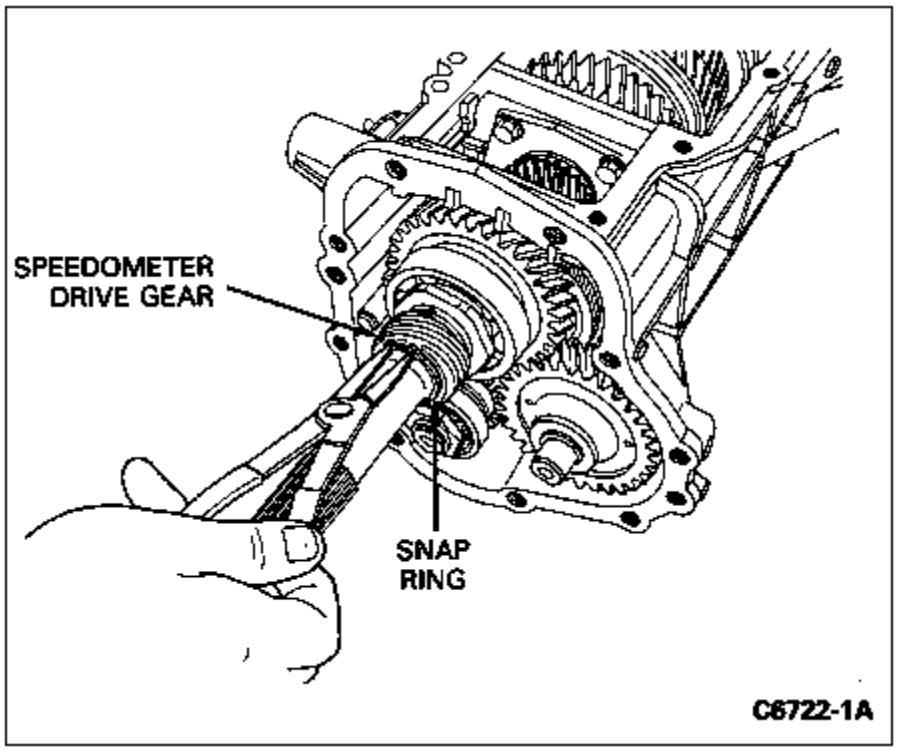

6. Remove thrust bearing (7C096) and thrust washer.

7. Using a 17mm wrench, remove holding bolt from reverse idler gear shaft (7140). Remove reverse idler gear and bushing (7141) by grasping and pulling rearward.

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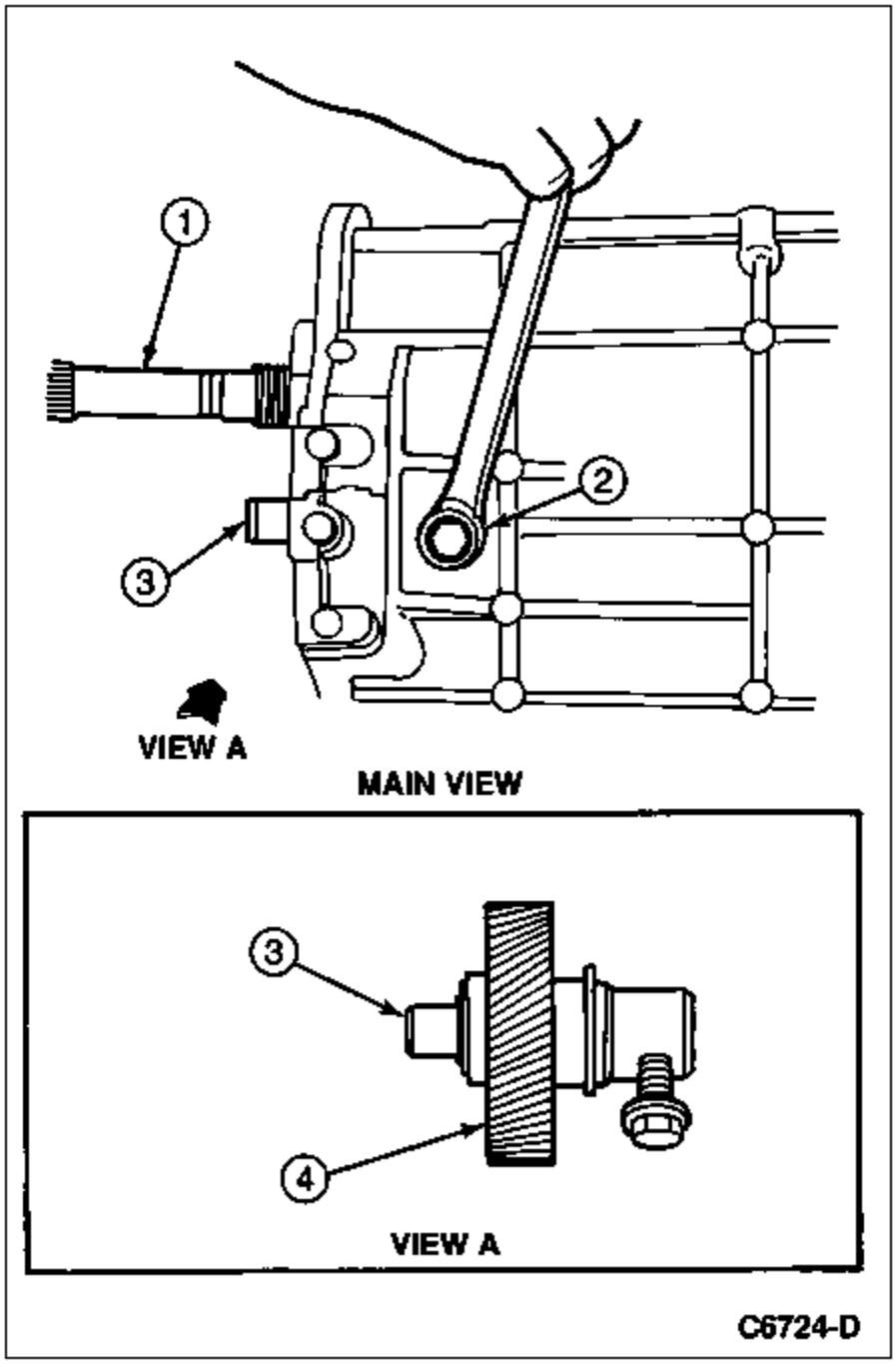

Item	Part Number	Description
1	7061	Output Shaft
2	7214	Bolt
3	7140	Reverse Idler Gear Shaft
4	7141	Reverse Idler Gear and Bushing

8. **CAUTION: Be sure tools are properly positioned so as not to damage parts being removed.**

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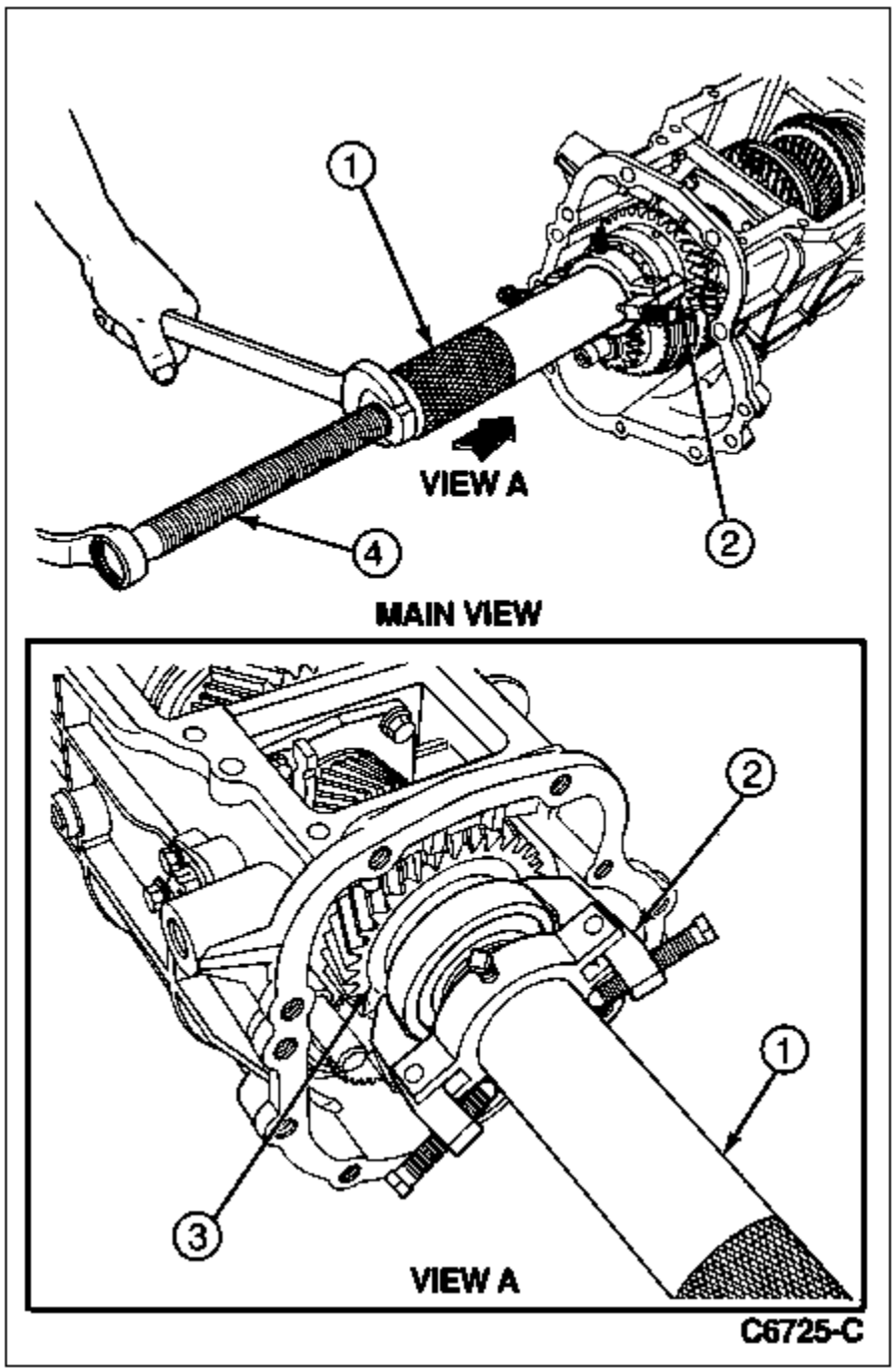
Remove output shaft bearing (7065) from mainshaft using Remover/Replacer Tube T75L-7025-B, TOD Forcing Screw T84T-7025-B, Bearing Puller T77J-7025-H.



Item	Part Number	Description
1	T75L-7025-B	Remover/Replacer Tube
2	T77J-7025-H	Bearing Puller
3	7R205	Output Shaft Rear Bearing

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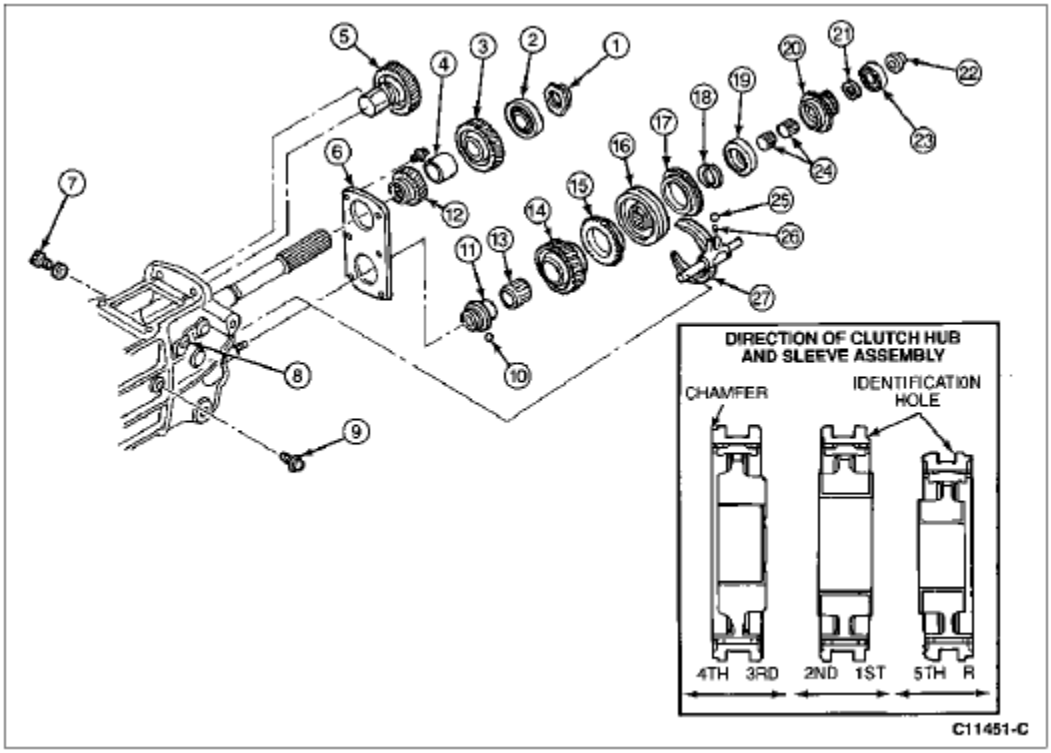
4	T84T-7025-B	TOD Forcing Screw

9. Remove reverse idler gear and bushing from output shaft.
10. Remove sleeve from output shaft.
11. Remove countershaft reverse gear (7N040) with two reverse idler gear bearings (7E139) and reversesynchronizer blocking ring (7107).

Transmission, Rear Housing



Item	Part Number	Description
1	7B364	Locknut
2	7R205	Output Shaft Rear Bearing
3	7142	Output Shaft Reverse Gear
4	7072	Spacer or Sleeve
5	7141	Reverse Idler Gear and Bushing
6	7085	Bearing Retainer
7	7K179	Reverse Idler Gear Holding Bolt
8	99796-0612	Bolt
9	7214	Fifth and Reverse Shift Rod Bolt
10	99611-2000	Ball

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11	7173	Input Bearing Spacer
12	7112	Fifth Gear
13	7R130	Needle Bearing, Fifth Gear
14	7142	Fifth Gear, Countershaft
15	7107	Synchronizer Blocking Ring
16	7124	Synchronizer
17	7107	Synchronizer Blocking Ring
18	7R482	Synchronizer Split Washer
19	7C340	Thrust Washer
20	7N040	Countershaft Reverse Gear
21	7L324	Thrust Washer
22	7N170	Locknut
23	7D283	Countershaft Rear Bearing
24	7N270	Needle Bearing
25	7289	Lockball (Steel) Shift Rail
26	99796-0612	Bolt
27	7289	Shift Fork (Fifth and Reverse)

12. Remove thrust washer and split washer from countershaft (7111).

13. Using a 12mm wrench, remove holding bolt from reverse gear shift rail (7240).

14. **NOTE: When performing the following, do not separate steel ball and shifter interlock spring (7234) (removed from shift fork groove) unless necessary.**

    Remove the following parts as an assembly:

    - Fifth/reverse synchronizer (7124) (countershaft)
    - Fifth/reverse gear shifter fork (7230) and reverse gear shift rail

15. Remove fifth gear synchronizer blocking ring.

16. **NOTE: Do not remove the Torx® nut retaining theshift lever connecting pin (7F301) at this time.**

    Remove the lockplate retaining bolt and inner circlip. Remove fifth and reverse shift lever (7243) from case (7005).

17. Remove fifth speed gear (7K316) with needle bearing.

18. Remove fifth speed gear from output shaft.

19. Remove fifth gear spacer or sleeve (7072) and (positioning) ball.

20. Remove front and rear bearing retainers. Refer to procedures in this section.

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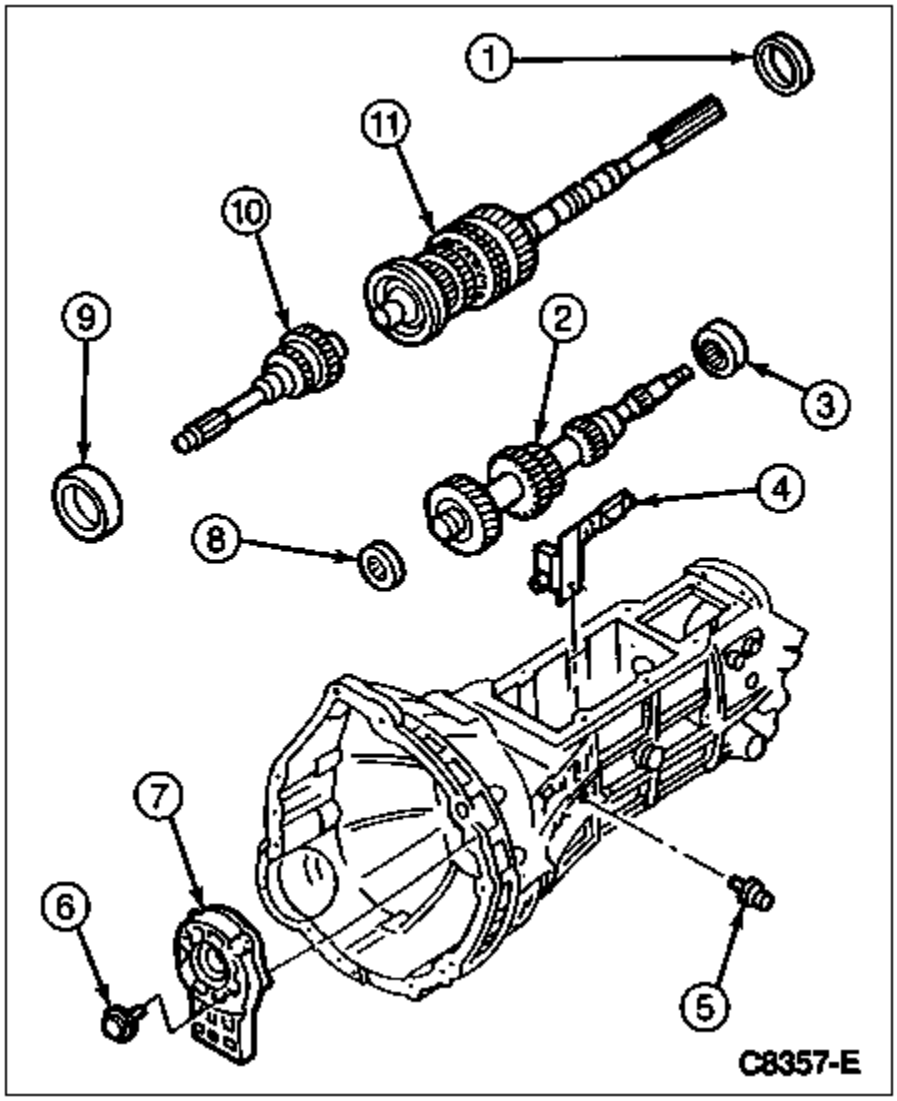
21. Using a 10mm socket, remove retaining bolt and oil bypass tube (7A174) from upper case.



Item	Part Number	Description
1	7052	Center Bearing Outer Race
2	7111	Countershaft
3	7C096	Thrust Bearing
4	7A174	Oil Bypass Tube
5	99796-0620	Bolt
6	99796-0825	Bolt
7	7050	Main Drive Gear Bearing Retainer
8	7065	Output Shaft Bearing
9	7025	Bearing

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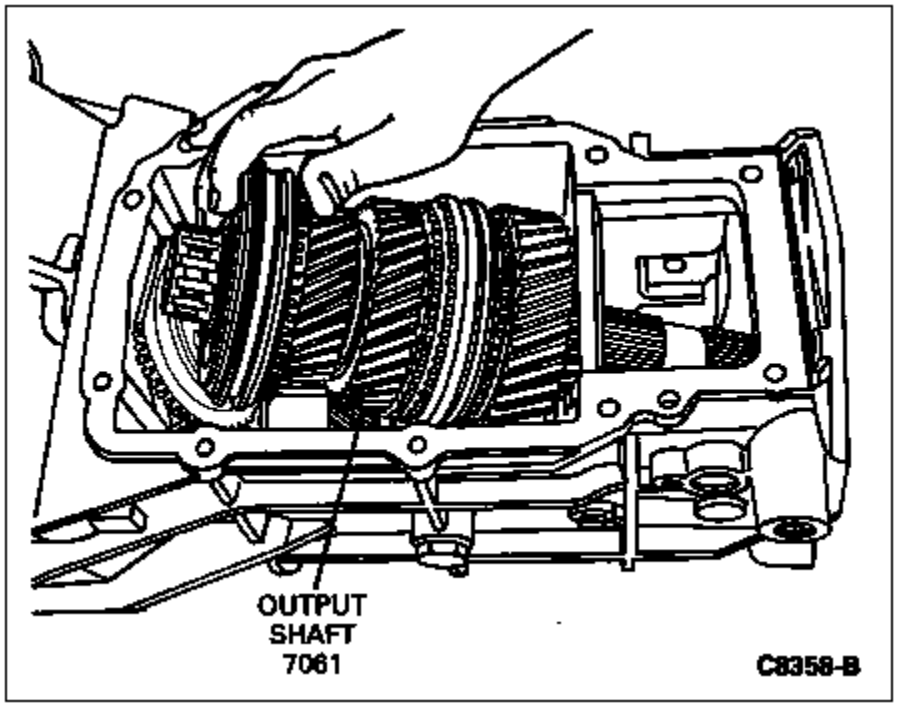
10	7017	Input Shaft
11	7061	Output Shaft

22. Pull input shaft (7017) forward and remove bearing (7025). Pull mainshaft rearward.
23. Pull input shaft forward and separate it from mainshaft.
24. Incline mainshaft upward and lift from case.



25. Tip (angle) input shaft and remove fromcase.
26. Remove countershaft through upper opening of case.

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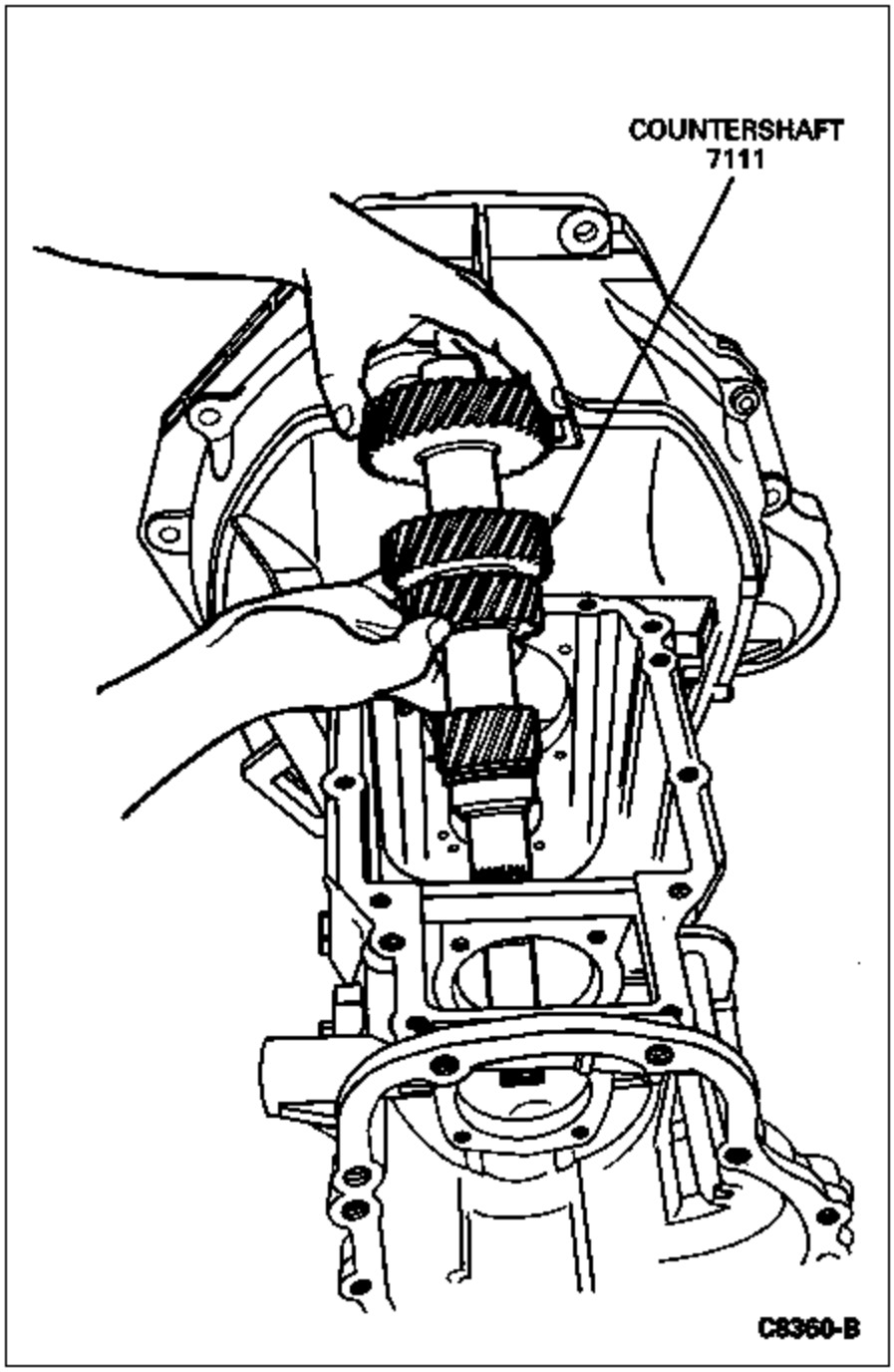

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Shift Control Housing

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Top Cover Holding Fixture	T88T-7025-C

Disassembly

1. **NOTE: For reference during assembly, notice that grooves in bushing align with slots in lower shift lever pivot ball. Notice that the notch in the lower gearshift lever (7210) faces toward front of transmission (7003).**

   If necessary, remove gearshift lever boot (7277) and gearshift lever from case cover (7222) if not removed during disassembly. Remove three dust cover retaining screws using a T30 Torx® Allen wrench. Remove dust cover.

2. Position case cover into Top Cover Holding Fixture T88T-7025-C.

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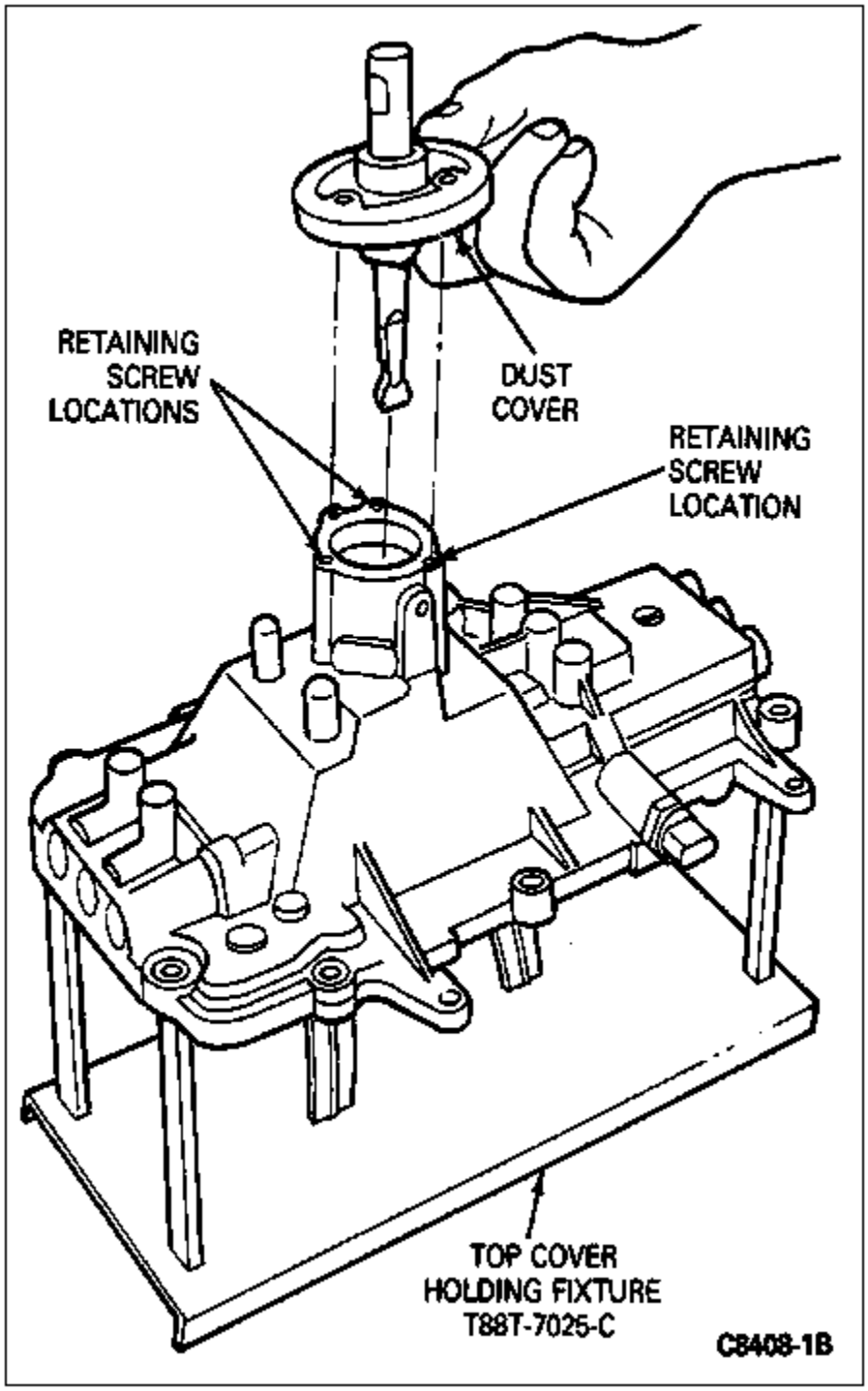

3. Remove backup lamp switch (15520) from case cover. Remove backup lamp switch pin from groove in case cover.

4. Remove manual lever position (MLP) switch and pin from case cover.

5. Invert case cover on Top Cover Holding Fixture T88T-7025-C. Using a 5/32-inch drift punch, remove and discard spring pins retaining gear shifter forks (7230) to the shift rail.

6. Make sure all shift rails and gates are positioned in NEUTRAL. Remove and discard spring pins

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retaining shift gates to shift rails. Remove shift gates.

7. Remove three rubber plugs sealing service bores.

8. **WARNING: WEAR SAFETY GLASSES WHILE PERFORMING SHIFT RAIL REMOVAL PROCEDURE.**

   CAUTION: Perform the following shift rail removal procedures with great care. Cover the lockball and friction device bores and spring seats with a clean cloth held firmly in place during shift rail removal. Failure to firmly cover lockball and friction device bores can result in component loss when the ball/friction device and spring forcefully leave their installed positions.

   Remove fifth/reverse shift rail from case cover through service bore. If necessary, insert a 5/16-inch drift punch through spring pin bore and gently rock shift rail from side to side while maintaining rearward pressure.

9. Remove first/second shift rail from case cover through service bore. If necessary, insert a 5/16-inch drift punch through spring pin bore and gently rock shift rail from side to side while maintaining rearward pressure.

10. Remove third/fourth shift rail from case cover through service bore. If necessary, insert a 5/16 drift punch through spring pin bore and gently rock shift rail from side to side while maintaining rearward pressure.

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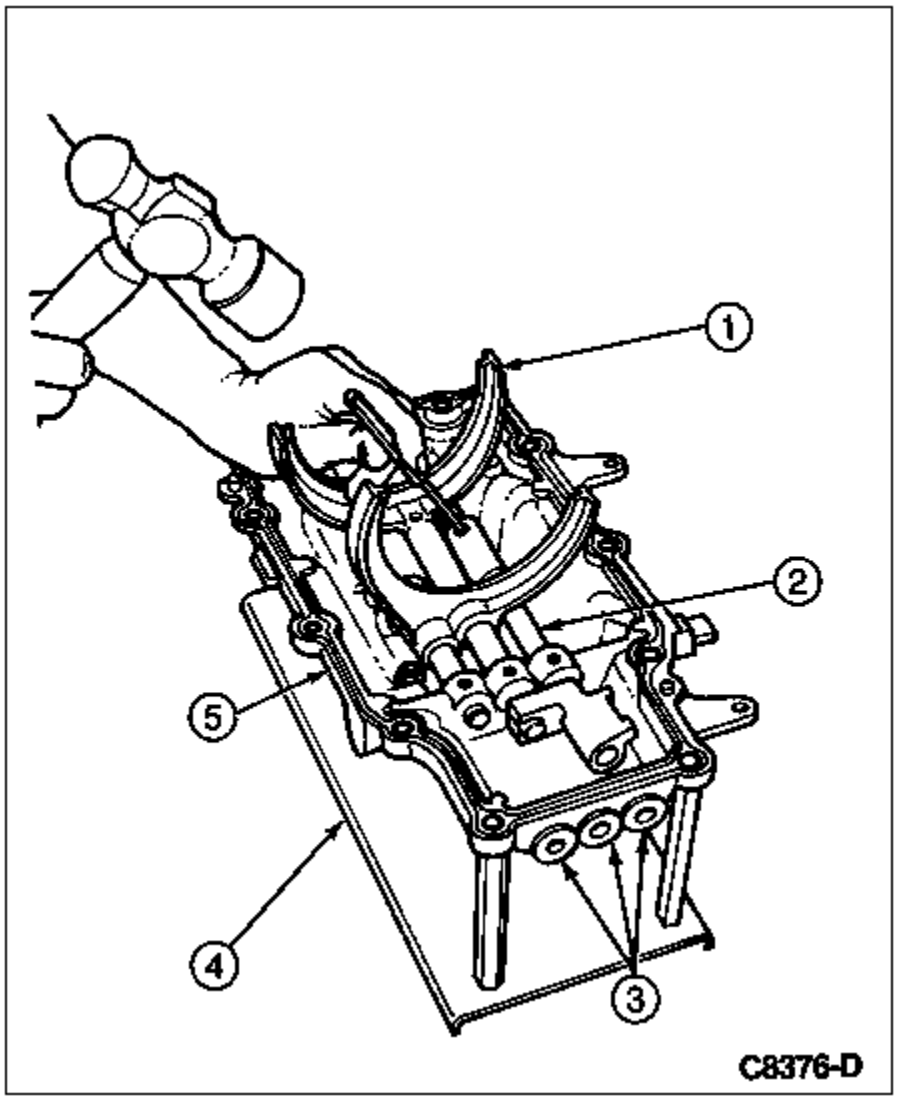

Item	Part Number	Description
1	7230	Shift Fork
2	7240	Shift Rail
3	—	Service Bore Plugs (Part of 7222)
4	T88T-7025-C	Top Cover Holding Fixture
5	7222	Case Cover

11. Remove retaining bolts using a 10mm socket. Remove gear selector interlock sleeve (7K201).

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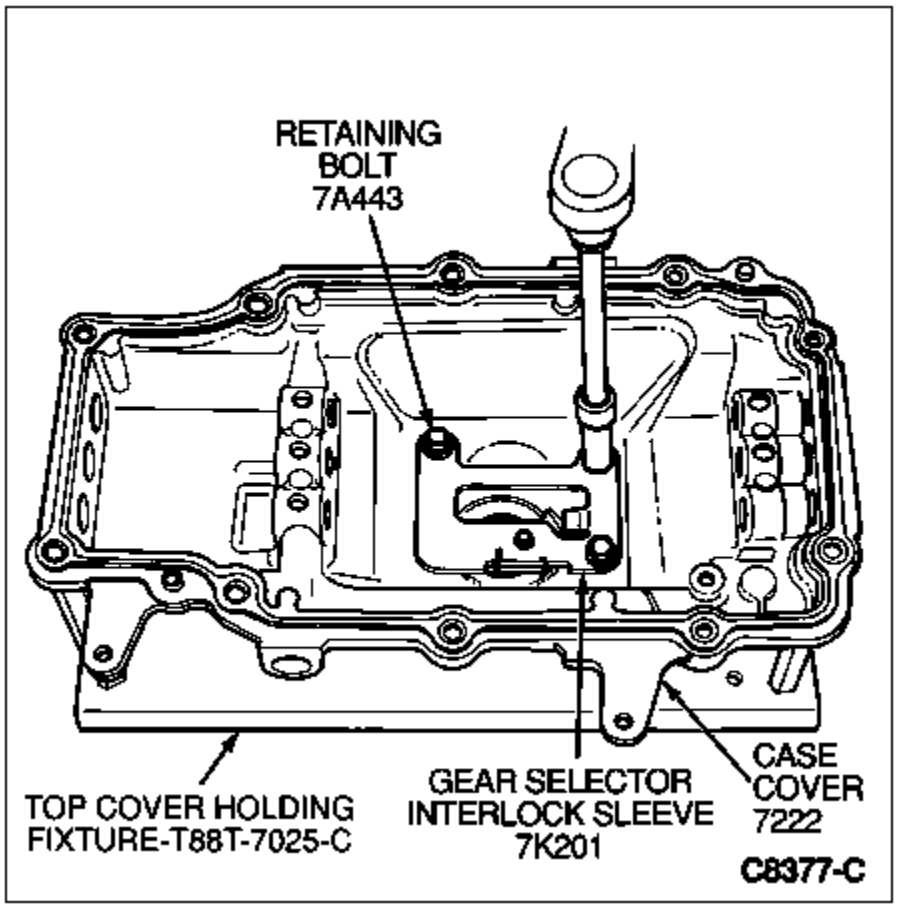

Assembly

1. **NOTE: During installation, apply Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX or equivalent MERCON® fluid to all moving parts.**

   Position case cover into Top Cover Holding Fixture T88T-7025-C.

2. Position fifth/reverse cam lockout plate to top case cover. Install retaining bolts and tighten to 8-10 Nm (6-7 lb-ft).

3. Position third/fourth shift control shaft into case cover through service bore. If necessary, insert a 5/16-inch drift punch through spring pin bore and gently rock third/fourth shift control shaft from side to side while maintaining forward pressure. Position detent ball and shifter interlock spring (7234) into shift rod spring seats (7D210). Compress the detent ball and spring assembly using a suitable tool, and push third/fourth shift control shaft into position over detent ball. Engage third/fourth gear shifter fork with third/fourth shift control shaft. Position friction device and spring into shift rod spring seats. Compress the friction device and spring assembly using a suitable tool, and push third/fourth shift control shaft into position over friction device. Install spring pins retaining third/fourth shift control shaft to case cover. Install shifter interlock spring retaining third/fourth gear shifter fork to third/fourth shift control shaft.

4. Position first/second shift control shaft into case cover through service bore. If necessary, insert a 5/16-inch drift punch through spring pin bore and gently rock shift control shaft from side to side while maintaining forward pressure. Position detent ball and shifter interlock spring into shift rod spring

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seats. Compress the detent ball and spring assembly using a suitable tool and push reverse shift control shaft (7241) into position over detent ball. Engage first/second gear shifter fork with shift control shaft. Position friction device and shifter interlock spring into shift rod spring seats. Compress friction device and spring assembly using a suitable tool, and push shift control shaft into position over friction device. Install spring pins retaining shift control shaft to case cover. Install spring pin retaining first/second gear shifter fork to shift control shaft.

5. Position fifth/reverse shift control shaft to case cover through service bore. If necessary, insert a 5/16-inch drift punch through spring pin bore and gently rock fifth/reverse shift control shaft from side to side while maintaining forward pressure. Position detent ball and shifter interlock spring into shift rod spring seats. Compress the detent ball and shifter interlock spring using a suitable tool, and push fifth/reverse shift control shaft into position over detent ball. Engage fifth/reverse gear shifter fork with fifth/reverse shift control shaft. Install spring pins retaining fifth/reverse shift control shaft tocase cover. Install spring pin retaining fifth/reverse gear shifter fork to fifth/reverse shift control shaft.

6. Install rubber plugs into service bores.

7. **NOTE: Improper installation of interlock pins will prevent activation of manual lever position (MLP) switch and backup lamp switch.**

   Install interlock pins into shift rails. Make sure that large and small interlock pins are installed into their original positions.

8. Apply sealant to backup lamp switch and manual lever position switch threads. Install switches tocase cover and tighten to 25-35 Nm (18-26 lb-ft).

9. Position lower gearshift lever and dust cover assembly to case cover. Install three retaining screws and tighten to 8-11 Nm (6-8 lb-ft).

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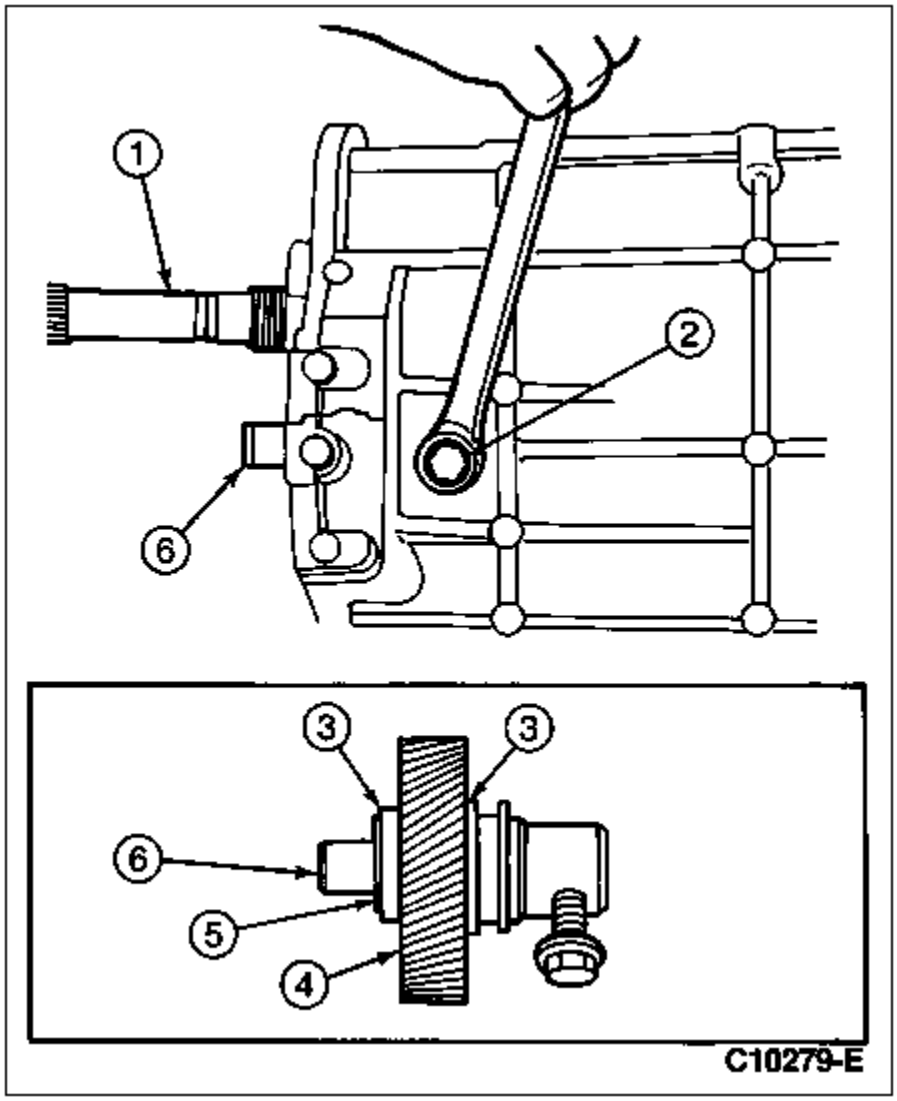
Reverse Idler Gear Shaft

1. Using a 17mm wrench, remove holding bolt from reverse idler gear shaft (7140) and pull rearward.



Item	Part Number	Description
1	7061	Output Shaft
2	7214	Bolt
3	7N037	Thrust Washer with Tang
4	7141	Reverse Idler Gear and Bushing
5	7156	Retaining Ring

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6	7140	Reverse Idler Gear Shaft

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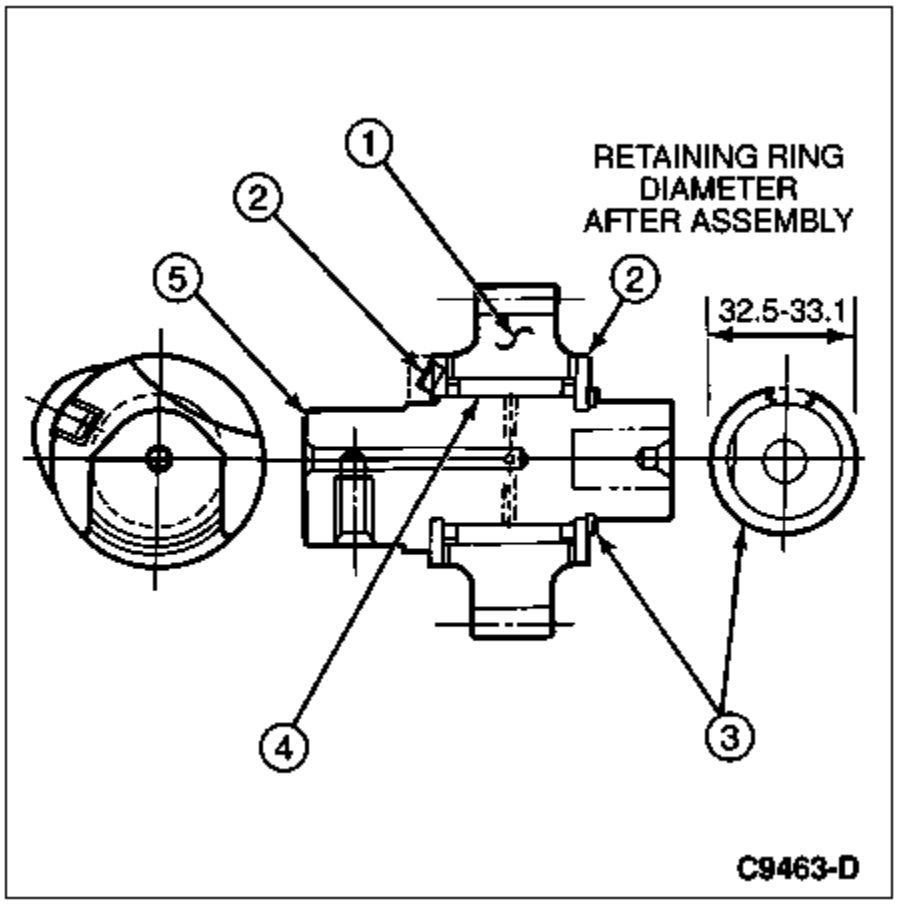
Reverse Idler Gear Retaining Rings

Disassembly

1. Remove the following parts from reverse idler gear shaft (7140):
    - Reverse idler gear retaining ring (7156)
    - Spacer
    - Reverse idler gear and bushing (7141)
    - Reverse idler gear bearings (7E139)
    - Reverse idler gear thrust washer (7N037)



Item	Part Number	Description
1	7141	Reverse Idler Gear and Bushing
2	7N037	Reverse Idler Gear Thrust Washer
3	7064	Reverse Idler Gear Retaining Ring
4	7E139	Reverse Idler Gear Bearing

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5	7140	Reverse Idler Gear Shaft

Assembly

1. **NOTE: During installation, apply Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX or equivalent MERCON® fluid to all rotating or sliding parts.**

   Install reverse idler gear thrust washer onto reverse idler gear shaft. Make sure that tab on reverse idler gear thrust washer mates with groove on reverse idler gear shaft to prevent rotation of reverse idler gear thrust washer.

2. Install the following parts onto reverse idler gear shaft in the order listed.

   - Reverse idler gear bearings
   - Reverse idler gear and bushing
   - Spacer

3. Install original reverse idler gear retaining ring onto reverse idler gear shaft. Insert a feeler gauge between reverse idler gear retaining ring and reverse idler gear and bushing to measure end play. Using the chart, adjust end play to 0.1mm-0.2mm (0.0039-0.0078 inch) by installing a retaining ring of necessary thickness.

REVERSE IDLER GEAR RETAINING RINGS

Part Number	Thickness
E8TZ-7156-A	1.5mm (0.059 In.)
E8TZ-7156-G	1.6mm (0.0629 In.)
E8TZ-7156-H	1.7mm (0.0669 In.)
E8TZ-7156-J	1.8mm (0.0708 In.)
E8TZ-7156-K	1.9mm (0.0748 In.)

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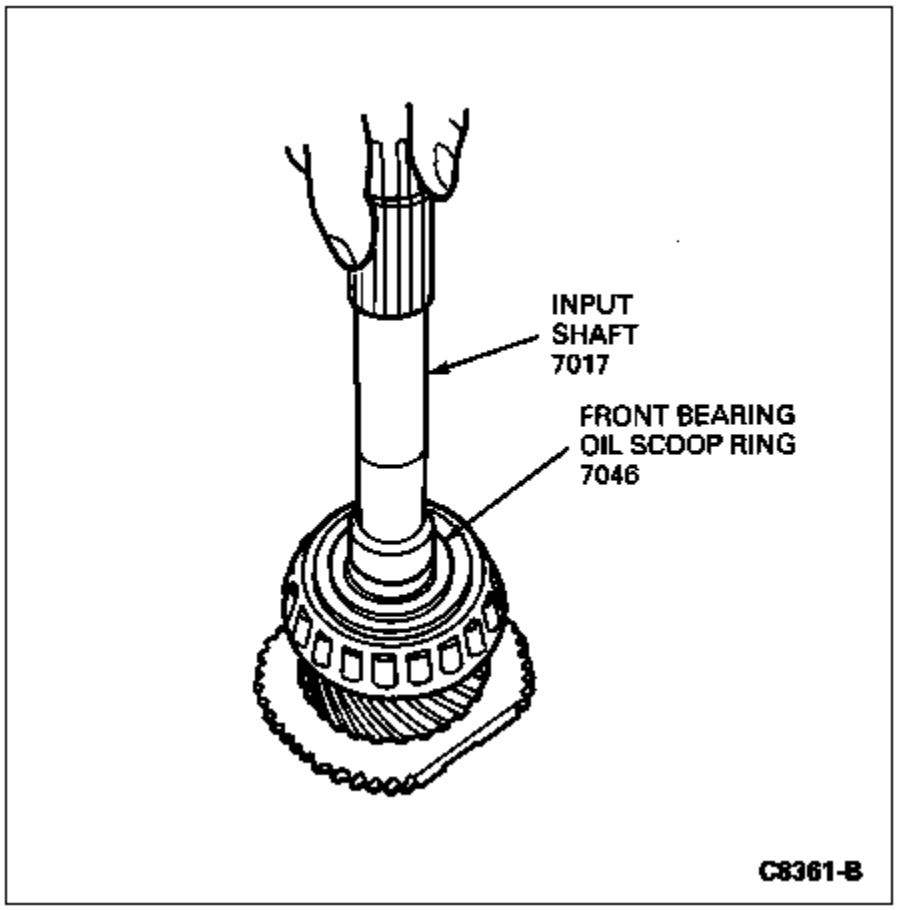
Input Shaft and Bearing

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Pinion Bearing Cone Remover	T71P-4621-B
Bearing Cone Replacer	T88T-7025-B

Disassembly

1. Remove and discard front bearing oil scoop ring (7046).



2. **CAUTION: Use of essential tools may cause damage to the bearings being removed.**

   Press bearing from input shaft (7017) using Pinion Bearing Cone Remover T71P-4621-B and arbor press.

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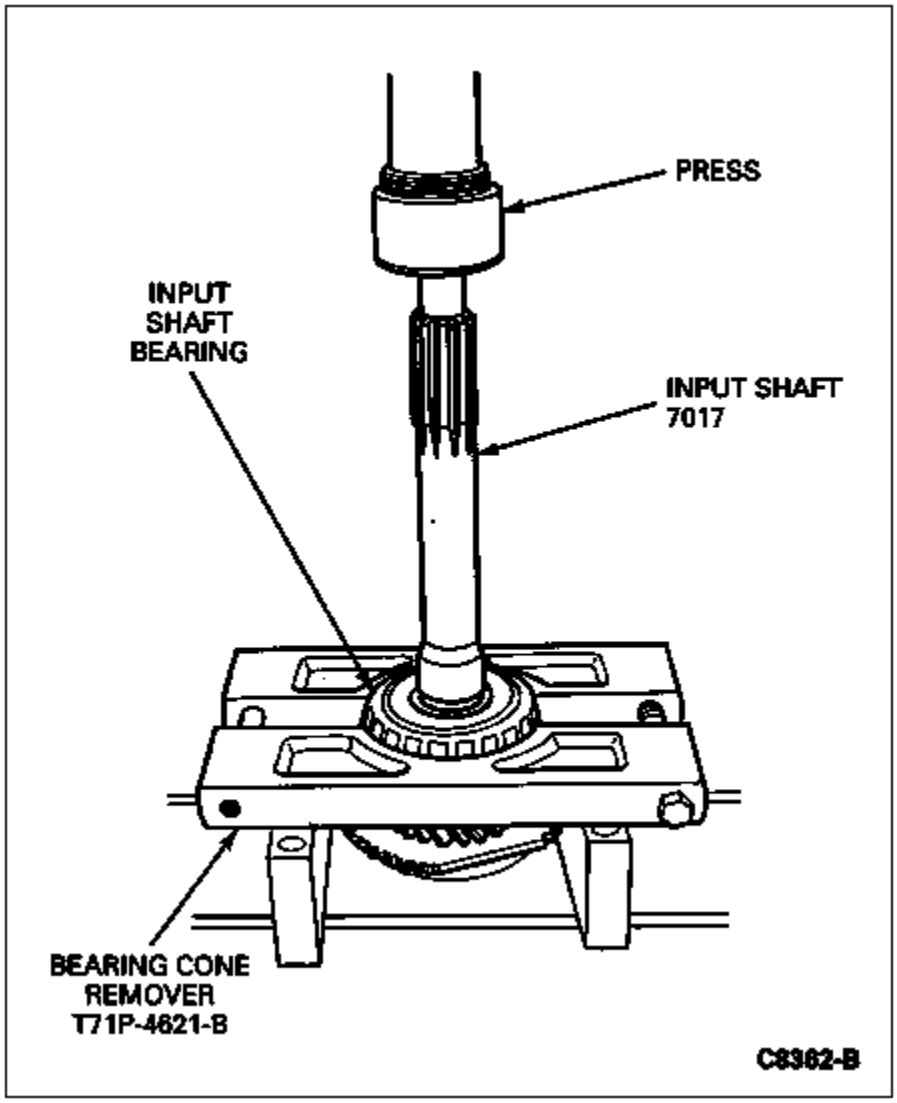

Assembly

1. Press tapered roller bearing onto input shaft using Bearing Cone Replacer T88T-7025-B and Pinion Bearing Cone Remover T71P-4621-B as a press plate.

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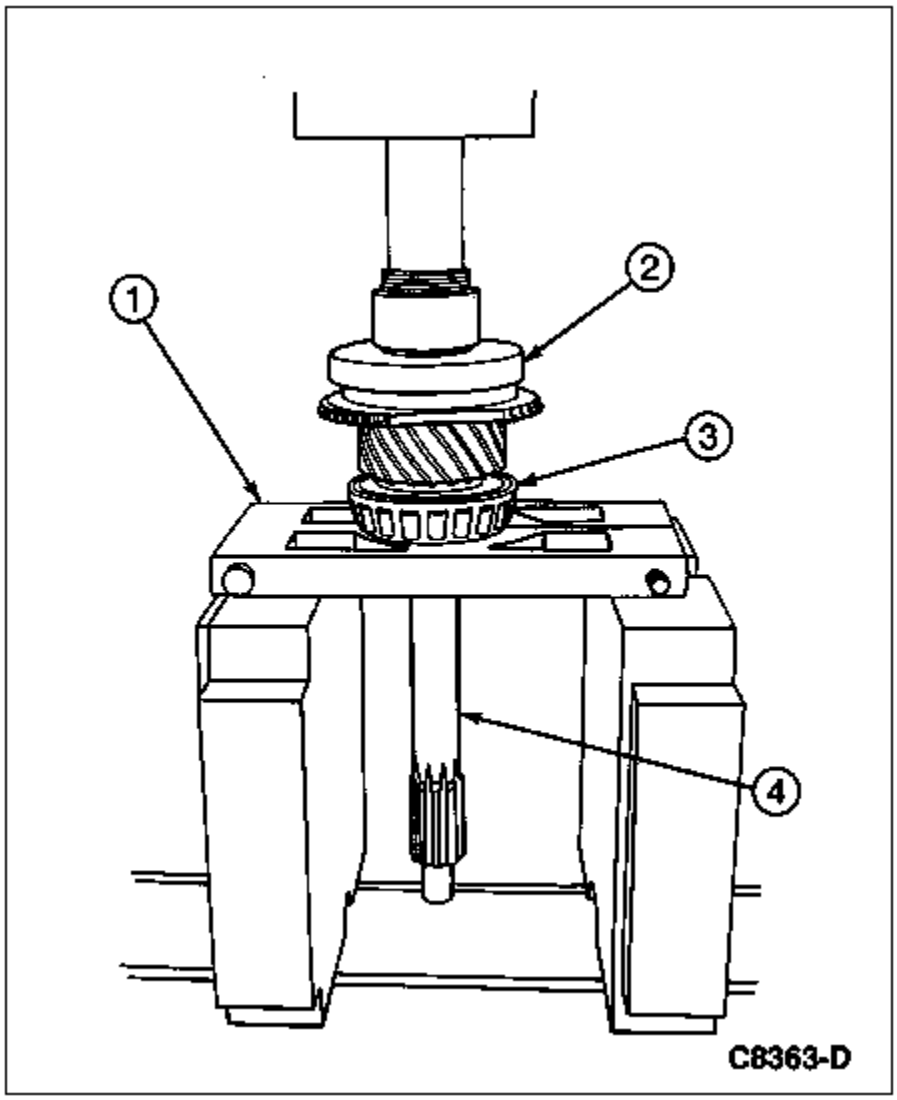

Item	Part Number	Description
1	T71P-4621-B	Bearing Cone Remover
2	T88T-7025-B	Bearing Cone Replacer
3	7025	Bearing
4	7017	Input Shaft

2. Install front bearing oil scoop ring onto input shaft. (Manually rotate clockwise to make sure that input shaft oil holes properly engage front bearing oil scoop ring. A click should be heard as scoop ring notches align with input shaft oil holes.)

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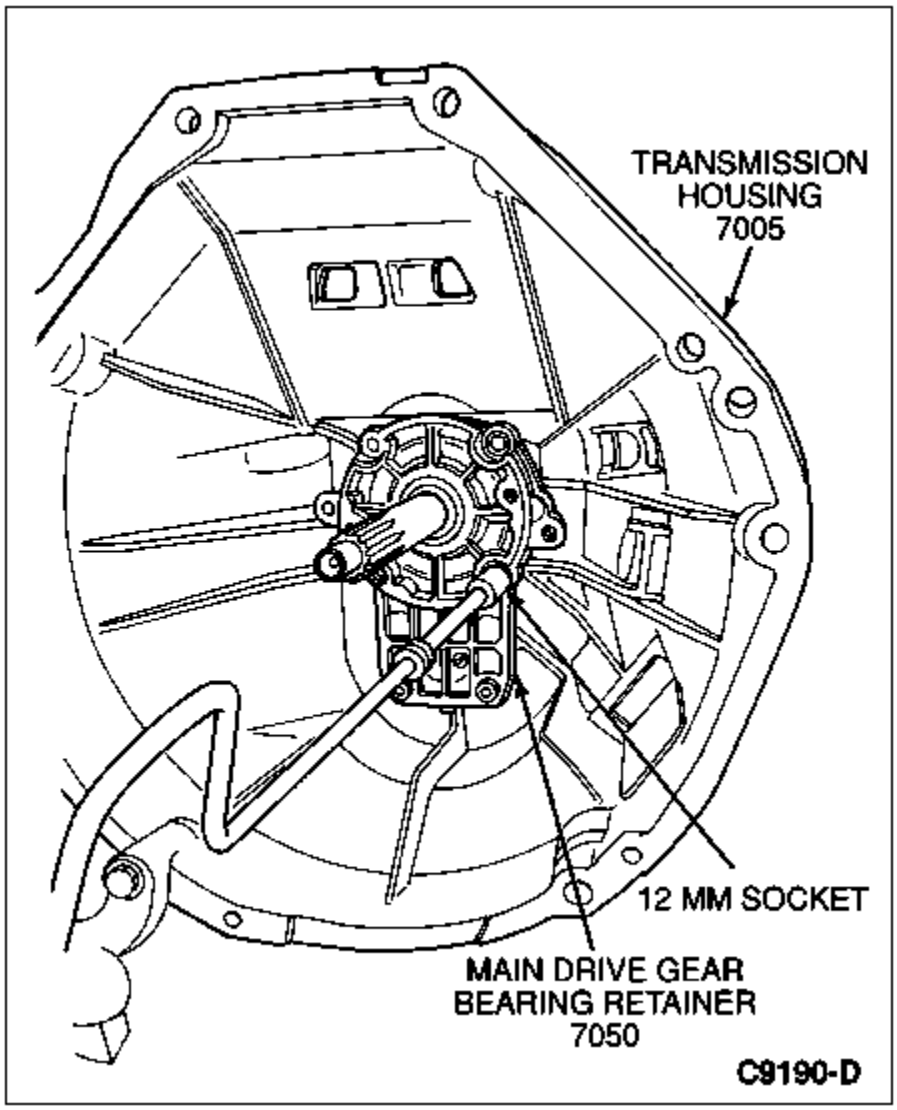
Bearing Retainer, Front

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Bell Housing Seal Replacer	T77J-7025-G

Disassembly

1. Using a 12mm socket, remove six attaching bolts from main drive gear bearing retainer (7050).



2. **NOTE: Bolts threaded into slave cylinder bolt locations will bottom out and lift main drive gear bearing retainer away from case (7005).**

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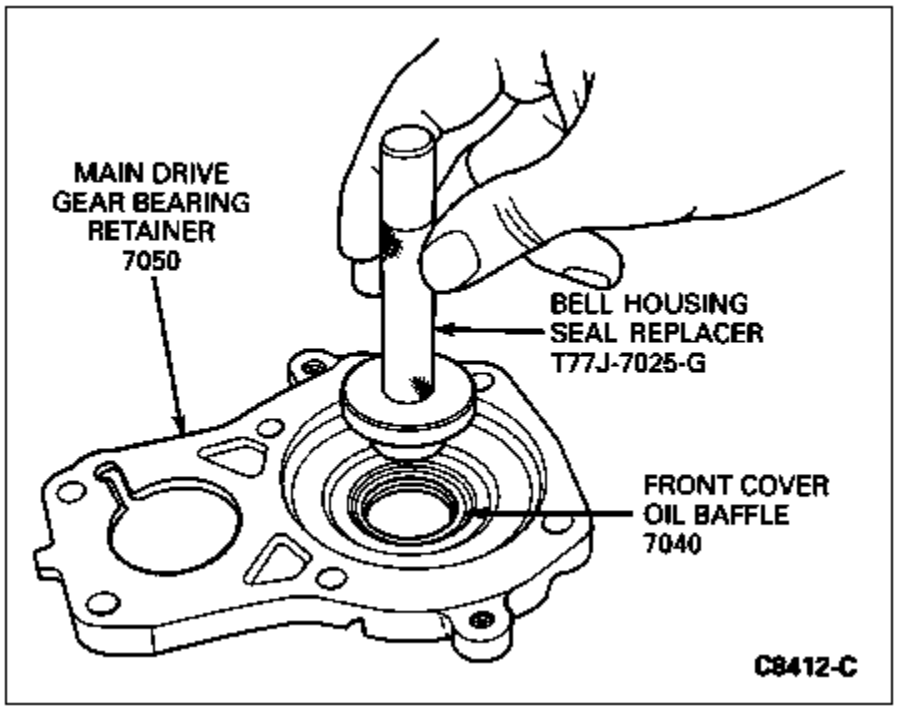
NOTE: Do not remove front bearing oil scoop ring (7046) at this time.

Remove main drive gear bearing retainer by threading two M8 x 1.25 (40mm or longer) bolts into the bearing retainer slave cylinder bolt locations. Alternately tighten bolts until main drive gear bearing retainer can be lifted away by hand.

Assembly

1. **NOTE: If any related parts (such as output shaft, bearing, etc.) have been replaced, measure dimensions A, B, C, and D as illustrated. After measuring all dimensions, select bearing shim to maintain end play within specified limits.**

   Position transmission (7003) vertically (input shaft (7017) and flywheel housing (6392) facing upward). Make sure that bearing (7025) is squarely positioned in bore. If removed, install front cover oil baffle (7040) using Bell Housing Seal Replacer T77J-7025-G.



2. Install output shaft bearing (7065) by hand.

Measuring to Select Shim Thickness

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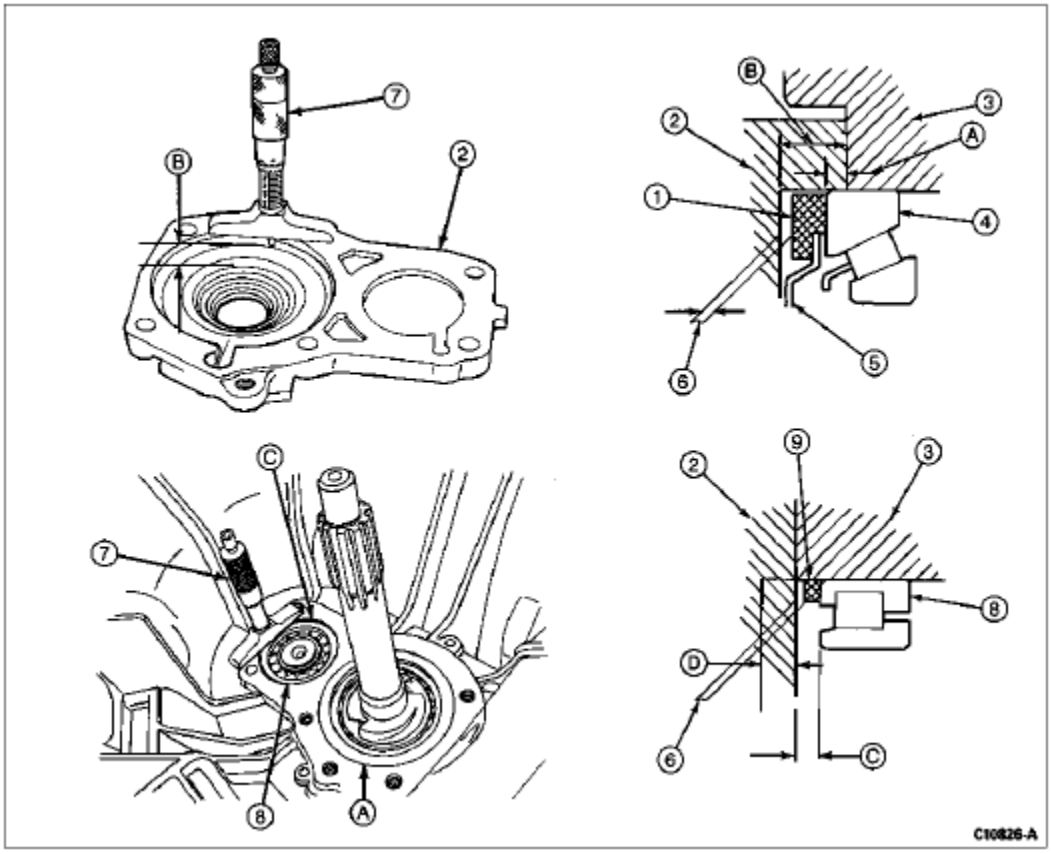

Item	Part Number	Description
1	7029	Selective Shim (Output Shaft)
2	7050	Main Drive Gear Bearing Retainer
3	7005	Case
4	7025	Bearing
5	7040	Oil Baffle
6	—	End Play Area
7	D82L-4201-C	Depth Micrometer
8	7065	Output Shaft Bearing
9	7C434	Selective Shim (Countershaft)
A	—	Dimension "A"
B	—	Dimension "B"
C	—	Dimension "C"
D	—	Dimension "D"

- **Dimension A:** Height of bearing above mating surface of main drive gear bearing retainer.
- **Dimension B:** Depth of bearing retainer bore (input shaft).
- **Dimension C:** Depth of countershaft front bearing race (transmission case-to-retainer mating surface).
- **Dimension D:** Depth of main drive gear bearing retainer bore (countershaft).

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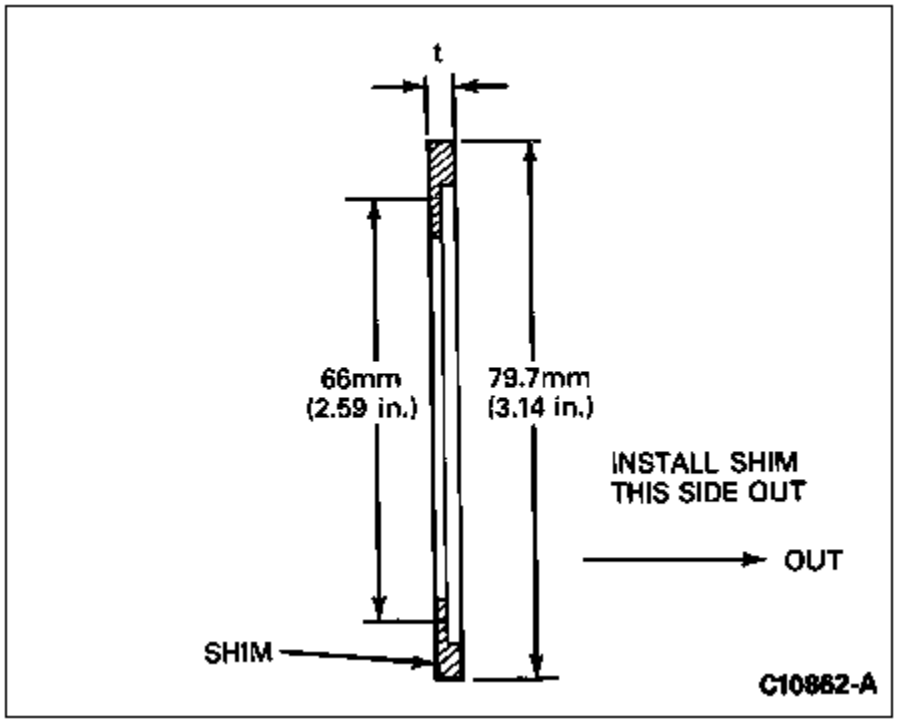
- Shim computation equations are as follows:

Dimension B - [Dimension A + shim thickness] = 0.05 to 0.15mm (0.002-0.006 inch)

Dimension C + [Dimension D - shim thickness] = 0.15 to 0.25mm (0.006-0.010 inch)



Output Shaft Shim Select Chart — M5OD — R1

Part Number	Thickness (t)
E8TZ-7029-C	2.7mm (0.106 In.)
E8TZ-7029-D	2.8mm (0.110 In.)
E8TZ-7029-E	2.9mm (0.114 In.)
E8TZ-7029-F	3.0mm (0.118 In.)
E8TZ-7029-G	3.1mm (0.122 In.)
E8TZ-7029-H	3.2mm (0.125 In.)
E8TZ-7029-J	3.3mm (0.129 In.)
E8TZ-7029-K	3.4mm (0.133 In.)
E8TZ-7029-L	3.5mm (0.137 In.)
E8TZ-7029-M	3.6mm (0.141 In.)
E8TZ-7029-N	3.7mm (0.145 In.)
E8TZ-7029-P	3.8mm (0.149 In.)

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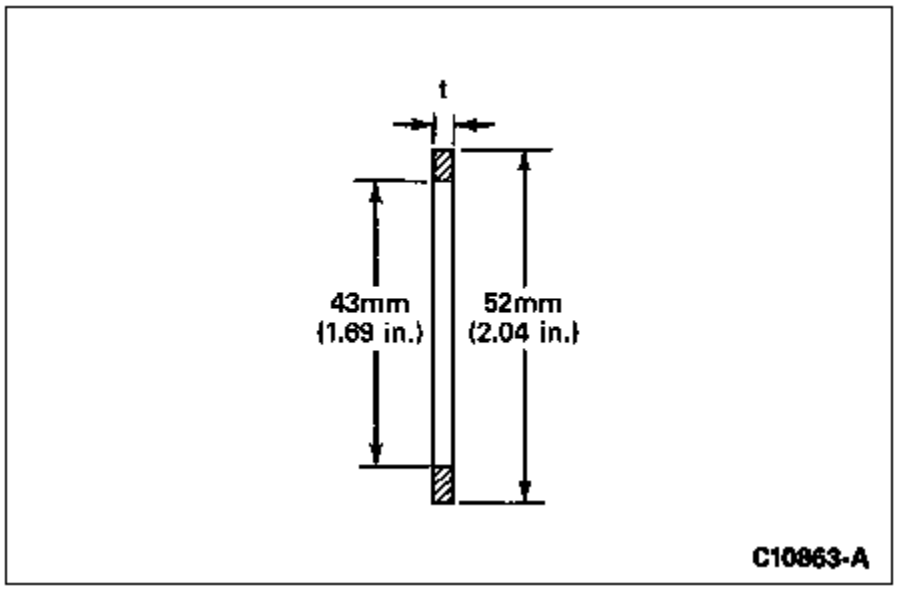
E8TZ-7029-R	3.9mm (0.153 In.)
E8TZ-7029-A	4.0mm (0.157 In.)
E8TZ-7029-B	4.1mm (0.161 In.)



Countershaft Spacer
Select Chart — M5OD — R1

Part Number	Thickness (t)
E8TZ-7C434-A	2.3mm (0.090 In.)
E8TZ-7C434-B	2.4mm (0.094 In.)
E8TZ-7C434-C	2.5mm (0.098 In.)
E8TZ-7C434-D	2.6mm (0.102 In.)
E8TZ-7C434-E	2.7mm (0.106 In.)
E8TZ-7C434-F	2.8mm (0.110 In.)
E8TZ-7C434-G	2.9mm (0.114 In.)
E8TZ-7C434-H	3.0mm (0.118 In.)
E8TZ-7C434-J	3.1mm (0.122 In.)

3. Remove any sealant residue remaining on mating surfaces of transmission and main drive gear bearing retainer.

4. **NOTE: To prevent damage to oil seal lip during assembly, tape the input shaft splines along their entire length.**

   NOTE: If necessary, apply a sufficient quantity of grease to shim, main drive gear bearing retainer and oil baffle to retain them in position during assembly.

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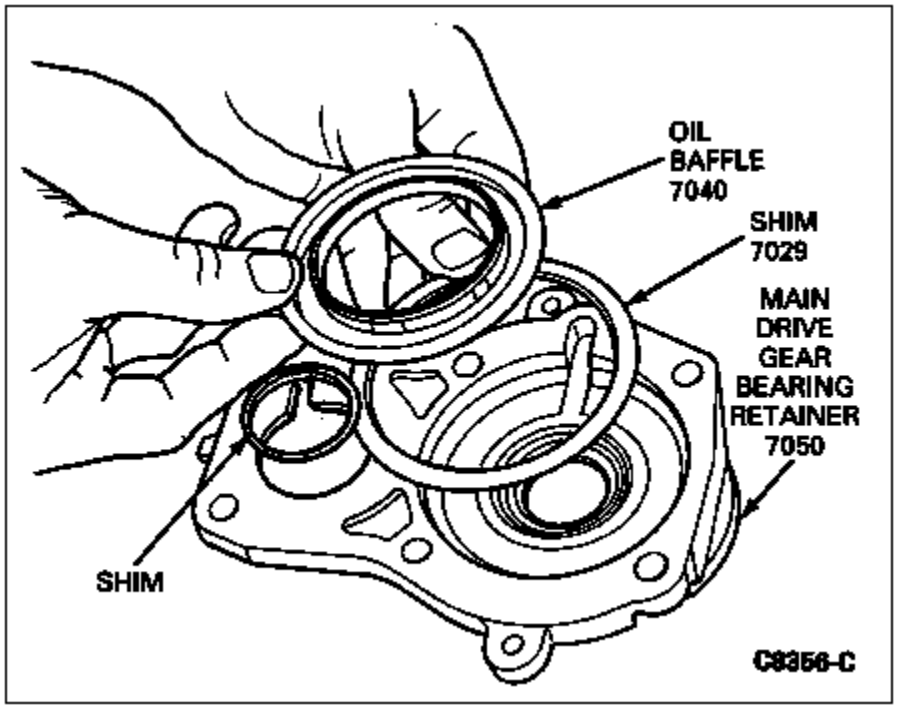
Apply a thin coat of oil to oil seal lip. Position bearing shim and oil baffle into main drive gear bearing retainer (install shim with groove showing). Install spacer to bore of output shaft bearing.



5. **NOTE: Make sure that retaining bolt heads are marked with a "6."**

   Apply a 3.18mm (1/8-inch) bead of silicone rubber D6AZ-19562-AA or equivalent meeting Ford specification ESB-M4G92-A or ESE-M4G195-A to main drive gear bearing retainer and retaining bolt threads. Install main drive gear bearing retainer to case. Install and tighten front bearing cover retaining bolts to 16-22 Nm (12-16 lb-ft).

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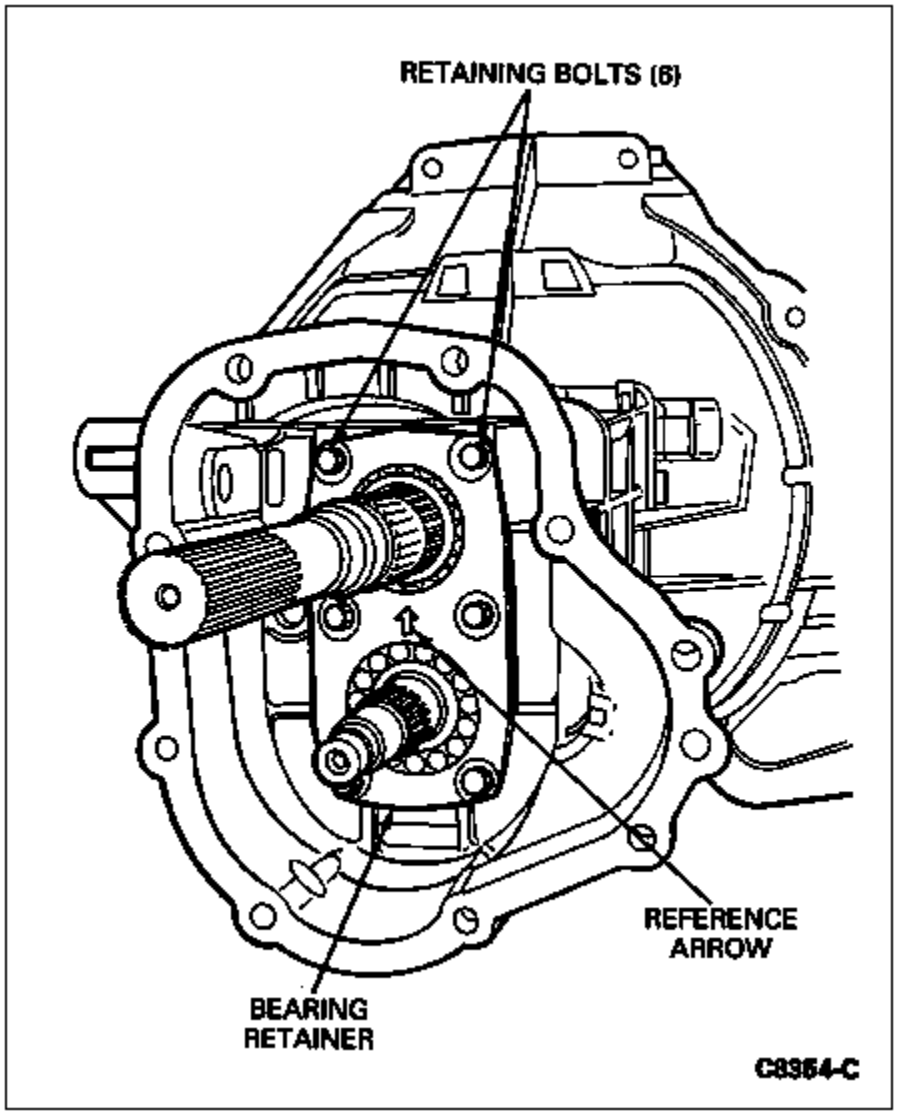
Bearing Retainer, Rear

Disassembly

1. **NOTE: For reference during assembly, observe that reference arrow in middle of bearing retainer points upward. Observe that flanged side faces inward.**

   Using a 12mm socket, remove retaining bolts. Remove bearing retainer (7085).



Assembly

1. **NOTE: Make sure that all retaining bolt heads are marked with an "8."**

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Position bearing retainer to case with reference arrow pointing upward. Install and tighten retaining bolts to 18-26 Nm (13-19 lb-ft).

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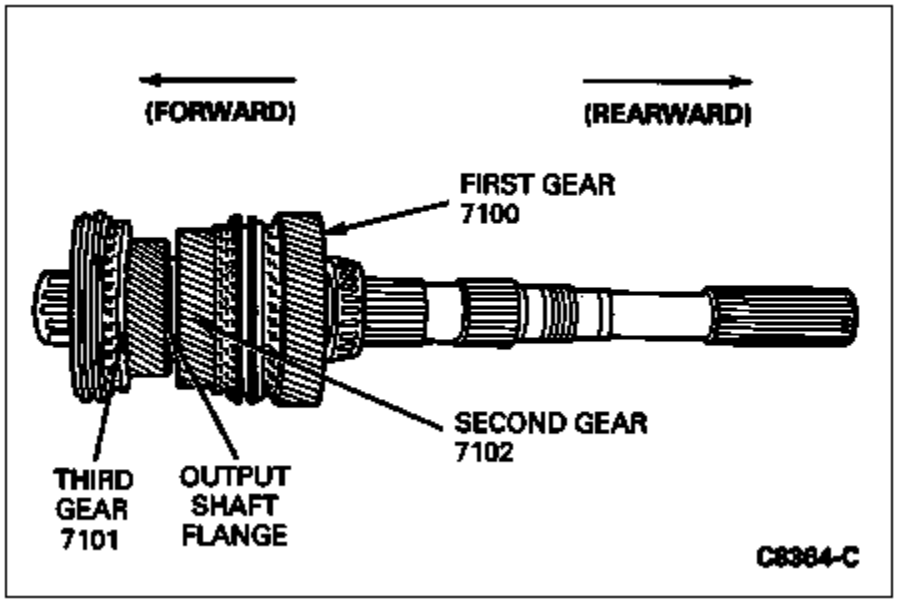
Output Shaft

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Remover/Replacer Tube	T75L-7025-B
Pinion Bearing Cone Replacer	T53T-4621-B
Axle Bearing/Seal Plate	T57L-1165-B
Bearing Cone Replacer	T88T-7025-B

Disassembly

1. Position front flange of output shaft forward as shown in the following illustration. Use this flange as a reference point and dividing line during assembly and disassembly procedures.



2. Remove transmission input shaft pilot bearing (7118), bearing outer snap ring (7030), thrust bearing (7C096), and third and fourth synchronizer spacer (7N112) from front (short side of flange) of output shaft.

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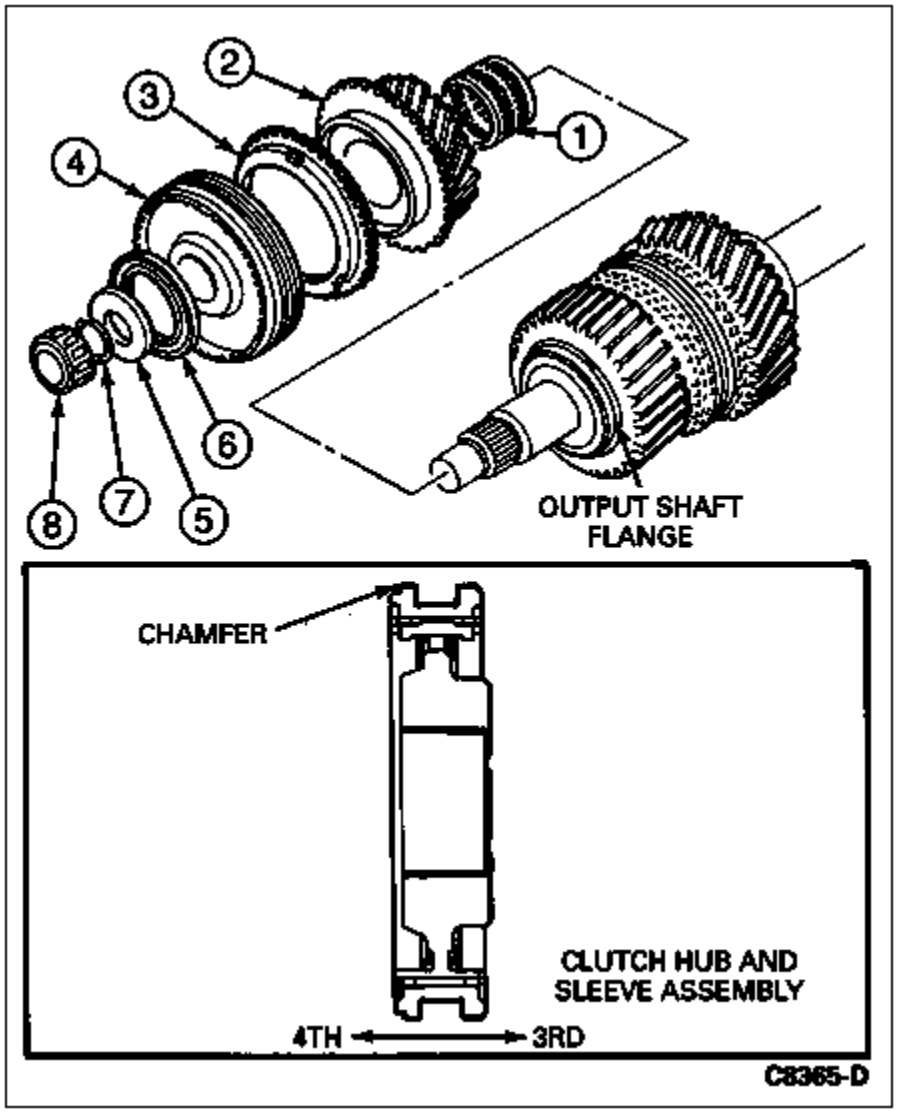

Item	Part Number	Description
1	7127	Gear Bearing
2	7101	Third Gear
3	7124	Synchronizer
4	7124	Synchronizer
5	7N112	Third and Fourth Synchronizer Spacer
6	7C096	Thrust Bearing
7	7030	Bearing Outer Snap Ring
8	7118	Transmission Input Shaft Pilot Bearing

3. Position the front (short side of flange) of the mainshaft so that it faces upward. Lift off the following components as a unit:

    - Synchronizer (7124) (third/fourth).

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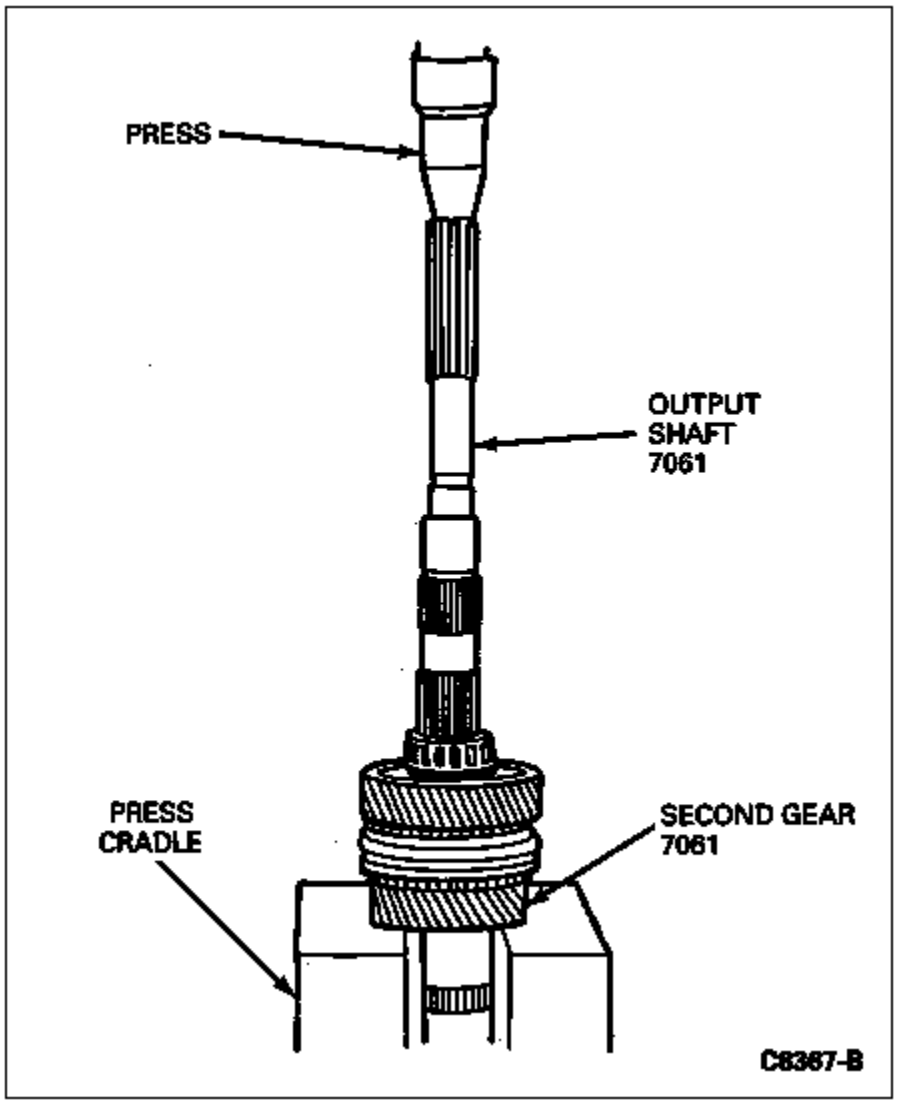
- Synchronizer blocking ring (7107) (third).
- Third gear.
- Gear bearing (7127).

4. **CAUTION: Make sure that flange does not contact or ride up onto press cradle. Improper positioning can result in component damage.**

   Position mainshaft, with rear end (long side of flange) facing upwards into press using Pinion Bearing Cone Replacer T53T-4621-B as a press plate, and Bearing Cone Replacer T88T-7025-B to protect inner race rollers.



5. Press off the following components as a unit:

   - Bearing (7025)
   - Input bearing spacer (7173)
   - First gear (1GR) (7100)

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- First and second speed gear bearing (7133)
- First/second synchronizer
- First/second Synchronizer blocking rings
- Second gear (2GR) (7102)
- First and second speed gear bearing.

Assembly

NOTE: Make note of the differences between the third gear synchronizer blocking ring and the first, second and fourth gear synchronizer blocking rings. The third gear synchronizer blocking ring has three teeth cut out 120 degrees apart from each other. Directly adjacent to one side of the missing teeth, two teeth have been bridged together. This is to help eliminate any upshift "crunch" that may occur.

NOTE: To install components onto output shaft, position components as illustrated. Press components into position using Pinion Bearing Cone Replacer T53T-4621-B and Axle Bearing/Seal Plate T75L-1165-B.

NOTE: Make sure that bearing is still positioned in case (7005).

1. **NOTE: During installation, apply Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX or equivalent MERCON® fluid to all rotating or sliding parts.**

   Position mainshaft so that the rear end (long side of flange) faces upward. Install the following parts in the order listed:

   - Second gear needle bearing
   - Second gear
   - Second gear synchronizer blocking ring
   - First/second synchronizer
   - First gear synchronizer blocking ring
   - First gear needle bearing
   - First gear
   - Input bearing spacer
   - Bearing

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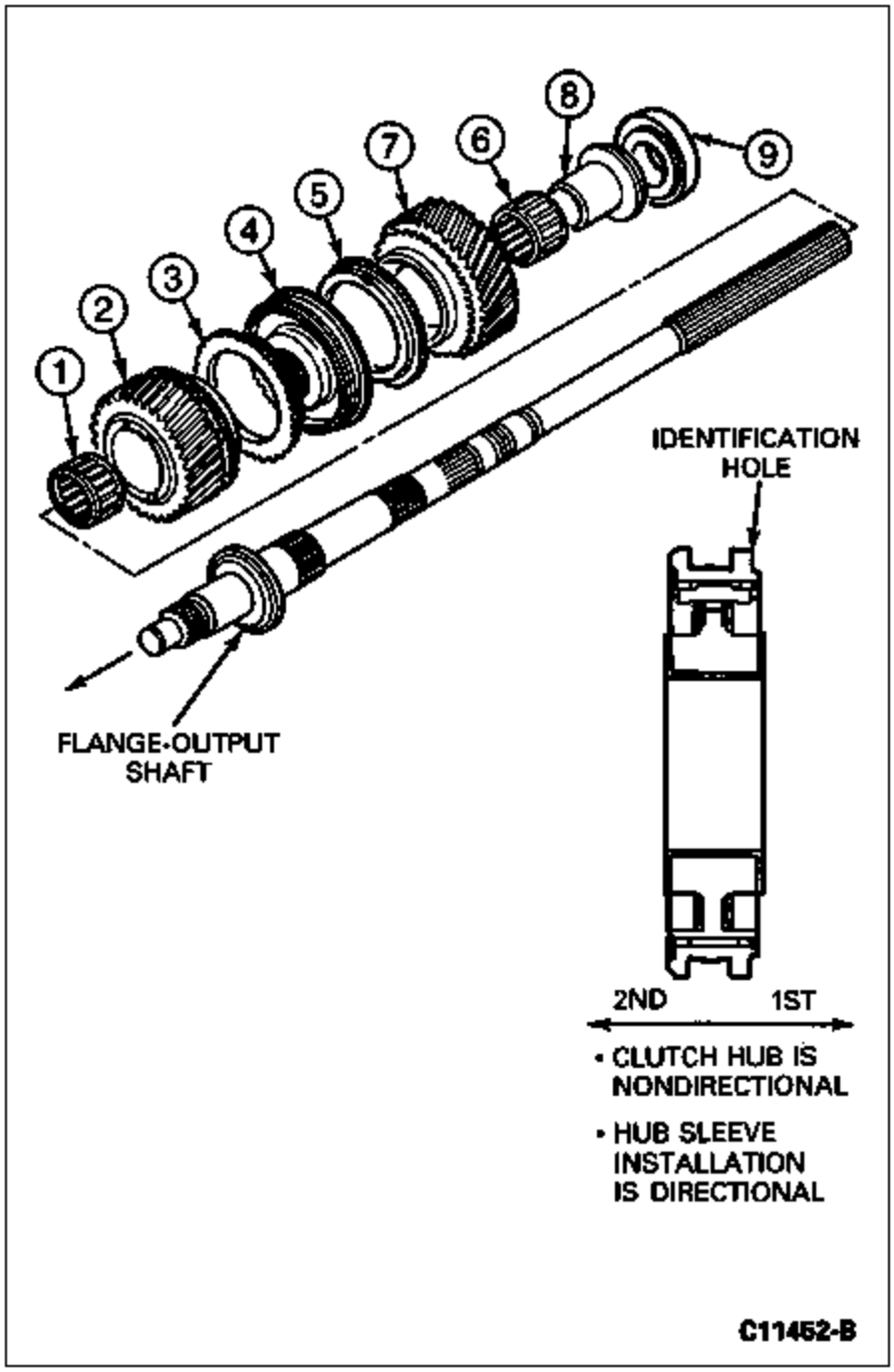

Item	Part Number	Description
1	7133	First and Second Speed Gear Bearing
2	7102	Second Gear
3	7107	Synchronizer Blocking Ring
4	7124	Synchronizer
5	7107	Synchronizer Blocking Ring
6	7133	First and Second Speed Gear Bearing

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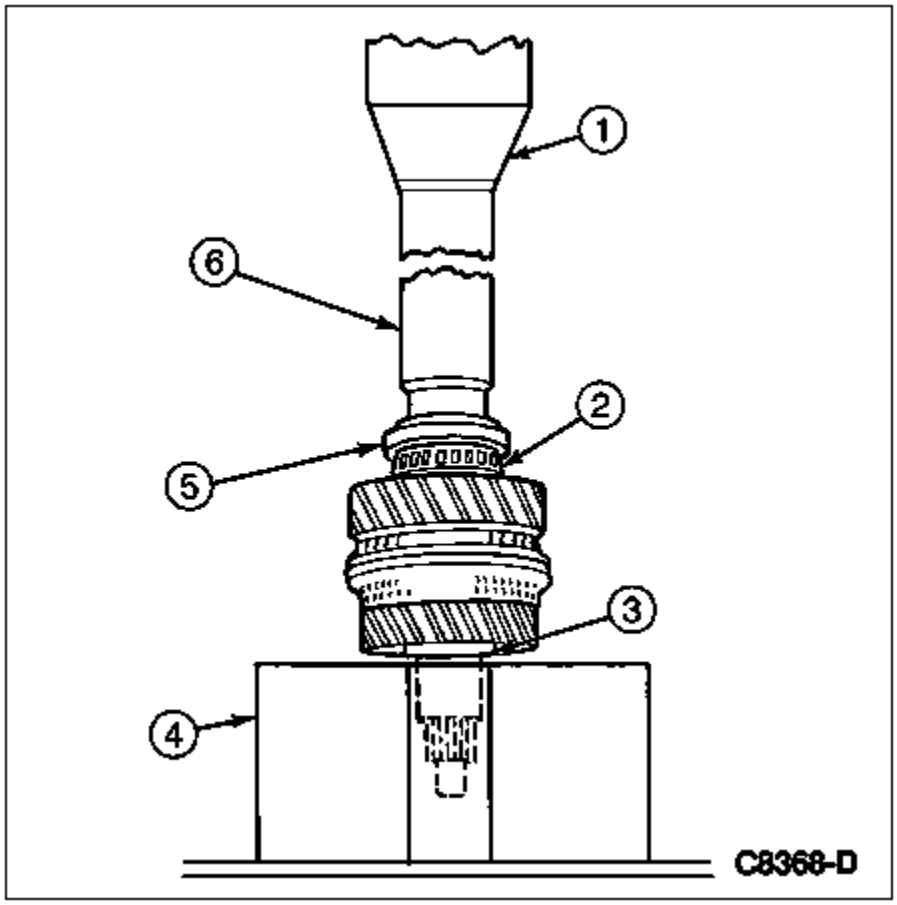
7	7100	First Gear
8	7173	Input Bearing Spacer
9	7025	Bearing

2. **NOTE: When installing first/second synchronizer, make sure that smaller width of sleeve faces second gear (front) side. Make sure that reference marks face rear of transmission (7003); they reference installation position of synchronizer hub insert (7A044).**

   Press the center bearing onto the mainshaft using the following tools:

   - Remover/Replacer Tube T75L-7025-B.
   - Locally fabricated sleeve where the inside diameter is large enough to fit over the output shaft but small enough to engage the inner bearing race.

   Position the mainshaft on a press cradle as shown in the following illustration. Using the sleeve and replacer tube as a press ram, seat the center bearing.



Item	Part Number	Description
1	—	Press
2	7C096	Thrust Bearing

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3	7061	Output Shaft
4	—	Bearing Plate
5	T83T-7025-B	Output Shaft Bearing Replacer
6	T75L-7025-B	Remover/Replacer Tube

3. **NOTE: Make note of the differences between the third gearsynchronizer blocking ring and the first, second and fourth gear synchronizer blocking rings. The third gear synchronizer blocking ring has three teeth cut out 120 degrees apart from each other. Directly adjacent to one side of the missing teeth, two teeth have been bridged together. This is to help eliminate any upshift "crunch" that may occur.**

   Position output shaft so that the front (short side) of flange faces upward. Install the following parts in the order listed.

   - Gear bearing
   - Third gear
   - Third gear synchronizer blocking ring

4. **NOTE: The front and rear sides of the clutch hub may appear to be similar. Be sure to install it with the chamfer facing toward fourth gear (4GR) (7112).**

   Install third/fourth synchronizer as follows:

   - Mate clutch hub synchronizer key groove with the slants on the inner surface of the clutch hub sleeve. The turned edge of the clutch hub sleeve should face toward fourth gear.
   - Install longer flange on clutch hub sleeve toward third gear (rear) side.

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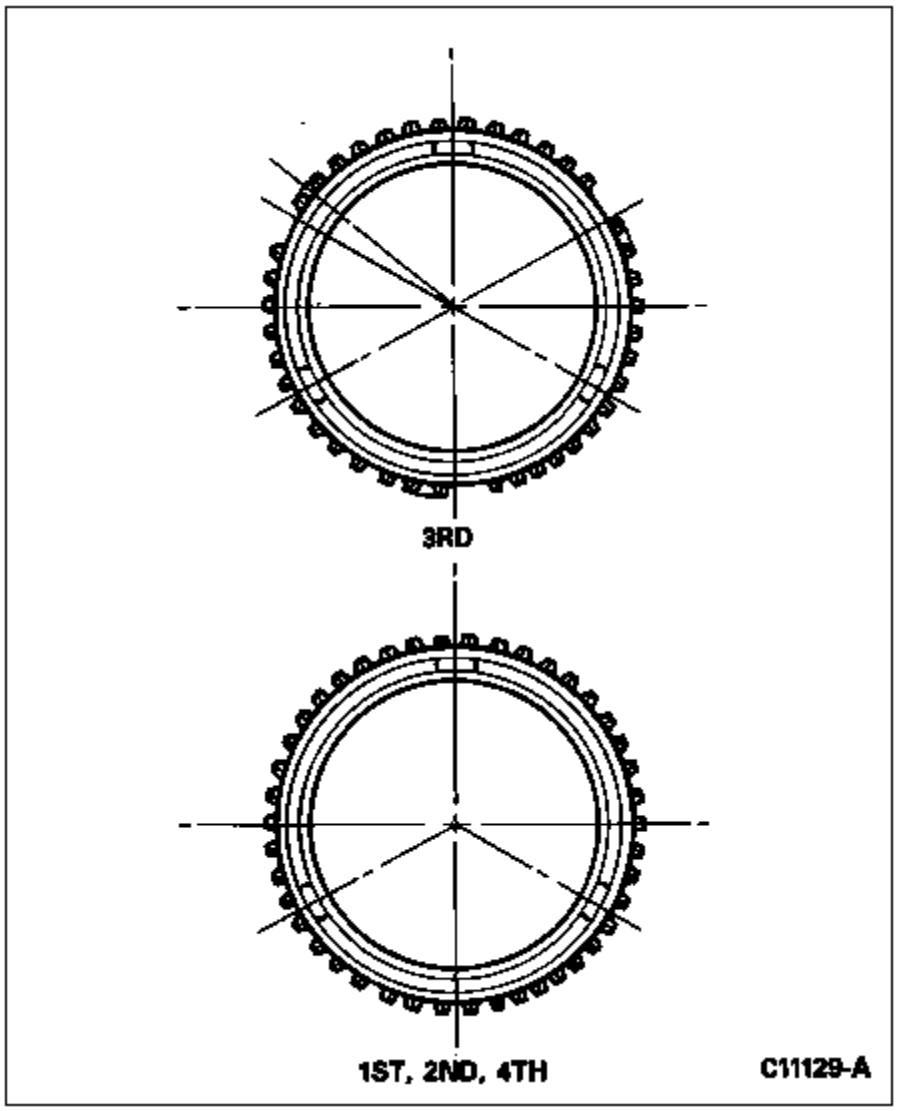

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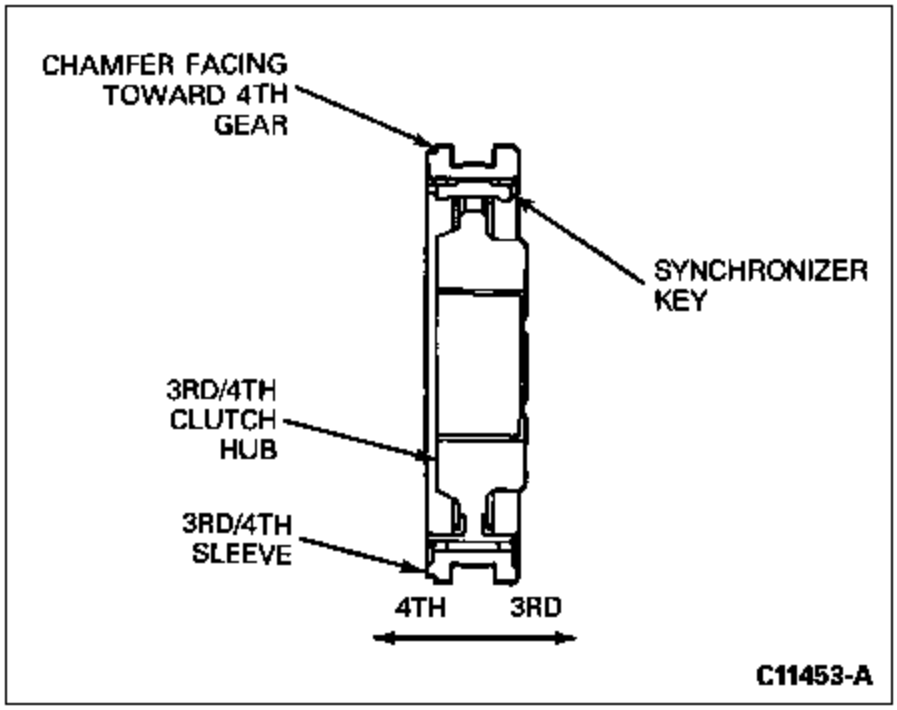
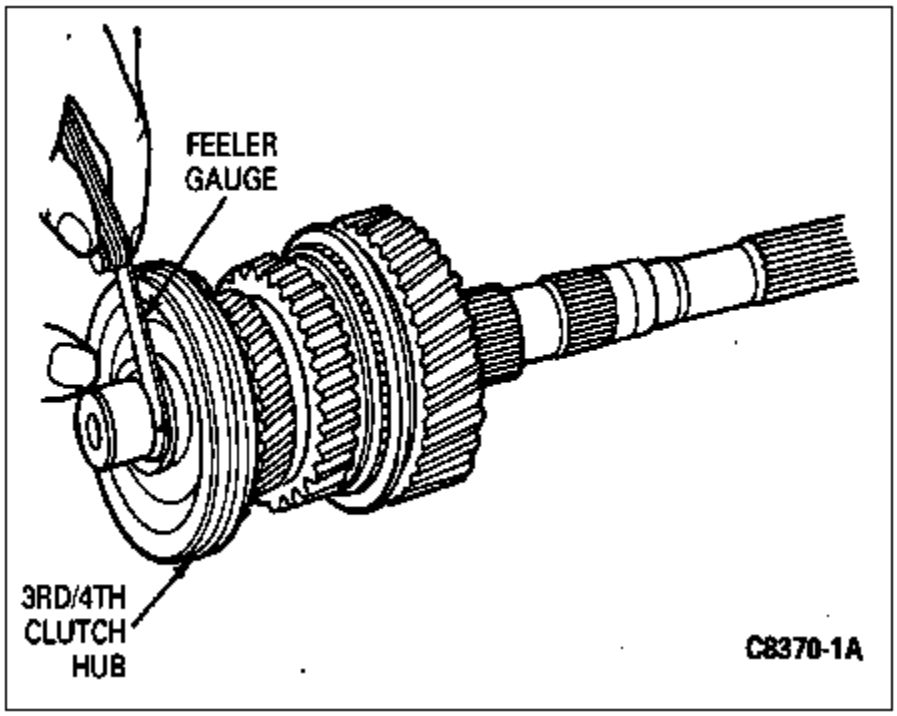


5. Install the spacer and bearing outer snap ring onto the output shaft.

6. With the original bearing outer snap ring installed, measure the clutch hub end play using a feeler gauge.



7. If necessary adjust third/fourth clutch hub end play to 0.00-0.05mm (0.00-0.0019 inch) by selecting required bearing outer snap ring according to the chart.

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8. After determining the correct retaining ring, install the needle bearing (with the rollers visible), bearing outer snap ring and pilot bearing.

BEARING OUTER SNAP RING SELECT CHART

Part Number	Thickness
E8TZ-7030-A	1.50mm (0.059 In.)
E8TZ-7030-B	1.55mm (0.061 In.)
E8TZ-7030-C	1.60mm (0.0629 In.)
E8TZ-7030-D	1.65mm (0.0649 In.)
E8TZ-7030-E	1.70mm (0.0669 In.)
E8TZ-7030-F	1.75mm (0.0688 In.)
E8TZ-7030-G	1.80mm (0.0708 In.)
E8TZ-7030-H	1.85mm (0.0728 In.)
E8TZ-7030-J	1.90mm (0.0748 In.)
E8TZ-7030-K	1.95mm (0.0767 In.)

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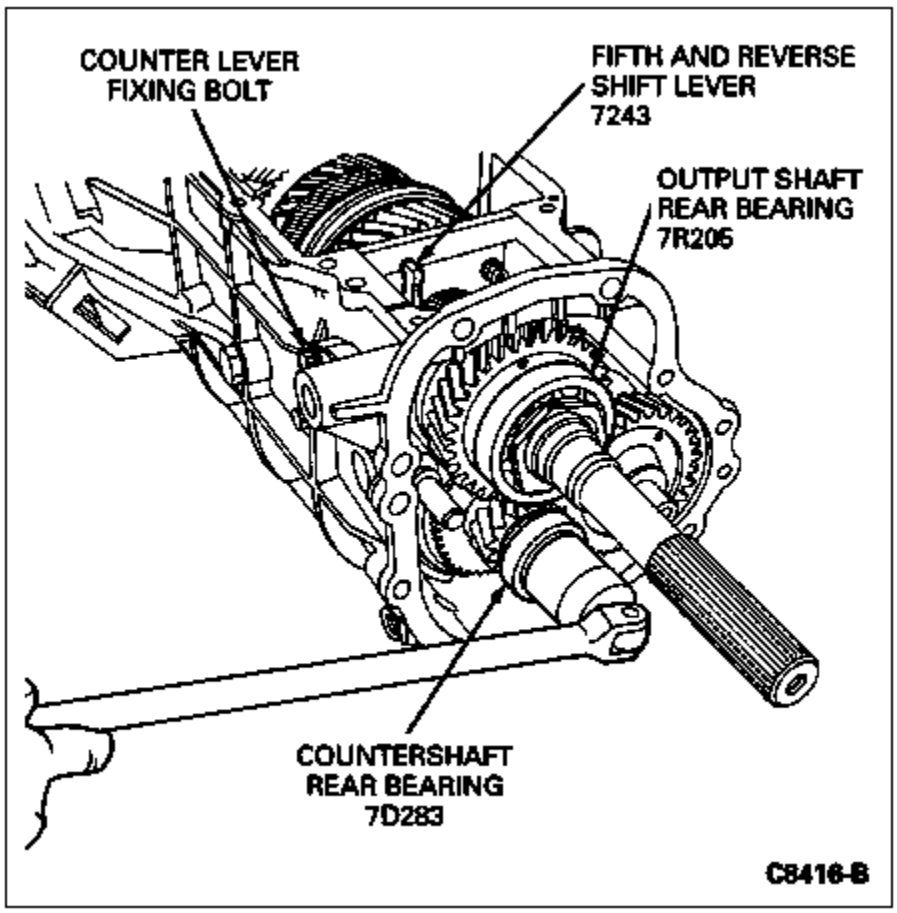
Bearing, Countershaft

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Mainshaft Locknut Wrench	T88T-7025-AR
Remover/Replacer Tube	T75L-7025-B

1. Lock transmission (7003) into first and third gears.

2. Using a 32mm socket, remove and discard locknut, then remove the countershaft rear bearing (7D283) and thrust washer.



3. Using Mainshaft Locknut Wrench T88T-7025-AR and Remover/Replacer Tube T75L-7025-B, remove and discard locknut from output shaft.

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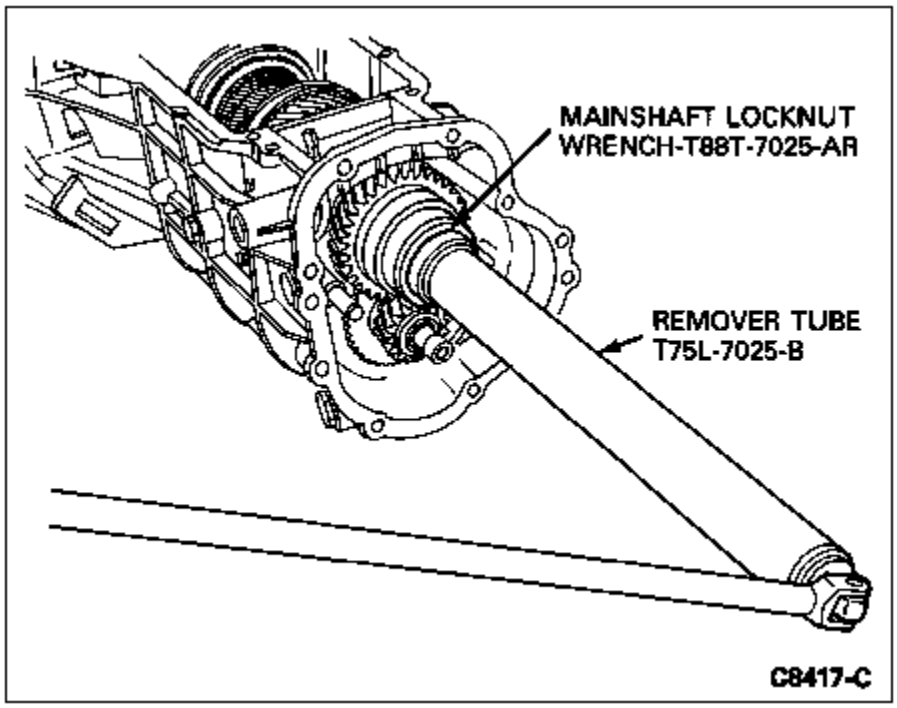

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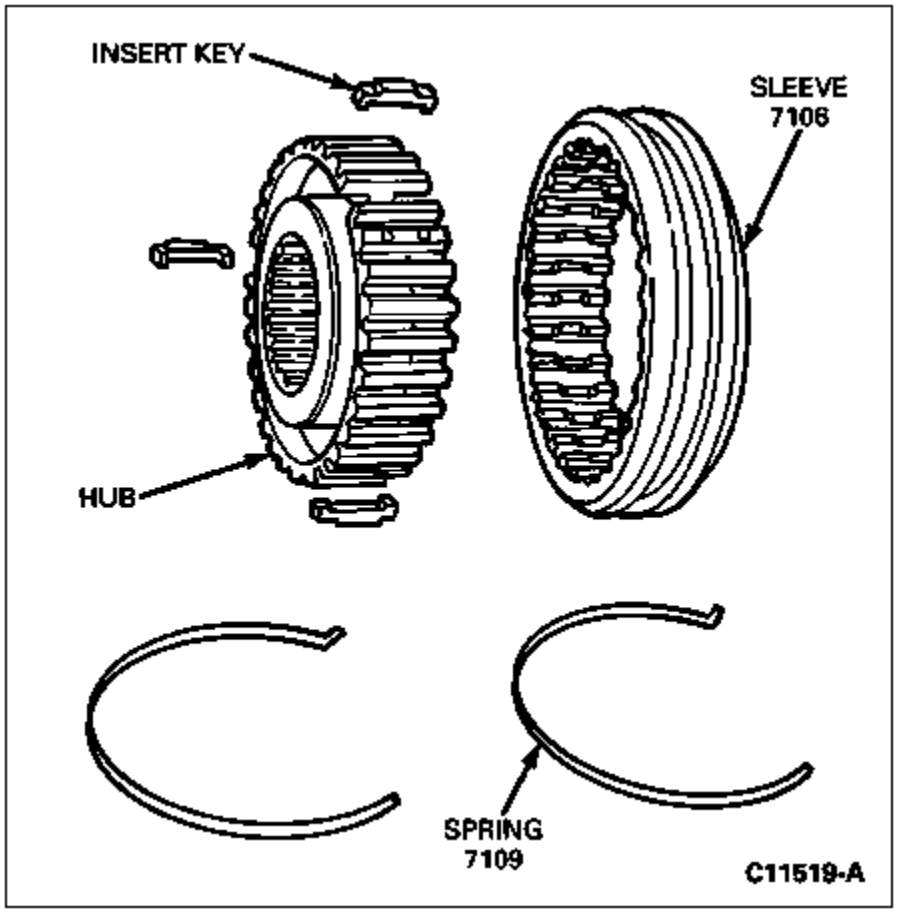
Synchronizers

1. Lay synchronizer (7124) face down and remove one synchronizer blocking spring (7109), using a suitable tool.
2. Hold synchronizer sleeve (7106) and hub assembly in place and turn assembly over to the opposite face and lay flat on work table.
3. Remove second synchronizer blocking spring and three insert keys.
4. Slide synchronizer sleeve from hub. Replace parts as necessary.



Assembly

1. Locate indented dot reference mark on the shoulder of one face side of synchronizer sleeve. Check drawing for direction of clutch hub to sleeve assembly. Insert hub into synchronizer sleeve with one of the three insert slots of hub aligned with reference mark. This will make certain of proper orientation of hub to sleeve splines. Make sure hub moves freely on synchronizer sleeve.

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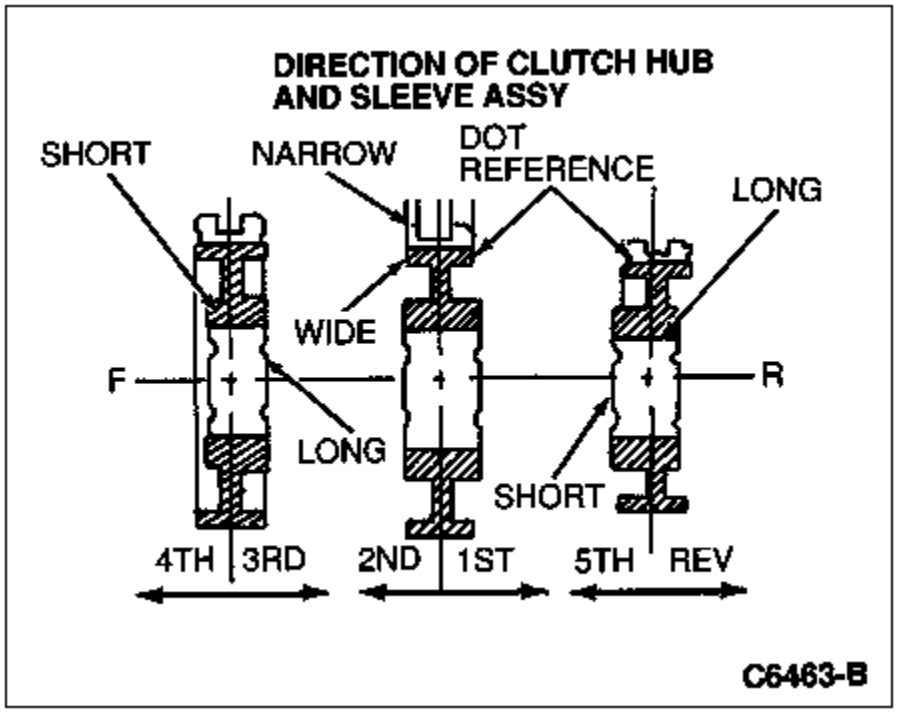

2. Lay hub and sleeve assembly face down on work table and place three insert keys into hub slots.

3. Insert one synchronizer blocking spring into clip hole located in inner shoulder of synchronizer sleeve, and place synchronizer blocking spring under protruding edge of each insert key.

4. Holding hub and synchronizer sleeve together, turn assembly over to opposite face side.

5. Insert second synchronizer blocking spring just like the first, but in the opposite direction. One synchronizer blocking spring should be counterclockwise to the other.

6. When sliding synchronizer assembly onto shaft, do not allow excessive movement between hub and sleeve. This will cause insert keys to pop out of hub slots and require reassembly.

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Transmission

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Gear Replacing Spacer	T88T-7025-F
Gear Replacing Spacer	T88T-7025-E
Shaft Collar	T75L-7025-M
Shaft Collar	T75L-7025-P
Shaft Sleeve — Replacer	T75L-7025-K
Remover/Replacer Tube	T75L-7025-B
Remover/Replacer Tube	T85T-7025-A
Shaft Adapter — Replacer	T75L-7025-L
Adapter	T88T-7025-J2

1. Position countershaft (7111) into case (7005) through top opening.

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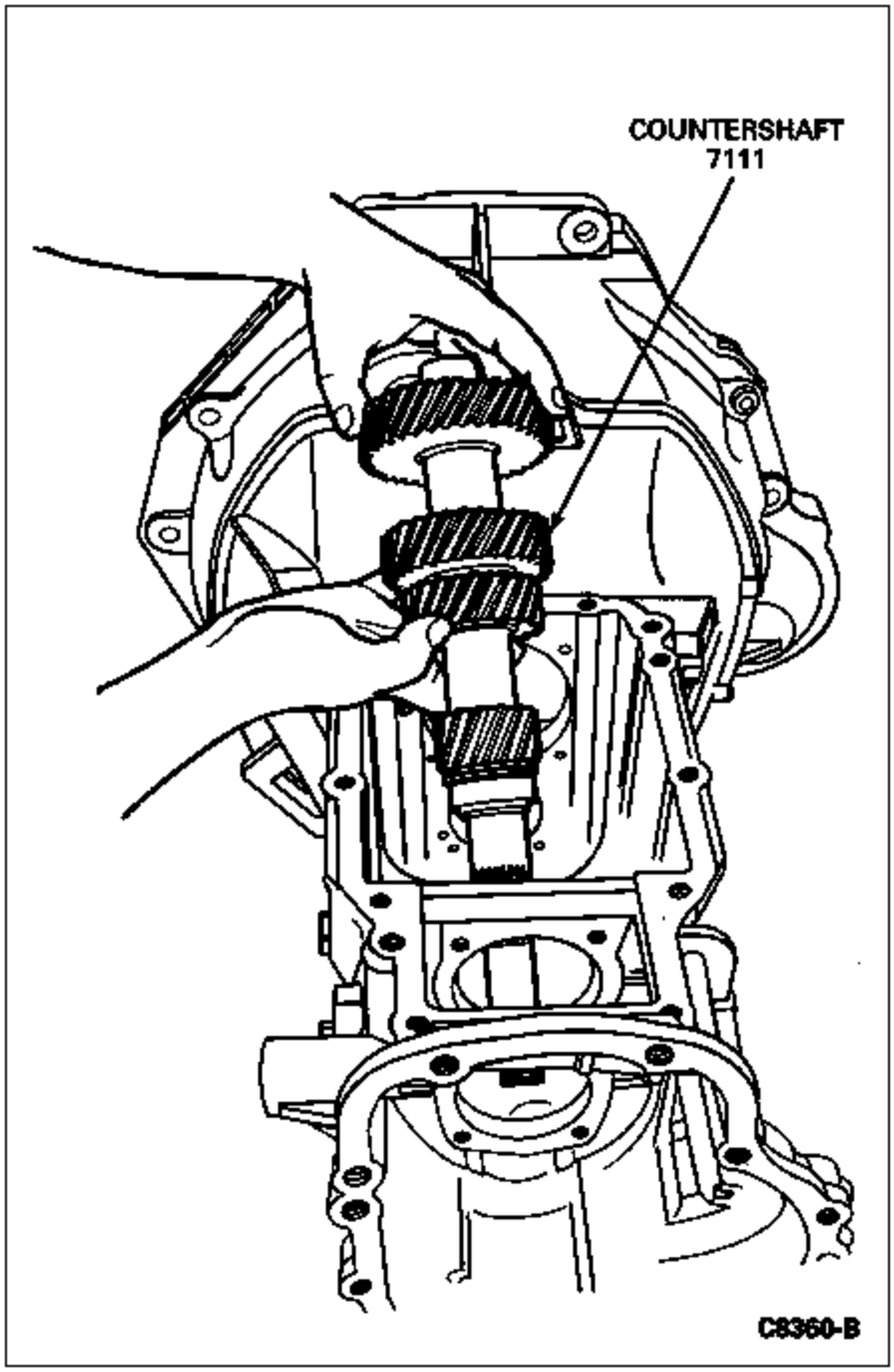

2. **NOTE: Make sure that needle roller bearing is installed into input shaft (7017).**

   NOTE: Needle bearing is symmetric.

   Position input shaft into case through top opening.

3. **NOTE: Make sure that fourth gear synchronizer blocking ring (7107) is installed at this time.**

   Position output shaft into case. Mate input shaft and output shaft by positioning them at an upward angle and setting them together.

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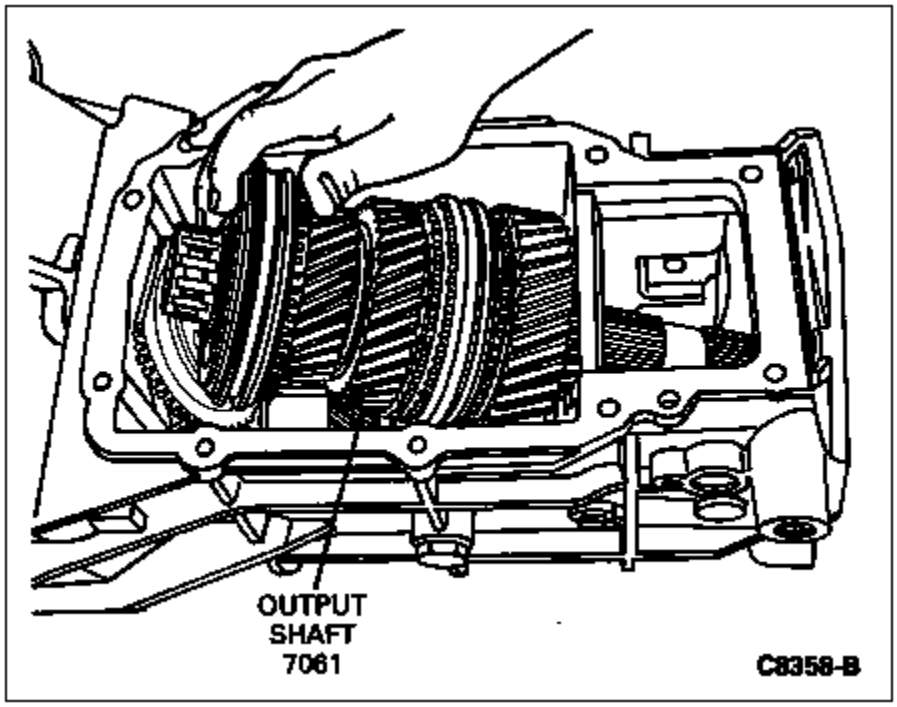

4. Install bearing (7025) using a brass drift.

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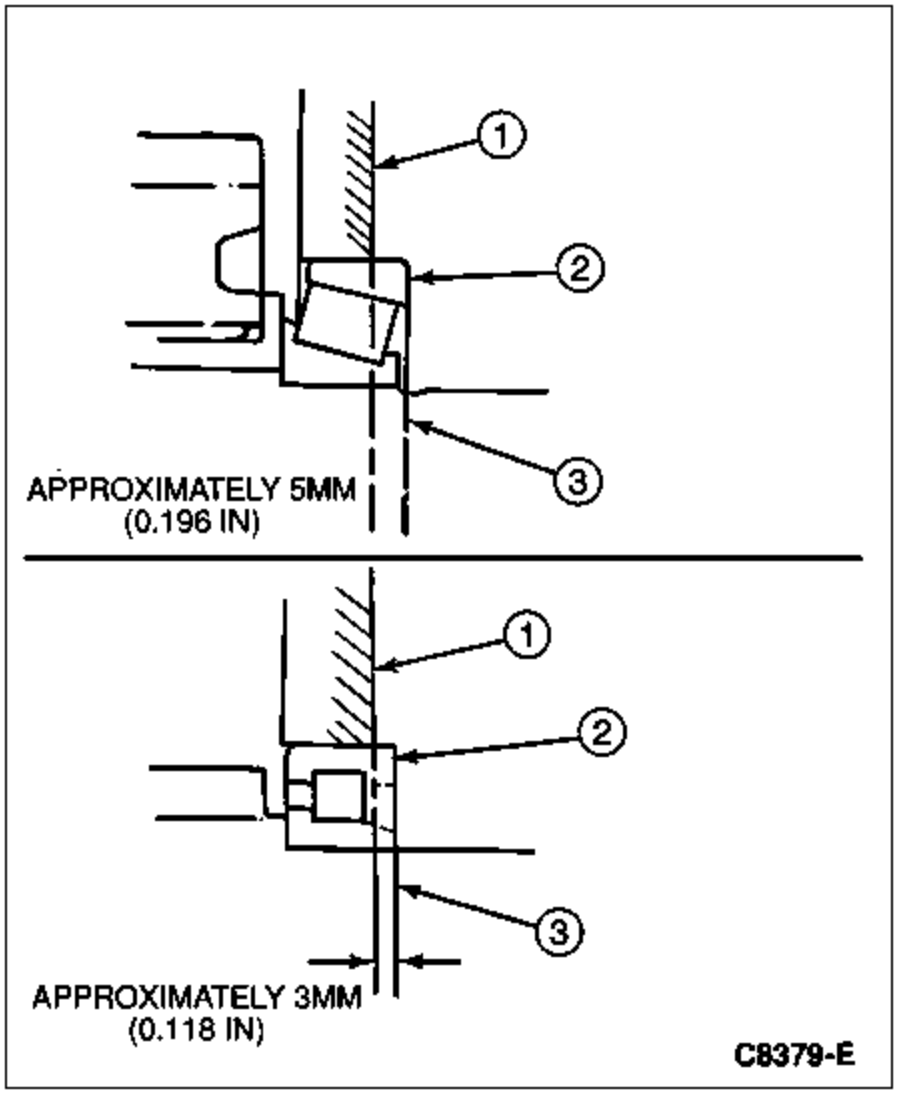

Item	Part Number	Description
1	—	Transmission Case Wall (Part of 7003)
2	7118	Bearing
3	7061	Output Shaft

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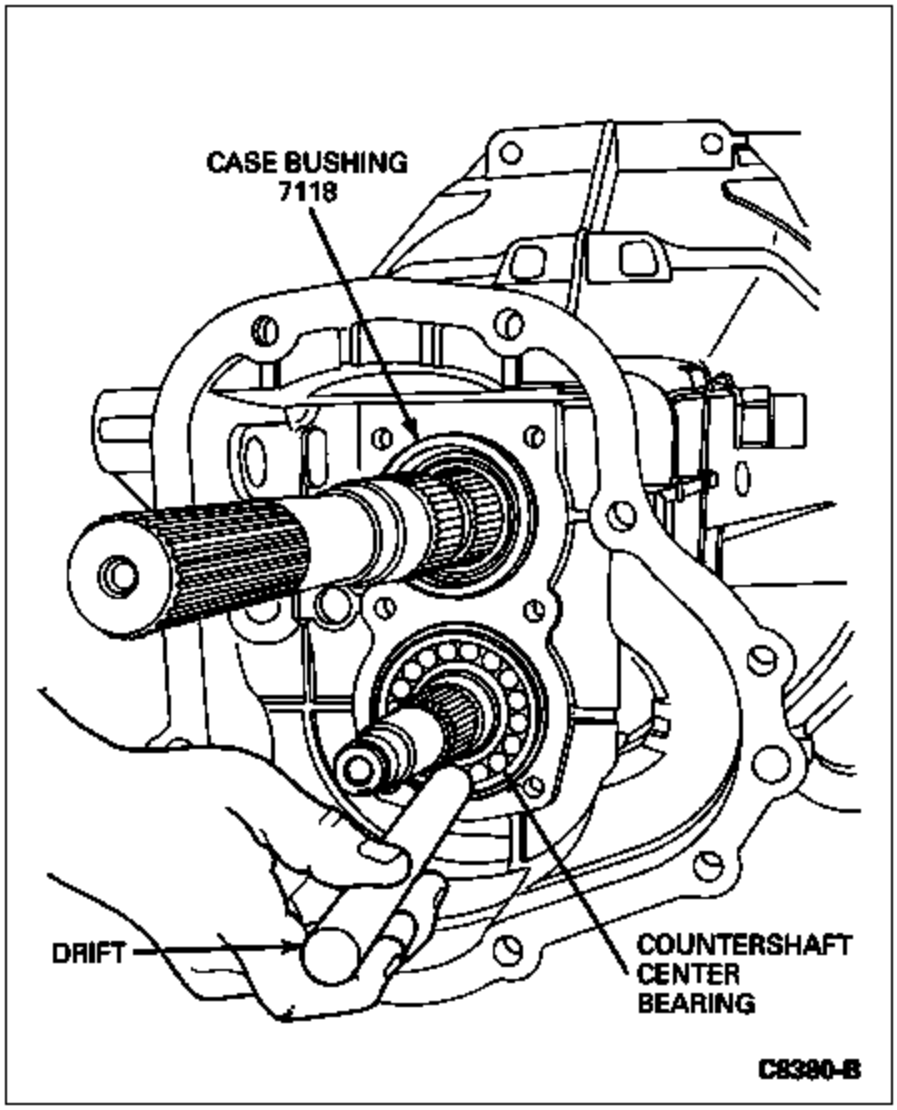

5. **NOTE: Make sure that center bearing outer races are squarely positioned in bores.**

   Install countershaft center bearing.

6. Install bearing retainer (7085) to case.

7. **NOTE: Install fifth gear sleeve using nut, Shaft Adapter — Replacer T75L-7025L, Adapter T88T-7025-J2 and Remover/Replacer Tube T75L-7025-B.**

   Position transmission (7003) horizontally in holding fixture. Assemble the following parts in the order listed.

   - Ball
   - Fifth gear sleeve

Transmission, Rear Housing

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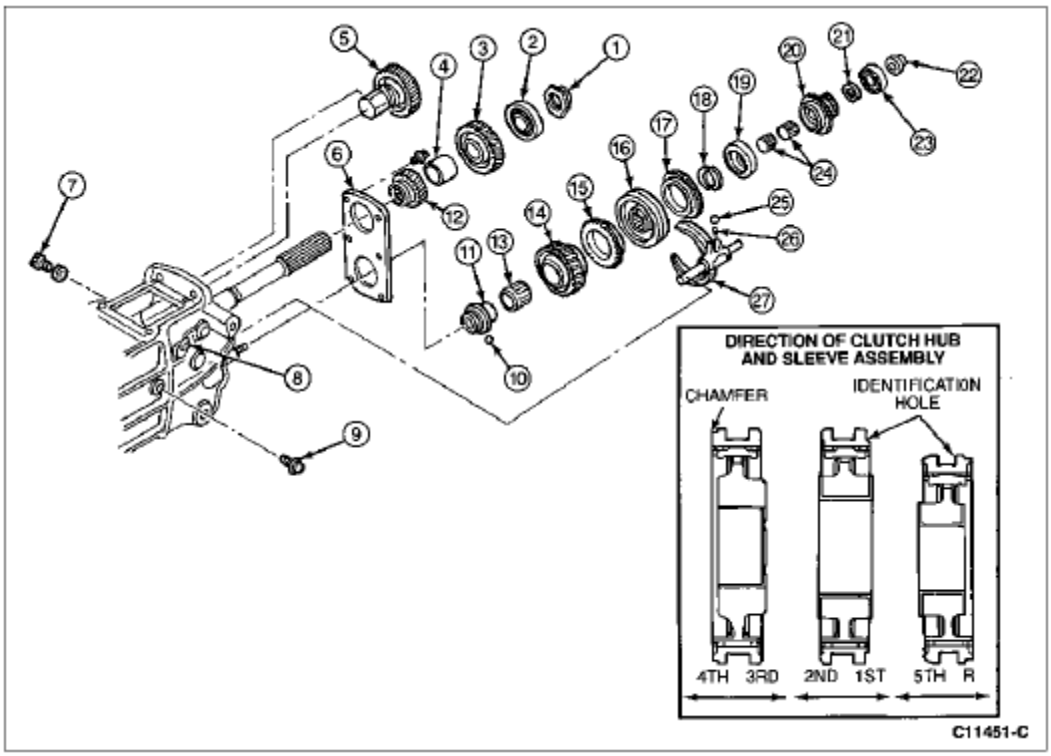

Item	Part Number	Description
1	7B364	Locknut
2	7R205	Output Shaft Rear Bearing
3	7142	Output Shaft Reverse Gear
4	7072	Spacer or Sleeve
5	7141	Reverse Idler Gear and Bushing
6	7085	Bearing Retainer
7	7K179	Reverse Idler Gear Holding Bolt
8	99796-0612	Bolt
9	7214	Fifth and Reverse Shift Rod Bolt
10	99611-2000	Ball
11	7173	Input Bearing Spacer
12	7112	Fifth Gear
13	7R130	Needle Bearing, Fifth Gear
14	7142	Fifth Gear, Countershaft
15	7107	Synchronizer Blocking Ring
16	7124	Synchronizer
17	7107	Synchronizer Blocking Ring
18	7R482	Synchronizer Split Washer
19	7C340	Thrust Washer
20	7N040	Countershaft Reverse Gear

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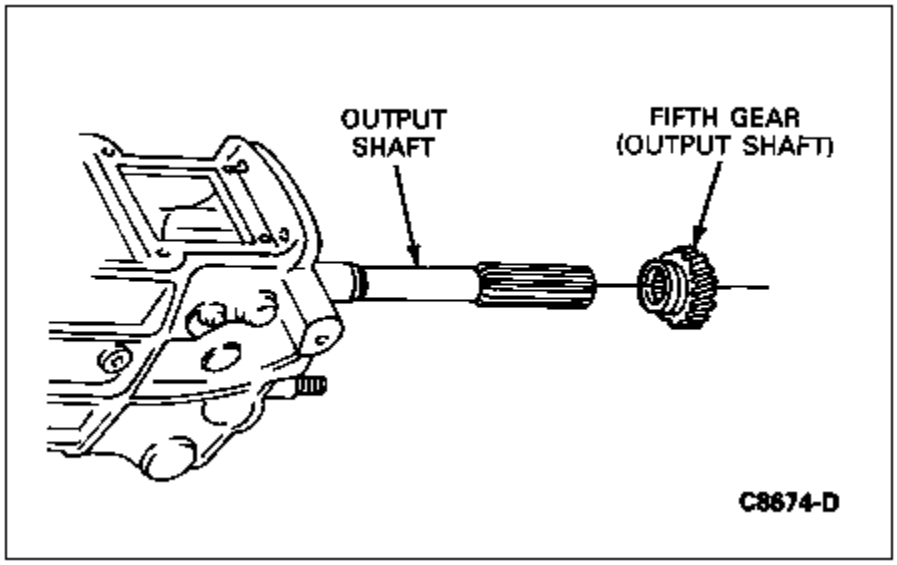
21	7L324	Thrust Washer
22	7N170	Locknut
23	7D283	Countershaft Rear Bearing
24	7N270	Needle Bearing
25	7289	Lockball (Steel) Shift Rail
26	99796-0612	Bolt
27	7289	Shift Fork (5th and Reverse)

8. Install fifth gear (countershaft) and needle bearing onto countershaft.

9. Install fifth gear onto output shaft. Make sure that long flange on fifth gear faces forward.



10. Position counter lever shaft assembly to transmission and install thrust washer and retaining ring. Apply sealant to holding bolt threads. Install bolt and tighten to 8-10 Nm (6-7 lb-ft).

11. If disassembled, install shifter interlock spring (7234) and detent ball into fifth/reverse gear shifter fork (7230). Depress ball and insert fifth/reverse shift rail. Locate to neutral position.

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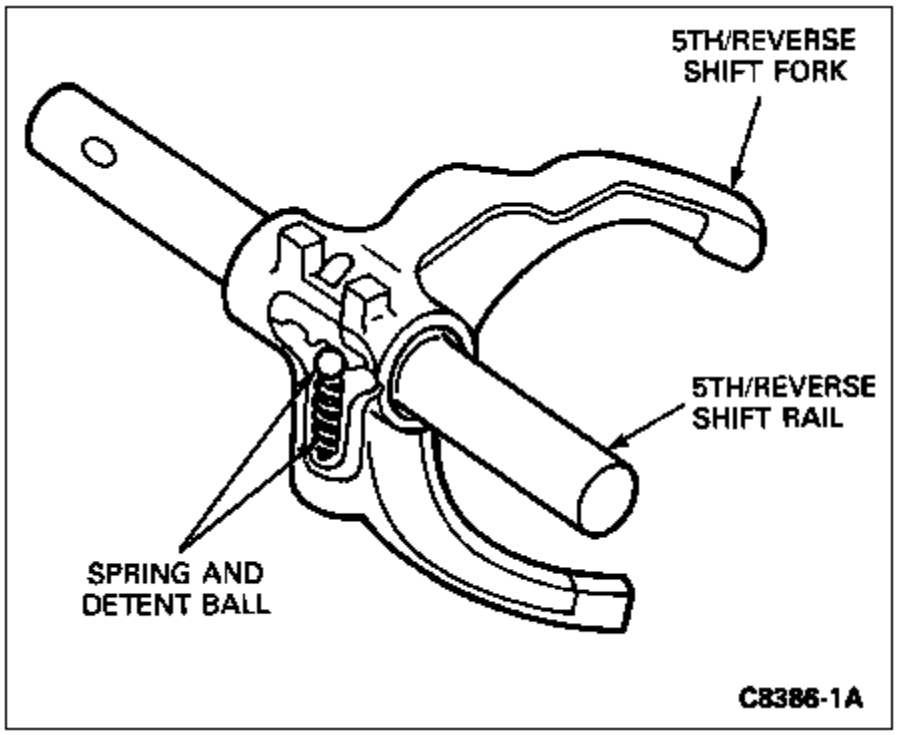
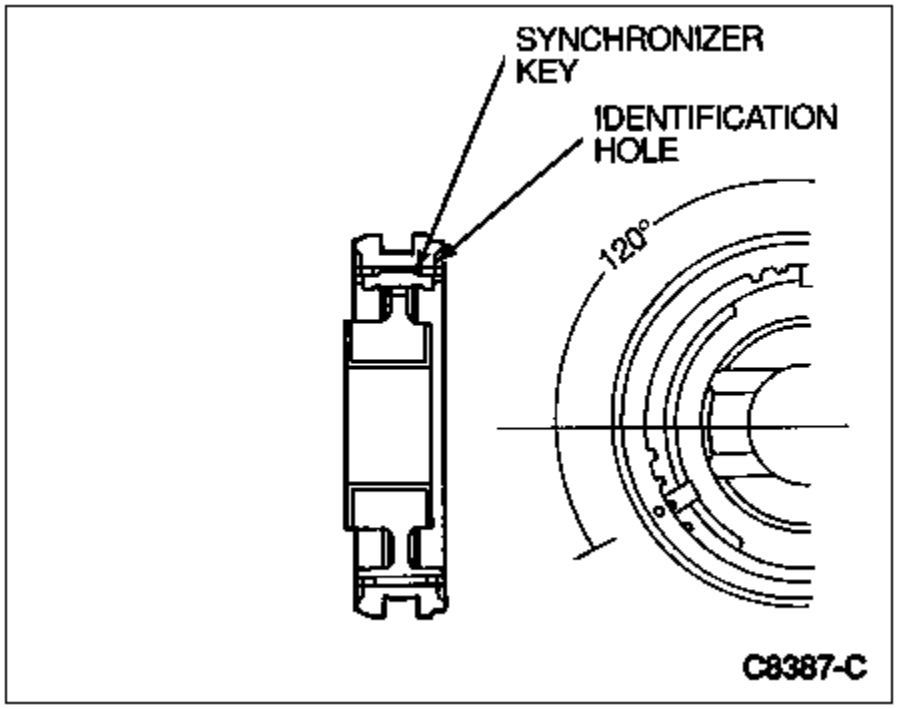


12. **NOTE: Install the longer flange (on the fifth/reverse synchronizer (7124)) toward the front of transmission. The reference mark on synchronizer sleeve must be installed toward reverse gear side.**

    Assemble the fifth/reverse synchronizer to fifth/reverse gear shifter fork and rail assembly.



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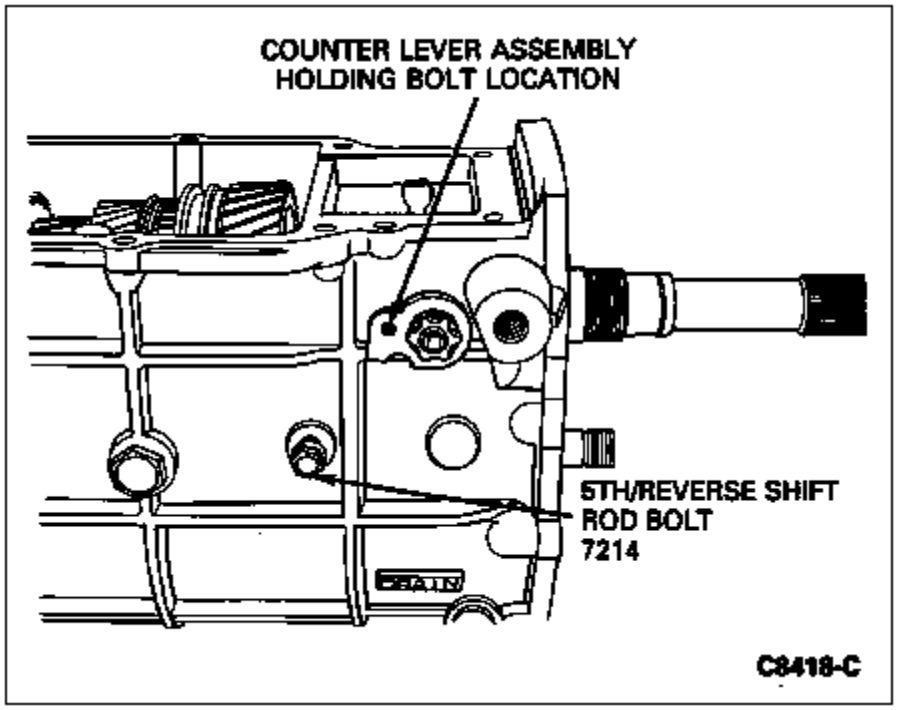
13. Install fifth/reverse shift fork and shift rail assembly (including fifth/reverse synchronizer) to countershaft. Mate shift fork gate to end of fifth/reverse counter lever end. Install fifth/reverse fork and shift rail assembly with threaded holding bolt bores (in rail and case) aligned with each other.

    a. Apply sealant to holding bolt threads. Install holding bolt to case. Tighten to 20-30 Nm (15-22 lb-ft).



14. Position oil bypass tube (7A174) to case and install retaining bolt. Tighten bolt to 8-10 Nm (6-7 lb-ft).

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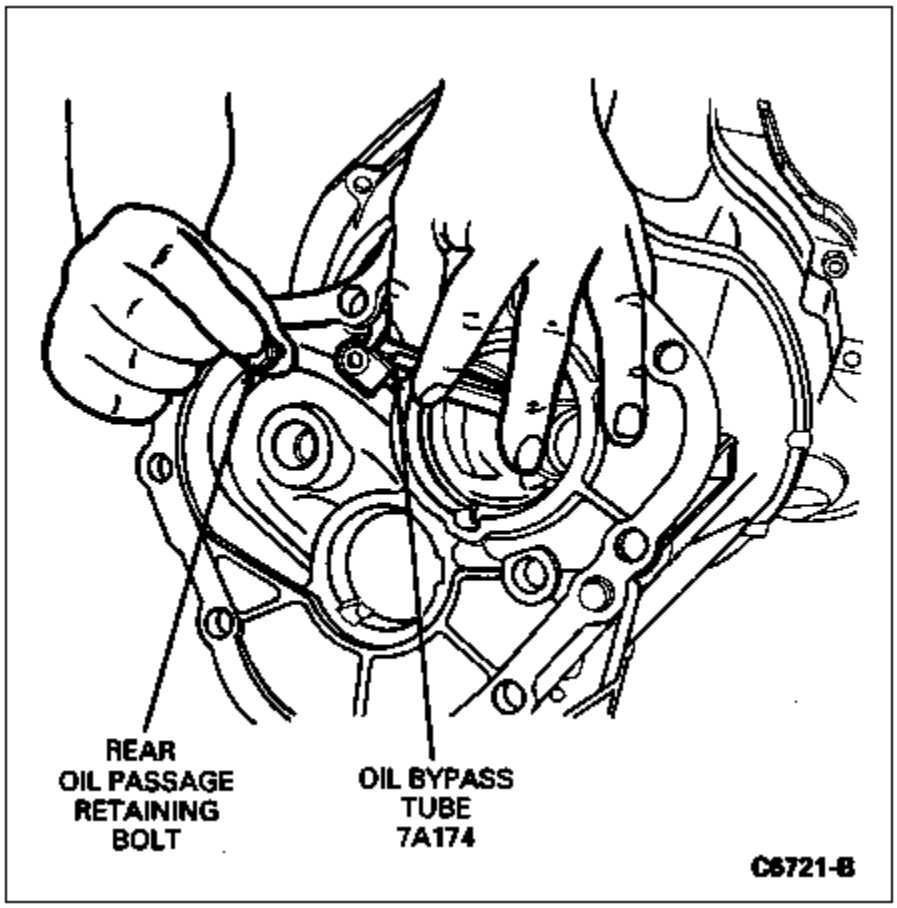

15. If original clutch hub and/or counter reverse gear are being used, install original split and thrust washers, then proceed to Step 22.

16. **NOTE: Make sure new synchronizer split washers (7R482) are matched, having identical thickness. Refer to Specifications for end play specifications.**

    If clutch hub and/or counter reverse gear have been replaced, measure end play using a feeler gauge. Select replacement synchronizer split washer using the following chart and install new synchronizer split washers onto output shaft.

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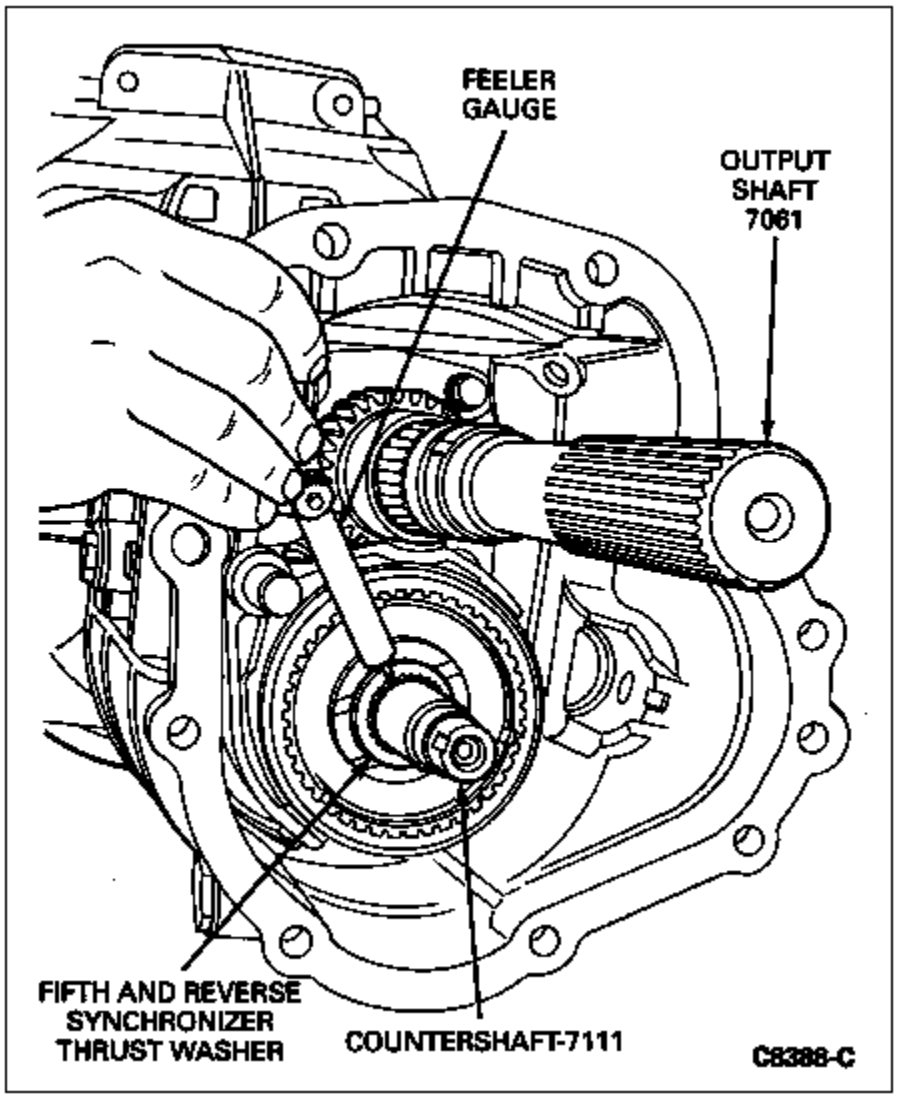

SPLIT WASHER SELECT CHART

Part Number	Thickness
E8TZ-7R482-A	3.0mm (0.118 In.)
E8TZ-7R482-B	3.1mm (0.122 In.)
E8TZ-7R482-C	3.2mm (0.125 In.)
E8TZ-7R482-D	3.3mm (0.129 In.)
E8TZ-7R482-E	3.4mm (0.133 In.)
E8TZ-7R482-F	3.05mm (0.120 In.)
E8TZ-7R482-G	3.15mm (0.124 In.)
E8TZ-7R482-H	3.25mm (0.127 In.)
E8TZ-7R482-J	3.35mm (0.131 In.)
E8TZ-7R482-K	3.45mm (0.135 In.)

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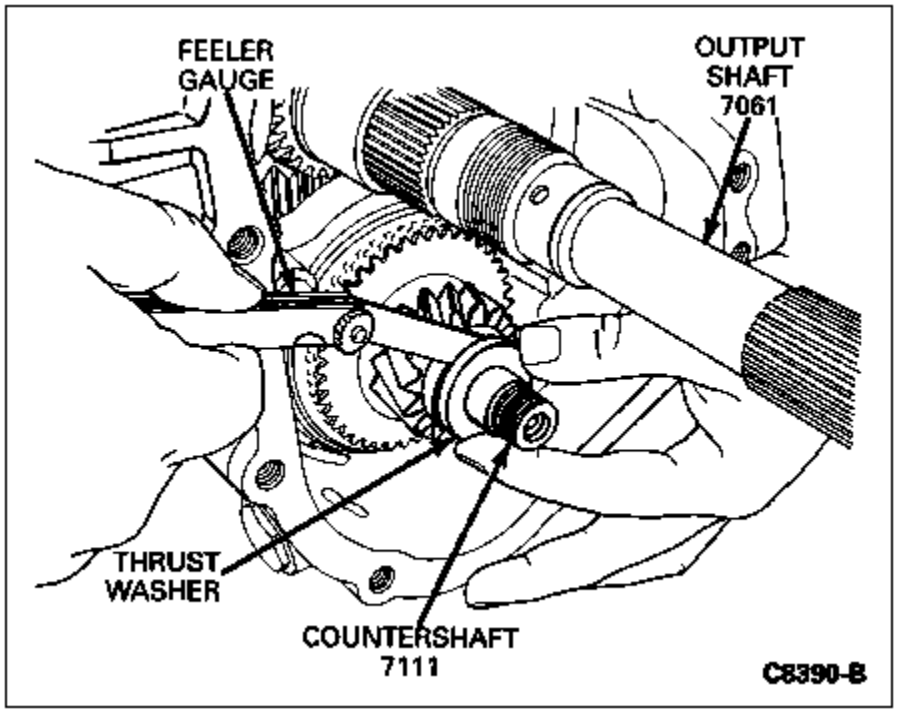
E8TZ-7R482-L	3.50mm (0.137 In.)

17. Install reverse synchronizer blocking ring and needle bearings into counter reverse gear. Install counter reverse gear and needle bearings onto countershaft as an assembly. Install thrust washer to countershaft.

18. **NOTE: If end play is not correct, the thrust washer that must be replaced is called out as item No. 21. Refer to the exploded view of the transmission rear housing.**

    Press thrust washer forward (by hand) against shoulder on countershaft. Maintain forward pressure against thrust washer and insert feeler gauge between thrust washer and counter reverse gear. Using the chart, determine correct thrust washer to obtain specified end play. Counter reverse gear end play: 0.25-0.35mm (0.010-0.014 inch).



THRUST WASHER SELECT CHART

Part Number	Thickness
E8TZ-7C340-A	7.45mm (0.293 In.)
E8TZ-7C340-B	7.65mm (0.301 In.)
E8TZ-7C340-C	7.85mm (0.309 In.)
E8TZ-7C340-D	7.35mm (0.289 In.)
E8TZ-7C340-E	7.55mm (0.297 In.)
E8TZ-7C340-F	7.75mm (0.305 In.)

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19. **NOTE: Installation of a suitable spacer prevents thrust washer and split washers from slipping off shaft, and avoids interference with reverse idler gears.**

    Temporarily install a suitable spacer (inner bore larger than 21mm [.83 inch], outer bore smaller than 36mm [1.4 inch], 15-20mm [.59-.78 inch] overall length) in place of countershaft bearing. Loosely install countershaft locknut to retain components.

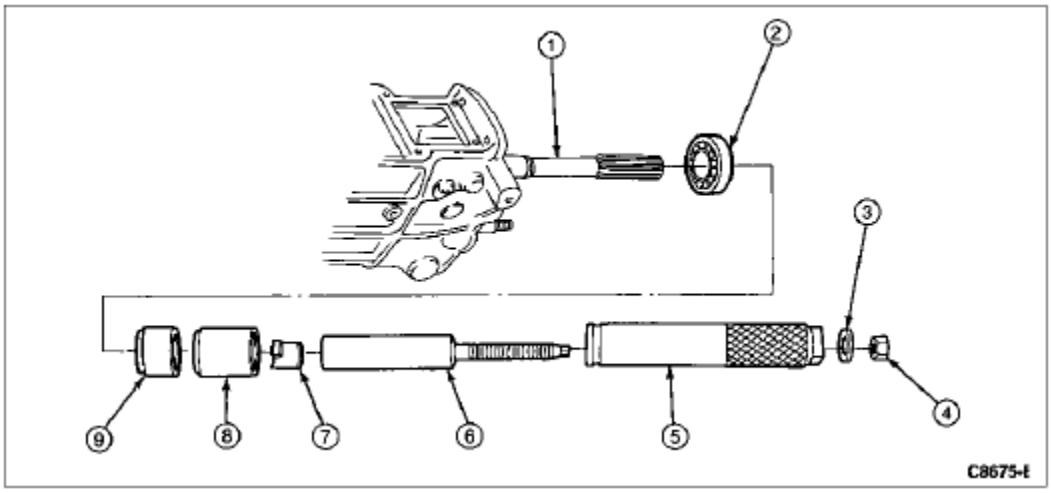
20. Install reverse idler gear and bushing (7141). Apply sealant Silicone Rubber D6AZ-19562-AA or equivalent meeting Ford specifications ESB-M4G92-A or ESE-M4G195-A to holding bolt threads. Install and tighten holding bolt to 79-117 Nm (58-86 lb-ft).

21. **NOTE: Install reverse gear with longer flange facing forward.**

    Install sleeve and reverse gear assembly onto mainshaft.

22. Install output shaft rear bearing (7R205) using Gear Installing Spacer T88T-7025-F (4x2 models only), Gear Installing Spacer T88T-7025-E, Shaft Adapter T75L-7025-P (4x2 models only), Shaft Adapter T75L-7025-M (4x4 models only), Shaft Sleeve — Replacer T75L-7025-K, Remover/Replacer Tube T75L-7025-B, nut and washer. (This procedure employs the same tools as fifth gear installation.)

Output Shaft Rear Bearing Installation



Item	Part Number	Description
1	7061	Output Shaft
2	7R205	Output Shaft Rear Bearing
3	—	Washer (Part of T75L-7025-K)
4	—	Nut (Part of T75L-7025-K)
5	T75L-7025-B	Remover/Replacer Tube
6	T75L-7025-K	Shaft Adapter Screw
7	T75L-7025-P	Shaft Adapter

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8	T88T-7025-F	Gear Replacing Spacer
9	T88T-7025-G	Gear Replacing Spacer

23. Remove temporary spacer from countershaft.

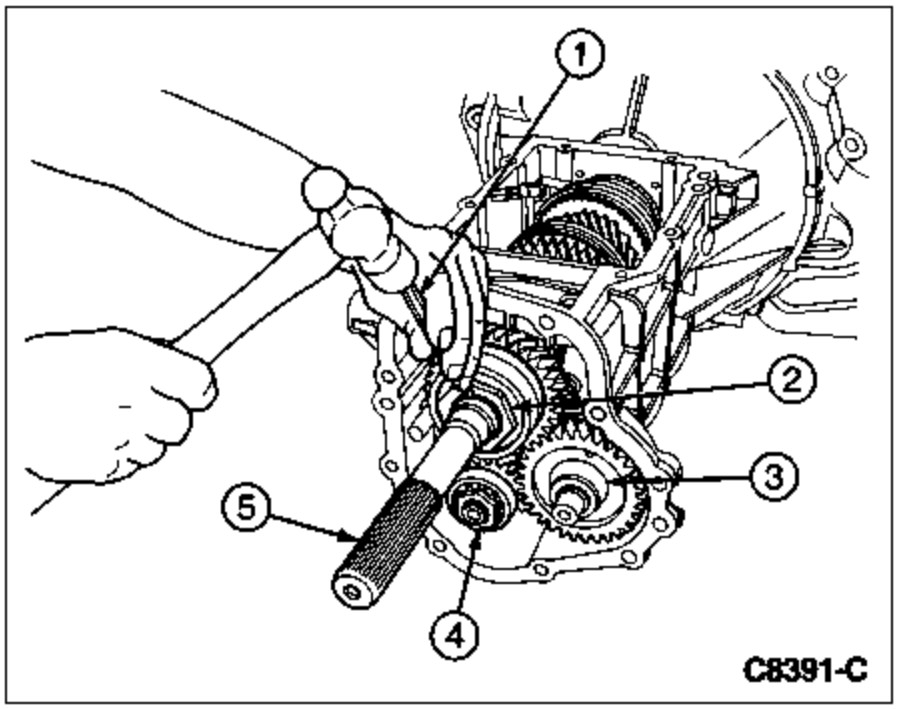
24. **NOTE: Tightening shaft locknuts without fully seating bearing can cause damage to mainshaft threads.**

    Install countershaft rear bearing (7D283) by hand.

25. **NOTE: Always install new output and countershaft locknuts when assembling transmission. Locknuts unstaked during disassembly cannot be reused.**

    Lock transmission into first and third gear. Install new output and countershaft locknuts hand-tight. Tighten output shaft locknut to 216-274 Nm (160-202 lb-ft). Tighten countershaft locknut to 128-196 Nm (94-144 lb-ft).

26. Stake (secure) locknuts to bottom of shaft groove using Countershaft Locknut Staking Tool T77J-7025-F.



Item	Part Number	Description
1	T77J-7025-F	Countershaft Locknut Staking Tool
2	7B364	Output Shaft Rear Bearing Lock Nut
3	7141	Reverse Idler Gear and Bushing
4	7N170	Countershaft Locknut
5	7061	Output Shaft

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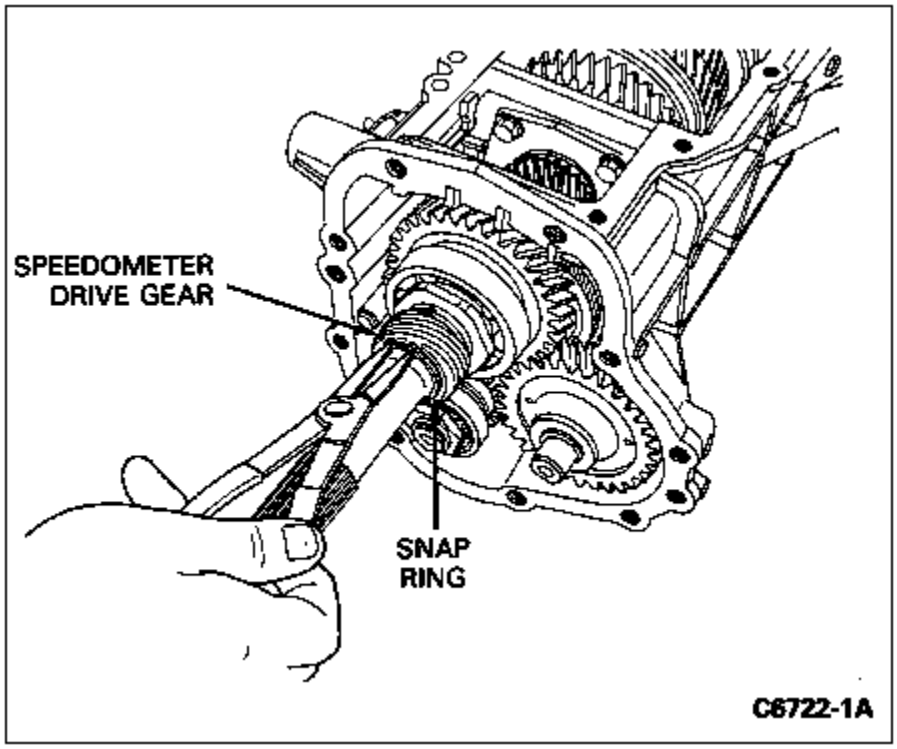
27. **NOTE: The speedometer drive gear contains three detents into which the steel drive ball can be installed. The steel drive ball can be installed into any of the three detents.**

    Install speedometer drive gear and steel ball to output shaft. Install speedometer gear snap ring (7059) retaining speedometer drive gear to output shaft (4x2 vehicles only).



28. Remove any sealant residue from mating surfaces of case and extension housing (7A039). Apply a 3.18mm (1/8-inch) bead of Silicone Rubber D6AZ-19562-AA or equivalent meeting Ford specification ESB-M4G92-A or ESE-M4G195-A to case.

29. Place synchronizers into neutral gear position. Make sure that shift forks on case cover (7222) are in neutral gear position.

30. **NOTE: When performing this next step, do not apply sealant to mating surfaces of case cover or case. If necessary, apply a small quantity of grease to case cover gasket (7223) to retain case cover gasket in position during assembly.**

    Position new case cover gasket and case cover to case, and carefully engage shift forks with synchronizers. Install the retaining bolts (no sealant). Tighten bolts to 16-22 Nm (12-16 lb-ft).

31. Install case plug (7A010) and tighten to 40-58 Nm (30-43 lb-ft).

32. Fill transmission with specified quantity of Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX or equivalent MERCON® fluid.

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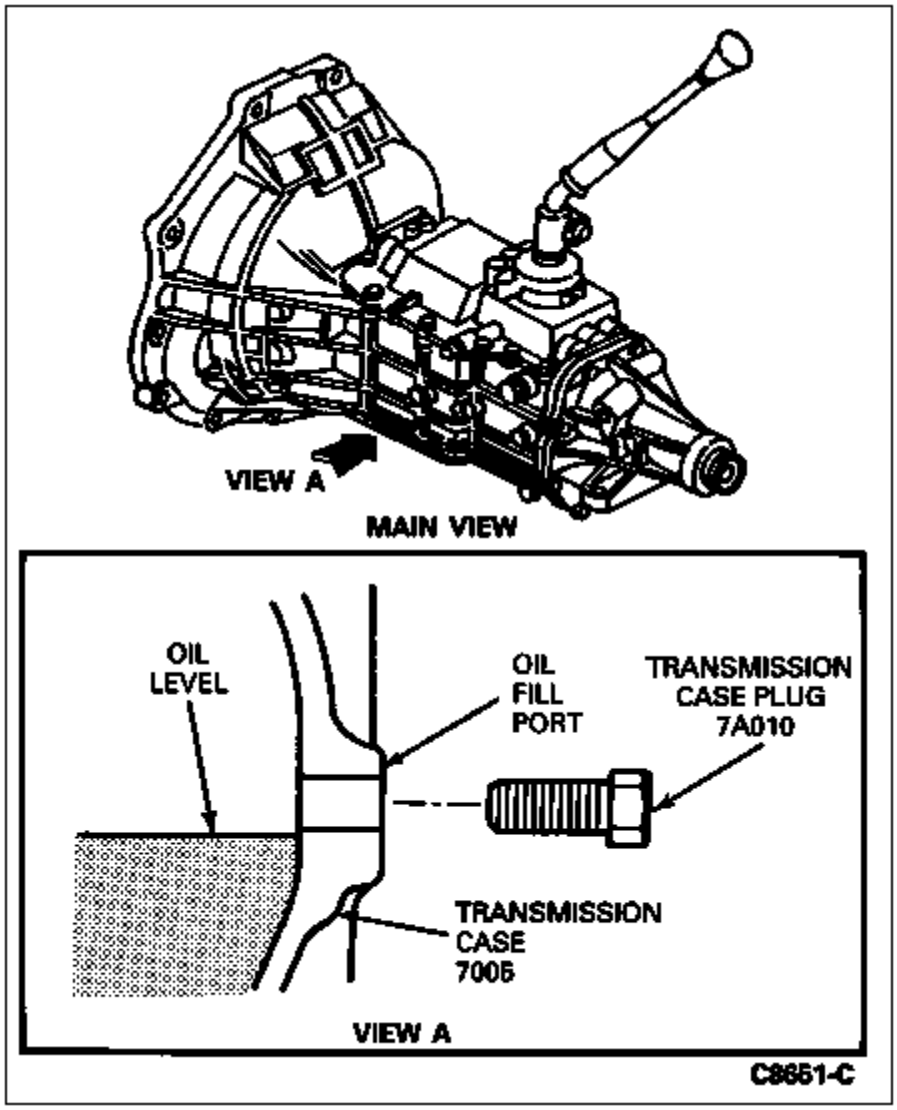

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Shift Lever and Boot

1. Install the retaining bolt in the shift lever hole such that the flat aligns with the mating flat on the transmission stub shaft. Push bolt fully into position. Install nut and tighten to 16-22 Nm (12-16 lb-ft).

2. Slide the gearshift lever boot into position on the shift control selector lever and housing, and install the retaining screws.

3. Install the isolator pad assembly. Install the floor pan cover and floor carpet (13000) if previously removed.

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Extension Housing Bushing

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Extension Housing Seal Replacer	T61L-7657-A

NOTE: Extension housing bushing cannot be serviced. If bushing requires service, extension housing (7A039) must be replaced as a unit.

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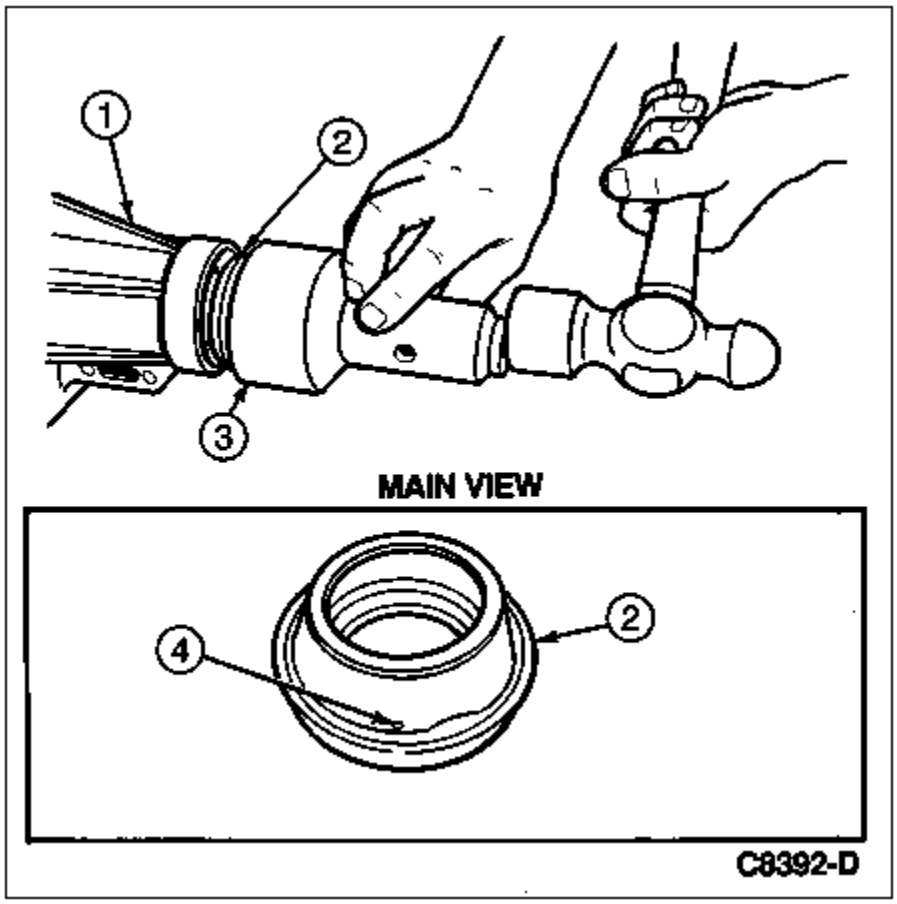
Extension Housing

1. Position extension housing (7A039) to case and install retaining bolts. Tighten bolts to 32-46 Nm (24-34 lb-ft).

2. If removed, install input shaft (7017) and extension housing seal using Extension Housing Seal Replacer T61L-7657-A. Make sure that oil seal drain hole faces downward.



Item	Part Number	Description
1	7A039	Extension Housing
2	7052	Input Shaft and Extension Housing Seal
3	T61L-7657-A	Extension Housing Seal Replacer
4	—	Drain Hole to Face Downward (Part of 7025)

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Transmission

1. Make sure that the machined mating surfaces and the locating dowels on the engine (6007) are free of burrs, dirt or paint. Check the mating face of the transmission (7003) and the locating dowel holes for burrs, dirt or paint.

2. Mount the transmission on a transmission jack such as Hi-Lift Transmission Jack 014-00942 or equivalent. Position it under the vehicle and start the input shaft (7017) into the clutch disc (7550). Align the splines on the input shaft with the splines in the clutch disc. Move the transmission forward and carefully seat the case (7005) on the locating dowels of the engine. The dowels must not shave or burr the dowel holes.

3. Install the bolts and flatwashers that attach the transmission to the engine and tighten to 38-51 Nm (28-38 lb-ft).

4. Install the starter motor (11001). Tighten the attaching bolts to specifications.

5. Raise the engine and install the rear crossmember, transmission support insulator (6068), and attaching nuts and washers. Tighten nuts to 65-85 Nm (48-63 lb-ft) for 3.0L applications. Tighten nuts to 88-115 Nm (65-85 lb-ft) for all other applications. Refer to Section 02-03 . Remove the transmission jack.

6. On 4x4 vehicles, install the transfer case (7A195) as described in Section 07-07A , Section 07-07B , Section 07-07C , or Section 07-07D .

7. On SuperCab vehicles, insert the driveshaft into theextension housing (7A039) and install the center bearing attaching nuts, washers and lockwashers. Tighten the nuts to specification.

8. Connect the driveshaft (4602) to the rear axle drive flange. Tighten the attaching nuts to specifications. Refer to Section 05-01 for torque specification.

9. Connect wires for the starter motor and backup lamp switch (15520).

10. Reinstall exhaust system (V-6 engines only). Refer to Section 09-00 .

11. Connect the hydraulic clutch hose (7T504) and bleed the system per instructions in Section 08-02 .

12. Install the speedometer cable (17260).

13. Check fluid level. Fill transmission with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX or equivalent MERCON® fluid.

14. Remove safety stands and lower the vehicle.

15. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

    Connect the battery ground cable (14301) to the battery terminal.

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Transmission

Cleaning

NOTE: Do not clean, wash or soak transmission seals in cleaning solvent.

1. Wash all parts, except ball bearings and seals, in a suitable cleaning solvent.
2. Brush or scrape all foreign matter from the parts. Be careful not to damage any parts with the scraper.
3. Dry all parts with compressed air.

Inspection

NOTE: If a transmission case thread is damaged, service kits may be purchased from local jobbers. To service a damaged thread, refer to Case Thread Service in this section.

1. Inspect case (7005) for cracks, worn or damaged bores, stripped or damaged threads, or any other damage that could affect operation of the transmission (7003).
2. Inspect the gasket surfaces and machined mating surfaces for burrs, nicks or damage.
3. Check the vent for obstructions, and check all fluid passages for obstructions and leakage.
4. Inspect the case bushing for scores.
5. Check all parking linkage parts for wear or damage.

Case Service

1. Drill out the damaged threads, **using the same drill size as the thread outside diameter** . For example, use a 5/16-inch drill for a 5/16-18 thread.
2. Select the proper special tap and tap the drilled hole. The tap is marked for the size of the thread being repaired. Thus, the special tap marked 5/16-18 will not cut the same thread as a standard 5/16-18 tap. It does cut a thread large enough to accommodate the insert, and after the insert is installed, the original thread size (5/16-18) is restored.
3. Select the proper coil inserting tool. These tools are marked with the thread size being repaired. Place the insert on the tool and adjust the sleeve to the length of the insert being used. Press the insert against the face of the tapped hole. Turn the tool clockwise and wind the insert into the hole until the insert is one-half turn below the face.
4. Working through the insert, bend the insert tang straight up and down until it breaks off at the notch.
5. Improperly installed inserts can be removed with the extractor tool. Place the extractor tool in the insert with the blade resting against the top coil, one-quarter to one-half turn away from the end of the coil. Tap the tool sharply with a hammer until the blade cuts into the insert. Exert downward pressure on the tool and turn it counterclockwise until the insert is removed.

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Extension Housing

1. **NOTE: The extension housing rear bushing cannot be serviced. If it requires service, the extension housing (7A039) must be replaced as a unit (4x2 vehicles only).**

   Inspect the extension housing for cracks.

2. Make sure that the machined mating surfaces are free from burrs, nicks, or any other damage.

   If necessary, replace the oil seal (7052) after the extension housing has been installed on the transmission (7003).

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Bearings

1. Rotate the bearings in a cleaning solvent until all lubricant is removed. Hold the bearing assembly to prevent it from rotating while drying it with compressed air.

2. Lubricate the bearings with Motorcraft MERCON® Automatic Transmission Fluid XT-2-DDX or -QDX or equivalent MERCON® fluid. Wrap them in a clean, lint-free cloth or paper, until ready for use.

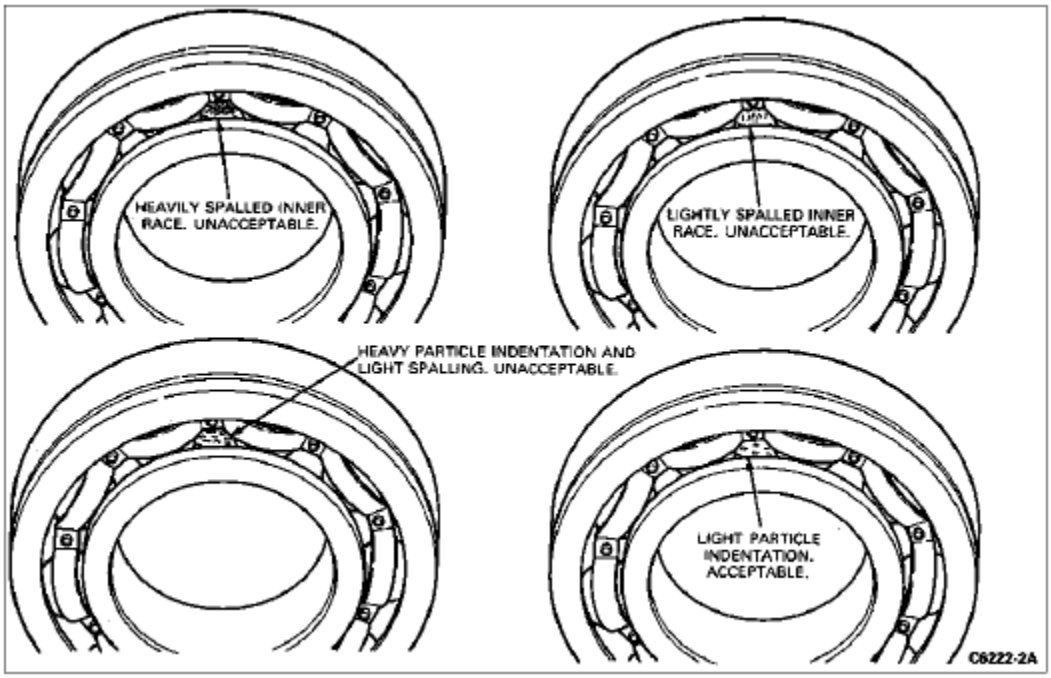
Raceways

1. **NOTE: Bearings that have been removed using special service tools may have been damaged simply due to the tool design. Be sure the following checks are made to determine if the bearing can be put back into service.**

   Inner Ring Raceway — While holding outer ring stationary, rotate inner ring at least three revolutions. Examine raceway of inner ring for pits or spalling. If pits or spalling are unacceptable, replace the bearing assembly. Light particle indentation is acceptable.

2. Outer Ring Raceway — While holding inner ring stationary, rotate outer ring at least three revolutions. Examine raceway of the outer ring from the same side as the raceway of the inner ring. If raceway is spalled or pitted, replace the bearing assembly. Light particle indentation is acceptable.

Bearing Inspection



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External Surfaces

The bearing must be replaced if damage in any of the following areas is found:

1. Radial cracks on front and rear faces of outer or inner rings.
2. Cracks on outside diameter or outer ring (particularly around snap ring groove).
3. Deformation or cracks in ball cage (particularly around rivets).

Spin Test

1. Lubricate bearing raceways with a slight amount of clean oil. Turn the bearing back and forth slowly until raceways and balls are coated with oil.
2. Hold bearing by inner ring in a vertical position. Vertical movement between the inner and outer rings is acceptable. Spin outer ring several times by hand (do not use compressed air). If roughness or vibration is noticeable or the outer ring stops abruptly, the bearing should be cleaned again and lubricated. Roughness in a bearing is usually caused by foreign particles in the bearing, which comes from inside the transmission case. If bearing is still rough after cleaning and relubricating three times, it must be replaced.
3. Hold bearing by the inner ring in a horizontal position with the snap ring groove up. Spin outer ring several times by hand (do not use compressed air). If bearing is still rough after cleaning and relubricating three times (if not done in Step 2), it must be replaced. If bearing passes the visual inspection and spin tests, it can be reinstalled in transmission.

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Gears

Inspect the teeth of each gear. If excessively worn (scratched, very shiny, etc), broken or chipped, replace the gear. Excessive wear increases backlash, which results in noise and unacceptable operating characteristics.

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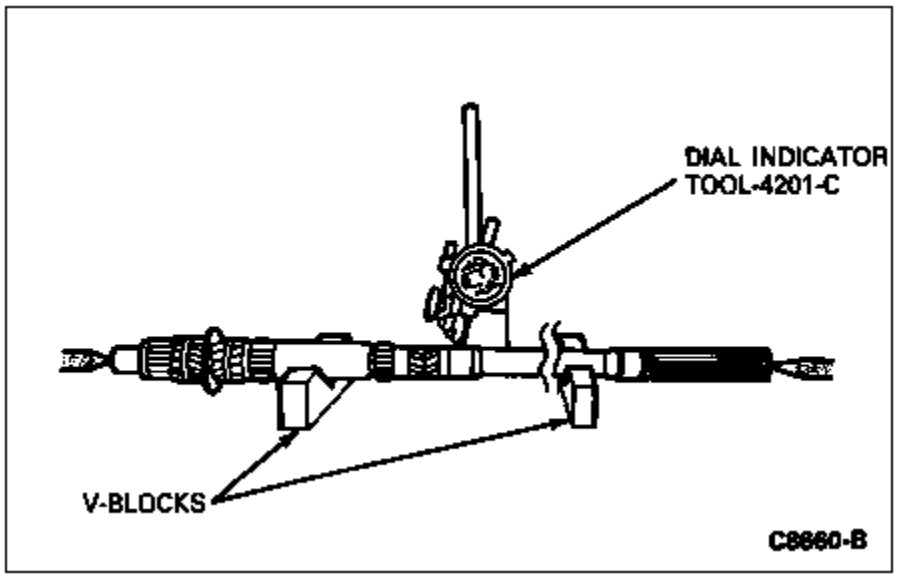
Output Shaft

Check output shaft for runout by mounting the shaft between V-blocks and applying Dial Indicator with Bracketry TOOL-4201-C or equivalent to several places along shaft. The standard reading of the indicator for runout should be less then 0.05mm (0.002 inch). If runout exceeds 0.05mm (0.002 inch), replace mainshaft.



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Input Shaft

Replace input shaft (7017) if splines are damaged. If needle bearing surface is worn or rough, or if other bearing contact surfaces are damaged, replace input shaft.

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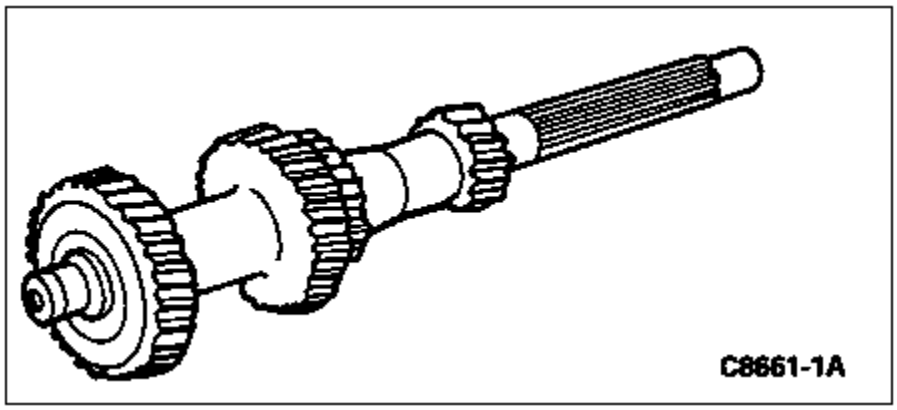
Countershaft

Check countershaft gear teeth and countershaft splines for wear or damage. Replace countershaft (7111) if bent, scored, or worn.



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Synchronizers

1. **NOTE: Make note of the differences between the 3rd gear synchronizer blocking ring (7107) and the 1st, 2nd and 4th gear synchronizer blocking rings. The 3rd gear synchronizer blocking ring has three teeth cut out 120 degrees apart from each other. Directly adjacent to one side of the missing teeth, two teeth have been bridged together. This is to help eliminate any upshift "crunch" that may occur.**

   Inspect gear teeth on synchronizer blocking ring. If there is evidence of chipping or excessively worn teeth, replace with new parts.

2. **NOTE: First/second, third/fourth and fifth reverse synchronizer-to-gear clearance specifications are the same.**

   Inspect synchronizer blocking ring for wear. To check the wear, fit synchronizer blocking ring evenly to gear cone. Measure clearance between side faces of synchronizer blocking ring and gear with a feeler gauge. If clearance is less than 0.8mm (0.031 inch), replace synchronizer blocking ring or gear.

3. Inspect contact between inner surface of synchronizer blocking ring and cone surface of gear. To inspect, apply a thin coat of Prussian Blue or equivalent on cone surface of gear and fit it into the synchronizer blocking ring. If the contact pattern is poor, correct this by applying compound and lapping surfaces together.

4. Make sure clutch sleeve slides easily onto clutch hub.

5. Check synchronizer hub inserts (7A044), inner surface of clutch sleeve, and insert groove on clutch hub for wear.

6. Check synchronizer insert spring for tension.

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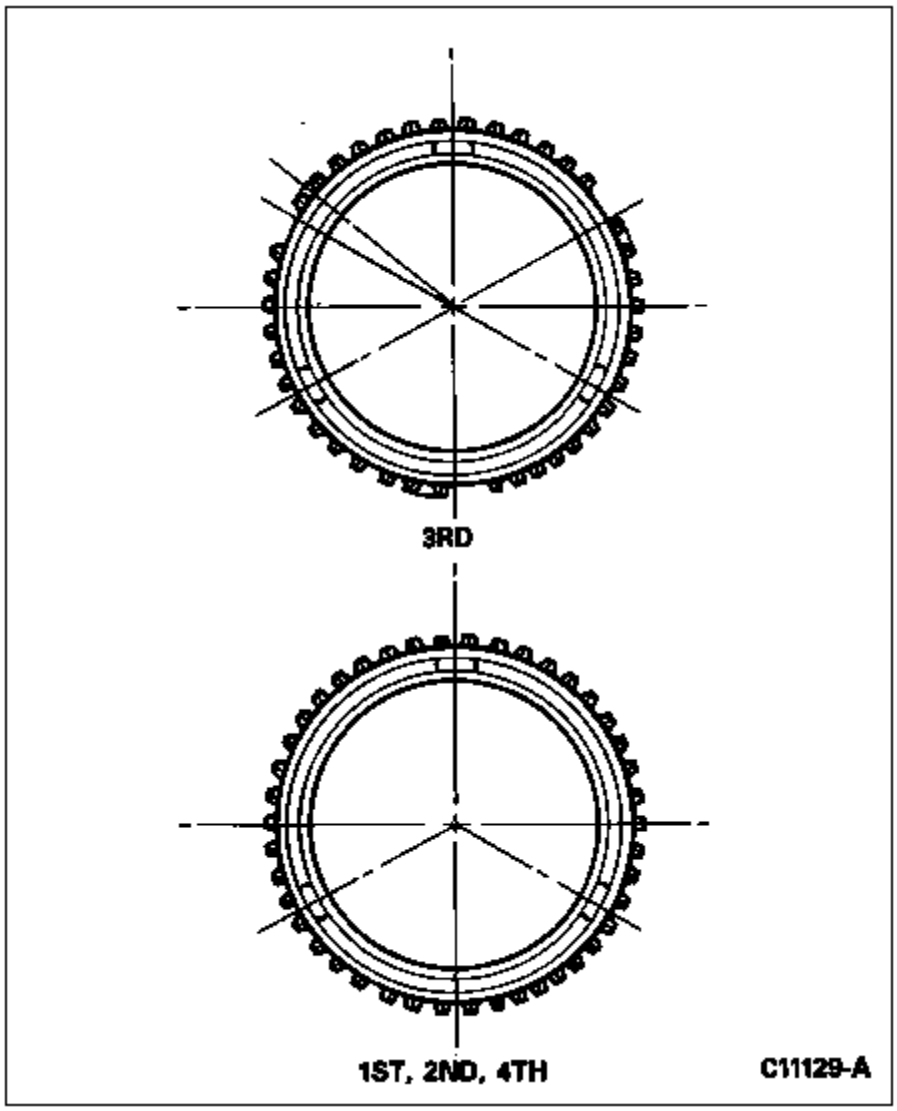

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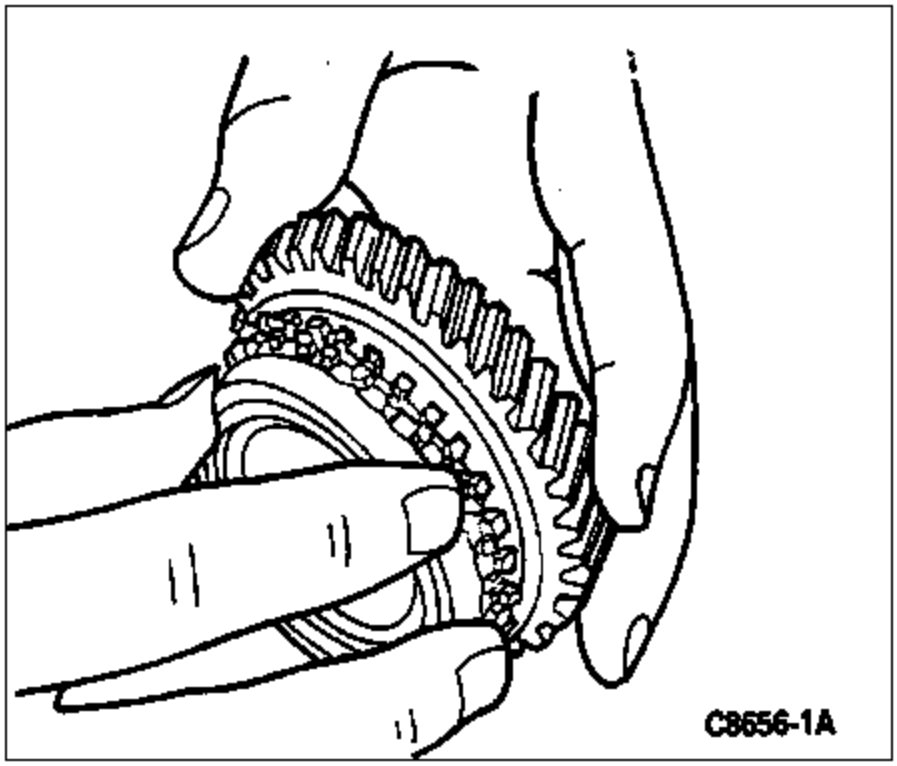

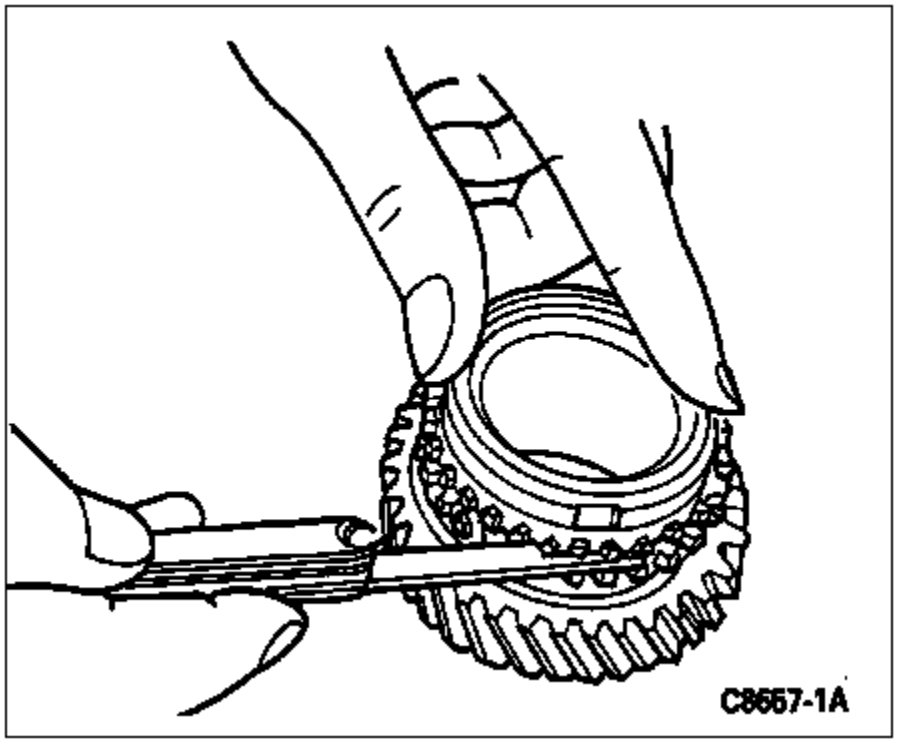

Shift Fork/Clutch Hub Sleeve

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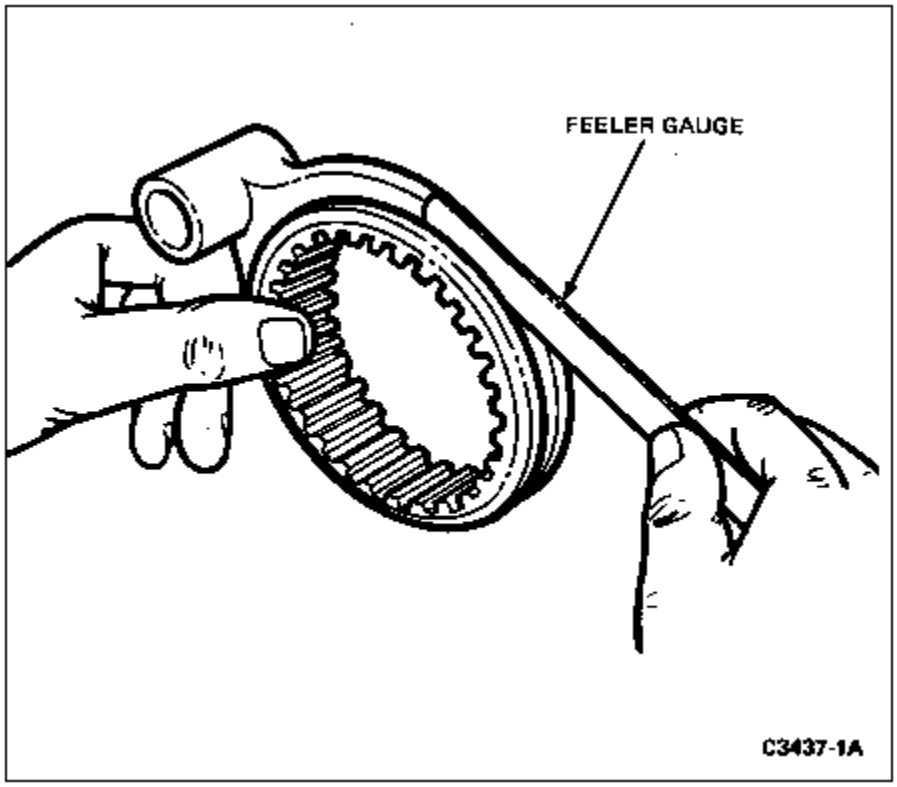
Check the contact surfaces of the shift fork and clutch hub sleeve for evidence of wear or damage. Measure from shift fork to the clutch hub sleeve. Clearance should not exceed 0.8mm (0.031 inch).



Clutch Hub

CLUTCH HUB SLEEVE-TO-SHIFT FORK CLEARANCE

Standard	Maximum
1st/2nd 0.05-0.37mm (0.0019-0.014 In.)	0.8mm (0.0314 In.)
3rd/4th 0.1-0.37mm (0.003-0.014 In.)	0.8mm (0.0314 In.)
5th/Rev. 0.1-0.37mm (0.003-0.014 In.)	0.8mm (0.0314 In.)

1. Check operation of clutch hub sleeve installed onto hub.

2. Position clutch hub and sleeve horizontally. Lift the hub approximately three-quarters of the way off the sleeve. Release the hub, and observe downward motion. Hub should slide downward into sleeve on its own. It should not be necessary to push hub into sleeve. Service as necessary.

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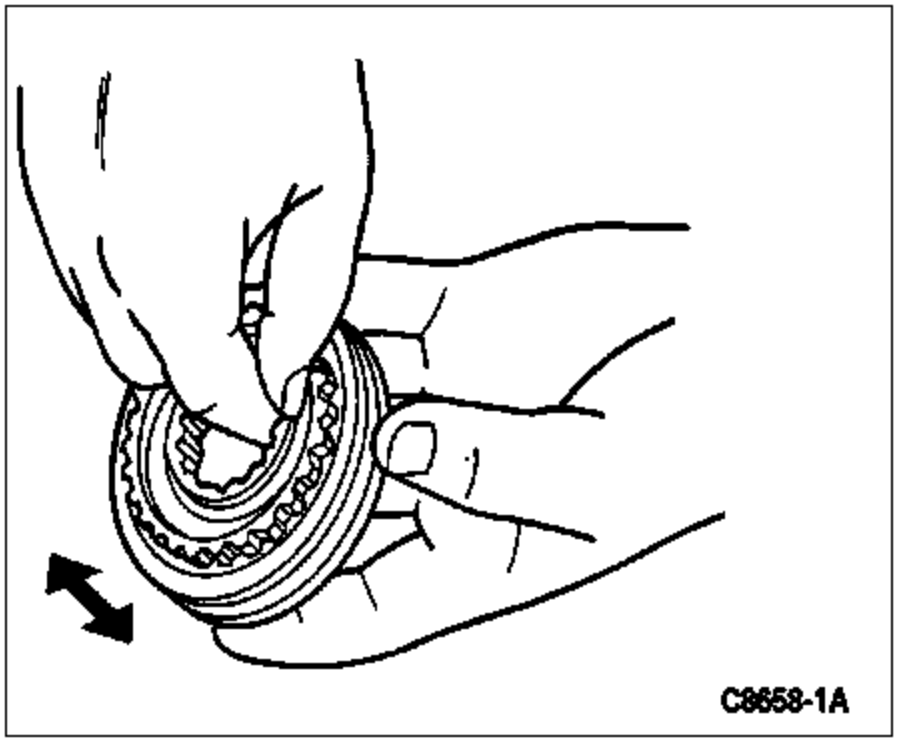

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Speedometer Gears

Check the drive gear and driven gear, and the driven gear shaft for wear or damage. Check the O-ring and oil seal for weakness or damage (4x2 vehicles only).

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Thrust Washers

1. Check the surfaces of all thrust washers that are scored or reduced in thickness.

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Bearing Retainers

1. Replace bearing covers that are grooved or showing wear from the thrust or adjacent bearings. Check the oil return threads in the bearing covers. If the sealing action of the threads has been destroyed by contact from the input shaft (7017) or output shaft, replace the covers.

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SPECIFICATIONS

Gear Ratios

Gear	Ratio R1	Ratio R2
First	3.72	3.90
Second	2.20	2.25
Third	1.50	1.50
Fourth	1.00	1.00
Fifth	.79	.80
Reverse	3.40	3.41

Inspection Standards And Tolerance

Component	Inches	Millimeters
Mainshaft Runout Not To Exceed	0.002	0.05
Shift Fork to Clutch Sleeve Not To Exceed	0.031	0.8
Synchronizer Ring to Conical Face of Gear	0.059	1.5
Synchronizer Blocking Ring Clearance	0.031	0.8

Assembly Standards

Component	Tolerance	
	Inches	Millimeters
3rd/4th Clutch Hub Play	0.00-0.0019	0.00-0.05
Reverse Idler Gear End Play	0.0039-0.0078	0.1-0.2
5th/Rev. Hub End Play	0.00-0.0019	0.00-0.05
Counter Reverse Gear	0.0098-0.0138	0.25-0.35

Lubricant Refill Capacities

Transmission	U.S. Pints	Imperial Pints	Liters
Five-Speed Manual Overdrive Transmission (Ford Manual Transmission) Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX (E4XZ-19582-B) or Equivalent	5.6	4.5	2.65

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Torque Specifications

Description	Nm	Lb-Ft
Output Shaft Locknut	216-274	160-202
Countershaft Locknut	128-196	94-144
Extension Housing Retaining Bolts	32-46	24-34
Reverse Idler Shaft Fixing Bolt	79-117	58-86
Center Bearing Cover	18-26	14-19
Front Bearing Cover Bolts	16-22	12-16
Fifth/Reverse Cam Lockout Plate	8-10	6-7
Dust Cover	8-11	6-8
Case Cover Retaining Bolt	16-22	12-16
Case Plug	40-58	30-43
Front Oil Passage	8-10	6-8
Counter Lever Shaft Fixing Bolt	8-10	6-7
Rock Plate	8-10	6-7
Filler Plug	40-58	29-43
Backup Lamp Switch	25-35	18-26
Neutral Switch (if Equipped)	25-35	18-26
Rear Oil Passage Retaining Bolt	8-10	6-7
5th/Reverse Shift Rail Fixing Bolt	20-30	15-22
Starter, 2.3L and 3.0L Engines	20-27	15-20
Starter, 4.0L Engine	25-34	18-25
Crossmember, 3.0L Engine	65-85	48-63
Crossmember, 2.3L, 4.0L Engines	88-115	65-85
Transmission Housing to Engine	38-51	28-38
Gear Shift Lever Bolt	27-40	20-30
Rear Bearing Retainer	18-26	13-19

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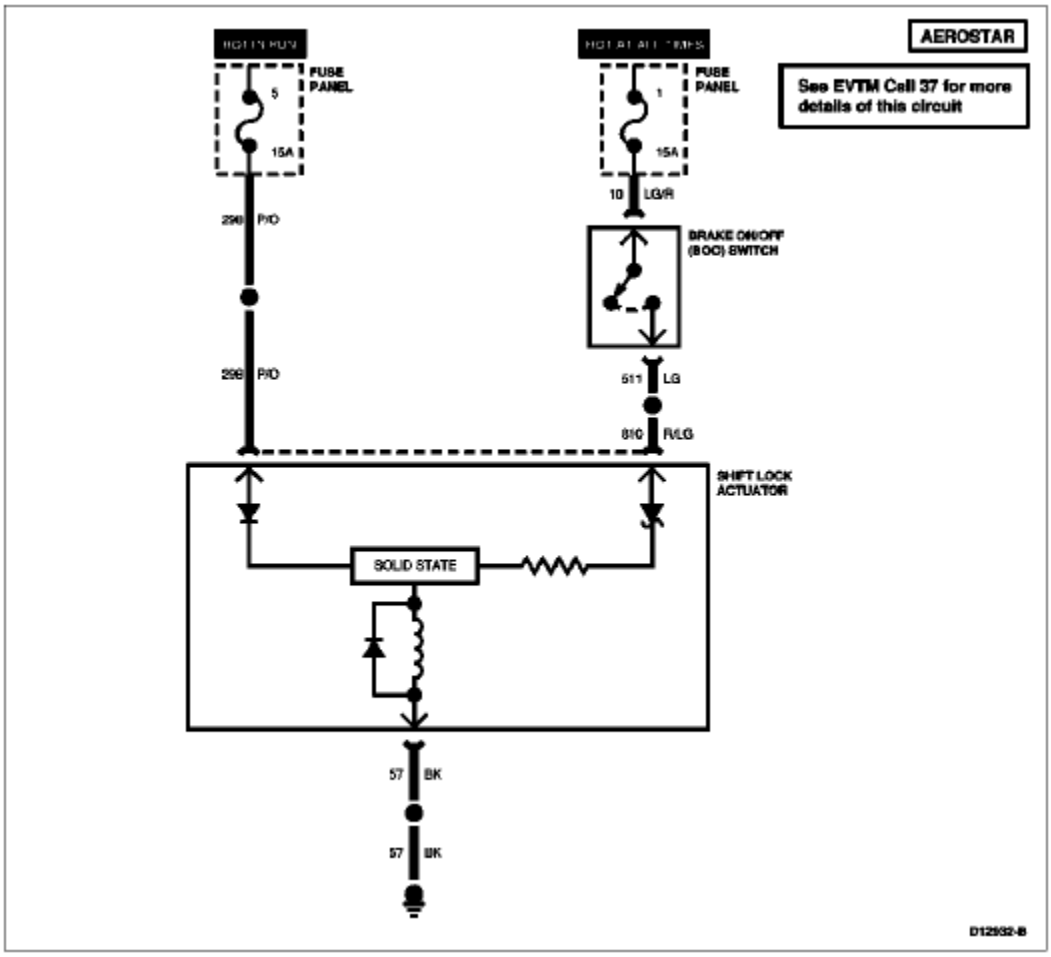
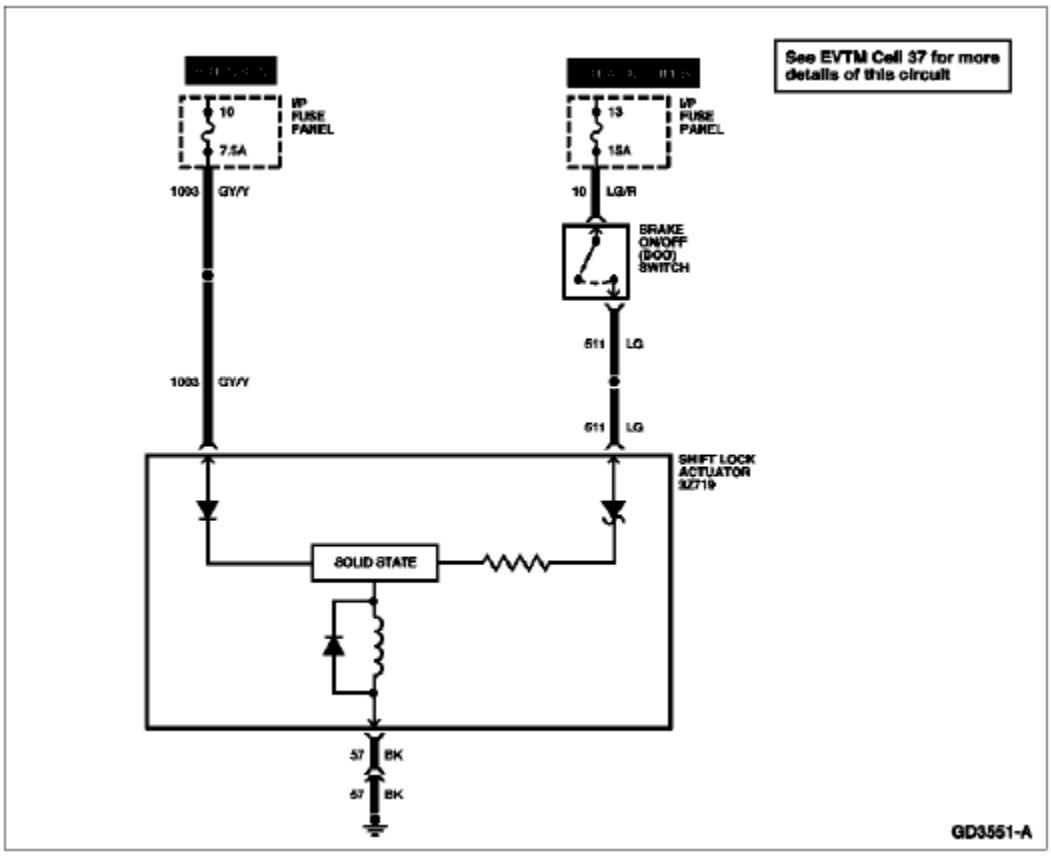
Electrical Schematic

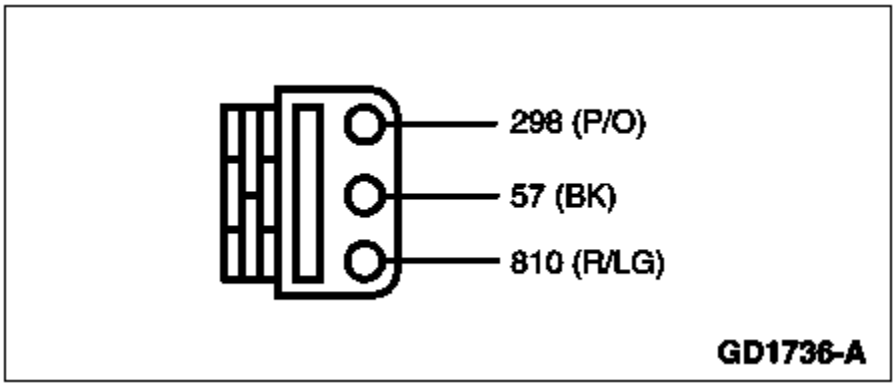
Shift Lock Actuator — Aerostar



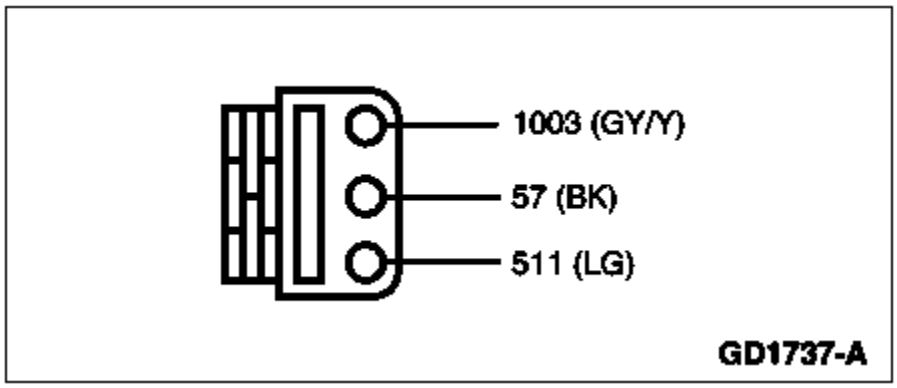
Shift Lock Actuator — Ranger



Shift Lock Actuator Connector (Aerostar)



Shift Lock Actuator Connector (Ranger)


1003 (GY/Y)
57 (BK)
511 (LG)
GD1737-A

Inspection and Verification

Visually inspect the following components of shift interlock system. Determine if any of the following electrical or mechanical concerns apply:

VISUAL INSPECTION CHART

Mechanical	Electrical
• Blown fuse(s)	Kinked or bound shift-lock cable
• Poor connections	Kinked or bound shift cable
• Damaged wiring harness	Damaged selector linkage
Shift control selector lever out of adjustment	

Symptom Chart — Shift Control Linkage

NOTE: Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent to perform electrical Pinpoint Tests.

Use the Symptom Chart as an aid in determining possible conditions, sources and necessary service actions for shift control linkage.

SHIFT CONTROL LINKAGE

Condition	Possible Source	Action
• Shift Interlock System Does Not Release or Lock Properly	• Circuitry open/shorted. • Blown fuse. • Damaged brake on/off (BOO) switch. • Damaged shift lock actuator.	• GO to Pinpoint Test A .
• Shift Control Linkage Binding, Out of Proper Gear Relationship	• Damaged shift cable and bracket. • Loose shift cable and bracket. • Loose retainer bracket. • Shift linkage misadjusted.	• GO to Pinpoint Test B .
• Transmission Range Indicator Does Not Correspond to the Gear	• Transmission shift cable bracket is loose.	• TIGHTEN bolts holding transmission shift cable bracket.
	• Transmission control indicator linkage misadjusted.	• ADJUST PRNDL at steering column housing.
	• Transmission shift cable loose from the transmission retainer bracket.	• TIGHTEN transmission shift cable bolts.
	• Shift linkage misadjusted.	• VERIFY shift cable adjustment. REFER to Adjustments in this section. ADJUST shift cable, if necessary.
	• Clip securing the transmission shift cable to the transmission range selector lever is loose.	• INSTALL clip properly.
• Transmission Range Indicator Lamp Does Not Illuminate	• Bulb burned out.	• REPLACE bulb.

	• Wiring harness damaged.	• INSTALL new wiring harness.
• Rattle, Noise, Buzz, etc.	• Selector lever knob loose. • Transmission range selector lever loose. • Shift interlock spring not hooked.	• REPLACE selector lever knob. • TIGHTEN housing bolts. • ATTACH shift interlock spring properly.
• Water Enters Inside the Vehicle	• Cable assembly grommet not secure to dash panel. • Cable assembly grommet torn.	• SECURE grommet to dash panel. • INSTALL new transmission shift cable.
• Excessive Shift Effort	• Kinked/broken transmission shift cable. • Cable bracket loose/bent.	• ADJUST cable. TIGHTEN cable bracket screws. • REPLACE transmission shift cable.
• Transmission Range Selector Lever Will Not Shift from Range	• Transmission shift cable detached from transmission bracket. • Lock tab loose. • Broken transmission shift cable. • Internal transmission components damaged.	• REINSTALL transmission shift cable. • REPLACE transmission shift cable. • REFER to Section 07-01A .
• Transmission Control Switch (TCS) Inoperative, DTC P1780	• Blown fuse. • Damaged TCS or TCS not cycled during self test. • Damaged powertrain control module. • Circuitry open/shorted.	• GO to Pinpoint Test C .
• Transmission Control Indicator Lamp (TCIL) Does Not Illuminate	• Burned out bulb. • Circuitry open/shorted. • Damaged powertrain control module.	• GO to Pinpoint Test D .
• Transmission Control Indicator Lamp (TCIL) Stays Illuminated	• Circuitry open/shorted. • Damaged powertrain control module.	• GO to Pinpoint Test E .

Pinpoint Tests

PINPOINT TEST A: SHIFT INTERLOCK SYSTEM DOES NOT RELEASE OR LOCK PROPERLY

A1 CHECK FUSES

Check the following fuses:

- In the instrument panel fuse box, Aerostar:

Fuse Location	Amperage
1	15
5	15

- In the instrument panel fuse box, Ranger:

Fuse Number	Amperage
10	7.5
13	15

Are fuses OK?

Yes	No
GO to **A3** .	GO to **A2** .

A2 CHECK SYSTEM

- Replace blown fuse(s).
- Key ON.

Do(es) fuse(s) fail again?

Yes	No
GO to **A8** .	GO to **A3** .

A3 CHECK POWER SUPPLY TO BRAKE ON/OFF (BOO) SWITCH

- Locate and disconnect brake on/off (BOO) switch.
- Measure voltage on the "LG/R" wire between the BOO switch connector and ground.

Is voltage greater than 10 volts?

Yes	No
GO to **A4** .	REPAIR "LG/R" wire for open. RETEST system.

A4 CHECK BRAKE ON/OFF (BOO) SWITCH

- BOO switch connected.
- Press brake pedal.
- Measure voltage at the "LG" wire terminal between the BOO switch connector and ground.

Is voltage greater than 10 volts?

Yes	No
GO to **A5** .	REPLACE BOO switch. RETEST system.

A5 CHECK POWER SUPPLY TO SHIFT LOCK ACTUATOR

- Locate and disconnect shift lock actuator.
- Key ON.
- Measure voltage on the "GY/Y" wire at the shift lock actuator connector.

Is voltage greater than 10 volts?

Yes	No
GO to **A6** .	REPAIR "GY/Y" wire for open. RETEST system.

A6 CHECK POWER SUPPLY TO SHIFT LOCK ACTUATOR

- Key OFF.
- Press brake pedal.
- Measure voltage on the "R/LG" (Aerostar) or "LG" (Ranger) wire at the shift lock actuator connector.

Is voltage greater than 10 volts?

Yes	No
GO to **A7** .	REPAIR "R/LG" OR "LG" wire foe open. RETEST system.

A7 CHECK SHIFT LOCK ACTUATOR GROUND

- Disconnect shift lock actuator connector.
- Measure resistance of the "BK" wire between the shift lock actuator connector and ground.

Is resistance less than 5 ohms?

Yes	No
REPLACE shift lock actuator.	REPAIR "BK" wire for open. RETEST system.

A8 CHECK POWER CIRCUITS FOR SHORT TO GROUND

- Disconnect shift lock actuator connector.
- Remove blown fuse.
- Check for continuity between blown fuse output circuit and know good ground.

Is continuity present?

Yes	No
REPAIR circuit for short to ground. REPLACE fuse. RETEST system.	CHECK all other circuits that are spliced into circuit having blown fuse. REPAIR as required. If all other circuits are OK, REPLACE shift lock actuator. RETEST system.

PINPOINT TEST B: SHIFT CONTROL LINKAGE BINDING, OUT OF PROPER GEAR RELATIONSHIP

B1 CHECK SHIFT CONTROL LINKAGE

- Gain access to shift control linkage.
- Actuate shift linkage in all ranges.
- Observe all linkages during operation.

Is linkage damaged?

Yes	No
REPLACE shift control linkage. RETEST system.	GO to **B2** .

B2 CHECK TRANSMISSION SHIFT CABLE

- Check transmission shift cable and bracket installation and tightness.

Is shift cable properly installed and adjusted?

Yes	No

VERIFY shift cable adjustment. REFER to Adjustments in this section. ADJUST shift cable, if necessary. GO to **B3**.	REPAIR as necessary. RETEST system.

B3 CHECK LINKAGE/CABLE FOR PROPER GEAR RELATIONSHIP

- Actuate transmission range selector lever in all ranges.

Does indicator match gear selection?

Yes	No
REPAIR is complete. RETEST system.	REPLACE damaged linkage/cable. RETEST system.

PINPOINT TEST C: TRANSMISSION CONTROL SWITCH (TCS) INOPERATIVE, DTC P1780

C1 CHECK FUSE 26

- Turn the ignition switch to the OFF position.
- Check the I/P fuse (10A).

Is the resistance less than 5 ohms?

Yes	No
REINSTALL fuse. Go to **C2**.	REPLACE failed fuse. RETEST system. If fuse fails again,check for short to ground in circuits 298 (P/O) and 224 (T/W). RETEST system.

C2 CHECK TRANSMISSION CONTROL SWITCH (TCS) CIRCUIT FOR VOLTAGE

- Disconnect the powertrain control module harness connector.
- Inspect the powertrain control module harness connector for damaged or pushed out pins, corrosion or loose wires.
- Install 104 Pin breakout box (014-00950); leave the PCM disconnected.
- Measure the voltage between test pin 29 and test pin 24 and 77 at the breakout box while cycling the several times.

Does the voltage cycle?

Yes	No
REPLACE PCM. REMOVE breakout box. RETEST system.	GO to **C3**.

C3 CHECK 224 (T/W) FOR SHORT TO GROUND

- Turn the ignition switch to the OFF position.
- Disconnect the transmission control switch harness connector.
- Inspect both ends of the TCS connector for damaged or pushed out pins, corrosion or, loose wires.
- Measure resistance between test pins 29 and test pins 24 and 77 at the breakout box.

Is the resistance greater than 10,000 ohms?

Yes	No
GO to **C4** .	REPAIR circuit 224 (T/W). RETEST system.

C4 CHECK CIRCUIT 298 (P/O) AND CIRCUIT 224 (T/W) FOR OPEN

- Disconnect the I/P fuse 26 (10A).
- Measure resistance between the I/P fuse 26 (10A) connector pin I and the power side of the TCS vehicle harness connector circuit 298 (P/O).
- Measure resistance between test pin 29 at the breakout box and the signal side of TCS vehicle harness connector circuit 224 (T/W).

Are all resistance's less than 5 ohms?

Yes	No
GO to **C5** .	REPAIR circuit 298 (P/O) and /or circuit 224 (T/W). REMOVE breakout box. RECONNECT all components. RETEST system.

C5 CHECK CIRCUIT 224 (T/W) FOR SHORT TO POWER

- Measure resistance between test pin 29 and test pins 71 and 97 at the breakout box.

Is the resistance greater than 10,000 ohms?

Yes	No
REPLACE transmission control switch. REMOVE breakout box. RECONNECT all components. RETEST system.	REPAIR circuit 224 (T/W). REMOVE breakout box. RECONNECT all components. RETEST system.

PINPOINT TEST D: TRANSMISSION CONTROL INDICATOR LAMP (TCIL) DOES NOT ILLUMINATE

D1 CHECK TRANSMISSION CONTROL INDICATOR LAMP (TCIL) CIRCUIT FOR VOLTAGE

- Turn the ignition switch to the OFF position.
- Disconnect the powertrain control module harness connector.
- Inspect the powertrain control module harness connector for damaged or pushed out pins, corrosion or loose wires.
- Install 104 Pin breakout box (014-00950); leave the PCM disconnected.
- Turn the ignition switch to the ON position.
- Measure the voltage between test pin 79 and test pins 24 and 76 at the breakout box.

Is the voltage reading greater than 2 volts?

Yes	No
REPLACE PCM. CYCLE TCS to check operation of TCIL.	CHECK indicator bulb and fuse. If OK, open is wiring between ignition switch and test pin 79 at the PCM harness connector. REPAIR as needed. RETEST system.

PINPOINT TEST E: TRANSMISSION CONTROL INDICATOR LAMP (TCIL) STAYS ILLUMINATED

E1 CYCLE TRANSMISSION CONTROL SWITCH

- Turn the ignition switch to the ON position.
- Cycle the transmission control switch (TCS).

Does the transmission control indicator lamp (TCIL) turn on and off?

Yes	No
OK at this time. Concern may be intermittent.	GO to **E2** .

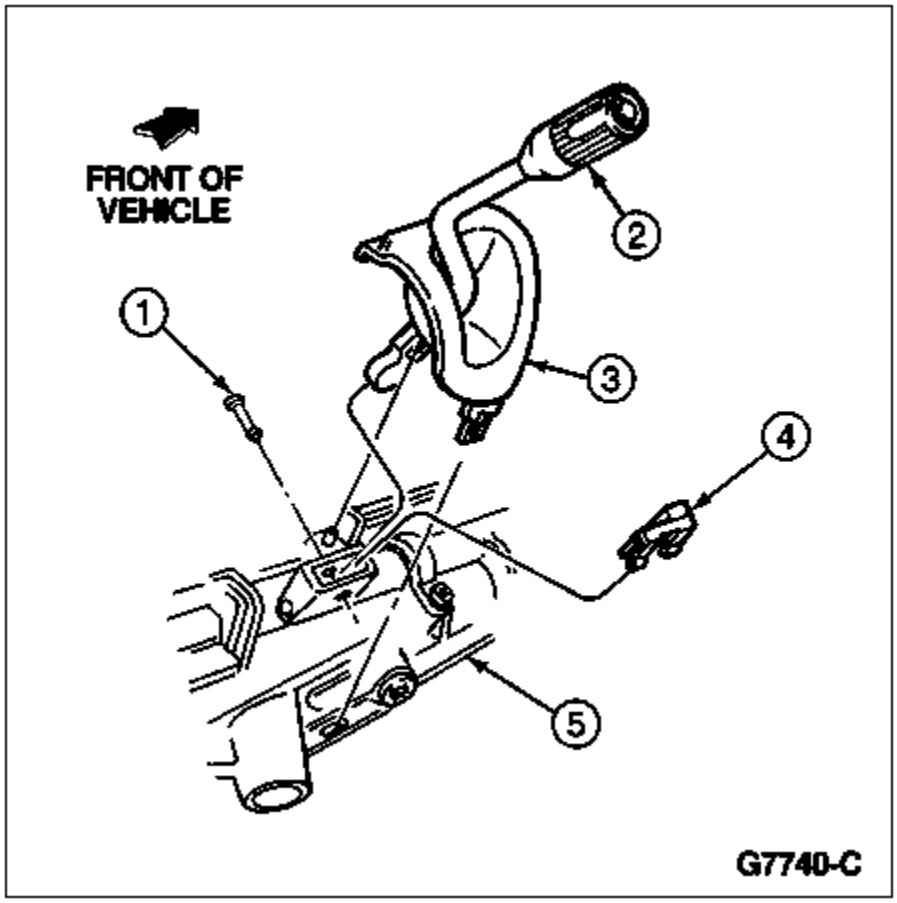
E2 CHECK CIRCUIT 911 (W/LG) FOR SHORT TO GROUND

- Turn the ignition switch to the OFF position.
- Disconnect the powertrain control module harness connector.
- Inspect the powertrain control module harness connector for damaged or pushed out pins, corrosion or loose wires.
- Turn the ignition switch to the ON position.

Does the TCIL remain on ?

Yes	No
REPAIR circuit 911 (W/LG). REMOVE breakout box. RECONNECT all components. RETEST system.	REPLACE PCM. RETEST system.

Transmission Range Selector Lever



Item	Part Number	Description
1	7G357	Gearshift Lever Pin
2	7210	Gearshift Lever
3	3513	Steering Column Opening Weather Seal
4	7C464	Clip
5	3514	Steering Column Tube

Removal

1. If required, remove tilt handle assembly by unscrewing from the column.
2. Disconnect battery ground cable.

3. Turn key lock cylinder to RUN position. Using a 1/8-inch drift, depress steering column lock cylinder pin through access hole and remove key lock cylinder.

4. Remove lower instrument panel cover retaining screws and remove cover.

5. Remove four retaining screws from steering column shroud. Remove the upper and lower steering column shrouds.

6. Using a small screwdriver, pry rubber shift lever cover upper attachment from pedestal on lock cylinder housing. Slide cover toward shift lever handle to expose shift lever retaining pin.

7. Using a small drift, tap retaining pin from bottom for removal. Discard lever retaining pin. Remove shift lever from shifter housing assembly.

Installation

1. Insert shift lever housing into opening in shifter housing assembly.

2. Install a new pin into position and tap in place until the head seats against shifter housing assembly.

3. Position shift lever cover on the lock cylinder housing. Insert lower attachment into the slot on side of housing.

4. Position upper attachment on mounting pin. Install a Tinnerman nut (Part No. 372659-S2) to secure cover to pedestal on lock cylinder housing.

5. Install steering upper and lower steering column shrouds with four screws.

6. Install lower instrument panel cover and retaining screws.

7. Install lock cylinder into lock cylinder housing.

8. Install tilt handle assembly onto column.

9. Connect battery ground cable.

Shift Lock Actuator

Removal

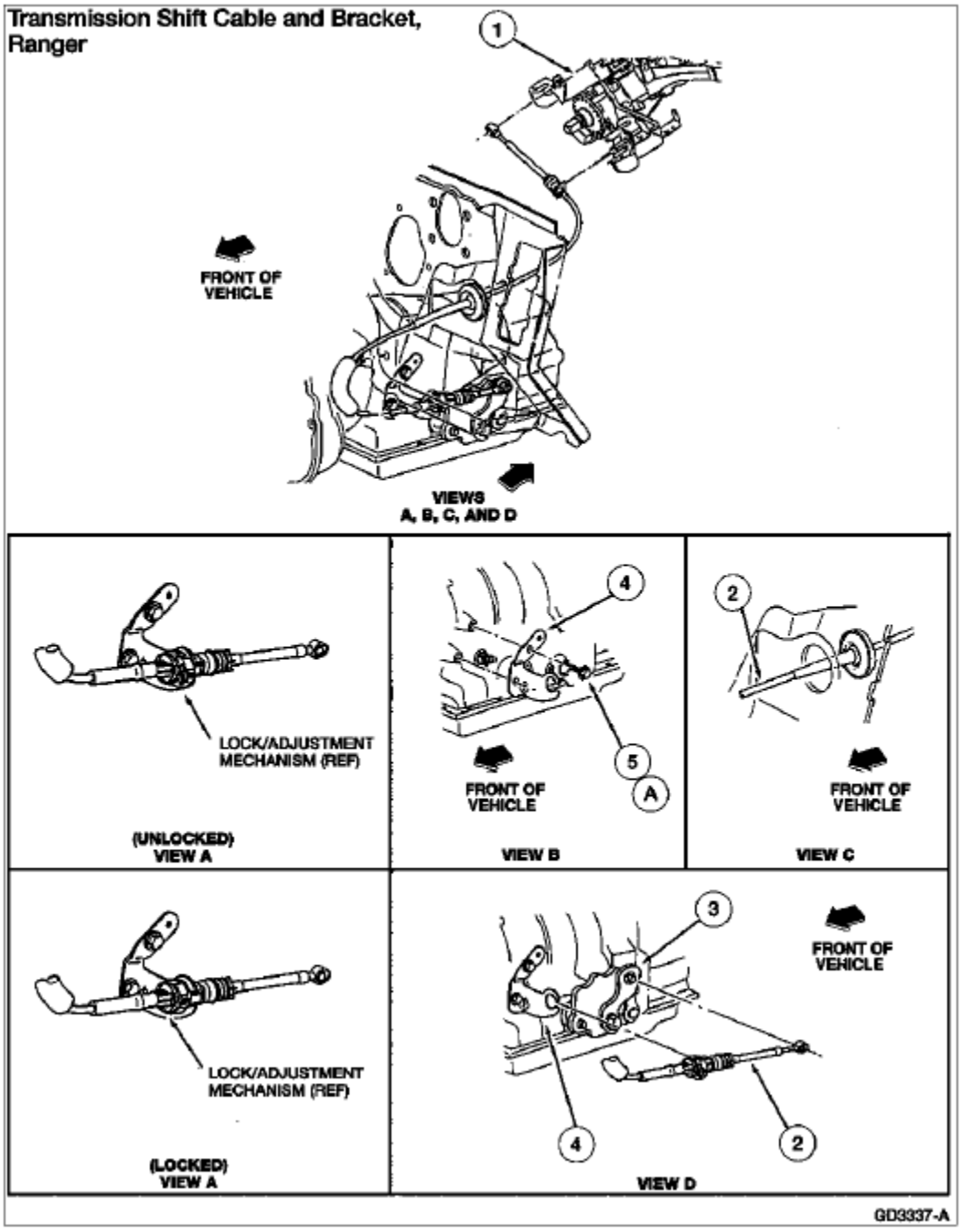
1. Remove steering column as outlined in Section 11-04A or Section 11-04B .
2. Unclip wire terminal from solenoid.
3. Remove insert plate and solenoid by removing three retaining screws.
4. Pry off clip.

Installation

1. **NOTE: The clip which retains the solenoid to the insert plate should not be replaced for service. The clip's sole purpose is an assembly aid for the assembly plant.**

   Position insert plate/solenoid assembly to the steering column and tighten the retaining screws.
2. Install the steering column in the vehicle as described in Section 11-04A or Section 11-04B .

Transmission Shift Cable and Bracket, Ranger



Item	Part Number	Description
1	7212	Transmission Column Shift Selector Tube

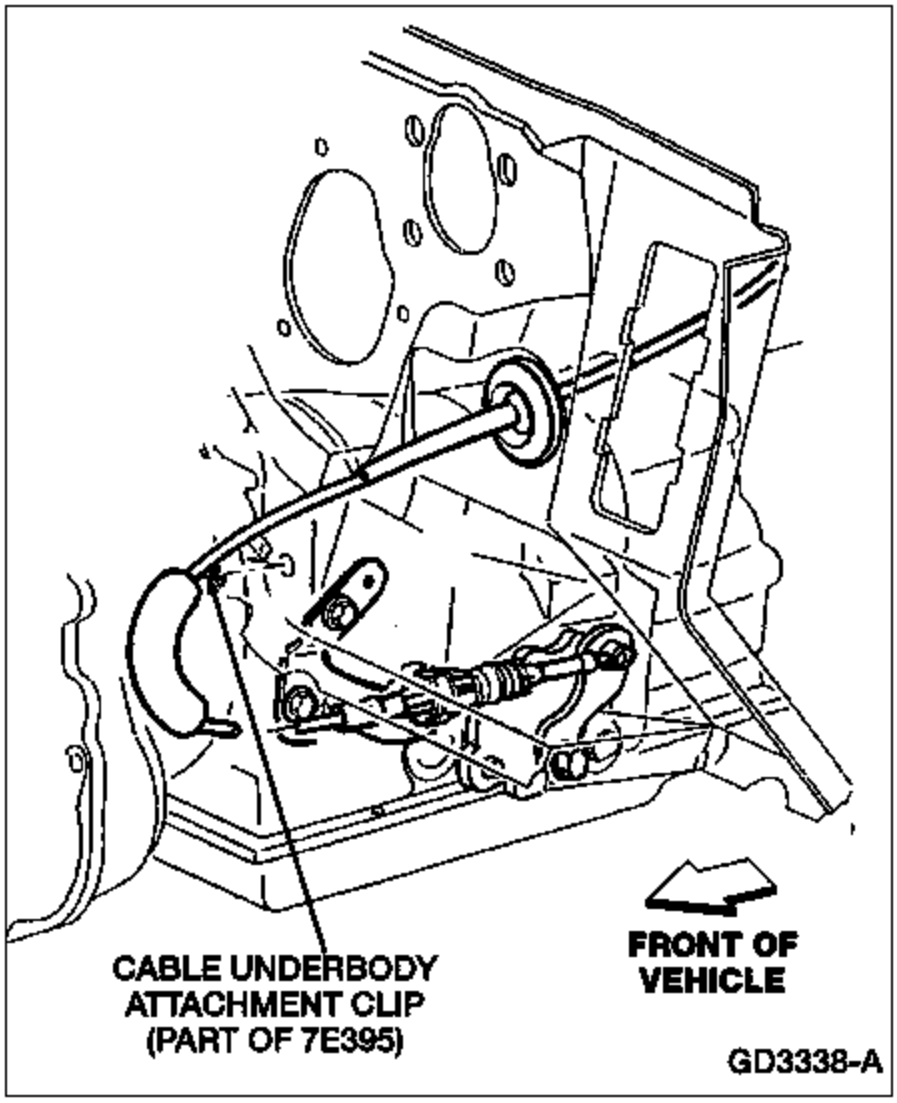
2	7E395	Shift Cable and Bracket
3	7A256	Manual Control Lever
4	7B229	Transmission Shift Cable Bracket
5	N605918-S300	Bolt (2 Req'd)
A	—	Tighten to 34-46 Nm (25-34 Lb/Ft)

Removal

1. Remove shift cable plastic terminal from the shift control selector lever pivot ball by prying with a screwdriver between cable plastic terminal and shift control selector lever and housing.

2. Remove transmission shift cable from steering column bracket by carefully lifting on the locking tab while pulling up on the fitting.

3. From inside passenger compartment, press tabs together on cable underbody attachment clip and push through the dash.



4. From engine compartment, pry cable grommet from dash panel.
5. Remove plastic slide adjuster from manual lever pivot ball, prying with a screwdriver between the slide adjuster and manual control lever.
6. Remove transmission shift cable from transmission shift cable bracket by carefully pressing on the locking tabs while pulling up on the fitting.
7. From engine compartment, pull cable through the instrument panel opening.

Installation

1. From instrument panel, feed plastic terminal end of cable through opening in dash panel to engine compartment.
2. Press rubber grommet on transmission shift cable into dash panel.

3. From engine compartment, install transmission shift cable into transmission shift cable bracket and make sure locking ears are properly located and seated into bracket.

4. Insert cable underbody attachment clip in proper position.

5. Place transmission shift cable on manual lever pivot ball and press into place.

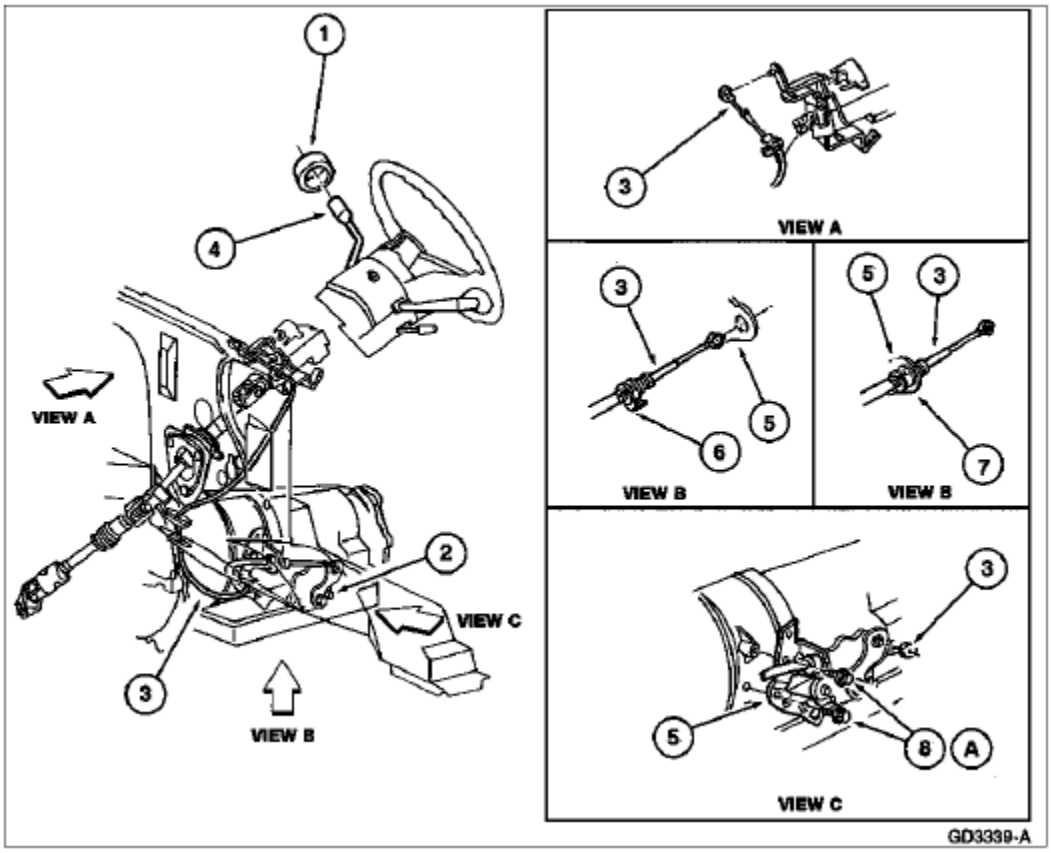
6. From the passenger compartment, install transmission shift cable into shift cable bracket and make sure locking tab is fully seated and locked into place.

7. Snap cable plastic terminal onto shift control selector lever pivot ball on the steering column.

8. Adjust transmission shift cable. Refer to Adjustments, Transmission Shift Cable and Bracket , Ranger in this section.

9. Remove the cable lock tab and replace with a new lock tab.

Transmission Shift Cable and Bracket, Aerostar



Item	Part Number	Description
1	—	1.4 kg (3 Lb.) Weight (To Be Improvised in Shop)
2	7A256	Manual Control Lever
3	7E395	Transmission Shift Cable
4	7210	Gearshift Lever
5	7B229	Transmission Shift Cable Bracket
6	—	Lock Mechanism Shown Unlocked (Part of 7E395)
7	—	Lock Mechanism Shown Locked (Part of 7E395)
8	N605918-S2	Bolt, M10-1.50 x 20 (2 Req'd)
A	—	Tighten to 34-46 Nm (25-34 Lb-Ft)

Removal

1. Raise vehicle on hoist and position suitable safety stands under the vehicle.
2. Unclip shift cable end fitting from transmission outer manual lever.
3. Remove shift cable from transmission shift cable bracket (7B229) by carefully squeezing shift cable ears together. Push shift cable out of transmission shift cable bracket.
4. Remove safety stands and lower vehicle.
5. Using a screwdriver, unclip the shift cable end fitting from the shift control selector lever.
6. Carefully remove shift cable from steering column bracket by prying back the lock tab with a small screwdriver and pushing the cable from the transmission shift cable bracket.
7. Peel back the carpet to expose shift cable grommet and clip.
8. Remove shift cable clip by gently squeezing shift cable ears together with suitable pliers.
9. Remove the shift cable from the vehicle by pulling or pushing shift cable through floorpan hole.

Installation

1. Route cable through floorpan hole.
2. Install the shift cable to the steering column bracket, making sure lock tabs are fully seated into bracket.
3. Seat shift cable grommet.
4. Place shift control selector lever in the (D) position and place a 1.4 kg (3 lb.) weight on the end of the shift control selector lever.
5. Raise vehicle on a hoist and position suitable safety stands under vehicle.
6. Route the shift cable away from exhaust and seat cable in transmission shift cable bracket.
7. Position the manual control lever (7A256) in the overdrive (D) position. This is three detents from the frontmost lever position with the first position counting as one.
8. Attach shift cable end fitting to the transmission outer manual lever.
9. Fully seat lock tab on transmission cable.
10. **CAUTION: Shift cable must be properly clipped to underbody. Failure to do so may result in the cable resting on the exhaust pipe, causing it to burn and ultimately causing complete loss of shifting ability.**

    Attach shift cable clip to vehicle underbody.
11. Remove safety stands and lower vehicle. Remove the weight from the shift control selector lever. Check for proper transmission engagement of all gears.

Transmission Control Switch

Removal

1. Disconnect the battery ground cable (14301).
2. Remove the plastic trim ring at the end of the transmission range selector lever.
3. Carefully pull the transmission control switch out of the transmission range selector lever.

Installation

To install, reverse the removal procedure.

Brake/Shift Interlock System

1. Turn ignition switch (11572) to RUN.
2. Verify that the transmission range selector lever is in PARK (P).
3. Without the brake pedal (2455) applied, verify that the transmission range selector lever cannot be shifted from PARK (P).
4. Apply the brake pedal. Verify that the transmission range selector lever can be shifted from PARK (P).
5. Shift to REVERSE (R).
6. Verify that the ignition switch cannot be turned to the LOCK position.
7. Shift to PARK (P).
8. Verify that the ignition switch can be turned to the LOCK position.
9. If the shift interlock system is not operating as specified, refer to Diagnosis and Testing in this section.

Transmission Range (TR) Selector Lever

Inspect the transmission range selector lever for damage, binding conditions and proper operation. Replace the transmission range selector lever as necessary. Refer to the procedure in this section.

Transmission Shift Cable and Bracket, Aerostar

1. Place shift control selector lever in the (D) (OVERDRIVE) position.
2. Hang a 1.4 kg (3 lb.) weight on the end of the shift control selector lever.
3. Raise the vehicle on a hoist and position suitable safety stands under the vehicle.
4. Use a screwdriver and pry the shift cable end from the manual control lever ball stud.
5. To unlock the adjuster body, release the lock tab on the top side of the cable by pushing down on two tangs.
6. Move the shift cable back and forth the full adjustment length four or five times to remove any dirt. Be sure the adjuster body moves freely.
7. Position the manual control lever (7A256) in the overdrive (D) position. This is three detents from the front-most lever position with the first position counting as one.
8. Holding the cable end fitting, push the cable rearward until the end fitting lines up with the outer manual control lever ball stud. Connect the cable end fitting to the ball stud.
9. Push up on the lock tab to lock the adjuster body in the correctly adjusted position. Be sure locator tab is properly seated in the bracket. Make sure shift cable is clipped to floorpan at white cable mark and cable is routed into tunnel.
10. Remove safety stands and lower vehicle.
11. Adjust shift indicator pointer while transmission (7003) is still in the (D) position.
12. Remove the 1.4 kg (3 lb.) weight from the shift control selector lever.
13. After adjustment, check for P (PARK) engagement. Check the shift control selector lever in all positions with the engine (6007) running to make sure that transmission/detent action is correct. Verify that the vehicle starts in Park/Neutral and back-up lamps illuminate in Reverse. If not, verify digital transmission range (DTR) adjustment in Neutral. Readjust if required. Refer to Section 07-01A or Section 07-01B.

Shift Indicator Cable

1. Remove tilt wheel handle and shank (3F609).
2. Remove ignition switch lock cylinder (11582). Refer to Section 11-04A or Section 11-04B .
3. Remove upper and lower steering column shrouds (3530).
4. Place gearshift lever (7210) in (D) (OVERDRIVE) position. A weight of 1.4 kg (3 lbs.) should be hung on the gearshift lever to make sure the gearshift lever is located firmly against the (D) detent.
5. Adjust shift cable (with adjustment wheel on PRNDL cable) until shift indicator completely covers (D) and calibration dots show no red.
6. Cycle gearshift lever through all of the positions and check that the shift indicator completely covers the proper letter or number in each position.
7. Install upper and lower steering column shrouds.
8. Install ignition switch lock cylinder. Refer to Section 11-04A or Section 11-04B .
9. Install tilt wheel handle and shank.

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft
Transmission Shift Cable Bracket Bolt (Ranger/Aerostar)	34-46	25-34

Transfer Case, Chain-Driven

CAUTION: Consult the vehicle owner guide before towing any 4x4. There are speed and distance restrictions that vary from vehicle to vehicle.

The Borg-Warner 13-54 is a chain-driven transfer case (7A195) in which the shifts may be activated electrically or mechanically. The basic functions of this system are much the same as any other 4x4 transfer case. By turning the control switch on the instrument panel, the driver can select either 2- or 4-wheel high and 4-wheel low. With the mechanical shift design, speed selection is controlled by a single-lever shift mechanism that provides neutral, 2-high, 4-high and 4-low.

The Borg-Warner 13-54 is a three-piece aluminum part-time transfer case. It transfers power from the transmission (7003) to the rear axle and, when actuated, also the front drive axle. The unit is lubricated by a gerotor oil pump that channels oil flow through drilled holes in the rear output shaft. The pump turns with the rear output shaft and allows towing of the vehicle at maximum legal road speeds for extended distances without disconnecting the front or rear driveshaft (4602).

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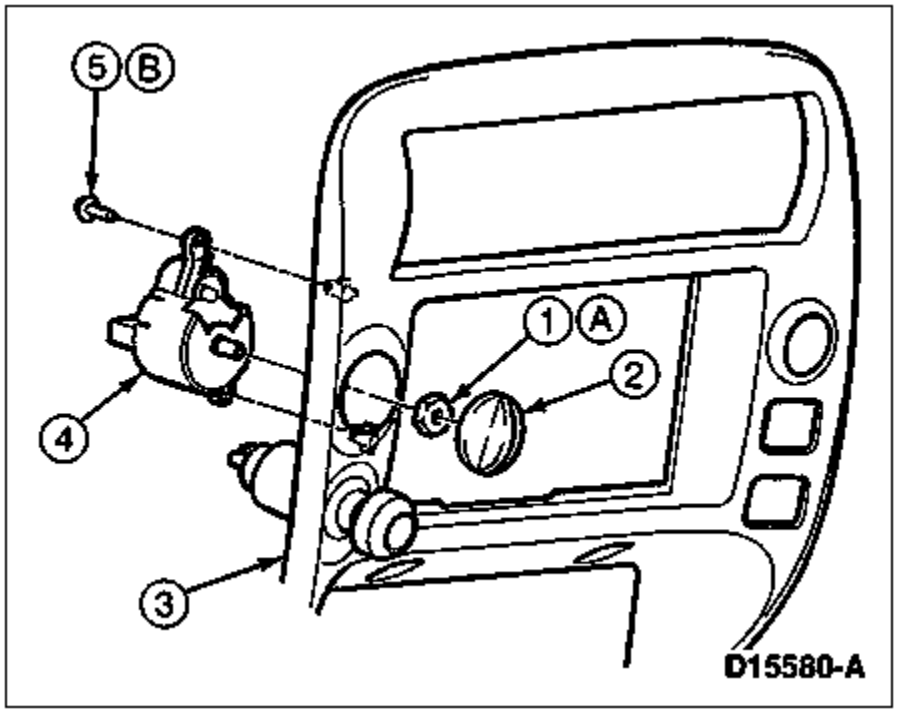
Transfer Case, Electronic Shift (Ranger)

NOTE: It is important to remember that the electronic shift transfer case (7A195) does not have a selectable neutral position. Because of this, if vehicles equipped with electronic shift are to be towed for long distances, the rear driveshaft (4602) should be disconnected. If this is not done, the transfer case (which is protected by positive lubrication) will drive the transmission (7003) (which is not lubricated under these conditions), and may cause damage to the transmission.

This feature allows for the electronic shifting of the vehicle transfer case between 2WD, 4WD HIGH and 4WD LOW. The system mode is selected by the operator through a three-position rotary switch on the instrument panel.

4x4 Mode Selector Switch, Ranger



Item	Part Number	Description
1	N803442-S36	Nut
2	—	Knob Assembly
3	—	Center Finish Panel
4	72155	4x4 Mode Selector Switch
5	385754-S36B	Screw
A	—	Tighten to 6-8 Nm (53-70 Lb-In)
B	—	Tighten to 2.1-2.9 Nm

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		(19-24 Lb-In)

The operator is informed which mode the system is in by two cluster indicator lamps, one for 4WD HIGH and one for 4WD LOW (in 4WD LOW, both lamps are on). The module accomplishes shifts between different system modes by interpreting inputs from 4x4 selector switch, the vehicle speed signal, and the transfer case contract plates. Based on these inputs, two relays (L2H and H2L directional control), the transfer case motor, and an output for the transfer case electric clutch, are used to shift into 2WD, 4WD HIGH, or 4WD LOW. The module will not allow shifts into 4WD LOW unless the brake is depressed, the vehicle is in NEUTRAL (with automatic transmission vehicles), the clutch is pressed (in manual transmission vehicles), and the speed is less than 3 mph.

Transfer Case, Electronic Shift

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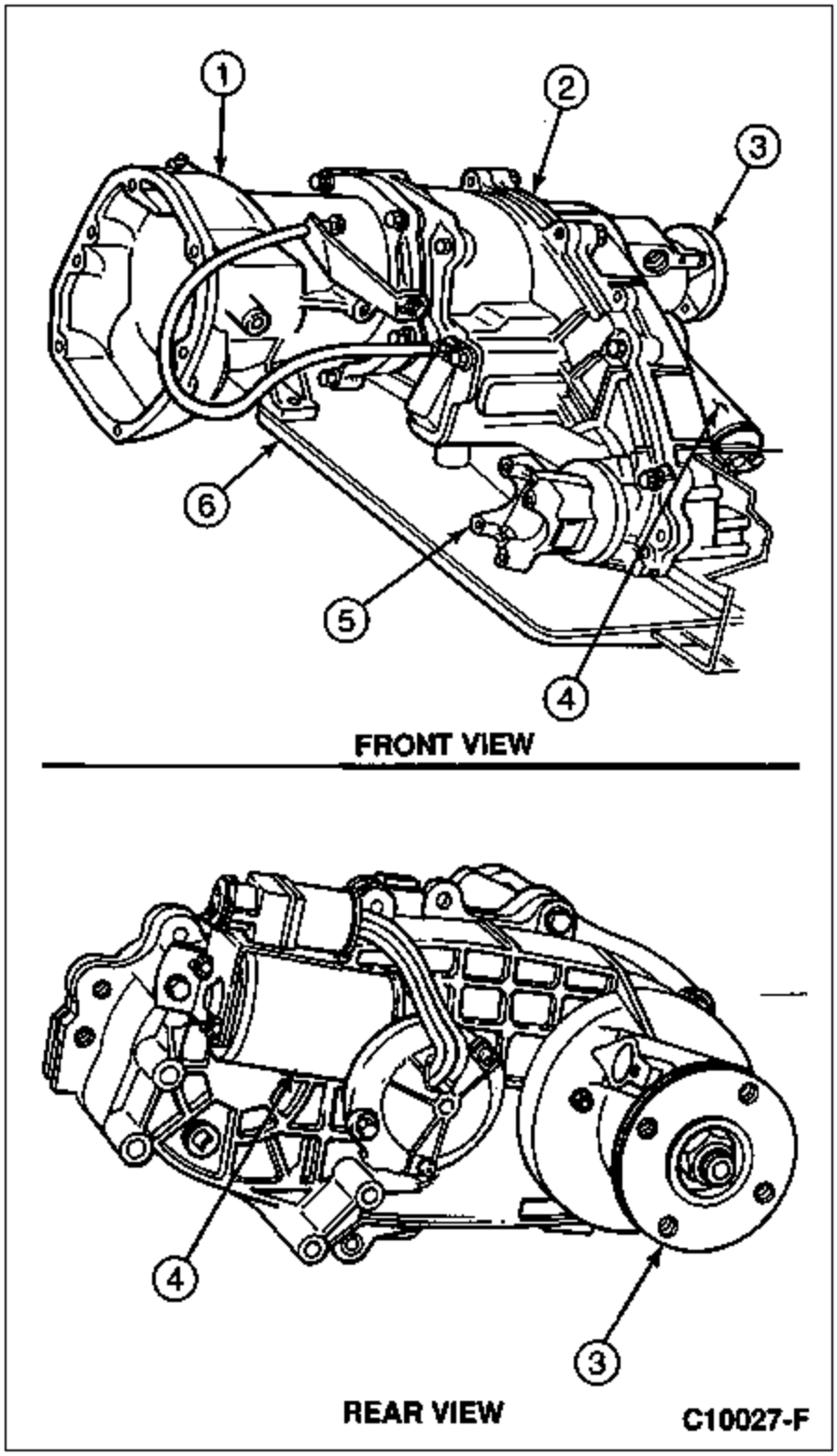

Item	Part Number	Description
1	7A039	Extension Housing
2	7A195	Transfer Case

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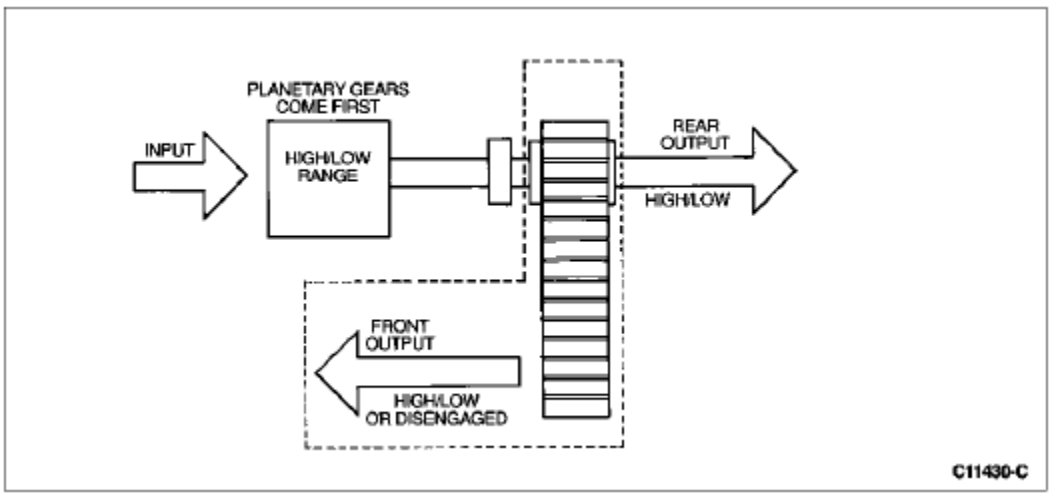
3	7B214	Case Yoke, Rear
4	7G360	Transfer Case Shift Motor
5	7B214	Case Yoke, Front
6	7E063	Skid Plate

Chain-Drive Advantages



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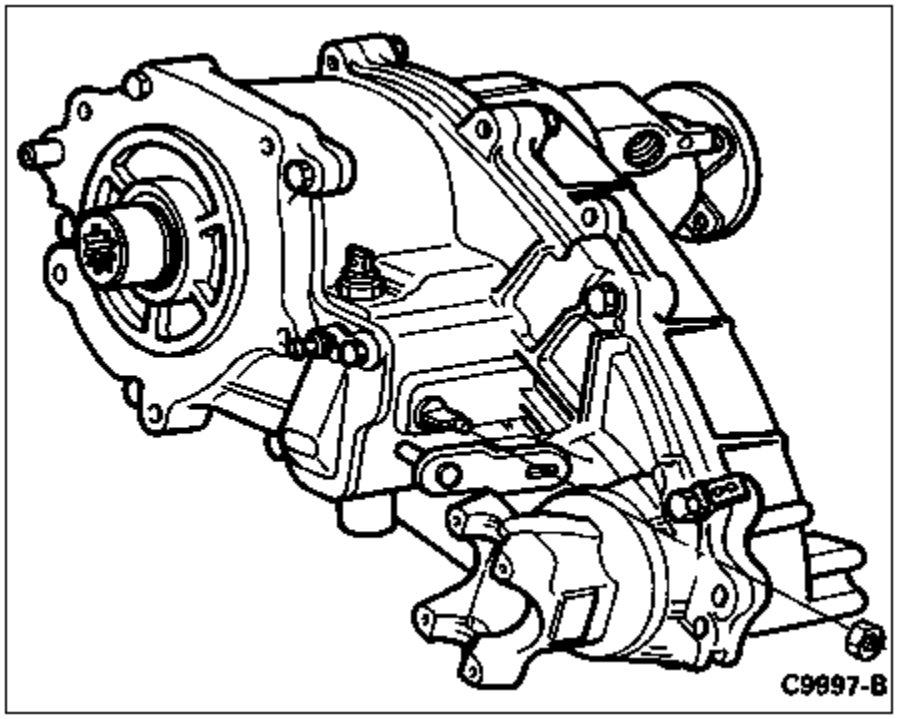
Mechanical Operation, Ranger

In the 4x2 mode, torque from the transmission (7003) is transferred to the input shaft (7017), which in turn drives the output shaft that drives the rear axle (4001).

The 2W-4W shift is accomplished when the 2W-4W shift fork moves the 2W-4W lockup sleeve to engage the drive sprocket on the rear output shaft splines. The drive sprocket turns the chain which turns the front output shaft driven sprocket on the front output shaft and the front driveshaft (4602).

Mechanical Shift Transfer Case



The high-low shift is accomplished when the high-low shift fork moves the high-low collar to engage the front planet (7A398) to the output shaft. Torque for the input shaft is then transmitted through the sun gear, which then turns the front planet. The front planet, which is now engaged to the output shaft, provides a reduction.

Neutral

With the shift selector in neutral, no power is transmitted to either front or rear axle. All the planetary gears turn freely with the input shaft, and the chain sprocket floats freely on the output shaft.

Power Flow in Neutral

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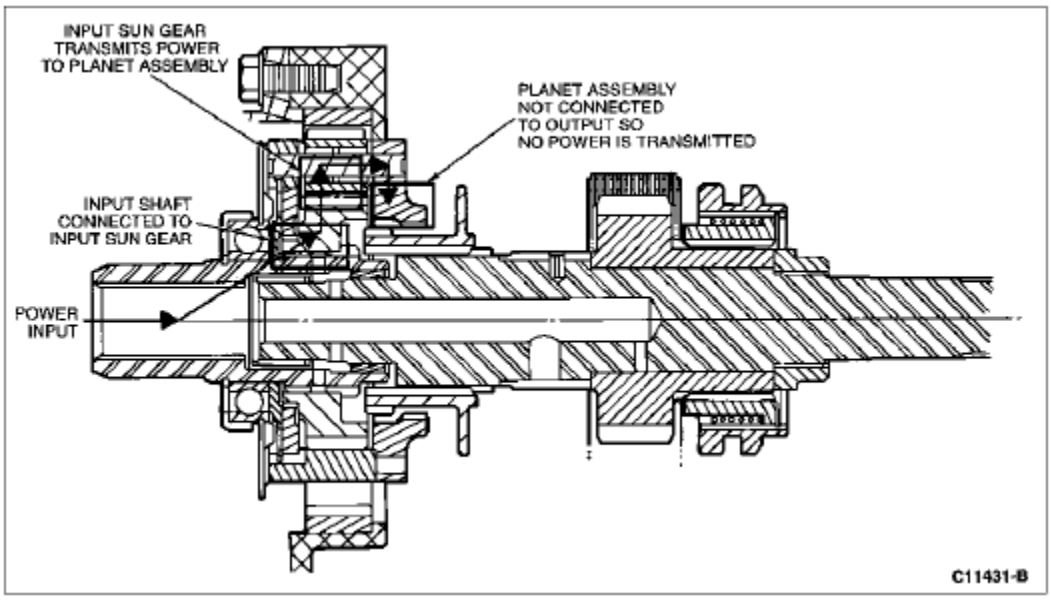
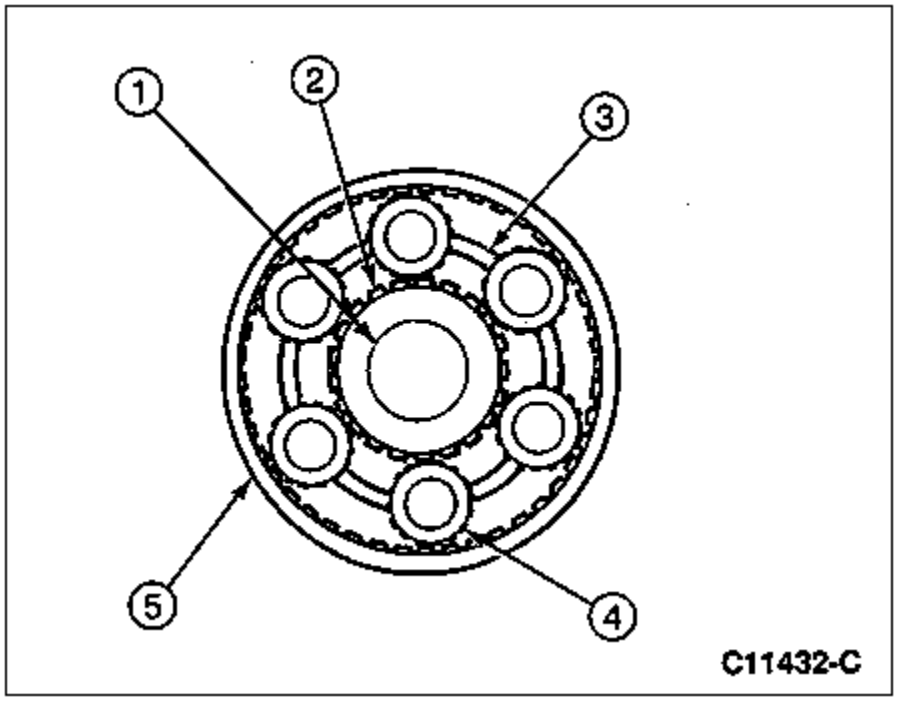


The following illustration shows a cross section of the front planet. At the center, attached to the input shaft, is the sun gear. This sun gear meshes with gears that surround it like planets (which is why this component is called a front planet). In turn, the gears mesh with an outer gear called the ring gear (7A153).

As the sun gear turns, the six planetary gears attempt to rotate. If the output shaft is locked to the front planet (as it is in low gear), the planetary gears "walk" around the inside of the annulus providing a gear reduction. If the output shaft is locked to the sun gear (as in high gear), the input shaft and output shaft rotate as a single unit.



Item	Part Number	Description
1	7061	Input Shaft

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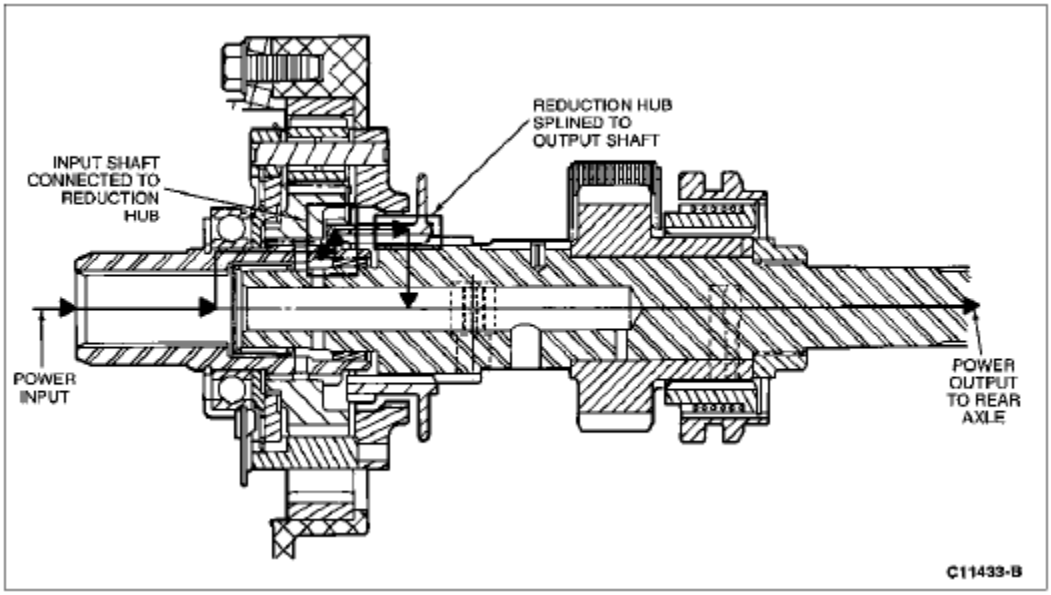
2	7D063	Sun Gear
3	7A398	Planetary Carrier
4	—	Planetary Gear (Part of 7A398)
5	7A153	Annulus (Ring Gear)

2-Wheel Drive, High Range

Power Flow in 2H



When the driver selects 2H, the high-low collar inside the front planet slides forward, putting the transfer case (7A195) into the high speed range (direct drive). The input shaft and the rear output shaft are locked together. This results in direct drive, straight through to the rear driveshaft. In addition, the 4-wheel drive lockup sleeve is disengaged so none of the 4WD components turn.

4-Wheel Drive, High Range

Power Flow in 4H

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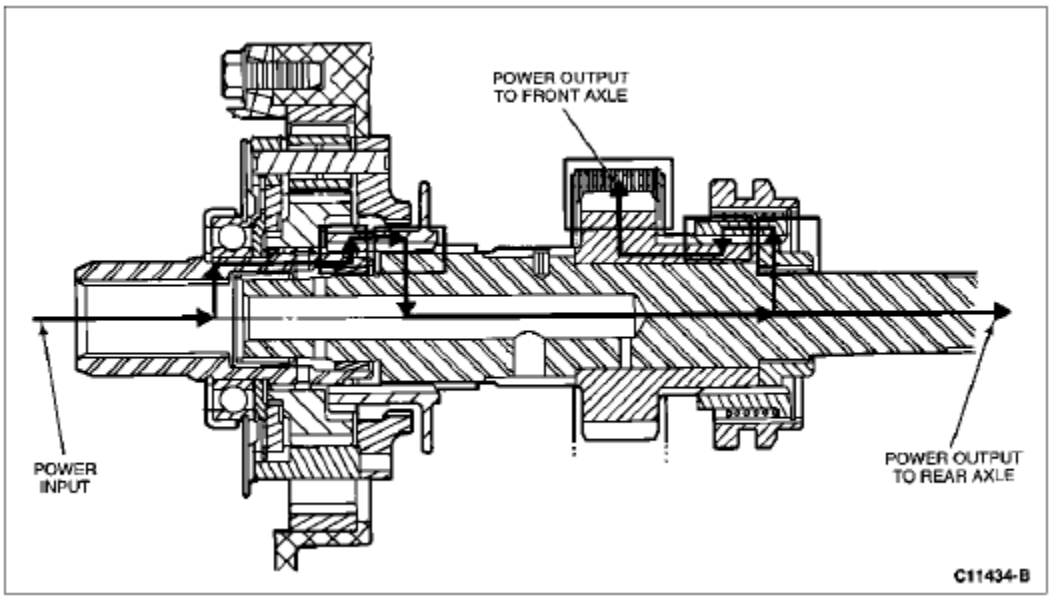
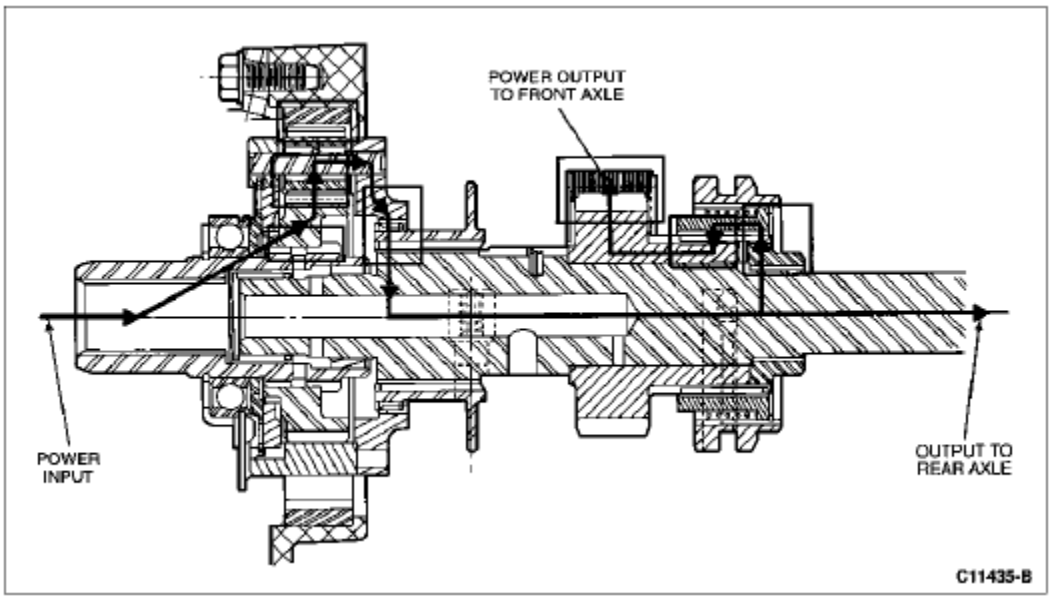


In 4-wheel drive, high range (4H), the front planet stays where it was in the 2H shift. The action of the shift lever causes the 4-wheel drive lockup hub to move rearward, locking the chain sprocket to the rear output shaft. Now, both the rear and the front wheels are being driven in the high range.

4-Wheel Drive, Low Range

Power Flow in 4L



To get maximum pulling power, the driver selects 4L. When this happens, the high-low collar moves rearward, and the front planet is locked to the output shaft. With the ring gear unable to turn, the planetary gears "walk" around the inside. The result is that the front planet now turns slower than the input shaft. Because the front planet is now locked to the output shaft, the output shaft rotates at a slower speed than

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the input shaft. This action increases the pulling power available to the wheels.

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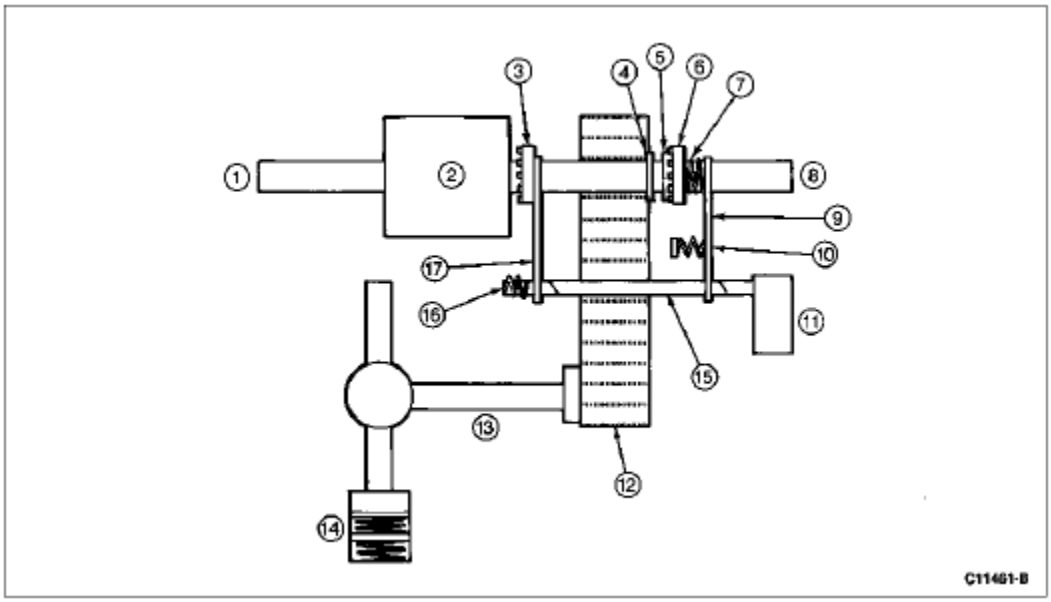
Electronic Shift Operation, Ranger

Electronic Shift Transfer Case



Item	Part Number	Description
1	7017	Input Shaft
2	7A398	Front Planet
3	7100	High-Low Collar
4	7177	Sprocket, Drive
5	7G361	Electromagnetic Clutch
6	7106	Lockup Sleeve
7	7D126	Lockup Spring
8	7061	Output Shaft Rear
9	7289	Shift Fork, 4WD
10	7219	Lockup Spring
11	7G360	Transfer Case Shift Motor
12	7A029	Drive Chain
13	7061	Output Shaft Front
14	3B396	Hub, Auto Locking
15	7N095	Shift Shaft

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16	7W074	Range Shift Spring
17	7289	Shift Fork, Range

The transfer case (7A195) is equipped with a magnetic clutch, similar to an air conditioning compressor clutch, which is located inside the transfer case adjacent to the lockup sleeve. The clutch is used to spin up the front drive system from zero to vehicle speed in milliseconds. This spin-up allows the shift between 2H and 4H to be made at vehicle speeds listed in the vehicle owner's guide. The spin-up engages the front lock hubs. When the transfer case rear and front output shaft reach synchronous speed, the spring-loaded shift collar mechanically engages the mainshaft lockup hub to the chain-drive sprocket and the magnetic clutch is then deactivated. Shifts between 4H and 4L can only occur with the transmission safety switches closed. The vehicle's speed must also be within specified limits as determined by the Generic Electronic Module (GEM).

The electronic shift control system consists of a rotary switch control system, a GEM, a transfer case shift motor (7G360) with an integral shift position sensor, a clutch pedal position switch or digital transmission range (DTR) sensor, and a brake signal input switch.

There is a control switch located on the instrument panel for fingertip shift control.

Switch Control System

When the switch on the instrument panel is turned, there is a one second delay, then the electronic control module verifies the transfer case positions (2H, 4H or 4L). Next, the GEM looks at the shift position sensor and the digital transmission range (DTR) sensor or clutch pedal position switch (depending on transmission type) and brake pedal switch. If all conditions are correct to allow the desired shift, the electronic control module will tell the transfer case shift motor to execute the shift. After the shift has been made and the transfer case shift motor is off, the control module again looks at the shift position sensor to make sure the proper shift has been accomplished. Finally, the dash indicator light on the control panel will be illuminated by a signal from the GEM indicating the desired shift has been completed.

GEM

The generic electronic module controls the operation of the transfer case in response to inputs to the rotary control by the vehicle operator, the shift position sensor, the transmission range sensor and the brake pedal switch.

Vehicle Speed Sensor (VSS)

The vehicle speed sensor (VSS) (9E731) generates an AC signal which is sent to the instrument cluster (10849). The signal is used as input to the powertrain control module (PCM) and the transmission control module (TCM).

Shift Position Sensor

The shift position sensor, an integral part of the electric shift motor, tells the GEM module the shift position of the transfer case.

Electric Shift Motor

The electric shift motor, mounted externally at the rear of the transfer case, drives a rotary helical cam which moves the 2W-4W shift fork and 4H-4L reduction shift fork to the selected vehicle drive position.

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4-Wheel Drive Operation

Locking Hubs, Ranger

There are two types of front hubs available for 4x4 vehicles.

- Manual (or free-running) that require the driver to get out of the cab to either lock or unlock them.
- Automatic locking which lock automatically when the axle shaft begins to turn.

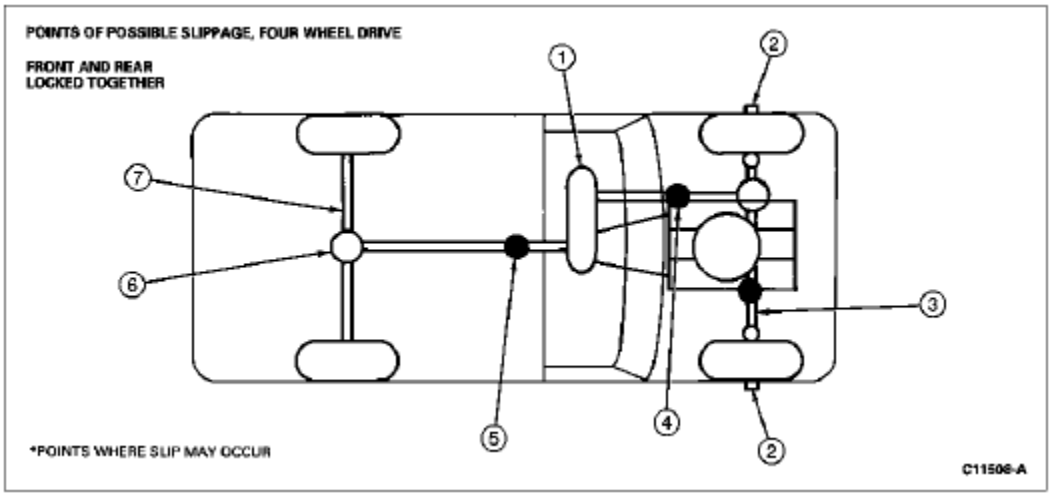
Manual (free-running) hubs feature seals that prevent entry of dirt and moisture and are very simple to operate. Automatic locking hubs use the front axle shaft rotation to actuate a cam that locks and unlocks the hub. Locking hubs may be locked at any time, and can be left in the locked position all the time, if desired.

On vehicles equipped with a manual shift transfer case (7A195) and manual locking hubs, low range can be selected when the vehicle's front hubs are unlocked. This is useful for short distances if very low, creeper gearing (but not 4WD) is needed. Refer to Section 05-03B for diagnosis, testing and repair procedures.

In 4WD, the front hubs are locked (either automatically or manually). As a result, the front wheels are **no longer free to turn independently** . The front and rear driveshafts (4602) are also now locked together and must turn as one. What's going to happen when the vehicle turns? That's a very important question.

In 4WD, just as in 2WD, each front wheel travels further than the rear wheel on its side. But this time, the front wheels aren't free to turn independently of the rear wheels. They are linked to the drivetrain by the transfer case and front driveshaft.

Points of Possible Slippage, Four-Wheel Drive



Item	Part Number	Description
1	7A195	Transfer Case
2	3B396	Locking Hub
3	3001	Front Axle

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4	4841	Driveshaft Slip Yoke Front
5	4841	Driveshaft Slip Yoke Rear
6	4026	Differential
7	4001	Rear Axle

Even though the difference between the inner and outer front wheels is compensated for by a front differential, torsional windup is still going to occur. Anytime one driveline component travels further than another, there will be driveline or torsional windup that must be released.

4WD in a 4x4 provides increased drive traction and performance in off-road situations and when driving on snow or ice. **It is not** designed for operation on dry surfaces and when traction is good. **It is not** suitable on dry paved roads or dry parking lots. Where 4WD should and shouldn't be used gives us the answer as to what releases the driveline or torsional windup.

When a 4x4 is driven off-road in 4WD, the wheels are in contact with dirt, sand and sometimes mud. The vehicle is also likely to bounce over bumps and ruts. In turns under these conditions, driveline or torsional windup will occur. If it does, the loose dirt, sand, or the slippery mud will allow wheels to slip a little, limiting the windup. Tension is also relieved when the wheel bounces in the air going over a bump. Snow and ice will also allow the wheels to slip and limit the windup.

When operating in 4WD on dry hard pavement, even more torsional windup occurs, which is not easily released. When the windup becomes great enough, the driver will feel the vehicle hop, skip or bounce. This is caused by the front or rear wheels slipping as the windup is released. Whichever wheels have the least traction are the ones that will slip. The tighter the turn, or the greater the traction, the greater the hop, skip or bounce. This torsional driveline windup is the cause of many owner complaints concerning the performance of their 4x4 vehicles.

Remember the effect of tire size, inflation, wear and loading. The following illustration shows that tires of even slightly different sizes roll different distances every revolution. The same effect is true for tires that are the same size but inflated or loaded differently. Operating a 4x4 in 4WD with tires of different size or inflation will produce driveline or torsional windup, even when driving straight ahead. If the vehicle is being driven in 4WD on dry, hard pavement, the driver will notice drag and may experience the hop, skip, bounce effect as the front or rear wheels release the windup.

Tire Rolling Differences Due to Size and Inflation Pressure

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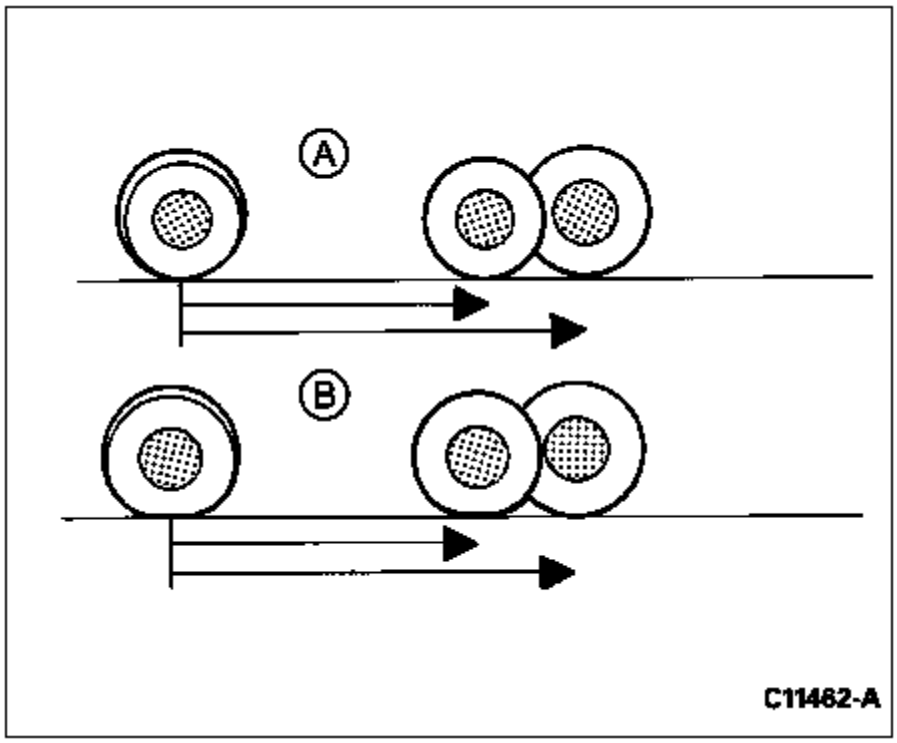

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4x4 Vehicle Driveline Windup

Driveline windup does more than just produce hop, skip and bounce. It can also cause delays in shifting out of 4WD. Vehicles with electronic shift transfer case (7A195) permit shifting from 2WD to 4WD and back on the fly. The vehicle must be stopped and the automatic transmission range selector lever put in neutral (not park) or the manual transmission clutch depressed in order to shift from 4H to 4L or back.

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Windup and Delay, Shifting Out of 4-Wheel Drive, Ranger

NOTE: To determine if driveline windup is causing delayed shifts to 2WD, jack the vehicle or lift it on a hoist with the wheels free to rotate. This should release the driveline windup, if it is present, and the transfer case (7A195) will complete its shift.

NOTE: Vehicles vary in terms of how "tight" they are. Some vehicles have a lot of "give" in the system. Softness in suspension and mounts will allow the driveline to absorb more windup before it affects performance. If driveline windup occurs, the system will tighten like a giant rubber band until the tires start slipping. A "tight" vehicle will signal the windup sooner, usually by a lot of chattering noises.

A delay or a failure to shift out of 4WD may be the result of driveline windup or extremely cold temperatures. In 4WD, windup can develop, especially if the vehicle is operated on hard, dry surfaces or in tight turns. The driver may select 2WD, but the shift doesn't take place even though the 4WD light goes out. Also, as long as the transfer case doesn't shift, the hubs remain locked and the vehicle remains in 4WD. If windup in the transfer case is severe, even backing up may not release it.

In order to return to 2WD under these conditions, two things must happen. First, if the transfer case doesn't shift right away, the vehicle will have to be driven in 4WD until the windup is relieved or the drive axle warms up. Second, when it does make the shift, the driver will have to stop the vehicle and go straight in the reverse direction for at least 3 meters (10 feet) to unlock the hubs.

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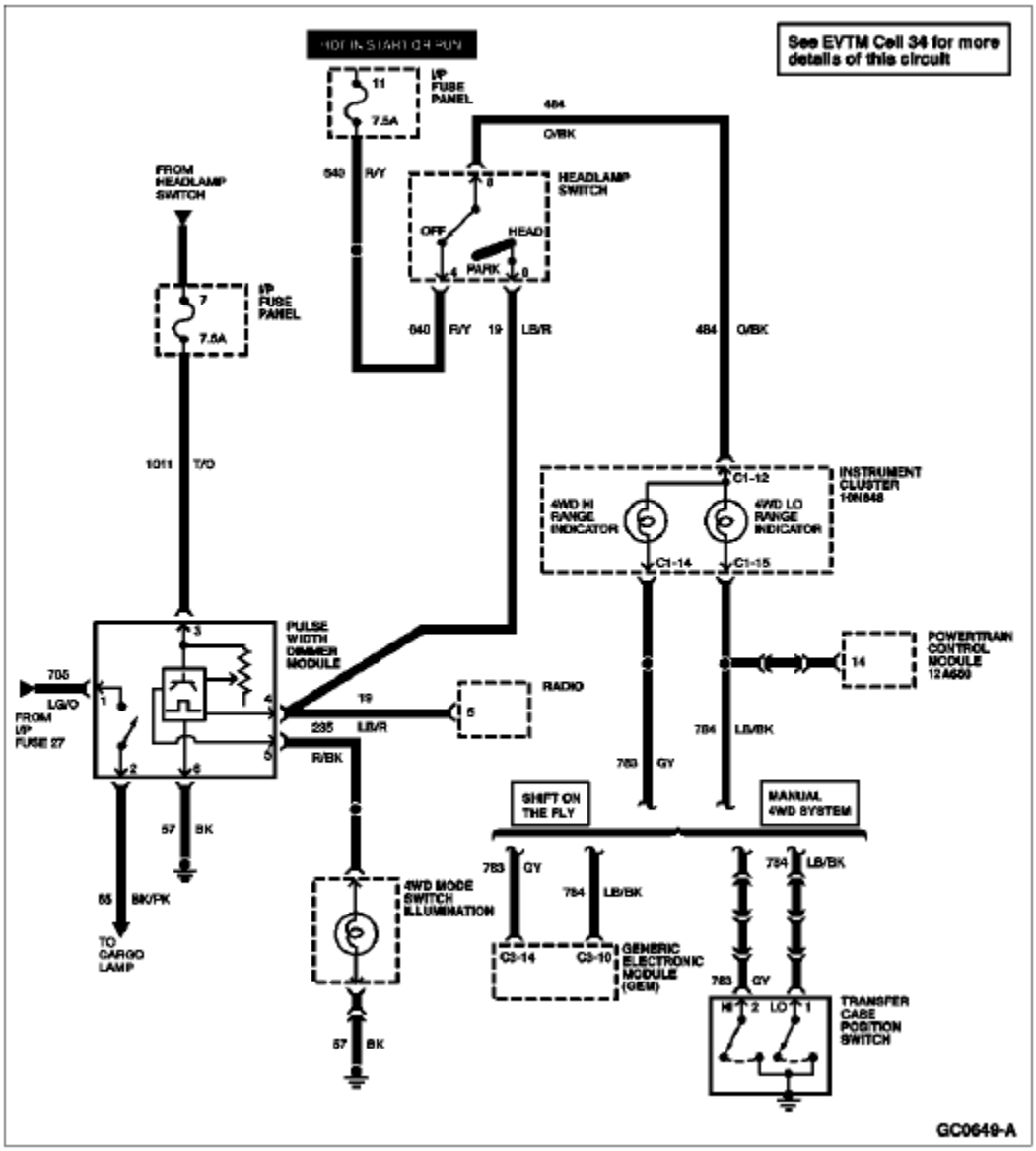
Electrical Schematics

Electronic Shift Transfer Case



Electronic Shift Transfer Case (Continued)

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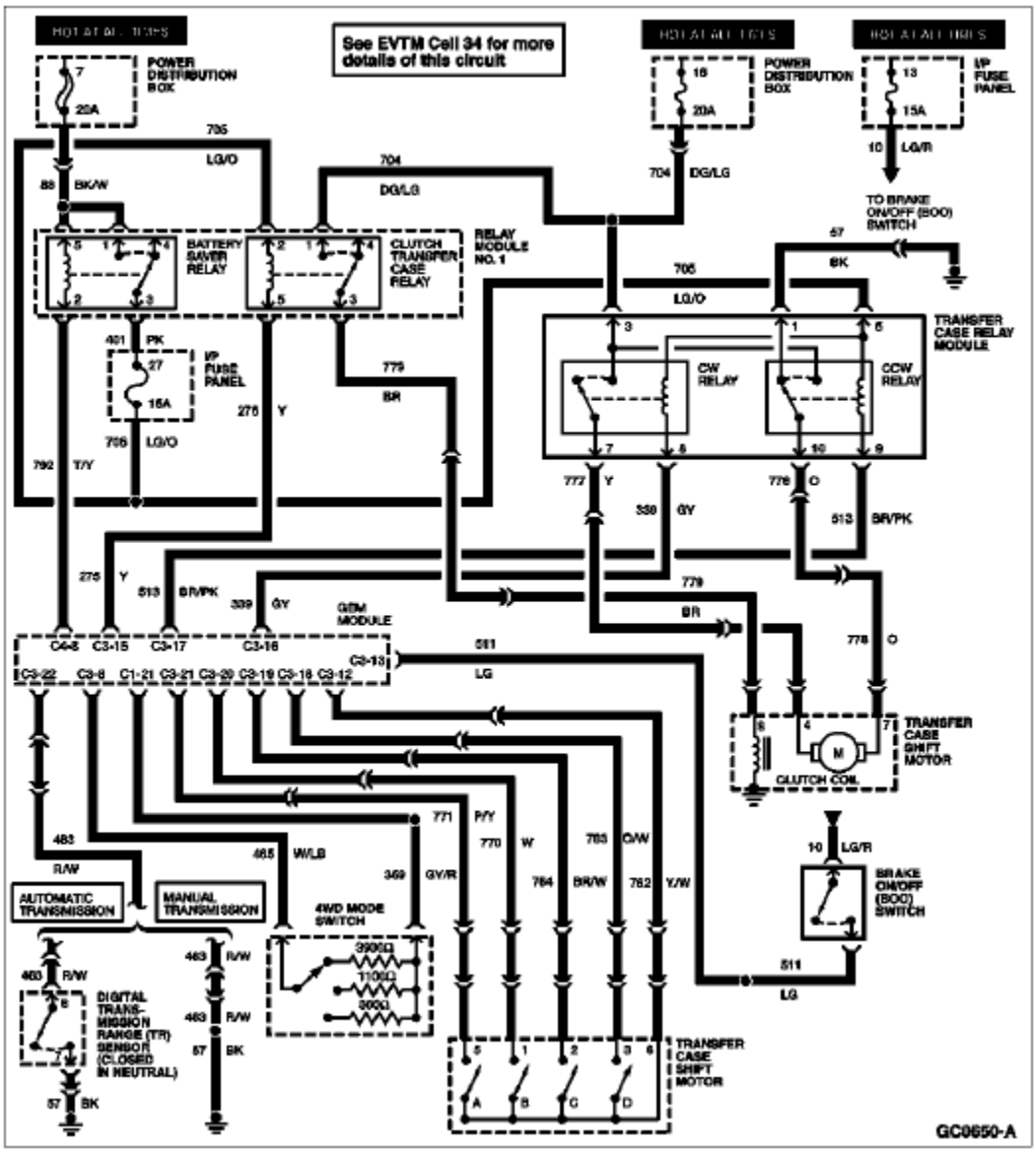

Clutch Pedal Switch, Ranger

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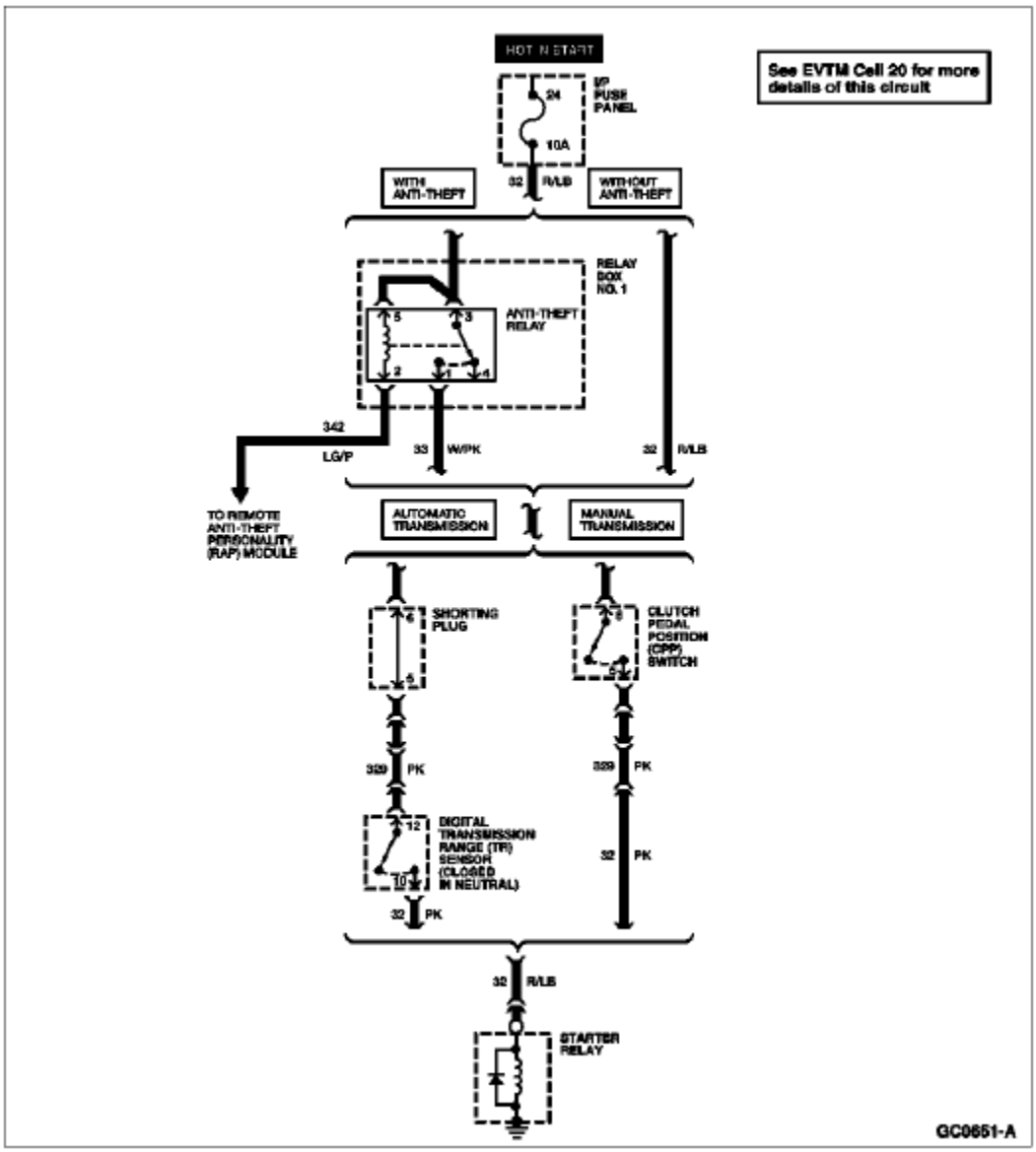

4-Wheel Drive Mode Switch Connector

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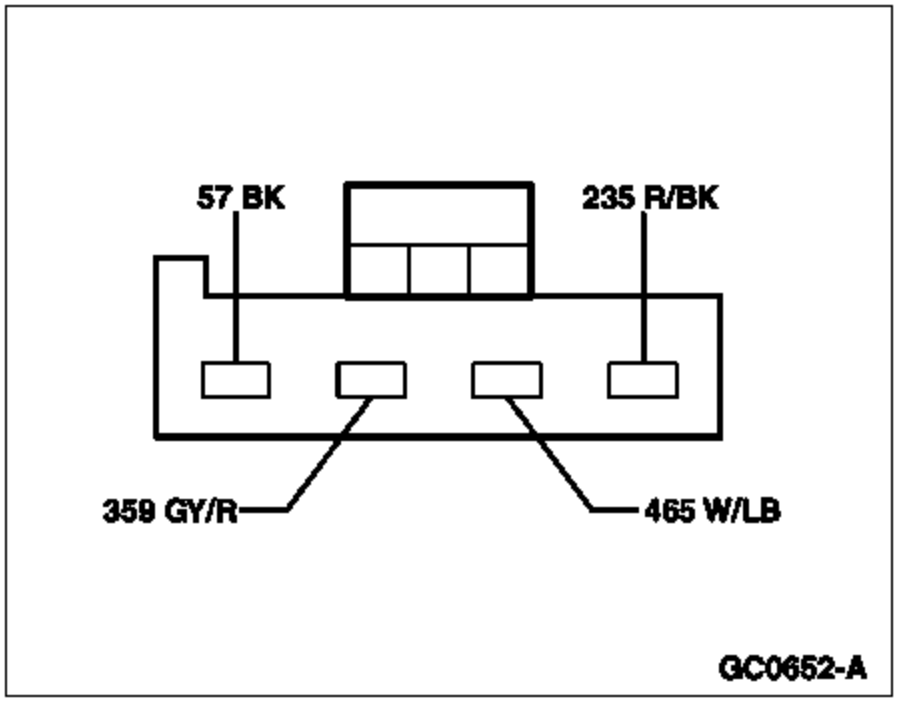
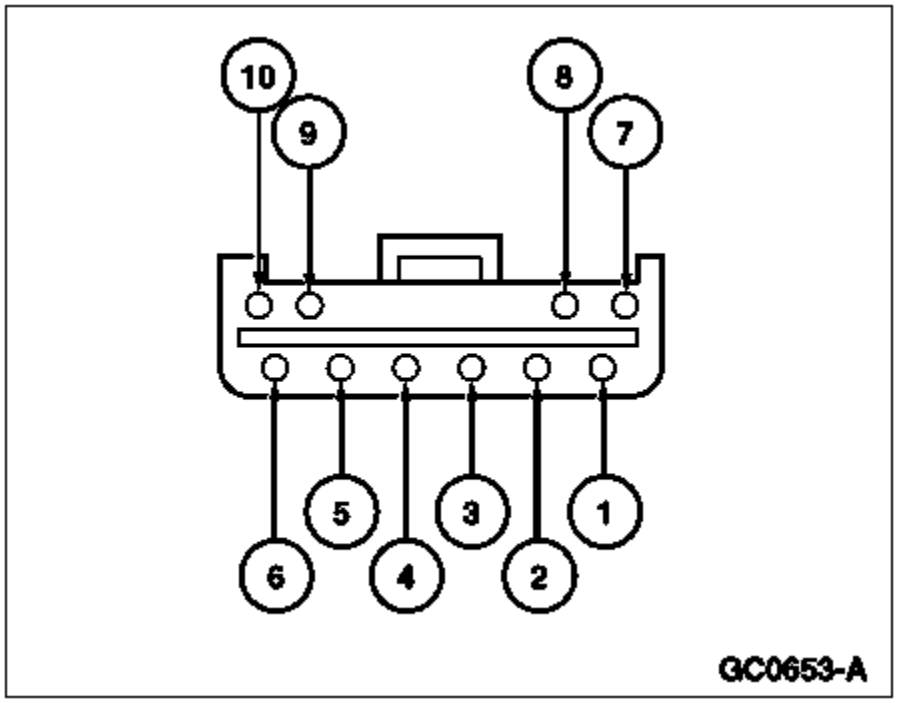


Transfer Case Relay Module Connector



Pin Number	Circuit	Circuit Function

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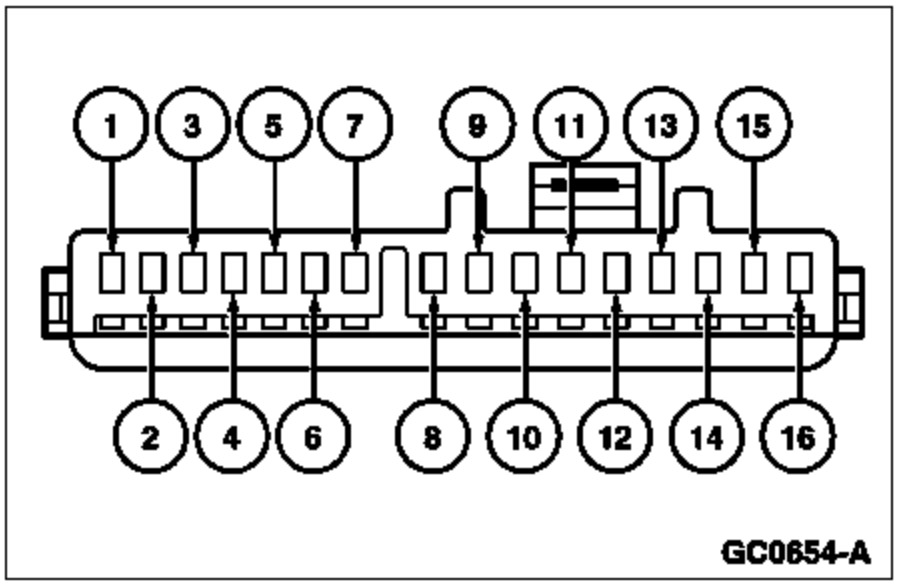
1	57 (BK)	Ground Circuit
2	—	NOT USED
3	704 (DG/LG)	Electrical Shift-on-the-Fly 4x4 Module Power
4	—	NOT USED
5	705 (LG/O)	Accessory Delay Relay and 4x4 Relay Module Feed
6	—	NOT USED
7	777 (Y)	Electric Shift 4x4 Module to Motor Control H2L
8	339 (GY)	Power Relay Coil to Module L2H Relay
9	513 (BR/PK)	Power Relay Coil to Module H2L
10	778 (O)	Electric Shift 4x4 Module to Motor Control, L2H

Instrument Cluster Connector C1



Pin Number	Circuit	Circuit Function
1	398 (BK/Y)	Tachometer Ground to Tach/Gauge Module
2	11 (T/Y)	ICM, Tach, EDM Signal
3	—	NOT USED
4	640 (R/Y)	Vehicle Power
5	253 (DG/W)	Oil Pressure Switch to PCM
6	921 (GY/O)	Feed to Fuel Shutoff Lamp
7	2 (W/LB)	Front Turn Signal Lamp (RH)
8	57 (BK)	Ground Circuit

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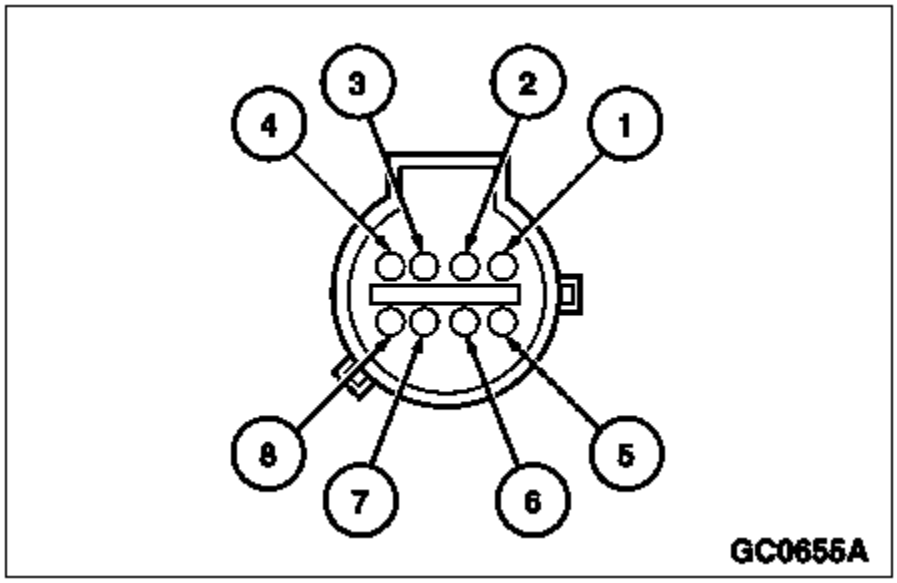
9	235 (R/BK)	Lamp Return to Pulse Width Dimmer Module
10	57 (BK)	Ground Circuit
11	343 (DB/LG)	Warning Lamp to Anti-Theft Module (Limited Edition Only)
12	484 (O/BK)	Indicator Lamp to Headlamp Switch
13	203 (O/LB)	Speed Control Indicating Lamp to Speed Control Lamp Interpace Module
14	783 (GY)	Electrical Shift Module to Graphic Display Roof Console
15	784 (LB/BK)	4x4 Low Range Switch to Module or Indicator Lamp
16	911 (W/LG)	PCM to Output Circuit Indicator Lamp/Overdrive Cancel Indicator

Transfer Case Shift Motor Connector



Pin Number	Circuit	Circuit Function
1	770 (W)	Electrical Shift 4x4 Module to Motor Position B
2	764 (BR/W)	Electrical Shift 4x4 Module to Motor Position C
3	763 (O/W)	Electrical Shift 4x4 Module to Motor Position D
4	777 (Y)	Electrical Shift 4x4 Module to Motor Control H2L
5	771 (P/Y)	Electrical Shift 4x4 Module to Motor Position A
6	762 (Y/W)	Electrical Shift 4x4 Module to Motor Position Return
7	778 (O)	Electrical Shift 4x4 Module to Motor Control L2H
8	779 (BR)	Electrical Shift 4x4 Module to Electric Clutch

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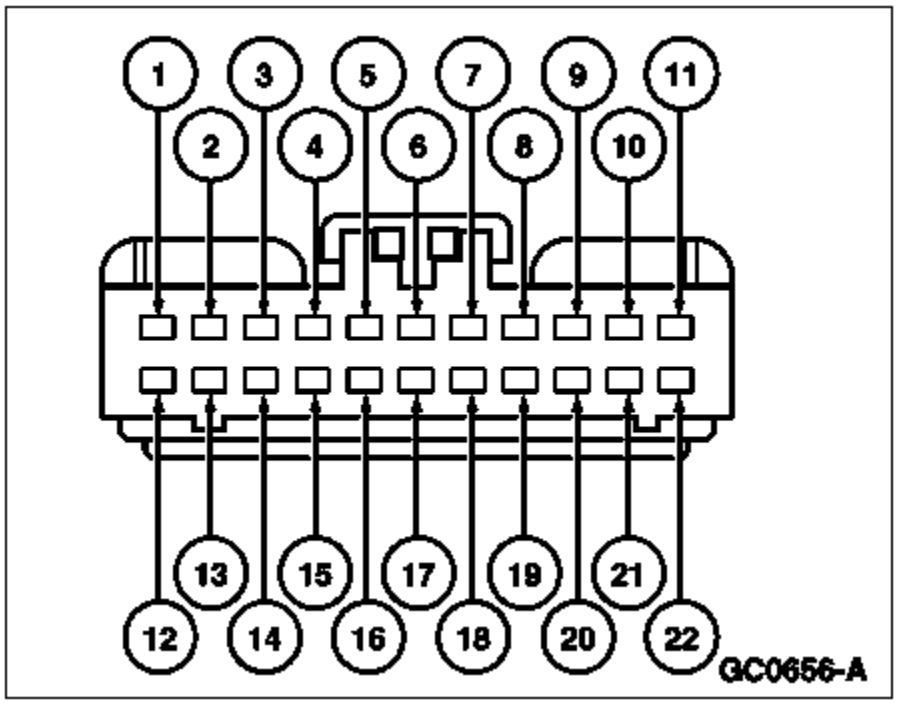
Generic Electronic Module (GEM) Connector C3



Pin Number	Circuit	Circuit Function
1	—	NOT USED
2	—	NOT USED
3	—	NOT USED
4	—	NOT USED
5	—	NOT USED
6	—	NOT USED
7	—	NOT USED
8	465 (W/LB)	Module to Switch
9	—	NOT USED
10	784 (LB/BK)	4x4 Low Indicator Lamps to GEM Module
11	—	NOT USED
12	762 (Y/W)	Electrical Shift 4x4 Module to Motor Return
13	511 (LG)	Brake On/Off (BOO) Switch to Stoplamps
14	783 (GY)	Electrical Shift Module to Graphic Display Roof Console
15	275 (Y)	Switch On to Relay
16	339 (GY)	GEM to L2H Transfer Case Relay Module
17	513 (BR/PK)	Power Relay Coil to Module

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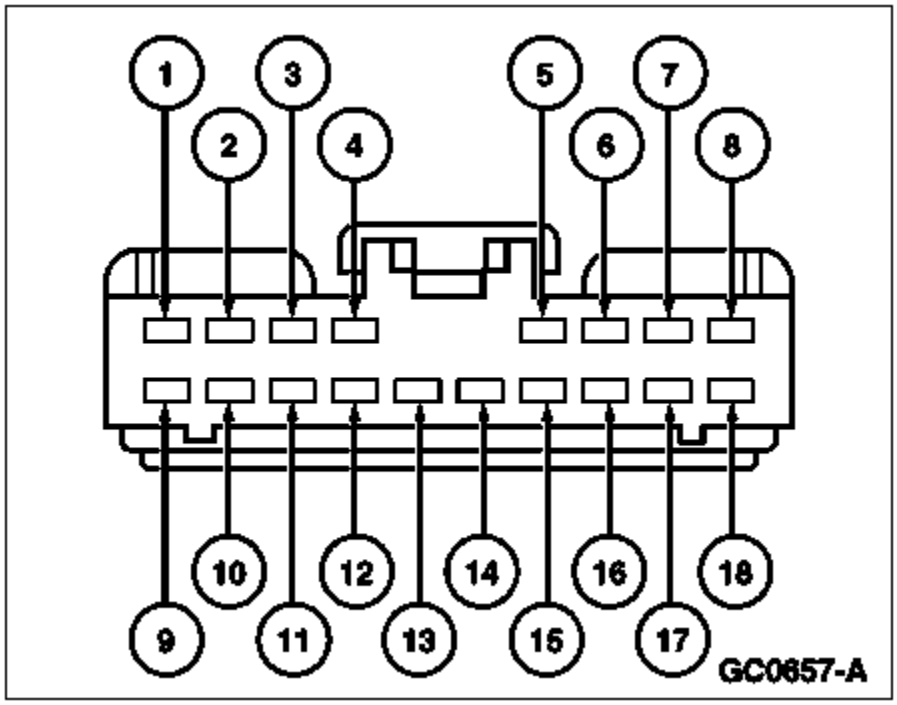
18	763 (O/W)	Electrical Shift 4x4 Module to Motor Position D
19	764 (BR/W)	Electrical Shift 4x4 Module to Motor Position C
20	770 (W)	Electrical Shift 4x4 Module to Motor Position B
21	771 (P/Y)	Electrical Shift 4x4 Module to Motor Position A
22	463 (R/W)	(Manual) Ground/(Automatic) Neutral Switch Input

Generic Electronic Module (GEM) / Central Timer Module (CTM) Connector C4



Pin Number	Circuit	Circuit Function
1	—	NOT USED
2	996 (O/W)	Window Motor Current Sensor "Low" to GEM Module — Input (LH)
3	991 (T/LB)	Master Window Control "Down" Command to GEM Module — Input
4	992 (W/BK)	Master Window Control "Up" Command to GEM — Input
5	1001 (W/Y)	Fused Battery Feed to GEM Module — Input
6	1003 (GY/Y)	Fused Ignition "Run" to GEM — Input
7	1007 (Y/R)	GEM Module to One-Touch "Down" Relay — Output
8	792 (T/Y)	Battery Saver Relay Control
9	679 (GY/BK)	Vehicle Speed Sensor — Plus to PCM
10	995 (GY)	Window Motor Current Sense "High" to GEM Module — Input (LH)

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11	1001 (W/Y)	Fused Battery Feed to GEM — Input
12	1008 (LG/O)	GEM to Interior Lamp Control Relay — Output
13	—	NOT USED
14	1000 (R/BK)	Fused Ignition "Start" to GEM — Input
15	1002 (BK/PK)	Fused Ignition "Run/Accessory" to GEM — Input
16	—	NOT USED
17	—	NOT USED
18	57 (BK)	Ground Circuit

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Inspection and Verification

NOTE: If the area of concern is indicated to be other than the transfer case (7A195), refer to the specific section or sections of the appropriate shop manual.

1. **NOTE: Owner driving habits as well as road and weather conditions should be noted.**

   Road test the vehicle to verify the concern, noting road speed, engine speed, speed range where the vehicle problem is evident.

2. Raise the vehicle on a hoist and position suitable safety floor stands under the vehicle.

3. Run the vehicle at the road speed and in the axle drive mode (4WD/2WD) where concern exists. Verify concern area:

   - Engine
   - Clutch/Transmission (7003)
   - Transfer Case
   - Front/Rear Driveline Components
   - Front/Rear Drive Axles
   - Front/Rear Brake Systems
   - Front Axle Locking Hubs
   - Front/Rear Wheels and/or Tires

4. Refer to the appropriate owner guide for operating data, if the concern is verified to be driveline or torsional windup, before servicing the transfer case.

5. If the 4WD system slips under load, find what has broken or is slipping. To locate where slip is taking place, put marks at various possible slip points. Test drive the vehicle, then check to see if marks at different points are still in the same relationship to each other. This will indicate where the slippage is taking place or where to look for broken parts, if any.

   a. On vehicles with auto hubs, find a suitable place where the vehicle can be tested. Mark the components, then drive vehicle without backing up. Stop and check the marks to see if they are in the same relationship to each other. If the vehicle is backed up before checking these marks, the hubs may re-index and not reveal the problem.

6. Check tires and vehicle loading if the concern is clearly driveline windup and not broken parts.

7. If the transfer case shift motor (7G360) operates properly and nothing happens, or if a manual shift lever fails to shift the transfer case , it will have to be serviced. Be sure driveline windup has been eliminated as a cause.

8. Driveline noise may be experienced if a vehicle is operated in 2WD with the hubs locked. This occurs because the 4WD components are in motion instead of at rest (the normal condition in 2WD with the hubs unlocked). However, it is important to remember that excessive noise may be a sign of a serious condition.

NOTE: It is important not to run for long periods with dirt and water in the hubs.

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Maintenance of the hubs is important. Easy shifting from one operating position to the other requires smooth movement of the inner clutch ring. This ring slides on splines which must be clean and well lubricated. To prevent dirt and water from entering the hub unit, the oil seals must be very carefully installed. If the vehicle is operated where the hub is constantly submerged in water or mud, the hubs should be serviced more frequently. The important thing is not to run for long periods with dirt and water in the hubs. Start with a short service interval and check for water and dirt. Stretch out the interval as experience shows how dirty they are actually getting.

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Symptom Chart — Electronic Shift Transfer Case Diagnosis, Ranger

NOTE: Use Rotunda 73 Digital Multimeter 105-R0051 with Rotunda Terminal Adapter Kit 105-00025 or equivalent to perform electrical pinpoint test.

ELECTRONIC SHIFT TRANSFER CASE DIAGNOSIS, RANGER

Condition	Possible Source	Action
• Cannot Change the 4WD Mode	• DTC P1812, P1815 self test and continuous.	• GO to Pinpoint Test A .
	• DTC P1803 self test, P1802 continuous.	• SHORT to battery between the neutral safety switch and GEM Circuit 463 (R/W) or OPEN circuit.
	• DTC B1483 continuous. DTC B1485 self test and continuous.	• GO to Pinpoint Test Step **A6** .
• Cannot Change 4WD Gears	• DTC P1820 self test and continuous.	• GO to Pinpoint Test Step **B1** .
	• DTC P1822 self test and continuous.	• GO to Pinpoint Test Step **B5** .
	• DTC P1824 self test and continuous.	• GO to Pinpoint Test Step **B9** .
	• DTC P1826 self test and continuous.	• GO to Pinpoint Test Step **B10** .
	• DTC P1820, P1828 self test and continuous.	• GO to Pinpoint Test Step **B12** .
	• DTC 1828 self test and continuous.	• GO to Pinpoint Test Step **B13** .
	• DTC P1830 self test and continuous.	• GO to Pinpoint Test Step **B19** .
	• DTC P1838 continuous.	• GO to Pinpoint Test Step **B37** .
	• DTC P1846, P1867 self test.	• GO to Pinpoint Test Step **B31** .
	• DTC P1850 self test; P1850, P1867 continuous.	• GO to Pinpoint Test Step **B33** .
	• DTC P1854, P1867 self test.	• GO to Pinpoint Test Step **B35** .
	• DTC P1858, P1867 self test.	• GO to Pinpoint Test Step **B37** .

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	• DTC P1862 self test and continuous. • DTC P1864 self test. • DTC P1848 self test and P1866 continuous. • DTC P1852 self test and P1866 continuous. • DTC P1856 self test and P1866 continuous. • DTC P1860 self test and P1866 continuous.	• GO to Pinpoint Test Step **B39**. • GO to Pinpoint Test Step **B41**. • GO to Pinpoint Test Step **B43**. • GO to Pinpoint Test Step **B44**. • GO to Pinpoint Test Step **B45**. • GO to Pinpoint Test Step **B46**.
• 4WD HIGH Indicator Lamp Never Illuminates	• DTC P1804 self test and continuous. • DTC P1806 self test and continuous.	• GO to Pinpoint Test Step **C1**. • GO to Pinpoint Test Step **C5**.
• 4WD HIGH Indicator Lamp Is Always On	• DTC P1804 self test and continuous.	• SERVICE Circuit 783 (GY) for short open or to ground between GEM module C3-14 and indicator lamp.
• 4WD LOW Indicator Lamp Never Illuminates	• DTC P1808 self test and continuous. • DTC P1810 self test and continuous.	• GO to Pinpoint Test Step **D1**. • GO to Pinpoint Test Step **D5**.
• 4WD LOW Indicator Lamp Is Always On	• DTC P1808 self test and continuous.	• SERVICE Circuit 784 (LB/BK) for short or open to ground between GEM module C3-10 and indicator lamp.
• 4WD System Drains Battery	• Defective wiring.	• SHORT to battery Circuit 705 (LG/O) to the H2L relay.
• 4WD Mode Switch Does Not Illuminate With Headlamp Switch ON	• Open circuit, short to ground, defective 4WD mode switch.	• REFER to Section 13-00.
• Transfer Case Makes Noise	• Incorrect tire inflation pressures or incorrect size tires and wheels. • Excessive tire tread wear. • Internal components.	• MAKE SURE that all tires and wheels are the same size, and that inflation pressures are correct. • CHECK tire tread wear to see if there is more than 0.06 inch difference in tread wear between front and rear. INTERCHANGE one front and one rear wheel. REINFLATE tires to specification. • OPERATE vehicle in all

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		transmission gears with transfer case in 2HI, or High range. • If there is noise in transmission in neutral gear, or in some gears and not in others, REFER to Section 07-01A or Section 07-01B . • If there is noise in all gears, OPERATE vehicle in all transfer case ranges. If noisy in all ranges or High range only, DISASSEMBLE transfer case. CHECK input gear, intermediate and front output shaft gear for damage. REPLACE as required. If noisy in Low range only, INSPECT intermediate gear and sliding gears for damage. REPLACE as required.
• Early or Delayed Shifts	• DTC P1781 self test and P1729 continuous.	• GO to Pinpoint Test **E1** .
• 4-Wheel Drive Transfer Case Jumps Out of Gear	• Incomplete shift linkage travel. • Loose mounting bolts. • Front and rear driveshaft slip yokes dry or loose. • Internal components.	• ADJUST linkage to provide complete gear engagement. ADJUST shift gearshift lever boot. • TIGHTEN mounting bolts. • LUBRICATE and REPAIR slip yokes as required. TIGHTEN flange yoke attaching nut to specifications. • DISASSEMBLE transfer case. INSPECT sliding clutch hub and gear clutch teeth for damage. REPLACE as required.
• Locking Hubs Will Not Release	• Driveline/vehicle torsional lockup. • Extremely cold ambient temperatures.	• STOP vehicle. DRIVE vehicle in reverse for 3 meters (10 feet). • DRIVE vehicle 16 km (10 miles) to warm axle, then try to DISENGAGE hub locks.
• Driveline/Torsional Windup. Vehicle Hop, Wheel/Tire Bounce, Vehicle Skip	• Incorrect tire inflation pressures or incorrect size tires and wheels. • Excessive tire tread wear. • Driving vehicle on hard surface/dry surface roads or areas. Driving vehicle in tight turns.	• MAKE SURE that all tires and wheels are the same size, and that inflation pressures are correct. • REFER to vehicle owner guide for correct usage of vehicle. ADVISE owner.
• Delayed Shifts to 2WD	• Driveline/torsional windup.	• SHIFT transmission into neutral. JACK the vehicle or lift on hoist

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	• Extremely cold ambient temperatures.	with wheels free to rotate. Windup will be released and transfer case will complete its shift. • DRIVE vehicle 16 km (10 miles) to warm axle, then try to DISENGAGE hub locks.
• Automatic Transmission Delayed Shifts in 4x4 L	• Transfer case in 4x4 H.	• Place transfer in 4x4 L. Diagnose and REPAIR. REFER to Section 07-01A or Section 07-01B .
• Early shifts in 4x2 or 4x4 H	• Transfer case in 4x4L or indicating 4x4L • Failed fuse.	• DIAGNOSE and REPAIR. REFER to Section 07-01A or Section 07-01B .

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Pinpoint Tests

PINPOINT TEST A: CANNOT CHANGE 4WD MODE, DTC P1812, P1815

A1 CHECK 4X4 SWITCH

- Remove and disconnect 4WD mode switch.
- Inspect wiring and connector for damage.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, test Circuits 465 (W/LB) and 359 (GY/R) for resistance values in listed positions below:
- 2WD — 3.4K-4.3K, A4WD/4WD High — 1K-1.2K, 4W Low — 320K-400K

Are the values correct?

Yes	No
GO to **A2** .	REPLACE 4WD mode switch. CLEAR all DTCs and RETEST system.

A2 CHECK CIRCUIT 465 (W/LB) FOR OPEN

- Gain access to the generic electronic module connector C3.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, measure resistance of Pin 08, Circuit 465 (W/LB) between GEM module and 4WD mode switch.

Is resistance less than 5 ohms?

Yes	No
GO to **A3** .	SERVICE Circuit 465 (W/LB) for open. RECONNECT and CLEAR all DTCs and RETEST system.

A3 CHECK CIRCUIT 465 (W/LB) FOR SHORT TO BATTERY

- Reconnect GEM connector C3.
- Key ON.
- Measure for voltage on Circuits 465 (W/LB) and 359 (GY/R).

Is B+ present?

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Yes	No
SERVICE battery short RECONNECT switch. CLEAR all DTCs and RETEST system.	GO to A4 .

A4 CHECK CIRCUIT 465 (W/LB) FOR SHORT TO GROUND

- Disconnect GEM connector C3.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check C3 Pin 08 for continuity to a known ground.

Is continuity present?

Yes	No
SERVICE Circuit 465 (W/LB) for short to ground. Clear all DTCs and RETEST system.	GO to A5 .

A5 CHECK CIRCUIT 359 (GY/R) FOR OPEN

- Remove GEM connector C1.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check Circuit 359 (GY/R) between 4x4 switch and GEM Connector C1 Pin 21 for continuity.

Is continuity present?

Yes	No
Circuit OK. RECONNECT GEM connector. CLEAR all DTCs and RETEST system.	SERVICE Circuit 359 (GY/R) for open. CLEAR all DTCs and RETEST system.

A6 READ PID BOO-GEM STATUS

- Connect NGS.
- Read PID BOO-GEM.
- Press brake pedal.

Does status change?

Yes	No
Switch OK.	GO to A7 .

A7 CHECK CIRCUIT 511 (LG) FOR SHORT TO GROUND DTC B1483

- Gain access to GEM connector C3-13, using Rotunda 73 Digital Multimeter 051-00051.
- Key OFF.

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- Check Circuit 511 (LG) for continuity to ground.

Is continuity present?

Yes	No
SERVICE Circuit 511 (LG) for short to ground, CLEAR all DTCs and RETEST system.	GO to **A8** .

A8 CHECK CIRCUIT 511 (LG) FOR OPEN

- With GEM removed, use Rotunda 73 Digital Multimeter 051-00051.
- Disconnect brake on/off (BOO) switch connector.
- Check for continuity between BOO switch and GEM connector C3-13.

Is continuity present?

Yes	No
GO to **A9** .	REPAIR open in Circuit 511 (LG). CLEAR all DTCs and RETEST system.

A9 CHECK CIRCUIT 511 (LG) FOR BATTERY SHORT DTC B1485

- Gain access to GEM connector C3-13, using Rotunda 73 Digital Multimeter 051-00051.
- Key OFF.
- Brake pedal not depressed.
- Check Circuit 511 (LG) for battery voltage.

Is B+ present?

Yes	No
SERVICE Circuit 511 (LG) for battery short. CLEAR all DTCs and RETEST system.	System OK. REFER to symptom chart.

PINPOINT TEST B: CANNOT CHANGE 4WD GEARS DTCS P1820, P1822, P1824,P1826, P1828, P1830, P1838, P1846, P1867, P1850, P1854, P1858, P1862, P1864, P1848, P1866, P1852, P1856, P1860

B1 CHECK FUSE 27 FOR OPEN

- Key OFF.
- Check fuse 27 15A for open.

Is fuse open?

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Yes	No
GO to **B2** .	GO to **B3** .

B2 CHECK CIRCUIT 339 (GY) FOR OPEN

- Key OFF.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, measure for continuity between GEM connector C3, Pin 16 and the transfer case relay module connector Pin 08, Circuit 339 (GY).

Is continuity present?

Yes	No
GO to **B3** .	SERVICE Circuit 339 (GY) for open. RECONNECT all connectors. CLEAR all DTCs and RETEST system.

B3 CHECK CIRCUIT 339 (GY) FOR SHORT TO GROUND

- Gain access to GEM connector C3.
- Using Rotunda 73 Digital Multimeter or equivalent, check C3 Pin 16, Circuit 339 (GY) for short to ground.

Is continuity present?

Yes	No
SERVICE Circuit 339 (GY) for short to ground. REPLACE fuse 27. CLEAR all DTCs and RETEST system.	GO to **B4** .

B4 CHECK TRANSFER CASE RELAY MODULE

- Key OFF.
- Disconnect transfer case relay module connector.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check for continuity between Pin 08 and Pin 01.

Is continuity present?

Yes	No
REPLACE transfer case relay module. CLEAR all DTCs and RETEST system.	GO to **B5** .

B5 CHECK TRANSFER CASE RELAY MODULE FOR OPEN

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- Key OFF.
- Disconnect transfer case relay module.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, measure resistance between Pins 08, 05 of relay module.

Is resistance between 85-140 ohms?

Yes	No
GO to **B6** .	REPLACE transfer case relay module. CLEAR all DTCs and RETEST system.

B6 CHECK CIRCUIT 339 (GY) FOR BATTERY SHORT

- Key OFF.
- Remove transfer case relay module.
- Key ON.
- Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent, measure for voltage at Pin 08 of the transfer case relay module.

Is B+ present?

Yes	No
SERVICE Circuit 339 (GY) for short to battery. CLEAR all DTCs and RETEST system.	GO to **B7** .

B7 CHECK TRANSFER CASE RELAY MODULE

- Key OFF.
- Remove transfer case relay module.
- Measure resistance of relay module Pin 09 and Pin 05.

Is resistance between 85-140 ohms?

Yes	No
GO to **B8** .	REPLACE transfer case relay module. CLEAR all DTCs and RETEST system.

B8 CHECK CIRCUIT 275 (Y) FOR SHORT TO GROUND

- Key OFF.
- Remove GEM connector C3.
- Remove clutch transfer case relay.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check Pin 15 for continuity to ground.

Is continuity present?

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Yes	No
SERVICE Circuit 275 (Y) for short to ground. CLEAR all DTCs and RETEST system.	GO to **B9** .

B9 CHECK CLUTCH TRANSFER CASE RELAY FOR INTERNAL SHORT

- Remove the clutch transfer case relay.
- Measure the resistance between clutch transfer case relay terminals 3 and 5.

Is continuity present?

Yes	No
REPLACE clutch transfer case relay. CLEAR all DTCs and RETEST system.	GO to **B10** .

B10 CHECK CIRCUIT 275 (Y) FOR OPEN

- Remove GEM connector C3.
- Remove clutch transfer case relay.
- Measure circuit 275 (Y) for resistance between GEM C3-15 and clutch transfer case relay connector.

Is resistance less than 5 ohms?

Yes	No
GO to **B11** .	SERVICE Circuit 275 (Y) for open. RECONNECT connectors. CLEAR all DTCs and RETEST system.

B11 CHECK CIRCUIT 275 (Y) FOR BATTERY SHORT

- Remove clutch transfer case relay.
- Key ON.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check Circuit 275 (Y) for B+.

Is B+ present?

Yes	No
SERVICE Circuit 275 (Y) for battery short. CLEAR all DTCs and RETEST system.	System OK. RECONNECT relay. CLEAR all DTCs and RETEST system.

B12 CHECK IP FUSE 27 FOR OPEN

Is fuse OK?

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Yes	No
GO to **B13** .	GO to **B16** .

B13 CHECK CIRCUIT 513 (BR/PK) FOR SHORT TO GROUND

- Key OFF.
- Transfer case relay module disconnected.
- Remove GEM connector C3.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check circuit 513 (BR/PK) for continuity to ground.

Is continuity present?

Yes	No
SERVICE circuit 513 (BR/PK) for short to ground. RECONNECT, CLEAR all DTCs and RETEST system.	GO to **B14** .

B14 CHECK CIRCUIT 513 (BR/PK) FOR OPEN

- Key OFF.
- Transfer case relay module disconnected.
- Remove GEM connector C3.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check for continuity between transfer case relay module Pin 09 and GEM connector C3, Pin 17 for continuity.

Is continuity present?

Yes	No
GO to **B15** .	SERVICE Circuit 513 (BR/PK) for open. CLEAR all DTCs and RETEST system.

B15 CHECK CIRCUIT 705 (LG/O) AND CIRCUIT 704 (DG/LG) FOR SHORT TO GROUND

- Remove fuse 27 and fuse 16.
- Key OFF.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check circuit 705 (LG/O) and 704 (DG/LG) for short to ground.

Is continuity present?

Yes	No
SERVICE Circuit 705 (LG/O) or 704 (DG/LG) for short to ground. CLEAR all DTCs and RETEST system.	GO to **B16** .

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B16 CHECK TRANSFER CASE RELAY MODULE

- Transfer case relay module disconnected.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check continuity between Pins 06, 10 and 03, 10.

Is continuity present?

Yes	No
REPLACE transfer case relay module. CLEAR all DTCs and RETEST system.	GO to **B17** .

B17 CHECK CIRCUIT 705 (LG/O) FOR OPEN

- Key OFF.
- Transfer case relay module disconnected.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check continuity between transfer case relay module connector Pin 05 and IP, fuse 27 Circuit 705 (LG/O).

Is continuity present?

Yes	No
REPLACE 15A IP fuse 27. CLEAR all DTCs and RETEST system. If fuse fails again, GO to **B18** .	SERVICE Circuit 705 (LG/O) for open. CLEAR all DTCs and RETEST system.

B18 CHECK CIRCUIT 401 (PK) FOR SHORT TO GROUND

- Key OFF.
- Remove Fuse 27.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check IP fuse 27, Circuit 401 (PK) for continuity to ground.

Is continuity present?

Yes	No
SERVICE Circuit 401 (PK) for short to ground. REPLACE 15A fuse 27. CLEAR all DTCs and RETEST system.	System is OK.

B19 CHECK CIRCUIT 513 (BR/PK) FOR BATTERY SHORT

- Gain access to the transfer case relay module.
- Disconnect transfer case relay module.

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- Gain access to GEM connector C3 and disconnect connector.
- Key ON.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check Pin 17, Circuit 513 (BR/PK) for battery voltage.

Is battery voltage present?

Yes	No
REPAIR short to battery on Circuit 513 (BR/PK). CLEAR all DTCs and RETEST.	REPLACE transfer case relay module. CLEAR all DTCs and RETEST system.

B20 CHECK 4X4 FUSES

- Check power distribution box 20A fuse 16 for open fuse.

Is fuse open?

Yes	No
GO to **B16** .	GO to **B21** .

B21 CHECK CLUTCH TRANSFER CASE RELAY

- Disconnect clutch transfer case relay.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check resistance of relay.

Is the resistance between 85-140 ohms?

Yes	No
GO to **B22** .	REPLACE damaged relay. CLEAR all DTCs and RETEST system.

B22 CHECK CIRCUIT 778 (O) FOR SHORT TO GROUND

- Disconnect transfer case relay module.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check Circuit 778 (O) for continuity to a known ground.

Is continuity present?

Yes	No
SERVICE Circuit 778 (O) for short to ground. CLEAR all DTCs and RETEST system.	GO to **B23** .

B23 CHECK CIRCUIT 778 (O) FOR BATTERY SHORT

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- Transfer case relay module disconnected.
- Key ON.
- Check for battery voltage on Circuit 778 (O).

Is battery voltage present?

Yes	No
SERVICE Circuit 778 (O) for battery short. CLEAR all DTCs and RETEST system.	GO to **B24** .

B24 CHECK CIRCUIT 778 (O) FOR OPEN

- With transfer case relay module disconnected, disconnect electric transfer case shift motor connector.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check Circuit 778 (O) for continuity between transfer case relay module and transfer case shift motor connector Circuit 778 (O).

Is continuity present?

Yes	No
GO to **B25** .	REPAIR open in Circuit 778 (O). CLEAR all DTCs and RETEST system.

B25 CHECK CIRCUIT 779 (BR) FOR BATTERY SHORT

- Disconnect transfer case relay module.
- Key ON.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check Circuit 779 (BR) for battery voltage.

Is battery voltage present?

Yes	No
SERVICE Circuit 779 (BR) for battery short. RECONNECT and CLEAR all DTCs and RETEST system.	GO to **B26** .

B26 CHECK CIRCUIT 779 (BR) FOR OPEN

- Key OFF.
- With clutch transfer case relay disconnected, disconnect transfer case shift motor connector.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check for continuity between clutch transfer case relay connector Circuit 779 (BR) and transfer case shift motor connector Circuit 779 (BR) for open.

Is less than 5 ohms of resistance present?

Yes	No

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GO to **B27** .	SERVICE Circuit 779 (BR) for open. RECONNECT, CLEAR all DTCs and RETEST system.

B27 CHECK CIRCUIT 779 (BR) FOR SHORT TO GROUND

- Key OFF.
- With clutch transfer case relay and transfer case shift motor disconnected, check Circuit 779 (BR) for continuity to a known good ground.

Is continuity present?

Yes	No
SERVICE Circuit 779 (BR) for short to ground. RECONNECT, CLEAR all DTCs and RETEST system.	GO to **B28** .

B28 CHECK CIRCUIT 777 (Y) FOR SHORT TO GROUND

- Disconnect transfer case relay module.
- Key OFF.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check Circuit 777 (Y) for continuity to ground.

Is continuity present?

Yes	No
SERVICE Circuit 777 (Y) for short to ground. RECONNECT, CLEAR all DTCs and RETEST system.	GO to **B29** .

B29 CHECK CIRCUIT 777 (Y) FOR BATTERY SHORT

- Transfer case relay module disconnected.
- Key ON.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check Circuit 777 (Y) for battery voltage.

Is battery voltage present?

Yes	No
SERVICE Circuit 777 (Y) for battery short. RECONNECT, CLEAR all DTCs and RETEST system.	GO to **B30** .

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B30 CHECK CIRCUIT 777 (Y) FOR OPEN

- Key OFF.
- With transfer case relay module disconnected, disconnect transfer case shift motor connector.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check for continuity between relay module Circuit 777 (Y) and transfer case shift motor connector.

Is continuity present?

Yes	No
System OK. CLEAR all DTCs and RETEST system.	REPAIR open in Circuit 777 (Y). CLEAR all DTCs and RETEST system.

B31 CHECK CIRCUIT 771 (P/Y) FOR SHORT TO GROUND

- Key OFF.
- Remove GEM connector C3.
- Disconnect transfer case shift motor.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check Circuit 771 (P/Y), Pin C3-21 for continuity to ground.

Is resistance greater than 100K ohms?

Yes	No
GO to **B32** .	SERVICE Circuit 771 (P/Y) for short to ground. RECONNECT all connectors. CLEAR all DTCs and RETEST system.

B32 CHECK CIRCUIT 771 (P/Y) FOR OPEN

- Key OFF.
- GEM connector C3 and transfer case shift motor connector disconnected.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check between connector on Circuit 771 (P/Y) for resistance.

Is resistance less than 5 ohms?

Yes	No
REPLACE transfer case shift motor. RECONNECT all connectors. CLEAR all DTCs and RETEST system.	SERVICE Circuit 771 (P/Y) for open. CLEAR all DTCs and RETEST system.

B33 CHECK CIRCUIT 770 (W) FOR SHORT TO GROUND

- Key OFF.

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- Remove GEM connector C3.
- Disconnect transfer case shift motor.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check Circuit 770 (W), Pin C3-20, for continuity to ground.

Is resistance greater than 100K ohms?

Yes	No
GO to **B34** .	SERVICE Circuit 770 (W) for short to ground. RECONNECT all connectors. CLEAR all DTCs and RETEST system.

B34 CHECK CIRCUIT 770 (W) FOR OPEN

- With both connectors still removed, using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check Circuit 770 (W) for continuity.

Is continuity less than 5 ohms?

Yes	No
REPLACE transfer case shift motor. CLEAR all DTCs and RETEST system.	SERVICE Circuit 770 (W) for open. CLEAR all DTCs and RETEST system.

B35 CHECK CIRCUIT 764 (BR/W) FOR SHORT TO GROUND

- Key OFF.
- Gain access to GEM.
- Disconnect GEM connector C3.
- Disconnect transfer case shift motor.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check Pin C3-19 for continuity to ground.

Is continuity present?

Yes	No
SERVICE Circuit 764 (BR/W) for short to ground. CLEAR all DTCs and RETEST system.	GO to **B36** .

B36 CHECK CIRCUIT 764 (BR/W) FOR OPEN

- With both connectors still removed, check Circuit 764 (BR/W) for continuity between connectors using Rotunda 73 Digital Multimeter 105-R0051 or equivalent.

Is continuity present?

Yes	No

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REPLACE transfer case shift motor. RECONNECT all connectors. CLEAR all DTCs and RETEST system.	SERVICE Circuit 764 (BR/W) for open. RECONNECT all connectors. CLEAR all DTCs and RETEST system.

B37 CHECK CIRCUIT 763 (O/W) FOR SHORT TO GROUND

- Key OFF.
- Gain access to GEM.
- Disconnect GEM connector C3.
- Disconnect transfer case shift motor.
- Using Rotunda 73 Digital Multimeter 105-R0051, check Pin C3-18 for continuity to ground.

Is continuity present?

Yes	No
SERVICE Circuit 763 (O/W) for short to ground. RECONNECT all connectors. CLEAR all DTCs and RETEST system.	GO to **B38** .

B38 CHECK CIRCUIT 763 (O/W) FOR OPEN

- With both connectors still disconnected, using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check for continuity between connectors on Circuit 763 (O/W).

Is continuity present?

Yes	No
REPLACE transfer case shift motor. RECONNECT all connectors. CLEAR all DTCs and RETEST system.	SERVICE Circuit 763 (O/W) for open. RECONNECT all connectors. CLEAR all DTCs and RETEST system.

B39 CHECK CIRCUIT 762 (Y/W) FOR SHORT TO GROUND

- Key OFF.
- Gain access to GEM.
- Remove GEM connector C3 and disconnect transfer case shift motor connector.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check Circuit 762 (Y/W) for continuity to ground.

Is continuity present?

Yes	No
SERVICE Circuit 762 (Y/W) for short to ground. RECONNECT all connectors. CLEAR all DTCs and RETEST system.	GO to **B40** .

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B40 CHECK CIRCUIT 762 (Y/W) FOR OPEN

- With both connectors still disconnected, using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check for continuity between connectors on Circuit 762 (Y/W).

Is continuity present?

Yes	No
REPLACE transfer case shift motor. RECONNECT all connectors. CLEAR all DTCs and RETEST system.	SERVICE Circuit 762 (Y/W) for open. RECONNECT all connectors. CLEAR all DTCs and RETEST system.

B41 CHECK CIRCUIT 762 (Y/W) FOR BATTERY SHORT

- Key OFF.
- Remove GEM connector C3.
- Disconnect transfer case shift motor.
- Key ON.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check for voltage on Circuit 762 (Y/W), C3-12.

Is battery voltage present?

Yes	No
SERVICE Circuit 762 (Y/W) for battery short. RECONNECT, CLEAR all DTCs and RETEST system.	GO to **B42** .

B42 CHECK CIRCUIT 762 (Y/W) FOR TRANSFER CASE MOTOR SHORT

- Key OFF.
- Reconnect transfer case shift motor.
- Reconnect GEM connector C3.
- Key ON.
- Using Rotunda 73 Digital Multimeter 105-R0051 with Rotunda Terminal Adapter Kit 105-00025 or equivalent, back probe C3-12 for battery voltage to ground.

Is battery voltage present?

Yes	No
REPLACE transfer case shift motor. CLEAR all DTCs and RETEST system.	CLEAR all DTCs and RERUN self test.

B43 CHECK CIRCUIT 771 (P/Y) FOR BATTERY SHORT

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- Remove GEM Connector C3.
- Key ON.
- Using Rotunda 73 Digital Multimeter 105-R0051 with Rotunda Terminal Adapter Kit 105-00025 or equivalents, check Circuit 771 (P/Y) for battery voltage.

Is battery voltage present?

Yes	No
DISCONNECT transfer case shift motor connector. RECHECK for voltage. If voltage still exists, SERVICE Circuit 771 (P/Y) for battery short. If voltage does not exist, REPLACE transfer case shift motor. RECONNECT, CLEAR all DTCs and RETEST system.	REFER to Section 18-04A .

B44 CHECK CIRCUIT 770 (W) FOR BATTERY SHORT

- Remove GEM connector C3.
- Key ON.
- Using Rotunda 73 Digital Multimeter 105-R0051 with Rotunda Terminal Adapter Kit 105-00025 or equivalents, check Circuit 770 (W) for battery voltage.

Is battery voltage present?

Yes	No
DISCONNECT transfer case shift motor connector. RECHECK for voltage. If voltage still exists, SERVICE Circuit 770 (W) for battery short. If voltage does not exist, REPLACE transfer case shift motor. RECONNECT, CLEAR all DTCs and RETEST system.	REFER to Section 18-04A .

B45 CHECK CIRCUIT 764 (BR/W) FOR BATTERY SHORT

- Remove GEM connector C3.
- Key ON.
- Using Rotunda 73 Digital Multimeter 105-R0051 with Rotunda Terminal Adapter Kit 105-00025 or equivalents, check Circuit 764 (BR/W) for battery voltage.

Is battery voltage present?

Yes	No
DISCONNECT transfer case shift motor connector. RECHECK for voltage. If voltage still exists, SERVICE Circuit 764 (BR/W) for battery short. If voltage does not exist, REPLACE transfer case shift motor. RECONNECT, CLEAR all DTCs and RETEST system.	REFER to Section 18-04A .

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B46 CHECK CIRCUIT 763 (O/W) FOR BATTERY SHORT

- Remove GEM connector C3.
- Key ON.
- Using Rotunda 73 Digital Multimeter 105-R0051 with Rotunda Terminal Adapter Kit 105-00025 or equivalents, check Circuit 763 (O/W) for battery voltage.

Is battery voltage present?

Yes	No
DISCONNECT transfer case shift motor connector. RECHECK for voltage. If voltage still exists, SERVICE Circuit 763 (O/W) for battery short. If voltage does not exist, REPLACE transfer case shift motor. RECONNECT, CLEAR all DTCs and RETEST system.	REFER to Section 18-04A .

PINPOINT TEST C: 4WD HIGH INDICATOR LAMP NEVER ILLUMINATES, DTC P1804, P1806

C1 CHECK IP FUSE 11 FOR OPEN

- Remove and inspect IP fuse 11.

Is fuse open?

Yes	No
REFER to Section 17-02 .	GO to **C2** .

C2 CHECK 4WD HIGH INDICATOR LAMP

- Remove instrument cluster.
- Inspect 4WD high indicator lamp.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check resistance of bulb.

Is resistance between 3-8 ohms?

Yes	No
Bulb Ok, GO to **C3** . If sent from C5, GO to **C4** .	REPLACE faulty bulb. REINSTALL connectors and RETEST system. CLEAR all DTCs. REINSTALL instrument cluster. INSPECT instrument cluster ribbon for damage. REPLACE as necessary. RECONNECT connectors.

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C3 CHECK CIRCUIT 783 (GY) FOR OPEN

- Remove instrument cluster.
- Gain access to GEM.
- Disconnect GEM connector C3 and Instrument Cluster connector C1.
- Using Rotunda 73 Digital Multimeter 105-R0051 and Rotunda Terminal Adapter Kit 105-00025 or equivalents, check for continuity between GEM connector C3-14 and Instrument Cluster connector C1-14 Circuit 783 (GY).

Is continuity present?

Yes	No
GO to **C5** .	SERVICE Circuit 783 (GY) for open. RECONNECT connectors. CLEAR all DTCs and RETEST system.

C4 CHECK CIRCUIT 484 (O/BK) FOR BATTERY VOLTAGE

- Instrument Cluster connector C1 disconnected.
- Key ON.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check Circuit 484 (O/BK) Connector C1, Pin 12 for battery voltage.

Is battery voltage present?

Yes	No
System OK. CLEAR all DTCs and RETEST system.	SERVICE Circuit 484 (O/BK) for open. REINSTALL connectors and CLEAR all DTCs. RETEST system.

C5 CHECK CIRCUIT 783 (GY) FOR BATTERY SHORT

- Remove GEM connector C3.
- Key ON.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check Circuit 783 (GY), Pin C3-14 for battery voltage.

Is battery voltage present?

Yes	No
SERVICE Circuit 783 (GY) for battery short. RECONNECT and CLEAR all DTCs. RETEST system.	GO to **C2** .

PINPOINT TEST D: 4WD LOW INDICATOR LAMP NEVER ILLUMINATES, DTC P1808, P1810

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D1 CHECK IP FUSE 11 FOR OPEN

- Remove and inspect IP fuse 11.

Is fuse open?

Yes	No
REFER to Section 17-02.	GO to **D2**.

D2 CHECK 4WD LOW INDICATOR LAMP

- Remove instrument cluster.
- Inspect 4WD low indicator lamp.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check resistance of bulb.

Is resistance between 3-8 ohms?

Yes	No
Bulb OK. GO to **D3**. If sent from **D5**, GO to **D4**.	REPLACE faulty bulb. REINSTALL connector and RETEST system. CLEAR all DTCs. REINSTALL instrument cluster. INSPECT instrument cluster ribbon for damage. REPLACE as necessary. RECONNECT connectors.

D3 CHECK CIRCUIT 784 (LB/BK) FOR OPEN

- Remove instrument cluster.
- Gain access to GEM.
- Disconnect GEM connector C3 and Instrument Cluster connector C1.
- Using Rotunda 73 Digital Multimeter 105-R0051 and Rotunda Terminal Adapter Kit 105-00025 or equivalents, check for continuity between GEM connector C3-10 and Instrument Cluster connector C1-15 Circuit 784 (LB/BK).

Is continuity present?

Yes	No
GO to **D4**.	SERVICE Circuit 784 (LB/BK) for open. RECONNECT connectors. CLEAR all DTCs and RETEST system.

D4 CHECK CIRCUIT 484 (O/BK) FOR BATTERY VOLTAGE

- Instrument Cluster connector C1 disconnected.

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- Key ON.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check Circuit 484 (O/BK) connector C1, Pin 12 for battery voltage.

Is battery voltage present?

Yes	No
System OK. CLEAR all DTCs and RETEST system.	SERVICE Circuit 484 (O/BK) for open. REINSTALL connectors and CLEAR all DTCs. RETEST system.

D5 CHECK CIRCUIT 784 (LB/BK) FOR BATTERY SHORT

- Remove GEM Module connector C3.
- Key ON.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check Circuit 784 (LB/BK), Pin C3-10 for battery voltage.

Is battery voltage present?

Yes	No
SERVICE Circuit 784 (LB/BK) for battery short. RECONNECT and CLEAR all DTCs. RETEST system.	GO to **D2** .

PINPOINT TEST E: EARLY OR DELAYED SHIFTS, DTC P1729, P1781

E1 VERIFY 4x4L POSITION

Diagnosis trouble code (DTC) P1729 indicates 4x4L switch failure either open or shorted. DTC P1781 indicates 4x4L position (closed) during KOEO Quick Test. Refer to Section 07-01A or Section 07-01B .

NOTE: The digital transmission range (DTR) sensor must indicate NEUTRAL position before 4x4L shift.

Possible causes:

- Damaged 4x4L switch.
- 4x4L harness open or shorted.
- Damaged GEM (shift on the fly) or transfer case position switch (manual 4WD system).
- Damaged PCM.

Is the selection 4x2 or 4x4H during Quick Test?

Yes	No
GO to **E2** .	VERIFY transmission shift lever in NEUTRAL position. SELECT 4X2 OR 4X4H. RETEST

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	system.

E2 CHECK FOR INTERMITTENT CIRCUIT FAULT

- Key off.
- Scan tool connected.
- Access 4x4L PID.
- Key on, engine off.
- Cycle the 4x4L switch to 4x2.
- Grasp the vehicle harness starting at the transfer case vehicle harness connector. Shake and bend a small section of the harness all the way to the GEM (shift on the fly) or transfer case position switch (manual 4WD system).
- Tap the vehicle harness connector at the transfer case.
- Shake and bend a small section of the harness between the GEM (shift on the fly) or transfer case position switch (manual 4WD system).

Is the voltage on the Scan Tool fluctuating?

Yes	No
ISOLATE fault and SERVICE as necessary. COMPLETE PCM Reset to clear DTCs (REFER to Section 2A, Powertrain Control Module (PCM) Reset). RETEST system.	GO to **E3** .

E3 CHECK 4x4L SIGNAL FROM MODULE

- Key off.
- Disconnect PCM.
- Inspect for damaged or pushed out pins, corrosion, loose wires, etc. Service as necessary.
- Install breakout box, leave PCM disconnected.
- Key on, engine off.
- Observe voltage between Test Pin 14 and Test Pin 24 at the breakout box while cycling the 4x4L switch.

Does the voltage cycle?

Yes	No
REPLACE PCM. REMOVE breakout box. RECONNECT all components. RETEST system.	GO to **E4** .

E4 CHECK CONTINUITY OF 4x4L WIRE

- Key off.
- Breakout box installed, PCM disconnected.
- Disconnect the GEM (shift on the fly) or transfer case position switch (manual 4WD system).

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- Inspect for damaged or pushed out pins, corrosion, loose wires, etc. Service as necessary.
- Measure resistance between Test Pin 14 at the breakout box and the same 4x4L pin at the GEM (shift on the fly) or transfer case position switch (manual 4WD system) vehicle harness connectors.

Are the resistances less than 5.0 ohms?

Yes	No
GO to **E5** .	SERVICE open circuit. REMOVE breakout box. RECONNECT all components. RETEST system.

E5 CHECK FOR SHORT TO POWER AND GROUND

- Key off.
- Breakout box installed, PCM disconnected.
- GEM (shift on the fly) or transfer case position switch (manual 4WD system) connected.
- Measure resistance between Test Pin 14 and Test Pin 24 at the breakout box.
- Measure resistance between Test Pin 14 and Test Pin 71 at the breakout box.

Is each resistance greater than 10,000 ohms?

Yes	No
REFER to Symptom Chart .	SERVICE short circuit. REMOVE breakout box. RECONNECT all components. RETEST system.

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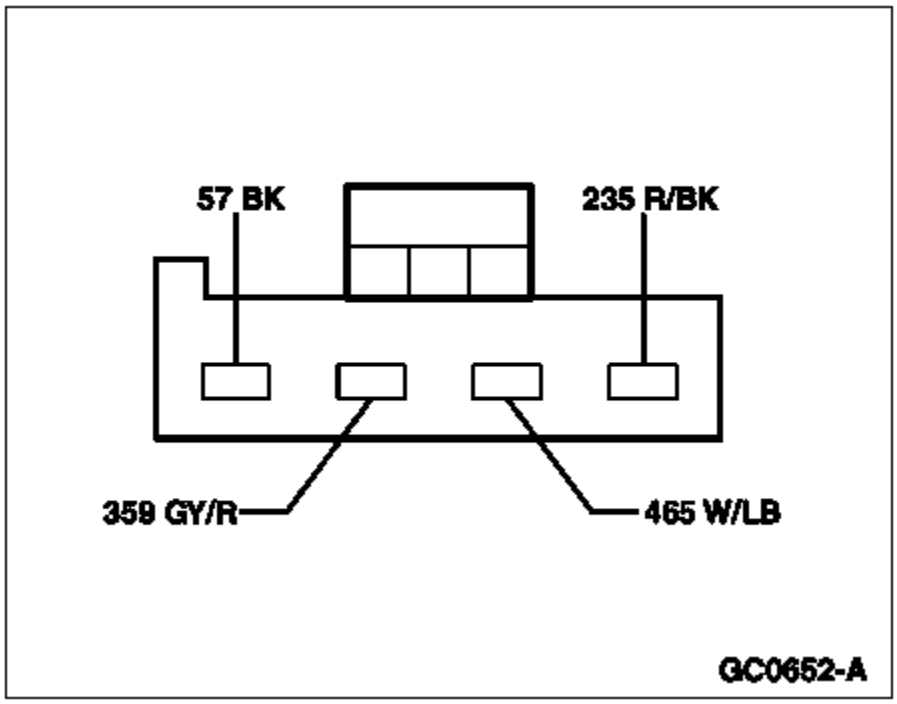
Component Tests

4x4 Mode Switch — Ranger

A variable resistance switch that signals the generic electronic module (GEM) to operate the "Select Drive" (Ranger 4x4), Four-wheel drive system in 2WD, 4WD High and 4WD Low range. The switch is checked as follows:

Measure resistance between Circuits 354 (GY/R), 465 (W/LG) using Rotunda 73 Digital Multimeter 105-R0051 (see diagram and table below for terminal location and resistance values).

4-Wheel Drive Mode Switch Connector



SWITCH RESISTANCE

Mode Switch Position	Resistance (Ideal Ranges)
OPEN	> 8.8K
Two-Wheel Drive	8.7K to 2.0k Ohms
4WD High/Auto	1.9K to 700 Ohms
4WD Low	600 Ohms to 150 Ohms
Short to Ground	< 150 Ohms

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Brake Signal Input to the GEM

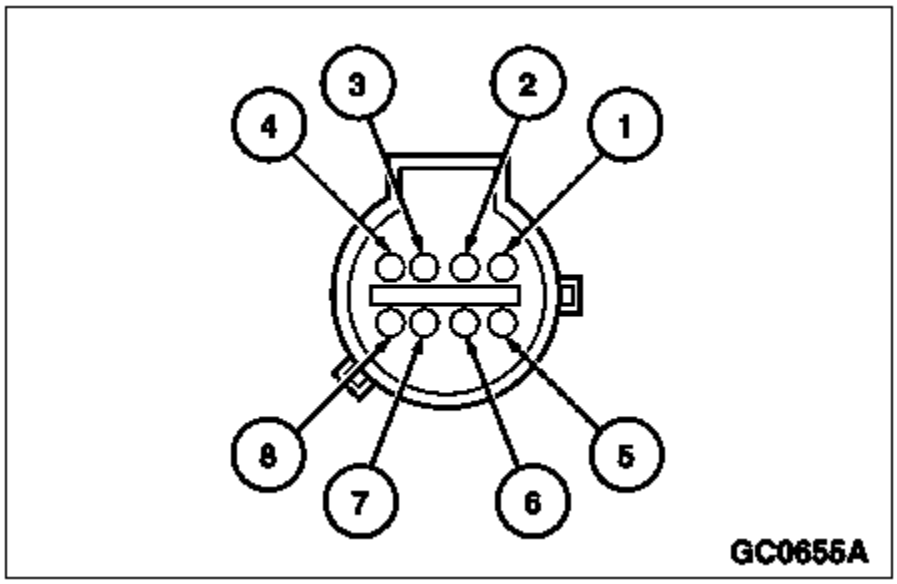
The brake signal input to the GEM is required to shift in and out of 4WD/Low. To verify the signal, gain access to generic electronic module (GEM), refer to Section 18-04A . Remove GEM Connector C3. Measure voltage at C3-13 harness side. With brake pedal depressed, voltage should be battery voltage.

Transfer Case Shift Motor

The transfer case shift motor allows shifting between 2WD, 4WD high and 4WD low .

The motor has a unique connector. The position of the motor may be verified using the table below along with the associated diagram.

Transfer Case Shift Motor Connector



Continuity is measured between transfer case shift motor Connector Pin 6 and the pins listed below.

Connector Pin	Sensor Position Feeds to the GEM								
	Mech Stop	L2H Stop	2H	2H E [a]	N E [a]	N	4L E [a]	4L	H2L Stop
5	1	1	1	1	1	0	0	0	1
1	0	0	0	1	1	1	1	1	1
2	0	1	1	1	1	1	1	0	0
3	0	0	1	1	0	0	1	1	1

[a] I - Ground
O - Open
E - Edge Transitional State (Non-Driveable)

Sensors

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Check the three sensors with the ignition on. The transfer case sensors (manual or automatic) should be closed with the clutch in or the transmission range selector lever in neutral. The speed sensor should show 225-275 ohms with the vehicle stopped. Check at the module connection.

Shift Switch Checks

If the concern is not in the sensors or the transfer case shift motor (7G360), check the control panel switches. Make this check with the ignition on. Disconnect the "B" and "C" connections to the sensors, so that their data won't confuse the diagnosis. Now check power at the C1 connection at the module. There should be 5 volts coming from the GEM to the 4H and 4L switch. Check C1, C2, and C3 for short to ground.

Check the switches themselves by disconnecting C1 and checking continuity across C1 to C2 and C1 to C3. If current passes when the switch buttons are pushed, the switches are OK.

Finally, check for a short between C2 and C3 by bridging between them and activating the 4H and 4L switch. There are situations where wiring harnesses get crushed in such a way that two wires are crushed together and short, even though there is no short to ground.

No Range Shift Checks

If the vehicle will not shift into 4L, check the speed sensor brake switch input transmission interlocks (neutral or clutch in), clutch pedal position (CCP) sensor, and digital transmission range (DTR) sensor. For diagnosis and testing of the DTR sensor, refer to Section 07-01A or Section 07-01B . Also check the 4L switch (C3) to see if the module is getting a signal. Check for corroded connections.

If the vehicle won't shift back to 4H, follow the proper sequence of being stopped and having the vehicle in neutral (or clutch in) when pushing the switch. Check the 4L switch and the motor position sensor.

Shifting on the Fly Is Not Smooth and May Require Stopping to Complete Shift

Look for concerns with the electromagnetic clutch. If the ratcheting or grinding goes on for more than four seconds, there may be a problem with power to the clutch from the GEM, the clutch ground or the clutch itself. Check the wiring harness as well.

Indicator Lamps Check

To check the lamps, turn the ignition on and ground C3 Pin 14 and C3 Pin 10 at the GEM. On manual shift vehicles, ground Circuit 783 (GY) and 784 (LB/BK) at the transfer case position switch. The lamps should light.

Indicator Lights Do Not Register the Correct Information

Ranger has indicator lights in two locations. There are lights on the instrument panel and LED indicator lights in the switches. If the instrument panel lights don't respond, look for no power or a burned-out bulb.

If the lights are on all the time, look for a short to ground. Check to see if the generic electronic module is activating them all as this is a malfunction.

If the button lights remain on all the time but the dash lights are not on, this means the dash lights have burned out. The button lights are on because a low current is still passing across, enough to light the LED.

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If no lights illuminate as you go through the shifts and ground power and bulbs are good, then the GEM is at fault or the transfer case shift motor has stopped at an intermediate point.

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Inspection and Verification

NOTE: If the area of concern is indicated to be other than the transfer case (7A195), refer to the specific section or sections of the appropriate shop manual.

1. **NOTE: Owner driving habits as well as road and weather conditions should be noted.**

   Road test the vehicle to verify the concern, noting road speed, engine speed, speed range where the vehicle problem is evident.

2. Raise the vehicle on a hoist and position suitable safety floor stands under the vehicle.

3. Run the vehicle at the road speed and in the axle drive mode (4WD/2WD) where concern exists. Verify concern area:

   - Engine
   - Clutch/Automatic Transmission/Transaxle (A/T) (7000)
   - Transfer Case
   - Front/Rear Driveline Components
   - Front/Rear Drive Axles
   - Front/Rear Brake Systems
   - Front Axle Locking Hubs
   - Front/Rear Wheels and/or Tires

4. Refer to the appropriate owner's guide for operating data, if the concern is verified to be driveline or torsional windup, before servicing the transfer case.

5. If the 4WD system slips under load, find what has broken or is slipping. To locate where slip is taking place, put marks at various possible slip points. Test drive the vehicle, then check to see if marks at different points are still in the same relationship to each other. This will indicate where the slippage is taking place or where to look for broken parts, if any.

   a. On vehicles with auto hubs, find a suitable place where the vehicle can be tested. Mark the components, then drive vehicle without backing up. Stop and check the marks to see if they are in the same relationship to each other. If the vehicle is backed up before checking these marks, the hubs may re-index and not reveal the problem.

6. Check tires and vehicle loading if the concern is clearly driveline windup and not broken parts.

7. If the transfer case shift motor (7G360) operates properly and nothing happens, or if a manual shift lever fails to shift the transfer case, it will have to be serviced. Be sure driveline windup has been eliminated as a cause.

8. Driveline noise may be experienced if a vehicle is operated in 2WD with the hubs locked. This occurs because the 4WD components are in motion instead of at rest (the normal condition in 2WD with the hubs unlocked). However, it is important to remember that excessive noise may be a sign of a serious condition.

NOTE: It is important not to run for long periods with dirt and water in the hubs.

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Maintenance of the hubs is important. Easy shifting from one operating position to the other requires smooth movement of the inner clutch ring. This ring slides on splines which must be clean and well lubricated. To prevent dirt and water from entering the hub unit, the oil seals must be very carefully installed. If the vehicle is operated where the hub is constantly submerged in water or mud, the hubs should be serviced more frequently. The important thing is not to run for long periods with dirt and water in the hubs. Start with a short service interval and check for water and dirt. Stretch out the interval as experience shows how dirty they are actually getting.

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E-4WD Transfer Case, Aerostar

Continuous Engagement, Transfer Case Clutch

Excessive NVH and wheel hop that occurs while driving straight or during a tight to moderate turn may be caused by the electronic clutch in the transfer case (7A195). The control module (located under the driver's seat) disengages the clutch every 1-3 seconds. Normally, the clutch releasing in a turn is what the driver is feeling. If the clutch is not disengaging, then a binding condition occurs that causes tire chirping and an excessive NVH condition. Refer to the following steps to correct this condition.

Initial Checks

1. Rear axle must be 3.73 ratio.

2. Check to see if any aftermarket electrical devices that have been added to the vehicle have caused wiring harness damage. If they have caused harness damage, then disconnect aftermarket component and repair wiring harness damage.

3. Check the following electrical plug connections:

    a. Control module 14-pin plug under driver's seat.
    b. 8-pin (8-way) plug at the transfer case.
    c. Two sensor plug locations (front and rear pickups) on the transfer case.
    d. Clutch wiring plug on the transfer case.

Determining and Servicing the Root Cause

1. If wheel hop condition can be made to happen again, then unplug the control module under the driver's seat. If the wheel hop condition STOPS, the problem is an electrical concern in the wiring, plug connectors or sensors.

2. Recheck wires and plug connections; drive vehicle to test if the problem has been corrected.

3. Replace sensors. Replace front sensor, then drive the vehicle to check if the problem has been corrected; if not, replace the rear sensor. If replacing both sensors does not correct the problem, repeat all of the steps listed above in the initial checks.

4. If wheel hop condition can be made to happen again, then unplug the control module under the driver's seat. If the wheel hop condition continues, the problem is a grounded/shorted wire from the dash to the control module, a mechanical problem in the front suspension, or an internal transfer case problem. Inspect these areas further.

5. If wheel hop condition CANNOT be made to happen again, then check the wiring and plugs and replace both sensors on the transfer case and return the vehicle to the customer. If the customer returns the vehicle for service with the same complaint, the problem could be intermittent wire short or plug connection.

6. If the wheel hop occurs after two or more hours of driving, the primary failure possibility is the sensors on the transfer case. Repeat previous Step 5.

If a problem is detected by the control module, a code will be selected and sent to the electronic four-wheel

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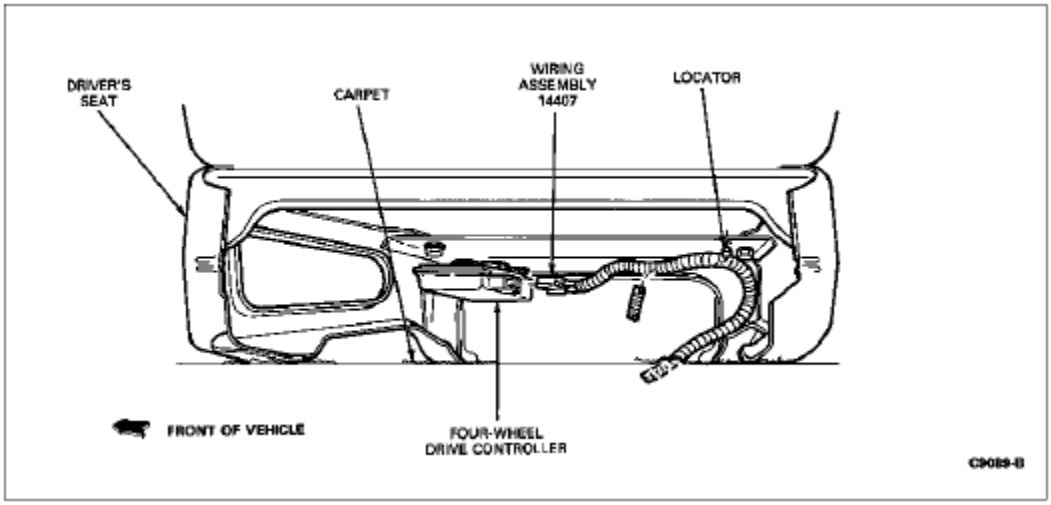
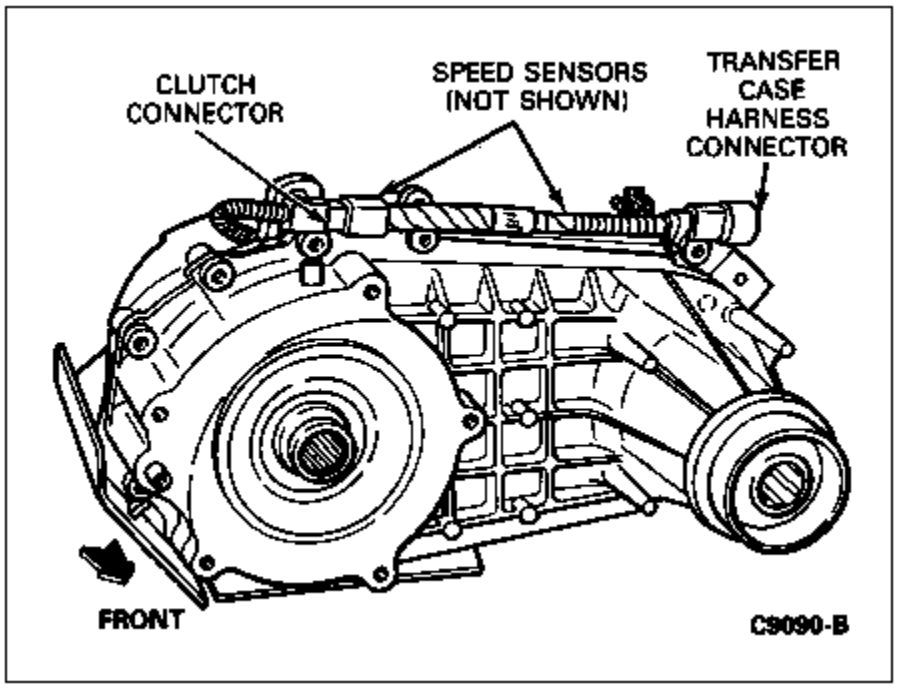
drive Malfunction Indicator Lamp located on the dash. The vehicle operator or service technician needs to count the flashes that occur between the pauses and refer to the Diagnostic Flash Code Chart in this section.

Control Module Location



Connector Locations at Transfer Case



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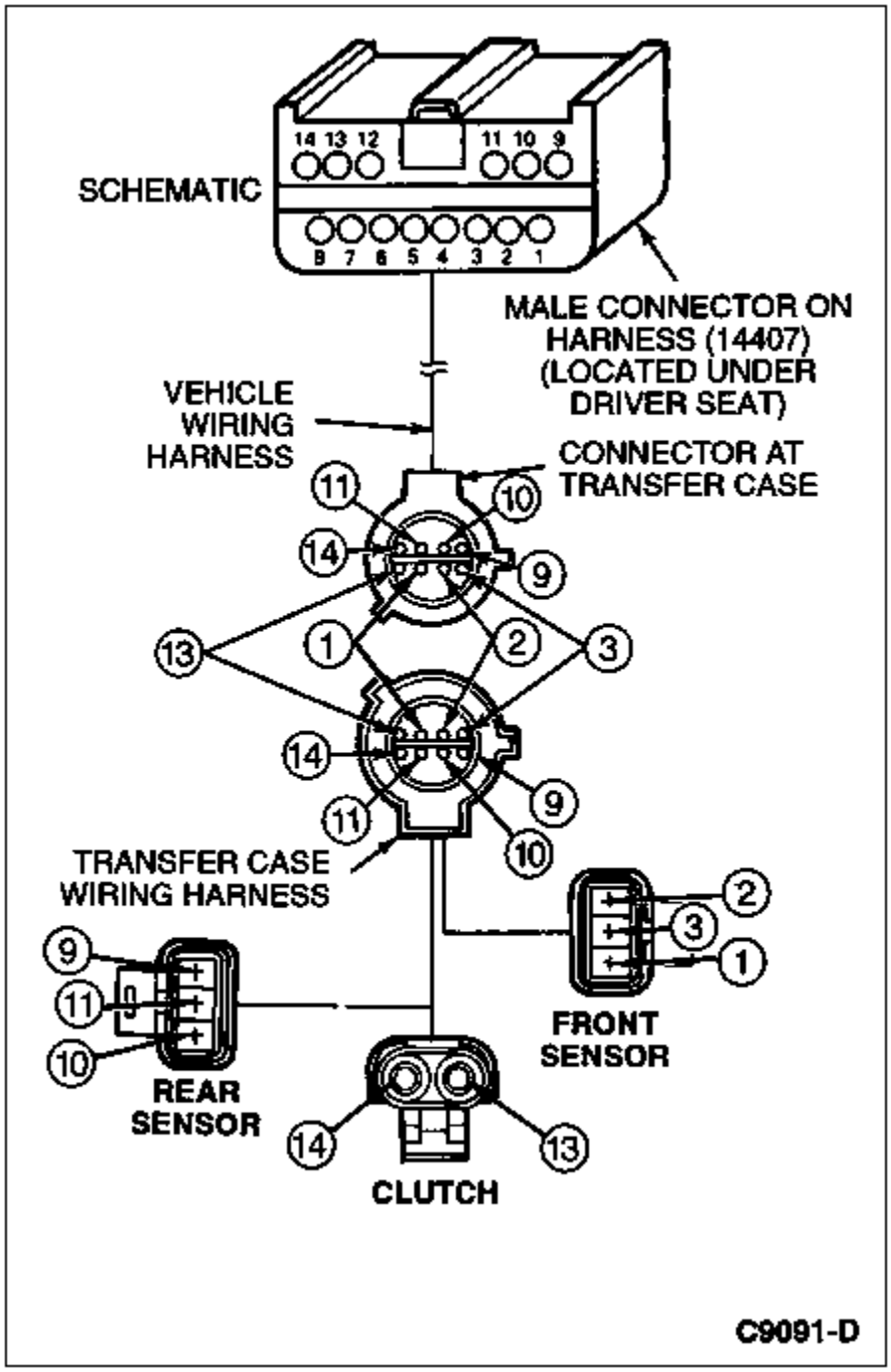

Pin Number	Circuit Function
01	Front Sensor Negative (-)
02	Front Sensor Signal (S)
03	Front Sensor Positive (+)
04	Electronic 4WD Malfunction Indicator Lamp
05	Digital Transmission Range (DTR) Sensor

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06	Brake Switch
07	Ground (-)
08	Battery (+)
09	Rear Sensor Negative (-)
10	Rear Sensor Signal (S)
11	Rear Sensor Positive (+)
12	Ground (-)
13	Clutch Negative (-)
14	Clutch Positive (+)

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Diagnostic Flash Code Information

NOTE: The following flash codes 1 through 16 are On-Board Diagnostic (OBD) codes generated by the control module. If a system fault is detected, the control module will "flash out" the corresponding fault code on the electronic four-wheel drive Malfunction Indicator Lamp (MIL) on the instrument panel. Also, notice that all the codes that can be generated pertain only to the speed sensors, the clutch coil and clutch with the exception of the first flash code.

The electronic four-wheel drive system also includes the brake switch input, digital transmission range (DTR) sensor, one power and two ground lines, along with the E-4WD MIL. The following pinpoint tests include testing on every electronic four-wheel drive circuit and not just those covered by the flash codes.

DIAGNOSTIC FLASH CODE CHART

Flash Code	Description	Action to Take
	—Inoperative or Erratic System Errors.	Complete Tests AA through DD.
1	Microprocessor RAM (Random Access Memory) access error.	Replace Control Module.
2	Clutch connector or clutch coil has discontinuity.	GO to Step EE1.
3	Front output speed sensor connector or internal circuitry of sensor has discontinuity.	Go to Step DD1.
4	Rear output speed sensor connector or internal circuitry of sensor has discontinuity.	Go to Step DD1.
5	Both front and rear speed sensor connectors and/or internal circuitry of sensors have discontinuity.	Go to Step DD1.
6	Clutch and front sensor connectors and/or clutch coil and/or internal circuitry of sensor have discontinuity.	First see Step EE1, then Step DD1.
7	Clutch and rear sensor connectors and/or clutch coil and/or internal circuitry of sensor have discontinuity.	First see Step EE1, then Step DD1.
8	Clutch and both sensor connectors and/or clutch coil and/or internal circuitry of sensors have discontinuity.	First see Step EE1, then Step DD1.
9	Mechanical problem that allows clutch plates to slip during clutch engagement (or faulty sensor output signal).	First see Step EE1, then Step DD1.
10	Both Code 9 and Code 2.	See action for Code 9.
11	Both Code 9 and Code 3.	See action for Code 9.
12	Both Code 9 and Code 4.	See action for Code 9.
13	Both Code 9 and Code 5.	See action for Code 9.
14	Both Code 9 and Code 6.	See action for Code 9.
15	Both Code 9 and Code 7.	See action for Code 9.
16	Both Code 9 and Code 8.	See action for Code 9.

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Regeneration (Recovery) of Flash Codes

If the ignition is turned OFF and the code is lost, the ignition will have to be turned ON again to regenerate codes 1 through 8, if the condition or conditions still exist. To regenerate codes 9 through 16, the vehicle must be driven again.

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Pinpoint Test Information

The pinpoint tests are labeled AA through EE and are arranged in a logical test order. If the system fault is not specific, then testing should begin at Pinpoint Test AA and follow order until the fault has been identified.

PINPOINT TEST INDEX, E-4WD

ELECTRONIC 4-WHEEL DRIVE PINPOINT TESTING	
Pinpoint Test	**Pinpoint Test Application**
AA	**Power and Grounds**
AA1	Bad or Intermittent Power to Control Module
AA2	Faulty Controller Ground
BB	**Electronic 4 Wheel Drive Malfunction Indicator Lamp**
BB1	Electronic 4 Wheel Drive Malfunction Indicator Lamp Not Functioning Properly
BB2	Electronic 4 Wheel Drive Malfunction Indicator Lamp Not Functioning
BB3	Electronic 4 Wheel Drive Malfunction Indicator Lamp Open or Shorted
CC	**Brake Switch Input**
CC1	Stoplamp Operation
CC2	Bad or Intermittent Brake Switch Input
D **Refer to Section 07-01A or Section 07-01B**	**Digital Transmission Range (DTR) Sensor**
DD	**E4WD Speed Sensors**
DD1	Speed Sensor Power Supply
DD2	Continuity Testing of the Speed Sensor Lines
DD3	Short to Ground Testing of Speed Sensor Lines
EE	**E4WD Clutch**
EE1	Bad or Intermittent Power to Clutch Circuit
EE2	Clutch Circuit Short to Ground
EE3	Continuity Testing of the Clutch Circuit
EE4	Verify the Clutch Coil Engages

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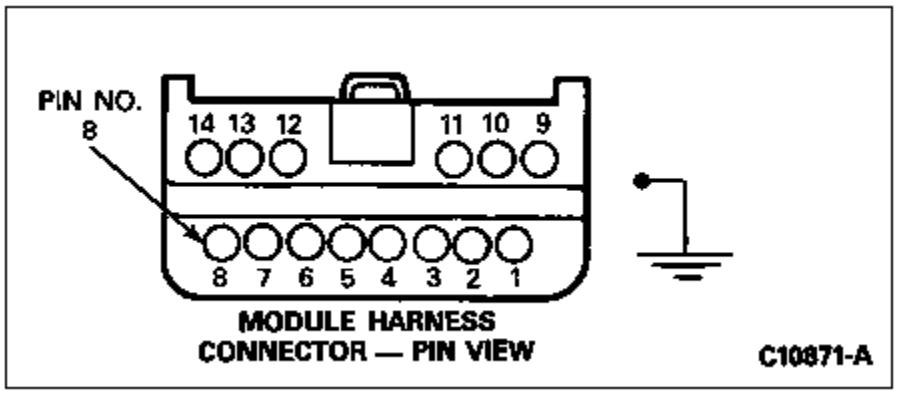
Pinpoint Tests

PINPOINT TEST AA: POWER AND GROUNDS

AA1 CHECK FOR OPEN OR INTERMITTENT IN CONTROL MODULE HARNESS CONNECTOR (MHC) PIN 8 (BATTERY +)

- Disconnect the module harness connector from the module.
- Set the voltmeter on the 20 VDC scale.
- Turn the ignition switch to the ON position.
- Check voltage between MHC pin 8 and chassis ground. (If there is no voltage, shake the module harness. Re-check for intermittent voltage.)



Is voltage steady (not intermittent) and greater than 9V?

Yes	No
GO to **AA2** .	REPAIR break in the B+ line. REFER toEVTM's on Aerostar with Electronic Four-Wheel Drive or the wiring diagrams.

AA2 CHECK FOR AN INTERMITTENT OR POOR CONTROL MODULE GROUND

- Disconnect the battery.
- Set the ohmmeter on the 20 ohm scale.
- Shake the module harness and check the resistance between MHC pin 12 and chassis ground. Repeat for pin 7 to chassis ground.

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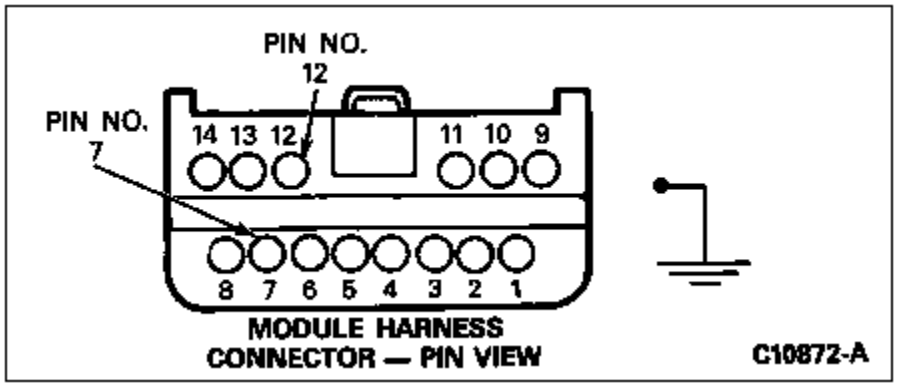


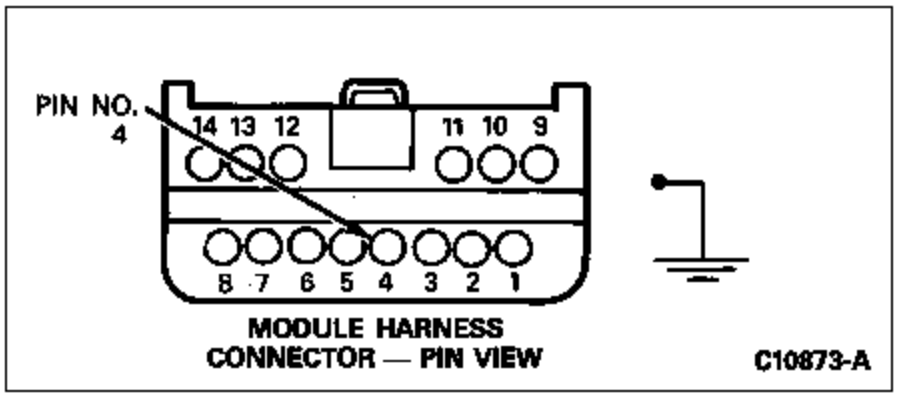
Is resistance steady (not fluctuating) and less than 1 ohm?

Yes	No
REPLACE control module.	REPAIR poor ground circuit(s). REFER to the EVTM's with Electronic Four-Wheel Drive or the wiring diagrams.

PINPOINT TEST BB: ELECTRONIC 4WD MALFUNCTION INDICATOR LAMP

BB1 CHECK FOR VOLTAGE AT CONTROL MODULE HARNESS CONNECTOR PIN 4

- Turn the ignition switch to the OFF position.
- Back-probe the module harness connector at pin 4 with **module connected** .
- Set voltmeter to the 20 VDC scale.
- Check the voltage between pin 4 of the control module and chassis ground with the ignition switch OFF.



Is voltage less than 3V?

Yes	No
GO to Test **BB2** .	REPAIR short to B+ between control module (pin 4) and the Electronic 4-Wheel Drive Malfunction Indicator Lamp.

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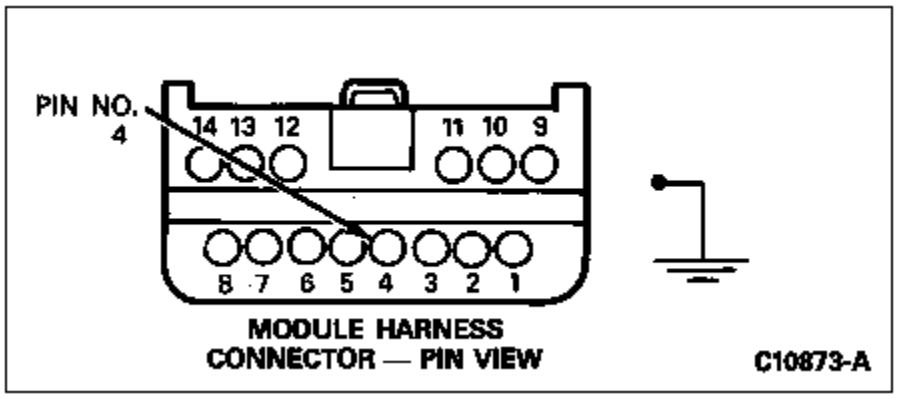
BB2 CHECK FOR VOLTAGE AT CONTROL MODULE PIN 4

- Back-probe the module harness connector pin 4 with the controller **module connected** .
- Set the voltmeter to the 20 VDC scale.
- Turn the ignition switch ON.
- Check the voltage between the MHC pin 4 and chassis ground.

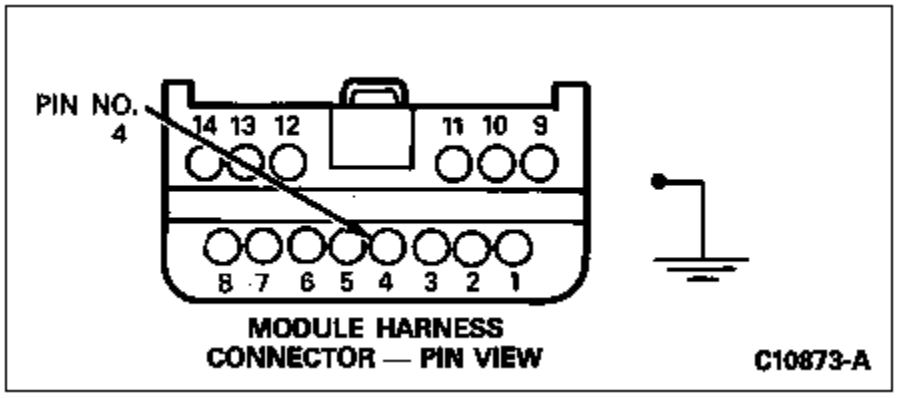


Is voltage steady and greater than 9V?

Yes	No
GO to **BB3** .	REPLACE control module.

BB3 CHECK FOR SHORT OR OPEN BETWEEN CONTROL MODULE HARNESS CONNECTOR PIN 4 AND ELECTRONIC 4-WHEEL DRIVE MALFUNCTION INDICATOR CIRCUIT

- Turn the ignition switch OFF.
- Disconnect the module harness connector from the module.
- Set the ohmmeter to the 20 ohm scale.
- Check the resistance between the module harness connector pin 4 and chassis ground.



Is resistance greater than 15 ohms?

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Yes	No
REPLACE the Electronic 4-Wheel Drive Malfunction Indicator Lamp or REPAIR open circuit.	REPAIR short to ground between module harness connector pin 4 and the Electronic 4-Wheel Drive Malfunction Indicator Lamp.

PINPOINT TEST CC: BRAKE SWITCH INPUT

CC1 CHECK FOR STOPLAMP OPERATION

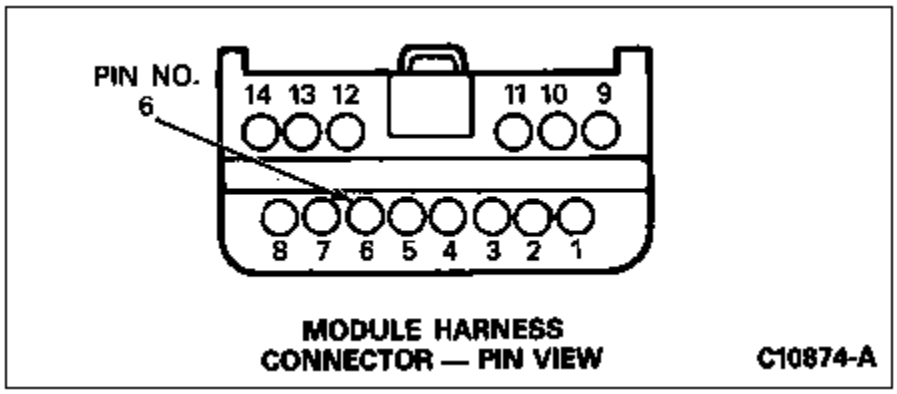
- Apply the service brakes and observe the rear brakelamps.

Do rear stoplamps illuminate with brake pedal depressed?

Yes	No
GO to CC2 .	REPAIR the stoplamp circuit and RE-TEST.

CC2 CHECK FOR INTERMITTENT OPEN IN CONTROL MODULE BRAKE SWITCH CIRCUIT

- Disconnect the module harness connector from the module.
- Set the voltmeter on the 20 VDC scale.
- Check the voltage between the module harness connector pin 6 and chassis ground while the brake pedal is depressed.
- Shake module harness. Recheck for intermittent voltage.



Is voltage steady (not intermittent) and greater than 9V?

Yes	No
REPLACE control module.	REPAIR break in the module to brake switch circuit. REFER to EVTM's on Aerostar with Electronic Four-Wheel Drive or wiring diagrams.

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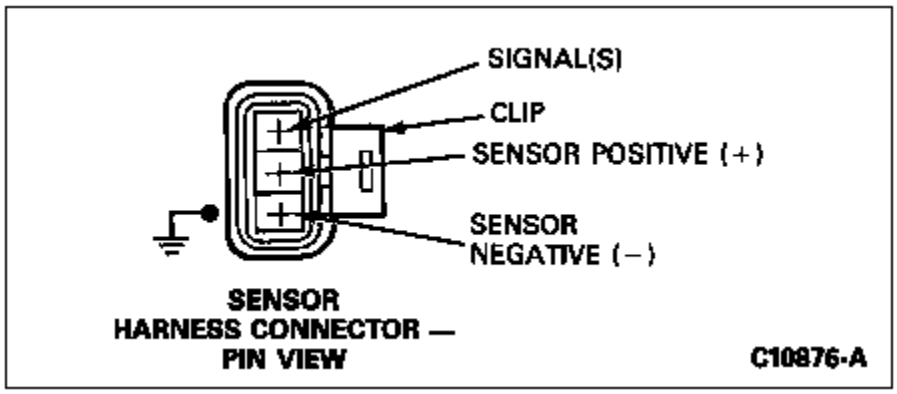
PINPOINT TEST DD: E4WD SPEED SENSORS

DD1 CHECK FOR VOLTAGE AT SPEED SENSOR POSITIVE (+) LINE

- Remove the speed sensor connector from each speed sensor.
- Set the voltmeter on the 20 VDC scale.
- Turn the ignition switch to the ON position.
- For each sensor, check the voltage between the sensor harness connector positive (+) pin and chassis ground.
- Shake the connector and harness while checking the voltage.



Is voltage steady (not intermittent) and greater than 4V?

Yes	No
GO to **DD2** .	REPAIR open circuit. If fault still occurs REPLACE control module. REFER to the wiring diagrams in this section.

DD2 CHECK CONTINUITY OF SPEED SENSOR SIGNAL AND GROUND LINES

- Turn the ignition key OFF.
- Disconnect the module harness connector from the module.
- Remove the speed sensor connector from the speed sensor.
- Set the ohmmeter to the 20 ohm scale.
- Test the continuity of each wire from the speed sensor connector, from their pins in the sensor harness connector to their corresponding pins in the MHC.

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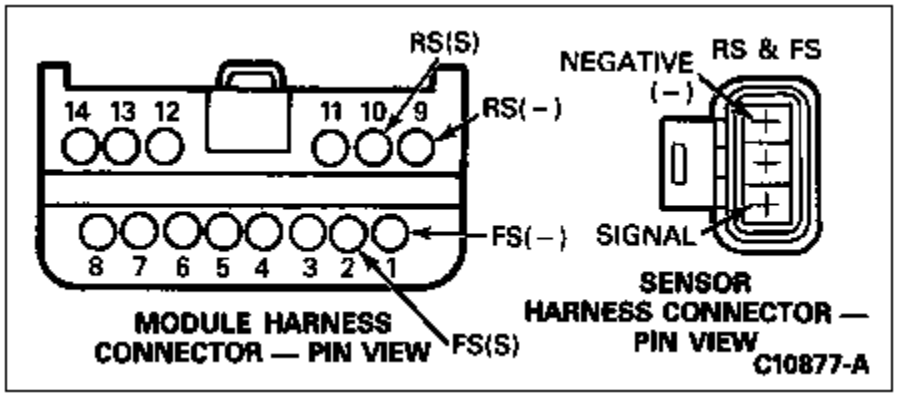
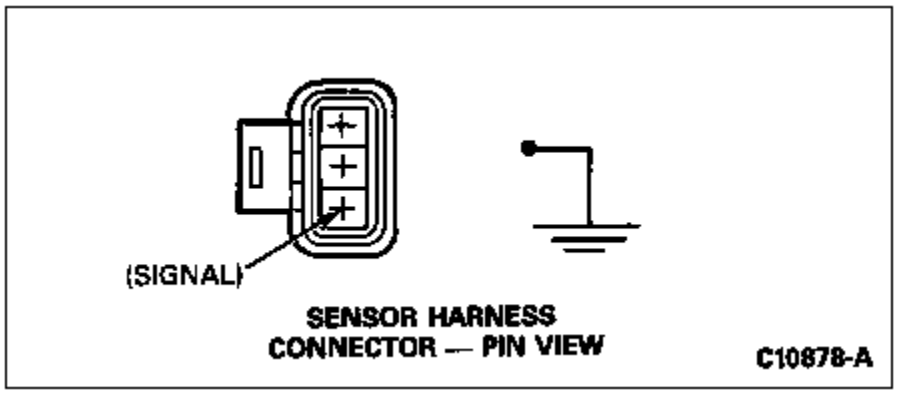


Is resistance greater than 1 ohm?

Yes	No
REPAIR open circuit. REFER to the wiring diagrams in this section.	GO to **DD3** .

DD3 CHECK FOR SHORT-TO-GROUND OR INTERMITTENT IN SPEED SENSOR SIGNAL CIRCUIT

- Turn the ignition switch OFF.
- Disconnect the module harness connector from the module.
- Disconnect the speed sensor connector from the speed sensor.
- Set the ohmmeter on the 20 ohm scale.
- Shake the module harness and sensor harness while checking the resistance between the sensor connector signal pin and chassis ground.



Is resistance below 1 ohm and fluctuating?

Yes	No
REPAIR short-to-ground in the speed sensor signal circuit. REFER to the wiring diagrams in this section.	REPLACE speed sensor. If the fault still occurs REPLACE controller.

PINPOINT TEST EE: E4WD CLUTCH

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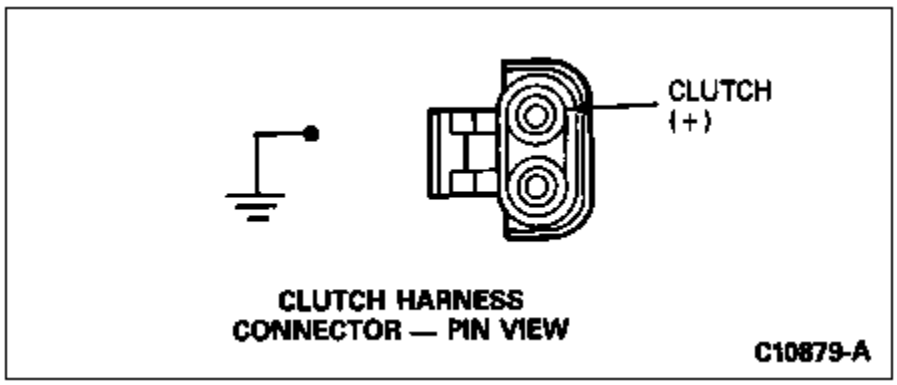
EE1 CHECK VOLTAGE AT CLUTCH CONNECTOR

- Disconnect the clutch harness connector from the clutch line on the transfer case housing.
- Set the voltmeter to the 20 VDC scale.
- Turn the ignition switch to ON.
- Shake the clutch harness and check for battery voltage between the clutch connector pin and chassis ground.

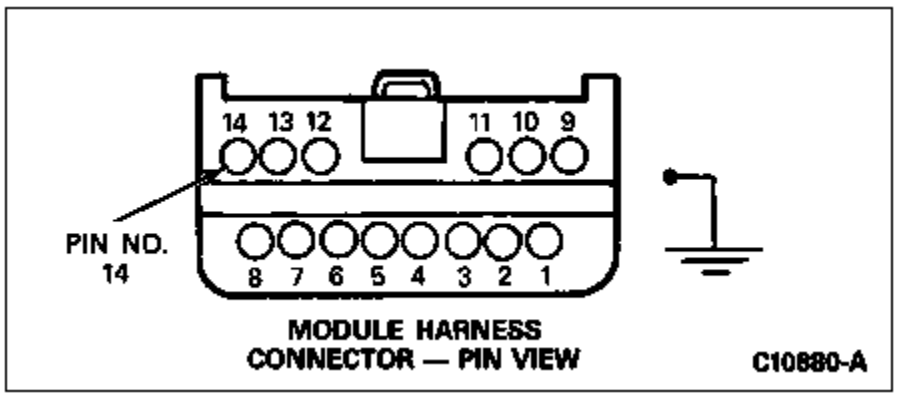


Is voltage present (steady or intermittent)?

Yes	No
REPAIR short to B+ on the clutch circuit or REPLACE control module. REFER to the wiring diagrams in this section.	GO to **EE2** .

EE2 CHECK FOR SHORT-TO-GROUND ON CLUTCH CIRCUIT

- Turn the ignition switch OFF.
- Disconnect the module harness connector from the module.
- Set the ohmmeter to the 20 ohm scale.
- Shake the module harness connector and check the resistance between MHC pin 14 and chassis ground.



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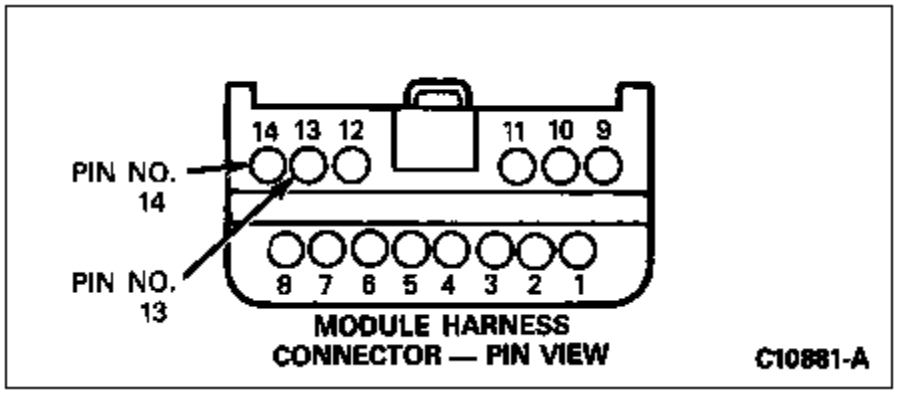
Is resistance intermittent or below 1 ohm?

Yes	No
REPAIR short-to-ground on the clutch circuit. REFER to the wiring diagrams in this section.	GO to **EE3** .

EE3 CHECK FOR AN OPEN ON THE CLUTCH CIRCUIT

- Turn the ignition switch OFF.
- Disconnect the module harness connector from the module.
- Set the ohmmeter to the 20 ohm scale.
- Shake the module harness connector and check the resistance between MHC pin 14 and pin 13.



Is resistance between 1.5 and 4 ohms?

Yes	No
GO to **EE4** .	REPAIR open in clutch circuit or REPLACE clutch.

EE4 CHECK CLUTCH BY POWERING CIRCUIT

- Disconnect the module harness connector from the module.
- Connect Clutch Coil Locking Tool D91T-50-CLT or equivalent to the MHC. If tool is not available, ground MHC pin 13 to ground.
- Jumper MHC pin 8 to MHC pin 14.
- Verify clutch engagement by test driving vehicle in tight turns and noticing driveline wind-up (driveline wind-up is noticed through steering wheel feedback or wheel hop).

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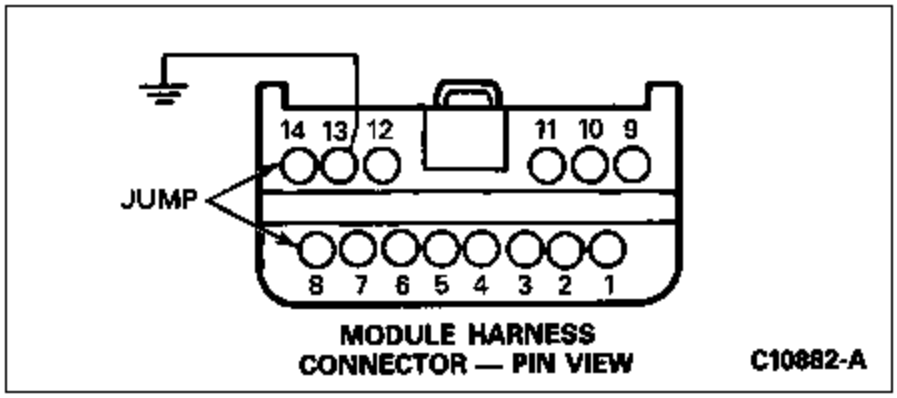

Does clutch engage (driveline wind-up)?

Yes	No
REPLACE the control module.	REPLACE clutch or look for a mechanical failure in the system.

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SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-In
4x4 Mode Selector Switch Nut	6-8	53-70
4x4 Mode Selector Switch Screw	2.1-2.9	19-24

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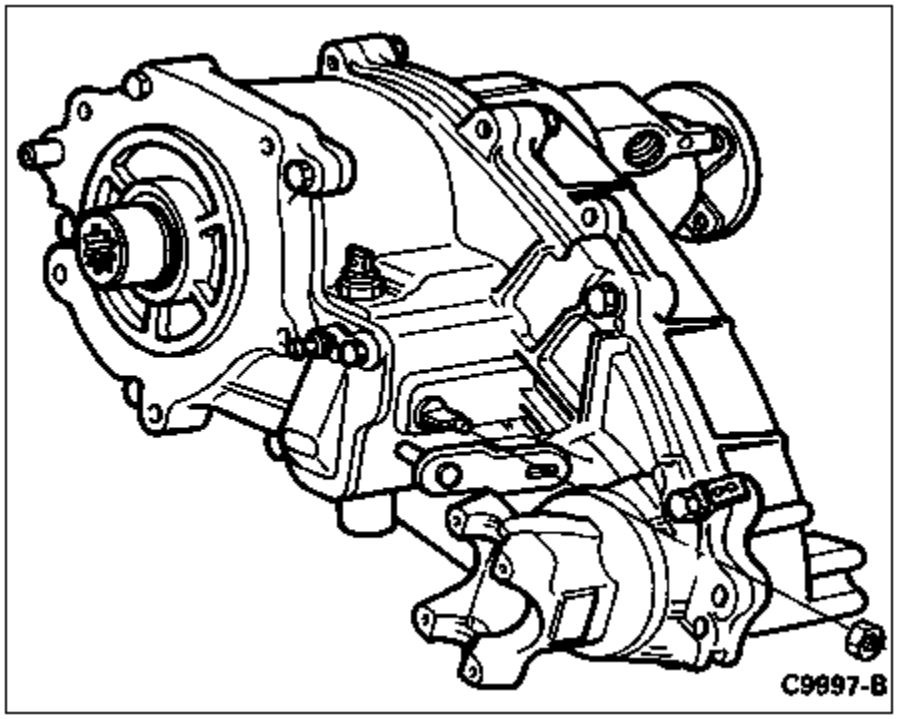
Mechanical Shift System

The Borg Warner 13-54 is a three-piece aluminum part-time transfer case (7A195). It transfers power from the transmission (7003) to the rear axle assembly (4006) and, when engaged into 4WD, also the front drive axle. The unit is lubricated by a positive displacement oil pump that channels oil flow through drilled holes in the rear output shaft. The pump turns with the rear output shaft and allows towing of vehicle (neutral position) at maximum legal road speeds for extended distances without disconnecting the front or rear driveshaft.



Transfer Case

CAUTION: The three way catalytic converter (TWC) (5E212) is located beside the transfer case (7A195). Be careful when working around the three way catalytic converter because of the extremely high temperatures generated by the three way catalytic converter.

Removal

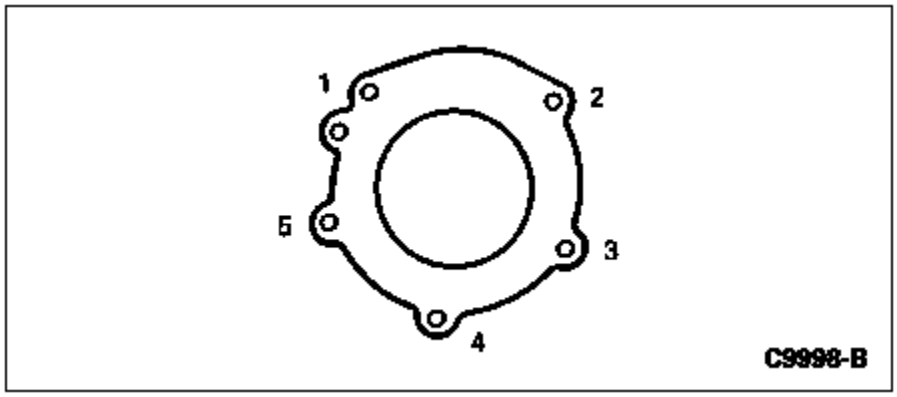
1. Raise the vehicle on a hoist and position suitable safety stands under vehicle.
2. If so equipped, remove the skid plate from the frame (5005).
3. Remove the damper from the transfer case, if so equipped.
4. **NOTE: Drain transfer case only if transfer case disassembly is required.**

   To drain transfer case oil, place a drain pan under transfer case, remove the drain plug and drain fluid from the transfer case.
5. Disconnect the wire connector of the four-wheel drive indicator switch at the transfer case.
6. Disconnect the front driveshaft (4602) from the case yoke (7B214) and wire the driveshaft out of the way.
7. Disconnect the rear driveshaft from the case yoke and wire the driveshaft out of the way.
8. Disconnect the speedometer cable (17260) from the case (7005).
9. Disconnect the transfer case breather tube from the gearshift lever housing.
10. Remove the nut from the shift lever and disconnect the shift lever.
11. Remove the large bolt and the small bolt retaining the shifter to the extension housing (7A039). Remove the gearshift lever (7210) and gearshift lever socket bushing (7335).
12. Support the transfer case with a Hi-Lift Transmission Jack, such as Rotunda 014-00942 (with Transfer Case Adapter 014-00213) or equivalent.
13. Remove the five bolts retaining the transfer case to the transmission (7003) extension housing.
14. Slide the transfer case rearward off the transmission output shaft and lower the transfer case from the vehicle. Remove the gasket from between the transfer case and transmission extension housing. Clean gasket mating surfaces prior to transfer case installation.

Installation

1. Place a new gasket on the front mounting face of the transfer case. If necessary, use a small daub of Premium Long-Life Grease XG-1-C or -K or equivalent meeting Ford specification ESA-M1C75-B to hold the gasket down.

2. Raise the transfer case with the Hi-Lift Transmission Jack 014-00942 (with Transfer Case Adapter 014-00213) so that the transmission output shaft aligns with the input shaft (7017). Slide the transfer case forward onto the transmission output shaft and onto the dowel pin. Install the five bolts (7A443) retaining the transfer case to the transmission extension housing. Tighten bolts to 34-48 Nm (25-35 lb-ft) in the sequence shown.



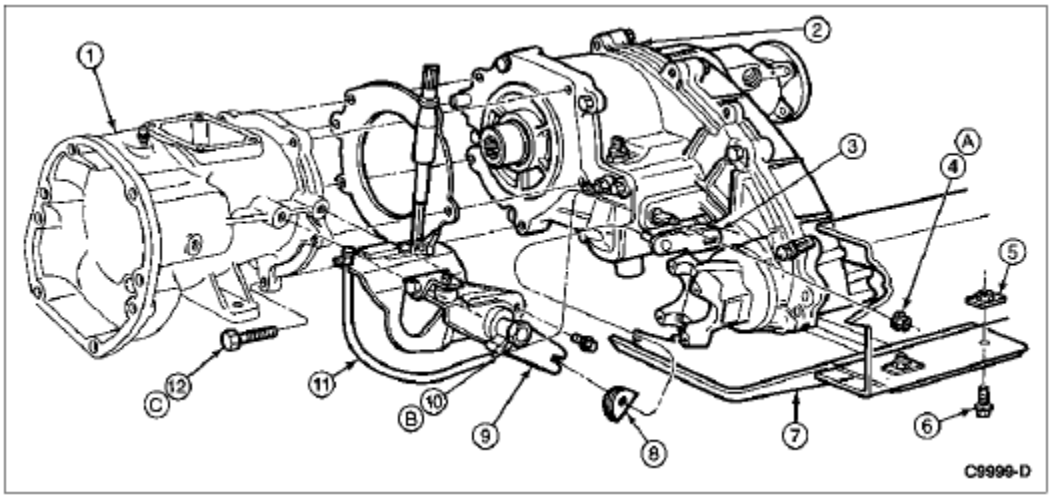
3. Remove the Hi-Lift Transmission Jack 014-00942 (with Transfer Case Adapter 014-00213) from the transfer case.

4. Install and adjust the shifter as outlined in this section.

5. **NOTE: The upper end of the transfer case breather tube should be 19mm (3/4 inch) above the top of the shifter and positioned just below the floor pan.**

   Install the vent assembly so the white marking on the transfer case breather tube is in position in the notch in the shifter.

Transfer Case Installation



Item	Part Number	Description

1	7A039	Extension Housing
2	7A195	Transfer Case
3	7B106	Shift Lever
4	620481	Nut
5	803802	Nut and Retainer
6	N620481-S2	Bolt
7	7E063	Skid Plate
8	7335	Gearshift Lever Socket Bushing
9	7210	Gearshift Lever
10	389240	Bolt
11	7A246	Vent Hose Extension
12	N605804	Bolt
A	—	Tighten to 26-35 Nm (19-26 Lb-Ft)
B	—	Tighten to 94-122 Nm (70-90 Lb-Ft)
C	—	Tighten to 35-48 Nm (26-35 Lb-Ft)

6. Connect the speedometer cable to the case. Tighten the screw to 2-3 Nm (20-25 lb-in).
7. Connect the rear driveshaft to the case yoke. Tighten the bolts to 83-118 Nm (61-87 lb-ft).
8. Connect the front driveshaft to the case yoke. Tighten the bolts to 16-22 Nm (12-16 lb-ft).
9. Connect the top gear indicator switch wire connector at the transfer case.
10. Install the drain plug and tighten to 19-30 Nm (14-22 lb-ft). Remove the fill plug and install Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX equivalent MERCON® fluid to the bottom of the fill hole. Install fill plug and tighten to 19-30 Nm (14-22 lb-ft).
11. Install the damper to the transfer case, if so equipped. Using new damper bolts, or previously removed bolts coated with Threadlock and Sealer E0AZ-19554-AA or equivalent meeting Ford specification WSK-M2G315-A5 TYPE II, tighten the bolts to 35-48 Nm (26-35 lb-ft).
12. Install the skid plate to frame (if so equipped). Tighten nuts and bolts to 20-27 Nm (15-20 lb-ft).
13. Remove safety stands and lower vehicle from the hoist.

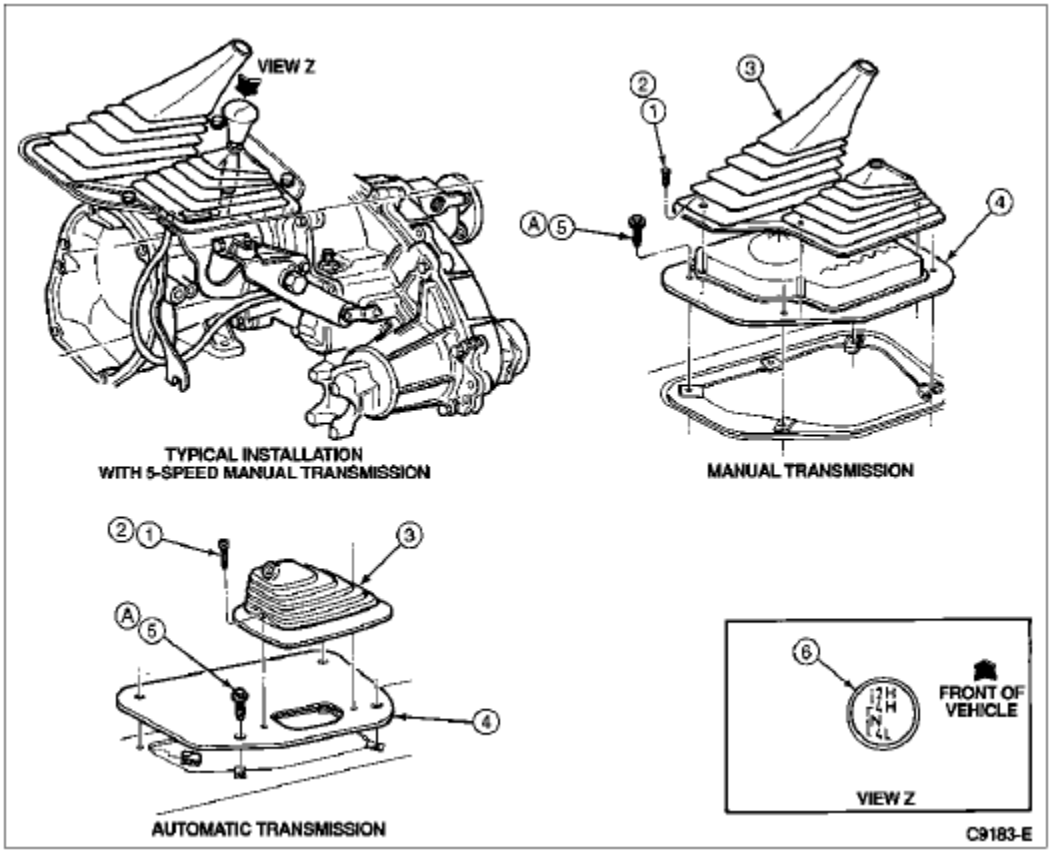
Shift Lever

NOTE: Remove the gearshift lever knob (7213) only if the knob, gearshift lever boot (7277) or gearshift lever (7210) is to be replaced.

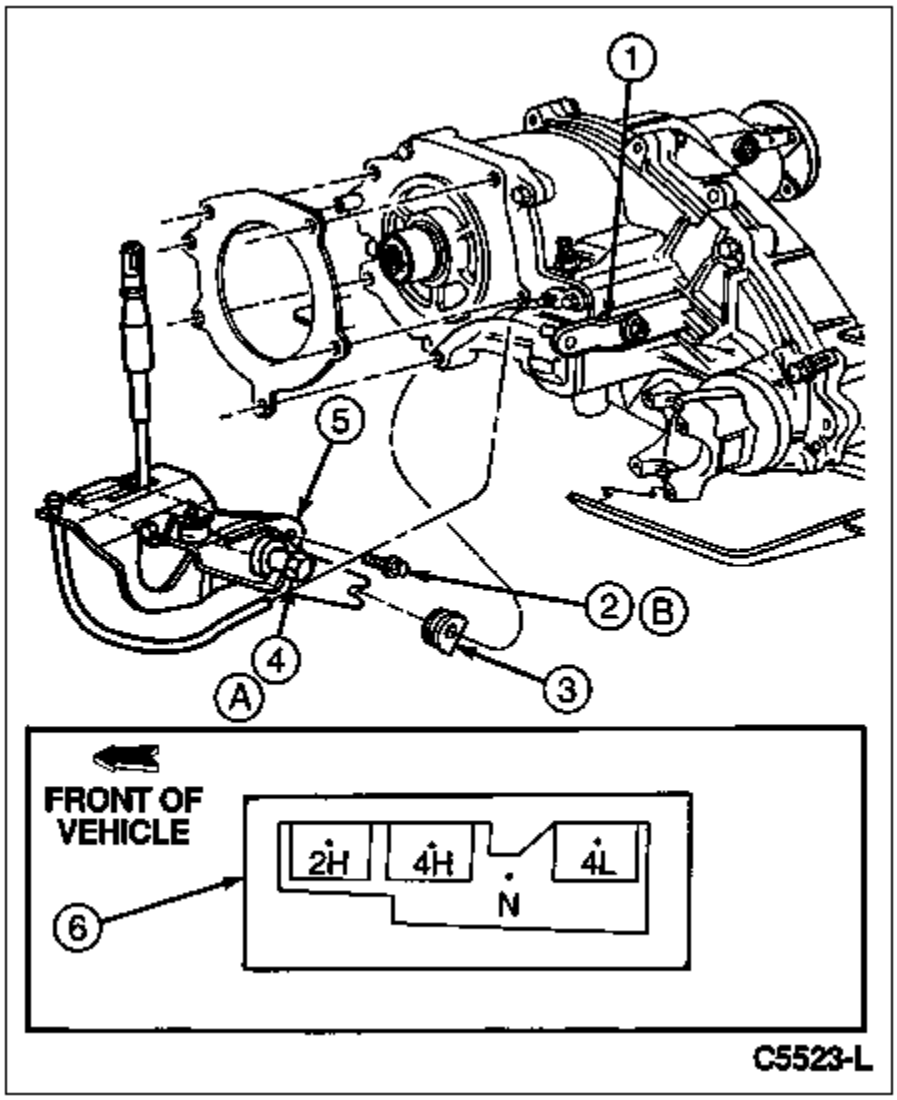
Removal

1. Shift transfer case (7A195) into the 4L position.
2. Remove the plastic shift pattern insert from the gearshift lever knob. Warm the knob with Rotunda Heat Gun 107-R0300 or equivalent to 60-87°C (140-189°F) and knock the knob off the gearshift lever with a U-shaped tool or appropriate size open-end wrench.
3. Remove the gearshift lever boot and floor pan cover.
4. Disconnect the transfer case breather tube from the gearshift lever.
5. Remove the nut and shift lever from the transfer case.
6. Remove the bolts retaining the shifter to the extension housing (7A039). Remove the gearshift lever and gearshift lever socket bushing (7335).

Shifter and Boot Installation



Item	Part Number	Description
1	55929	Screw (Manual Transmission)
2	55930	Screw (Automatic Transmission)
3	7277	Gearshift Lever Boot (Manual Transmission)
4	7C306	Floor Pan Opening Cover
5	N60589-1	Bolt
6	7213	Shift Lever Ball (Transfer Case)
A	—	Tighten to 5-9 Nm (48-78 Lb-In)



Item	Part Number	Description
1	7B106	Transfer Case Shift Lever in 4L Position
2	383107-S100	Bolt
3	7335	Gearshift Lever Socket Bushing
4	389240-S	Bolt
5	7210	Gearshift Lever
6	7F087	Cam Plate
A	—	Tighten to 94-122 Nm (70-90 Lb-Ft)
B	—	Tighten to 43-56 Nm (32-42 Lb-Ft)

Installation

1. Prior to installing the gearshift lever, lubricate the pivot bolt and bushing bore with Premium Long-Life Grease XG-1-C or -K or equivalent meeting Ford specification ESA-M1C75-B.

2. Prior to installing the gearshift lever, move the transfer case lever to the 4L position.

3. Install gearshift lever to the extension housing with bolts turned to one turn loose. Install gearshift lever socket bushing to gearshift lever with flat facing out. Install lever to gearshift lever socket bushing and transfer case shift shaft. Tighten nut to 26-35 Nm (19-26 lb-ft).

4. Adjust the linkage as outlined. Always tighten the large bolt (A) retaining the shifter to the extension housing before tightening the small bolt (B).

5. **NOTE: The upper end of the transfer case breather tube should be 19mm (3/4 inch) above the top of the shifter and positioned just below the floor pan.**

   Install the vent assembly so the white marking on the transfer case breather tube is in position in the notch in the shifter.

6. Install the gearshift lever boot and the floor pan cover.

7. **NOTE: The end of the gearshift lever knob should be to the end of the knurl on the upper portion of the shift lever.**

   Warm the gearshift lever knob with Rotunda Heat Gun 107-00300 or equivalent to 60-87℃ (140-189° F) and tap the knob on the lever with a 7/16 socket and a mallet. Install the plastic shift pattern insert.

8. Check the transfer case for proper shifting and operation.

Oil Seal

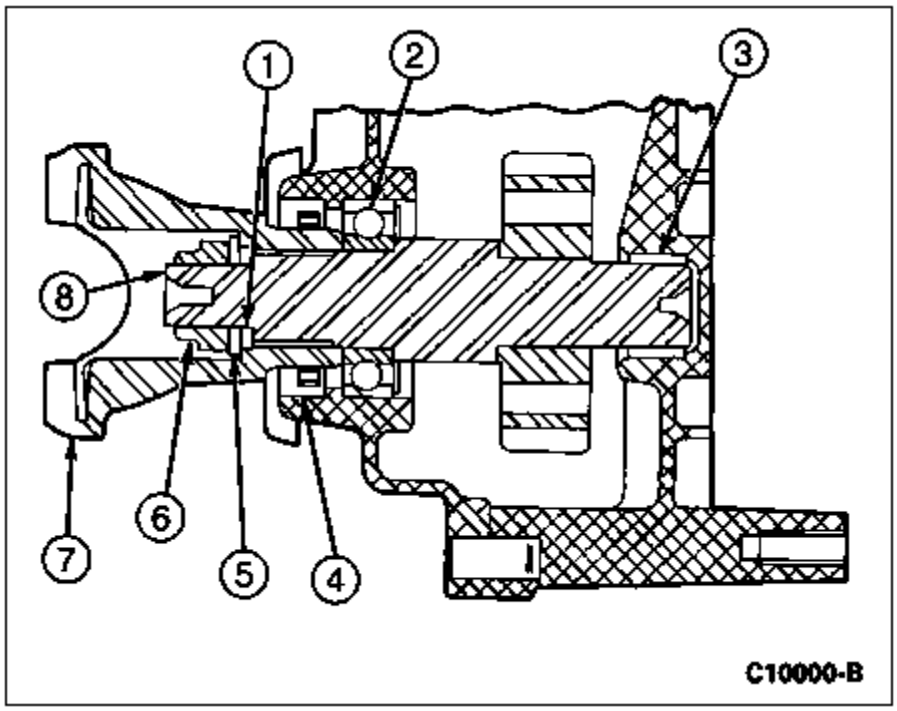
Output Shaft, Front

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Impact Slide Hammer	T50T-100-A
Driver Handle	T80T-4000-W
Output Shaft Seal Replacer	T83T-7065-B

Removal

1. Place transfer case (7A195) in 4WD, set automatic transmission (7003) in Park, manual transmission in gear.
2. Raise the vehicle on a hoist and position suitable safety stands under vehicle.
3. If equipped, remove the damper from the transfer case and the skid plate from the frame (5005).
4. Place a drain pan under the transfer case, remove the drain plug and drain the fluid from the transfer case.
5. Remove the driveshaft (4602) from the front output shaft and wire the driveshaft out of the way.
6. Using a 30mm thin-wall socket, remove the front output shaft nut, output shaft yoke washer (7B368), rubber seal and front case yoke (7B214).



Item	Part Number	Description
1	7052	Rubber Seal
2	7025	Bearing
3	7127	Needle Bearing, Front
4	7B215	Yoke to Flange Seal
5	7B368	Output Shaft Yoke Washer
6	7045	Shaft Nut
7	7B214	Case Yoke, Front
8	7061	Output Shaft, Front

7. Remove the yoke to flange seal (7B215) from the front output housing bore by prying and pulling on the curved-up lip of the yoke to flange seal or use the Impact Slide Hammer T50T-100-A to pop off the yoke to flange seal. Do not damage the bearing, bearing cage or case.

Installation

1. Make sure the housing face is free from nicks and burrs. Coat the yoke to flange seal with Premium Long-Life Grease XG-1-C or -K or equivalent meeting Ford specification ESA-M1C75-B. Position the seal into the front output housing bore, making sure the seal is not cocked in the bore. Drive the seal into the bore with Output Shaft Seal Replacer T83T-7065-B and Driver Handle T80T-4000-W.

2. Install the front case yoke, rubber seal, output shaft yoke washer and the nut. Tighten the nut to 203-244 Nm (150-180 lb-ft).

3. Connect the front driveshaft to the front case yoke. Tighten the bolts to 16-22 Nm (12-16 lb-ft).

4. Install drain plug and tighten to 19-30 Nm (14-22 lb-ft). Remove fill plug and install Motorcraft

MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX or equivalent MERCON® fluid to the bottom of the fill hole. Install fill plug to 19-30 Nm (14-22 lb-ft).

5. Install the damper to the transfer case, if so equipped. Using new damper bolts, or previously removed bolts coated with Threadlock and Sealer E0AZ-19554-AA or equivalent meeting Ford specification WSK-M2G315-A5 TYPE II, tighten the bolts to 35-48 Nm (26-35 lb-ft).

6. If equipped, install the skid plate to the frame. Tighten nuts and bolts to 20-27 Nm (15-20 lb-ft).

7. Remove safety stands and lower the vehicle from the hoist.

Output Shaft, Rear

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Driver Handle	T80T-4000-W
Output Shaft Seal Replacer	T83T-7065-B

Removal

1. Raise the vehicle on a hoist and position suitable safety stands under vehicle.

2. Remove the rear driveshaft from the rear case yoke. Wire the driveshaft out of the way.

3. Using a 30mm thin wall socket, first remove the rear output nut, then the output shaft yoke washer, oil seal (7052) and rear case yoke.

4. Remove the yoke to flange seal from the rear output housing bore by prying and pulling on the curved-up lip of the seal or use the Impact Slide Hammer T50T-100-A to pop off the yoke to flange seal. Do not damage the bearing, bearing cage or case.

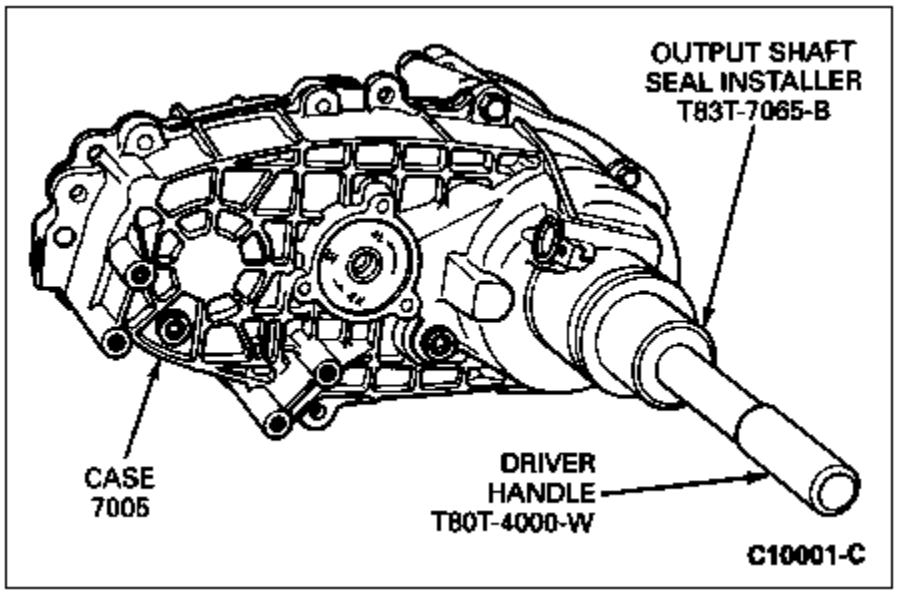
Installation

1. Make sure the output housing bore and face are free from nicks and burrs. Coat the yoke to flange seal with Premium Long-Life Grease XG-1-C or -K or equivalent meeting Ford specification ESA-M1C75-B. Position the seal into the rear output housing bore, making sure that the seal is not cocked in the bore. Drive the seal into the bore with Output Shaft Seal Replacer T83T-7065-B and Driver Handle T80T-4000-W.

2. Install the rear case yoke, rubber seal, output shaft yoke washer and nut on the output shaft. Tighten the nut to 339-380 Nm (250-280 lb-ft).

3. Connect the rear driveshaft to the transfer case and tighten the retaining bolts to 83-118 Nm (61-87 lb-ft).

4. Remove safety stands and lower the vehicle from the hoist.


OUTPUT SHAFT
SEAL INSTALLER
T83T-7065-B
CASE
7005
DRIVER
HANDLE
T80T-4000-W
C10001-C

Transfer Case, Mechanical Shift

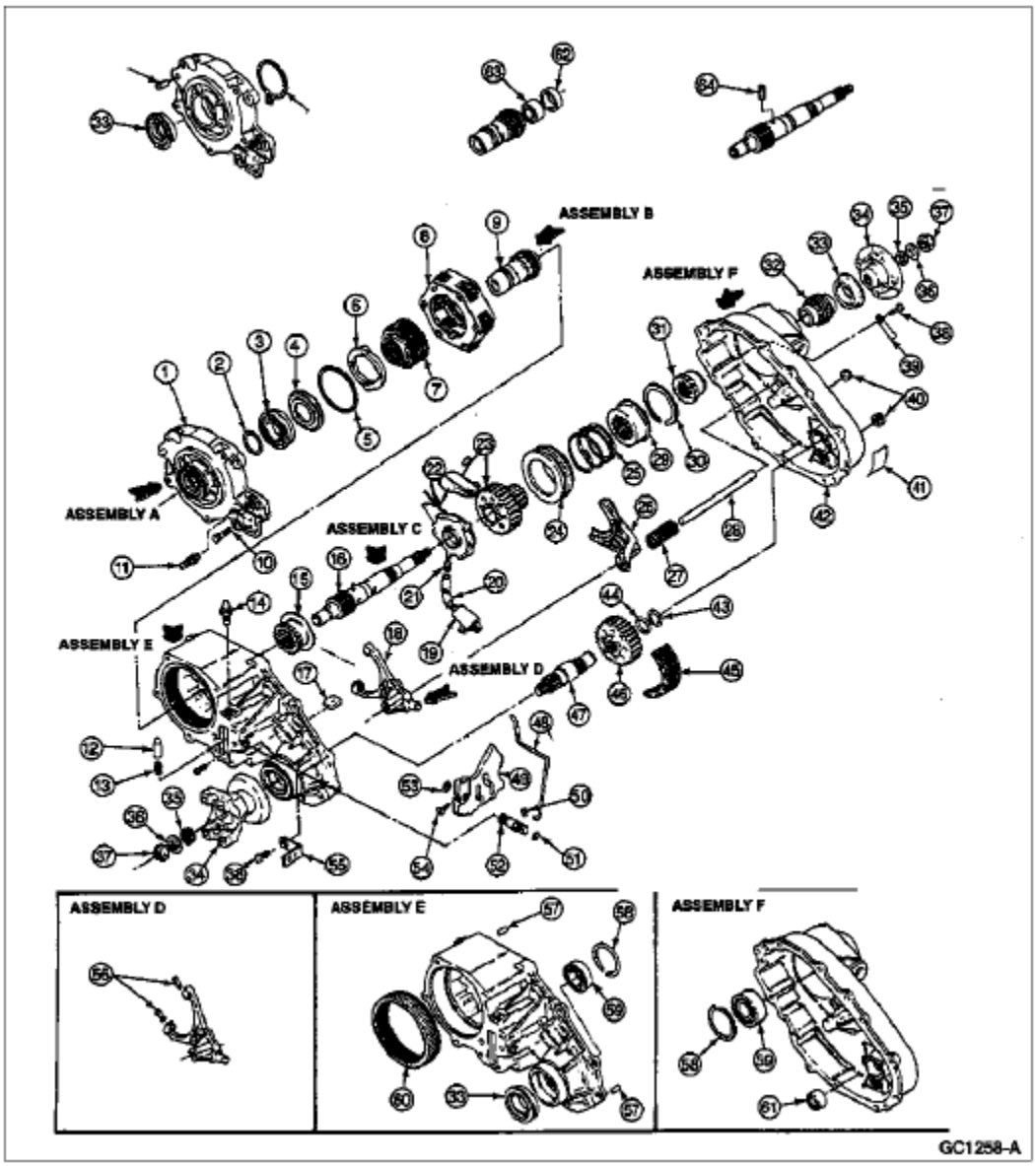
SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Impact Slide Hammer	T50T-100-A
Pinion Bearing Cone Replacer	T53T-4621-C
Axle Bearing/Seal Plate	T75L-1165-B
Driver Handle	T80T-4000-W
Output Shaft Bearing Replacer	T83T-7025-B
Output Shaft Seal Replacer	T83T-7065-B
Front Shaft Needle Bearing Replacer	T83T-7127-A
Input Shaft Bushing/Bearing Replacer	T87T-7127-A
Input Shaft Bearing Remover	T91T-7127-A
Input Shaft Bearing Replacer	T91T-7127-B

Disassembly

1. Remove the transfer case (7A195) from the vehicle as described and place on workbench.
2. Remove the transfer case drain plug with a 3/8-inch drive ratchet and drain the fluid.
3. Remove the four-wheel drive indicator switch.

Transfer Case, Borg-Warner 13-54 Manual Shift, Disassembled View



Item	Part Number	Description
1	7050	Main Drive Gear Bearing Retainer
2	7917	Snap Ring
3	7025	Bearing
4	7A385	Washer, Thrust
5	7C122	Ring, Retaining
6	7B066	Thrust Plate
7	7D063	Sun Gear
8	7A398	Carrier Assembly, Planet
9	7017	Input Shaft
10	7A443	Bolt (14)
11	383976	Barb, Breather

12	7233	Detent Plunger
13	7219	Lockup Return Spring
14	7E440	Four-Wheel Drive Indicator Switch
15	—	High-Low Collar (Part of 7D164)
16	7061	Output Shaft
17	7L027	Oil Pan Magnet
18	7289	Fork, Lockup
19	7A098	Strainer, Oil
20	7A210	Hose, Coupling
21	382846	Clamp, Hose
22	7A149	Housing, Pump
23	7177	Sprocket, (24T)
24	7106	Lockup Sleeve
25	7D126	Spring, Sleeve Return
26	7289	Fork, Lockup
27	7219	Spring
28	7240	Shift Rail
29	7D164	Lockup Collar
30	7917	Snap Ring
31	7100	Shift Collar Hub
32	17285	Speedometer Drive Gear
33	7B215	Yoke to Flange Seal (3)
34	7B214	Case Yoke
35	7052	Seal, Oil
36	7B368	Output Shaft Yoke Washer
37	7045	Nut, Metric
38	7A443	Bolt
39	—	Identification Tag (Part of 7A195)
40	87675	Plug, Pipe (1/2-14)
41	—	Decal (Part of 7005)
42	7005	Case
43	7917	Snap Ring
44	7119	Thrust Washer
45	7A029	Chain Drive
46	7177	Sprocket
47	7061	Shaft, Output Front
48	7C349	Spring, 4L Assist

49	7F063	Cam, Shift
50	7C191	Roller, 4L Assist
51	7288	Shifter Shaft Seal
52	7N095	Shaft, Shift
53	387949	Ring, Clip
54	7A443	Screw
55	—	Wire Harness Bracket (Part of 14401)
56	7C430	Facing, Shift Fork
57	—	Dowel (Part of 7005)
58	7917	Snap Ring
59	7025	Bearing
60	7A153	Ring Gear
61	7127	Needle Bearing, Front Output
62	7065	Output Shaft Bushing
63	7120	Input Shaft Bearing
64	7B362	Pin, Pump

4. Using a 30mm thin wall socket, remove the rear output nut, output shaft yoke washer (7B368), rubber seal and case yoke (7B214).

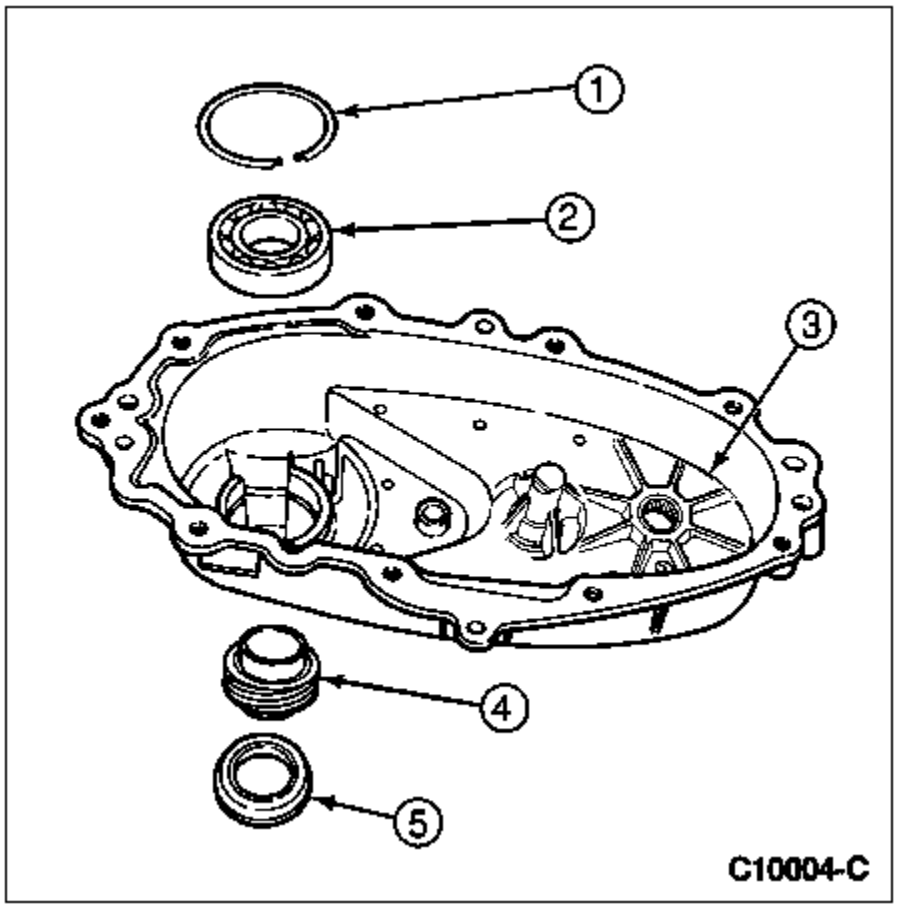
5. Using a 30mm thin wall socket, remove the front output shaft nut, output shaft yoke washer, rubber seal and case yoke.

6. **CAUTION: When removing RTV sealant, take care not to damage the mating surfaces of the aluminum case.**

   Remove the nine 10mm bolts (7A443) which retain the front case (7005) to the rear case. Remove the wiring harness bracket. Insert a 1/2-inch drive breaker bar between the three pry bosses and separate the front case from the rear case. Remove all traces of RTV gasket sealant from the mating surfaces of the front case and rear case.

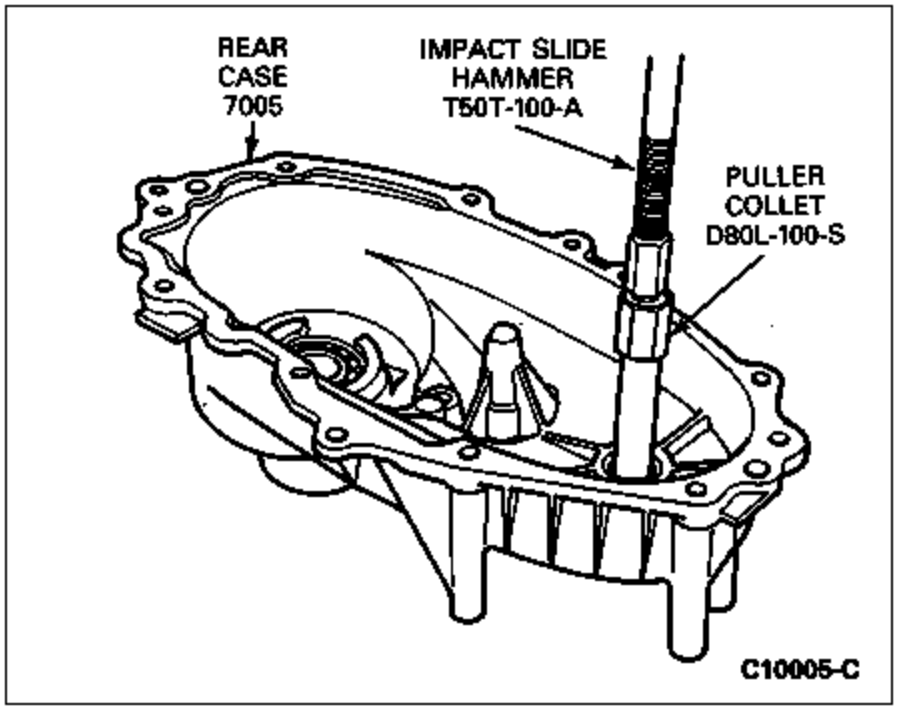
7. If the speedometer drive gear (17285) or bearing (7025) is to be replaced, remove the yoke to flange seal (7B215) by prying and pulling on the curved-up lip of the seal or use the Impact Slide Hammer T50T-100-A to pop off the yoke to flange seal. Take care not to damage the bearing, bearing cage or case.

8. Remove the internal snap ring that retains the bearing in the bore. From the outside of the case, drive out the bearing using Step Plate D80L-630-4 or equivalent with a suitable drift.

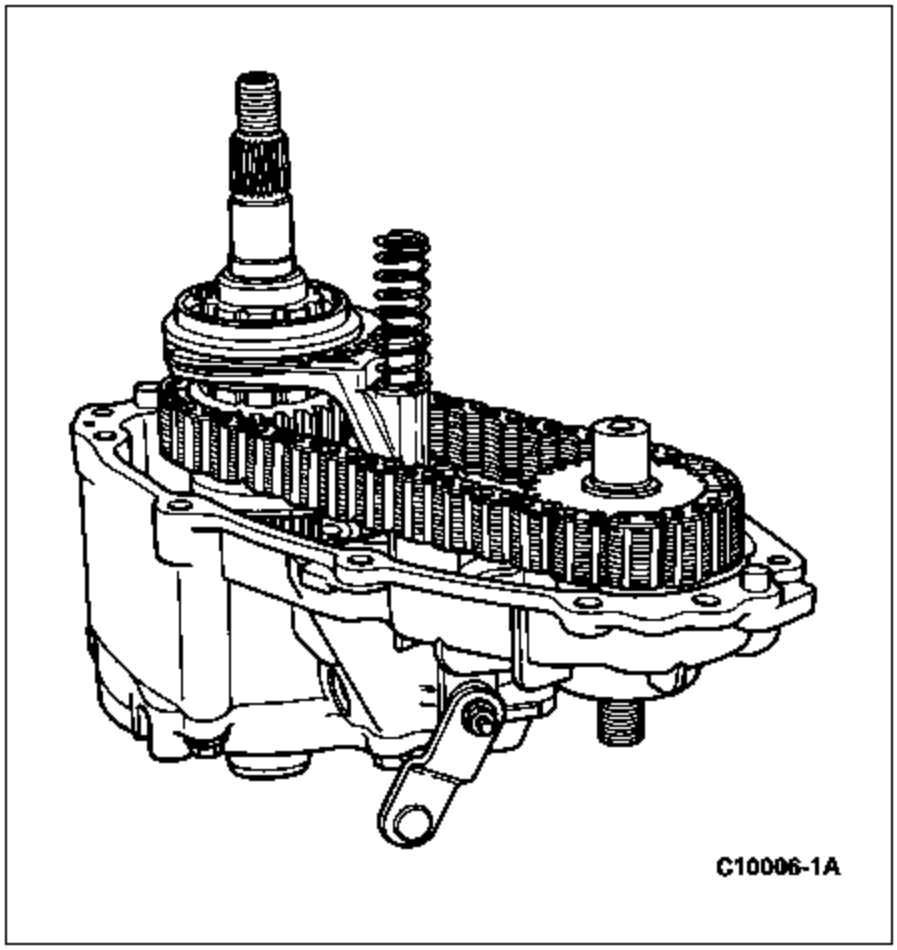


Item	Part Number	Description
1	7917	Snap Ring
2	7025	Bearing
3	7005	Case
4	77285	Speedometer Drive Gear
5	7B215	Yoke to Flange Seal

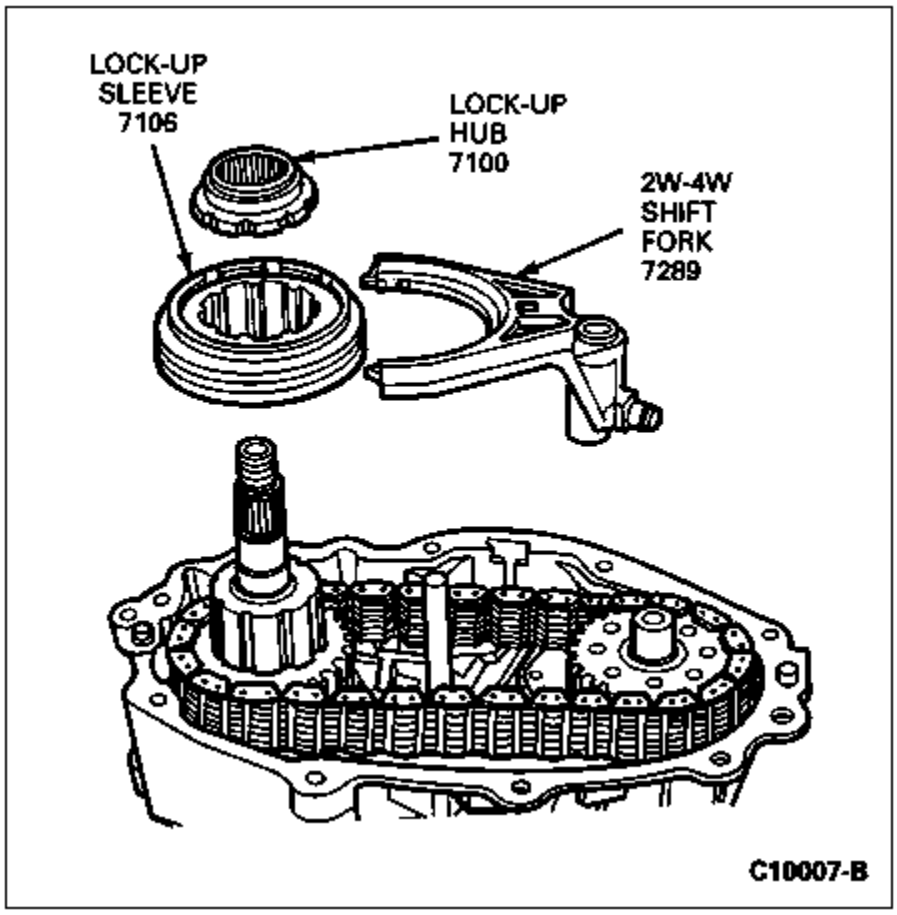
9. If required, remove the front needle bearing from the rear case with Collet D80L-100-S or equivalent and Impact Slide Hammer T50T-100-A.



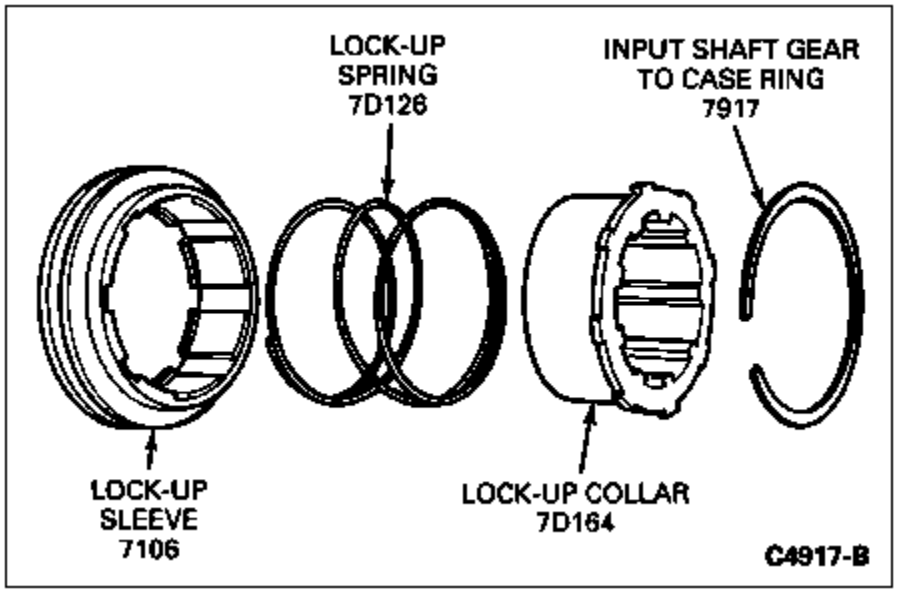
10. Remove the 2W-4W shift fork lockup return spring from the boss on the 2W-4W shift fork.



11. Remove the lockup hub from the output shaft. Remove the 2W-4W lockup and the 2W-4W shift fork together as an assembly. Remove the 2W-4W fork from the 2W-4W lockup assembly.



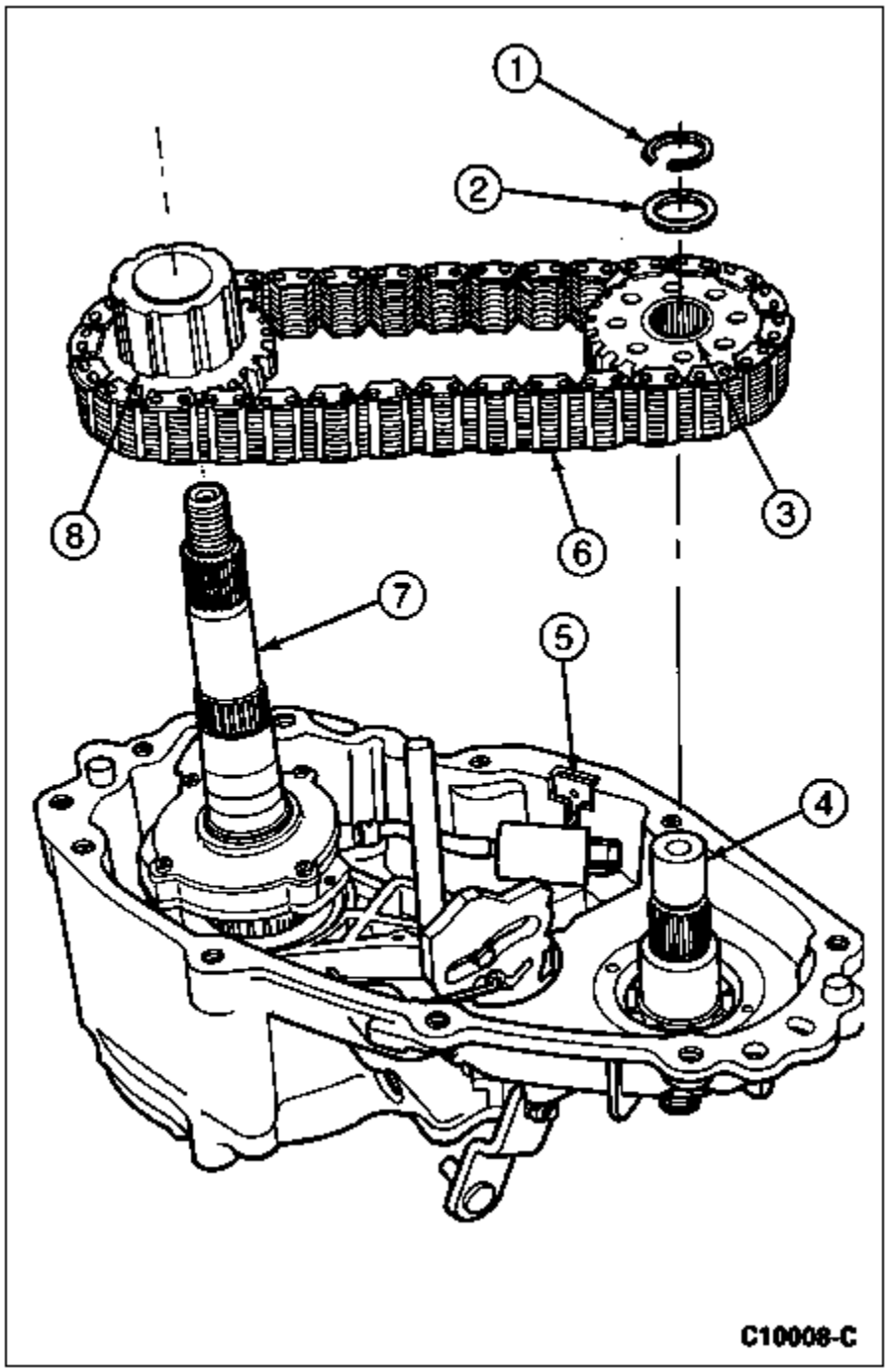
12. If required, disassemble the 2W-4W lockup, remove the internal snap ring and pull the lockup collar and spring from the lockup sleeve.



13. Remove the external snap ring and thrust washer (7119) that retains the driven sprocket to the front

output shaft.

14. Remove the chain, driven sprocket and drive sprocket as an assembly.

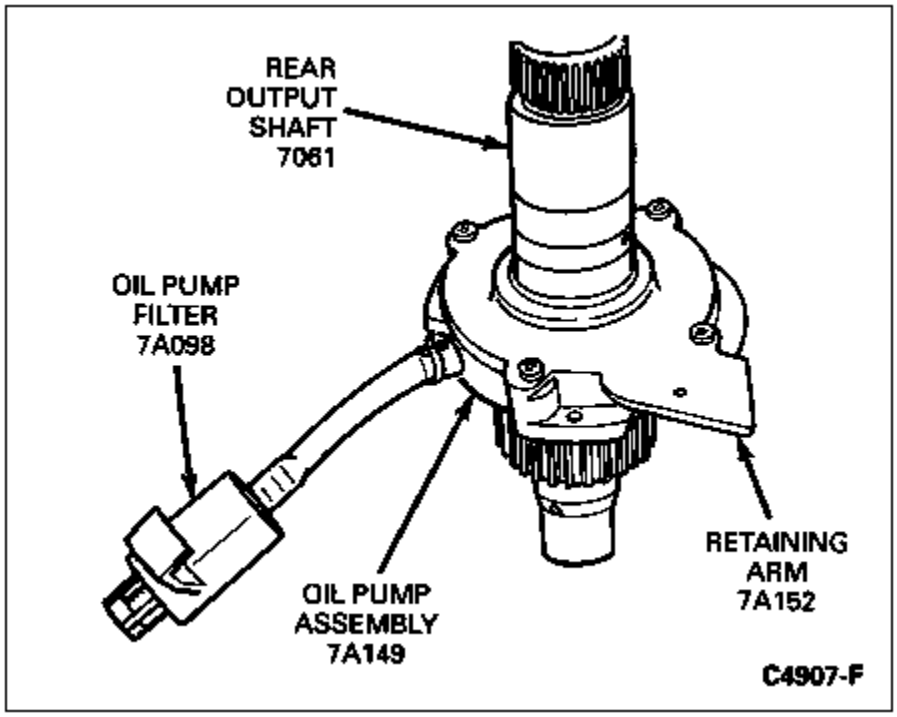


Item	Part Number	Description
1	7917	External Snap Ring
2	7119	Thrust Washer

3	7177	Driven Sprocket
4	7061	Output Shaft (Front)
5	7L027	Oil Pan Magnet
6	7A029	Chain
7	7061	Output Shaft (Rear)
8	7177	Drive Sprocket

15. Remove the oil pan magnet (7L027) from the slot in the front case bottom.

16. Remove the rear output shaft and oil pump as an assembly.



17. **CAUTION: If there is removal resistance, do not pound or use force to disassemble the pump; start over again.**

    If required, rotate the pump to align the cover keyway to shaft pin of the output shaft and pull the pump assembly straight out.

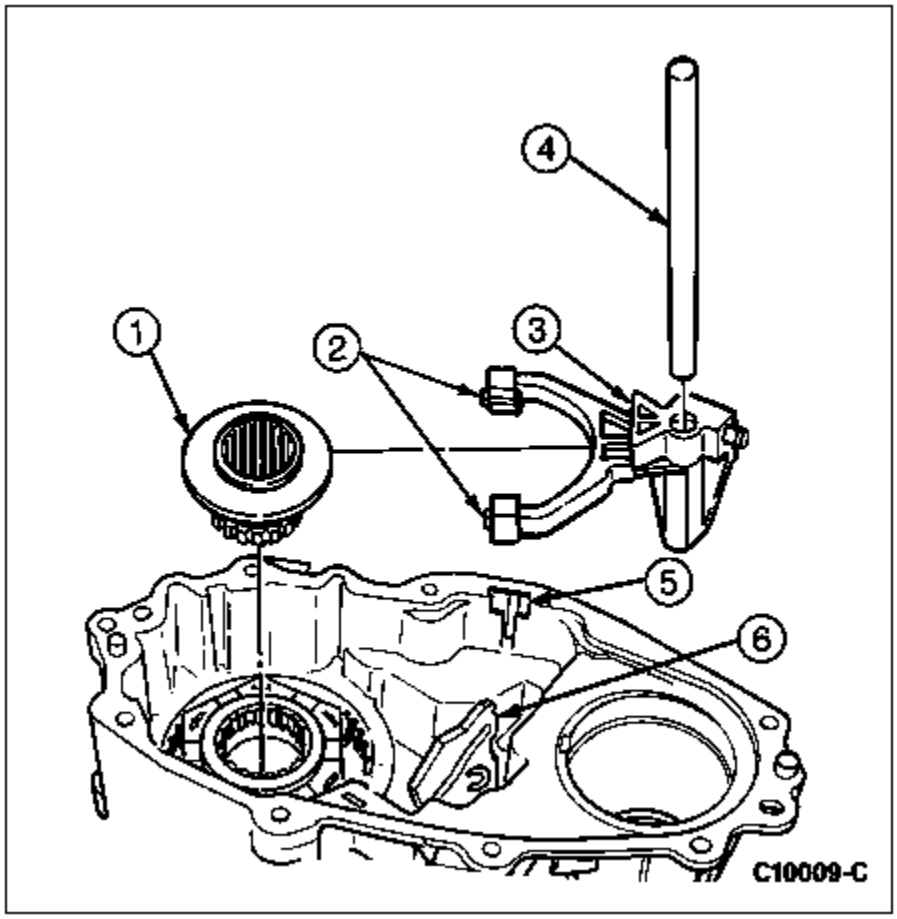
18. If necessary to replace the oil pump drive pin, perform the following.

    - Measure **and record** the drive pin height above the output shaft diameter. This information is required for installing the new drive pin.
    - Remove the drive pin from the output shaft.

19. Remove the front output shaft.

20. Pull out the shift rail.

21. Slip the high-low range shift fork out of the inside track of the shift cam and remove the high-low shift fork and reduction hub together.



Item	Part Number	Description
1	7D164	Reduction Hub
2	—	Nylon Wear Pads (Part of 7289)
3	7289	High-Low Shift Fork
4	7240	Shift Rail
5	7L027	Oil Pan Magnet
6	7F063	Shift Cam

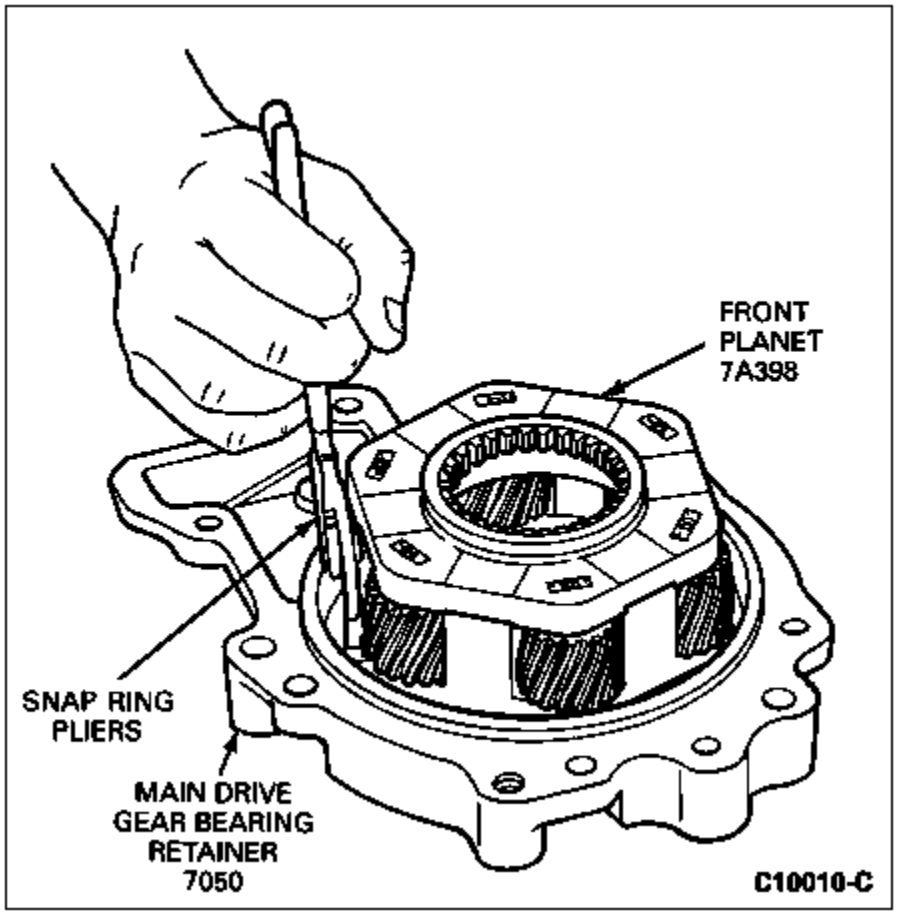
22. Push and pull out the anchor end of the assist spring from the locking post in the front case half. Remove the assist spring and roller out of the shift cam.

23. Turn the front case over and remove the six 10mm bolts retaining the main drive gear bearing retainer (7050) to the front case. Remove the main drive gear bearing retainer, input shaft (7017) and front planet (7A398) as an assembly.

24. Expand the tangs of the large snap ring in the main drive gear bearing retainer. With the input shaft

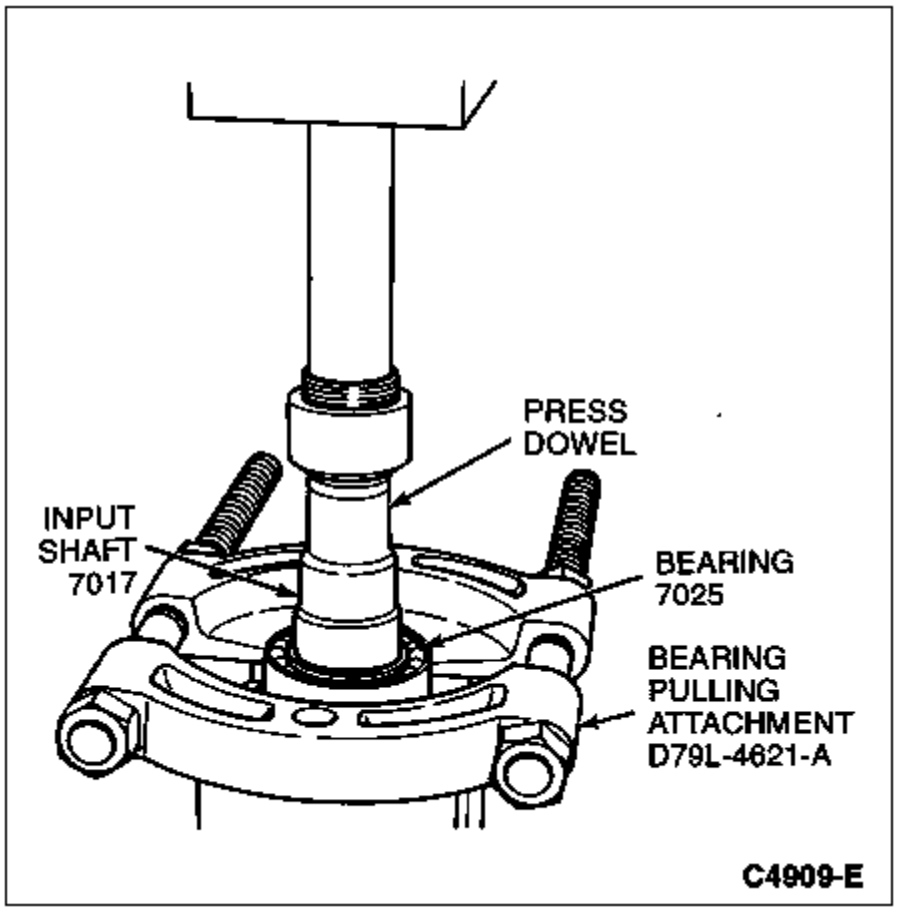
against a bench, push the main drive gear bearing retainer down and slide it off the bearing. Lift the input shaft and front planet from the main drive gear bearing retainer.

25. If required, remove the yoke to flange seal from the main drive gear bearing retainer by prying and pulling on the curved-up lip of the yoke to flange seal or use the Impact Slide Hammer T50T-100-A to pop off the yoke to flange seal. Do not damage the bearing, bearing cage or case.



26. Remove the internal snap ring from the planetary carrier and separate the front planet from the input shaft.

27. Remove the external snap ring from the input shaft. Place the input shaft in a press and remove the bearing from the input shaft using Bearing Pulling Attachment D79L-4621-A or equivalent. Remove the thrust washer, thrust plate and sun gear off the input shaft.

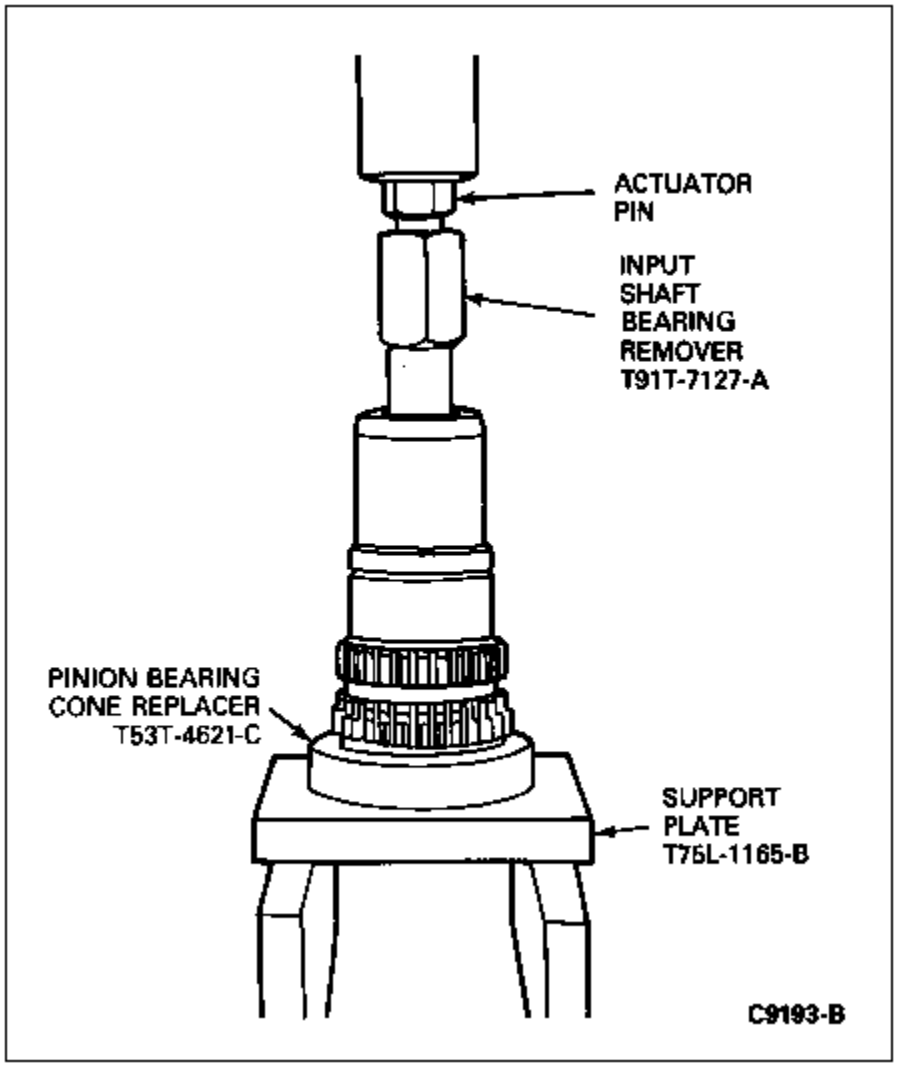


28. Inspect the bushing and needle bearing in the end of the input shaft for wear or damage.

29. **NOTE: Under normal use, the needle bearing and bushing should not require replacement. If replacement is required, the bushing and needle bearing must be replaced as a set.**

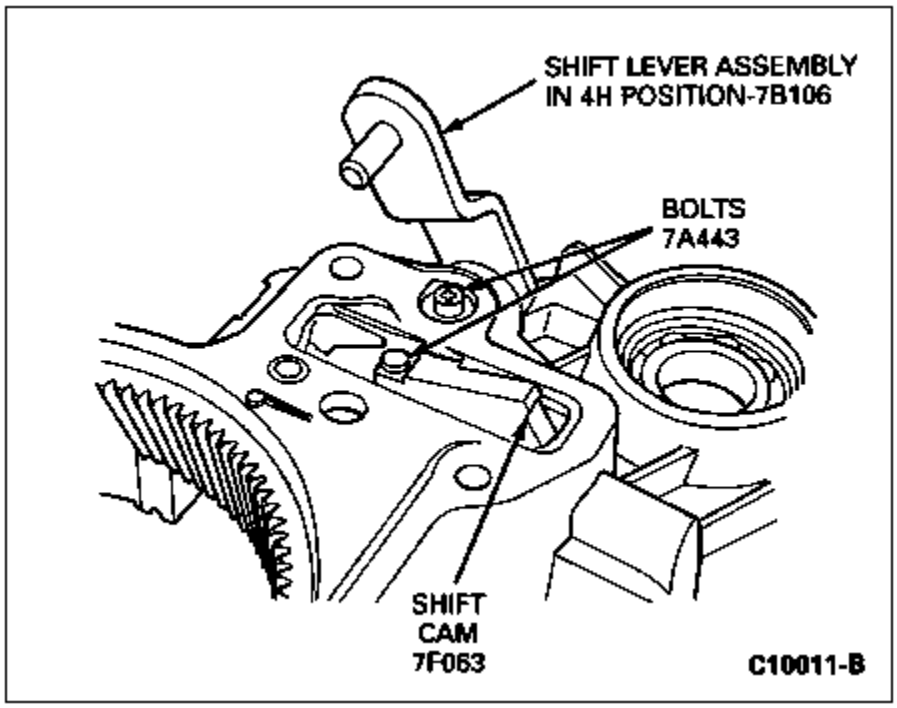
    If replacement of the needle bearing and bushing is required, press the bearing and bushing out as follows:

    a. Position the input shaft on Support Plate T75L-1165-B and Pinion Bearing Cone Replacer T53T-4621-C as a spacer.
    b. Insert Input Shaft Bearing Remover T91T-7127-A into the input shaft so it is resting on top of the bearing cage.
    c. Tighten the actuator pin until it stops, then press the bearing and bushing out together.



30. Move the shift lever by hand down to the 4L position, then up two detents to the 4H position. Mark a line on the outside of the front case using the side of the shift lever and a grease pencil.

31. Remove the two Torx® head bolts from the front case and from shift cam.



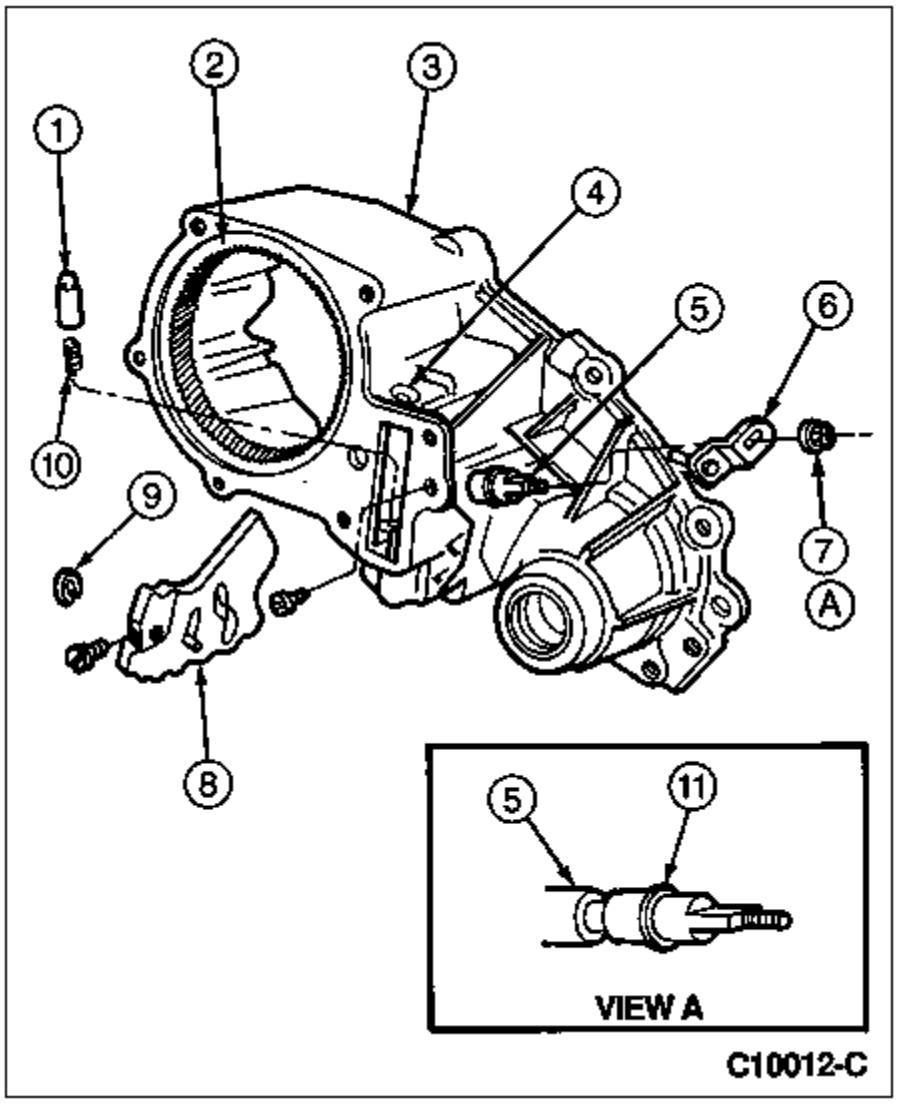
32. **NOTE: Do not pound on the external clip during removal.**

    NOTE: The shift lever and shift cam do not have to be disassembled unless the parts have to be replaced.

    Turn the front case over and remove the C-clip. With the aid of a screwdriver, pry the shift shaft out of the front case and shift cam.

33. Remove the O-ring from the second groove in the shift shaft and discard O-ring.

34. Remove the detent plunger and detent spring from the inside of the front transfer case.

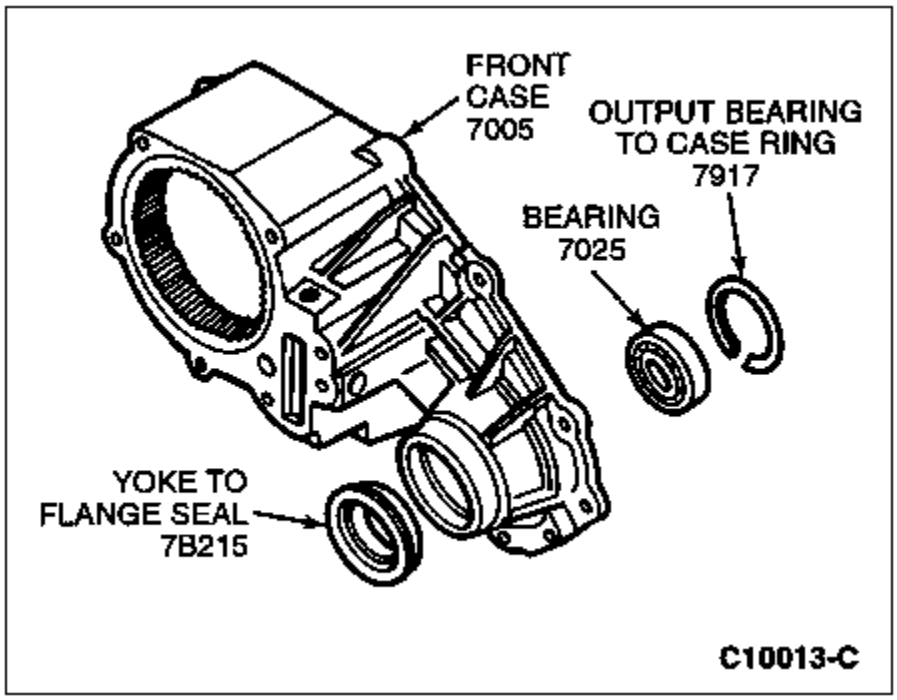


Item	Part Number	Description
1	7233	Detent Plunger
2	7A153	Ring Gear
3	7005	Case (Front)
4	7E440	Four-Wheel Drive Switch
5	7N095	Shift Shaft
6	7B106	Shift Lever
7	N620481-S2	Nut
8	7F063	Shift Cam
9	387949-S	C-Clip
10	7219	Detent Spring
11	7288	Shifter Shaft Seal
A	—	Tighten to 26-35 Nm (19-26 Lb-Ft)

35. If required, remove the ring gear (7A153) from the front case half using press. Note the relationship of the serrations to the chamfered pilot diameter during removal.

36. If required, remove the front yoke to flange seal by prying and pulling on the curved-up lip of the yoke to flange seal or use the Impact Slide Hammer T50T-100-A to pop off the yoke to flange seal. Do not damage the bearing, bearing cage or case.

37. If required, remove the internal snap ring and drive the bearing out of the front case bore using Step Plate D80L-630-A or equivalent with a drift.



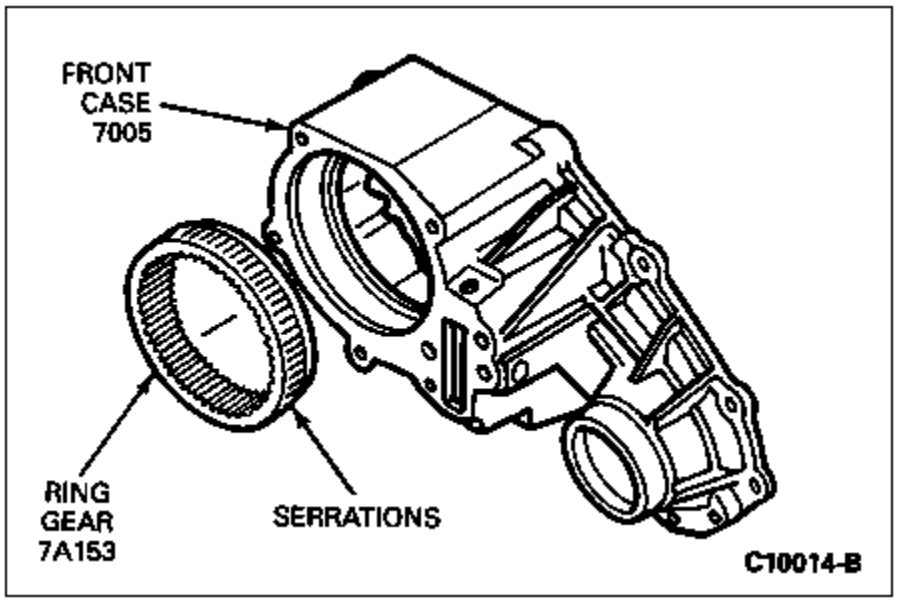
Assembly

Before assembly, lubricate all parts with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX or equivalent.

1. If removed, drive the bearing into the front output case bore using Output Shaft Bearing Replacer T83T-7025-B and Driver Handle T80T-4000-W. Drive the bearing in straight, making sure that it is not cocked in the bore. Install the internal snap ring that retains the bearing to the front case.

2. If removed, install the front yoke to flange seal in the front case bore using Output Shaft Seal Replacer T83T-7065-B and Driver Handle T80T-4000-W.

3. If removed, install the ring gear in the front case. Align the serrations on the outside diameter of the ring gear to the serrations previously cut in the front case bore. Using a press, start the piloted chamfered end of the ring gear first and press in until it is fully seated. Make sure the ring gear is not cocked in the bore.



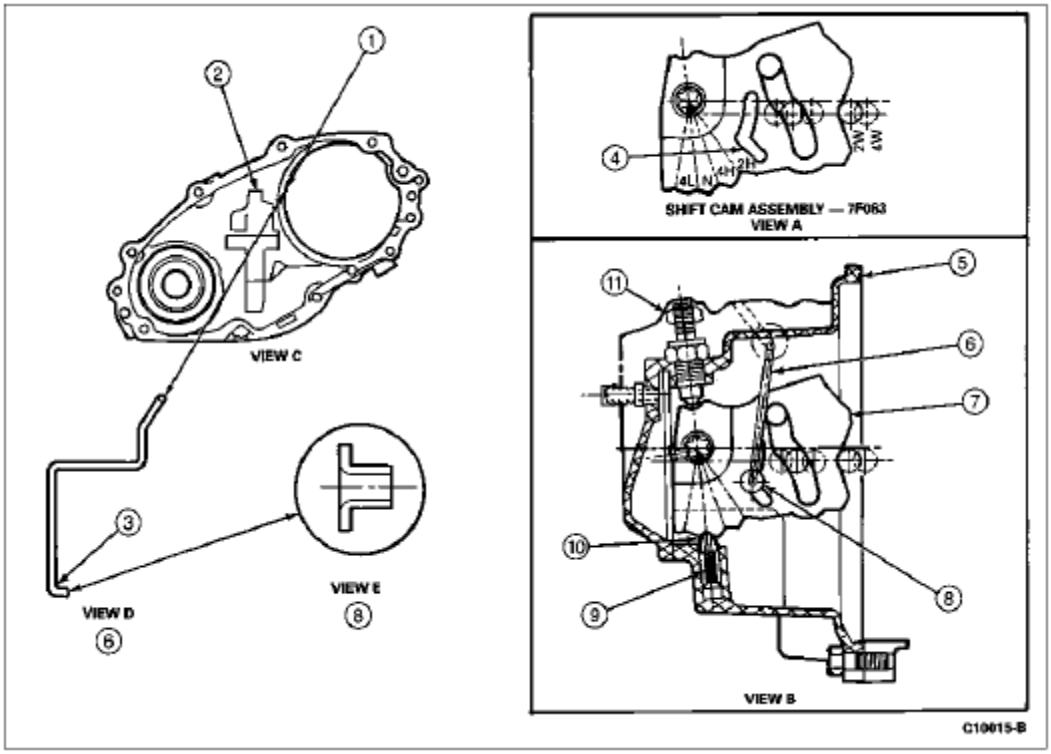
4. Install the detent spring and the detent plunger into the bore from the inside of the front case.

5. **NOTE: Use a rubber band to fill the first groove so as not to cut the O-ring. Discard the rubber band.**

   Fill the second groove of the shift shaft with Premium Long-Life Grease XG-1-C or -K or equivalent meeting Ford specification ESA-M1C75-B and install a new O-ring.

6. After the shift cam, shift shaft and C-clip have been installed in the front case and with the shift shaft positioned in the 4H detent position, place the assist spring roller into part-position on the 90 degree bent tang of the assist spring (Views D and E) and insert the assist roller into the assist spring/roller slot of the shift cam (Views A and B). Position the middle section of the assist spring into the groove of the front case pivot boss (Views C and D) and push to lock the upper end of the assist spring behind the front case spring anchor tab (Views C and D).

Shift Cam Installation

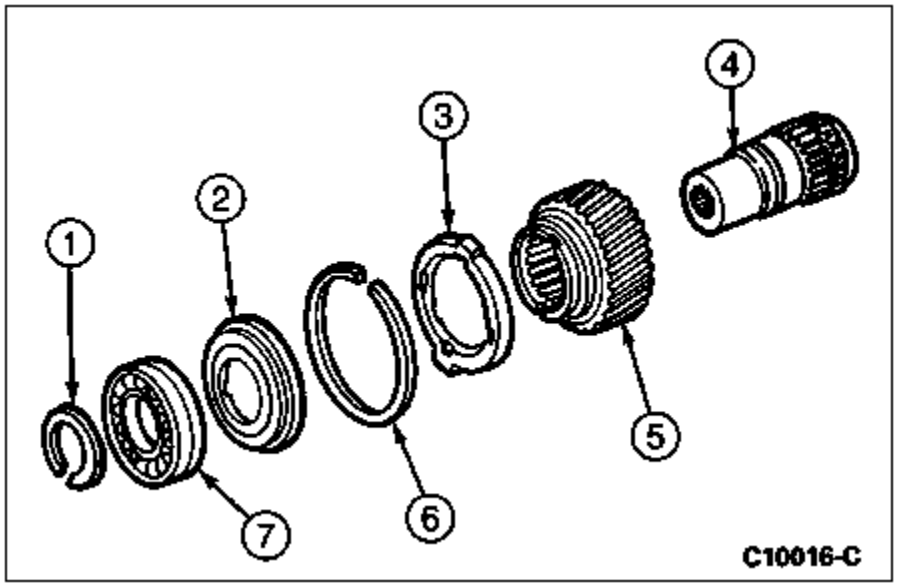


Item	Part Number	Description
1	—	Anchor Tab Assist Spring (Part of 7C349)
2	—	Pivot Boss Assist Spring (Part of 7C349)
3	—	90 Degree Bent Tang (Part of 7C349)
4	—	Assist Spring Roller Slot (Part of 7F063)
5	7005	Case (Front)
6	7C349	Assist Spring
7	7F063	Shift Cam
8	7C191	Roller, 4L Assist
9	7219	Detent Spring
10	7233	Detent Plunger
11	7E440	Four-Wheel Drive Indicator Switch

7. Install the two Torx® head bolts in the front case and in the shift cam. Tighten the screws to 7-10 Nm (60-84 lb-in). Make sure that bolt in the front case is in the first groove of the shift shaft and not bottomed against the shaft itself. The shift shaft should be able to move freely at all detent positions.

8. **NOTE: The sun gear recessed face and the snap ring groove on the bearing outer race should be toward the rear of the transfer case. The stepped face of the thrust washer should face toward the bearing.**

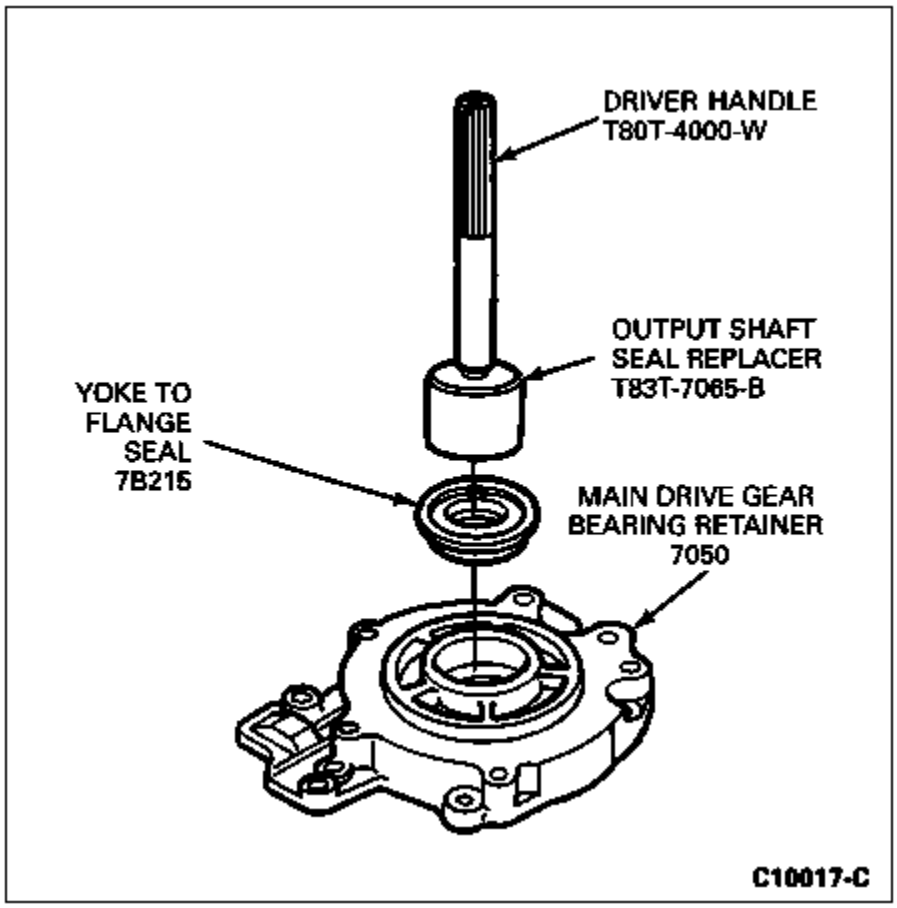
   Slide the sun gear, thrust plate and thrust washer into position on the input shaft. Press the bearing over the input shaft and install the external snap ring to the input shaft.



Item	Part Number	Description
1	7917	External Snap Ring
2	7119	Thrust Washer
3	7B066	Thrust Plate
4	7017	Input Shaft
5	7D063	Sun Gear
6	7064	Snap Ring (Internal)
7	7025	Bearing

9. Install the front planet to the sun gear and input shaft. Install the internal snap ring to the planetary carrier.

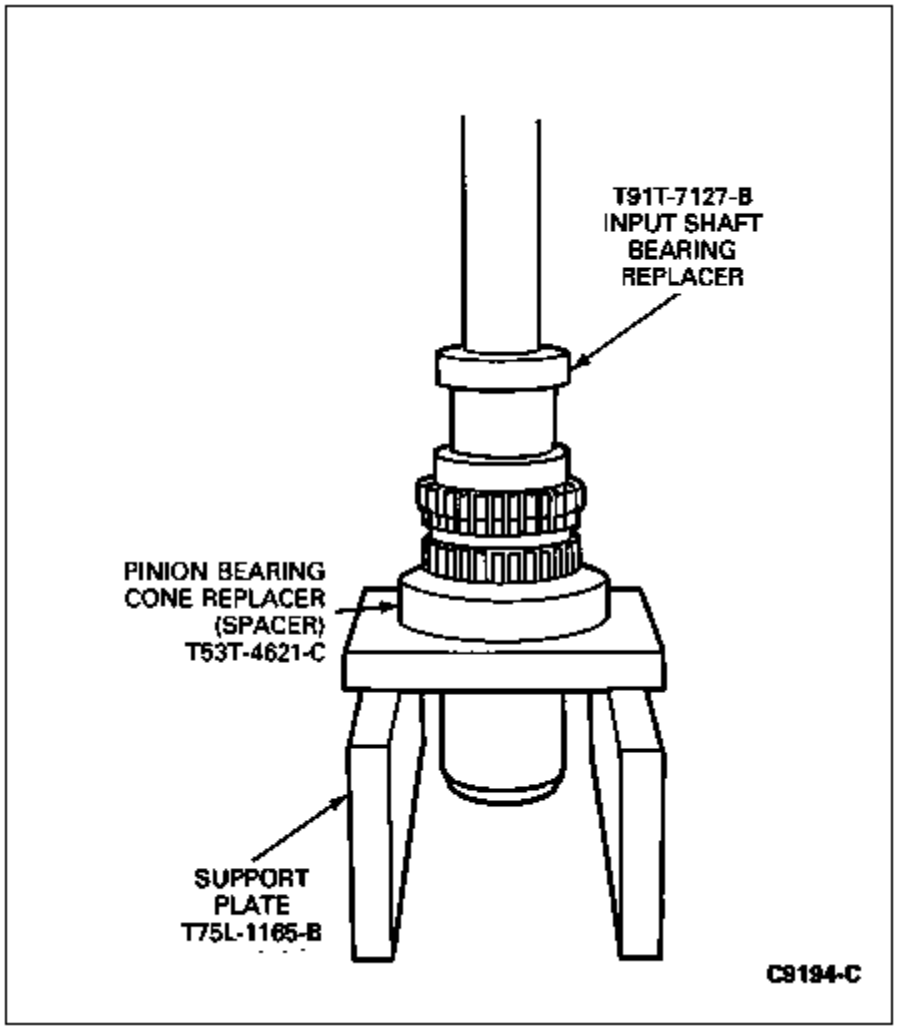
10. If removed, install the yoke to flange seal into the mounting adapter bore using Output Shaft Seal Replacer T83T-7065-B and Driver Handle T80T-4000-W.



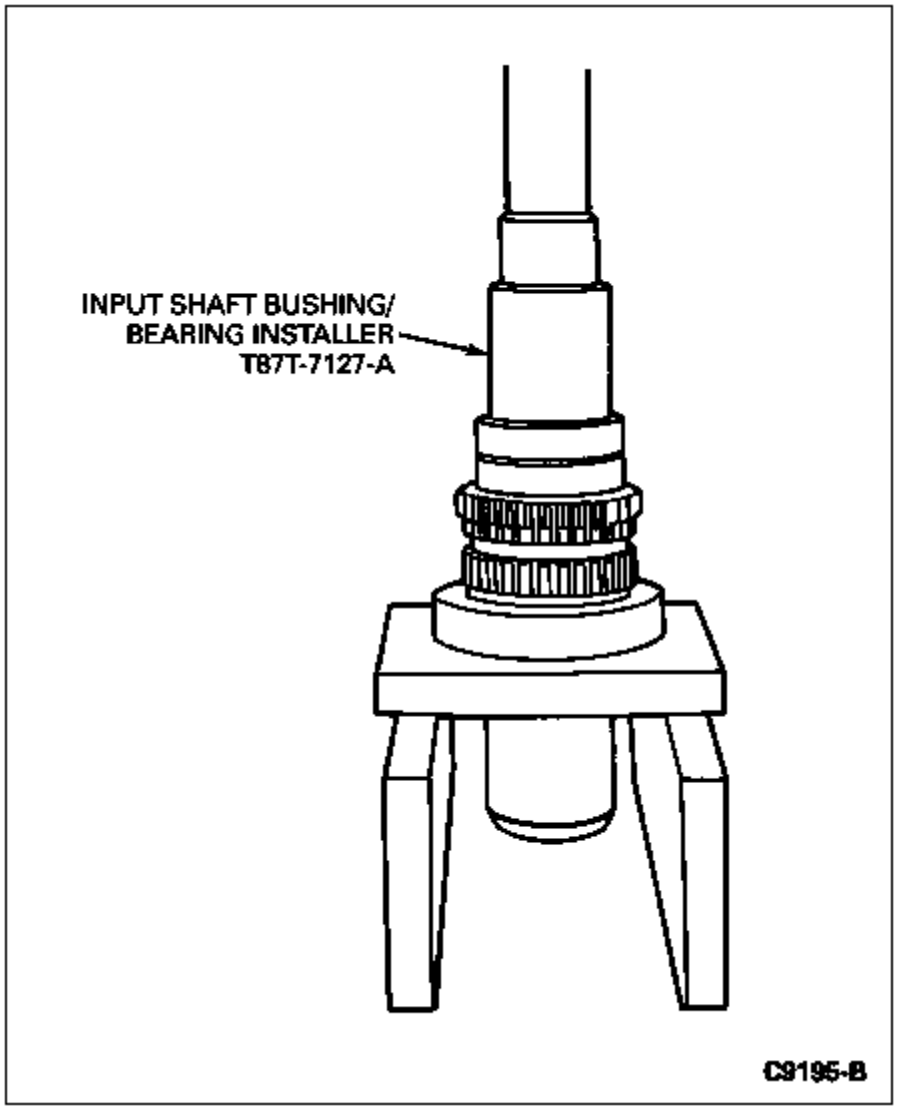
11. **NOTE: If the input shaft needle bearing and bushing were removed, install a new bearing and bushing as detailed in the following steps.**

    Press a new needle bearing, then a new bushing in the input shaft as follows:

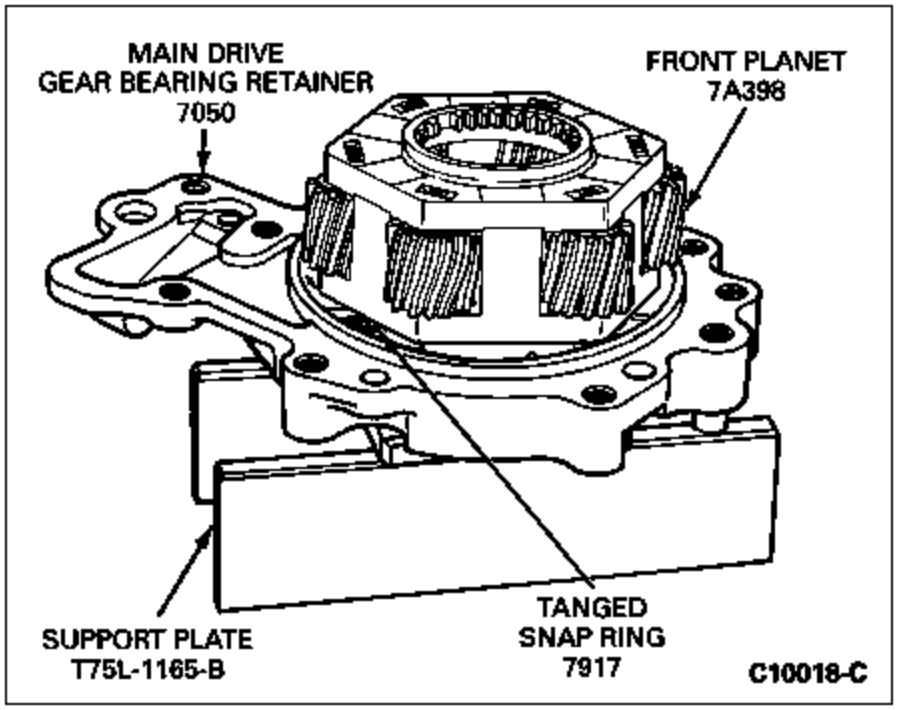
    a. Position the input shaft on Support Plate T75L-1165-B or equivalent and Pinion Bearing Cone Replacer T53T-4621-C as a spacer.
    b. Using Input Shaft Bearing Replacer T91T-7127-B press a new needle bearing into the end of the input shaft until it seats in the input shaft.



c. Press in a new bushing using Input Shaft Bushing Bearing Replacer T87T-7127-A.



12. Place the tanged snap ring in the groove of the main drive gear bearing retainer. Using Support Plate T75L-1165-B, place the input shaft and front planet in the main drive gear bearing retainer and expand the tanged snap ring while pushing inward until the front planet and input shaft are seated in the main drive gear bearing retainer. When properly seated, the tanged snap ring will snap into place. Check installation by holding the main drive gear bearing retainer by hand and carefully tapping the face of the input shaft against a wooden block to make sure that the snap ring is engaged.



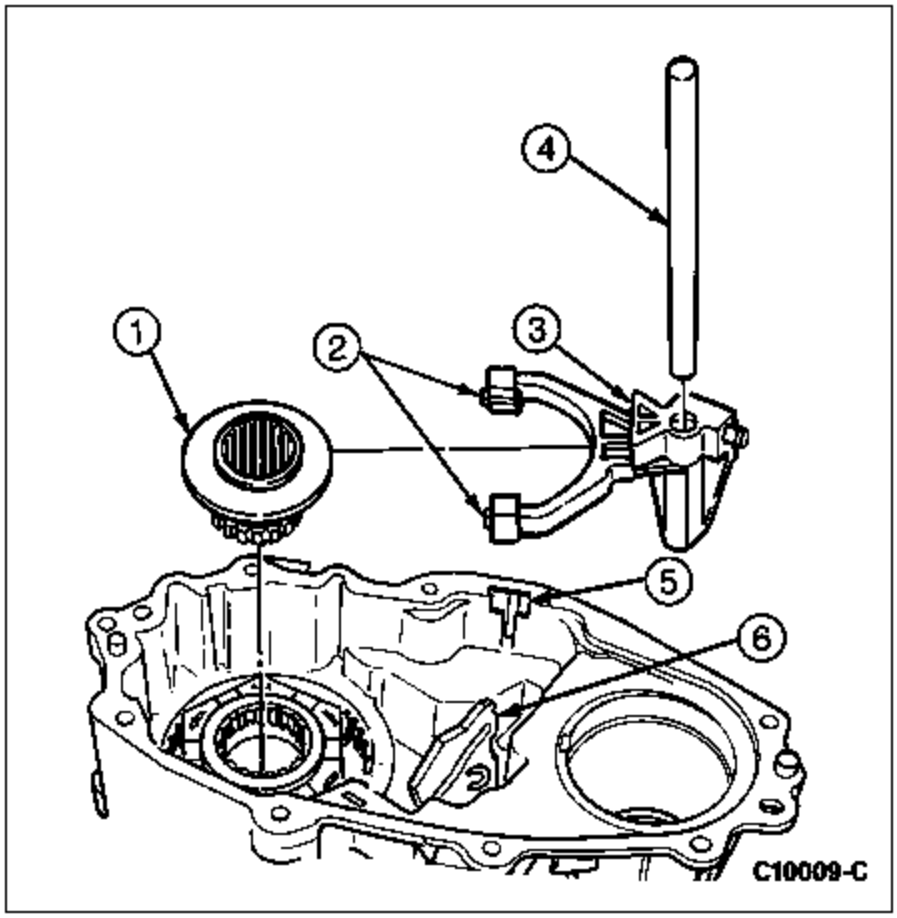
13. Remove all traces of RTV gasket sealant from the mating surfaces of the front case and main drive gear bearing retainer. Install a bead of RTV gasket sealant on the surface of the front case. Use Black Non-Acid Cure Silicone Rubber E7TZ-19562-A or equivalent meeting Ford specification ESL-M4G273-A.

14. Position the main drive gear bearing retainer on the front case. Install six bolts and tighten to 31-41 Nm (23-30 lb-ft).

15. **NOTE: Make sure the nylon wear pads are installed on the shift fork and snapped securely into place.**

    Install the high-low shift fork and reduction hub on the output shaft together, and slip the high-low shift fork roller bushing into the high-low roller track of the shift cam.

16. Install the shift rail through the high-low fork and make sure the shift rail is seated in the bore in the front case. Using the shift lever, position the high-low shift fork in the 4H position.



Item	Part Number	Description
1	7D164	Reduction Hub
2	—	Nylon Wear Pads (Part of 7289)
3	7289	High-Low Range Shift Fork
4	7240	Shift Rail
5	7L027	Oil Pan Magnet
6	7F063	Shift Cam

17. If removed, press a new pin into the rear output shaft pin hole to the same height or 1mm (0.040 inch) (**minimum**) above the diameter of the rear output shaft.

18. **NOTE: Do not disassemble oil pump, as it is serviced only as an assembly.**

    NOTE: Do not remove the plastic insert from the bore of the new pump. Discard it after it slides out during pump installation to the output shaft.

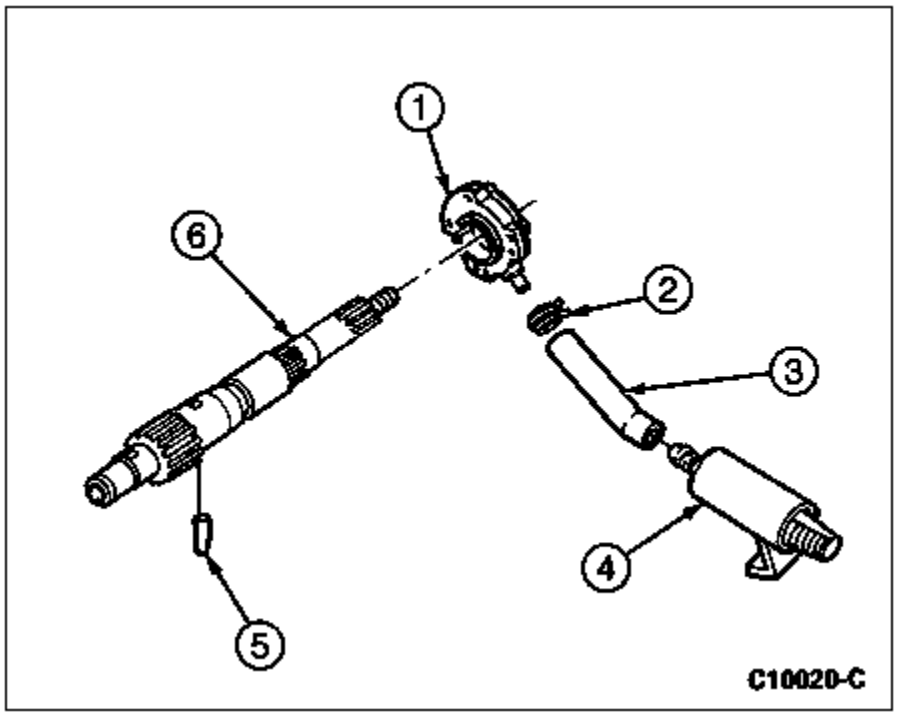
    NOTE: While turning the output shaft, prime the pump through the oil filter pick-up tube or housing inlet hole with clean MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX or equivalent MERCON® fluid.

    If pump does not turn freely after installation to the output shaft, re-align the cover keyway to pin of

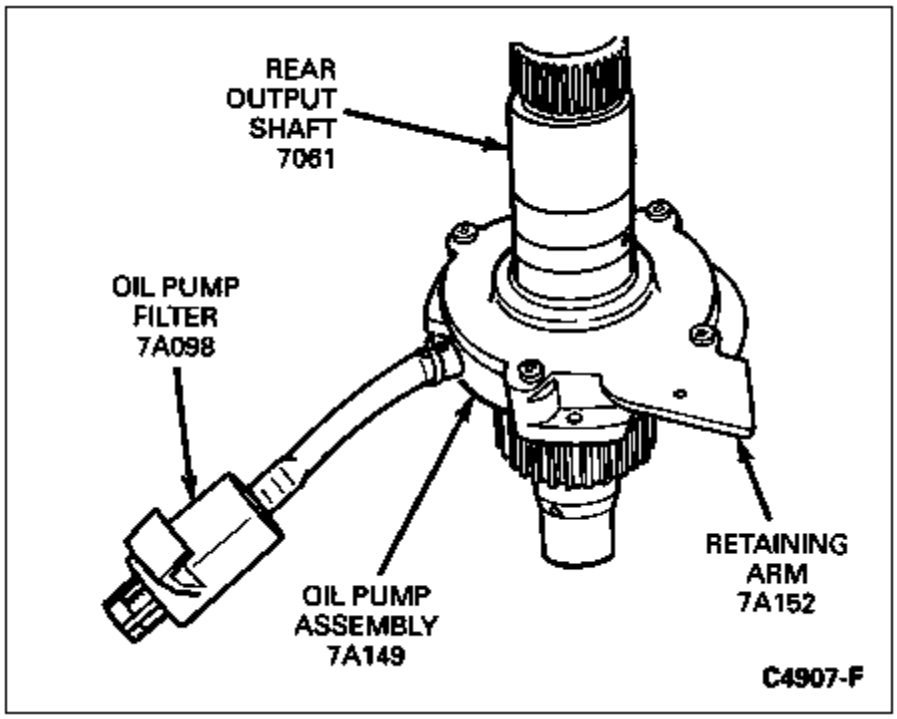
the output shaft and jiggle the pump until it fully seats and rotates freely.

If a new pump is used, slide the pump housing slot onto the pin of the output shaft with the retaining arm of the pump cover toward the rear of the case. If the pump does not rotate freely, follow the direction in the above paragraph.

Inspect outside surfaces and bore of the oil pump. If there is no discoloration in the pump housing, gear or cover, and the pump bore and the lube holes of the output shaft show evidence of oil, the pump is working. Hand align the keyways and the bores of the housing, gear and cover and slide the pump onto the pin of the output shaft with the retaining arm of the cover toward the rear of the case.



Item	Part Number	Description
1	7A149	Pump Body
2	382846-S	Clamp
3	7A210	Hose
4	7A098	Filter/Pickup
5	7A250	Pin
6	7061	Output Shaft (Rear)



19. Install the output shaft and oil pump in the input shaft. Make sure the external splines of the output shaft engage the internal splines of the lockup hub. Make sure the oil pump retainer arm and the oil filter leg are in the groove and notch of the front case.

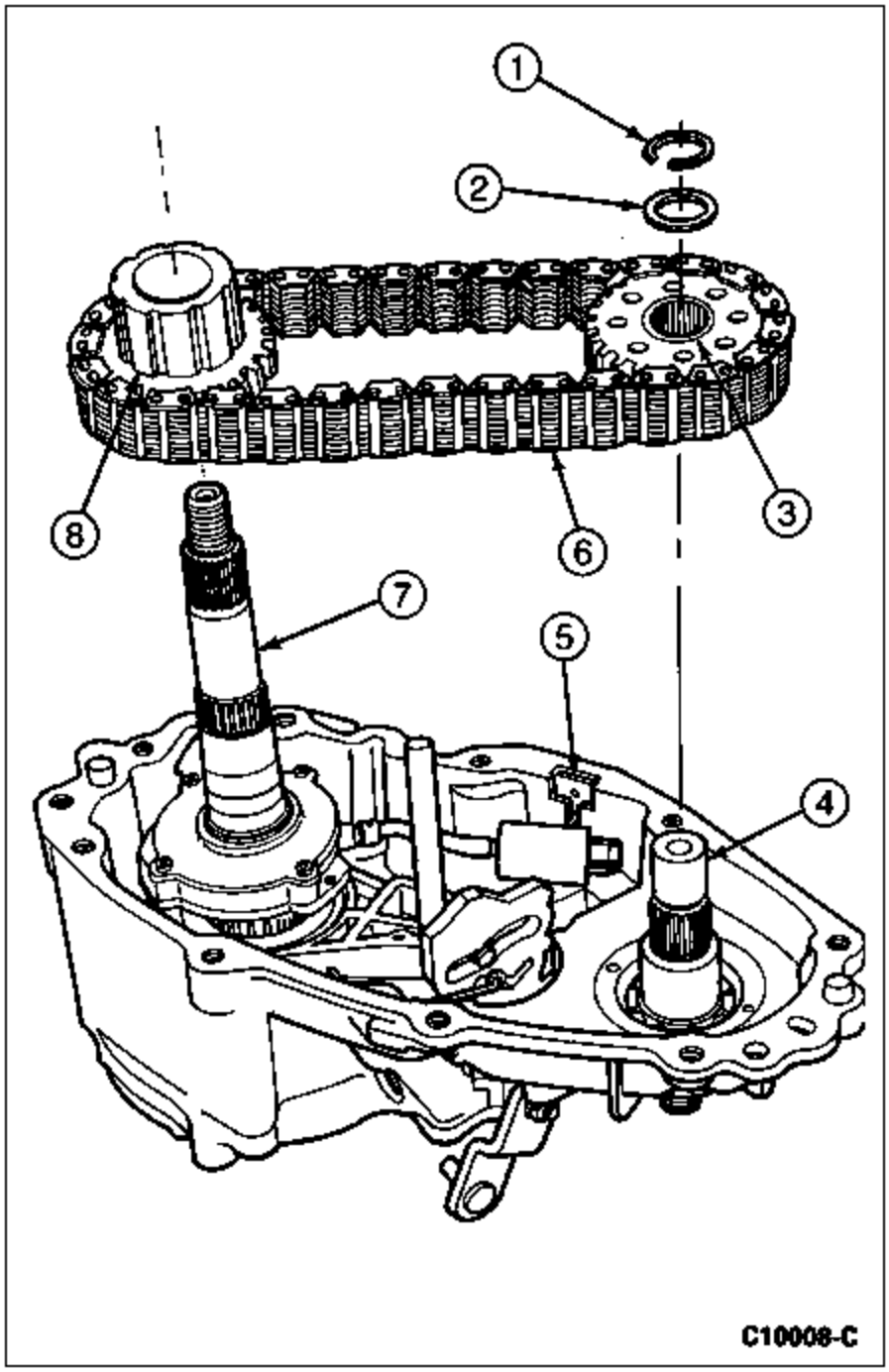
20. Install the oil pan magnet in the slot in the front case just above the oil filter leg.

21. Install the front output shaft in the front case.

22. **NOTE: The driven sprocket (on the output shaft) must be installed with the marking "REAR" facing toward the rear case, if so marked.**

    Install the chain, drive sprocket and driven sprocket as an assembly over the output shafts.

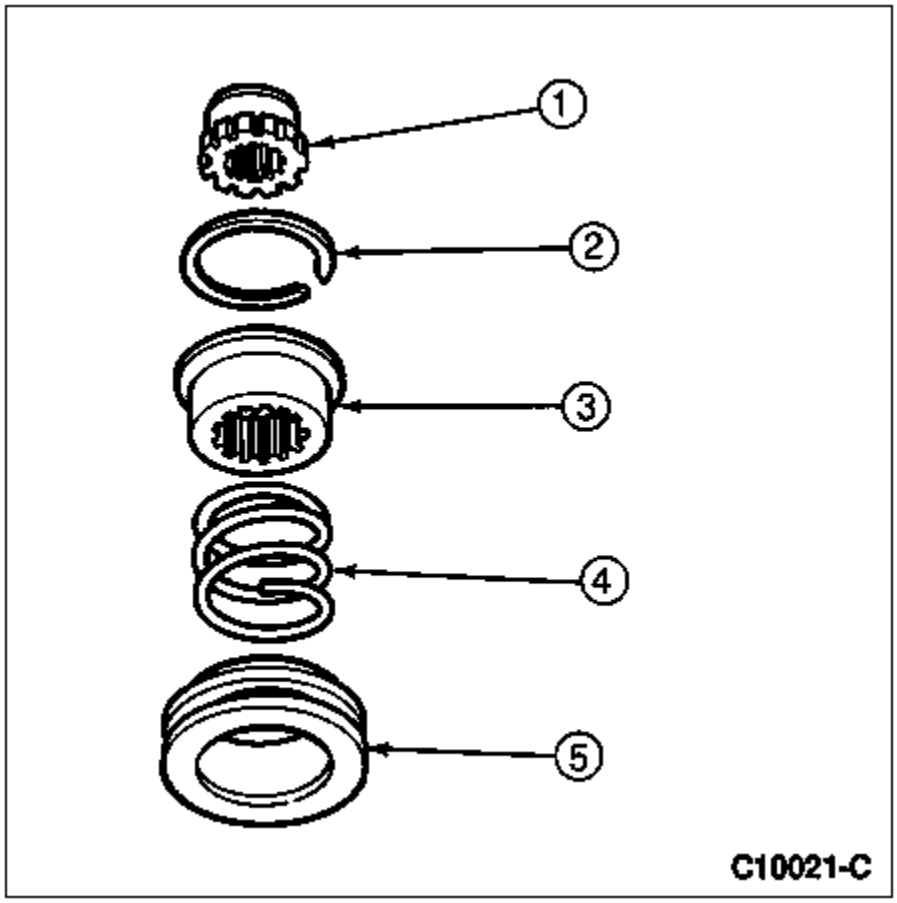
23. Install the thrust washer on the front output shaft and install a new external snap ring over the thrust washer to retain the driven sprocket.



Item	Part Number	Description
1	7917	External Snap Ring
2	7119	Thrust Washer
3	7177	Driven Sprocket
4	7061	Output Shaft Front
5	7L027	Oil Pan Magnet
6	7A029	Chain

7	7061	Output Shaft (Rear)
8	7177	Drive Sprocket

24. If disassembled, assemble the 2W-4W lockup assembly. Install the spring in the lockup sleeve. Place the lockup collar over the spring and engage the lockup collar in the notches in the lockup sleeve. Retain the lockup collar in the lockup sleeve with an internal snap ring.



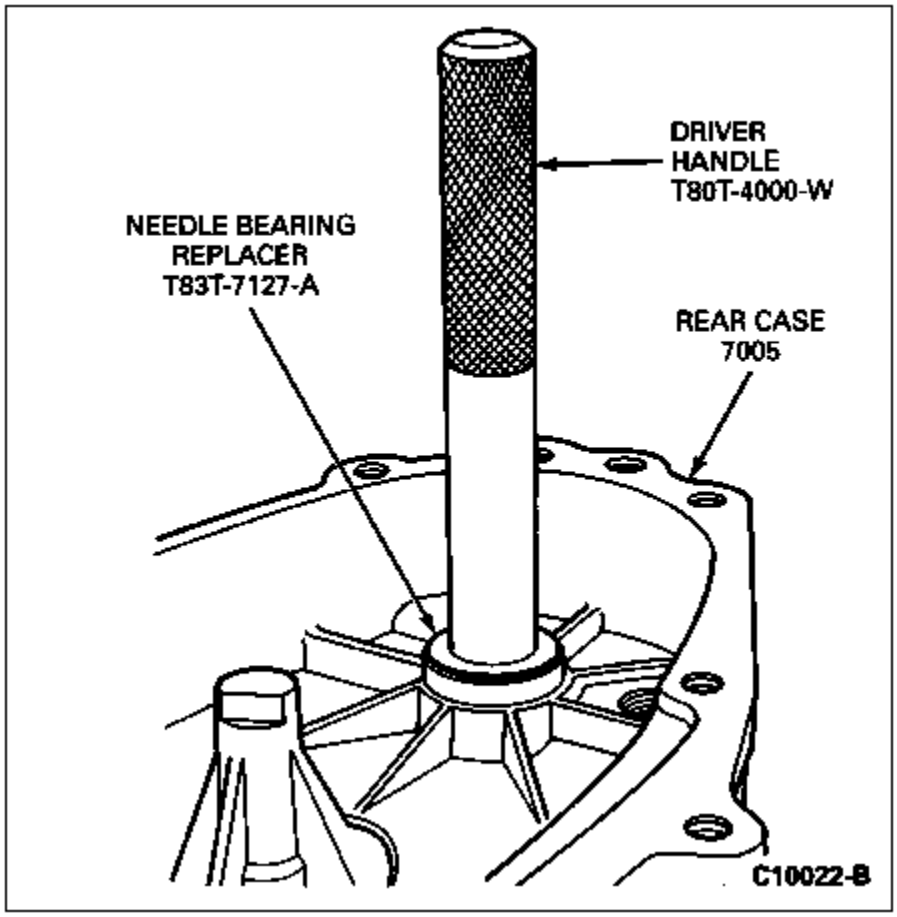
Item	Part Number	Description
1	—	Lockup Hub (Part of 7D164)
2	7917	Snap Ring
3	7D164	Lockup Collar
4	7D126	Lockup Spring
5	7106	Lockup Sleeve

25. Install the 2W-4W shift fork and lockup over the output shaft and onto the shift rail.

26. Install the lockup hub to the output shaft.

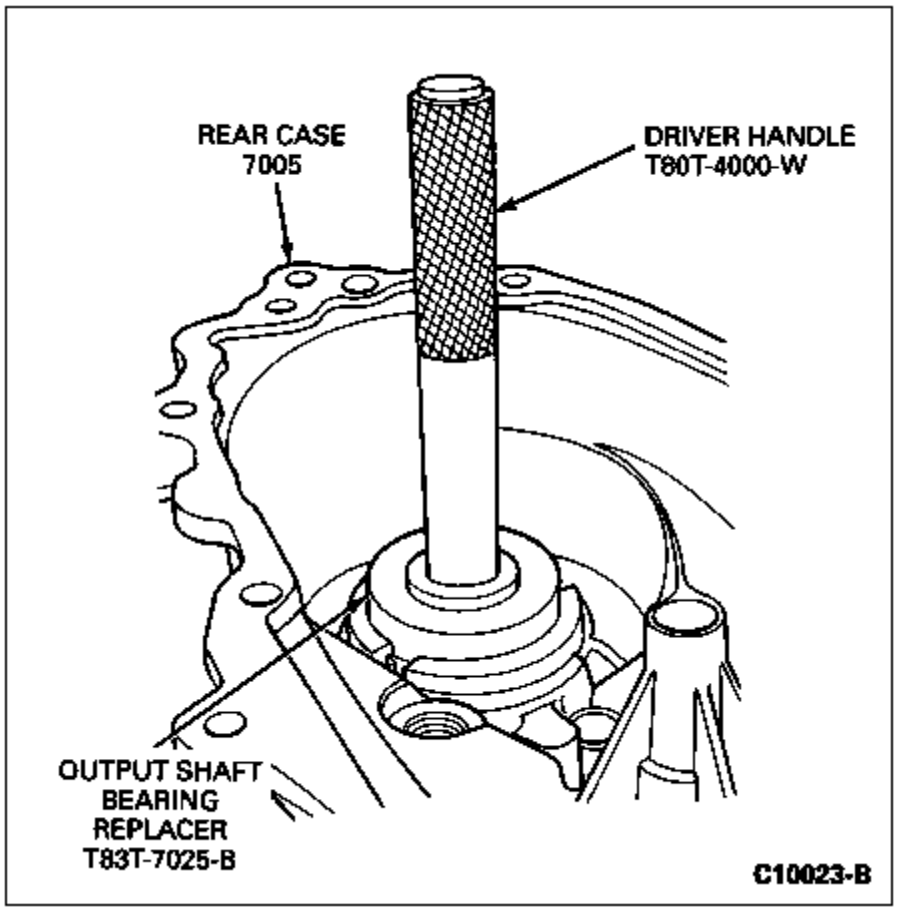
27. If removed, drive the caged needle bearing into the rear case bore with Needle Bearing Replacer

T83T-7127-A and Driver Handle T80T-4000-W.



28. If removed, install the bearing in the rear case bore. Drive the bearing into the rear case bore with Output Shaft Bearing Replacer T83T-7025-B and Driver Handle T80T-4000-W. Make sure the bearing is not cocked in the bore.

29. Install the internal snap ring that retains the bearing to the case.



30. Prior to the final assembly of rear case to front case half, the transfer case shift shaft should be shifted into the 4H detent position to ensure positioning of the shift rail to the rear case.

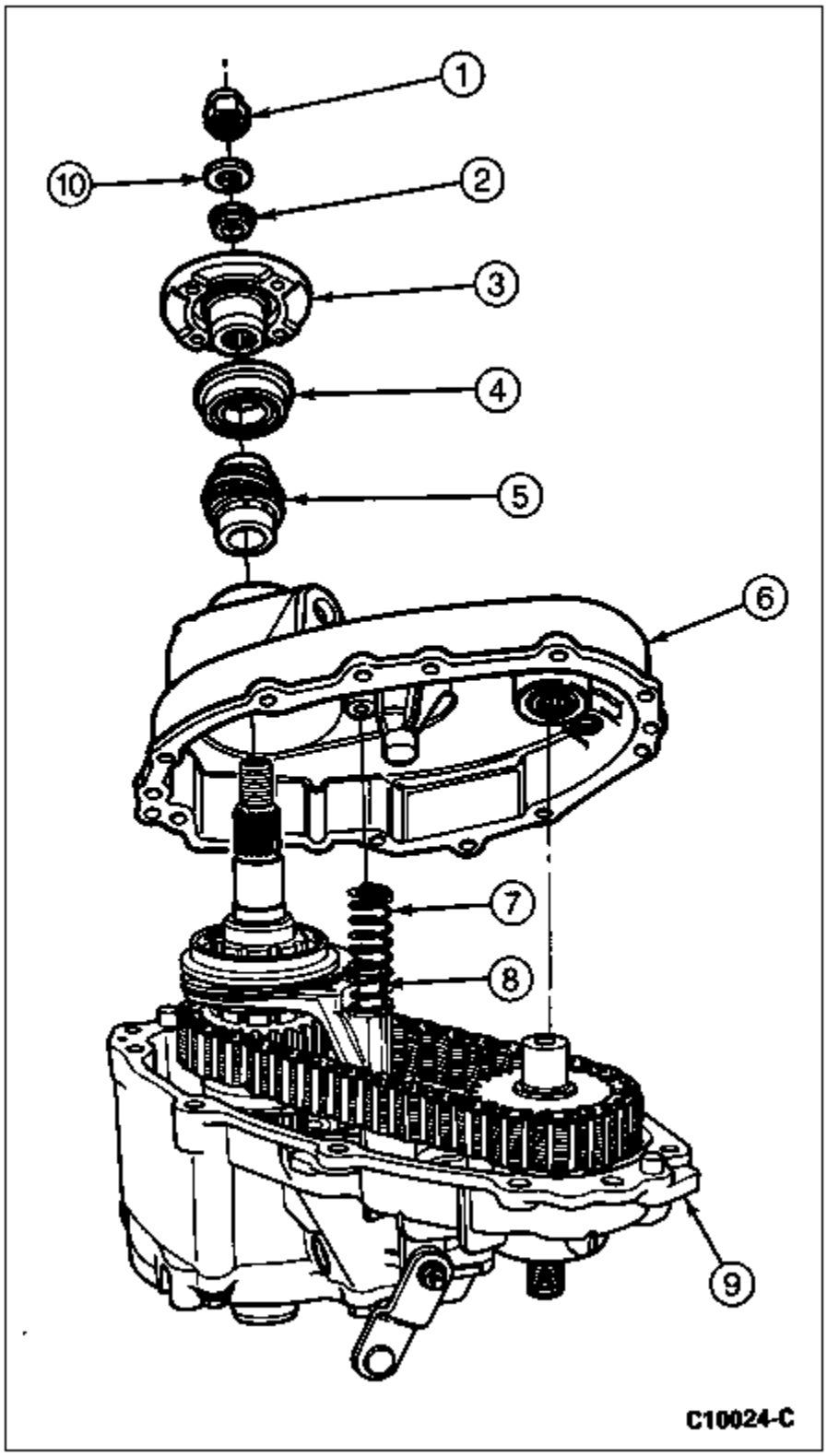
31. Coat the mating surface of the front case with a bead of Black Non-Acid Cure Silicone Rubber E7TZ-19562-A or equivalent meeting Ford specification ESL-M4G273-A.

32. Install the lockup return spring to the shift rail and shift fork with lockup return spring mounted in a vertical position.

33. **NOTE: If the rear case does not seat properly, move the rear case up and down slightly to permit the end of the shift rail to enter the shift rail hole in the rear case boss or tap the output shaft with a sharp blow using a rubber mallet in a direction away from the output shaft while pushing down on the rear case.**

    Position the rear case so that the spring boss engages the lockup return spring and shift rail. Install the nine bolts starting with the bolts on the rear case. Install the wiring harness bracket. Tighten bolts to 31-41 Nm (23-30 lb-ft).

34. Install the speedometer drive gear into the rear case bore. Drive the yoke to flange seal into the rear case bore with the Output Shaft Seal Replacer T83T-7065-B and Driver Handle T80T-4000-W.



Item	Part Number	Description
1	7045	Output Shaft Nut
2	7052	Input Shaft Seal

3	7B214	Case Yoke
4	7B215	Yoke to Flange Seal
5	17285	Speedometer Drive Gear
6	7005	Case (Rear)
7	7219	Lockup Return Spring
8	7240	Shift Rail
9	7005	Case (Front)
10	7B368	Output Shaft Yoke Washer

35. Install the rear case yoke on the output shaft. Install the rubber seal, output shaft yoke washer and lock nut. Tighten the nut to 339-380 Nm (250-280 lb-ft).

36. Install the frontcase yoke, rubber seal, output shaft yoke washer and locknut to the output shaft. Tighten nut to 203-244 Nm (150-180 lb-ft).

37. Install the four-wheel drive indicator switch with Teflon® tape and tighten to 35-48 Nm (26-35 lb-ft).

38. Install the drain plug and tighten to 19-30 Nm (14-22 lb-ft).

39. Place a 3/8-inch drive ratchet in the fill plug and remove the plug. Fill the transfer case with 1.2 liters (2.5 U.S. pints) of Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX or equivalent MERCON® fluid. Install the fill plug and tighten to 19-30 Nm (14-22 lb-ft).

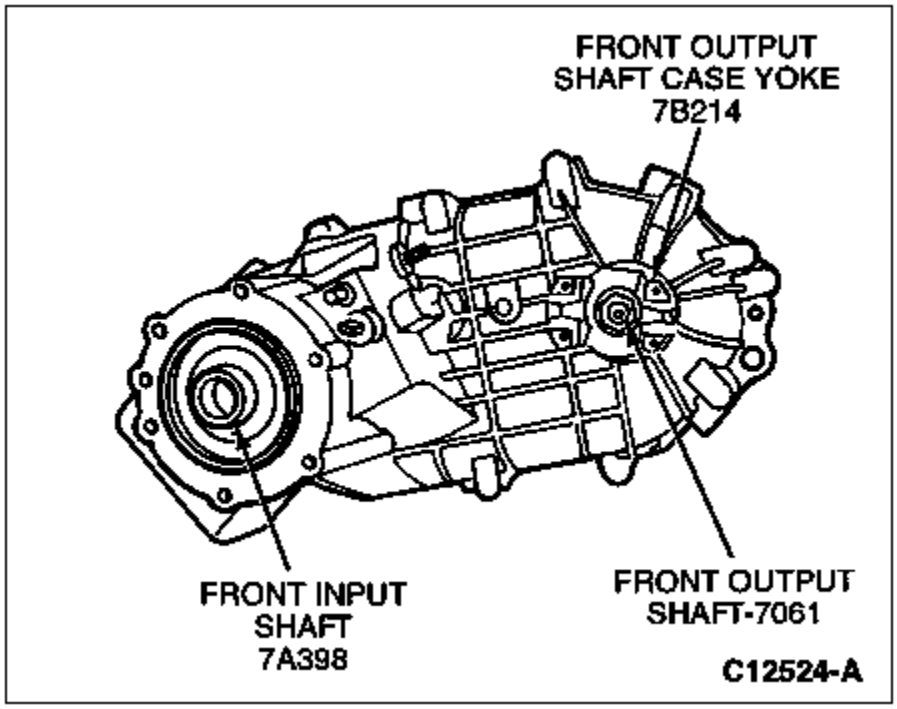
40. Install the transfer case as described in this section.

Fluid Level Check

Transfer Case

Remove the fill plug from the rear transfer case. Fluid level should be just below the fill plug. If the fluid is below the level, fill with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX or equivalent MERCON® fluid to correct level.

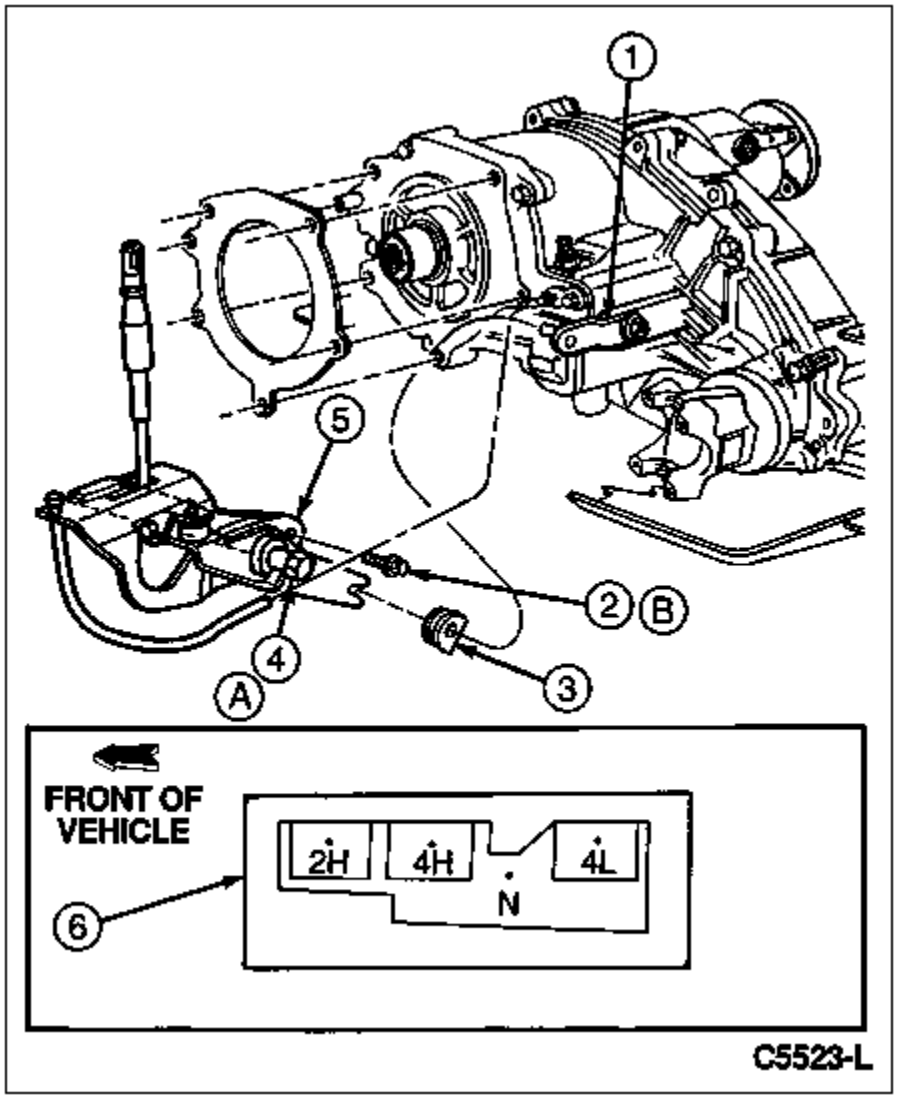
CAUTION: If the proper fill procedures are not followed, transfer case failure could result.



Linkage Adjustment

If partial or incomplete engagement of the transfer case shift lever detent occurs, or should the transfer case control assembly require removal, refer to the following procedure:

1. Raise the shift boot to expose the top surface of the cam plate.
2. Loosen bolts "A" and "B" approximately one turn. Move the transfer case shift lever to the 4L position (lever in rearmost position on cam plate as shown by the arrow).
3. Rotate the cam plate clockwise around bolt "A" until the bottom chamfered corner of the neutral lug just contacts the forward right edge of the shift lever.
4. Hold the cam plate in this position and tighten bolt "A" **first** to 94-122 Nm (70-90 lb-ft). Then tighten bolt "B" to 43-56 Nm (32-42 lb-ft).
5. Move the transfer case in-cab shift lever to all shift positions to check for positive engagement. There should be clearance between the shift lever and cam plate in the "2H" front "4H" rear (clearance not to exceed 3.30mm or 0.13 inch), and "4L" shift positions.
6. Lower the shift boot assembly onto the cam plate.



Item	Part Number	Description
1	7B106	Transfer Case Shift Lever in 4L Position
2	383107-S100	Bolt
3	7335	Gearshift Lever Socket Bushing
4	389240-S	Bolt
5	7210	Gearshift Lever
6	7F087	Cam Plate
A	—	Tighten to 94-122 Nm (70-90 Lb-Ft)
B	—	Tighten to 43-56 Nm (32-42 Lb-Ft)

SPECIFICATIONS

BORG-WARNER 13-54 TRANSFER CASE, LUBRICANT CAPACITY

Lubricant	Capacity		
	Liters	Imperial Pints	U.S. Pints
Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid, XT-2-QDX or -DDX or Equivalent	1.2	2.1	2.5

TORQUE SPECIFICATIONS

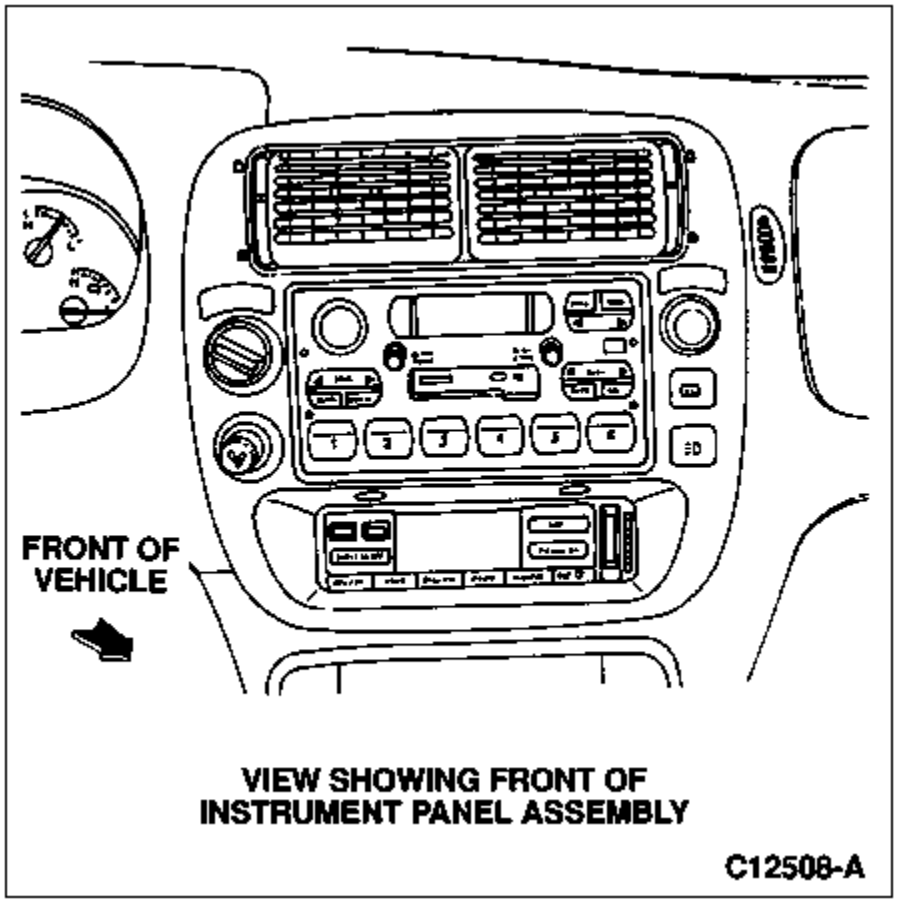
Description	Nm	Lb-Ft	Lb-In
Breather Vent	8-19	6-14	—
Case to Cover Bolts	31-41	23-30	—
Drain and Fill Plug	19-30	14-22	—
Four-Wheel Drive Indicator Switch	35-48	26-35	—
Front Driveshaft Yoke Bolts	16-22	12-16	—
Rear Driveshaft Flange Bolts	83-118	61-87	—
Shift Control Bolts — Large (A)	94-122	70-90	—
Shift Control Bolts — Small (B)	43-56	32-42	—
Shift Shaft and Shift Cam Set Screw	7-10	—	60-84
Shift Lever Nut	26-35	19-26	—
Skid Plate to Frame Bolt	20-27	15-20	—
Transfer Case to Transmission Adapter	35-48	26-35	—
Rear Output Shaft Flange	339-380	250-280	—
Front Output Shaft Yoke Nut	203-244	150-180	—
Speedometer Screw	2-3	—	20-25
Damper	35-48	26-35	—
Floor Pan Opening Cover	5-9	—	48-78
Mounting Adapter to Front Case	31-41	23-30	—

BORG-WARNER 13-54 TRANSFER CASE

Shift Control System, Electronic

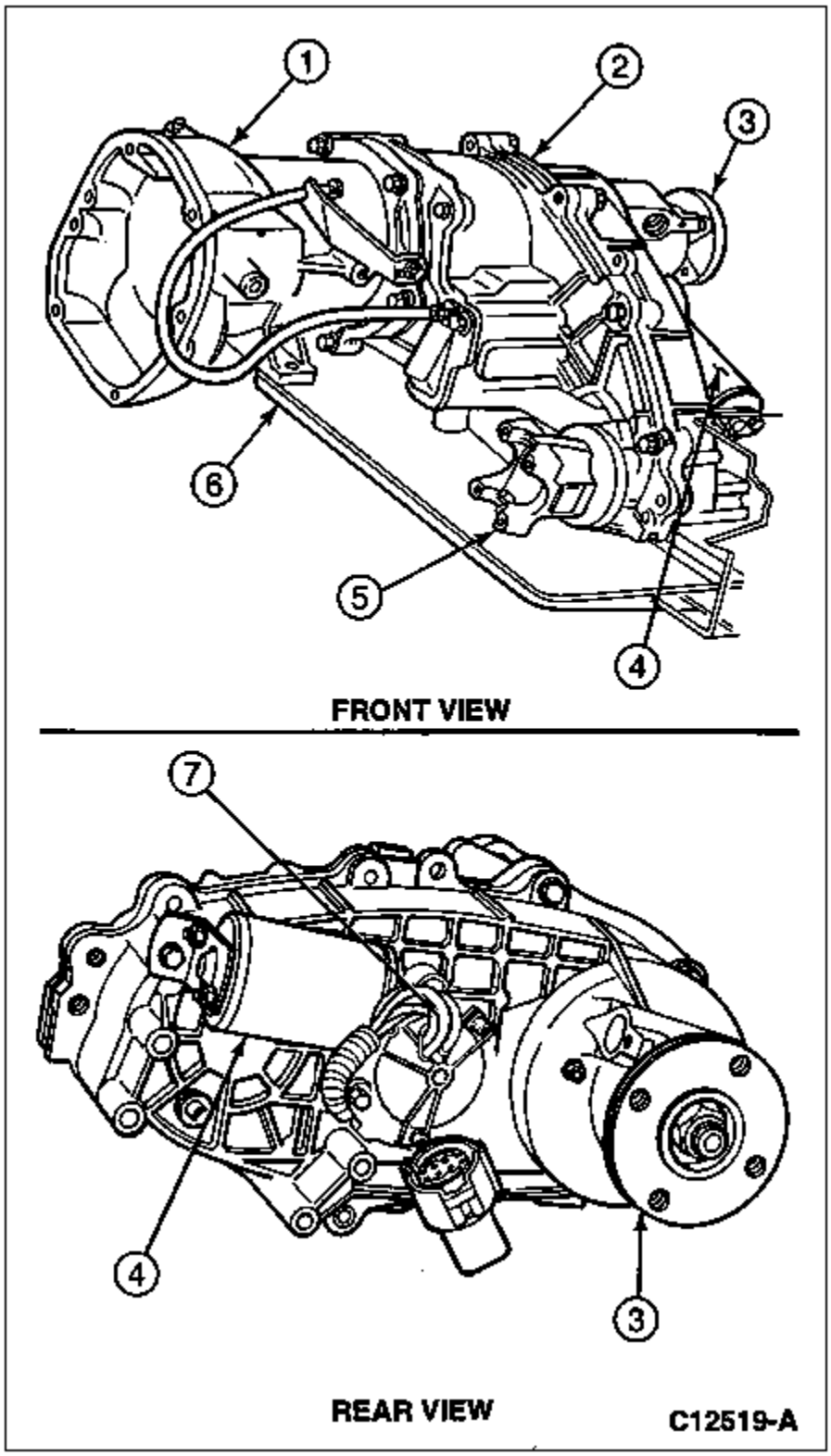
Four-wheel drive mode is selected using a rotary switch located on the instrument panel. With the vehicles ignition on, the on-board controller verifies and matches the transfer case shift motor position (i.e., 2WD, 4WD or 4WD Low) to the switch.

NOTE: To shift in and out of 4WD low, three initial conditions must be met before the shift will occur. The automatic transmission must be in neutral or the manual clutch depressed and the brake must be applied and vehicle speed must be less than 5 km/h (3 mph).



Shift Motor, Electric

The electric shift transfer case shift motor (7G360), mounted externally at the rear of the transfer case (7A195), drives a rotary helical cam which moves the 2W-4W shift fork and 4H-4L reduction shift fork to the selected vehicle drive position. An integral position sensor provides information to the electronic module on current motor position.



Item	Part Number	Description
1	7A039	Extension Housing
2	7A195	Transfer Case

3	7B214	Case Yoke, Rear
4	7G360	Transfer Case Shift Motor
5	7B214	Case Yoke, Front
6	7E063	Skid Plate
7	—	Shift Position Sensor (Part of 7G360)

Transmission Range (TR) Sensor

The TR sensor is transmission-mounted.

The Digital Transmission Range (TR) Sensor is located on the outside of the transmission at the manual lever. The TR sensor completes the start circuit in Park and Neutral, the Back-Up Lamp circuit in Reverse and Neutral Sense circuit (4x4 ONLY) in Neutral. The TR Sensor also sends a Digital Output signal to the Powertrain Control Module (PCM) indicating the position of the manual lever (P, R, N, D, 2, 1).

For diagnosis of the Digital Transmission Range (TR) Sensor, refer to Section 07-01B .

Clutch Pedal Position Switch

The clutch pedal position switch is located on the clutch pedal bracket. On vehicles equipped with manual transmission/transaxles (7002) and electric shift transfer cases, the clutch pedal must be fully depressed with vehicle stopped in order to make a range shift from 4H or 4L, or from 4L to 4H.

Brake Switch

The brake switch is located on the brake pedal. The brake must be depressed in order to make a range shift from 4WD high to 4WD low or back.

Rotary Control Switch

The rotary control switch is located on the instrument panel. The switch consists of a knob with a nighttime illuminated pointer. The switch is used to select 2WD, 4WD high or 4WD low. The dash indicator light will illuminate when the 4WD high or low positions are engaged.

Control Module, Electronic

The electronic control module controls the operation of the transfer case (7A195) in response to inputs from the brake switch, the Transmission Range (TR) sensor clutch interlock switch and electric shift transfer case shift motor (7G360) through driver actuation of the rotary control switch.

Transfer Case

The Borg-Warner 13-54 Shift Transfer Case transfers power from the transmission/transaxle (7002) to the rear axle assembly (4006) and to the front axle when actuated. The 13-54 provides LOW RANGE driving. This system has no selectable neutral.

Mechanical Operation

In the 4x2 mode, torque from the transmission (7003) is transferred to the input shaft (7017) , which in turn drives the rear output shaft that drives the rear axle assembly (4006).

The 2W-4W shift is accomplished through the shifting of 2W-4W lockup collar, to engage the drive sprocket on the rear output shaft. The drive sprocket turns the chain which turns the driven sprocket on the front output shaft and the front driveshaft.

The high-low shift is accomplished when the high-low shift fork moves the high-low reduction collar to engage the front planet (7A398) to the output shaft. Torque from the input shaft is then transmitted through the sun gear, which then turns the front planet. The front planet, which is now engaged to the output shaft, provides a reduction.

Electronic Shift Operation

The transfer case (7A195) is equipped with a magnetic clutch, similar to an air conditioning compressor clutch, which is located inside the transfer case adjacent to the 2W-4W shift collar. The clutch is used to spin up the front drive system from zero to vehicle speed in milliseconds. This spin-up allows the shift between 2-high and 4-high to be made at any vehicle speed. When the transfer case rear and front output shafts reach synchronous speed, the spring-loaded shift collar mechanically engages the hub of the output shaft to the chain drive sprocket and the magnetic clutch is then deactivated. Shifts between 4-high and 4-low can only occur with the clutch interlock switch or digital transmission range (DTR) sensor and the brake switch closed. The vehicle's speed must also be within specified limits as determined by the transfer case speed sensor (5 km/h [3 mph or under]).

When the operator selects the drive combination through the rotary control switch, an electric motor turns a helical-cam, which is linked to the high-low and 2W-4W shift forks through fork-mounted roller and bushing assemblies. As the electric motor turns the helical-cam, the high-low fork bushing rides in a slotted lobe in the cam to make the low-high or high-low range change; and the 2W-4W fork bushing rides on lobes at the end of the cam to make the 2W-4W or 4W-2W shift.

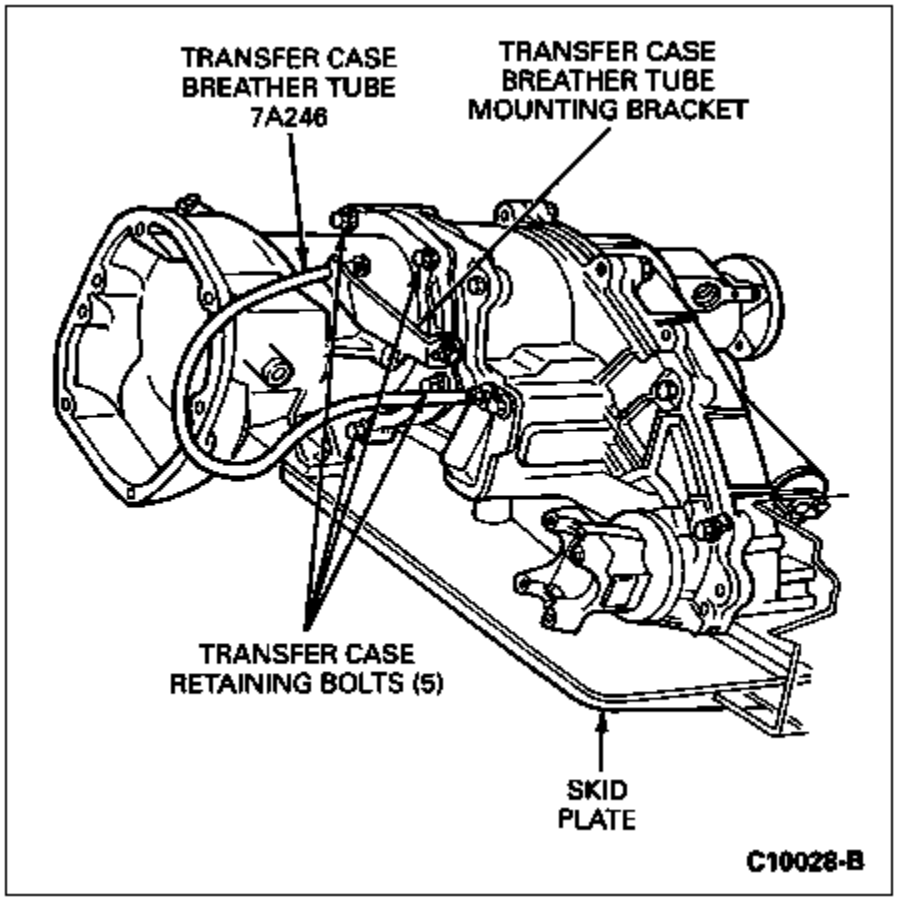
The unit is lubricated by a gerotor oil pump that channels oil through the bore in the transfer case rear output shaft.

Transfer Case, Electronic Shift

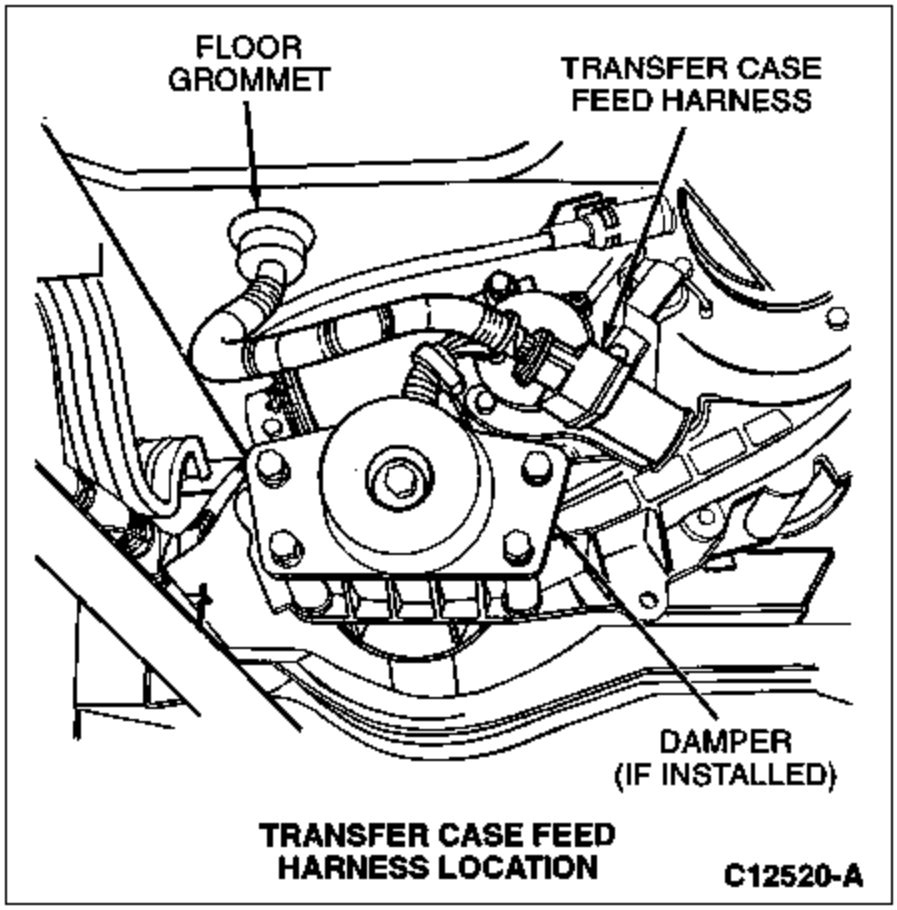
Removal

CAUTION: The three way catalytic converter (TWC) (5E212) is located beside the transfer case (7A195). Be careful when working around the three way catalytic converter because of the extreme high temperatures generated by the three way catalytic converter.

1. Raise the vehicle on a hoist and position suitable safety stands under vehicle.
2. Remove skid plate from frame (5005), if equipped.



3. Remove the damper from the transfer case, if equipped.

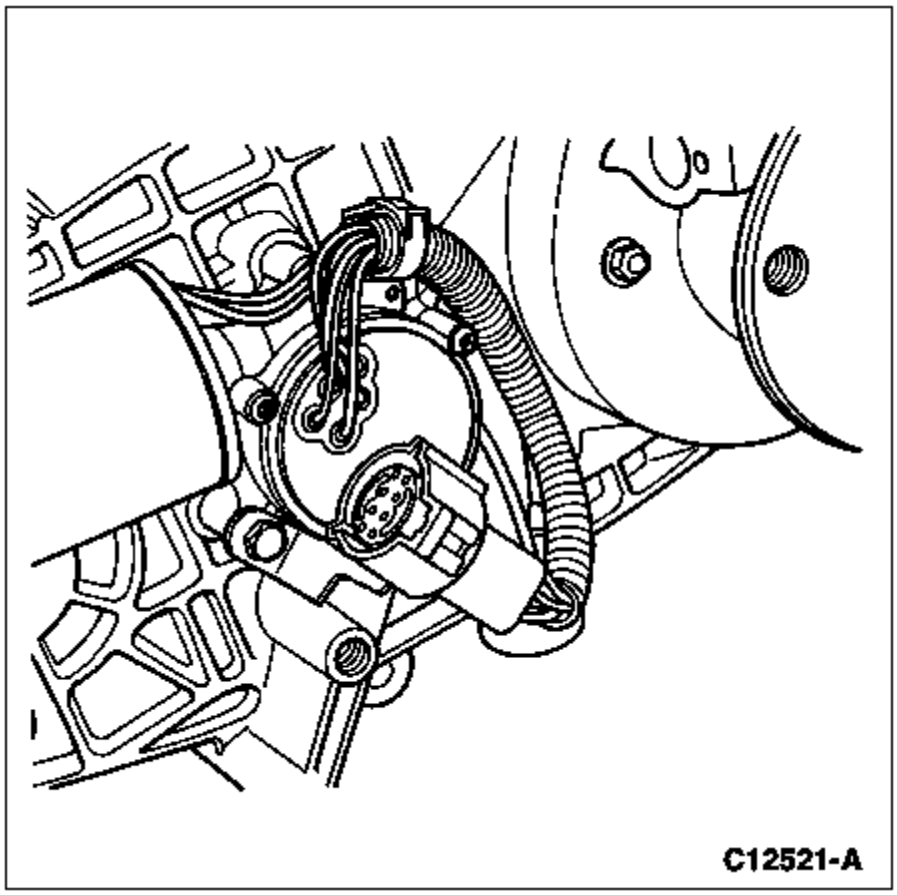


4. **NOTE: Drain transfer case only if transfer case disassembly is required.**

   Place a drain pan under the transfer case. Remove the drain plug and drain the fluid from the transfer case.

5. **CAUTION: Do not pull directly on the wires or pull outwardly on the locking tabs.**

   Remove the wire connector from the feed wire harness at the rear of the transfer case. First squeeze the locking tabs, then pull the connectors apart. Remove the connector for the transfer case shift motor (7G360) from the mounting bracket.



6. **NOTE: For detailed instruction on front and rear driveshaft (4602) removal and installation, refer to Section 05-01 .**

   Disconnect the front driveshaft from the front case yoke (7B214) and wire the driveshaft out of the way.

7. Disconnect the rear driveshaft from the rear case yoke and wire the driveshaft out of the way.

8. Disconnect the speedometer cable from the rear case (7005).

9. Disconnect the transfer case breather tube from the mounting bracket if required.

10. Support the transfer case with Rotunda Hi-Lift Jack 014-00942 (with Transfer Case Adapter 014-00213) or equivalent.

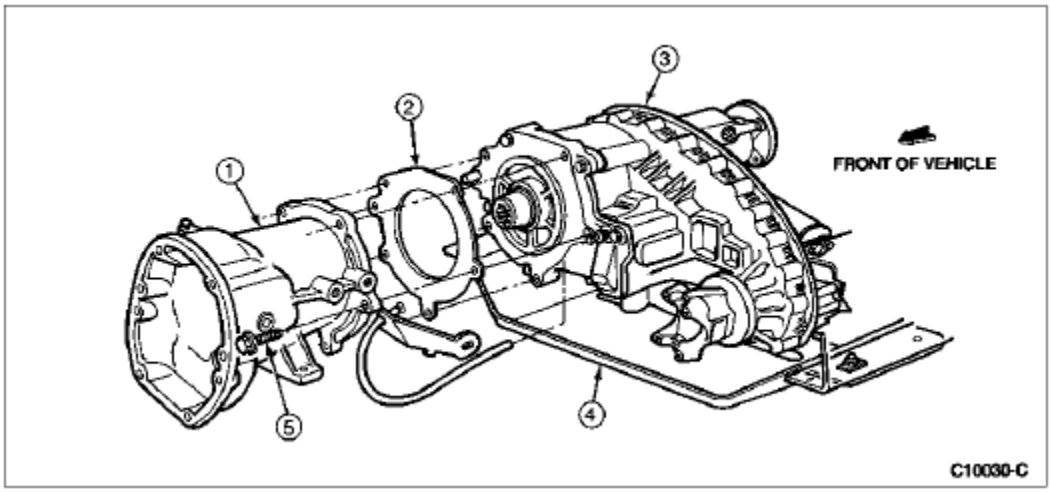
11. Remove the five bolts retaining the transfer case to the transmission (7003) and the extension housing (7A039).

12. Slide the transfer case rearward off the transmission output shaft and lower the transfer case from the vehicle. Remove the extension housing gasket (7086) from the transfer case and transmission case area. Clean gasket surfaces before transfer case is reinstalled.

Installation

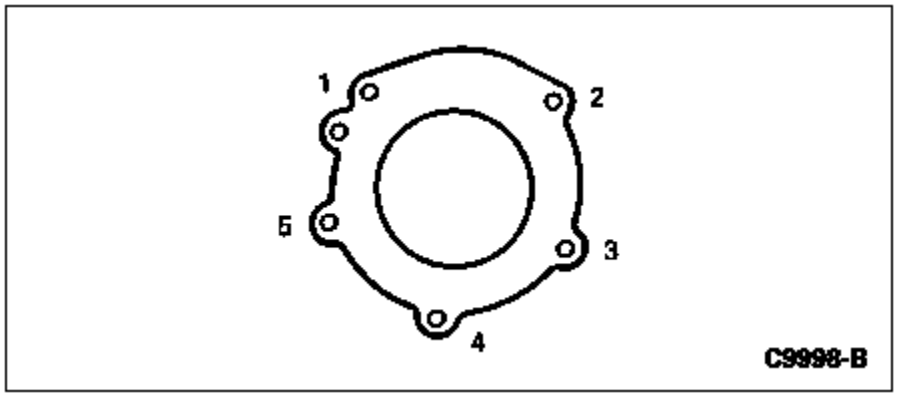
1. Place a new extension housing gasket on the front mounting face of the transfer case. If necessary, apply a small amount of grease to the extension housing gasket to hold it in place during assembly.

Transfer Case, 13-54 Electronic Shift, Installation



Item	Part Number	Description
1	7A039	Extension Housing
2	7086	Extension Housing Gasket
3	7A195	Transfer Case
4	7E063	Skid Plate
5	N605804	Transfer Case Retaining Bolt

2. Raise the transfer case with the Hi-Lift Jack 014-00942 (with Transfer Case Adapter 014-00213) so that the transmission output shaft aligns with the splined input shaft (7017). Slide the transfer case forward onto the transmission output shaft and onto the dowel pin. Install the five transfer case retaining bolts to the extension housing. Tighten the bolts to 34-48 Nm (25-35 lb-ft) in the sequence shown.



3. Remove the transmission jack from the transfer case.
4. If removed, install the transfer case breather tube so that the white marking on the transfer case breather tube aligns with the notch in the mounting bracket.
5. Connect the speedometer cable to the rear case. Tighten the bolt (7A443) to 2-3 Nm (18-27 lb-in).
6. Connect the rear driveshaft to the case yoke. Tighten the bolts to 83-118 Nm (61-87 lb-ft).
7. Connect the front driveshaft to the case yoke. Tighten the bolts to 16-22 Nm (12-16 lb-ft).
8. Attach the connector for the transfer case shift motor to the mounting bracket.
9. Connect the wire connectors on the rear of the transfer case, making sure that the retaining tabs lock.
10. Check transfer case fluid level. If transfer case was drained during removal procedure, install the drain plug and tighten to 19-30 Nm (14-22 lb-ft). Remove the fill plug and install Motorcraft Mercon® Multi-Purpose Automatic Transmission Fluid WSP-M2C185-A or equivalent to the bottom of the fill hole. Install fill plug and tighten to 19-30 Nm (14-22 lb-ft).
11. Install the damper (if so equipped) using new bolts. Tighten the damper bolts to 34-48 Nm (25-35 lb-ft). If new bolts are not available, coat the threads of the used bolts with Ford Threadlock 262 meeting Ford specification WSK-M2G315-A5 Type II or equivalent and install. Tighten bolts to 34-48 Nm (25-35 lb-ft).
12. Install the skid plate, bolts and nuts to the frame and tighten to 20-27 Nm (15-20 lb-ft).
13. Remove safety stands and lower the vehicle.

Oil Seal, Output Shaft, Rear

Removal

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Impact Slide Hammer	T50T-100-A
Output Shaft Seal Replacer	T83T-7065-B
Driver Handle	T80T-4000-W

1. Raise the vehicle on a hoist and position suitable safety stands under vehicle.
2. Remove the rear driveshaft (4602) from the case yoke (7B214). Wire the driveshaft out of the way.
3. Using a 30mm thin-wall socket, first remove the rear output shaft nut. Then remove the output shaft yoke washer (7B368), rubber seal and case yoke.
4. Remove the yoke to flange seal (7B215) from the rear output housing bore using Impact Slide Hammer T50T-100-A to pop off the yoke to flange seal. Do not damage the bearing, bearing cage or case.

Installation

1. Make sure the output housing bore and face are free from nicks and burrs. Coat the yoke to flange seal with Premium Long-Life Grease XG-1-C or -K or equivalent meeting Ford specification ESA-M1C75-B. Position the yoke to flange seal into the rear output housing bore, making sure that the yoke to flange seal is not cocked in the bore. Drive the yoke to flange seal into the bore with Output Shaft Seal Replacer T83T-7065-B and Driver Handle T80T-4000-W.
2. Install the case yoke, rubber seal, output shaft yoke washer and output shaft nut on the output shaft. Tighten the output shaft nut to 339-381 Nm (250-280 lb-ft).
3. Connect the rear driveshaft to the transfer case (7A195), and tighten the bolts to 83-118 Nm (61-87 lb-ft).
4. Remove safety stands and lower the vehicle from the hoist.

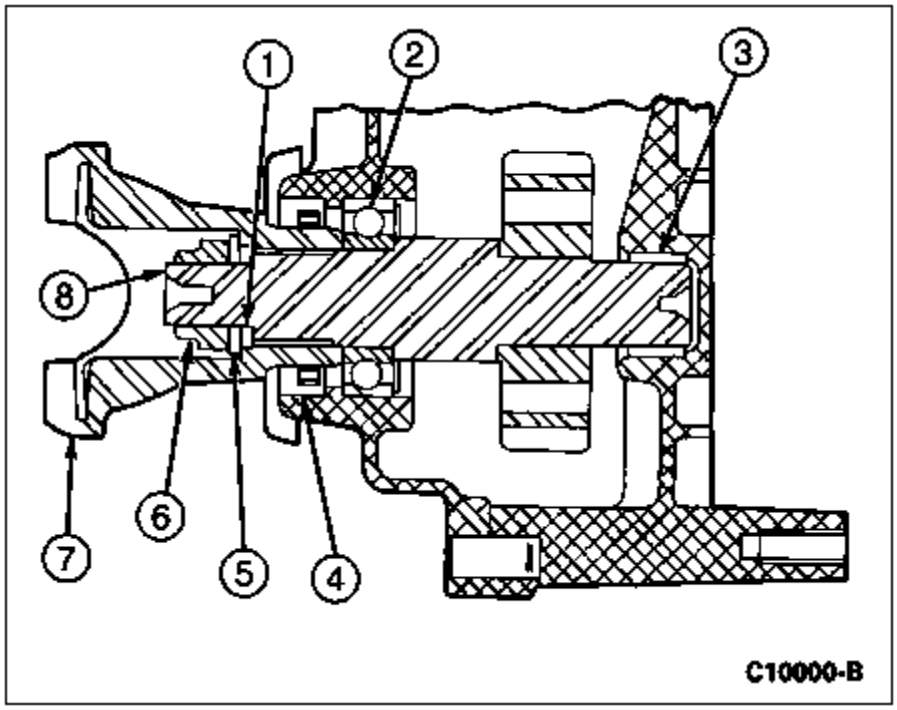
Oil Seal, Output Shaft, Front

Removal

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Output Shaft Seal Replacer	T83T-7065-B
Driver Handle	T80T-4000-W
Impact Slide Hammer	T50T-100-A

1. Raise the vehicle on a hoist and position suitable safety stands under vehicle.
2. If so equipped, remove the nut, bolts and skid plate from the frame.
3. Remove the damper from the transfer case (7A195) if so equipped.
4. Place the drain pan under the transfer case, remove the drain plug and drain the fluid from the transfer case.
5. Remove the front driveshaft (4602) from the output shaft. Wire the driveshaft out of the way.
6. Using a 30mm thin-wall socket, remove the output shaft nut, output shaft yoke washer (7B368), rubber seal and front case yoke (7B214).
7. Remove the yoke to flange seal (7B215) from the front output housing bore by prying and pulling on the curved-up lip of the yoke to flange seal or use the Impact Slide Hammer T50T-100-A to pop off the yoke to flange seal. Do not damage the bearing, bearing cage or case.



Item	Part Number	Description
1	7052	Rubber Seal
2	7025	Bearing
3	7127	Needle Bearing, Front
4	7B215	Yoke to Flange Seal
5	7B368	Output Shaft Yoke Washer
6	7045	Shaft Nut
7	7B214	Case Yoke, Front
8	7061	Output Shaft (Front)

Installation

1. Make sure the housing face and bore are free from nicks and burrs. Coat the yoke to flange seal with Premium Long-Life Grease XG-1-C or -K or equivalent meeting Ford specification ESA-M1C75-B. Position the yoke to flange seal into the front output housing bore, making sure the yoke to flange seal is not cocked in the bore. Drive the yoke to flange seal into the bore with Output Shaft Seal Replacer T83T-7065-B and Driver Handle T80T-4000-W.

2. Install the case yoke, rubber seal, output shaft yoke washer and the nut. Tighten the nut to 250-275 Nm (184-203 lb-ft).

3. Connect the front driveshaft to the case yoke. Tighten the yoke bolts to 16-22 Nm (12-16 lb-ft).

4. Install drain plug and tighten to 19-30 Nm (14-22 lb-ft). Remove fill plug and install Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid WSP-M2C185-A or equivalent to the bottom of the fill hole. Install fill plug to 19-30 Nm (14-22 lb-ft).

5. Install the damper, with new bolts, and tighten the bolts to 34-48 Nm (25-35 lb-ft).

6. If equipped, install the skid plate. Tighten the nuts and bolts to 20-27 Nm (15-20 lb-ft). Remove safety stands and lower the vehicle from the hoist.

4x4 Shift Switch

Removal

1. Remove instrument panel finish panel (044D70). Refer to Section 01-12 for removal and installation procedure.
2. Remove shift control knob.
3. Remove two screws retaining shift control switch.
4. Remove shift control switch.

Installation

1. Install shift control switch.
2. Install two screws retaining shift control switch.
3. Install shift control knob.
4. Install instrument panel finish panel.

Transfer Case, Electronic Shift

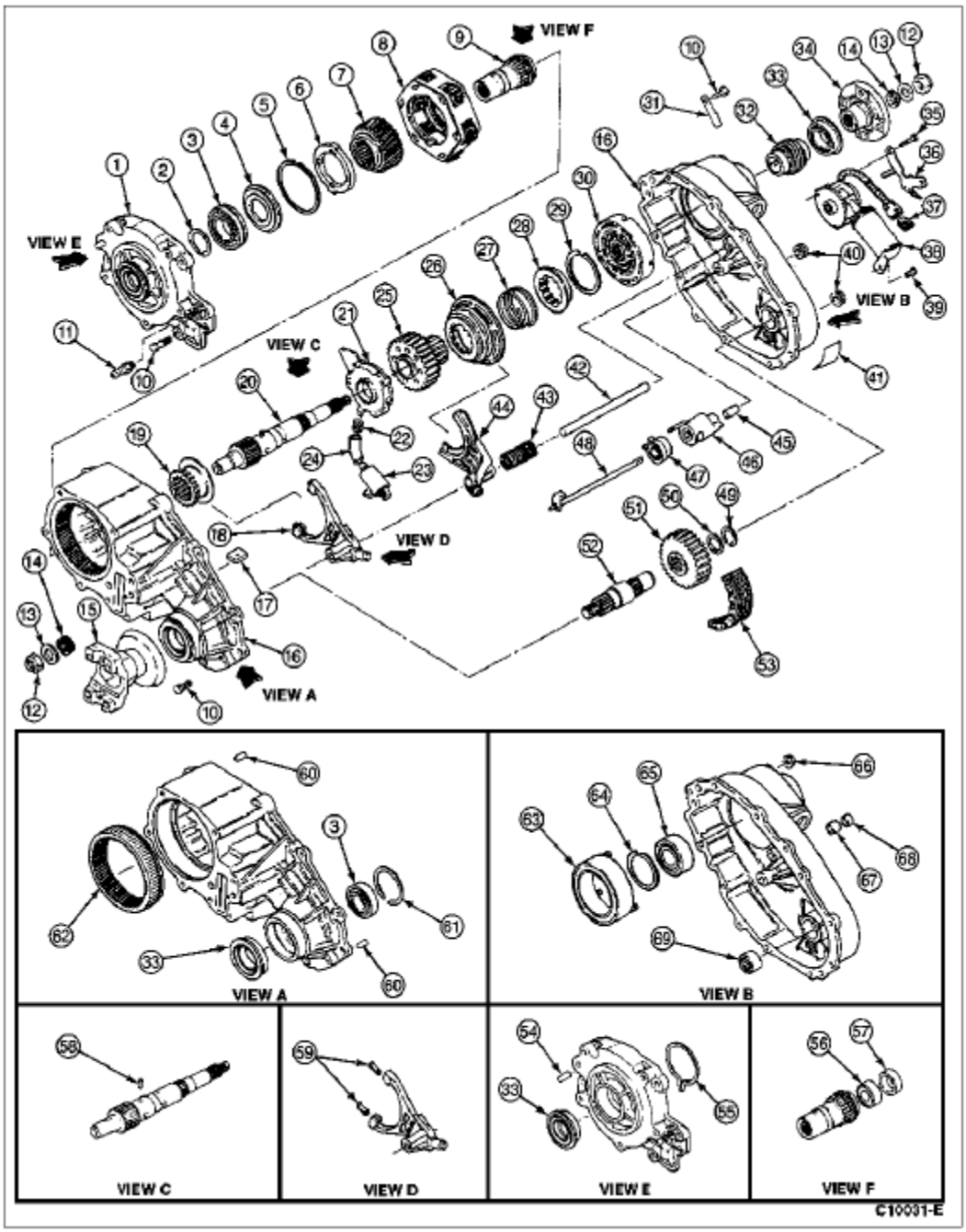
SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Input Shaft Bearing Remover	T91T-7127-A
Impact Slide Hammer	T50T-100-A
Axle Bearing/Seal Plate	T75L-1165-B
Pinion Bearing Cone Replacer	T53T-4621-C
Output Shaft Bearing Replacer	T83-7025-B
Driver Handle	T80T-4000-W
Output Shaft Bearing Replacer	T83T-7065-B
Input Shaft Bearing Replacer	T91T-7127-B
Input Shaft Bushing/Bearing Replacer	T87T-7127-A
Front Shaft Needle Bearing Replacer	T83T-7127-A
Step Plate	D80L-630-3
Puller Collot	D80L-100-S

Disassembly

1. Remove the transfer case (7A195) from the vehicle as outlined, and place on workbench.
2. Using a 30mm thin-wall socket, first remove the rear output nut, case yoke (7B214), yoke to flange seal (7B215), then the output shaft yoke washer (7B368).

Transfer Case, 13-54 Electronic Shift, Disassembled View

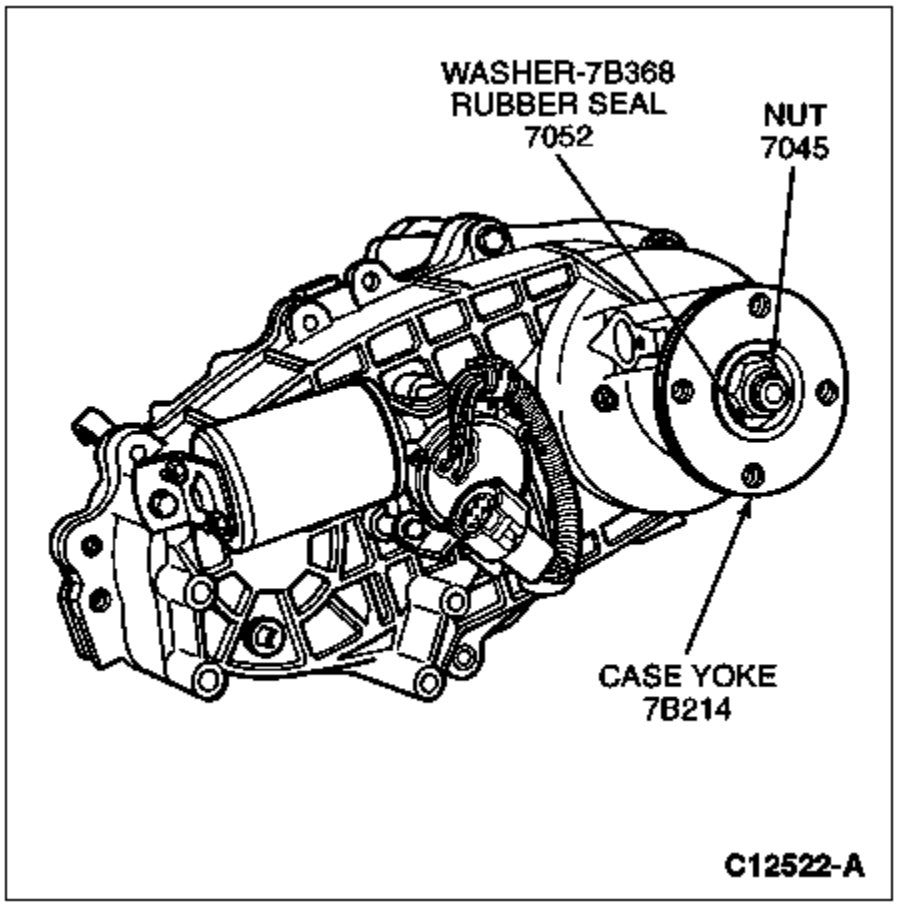


Item	Part Number	Description
1	7050	Main Drive Gear Bearing Retainer (1)
2	7917	Ring, Retaining (1)
3	7025	Bearing (1)
4	7A385	Output Shaft Thrust Washer (1)
5	7C122	Snap Ring (1)
6	7B066	Thrust Plate (1)
7	7D063	Sun Gear (1)

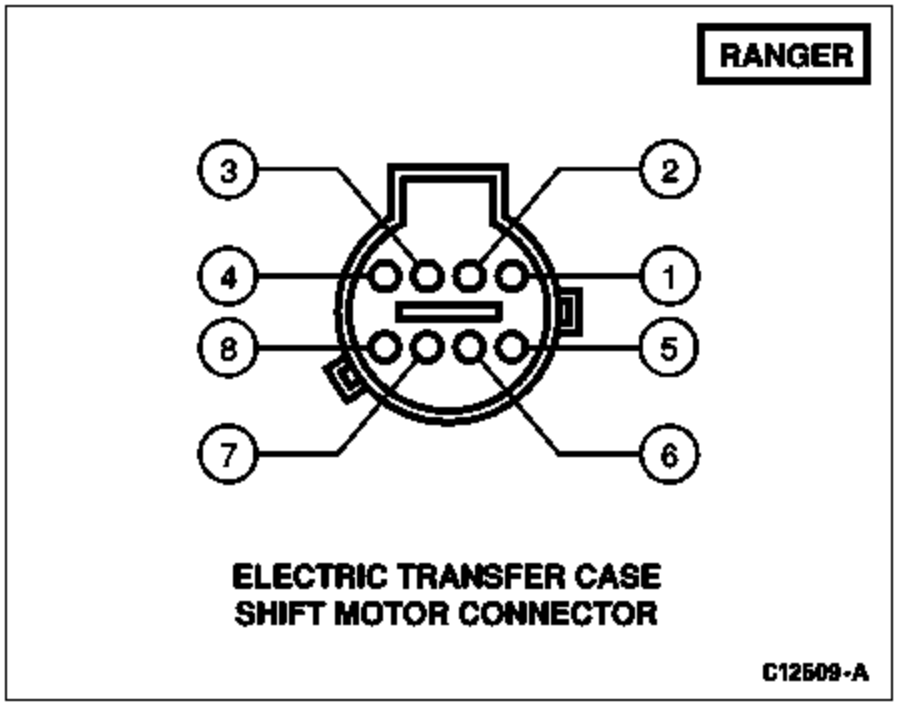
8	7A398	Front Planet (1)
9	7017	Input Shaft (1)
10	7A443	Bolt, Hex-Head (M10 x 1.5 x 30.0) (15)
11	383976	Barb, Breather (1)
12	7045	Nut, Metric (2)
13	7B368	Output Shaft Yoke Washer (2)
14	7052	Seal, Oil (2)
15	7B214	Yoke Assembly (1)
16	7005	Case (2)
17	7L027	Oil Pan Magnet (1)
18	—	Fork, Reduction Shift (1) (Part of 7298)
19	7100	High-Low Collar (1)
20	7061	Shaft, Rear Output (1)
21	7A149	Pump Assembly (1)
22	382846	Clamp, Hose (1)
23	7A098	Strainer, Oil (1)
24	7A210	Hose, Coupling (1)
25	7177	Sprocket, Drive (24T) (1)
26	7106	Lockup Collar (1)
27	7D126	Spring, Sleeve Return (1)
28	7D164	Lockup Hub (1)
29	7917	Snap Ring (1)
30	7G362	Housing, Clutch (1)
31	—	Tag, Identification (1) (Part of 7003)
32	17285	Speedometer Drive Gear (1)
33	7B215	Yoke to Flange Seal (1)
34	7B214	Case Yoke (2)
35	N800670	Bolt, Hex-Head (3)
36	7K470	Bracket, Speed Sensor and Wiring Harness (1)
37	—	Wire Connector Spacer (Part of 7G360)
38	7G360	Transfer Case Shift Motor (1)
39	N802503	Bolt, Hex-Head (1)
40	87675	Plug, Pipe (1/2-14) (Not Serviced as Part of Index No. 17) (2)
41	—	Broadcast Code Decal (Part of 7005)
42	7240	Shift Rail (1)

43	7219	Lockup Return Spring (1)
44	7289	Fork, Lockup (1)
45	7Z112	Spacer (1)
46	7F063	Cam, Electric Shift (1)
47	7W074	Spring, Torsion (1)
48	7N095	Shaft, Shift (1)
49	7917	Snap Ring (1)
50	7119	Thrust Washer (1)
51	7177	Sprocket, Driven (24T) (1)
52	7061	Output Shaft, Front (1)
53	7A029	Chain, Drive (1)
54	—	Pin, Spiral (1) (Part of 7050)
55	7917	Snap Ring (1)
56	7025	Bearing (1)
57	7065	Output Shaft Bearing (1)
58	7B362	Pin, Spring (1)
59	7C430	Facing, Shift Fork (2)
60	—	Pin, Dowel (2)
61	7917	Snap Ring (1)
62	7A153	Ring Gear (1)
63	7G361	Coil Assembly, Clutch (1)
64	7917	Snap Ring (1)
65	7025	Bearing (1)
66	N620480	Nut, Hex (3)
67	7W073	Bearing, Sleeve-Self Lube (1)
68	7B216	Seal, Oil (1)
69	7127	Bearing, Needle Front Output (1)

3. Using a 30mm thin-wall socket, remove the front output nut, then the output shaft yoke washer, rubber seal and case yoke.



4. Remove the two bolts from the connector bracket and remove the bracket.



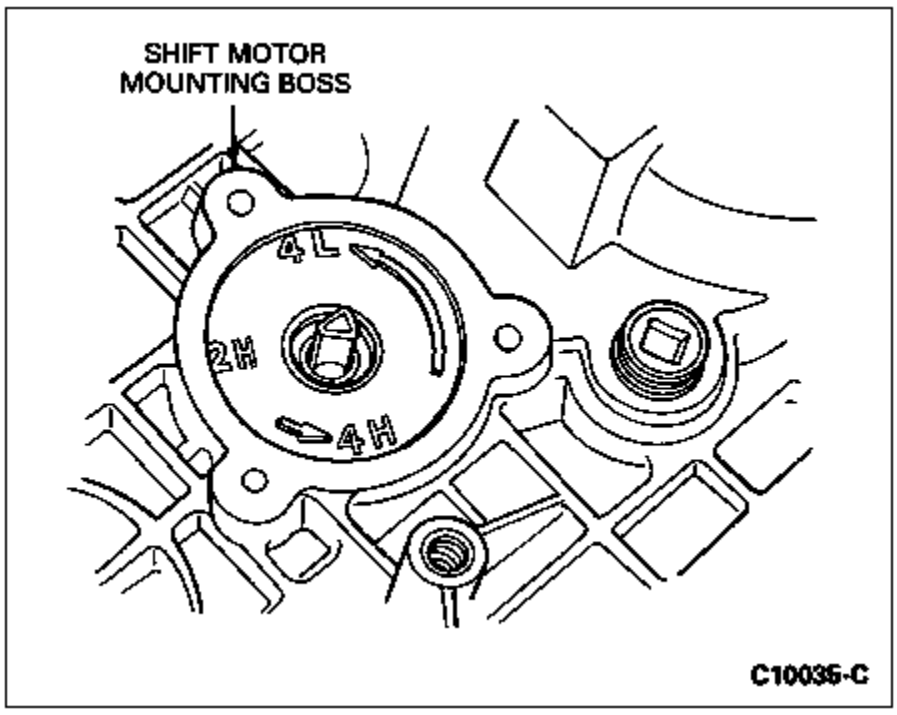
Pin Number	Circuit	Circuit Function
1	770 (W)	Electrical Shift 4x4 Module to Motor Position B
2	764 (BR/W)	Electrical Shift 4x4 Module to Motor Position C
3	763 (O/W)	Electrical Shift 4x4 Module to Motor Position D
4	777 (Y)	Electrical Shift 4x4 Module to Motor Control Counterclockwise
5	772 (P/Y)	Electrical Shift 4x4 Module to Motor Position A
6	762 (Y/W)	Electrical Shift 4x4 Module to Motor Position Return
7	778 (O)	Electrical Shift 4x4 Module to Motor Control Clockwise
8	779 (BR)	Electrical Shift 4x4 Module to Electric Clutch

5. Remove the brown wire from the No. 8 position in the connector by grasping the back plate of the connector body and pulling.

6. Remove the remaining bolt retaining the transfer case shift motor (7G360) to the rear case (7005) and remove the transfer case shift motor. Note the position of the triangular shaft extending out of the rear case and the triangular slot in the transfer case shift motor.

7. **CAUTION: When removing the RTV sealant, use care not to damage the mating surfaces of the rear case and motor mounting face.**

   Remove all traces of RTV gasket sealant from the mating surfaces of the rear case and the motor mounting face.

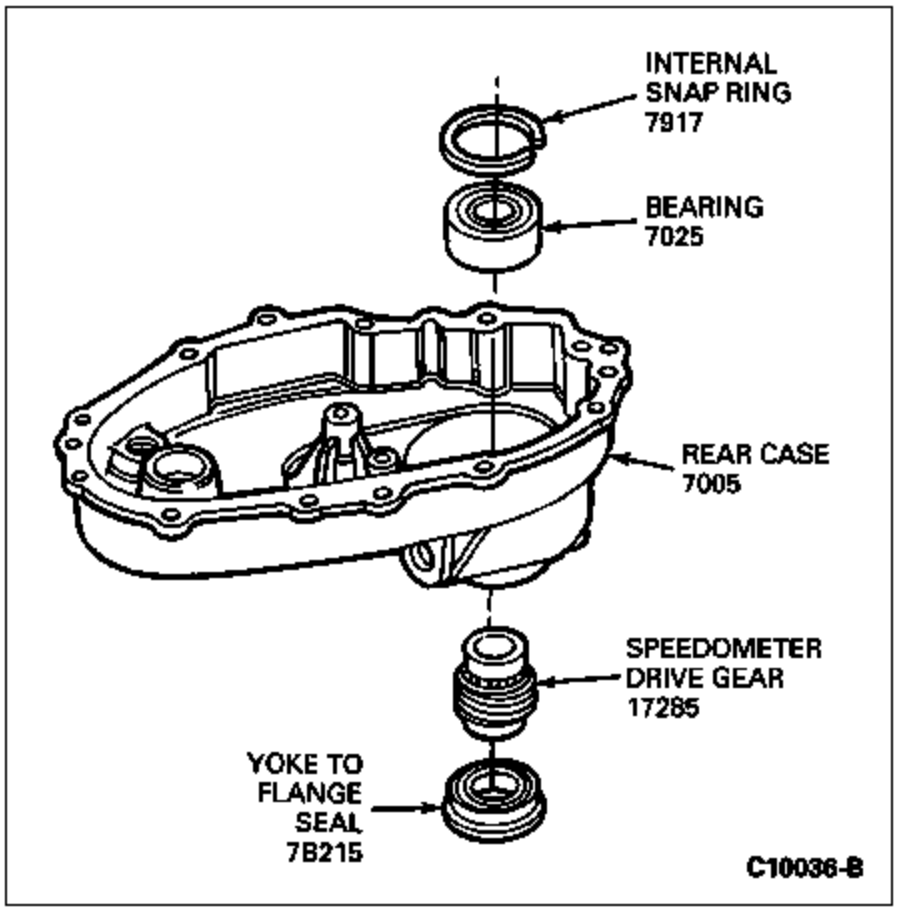


8. **CAUTION: The transfer case shift motor is serviced as a complete assembly. Do not remove the screws that secure the rear case to the motor gear housing.**

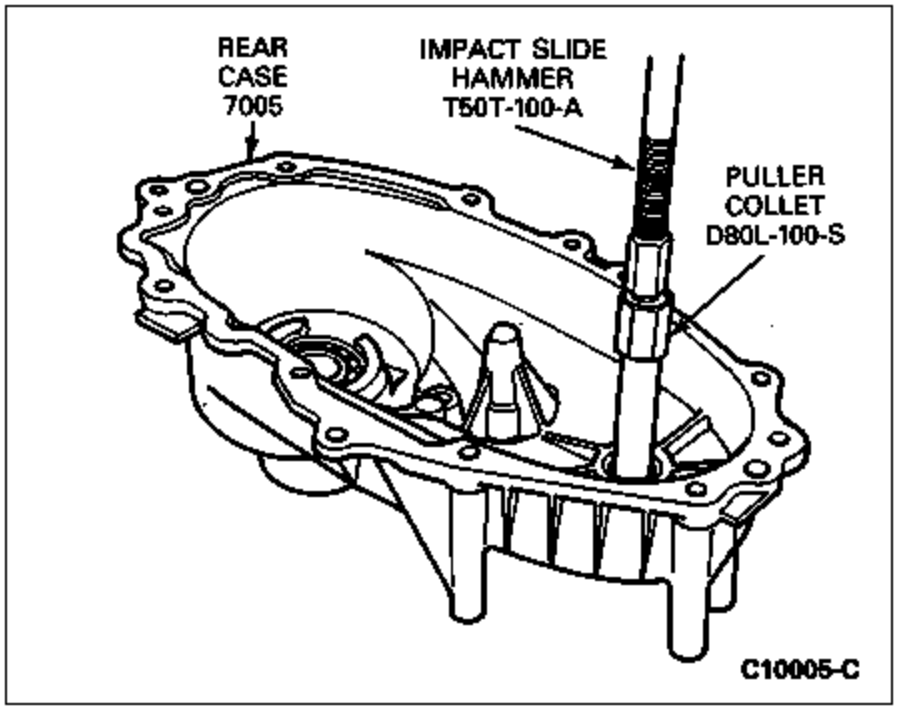
   Remove the nine bolts that retain the front case to the rearcase. Make sure that the front case is facing downward so that the rear cover is facing upwards. Insert a breaker bar between the pry bosses and separate the front case from the rear case. Remove all traces of RTV Gasket Sealant from the mating surfaces of the front case and rear case.

9. If the speedometer drive gear (17285) is to be replaced, first remove the yoke to flange seal by prying and pulling the yoke to flange seal or use the Impact Slide Hammer T50T-100-A to pop off the yoke to flange seal. Do not damage the bearing, bearing cage or case. Remove the speedometer drive gear.

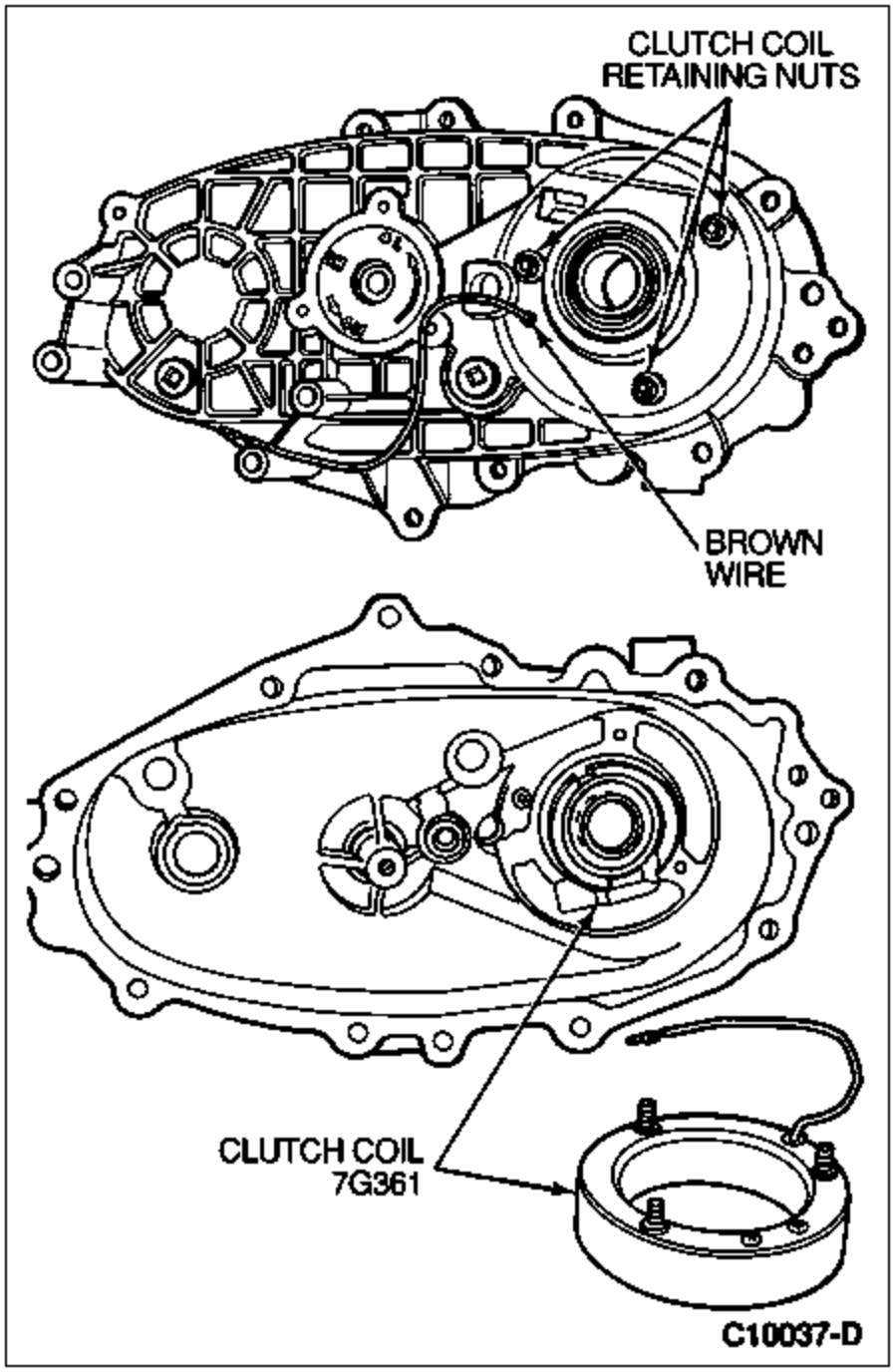
10. If the rear output shaft bearing (7025) requires replacing, remove the internal snap ring that retains the bearing in the bore. From the outside of the case, drive out the bearing using Step Plate D80L-630-3 or equivalent and a drift.



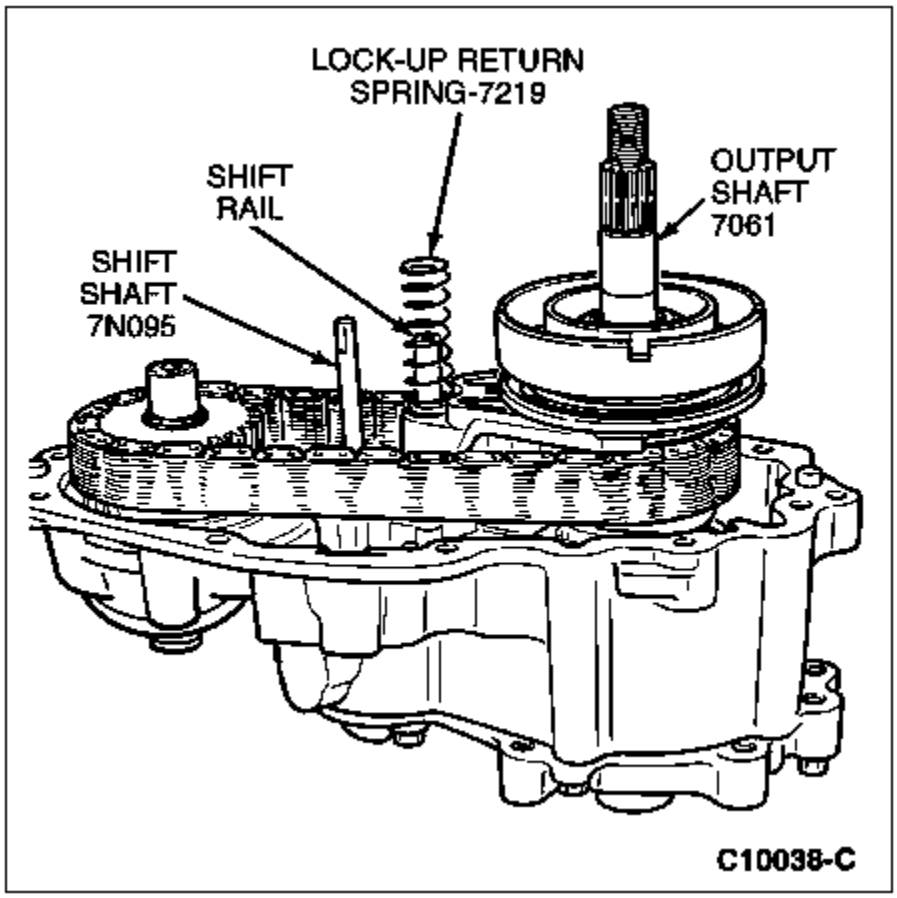
11. If required, remove the front output needle bearing from the rear case with Puller Collet D80L-100-S or equivalent and Impact Slide Hammer T50T-100-A.



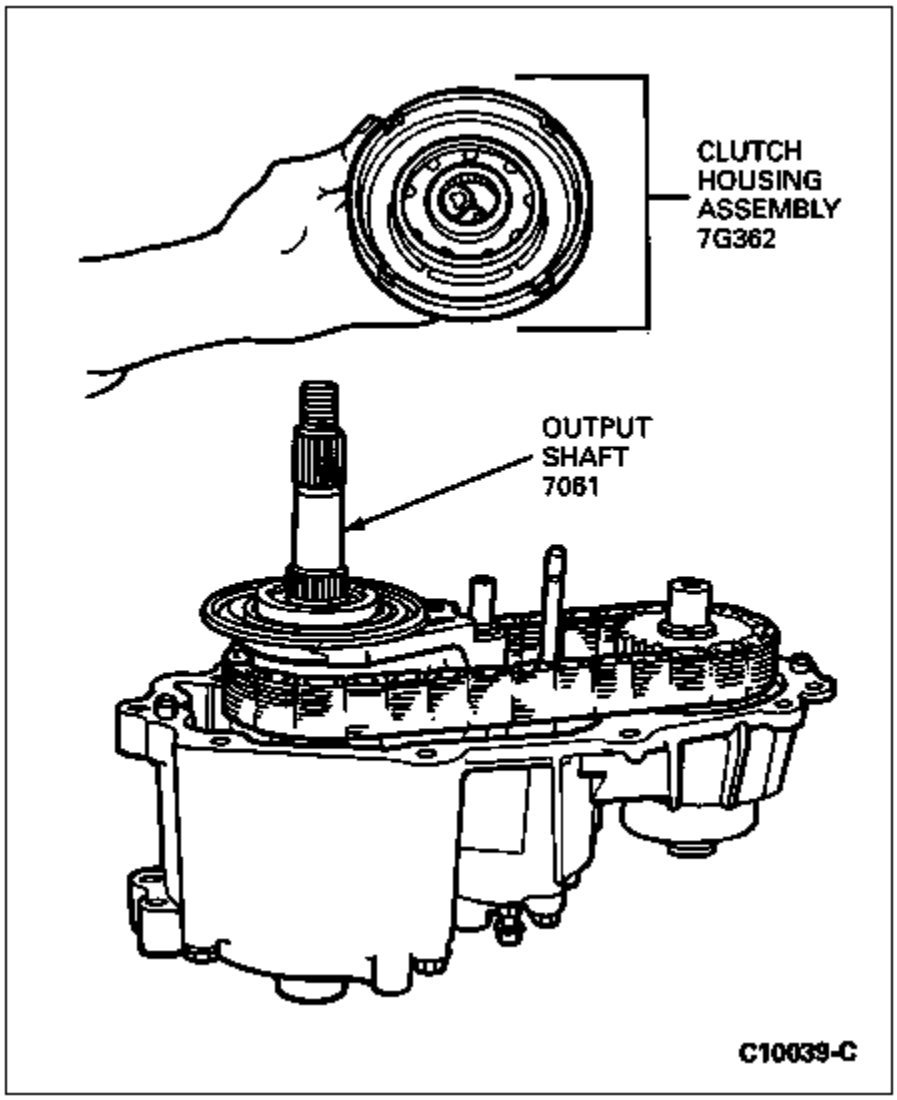
12. Remove the three nuts retaining the clutch coil assembly to the rear case. Pull the assembly, along with the O-rings and brown wire, from the case.



13. Remove the Lock-up return spring from the boss on the fork.

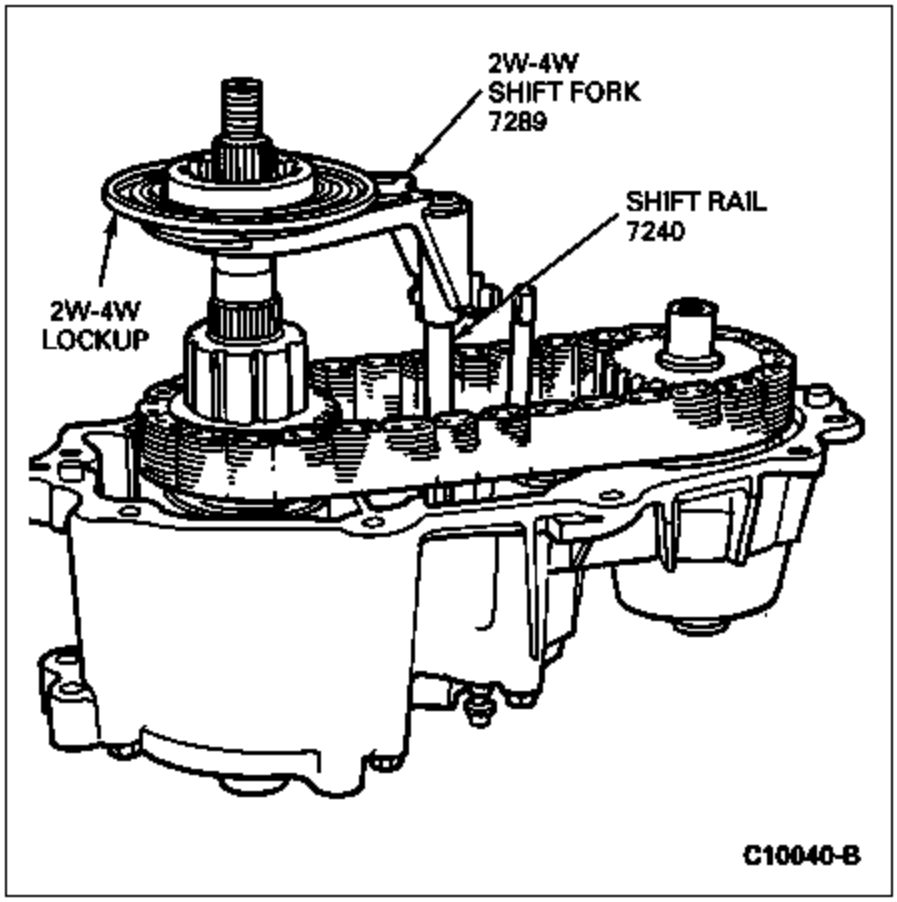


14. Remove the clutch housing from the output shaft.

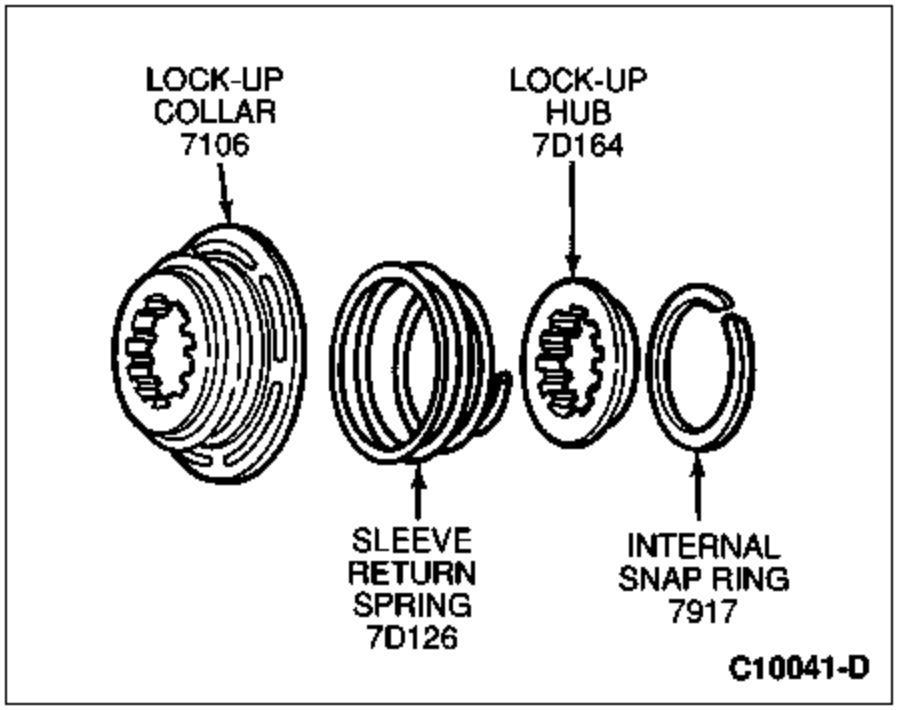


15. Remove the 2W-4W lockup and the 2W-4W shift fork as an assembly. Remove the shift fork from the lockup.

16. Pull out the shift rail.

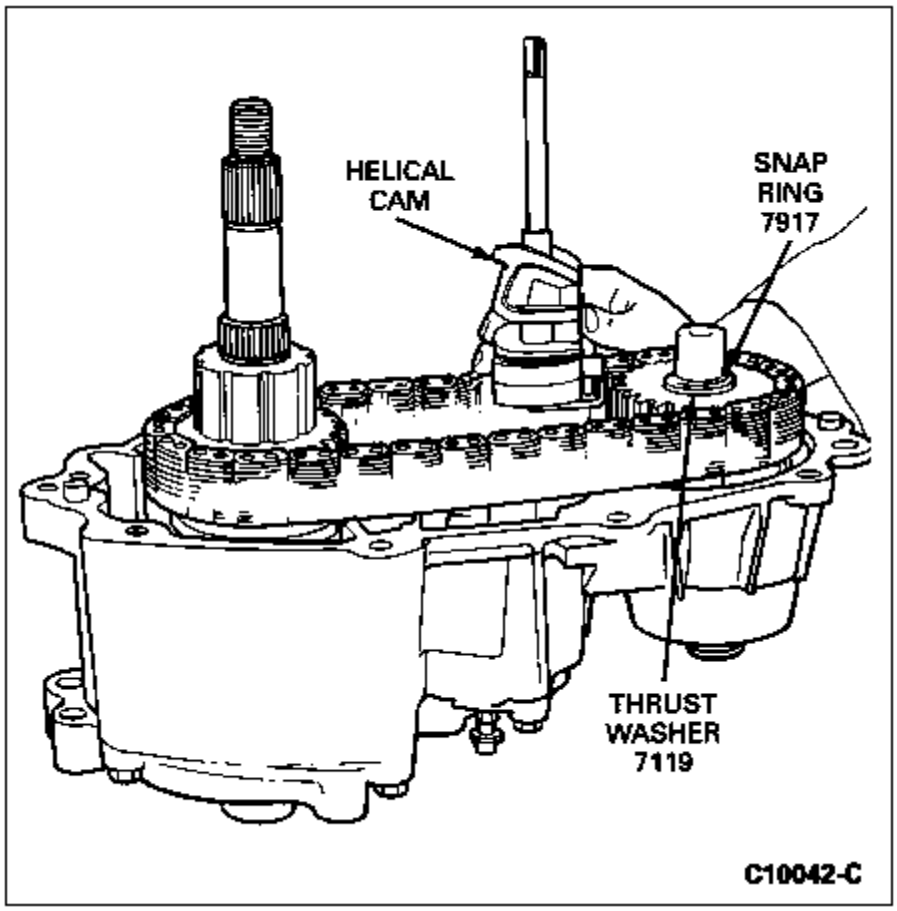


17. If disassembly of the 2W-4W lock-up is required, remove the internal snap ring and pull the lock-up hub and sleeve return spring from the lock up collar.

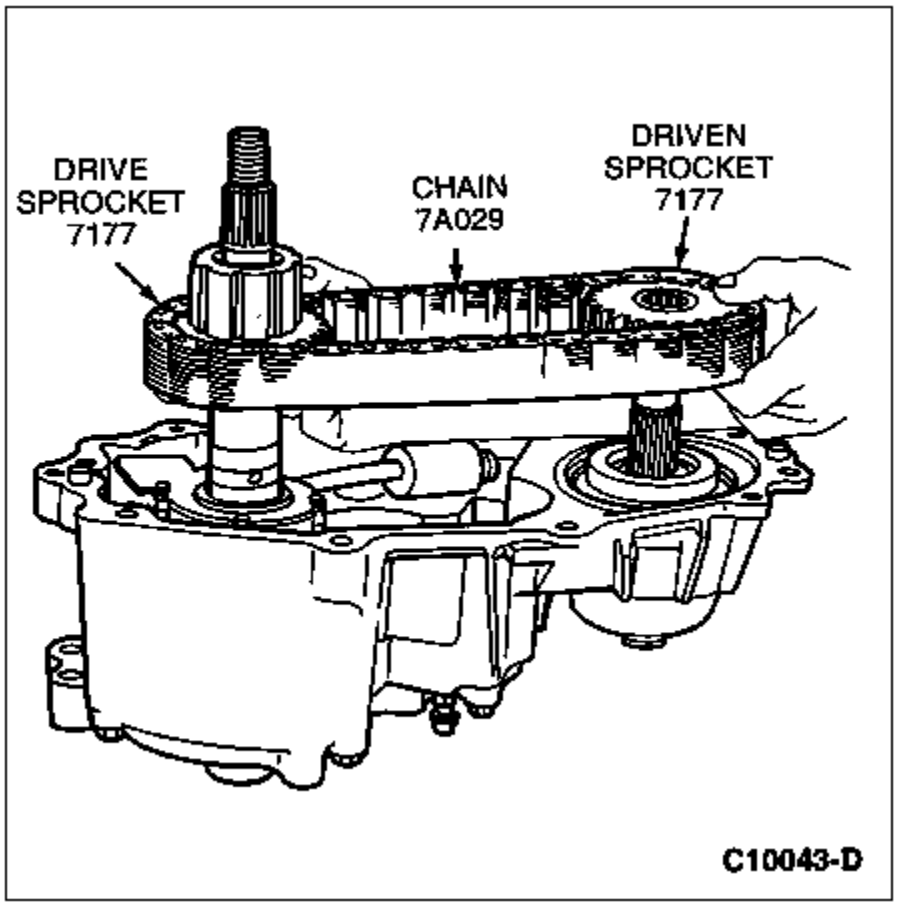


18. Remove the helical cam from the front case. If required, remove the helical cam, torsion spring and sleeve from the shaft.

19. Remove the external snap ring and thrust washer (7119) that retains the driven sprocket to the front output shaft.

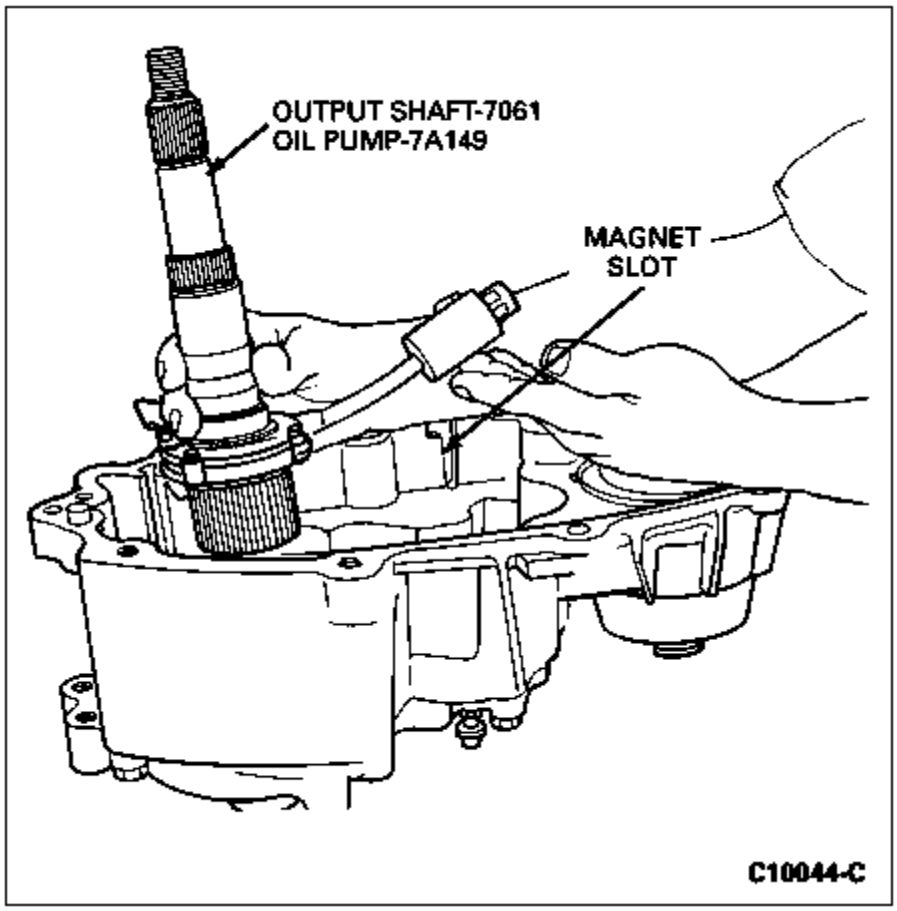


20. Remove the chain, driven sprocket and drive sprocket as an assembly.



21. **CAUTION: If there is removal resistance, do not pound or use force to disassemble the pump; start over again.**

Remove the oil pan magnet (7L027) from the slot in the front of the case bottom. Remove the output shaft and oil pump as an assembly.



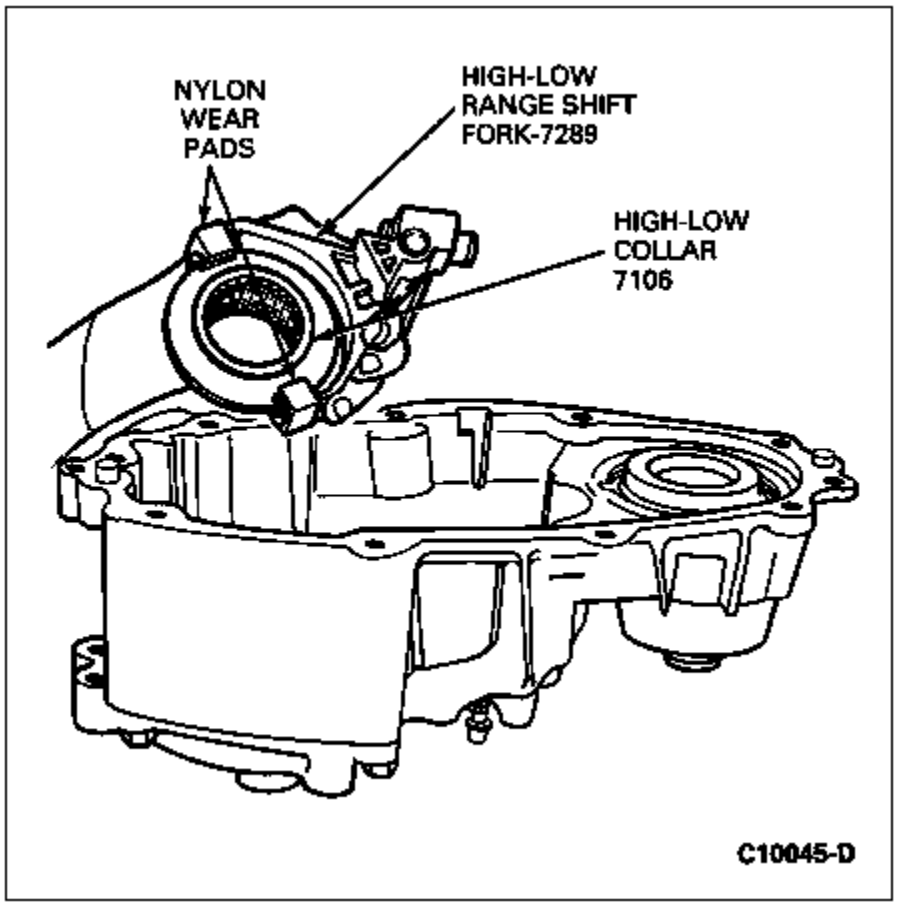
22. If required, rotate the pump to align the cover keyway to pin of the output shaft and pull the pump straight out.

23. If required to replace the oil pump drive pin, perform the following.

    a. Measure **and record** the drive pin height above (sticking out from) the diameter of the output shaft. This information will be required during installation.
    b. Remove the drive pin from the output shaft.

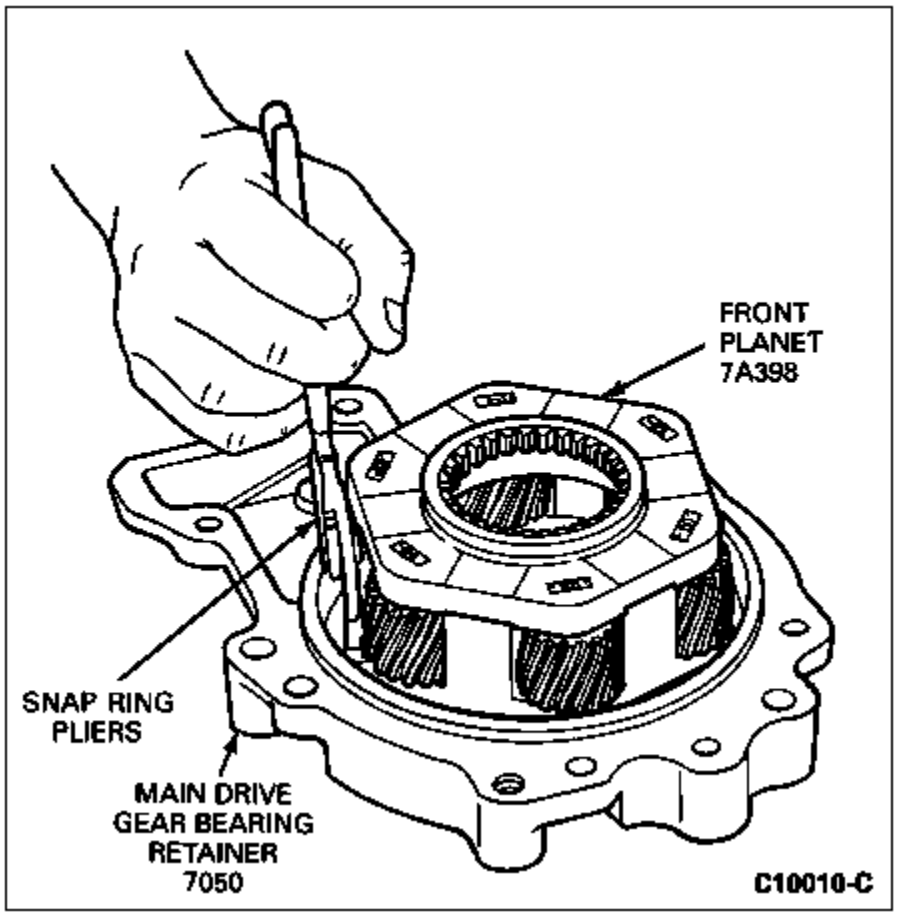
24. Remove the front output shaft.

25. Remove the high-low range shift fork and collar as an assembly.



26. Turn the front case over and remove the six bolts (7A443) retaining the main drive gear bearing retainer (7050) to the front case. Remove the main drive gear bearing retainer, input shaft (7017) and front planet (7A398) as an assembly.

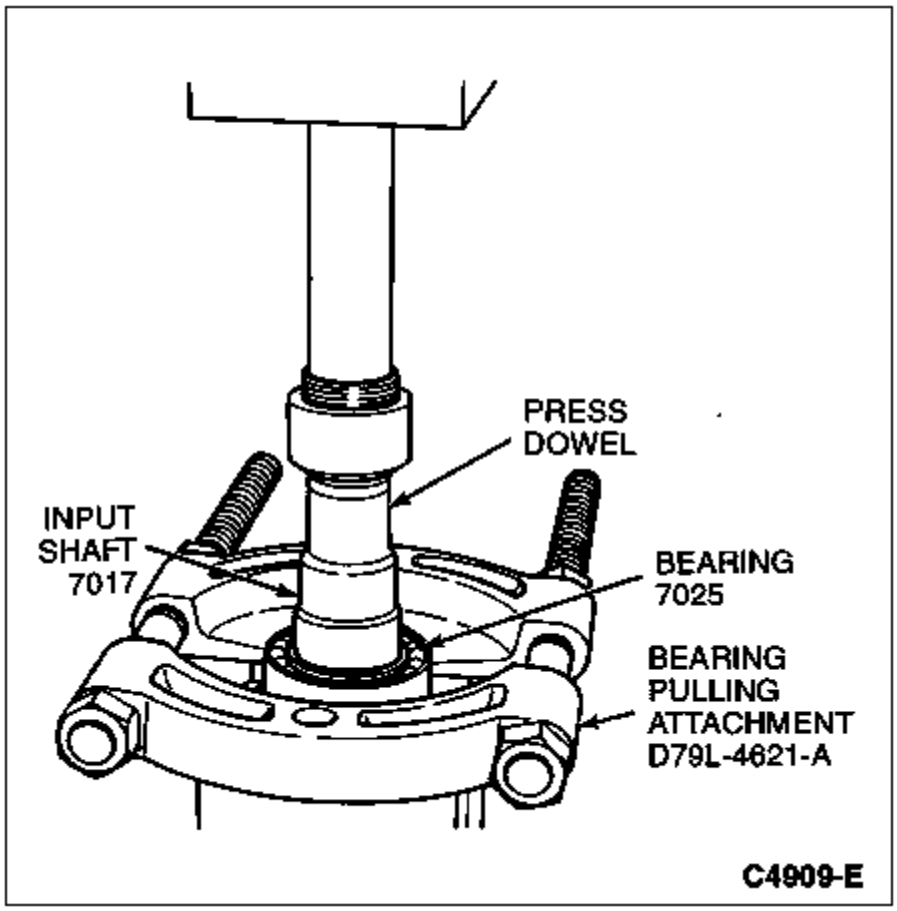
27. Expand the tangs of the large snap ring in the main drive gear bearing retainer. With the input shaft against a bench, push the main drive gear bearing retainer down and slide the main drive gear bearing retainer off the bearing. Lift the input shaft and front planet from themain drive gear bearing retainer.



28. If required, remove the input yoke to flange seal from the main drive gear bearing retainer using Impact Slide Hammer T50T-100-A to pop off the yoke to flange seal. Do not damage the bearing, bearing cage or case.

29. Remove the internal snap ring from the planetary carrier and separate the front planet from the input shaft.

30. Remove the external snap ring from the input shaft. Place the input shaft in a vise and remove the bearing with Bearing Pulling Attachment D79L-4621-A or equivalent. Remove the thrust washer, thrust plate and the sun gear off the input shaft.

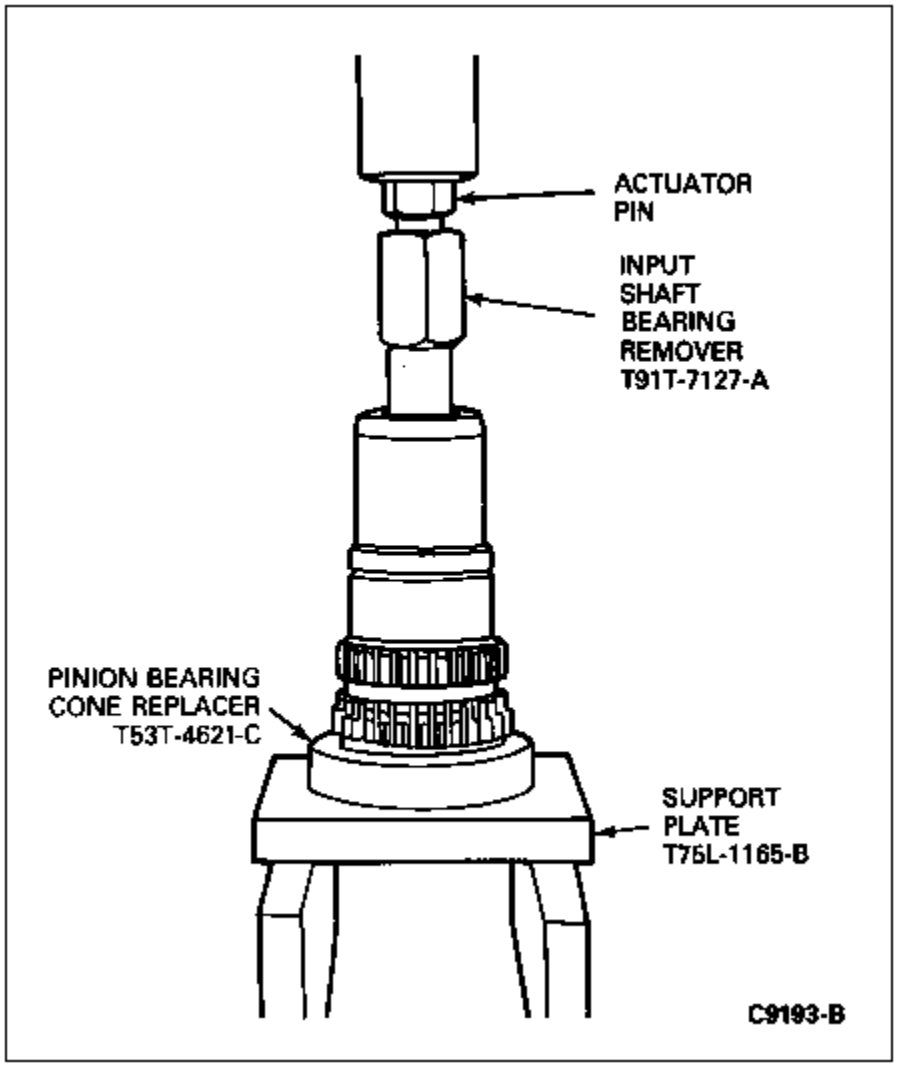


31. **NOTE: Under normal use, the needle bearing and bushing should not require replacement. If replacement is required, the bushing and needle bearing must be replaced as a set.**

    Inspect the bushing and needle bearing in the end of the input shaft for wear or damage.

32. If replacement of the needle bearing and bushing is required, press the bearing and bushing out as follows:

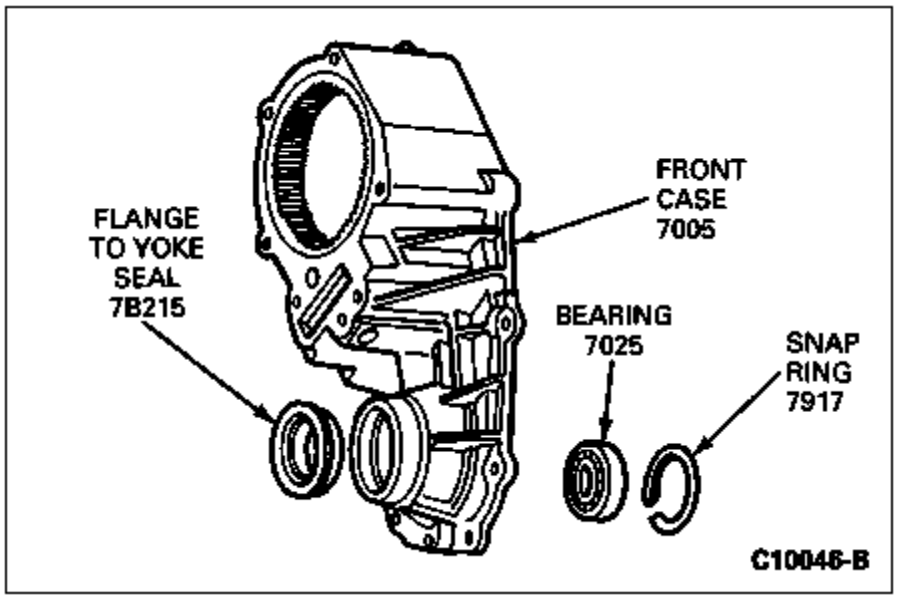
    a. Position the input shaft on Axle Bearing/Seal Plate T75L-1165-B or equivalent, and using Pinion Bearing Cone Replacer T53T-4621-C as a spacer.
    b. Insert Input Shaft Bearing Remover T91T-7127-A into the input shaft so it is resting on top of the bearing cage.
    c. Tighten the actuator pin until it stops, then press the bearing and bushing out together.



33. If required, remove the ring gear (7A153) from the front case half using a press. Note the relationship of the serrations to the chamfered pilot diameter during removal.

34. If required, remove the front yoke to flange seal using Impact Slide Hammer T50T-100-A to pop off the yoke to flange seal. Do not damage the bearing, bearing cage or case.

35. If required, remove the internal snap ring retaining the front output shaft ball bearing and remove the bearing using Step Plate D80L-630-3 or equivalent with a drift.



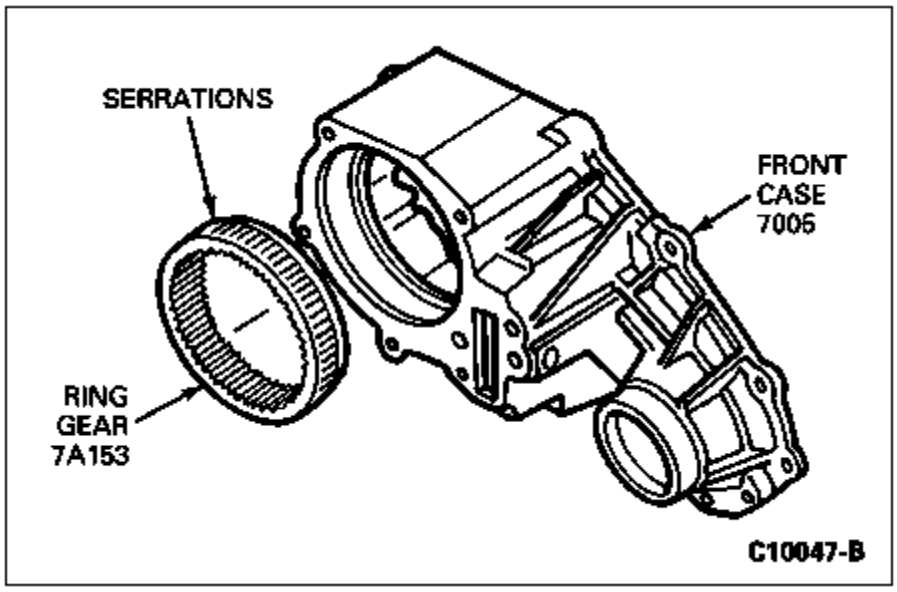
Assembly

Before assembly, lubricate all parts with MERCON® Multi-Purpose Automatic Transmission Fluid WSP-M2C185-A or equivalent.

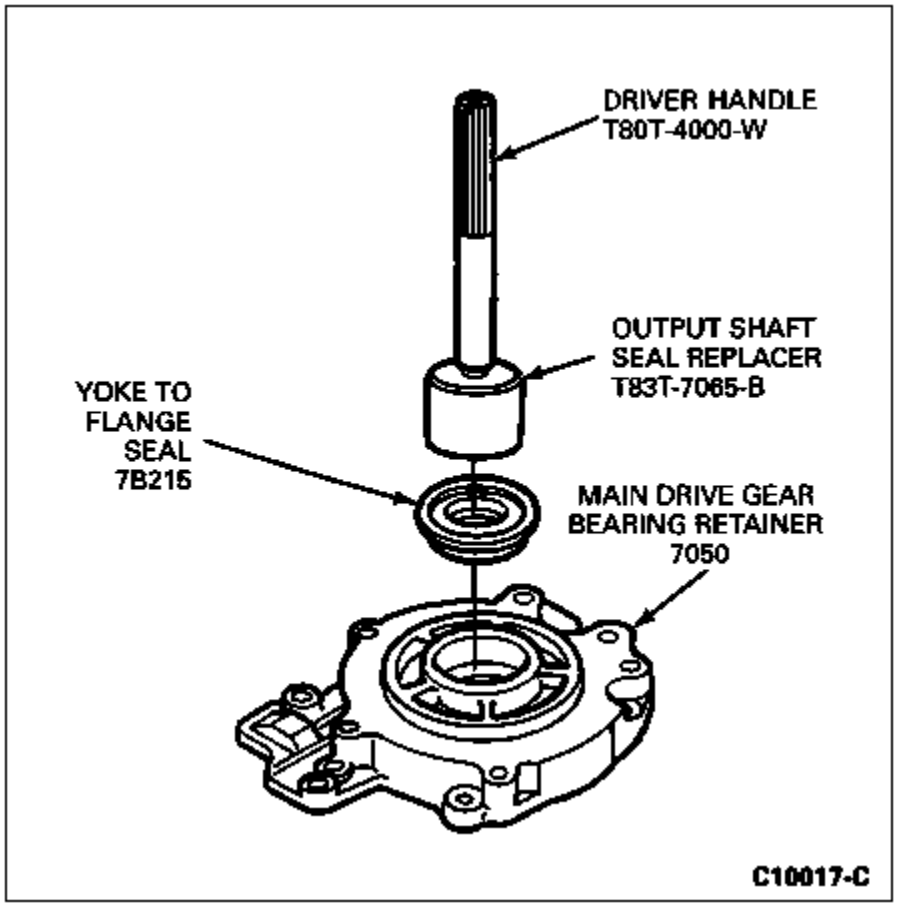
1. If removed, drive the bearing into the front output case bore using Output Shaft Seal Replacer T83T-7025-B and Driver Handle T80T-4000-W. Drive the bearing in straight, making sure it is not cocked in the bore. Install the internal snap ring that retains the bearing to the front case.

2. If removed, install the front yoke to flange seal in the front case bore using Output Shaft Seal Replacer T83T-7065-B and Driver Handle T80T-4000-W.

3. If removed, install the ring gear in the front case. Align the serrations on the outside of the ring gear to the serrations previously cut in the front case bore. Using a press, start the piloted chamfered end of the ring gear first and press in until it is fully seated. Make sure that the ring gear is not cocked in the bore.



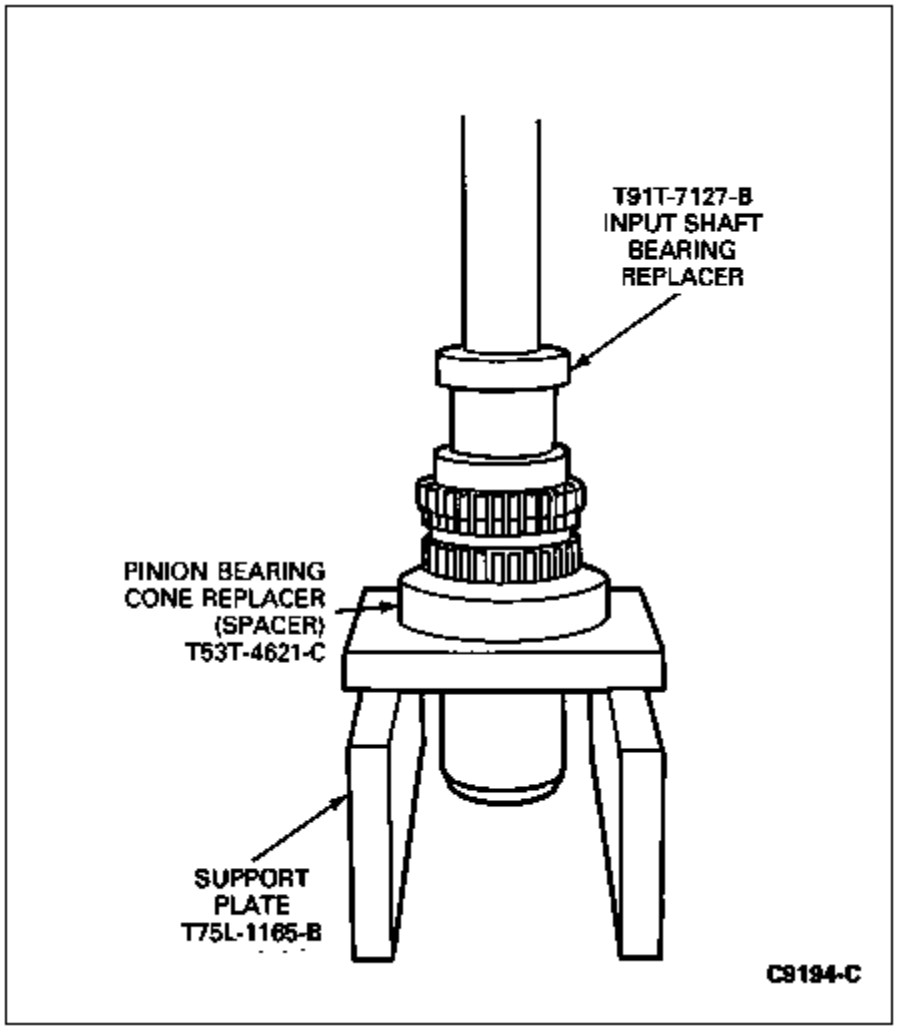
4. If removed, install the input yoke to flange seal into the mounting adapter bore. Use Output Shaft Seal Replacer T83T-7065-B and Driver Handle T80T-4000-W.



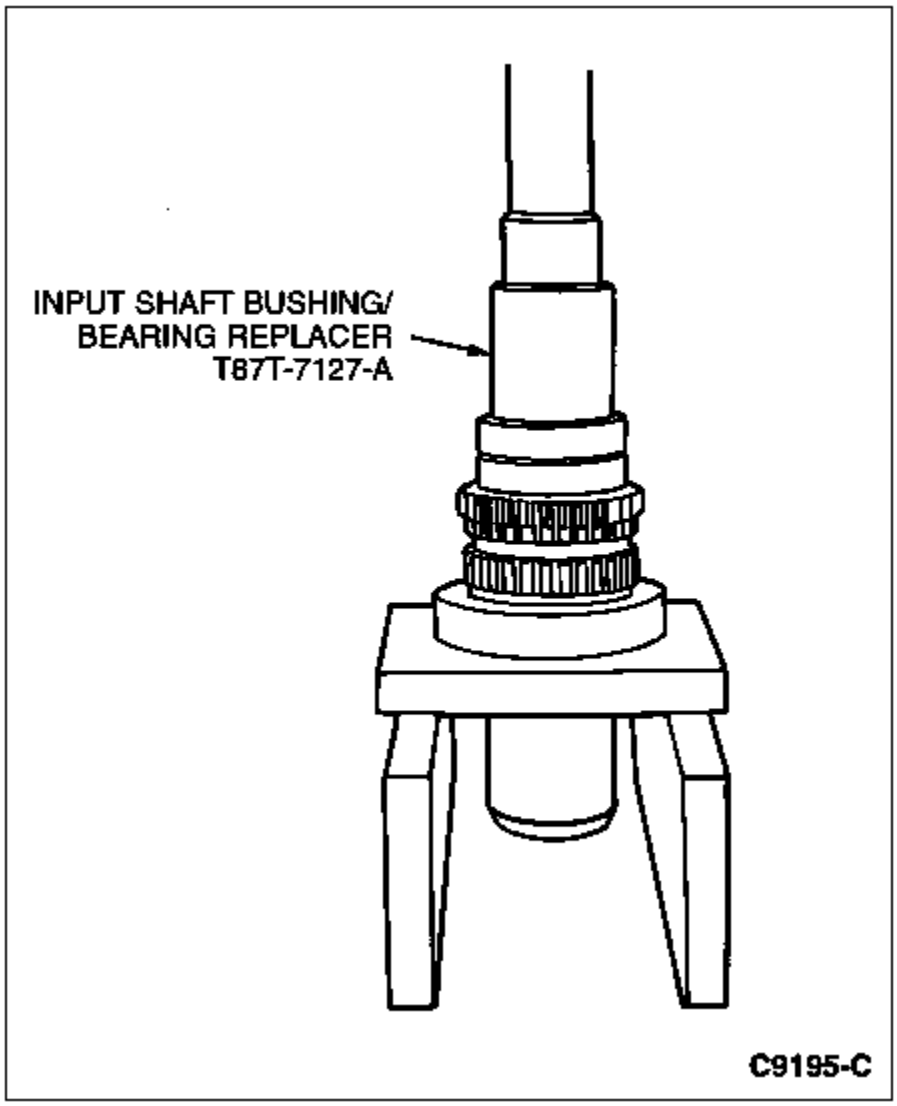
5. **NOTE: If the input shaft needle bearing and bushing were removed, install a new bearing and bushing as detailed in the following steps:**

Press a new needle bearing, then a new bushing in the input shaft as follows:

a. Position the input shaft on Axle Bearing/Seal Plate T75L-1165-B or equivalent, and Pinion Bearing Cone Replacer T53T-4621-C as a spacer.
b. Using Input Shaft Bearing Replacer T91T-7127-B, press a new needle bearing into the end of the input shaft until it seats in the input shaft

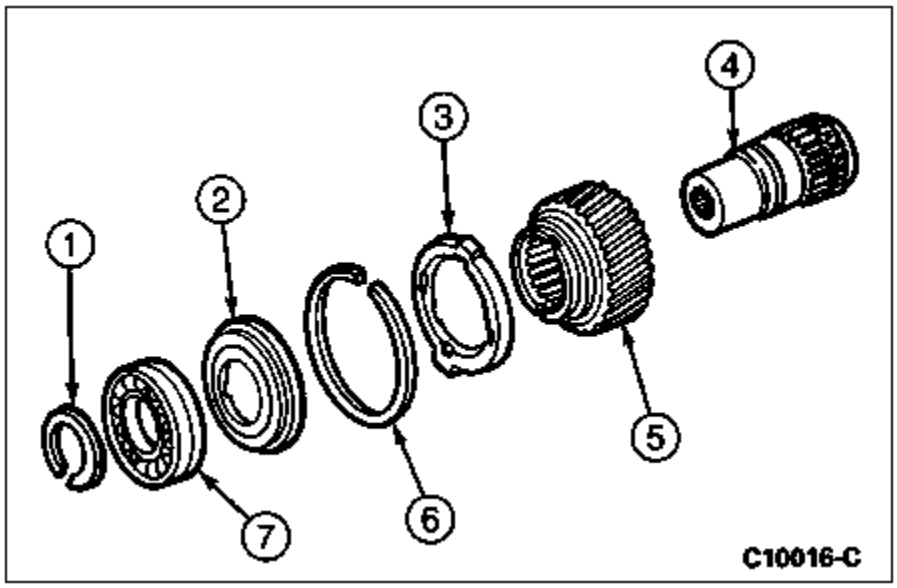


c. Press in a new bushing using Input Shaft Bushing/Bearing Replacer T87T-7127-A.



6. **NOTE: The recessed face of the sun gear and the snap ring groove on the bearing outer race should be toward the rear of the transfer case. The stepped face of the thrust washer should face toward the bearing.**

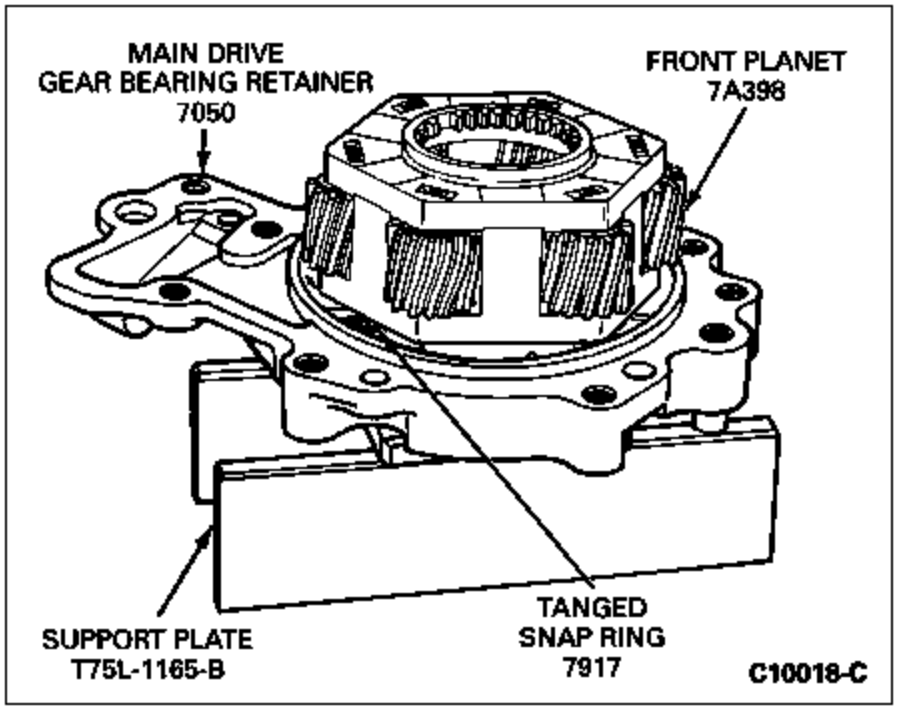
   Slide the sun gear, thrust plate and thrust washer into position on the input shaft. Press the bearing over the input shaft. Install the external snap ring to the input shaft.



Item	Part Number	Description
1	7917	External Snap Ring
2	7A385	Thrust Washer
3	7B066	Thrust Plate
4	7017	Input Shaft
5	7D063	Sun Gear
6	7C122	Internal Snap Ring
7	7025	Bearing

7. Install the front planet to the sun gear and input shaft. Install the internal snap ring to the planetary carrier.

8. Place the tanged snap ring in the mounting adapter groove. Using Axle Bearing/Seal Plate T75L-1165-B place the input shaft and front planet in the main drive gear bearing retainer and expand the tanged snap ring while pushing inward until the front planet and input shaft are seated in the main drive gear bearing retainer. When properly seated, the tanged snap ring will snap into place. Check installation by holding the main drive gear bearing retainer by hand and carefully tapping the face of the input shaft against a wooden block to make sure that the snap ring is engaged.

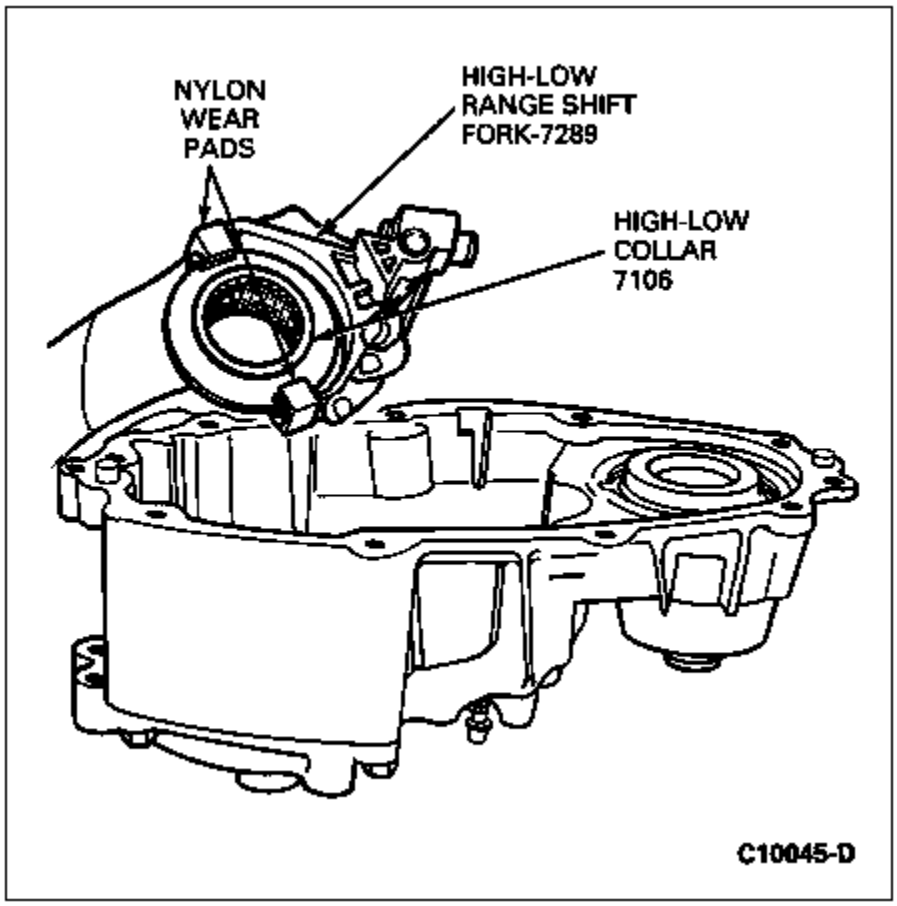


9. Remove all traces of RTV Gasket Sealant from the front case and mounting adapter mating surfaces. Install a bead of RTV Gasket Sealant on the surface of the front case. Use Non-Acid Cure Silicone Rubber E7TZ-19562-A or equivalent meeting Ford specification ESL-M4G273-A.

10. Position the main drive gear bearing retainer on the front case. Install the six bolts and tighten to 31-41 Nm (23-30 lb-ft).

11. **NOTE: Make sure that the nylon wear pads are installed on the shift fork and snapped securely into place.**

    Install the high-low shift fork and high-low collar as an assembly into the front planet.



12. If removed, press the pin into the rear output shaft pin hole to the same height or 1mm (0.040 inch) **minimum** above the diameter of the output shaft.

13. **NOTE: Do not disassemble oil pump. It is serviced only as an assembly.**

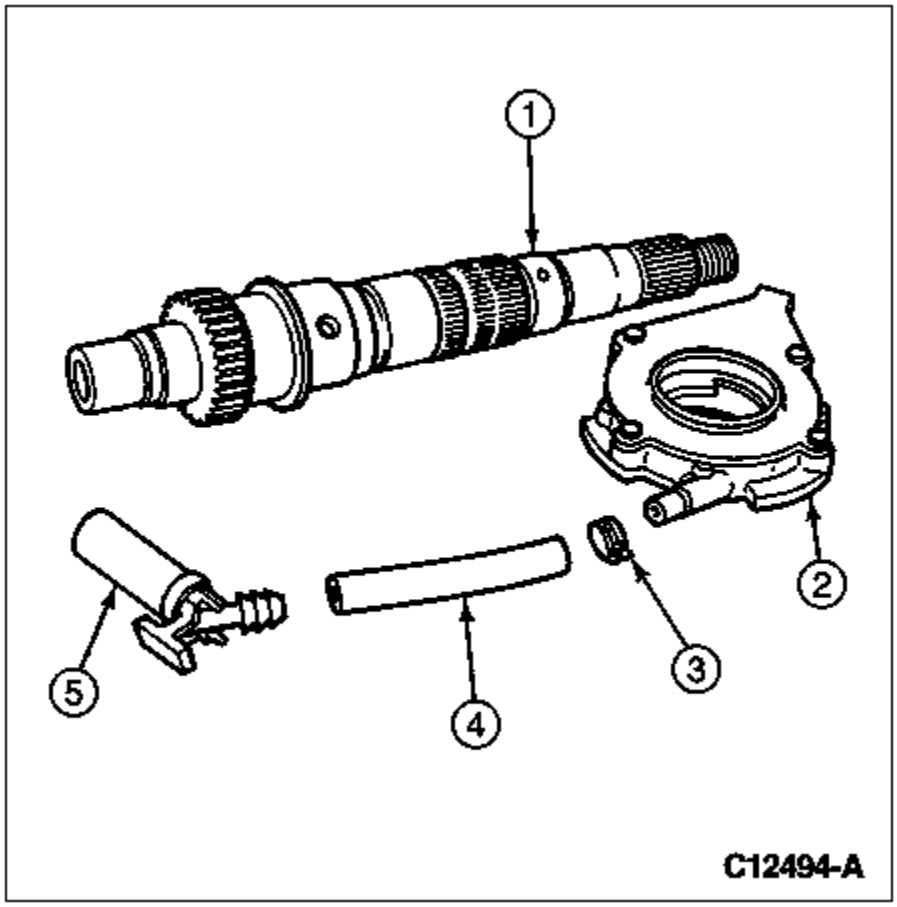
    NOTE: Do not remove the plastic insert from the bore of the new pump. Discard it after it slides out during pump installation to the rear output shaft.

    NOTE: While turning the output shaft, prime the pump through the oil filter pickup tube or housing inlet hole with clean Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX or equivalent.

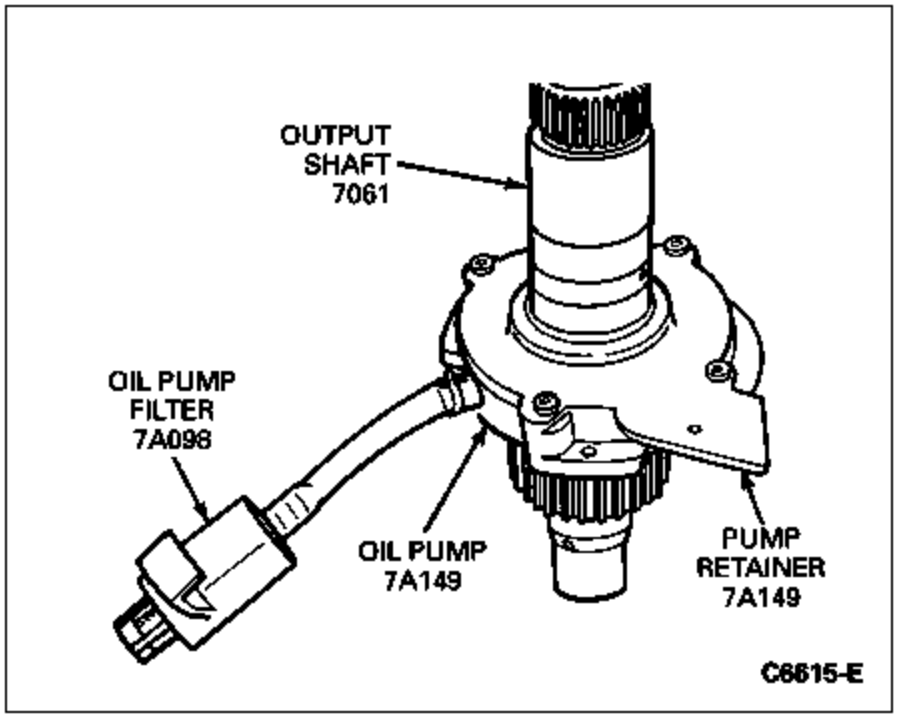
    If the pump does not turn freely after installation to the rear output shaft, realign the cover keyway to the pin of the rear output shaft and jiggle the pump until it fully seats and rotates freely.

    If new pump is used, slide the pump housing slot onto the pin of the output shaft with the retaining arm of the cover toward the rear of the case. If the pump does not turn freely, follow the instructions as listed in the previous paragraph.

    Inspect the outside surfaces and bore of the oil pump. If there is no discoloration in the pump housing, gear or cover, and the pump bore and the lube holes of the output shaft show evidence of oil, the pump is working. Hand align the keyways and bores of the housing, gear and cover and slide the pump onto the rear output and fifth gear driveshaft pin with the retaining arm of the cover toward the rear of the case.

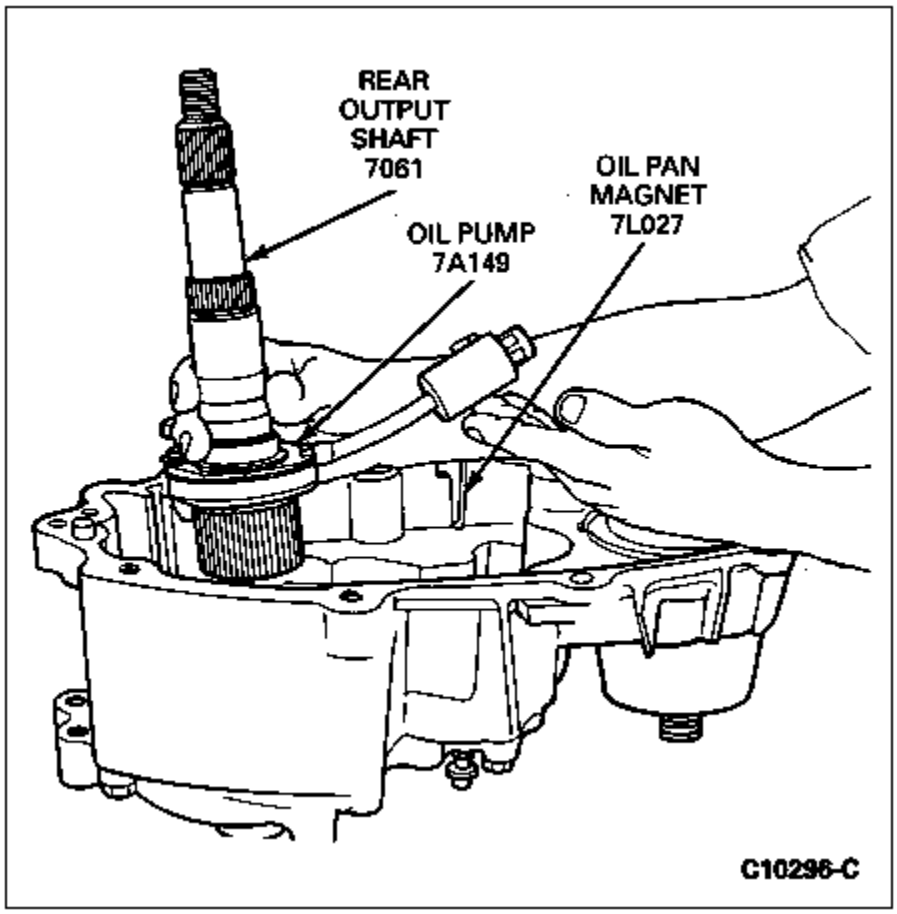


Item	Part Number	Description
1	7061	Output Shaft Rear
2	7A149	Pump Body
3	382846	Clamp
4	7A210	Hose
5	7A098	Filter/Pickup



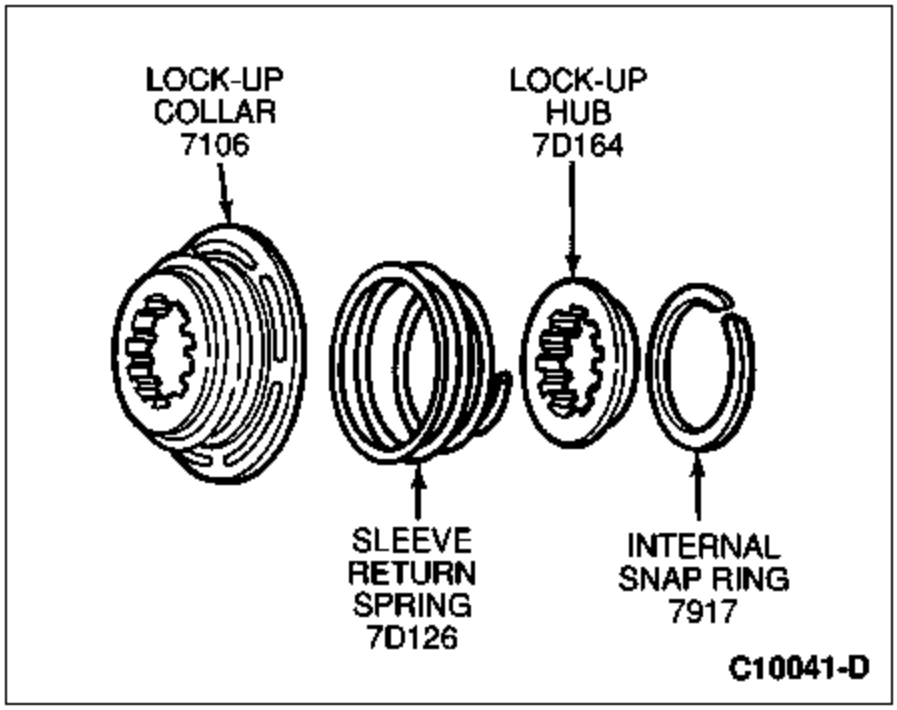
14. Install the output shaft and oil pump in the input shaft. Make sure that the internal splines of the output shaft engage the internal splines of the high-low shift collar. Make sure that the oil pump retainer arm and oil filter leg are in the groove and slot of the front case.

15. Install the oil pan magnet in the slot in the front case just above the oil filter leg.



16. Install the front output shaft in the front case.

17. If disassembled, assemble the 2W-4W lockup assembly. Install the sleeve return spring into the bore of the lockup collar with the large end installed first. Place the lockup hub over the spring and install the lockup hub into the lockup collar. Install the internal snap ring.

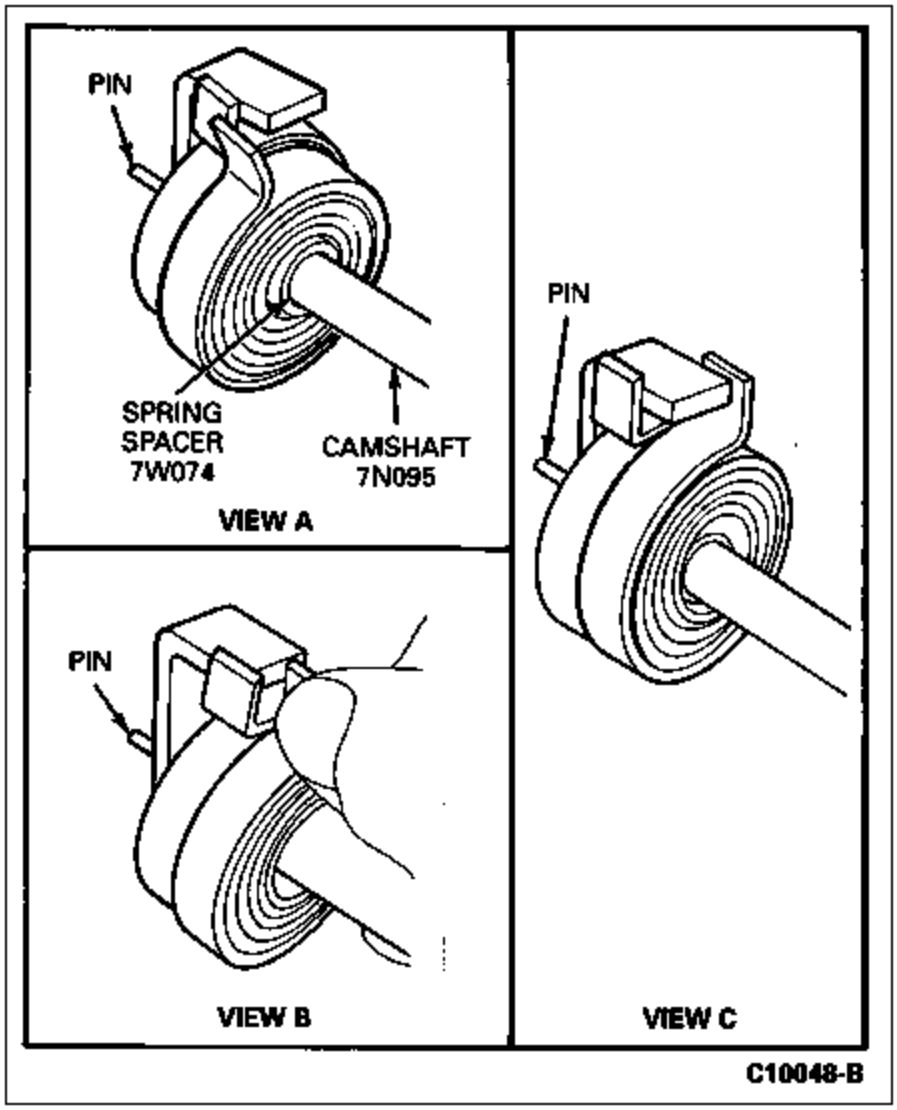


18. **NOTE: The driven sprocket (on the front output shaft) must be installed with the marking REAR facing toward the rear case, if so marked.**

    Install the chain, drive sprocket and driven sprocket as an assembly over the output shaft.

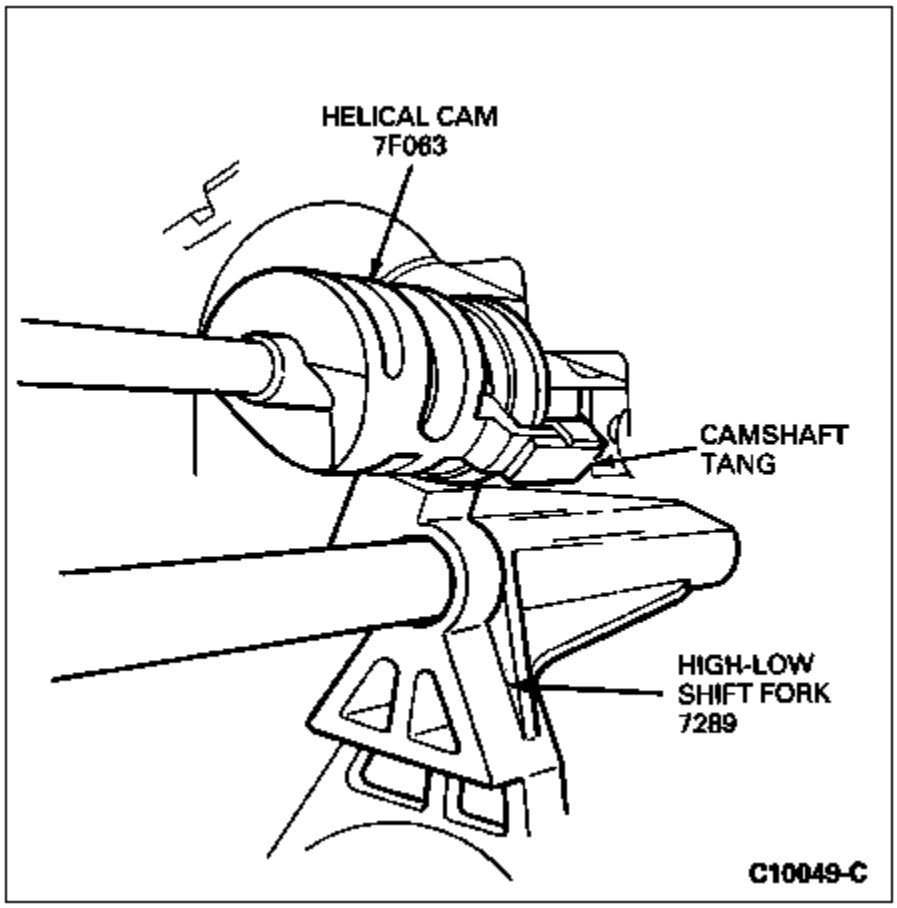
    Install the thrust washer on the front output shaft and install the external snap ring over the thrust washer to retain the driven sprocket.

19. Slide the spring spacer on the camshaft and position it beneath the drive tang. Place the torsion spring on the camshaft. Position the first spring tang to the left of the camshaft drive tang (View A). Wind the second spring tang clockwise past the drive tang (View B). Push the torsion spring and sleeve in as far as it will go (View C). This will seat the second spring tang on the right side of the drive tang. Install the helical cam and slide the drive tang between the torsion spring tangs as far as it will go.



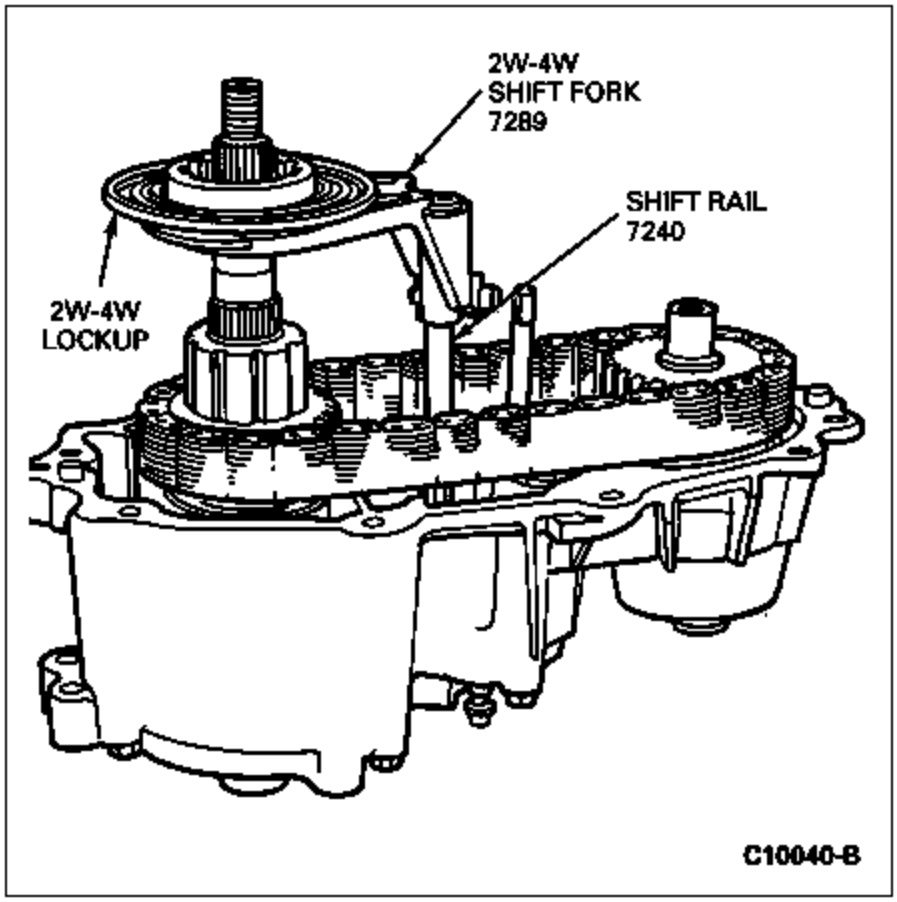
20. **CAUTION: Do not bend the helical cam during installation to the front case because of possible damage to the pin at the tang end of the motor shaft.**

Install the pin on the tang end of the helical cam into the hole in the front case. Position the torsion spring tangs so that they are pointing toward the top side of the transfer case and just touching the high-low shift fork.



21. Install the shift rail through the high-low shift fork and make sure that the shift rail is seated in the front case bore.

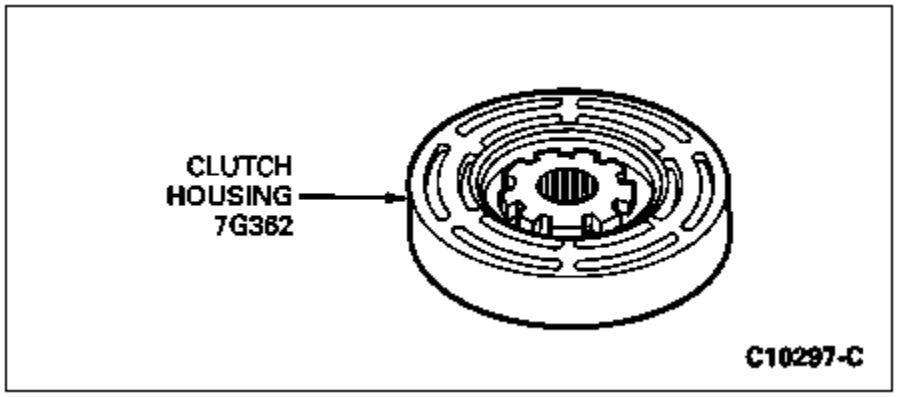
22. Install the 2W-4W shift fork to the 2W-4W lockup. Install the 2W-4W lockup and shift fork over the output shaft and onto the shift rail.



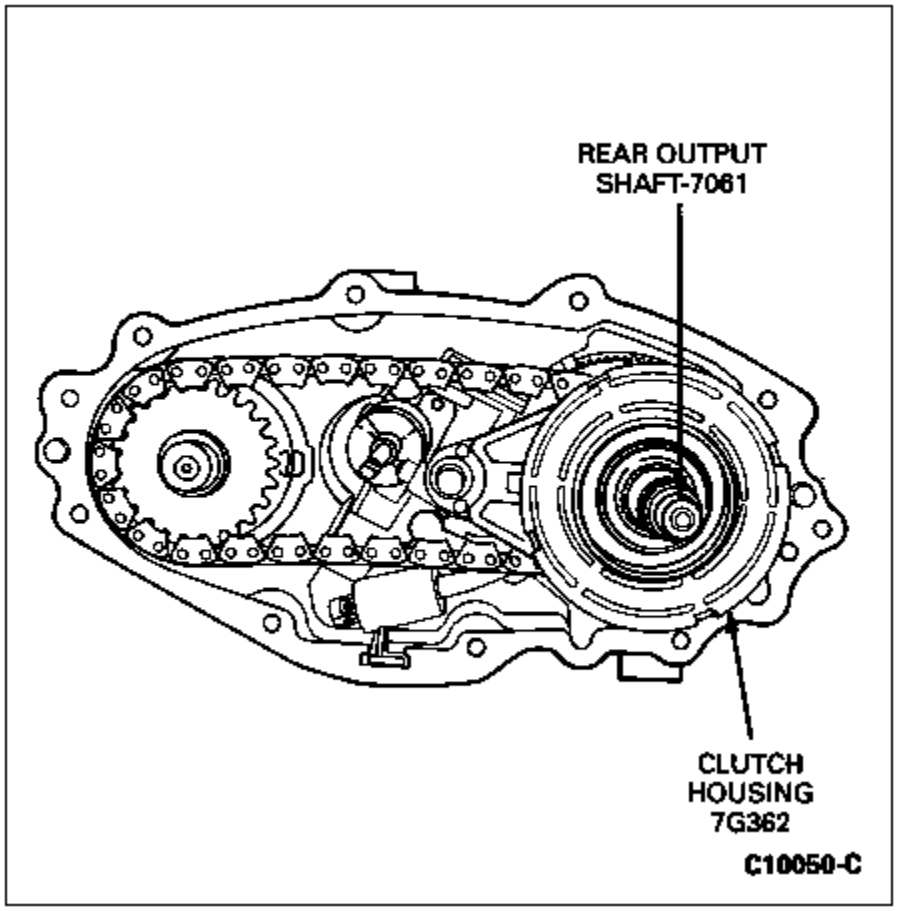
23. **NOTE: After the 2W-4W shift fork is released, the 2W-4W fork roller bushing should rest on the top surface of the helical cam and not into an inside track.**

    NOTE: The triangular shaft will be in the two wheel high (2H) position at final assembly.

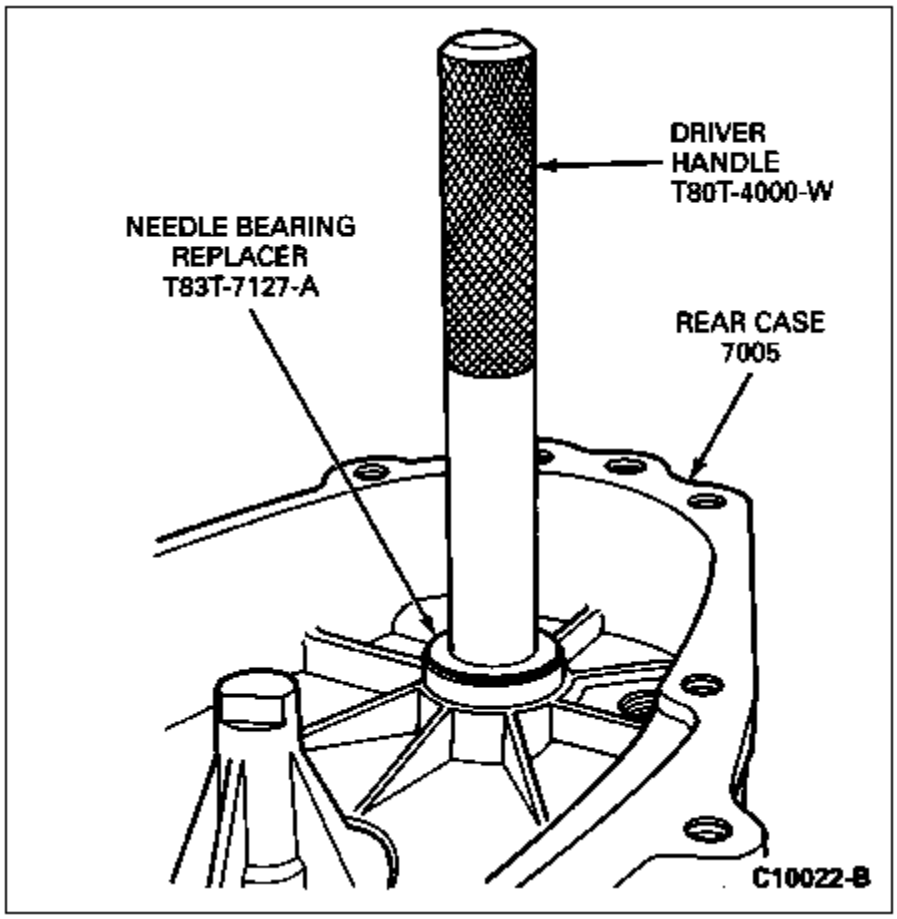
    Lift the 2W-4W shift fork slightly while holding the shift rail down and rotate the helical cam track into the high-low fork roller bushing by turning the helical cam.



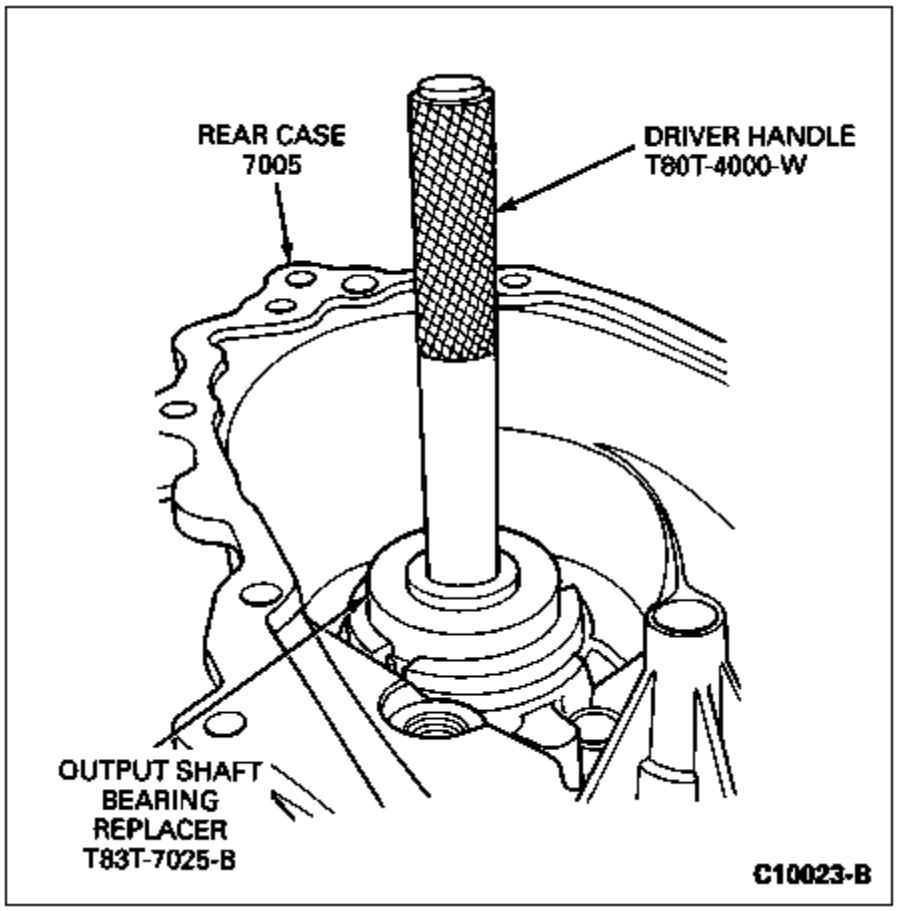
24. Install the clutch housing on the output shaft with the cavity side or notches facing the rear case.



25. If removed, drive the front output shaft needle bearing into the rear cover bore with Front Shaft Needle Bearing Replacer T83T-7127-A and Driver Handle T80T-4000-W.

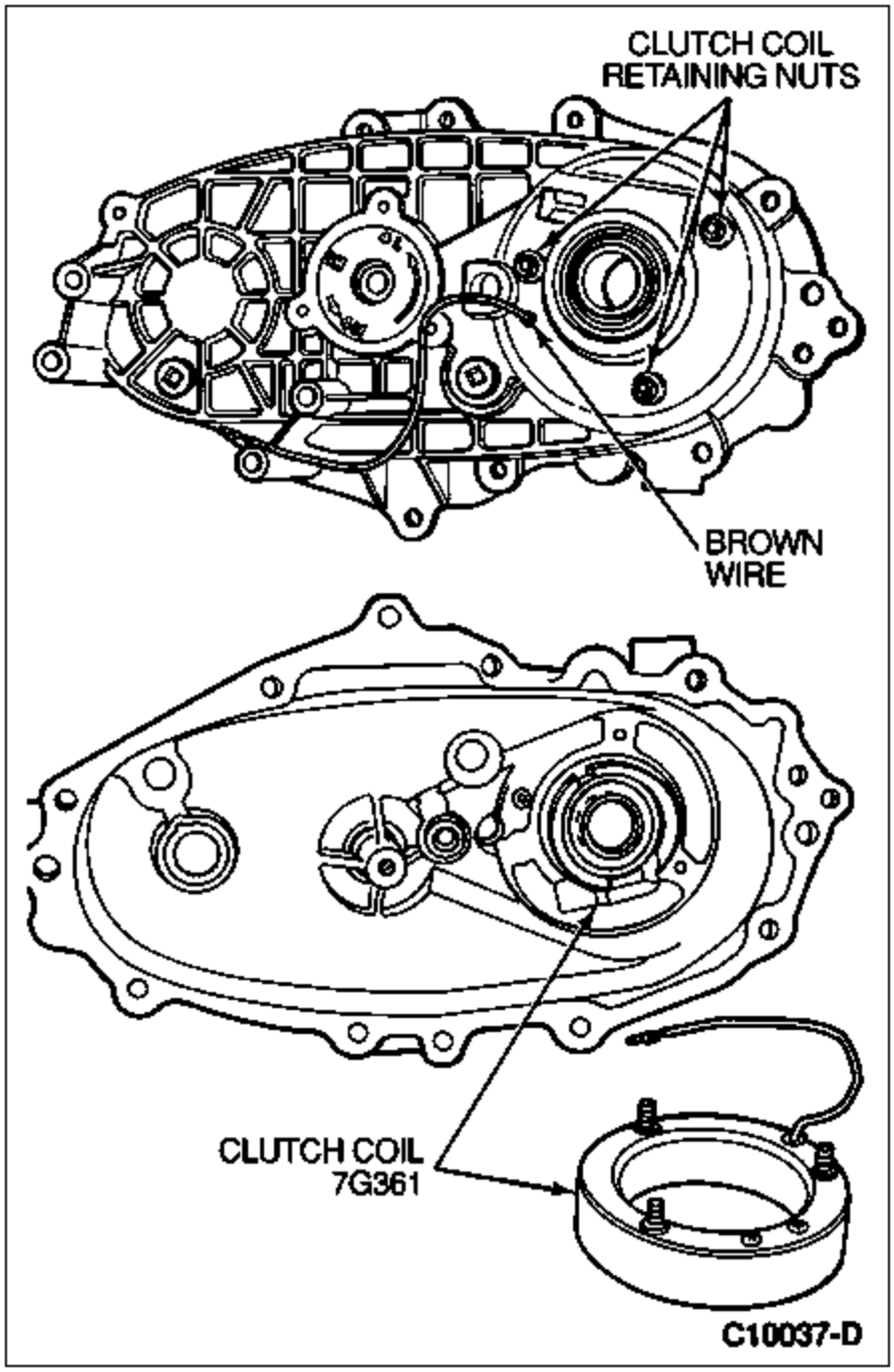


26. If removed, install the rear output bearing in the rear case bore. Drive the bearing into the rear case bore with Output Shaft Bearing Replacer T83T-7025-B and Driver Handle T80T-4000-W. Make sure that the bearing is not cocked in the bore. Install the internal snap ring that retains the bearing to the rear case.



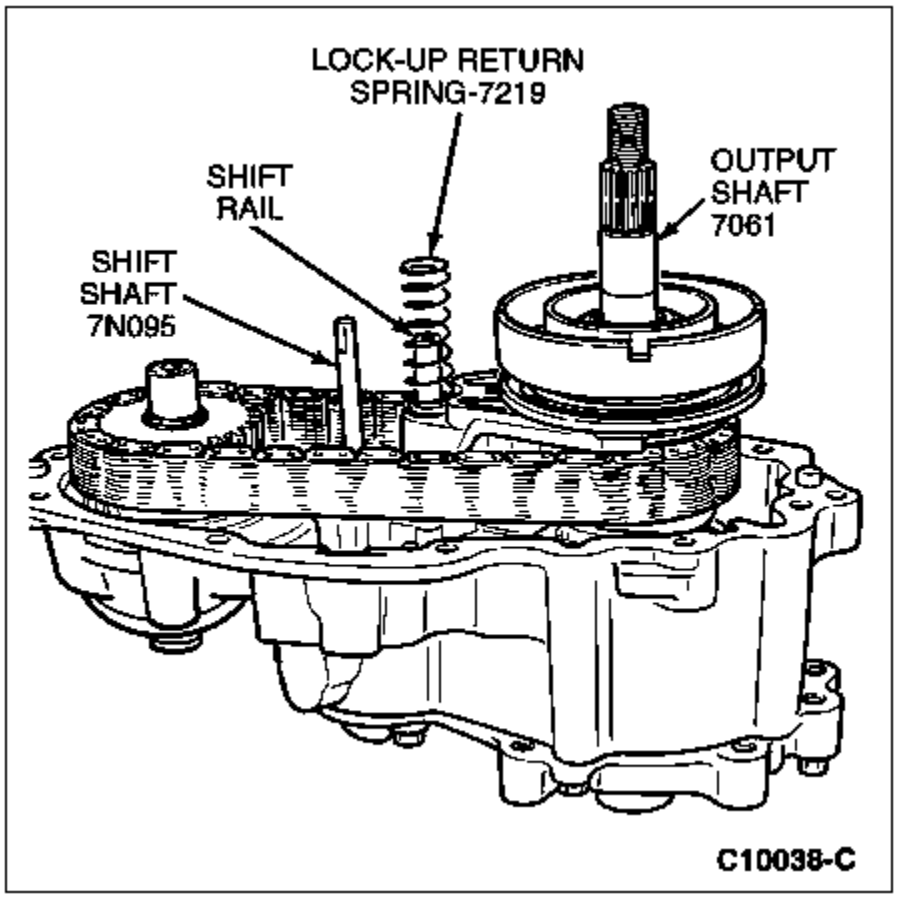
27. **CAUTION: Do not kink or trap the wire while seating the clutch coil to the case.**

Apply a bead of Non-Acid Cure Silicone Rubber E7TZ-19562-A or equivalent meeting Ford specification ESL-M4G273-A to the base of the clutch coil studs and grommet. Install the clutch coil from inside the rear case until the wire and studs extend through the cover. Install the nuts and tighten to 8-11 Nm (71-97 lb-in).



28. Coat the mating surface of the front case with a bead of Non-Acid Cure Silicone Rubber E7TZ-19562-A or equivalent meeting Ford specification ESL-M4G273-A.

29. Install the lockup return spring to the shift rail and shift fork with the spring mounted in a vertical position.



30. The following procedure must be followed prior to installing the rear case onto the front case half:

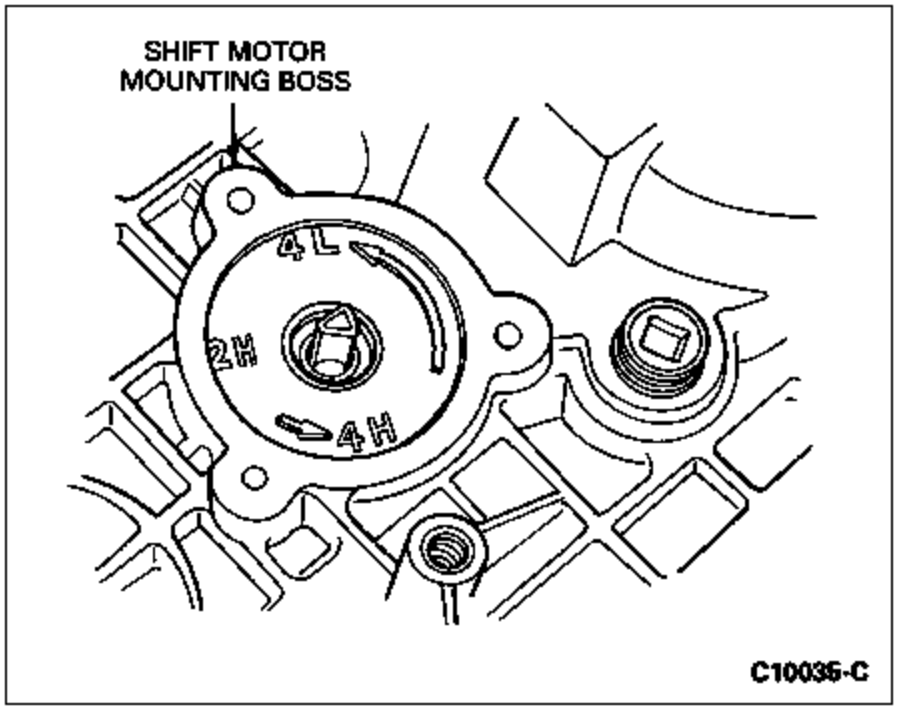
    a. Align the output shaft with the rear case output shaft bore.
    b. Align the helical cam with the rear case motor bore.
    c. Align the rear case so that the spring boss engages the lockup return spring and shift rail.

    If difficulty is encountered with seating the rear case, tap the rear output shaft with a sharp blow using a rubber mallet in a direction away from the triangular shaft while pushing down on the rear case.

31. Install the bolts retaining the case halves and tighten to 31-41 Nm (23-30 lb-ft).

32. **NOTE: If the shaft will not stay in the 4H position, rotate the shaft clockwise to the 2H position. During motor installation, rotate the transfer case shift motor counterclockwise until the transfer case shift motor is aligned with the mounting holes.**

    Using pliers equipped with soft jaws, rotate the triangular shaft so it is aligned with the triangular slot in the transfer case shift motor.



33. **NOTE: Do not loosen the two nuts or studs that attach the motor end cap to the motor housing.**

    Slightly loosen the two nuts that attach the slotted support bracket to the end of the motor house.

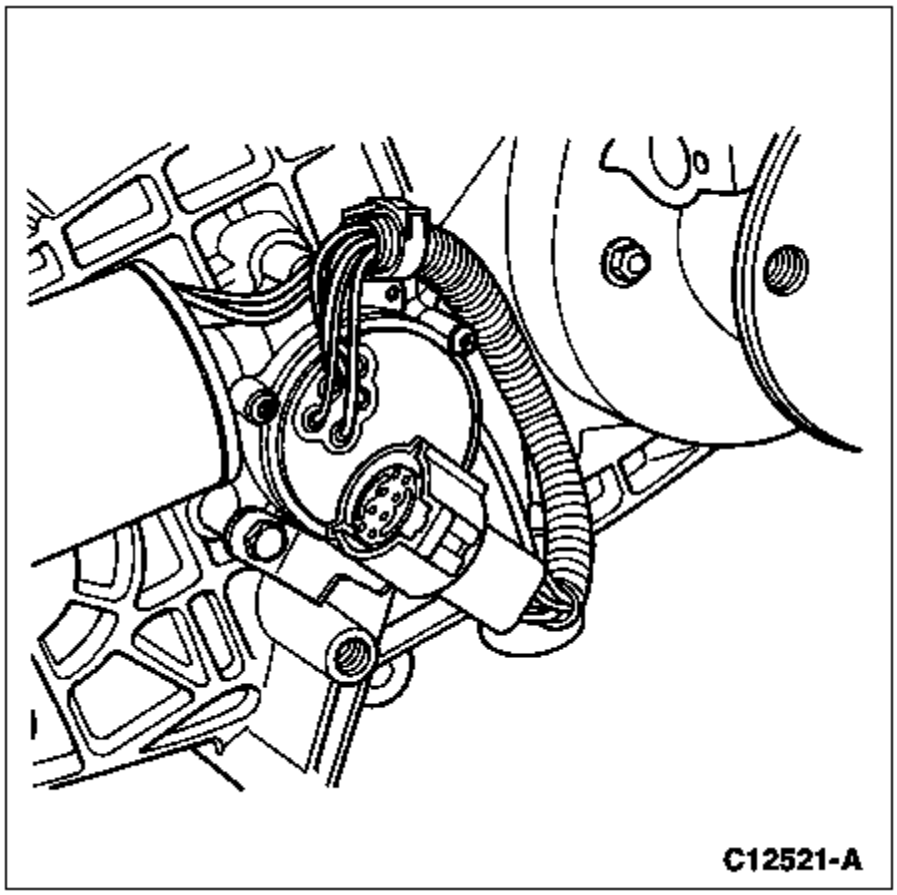
34. Apply Black Non-Acid Cure Silicone Rubber E7TZ-19562-A meeting Ford specification ESL-M4G273-A to motor housing base and install on transfer case.

35. **NOTE: The wire harness must be routed as shown to provide clearance and to prevent the wire harness from grounding the damper.**

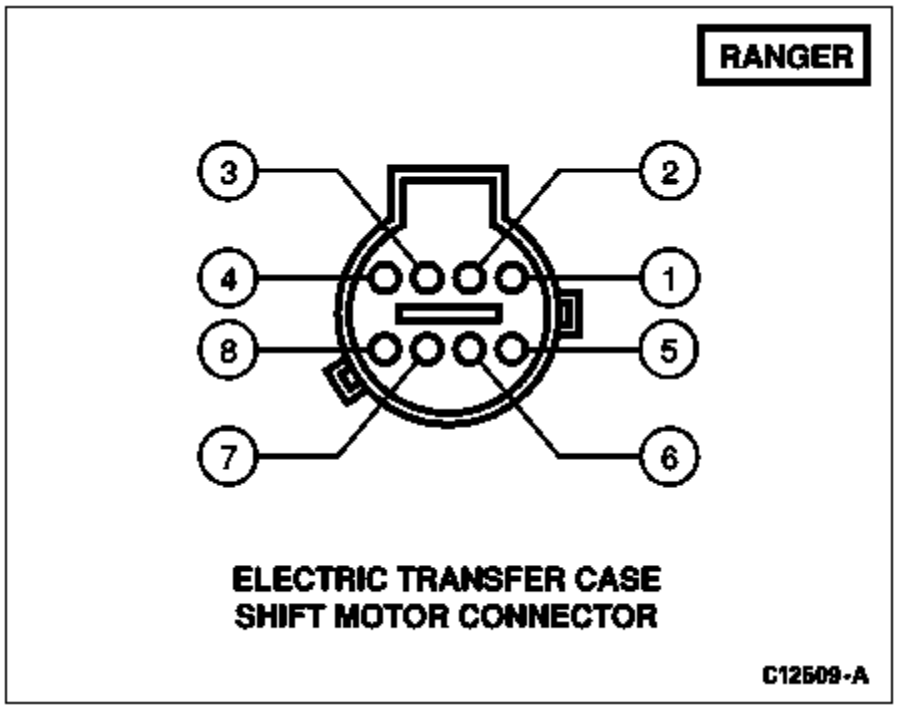
    Install the transfer case shift motor and three bolts. Tighten to 8-11 Nm (71-97 lb-in).

36. Holding the slotted support bracket tight against the motor housing end, secure the bracket to the transfer case, tightening the bolt with lockwasher to 8-11 Nm (71-97 lb-in).

37. Retighten the two nuts that attach the slotted support bracket to the end of the motor to 3-4 Nm (27-35 lb-in).



38. Install the brown clutch coil wire to the No. 8 terminal. Install the red locking sleeve.



Pin Number	Circuit	Circuit Function
1	770 (W)	Electrical Shift 4x4 Module to Motor Position No. 4
2	764 (BR/W)	Electrical Shift 4x4 Module to Motor Position No. 3
3	763 (O/W)	Electrical Shift 4x4 Module to Motor Position No. 2
4	777 (Y)	Electrical Shift 4x4 Module to Motor Control Counterclockwise
5	771 (P/Y)	Electrical Shift 4x4 Module to Motor Position No. 5
6	762 (Y/W)	Electrical Shift 4x4 Module to Motor Position No. 1
7	778 (O)	Electrical Shift 4x4 Module to Motor Control
8	779 (BR)	Electrical Shift 4x4 Module to Electric Clutch

39. Install the speedometer drive gear to the rear case bore. Drive the yoke to flange seal into the rear case bore with Output Shaft Seal Replacer T83T-7065-B and Driver Handle T80T-4000-W.

40. Install the rear case yoke on the output shaft. Install the rubber seal, output shaft yoke washer and nut. Tighten the nut to 339-381 Nm (250-280 lb-ft).

41. Install the drain plug and tighten to 19-30 Nm (14-22 lb-ft).

42. Install the front case yoke, rubber seal, output shaft yoke washer and the nut to front output shaft. Tighten the nut to 250-275 Nm (184-203 lb-ft).

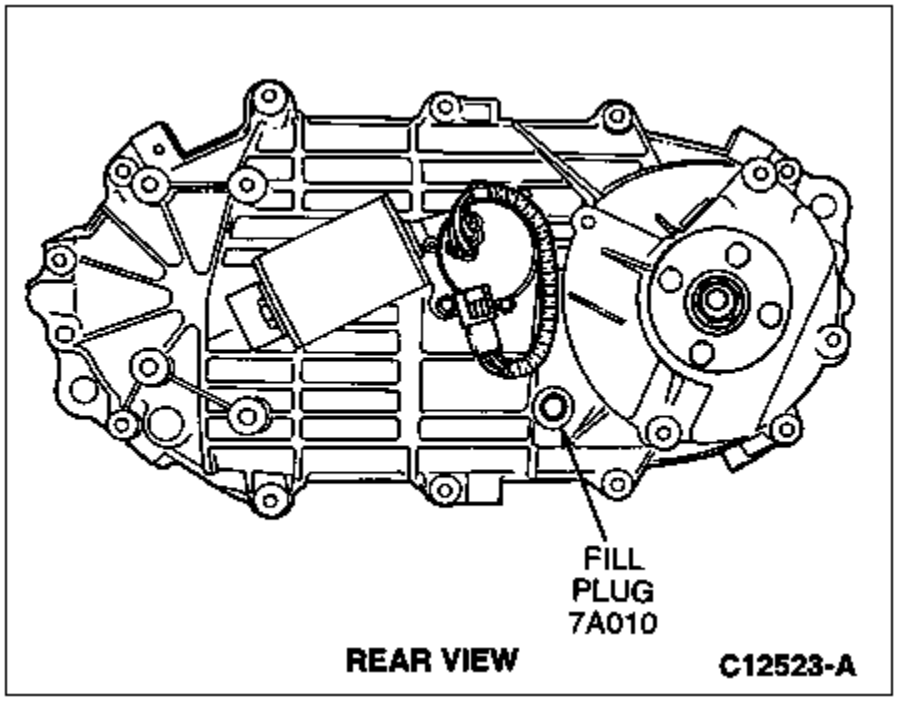
43. Place a 3/8-inch drive ratchet in the fill plug and remove the plug. Fill the transfer case with 1.2 liters (2.5 U.S. pints) of Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid WSP-M2C185-A or equivalent.

44. Install the fill plug and tighten to 19-30 Nm (14-22 lb-ft).

45. Install the Transfer Case as outlined in the installation portion of this section.

Fluid Level Check

Remove the fill plug from the rear case (7005). Fluid level should be just below the fill plug hole. If the fluid level is below this level, fill with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid WSP-M2C185-A or equivalent to the correct fill level. Reinstall the fill plug and tighten to 19-30 Nm (14-22 lb-ft).



SPECIFICATIONS

BORG-WARNER 13-54 TRANSFER CASE
LUBRICANT CAPACITY

Lubricant	Capacity		
	Liters	Imperial Pints	U.S. Pints
Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid, WSP-M2C185-A or Equivalent	1.2	2.1	2.5

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft
Breather Vent	8-19	6-14
Cover to Case Bolts	31-41	23-30
Damper Bolts	34-48	25-35
Drain and Fill Plug	19-30	14-22
Front Driveshaft Yoke Bolts	16-22	12-16
Skid Plate to Frame Bolt	20-27	15-20
Transfer Case to Transmission	34-48	25-35
Rear Output Driveshaft Nut	339-381	250-280
Front Output Driveshaft Nut	250-275	184-203
Electric Shift Motor Mount Bolts, Motor Bracket Bolt and Clutch Coil Nuts	8-11	71-97 (Lb-In)
Motor Bracket Nuts	3-4	27-35 (Lb-In)
Rear Driveshaft Flange Bolts	83-118	61-87
Speedometer Screw	2-3	18-27 (Lb-In)
Main Drive Gear Bearing Retainer to Front Case Bolts	31-41	23-30

BORG-WARNER 13-54 ELECTRONIC SHIFT TRANSFER CASE

Clutch System

The primary function of the clutch system is to couple and uncouple engine power to the transmission upon driver command. For additional information, refer to Section 08-01 and Section 08-02 .

Engine output is coupled to the transmission input shaft (7017) by friction existing between the clutch disc facings and the flywheel (6375)/ clutch pressure plate (7563) assembly. The extent of this friction is directly related to the composition of the facing material and the magnitude of the clamping forces exerted by the clutch pressure plate and flywheel on the facings. These factors limit the amount of torque that can be transmitted without slippage.

The clamping force is obtained from a diaphragm spring contained within the clutch pressure plate assembly. This force is developed during the attachment of the clutch pressure plate assembly to the flywheel.

Disengagement of the clutch by depressing the clutch pedal (7519) is accomplished when the release fingers are fully displaced toward the flywheel. This displacement removes the Belleville spring load from the clutch pressure plate and eliminates the coupling friction between the engine and the transmission.

The release fingers are moved by the clutch release hub and bearing (7548), which receives its motion through a control system from the clutch pedal. The partial finger displacement does not release the clutch but results in lower coupling friction which can cause slippage under load.

The secondary function of the clutch pressure plate and clutch disc (7550) assemblies is to aid in isolating engine power pulses from the remainder of the powertrain.

The weight of the clutch pressure plate assembly adds to that of the flywheel and improves its function as a vibration damper.

Contained within the clutch disc assembly are several coil springs. These springs, along with a controlled amount of friction between the hub and the drive plates, also absorb engine pulsations.

The spring and friction characteristics are tailored to each engine/powertrain/vehicle application. Therefore, only specified clutch discs should be used for replacement.

This system uses a self-adjusting clutch system operated by hydraulic pressure. The clutch release fingers are actuated by a constantly running, self-centering clutch release hub and bearing.

The new 2.3/3.0L engine pressure plate utilizes a moving fulcrum point. The fulcrum point moves corresponding to disc wear. The reason for this is to keep consistent finger geometry to maintain constant pedal effort over the life of the clutch disc.

Pedal efforts of conventional clutches increase because of geometry changes in the pressure plate diaphragm spring.

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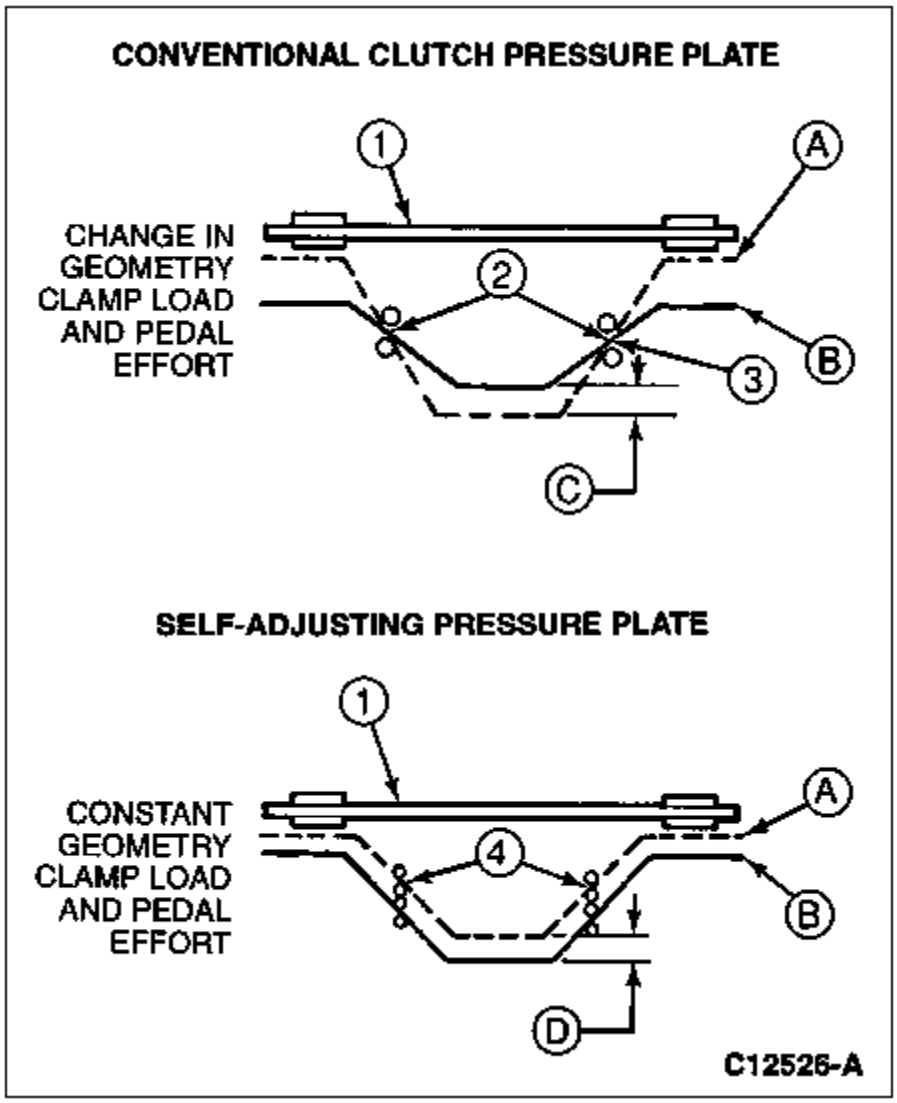

Item	Part Number	Description
1	7550	Clutch Disc
2	—	Fixed Fulcrum (Part of 7563)
3	7563	Clutch Pressure Plate
4	—	Adjustable Fulcrum
A	—	Worn Disc Portion
B	—	New Disc Portion
C	—	10mm (0.3937-Inch) Movement
D	—	2mm (0.07874-Inch) Movement

NOTE: The clutch release hub and bearing is a constant-run, full-angular contact, self-aligning design that will not necessarily require replacement every time the clutch is serviced. The clutch release hub and bearing can be reused and should not be replaced unless roughness, binding or any other service condition is noted.

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For more information, refer to Section 08-01 and Section 08-02 .

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Inspection and Verification

1. Verify the vehicle owner's original concern by operating the clutch system to duplicate the condition.
2. Check for obvious damage to any accessible mechanical components.
3. Check transmission fluid level and check fluid for specified lubricant.
4. Check the vehicle for signs of brake fluid leakage from clutch system. Refer to Section 08-02 for an illustration of the clutch systems.
5. If the concern(s) remain after the inspection, determine the symptoms and proceed to the Symptom Chart.

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Symptom Chart — Clutch System

CLUTCH SYSTEM

Condition	Possible Source	Action
• Clutch Slippage	• Sticking clutch pedal. • Damaged or weakened diaphragm spring. • Damaged clutch pressure plate. • Worn clutch disc facing. • Hardened or oiled clutch disc facing surface. • Residual pressure in hydraulic system. (Open bleed screw to verify.) • Loose or missing clutch cover to flywheel attachment bolts.	• GO to Pinpoint Test A .
• Clutch Chatter or Shudder **NOTE: A light chatter or shudder in the vehicle when engaging the clutch at low engine rpm is a normal occurrence. Therefore, drivetrain components, particularly the clutch disc and the clutch pressure plate, should not be replaced or rebuilt in an attempt to eliminate this condition.**	• Loose or worn engine mount. • Oil on clutch disc facing. • Damaged clutch pressure plate or has excessive runout. • Hardened or worn clutch disc facing. • Damaged or hardened flywheel surface. • Loose or missing clutch cover to flywheel attachment bolts.	• GO to Pinpoint Test B .

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• Clutch Drag/Hard Shifting	• Insufficient brake fluid. • Leakage of brake fluid. • Air in system. • Cracked diaphragm spring. • Excessive runout or damaged clutch disc. • Rusted or worn clutch disc or input shaft splines. • Oil on facing. • Damaged clutch release hub and bearing. • Manual transmission concern.	• GO to Pinpoint Test C .
• Clutch Pedal Pulsation	• Clutch and brake pedal pivot shaft not properly lubricated. • Excessive flywheel runout. • Uneven pressure plate finger heights.	• GO to Pinpoint Test D .
• Clutch-Related Vibrations	• Engine component grounding against frame. • Accessory drive belt loose or damaged. • Loose flywheel bolts. • Excessive flywheel runout. • Imbalanced clutch pressure plate. • Loose pressure plate bolts.	• GO to Pinpoint Test E .
• Fluid Leakage	• Clutch master cylinder. • Clutch slave cylinder. • Hydraulic lines (tubes and connections).	• GO to Pinpoint Test F .
• Excessive Noise	• Damaged clutch release hub and bearing. • Poor lubrication of	• GO to

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	clutch release hub and bearing sleeve. • Damaged or worn pilot bearing. • Excessive crankshaft end play.	Pinpoint Test G .

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Pinpoint Tests

PINPOINT TEST A: CLUTCH SLIPPAGE

A1 VERIFY CLUTCH SLIPPAGE

- Block the wheels and set the parking brake.
- Start the engine, shift into fourth gear and increase engine speed to 2,000 rpm.
- Slowly release the clutch pedal.

Does the engine stall within five seconds?

Yes	No
Clutch is not slipping. RETURN to the Symptom Chart .	GO to **A2** .

A2 INSPECT CLUTCH PEDAL

- Inspect the clutch pedal pivot point for proper lubrication.

Is the clutch pedal pivot point properly lubricated?

Yes	No
GO to **A3** .	LUBRICATE the clutch pedal pivot point.

A3 INSPECT FOR RESIDUAL PRESSURE

- Open bleeder screw.

Is there pressure?

Yes	No
REPLACE master cylinder.	GO to **A4** .

A4 INSPECT CLUTCH ASSEMBLY (DISC/PRESSURE PLATE)

- Remove transmission.

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- Inspect clutch disc for oil or grease.

Is clutch disc contaminated with oil, grease or fluid?

Yes	No
CHECK and REPAIR source of grease, fluid or oil leak. REPLACE clutch disc. REFER to Section 08-01 .	INSPECT clutch disc, clutch pressure plate, and flywheel for wear. REFER to Clutch Pressure Plate or Flywheel Runout Check in this section. REPLACE as necessary. REFER to Section 08-01 for replacement procedures.

PINPOINT TEST B: CLUTCH CHATTER OR SHUDDER

B1 VERIFY CLUTCH CHATTER OR SHUDDER

- Start the engine.
- Depress the clutch pedal and shift the vehicle into first gear.
- Increase the engine speed to between 1,200 and 1,500 rpm.
- Slowly release the clutch pedal and observe the clutch operation.
- Shift the vehicle into REVERSE and repeat test.

Does the vehicle shudder?

Yes	No
GO to **B2** .	No clutch chatter or shudder present. RETURN to the Symptom Chart .

B2 CHECK ENGINE OR TRANSMISSION MOUNTS

- Inspect all engine and transmission mounts for looseness. Refer to Section 02-03 if necessary.

Were any engine or transmission mounts loose or damaged?

Yes	No
TIGHTEN or REPLACE the engine or transmission mounts.	GO to **B3** .

B3 INSPECT CLUTCH PRESSURE PLATE

- Remove the clutch pressure plate. Refer to Section 08-01 .
- Inspect the clutch pressure plate for wear. Check for warping and discolored surface.

Are there any signs of wear present on the clutch pressure plate.

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Yes	No
REPLACE the clutch pressure plate.	GO to **B4** .

B4 CHECK CLUTCH DISC

- Perform the Clutch Disc Inspection procedure in this section.

Is the clutch disc OK?

Yes	No
INSPECT the flywheel for damage (warpage or discoloring from excessive heat). REFER to the Flywheel Runout Check in this section. INSPECT clutch release hub and bearing. REFER to Section 08-02 .	REPLACE the clutch disc.

PINPOINT TEST C: CLUTCH DRAG/HARD SHIFTING

C1 CHECK HIGH SHIFTING EFFORTS

- Set parking brake.
- With shift control selector in reverse, clutch disengaged and engine idling, move shift lever to a position halfway between reverse and neutral.
- Slowly engage clutch.
- Gear clash can now be heard if an attempt is made to shift into reverse with clutch engaged, and reserve can now be measured.
- While maintaining light pressure on shift selector, slowly press clutch pedal toward the floor. At a point in the travel of the clutch pedal the gear clash will stop and the shift selector will slide easily into reverse position. The amount of travel remains until the pedal touches the floor is defined as reserve. If pedal is all the way to the floor before stopping gear clash, clutch pedal reserve is not adequate.

Is there adequate clutch pedal reserve?

Yes	No
Clutch system OK.	GO to **C2** .

C2 CHECK FOR CLUTCH DRAG

- Start engine, press clutch pedal and shift into first gear.
- With clutch pedal still pressed, shift into neutral.
- Wait five seconds and shift into reverse.

Are gears clashing or dragging?

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Yes	No
GO to **C3** .	RETURN to Symptom Chart .

C3 CHECK HYDRAULIC CLUTCH FLUID LEVEL

- Engine off.
- Inspect the fluid level in the clutch master cylinder reservoir.

Is the fluid level full?

Yes	No
GO to **C4** .	ADD brake fluid and CHECK for leaks in the clutch hydraulic system.

C4 CHECK FLUID BYPASS

- Remove cap and seal from clutch reservoir.
- Actuate clutch pedal.

Does fluid level go up and down?

Yes	No
REPLACE clutch master cylinder.	GO to **C5** .

C5 CHECK FOR AIR IN CLUTCH

- Actuate clutch pedal.

Does pedal feel spongy?

Yes	No
Bench BLEED system. REFER to procedure in this section.	REPLACE clutch disc, clutch pressure plate, clutch release hub and bearing. INSPECT splines on input shaft for wear.

PINPOINT TEST D: CLUTCH PEDAL PULSATION

D1 CHECK CLUTCH PEDAL PULSATION

- With vehicle in neutral, start engine and slowly press clutch pedal.

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Does clutch pedal pulsate?

Yes	No
GO to **D2** .	RETURN to Symptom Chart .

D2 CHECK PRESSURE PLATE

- Remove transmission.
- Check pressure plate finger heights.

Are heights even?

Yes	No
GO to **D3** .	REPLACE pressure plate. REFER to Section 08-01 .

D3 CHECK FLYWHEEL RUNOUT

- Remove transmission. Inspect flywheel for excessive runout. Refer to procedure in this section.

Is flywheel runout excessive?

Yes	No
REPLACE as necessary. REFER to Section 08-01 .	INSPECT clutch disc for excessive runout.

PINPOINT TEST E: CLUTCH-RELATED VIBRATIONS

E1 CHECK FOR ENGINE COMPONENT GROUNDING

- Raise the vehicle on a hoist.
- Check the engine mount interlocks for grounding.
- Check the exhaust manifold or other engine component grounding on the body or frame.

Is there evidence of grounding on body or frame?

Yes	No
REPAIR the components as necessary.	GO to **E2** .

E2 CHECK FOR RELEASE BEARING NOISE

- Start the engine.

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Is a whirring, grating or grinding noise present?

Yes	No
REPLACE the clutch release hub and bearing. REFER to Section 08-02 .	GO to **E3** .

E3 INSPECT FLYWHEEL

- Remove the transmission.
- Inspect for loose flywheel bolts.
- Perform the flywheel runout check in this section.

Is the flywheel OK?

Yes	No
REFER to Section 03-00 to DIAGNOSE the engine vibration concerns.	TIGHTEN or REPLACE the flywheel.

PINPOINT TEST F: FLUID LEAKAGE

F1 INSPECT CLUTCH MASTER CYLINDER

- Inspect clutch master cylinder (from underneath dash also).
- Check all tube connections.
- Inspect clutch slave cylinder.

Is clutch hydraulic system leaking?

Yes	No
REPLACE parts as necessary. REFER to Section 08-01 and Section 08-02 . BLEED system. REFER to Bleed Procedure in this section.	Clutch hydraulic system OK.

PINPOINT TEST G: EXCESSIVE NOISE

G1 CHECK HYDRAULIC CLUTCH FLUID LEVEL

- Check the fluid level in the clutch master cylinder.

Is the fluid level full?

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Yes	No
GO to **G2** .	ADD brake fluid and CHECK clutch hydraulic system for leaks. BLEED system.

G2 CHECK RELEASE HUB AND BEARING

- Remove the transmission. Refer to Section 07-03 .
- Inspect the clutch release hub and bearing for wear or loss of lubrication.

Are there any signs of wear or loss of lubrication?

Yes	No
REPLACE the clutch release hub and bearing.	GO to **G3** .

G3 CHECK PILOT BEARING

- Inspect the pilot bearing for damage. Refer to the Inspection procedures in this section.

Is the pilot bearing OK?

Yes	No
GO to **G4** .	REPLACE the pilot bearing. REFER to Section 08-01 .

G4 CHECK TORSION SPRING

- Inspect the torsion spring for fatigue.

Are there any signs of fatigue?

Yes	No
REPLACE the clutch disc. REFER to Section 08-01 .	INSPECT the crankshaft end play. REFER to Section 03-00 .

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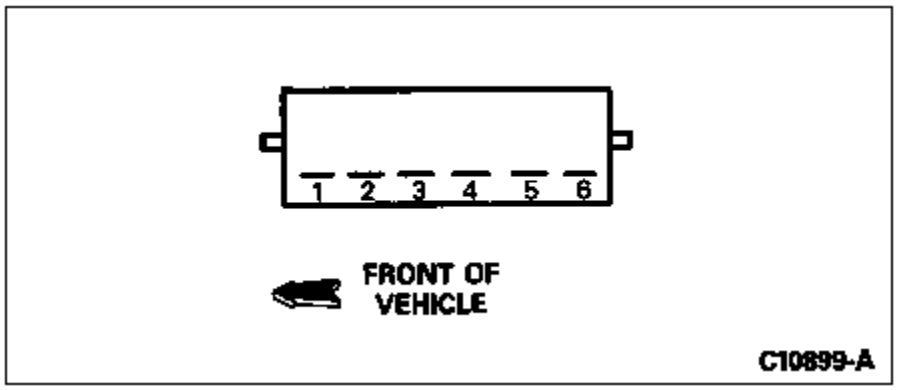
Component Tests

Clutch Pedal Position Switch Operation

1. To check the clutch pedal position switch (CPP) (11A152) for proper starting function, disconnect the wiring harness from the clutch pedal position switch.

2. Using an ohmmeter, probe Pins 1 and 2 for continuity. The indicator should read OPEN while moving the pedal from a full up position to within approximately 25mm (1 inch) of full travel. Measurement beyond this point should be a CLOSED reading (0 ohms).



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Dowels, Flywheel Housing to Block

Removal and Installation

1. Remove the transmission. Refer to the procedure in Section 07-03 .

2. **NOTE: Flywheel housing to block dowels (6397) should be pulled or driven from their seat. Do not damage surface area around the flywheel housing to block dowel.**

   Use a drift pin on through holes and vice grip pliers or a similar tool on blind holes to remove flywheel housing to block dowels.

3. **NOTE: Drive flywheel housing to block dowel squarely into place until fully seated. Do not damage the surrounding surface area.**

   Install all solid type flywheel housing to block dowels by driving into place using a brass or plastic mallet.

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Dowels, Flywheel

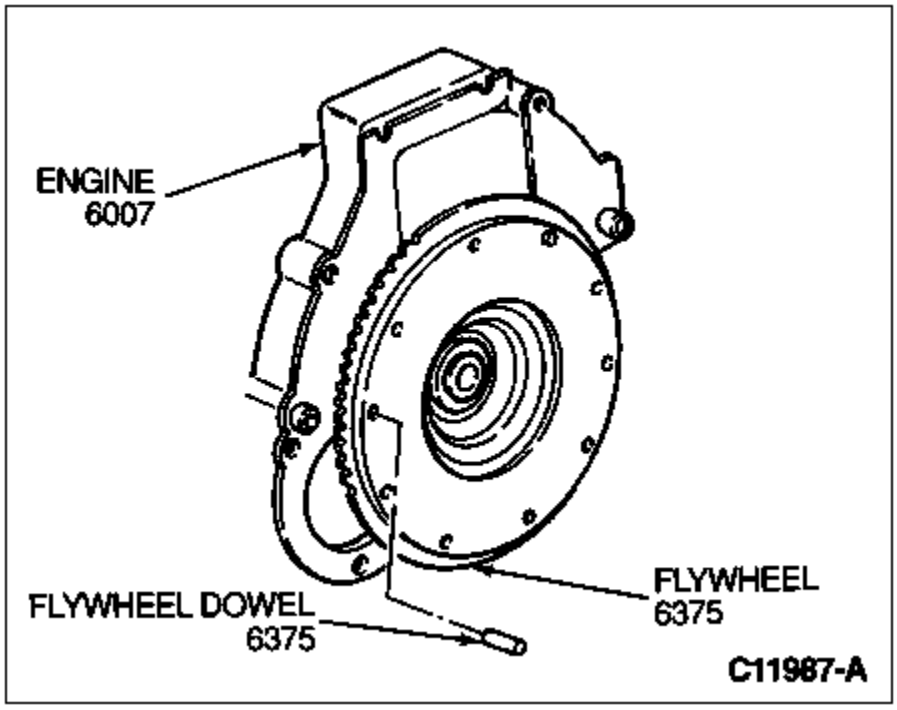
Removal

Prior to dowel removal, you must remove the clutch pressure plate. Refer to Section 08-01 for procedure.

Dowels can be removed by using a drift pin where the dowel is installed in a drilled hole and vise grip pliers where the dowel is installed in a blind hole. They should be pulled or driven from their seat, taking care not to damage dowel hole or surface area around dowel during removal.

Installation

All dowels can be installed by driving them into place using a brass or plastic mallet. Care should be exercised to drive the dowel squarely into place until fully seated and not to damage surrounding surface areas.



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Clutch Pressure Plate

1. **CAUTION: Do not use cleaners with a petroleum base, and do not immerse the clutch pressure plate (7563) in the solvent.**

   NOTE: The Belleville design clutch pressure plates do not need to be lubricated.

   Clean clutch pressure plate and flywheel (6375) with a suitable commercial alcohol base solvent so surfaces are free from any oil film.

2. Inspect surface of clutch pressure plate for burn marks, scores, flatness or ridges.

3. If the clutch pressure plate is badly heat-checked or deeply scored, replace clutch pressure plate and cover assembly.

4. Check clutch pressure plate finger heights with pressure plate installed.

5. If a substantial difference in finger wear exists, the heavily worn finger is binding. Replace the clutch pressure plate.

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Clutch Disc

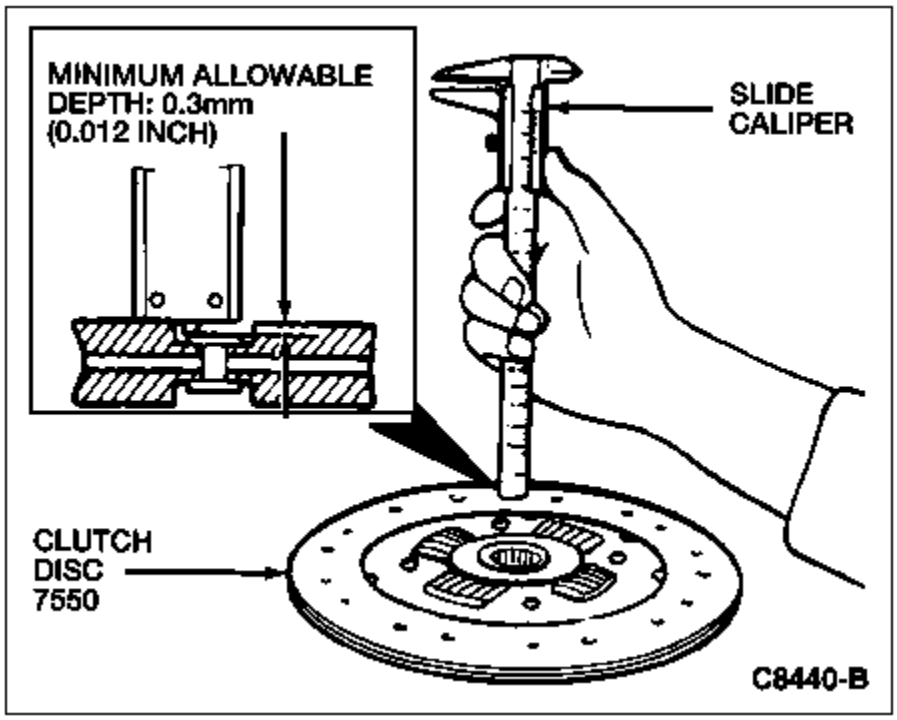
1. **NOTE: Replace clutch disc (7550) if any of these conditions are present. When installing a new clutch disc, do not drop or contaminate with oil or grease.**

   Inspect the clutch disc facings for oil or grease. Eliminate the source of any oil or grease before replacing the clutch disc.

   - An excessive amount of grease on the clutch release hub and bearing (7548) will find its way to the clutch disc facings.
   - Too much lubricant in the transmission or a plugged transmission vent will force the transmission lubricant out the input shaft (7017) and onto the disc facings.
   - Leaking rear engine seals or loose or unsealed flywheel housing attaching bolts allows engine oil to flow onto the disc facings.

2. **NOTE: Use emery cloth to remove minor imperfections in the clutch disc lining surface.**

   Check for worn clutch disc lining. Measure the depth to the rivet heads with a slide caliper or depth micrometer. The minimum allowable depth is 0.3mm (0.012 inch).



3. Inspect the clutch disc for worn or loose facings.

4. Check the clutch disc for warpage and for loose rivets at the hub.

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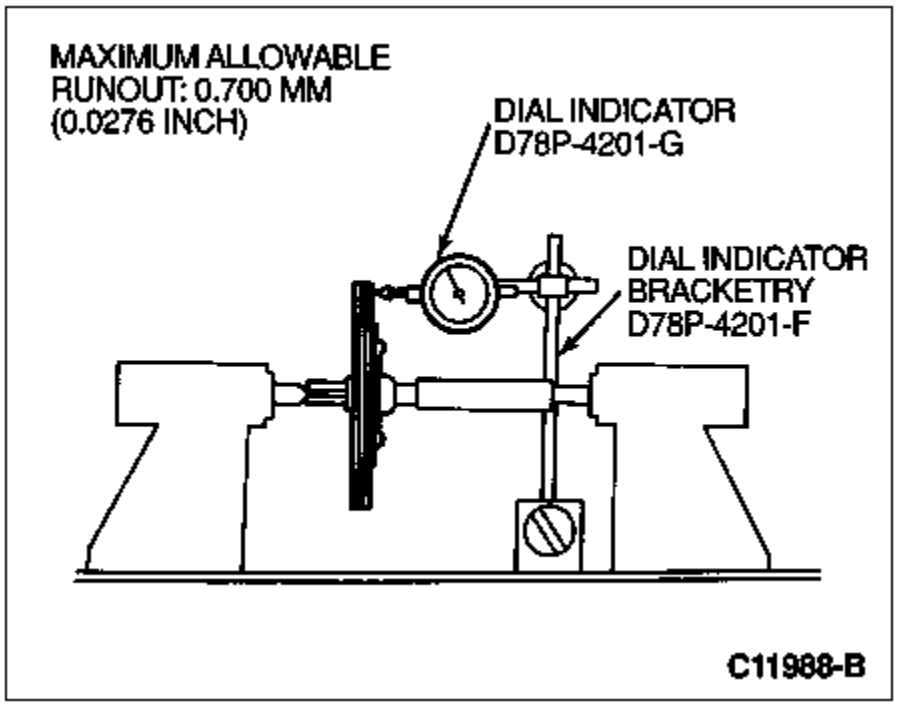
5. Check for broken springs.

6. Check the runout of the clutch disc using Dial Indicator D78P-4201-G and Dial Indicator Bracketry D78P-4201-F or equivalent. The maximum allowable runout is 0.700mm (0.0276 inch).



7. Check for wear or rust on the splines and remove with an emery cloth.

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Flywheel

1. Inspect flywheel (6375) for cracks, heat checks or other damage.
2. Machine friction surface of flywheel if scored or worn.
3. If more than 1.143mm (0.045 inch) of stock from original thickness of flywheel needs to be removed, replace flywheel.

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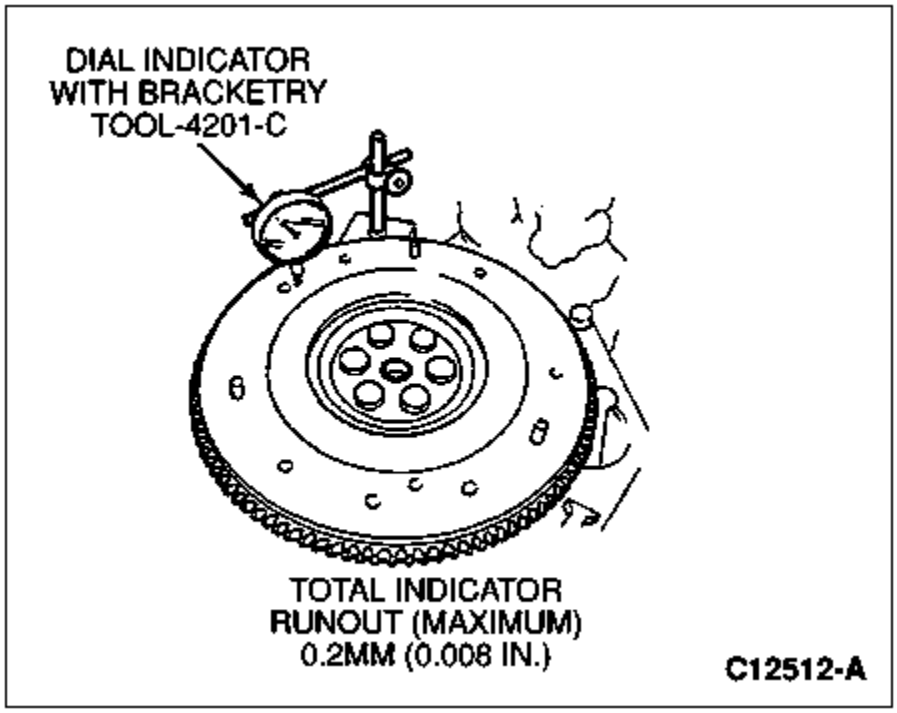
Flywheel Runout Check

1. Install Dial Indicator D78P-4201-G and Dial Indicator Bracketry D78P-4201-F or equivalent so that the indicator point contacts the flywheel (6375) face. Turn the flywheel, making sure to hold it in the full forward or rearward position so that the crankshaft end play will not be indicated as flywheel runout.

2. If the clutch face runout exceeds specification, remove the flywheel and check for burrs between the flywheel and face of the crankshaft mounting flange. If no burrs exist, check the runout of the crankshaft mounting flange. Replace the flywheel or crankshaft (6303) if the mounting flange runout exceeds the specification of 0.2mm (0.008 inch).



3. Check for damaged or worn ring gear teeth.

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Pilot Bearing

Needle Type

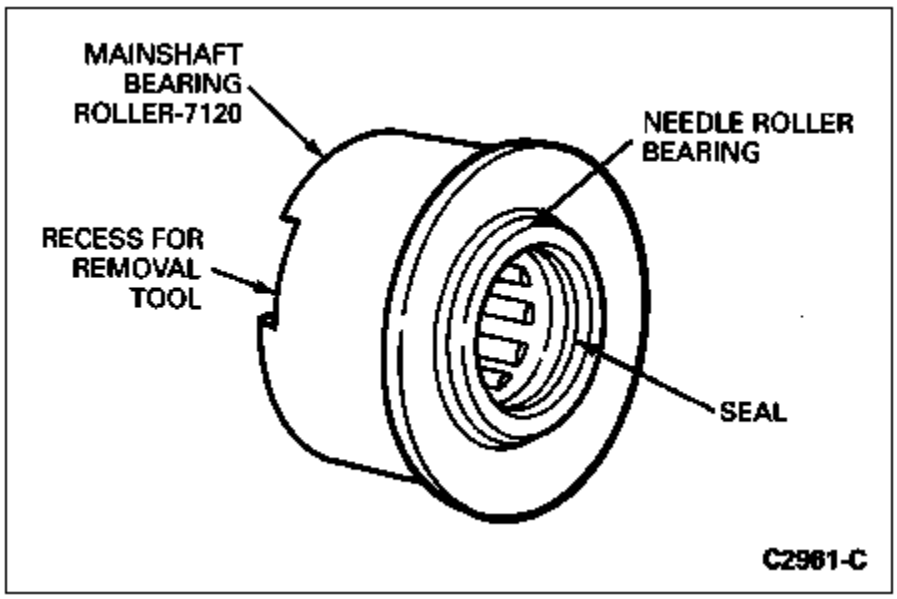
1. **NOTE: Pilot bearing is pressed into crankshaft and should not be loose.**

   Check pilot bearing fit in crankshaft bore.

2. Check the pilot bearing (needle type) for misalignment and press fit condition in crankshaft (6303).

3. Visually inspect the needle rollers and transmission input shaft (7017) for scoring, worn or broken rollers, inadequate grease and discoloration due to heating.

4. Check the condition of the pilot bearing seal. There should be no visible grease leakage on the pilot bearing retainer or the crankshaft. Refer to Section 08-01 .



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Clutch Pedal

Check the clutch pedal (7519) for the following conditions:

- Worn or damaged clutch pedal
- Twisted or bent pedal
- Worn or damaged pedal pad

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Clutch Master Cylinder

1. **CAUTION: Clean all rubber clutch master cylinder parts with specified brake fluid.**

   Clean all of the clutch master cylinder components.

2. Check the clutch master cylinder (7A543) for damage to any reservoir components.

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Cylinder Clutch Slave

1. Clean all of the cylinder clutch slave components.

2. Check the clutch slave cylinder (7A508) for the following conditions:

   - Weak spring
   - Worn or damaged piston cup
   - Worn or damaged boot
   - Leaking fluid

3. Check for traces of fluid inside the clutch housing portion of the case (7005). If fluid is visible, replace clutch slave cylinder. Refer to Section 08-02 .

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Clutch Pedal

The clutch pedal (7519) is self-adjusting. Whenever the clutch system is serviced the clutch pedal must be pumped at least five times to set tension.

Bench Bleed

The downward angle of the clutch master cylinder (7A543) makes it difficult for air to escape up into the reservoir. Therefore, if the clutch master cylinder is removed from the vehicle and bled while held in a vertical orientation (a bench bleed), air can escape much more efficiently.

Clutch Master Cylinder

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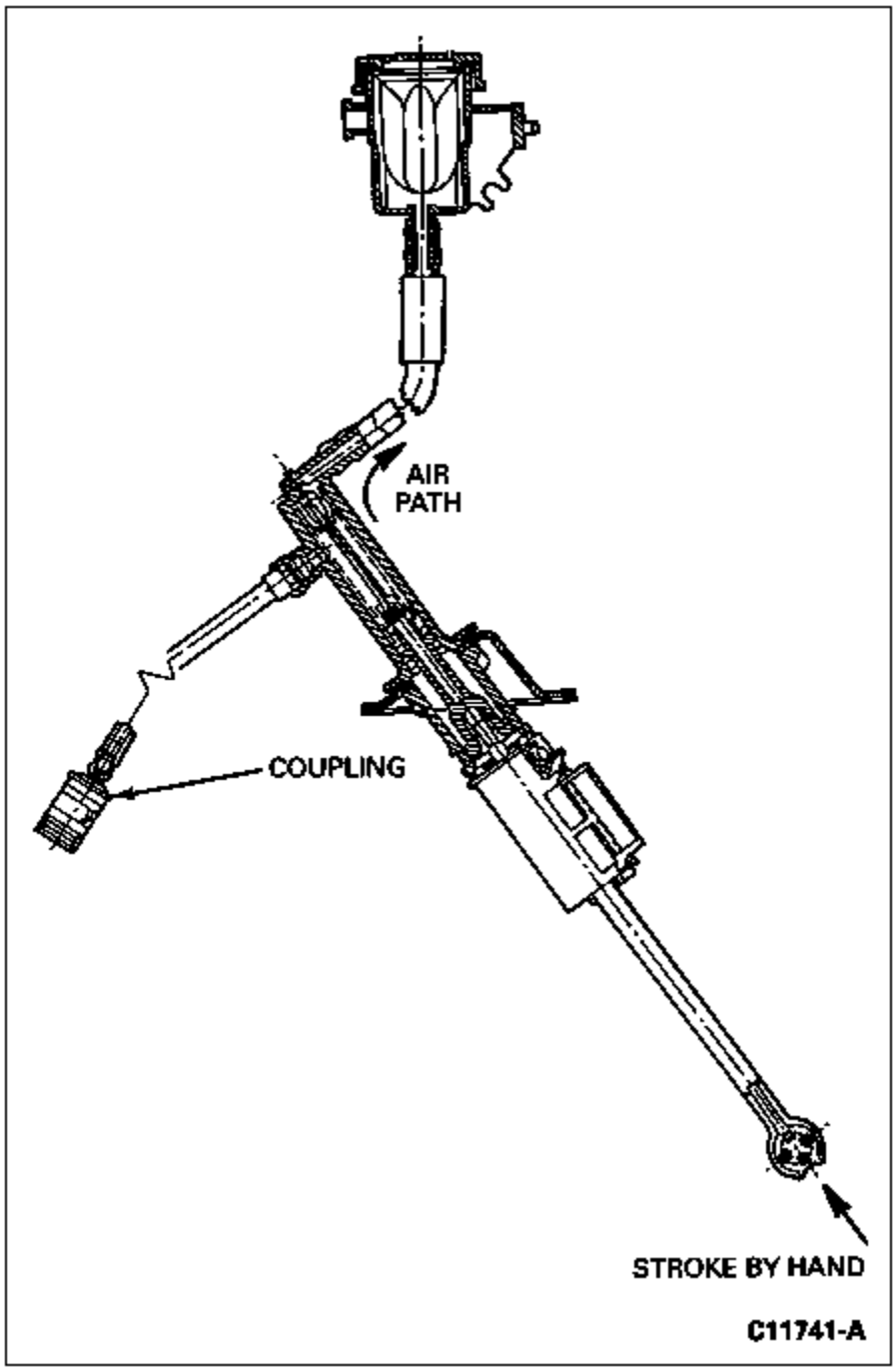

1. Start with tube and reservoir attached to clutch master cylinder, but system removed from vehicle. Lightly clamp reservoir is a vise.

2. Hold the clutch master cylinder vertically with reservoir feed hose in the highest position on the body.

3. Fill reservoir and extend above clutch master cylinder and make sure the quick connect on clutch line is below the clutch master cylinder.

4. Using a small screwdriver, depress the internal mechanism of the male quick connect coupling to open the valve.

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5. Stroke and hold master cylinder push rod.
6. Close quick connect valve.
7. Release master cylinder push rod.
8. Fill reservoir.
9. Repeat Steps 4 through 8 four more times.
10. With the clutch master cylinder still being held with the outlet tube and reservoir feed tube ends high, quick connect closed and the reservoir full, push the push rod into the body several times quickly to expel any remaining air. (If remote reservoir, pinch supply hose with fingers two or three times to help move air into reservoir.)
11. When the movement of the push rod is 4mm (.160 inch) or less when stroked in Step 10 above, the clutch master cylinder may be reinstalled into the vehicle and coupled to the concentric clutch slave cylinder.

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Bleed Procedure

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Clutch Coupling Tool	T88T-70522-A

1. Disconnect the coupling at the transmission with Clutch Coupling Tool T88T-70522-A by sliding the white plastic sleeve toward the clutch slave cylinder (7A508) while applying a slight tug on the clutch tube.
2. Clean dirt and grease from around the reservoir cap.
3. Remove cap and diaphragm and fill reservoir to the step with Ford High Performance DOT 3 Brake C6AZ-19542-AB or DOT 3 equivalent fluid meeting Ford specification ESA-M6C25-A. By hand, apply 22-33 kg (10-15 lbs.) to clutch pedal (7519); if pedal is hard (6-13mm [.25-.50-inch] movement), skip to Step 9. If pedal is spongy, proceed to next step.
4. Using a small screwdriver, depress the internal mechanism of the male coupling to open the valve. While continuing to hold the valve open, slowly depress the clutch pedal to the floor and hold.
5. Remove the screwdriver from the coupling, closing the valve.
6. Release the clutch pedal.
7. **NOTE: The reservoir must be kept full at all times to ensure there will be no additional introduction of air into the system.**

   Refill reservoir to level at step.
8. Repeat Steps 4 through 7.
9. Close reservoir. Reconnect the coupling to the clutch slave cylinder. Check that the connection is secure by applying a slight tug to the clutch tube.
10. Stroke the clutch pedal as rapidly as possible for five to ten strokes.
11. Wait one to three minutes.
12. Repeat Steps 10 and 11 three more times.
13. Loosen bleed screw (located in the slave cylinder body next to the inlet connection).
14. Depress and hold clutch pedal while tightening bleed screw 3-5 Nm (27-44 lb-in).
15. Refill the reservoir to level at step.
16. The hydraulic system should now be fully bled and should properly release the clutch.

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SPECIFICATIONS

GENERAL SPECIFICATIONS

Item	Specification
Transmission	5-Speed
Clutch Control	Hydraulic
Clutch Pedal Type	Suspended

FLYWHEEL SPECIFICATIONS

Flywheel Runout	
Maximum Runout	0.2mm (0.008 Inch)

CLUTCH SPECIFICATIONS

Description	Specification
Clutch Disc Lining Depth	0.3mm (0.012 Inch) Minimum
Clutch Disc Runout	0.7mm (0.0276 Inch) Maximum

TORQUE SPECIFICATIONS

Description	Nm	Lb-In
Bleeder Screw	3-5	27-44

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Clutch System

The primary function of the clutch system is to couple and uncouple engine power to the transmission upon driver command. For additional information, refer to Section 08-02 .

- Engine output is coupled to the transmission input shaft (7017) by friction existing between the clutch disc facings and the flywheel (6375)/ clutch pressure plate (7563) assembly. The extent of this friction is directly related to the composition of the facing material and the magnitude of the clamping forces exerted by the clutch pressure plate and flywheel on the facings. These factors limit the amount of torque that can be transmitted without slippage.
- The clamping force is obtained from a diaphragm spring contained within the clutch pressure plate assembly. This force is developed during the attachment of the clutch pressure plate assembly to the flywheel.
- Disengagement of the clutch (clutch pedal pressed) is accomplished when the release fingers are fully displaced toward the flywheel. This displacement removes the Belleville spring load from the clutch pressure plate and eliminates the coupling friction between the engine and the transmission.
- The release fingers are moved by the clutch release hub and bearing (7548), which receive motion through a control system from the clutch pedal (7519). Partial finger displacement does not release the clutch but results in lower coupling friction which can cause slippage under load.

The secondary function of the clutch pressure plate and clutch disc (7550) assemblies is to aid in isolating engine power pulses from the rest of the powertrain.

- The weight of the clutch pressure plate assembly adds to that of the flywheel and improves its function as a vibration damper.
- Contained within the clutch disc assembly are several coil springs. These springs, along with a controlled amount of friction between the hub and the drive plates, also absorb engine pulsations.
- The spring and friction characteristics are tailored to each engine/powertrain/vehicle application. Therefore, only specified clutch discs should be used for replacement.

NOTE: The clutch release hub and bearing is a constant-run, full-angular contact, self-aligning design that will not necessarily require replacement every time the clutch is serviced. The clutch release hub and bearing can be reused and should not be replaced unless roughness, binding or any other service condition is noted.

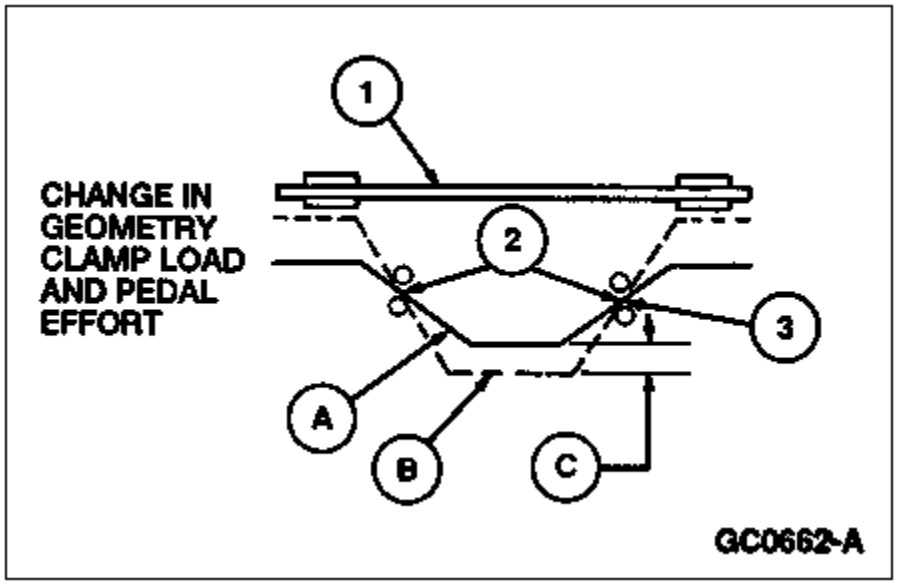
This system uses a self-adjusting clutch system operated by hydraulic pressure. The clutch release fingers are actuated by a constantly running, self-centering clutch release hub and bearing.

Clutch pressure plate assemblies will incorporate a self-adjusting mechanism which extends the normal wear life of these clutch systems. The mechanism consists of plastic ring, located directly under a series of ramps stamped into the top of the pressure plate cover and three small equally spaced coil springs loaded between the ring and the cover through three guide tabs.

The 2.3L/3.0L pressure plate utilizes a moving fulcrum point. The fulcrum point moves corresponding to disc wear in order to keep consistent finger geometry to maintain constant pedal effort over the life of the clutch disc.

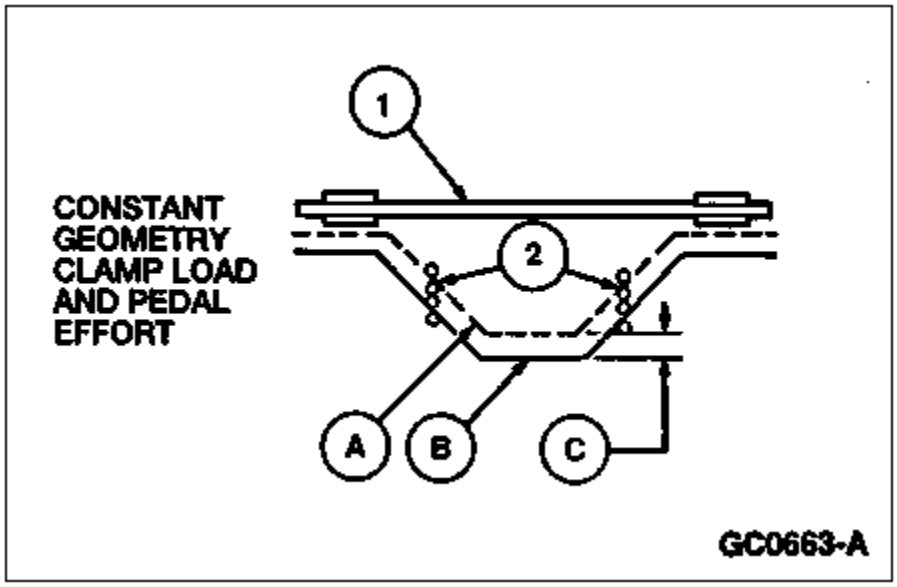
Pedal efforts of conventional clutches increase because of geometry changes in the pressure plate diaphragm spring.

CONVENTIONAL CLUTCH PRESSURE PLATE (4.0L)



Item	Part Number	Description
1	7550	Clutch Disc
2	—	Fix Fulcrum (Part of 7563)
3	7563	Clutch Pressure Plate
A	7563	Worn Disc Position
B	7563	New Disc Position
C	—	10mm (0.3937-Inch) Movement

SELF-ADJUSTING PRESSURE PLATE



Item	Part Number	Description
1	7550	Clutch Disc
2	—	Adjustable Fulcrum (Part of 7563)
A	7563	Worn Disc Portion
B	7563	New Disc Portion
C	——	3mm (0.12 inch) Movement

Disc and Pressure Plate

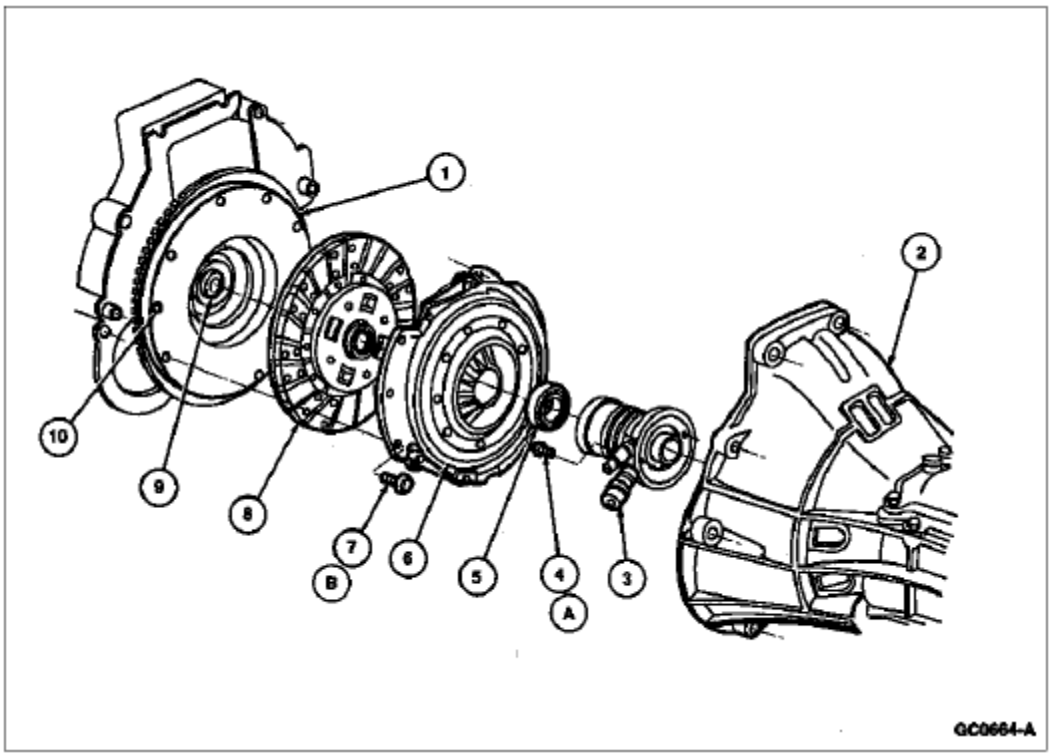
SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Clutch Coupling Tool	T88T-70522-A
Clutch Aligner	T74P-7137-K

Removal

1. Disconnect the battery negative cable.
2. Disconnect clutch hydraulic system master cylinder push rod from clutch pedal (7519).
3. Raise the vehicle on a hoist and position suitable safety stands under vehicle.
4. Remove starter motor (11001).
5. Disconnect the hydraulic coupling at transmission with Clutch Coupling Tool T88T-70522-A. Slide the white plastic sleeve toward clutch slave cylinder, and apply a slight tug on tube.
6. Remove transmission (7003). Refer to Section 07-03 .
7. Check pressure plate finger height variations before removing.

Clutch Disc and Clutch Pressure Plate, Ranger 2.3L, 3.0L, 4.0L



Item	Part Number	Description
1	6375	Flywheel
2	7003	Transmission
3	7A508	Clutch Slave Cylinder
4	N605905-S	Bolt
5	7548	Clutch Release Hub and Bearing
6	7563	Clutch Pressure Plate
7	N802096	Box 7
8	7550	Clutch Disc
9	7120	Transmission Input Shaft Pilot Bearing
10	7K578	Flywheel Dowel Pin
A	—	Tighten to 19-26 Nm (14-19 Lb-Ft)
B	—	Tighten to 23-32 Nm (17-24 Lb-Ft)

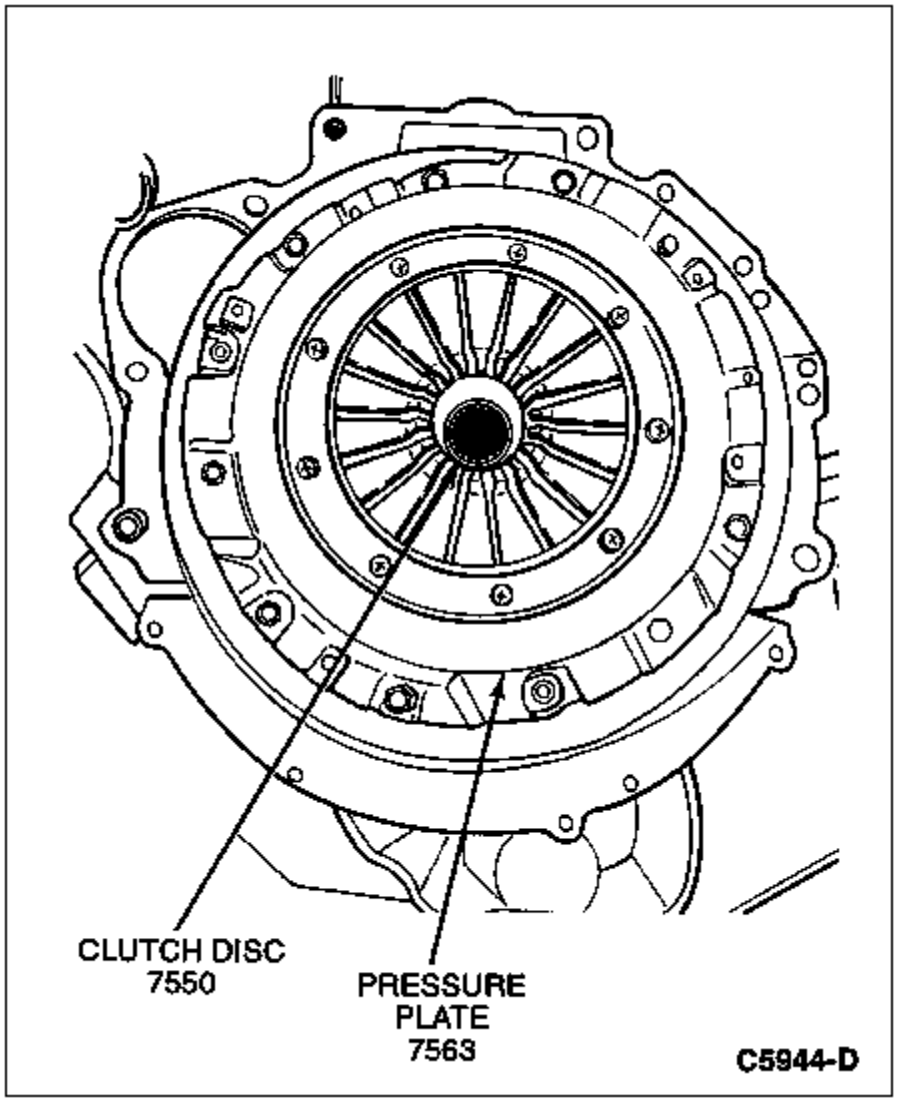
8. Mark assembly position of clutch pressure plate (7563) and cover to flywheel (6375) if installing original components.

9. **CAUTION: If cover and plate are to be reinstalled, bolts must be removed evenly or permanent damage to diaphragm spring will occur causing clutch to not release fully.**

   Loosen clutch pressure plate and cover attaching bolts evenly in a star pattern until clutch pressure plate diaphragm spring is expanded. Remove bolts.

10. Remove clutch pressure plate and clutch disc (7550) from flywheel.

2.3L, 3.0L and 4.0L



Installation

1. **CAUTION: Do not force the adjusting ring. Additional pressure may be required on the diaphragm fingers if the adjusting ring does not turn readily.**

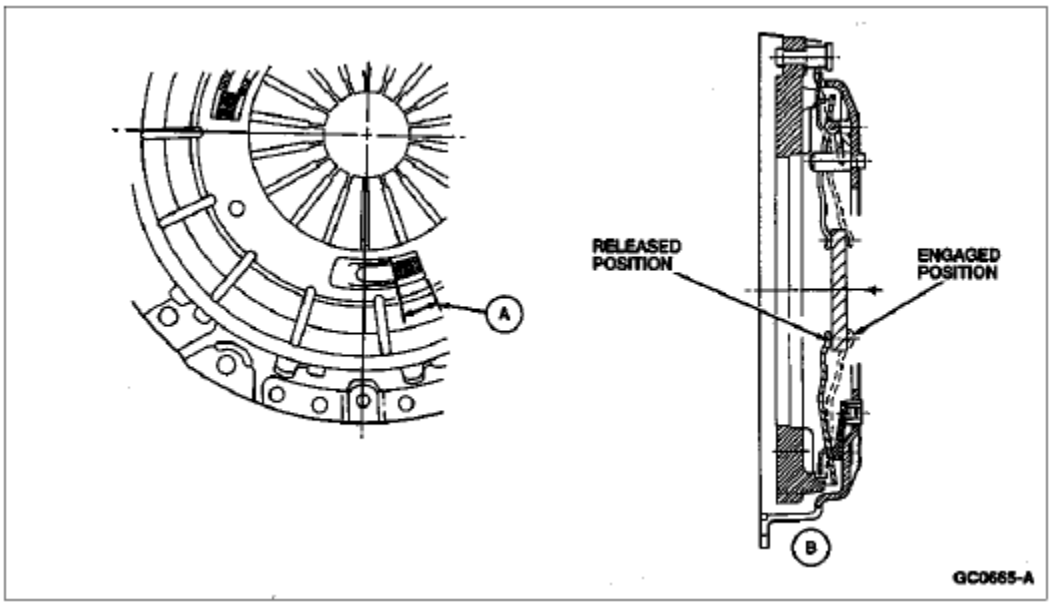
   NOTE: Clean clutch pressure plate and flywheel with a suitable commercial alcohol base solvent so surfaces are free from any oil film.

   NOTE: Do not use cleaners with a petroleum base. Do not immerse the clutch pressure plate in the solvent.

NOTE: It is not necessary to service as a set if procedure below is followed.

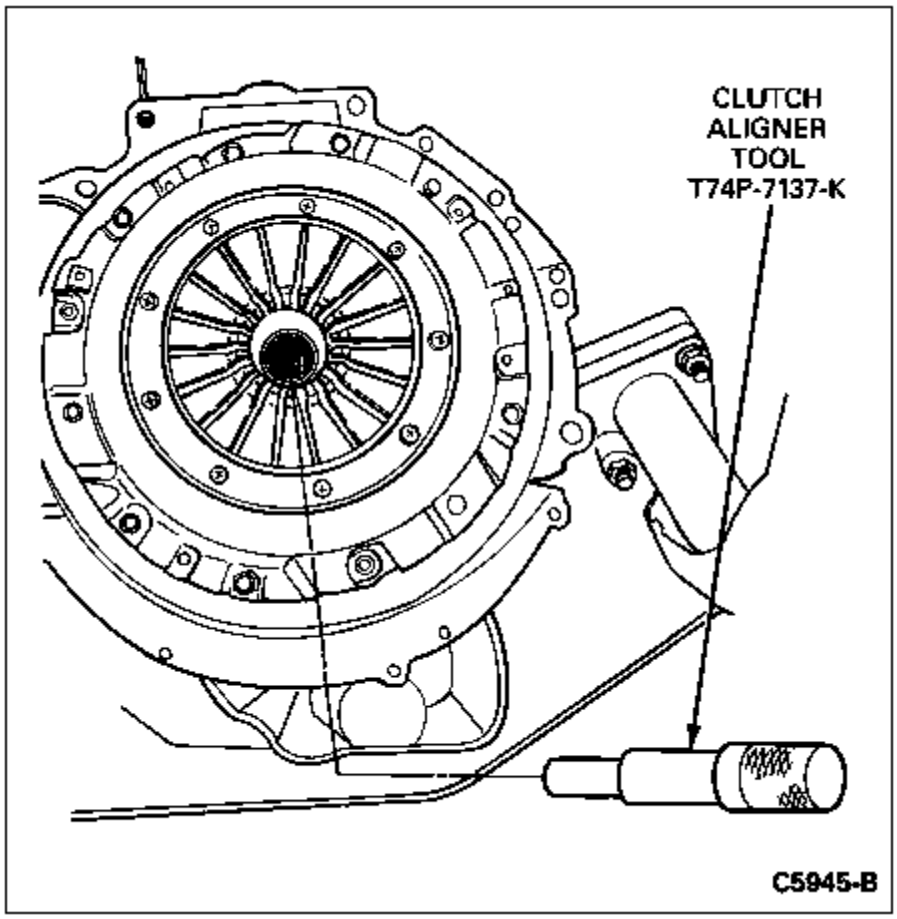
Both new and used clutch cover assemblies should always be adjusted to their new installation position before vehicle installation to ensure that the compressed adjusting ring actuation spring is approximately 14 mm as in A. If not, the cover assembly should be placed on a drill press table and the diaphragm fingers depressed to their released position using a simulated release bearing as shown in B. Minimal pressure in a counter clockwise direction should then be exerted on the adjusting ring in one or more locations to compress the adjusting ring springs to the desired 14 mm of compressed thickness.

Adjustment Indicator



2. Position clutch disc on flywheel so Clutch Aligner T74P-7137-K can enter clutch transmission input shaft pilot bearing (7118) and align clutch disc.

2.3L, 3.0L and 4.0L



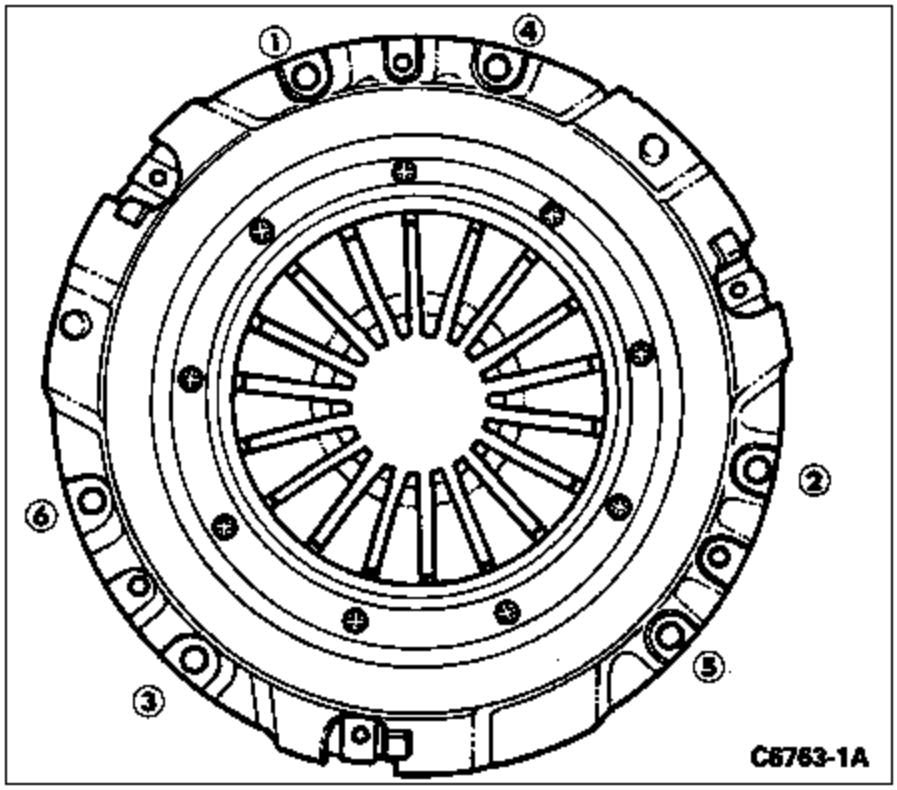
3. When installing original clutch pressure plate and cover, align assembly and flywheel with marks made during removal and with dowels on flywheel.

4. Position clutch pressure plate and cover on flywheel and dowels. Align the clutch pressure plate and clutch disc.

5. Install assembly bolts to flywheel. Tighten bolts to 23-32 Nm (17-24 lb-ft) uniformly in sequence shown.

6. Remove Clutch Aligner T74P-7137K.

2.3L, 3.0L and 4.0L



7. Install transmission. Refer to Section 07-03 .

8. Connect coupling by pushing the male coupling into female coupling of clutch slave cylinder.

9. Connect hydraulic clutch master cylinder push rod to clutch pedal.

10. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.**

    Connect battery negative cable.

11. Bleed clutch system if required. Refer to Section 08-02 .

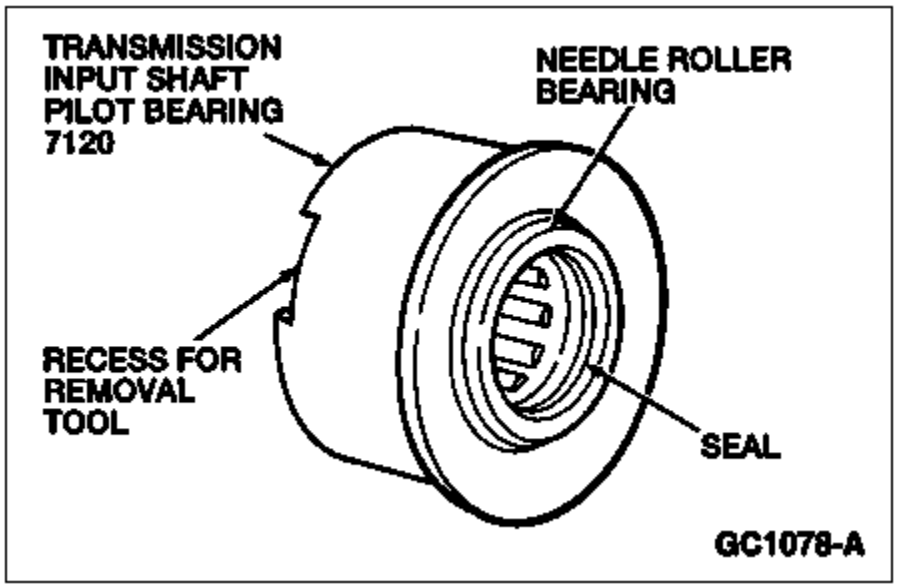
Pilot Bearing

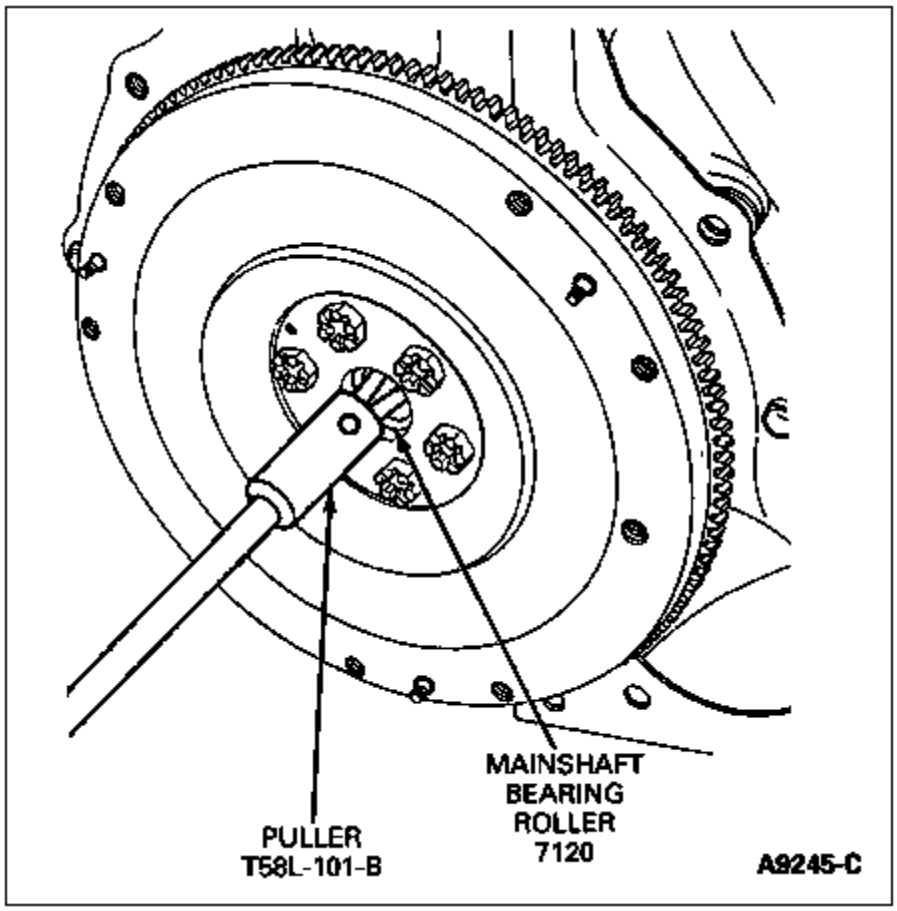
SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Puller	T58L-101-B
Clutch Aligner	T71P-7137-H
Pilot Bearing Replacer	T71P-7137-C

Removal

1. Remove transmission (7003). Refer to Section 07-03 .
2. Remove the clutch pressure plate (7563) and clutch disc (7550) according to the procedures in this section.
3. Using Puller T58L-101-B, remove transmission input shaft pilot bearing (7118).





Installation

WARNING: AVOID USING TOO MUCH LUBRICANT AS IT MAY BE THROWN ON THE CLUTCH DISC WHEN THE CLUTCH REVOLVES.

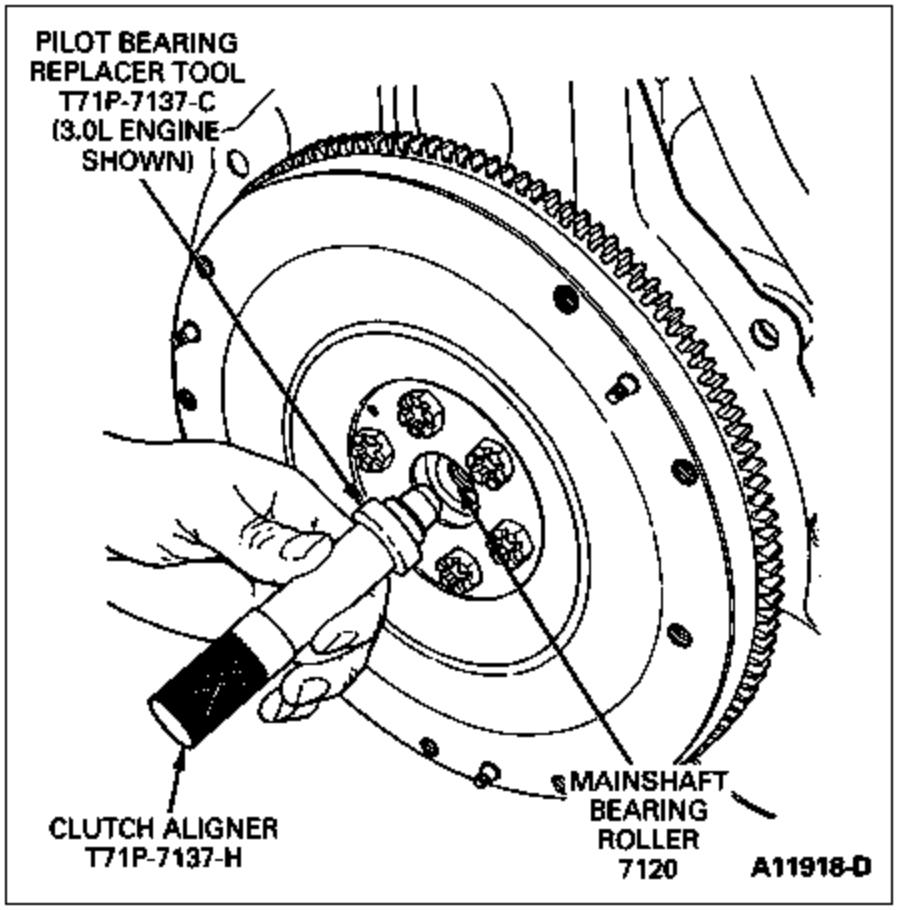
NOTE: The transmission input shaft pilot bearing and seal are pregreased and do not require additional lubrication. A new transmission input shaft pilot bearing must be installed whenever a transmission input shaft pilot bearing is removed.

1. Coat crankshaft pilot bore with a small quantity of Premium Long-Life Grease XG-1-C or -K or equivalent grease meeting Ford specification ESA-M1C75-B.

2. Using Clutch Aligner T71P-7137-H and Pilot Bearing Replacer T71P-7137-C, install transmission input shaft pilot bearing with the seal facing the transmission.

3. **NOTE: Do not damage transmission input shaft pilot bearing during installation of transmission while transmission input shaft (7017) is being inserted into transmission input shaft pilot bearing.**

   Install clutch disc, clutch pressure plate and transmission following the procedures in this section and Section 07-03 .


PILOT BEARING
REPLACER TOOL
T71P-7137-C
(3.0L ENGINE
SHOWN)
MAINSHAFT
BEARING
ROLLER
7120
CLUTCH ALIGNER
T71P-7137-H
A11918-D

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft
Clutch Housing to Engine Block Bolt	38-51	28-38
Pressure Plate to Flywheel Bolt	23-32	17-24
Insulator to Crossmember Bolt	97-127	71-94
Insulator to Transmission	81-108	60-80
Driveshaft U-Bolts	11-20	8-15
Starter to Clutch Housing	21-27	15-20
Crossmember to Right Frame Nut	150-189	110-140
Crossmember to Left Frame Nut — All Except 2.3L (Ranger 4x4)	150-189	110-140
Crossmember to Left Frame Nut — 2.3L (Ranger 4x4) Only	102-129	75-95
Driveshaft to Companion Flange	95-130	70-95
Clutch Housing to Transmission Nut	41-54	30-40

Clutch Pedal

Removal

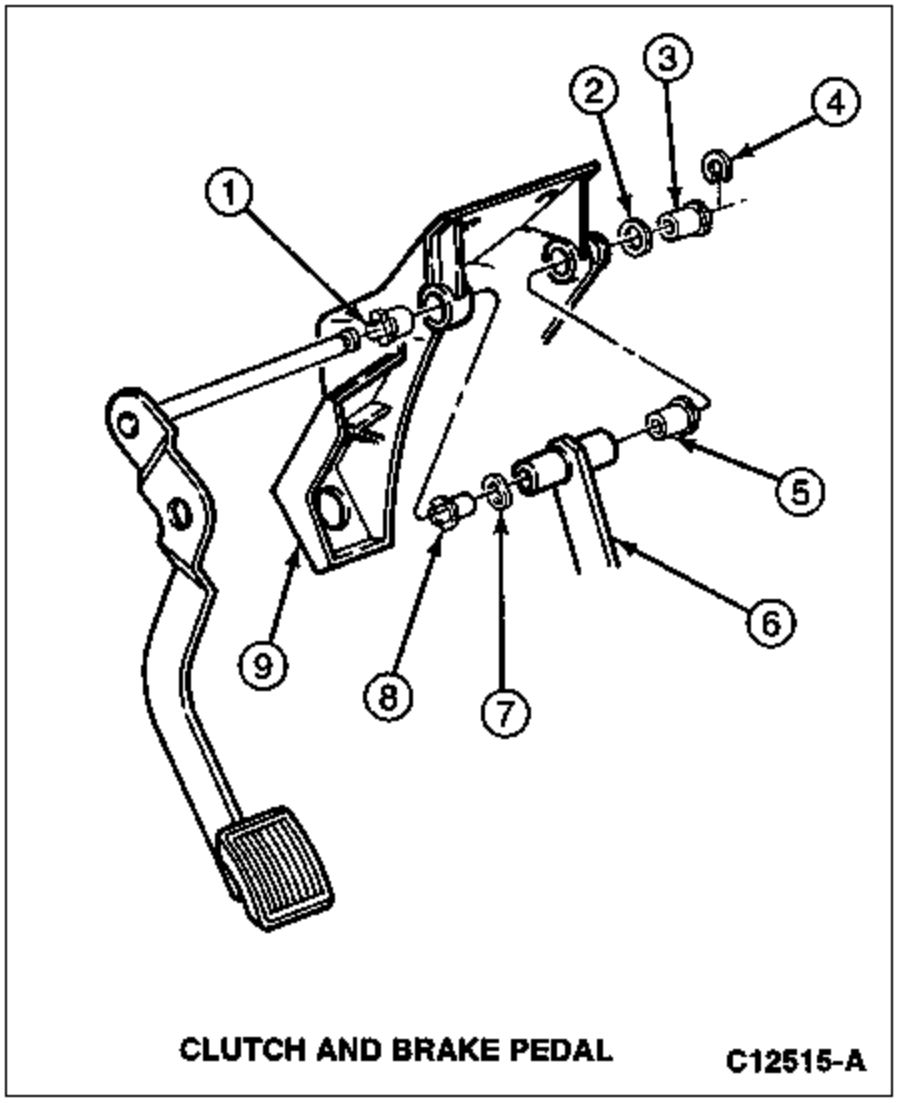
1. Disconnect the clutch master cylinder push rod by prying the retainer bushing and push rod off pedal pin.
2. Remove left side plastic cowl side panel. Refer to Section 01-05A .
3. Remove bolts securing parking brake mechanism. Swing mechanism out of the way.
4. Remove the retainer ring.
5. **NOTE: When the clutch pedal shaft is removed from the bracket, the brake pedal (2455), brake and clutch pedal bushings (2471) and spring washer become accessible.**

   Remove the clutch pedal (7519) from pedal support bracket.

Installation

1. **NOTE: Before installation of the clutch pedal shaft or clutch pedal, remove and inspect the brake and clutch pedal bushings, clean and lubricate with a light film of SAE 30 engine oil or equivalent and replace the brake and clutch pedal bushings if excessive wear is evident.**

   Install clutch pedal shaft through clutch and brake pedal support, brake and clutch pedal bushings, brake pedal and washers (as shown).
2. Install retainer ring.
3. Install clutch master cylinder push rod to pedal pin.
4. Secure parking brake mechanism. Refer to Section 06-05 .
5. Attach left side plastic kick panel.



CLUTCH AND BRAKE PEDAL C12515-A

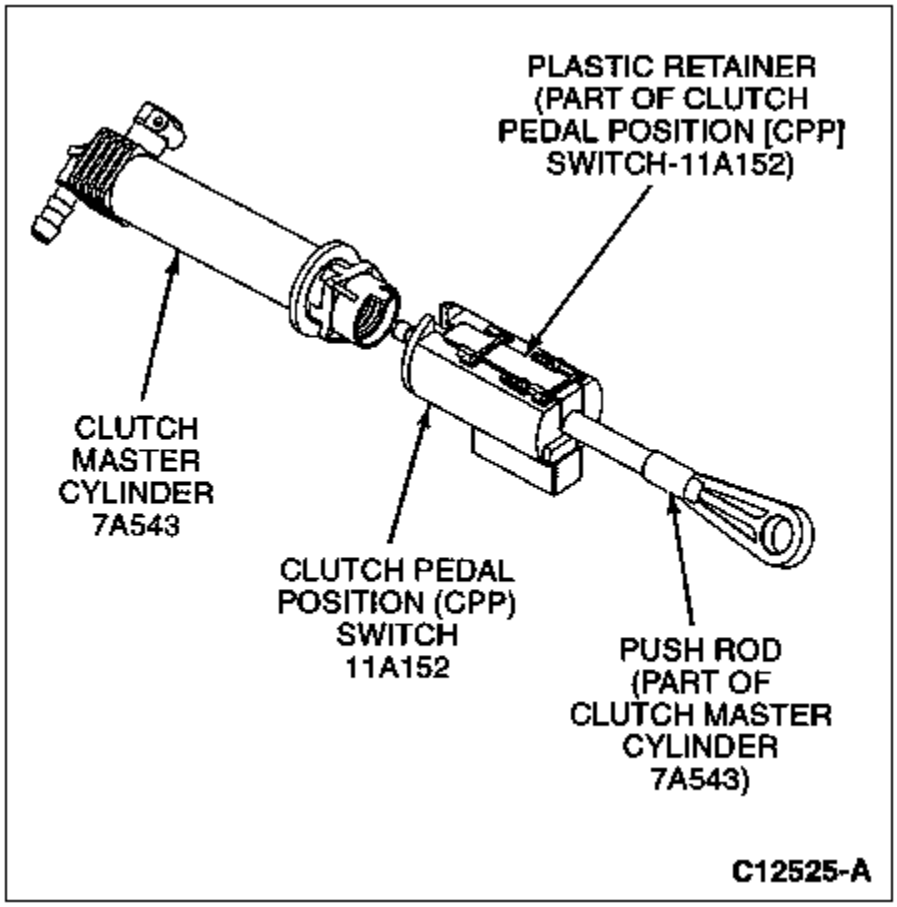
Item	Part Number	Description
1	7508	Bushing
2	353574	Washer
3	7508	Bushing
4	97414	Retainer Ring
5	7508	Bushing
6	2455	Brake Pedal
7	353574	Washer
8	7508	Bushing
9	2L252	Clutch and Brake Pedal Support

Clutch Pedal Position (CPP) Switch

Removal and Installation

1. Disconnect the wiring harness fromclutch pedal position switch (CPP) (11A152).
2. Pull down on orientation clip to separate from switch tab.
3. Rotate clutch pedal position switch one-half turn to expose plastic retainer.
4. Push tabs together and slide retainer rearward and separate fromclutch pedal position switch.
5. Remove clutch pedal position switch from clutch master cylinder (7A543) push rod.

For installation, follow removal procedures in reverse order.



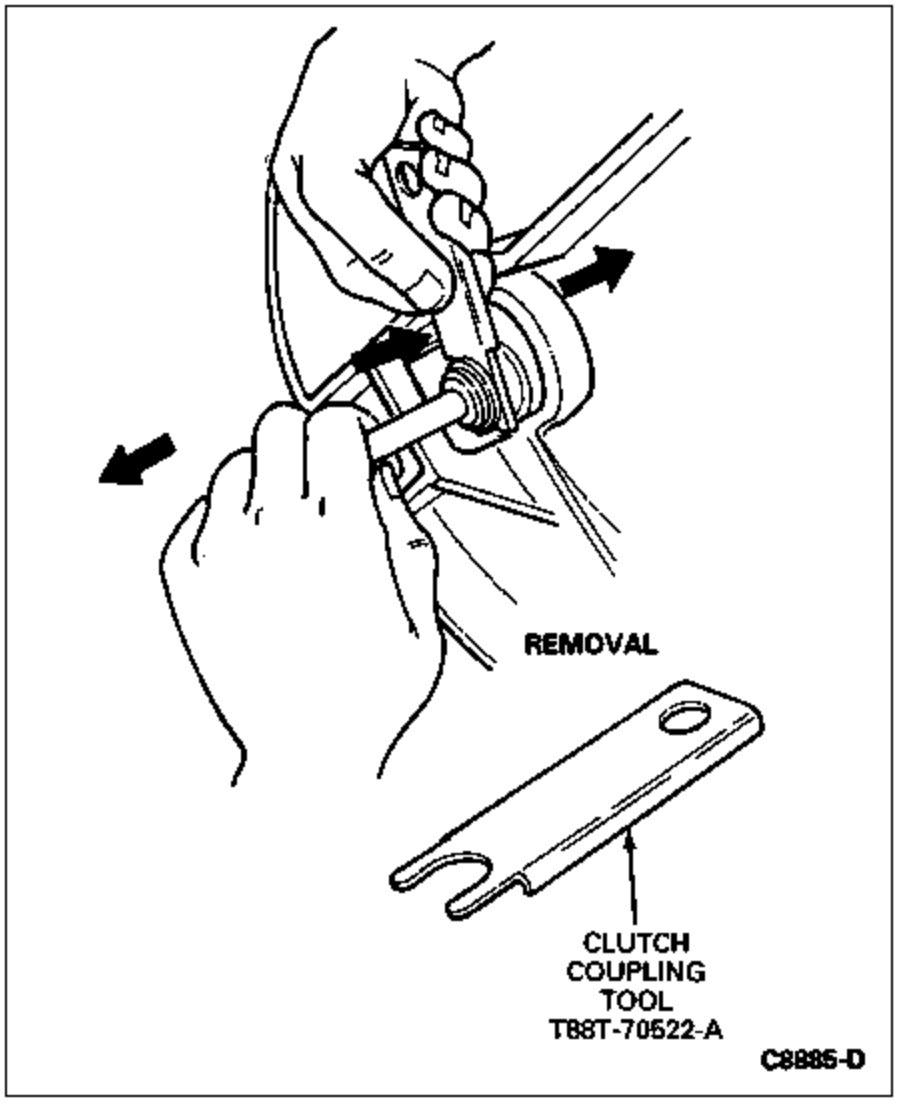
Clutch Slave Cylinder to Clutch Master Cylinder Tube

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Clutch Coupling Tool	T88T-70552-A

Removal and Installation

1. Raise vehicle on a hoist and position suitable safety stands under vehicle.
2. Disconnect the line from the plastic clip at the floor flange.
3. Uncouple the lower end of the line from the clutch slave cylinder using Clutch Coupling Tool T88T-70552-A by sliding the white plastic sleeve toward the clutch slave cylinder while pulling the line away from the clutch slave cylinder.



4. Remove the safety stands and lower the vehicle.
5. Remove clutch master cylinder (7A543) and line assembly.
6. Remove and discard the roll pin holding the line to the clutch master cylinder.
7. Disconnect the line from the clutch master cylinder by applying a slight tug on the line pulling away from the clutch master cylinder.
8. Check to be sure the O-ring is still in the outlet port of the clutch master cylinder. If not, replace.
9. Insert the new line into the clutch master cylinder outlet port.
10. Install a new roll pin to secure the line in place at the clutch master cylinder. Check installation by pulling the line away from the clutch master cylinder outlet port.
11. Bench bleed the system as described in Section 08-00 .
12. If a new line is installed, remove the yellow rubber protective cap and check that the O-ring is in

place. Check the master cylinder port to be sure there is no O-ring in the master cylinder before installing the new line. Insert the male coupling end into the female coupling of the clutch slave cylinder (7A508).

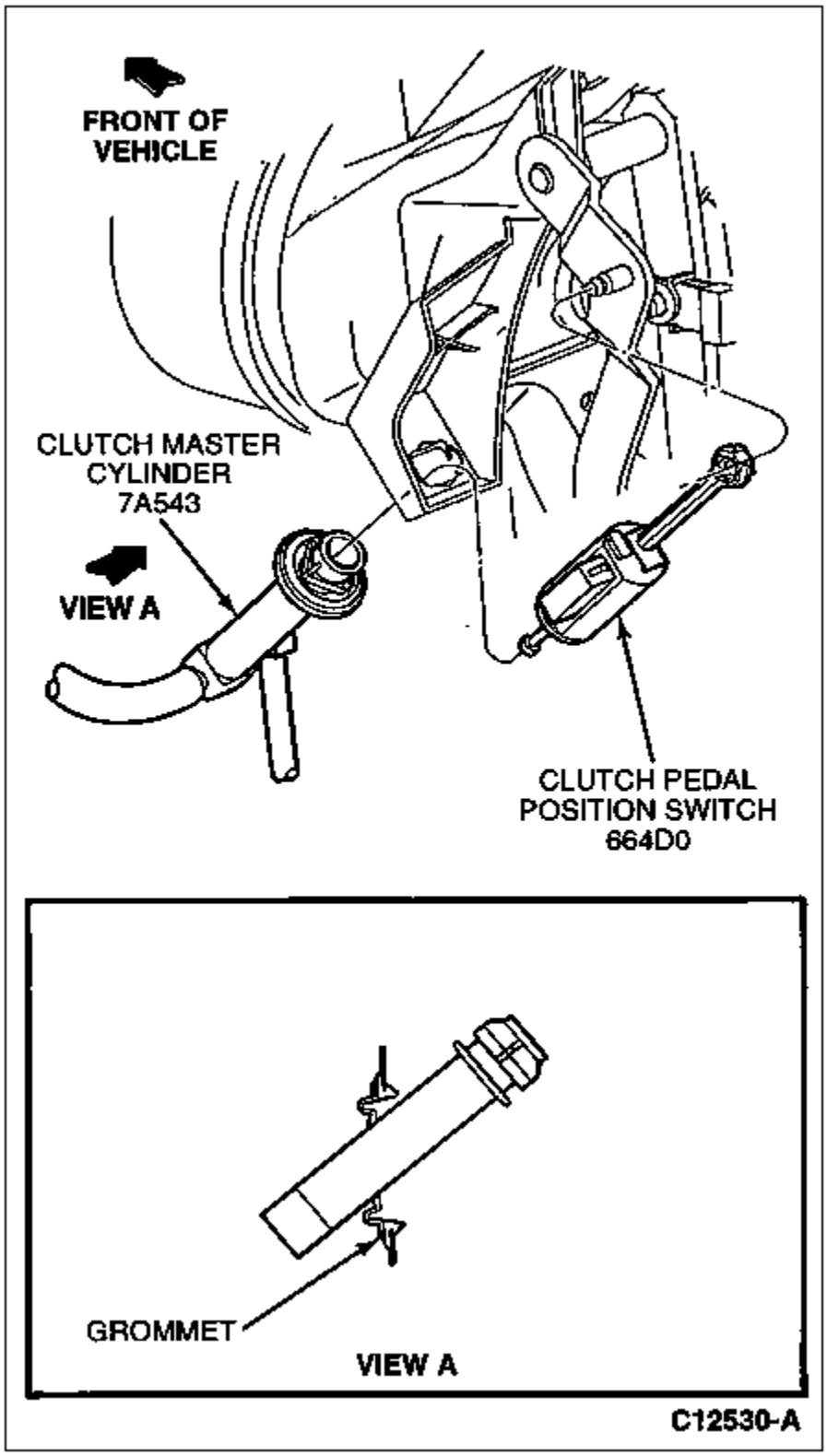
- Once the line is attached to the clutch slave cylinder, check that the connection is secure by applying a slight tug to the clutch tube.

13. Connect the line to the plastic clip at the floor flange.

Clutch Master Cylinder and Reservoir

Removal

1. Disconnect the clutch master cylinder push rod from the clutch pedal (7519) by prying the retainer bushing and push rod off the clutch pedal pin.
2. Remove the clutch pedal position switch (CPP) (11A152) from the clutch master cylinder (7A543). Refer to the procedure in this section.
3. Remove clutch master cylinder reservoir screw from the inner fender panel.
4. Uncouple the line from the clutch slave cylinder. Refer to Removal and Installation, Clutch Slave Cylinder to Clutch Master Cylinder Tube in this section.
5. Disconnect line from the mounting clips.
6. Twist the clutch master cylinder 1/8 turn counterclockwise as viewed from the driver's position, while pushing inward toward the driver's position. The rubber dash boot is removed with the master cylinder.



Installation

1. Bench bleed the clutch master cylinder. Refer to Section 08-00 .
2. Install the push rod through the hole in the engine compartment. Be sure it is located on the correct

side of the clutch pedal.

3. Place the clutch master cylinder in position and rotate the body 1/8 turn clockwise as viewed from the driver's position while pushing inward. Install the dash seal into the dash hole and check that it is completely inserted into the hole.

4. Position the clutch master cylinder reservoir on the cowl access cover and install the retaining screws.

5. Replace clutch master cylinder push rod retainer bushing if worn or damaged.

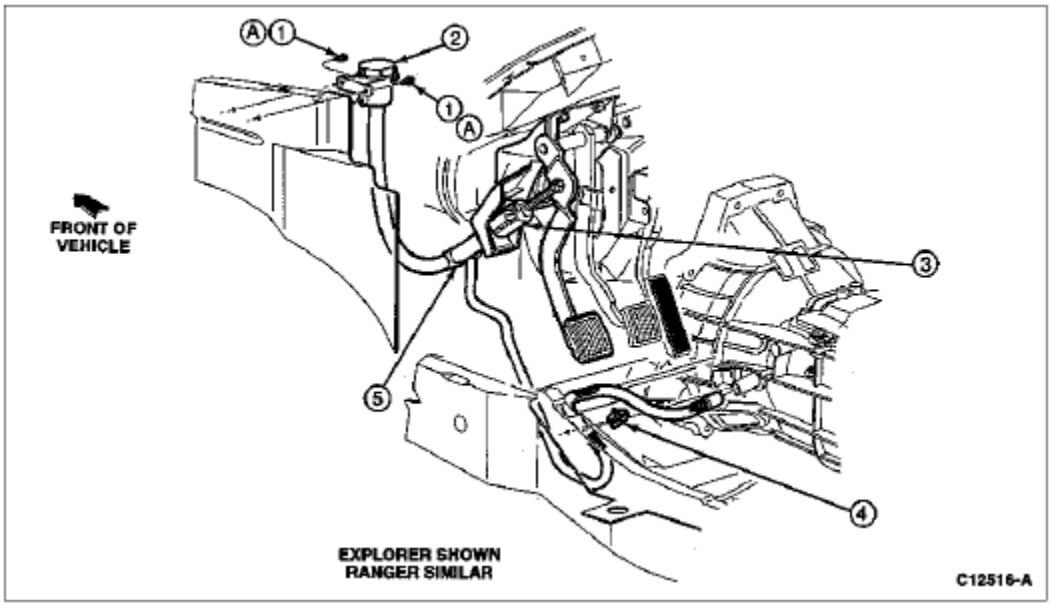
6. Install the clutch pedal position switch. Refer to the procedure in this section.

7. Install the retainer and push rod on the clutch pedal pin with the flange portion of the bushing facing away from the pedal blade of the clutch pedal.

8. Bleed the system. Refer to Section 08-00 .

9. Insert the coupling end into the clutch slave cylinder, and install line into clip(s).

Hydraulic Clutch Controls



Item	Part Number	Description
1	N610959-S301	Screw
2	7K500	Reservoir Assembly
3	7C534	Switch
4	N806750-S	Clip
5	7A543	Clutch Master Cylinder
A	—	Tighten to 2-3 Nm

		(18-27 Lb-In)

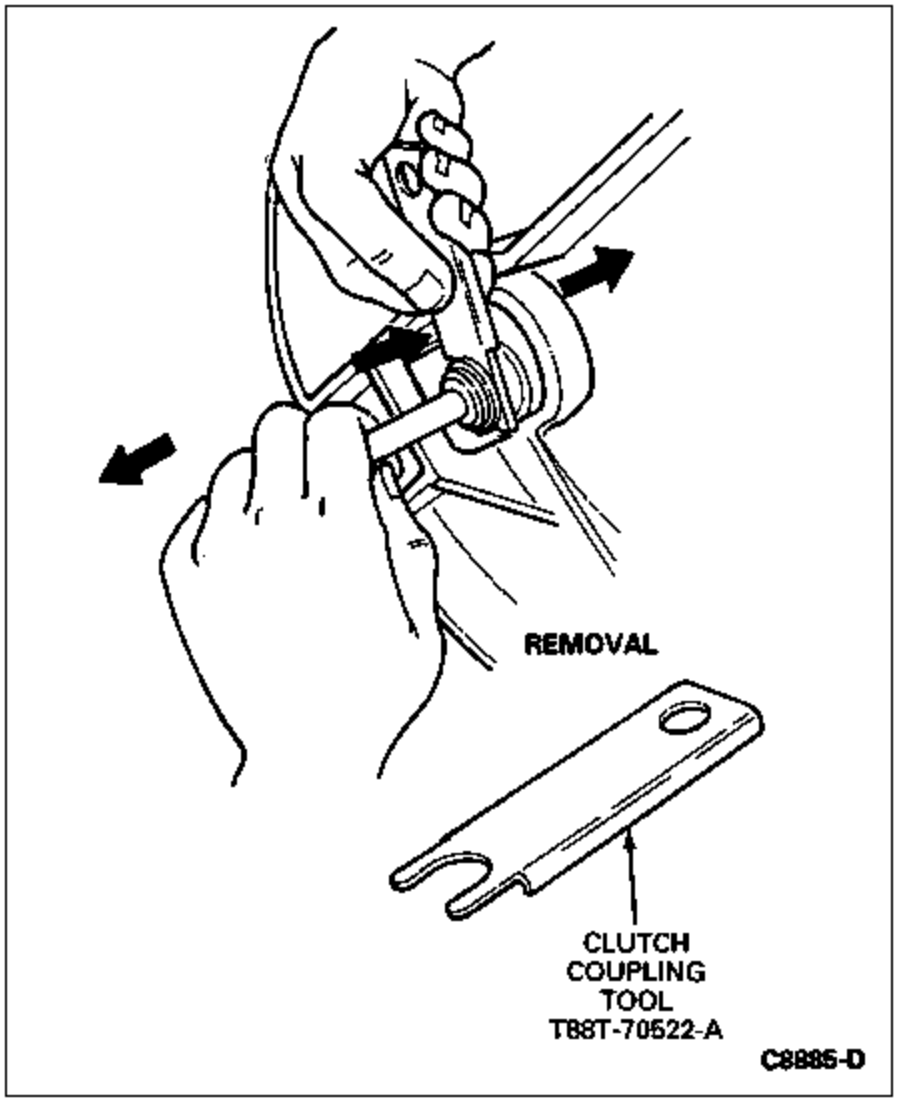
Clutch Slave Cylinder

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Clutch Coupling Tool	T88T-70522-A

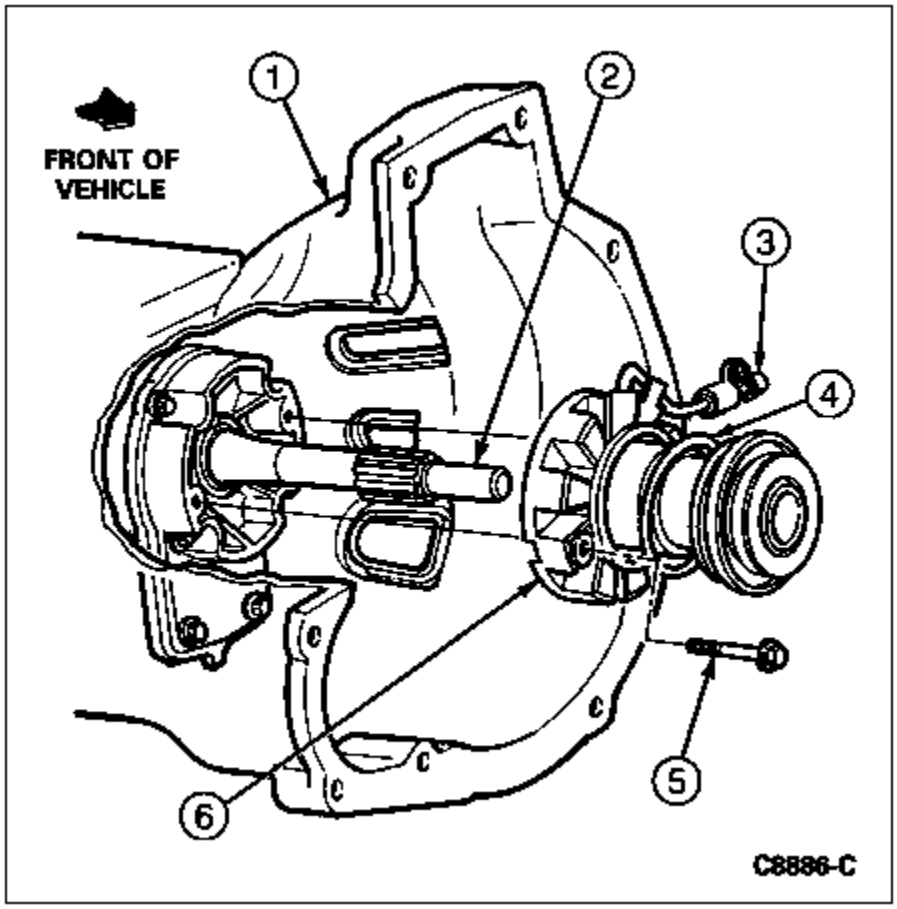
Removal and Installation

1. Disconnect the coupling at the transmission (7003) with Clutch Coupling Tool T88T-70522-A.
2. Slide white plastic sleeve toward the clutch slave cylinder while applying a slight tug on the tube.



3. Remove the transmission. Refer to Section 07-03 .
4. Remove clutch slave cylinder-to-transmission bolts.
5. Remove the clutch slave cylinder from the transmission input shaft (7017).

Refer to Section 08-00 for Hydraulic Clutch Bleed procedures. For installation, follow removal procedures in reverse order. Install the cylinder clutch slave attaching bolts and tighten to 19-26 Nm (14-19 lb-ft).



Item	Part Number	Description
1	7003	Transmission Housing
2	7017	Input Shaft
3	—	Hydraulic Bleed Screw (Part of 7A508)
4	—	Hydraulic Clutch Line Coupling (Part of 7A508)
5	N605907-S101	Bolt (2 Req'd)
6	7A508	Clutch Slave Cylinder

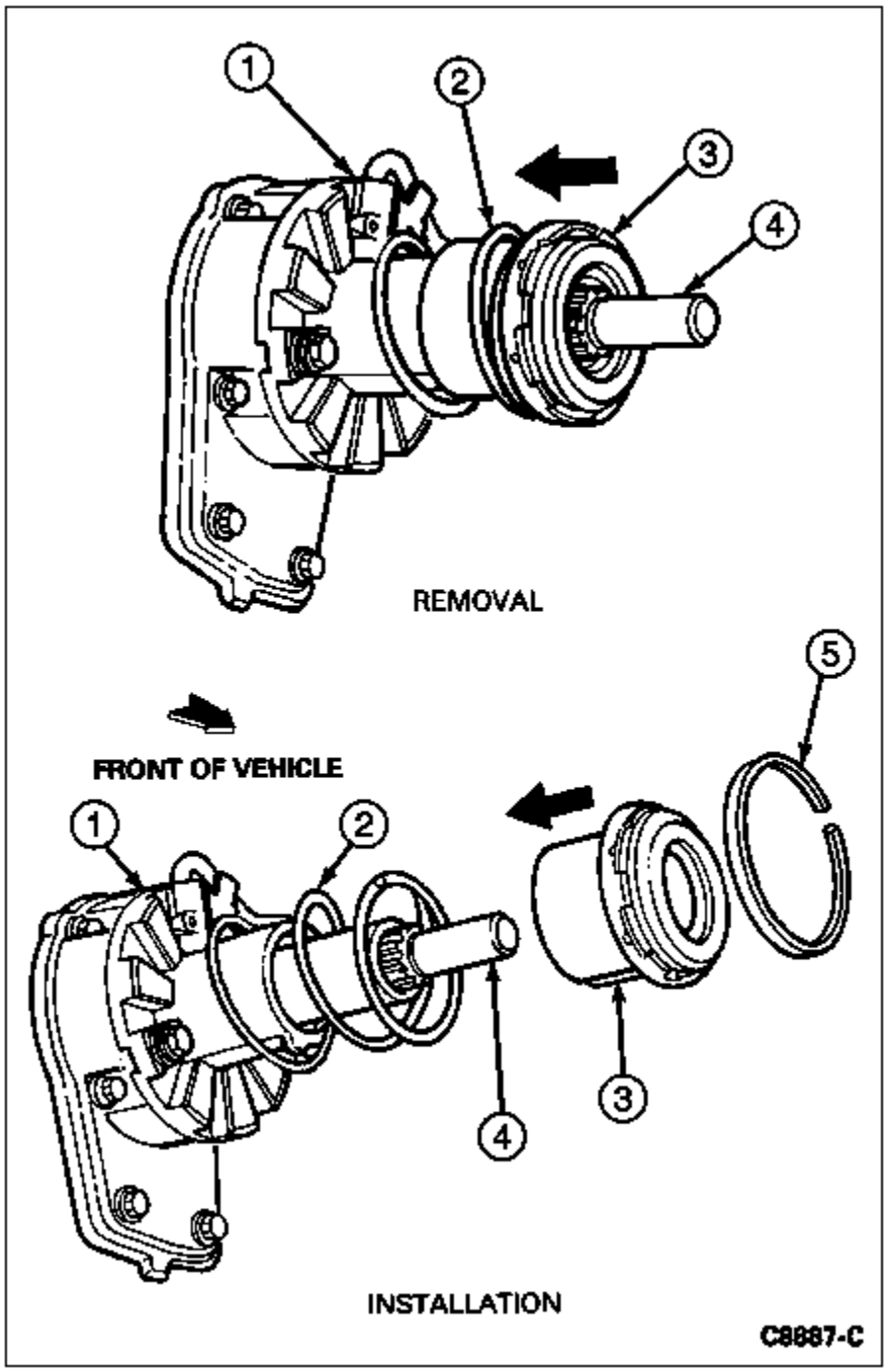
Clutch Release Hub and Bearing

Removal

1. Remove transmission (7003). Refer to Section 07-03 .
2. Push the clutch release hub and bearing (7548) toward transmission exposing retaining ring.
3. Remove retaining ring, pull clutch release hub and bearing off the clutch slave cylinder.

Installation

1. Install the clutch release hub and bearing to the clutch slave cylinder (7A508) by pushing into place.
2. Replace retaining ring.
3. Install transmission. Refer to Section 07-03 .



Item	Part Number	Description
1	7A508	Clutch Slave Cylinder
2	—	Preload Spring (Part of 7A508)
3	7548	Clutch Release Hub and Bearing
4	7017	Input Shaft
5	—	Retaining Ring (Part of 7A508)

Clutch Pedal, Clutch Linkage

The hydraulic clutch system provides automatic clutch adjustment for disc wear. The clutch actuation system does not have free play; it is automatically self-adjusting and will not require any routine service throughout the life of the clutch. No adjustment of clutch linkage or clutch pedal position is required.

Clutch Pedal Position (CPP) Switch

The clutch pedal position switch (CPP) (11A152) is not adjustable. If the CPP switch does not function properly, replace the CPP. Refer to the procedure in this section.

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Slave Cylinder to Transmission Bolts	19-26	14-19	—
Clutch Reservoir to Dash Panel Screw	2.1-2.7	—	19-23
Bleed Screw	3-5	—	27-44
Clutch Master Cylinder Bolts	2-3	—	18-27

Exhaust System

This section covers general exhaust system alignment procedures and specifications.

Three-Way Catalytic Converter (TWC)

The exhaust systems vary between engines (6007). Three way catalytic converters (TWC) (5E212) in single-catalyst systems use a catalyst of monolithic construction in a clamshell container.

All Ford gasoline-powered compact trucks employ a three way catalytic converter in their emissions control systems and require the use of unleaded fuel.

The catalytic agent used in the TWC is an alloy of platinum and rhodium and/or palladium and rhodium, or palladium only.

The location and type of exhaust system gaskets, retaining clamps, and support brackets are shown in the illustrations.

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Inspection and Verification

Exhaust system performance complaints such as excessive back pressure are usually noticeable by their effect on the performance of the engine (6007).

However, other malfunctioning components may have similar effects on the performance of the engine and be characterized by the same symptoms or complaints. It is, therefore, necessary to refer to Section 4A in the Powertrain Control/Emissions Diagnosis Manual for diagnosis and testing of the engine.

For general exhaust system complaints, refer to the symptom chart and pinpoint tests before removing and replacing any parts.

1. Visually inspect exhaust manifold, exhaust inlet pipe, three way catalytic converter (TWC) (5E212), and muffler for cracks, leaks, punctures, improper welds or split seams with the exception of drain holes. Replace components as necessary.

2. Visually inspect the components of the TWC and exhaust system and related controls that may affect exhaust gas quality or cause backfire or loss of power.

VISUAL INSPECTION CHART

Mechanical	Electrical
• Leaking fuel injectors	• Misrouted, damaged wiring
• Damaged air inlet passages	• Damaged ignition coil, spark plugs
• Inoperative Exhaust Gas Recirculation (EGR) valve	• Corroded, loose connectors
• Exhaust pipe pinched, crushed	
• Damaged, loose vacuum hoses	
• Incorrect idle speed	
• Dirty engine air filter • Damaged three way catalytic converter	

3. Check for broken or loose clamps, brackets or fasteners. Check all flanges between exhaust system components for loose fasteners and damaged gaskets. Tighten or replace as necessary.

4. Inspect wiring, connectors, and other components for obvious concerns due to looseness, corrosion, or other damage. This must be done when the engine is fully warmed so as to activate the system controls.

5. Check the vacuum lines and connections for looseness, pinching, leakage, splitting, blockage, or other damage that may cause malfunction.

6. If a vacuum line or orifice (restrictor) blockage is suspected as the obvious cause of a concern, correct the cause before proceeding to the next step.

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7. Check engine oil for fuel dilution.

8. If all checks are OK, proceed to the symptom chart.

Exhaust Leakage or Noise

NOTE: In the event of a three way catalytic converter (TWC) failure, always check the muffler (5230) to be sure converter debris has not entered the muffler.

NOTE: Do not confuse drain holes with muffler body leaks.

External leaks in the exhaust system are often accompanied by noises and exhaust fumes. A visual inspection of the exhaust system will usually determine the location of a leak. When checking for exhaust leakage or noise, inspect the entire system for burnout holes and loose or corroded exhaust pipe flanges. Examine the underbody for greyish-white or black exhaust soot which indicates exhaust leakage at that point. For small leaks, have an assistant hold rags over the muffler outlet pipe (5255) while listening for the leak. This helps magnify the leak.

When testing for a rattle or vibration condition, it is helpful to use a rubber mallet. Tap on the exhaust components to simulate the bouncing action of the exhaust, while watching for exhaust-to-body/chassis contact. Also look for loose or damaged heat shields or exhaust pipe flanges.

Lightly tapping on the muffler and TWC can determine if there are loose or broken baffles in the muffler or a loose or broken element in the TWC.

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Symptom Chart — Exhaust System

EXHAUST SYSTEM

Condition	Possible Source	Action
• Noisy or Leaking Exhaust	• Broken or loose clamps or brackets. • Punctures in muffler. • Exhaust manifold fasteners or gaskets.	• GO to Pinpoint Test A.
• Restricted Exhaust System	• Vacuum above 53.8 kPa (16 in-Hg). • Restricted exhaust manifold.	• GO to Pinpoint Test B.

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Pinpoint Tests

PINPOINT TEST A: NOISY OR LEAKING EXHAUST

A1 CLAMPS AND BRACKETS

- Check for broken or loose clamps and/or brackets.

Are clamps and brackets OK?

Yes	No
GO to **A2**.	REPAIR or REPLACE as necessary. RESTART engine. If noise still exists, GO to **A2**.

A2 SYSTEM COMPONENTS

- Check muffler inlet pipe and muffler for punctures, split seams or improper welds.

Are system components OK?

Yes	No
GO to **A3**.	REPLACE muffler inlet pipe and/or muffler as necessary. If noise still exists, GO to **A3**.

A3 EXHAUST MANIFOLD

- Inspect exhaust manifold for loose fasteners or cracks.
- Inspect exhaust manifold gasket.

Are exhaust manifold and gasket OK?

Yes	No
GO to **B1**.	TIGHTEN fasteners to specification or REPLACE exhaust manifold. REFER to specific engine section in this manual. REPLACE exhaust manifold gasket.

PINPOINT TEST B: RESTRICTED EXHAUST SYSTEM TEST

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B1 CHECK EXHAUST SYSTEM

Is the exhaust system visually OK?

Yes	No
GO to **B2** .	REPLACE any collapsed exhaust components. GO to **B2** .

B2 VACUUM TEST

- Attach a Rotunda Vacuum Pressure Tester 164-R0253 or equivalent to the intake manifold vacuum source.
- Hook up a tachometer.
- Start engine and gradually increase speed to 2000 rpm with transmission in NEUTRAL.

Is neutral vacuum above 53.8 kPa (16 in-Hg)?

Yes	No
REFER to Section 4A in the Powertrain Control/Emissions Diagnosis Manual for diagnosis and testing of the driveability concerns.	GO to **B3** .

B3 VACUUM TEST — EXHAUST DISCONNECTED

- Turn engine off.
- Disconnect exhaust system at manifold(s).
- Repeat vacuum test.

Is the manifold vacuum above 53.8 kPa (16 in-Hg)?

Yes	No
GO to **B4** .	GO to **B5** .

B4 VACUUM TEST — THREE WAY CATALYTIC CONVERTER ON, MUFFLER(S) OFF

- Turn engine off.
- Reconnect exhaust system at exhaust manifold.
- Disconnect muffler.
- Repeat vacuum test.

Is the manifold vacuum above 53.8 kPa (16 in-Hg)?

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Yes	No
REPLACE muffler and RETEST.	REPLACE three way catalytic converter and INSPECT muffler to be sure three way catalytic converter debris has not entered muffler.

B5 EXHAUST MANIFOLD RESTRICTED

- Remove the exhaust manifold(s). Inspect the ports for casting flash by dropping a length of chain into each port. Do not use a wire or light to check ports. The restriction may be large enough for them to pass through but small enough to cause excessive back pressure at high engine rpm.

Is restriction OK?

Yes	No
REFER to Powertrain Control/Emissions Diagnosis Manual — lack of power.	REMOVE casting flash. If flash cannot be removed, REPLACE exhaust manifold(s) and RETEST.

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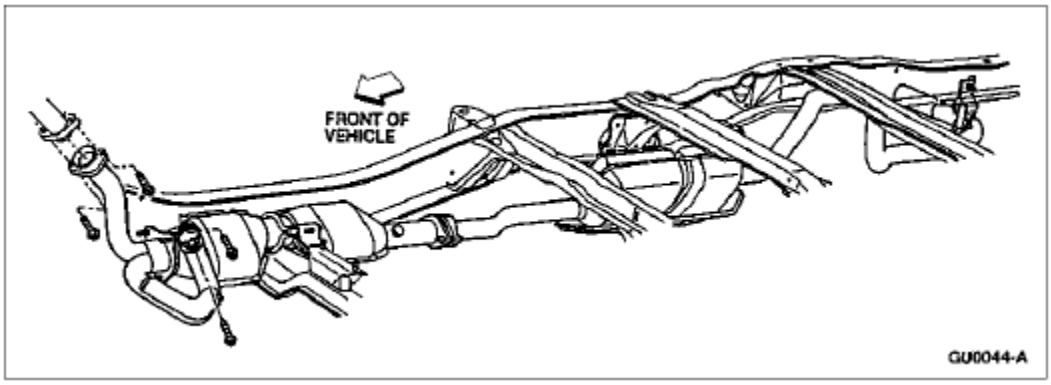
Muffler

Securing Heat Shields, Typical



Exhaust System — Ranger 3.0L and 4.0L

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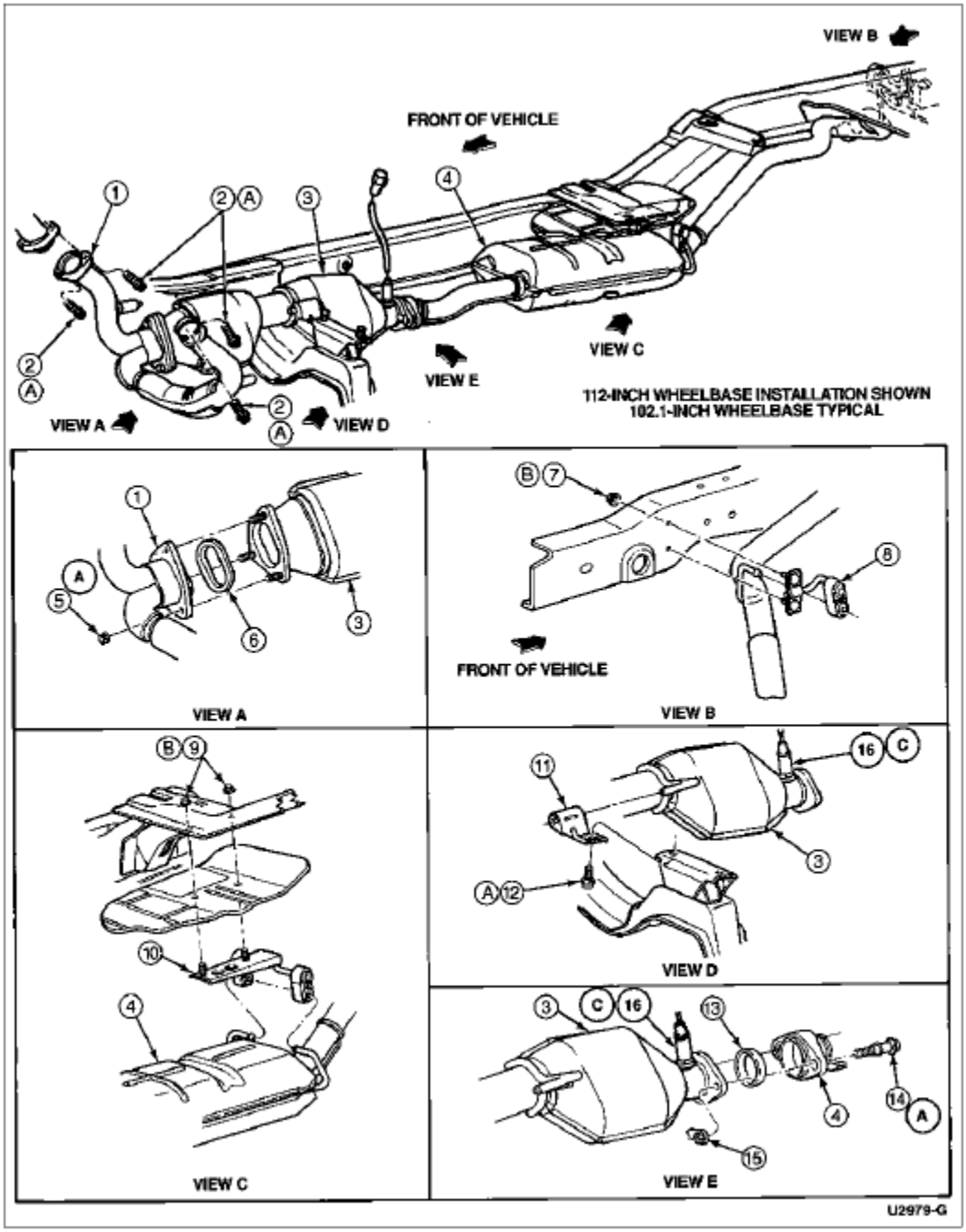

Item	Part Number	Description
1	5246	Exhaust Inlet Pipe
2	N803420-S2	Exhaust Manifold-to-Inlet Pipe Bolts (4 Req'd)
3	5E212	Three Way Catalytic Converter
4	5230	Muffler
5	N620482-S2	Exhaust Inlet Pipe-to-Converter Nut (3 Req'd)
6	5B266	Exhaust Converter Inlet Pipe Gasket
7	N620481-S2	Nut

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8	5E269	Exhaust Converter Frame Bracket
9	N620481-S2	Nut
10	5260	Exhaust Outlet Pipe Frame Bracket
11	5E269	Exhaust Converter Frame Bracket
12	39006	Screw and Washer
13	5E241	Exhaust Converter Outlet Gasket
14	5G215	Exhaust Pipe Flange Hold Down Spring
15	N802641-S2	Nut and Retainer
16	—	Rear Heated Oxygen Sensor (HO2S)
A	—	Tighten to 34-46 Nm (25-34 Lb-Ft)
B	—	Tighten to 20-25 Nm (15-19 Lb-Ft)
C	—	Tighten to 34-46 Nm (25-34 Lb-Ft)

Exhaust System — Aerostar, 4.0L (3.0L Similar)

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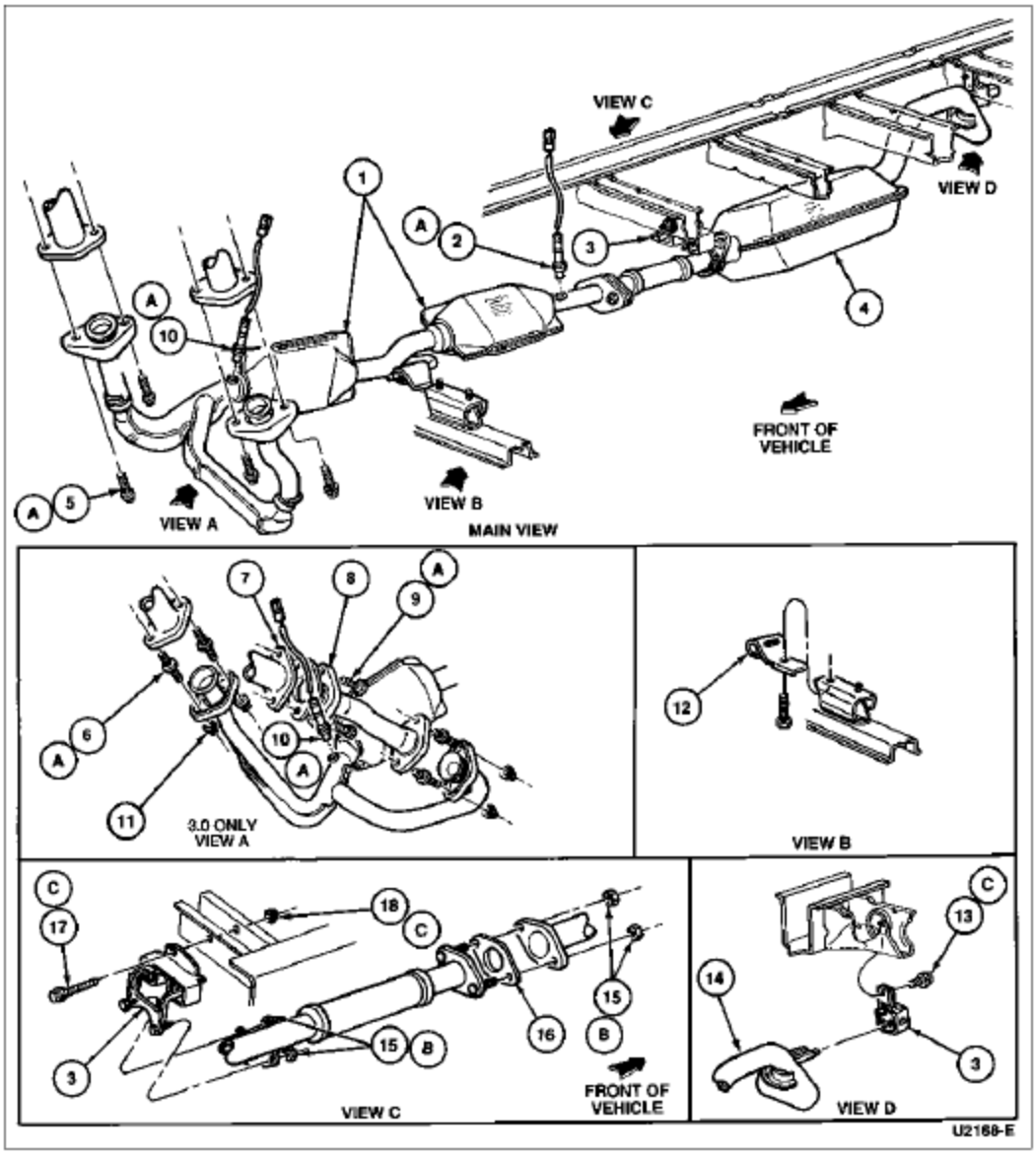

Item	Part Number	Description
1	5F250	Dual Converter Y Pipe
2	—	Rear Heated Oxygen Sensor (HO2S)
3	5260	Exhaust Outlet Pipe Frame Bracket
4	5230	Muffler
5	N804278-S2	Y-Pipe-to-Exhaust Manifold Bolt
6	N802110-S2	Stud, M10 — 1.50x61.0
7	5C226	Gasket
8	5E257	Pipe Assembly
9	N804278-S2	Bolt
10	9F472	Front Heated Oxygen Sensor (HO2S)

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11	N800152-S2	Nut, M10 — 1.50
12	5E269	Exhaust Converter Frame Bracket
13	N605905-S101	Bolt, M8 — 1.25x23
14	5255	Muffler Outlet Pipe
15	N620482-S2	Nut
16	5C250	Gasket
17	N606047-S2	Bolt, M8 — 1.25x20
18	N602481-S2	Nut, M8 — 1.25
A	—	Tighten to 34-46 Nm (25-34 Lb-Ft)
B	—	Tighten to 25-35 Nm (18-26 Lb-Ft)
C	—	Tighten to 20-27 Nm (15-20 Lb-Ft)

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Oxygen Sensor Wrench	T94P-9472-A

Removal

1. Disconnect battery ground cable (14301).
2. Raise and support vehicle.
3. Disconnect rear Heated Oxygen Sensor (HO2S) electrical connector.
4. Use Oxygen Sensor Wrench T94P-9472-A to remove rear HO2S.
5. Remove the two nuts and two bolts from exhaust pipe flange hold down spring (5F264) attaching three way catalytic converter (TWC) (5E212) tomuffler (5230) .
6. Remove the three exhaust inlet pipe-to-converter nuts that connect the three way catalytic converter to exhaust inlet pipe (5246). Swing the muffler and muffler outlet pipe (5255) to the rear, and then remove the three way catalytic converter and exhaust converter outlet gaskets (5E241), disengaging rod from insulator.

Installation

1. Position three way catalytic converter in place, engaging rod into insulator.
2. Install a new exhaust converter outlet gasket between the three way catalytic converter and muffler. Secure the flange gasket and flanges with two muffler-to-converter bolts, exhaust pipe flange hold

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down springs and two nuts. Tighten muffler-to-converter bolts and nuts to 34-46 Nm (25-34 lb-ft).

3. Install an exhaust converter inlet pipe gasket (5B266) between the three way catalytic converter and exhaust inlet pipe. Install three exhaust inlet pipe-to-converter nuts and tighten to 34-46 Nm (25-34 lb-ft).

4. Tighten exhaust manifold connections by alternately tightening the manifold nuts to 34-46 Nm (25-34 lb-ft).

5. Use Oxygen Sensor Wrench T94P-9472-A to install rear HO2S. Tighten the rear HO2S to 34-46 Nm (25-34 lb-ft).

6. Connect rear HO2S electrical connector.

7. Connect battery ground cable.

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Dual Three Way Catalytic Converter (TWC) and Pipe — Aerostar

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Oxygen Sensor Wrench	T94P-9472-A

Removal

1. Disconnect battery ground cable (14301).
2. Raise and support vehicle.
3. Disconnect rear Heated Oxygen Sensor (HO2S) electrical connector.
4. Use Oxygen Sensor Wrench T94P-9472-A to remove rear HO2S.
5. Remove the two muffler-to-converter bolts.
6. Loosen and remove the exhaust manifold-to-Y pipe nuts. Slide flexible link, muffler (5230) and muffler outlet pipe rearward. Remove the gasket. Move the dual converter Y pipe (5F250) rearward. Rotate to clear studs and remove.

Installation

1. Install dual converter Y pipe onto exhaust manifold studs and loosely secure in place with exhaust manifold-to-Y pipe nuts.
2. Install a new non-asbestos gasket between three way catalytic converter and muffler. Secure flange gasket with two nuts. Tighten to 34-46 Nm (25-34 lb-ft).
3. Secure muffler to exhaust converter frame bracket (5E269). Tighten nuts to 25-35 Nm (18-26 lb-ft).
4. Tighten exhaust manifold connections by alternating the tightening of the manifold bolts or nuts to 34-46 Nm (25-34 lb-ft).
5. Use Oxygen Sensor Wrench T94P-9472-A to install rear HO2S.
6. Connect rear HO2S electrical connector.
7. Connect battery ground cable.

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Three-Way Catalytic Converter, Ranger 2.3L Engine

Removal

1. Remove the two nuts and two bolts attaching three way catalytic converter (TWC) (5E212) to muffler (5230) and muffler outlet pipe (5255).
2. Remove two bolts attaching three way catalytic converter to the exhaust manifold.
3. Remove the three way catalytic converter from vehicle.

Installation

1. Install three way catalytic converter onto exhaust manifold studs and loosely secure in place.
2. Install a new exhaust converter outlet gasket (5E241) between three way catalytic converter and muffler and muffler outlet pipe.
3. Tighten the converter-to-muffler flange exhaust pipe flange hold down spring (5F264) to 37-50 Nm (27-37 lb-ft).
4. Position the exhaust outlet pipe frame bracket (5260) so the rod is aligned throughout the entire length of the exhaust outlet pipe frame bracket. Tighten nuts to 20-27 Nm (15-20 lb-ft) while maintaining alignment.
5. Tighten the exhaust manifold connection by alternately tightening the manifold bolts to 34-46 Nm (25-34 lb-ft).

Exhaust System Installation, Ranger Regular Cab and SuperCab, 2.3L Engine, 4x2 and 4x4

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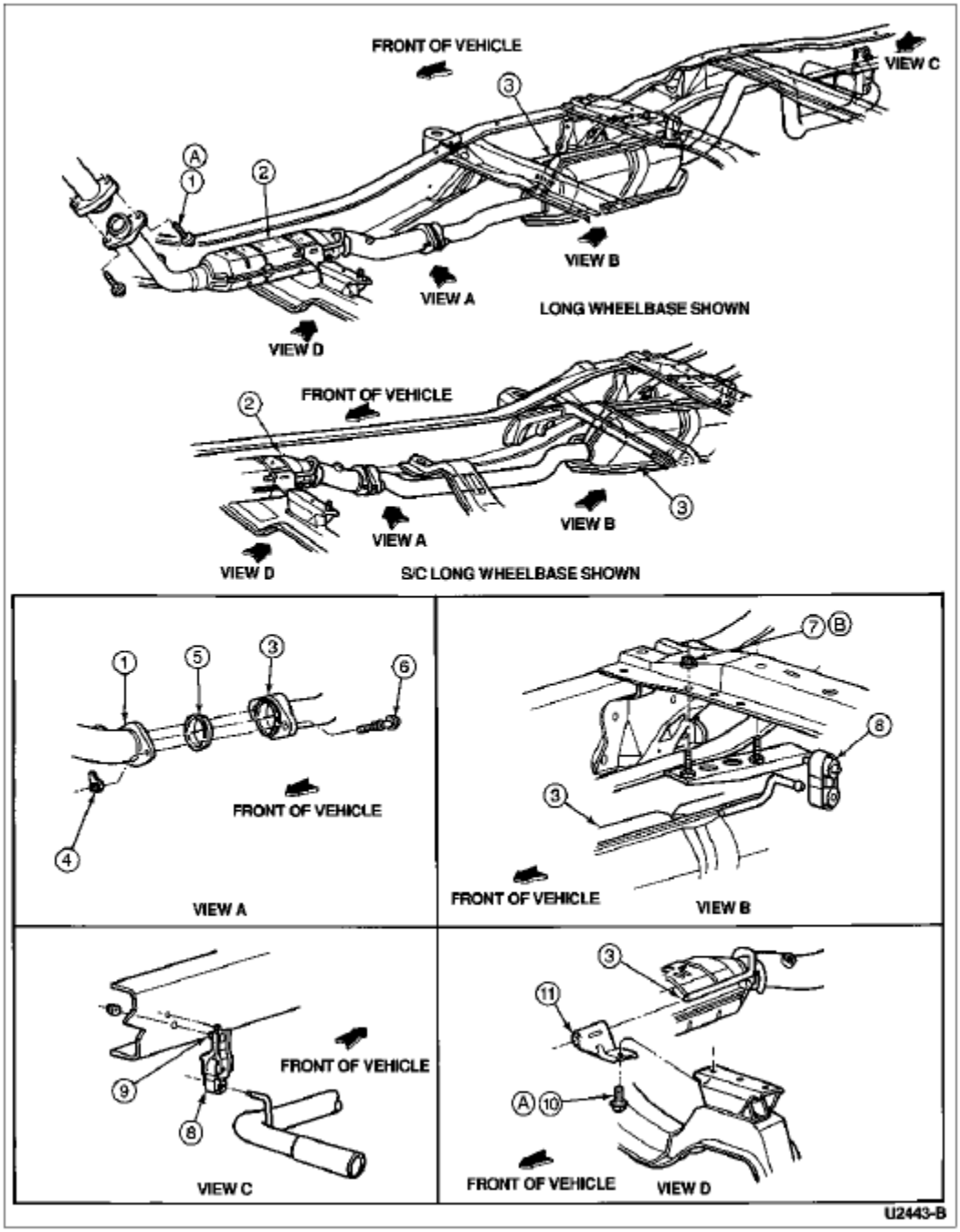

Item	Part Number	Description
1	N803420-S2	Bolt
2	5E212	Three Way Catalytic Converter
3	5230	Muffler
4	N802641-S2	Nut and Retainer
5	5E241	Exhaust Converter Outlet Gasket
6	5F264	Exhaust Pipe Flange Hold Down Spring
7	N620481-S2	Nut

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8	5260	Exhaust Outlet Pipe Frame Bracket
9	N647096-S	Rivet
10	39006	Screw and Washer
11	5E269	Exhaust Converter Frame Bracket
A	—	Tighten to 34-46 Nm (25-34 Lb-Ft)
B	—	Tighten to 20-27 Nm (15-20 Lb-Ft)

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Three-Way Catalytic Converter, Ranger 3.0L MFI and 4.0L MFI

Removal

1. Remove the two nuts and two bolts from exhaust pipe flange hold down spring attaching three way catalytic converter to muffler and muffler outlet pipe.

2. Loosen and remove the three nuts that connect the three way catalytic converter to dual converter Y pipe (5F250). Swing the muffler and muffler outlet pipe to the rear, and then remove the three way catalytic converter and exhaust converter outlet gaskets, disengaging rod from insulator.

3. Loosen and remove the exhaust manifold-to-inlet pipe bolts. Move the inlet pipe rearward, rotate to clear studs and remove.

Installation

1. Install exhaust inlet pipe (5246) onto exhaust manifold and loosely secure in place with retaining bolts.

2. Position three way catalytic converter in place, engaging rod into insulator.

3. Install a new exhaust converter outlet gasket between the three way catalytic converter and muffler. Secure the flange gasket and flanges with two bolts exhaust pipe flange hold down spring and two nuts. Tighten to 34-46 Nm (25-34 lb-ft).

4. Install an exhaust converter inlet pipe gasket (5B266) between the three way catalytic converter and dual converter Y pipe. Secure with three nuts and tighten to 34-46 Nm (25-34 lb-ft).

5. Tighten exhaust manifold connections by alternately tightening the manifold nuts to 34-46 Nm (25-34 lb-ft).

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Muffler Shield

The muffler shields are crimped onto the muffler and are serviced with the muffler.

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Hanger Brackets

Removal

1. Remove muffler (5230) and muffler outlet pipe (5255) from exhaust outlet pipe frame brackets (5260) as previously described.

2. Remove rivets which hold brackets to frame.

Installation

1. Position exhaust outlet pipe frame brackets on frame and attach with 7/16-14 nut and bolt. Tighten to 20-25 Nm (15-19 lb-ft).

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Exhaust System

Inspect exhaust inlet pipes (5246), muffler outlet pipes (5255) and mufflers (5230) for cracked joints, broken welds and corrosion damage that would result in a leaking exhaust system.

It is normal for a certain amount of moisture and staining to be present around the seams of the muffler. The presence of soot, light surface rust or moisture does not indicate a damaged exhaust system.

Inspect the muffler pipe brackets (5277), exhaust outlet pipe frame brackets (5260) for cracks and stripped or badly corroded bolt threads. When flat flange joints are loosened and/or disconnected to replace a shield pipe or muffler, always replace gasket and bolts and flange nuts if there is reasonable doubt that its service life is limited.

The exhaust system, including heat shields, must be free of leaks, binding, grounding and excessive vibrations.

These conditions are usually caused by loose or broken flange bolts, shields, brackets or pipes. If any of these conditions exist, check the exhaust system components and alignment. Align or replace as necessary.

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Exhaust Shield Inspection

Raise the vehicle on a hoist. Shields are positioned on the topside and underside (if horizontal) or sides (if vertical) of the three way catalytic converter (TWC) (5E212). Shields should be free from bends which would bring any part of the shield in contact with the three way catalytic converter or muffler (5230). The shield should be clear of any combustible matter.

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Exhaust System Alignment, Aerostar

NOTE: Aerostar exhaust systems contain a flexible coupling and should not require alignment.

If alignment is required, perform the following procedures to align the complete exhaust system:

1. Loosen pipe connections at exhaust manifold and all other flanges.

2. Align the flat flanges between the three way catalytic converter (TWC) (5E212) and muffler (5230).

3. Rotate the muffler to provide sufficient clearance to the frame, body and drivetrain to avoid ground-out conditions. Tighten flange nuts to 25-35 Nm (18-26 lb-ft).

4. **NOTE: Manifold nuts or bolt heads must bottom out on the fixed flange.**

   Tighten exhaust manifold connection by alternately tightening the right side and left side nuts to 34-46 Nm (25-34 lb-ft).

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Exhaust System Alignment, Ranger

Perform the following procedures to align the complete exhaust system:

1. Loosen pipe connections at exhaust manifold, all flanges and the catalyst-to-rear engine mount U-bolt.

2. On six-cylinder engines (6007) (2.3L is a welded assembly), align the flat flanges between the exhaust damper (5F240) and three way catalytic converter (TWC) (5E212), and the three way catalytic converter and muffler (5230). Tighten nuts to 36-42 Nm (27-31 lb-ft).

3. On 2.3L engines, rotate the muffler to provide sufficient clearance to the frame, body and drivetrain to avoid ground-out conditions. Tighten flange nuts to 36-42 Nm (27-31 lb-ft).

4. On 2.3L engines, position the U-bolt and bracket assembly so the rod is aligned throughout the entire length of the bracket and insulator assembly, and the U-bolt saddle notch is on the converter keyway. Tighten U-bolt nuts to 36-42 Nm (27-31 lb-ft) while maintaining alignment.

5. Tighten exhaust manifold connection by alternately tightening the right side and left side bolts or nuts to 34-46 Nm (25-34 lb-ft).

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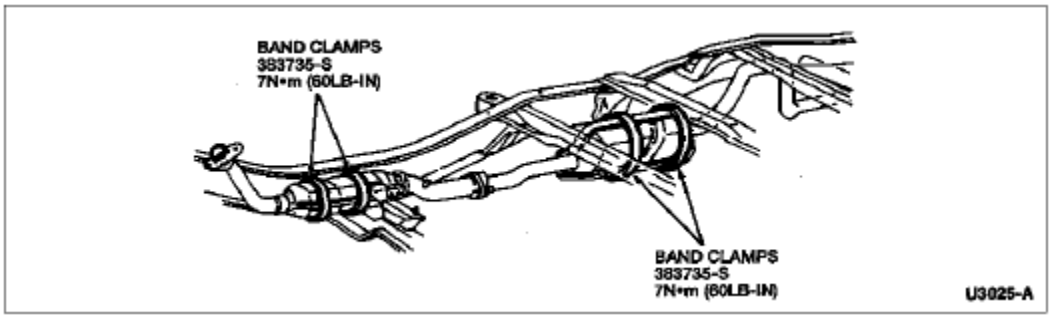
Muffler Shield and Three Way Catalytic Converter (TWC) Shields

Securing Heat Shields



NOTE: At idle or during normal driving conditions, a buzz or rattle may be detected, which can be traced to the exhaust system. The heat shield attachment to the muffler or three way catalytic converter (TWC) (5E212) may come free. The loose shield will vibrate off the muffler (5230) or three way catalytic converter and cause the buzz or rattle.

NOTE: The three way catalytic converter may have two cans. If shields on both cans are loose, four clamps (two for each) will be required.

1. Attach two band clamps to the three way catalytic converter or muffler as shown in the illustration.
2. Align the clamp to secure the heat shield to the muffler or three way catalytic converter. Tighten the clamp to 7 Nm (60 lb-in).
3. Trim excess "ear" to approximately 25mm (1 inch).

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SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft
Aerostar		
Bolt, Y-Pipe-to-Manifold	34-46	25-34
Stud, Y-Pipe-to-Manifold	34-48	25-35
Nut, Y-Pipe-to-Stud	40-55	25-47
Nut, Bracket and Insulator-to-Crossmember	20-27	15-20
Nut, Bracket and Insulator-to-Muffler	25-35	18-26
Nut, Muffler-to-Catalyst	25-35	18-26
Bolt, Bracket and Insulator-to-Crossmember	20-27	15-20
Ranger 2.3L		
Bolt, Catalyst-to-Manifold	34-46	25-34
Nut, Bracket and Insulator-to-Crossmember	20-27	15-20
Spring Assembly	37-50	27-37
U-Bolt Nuts	23-31	17-23
Ranger 3.0L and 4.0L		
Bolt, Y-Pipe-to-Manifold	34-46	25-34
Nut, Catalyst-to-Y-Pipe	34-46	25-34
Nut, Bracket and Insulator-to-Crossmember	20-27	15-20
Muffler-to-Converter Bolts	34-46	25-34

TORQUE LIMITS — EXHAUST SYSTEM BOLTS AND NUTS

Bolt or Nut Diameter	Class 9.8 (Grade 5)	Class 10.9 (Grade 8)
8mm (5/16 Inch)	20-27 Nm (15-20 Lb-Ft)	26-35 Nm (20-25 Lb-Ft)
10mm (3/8 Inch)	37-50 Nm (28-36 Lb-Ft)	47-64 Nm (34-47 Lb-Ft)
12mm (7/16 Inch)	65-90 Nm (48-66 Lb-Ft)	80-110 Nm (59-80 Lb-Ft)

Note: Unless otherwise specified, the above torque ranges may be used for fitting or fastener diameters as indicated.

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Fuel System, Service

The fuel charging assembly is the most important component in the fuel system. However, the fuel charging assembly cannot operate efficiently unless all other components in the system are performing correctly.

Section 10-01 of this group covers those test and adjustment procedures related directly to specific vehicle fuel supply problems. Other emission systems related to the fuel system are covered in the Powertrain Control/Emissions Diagnosis Manual.

Engine Air Cleaner

WARNING: DO NOT SMOKE OR CARRY LIGHTED TOBACCO OR OPEN FLAME OF ANY TYPE WHEN WORKING ON OR NEAR ANY FUEL RELATED COMPONENT. HIGHLY FLAMMABLE MIXTURES ARE ALWAYS PRESENT AND MAY BE IGNITED, RESULTING IN POSSIBLE PERSONAL INJURY.

- Refer to Section 03-12 .
- Refer to the Pre-Delivery manual or the Vehicle Owner Guide for the recommended air cleaner maintenance mileage interval.
- Cleaning the air cleaner filter element is not recommended. It should be replaced at the specified mileage intervals.
- Clean the air cleaner body and cover with solvent or compressed air. Wipe the air cleaner body and the cover dry if a solvent is used. Inspect the air cleaner body and cover for distortion or damage. Replace if required.
- Hold the filter element in front of a light and carefully inspect it for splits or cracks. Replace filter element if required.

Idle Air Control Valve

Refer to Section 03-04A or Section 03-04B .

Throttle Body

Refer to Section 03-04A or Section 03-04B .

Fuel Pump, Electric

Refer to Section 10-01 .

Fuel System

CAUTION: All adjustments affecting engine emissions should be performed by competent personnel using specified equipment. Refer to the Powertrain Control/Emissions Diagnosis Manual and to the specific fuel system section or specific engine section before performing critical fuel system adjustments.

SPECIFICATIONS

Refer to Section 10-01 for torque specifications.

Fuel Injected Engines

WARNING: DO NOT SMOKE, CARRY LIGHTED TOBACCO, OR OPEN FLAME OF ANY TYPE WHEN WORKING ON OR NEAR ANY FUEL-RELATED COMPONENT. HIGHLY FLAMMABLE MIXTURES ARE ALWAYS PRESENT AND MAY BE IGNITED, RESULTING IN POSSIBLE PERSONAL INJURY.

The multiport fuel injection system (MFI) is classified as a multi-point, pulse time, speed density control, fuel injection system. Fuel is metered into each intake port in a sequential firing order. Fuel injectors pulse to follow engine firing order in accordance with engine demand through fuel injectors mounted on a tuned lower intake manifold.

The powertrain control module (PCM) (12A650) accepts inputs from various engine sensors to compute the required fuel flow rate necessary to maintain a prescribed air/fuel ratio throughout the entire engine operational range. The powertrain control module then outputs a command to the fuel injector nozzle tips (9E527) to meter the appropriate quantity of fuel.

The powertrain control module also determines and compensates for the age of the vehicle and its uniqueness. The powertrain control module will automatically sense and compensate for changes in altitude (i.e., from sea level to mountains) and will also permit push-starting the vehicle should it become necessary (manual transmission only).

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Fuel Tank and Fuel Tank Filler Pipe

Fuel tanks (9002) are designed and fabricated of either non-corrosive metal or polyethylene molded plastic.

The fuel tank stores fuel for engine usage. Each fuel tank is of one-piece construction, either welded or molded design.

Fuel filling is accomplished through a fuel tank filler pipe (9034) attached to the fuel tank and/or external vent lines within the fuel tank filler pipe and fuel tank.

A venting system is used to provide an air space within the fuel tank when the fuel tank is filled to capacity. This air space provides for thermal expansion of the fuel as well as being an aid to the in-tank vapor vent system.

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Fuel Tank Filler Cap

NOTE: Use of an aftermarket fuel tank filler cap (9030) other than an authorized Ford/Motorcraft service part could result in damage to the fuel system or improper system operation if not properly designed/manufactured for pressure vacuum relief. Customer warranty is void for fuel tank and/or fuel system damage resulting from the use of such fuel tank filler caps.

The fuel tank filler cap is designed to seal in fuel vapors, reducing unburned hydrocarbon emissions, while allowing air to enter as fuel is used. It is also designed to relieve high pressure inside the fuel tank (9002) due to fuel expansion and vaporizing because of high ambient temperature. The fuel tank filler cap has a built-in pressure/vacuum relief valve to achieve this. The valve opens to allow air to enter at -3.44 kPa (-0.50 psi, -1.0 in Hg). The valve opens to relieve pressure at 12.4 kPa (1.8 psi).

Fuel tank filler cap relief only operates when the fuel vapor canister cannot handle vapor adequately to preclude pressure buildup.

Air must enter the fuel tank as fuel is used because the fuel leaving the fuel tank would create a partial vacuum which could become strong enough that the fuel pump (9350) could not overcome it, causing fuel starvation. Also, air pressure on the outside of the fuel tank could collapse the fuel tank.

If pressure from fuel expansion and vaporization were to rise too high, the pressure could bulge the fuel tank, blow off hoses, and cause seals to leak. The risk would be greatest on a hot day when the fuel tank was filled with fuel from a cool underground storage tank. Normally, positive fuel tank pressures do not rise high enough to open the valve so fuel vapor can only escape via the vapor valve and tube to the charcoal evaporative emissions canister (EVAP canister) (9D653) and, ultimately, the engine (6007). Refer to Section 03-13.

The fuel tank filler cap is secured to the vehicle by a nylon tether to prevent loss during refueling.

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Fuel Filter

Fuel is filtered at two locations on Aerostar and Ranger vehicles.

In-Line

The fuel filter (9155) on MFI applications provides extremely fine filtration to protect the small metering orifices of the fuel injector (9F593). The fuel filter cannot be cleaned. If the fuel filter becomes clogged or restricted, it should be replaced.

In-Tank

A nylon filter element (inlet filter sock) is mounted on the in-tank electric fuel pump inlet inside the fuel tank (9002) and is used to protect the fuel pump (9350) from fuel tank contaminants.

The in-tank filter is not serviced separately. To service the in-tank filter, replace the fuel pump and sender assembly.

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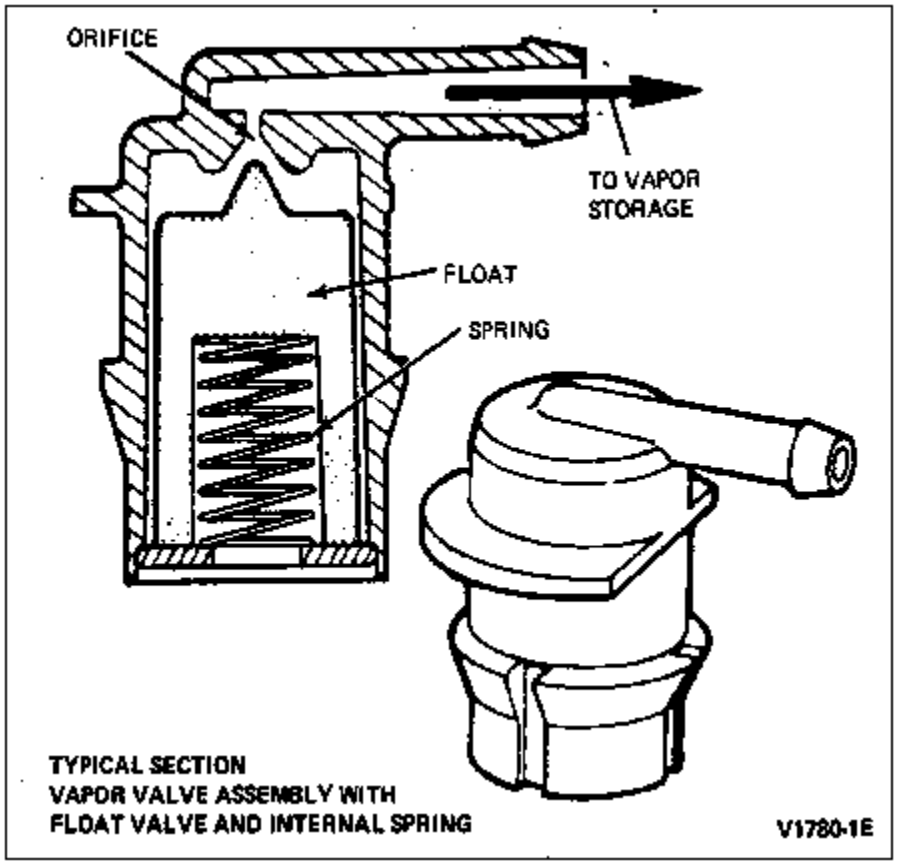
Fuel Vapor Valve, Aerostar

All fuel tank evaporative emission valves (9B593) make use of a small orifice that tends to allow only vapor and not liquid fuel to pass into the line running forward to the evaporative emissions canister (EVAP canister) (9D653). This evaporative emission valve mounts directly into the fuel tank (9002) using a rubber grommet. This evaporative emission valve is used for Aerostar 3.0L engines. For 4.0L engines, a differential evaporative emission valve is used.

Fuel vapors contained in the sealed fuel tank are vented through the orificed fuel tank evaporative emission valve in the top of the fuel tank. The vapors leave the evaporative emission valve through a single vapor line and continue to the evaporative emissions canister in the engine compartment for storage, until such time as they are purged to the engine (6007).

In the event of extreme conditions (excessive fuel tank pressure) the purge port of the evaporative emission valve opens up, allowing fuel vapor to vent the atmosphere. This purging action stabilizes pressure in the fuel tank.

Fuel Vapor Valve, Aerostar



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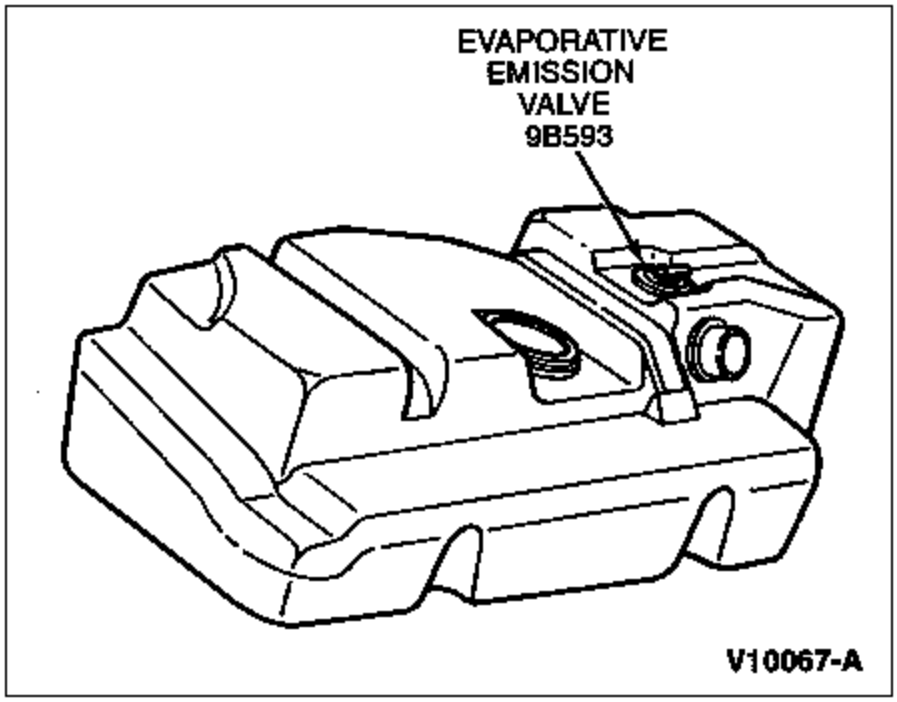

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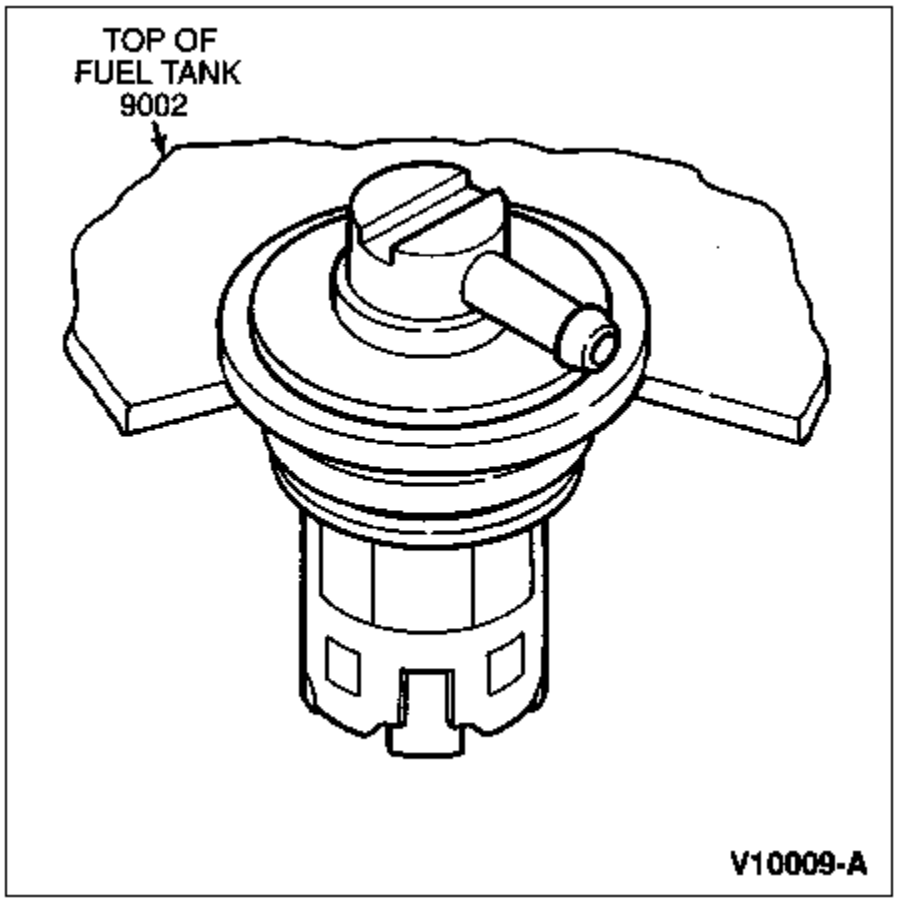
Fuel Vapor Valve, Ranger

The evaporative emission valve (9B593) makes use of a small orifice that tends to allow only vapor and not liquid fuel to pass into the line running forward to the fuel vapor canister. The evaporative emission valve mounts directly into the fuel tank (9002) using a rubber grommet.

Fuel vapors contained in the sealed fuel tank are vented through the orificed fuel tank evaporative emission valve in the top of the fuel tank. The vapors leave the evaporative emission valve through a single vapor line and continue to the fuel vapor canister in the engine compartment for storage, until such time as they are purged to the engine (6007).

Fuel Vapor Valve, Ranger



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Fuel Tank Pressure Transducer

The fuel tank pressure (FTP) transducer is used to monitor the fuel tank pressure or vacuum during the OBD II purge monitor test of the Evaporative Emission System. It also performs a fuel system integrity check to determine if there is an evaporative leak. Variations in pressure will be converted into an analog voltage input signal to the powertrain control module (PCM) (12A650).

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Fuel Lines

MFI engines use Teflon® stainless steel for fuel supply and return lines and carbon steel for vapor line in the engine compartment. Outside the engine compartment the materials are nylon (Aerostar and Ranger).

On Aerostar, the plastic fuel tube assemblies are secured to the body rails with nylon wraparound clips and push-in pins. The clips are located along the tube assembly by upsets on the fuel tube. On Ranger vehicles, the plastic fuel and vapor tube assemblies are secured to the frame rails with integral clips.

Spring Lock Coupling

Fuel tubes which connect to MFI engines utilize spring lock couplings in the engine compartment instead of the plastic or stainless steel push connect fittings. The spring lock couplings work by insertion of the fitting's male end, which is surrounded by two O-rings, into a female flared end engine fitting. The coupling engagement is secured by a garter spring which prevents the female flared end from becoming disengaged from the male end.

Spring Lock Coupling Disconnect Tool D87L-9280-B or equivalent is used to disconnect the 12.7mm (1/2-inch) spring lock coupling supply fitting. Tool D87L-9280-A or equivalent is used to disconnect the 9.52mm (3/8-inch) spring lock coupling return fitting.

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Fuel Pump, Electric — Ranger

The multiport fuel injection (MFI) system uses a fuel tank (9002) and a fuel pump and sender assembly. The fuel tank has an internal pump cavity where the fuel pump and sender assembly rest. This design provides satisfactory operation during extreme vehicle maneuvers and steep vehicle climbing with low tank fill levels.

The fuel pump (9350) is mounted on the fuel pump and sender assembly inside the fuel tank. This assembly includes a check valve which is in the outlet of the fuel pump. The function of this valve is to maintain pressure in the system after the vehicle is shut down. The pressure retention helps prevent long cranks and hot starting problems. This fuel pump is capable of supplying 60 liters (15.9 gallons) of fuel per hour at 310 kPa (45 psi). The fuel pump has an internal pressure relief valve which limits the maximum fuel pump pressure to 850 kPa (125 psi). This only takes effect if there is a system blockage, causing system pressure to rise too high. The system pressure is controlled by a pressure regulator on the engine (6007).

The fuel pump is protected at its inlet by a nylon pickup element. This nylon element filters dirt and contaminants which could plug or damage the internal pump components while at the same time allowing passage of small quantities of water which may accumulate within the fuel tank sump.

The electrical system has a fuel pump control relay controlled by the powertrain control module (PCM) (12A650), which provides power to the fuel pump under various operating conditions. When the ignition switch (11572) is in the OFF position, the contacts of the PCM power and fuel pump relays are open.

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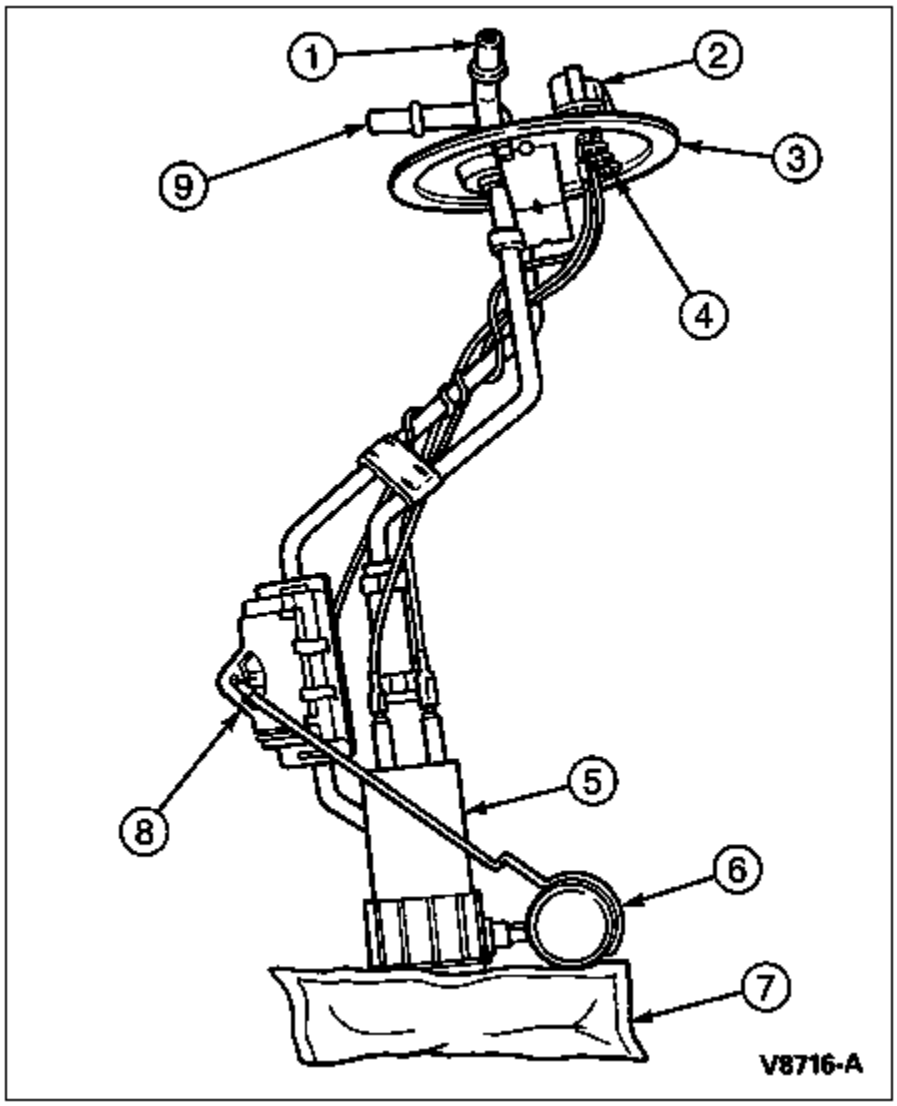

Item	Part Number	Description
1	—	Fuel Supply Tube (Part of 9H307)
2	—	Electrical Connector (Part of 9H307)
3	—	Flange (Part of 9H307)
4	—	Fuel Gauge Sender to Electrical Connector-Spade Connection (Part of 9H307)
5	9350	Fuel Pump
6	—	Sender Float (Part of 9H307)
7	—	Inlet Filter Sock (Part of 9H307)

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8	—	Fuel Gauge Sender Assembly (Part of 9H307)
9	—	Fuel Return Tube (Part of 9H307)

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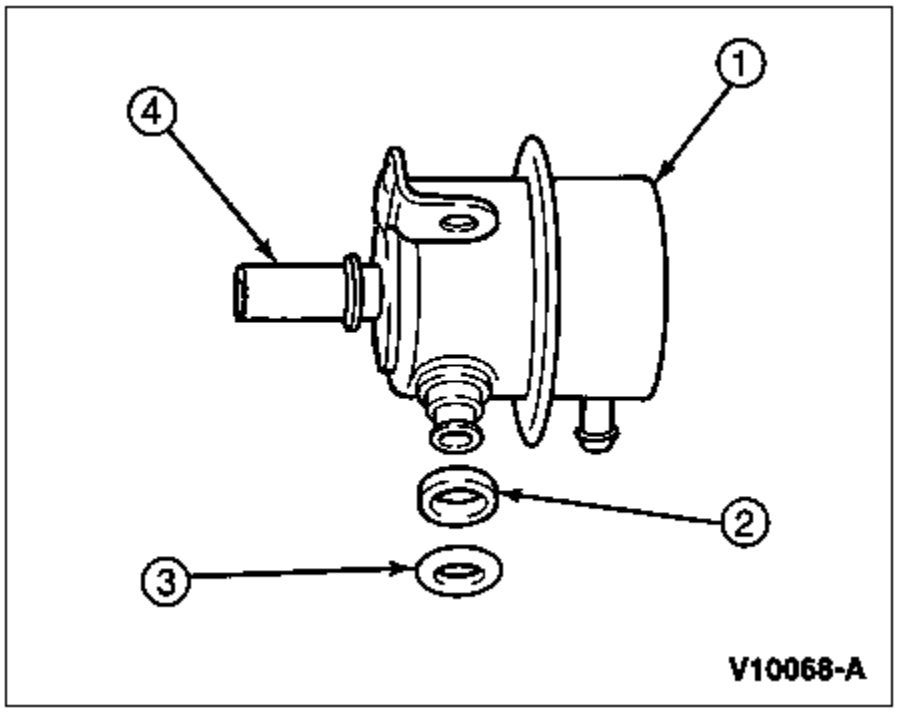
Fuel Pressure Regulator

The fuel pressure regulator (9C968) is attached to the fuel supply manifold assembly downstream of the fuel injectors. It regulates the fuel pressure supplied to the injectors. The regulator is a diaphragm-operated relief valve in which one side of the diaphragm senses fuel pressure and the other side is subjected to intake manifold vacuum. The nominal fuel pressure is established by a spring preload applied to the diaphragm. Balancing one side of the diaphragm with manifold pressure maintains a constant fuel pressure drop across the injectors. Fuel, in excess of that used by the engine, is bypassed through the regulator and returns to the fuel tank (9002).



Item	Part Number	Description
1	9C968	Fuel Pressure Regulator
2	—	Washer (Part of 9C968)
3	—	O-Ring (Part of 9C968)
4	—	Fuel Return Tube (Part of 9H307)

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Inertia Fuel Shutoff Switch

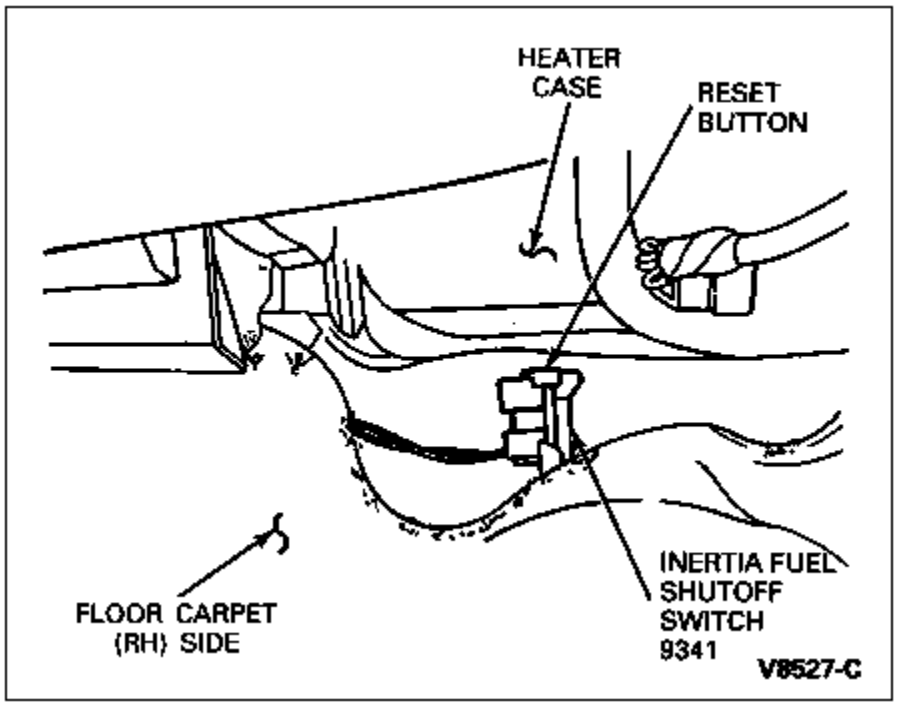
WARNING: IF YOU SEE OR SMELL GASOLINE AT ANY TIME OTHER THAN DURING FUELING, DO NOT RESET THE INERTIA FUEL SHUTOFF SWITCH (IFS SWITCH) (9341).

The inertia fuel shutoff switch shuts off fuel to the engine (6007) in event of collision. Once the inertia fuel shutoff switch has shut off the fuel pump (9350) it must be manually reset to start engine.

On Ranger vehicles, the inertia fuel shutoff switch is located on the toe-board to the right of the transmission hump.

On Aerostar vehicles, it is located on the kick panel to the right of the front passenger seat.

Inertia Fuel Shutoff Switch Location, Ranger



Inertia Fuel Shutoff Switch Location, Aerostar

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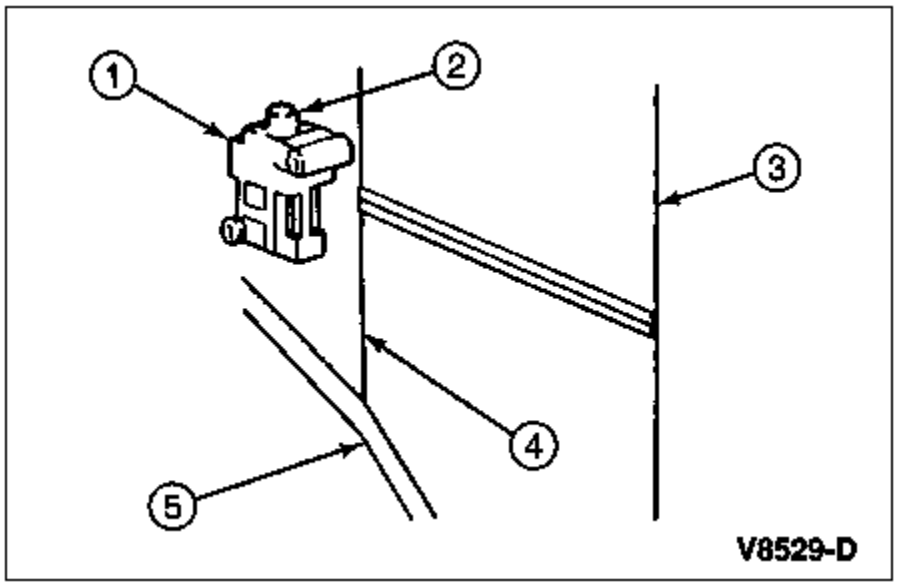

Item	Part Number	Description
1	9341	Inertia Fuel Shutoff Switch
2	—	Reset Button (Part of 9341)
3	20124	Door RH Side
4	02018	Cowl Panel RH Side
5	01610	Dash Panel RH Side

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Fuel Draining

Use appropriate adapter to connect Rotunda Fuel Storage Tanker 034-00002 or equivalent suction pump to the fuel hose (at the fuel pump-to-fuel tube connection) and drain the fuel tank (9002).

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Fuel Filling

The fuel filler nozzle openings for the fuel tanks (9002) on vehicles with gasoline engines (6007) have been made smaller to prevent accidental filling with other than unleaded fuel. Gasoline pumps in the United States dispensing unleaded fuel are equipped with dispensing nozzles to accommodate the smaller filler opening in the fuel tank filler pipe (9034).

Expansion of fuel due to temperature increases or overfilling (topping off) can cause fuel overflow at the fuel tank filler cap (9030) when the vehicle is standing or the fuel tank filler cap is removed. To minimize this condition, it is recommended that the amount of fuel put in the fuel tank be limited to the third automatic pump shutoff.

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Fuel Tanks

Steel Midship, Aerostar

Removal and Installation

1. **NOTE: Make sure fuel tank (9002) is properly supported during removal and installation procedures.**

   Drain fuel from fuel tank.

2. Loosen fuel tank filler pipe clamp.

3. Remove fuel tank heat shield (9A032) from vehicle.

4. Support fuel tank.

5. Remove bolt from rear fuel tank support strap (9092) and remove rear fuel tank support strap.

6. Remove bolt from front fuel tank support strap and remove front fuel tank support strap.

7. Partially lower fuel tank to gain access and remove feed and return lines from sender ports. To disconnect push connect fittings, refer to Push Connect Fittings in this section.

8. Remove electrical connector from sender unit.

9. Remove fuel vapor hose from evaporative emission valve (9B593).

10. Lower fuel tank from vehicle.

11. For installation, follow removal procedures in reverse order. The fittings used on 7.9mm (5/16-inch) nominal diameter nylon tubing use a hairpin clip. Clips should be replaced whenever a connector is removed. Refer to Push Connect Fittings in this section. Tighten bolts securing fuel tank support straps to 47-61 Nm (35-45 lb-ft). Tighten screws securing fuel tank heat shield to 3-6 Nm (27-53 lb-in). Tighten clamp securing fuel tank filler pipe (9034) to 3-4 Nm (27-35 lb-in).

Fuel Tank and Fuel Tank Filler Pipe Installation, Aerostar

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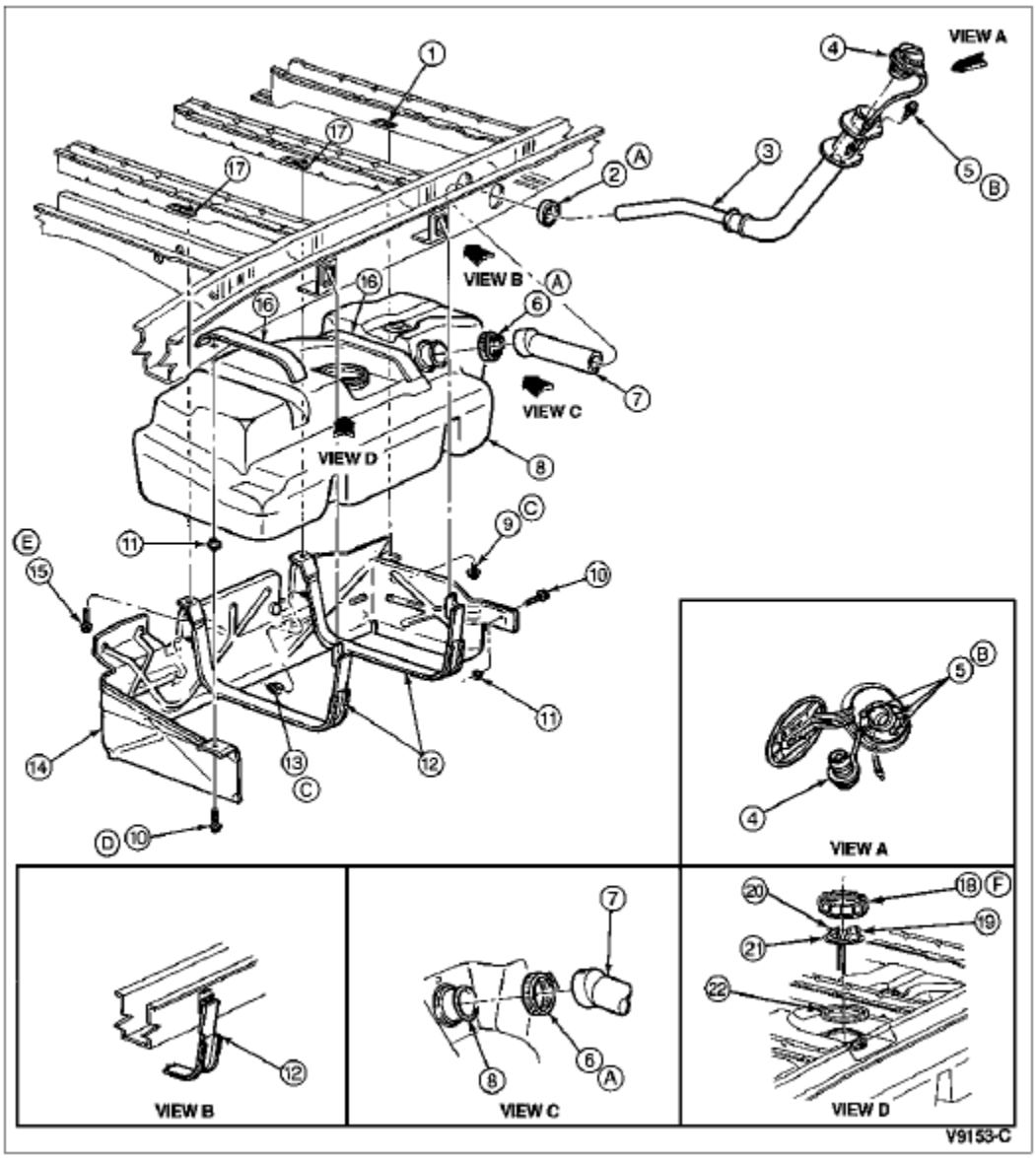

Item	Part Number	Description
1	N802810-S36	U-Nut
2	383526-S	Clamp
3	9034	Fuel Tank Filler Pipe
4	9030	Fuel Tank Filler Cap
5	42127-S2	Screw and Washer
6	383526-S	Clamp
7	9047	Fuel Tank to Filler Pipe Hose
8	9002	Fuel Tank
9	N800394-S36	Bolt
10	N800312-S36	Screw and Washer
11	385701-S	Nut, 1/4 Insert

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12	9092	Fuel Tank Support Strap
13	N620480-S36	Nut
14	9A032	Fuel Tank Heat Shield
15	N802253-S36	Bolt
16	9240	Insulator, Fuel Tank
17	N801107-S36	U-Nut
18	9A307	Fuel Tank Sending Unit Locking Retainer Ring
19	9323	Tube Assembly, Fuel Tank to Filter
20	9B324	Tube Assembly, Fuel Rear
21	9H307	Fuel Pump and Sender Assembly
22	9417	Fuel Pump Mounting Gasket
A	—	Tighten to 3.5-4.5 Nm (31-39 Lb-In)
B	—	Tighten to 2-3 Nm (18-25 Lb-In)
C	—	Tighten to 8-11 Nm (6-8 Lb-Ft)
D	—	Tighten to 3.5-4.5 Nm (31-39 Lb-In)
E	—	Tighten to 47-63 Nm (35-46 Lb-Ft)
F	—	Tighten to 54-71 Nm (40-52 Lb-Ft)

Plastic Midship, Ranger

Removal and Installation

1. **NOTE: Make sure fuel tank is properly supported during removal and installation procedures.**

   Drain fuel from fuel tank.

2. Loosen fill pipe clamp.

3. (4x4 only) Remove bolts securing skid plate assembly to frame (5005) and remove assembly from vehicle.

4. Remove fuel tank filler pipe from vehicle.

5. Support fuel tank.

6. Remove bolts and nuts from rear fuel tank support strap and remove rear fuel tank support strap.

7. Remove bolt and nut from front fuel tank support strap and remove front fuel tank support strap.

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8. Lower fuel tank.

9. Remove fuel supply hose at sender push connector. To disconnect push connect fittings, refer to Push Connect Fittings in this section.

10. Remove fuel return hose at sender unit push connector. To disconnect push connect fittings, refer to Push Connect Fittings in this section.

11. Disconnect sender and fuel pump electrical connector.

12. Remove fuel vapor hose from evaporative emission valve.

13. Lower fuel tank from vehicle.

14. For installation, follow removal procedures in reverse order. The fittings used on 7.9mm (5/16-inch) nominal diameter nylon tubing use a hairpin clip. Clips should be replaced whenever a connector is removed. Refer to Push Connect Fittings in this section. Tighten U-lock nuts securing front and rear fuel tank support straps to 34-46 Nm (25-34 lb-ft). Tighten clamp securing fuel tank filler pipe to 3-4 Nm (27-35 lb-in).

Fuel Tank Installation, Ranger Regular Cab, Standard Tank

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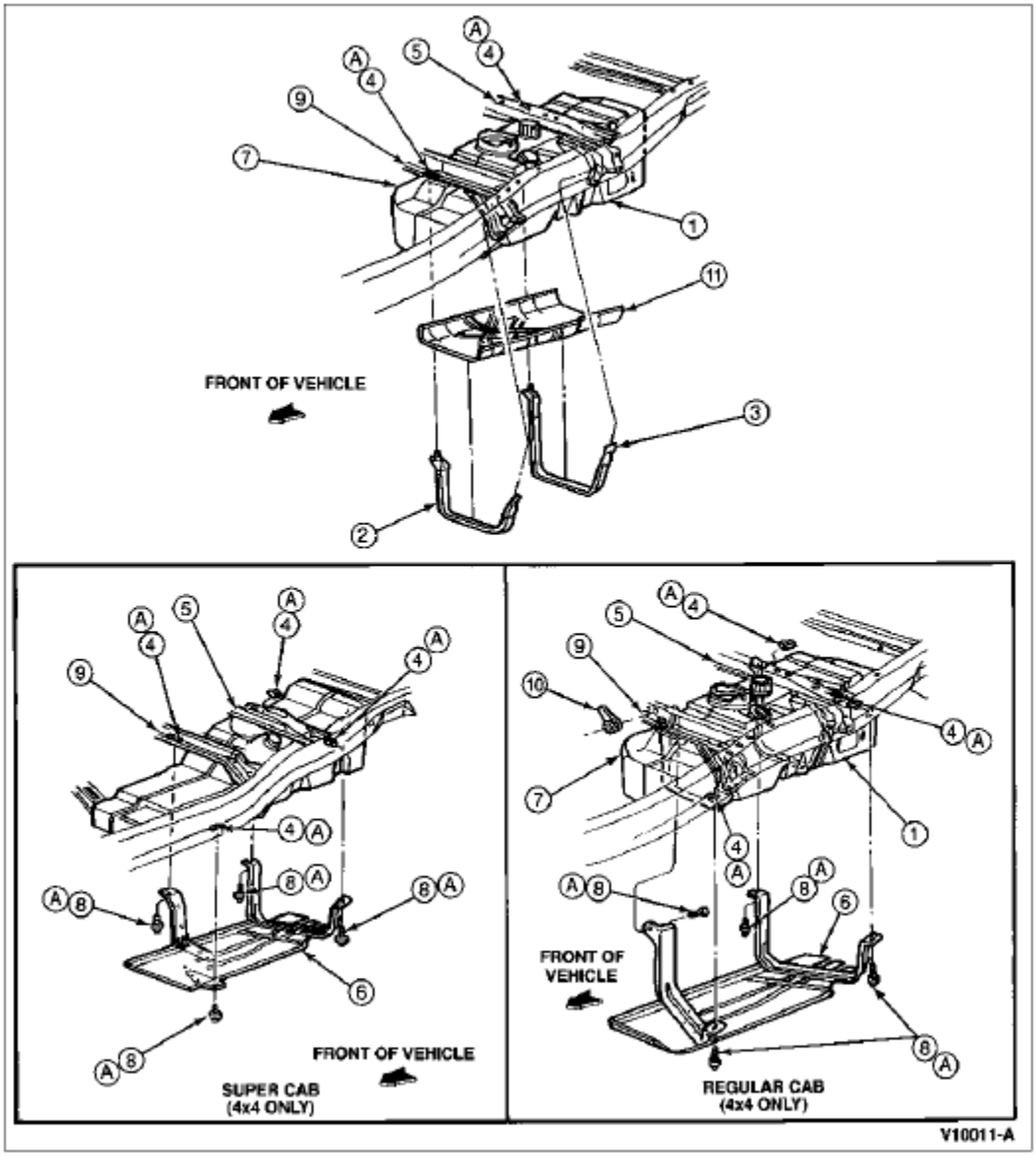

Item	Part Number	Description
1	9002	Fuel Tank
2	9054	Fuel Tank Support Strap, Front
3	9092	Fuel Tank Support Strap, Rear
4	N801107-S426	Nut, U-Lock
5	5030	Crossmember, No. 4
6	9A147	Skid Plate Assembly (4x4 Only)
7	9A032	Fuel Tank Heat Shield
8	N605920-S426	Bolt
9	5025	Crossmember
10	N807164-S426	Nut and Retainer

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11	9A032	Fuel Tank Heat Shield
A	—	Tighten to 34-46 Nm (25-34 Lb-Ft)

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Fuel Tank Filler Pipe, Aerostar

Lower Fill Hose

Removal and Installation

1. **NOTE: Fuel tank (9002) must be removed before lower fuel tank filler pipe (9034) can be removed from the fuel tank.**

   Remove fuel tank as described in this section.

2. Remove clamp which secures lower fuel tank to filler pipe hose (9047) to the fuel tank spud.

3. Pull lower fuel tank filler pipe from fuel tank.

4. For installation, follow removal procedures in reverse order. Tighten fill pipe hose clamp to 3-4 Nm (27-35 lb-in).

Upper Fill Pipe

Removal and Installation

1. **NOTE: Fuel tank must be less than half full before removing upper fuel tank filler pipe.**

   Drain fuel tank to less than half-full level.

2. Remove three bolts which secure the fuel tank filler pipe to the body side.

3. Loosen clamp that secures the outer fuel tank filler pipe to the lower fuel tank to filler pipe hose.

4. Disconnect the fuel tank filler pipe from the lower fuel tank to filler pipe hose.

5. Remove the upper fuel tank filler pipe by pulling the assembly up through the body side.

6. If required, the fuel tank filler cap (9030) may be slipped off the fuel tank filler pipe by pulling on the tether.

7. For installation, follow removal procedures in reverse order. Tighten clamp securing fuel tank filler pipe to 3.5-4.5 Nm (31-39 lb-in).

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Fuel Tank Filler Pipe, Ranger

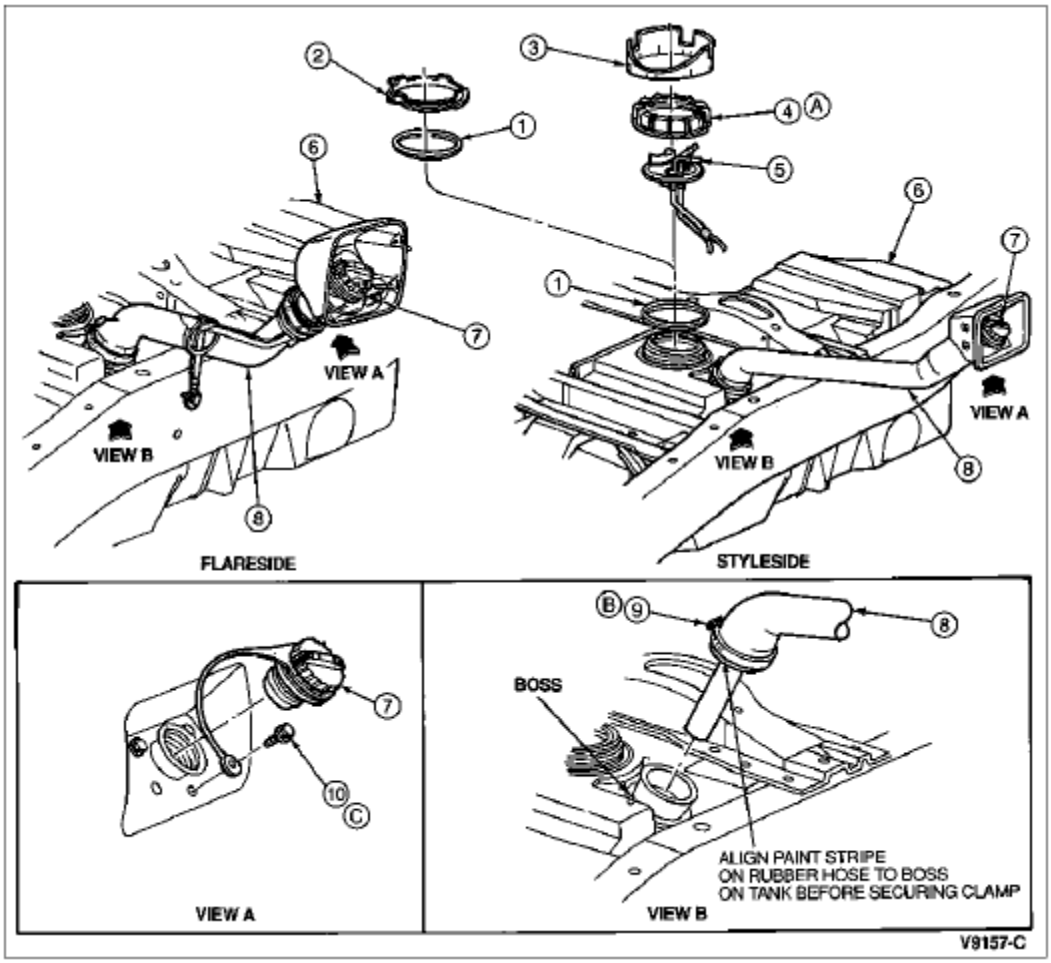
Removal

1. Loosen screw clamp attaching fuel tank to filler pipe hose (9047) to fuel tank (9002).
2. Remove three screws attaching fuel tank filler pipe (9034).

Installation

1. Replace three screws attaching the fuel tank filler pipe to body housing. Tighten screws to 3.5 Nm (30 lb-in).
2. Tighten screw clamps attaching fuel tank to filler pipe hose to 3-4 Nm (27-35 lb-in).

Fuel Filler System, Ranger



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Item	Part Number	Description
1	9417	Fuel Pump Mounting Gasket
2	9C385	Ring, Sender (SuperCab Only)
3	9C291	Fuel Tube Shield
4	9A307	Fuel Tank Sending Unit Locking Retainer Ring
5	9H307	Fuel Pump and Sender Assembly
6	9002	Fuel Tank
7	9030	Fuel Tank Filler Cap
8	9034	Fuel Tank Filler Pipe
9	—	Clamp (Part of 9034)
10	N807605-S412	Screw Assembly
A	—	Tighten to 53-72 Nm (39-53 Lb-Ft)
B	—	Tighten to 3-4 Nm (27-35 Lb-In)
C	—	Tighten to 4 Nm (30 Lb-In)

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Fuel Filters

NOTE: Ignition switch (11572) must be in OFF position before removing the filter.

Fuel is filtered at two locations on Aerostar and Ranger vehicles.

In-Tank

A nylon filter element (inlet filter sock) is mounted on the in-tank electric fuel pump inlet inside the fuel tank and is used to protect the fuel pump from fuel tank contaminants.

The in-tank filter is not serviced separately. To service the in-tank filter, replace the fuel pump and sender assembly.

In-Line

The fuel filter on MFI applications provides extremely fine filtration to protect the small metering orifices of the fuel injector nozzle tips (9E527). The filter is a one-piece construction which cannot be cleaned. If the filter becomes clogged or restricted, it should be replaced.

MFI engines with electric fuel pumps (9350) have an in-line fuel filter, located on the left frame (5005) or body side rail downstream from the fuel pump.

The in-line fuel filter should last the life of the vehicle under normal driving conditions. If the filter does need to be replaced, proceed as follows.

Removal

CAUTION: If the fuel filter is being serviced with the rear of the vehicle higher than the front, or if the fuel tank (9002) is pressurized, fuel leakage (or siphoning from the tank fuel) from the lines could occur. To prevent this condition, maintain the vehicle front end at or above the level of the rear of vehicle. Also, relieve tank pressure by loosening the fuel tank filler cap (9030). Fuel tank filler cap should be retightened after pressure is relieved. If vehicle is warm, change the fuel filter before the pressure rebuilds.

1. **NOTE: Refer to installation figures under Removal and Installation, Fuel and Vapor Return Lines in this section.**

   Shut engine (6007) off. Depressurize fuel system. Refer to Service Procedures, Fuel System Pressure Relief in this section. Use caution to prevent combustion from fuel spillage.

2. Raise vehicle on hoist.

3. Remove push connect fittings at both ends of fuel filter as described in Removal and Installation, Push Connect Fittings in this section. Install new retainer clips in each plastic push connect fitting.

4. **NOTE: The "flow" arrow direction should be positioned as installed in bracket to make sure of proper flow of fuel through the replacement filter.**

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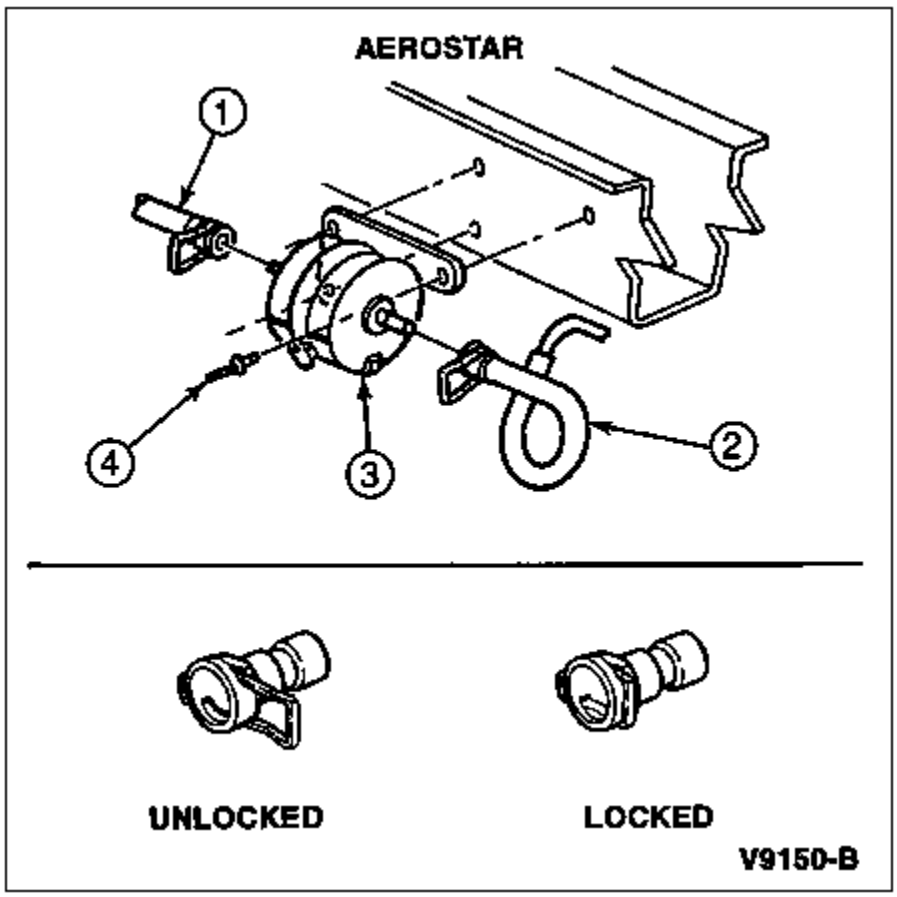
Remove filter from bracket by loosening filter retaining clamp enough to allow filter to pass through.

Installation

1. Install filter in bracket, ensuring proper direction of flow as noted by arrow. Tighten clamp to 1.7-2.8 Nm (15-25 lb-in).
2. Install push connect fittings at both ends of filter as described in Removal and Installation, Push Connect Fittings in this section.
3. Lower vehicle.
4. Start engine and check for leaks.



Item	Part Number	Description
1	9323	Fuel Tank to Filter Tube
2	9H334	Front Tube
3	9B072	Filter and Bracket
4	N802693-S36	Rivet

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Fuel Tank Sending Unit and Pump — Aerostar, Ranger

CAUTION: Fuel supply lines remain pressurized for long periods of time after the engine (6007) is shut down. This pressure must be relieved before the fuel system is serviced. The fuel system on these vehicles is depressurized by disconnecting the inertia fuel shutoff switch (IFS switch) (9341) and cranking the engine for a minimum of 15 seconds.

NOTE: On some vehicles, fuel tank sending unit is not available separately. On those vehicles, to replace sending unit, replace entire fuel pump and sender assembly.

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Fuel Tank Lockring Wrench	T90T-9275-A
Fuel Tank Sender Wrench	T86T-9275-A

Removal

1. Remove fuel tank (9002) as described in this section.
2. Remove fuel tank to bench. Remove any dirt that has accumulated around the fuel pump attaching flange so that it will not enter the fuel tank during fuel pump removal.
3. Turn the fuel tank sending unit locking retainer ring (9A307) counterclockwise with the Fuel Tank Lockring Wrench T90T-9275-A or Fuel Tank Sender Wrench T86T-9275-A and remove fuel tank sending unit locking retainer ring.
4. Remove the fuel pump and sender assembly.
5. Remove fuel pump mounting gasket (9417) and discard.

Installation

1. Clean the fuel pump mounting flange and the fuel tank mounting surface and groove in fuel tank sending unit locking retainer ring.
2. Put a light coating of Premium Long-Life Grease XG-1-C or -K or equivalent meeting Ford specification ESA-M1C75-B on a new fuel pump mounting gasket to hold it in place during assembly and install it in the fuel ring groove.
3. Install fuel pump and sending unit assembly carefully to make sure that the filter is not damaged. Be sure that the locating keys are in keyways and the fuel pump mounting gasket remains in place.
4. Hold the fuel sending unit and fuel pump mounting gasket in place. Install and rotate the fuel tank sending unit locking retainer ring clockwise using Fuel Tank Lockring Wrench T90T-9275-A.

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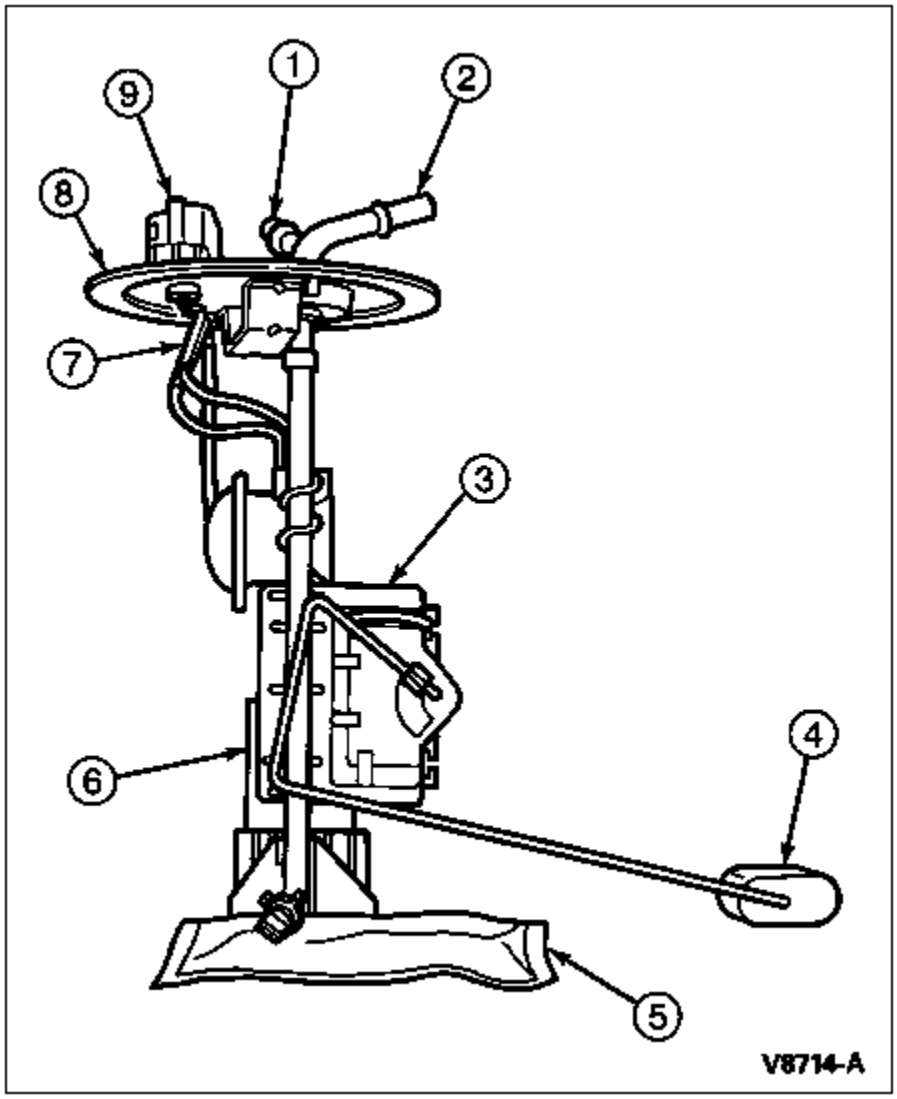
a. For Ranger and Aerostar, tighten the fuel tank sending unit locking retainer ring to 55-74 Nm (40-55 lb-ft).
b. For Ranger SuperCab, tighten fuel tank sending unit locking retainer ring clockwise until stop.

5. Install fuel tank as described in Removal and Installation, Fuel Tanks in this section.

Fuel Pump and Sending Unit, Aerostar



Item	Part Number	Description
1	—	Fuel Supply Tube (Part of 9H307)
2	—	Fuel Return Tube (Part of 9H307)
3	—	Fuel Gauge Sender Assembly (Part of 9H307)

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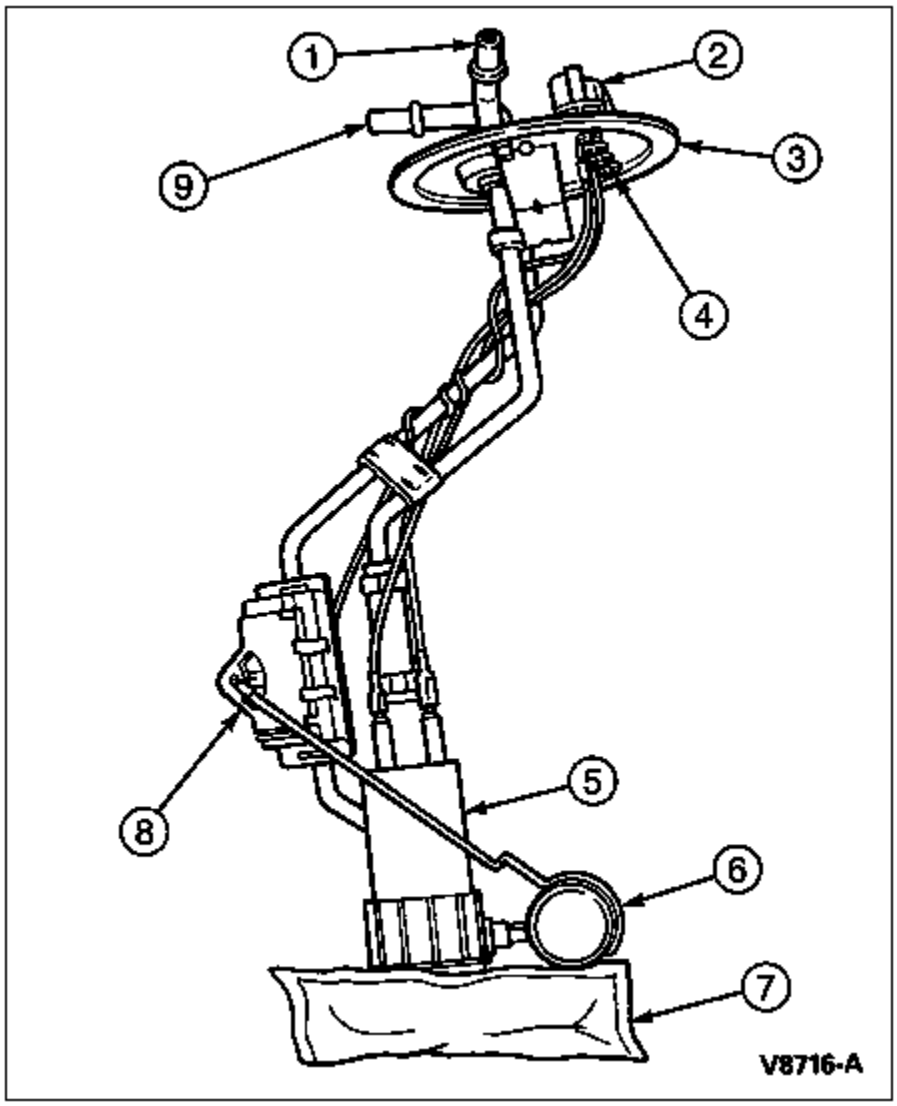
4	—	Sender Float (Part of 9H307)
5	—	Inlet Filter Sock (Part of 9H307)
6	—	Fuel Pump (Part of 9H307)
7	—	Fuel Gauge Sender to Electrical Connector-Spade Connection (Part of 9H307)
8	—	Flange (Part of 9H307)
9	—	Electrical Connector (Part of 9H307)

Fuel Pump and Sending Unit, Ranger Regular Cab



Item	Part Number	Description

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1	—	Fuel Supply Tube (Part of 9H307)
2	—	Electrical Connector (Part of 9H307)
3	—	Flange (Part of 9H307)
4	—	Fuel Gauge Sender to Electrical Connector-Spade Connection (Part of 9H307)
5	—	Fuel Pump (Part of 9H307)
6	—	Sender Float (Part of 9H307)
7	—	Inlet Filter Sock (Part of 9H307)
8	—	Fuel Gauge Sender Assembly (Part of 9H307)
9	—	Fuel Return Tube (Part of 9H307)

Fuel Pump and Fuel Tank Sending Unit, Ranger SuperCab

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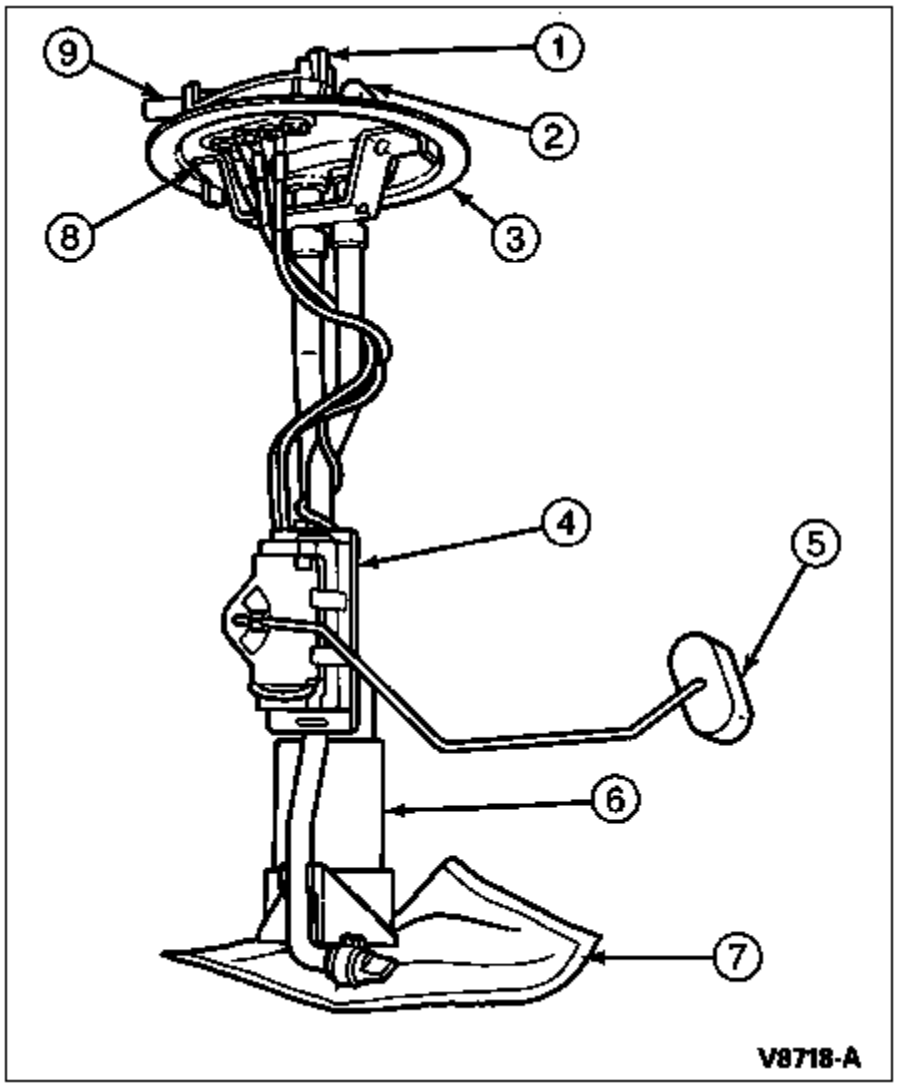

Item	Part Number	Description
1	—	Electrical Connector (Part of 9H307)
2	—	Fuel Return Tube (Part of 9H307)
3	—	Flange (Part of 9H307)
4	—	Fuel Gauge Sender Assembly (Part of 9H307)
5	—	Sender Float (Part of 9H307)
6	—	Fuel Pump (Part of 9H307)
7	—	Inlet Filter Sock (Part of 9H307)
8	—	Fuel Gauge Sender to Electrical Connector-Spade Connection (Part of 9H307)
9	—	Fuel Supply Tube (Part of 9H307)

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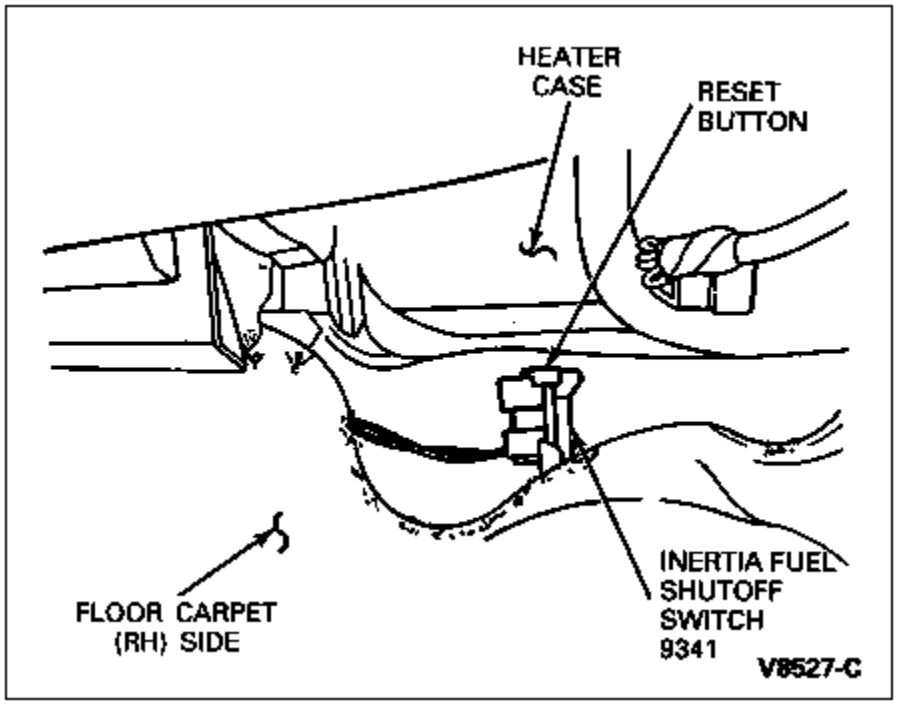
Inertia Fuel Shutoff Switch

WARNING: IF YOU SEE OR SMELL GASOLINE AT ANY TIME OTHER THAN DURING FUELING, DO NOT RESET THE INERTIA FUEL SHUTOFF SWITCH.

To Reset Switch

1. Turn ignition switch (11572) to OFF.
2. Check for leaking fuel in the engine compartment, fuel lines and fuel tanks.
3. If no fuel leak is apparent, reset the inertia fuel shutoff switch by pushing the reset button on the top of the inertia fuel shutoff switch.
4. Turn ignition switch to START for a few seconds, then to OFF.
5. Again, check for leaking fuel.

Inertia Fuel Shutoff Switch Location, Ranger



Inertia Fuel Shutoff Switch Location, Aerostar

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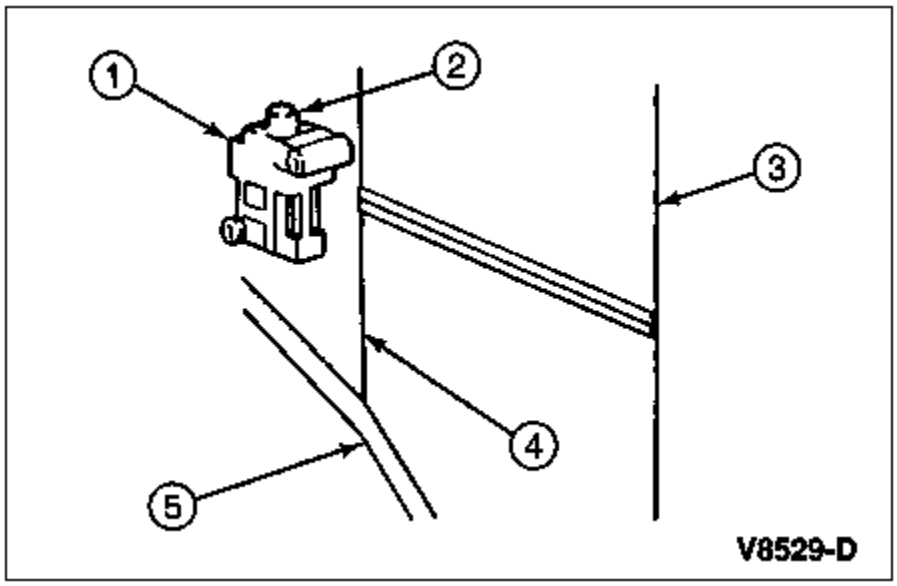

Item	Part Number	Description
1	9341	Inertia Fuel Shutoff Switch
2	—	Reset Button (Part of 9341)
3	20124	Door RH Side
4	02018	Cowl Panel RH Side
5	01610	Dash Panel RH Side

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Fuel Vapor Valve

The evaporative emission valve (9B593) is not repairable. It must be replaced as a complete assembly. To replace the evaporative emission valve refer to Removal and Installation, Fuel Tanks in this section.

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Fuel and Vapor Return Tubes

Plastic

CAUTION: Ford-approved nylon fuel tubing is made from material which has been tested and proven to be acceptable for use with commercially available fuels. It is also resistant to most environmental conditions. Avoid using alternate tubing materials. Use of non-approved tubing could pose a hazard in service.

CAUTION: Plastic fuel tube must not be repaired using hose and hose clamps. Push connect fittings cannot be repaired except to replace the retaining clips.

CAUTION: The plastic fuel lines can be damaged by torches, welding sparks, grinding and other operations which involve heat and high temperatures. If any repair or service operation will be used which involves heat and high temperatures, locate all fuel system components, especially the plastic fuel lines to be certain they will not be damaged. It is recommended that the plastic fuel tubes be removed from the vehicle if a torch or high heat producing equipment is to be used for service in the following areas:

1. Exhaust or suspension components in proximity to fuel tubes.
2. Underbody, rails and crossmembers (left side).
3. Dash panel; under vehicle or inside the passenger compartment (lower right side).
4. Front or rear wheel house/fender apron (right side).

PTFE (Teflon®) and Stainless Steel

In a high heat environment, Teflon® hose and stainless steel tubes with crimped joints are used. These tubes have been tested, and proven to be acceptable for use with commercial fuels. Avoid using alternate tubing materials. Use of non-approved tubing could pose a hazard in service.

CAUTION: Teflon® hose and stainless steel fuel tube assemblies must not be repaired using hose and hose clamps. If damaged, they must be replaced.

Vapor Hoses

Removal

To disconnect a hose from any component, refer to the following:

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1. Securely grip component with one hand, and hose with the other hand as close as possible to connection.

2. Sharply twist hose along its axis to "break" the temporary bond between hose and component. (No adhesive is used to make hose connections during vehicle assembly, but natural aging of the connections causes a temporary bond to exist.)

3. It is important to "break free" the hose at its connection point as indicated in Step 2. If the joint is stubborn and the above method does not work, grip the hose with a pair of pliers directly over the joint and twist again.

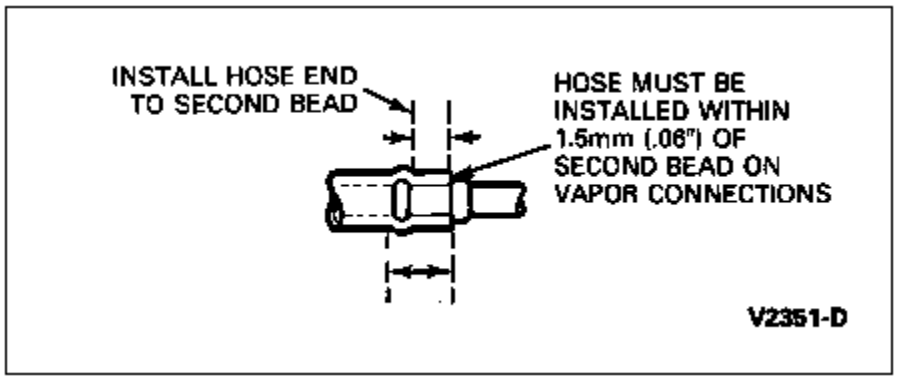
4. **WARNING: MOST CONNECTIONS IN THE EVAPORATIVE EMISSION SYSTEM ARE VERY SECURE. A STRONG PULLING AND SIMULTANEOUS TWISTING ACTION IS REQUIRED TO DISCONNECT. WHEN DISCONNECTION OCCURS, BOTH HANDS COULD SHARPLY AND UNCONTROLLABLY MOVE IN THE DIRECTION OF EACH HAND'S PULLING. BE CAREFUL THAT NO SHARP OR POSSIBLE DAMAGING OBJECTS ARE IN LINE WITH THE DIRECTION OF PULL TO PREVENT PHYSICAL INJURY AND/OR DAMAGE TO THE OBJECTS THAT WILL BE IMPACTED BY THE HANDS WHEN DISCONNECTION OCCURS.**

   Once the hose/component joint has been broken, disconnect by securely gripping the component with one hand and hose with the other. Twist hose and at the same time pull apart.

Installation

1. To reconnect a hose to a component, wet the hose with water and push onto component.

2. Vapor hoses should be assembled with the minimum engagement shown in the following illustration.



Fuel Line System, Aerostar

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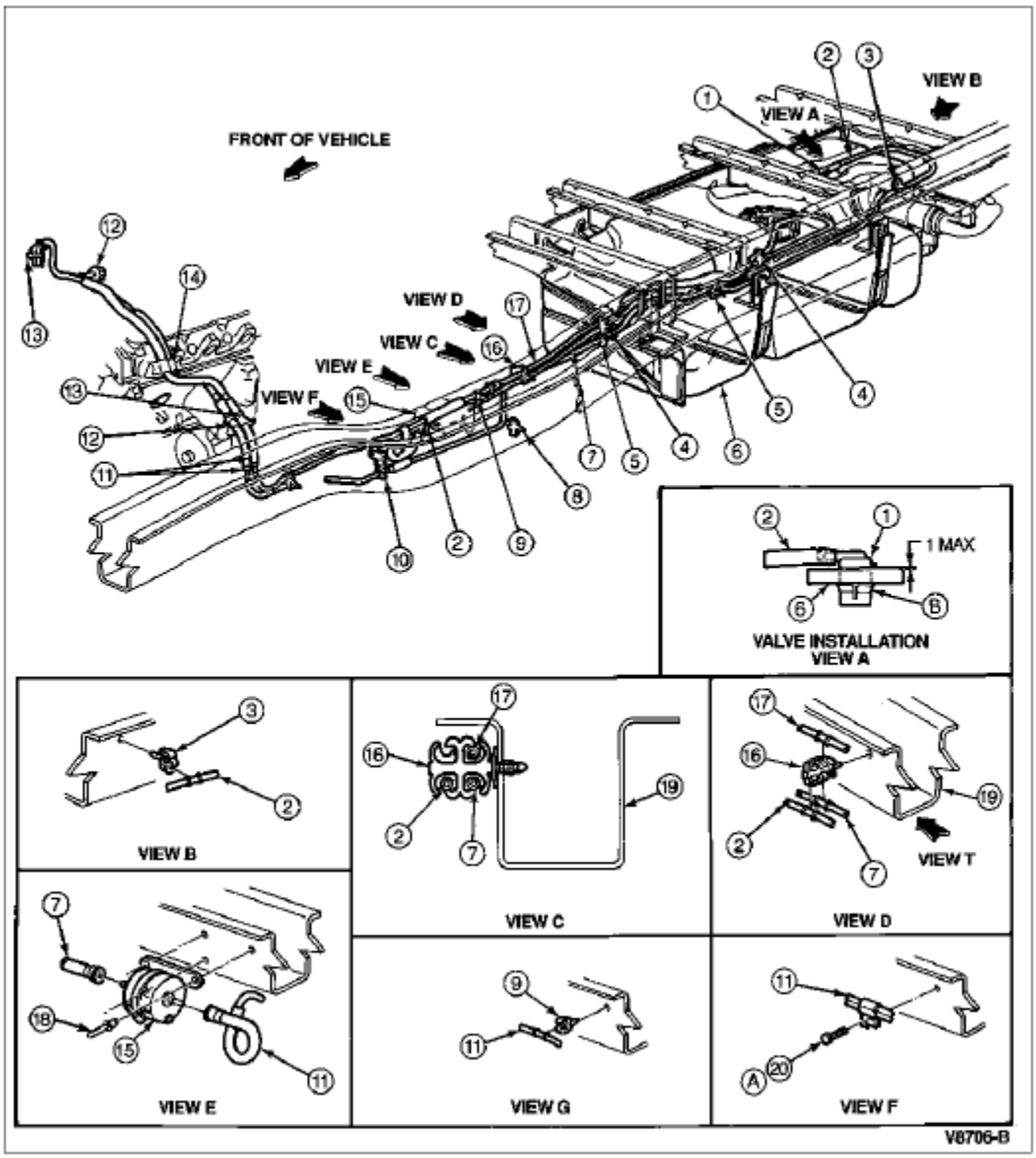

Item	Part Number	Description
1	9B593	Evaporative Emission Valve
2	9B033	Tube Assembly — Fuel Tank Vapor Outlet
3	14A163	Clip
4	N802769-S	Clip — Double
5	N802769-S	Clip — Double
6	9002	Fuel Tank
7	9323	Tube Assembly — Fuel Tank to Filter
8	N802769-S	Brake Line Clip — Do Not Install Vapor Line in Brake Line Clip
9	N802768-S	Clip — Single
10	N803994-S	Clip — Triple

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11	9H334	Tube Assembly — Front
12	N805528-S190	Clip
13	N805526-S190	Clip
14	9J338	Tube Assembly — Engine Supply and Return (3.0L Only)
15	9B072	Fuel Filter and Base
16	9A317	Fuel Tube Clip
17	9B324	Rear Fuel Tube
18	N802693-S36	Rivet, 4.8 x 11.5
19	5005	Frame
20	N807364-S2	Bolt, M6-1.0
A	—	Tighten to 11-13 Nm (98-115 Lb-In)
B	—	Valve Must Be Installed As Shown and Fully Seated

Fuel Line System, Front Lines, Ranger, 2.3L, 3.0L and 4.0L Engines

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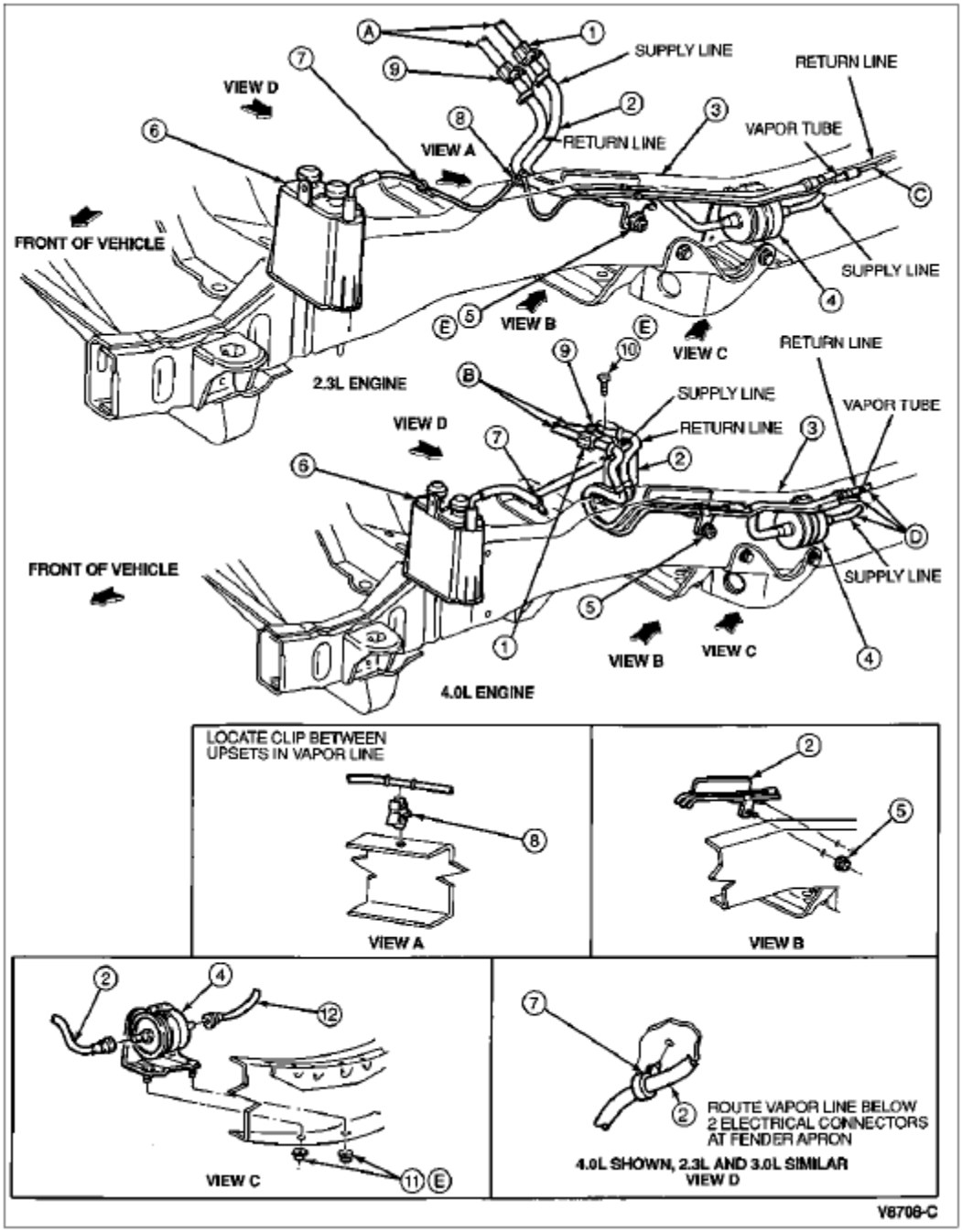

Item	Part Number	Description
1	N805528-S190	Clip, 1/2
2	9S286	Front Fuel Supply Return and Vapor Tube
3	5005	Frame
4	9B262	Filter
5	N620481-S2	Nut, M8-1.25

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6	9D653	Evaporative Emissions Canister
7	N803640-S	Clip
8	390617-S	Clip
9	N805526-S190	Clip, 3/8
10	N611192-S2	Screw, M8-1.25 x 12 Hex Washer Tap
11	N620481-S2	Nut, M8-1.25
12	9J279	Fuel and Vapor Return Tube
A	—	For Continuation (Fuel Supply Manifold) See Section 03-04C Fuel Charging and Controls 2.3L.
B	—	For Continuation (Fuel Supply Manifold) See Section 03-04C , Fuel Charging and Controls, 4.0L.
C	—	For Continuation See Illustration "Fuel Line System, Rear Lines, Ranger" in this Section.
D	—	For Continuation See Illustration "Fuel Line System, Rear Lines, Ranger" in this Section.
E	—	Tighten to 15-20 Nm (11-15 Lb-Ft)

Fuel Line System, Front Lines, Ranger, 3.0L Engine

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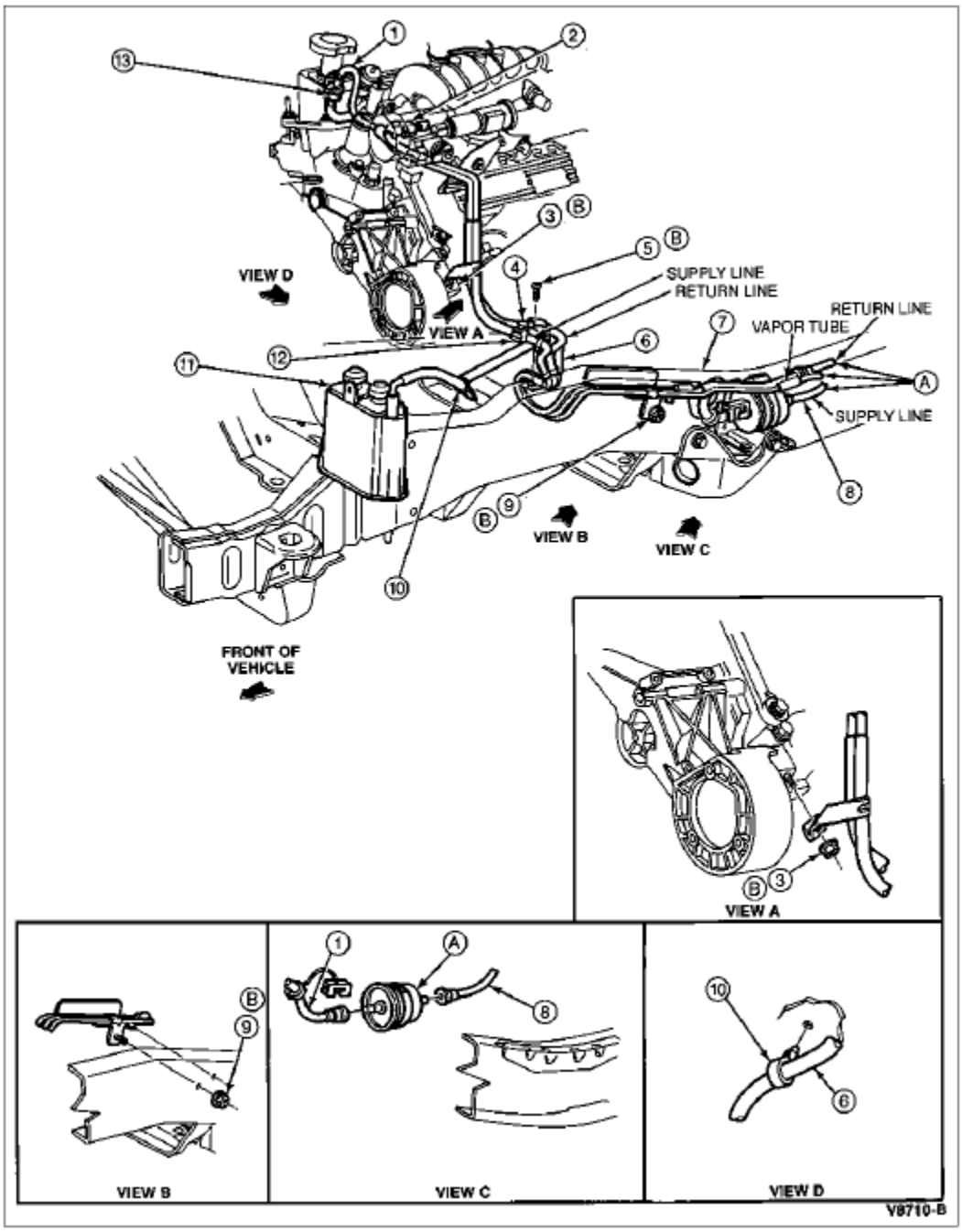

Item	Part Number	Description
1	9J338	Tube Fuel Front
2	N805528-S190	Clip, 1/2
3	N620481-S2	Nut, M8-1.25
4	N805526-S190	Clip, 3/8
5	N611192-S2	Screw, M8-1.25 x 12 Hex Washer Tap

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6	9S286	Front Fuel Supply Return and Vapor Tube
7	5005	Frame
8	9J279	Fuel and Vapor Return Tube
9	N620481-S2	Nut, M8-1.25
10	N803640-S	Clip
11	9D653	Evaporative Emissions Canister
12	N805528-S190	Clip, 1/2
13	N805526-S190	Clip, 3/8
A	—	For Continuation See Illustration Fuel Line System, Rear Lines, Ranger in This Section.
B	—	Tighten to 15-20 Nm (11-15 Lb-Ft)

Fuel Line System, Ranger, Rear Lines

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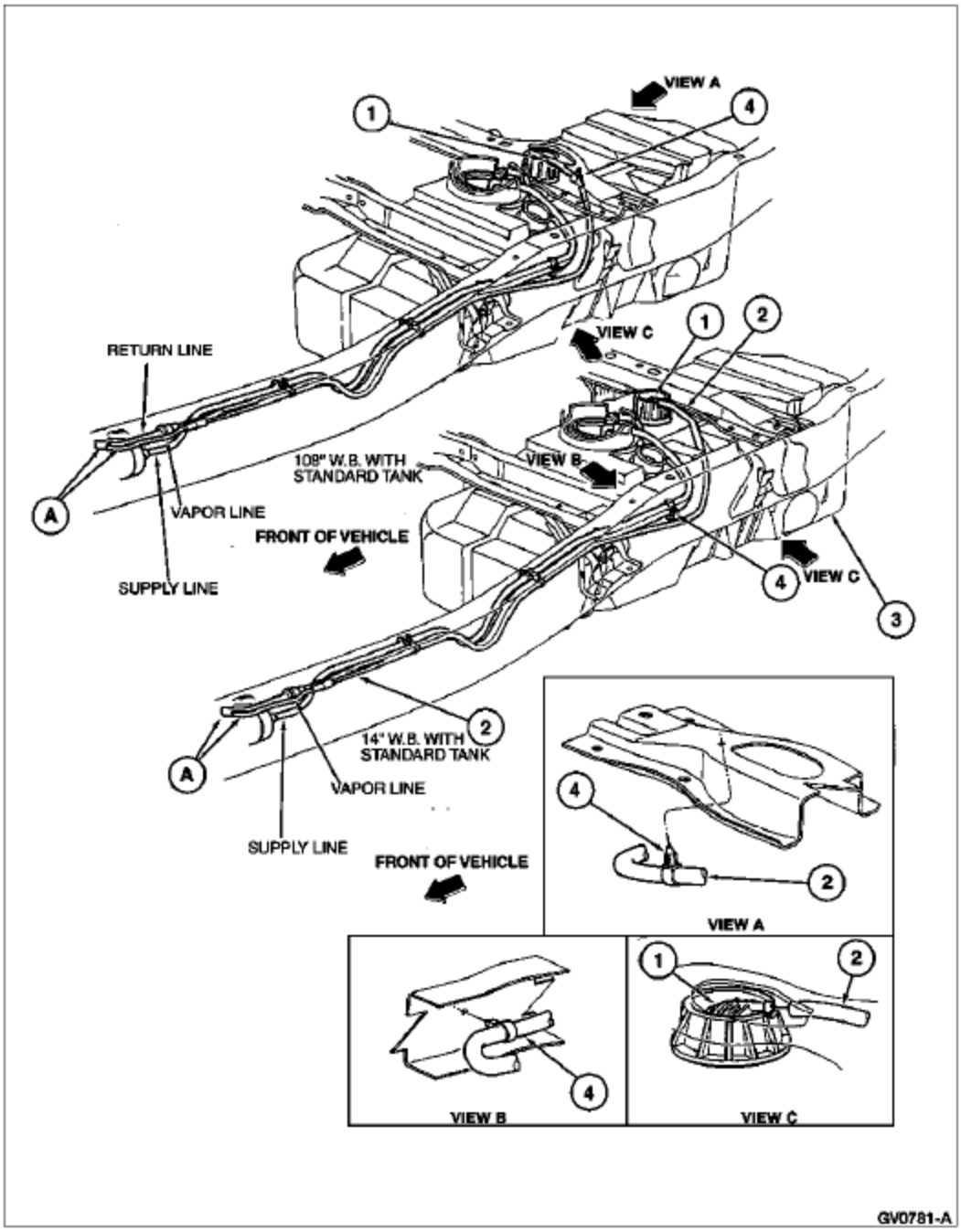

Item	Part Number	Description
1	9B593	Fuel Vapor Valve
2	9J279	Fuel and Vapor Return Tube
3	9002	Fuel Tank
4	N803640-S	Clip
A	—	For Continuation See: Fuel Line System, Front Lines, Ranger, 2.3L and 4.0L Engines, or Fuel Line System,

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		Front Lines, Ranger, 3.0L Engines in This Section.

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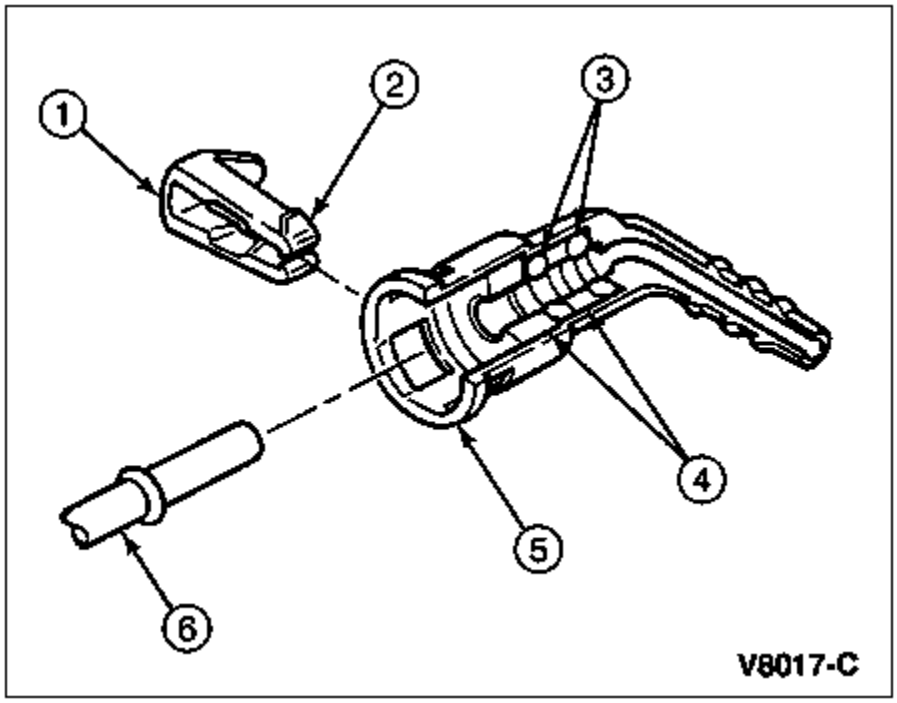
Push Connect Fittings

The fittings used on 7.9mm (5/16-inch) nominal diameter nylon tubing use a hairpin clip. Clips should be replaced whenever a connector is removed.

Disconnect all push connect fittings from components (filter, engine) prior to component removal. The push connect fittings that connect flexible fuel lines to the fuel tank sender cannot be disconnected until the fuel tank heat shield is removed and the tank is partially lowered just before removing the fuel tank (9002) completely.



Item	Part Number	Description
1	N802239-S	Hairpin Clip
2	—	Shipping Tab (Part of N802239-S)
3	—	O-Rings (Part of 3H307)
4	—	Spacers (Part of 3H307)
5	3H307	Sender
6	9J276	Steel or Nylon Tube

Plastic (Hairpin Clip)

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Removal

1. Inspect visible internal portion of fitting for dirt accumulation. If more than a light coating of dust is present, clean the fitting before disassembly.

2. **CAUTION: Do not use any tools.**

   Some adhesion between the seals in the fitting and the tubing will occur with time. To separate, twist the fitting on the tube, then push and pull the fitting until it moves freely on the tube.

3. Remove hairpin type clip from fitting by first bending the shipping tab downward so that it will clear the body. Next (using hands only), spread the two clip legs approximately 3.0mm (1/8 inch) each to disengage the body and push the legs into the fitting. To remove completely, lightly pull the triangular end of the clip and work it clear of the tube and fitting. Discard clip. It must be replaced with a new one during installation.

4. Grasp the fitting and hose assembly and pull in an axial direction to remove the fitting from the steel or nylon tube.

5. When fitting is removed from the tube end, inspect the fitting and tube for any internal parts that may have been dislodged from the fitting. Any loose internal parts should be immediately installed, using the mating tube to insert the parts.

Installation

1. Install the new clip by inserting clip into any two adjacent openings with the triangular portion pointing away from the fitting opening. Install clip to fully engage the body (legs of hairpin clip locked on outside of body). Piloting with an index finger is necessary.

2. Before installing fitting on the tube, wipe tube end with a clean cloth. Inspect the inside and outside of the fitting to make sure it is free of dirt and/or obstructions.

3. To install the fitting onto the tube, align the fitting and tube axially and push the fitting onto the tube end. When the fitting is engaged, a definite click will be heard. Pull on fitting to make sure it is fully engaged.

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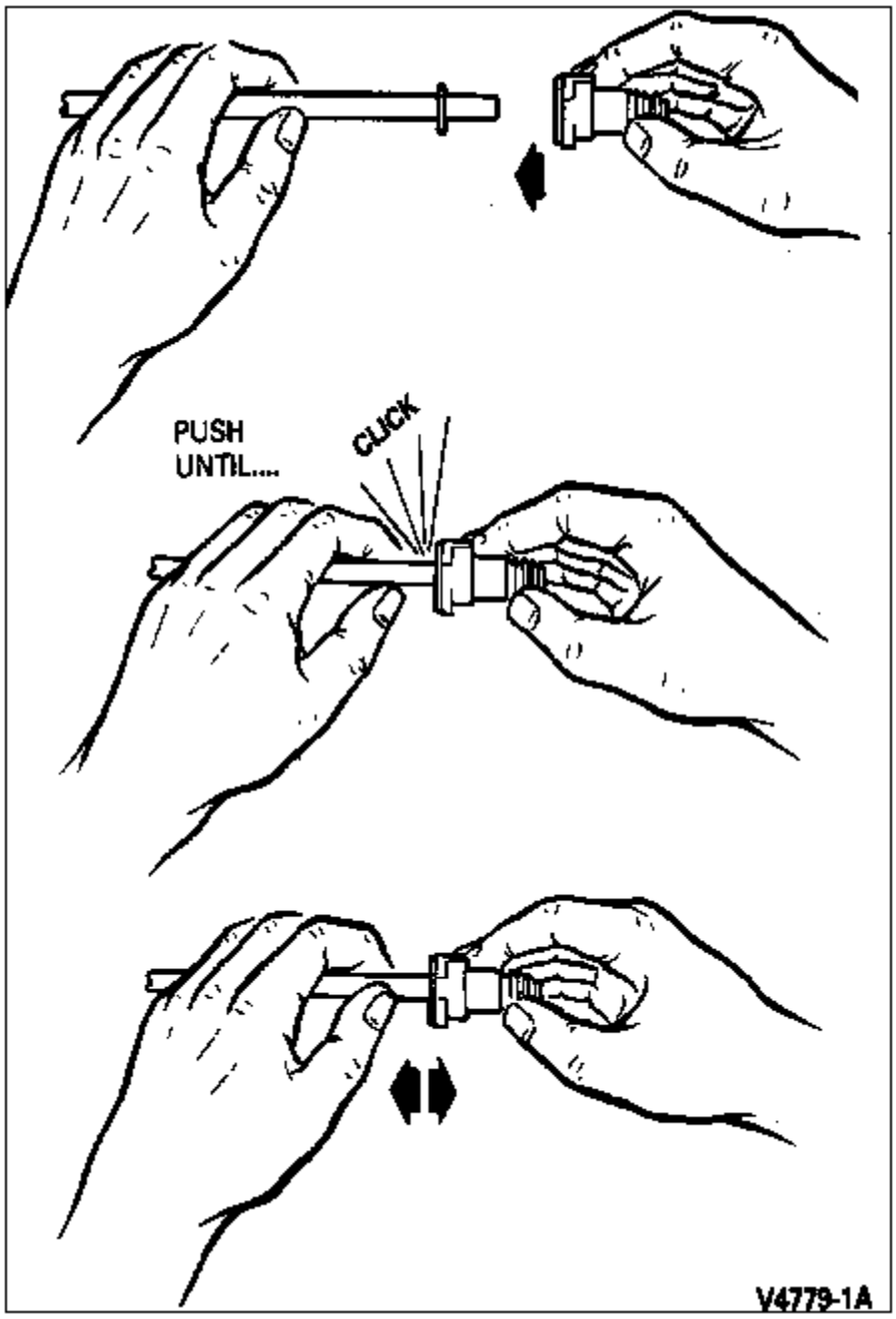

Steel

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Quick Disconnect Tool (5/16-Inch) (Part of T90T-9550-S)	T90T-9550-B
Quick Disconnect Tool (3/8-Inch) (Part of T90T-9550-S)	T90T-9550-C

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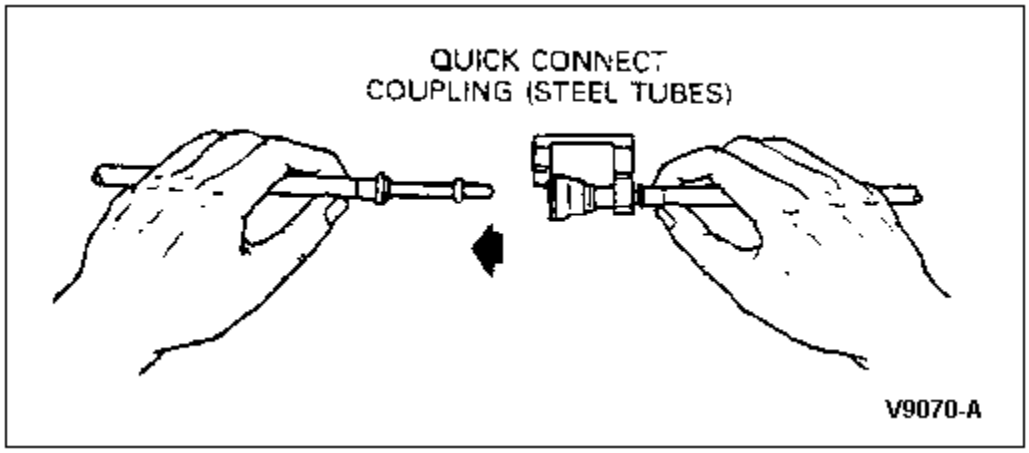
Removal

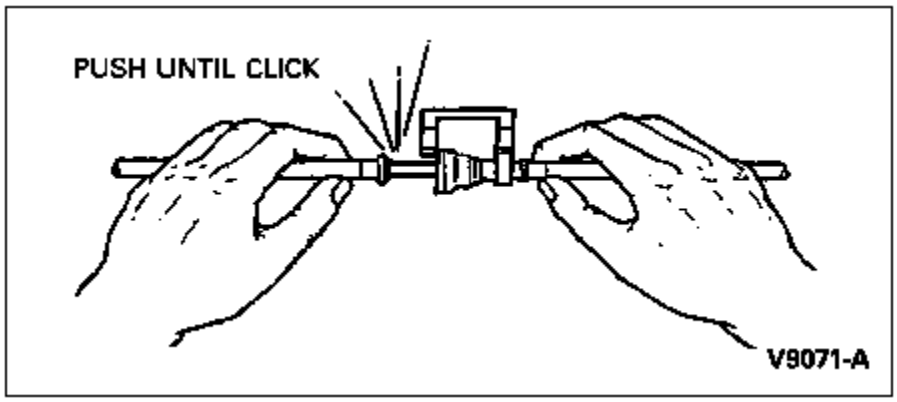
1. Release safety clip from fitting.
2. Fit Quick Disconnect Tool T90T-9550-B (5/16-inch) or T90T-9550-C (3/8-inch) to fitting body so the tool can enter the body and release the retaining fingers.
3. Push the tool into the fitting body to release the retaining fingers from the formed male tube end.
4. Pull the female fitting and the male tube end apart.
5. Remove the tool from the disconnected fitting.
6. Inspect the fitting for any internal parts that may have been damaged. Fuel tube should be replaced if internal parts are damaged.

Installation

1. Align the fitting and tube axially.



2. Push the tube into the fitting. When properly engaged, a click will be heard.



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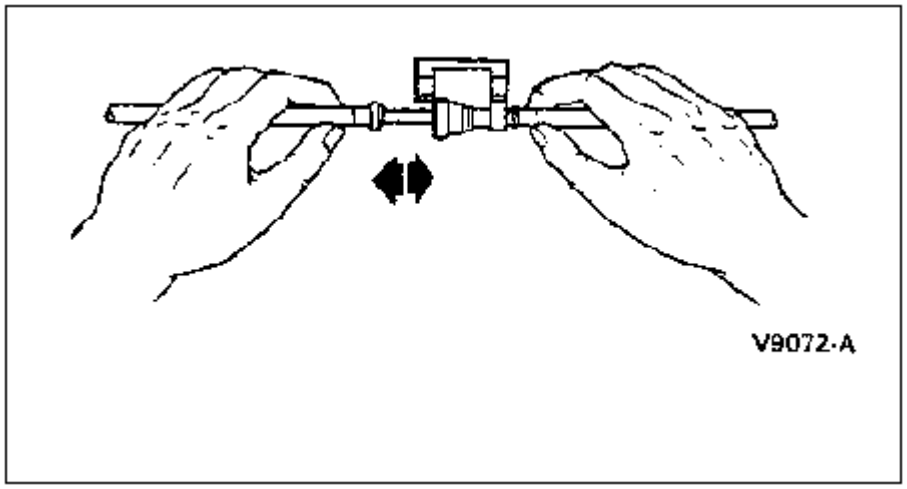
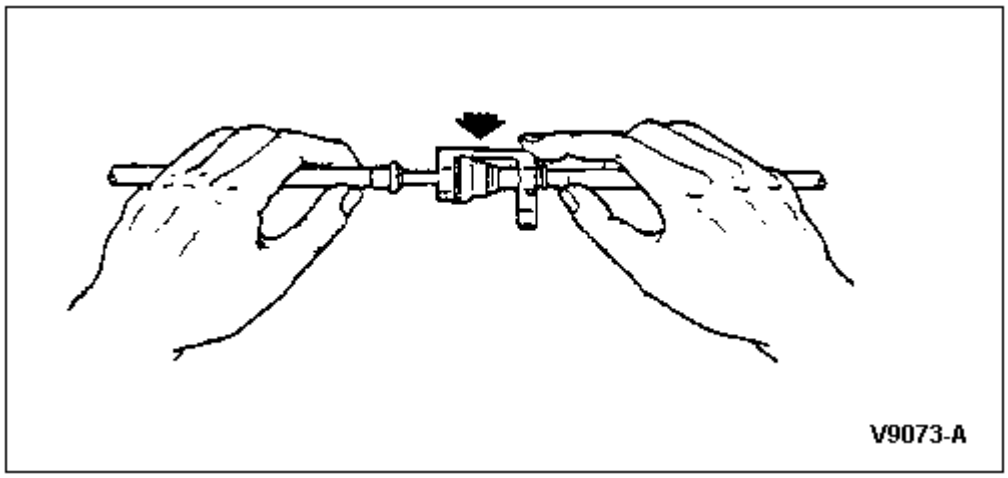
3. Pull on the fitting to make sure it is fully engaged.



4. Lock assembly with safety clip.



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Spring Lock Connectors

Fuel tubes which connect to MFI engines utilize spring lock push connect fittings in the engine compartment instead of the plastic or stainless steel push connect fittings. The spring lock push connect fittings work by insertion of the fitting's male end, which is surrounded by two O-rings, into a female flared end engine fitting. The coupling engagement is secured by a garter spring which prevents the female flared end from becoming disengaged from the male end.

Spring Lock Coupling Disconnect Tool D87L-9280-B or equivalent is used to disconnect the 12.7mm (1/2-inch) spring lock coupling supply fitting. Tool D87L-9280-A or equivalent is used to disconnect the 9.52mm (3/8-inch) spring lock coupling return fitting.

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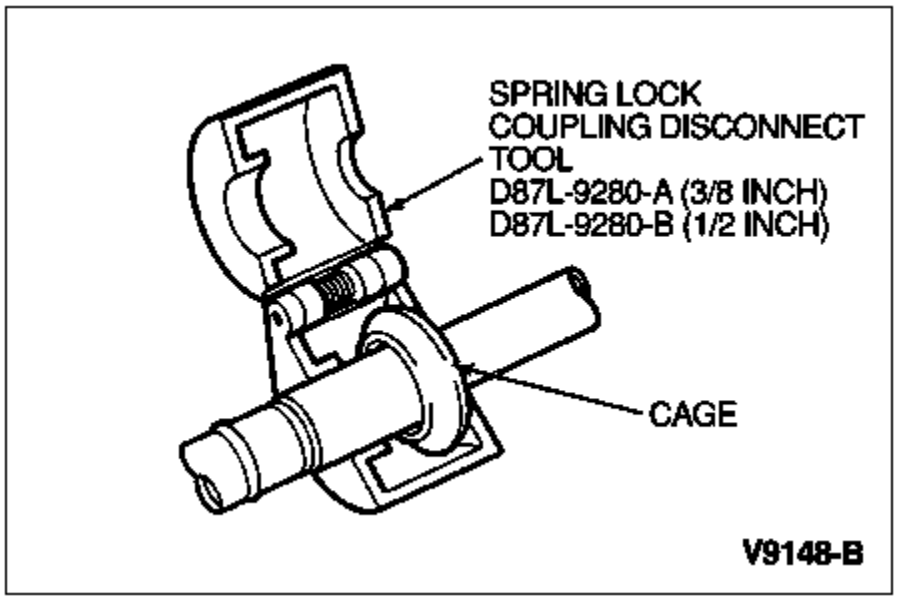
Spring Lock Couplings

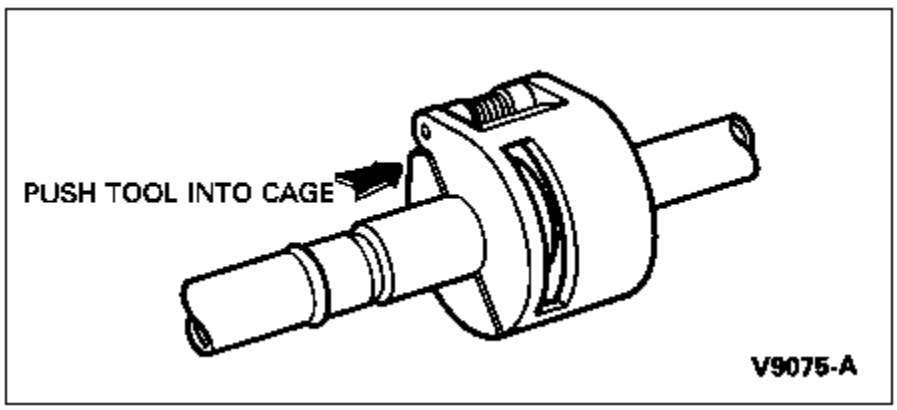
CAUTION: Discharge fuel system before disconnecting coupling.

Disconnecting

1. Remove safety strap. Fit tool to coupling so that tool can enter cage to release the garter spring.



2. Push the tool into the cage opening to release the female fitting from the garter spring.



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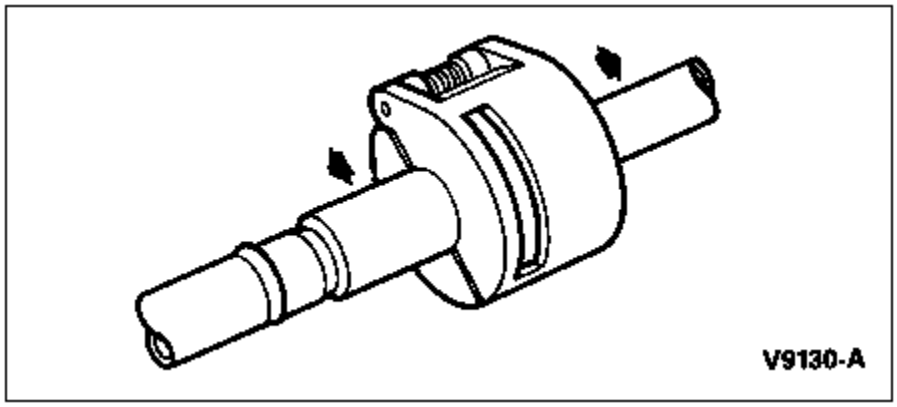
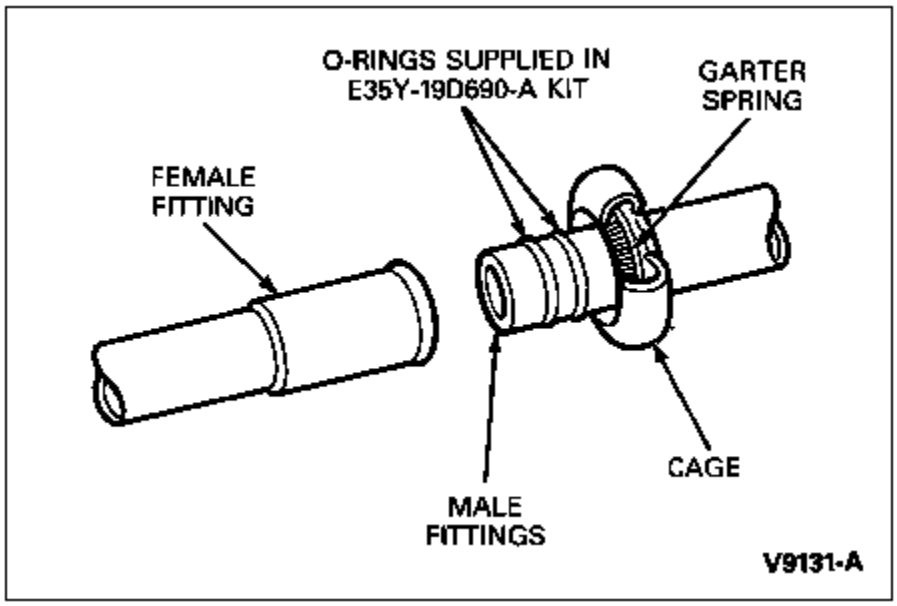
3. Pull the coupling male and female fittings apart.



4. Remove the tool from the disconnected spring lock coupling.



Connecting

1. Check for missing or damaged garter spring. If spring is damaged or missing: remove damaged spring with small hooked wire and install a new spring.

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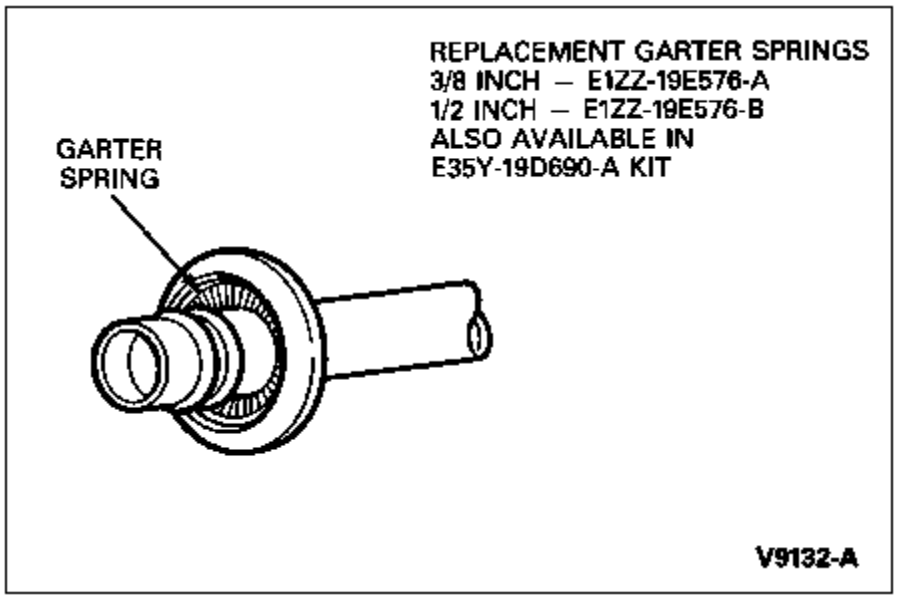
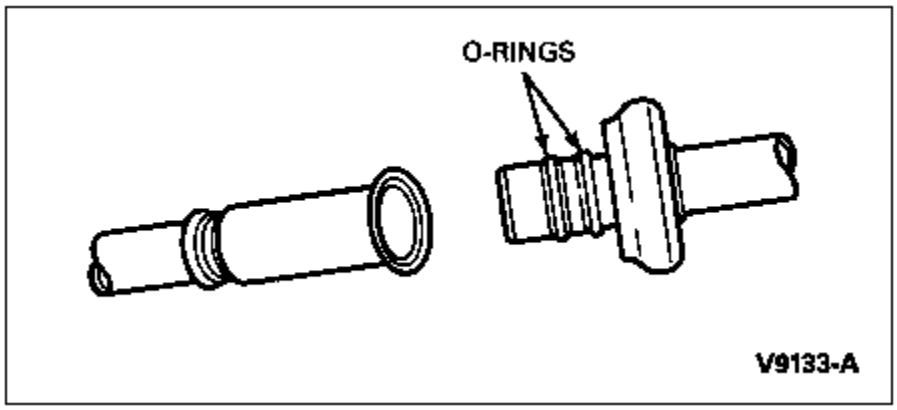


2. Clean fittings and install new O-rings. Use only specified O-rings supplied in Kit E35Y-19D690-A. Lubricate with clean refrigerant oil and assemble fitting by pushing with a slight twisting motion.



3. Visually check to be sure garter spring is over flared end of female fitting and pull on fitting to ensure full engagement.

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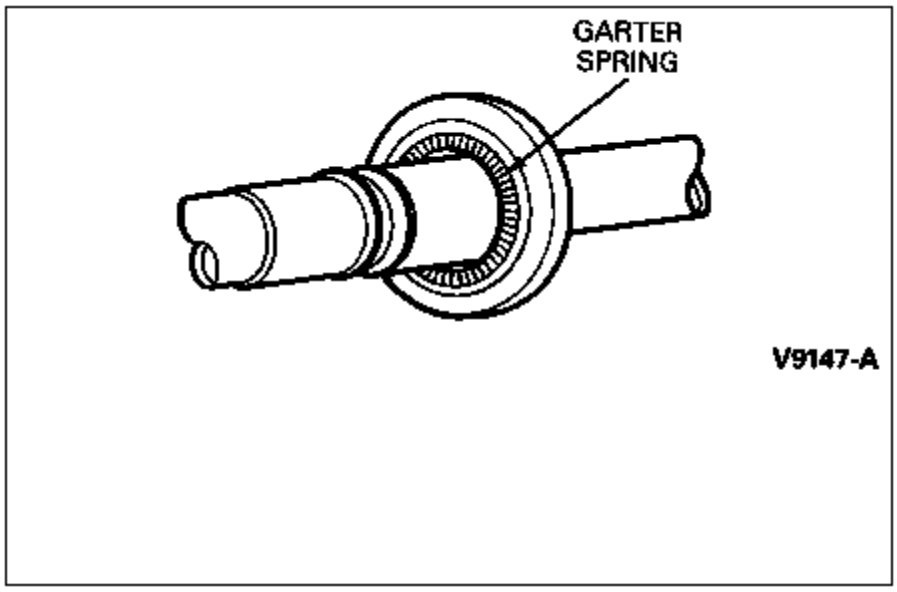
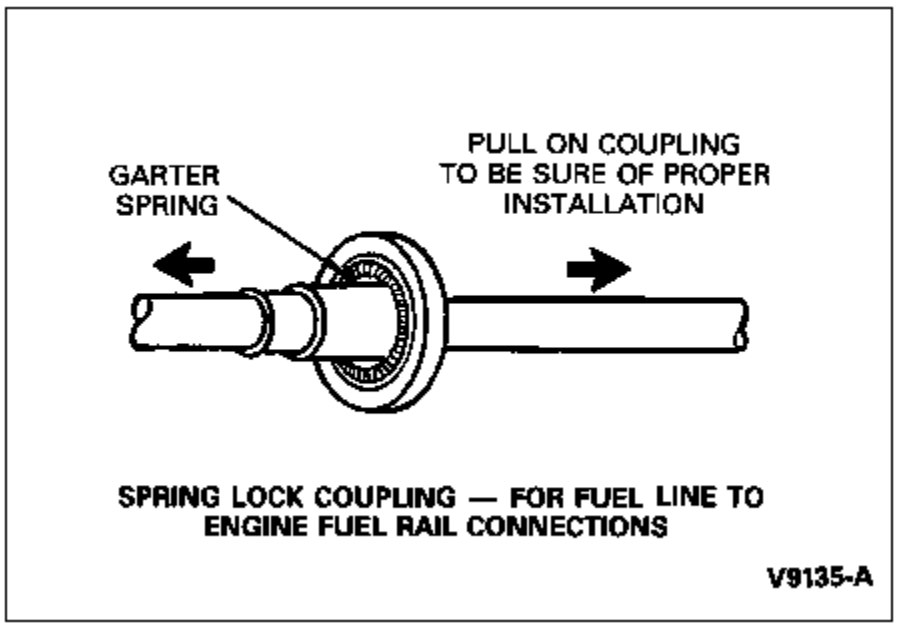


Spring Lock Coupling Safety Clip Installation

1. Visually check to be sure garter spring is over flared end of female fitting.

2. Pull on connector opposite the direction of installation to verify that the connector is locked in place. If connector is not locked in place, refer to Connecting Spring Lock Connector procedure in this section.



3. **NOTE: The black 12.7mm (1/2-inch) clip fits the fuel supply line. The silver 9.5mm (3/8-inch) clip fits fuel return line.**

   Install large end of clip to garter spring side of fuel line making sure that clip is properly positioned.

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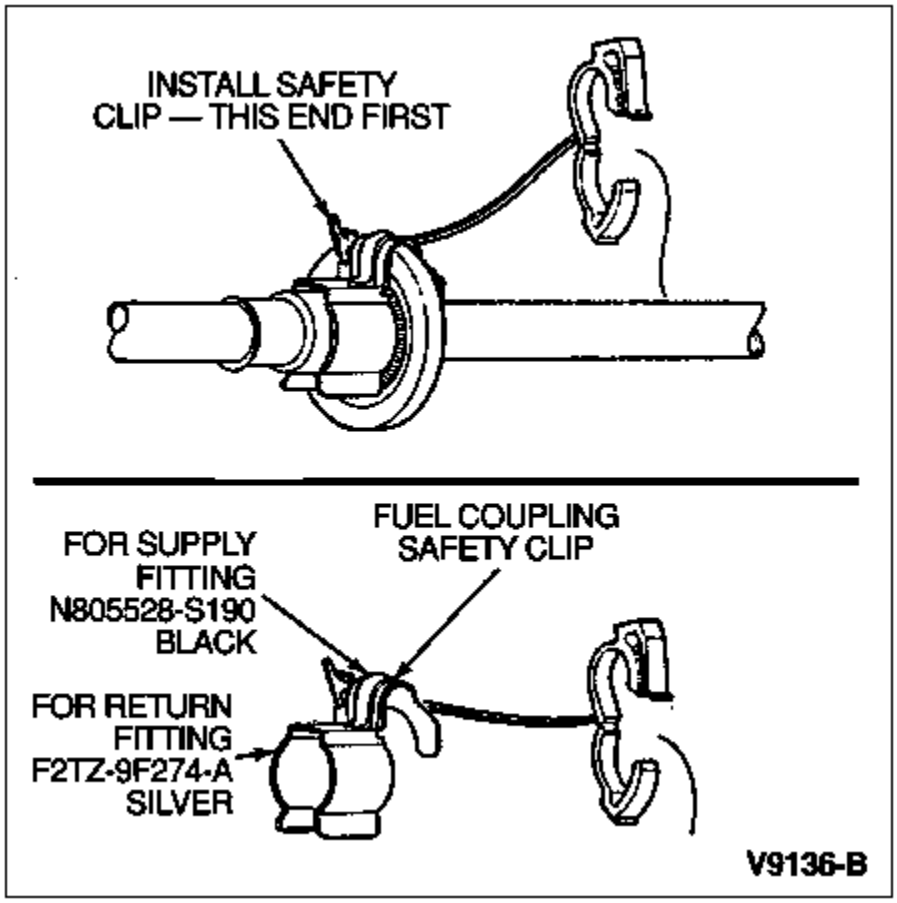
Refer to the following illustration.



4. Attach the tether to the fuel line and snap shut.

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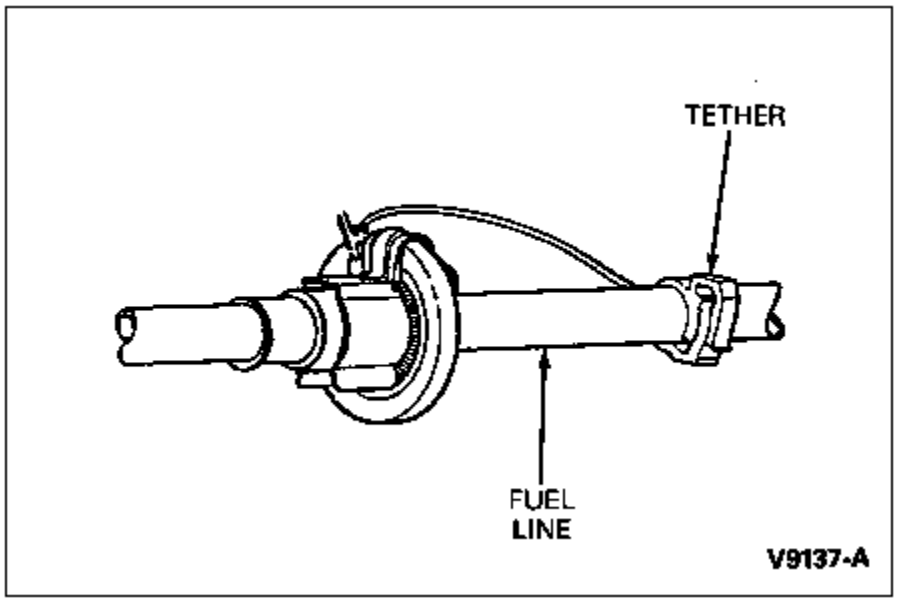

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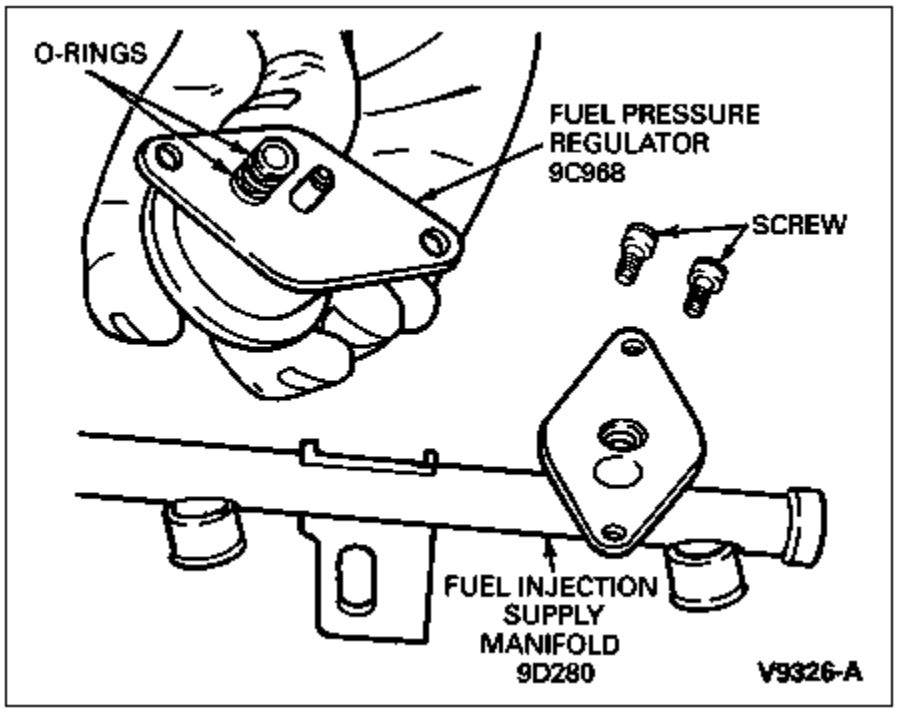
Fuel Pressure Regulator

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Multiport Fuel Injection (MFI) Fuel Pressure Gauge (EFI/CFI Fuel Pressure Gauge)	T80L-9974-B

Removal

1. Make sure assembly is depressurized by removing fuel tank filler cap (9030) and releasing pressure from fuel system by opening the pressure relief valve on the fuel injection supply manifold assembly in the upper right corner of the engine compartment. Use Multiport Fuel Injection (MFI) Fuel Pressure Gauge (EFI/CFI Fuel Pressure Gauge) T80L-9974-B.
2. Remove vacuum line at fuel pressure regulator (9C968).
3. Remove two Allen retaining screws from regulator housing and discard.
4. Remove fuel pressure regulator O-rings. Discard O-rings.
5. If scraping is necessary, be careful not to damage fuel pressure regulator or fuel supply line O-ring surfaces.



Installation

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1. Lubricate new fuel pressure regulator O-rings with light oil meeting Ford Specification ESE-M2C39-F or equivalent. Never use silicone grease. It will clog the injectors.

2. Make sure O-ring surfaces of fuel pressure regulator and fuel injection manifold are clean.

3. Install new O-rings on fuel pressure regulator.

4. Using new Allen head retaining screws, install fuel pressure regulator on injector manifold. Tighten two retaining screws to 3-5 Nm (27-44 lb-ft).

5. Install vacuum line at fuel pressure regulator.

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Fuel Tanks

Fuel tanks (9002) do not require special service procedures and may be steam-cleaned and/or serviced using standard procedures. After cleaning, allow to thoroughly air dry. The evaporative emission valve (9B593) should be replaced. Replace fuel tank strap bolts. The tank vapor valve assembly grommet (Ranger only), and fuel gauge sender and fuel pump assembly seal must be replaced. Failure to do so may result in tank leak.

Take care not to let steam cleaning tubing touch plastic as it will damage/distort fuel tank. Do not direct steam jet at one spot on plastic fuel tank for a prolonged period as it may damage/distort fuel tank.

Plastic Fuel Tank Repair

CAUTION: Leaks or damage to the polyethylene fuel tanks are not repairable. This applies to Aerostar and Ranger fuel tanks including all polyethylene portions of the fuel tank body and fittings. Fuel tank replacement is the only acceptable service. There are no reliable repair procedures that meet the same standards as a new fuel tank. Methods which appear to work may not function for the long term or after being subjected to normal use or abuse.

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Fuel System Pressure Relief

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Multiport Fuel Injection (MFI) Fuel Pressure Gauge (EFI/CFI Fuel Pressure Gauge)	T80L-9974-B

CAUTION: Fuel supply lines on MFI engines (6007) will remain pressurized for some period of time after the engine is shut off. This residual pressure must be relieved before servicing of the fuel system is begun.

On all MFI engines, the residual pressure in the fuel system can be relieved as follows:

- Use Multiport Fuel Injection (MFI) Fuel Pressure Gauge (EFI/CFI Fuel Pressure Gauge) T80L-9974-B attached to the pressure measuring port on the engine fuel rail.
- Direct drain hose to a suitable container and depress the pressure relief button.

Alternate Method

- Disconnect the inertia switch.
- Crank the engine for 15 to 20 seconds to relieve pressure.

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SPECIFICATIONS

FUEL TANK CAPACITY

Vehicle	Location	Tank Capacity — Liters (Gallons)
Ranger	Midship — Std. Midship — LWB Only RPO	62.5 (16.5) 75.7 (20.0)
Midship — S.C.	75.7 (20.0)	
Aerostar	Midship	79 (21.0)

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Fuel Tank Support Strap Bolts	47-61	35-45	—
Fuel Tank Heat Shield Screws	3-6	—	27-53
Fuel Tank Filler Pipe Clamp	3-4	—	27-35
Fuel Tank Support Strap U-Nuts	34-46	25-34	—
Ground Strap-to-Frame Attaching Screw	12-15	9-11	—
Fuel Tank Sending Unit Locking Retainer Ring	55-74	40-55	—
Fuel Pressure Regulator-to-Injector Manifold Retaining Screws	3-5	—	27-44
Fuel Tank Filler Pipe	2-3	—	18-25
Fuel Tank Support Strap Bolt	47-61	35-45	—
Fuel Filter Bracket	15-20	11-15	—
Skid Plate Bolts	8-11	6-8	—
Cantilever Bracket Bolts	21.2-28.8	16-21	—

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Accelerator Pedal and Linkage, Aerostar

The accelerator cable (9A758) is routed from the accelerator pedal assembly to the throttle lever.

Accelerator Pedal and Linkage, Ranger

The Ranger has been given new electronic transmissions (4R44E and 4R55E) which eliminates the kickdown control shaft rod previously used with the accelerator pedal and linkage system.

The accelerator cable (9A758) is controlled by an accelerator pedal and shaft (9725). The accelerator pedal and shaft should travel smoothly from the idle to wide-open throttle positions. Failure to return or hesitation on return to the idle position must not occur.

Surrounding components such as wiring, hoses, sound insulator, and floor covering must not contact the sliding inner member of the accelerator cable or the accelerator pedal and shaft.

On vehicles equipped with speed control, the speed control actuator and the accelerator cable are attached at the throttle lever on the throttle body (9E926). For further information on the speed control system, refer to the speed control under Description and Operation in Section 10-03.

Inspection and Verification

Exercise care when performing service on or around accelerator pedal linkage and controls. Inspect the accelerator pedal rod and attaching linkage for damage or distortion which would bind or limit accelerator pedal travel. Inspect the accelerator cable (9A758) for kinks or fraying which may cause binding. Also, inspect the engine idle speed adjustment to ensure correct idle speed specification after any accelerator linkage adjustment or repair.

Symptom Chart — Accelerator Pedal And Throttle Body Diagnosis

ACCELERATOR PEDAL AND THROTTLE BODY DIAGNOSIS

Condition	Possible Source	Action
• Accelerator Pedal Is Hard to Push Down or It Has a Rough, Raspy or Sticky Feel	• Full accelerator pedal travel is restricted. • Worn or damaged accelerator cable. • Restricted accelerator pedal operation.	• GO to Pinpoint Test A .
• High Engine Idle Speed	• Accelerator cable ball socket extends beyond the throttle lever ball stud.	• REFER to the throttle body diagnosis procedure in the appropriate section of the Powertrain Control/Emissions Diagnosis Manual.
	• Restricted accelerator pedal operation.	• ADJUST carpet, mat or wiring as required.
	• Worn or damaged accelerator cable.	• REPLACE as required.

PINPOINT TEST A: ACCELERATOR PEDAL AND CABLE CHECK

A1 WIDE-OPEN THROTTLE (WOT) ACCELERATOR CABLE ADJUSTMENT CHECK

- Disconnect the accelerator cable end from ball stud at throttle body.
- Make sure the disconnected end of the accelerator cable does not come in contact with any of the surrounding parts.
- Operate the accelerator pedal assembly by hand.

Is the full accelerator pedal travel to WOT restricted?

Yes	No
ADJUST insulator or trim items as required.	GO to **A2** .

A2 CHECK FOR SMOOTH ACCELERATOR PEDAL OPERATION

- Operate the accelerator pedal by foot.

NOTE: Accelerator cable should not be lubricated and it is not serviceable.

Is the accelerator pedal operation smooth?

Yes	No
REFER to the throttle body diagnosis procedures in the appropriate section in the Powertrain Control/Emissions Diagnosis Manual.	CHECK the accelerator pedal assembly for free operation or CHECK for worn or damaged cable. REPAIR or REPLACE as required.

Accelerator Cable

Removal

WARNING: NO SURROUNDING ENGINE COMPARTMENT COMPONENTS SUCH AS WIRING OR HOSES MAY CONTACT ANY MOVING MEMBER OF THE ACCELERATOR CONTROLS. ALL VEHICLES ARE TO BE CHECKED FOR RETURN TO IDLE AS FOLLOWS: NO PERCEPTIBLE HESITATION OR PREVENTION OF RETURN TO IDLE MAY OCCUR DURING SLOW REMOVAL OF THE FOOT FROM THE ACCELERATOR PEDAL AND SHAFT STARTING AT THE FULLY DEPRESSED WIDE-OPEN THROTTLE POSITION.

1. Remove the accelerator control splash shield screws/push pins, then remove accelerator control splash shield (9E766).

2. **CAUTION: Take special care when removing the accelerator cable so that the cable end tube and guide tube are not damaged.**

   Disconnect accelerator cable (9A758) from throttle lever ball stud at throttle body (9E926). Grasp cable at ball stud end and carefully remove accelerator cable from the ball stud.

3. Separate accelerator cable from speed control actuator cable (9A825) at the throttle lever.

4. Remove accelerator cable from accelerator cable bracket (9723) on intake manifold (9424).

5. From inside vehicle, remove accelerator cable end from top of accelerator pedal and shaft (9725).

6. Collapse clips at dash panel and push accelerator cable through dash panel into engine compartment to remove accelerator cable.

Installation

1. **CAUTION: Make sure accelerator cable is routed as shown in appropriate illustration.**

   Install accelerator cable through dash panel into passenger compartment, making sure clips are fully seated.

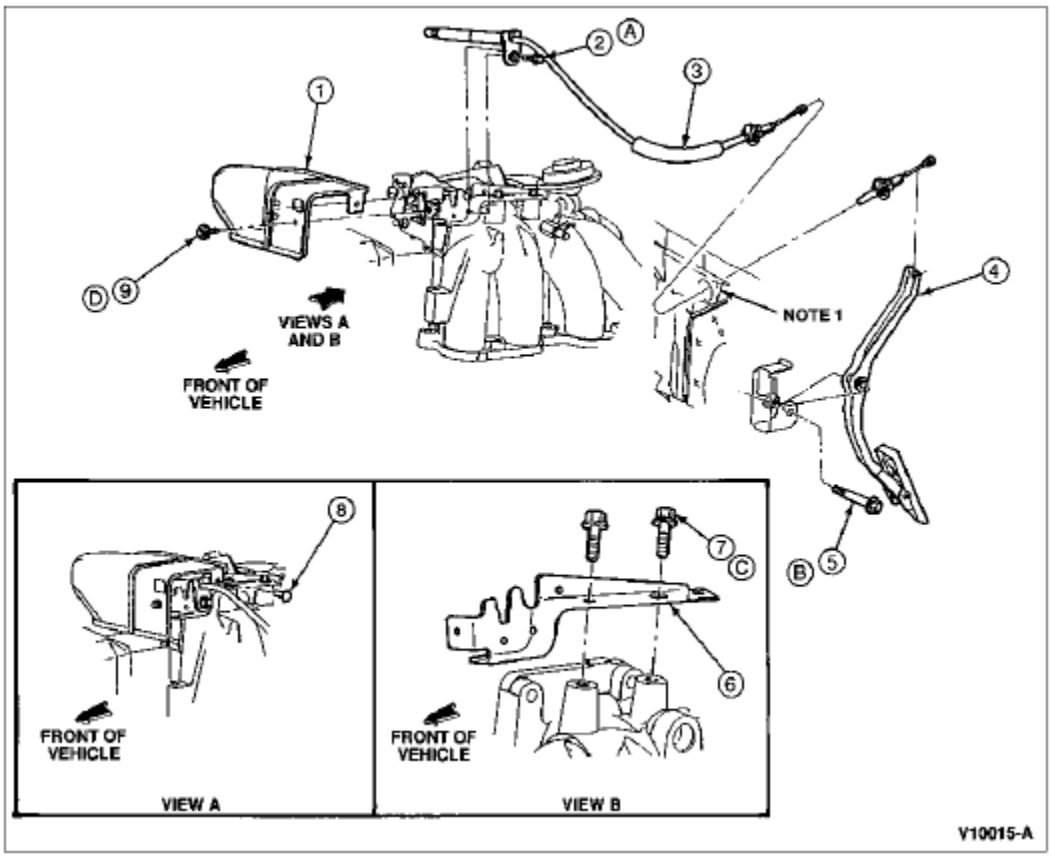
2. From inside vehicle, attach accelerator cable end to accelerator pedal and shaft, seating returner on accelerator cable end onto accelerator pedal and shaft.

3. Install accelerator cable into accelerator cable bracket on intake manifold, making sure that tab or pin on accelerator cable aligns with hole in accelerator cable bracket.

4. Attach accelerator cable end to throttle lever ball stud at throttle body. Carefully push only on the end of accelerator cable when snapping accelerator cable end over ball stud.

5. Position the accelerator control splash shield and install the accelerator control splash shield screws. Tighten the accelerator control splash shield screws to 7-9 Nm (62-79 lb-in).

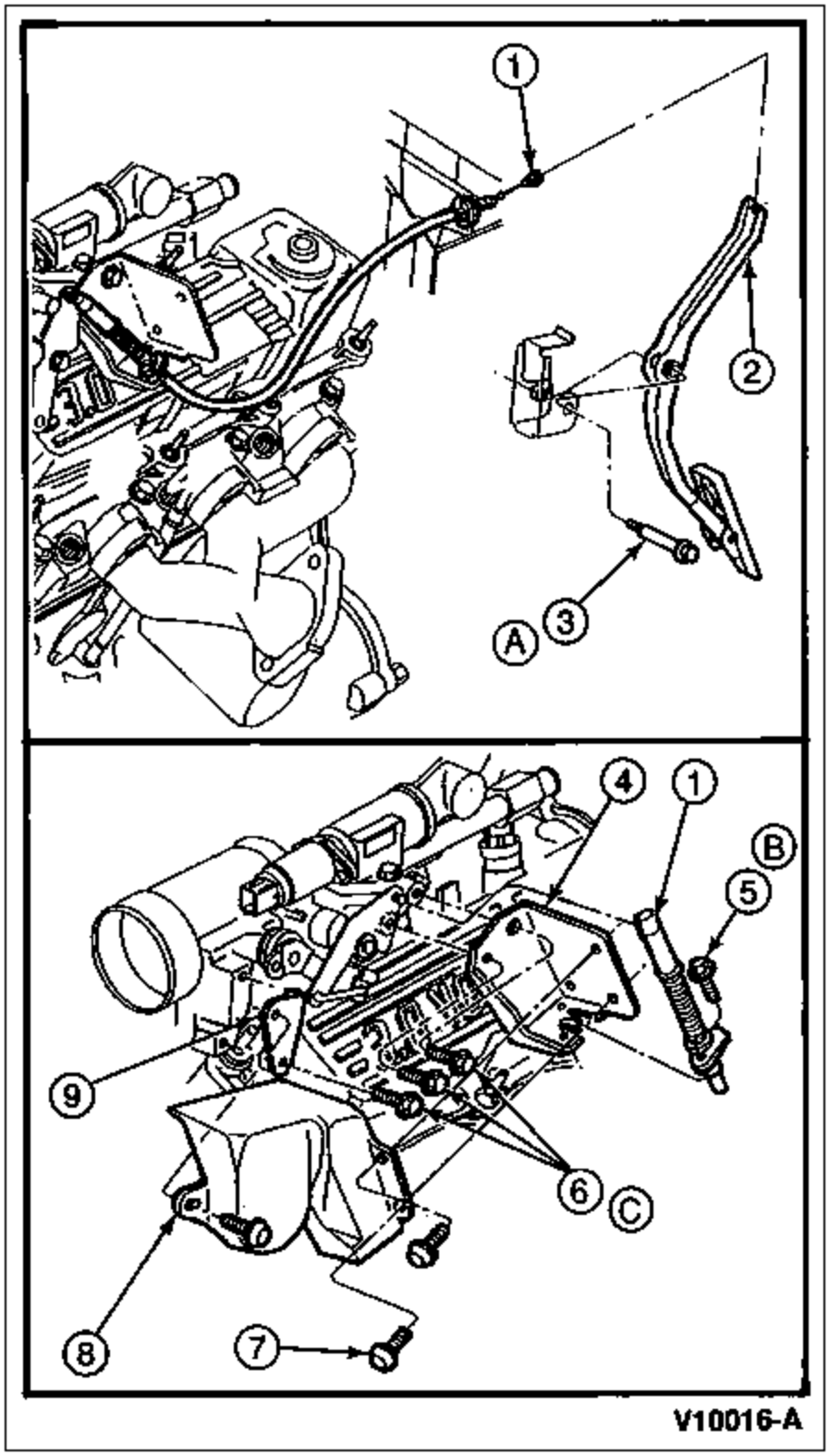
Accelerator Cable, Ranger, 2.3L Engine



Item	Part Number	Description
1	9E766	Accelerator Control Splash Shield
2	N610959-S2	Screw
3	9A758	Accelerator Cable
4	9725	Accelerator Pedal and Shaft
5	N804397-S190	Screw
6	9723	Accelerator Cable Bracket
7	N605786-S2	Bolt
8	N804527-S100	Pushpin
9	N610959-S2	Screw
A	—	Tighten to 7-9 Nm (62-79 Lb-In)
B	—	Tighten to 9-12 Nm (80-106 Lb-In)
C	—	Tighten to 21-29 Nm (15-21 Lb-Ft)

D	—	Tighten to 6-8 Nm (53-71 Lb-Ft)

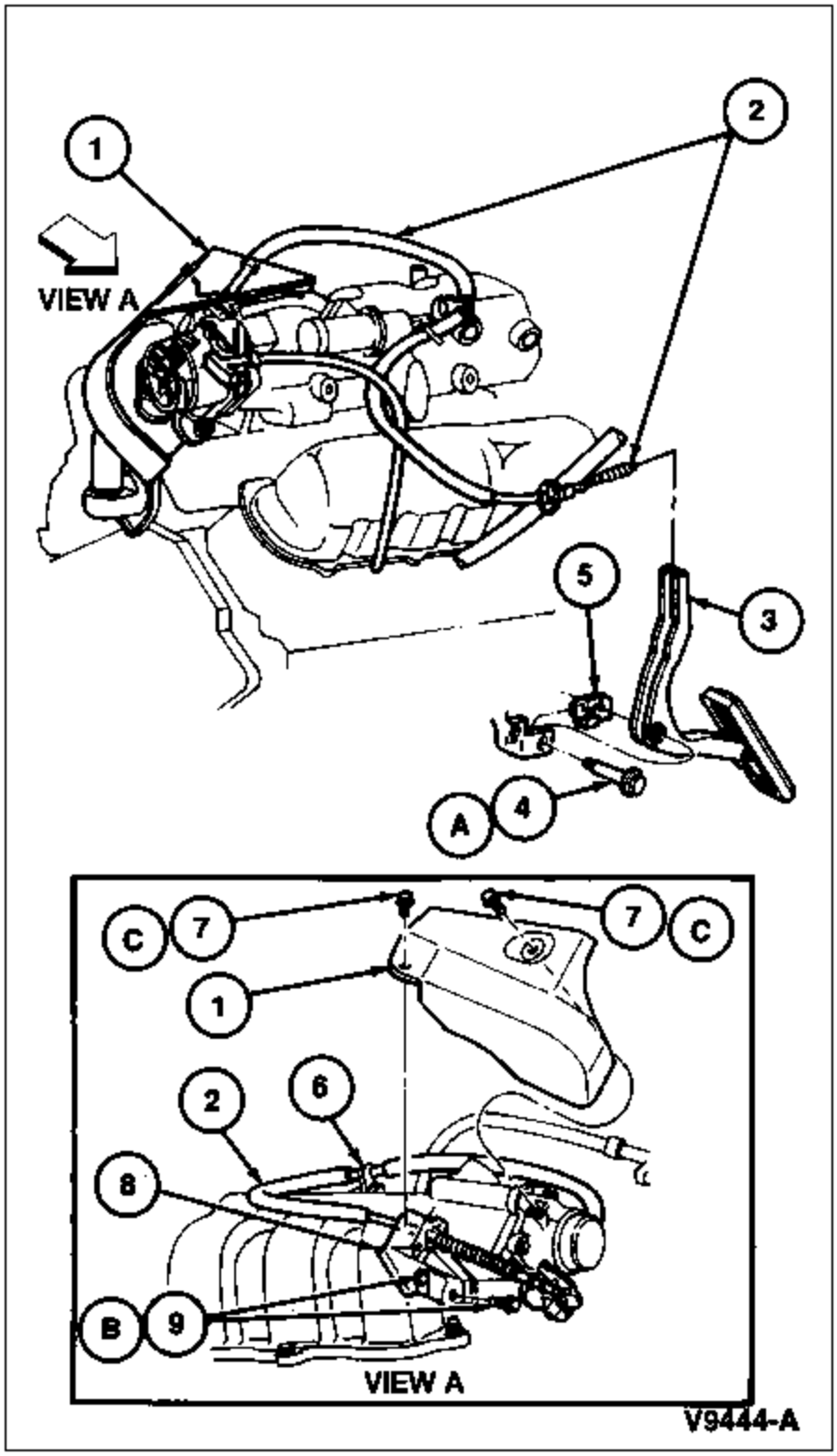
Accelerator Cable, Ranger, 3.0L Engine



Item	Part Number	Description
1	9A758	Accelerator Cable
2	9725	Accelerator Pedal and Shaft

3	N804397-S190	Bolt, M6
4	9723	Accelerator Cable Bracket
5	N610959-S2	Screw
6	N605786-S2	Bolt, M8
7	N804527-S100	Pushpin
8	9E766	Accelerator Control Splash Shield
9	9N818	Bracket, Accelerator Shield
A	—	Tighten to 9-12 Nm (80-106 Lb-In)
B	—	Tighten to 7-9 Nm (62-79 Lb-In)
C	—	Tighten to 8-10 Nm (71-89 Lb-In)

Accelerator Pedal and Shaft



Item	Part Number	Description
1	9E766	Accelerator Control Splash Shield
2	9A758	Accelerator Cable

3	9725	Accelerator Pedal and Shaft
4	N804397-S190	Accelerator Pedal Pivot Screw
5	N802172-S2	J-Nut
6	N802769-S	Clip
7	N610959-S2 (2 Req'd)	Accelerator Control Splash Shield Screw
8	9723	Accelerator Cable Bracket
9	N605786-S2 (2 Req'd)	Accelerator Cable Bracket Bolt
A	—	Tighten to 9-12 Nm (80-106 Lb-In)
B	—	Tighten to 21-29 Nm (15-21 Lb-Ft)
C	—	Tighten to 7-9 Nm (62-79 Lb-In)

Removal

1. Disconnect accelerator cable (9A758) from accelerator pedal and shaft (9725).

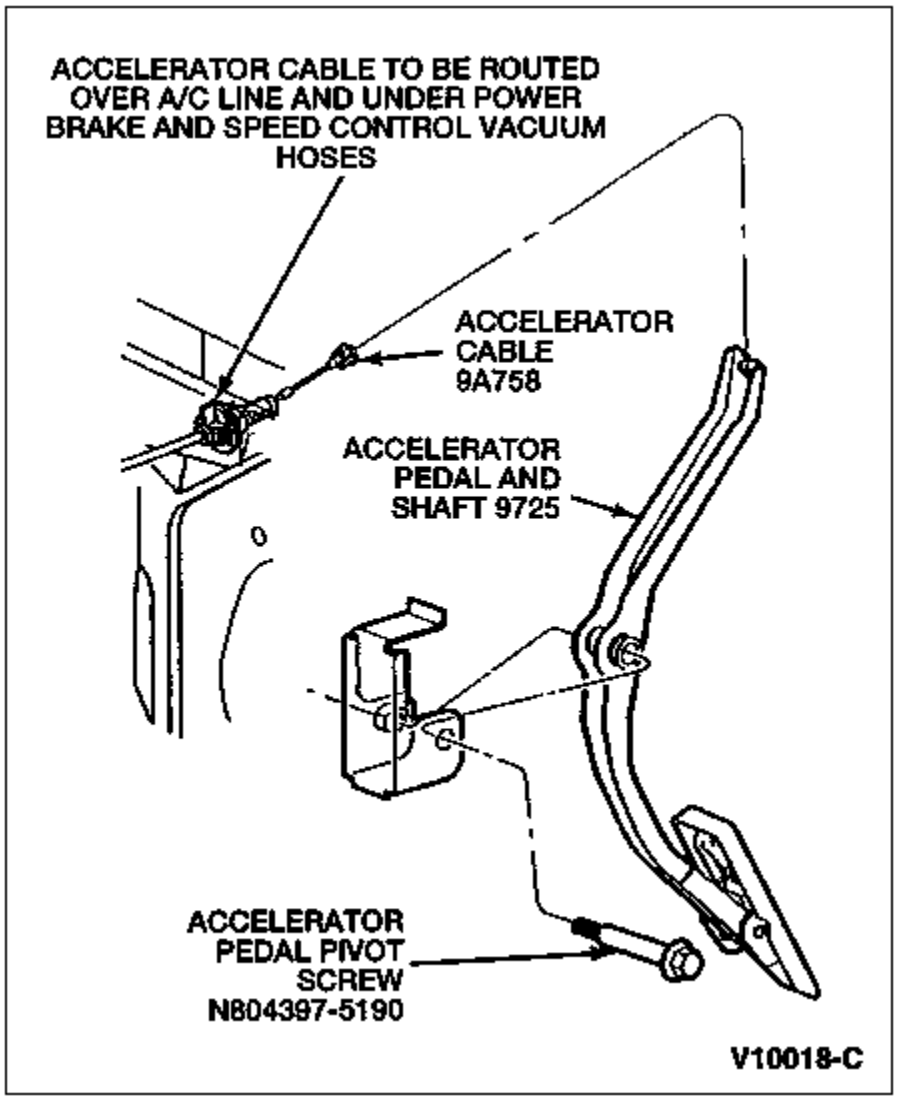
2. Remove accelerator pedal pivot screw attaching accelerator pedal and shaft to dash panel and remove accelerator pedal and shaft.

Installation

1. Position accelerator pedal and shaft to dash panel and install accelerator pedal pivot screw (and J-nut on Aerostar only). Tighten accelerator pedal pivot screw to 9-12 Nm (80-106 lb-in).

2. Connect accelerator cable to accelerator pedal and shaft.

Accelerator Pedal, Ranger


ACCELERATOR CABLE TO BE ROUTED OVER A/C LINE AND UNDER POWER BRAKE AND SPEED CONTROL VACUUM HOSES
ACCELERATOR CABLE 9A758
ACCELERATOR PEDAL AND SHAFT 9725
ACCELERATOR PEDAL PIVOT SCREW N804397-5190
V10018-C

Accelerator Cable Bracket

Removal

1. Remove the accelerator control splash shield (9E766), if equipped.
2. Remove the accelerator cable (9A758) from the accelerator cable bracket (9723).
3. Remove the accelerator cable bracket bolts and remove the accelerator cable bracket from the upper intake manifold (9424).

Installation

To install, reverse the removal procedure.

Tighten the accelerator cable bracket bolts to 21-29 Nm (15-21 lb-ft).

Kickdown Control Shaft Rod, Aerostar

If transmission kickdown at wide-open throttle is difficult to achieve, requiring excessive effort or kickdown is not attained, check to make sure that aftermarket floormats have not been installed or mispositioned behind or under the accelerator pedal pad or shaft, which could result in the above listed symptoms by restricting full pedal movement.

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Accelerator Pedal Pivot Screw	9-12	—	80-106
Accelerator Cable Bracket Bolt	21-29	15-21	—
Accelerator Cable Hold-Down Screw — Aerostar with 3.0L Engine, Ranger with 2.3L and 3.0L Engines Only	7-9	—	62-79
Accelerator Shield Screw	7-9	—	62-79

Speed Control System

The speed control system consists of:

- Speed control servo (9C735).
- Speed control actuator cable (9A825).
- Vehicle speed sensor (VSS) (9E731) (Ranger only).
- Operator controls, located on the steering wheel (3600).
- Speed control actuator switch (9D743).
- Stoplight switch.
- Deactivator switch.
- Deactivator switch located on the brake master cylinder (2140) (Ranger only).
- Deactivator switch located on the brake pedal (2455) (Aerostar only).
- Instrument cluster indicator light (Ranger only).

The system operates independently of engine vacuum, therefore no vacuum lines are required.

Speed Control Actuator Switch Assembly

- Is mounted in the steering wheel.

It consists of:

- LH buttons (ON, OFF)
- RH buttons (RSM, SET/ACCEL, COAST)
- Necessary wiring

Ranger Shown, Aerostar Similar

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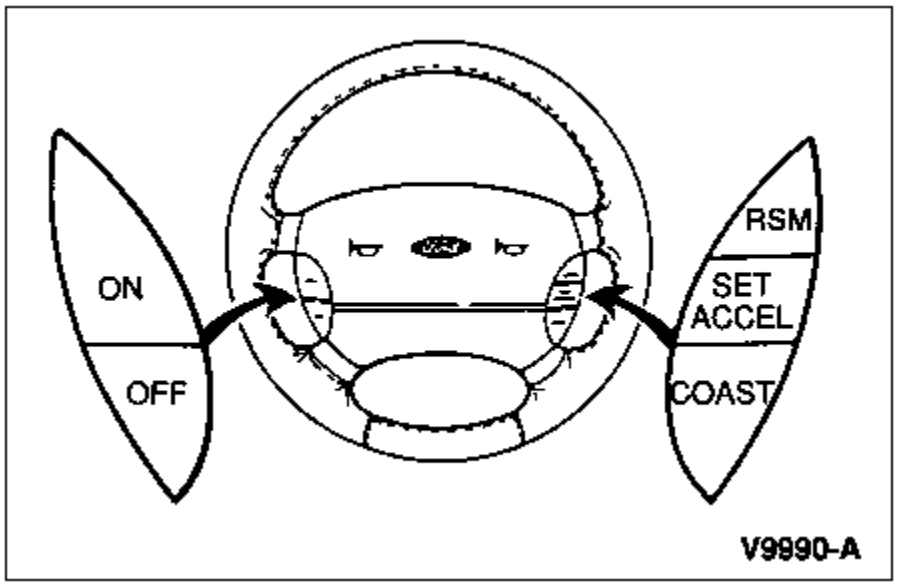

Speed Control Indicator Light (Ranger Only)

- Is located in the instrument cluster (10849) above the speedometer.
- Comes on when speed control is ON and speed is set.
- Light goes out when brakes are applied or system is turned OFF.
- When ignition key is turned to ON position, light comes on briefly as part of cluster display self test.
- Light does not indicate problem with speed control system.

Speed Control Servo

- Is mounted on the right front fender on Ranger, and is located on the left side of the engine compartment on Aerostar.
- Is connected to the throttle linkage with a speed control actuator cable.
- Electronics are integrated into the speed control servo, eliminating the need for any other speed control electronic modules in the vehicle.

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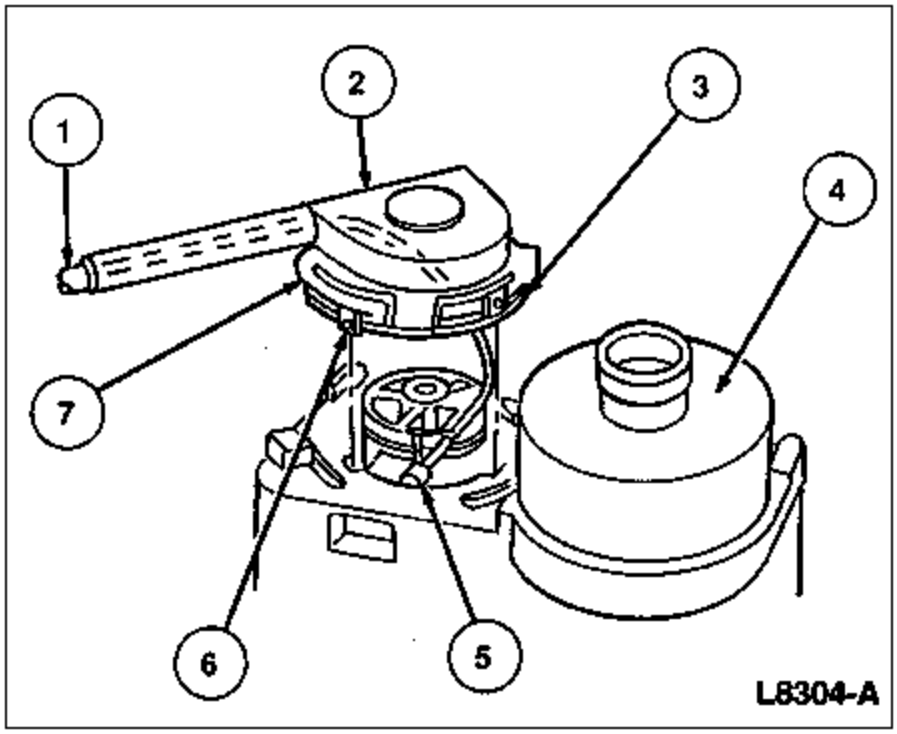

Item	Part Number	Description
1	9A825	Speed Control Actuator Cable
2	—	Actuator Cable Cap (Part of 9A825)
3	—	Seal (Part of 9A825)
4	9C735	Speed Control Servo
5	—	Cable Ball Slug (Part of 9A825)
6	—	Cap Locking Tabs (Part of 9A825)
7	—	Locking Arm (Part of 9A825)

Stoplight Switch

- Is a normally open switch that closes when the brake pedal is applied.
- Sends an electrical signal to the speed control servo when closed and disengages speed control system.
- Returns to its open position when the brake pedal is released.

Air Bag Sliding Contact

- Is located behind the center of steering wheel.
- Transfers electrical signals from the steering column wiring to the following components.

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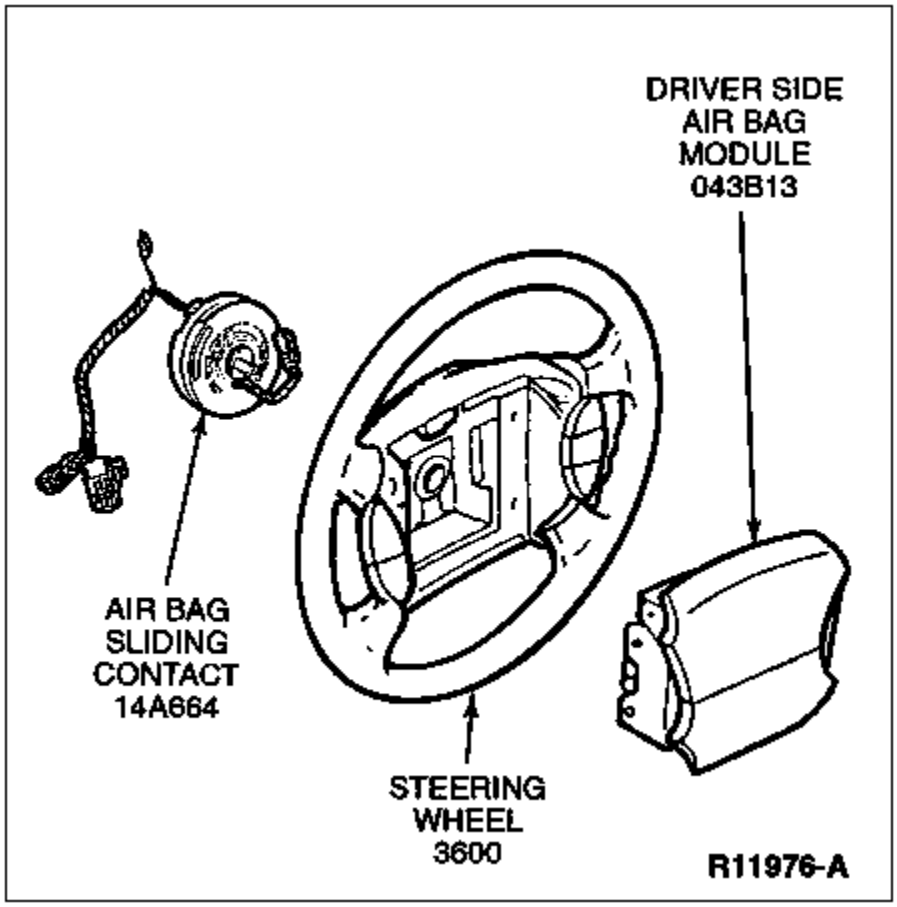
- Driver side air bag module (043B13)
- Steering wheel horn switch
- Speed control actuator switch assembly

Air Bag Sliding Contact, Ranger



Vehicle Speed Sensor (VSS), (Ranger Only)

- Is mounted to the transmission on Ranger, and mounted on the rear axle assembly on Aerostar vehicles.
- On Ranger it is a magnetic pickup driven by a gear which is driven by the transmission.
- On Aerostar, the signal is routed directly to the anti-lock brake control module (2B373) and the programmable electronic speedometer/odometer module (PSOM).
- Sends a signal to the speed control servo proportional to vehicle speed.

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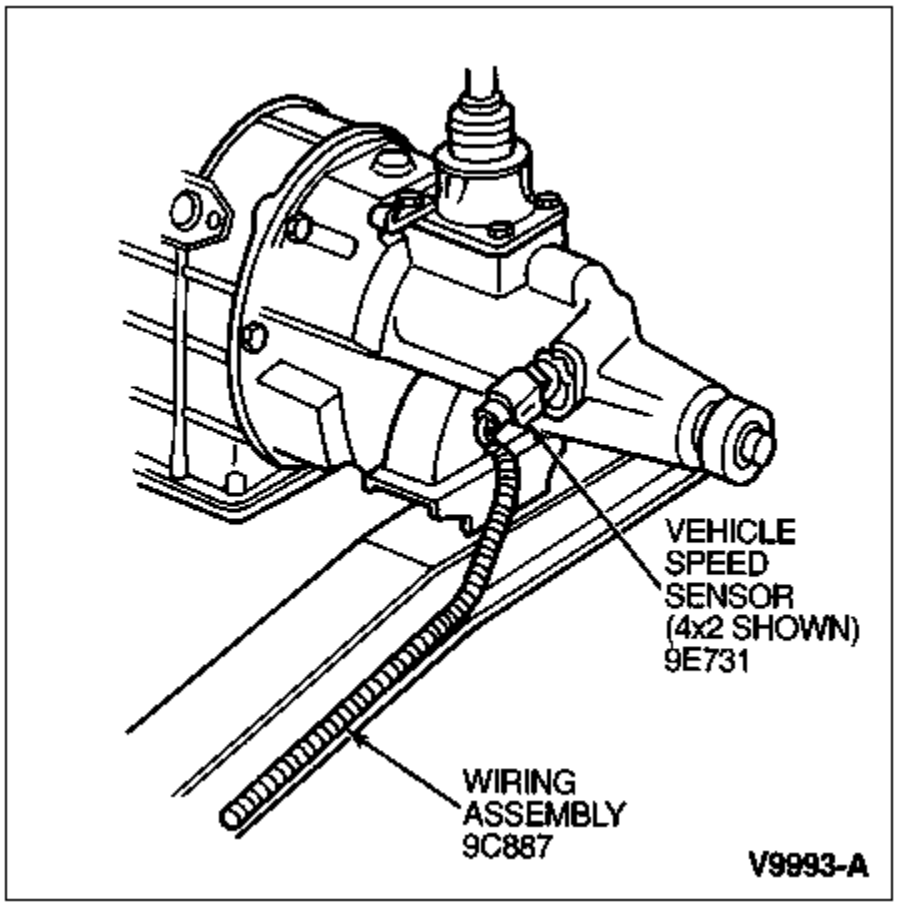

Deactivator Switch

- Under increased brake pedal motion, the deactivator switch will open and remove power from the speed control servo, releasing the throttle from servo control.
- On Aerostar, the switch is located on the brake pedal. On Ranger, it is located on the brake master cylinder.

Deactivator Switch, Ranger

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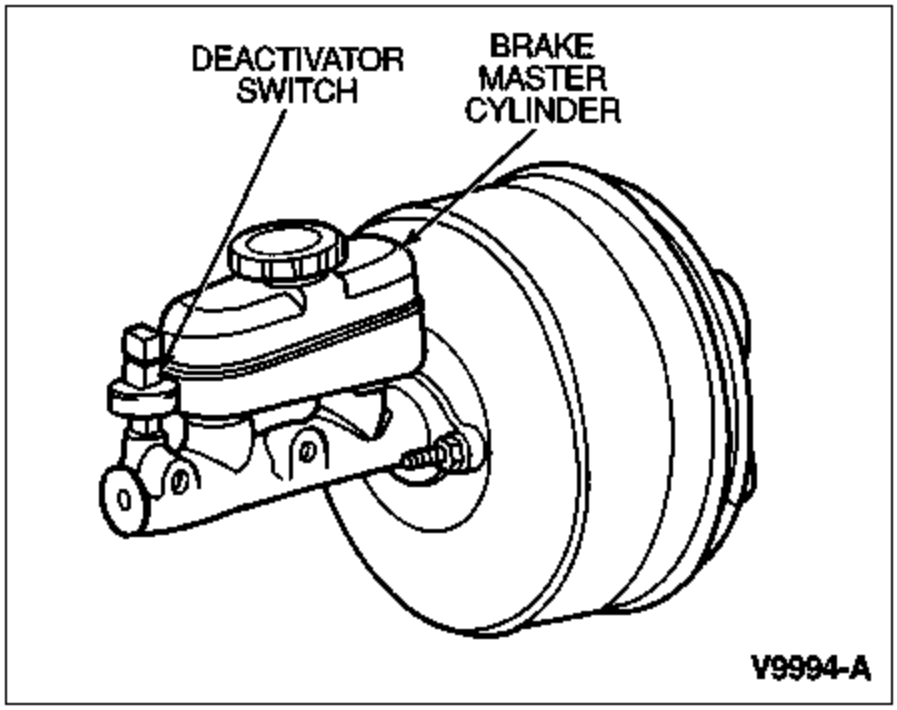
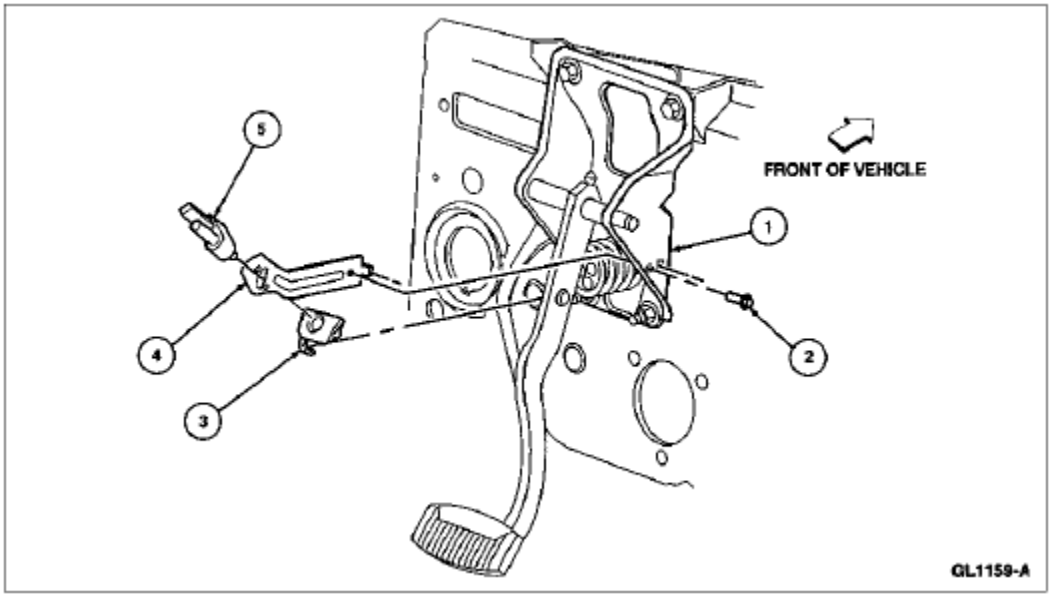


Deactivator Switch, Aerostar



Item	Part Number	Description
1	2455	Brake Pedal
2	N611173-S2	Screw
3	9C962	Speed Control Vacuum Valve Actuator Adapter

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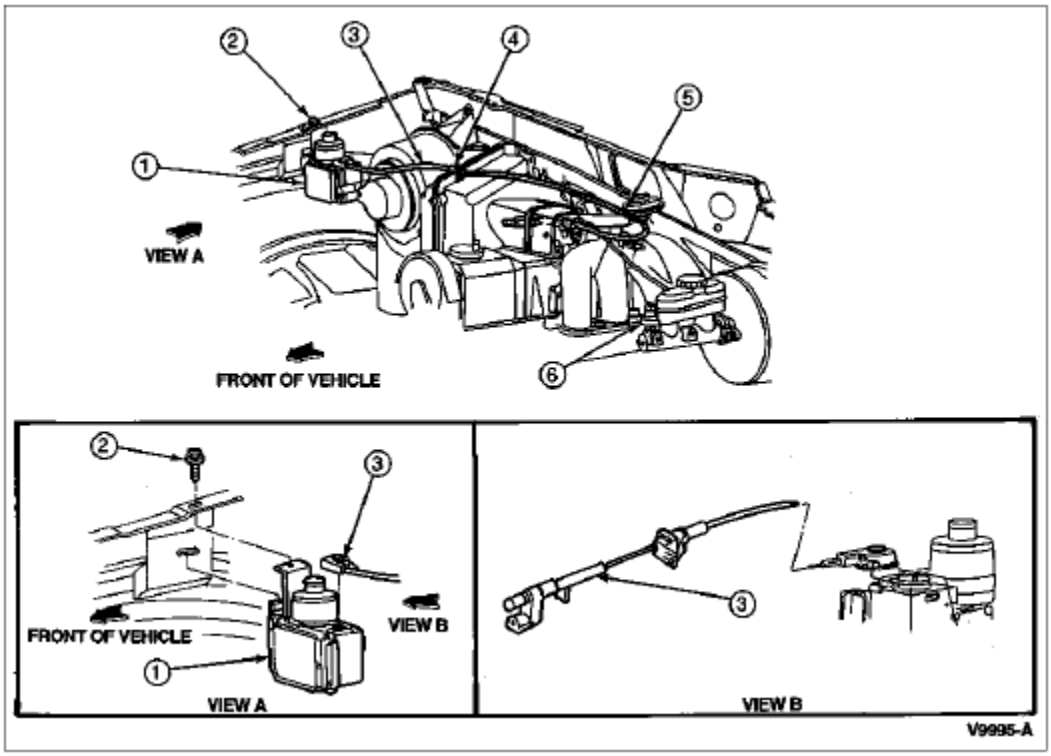
4	9A812	Speed Control Bracket
5	—	Deactivator Switch

Speed Control System, Engine Compartment Layout — Ranger 2.3L



Item	Part Number	Description
1	9C735	Speed Control Servo
2	N606689-S106	Bolt
3	9A825	Speed Control Actuator Cable
4	N802768-SB	Clip
5	9D726	Clip
6	9F924	Deactivator Switch

System Activation

To operate the speed control system, the engine (6007) must be running and the vehicle speed must be greater than 48 km/h (30 mph). Under these conditions, the system is activated by pressing the ON switch in the steering wheel. Then, the operator must depress and release the SET/ACCEL switch. This will result in the current speed being maintained until a new speed is set, the brake pedal is depressed, or the OFF switch is depressed. Only one switch button should be depressed at a time because the speed control system will accept only one command at a time.

Increasing Set Speed

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Accel

A continuous depression of the SET/ACCEL switch will cause a smooth increase in vehicle speed. Upon release of the SET/ACCEL switch the new vehicle speed will be maintained.

The vehicle speed can be manually increased at any time by depressing the accelerator pedal and shaft (9725) until the higher speed is reached and stabilized, then depressing and releasing the SET/ACCEL switch.

Tap-Up

Current vehicle set speed may be increased 1.6 km/h (1 mph) by a momentary tap of the SET/ACCEL switch. Multiple taps of the SET/ACCEL switch will cause vehicle speed to increase in increments of 1.6 km/h (1 mph). For example, if currently set at 80 km/h (50 mph) then five taps will increase vehicle speed and set it at 89 km/h (55 mph).

Decreasing Set Speed

Coast

A continuous depression of the COAST switch will cause a smooth decrease in vehicle speed. Upon release of the COAST switch the new vehicle speed will be maintained.

The vehicle speed can be manually decreased at any time by momentarily depressing the brake pedal until the lower speed is reached and stabilized, then depressing and releasing the SET/ACCEL switch.

If vehicle speed is reduced below 48 km/h (30 mph) then the driver must manually increase the speed to over 48 km/h (30 mph) and reset the system.

Tap-Down

Current vehicle set speed may be decreased 1.6 km/h (1 mph) by a momentary tap of the COAST switch. Multiple taps of the COAST switch will cause vehicle speed to decrease in increments of 1.6 km/h (1 mph). For example, if currently set at 89 km/h (55 mph) then five taps will decrease vehicle speed and set it at 80 km/h (50 mph).

Resume

When the speed control system is disabled by pressing the brake pedal, the previous set speed may be re-established by momentarily depressing the RSM switch. The resume feature will not function if the system has been turned off with the OFF switch or if the ignition switch (11572) is turned off. If the vehicle speed has dropped below 48 km/h (30 mph) then RESUME will not function until the vehicle speed becomes greater than 48 km/h (30 mph).

Contact Assembly (Clockspring)

The contact assembly provides electrical interface between the steering column tube (3514) and the control switches in the steering wheel.

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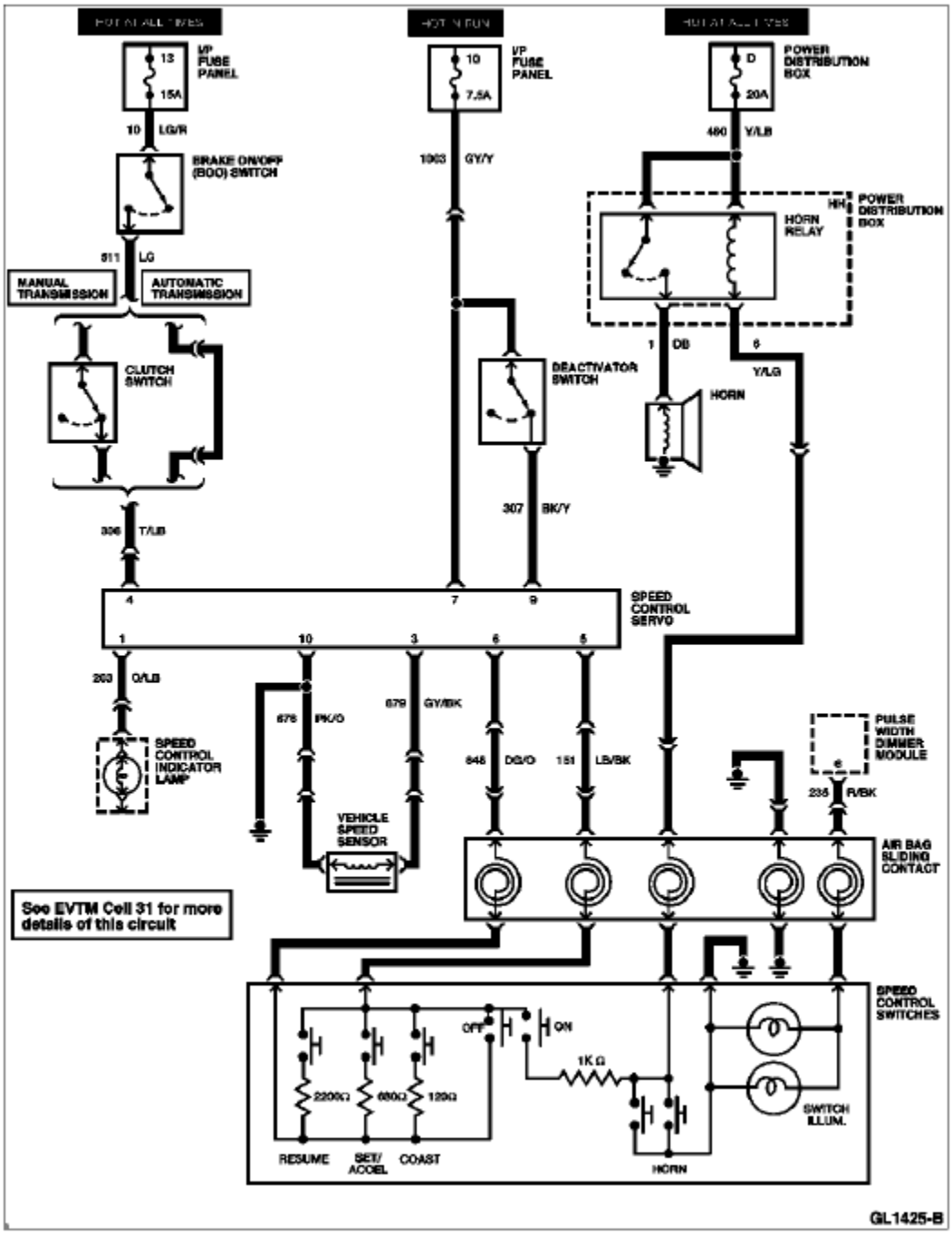
Electrical Schematics

Speed Control System — (Ranger)



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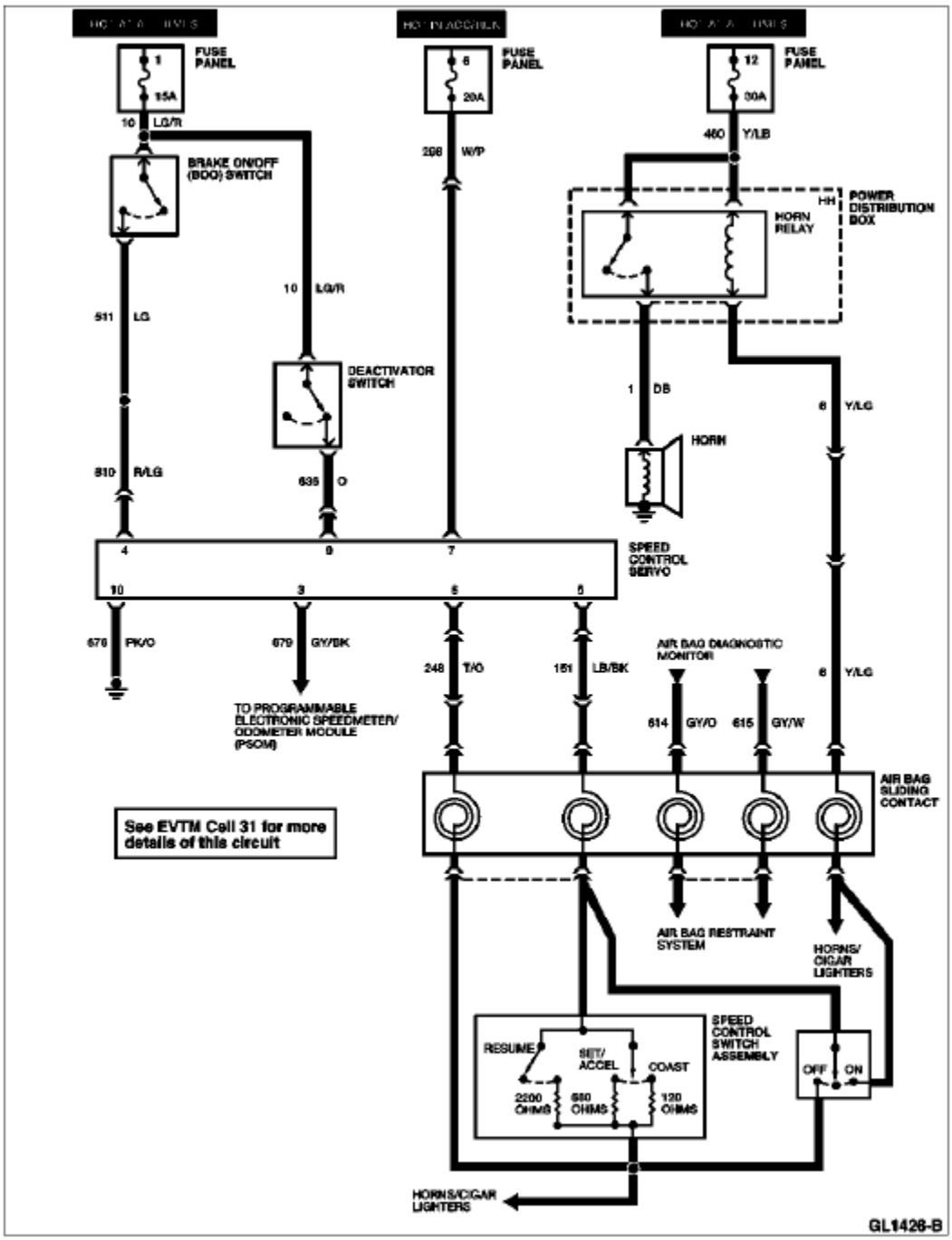
Speed Control System — (Aerostar)



Speed Control Module Connector

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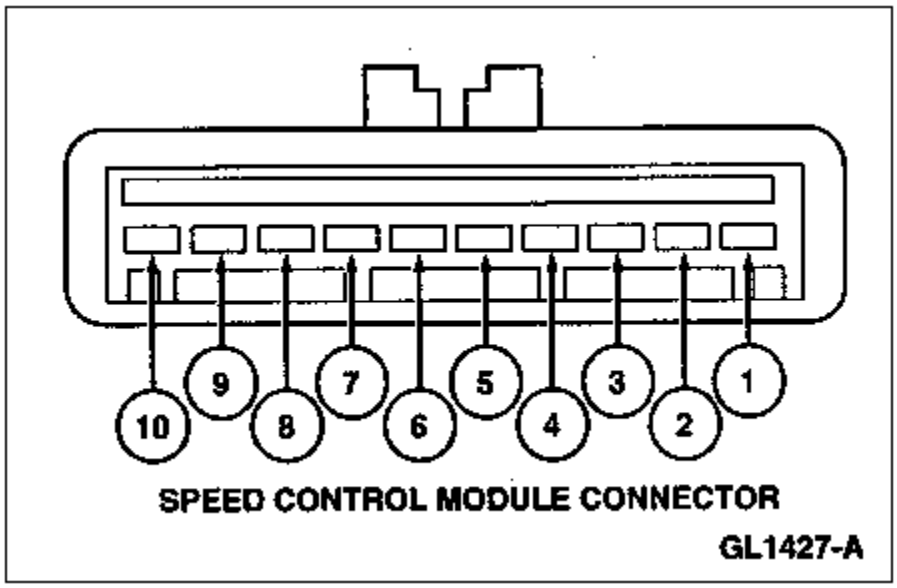

Pin Number	Circuit	Circuit Function
1	203 (O/LB)	Speed Control Servo to Instrument Cluster Indicator Lamp
2	—	NOT USED
3	679 (GY/BK)	Vehicle Speed Sensor — Plus to Speed Control Servo
4	306 (T/LB)	Brake On/Off (BOO) Switch to Speed Control Servo
5	151 (LB/BK)	Speed Control Actuator Switch to Speed Control Servo
6	848 (DG/O)	Command Switch to Speed Control Servo
7	1003 (GY/Y)	Fused Ignition "RUN" to Speed Control Servo
8	—	NOT USED
9	307 (BK/Y)	Deactivator Switch to Speed Control Servo
10	676 (PK/O)	Ground

Clutch Switch Connector

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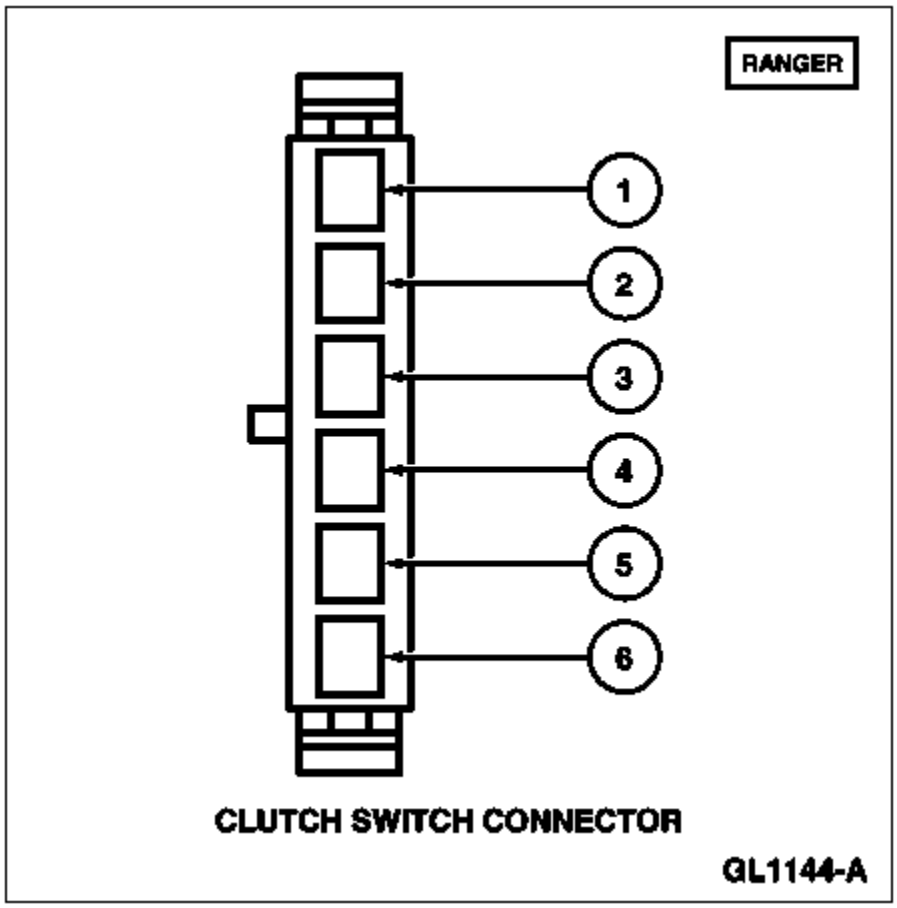

Pin Number	Circuit	Circuit Function
1	199 (LB/Y)	Transmission Range Sensor to PCM Module
2	359 (GY/R)	Sensor Signal Return
3	306 (T/LB)	Clutch Switch to Speed Control Servo
4	511 (LG)	Brake On/Off (BOO) Switch to Stoplamps
5	329 (PK)	Crank Enable Relay
6	32 (R/LB) 33 (W/PK)	Battery Feed from Fuse Panel — Hot in Start (W/O Anti-Theft) Battery Feed from Starter Interrupt Relay — (Hot in Start w/Anti-Theft)

Air Bag Sliding Connector — At Base of Steering Column

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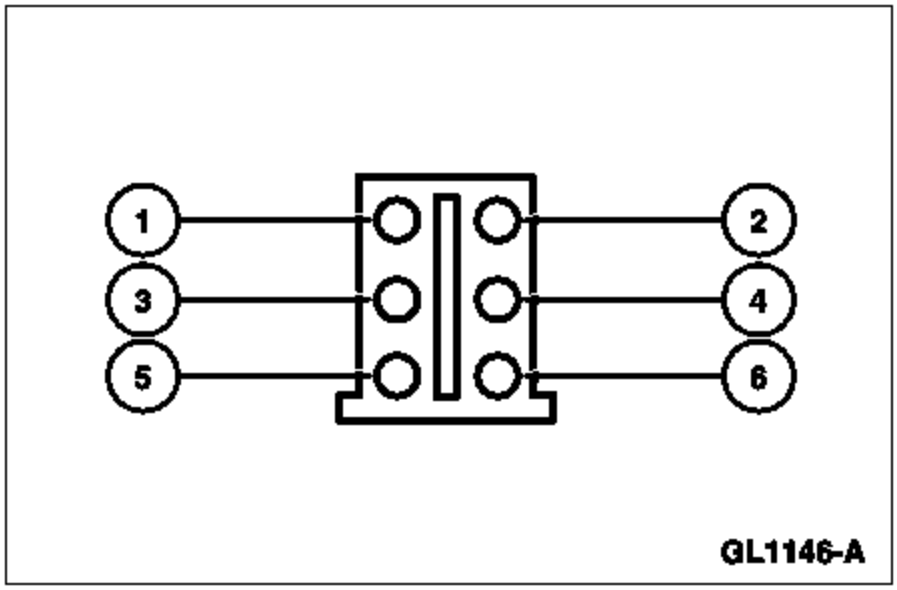

Pin Number	Circuit	Circuit Function
1	151 (LB/BK)	On-Off Switch to Speed Control Servo
2	6 (Y/LG)	Horn Relay to Horn Switch and Speed Control On/Off Switch
3	19 (LB/R)	Speed Control Switch Backlighting Power
4	848 (DG/O)	Command Switches to Speed Control Servo
5	570 (BK/W)	Dedicated Ground — PCM
6	—	NOT USED

Air Bag Sliding Contact Connector to Steering Wheel Wiring Harness

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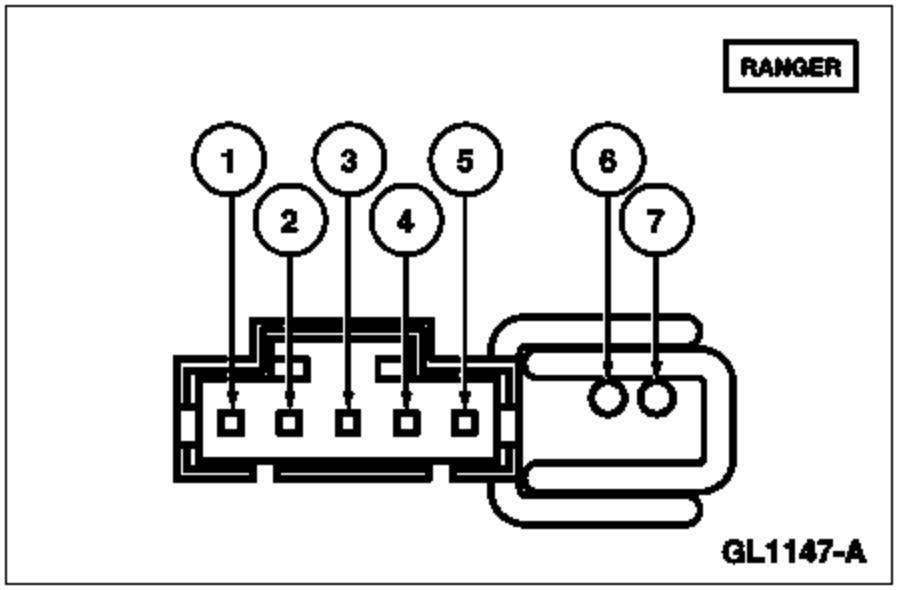

Pin Number	Circuit	Circuit Function
1	6 (Y/LG)	Horn Relay to Horn Switch and Speed Control On/Off Switch
2	848 (DG/O)	Command Switches to Speed Control Servo
3	151 (LB/BK)	On-Off Switch to Speed Control Servo
4	19 (LB/R)	Speed Control Switch Backlighting Power
5	—	NOT USED
6	614 (GY/O)	Air Bag Feed
7	615 (GY/W)	Air Bag Ground

Speed Control Switch Terminals (Ranger)

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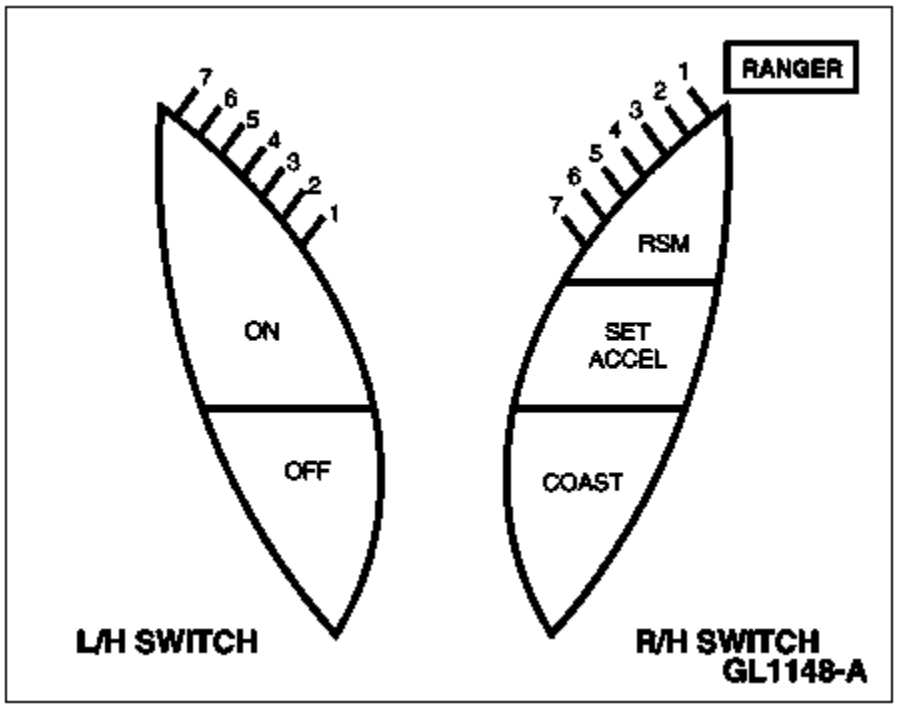

Pin Number		Circuit	Circuit Function
LH	RH		
1	7	570 (BK/W)	Ground: Speed Control Switch Backlighting
2	6	235 (R/BK)	Power: Speed Control Switch Backlighting
3	5	151 (LB/BK)	Speed Control Switch Assembly Input
4	4	848 (DG/O)	Speed Control Switch Ground
5	3	6 (Y/LG)	Hot: Speed Control and Horn Switches
6	2	—	NOT USED
7	1	6 (Y/LG)	Hot: Speed Control and Horn Switches

Speed Control Module Connector

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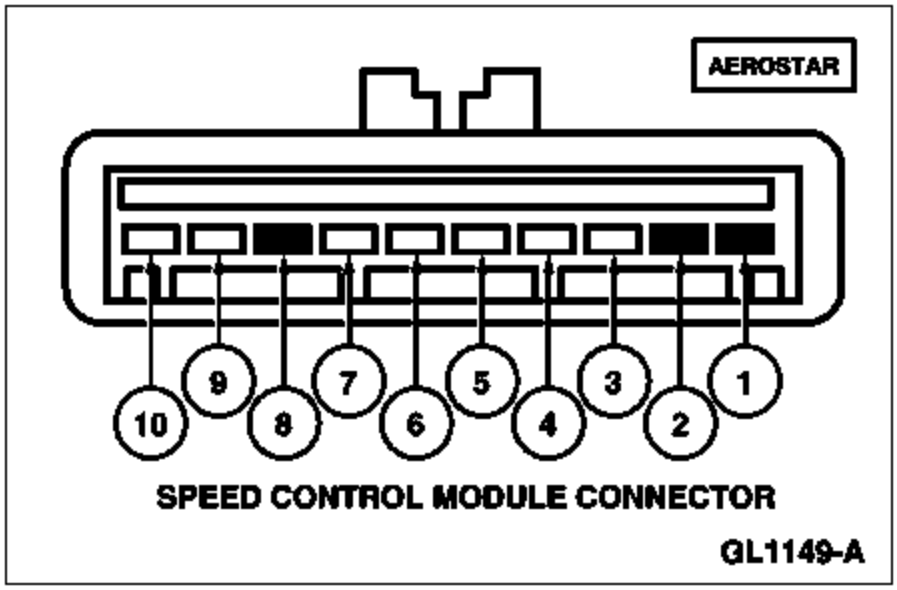

Pin Number	Circuit	Circuit Function
1	—	NOT USED
2	—	NOT USED
3	679 (GY/BK)	Programmable Electronic Speedometer/Odometer Module (PSOM)
4	810 (R/LG)	Brake On/Off (BOO) Switch to Speed Control Servo
5	151 (LB/BK)	Speed Control Actuator Switch to Speed Control Servo
6	248 (T/O)	Command Switch to Speed Control Servo
7	296 (W/P)	Fused Ignition "RUN" to Speed Control Servo
8	—	NOT USED
9	636 (O)	Deactivator Switch to Speed Control Servo
10	676 (PK/O)	Ground

Air Bag Sliding Contact Connector — Base of Steering Column

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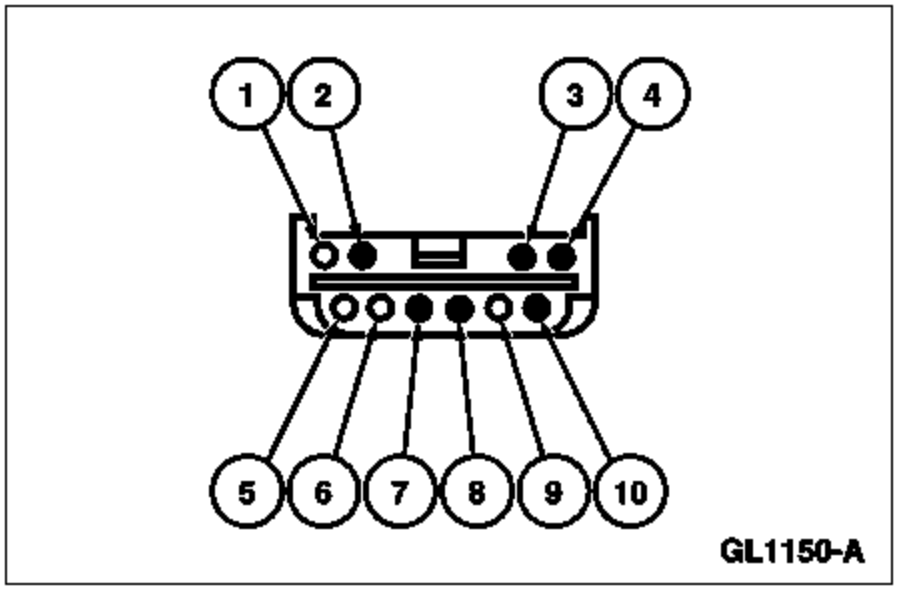

Pin Number	Circuit	Circuit Function
1	158 (PK/PK)	—
2	—	NOT USED
3	—	NOT USED
4	—	NOT USED
5	6 (Y/LG)	Horn Relay to Horn Switch and Speed Control On/Off Switch
6	151 (LB/PK)	On/Off Switch to Speed Control Servo
7	—	NOT USED
8	—	NOT USED
9	248 (T/O)	Command Switches to Speed Control Servo
10	—	NOT USED

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Inspection and Verification

Visual inspection is an important part of diagnosis. The inspection should be done to locate obvious reasons for customer concern.

When performing visual inspection, check all items for abnormal conditions. Look for such items as bare, broken or disconnected wires. For the speed control to function properly, speed control servo (9C735) (throttle actuator) and throttle linkage should operate freely and smoothly.

Any concerns found by the visual inspection should be corrected before further tests of the speed control system are made. The following items should be inspected.

- If the amber RABS, ABS or 4WABS indicator in the instrument cluster stays lit when the ignition switch (11572) is in the RUN position, then refer to Section 06-09A or Section 06-09B before continuing with the speed control diagnostics.
- Does the horn (13832) work? If not, check the horn circuit fuse, horn relay and horn circuit wiring. Refer to Section 13-06 .
- Do the stoplamps light when the brake pedal (2455) is depressed? If not, check the stoplamp circuit fuse, rear lamps (13404), wiring and stoplamp switch. Refer to Section 17-01 .

Electronic Servo Assembly

Check for unseated connectors at the speed control servo.

- Look for loose or unseated connector pins.
- Check for broken wires at the connectors.

Actuator Cable

- Misadjusted speed control actuator cable (9A825). If misadjustment is suspected, refer to Adjustments, Actuator Cable , in this section.
- Broken speed control actuator cable.

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Self-Test Diagnostics — (Ranger Only)

WARNING: THIS IS A KEY ON ENGINE OFF (KOEO) TEST ONLY THAT'S CONDUCTED IN PARK ONLY WITH EMERGENCY BRAKE FULLY ENGAGED.

1. Enter Self-Test Diagnostics by depressing the speed control OFF switch while turning the ignition key to ON, ensuring engine DOES NOT start and is not running. The speed control indicator lamp on the instrument panel will flash ONCE to indicate that speed control module entered the diagnostic mode. Release the OFF switch.

2. **NOTE: If the ON switch is not pressed within 5 seconds after entering diagnostics mode, the module times out and the procedure must be started over.**

   Press the remaining switches in this sequence: ON, RESUME (RSM), COAST (CST), and SET/ACCEL.

3. The speed control indicator lamp will flash as each switch is pressed. Press each switch in the sequence immediately after the light goes out for the previous switch.

4. After all five speed control switches complete the sequence, the indicator lamp will flash to indicate a Pass or Fail:

   a. 1 Flash — Test passed.
   b. 2 Flashes — BOO SWITCH defective, circuit defective, or Brake Pedal applied.
   c. 3 Flashes — BRAKE DEACTIVATION SWITCH is open or circuit defective.
   d. 4 Flashes — SPEED SENSOR is out of range or not connected.
   e. 5 Flashes — SPEED CONTROL SERVO is defective.

5. Immediately after a passed STATIC test, the speed control module then performs a DYNAMIC test automatically by actuating the throttle lever from 1 mm to 10 mm of travel from the idle position. During this DYNAMIC throttle pull, observe throttle movement to witness any binding or sticking of actuator cable, proper connection of actuator cable to throttle lever, and ensure THROTTLE RETURNS BACK TO IDLE POSITION. If improper connection and/or binding or sticking of actuator is observed, go to the Pinpoint Test Section.

6. Return Ignition Switch to OFF position and go to the Pinpoint Test section, if necessary.

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Symptom Chart — Electronic Speed Control System

NOTE: Self-Test diagnostics must be performed before Pinpoint Test (Ranger Only).

ELECTRONIC SPEED CONTROL SYSTEM

Condition	Possible Source	Action
• Speed Control Inoperative	• Blown fuse. • Circuitry. • Stoplight switch. • Burnt stoplamp bulb. • Speed control actuator switch. • Vehicle speed sensor. (Ranger only). • Speed control servo. • Programmable electronic speedometer/odometer module (PSOM). (Aerostar only).	• GO to Pinpoint Test A .
• SET/ACCEL Switch Inoperative	• Speed control actuator switches. • Speed control servo. • Circuitry.	• GO to Component Test .
• COAST Switch Inoperative	• Speed control actuator switch. • Speed control servo. • Circuitry.	• GO to Component Test .
• RSM Switch Inoperative	• Speed control actuator switch. • Speed control servo. • Circuitry.	• GO to Component Test .
• OFF Switch Inoperative	• Speed control actuator switch. • Speed control servo. • Circuitry.	• GO to Component Test .
• Set Speed Fluctuates	• Vehicle speed sensor (Ranger only). • Speed control servo. • Speed control actuator switch. • Circuitry. • Loose fit or binding between	• GO to Pinpoint Test B .

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	speed control actuator cable and throttle body. • Programmable electronic speedometer/odometer module (PSOM) (Aerostar only). • Engine.	• REFER to Powertrain Control/Emissions Diagnosis Manual. SERVICE engine as required.
• Speed Control Does Not Disengage When Brakes Are Applied	• Stoplight switch. • Speed control servo. • Blown fuse. • Circuitry. • Deactivator switch. • Binding actuator cable.	• GO to Pinpoint Test C .

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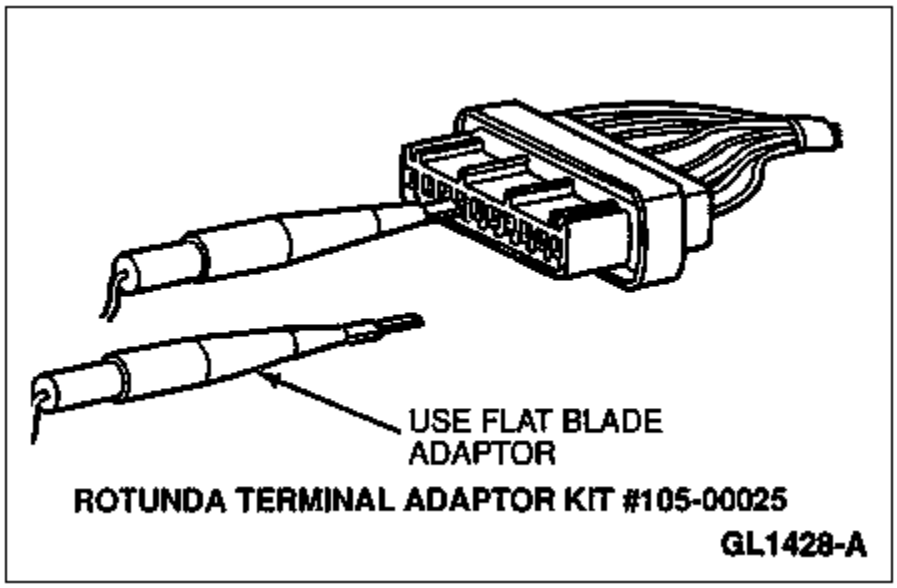
Pinpoint Tests

PINPOINT TEST A: SPEED CONTROL INOPERATIVE

A1 VERIFY THERE IS POWER TO SPEED CONTROL SERVO

- Disconnect harness connector from the speed control servo.
- Use Rotunda 73 Digital Multimeter 105-R00051 or equivalent to make the specified measurements at the harness connector. To avoid terminal damage, use Rotunda Terminal Adapter Kit 105-00025 or equivalent.
- With the ignition switch in RUN, measure voltage between Pin 7 (Circuit 1003 [GY/Y], Ranger, Circuit 296 [W/P], Aerostar) ground.

Is battery voltage measured (12v nom.)?



Yes	No
GO to **A2** .	SERVICE Circuit 1003 (GY/Y) (Ranger) or Circuit 296 (W/P) (Aerostar) as necessary. REPLACE fuse if necessary.

A2 CHECK FOR STUCK STOPLIGHT SWITCH

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- With no brakes applied, measure the voltage between Pin 4 (Circuit 306 [T/LB], Ranger, Circuit 810 [R/LG], Aerostar) and Pin 10 (Circuit 676 [PK/O]).

Is battery voltage measured (12v nom.)?

Yes	No
Stoplight switch is stuck on. REPLACE stoplight switch.	Stoplight switch is OK. GO to **A3** .

A3 CHECK BRAKE/CLUTCH CIRCUIT

- With the ignition switch in OFF position, measure the resistance between Pin 4 (Circuit 306 [T/LB], Ranger, Circuit 810 [R/LG], Aerostar) and Pin 10 (Circuit 676 [PK/O]).

Is resistance less than 20 ohms?

Yes	No
Brake input Circuit OK. GO to **A4** .	Brake light bulbs blown or brake circuit open. SERVICE circuit.

A4 CHECK DEACTIVATOR SWITCH CIRCUIT

- Turn the ignition switch to RUN position.
- With no brakes applied, place a 12-volt circuit test light between Pin 9 (Circuit 307 [BK/Y], Ranger, Circuit 636 [O], Aerostar) and Pin 10, (GND, Circuit 676 PK/O).

Is the light illuminated?

Yes	No
GO to **A7** .	GO to **A5** .

A5 VERIFY POWER AT DEACTIVATOR SWITCH HARNESS CONNECTOR

- Remove wiring harness connector from deactivator switch.
- Place 12-volt circuit test light between Circuit 1003 ([GY/Y], Ranger, Circuit 10 [LG/R], Aerostar) of deactivator switch connector and chassis ground.

Is the light illuminated?

Yes	No
GO to **A6** .	SERVICE blown fuse 11 or open Circuit 1003 (GY/Y) for Ranger or Circuit 10 (LG/R) for Aerostar.

A6 CHECK FOR OPEN CIRCUIT BETWEEN DEACTIVATOR SWITCH AND SPEED

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CONTROL SERVO

- Measure resistance of Circuit 307 (BK/Y), Ranger, circuit 636 (O), Aerostar from deactivator switch connector to Pin 9 of speed control servo connector.

Is resistance less than 1 ohm?

Yes	No
REPLACE deactivator switch.	SERVICE open Circuit 307 (BK/Y), Ranger or Circuit 636 (O), Aerostar in harness.

A7 CHECK FOR STUCK "ON" SPEED CONTROL ACTUATOR SWITCH ASSEMBLY

- With no steering wheel switches pressed, measure voltage between Pin 5 (Circuit 151 [LB/BK]) and Pin 10 (GND, Circuit 676 [PK/O]).

Is there battery voltage?

Yes	No
REPLACE left (ON/OFF) speed control actuator switch.	GO to **A8** .

A8 CHECK "ON" SWITCH OPERATION

- With steering wheel ON switch pressed, measure voltage between Pin 5 (COMMAND, Circuit 151 [LB/BK]) and Pin 10 (GND, Circuit 676 [PK/O]).

Is there battery voltage (12v nom.)?

Yes	No
GO to **A12** .	GO to **A9** .

A9 VERIFY POWER AT AIR BAG SLIDING CONTACT CONNECTOR AT BASE OF STEERING COLUMN

- Disconnect air bag sliding contact at 6-pin connector at the base of steering column.
- Measure voltage between Circuit 6 (Y/LG) at air bag sliding contact connector on instrument panel harness and Pin 10 (Circuit 676 [PK/O]) of speed control servo connector.

Is there battery voltage?

Yes	No
GO to **A10** .	CHECK fuse 12 (Aerostar) or fuse D (Ranger), Circuit 460 (Y/LB), horn relay, and Circuit 6 (Y/LG). SERVICE as necessary.

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A10 CHECK AIR BAG SLIDING CONTACT FOR HIGH RESISTANCE

- Disconnect speed control actuator switch connector from air bag sliding contact.
- Measure resistance across each of the air bag sliding contact windings between the air bag sliding contact connector at the base of steering column and speed control switches connector in steering wheel.

Is each resistance reading less than 1.0 ohm?

Yes	No
GO to **A11** .	REPLACE air bag sliding contact.

A11 CHECK FOR OPEN CIRCUIT IN STEERING WHEEL WIRING HARNESS

- Reconnect air bag sliding contact assembly at base of steering column.
- Disconnect connector at ON/OFF switch.
- Measure voltage between Pin 5 (Circuit 151 [LB/BK]) and chassis ground (steering wheel).

Is there battery voltage?

Yes	No
REPLACE left (ON/OFF) speed control actuator switch.	REPLACE steering wheel wiring harness.

A12 CHECK FOR STUCK COMMAND SWITCHES

- With no steering wheel switches pressed, measure resistance between Pin 5 (Circuit 151 [LB/BK]) and Pin 6 (COMMAND RTN, Circuit 848 [DG/O], Ranger, Circuit 248 [T/O], Aerostar).

Is resistance greater than 3k Ohms?

Yes	No
GO to **A13** .	If resistance is less than 100 ohms, REPLACE left (ON/OFF) switch. If greater than 100 ohms, REPLACE right (RSM/SET/COAST) switch.

A13 CHECK SET/ACCEL SWITCH OPERATION

- With the SET/ACCEL switch pressed, measure the resistance between Pin 5 (COMMAND, Circuit 151 [LB/PK]) and Pin 6 (COMMAND RTN, Circuit 848 [DG/O], Ranger, Circuit 248 [T/O], Aerostar).

Is resistance between 646 and 714 ohms?

Yes	No
GO to **A14** .	REPLACE right (RSM/SET/COAST) speed

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	control actuator switch.

A14 CHECK COAST SWITCH OPERATION

- With COAST switch pressed, measure resistance between Pin 5 (Circuit 151 [LB/BK]) and Pin 6 (Circuit 848 [DG/O], Ranger, Circuit 248, [T/O] Aerostar).

Is resistance between 114 and 126 ohms?

Yes	No
GO to **A15** .	REPLACE right (RSM/SET/COAST) speed control actuator switch.

A15 CHECK RESUME SWITCH OPERATION

- Disconnect harness connector from speed control servo assembly.
- With RSM switch pressed, measure resistance between Pin 5 (Circuit 151) and Pin 6 (Circuit 848 [DG/O], Ranger, Circuit 248, [T/O] Aerostar).

Is resistance between 2090 and 2310 ohms?

Yes	No
GO to **A16** .	REPLACE right (RSM/SET/COAST) speed control actuator switch.

A16 CHECK OFF SWITCH OPERATION

- Disconnect harness connector from speed control servo. With OFF switch pressed, measure resistance between Pin 5 (Circuit 151) and Pin 6 (Circuit 848 [DG/O], Ranger, Circuit 248, [T/O] Aerostar).

Is resistance less than 4 ohms?

Yes	No
GO to **A17** .	REPLACE left (ON/OFF) speed control actuator switch.

A17 CHECK COMMAND SWITCH RETURN CIRCUIT

- Measure resistance between Pin 6 (Circuit 848 [DG/O], Ranger, Circuit 248 [T/O], Aerostar) and Pin 10 (GND, Circuit 676 [PK/O]).

Is resistance greater than 1 ohm?

Yes	No

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If Ranger, GO to **A18**. If Aerostar, GO to **A22**.	SERVICE short in Circuit 848 or Circuit 248. RECONNECT speed control servo.

A18 CHECK VSS CIRCUIT (RANGER)

- Measure resistance between Pin 3 (Circuit 679 [GY/BK]) and Pin 10 (Circuit 676 [PK/O]).

Is resistance between 200 and 300 ohms?

Yes	No
GO to **A20**.	GO to **A19**.

A19 CHECK VSS (RANGER)

- Remove VSS connector.
- Measure resistance across VSS terminals.

Is resistance between 200 and 300 ohms?

Yes	No
CHECK for opens or shorts in Circuit 679 (GY/BK) and 676 (PK/O).	REPLACE vehicle speed sensor.

A20 ROAD TEST VEHICLE

- Road test vehicle and observe speedometer needle.

Does the needle waver?

Yes	No
REPLACE vehicle speed sensor.	Vehicle speed sensor checks OK. GO to **A21**.

A21 CHECK FOR BROKEN OR BINDING CABLE

- Remove speed control actuator cable from speed control servo assembly.
- Check for broken or binding cable by pulling on cable ball slug to ensure throttle moves freely.

Is cable OK?

Yes	No
REPLACE speed control servo assembly.	REPLACE speed control actuator cable.

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A22 CHECK PSOM CIRCUIT (AEROSTAR)

- Disconnect the harness connector from PSOM.
- Measure resistance between speed control servo connector Pin 3 (Circuit 679 [GY/BK]) and PSOM connector Pin 7 (Circuit 679 [GY/BK]).

Is resistance less than 5 ohms?

Yes	No
GO to **A23** .	SERVICE open in Circuit 679 (GY/BK).

A23 CHECK PSOM CIRCUIT FOR SHORT (AEROSTAR)

- Measure resistance between PSOM connector Pin 7 (Circuit 679 [GY/BK]) and ground.

Is resistance greater than 10,000 ohms?

Yes	No
REFER to Section 13-01 for diagnosis of PSOM. If PSOM is OK, GO to **A24** .	SERVICE short to ground in Circuit 679 (GY/BK).

A24 CHECK FOR BROKEN OR BINDING CABLE

- Remove speed control actuator cable from speed control servo assembly.
- Check for broken or binding cable by pulling on cable ball slug to ensure throttle moves freely.

Is cable OK?

Yes	No
REPLACE speed control servo assembly.	REPLACE speed control actuator cable.

PINPOINT TEST B: SET SPEED FLUCTUATES

B1 CHECK THE CONDITION WITHOUT SPEED CONTROL

- Verify that engine is properly tuned.
- Verify that condition does not occur when driving without speed control.

Does condition occur without speed control?

Yes	No
SERVICE engine as required.	GO to **B2** .

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B2 CHECK FOR BINDING IN SPEED CONTROL ACTUATOR CABLE AND THROTTLE BODY LINKAGE

- Check for binding or sticking of speed control cable or throttle linkage and throttle plate.
- Make sure throttle cable bracket and speed control servo bracket are not loose.

Are components OK?

Yes	No
If Ranger, GO to **B3** . If Aerostar, GO to **B7** .	SERVICE as required.

B3 CHECK VSS CIRCUIT (RANGER)

- Measure resistance between Pin 3 (Circuit 679 [GY/BK]) and Pin 10 (Circuit 676 [PK/O]).

Is resistance between 200 and 300 ohms?

Yes	No
GO to **B5** .	GO to **B4** .

B4 CHECK VSS (RANGER)

- Remove VSS connector.
- Measure resistance across VSS terminals.

Is resistance between 200 and 300 ohms?

Yes	No
CHECK for opens or shorts in circuit 679 (GY/BK) and 676 (PK/O).	REPLACE vehicle speed sensor.

B5 ROAD TEST VEHICLE

- Road test vehicle and observe speedometer needle.

Does the needle waver?

Yes	No
REPLACE vehicle speed sensor.	Vehicle speed sensor checks OK. GO to **B6** .

B6 CHECK SPEED CONTROL SERVO ASSEMBLY

- Substitute known good speed control servo.

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- Test vehicle for proper operation.

Does system operate properly?

Yes	No
REPLACE speed control servo assembly.	CHECK MAP sensor and EGR valve position (EVP) sensor and speed control cable adjustment. SERVICE as necessary.

B7 CHECK PSOM CIRCUIT (AEROSTAR)

- Disconnect the harness connector from PSOM.
- Measure resistance between speed control servo connector Pin 3 (Circuit 679 [GY/BK] and PSOM connector Pin 7 (Circuit 679 [GY/BK]).

Is resistance less than 5 ohms?

Yes	No
GO to **B8** .	SERVICE open in Circuit 679 (GY/BK).

B8 CHECK PSOM CIRCUIT FOR SHORT (AEROSTAR)

- Measure resistance between PSOM connector Pin 7 (Circuit 679 [GY/BK] and ground.

Is resistance greater than 10,000 ohms?

Yes	No
REFER to Section 13-01 for diagnosis of PSOM. If PSOM is OK, GO to **B9** .	SERVICE short to ground in Circuit 679 (GY/BK).

B9 CHECK FOR BROKEN OR BINDING CABLE

- Remove speed control actuator cable from speed control servo assembly.
- Check for broken or binding cable by pulling on cable ball slug to ensure throttle moves freely.

Is cable OK?

Yes	No
REPLACE speed control servo assembly.	REPLACE speed control actuator cable.

PINPOINT TEST C: SPEED CONTROL DOES NOT DISENGAGE WHEN BRAKES ARE APPLIED

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C1 CHECK DEACTIVATOR SWITCH CIRCUIT

- Turn ignition switch to RUN.
- Disconnect harness connector from the speed control servo.
- With no brakes applied, place a 12 Volt Circuit Test Light between Pin 9 (Circuit 307, Ranger [BK/Y], Circuit 636 [O], Aerostar) and Pin 10 (GND, Circuit 676 [PK/O]).

Is the light illuminated?

Yes	No
GO to **C2** .	REFER to Pinpoint Test A — Speed Control Inoperative.

C2 CHECK DEACTIVATOR SWITCH OPERATION

- Leave ignition switch in RUN.
- Fully apply brakes with the 12-Volt Circuit Test Light still between Pin 9 (Circuit 307, Ranger [BK/Y], Circuit 636 [O], Aerostar) and Pin 10 (GND, Circuit 676 [PK/O]).

Does the light turn off?

Yes	No
GO to **C3** .	REPLACE deactivator switch.

C3 CHECK STOPLIGHT SWITCH CIRCUIT

- With brakes applied, measure voltage between Pin 4 (Circuit 306 [T/LB], Ranger, Circuit 801 [R/LG], Aerostar) and Pin 10 (GND Circuit 676 [PK/O]).

Is there battery voltage?

Yes	No
GO to **C4** .	SERVICE stoplight switch, Fuse 11, or open in Circuit 306 (T/LB), Ranger or Circuit 810 (R/LG), Aerostar. RECONNECT speed control servo.

C4 CHECK FOR BINDS IN SPEED CONTROL ACTUATOR CABLE AND THROTTLE BODY ATTACHMENT

- Remove speed control actuator cable from speed control servo.
- Check for broken or binding cable by pulling on cable ball slug to ensure throttle moves freely.

Is cable OK?

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Yes	No
REPLACE speed control servo.	REPLACE speed control actuator cable.

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Component Test

Speed Control Actuator Switch Assembly

To test speed control actuator switch (9D743), perform the following voltage and resistance measurements.

Voltage Measurements: remove connector from speed control servo (9C735). Connect the negative lead of voltmeter to Pin 10 (Circuit 676 [PK/O]) of connector. Measure the DC or AC voltage of the following circuits with positive lead of meter.

VOLTAGE MEASUREMENT — DC

Circuit Name	Pin	Circuit	Wire Color	Test Condition	Approximate Voltage
Ignition Feed	7	1003 (Ranger) 296 (Aerostar)	GY/Y (Ranger) W/P (Aerostar)	Ignition switch in RUN	Battery voltage (12 volts)
Deactivator Switch Feed	9	307 (Ranger)	BK/Y (Ranger)	No brakes applied	Battery Voltage (12 volts)
		636 (Aerostar)	O (Aerostar)	Brake pedal applied	Less than 0.5 volt
Stoplight Switch Feed	4	306 (Ranger)	T/LB (Ranger)	No brakes applied	Less than 0.5 volt
		810 (Aerostar)	R/LG (Aerostar)	Brake pedal applied	Battery voltage (12 volts)
Command Signal (Control Line)	5	151	LB/BK	No switches pressed	Less than 0.5 volt
				Press and hold ON switch	Battery voltage (12 volts)
Indicator Lamp (Ranger)	1	203	O/LB	Ignition Switch in RUN	Battery Voltage (12 volts)

VOLTAGE MEASUREMENT — AC

Circuit Name	Pin	Circuit	Wire Color	Test Condition	Approximate Voltage
VSS Output Signal (Ranger)	3	679	GY/BK	Vehicle on road about 30 mph	1.4 volts AC minimum
				Vehicle on road about 45 mph	1.6 volts AC minimum

Resistance Measurements: remove connector at speed control servo. Connect an ohmmeter between the designated circuits with ignition switch (11572) off.

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RESISTANCE MEASUREMENTS

Circuit Name	Pin	Circuit	Wire Color	Test Condition	Approximate Resistance
Stoplight Switch to Ground	4 to 10	306 to 676 (Ranger) 810 to 676 (Aerostar)	T/LB to PK/O (Ranger) R/LG to PK/O (Aerostar)	Brakes not applied	Less than 10 ohms
VSS Signal to Ground (Ranger)	3 to 10	679 to 676	GY/BK to PK/O	Harness disconnected from servo	200-300 ohms
Command Signal to Command Return	5 to 6	151 to 848 (Ranger) 151 to 248 (Aerostar)	LB/BK to DG/O (Ranger) LB/BK to T/O (Aerostar)	No switches pressed Press OFF switch Press COAST switch Press ACCEL switch Press RSM switch	Greater than 3000 ohms Less than 4 ohms 114-126 ohms 646-714 ohms 2090-2310 ohms
Command Return to Ground	6 to 10	848 to 676 (Ranger) 248 to 676 (Aerostar)	DG/O to PK/O (Ranger) T/O to PK/O (Aerostar)	No switches pressed	Open circuit

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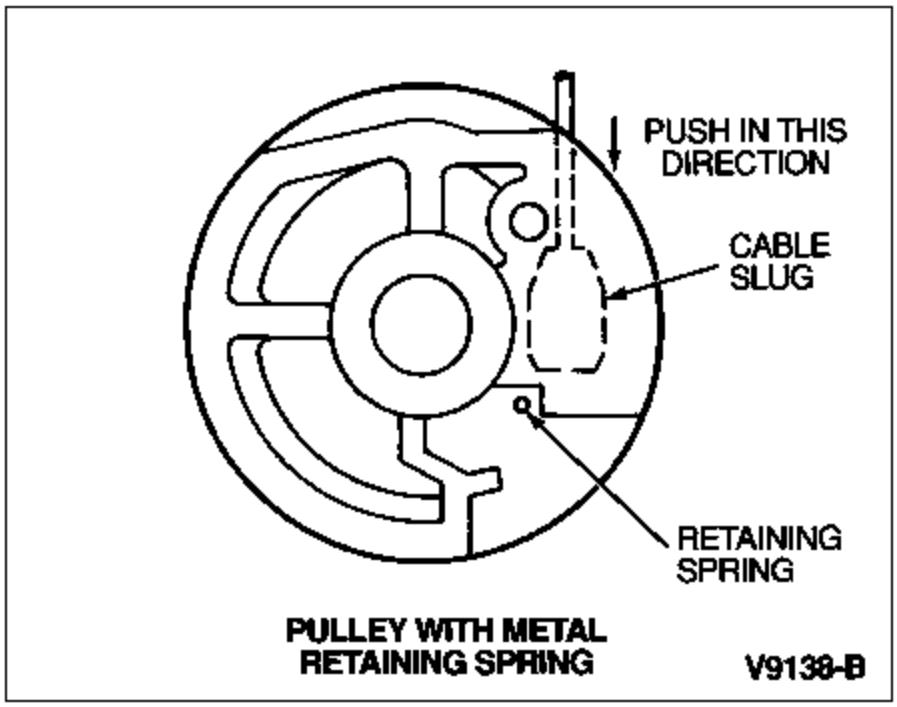
Speed Control Servo

Removal

1. Remove the screw(s) that mount speed control bracket to vehicle.
2. Disconnect speed control 10-way connector.
3. Depress accelerator pedal and shaft (9725), then push locking arm on speed control actuator cap and rotate cap counterclockwise.
4. Remove cable ball slug from servo rotor.
5. Remove speed control actuator cable slug from speed control servo pulley. Gently push actuator cable slug past retaining spring using a small screwdriver.
6. Remove bracket from the speed control servo (9C735); keep bracket, screw(s), eyelets and insulators for reuse.

Speed Control Servo Rotor



Installation

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1. Attach bracket to speed control servo with three screws, eyelets and insulators. Tighten to 6-7 Nm (53-62 lb-in).
2. Attach speed control 10-way connector to speed control servo.
3. Make sure the rubber seal is fully seated on actuator cable cap.
4. Depress accelerator pedal and shaft if accelerator cable (9A758) is attached to throttle and lock cable ball in slot located in servo pulley.
5. Release accelerator cable or pull accelerator cable at throttle end.
6. Insert cap locking tabs into speed control servo slots as shown.
7. Rotate cap clockwise until locking arm engages locking tab on servo.
8. Position speed control actuator cable (9A825) and mount with screws.
9. Adjust speed control actuator cable as described in Adjustments, Actuator Cable in this section.

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Speed Control Actuator

Removal

1. Remove speed control actuator cable (9A825) from speed control servo (9C735) as described in Removal and Installation, Speed Control Servo in this section.
2. Remove speed control actuator cable from throttle bracket.
3. Remove speed control actuator cable from accelerator cable (9A758).

Installation

1. Snap speed control actuator cable onto accelerator cable.
2. Snap speed control actuator cable to throttle cable bracket.
3. Attach speed control actuator cable to speed control servo as described in Removal and Installation, Speed Control Servo in this section.
4. Adjust speed control actuator cable as described in Adjustments, Actuator Cable in this section.

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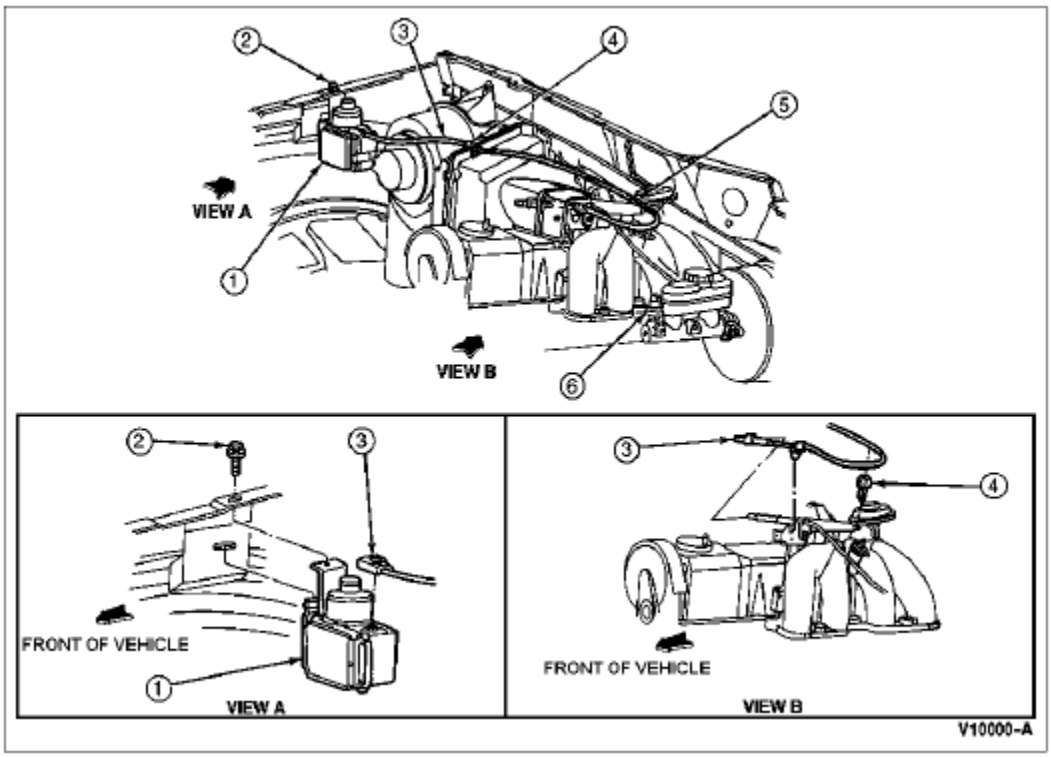
Brake ON/OFF (BOO) Switch

Refer to Section 17-01 .

Speed Control System Components, 2.3L Engine — Ranger



Item	Part Number	Description
1	9C735	Speed Control Servo
2	N606689-S106	Bolt
3	9A825	Speed Control Actuator Cable
4	N802768-SB	Clip
5	9D726	Clip
6	9F924	Deactivator Switch

Speed Control System Components, 3.0L Engine — Ranger

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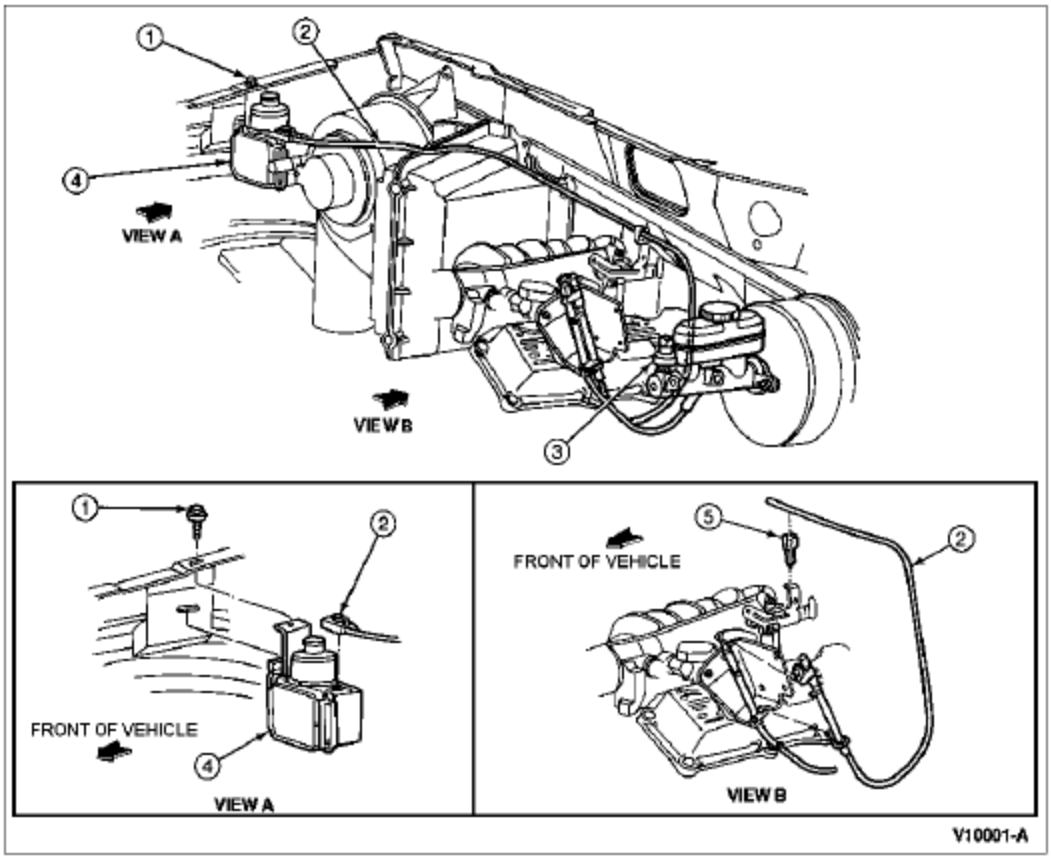

Item	Part Number	Description
1	N606689-S106	Bolt
2	9A825	Speed Control Actuator Cable
3	9F924	Deactivator Switch
4	N802768-SB	Clip
5	9C735	Speed Control Servo

Speed Control System Components, 4.0L Engine — Ranger

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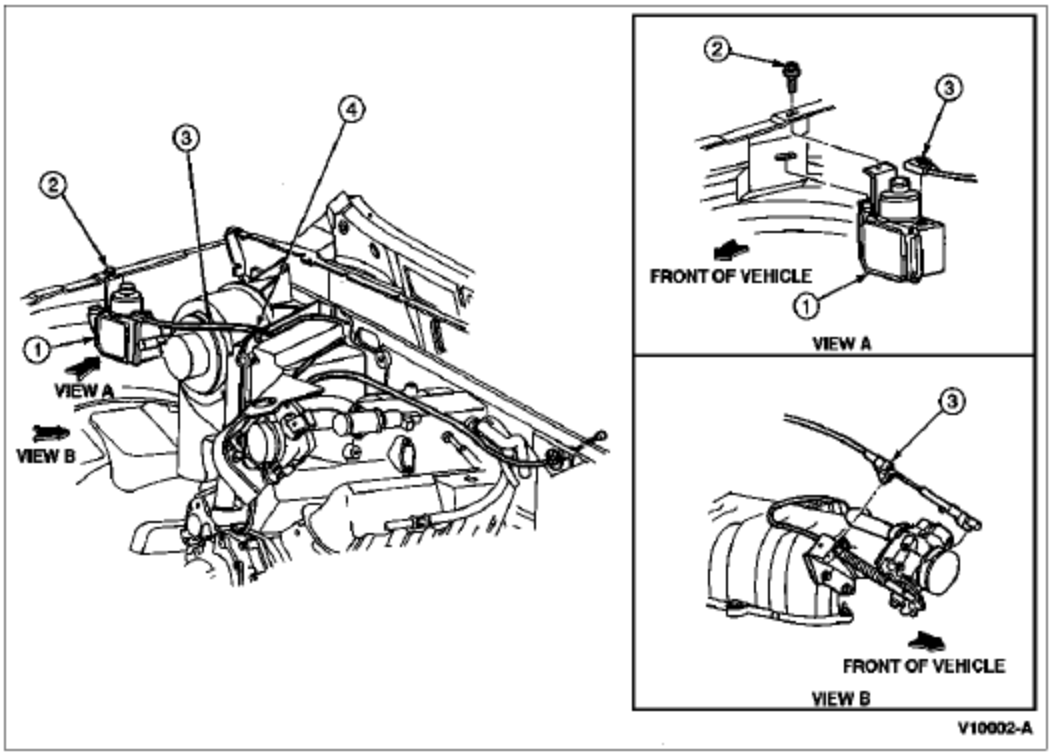

Item	Part Number	Description
1	9C735	Speed Control Servo
2	N606689-S106	Bolt
3	9A825	Speed Control Actuator Cable
4	9D726	Clip

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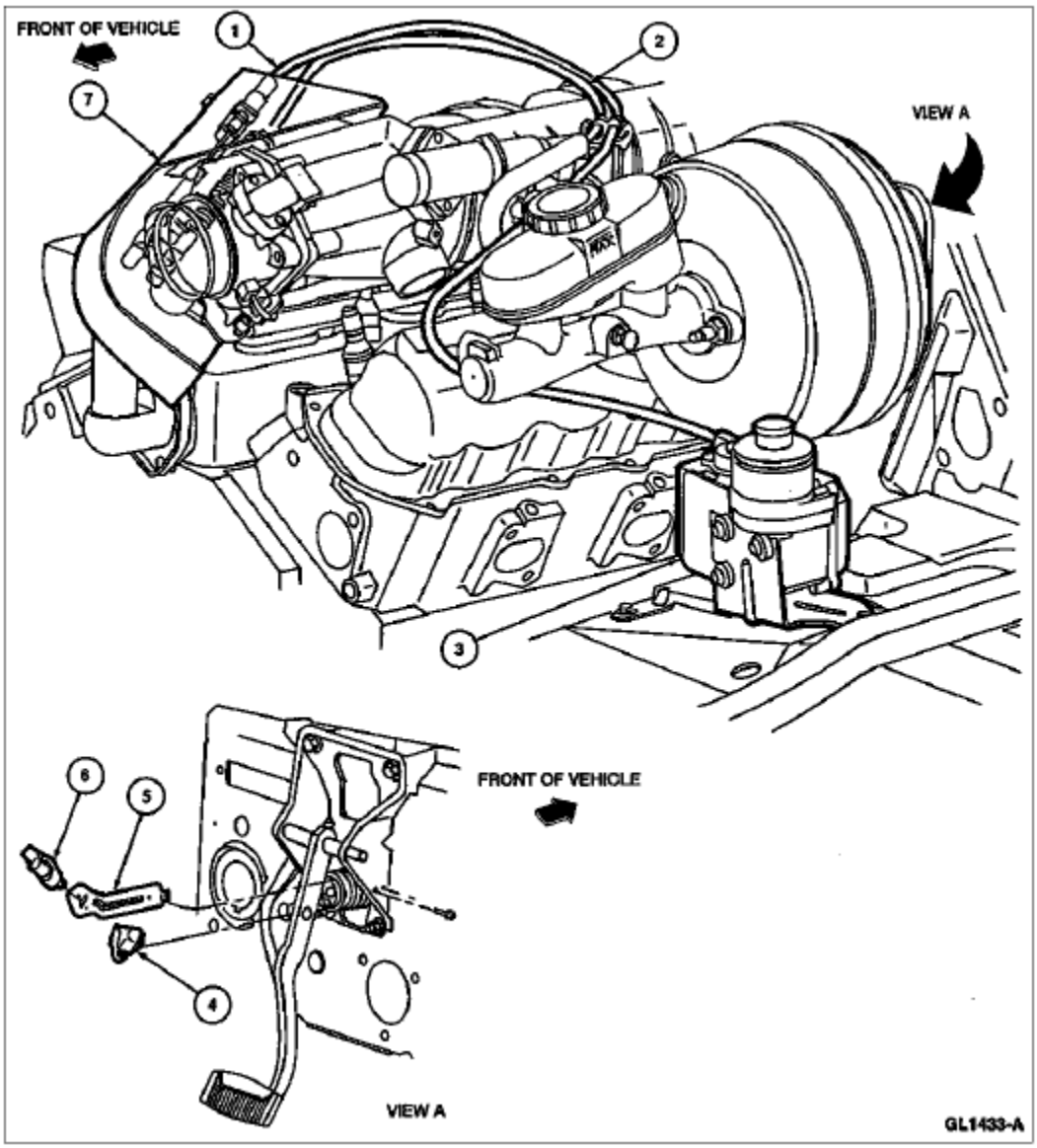
Section 10-03: Speed Control System, Electronic — Aerostar, Ranger 1997 Aerostar, Ranger Workshop Manual
REMOVAL AND INSTALLATION

Vehicle Speed Sensor, Aerostar

Refer to Section 06-09A .

Speed Control Components, Aerostar — 3.0L



Item	Part Number	Description
1	9A825	Speed Control Actuator Cable
2	9A758	Accelerator Cable
3	9C734	Speed Control Servo and Bracket Assembly

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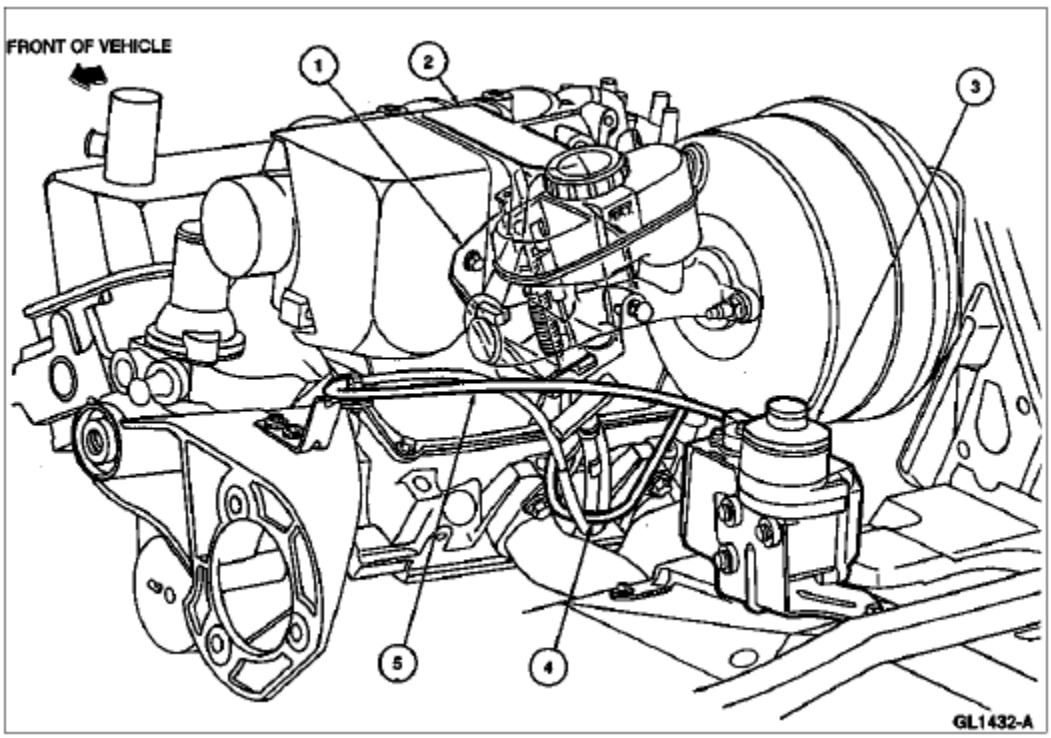
4	9C962	Speed Control Vacuum Valve Adapter
5	9A812	Speed Control Servo Boot
6	—	Deactivator Switch
7	9E766	Accelerator Control Splash Shield

Speed Control Components, Aerostar — 4.0L



Item	Part Number	Description
1	9728	Accelerator Cable Bracket
2	9E766	Accelerator Control Splash Shield
3	9C734	Speed Control Servo and Bracket Assembly
4	9A758	Accelerator Cable
5	9A825	Speed Control Actuator Cable

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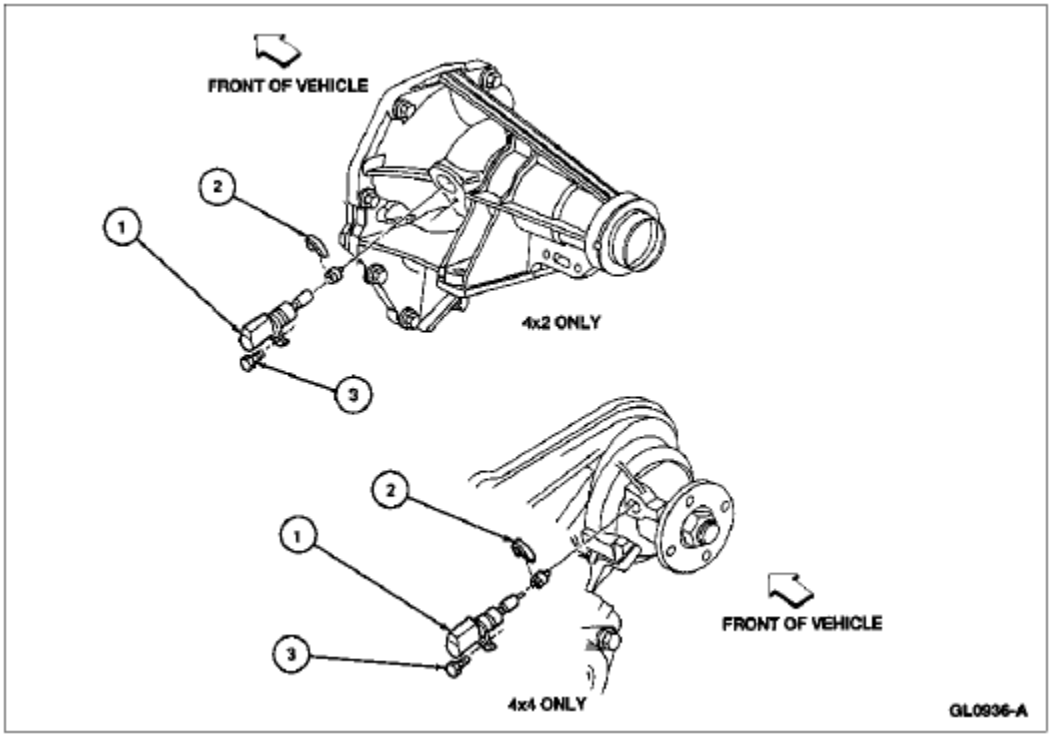
Vehicle Speed Sensor, Ranger

Removal and Installation

1. Separate the electrical connector to speed sensor on the automatic transmission/transaxle.
2. Remove retaining bolt or nut.
3. Remove vehicle speed sensor (VSS) (9E731).
4. Remove drive gear.

For installation, follow removal procedures in reverse order. Make sure to install drive gear on vehicle speed sensor before installing vehicle speed sensor into transmission.

Vehicle Speed Sensor, Ranger Shown



Item	Part Number	Description
1	9E731	Vehicle Speed Sensor
2	57622-S2	Bolt
3	W620397-S36	Nut and Washer Assembly

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4	C1DD-17292-A	Retainer

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Deactivator Switch, Ranger

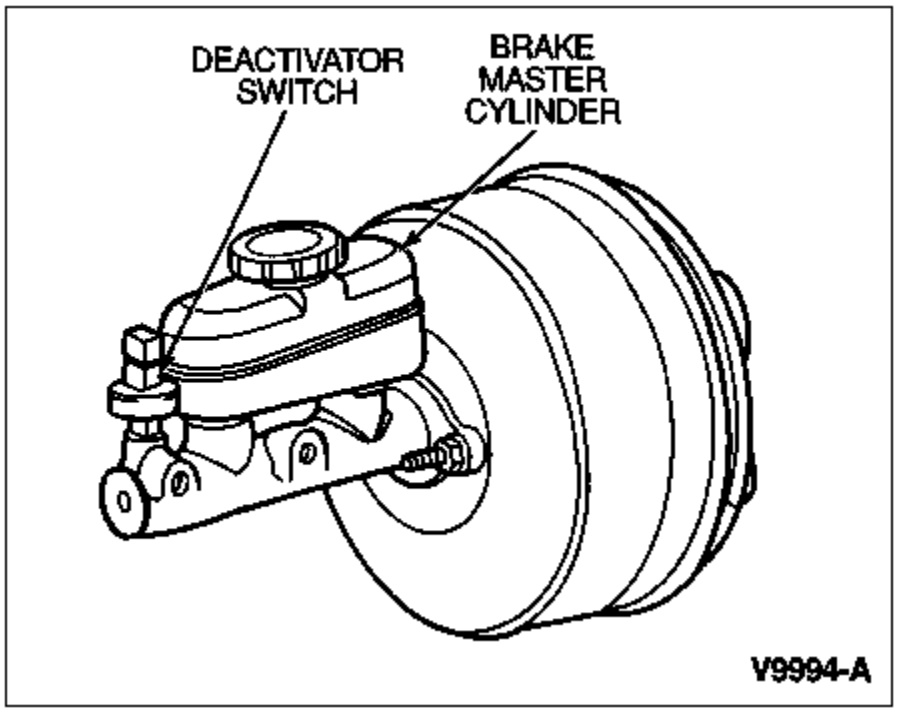
Removal

1. Disconnect deactivator switch connector. Deactivator switch is located on brake master cylinder (2140).

2. Unscrew switch and remove.

Installation

For installation, follow removal procedures in reverse order. Tighten switch to 15-20 Nm (12-14 lb-ft) and bleed brake lines as described in Section 06-06 .



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Deactivator Switch, Aerostar

Removal

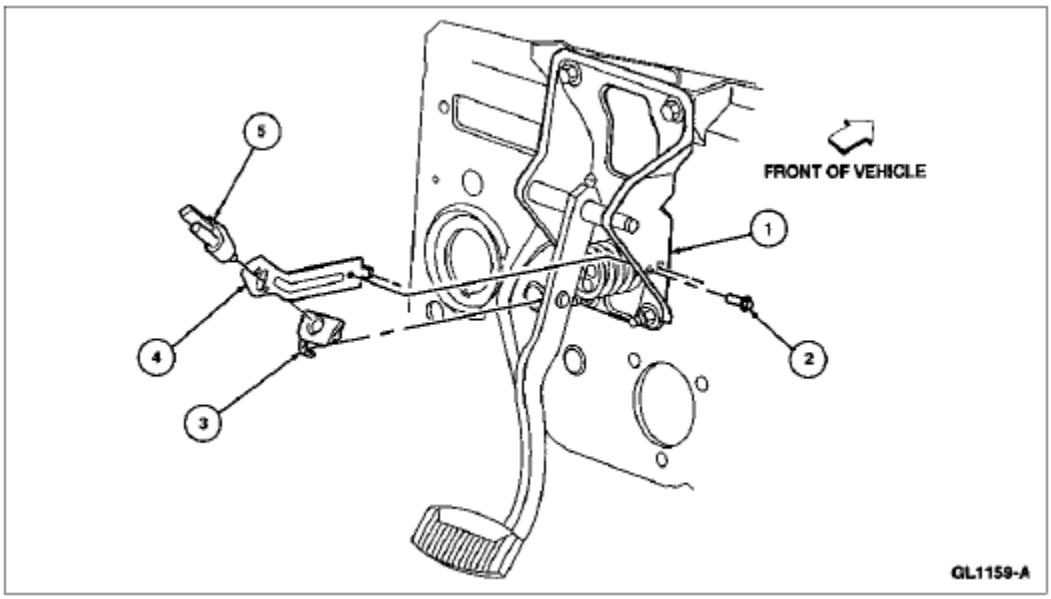
1. Disconnect the deactivator switch electrical connector.
2. Twist the deactivator switch counterclockwise slightly and remove.

Installation

1. **NOTE: Inspect the deactivator switch bracket for damage. If necessary, remove the screw and replace with a new bracket. Be sure the guide tab is aligned in the slot on the brake pedal (2455).**

   Install the bracket. Tighten the screw to 7.6-10.4 Nm (67-92 Lb-In).
2. While slightly depressing the brake pedal, insert a new deactivator switch and turn counterclockwise until it locks in place.
3. **NOTE: In the installed position, with the brake pedal applied, the deactivator switch is closed. Be sure the two pins of the switch are aligned alike before releasing the brake pedal.**

   Release the brake pedal.
4. Connect the electrical connector.



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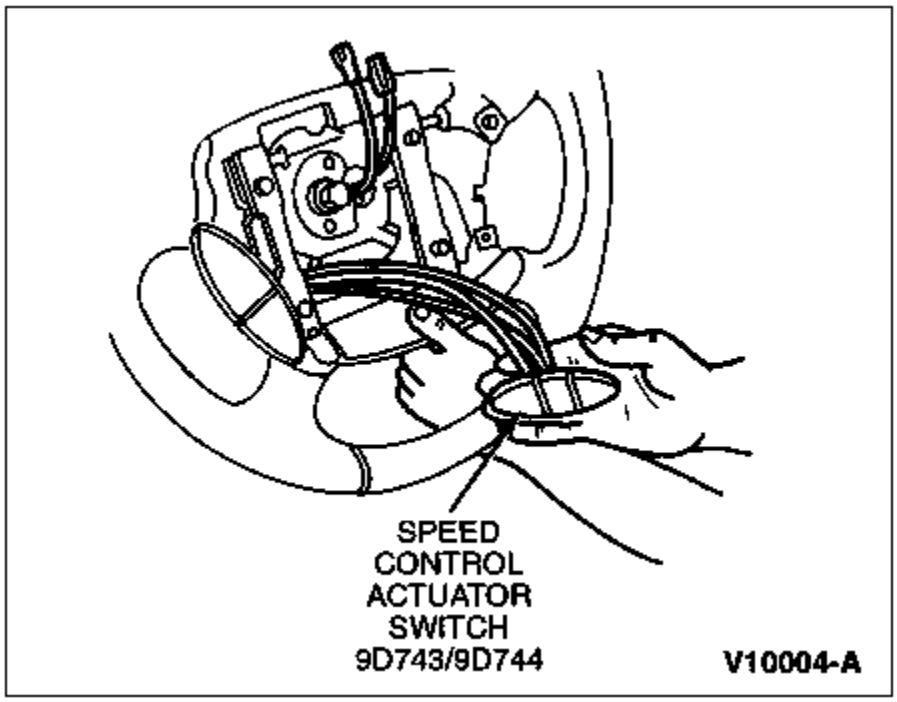
Switch, Speed Control (Ranger Only)

Removal

NOTE: The left actuator switch, right actuator switch, and wiring assembly can be serviced independently. The bulb for switch graphics backlighting is not serviceable as a separate item. To service a bulb, replace the left or right actuator switch.

1. Make sure the vehicle's front wheels are facing straight ahead, and the steering wheel (3600) is oriented in the straight-ahead position.
2. Disconnect the battery to starter relay cable. Wait at least one minute before proceeding to allow the air bag backup power supply to discharge.
3. Remove driver side air bag module (043B13). Refer to Section 01-20B .
4. Disconnect the wiring connector(s) at the sides of the switch(es) to be serviced.
5. Remove the (2) retaining screws per actuator switch, and remove switch from steering wheel.

Ranger Shown, Aerostar Similar



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Installation

1. **NOTE: Install ground eyelet under the upper screw on the right switch.**

   Position the left and right speed control actuator switches on the steering wheel and install four Phillips head attaching screws.

2. Connect the wiring harness connectors to each switch by pushing onto the switch pins until the connector snaps in place.

3. Install the driver side air bag module. Refer to Section 01-20B .

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Switch, Speed Control (Aerostar Only)

Removal and Installation

WARNING: ON AEROSTAR VEHICLES EQUIPPED WITH A SUPPLEMENTAL AIR BAG SYSTEM, REFER TO THE BODY, CHASSIS MANUAL, SECTION 01-20C FOR INFORMATION RELATED TO AIR BAG SYSTEM OPERATION AND SPECIAL HANDLING PROCEDURES. FAILURE TO ADHERE TO THESE PROCEDURES MAY RESULT IN AIR BAG DEPLOYMENT WHICH COULD RESULT IN PERSONAL INJURY.

WARNING: THE ELECTRICAL CIRCUIT NECESSARY FOR SYSTEM DEPLOYMENT IS POWERED DIRECTLY FROM THE BATTERY. TO AVOID ACCIDENTAL DEPLOYMENT AND POSSIBLE PERSONAL INJURY, BOTH BATTERY CABLES MUST BE DISCONNECTED PRIOR TO SERVICING OR REPLACING ANY SYSTEM COMPONENT.

WARNING: PLACE DRIVER SIDE AIR BAG MODULE (043B13) IN BENCH WITH TRIM COVER FACING UP.

WARNING: THE BACKUP POWER SUPPLY MUST BE DISCONNECTED BEFORE ANY AIR BAG COMPONENT IS SERVICED.

NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 mi) or more to relearn the strategy.

1. Remove driver side air bag module from steering wheel (3600). Refer to Section 01-20C for removal and installation procedures.
2. Disconnect horn/speed control black wire harness connection from clockspring contact connector located in upper center of steering wheel.
3. Remove two retaining screws from base of each speed control actuator switch (9D743).
4. Remove electrical tape from wire connectors located at each upper clip in steering wheel.
5. Disconnect speed control switch wires at untaped wire connectors and remove switches.

   For installation, follow removal steps in reverse order.

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Harness, Speed Control Switch Wiring

Removal

1. Remove speed control switch. If necessary, refer to the procedure in this section.
2. Disconnect the steering wheel wiring harness connector at the air bag sliding contact (14A664). Connector is located at the right side of the steering wheel attaching bolt.
3. Remove steering wheel. Refer to Section 11-04A for Ranger and Section 11-04B for Aerostar.
4. Disconnect wiring harness flag terminals from the (2) horn switches.
5. Remove right horn switch. Refer to Section 13-06 .
6. On back side of steering wheel, remove (2) screws attaching back cover.
7. Carefully remove back cover from steering wheel.
8. Disconnect wiring harness from retaining clips near right horn switch, and remove wiring harness from steering wheel (3600).

Installation

1. With the steering wheel rim facing down on a bench, route the wiring harness around the steering wheel upper spokes to the switch locations. Route the wiring with the black 5-pin air bag sliding contact connector from the right speed control switch through the 2 retaining clips and through the 2 wire locating ribs beneath the right horn switch.
2. Route the horn switch wires as follows:
   - wire from the right speed control switch to the left horn switch
   - wire from the left speed control switch to the right horn switch
3. Carefully install steering wheel back cover, and install back cover attaching screws.
4. Carefully route the wiring between the locator posts and the top inside of the back cover.
5. Reinstall the right horn switch, being careful to not pinch the wiring. Tighten horn switch attaching bolts to 6.5-7.5 Nm (4.8-5.5 lb-ft).
6. Connect the wiring harness terminals to each horn switch.
7. Install the steering wheel. Refer to Section 11-04A .

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8. Install the steering wheel wiring harness 5-pin connector into the air bag sliding contact at the right side of the steering wheel bolt.

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Actuator Cable

1. Remove cable retaining clip from actuator cable at accelerator cable bracket (9723).
2. Set throttle plate to closed position.
3. Pull on the actuator cable to take up any slack. Back off at least one notch so that there is 1mm (.040 inch) of slack in the cable. The cable must not be pulled tight for proper operation.
4. While holding the cable, insert the retaining clip and snap securely.

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SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Air Bag Module Nuts, Aerostar	4-6	—	35-53
Deactivator Switch, Ranger	15-20	12-14	—
Deactivator Switch Bracket Screw, Aerostar	7.6-10.4	—	67-92
Ground Brush-to-Upper Retainer Plate Screws, Aerostar	2-3	—	18-27
Horn Switch Bolts	6.5-7.5	4.8-5.5	—
Servo Bracket Bolt, Ranger	9-12	—	80-107
Servo Bracket Screws, Ranger	6-7	—	53-62
Steering Column Shroud Screws, Aerostar	2-3	—	18-27
Steering Wheel Bolt, Aerostar	31-45	23-33	—

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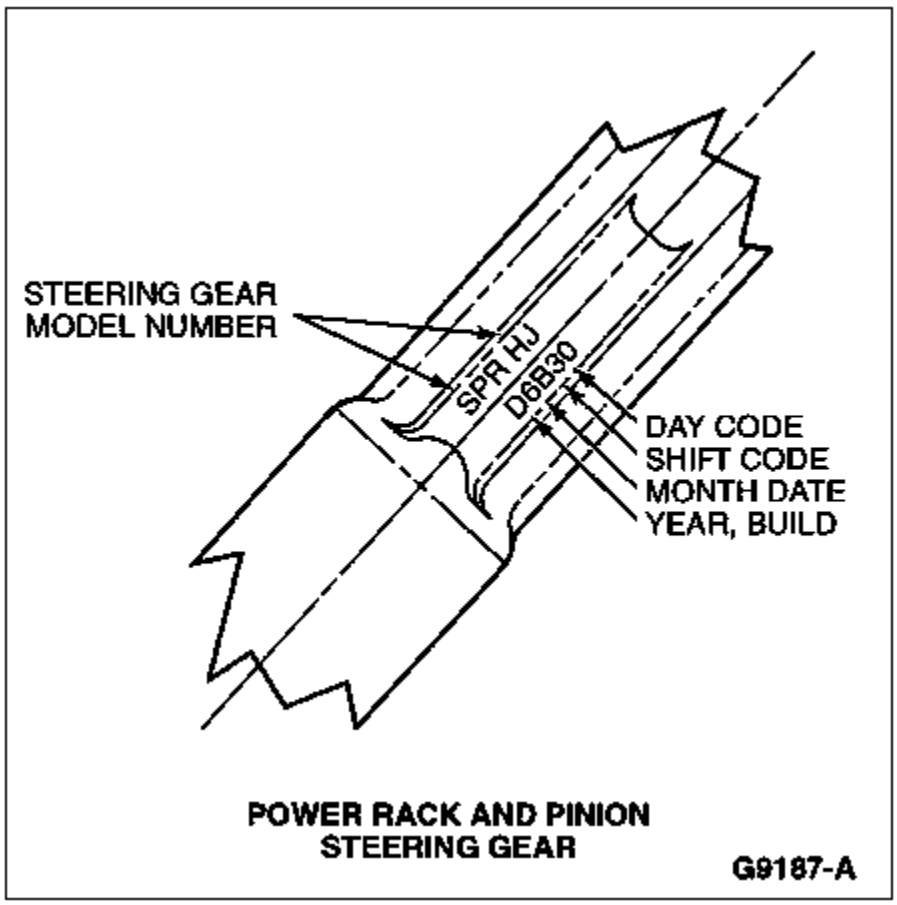
Identification

Steering Gear Model

Steering gears (3504) are identified by a service identification tag fastened to the assembly, or by the steering gear model number stamped on the housing. Tags and stamped model numbers contain coded information. The power rack and pinion Aerostar has a date stamp on the steering gear housing (3548) steering gear housing (3548). The Ranger has an identification tag attached to the piston cylinder of the steering gear. The date stamp is on the housing assembly. An optional dot matrix ID may be substituted on Ranger only and is located on the sector cover.



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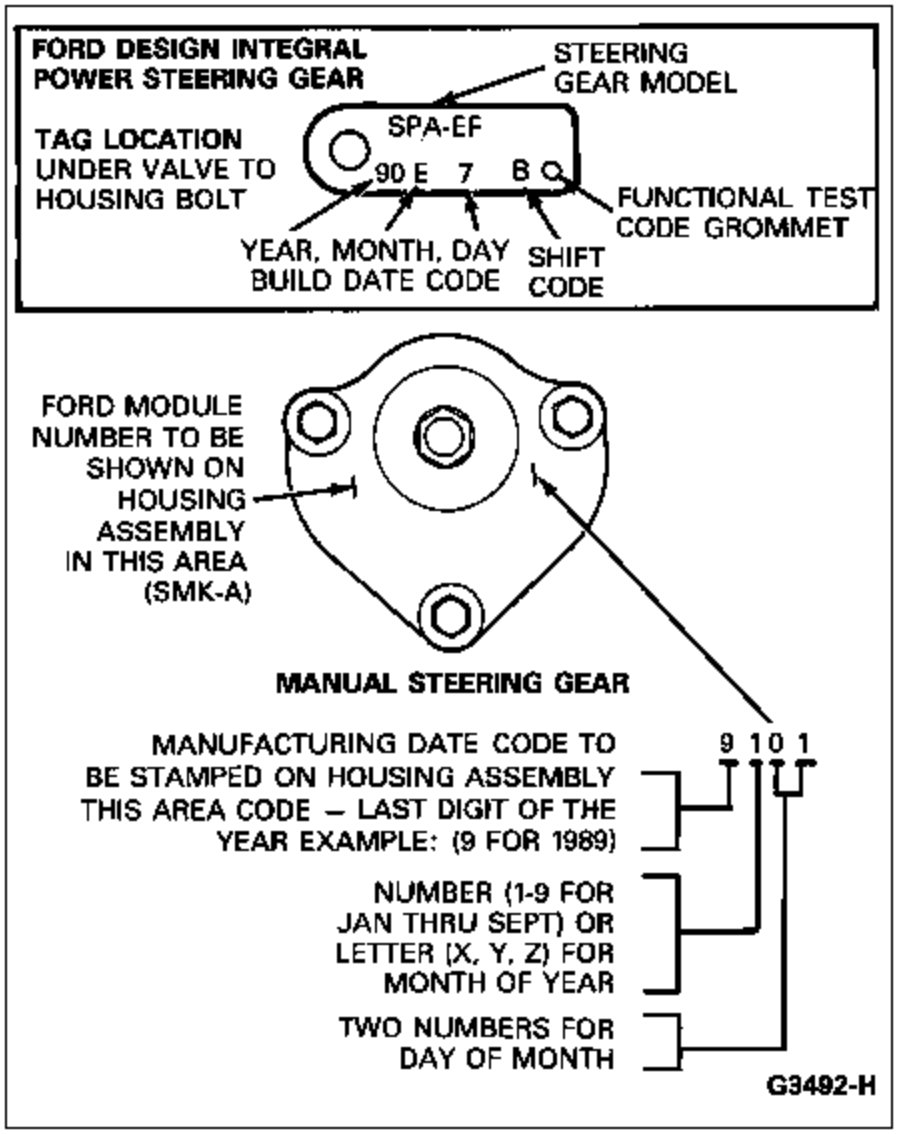

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Pump, Power Steering

NOTE: Always use these tags when requesting service parts as there may be slight differences in internal components.

A pressure-sensitive identification tag is attached to the power steering fluid reservoir. The top line of this tag indicates the basic model number (HBC) and the suffix.

The C-II power steering pump (3A674) is a drive belt, slipper-type pump with a fiberglass-reinforced nylon power steering fluid reservoir . The power steering fluid reservoir is attached to the rear side of the pump housing front plate and the power steering pump housing (3A643) is encased within the housing and reservoir. The power steering pressure hose (3A719) is attached with a quick connect fitting, located below the filler neck at the outboard side of the power steering fluid reservoir. The fitting allows the line to swivel. This is normal and does not indicate an untorqued fitting.

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Inspection and Verification

Inspect steering system for worn or damaged components. Inspect hoses and connections for leaks. Refer to appropriate Group 11 section.

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Symptom Charts

The charts in this section can be used as an aid in diagnosing steering system conditions. For suspension system diagnosis guides, refer to Section 04-00 and for normal steering gear diagnosis refer to Diagnosis and Testing in this section. Additional diagnosis procedures can be found in Section 05-00.

STEERING SYSTEM DIAGNOSIS

Condition	Possible Source	Action
• Feedback — (Rattle, Chuckle, Knocking Noises in the Steering Gear or Inside the Vehicle) Roughness Is Felt in the Steering Wheel by the Driver When the Vehicle Is Driven Over Rough Pavement	• Steering column gear input shaft couplings loose.	• CHECK steering column gear input shaft couplings for damage and REPLACE if required. If not damaged, TIGHTEN retaining bolts to 41-57 Nm (31-42 lb-ft).
	• Loose steering gear locknut (Ranger).	• CHECK steering gear locknut for damage and REPLACE if required. If no damage is found, TIGHTEN locknut to 40-55 Nm (30-40 lb-ft).
	• Connecting bolts on steering column shaft intermediate loose (Aerostar).	• CHECK bolts for damage and REPLACE if required. If not damaged, TIGHTEN to 41-57 Nm (31-42 lb-ft).
	• Gear loose on frame (Ranger).	• CHECK bolts for damage and REPLACE as required. If bolts are not damaged, TIGHTEN mounting bolts to 68-84 Nm (50-62 lb-ft).
	• Insufficient meshload (Ranger).	• SET meshload to specification. REFER to Meshload in the Adjustments portion of Section 11-02B .
	• Loose worm race locknut (Ranger).	• CHECK nut for damage and REPLACE as required. If nut is not damaged, TIGHTEN nut to 75-122 Nm (55-90 lb-ft).
	• Insufficient worm thrust bearing preload (Ranger).	• REPLACE valve assembly. REFER to Disassembly and Assembly procedures in Section 11-02B .
	• Damaged/omitted sector shaft bearing (gear might also exhibit external leakage from sector seals) (Ranger).	• REPLACE steering gear housing. REFER to Disassembly and Assembly procedures in Section 11-02B .

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• Noise in Steering — Squeak, Creak or Rattle	• Steering column shroud interference with steering wheel.	• REPLACE steering column shrouds or steering wheel or REPOSITION steering column shroud as required. REFER to Section 11-04B , Aerostar or Section 11-04A , Ranger for repair procedures.
	• Air bag sliding contact.	• REFER to Section 01-20B .
	• Loose steering column mounting bolts or screws.	• CHECK bolts for damage and REPLACE if required. If bolts are not damaged, TIGHTEN to specification. REFER to Section 11-04B , Aerostar or Section 11-04A , Ranger for individual bolt or screw torque specifications.
	• Looseness of ball bearings or insufficient lube.	• CHECK bearings for damage or excessive wear and REPLACE if required. If no damage is found, LUBE bearings and TIGHTEN to specification. REFER to Section 11-04B , Aerostar or Section 11-04A , Ranger.
	• Steering shaft insulators cracked or dry (Aerostar).	• CHECK insulators for cracks and REPLACE if required. If no cracks are found, LUBE insulators.
	• Steering column shaft bearing sleeve out of position.	• CHECK steering column bearing sleeves for damage and REPLACE if required. If no damage is found, REPOSITION steering column bearing sleeve. REFER to Section 11-04B , Aerostar or Section 11-04A , Ranger.
	• Bearing retainer out of position.	• CHECK bearing retainers for damage and REPLACE if required. If no damage is found, RESEAT bearing retainers. REFER to Section 11-04B , Aerostar or Section 11-04A , Ranger.
• Noise in Steering Column — Clunk	• Loose steering column intermediate shaft coupling to steering column bolt.	• CHECK steering column gear input shaft coupling bolt for damage and REPLACE if required. If no damage is found, TIGHTEN bolt to 41-57 Nm (31-42 lb-ft).
	• Improper steering gear meshload (Ranger).	• READJUST to specification. REFER to Section 11-02B , Ranger for adjustment procedures.
	• Defective steering column intermediate shaft coupling.	• REMOVE steering column intermediate shaft coupling from lower steering column shaft. Manually INSPECT steering

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		column intermediate shaft coupling and lower steering column shaft for metallic lash. INSPECT steering column intermediate shaft coupling for loose plug. REPLACE assembly as required. REFER to Section 11-04A , Ranger for repair procedures.
	• Looseness of bearings or insufficient bearing lube at the interface of balls to inner and outer face.	• CHECK ball bearings for damage. If damage is found REPLACE as required. REFER to Section 11-04B , Aerostar or Section 11-04A , Ranger for bearing replacement procedures.
• Noise, Knock, Clunk, Rapping, Squeaking Noise When Turning	**Power Steering Only**	
	• Steering wheel-to-steering column shroud interference.	• ADJUST or REPLACE as required. REFER to Section 11-04B , Aerostar or Section 11-04A , Ranger.
	• Air bag sliding contact.	• Refer to Section 01-20B .
	• Steering column mounting nuts loose.	• CHECK nuts for damage and REPLACE if required. If nuts are not damaged, TIGHTEN nuts to 26-36 Nm (19-27 lb-ft) for Ranger and 13-17 Nm (10-13 lb-ft) for Aerostar.
	• Intermediate shaft connecting bolts loose.	• CHECK bolts for damage and REPLACE if required. If bolts are not damaged, TIGHTEN bolts to 41-57 Nm (31-42 lb-ft).
	• Steering gear mounting bolts loose (Ranger).	• CHECK bolts for damage and REPLACE if required. If bolts are not damaged, TIGHTEN bolts to 68-84 Nm (50-62 lb-ft).
	• Intermediate shaft rubbing against steering column (Ranger).	• REMOVE intermediate shaft from steering column. PULL steering shaft out from column 6mm (1/4 inch). REATTACH lower steering column shaft.

FORD INTEGRAL AND POWER RACK AND PINION STEERING GEAR

Condition	Possible Source	Action
• Hissing Sound	• Hiss may be expected when the steering wheel is at the end of travel or when turning at standstill.	• Hiss is a normal characteristic of rotary steering gears and in no way affects steering. DO NOT REPLACE the power steering gear input shaft and control valve assembly unless the hiss is extremely objectionable. A replacement valve will also exhibit a slight noise and will not always correct the condition. INVESTIGATE for a grounded steering column tube or a loose steering column opening weather seal at the dash panel. Any metal to metal contact will transmit valve hiss into the

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		passenger compartment through the steering column. VERIFY clearance between steering column intermediate shaft coupling components. Be sure steering column intermediate shaft coupling and steering gear are aligned so steering column intermediate shaft coupling rotates in a flat plane and is not distorted as lower steering column shaft rotates.
• Grunt in 4WD only.	• Grunt expected when the steering wheel is turning during parking maneuvers.	• Grunt in 4WD is a characteristic of the routing of the hoses. DO NOT REPLACE the steering gear as it will not eliminate the grunt.

POWER STEERING PUMP AND DRIVE BELT NOISE

Condition	Possible Source	Action
• Power Steering Drive Belt Squealing	• Check drive belt for proper tension or glazing.	• TIGHTEN or REPLACE drive belt as required.
• Power Steering Pump Noisy	• Low fluid level and possible leakage.	• REFILL to specified level. PURGE air from system. CHECK for leaks. SERVICE as required.
• Swish-Type Noise	• Fluid flow into the power steering pump valve of the pump valve housing with fluid temperature below 54℃ (130° F).	• Normal noise.
• Whine-Type Noise	• Aerated fluid, or power steering pump rotor cam contour damaged.	• PURGE system of air. If condition not resolved, REPLACE pump assembly.
• Clicking Mechanical-Type Noise	• Pump slippers too long, excessive wear of pumping elements. Excessive slipper to slot clearance, or out of square slipper springs.	• REPLACE power steering pump.
• Chatter-Type Noise	• Chipped corners on rotor outside diameter or distorted slipper spring.	• REPLACE power steering pump.
• Other Cause of Noise	• Improper assembly of components such as slippers.	• REPLACE power steering pump.
	• Imperfections on power steering pump rotor outside diameter or power steering pump rotor end surface.	• REPLACE power steering pump.
	• Damaged power steering pump rotor splines.	• REPLACE power steering pump.
	• Hairline crack on cam inner surface.	• REPLACE power steering pump.
	• Interference between power steering pump rotor and cam.	• REPLACE power steering pump.

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	• Excessively worn or scored pumping elements and power steering pump pressure plates.	• REPLACE power steering pump.
• Power Steering Pump Leaks	• Fluid, power steering pump fluid reservoir filler cap.	• CHECK for indications of false leakage — overfilled power steering fluid reservoir, improperly installed, damaged or lost power steering pump fluid reservoir filler cap.
	• Loose or damaged hose connections.	• REPAIR or REPLACE as required.
	• Leakage between power steering fluid reservoir and power steering pump housing.	• REPAIR or REPLACE as required. REFER to Section 11-02A for power steering pump repair.
	• Leakage at power steering pump rotor shaft oil seal.	• REPLACE power steering pump. REFER to Section 11-02A for power steering pump repair.

STEERING SYSTEM PROBLEMS

Condition	Possible Source	Action
• Steering Very Difficult/Very Easy.	• Restricted hoses. • Power steering pump. • Steering gear. • Ball joints.	• Go to Pinpoint Test A .
• Steering Wheel Off-Center (Clear Vision)	• Incorrect toe setting. (Steering wheel is positively aligned to steering shaft. Position is not adjustable.)	• REFER to Section 04-00 for adjustment procedure.
• Pulls or Drifts to One Side	• Insufficient tire pressure.	• ADJUST tire pressure.
	• Improperly adjusted wheel alignment.	• ADJUST wheel alignment.
	• Tire conicity.	• ROTATE tires. If wander or pull moves with worn tires, REPLACE tires.
	Power Steering Only • Steering gear valve binding or out of balance.	• REPLACE steering gear.
• Wanders Side to Side — Loose Steering	• Insufficient tire pressure.	• ADJUST tire pressure.
	• Improperly adjusted wheel alignment.	• ADJUST wheel alignment.
	• Flexible coupling damaged or worn	• REPLACE as required. REFER to Section 11-04A for steering

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	(Ranger).	column repair.
	• Steering column intermediate shaft bolts.	• CHECK bolts for damage and REPLACE if required. If not damaged, TIGHTEN to 41-57 Nm (30-42 lb-ft).
	• Column intermediate shaft joints loose or worn.	• REPLACE lower steering column shaft. REFER to Section 11-04B , Aerostar or Section 11-04A , Ranger for steering column repair.
	• Steering gear meshload adjustments (Ranger).	• ADJUST to specification. REFER to Section 11-02B for adjustments.
	• Steering gear loose on frame.	• CHECK mounting bolts for damage and REPLACE if required. If no damage is found, TIGHTEN bolts to 108-142 Nm (80-105 lb-ft) for Aerostar 4x2, 83-111 Nm (61-82 lb-ft) for Aerostar E4WD, 68-84 Nm (50-62 lb-ft) for Ranger.
	• Incorrect meshload (Ranger).	• SET meshload to specification. REFER to Meshload in the Adjustments portion of Section 11-02B .
	• Loose race locknut (Ranger).	• CHECK race locknut for damage and REPLACE as required. If no damage is found, TIGHTEN nut to 75-122 Nm (55-90 lb-ft).
	• Insufficient worm thrust bearing preload (Ranger).	• REPLACE valve assembly. REFER to Steering Gear in the Disassembly and Assembly portion of Section 11-02B .
	• Damaged sector shaft bearing (gear might also exhibit external leakage from sector seal) (Ranger).	• REPLACE gear housing assembly. REFER to Steering Gear Housing in the Disassembly and Assembly portion of Section 11-02B .
	• Center lash (Ranger).	• Improper fit or worm to piston. REPLACE valve assembly (be certain to CHECK meshload prior to replacing valve for center lash).
• Heavy Steering Effort — Poor or Loss of Assist During Turns and Parking	• Steering wheel-to-column shroud interference.	• REMOVE interference.
	• Misaligned lower steering column shaft (if so equipped) to steering gear interference.	• ALIGN or ADJUST as required. REFER to Section 11-04A for Ranger flex coupling alignment procedures.

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		• Steering column alignment.	• ALIGN or ADJUST as required. REFER to Section 11-04B , Aerostar or Section 11-04A , Ranger for column alignment procedures.
		• Bent or damaged rack (Aerostar).	• REPLACE steering gear. REFER to Section 11-02C .
		• Leakage or loss of fluid.	• REFER to External Leak Diagnosis in this section for repair.
		• Low power steering pump fluid.	• FILL as necessary.
		• Contaminated fluid, incorrect fluid.	• REPLACE with correctly specified fluid.
		• Air in power steering system.	• ADD fluid, TIGHTEN connections and BLEED system. REFER to Air Bleeding in this section for repair.
		• Glazing or improper drive belt tension.	• TIGHTEN or REPLACE drive belt as required. REFER to Section 03-05 in the Powertrain, Drivetrain Manual for belt service.
		• Hose or cooler line restrictions.	• CLEAR or REPLACE as required.
		• Improper engine idle speed.	• READJUST idle speed.
		• Power steering pump pulley loose or warped.	• REPLACE power steering pump pulley. REFER to Section 11-02A for replacement procedures.
		• Loose rack piston (Aerostar).	• REPLACE steering gear. REFER to Section 11-02C for Aerostar steering gear repair.
		• Low steering system fluid fill.	• ADD steering fluid to proper level.
		• Engine idle too low.	• SET engine idle to specification. REFER to the Powertrain Control/Emissions Diagnosis Manual.
		• Loose drive belt tension.	• CHECK drive belt tension and SET to specification. REFER to Section 03-05 for tightening procedure.
		• Power steering pump flow/relief pressure not to specification.	• TEST power steering pump and SERVICE as necessary. REFER to Pump Flow and Pressure Tests in this section for power steering pump testing procedures.
		• External leakage	• REFER to Pump Flow and

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	giving low fluid level.	Pressure Tests in this section.
	• Piston Teflon® seal cut or twisted (Ranger).	• REPLACE piston Teflon® seal. REFER to Piston in the Disassembly and Assembly portion of Section 11-02B.
	• Loose/missing rubber backup piston rack seal (Ranger).	• REPLACE/INSTALL rubber backup rack seal. REFER to Piston in the Disassembly and Assembly portion of Section 11-02B.
	• Valve/steering gear housing oil passages blocked (Ranger).	• REPLACE steering gear input worm gear and rack as required. REFER to Disassembly and Assembly procedures in Section 11-02B.
• Heavy Steering Effort — Poor or Loss of Assist During Turns and Parking (Continued)	• Leakage past piston end cap (Ranger).	• CHECK piston end cap for damage. If no damage is found, TIGHTEN piston end cap to 95-149 Nm (70-110 lb-ft). If damage is found, REPLACE valve assembly. REFER to the Disassembly and Assembly portion of Section 11-02B.
	• Porosity in the piston bore (housing casting).	• REPLACE steering gear housing. REFER to Section 11-02B, Ranger or Section 11-02C, Aerostar.
	• Porosity in piston (Ranger).	• REPLACE valve assembly. REFER to Valve Housing in the Disassembly and Assembly portion of Section 11-02B.
	• Valve sleeve Teflon® seal(s) damaged (Ranger).	• REPLACE valve sleeve Teflon® seal(s). REFER to Worm and Valve Sleeve in the Disassembly and Assembly portion of Section 11-02B.
	• Bent or damaged rack assembly (Aerostar).	• REPLACE steering gear. REFER to Section 11-02C.
• Returnability Poor	• Column bearing damaged.	• REPLACE bearing. REFER to Section 11-04B, Aerostar or Section 11-04A, Ranger for service procedures.
	• Binding steering linkage.	• REFER to Section 11-03 for Ranger.
	• Steering gear adjustment (Ranger).	• ADJUST to specification. REFER to Section 11-02B for power steering gear adjustments.
	• Kinked power steering pressure hose or tube.	• INSPECT and REPAIR or REPLACE as required.
	• Obstruction within steering gear or lines	• INSPECT, REMOVE obstructions and REPAIR or

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	(Ranger). • Bent or damaged rack (Aerostar). • Binding in the valve assembly (Ranger). • Steering gear meshload too high (Ranger). • Contamination in system. • Wheel alignment.	REPLACE as required. • REPLACE steering gear. REFER to Section 11-02C . • REPLACE power steering gear input shaft and control of valve assembly. REFER to Section 11-02B for steering gear repair procedures. • REPAIR gear assembly as required. REFER to Section 11-02B for steering gear repair procedures. • FLUSH power steering system. • Refer to Section 04-00 .
• Rough, Lumpy or Binding Steering — Sticky or Catchy Feel While Turning	• Steering gear adjustments set too high. • Rack and pinion teeth or bearings damaged due to high impact loads (Aerostar).	• ADJUST as required. REFER to Section 11-02B , Ranger for adjustment procedures. • REPLACE complete gear assembly. REFER to Section 11-02C , Aerostar for replacement procedures.
• Pointing, Darting, Sticky Steering — Road Feel Is Not Smooth, Cannot Make Minor Corrections with Ease	• Steering gear adjustment set too high (Ranger). • Steering column shaft sticky. • Binding steering linkage, tie rods and ends. • Lower steering column shaft binding because of worn out steering column intermediate shaft coupling.	• ADJUST as required. REFER to Section 11-02B , Ranger for adjustment procedures. • DISCONNECT lower steering column shaft and VERIFY free rotation of the steering column. REPAIR as required. REFER to Section 11-04B , Aerostar or Section 11-04A , Ranger for repair procedures. • REPLACE as required. REFER to Section 11-02B , Ranger or Section 11-02C for Aerostar. • REPLACE lower steering column shaft steering column intermediate shaft coupling. REFER to Section 11-04B , Aerostar or Section 11-04A , Ranger for repair procedures.
• Shimmy — A Consistent Side-to-Side Wobble in the Steering Wheel and Road Wheels. Usually Felt at Speeds over 64 km/h (40 mph) and	**Power Steering Only**	

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Amplified When Driven over Pot Holes or Bumps		
	• Rack and pinion insulators worn.	• REPLACE as required. REFER to Section 11-02C for gear insulator replacement procedures.
	• Steering gear mounting bolts loose.	• CHECK bolts for damage and REPLACE as required. If not damaged, TIGHTEN to the following specifications: 108-142 Nm (80-105 lb-ft) Aerostar 4x2 models; 83-111 Nm (61-82 lb-ft) Aerostar E4WD models; 68-84 Nm (50-62 lb-ft) Ranger.
	• Improperly adjusted wheel alignment.	• ADJUST wheel alignment.
• External Leakage	• Loose hose fittings.	• CHECK hose fittings for damage and REPLACE as required. If no damage is found, TIGHTEN fittings to specification. REFER to Specifications portion of Section 11-02B, Ranger and Section 11-02C, Aerostar for torque specification.
	• Missing/damaged hose fitting tube seats (Ranger).	• INSTALL/REPLACE tube seats. REFER to Valve Housing in the Disassembly and Assembly portion of Section 11-02B.
	• Seal leak from power steering gear input shaft and control.	• CHECK shaft for damage. CHECK housing bore for porosity or damage. REPLACE steering gear if necessary.
	• Leak at valve mounting face (Ranger).	• CHECK bolts for proper torque. REPLACE valve housing O-ring (s). REFER to Valve Housing in the Disassembly and Assembly portion of Section 11-02B.
	• Leak at sector shaft adjuster screw locknut (Ranger).	• CHECK locknut for damage and REPLACE as required. If no damage is found, TIGHTEN locknuts to 48-61 Nm (35-45 lb-ft).
	• Seal leak at steering gear sector shaft (Ranger).	• REPLACE seals of steering gear sector shaft and EXAMINE steering gear sector shaft for pitting or corrosion. REPLACE steering gear sector shaft if necessary. CHECK housing seal bore for porosity or damage. REPLACE housing if necessary.
	• Leak from steering gear.	• REPLACE steering gear. REFER to Steering Gear Housing in the

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	• Leak at steering gear sector shaft housing cover, or cracked steering gear sector shaft housing cover (Ranger).	Disassembly and Assembly portion of Section 11-02B , Ranger and Section 11-02C , Aerostar. • CHECK bolt torques. CHECK O-ring seal and system relief pressure.

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Pinpoint Tests

PINPOINT TEST A: STEERING VERY DIFFICULT/VERY EASY

A1 FLOW RATE AND PRESSURE CHECK

- Remove the pressure fitting from the power steering pump and connect it into the appropriate adapter of the analyzer.
- Thread the other adapter of the analyzer into the power steering pump.

  NOTE: The analyzer may be connected at any accessible point between the power steering pump and the steering gear on the pressure side.

- Connect the analyzer to the adapters and tighten both to 20 Nm (15 lb-ft).
- Add power steering fluid to the power steering pump as required.
- Start engine and run at idle for approximately 2 minutes.
- Record the flow and pressure at 74-79°C (165-175°F).

Is the pressure above 1034 kPa (150 psi)?

Yes	No
CHECK for restricted hoses or restricted gear passages. REPAIR or REPLACE as required.	GO to **A2** .

A2 FLOW RATE CHECK, POWER STEERING PUMP VALVE PARTIALLY CLOSED

- Partially close the power steering pump valve and allow the pressure to build to 5100 kPa (740 psi). Record the flow at 74-79°C (165-175°F).

Is the flow rate below specifications?

Yes	No
REPLACE power steering pump. REFER to Section 11-02A .	GO to **A3** .

A3 PRESSURE CHECK, POWER STEERING PUMP VALVE OPENED AND CLOSED

NOTE: Do not allow the power steering pump valve to remain closed for more than 5 seconds.

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- Completely close and partially open the power steering pump valve three times.
- Record the pressure when the power steering pump valve is closed.

Is pressure within specifications?

Yes	No
GO to **A4** .	REPLACE power steering pump.

A4 FLOW RATE CHECK, ENGINE RUNNING AT 1500 RPM

- Increase engine speed to 1500 rpm.
- Record free flow rate.

Is the flow rate greater than the maximum free flow specified in the chart?

Yes	No
REPAIR or REPLACE the flow control power steering pump valve as required.	GO to **A5** .

A5 PRESSURE AND FLOW RATE CHECK, STEERING WHEEL TURNED FROM STOP TO STOP

- Turn the steering wheel from the left stop to the right stop.

  NOTE: Do not hold against stop for more than 5 seconds.

- Record the pressure and the flow rate while holding the steering wheel hard against the stops.

Is the recorded pressure at both stops approximately the same as the pressure recorded in Step A3 and does the flow rate drop below 0.5 gallons/min?

Yes	No
GO to **A6** .	Excessive internal leakage in steering gear. REPAIR or REPLACE steering gear.

A6 BACK PRESSURE CHECK

- Turn steering wheel slightly in both directions and release quickly while observing the pressure gauge.

Does the needle move from the normal back pressure reading and snap back as the steering wheel is released?

Yes	No
System is OK.	CHECK ball joints. CHECK the column for free rotation before disassembling the steering gear.

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	REPLACE as required.

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Preliminary Procedures

Make the following preliminary checks before servicing the steering system. If hoses are to be disconnected, label them prior to removal so they can be easily identified for reassembly.

Air Bleeding

Verify the power steering pump (3A674) has been filled as instructed above. Run the engine until it reaches normal operating temperature. Turn the steering wheel (3600) to the left and right several times without hitting the stops. Recheck the fluid level and if any air bubbles are present, refer to Service Procedures, Purging Power Steering System of Air in this section.

Fluid Level

The fluid level can be checked either hot or cold, but use the appropriate mark on the dipstick. Check for bubbles in the fluid when taking a fluid level reading. If bubbles are evident, refer to Service Procedures, Purging Power Steering System of Air in this section. If a low level is indicated on the dipstick, add MERCON® Power Steering Fluid.

Pump Belt

NOTE: Drive belt tension adjust is not required on vehicles with drive belt tensioner (6B209).

Check the tension of the belt. Refer to Section 03-05 for belt tension check and belt removal and installation, if necessary.

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External Leakage

When looking for leaks, use the following procedure to pinpoint the exact cause and location to avoid misdiagnosis:

1. Check for overfill condition.
2. Wipe the suspected area dry.
3. Check for fluid overflow and aeration.
4. Check for exact source of leak. For example, oil may be running down from another area (engine (6007), etc.) and the drip may not be the leak point.
5. **CAUTION: Do not hold the steering wheel (3600) against a stop for more than three to five seconds at a time. Cycle the steering wheel from stop to stop ten times and check for leaks. The bellows may have to be moved back from the steering gear housing (3548) to observe the leak.**

   With the engine idling, turn the steering wheel from left to right several times. Check all possible leakage points. Some leaks are high pressure leaks and may require holding the steering wheel against the stops for fluid to seep out.
6. Tighten all loose fittings to specifications. Replace damaged lines and seals.
7. Check hoses for cut O-rings.
8. Refer to the following component areas for detailed leakage checks.

   The numbered parts in the following illustration correspond to the numbered categories in the External Leak Checks Chart.

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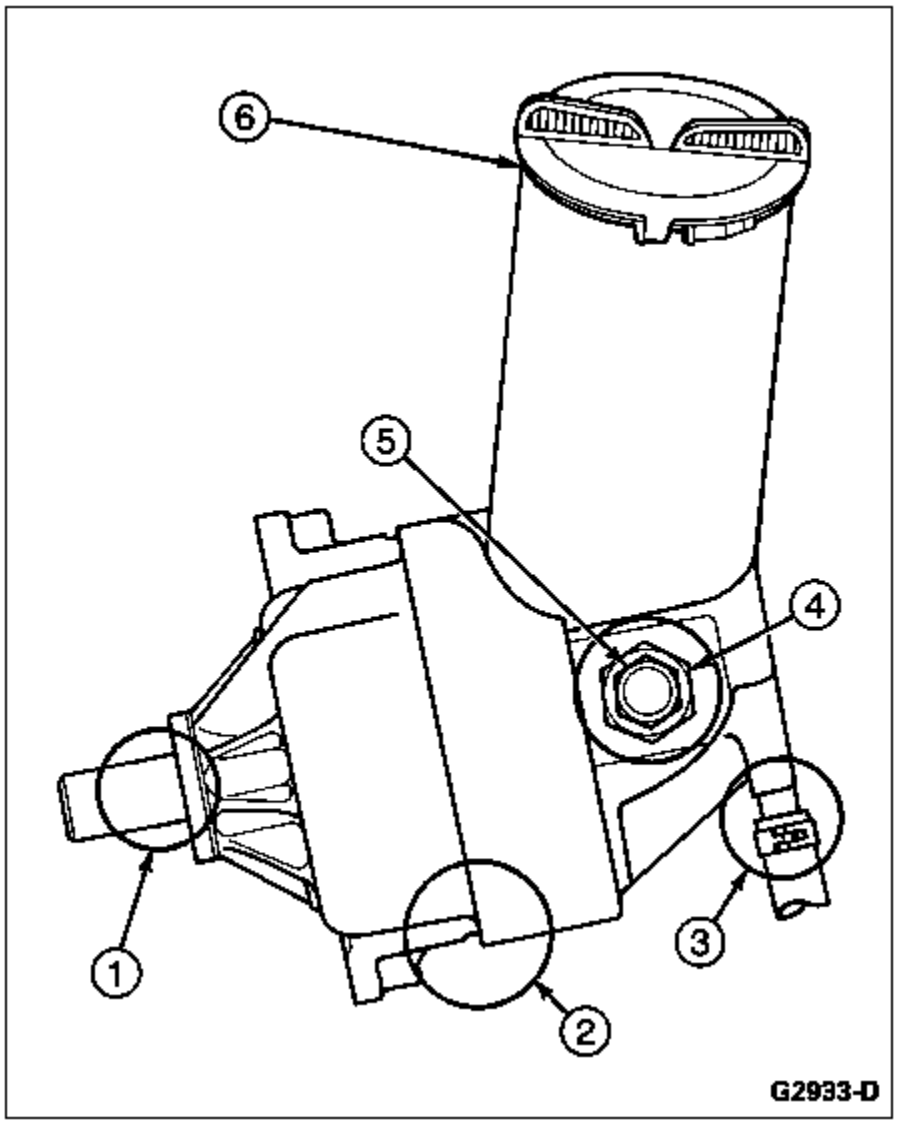

EXTERNAL LEAK CHECKS

Leak Category	Parts Required for Service
1. Power steering pump rotor shaft oil seal	• Replace power steering pump assembly.
2. Reservoir O-ring seal (Part of 3A674)	• Replace pump assembly.
3. Power steering return hose	• Reposition or replace return hose clamp.
4. Power steering fluid reservoir	• Tighten power steering pump assembly. ▪ replace O-ring seal ▪ check for damaged threads (cross-threaded) • Replace power steering pump assembly. ▪ housing cover threads are stripped; replace power steering pump housing
5. Power steering pressure, return and pump outlet line	• Tighten power steering pressure hose tube nut to 41-54 Nm (31-40 lb-ft).

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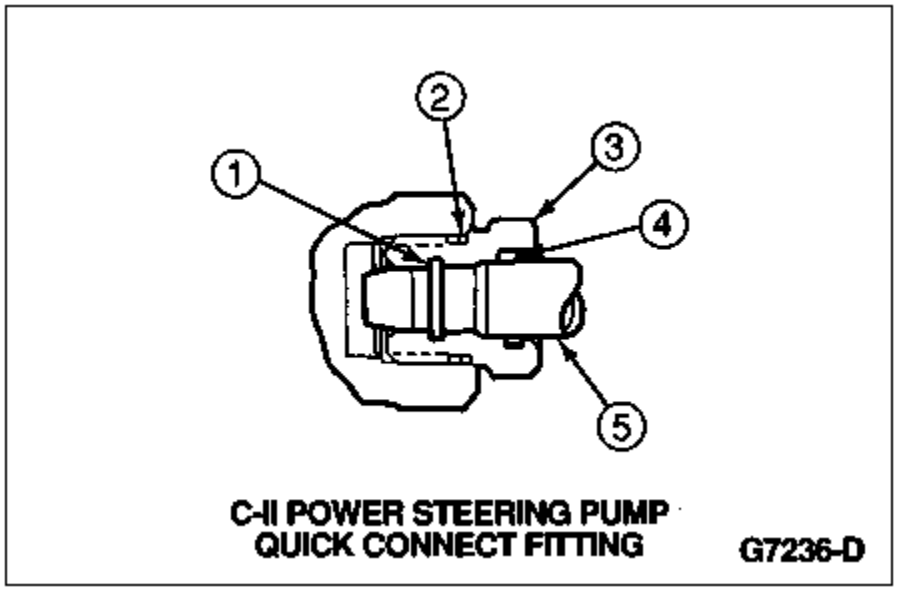
connector kit	• If leak continues, remove tube nut and: ▪ inspect Teflon® washer ▪ replace Teflon® washer **Note:** A tapered shaft may be required to stretch washer prior to installation on the tube nut, so it may be slipped over the nut threads. • Replace power steering pressure hose assembly if leak is caused by O-ring.
6. Power steering pump fluid reservoir filler cap	• Check for damaged or missing reservoir cap or power steering pump reservoir fluid level indicator. • Check fluid level; correct as required. • If leak continues, replace filler cap.



Item	Part Number	Description
1	—	Snap Ring (Part of 3A713)
2	—	Plastic Washer (Part of 3A713)
3	—	Tube Nut (Part of 3A713)
4	—	O-Ring (Part of 3A713)
5	3A713	Power Steering Return Hose

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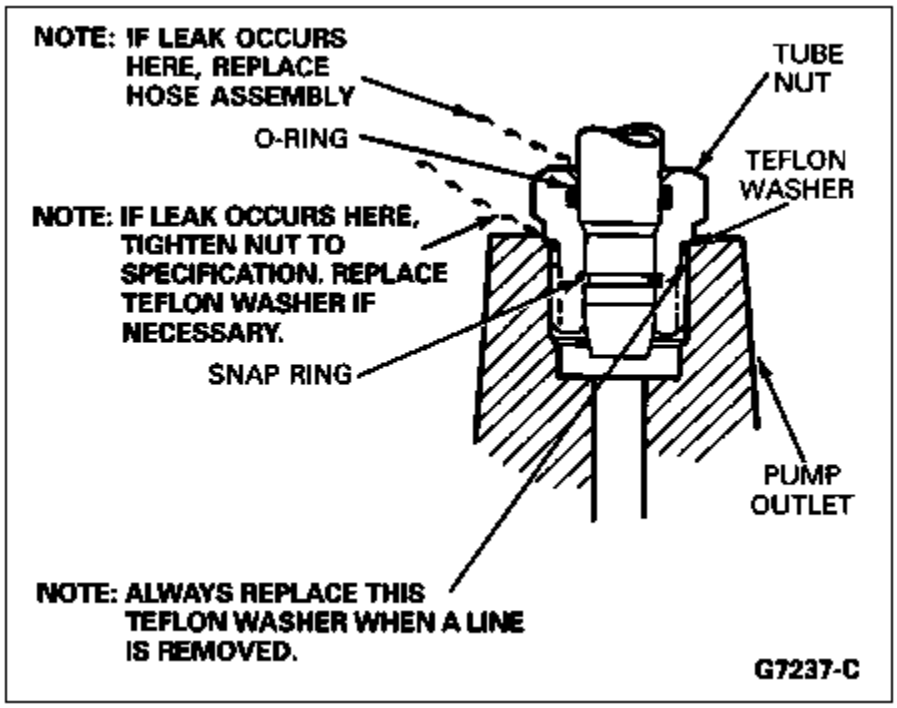

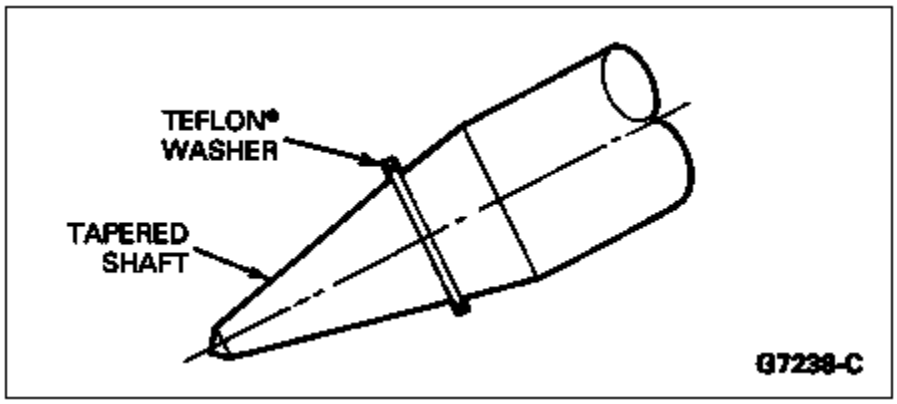

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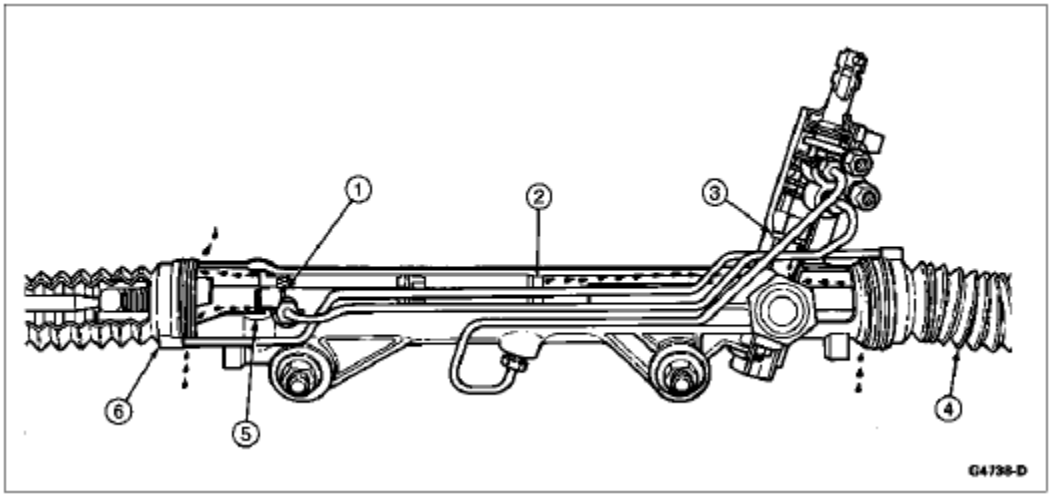
External Leakage — Leak Inspection, Ford Rack and Pinion Power Steering Gear, Aerostar

If the pinion seal leaks, it will show up as a bellows leak.

Steering Gear Bellows Leak Points, Aerostar



Item	Part Number	Description
1	—	Outer Rack Seal (Part of 3E501)
2	—	Inner Rack Seal (Part of 3E501)
3	—	Pinion Seal (Part of 3E501)
4	—	Left Bellows (Part of 3E501)
5	—	Leak Category 4
6	—	Right Bellows (Part of 3332)

LEAK INSPECTION

Leak Category	Part Required for Service
1. Line fittings	• Loose. Tighten to 27-34 Nm (20-25 lb-ft). Do not overtighten. • Plastic seals at tube nut. Plastic seals should be replaced each time hose is disconnected. • Replace power steering return hose or power steering pressure hose as required.
2. Leak at (right or left) transfer line	• Loose. Tighten to 20-34 Nm (15-25 lb-ft). Do not overtighten. • Replace O-ring seals.

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	• Replace line assembly as required.
3. Leak at power steering gear input shaft seal (Aerostar only)	• Replace power steering gear input shaft seal.
4. Leak at either or both bellows (Aerostar only)	• Replace steering gear.
5. Leak at end of power steering gear input shaft and control (Aerostar only)	• Replace steering gear.
6. Steering gear — porosity, cracked or stripped threads (Aerostar only)	• Replace the steering gear housing.

Note: Whenever a gear assembly is disassembled for seal replacement, the gear seal contact surfaces should be checked for roughness and cleaned. Replace components such as input shaft/valve assembly or rack assembly only if the sealing surfaces cannot be cleaned satisfactorily with crocus cloth.

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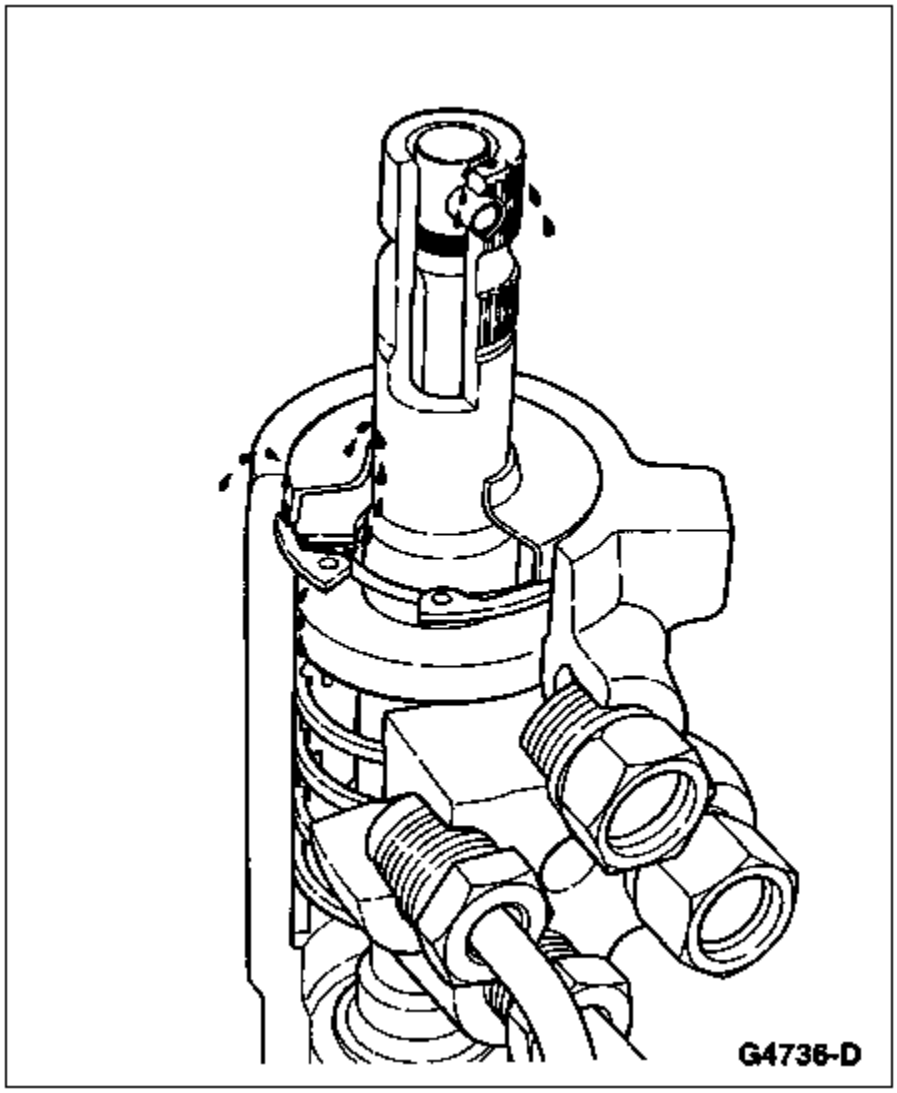
External Leakage — Leak Points, Power Steering Input Shaft and Control Valve Assembly, Aerostar



Since most fluid leaks occur at the fittings and connections in a power steering hydraulic system, these parts should be checked before steering gear (3504) is replaced. Leakage at any of the areas shown in the illustration requires steering gear replacement.

1. Clean the outside of the steering gear, the bottom surfaces of the power steering pump (3A674), all lines and fittings. Be sure all dirt, oil, and grease is removed from areas where leaks may exist.

2. Tighten all fittings, using a flare-nut wrench. **Do not tighten the fittings with a standard open-end wrench.** If a properly tightened fitting leaks, replace the tube seat.

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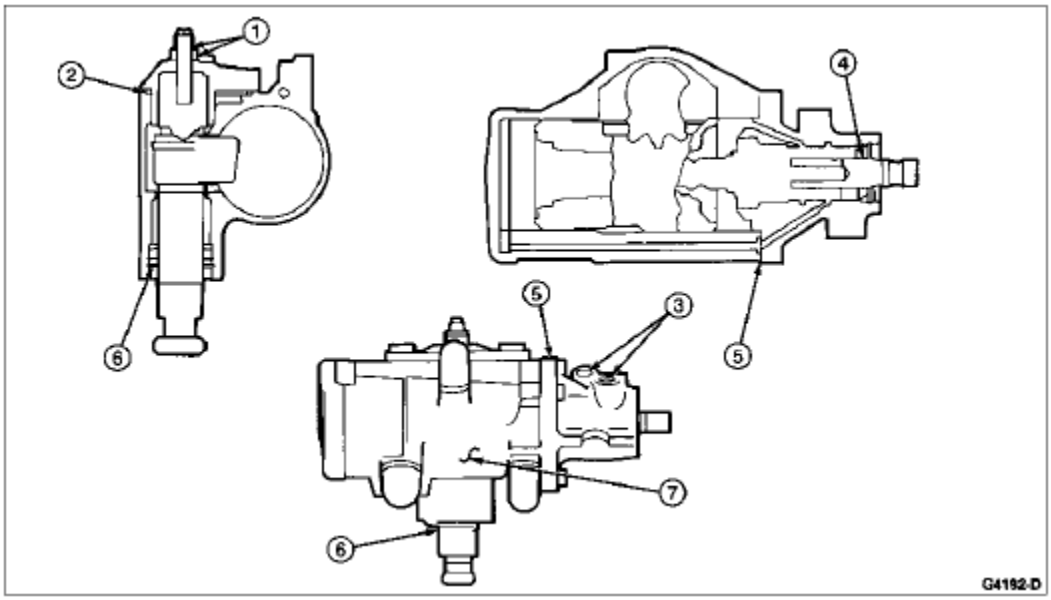
External Leakage — Leak Inspection, Power Steering Gear, Ranger

1. With the vehicle engine (6007) off, wipe the complete power system dry (steering gear (3504), power steering pump (3A674), hoses and connections).
2. Check oil level in pump power steering fluid reservoir and adjust as directed in this section.
3. Start the engine and turn the steering wheel (3600) from stop to stop several times. **Do not hold the steering wheel against the stops as damage to the power steering pump could result.**
4. Determine the exact source of leakage by carefully observing the leakage areas, as shown in the following illustration.

Power Steering Gear Leak Inspection, Ranger



POWER STEERING GEAR LEAK INSPECTION, RANGER

Leak Category	Part Required for Service
1. Sector shaft adjuster screw lock nut (Part of 3575)	• Tighten locknut to 48-61 Nm (35-45 lb-ft). Replace nut if leakage continues. Check the cover surface for damage.
2. Steering gear housing end cover	• Tighten bolts to 75-94 Nm (50-70 lb-ft). Replace steering gear sector shaft seal. Examine steering gear sector shaft seal for damage when replacing steering gear sector shaft seal.
3. Hose fittings (Part of 3548)	• Tighten fitting nuts to 30-40 Nm (22-30 lb-ft). If leakage continues, remove hose and clean interface area. If tube nut threads are

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	damaged, replace hose. If tube seats are damaged, replace tube seat. If housing threads are badly stripped, replace the valve housing only.
4. Power steering gear input shaft seals	• Replace power steering gear input shaft seals and snap ring. Check power steering gear input shaft and control surface for damage. Check steering gear housing seal bore for damage.
5. Control valve housing mounting face (Part of 3548)	• Tighten control valve housing bolts to 42-62 Nm (30-45 lb-ft). If leak continues, replace O-ring. Examine sealing surface for damage.
6. Steering gear sector shaft seal and snap ring	• Replace steering gear sector shaft seal. Check seal bore, steering gear sector shaft, and snap ring groove for damage. Check sector housing roller bearing for damage.
7. Steering gear housing	• Replace steering gear housing.

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External Leakage — Leak Check, Manual Steering Gear, Ranger

1. With the engine (6007) off, wipe the steering gear (3504) clean.

2. **WARNING: WHEN USING A JACK TO LIFT THE VEHICLE, ALWAYS SUPPORT THE VEHICLE PROPERLY USING JACKSTANDS.**

   NOTE: To ease the turning effort of the steering wheel (3600), lift the front of the vehicle just enough to raise the front tires off the ground.

   Turn the steering wheel from stop to stop several times.

3. Check the sector shaft seal and steering gear input shaft seal for leakage. Also check the sector cover area, the steering gear worm thrust bearing adjuster (3A670) and the steering gear housing (3548) of the steering gear for signs of steering gear grease leakage.

4. If leakage is observed, replace the seals.

5. If leakage is observed at the steering gear housing end cover (3568), tighten the bolts to specification. If leakage still occurs at the steering gear housing end cover, replace the steering gear housing end cover. Refer to Section 11-01 for replacement procedures.

6. If leakage occurs at the steering gear worm thrust bearing adjuster, check the plug for cracks. Refer to Section 11-01 for service.

7. If the steering gear housing leaks, it must be replaced. Refer to Section 11-01 for replacement procedures.

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Pump Flow and Pressure Tests

The flow and pressure tests will measure system component performance. Follow the steps below.

Prior to performing the Pump Flow and Pressure Test, the following checks for conditions which could cause loss of power assist must be performed and corrective action taken if necessary.

1. Check power steering fluid reservoir for proper fluid level and contamination.
2. Check tires for correct air pressure.
3. Check drive belt (8620) for proper tension.
4. Check power steering pump (3A674) for correct model and vehicle application.
5. Check part number for correct power steering pump pulley (3A733) on power steering pump and steering gear (3504).
6. Visually check entire system for damage, replacing parts as necessary.

If the above items are to specifications, or have been corrected, and the loss of assist still exists, test the power steering pump flow and pressure to determine whether the trouble is in the power steering pump, steering gear, or control valve using the following test equipment.

Test Equipment

1. Engine tachometer.
2. Thermometer — 17° to 140° C (0° to 300° F).
3. **CAUTION: Possible contamination of the power steering system fluid may cause permanent damage to gauges and instruments incorporated in the analyzer.**

   Power Steering Analyzer D79L-33610-A or equivalent.
4. One set of adapter fittings.

Test Procedure

The following test procedure used in conjunction with the Power Steering Analyzer D79L-33610-A or Rotunda Power Steering Analyzer 014-00207 or equivalent provides a method for checking the complete power steering system. The Power Steering Analyzer can be used to determine the cause of hard steering and/or lack of assist problems. The analyzer provides readouts for the following:

1. System back pressure.

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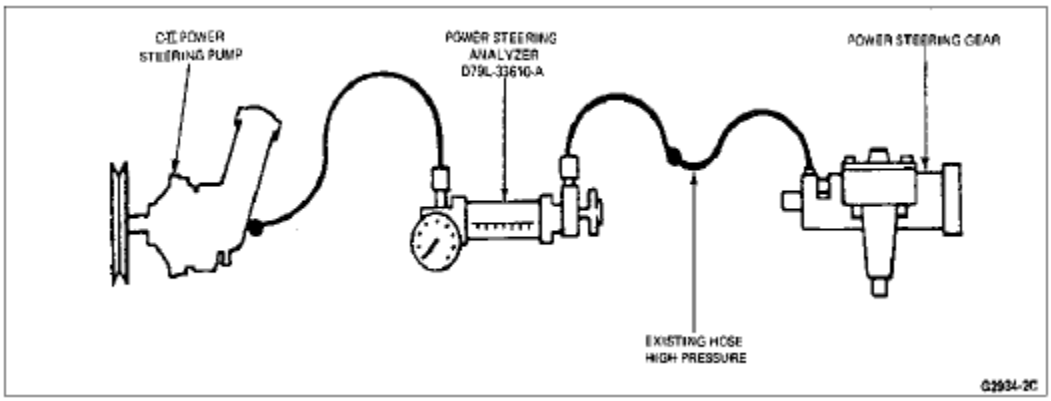
2. Pump flow.
3. Power steering control valve and cylinder internal leakage.

The interpretation of the above readouts will determine which of the following conditions or components are the cause of the problem:

4. Restriction in hoses or fittings.
5. Power steering gear input shaft and control valve and cylinder.
6. Sticking power steering gear input shaft and control valve.
7. Inefficient power steering pump rotor (3D607) and cam pack.
8. Sticking relief valve.
9. Binding in suspension.

Power Steering Analyzer Hookup, Typical Installation



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Tie Rod Articulation Torque

1. **NOTE: The articulation effort may be checked with the steering gear (3504) removed or installed in the vehicle. Refer to the appropriate steps.**

   Disconnect the tie rod end (3A130) from the front wheel spindle (3105) as described under Steering Gear in the Removal and Installation portion of the appropriate Group 11 Section.

2. **CAUTION: When replacing tie rod ends, make sure the new tie rod end is adjusted to the same length as the original tie rod end.**

   Check tie rod ends for looseness and replace as necessary.

3. Connect the tie rod ends to the front wheel spindles as described under Steering Gear in the appropriate Group 11 Section. Check and adjust toe as described in Section 04-00 .

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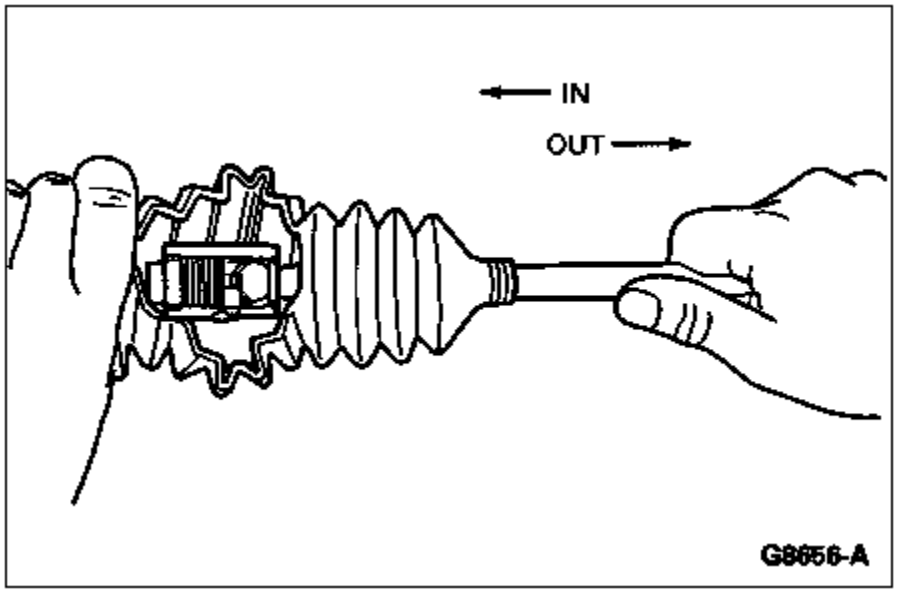
Front Wheel Spindle Connecting Rod or End

1. If tie rod end (3A130) is worn or exhibits excessive lash or axial free play, the following symptoms may occur:

    a. Clunk or rattle noise in front end during deceleration.
    b. Front tire wear.
    c. Inability of consistent alignment setting by service.
    d. Lack of center feel.
    e. Vehicle wander.

2. Replace both tie rod ends if one tie rod end is worn.

Inner Tie Rod Lash Check



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Purging Power Steering System of Air

1. Tightly insert the rubber stopper of the air evacuator assembly into power steering fluid reservoir.
2. Start the engine.
3. Apply 68-85 kPa (20-25 in-Hg) maximum vacuum for minimum of three minutes at idle; maintain maximum vacuum with vacuum source. Refer to the illustration.
4. Release vacuum and remove vacuum source.
5. Turn the engine off.
6. Add fluid to FULL WARM or power steering oil reservoir (3A697) center mark.
7. Reinstall vacuum source and apply 68-85 kPa (20-25 in-Hg) vacuum.
8. Start the engine engine (6007)
9. **NOTE: Do not hold steering wheel on stops.**

   Cycle steering wheel (3600) from lock to lock every 30 seconds for approximately 5 minutes.
10. Turn engine off, release vacuum and remove vacuum source.
11. Add fluid if necessary and install dipstick or reservoir cap.
12. **NOTE: Do not hold steering wheel on stops.**

    Start engine and cycle steering wheel from lock to lock every 30 seconds for approximately 5 minutes.
13. **NOTE: In severe cases, it may be necessary to repeat air purge with vacuum source procedure.**

    Check for oil leaks at all connections.

Purging Power Steering System of Air

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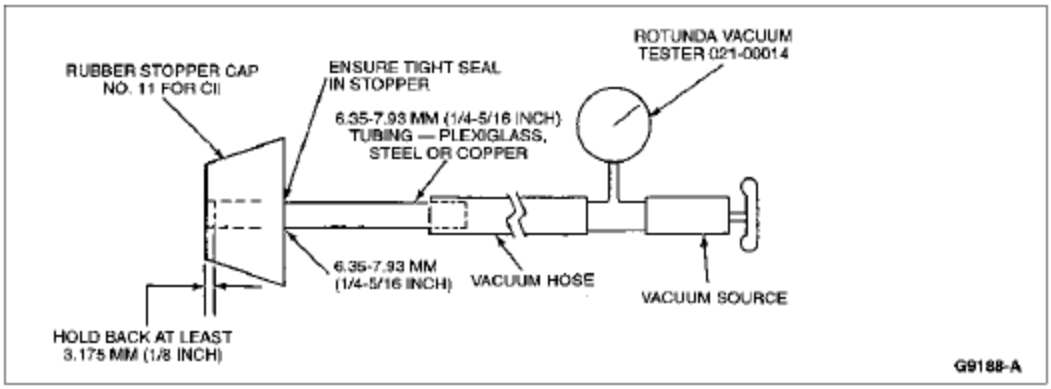

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Start-Up Procedure After Power Steering Pump or Gear Service

Upon initial engine start-up after a power steering pump or gear overhaul (particularly the pump), there is very frequently much noise and aeration. This is due to air trapped in the overhauled unit which mixes with the surging fluid and causes aeration. The problem can be minimized if the following procedure is used.

1. Disconnect ignition control module (ICM) (12A199) connector to prevent engine (6007) from starting.

2. Fill the power steering oil reservoir (3A697).

3. Crank the engine with the starter motor (11001) and continue adding fluid until the level remains constant. Be careful to avoid prolonged cranking as the battery (10653) may be drained and the starter motor damaged.

4. Rotate the steering wheel (3600) approximately 30 degrees each side of center while continuing to crank the engine.

5. Recheck the fluid level and fill as required.

6. Reconnect the ICM connector.

7. To clear diagnostic trouble codes, disconnect battery for one minute and then reconnect battery.

8. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 mi) or more to relearn the strategy.**

   Start the engine and allow it to run for several minutes. Rotate the steering wheel from stop to stop.

9. Shut off the engine and recheck the fluid level. Add as required.

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Pump, Power Steering

Flushing

When contamination is noted while overhauling the steering gear (3504), it will be necessary to flush the power steering pump (3A674).

1. Leave all hoses connected, except the power steering pressure hose (3A719) at the steering gear.
2. Place the power steering pressure hose in a suitable container.
3. Fill the power steering oil reservoir (3A697) with MERCON® Power Steering Fluid.
4. Disconnect the ICM connector to prevent the engine from starting.
5. While approximately two quarts of the power steering gear fluid are being poured into the power steering fluid reservoir, engage the starter motor (11001).
6. As soon as all the fluid has been poured in, turn off the ignition switch (11572).
7. Attach the power steering pressure hose at the steering gear.
8. Check the fluid level.
9. Crank the engine (6007) with the starter motor and continue adding fluid until the level remains constant. Connect the ICM connector.
10. Start the engine and cycle the steering wheel (3600) from stop to stop to expel any air from the system.

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Steering Gear

Flushing

Flushing the steering gear (3504) is required when installing a repaired power steering pump (3A674).

1. Remove the power steering pump and remove the power steering pump rotor (3D607) as outlined in Section 11-02A .

2. Install the power steering pump rotor on the repaired power steering pump. Install the power steering pump and connect only the power steering pressure hose (3A719) to the power steering pump.

3. Place the power steering return hose (3A713) from the steering gear in a suitable container and plug the power steering fluid reservoir return tube.

4. Fill the power steering fluid reservoir with MERCON® Power Steering Fluid.

5. Disconnect the ICM connector to prevent the engine (6007) from starting and raise the front wheels (1007) off the ground.

6. While approximately two quarts of steering gear fluid are being poured into the reservoir, crank the engine using the ignition switch (11572). At the same time, cycle the steering wheel (3600) from stop to stop. Do not hold the steering wheel against a stop for more than three to five seconds at a time.

7. **NOTE: Be careful to avoid excessive cranking as the battery (10655) will be drained and the starter motor (11001) damaged.**

   As soon as all of the fluid has been poured in, turn the ignition switch off and attach the ICM connector.

8. **NOTE: When the battery (10653) is disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 mi) or more to relearn the strategy.**

   To clear fault codes, disconnect the battery for one minute, and then reconnect thebattery.

9. Remove the plug from the power steering oil reservoir return tube, and attach the power steering return hose to the power steering fluid reservoir.

10. Check the power steering fluid reservoir fluid level, add fluid to the proper level.

11. Start the engine and cycle the steering from stop to stop to expel any trapped air from the system.

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Lubrication Schedule, Manual Steering Gear

The steering gear (3504) is factory-filled with steering gear lubricant. Seasonal change of this lubricant should not be performed and the steering gear housing (3548) should not be drained. No additional lubricant is required for the life of the steering gear unless leakage is noted or repairs performed.

Every 50,000 km (30,000 mi), the steering gear should be inspected for seal leakage (actual solid grease, not just oil film). If the seal is replaced or the steering gear is overhauled, the steering gear housing should be refilled. Refer to Section 11-01 for recommended lubricant and fill procedures.

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SPECIFICATIONS

Belt Tension

Tension Codes	New [a] N (Lbs)	Used/Reset [b] N (Lbs)	Allowable Minimum [c] N (Lbs)
4.0L	480-586 (108-132)	480-586 (108-132)	480 (108)
3.0L	444-622 (100-140)	355-444 (80-100)	266 (60)

[a] New installation, no run time.
[b] Used belt, more than 5 minutes of operation.
[c] When checking belt tension or a used belt, the tension must be above the "allowable minimum." If below minimum, it must be reset (adjusted).

Note: The 2.3L and 3.0L engines are equipped with drive belt tensioners that indicate when the drive belt is worn (stretched). A pointer and gauge are built into the drive belt tensioner. When the pointer no longer registers within the range limits of the gauge, the drive belt must be replaced.

Power Steering Pump Specifications

Vehicle Model	Minimum Flow @ 5100 kPa (740 psi)		Minimum Relief Pressure		Maximum Relief Pressure		Maximum Free Flow @ 1500 RPM	
	Liters/ Minute 76℃ (170℉)	Gallons/Minute 76° C (170°F)	kPa	psi	kPa	psi	Liters/ Minute	Gallons/Minute
Aerostar	3.4	.95	8964	1300	10205	1480	9.8	2.6
Ranger	3.4	.95	7240	1050	8480	1230	9.8	2.6
Ranger 3.0L	3.4	.95	8964	1300	10205	1480	9.8	2.6

Note: Flow depends on pump model, engine rpm and pulley drive ratio. Engine idle rpm must be set to specification when checking pump minimum flow capacity.

Power Steering Gear Operational Specifications— Ranger

Description	Specification
Type	Recirc. Ball Torsion Bar
Ratio	17:1
Turns of Steering Wheel (Lock-to-Lock — Linkage Disconnected)	4
Fluid Capacity (Included in Pump Reservoir Fill)	.75L (1.6 Pint Approx.)
Power Steering Fluid	MERCON® Power Steering Fluid.

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Worm Bearing Preload	0.45-1.0 Nm (4-9 Lb-In) Not Adjustable in Field. Specification Given for Inspection Purposes Only.
Worm to Piston Preload	0.11-0.34 Nm (1-3 Lb-In) Not Adjustable in Field. Specification Given for Inspection Purposes Only.

Power Steering Gear Operational Specifications— Aerostar

Description	Specification
Steering Gear Ratio	17:1
Number of Turns	3.13
Power Steering Fluid Capacity (Including Steering Pump)	1.2 Liters (2.5 U.S. Pints) (Approximately)
Power Steering Fluid	MERCON® Power Steering Fluid.
Effort Required to Initiate Proper Input Shaft Rotation (Power Cylinder Drained and Gear Removed from Vehicle)	1-1.5 Nm (5-15 Lb-In)
Steering Sector Shaft Arm Idler Arm Rod Articulation Effort (on Pull Scale)	8.9-44.5 Nm (2-10 Lb-Ft)
Steering Sector Shaft Arm Idler Arm Rod Outer End Thread Lubricant	Disc Brake Caliper Slide Grease, D7AZ-19590-A or Equivalent Meeting Ford Specification ESA-M1C172-A

Torque Specifications

Description	Nm	Lb-Ft
Control Valve Housing Bolts	42-62	30-45
Left and Right Transfer Line Fittings	20-34	15-25
Line Fittings	27-34	20-25
Piston End Cap	95-149	70-110
Power Steering Hose Fitting	30-40	22-30
Power Steering Pressure Hose Tube Nut	41-54	31-40
Race Locknut	75-122	55-90
Sector Shaft Adjuster Screw Lock Nut	48-61	35-45
Steering Column Intermediate Shaft Connecting Bolts, Aerostar	41-57	31-42
Steering Column Mounting Nuts, Aerostar	13-17	10-13
Steering Column Mounting Nuts, Ranger	26-36	19-27
Steering Gear Housing End Cover	75-94	50-70
Steering Column Gear Input Shaft Coupling Bolts	41-57	31-42
Steering Gear Locknut (Ranger)	40-55	30-40

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Steering Gear Mounting Bolts, Aerostar 4x2	108-142	80-105
Steering Gear Mounting Bolts (Aerostar E4WD)	83-111	61-82
Steering Gear Mounting Bolts (Ranger)	68-84	50-62

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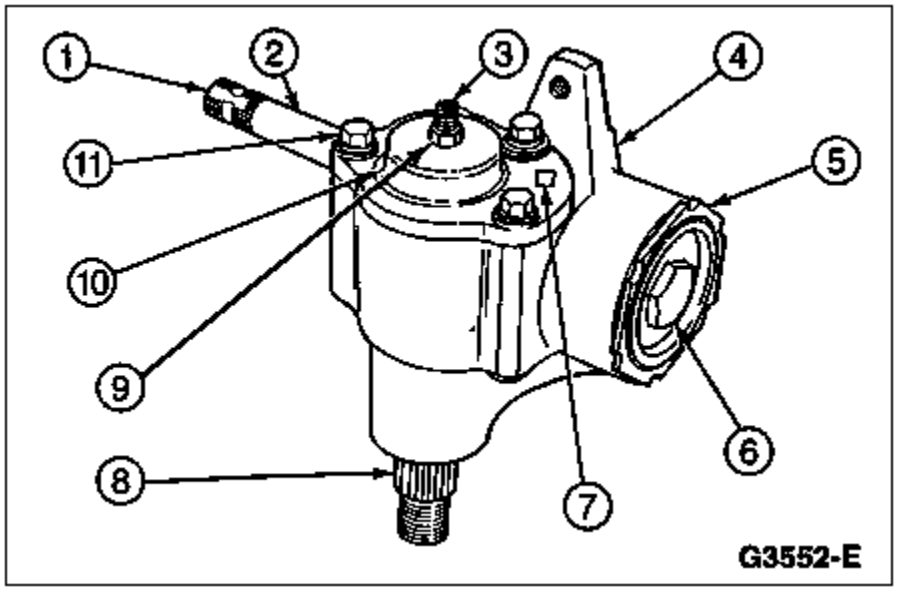
Steering Gear

The steering gear (3504) is of the worm and recirculating ball type. The steering gear sector shaft (3575) is supported by a needle bearing in the steering gear housing (3548) and a bushing in the steering gear housing end cover (3568). A steering gear input worm gear and rack (3524) is used which has threads that mate to the threads of the steering gear input worm gear and rack via continuous rows of steering gear worm balls (3647) between the two. Steering gear worm balls recirculate through two steering gear ball return guides (3523). The steering gear input worm gear and rack has gear teeth cut on one face which mesh with gear teeth on the steering gear sector shaft. As the steering wheel (3600) is rotated, the steering gear input worm gear and rack rotates, causing the steering gear input worm gear and rack to move up or down the steering gear input worm gear and rack. Since the gear teeth on the steering gear input worm gear and rack are meshed with the gear teeth on the steering gear sector shaft, the movement of the steering gear input worm gear and rack causes the steering gear sector shaft to rotate and swing the steering gear sector shaft arm (3590).

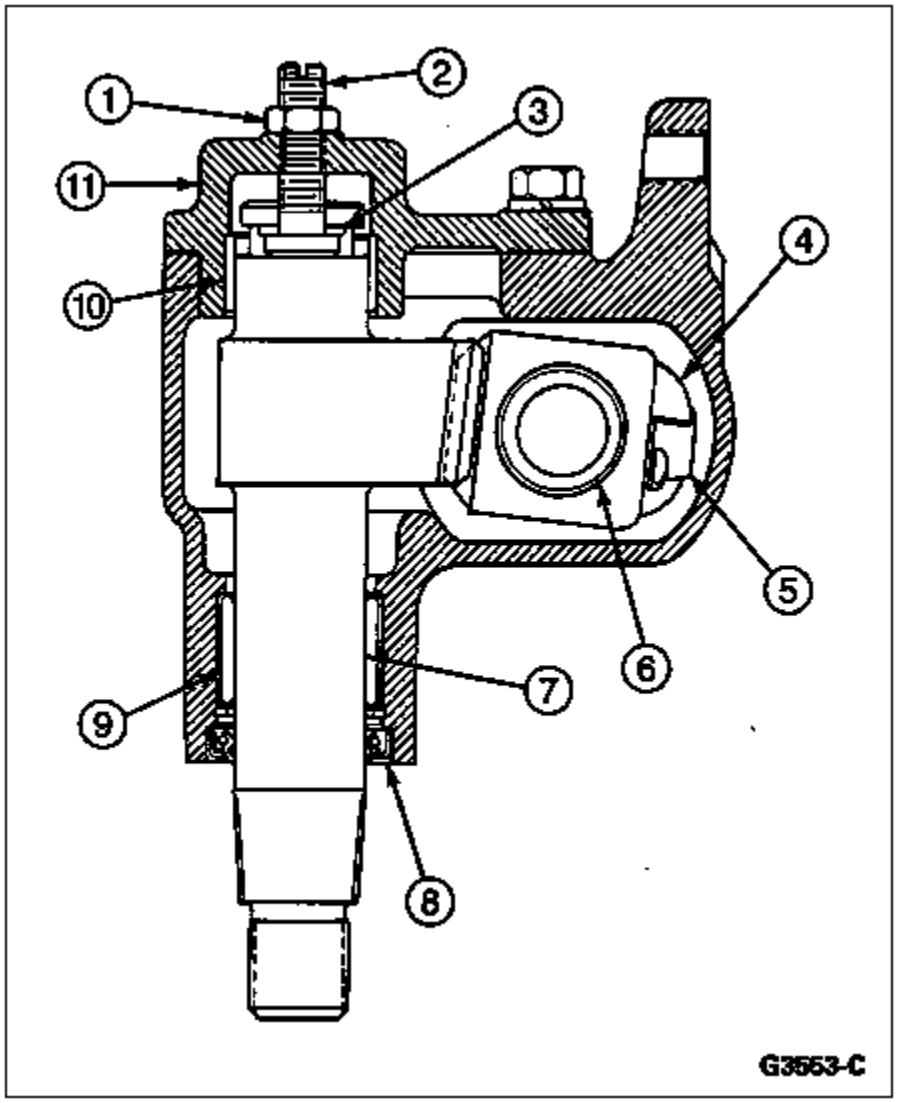


Item	Part Number	Description
1	3A525	Steering Column Intermediate Shaft Coupling
2	3524	Steering Gear Input Worm Gear and Rack
3	3577	Steering Gear Sector Shaft Adjusting Screw
4	3548	Steering Gear Housing
5	3707	Steering Gear Worm Thrust Bearing Locknut
6	3A670	Steering Gear Worm Thrust Bearing Adjuster
7	—	Location of Gear Model Number
8	3575	Steering Gear Sector Shaft
9	—	Steering Gear Sector Shaft Adjusting Screw Locknut

		(Part of 3577)
10	3568	Steering Gear Housing End Cover
11	—	Sector Cover Bolts (Part of 3548)

The design of two separate circuits of balls results in an almost friction-free operation of the steering gear input worm gear and rack and the steering gear input worm gear and rack. When the steering wheel is turned, the steering gear worm balls roll in the ball thread grooves of the steering gear input worm gear and rack and steering gear input worm gear and rack. When the steering gear worm balls reach the end of their respective circuit, they enter the steering gear ball return guides and are returned to the other end of the circuits.

The teeth on the steering gear sector shaft and the steering gear input worm gear and rack are designed so that an interference fit exists between the two when the front wheels are straight ahead. This interference fit eliminates gear tooth lash on center for a positive feel when driving straight ahead. Proper mesh engagement between the steering gear sector shaft and steering gear input worm gear and rack is obtained by an adjusting screw which moves the steering gear sector shaft axially.



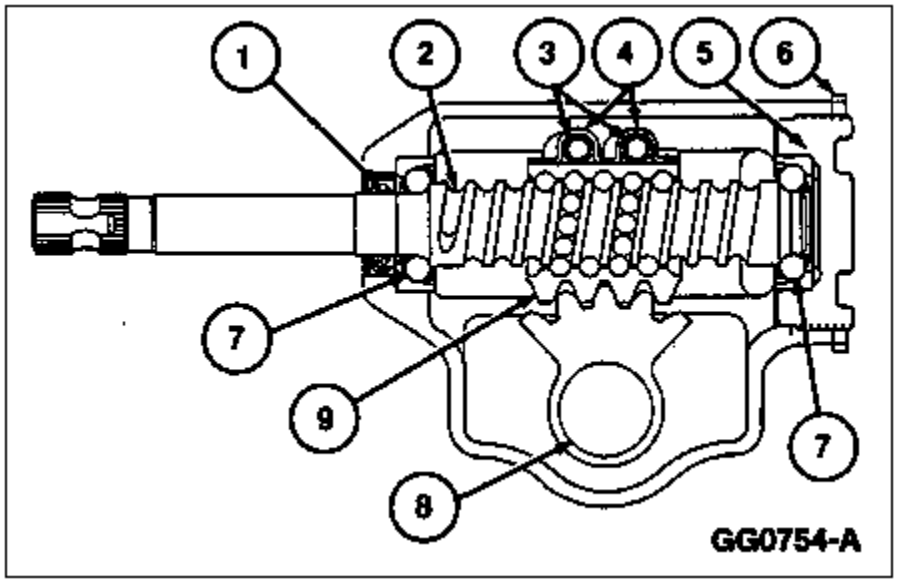
Item	Part Number	Description
1	—	Locknut (Part of 3577)
2	3577	Steering Gear Sector Shaft Adjusting Screw
3	—	Shim (Part of 3575)
4	3523	Steering Gear Ball Return Guide
5	3544	Steering Gear Ball Return Guide Clamp
6	3524	Steering Gear Input Worm Gear and Rack
7	3575	Steering Gear Sector Shaft
8	—	Seal (Part of 3575)
9	—	Needle Bearing (Part of 3575)
10	—	Bushing (Part of 3575)
11	3568	Steering Gear Housing End Cover

The steering gear worm thrust bearing adjuster (3A670) can be turned to provide proper preloading of the steering gear worm thrust bearings (3571). Worm bearing preload eliminates worm end play and is necessary to prevent steering free play and vehicle wander.

NOTE: The manual steering gear will not cause the vehicle to pull to one side. A minor pull condition caused by the tires or suspension misalignment can be masked (covered up) by setting preload and meshload to specifications. The steering gear will not cause road wheel shimmy, although if the steering gear meshload/preload is set too low, it may amplify an existing shimmy condition in the suspension.

The manual steering gear is a constant (23.75:1) ratio.

Manual Steering Gear



Item	Part Number	Description
1	—	Input Shaft Oil Seal
2	3524	Steering Gear Input Worm Gear and Rack
3	3647	Steering Gear Worm Ball
4	3523	Steering Gear Ball Return Guide
5	3A670	Steering Gear Worm Thrust Bearing Adjuster
6	—	Locknut (Part of 3577)
7	3571	Steering Gear Worm Thrust Bearing
8	3575	Steering Gear Sector Shaft
9	3524	Steering Gear Input Worm Gear and Rack

Steering Gear

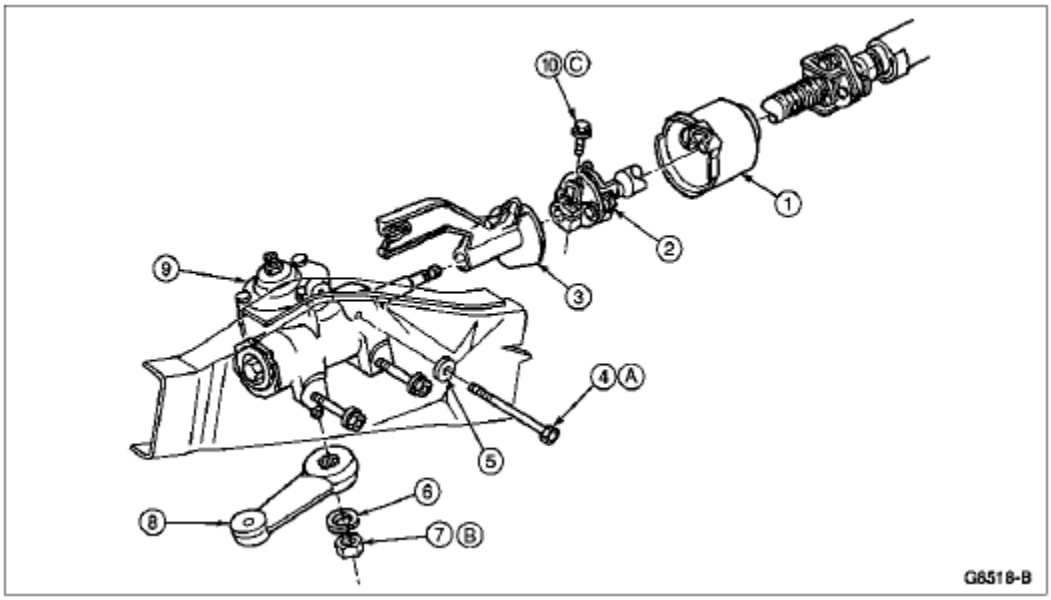
SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Pitman Arm Puller	T64P-3590-F

Removal

1. Slide the upper steering shaft u-joint shield (3F540) from the lower steering column intermediate shaft coupling (3A525) to access the pinch bolt.
2. Disconnect the lower steering column shaft (3B676) at the steering gear (3504).
3. Remove the lower steering shaft u-joint shield.
4. Remove the nut and washer that secures the steering gear sector shaft arm (3590) to the steering gear sector shaft (3575).

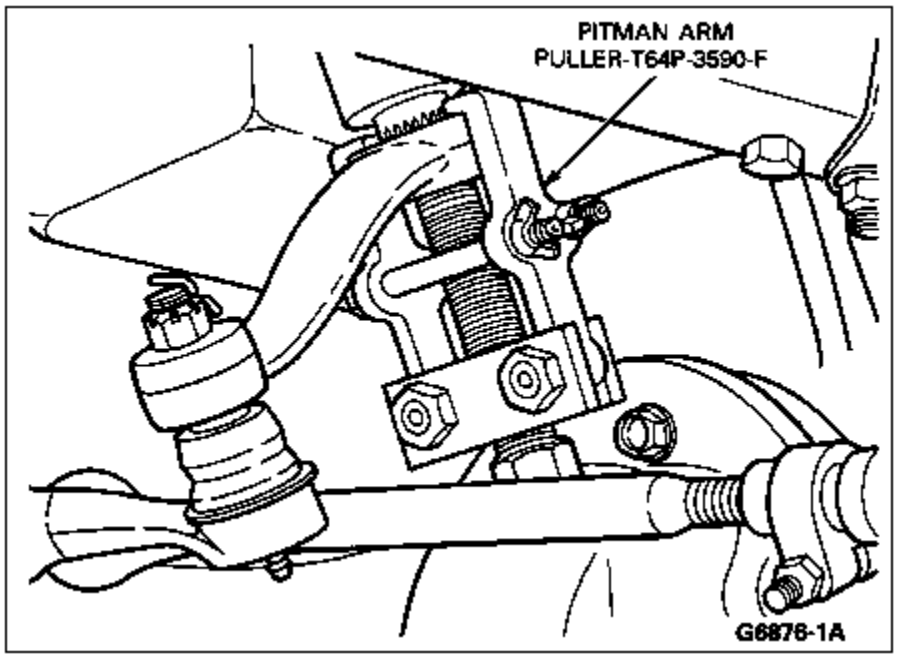
Steering Gear



Item	Part Number	Description

1	3F540	Steering Shaft U-Joint Shield (Upper)
2	—	Steering Column Intermediate Shaft
3	3C662	Steering Shaft U-Joint Shield (Lower)
4	389564-5190	Bolt
5	388273-S100	Washer
6	34798-S2	Washer
7	380771-S101	Nut
8	3590	Steering Gear Sector Shaft Arm
9	3504	Steering Gear
10	N803942-S100	Intermediate Shaft Pinch Bolt
A	—	Tighten to 68-84 Nm (50-62 Lb-Ft)
B	—	Tighten to 230-310 Nm (170-230 Lb-Ft)
C	—	Tighten to 40.3-54.7 Nm (29.4-39.9 Lb-Ft)

5. Remove the steering gear sector shaft arm using Pitman Arm Puller T64P-3590-F. Do not hammer on the end of the puller as this can damage the steering gear.



6. Remove the bolts and washers that attach the steering gear to the side rail. Remove the steering gear.

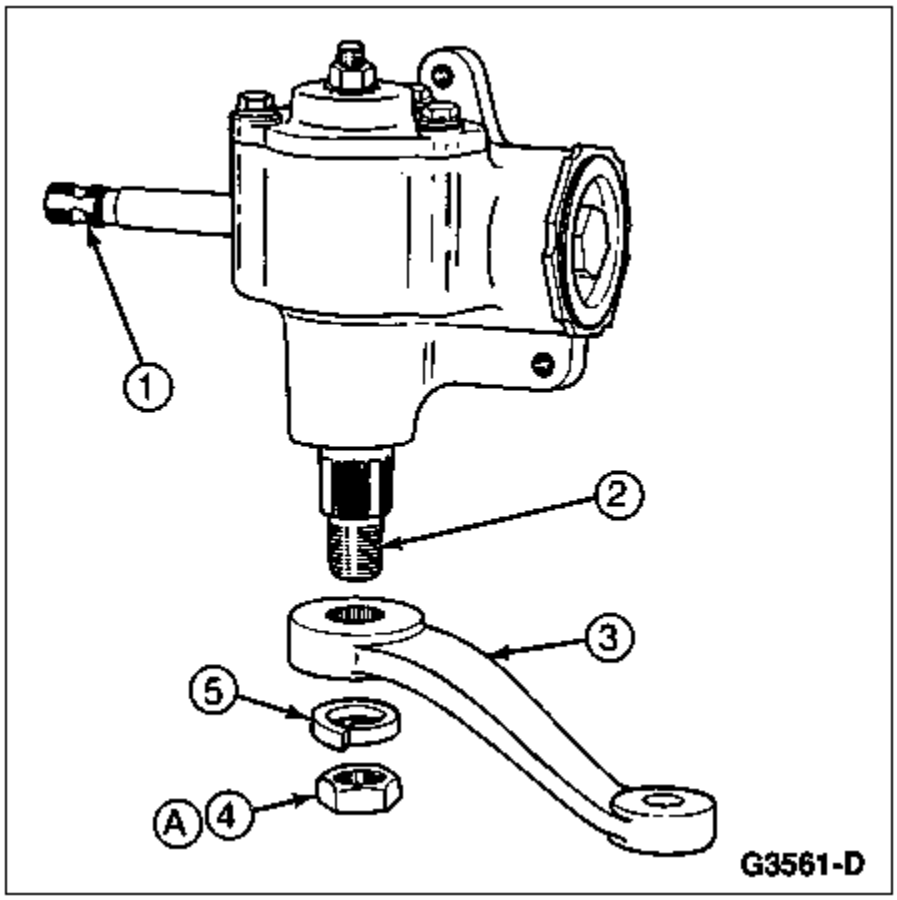
Installation

1. Rotate the steering gear input worm gear and rack (3524) from stop to stop, counting the total number of turns. Then turn back exactly half-way, placing the steering gear on center.

2. Slide the lower steering shaft u-joint shield on the steering gear input worm gear and rack.

3. Position the steering column intermediate shaft coupling on the steering gear input worm gear and rack. Make sure that the flat on the steering gear input worm gear and rack is facing straight up and aligns with the flat on the steering column intermediate shaft. Install the steering gear to side rail with bolts and washers. Tighten the bolts to 68-84 Nm (50-62 lb-ft).

4. Install the steering column intermediate shaft coupling to steering gear input worm gear and rack pinch bolt and tighten to 40.3-54.7 Nm (29.4-39.9 lb-ft).



Item	Part Number	Description
1	3524	Steering Gear Input Gear Worn and Rack
2	3575	Steering Gear Sector Shaft
3	3590	Steering Gear Sector Shaft Arm
4	380771	Nut
5	34814	Washer
A	—	Tighten to 230-310 Nm (170-230 Lb-Ft)

5. Align the two blocked teeth on the steering gear sector shaft arm with four missing teeth on the steering gear sector shaft. Place the steering gear sector shaft arm on the steering gear sector shaft and install the attaching washer and nut. Tighten the nut to 230-310 Nm (170-230 lb-ft).

6. Snap the upper steering shaft u-joint shield to the lower steering shaft u-joint shield.

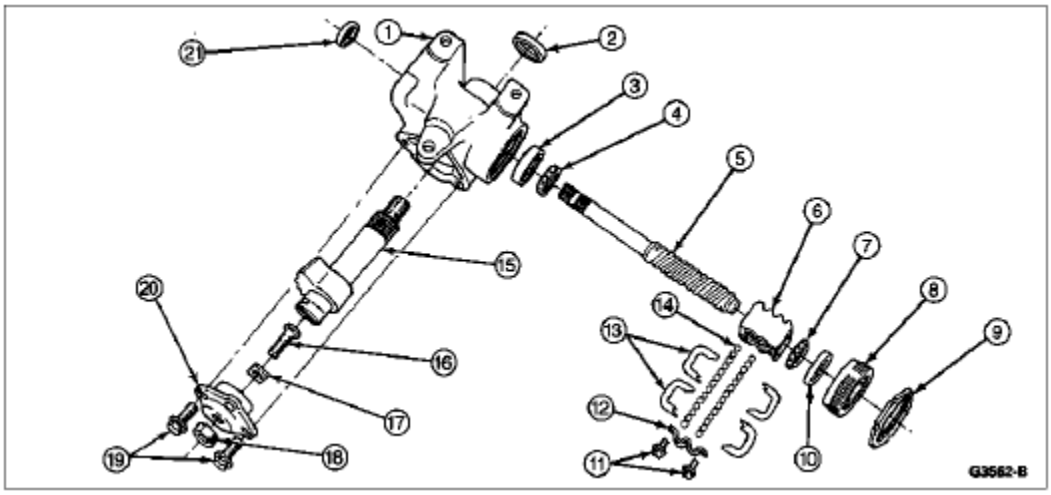
7. Count the steering wheel rotations for a full left-hand and full right-hand turn, making sure they are equal.

Steering Gear

CAUTION: The steering gear parts must be kept free of dirt. Clean paper or rags should be spread on the work bench before starting disassembly of the steering gear (3504).

Disassembly

Steering Gear, Exploded View



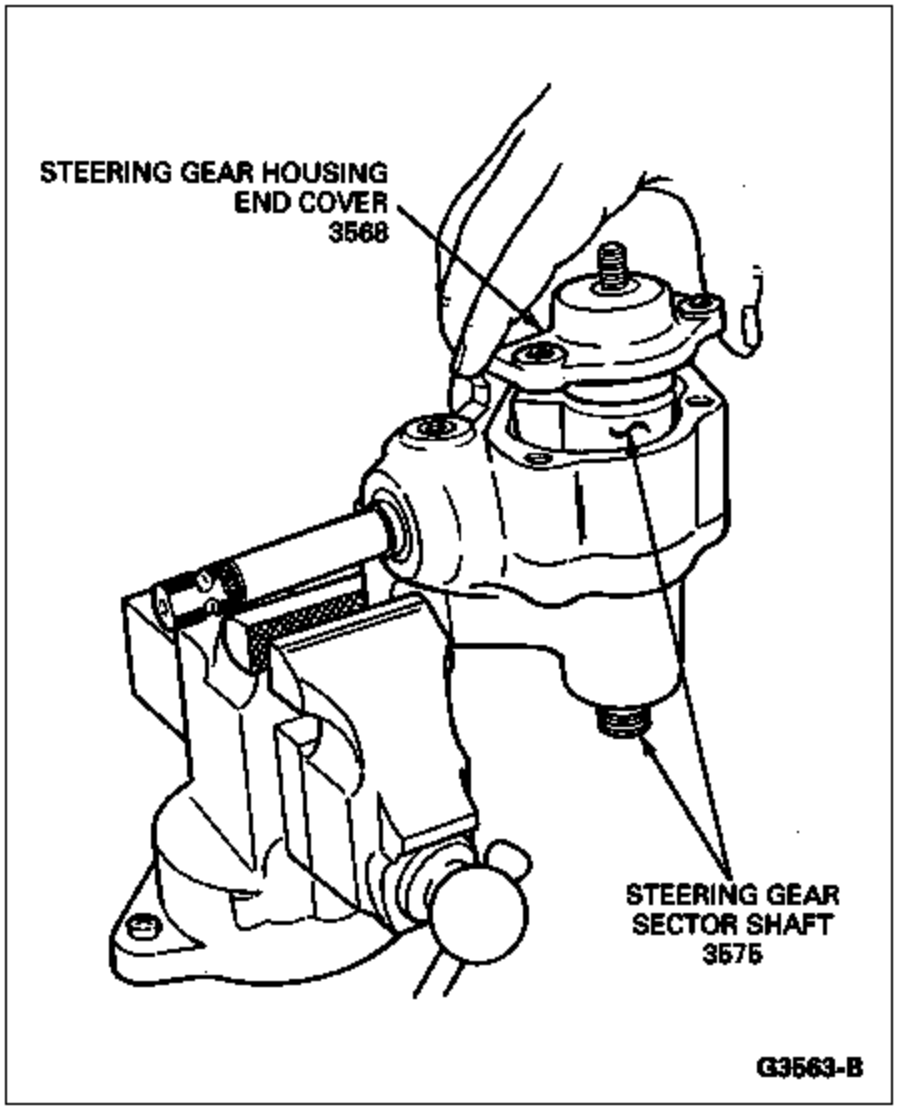
Item	Part Number	Description
1	3548	Steering Gear Housing
2	3591	Steering Gear Sector Shaft Housing Oil Seal
3	3552	Steering Gear Worm Bearing Cup
4	3571	Steering Gear Worm Thrust Bearing
5	3524	Steering Gear Input Worm Gear and Rack
6	3524	Steering Gear Input Worm Gear and Rack
7	3571	Steering Gear Worm Thrust Bearing
8	3A670	Steering Gear Worm Thrust Bearing Adjuster
9	3707	Steering Gear Worm Thrust Bearing Locknut
10	3552	Steering Gear Worm Bearing Cup
11	388889-S	Ball Guide Clamp Bolts
12	—	Ball Return Guide Clamps

13	3523	Steering Gear Ball Return Guide
14	3647	Steering Gear Worm Ball
15	3575	Steering Gear Sector Shaft
16	3577	Steering Gear Sector Shaft Adjusting Screw
17	3A657	Steering Gear Sector Shaft Adjusting Shim Kit
18	34690-S	Lash Adjuster Locknut
19	383685-S2	Sector Cover Bolts
20	3568	Steering Gear Housing End Cover
21	—	Input Shaft Oil Seal

1. Remove steering gear; refer to procedure in this section.

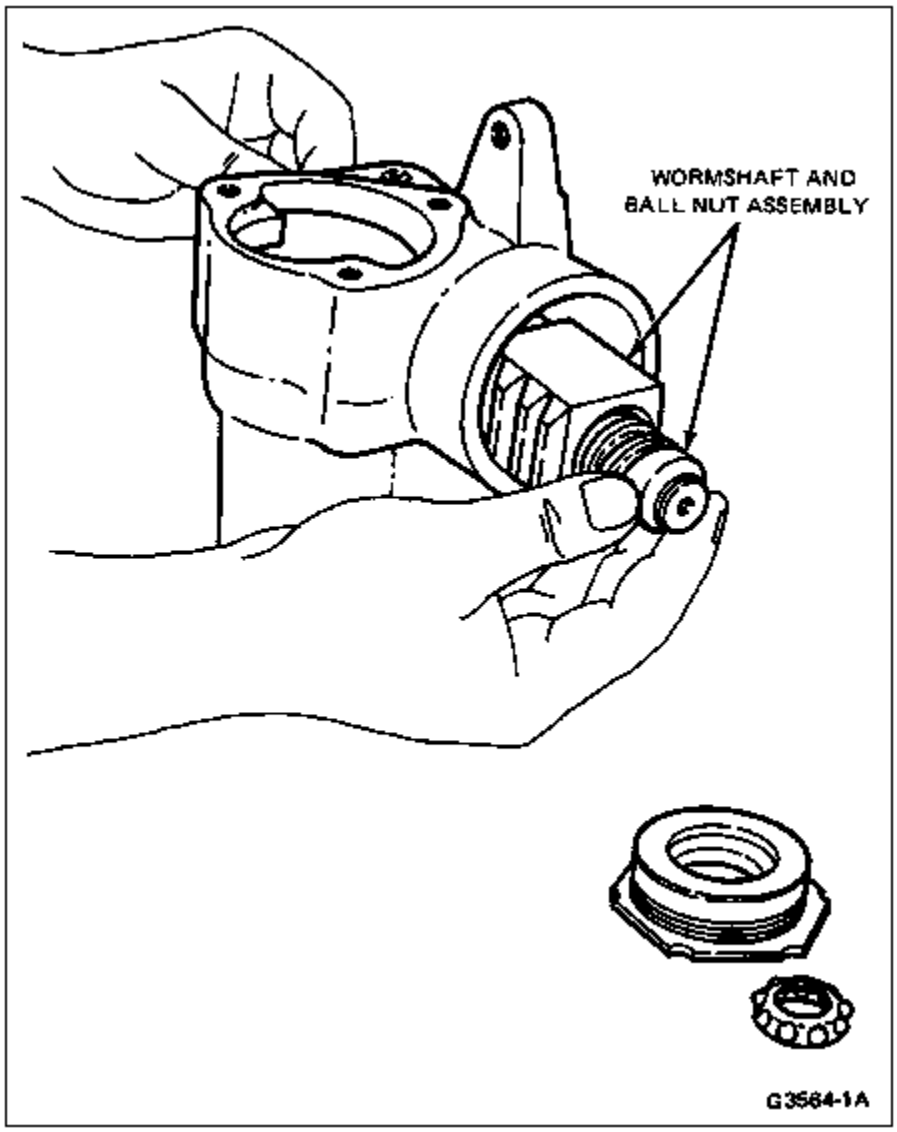
2. Rotate the steering gear input worm gear and rack (3524) from stop to stop, counting the total number of turns. Then turn back exactly half-way, placing the steering gear on center.

3. Remove the sector adjusting cover bolts. Remove the steering gear sector shaft (3575) with steering gear housing end cover (3568). Remove steering gear housing end cover from the steering gear sector shaft by turning the screw clockwise. KEEP THE SHIM WITH THE SCREW.



4. Loosen the steering gear worm thrust bearing locknut (3707) with Locknut Wrench T82T-3504-BH and remove the steering gear worm thrust bearing adjuster (3A670) and the steering gear worm thrust bearing (3571).

5. Carefully pull steering gear input worm gear and rack from steering gear housing (3548) and removesteering gear worm thrust bearing. To avoid damage to the steering gear ball return guide (3523), keep the ball nut from running down to either end of the worm.



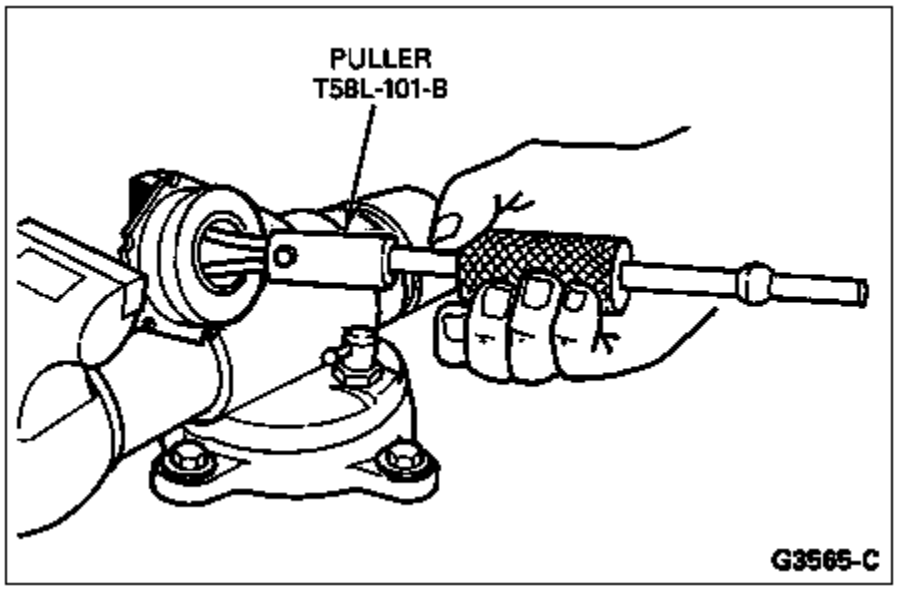
6. **NOTE: Because the individual parts of the worm and ball nut are not available for service, do not disassemble parts. If the steering gear sector shaft cannot rotate freely in the steering gear input worm gear and rack, replace the entiresteering gear.**

   NOTE: To avoid damage to the steering gear ball return guides, keep the steering gear input worm gear and rack from running down to either end of the steering gear input worm gear and rack.

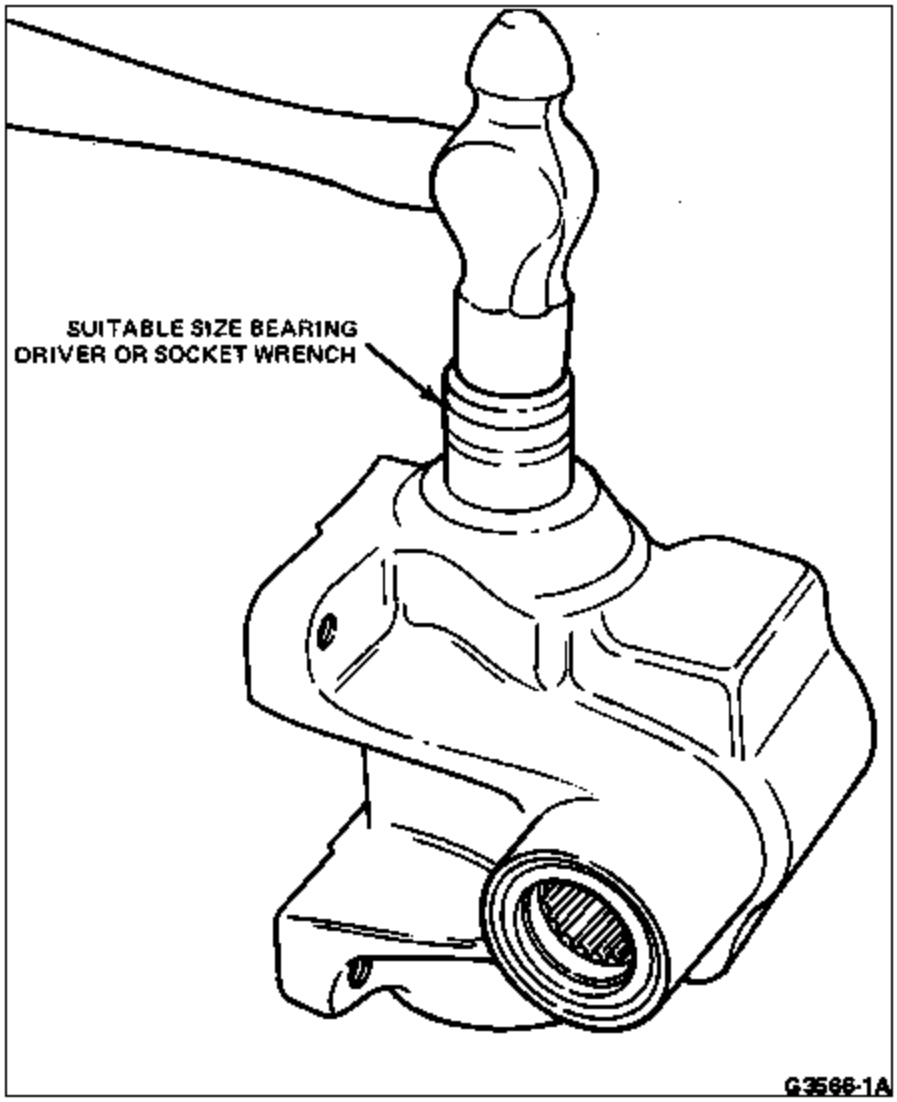
   Pry out the sector shaft and steering gear sector shaft oil seals (3738). Discard the seals.

Housing Bearing Cup Removal

Remove the steering gear worm bearing cup (3552) using Puller T58L-101-B.



Remove the steering gear worm bearing cup from the steering gear housing (3548) using a hammer and a suitable size bearing driver or socket.


SUITABLE SIZE BEARING
DRIVER OR SOCKET WRENCH
G3566-1A

Sector Shaft Needle Bearing

NOTE: The sector shaft needle bearing is serviced only as a unit with the housing. Do not attempt to remove the sector needle assembly.

NOTE: All the parts must be washed in cleaning solvent and dried thoroughly with air prior to inspection.

Inspection

1. Scrape off the gasket material from the mating surfaces of the steering gear housing end cover (3568) and steering gear housing (3548) and inspect surface.

2. Carefully inspect steering gear worm balls (3647) and steering gear worm bearing cups (3552) for signs of indentation. Also, check for any signs of chipping or breakdown of the surface. Any part that shows signs of damage must be replaced.

3. Inspect the fit of steering gear sector shaft (3575) in steering gear sector shaft housing cover (3580). If the bushing is worn, a new steering gear housing end cover and steering gear sector shaft housing cover must be installed.

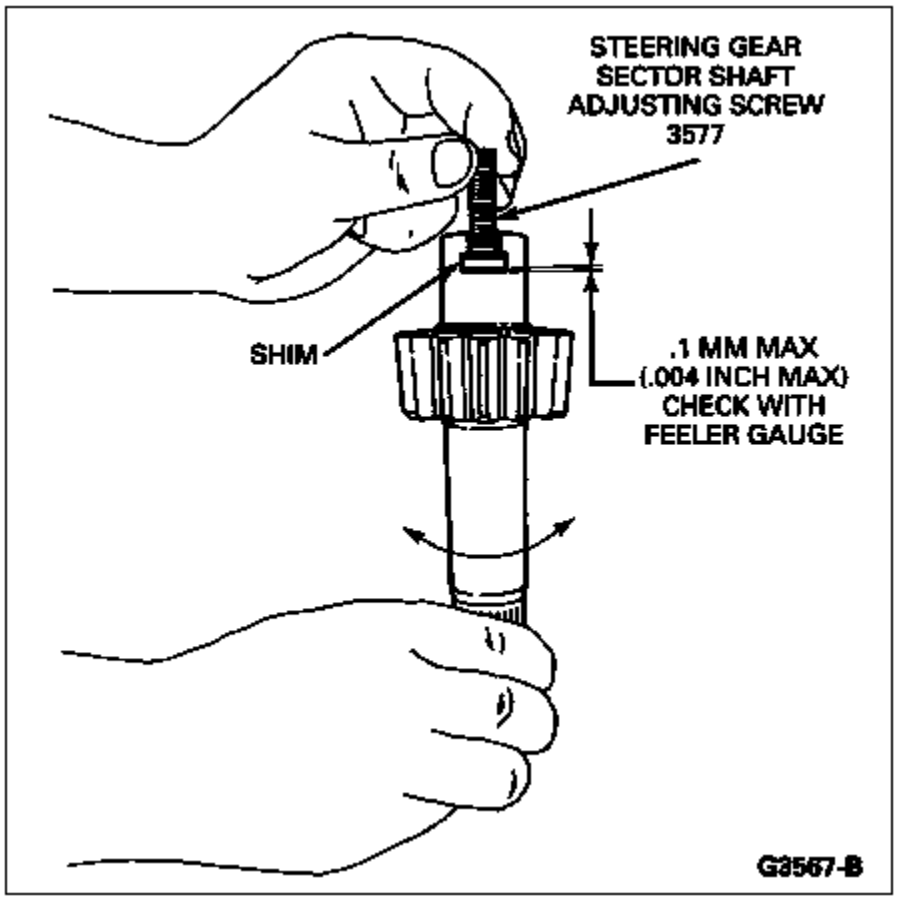
4. Inspect the steering gear input worm gear and rack (3524) for chipping, excessive wear or surface breakdown. If the steering gear input worm gear and rack is damaged, replace the steering gear input worm gear and rack as a unit.

5. Inspect the steering gear input worm gear and rack for tightness or binding by turning the steering gear input worm gear and rack. If binding or tightness are indicated, replace steering gear input worm gear and rack as a unit.

6. **NOTE: If one or more needles fall out, they may be cleaned and put back using steering gear lube to hold them in place.**

   Inspect the steering gear housing for cracks or damage. Inspect the needle bearing inside the steering gear housing for missing needles. Replace the steering gear housing which includes needle bearing if damage is found.

7. Inspect the sector gear teeth for chipping, excessive wear and surface breakdown. Replace the steering gear sector shaft if damage is found.



Assembly

SPECIAL SERVICE TOOL(S) REQUIRED

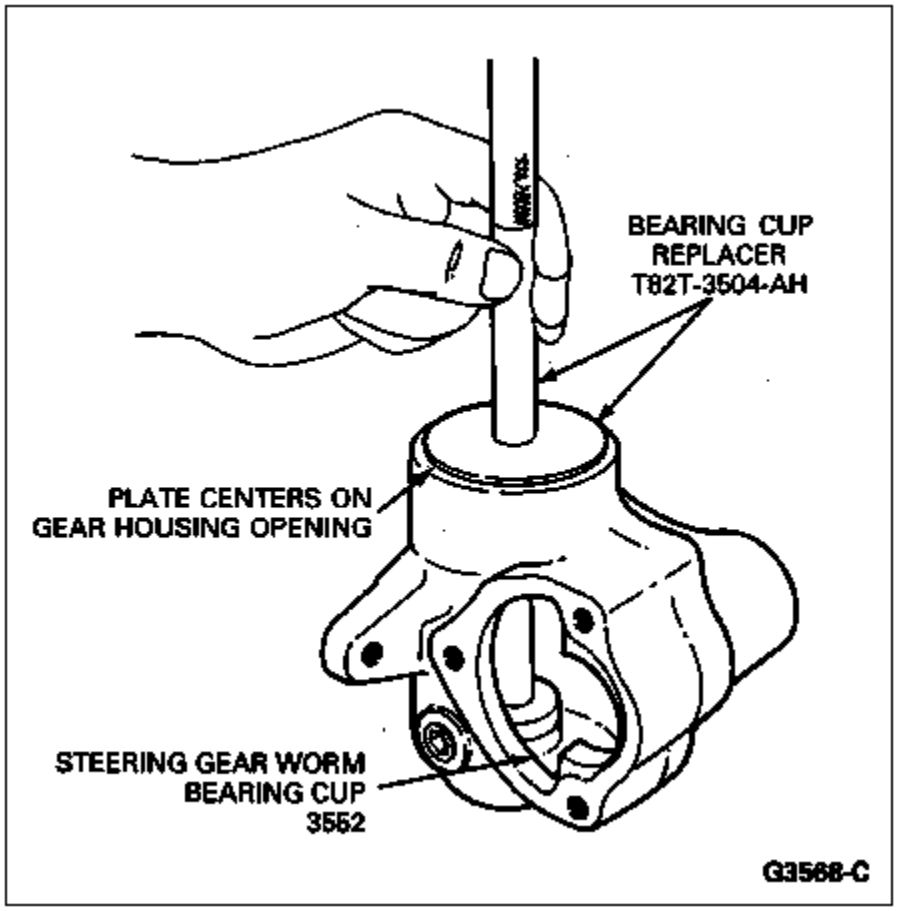
Description	Tool Number
Bearing Cup Replacer	T82T-3504-AH

Prior to assembling the steering gear (3504), make sure that all of the internal gear component parts removed from the steering gear housing have been cleaned and dried.

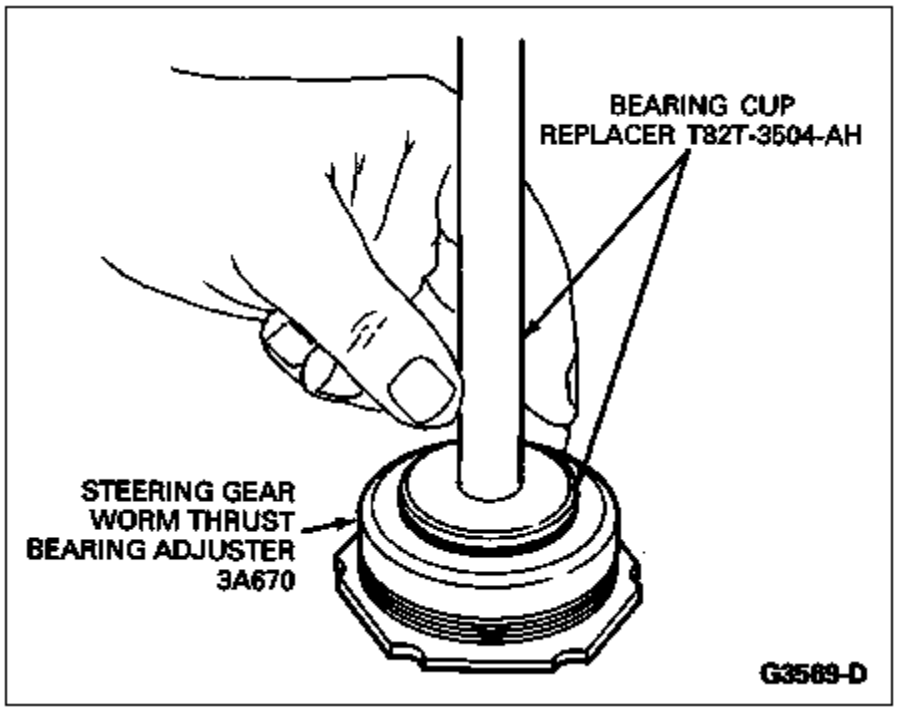
1. Check the clearance between the sector adjusting screw head and the bottom of the sector shaft T-slot. If the clearance is more than 0.1mm (0.004 inch), install a new shim as required to reduce the clearance to 0.10mm (0.004 inch) or less. Steering gear lash adjuster kit contains five shims: 1.95mm (0.078 inch), 2.00mm (0.080 inch), 2.05mm (0.082 inch), 2.10mm (0.084 inch) and 2.15mm (0.086 inch).

2. While holding the sector adjuster screw, turn the steering gear sector shaft back and forth. The steering gear sector shaft must turn freely. If the steering gear sector shaft does not turn freely, increase the T-slot clearance using an appropriate shim from the steering gear sector shaft adjusting shim kit (3A657). However, make sure that the resulting clearance is not more than 0.10mm (0.004 inch).

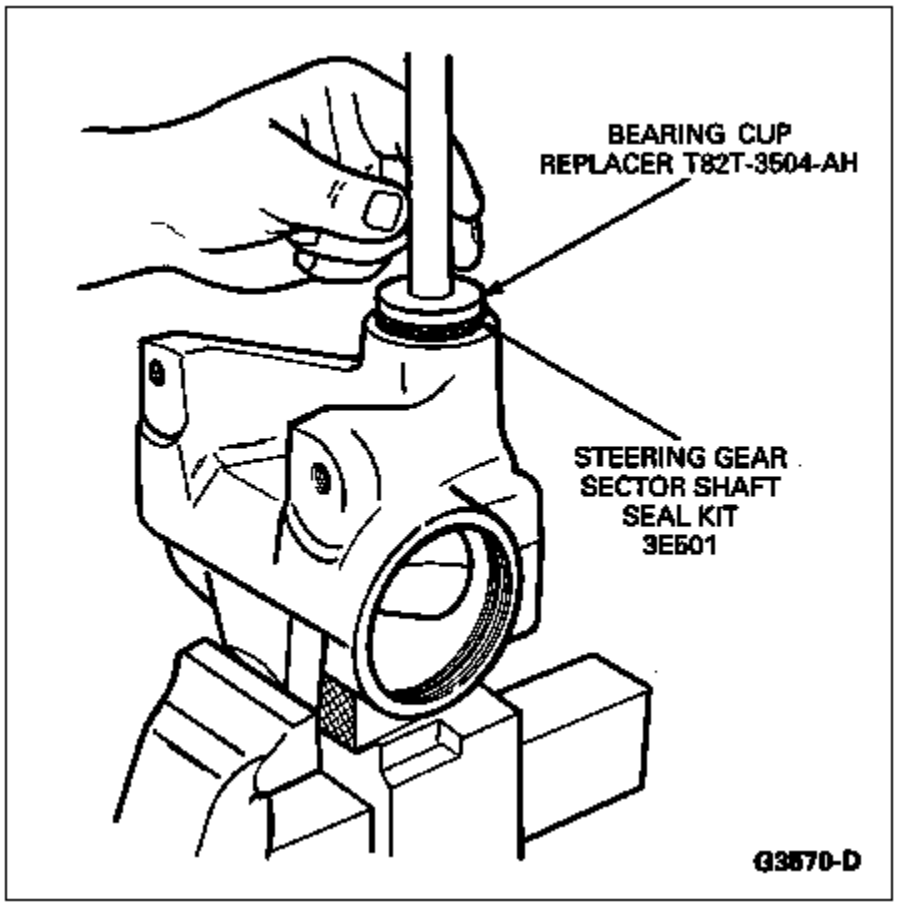
3. If the steering gear worm bearing cup was removed from the steering gear housing, install a new steering gear housing end cover using Bearing Cup Replacer T82T-3504-AH.



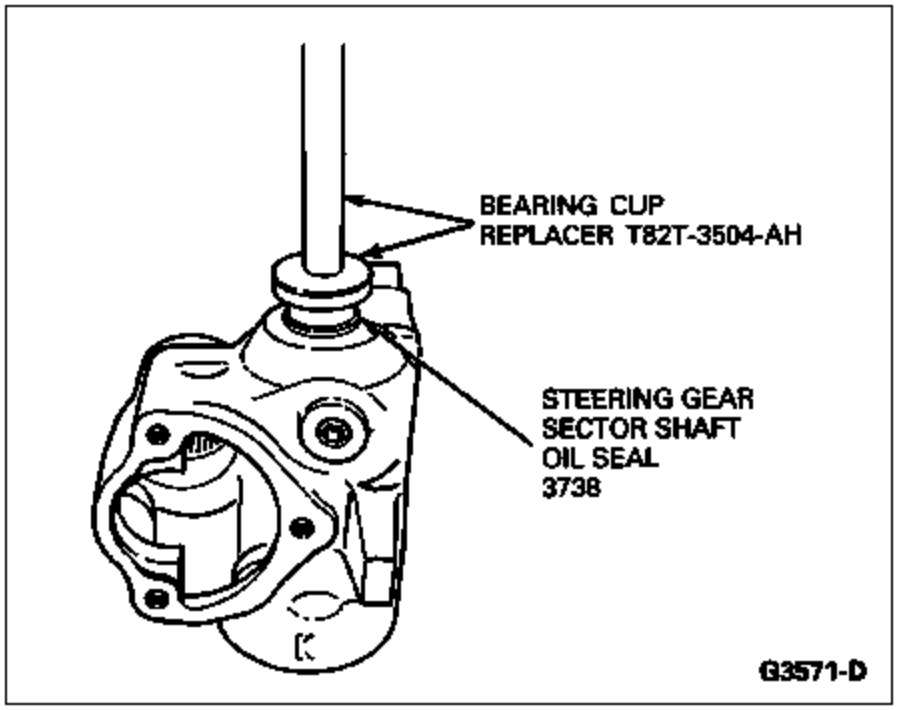
4. If the steering gear worm thrust bearing adjuster (3A670) was removed, install a steering gear housing end cover using Bearing Cup Replacer T82T-3504-AH.



5. Install the steering gear sector shaft seal (3E501) in thesteering gear housing using Bearing Cup Replacer T82T-3504-AH. Press the steering gear sector shaft seal until it bottoms out.



6. Tap thesteering gear sector shaft oil seal (3738) in the steering gear housing using Bearing Cup Replacer T82T-3504-AH. The steering gear sector shaft oil seal should be assembled flush with the housing surface.



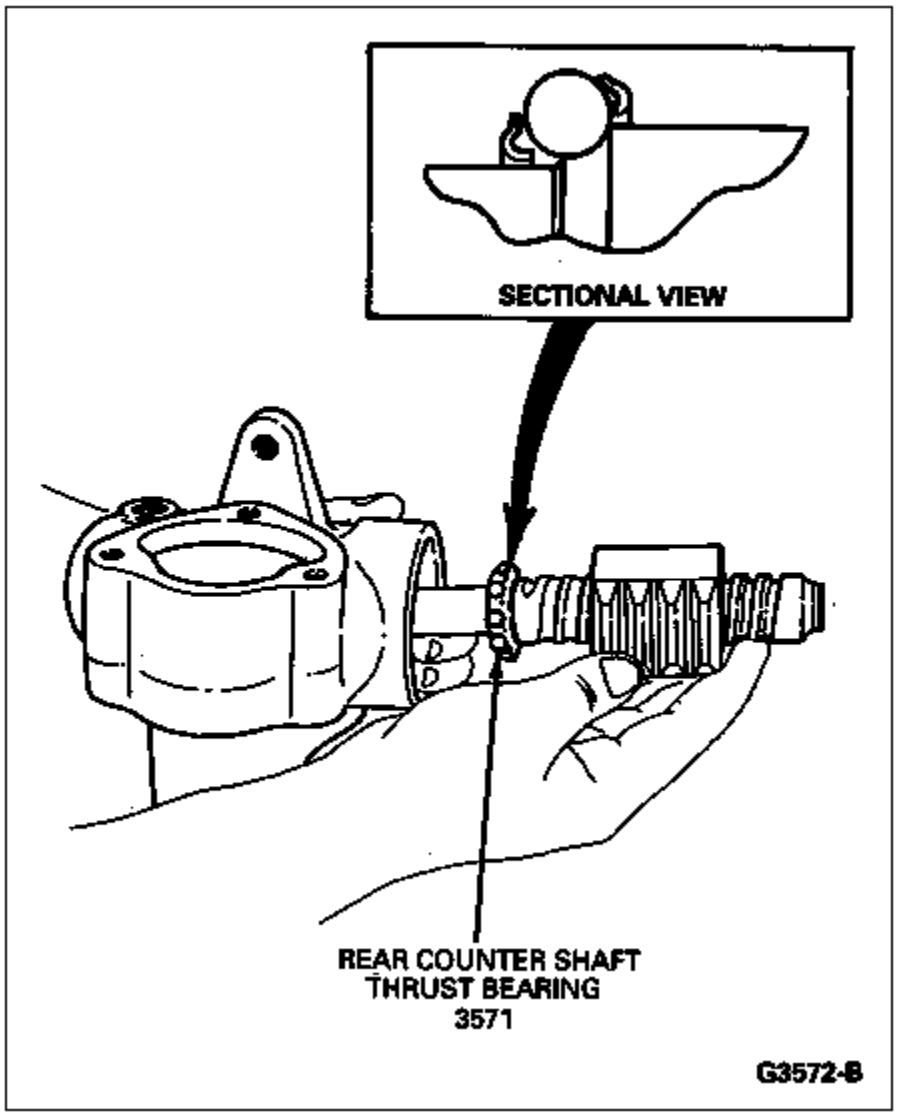
7. Clamp the steering gear housing in a vise with the wormshaft bore horizontal and the steering gear sector shaft facing up.

8. Apply Steering Gear Grease C3AZ-19578-A or equivalent meeting Ford specification ESW-M1C87-A to the steering gear worm thrust bearings (3571), sector shaft needle bearing in the steering gear housing and the sector cover bushing.

9. Slip one of the steering gear worm thrust bearings over the steering gear input worm gear and rack. Make sure that the bearing cage is positioned correctly as shown.

   Insert the steering gear input worm gear and rack into the steering gear housing. Feed the splined end of the wormshaft through the steering gear worm thrust bearing and steering gear sector shaft oil seal. Place the remaining steering gear worm thrust bearing in the steering gear worm thrust bearing adjuster.

Steering Gear Input Gear Worm and Rack



10. Install the steering gear worm thrust bearing adjuster and steering gear worm thrust bearing locknut (3707) into the housing opening, being careful to guide the wormshaft end into the steering gear worm thrust bearing until nearly all end play has been removed from the steering gear input worm gear and rack.

11. Position the steering gear sector shaft adjusting screw (3577) and shim into the sector shaft slot. Check the clearance between the screw head and the bottom of the sector shaft T-slot. The clearance must not be greater than 0.1mm (0.004 inch). If the clearance is greater than 0.1mm (0.004 inch), install a new shim as required to reduce the clearance to 0.1mm (0.004 inch) or less. Steering gear sector shaft adjusting shim kit contains five shims: 1.95mm (0.078 inch), 2.00mm (0.080 inch), 2.05mm (0.082 inch), 2.10mm (0.084 inch), and 2.15mm (0.086 inch).

12. Lubricate the steering gear with 290 grams (10.2 oz. by weight) of Steering Gear Grease C3AZ-19578-A or equivalent meeting Ford specification ESW-M1C87-A. Rotate the steering gear input worm gear and rack until the steering gear input worm gear and rack is near the end of its travel. Pack as much of the measured grease into the steering gear housing as possible through the sector shaft opening. Rotate the steering gear input worm gear and rack to move the steering gear input worm gear and rack near the other end of its travel and pack more grease through the steering gear housing.

13. Rotate the steering gear input worm gear and rack until the steering gear input worm gear and rack is in the center of travel.

14. Insert the steering gear sector shaft containing the steering gear sector shaft adjusting screw and shim into the steering gear housing so that the center tooth of the steering gear sector shaft enters the center rack tooth space in the steering gear input worm gear and rack. Rotating the ball nut teeth slightly up will aid in alignment of the gear teeth and installation of the steering gear sector shaft.

15. Pack the remaining grease into the steering gear housing.

16. Apply a 3.20mm (1/8-inch) wide x 3.20mm (1/8-inch) high bead of sealant, Silicone Rubber D6AZ-19562-AA or equivalent meeting Ford specifications ESB-M4G92-A and ESE-M4G195-A, to the mating surfaces of the steering gear housing end cover and steering gear housing. The two mating surfaces must be dry and free of grease and all foreign materials prior to applying the sealant material and assembly of the steering gear housing end cover.

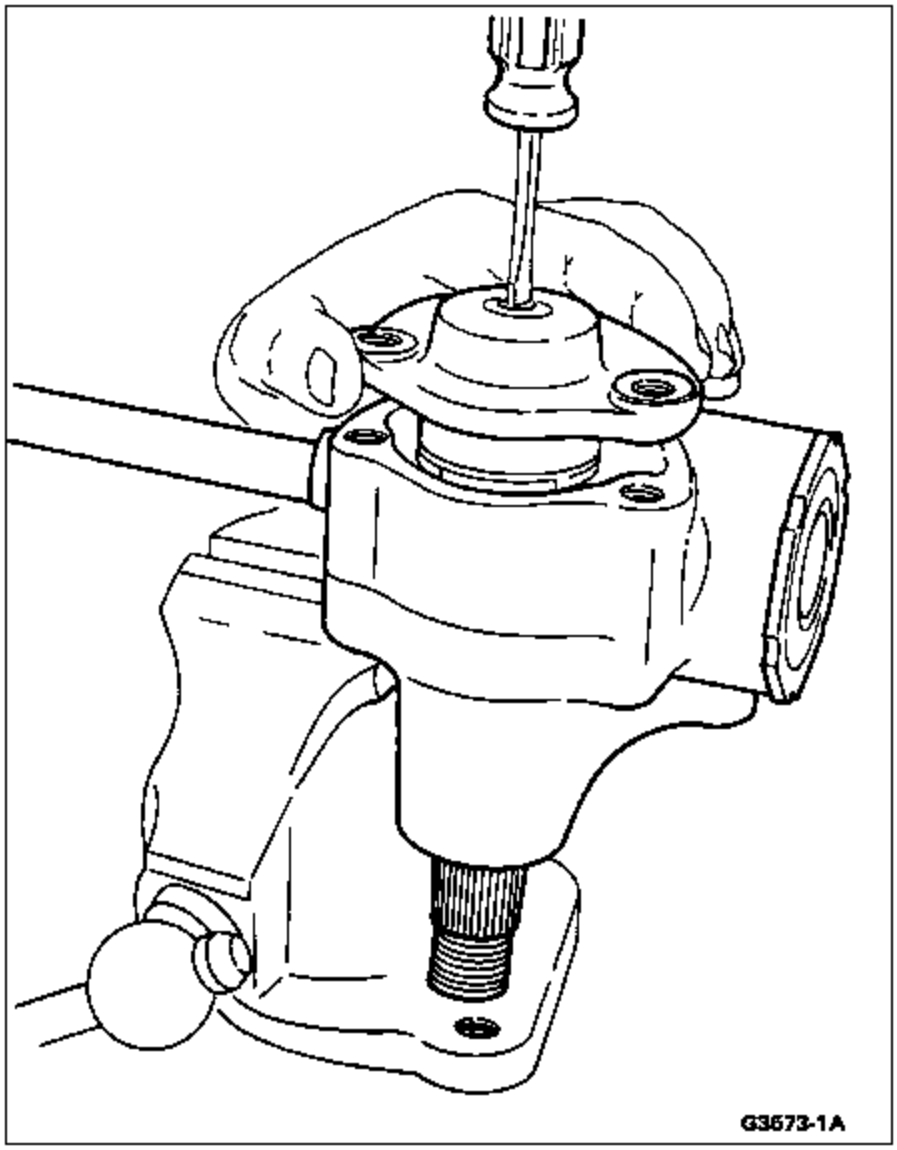
17. Approximately five minutes after applying the sealant, engage the steering gear sector shaft adjusting screw with the tapped hole in the center of the steering gear housing end cover. Turn the steering gear sector shaft adjusting screw counterclockwise as shown. Continue turning the steering gear sector shaft adjusting screw until the steering gear housing end cover is flush with the steering gear housing.

18. Install the steering gear housing end cover to steering gear housing by attaching washer and bolts. Do not torque the bolts unless there is a lash between the steering gear sector shaft and the steering gear input worm gear and rack. The lash can be obtained by turning the steering gear sector shaft adjusting screw counterclockwise.

19. Tighten the sector cover attaching bolts to 43-54 Nm (32-40 lb-ft).

20. Adjust the steering gear preload and meshload. Refer to the Adjustment portions of this section.

21. Install steering gear; refer to procedure in this section.


G3673-1A

Adjustment Procedure

Preload and Meshload Check, In Vehicle

1. **NOTE: Prior to checking preload and meshload in vehicle, make sure that the steering column is properly aligned and that the steering column intermediate shaft coupling (3A525) is not distorted.**

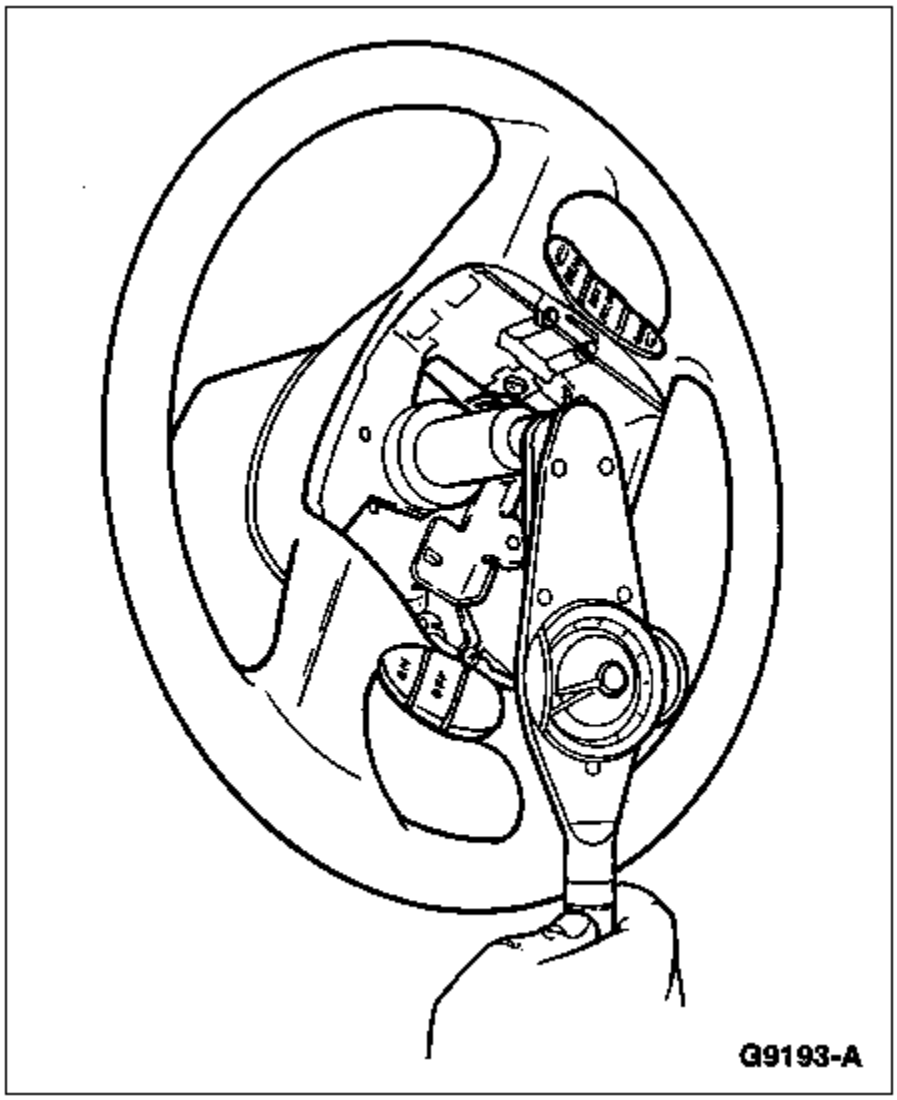
   Disconnect steering linkage at the steering gear sector shaft arm (3590) at the ball stud. Refer to Section 11-03 for procedure.

2. Lubricate steering gear sector shaft oil seal (3738) with a drop of Premium Power Steering Fluid E6AZ-19582-AA or equivalent meeting Ford specification ESW-M2C33-F.

3. Remove the horn pad assembly from the steering wheel (3600).

4. Turn the steering wheel slowly to one stop.

5. Place a lb-in torque wrench on the steering wheel nut. Measure the torque (preload) required to rotate the steering wheel at a constant speed for approximately 1-1/2 turns. If the preload is not within .22-.68 Nm (2-6 lb-in), readjust preload (see following text Worm and Roller Mesh Preload, Out-of-Vehicle). Worm preload cannot be adjusted in the vehicle.



6. Rotate the steering wheel from stop to stop, counting the total number of turns then back half-way, placing the steering gear (3504) on center. (Approximately six turns, stop to stop.)

7. Place a lb-in torque wrench on the steering wheel nut. Observe the highest reading (meshload) by rotating the steering shaft back and forth approximately 90 degrees either way across center. The meshload must be within .68-1.24 Nm (6-11 lb-in) and at least .23 Nm (2 lb-in) over the preload. If the meshload is out of specifications, readjust it.

Worm and Roller Mesh Preload, Out-of-Vehicle

1. Tighten bolts of steering gear housing end cover (3568) to 43-54 Nm (32-40 lb-ft). This step will aid in meshload retention.

2. Loosen steering gear worm thrust bearing adjuster (3A670) and tighten the steering gear worm thrust bearing locknut (3707) until all end play has been removed. Lubricate steering gear sector shaft oil seal (3738) with a drop of Premium Power Steering Fluid E6AZ-19582-AA or equivalent meeting Ford specification ESW-M2C33-F.

3. Using an 11/16-inch, 12-point socket and a lb-in torque wrench, carefully turn the steering gear input worm gear and rack (3524) all the way to the right. Measure the left turn torque required to rotate the steering gear input worm gear and rack at a constant speed for approximately 1-1/2 turns. This torque reading is "preload."

4. Tighten or loosen the steering gear worm thrust bearing locknut as required until the correct preload .56-.68 Nm (5-6 lb-in) is obtained. Tighten the steering gear worm thrust bearing locknut to 225-253 Nm (166-187 lb-ft).

5. Rotate the steering gear (3504) from stop to stop, counting the total number of turns, then turn back half-way, placing the steering gear on center. (Approximately six turns stop to stop.)

6. Again, using the 11/16-inch, 12-point socket and lb-in torque wrench, observe the highest reading while the steering gear is turned approximately 90 degrees either way across center. If the highest reading (meshload) is not within 102-124 Nm (9-11 lb-in) and at least .45 Nm (4 lb-in) over the preload, turn the steering gear sector shaft adjusting screw (3577) as required.

7. Hold the steering gear sector shaft adjusting screw and tighten the locknut to 19-34 Nm (14-25 lb-ft).

SPECIFICATIONS

MANUAL STEERING GEAR PRELOAD SPECIFICATIONS

Description	Specification
Gear Ratio	Model SMK-A — 23.75:1 (Constant)
Number of Turns (Lock to Lock)	6.1
Lubricant Type	Steering Gear Grease, C3AZ-19578-A (ESW-M1C87-A) or Equivalent
Lubricant Capacity	290 Grams (10.2 Ounces)
Liquid Gasket Type	Silicone Rubber, D6AZ-19562-AA (ESB-M4G92-A and ESE-M4G195-A) or Equivalent
Worm Bearing Preload for Checking	22-68 N · Cm (2-6 Lb-In)
Total Center Meshload for Checking	68-124 N · Cm (6-11 Lb-In)
Minimum Meshload Over Preload for Checking	45 N · Cm (4 Lb-In)
Worm Bearing Preload When Readjusting	56-68 N · Cm (5-6 Lb-In)
Total Center Meshload When Readjusting	102-124 N · Cm (9-11 Lb-In)
Minimum Meshload Over Preload When Readjusting	45 N · Cm (4 Lb-In)
Maximum Clearance Between Adjusting Screw Head and Sector Shaft	0.1mm (0.004 Inch)

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Sector Cover Bolts	43-54	32-40	—
Meshload Adjusting Screw Locknut	19-34	14-25	—
Preload Adjuster Locknut	225-253	166-187	—
Steering Gear to Frame Side Rail Attaching Bolts	68-84	50-62	—
Intermediate Shaft Pinch Bolt	40.3-54.7	29.4-39.9	—
Sector Shaft Arm to Steering Gear Sector Shaft Nut	230-310	170-230	—
Ball Return Guide Tube Clamp Bolts	300-440 (N · Cm)	—	26-39

Manual Steering Gear

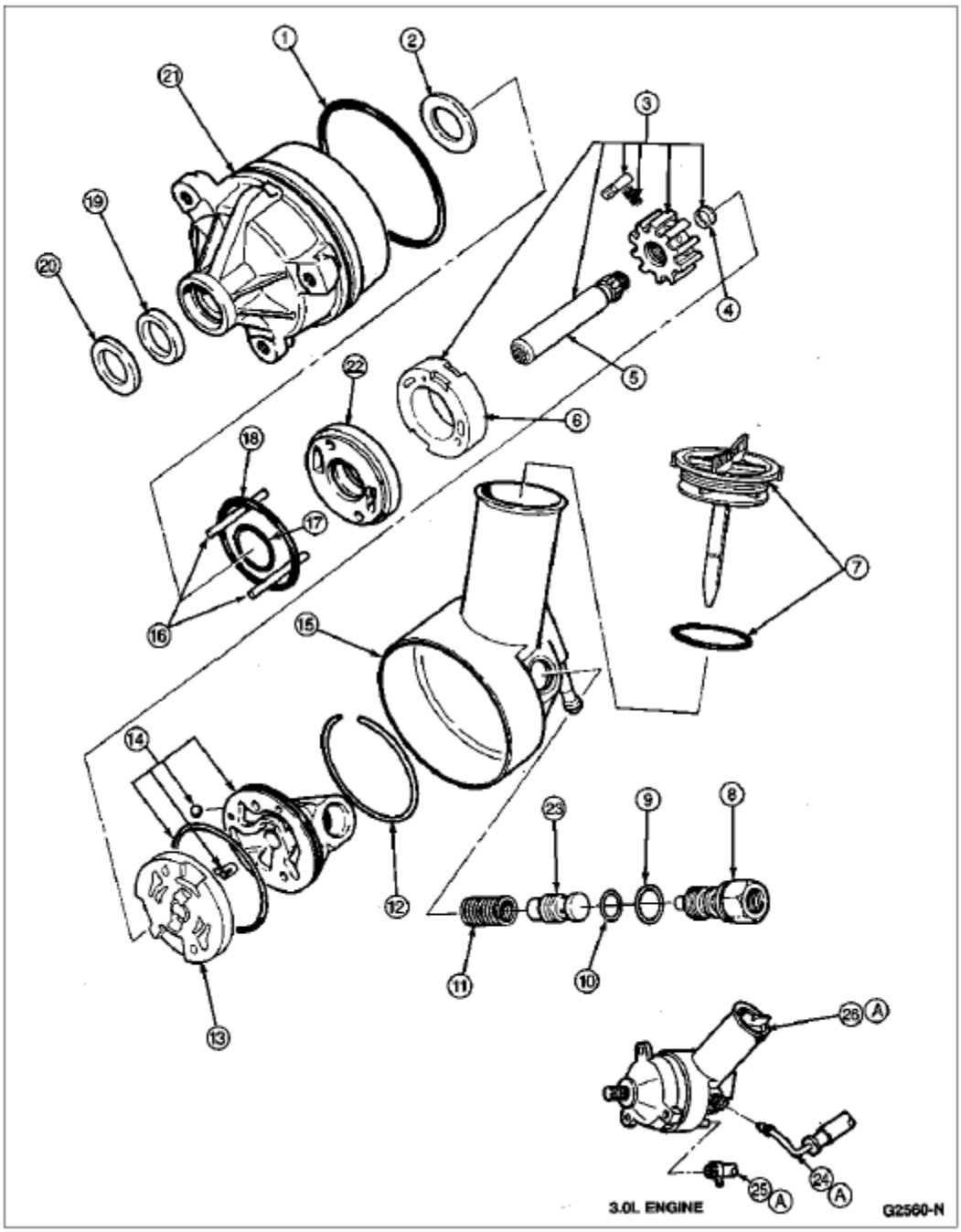
Steering Pump

The C-II power steering pump (3A674) is a belt-driven slipper-type pump with a fiberglass-reinforced nylon power steering fluid reservoir, attached to the rear of power steering pump pressure plate (3D590). The power steering pump is encased within the power steering pump housing (3A643) and power steering fluid reservoir. The power steering pressure hose (3A719) is attached with a quick-connect fitting, located below the power steering fluid reservoir. The fitting allows the line to swivel. This is normal and does not indicate an untorqued fitting.

An identification tag is attached to the power steering fluid reservoir. The top line of this tag indicates the basic model number (HBC) and the suffix.

NOTE: Always use these tags when requesting service assemblies as there may be slight differences in internal components.

C-II Power Steering Pump, Exploded View



Item	Part Number	Description
1	3B584	Power Steering Pump Seal and Gasket Kit
2	3D596	Power Steering Pump Pressure Plate Spring
3	3D607	Power Steering Pump Rotor
4	3D607	C-Clip
5	3B559	Power Steering Pump Rotor Shaft
6	3D590	Low Displacement Cam
7	—	Power Steering Pump Fluid Reservoir Filler Cap

8	3D654	Power Steering Pump Valve Outlet Fitting
9	389349-S	Seal
10	387571-S94	Seal
11	3D586	Power Steering Pump Flow Control Valve Spring
12	387573-S	Retaining Ring
13	3D590	Power Steering Pump Pressure Plate
14	36544	Valve Cover
15	—	Power Steering Fluid Reservoir
16	387579-S	Dowel Pins
17	387570-S100	Seal
18	387569-S100	Seal
19	3B592	Power Steering Pump Rotor Shaft Oil Seal
20	—	Retainer (Part of 3B592)
21	3A643	Power Steering Pump Housing
22	3D590	Power Steering Pump Pressure Plate
23	3A561	Power Steering Pump Valve
24	3A719	Power Steering Pressure Hose
25	3A713	Power Steering Return Hose
26	3A674	Power Steering Pump
A	—	Tighten to 30-40 Nm (22-30 Lb-Ft)

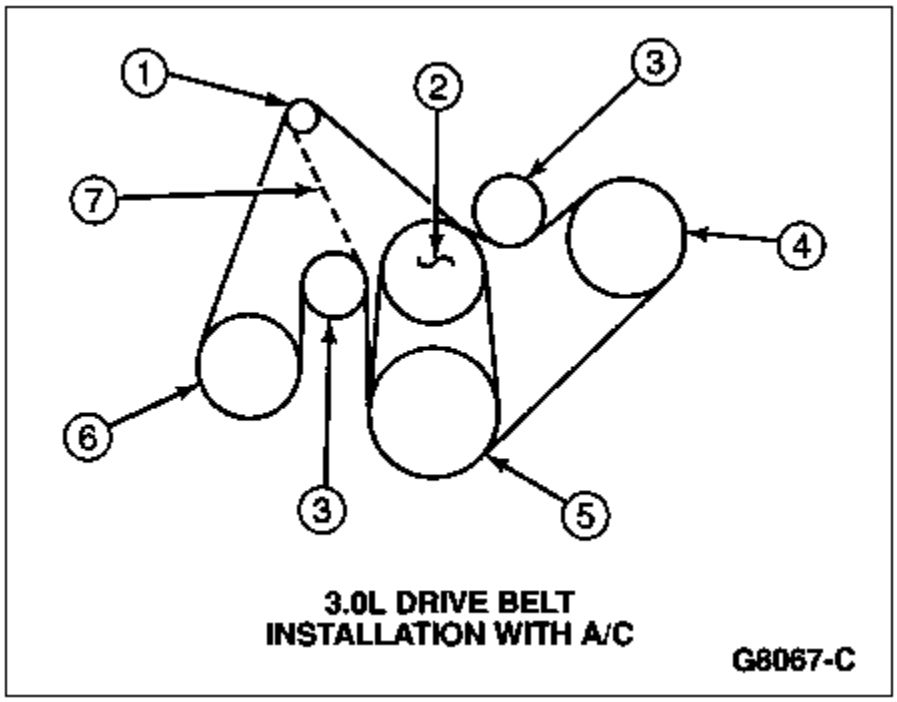
Pump and Pulley

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Steering Pump Pulley Remover	T69L-10300-B
Steering Pump Pulley Replacer	T65P-3A733-C

Removal

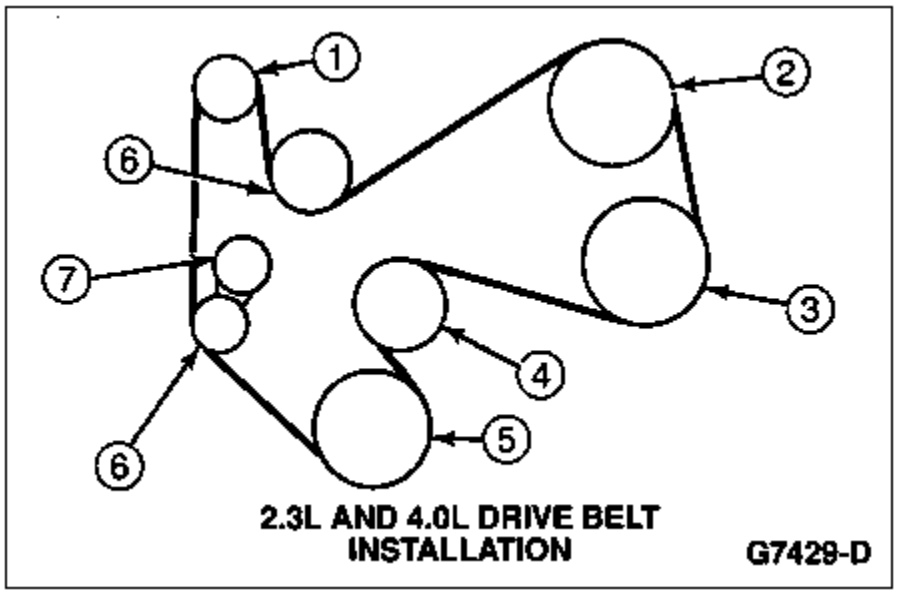
1. Disconnect the power steering return hose (3A713) at the pump and drain fluid.
2. Remove the power steering pressure hose (3A719) by unscrewing connector from the pump.
3. On the Aerostar 3.0L V-6 engine (6007), loosen the drive belt tensioner (6B209) and adjustment bolts.



Item	Part Number	Description
1	10346	Generator
2	8501	Water Pump
3	8678	Belt Idler Pulley
4	3A733	Power Steering Pump Pulley

5	6303	Crankshaft
6	2884	A/C Clutch
7	—	Without A/C

On the 2.3L I-4 and 4.0L V-6 engines, slacken belt tension by lifting drive belt tensioner in a counterclockwise direction. On Ranger 3.0L V-6 engines, slacken belt tension by lifting drive belt tensioner in a clockwise direction. Remove drive belt (8620) from under drive belt tensioner and slowly lower pulley to stop. Remove the drive belt from the power steering pump pulley (3A733).



Item	Part Number	Description
1	10346	Generator
2	2884	A/C Clutch
3	3A733	Power Steering Pump Pulley
4	8501	Water Pump
5	6303	Crankshaft
6	8678	Belt Idler Pulley
7	6B209	Drive Belt Tensioner

4. **NOTE: If the drive belt requires servicing, refer to Section 03-05 .**

   Remove the drive belt from the power steering pump pulley.

5. Remove the oil dipstick tube.

6. Remove the power steering pump support (3C511).

7. Install Steering Pump Pulley Remover T69L-10300-B on the pulley.

8. **NOTE: Do not apply pressure on the power steering pump rotor shaft (3B559). Pressure will damage internal thrust areas of the power steering pump (3A674).**

   While holding the remover tool nut stationary with a wrench, rotate the inner spindle of the remover tool clockwise until the pulley is pulled off the power steering pump rotor shaft.

9. Remove the bolts attaching the power steering pump to the A/C compressor mounting bracket (2882).

Installation

1. Install the power steering pump on the A/C compressor mounting bracket. Install and tighten attaching bolts to 41-61 Nm (30-44 lb-ft). On 4.0L engine, tighten to 47-64 Nm (35-47 lb-ft).

2. Position the support on the A/C compressor mounting bracket. Install mounting bolts and tighten to 47-64 Nm (35-47 lb-ft).

3. **NOTE: Fore/aft location of power steering pump pulley on power steering pump rotor shaft is critical. Incorrect belt alignment may cause drive belt squeal or chirp. Make sure pull-off groove on power steering pump pulley is facing front and flush with end of shaft ± 0.254mm (± 0.010 inch).**

   Install the Steering Pump Pulley Replacer T65P-3A733-C and install the power steering pump pulley.

4. Install the drive belt on the power steering pump pulley.

5. On the 2.3L I-4, Ranger 3.0L V-6, and 4.0L V-6 engines, position and rotate drive belt on engine. While lifting drive belt tensioner in a counterclockwise direction (clockwise on Ranger 3.0L V-6), slide drive belt under drive belt tensioner and lower drive belt tensioner to drive belt.

   On Aerostar 3.0L V-6 engine, position the belt idler pulley (8678) assembly to give the drive belt the tension specified. Refer to belt tension check in Section 03-05 . Tighten the drive belt tensioner and adjustment bolts to 47-64 Nm (35-47 lb-ft).

6. Install the power steering pump support, if removed.

7. Install the oil dipstick tube.

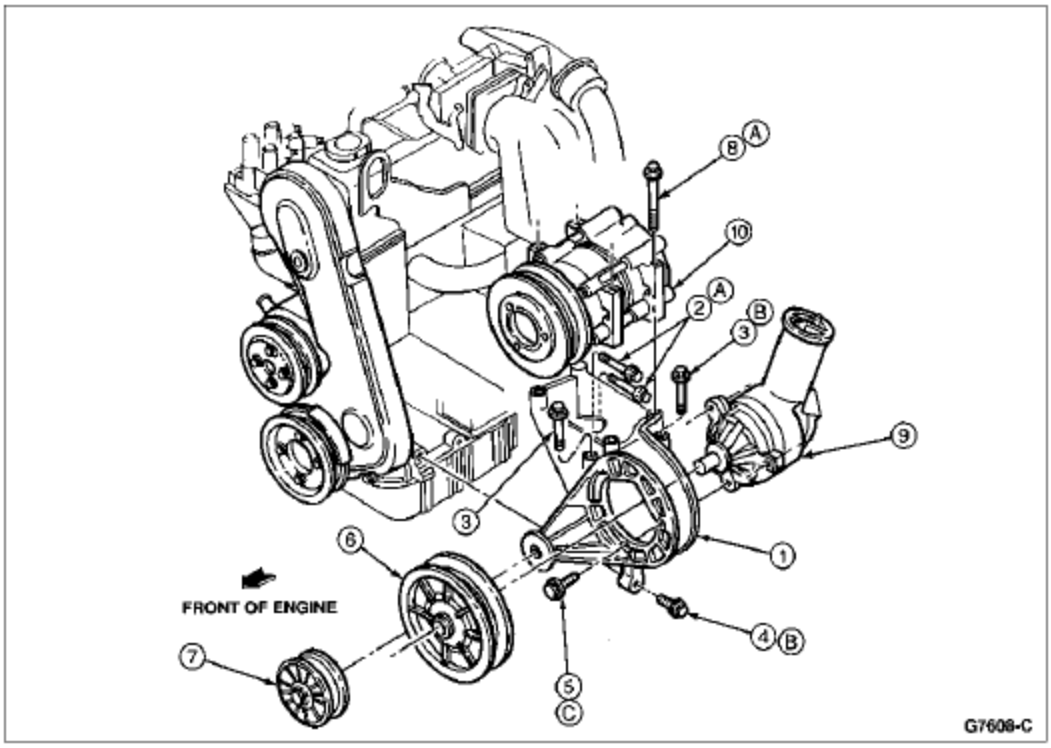
8. Install the pressure hose tube nut and new Teflon® wagner into power steering pump valve outlet fitting (3D654) and tighten to 30-40 Nm (22-30 lb-ft).

9. Connect the power steering return hose to the power steering pump, and reposition the clamp.

10. Fill the power steering fluid reservoir with Motorcraft MERCON® ATF Power Steering fluid meeting Ford specifications MERCON® . Start the engine and turn the steering wheel (3600) from left to right without hitting stops to remove air from the system.

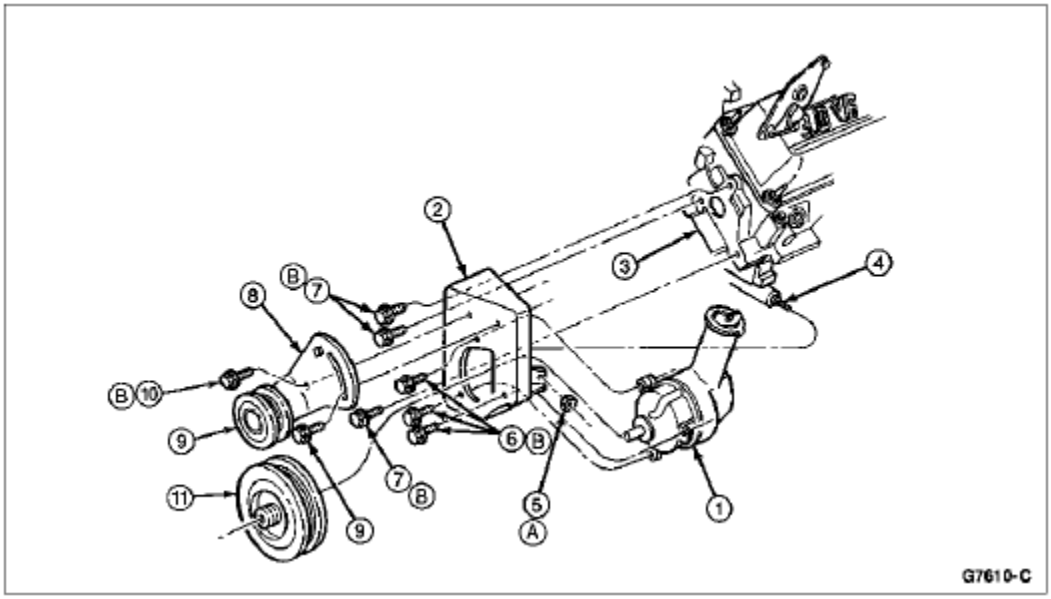
11. Check for leaks and recheck the fluid level. Add fluid if necessary to proper level as specified in Section 11-00 .

Power Steering Pump and Power Steering Pulley, 2.3L TPH Engine, Ranger Only



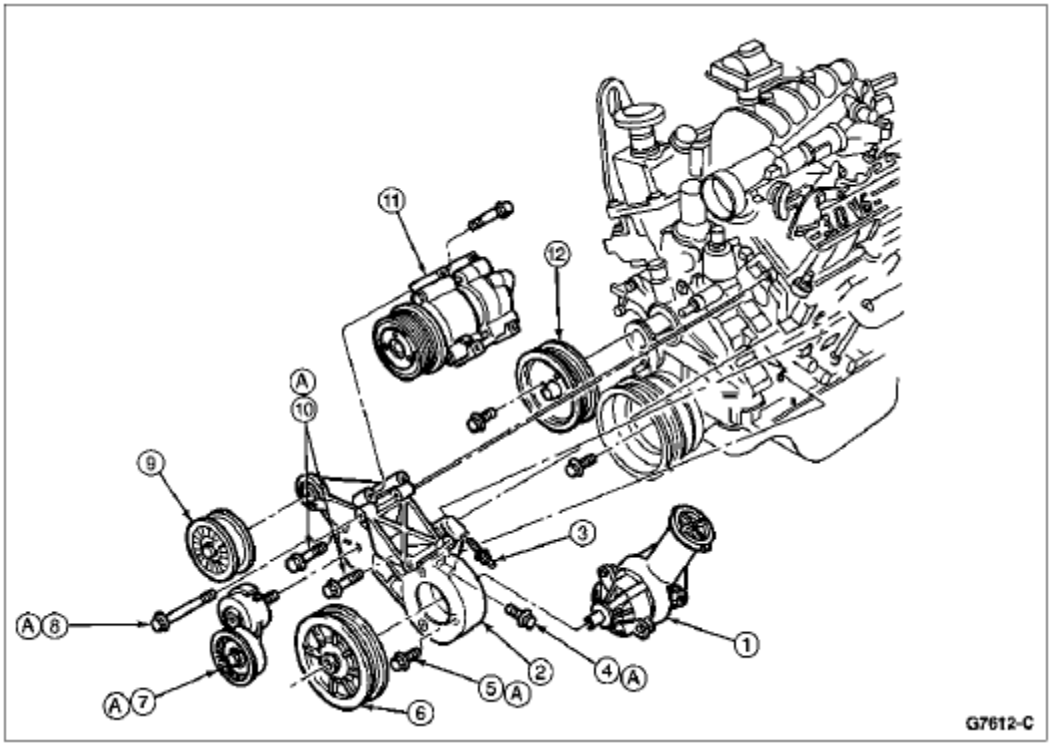
Item	Part Number	Description
1	2882	A/C Compressor Mounting Bracket
2	N606543-S2	Bolt (2 Req'd)
3	N606069-S2	Bolt (2 Req'd)
4	N605803-S2	Bolt
5	N800199-S8M	Screw
6	3D673	Power Steering Pump Pulley
7	3F671	Power Steering Belt Idler Support
8	N806020-S2	Bolt
9	3A674	Power Steering Pump
10	19703	A/C Compressor
A	—	Tighten to 21-29 Nm (16-21 Lb-Ft)
B	—	Tighten to 40-55 Nm (30-41 Lb-Ft)
C	—	Tighten to 41-61 Nm (30-44 Lb-Ft)

Power Steering Pump and Power Steering Pulley, 3.0L Engine, Aerostar



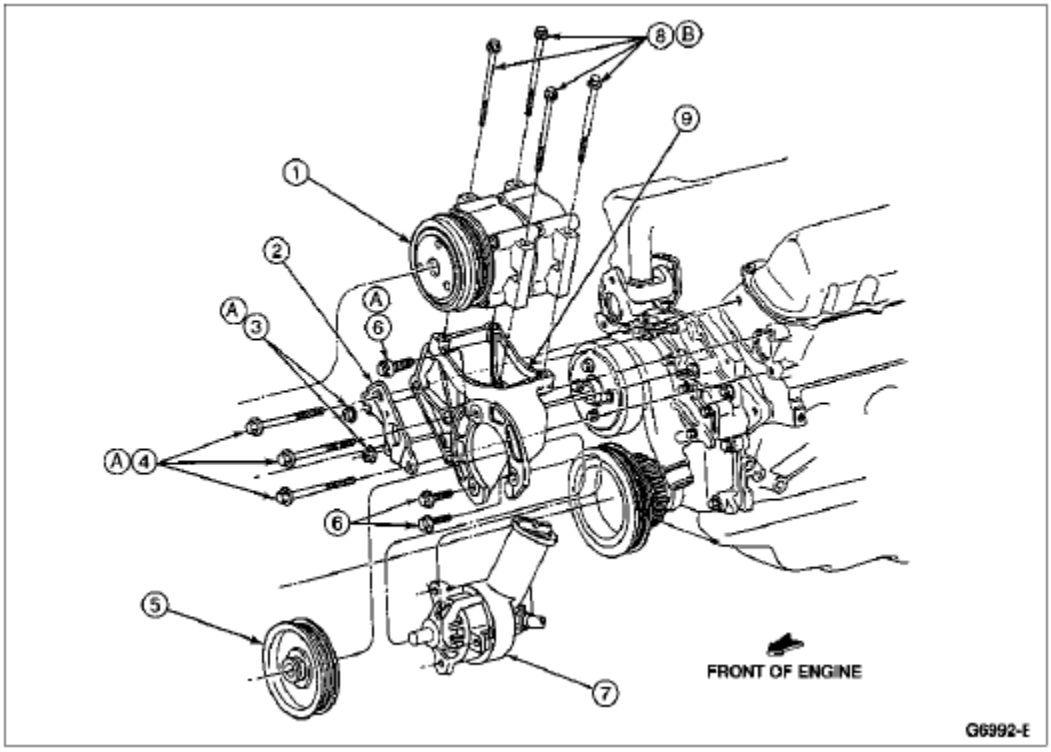
Item	Part Number	Description
1	3A674	Power Steering Pump
2	3C511	Power Steering Pump Support
3	6007	Engine
4	N803564	Stud
5	N802827-S2	Nut
6	N800199-S8M	Screw (3 Req'd)
7	N8011179-S2	Screw (3 Req'd)
8	3F671	Power Steering Belt Idler Support
9	8678	Belt Idler Pulley
10	N800199-S8M	Screw
11	3A733	Power Steering Pump Pulley
A	—	Tighten to 34-47 Nm (25-34 Lb-Ft)
B	—	Tighten to 47-64 Nm (34-47 Lb-Ft)

Power Steering Pump and Power Steering Pulley, 3.0L Engine, Ranger



Item	Part Number	Description
1	3A674	Power Steering Pump
2	2882	A/C Compressor Mounting Bracket
3	N803801	Stud
4	N605804-S2	Bolt
5	N800199-S8M	Bolt
6	3A733	Power Steering Pump Pulley
7	6B209	Drive Belt Tensioner
8	N803958-S2	Bolt
9	8678	Belt Idler Pulley
10	N606068-S2	Bolt (2 Req'd)
11	19D627	A/C Compressor
12	8509	Water Pump Pulley
A	—	Tighten to 47-64 Nm(34-47 Lb-Ft)

Power Steering Pump and Power Steering Pulley, 4.0L Engine, Aerostar, Ranger



Item	Part Number	Description
1	19703	A/C Compressor
2	3A732	Power Steering Pump Bracket
3	N620481-S2	Nut (2 Req'd)
4	N606572-S2	Bolt (3 Req'd)
5	3A733	Power Steering Pump Pulley
6	N800199-S8M	Screw
7	3A674	Power Steering Pump
8	N806020-S2	Bolt (4 Req'd)
9	2882	A/C Compressor Mounting Bracket
A	—	Tighten to 40-55 Nm (30-40 Lb-Ft)
B	—	Tighten to 21-29 Nm (15-21 Lb-Ft)

SPECIFICATIONS

GENERAL SPECIFICATIONS

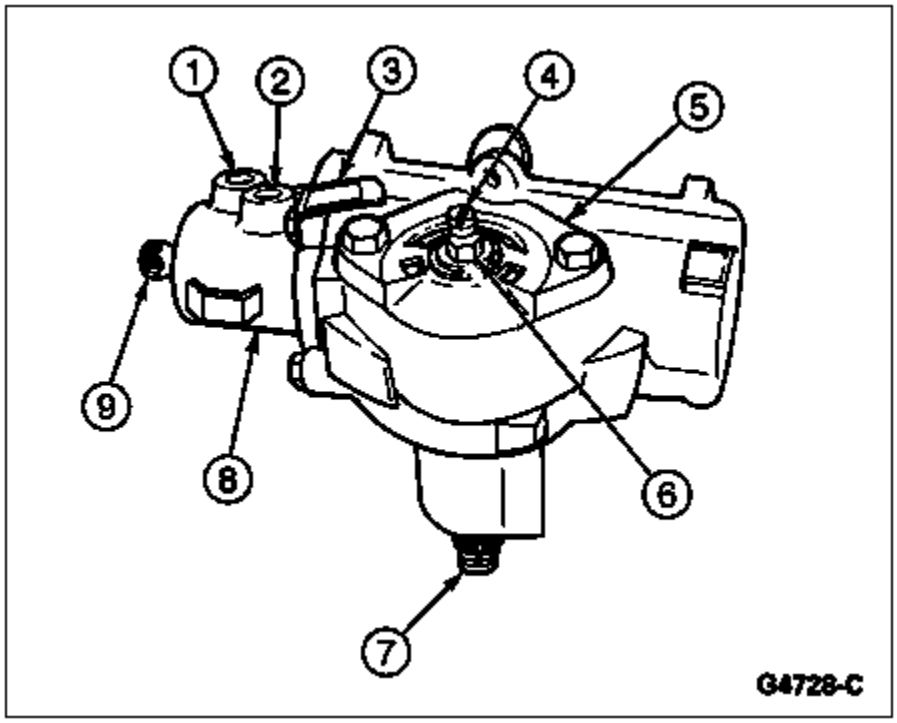
Item	Specification
Lubricants	
Motorcraft MERCON® ATF Power Steering Fluid Meeting Ford Specification	MERCON®

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft
Power Steering Pump to A/C Bracket, Bolt 2.3	41-61	30-44
Power Steering Pump to A/C Bracket, Bolt 3.0	47-64	34-47
Power Steering Pump to A/C Bracket, Bolt 4.0	40-55	30-40
A/C Compressor Bracket to Engine Block, Bolt	47-64	34-47
A/C Compressor to A/C Compressor Bracket, Bolt	21-29	15-21
Power Steering Mounting Bracket, Nut 3.0	34-47	25-35
Power Steering Support Bracket to Engine Block, Nut 3.0	34-47	24-34
Power Steering Support Bracket to Engine Block, Nut 4.0	40-55	30-40
Power Steering Idler Pulley Assembly Pivot Bolt 3.0	47-64	35-47
Power Steering Idler Pulley Assembly Adjusting Bolt 3.0	47-64	35-47
Power Steering Pressure Hose to Pump	30-40	22-30

Steering Gear

The steering gear (3504) is a torsion-bar type of hydraulic assisted system. The system includes steering gear input worm gear and rack (3524) which is meshed to the gear teeth on the steering gear sector shaft (3575). The steering gear also includes a rotary-style hydraulic valve consisting of an input shaft, control valve sleeve and torsion bar. The valve sleeve is pinned to the worm. The input shaft is connected to the worm through the torsion bar. The other end of input shaft attaches to the steering column and steering wheel (3600).



Item	Part Number	Description
1	—	Outlet Port (Part of 3504)
2	—	Inlet Port (Part of 3504)
3	—	Identification Tag (Part of 3504)
4	—	Sector Shaft Adjusting Screw (Part of 3575)
5	3568	Steering Gear Housing End Cover
6	—	Locknut (Part of 3575)
7	3575	Steering Gear Sector Shaft
8	3C516	Control Valve Housing
9	3524	Steering Gear Input Worm Gear and Rack

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Steering Gear

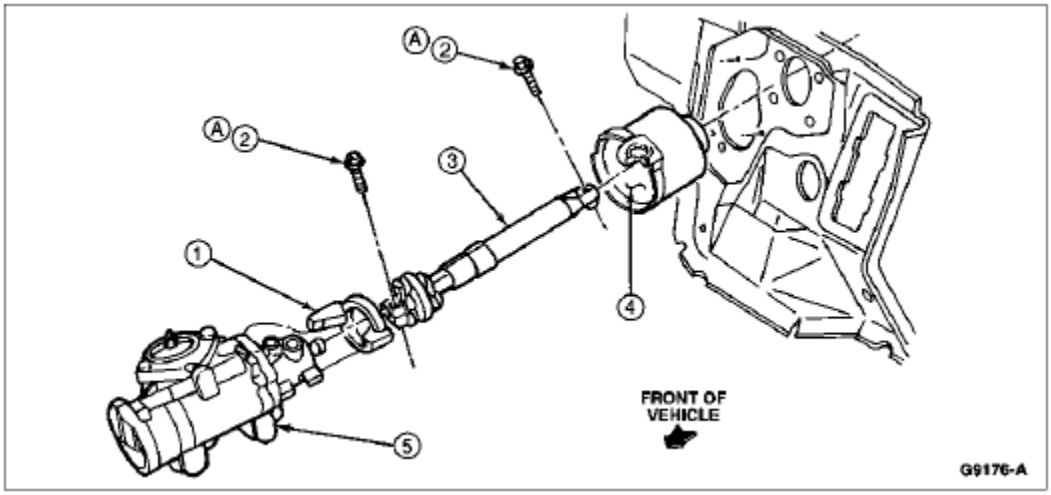
SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Pitman Arm Puller	T64P-3590-F

Removal

1. Unscrew the nuts attaching the power steering pressure hose (3A719) and power steering return hose (3A713) to the steering gear (3504) using a flare nut wrench. Plug the lines and the ports in the steering gear.

Power Steering Installation



Item	Part Number	Description
1	3F540	Steering Shaft U-Joint Shield (Lower)
2	N803942-S100	Steering Column Intermediate Shaft Pinch Bolt
3	3A525	Steering Column Intermediate Shaft Coupling
4	3F540	Steering Shaft U-Joint Shield (Upper)
5	3504	Steering Gear
A	—	Tighten to 40.3-54.7 Nm (29.4-39.9 Lb-Ft)

2. Slide the upper steering shaft u-joint shield (3F540) from the lower steering column shaft (3B676) to access pinch bolt. Remove the bolt and disconnect the lower steering column shaft at the steering gear.

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3. Raise the vehicle and remove the steering gear sector shaft arm (3590) from the steering gear sector shaft (3575) using Pitman Arm Puller T64P-3590-F. Remove the tool from the steering gear sector shaft arm.

4. Support the steering gear, and remove the bolts attaching the steering gear.

5. Work the steering gear free of the steering column intermediate shaft. Remove the steering gear from the vehicle, then remove the lower steering shaft u-joint shield.

Installation

1. Install the steering shaft u-joint shield onto the steering gear lugs.

2. Slide the steering shaft u-joint shield into place on the steering shaft assembly. Turn the steering wheel so the spokes are in the horizontal position.

3. Center the steering gear input shaft with the indexing flat facing down.

4. Slide the steering gear input shaft into the steering column intermediate shaft and into place on the frame side rail. Install the attaching bolts and tighten to 68-84 Nm (50-62 lb-ft). Tighten the steering column intermediate shaft pinch bolt to 40.3-54.7 Nm (29.4-39.9 lb-ft).

5. Be sure the wheels are in the straight ahead position, then install the steering gear sector shaft arm on the sector shaft. Install the steering gear sector shaft arm attaching washer and nut. Tighten nut to 230-310 Nm (170-228 lb-ft).

6. Connect and tighten the pressure and the return lines to the steering gear to 27-41 Nm (20-30 lb-ft).

7. Snap the upper and lower steering gear shaft U-joint shields together.

8. Disable ignition. Fill the reservoir to specifications listed in Section 11-00 . Crank the engine by operating the ignition switch in start mode while turning the steering wheel from left to right to distribute the fluid.

9. Recheck fluid level and add Premium Power Steering Fluid E6AZ-19582-AA or equivalent meeting Ford specification ESW-M2C33-F if necessary. Restore ignition. Start the engine and turn the steering wheel from side to side. Inspect for fluid leaks. Recheck fluid level. Refer to Section 11-00 to purge the system of air if necessary.

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Steering Gear Input Shaft Oil Seal Kit, XR50

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Adjuster and Locknut Wrench	T66P-3553-B
Bench Mounted Holding Fixture	T57L-500-B
Puller	T58L-101-B
Impact Slide Hammer	T59L-100-B
Input Shaft Bearing/Seal Tool Set	T65P-3524-A1, T65P-3524-A2 and T65P-3524-A3

Removal

Take precautions when removing the steering gear; use a clean workbench and tools; handle all parts carefully to avoid nicks, burrs, scratches and dirt.

1. Remove the steering gear (3504) from the vehicle. Refer to the procedure in this section.
2. Drain all the remaining fluid from the steering gear into a suitable container.
3. Mount the steering gear vertically in a soft-jawed vice with the power steering gear input shaft and control (3D517) pointing up.
4. Remove the four bolts retaining the valve housing to the steering gear.
5. Turn the loosened valve housing clockwise until there is approximately 34mm (1.5 inch) between the valve housing and the steering gear housing (3548).
6. Insert two bolts, approximately 62mm in length, through the valve housing to the steering gear keeping the 34mm clearance between the valve housing and the steering gear.
7. Remove the locknut retaining setscrew from the valve housing.
8. Using Adjuster and Locknut Wrench T66P-3553-B remove the steering gear worm thrust bearing locknut (3707).
9. Remove the previously installed 62mm bolts and then remove the valve housing.
10. Mount the valve housing into Bench Mounted Holding Fixture T57L-500-B.
11. Using Puller T58L-101-B and Impact Slide Hammer T59L-100-B, remove the dust seal from the valve housing.
12. Remove the snap ring from the valve housing.
13. Turn the bench mounted holding fixture to invert the valve housing.

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14. Insert Input Shaft Bearing/Seal Tool Set T65P-3524-A2 and T65P-3524-A3 into the valve body assembly opposite the oil seal end, and gently tap the bearing and the pressure seal out of the housing.

Installation

1. Inspect steering gear worm ball (3647) and power steering gear input shaft and control for any damage. Replace components as required.

2. Coat the steering gear worm ball and seal surface of the housing with petroleum jelly or equivalent.

3. Install the steering gear worm ball with the metal side covering, facing the rollers outward. Seat the steering gear worm ball in the valve housing using Tool T65P-3524-A1. Be sure steering gear worm ball rotates freely.

4. Dip a new oil seal in Manual Transmission Fluid (SAE 80W) F2ZZ-19C547-A or equivalent lubricant meeting Ford specification ESP-M2C83-C and place it in the housing with the metal side facing outward. Drive the seal into the housing until the outer edge does not quite clear the snap ring groove.

5. Insert the snap ring in the housing until it is fully seated in the groove.

6. **NOTE: When the valve housing is reinstalled, the seal will be located just past the undercut in the power steering gear input shaft and control.**

   Place the new dust seal in the housing with the dished side facing out. Using Tool T65P-3524-A3 drive dust seal into place.

7. Pack the area between the two seals with Multi-Purpose Grease D0AZ-19584-AA or equivalent meeting Ford specification ESB-M1C93-B and ESR-M159-A.

8. Inspect valve housing O-ring for damage. Replace if required.

9. Install the valve housing on the power steering gear input shaft and control. Install the two 62mm temporary bolts keeping 34mm between the valve housing and the steering gear housing as done during Step 6 of the removal process.

10. Install the steering gear worm thrust bearing locknut and tighten to 75-122 Nm (55-90 lb-ft). Install the locknut setscrew.

11. Remove the 62mm temporary bolts and position the valve housing onto the steering gear housing. Install the valve housing retaining bolts and tighten to 40-60 Nm (30-45 lb-ft).

12. Remove the steering gear from the soft-jawed vise and install it into the vehicle. Refer to the procedure in this section.

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Steering Gear

Take the following precautions when servicing the steering gear (3504):

- Use a clean workbench and tools.
- Thoroughly clean the exterior of the steering gear with solvent and drain off excess hydraulic fluid, if necessary.
- Handle all parts carefully to avoid nicks, burrs, scratches and dirt.
- Do not use solvent on seals.

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Bench Mounted Holding Fixture	T57L-500-B
Adjuster and Locknut Wrench	T66P-3553-B
Spacer — Valve Housing to Piston	T66P-3553-C

Disassembly

1. Remove steering gear; refer to procedure in this section.

2. Hold the steering gear upside down over a drain pan and cycle the power steering gear input shaft and control (3D517) several times to drain the fluid from the steering gear.

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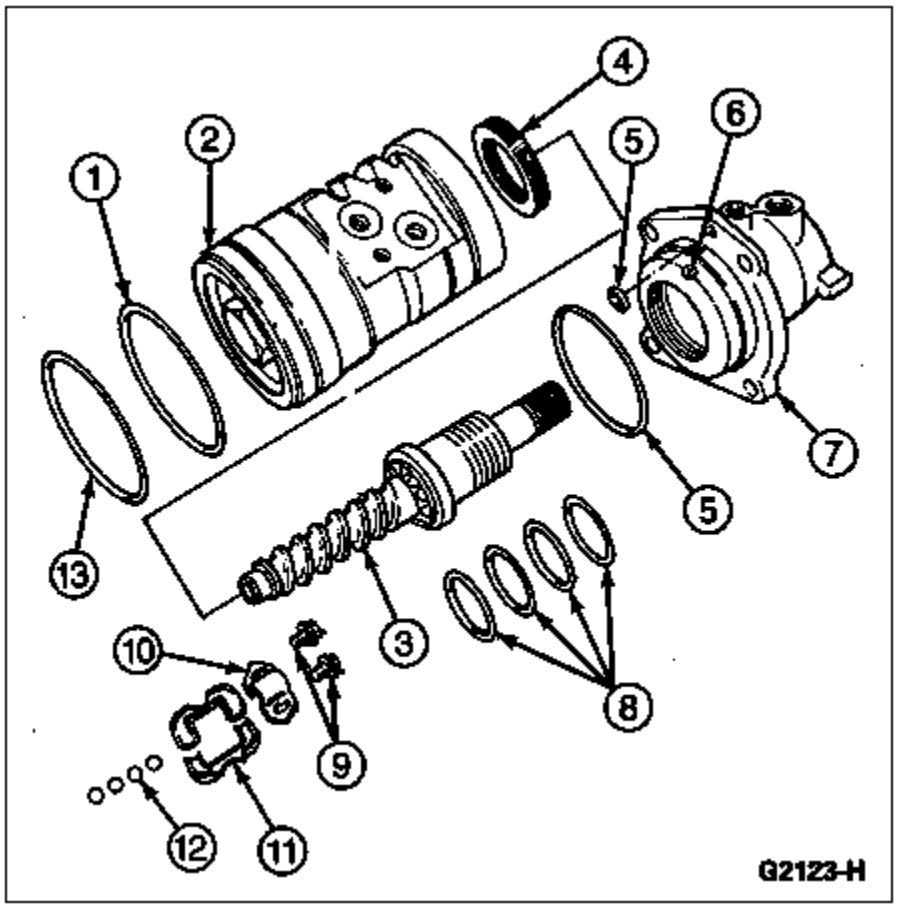

Item	Part Number	Description
1	—	Piston Ring (Part of 3E502)
2	—	Piston (Part of 3E502)
3	3524	Steering Gear Input Worm Gear and Rack
4	3707	Steering Gear Worm Thrust Bearing Locknut
5	—	O-Ring (Part of 3E502)
6	—	Race Locknut Setscrew (Part of 3C516)
7	3C516	Valve Housing
8	—	Valve Sleeve Seals (Part of 3E501)
9	—	Clamp Guide Bolts
10	3544	Steering Gear Ball Return Guide Clamp
11	3523	Steering Gear Ball Return Guide
12	3647	Steering Gear Worm Ball
13	3F520	Rack Seal

3. Secure the steering gear in a soft-jawed vise.

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4. **NOTE: The indexing flat on the power steering gear input shaft and control should be facing downward.**

   Turn the power steering gear input shaft and control to either stop; then turn it back two turns to center the steering gear.

5. Remove the attaching bolts of the steering gear housing end cover (3568).

6. Tap the lower end of the steering gear sector shaft (3575) with soft hammer and lift the steering gear housing end cover and steering gear sector shaft from the steering gear **as an assembly.** Discard the O-ring.

7. **NOTE: The following step is required only when it is necessary to remove steering gear sector shaft from the steering gear.**

   Remove the nut from the sector shaft adjusting screw. Turn the steering gear housing end cover counterclockwise and remove it from the sector shaft adjuster screw. It may be necessary to hold the screw with a screwdriver.

8. **NOTE: If valve housing or the valve sleeve seals are to be replaced, proceed to Step 11. If steering gear sector shaft housing oil seals (3591) are to be replaced go to steering gear procedure. The steering gear worm ball (3647) needs to be removed if the valve sleeve rings are to be replaced.**

   Remove the valve housing attaching bolts and identification tag. Lift the valve housing off the steering gear. Remove the valve, piston assembly and control valve gasket. Discard the gasket.

9. With the piston held so the steering gear ball return guide (3523) faces up, remove the steering gear ball return guide clamp (3544).

10. With a finger over the opening in the steering gear ball return guide turn the piston so the steering gear ball return guide faces down over a clean container. Let the steering gear ball return guide drop into the container.

11. Rotate the power steering gear input shaft and control from stop to stop until all steering gear worm balls fall from the piston into the container. The valve assembly can then be removed from the piston. Inspect the piston bore to make sure all balls have been removed.

12. Install the valve body assembly in the Bench Mounted Holding Fixture T57L-500-B and loosen the steering gear worm thrust bearing locknut (3707) from the valve housing.

13. Remove the steering gear worm thrust bearing locknut using Adjuster and Locknut Wrench T66P-3553-B and Spacer — Valve Housing to Piston T66P-3553-C.

14. **NOTE: Piston need not be in place if removed to facilitate valve sleeve seal replacement.**

    Carefully slide the power steering gear input shaft and control, steering gear and valve assembly out of the valve housing.

15. Clean and inspect all components; refer to the procedure in this section.

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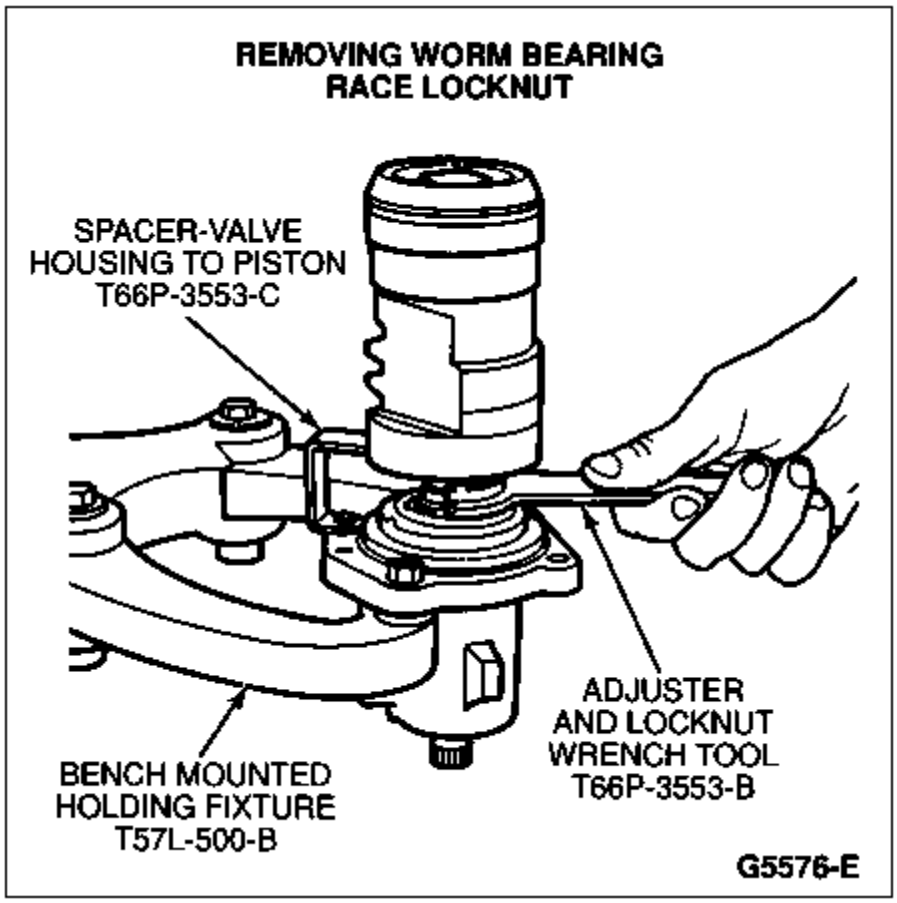

Assembly

1. Mount the valve housing in the bench mounted holding fixture with the flanged end up.
2. Apply a light coat of Premium Power Steering Fluid E6AZ-19582-AA or equivalent meeting Ford specification ESW-M2C33-F to the Teflon® rings on the valve sleeve.
3. Carefully install the steering gear input worm gear and rack (3524) in the housing.
4. Install the steering gear worm thrust bearing locknut in the housing and tighten to 75-122 Nm (55-90 lb-ft).
5. Install the Allen head race locknut setscrew through the power steering gear control valve housing o-ring (3756) and tighten to 1.7-2.8 Nm (15-25 lb-in).
6. Place the piston on the bench with the steering gear ball return guide holes facing up. Insert the steering gear input worm gear and rack into the piston so the first groove is in line with the hole nearest the center of the piston.
7. Place the steering gear ball return guide in the piston. Turning the power steering gear input shaft and control counterclockwise, place the same steering gear worm ball as removed in Step 9 of Steering Gear Disassembly in the steering gear ball return guide. During assembly 27 to 29 balls are required. If all the balls have not been inserted upon reaching the left stop, rotate the power steering gear input shaft and control in one direction, then the other while inserting the remaining balls.

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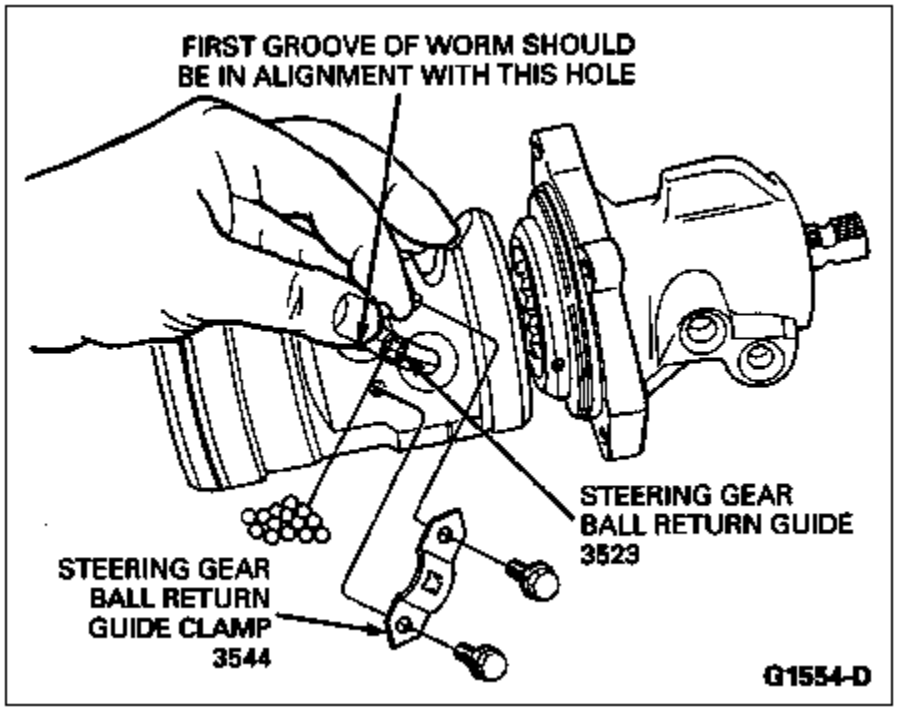
Steering Gear Assembly



8. Secure the steering gear ball return guide in the ball nut with the steering gear ball return guide clamp. Tighten bolts to 4.8-7.9 Nm (42-70 lb-in).

9. Apply petroleum jelly or equivalent to the Teflon® seal on the piston.

10. Place a new steering gear sector shaft housing cover gasket (3581) on the valve housing.

11. Slide the piston and valve into the steering gear housing (3548) being careful not to damage the front suspension steering ball stud dust seal (3332).

12. Align the oil passage in the power steering gear control valve housing o-ring with the passage in the steering gear housing. Place a new O-ring onto the oil passage hole of the steering gear housing. Install identification tag onto the steering gear housing. Install, **but do not tighten,** the attaching bolts. Identification tag is to be installed under upper right valve housing bolt.

13. Rotate the piston so the teeth are in the same plane as the steering gear sector shaft. Tighten the attaching bolts of power steering gear control valve housing o-ring to 41-62 Nm (30-45 lb-ft).

14. Position the steering gear sector shaft housing oil seal in the steering gear housing. Turn the power steering gear input shaft and control to center the piston.

15. Apply petroleum jelly or equivalent to the steering gear housing, and position the steering gear sector shaft and steering gear housing end cover assembly in the gear housing. Install the steering gear housing end cover. Tighten the bolts to 75-94 Nm (55-70 lb-ft).

16. Attach an inch-pound torque wrench to the power steering gear input shaft and control. Adjust meshload to specification. Refer to Specifications chart.

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Piston

Disassembly

1. Disassemble steering gear; refer to procedure in this section.
2. Remove the Teflon® piston seal and O-ring from the piston and ball nut. Discard both seal and O-ring.

Assembly

1. Dip a **new** O-ring in Premium Power Steering Fluid E6AZ-19582-AA or equivalent meeting Ford specification ESW-M2C33F and install it on the piston and ball nut.
2. Install a **new** Teflon® piston seal on the piston and ball nut being careful not to stretch it more than necessary.
3. Assemble the steering gear. Refer to the procedure in this section.

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Steering Gear Housing

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Bench Mounted Holding Fixture	T57L-500-B
Puller	T58L-101-B
Impact Slide Hammer	T59L-100-B
Sector Shaft Seal Replacer	T77L-3576-A

Disassembly

1. Disassemble steering gear; refer to procedure in this section.
2. Remove the snap ring from the lower end of the steering gear housing (3548).
3. Remove dust seal using Puller T58L-101-B and Impact Slide Hammer T59L-100-B. Discard the seal.
4. Remove pressure seal in the same manner. Discard the seal.

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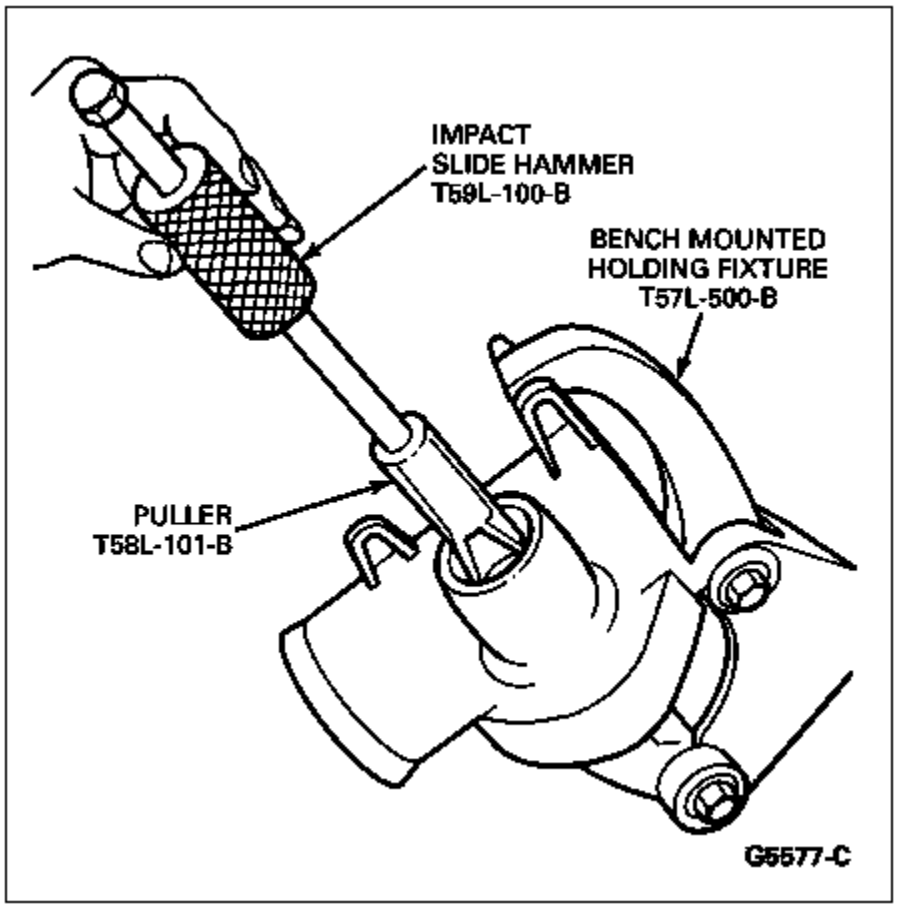

Assembly

1. **NOTE: Proper seal installation tools and procedures must be used to prevent damage to seals during assembly.**

   Lubricate the new pressure seal and dust seal with Ford Multi-Purpose Grease D0AZ-19584-AA or equivalent meeting Ford specification ESB-M1C93-B and ESR-M159-A.

2. Apply Ford Multi-Purpose Grease D0AZ-19584-AA or equivalent meeting Ford specification ESB-M1C93-B and ESR-M159-A to the sector shaft seal bore.

3. Place the dust seal on Sector Shaft Seal Replacer T77L-3576-A so the raised lip of the seal is toward the tool.

4. **NOTE: Failure to use proper seal installation tools and procedures may damage the seals and cause a fluid leak.**

   Place the pressure seal on the tool with lip away from the tool. The flat back side of the pressure seal should be against the flat side of the dust seal.

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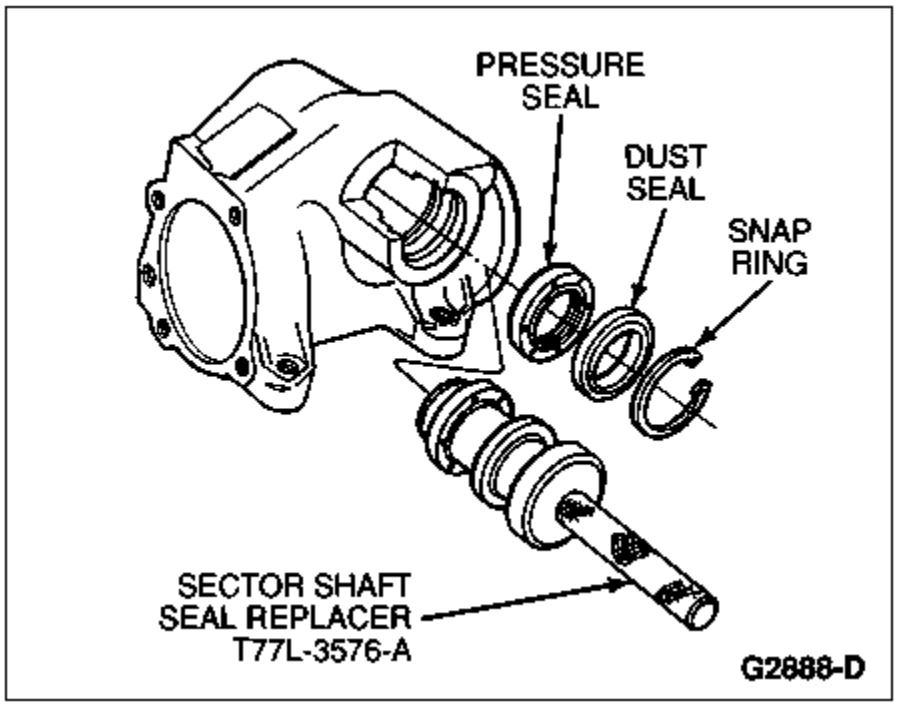

5. **CAUTION: Do not bottom seals against bearing.**

   Insert the seal driver tool into the sector shaft bore and drive the tool until the seals clear the snap ring groove. The seal will not function properly when bottomed against the bearing.

6. Install snap ring in the groove in the steering gear housing.

7. Apply a generous amount of Ford Multi-Purpose Grease D0AZ-19584-AA or equivalent meeting Ford specification ESB-M1C93-B and ESR-M159-A, to the areas between the two seal lips.

8. Assemble the steering gear; refer to the procedure in this section.

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Valve Housing

SPECIAL SERVICE TOOL(S) REQUIRED

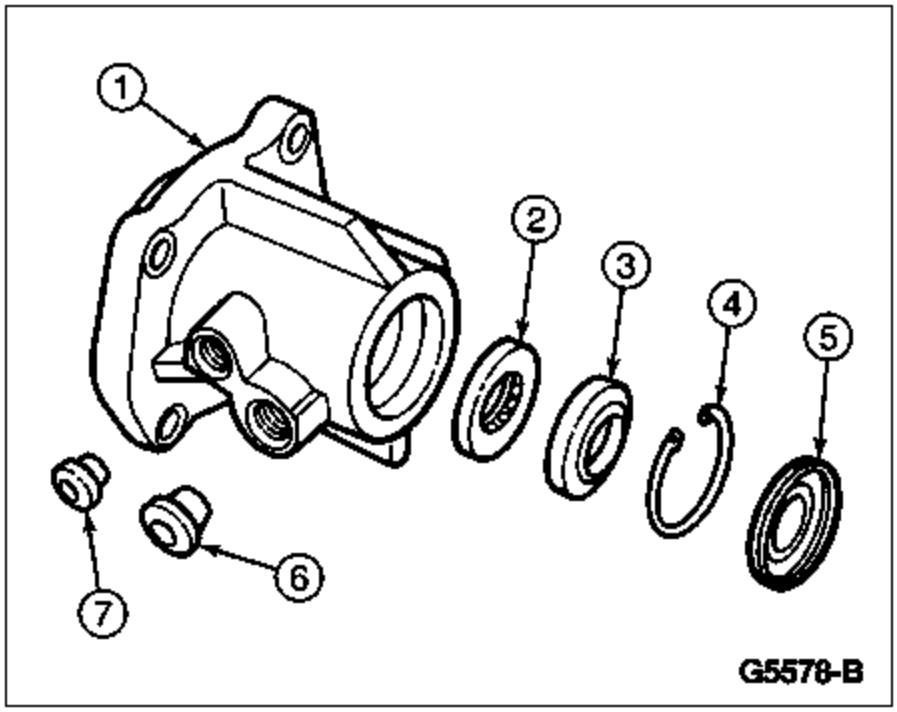
Description	Tool Number
Puller	T58L-101-B
Impact Slide Hammer	T59L-100-B
Bench Mounted Holding Fixture	T57L-500-B
Input Shaft Bearing/Seal Tool Set	T65P-3524-A1, T65P-3524-A2 and T65P-3524-A3
Brass Tube Seat Remover	T74P-3504-L
Brass Tube Seat Replacer	T74P-3504-M

CAUTION: Do not damage the housing when inserting and removing the tools.

Disassembly

1. Disassemble steering gear; refer to procedure in this section.

2. With worm shaft removed remove the dust seal from the valve housing using Puller T58L-101-B and Impact Slide Hammer T59L-100-B. Discard the seal.



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Item	Part Number	Description
1	3A587	Valve Housing
2	—	Bearing (Part of 3D526)
3	3D526	Power Steering Input Shaft Seal
4	352109-S	Snap Ring
5	3D527	Power Steering Gear Input Shaft Dust Seal
6	374480-S	Output Tube Seat
7	374309-S	Inlet Tube Seat

3. Remove the snap ring from the valve housing.

4. Turn Bench Mounted Holding Fixture T57L-500-B to invert valve housing.

5. Insert Input Shaft Bearing/Seal Tool Set T65P-3524-A2 and T65P-3524-A3 in the valve housing opposite the oil seal end and gently tap the bearing and seal out of the housing. Discard the seal.

6. Remove the fluid inlet and outlet tube seats with Brass Tube Seat Remover T74P-3504-L if they are damaged.

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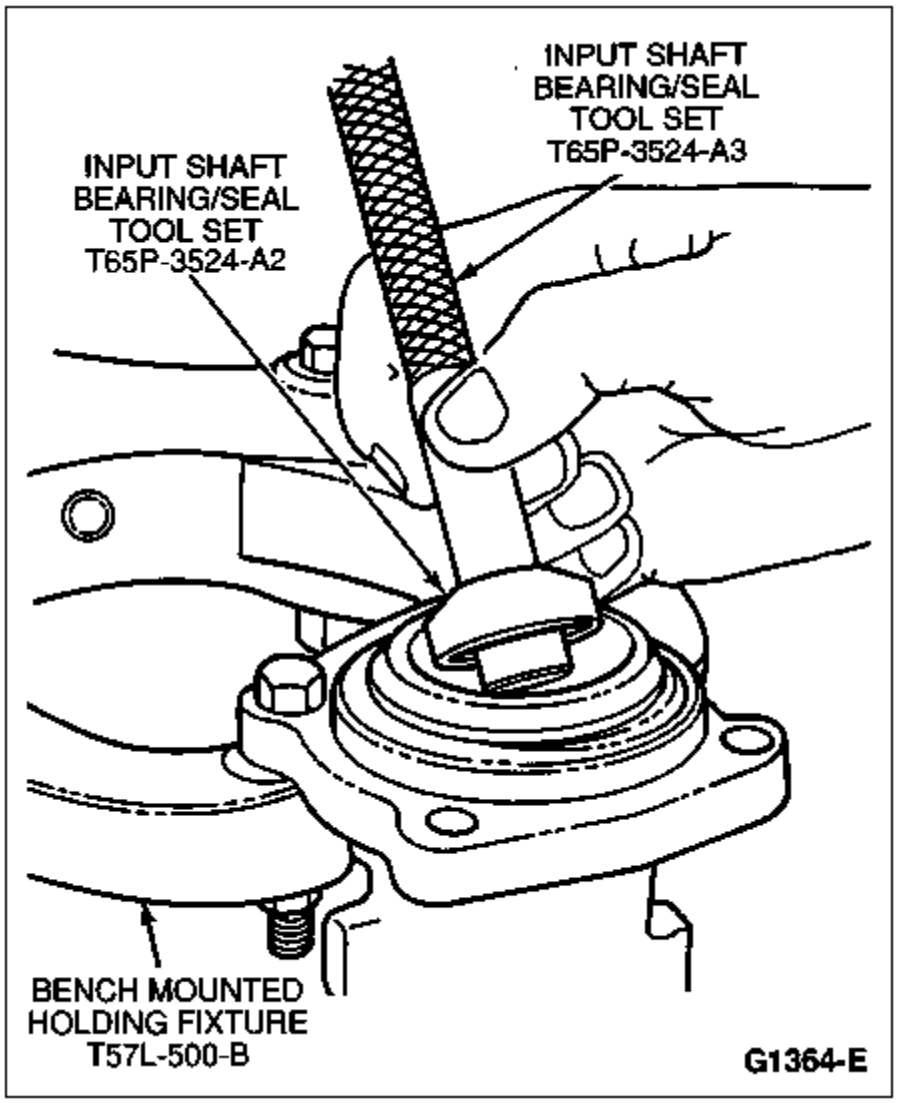

Assembly

1. Coat the fluid inlet and outlet tube seats with petroleum jelly or equivalent. Install seats in the housing with a Brass Tube Seat Replacer T74P-3504-M.

2. Coat the bearing and seal surface of the steering gear housing (3548) with petroleum jelly or equivalent.

3. Install the bearing with the metal side covering the rollers facing outward. Seat the bearing in the valve housing using Input Shaft Bearing/Seal Tool Set T65P-3524-A1. Be sure the bearing rotates freely.

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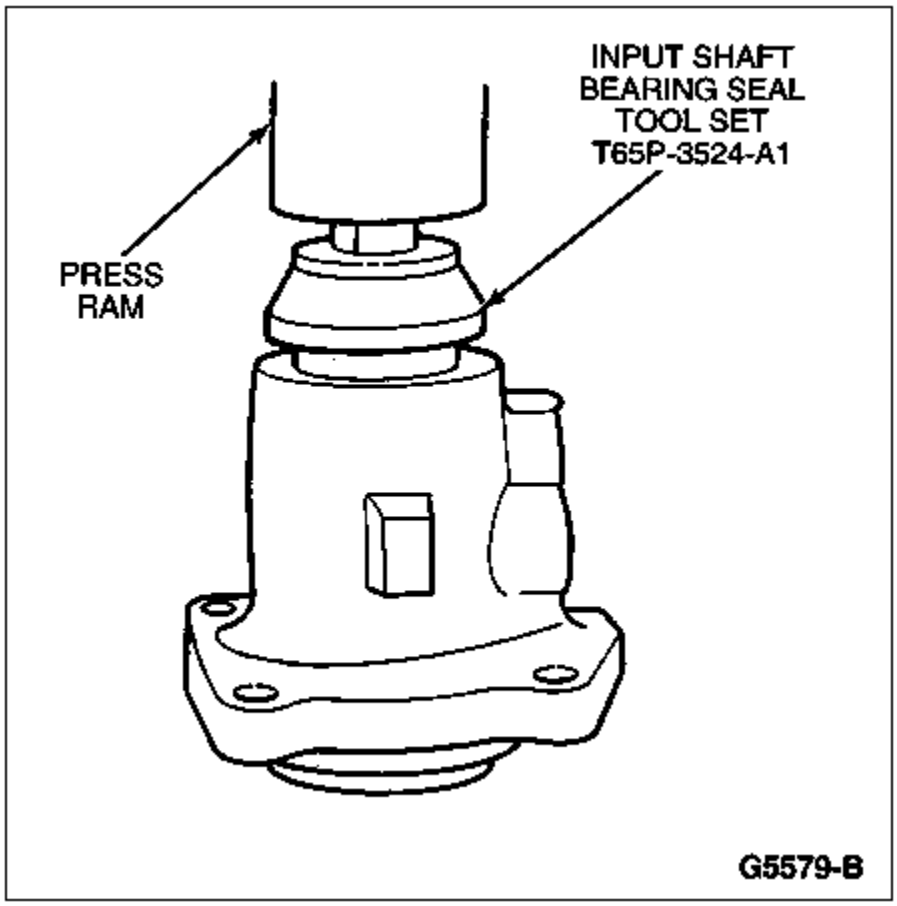

4. Dip a new oil seal in Premium Power Steering Fluid E6AZ-19582-AA or equivalent meeting Ford specification ESW-M2C33-F and place it in the housing with the metal side facing outward. Drive the seal into the housing until the outer edge does not quite clear the snap ring groove.

5. Place the snap ring in the housing and drive on the ring using Input Shaft Bearing/Seal Tool Set T65P-3524-A1 until the snap ring seats in its groove.

6. Place the dust seal in the housing with the dished side (rubber side) facing out. Drive the dust seal into place using Input Shaft Bearing/Seal Tool Set T65P-3524-A1. When properly installed, the seal will be located behind the undercut in the power steering gear input shaft and control (3D517).

7. Apply a generous amount of Ford Multi-Purpose Grease D0AZ-19584-AA or equivalent meeting Ford specification ESB-M1C93-B and ESR-M159-A to the area between the two seals.

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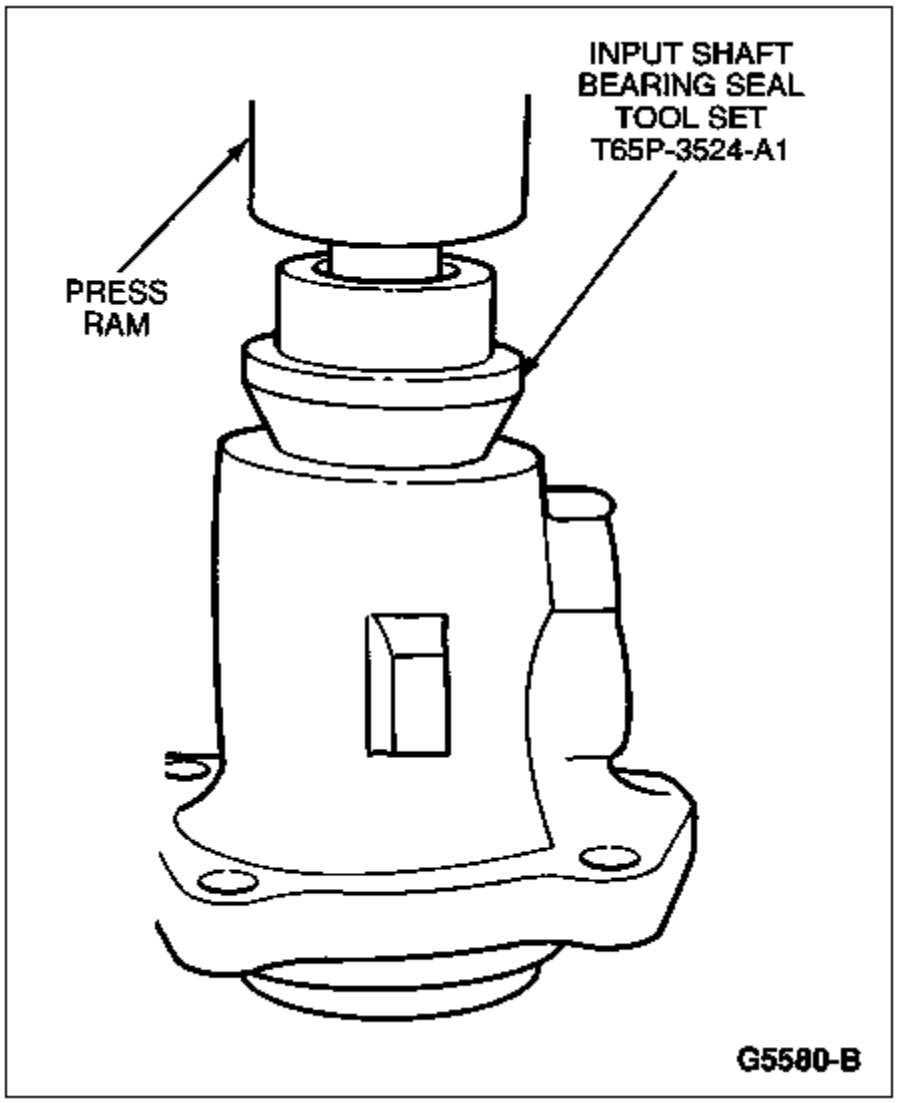

8. Assemble the steering gear; refer to the procedure in this section.

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Steering Gear

Cleaning

CAUTION: Do not clean, wash or soak in the cleaning solvent,

Disassembly and assembly of the steering gear and subassemblies must be made on a clean workbench. As in repairing any hydraulically operated unit, cleanliness is of utmost importance. The bench, tools, and parts must be kept clean at all times. Thoroughly clean the exterior of the unit with a suitable solvent and, when necessary, drain as much of the hydraulic fluid (or gear grease) as possible. Handle all parts very carefully to avoid nicks, burrs, scratches and dirt, which could make the parts unfit for use.

Inspection

1. Check input shaft bearing for damage. Replace if necessary.
2. Inspect the valve housing for scoring or burrs.
3. Inspect the tube seats (if equipped) in the pressure and return ports in the housing. If nicks, etc., are present replace tube seats.
4. Check all fluid passages for obstruction or leakage.
5. Inspect the steering gear housing for cracks, stripped threads, and mating surfaces for burrs. Inspect the piston bore of the housing for scoring. Check roller bearing for damage. If necessary, replace the housing.
6. Check the input shaft bearing after installation to be sure that it rotates without binding or roughness.
7. Check the pinion and rack teeth or sector shaft teeth and piston rack teeth for nicks and burrs.

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In-Vehicle Adjustment

Adjust total on center load to eliminate excessive lash between the sector and rack teeth as follows. This is the only adjustment required.

1. With the engine (6007) off, turn the steering wheel (3600) from full right lock to full left lock, at least once.

2. Refer to the appropriate section of the service manual for proper steering wheel hub cover removal procedure.

3. Disconnect the steering gear sector shaft arm (3590) from the steering gear sector shaft (3575) using Pitman Arm Puller T64P-3590-F.

4. Attach an inch-pound torque wrench to the steering wheel hub nut and determine the torque required to rotate the power steering gear input shaft and control (3D517) back and forth across the center position (± 90 degrees).

5. Reset the meshload only, if the measured torque for total on-center load is less than 1.5 Nm (13 lb-in). If reset is required, loosen the adjuster locknut and turn the sector shaft adjuster screw until the measured total on-center load torque is 2.0 Nm (18 lb-in). Hold the sector shaft screw in place and tighten the locknut to 48-61 Nm (35-44 lb-ft).

6. Recheck torque readings and replace the steering gear sector shaft arm. Torque the nut to 230-310 Nm (170-228 lb-ft).

7. Verify no binding condition in steering throughout full lock to lock travel. Verify customer concern is resolved.

8. Replace steering wheel hub cover.

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Rotary Valve Centering Check

1. **NOTE: The only service that can be performed on the control valve assembly is the replacement of the four Teflon® seals on the valve sleeve and replacement of the control valve housing.**

   Install a 0-13,789 kPa (0-2000 psi) pressure-gauge (Power Steering Analyzer D79L-33610-A or equivalent) in the pressure line between the power steering pump outlet port and the integral steering gear inlet port. Be sure that the valve on the gauge is fully open.

2. **NOTE: Refer to Section 11-00 , Fill Process, for proper filling procedures.**

   Check the fluid level in the reservoir and add Premium Power Steering Fluid E6AZ-19582-AA or equivalent meeting Ford specification ESW-M2C33-F if necessary.

3. Start the engine and turn the steering wheel from stop to stop to bring the steering fluid to normal operating temperature. Turn off the engine and recheck the fluid level. Add Premium Power Steering Fluid E6AZ-19582-AA or equivalent meeting Ford specification ESW-M2C33-F if necessary.

4. With the engine running at approximately 1000 rpm and the steering wheel centered, attach an inch-pound torque wrench to the steering wheel nut. Apply sufficient torque in each direction to get a gauge reading of 1723 kPa (250 psi).

5. The torque wrench readings should be the same in both directions at 1723 kPa (250 psi). If the difference between the readings exceeds 0.68 Nm (6 lb-in), remove the steering gear and replace the shaft and control assembly (3D517).

6. **NOTE: A hissing noise is a normal characteristic of rotary valve steering gears and in no way affects steering. Do not replace the shaft and control assembly unless the hiss is EXTREMELY objectionable. A replacement valve will also exhibit slight noise, and is not usually a cure for the complaint. Any metal-to-metal contacts, such as column grounding, coupling grounding, or sheet metal to steering components will transmit valve hiss noise into the passenger compartment.**

   When performing the valve centering check outside the vehicle, use the procedures described above, except take the torque and pressure readings at the right and left stops instead of either side of center.

   The only service that can be performed on the 3D517 worm end valve assembly is the replacement of the four valve sleeve O-rings on the valve sleeve and replacement of the control valve housing.

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SPECIFICATIONS

FORD INTEGRAL POWER STEERING GEAR SPECIFICATIONS

Description	Specification
Type	Recirc. Ball Torsion Bar
Ratio	17:1
Turns of Steering Wheel (Lock to Lock — Linkage Disconnected)	4.2
Fluid Capacity (Included in Pump Reservoir Fill)	.75L (1.6 Pint Approx.)
Fluid Specification	ESW-M2C33-F [a]
Gear Assembly Preload 1/2 Turn from Stops	0.45-1.0 Nm (4-9 Lb-In) [b]
Worm to Piston Preload [c]	0.11-0.34 Nm (1-3 Lb-In) [b]

[a] Premium Power Steering Fluid, E6AZ-19582-AA or equivalent meeting Ford specification ESW-M2C33-F.
[b] Not adjustable in field, specification given for inspection purposes only.
[c] Not adjustable in field, specification given for inspection purposes only.

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Ball Return Guide Clamp Bolts	4.8-7.9	—	42-70
Control Valve Housing Bolts	41-62	30-45	—
Mesh Load Adjusting Screw Lock Nut	48-61	35-44	—
Mesh Load Capacity (Vehicle with 0-5000 mi. 0-8046 km.)	1.3-2.7	—	12-24
Mesh Load Checking (More than 5000 mi. 8045 km.)	1.13	—	10
Mesh Load Reset (Vehicle with 0-5000 mi. 0-8045 km.)	1-1.4	—	9-13
Mesh Load Reset (More than 5000 mi. 8045 km.)	1-1.4	—	9-13
Power Steering Pressure Line to Gear	27-41	20-30	—
Power Steering Return Line to Gear	27-41	20-30	—
Race Locknut Setscrew	1.7-2.8	—	15-25
Steering Column Intermediate Shaft Pinch Bolts	40.3-54.7	29.4-39.9	—
Steering Gear Bolts	68-84	50-62	—
Steering Gear Housing End Cover Bolts	75-94	55-70	
Steering Gear Sector Shaft Arm Nut	230-310	170-228	—
Valve Housing Retaining Bolts	40-60	30-45	—
Worm Thrust Bearing Locknut	75-122	55-90	—

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Spindle Connecting Rod or End, Front Wheel

Replace the tie rod end (3A130) if the tie rod end is loose in the socket or the tie rod end is bent. Replace boot seal if any nicks, cuts or tears are present. **Do not attempt to straighten a bent tie rod end.**

Removal

1. Raise the vehicle on a hoist with the wheels in the straight-ahead position. Refer to Section 00-02 .
2. Remove the nut and cotter pin from the tie rod end on the steering sector shaft arm drag link (3304).
3. Remove the tie rod end from the tie rod adjusting sleeve (3281) using Pitman Arm Puller T64P-3590-F.
4. Loosen the bolts on the tie rod adjusting sleeve. Count the number of turns it takes to remove tie rod end.

Installation

1. Install the tie rod end into the tie rod sleeve the same number of turns it took to remove it. Tighten the tie rod adjusting sleeve nuts to 40-57 Nm (30-42 lb-ft). Be certain that tie rod adjusting sleeve clamps (3287) are pointed down ± 45 degrees.
2. Position the tie rod end in the steering sector shaft arm drag link. Maintain the front wheel (1007) and steering wheel in the straight-ahead position. Install nut and tighten to 70-100 Nm (51-73 lb-ft).
3. Install new cotter pins.
4. Check toe-in and adjust toe-in and clear vision as described in Section 04-00 .

Adjusting Sleeve

Replace the tie rod end (3A130) if it is loose in the socket or the tie rod end is bent. Replace boot seal if any nicks, cuts or tears are present. **Do not attempt to straighten a bent tie rod end.**

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Pitman Arm Puller	T64P-3590-F

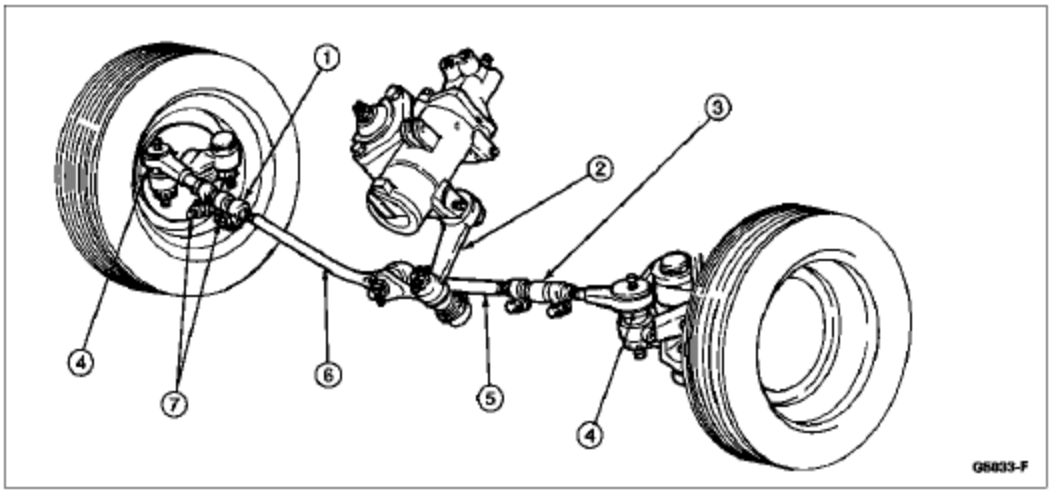
Removal

1. Raise the vehicle on a hoist with the wheels in the straight-ahead position. Refer to Section 00-02 .
2. Remove the nut and cotter pin from the tie rod end at the front wheel spindle (3105).
3. Remove the tie rod end from the front wheel spindle using Pitman Arm Puller T64P-3590-F.
4. Loosen the nuts on the adjacent tie rod adjusting sleeve (3281). Count the number of turns it takes to remove the tie rod end from the tie rod adjusting sleeve.

Installation

1. Install the tie rod end into the tie rod adjusting sleeve the same number of turns it took to remove it to aid in adjusting toe-in. Loosely assemble the tie rod end in the front wheel spindle.
2. Tighten adjusting sleeve nuts to 40-57 Nm (30-42 lb-ft). Make sure the tie rod adjusting sleeve clamps (3287) are pointed down ± 45 degrees.
3. With the front wheel (1007) and steering wheel (3600) in the straight-ahead position, install tie rod ball stud nut and tighten to 70-100 Nm (51-73 lb-ft).
4. Install new cotter pins.
5. Check toe-in and set toe-in as described in Section 04-00 .

Tie Rod Adjusting Sleeve and Front Wheel Spindle Connecting Rod or End

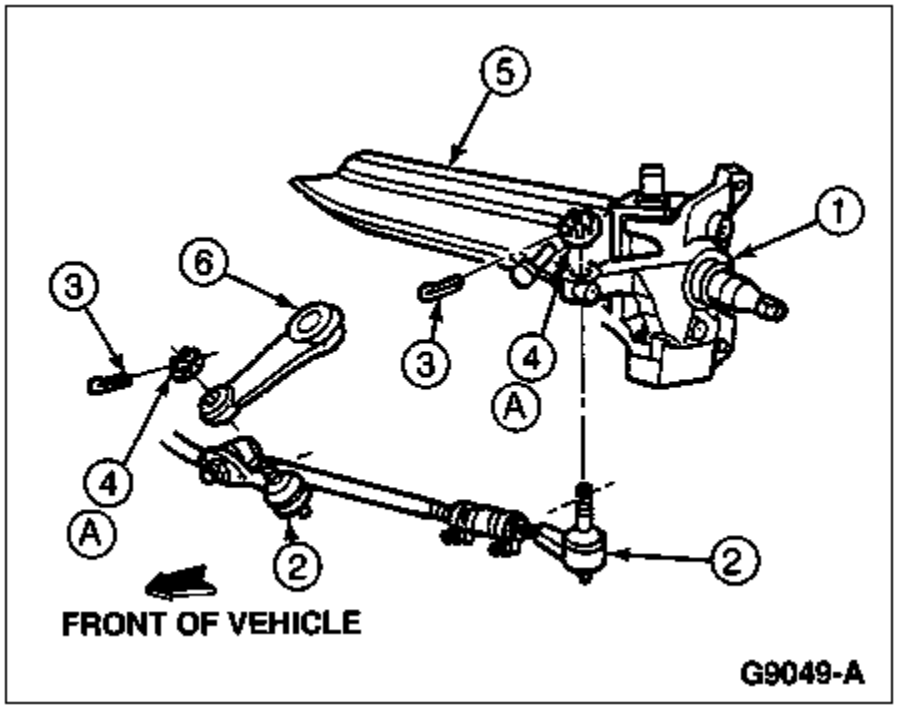


Item	Part Number	Description
1	3281	Spindle Connecting Rod Tube
2	3590	Steering Gear Sector Shaft Arm
3	3281	Tie Rod Adjusting Sleeve
4	3A131	Front Wheel Spindle Connecting Rod or End
5	3B008	Steering Tie Rod and Link Assembly
6	3304	Steering Sector Shaft Arm Idler Arm Rod
7	3287	Front Wheel Spindle Connecting Rod Clamp

Steering Sector Shaft Arm Drag Link

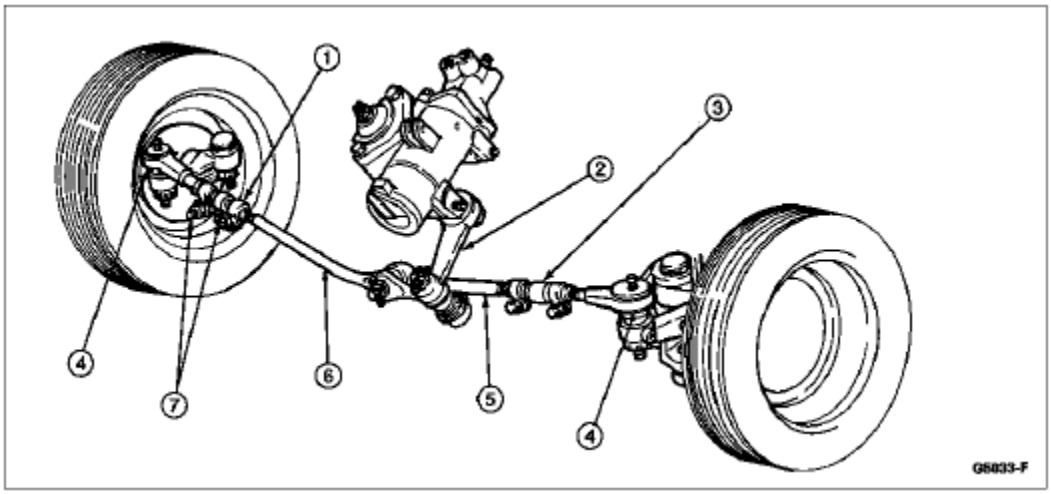
Replace the steering sector shaft arm drag link (3304) if either the tie rod end (3A130) is loose or the steering sector shaft arm drag link is bent or the threads of the tie rod adjusting sleeve clamp (3287) are loose or damaged. Replace boot seal if any nicks, cuts or tears are present. **Do not attempt to straighten a steering sector shaft arm drag link.**

Steering Sector Shaft Arm Drag Link, Ranger (4x2)



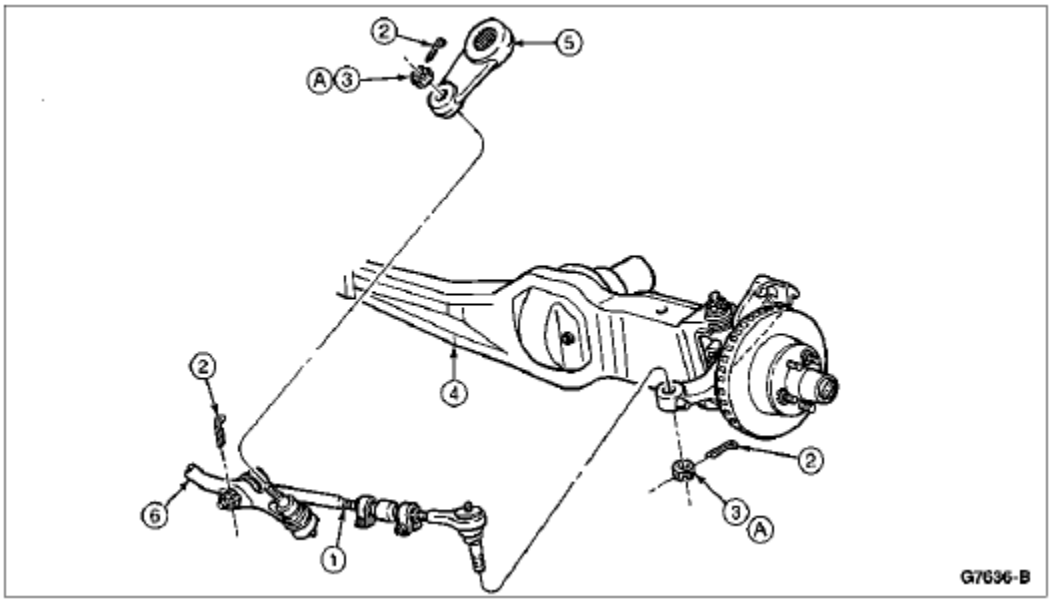
Item	Part Number	Description
1	3105	Front Wheel Spindle
2	3B008	Steering Tie Rod and Link Assembly
3	N642569-S36	Cotter Pin
4	N800895-S52	Nut
5	3006/3007	Axle Assembly (RH/LH)
6	3590	Steering Gear Sector Shaft Arm
A	—	Tighten to 70-100 Nm (51-73 Lb-Ft)

Steering Sector Shaft Arm Drag Link Tie Rod Adjusting Sleeve and Front Wheel Spindle Connecting Rod or End



Item	Part Number	Description
1	3281	Spindle Connecting Rod Tube
2	3590	Steering Gear Sector Shaft Arm
3	3281	Tie Rod Adjusting Sleeve
4	3A131	Front Wheel Spindle Inner Connecting Rod or End
5	3B008	Steering Tie Rod and Link Assembly
6	3304	Steering Sector Shaft Arm Drag Link
7	3287	Front Wheel Spindle Connecting Rod Clamp

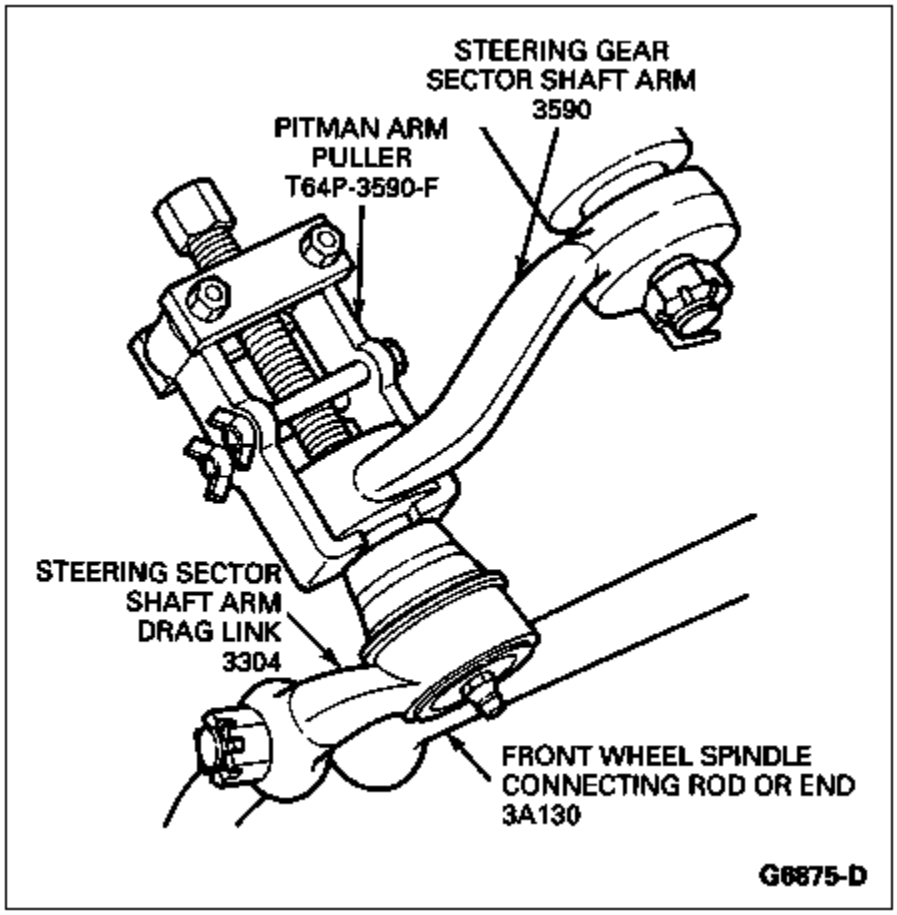
Steering Sector Shaft Arm Drag Link, Ranger 4x4



Item	Part Number	Description
1	3A130	Tie Rod End
2	N642569-S36	Cotter Pin
3	N800895-S56	Nut
4	3002	Front Axle Assembly
5	3590	Pitman Arm
6	3304	Steering Sector Shaft Arm Drag Link
A	—	Tighten to 70-100 Nm (51-73 Lb-Ft)

Removal

1. Raise the vehicle on a hoist. Refer to Section 00-02 .
2. Remove the cotter pins and nuts from the tie rod end at the steering gear sector shaft arm (3590) and tie rod end.
3. Remove the tie rod ends from the steering gear sector shaft arm drag link using Pitman Arm Puller T64P-3590-F.



4. Loosen the bolts on the tie rod adjusting sleeve (3281). Count the number of turns it takes to remove the steering sector shaft arm drag link.

Installation

Must orient drag link to steering gear sector shaft arm before tightening clamp.

1. Install the steering sector shaft arm drag link the same number of turns it took to remove it from the tie rod adjusting sleeve.

2. Position the tie rod end in the steering gear sector shaft arm drag link. Position the steering tie rod ball stud in the steering sector shaft arm drag link. Install nuts and tighten to 70-100 Nm (51-73 lb-ft).

3. Tighten the adjusting sleeve nuts to 40-57 Nm (30-42 lb-ft). Be certain that tie rod adjusting sleeve clamps point down ± 45 degrees.

4. Install new cotter pins.

5. Check toe-in and adjust toe-in as described in Section 04-00 .

Steering Gear Sector Shaft Arm

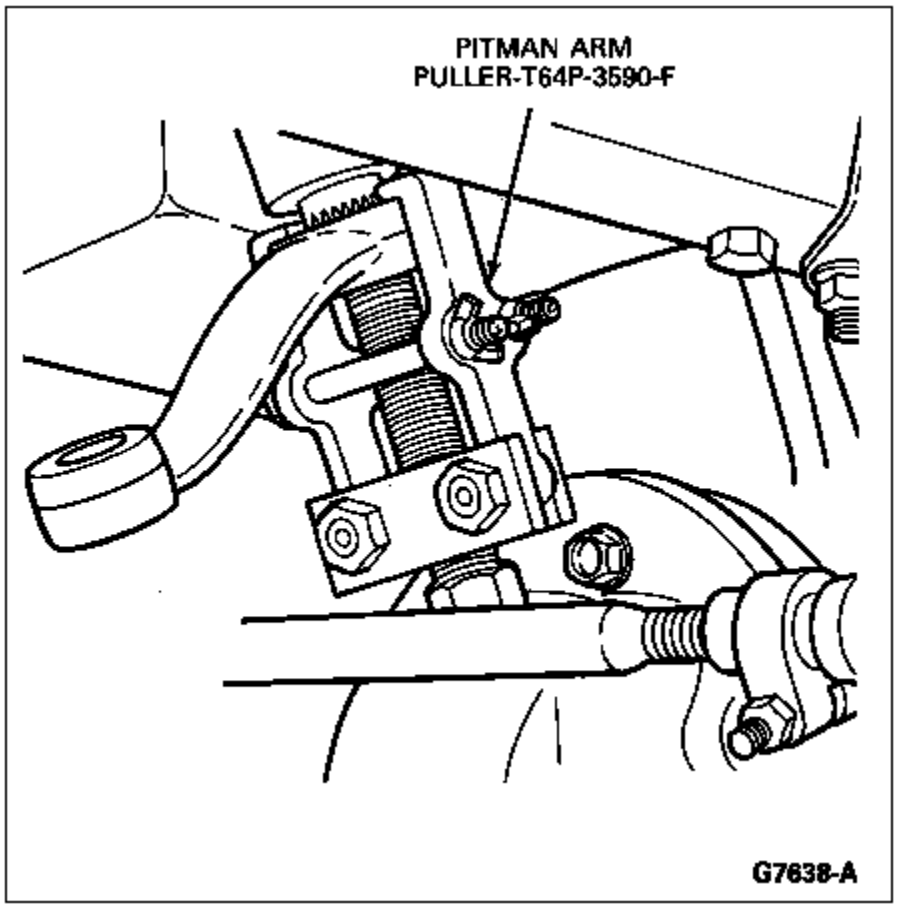
Replace the steering gear sector shaft arm (3590) if it is bent. Also check the steering sector shaft arm drag link (3304), tie rod end (3A130), tie rod adjusting sleeves (3281) and tie rod ends for signs of damage. Replace damaged steering linkage as required. **Do not attempt to straighten the steering gear sector shaft arm or any other steering linkage components.**

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Pitman Arm Puller	T64P-3590-F

Removal

1. Remove the cotter pin and nut from the tie rod end at the steering gear sector shaft arm.
2. Remove the tie rod end from the steering gear sector shaft arm using Pitman Arm Puller T64P-3590-F.
3. Remove the steering gear sector shaft arm attaching nut and washer from steering gear output/sector shaft.
4. Remove the steering gear sector shaft arm from the steering gear output/sector shaft using Pitman Arm Puller T64P-3590-F. Remove the tool from the steering gear sector shaft arm.



Installation

1. Install the new steering gear sector shaft arm on the steering gear output/sector shaft indexing blind splines in arm to those on sector shaft. Install the steering gear sector shaft arm attaching washer and nut. Tighten the nut to 230-310 Nm (170-228 lb-ft).

2. Install the tie rod end into the steering gear sector shaft arm. Maintain the steering wheel and wheels (1007) in the straight-ahead position. Make sure the tie rod end is seated in the taper to prevent rotation while tightening.

3. Tighten the nut to 70-100 Nm (51-73 lb-ft).

4. Install a new cotter pin.

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft
Drag Link to Tie Rod Ball Stud Nut	70-100	51-73
Drag Link to Pitman Arm Ball Stud Nut	70-100	51-73
Steering Gear Sector Shaft Arm to Steering Gear Nut	230-310	170-228
Adjusting Sleeve Nuts	40-57	30-42
Tie Rod to Spindle Ball Stud Nut	70-100	51-73

Steering Column

NOTE: All fasteners are important in that they could affect the performance of vital parts and systems, and/or could result in major service expenses. They must be replaced with new fasteners of the same part number if replacement becomes necessary. Do not use a replacement part of lesser quality or substitute design. Torque values must be used as specified during assembly to ensure proper functioning of these parts.

The steering column is of a modular construction and features easy to service electrical switches.

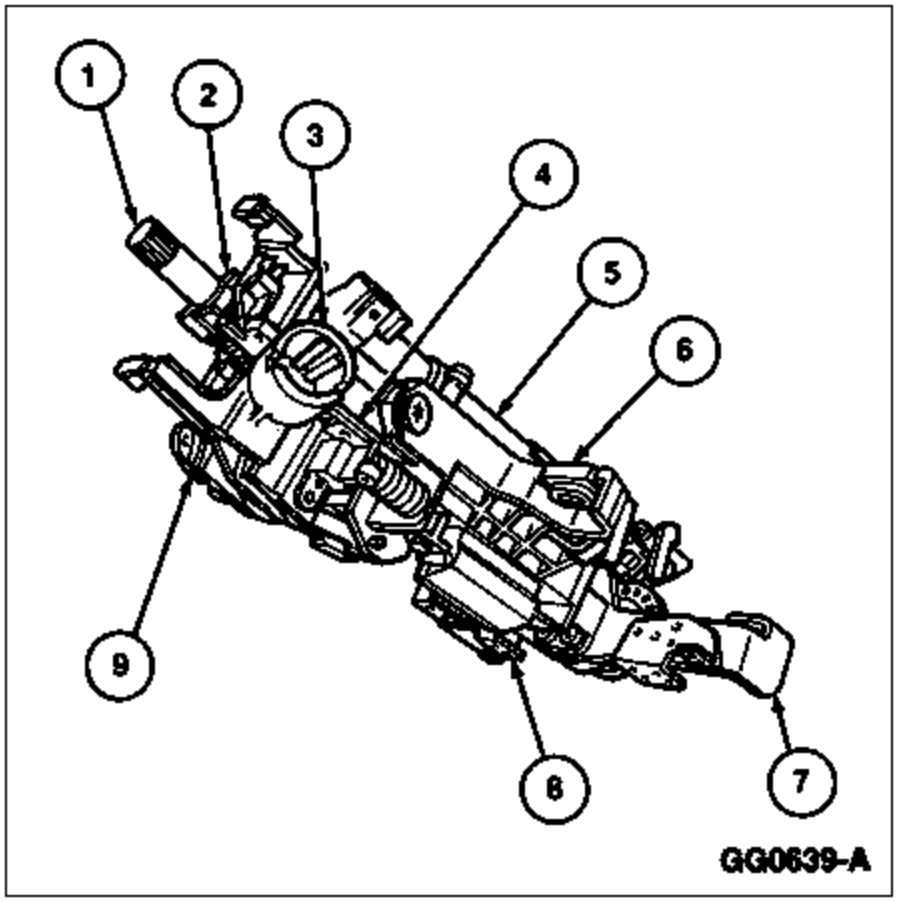
The structural part of the steering column is made of magnesium die castings.

At the lower end, the steering column is attached to the instrument panel support by a bend bracket. The bend bracket is designed so that during a collision:

a. The steering column will remain stationary during air bag deployment.
b. If, after air bag deflation, the driver should strike the steering column, the bend bracket will bend in a controlled manner absorbing the impact of the driver striking the column and reducing injury.

The upper end of the steering column is attached to the instrument panel support by shear modules. They are designed to shear if, during a collision, the driver should strike the steering column after air bag deployment and deflation. This allows the bend bracket to absorb the force of the impact as described above.

Tilt Steering Column, Ranger



Item	Part Number	Description
1	3524	Steering Shaft
2	13318	Turn Indicator Cancel Cam
3	—	Ignition Lock Cylinder Pocket (Part of 3511)
4	3511	Lock Cylinder Housing
5	3F723	Steering Actuator Housing
6	—	Shear Module (Part of 3F723)
7	3676	Bend Bracket
8	11572	Ignition Switch
9	3D544	Steering Column Release Lever

Fixed and Tilt Columns

Both fixed and tilt columns are similar in design. On the tilt column, a latch mechanism is included to allow unlatching, raising, and lowering the upper third of the steering column with the steering wheel. The tilt column has pivot screws and a universal joint in the steering shaft to allow tilting. On a fixed column, the steering shaft is rigid.

A unique steering column-mounted shift mechanism is used. It has the transmission shift selector position insert (7A216) plate located away from the gearshift lever (7210) and interacts with the gearshift lever through a linkage system. This system incorporates a brake shift interlock which prevents shifting out of Park unless the brake pedal (2455) is depressed.

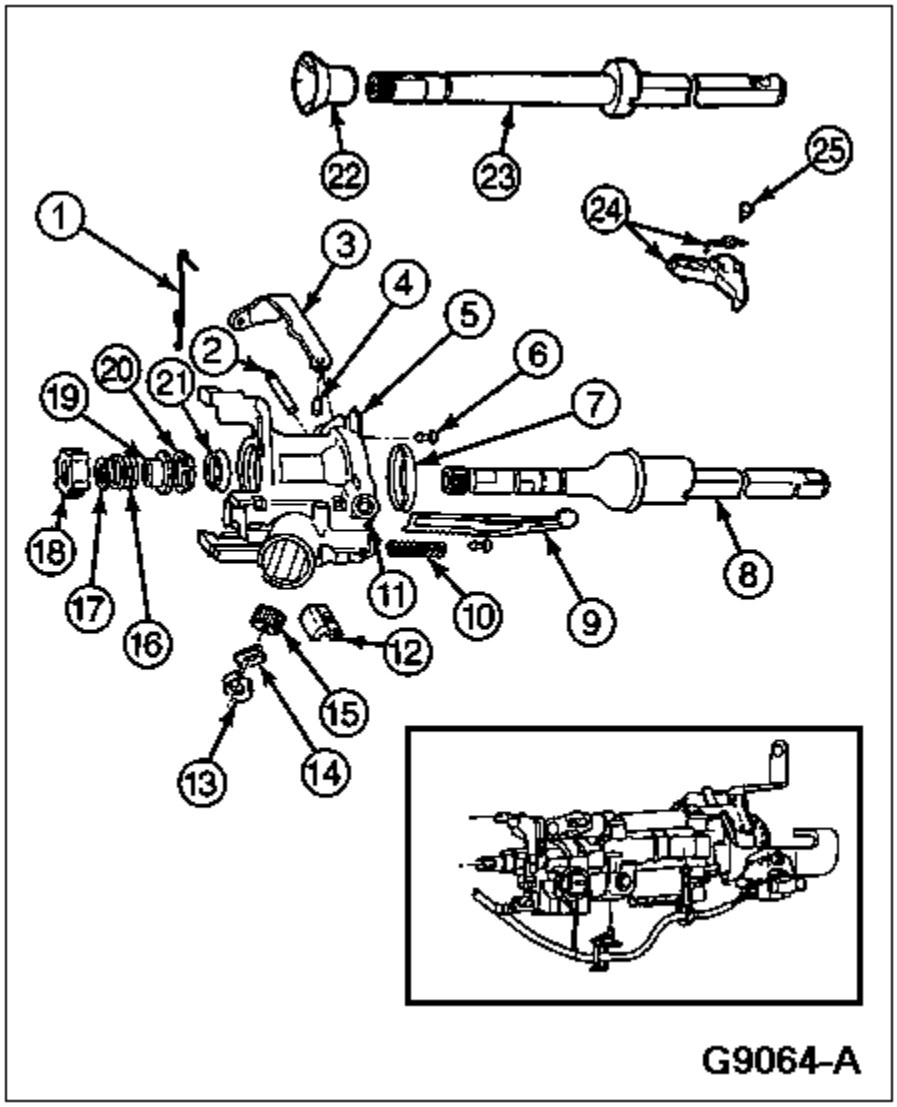
Steering Column with Air Bag

The steering column incorporates a driver side air bag module (043B13) in the steering wheel (3600). Refer to Section 01-20B for passive restraint information.

Steering Column Lock

The steering column is equipped with a lock mechanism which locks the steering wheel (3600), ignition switch, and gearshift lever (7210) when the ignition switch lock cylinder (11582) is turned to the LOCK position.

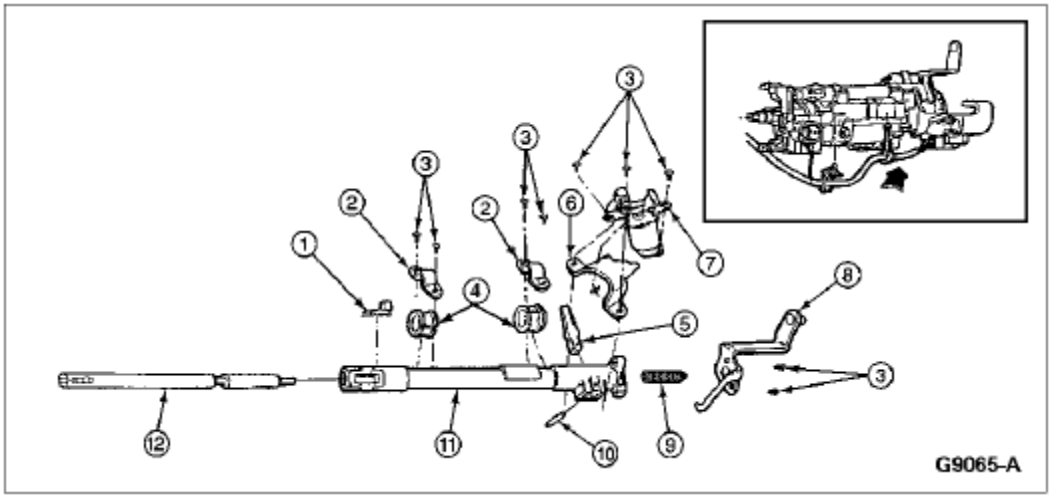
Lock Cylinder Housing Assembly, Steering Column



Item	Part Number	Description
1	3D655	Steering Column Position Spring
2	N808114-S	Pin, Knurled Straight, M4.7 x 3.97mm x 53.8mm

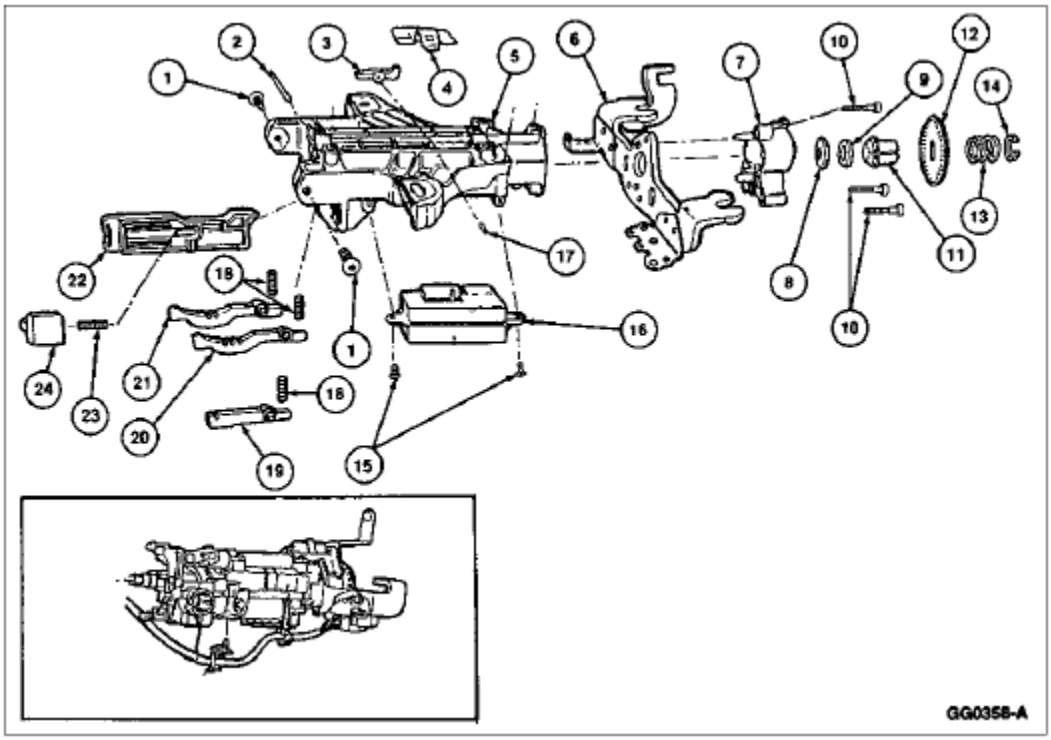
3	3D544	Steering Column Release Lever
4	N805857-S	Pin, Knurled Straight
5	3511	Lock Cylinder Housing
6	3D656	Bumper
7	3517	Steering Column Bearing (Large)
8	3524	Steering Shaft — Tilt
9	3E715	Steering Column Lock Lever Actuator
10	3D655	Steering Column Position Spring
11	3B654	Bushing
12	3E695	Steering Column Lock Cam
13	3C610	Bearing Retainer
14	3E700	Steering Column Lock Housing Bearing
15	3E717	Steering Column Lock Gear
16	3520	Steering Column Upper Bearing Spring
17	3C610	Bearing Retainer
18	13318	Turn Indicator Cancel Cam
19	3518	Steering Column Bearing Sleeve
20	3L539	Steering Column Bearing Tolerance Ring
21	3517	Steering Column Bearing (Small)
22	3F578	Spacer (Fixed Column)
23	3E729	Steering Shaft (Fixed Column)
24	3F527	Lever Assembly (Manual Transmission)
25	3F530	Pin (Manual Transmission)

Shift Tube Assembly, Steering Column — Automatic Transmission



Item	Part Number	Description
1	7C464	Clip, Transmission Control Select Lever Spring
2	7E400	Gearshift Tube Bushing Clamp
3	N806584-S36	Screw
4	7L278	Gearshift Tube Bushing
5	7D282	Transmission Shift Selector Position Lever
6	7A216	Transmission Shift Selector Position Insert
7	3Z719	Brake Shift Interlock Solenoid
8	7302	Transmission Selector Lever Arm and Support
9	7379	Gearshift Selector Tube Spring
10	7W441	Gearshift Lever Pin
11	7212	Transmission Column Shift Selector Tube
12	7R264	Column Shift Selector Lever Plunger

Steering Actuator Assembly, Steering Column



Item	Part Number	Description
1	N806582-S36	Screw
2	N808114	Pin

3	3E691	Steering Column Lock Pawl
4	14A099	Steering Column Lock Actuator Cover (Manual Transmission)
5	3F723	Steering Actuator Housing
6	3676	Bend Bracket (Automatic Transmission Shown)
7	3D681	Steering Column Lower Bearing Retainer
8	3518	Steering Column Lower Bearing Sleeve
9	3517	Steering Column Lower Bearing
10	N806583-S36	Screw
11	3L539	Steering Column Lower Bearing Tolerance Ring
12	3C131	Suspension Height Sensor Control Ring
13	3520	Steering Column Lower Bearing Spring
14	3C610	Retainer, Steering Column Lower Bearing (Fixed Column)
15	N806584-S36	Screw
16	11572	Ignition Switch (High Profile)
17	3B663	Steering Column Lock Lever Pin
18	3B768	Steering Column Position Lock Spring
19	3D653	Steering Column Lock Left Hand Lever
20	3D653	Steering Column Lock Left Hand Lever (with Tilt Column)
21	3B662	Steering Column Lock Right-Hand Lever (with Tilt Column)
22	3E715	Steering Column Lock Lever Actuator
23	3E696	Steering Column Lock Spring
24	3E691	Steering Column Shaft Lock Pawl

Steering Wheel with Air Bag

CAUTION: Do not remove the steering column, steering wheel (3600), and driver side air bag module (043B13) as an assembly from the vehicle unless the column is locked to prevent rotation. Lower end of steering shaft should be wired to prevent the steering wheel from being rotated and causing the air bag sliding contact (14A664) to become misindexed.

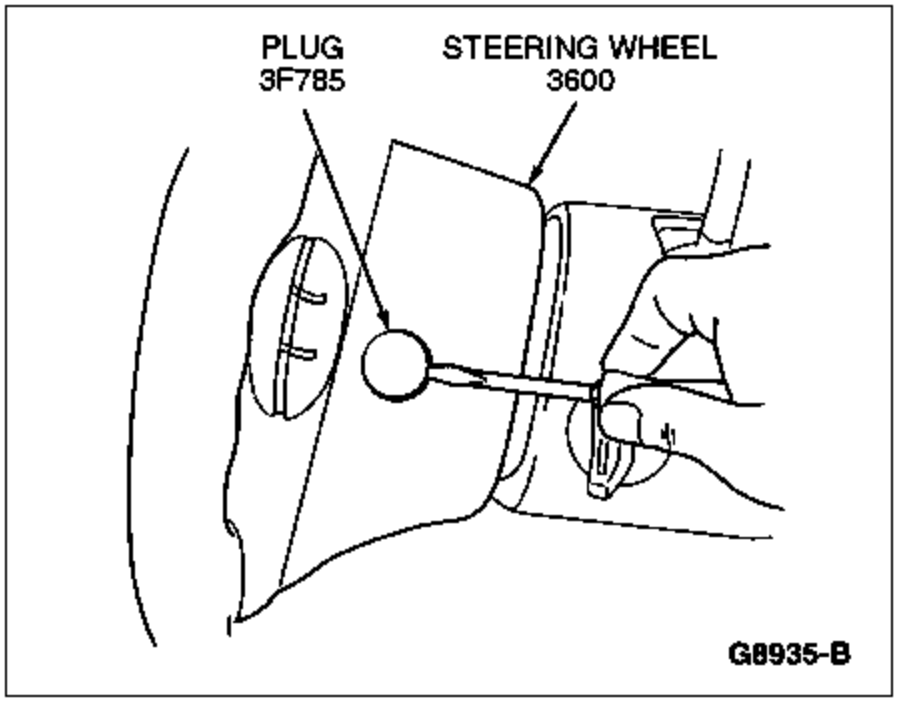
SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Differential Side Bearing Puller	T77F-4220-B1

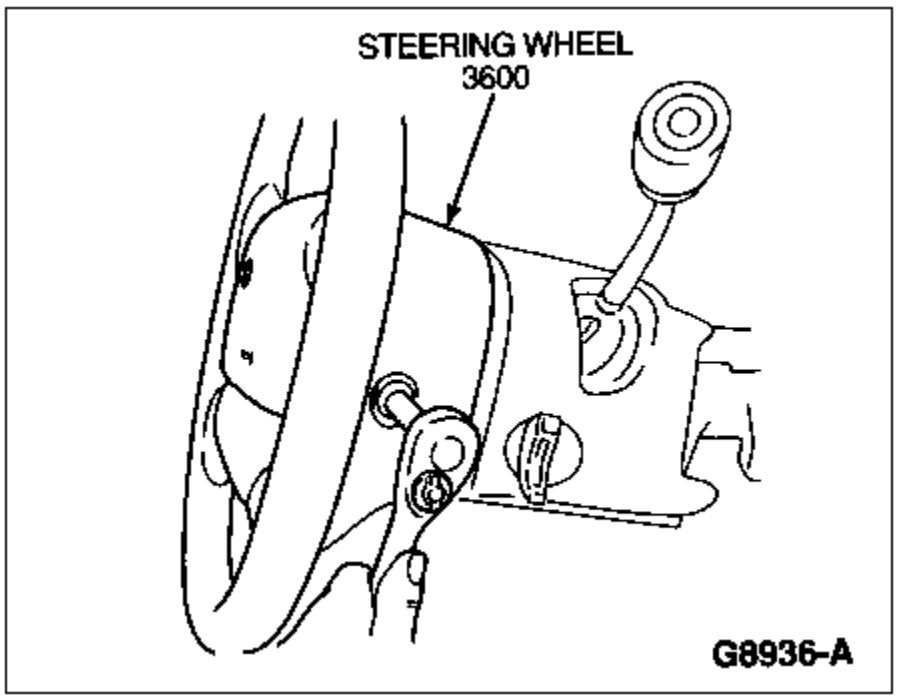
Removal

WARNING: THE ELECTRICAL CIRCUIT FOR AIR BAG DEPLOYMENT IS POWERED DIRECTLY FROM THE BATTERY AND BACKUP POWER SUPPLY. TO AVOID ACCIDENTAL DEPLOYMENT AND POSSIBLE PERSONAL INJURY, THE BATTERY POSITIVE CABLE MUST BE DISCONNECTED FOR A MINIMUM OF ONE MINUTE TO DE-ENERGIZE THE BACKUP POWER SUPPLY PRIOR TO SERVICING OR REPLACING ANY AIR BAG SYSTEM COMPONENTS.

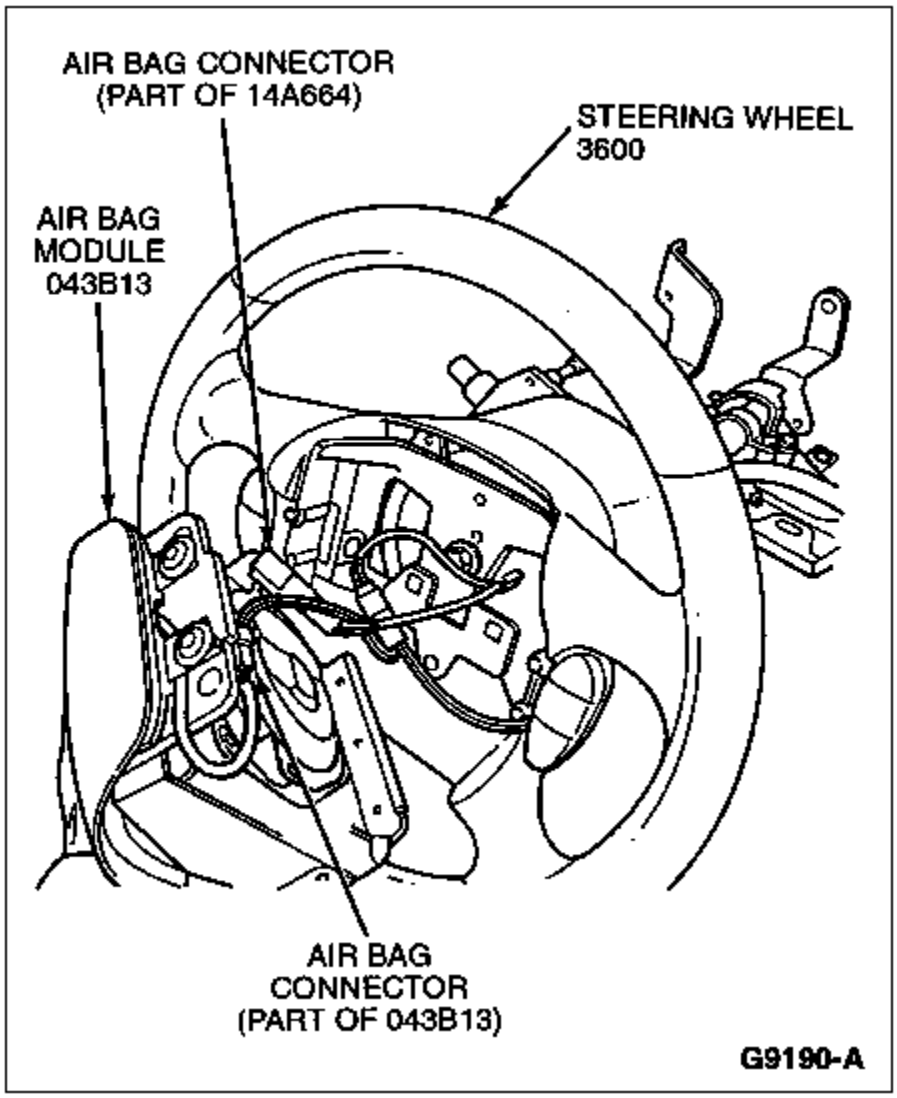
1. Center front wheels (1007) to the straight-ahead position.
2. Disconnect battery to starter relay cable (14300) and wait at least one minute to let the air bag backup power supply discharge. Refer to Section 01-20B .
3. Pry out two plugs covering driver side air bag module screws on sides of steering wheel.



4. Remove two driver side air bag module retaining screws on side of steering wheel from driver side air bag module, and lift driver side air bag module away from steering wheel.



5. Disconnect driver side air bag wire harness connector at the air bag sliding contact, horn control wire harness connector, and, if equipped, speed control harness connector.



6. Loosen, but do not remove, steering wheel retaining bolt approximately 2 to 3 turns.
7. Install Differential Side Bearing Puller T77F-4220-B1 at the areas marked PULL near the loosened steering wheel retaining bolt.
8. **CAUTION: Be sure air bag sliding contact assembly wire harness does not get caught on steering wheel assembly when lifting steering wheel off steering shaft.**

   Pull steering wheel loose and remove Differential Side Bearing Puller T77F-4220-B1.
9. Remove and discard original steering wheel bolt.
10. Remove steering wheel while routing wires from air bag sliding contact through steering wheel.

Installation

NOTE: If a new air bag sliding contact is being installed, remove the plastic lock tool after

intermediate shaft is connected to steering gear.

1. Make sure the vehicle's front wheels are in the straight-ahead position.

2. **CAUTION: Be sure wiring does not get trapped between steering wheel and air bag sliding contact.**

   Route air bag sliding contact wire harnesses through steering wheel opening at the three o'clock position. Position steering wheel on steering shaft so the alignment marks on wheel and shaft are aligned. Be sure air bag contact wire is not pinched.

3. Install new steering wheel retaining bolt and tighten to 34-46 Nm (25-34 lb-ft).

4. Connect horn/speed control wire harness to air bag sliding contact wire harness. Connector is located on right side of steering wheel retaining bolt.

5. Connect air bag sliding contact wire harness to driver side air bag module and position air bag into steering wheel. Install driver side air bag module retaining bolts.

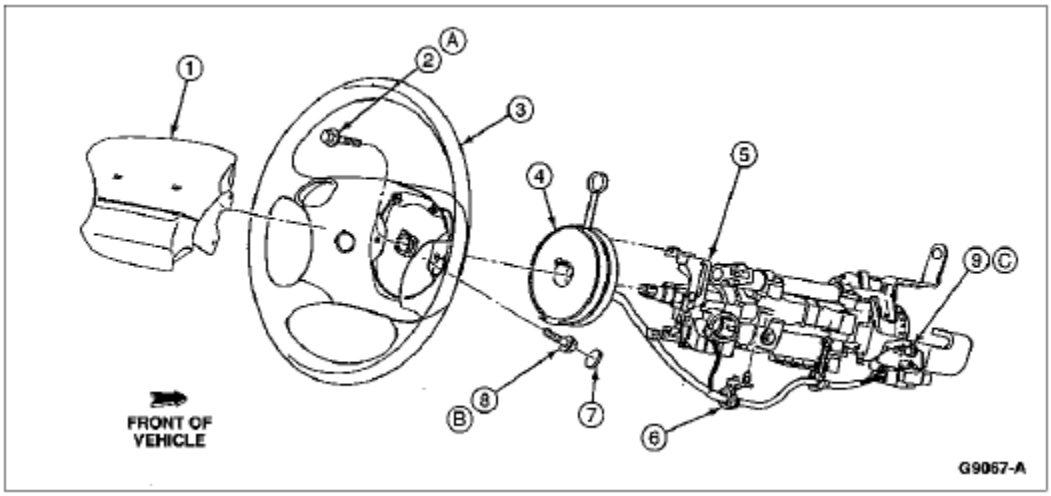
6. Hold driver side air bag module in position in steering wheel while bolts are being torqued to ensure proper fit. Tighten bolts to 7.6-10.4 Nm (67-92 lb/in).

7. Install two cover plugs by snapping into holes on sides of steering wheel.

8. **NOTE: When the battery (10655) has been disconnected and reconnected, some abnormal driving symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more for the powertrain control module to relearn the strategy.**

   Connect battery to starter relay cable. Verify air bag warning indicator.

Steering Wheel with Air Bag



Item	Part Number	Description

1	043B13	Driver Side Air Bag Module
2	N807493-S100	Torx® Head Screw, M10-1.5 x 18
3	3600	Steering Wheel
4	14A664	Air Bag Sliding Contact
5	3C529	Steering Column
6	—	Clip (Part of 14A664)
7	3F785	Plug
8	N808944-S424	Bolt
9	N805375-S36MG	Bolt
A	—	Tighten to 34-46 Nm (25-33 Lb-Ft)
B	—	Tighten to 7.6-10.4 Nm (61-92 Lb-In)
C	—	Tighten to 10.2-13.8 Nm (7.5-10.1 Lb-Ft)

Steering Column, Fixed and Tilt

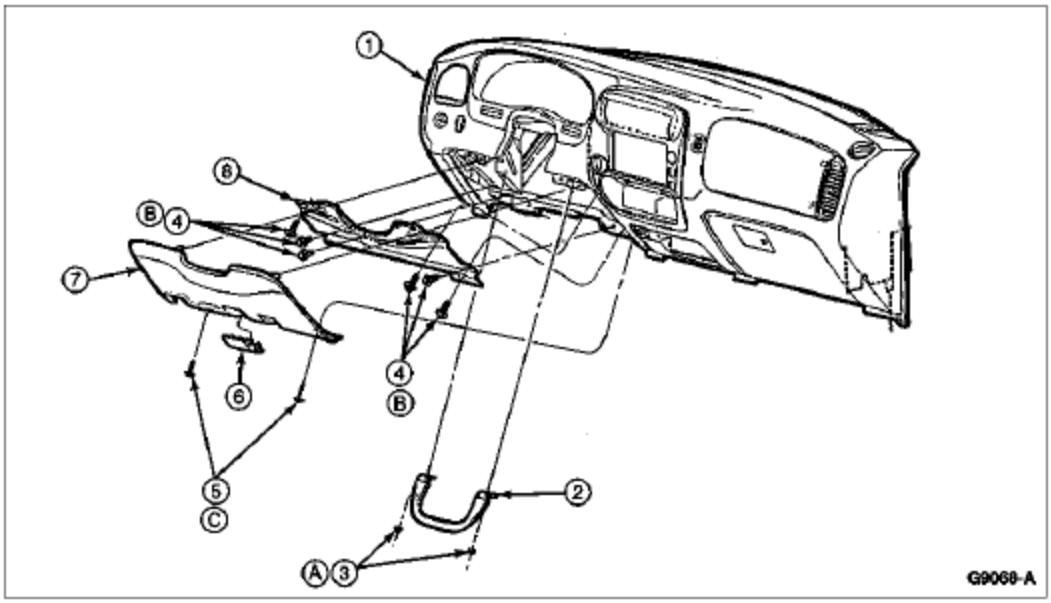
Removal

WARNING: THE ELECTRICAL CIRCUIT NECESSARY FOR AIR BAG SYSTEM DEPLOYMENT IS POWERED DIRECTLY FROM THE BATTERY AND A BACKUP POWER SUPPLY. TO AVOID ACCIDENTAL DEPLOYMENT AND POSSIBLE PERSONAL INJURY, THE BATTERY POSITIVE CABLE MUST BE DISCONNECTED FOR A MINIMUM OF ONE MINUTE TO DE-ENERGIZE THE BACKUP POWER SUPPLY PRIOR TO REMOVING ANY OF THE AIR BAG SYSTEM COMPONENTS.

NOTE: All components of the steering column are assembled with fasteners which are designed to prevent loosening due to vibrations associated with normal vehicle operation.

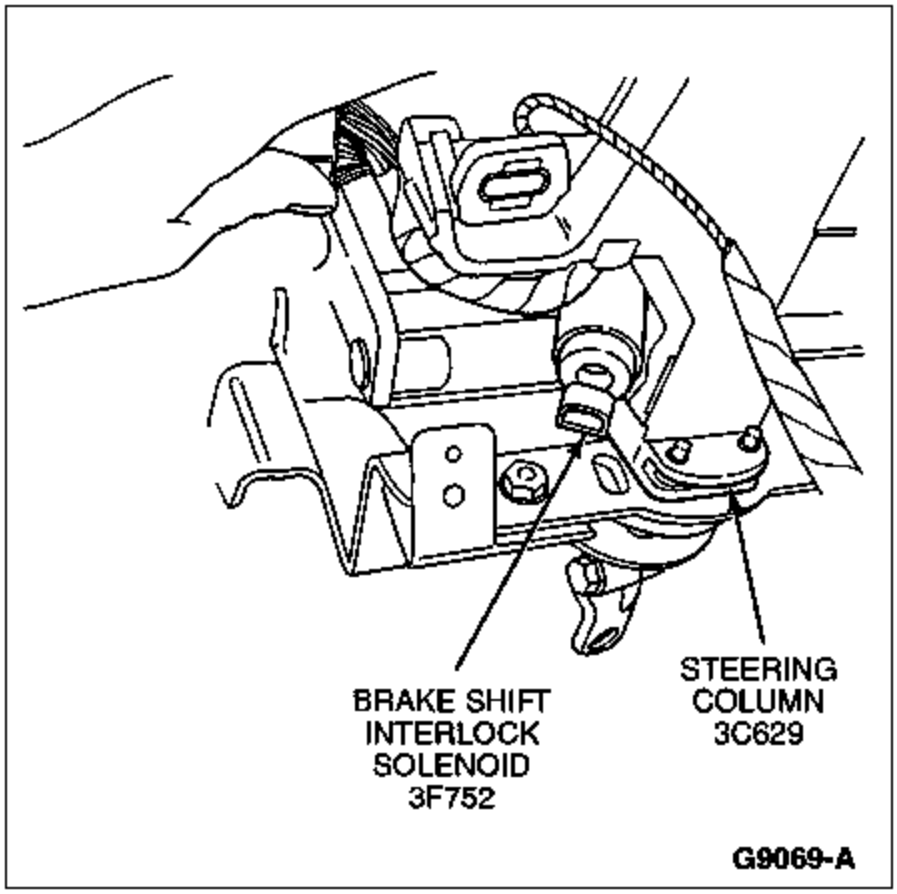
1. Park vehicle with the wheels (1007) in a straight-ahead position.
2. Disconnect the battery to starter relay cable (14300) and wait for one minute before beginning to remove steering column assembly.
3. Remove steering wheel (3600) as outlined in this section.
4. Remove two screws and instrument panel steering column cover (04459).
5. Remove six screws and instrument panel reinforcement (017A28).
6. Remove two screws and steering column opening center reinforcement.

Instrument Panel Steering Column Cover and Reinforcement

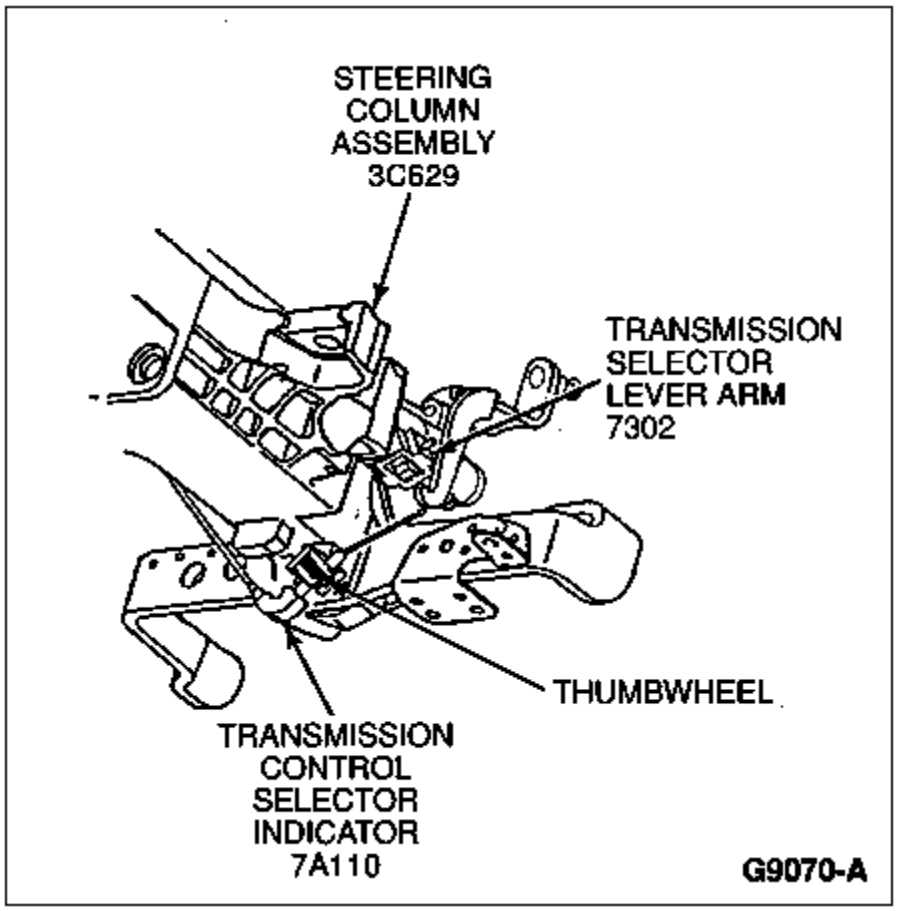


Item	Part Number	Description
1	04320	Instrument Panel
2	044C86	Instrument Panel Steering Column Opening Center Reinforcement
3	N806423-S58	Nuts
4	N606677-S36	Screw
5	N807122-S411	Screw
6	044D82	Instrument Panel Access Hole Cover
7	04459	Instrument Panel Steering Column Cover
8	017A28	Instrument Panel Reinforcement
A	—	Tighten to 13-17 Nm (115-150 Lb-In)
B	—	Tighten to 10-14 Nm (88-123 Lb-In)
C	—	Tighten to 2.1-2.9 Nm (19-25 Lb-In)

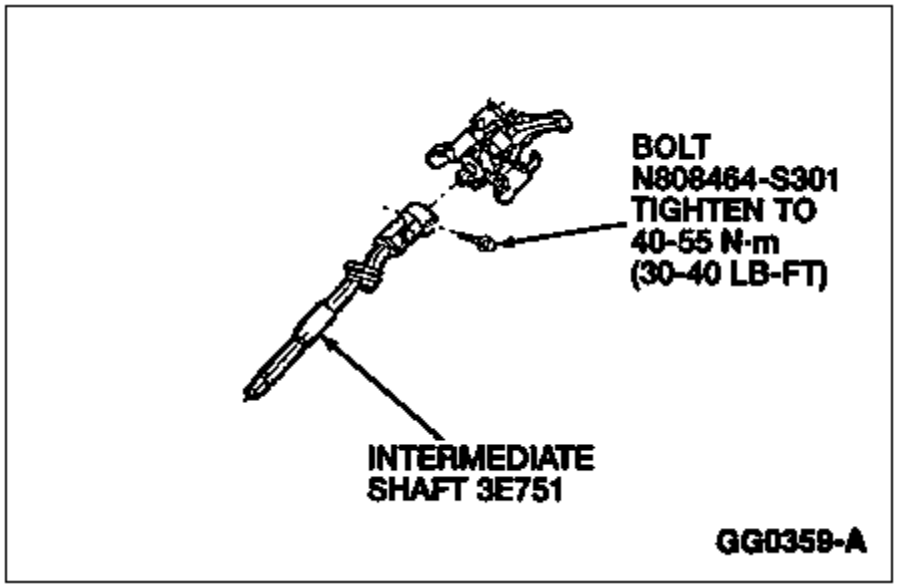
7. Disconnect electrical connectors between main wiring (14401) and steering column. Disconnect brake shift interlock solenoid.



8. Disconnect transmission control selector indicator loop from transmission column shift selector tube (7212). Remove screw and transmission range indicator (7A110) from steering column.



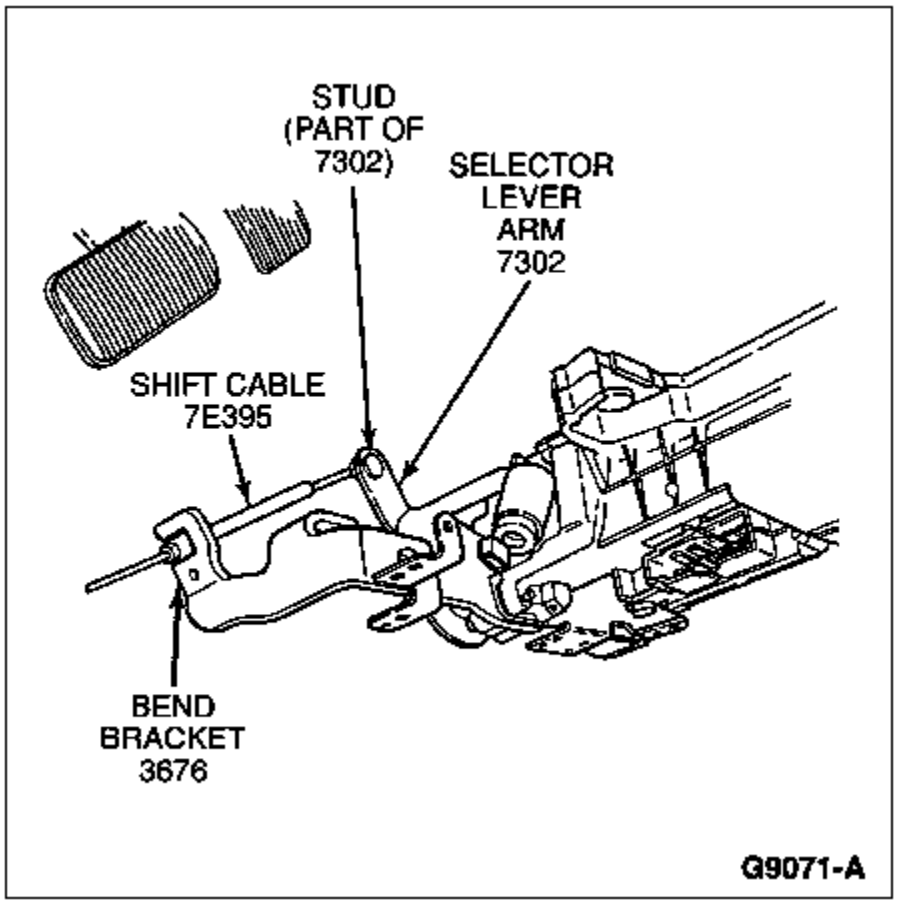
9. Remove steering shaft-to-intermediate shaft universal joint pinch bolt.



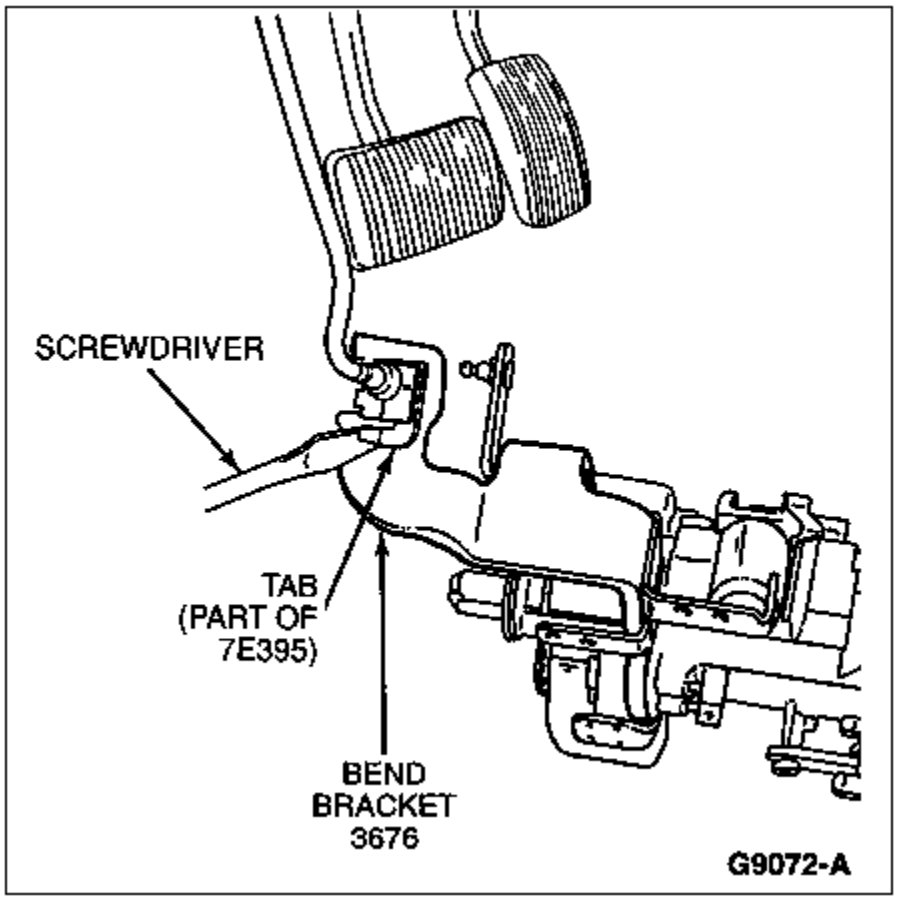
10. Remove four nuts securing steering column to instrument panel reinforcement (04545).

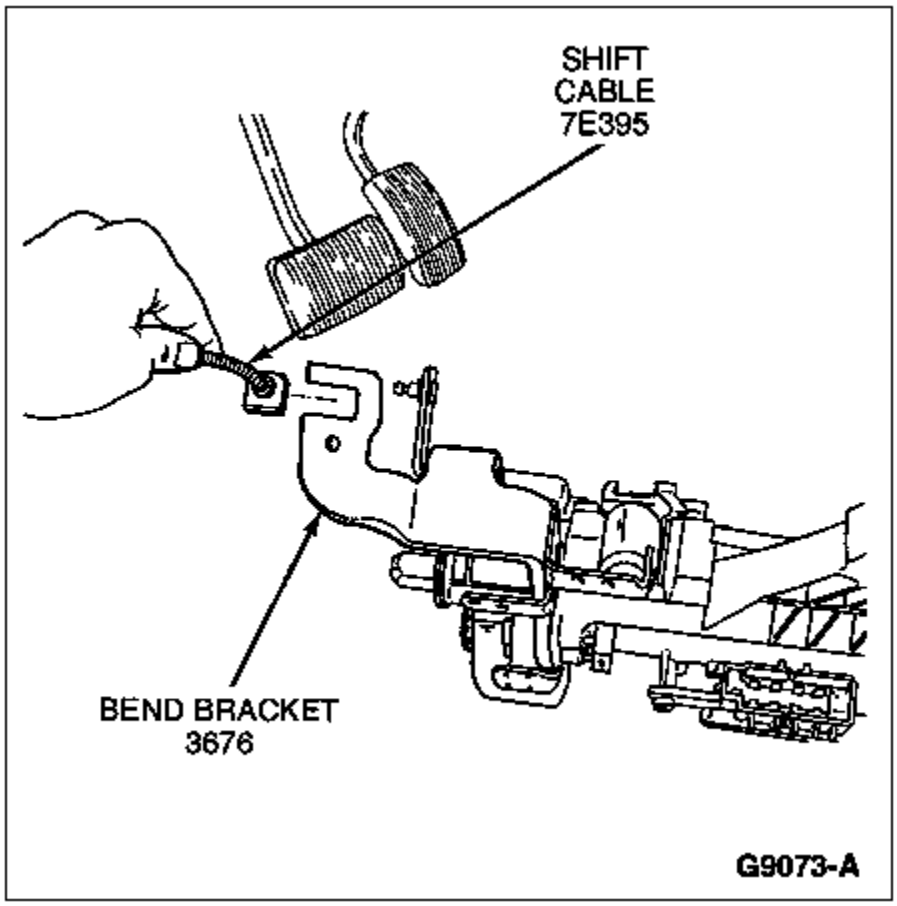
11. Lower steering column to floor.

12. Using screwdriver, snap shift cable off of selector lever arm.



13. Using screwdriver, lift tab on shift cable retainer and remove shift cable from bend bracket.


SCREWDRIVER
TAB
(PART OF
7E395)
BEND
BRACKET
3676
G9072-A



14. Remove steering column from vehicle.

Installation

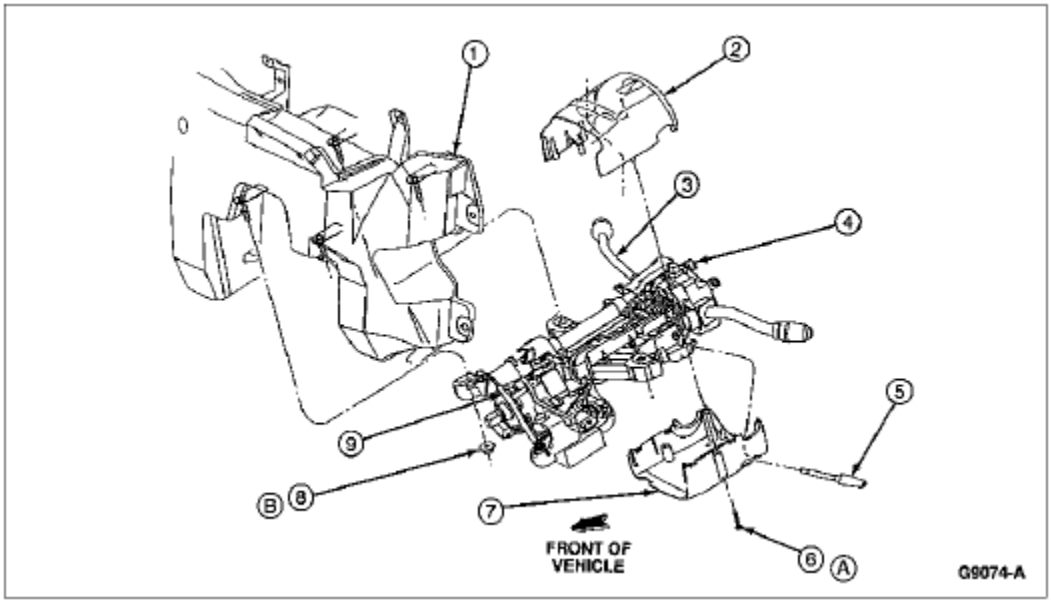
1. Position steering column on floor of vehicle.
2. Push shift cable retainer into slot on bend bracket and snap shift cable end onto shaft of selector lever arm.
3. Insert steering column shaft into universal joint, (part of intermediate shaft) making sure cutout in steering column shaft aligns with universal joint pinch bolt hole.
4. Raise steering column into position onto instrument panel reinforcement studs.
5. Install instrument panel steering column opening brace.
6. Install four nuts securing steering column. Tighten to 13-17 Nm (10-12 lb/ft).
7. Install steering column shaft-to-universal joint pinch bolt. Tighten to 40-55 Nm (30-40 lb-ft).
8. Install transmission range indicator. Connect cable loop to transmission column shift selector lever.
9. Connect main wiring to steering column electrical connectors. Connect shift lock actuator (3Z719).

10. Install instrument panel steering column cover reinforcement and tighten screws to 10-14 Nm (88-123 lb-in).

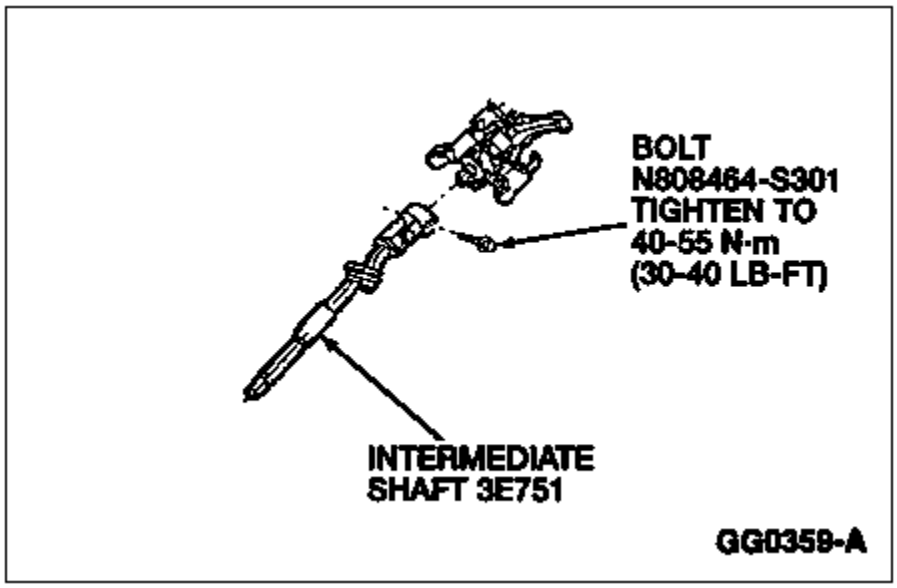
11. Install instrument panel steering column cover and tighten screws to 2.1-2.9 Nm (19-25 lb-in).

12. Install steering wheel as outlined in this section.

Steering Column Installation



Item	Part Number	Description
1	04545	Instrument Panel Reinforcement
2	3530	Steering Column Shroud (Upper)
3	7210	Gearshift Lever
4	3C529	Steering Column
5	3F609	Tilt Wheel Handle and Shank
6	55929-S2	Screw
7	3530	Steering Column Shroud (Lower)
8	N806423-S58	Nut
9	7E395	Shift Cable and Bracket
A	—	Tighten to .7-1.1 Nm (7-9 Lb-In)
B	—	Tighten to 13-17 Nm (10-12 Lb-Ft)

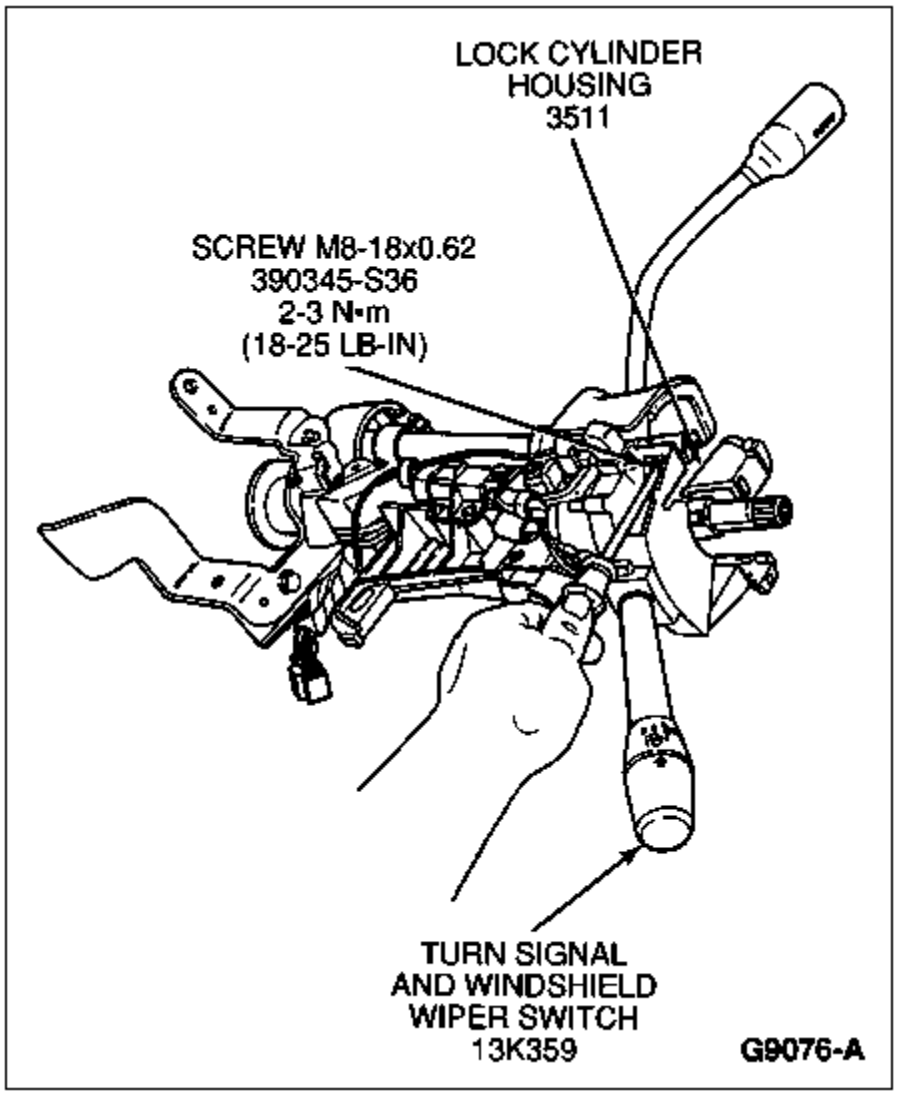

BOLT
N808464-S301
TIGHTEN TO
40-55 N·m
(30-40 LB-FT)
INTERMEDIATE
SHAFT 3E751
GG0359-A

Multi-Function Switch

Removal

WARNING: THE ELECTRICAL CIRCUIT FOR AIR BAG DEPLOYMENT IS POWERED DIRECTLY FROM THE BATTERY AND BACKUP POWER SUPPLY. TO AVOID ACCIDENTAL DEPLOYMENT AND POSSIBLE PERSONAL INJURY, THE BATTERY POSITIVE CABLE MUST BE DISCONNECTED FOR A MINIMUM OF ONE MINUTE TO DE-ENERGIZE THE BACKUP POWER SUPPLY.

1. Disconnect battery to starter relay cable (14300) and wait at least one minute for air bag backup power supply to discharge before beginning work. Refer to Section 01-20B .
2. Remove upper and lower steering column shrouds (3530) as outlined in this section.
3. Remove two self-tapping screws retaining multi-function switch (13K359) to steering column tube casting. Disengage multi-function switch from casting.



4. Disconnect the three electrical connectors.

Installation

1. Install three electrical connectors to full engagement.

2. Align turn signal and windshield wiper switch mounting holes with corresponding holes in steering column tube casting. Install two self-tapping screws, making sure to start screws in the previously tapped holes. Tighten to 2-3 Nm (18-25 lb-in).

3. Install upper steering column shroud and lower steering column shroud with screws. Tighten to 0.7-1.1 Nm (7-9 lb-in).

4. **NOTE: When the battery (10655) has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns it adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

   Connect battery to starter relay cable.

5. Check tilt lock lever and multi-function switch for proper operation.

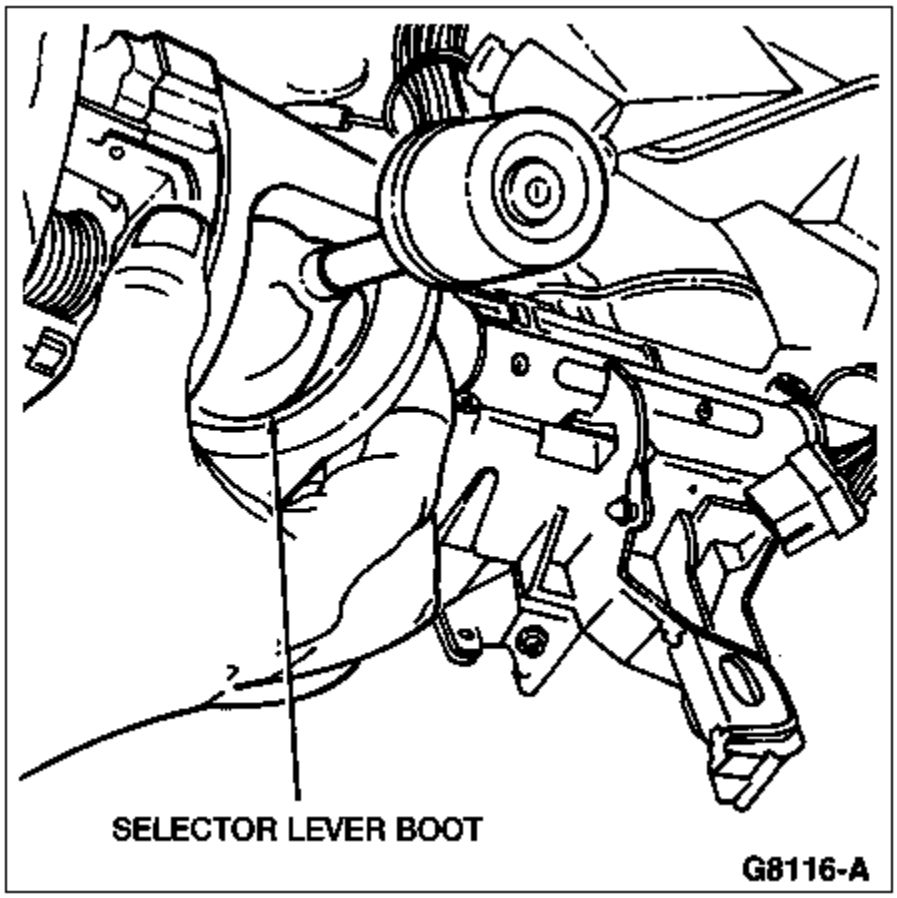
Gear Shift Lever

Column Shift

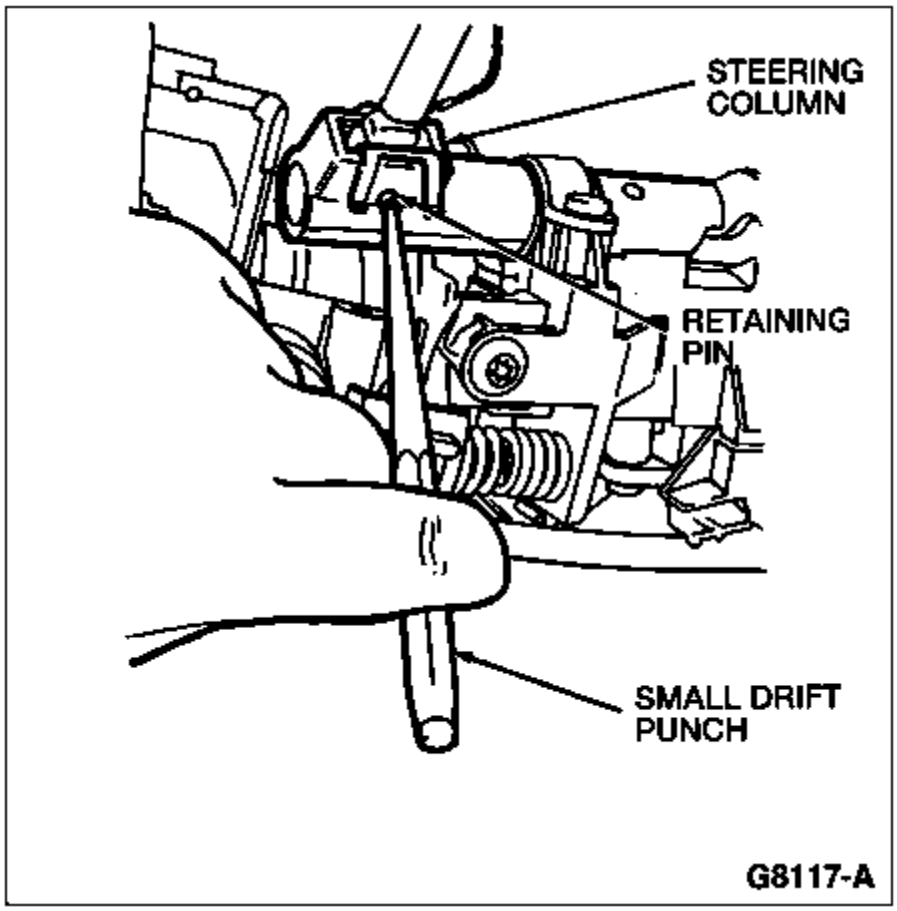
Removal and Installation

WARNING: THE ELECTRICAL CIRCUIT FOR AIR BAG DEPLOYMENT IS POWERED DIRECTLY FROM THE BATTERY AND BACKUP POWER SUPPLY. TO AVOID ACCIDENTAL DEPLOYMENT AND POSSIBLE PERSONAL INJURY, THE BATTERY POSITIVE CABLE MUST BE DISCONNECTED FOR A MINIMUM OF ONE MINUTE BEFORE BEGINNING WORK TO DE-ENERGIZE THE BACKUP POWER SUPPLY.

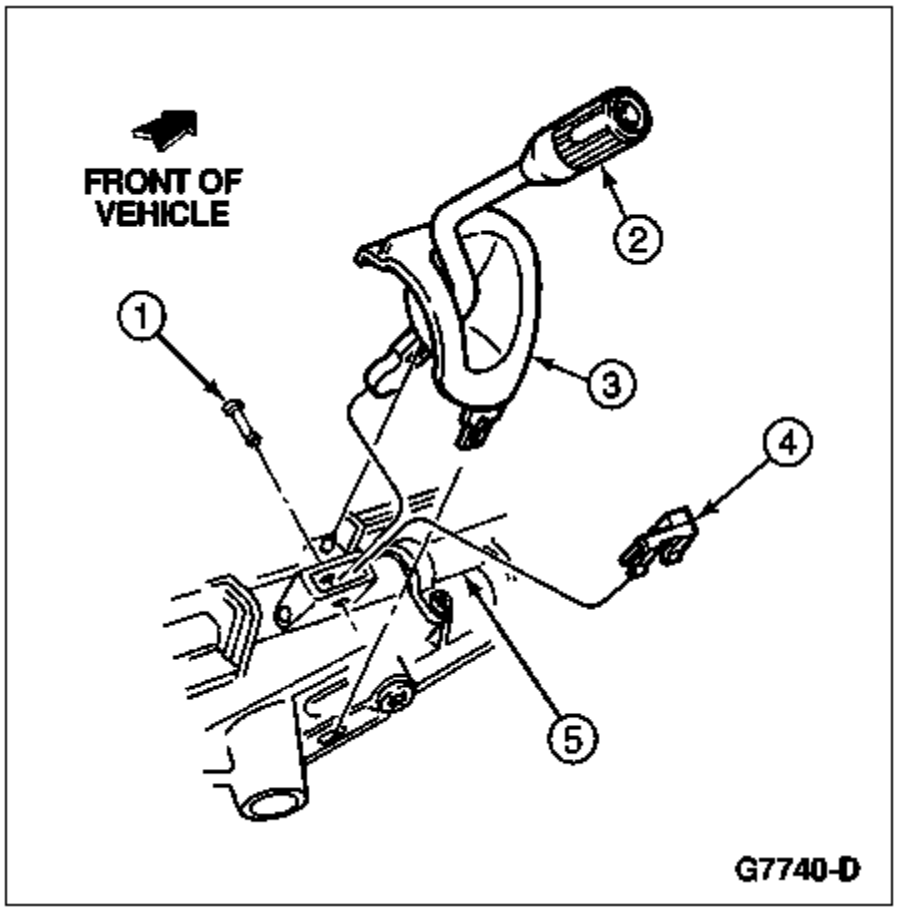
1. Disconnect battery to starter relay cable (14300) and wait at least one minute for air bag backup power supply to discharge before beginning work. Refer to Section 01-20B .
2. Remove upper and lower steering column shrouds (3530) as outlined in this section.
3. Disconnect the overdrive on/off switch electrical connector.
4. Remove the selector lever boot.



5. Use a small drift punch or suitable tool and drive the retaining pin from the steering column.



6. Remove the gearshift lever (7210) from the steering column.
7. To install, reverse the removal procedure.



Item	Part Number	Description
1	7G357	Gearshift Lever Pin
2	7210	Gearshift Lever
3	3513	Steering Column Opening Weather Seal
4	7C464	Clip
5	7212	Transmission Column Shift Selector Tube

Steering Shaft, Upper

Removal and Installation

To remove upper steering shaft, refer to Steering Column disassembly in this section.

Steering Shaft, Intermediate

Removal

1. **CAUTION: Steering column should be in the locked position, or the lower end of the steering column is to be secured or wired in such a way as to prevent the steering column or steering wheel (3600) from rotating and damaging the air bag sliding contact (14A664).**

   Remove the bolt securing the intermediate shaft and lower shaft, at the midpoint connection. Collapse the lower shaft. Discard original bolt.

2. Remove the bolt securing the intermediate shaft to the steering column assembly. Remove the intermediate shaft from inside the vehicle. Discard original bolt.

3. Remove the bolt securing the lower shaft to the steering gear input shaft. Remove lower shaft from vehicle.

Installation

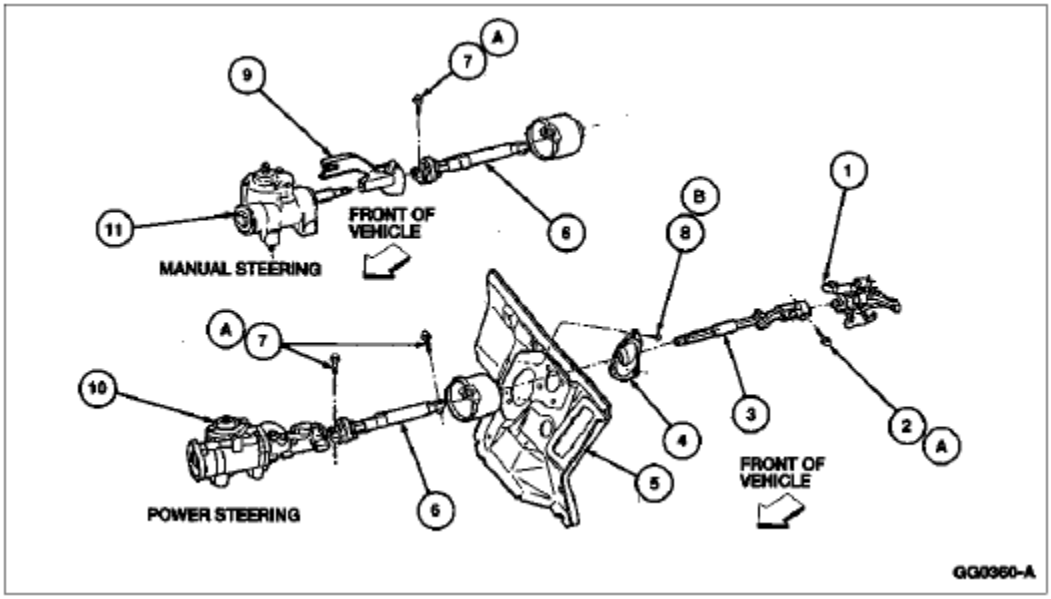
1. **NOTE: Use new bolt to attach intermediate shaft to steering gear input shaft and steering column shaft to intermediate shaft.**

   Install lower shaft on to the steering gear input (part of steering gear) shaft. Install new bolt and tighten bolt to 40-55 Nm (30-40 lb-ft).

2. Install intermediate shaft through the steering column opening weather seal (3513) and onto the steering column assembly. Install new bolt and tighten to 40-55 Nm (30-40 lb-ft).

3. Extend lower shaft and connect the upper shaft. Install and tighten bolt to 40-55 Nm (30-40 lb-ft).

Steering Column, Intermediate Shaft Installation



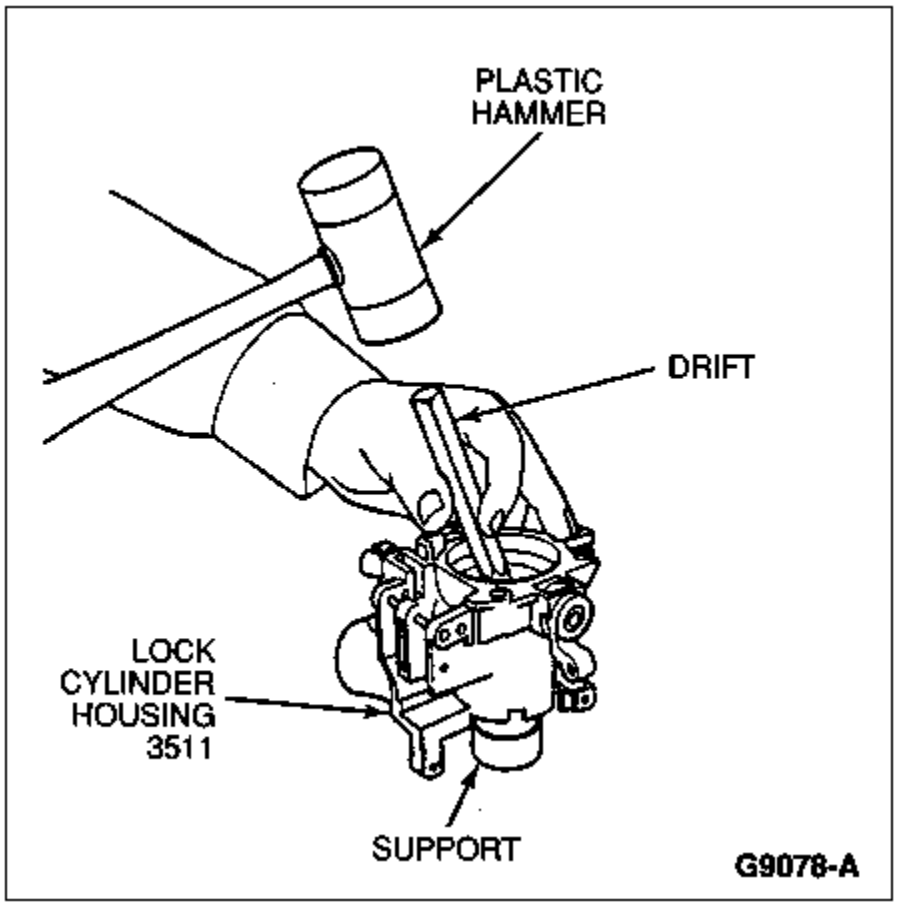
Item	Part Number	Description
1	3C529	Steering Column
2	N808464-S301	Bolt, M10-1.5 x 35
3	3B676	Steering Gear Intermediate Shaft
4	3513	Steering Column Opening Weather Seal
5	01610	Dash Panel
6	3A525	Steering Gear Lower Shaft
7	N803942-S100	Bolt, M10-1.5 x 35
8	N805375-S36MG	Screw, M6-1 x 20
9	3F540	Steering Shaft U-Joint Shield
10	3504	Steering Gear (Power)
11	3504	Steering Gear (Manual)
A	—	Tighten to 40-55 Nm (30-40 Lb-Ft)
B	—	Tighten to 15-20 Nm (11-14 Lb-Ft)

Steering Column Lock Housing Bearing

Upper

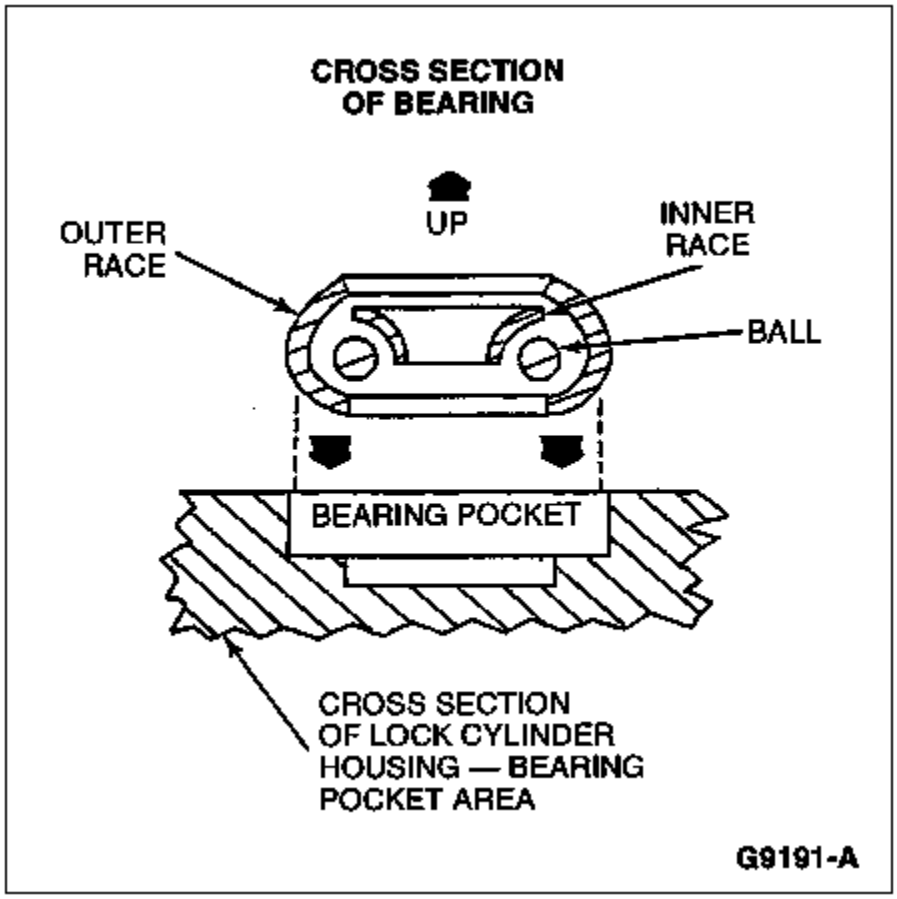
Removal

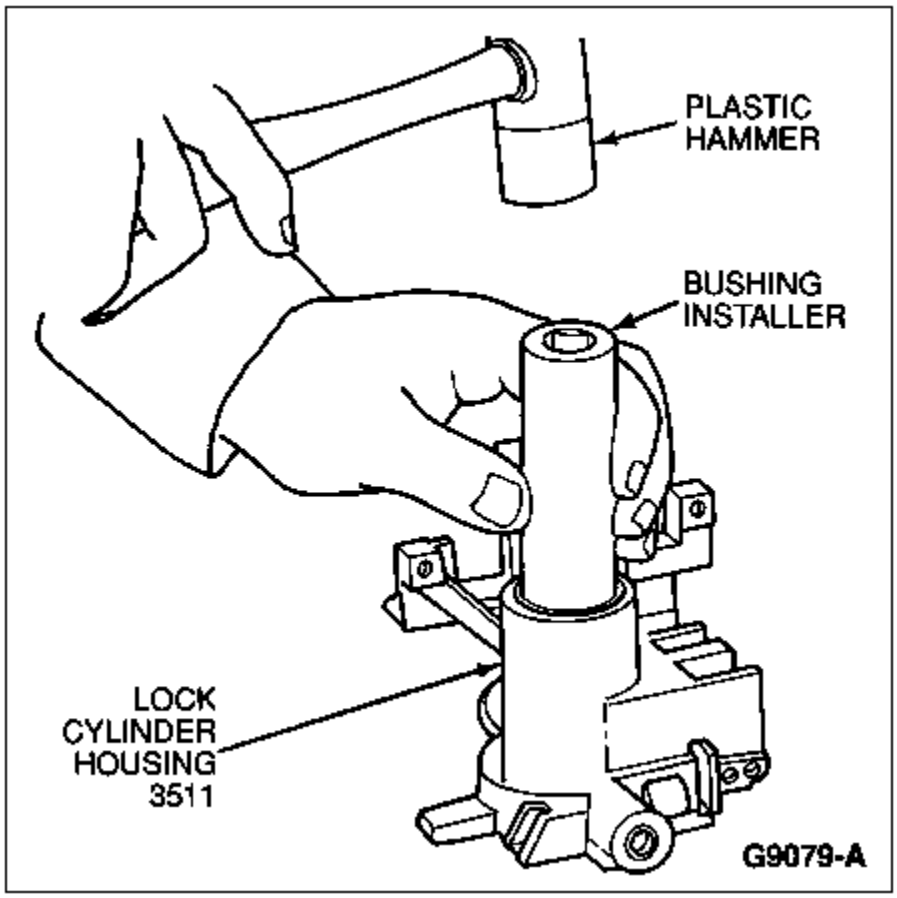
1. Remove lock cylinder housing from steering column as described in this section.
2. Suitably support lock cylinder housing and tap out small steering column upper bearing with an appropriate drift and a plastic hammer.



Installation

1. Suitably support lock cylinder housing. Position small steering column upper bearing so that the inner race is "up." Tap into place with a plastic hammer and a bushing driver installer or socket the same size as outer race of steering column bearing.


CROSS SECTION
OF BEARING
UP
OUTER
RACE
INNER
RACE
BALL
BEARING POCKET
CROSS SECTION
OF LOCK CYLINDER
HOUSING — BEARING
POCKET AREA
G9191-A



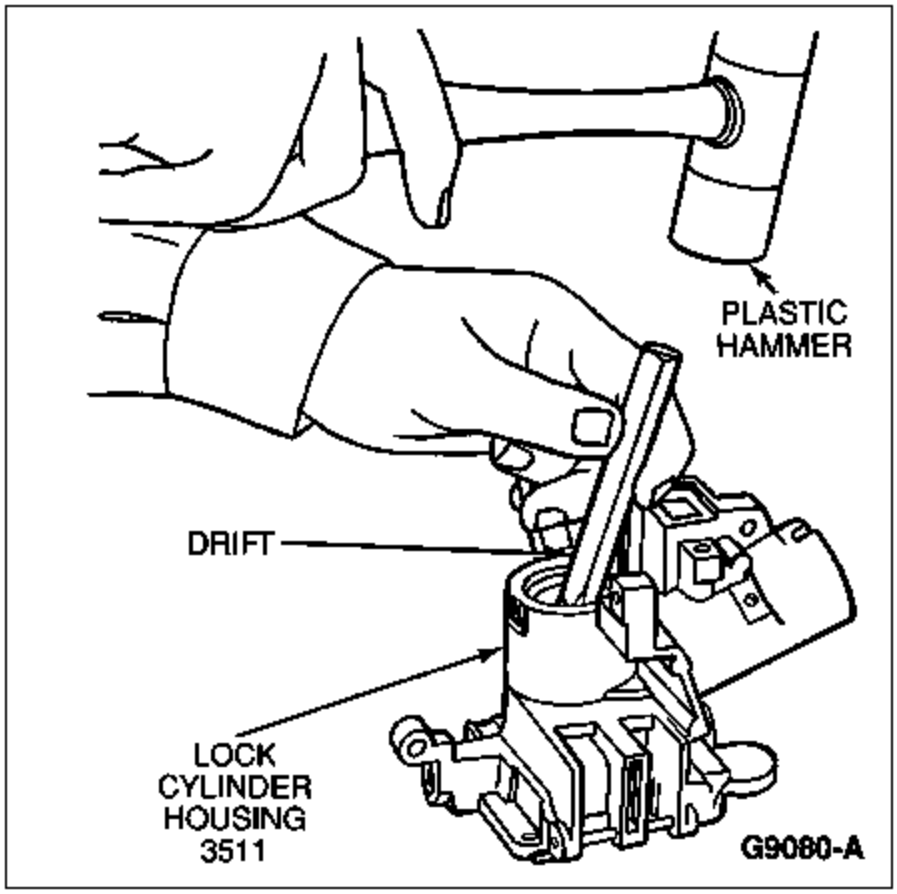
2. Install lock cylinder housing on steering column tube (3514) as outlined.

Intermediate

Removal

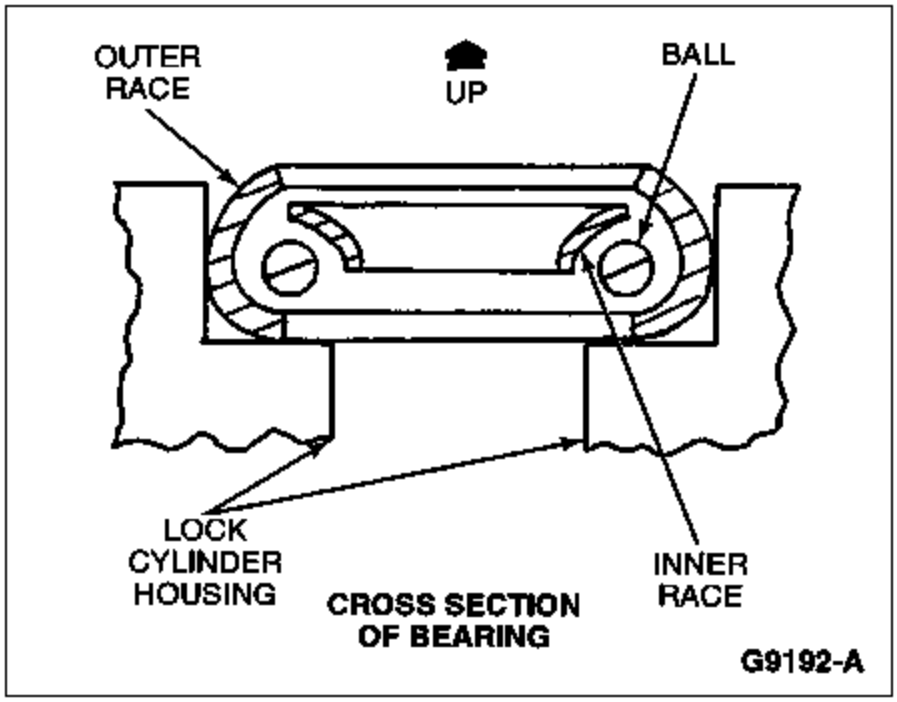
1. Remove lock cylinder housing as described in this section.

2. Set lock cylinder housing flat on workbench and tap steering column bearing loose with suitable drift and a plastic hammer.

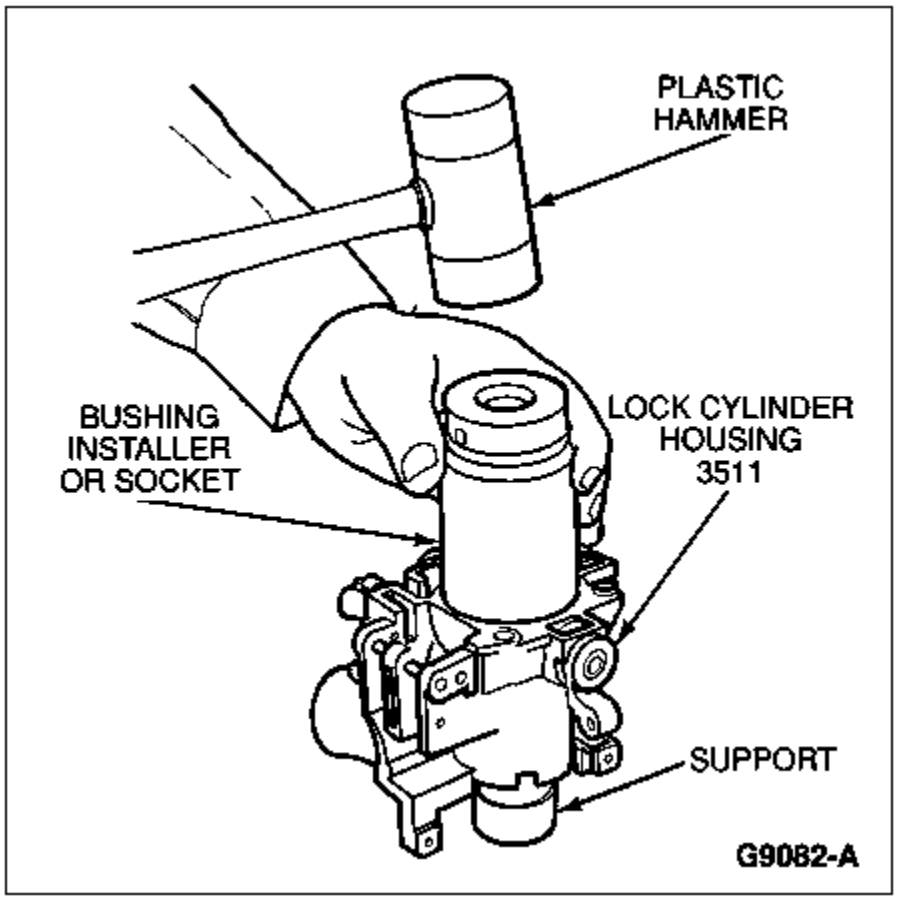


Installation

1. Support lock cylinder housing on workbench.
2. Position steering column bearing so that the inner race will face up (inner race fully visible in up position), or out from lock cylinder housing, when installed.



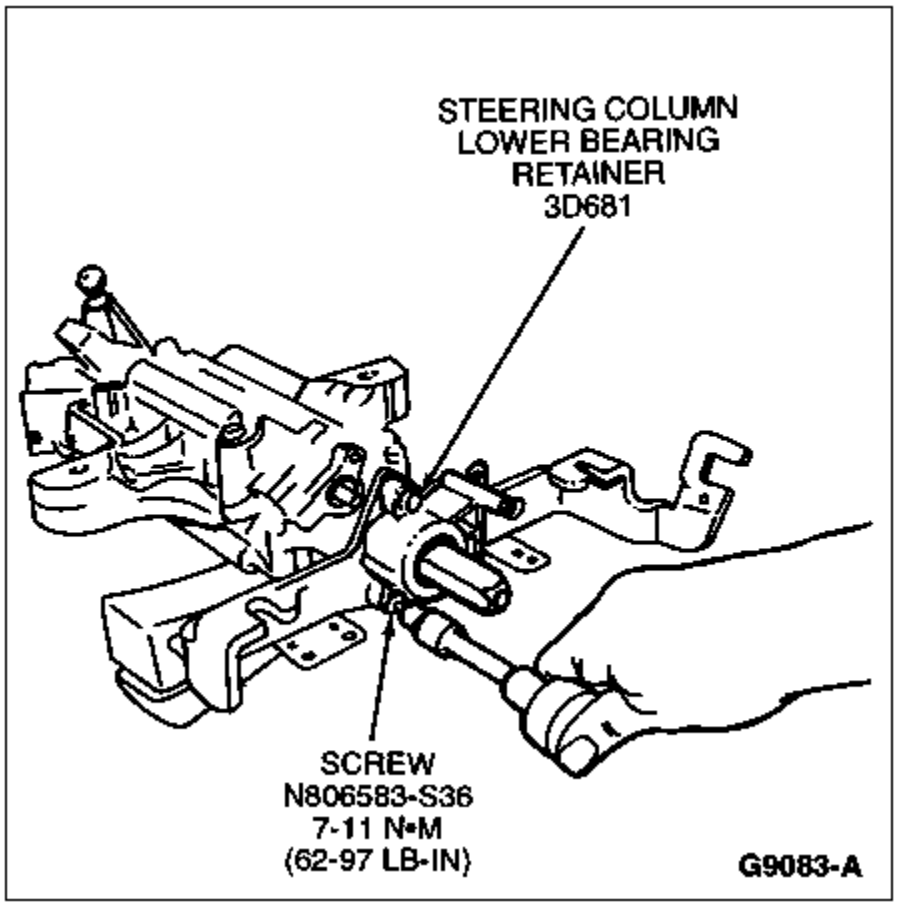
3. Using a socket or bushing driver the same size as outer race of steering column bearing, tap steering column bearing into lock cylinder housing with a plastic hammer until fully seated.



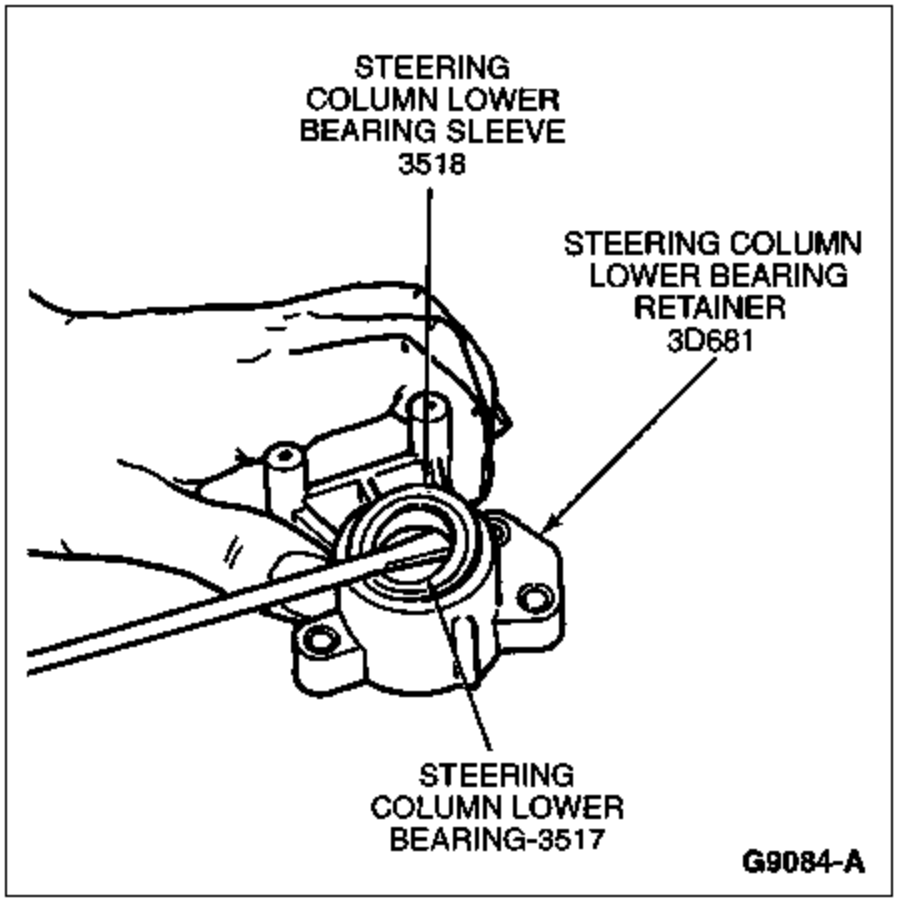
Lower

Removal

1. Remove steering column lower bearing retainer (3D681) as outlined in this section.

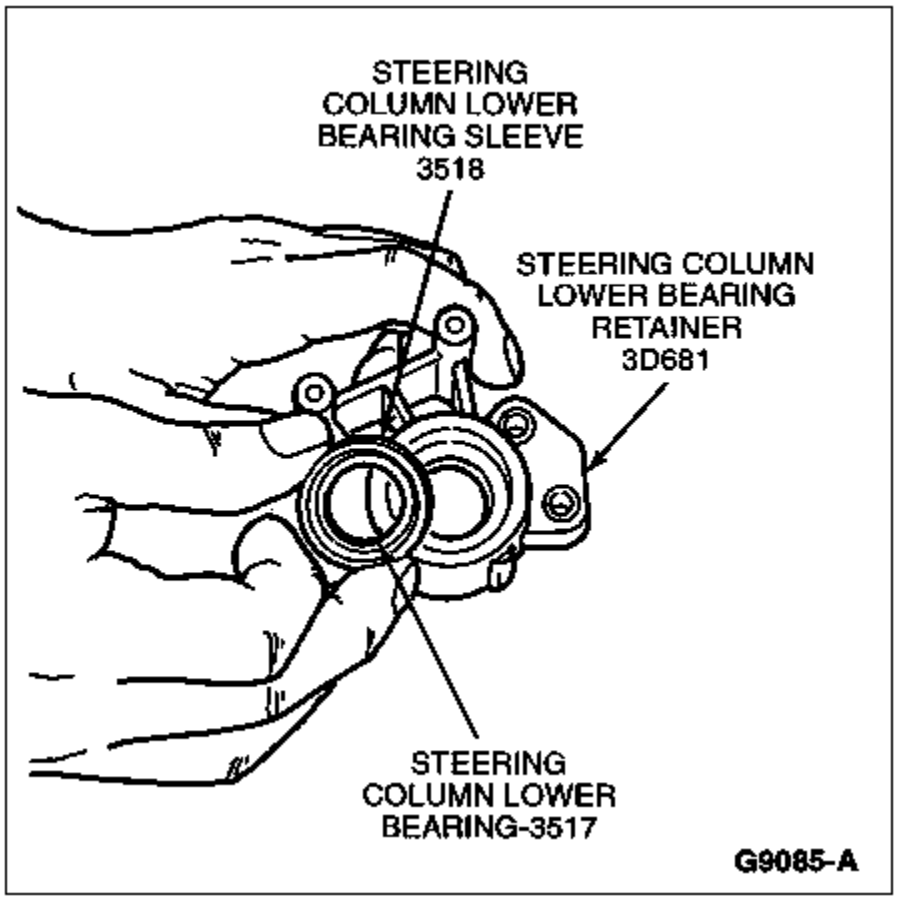


2. Remove steering column lower bearing and steering column lower bearing sleeve from steering column lower bearing retainer by hand.



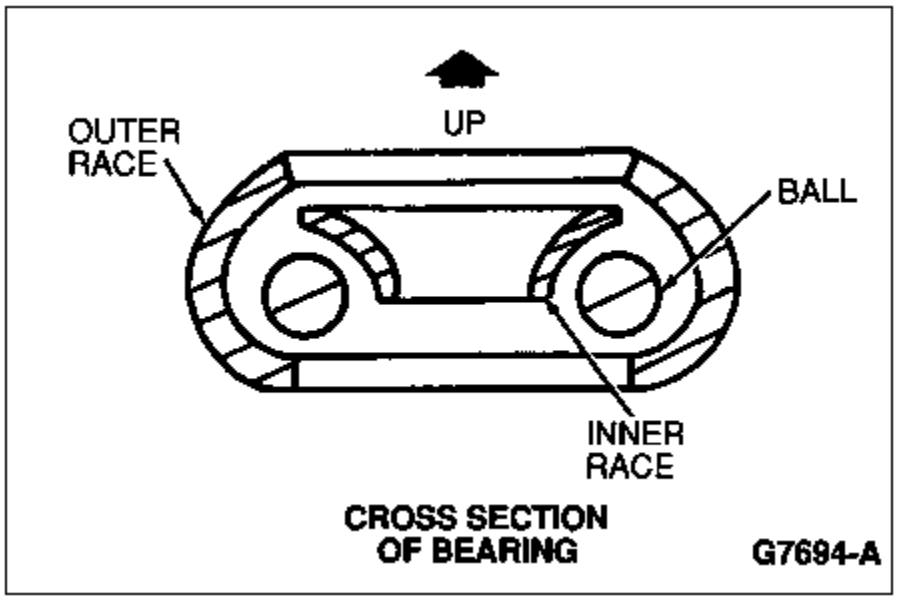
Installation

1. Inspect flexible steering column lower bearing. Replace if damaged.
2. Position steering column lower bearing sleeve in steering column lower bearing retainer.



3. Press in assembled steering column lower bearing and steering column tube bearing sleeve with thumb pressure until seated. Inner race should face toward engine (inner race should be fully visible when bearing retainer is installed on steering column) when installed in the vehicle.

4. Install steering column lower bearing retainer on steering column as outlined in this section.



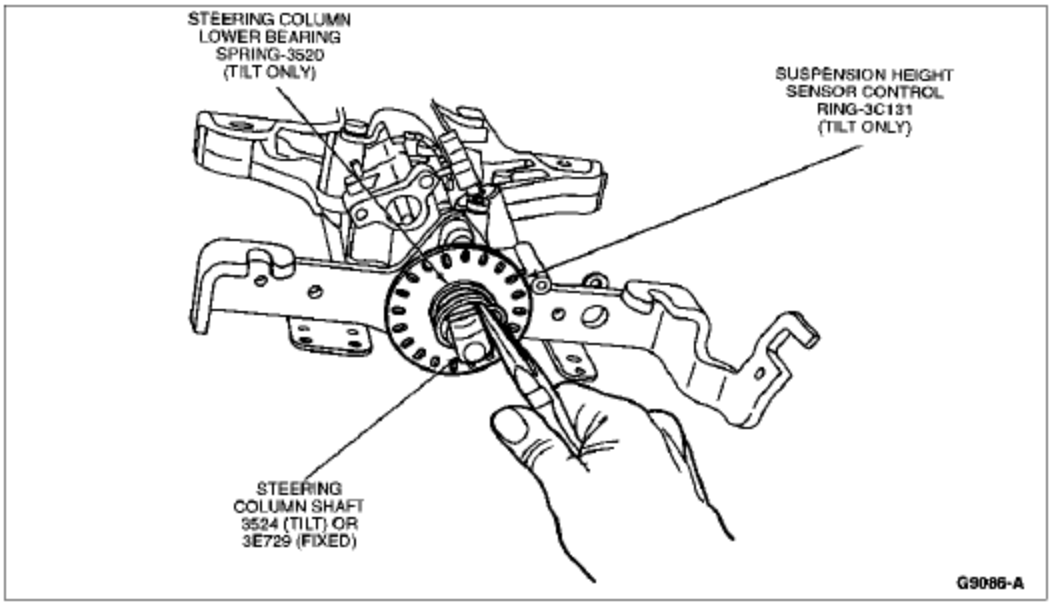
Bearing Retainer

Lower

Removal

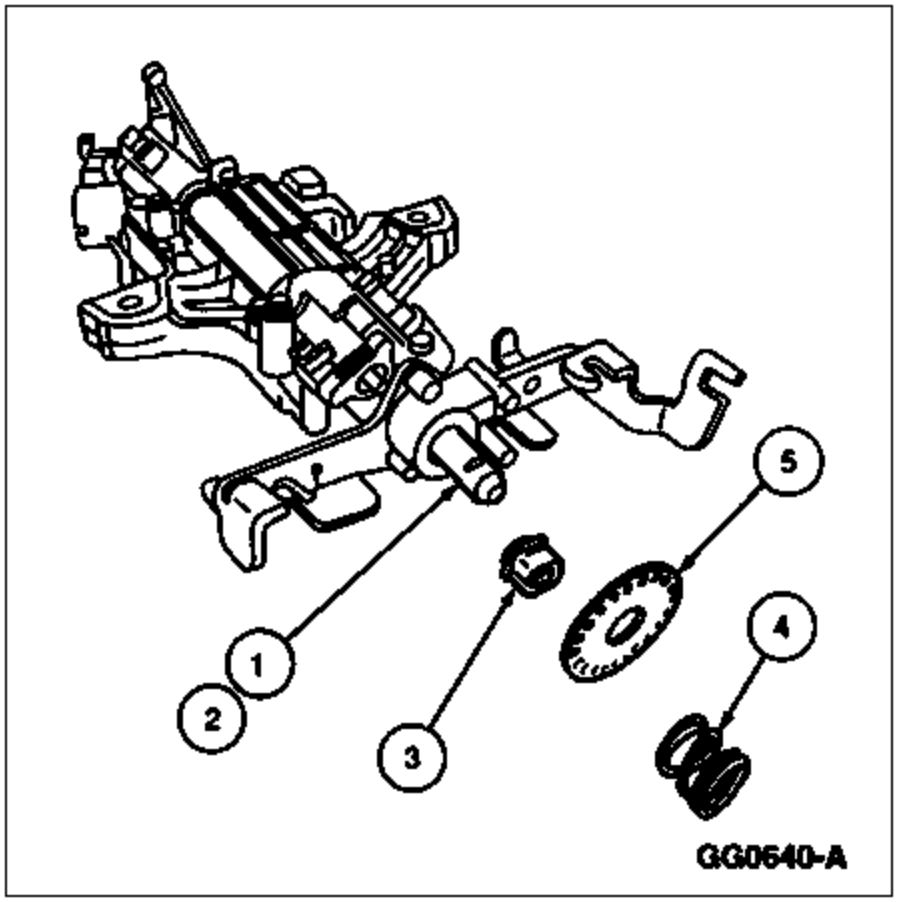
1. Remove steering column as outlined in this section.
2. Using pliers, remove steering column lower bearing spring on tilt columns or bearing retainer (3C610) on fixed columns.

Steering Column Lower Bearing Spring (Tilt Only)



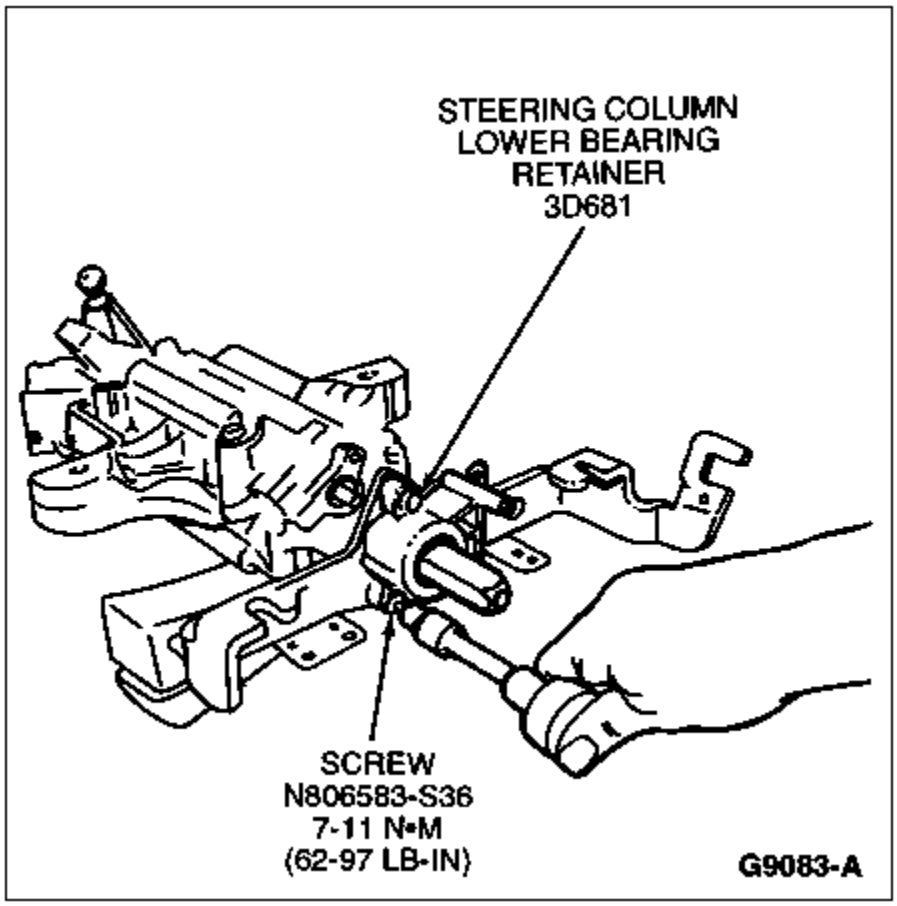
3. Remove suspension height sensor control ring (3C131) (tilt only) and steering column lower bearing tolerance ring.

Suspension Height Sensor Control Ring (Tilt Only)



Item	Part Number	Description
1	3524	Steering Column Shaft (Tilt)
2	3E729	Steering Column Shaft (Fixed)
3	3L539	Steering Column Upper Bearing Tolerance Ring
4	3520	Steering Column Upper Bearing Spring
5	3C131	Suspension Height Sensor Control Ring

4. Remove three screws and steering column lower bearing retainer (3D681).



5. For tilt column installation, reverse removal procedure.

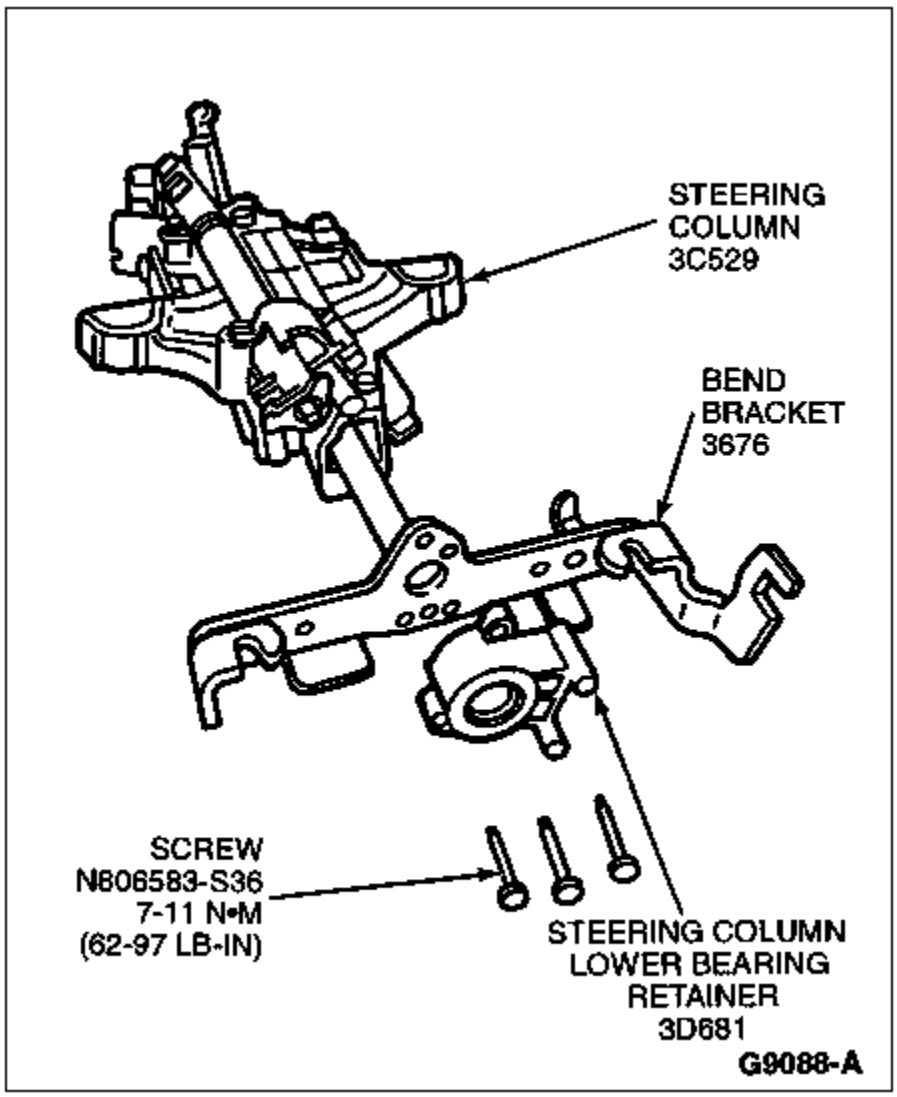
6. For fixed column installation, compress upper shaft spring to allow bearing retainer to be seated in its grooves in the lower end of the steering shaft.

Support Brackets, Steering Column

Bend Bracket

To remove bend bracket, remove steering column lower bearing retainer (3D681) as outlined in this section, then remove bend bracket. The same screws secure the steering column lower bearing retainer and the bend bracket.

Steering Column Lower Bearing Retainer and Bend Bracket

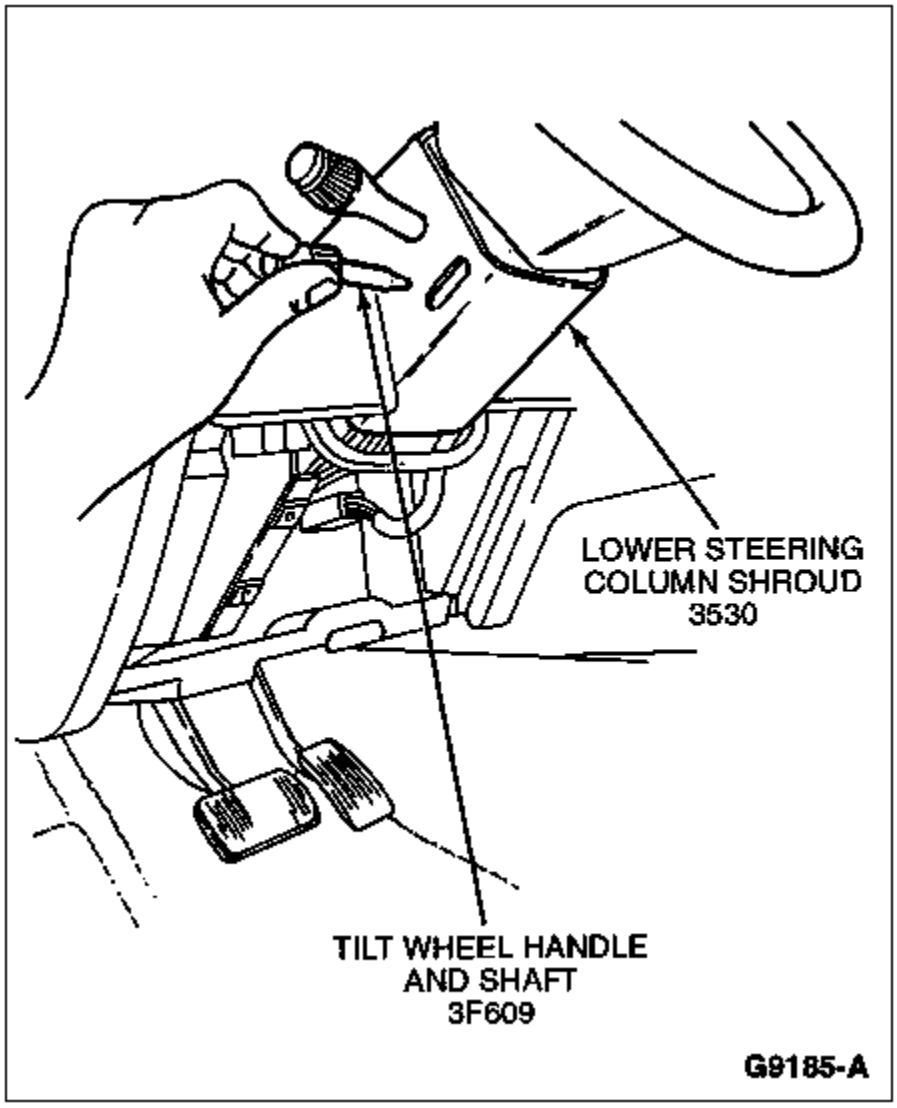


Tilt Wheel Handle and Shank

Removal and Installation

1. To remove tilt wheel handle and shank (3F609), rotate the tilt wheel handle and shank counterclockwise.

2. To install, position tilt wheel handle and shank and rotate clockwise until tight.



Air Bag Sliding Contact

Removal

WARNING: THE ELECTRICAL CIRCUIT FOR AIR BAG DEPLOYMENT IS POWERED DIRECTLY FROM THE BATTERY AND BACKUP POWER SUPPLY. TO AVOID ACCIDENTAL DEPLOYMENT AND POSSIBLE PERSONAL INJURY, THE BATTERY POSITIVE CABLE MUST BE DISCONNECTED FOR A MINIMUM OF ONE MINUTE BEFORE BEGINNING WORK TO DE-ENERGIZE THE BACKUP POWER SUPPLY.

1. Make sure the vehicle's front wheels (1007) are facing straight ahead, and the steering wheel (3600) is oriented in the straight-ahead position. If the steering wheel is turned, the new air bag sliding contact (14A664) to be installed (which is locked in its shipping orientation) will not line up with the steering column casting and shaft.

2. Disconnect the battery to starter relay cable (14300). Wait at least one minute before proceeding, to allow the air bag backup power supply to discharge.

3. Remove steering wheel as described in this section.

4. Remove upper and lower steering column shrouds (3530) as described in this section. (Unscrew tilt lock lever to remove lower steering column shroud, if so equipped.)

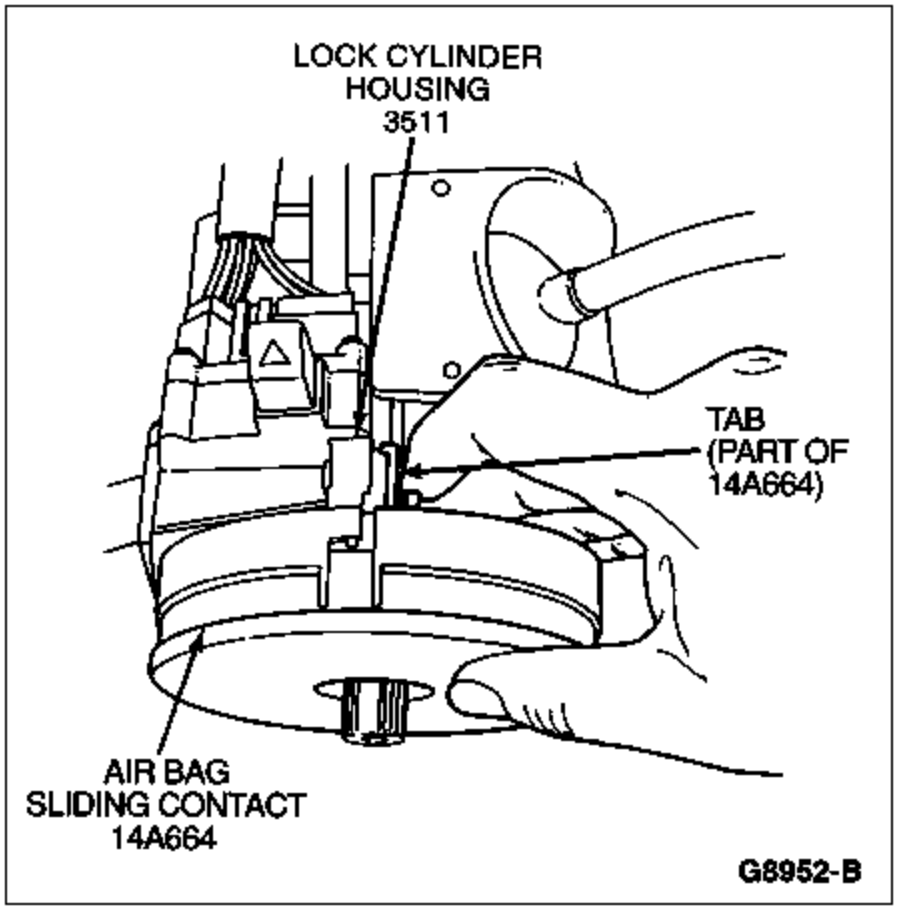
5. Remove ignition switch lock cylinder as described in this section. Remove key warning chime contact from lock cylinder casting by pulling out.

6. Remove ground wire eyelet bolt (N805375) from steering column bend bracket hole.

7. Remove the two air bag sliding contact down lead wire harness hanger clips from the steering column casting.

8. Disconnect the two air bag sliding contact lower wire harness electrical connectors from the instrument panel wiring harness at the steering column bend bracket, and remove connectors from bend bracket (remove ground wire eyelet bolt N805375).

9. Remove the air bag sliding contact from the steering column by prying the three snaps back from the small ramps on the steering column lock cylinder housing as the air bag sliding contact is pulled away from the housing. The snaps are located at the 12 o'clock, 3 o'clock, and 6 o'clock positions on the back of the air bag sliding contact.



Installation

1. Make sure the vehicle's front wheels are straight ahead and the steering column shaft alignment mark (punch mark on end of shaft) is at the 12 o'clock position.

2. If a new air bag sliding contact is being installed, orient the air bag sliding contact prior to installation by depressing the yellow hub lock with your finger and rotating the white hub approximately 1/4 turn clockwise until the arrow lines up with the shaft lock (yellow loop). Release hub lock.

3. If a new air bag sliding contact is being installed, position the new air bag sliding contact with the shaft lock (yellow loop) at the top, and slide the new air bag sliding contact onto the steering column shaft. (If the old air bag sliding contact is being reinstalled, position the black housing so that the three pins on the back side lineup with the three holes in the steering column lock cylinder housing at 12 o'clock, 3 o'clock, and 6 o'clock.) Push the air bag sliding contact firmly until the three guide pins on the back of the air bag sliding contact engage the holes in the steering column lock cylinder housing, and the three snaps on the back of the air bag sliding contact engage the three ramps on the steering column lock cylinder housing.

4. Push the two wire hanger clips into the steering column casting.

5. Install the down lead harness wire connectors in the original locations on the steering column lower bend bracket and connect to the instrument panel wiring harness.

6. Route the ground wire from the air bag sliding contact lower 6-pin wiring connector to the steering column bend bracket hole, and secure the eyelet to the bend bracket with bolt (N805375).

7. Install the key warning chime wire (first remove black protective cover from the connector) into the key lock cylinder by pushing firmly until it snaps into place.

8. Reinstall the upper and lower steering column shrouds. Reinstall tilt lever.

9. Reinstall the steering wheel as outlined in this section. Connect steering wheel wiring connector to air bag sliding contact.

10. Unlock the air bag sliding contact by pulling up on the yellow loop at the top of the air bag sliding contact to remove.

11. Connect driver air bag to air bag sliding contact connector. Place driver side air bag module (043B13) into steering wheel and install air bag retaining bolts. Hold driver side air bag module in position in steering wheel while bolts are being tightened to ensure proper fit.

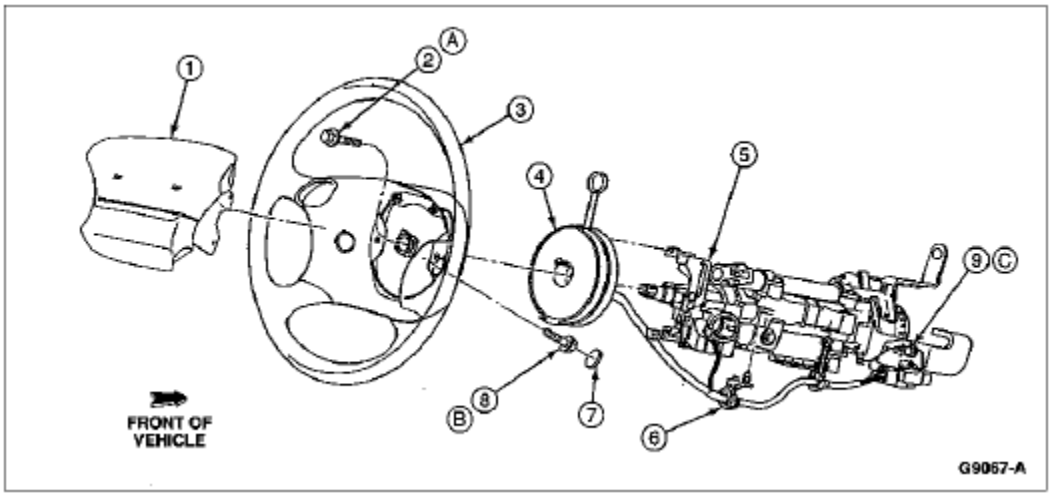
12. Reinstall two steering wheel cover plugs by snapping into holes on sides of steering wheel.

13. **NOTE: When the battery (10655) has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven to relearn the strategy.**

    Connect battery to starter relay cable. Refer to Section 01-20B .

14. Verify air bag warning indicator operation.

Steering Wheel with Air Bag



Item	Part Number	Description
1	043B13	Driver Side Air Bag Module
2	N807493-S100	Torx® Head Screw, M10-1.5 x 18
3	3600	Steering Wheel
4	14A664	Air Bag Sliding Contact
5	3C529	Steering Column

6	—	Clip (Part of 14A664)
7	3F785	Plug
8	N808944-S424	Bolt
9	N805375-S36MG	Bolt
A	—	Tighten to 34-46 Nm (25-33 Lb-Ft)
B	—	Tighten to 7.6-10.4 Nm (67-92 Lb-In)
C	—	Tighten to 10.2-13.8 Nm (7.5-10.1 Lb-Ft)

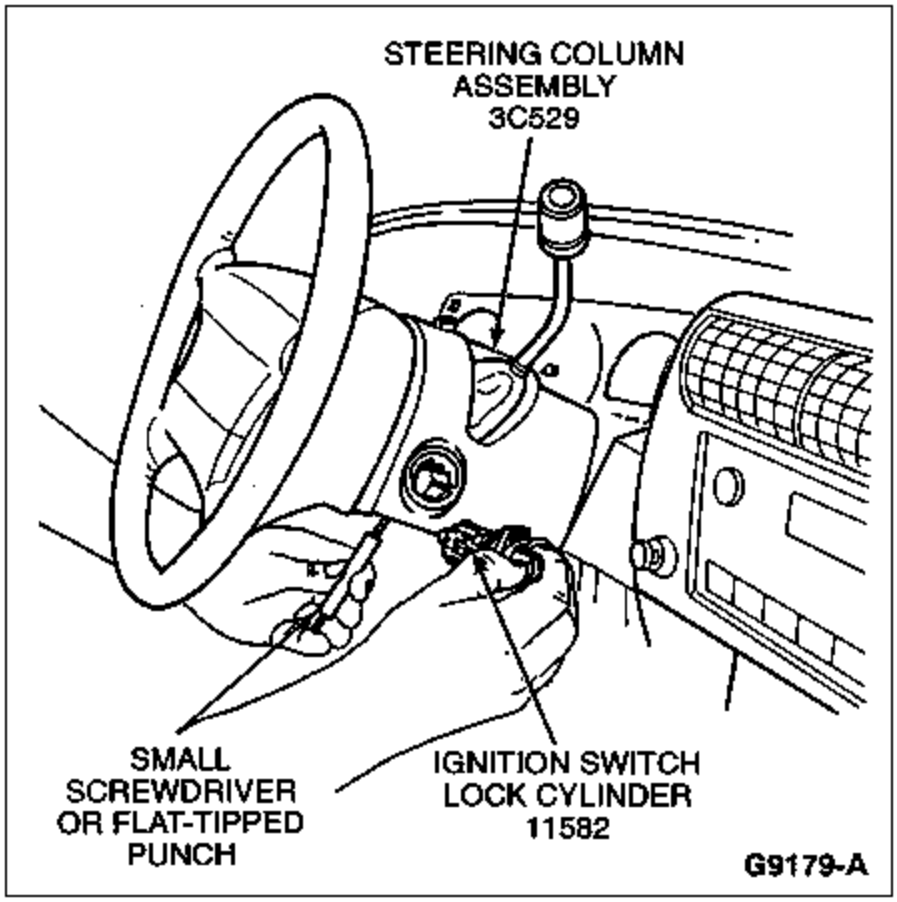
Ignition Switch Lock Cylinder

NOTE: The following procedure applies to vehicles that have functional lock cylinders and keys. If key numbers are known, the proper key can be made.

Lock Cylinder Functional

Removal

1. Disconnect battery ground cable (14301).
2. Turn lock cylinder key to RUN position.
3. Remove lower shroud as outlined in this section under shroud removal.
4. Place a 3.17mm (1/8-inch) diameter wire pin or small drift punch in hole in steering column under lock cylinder. Depress retaining pin while pulling out on lock cylinder to remove it from housing of steering column.



Installation

1. Install lock cylinder by turning it to RUN position and depressing retaining pin. Insert lock cylinder into steering column housing. Make sure ignition switch lock cylinder is fully seated and aligned in interlocking washer before turning key to OFF position. This will permit retaining pin of ignition lock cylinder to extend into hole of steering column.

2. Rotate lock cylinder, using key, to make sure of correct mechanical operation in all positions.

3. **NOTE: When the battery (10655) has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more for powertrain control module to relearn the strategy.**

   Connect battery ground cable.

Lock Cylinder Non-Functional

Removal

NOTE: The following procedure applies to vehicles in which the ignition lock is inoperative and the ignition switch lock cylinder (11582) cannot be rotated due to a lost or broken key, unknown key number, or a cap that has been damaged or broken to the extent that the ignition switch lock cylinder cannot be rotated.

1. Disconnect battery ground cable.

2. Using channel lock or vise grip pliers, twist cap until it separates from the ignition switch lock cylinder.

3. Remove lower shroud as outlined in this section under shroud removal.

4. Prick-punch pin and drill out with 1/8-inch bit. Do not drill deeper than 13mm (1/2 inch). Put a piece of masking tape 13mm (1/2 inch) from tip on bit. Take care not to damage housing.

5. Using a 3/8-inch diameter drill, drill down middle of ignition lock key slot approximately 44mm (1-3/4 inch) until ignition switch lock cylinder breaks loose from breakaway base of ignition switch lock cylinder. Remove ignition switch lock cylinder and drill shavings from lock cylinder housing.

6. Remove column lock gear retainer, steering column lock housing bearing (3E700) and steering column lock gear (3E717). Thoroughly clean all drill shavings and other foreign materials from lock cylinder housing.

7. Carefully inspect lock cylinder housing for damage from the above operation. If damage is apparent, lock cylinder housing must be replaced.

Installation

1. Replace lock cylinder housing, if damaged.

2. Install steering column lock gear, steering column lock housing bearing and column lock gear retainer.

3. Install trim and electrical parts.

4. Install new ignition switch lock cylinder as described in this section.

5. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

   Connect battery ground cable.

6. Check operation of lock cylinder.

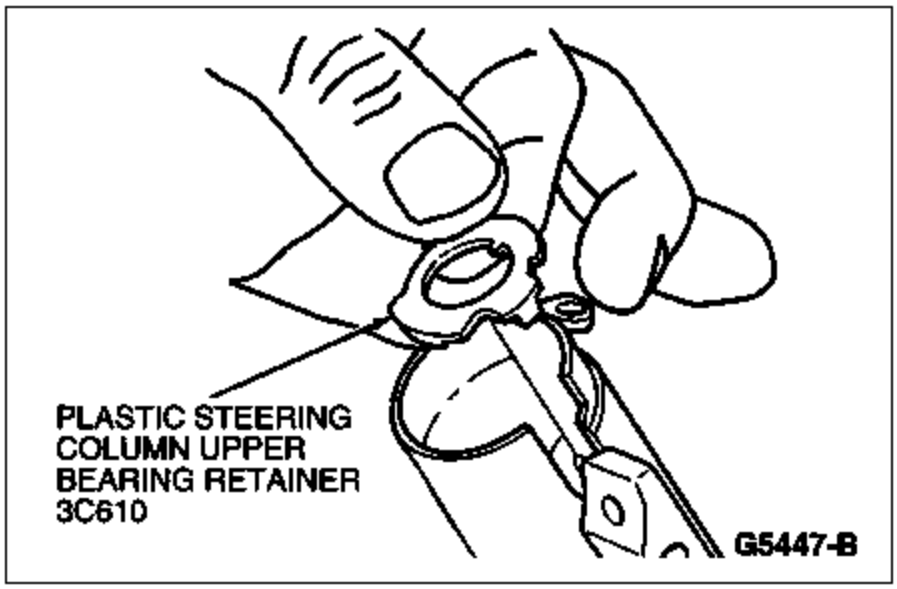
Ignition Lock Drive Gear

Removal

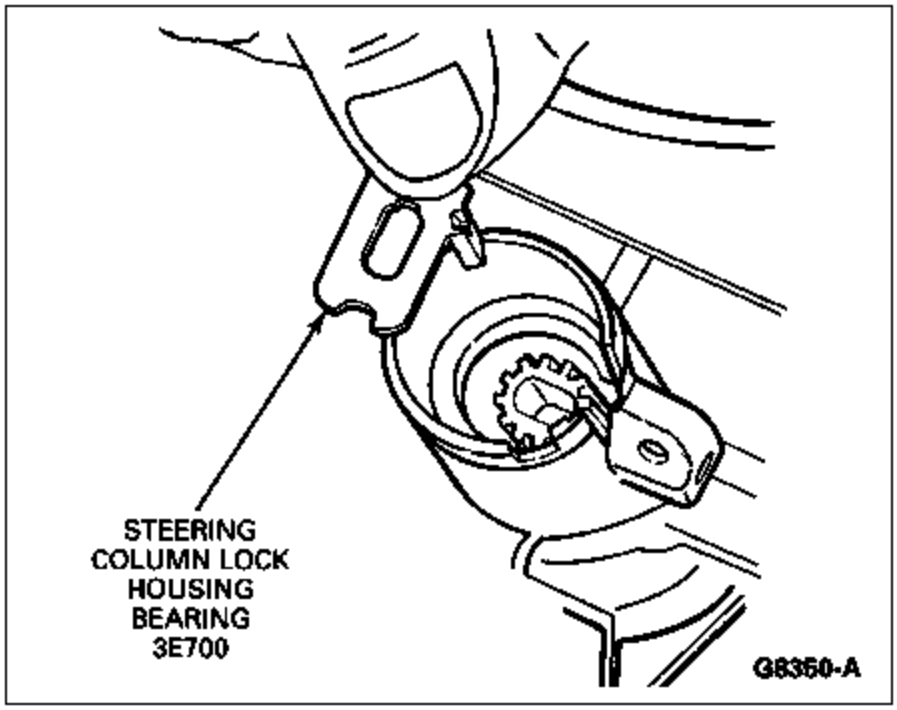
1. **CAUTION: Carefully note the position of the column lock gear retainer prior to removal.**

   Rotate ignition switch lock cylinder (11582) to RUN position. Using a 1/8-inch drift, press lock cylinder retaining pin through access hole and remove ignition switch lock cylinder.

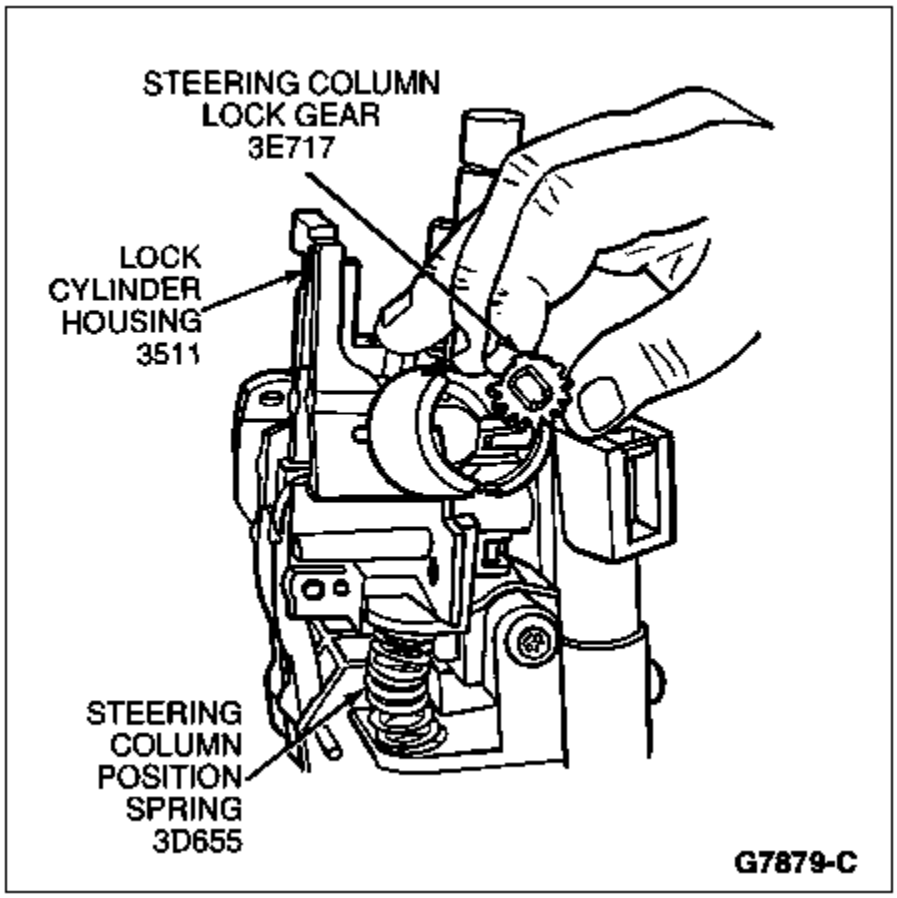
2. Remove column lock gear retainer by inserting a screwdriver or similar tool, with a 90 degree bend on the tip, between steering column upper bearing retainer and steering column lock housing bearing (3E700) and by prying upward.



3. Insert tip of a screwdriver into Double-D slot of steering column lock housing bearing, then rotate 90 degrees. Remove steering column lock housing bearing.



4. Remove steering column lock gear (3E717). Carefully note relationship of steering column lock gear to position of rack teeth.



Installation

1. Position steering column lock gear in base of lock cylinder housing in the same position as that noted during removal procedure. The position of steering column lock gear is correct if last tooth on steering column lock gear is meshed with last tooth on steering column lock lever actuator (3E715).

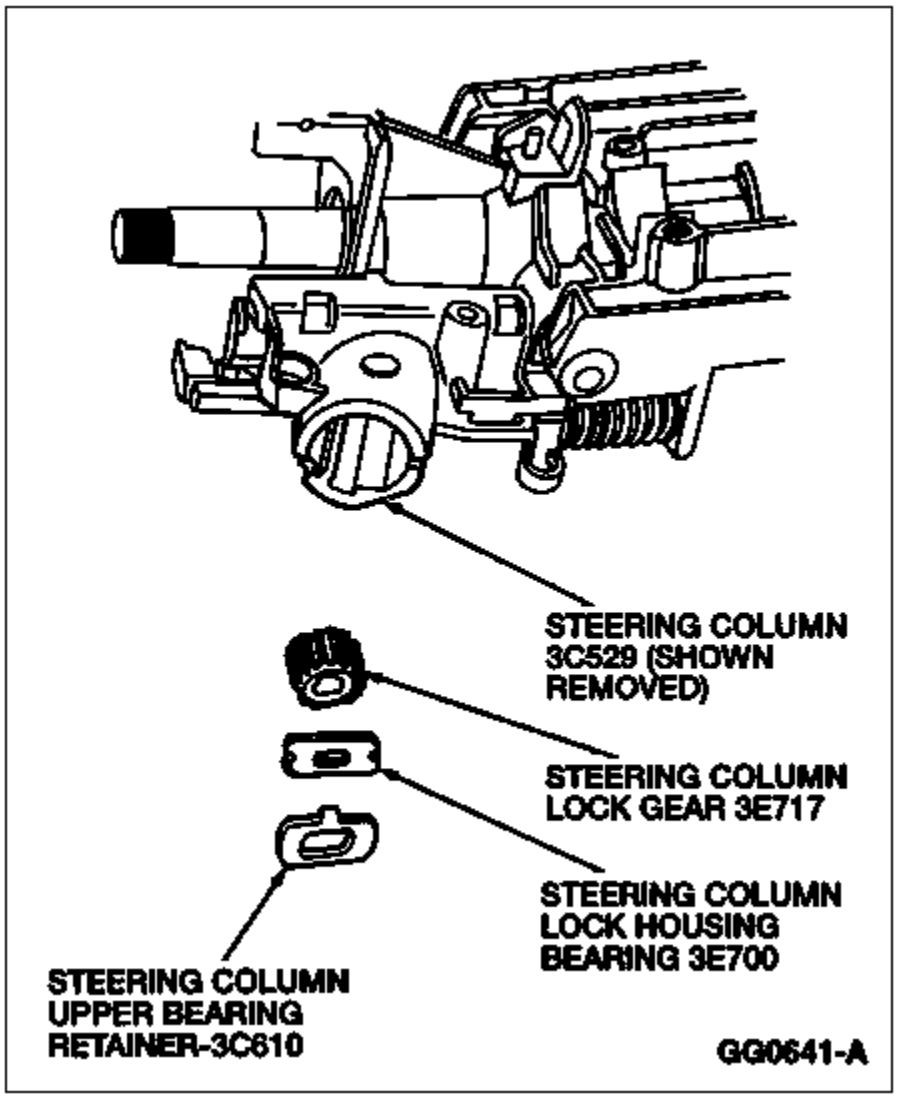
2. Position bearing retainer (3C610) in lock cylinder housing. Insert tip of a screwdriver into Double-D slot of steering column lock housing bearing, then rotate 90 degrees.

3. Press blue plastic column lock gear retainer into steering column lock cylinder housing. Make sure column lock gear retainer is in its original position.

4. Line up flats of steering column lock gear with flats of washer by pulling down on the steering column lock lever actuator.

5. Install ignition switch lock cylinder.

6. Check for proper start in Park and Neutral. Also, check to make sure start circuit cannot be actuated in Drive or Reverse positions and the steering column tube is locked in Lock position.


STEERING COLUMN 3C529 (SHOWN REMOVED)
STEERING COLUMN LOCK GEAR 3E717
STEERING COLUMN LOCK HOUSING BEARING 3E700
STEERING COLUMN UPPER BEARING RETAINER-3C610
GG0641-A

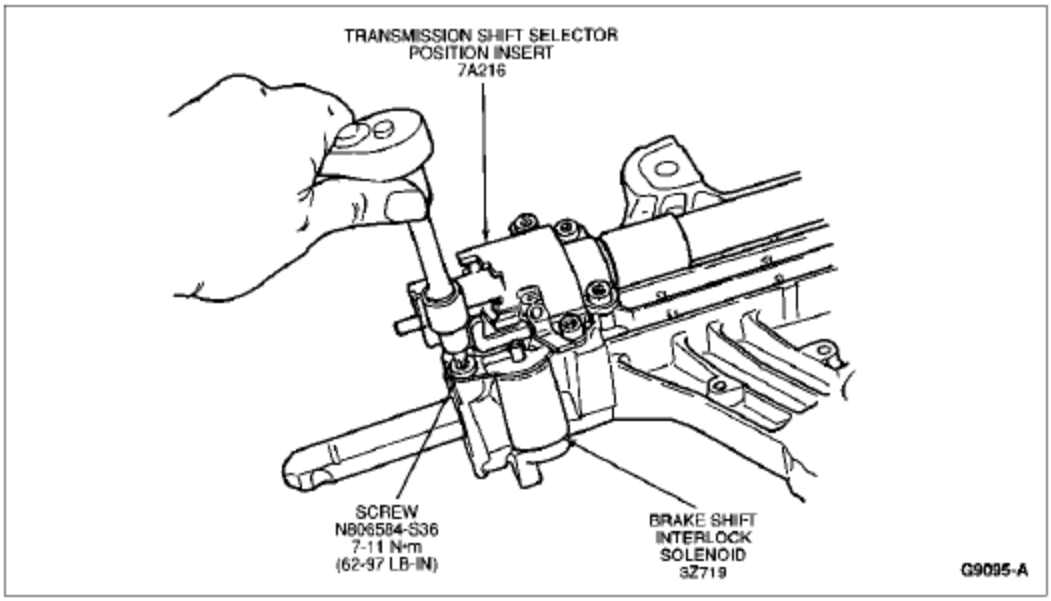
Brake Shift Interlock Solenoid

Removal and Installation

1. Remove steering column as outlined in this section.
2. **NOTE: Brake shift interlock solenoid is retained to the transmission shift selector position insert (7A216) with a pushnut.**

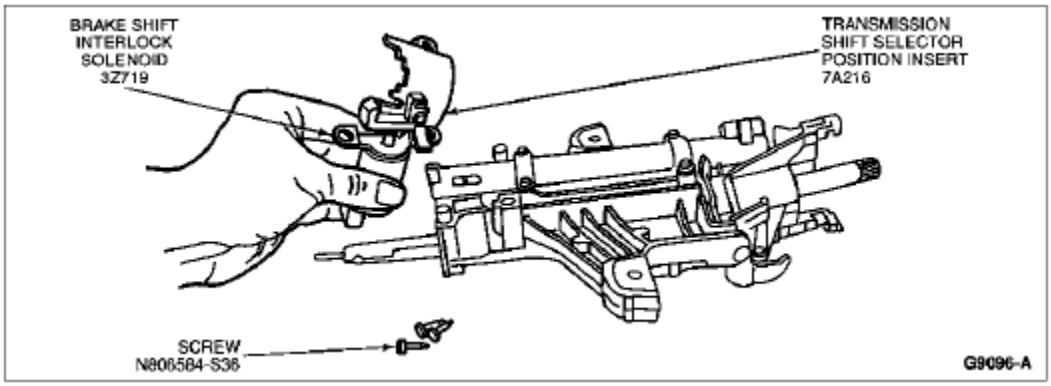
   Remove three screws attaching brake shift interlock solenoid and transmission shift selector position insert.

Brake Shift Interlock Solenoid Retainer Screws

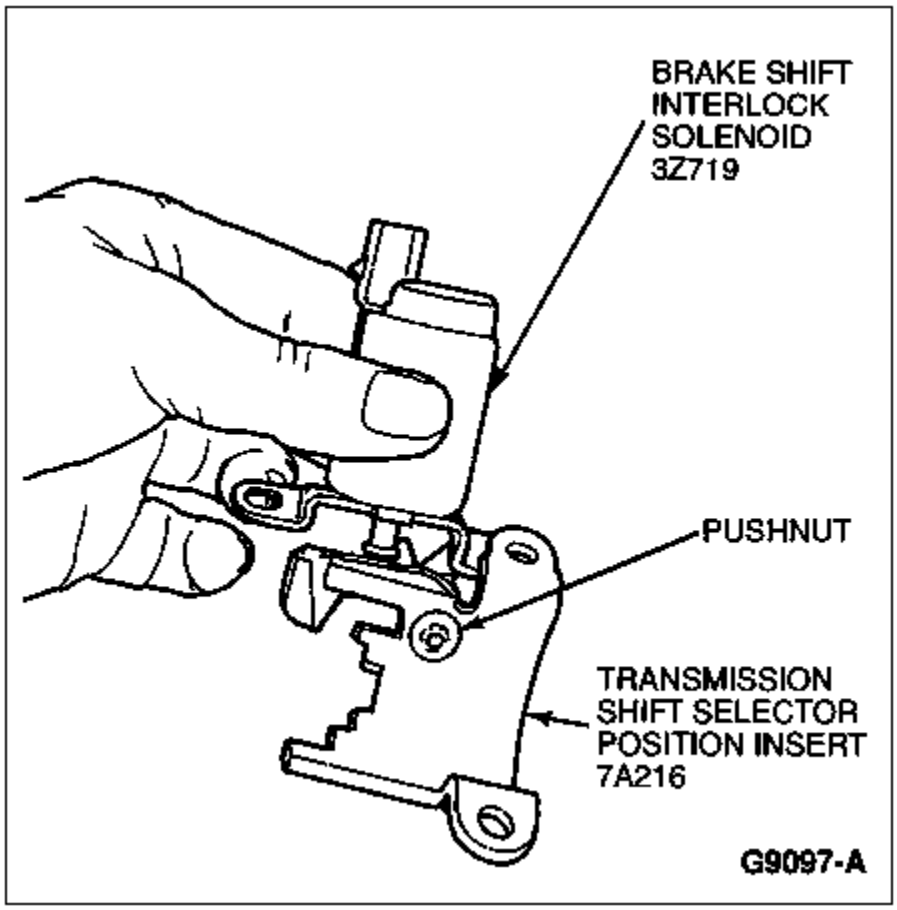


3. Remove brake shift interlock solenoid and transmission shift selector position insert.

Brake Shift Interlock Solenoid



4. If necessary, remove pushnut and separate brake shift interlock solenoid from transmission shift selector position insert.



To install, reverse removal procedures. Tighten attaching screws to 7-11 Nm (62-97 lb-in).

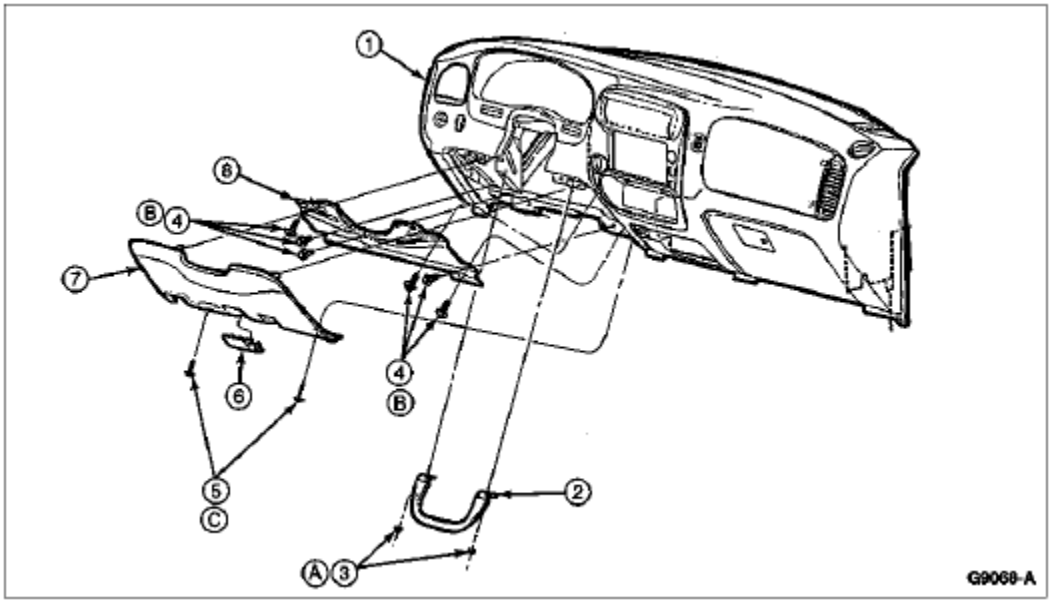
Steering Column Shroud

Lower

Removal

1. Disconnect battery ground cable (14301).
2. Remove two screws and instrument panel steering column cover (04459).
3. Remove three screws and instrument panel steering column cover reinforcement.

Instrument Panel Steering Column Cover and Reinforcement

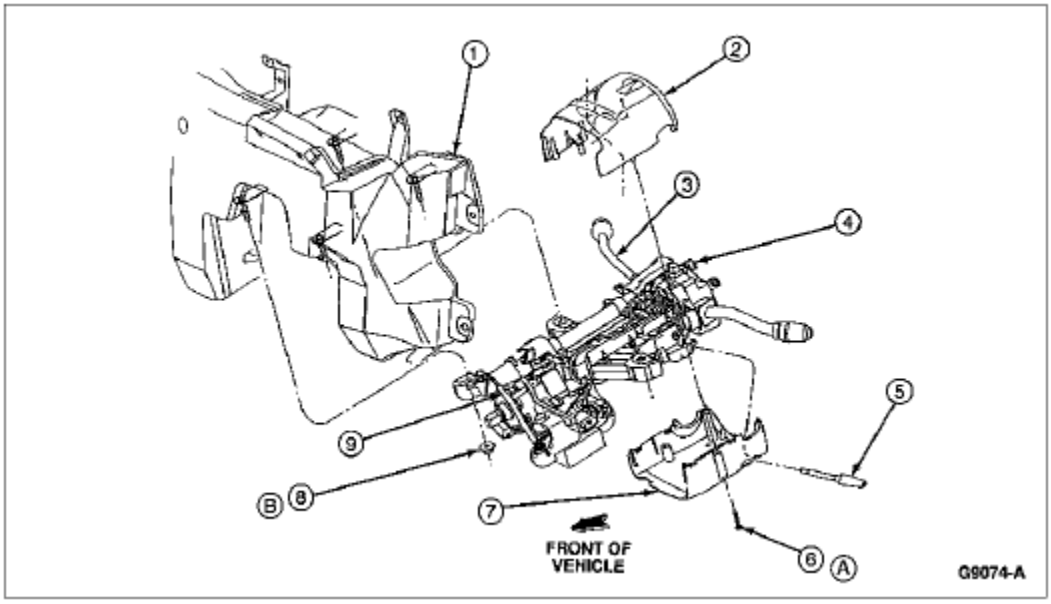


Item	Part Number	Description
1	04320	Instrument Panel
2	044C86	Instrument Panel Steering Column Opening Center Reinforcement
3	N806423-S58	Nuts
4	N606677-S36	Screw
5	N807122-	Screw

	S411	
6	044D82	Instrument Panel Access Hole Cover
7	04459	Instrument Panel Steering Column Cover
8	017A28	Instrument Panel Reinforcement
A	—	Tighten to 13-17 Nm (115-150 Lb-In)
B	—	Tighten to 10-14 Nm (88-123 Lb-In)
C	—	Tighten to 2.1-2.9 Nm (19-25 Lb-In)

4. Unscrew and remove tilt wheel handle and shank (3F609), if equipped.
5. Remove retaining screws and lower steering column shroud (3530).

Steering Column Installation



Item	Part Number	Description
1	04545	Instrument Panel Reinforcement
2	3530	Steering Column Shroud (Upper)
3	7210	Gearshift Lever
4	3C529	Steering Column
5	3F609	Tilt Wheel Handle and Shank
6	55929-S2	Screw
7	3530	Steering Column Shroud (Lower)

8	N806423-S58	Nut
9	7E395	Shift Cable and Bracket
A	—	Tighten to .7-1.1 Nm (6.2-9.7 Lb-In)
B	—	Tighten to 13-17 Nm (10-12 Lb-Ft)

Installation

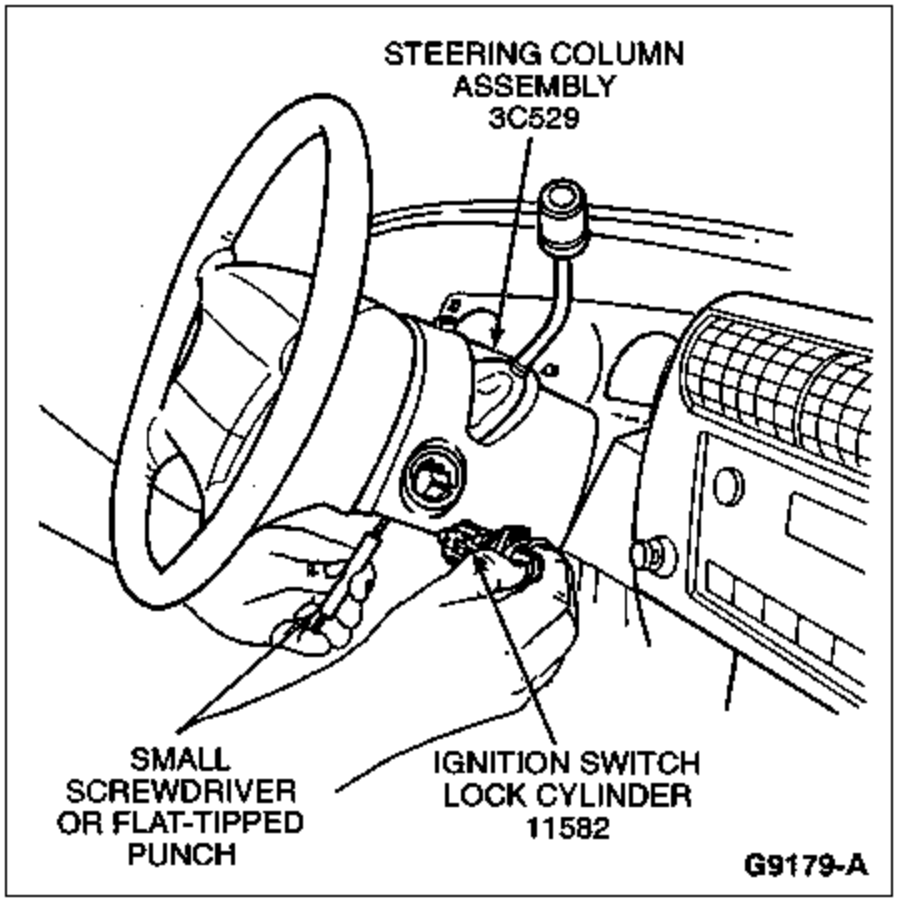
1. Position lower steering column shroud into place on upper steering column shroud.
2. Install retaining screws and tighten to 0.7-1.1 Nm (7-9 lb-in).
3. Install tilt wheel handle and shank, if equipped with tilt wheel.
4. Install instrument panel steering column cover reinforcement and retaining screws. Tighten screws to 10-14 Nm (88-123 lb-in).
5. Install instrument panel steering column cover and two screws. Tighten to 2.1-2.9 Nm (19-25 lb-in).
6. **NOTE: When the battery (10655) has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

   Reconnect battery ground cable.

Upper

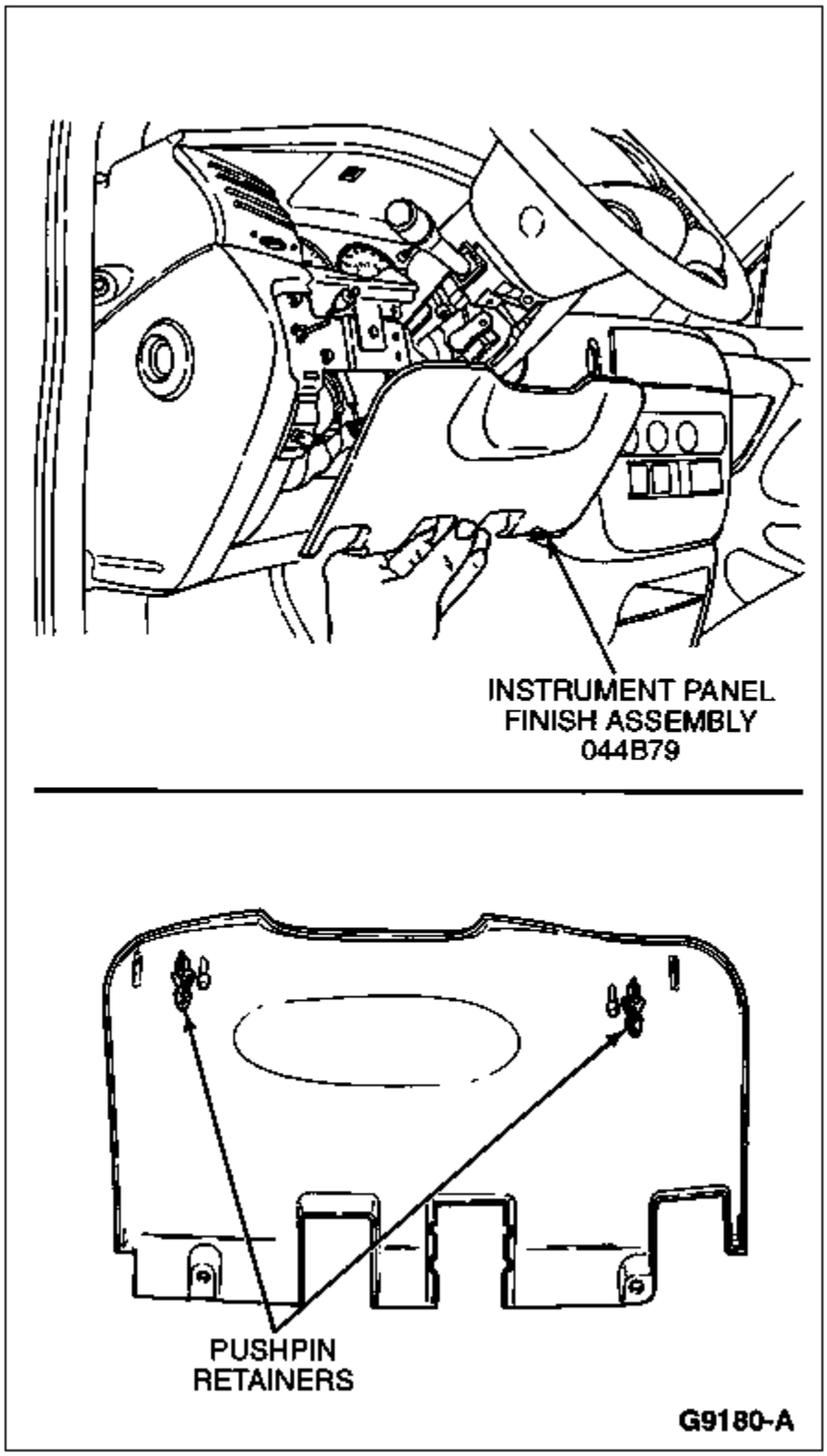
Removal and Installation

1. Remove lower steering column shroud as outlined above.
2. Turn ignition switch lock cylinder (11582) to RUN position.
3. Using flat-tipped punch, push on button below ignition switch lock cylinder and pull out ignition switch lock cylinder.



4. Pull off knob (18519).

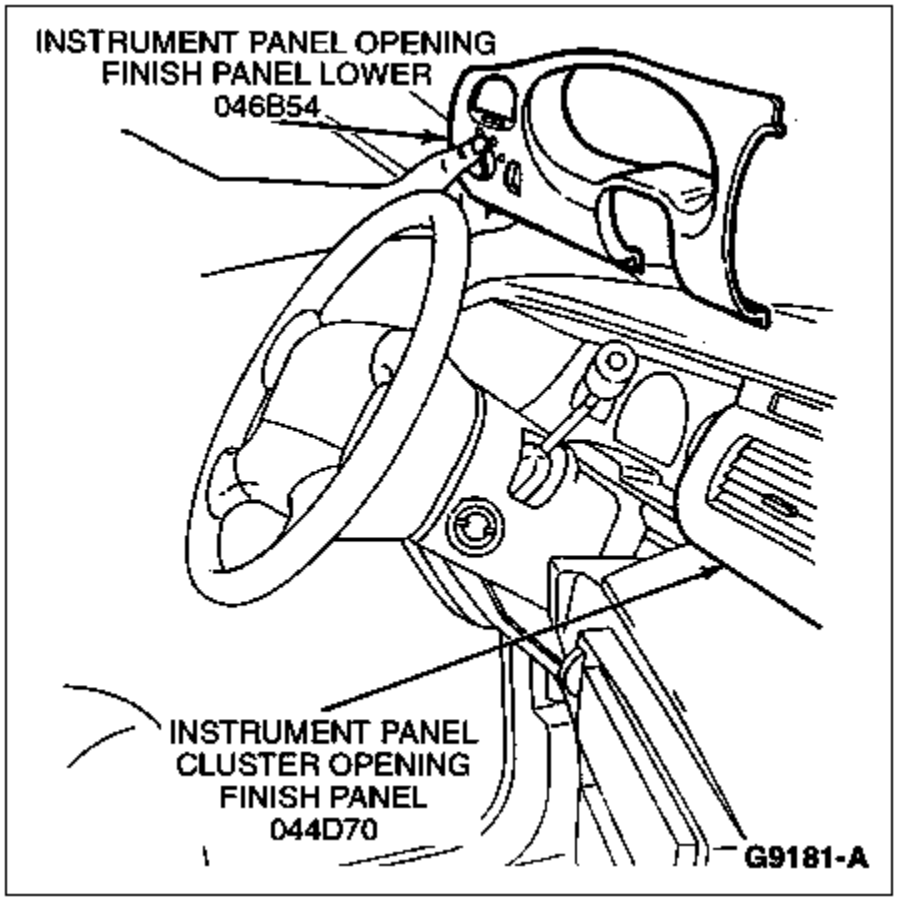
5. Using wide-blade screwdriver, pry loose left-hand instrument panel finish panel (04338). Twist 45 degrees and remove headlamp switch electrical connector from instrument panel finish panel.



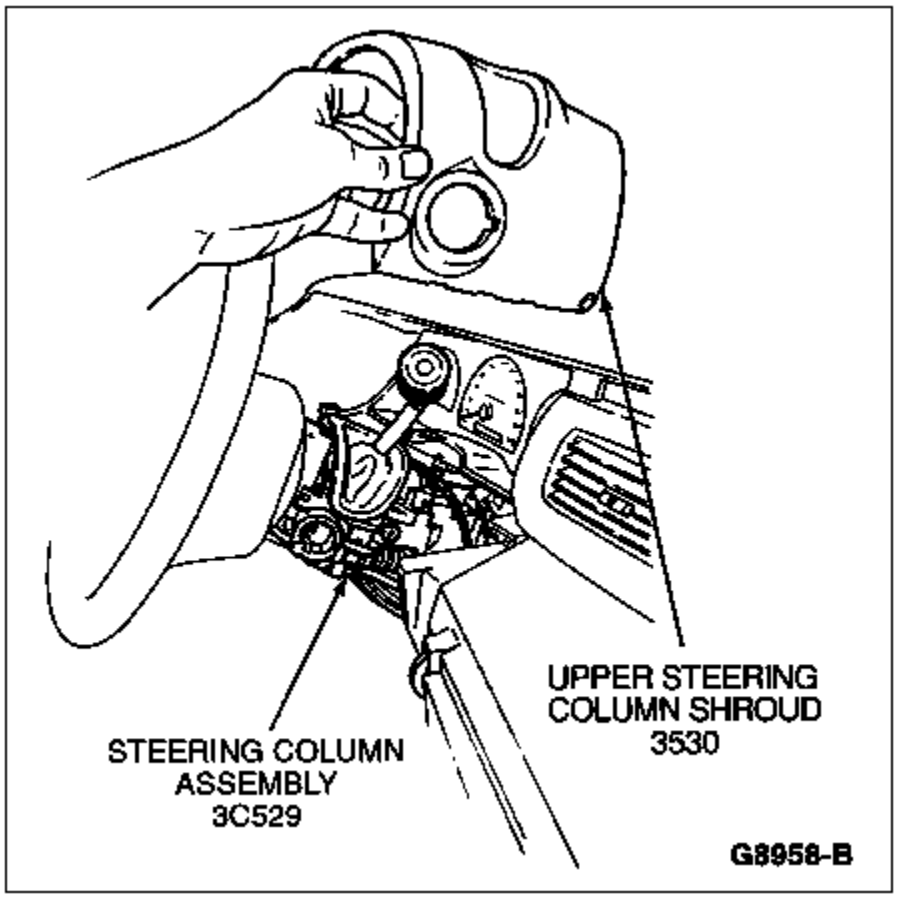
6. Remove retaining screws securing instrument panel lower center finish panel.

7. Using wide-blade screwdriver, pry loose instrument panel lower center finish panel. Pull lower finish panel away from instrument panel assembly.

8. Remove two screws securing lower instrument panel opening finish panel. Pry panel loose. Hold instrument panel finish panel (044D70) while prying loose right side of lower instrument panel finish panel. Remove finish panel.



9. Remove upper steering column shroud.



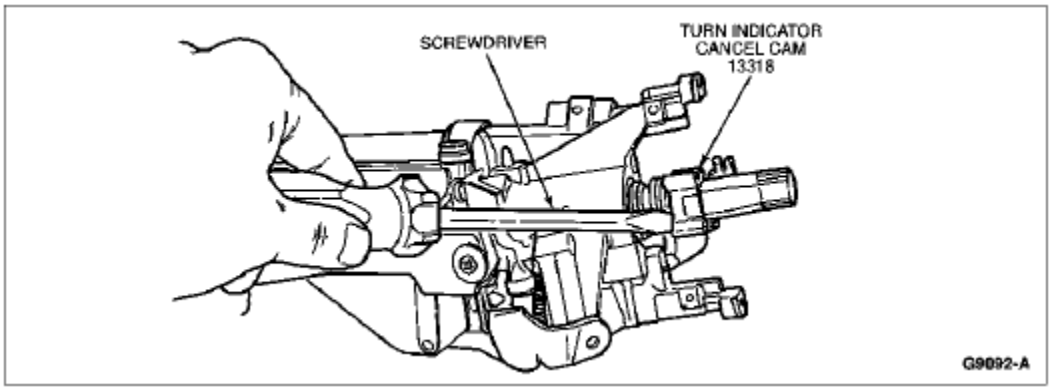
10. To install, reverse removal procedure. Ignition switch lock cylinder simply pushes back in. Tighten instrument panel finish panel screws to 2.1-2.9 Nm (19-25 lb-in).

Turn Signal Cancel Cam Service

Removal

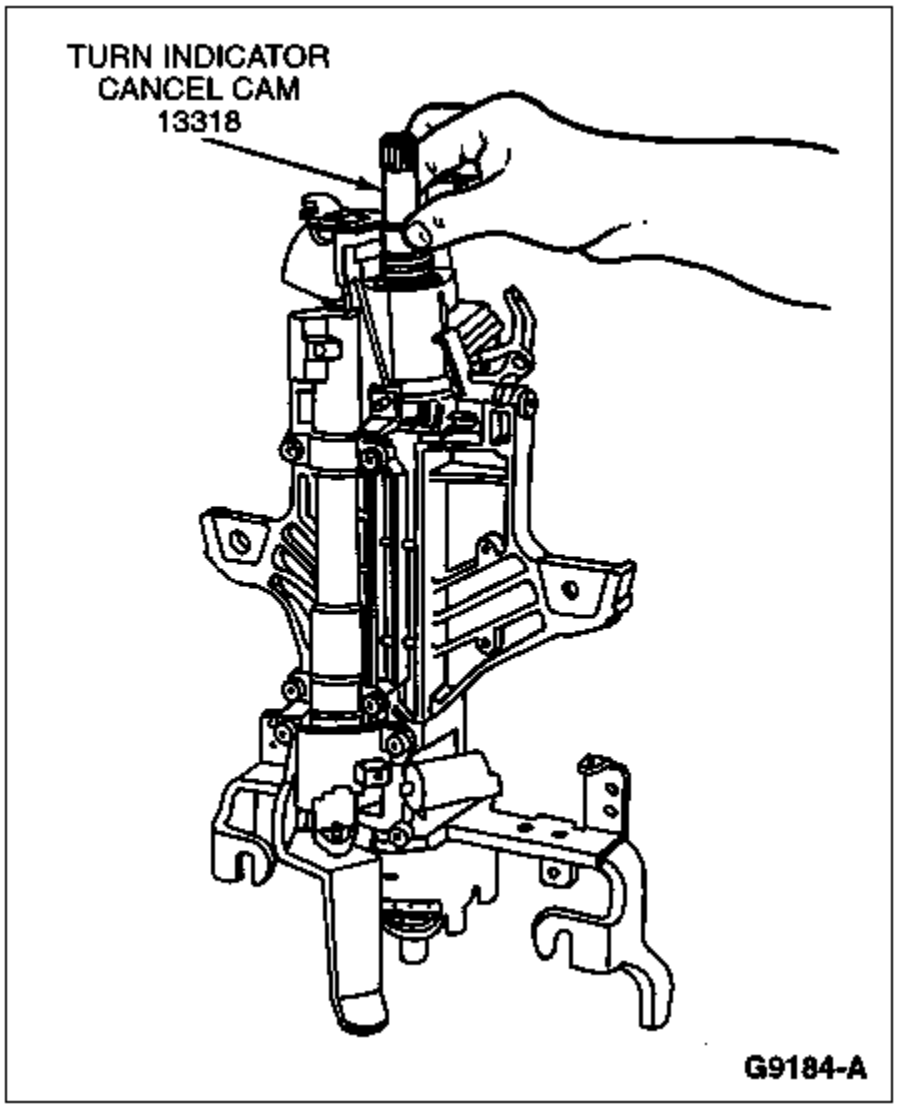
1. Remove steering wheel (3600) as outlined in this section.
2. Remove air bag sliding contact (14A664) as outlined in this section.
3. Unplug multi-function switch (13K359).
4. Remove two screws and multi-function switch.
5. Using screwdriver, pry loose turn indicator cancel cam (13318) and remove.

Turn Indicator Cancel Cam Removal



Installation

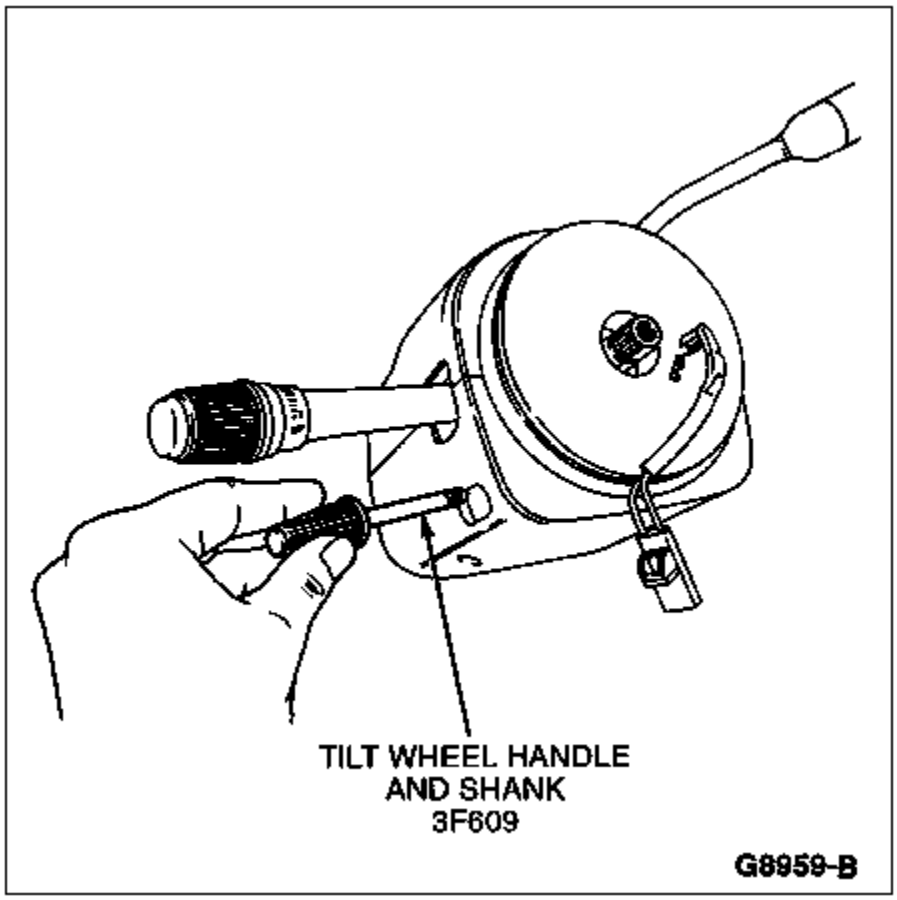
1. Push on turn indicator cancel cam with flush surface "up."
2. Install multi-function switch and tighten screws to 2.1-2.9 Nm (19-25 lb-in).
3. Plug in multi-function switch.
4. Install air bag sliding contact.
5. Install steering wheel as outlined in this section.


TURN INDICATOR
CANCEL CAM
13318
G9184-A

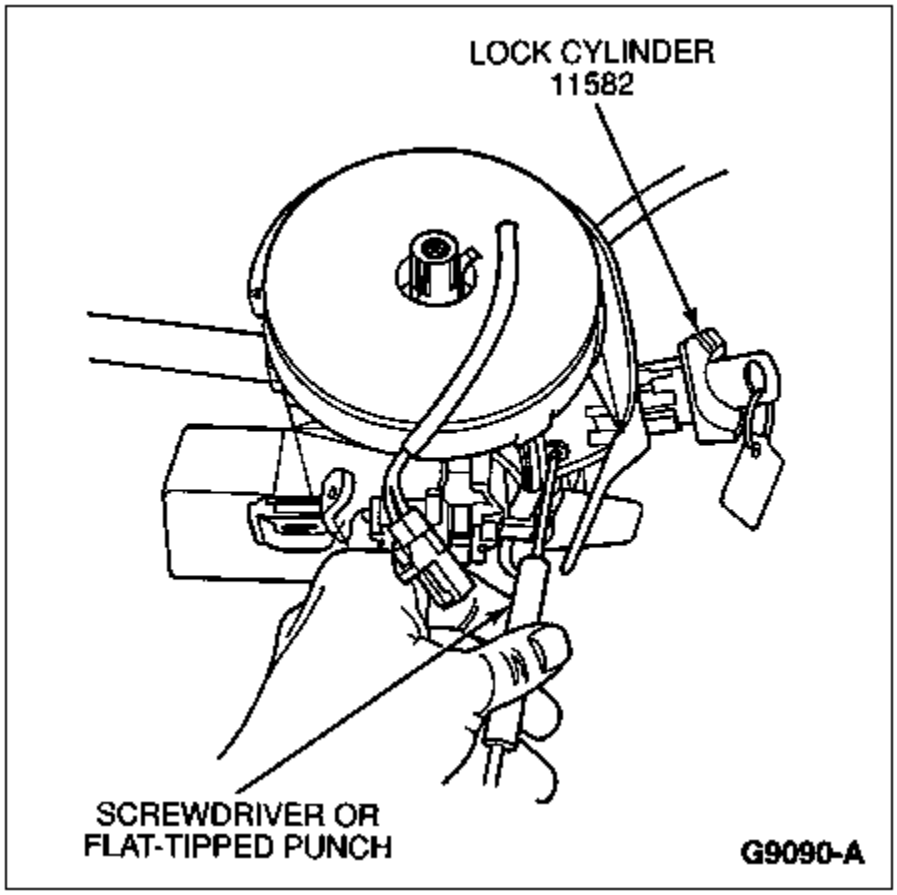
Steering Column

Disassembly

1. Remove instrument panel cover and reinforcement from vehicle as described in this section.
2. Unscrew and remove tilt wheel handle and shank (3F609), if equipped.



3. Remove three screws and lower steering column shroud (3530).
4. Turn ignition switch lock cylinder (11582) to RUN position.
5. Using flat-tipped punch, push on button below ignition switch lock cylinder and pull out ignition switch lock cylinder.



6. Remove upper steering column shroud.

7. **CAUTION: Be sure air bag sliding contact internal lock is engaged. Hub should not turn more then 45 degrees in either direction.**

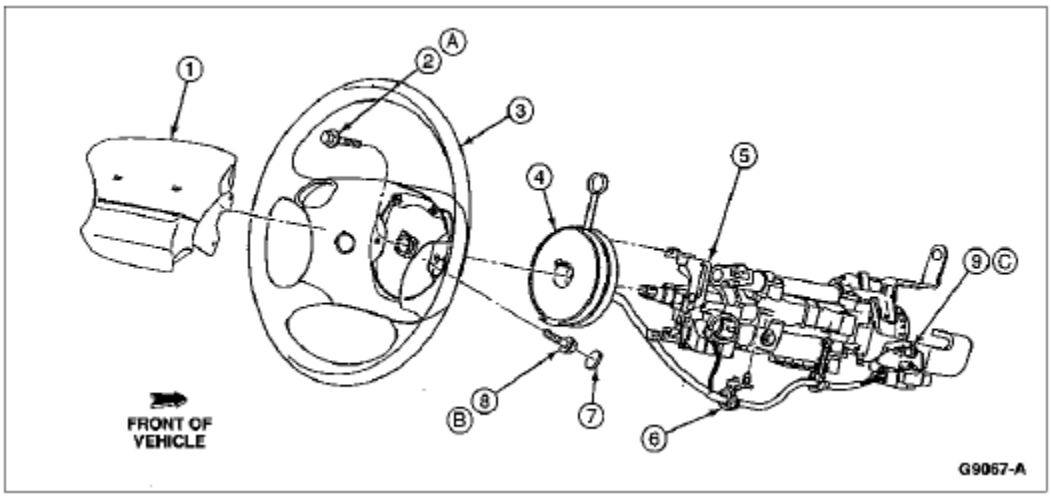
   Using door trim removal tool, remove air bag sliding contact electrical connectors from bend bracket.

8. **CAUTION: Do not remove wire harness clips from wire bundle.**

   Using door trim removal tool, disconnect two wire harness clips from steering column.

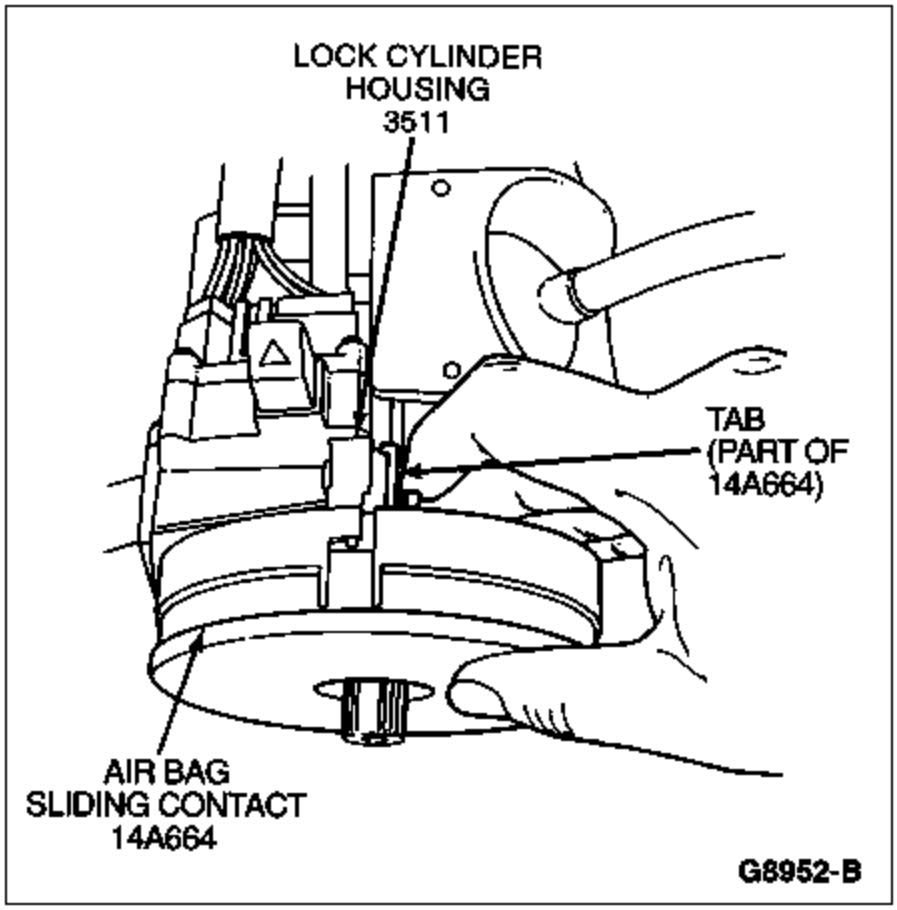
9. Remove key warning chime contact and anti-theft contact from ignition lock cylinder pocket of lock cylinder housing.

Steering Wheel with Air Bag

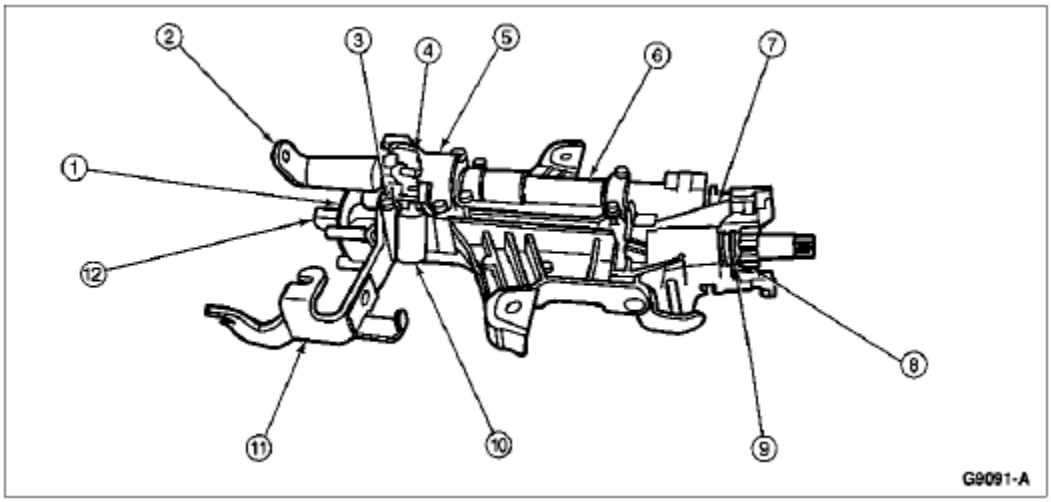


Item	Part Number	Description
1	043B13	Driver Side Air Bag Module
2	N807493-S100	Torx® Head Screw, M10-1.5 x 18
3	3600	Steering Wheel
4	14A664	Air Bag Sliding Contact
5	3C529	Steering Column
6	—	Clip (Part of 14A664)
7	3F785	Plug
8	N808944-S424	Bolt
9	N805375-S36MG	Bolt
A	—	Tighten to 34-46 Nm (25-33 Lb-Ft)
B	—	Tighten to 7.6-10.4 Nm (67-92 Lb-In)
C	—	Tighten to 10.2-13.8 Nm (7.5-10.1 Lb-Ft)

10. Remove air bag sliding contact (14A664) by pushing snap back at 6 o'clock position, then 3 o'clock position, then 12 o'clock position and remove from steering shaft.



Steering Column

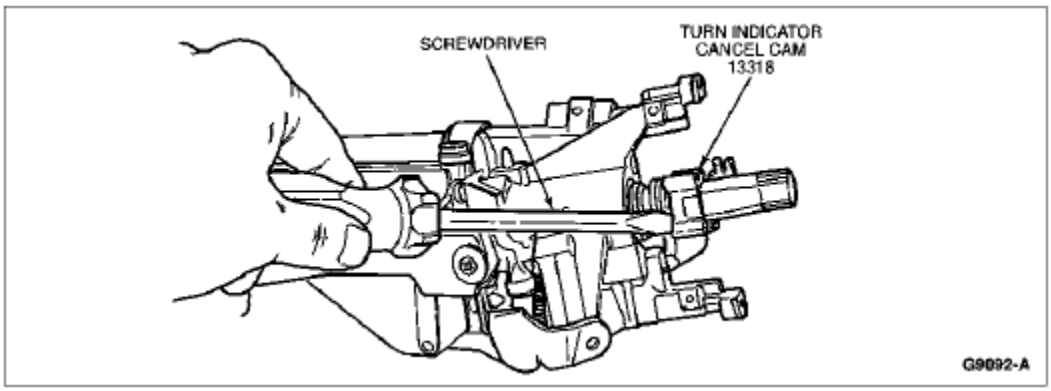


Item	Part Number	Description
1	3C131	Suspension Height Sensor Control Ring
2	7302	Transmission Selector Lever Arm and Support

3	3D681	Steering Column Lower Bearing Retainer
4	7A216	Transmission Shift Selector Position Insert
5	—	Attachment Point (Part of 7302)
6	7212	Transmission Column Shift Selector Tube
7	3511	Steering Column Lock Cylinder Housing
8	13318	Turn Indicator Cancel Cam
9	3520	Steering Column Upper Bearing Spring
10	3Z719	Brake Shift Interlock Solenoid
11	3676	Steering Column Bend Bracket
12	3520	Steering Column Bearing Spring (Tilt Only)

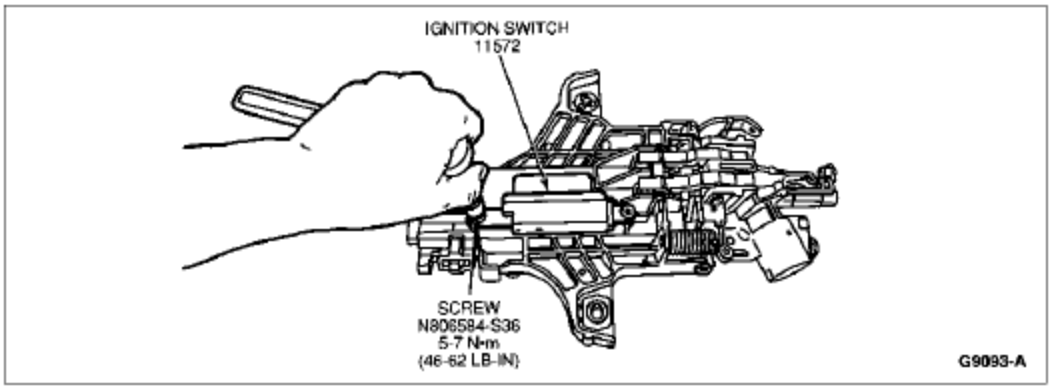
11. Remove turn indicator cancel cam (13318) by pushing up with flat-bladed screwdriver. Note direction of flush surface.

Turn Indicator Cancel Cam Removal



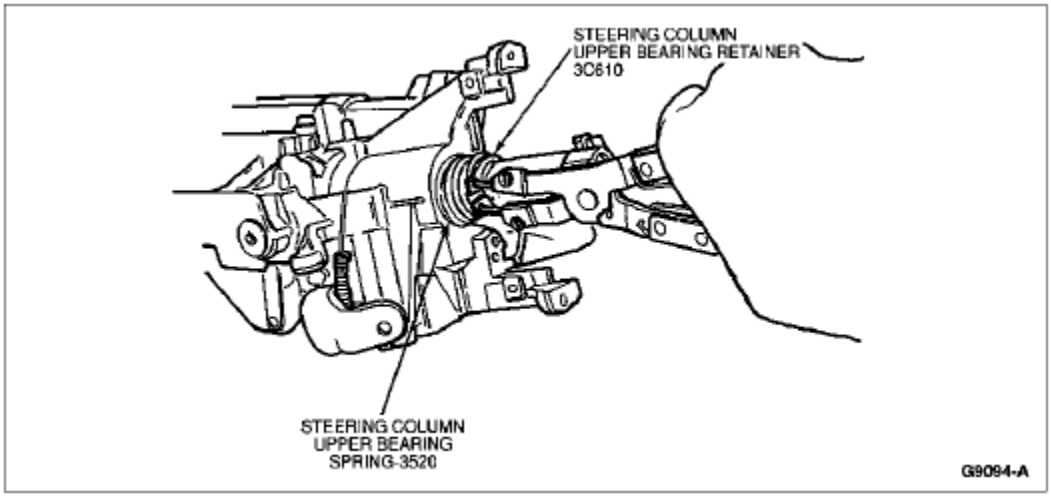
12. Remove ignition switch.

Ignition Switch Removal



13. Remove upper bearing retainer snap ring and steering column upper bearing spring (3520).

Steering Column Upper Bearing Spring and Upper Bearing Retainer



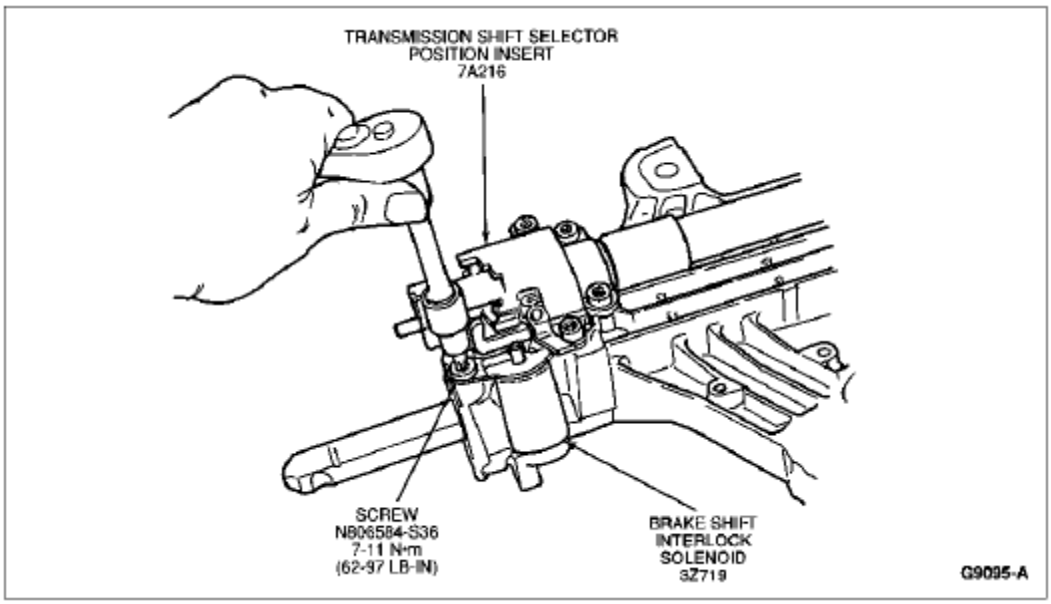
14. Remove steering column bearing sleeve (3518) and steering column bearing tolerance ring (3L539).

15. Remove gearshift lever (7210).

16. **NOTE: Brake shift interlock solenoid is retained to the transmission shift selector position insert (7A216) with a pushnut.**

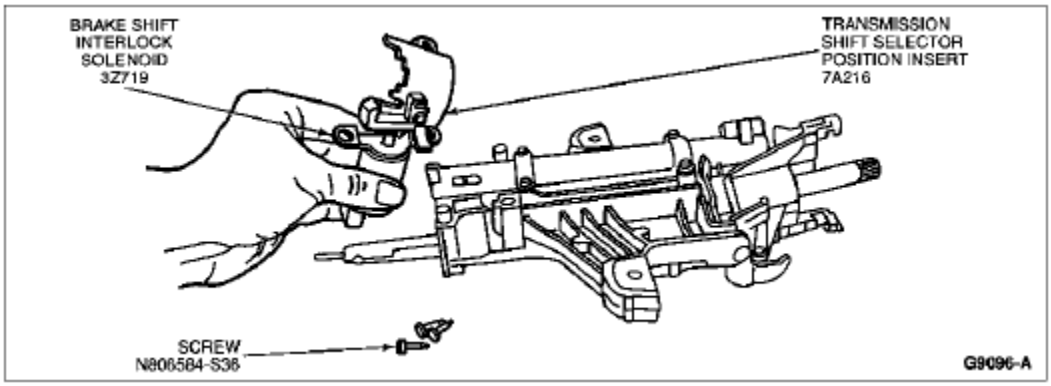
    Remove three screws attaching brake shift interlock solenoid and transmission shift selector position insert.

Brake Shift Interlock Solenoid Screws

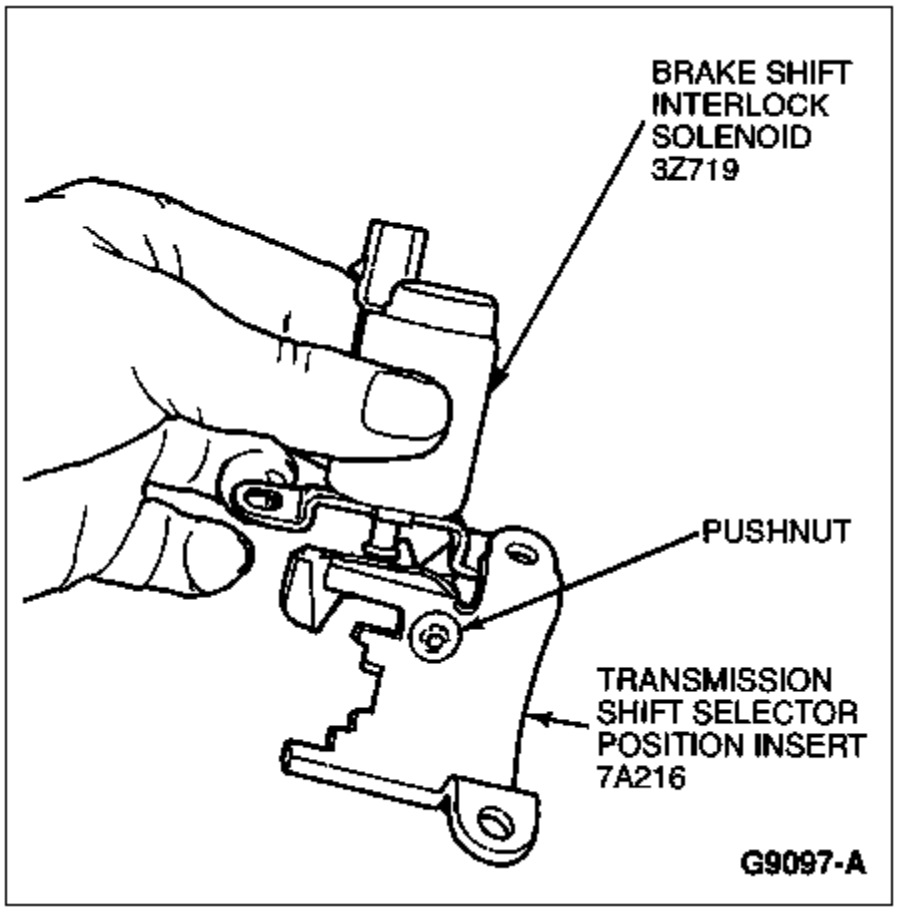


17. Remove brake shift interlock solenoid and transmission shift selector position insert together.

Transmission Shift Selector Position Insert

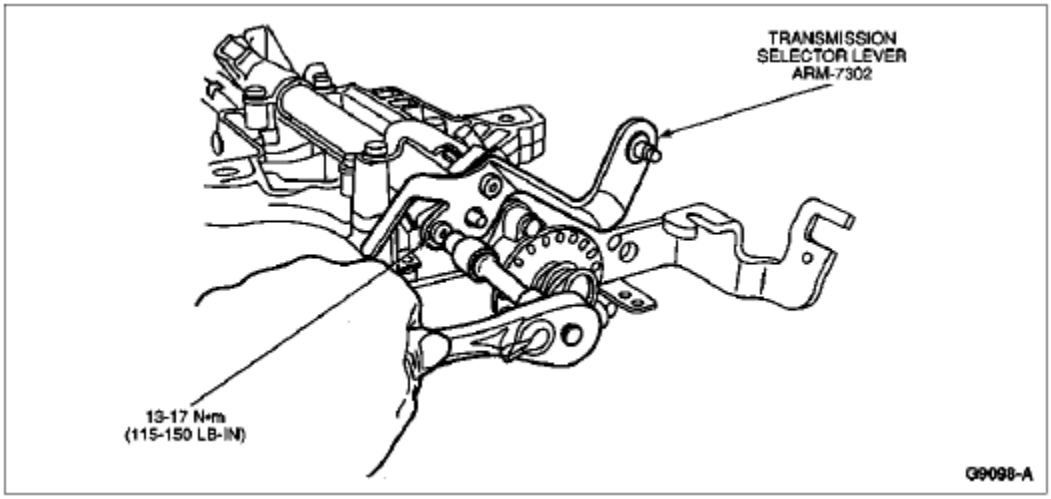


18. If necessary, remove pushnut and separate brake shift interlock solenoid and transmission shift selector position insert.

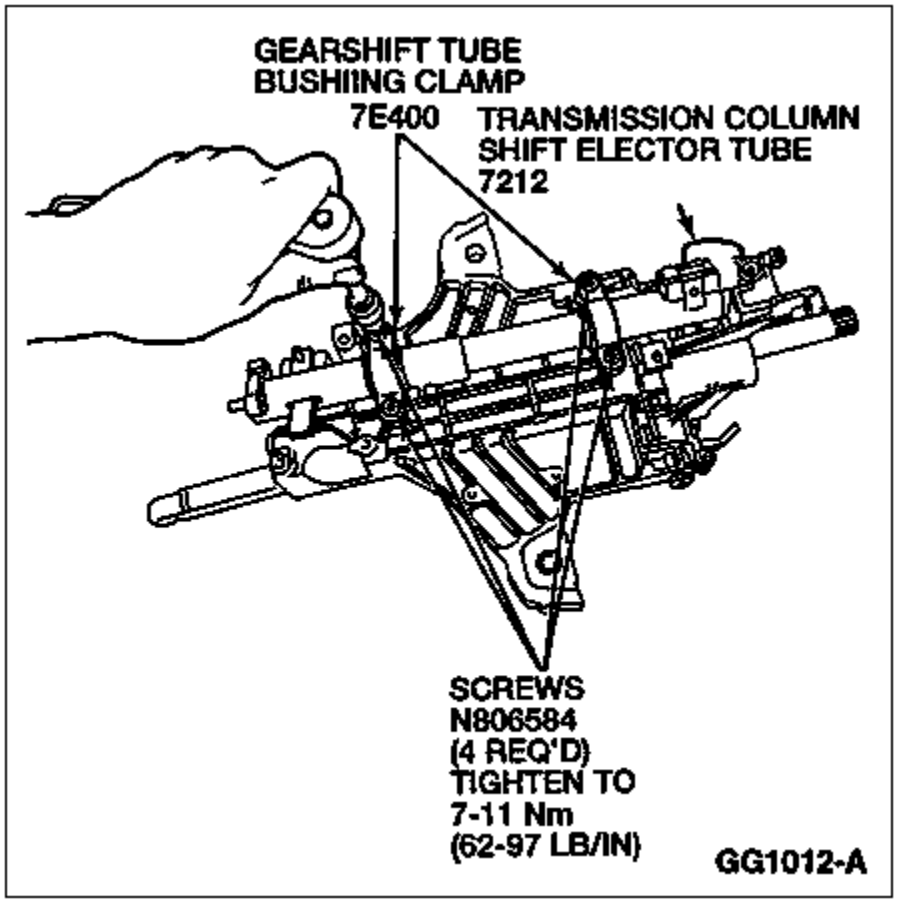


19. Remove two screws and transmission control selector arm.

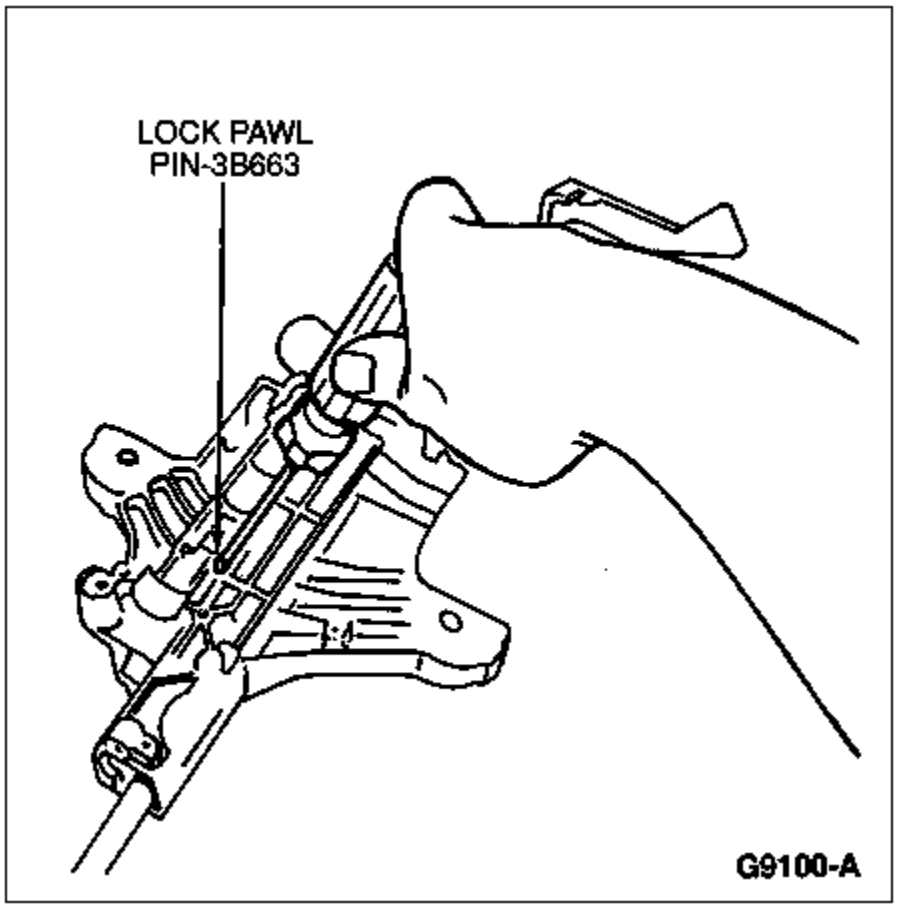
Transmission Selector Lever Arm



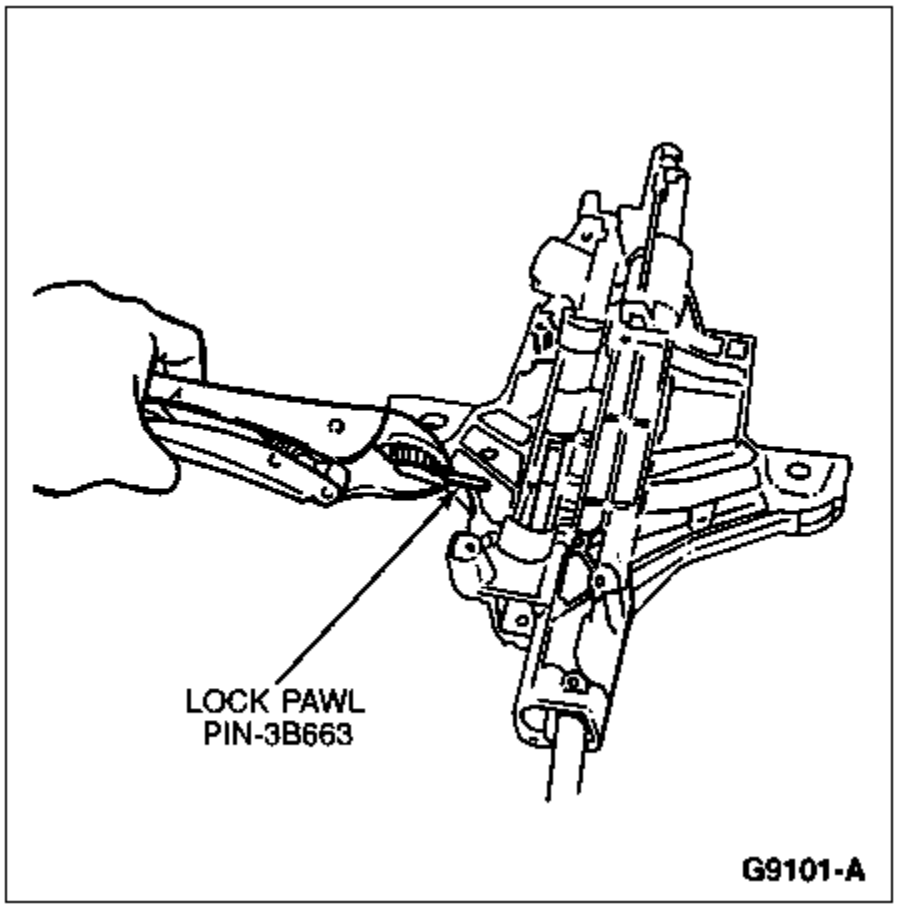
20. Remove four screws, two gearshift tube bushing clamps (7E400), transmission column shift selector tube (7212) and assembled parts.



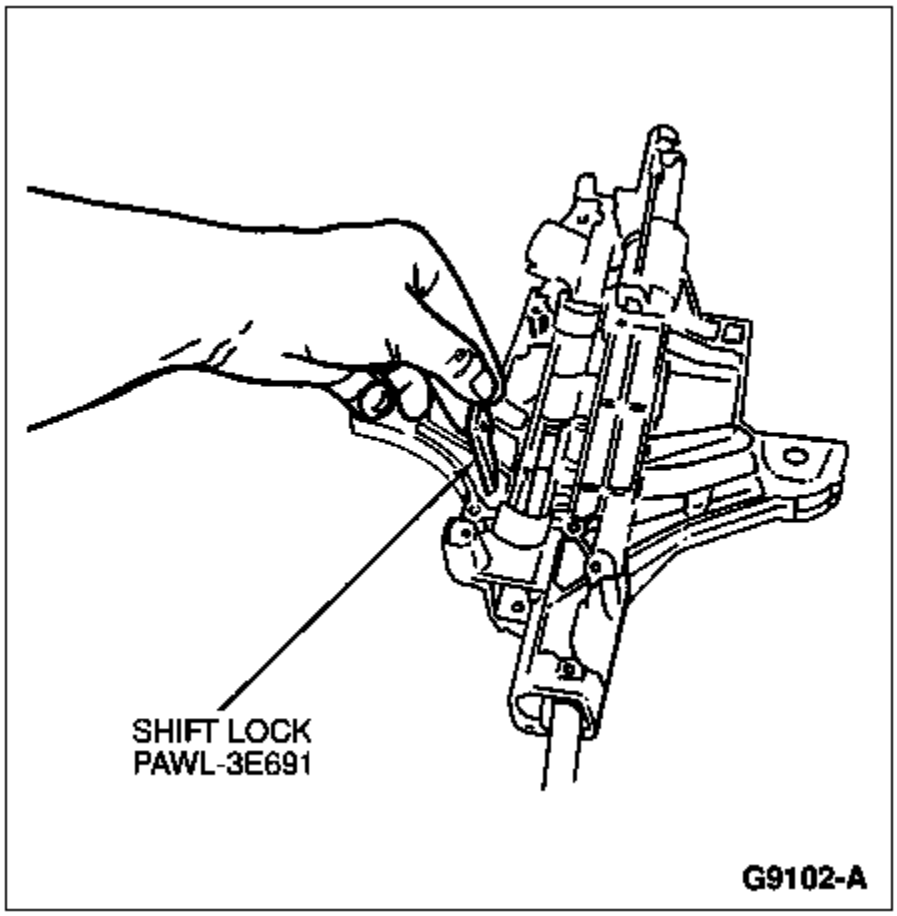
21. Pry on end of steering column lock lever pin (3B663) which is sticking out.



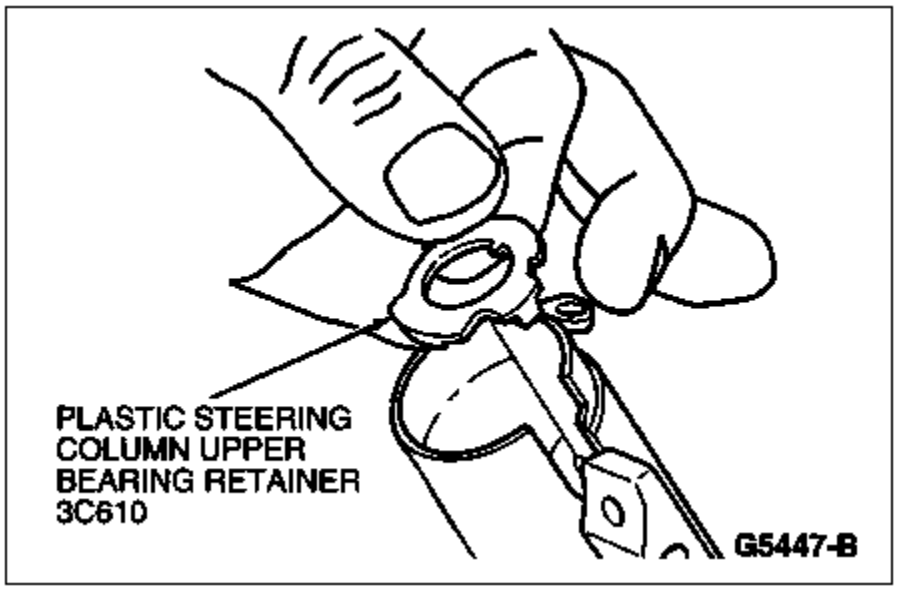
22. Pull steering column lock lever pin with Vise-Grips®.



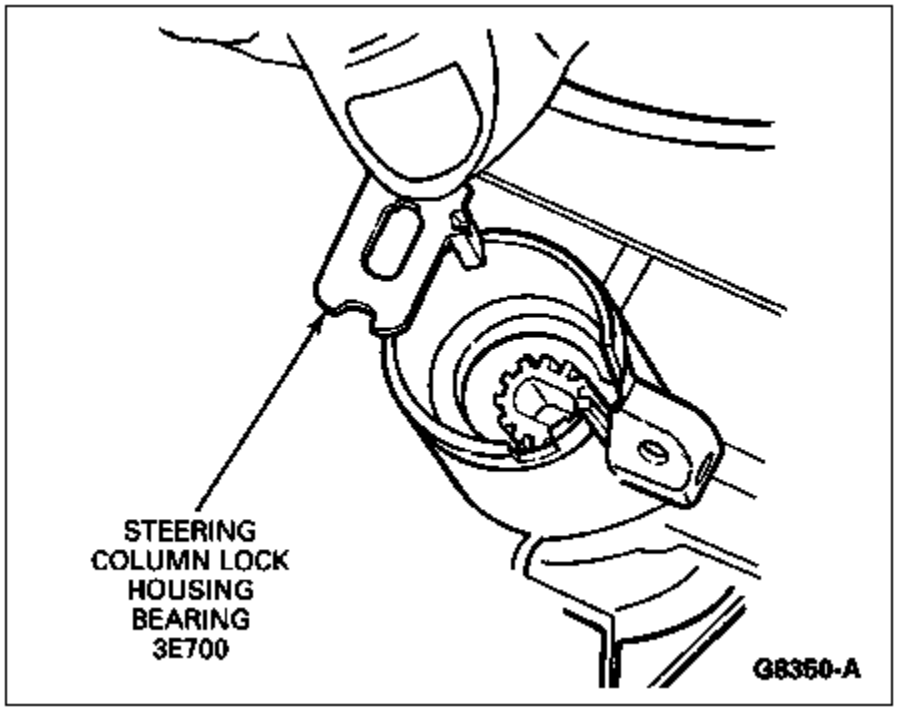
23. Remove column shift lock pawl.



24. Remove plastic bearing retainer from bore of lock cylinder.



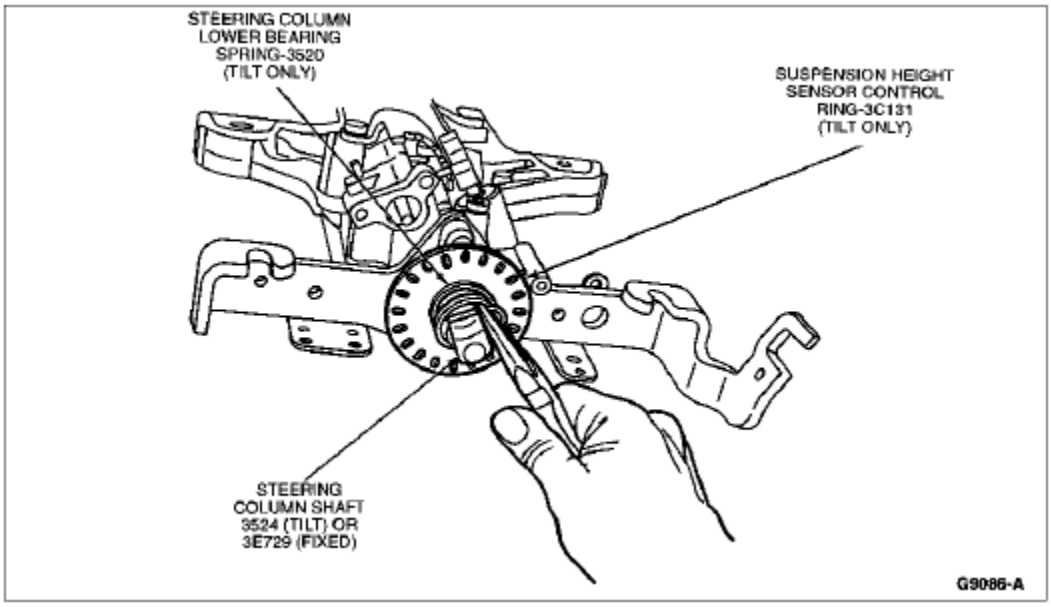
25. Remove steering column lock housing bearing (3E700) from lock cylinder bore.



26. Remove steering column lock gear (3E717).

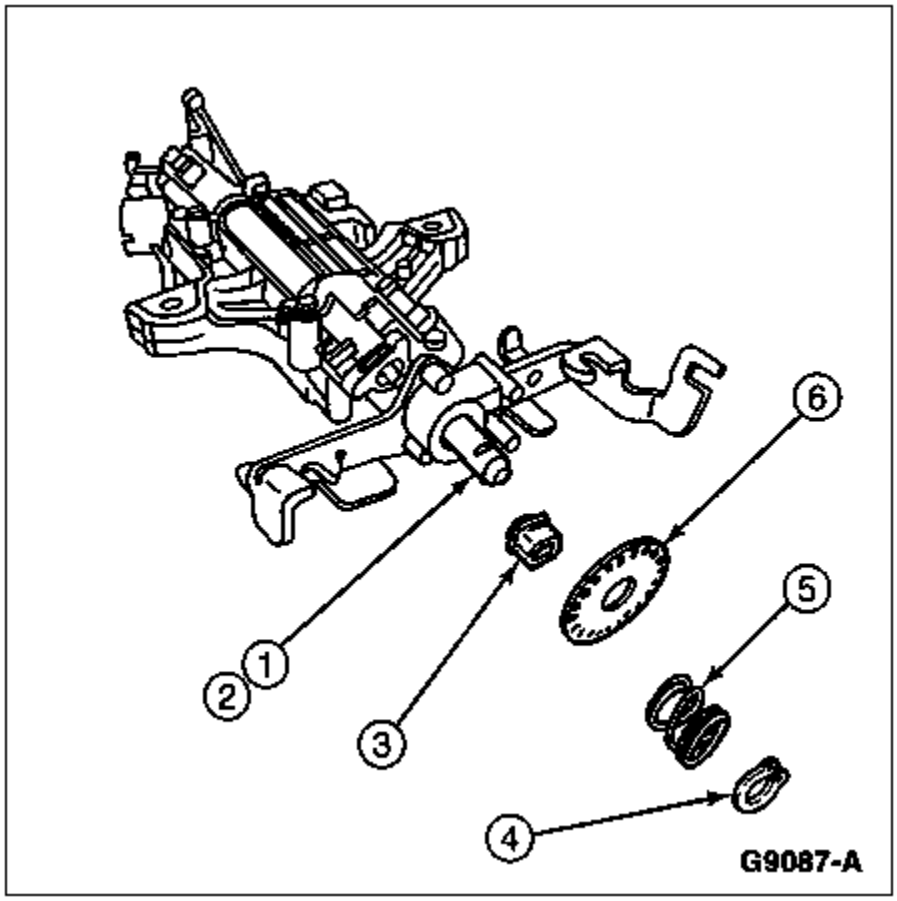
27. On tilt column, remove steering column lower bearing spring. Using long-nose pliers, lift spring out of grooves in steering shaft and pull off.

Steering Column Lower Bearing Spring (Tilt Only)



28. Remove suspension height sensor control ring (3C131) and lower column bearing tolerance ring.

Suspension Height Sensor Control Ring

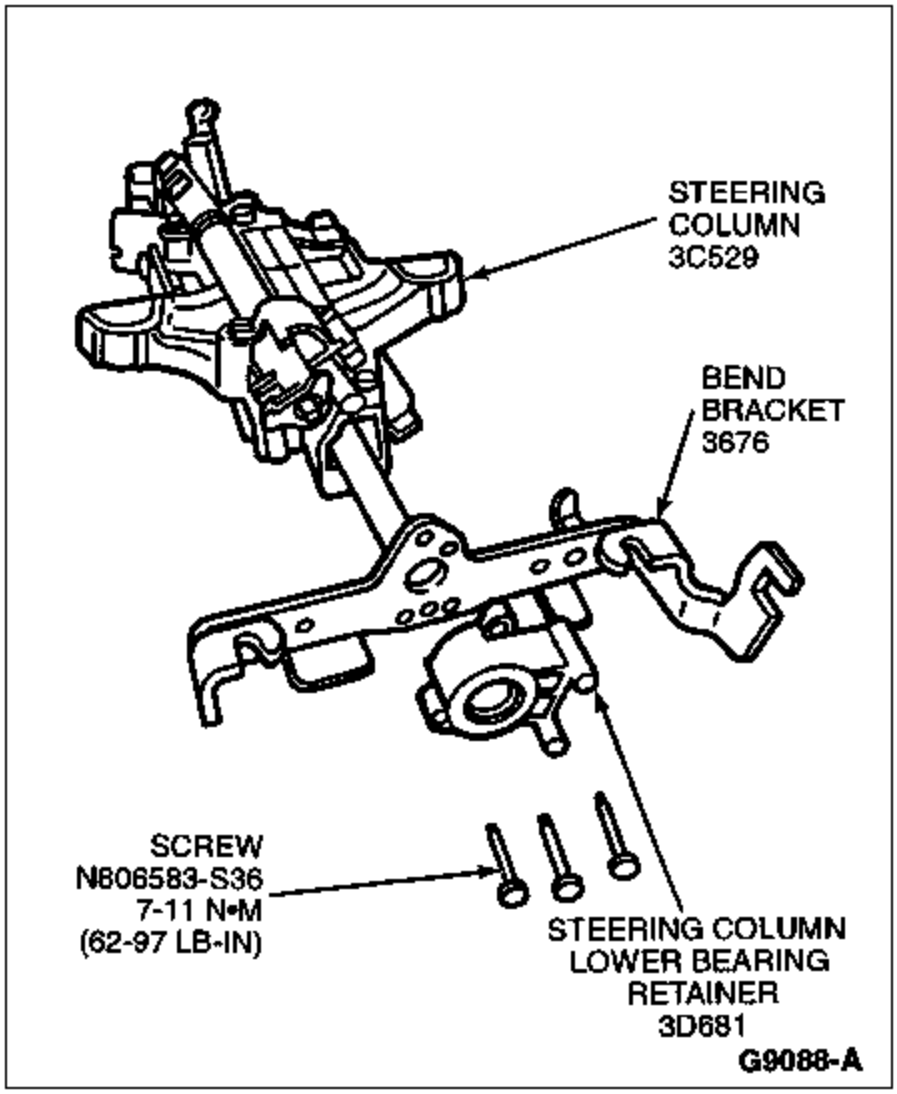


Item	Part Number	Description
1	3524	Steering Gear Column Shaft (Tilt)
2	3E729	Steering Gear Column Shaft (Fixed)
3	3L539	Steering Column Upper Bearing Tolerance Ring
4	3C610	Bearing Retainer (Fixed Only)
5	3520	Steering Column Upper Bearing Spring
6	3C131	Suspension Height Sensor Control Ring

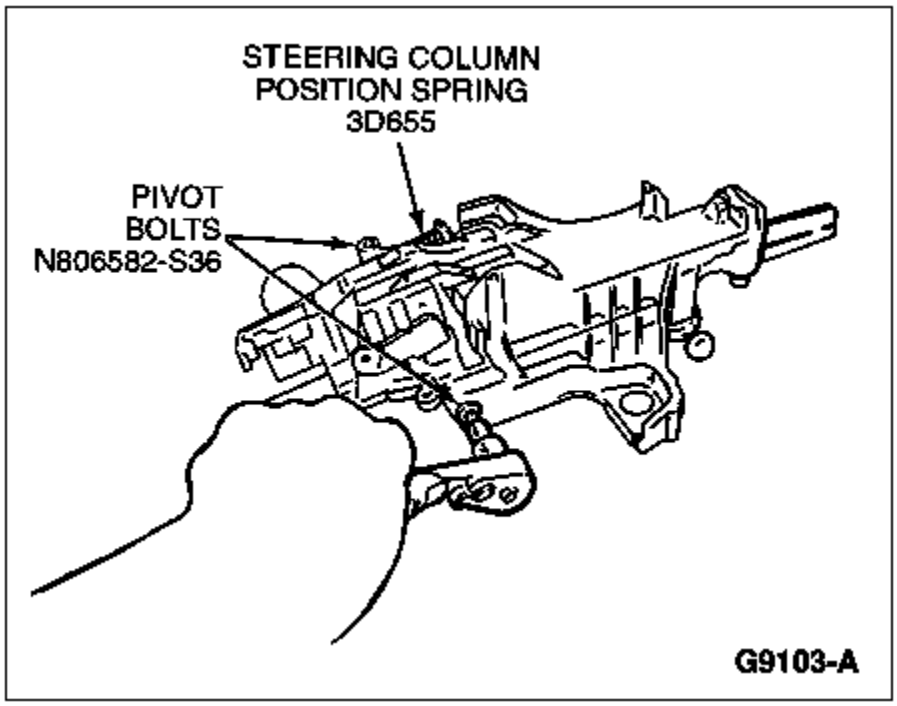
29. On fixed column, remove steering column bearing retainer and steering column tolerance ring.

30. Remove steering column lower bearing retainer (3D681) and steering column bend bracket.

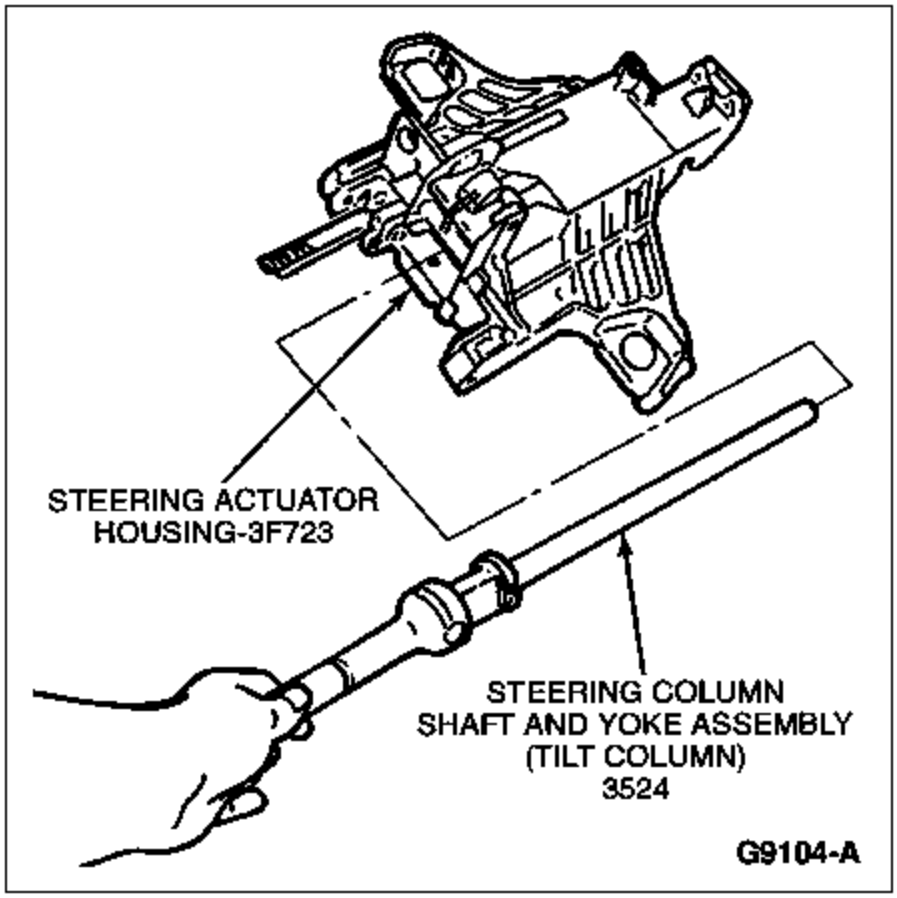
Steering Column Lower Bearing Retainer and Bend Bracket



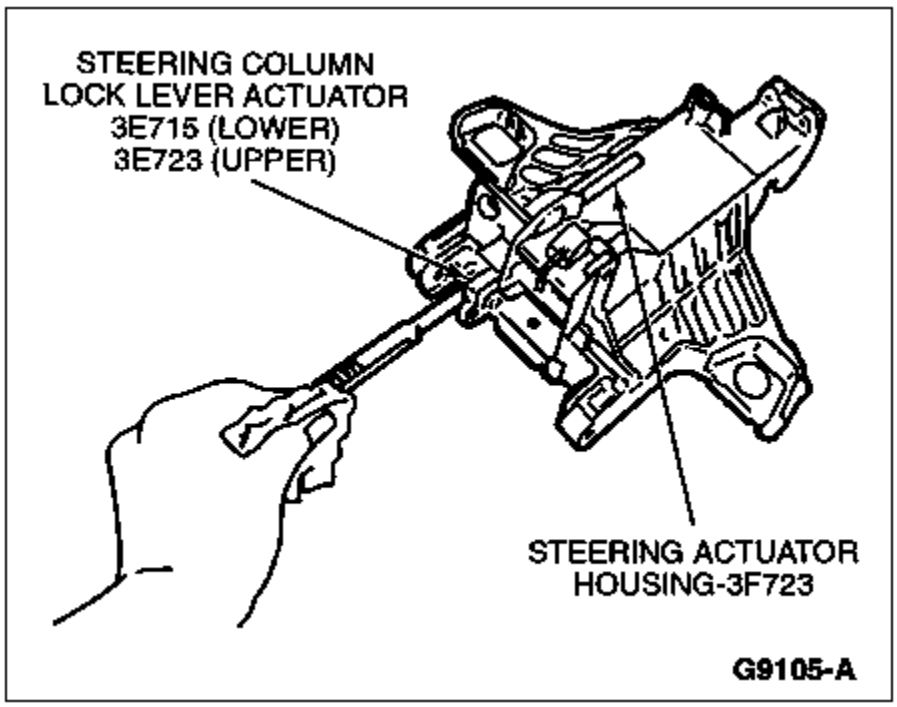
31. Remove two pivot bolts. Use caution as steering column position spring (3D655) will release when bolts are removed. Remove lock cylinder housing.



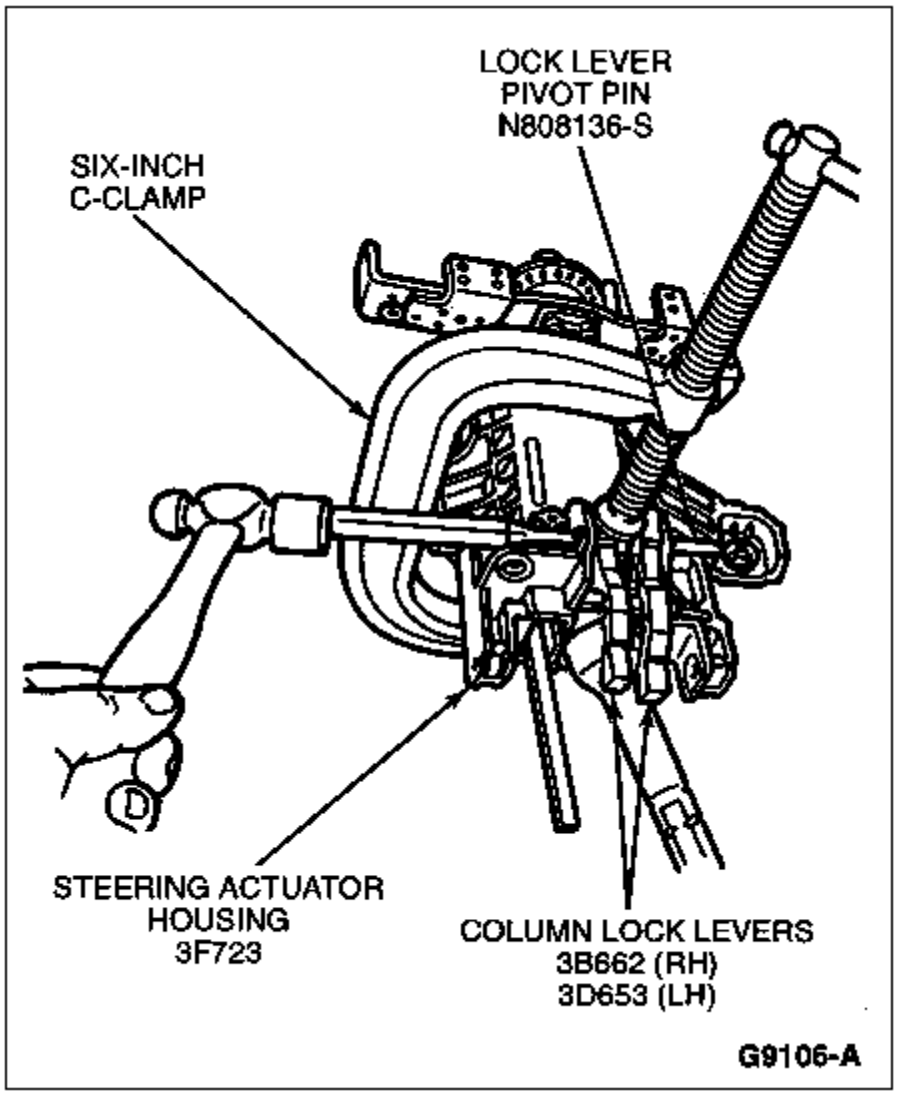
32. Remove steering shaft from steering column.



33. Remove upper and lower steering column lock actuators.

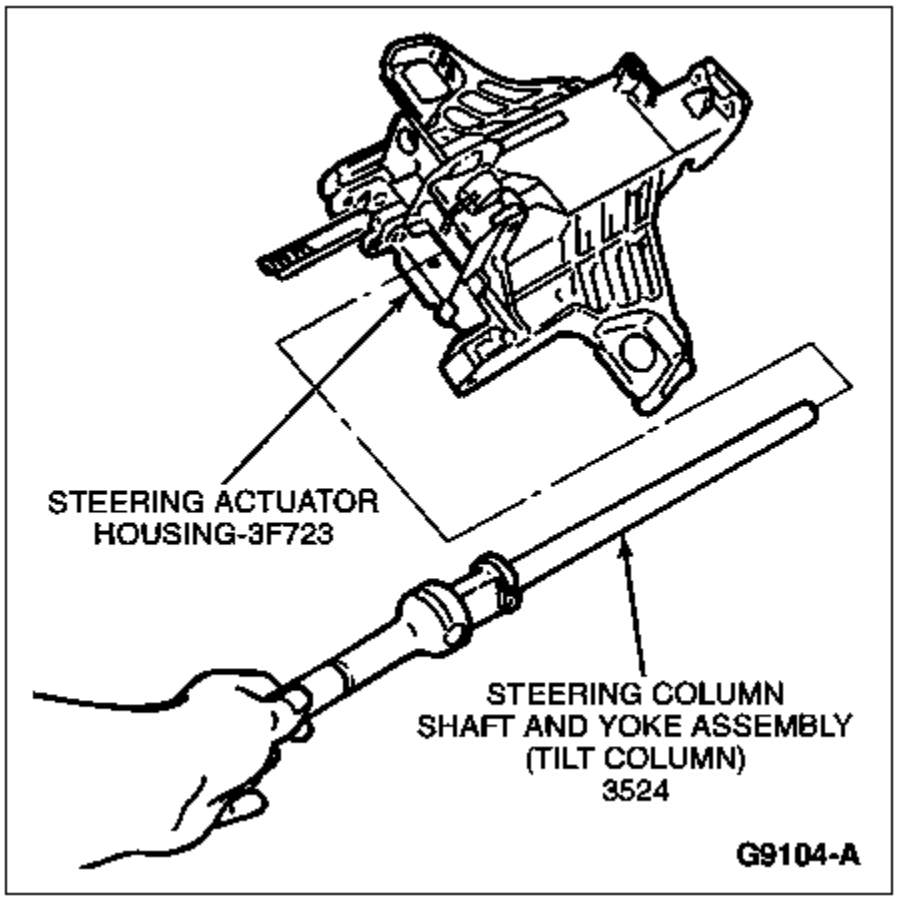


34. On tilt columns, secure locating levers with a six-inch C-clamp. Remove tilt lock lever pivot pin using a drift. Slowly release spring tension by loosening C-clamp and remove steering column locking levers and springs.

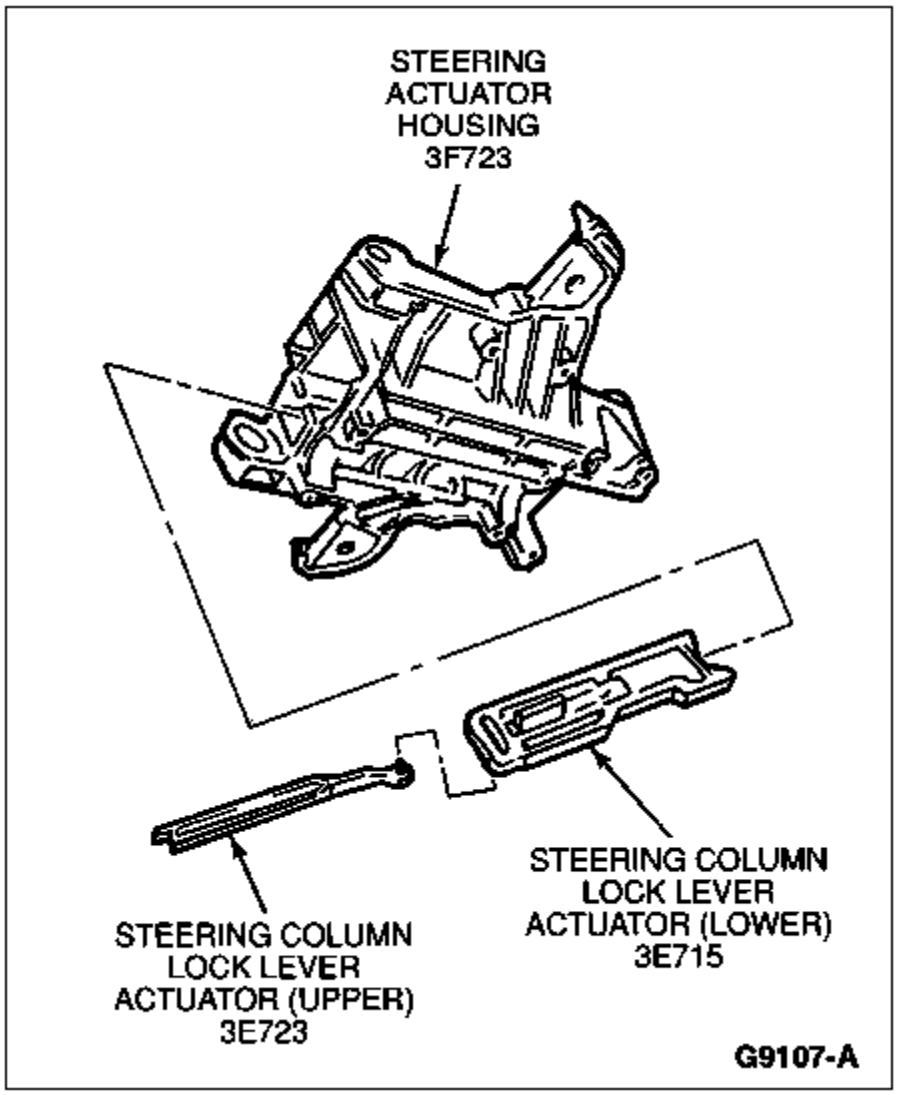


Assembly

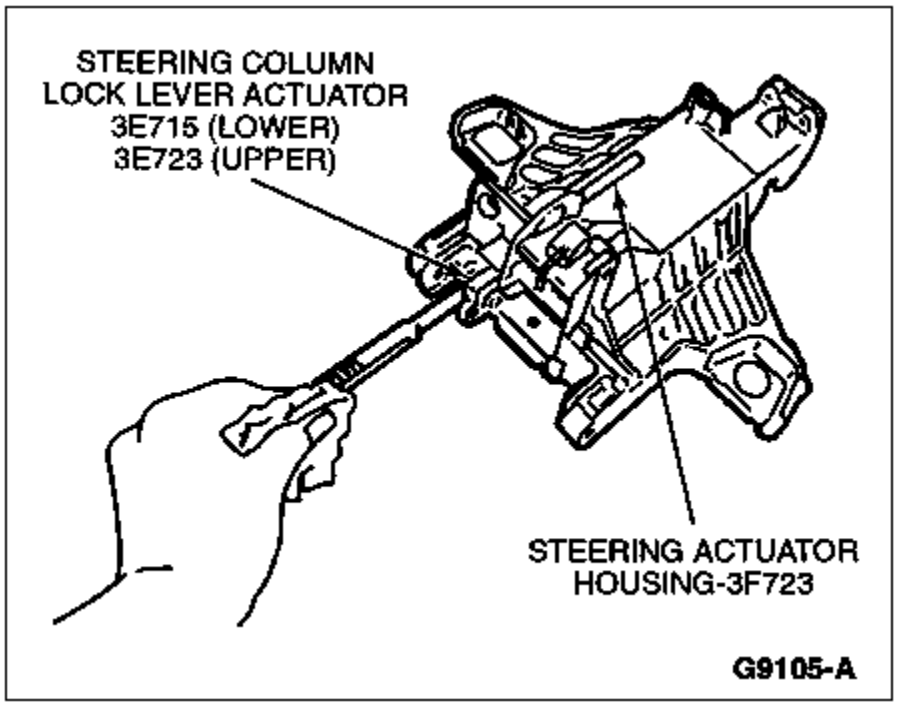
1. With actuator housing upside down, slide steering shaft into steering actuator housing.



2. Lubricate lower steering column lock lever actuator (3E715) and upper steering column lock lever actuator with Ignition Lock Grease F0AZ-19584-A or equivalent meeting Ford specification ESA-M1C232-A.

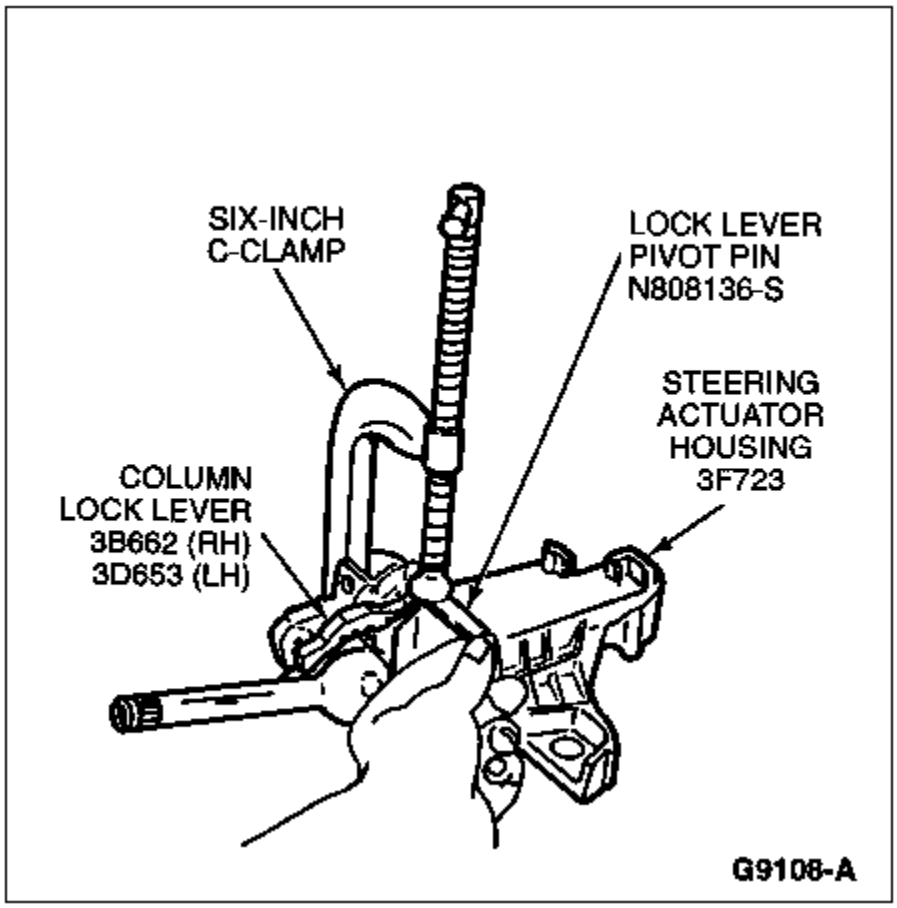


3. Put together lower steering column lock lever actuator and upper steering column lock lever actuator and slide into place in steering actuator housing.

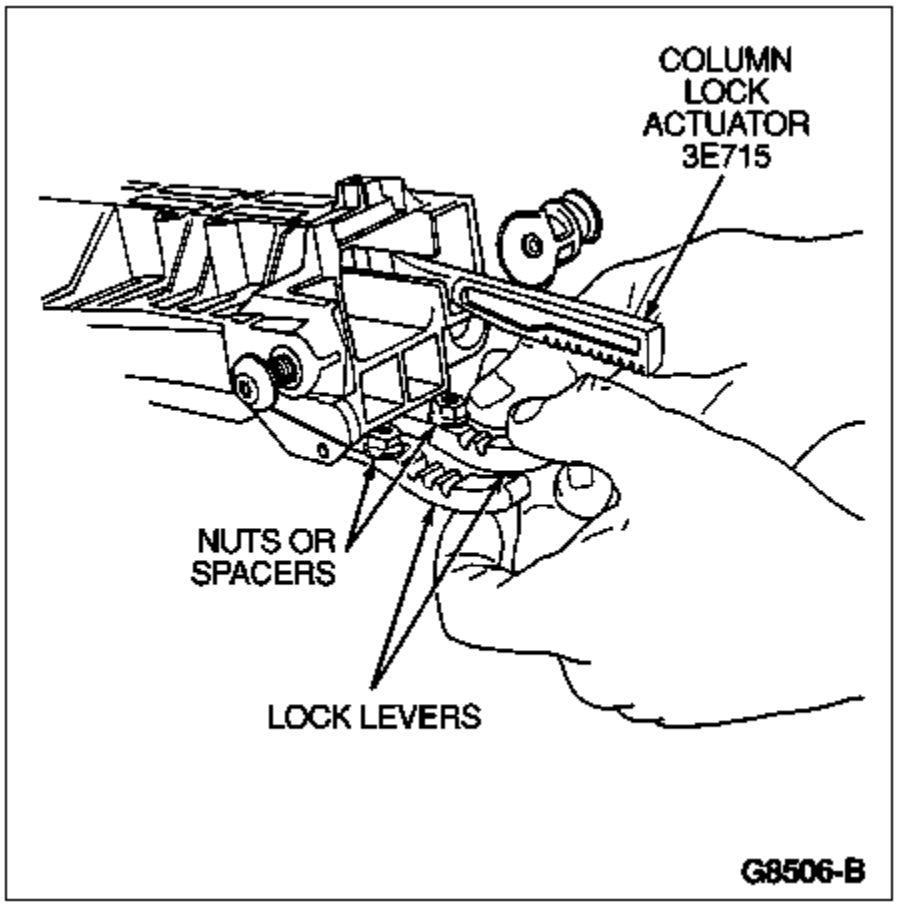


4. **NOTE: Remember, steering column actuator housing is upside down.**

   Position steering column position lock spring (3B768) and left (your right) column lock lever. Using approximately 150mm (six-inch) C-clamp, compress steering column position lock spring while aligning pin hole in column lock lever with pin holes in steering actuator housing. Tap in lock lever pivot pin up to center pin support of steering actuator housing.



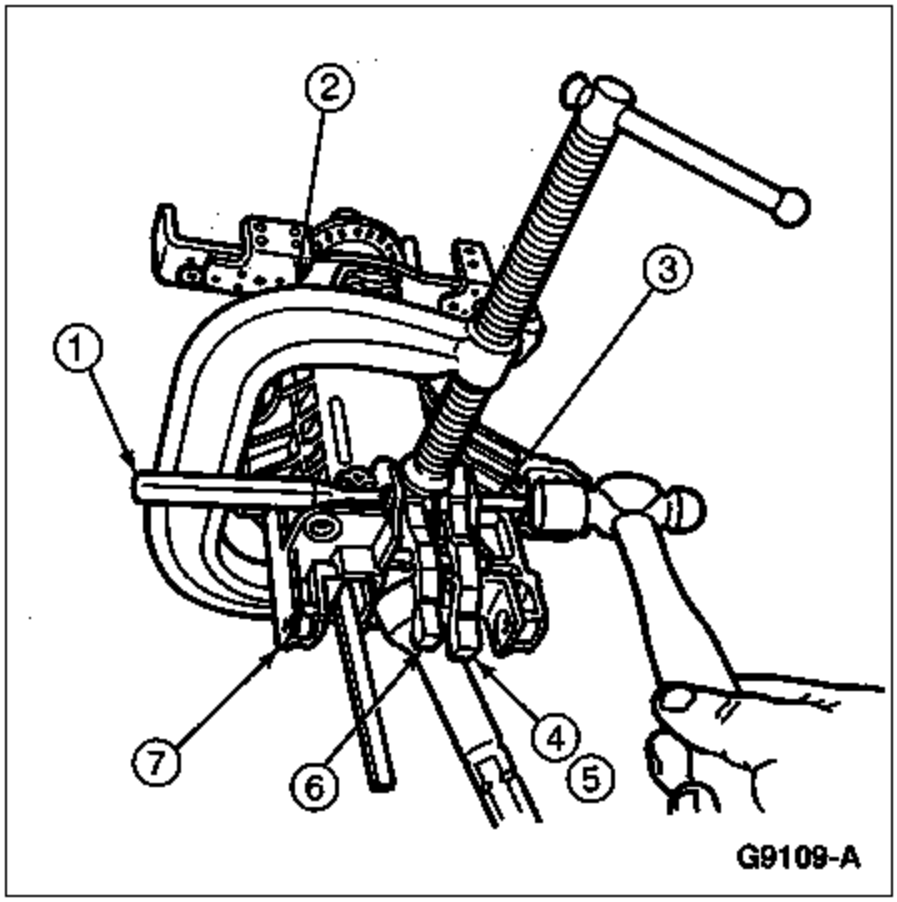
5. Insert a small nut between the column lock lever and steering actuator housing to hold up the column lock lever. Slowly loosen and remove C-clamp.



6. **NOTE: Remember that steering column actuator housing is upside down.**

   Position steering column position lock spring and right column lock lever. Using approximately 150mm (six-inch) C-clamp, compress steering column position lock spring while aligning pin hole in column lock lever with pin holes in steering actuator housing. Align with a punch; leave punch in place.

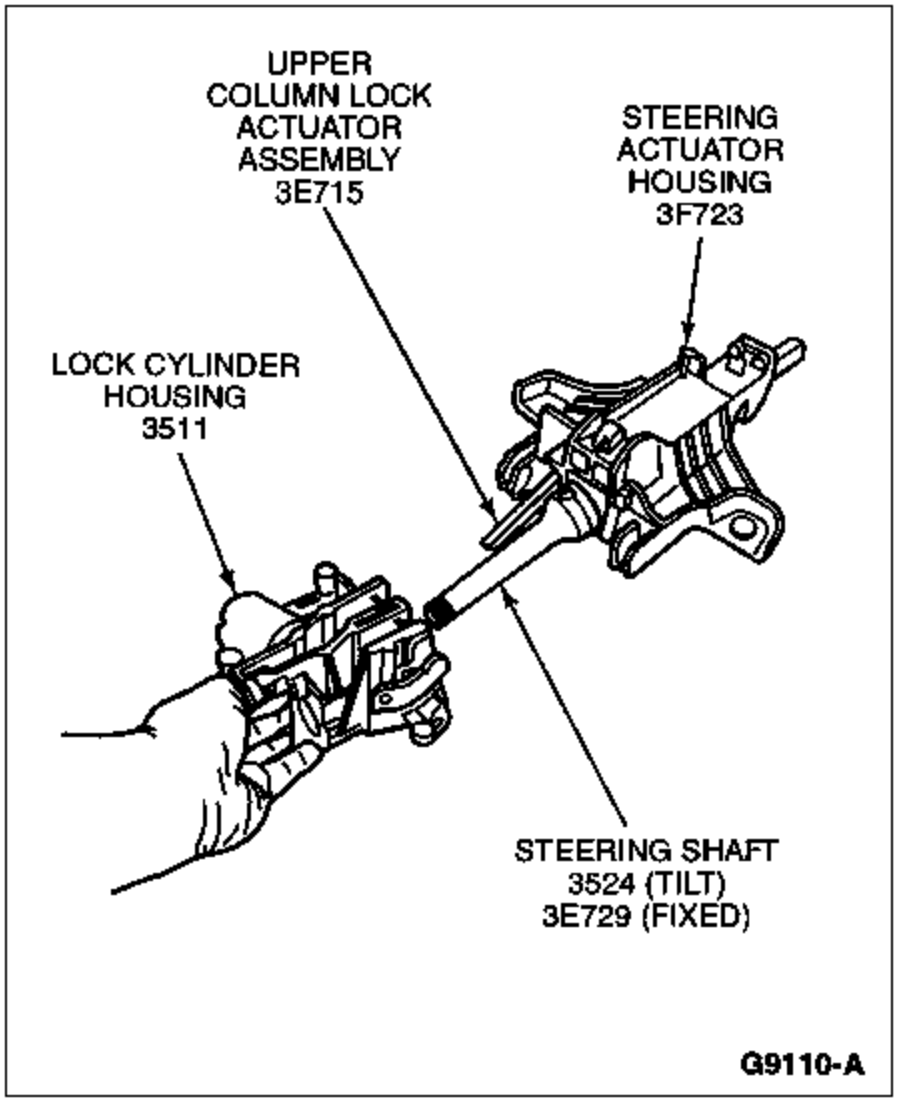
7. Tap in lock lever pivot pin, driving out punch at the same time, until left end of pin (your right) is flush with the pin support of the steering actuator housing.



Item	Part Number	Description
1	—	Punch
2	—	Six-Inch C-Clamp
3	N808136-S	Lock Lever Pivot Pin
4	3D653	Column Lock Lever, Tilt (Left)
5	3D653	Column Lock Lever, Fixed (Left)
6	3B662	Column Lock Lever, Tilt (Right)
7	3F723	Steering Actuator Housing

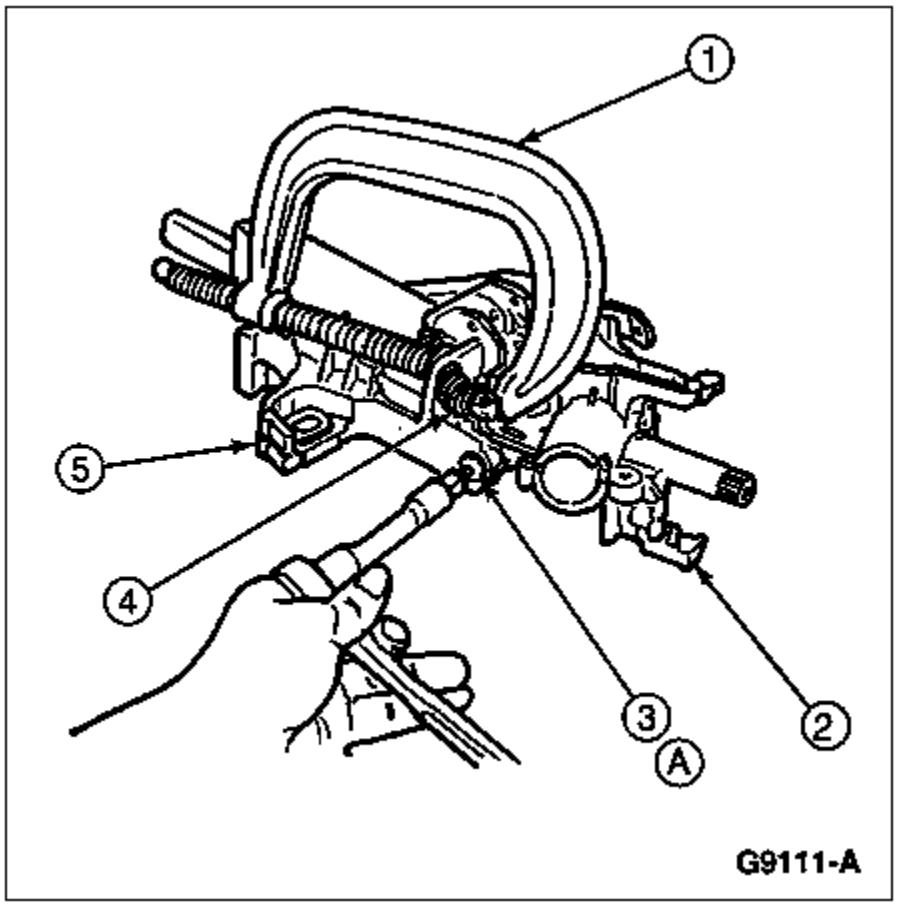
8. Position nut between right (your left) column lock lever and steering actuator housing. Slowly unscrew C-clamp and remove.

9. Position lock cylinder housing on steering shaft and upper steering column lock lever actuator.



10. On tilt column:

    a. Insert steering column position lock spring between lock cylinder housing and steering actuator housing.
    b. Position approximately 150mm (six-inch) C-clamp on outsides of column position spring pads.
    c. Tighten C-clamp drawing lock cylinder housing and steering actuator housing together, compressing steering column position lock spring. At the same time, use punch to align bushings in lock cylinder housing with threaded pivot bolt holes in steering actuator housing.
    d. Lubricate pivot bolts with grease meeting Ford specification ESB-M1C163-C.
    e. When holes and bushings are aligned, install pivot bolts and tighten to 18-26 Nm (14-19 lb-ft).
    f. Using long, thin screwdriver, remove nuts from underneath right and left column lock levers.
    g. Slowly loosen and remove C-clamp.

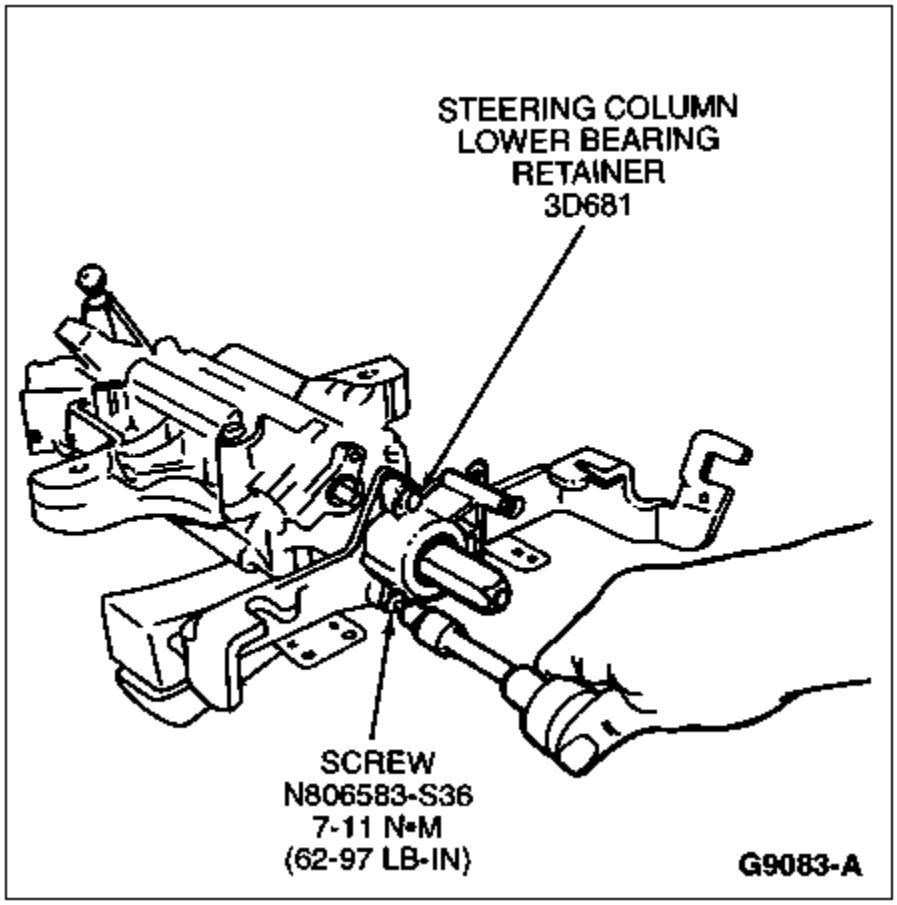


Item	Part Number	Description
1	—	Six-Inch C-Clamp
2	3511	Lock Cylinder Housing
3	N806582-S36	Pivot Bolt
4	3D655	Column Position Spring
5	3F723	Steering Actuator Housing
A	—	Tighten to 18-26 Nm (14-19 Lb-Ft)

11. On fixed column:

    a. Position lock cylinder housing on upper steering column lock lever actuator and steering shaft.
    b. Align bushings in lock cylinder housing with threaded pivot bolt holes in lock lever actuator housing.
    c. Lubricate pivot bolts with grease meeting Ford specification ESB-M1C163-C.
    d. When holes and bushings are aligned, install pivot bolts and tighten to 18-26 Nm (14-19 lb-ft).
    e. Using long, thin screwdriver, remove nut from underneath left column lock lever.

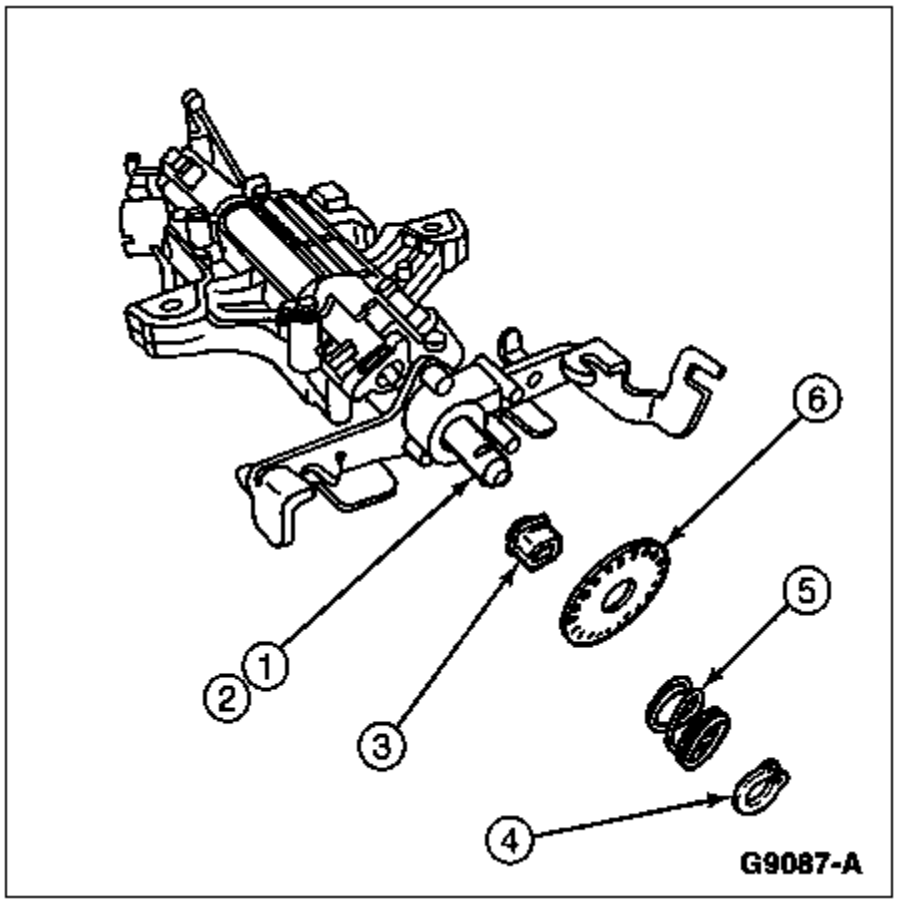
12. Install steering column lower bearing retainer and steering column lower mounting bracket. Tighten screws to 7-11 Nm (62-97 lb/in).



13. On tilt column: install suspension height sensor control ring, steering column bearing tolerance ring and steering column upper bearing spring to steering shaft.

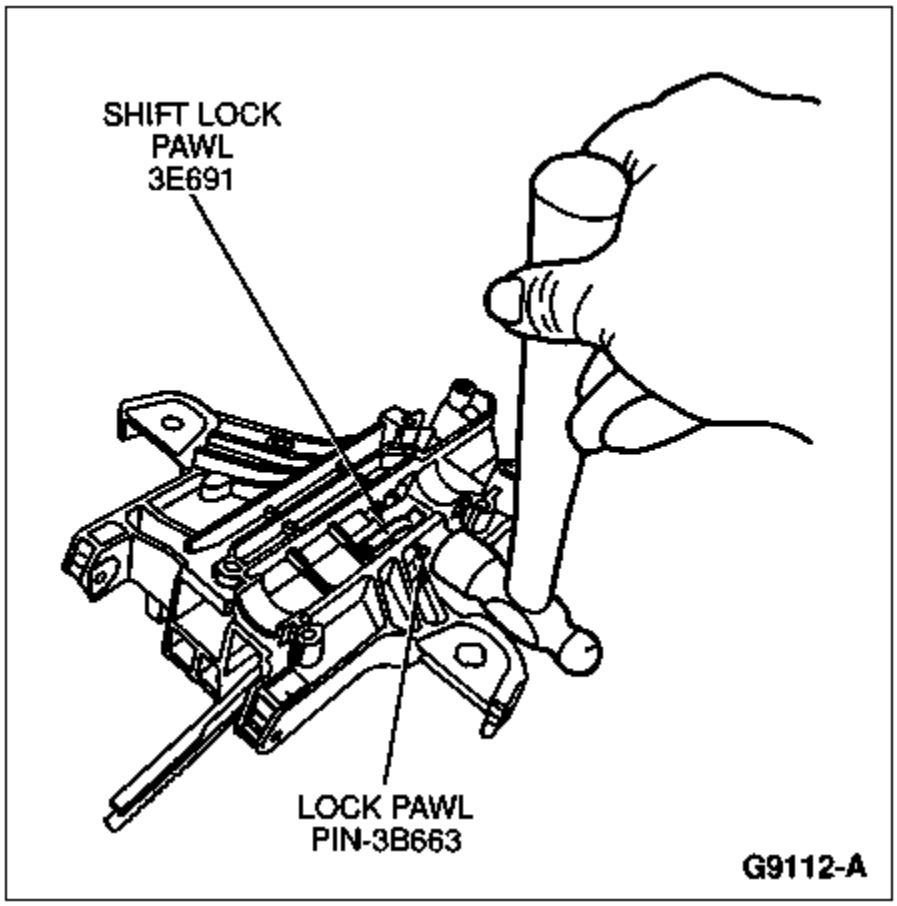
14. On fixed column: install steering column bearing tolerance ring and bearing retainer (3C610).

Suspension Height Sensor Control Ring

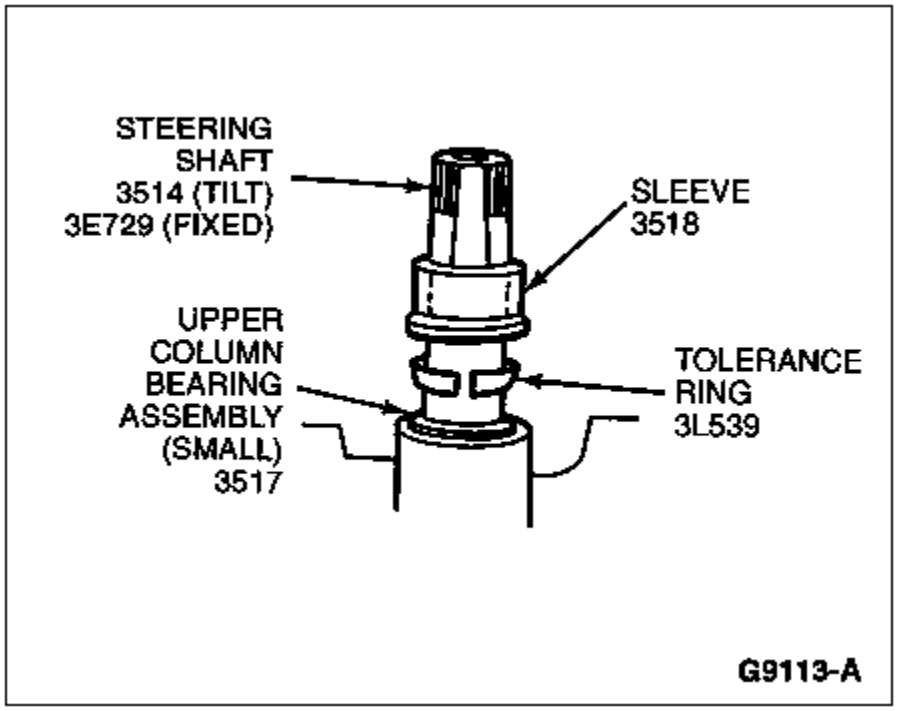


Item	Part Number	Description
1	3524	Steering Gear Column Shaft (Tilt)
2	3E729	Steering Gear Column Shaft (Fixed)
3	3L539	Steering Column Upper Bearing Tolerance Ring
4	3C610	Bearing Retainer (Fixed Only)
5	3520	Steering Column Upper Bearing Spring
6	3C131	Suspension Height Sensor Control Ring

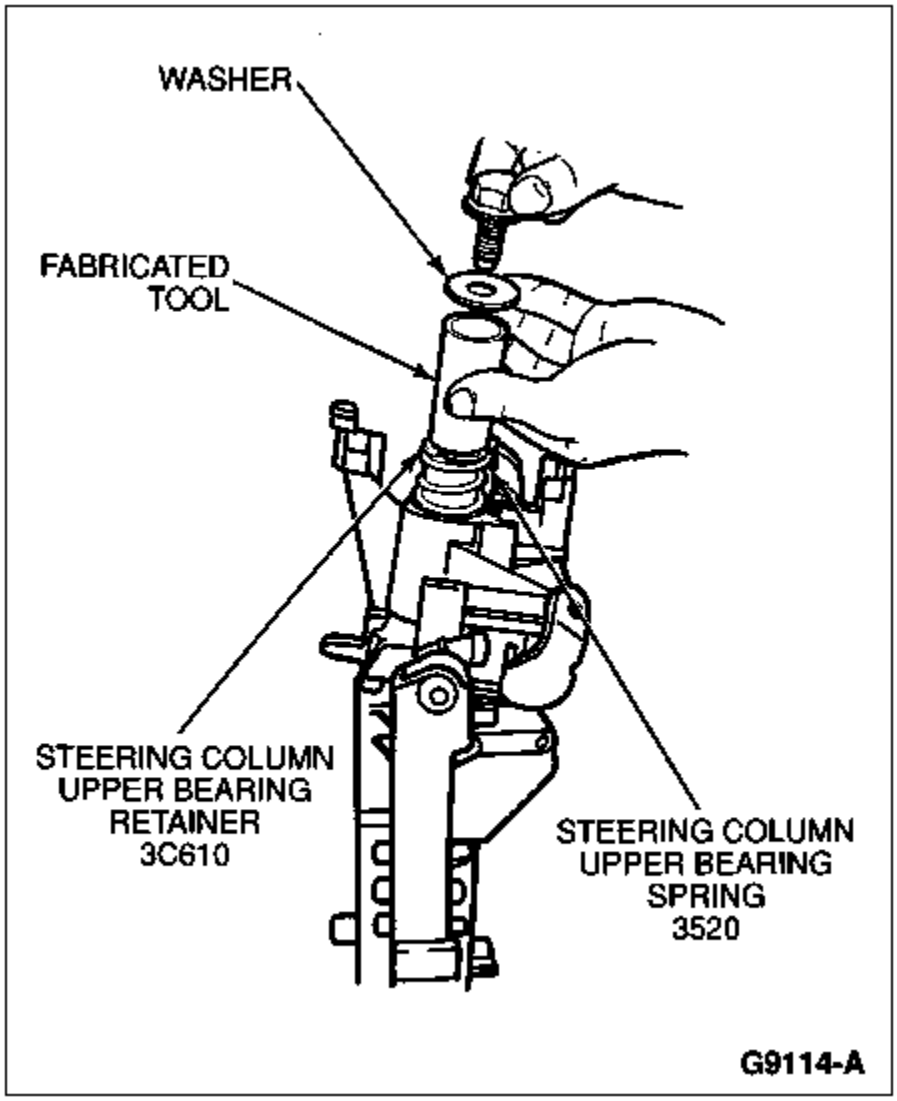
15. Position steering column lock pawl (3E691) in steering actuator housing (3F723) and install steering lock with small hammer. Tap steering lock pawl pin in until flush with steering actuator housing.



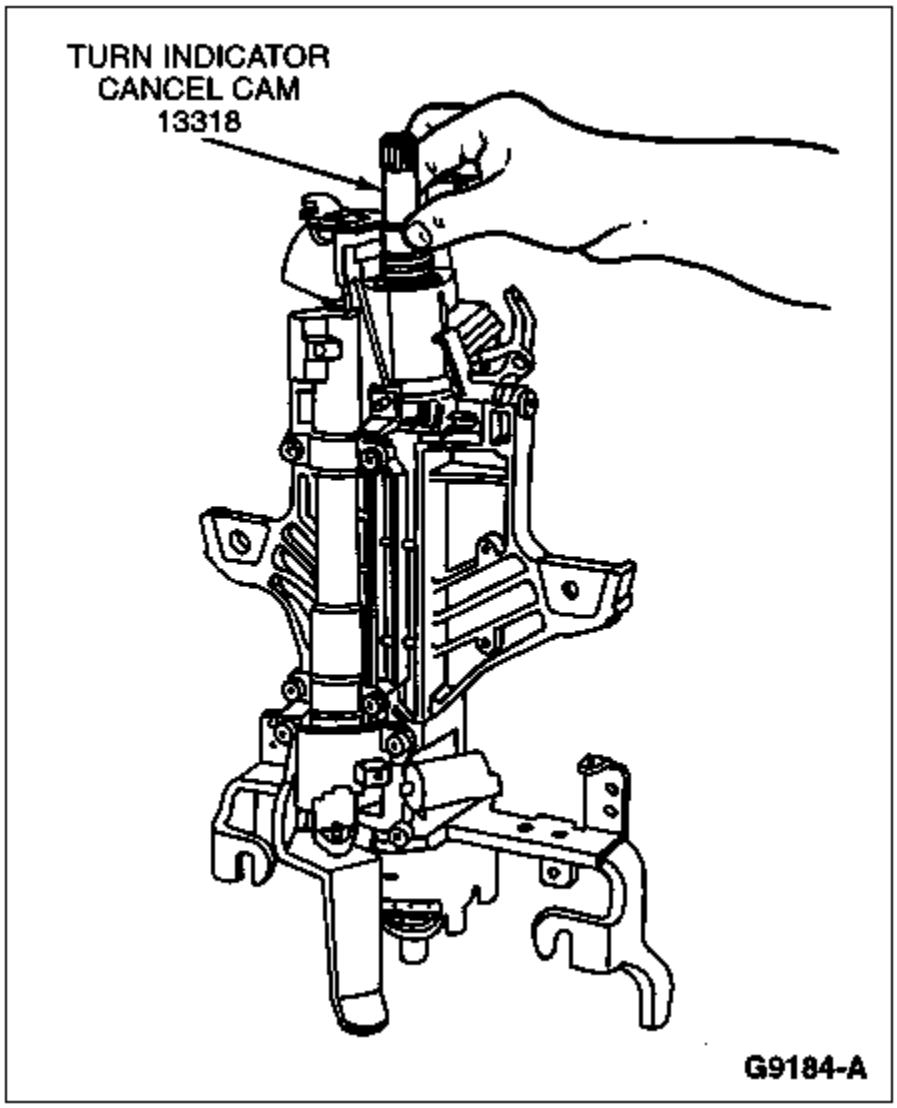
16. Install tolerance ring and sleeve over steering shaft to upper bearing.



17. Install steering column upper bearing spring and new snap ring on top side of steering column upper bearing spring using a 19mm (3/4-inch) I.D. by 63.5mm (2-1/2-inch) long PVC pipe.



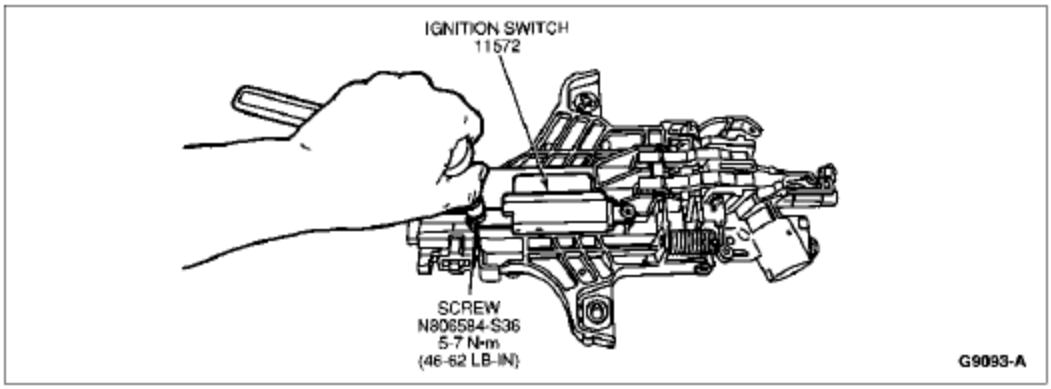
18. Install turn indicator cancel cam, flush surface "up."



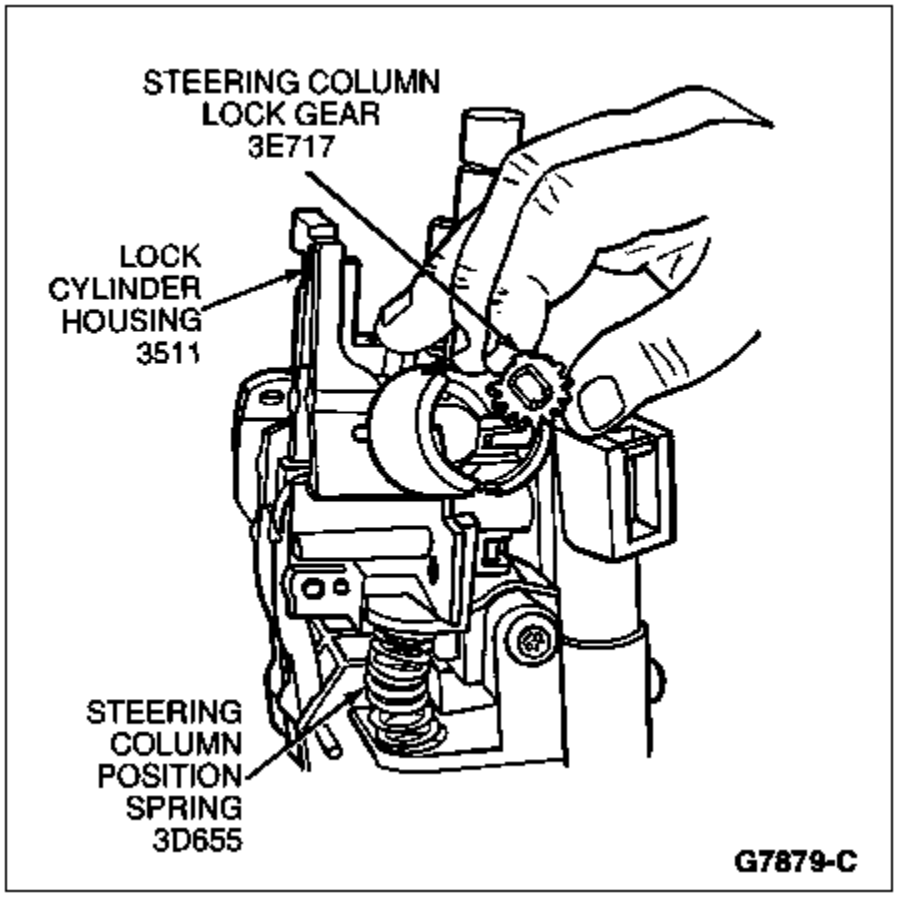
19. Install ignition switch. Align pin from ignition switch with slot in lock/column assembly. Position slot in lock/column assembly with index mark on casting. Ignition switch should be in RUN position.

20. Tighten two retaining screws to 5-7 Nm (46-62 lb-in).

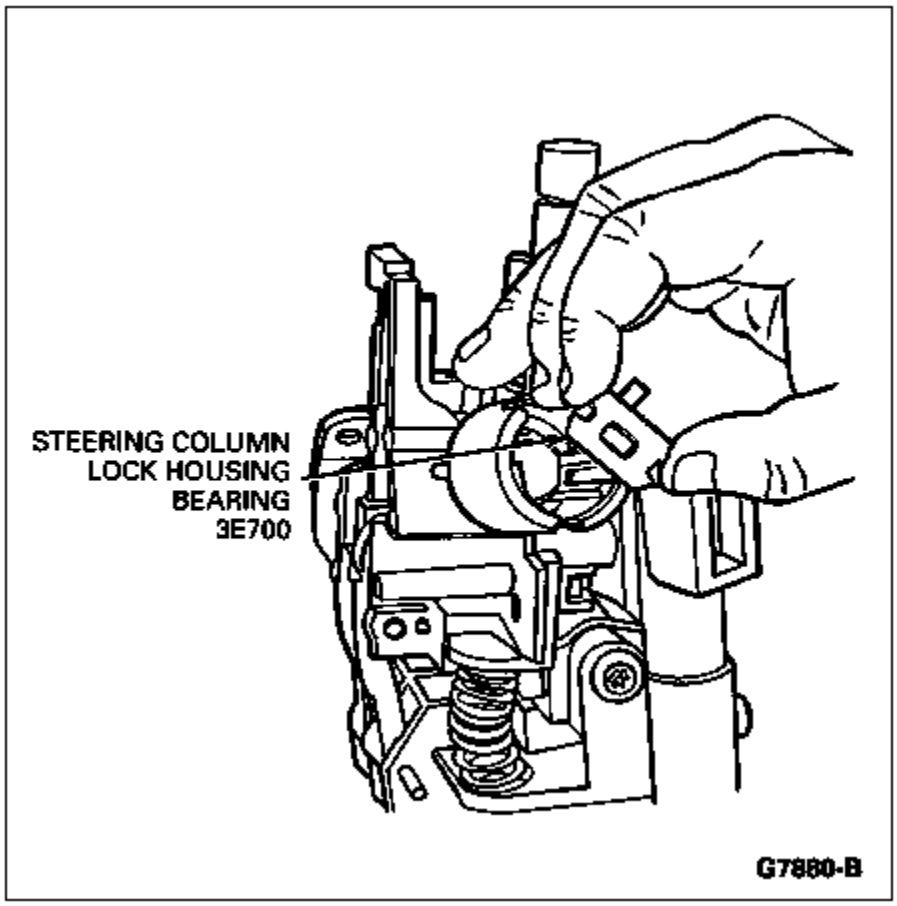
Ignition Switch



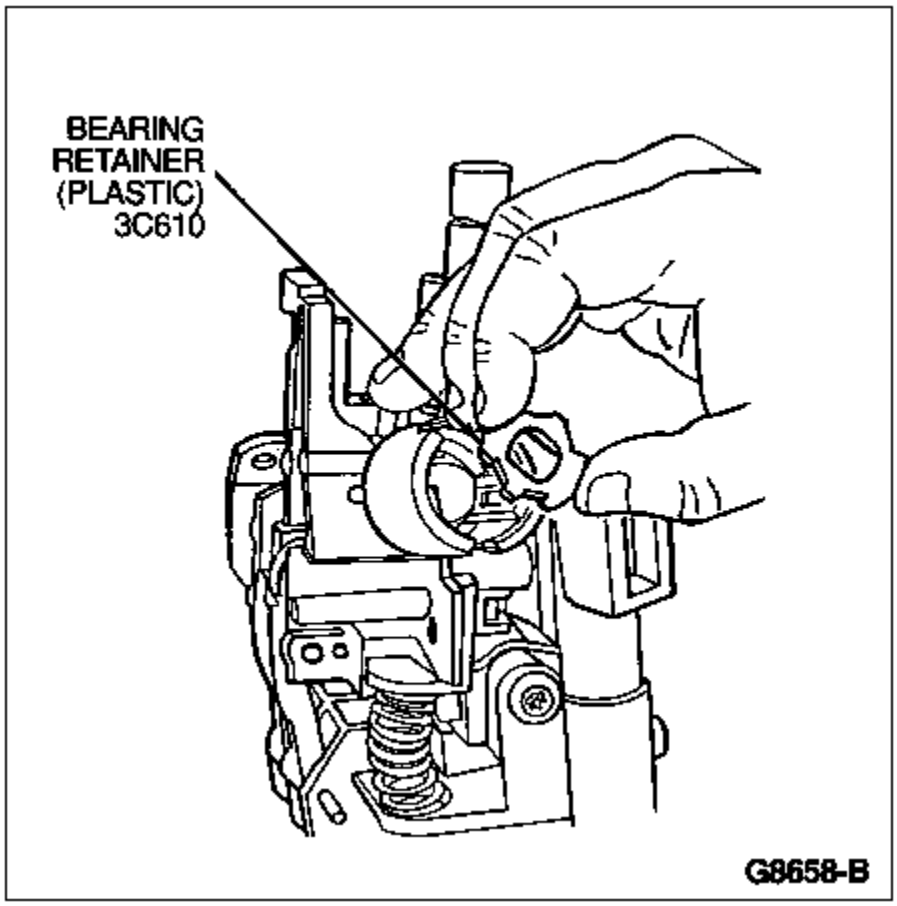
21. Install steering column lock gear. Coat gear with Ignition Lock Grease F0AZ-19584-A or equivalent meeting Ford specification ESA-M1C232-A.



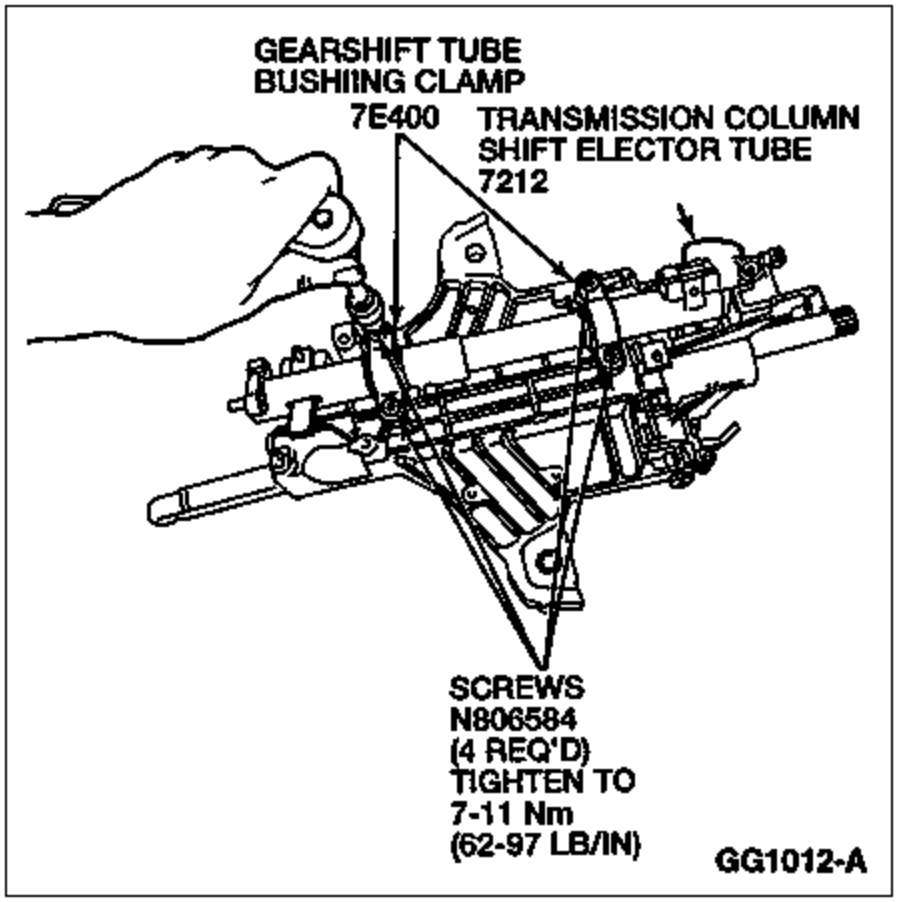
22. Lubricate steering column lock housing bearing. Lubricate with Ignition Lock Grease F0AZ-19584-A or equivalent meeting Ford specification ESA-M1C232-A. With actuator rack in 12 o'clock position, position bearing with tang inboard and in 5 o'clock position in lock cylinder. Insert tip of a screwdriver into double-D slot of bearing, then turn counterclockwise 90 degrees.



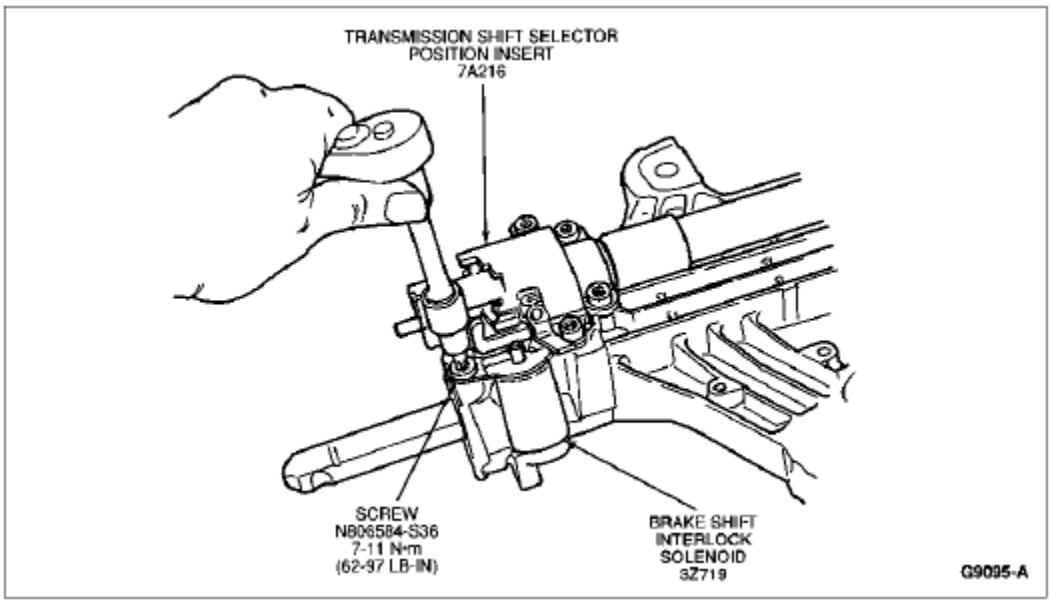
23. Install plastic bearing retainer.



24. Install shift control tube assembly (column shift only). Coat bushings with grease meeting Ford specification ESB-M1C163-C. Tighten screws to 7-11 Nm (62-97 lb/in).



Brake Shift Interlock Solenoid Screws



25. Install transmission shift selector position insert and brake shift interlock solenoid assembly. Tighten screws to 7-11 Nm (62-97 lb-in).

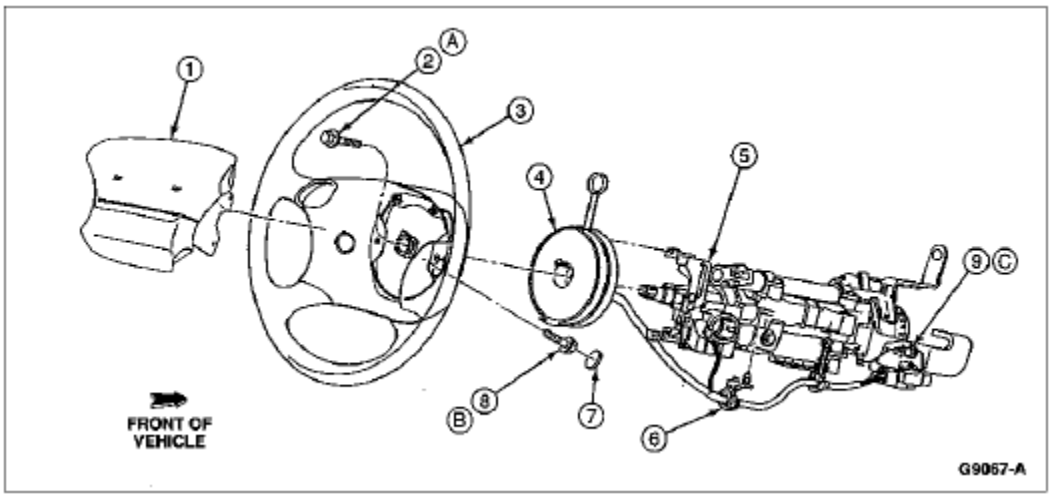
26. Align air bag sliding contact to column shaft and mounting tabs and slide onto shaft. Push on air bag sliding contact to snap three tabs onto lock cylinder housing.

27. Install air bag sliding contact connector retainers into holes in steering column.

28. Install air bag sliding contact retainers into holes in steering column bend bracket.

29. Install key warning chime contact and anti-theft contact into ignition lock cylinder pocket in lock cylinder housing. Make sure contacts do not slip out of ignition lock cylinder pocket.

Steering Wheel with Air Bag



Item	Part Number	Description
1	043B13	Driver Side Air Bag Module
2	N807493-S100	Torx® Head Screw, M10-1.5 x 18
3	3600	Steering Wheel
4	14A664	Air Bag Sliding Contact
5	3C529	Steering Column
6	390345-S424	Clip
7	3F785	Plug
8	N808944-S424	Bolt
9	N805375-S36MG	Bolt
A	—	Tighten to 34-46 Nm (25-33 Lb-Ft)
B	—	Tighten to 7.6-10.4 Nm (67-92 Lb-In)
C	—	Tighten to 10.2-13.8 Nm (7.5-10.1 Lb-Ft)

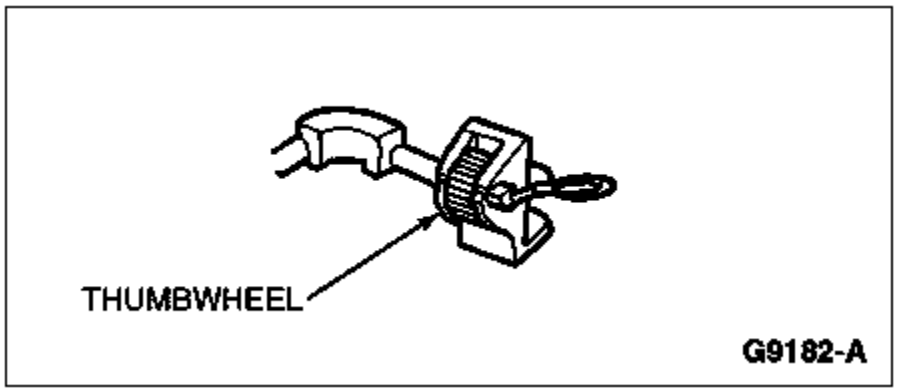
30. Install upper steering column shroud.

31. Push ignition switch lock cylinder into place.
32. Install lower steering column shroud.
33. Screw in tilt wheel handle and shank and tighten on tilt column.
34. Install steering column assembly as outlined in this section.

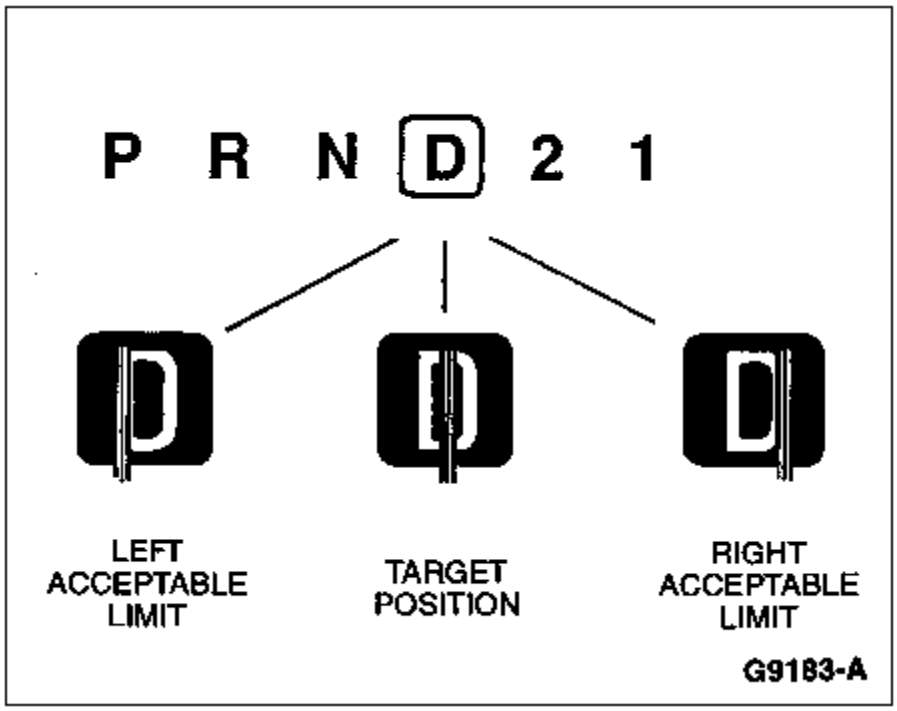
Transmission Range Indicator

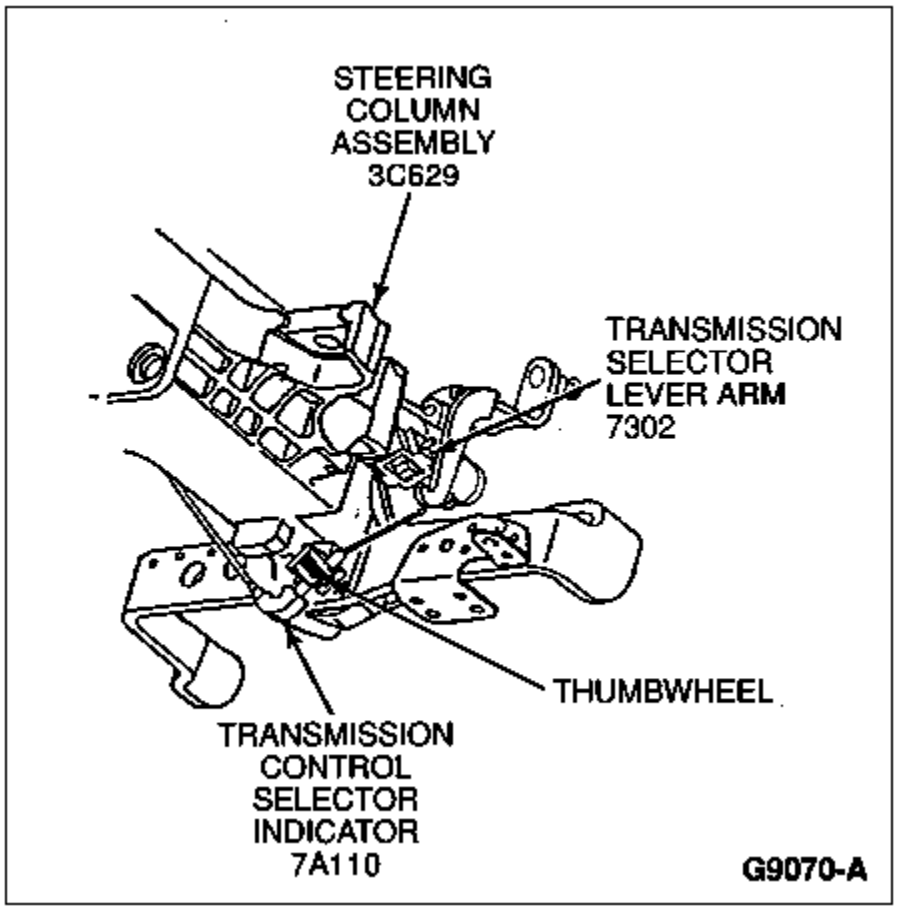
Use the following procedure to adjust the automatic transmission indicator flag:

1. Rotate gearshift lever (7210) clockwise until it bottoms out in first gear.
2. Rotate gearshift lever counterclockwise two detents (overdrive position).
3. Hang a three-pound weight on the gearshift lever.
4. Center pointer in the middle of (D) by rotating the thumbwheel located on right-hand side of steering column.



5. For "flag" type indicator, adjust the flag in the overdrive position by rotating the thumb wheel until no red is visible in the calibration window. The flag must fully cover the overdrive symbol after adjustment.
6. Remove three-pound weight from gearshift lever.





Functional Test

Road test vehicle making sure pointer is positioned as shown when vehicle is operating in indicated range.

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Air Bag Module-to-Steering Wheel Screw	7.6-10.4	—	67-92
Brake Shift Interlock Solenoid Retainer Screws	7-11	—	62-97
Contact Assembly Ground Wire to Bend Bracket Screw	10.2-13.8	7.5-10.1	—
Gear Shift Tube Bushing Clamp Screws	7-11	—	62-97
Ignition Switch Screws	5-7	—	46-62
Instrument Panel Steering Column Opening Center Reinforcement Nuts	13-17	—	115-150
Instrument Panel Steering Column Cover Screws	2.1-2.9	—	19-25
Intermediate Shaft-to-Steering Column Bolt (2 Places)	40-55	30-40	—
Intermediate Shaft-to-Steering Gear Bolt	34-46	25-33	—
Screw, Multi-Function Switch-to-Steering Column	2-3	—	18-25
Pivot Bolts	18-26	14-19	—
Primary/Secondary Boot to Dash Nut	4.5-6.3	—	40-56
Steering Column Cover Reinforcement Screws	10-14	—	88-123
Steering Column-to-Cross Car Beam Nut	12.5-17.5	9-13	—
Steering Column Lower Bearing Retainer Screws	7-11	—	62-97
Steering Column Nuts	13-17	10-12	—
Steering Column Opening Wheater Seal Screw	15-20	11-14	—
Steering Gear-to-Sub-Frame Nut	113-153	83-112	—
Steering Wheel-to-Steering Column Bolt	34-46	25-33	—
Transmission Selector Lever Arm Screws	13-17	—	115-150
Tilt Handle Shank to Tilt Lever	3.5-5	3-4	—
Upper/Lower Shroud-to-Steering Column Screw	0.7-1.1	—	7-9
Wiring Bracket-to-Steering Column Bolt	9-12	7-9	—

Multi-Function Switch

The multi-function switch (13K359) provides electrical switching for the turn signal, headlamp dimmer, headlamp flash-to-pass, hazard warning, windshield washer and windshield wiper. The multi-function switch is mounted on the left side of the steering column.

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Turn Signal Switch

The turn indicator lever is located on the LH side of the upper steering column. To operate the turn signal(s), the ignition switch lock cylinder must be in the RUN position. To indicate a normal full turn, move the turn indicator lever to the end-of-travel position for the turn desired. The lever will remain in position without effort until the turn is completed, at which time the turn indicator cancel cam will automatically cancel the turn signal.

The turn indicator lever also has a lane change feature. To operate the lane change feature, move and hold the turn indicator lever to the first stop position when changing lanes. When the lane maneuver is completed, release the turn indicator lever and it will return to its normal position.

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Ignition Switch, Blade Type

The ignition switch (11572) has blade-type terminals that engage with one multiple connector. The multiple connector is secured to the ignition switch by an attaching bolt integral with the wiring connector.

The lock cylinder positions are ACC, LOCK, OFF, RUN and START. With column shift automatic transmissions, the lock cylinder key can be removed from the lock cylinder only when the shift lever is in PARK position and the key is in LOCK position. The ACC position operates while the steering and transmission systems remain locked. Turning the key to OFF position shuts off the engine without locking the steering or transmission systems.

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Wiper Control Switch, Intermittent

The wiper switch is located in the knob at the end of the turn indicator lever. To operate the wiper, the key lock cylinder must be in the RUN position. In addition to OFF there are two fixed speed wiper positions: LO, (low), HI, (high) and an interval position. The positions are selected by rotating the knob actuator relative to the turn indicator lever. If interval position is selected, the time between wiper cycles will decrease as the knob is rotated away from OFF position and will increase as the knob is rotated toward OFF position. The time interval between wipes will vary depending on the knob's position from OFF position.

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Windshield Washer Switch

The washer switch is located at the end of the turn indicator lever. To operate the washer, the ignition switch lock cylinder must be in the RUN position. To actuate the washer, push the end of the turn indicator lever toward the steering column. Releasing the turn indicator lever will then turn off the washer. The windshield wiper blades will continue to operate for a few wipes and then automatically return to the wiper speed setting (OFF, LO, HI, INT) previously selected. Washer operation is available in all positions of wiper operation.

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High Beam/Flash-to-Pass Switch

NOTE: Excessive force used to hold the turn indicator lever in the flash-to-pass function followed by quick release may result in incorrect headlamp dimmer selection of high beam. The driver must be cautioned to avoid this condition.

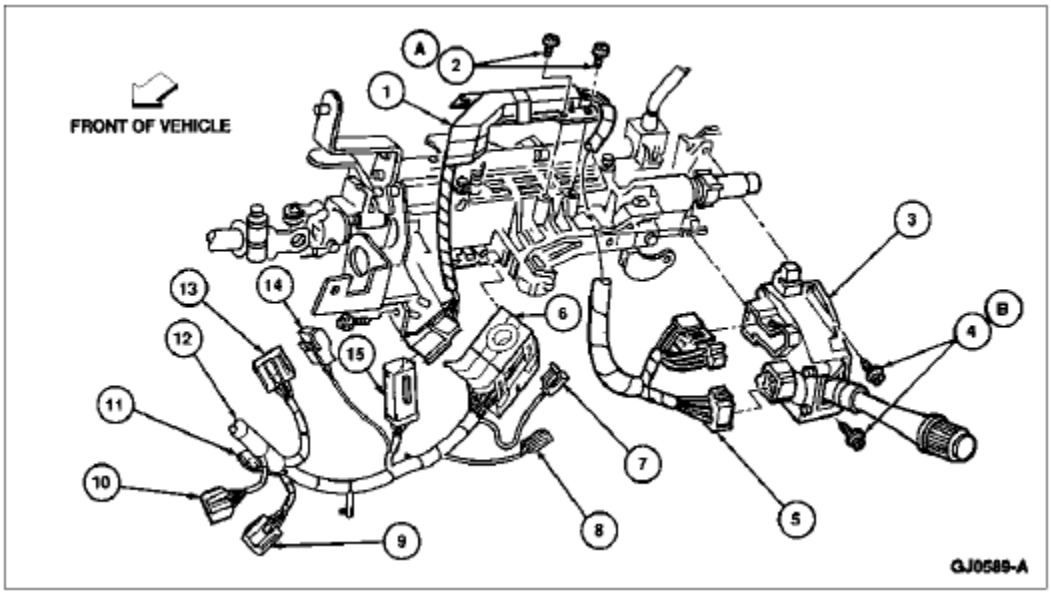
The turn indicator lever also operates the headlamp dimmer switch and the flash-to-pass feature. High beam is selected by pushing the turn indicator lever away from the driver to the STOP position.

To change the headlamp beam back, pull turn indicator lever toward driver until the switch is in the central position.

To operate the flash-to-pass feature, pull the turn indicator lever gently toward the driver. When the lever is released, it will return to the LO beam position. If driving without headlamps on, use of the flash-to-pass feature will turn on the high beams until the turn signal lever is released. If the headlamps are turned on, the low and high beams will be on until the turn signal lever is released.

NOTE: Excessive force used to hold the turn indicator lever in the flash-to-pass function followed by quick release may result in incorrect headlamp dimmer selection of high beam. The driver must be cautioned to avoid this condition.

Steering Column Switches, Aerostar



Item	Part Number	Description
1	14536	Shield, Wiring

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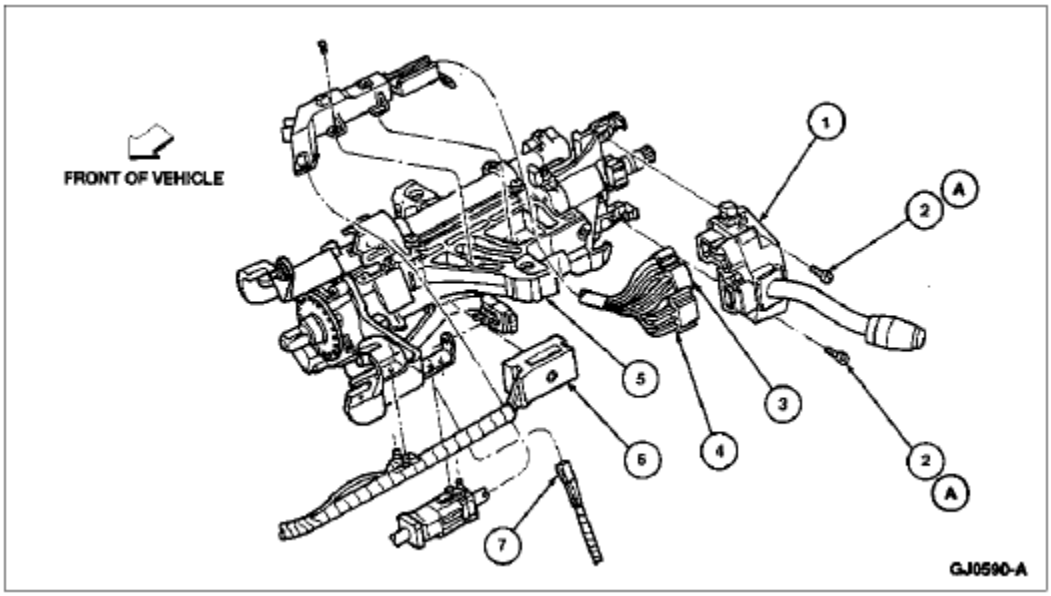
2	56902-S58	Screw
3	13K359	Multi-Function Switch
4	390345-S36	Screw
5	13B319	Wiring Assembly
6	—	Connector (to Ignition Switch) (Part of 14401)
7	—	Connector (to Brake Shift Interlock) (Part of 14401)
8	—	Connector (to Air Bag Slip Ring) (Part of 14401)
9	—	Connector (to Horn Brush) (Part of 14401)
10	—	Connector (to Oil Level Relay) (Part of 14401)
11	—	Connector (to Brake Test) (Part of 14401)
12	14401	Main Wiring
13	—	Connector (to Windshield Washer Module) (Part of 14401)
14	—	Connector (to Stoplamp Switch) (Part of 14401)
15	—	Connector (to 13B319 Wiring Assembly) (Part of 14401)
A	—	Tighten to 1.2-1.8 Nm (11-15.9 Lb-In)
B	—	Tighten to 2-3 Nm (18-27 Lb-In)

Steering Column Switches, Ranger



Item	Part Number	Description

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1	13K359	Multi-Function Switch
2	52794-S2	Screw
3	—	Wiring Connector (Turn Signal/Flasher Switch) (Part of 14401)
4	—	Wiring Connector (Windshield Wash, Wiper Control, Headlamp High/Low Beam) (Part of 14401)
5	3514	Steering Column Assembly
6	—	Wiring Connector (Ignition Switch) (Part of 14401)
7	—	Wiring Connector (Park Lock) (Part of 14401)
A	—	Tighten to 2-3 Nm (18-27 Lb-In)

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Hazard Flasher Switch

The hazard flasher system operates independently from the ignition switch lock cylinder. All turn signal lamps can be made to flash in unison by depressing and releasing the hazard actuation knob located on the steering column. The switch is identified by a "double triangle" symbol.

The actuator will move out or away from the steering column to the ON position. The hazard flasher system is turned off by first pushing in the actuator and then releasing the actuator. The actuator should remain in or toward the steering column in the OFF position.

NOTE: The turn signal system is deactivated when the hazard flasher system is on and turn indicator lever motion does not affect the hazard flasher system.

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Brake-Shift Interlock Switch

The brake-shift interlock switch (used on automatic transmission-equipped vehicles) prevents moving the shift lever out of PARK position unless brake pedal is depressed.

The brake-shift interlock system consists of an electrical solenoid mounted at the base of the steering column. If the ignition key is in the run position, the solenoid continually runs unless the brake is depressed.

SUMMARY OF INTERLOCK OPERATIONAL STATUS

Ignition Switch Position	Ignition Interlock Shift Lever and Steering Wheel	Brake-Shift Interlock Status
Accessory	Locked	Shift Unlocked — No Power to Solenoid
Locked	Locked	Shift Unlocked — No Power to Solenoid
Off	Unlocked	Shift Unlocked — No Power to Solenoid
Run	Unlocked	Shift Locked (Unless Brake Pedal Is Depressed) — Power to Solenoid

If the brake circuit fuse is blown or the solenoid has internally shorted, the vehicle will not shift from the PARK position even if the ignition is on and brake pedal is depressed. The interlock can be temporarily overridden by the following procedure:

1. Apply parking brake.
2. Remove the ignition key.
3. Insert the ignition key and rotate one position clockwise (ignition off).
4. Shift the selector lever to NEUTRAL.
5. Start the vehicle.

If the vehicle is shifted into PARK, the above procedure must be repeated.

Brake-Shift Interlock Switch Location

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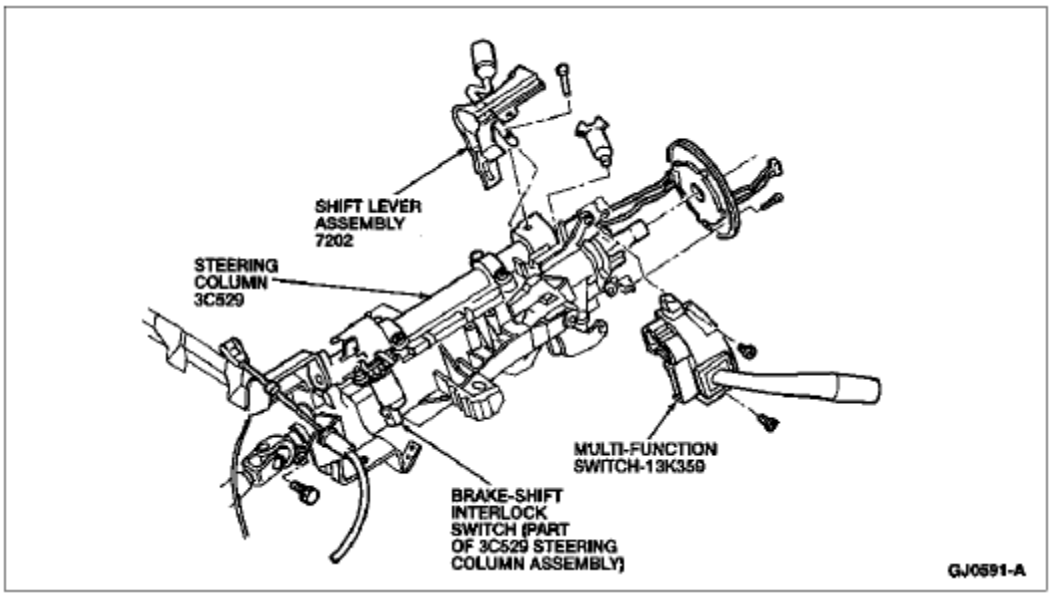

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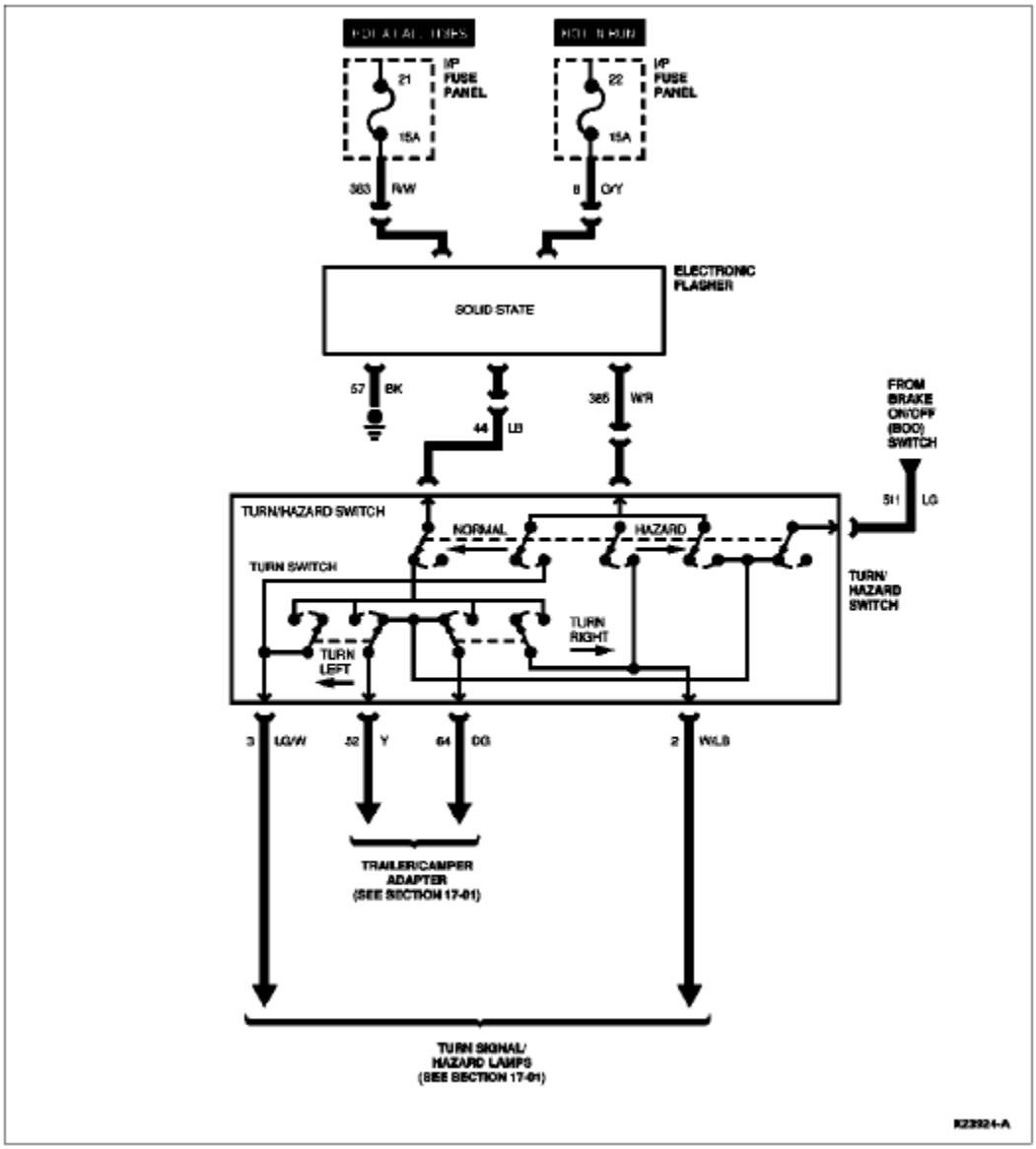
Electrical Schematics

Multi-Function Switch — Turn Signals (Ranger)



Multi-Function Switch — Headlamps (Ranger)

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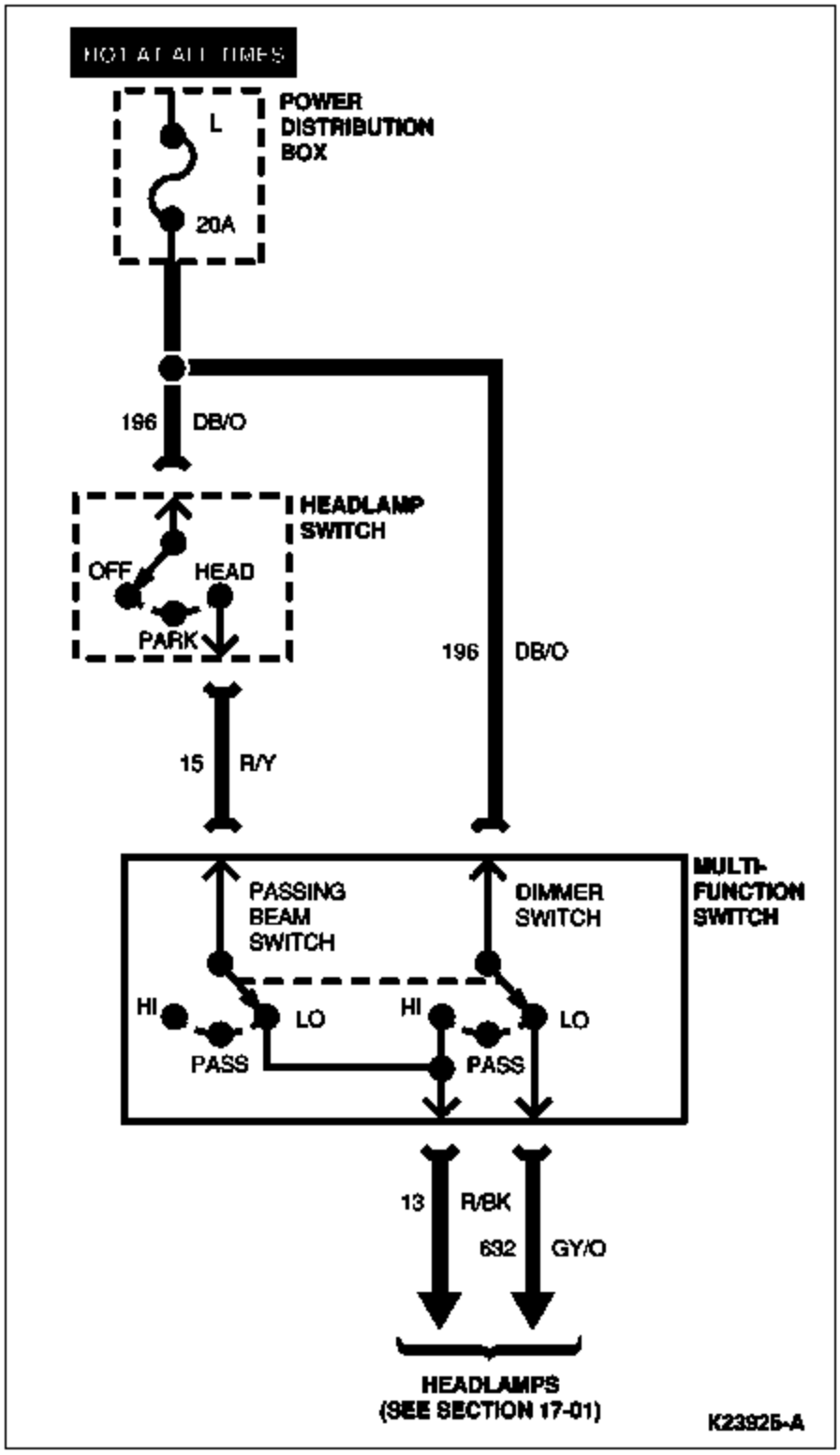

Multi-Function Switch — Windshield Wipers (Ranger)

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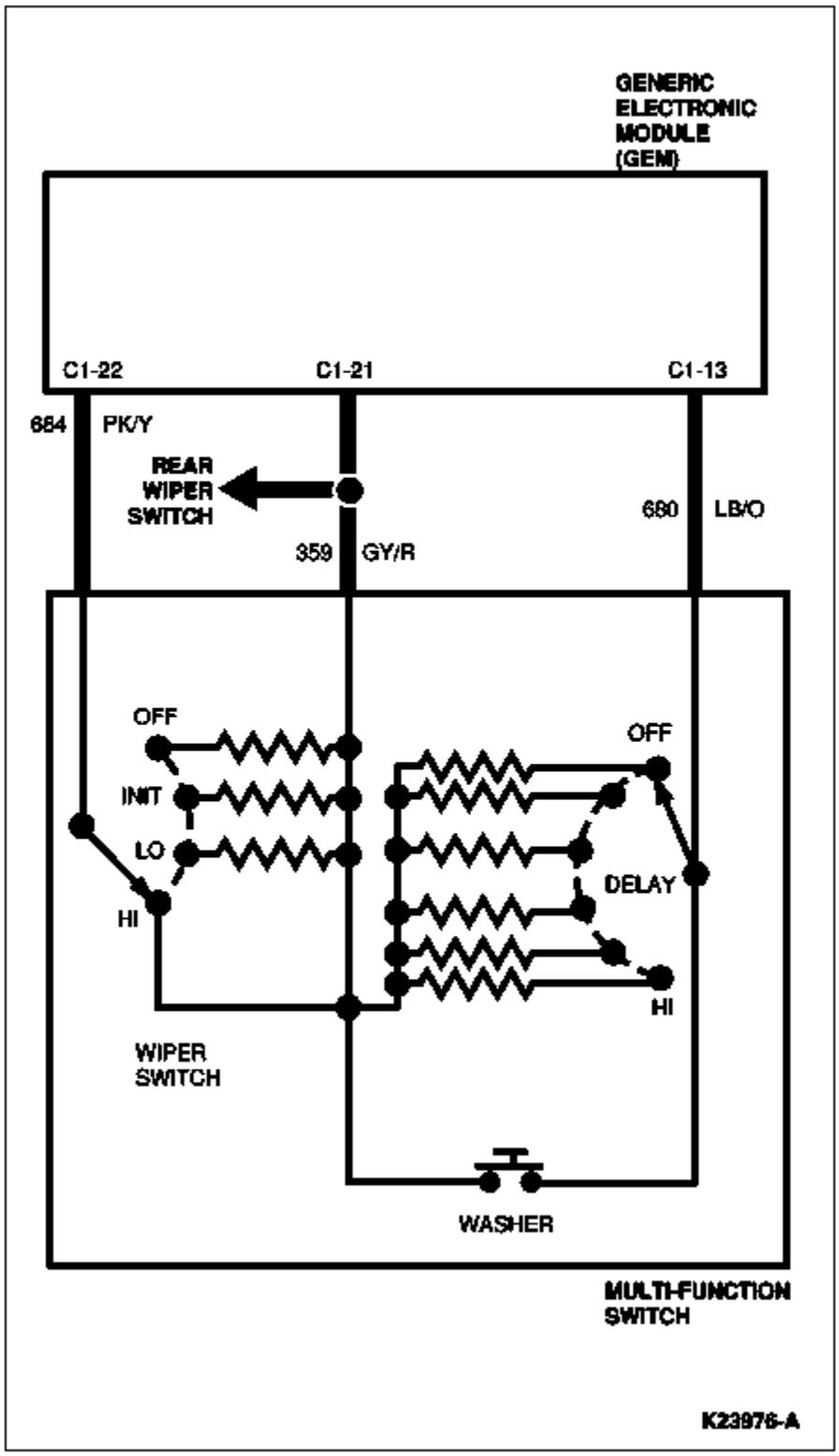

Ignition Switch (Ranger)

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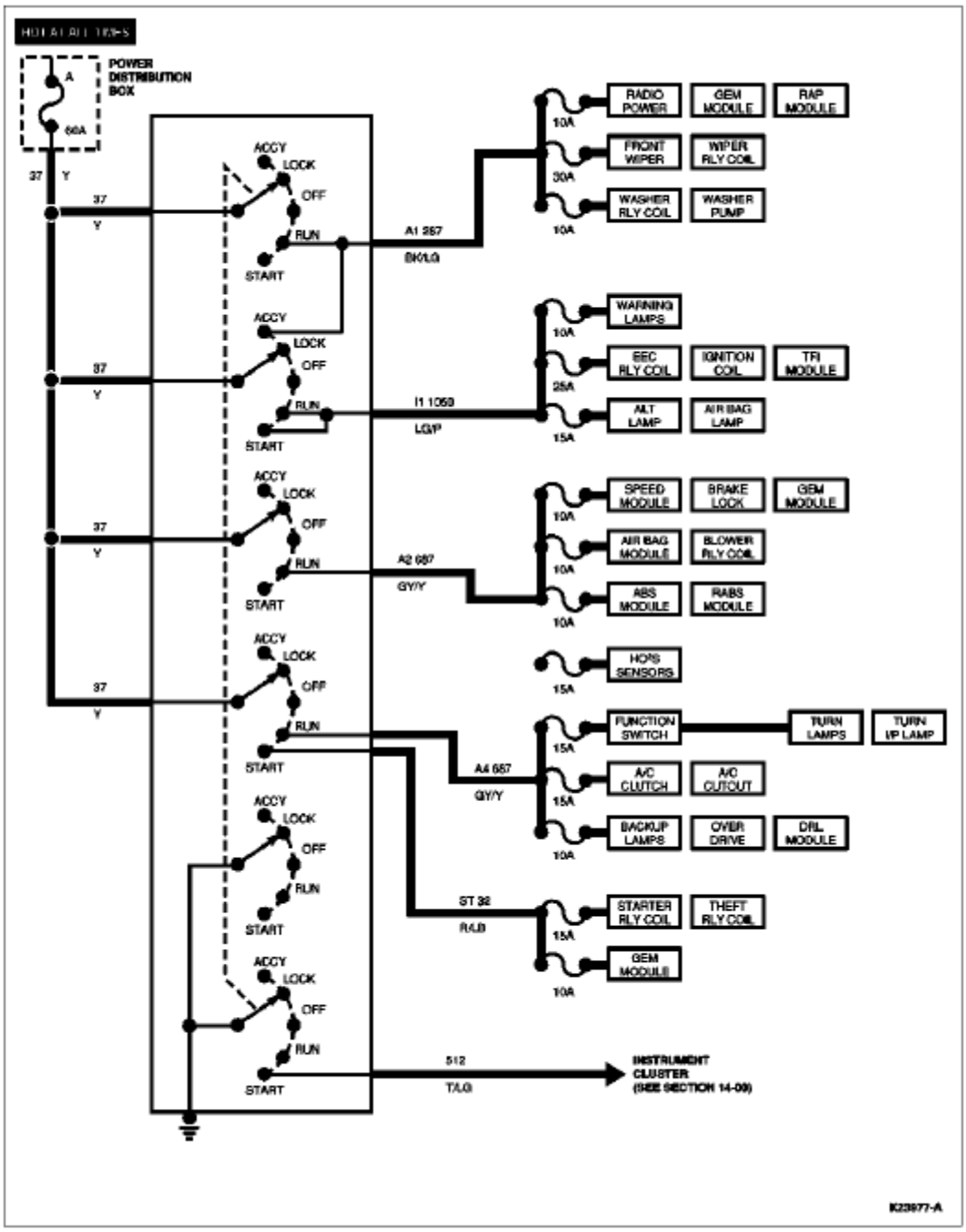

Multi-Function Switch — Turn Signals (Aerostar)

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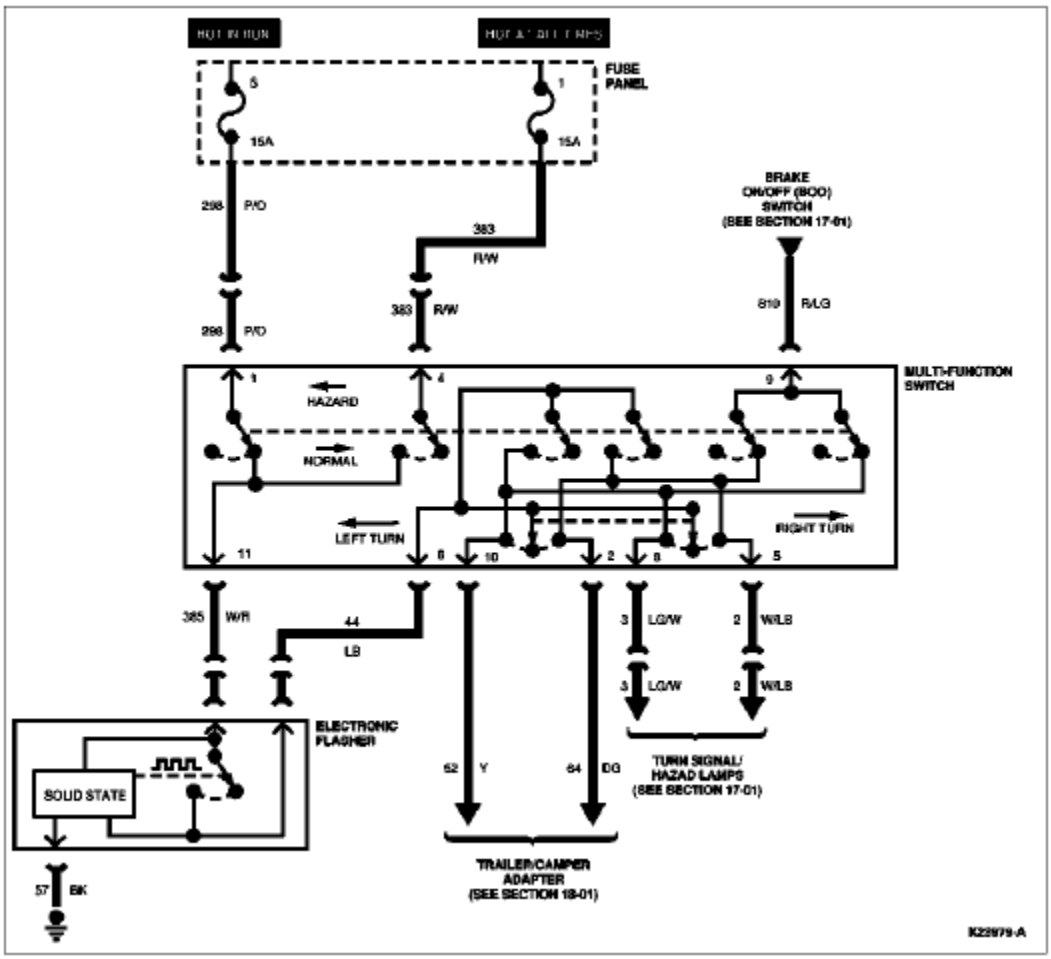

Multi-Function Switch — Headlamps (Aerostar)

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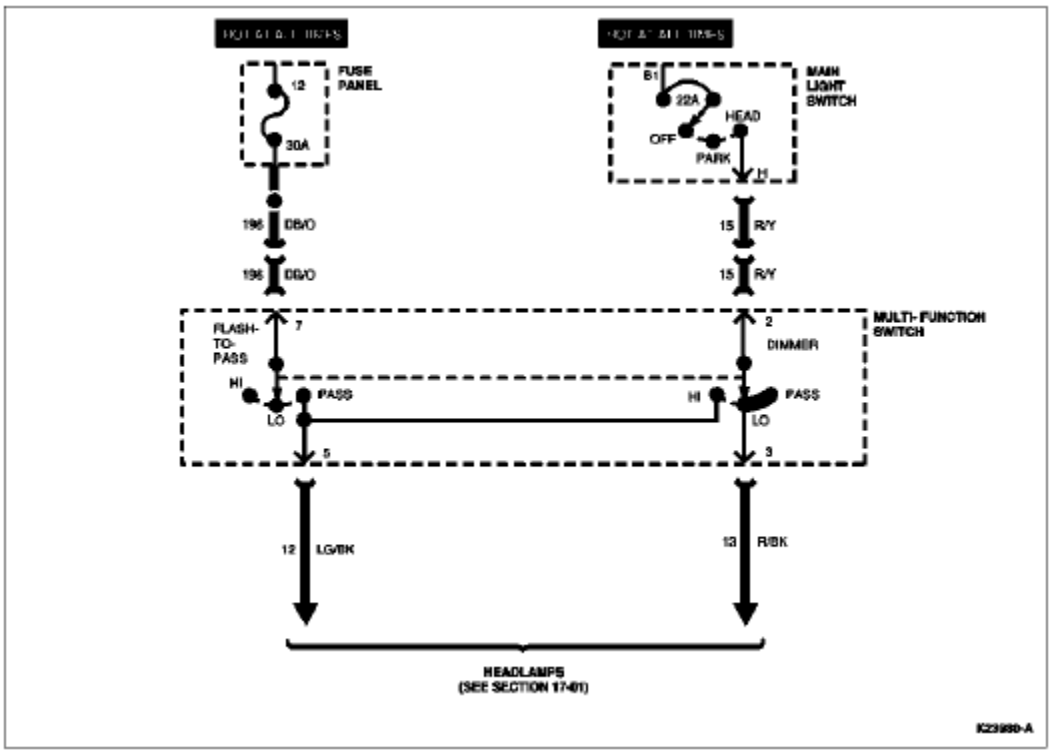

Multi-Function Switch — Windshield Wipers (Aerostar)

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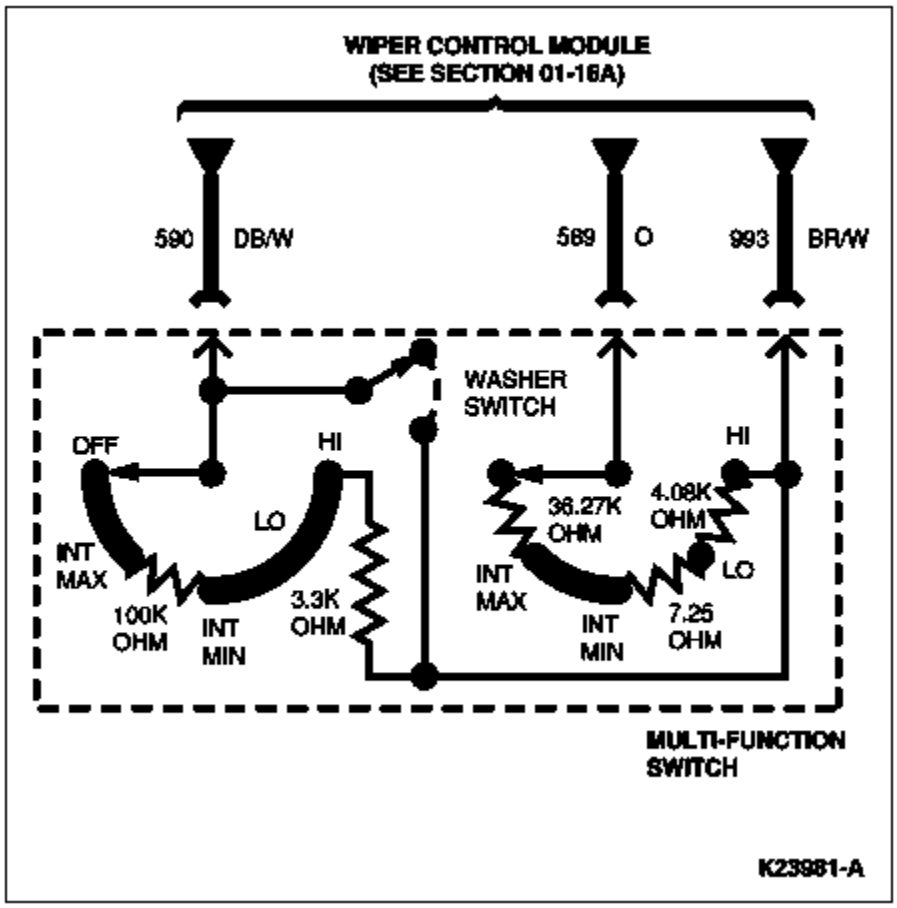

Ignition Switch (Aerostar)

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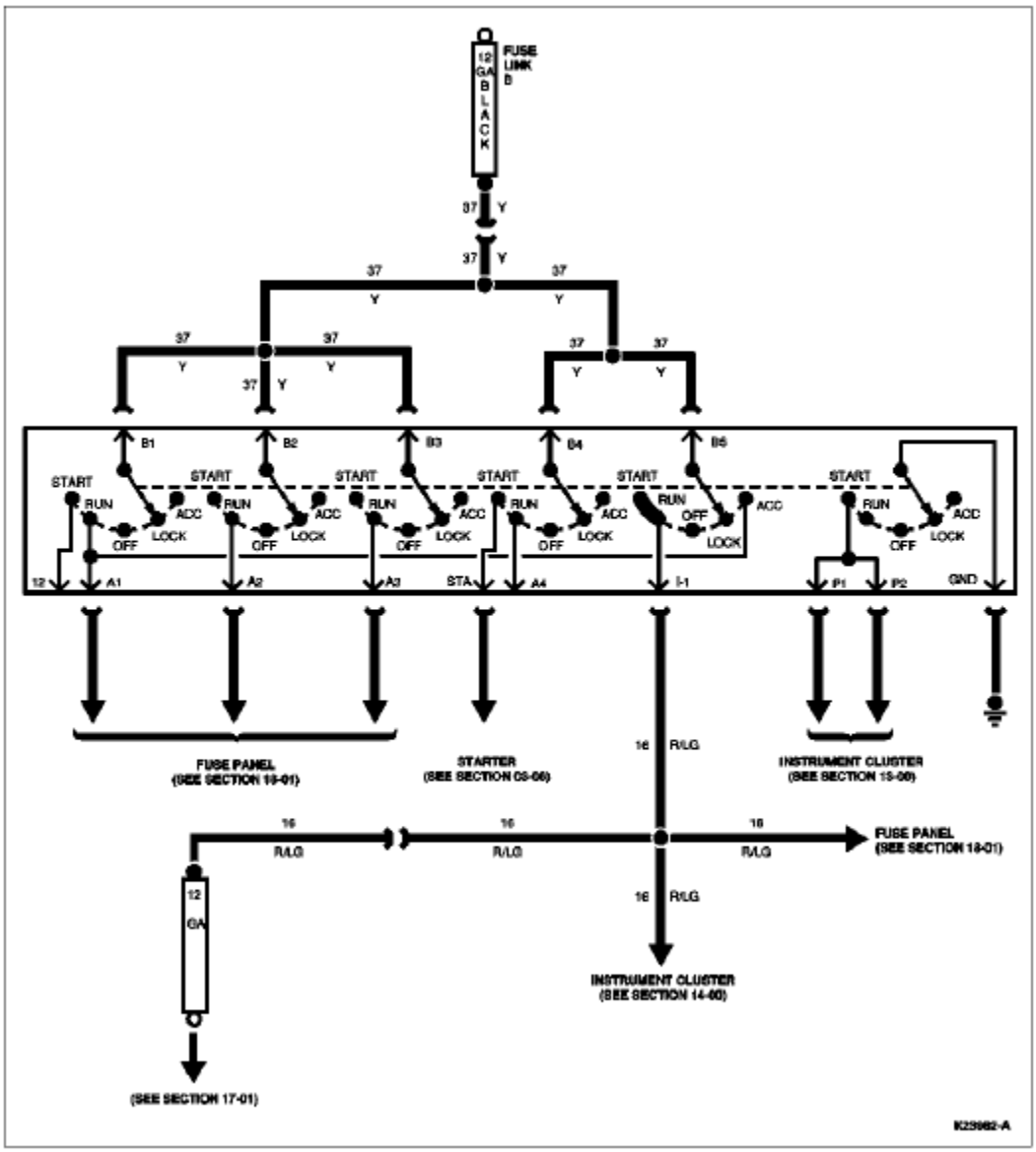

Ignition Switch Connector — Aerostar

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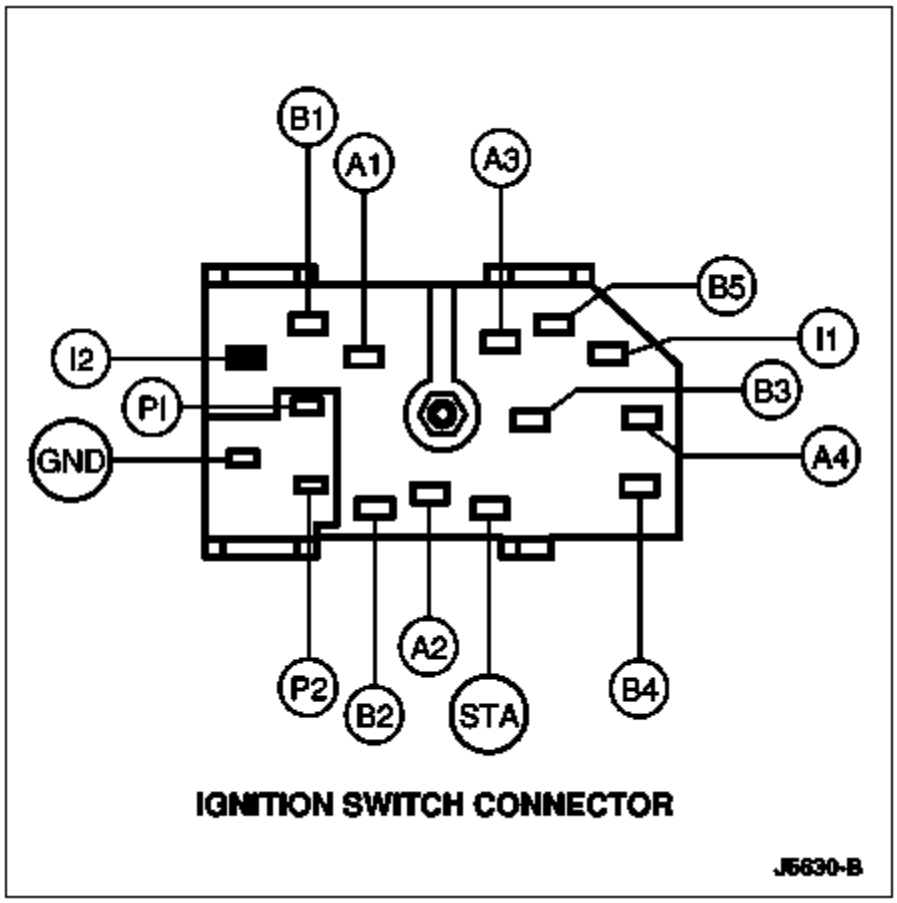

Pin Number	Circuit	Circuit Function
A1	297 (BK/LG)	Fused Run/Accessory Feed
A2	687 (GY/Y)	Accessory Feed (Hot in Run)
A3	687 (GY/Y)	Accessory Feed (Hot in Run)
A4	687 (GY/Y)	Accessory Feed (Hot in Run)
B1	37 (Y)	Battery Input
B2	37 (Y)	Battery Input
B3	37 (Y)	Battery Input
B4	37 (Y)	Battery Input
B5	37 (Y)	Battery Input
I1	16 (R/LG)	Ignition Switch to Ignition Coil
I2	—	Not Used
PI	512 (T/LG)	Brake Indicator Prove Out
P2	41 (BK/LB)	Warning Lamp Prove Out
STA	33 (W/PK)	Starter Control (Hot in Start)
GND	57 (BK)	Ground Circuit

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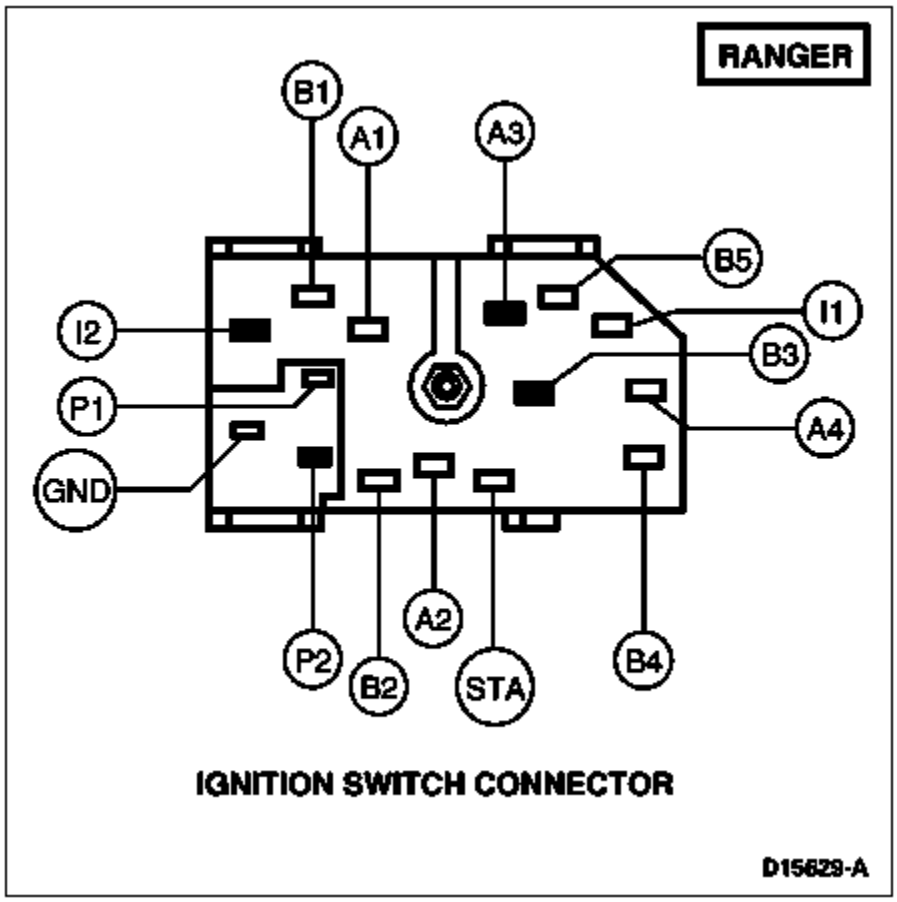
Ignition Switch Connector, Ranger



Pin Number	Circuit	Circuit Function
A1	297 (BK/LG)	Fused Run/Accessory Feed
A2	687 (GY/Y)	Accessory Feed (Hot in Run)
A3	—	Not Used
A4	687 (GY/Y)	Accessory Feed (Hot in Run)
B1	37 (Y)	Battery Input
B2	37 (Y)	Battery Input
B3	—	Not Used
B4	37 (Y)	Battery Input
B5	37 (Y)	Battery Input
I1	1050 (LG/P)	Fused Ignition Switch Feed to Run/Run Start
I2	—	Not Used
P1	512 (T/LG)	Brake Indicator Prove Out

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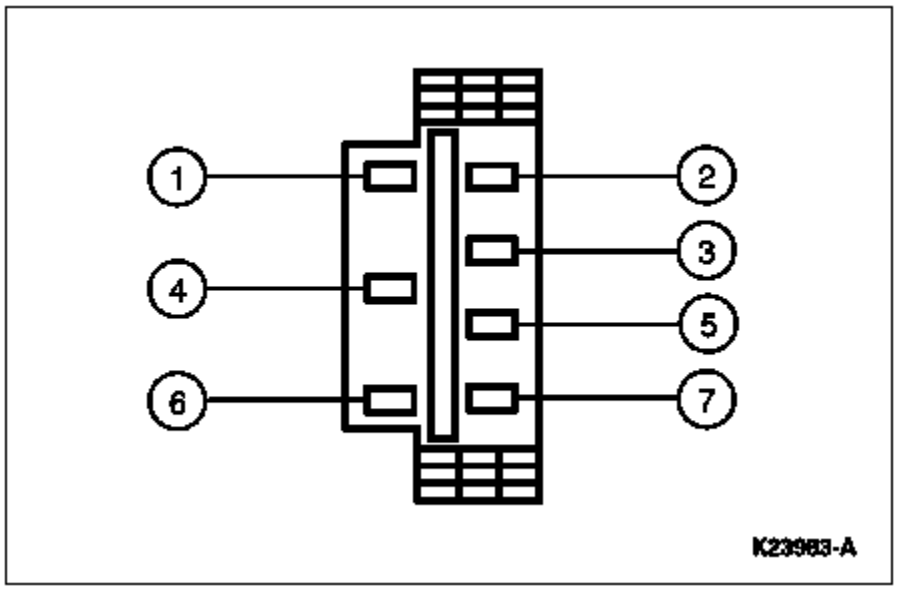
P2	—	Not Used
STA	32 (R/LB)	Starter Control (Hot in Start)
GND	57 (BK)	Ground Circuit

Multi-Function Switch Connector, Aerostar



Pin Number	Circuit	Circuit Function
1	589 (O)	Wiper Switch Mode Select Function to Wiper Control Module
2	15 (R/Y)	Main Lamp Switch Feed to Dimmer Switch Function
3	13 (R/BK)	Dimmer Switch Function to Headlamp LO Beams
4	993 (BR/W)	Wiper Switch Reference Voltage from Wiper Control Module
5	12 (LG/BK)	Dimmer Switch Function to Headlamp HI Beams
6	590 (DB/W)	Wiper Switch Windshield Washer Function to Wiper Control Module
7	196 (DB/O)	Fused Battery Feed to Flash-to-Pass Switch Function

Multi-Function Switch Connector, Ranger

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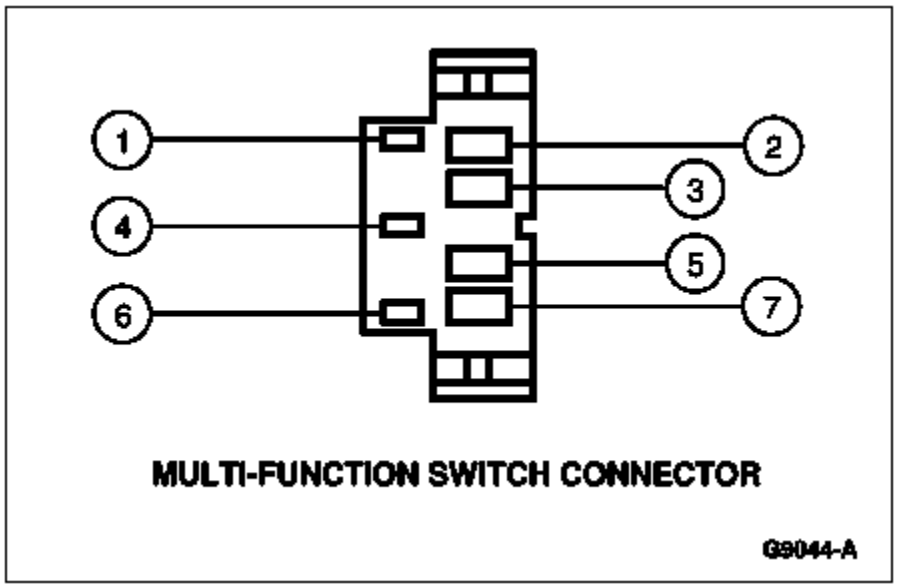

Pin Number	Circuit	Circuit Function
1	684 (PK/Y)	Front Wiper Switch Mode Select to GEM Input
2	15 (R/Y)	Headlamp Dimmer Switch Feed
3	13 (R/BK)	Headlamp Dimmer Switch to Low Beams
4	359 (GY/R)	Front Wiper Switch Delay/Washer to GEM — Signal Return
5	632 (GY/O)	Dimmer Switch to High Beam Headlamp Fuse
6	680 (LB/O)	Front Wiper Switch Delay/Washer to GEM — Input
7	196 (DB/O)	Headlamp Flash-to-Pass Switch Feed

Multi-Function Switch Connector, Aerostar

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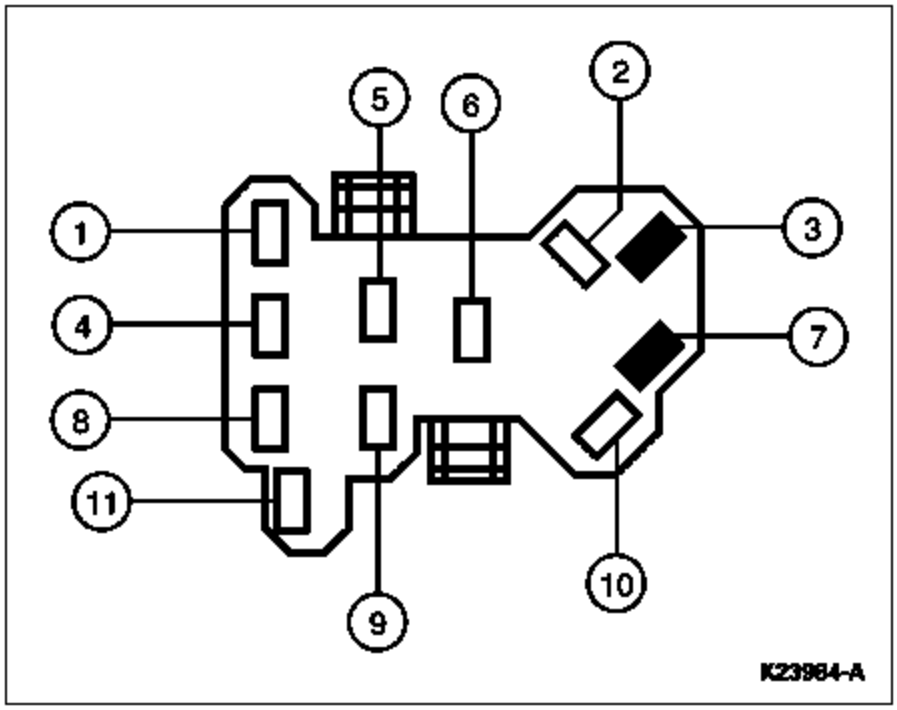

Pin Number	Circuit	Circuit Function
1	298 (P/O)	Fused Battery Feed (Hot in Run)
2	64 (DG)	To Trailer Right Turn/Stoplamp Fuse (If Equipped)
3	—	Not Used
4	383 (R/W)	Fused Battery Feed (Hot at All Times)
5	2 (W/LB)	Turn Signal Lamps (RH)
6	44 (LB)	Flasher Feed to Turn Signal Switch
7	—	Not Used
8	3 (LG/W)	Turn Signal Lamps (LH)
9	810 (R/LG)	Brake On/Off (BOO) Switch Feed
10	52 (Y)	To Trailer Left Turn/Stoplamp Fuse (If Equipped)
11	385 (W/R)	Battery Feed to Electronic Flasher

Multi-Function Switch Connector, Ranger

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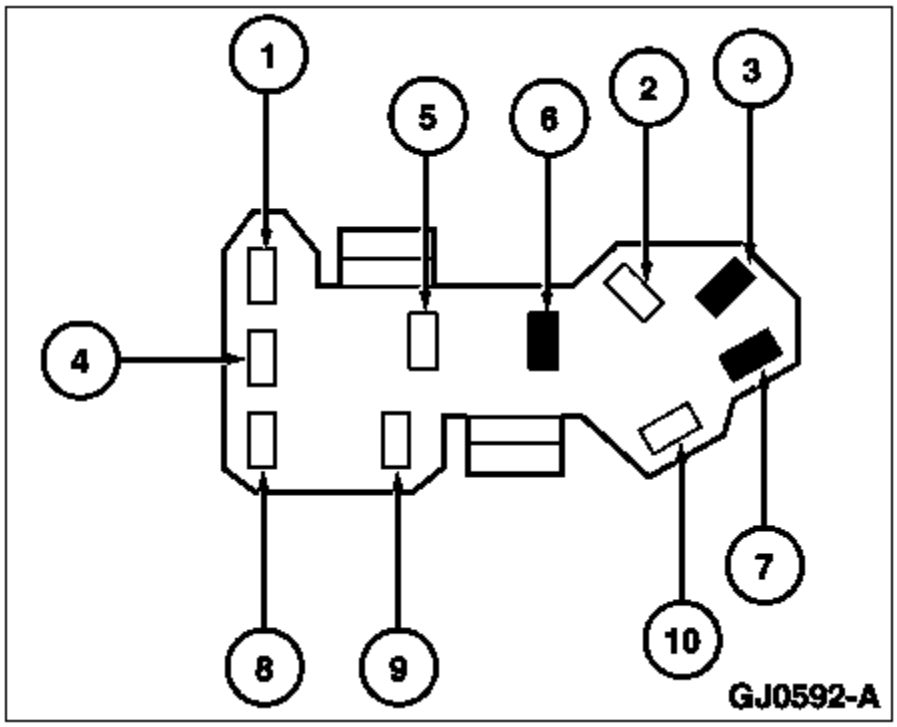

Pin Number	Circuit	Circuit Function
1	44 (LB)	Turn Signal Flasher to Turn Signal Switch
2	378 (BR/Y)	Turn Signal Switch to Right Trailer Park/Turn Relay (If Equipped)
3	—	Not Used
4	385 (W/R)	Flasher to Emergency Warning Switch
5	2 (W/LB)	Turn Signal Lamps (RH)
6	—	Not Used
7	—	Not Used
8	3 (LG/W)	Turn Signal Lamps (LH)
9	511 (LG)	Brake On/Off (BOO) Switch to Turn Signal Switch
10	374 (DB/W)	Turn Signal Switch to Left Trailer Park/Turn Relay (If Equipped)

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Symptom Chart — Ignition Switch Electrical Diagnosis

NOTE: Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent to perform electrical pinpoint tests.

IGNITION SWITCH ELECTRICAL DIAGNOSIS

Condition	Possible Source	Action
• Ignition Switch Inoperative	• Main fuse in power distribution box is blown. • Short circuit in wiring.	• GO to Pinpoint Test A.
• No Power in ACC or RUN Position	• Fuse blown in I/P fuse panel. • Internal open circuit in ignition switch.	• GO to Pinpoint Test B.
• No Power in Start Position	• Fuses blown in I/P fuse panel. • Internal open circuit in ignition switch.	• GO to Pinpoint Test C.
• Multi-Function Switch Does Not Operate	• Turn signal cancel cam damaged. • Damaged hazard switch. • Damaged high beam and flash-to-pass switch. • Damaged wiper switch.	• GO to Pinpoint Test D.

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Pinpoint Tests

PINPOINT TEST A: IGNITION SWITCH INOPERATIVE

A1 CHECK CIRCUIT PROTECTION

- On Aerostar vehicles, check for open fuse link B. On Ranger vehicles, check for open fuse 1 in power distribution box.

Is fuse link/fuse OK?

Yes	No
GO to **A2** .	REPLACE fuse link/fuse. REPEAT **A1** .

A2 CHECK POWER FEED

- Locate and disconnect the ignition switch connector.
- Measure the voltage between Circuit 37 (Y) on the wiring harness side and a known good ground.

Is the voltage 10 volts or greater?

Yes	No
REPLACE ignition switch.	REPAIR open in Circuit 37.

PINPOINT TEST B: NO POWER IN ACC OR RUN POSITION

B1 IGNITION SWITCH CONTINUITY CHECK

- Check ignition switch continuity. Refer to Component Tests in this section.

Did ignition switch pass continuity check?

Yes	No
REPAIR open in circuit from ignition switch to affected components.	REPLACE ignition switch.

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PINPOINT TEST C: NO POWER IN START POSITION

C1 CIRCUIT PROTECTION

- If vehicle is an Aerostar, go to C2 .
- On Ranger, check fuse 15 in instrument panel fuse panel.

Is fuse OK?

Yes	No
GO to **C2** .	REPLACE fuse. If fuse opens again, REPAIR short to ground in Circuit 32.

C2 STARTER CIRCUIT FROM IGNITION SWITCH

- While holding ignition switch in START position, check for battery voltage at ST Circuit 33 (W/PK Aerostar; R/LB Ranger).

Is battery voltage present?

Yes	No
REFER to starter system diagnosis in Section 03-06 .	REPLACE ignition switch.

PINPOINT TEST D: MULTI-FUNCTION SWITCH DOES NOT OPERATE

D1 CHECK TURN SIGNAL LEVER POSITIONS

- Turn ignition switch to RUN position.
- Check turn signal lever in the RH and LH turn positions with steering wheel locked in the straight-ahead position. Lock the lever in position for each.
- Check lever by slightly holding it in the RH and LH turn positions. When releasing, observe whether lever springs back to normal position.
- Road test vehicle and observe turn signals for RH and LH turn positions while manually turning steering wheel for each position. Verify lever cancels when steering returns from desired turn position.

Does turn signal lever operate properly?

Yes	No
GO to **D2** .	If lever will not cancel, CHECK steering wheel cancel cam for damage. If lever is worn or damaged, REPLACE multi-function switch.

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D2 CHECK HAZARD SWITCH

- Fully press hazard switch and release to turn on warning lamps. Verify switch operation. Fully press switch and release to turn off warning lamps. Verify switch operation.

Does hazard switch operate properly?

Yes	No
GO to **D3** .	If switch is worn or damaged, REPLACE.

D3 CHECK HIGH BEAM AND FLASH-TO-PASS

- Turn on headlamp bulbs.
- Press multi-function switch lever toward instrument panel to STOP position. Release lever. Verify high beams.
- Move lever back toward seat. Release lever. Verify low beams.
- Pull lever toward driver seat gently to flash-to-pass. Hold position. Verify both high and low beams are on. Release lever. Verify low beams.
- Turn off headlamp bulbs.
- Pull lever to flash-to-pass again and hold. Verify high beams come on. Release lever. Verify headlamp bulbs are off.

Does high beam, low beam and flash-to-pass operate?

Yes	No
GO to **D4** .	If lever is worn or damaged, REPLACE multi-function switch. If lamps are not lighting properly, CHECK lamps and lamp circuitry.

D4 CHECK WINDSHIELD WIPER AND WASH

- Rotate windshield wiper switch to low, high and interval positions. Verify rotation of switch and wiper operation. Turn switch to OFF position. Verify that switch rotates to OFF and wipers stop operation.
- Push the end of the switch in toward center of steering column to WASH position. Release WASH position. Verify wipers operate for a few wipes and return to OFF.
- Operate WASH in all speeds of wiper switch. Verify wipers return to selected speed after releasing from WASH position.

Does the windshield wiper switch and WASH operate properly?

Yes	No
Multi-function switch operates.	If switch or lever is worn or damaged, REPLACE multi-function switch.

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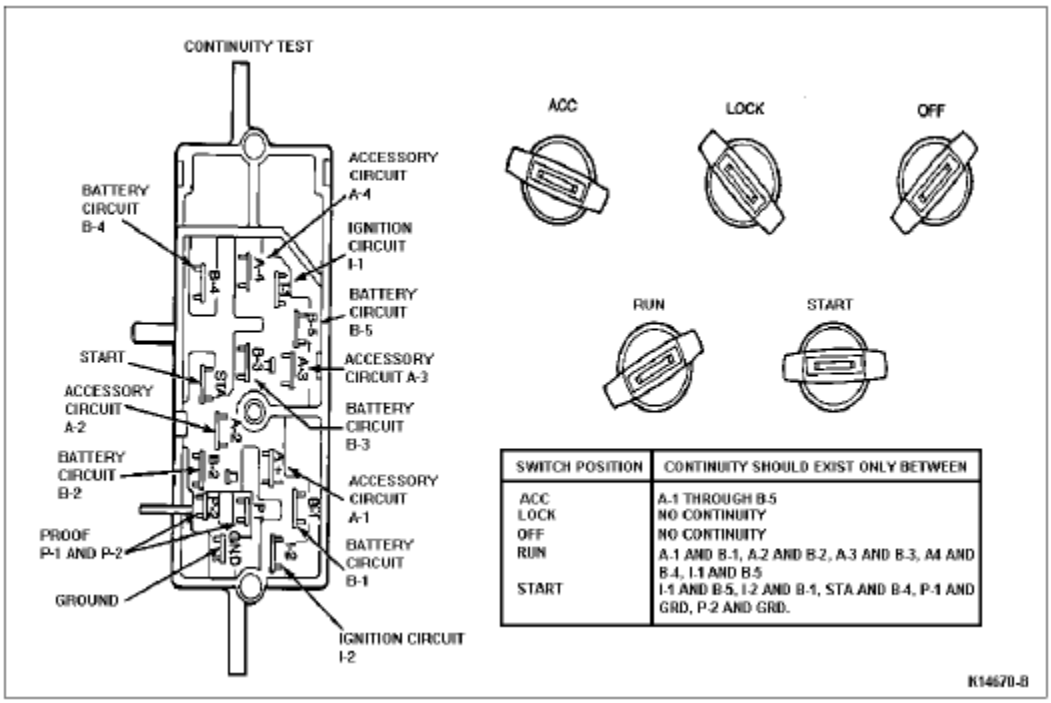
Component Tests

Ignition Switch Continuity Test

Disconnect the multiple connector from the ignition switch (11572). Test the ignition switch continuity as described in the following illustration. Connect a continuity tester or ohmmeter, such as Rotunda 73 Digital Multimeter 105-R0051 or equivalent, between the blade terminals indicated on the chart in the illustration.

For an "engine won't crank" condition, determine if the condition exists with the vehicle in the park and neutral position, (automatic transmission) or with the clutch pedal depressed (manual transmission). If the "no-crank" condition continues to occur, the transmission range sensor (automatic) or the clutch pedal position switch (CPP) (11A152) (manual) may be at fault.

Ignition Switch Continuity Test, Ranger and Aerostar



SWITCH POSITION	CONTINUITY SHOULD EXIST ONLY BETWEEN
ACC	A-1 THROUGH B-5
LOCK	NO CONTINUITY
OFF	NO CONTINUITY
RUN	A-1 AND B-1, A-2 AND B-2, A-3 AND B-3, A-4 AND B-4, I-1 AND B-5
START	I-1 AND B-5, I-2 AND B-1, STA AND B-4, P-1 AND GRD, P-2 AND GRD.

Ignition Switch Mechanical Test, Ranger and Aerostar

Test the mechanical operation of ignition switch by rotating ignition switch lock cylinder through all switch positions. The movement should feel smooth with no sticking or binding. The ignition switch should return from the START position back to the RUN position without assistance (spring return). If sticking or binding is encountered, check for the following:

- Burrs on the lock cylinder key

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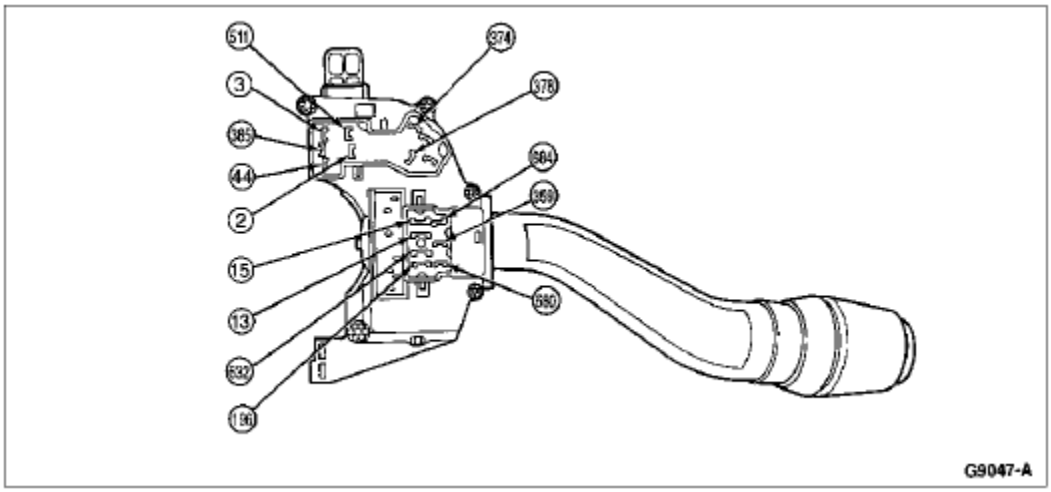
- Binding lock cylinder
- Shroud rubbing against lock cylinder
- Burrs or foreign material around the rack-and-pinion actuator in the lock cylinder housing
- Insufficient lube on actuator. (DO NOT apply lubricant to the inside of ignition switch)
- Binding ignition switch

Multi-Function Switch Continuity Test

Testing for electrical malfunctions can be accomplished using a continuity tester or ohmmeter such as Rotunda 73 Digital Multimeter 105-R0051, or equivalent.

Prior to testing, make sure hazard knob is pushed in fully to the OFF position. Disconnect the connector from the multi-function switch (13K359) and perform the following continuity checks.

Multi-Function Switch, Ranger



Circuit No.	Description
2	Turn Signal Lamps (RH)
3	Turn Signal Lamps (LH)
378	Trailer Park/Turn Relay (If Equipped) (RH)
374	Trailer Park/Turn Relay (If Equipped) (LH)
44	Turn Signal Flasher Feed
385	Hazard Feed
511	Brake Feed
632	High Beam
13	Low Beam
15	Lighting Switch Feed
196	Flash-to-Pass Feed

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W1 (359)	Wiper Return/Common
W2 (680)	Wiper Delay Signal
W3 (689)	Wiper Mode Signal

Continuity Checks, Ranger Switches

To Test	Connect Self-Powered Test Lamp or Ohmmeter to Terminals	Move Switch to These Positions	A Good Switch Will Indicate
Stoplamp Feed-Through Circuit	511 (LG) and 374 (DB/W)	Turn Switch to Center (No Turn) Position	Closed Circuit
	511 (LG) and 378 (BR/Y)	Turn Switch to Center (No Turn) Position	Closed Circuit
Turn Switch Circuit	44 (LB) and 374 (DB/W)	Turn Switch to Turn Left and Hazard Switch to Normal	Closed Circuit
	44 (LB) and 3 (LG/W)	Turn Left	Closed Circuit
	44 (LB) and 5 (O/LB)	Turn Right	Closed Circuit
	44 (LB) and 2 (W/LB)	Turn Right	Closed Circuit
Hazard Switch Circuit	385 (W/R) and 511 (LG) (Rear Lamps)	Hazard	Closed Circuit
	385 (W/R) and 2 (W/LB) (RH Front Lamps)	Hazard	Closed Circuit
	385 (W/R) and 3 (LG/W) (LH Front Lamps)	Hazard	Closed Circuit
Dimmer Switch Circuit	15 (R/Y) and 12 (LG/BK)	Pull Up and Release	Closed Circuit Only When Switch Is in HI Position
	15 (R/Y) and 13 (R/BK)	Pull Up and Release	Closed Circuit Only When Switch Is in LO Position
Flash-to-Pass	196 (DB/O) and 632 (GY/O) - 15 (R/Y) and 13 (R/BK)	Lever Stalk Pull and Hold Toward Steering Wheel	Closed Circuit
Hi Beam	15 (R/Y) and 632 (GY/O)	Lever Stalk Away from Steering Wheel	Closed Circuit
Lo Beam	15 (R/Y) and 13 (R/BK)	Lever Stalk in Detent Closest to Steering Wheel	Closed Circuit
Washer Switch Circuit	680 (LB/O) and 359 (GY/R)	With Wiper Switch OFF: Push Washer Switch in; Release Washer Switch	Closed Circuit 103.3k Ohm
Wiper Switch Circuit	684 (PK/Y) and 359 (GY/R)	OFF INT LO	47.6k Ohm 11.33k Ohm 4.08k Ohm

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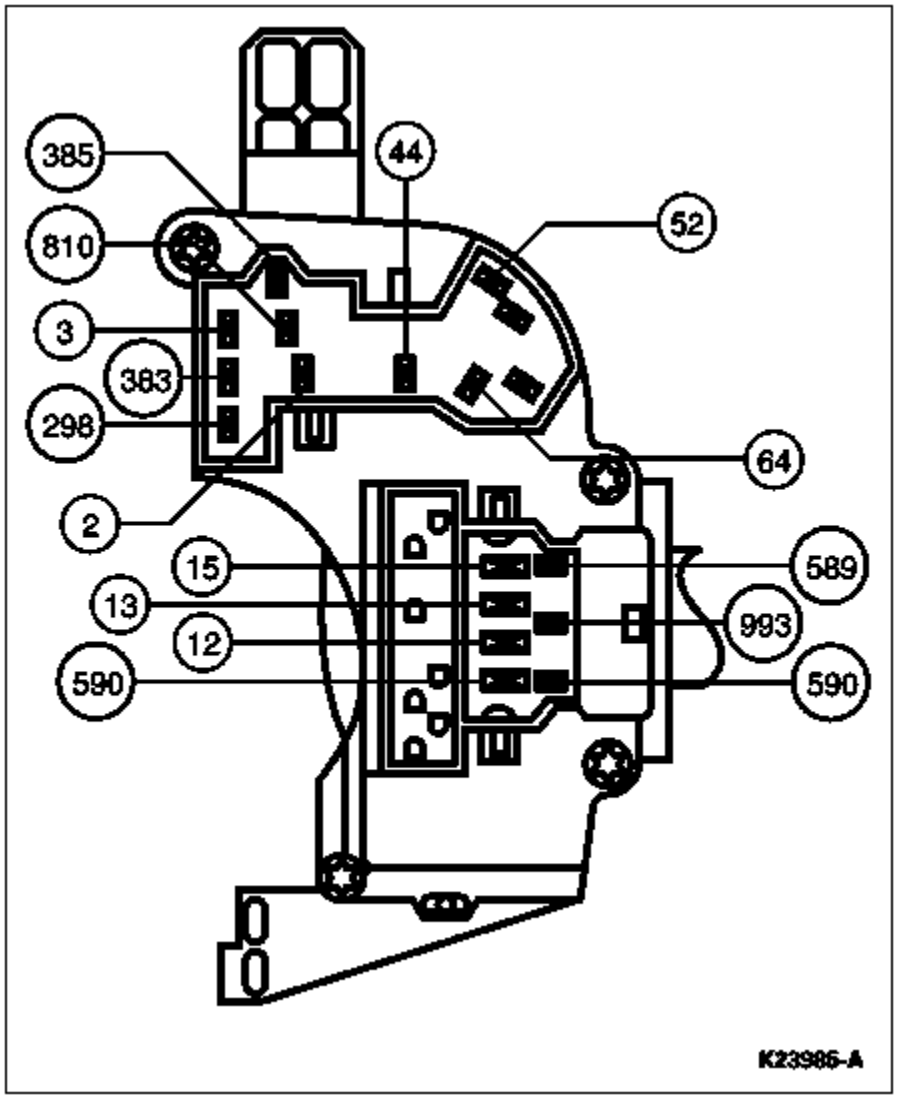
		HI	Closed Circuit
Interval Time Adjust	680 (LB/O) and 359 (GY/R)	INT and OFF	Rotate Control Toward OFF; Ohmmeter Will Show Smoothly Increasing Resistance from 3.3k Ohm Minimum to 103.3k Ohm Maximum
		LO and HI	3.3k ohm

Multi-Function Switch, Aerostar



Circuit No.	Description
2	Turn Signal Lamps (RH)
3	Turn Signal Lamps (LH)
12	Dimmer to HI Beams

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13	Dimmer to LO Beams
15	Battery Feed (Dimmer Switch)
44	Feed from Flasher
52	LH Trailer Fuse (If Equipped)
64	RH Trailer Fuse (If Equipped)
196	Battery Feed (Flash-to-Pass)
298	Battery Feed (Turn Signal Switch)
383	Battery Feed (Turn Signal Switch)
385	Feed to Flasher
589	Output to Wiper Control Module
590	Output to Wiper Control Module
810	Feed from Brake Switch
993	Reference Voltage from Wiper Control Module

Continuity Checks, Aerostar Switches

To Test	Connect Self-Powered Test Lamp or Ohmmeter to Terminals	Move Switch to These Positions	A Good Switch Will Indicate
Stoplamp Feed-Through Circuit	810 (R/LG) and 52 (Y), 3 (LG/W)	Turn Switch to Neutral (No Turn), and Hazard Switch to OFF	Closed Circuit
	810 (R/LG) and 64 (DG) 2 (W/LB)	Turn Switch to Neutral (No Turn), and Hazard Switch to OFF	Closed Circuit
Turn Switch Circuit	44 (LB) and 52 (Y), 44 (LB) and 3 (LG/W)	Turn Switch to Turn Left and Hazard Switch to OFF	Close Circuit
	44 (LB) and 62 (DG), 44 (LB) and 2 (W/LB)	Turn Switch to Turn Right and Hazard Switch to OFF	Closed Circuit
Hazard Switch Circuit	44 (LB) and 52 (Y), 64 (DG) - 383 (R/W) and 385 (W/R)	Hazard Switch On (Button Depressed Then Released to Full Out Position)	Closed Circuit
	298 (P/O) and 385 (W/R)	Hazard Switch OFF	Closed Circuit
Flash-to-Pass	196 (DB/O) and 12 (LG/BK) - 15 (R/Y) and 13 (R/BK)	Lever Stalk Pull and Hold Toward Steering Wheel	Closed Circuit
Hi Beam	15 (R/Y) and 12 (LG/BK)	Lever Stalk Away from Steering Wheel	Closed Circuit
Lo Beam	15 (R/Y) and 13 (R/BK)	Lever Stalk in Detent Closest to Steering	Closed Circuit

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		Wheel	
Washer Switch Circuit	590 (DB/W) and 993 (BR/W)	With Wiper Switch OFF; Push Washer Switch in; Release Washer Switch	Closed Circuit 103.3k Ohm
Wiper Switch Circuit	589 (O) and 993 (BR/W)	OFF INT LO HI	47.6k Ohm 11.33k Ohm 4.08k Ohm Closed Circuit
Internal Time Adjust	590 (DB/W) and 993 (BR/W) LO and HI	INT and OFF 3.3k Ohm	Rotate Control Toward OFF; Ohmmeter Will Show Smoothly Increasing Resistance from 3.3k Ohm Min. to 103.3k Ohm Max.

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Multi-Function Switch

NOTE: Wiring for the multi-function switch (13K359) is routed under the PRNDL cable.

Removal

1. Disconnect battery ground cable (14301).
2. Remove the steering column shroud as described in Section 11-04B or Section 11-04A .
3. Remove two screws attaching the multi-function switch to the steering column casting. Disengage multi-function switch from casting.
4. On Ranger, disconnect the three electrical connectors, using caution not to damage the locking tabs. Do not damage the PRNDL cable. On Aerostar, disconnect the two electrical connections. Do not damage locking tabs.

Installation

1. On Ranger, install the three switch electrical connectors to full engagement. On Aerostar, install the two electrical connectors to full engagement.
2. Align the multi-function switch mounting holes with the holes in the steering column casting.
3. Install two self-tapping screws making sure to start the screws in the previously tapped holes. Tighten to 2-3 Nm (18-27 lb-in).
4. For automatic transmission, verify that the PRNDL adjustment is correct.
5. Install the steering column shroud as described in Section 11-04B or Section 11-04A .
6. Connect the battery ground cable.
7. Check the steering column for proper operation.

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Ignition Switch

Ranger/Aerostar

1. Disconnect battery negative cable.
2. Remove attaching screws (2) and instrument panel steering column cover.
3. Remove attaching screws (4) and instrument panel reinforcement plate.
4. If equipped with an automatic transmission, remove PRND12 indicator cable attaching screw.
5. Remove steering column to brake pedal support bracket attaching screws (2).
6. Lower column until steering wheel rests on driver's seat.
7. Remove ignition switch attaching screws.
8. Disconnect wiring and remove ignition switch.

To install ignition switch, reverse removal procedure.

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Flasher, Indicator

NOTE: When replacing the indicator flasher, make sure to install one having the same color-code and number as the one removed.

NOTE: Do not replace multi-function switch or wiring if:

- Turn signal lamps do not flash on demand with ignition key turned on, or
- Indicator flasher makes normal pulsing noise, or
- Turn signal lamps prove satisfactory when bench-tested or checked by activating brake stoplamp switch for rear only.

Removal and Installation

To remove the indicator flasher, grasp indicator flasher and pull straight out. To replace flasher, align indicator flasher terminals to connector and push straight in.

1. Check the power at indicator flasher output terminal (pulsing noise indicates power is coming into the indicator flasher).

2. If there is **no or very weak power** at the indicator flasher output terminal (12-volt test lamp will not light or is dim), **replace the indicator flasher.**

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Brake-Shift Interlock Switch

Removal

1. Remove steering column as described in Section 11-04A or Section 11-04B .
2. Unclip wire terminal from solenoid.
3. Remove insert plate and solenoid by removing three retaining screws.
4. Pry off clip.

Installation

NOTE: The clip which retains the solenoid to the insert plate should not be replaced for service. The clip's sole purpose is an assembly aid for the assembly plant.

1. Position insert plate/solenoid assembly to the steering column and tighten the screws.
2. Install the steering column in the vehicle as described in Section 11-04A or Section 11-04B .

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Ignition Switch

1. Install ignition switch (11572).
2. Align pin from switch with slot in lock/column assembly.
3. Position slot in lock/column assembly with index mark on casting. Ignition switch should be in RUN position.
4. Tighten two screws to 5.3-7.2 Nm (50-63 lb-in).

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SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-In
Multi-Function Switch Screws	2-3	18-27
Wire Shield Screws		
Aerostar	1.2-1.8	11-15
Ranger	1.8-2.6	15.9-23
Ignition Switch Connector Screw	0.8-1.2	7.1-10.6
Brake-Shift Interlock Switch Plate/Solenoid Screws	1.8-2.6	15.9-23
Ignition Switch	5.3-7.2	50-63

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Climate Control System

This section provides some basic principles and covers some of the service procedures which apply to all compact truck air conditioning systems. In sequence, the text deals with principles, diagnosis and testing procedures, and finally those unique procedures that apply to servicing the refrigerant system.

Immediately following coverage of basic principles, the text provides a diagram of the major components in a refrigerant system. The text continues after the diagram with a detailed description of each major component.

Automotive air conditioning is a process which uses an electro-mechanical system to apply those scientific principles which work together to produce a desirable comfort level in the passenger compartment of a vehicle. These principles are Heat Transfer, Latent Heat of Vaporization, the Effects of Pressure and Temperature Changes and the effects of Relative Humidity. The text which follows highlights the content of these principles.

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Heat Transfer

If two substances of different temperature are placed near each other, the heat in the warmer substance will always travel to the colder substance until both are of equal temperature. For example, a cake of ice in an ice box does not communicate its coldness to the bottle of milk standing nearby. Rather, the heat in the warm milk automatically flows into the ice.

To determine the amount of heat that transfers from one substance to another, we use the British Thermal Unit or BTU. One BTU is the amount of heat required to raise the temperature of one pound of water -17.2° C (1℉). For example, to raise the temperature of o ne pound of water from 0℃ (32℉) to 100°C (212℉) , one BTU of heat must be added for each degree rise in temperature or a total of 180 BTUs of heat. Conversely, in order to lower the temperature of one pound of water from 100°C (212℉) to 0℃ (32°F) , 180 BTUs of heat must be removed from the water.

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Latent Heat of Vaporization

When a liquid boils (changes to a gas) it absorbs heat without raising the temperature of the resulting gas. When the gas condenses (changes back to a liquid) it gives off heat without lowering the temperature of the resulting liquid.

For example, place one pound of water at 0°C (32°F) in a container over a flame. With each BTU of heat that the water absorbs from the flame, its temperature rises -17.2°C (1°F). Thus, after it has absorbed 180 BTUs of heat, the water reaches a temperature of 100°C (212°F). Even though the flame continues to give its heat to the water, the temperature of the water remains at 100°C (212°F). The water, however, starts to boil or change from the liquid to the gaseous state. It continues to boil until the water has passed off into the atmosphere as vapor. If this vapor were checked with a thermometer, it also would show a temperature of 100°C (212°F). In other words, there was a rise of only 82.2°C (180°F) [from 0-100 (from 32 to 212)] in the water and vapor temperature even though the flame applied many more than 180 BTUs of heat. In this case, the heat is absorbed by the liquid in the process of boiling and disappears in the vapor. If the vapor were brought in contact with cool air, the hidden heat would flow into the cooler air as the vapor condensed back to water. Scientists refer to this natural law as the latent (hidden) heat of vaporization.

Water has a latent heat of vaporization of 970 BTUs and a boiling point of 100°C (212°F). This means that one pound of water at 100°C (212°F) will absorb 970 BTU's of heat in changing to vapor at 100°C (212°F). Conversely, the vapor will give off 970 BTUs of heat in condensing back to water at 100°C (212°F).

This tremendous heat transfer that occurs when a liquid boils or a vapor condenses forms the basic principle of all conventional refrigeration systems.

For a liquid to be a refrigerant, it must also have a low boiling point. That is, the temperature at which it boils must be lower than the substance to be cooled. Refrigerant-134a is the liquid most commonly used in automotive air conditioning systems because in an open container it boils at -26.2°C (-15.1°F). Here is a liquid that boils or vaporizes well below passenger compartment temperatures and, in vaporizing, will absorb tremendous amounts of heat without getting any warmer itself.

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Effect of Pressure on Boiling or Condensation

As refrigerant passes through an air conditioning system, it flows under high-pressure conditions, first as a high-pressure vapor between the compressor and A/C condenser core (19712), then, as a high-pressure liquid between the A/C condenser core and the A/C evaporator core orifice (19D990). It is converted to a low-pressure system between the A/C evaporator core orifice and the refrigerant return port in the A/C compressor (19703). As pressures in the closed refrigerant circuit vary, temperatures will also vary. As pressures increase, temperatures also increase; as they decrease, temperatures also decrease.

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Safety Precautions

The refrigerant R-134a is a hydrofluorocarbon refrigerant. R-134a is noncorrosive, nonexplosive, nonflammable and has a slight ether-like odor. R-134a is heavier than air. Although it is classified as a safe refrigerant, certain precautions must be observed to protect the parts involved and the person working on the unit.

Use only R-134a refrigerant. Due to environmental concerns, when the air conditioning system is drained, the refrigerant must be collected using refrigerant recovery/recycling equipment. R-134a must never be removed without the appropriate equipment or released into the atmosphere. Use of a recovery machine dedicated for R-134a is necessary to reduce the possibility of oil and refrigerant incompatibility concerns. Refer to the instructions provided by the equipment manufacturer when removing refrigerant from or charging the air conditioning system.

Avoid breathing A/C refrigerant and lubricant vapor or mist. If accidental system discharge occurs, ventilate the work area before resuming service.

Liquid R-134a, at normal atmospheric pressures and temperatures, evaporates so quickly that it has the tendency to freeze anything it contacts. For this reason, **be very careful to prevent any liquid refrigerant from coming in contact with the skin and especially the eyes. Should any liquid refrigerant get into the eyes or on the skin, immediately flush eyes and skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Call a physician.**

Refrigerant R-134a is always under pressure. Because the system is tightly sealed, heat applied to any part could cause this pressure to build up excessively. **To avoid a dangerous explosion, keep away from open flames, glowing metal surfaces, blow torch, steam cleaning and welding.**

Make sure that containers are never heated to over 52°C (125°F). Containers should be stored and installed in accordance with all state and local ordinances.

When admitting R-134a into the refrigerant system, always keep the tank in an upright position. If the tank is on its side or upside down, liquid R-134a will enter the system and may damage the compressor.

Refrigerant R-134a should not be mixed with air for leak testing or used with air for any other purpose above atmospheric pressure. R-134a is combustible when mixed with high concentrations of air and higher pressures.

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Service Precautions

Observe the following service precautions.

1. Never open or loosen a connection before discharging the system.
2. When loosening a connection, if any residual pressure is evident, allow it to leak off before opening the fitting.
3. Evacuate a system which has been opened to replace a component or one which has discharged through leakage before charging.
4. Seal open fittings with a cap or plug immediately after disconnecting a component from the system.
5. Clean the outside of the fittings thoroughly before disconnecting a component from the system.
6. Do not remove the sealing caps from a replacement component until ready to install.
7. Refrigerant oil will absorb moisture from the atmosphere if left uncapped. Do not open an oil container until ready to use and install the cap immediately after using. Store the oil only in a clean, moisture-free container.
8. Install a new seal ring before connecting an open fitting. Coat the fitting and seal with refrigerant oil before connecting.
9. When installing a refrigerant line, avoid sharp bends. Position the line away from the exhaust or any sharp edges which may chafe the line.
10. Tighten fittings only to specifications. The steel and aluminum fittings used in the refrigeration system will not tolerate over-tightening.
11. When disconnecting a fitting, use a wrench on both halves of the fitting to prevent twisting of the refrigerant lines or tubes.
12. Do not open a refrigerant system or uncap a replacement component unless it is as close as possible to room temperature. This will prevent condensation from forming inside a component which is cooler than the surrounding air.
13. Keep service tools and the work area clean to avoid contamination of a refrigerant system.

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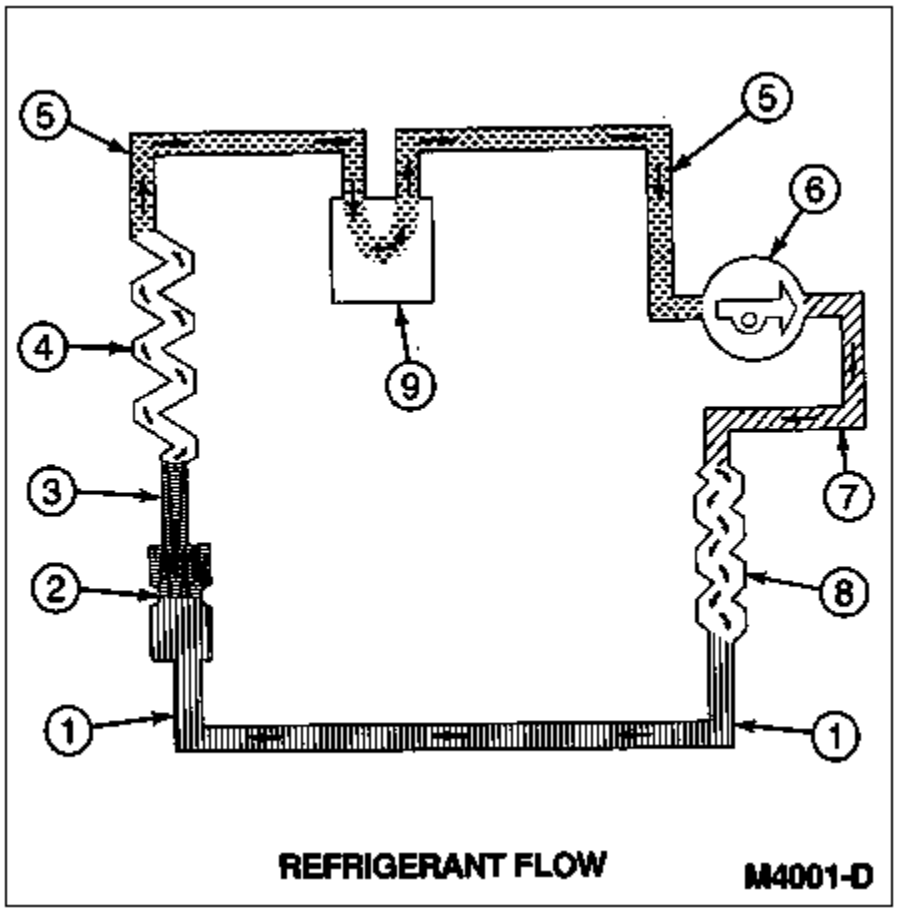
A/C Refrigerant System Operation

Refrigerant Flow

During stabilized conditions (air conditioning system shutdown), refrigerant system pressures are equalized on both the high and low pressure sides of the system.

When the blower motor (18527) is on and the function selector lever is in any air conditioner position, the A/C clutch field coil (2987) is energized and the clutch plate is pulled into contact with the compressor clutch pulley. The clutch plate and hub assembly then rotates the compressor shaft.

When the compressor shaft is rotated, the pistons are alternately moved back and forth with respect to their cylinder bores. As each piston is pulled through its cylinder bore, the pressure in the cylinder suddenly reduces to a pressure (or vacuum) considerably lower than the refrigerant vapor pressure on the suction side of the refrigerant system. The higher refrigerant system vapor pressure overcomes the suction reed valve spring pressure, forcing itself through the reed valve and into the lower pressure (or vacuum) area inside the compressor cylinder. The spring pressure on the reed valve closes the valve when the refrigerant system suction vapor pressure and the compressor cylinder vapor pressure are equalized.



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Item	Part Number	Description
1	—	High Pressure Liquid
2	19D990	A/C Evaporator Core Orifice (Creates Restriction)
3	—	Low Pressure Liquid
4	19860	A/C Evaporator Core
5	—	Low Pressure Vapor
6	19703	A/C Compressor
7	—	High Pressure Vapor
8	19712	A/C Condenser Core
9	19C836	Suction Accumulator/Drier

As each piston is forced into its respective cylinder bore, the refrigerant vapors from the suction side of the refrigerant system are compressed into a decreasingly smaller area, thus increasing the refrigerant vapor pressure and also raising the refrigerant vapor temperature. The higher refrigerant vapor pressure now assists in sealing the suction reed valve closed and also opens the discharge (high pressure) reed valve as the cylinder pressure exceeds the higher pressure side of the refrigerant system. When the compressed higher pressure and temperature refrigerant vapor is discharged into the high pressure side of the refrigerant system, the discharge reed valve spring pressure and the high side refrigerant pressure closes and seals the reed valve, thus preventing the discharge gas from entering the compressor cylinder. The compressor's refrigerant vapor compression cycle then begins again.

The high pressure and high temperature compressor discharge refrigerant gas is released into the top of the A/C condenser core (19712), via the compressor's discharge hose. The A/C condenser core, being close to ambient temperature, causes the refrigerant vapor to condense into a liquid when heat is removed from the refrigerant by ambient air passing over the fins and tubing of the A/C condenser core.

Liquid refrigerant from the A/C condenser core exits from the bottom of the A/C condenser core and enters the high pressure liquid line and then the inlet side of the A/C condenser core. The inlet filter screen of the A/C evaporator core orifice (19D990) removes coarse contaminant particulates, which may be present in the liquid refrigerant, before the liquid refrigerant enters the calibrated opening of the A/C evaporator core orifice. The outlet end of the A/C evaporator core orifice has a fine mesh filter with four open side slots in the body, upstream from the filter. This filter removes fine contaminants and causes some of the refrigerant to exit through the non-filtered side slots. The side slots and filter act as a refrigerant flow noise suppressor.

Pressure in the A/C evaporator core (19860) is reduced as a result of the restriction at the A/C evaporator core orifice. The pressure is lowered and the liquid refrigerant passes through the A/C evaporator core orifice and enters the A/C evaporator core at a low pressure and as a cold liquid. As airflow passes over the plate/fin sections of the A/C evaporator core, the refrigerant inside absorbs the heat and changes into a vapor.

Compressor suction draws the vaporized refrigerant and oil mixture into the suction accumulator/drier (19C836) where the heavier oil-laden vapors fall to the bottom and the lighter vapors and oil mixture continue their path to the A/C compressor (19703) via the top of the vapor return tube. A desiccant bag, located inside the suction accumulator/drier, absorbs and retains moisture which may be circulating in the refrigerant system. The heavier oil-laden refrigerant also returns to the A/C compressor through a small liquid bleed hole near the bottom of the vapor return tube. The liquid bleed hole provides a controlled second opportunity for the accumulated refrigerant and oil mixture to revaporize as it passes through the opening to re-enter into the main vapor flow path to the suction side of the A/C compressor.

As a general observation, it is known that the more heat there is in the air, the more moisture (water vapor) the air can hold. It is also known that warm air holding its maximum vapor content will, if it is chilled, condense and form drops of water. The temperature at which this condensation occurs is called the dew point. In percentage figures, the dew point is known as 100% relative humidity. Relative humidity can be

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defined as the measured percentage of moisture in a given sample of air compared with the maximum amount of moisture that the same sample of air can hold at the same temperature.

The direct effect of relative humidity on driver and passenger comfort is almost common knowledge. If the humidity is low, the air has the capacity to absorb moisture up to the point where it reaches its dew point. This capacity to absorb includes the perspiration produced by the body.

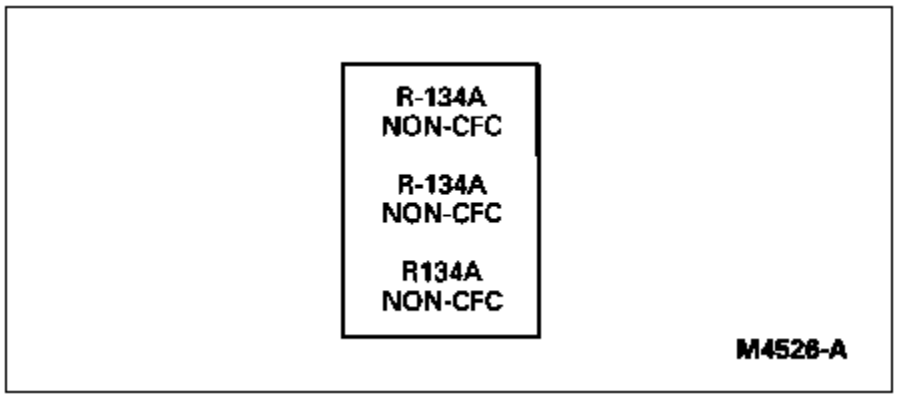
When the dew point is reached, absorption capacity no longer exists. As a result, body heat causes discomfort in the form of unabsorbed perspiration.

Air conditioning does two things to cope with the problems of high heat and humidity: (1) it cools the air to a comfortable level, and (2) it lowers the relative humidity to a comfortable percentage below the dew point.

Refrigerant Systems

All Ford Motor Company vehicles currently in production offer R-134a refrigerant systems.

The label stating A/C refrigerant use in the vehicle is attached in the engine compartment so the proper service procedure and equipment can be referenced in the service manual. An R-134a refrigerant system will have gold R-134a NON-CFC tags in addition to the refrigerant charge tag.



CAUTION: If a component has been used with R-12, it cannot be used again in an R-134a system. If used in an R-134a system, it cannot be put into an R-12 system. Contamination can occur and performance can be adversely affected because each system uses a different oil designed for that system.

Individual descriptions of the components shown are not provided in this section of the manual. They are covered in detail in Sections 12-03A and 12-03B. Detailed FS-10 compressor coverage is provided in Section 12-03D . Exceptions to these referrals are those parts and equipment which are most directly involved in the diagnosis of concerns, testing of system performance, and handling of refrigerant.

Refrigerant System Components

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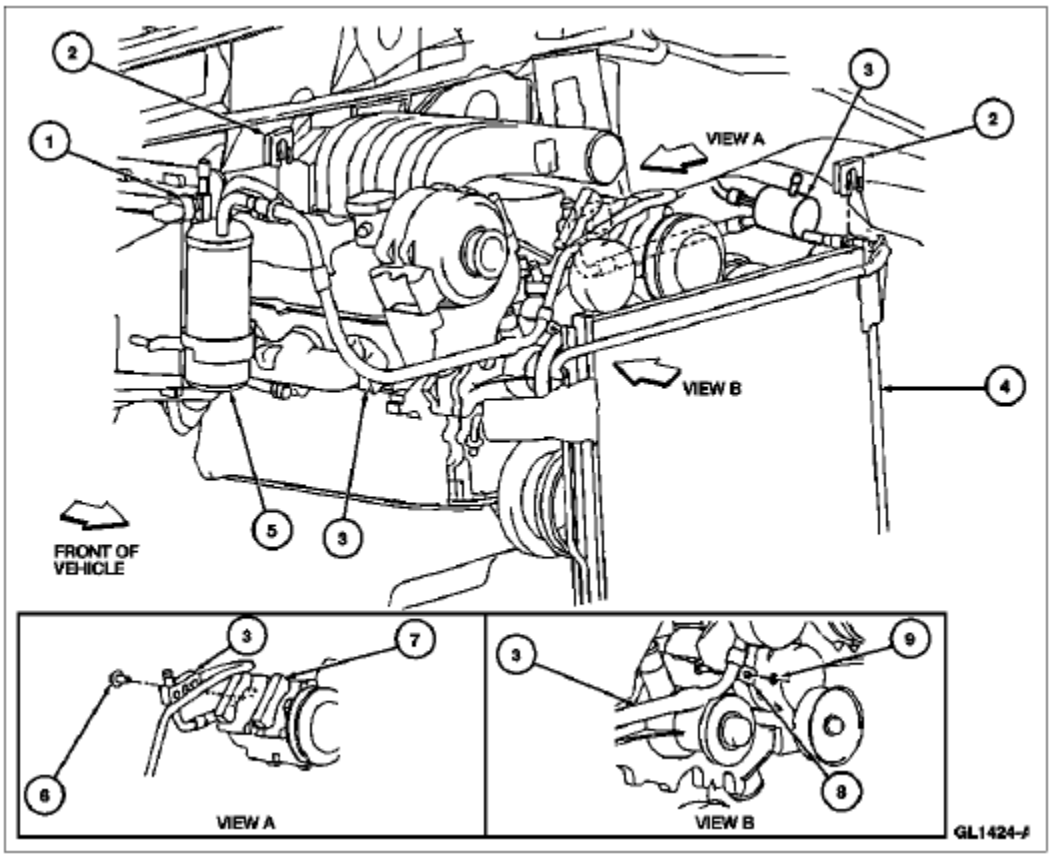

Item	Part Number	Description
1	19E561	A/C Cycling Switch
2	19E746	A/C Tube Lock Coupling Clip
3	19D734	A/C Manifold and Tube
4	19712	A/C Condenser Core
5	19C836	Suction Accumulator/Drier
6	—	Screw (Part of 19D629)
7	19703	A/C Compressor
8	—	A/C Hose Clamp (Part of 19D734)
9	N621940-S301	Nut

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A/C Compressor and A/C Clutch Assemblies

The FS-10 is a swash-plate design 10-cylinder aluminum compressor utilizing the tangential design of mount. The compressor mainshaft is driven by a belt from the engine crankshaft pulley. A one-piece lip-type seal (replaceable from the front of the compressor) is used to seal the A/C compressor (19703) at the shaft opening of the A/C compressor assembly. Five double-acting pistons, positioned axially around the compressor shaft, operate within the cylinder assembly. The pistons are actuated by a swash plate that is pressed on the compressor shaft. The swash plate changes the rotating action of the shaft to provide a reciprocating driving force to each of the five pistons. This driving force is applied, through shoes, to the midpoint of each of the double-ended pistons.

Reed-type discharge valves are assembled on the valve plate that is located with the suction reed valve between the cylinder assembly and the head at each end of the A/C compressor. The heads are connected to each other by gas-tight passageways through the cylinder assembly, that direct the refrigerant gas to the suction and discharge ports located in the rear head.

A magnetic clutch is used to drive the compressor shaft. When voltage is applied to the clutch field coil, the clutch plate and hub assembly (which is solidly coupled to the compressor shaft) is drawn rearward by magnetic force toward the pulley that rotates freely on the compressor front head casting. The magnetic force locks the clutch plate and hub assembly and the pulley together as one unit. The compressor shaft then turns with the pulley. When voltage is removed from the clutch field coil, springs in the clutch plate and hub assembly move the clutch plate away from the pulley. As a result, the clutch plate and hub assembly and the compressor shaft cease to rotate.

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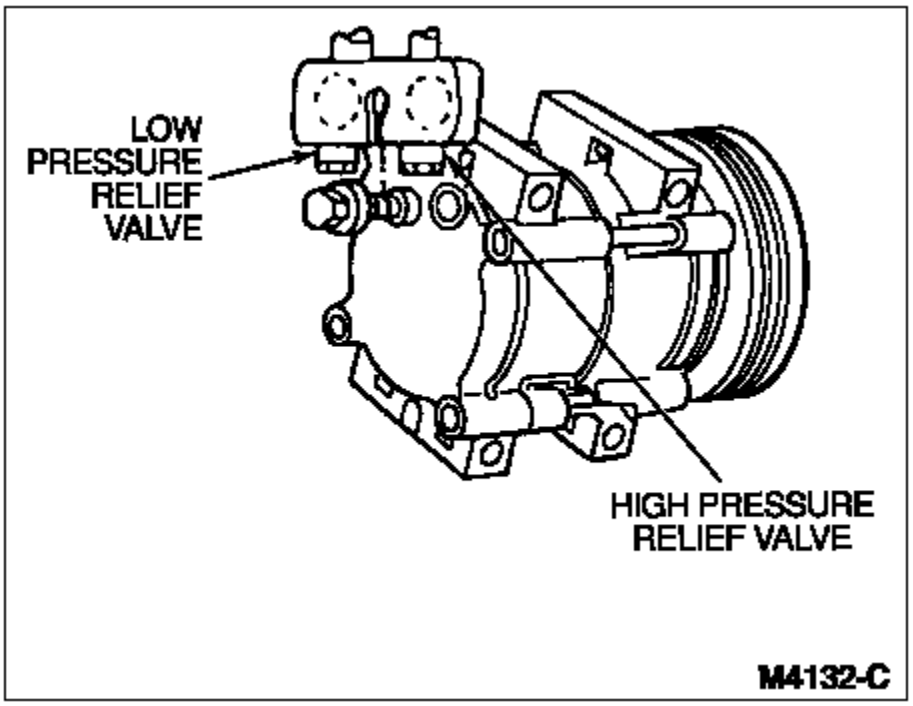
Refrigerant System Protection

A/C Compressor Pressure Relief Valve

Under extreme pressure conditions, the A/C compressor pressure relief valve (19D644) located in the discharge manifold at the top of the A/C compressor (19703), will momentarily open, allowing refrigerant vapor to escape. This relieves excessive pressure that might damage the A/C compressor. The A/C compressor pressure relief valve closes as soon as pressure is lower than the relief setting. This prevents loss of the complete refrigerant charge.



A/C Pressure Cutoff Switch

The A/C pressure cutoff switch is located in the discharge line between the A/C compressor and the A/C condenser core (19712). The A/C pressure cutoff switch has two sets of contacts. One electrical contact is normally closed.

- When compressor head pressure rises to approximately 3242 kPa (450 psi), the contacts open and the A/C compressor operation is shut off.
- When head pressure drops to approximately 1724 kPa (250 psi), the contacts again close and allow operation of the A/C compressor.
- Shutting down A/C compressor operation prior to the A/C compressor pressure relief valve set point 3103 kPa (450 psi) ensures containment of the refrigerant in the A/C system.

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A/C Condenser Core

The A/C condenser core (19712) is a component of the refrigerant system that removes heat from the system by transferring it to the outside air. This heat transfer takes place when the high-pressure vapor delivered by the A/C compressor (19703) to the A/C condenser core is changed by the condensation process to a high-pressure liquid as it leaves the A/C condenser core. It is important to remember that the amount of heat given up by the A/C condenser core will exactly match the amount of heat absorbed by the A/C evaporator core (19860).

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Spring Lock Coupling

A spring lock coupling is used to make some refrigerant line connections. The spring lock coupling is a refrigerant line coupling held together by a garter spring inside a circular cage. When the spring lock coupling is connected together, the flared end of the female fitting slips behind the garter spring inside the male fitting cage. The garter spring and cage then prevent the flared end of the female fitting from pulling out of the cage.

Two O-rings are used to seal between the two halves of the spring lock coupling. These O-rings are made of special material and must be replaced with an O-ring made of the same material. Use only the O-rings specified in the illustration.

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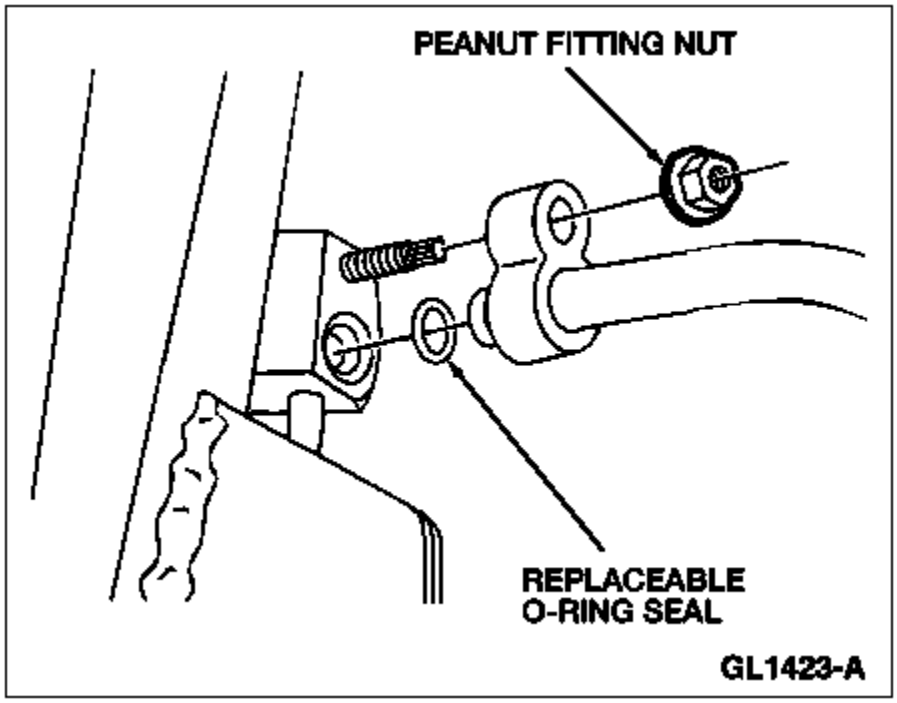
Peanut Fitting

The peanut fitting is used for refrigerant line coupling. a replaceable O-ring is housed inside. The fitting is retained by a nut and a replaceable stud.

Peanut Fitting



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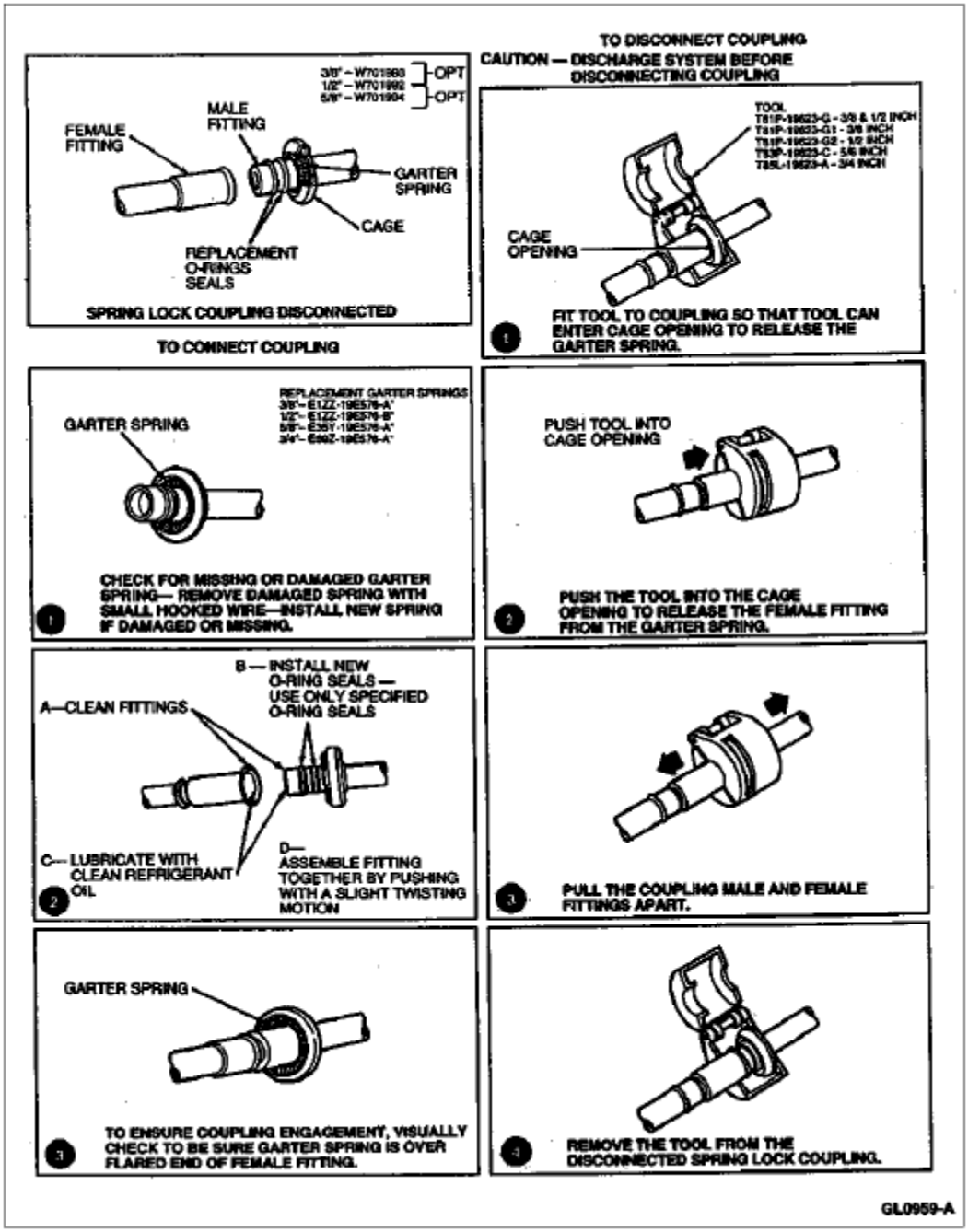

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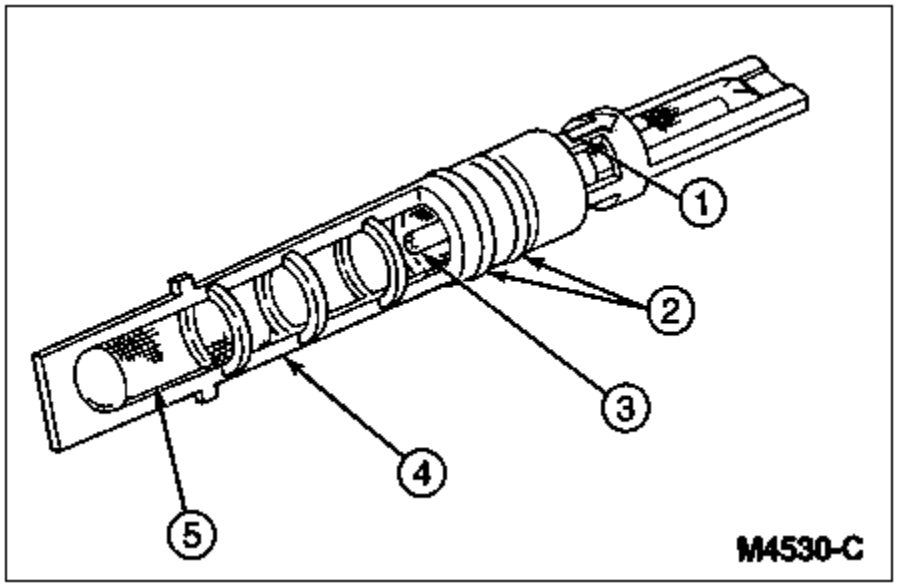
A/C Evaporator Core Orifice

The A/C evaporator core orifice (19D990) is located in the inlet tube and has filter screens on the inlet and outlet ends of the tube body. The filter screens act as strainers for the liquid refrigerant flowing through the fixed orifice opening. O-rings, on the tube body, prevent the high pressure liquid refrigerant from bypassing the orifice. Adjustment or repairs cannot be made to the A/C evaporator core orifice and it must be replaced as a unit.

The A/C evaporator core orifice is a restriction between the high and low pressure refrigerant and meters the flow of liquid refrigerant into the A/C evaporator core (19860). Temperature is controlled by sensing the pressure within the A/C evaporator core with an A/C cycling switch (19E561). The A/C cycling switch cycles the A/C compressor (19703) on or off as necessary to maintain the pressure within specified limits.



Item	Part Number	Description
1	—	Flow Direction
2	YF-1369	O-Rings (See Note)
3	—	Inside Diameter 0.067 Inch (Part of 19D990)
4	—	Color Code Blue (Part of 19D990)
5	—	Fine Mesh Screen (Part of 19D990)

NOTE: Service replacement includes O-rings. Replacement O-rings available from Motorcraft only.

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A/C Evaporator Core

The A/C evaporator core (19860) is functionally a heat exchanger in which the refrigerant absorbs heat from the surrounding air as it passes over the outer surface of the core. The refrigerant, when it is delivered through the circuit to the A/C evaporator core, is in a low-pressure liquid form. Then, as a result of the evaporation process, the liquid is converted to a low-pressure vapor and simultaneously the metal surfaces of the core are cooled.

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Suction Accumulator/Drier

The suction accumulator/drier (19C836) is a canister that receives the output of low-pressure vapor from the A/C evaporator core (19860).

The heavier, incoming oil-laden vapor settles to the bottom of the canister from which it feeds, at a controlled rate, into the compressor suction line through a bleed hole and filter. The refrigerant and oil mixture, upon entering the compressor suction line, further vaporizes, thereby preventing A/C compressor (19703) damage by eliminating the potential for refrigerant slugging.

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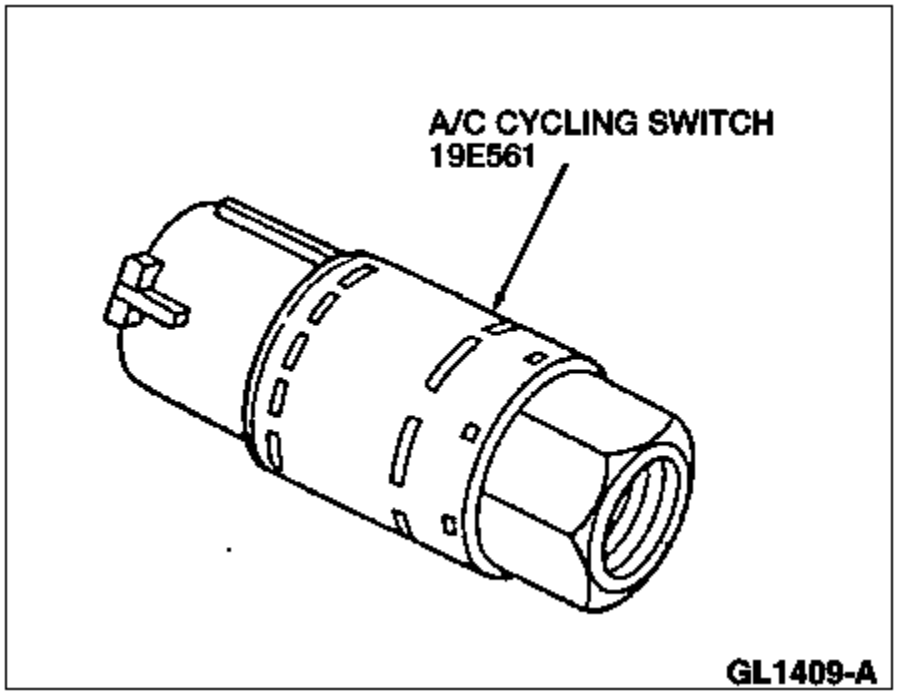
A/C Cycling Switch

The A/C cycling switch (19E561) is mounted on a Schrader valve-type fitting on the side of the suction accumulator/drier (19C836) in Aerostar vehicles, and on the top of the suction accumulator/drier in Ranger and Explorer vehicles. A valve depressor, located inside the threaded end of the A/C cycling switch, depresses the Schrader valve stem as the A/C cycling switch is mounted and allows the suction pressure inside the accumulator/drier housing to control operation. The electrical contacts are normally open when the suction pressure is at or below 23±1 psi; they will close when the suction pressure rises to approximately 40-60 psi or above. Lower ambient temperatures (below 8°C or 46°F), during cold weather seasons, will also open the contacts due to the pressure/temperature relationship of the refrigerant in the system. The electrical contacts control the circuit to the A/C compressor (19703) A/C clutch field coil (2987) when the function selector lever is set for air conditioner operation. When the contacts are closed, the A/C clutch field coil is energized and the A/C clutch (2884) is engaged to drive the A/C compressor. When the contacts are open, the A/C compressor A/C clutch field coil is de-energized, the A/C clutch is disengaged and the A/C compressor does not operate. The A/C cycling switch, when functioning properly, will control the pressure at a point where the plate/fin surface temperature will be maintained slightly above freezing, which prevents icing and the blockage of airflow.



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Special Service Equipment

The refrigerant system has a high-pressure (discharge) and a low-pressure (suction) gauge port valve.

CAUTION: Do not use R-12 special tools and equipment when servicing an R-134a system. Doing so may cause damage to the R-134a A/C system.

CAUTION: Use extreme care and observe all safety and service precautions related to the use of refrigerants.

NOTE: Hoses should have shutoff devices or check valves within 305mm (12 inches) of the hose end to minimize the introduction of non-condensable gases (air) into the recycling station and to minimize the amount of refrigerant released when the hose(s) is (are) disconnected.

R-134a systems require the use of special servicing equipment designed specifically for R-134a systems. R-12 servicing equipment cannot be used when servicing R-134a A/C systems. R-134a special service equipment includes R-134a recovery/recycling/recharging station, R-134a leak detector, R-134a vacuum pump and R-134a manifold gauge set.

Ford Motor Company supports the efficient use, recovery, and recycling of R-134a in specified vehicle air conditioners. Ford Motor Co. recommends the use of a U.L. approved recovery/recycling device such as Rotunda R-134a A/C Service Center (or other device which meets SAE Standard J1991) during any air conditioning system repair and recharge procedure which requires the air conditioning system to be discharged.

Rotunda R-134a A/C Service Center

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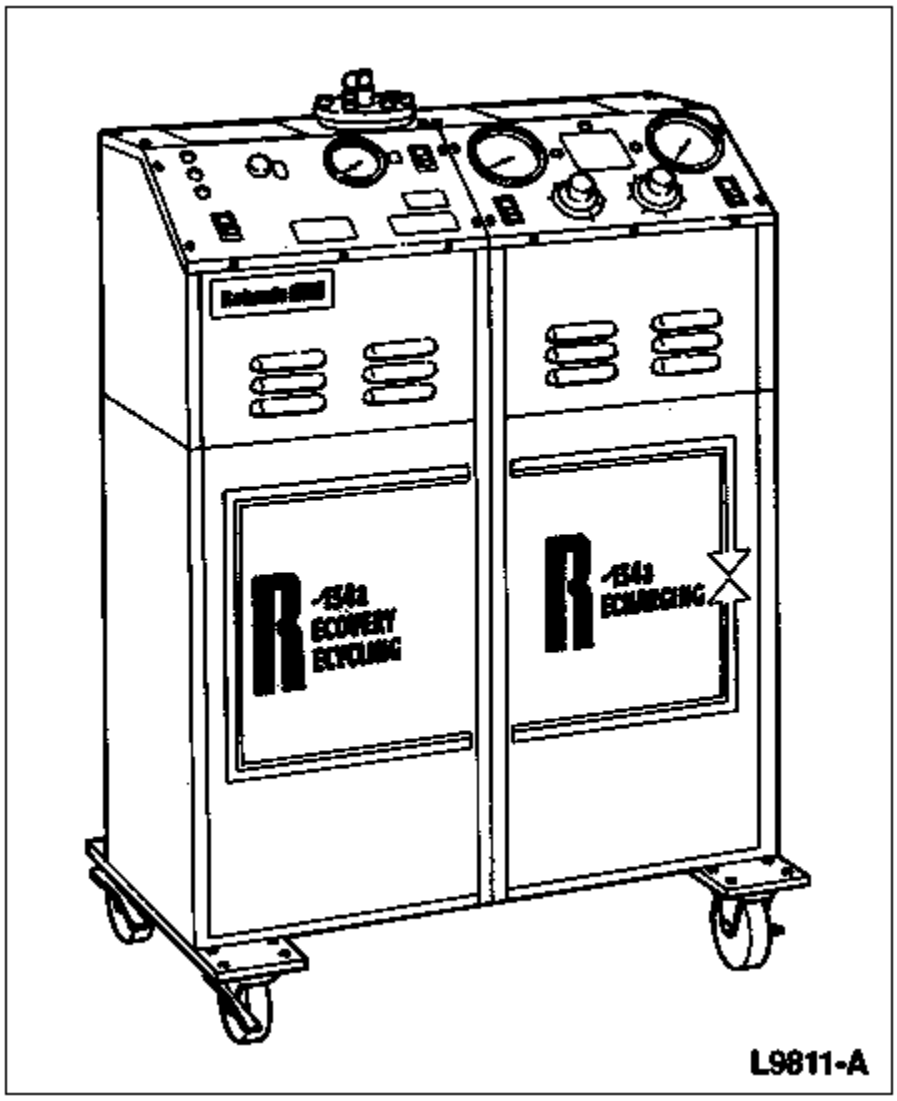

Additional information and a typical procedure for operating a refrigerant recovery device follows:

Refrigerant recovery systems and recycling stations are in use in an increasing number of automotive air conditioning service facilities. The use of such equipment makes possible the recovery and use of air conditioning system refrigerant after contaminants and moisture have been removed.

If a refrigerant recovery or recycling station is used, the following general procedures should be observed, in addition to the operating instructions provided by the equipment manufacturer.

1. Connect the refrigerant recycling station hose(s) to the vehicle air conditioning service ports and the recovery station inlet fitting.

2. Turn the power to the recycling station on to start the recovery process. Allow the recycling station to pump the refrigerant from the system until the station pressure goes into a vacuum. On some stations the pump will be shut off automatically by a low pressure switch in the electrical system. On other units it may be necessary to manually turn off the pump.

3. Once the recycling station has evacuated the vehicle air conditioning system, close the station inlet valve (if so equipped). Then, switch off the electrical power.

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4. Allow the vehicle air conditioning system to remain closed for about two minutes. Observe system vacuum level as shown on the gauge. If the pressure does not rise, disconnect the recycling station hose(s).

5. If the system pressure rises, repeat the above three steps until the vacuum level remains stable for two minutes.

6. Perform required service operations, evacuate and recharge the air conditioning system.

   The refrigerant system has a high-pressure (discharge) and a low-pressure (suction) gauge port valve. They provide access to both sides (high-pressure and low-pressure) of the system for service hoses and a manifold gauge set so system pressures can be read.

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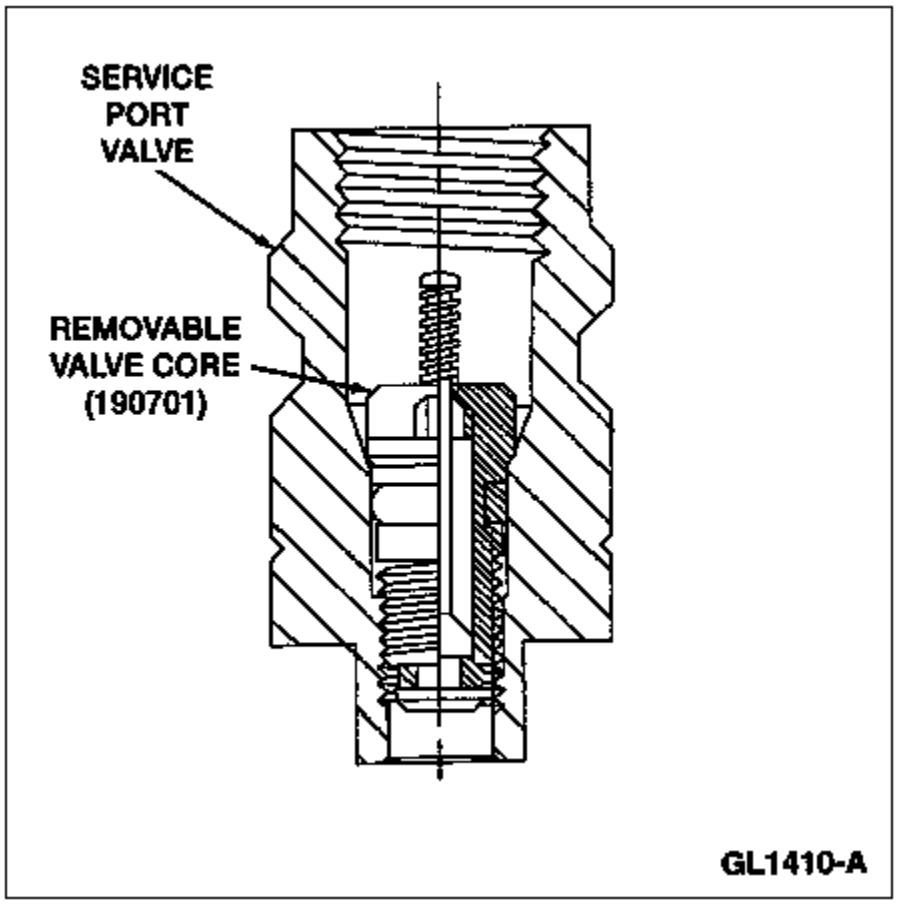
Service Gauge Port Valves

The service valve in the A/C compressor to condenser discharge line (19972) allows access to the high pressure side of the system for attaching a service hose and pressure gauge.



The service valve on the suction accumulator/drier (19C836) allows access to the low pressure side of the system for attaching a service hose and pressure gauge.

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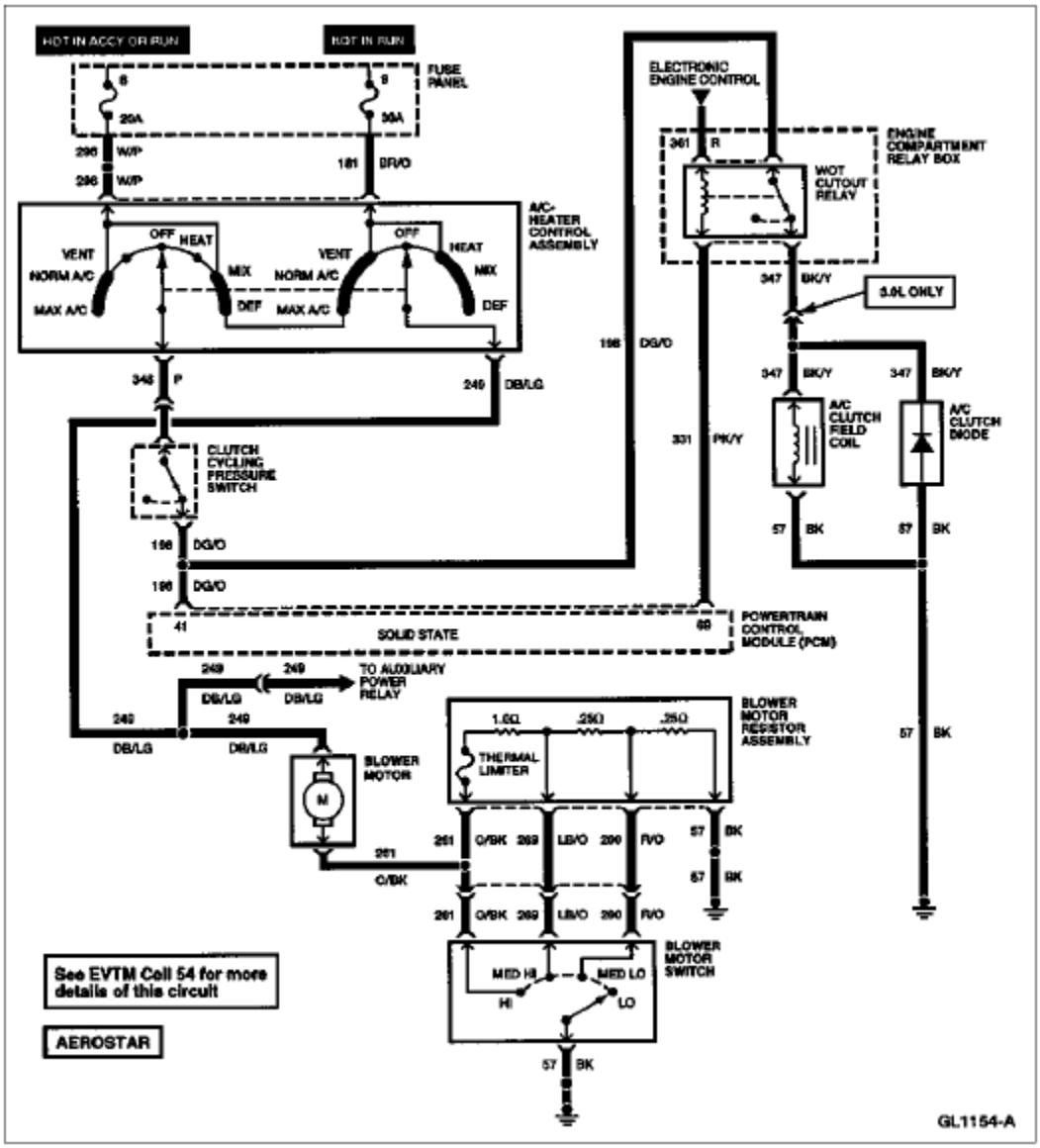
Electrical Schematics

Air Conditioner-Heater System Electrical Schematic, Aerostar



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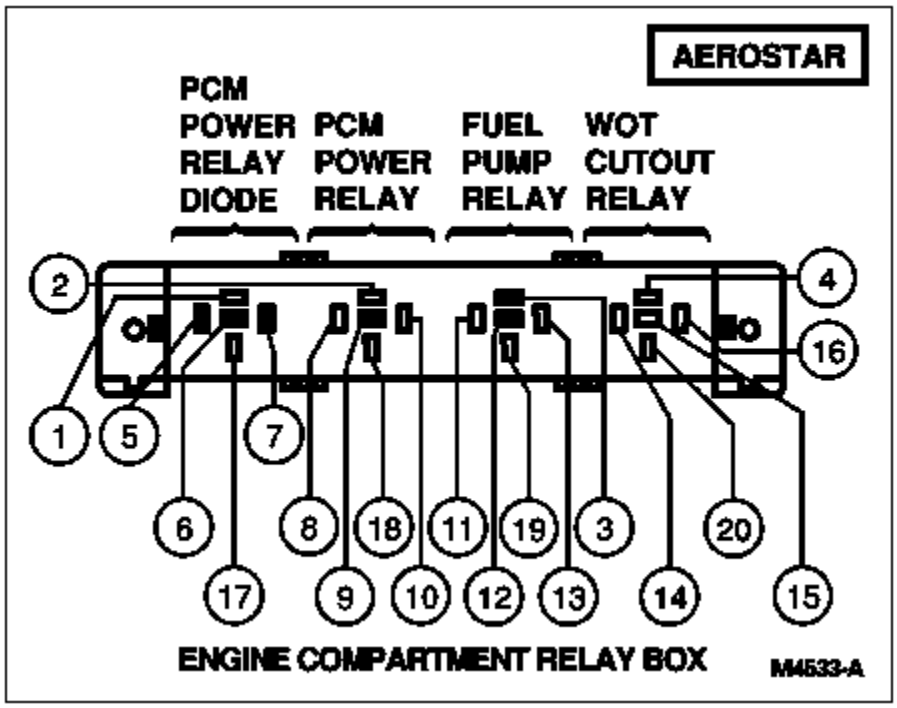

Pin Number	Circuit	Circuit Function
1	454 (R/LG)	Ignition Switch Coil Terminal to Circuit Breaker
2	361 (R)	Power Output from Closed Loop Relay
3	—	Not Used
4	238 (DG/Y)	Fuel Pump Relay to Safety Switch
5	—	Not Used
6	—	Not Used
7	—	Not Used
8	60 (BK/LG)	Constant Voltage Unit to Gauge
9	—	Not Used
10	454 (R/LG)	Ignition Switch Coil Terminal to Circuit Breaker
11	926 (LB/O)	PCM to Fuel Pump Relay Control
12	—	Not Used
13	361 (R)	Power Output from Closed Loop Relay
14	331 (PK/Y)	Wide-Open Throttle A/C Cutout Switch
15	347 (BK/Y)	A/C Cycling Pressure Switch to PCM
16	361 (R)	Power Output from Closed Loop Relay
17	16 (R/LG)	Ignition Switch to Ignition Coil "Battery" Terminal
18	37 (Y)	Battery to Load
19	37 (Y)	Battery to Load
20	198 (DG/O)	A/C Pressure Switch to Control Relay

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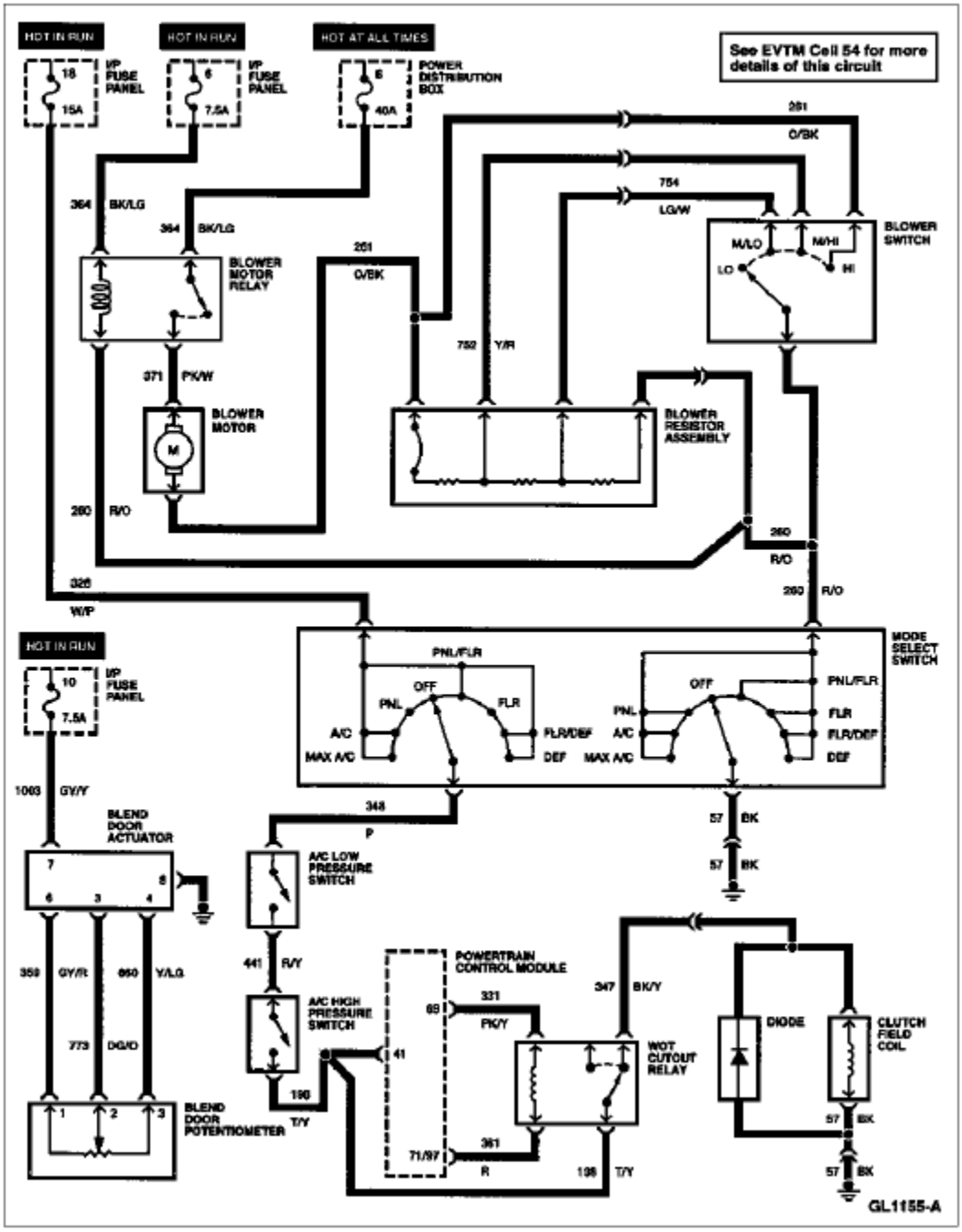
Air Conditioner-Heater System Electrical Schematic, Ranger



Heater Only Unit — Electrical Schematic

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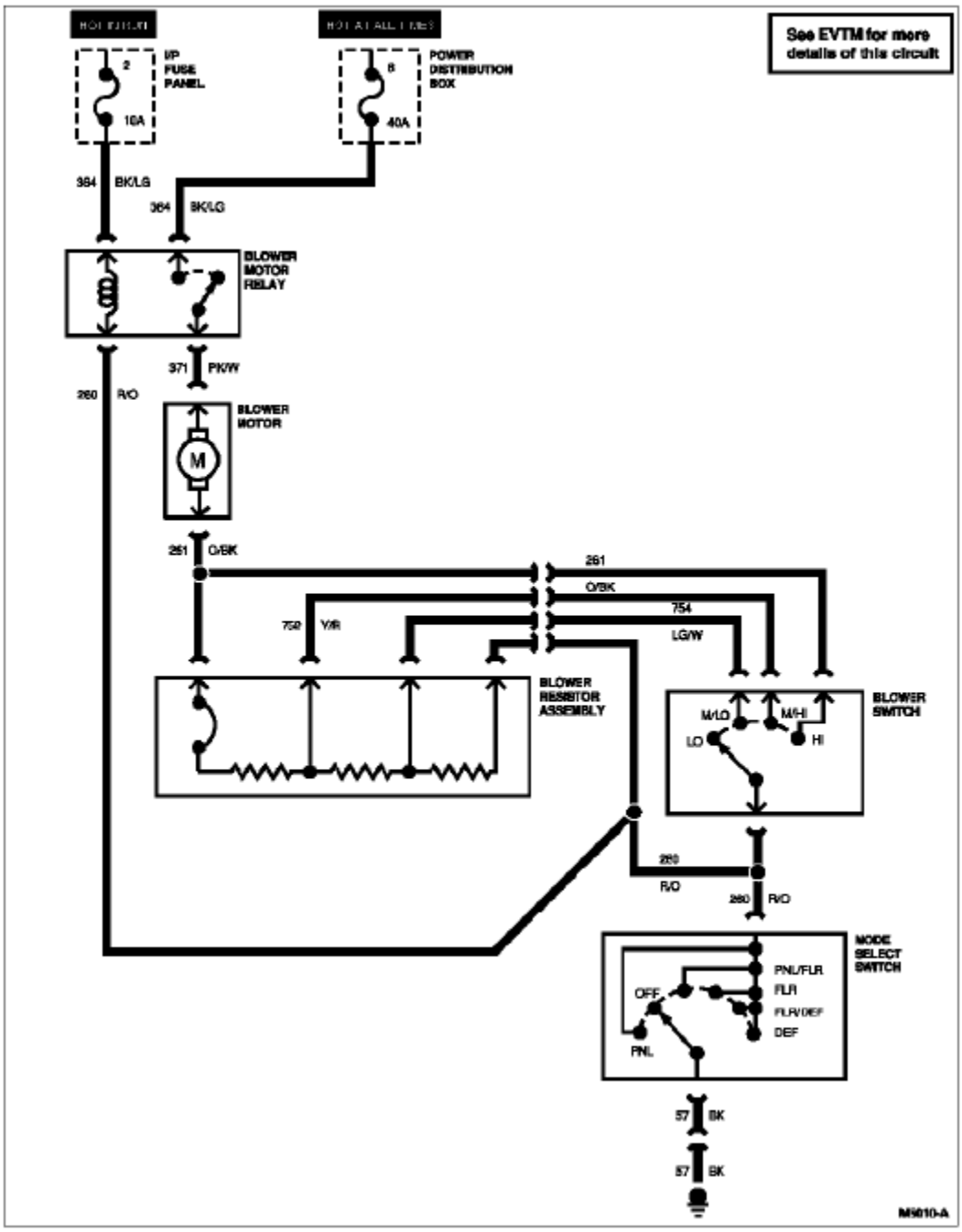

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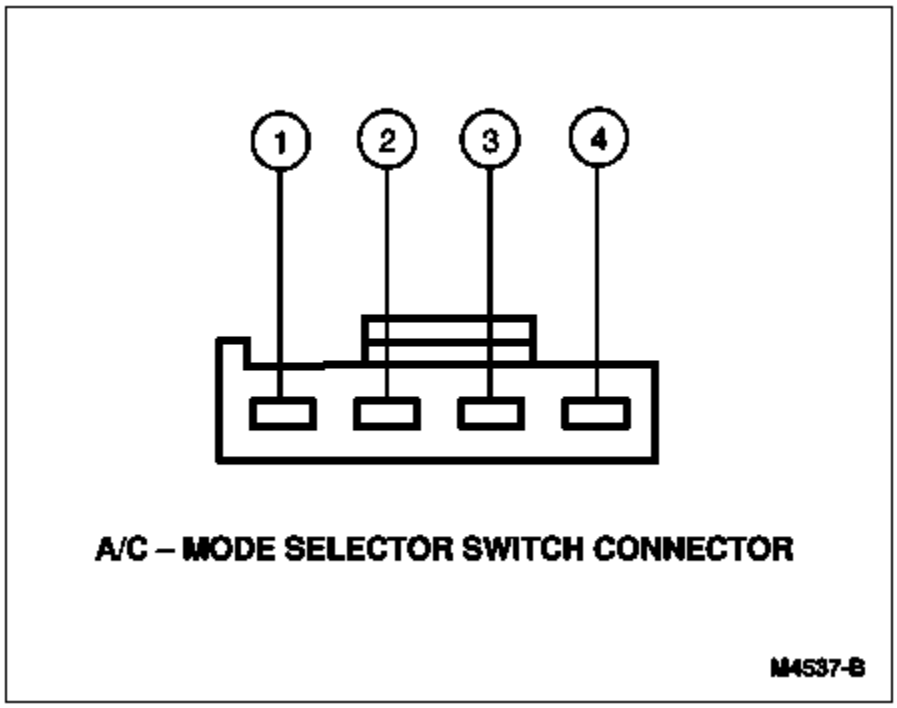
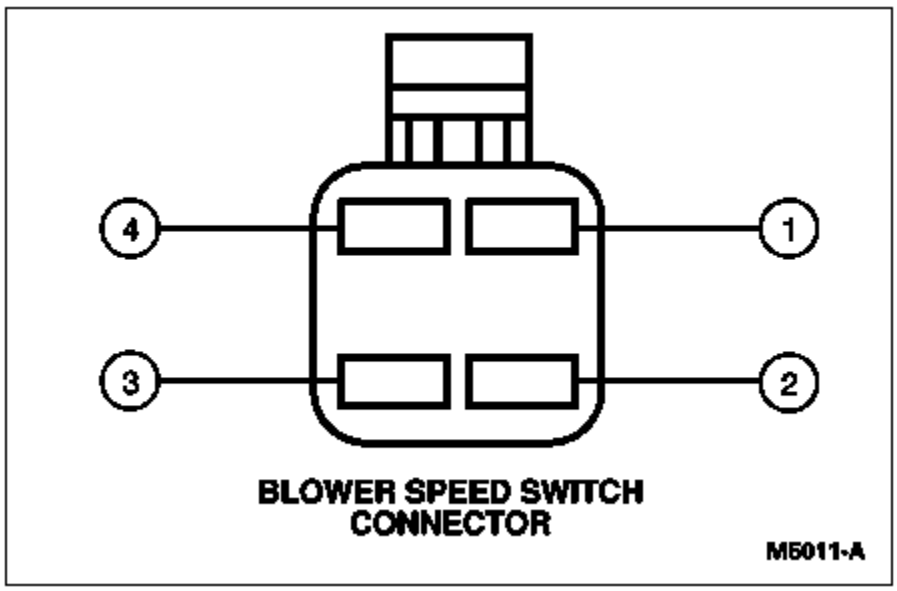


Pin Number	Circuit	Circuit Function
1	260 (R/O)	Mode Switch Power Input
2	57 (B/K)	Mode Switch Ground
3	348 (LG/P)	Mode Switch Output (With A/C)
4	326 (W/P)	Mode Switch Power (With A/C)



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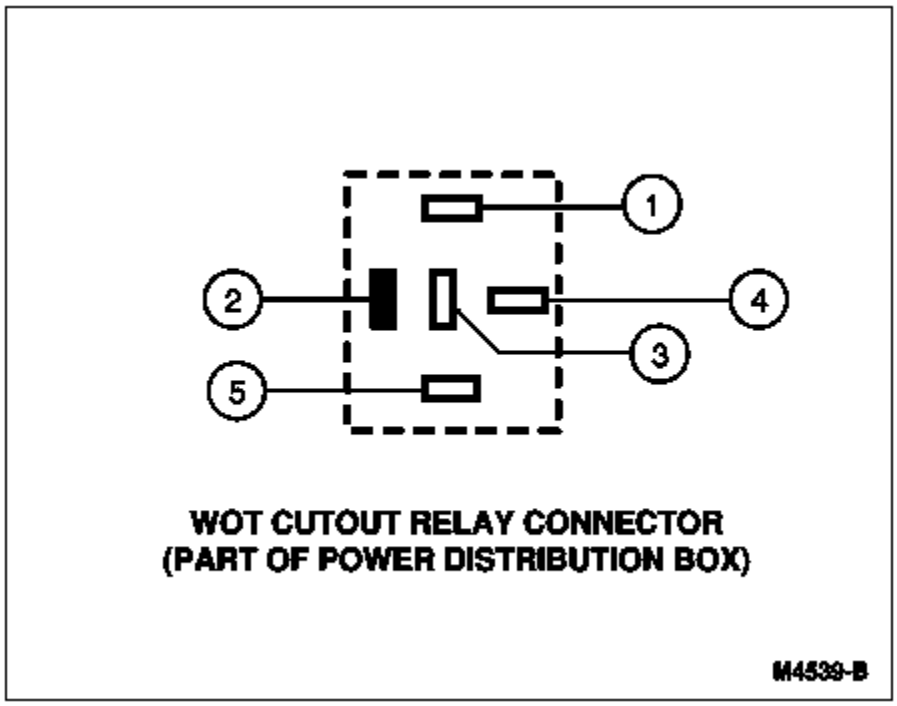
Pin Number	Circuit	Circuit Function
1	260 (R/O)	Blower Speed Switch Output
2	752 (Y/R)	Med-High Speed
3	745 (LG/W)	Med-Low Speed
4	261 (O/BK)	High Speed



Pin Number	Circuit	Circuit Function
1	331 (PK/Y)	From EEC to WOT Cutout Relay Coil
2	—	Not Used
3	347 (BK/Y)	Switch Output to A/C Compressor and Diode
4	198 (T/Y)	Pressure Switches to WOT Switch Input
5	361 (R)	From EEC to WOT Cutout Relay Coil

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Inspection and Verification

Obstructed air passages, broken drive belts (8620), disconnected or broken wires, damaged A/C clutch (2884), or loose or broken mounting brackets and certain refrigerant leaks may be located by visual inspection of the parts.

A refrigerant leak will usually appear as an oily residue at the leakage point in the system. The oily residue soon picks up dust or dirt particles from the surrounding air and appears greasy. Through time, this will build up and appear to be a heavy dirt-impregnated grease.

Most common leaks are caused by damaged or missing O-ring seals at the various hose and component connections. When these O-rings are replaced, lubricate the new O-rings with refrigerant oil. Be careful to prevent shop towel lint from contaminating the internal surfaces of the connection. Leakage may occur at a spring lock coupling if the wrong O-rings are used. Use **only** the O-rings listed in the Ford Master Parts Catalog for the spring lock coupling being serviced.

Another type of leak may appear at the internal Schrader-type air conditioner charging valve core in the service gauge port valve fittings. If tightening the valve core does not stop the leak, replace it with a new air conditioner charging valve core or equivalent.

Missing A/C charging valve caps (19D702) can also cause a refrigerant leak. If this important primary seal is missing, dirt will enter the area of the air conditioner charging valve core. When the service hose is attached, the valve compressor in the end of the service hose forces the dirt into the valve seat area and the dirt will destroy the sealing surface of the air conditioner charging valve core. When a A/C charging valve cap is missing, clean the protected area of the air conditioner charging valve core and install a new A/C charging valve cap.

CAUTION: A/C charging valve caps must be installed finger-tight. If tightened with pliers, the sealing surface of the service gauge port valve may be damaged.

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Symptom Chart — Climate Control System, Service

CLIMATE CONTROL SYSTEM, SERVICE

Condition	Possible Source	Action
• Insufficient, Erratic, or No Heat or Defrost	• Low radiator coolant level due to coolant leaks.	• CHECK radiator cap pressure. REPLACE if below minimum pressure as marked on cap. FILL to specified coolant level. PRESSURE TEST for engine cooling system and heater system leaks. SERVICE as required.
	• Engine overheating.	• CHECK radiator cap. REPLACE if below minimum pressure as marked on cap. REMOVE bugs, leaves, etc. from radiator or condenser fins. • CHECK for: ▪ Loose drive belt ▪ Sticking thermostat ▪ Incorrect ignition timing ▪ Water pump impeller damage ▪ Restricted cooling system • SERVICE as required. REFER to Group 03.
	• Loose drive belt.	• REPLACE if cracked or worn and/or ADJUST tension. REFER to Section 03-05 .
	• Thermostat.	• CHECK coolant temperature at radiator filler neck. If under 170°F, REPLACE thermostat. REFER to Section 03-03 .
	• Plugged or partially plugged heater core.	• CLEAN and BACKFLUSH engine cooling system and heater core.
	• Loose or improperly adjusted heater temperature cables.	• ADJUST to specifications. REFER to Section 12-02A or Section 12-02B .
	• Kinked, clogged, collapsed, soft, swollen, or decomposed engine cooling system or heater system hoses.	• REPLACE damaged hoses and BACKFLUSH engine cooling system, then heater system, until all particles have been removed. REFER to Section 03-03 .
	• Blocked air inlet.	• CHECK cowl air inlet for leaves, foreign material, etc. REMOVE as required. CHECK internal blower inlet screen (on vehicles so equipped) for leaves and foreign material.
• Blower Motor Does Not Operate Properly	• Blower motor.	• CHECK fuse. CONNECT a No. 10 gauge (or larger diameter) jumper wire directly from the positive battery terminal to the positive lead (orange wire) of the blower

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		motor. If the blower motor runs, the problem must be external to the blower motor. If the blower motor will not run, CONNECT a No. 10 gauge (or larger diameter) jumper wire from the heater blower motor black lead to a good ground. If the blower motor runs, the trouble is in the ground circuit. On vehicles with ground side switching, CHECK the heater blower motor switch resistor, the heater blower motor switch and the harness connections. SERVICE as required. If blower motor still will not run, the blower motor is inoperative and should be replaced.
	• Heater blower motor switch resistor. • Wire harness to blower motor.	• CHECK continuity of resistors for opens or shorts (self-powered test lamp). SERVICE or REPLACE as required. • CHECK for proper installation of harness connectors. CHECK wire-to-terminal continuity. CHECK continuity of wires in harness for shorts, opens, abrasions, etc. SERVICE as required. GO to Pinpoint Test H .
• Improper/Erratic Direction of Airflow From Outlets	• Vacuum leak. • Loose or disconnected vacuum hose. • Damaged. • Misrouted vacuum connections.	• REPLACE or REPAIR system components, as required. GO to Pinpoint Test A .
• Insufficient, Erratic or No Heat	• Heater core. • Broken or out of adjustment function or temperature control cables. • Vacuum leak.	• GO to Heater Core Tests in this section. • REFER to Section 12-02A or Section 12-02B . • GO to Pinpoint Test B .
• Defrost Always On	• Vacuum system failure. • Heater air cable and/or function control switch not working properly.	• GO to Pinpoint Test C . • REFER to Section 12-02A or Section 12-02B .
• A/C Does Not Operate	• Wiring circuit failure.	

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	• Defective A/C clutch. • A/C clutch.	• GO to Pinpoint Test D .
• A/C Always On	• Electrical circuits. • Function control switch.	• GO to Pinpoint Test E .
• Insufficient A/C Cooling	• A/C clutch. • Leaks in system. • Low refrigerant charge.	• GO to Pinpoint Test F .
• No Operation In All Function Settings	• Electrical circuits.	• GO to Pinpoint Test G .
• No Blower Operation, Constant Blower or Improper Operation	• Electrical circuit, blower motor, resistor or switch.	• GO to Pinpoint Test H , Pinpoint Test J , Pinpoint Test K , Pinpoint Test L , and Pinpoint Test M for specific condition.
• Noise in Climate Control System	• Vacuum leak.	• GO to Pinpoint Test N and Pinpoint Test P for specific condition.

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Pinpoint Tests

PINPOINT TEST A: IMPROPER/ERRATIC DIRECTION OF AIRFLOW FROM OUTLETS

A1 NO VENT OPERATION

- Check vacuum source tube (black) for being pinched, split, kinked, or disconnected.

Is vacuum tube OK?

Yes	No
GO to **A2** .	SERVICE vacuum source tube (black). RESTORE vehicle. RETEST system.

A2 CHECK VEHICLE FOR VACUUM

- Start engine and allow to idle.
- Locate vacuum distribution block at engine.
- Disconnect A/C, heater vacuum source tube and check for vacuum.

Is vacuum present?

Yes	No
RECONNECT vacuum tube. GO to **A3** .	SERVICE vacuum distribution block. RESTORE vehicle. RETEST system.

A3 CHECK VENT VACUUM TUBES FOR LEAK

- Check in-line and control assembly multiple connectors for proper installation and connection.

Does vacuum hiss stop?

Yes	No
RESTORE vehicle. RETEST system.	GO to **A4** .

A4 CHECK FUNCTION CONTROL FOR LEAK

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- Actuate function knob to all positions to determine which selector positions are leaking.

Do all positions leak?

Yes	No
GO to **A5** .	GO to **A6** .

A5 CHECK FUNCTION CONTROL VACUUM SUPPLY

- Pinch off source tube (black) at control assembly.

Did vacuum hiss stop?

Yes	No
REPLACE function control selector. RESTORE vehicle. RETEST system.	SERVICE source tube, vacuum harness. RESTORE vehicle. RETEST system.

A6 DETERMINE LEAKING HOSE(S)

- Determine what color hose is leaking in selected switch position.
- Pinch off suspect hose near respective vacuum control motor.

Did vacuum hiss stop?

Yes	No
REPLACE vacuum control motor. RESTORE vehicle. RETEST system.	GO to **A7** .

A7 CHECK VACUUM HARNESS FOR LEAK

- Carefully listen for location of vacuum leak.
- Pinch off suspect hose(s) one at a time, near control assembly, and/or in-line connector.

Did vacuum hiss stop?

Yes	No
SERVICE hose for cut or damage. RESTORE vehicle. RETEST system.	REPLACE function control switch. RESTORE vehicle. RETEST system.

PINPOINT TEST B: INSUFFICIENT, ERRATIC, OR NO HEAT

B1 CHECK FOR VACUUM TO FUNCTION CONTROL

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- Start engine and allow engine to idle.
- Disconnect A/C, heater vacuum source tube (black), check for vacuum.

Is vacuum present?

Yes	No
GO to **B2** .	SERVICE vacuum source tube (black) as required. RESTORE vehicle. RETEST system.

B2 CHECK FLOOR PANEL DOOR OPERATION

- Actuate function control switch to the floor position.
- Locate heater air damper door vacuum control motor.
- Check for vacuum at blue tube and red tube.

Is vacuum present at each vacuum tube?

Yes	No
REPLACE heater air damper door vacuum control motor. GO to **B3** .	SERVICE suspect hose for cut or damage. RESTORE vehicle. RETEST system.

B3 CHECK HEATER FOR PROPER TEMPERATURE

- Allow engine to run until operating temperature is achieved.
- Actuate A/C control to floor position.
- Actuate temperature to full heat position.
- Actuate A/C, heater blower switch.

Is heater temperature OK?

Yes	No
GO to **B4** .	GO to Heater Core Test and SERVICE as outlined. RETEST system.

B4 CHECK A/C BLOWER MOTOR OPERATION

- Actuate A/C blower motor in all positions.

Did A/C blower motor operate properly?

Yes	No
RESTORE vehicle. RETEST system.	GO to Pinpoint Test H , Pinpoint Test J , Pinpoint Test K , Pinpoint Test L , or Pinpoint Test M for specific condition(s).

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PINPOINT TEST C: DEFROST ALWAYS ON

NOTE: The air handling system is designed to provide defrost when no vacuum is applied to any of the three air door vacuum motors. This is done to prevent a situation where defrost cannot be obtained due to a system vacuum leak. Instead, a leak in the vacuum control circuit will send all airflow to the defroster outlets. This condition may occur during acceleration (slow leak), may exist at all times (large leak) and may happen only when certain specific functions are selected, indicating a leak in that portion of the circuit.

The vacuum hoses used in the passenger compartment control circuit are constructed from PVC plastic material. The vacuum hoses used in the engine compartment are constructed of Hytrel. Because of the materials used, the vacuum hoses should never be pinched off during diagnosis to locate a leak. Use Rotunda Vacuum Tester or equivalent to locate vacuum leaks. A wood golf tee can be used as a plug when it is necessary to plug one end of a vacuum hose for leak test purposes.

C1 CHECK SYSTEM AIRFLOW

- With engine running and blower motor on high, check system airflow in each function selector position to determine which position(s) have incorrect airflow.

Is airflow from the defroster outlets for all positions?

Yes	No
GO to C2.	GO to C13.

C2 CHECK VACUUM SUPPLY HOSE

- Check vacuum supply hose to be sure it is connected to both the engine manifold and vacuum check valve.

Is hose disconnected?

Yes	No
RECONNECT hose. GO to C1.	GO to C3.

C3 CHECK VACUUM SUPPLY HOSE FOR LEAK

- Disconnect vacuum supply hose from engine manifold fitting and from check valve. Plug one end of hose and leak test with vacuum pump.

Does hose leak?

Yes	No
REPLACE or REPAIR as necessary. GO to C1.	CONNECT hose to manifold fitting. GO to C4.

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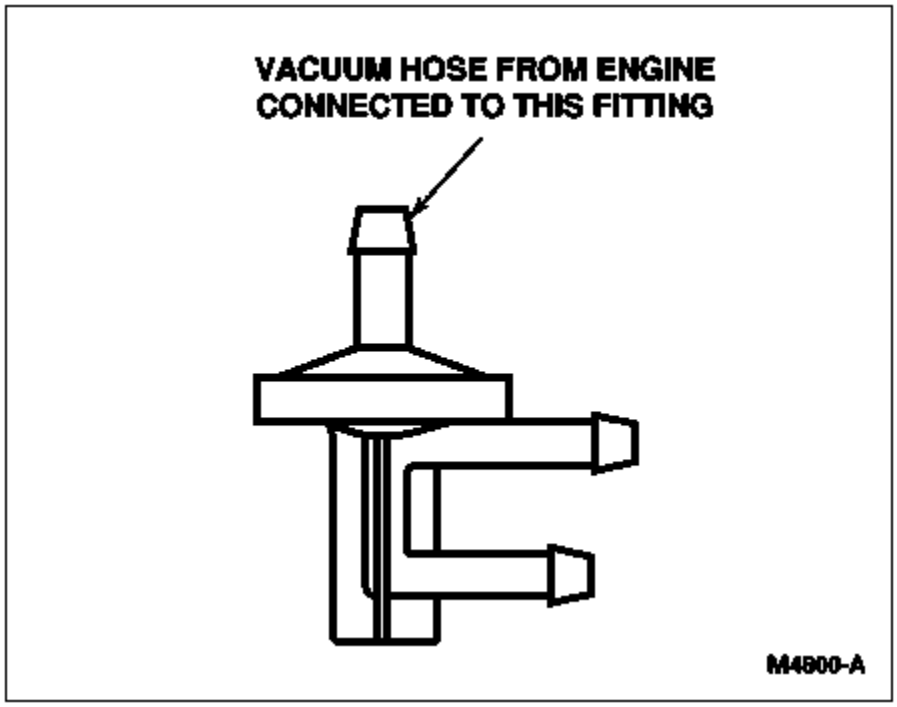
C4 CHECK VACUUM CHECK VALVE

- Check vacuum check valve for correct installation by removing the reservoir hose and the control assembly source hose (one at a time) from check valve and check for vacuum. Engine must be running for this test.



Is vacuum available at both check valve ports?

Yes	No
RECONNECT both hoses. GO to C6 .	GO to C5 .

C5 INSPECT VACUUM CHECK VALVE

- Inspect vacuum check valve for an obstruction and/or proper operation. Airflow through the check valve should be in the direction toward engine (engine connection side is marked VAC).

Is check valve plugged or obstructed?

Yes	No
REPLACE check valve. GO to C1 .	GO to C6 .

C6 LEAK TEST VACUUM CHECK VALVE

- Remove vacuum check valve from vehicle. Connect two hoses and a Tee fitting to outlet ports of check valve. Connect vacuum tester, Rotunda Model No. 014-R1054 or equivalent, to Tee fitting.

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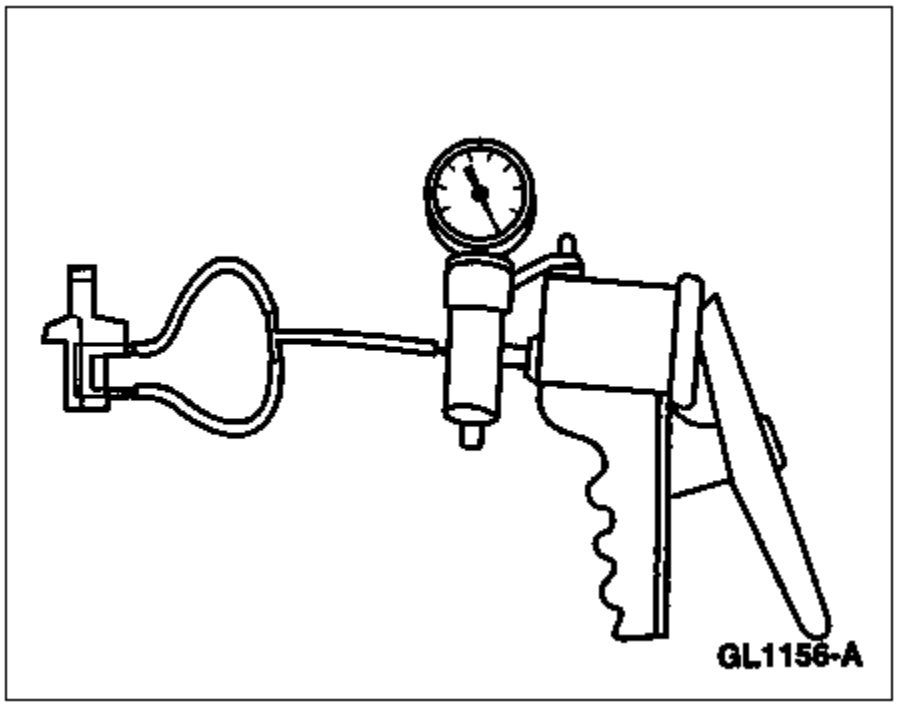
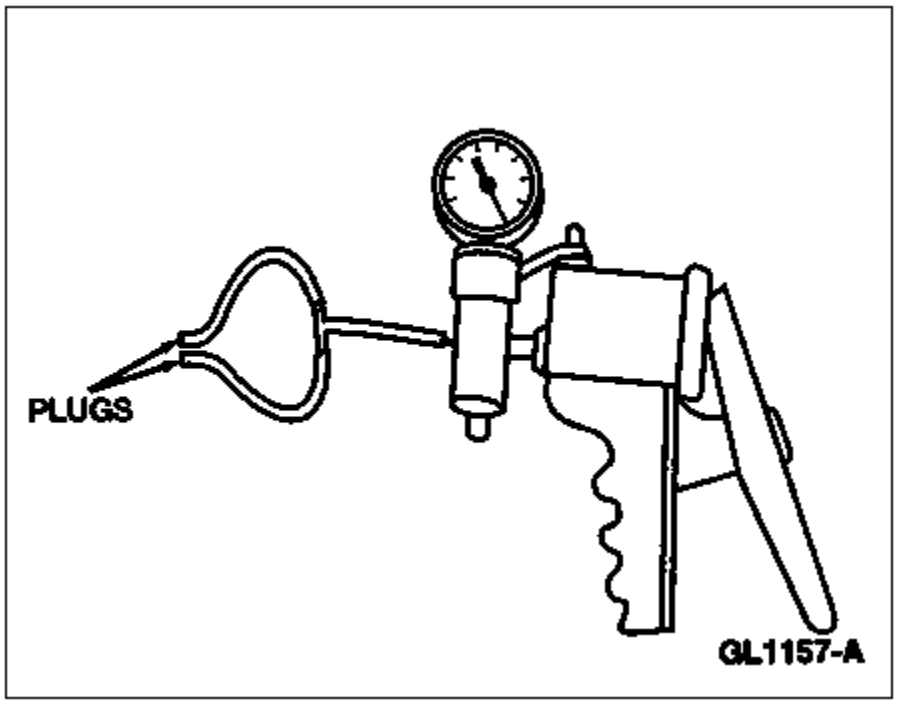


- Pump 15 inches vacuum on check valve and observe gauge reading. If vacuum loss exceeds 1 inch per minute, remove check valve from tester and plug vacuum hoses. Pull a vacuum with the tester to be certain hoses and tester are not cause of leak.



- If tester and hoses do not leak, check valve is cause of leak.

Does check valve lose more than 1 inch vacuum in one minute?

Yes	No

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REPLACE check valve. GO to C1 .	REINSTALL check valve and GO to C7 .

C7 CHECK VACUUM RESERVOIR

- Connect vacuum tester to vacuum reservoir and leak test reservoir. Reservoir must hold vacuum.

Does reservoir leak?

Yes	No
REPLACE reservoir. GO to C1 .	CONNECT hose to reservoir. GO to C8 .

C8 CHECK SUPPLY HOSE FOR LEAK

- Disconnect and plug black supply hose at control assembly. Disconnect other end of supply hose from check valve and leak test hose with vacuum tester.

Does supply hose leak?

Yes	No
REPAIR or REPLACE hose. GO to C1 .	REMOVE plug and RECONNECT vacuum hoses. GO to C9 .

C9 CHECK CONTROL ASSEMBLY

- Disconnect vacuum harness at in-line multiple connector near control. Plug all vacuum hoses except black. Connect vacuum tester to black hose. Select each function position, apply 15 inches vacuum and check for vacuum drop. Drop should not exceed 1 inch vacuum per minute for any function position.

Does drop exceed 1 inch vacuum per minute?

Yes	No
NOTE function positions where vacuum drops. GO to C10 .	GO to C11 .

C10 LEAK TEST CONTROL ASSEMBLY

- Remove vacuum harness from control assembly. Connect vacuum tester to control supply port and plug control port that indicated a leak in Step C9. Select function positions noted in Step C9 and apply 15 inches vacuum after selecting each position. Vacuum drop should not exceed 1/2 inch per minute.

Does vacuum drop exceed 1/2 inch in one minute?

Yes	No

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REPLACE control assembly. GO to C1 .	GO to C12 .

C11 CHECK SUPPLY HOSE

- Disconnect black supply hose from check valve. Connect vacuum tester to supply hose and operate tester as if pulling a vacuum. If tester can pull a vacuum, hose is plugged. If tester pulls a partial vacuum, hose is restricted.

Is hose plugged or restricted?

Yes	No
REPLACE supply hose. GO to C1 .	GO to C15 .

C12 LEAK TEST JUMPER VACUUM HARNESS

- Plug one end of vacuum hose that indicated a leak in Step C9. Apply 15 inches vacuum to hose and observe vacuum gauge. Vacuum should not drop.

Does vacuum drop?

Yes	No
REPAIR and/or REPLACE vacuum jumper harness. GO to C1 .	CHECK connection of vacuum harness to control assembly for leak. REPAIR as necessary. GO to C1 .

C13 EVALUATE SYSTEM AIRFLOW

Is the airflow in Step C1 correct for each function position?

Yes	No
GO to C14 .	GO to C15 .

C14 ISOLATE LEAKING VACUUM CIRCUIT

- Repeat Step C1 and accelerate engine speed for each function position.

Does airflow go to defrost during acceleration?

Yes	No
GO to C19 .	GO to C15 .

C15 REVIEW VEHICLE HISTORY

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Did system function properly prior to this concern?

Yes	No
GO to C18.	GO to C16.

C16 CHECK VACUUM HOSES

- Check each vacuum hose to be sure it is not plugged.

Is a hose plugged?

Yes	No
REPAIR or REPLACE as necessary. GO to C1.	GO to C17.

C17 CHECK VACUUM HARNESS

- Compare vacuum hose colors in each vacuum harness to the vacuum schematic. Refer to Electrical and Vacuum Troubleshooting Manual,Aerostar or Ranger.

Do the hose colors agree with the schematic?

Yes	No
GO to C18.	REPLACE vacuum harness. GO to C1.

C18 CHECK VACUUM CIRCUIT FOR KINKS

- Check vacuum circuit for pinched or kinked vacuum hose.

Is hose pinched or kinked?

Yes	No
REPAIR as necessary. GO to C1.	GO to C19.

C19 CHECK VACUUM CIRCUIT

- Check each vacuum hose connection to determine if it is partially connected or disconnected.

Is a vacuum hose connection disconnected or partially connected?

Yes	No
RECONNECT hose. GO to C1.	GO to C20.

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C20 CHECK VACUUM HOSE

- Disconnect both ends of vacuum hose in suspected circuit. Plug one end and leak test with vacuum tester.

Does vacuum hose leak?

Yes	No
REPAIR or REPLACE hose. GO to **C1** .	GO to **C21** .

C21 CHECK VACUUM MOTOR

- Check vacuum control motor for leaks with vacuum tester.

Does motor hold vacuum?

Yes	No
GO to **C22** .	REPLACE vacuum control motor. GO to **C1** .

C22 CHECK VACUUM MOTOR INSTALLATION

- Check attachment of vacuum motor arm to damper door.

Is motor arm attached to door or door crank arm?

Yes	No
CHECK for binding or damaged damper door. REPAIR as necessary. GO to **C1** .	CONNECT motor arm to door and/or crank arm and CHECK operation. GO to **C1** .

PINPOINT TEST D: A/C DOES NOT OPERATE

D1 CHECK COMPRESSOR CLUTCH

- Prepare vehicle as follows:
  - Connect manifold gauge.
  - Set function control at MAX A/C.
  - Set blower switch on HIGH.
  - Set temperature lever full cold.
  - Close doors and windows.
  - Run engine at approximately 1500 rpm.

Does A/C clutch operate?

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Yes	No
GO to **D16** .	GO to **D2** .

D2 CHECK VOLTAGE SUPPLY AT SWITCH

- Turn engine off. Leave ignition switch ON.
- Using a test lamp, check for voltage at Circuit 296 (W/P) Aerostar or 326 (W/P) Ranger at A/C heater control switch.

Did test lamp illuminate?

Yes	No
GO to **D5** .	GO to **D3** .

D3 CHECK VOLTAGE SUPPLY TO SWITCH

- Using a test lamp, check voltage at output side of Fuse 18 (15A) Ranger or Fuse 6 (20A) Aerostar.

Did test lamp illuminate?

Yes	No
SERVICE the W/P wire. RESTORE vehicle. RETEST system.	GO to **D4** .

D4 CHECK CIRCUIT 296 (W/P) OR 326 (W/P) FOR SHORT

- Disconnect A/C heater control switch.
- Using an ohmmeter, Rotunda 73 Digital Multimeter 105-R0051 or equivalent, connect one lead to output side of Fuse 18 (15A) Ranger or 6 (20A) Aerostar. Connect second lead to a known good ground.

Is resistance 5 ohms or less?

Yes	No
SERVICE the W/P wire. REPLACE Fuse 18 (15A) Ranger or Fuse 6 (20A) Aerostar. RESTORE vehicle. RETEST system.	RESTORE vehicle. GO to **D1** .

D5 CHECK A/C, HEATER CONTROL SWITCH

- Reconnect A/C, heater control switch.
- Using a test lamp, check voltage at Pin 3 Circuit 348 (P).

Did test lamp illuminate?

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Yes	No
If Aerostar, GO to D6 . If Ranger, GO to D7 .	REPLACE A/C, heater control switch. RESTORE vehicle. RETEST system.

D6 CHECK CLUTCH CYCLING PRESSURE SWITCH

- Disconnect A/C cycling switch.
- Start engine, A/C should be in MAX A/C mode.
- Using a jumper wire, connect one end to Pin 1 at cycling switch connector. Connect second lead to Pin 2 at A/C cycling switch.
- Observe A/C clutch.

Did A/C clutch engage?

Yes	No
REPLACE A/C cycling switch. Do not discharge system. Switch has a Schrader valve. RESTORE vehicle. RETEST system.	GO to D10 .

D7 CHECK THE A/C LOW PRESSURE SWITCH

- Disconnect the A/C low pressure switch.
- Start engine, A/C should be in MAX A/C mode.
- Using a jumper wire, connect one end to circuit 348 (P) and the other end to circuit 441 (R/Y) of the A/C low pressure switch connector.
- Observe A/C clutch.

Did A/C clutch engage?

Yes	No
REPLACE the A/C low pressure switch. RETEST system.	GO to D8 .

D8 CHECK CIRCUIT 441 (R/Y)

- Turn engine off.
- Disconnect the A/C high pressure switch.
- Using Rotunda 73 Digital Multimeter 105-R0051, or equivalent, check circuit 441 (R/Y) for open between the A/C low and high pressure switch, and between A/C low pressure switch 441 (R/Y) for short.

Is there a short or an open?

Yes	No
SERVICE circuit 441 (R/Y) for short or an open. RETEST system.	GO to D9 .

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D9 CHECK THE A/C HIGH PRESSURE SWITCH

- Reconnect the A/C low pressure switch.
- Start engine, A/C should be in MAX A/C mode.
- Using a jumper wire, connect one end to circuit 441 (R/Y) and the other to Circuit 198 (T/Y) of the A/C high pressure switch connector.
- Observe A/C clutch.

Did A/C clutch engage?

Yes	No
REPLACE A/C high pressure switch. RETEST system.	GO to **D10** .

D10 CHECK POWER SUPPLY TO A/C

- Using a test lamp, check Circuit 348 (P) at A/C cycling switch Aerostar or A/C low pressure switch Ranger connector.

Did test lamp illuminate?

Yes	No
GO to **D11** .	SERVICE circuit 348 (P) for open circuit or short to ground.

D11 CHECK CIRCUIT 198 (T/Y)

- Disconnect the WOT cut out relay.
- Using a Rotunda 73 Digital Multimeter 105-R0051, check Circuit 198 (T/Y) between the A/C cycling switch Aerostar or A/C high pressure switch Ranger connector and WOT cutout relay connector for open, and between WOT cutout relay connector and known good ground for short.
- Measure resistance.

Is there an open or a short?

Yes	No
REPAIR circuit 198 (T/Y). RETEST system.	GO to **D12** .

D12 CHECK THE WOT CUTOUT RELAY

- Perform the Relay component test for the WOT cutout relay in this section.

Is the relay OK?

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Yes	No
GO to **D13** .	REPLACE the WOT cutout relay. RETEST system.

D13 CHECK THE A/C CLUTCH FIELD COIL

- Disconnect the A/C clutch field coil.
- Using a Rotunda 73 Digital Multimeter 105-R0051, check the resistance between the A/C clutch field coil terminals.
- Measure resistance.

Is the resistance 5 ohms or less?

Yes	No
GO to **D14** .	REPLACE the A/C clutch field coil. RETEST system.

D14 CHECK CIRCUIT 347 (BK/Y)

- Using Rotunda 73 Digital Multimeter 105-R0051, check circuit 347 (BK/Y) between the WOT cutout relay and the A/C clutch field coil for an open, and check circuit 347 (BK/Y) between the WOT cutout relay and known good ground.
- Measure resistance.

Is there an open or a short?

Yes	No
REPAIR circuit 347 (BK/Y) as necessary. RETEST system.	GO to **D15** .

D15 CHECK A/C CLUTCH GROUND CIRCUIT

- Using an ohmmeter, Rotunda 73 Digital Multimeter 105-R0051 or equivalent, connected to ground, connect second lead to Circuit 57 (BK) at A/C clutch field coil connector.
- Measure resistance.

Is resistance 5 ohms or less?

Yes	No
REFER to Section 3A of the Powertrain Control/Emission Diagnostic Manual for diagnosis and testing of the powertrain control module (PCM).	SERVICE Circuit 57 (BK) for open circuit. RESTORE vehicle. RETEST system.

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D16 CHECK A/C CLUTCH CYCLING

- Use refrigerant system pressure/clutch cycle rate and timing evaluation charts.
- After preparing vehicle as follows:
  - Connect manifold gauge set, Rotunda R134a Manifold Gauge Set 176-R032A or equivalent.
  - Set function control at MAX A/C.
  - Set blower switch on HIGH.
  - Set temperature lever full COLD.
  - Close doors and windows.
  - Use a thermometer to check temperature at center discharge register, record outside temperature.
  - Run engine at approximately 1500 rpm with A/C clutch engaged.
  - Stabilize with above conditions for 10-15 minutes.
- Check A/C clutch on/off time with watch. Refer to charts for normal clutch cycle timing rates.

Did A/C compressor cycle very rapidly?

Yes	No
If Aerostar, GO to **D17** . If Ranger, DISCHARGE system and service as outlined. RETEST system.	System OK.

D17 CHECK CLUTCH CYCLING SWITCH

- Using a jumper wire, bypass A/C cycling switch.
- Hand feel A/C evaporator inlet and outlet tubes.

Is outlet tube approximately same temperature -2°C, 4°C (28°F, 40°F) or slightly colder than inlet tube?

Yes	No
REPLACE A/C cycling switch. Do not discharge system. Switch has a Schrader valve. RESTORE vehicle. RETEST system.	DISCHARGE system and SERVICE as outlined. RETEST system.

PINPOINT TEST E: A/C ALWAYS ON

E1 TEST FUNCTION CONTROL OPERATION

- Place function control lever in OFF position.
- Turn ignition switch to RUN position.
- Check for voltage using Rotunda 73 Digital Multimeter 105-R0051 or equivalent between function control and A/C low pressure switch Ranger or A/C cycling switch Aerostar.

Is voltage present?

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Yes	No
REPLACE function control switch.	GO to **E2** .

E2 CHECK FOR VOLTAGE AT COMPRESSOR

- Place function control lever in OFF position.
- Turn ignition switch to RUN position.
- Check for voltage at A/C compressor.

Is voltage present?

Yes	No
CHECK electrical circuits for exposed wires, chafing or exposed connectors. CORRECT all suspected sources. RETEST system.	System OK. EXPLAIN system operation to owner. INFORM owner that the A/C compressor operates in defrost mode as well as all A/C modes.

PINPOINT TEST F: INSUFFICIENT A/C COOLING

F1 CHECK COOLING OPERATION

Is the A/C system cooling properly?

Yes	No
EXPLAIN system operation to owner.	GO to **F2** .

F2 CHECK A/C COMPRESSOR CLUTCH

Does the A/C clutch engage?

Yes	No
GO to **F3** .	REFER to Pinpoint Test D .

F3 CHECK UNDER HOOD

- Check underhood for:
  - Low engine speed.
  - Fan shroud misalignment.
  - Fan clutch damage.
  - Engine cooling fan damage.
  - Airflow obstructions in front of grille or between the fins of theA/C condenser core or radiator.

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- In-vehicle check for:
  - Blown fuse/proper operation of heater blower motor switch.
  - Electrical connections at the A/C control.

Does underhood check show a concern?

Yes	No
REPAIR CONCERN and GO to **F4** .	GO to **F5** .

F4 CHECK SYSTEM OPERATION

- Check system operation.

Is the A/C system cooling properly?

Yes	No
Condition corrected. GO to **F1** .	GO to **F5** .

F5 CHECK PRESSURE/CYCLE RATE

- Use Refrigerant System Pressure/Cycle Rate And Timing Evaluation Charts .
  - Connect gauge set, Rotunda 176-R032A or equivalent.
  - Set function at MAX A/C.
  - Set heater blower motor switch on HIGH.
  - Set temp lever full cool.
  - Close doors and windows.
  - Use a thermometer to check temperature at center discharge register. Record outside temperature.
  - Run engine at approximately 1500 rpm with A/C clutch engaged.
  - Stabilize at 23.9℃ (75℉) interior temperature wit h above conditions for 10-15 minutes.
- Check OFF/ON time of A/C clutch with watch. See Charts for normal cycle and timing rates.

Is cycling rate OK?

Yes	No
GO to **F6** .	GO to **F7** .

F6 CHECK PRESSURES

- Check system pressures.
- Compare readings with normal system pressure ranges.

Are system pressures normal?

Yes	No

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System OK. GO to **F1** .	GO to Refrigerant System Pressure and Timing Evaluation Chart in this section and COMPARE observed pressures with chart. REPAIR as required and GO to **F4** . If A/C compressor cycles high or low (ON above 259 kPa [52 psi], OFF below 144 kPa [21 psi]) GO to **F7** .

F7 CHECK FOR LEAKS

- Leak check system.

Is leak found?

Yes	No
SERVICE, LEAK TEST, EVACUATE and CHARGE system. GO to **F1** .	Low refrigerant charge or moisture in system. DISCHARGE, EVACUATE and CHARGE system. GO to **F4** .

PINPOINT TEST G: NO OPERATION IN ALL FUNCTION SETTINGS

G1 TEST FUSE

- Check fuse for continuity using Rotunda 73 Digital Multimeter 105-R0051 or equivalent.

Does fuse test OK?

Yes	No
GO to **G2** .	REPLACE fuse with another of equal amperage rating. RETEST system.

G2 TEST FEED CIRCUIT

- Turn ignition switch to RUN position.
- Place function control lever in any ON position.
- Check for voltage from instrument panel fuse to A/C control circuit.

Is voltage present?

Yes	No
GO to **G3** .	LOCATE and SERVICE open or short in circuit. RETEST system.

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G3 TEST FUNCTION CONTROL SWITCH

- Turn ignition switch to RUN position.
- Place function control lever to any ON position.
- Test for voltage between function control and blower motor switch.

Is voltage present?

Yes	No
Condition is intermittent. ATTEMPT to recreate condition by wiggling wires, connectors, crimps, etc. Also CYCLE function control lever. SERVICE system fault as necessary.	REPLACE function control switch. RETEST system.

PINPOINT TEST H: BLOWER MOTOR DOES NOT OPERATE

H1 CHECK BLOWER MOTOR OPERATION

- Turn ignition switch to ON, function selector switch to FLOOR and blower knob to HI.

Does blower motor operate?

Yes	No
GO to **H2** .	GO to **H4** .

H2 CHECK BLOWER LO SPEED

- Rotate blower knob to LO.

Does blower motor operate?

Yes	No
WIGGLE wires and CHECK for intermittent operation. REPAIR if necessary.	GO to **H3** .

H3 CHECK BLOWER MOTOR RESISTOR

- CHECK heater blower motor switch resistor for continuity of coils and thermal limiter.

Is resistor good?

Yes	No
CHECK Circuit 261 (O/BK) from blower motor to	

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heater blower motor switch resistor and if Aerostar, check Circuit 57 (BK) from heater blower motor switch resistor to ground. If Ranger, check Circuit 260 (R/O) from heater blower motor switch resistor for open or short to ground. REPAIR as necessary.	REPLACE heater blower motor switch resistor and CHECK blower motor operation.

H4 CHECK BLOWER MOTOR

- Turn ignition switch off.
- Ground Circuit 261 (O/BK) at the blower motor.
- Position function selector knob at FLOOR and turn key to RUN long enough to check for blower motor operation.

Does blower motor operate?

Yes	No
CHECK CIrcuit 261 (O/BK) between blower motor and the splice to blower motor switch and heater blower motor switch resistor for an open. REPAIR as necessary.	If Ranger, GO to **H5** . If Aerostar, GO to **H6** .

H5 CHECK THE BLOWER MOTOR RELAY

- Disconnect the blower motor relay.
- Perform the Relay component test for the blower motor relay. Refer to component test in this section.

Is the relay OK?

Yes	No
GO to **H6** .	REPLACE the blower motor relay. RETEST system.

H6 CHECK FUSE

- Check blower motor fuse.

Is fuse OK?

Yes	No
GO to **H7** .	GO to **H10** .

H7 CHECK THE CIRCUITS FOR VOLTAGE

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- If Aerostar, disconnect the A/C heater control assembly.
- If Ranger, check Circuit 364 (BK/LG) between the blower motor relay and known good ground for both (BK/LG) wires when in the RUN position.
- If Aerostar, check Circuit 181 (BR/O) between the A/C heater control assembly and known good ground when in the RUN position.
- Measure voltage.

Is or are the voltage(s) 10 volts or greater?

Yes	No
GO to **H8** .	REPAIR circuit(s) as necessary. RETEST system.

H8 CHECK CIRCUIT 371 (PK/W) OR 249 (DB/LG)

- Disconnect the blower motor.
- If Aerostar, check Circuit 249 (DB/LG) between A/C heater control assembly and the blower motor for an open.
- If Ranger, check Circuit 371 (PK/W) between blower motor relay and blower motor for an open.

Is there an open?

Yes	No
SERVICE as necessary. RETEST system.	GO to **H9** .

H9 CHECK THE BLOWER MOTOR

- Perform the Blower Motor Check in this section.

Is the blower motor OK?

Yes	No
If Aerostar, REPLACE the A/C heater control. If Ranger, SERVICE Circuit 260 (R/O). If OK, REPLACE the A/C heater control. RETEST system.	REPLACE the blower motor. RETEST system.

H10 CHECK CIRCUIT(S) 364 (BK/LG) OR 181 (BR/O)

- If Aerostar, disconnect the A/C heater control.
- If Ranger, disconnect the blower motor relay.
- If Aerostar, check Circuit 181 (BR/O) for a short.
- If Ranger, check Circuit 364 (BK/LG) for a short.

Is there a short?

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Yes	No
SERVICE as necessary. RETEST system.	If Ranger, GO to **H11**. If Aerostar, GO to **H12**.

H11 CHECK THE BLOWER MOTOR RELAY FOR NORMAL OPERATION

- Perform the Blower Motor Relay Check as discussed in this section.

Is the relay OK?

Yes	No
GO to **H12**.	REPLACE the blower motor relay. RETEST system.

H12 CHECK CIRCUIT 371 (PK/W) OR 249 (DB/LG)

- Disconnect blower motor.
- If Ranger, check Circuit 371 (PK/W) for a short between the blower motor and ground.
- If Aerostar, check Circuit 249 (DB/LG) for a short between the blower motor and ground.

Is there a short?

Yes	No
SERVICE as necessary. RETEST system.	If Ranger, REPLACE blower motor. RETEST system. If Aerostar, GO to **H13**.

H13 CHECK THE BLOWER MOTOR FOR A SHORT

- Reconnect blower motor.
- Place a jumper wire between the A/C heater control Circuit 181 (BR/O) and Circuit 249 (DB/LG).
- Turn the ignition to the RUN position. Do this for 10 seconds and turn off.

Does fuse 9 (30A) fail?

Yes	No
REPLACE the blower motor. RETEST system.	REPLACE the A/C heater control. RETEST system.

PINPOINT TEST J: BLOWER MOTOR RUNS CONSTANTLY

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J1 TEST OPERATION

- Turn ignition switch to RUN position.
- Place function control lever in the OFF position.

Does blower motor run?

Yes	No
GO to **J2** .	System OK. EXPLAIN proper operation to owner.

J2 TEST FUNCTION CONTROL

- Remove A/C control from instrument panel far enough to gain access to electrical connectors.
- Turnignition switch to ON position.
- Place function control lever in the OFF position.
- Test for voltage using Rotunda 73 Digital Multimeter 105-R0051 or equivalent. Check Circuit 371 (PK/W) for Ranger, Circuit 249 (DB/LG) for Aerostar.

Is voltage present?

Yes	No
REPLACE function selector switch for Aerostar. REPLACE blower motor relay for Ranger. RETEST system.	CHECK all adjacent wiring and connectors for exposed wires. SERVICE as necessary.

PINPOINT TEST K: NO OPERATION IN LOW BLOWER SETTING

K1 TEST SYSTEM OPERATION

- Place function control lever in any ON position.
- Turn blower motor switch to LO position.
- Turn ignition switch to RUN position and listen for blower motor operation.

Does blower motor operate in LO speed?

Yes	No
System OK.	GO to **K2** .

K2 TEST BLOWER MOTOR SWITCH

- Perform the Heater Blower Motor Switch Components Test in this section.

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NOTE: Make certain ignition is in OFF position while performing this test.

Does switch test as continuous?

Yes	No
GO to K3 .	REPLACE blower motor switch. RETEST system.

K3 TEST BLOWER MOTOR RESISTOR

- Turn ignition switch to OFF position.
- Test heater blower motor switch resistor for continuity using Rotunda 73 Digital Multimeter 105-R0051 or equivalent.

Does resistor test as continuous?

Yes	No
If Aerostar, LOCATE and SERVICE open in Circuit 260 (R/O) or Circuit 57 (BK). If Ranger, LOCATE and SERVICE open in Circuit 754 (LG/W).	REPLACE heater blower motor switch resistor.

PINPOINT TEST L: NO OPERATION IN MEDIUM BLOWER SETTING

L1 TEST SYSTEM OPERATION

- Place function control lever in any ON position.
- Turn ignition switch to RUN position.
- Cycle blower motor switch between MED/LOW and MED/HI. Listen for blower motor operation.

Does blower motor operate in MEDIUM settings?

Yes	No
System OK.	GO to L2 .

L2 TEST BLOWER MOTOR SWITCH

CAUTION: The ignition switch must remain in the OFF position while performing this test.

- Remove A/C control from instrument panel far enough to gain access to electrical connectors.
- Connect Rotunda 73 Digital Multimeter 105-R0051 or equivalent to Circuit 57 (BK) and Circuit 752 (Y/R) (Ranger) or 269 (LB/O) (Aerostar).

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- Position blower motor switch in the MED/HI position and check for continuity.
- Repeat test steps on Circuit 57 (BK) and 754 (LG/W) or 260 (R/O) with blower motor switch in the MED/LO position.

Does switch test as continuous?

Yes	No
GO to **L3** .	REPLACE blower motor switch. RETEST system.

L3 TEST BLOWER MOTOR RESISTOR

- Test heater blower motor switch resistor for continuity using Rotunda 73 Digital Multimeter 105-R0051 or equivalent.

Does resistor test as continuous?

Yes	No
LOCATE and SERVICE open in Circuit 754 (LG/W), Circuit 752 (Y/R) Circuit 269 (LB/O) or Circuit 260 (R/O). RETEST system.	REPLACE heater blower motor switch resistor. RETEST system.

PINPOINT TEST M: NO OPERATION IN HIGH BLOWER SETTING

M1 CHECK BLOWER MOTOR OPERATION

- Turn ignition switch to RUN, function selector knob to FLOOR and blower knob to first position from HI.

Does blower motor operate?

Yes	No
GO to **M2** .	GO to **M4** .

M2 CHECK BLOWER SPEED

- Turn blower knob to HI.

Does blower motor operate on HI?

Yes	No
CYCLE blower switch from HI to LO several times. If blower motor operates each time, ADVISE owner of system operation. If blower motor does not operate in HI each time,	GO to **M3** .

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REPLACE blower switch.	

M3 CHECK BLOWER SWITCH

- Check continuity of blower switch.
- Perform the Heater Blower Motor Switch Component Test in this section.

Is switch continuous in all positions?

Yes	No
SERVICE Circuit 261 (O/BK).	REPLACE blower motor switch.

M4 CHECK BLOWER SPEEDS (LO/HI)

- With ignition in RUN and function selector knob at FLOOR, rotate blower knob to LO and then one position toward HI.

Does blower motor operate in both positions?

Yes	No
INSPECT harness connector at blower switch. REPLACE harness connector if damaged. If OK, REPLACE blower switch.	GO to **M5** .

M5 CHECK BLOWER SPEEDS (LO)

- Reference blower motor speeds in Step M4 .

Does blower motor operate in LO?

Yes	No
GO to **M6** .	REPLACE heater blower motor switch resistor.

M6 CHECK BLOWER SWITCH CONNECTOR

- Check to ensure connector is correctly and securely connected to blower switch.

Is connector properly attached to blower switch?

Yes	No
REPLACE blower switch.	RECONNECT and CHECK blower motor operation.

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PINPOINT TEST N: NOISE WHILE OPERATING CLIMATE CONTROL SYSTEM

N1 CHECK CONNECTORS

- Check in-line and control assembly multiple connectors for proper connection.

Does hiss stop?

Yes	No
RECHECK system for proper operation.	GO to **N2** .

N2 DETERMINE LEAKING VALVE

- Rotate function knob to determine what A/C damper door switch positions are leaking.

Do all positions leak?

Yes	No
GO to **N3** .	GO to **N5** .

N3 CHECK SOURCE TUBE

- Check A/C vacuum tank hose (black) from A/C vacuum reservoir tank and bracket to control assembly for cut or disconnection.

Does hiss stop?

Yes	No
SERVICE A/C vacuum tank hose. RECHECK system for proper operation.	GO to **N4** .

N4 PINCH OFF SOURCE TUBE

- Pinch off A/C vacuum tank hose (black) at control assembly.

Does hiss stop?

Yes	No
REPLACE A/C damper door switch valve. RECHECK system for proper operation.	RECHECK A/C vacuum tank hose (black), connections, A/C vacuum reservoir tank and bracket and A/C vacuum check valve. SERVICE or REPLACE as required.

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N5 DETERMINE LEAKING HOSE(S)

- Determine what color hose(s) is used in leaking A/C damper door switch position(s).
- Pinch off suspect hose(s), one at a time, near each respective vacuum control motor.

Does hiss stop?

Yes	No
CHECK hose connection to vacuum control motor and SERVICE and/or RECONNECT if loose or split. RECHECK for hiss. If hiss still continues, REPLACE vacuum control motor. RECHECK system for proper operation. **CAUTION: Never manually operate any vacuum control motor or vacuum control motor door — this may cause internal damage to the vacuum control motor diaphragm.**	GO to **N6** .

N6 PINCH OFF SUSPECT HOSE(S)

- Pinch off suspect hose(s), one at a time, near control assembly and/or in-line connector.

Does hiss stop?

Yes	No
CHECK hose for cut or damage. SERVICE as required. RECHECK system for proper operation.	REPLACE A/C damper door switch.

PINPOINT TEST P: NOISE WHILE NOT OPERATING CLIMATE CONTROL SYSTEM

P1 CHECK FOR NOISE SOURCE

- Visually inspect all drive belts and component mounting brackets for proper installation and tightness.
- Start engine and turn A/C system to the OFF position.
- Listen for source of noise.

Is hiss noise in climate control system?

Yes	No
GO to **P2** .	System operation OK at this time.

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P2 CHECK CLIMATE CONTROL OPERATION

- Operate A/C control in all positions.
- Note the pitch and approximate source of noise.

Is the noise still present?

Yes	No
SERVICE leaking vacuum hose as necessary and/or REPLACE function select or switch.	System operation OK at this time.

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Component Tests

Heater Blower Motor Switch

To test the heater blower switch for continuity, connect Rotunda 73 Digital Multimeter 105-R0051 or equivalent and proceed with the following steps.

RANGER/AEROSTAR

To Test	Connect to Terminal		Move Switch to Position	A Good Switch Will Indicate
	Aerostar	Ranger		
Low Speed	57 (BK) 260 (R/O) 269 (LB/O) 261 (O/BK)	260 (R/O) 754 (LG/W) 752 (Y/R) 261 (O/BK)	LO	Open Circuit Open Circuit Open Circuit Open Circuit
Med/Low Speed	57 (BK) 260 (R/O) 269 (LB/O) 261 (O/BK)	260 (R/O) 754 (LG/W) 752 (Y/R) 261 (O/BK)	Med/Low	Open Circuit Closed Circuit Open Circuit Open Circuit
Med/High Speed	57 (BK) 260 (R/O) 269 (LB/O) 261 (O/BK)	260 (R/O) 754 (LG/W) 752 (Y/R) 261 (O/BK)	Med/High	Open Circuit Open Circuit Closed Circuit Open Circuit
High Speed	57 (BK) 260 (R/O) 269 (LB/O) 261 (O/BK)	260 (R/O) 754 (LG/W) 752 (Y/R) 261 (O/BK)	HI	Open Circuit Open Circuit Open Circuit Closed Circuit

Heater Core

Plugged Heater Core

Check to make sure the engine coolant is at the proper level, then start the engine and let it run until it is warmed to operating temperature. Turn on the heater, feel the inlet and outlet heater water hose (18472) connected to the heater core. If the inlet heater water hose is hot and outlet heater water hose is cooler, the heater core may be plugged.

Leak Test, Aerostar

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SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Heater Hose Disconnect Tool	T85T-18539-AH

1. Inspect for visible evidence of coolant leakage at the heater water hose to heater core. A coolant leak at the heater water hose could follow the tube on the heater core and appear as a leak in the heater core.

2. For front heater core, remove the heater water hoses at the heater core using Heater Hose Disconnect Tool T85T-18539-AH.

3. Check for damaged or missing O-rings. Replace if necessary and install heater water hoses by pushing heater water hose on tube until connector snaps in place over white heater hose quick connect couplings (18D434). Check tubes for damage. If damaged, replace heater core. Refer to Section 12-03B . Install heater water hoses.

4. For auxiliary core, check the system for loose heater hose clamps. The clamps should be tightened to 2-3 Nm (18-27 lb-in). If clamps are tight and leakage is found, check the heater core tubes for distortion. Severe distortion of the tubes could cause leakage at the hose connection. Replace heater core if necessary. Refer to Section 12-03D . Install heater water hoses.

Leak Test, Ranger

1. Inspect for visible evidence of coolant leakage at the heater water hoses to heater core. A coolant leak at the heater water hose could follow the heater core tube in the heater core and appear as a leak in the heater core.

2. Check the system for loose heater hose clamps. The clamps should be tightened to 2-3 Nm (18-27 lb-in).

3. If leakage is found and the hose clamps are tight, check the heater core tubes for distortion. Severe distortion of the tubes could cause leakage at the hose connection.

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Pressure Test

1. Drain the coolant from the cooling system.

2. Disconnect the heater water hoses (18472) from the heater core (18476).

3. Install a short piece of heater water hose (approximately 101.6mm [4 inches] long) on each 19.05mm (3/4-inch) heater core coupling. Connect couplings to heater core.

4. Fill the heater core and heater water hoses with water and install Plug BT-7422-B and Adapter BT-7422-A from Rotunda Radiator/Heater Core Pressure Tester or equivalent in the ends. Secure the heater water hoses, plug and adapter with hose clamps.

5. Attach the Rotunda Radiator/Heater Core Pressure Tester or equivalent to the adapter. Close the bleed valve at the base of the gauge and pump 206kPa (30 psi) of air pressure into the heater core.

6. Observe the pressure gauge for a minimum of three minutes. The pressure should not drop.

7. If the pressure does not drop, no leaks are indicated.

8. **NOTE: Severe distortion of the core tubes could cause leakage at the coupling connection; repair or replace as necessary.**

   If the pressure drops, check the coupling or hose connections to the core tubes for leaks. If the couplings or heater water hoses do not leak, remove the heater core from the vehicle and bench test the heater core.

Heater Core Leak Test (In-Vehicle)

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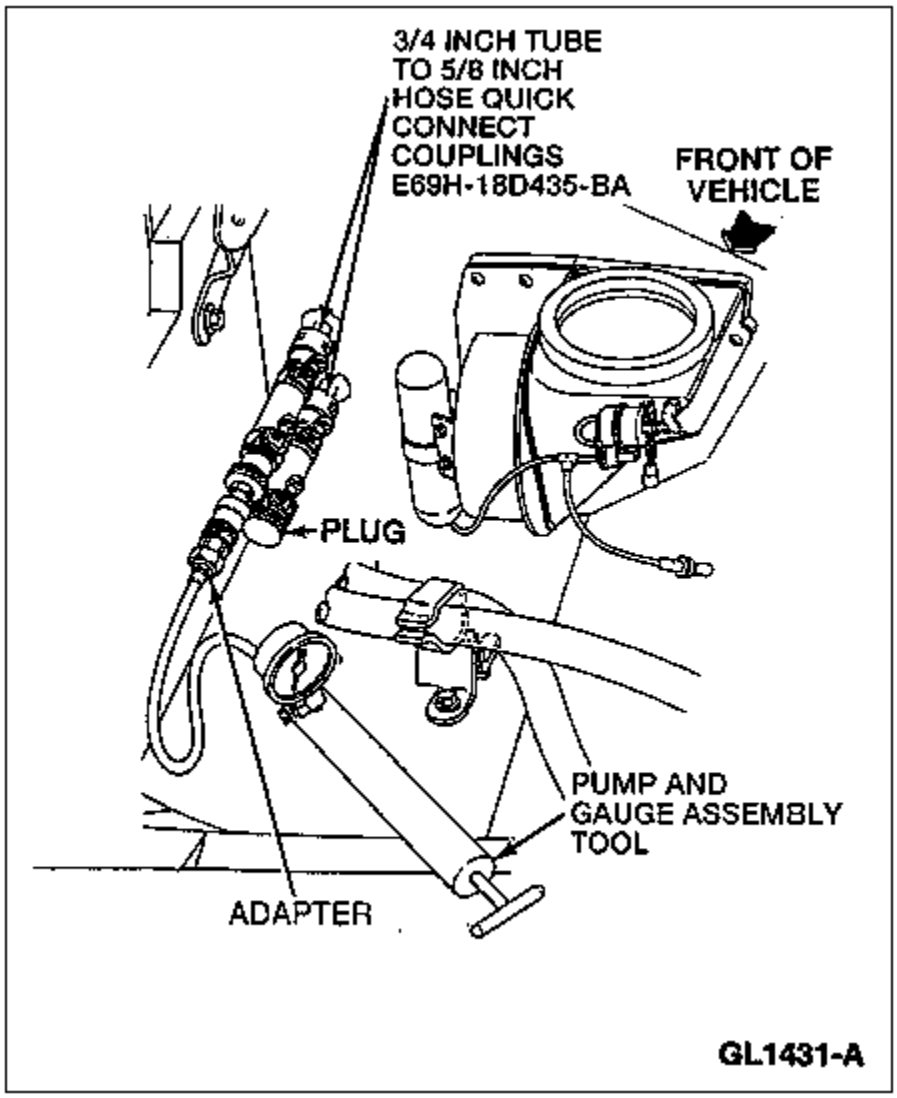

Bench Test

1. Drain all coolant from the heater core.
2. Connect the 101.6mm (4 in) test heater water hoses with plug and adapter to the core tubes. Then connect Rotunda Radiator/Heater Core Pressure Tester or equivalent to the adapter.
3. Apply 206 kPa (30 psi) of air pressure to the heater core with Rotunda Radiator/Heater Core Pressure Tester or equivalent and submerge the heater core in water.
4. If a leak is observed, repair or replace the heater core as necessary.

Heater Core Leak Test (On-Bench)

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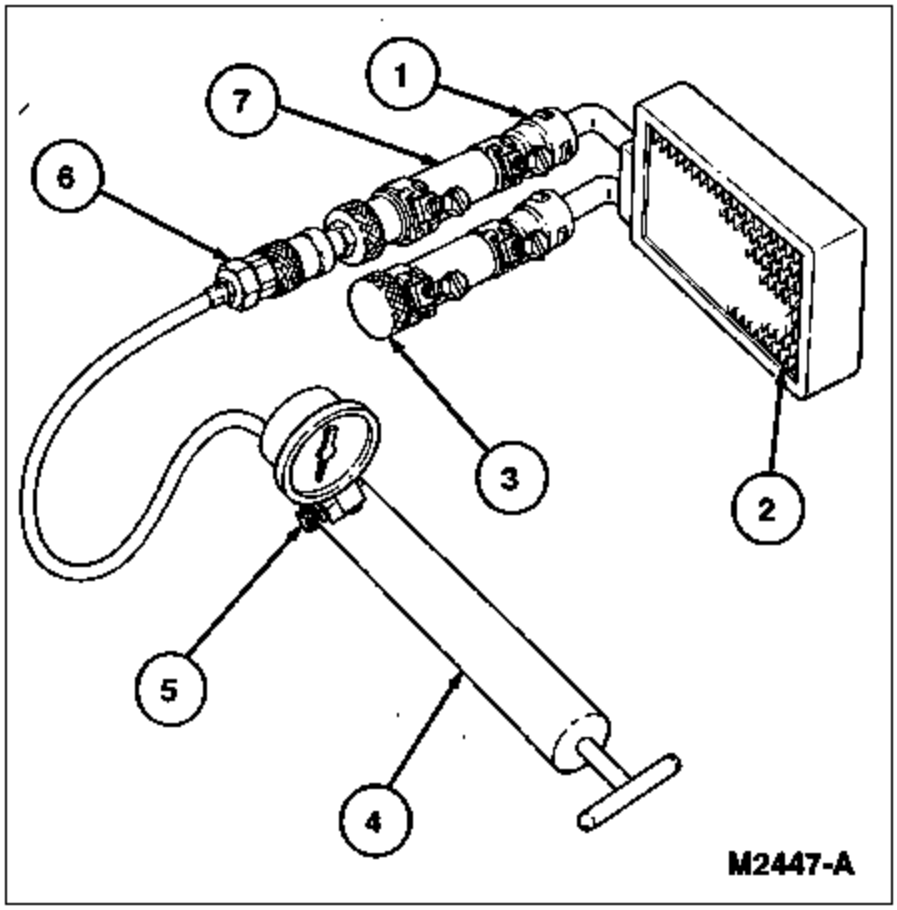

Item	Part Number	Description
1	18D435	3/4 Inch Tube to 5/8 Inch Hose Quick Connect Couplings
2	18476	Heater Core
3	7422	Plug
4	—	Radiator/Heater Core Pressure Tester
5	—	Bleed Valve
6	7422	Adapter
7	18472	Heater Water Hose

Leak Detector, Electronic

NOTE: Some vehicles may have signs of refrigerant oil at the spring lock couplers. This may be caused from the assembly process which applies oil to the fittings before installation to aid in assembly. When a spring lock coupler is suspected of leaking, always wipe the fitting clean and verify the leak with Rotunda R-134a Automatic Calibration Halogen Leak Detector 023-R1003 and Fluorescent Tracer Dye 164-R3704 and Tracer Dye Injector 164-R3711.

NOTE: All new systems contain detection dye. Leaks may be detected using ultra-violet light 164-

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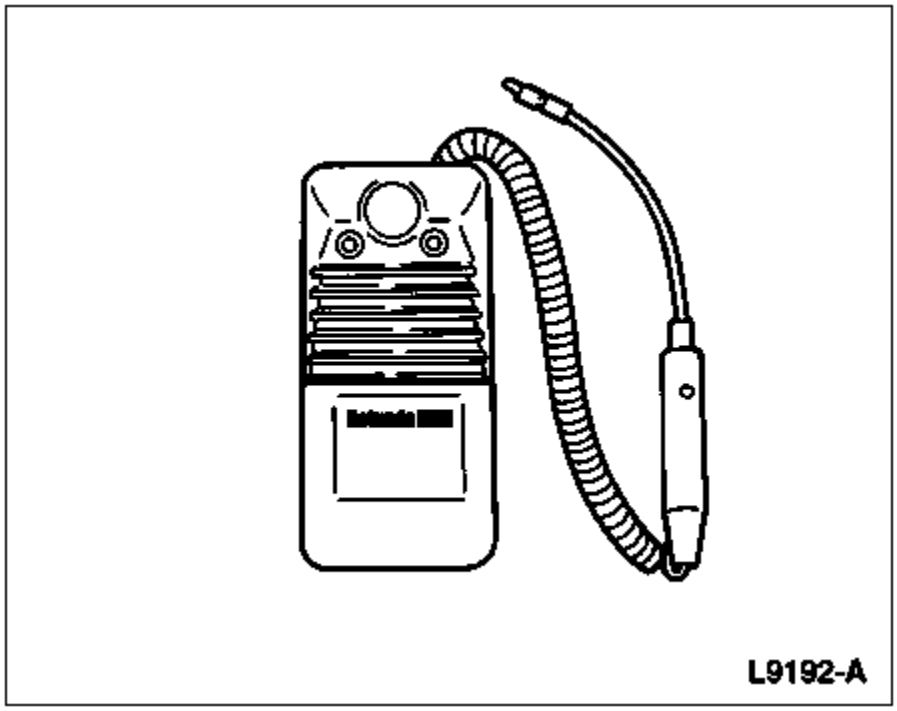
R0721.

Check all system connections, the compressor head gasket and shaft seal for leaks, using a good leak detector. Use Rotunda R-134a Automatic Calibration Halogen Leak Detector 023-R1003 or equivalent. Pass the leak detector along the underside of all points being checked. Refrigerant is heavier than air and will show most readily in those locations.

Operate leak detector according to manufacturer's directions.



Blower Motor

Current Draw Test

1. Disconnect the electrical wire harness from the blower motor (18527).

2. Connect ammeter such as Rotunda 73 Digital Multimeter 105-R0051 or equivalent, between the right (positive) terminal on the blower motor and the corresponding terminal of the wire harness connector. Connect a jumper wire between the left (ground) terminal on the blower motor and the corresponding terminal of the wire harness connector.

3. Place the system temperature control knob in the med-range position (halfway between COOL and WARM) and the function control knob in VENT position (air through registers).

4. With the battery fully charged, start the engine (6007) and operate the blower motor in all speeds. Record the current draw for each speed.

5. The current draw for each speed should be within the limits shown in Specifications at the end of this section.

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6. Disconnect the ammeter and jumper wire, reconnect the harness connector to the blower motor.

7. Check the system for proper operation.

Open Circuit Test

Electrical circuits are used to control the blower motor.

The heater blower motor switch and heater blower motor switch resistor (18591) are connected between the blower motor and ground. Battery voltage is available at the blower motor whenever the ignition switch (11572) is ON.

On all electrical circuits, continuity must exist from the source of power (battery), to the unit where the power is used, and back up to the source of power (ground). A check at each connection in a circuit, starting at the battery, will locate an open circuit or will show that the circuit is complete. Refer to the electrical schematic in the applicable section.

An ohmmeter or self-powered test light connected at any two points of a circuit with the power removed from the circuit will show if the circuit between the two connections is open or continuous.

If the meter does not move, or has a slight movement, (high resistance), the circuit may have a poor connection or broken wire. If the bulb does not light, the circuit is open.

If the meter movement is great or full (low resistance), the circuit is complete. If the bulb lights, the circuit is continuous.

Blower Motor Resistor

The heater blower motor switch resistor contains a non-serviceable thermal limiter. If the heater blower motor switch resistor does not pass a continuity test, it must be replaced.

Relay Component Test

Testing of an ISO relay can be accomplished through the use of three No. 10 (or larger gauge) jumper wires and a Rotunda 73 Digital Multimeter 105-R0051 or equivalent. Remove (unplug) the relay to be tested from the power distribution box, fuse junction panel or individual connector.

Mini ISO Relay

Using the multimeter, check for the continuity between terminal 85 and all other terminals. If resistance is 5 ohms or less between terminal 85 and any other terminal, replace the relay. If resistance is greater than 5 ohms, continue with the test. Using two jumper wires, connect relay terminals 86 and 30 directly to the positive battery terminal. Using the multimeter set in volts position, check for voltage at terminal 87A. If battery voltage is not indicated, replace the relay. If battery voltage is indicated, connect a third jumper wire to terminal 85 and ground the jumper wire to a known good ground. Check for voltage at terminal 87. If battery voltage is not indicated, replace the relay.

Micro ISO Relay

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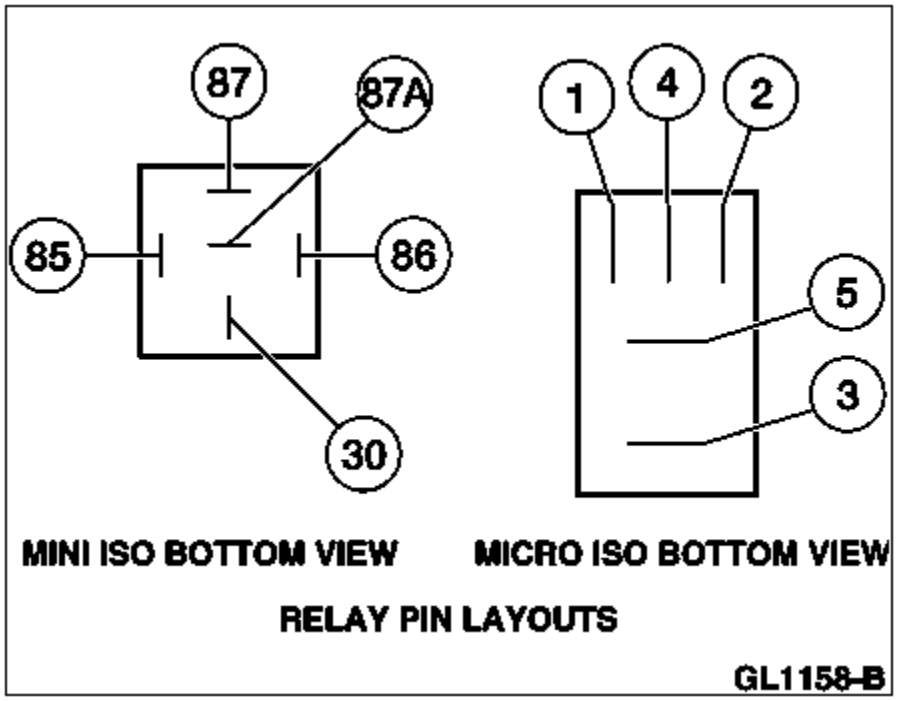
Using the multimeter, check for the continuity between terminal 2 and all other terminals. If resistance is 5 ohms or less between terminal 2 and any other terminal, replace the relay. If resistance is greater than 5 ohms, continue with the test. Using two jumper wires, connect relay terminals 1 and 3 directly to the positive battery terminal. Using the multimeter set in volts position, check for voltage at terminal 4. If battery voltage is not indicated, replace the relay. If battery voltage is indicated, connect a third jumper wire to terminal 2 and ground the jumper wire to a known good ground. Check for voltage at terminal 5. If battery voltage is not indicated, replace the relay.



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A/C System Check — Retail Procedure

NOTE: This Retail Procedure is not eligible for claiming on Ford paid repairs (warranty and ESP).

WARNING: CARBON MONOXIDE IS COLORLESS, ODORLESS AND DANGEROUS. IF IT IS NECESSARY TO OPERATE THE ENGINE WITH THE VEHICLE IN A CLOSED AREA SUCH AS A GARAGE, ALWAYS USE AN EXHAUST COLLECTOR TO VENT THE EXHAUST GASES OUTSIDE THE CLOSED AREA.

WARNING: R-134A IS CLASSIFIED AS A SAFE REFRIGERANT, BUT MISUSE CAN MAKE IT DANGEROUS. THE FOLLOWING PRECAUTIONS MUST BE OBSERVED:

- **ALWAYS WEAR SAFETY GOGGLES WHEN REPAIRING AN AIR CONDITIONING SYSTEM.**
- **AVOID CONTACT WITH LIQUID R-134A. R-134A VAPORIZES AT APPROXIMATELY -25 DEGREES C (-13 DEGREES F) UNDER ATMOSPHERIC PRESSURE AND IT WILL FREEZE SKIN TISSUE.**
- **NEVER ALLOW REFRIGERANT R-134A GAS TO ESCAPE IN QUANTITY IN AN OCCUPIED SPACE. R-134A IS NON-TOXIC, BUT IT WILL DISPLACE THE OXYGEN NEEDED TO SUPPORT LIFE.**
- **NEVER USE A TORCH IN AN ATMOSPHERE CONTAINING R-134A GAS. R-134A IS NON-TOXIC AT ALL NORMAL CONDITIONS, BUT WHEN IT IS EXPOSED TO HIGH TEMPERATURES, SUCH AS A TORCH FLAME, IT DECOMPOSES. DURING DECOMPOSITION IT RELEASES IRRITATION AND TOXIC GASES (AS DESCRIBED IN THE MSDS SHEET FROM THE MANUFACTURER). DECOMPOSITION PRODUCTS ARE HYDROFLUORIC ACID, CARBON DIOXIDE, AND WATER.**
- **DO NOT ALLOW ANY PORTION OF THE CHARGED AIR CONDITIONING SYSTEM TO BECOME TOO HOT. THE PRESSURE IN AN AIR CONDITIONING SYSTEM RISES AS THE TEMPERATURE RISES AND TEMPERATURES OF APPROXIMATELY 85 DEGREES C (185 DEGREES F) CAN BE DANGEROUS.**
- **ALLOW THE ENGINE TO COOL SUFFICIENTLY PRIOR TO CARRYING OUT MAINTENANCE OR SERIOUS BURNS AND INJURY CAN OCCUR.**

WARNING: AVOID CONTACT OF LIQUID R-12 WITH SKIN AND EYES. AT NORMAL ATMOSPHERIC PRESSURES AND TEMPERATURES, R-12 EVAPORATES SO QUICKLY THAT IT HAS THE TENDENCY TO FREEZE ANYTHING IT CONTACTS. SHOULD LIQUID REFRIGERANT COME IN CONTACT WITH THE EYES, IMMEDIATELY WASH WITH A FEW DROPS OF MINERAL OIL FOLLOWED BY A WEAK BORIC ACID SOLUTION. CONTACT A PHYSICIAN IMMEDIATELY.

WARNING: ALWAYS WEAR SAFETY GOGGLES WHEN SERVICING ANY PART OF THE REFRIGERANT SYSTEM. R-12 IS ALWAYS UNDER PRESSURE. BECAUSE THE SYSTEM IS TIGHTLY SEALED, HEAT APPLIED TO ANY PART OF THE SYSTEM WILL CAUSE EXCESSIVE PRESSURE BUILDUP. TO AVOID A DANGEROUS EXPLOSION, NEVER WELD, USE A BLOW TORCH, SOLDER, STEAM CLEAN, BAKE BODY FINISHES OR USE AN EXCESSIVE AMOUNT OF HEAT ON OR IN THE IMMEDIATE AREA OF ANY PART OF THE AIR COOLING SYSTEM OR REFRIGERANT SUPPLY TANK, WHILE CLOSED TO ATMOSPHERE, WHETHER FILLED WITH REFRIGERANT OR NOT.

WARNING: LIQUID REFRIGERANT EVAPORATES RAPIDLY, DISPLACING AIR WHERE THE REFRIGERANT IS RELEASED. TO PREVENT POSSIBLE SUFFOCATION IN ENCLOSED AREAS, DISCHARGE THE REFRIGERANT FROM AN AIR COOLING SYSTEM INTO THE GARAGE EXHAUST

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COLLECTOR. MAINTAIN GOOD VENTILATION SURROUNDING THE WORK AREA.

WARNING: ALTHOUGH R-12 GAS, UNDER NORMAL CONDITIONS, IS NON-POISONOUS, THE DISCHARGE OF REFRIGERANT GAS NEAR AN OPEN FLAME CAN PRODUCE A VERY POISONOUS GAS. IT IS GENERATED WHEN THE FLAME-TYPE LEAK DETECTOR IS USED. AVOID INHALING FUMES FROM THE LEAK DETECTOR. MAKE CERTAIN THAT R-12 IS STORED AND INSTALLED IN ACCORDANCE WITH ALL STATE AND LOCAL ORDINANCES.

CAUTION: To avoid damaging the vehicle or A/C components, the following precautions must be observed:

- **The A/C refrigerant of all vehicles must be identified and analyzed prior to refrigerant charging. Failure to do so can contaminate the shop bulk refrigerant and other vehicles.**
- **Do not add R-12 refrigerant to an A/C system that requires the use of R-134a refrigerant. These two types of refrigerant must never be mixed. Doing so can damage the A/C system.**
- **Charge the A/C system with the engine running only at the low-pressure side to prevent refrigerant slugging from damaging the A/C compressor.**
- **R-134a must not be mixed with air for leak testing or used with air for any other purpose above atmospheric pressure. R-134a is combustible when mixed with high concentrations of air and higher pressures.**
- **A number of manufacturers are producing alternative refrigerant products that are designed to be used instead of R-134a refrigerant. The use of any unauthorized substitute refrigerant can severely damage the A/C components. If repair is required, use only new or recycled refrigerant R-134a.**

CAUTION: To avoid contamination of the A/C system, always observe the following:

- **Keep service tools and the work area clean.**
- **Never open or loosen a connection before discharging the system.**
- **When loosening a connection, if any residual pressure is evident, allow it to leak out before opening the fitting.**
- **Evacuate a system that has been opened to install a new component or one that has been discharged through leakage before charging.**
- **Seal an open fitting with a cap or plug immediately after disconnecting a component from the system.**
- **Clean the outside of the fittings thoroughly before disconnecting a component from the system.**
- **Do not remove the sealing caps from a new component until ready to install.**
- **Refrigerant oil will absorb moisture from the atmosphere if left uncapped. Do not open an oil container until ready to use, and install the cap immediately after using. Store the oil in a clean, moisture-free container.**
- **Install a new O-ring seal before connecting an open fitting. Coat the fitting and the O-ring seal with refrigerant oil before connecting.**
- **When installing a refrigerant line, avoid sharp bends. Position the line away from the exhaust or any sharp edges that can chafe the line.**
- **Do not open a refrigerant system or uncap a new component unless it is as close as possible to room temperature. This will prevent condensation from forming inside a component that is cooler than the surrounding air.**

CAUTION: A number of manufacturers are producing refrigerant products which are described as being direct replacements for R-12. The use of any unauthorized substitute refrigerant may

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severely damage the A/C components. If service is required, use only new or recycled R-12.

NOTE: The engine should be run at idle for 10 minutes with the air conditioning on and set to MAX A/C before carrying out this retail procedure.

1. Visual inspection

   Open the hood and visually inspect the heating and air conditioning systems for the following:

   - Coolant reservoir for correct coolant level.
   - Heater hoses for deterioration or loose connections.
   - Radiator and condenser for debris or damaged fins restricting airflow, loose mounting or connections.
   - Accessory drive belt(s) and cooling fan(s) for wear or physical damage.
   - Refrigerant lines and connections for physical damage or loose connections.
   - Compressor for physical damage or loose connections.
   - Suction accumulator/drier for physical damage or loose connections.
   - Wiring and connectors for excessive wear, loose or damaged connections, or incorrect routing.

2. A/C refrigerant analysis

   - Carry out air conditioning refrigerant analysis as outlined in TSB # 98-12-08.
   - If the refrigerant fails the analysis, discontinue diagnosis and make recommendations for repairs.
   - If the refrigerant passes the analysis, carry out the air conditioning system check.

3. Air conditioning system check

   - Connect manifold gauge set or charging station with gauges to refrigerant system.
   - With the vehicle in park, parking brake set, thermometer installed in center panel vent, and air conditioning system on and set to MAX A/C, start the engine.
   - Record air refrigerant system pressures while running the engine at 1500 RPM and allow engine to return to idle.
   - Operate the blower motor in all control positions and check for correct blower speed changes.
   - With the blower motor on HI, operate air discharge mode selector in all positions and check for correct airflow in each position.
   - Operate the temperature blend selector in all positions and check for correct change in discharge temperature. Check the air discharge temperature with the selector in the coolest position and the air conditioning on and set to MAX A/C to determine if the air discharge temperature is acceptable for the current ambient air temperature.
   - Carry out the EATC self-test (if applicable).

   If the refrigerant system pressures were low, carry out the refrigerant system leak test.

4. Refrigerant system leak test

   - Pre-1995 vehicles - Use an electronic leak detector to check for leaks at all refrigerant lines, connections, and components.
   - 1995 and newer vehicles - Use either an ultraviolet (UV) or an electronic leak detector to check for leaks at all refrigerant lines, connections, and components.

   After all tests have been completed, report all findings and recommended repairs to your service advisor before carrying out further diagnostic procedures.

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A/C System Flushing

WARNING: USE EXTREME CARE AND OBSERVE ALL SAFETY AND SERVICE PRECAUTIONS RELATED TO THE USE OF REFRIGERANTS.

WARNING: DUE TO REFRIGERANT HAZARDS. ALWAYS WEAR SAFETY GOGGLES AND NON-PENETRABLE GLOVES WHEN WORKING ON OR FLUSHING A/C SYSTEMS.

CAUTION: A/C Refrigerant Analyzer must be used before the recovery of any vehicle's A/C refrigerant. Failure to do so puts the shop's bulk refrigerant at risk of contamination. If the vehicle's A/C refrigerant is contaminated, refer the customer to the service facility that performed the last A/C service. If the customer wishes to pay the additional cost, use the A/C recovery equipment that is designated for recovering contaminated A/C refrigerant. All contaminated A/C refrigerant must be disposed of as hazardous waste. For all equipment, follow the equipment manufacturer's procedures and instructions.

CAUTION: Suction accumulator/drier, muffler, hoses, thermal expansion valve, and fixed orifice tube should be removed when flushing the A/C system. Internal plumbing of these devices makes it impossible to properly remove any residual-flushing agent. Except for the hoses, these components are typically discarded after A/C system contamination. Hoses can normally be reused unless they are clogged with debris. The 3.78 liters (1 gal) of Ford A/C Flushing Solvent F4AZ-19579-A and FL1-A filter used in A/C Flusher, 219-00002 are intended for use on one vehicle only. They may be used to flush both the A/C condenser core and the A/C evaporator core on an individual vehicle, but under no circumstances should they be used on more than one vehicle.

1. **NOTE: Prior to using the A/C Flusher, 219-00002 for the first time, review the operating instructions.**

   NOTE: Only the A/C Flusher Kit,219-00002 which includes A/C Flusher, A/C Flusher Fitting Kit and the Ford Part number F4AZ-19579-A A/C system Flushing Solvent, is approved for use on Ford vehicles. No other flushing device or solvent is approved for flushing heat exchangers. Use of any other Flusher or solvent may cause damage to the A/C system and the flushing unit.

   Ford Motor Company has approved a procedure to provide technicians with a non-CFC method of flushing contaminated A/C system heat exchangers, A/C evaporator core, A/C condenser core. The procedure allows the specific components to be cleaned and flushed while installed in their normal in-vehicle location. The types of contamination flushed include particle matter that results from A/C compressor and/or desiccant failure within the suction accumulator/drier and gummy residue that may form when refrigerant oil is overheated during A/C compressor seizure. The flushing process is a two step procedure that involves the use of an A/C Flusher, 219-00002 to:

   - Circulate the flushing solvent through the heat exchanger in the reverse direction of normal refrigerant flow (back-flushing). Particulate matter picked up during flushing is filtered from the returning solvent before the solvent is returned to the reservoir for continued circulation.
   - Remove the flushing solvent from the heat exchanger. In this step of the procedure, pressurized air 621-862 kPa (90-125 psi) is used to push and/or evaporate any remaining flush solvent from the heat exchanger.

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2. Discharge the A/C system. Observe all safety precautions. For additional information, refer to the procedure in this section.

3. Disconnect the refrigerant lines from the heat exchanger(s) to be flushed.

4. Connect the A/C Flusher, 219-00002 and A/C System Flusher Fitting Kit to the heat exchanger to be flushed. Do not flush through the A/C evaporator core orifice, mufflers or hoses. Internal plumbing and material make-up of these components make it impossible to properly remove debris and/or residual flushing solvent.

5. Use four liters (one gallon) of Ford A/C Flushing part number F4AZ-195790A to flush the heat exchanger for a minimum of 15 minutes. The flush solvent may be used for one or both heat exchangers in the A/C system. However, the flush solvent is intended for one vehicle only. The filter is used on the flushing unit is also intended for use on one vehicle only.

6. Flush the component for a minimum of 15 minutes.

7. Apply 621-862 kPa (90-125psi) pressurized air to the component for a minimum of 30 minutes. The 30-minute purger time is required to force and/or evaporate all residual solvent from the A/C system component. Failure to successfully remove all residual solvent within the component can result in system damage when reconnected and operated. Dispose of the used flush solvent and filter in accordance with local, state and federal emissions.

8. **NOTE: A/C system filtering as described in this section is optional if system flushing is performed. However, the filter kit use is recommended after flushing if the A/C system contamination is extensive.**

   Replace the A/C evaporator core orifice in any vehicle being serviced for A/C compressor or desiccant failure.

9. Replace the refrigerant hoses if clogged with debris.

10. Reconnect the heat exchanger being serviced.

11. Add additional refrigerant oil as required. For additional information, refer to the procedure in this section.

12. Evacuate, leak test and charge the A/C system. For additional information, refer to the procedure in this section

13. Check the system for proper operation.

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Refrigerant System Tests

The following test conditions must be established to obtain accurate pressure readings:

- Run engine (6007) at 1500 rpm for 10 minutes.
- Operate air conditioning system on MAX air conditioning (recirculating air).
- Run blower motor (18527) at HI speed.
- Stabilize vehicle interior temperature at 21°C to 2 7°C (70°F to 80°F).

Service Access Gauge Port Valves

When attaching Rotunda R-134a Manifold Gauge Set 176-R032A or equivalent with quick disconnects Rotunda 176-R0026 and 176-R0027 or equivalents to the system, the low pressure gauge hose must be connected to the service access gauge port valve on top of the suction accumulator/drier (19C836). The high pressure service access gauge port valve is located in the discharge line near the A/C condenser core (19712).

Diagnosis of the refrigerant system must be done by analyzing the high pressure readings in the charts shown to determine if the system pressures are normal. The conditional requirements for the refrigerant systems tests must be satisfied to obtain accurate pressure readings.

Normal Cycling, Refrigerant System Center Register Temperature Range

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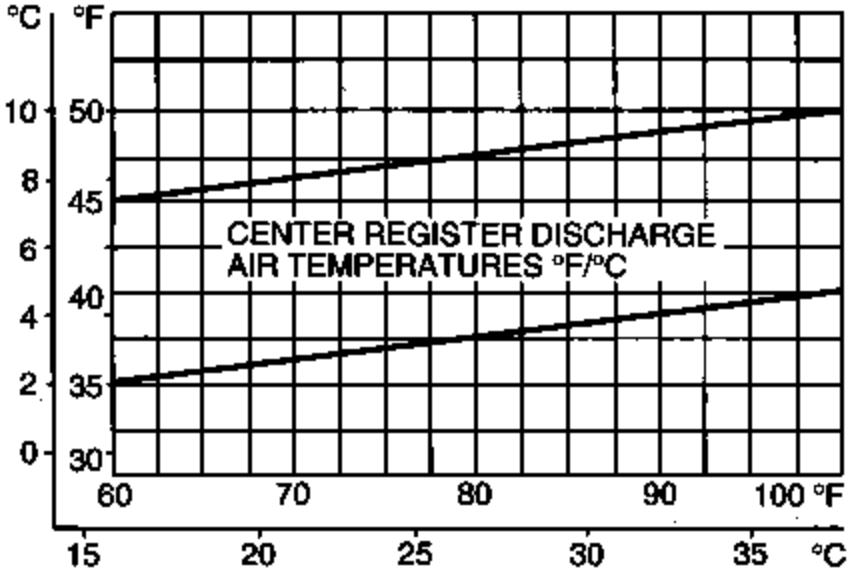
THESE CONDITIONAL REQUIREMENTS FOR THE CYCLING SYSTEM TESTS MUST BE SATISFIED TO OBTAIN ACCURATE PRESSURE READINGS.

- STABILIZED PRESSURES
- STABILIZED IN VEHICLE TEMPERATURES @ 70° TO 80°F (21° TO 27°C)
- MAXIMUM AIR CONDITIONING (RECIRCULATING AIR)
- MAXIMUM SPEED OF HEATER BLOWER MOTOR
- 1500 ENGINE RPM

NORMAL CENTER REGISTER DISCHARGE TEMPERATURES



Normal Cycling, Refrigerant System Pressure Ranges

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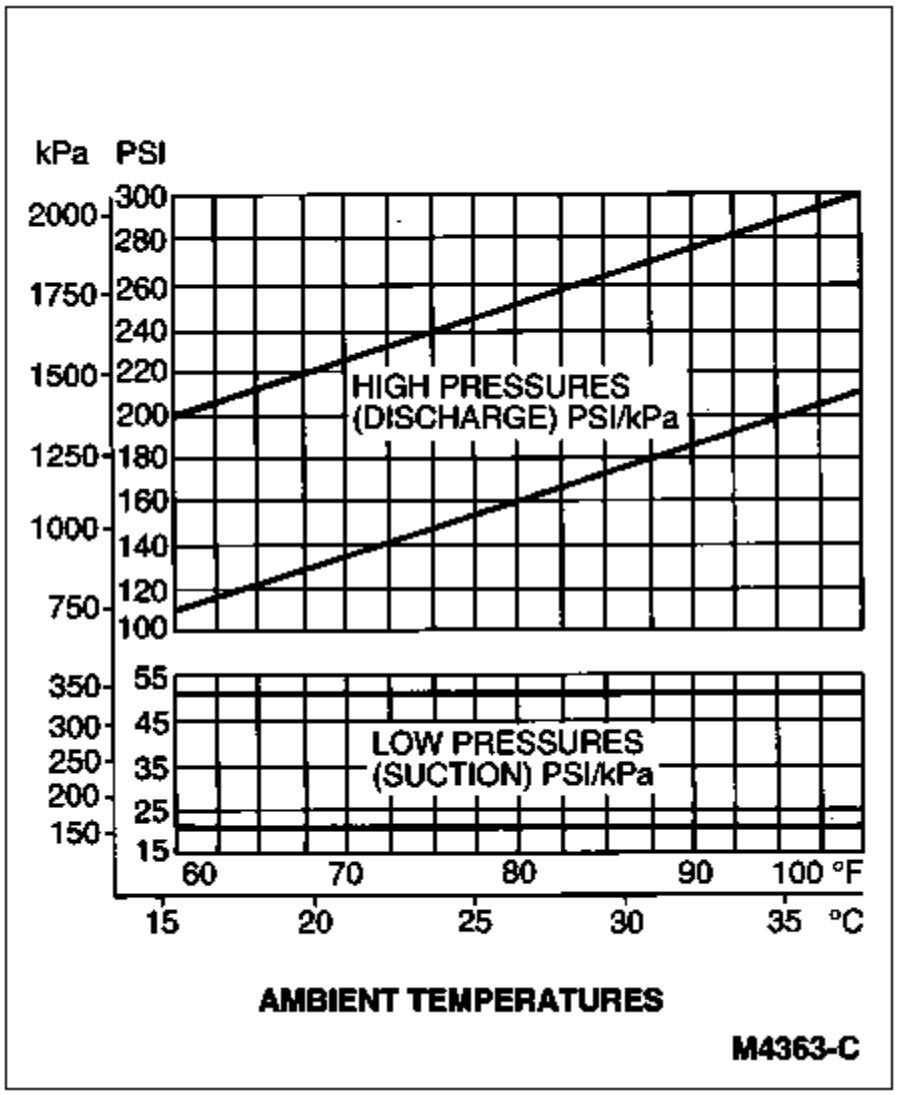

Normal On, Off and Total Cycling Time-Per-Second

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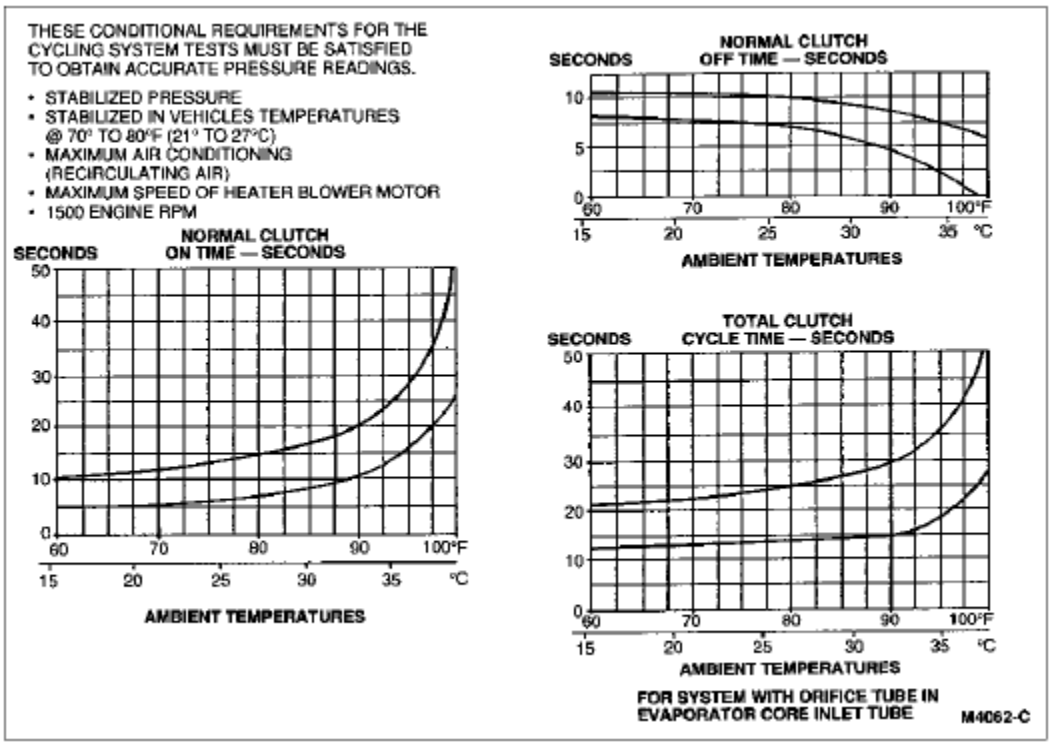

Refrigerant System Pressure and Timing Evaluation Chart

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NOTE: SYSTEM TEST REQUIREMENTS MUST BE MET TO OBTAIN ACCURATE TEST READINGS FOR EVALUATION. REFER TO THE NORMAL REFRIGERANT SYSTEM PRESSURE/TEMPERATURE AND THE NORMAL CLUTCH CYCLE RATE AND TIMES CHARTS.

HIGH (DISCHARGE) PRESSURE	LOW (SUCTION) PRESSURE	CLUTCH CYCLE TIME			COMPONENT – CAUSES
		RATE	ON	OFF	
HIGH	HIGH	CONTINUOUS RUN			CONDENSER – Inadequate Airflow
HIGH	NORMAL TO HIGH				ENGINE OVERHEATING
NORMAL TO HIGH	NORMAL				REFRIGERANT OVERCHARGE (a). AIR IN REFRIGERANT. HUMIDITY OR AMBIENT TEMP. VERY HIGH (b).
NORMAL	HIGH				FIXED ORIFICE TUBE – Missing O-Rings Leaking/Missing
NORMAL	NORMAL	SLOW OR NO CYCLE	LONG OR CONTINUOUS	NORMAL OR NO CYCLE	MOISTURE IN REFRIGERANT SYSTEM. EXCESSIVE REFRIGERANT OIL
NORMAL	LOW	SLOW	LONG	LONG	CLUTCH CYCLING SWITCH – Low Cut-Out
NORMAL TO LOW	HIGH	CONTINUOUS RUN			Compressor – Low Performance
NORMAL TO LOW	NORMAL TO HIGH				A/C SUCTION LINE – Partially Restricted or Plugged (c)
NORMAL TO LOW	NORMAL	FAST	SHORT	NORMAL	EVAPORATOR – Low or Restricted Airflow
			SHORT TO VERY SHORT	NORMAL TO LONG	CONDENSER, FIXED ORIFICE TUBE, OR A/C LIQUID LINE – Partially Restricted or Plugged
			SHORT TO VERY SHORT	SHORT TO VERY SHORT	LOW REFRIGERANT CHARGE
			SHORT TO VERY SHORT	LONG	EVAPORATOR CORE – Partially Restricted or Plugged
NORMAL TO LOW	LOW	CONTINUOUS RUN			A/C SUCTION LINE – Partially Restricted or Plugged (d). CLUTCH CYCLING SWITCH – Sticking Closed
ERRATIC OPERATION OR COMPRESSOR NOT RUNNING		–	–	–	CLUTCH CYCLING SWITCH – Dirty Contacts or Sticking Open. POOR CONNECTION AT A/C CLUTCH CONNECTOR OR CLUTCH CYCLING SWITCH CONNECTOR. A/C ELECTRICAL CIRCUIT ERRATIC – See A/C Electrical Circuit Wiring Diagram.

ADDITIONAL POSSIBLE CAUSE COMPONENTS ASSOCIATED WITH INADEQUATE COMPRESSOR OPERATION

- COMPRESSOR DRIVE BELT – Loose
- COMPRESSOR CLUTCH – Slipping
- CLUTCH COIL Open – Shorted, or Loose Mounting
- CONTROL ASSEMBLY SWITCH – Dirty Contacts or Sticking Open
- CLUTCH WIRING CIRCUIT – High Resistance, Open or Blown Fuse
- COMPRESSOR OPERATION INTERRUPTED BY ENGINE COMPUTER

ADDITIONAL POSSIBLE CAUSE COMPONENTS ASSOCIATED WITH A DAMAGED COMPRESSOR

- CLUTCH CYCLING SWITCH – Sticking Closed or Compressor Clutch Seized
- SUCTION ACCUMULATOR DRIER – Refrigerant Oil Bleed Hole Plugged
- REFRIGERANT LEAKS

(a) Compressor may make noise on initial run. This is slugging condition caused by excessive liquid refrigerant.
(b) Compressor clutch may not cycle in ambient temperatures above 80°F depending on humidity conditions.
(c) Low pressure reading will be normal to high if pressure is taken at accumulator and if restriction is downstream of service access valve.
(d) Low pressure reading will be low if pressure is taken near the compressor and restriction is upstream of service access valve.

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Checking for A/C Leaks

Avoid breathing A/C refrigerant and lubricant vapor or mist. If accidental system discharge occurs, ventilate the work area before resuming service.

WARNING: GOOD VENTILATION IS NECESSARY IN THE AREA WHERE A/C LEAK TESTING IS TO BE DONE. IF THE SURROUNDING AIR IS CONTAMINATED WITH REFRIGERANT GAS, THE LEAK DETECTOR WILL INDICATE THIS GAS ALL THE TIME. ODORS FROM OTHER CHEMICALS SUCH AS ANTIFREEZE, DIESEL FUEL, DISC BRAKE CLEANER OR OTHER CLEANING SOLVENTS CAN CAUSE THE SAME CONCERN. A FAN, EVEN IN A WELL-VENTILATED AREA, IS VERY HELPFUL IN REMOVING SMALL TRACES OF AIRBORNE CONTAMINATION THAT MIGHT AFFECT THE LEAK DETECTOR.

Attach the Rotunda R-134a Service Center 176-00001 or equivalent to the system. Leave both manifold gauge valves at the maximum open position. Both gauges should show approximately 413-551 kPa (60-80 psi) at 24°C (75°F) with engine not running.

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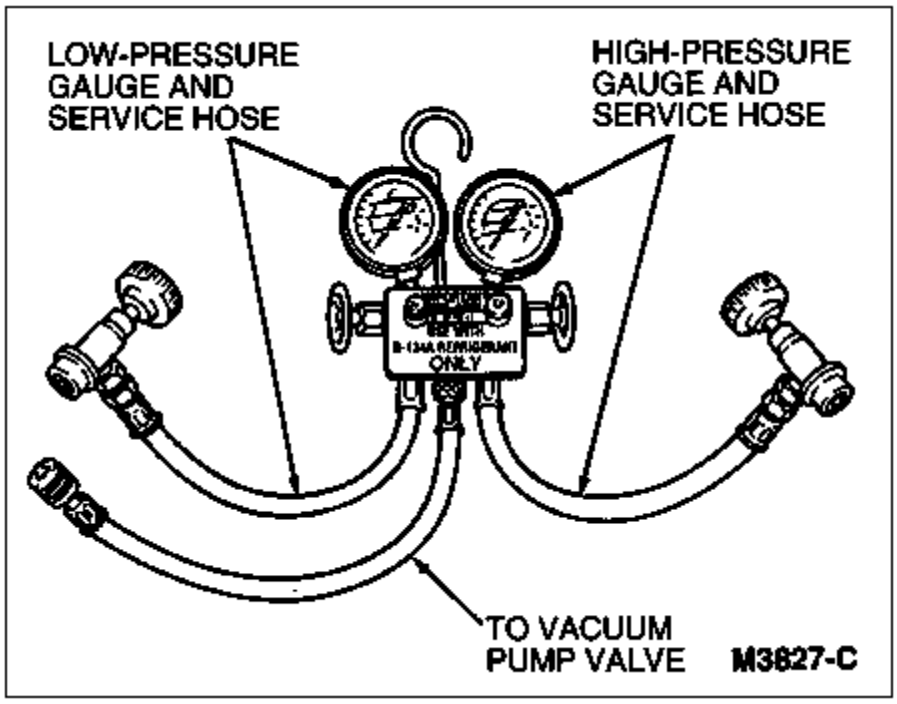

Leak Detector, Electronic

Check all system connections, the compressor head gasket and shaft seal for leaks, using a good leak detector. Use Rotunda R-134a Automatic Calibration Halogen Leak Detector or equivalent. Pass the leak detector along the underside of all points being checked. Refrigerant is heavier than air and will show most readily in those locations.

Operate leak detector according to manufacturer's directions.

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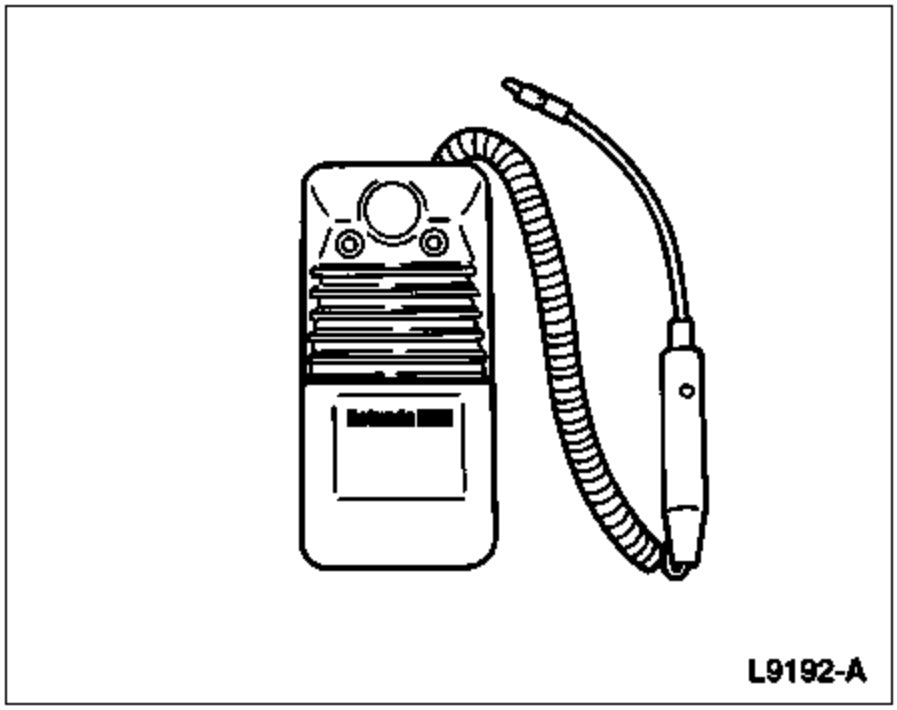

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A/C Evaporator Core and/or A/C Condenser Core

When performing leak tests of the A/C evaporator core (19860) with an electronic leak detector, test only at the evaporator core drain tube and the evaporator core refrigerant line connections. Do not attempt to leak test at the instrument panel A/C registers or inside the passenger compartment. Airflow from the blower motor (18527) and/or chemical odors inside the vehicle may cause false readings. This is especially important after the vehicle has sat in the sun and the interior temperature has risen above the ambient level.

If an A/C evaporator core leak is suspected, the leak test procedure should be performed before replacing the A/C evaporator core. Use of this leak test procedure will help to prevent unnecessary replacement of non-leaking A/C evaporator cores. If a leak is indicated at a refrigerant line connection to the A/C evaporator core, remove the refrigerant from the system and disassemble the fitting. Clean the fitting components and inspect for damage. Service as necessary.

NOTE: Use the previous procedure to also test the A/C condenser core (19712).

On-Vehicle Leak Test

Disconnect the liquid line and suction accumulator/drier (19C836) from the evaporator core tubes. **DO NOT** leak test an A/C evaporator core with the suction accumulator/drier attached to the A/C evaporator core. If the evaporator core tube fittings are the female spring lock design, check the inside of each fitting if possible for scratches and/or corrosion. If scratches or corrosion are found, the leak test results may not be accurate if a leak is indicated because of possible leaks at the fitting(s).

Connect the appropriate test fittings from Test Adapter Set D93L-19703-B or equivalent to the evaporator tube connections. Then, connect the gauge set RED and BLUE hoses to the test fittings. Connect the YELLOW gauge set hose to a known quality vacuum pump.

Before leak testing the A/C evaporator core, attach the high-side and low-side manifold gauge set hoses together and apply vacuum to verify the manifold gauge set and the hoses do not leak.

NOTE: The automatic shutoff valves on some gauge set hoses do not open when connected to the test fittings. Use hoses without shutoff valves if available. If hoses with shutoff valves are used, check to be sure the valve opens when attached to the test fittings before installing the fittings and proceeding with the leak test. The test is not valid if the shutoff valve does not open because only the hose will be tested.

Open both gauge set valves and start the vacuum pump. Turn the blower motor on low and allow the vacuum pump to operate for a minimum of 45 minutes after the gauge set low pressure gauge indicates 30 in-Hg. This evacuation is necessary to remove any refrigerant from oil left in the A/C evaporator core. If the refrigerant is not completely removed from the oil, gassing will occur and degrade the vacuum and appear as a refrigerant leak. After evacuating for 45 minutes, close the gauge set valves and stop the vacuum pump. Observe the low pressure gauge. It should remain at the 30 mark.

NOTE: Use only a known quality vacuum pump. Make sure pump is maintained according to manufacturer's directions.

If the low-pressure gauge reading will not drop to 30 in-Hg when the valves are open and the vacuum pump is operating, close the gauge set valves and observe the low pressure gauge. If the pressure rises rapidly to zero, a large leak is indicated. Recheck the test fitting connections and gauge set connections before replacing the A/C evaporator core.

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If the low pressure gauge reading rises 10 or more inches of vacuum from the 30 inch position in ten minutes, a leak is indicated. If a small leak is suspected, wait 30 minutes and observe the vacuum gauge. If a small amount of vacuum is lost, operate the vacuum pump with the gauge valves open for an additional 45 minutes with the system blower motor on low to remove any remaining refrigerant from the oil in the A/C evaporator core. Then, recheck for loss of vacuum. If a very small leak is suspected, allow the system to sit overnight with vacuum applied and check for vacuum loss. Always remember that a leaking fitting, gauge set or hose connection will appear as a leaking A/C evaporator core.

If a vehicle passes the vacuum leak test and is returned within 60 days for loss of cooling due to no refrigerant charge, look elsewhere in the system for refrigerant leaks such as the compressor shaft seal or refrigerant line connections.

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A/C Compressor

A/C Manifold and Tube Leak Test

1. Tighten the manifold retaining bolt to 17-23 Nm (12-17 lb-ft).
2. Add refrigerant to the system if necessary.
3. Leak test the manifold O-ring seals using Rotunda R-134a Automatic Calibration Halogen Leak Detector or equivalent.
4. If no leaks are found, the manifold O-ring seals are good.
5. If a leak is found at the manifold and the manifold attaching bolt is tightened to 18-23 Nm (13-17 lb-ft), install new manifold O-ring seals. Then, repeat the leak test.

External Leak Test

1. If the A/C compressor (19703) is on the vehicle, discharge the system. Remove the A/C compressor from the vehicle. Observe all safety precautions.
2. Remove the manifold retaining bolt and remove the manifold from the rear head of the A/C compressor. Install pressure test adapter on the rear head of the A/C compressor using the existing manifold attaching bolt.
3. Connect the high and low pressure lines of Rotunda R-134a Manifold Gauge Set 176-R032A or equivalent to the corresponding fittings on the pressure test adapter.
4. Attach the center hose of the manifold gauge set to a refrigerant container standing in an upright position.
5. Using the clutch hub, hand-rotate the A/C compressor shaft ten revolutions to distribute the oil inside the A/C compressor.
6. Open the low pressure gauge valve, the high pressure gauge valve and the valve on the refrigerant container to allow the refrigerant vapor to flow into the A/C compressor.
7. Using Rotunda R-134a Automatic Calibration Halogen Leak Detector or equivalent check for leaks at the compressor shaft seal and the compressor center seal.
8. If a shaft seal leak is found, install a new shaft seal. If an external leak is found at the center joint of the A/C compressor, install a new A/C compressor assembly.
9. When the leak test is completed, close the manifold gauge valves (both high and low) as well as the valve on the refrigerant container.
10. Slowly remove the gauge set hoses from the pressure test fitting tool. (Allow the refrigerant to escape from the compressor).
11. Install the A/C compressor on the vehicle.

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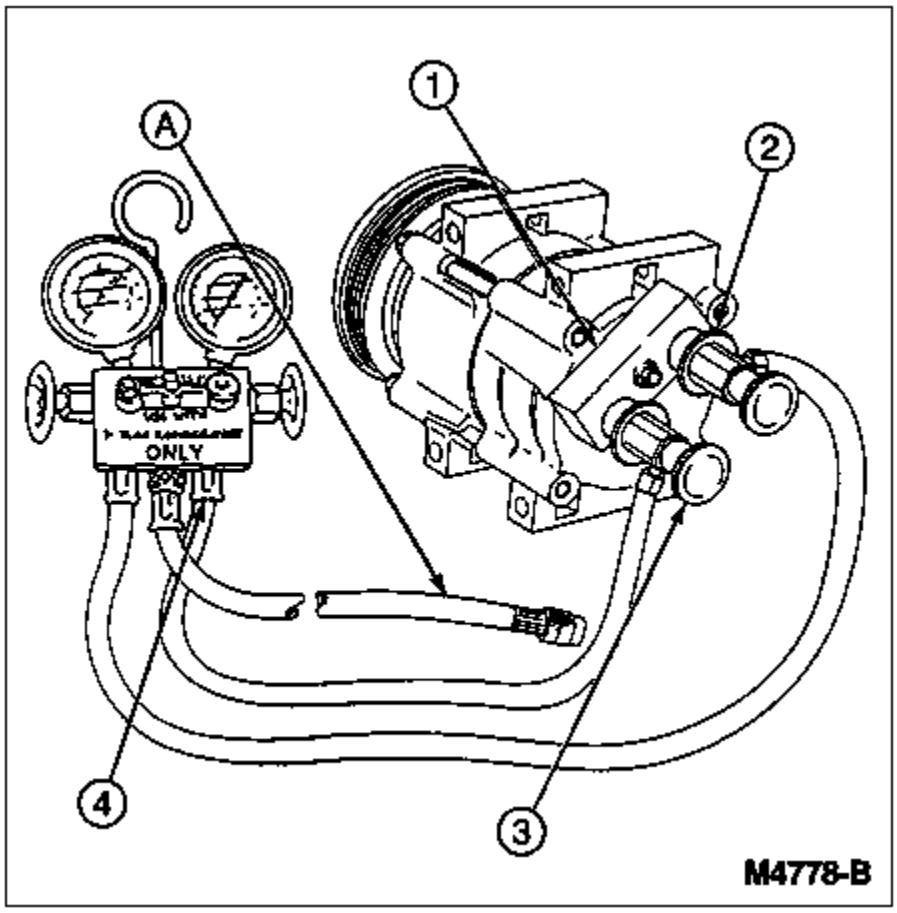
12. Leak test, evacuate and charge the system. Observe all safely precautions.

Rotating Torque Check

The rotational torque of a used A/C compressor should be checked as follows if excessive compressor drag is suspected.

1. Discharge refrigerant system. Observe all safety precautions.
2. Remove A/C manifold and tube (19D734) from A/C compressor. Use care not to allow dirt to enter A/C compressor.
3. Remove the A/C compressor from the vehicle. With the A/C clutch (2884) disengaged, rotate the compressor shaft one complete revolution and note the torque required to rotate the shaft another complete revolution.
4. If the rotational torque exceeds 13.015 Nm (9.6 lb-ft), replace the A/C compressor assembly.
5. If the rotational torque is less than specified, excessive drag does not exist in the A/C compressor. Install the A/C manifold and tube and leak test, evacuate and charge the system.
6. Check the system for proper operation.



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Item	Part Number	Description
1	T94P-19623-E	Pressure Test Adapter R-134a
2	176-R0026	Low Side Quick Disconnect
3	176-R0027	High Side Quick Disconnect
4	176-R032A	R-134a Manifold Gauge Set
A	—	To Refrigerant Supply (Part of 176-A0032)

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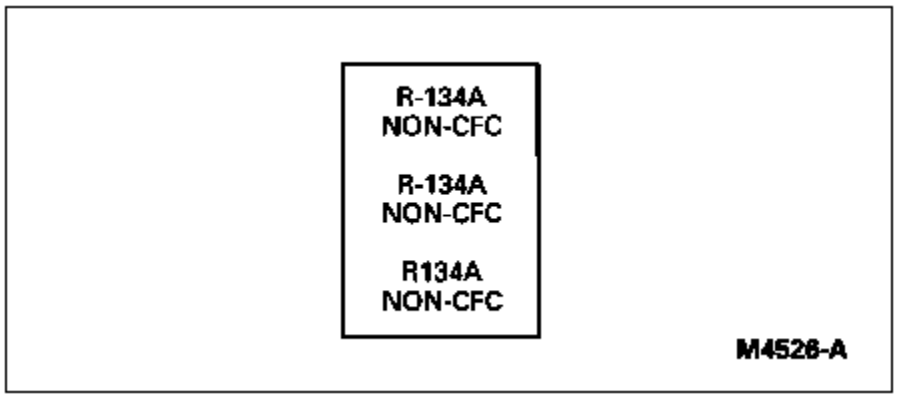
Refrigerant System

Refrigerant System Identification

Two refrigerants (R-12 and R-134a) are used in today's air conditioning systems. The refrigerants are not compatible and while system operations and procedures are the same for both, the equipment to service is unique and cannot be used interchangeably.

The label stating A/C refrigerant use in the vehicle is attached in the engine compartment so the proper service procedure and equipment can be referenced in the service manual. An R-134a refrigerant system will have gold R-134a non-CFC tags in addition to the refrigerant charge tag.



If a component has been used with R-12, it cannot be used again in an R-134a system. If used in an R-134a system, it cannot be put into a R-12 system. Contamination can occur and performance can be adversely affected because each system uses a different oil designed for that system.

Special Service Equipment

CAUTION: Do not use R-12 special tools and equipment when servicing a R-134a system. Doing so may cause damage to the R-134a A/C system.

The refrigerant system has a high-pressure (discharge) and a low-pressure (suction) gauge port valve. These are Schrader-type valves. They provide access to both sides (high-pressure and low-pressure) of the system for service hoses and a manifold gauge set so system pressures can be read.

R-134a systems require the use of special servicing equipment designed specifically for R-134a systems. R-12 servicing equipment cannot be used when servicing R-134a A/C systems. R-134a special service equipment includes R-134a recovery/recycling/recharging station, R-134a leak detector, R-134a vacuum pump and R-134a manifold gauge set.

For the R-134a A/C system, Ford Motor Company recommends the use of a recovery/recycling device such as Rotunda R-134a Service Center or equivalent during any air conditioning service repair or discharge/recharge procedure.

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A/C-Heater System Deodorizing

The A/C System Deodorizer, product EP-1710-FF, is a full-strength deodorizer which requires no dilution or mixing. Each vehicle treated will require 10 fluid ounces to complete the procedure.

The A/C System Deodorizer can be applied using the A/C Disinfectant Sprayer Unit, a siphon type sprayer, or a refillable aluminum or stainless-steel aerosol paint sprayer (touch-up guns provide better access).

1. Set the A/C control (19980) to the **NORMAL A/C** position. On vehicles equipped with a manually operated fresh air/recirculate air door, set the door to the fresh air position.

2. With the blower motor (18527) operating at high speed, spray three ounces of the deodorizer product into the fresh air inlet.

3. Set the A/C control to the **MAX A/C** position. Move the temperature control lever to the full cold position. On vehicles equipped with a manually operated fresh air/recirculate air door, set the door to the recirculate (interior air) position.

4. With the blower motor operating at high speed, spray 1-1/2 ounces of the deodorizer product into the recirculate air opening (located in the passenger side foot area of the vehicle). Set the temperature control to provide full heat and spray an additional 1-1/2 ounces into the recirculate air opening.

5. Shut the blower motor off.

6. Spray equal amounts of the remaining four ounces of the deodorizer product into each of the air outlet openings (defroster, instrument panel registers, and floor ducts).

7. Allow the vehicle to sit for approximately 30 minutes before returning to the customer.

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Refrigerant Recovery

Refrigerant Reclaiming/Recovery/Recycling Equipment

Ford Motor Company recommends the use of a recovery/recycling device such as Rotunda R-134a Service Center or equivalent during any air conditioning service repair or discharge/recharge procedure.

Refrigerant recovery systems and recycling stations are in use in a number of automotive air conditioning service facilities. The use of such equipment makes possible the recovery and use of air conditioning system refrigerant after contaminants and moisture have been removed.

If a refrigerant recovery or recycling station is used, the following general procedures should be observed, in addition to the operating instructions provided by the equipment manufacturer.

CAUTION: Use extreme care and observe all safely and service precautions related to the use of refrigerants.

NOTE: Hoses should have shutoff devices or check valves within 25.4cm (12 inches) of the hose end to minimize the introduction of non-condensable gases (air) into the recycling station and to minimize the amount of refrigerant released when the hose(s) is disconnected.

1. Connect refrigerant recycling station hose(s) to vehicle air conditioning service ports and recovery station inlet fitting.

2. Turn power to the recycling station on to start recovery process. Allow recycling station to pump refrigerant from the system until the station pressure goes into a vacuum. On some stations, the pump will be shut off automatically by a low pressure switch in the electrical system. On other units it may be necessary to manually turn off the pump.

3. Once recycling station has evaluated vehicle air conditioning system, close the station inlet valve (if so equipped). Then, switch off electrical power.

4. Allow vehicle air conditioning system to remain closed for about two minutes. Observe system vacuum level as shown on the gauge. If pressure does not rise, disconnect recycling station hose(s).

5. If system pressure rises, repeat the above 3 steps until the vacuum level remains stable for two minutes.

6. Perform required service operations, evacuate and recharge the air conditioning system.

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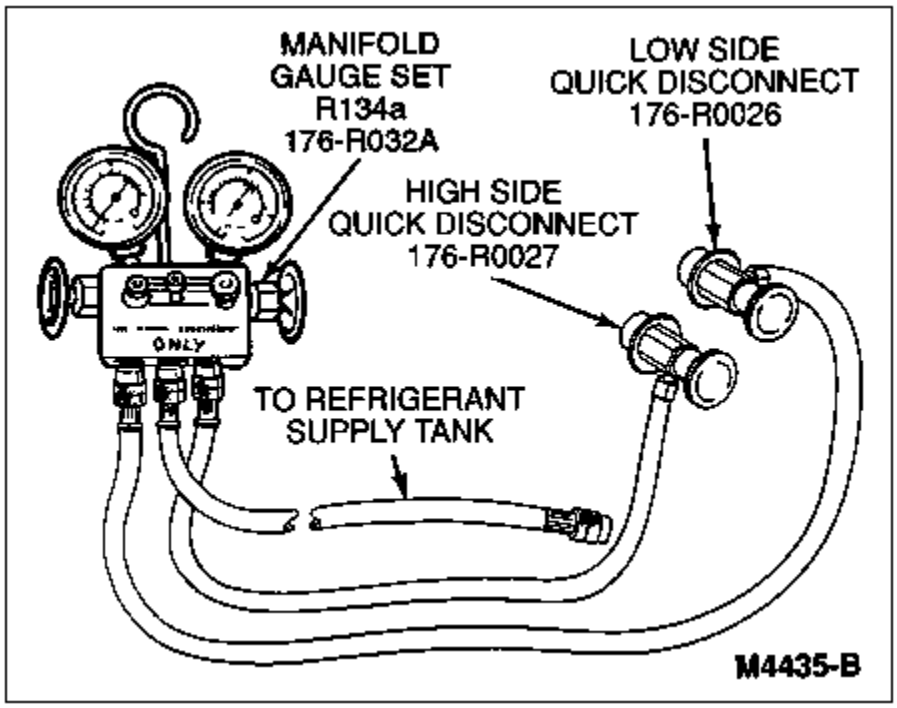
A/C Manifold Gauge Set Connection

When performing any of the various tests for the system's state-of-charge, or internal pressures, the appropriate test equipment must be connected to the refrigerant system. If a charging station is used, follow the instructions of the manufacturer.

To attach a manifold gauge set such as Rotunda R-134a Manifold Gauge Set 176-R032A or equivalent to the service port valves, proceed as follows:

1. Turn both manifold gauge set valves fully clockwise to close the high and low pressure hoses at the gauge set refrigerant center outlet hoses. Rotunda Quick Disconnect Adapters 176-R0027 and 176-R0026 or equivalents are required to connect the manifold gauge set or a charging station to the high and low pressure service gauge port valves.

Manifold Gauge Set



2. Remove the A/C charging valve caps (19D702) from the high and low pressure service gauge port valves.

3. If the manifold gauge set or charging station refrigerant hoses do not have the quick disconnect fittings on them, install Rotunda Quick Disconnect Fittings 176-R0027 and 176-R0026 or equivalents on the manifold gauge set low and high pressure hoses.

4. Connect the high and low pressure refrigerant hoses with adapters to the respective high and low pressure service gauge port valves.

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5. Connect the hoses attached to the manifold center fitting to refrigerant supply tank and vacuum pump valves.

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System Discharging

Discharge the refrigerant from the system into an approved recovery unit. With the exception of the A/C cycling switch (19E561), be sure to discharge the system before removing any other part.

1. Remove the A/C charging valve caps (19D702) from the high and low pressure service gauge ports.
2. Turn both gauge valves fully clockwise to close the high and low pressure hoses to the center hose.
3. Connect the gauge set high and low pressure hoses, with adapters, to the respective high and low pressure service gauge ports.
4. Slowly depressurize the refrigeration system by opening the low pressure valve of the gauge set a slight amount and allow the refrigerant to discharge slowly from the system.
5. After the system is nearly discharged, open the high pressure gauge valve very slowly to avoid losing any refrigerant oil while still allowing any refrigerant remaining in the compressor and high pressure line to discharge.

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System Evacuating

1. Discharge the refrigerant system.

2. Be certain that the manifold gauge set is connected as follows:

    a. Low pressure hose connected to the low pressure service gauge port on the suction accumulator/drier (19C836).
    b. High pressure hose to the high pressure gauge port on the compressor discharge line at the A/C condenser core (19712).
    c. Connect the gauge set center hose to a vacuum pump.

3. Open the gauge set valves and start the vacuum pump.

4. Evacuate the system with the vacuum pump until the low pressure gauge reads at least 99.4 kPa (29.5 inches of mercury) (vacuum) and as close to 101 kPa (30 inches of mercury) as possible. Continue the vacuum pump operation for a minimum of 15 minutes. If a part of the system has been replaced or excessive moisture is suspected, continue the vacuum pump operation for at least 30 minutes.

5. When evacuation of the system is complete, close the gauge set valves and turn the vacuum pump off.

6. Observe the low side gauge to be sure the system holds vacuum for five minutes. If vacuum is held for five minutes, proceed to charging the system. If vacuum is not held for five minutes, leak test the system, repair leak(s) and again evacuate the system.

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System Charging Set-Up

Follow manufacturer's guidelines for correct charging station set-up and operation.

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System Charging

Charging with a Charging Cylinder

1. With the gauge set valve closed to the center hose, disconnect the vacuum pump from the gauge set.
2. Connect the center hose of the gauge set to a charging cylinder or refrigerant tank.
3. Loosen the center hose at the gauge set and open the charging cylinder or refrigerant drum valve. Allow refrigerant to escape to purge air and moisture from the center hose. Then, tighten the center hose connection at the gauge set.
4. Open the gauge set low side valve to allow refrigerant to enter the system.
5. When no more refrigerant is being drawn into the system, start the engine (6007) and move the function selector lever to the NORM/A/C position in Aerostar vehicles, and the VENT/HEAT/A/C position in Ranger vehicles. Move the heater blower motor switch (18578) to HI to draw the remaining refrigerant into the system.

   Continue to add refrigerant to the system until the specified weight of R-134a is in the system. Then, close the gauge set low pressure valve and the refrigerant supply valve.
6. Operate the system until the pressures stabilize to verify normal operation and system pressures.
7. In high ambient temperatures, it may be necessary to operate a high volume fan positioned to blow air through the radiator and A/C condenser core (19712) to aid in cooling the engine and prevent excessive refrigerant system pressures.
8. When charging is completed and system operating pressures are normal, disconnect the gauge set from the vehicle. Install A/C charging valve caps (19D702) on the service gauge port valves.

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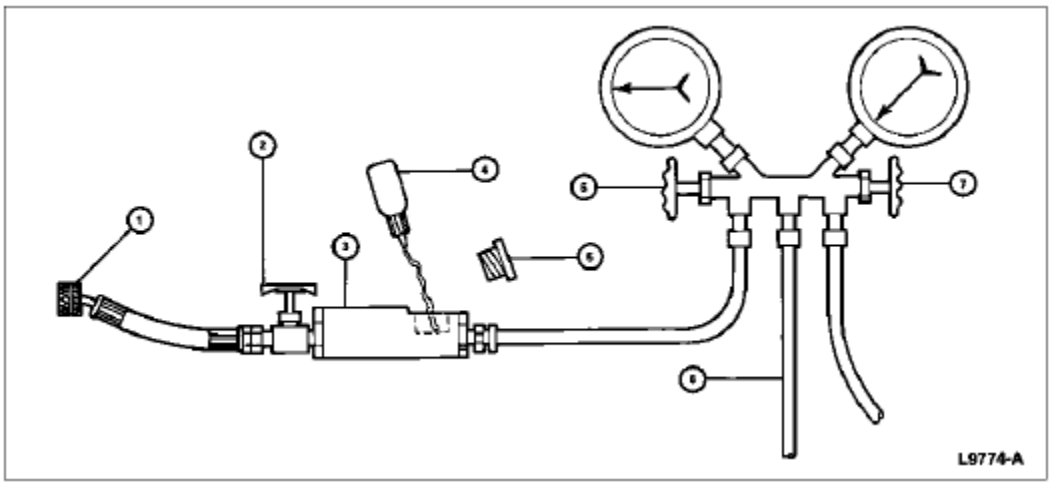
Leak Tracer Dye

NOTE: R-134a fluorescent tracer dye is incorporated into the A/C system at assembly. If it is necessary to add dye, use Rotunda Dye Injector 164-R2610. A/C systems require 7.39ml (0.25 oz) of Rotunda Fluoro-Lite/P® Fluorescent Tracer Dye 164-R3712.



Item	Part Number	Description
1	—	To Low Pressure Service Port
2	—	Reservoir Valve (Part of 164-R2610)
3	—	Tracer Dye Reservoir 7.39ml (.25 oz) Capacity (Part of 164-R2610)
4	164-R3712	Fluoro-Lite/P® Fluorescent Tracer Dye
5	—	Reservoir Cap (Part of 164-R2610)
6	—	Low Pressure Valve (Part of 176-R032A)
7	—	High Pressure Valve (Part of 176-R032A)
8	—	To R-134a Cylinder

1. **NOTE: Periodically lubricate dye injector reservoir valve stem with refrigerant oil.**

   Close valve on dye injector.

2. Connect hose end of dye injector to system low pressure gauge port valve and tighten it securely.

3. **NOTE: If the system pressure is above 414 kPa (60 psi), there is no need to add refrigerant to the system for this operation.**

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Close both valves on gauge manifold set and connect center hose to a charging cylinder. Leave center hose loose at the gauge manifold connection. Close valve on charging cylinder.

4. Connect gauge manifold low pressure hose to dye injector, leaving connection at the gauge manifold loose.

5. Open injector valve to allow A/C system pressure to purge air from the dye injector reservoir and the low pressure hose to the gauge manifold. Tighten hose connection at gauge manifold gauge set. Close valve on the dye injector.

6. Remove reservoir cap from the top of dye injector and fill reservoir with 7.39ml (0.25 oz) of Rotunda Fluoro-Lite/P® Fluorescent Tracer Dye 164-R3712.

7. Replace reservoir cap. Tighten securely.

8. Open valve on charging cylinder, then open the manifold gauge low pressure valve. Open valve on the dye injector for 5 to 10 seconds to allow the dye to be forced into A/C system. Close dye injector valve. Close manifold gauge low pressure valve and valve on the charging cylinder.

9. Start engine and operate the A/C system at MAX to stabilize system (approximately 10-15 minutes).

10. Engine OFF.

11. Disconnect all hoses slowly to dissipate any residual refrigerant pressure that may be present.

12. Start engine and operate the A/C system to thoroughly mix the tracer dye with the system's compressor oil.

13. Continue to operate the A/C system in order to allow the tracer dye to circulate through the system and penetrate the leak(s). The time needed for the leak to appear will depend on the type of system and size of the leak.

14. **NOTE: Fluoro-Lite/P® Fluorescent Tracer Dye 164-R3712 combines and circulates with both the compressor oil and the refrigerant. For the tracer dye to show leakage in an A/C system, the compressor oil must flow throughout the system you are checking. As the refrigerant escapes, it will leave a trace of compressor oil with the dye at the point of leakage.**

    Check for leak(s) with Rotunda UV Lamp 164-R0721 or equivalent. Scan all components, fittings and lines of the system. The exact location of the leak(s) can be pinpointed by the bright yellow-green glow of the tracer dye. Since more than one leak may exist in the system, always inspect each component.

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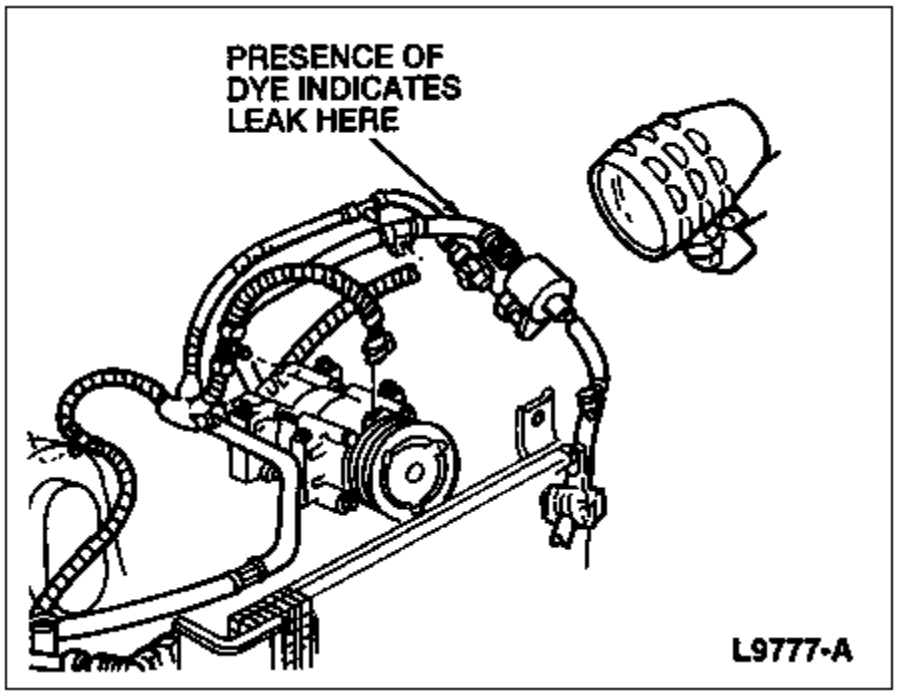

15. **NOTE: The best leak detection results will be achieved in conditions of low ambient light. In areas that cannot be reached by the UV lamp, use a mechanic's mirror or use a non-fluorescent shop towel. Wipe the suspected leak area and then check the towel with the UV lamp for a trace of the fluorescent dye. If no leak is found, return the vehicle to the customer with instructions to bring it back at a later date to allow time for the fluorescent material to collect around the leak site.**

    After the leak is repaired, the traces of fluorescent dye can be removed from the previously leaking areas by using any general-purpose oil solvent.

16. Verify the repair to ensure that the leaks have been successfully repaired and all fittings are tight. Steps 12, 13 and 14 can be repeated without adding more tracer dye (unless the dye has been removed during the servicing). While Rotunda Fluoro-Lite/P® Fluorescent Tracer Dye 164-R3712 can safely remain in the A/C system indefinitely without harm to components, its fluorescent lifespan is roughly 500 hours of A/C system use, after which time another infusion of dye would be required.

17. Write the dye installation date on a label (labels are included with the dye) and apply it to the engine compartment in an area where it will be seen easily by a future technician. Labeling the vehicle will tell others that dye has already been installed.

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Refrigerant Identifier

Prior to recovering or charging the refrigerant from any vehicle, you must use the Rotunda Refrigerant Identifier or equivalent. The Rotunda Refrigerant Identifier or equivalent is used to identify gas samples taken directly from the refrigeration system or storage containers. The identifier will display either R-12 or R-134a if the purity is better than 98% by weight. The unit will display FAIL if neither of the two gases have been identified or if they are not at least 98% pure. If the gas detected contains a hydrocarbon (flammable material), a horn will sound and the unit will display "HC." After analysis is made and displayed, the identifier purges the unit of the sampled refrigerant gas and is ready for the next sample.

If neither R-12 nor R-134a has been identified as 98% pure, do not service the A/C refrigeration system. Always refer to the refrigerant identifier manufacturer's instructions for proper tool usage.

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System Flushing

WARNING: DUE TO REFRIGERANT HAZARDS, ALWAYS WEAR SAFETY GOGGLES AND NON-PENETRABLE GLOVES WHEN WORKING ON OR FLUSHING A/C SYSTEMS.

1. Perform all A/C system diagnostics per the Service Manual specified procedures.

2. Recover the refrigerant from the A/C system. Refer to the procedure using a U.L./E.P.A. approved recovery/recycling device. Follow the recovery procedure specified by the equipment manufacturer.

3. Disconnect the A/C hoses from the heat exchangers (A/C evaporator core (19860) and A/C condenser core (19712)) to be flushed.

4. **CAUTION: Suction accumulator/driers (19C836), receiver/driers, A/C evaporator core orifices (19D990), thermal expansion valves, hoses, and mufflers should be removed. Do not flush these components. Internal plumbing and material makeup of these components makes it impossible to properly remove debris and/or residual flushing solvent. Except for the hoses, these components are typically discarded after A/C system contamination. Hoses can typically be reused unless they are clogged with debris.**

   Remove A/C evaporator core orifices, thermal expansion valve, suction accumulator/drier, receiver/drier, and/or mufflers which may be attached to the heat exchangers (A/C evaporator core/A/C condenser core) being flushed.

5. Clean all dirt and debris from the fittings on the heat exchanger to be flushed.

6. Select the proper fittings, clean and lubricate connections, and securely attach to the heat exchanger. O-rings must be used with these fittings to ensure proper, leak free connections.

7. **NOTE: All flushing/purging will be performed in the direction opposite the normal flow of refrigerant in an operating A/C system.**

   If the A/C evaporator core is being flushed, connect the flusher outlet hose to the suction fitting on the A/C evaporator core. This fitting is normally connected to the suction accumulator/drier. Connect the return hose to the other fitting.

   If the A/C condenser core is being flushed, connect the flusher outlet hose to the liquid side fitting of the A/C condenser core. This fitting is normally connected by hose to the evaporator core. Connect the return hose to the other fitting.

8. **CAUTION: This Rotunda A/C Tool Flusher 014-00991 is intended for use with only Ford A/C Flushing Solvent F4AZ-19579-A or equivalent. Use of any other flushing solvent or agent may cause damage to the flusher. Substitute solvents or agents may not be removed during the purging process and may leave residues which can damage A/C system components.**

   Fill the fluid reservoir with 3.8L (1.0 gallon) of Ford A/C System Flushing Solvent F4AZ-19579-A or equivalent.

9. Connect static ground strap to vehicle.

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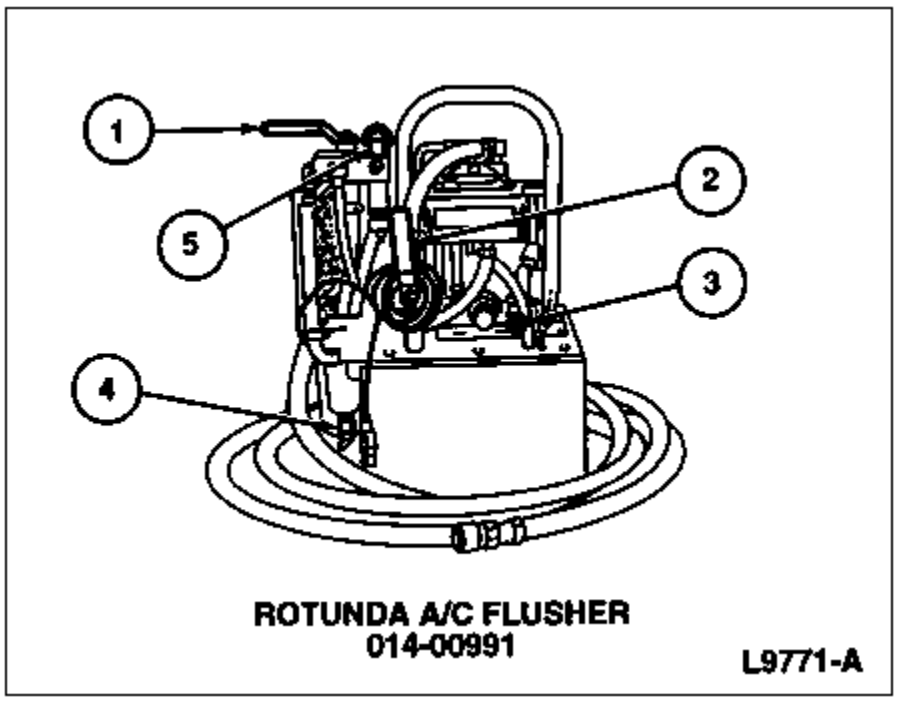
10. Make sure the purge air supply valve is released from its locked-on position. Place valve #1 in PURGE position. Attach the shop air supply to the flush quick coupler.



Item	Part Number	Description
1	—	Valve #1
2	—	Valve #2
3	—	Flush Quick Coupler
4	—	Moisture Trap
5	—	Air Purge Valve

11. Slowly turn valve #1 to FLUSH position.

12. Observe for flush solvent flow through the outlet hose.

13. **NOTE: If the pump stalls during operation, remove air hose immediately. Pump stalling may occur as a result of large particles of debris. To dislodge debris which impedes pump operation, connect air hose to purge quick coupler, gradually depress the purge air hose valve to force debris and flush solvent back into the reservoir. Reconnect air hose to flush quick coupler and observe for flow.**

    Operate the pump for a minimum of 15 minutes to flush all debris and dissolve any gummy oil residues which may be present in the component being flushed.

14. Return valve #1 to PURGE position for 1 minute.

15. Disconnect air hose from flush quick coupler.

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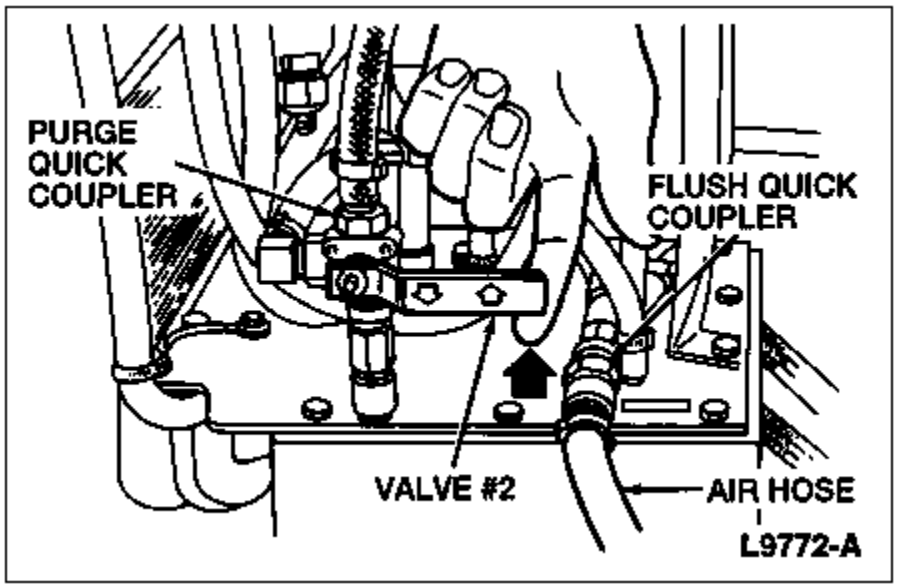
16. Attach air hose to purge quick coupler. Gradually engage the air purge valve to full flow for approximately one minute to remove the majority of the flushing agent from the heat exchanger being flushed.

17. Stop all purge air flow by releasing the air purge valve lever.

18. Place valve #2 in PURGE position.



19. Gradually engage the purge air supply valve and lock in the full flow position.

20. **CAUTION: Failure to continue air purge for the entire 30 minutes as specified may result in residual amounts of flush solvent contaminating the A/C system. Residual flush solvent in a functioning A/C system may lead to A/C system failure. The manufacturer of this flusher and the specified flushing solvent accept no responsibility for damages caused by misuse of, or failure to follow this procedure in its entirety as specified.**

    Allow the system air purge to continue for a minimum of 30 minutes.

21. Periodically, during the 30 minute air purge, check the moisture trap on the outlet side of the flusher and drain any water buildup using the petcock on the bottom of the moisture trap.

22. After completion of the 30 minute air purge, release the purge air supply valve to stop all air flow.

23. Disconnect the air hose from the flusher.

24. Disconnect the flusher hoses from the flushed heat exchanger.

25. Disconnect static ground strap. Move the flusher away from the vehicle.

26. Disconnect flusher fittings from the heat exchanger and retain for future use.

27. If the remaining A/C heat exchanger in the vehicle is to be flushed, repeat steps 1-28.

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28. **CAUTION: The gallon of Ford A/C Flushing Solvent F4AZ-19579-A, and Filter FL-1A used in this flusher are intended for use on one vehicle only. They may be used to flush both heat exchangers on an individual vehicle, but under no circumstances should they be used on more than one vehicle. Residual contamination may contaminate other vehicles, causing possible damage to A/C system components.**

    Drain the flushing solvent from the flusher reservoir and replace filter. If filter becomes overtightened, use Oil Filter Wrench D79L-6731-B or equivalent to remove it.

29. Dispose of the drained flushing solvent and filter in accordance with federal, state, and local regulations.

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Spring Lock Coupling

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Spring Lock Coupling Disconnect Tools	T81P-19623-G1, T81P-19623-G2, T83P-19623-C, T85L-19623-A

Coupling — Disconnect

1. Discharge refrigerant from system with a refrigerant recycling machine. Fit Spring Lock Coupling Disconnect Tools T81P-19623-G1 (3/8-inch), T81P-19623-G2 (1/2-inch), T83P-19623-C (5/8-inch) or T85L-19623-A (3/4-inch) to the coupling.

2. **NOTE: The garter spring may not release if the tool is cocked while pushing it into the cage opening.**

   Close tool and push into open side of cage to expand garter spring and release female fitting.

3. After garter spring is expanded, pull fitting apart.

4. Remove tool from disconnected coupling.

5. **CAUTION: Use of metal O-Ring Tool T71P-19703-C or a screwdriver to remove O-rings can cause scratches across the O-ring groove, leading to loss of refrigerant charge. Only plastic O-Ring Tool F5VH-17B017-AA or equivalent is approved for O-ring removal.**

   Remove O-ring seal from male fitting.

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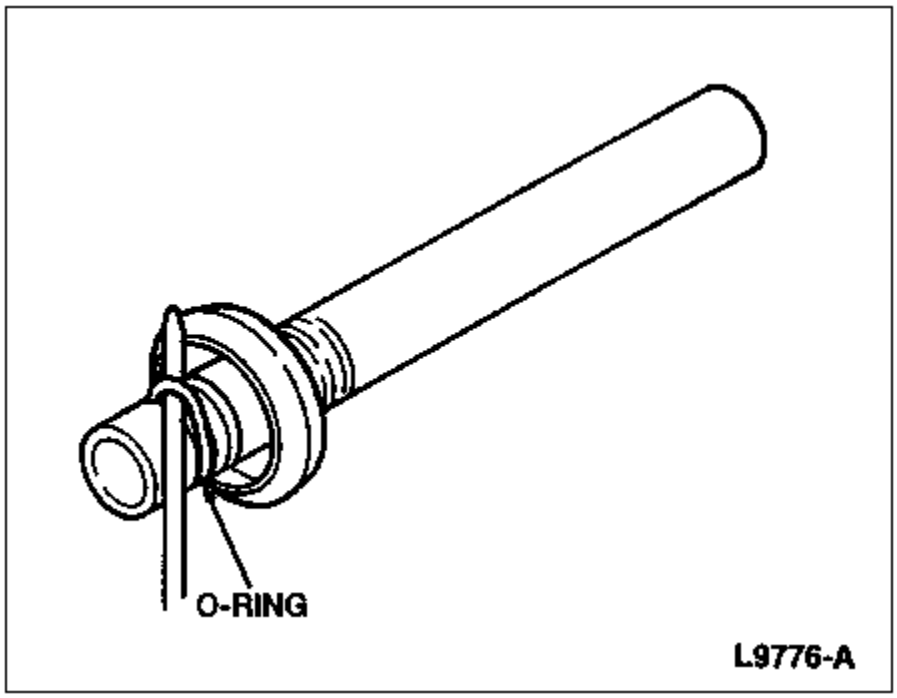

Coupling — Connect

1. Make sure garter spring is in cage of male fitting. If garter spring is missing, install a new spring by pushing it into cage opening. If garter spring is damaged, remove it from cage with a small wire hook (do not use a screwdriver) and install a new spring.

2. Clean all dirt or foreign material from both pieces of coupling.

3. Lubricate and install new green O-ring seals on male fitting.

   Use only the specified green O-ring seals as they are made of a special material. The use of any O-ring seal other than the specified green O-ring seal may allow the connection to leak intermittently during vehicle operation. Refer to service parts list.

4. Lubricate male fitting and O-rings and inside of female fitting with clean refrigerant oil.

5. Install plastic indicator ring into cage opening if indicator ring is to be used.

6. Fit female fitting to male fitting and push until garter spring snaps over flared end of female fitting.

   If plastic indicator ring is used, it will snap out of cage opening when coupling is connected to indicate engagement.

7. If indicator ring is not used, ensure coupling engagement by visually checking to verify garter spring is over flared end of female fitting.

Service Parts List

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Part Number	Description
E35Y-19D690-D	O-Ring Seal Kit-A/C Spring Lock Coupling (Kit Contains 3/8, 1/2 and 5/8 Coupling O-Rings and 3/8, 1/2 and 5/8 Inch Coupling Garter Springs.)

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A/C System Filtering

CAUTION: Follow all refrigerant system safety and service precautions in Section 12-00 .

A Filter Kit should be installed in the refrigerant system prior to the installation of the replacement A/C compressor (19703). The pancake filter, supplied with each kit, should be temporarily installed in the liquid line between the A/C condenser core (19712)the A/C evaporator core orifice (19D990). The suction filter, supplied with each kit, should be installed in the suction line between the suction accumulator/drier (19C836) and the A/C compressor. Install the replacement A/C compressor and the filters as outlined in the following procedure. Filter Kit for systems with nylon lined suction hose is Ford part number F2VY-19E773-C.

1. Before removing any refrigerant system components, discharge the system refrigerant following the approved recycling methods.

2. Remove the suction accumulator/drier and drain the oil into a calibrated container.

3. **NOTE: Due to the internal design of the suction accumulator/drier, it will be necessary to drill two 13mm (0.5 inch) holes in the suction accumulator/drier cylinder to drain the oil from the suction accumulator/drier.**

   Install a new suction accumulator/drier and add new Motorcraft YN-12b refrigerant oil or equivalent meeting Ford specification WSH-M1C231-B to replace the old oil. The quantity of new oil to be added is the amount to match that drained from the old accumulator plus 60 ml (2 oz.).

4. Install a new A/C evaporator core orifice. If the A/C evaporator core orifice is located in the condenser to evaporator tube (19835) between the A/C condenser core and the A/C evaporator core (19860), replace the condenser to evaporator tube assembly.

5. Temporarily install the pancake filter in the condenser to evaporator tube between the A/C condenser core and the A/C evaporator core orifice. Be sure the filter inlet is toward the A/C condenser core. Connections can be made using A/C Test Adapter Set, D93L-19703-B, and flexible refrigerant hose of 2500 psi burst rating. Individual fittings are also available.

6. Remove the old A/C compressor and drain the oil into a calibrated container.

7. Drain the oil from the replacement A/C compressor into a clean calibrated container.

8. A new service replacement FS-10 A/C compressor may or may not contain 207ml (7 oz.) of refrigerant oil. If the amount of oil drained from the removed A/C compressor is between 90 and 148ml (3 to 5 oz.), pour the same amount of clean refrigerant oil into the new A/C compressor. If the amount of oil drained from the old A/C compressor is greater than 148ml (5 oz.), add an equivalent of clean refrigerant oil into the new A/C compressor. If the amount of refrigerant oil drained from the old A/C compressor is less than 90ml (3 oz.), pour 90ml (3 oz.) of clean refrigerant oil into the new A/C compressor. Use Motorcraft YN-12b Refrigerant Oil or equivalent meeting Ford specification WSH-M1C231-B.

9. **NOTE: It will be necessary to transfer the A/C clutch (2884) from the old A/C compressor to the replacement A/C compressor. Refer to Section 12-03C .**

   Install the new A/C compressor. Be sure all mounting bolts are tightened properly. Check the tension of the A/C compressor drive belt (8620).

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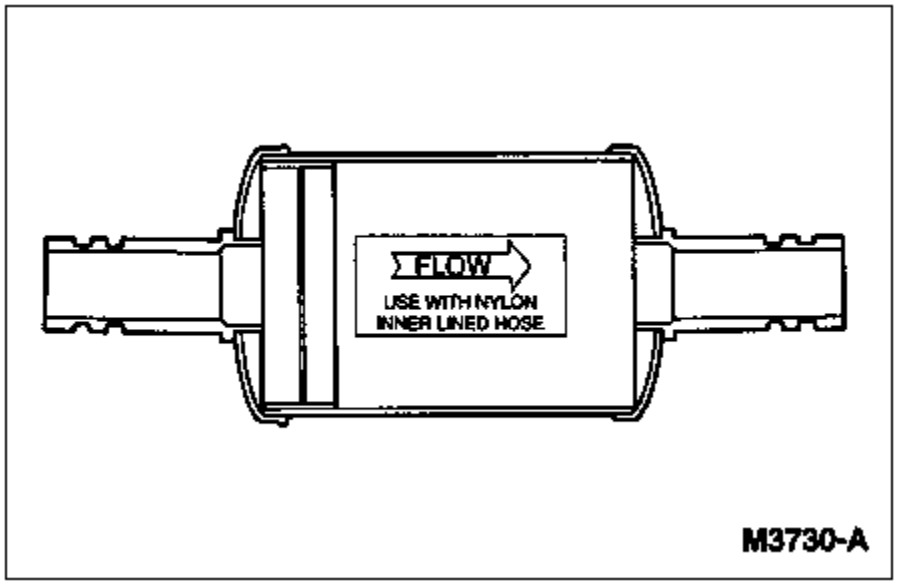
10. Install the suction filter in the suction hose close to the A/C compressor. Suction filter is for nylon lined core hose. These filters have two grooves in the end tubes to accommodate O-ring seals.



11. Remove a length of suction hose (close to the A/C compressor end) to accommodate the suction filter and install the filter using A/C hose clamps. Be sure filter is correctly oriented for refrigerant system flow. Check the label on the filter. If using the filter for a nylon lined hose, install O-ring seals included in the Filter Kit, Ford part number F2VY-19E773-C (two on each filter tube).

12. Leak test, evacuate, and charge the system as outlined in Section 12-00 .

13. Check all refrigerant system hoses, lines and the positioning of the newly installed filters to be sure they do not interfere with other engine compartment components. If necessary, use tie straps to make adjustments.

14. Set the A/C control (19980) on MAX A/C, high blower motor (18527) and temperature control at full cold. Start engine and let it idle briefly. Make sure the A/C system is operating properly.

15. Gradually bring the engine up to 1200 rpm by running it at lower rpms for short periods (first at 800 rpm, then at 1000 rpm). Set the engine at 1200 rpm and run it for an hour with the A/C system operating.

16. Stop the engine.

17. Remove the refrigerant from the system using a recovery machine. Refer to Section 12-00 .

18. Allow the engine to cool sufficiently to remove the fittings, flexible hoses and pancake filter from the condenser to evaporator tube.

19. Discard the pancake filter. It can be used one time only.

20. Reconnect the condenser to evaporator tube back into the system.

21. Evacuate, charge and leak test the system. Make any necessary adjustments.

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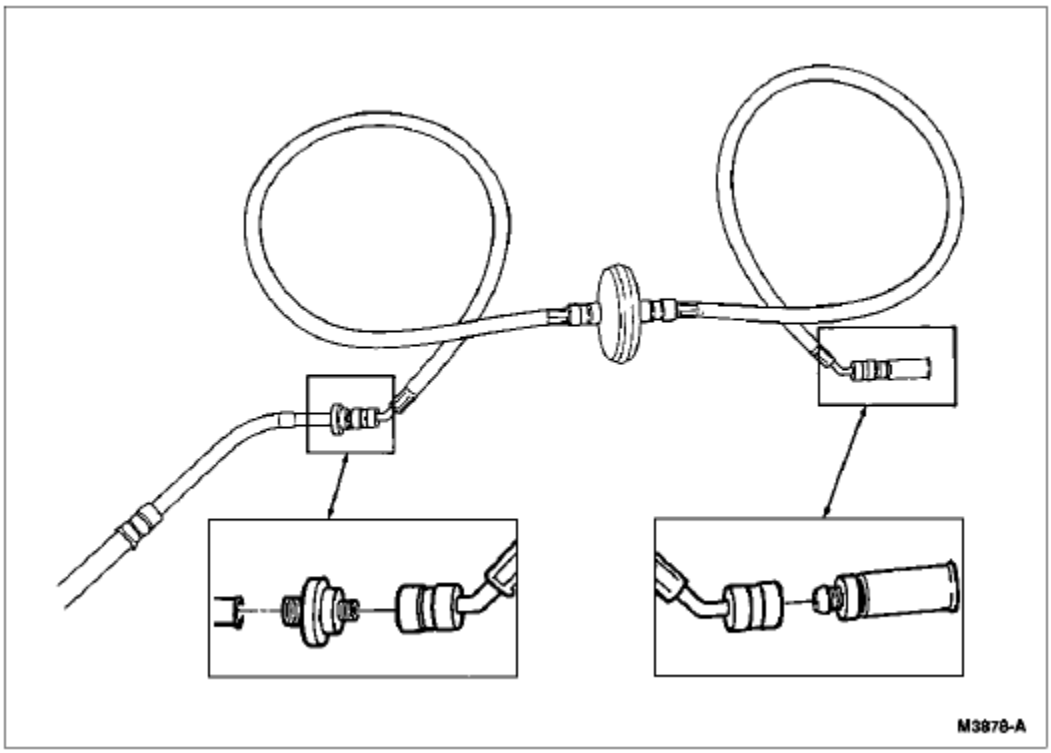
22. Check the operation of the system in all control function selector lever positions.

A/C System Filtering



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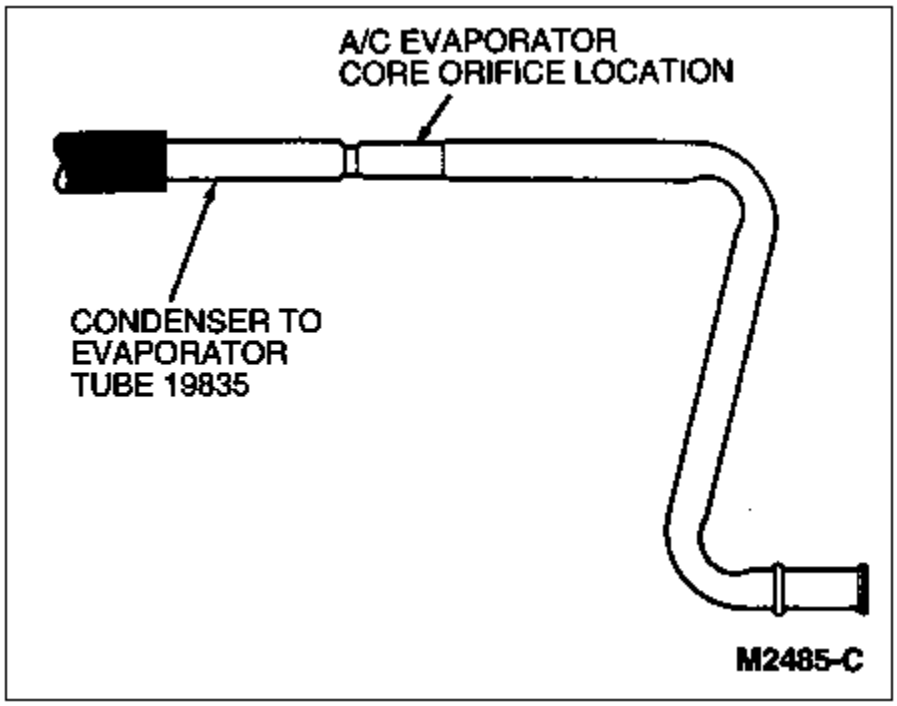
A/C Evaporator Core Orifice Replacement Kit

Installation

1. Discharge the A/C refrigerant system.
2. Remove the condenser to evaporator tube (19835) from the vehicle.
3. Locate the A/C evaporator core orifice (19D990) by the three indented notches or a circular depression in the metal portion of the liquid line.



4. Note the angular position of the ends of the condenser to evaporator tube so that it can be reassembled in correct position.
5. Cut a 63.5mm (2 1/2-inch) section from condenser to evaporator tube a t A/C evaporator core orifice location. Do not cut closer than 25.4mm (1 inch) from the start of a bend in tube.

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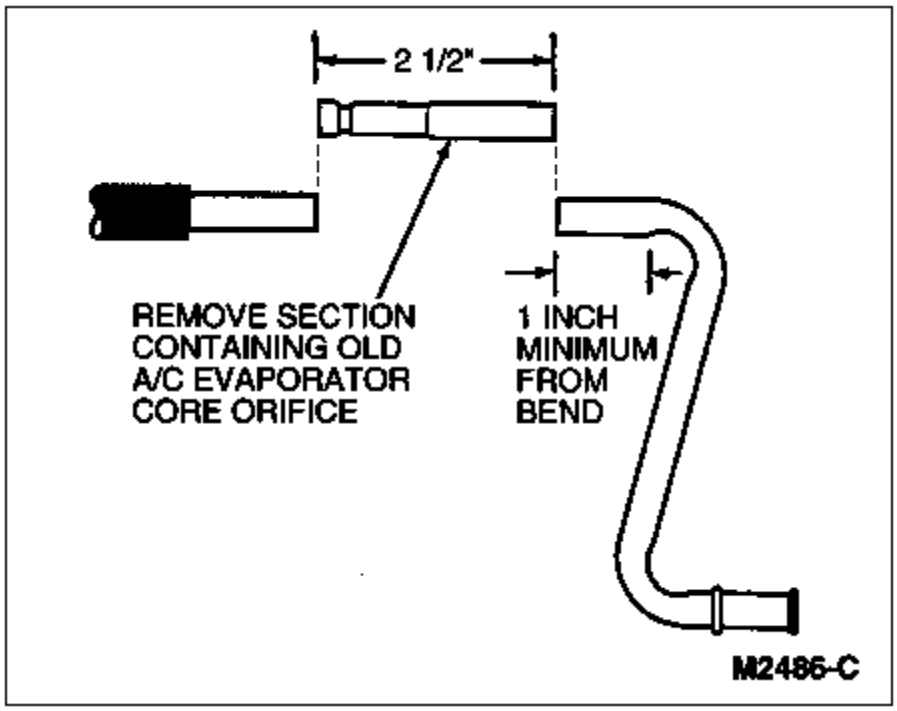

6. Flush the two pieces of condenser to evaporator tube to remove any contaminants.

7. Lubricate fitting O-ring seals with clean refrigerant oil and assemble orifice tube kit (with orifice tube installed) to condenser to evaporator tube as shown in the following illustration. Make sure flow direction arrow is pointing toward A/C evaporator core (19860) end of condenser to evaporator tube, and taper of each compression ring is pointing toward compression nut.

Orifice Tube Kit Disassembled

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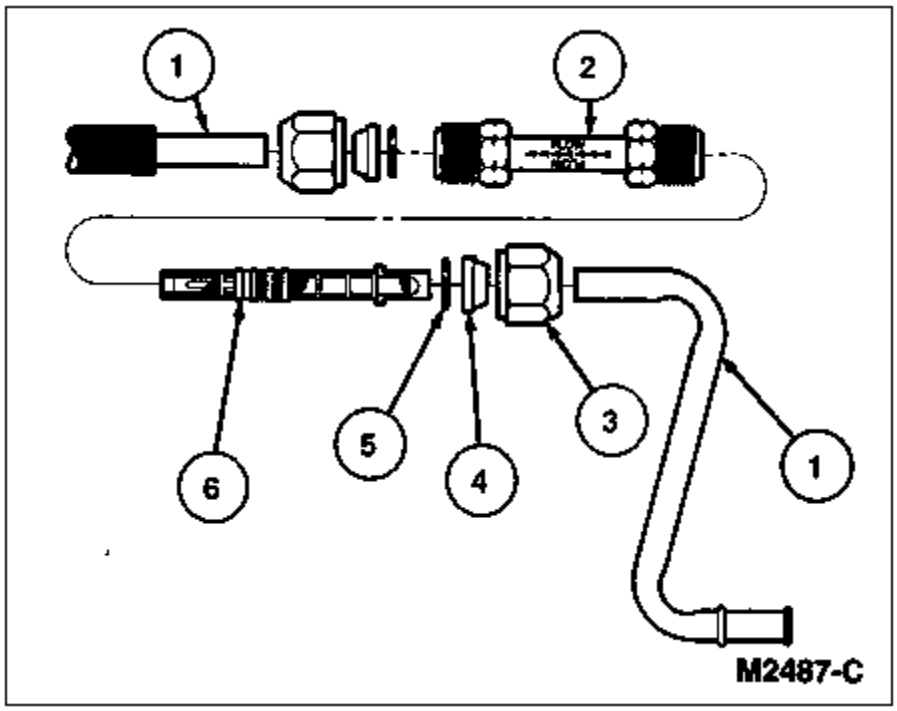

Item	Part Number	Description
1	19835	Condenser to Evaporator Tube
2	—	A/C Evaporator Core Orifice Housing (Part of 19D695)
3	—	Compressor Nut (Part of 19D695)
4	—	Brass Compression Ring (Part of 19D695)
5	—	O-Ring Seal (Part of 19D695)
6	19D990	A/C Evaporator Core Orifice

8. **NOTE: The inlet tube will be positioned against the A/C orifice tube (19D695) tabs when correctly assembled.**

   While holding hex of tube in a vise, tighten each compression nut to 88-95 Nm (65-70 lb-ft) with a crow-foot wrench.

Orifice Tube Kit Installed

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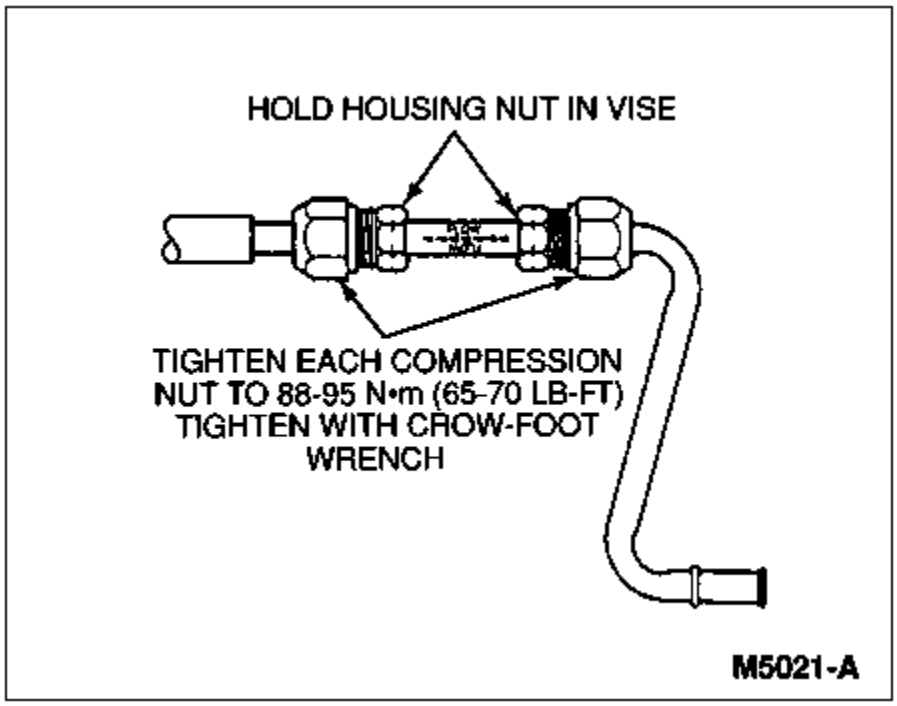

9. Assemble condenser to evaporator tube to vehicle using new green O-rings lubricated with clean refrigerant oil. Use only specified green O-rings at spring lock coupling.

10. Leak-test, evacuate and charge system following approved procedures.

11. Check system for proper operation.

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Suction Accumulator/Drier Replacement Guidelines

The suction accumulator/drier (19C808) should be replaced if one of the following conditions exist:

- The suction accumulator/drier is perforated.
- There is physical evidence of system contamination from a failed A/C compressor or damage to the suction accumulator/drier.

NOTE: The compressor oil from vehicles equipped with an FS-10 A/C compressor (19D629) may have a dark color while maintaining a normal oil viscosity. This is normal for this A/C compressor because carbon from the piston rings will discolor the oil.

When replacing the suction accumulator/drier, the procedure given here must be followed to make sure that the total oil change in the system is correct after the new suction accumulator/drier is installed.

1. Drain the oil from the removed suction accumulator/drier into a suitable measuring container. Drill one or two 12.7mm (1/2-inch) holes in the bottom of the old suction accumulator/drier to ensure that all the oil has drained out.

2. Add the same amount of clean new refrigerant oil plus two fluid ounces to the new suction accumulator/drier. Use only the oil specified for the specific vehicle being serviced (Motorcraft YN-12b or an equivalent oil containing the same additives).

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Refrigerant Oil Addition

It is important that only the specified type and quantity of refrigerant oil be used in the A/C compressor (19703). If there is surplus oil in the system, too much oil will circulate with the refrigerant, reducing the cooling capacity of the system. Too little oil will result in poor lubrication of the A/C compressor.

During A/C Compressor Replacement

The FS-10 A/C compressor used will require a special refrigerant oil with special additives. The A/C compressor used on R-134a systems requires YN-12b/F2AZ-19577-A oil, meeting Ford Specification WSH-M1C231-B.

R-134a Refrigerant Oil

The refrigerant oil required for R-134a A/C systems is a polyalkalylene glycol (PAG) oil, meeting Ford specification WSH-M1C231-B or equivalent. This type of refrigerant oil was made specifically for R-134a systems and is not suitable for use in R-12 systems. Never use an R-134a refrigerant oil in R-12 systems.

DURING COMPONENT REPLACEMENT

Refrigerant Oil Capacity (Main System Only):	267 ml (9 oz.)
Refrigerant Oil Capacity (Main and Auxiliary Systems):	385 ml (13 oz.)
Refrigerant Oil Replacement Capacities:	Evaporator Core = 118 ml (4 oz.)
	A/C condenser core = 40 ml (1.5 oz.)
	Suction accumulator/drier = 80 ml (3 oz.)
	Any 1 Refrigerant Line = 30 ml (1 oz.)
	A/C compressor — If the amount of oil drained from the removed A/C compressor is between 118 and 148 ml (4 and 5 oz.), pour the same amount of new refrigerant oil into the new A/C compressor.
	If the amount drained is greater than 148 ml (5 oz.), pour 148 ml (5 oz.) of new refrigerant oil into the new A/C compressor. If the amount drained is less than 118 ml (4 oz.), pour 118 ml (4 oz.) of new refrigerant oil into the new A/C compressor.

When it is necessary to replace a component of the refrigerant system, the correct procedures must be followed to make sure the total oil charge on the system is correct after the new component is installed. During normal A/C operation, some refrigerant oil is circulated through the system with the refrigerant and some is retained in the compressor. If certain components of the system are removed for replacement, some of the refrigerant oil will go with the component. To maintain the original total oil charge, it is necessary to compensate for the oil lost by adding oil to the system with the replacement part.

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Other Refrigerant System Components

Replacement of other refrigerant system components such as hoses, O-rings and pressure switches does not require the addition of refrigerant oil.

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SPECIFICATIONS

REFRIGERANT SYSTEM SPECIFICATIONS

Type	Specification	Part No.
Refrigerant-134a (R-134a)	WSH-M1C231-B	1F2AZ-19577-AA Motorcraft YN-12b

HEATER BLOWER MOTOR AND CIRCUIT

Switch Setting	Amps	Volts
Off	0	0
Low	3.5-5.5	5
Medium-Low	5-7.5	8
Medium-High	7-9.5	10
High	9.5-11.5	12

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
A/C Manifold and Tube	17-23	12-17	—
Heater Hose Clamps	2-3	—	18-27
Condenser to Evaporator Tube	10.2-13.8	7-10	—

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Heater-Ventilation System

The heater-ventilation system used is a blend-air design which includes the following major components:

- The heater plenum chamber case (18A484) located on the engine compartment side of the dash panel. This assembly includes the following:
  - blower motor (18527)
  - blower motor wheel (18504)
  - heater blower motor switch resistor (18591)
  - heater plenum chamber case
- The heater air plenum chamber (18471) is located on the passenger compartment side of the dash panel. It includes the following:
  - outside/recirculating air inlet door
  - panel door
  - floor/defrost door
  - temperature blend door
  - heater core (18476)
- Other components which link and/or control the heating system include the following:
  - heater control (18549)
  - ducts and registers
  - windshield defroster hose nozzle (18490)
  - control cables
  - vacuum lines

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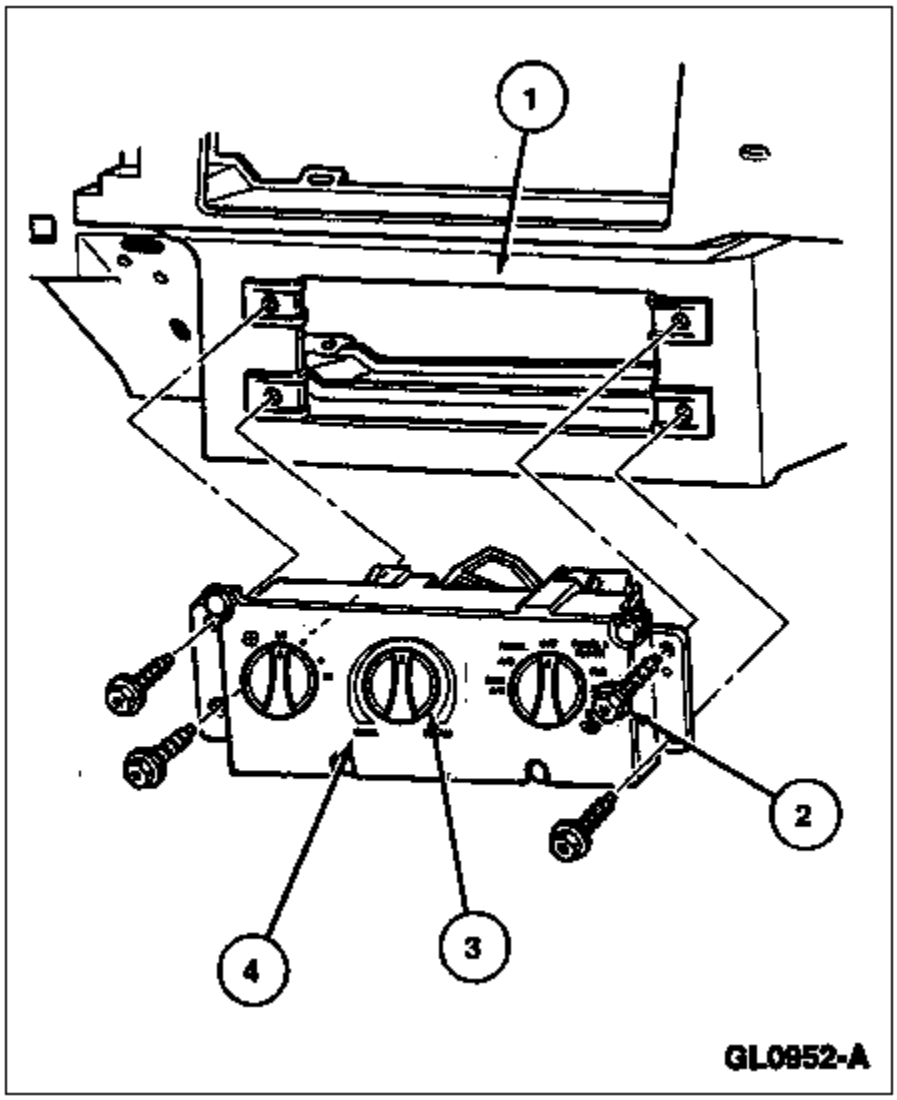
Heater Control Assembly

The following illustration shows the heater control (18549).



Item	Part Number	Description
1	04320	Instrument Panel
2	N803876-S2	Screw (4 Req'd)
3	—	Temperature Control Knob
4	18549	Heater Control

The heater control is installed in a rectangular cutout in the lower center area of the instrument panel (04320). It contains three rotary switches. The extreme left switch is the heater blower motor switch (18578).

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Airflow Control

The function selector knob is located on the extreme right of the heater control. The knob rotates to positions: PANEL, OFF, PNL/FLR, FLOOR, FLR/DEF and DEFROST. In the OFF position, the recirculation door is closed to stop outside air from passing through the climate control system and to keep the in-vehicle air circulating. To shut off the blower motor, the function selector knob must be turned to the OFF position.

Temperature Control

The temperature blend door, located in the heater air plenum chamber (18471), directs outside air to flow through the heater core (18476) for heating, or to bypass the heater core for ventilation. It is controlled by the temperature control knob of the heater control.

A heater temperature cable (18518) connects the temperature control knob to a cam which operates the temperature blend door. When the temperature control knob is at the COOL position, the temperature blend door directs outside air to bypass the heater core. When the temperature control knob is at WARM, the temperature blend door directs outside air through the heater core where the air is heated.

Positioning the temperature control knob in any position between COOL and WARM causes the temperature blend door to direct more or less outside air through or around the heater core for whatever proportion of heated or unheated outside air is desired.

The air blends together as it leaves the heater core into the heater air plenum chamber for distribution.

Blower Motor Control

The blower motor (18527) is controlled by a four-position heater blower motor switch located on the left side of the heater control. The four positions are LOW, MEDIUM LOW, MEDIUM HIGH and HIGH. The four operating speeds are obtained with a heater blower motor switch resistor (18591) connected in series with the heater blower motor switch operating on the ground side of the blower motor.

With the heater blower motor switch at LOW, current flow in the ground circuit is through three heater blower motor switch resistor coils to obtain the lowest operating speed.

With the heater blower motor switch at MEDIUM LOW, current flow in the ground circuit is through two heater blower motor switch resistor coils to obtain a medium low motor operating speed.

With the heater blower motor switch at MEDIUM HIGH, current flow in the ground circuit is through one heater blower motor switch resistor coil to obtain a medium high operating speed.

With the heater blower motor switch at HIGH, current flow in the ground circuit bypasses the heater blower motor switch resistor to obtain the maximum operating speed.

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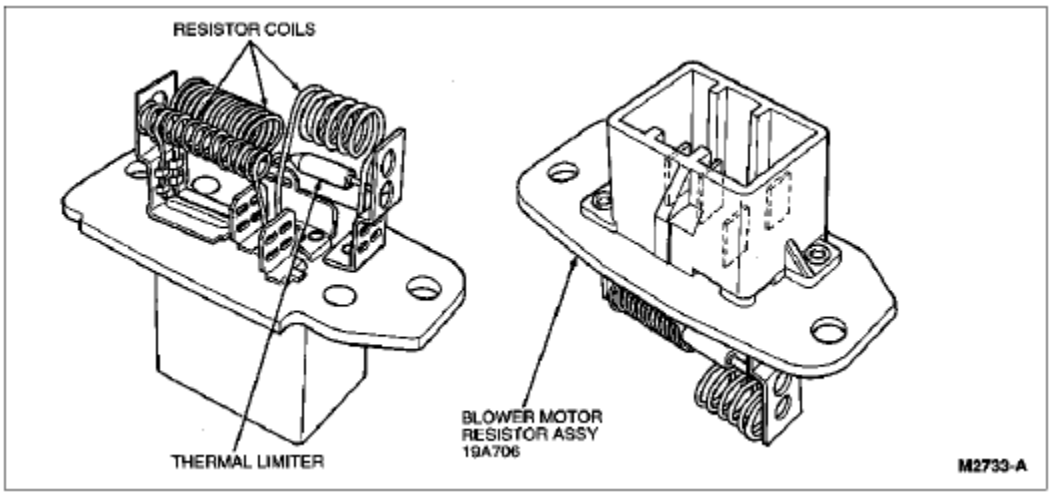
Heater Blower Motor Switch Resistor

The thermal limiter is mounted in theheater blower motor switch resistor (18591). Theheater blower motor switch resistor is used with the heater blower motor switch (18578) to obtain the desired fan speed. The heater blower motor switch resistor is shown disassembled from the heater plenum chamber case (18A484).

Heater Blower Motor Switch Resistor



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Heater Blower Motor Thermal Limiter

The thermal limiter in the switch serves as a temperature sensitive fuse. When the thermal limiter is opened, the heater blower motor switch resistor (18591) must be replaced.

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Instrument Panel Registers

The louvers in the registers can be adjusted to direct air as desired. The louvers can also be closed to block most of the airflow.

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Heater Core

Outside air is heated as it passes through the fins of the heater core (18476). Hot engine coolant is used to heat the core.

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System Airflow

The following illustrations provide vacuum schematics and vacuum control motor charts which illustrate vacuum line routings and air distribution during the various system operating conditions.

Heater and Vent System Airflow Schematic, Panel Position

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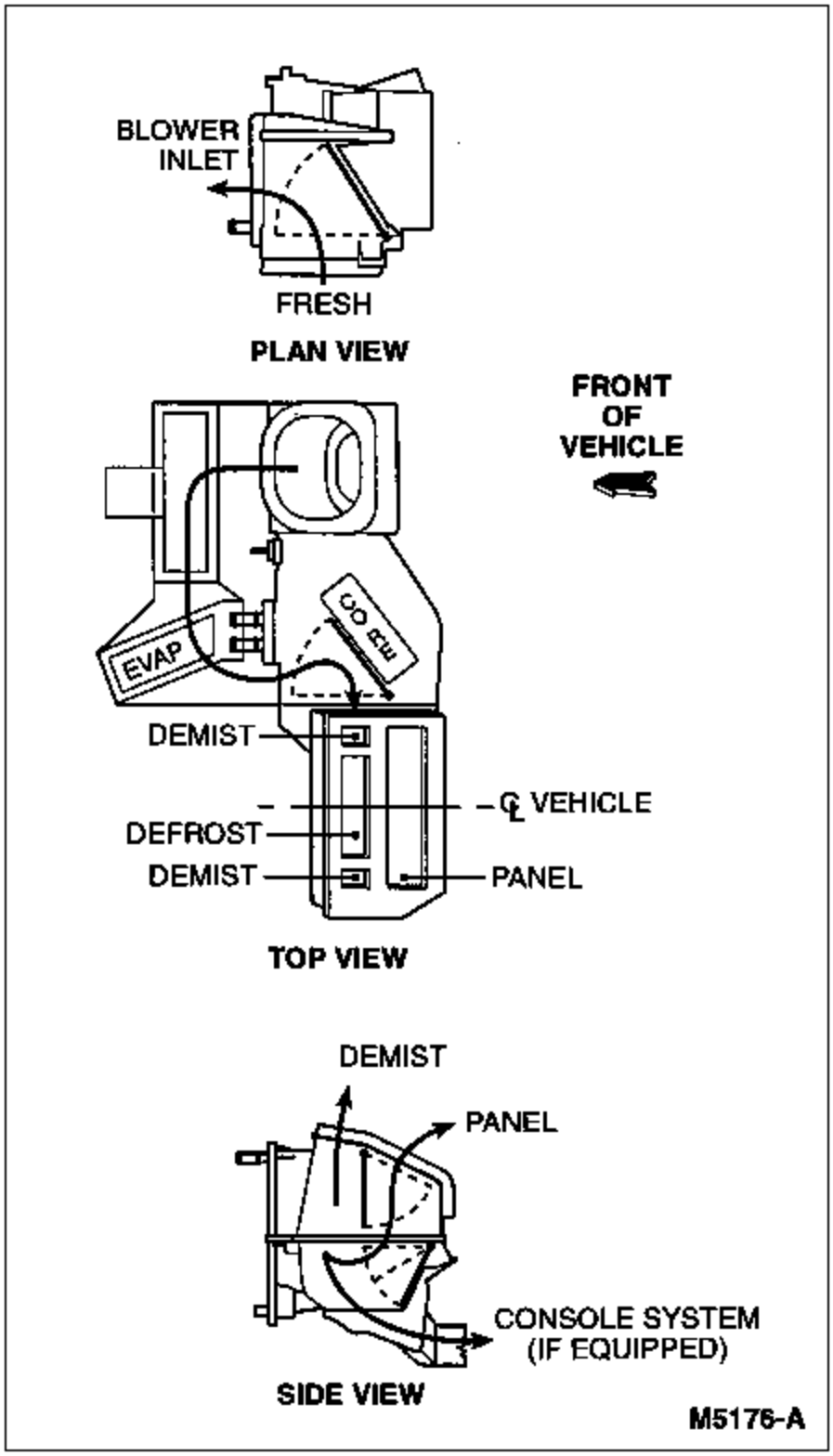

Heater and Vent System Airflow Schematic, OFF Position

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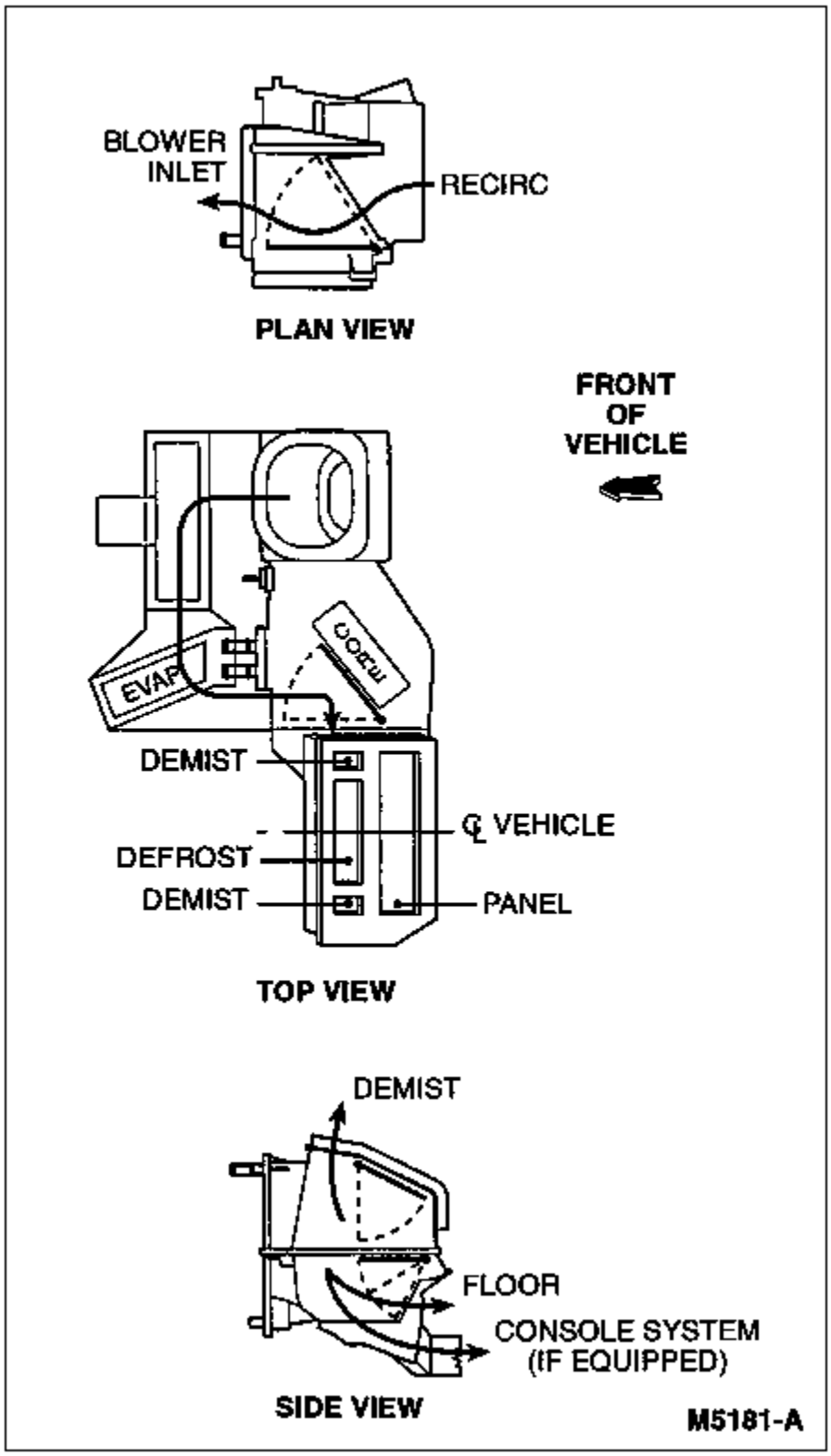

Heater and Vent System Airflow Schematic, Panel/Floor Position

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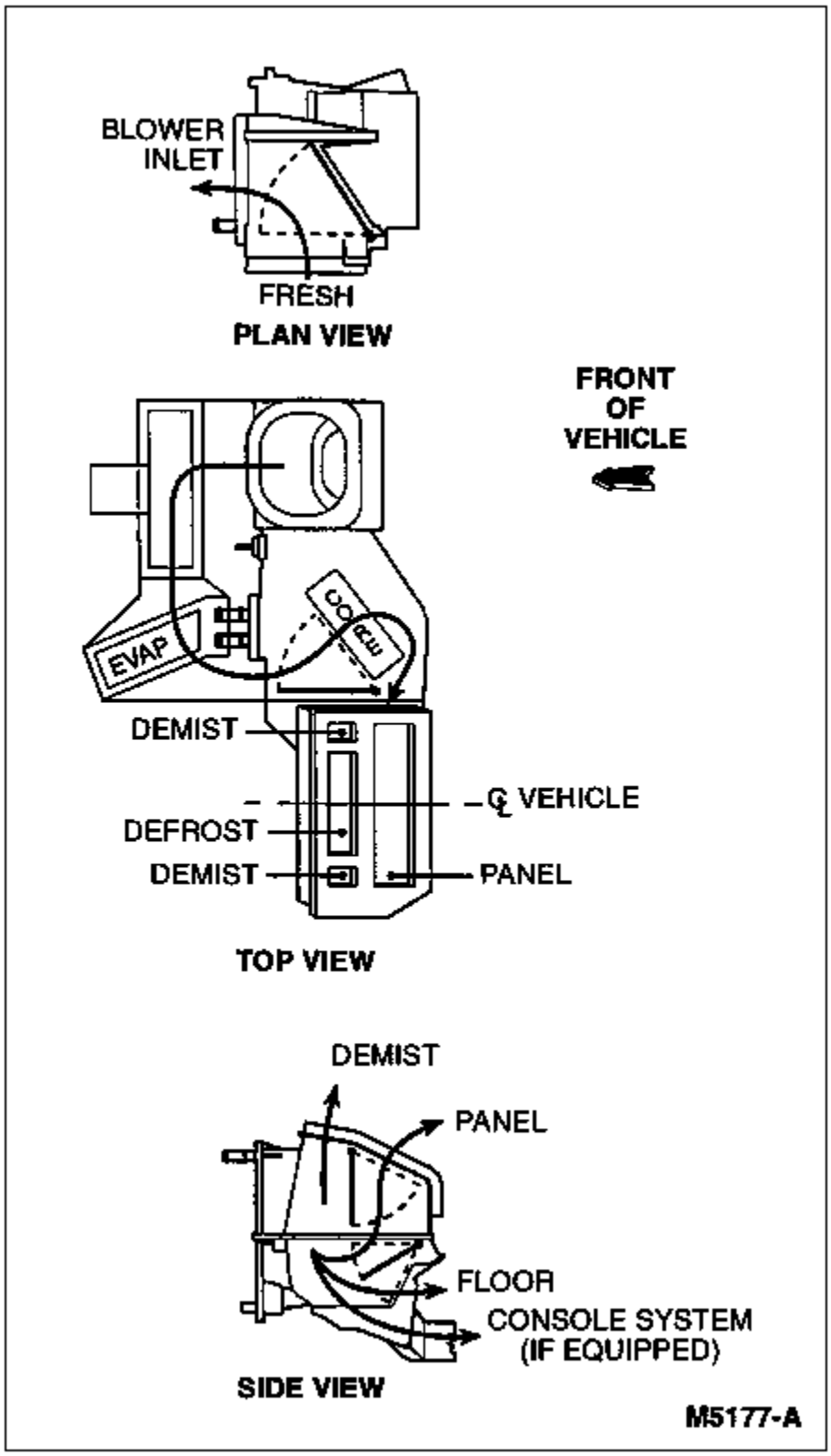

Heater and Vent System Airflow Schematic, Floor Position

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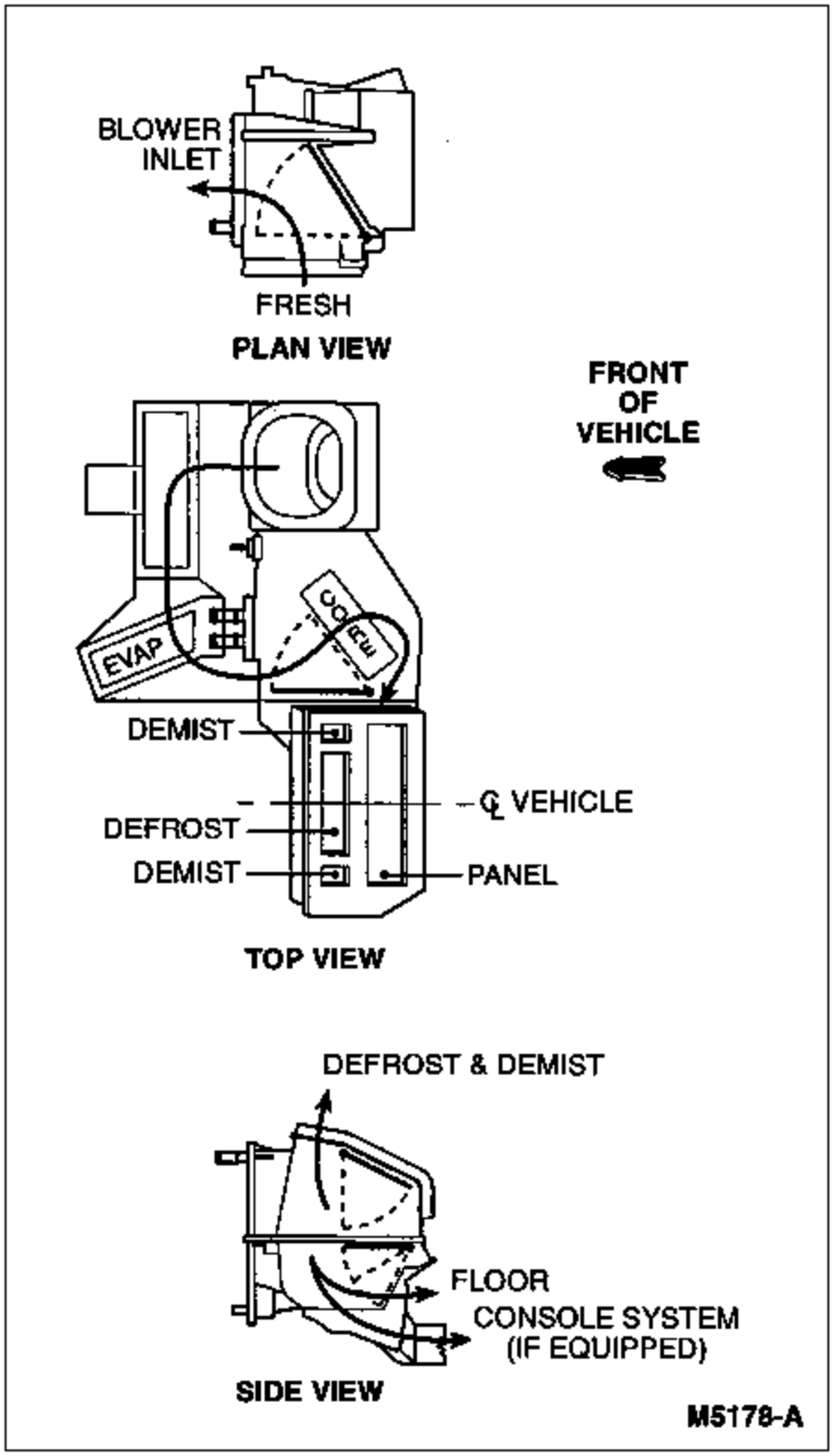

Heater and Vent System Airflow Schematic, Floor/Defrost Position

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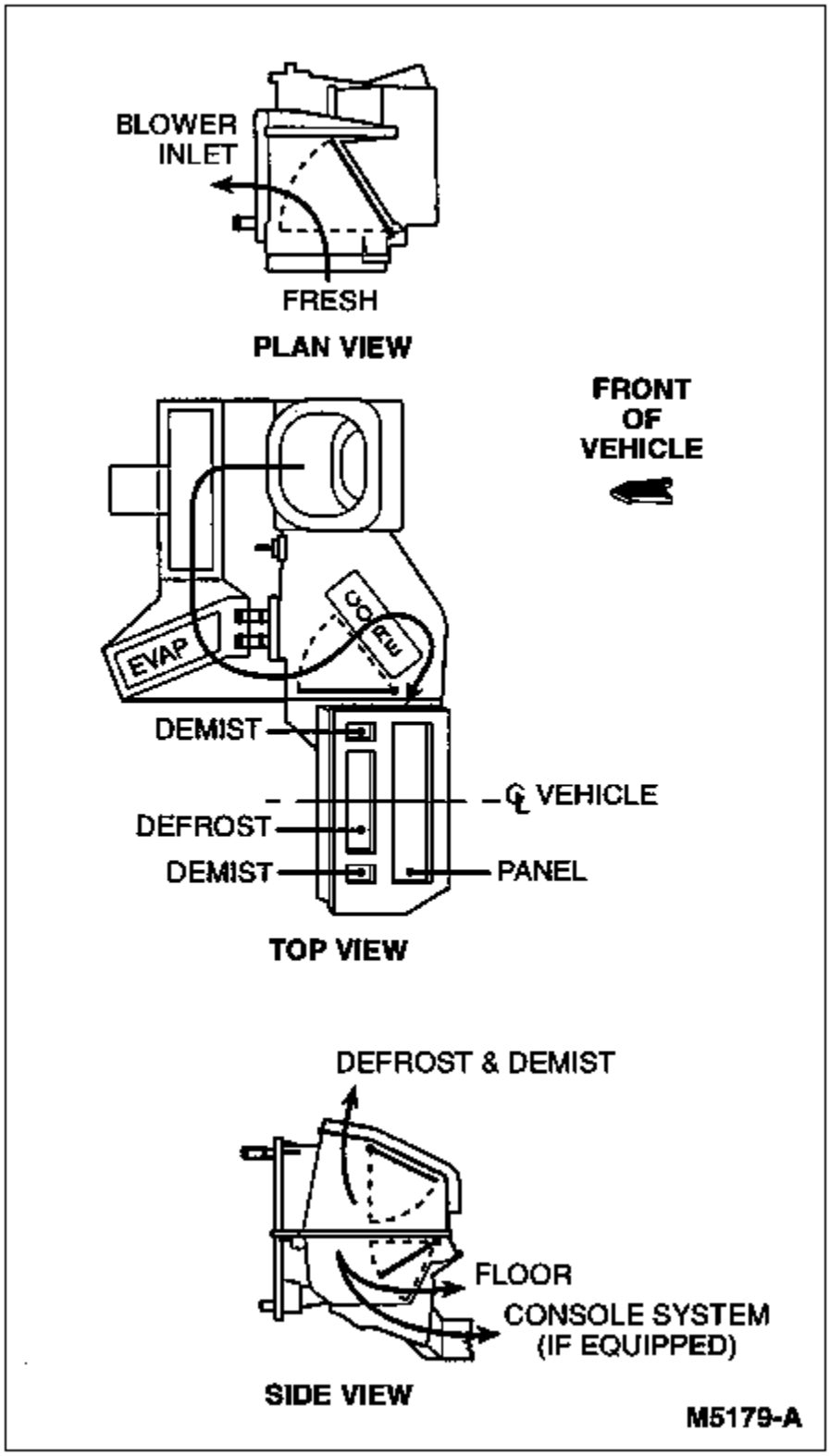

Heater and Vent System Airflow Schematic, Defrost Position

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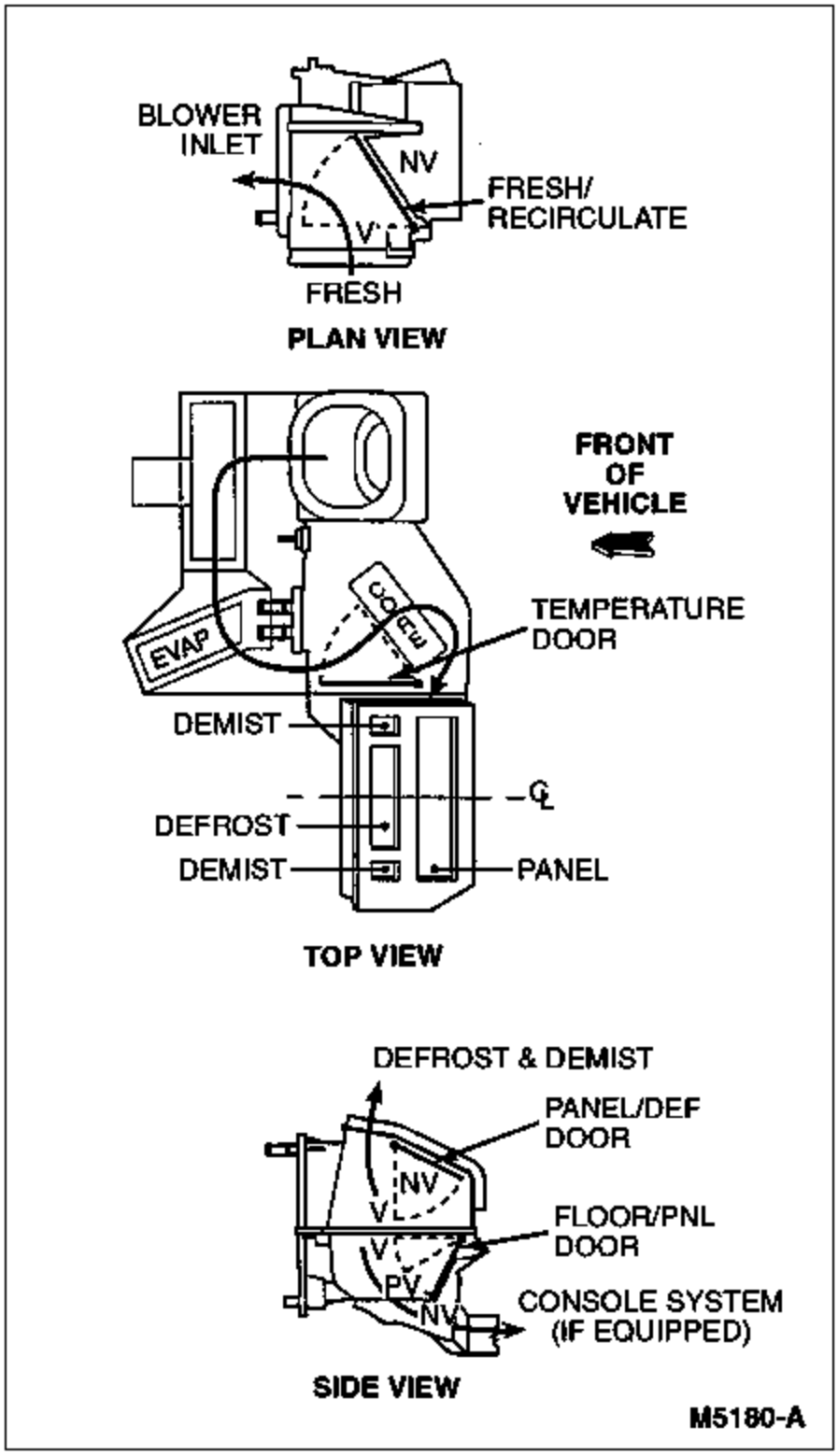

Heater System Vacuum Schematic and Selector Test

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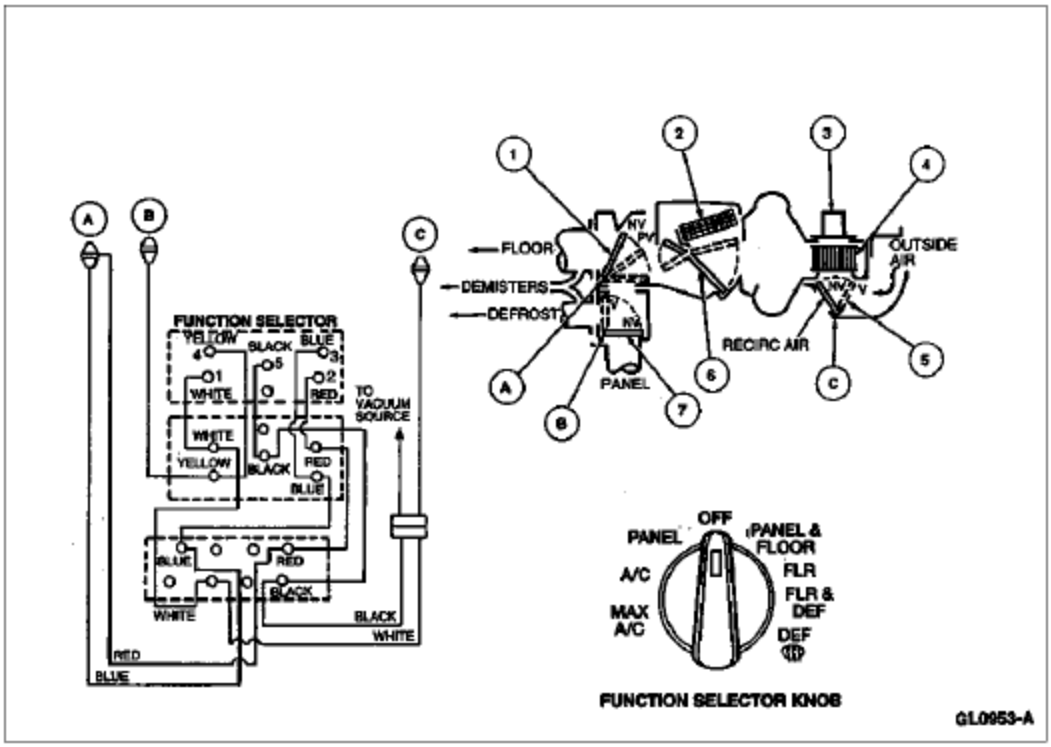

Item	Part Number	Description
1	—	Heater Air Damper Door (Part of 18456)
2	18476	Heater Core
3	18527	Blower Motor
4	18504	Blower Motor Wheel
5	—	Heater and A/C Air Inlet Duct Door (Part of 18456)
6	—	A/C Air Temperature Control Door (Part of 18456)
7	—	Windshield Defroster Door (Part of 18471)
A	—	Airflow Control Door (Part of 18471)
B	—	Airflow Control Door (Part of 18471)
C	—	Airflow (Fresh/Recirc.) (Part of 18471)

OFF

In the OFF position, vacuum is applied to the outside/recirc. door. In this position, outside airflow is shut off.

PANEL

Ventilation is delivered through the instrument panel registers when the function control knob in the control assembly is set in the PANEL position. In the PANEL position, no vacuum is applied to the door motor and the outside/recirc. door is open to the outside. The air coming in through the cowl is discharged through the

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panel registers.

PNL/FLR

In the PNL/FLR position, no vacuum is applied to the door motor and the outside/recirc. door is open to the outside. Air is discharged through the floor outlets and the instrument panel registers.

FLOOR

In the FLOOR position, no vacuum is applied to the door motor and the outside/recirc. door is open to the outside. Air is discharged through the floor outlets only.

FLR/DEF

In the FLR/DEF position, outside air is discharged through the defroster nozzles and the floor outlets.

DEFROST

In the DEFROST position, outside air is discharged through the defrosters only.

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Vacuum System

The outside/recirc. air inlet door is vacuum-operated. The vacuum system schematic diagram illustrates, in schematic form, how system components are involved.

The source of power for the vacuum control motor (18A318) which controls movement of the outside/recirc. air intake door is the engine intake manifold. This door has two operating positions, either of which is determined by the setting of the function selector lever in the heater control (18549).

When the vehicle is equipped with heater only and the function selector lever is in its OFF position, vacuum will be applied and the outside/recirc. door will move to shut off airflow from the outside. In all other positions of the selector lever (PANEL, PNL/FLR, FLOOR, FLR/DEF, or DEFROST) no vacuum is applied. Since the door is open to admit the input of outside air, it is closed to the admission of air from inside the vehicle.

Door position can be checked by lowering the glove compartment door on its hinges so that the recirculating air will be exposed.

If it should be necessary to service the vacuum control valve on the heater control, refer to the Removal and Installation procedures in this section.

Vacuum System Schematic

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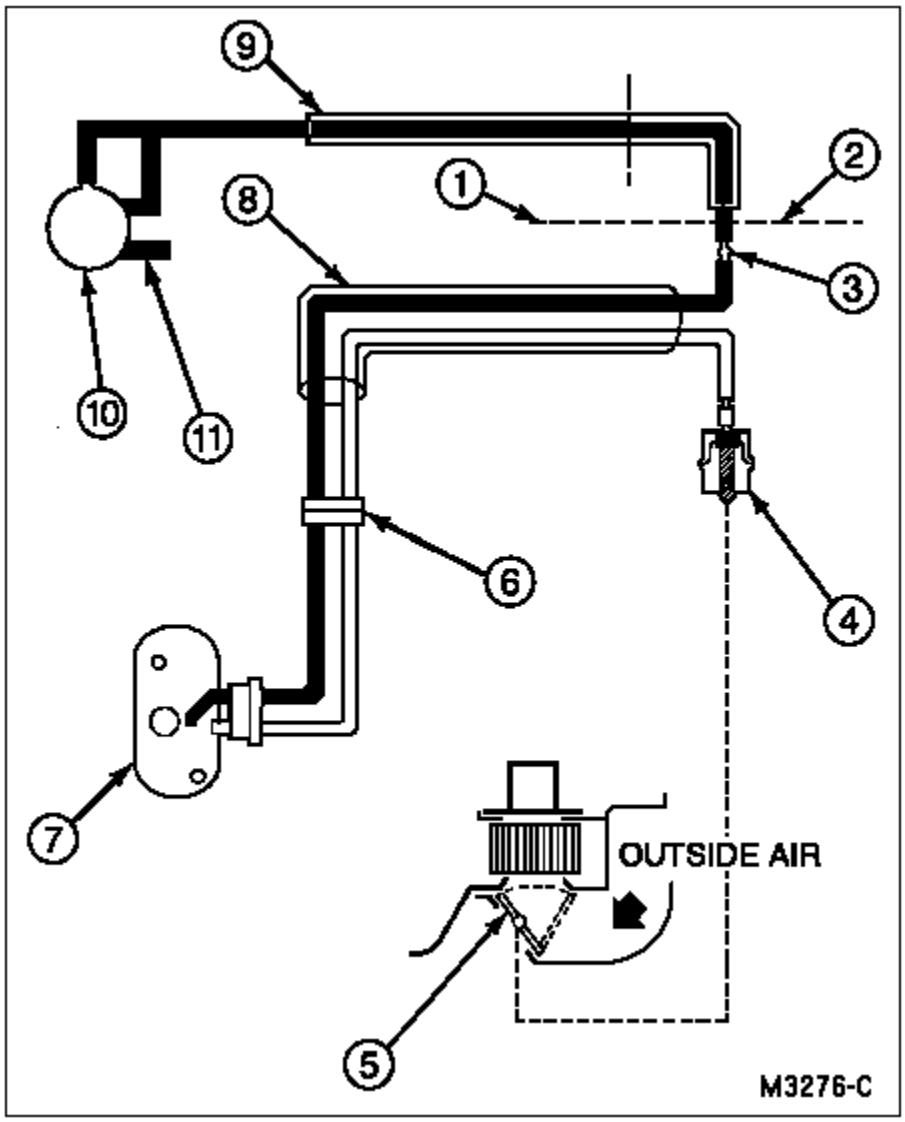

Item	Part Number	Description
1	01610	Dash Panel Engine Compartment Side
2	01610	Dash Panel Passenger Compartment Side
3	—	Connector (at Dash Panel)
4	18A318	Vacuum Control Motor (Outside/Recir. Air Door)
5	—	Outside/Recirc. Air Door (Part of 18A484)
6	—	Connector between Plenum and Control
7	—	Vacuum Control Valve (Part of 18549)
8	14401	Main Wiring
9	19C828	A/C Vacuum Harness
10	19D848	A/C Vacuum Reservoir Tank and Bracket
11	—	Vacuum from Engine Manifold (Part of 9D446)

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Safety Precautions

CAUTION: Whenever components in the engine compartment or instrument panel areas are being serviced, the battery ground cable must be disconnected to eliminate the possibility of electrical shorts, burned-up wiring and fires. Extreme care must be exercised when performing electrical tests where the battery must be connected to operate the system.

CAUTION: Carbon monoxide is colorless, odorless and dangerous. If it is necessary to operate the engine with the vehicle in a closed area such as a garage, always use an exhaust collector to vent the exhaust gases outside the closed area.

The various tests needed to check heater system operation are covered in Section 12-00 . In addition to these tests, visual inspection of all heater system components and connections should be made. Inspections should also be made especially in the dash panel area, to make sure that air leaks in the body are not having a significant effect on heating system performance.

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Climate Control Assembly

Removal

1. Disconnect battery ground cable.
2. Snap control opening finish panel away from instrument panel (04320). Refer to Section 01-12 .
3. Remove four screws attaching heater control (18549) assembly to instrument panel.
4. Pull heater control from instrument panel and disconnect electrical connectors from the heater control.
5. Disconnect A/C plenum vacuum harness (18C581).
6. Disconnect heater temperature cable (18518) from heater control.
7. The knobs (18519) can be removed by pulling.
8. Remove heater control.

Installation

1. Push control knobs on appropriate shafts, if they were removed.
2. Connect heater temperature cable to heater control.
3. Connect electrical connector(s) and vacuum hose harness to heater control assembly.
4. Position heater control in instrument panel opening and install four retaining screws.
5. Install control opening finish panel by snapping it into place.
6. Connect battery ground cable.
7. Check system for proper operation.

Climate Control Assembly

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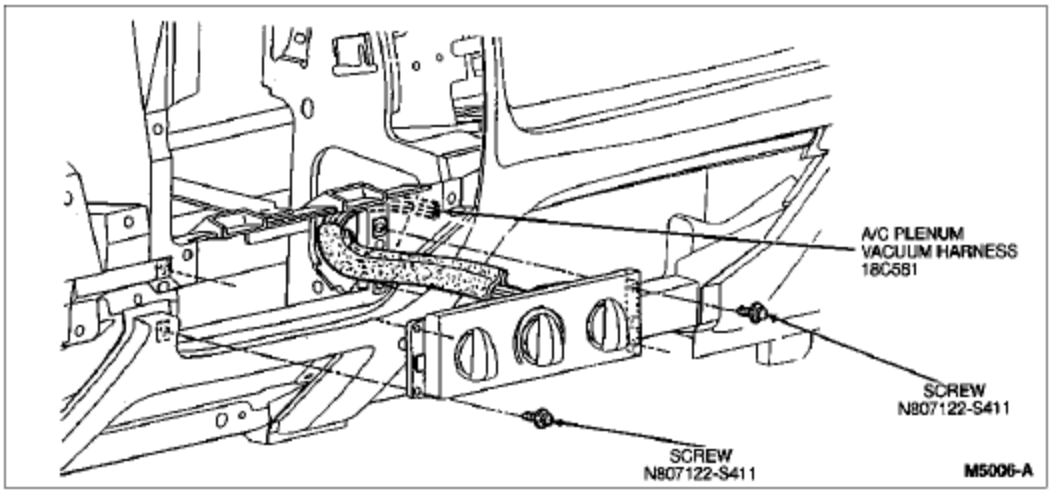
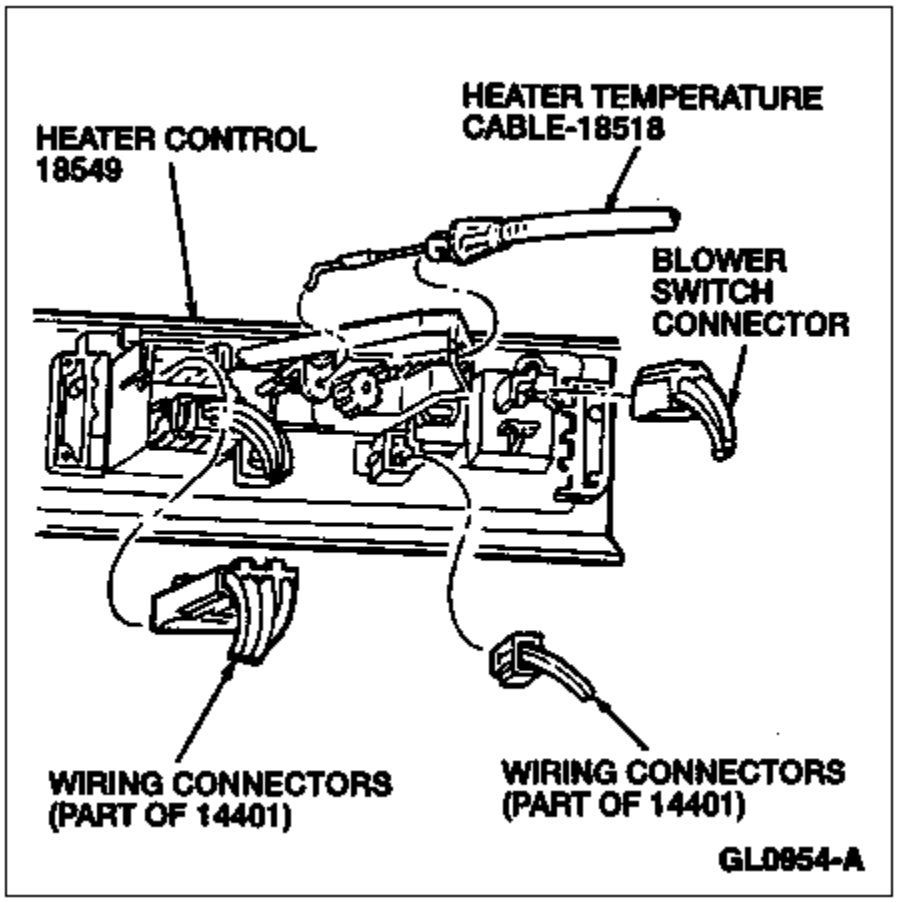


Heater Control, Rear View



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Climate Control Assembly Illumination Bulbs

Removal and Installation

1. Remove control assembly.
2. Rotate the miniature bulb assembly until the notch on the assembly is aligned with slot in the miniature bulb assembly access hole in the back of the control assembly.
3. Remove miniature bulb assembly.
4. Remove miniature bulb (13466).

For installation, follow removal procedures in reverse order.

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Climate Control Assembly Switch Knob(s)

Removal and Installation

Grasp knobs (18519) in fingers and carefully pull directly away from heater control (18549).

To install, align knob with appropriate heater control shaft and press into position. Make sure the flat points on both the shaft and knob are properly aligned.

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Climate Control Assembly Switches

Heater Blower Motor Switch

Removal

1. Disconnect battery ground cable.
2. **NOTE: Do not detach the cables.**

   Remove the heater control (18549) from the instrument panel (04320) as described in this section.
3. Remove the wire harness hard shell connector from the connection by lifting the snap lock retainer with a screwdriver and pulling on the connector.
4. Remove the heater blower switch knob.
5. Remove the hex-head screw which attaches the heater blower motor switch (18578) to the heater control. Remove the switch by rotating and pulling it straight out from the rear of the control.

Installation

1. Position the heater blower motor switch against its mounting bracket in the heater control by inserting and rotating the switch to lock the tabs. Hold the heater blower motor switch tightly against the bracket, and install the hex-head screw.
2. Place the knob (18519) on its shaft and push in to secure attachment.
3. Connect the wire harness connector to the heater blower motor switch.
4. Position the heater control to the opening and install the four attaching screws.
5. Install the heater control as described in this section.
6. Connect the battery ground cable(s).
7. Check the heater blower motor switch for proper operation.

Vacuum Selector Switch

Removal

1. **NOTE: Do not detach the cables.**

   Remove the heater control as described in this section.
2. Move the function control knob to the OFF position. Remove the A/C plenum vacuum harness

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(18C581) from the vacuum control valve by carefully opening the snap lock and pulling straight out on the vacuum harness connector.

3. Remove the hex head screw which attaches the vacuum selector valve switch. Rotate the switch and pull it straight out.

Installation

1. Position the vacuum control valve against its bracket in the heater control. Secure the valve with two hex-head screws.

2. Connect the A/C plenum vacuum harness to the vacuum valve assembly.

3. Install the heater control in its opening in the instrument panel as described in Removal and Installation, Climate Control Assembly in this section.

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Climate Control Cable

Removal

1. Disconnect the battery ground cable.
2. Remove the heater control (18549) as described in this section.
3. Disengage the glove compartment door by squeezing the sides together, allowing the door to hang free, and remove the glove compartment assembly.
4. Working through the glove compartment and/or control opening, remove the temperature cable jacket from clips on top of the heater air plenum chamber (18471) by compressing the clip tabs and pulling the cables upward.
5. Reach through the glove compartment opening, and disconnect the heater temperature cable (18518) from its cam.
6. The cable is routed inside the instrument panel (04320) with two routing aids. Remove the cables from these devices. Reaching through the opening, pull the cable upward out of the wiring shield cut-out. Reaching through the glove box opening pull the cable out of the plastic clip up inside the instrument panel.
7. Pull the cable from the instrument panel through the opening for the heater control.

Installation

1. Working through the glove compartment opening and the opening in the instrument panel, feed the end of the cable to the cam assembly area. Feed the cable in from the glove compartment opening, ensuring that the round hole diecast end of the black heater temperature cable goes in first.
2. Attach the diecast end of the heater temperature cable to the temperature cam making sure that the cable is routed under the cable hold-down feature on the cam assembly.
3. Route the control end of the cable through the instrument panel until the ends stick out of the control opening. It is not necessary to insert the cable into any routing devices previously used. Those routing aids are only necessary when the entire instrument panel is removed and reinstalled.
4. Attach the heater temperature cable to the heater control. Install the heater control in the instrument panel as described in Removal and Installation, Climate Control Assembly in this section.
5. **NOTE: Make sure the radio antenna cable does not become disengaged from its mounting and fall into the plenum cam area where it could cause an increase in control assembly operating effort or a faulty selection of system functions.**

   Adjust the cable in its clips on top of the heater air plenum chamber by following the adjustment procedures described in Adjustments, Temperature Control Cable in this section.
6. Make a final check of the heater system for proper control cable operation.

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Instrument Panel Registers

There are four instrument panel register assemblies, each of which can be adjusted horizontally and vertically to control directional airflow.

Register Louver Assembly (RH)

Removal and Installation

1. Carefully insert a small pry tool between the right-hand edge of the A/C register (19893) and the instrument panel pad. Use caution not to damage the pad finish.
2. Pry over and out to release the fixed snaps in line with center control knob. Three other flex tabs retain the assembly, one middle left side, one top left and one bottom left. These release the same as previously described.
3. Remove RH register from the face of the instrument panel (04320).

For installation, press the replacement RH register into its opening.

Instrument Panel Cluster, Center

The center register is actually two louver assemblies which can be adjusted and serviced independently of each other.

To remove the louver assemblies, proceed as follows:

1. Depress the center division bar to the side.
2. Pull the end of the louver assembly from the opening.
3. To install, snap each end of the louver assembly into position. Louvers will not assemble upside down, but will interchange with each other.
4. To service the entire register assembly, remove the center finish trim panel. Refer to Section 01-12 .
5. Release eight tabs from the backside and remove the assembly.

To install the register assembly, follow removal steps in reverse order.

Instrument Panel Cluster, Left Register

Removal and Installation

1. Remove the instrument panel applique as described in Section 01-12 .
2. From the back side of the applique, remove three screws from the left A/C register and push it out of the applique.
3. To install the register, set in position and install the screws.

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4. Install the applique.

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Heater Core

Removal and Installation

1. Allow the engine (6007) to cool. Following all safety precautions (refer to Section 03-03) and using a thick cloth, turn radiator cap slowly to the first stop. Step back while pressure is released. When the pressure has been released, tighten the radiator cap on the radiator.

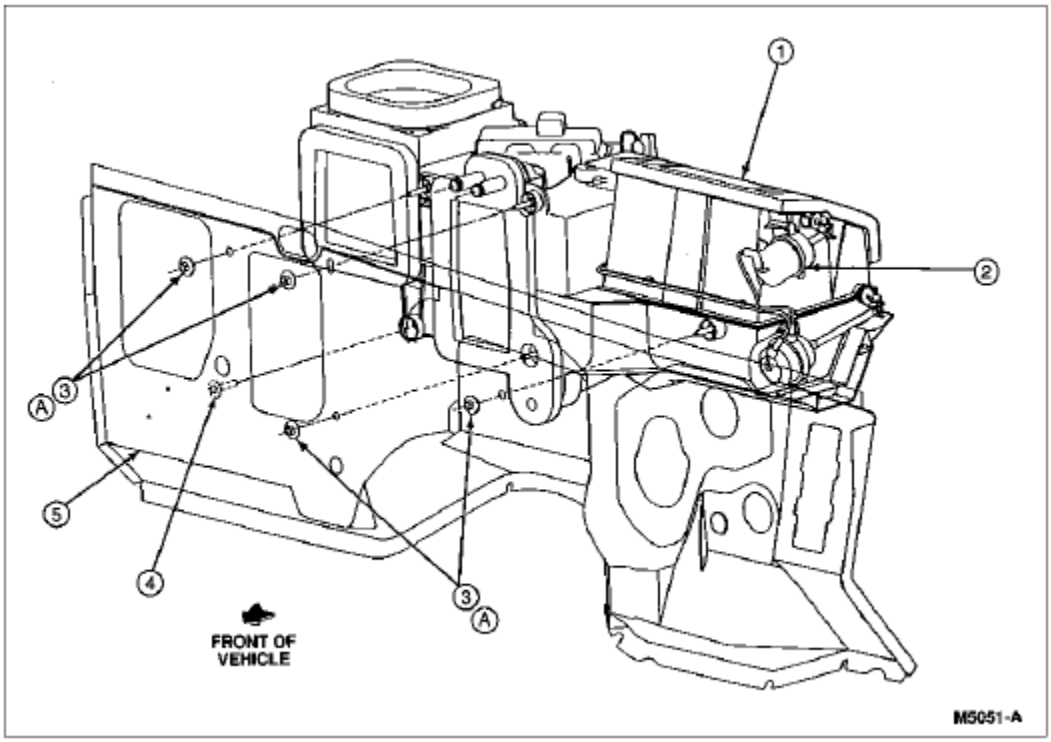
2. Disconnect the heater water hoses (18472) from the heater core (18476) and plug the heater water hoses.

3. In the passenger compartment, remove the instrument panel (04320). Refer to Section 01-12 .

4. Remove heater air plenum chamber (18471). Refer to Removal and Installation, Air Plenum Chamber and Duct in this section.

5. Remove heater core from heater air plenum chamber. For installation, follow removal procedures in reverse order.

Heater Air Plenum Chamber Installation



Item	Part Number	Description

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1	18471	Heater Air Plenum Chamber
2	18A318	Vacuum Control Motor
3	N621907-S2	Nut (5 Req'd)
4	—	Stud (Part of 19850)
5	01610	Dash Panel
A	—	Tighten to 3-5 Nm (27-44 Lb-In)

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Air Plenum Chamber and Duct

Removal

1. Disconnect the battery ground cable.
2. Remove heater water hoses (18472) fromheater core (18476) and plug heater water hoses as described in this section.
3. Remove the heater plenum chamber case (18A484).
4. Remove the remaining nuts which secure the heater air plenum chamber (18471) to the dash panel on the engine side of the panel.
5. In the passenger compartment, remove the instrument panel (04320), following procedures given in Section 01-12 .
6. Pull heater air plenum chamber from the dash panel and remove from the vehicle.

Installation

1. Position the heater air plenum chamber to the dash panel, aligning the studs with the holes in the panel.
2. Install the nuts on the studs at the dash panel in the engine compartment.
3. Install heater plenum chamber case.
4. Install the heater water hoses on the heater core.
5. Install the instrument panel, following procedures given in Section 01-12 .
6. Connect the battery ground cable. Check system for proper installation.

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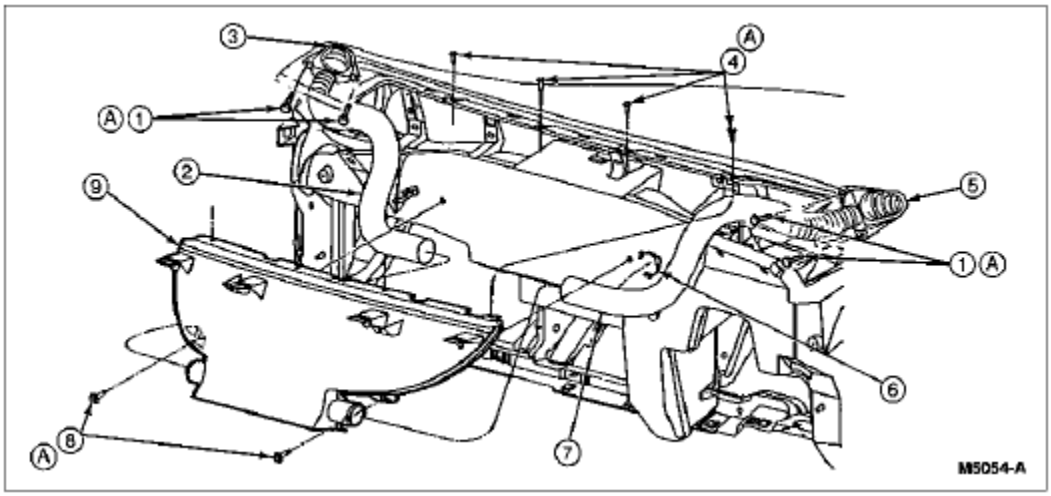
Defroster Ducts

Removal and Installation

1. Remove instrument panel (04320) and lay it back against front seat. Refer to Section 01-12 .
2. Remove four screws at the top of the defroster, front of the instrument panel pad.
3. Remove two screws attaching the defroster nozzle to the instrument panel duct beam.
4. Disconnect demister hoses from the defroster nozzle (pull off).
5. Remove defroster nozzle assembly.

To install, follow removal steps in reverse order.

Defroster Nozzle Installation



Item	Part Number	Description
1	N803875-S36	Screw (4 Req'd)
2	19E659	Side Window Demister Hose (RH)
3	19E656	Side Window Demister Nozzle (RH)
4	N804306-S36	Screw (4 Req'd)
5	19E657	Side Window Demister Nozzle (LH)
6	—	Clip (Part of 04320)
7	19E659	Side Window Demister Hose (LH)

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8	N803875-S36	Screw (2 Req'd)
9	18490	Windshield Defroster Nozzle
A	—	Tighten to 2.1-2.9 Nm (18-27 Lb-In)

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Outlet Floor Duct

Removal

1. Disconnect battery negative cable, then unplug connector assembly attached to front floor duct.
2. Using trim panel remover tool, remove connector assembly from front floor duct.
3. Remove the screw which attaches the rear of the front floor duct to the plenum.
4. Disengage the front floor duct from the tab on the left side of the plenum and remove the front floor duct.

Installation

1. Position the front floor duct so that the tab on the left side of the plenum protrudes through the oval hole in the duct. Install front floor duct attaching screw.
2. Install connector assembly to front floor duct.
3. Reconnect battery negative cable.

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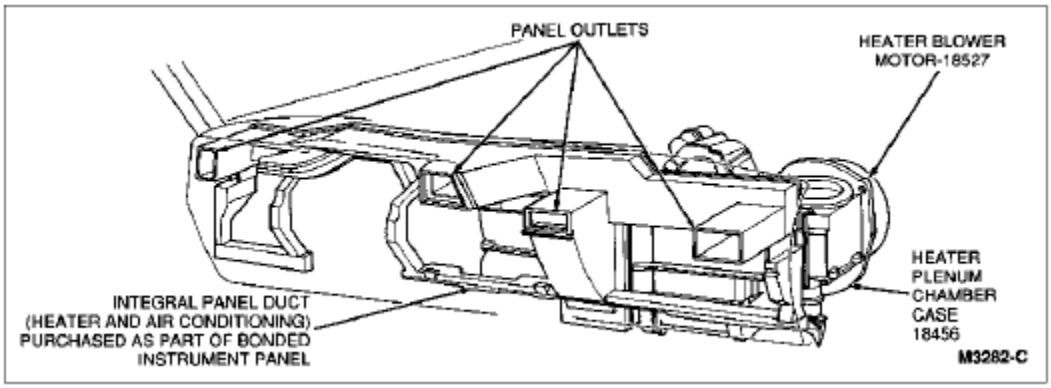
Ducts, Instrument Panel

The illustration shows the location of each of the four outlets in the instrument panel and duct assembly which direct air to the registers. The duct is a purchased-in-assembly component of the instrument panel (04320). It can be removed from the instrument panel assembly as follows.

Removal and Installation

1. Remove the instrument panel as described in Section 01-12 .
2. Remove the four screws which secure the instrument cluster. Remove the cluster.
3. Remove the windshield defroster hose nozzle (18490) as described in this section.
4. Remove the wiring channel cover (four screws).
5. Remove the wiring loom by disconnecting all connectors.
6. Remove all relays and modules.
7. Remove the glove compartment.

Instrument Panel Duct Assembly



8. Remove the radio and bracket.
9. Remove the climate control head assembly.
10. Remove eighteen screws which secure the duct. Remove the duct.

For installation, follow removal steps in reverse order.

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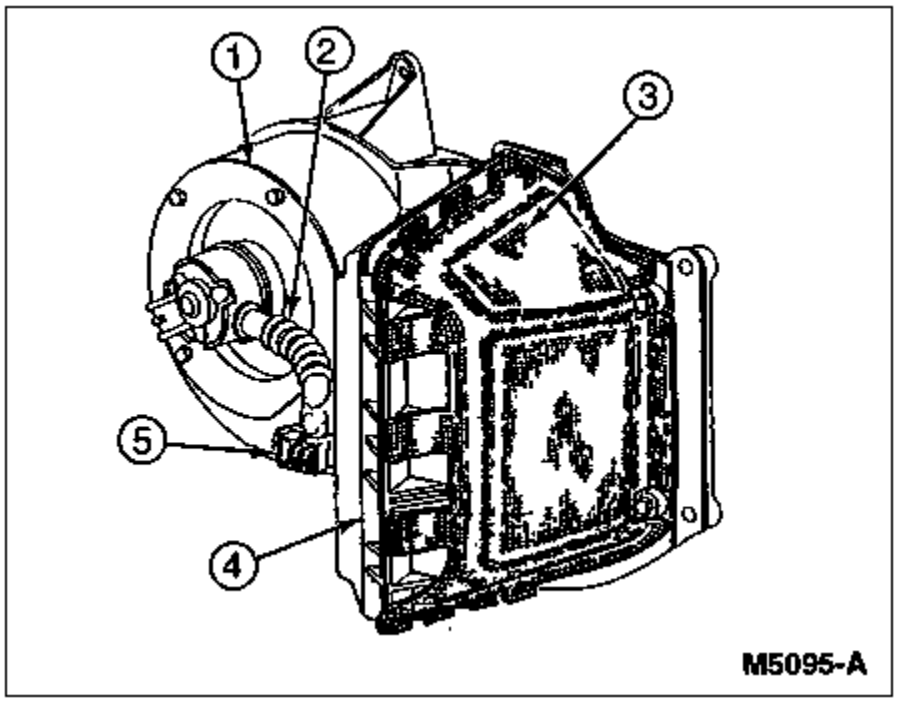
Blower Motor and Blower Motor Wheel Assembly

Removal and Installation

1. Disconnect the battery ground cable.
2. Remove the speed control module and windshield/washer bottle.
3. Disconnect the wire harness connector from blower motor (18527) by pushing down on the connector tabs and pulling the connector off the blower motor.



Item	Part Number	Description
1	18527	Blower Motor
2	19A786	Blower Motor Housing Tube
3	—	Heater Case Insulator (Part of 19850)
4	19930	Blower Housing
5	—	Electrical Connector (Part of 19805)

4. Disconnect the blower motor housing tube (19A786) at the blower motor.

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5. Remove three screws attaching the blower motor to the A/C blower housing (19930).

6. Holding blower motor housing tube aside, pull the blower motor from the heater plenum chamber case (18A484) and remove it from the vehicle.

7. Remove the blower wheel hub pushnut and, if applicable, the clamp from the shaft. Then, pull the blower motor wheel (18504) from the shaft.

For installation, follow removal steps in reverse order. Check system for proper operation.

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Blower Motor Switch Resistor Assembly

The heater blower motor switch resistor (18591) is located on the blower housing in the engine compartment.

Removal and Installation

1. Disconnect the wire connector from the heater blower motor switch resistor.

2. Remove the two attaching screws and lift the heater blower motor switch resistor from the opening in the blower housing.

For installation, follow removal steps in reverse order. Position resistor with notched edge toward blower motor. Check the blower for proper operation in all blower speeds.

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Blower Case Assembly

Removal and Installation

1. Disconnect battery ground cable.
2. In the engine compartment, remove the electrical connector from the blower motor (18527) by pushing on the connector tab while pulling the connector off the blower motor. Remove the connector from the heater blower motor switch resistor (18591).
3. Disconnect the vacuum line from A/C vacuum reservoir tank and bracket (19A566).
4. Remove four nuts which attach the heater case to the dash panel.
5. Remove speed control module and windshield/washer bottle.
6. Pull heater case away from the dash panel and remove it from the vehicle.

For installation, follow removal steps in reverse order. Check system for proper operation.

NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.

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Vacuum Control Motors

Recirculation/Fresh Air Door

Removal and Installation

1. Open the glove compartment and remove contents. Push inward on the sides of the compartment and pull rearward until it disengages from its latched position and hangs down. The vacuum control motor (18A318) should be visible on the right side of the heater air plenum chamber (18471).

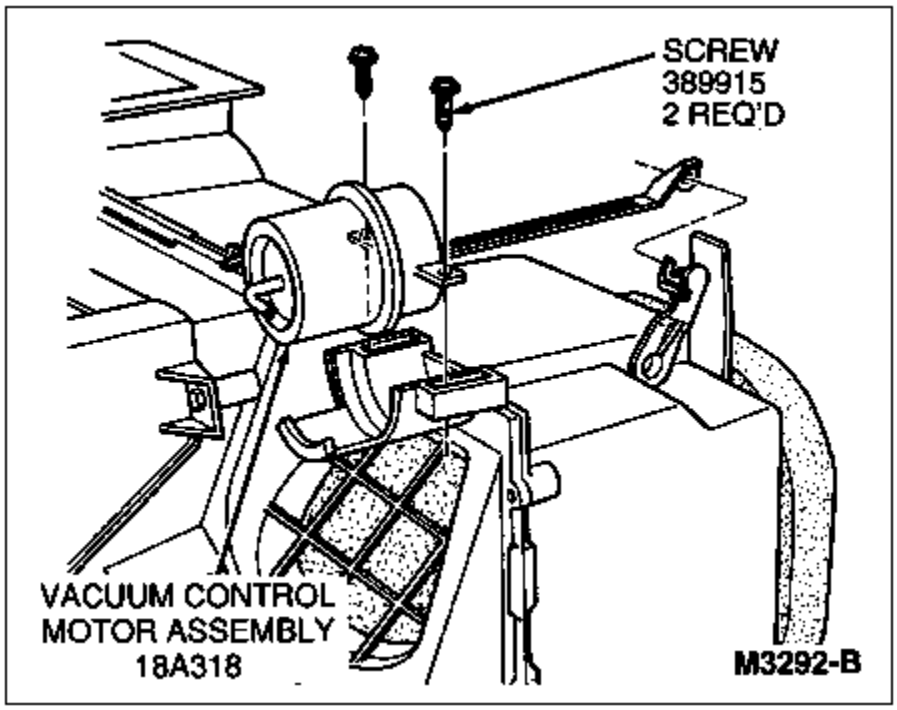
2. Disconnect the vacuum hose from the nipple.

3. Remove the two screws which attach the vacuum control motor to the heater air plenum chamber.

4. Swing the vacuum control motor rearward and disconnect its arm from the shaft on the heater air plenum chamber by sliding the arm to the left.

5. Start the engine and verify that the vacuum control motor responds properly to the function control knob (18519) when it is moved from its OFF position to one of the functional settings.

For installation, follow removal steps in reverse order.



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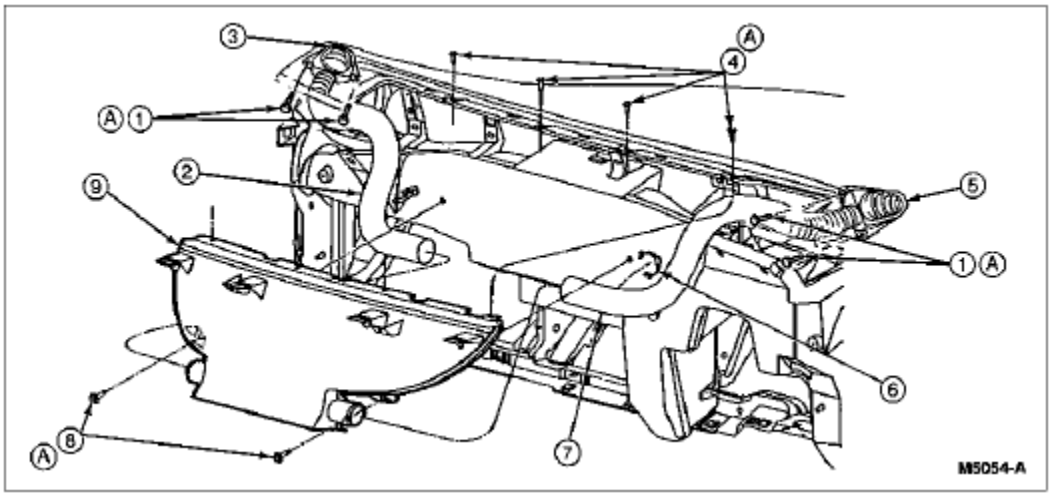
Windshield Defroster Nozzle

Removal and Installation

1. Remove instrument panel. Refer to Section 01-12 .
2. Remove four screws at the top of the defroster, on front of instrument panel pad.
3. Remove two screws attaching defroster to the instrument panel duct beam.
4. Disconnect demister hoses from defroster (pull off).
5. Remove nozzle assembly.
6. To install, follow installation procedures in reverse order.

Windshield Defroster Nozzle Installation



Item	Part Number	Description
1	N803875-S36	Screw (4 Req'd)
2	19E659	Side Window Demister Hose (RH)
3	19E656	Side Window Demister Nozzle (RH)
4	N804306-S36	Screw (4 Req'd)
5	19E657	Side Window Demister Nozzle (LH)
6	—	Clip (Part of 04320)
7	19E659	Side Window Demister Hose (LH)

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8	N803875-S36	Screw (2 Req'd)
9	18490	Windshield Defroster Nozzle
A	—	Tighten to 2.1-2.9 Nm (18-27 Lb-In)

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Side Window Demister and Hose

1. Remove instrument panel (04320). Refer to Section 01-12 .
2. Remove screws (two each side) which retain demister nozzles to the instrument panel.
3. Release RH A/C side window demister and hose (19E630) and the LH A/C side window demister and hose from the windshield defroster nozzle and the support clips and carefully remove hose assemblies from their locations.

For installation, follow removal procedures in reverse order.

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Vacuum Hoses

Removal and Installation

1. Working in the engine compartment at the blower housing, disconnect the vacuum line (which is part of the A/C blower motor feed extension (19D605)).

2. Disconnect the vacuum line from the vacuum source on the engine intake manifold, and remove it from the routing channel.

3. Disconnect the vacuum line from the A/C vacuum reservoir tank and bracket (19A566), and remove the rosebud from the heater plenum chamber case (18A484).

For installation, follow removal steps in reverse order.

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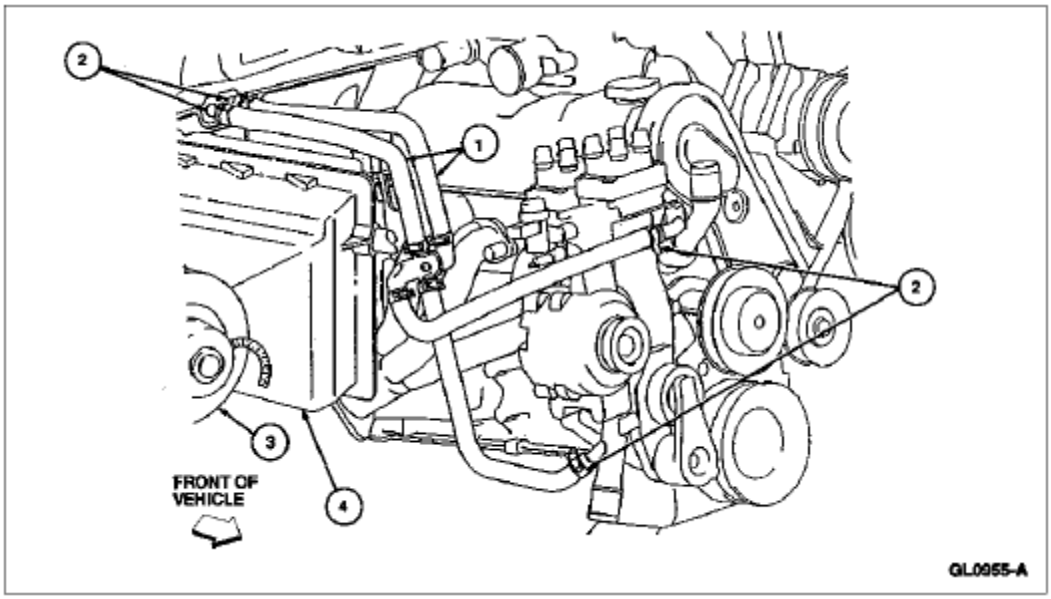
Heater Water Hoses

Removal and Installation

1. Drain the coolant from the cooling system. Observe the safety precautions covered in Section 03-03 .
2. Loosen the clamps and remove the heater water hose (18472) from the vehicle. Refer to the applicable engine illustration.

Heater Hose Installation, 2.3L Engine



Item	Part Number	Description
1	18472	Heater Water Hose
2	390761-S100	Clamp (4 Req'd)
3	19930	Blower Housing
4	19850	A/C Evaporator Housing

Heater Hose Installation, 3.0L Engine

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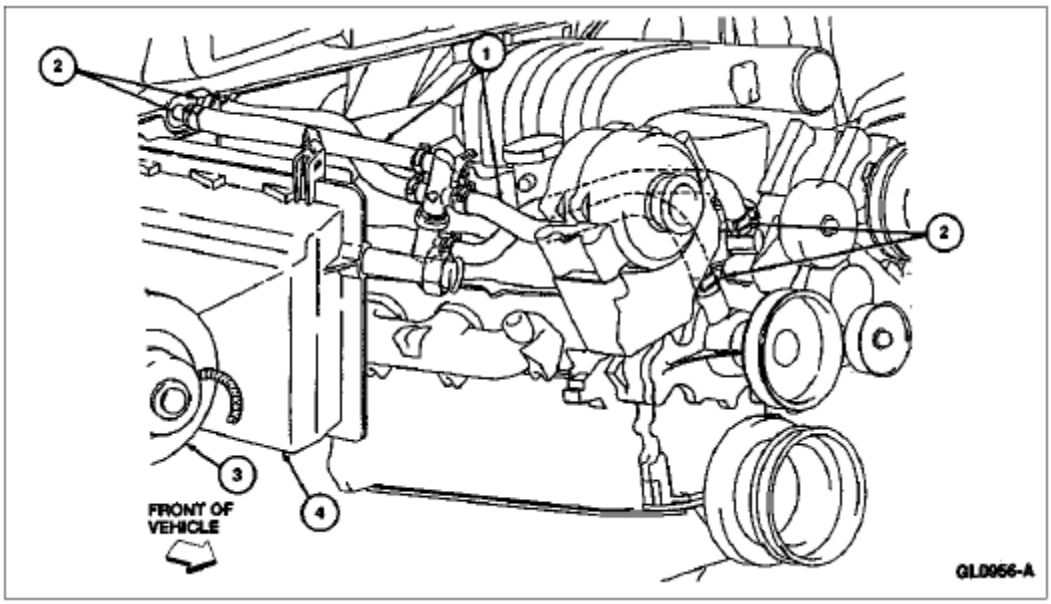
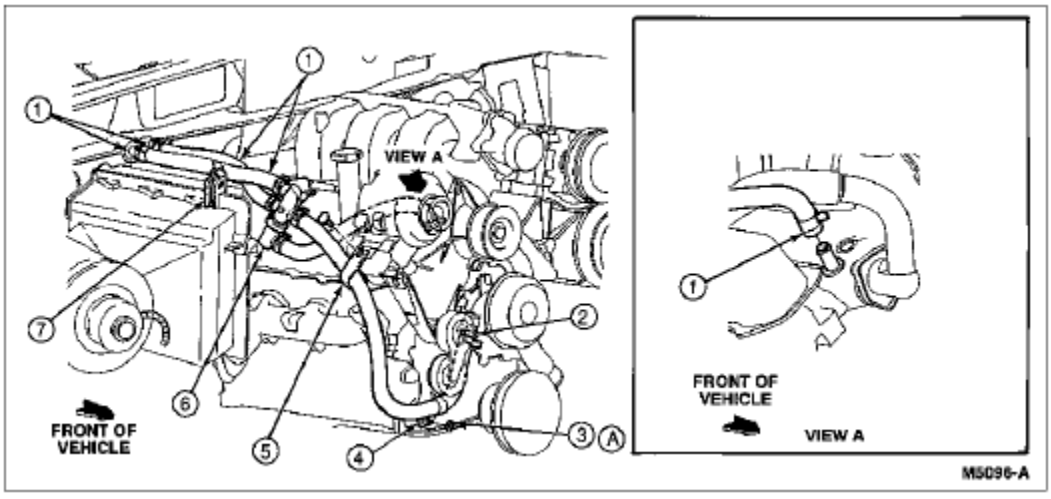


Item	Part Number	Description
1	186266	Heater Hoses
2	8287	Clamp
3	19930	Blower Housing
4	19850	A/C Evaporator Housing

Heater Hose Installation, 4.0L Engine



Item	Part Number	Description
1	18472	Heater Water Hoses
2	8501	Water Pump
3	N621940-S54	Nut

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4	N807327-S100	Clip
5	353859-S100	Clip
6	18495	Heater Water Control Valve
7	18D255	Heater Water Control Valve Bracket
A	—	Tighten to 10-14 Nm (7-10 Lb-Ft)

3. Route the heater water hose, as shown.
4. **NOTE: DO NOT overtighten the hose clamps.**

   Connect the heater water hose to the fittings and tighten the clamps to specification.
5. Fill and bleed the cooling system (refer to Section 03-03).
6. Check for coolant leaks and for proper operation of the system.

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Temperature Control Cable

To check the adjustment of the heater temperature cable (18518), move the temperature control knob all the way to the left; then, move it all the way to the right. At the extreme ends of travel, the door should be heard to firmly seat allowing either maximum or no airflow through the heater core (18476). To check the adjustment of heater air cable (18552), establish that the function knob will reach the detents at the far left and right of its travel. In addition, determine that airflow is correct when the function knob is moved through each detent provided in the heater control (18549). If cable adjustment is needed, proceed as follows.

To adjust the cables:

1. Disengage the glove compartment door by squeezing the sides together, allow door to hang free and remove glove compartment assembly.

2. **NOTE: Cable end should remain attached to door cams.**

   Working through glove compartment opening, remove cable jacket from metal attaching clip on top of heater air plenum chamber (18471) by depressing clip tab and pulling cable out of the clip.

3. To adjust the heater temperature cable, set the temperature knob to COOL and hold. With the end attached to the temperature door cam, push gently on the jacket (black) to seat the blend door (push until you feel resistance). Reinstall heater temperature cable to clip by pushing jacket into clip from top until it snaps in place.

4. To adjust the heater air cable, set the function knob in the DEFROST detent and hold. With the end attached to the function cam, pull on the cam jacket (white) until cam travel stops. Reinstall heater air cable to clip by pushing cable jacket into clip from top until it snaps in place.

5. Run the blower motor (18527) on HIGH and actuate the knobs, checking for proper adjustment.

6. Install glove compartment.

7. **NOTE: If the heater temperature cable will move neither left nor right and appears to be locked in place, the adjustment pins may have been inadvertently left in the control cams during assembly. To remove these pins, refer to the following procedure.**

   Disengage the glove compartment door by squeezing its sides together. Allow the door to hang down and remove glove compartment assembly.

8. Working through the glove compartment opening, feel along the cable(s) until the cam(s) is reached. Then, feel the upper surface of the cam(s) to locate a small snap-in pin. (This pin should protrude approximately 9mm (3/8 inch) above the cam surface.

9. Remove and discard the pin.

10. Check for proper control cable operation.

11. Reinstall glove compartment assembly and door.

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Mini-Tube Vacuum Hose

Mini-tube vacuum hoses are provided in the A/C plenum vacuum harness (18C581) assemblies. They provide greater flexibility with less tendency to collapse and are less susceptible to pinching. Service of damaged hoses are easily made using a short piece of standard 3mm (1/8 inch) ID vacuum hose and inserting the cut ends of the mini-tube into the ends of the standard 3mm (1/8 inch) ID vacuum hose. The following illustrates an in-line and tee connector installation.

1. Measure length of damaged area of the mini-tube vacuum hose.
2. Cut a piece of standard 3mm (1/8 inch) ID vacuum hose approximately 25mm (1 inch) longer than damaged area of the mini-tube vacuum hose.
3. Cut off the mini-tube vacuum hose on each side of damaged area.
4. Dip the mini-tube hose ends in Tetra Hydro Furan (THF) or Methyl Ethyl Ketone (MEK) to act as solvent and seal the repair joints.
5. Insert ends of the mini-tube vacuum hose approximately 9mm (0.375 inch) into ends of standard 3mm (0.125 inch) service vacuum hose section.
6. Shake service joint after assembly to ensure solvent is dispersed and vacuum line is not plugged.
7. Test system for a vacuum leak in service area using a Vacuum Tester.

Mini-Tube Vacuum Hose Service

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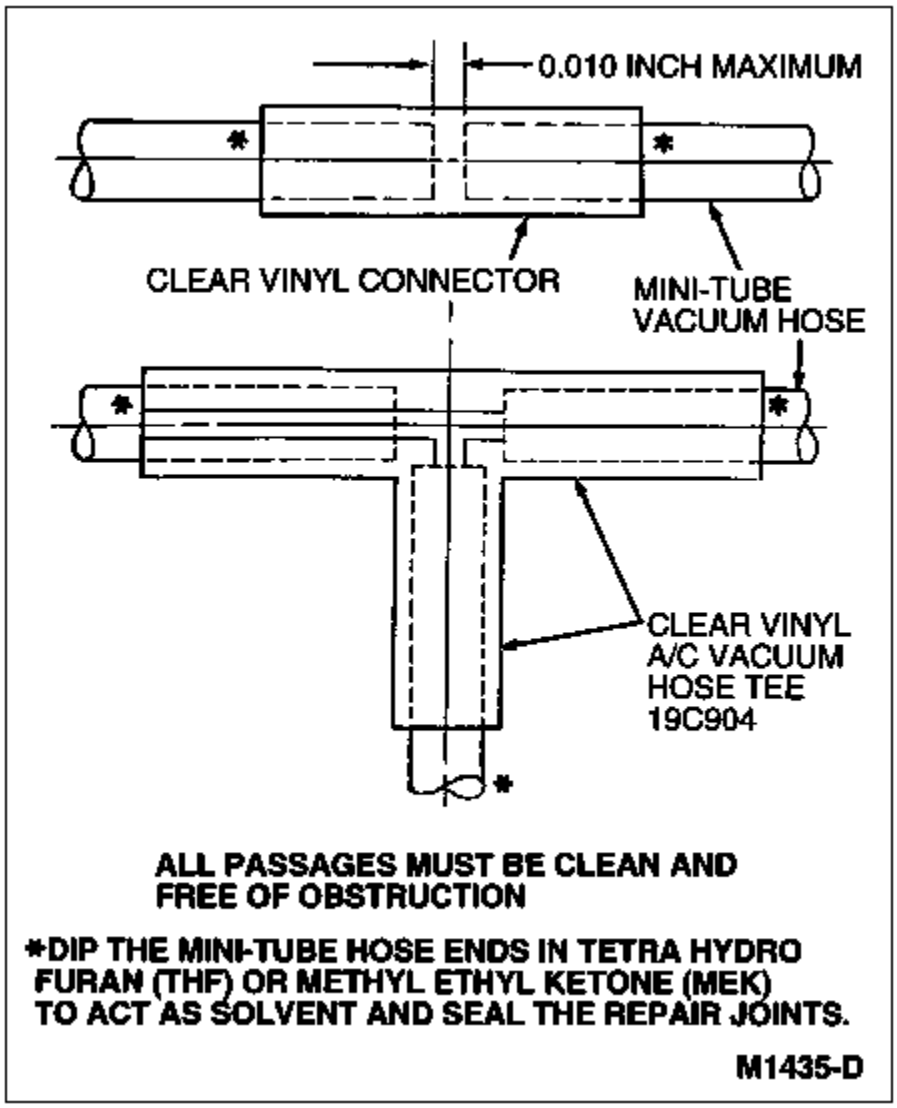

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SPECIFICATIONS

ELECTRICAL SPECIFICATIONS

Switch Setting	Amps	Volts
Off	0	0
Low	3.5-5.5	5
Medium Low	5-7.5	8
Medium High	7-9.5	10
High	9.5-11.5	12
Heater Control Assembly, Illumination	One ICP — 161 Bulb	
System Protection	30 Amp Mini-Fuse (Light Green) in Panel F-9	

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Heater Hose Clamps	1.8-2.5	—	16-22
Heater Air Plenum to Dash Panel Nuts	3-5	—	27-44
Side Window Demister Nozzle Screws	2.1-2.9	—	18-27
Heater Water Hose Clip Screws	10-14	7-10	—

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R-134a Refrigerant System

CAUTION: Never mix the two refrigerants or the oils.

CAUTION: Do not add R-12 refrigerant to an A/C system that requires the use of R-134a refrigerant. Also, do not add R-134a refrigerant to an A/C system that requires the use of R-12 refrigerant. These two types of refrigerant should never be mixed. Doing so may cause damage to the A/C system.

NOTE: R-12 refrigerant and refrigerant oil is not compatible with R-134a refrigerant and R-134a refrigerant oil.

In an effort to avoid the use of CFC refrigerants that may harm the ozone layer of the atmosphere, Ford Motor Company has introduced a new refrigerant system on all Ford vehicles that requires the use of a non-CFC based refrigerant known as R-134a. This new type of refrigerant has many of the same properties as R-12 and is similar in form and function. However, R-134a is a hydrofluorocarbon (HFC)-based refrigerant while R-12 is a chlorofluorocarbon (CFC)-based refrigerant. Because of the absence of chlorine in its molecular structure, the use of R-134a refrigerant will not have any harmful effects on the ozone layer of the atmosphere.

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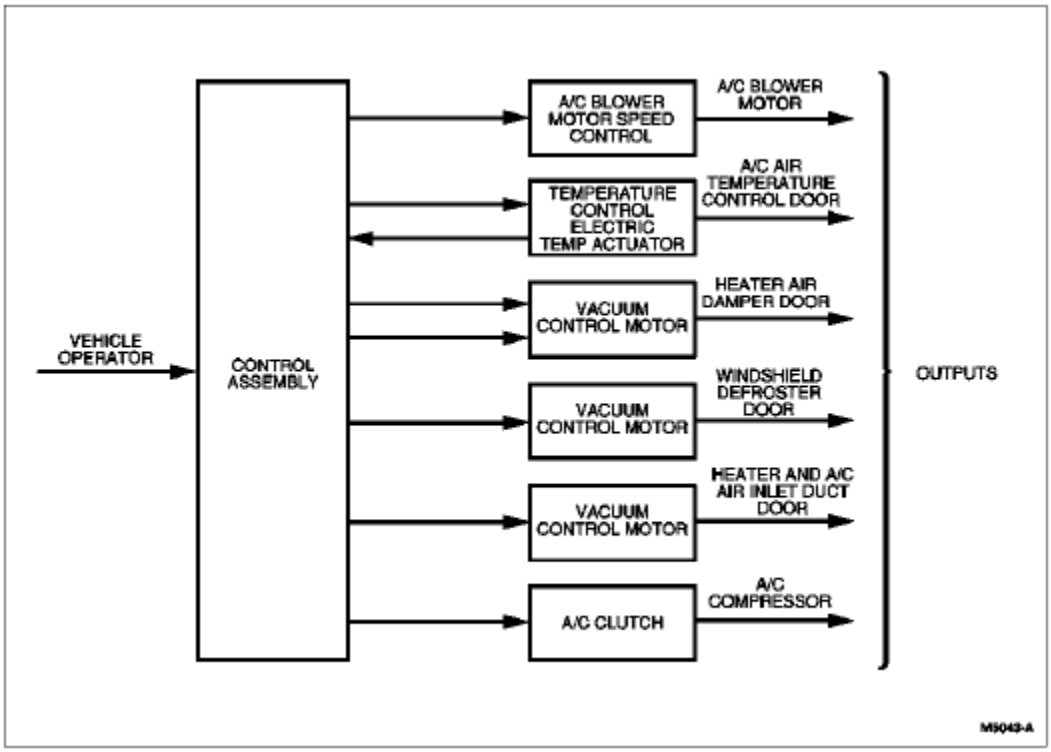
A/C-Heater System, Manual

The manual air conditioning/heater system used in these vehicles is a split-case, blend air design. This design includes the following major components:

- An A/C evaporator housing (19850) which is attached to the engine compartment side of the dash panel (01610). This assembly includes: (1) the A/C evaporator core (19860), (2) the suction accumulator/drier (19C836), (3) the A/C cycling switch (19E561), (4) an internal A/C evaporator core orifice (19D990) located inside the inlet line to the A/C evaporator core, (5) a blower motor (18527), (6) a blower motor wheel (18504), (7) a heater blower motor switch resistor (18591), and (8) the A/C evaporator case (19897).
- A heater air plenum chamber (18471) which is attached to the passenger compartment side of the dash panel. This assembly includes: (1) the outside/recirculating air inlet door, (2) the panel door, (3) the floor defrost door, (4) the temperature blend door, and (5) the heater core (18476).
- Other components which link and/or control the heating and air conditioning systems include: (1) the A/C control (19980), (2) the ducts and registers, (3) the windshield defroster hose nozzle (18490), (4) the control cables, (5) the vacuum lines, (6) the refrigerant tubes and hoses, (7) the A/C compressor (19703), and (8) the A/C condenser core (19712).

System Block Diagram



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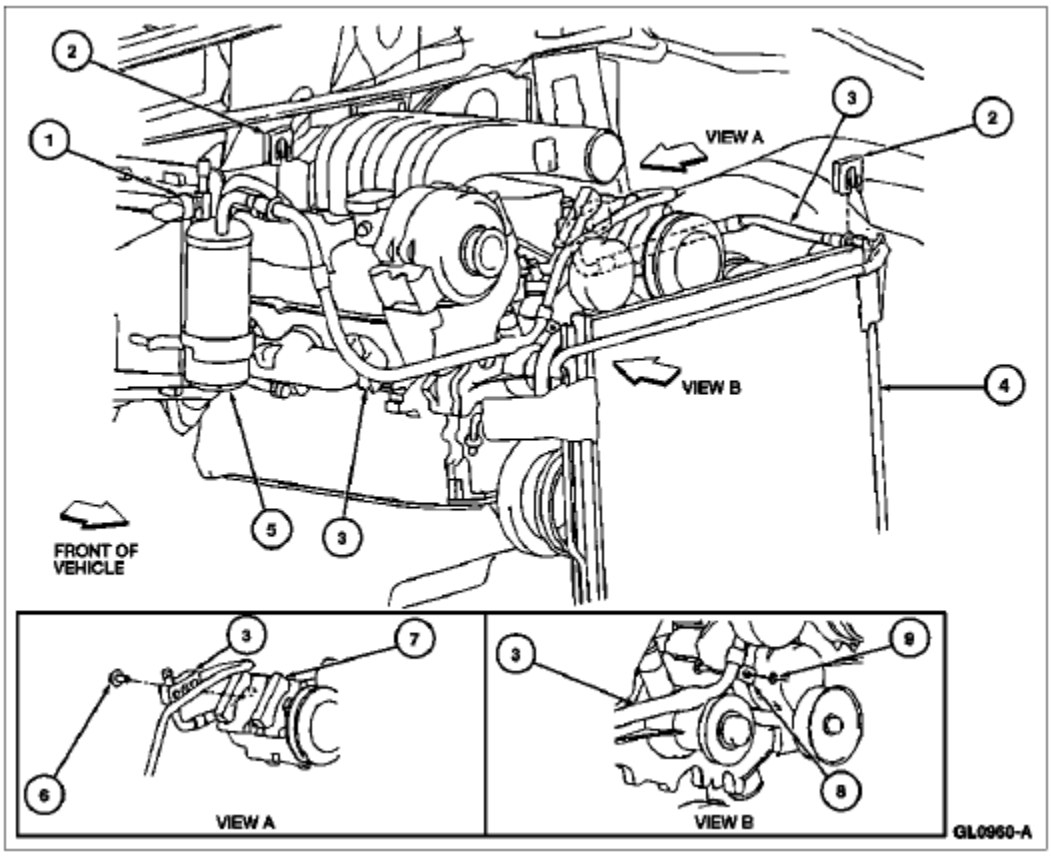
A/C Component Installation, Ranger, 3.0L Engine



Item	Part Number	Description
1	19E561	A/C Cycling Switch
2	19E746	A/C Tube Lock Coupling Clip
3	19D734	A/C Manifold and Tube
4	19712	A/C Condenser Core
5	19C836	Suction Accumulator/Drier
6	—	Screw (Part of 19D629)
7	19703	A/C Compressor
8	—	A/C Hose Clamp (Part of 19D734)
9	N621940-S301	Nut

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Climate Control Assembly

The manual A/C-heater control includes the following features:

Airflow Control

- A function selector knob which has positions: OFF, MAX-A/C, A/C, Panel, Panel/Floor, Floor, Floor/Defrost.
- The position of the knob determines the manner in which the system will operate.
  - A temperature control knob manually sets the desired comfort temperature.
  - Fan control knob controls the volume of air movement.
- Each position of the function selector knob and fan control knob is detented for positive engagement.
- The fan control knob provides four manually-selected A/C blower motor speeds and may be operated in any position of the function selector knob except OFF to select the desired amount of airflow.

The A/C control (19980) assembly consists of three main parts:

- The function selector knob, a vacuum selector valve combined with an internal electrical switch.
- Heater blower motor switch (18578), an electrical switch that provides four speeds of A/C blower motor operation.
- A temperature control knob, which controls the position of the temperature blend door mounted on the A/C evaporator housing (19850) assembly.

Front A/C and Heat

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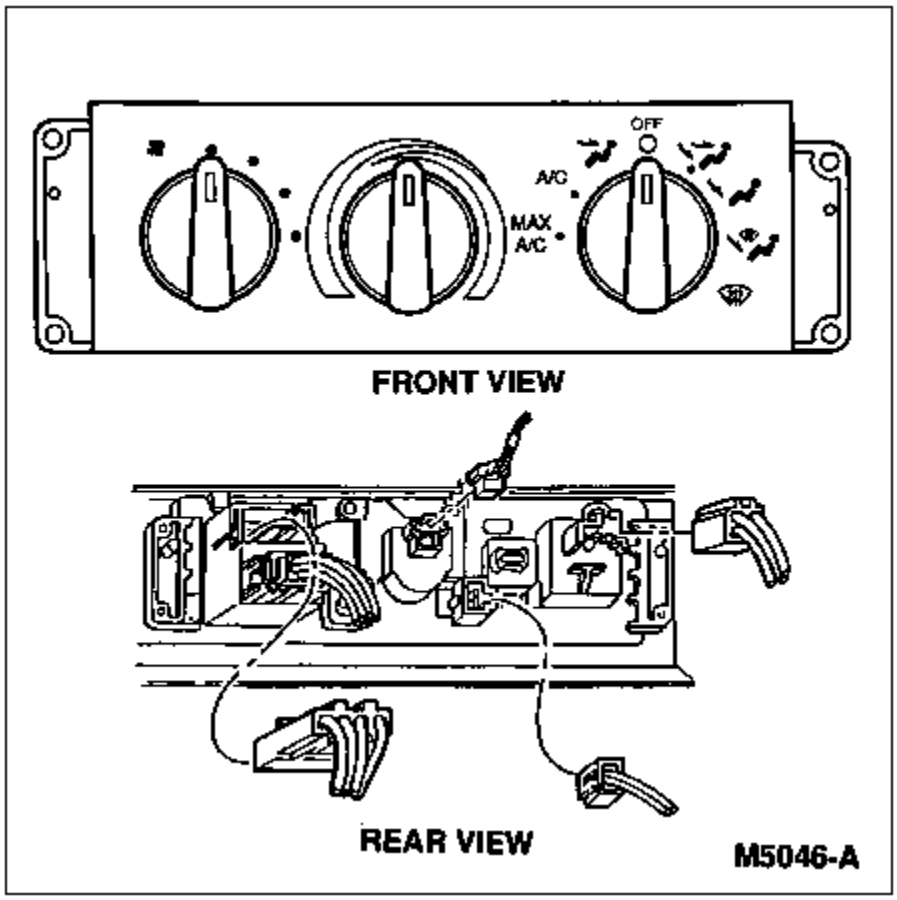

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Airflow Control

The function selector actuates an eight-port air conditioner control that controls the vacuum control motor (18A318) at the floor/defrost, panel/defrost, and outside/recirc. air doors. The function selector also controls the OFF-ON operation of the heater blower motor switch (18578) and activates the circuit for the A/C clutch (2884) circuit in the A/C position.

In either A/C position and in FLOOR/DEFROST and DEFROST positions, compressor operation is dependent upon the A/C cycling switch (19E561).

The cutout pressure is approximately 161 kPa (23 psi). Cut-in pressure is approximately 321 kPa (46 psi).

The following chart relates function and temperature lever settings for direction of airflow into the passenger compartment.

FUNCTION AND TEMPERATURE LEVER SETTINGS AND RELATED AIRFLOW DIRECTIONS

Lever Position	Airflow Direction
Function Lever	
Panel	Instrument panel registers.
PNL/FLR	Split between instrument panel registers and floor outlets.
Floor	Floor outlets with bleed to defrosters.
FLR/DEF	Split between floor outlets and defrosters.
Defrost	Defroster with bleed to floor outlets.
Max A/C	Instrument panel registers.
Temperature Lever	
Cool (Full)	All air bypasses heater core.
Warm (Full)	All air flows through heater core.
Between Cool and Warm	Amount of air through heater core is proportionate to the amount that the blend air door is opened or closed to the extremes of cool or warm.

Temperature Control

The temperature selector actuates a variable resistance switch. This switch varies the voltage to an electric actuator used to position the temperature blend door.

Positioning the temperature control in any position between COOL and WARM causes the temperature blend door to direct more or less outside air through or around the heater core (18476) for whatever proportion of heated or unheated outside air is desired.

The air blends together as it leaves the heater core and enters the heater air plenum chamber (18471) for distribution.

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Blower Motor Speed Control

The blower motor (18527) is controlled by a four-position heater blower motor switch (18578) located on the left side of the control assembly. The four positions are LOW, MEDIUM LOW, MEDIUM HIGH and HIGH. The four operating speeds are obtained with a heater blower motor switch resistor connected in series with the heater blower motor switch operating on the ground side of the blower motor.

With the function control knob in the OFF position, the blower motor will not operate.

With the heater blower motor switch at LOW, current flow in the ground circuit is through three resistors to obtain the lowest operating speed.

With the heater blower motor switch at MEDIUM LOW, current flow in the ground circuit is through two resistors to obtain a medium low operating speed.

With the heater blower motor switch at MEDIUM HIGH, current flow in the ground circuit is through one resistor to obtain a medium high operating speed.

With the heater blower motor switch at HIGH, current flow in the ground circuit by-passes the heater blower motor switch resistor (18591) to obtain the maximum operating speed.

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Blower Motor Switch Resistor

A heater blower motor switch resistor (18591) with a thermal limiter is mounted in the A/C evaporator housing (19850). The heater blower motor switch resistor is used with the heater blower motor switch (18578) to obtain the desired fan speed.

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Blower Motor Thermal Limiter

The thermal limiter in the heater blower motor switch (18578) serves as a temperature sensitive fuse. When the thermal limiter is opened, the heater blower motor switch resistor (18591) must be replaced.

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Instrument Panel Registers

The louvers in the registers can be adjusted to direct air as desired. The louvers can also be closed to block most of the airflow.

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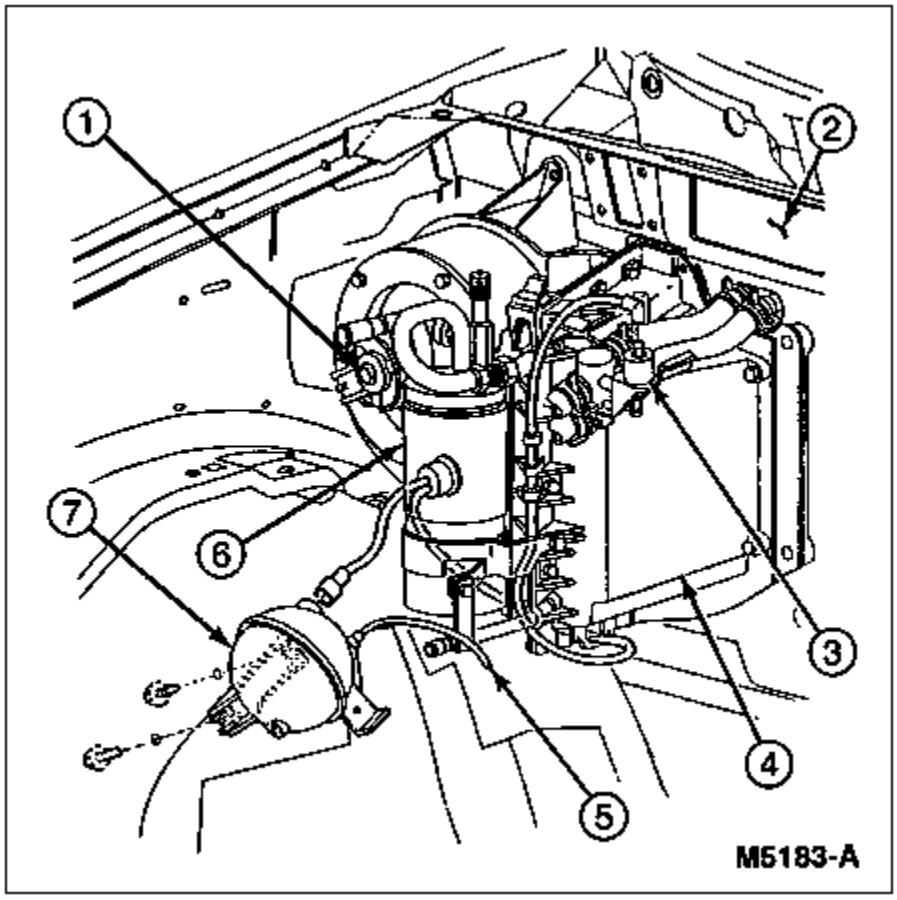
A/C Evaporator Housing

The A/C evaporator housing (19850) is located on the engine compartment side of the dash panel (01610). It contains the A/C evaporator core (19860) and has the suction accumulator/drier (19C836) attached to the outside.

A/C Evaporator Housing



Item	Part Number	Description
1	18527	Blower Motor
2	01610	Dash Panel
3	18495	Heater Water Control Valve
4	19850	A/C Evaporator Housing
5	—	Vacuum Hose to Engine (Part of 18C581)
6	19C836	Suction Accumulator/Drier
7	19A566	A/C Vacuum Reservoir Tank and Bracket

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Blower Motor Assembly

The blower motor (18527) is housed in the A/C evaporator housing (19850) and is serviced from the engine compartment side of the vehicle dash panel (01610).

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Defroster, Demister and Register Ducts

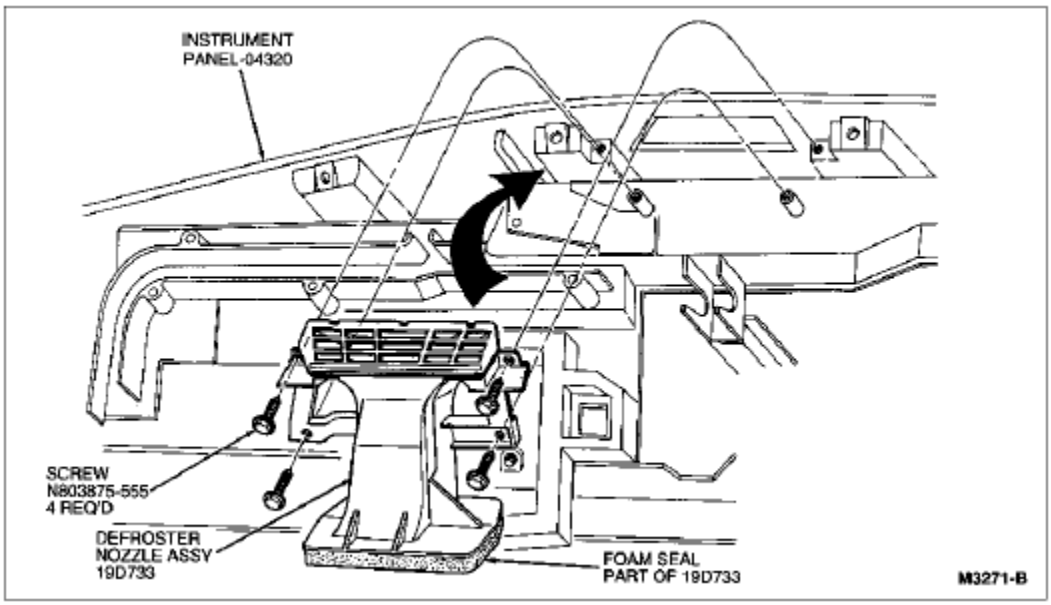
Register Duct

An air conditioner instrument panel duct and support assembly supplies air to the instrument panel registers as well as to the demisters. In addition, the assembly provides full support for the instrument panel (04320). It is attached to the instrument panel with 18 screws.

Windshield Defroster Hose Nozzle

The windshield defroster hose nozzle (18490) is attached with two screws to the under surface of the instrument panel as shown. It is also attached with two screws to the main air duct and support assembly, as shown.

Windshield Defroster Hose Nozzle



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Vacuum Control Motor

The outside/recirculating inlet air door is vacuum-operated. The following illustrates, in schematic form, how system components are involved. The recirc. door is controlled by a vacuum control motor (18A318), which is powered by engine intake manifold vacuum. The function selector in the A/C control (19980) sets the door in either of its two operating positions: (1) closed to the vehicle interior (outside air position) when no vacuum is applied, or (2) open to the vehicle interior (recirculated air position) when vacuum is applied. In vehicles with A/C, vacuum is applied when the function selector is placed in the MAX A/C or OFF position only. This is to allow the driver of the vehicle the opportunity to improve the air conditioning performance in hot weather by cooling recirculated air or the opportunity to shutoff the flow of outside air. (In heater-equipped vehicles, vacuum is applied to shut off outside air in the OFF position.) In all other function selector lever positions (PANEL, PNL/FLOOR, FLOOR, FLR/DEF, or DEFROST), no vacuum is applied and the door remains closed to the vehicle interior. The inlet air door position can be observed through the recirculating inlet, located below the glove compartment.

Vacuum Diagram

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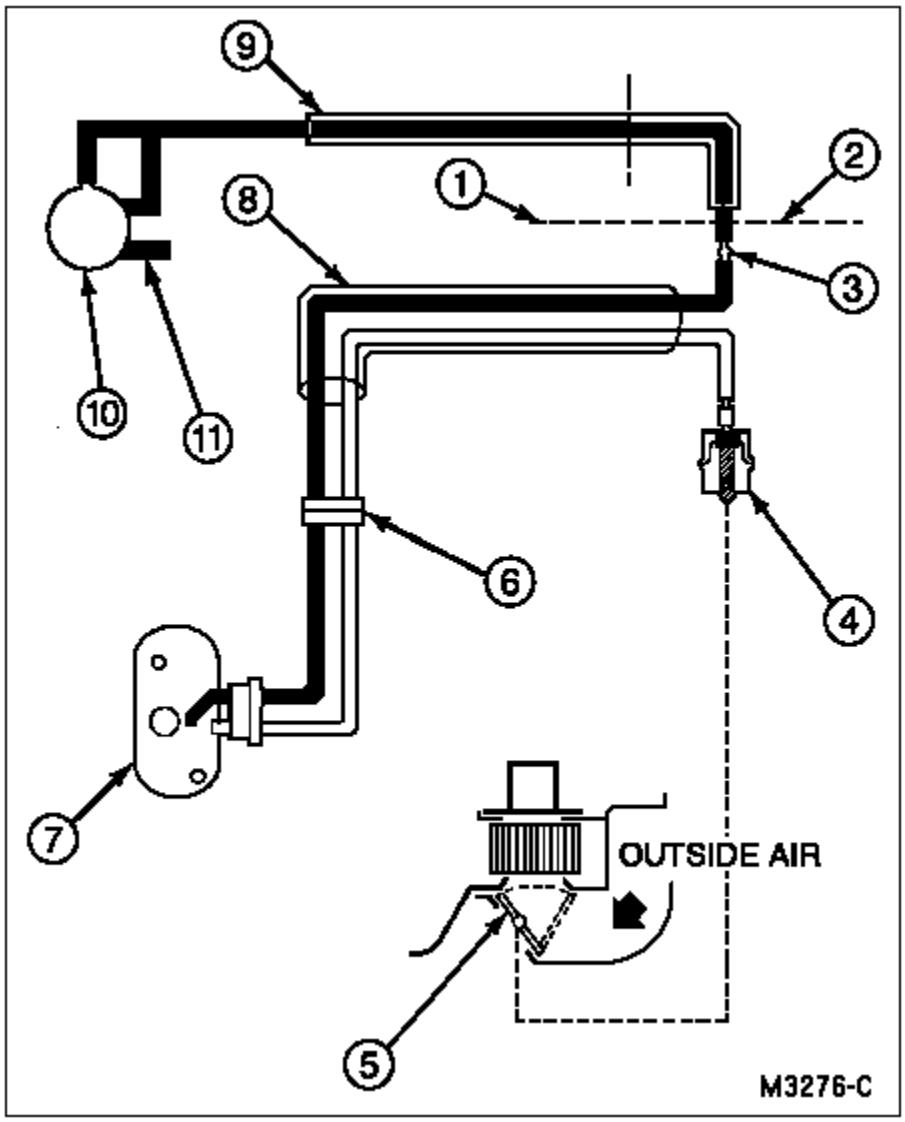

Item	Part Number	Description
1	01610	Dash Panel, Engine Compartment Side
2	01610	Dash Panel, Passenger Compartment Side
3	—	Connector (Between Evaporator and Plenum at Dash Panel)
4	18A318	Vacuum Control Motor, Outside/Recirc. Air Door
5	—	Outside/Recirc. Air Door (Part of 18471)
6	—	Connector (Between Plenum and Control)
7	—	Vacuum Control Valve (Part of 19980)
8	14401	Main Wiring
9	19C828	A/C Vacuum Harness
10	19A566	A/C Vacuum Reservoir Tank and Bracket

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11	—	Vacuum from Engine Manifold (Part of 18C581)

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Vacuum Hoses

Mini-tube vacuum hoses are used in the A/C plenum vacuum harness (18C581).

- They provide greater flexibility with less tendency to collapse and are less susceptible to pinching.
- Service is easily performed using a short piece of standard 3mm (1/8-inch) ID vacuum hose and inserting the cut ends of the mini-tube into the ends of the standard 3mm (1/8-inch) ID vacuum hose.

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Electrical System

The components of the electrical system are the blower motor relay, blower motor (18527), a heater blower motor switch (18578), a heater blower motor switch resistor (18591) with thermal limiter, an A/C cycling switch (19E561), a high pressure cut-off switch, an A/C clutch (2884), and the fuse and wiring needed to protect and link the total circuit.

The blower motor is installed in the A/C evaporator core housing (19A559), which is part of the A/C evaporator case. The blower motor is connected to the electrical circuit with one hard shell connector located on the blower motor, which feeds back through the relay.

The mode function switch is installed on the A/C control (19980) and, with the heater blower motor switch resistor, provides four operating speeds.

The heater blower motor switch resistor is installed in the A/C evaporator case between the blower motor and the A/C evaporator core.

The heater blower motor switch is connected in series with the A/C cycling switch to control A/C compressor (19703) operation.

The A/C cycling switch is located on top of the suction accumulator/drier (19C836) assembly and controls cycling of the A/C clutch. When the pressure rises to 276-324 kPa (40-47 psi), the A/C cycling switch closes. When the pressure drops to approximately 152-179 kPa (22-26 psi), the A/C cycling switch opens to stop the A/C compressor operation. In ambient temperatures below approximately 10°C (50°F), the A/C cyclin g switch will not allow A/C compressor operation because low system pressures are not high enough to close the switch.

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Relays

A/C Time Delay and WOT Cutout Relay

The air conditioning system is monitored and regulated by the closed loop engine control system. This system, working through the wide-open throttle (WOT) relay disengages the A/C clutch (2884) under the following conditions:

- Immediately after start-up.
- For a brief interval during wide open throttle performance to allow extra engine power for passing.
- When engine coolant temperature approaches an overheating condition.
- When engine idle rpm is approaching its stall speed.

In addition, the closed loop engine control system senses the output of the A/C cycling switch (19E561) and momentarily delays engaging the A/C clutch until engine idle rpm is boosted to an acceptable rate. Briefly, closed loop engine control provides smooth engine performance at slower speeds, as well as when the engine is operating in the idle range.

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System Airflow Description

Air is drawn into the system by the blower motor (18527) through the outside-recirc. door opening. The air is blown through the A/C evaporator core (19860) and then the heater core (18476) (when the temperature control is moved toward the WARM position). When the temperature blend door is in the maximum cool position, the air bypasses the heater core. When the temperature control is moved to the right, away from the maximum cool position, air passes through the heater core where it is warmed, and then mixed with the cool air before it is discharged through the registers.

OFF

With the function selector in the OFF position, the outside-recirc. door is in the recirculated air position. It is closed to outside air and no air passes through the system. The blower motor is off.

MAX A/C

NOTE: No temperature modulation is possible in the MAX A/C position.

In the MAX A/C position, the outside-recirc. air door is in the recirculated air position. All of the air discharges through the panel registers except for a small amount of floor bleed. The A/C compressor (19703) operates in this function control setting.

PANEL/FLOOR

In the PANEL/FLOOR position, the outside/recirc. air door is open to outside air (no vacuum). Air is discharged through the heater outlet floor ducts (18C433) and panel registers. The A/C compressor will engage in this mode if outside air temperatures are above approximately 10°C (50°F).

NORM A/C

In the NORM A/C position the outside-recirc. air door is open to the outside (no vacuum) and outside air is discharged through the panel register with a small amount of floor bleed. The A/C compressor operates in this control setting.

PANEL

In the PANEL position the outside-recirc. air door is open to the outside (no vacuum), and outside air is discharged through the panel registers except for a small amount of floor bleed. The A/C compressor does not operate in this control setting.

FLOOR

In the FLOOR position, the outside-recirc. air door is open to outside air (no vacuum). Air is discharged through the heater outlet floor ducts plus a small amount of bleed is directed to the windshield.

DEF/FLR

In the DEF/FLR position air is discharged through both the windshield defroster hose nozzle (18490) and heater outlet floor ducts in approximate equal amounts. The A/C compressor operates in this control setting when the A/C cycling switch (19E561) is energized.

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DEFROST

In the DEFROST position, the air is discharged through the windshield defroster hose nozzles. There is also a small amount of floor bleed. The A/C compressor operates in this control setting to help dehumidify the air.

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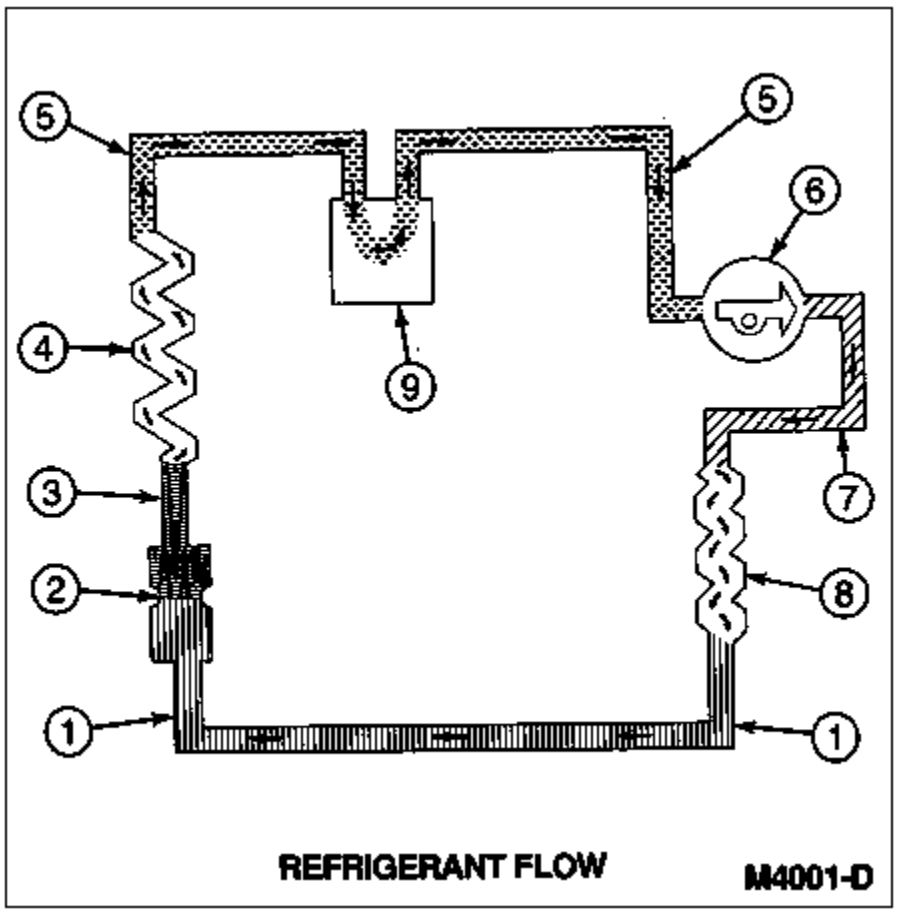
Refrigerant System

The air conditioning system uses a swash plate A/C compressor (19703), an A/C condenser core (19712) and inlet tube, a suction accumulator/drier (19C836), a A/C cycling switch (19E561), Schrader-type service access gauge port valves, and the necessary refrigerant lines. Subsequent text covering service procedures for the A/C evaporator core orifice (19D990) and refrigerant lines includes illustrations of the components involved.

Refrigerant Containment Switch — R-134a System

A refrigerant containment switch is used on all models with air conditioning to interrupt A/C compressor operation in the event of high system discharge pressures which could result in loss of refrigerant charge. The switch is located in the discharge line between the A/C compressor and the A/C condenser core. The switch is sensitive to the discharge pressure and functions to interrupt the A/C compressor operation if the discharge pressure exceeds a setting of 2751.1-3068.2 kPa (399-445 psi). The switch is a single function switch which only controls the circuit to the A/C cycling switch.

To introduce the subject of refrigerant flow, a simplified diagram follows which illustrates the pressure changes which take place in a typical refrigerant circuit. The diagram also calls out the physical state of the refrigerant as it passes through the circuit.



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Item	Part Number	Description
1	—	High-Pressure Liquid
2	—	Restriction
3	—	Low-Pressure Liquid
4	19860	A/C Evaporator Core
5	—	Low-Pressure Vapor
6	19703	A/C Compressor
7	—	High-Pressure Vapor
8	19712	A/C Condenser Core
9	19C836	Suction Accumulator/Drier

When the A/C clutch field coil (2987) in the A/C clutch (2884) is energized and the A/C clutch engages and rotates the compressor drive shaft, the double-ended pistons move backward and forward in their respective cylinder bores pulling the low-pressure gas past the suction reed into the cylinder.

As each piston is forced into its respective cylinder bore, the refrigerant vapors from the suction side of the system are compressed into an increasingly smaller area, thus increasing the refrigerant vapor pressure and raising its temperature. The higher refrigerant vapor pressure now assists in seating the suction reed valve and the discharge (high pressure) reed valve as cylinder pressure exceeds the high pressure side of the system. When the compressed vapor is discharged into the high pressure side of the refrigerant system, the discharge reed valve spring pressure and the high side refrigerant pressure close and seal the reed valve, thus preventing the discharge pressure from re-entering the compressor cylinder. The A/C compressor refrigerant vapor compression cycle begins again as the pistons are pulled from their respective compressor cylinder bores by the rotating compressor shaft.

The high-pressure, high temperature compressor discharge refrigerant vapor is released into the top of the A/C condenser core, via the discharge hose. The A/C condenser core, being close to ambient temperature, causes the refrigeration vapor to condense into a liquid when heat is removed from the refrigerant vapor by ambient air passing over the fins and tubing.

Liquid refrigerant from the outlet enters the high-pressure liquid line which then flows to the inlet side of the A/C evaporator core orifice located in the inlet tube. The A/C evaporator core orifice is the refrigerant flow control device which controls refrigerant flow to the A/C evaporator core (19860) and separates the high- and low-pressure sides of the air conditioning system. The inlet filter screen of the A/C evaporator core orifice removes coarse contaminant particles, which may be present in the liquid refrigerant, before the liquid refrigerant enters the calibrated opening in the A/C evaporator core orifice. The outlet end of the A/C evaporator core orifice has a fine mesh filter with four open side slots. It is located in the body of the A/C evaporator core orifice, upstream from the filter. The side slots and filter act as a refrigerant flow noise suppressor.

The liquid refrigerant passes through the A/C evaporator core orifice tube and enters the A/C evaporator core as a cold low-pressure liquid. As airflow passes over the plate/fin sections of the A/C evaporator core, the refrigerant inside absorbs the heat and changes into a vapor.

A/C compressor suction draws the vaporized refrigerant and oil mixture into the suction accumulator/drier where the heavier oil laden vapors fall to the bottom and the lighter vapors and oil mixture continue their path to the A/C compressor via the top of the vapor return tube.

A desiccant bag, located inside the suction accumulator/drier, absorbs and retains moisture which may be circulating in the refrigeration system. The heavier oil laden refrigerant also returns to the A/C compressor through a small liquid bleed hole near the bottom of the vapor return tube. The liquid bleed hole provides a controlled second opportunity for the accumulated refrigerant and oil mixture to revaporize as it passes

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though the opening to re-enter the main vapor flow path to the suction side of the A/C compressor and ensures adequate oil return to the A/C compressor.

Service Access Gauge Port Valves

Service gauge ports are located as follows:

NOTE: An adapter, Rotunda R-134a High Side Quick Disconnect 176-R0037 or equivalent is required to accommodate installation of service equipment.

- High-pressure port — In the compressor discharge line near the A/C condenser core.

  NOTE: An adapter, Rotunda R-134a Low Side Quick Disconnect 176-R0036 or equivalent is required to accommodate installation of service equipment.

- Low-pressure port — On top of the suction accumulator/drier near the A/C cycling switch.

A/C Evaporator Core

The A/C evaporator core is a "flooded type" (plate-fin) similar to those used in passenger cars. The condenser to evaporator tube (19835) connects to the bottom of the A/C evaporator core and suction accumulator/drier assembly connects to the top of the A/C evaporator core. The evaporator inlet tube is fitted with an A/C evaporator core orifice to control refrigerant flow. This A/C evaporator core orifice can be removed from the inlet tube for replacement if it becomes necessary. However, a special tool, Orifice Tube Remover and Installer D80L-19990-A or equivalent, is necessary to prevent breakage when removing the A/C evaporator core orifice.

A/C Evaporator Core Orifice

The A/C evaporator core orifice is a device which provides a restriction between the high- and low-pressure segments of the refrigerant circuit and meters the flow of liquid refrigerant into the A/C evaporator core. Temperature is controlled by sensing the pressure within the A/C evaporator core with a pressure operated electric switch. The pressure switch controls A/C compressor operation as necessary to maintain the pressure within specified limits.

The A/C evaporator core orifice is located in the inlet tube and has a filter screen on the inlet end of the body. The filter screen acts as a strainer for the liquid refrigerant flowing through the opening. O-rings, on the body, prevent the high-pressure liquid refrigerant from bypassing the A/C evaporator core orifice. Adjustment or repairs cannot be made to the A/C evaporator core orifice and it must be replaced as a unit. The replacement A/C evaporator core orifice must have a 0.067-inch orifice and be color-coded blue. Refer to Removal and Installation procedures in this section.

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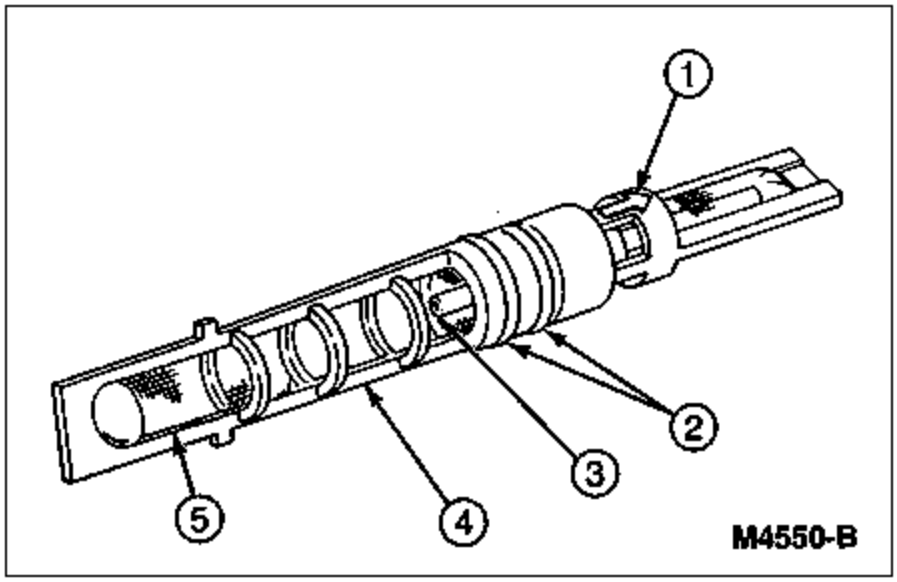

Item	Part Number	Description
1	—	Flow Direction (Part of 19D990)
2	—	O-Rings (Part of 19D990). Service Replacement A/C Evaporator Core Orifice Tube Includes O-Rings, Replacement O-Rings Available from Motorcraft Only. Part Number YF-1369
3	—	Inside Diameter 0.067 (Part of 19D990)
4	—	Color Code Red (Part of 19D990)
5	—	Fine Mesh Screen (Part of 19D990)

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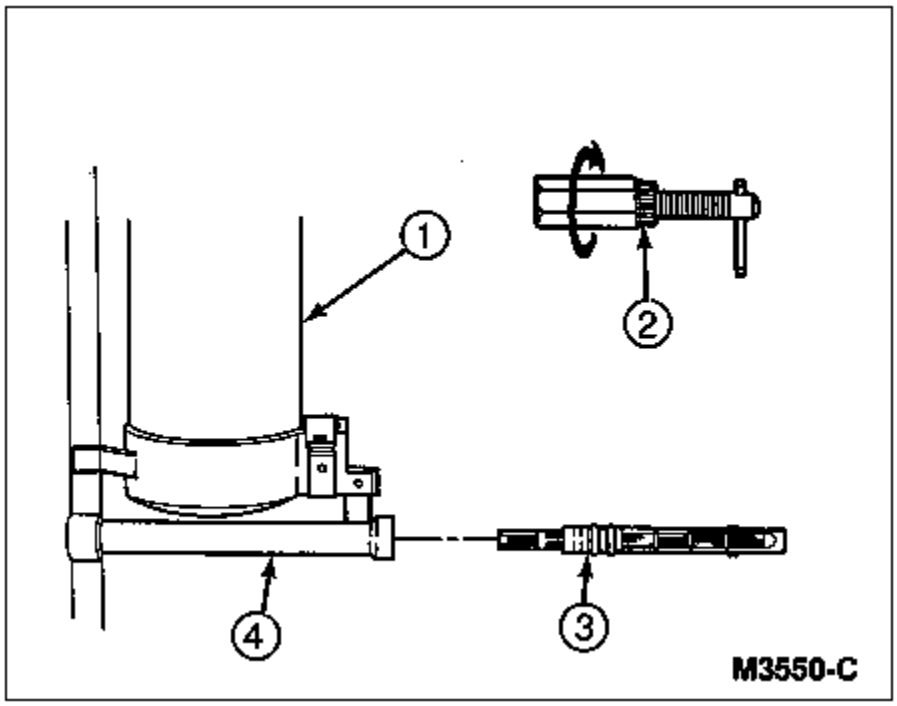

Item	Part Number	Description
1	19C836	Suction Accumulator/Drier
2	D80L-19990-A	Fixed Orifice Tube Tool
3	19D990	A/C Evaporator Core Orifice
4	—	Inlet Tube (Part of 19860)

Suction Accumulator/Drier

The suction accumulator/drier is mounted on the front of the A/C evaporator core and attaches directly to the outlet tube. A suction service access gauge port valve is mounted on top of the suction accumulator/drier. Its purpose is to provide service access to the suction side of the refrigeration system for pressure reading and system diagnosis.

As refrigerant enters the suction accumulator/drier when charging or during air conditioning system operation, the liquid portion of the refrigerant and the system lubricating oil fall to the bottom of the accumulator can. A small diameter oil bleed hole, approximately 8mm (3/10 inch) above the bottom of the can in the J-shaped outlet tube, allows the accumulated heavier liquid refrigerant and oil mixture to re-enter the evaporator to compressor suction line at a controlled rate. As the heavier liquid refrigeration and oil mixture passes through the small diameter liquid bleed hole, it has a second opportunity to vaporize and recirculate through the A/C compressor without causing A/C compressor damage due to liquid slugging. The gaseous portion of the refrigerant is drawn out of the accumulator can at the upper end of the J-shaped tube by compressor suction.

A fine mesh screened filter fits tightly around the oil bleed tube to prevent contaminants from plugging the oil bleed hole.

A desiccant bag is mounted inside the suction accumulator/drier to absorb moisture which may be in the refrigerant system.

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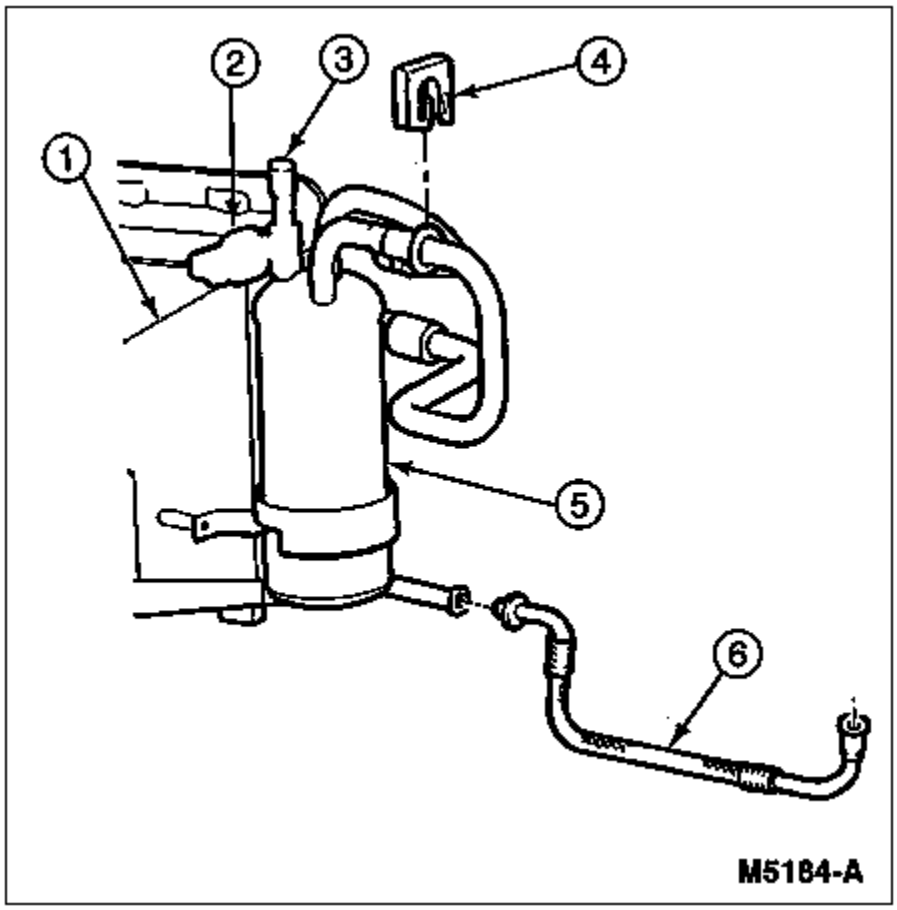
A fitting on the top of the suction accumulator/drier is used to mount the A/C cycling switch. It has a long travel Schrader-type valve stem core installed in the fitting opening to prevent refrigerant loss when the A/C cycling switch is removed. Use only the correct service replacement part which has a standard short travel valve. That will prevent the A/C cycling switch from seating when installed, causing refrigerant to leak from the system or causing damage to the A/C cycling switch.



Item	Part Number	Description
1	19850	A/C Evaporator Housing
2	19E561	A/C Cycling Switch
3	—	Low Pressure Access (Part of 19C808)
4	19E746	A/C Tube Lock Coupling Clip
5	19C836	Suction Accumulator/Drier
6	19835	Condenser to Evaporator Tube

The suction accumulator/drier should be replaced if one of the following exist:

1. The suction accumulator/drier is perforated.

2. There is physical evidence of system contamination from a failed A/C compressor or damage to the suction accumulator/drier.

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When replacing the suction accumulator/drier, the procedure given here must be followed to make sure that the total oil charge in the system is correct after the new suction accumulator/drier is installed.

- Drain the oil from the removed suction accumulator/drier into a suitable measuring container. It may be necessary to drill one or two 1/2-inch holes in the bottom of the old suction accumulator/drier to make sure that all the oil has drained out.
- Add the same amount of clean new refrigerant oil plus two fluid ounces to the new A/C compressor. Use only the oil specified.

All A/C compressors use oil that contains special additives not found in most other refrigerant oils. This refrigerant oil is Motorcraft Part No. YN-12b or an equivalent oil meeting Ford Specification WSH-M1C231-B. This oil is a mandatory requirement because of the aluminum swash plate used in Ford 10-cylinder compressors. The use of any oil other than one meeting Ford Specification WSH-M1C231-B could result in reduced suction accumulator/drier life.

A/C Cycling Switch

The A/C cycling switch is mounted on a Schrader-type valve fitting on the top of the suction accumulator/drier assembly. A valve depressor, located inside the threaded end of the A/C cycling switch, presses in on the Schrader valve stem as the A/C cycling switch is mounted and allows the suction pressure inside the accumulator/drier housing to activate the A/C cycling switch. The electrical contacts are normally open when the suction pressure is at or below 169 kPa (23 ± 1 psi); they will close, activating the A/C clutch, when the suction pressure rises to approximately 275-324 kPa (40-47 psi) or above. Lower ambient temperatures (below approximately 7℃ or 45℉), dur ing cold weather, will prevent the contacts from closing, due to the pressure/temperature relationship of the refrigerant in the system. The electrical contacts control the electrical circuit to the A/C clutch field coil. When the contacts are closed, the A/C clutch field coil is energized and the A/C clutch is engaged to drive the compressor. When the contacts are open, the A/C clutch field coil is de-energized, the A/C clutch is disengaged and the compressor does not operate. The A/C cycling switch, when functioning properly, will control the pressure at a point where the plate/fin surface temperature will be maintained slightly above freezing which prevents icing and the blockage or airflow.

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Refrigerant System

A/C Pressure Cut-Off Switch

A refrigerant A/C pressure cut-off switch is used on all models with air conditioning to interrupt A/C compressor (19703) operation in the event of high system discharge pressures which could result in loss of refrigerant charge. The switch is located in the discharge line between the A/C compressor and the A/C condenser core (19712). The switch is sensitive to the discharge pressure and functions to interrupt the A/C compressor operation if the discharge pressure exceeds a setting of 2751-3068 kPa (399-445 psi). The switch is a single function switch which only controls the circuit to the A/C cycling switch (19E561).

A/C Condenser Core

The A/C condenser core is attached to the radiator support in front at the radiator with two mounting brackets at the top and bottom of the A/C condenser core. The top mounting brackets attach to the rear side of the radiator support and the lower bracket attaches to the front side of the radiator support.

A/C Compressor

The FS-10 A/C compressor is used on all Ranger vehicles.

Refer to Section 12-00 and Section 12-03D for service data, including specifications, for the FS-10 A/C compressor assembly.

Spring Lock Coupling

The A/C spring lock coupling is a refrigerant line coupling held together by a garter spring inside a circular cage. When the A/C spring lock coupling is connected together, the flared end of the female fitting slips behind the garter spring inside the male fitting cage. The garter spring and cage then prevent the flared end of the female fitting from pulling out of the cage.

A/C Compressor Pressure Relief Valve

An A/C compressor pressure relief valve (19D644) is installed on the compressor discharge manifold to relieve excessively high-pressure buildups (3103 kPa or 450 psi and above) as well as prevent damage to the A/C compressor and other air conditioner components.

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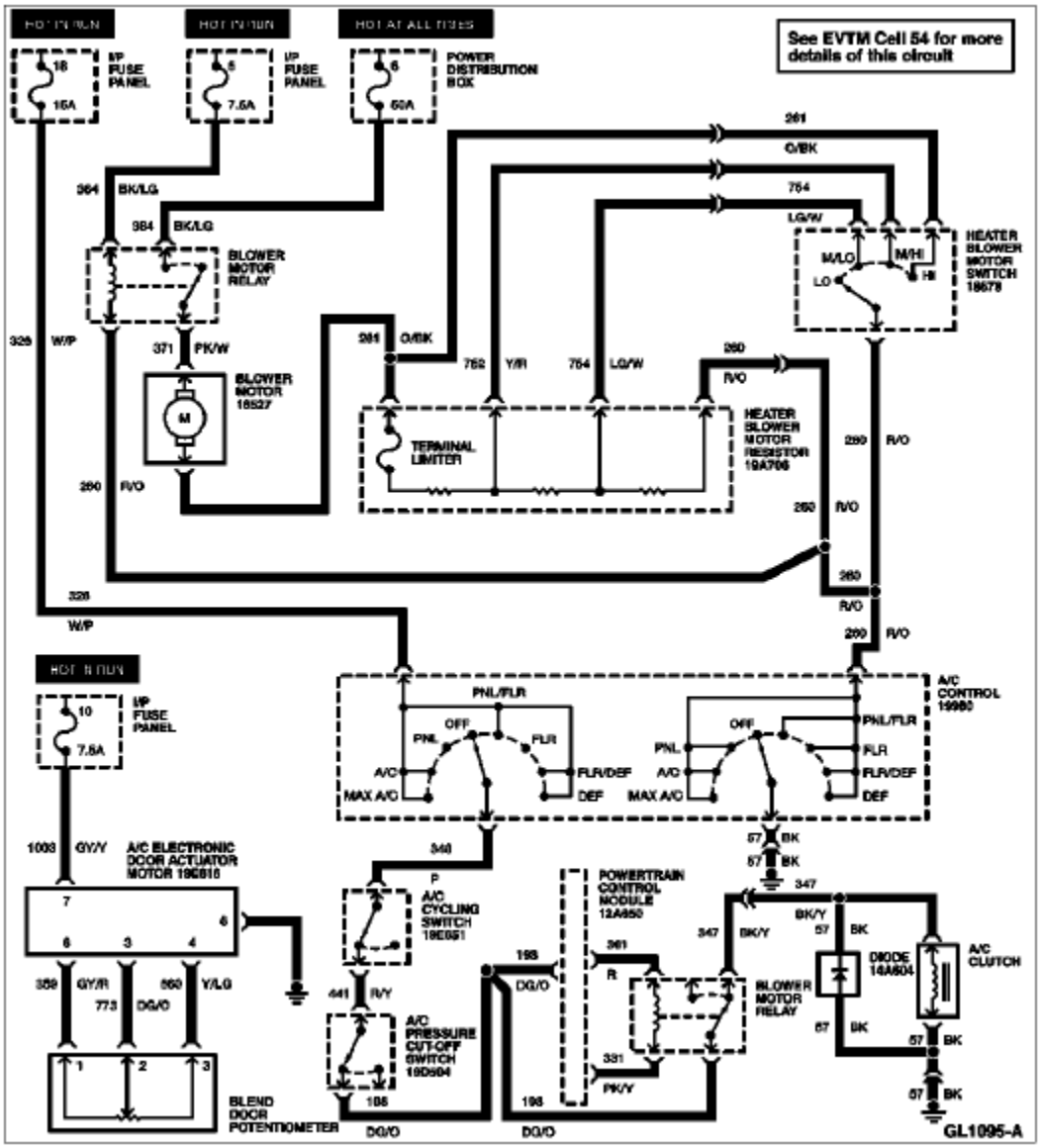
Electrical Schematics

Air Conditioner — Heater System, Ranger



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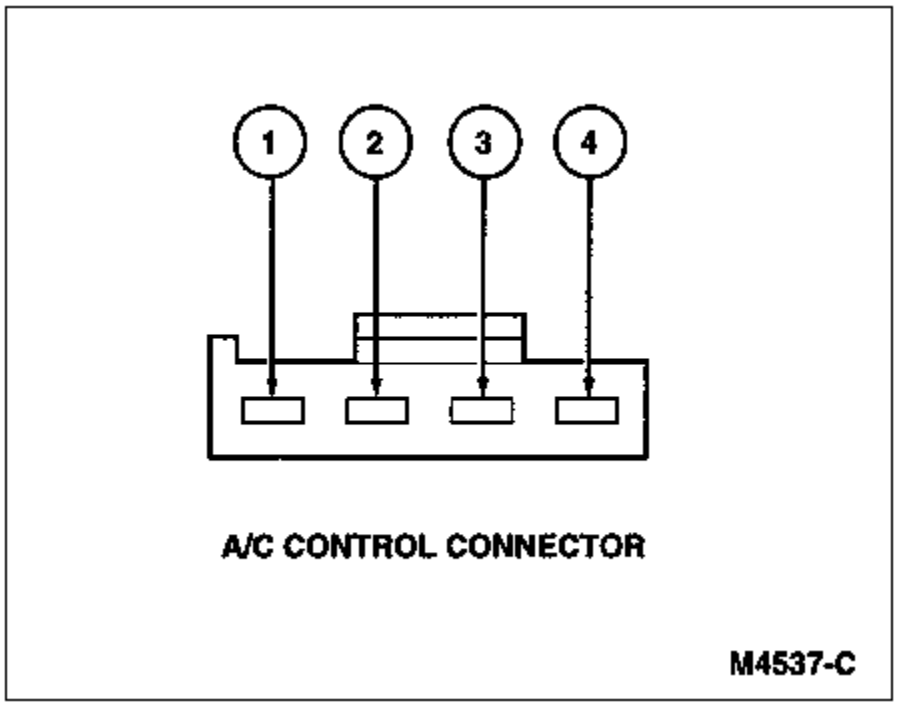

Pin Number	Circuit	Circuit Function
1	260 (R/O)	Heater Blower Motor Switch to A/C Control
2	57 (BK)	Ground
3	348 (P)	A/C Cycling Switch to A/C Control
4	326 (W/P)	Fused Power Input to A/C Control

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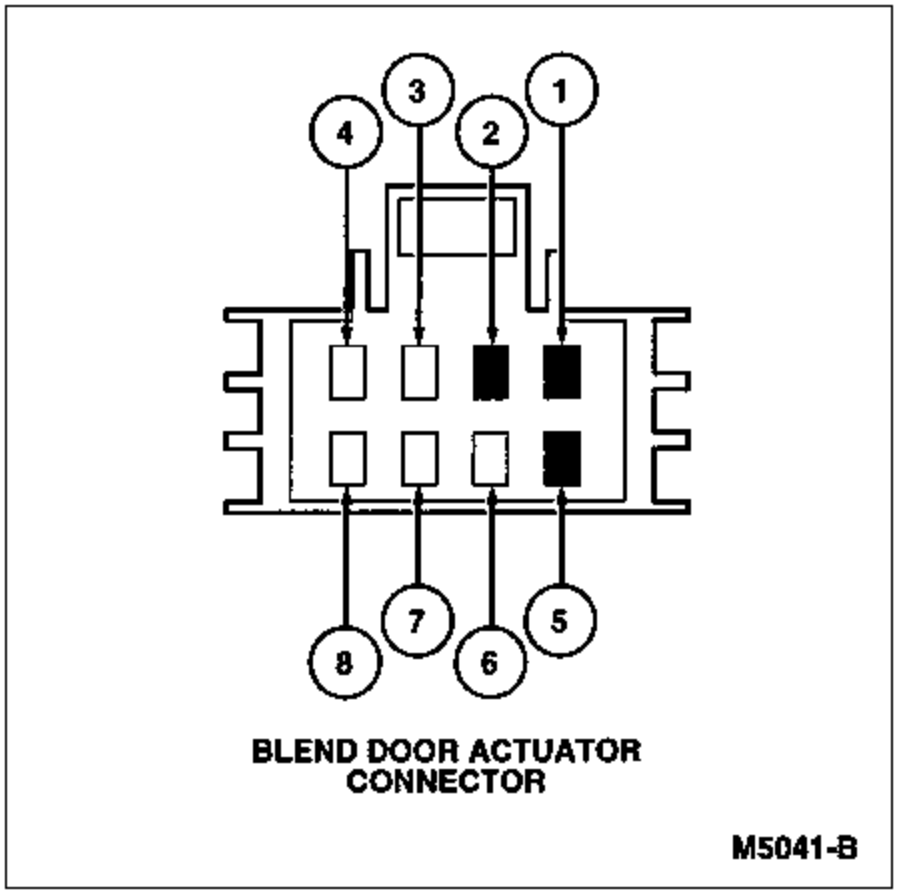

Pin Number	Circuit	Circuit Function
1	—	NOT USED
2	—	NOT USED
3	773 (DG/O)	A/C Electronic Door Actuator Motor to Blend Door Potentiometer
4	660 (Y/LG)	A/C Electronic Door Actuator Motor to Blend Door Potentiometer
5	—	NOT USED
6	359 (GY/R)	A/C Electronic Door Actuator Motor to Blend Door Potentiometer
7	1003 (GY/Y)	Fused Power Input to A/C Electronic Door Actuator Motor
8	57 (BK)	Ground

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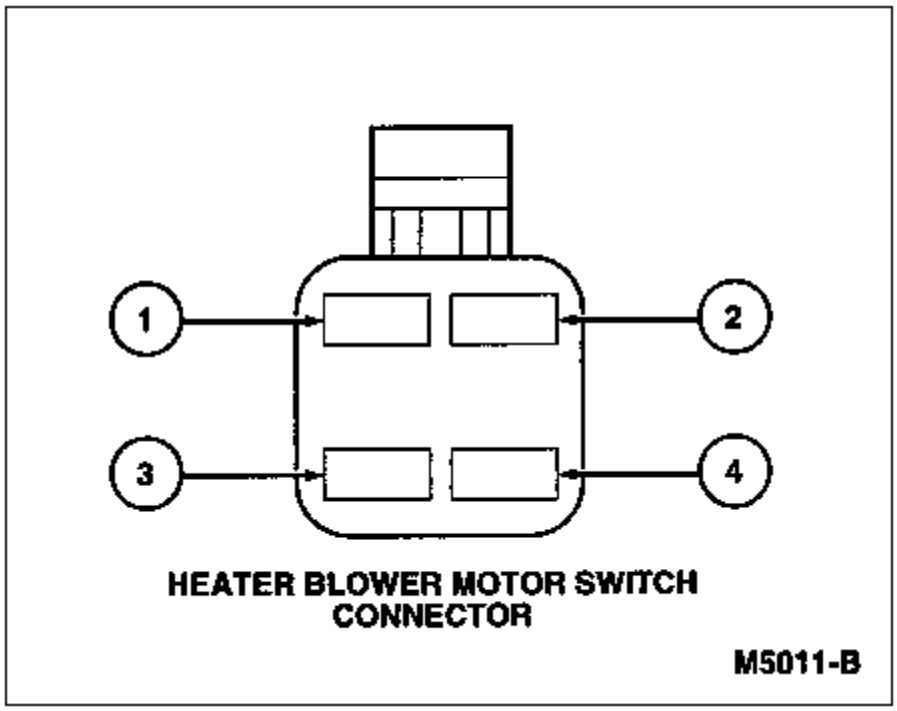

Pin Number	Circuit	Circuit Function
1	261 (O/BK)	Blower Motor to Heater Blower Motor Switch
2	260 (R/O)	A/C Control to Heater Blower Motor Switch
3	754 (LG/W)	Heater Blower Motor Switch to A/C Blower Motor Resistor
4	752 (Y/R)	Heater Blower Motor Switch to A/C Blower Motor Resistor

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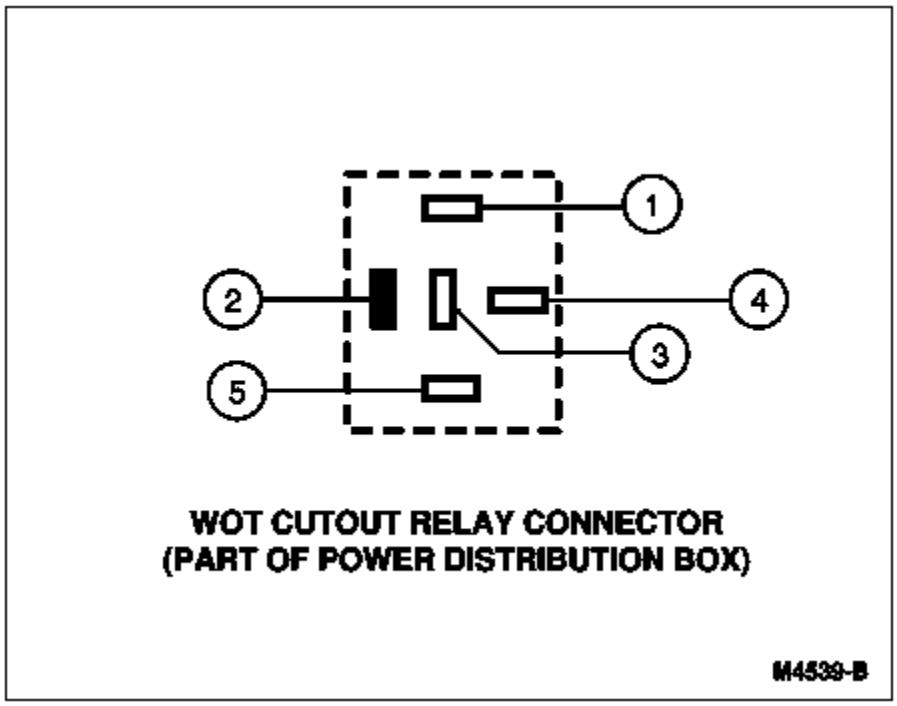

Pin Number	Circuit	Circuit Function
1	331 (PK/Y)	From PCM to WOT Cutout Relay Coil
2	—	NOT USED
3	347 (BK/Y)	WOT Cutout Relay to A/C Clutch and Diode
4	198 (DG/O)	A/C Pressure Cut-Off Switch to WOT Relay
5	361 (R)	From PCM to WOT Cutout Relay Coil

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Inspection and Verification

Obstructed air passages, a broken drive belt (8620), disconnected or broken wires, damaged A/C clutch (2884), loose or broken mounting brackets and many refrigerant leaks may be determined by visual inspection of the parts.

A refrigerant leak will usually appear as an oily residue at the leakage point in the system. The oily residue soon picks up dust or dirt particles from the surrounding air and appears greasy. Through time, this will build up and appear to be heavy dirt impregnated grease.

Most common leaks are caused by damaged O-ring seals at the various hose and component connections. When these O-rings are replaced, the new O-rings should be lubricated with refrigerant oil and care should be taken to keep lint from the shop towels or rags from contaminating the internal surfaces of the connection.

Another type of leak may appear at the service ports. If leak appears at the service port(s), A/C system must be discharged before removal and replacement of the service port(s).

CAUTION: A/C charging valve caps (19D702) must be installed finger-tight. If tightened with pliers, the sealing surface of the service access gauge port valve may be damaged.

A missing A/C charging valve cap can also cause a refrigerant leak. If the A/C charging valve cap is missing, dirt will enter the area of the air conditioner charging valve core. When the service hose is attached, the valve depressor in the end of the service hose forces the dirt into the valve seat area and the dirt will destroy the sealing surface of the air conditioner charging valve core. When an A/C charging valve cap is missing, the protected area of the air conditioner charging valve core should be cleaned and a new A/C charging valve cap should be installed.

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Symptom Chart — A/C, Heater System

NOTE: Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent to perform electrical pinpoint tests.

A/C, HEATER SYSTEM

Condition	Possible Source	Action
• Manual A/C-Heater System Inoperative, Intermittent or Improper Operation	• Low refrigerant charge.	• REFER to Section 12-00 .
	• Damaged A/C clutch.	• REFER to Section 12-03D .
	• Loose drive belt.	• REFER to Section 03-05 .
	• Loose electrical connections.	• GO to Pinpoint Test Step **A1** .
• A/C Electronic Door Actuator Motor Inoperative, Intermittent or Improper Operation	• Loose electrical connections.	• CHECK for loose or corroded electrical connections.
	• Damaged A/C control.	• REPLACE A/C control. • GO to Pinpoint Test Step **B1** .

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Pinpoint Tests

PINPOINT TEST A — MANUAL A/C-HEATER SYSTEM INOPERATIVE, INTERMITTENT OR IMPROPER OPERATION

A1 TEST BLOWER MOTOR OPERATION

- Turn ignition switch to RUN position.
- Place A/C control in any position except OFF.
- Cycle the heater blower motor switch through all speeds and listen for operation of the blower motor.

Does the blower motor operate?

Yes	No
GO to **A2** .	REFER to Section 12-00 .

A2 CHECK COMPRESSOR OPERATION

- Start vehicle engine.
- Place A/C control in any A/C position.
- Raise vehicle hood and observe A/C compressor operation.

Does A/C compressor operate normally?

Yes	No
GO to **A3** .	REFER to Section 12-00 .

A3 CHECK FUNCTION CONTROL OPERATION

- Start vehicle engine.
- Cycle A/C control through all detent positions and check for proper operation.

Does system operate correctly?

Yes	No
Complaint may be intermittent. Try to RECREATE condition by wiggling wiring harness and all connectors. SERVICE as necessary.	REFER to Section 12-00 .

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PINPOINT TEST B — A/C ELECTRONIC DOOR ACTUATOR MOTOR INOPERATIVE, INTERMITTENT OR IMPROPER OPERATION

B1 CHECK TEMPERATURE CONTROL

- Start vehicle engine and bring up to normal operating temperature.
- Place A/C control in FLOOR position and temperature control in full warm position. Physically feel discharge air temperature at the heater outlet floor duct.
- Rotate temperature control to full cool and again check discharge air temperature at the heater outlet floor duct.

Does discharge air temperature vary?

Yes	No
Condition may be intermittent. Attempt to RECREATE condition by wiggling all connectors, splices, crimps, etc. SERVICE as necessary.	GO to **B2** .

B2 TEST FUSE

- Turn ignition switch to OFF position.
- Remove 7.5 amp fuse from fuse cavity 10 and test for continuity.

Does fuse test OK?

Yes	No
REINSTALL fuse. GO to **B3** .	REPLACE fuse. VERIFY system operation.

B3 TEST FEED CIRCUIT

- Measure voltage of Circuit 1003 (GY/Y) at the blend door actuator Pin 7.
- Turn ignition switch to run position and A/C control to FLOOR position. Read display on meter.

Is voltage present?

Yes	No
GO to **B4** .	SERVICE open in Circuit 1003 (GY/Y). VERIFY system operation.

B4 TEST BLEND DOOR POTENTIOMETER

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- Turn ignition switch to OFF position.
- Remove A/C control from instrument panel far enough to gain access to electrical connectors.
- Rotate temperature control knob from full warm to full cool when performing the following 2 steps.
- Measure resistance between Pin 1, Circuit 359 (GY/R) and Pin 2, Circuit 773 (DG/0) of the blend door potentiometer.
- Measure resistance between Pin 2, Circuit 773 (DG/O) and Pin 3, Circuit 660 (Y/LG) of the blend door potentiometer.

Does the resistance vary for both measurements?

Yes	No
GO to **B5** .	REPLACE blend door potentiometer.

B5 CHECK RESISTANCE

- Key OFF.
- Measure resistance of Circuit 359 (GY/R), Circuit 773 (DG/O) and Circuit 660 (Y/LG) between the blend door potentiometer and A/C electronic door actuator motor.

Does each circuit test as continuous?

Yes	No
GO to **B6** .	REPAIR circuit in question.

B6 CHECK FOR SHORT

- Key OFF.
- Disconnect A/C electronic door actuator motor connector.
- Disconnect blend door potentiometer connector.
- Measure resistance to ground of circuit 359 (GY/R), Circuit 773 (DG/O) and Circuit 660 (Y/LG).

Is there greater than 10,000 ohms for each circuit?

Yes	No
GO to **B7** .	SERVICE short to ground circuit in question.

B7 TEST BLEND DOOR ACTUATOR

- Measure voltage between Pin 7, Circuit 1003 (GY/Y) and Pin 8, Circuit 57 (BK) of the A/C electronic door actuator motor.
- Turn ignition switch to RUN position and A/C control to FLOOR position. Read display on meter.

Is voltage present?

Yes	No
	Condition may be intermittent. Try to

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REPLACE blend door actuator.	RECREATE condition by wiggling all wires, connectors, crimps, etc. CHECK for sticking or stuck blend door. SERVICE as necessary.

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Refrigerant Oil Addition

During A/C Compressor Replacement

CAUTION: The R-134a A/C system FS-10 A/C compressor (19703) uses a unique high-quality refrigerant oil F2AZ-19577-AC, Motorcraft Part Number YN-12b or equivalent refrigerant oil meeting Ford specification WSH-M1C231-B. An oil charge of 207 ml (7 oz) is used in a new system. It is extremely important that only the specified type and quantity of refrigerant oil be used in the FS-10 A/C compressor. If there is a surplus of oil in the system, it will circulate with the refrigerant, reducing the cooling capacity of the system. Using too little oil or oil not meeting the Ford specification will result in poor lubrication of the A/C compressor.

When replacing a component of the refrigerant system, the procedures in this section must be followed to make sure that the total oil charge in the system is correct after the new part is installed.

During Component Replacement

When replacing other components of the air conditioning system, measured quantities of the specified refrigerant oil should be added to the component to make sure that the total oil charge in the system is correct before the system is operated.

Clean refrigerant oil should be poured directly into the replacement components as follows:

NOTE: Add an additional 60ml (2 oz) when repairing a leak.

- A/C evaporator core: add 90ml (3 oz).
- A/C condenser core (19712): add 30ml (1 oz).
- Suction accumulator/drier (19C836): drain oil from removed suction accumulator/drier. Add same amount plus 60ml (2 oz) of clean refrigerant oil to new suction accumulator/drier.

If any other component such as an orifice tube or a hose is replaced, no additional refrigerant oil is necessary unless a hose bursts with a fully charged system. Then, additional refrigerant oil may be necessary with the amount to be determined by the technician. The suction accumulator/drier should also be replaced under this circumstance.

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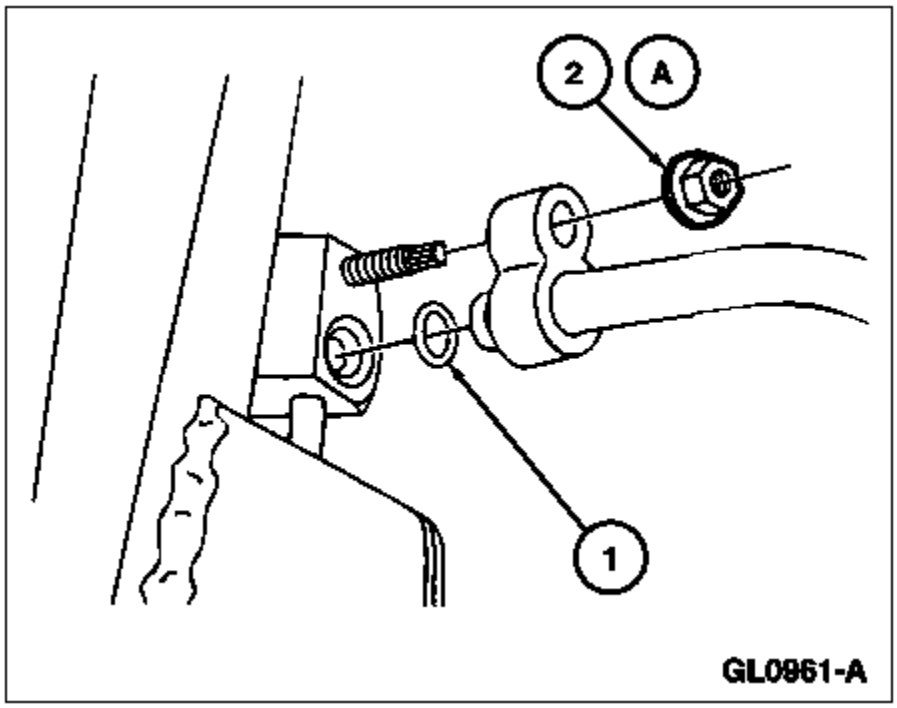
Spring Lock Coupling

The spring lock coupling is a refrigerant line coupling held together by a garter spring inside a circular cage. When the spring lock coupling is connected together, the flared end of the female fitting slips behind the garter spring inside the male fitting cage. The garter spring and cage then prevent the flared end of the female fitting from pulling out of the cage. The following illustrations explain the removal and installation procedures for the spring lock couplings.

Peanut Fitting

The peanut fitting is used for refrigerant line coupling. A replaceable O-ring is housed inside. The fitting is retained by a nut and a replaceable stud.



Item	Part Number	Description
1	—	Replaceable O-Ring Seal
2	—	Peanut Fitting Nut
A	—	6.8-9.2 Nm (61-82 lb-in)

Spring Lock Couplings

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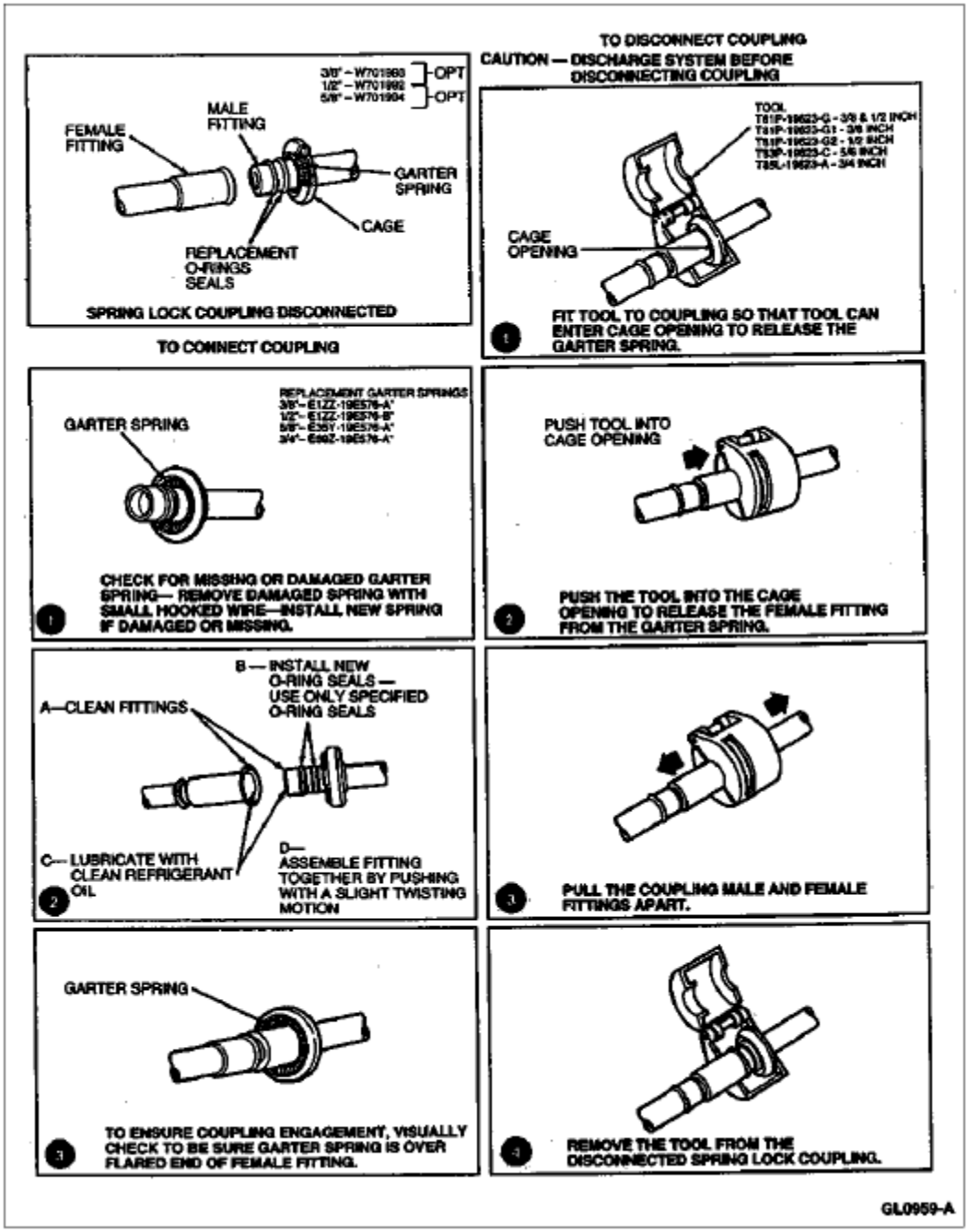

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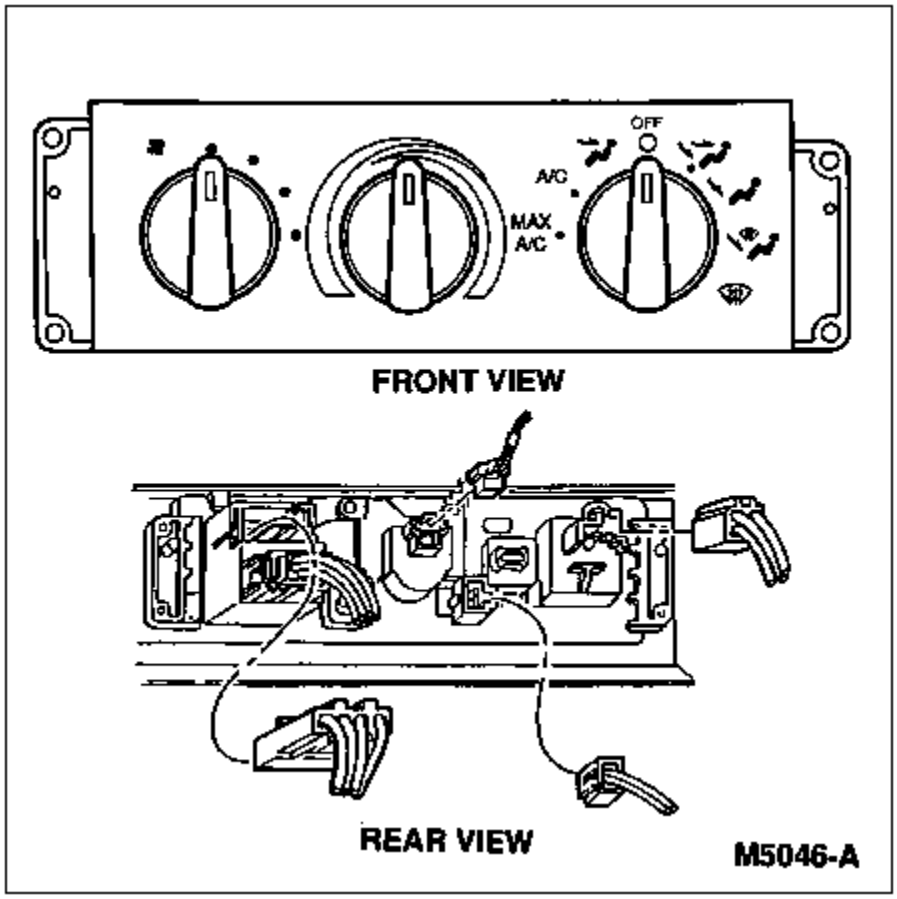
Climate Control Assembly

Removal

1. Disconnect battery ground cable.
2. Remove radio, refer to Section 15-01 .
3. Gently pull the finish panel away from the instrument panel (04320), and cluster. The finish panel pops straight back for approximately one inch, then "up" to remove. Take care so as not to wrap the finish panel around the steering column. If the vehicle is equipped with the electronic 4x4 electronic shift control, disconnect the wire from the rear of the 4x4 electronic shift control switch before trying to remove the finish panel from the instrument panel.
4. Remove the four screws attaching the A/C control (19980) to the instrument panel.



5. Pull the A/C control through the opening far enough to allow removal of electrical connections from heater blower motor switch (18578) and control lamp socket and wire (18541). Working with a small screwdriver, remove the A/C plenum vacuum harness (18C581) from the vacuum switch which is part of the A/C control.

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6. Remove the A/C control from the instrument panel.

7. For installation, follow removal procedures in reverse order.

Illumination Bulbs

Removal and Installation

1. Remove control assembly as described under Climate Control, Removal and Installation in this section.

2. Rotate the miniature bulb assembly until the notch on the assembly is aligned with slot in the miniature bulb assembly access hole in the back of the control assembly.

3. Remove miniature bulb assembly.

4. Remove miniature bulb.

5. For installation, follow removal procedures in reverse order.

A/C Switch

Removal and Installation

1. Remove A/C control as described in Removal and Installation in this section.

2. Remove one screw retaining the function control switch to the back of the A/C control.

3. Grasp function control knob in fingers and pull away from the face of the A/C control.

4. Working from the back of the A/C control rotate function control switch counterclockwise until the retaining tabs are free from the A/C control and remove the function control switch from the A/C control.

5. For installation, follow removal procedures in reverse order.

Switch Knobs

Removal

1. Grasp knobs in fingers and pull directly away from A/C control.

Installation

1. Align knob with appropriate shaft. Make sure flat (keyed) area of knob matches with flat (keyed) portion of appropriate switch shaft.

2. Gently push knob onto shaft until fully seated.

Heater Blower Motor Switch

Removal and Installation

1. Disconnect battery ground cable.

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2. Remove A/C control from the instrument panel as outlined under Removal and Installation in this section.

3. Remove the wire harness hard shell connector from the heater blower motor switch by gently prying with a screwdriver and pulling on the connector.

4. Remove switch knob as outlined under Removal and Installation in this section.

5. Remove the hex-head screw which attaches the heater blower motor switch to the bracket. Remove the heater blower motor switch by rotating it counterclockwise until it is free from the retaining tabs on the A/C control and pulling it straight out the rear of the A/C control panel (19808).

6. For installation, follow removal procedures in reverse order.

Temperature Control Module

Removal and Installation

1. Remove A/C control as outlined under Removal and Installation in this section.

2. Remove the temperature control knob as outlined under Removal and Installation in this section.

3. Remove the hex-head screw retaining the temperature control module to the A/C control.

4. Rotate the temperature control module clockwise until it is free from the retaining tabs on the A/C control and remove from the A/C control.

5. For installation, follow removal procedures in reverse order.

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Relays

Blower Motor Relay

Removal and Installation

1. Raise vehicle hood and locate relay module one on the vehicle right fender apron.
2. Remove blower motor relay by unplugging it from relay module number one.
3. For installation, follow removal procedures in reverse order.

WOT Relay

Removal and Installation

1. Raise the vehicle hood and locate the power distribution box situated on the vehicle left fender apron.
2. Remove the power distribution box cover and locate the WOT relay.
3. Remove relay by pulling directly away from the power distribution box.
4. For installation, follow removal procedures in reverse order.

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A/C Electronic Door Actuator Motor

Removal

1. Disconnect battery ground cable.
2. **NOTE: Refer to Section 01-12 for instrument panel removal and installation procedure.**

   Loosen instrument panel (04320) and pull back from cowl.
3. Remove A/C electronic door actuator motor electrical connector from bracket on A/C evaporator housing.
4. Remove three A/C electronic door actuator motor retaining screws.
5. **NOTE: The mounting bracket remains in place on the A/C evaporator housing.**

   Lift A/C electronic door actuator motor vertically approximately 12mm (1/2 inch) to disengage it from bracket and actuator shaft, then pull A/C electronic door actuator motor back toward passenger compartment.

Installation

1. Insert A/C electronic door actuator motor horizontally over actuator bracket on A/C evaporator housing.
2. Insert actuator shaft into A/C air temperature control door. (Manually moving A/C air temperature control door will help engage shaft.)
3. Attach actuator bracket with three retaining screws.
4. Attach actuator electrical connector to bracket on A/C evaporator housing.
5. Install instrument panel.
6. Connect battery ground cable.

Electronic Blend Door Actuator

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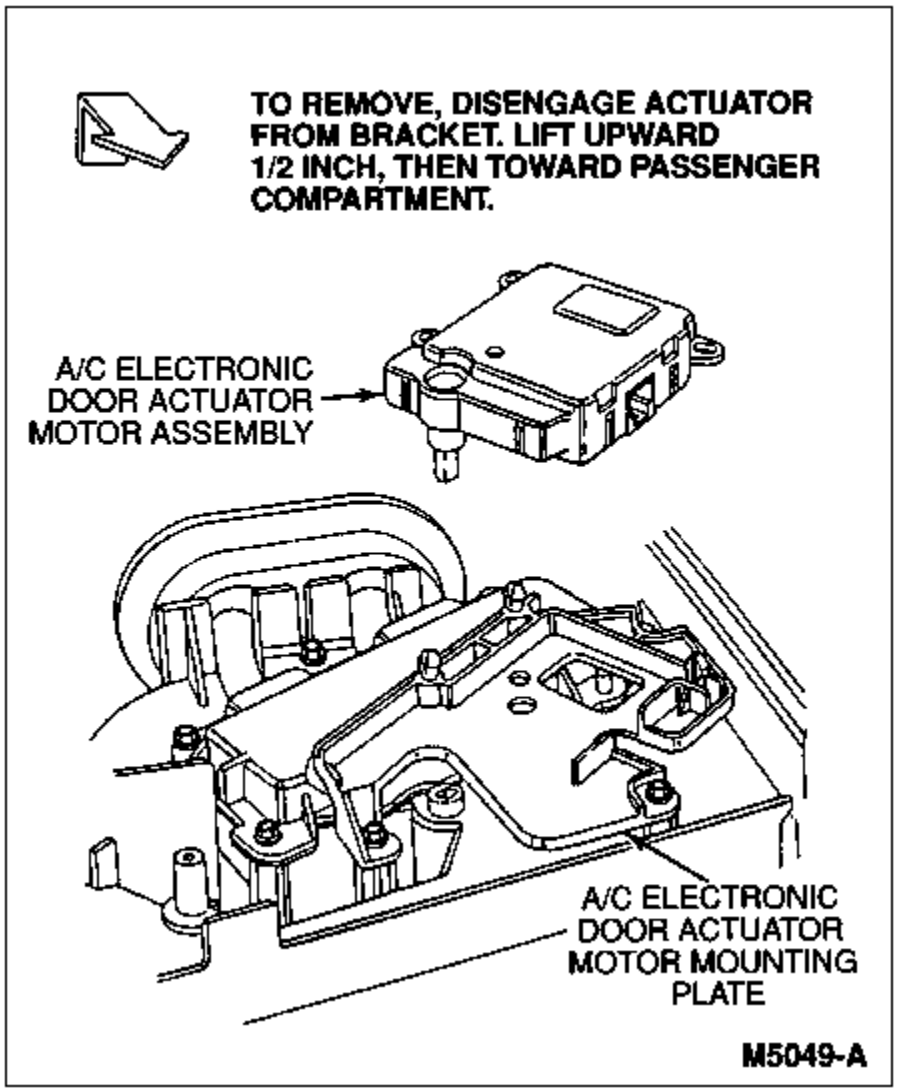

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A/C Evaporator Core Housing

Removal

1. Disconnect the ground cable.
2. Discharge the refrigerant system. Refer to Section 12-00 . Observe all safety precautions.
3. Disconnect the electrical hardshell connectors from the blower motor (18527), the heater blower motor switch resistor (18591) and the A/C cycling switch (19E561).
4. Disconnect the vacuum line (part of A/C blower motor feed extension (19D605)) from the A/C vacuum check valve (19A563).
5. Disconnect the vacuum line (part of the vacuum assembly) from the vacuum source on the engine intake manifold; then, remove the line from the routing channel.
6. Disconnect the condenser to evaporator tube (19835) from the inlet tube and cap the openings to prevent the entry of dirt and moisture.
7. Disconnect the A/C manifold and tube (19D734) from the suction accumulator/drier (19C836).
8. Remove speed control module from fender.
9. Remove the coolant recovery reservoir.
10. Remove the solenoid box cover, if so equipped, by removing the three bolts fastened through the fender liner. Remove the air cleaner and A/C vacuum reservoir tank and bracket (19A566), if so equipped.
11. Remove three nuts from the engine compartment side of the A/C evaporator housing (19850) and one nut from the passenger compartment side of the A/C evaporator housing.
12. Remove the A/C evaporator housing from the vehicle.

Installation

1. Position the A/C evaporator housing to the dash panel and install the three retaining nuts in the A/C evaporator housing and one nut in the passenger compartment.
2. Install the air cleaner, speed control module and coolant recovery reservoir.
3. Using a new O-ring lubricated with clean refrigerant oil, connect the condenser to evaporator tube to the inlet tube.
4. Connect the A/C manifold and tube to the suction accumulator/drier outlet tube after checking for a missing or damaged garter spring and/or repairing or replacing the spring. Install two new specified (special material) O-rings, lubricated with clean refrigerant oil onto the coupling male fitting.
5. Connect the vacuum line to the A/C vacuum check valve.

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6. Connect the vacuum line (part of A/C vacuum reservoir tank and bracket) to the source on the engine intake manifold and route it as illustrated.

7. Connect the electrical hardshell connectors to the heater blower motor switch (18578), the A/C cycling switch, and the blower motor.

8. Leak test, evacuate and charge the system. Refer to Section 12-00 . Observe all safety precautions.

9. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

   Connect battery ground cable.

10. Check the air conditioning/heater system for proper operation.

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A/C Evaporator Core

NOTE: Replacement of the suction accumulator/drier is not required when repairing the air conditioning system except when there is physical evidence of system contamination from a failed A/C compressor or damage to the suction accumulator/drier.

NOTE: Before replacing the A/C evaporator core it is mandatory that an On-Vehicle Leak Test be performed. Refer to Section 12-00 .

Removal

1. Disconnect the cable from the battery negative (ground) terminal.
2. Discharge the refrigerant from the A/C system.Refer to Section 12-00 . Observe all safety precautions.
3. Disconnect the electrical connector from the A/C cycling switch (19E561) located on top of the suction accumulator/drier.
4. Remove the A/C cycling switch from the suction accumulator/drier.
5. Disconnect the suction hose from the suction accumulator/drier and cap openings to prevent dirt and/or moisture from entering.
6. Disconnect the condenser to evaporator tube (19835) from the inlet tube using the appropriate spring lock coupling disconnect tool. Cap the openings to prevent dirt and/or moisture from entering.
7. Remove the screws holding the service cover to the A/C evaporator housing (19850).
8. Remove the service cover from the A/C evaporator housing.
9. Remove the A/C evaporator core from the vehicle.

Installation

1. Position the A/C evaporator core in the A/C evaporator housing.
2. Position the service cover into place on the A/C evaporator housing.
3. Install the two dash panel mounting nuts.
4. Install the screws holding the service case half to the A/C evaporator housing.
5. Install the suction accumulator/drier into the bracket (3 screws), then install inlet clamp (1 screw).
6. Connect the condenser to evaporator tube to the A/C evaporator housing inlet tube.
7. Connect the A/C manifold and tube (19D734) to the outlet side of the suction accumulator/drier. Install two new specified (special material) O-rings, lubricated with clean refrigerant oil, onto the male fitting.

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8. **CAUTION: DO NOT use a wrench to tighten the A/C cycling switch.**

   Install (screw) the A/C cycling switch to the suction accumulator/drier and tighten finger-tight.

9. Connect the electrical connector to the A/C cycling switch.

10. Charge the air conditioning system. Refer to Section 12-00 . Observe all safety precautions.

11. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

    Connect the cable to the battery negative (ground) terminal.

12. Check the air conditioning system for refrigerant leaks and proper operation.

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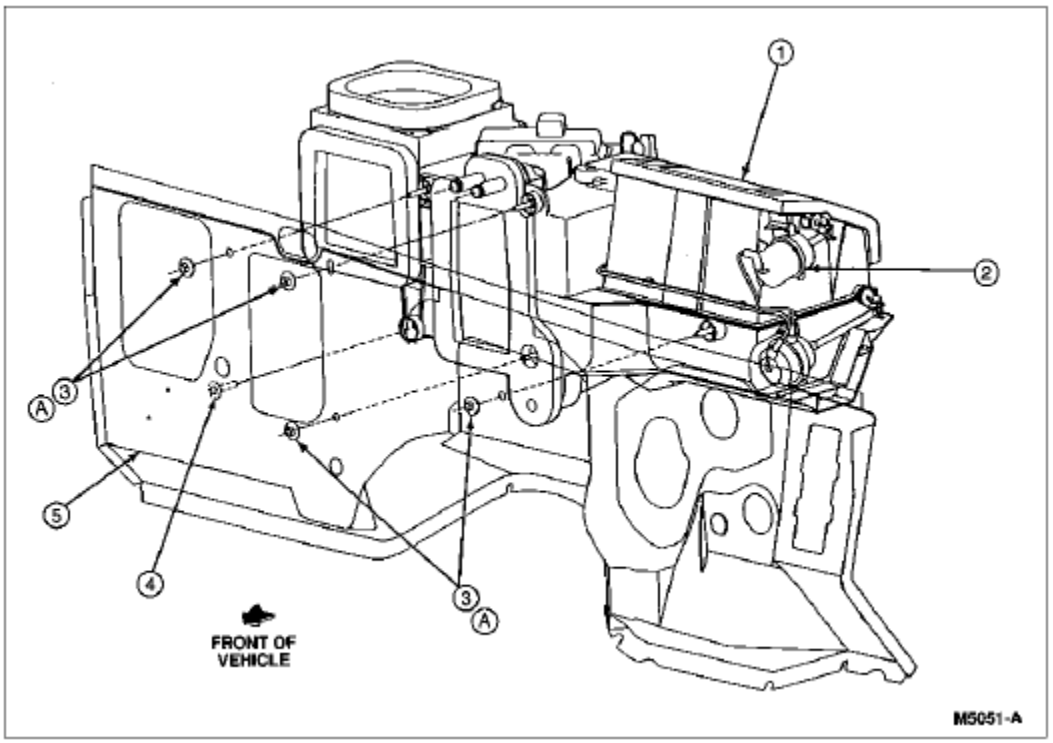
Heater Case

Removal and Installation

Refer to Heater Air Plenum Chamber under Removal and Installation in this section.

Air Conditioning/Heater Plenum Chamber Case



Item	Part Number	Description
1	18471	Heater Air Plenum Chamber
2	18A318	Vacuum Control Motor
3	N621907-S2	Nut (5 Req'd)
4	—	Stud (Part of 19850)
5	01610	Dash Panel
A	—	Tighten to 3-5 Nm (27-44 Lb-In)

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Heater Core

Removal and Installation

1. Allow the engine to cool. Observe the safety precautions outlined in Section 03-03 . Using a thick cloth, turn the radiator cap slowly to its first stop. Step back while the pressure is being released; then, when no more pressure is escaping, place a drain pan beneath the radiator. Open drain valve and allow engine and radiator to fully drain.
2. Disconnect the heater water hose (18472) from the heater core (18476), then, plug the heater water hose.
3. Working inside the passenger compartment, remove the instrument panel. Refer to Section 01-12 .
4. Remove Heater Air Plenum Chamber (18471). Refer to Removal and Installation in this section.
5. Remove heater core from heater air plenum chamber.
6. For installation, follow removal procedures in reverse order.

Blower Motor and Blower Motor Wheel Assembly

Removal

1. Disconnect the battery ground cable (14301).
2. Remove the air cleaner in front of the blower motor (18527).
3. Disconnect the wire harness connector from the blower motor by pushing down on the connector tabs and pulling the connector off the blower motor.

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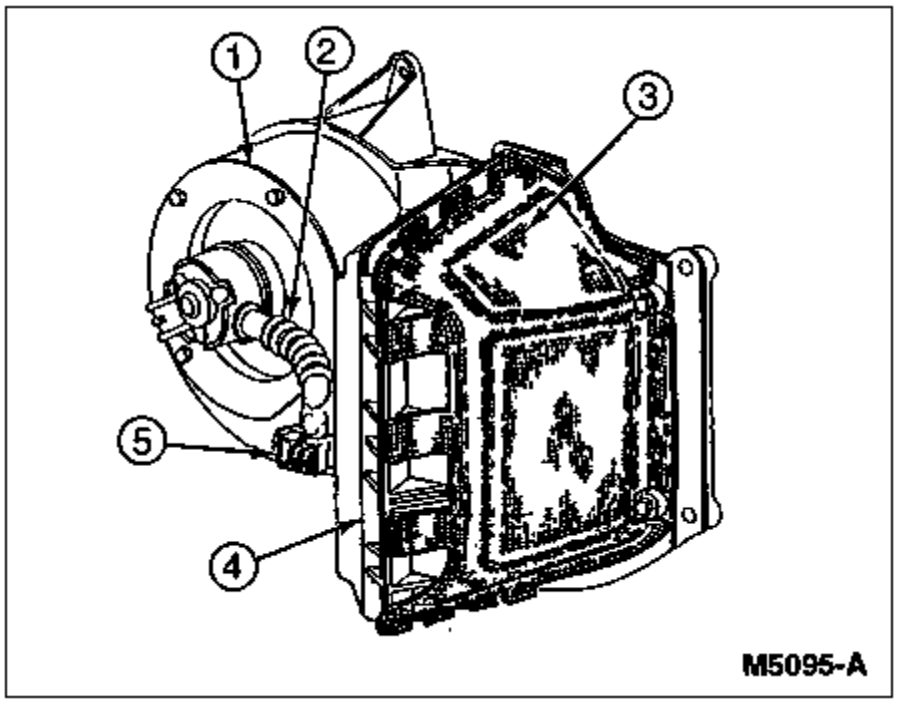

Item	Part Number	Description
1	18527	Blower Motor
2	19A786	Blower Motor Housing Tube
3	—	Heater Case Insulator (Part of 19850)
4	19930	Blower Housing
5	—	Electrical Connector (Part of 19805)

4. Disconnect the blower motor housing tube at the blower motor.
5. Remove four screws attaching the blower motor to the A/C blower housing.
6. Holding blower motor housing tube (19A786) aside, pull the blower motor from the heater plenum chamber case and remove it from the vehicle.
7. Remove the blower wheel hub pushnut and, if applicable, the clamp from the shaft. Then, pull the blower motor wheel from the shaft.

Installation

To install, reverse the removal procedure. Check system for proper operation.

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Heater Blower Motor Wheel

Removal

1. Remove blower motor (18527). Refer to Heater Blower Motor and Blower Motor Wheel Assembly under Removal and Installation in this section.
2. Place blower motor assembly on bench with blower motor wheel (18504) facing up.
3. Remove pushnut, then gently remove the blower motor wheel from the blower motor shaft.

Installation

1. Install blower motor wheel onto blower motor shaft until it bottoms on the hub and secure with a new pushnut.
2. Install blower motor and blower motor wheel assembly by following removal procedures in reverse order.

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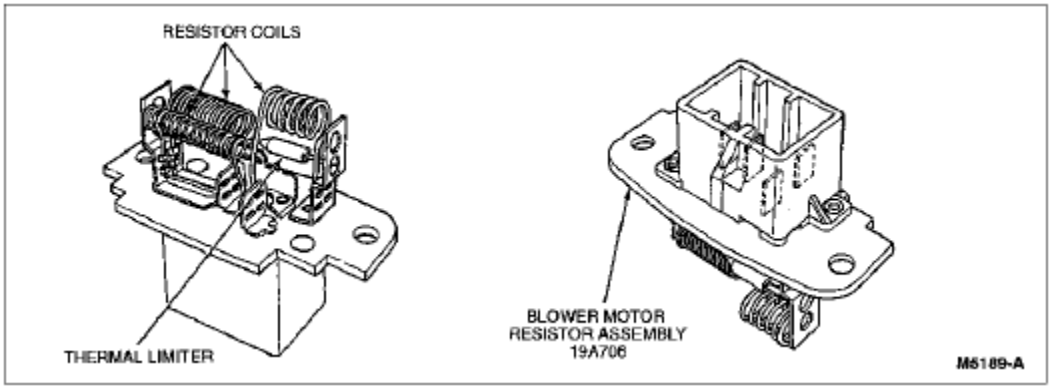
Blower Motor Switch Resistor

Removal and Installation

1. Disconnect battery ground cable.
2. Disconnect the wire connector from the heater blower motor switch resistor (18591), located on the A/C evaporator housing (19850).
3. Remove two screws attaching the heater blower motor switch resistor to the A/C evaporator housing then remove the heater blower motor switch resistor.
4. For installation, follow removal procedures in reverse order. Check system for proper operation.

Heater Blower Motor Switch Resistor with Thermal Limiter



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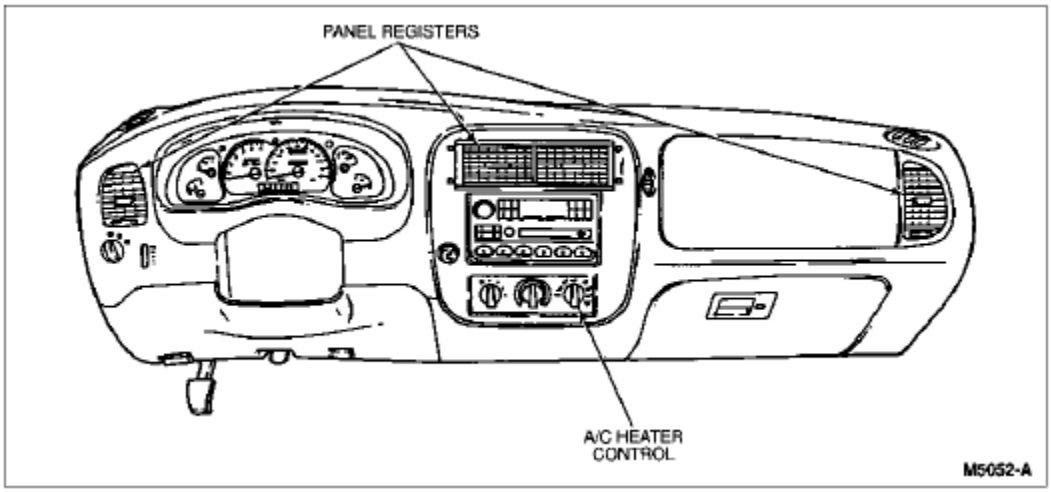
Instrument Panel Register Assemblies

There are four instrument panel register assemblies each of which can be adjusted horizontally and vertically to control airflow. Shutoffs are independent of air directional controls.

A/C Register Locations



RH

The right-hand A/C register (19893) is above the glove compartment door. It is supplied to production as a "purchased-in-assembly" component of the instrument panel (04320); but it is available for service replacement.

Removal and Installation

1. Carefully insert a small pry tool between the right-hand edge of the A/C register and the instrument panel pad. Use caution not to damage the pad finish.

2. Pry over and out to release fixed snaps in line with center control knob. Three other flex tabs retain assembly, one middle left side, one top left and one bottom left. These release the same as described.

3. Remove RH A/C register from face of the instrument panel.

4. Move the RH A/C register rearward far enough to prevent the tab from re-engaging.

5. For installation, press the replacement RH A/C register into its opening.

Center

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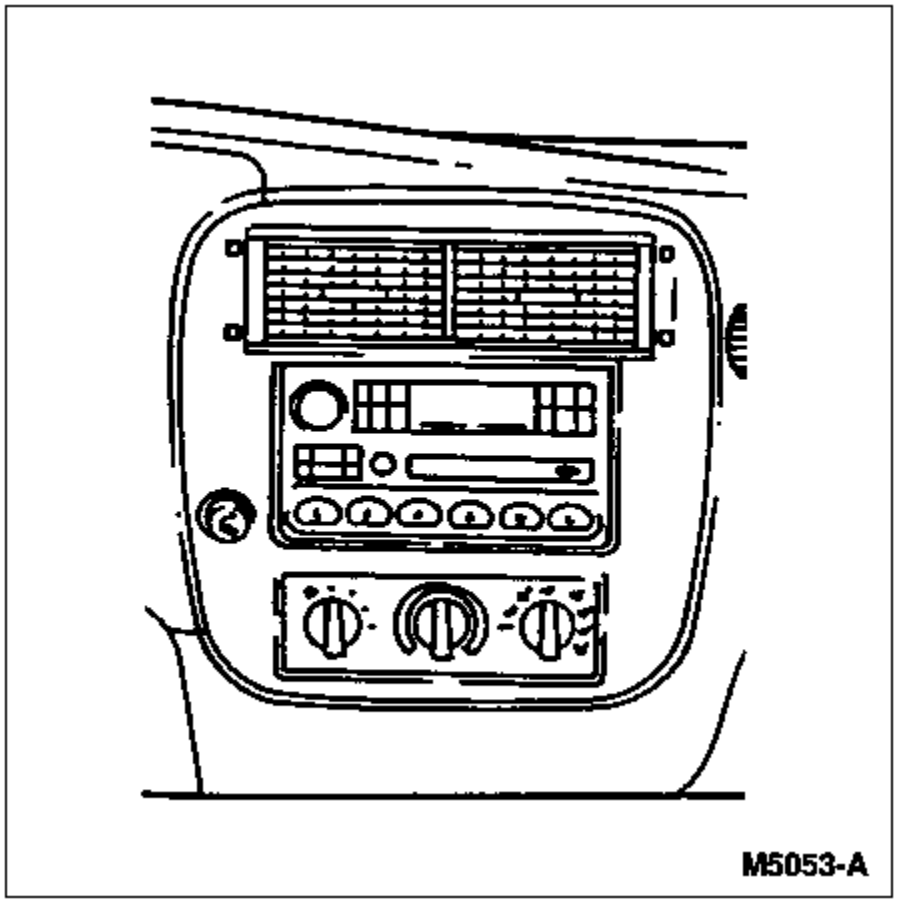
Removal and Installation

The center A/C register is actually two louver assemblies which can be adjusted and serviced independent of each other.

To remove the louver assembly, proceed as follows:

1. Depress the center division bar to the side.
2. Pull the end of the louver assembly from opening.
3. To install, snap each end of louver assembly into position. Louvers will not assemble upside down but will interchange with each other.
4. To service the entire register assembly, remove the center finish panel. Refer to Section 01-12 .
5. Release eight tabs from the backside and remove assembly.
6. To install, follow removal steps in reverse order.



LH

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Removal and Installation

1. Remove the instrument panel applique. Refer to Section 01-12 .
2. From the backside of the applique, remove three screws from the left-hand A/C register and push it out of the applique.
3. To install the A/C register, set in position and install the screws.
4. Install the applique.

Rear

Removal and Installation

NOTE: The rear registers are part of the console rear panel assembly but can be serviced.

1. Access and remove the three screws in the top of the console rear panel assembly. Refer to Section 01-12 .
2. Lower the convenience tray in the console rear panel assembly.
3. Remove the four remaining screws retaining the console rear panel assembly.
4. Remove the console rear panel assembly.
5. When the panel assembly is free, the louver assembly can be rotated to a position to allow removal in a downward direction from the front side.
6. To install, push rear register assembly(s) into rear panel assembly until retaining tabs engage. Reassemble following removal procedures in reverse order.

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Heater Air Plenum Chamber

Removal

1. Disconnect battery ground cable.
2. Remove the heater water hose (18472) from the heater core (18476) and plug the heater water hose as outlined.
3. Remove the A/C evaporator housing (19850) as outlined.
4. Remove five nuts from studs located in the engine compartment at the dash panel.
5. Working in the passenger compartment, remove the instrument panel (04320). Refer to Section 01-12 .
6. Pull the heater air plenum chamber (18471) rearward from the dash panel, and remove it from the vehicle.

Installation

1. Position heater air plenum chamber to dash panel, aligning studs to holes in panel.
2. Install new nuts on studs at dash panel in engine compartment.
3. Install A/C evaporator housing as outlined.
4. Install heater water hose on heater core.
5. Install instrument panel. Refer to Section 01-12 .
6. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

   Connect battery ground cable. Check system for proper installation.

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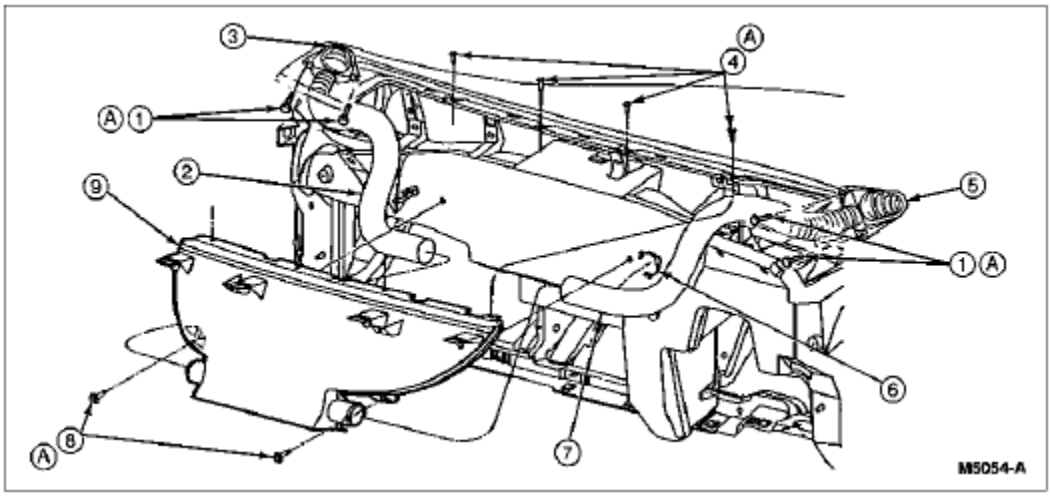
Ducts

Windshield Defroster Nozzle

Removal and Installation

1. Remove instrument panel (04320). Refer to Section 01-12 .
2. Remove four screws at the top of the defroster, front of instrument panel pad.
3. Remove two screws attaching defroster to the instrument panel duct beam.
4. Disconnect demister hoses from defroster (pull off).
5. Remove nozzle assembly.
6. To install, follow installation steps in reverse order.

Defroster Nozzle Installation



Item	Part Number	Description
1	N803875-S36	Screw (4 Req'd)
2	19E659	A/C Side Window Demister Hose (RH)
3	19E656	A/C Side Window Demister Nozzle (RH)
4	N804306-S36	Screw (4 Req'd)
5	19E657	A/C Side WIndow Demister Nozzle (LH)
6	—	Clip (Part of 04320)

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7	19E659	A/C Side Window Demister Hose (LH)
8	N803875-S36	Screw (2 Req'd)
9	18490	Windshield Defroster Nozzle
A	—	Tighten to 2.1-2.9 Nm (18-27 Lb-In)

A/C Side Window Demister and Hose

Removal and Installation

1. Remove instrument panel. Refer to Section 01-12 .
2. Remove the screws (two each side) which retain the demister nozzles to the instrument panel.
3. Release RH A/C side window demister and hose (19E630) and the LH A/C side window demister and hose from the windshield defroster nozzle and the support clips and carefully remove hose assemblies from their locations.
4. For installation, follow removal procedures in reverse order.

Register Distribution Ducts

The ducts are a "purchased-in-assembly" component of the instrument panel. They can be removed from the panel as follows:

Removal and Installation

LH Duct

1. Remove cluster trim cover. Refer to Section 01-12 .
2. Remove two screws retaining duct.
3. Remove duct.
4. For installation, follow removal steps in reverse order.

Center Duct

1. Remove center trim panel. Refer to Section 01-12 .
2. Remove two screws retaining duct.
3. Remove duct.
4. For installation, follow removal steps in reverse order.

RH Duct

1. Remove RH air register.

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2. Remove passenger side air bag module or simulator. Refer to Section 01-20B .
3. Remove two screws retaining duct.
4. Remove duct.
5. For installation, follow removal steps in reverse order.

Heater Outlet, Floor

Removal

1. Disconnect battery negative cable, then unplug connector assembly attached to front floor duct.
2. Using trim panel remover tool, remove connector assembly from front floor duct.
3. Remove the screw which attaches the rear of the front floor duct to the plenum.
4. Disengage the front floor duct from the tab on the left side of the plenum and remove the front floor duct.

Installation

1. Position the front floor duct so that the tab on the left side of the plenum protrudes through the oval hole in the duct. Install front floor duct attaching screw.
2. Install electrical connector to front floor duct and plug in.
3. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

   Reconnect battery negative cable.

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Vacuum Control Motors

Heater and A/C Air Inlet Duct Door

Removal and Installation

1. Open glove compartment, and remove contents. Press in sides of glove compartment and pull back so it hangs down. The vacuum control motor (18A318) should be visible on the right side of heater air plenum chamber (18471).
2. Disconnect vacuum hose from nipple.
3. Remove two screws attaching the vacuum control motor to the heater air plenum chamber.
4. Release vacuum control motor arm from shaft on heater air plenum chamber and remove.
5. For installation, follow removal procedures in reverse order. Check system for proper operation.

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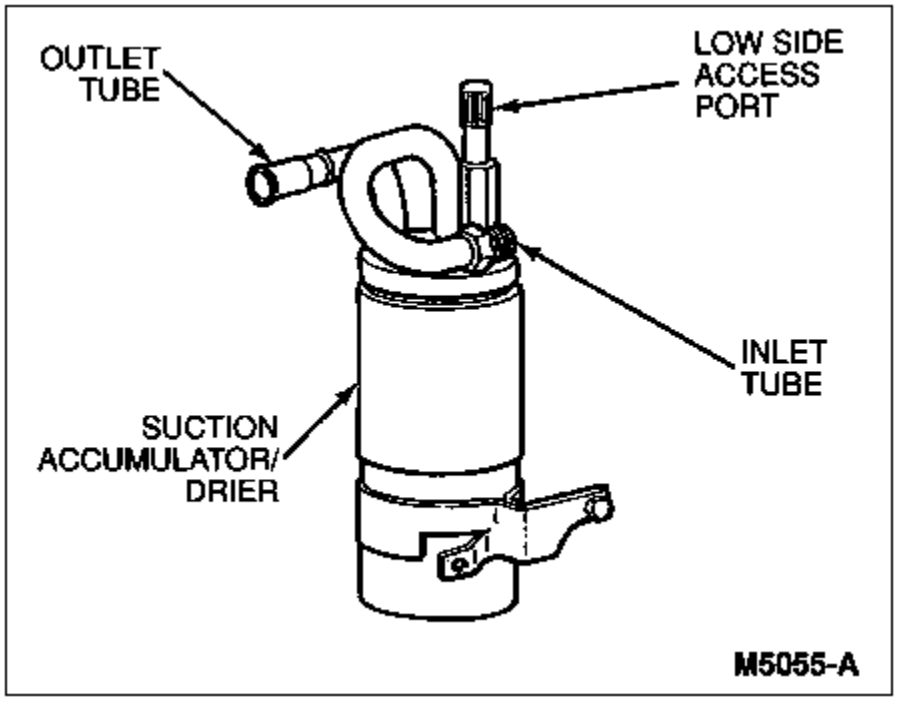
Suction Accumulator/Drier

NOTE: Replacement of the suction accumulator/drier is not required when repairing the air conditioning system except when there is physical evidence of system contamination from a failed A/C compressor or damage to the suction accumulator/drier.

Removal

1. Discharge the refrigerant from the A/C system. Refer to Section 12-00 . Observe all safety precautions.
2. Disconnect the electrical connector from the A/C cycling switch (19E561).

Suction Accumulator/Drier



3. Remove the A/C cycling switch by unscrewing it from the suction accumulator/drier.
4. Disconnect the suction accumulator/drier, using Spring Lock Coupling Disconnect Tool, and cap the openings to prevent the entry of dirt and moisture.
5. Loosen the fitting connecting the suction accumulator/drier to the A/C evaporator core (19860). Use a backup wrench to prevent component damage.
6. Remove the suction/accumulator drier bracket pinch screw.

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7. Disconnect the suction accumulator/drier from the A/C evaporator core and remove the suction accumulator/drier from the bracket.

Installation

1. Position the new suction accumulator/drier into the bracket.

2. Using a new O-ring lubricated with clean refrigerant oil, connect the suction accumulator/drier to the tube while aligning the bracket to the evaporator housing.

3. Tighten the suction accumulator/drier to fitting to 35-42 Nm (26-31 lb-ft) using a backup wrench. Install the bracket to the evaporator housing. Tighten the accumulator bracket pinch screw.

4. Connect the suction hose to suction accumulator/drier after checking for a missing or a damaged garter spring and replacing the spring. Install two new specified (special material) O-rings, lubricated with clean refrigerant oil, onto the male fitting.

5. Use a new O-ring lubricated with clean refrigerant oil on the nipple of the suction accumulator/drier. Then, install the A/C cycling switch and tighten the A/C cycling switch to 7-13 Nm (62-115 lb-in) if A/C cycling switch has metal base and hand-tighten only if A/C cycling switch has plastic base.

6. Connect the electrical connector to the A/C cycling switch.

7. Leak test, evacuate and charge the system. Refer to Section 12-00 . Observe all safety precautions.

8. Check the system for proper operation.

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A/C Cycling Switch

NOTE: Do not vent the refrigerant charge.

Removal

1. Disconnect battery ground cable.
2. Disconnect the wire connector from the A/C cycling switch (19E561).
3. Unscrew the A/C cycling switch from the suction accumulator/drier (19C836).

Installation

1. Install a new O-ring lubricated with clean refrigerant oil on the accumulator fitting.
2. Screw the A/C cycling switch on the accumulator fitting. Tighten the A/C cycling switch to 7-13 Nm (62-115 lb-in) if A/C cycling switch has metal base and hand-tighten only if A/C cycling switch has plastic base.
3. Connect the wire connector to the A/C cycling switch.
4. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

   Connect battery ground cable.
5. Check the system for proper operation.

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A/C Evaporator Core Orifice

The A/C evaporator core orifice (19D990) is constructed with a plastic body, two screens and a small brass tube down the center of the body. Two O-rings are around the body to seal against leakage.

CAUTION: Do not attempt to remove the A/C evaporator core orifice with pliers or by twisting. To do so will break the body in the tube. Use only the recommended tool and follow the recommended service procedures.

Removal

1. Discharge the refrigerant from the air conditioning system. Refer to Section 12-00 . Observe all safety precautions.

2. Disconnect the condenser to evaporator tube (19835) from the A/C evaporator core (19860). Cap the condenser to evaporator tube to prevent the entry of dirt and excessive moisture.

3. Squirt a small amount of clean refrigerant oil into the inlet tube to lubricate the A/C evaporator core orifice and O-rings during removal of the A/C evaporator core orifice or the tube.

4. **CAUTION: Do not twist or rotate the A/C evaporator core orifice in the tube as it may break off in the tube.**

   Engage the Rotunda Orifice Tube Tool D80L-19990-A or equivalent with the two tangs on the A/C evaporator core orifice.

5. Hold the T-handle of the Orifice Tube Tool to keep it from turning and run the nut on the tool down against the tube until the A/C evaporator core orifice is pulled from the tube.

6. If the A/C evaporator core orifice breaks in the tube, it must be removed from the tube with Rotunda Broken Orifice Tube Extractor D80L-19990-B or equivalent.

7. To remove a broken A/C evaporator core orifice, insert the screw end of the Broken Orifice Tube Extractor D80L-19990-B or equivalent into the tube and thread the screw end of the tool into the brass tube in the center of the A/C evaporator core orifice. Then, pull the A/C evaporator core orifice from the tube.

8. If only the brass center tube is removed during Step 7, insert the screw end of Broken Orifice Tube Extractor D80L-19990-B into the tube and screw the end of the tool into the A/C evaporator core orifice. Then, pull the A/C evaporator core orifice from the tube.

Installation

1. Liberally lubricate the O-rings on the A/C evaporator core orifice with clean refrigerant oil.

2. Place the A/C evaporator core orifice in the remover, Rotunda Orifice Tube Tool D80L-19990-A or equivalent, and insert the A/C evaporator core orifice into the tube until the A/C evaporator core orifice is seated at the stop.

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3. Remove the tool from the A/C evaporator core orifice.
4. Using a new O-ring lubricated with clean refrigerant oil, connect the condenser to evaporator tube to the tube. Tighten the fitting to 21-27 Nm (15-20 lb-ft) using a backup wrench.
5. Leak test, evacuate and charge the system. Refer to Section 12-00 . Observe all safety precautions.
6. Check the system for proper operation.

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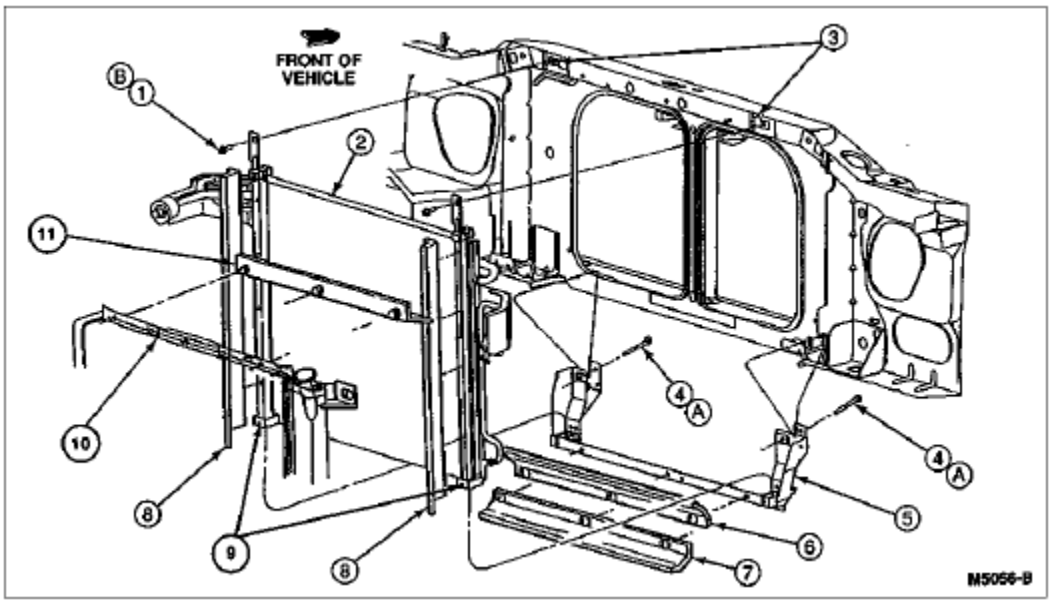
A/C Condenser Core — Ranger

NOTE: The illustrations included in this procedure detail the location of the various A/C condenser seals.

Removal

1. Discharge the refrigerant from the air conditioning system. Refer to Section 12-00 . Observe all safety precautions.
2. Disconnect the compressor discharge line from the A/C condenser core (19712) at the spring lock coupling using Spring Lock Coupling Disconnect Tool and cap the openings to prevent the entry of dirt and moisture.
3. Disconnect the condenser to evaporator tube (19835) from the A/C condenser core at the spring lock coupling using Spring Lock Coupling Disconnect Tool. Cap the openings to prevent the entry of dirt and moisture.
4. Tilt the top of the radiator rearward, after removing the upper radiator bracket bolts, being careful not to damage the cooling fan or radiator. Refer to Section 03-03 . Remove two bolts attaching the two upper mounting brackets of the A/C condenser core to the rear side of the radiator support.
5. Lift the A/C condenser core from the vehicle.

A/C Condenser Core Installation



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Item	Part Number	Description
1	N605894-S57	Bolt (2 Req'd)
2	19712	A/C Condenser Core
3	N623342-S426	U-Nut (2 Req'd)
4	N606525-S57	Bolt (2 Req'd)
5	19702	A/C Condenser Mounting Bracket
6	19T555	Lower Seal (2.3/3.0L Engines)
7	19T555	Lower Seal (4.0L Engine)
8	19E572	A/C Condenser Seal
9	—	Rubber Mounting Bracket Inserts
10	8005	Radiator
11	19T554	Top Seal
A	—	Tighten to 6-8 Nm (53-71 Lb-In)
B	—	Tighten to 10-14 Nm (7-10 Lb-Ft)

Installation

1. Place the A/C condenser core in position aligning the bottom ends of the condenser side supports with the A/C condenser rubber mounting bracket inserts.
2. Position the A/C condenser core to the vehicle with the lower mounts and upper brackets on the rear face of the radiator support.
3. Install the two bolts attaching the two upper mounting brackets to the rear side of the radiator support.
4. Move the radiator into the correct installed position and install the two upper retaining brackets (two screws each). Refer to Section 03-03 .
5. Install hoses to the spring lock coupling after checking for a missing or damaged garter spring and repairing or replacing the spring. Install two new specified (special material) O-rings lubricated with clean refrigerant oil into the male fittings.
6. Leak test, evacuate and charge the system. Refer to Section 12-00 . Observe all safety precautions.
7. Check the air conditioning system for proper operation.

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Refrigerant Lines

NOTE: The suction accumulator/drier (19C836) should be replaced if a refrigerant hose is replaced due to the possibility of dirt or moisture entering the system.

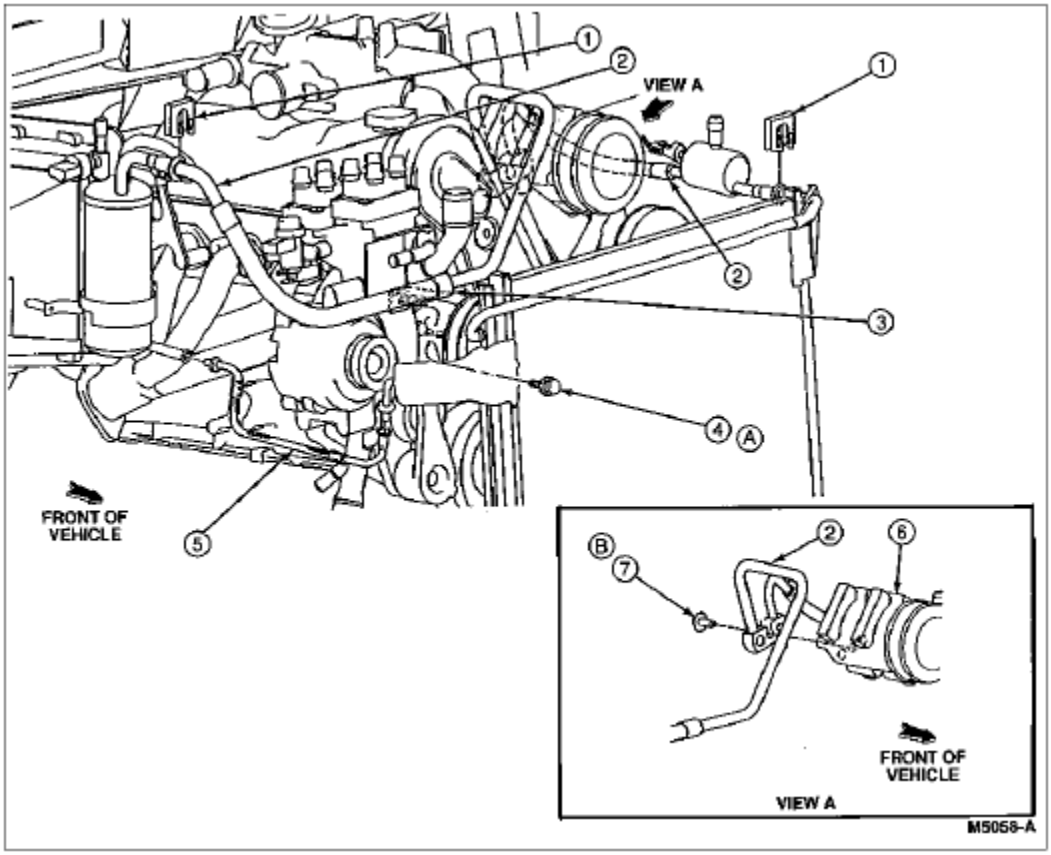
Removal

1. Discharge the refrigerant from the system. Refer to Section 12-00 . Observe all safety precautions.
2. Disconnect and remove the refrigerant line(s) using a wrench on each side of the fitting, or proper Spring Lock Coupling Disconnect Tool.

Installation

1. Route the new refrigerant line(s) (with protective caps installed). Refer to the appropriate illustration which follows.

Air Conditioner Hose Installation, 2.3L Engine



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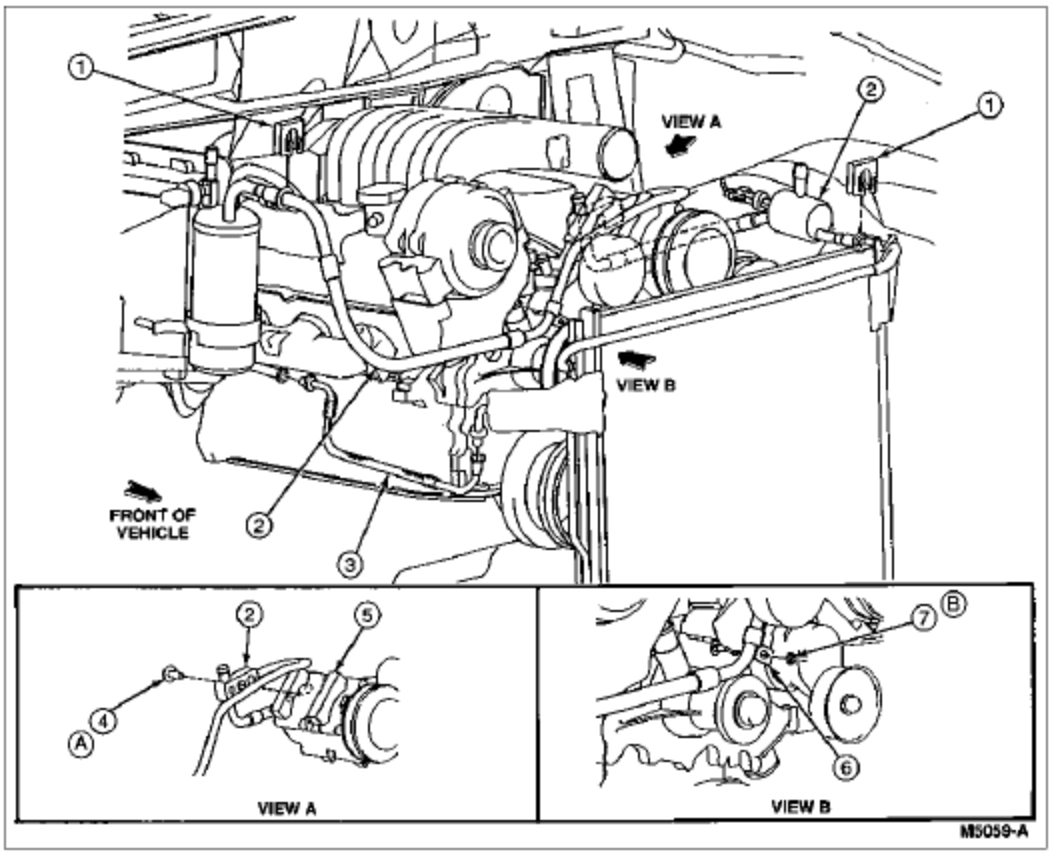
Item	Part Number	Description
1	19E746	A/C Tube Lock Coupling Clip
2	19D734	A/C Manifold and Tube
3	19812	A/C Hose Support Bracket
4	N605770-S2	Bolt
5	19835	Condenser to Evaporator Tube
6	19703	A/C Compressor
7	—	Screw (Part of 19D629)
A	—	Tighten to 7-9 Nm (62-80 Lb-In)
B	—	Tighten to 17-23 Nm (13-17 Lb-Ft)

Air Conditioner Line Installation, 3.0L Engine



Item	Part Number	Description
1	19E746	A/C Tube Lock Coupling Clip
2	19D734	A/C Manifold and Tube
3	19835	Condenser to Evaporator Tube

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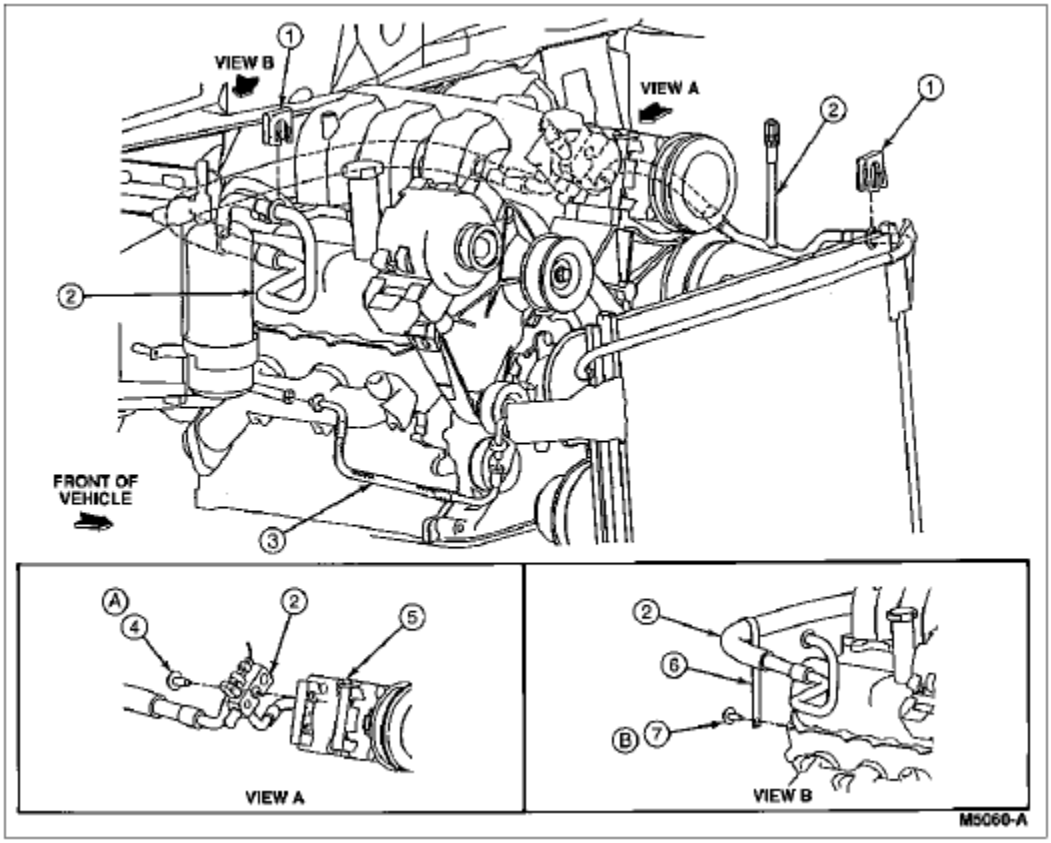
4	—	Screw (Part of 19D629)
5	19703	A/C Compressor
6	19812	A/C Hose Support Bracket
7	N621940-S303	Nut
A	—	Tighten to 17-23 Nm (13-17 Lb-Ft)
B	—	Tighten to 10-14 Nm (7-10 Lb-Ft)

Air Conditioner Line Installation, 4.0L Engine



Item	Part Number	Description
1	19E746	A/C Tube Lock Coupling Clip
2	19D734	A/C Manifold and Tube
3	19835	Condenser to Evaporator Tube
4	—	Screw (Part of 19D629)
5	19703	A/C Compressor
6	19B679	A/C Hose Clamp
7	N610958-S2	Screw

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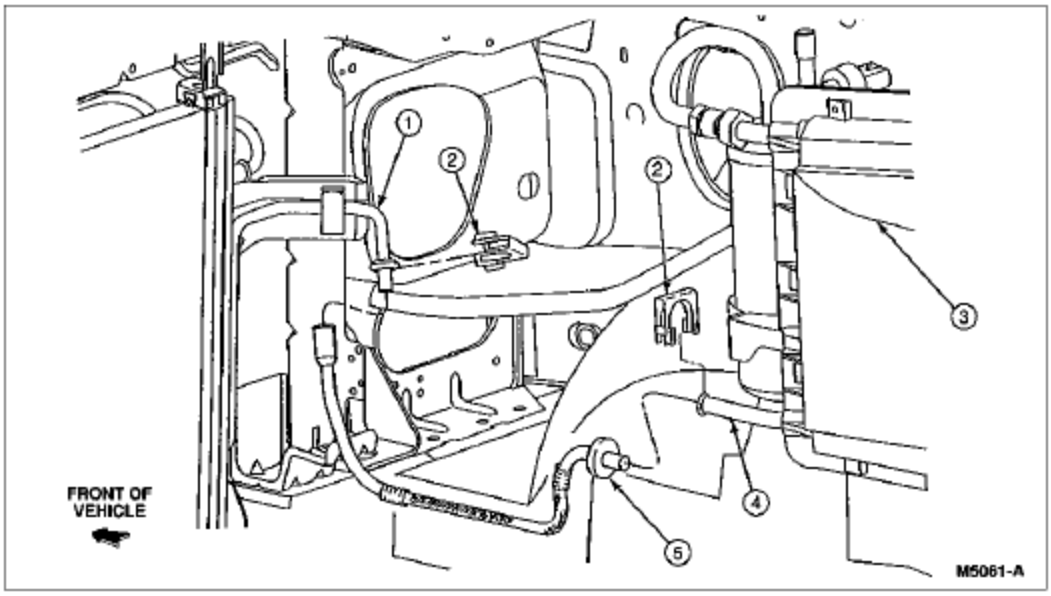
A	—	Tighten to 17-23 Nm (13-17 Lb-Ft)
B	—	Tighten to 13-17 Nm (10-13 Lb-Ft)

Air Conditioner Liquid Line Installation



Item	Part Number	Description
1	—	Tube (Part of 19710)
2	19E746	A/C Tube Lock Coupling Clip
3	19850	A/C Evaporator Housing
4	—	Tube (Part of 19850)
5	19835	Condenser to Evaporator Tube

2. Connect the refrigerant line into the system using new O-rings lubricated with clean refrigerant oil or new specified O-rings if coupled. Use two wrenches to tighten the threaded fittings to the torque specified or connect the spring lock coupling in accordance with the proper procedure.

3. Leak test, evacuate and charge the refrigerant system. Refer to Section 12-00 . **Observe all safety precautions.**

4. Check the air conditioning system for proper operation.

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Heater Water Hoses

1. Drain the coolant from the cooling system.
2. Loosen the clamps and remove the heater water hoses (18472) from the vehicle. Refer to Section 03-03 .
3. Cut a new length of heater water hose to the dimension of the removed heater water hoses.
4. Route the new heater water hoses in the same manner as those removed.
5. Connect the heater water hose to the fittings and install the clamps.
6. Fill the cooling system. Refer to Section 03-03 .
7. Check for coolant leaks and for proper operation of the system.

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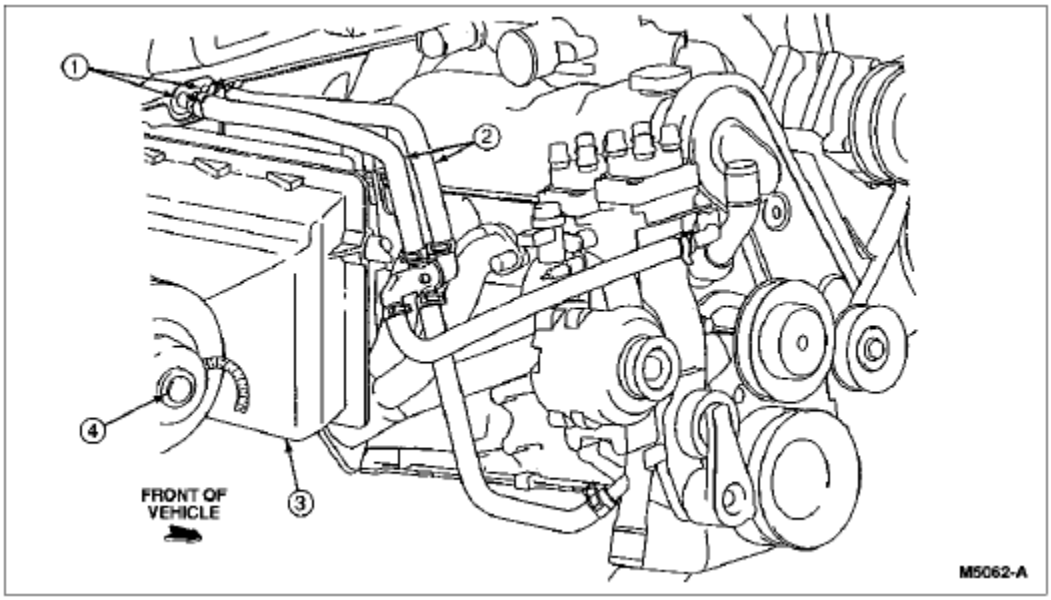
A/C Compressor

Heater Hose Routing, 2.3L Engine



Item	Part Number	Description
1	—	Inlet/Outlet Tubes (Part of 18476)
2	18472	Heater Water Hoses
3	19850	A/C Evaporator Housing
4	18527	Blower Motor

Heater Hose Routing, 3.0L Engine

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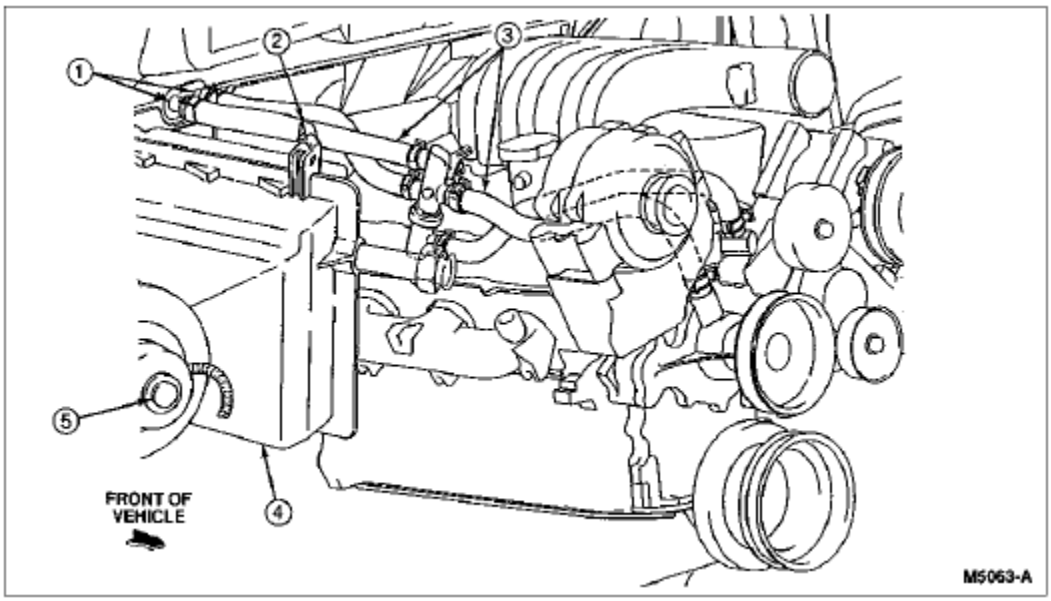

Item	Part Number	Description
1	—	Inlet/Outlet Tubes (Part of 18476)
2	18D255	Heater Valve Bracket
3	18472	Heater Water Hoses
4	19850	A/C Evaporator Housing
5	18527	Blower Motor

Heater Hose Routing, 4.0L Engine

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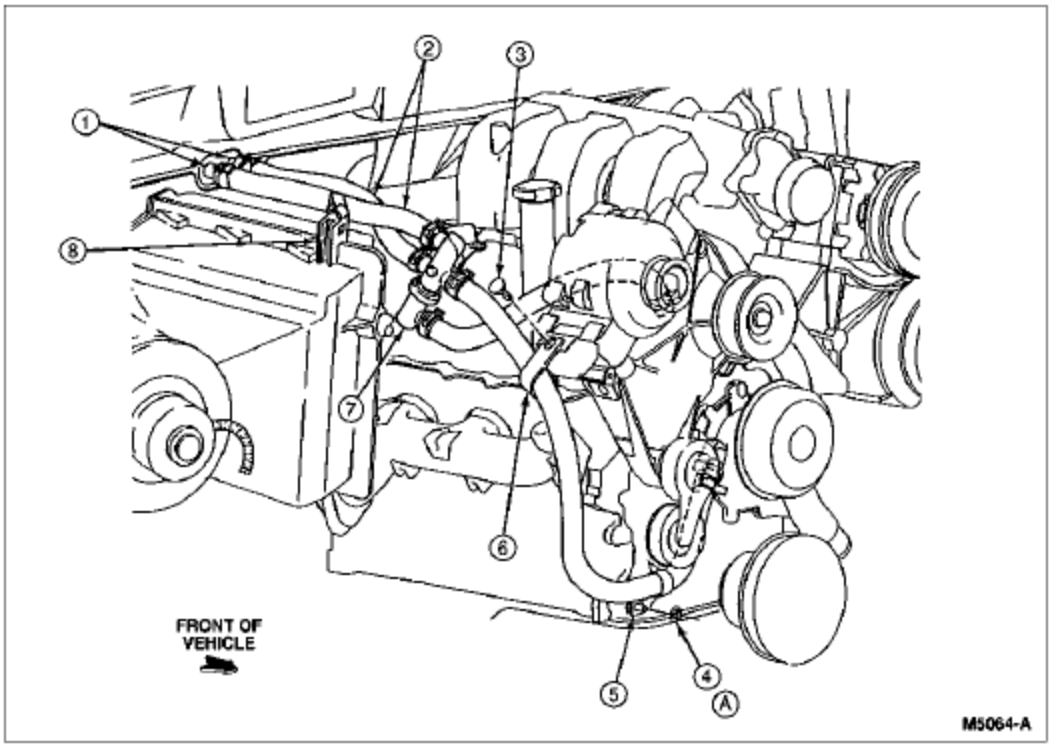

Item	Part Number	Description
1	—	Inlet/Outlet Tubes (Part of 18476)
2	18472	Heater Water Hoses
3	—	Push Pin (Part of 353859-S100)
4	N621940-S54	Nut
5	N807327-S100	Clip
6	353859-S100	Clip
7	18495	Heater Water Control Valve
8	18D255	Heater Valve Bracket
A	—	Tighten to 10-14 Nm (7-10 Lb-Ft)

Refer to the following illustrations for compressor removal and installation.

Compressor Mounts, 2.3L Engine

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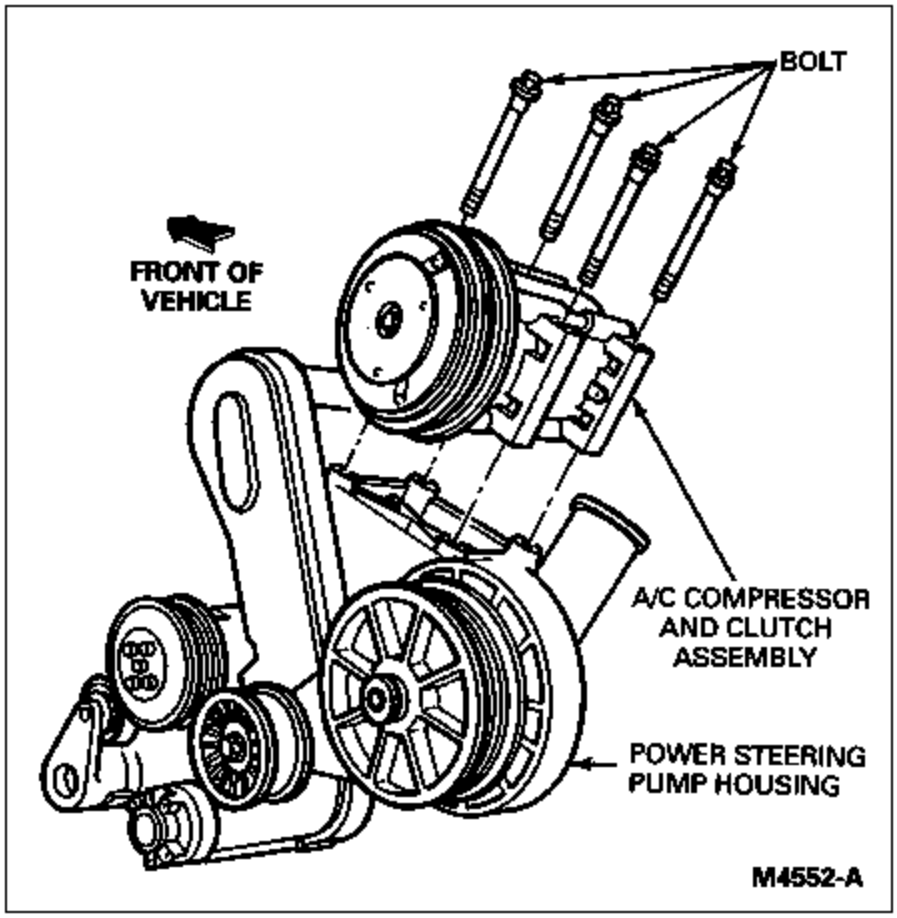

Removal

1. **NOTE: Vehicles that have an inoperative A/C compressor due to internal causes, must have the A/C system flushed to prevent damage to the replacement A/C compressor (19703). If the flushing procedure is not performed, the system will need to be filtered. For additional information, refer to Section 12-00.**

   NOTE: Replacement of the suction accumulator/drier is not required when repairing the air conditioning system except when there is physical evidence of system contamination from a failed A/C compressor or damage to the suction accumulator/drier.

   NOTE: The A/C evaporator core orifice (19D990) should be replaced whenever the A/C compressor is replaced for lack of performance or when there is debris in the system.

   Discharge the A/C system. For additional information, refer to Section 12-00.

2. Remove manifold attaching bolt.
3. Remove the A/C manifold and tube.
4. Remove drive belt (8620). For additional information, refer to Section 03-05 .
5. Disconnect electrical connector from A/C compressor clutch.

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6. Remove the A/C compressor bolts.

7. Remove the A/C compressor from the power steering pump and A/C compressor bracket.

Installation

1. Transfer the old A/C compressor clutch to the new A/C compressor.

2. **NOTE: If installing a new A/C compressor, lubricate with 30 ml (one fluid ounce) of clean compressor oil, and fill to system capacity. If installing a compressor after repairing for leaks, add the same amount of oil that was removed from the old compressor. If that amount is 90 ml (three ounces) or less, add an additional two ounces.**

   Lubricate new O-ring seals with clean refrigerant oil. Use only the O-ring seals specified for the type of manifold being used.

3. Apply Pipe Sealant with Teflon® D8AZ-19554-A or equivalent meeting Ford specifications WSK-M2G350-A2 and ESR-M18P7-A to threads of manifold retaining bolt.

4. **NOTE: When replacing an A/C compressor (19703), use original manifold bolt from removed A/C compressor to attach A/C manifold and tube to new A/C compressor. DO NOT USE THE SHIPPING CAP BOLTS.**

   Position A/C compressor in the power steering pump and A/C compressor bracket.

5. Install the A/C compressor bolts. Tighten the A/C compressor bolts to 21.2-28.8 Nm (15.6-21 lb-ft).

6. Install electrical connector to A/C clutch (2884).

7. Install drive belt.

8. Position the A/C manifold and tube.

9. Charge the A/C system. For additional information, refer to Section 12-00.

10. Operate A/C system to determine if A/C system is operating properly.

Compressor Mounts, 3.0L and 4.0L Engines

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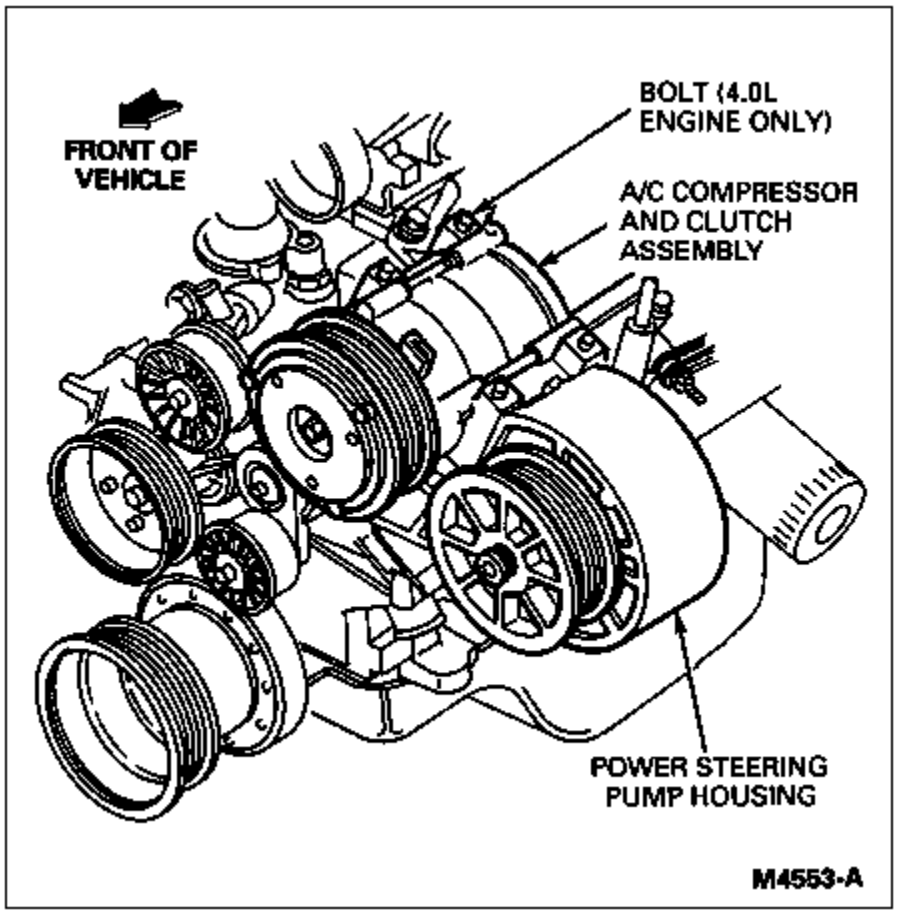

Removal

1. **NOTE: Vehicles that have an inoperative A/C compressor due to internal causes, must have the A/C system flushed to prevent damage to the replacement A/C compressor (19703). If the flushing procedure is not performed, the system will need to be filtered. For additional information, refer to Section 12-00.**

   NOTE: Replacement of the suction accumulator/drier is not required when repairing the air conditioning system except when there is physical evidence of system contamination from a failed A/C compressor or damage to the suction accumulator/drier.

   NOTE: The A/C evaporator core orifice (19D990) should be replaced whenever the A/C compressor is replaced for lack of performance or when there is debris in the system.

   Discharge the A/C system. For additional information, refer to Section 12-00.

2. Remove A/C manifold and tube. For additional information, refer to the procedure in this section.

3. Remove drive belt (8620). For additional information, refer to Section 03-05 .

4. Disconnect electrical connector from A/C compressor clutch.

5. Remove the power steering hose bracket nut from the A/C compressor stud and remove power

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steering hose bracket.

6. Remove the A/C compressor bolts and stud from the power steering pump and A/C compressor bracket.

7. Remove the A/C compressor from the power steering pump and A/C compressor bracket.

Installation

NOTE: The FS-10 A/C compressor used will require a special refrigerant oil with special additives. The A/C compressor used on R-134a systems requires YN-12c/F2AZ-19577-A oil, meeting Ford Specification WSH-M1C231-B.

NOTE: If installing a new A/C compressor, lubricate with 30 ml (one fluid ounce) of clean compressor oil, and fill to system capacity. If installing a compressor after repairing for leaks, add the same amount of oil that was removed from the old compressor. If that amount is 90 ml (three ounces) or less, add an additional two ounces.

1. Position A/C compressor in the power steering pump and A/C compressor bracket.

2. Install the A/C compressor bolts and stud. Tighten the A/C compressor bolts and stud to 21.2-28.8 Nm (15.6-21 lb-ft).

3. Install power steering hose bracket on A/C compressor stud. Tighten power steering hose bracket nut to 7.6-10.4 Nm (67-92 lb-in).

4. Install electrical connector to A/C clutch (2884).

5. Install drive belt.

6. Install A/C manifold and tube. Refer to the procedure in this section.

7. Charge the A/C system. For additional information, refer to Section 12-00.

8. Operate A/C system to determine if A/C system is operating properly.

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A/C System Filtering

CAUTION: Follow all refrigerant system safety and service precautions in Section 12-00 .

A Filter Kit should be installed in the refrigerant system prior to the installation of the replacement A/C compressor (19703). The pancake filter, supplied with each kit, should be temporarily installed in the liquid line between the A/C condenser core (19712) and the A/C evaporator core orifice (19D990). The suction filter, supplied with each kit, should be installed in the suction line between the suction accumulator/drier (19C836) and the A/C compressor. Install the replacement A/C compressor and the filters as outlined in the following procedure. Filter Kit for systems with nylon lined suction hose is Ford part number F2VY-19E773-C.

1. Before removing any refrigerant system components, discharge the system refrigerant following the approved recycling methods.

2. Remove the suction accumulator/drier and drain the oil into a calibrated container.

3. **NOTE: Due to the internal design of the suction accumulator/drier, it will be necessary to drill two 13mm (1/2-inch) holes in the suction accumulator/drier cylinder to drain the oil from the suction accumulator/drier.**

   Install a new suction accumulator/drier and add new YN-12b refrigerant oil to replace the old oil. The quantity of new oil to be added is the amount to match that drained from the old accumulator plus 60 ml (2 oz.).

4. Install a new A/C evaporator core orifice. If the A/C evaporator core orifice is located in the liquid line between the A/C condenser core and the A/C evaporator core (19860), replace the liquid line assembly.

5. Temporarily install the pancake filter in the liquid line between the A/C condenser core and the A/C evaporator core orifice. Be sure the filter inlet is toward the A/C condenser core. Connections can be made using A/C Test Fitting Set, D93L-19703-B, and flexible refrigerant hose of 2500 psi burst rating. Individual fittings are also available.

6. Remove the old A/C compressor and drain the oil into a calibrated container.

7. Drain the oil from the replacement A/C compressor into a clean calibrated container.

8. A new service replacement FS-10 A/C compressor may or may not contain 207ml (7 oz.) of refrigerant oil. If the amount of oil drained from the removed A/C compressor is between 90 and 148ml (3 to 5 oz.), pour the same amount of clean refrigerant oil into the new A/C compressor. If the amount of oil drained from the old A/C compressor is greater than 148ml (5 oz.), add an equivalent of clean refrigerant oil into the new A/C compressor. If the amount of refrigerant oil drained from the old A/C compressor is less than 90ml (3 oz.), pour 90ml (3 oz.) of clean refrigerant oil into the new A/C compressor. Use Motorcraft YN-12b Refrigerant Oil.

9. **NOTE: It will be necessary to transfer the A/C clutch (2884) from the old A/C compressor to the replacement A/C compressor. Refer to Section 12-03C for FS-10 A/C compressor.**

   Install the new A/C compressor. Be sure all mounting bolts are tightened properly. Check the tension of the A/C compressor drive belt (8620). Adjust if necessary.

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10. Install the suction filter in the suction hose close to the A/C compressor. The suction filter shown in the following illustration is for nylon lined core hose. These filters have two grooves in the end tubes to accommodate O-ring seals.

11. Remove a length of suction hose (close to the A/C compressor end) to accommodate the suction filter and install the filter using A/C hose clamps. Be sure the filter is correctly oriented for refrigerant system flow. Check the label on the filter. If using the filter for a nylon lined hose, install O-ring seals included in the kit (two on each filter tube).

12. Leak test, evacuate, and charge the system as outlined in Section 12-00 .

13. Check all refrigerant system hoses, lines and the positioning of the newly installed filters to be sure they do not interfere with other engine compartment components. If necessary, use tie straps to make adjustments.

14. Set the A/C control (19980) on MAX A/C, high blower motor (18527) and temperature control at full cold. Start engine and let it idle briefly. Make sure the A/C system is operating properly.

15. Gradually bring the engine up to 1200 rpm by running it at lower rpms for short periods (first at 800 rpm, then at 1000 rpm). Set the engine at 1200 rpm and run it for an hour with the A/C system operating.

16. Stop the engine.

17. Remove the refrigerant from the system using a recovery machine. Refer to Section 12-00 .

18. Allow the engine to cool sufficiently to remove the fittings, flexible hoses and pancake filter from the liquid line.

19. Discard the pancake filter. It can be used one time only.

20. Reconnect the liquid line back into the system.

21. Evacuate, charge and leak test the system. Make any necessary adjustments.

22. Check the operation of the system in all control function selector lever positions.

A/C System Filtering

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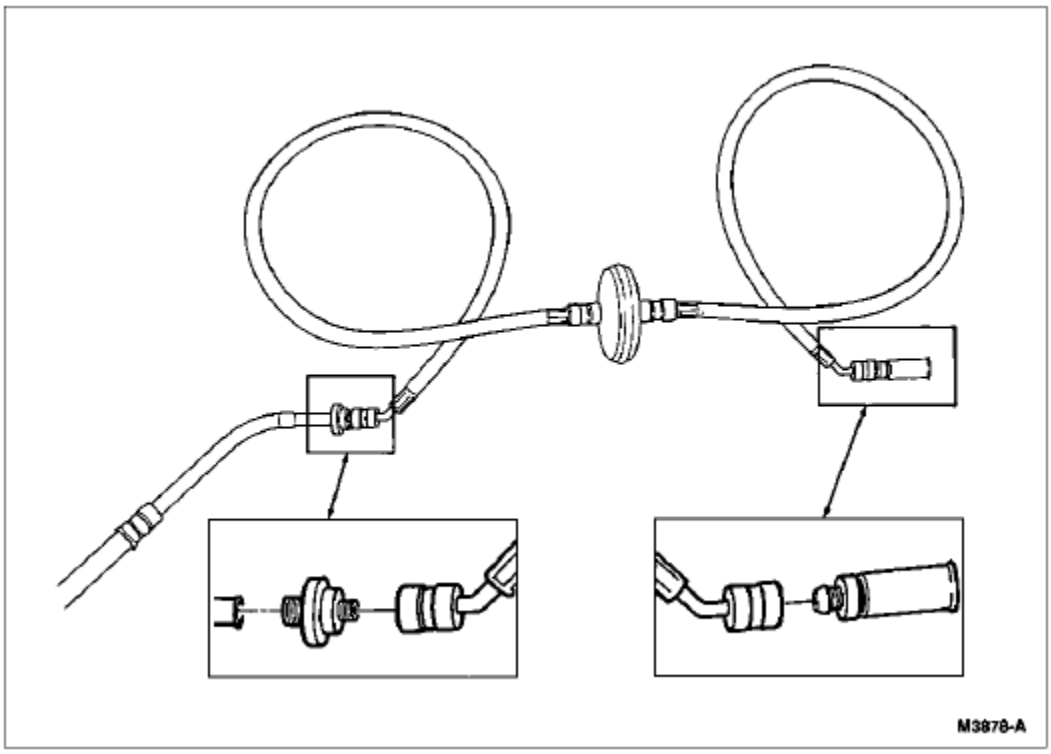

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A/C Manifold and Tube

NOTE: Two different O-ring seals are used on the A/C manifold and tube (19D734) and they are not interchangeable. One is black and is used with aluminum manifolds. The other O-ring seal is red and is used with brazed steel manifolds. Either O-ring seal must be replaced with one of the same color.

Removal

1. Discharge refrigerant from system. Observe all safety precautions. Refer to Section 12-00 .
2. Remove manifold attaching bolt.
3. Disconnect pressure cutoff switch connector.
4. Remove A/C tube lock coupling clips (19E746) at the condenser tube and at the suction accumulator/drier (19C836). Disconnect spring lock coupling at these two locations.
5. Remove the A/C manifold and tube.

Installation

1. Position the A/C manifold and tube.
2. Connect the spring lock couplings.
3. Connect the pressure cutoff switch connector.
4. Lubricate new O-ring seals with clean refrigerant oil and position them in O-ring seal grooves of manifold. Use only the O-ring seals specified for the type of manifold being used.
5. Apply Pipe Sealant with Teflon® D8AZ-19554-A or equivalent meeting Ford specifications WSK-M2G350-A2 and ESR-M18P7-A to threads of manifold retaining bolt.
6. **NOTE: When replacing an A/C compressor (19703), use original manifold bolt from removed A/C compressor to attach A/C manifold and tube to new A/C compressor. DO NOT USE THE SHIPPING CAP BOLTS.**

   Position manifold with O-ring seals to A/C compressor. Install retaining bolt and tighten to 17-23 Nm (12.5-17.0 lb-ft).
7. Leaktest, evacuate and charge system following recommended procedures. Observe all safety precautions.

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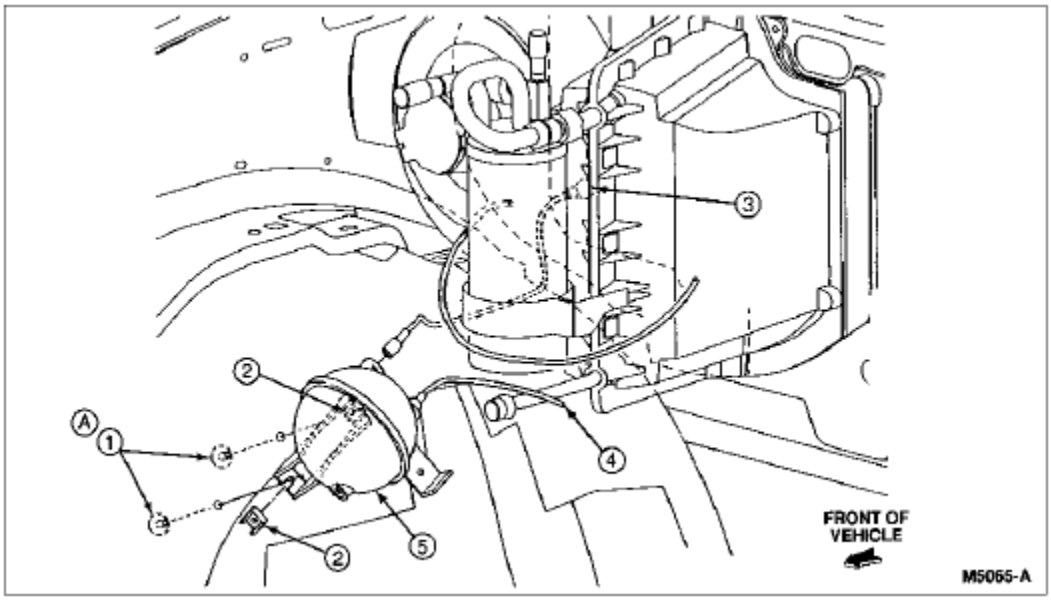
A/C Vacuum Reservoir Tank and Bracket

Removal and Installation

1. Disconnect the vacuum lines from the A/C vacuum reservoir tank and bracket (19A566).
2. Remove the two screws from the mounts and remove the A/C vacuum reservoir tank and bracket.
3. For installation, follow removal procedures in reverse order. Check system for proper operation.

Vacuum Reservoir Installation



Item	Part Number	Description
1	N611080-S2	Screw (2 Req'd)
2	45258-S2	J-Nut (2 Req'd)
3	19850	A/C Evaporator Housing
4	—	To Vacuum Source (Part of 19D848)
5	19A566	A/C Vacuum Reservoir Tank and Bracket
A	—	Tighten to 7-9 Nm (62-80 Lb-In)

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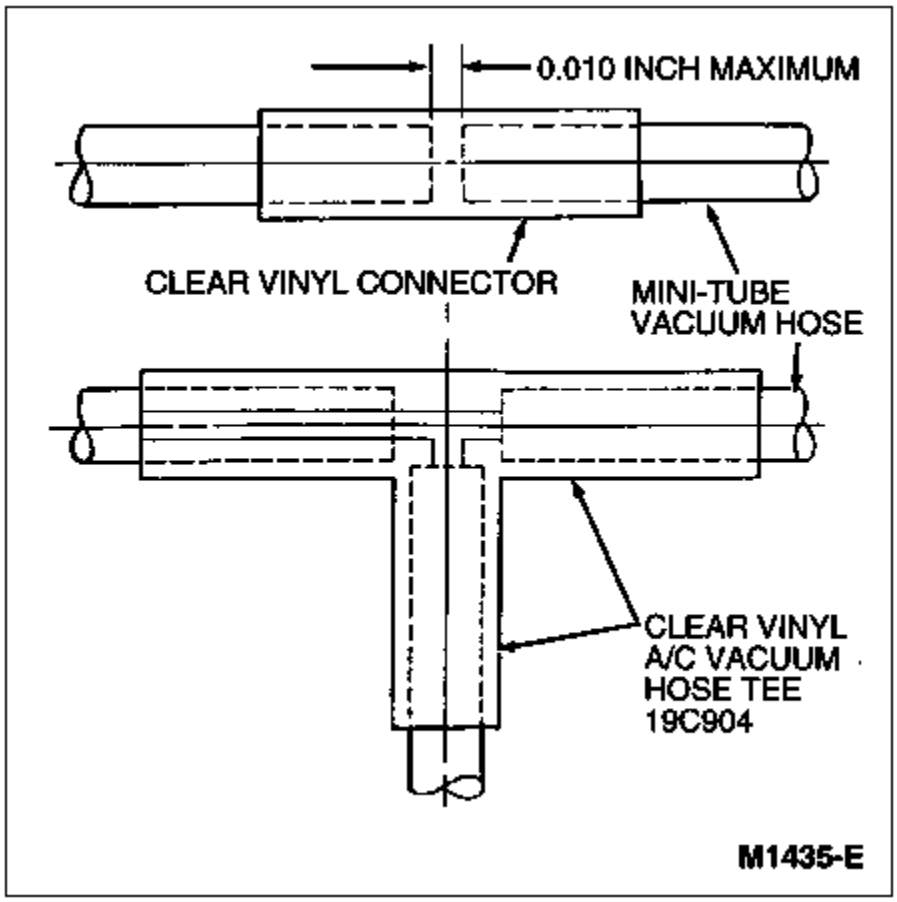
Mini-Tube Vacuum Hoses

Mini-tube vacuum hoses are used in the vacuum harness assemblies. They provide greater flexibility with less tendency to collapse and are less susceptible to pinching. Service is easily made using a short piece of standard 3mm (1/8 inch) ID vacuum hose.

1. Measure length of damaged area of mini-tube vacuum hose.
2. Cut a piece of standard 3mm (1/8 inch) ID vacuum hose approximately 25mm (1 inch) longer than the damaged area of mini-tube vacuum hose.
3. Cut off mini-tube vacuum hose on each side of damaged area.
4. Dip mini-tube hose ends in methyl ethyl ketone (MEK). Some paint thinners contain MEK. Check with your paint shop. This solvent will seal mini-tube to vacuum hose.
5. Insert ends of mini-tube vacuum hose approximately 9mm (3/8 inch) into ends of standard 3mm (1/8 inch) service vacuum hose section.



6. Shake repair joint after assembly to ensure solvent is dispersed and vacuum line is not plugged.

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7. Use Rotunda Vacuum Leak Tester 014-R1054 or equivalent to test system for a vacuum leak.

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SPECIFICATIONS

Refrigerant System

Description	Specification
System Protection A/C Cyclic	Close Maximum 52 psi Open MInimum 23 psi
Refrigerant Containment Switch (RCS) A/C Compressor Pressure Relief Valve (Located on Compressor High-Pressure Manifold)	3103 kPa (450 psi)
Capacity	22 oz.
Refrigerant 134a (R-134a) F2AZ-19577-AC	WSH-M1C231-B Motorcraft YN-12

Electrical System

Switch Seating	Amps	Volts
Off	0	—
Low	9-11.5	5
Medium Low	11.5-14	8
Medium High	14-16.5	10
High	16-18.5	12
Control Assembly, Illumination	One — 1 C.P. — 161 Bulb One — .75 C.P. — 1982 Bulb	
System Protection	30 Amp Fuse in Heater Blower Motor Circuit Brown-Orange F-9 10 Amp Fuse in Clutch Circuit White-Purple F-7 50 Amp Fuse in Network Box Thermal Limiter in Heater Blower Motor Switch Resistor Circuit (Integral with Resistor)	

Spring Lock Coupling Components

O-Rings	
3/8 Inch	W701993
1/2 Inch	W701992
5/8 Inch	W701994

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Garter Springs	
3/8 Inch	E1ZZ-19E576-A
1/2 Inch	E1ZZ-19E576-B
5/8 Inch	E35Y-19E576-A
3/4 Inch	E69Z-19E576-A

Torque Specifications

Description	Nm	Lb-Ft	Lb-In
A/C Cyclic Switch to Accumulator Nipple Steel Base	7-13	—	62-115
A/C Cyclic Pressure Switch (Plastic Base)	Hand Tighten Only		
Liquid Line to Evaporator Core	20-27	15-20	—
Accumulator to Evaporator Core	35-42	26-31	—
Discharge Hose to Compressor Manifold	23-37	21-27	—
Clutch Hub Nut	13-20	10-14	—
Compressor Head Bolts	24.5-26.5	18-19	—
Compressor Attaching Bolts	34-47	25-35	—
Compressor Bracket to Engine	42-58	31-43	—
Evaporator Housing to Dash Panel Nuts	3.4-4.8	—	27-44
Evaporator Housing to Dash Panel Screw	8	—	71
Heater Hose Clamps	21-27	15-20	—
Heater Plenum Chamber to Dash Panel Nuts	3-5	—	27-44
A/C Condenser Mounting Bracket Bolts	6-8	—	53-71
Peanut Fitting Nut	6.8-9.2	—	61-82
A/C Condenser Mounting Screws	10-14	7-10	—
A/C Hose Support Bracket Bolt	7-9	—	62-80

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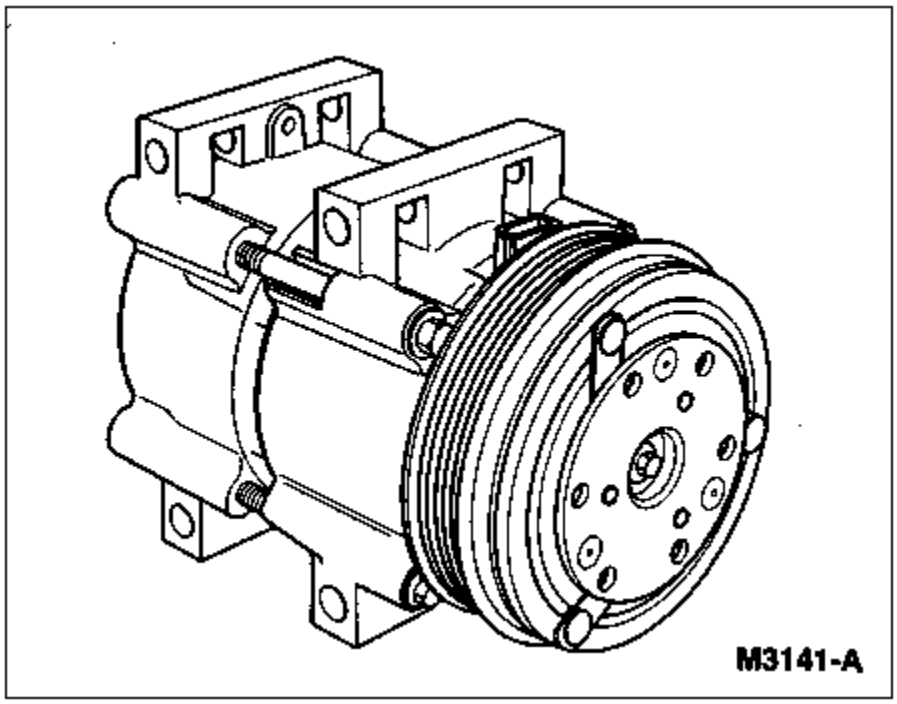
A/C Compressor

The FS-10 is a swashplate design ten-cylinder aluminum A/C compressor (19703) utilizing the tangential-design mount. The compressor mainshaft is driven by a belt from the engine crankshaft pulley. A one-piece lip-type seal (replaceable from the front of the compressor) is used to seal it at the shaft opening in the assembly. Five double-acting pistons, positioned axially around the compressor shaft, operate within the cylinder assembly. The pistons are actuated by a swashplate that is pressed on the compressor shaft. The swashplate changes the rotating action of the shaft to provide a reciprocating driving force to each of the five pistons. This driving force is applied, through shoes, to the midpoint of each of the double end pistons.

Reed-type discharge valves are assembled on the valve plate which is located with the suction reed valve between the cylinder assembly and the head at each end of the A/C compressor. The heads are connected to each other by gas-tight passageways through the cylinder assembly which direct the refrigerant gas to the suction and discharge ports located in the rear head.

A magnetic A/C clutch (2884) is used to drive the compressor shaft. When voltage is applied to the A/C clutch field coil (2987) the clutch plate and hub assembly (which is solidly coupled to the compressor shaft) is drawn rearward by magnetic force toward the A/C clutch pulley (2E884) which rotates freely on the A/C compressor front head housing. The magnetic force locks the clutch plate and hub assembly and the pulley together as one unit. The compressor shaft then turns with the pulley. When voltage is removed from the clutch field coil, springs in the clutch plate and hub assembly move the clutch plate away from the pulley. The clutch plate hub assembly and compressor shaft cease to rotate.



A/C Clutch

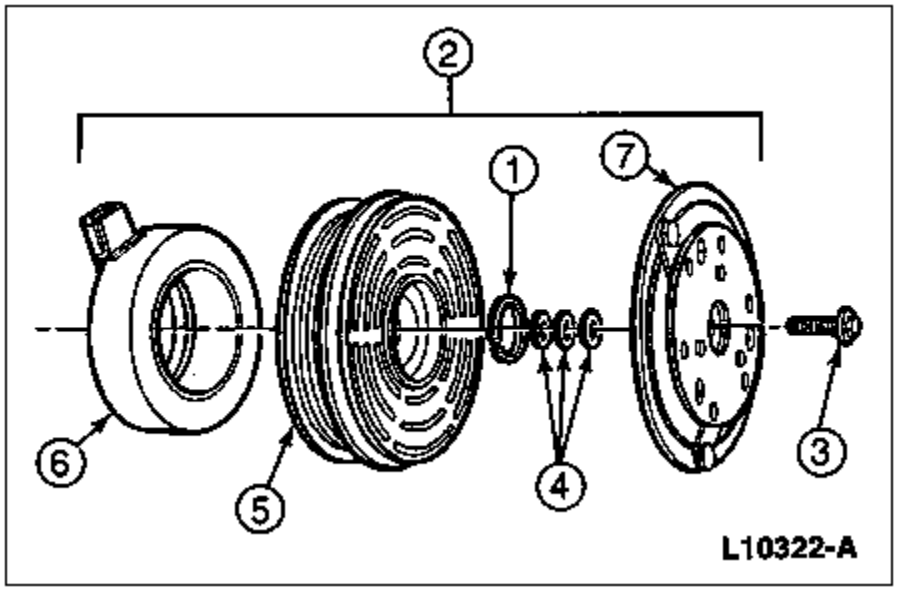
A/C Clutch and A/C Clutch Pulley

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Spanner Wrench	T70P-4067-A
Compressor Clutch Holding Tool (4.0L)	T94P-19703-AH

A disassembled view of the A/C clutch (2884) and related parts is shown in the illustration.

A/C Clutch and Pulley



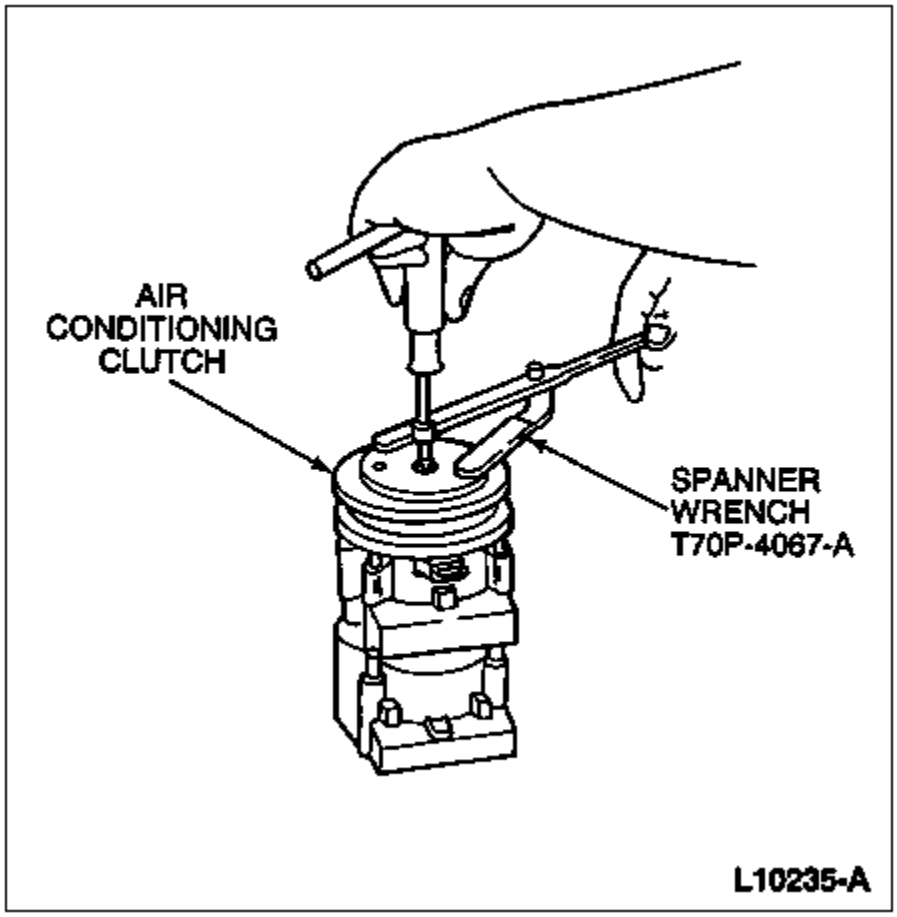
Item	Part Number	Description
1	N800620-S2	Pulley Snap Ring
2	2884	A/C Clutch
3	—	Bolt (8mm) (Part of 2884)
4	—	Shims (Part of 2884)
5	19D784	
6	2987	A/C Clutch Field Coil
7	19D786	A/C Clutch Hub

Removal

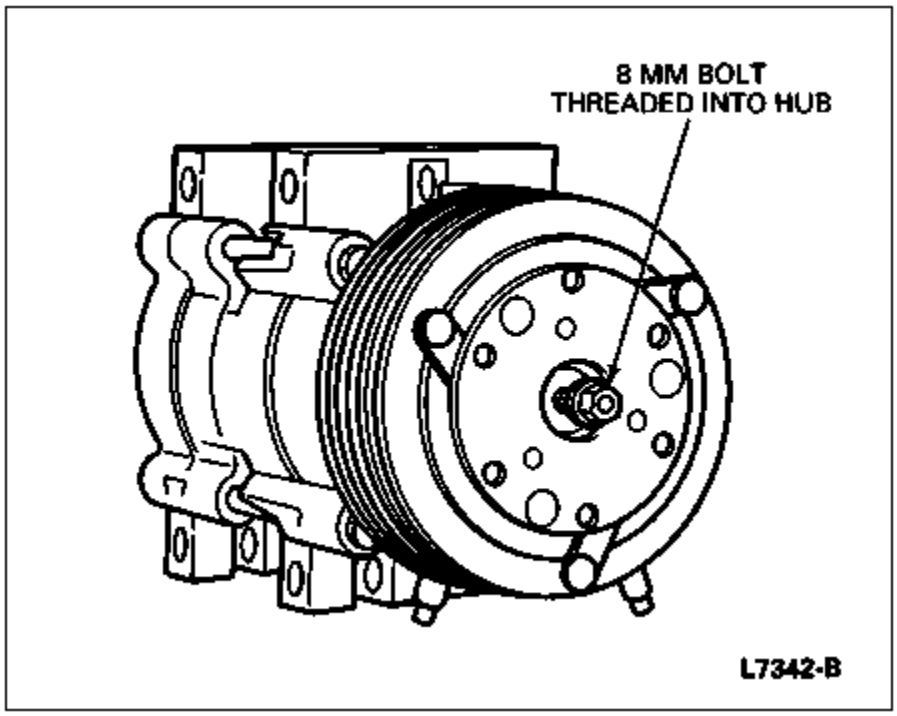
NOTE: Before disassembling the A/C compressor/clutch assembly for repair, it is important to check the A/C clutch air gap. This will help determine if the clutch is not engaging or if the A/C compressor is failing internally. For additional information, refer to Adjustments in this section.

1. Remove the clutch hub retaining bolt. Use Spanner Wrench T70P-4067-A (Compressor Clutch Holding Tool T94P-19703-AH for 4.0L.) Note position of the coil electrical connector.

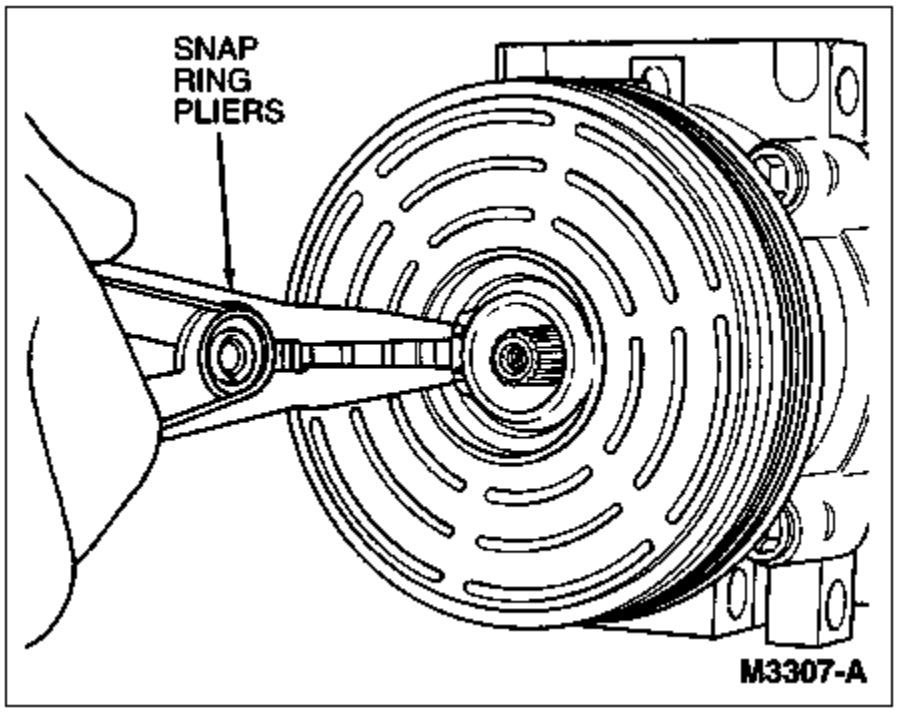
2.3L and 3.0L Shown; 4.0L Typical



2. Pull clutch hub and shims from compressor shaft. If hub cannot be pulled from compressor shaft, screw an 8mm bolt into the shaft hole of the clutch hub to force the hub from the shaft.

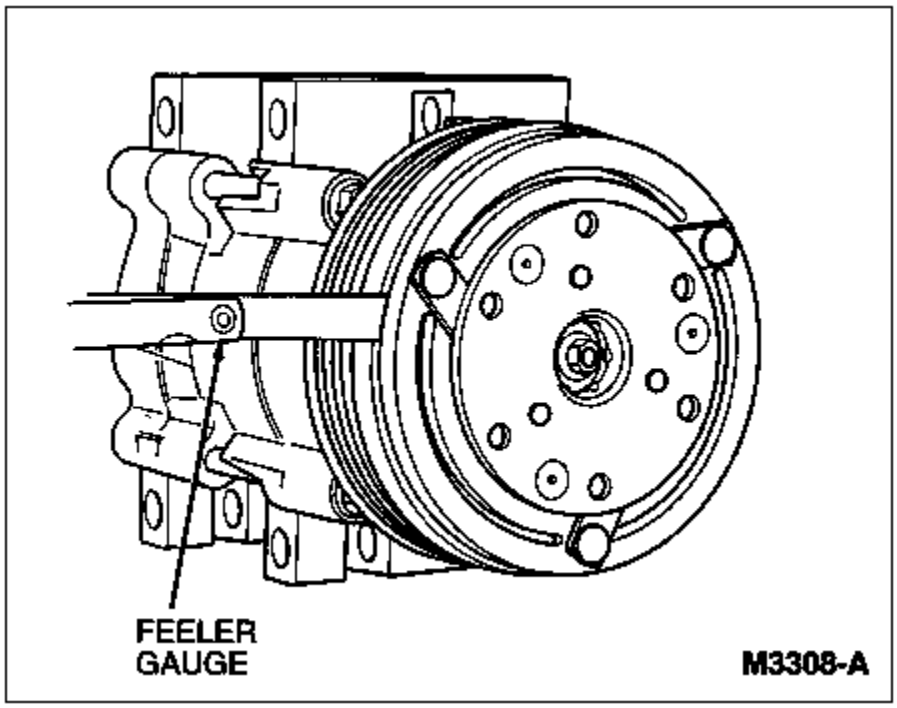


3. Remove pulley retaining snap ring.
4. Pull the pulley and A/C clutch pulley (2E884) assembly from compressor.



Installation

1. Clean pulley bearing surface of A/C compressor (19703) head to remove any dirt or corrosion.
2. Install pulley and A/C compressor pulley bearing (2990) on A/C compressor. The bearing is a slip-fit on the A/C compressor head and, if properly aligned, it should slip on easily.
3. Install pulley retaining snap ring with bevel side of snap ring out.
4. Place one nominal thickness spacer shim on the end of the splined shaft and slide the hub on the end of the compressor shaft.
5. Thread a new 8mm hub retaining bolt into end of compressor shaft. Tighten hub retaining bolt to 11-14 Nm (8-10 lb-ft). DO NOT USE AIR TOOLS.
6. Check clutch air gap between clutch disc and pulley mating surfaces with a feeler gauge. The air gap should be between 0.35 and 0.85mm (0.014 and 0.033 inch). Check at three locations equally spaced around the A/C clutch pulley.



7. If clutch air gap is not within 0.35 to 0.85mm (0.014 to 0.033 inch), repeat Steps 4 through 6 with various thickness shims until air gap is within specified limits.
8. Leak test, evacuate and charge the A/C system. For additional information, refer to Section 12-00 .
9. When installing a new A/C clutch, cycle it ten times at idle to burnish the A/C clutch and prevent slippage.

A/C Clutch Field Coil

NOTE: The A/C clutch field coil (2987) is pressed on the front head of the compressor. Special

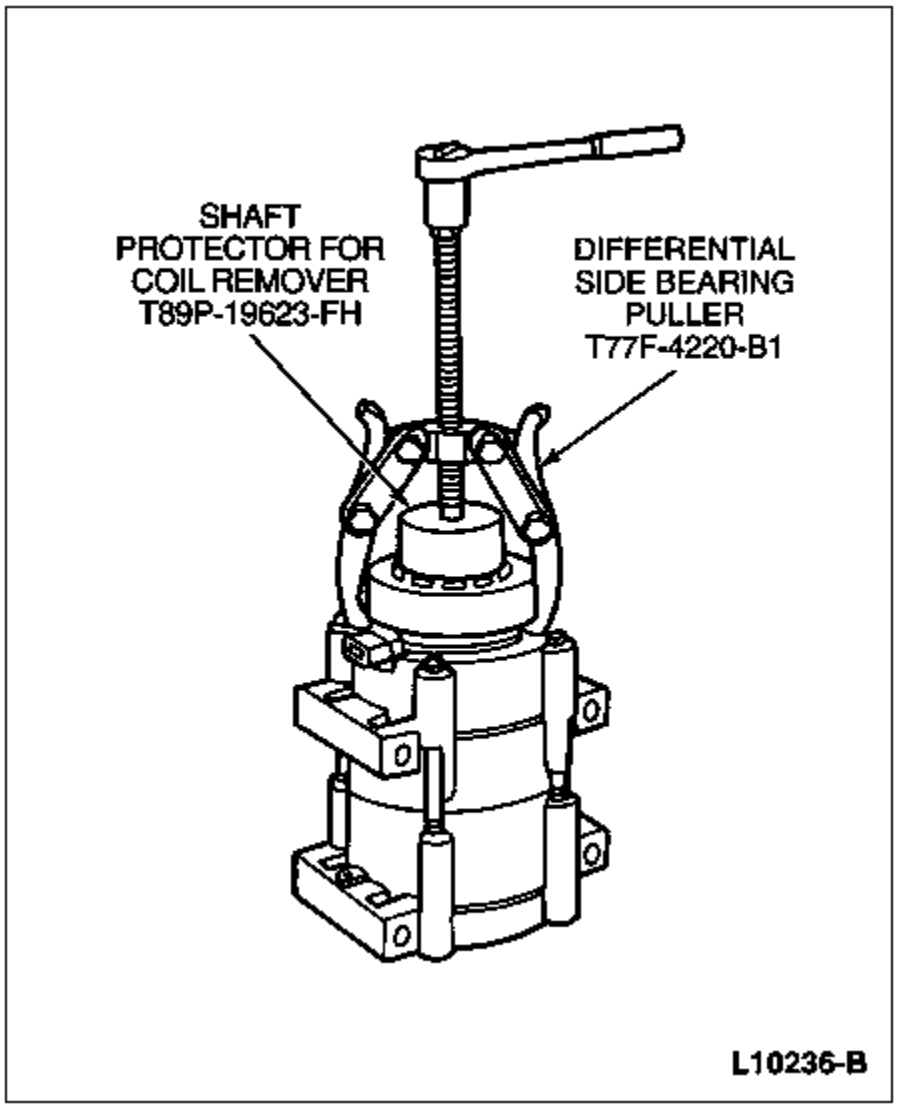
service tools are required to remove and install the A/C clutch field coil.

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Shaft Protector for Coil Remover	T89P-19623-FH
Shaft Seal Protector	T89P-19623-CH
Differential Side Bearing Puller	T77F-4220-B1
Coil Pressing Installer Tool	T89P-19623-EH
Field Coil Replacer	T91L-19623-CH

Removal

1. Remove the A/C compressor from the vehicle following the recommended service procedure.
2. Remove the clutch hub and pulley as described in this section. Note the location of coil electrical connection for proper orientation during compressor clutch coil installation.
3. Install Shaft Protector for Coil Remover T89P-19623-FH on the nose opening of the A/C compressor.
4. Install a Differential Side Bearing Puller T77F-4220-B1 or equivalent on the compressor. Place the tip of the puller forcing screw in the center pilot of the shaft protector and the jaws of the puller around the back edge of the A/C clutch field coil.
5. Tighten the puller forcing screw to pull the A/C clutch field coil from the compressor head. DO NOT USE AIR TOOLS.



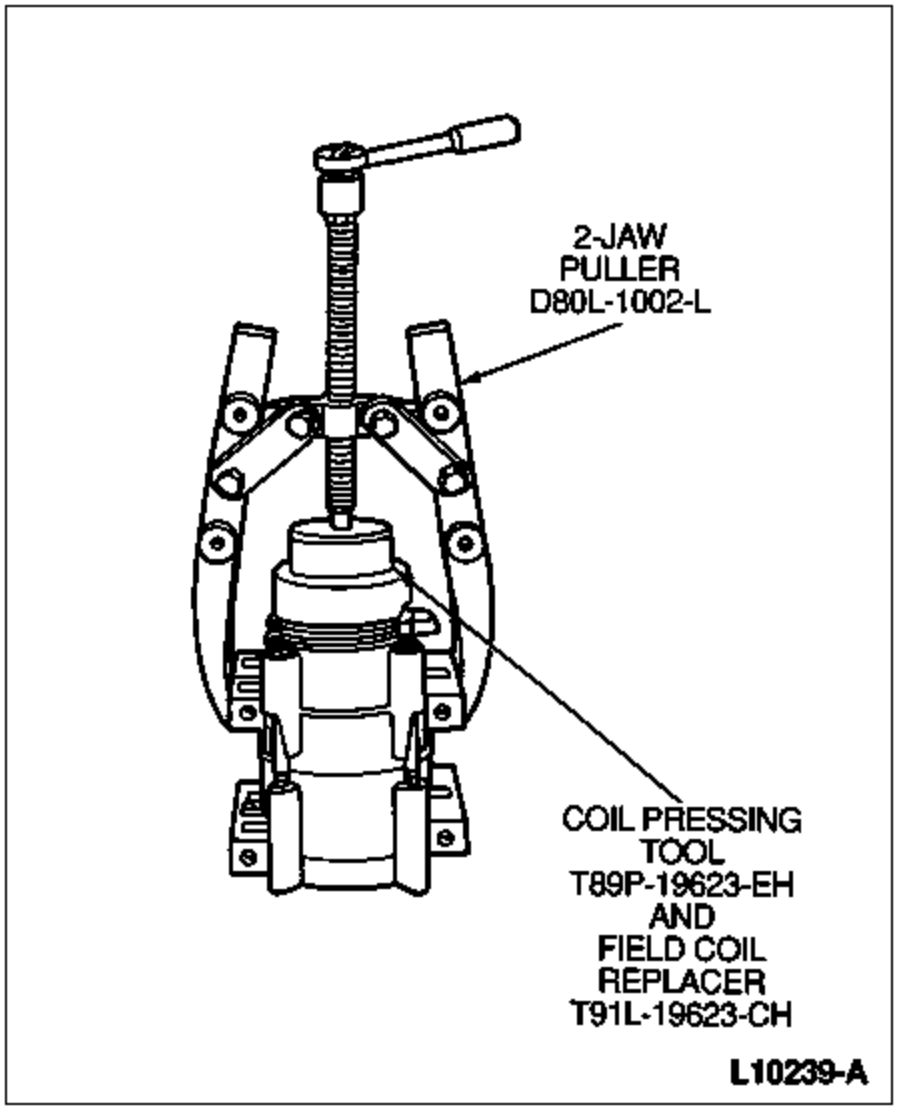
Installation

1. Clean the mounting surface on the front head to remove any dirt or corrosion.

2. With the A/C compressor in a vertical position (nose up), place the A/C clutch field coil in position on the compressor front head. Make sure the electrical connector is positioned correctly.

3. Place the Coil Pressing Tool T89P-19623-EH and Field Coil Replacer T91L-19623-CH in position over the compressor nose and to the inner radius of the A/C clutch field coil.

4. Position 2-Jaw Puller Tool D80L-1002-L or equivalent on the compressor and the Coil pressing tool. The jaws of the puller should be firmly engaged with the rear side of the compressor front mounts. The forcing screw must be piloted on the center mark of the pressing tool.



5. Tighten the forcing screw with a hand wrench until the A/C clutch field coil is pressed on the compressor front head. DO NOT USE AIR TOOLS. Check to make sure that the A/C clutch field coil bottoms against the head at all points around the outer diameter.

6. Install the clutch pulley and hub on the A/C compressor as outlined. Adjust the air gap, as necessary.

7. Install the compressor on the vehicle following the recommended procedure.

Shaft Seal

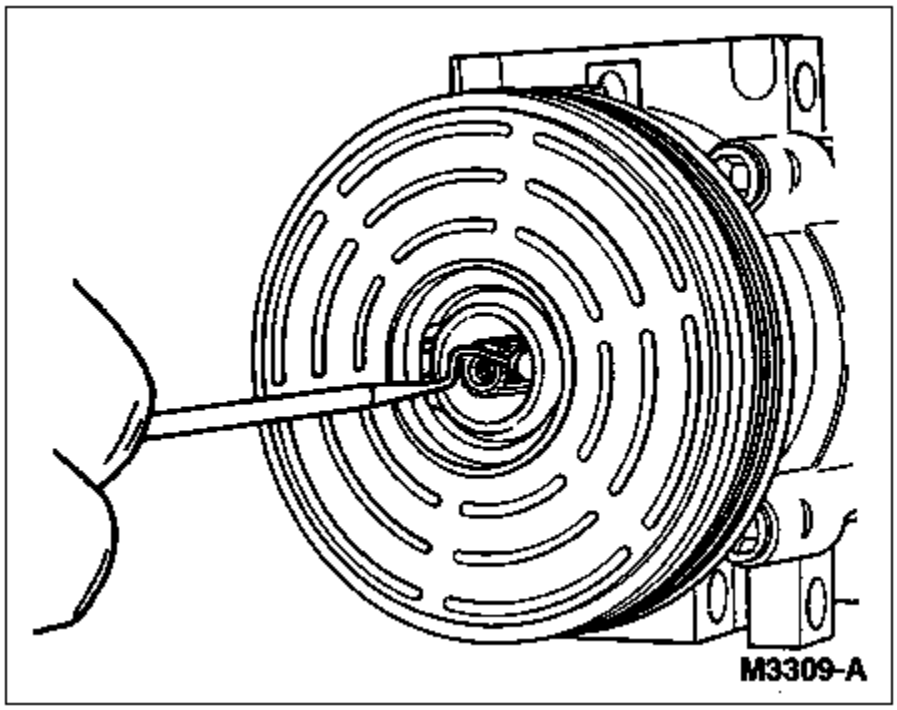
The refrigerant system must be discharged and the compressor must be removed from the vehicle prior to replacing the compressor shaft seal. Refer to Section 12-00 for discharging procedures and to Section 12-03A for Compressor Removal.

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Snap Ring Remover	T89P-19623-DH
Shaft Seal Remover	T89P-19623-BH
Shaft Seal Replacer	T89P-19623-AH
Shaft Seal Protector	T89P-19623-CH

Removal

1. Remove clutch hub from compressor as outlined.
2. Remove shaft seal felt from nose of compressor.



3. Blow any debris from inside the compressor nose with **low pressure** compressed air. Then clean the

inside and outside nose area of the compressor with a lint free cloth to remove any oil and dirt.

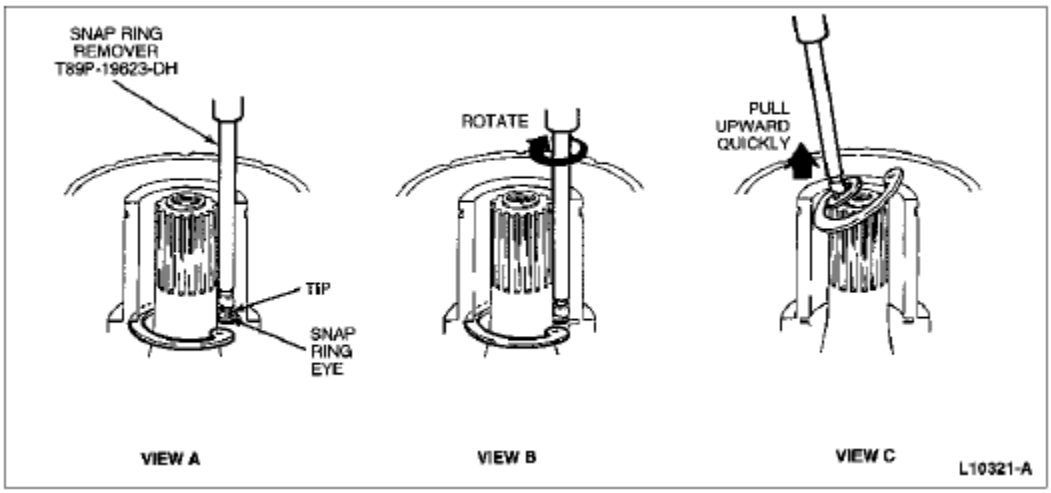
4. Remove shaft seal retaining snap ring from inside compressor nose with Snap Ring Remover T89P-19623-DH as described in the following steps. Refer to the illustrations.

5. Insert the tip of the Snap Ring Remover T89P-19623-DH into one of the snap ring eyes (View A).

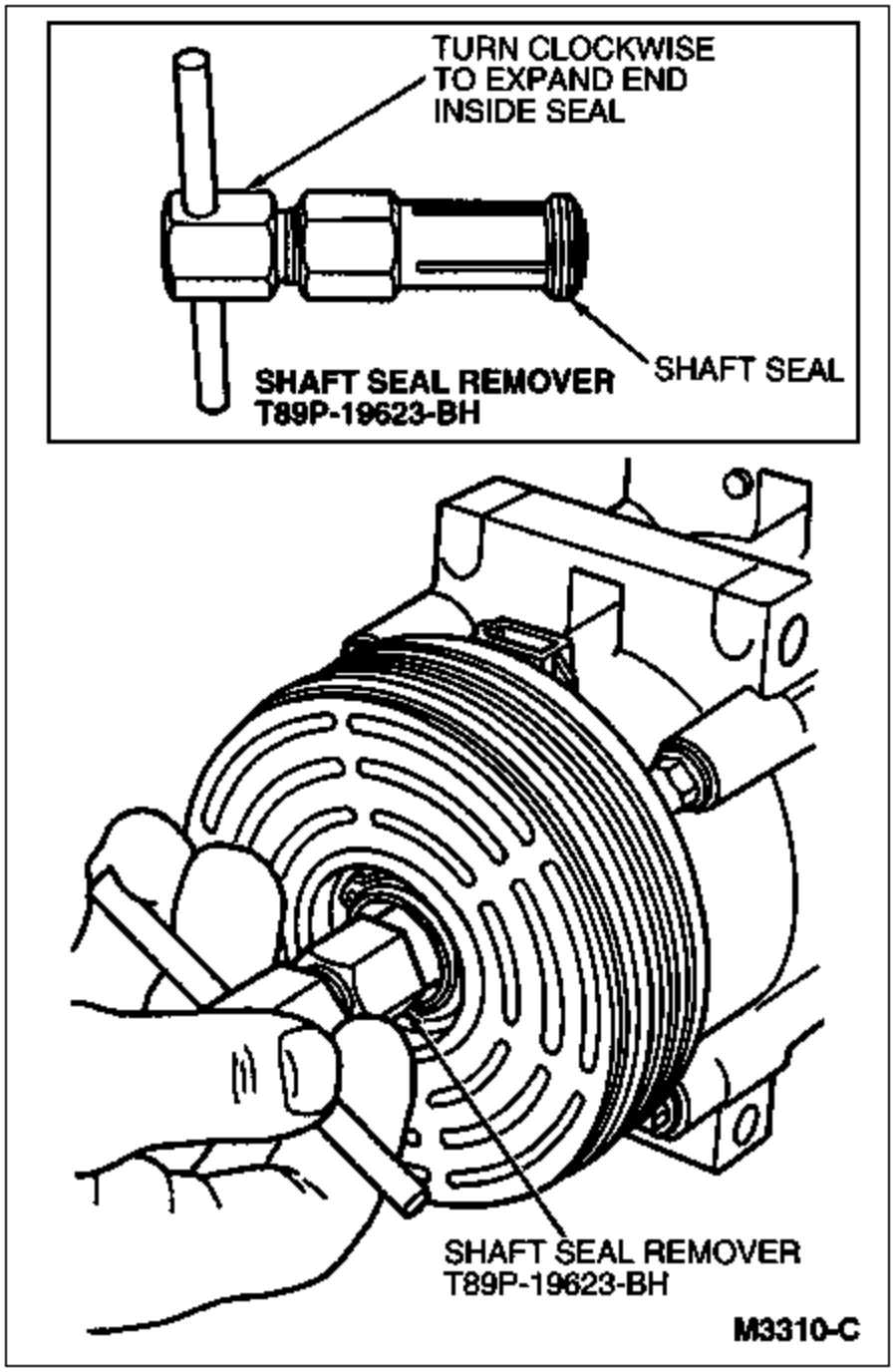
6. Rotate the snap ring remover to position the tool tip and the snap ring eye closest to the compressor shaft (View B).

7. Pull the snap ring remover up quickly while keeping the tool shaft against the side of the nose opening and remove the snap ring (View C).

Snap Ring Removal



8. Position Shaft Seal Remover T89P-19623-BH over compressor shaft and push tool into nose of compressor and down against shaft seal. Engage end of tool with internal diameter of shaft seal. While holding the hex part of the tool, turn tool handle clockwise to expand tool tip inside seal inner radius. Then, pull shaft seal from the A/C compressor (19703) with the tool.



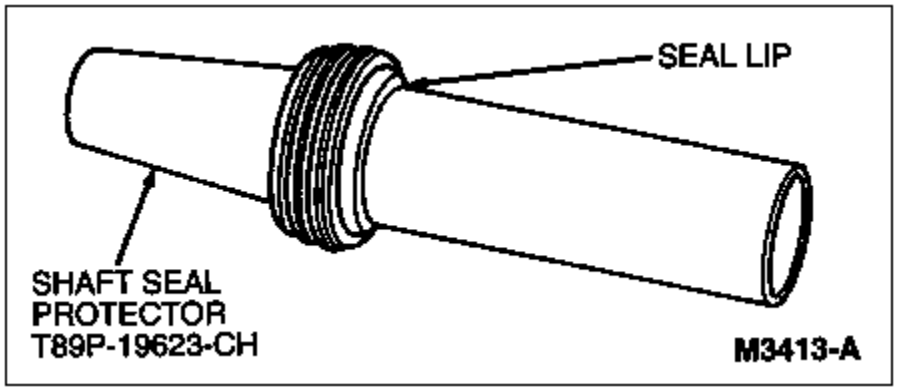
Installation

1. Obtain a new Shaft Seal Kit (Basic Part No. 19D665). Carefully remove the contents of the kit from the package. A plastic shaft seal protector is included with each kit. Inspect the protector for any burrs or other damage. Do not use the protector if it is damaged. Obtain another shaft seal kit, if necessary, and use the protector from it.

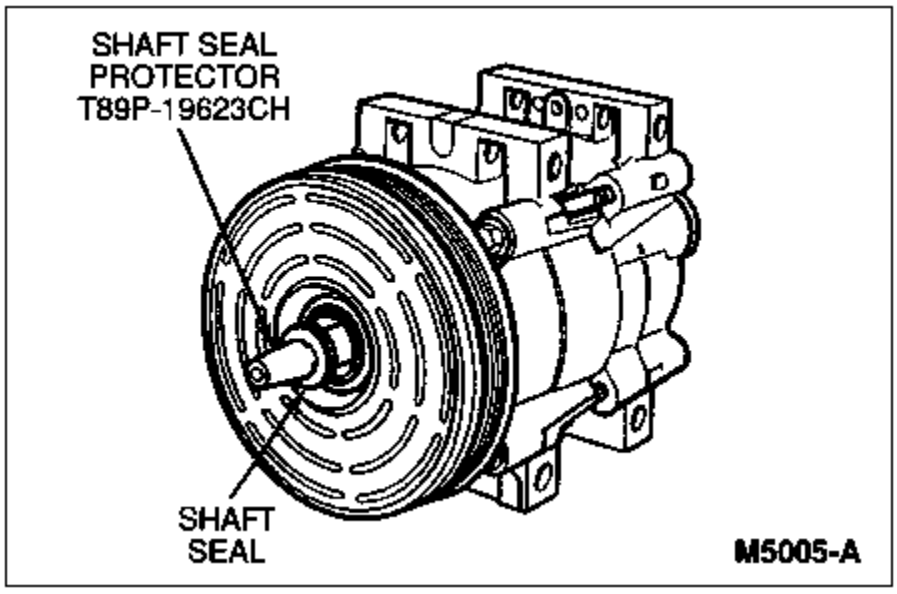
2. **CAUTION: Do not allow any dirt or foreign materials to enter the compressor.**

Using a clean lint free cloth, clean the compressor shaft and the seal pocket inside the compressor nose.

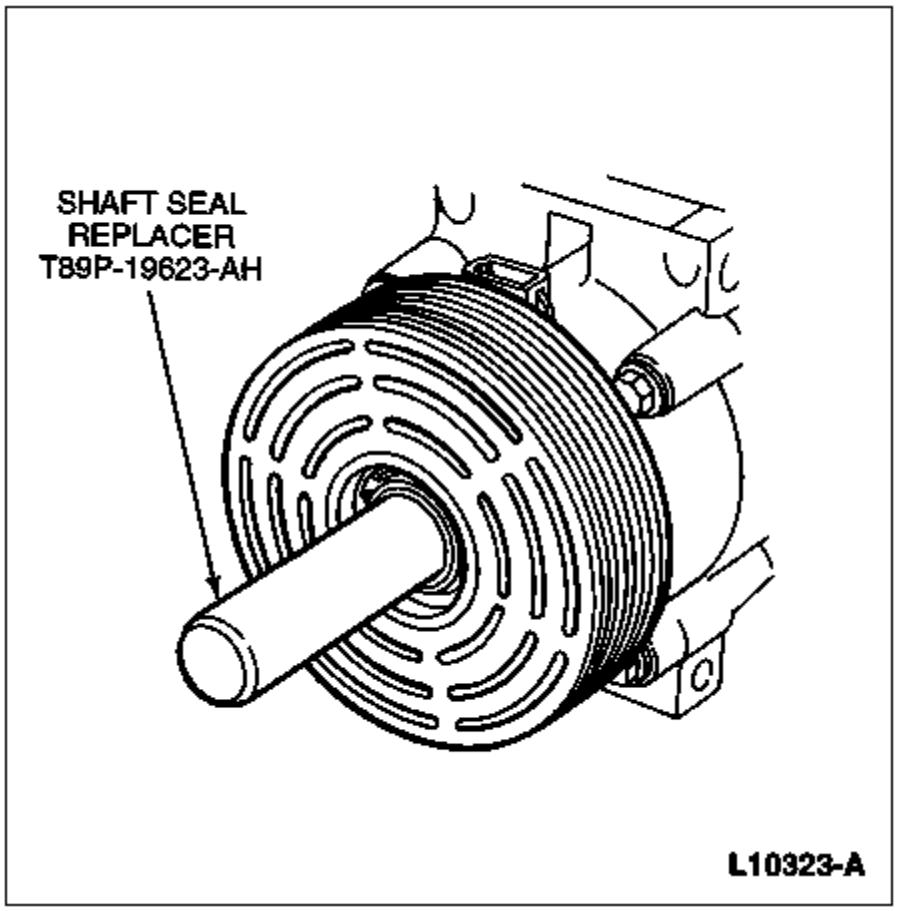
3. Dip the shaft seal protector T89P-19623-CH and shaft seal in clean Refrigerant Oil E73Z-19577-A or equivalent. Position the shaft seal on the protector with the lip of the seal pointing toward the large end of the protector as shown.



4. Place the shaft seal protector with shaft seal over the end of the compressor shaft.



5. Using Shaft Seal Replacer T89P-19623-AH, carefully push seal down shaft protector onto compressor shaft until seated.



6. Remove installer tool and shaft protector from compressor shaft.
7. Place a new shaft seal retaining snap ring into the compressor nose opening and seat the snap ring into the groove.
8. Leak test the shaft seal installation after rotating the compressor shaft about ten revolutions with the clutch hub. Refer to Section 12-00 .
9. Install a new shaft seal felt in nose of compressor.
10. Install clutch hub on compressor as outlined.
11. Check and adjust the air gap as necessary.

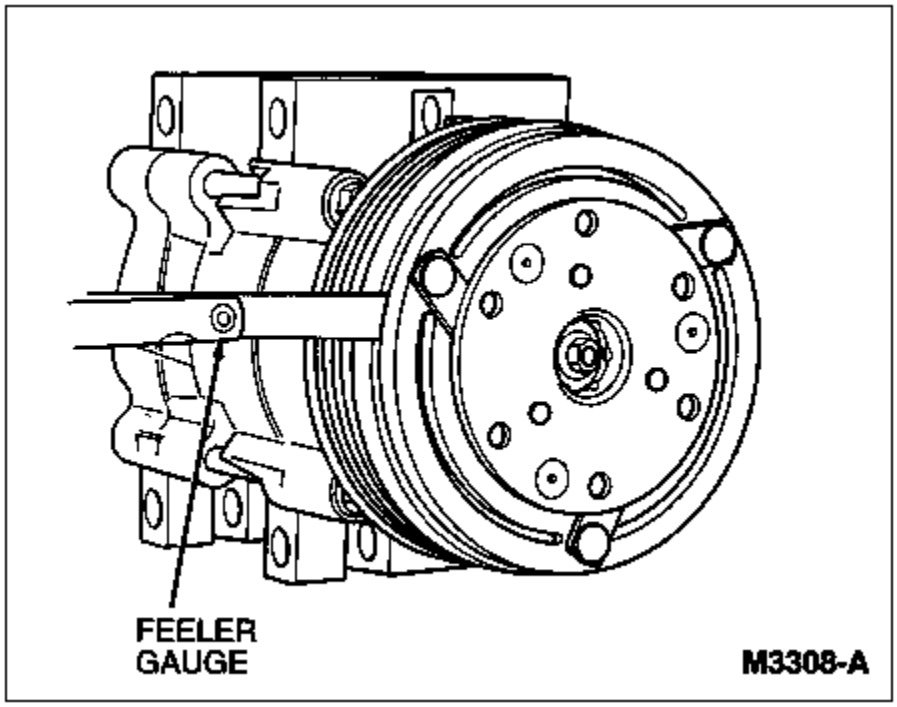
A/C Clutch Air Gap

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Spanner Wrench	T70P-4067-A
Compressor Clutch Holding Tool (4.0L)	T94P-19703-AH

Before disassembling A/C compressor (19703) for repair, it is important to check the A/C clutch air gap. This will help determine if the clutch is not engaging, or if the A/C compressor is failing internally.

1. Check A/C clutch air gap between clutch hub and pulley mating surfaces with a feeler gauge. The air gap should be between 0.35 and 0.85mm (0.014 and 0.033 inch). Check at three locations equally spaced around the pulley.

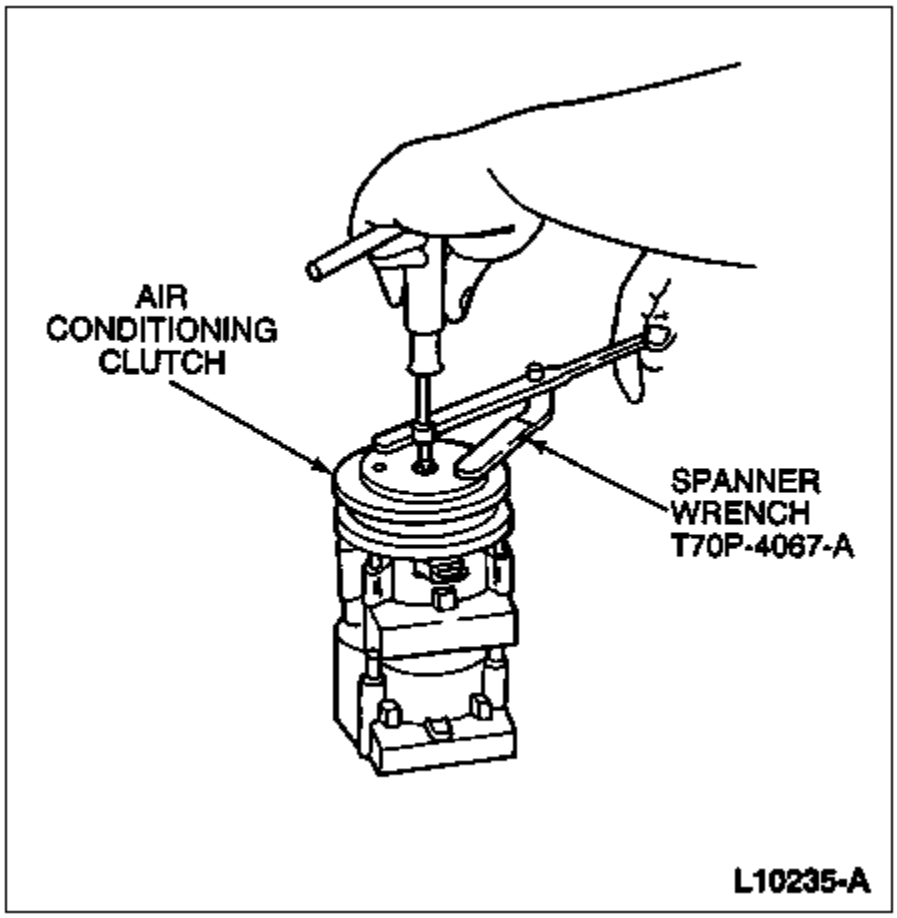


2. **NOTE: If desired gap is not attainable with the available shims, clutch disc and pulley should be inspected for wear or damage. Replace as required.**

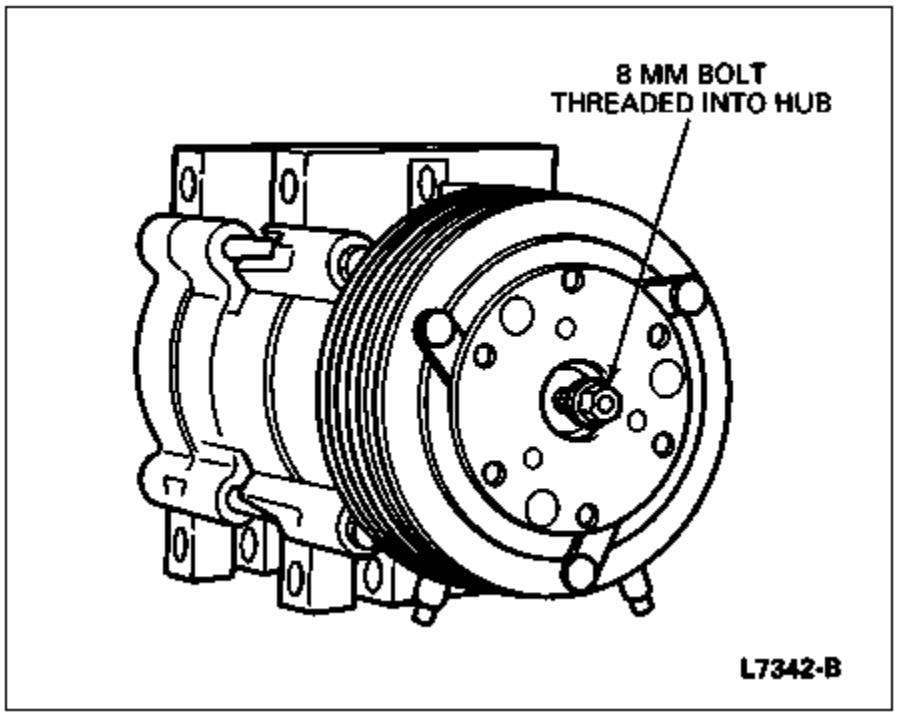
   If A/C clutch air gap is not within specification, use the following steps to adjust air gap.

3. Use Spanner Wrench T70P-4067-A to (or Compressor Clutch Holding Tool T94P-19703-AH for 4.0l.) hold the A/C clutch disc and hub assembly in position while removing the clutch bolt.

2.3l and 3.0l Shown; 4.0l Similar



4. Pull the A/C clutch (2884) and shims from the A/C compressor shaft. If the A/C compressor clutch disc and hub assembly cannot be removed, screw an 8mm bolt into the clutch pulley hub to force the A/C compressor clutch from the shaft.

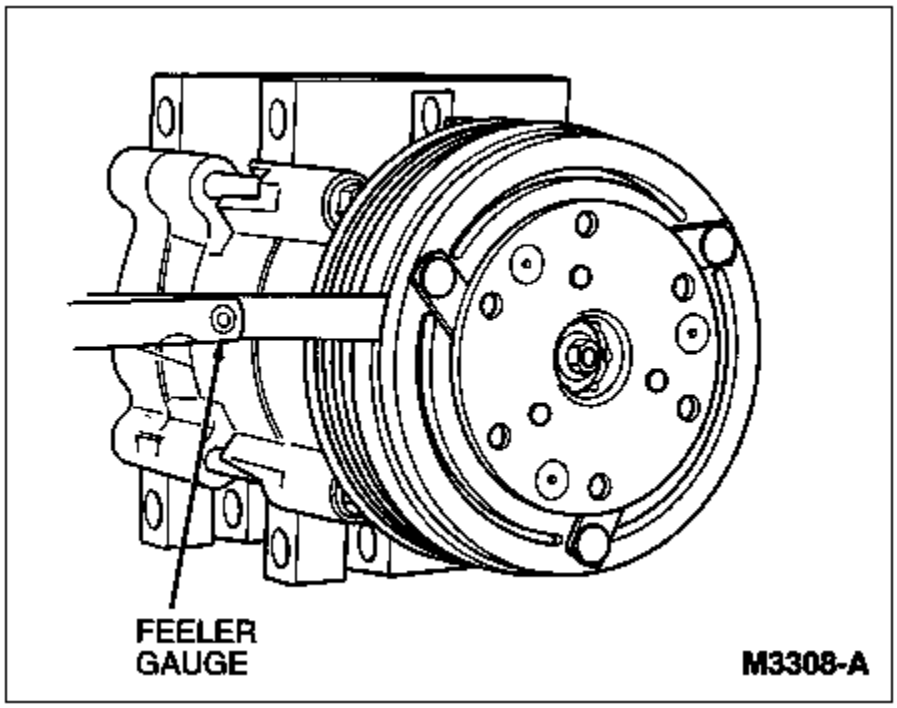


5. Start by placing the nominal thickness shim on the end of the splined shaft and slide the A/C compressor clutch disc and hub assembly onto the end of the A/C compressor shaft.

6. **CAUTION: Do not use air tools to tighten the bolt.**

   Install the clutch bolt into the end of the compressor shaft. Use Spanner Wrench T70P-4067-A (or Compressor Clutch Holding Tool T94P-19703-AA for 4.0l.) to hold the A/C clutch disc and hub assembly in position while tightening the clutch bolt. Tighten the A/C clutch bolt to 11-14 Nm (8-10 lb-ft).

7. Recheck A/C clutch air gap between clutch disc and pulley mating surfaces with a feeler gauge. The air gap should be between 0.35 and 0.85mm (0.014 and 0.033 inch). Check at three locations equally spaced around the pulley.



8. If A/C clutch air gap is not within specification, repeat Steps 3 through 7. Install the correct shim to achieve the desired air gap.

SPECIFICATIONS

A/C COMPRESSOR SPECIFICATIONS

Description	Specification
Type	Swashplate, 5 Double Acting Pistons — Axial Type
Displacement	10.4 CID (170cc)
Cylinder Bore (Dia.)	29.0mm (1.14 Inch)
Stroke	25.7mm (1 Inch)
Rotation	Clockwise
Rotational Torque (Maximum, manifold removed)	10 Nm (7 Lb-Ft)
Refrigerant Oil Ford Specification	WSH-M1C231-B R-134a
Capacity (System Total)	207ml (7 Ounces)
	295ml (10 Ounces) with Auxiliary A/C
Part Number R-134a	F2AZ-19577-AC Motorcraft YN-12-B
Magnetic Clutch Air Gap Between Pulley and Hub	0.35mm-0.85mm (0.014-0.033 Inch)
Current Draw	4.36 Amps @ 12.8 Volts
Runout (Maximum)	.5mm (0.02 Inch) — Radial or Axial

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft
Hose and Manifold Assembly to Compressor Bolt	18-23	13-17
Clutch Hub Bolt	11-14	8-10

Instrument Cluster and Panel Lighting

Ranger

The instrument cluster (10849) and panel lighting are powered through the headlamp switch (11654) and pulse width module. The instrument cluster illumination is controlled by the output of the pulse width module.

Theinstrument clusterand panel lighting circuit provides illumination to:

- Heater control (18549)
- Instrument cluster
- Instrument panel ash receptacle (04810)
- Radio chassis.

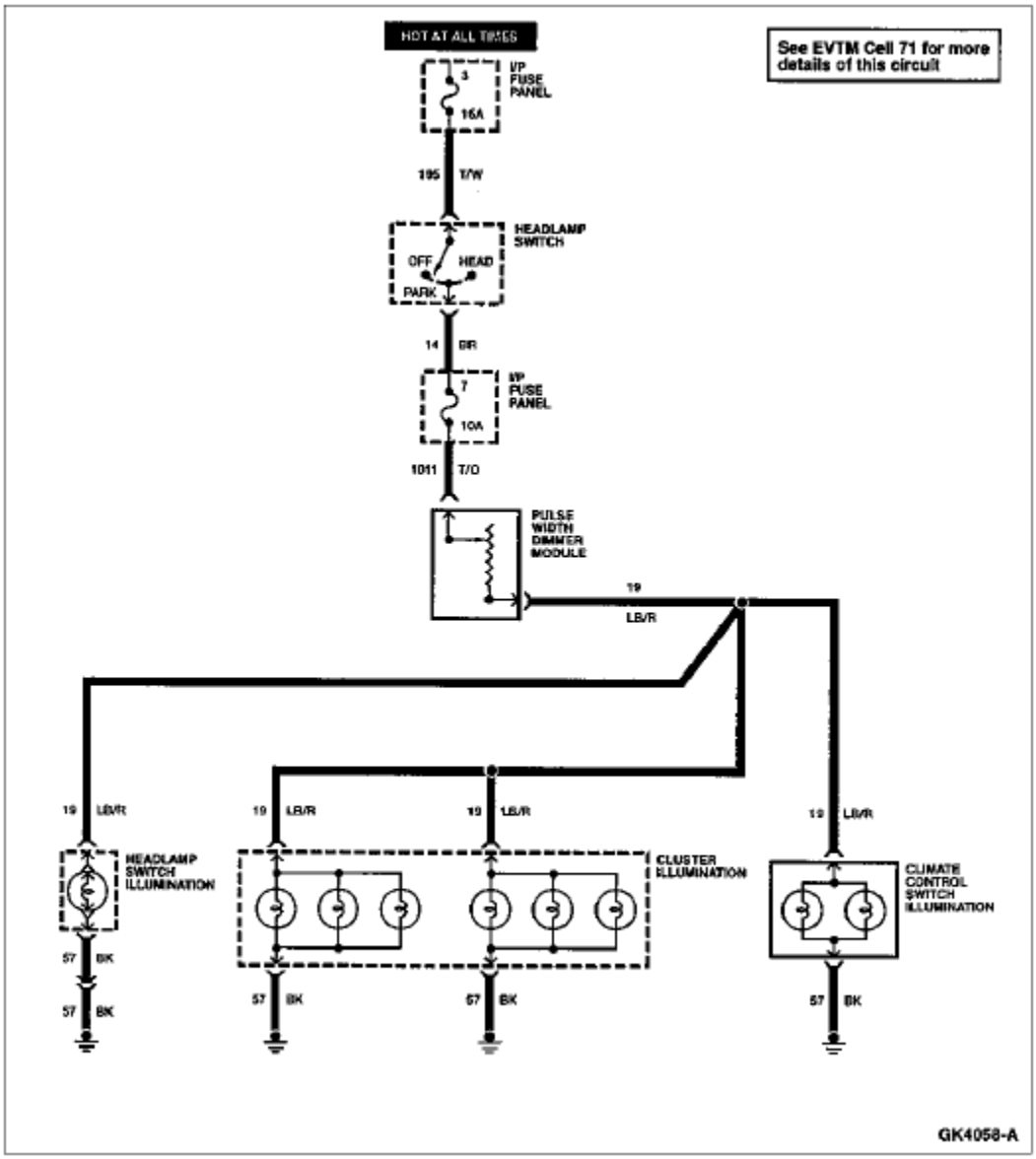
Aerostar

Intensity of illumination is controlled by rotating the headlamp switch knob and shaft (11661) which controls the output of the pulse width module.

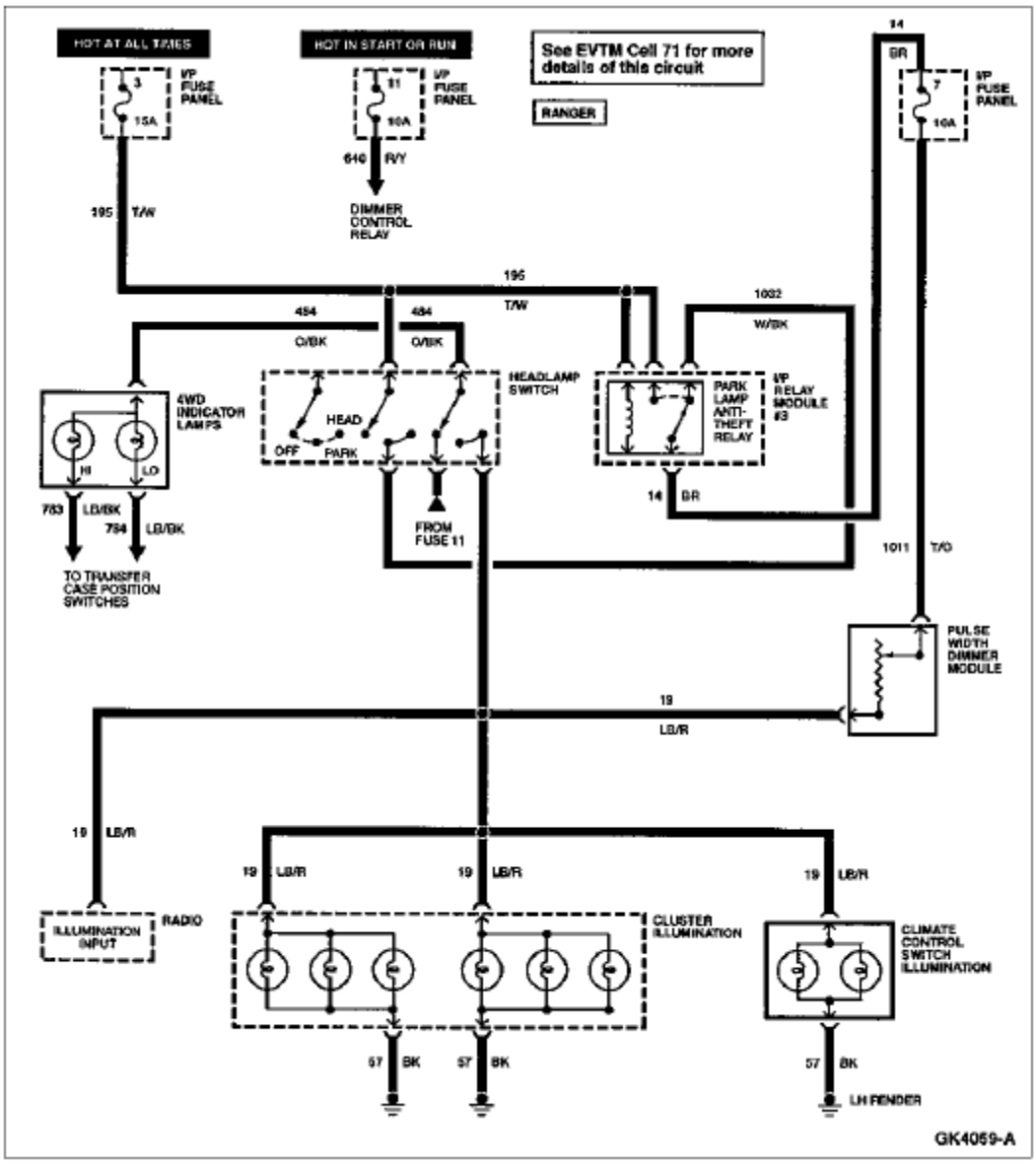
Electrical Schematics

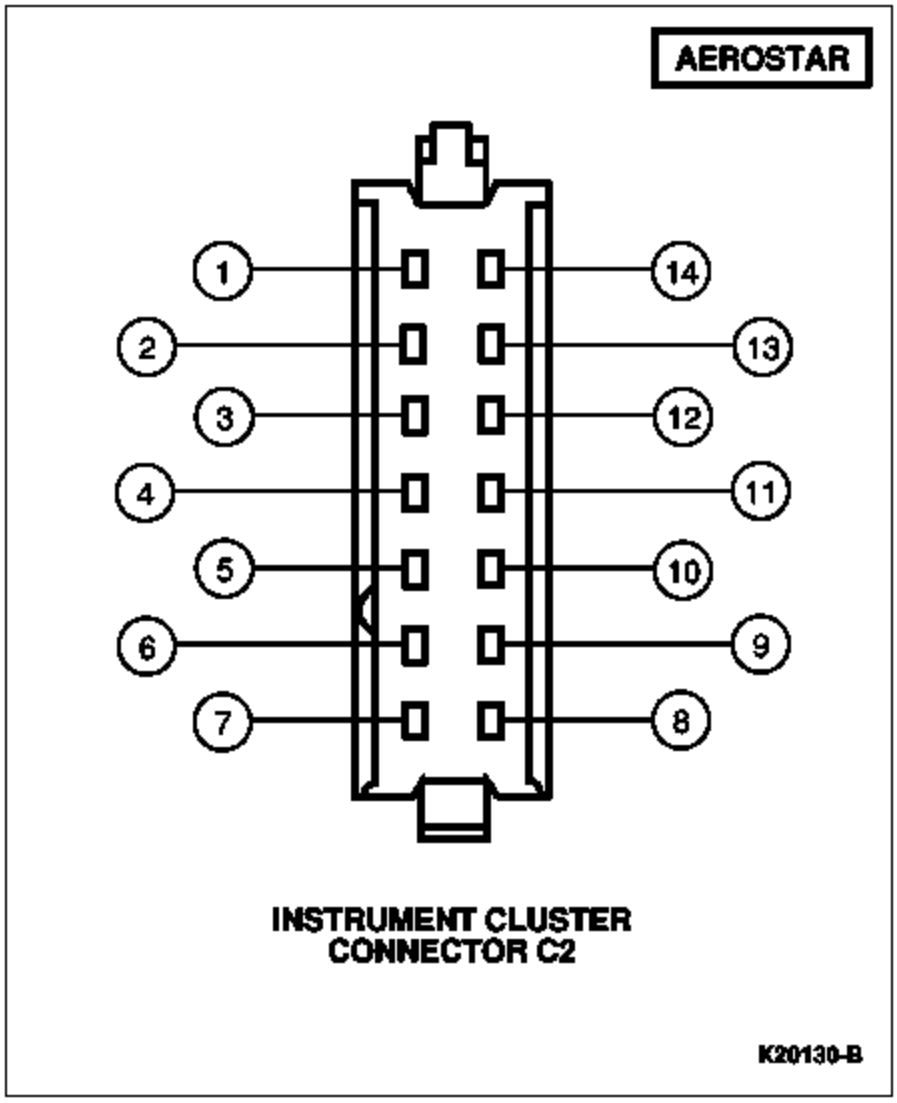
Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent to perform electrical Pinpoint Tests. Refer to Diagnosis and Testing in this section.

Instrument Panel Illumination, Ranger (Without RAP Module)



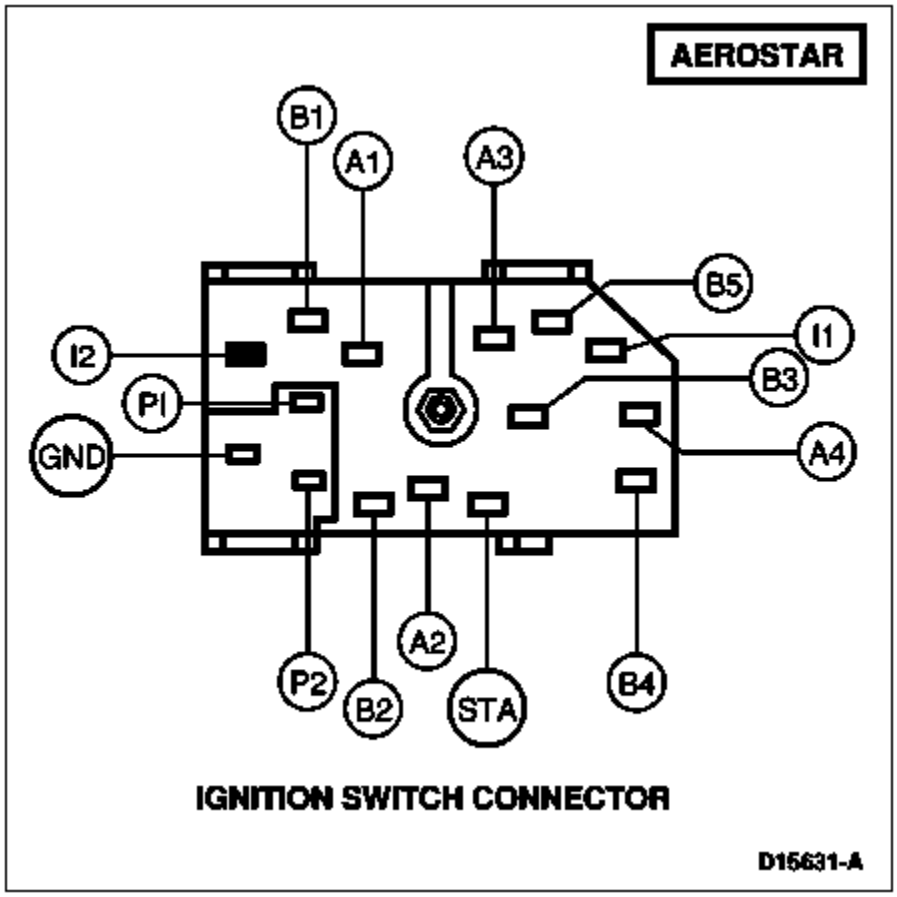
Instrument Panel Illumination, Ranger (with RAP Module)


HOT AT ALL TIMES
HOT IN START OR RUN
See EVTM Cell 71 for more details of this circuit
RANGER
I/P FUSE PANEL
3
15A
11
10A
7
10A
640 R/Y
DIMMER CONTROL RELAY
195 T/W
196 T/W
454 O/BK
454 O/BK
1032 W/BK
14 BR
4WD INDICATOR LAMPS
HI
LO
783 LB/BK
784 LB/BK
TO TRANSFER CASE POSITION SWITCHES
HEADLAMP SWITCH
HEAD
OFF
PARK
FROM FUSE 11
I/P RELAY MODULE #3
PARK LAMP ANTI-THEFT RELAY
1011 T/O
PULSE WIDTH DIMMER MODULE
19 LB/R
RADIO
ILLUMINATION INPUT
CLUSTER ILLUMINATION
CLIMATE CONTROL SWITCH ILLUMINATION
57 BK
LH FENDER
GK4059-A



Pin Number	Circuit	Circuit Function
1	208 (GY)	Check Oil to Low Oil Level Relay
2	640 (R/Y)	Power to Check Oil Indicator
3	932 (GY/W)	Power to High Beam Indicator
4	450 (DG/LG)	Power to Fasten Belts Indicator
5	57 (BK)	Illumination High Beam and Fasten Belts to Ground
6	19 (LB/R)	Power to Illumination
7	57 (BK)	Turn Indicators to Ground
8	397 (BK/W)	Voltmeter to Ground
9	570 (BK)	Fuel Gauge to Ground
10	640 (R/Y)	Power to Gauges, Hot in Start or Run
11	608 (BK/Y)	Air Bag to Air Bag Module

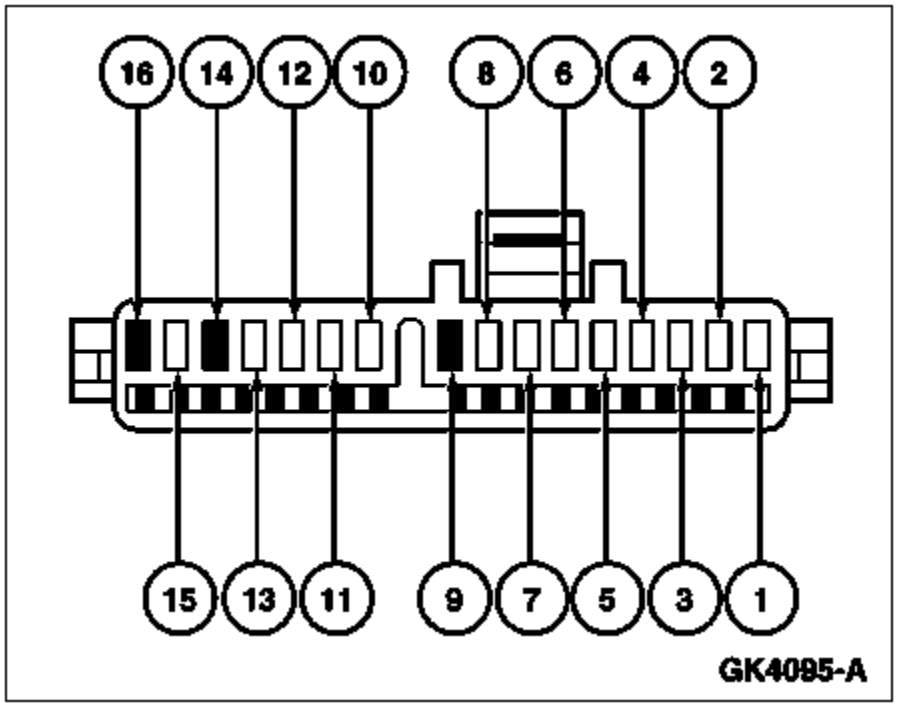
12	994 (W)	Power to Electronic 4WD Indicator
13	57 (BK)	Ground
14	2 (W/LB)	Power to Right Turn Indicator



Pin Number	Circuit	Circuit Function
A1	297 (BK/LG)	Hot in Acc. or Run
A2	687 (GY/Y)	Hot in Run
A3	687 (GY/Y)	Hot in Run
A4	687 (GY/Y)	Hot in Run
B1	37 (Y)	Battery Input
B2	37 (Y)	Battery Input
B3	37 (Y)	Battery Input
B4	37 (Y)	Battery Input
B5	37 (Y)	Battery Input
I1	16 (R/LG)	Hot in Run or Start
I2	—	Not Used

P1	512 (T/LG)	Bulb Test
P2	41 (BK/LB)	Bulb Test with Analog Cluster
GND	57 (BK)	Ground
STA	32 (R/LB)	Starter Control

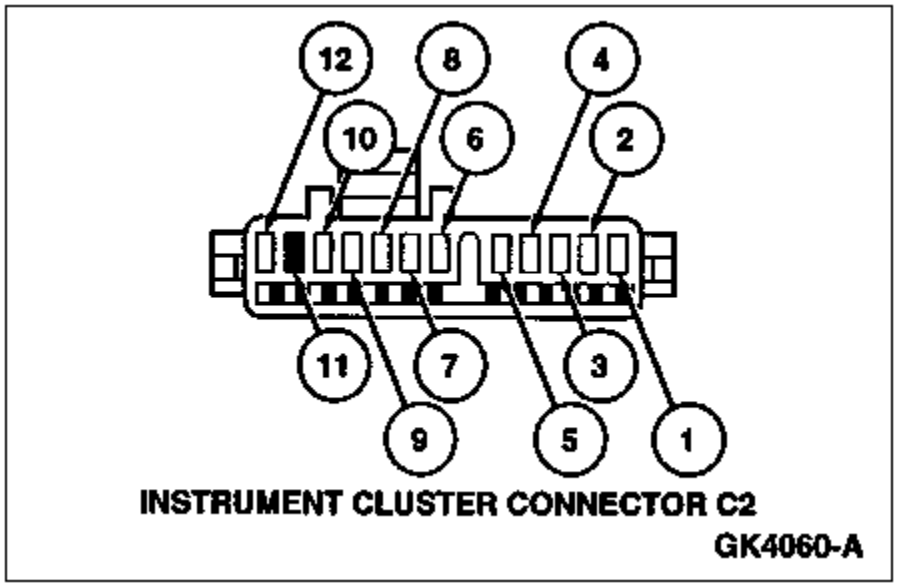
Instrument Cluster Connector C1



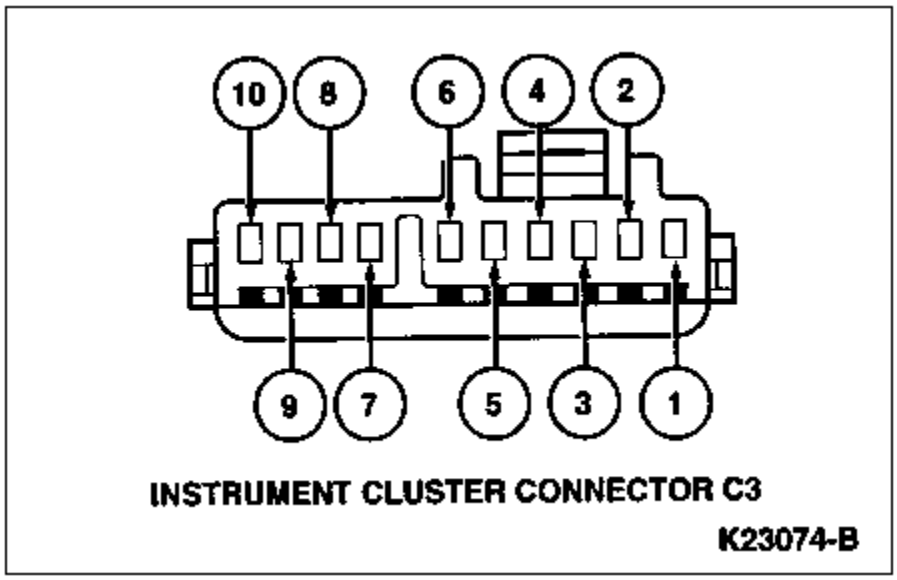
Pin Number	Circuit	Circuit Function
1	911 (W/LG)	EEC Module to Output Circuit Indicator Lamp/Overdrive Cancel Indicator
2	784 (LB/BK)	4x4 Low Range Indicator Ground Input
3	783 (GY)	4x4 High Range Indicator Ground Input
4	203 (O/LB)	Speed Control Indicator Ground Input
5	484 (O/BK)	Headlamp Switch Power Input
6	343 (DB/LG)	Warning Lamp to Anti-Theft Module
7	57 (BK)	Ground
8	19 (LB/R)	Lamp Return to Pulse Width Dimmer Module
9	—	NOT USED
10	2 (W/LB)	RH Front Turn Signal Lamp
11	921 (GY/O)	Inertia Fuel Shutoff Switch (IFS) Ground Input
12	253 (DG/W)	Oil Pressure Sensor

13	640 (R/Y)	Vehicle Power (Hot in Start or Run)
14	—	NOT USED
15	11 (T/Y)	ICM, Tachometer, EDM Signal
16	—	NOT USED

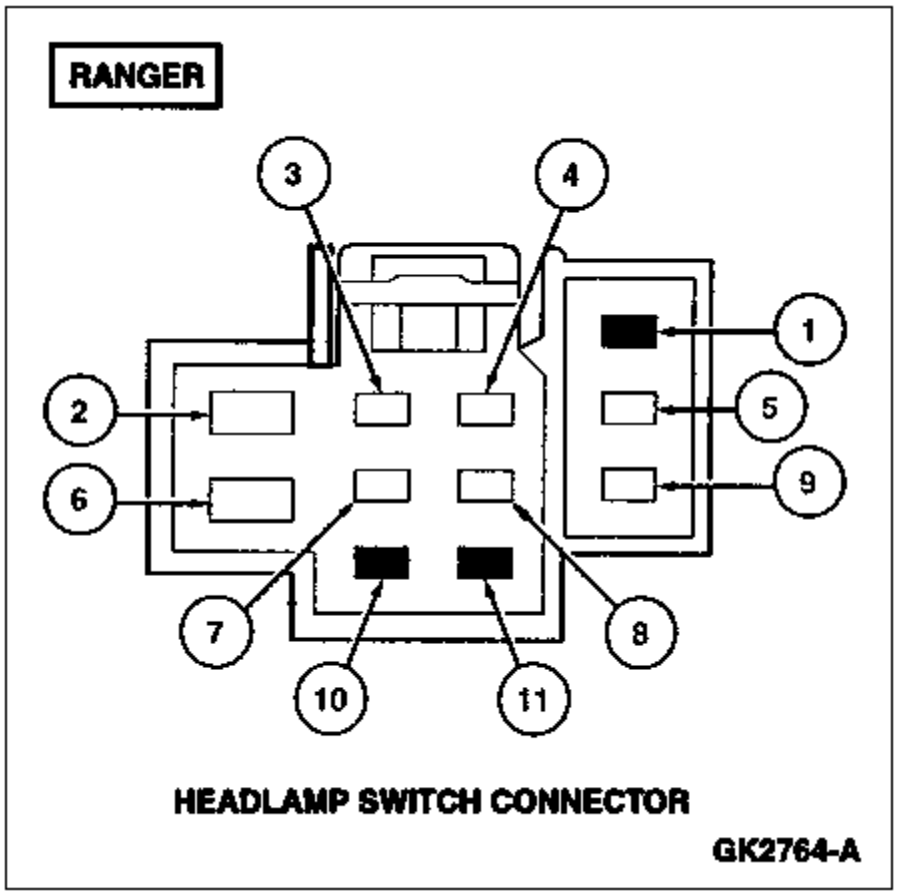
Instrument Cluster Connector C2



Pin Number	Circuit	Circuit Function
1	679 (GY/BK)	Vehicle Speed Sensor (VSS) Signal Input
2	570 (BK/W)	Ground
3	39 (R/W)	Temperature Gauge to Water Temperature Indicator Sender Unit
4	19 (LB/R)	Lamp Return to Pulse Width Dimmer Module
5	3 (LG/W)	LH Turn Signal Lamp Power
6	932 (GY/W)	High Beam Indicator Lamp Power
7	57 (BK)	Ground
8	640 (R/Y)	Warning Lamp Feed (Hot in Start or Run)
9	658 (PK/LG)	Malfunction Indicator Lamp (MIL) Ground Input
10	627 (BK/O)	Door Ajar Indicator Lamp to GEM
11	—	NOT USED
12	29 (Y/W)	Fuel Gauge to Fuel Gauge Sender

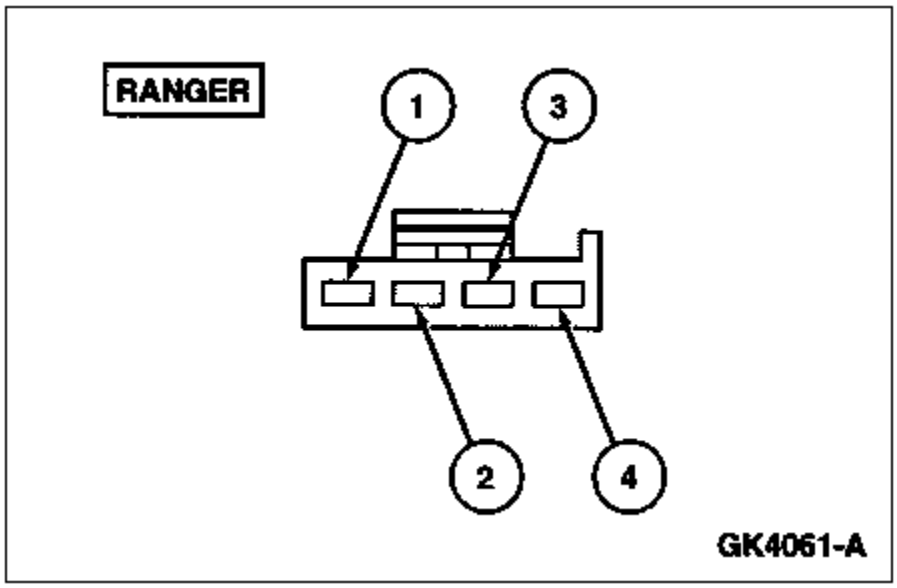


Pin Number	Circuit	Circuit Function
1	640 (R/Y)	Warning Lamps Feed (Hot in Start or Run)
2	584 (Y)	Alternator Lamp/Air Bag Lamp Feed (Hot in Start or Run)
3	904 (LG/R)	Ignition Switch "COIL"/"ACC" to Voltage Regulator "IGN" Terminal
4	608 (BK/Y)	Air Bag Diagnostic Lamp Driver
5	977 (P/W)	Brake Warning Switch to Indicator Lamp
6	603 (DG)	Anti-Lock Brake Lamp to Module
7	1001 (W/Y)	Speedometer Battery Power
8	398 (BK/Y)	Ground to Tachometer/Gauge Module Through 4.32 Kohms Resistor (4.0L Only)
9	—	NOT USED
10	871 (Y)	Seat Belt Indicator Lamp to GEM Module



Pin Number	Circuit	Circuit Function
1	—	NOT USED
2	15 (R/Y)	Pulse Width Dimmer Module Feed
3 [a]	1032 (W/BK)	Headlamp Switch to Tail Lamps and Side Marker Lamps
4	640 (R/Y)	Warning Lamps Feed
5	195 (T/W)	Tail Lamp Switch Feed
6	196 (DB/O)	Headlamp Flash to Pass Switch Feed
7	57 (BK)	Ground
8	484 (O/BK)	4x4, Speed Control, Overdrive Indicator
9	19 (LB/R)	Instrument Panel Lamps Feed
10	—	NOT USED
11	—	NOT USED

[a] Note: Pin 3 is Circuit 1032 (W/BK) for anti-theft park lamp switch to module.



Pin Number	Circuit	Circuit Function
1	1011 (T/O)	Pulse Width Dimmer Module — Fused Feed
2	705 (LG/O)	Battery Saver Lamp Feed
3	19 (LB/R)	Instrument Panel Lamps Feed
4	55 (BK/PK)	Cargo Lamp Switch to Cargo Lamp/Dome Lamp

Inspection and Verification

1. Verify the vehicle owner's original concern by operating the headlamp switch (11654) in the PARK position with the headlamp switch knob and shaft (11661) rotated fully counterclockwise without turning on courtesy lamps to duplicate the condition.

2. Inspect to determine if any of the following electrical concerns apply:

    - Fuse
    - Circuit wiring
    - Headlamp switch

3. If the concern(s) remain after the inspection, determine the symptoms and proceed to the following Symptom Chart.

Symptom Chart — Instrument Cluster And Panel Lighting

INSTRUMENT CLUSTER AND PANEL LIGHTING

Condition	Possible Source	Action
• Control Illumination Inoperative	• Fuse. • Headlamp switch. • Circuit wiring.	• GO to Pinpoint Test A .
• Instrument Panel Illumination Does Not Dim	• Headlamp switch.	• GO to Pinpoint Test B .
• Instrument Cluster Illumination Inoperative	• Circuit wiring. • Illumination bulbs. • Instrument cluster printed circuit.	• GO to Pinpoint Test C .
• Climate Control Illumination Inoperative	• Circuit wiring. • Illumination bulbs.	• GO to Pinpoint Test D .
• Audio System Illumination Inoperative	• Circuit wiring. • Illumination bulbs.	• GO to Pinpoint Test E .
• Single Illumination Source Inoperative	• Circuit wiring. • Illumination bulbs.	• GO to Pinpoint Test F .

Pinpoint Tests

PINPOINT TEST A: CONTROL ILLUMINATION INOPERATIVE

A1 CHECK FUSE

- Check fuse 7 (10A) (Ranger) or 13 (5A) (Aerostar) located in the I/P fuse panel.

Is the fuse OK?

Yes	No
GO to **A4** .	GO to **A2** .

A2 CHECK SYSTEM

- Key OFF.
- Replace fuse 7 (10A) (Ranger) or 13 (5A) (Aerostar).

Does the fuse fail again?

Yes	No
GO to **A3** .	GO to **A4** .

A3 CHECK FOR SHORT TO GROUND

- Key OFF.
- Remove fuse 7 (Ranger) or 13 (Aerostar).
- Measure the resistance of the "T/O" (Ranger) or "LB/R" (Aerostar) wire between the RH terminal of fuse 7 or 13 and ground.

Is the resistance less than 5 ohms?

Yes	No
SERVICE the "T/O" wire.	REPLACE fuse 7 or 13. GO to **A4** .

A4 CHECK POWER SUPPLY TO HEADLAMP SWITCH

- Key OFF.
- Reconnect fuse 7 or 13.
- Disconnect the headlamp switch connector located on the instrument cluster.
- Measure the voltage on the "T/W" wire at the headlamp switch connector.

Is the voltage greater than 10 volts?

Yes	No
GO to **A5** .	SERVICE the "T/W" wire.

A5 CHECK HEADLAMP SWITCH

- Key OFF.
- Disconnect the headlamp switch connector.
- Headlamp switch OFF.
- Measure the resistance between the "T/W" wire terminal and the "BR" (Ranger) or "LB/R" (Aerostar) wire terminal on the headlamp switch.
- Headlamp switch in the parking lamp position.
- Measure the resistance between the "T/W" wire terminal and the "BR" (Ranger) or "LB/R" (Aerostar) wire terminal on the headlamp switch. Rotate the panel dimmer switch while performing this test (Aerostar Only).

Is the resistance less than 5 ohms with the headlamp switch in the parking lamp position, (Ranger), vary with the dimmer control being rotated, (Aerostar), and greater than 10,000 ohms with the headlamp switch in the OFF position?

Yes	No
Aerostar, REPAIR the "LB/R" wire; Ranger, GO to **A6** .	REPLACE the headlamp switch.

A6 CHECK POWER SUPPLY TO PULSE WIDTH MODULE

- Key OFF.
- Reconnect the headlamp switch connector.
- Disconnect the pulse width module connector.
- Headlamp switch in the parking lamp position.
- Measure the voltage on the "T/O" wire at the pulse width module connector.

Is the voltage greater than 10 volts?

Yes	No
GO to **A7** .	SERVICE the "T/O" wire.

A7 CHECK PULSE WIDTH MODULE

- Key OFF.

- Reconnect the pulse width module connector.
- Headlamp switch in PARK or HEAD.
- Probe "LB/R" wire.

Is the voltage greater than 10 volts?

Yes	No
System OK.	REPLACE the pulse width module.

PINPOINT TEST B: INSTRUMENT PANEL ILLUMINATION DOES NOT DIM

B1 TEST SYSTEM

- Headlamp switch to PARK position.
- Rotate dimmer control from fully clockwise to fully counterclockwise.

Does instrument panel illumination dim?

Yes	No
System OK.	GO to **B2** .

B2 TEST PULSE WIDTH MODULE

- Headlamp switch in PARK or HEAD.
- Turn the pulse width module dial to the bright position.
- Probe voltage between Circuit 19 (LB/R) and a known good ground.
- Slowly turn the dial toward the dim position while watching the voltage indicated.

Does the voltage drop from the bright position to the dim position?

Yes	No
System OK.	REPLACE pulse width module.

PINPOINT TEST C: INSTRUMENT CLUSTER ILLUMINATION INOPERATIVE

C1 CHECK CIRCUIT 19 (LB/R) FOR BATTERY VOLTAGE

- Gain access to cluster connectors as outlined in Section 13-01 .
- Actuate headlamp switch to park lamp position.
- Rotate dimmer module control to bright position.
- Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent connected to a known good ground to

check Circuit 19 (LB/R) for voltage.

Is battery voltage present?

Yes	No
GO to **C2** .	SERVICE Circuit 19 (LB/R) for open. RETEST system.

C2 CHECK GROUND CIRCUIT

- Key OFF.
- Disconnect the instrument cluster.
- Check Circuit 57 (BK) for continuity to ground.

Is continuity present?

Yes	No
SERVICE wiring or REPAIR the instrument cluster. RETEST the system.	SERVICE Circuit 57 (BK). RETEST the system.

PINPOINT TEST D: CLIMATE CONTROL ILLUMINATION INOPERATIVE

D1 CHECK POWER SUPPLY TO CLIMATE CONTROL ASSEMBLY

- Key OFF.
- Headlamp switch in the parking lamp position or the headlamp position.
- Rotate dimmer module control to bright position.
- Check Circuit 19 (LB/R) for voltage.

Is the voltage greater than 10 volts?

Yes	No
GO to **D2** .	SERVICE Circuit 19 (LB/R).

D2 CHECK CLIMATE CONTROL ASSEMBLY MINIATURE BULB(S)

- Key OFF.
- Remove the climate control assembly miniature bulb.
- Check the continuity between the terminals of the front climate control assembly miniature bulbs.

Does continuity exist?

Yes	No
	REPLACE the front climate control assembly

GO to **D3** .	miniature bulb(s).

D3 CHECK CLIMATE CONTROL ASSEMBLY GROUND CIRCUIT

- Key OFF.
- Disconnect the climate control assembly connector.
- Check the continuity between Circuit 57 (BK) and ground.

Does continuity exist?

Yes	No
REPLACE the climate control assembly.	SERVICE Circuit 57 (BK).

PINPOINT TEST E: AUDIO SYSTEM ILLUMINATION INOPERATIVE (FRONT AND REAR)

E1 CHECK POWER SUPPLY TO RADIO AND COMPACT DISC PLAYER (IF EQUIPPED)

- Key OFF.
- Disconnect the radio connector.
- Headlamp switch in the parking lamp position or headlamp position.
- Rotate dimmer module control to bright position.
- Measure the voltage on Circuit 19 (LB/R) at the radio connector and/or compact disc player connector.

Is the voltage greater than 10 volts?

Yes	No
GO to **E2** .	SERVICE Circuit 19 (LB/R).

E2 CHECK ILLUMINATION CONTROL CIRCUIT

- Key OFF.
- Disconnect the radio connector.
- Check continuity between Circuit 57 (BK) and ground.

Does continuity exist?

Yes	No
SERVICE the radio at an authorized Ford Audio Service Center.	SERVICE Circuit 57 (BK).

PINPOINT TEST F: SINGLE ILLUMINATION SOURCE INOPERATIVE

F1 DETERMINE SERVICEABILITY OF BULB

- Check continuity of bulb.

Is illumination bulb serviceable?

Yes	No
REPLACE illumination bulb. RESTORE system. RETEST system.	REPLACE component. RESTORE system. RETEST system.

Instrument Cluster (IC), Aerostar

The cluster warning lamps are located in two vertical columns, one on each side of the instrument cluster (10849) and also along the bottom of the instrument cluster. The following indicator lamps are found on the instrument cluster:

Left side, top-to-bottom

- DOOR AJAR
- BRAKE warning
- rear anti-lock brake (REAR ABS)

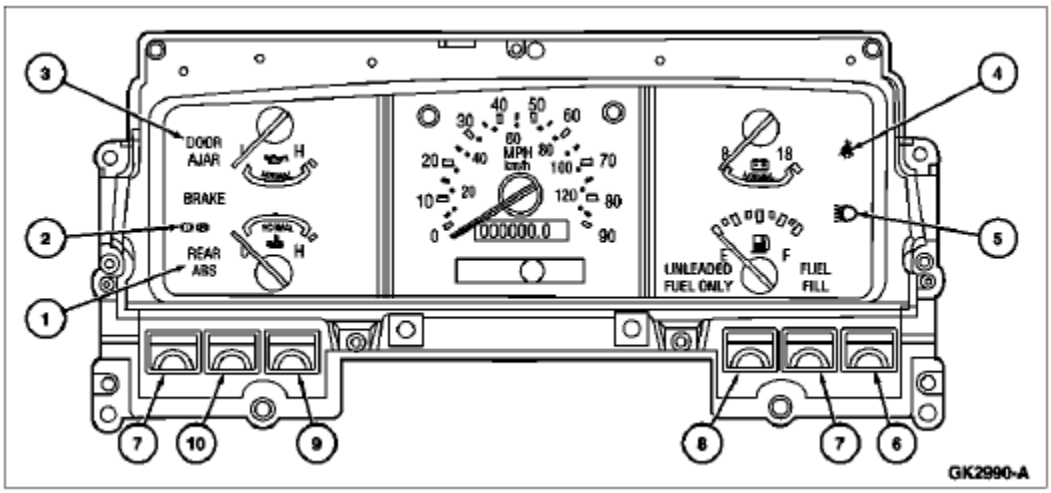
Right side, top-to-bottom

- fasten belts
- high beam

Bottom, left to right

- turn signal
- check engine
- charging system
- electronic 4-wheel drive (only on E-4WD)
- air bag
- turn signal

Instrument Cluster, Aerostar



tomsn048@gmail.com

Item	Part Number	Description
1	—	Rear Anti-Lock Brake (Part of 10849)
2	—	Brake (Part of 10849)
3	—	Door Ajar (Part of 10849)
4	—	Fasten Belts (Part of 10849)
5	—	High Beam (Part of 10849)
6	—	Turn Signal Indicators (Part of 10849)
7	—	Air Bag Readiness Light (Part of 10849)
8	—	Electronic 4-Wheel Drive (Part of 10849)
9	—	Charging System (Part of 10849)
10	—	Check Engine (Part of 10849)

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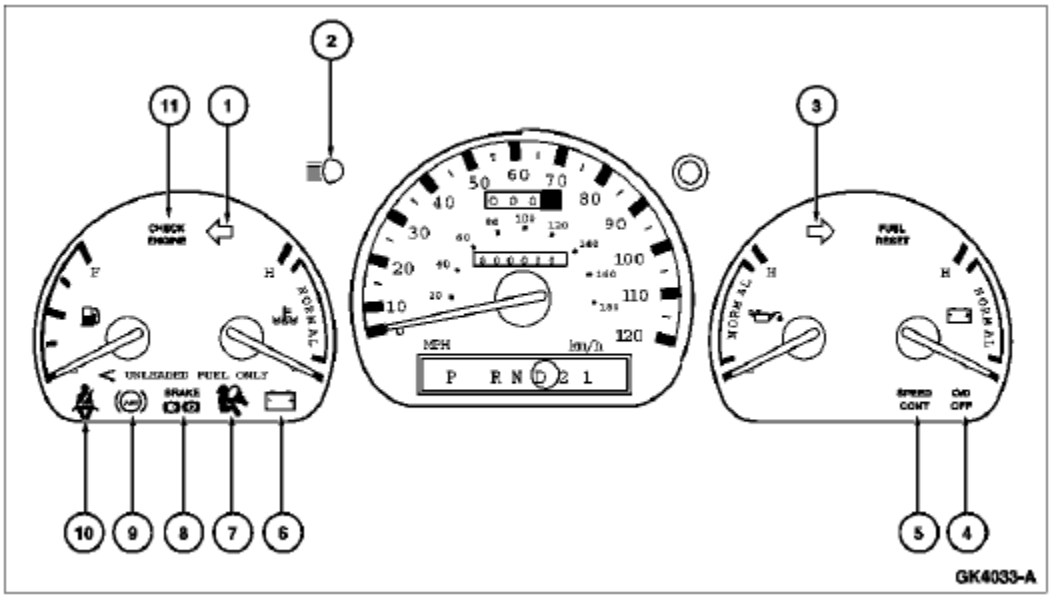
Instrument Cluster (IC), Ranger

The instrument cluster (10849) is available in two versions, standard and tachometer (17360) cluster. Both versions include a voltage indicator gauge (10A835), engine coolant temperature gauge (10883), fuel gauge (9280), and oil pressure gauge (9273) with an odometer (17A265) and tripometer as standard. The standard and tachometer clusters are available for the Ranger with the tachometer cluster. Warning indicators are provided as follows:

- Safety belt
- Air bag
- CHECK ENGINE
- O/D off
- Anti-theft (Tach only)
- Brake
- Anti-lock
- High beam
- Left turn signal
- Right turn signal
- FUEL RESET (Tach only)
- 4WD low range (Tach only)
- 4x4/AWD (Tach only)
- Door ajar (Tach only)
- Check gauge (Tach only)
- Speed control (Tach only)

Instrument Cluster (Base), Ranger



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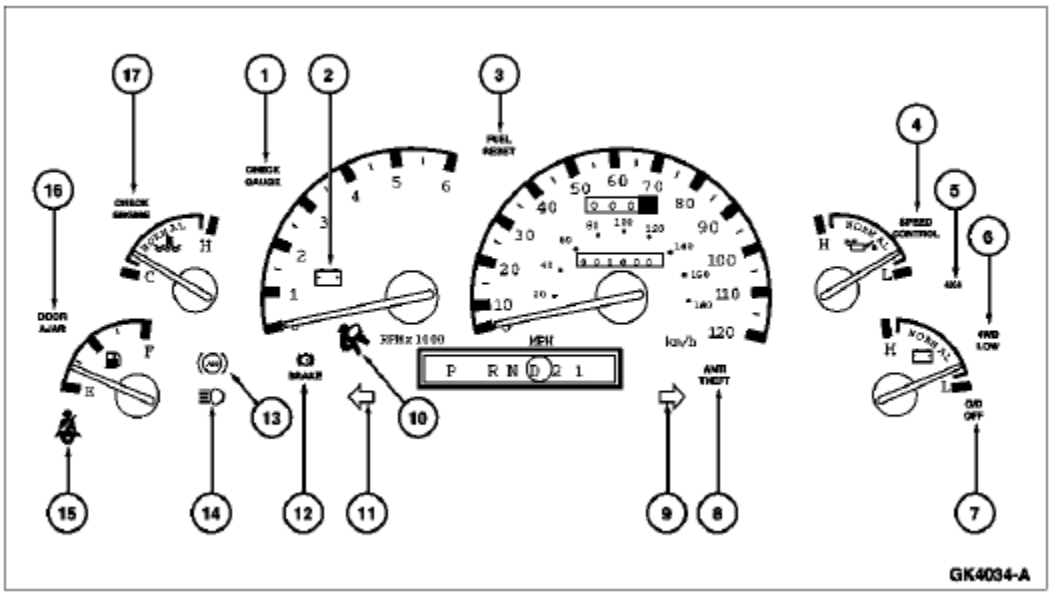
Item	Part Number	Description
1	—	Left Turn Signal (Part of 10849)
2	—	High Beam Indicator (Part of 10849)
3	—	Right Turn Signal (Part of 10849)
4	—	Overdrive Off (O/D Off) (Part of 10849)
5	—	Speed Control Indicator (Part of 10849)
6	—	Charging System (Part of 10849)
7	—	Air Bag (Part of 10849)
8	—	Brake Indicator (BRAKE) (Part of 10849)
9	—	Anti-Lock Brake (Part of 10849)
10	—	Fasten Seat Belts (Part of 10849)
11	—	CHECK ENGINE (PCM Warning Lamp) (Part of 10849)

Instrument Cluster, Ranger



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Item	Part Number	Description
1	—	CHECK GAUGE Indicator (Part of 10849)
2	—	Charging System Indicator (Part of 10849)
3	—	FUEL RESET Indicator (Part of 10849)
4	—	Speed Control Indicator (Part of 10849)
5	—	4x4 Indicator (Part of 10849)
6	—	Four-Wheel Drive Low (4WD Low) Range Indicator (Part of 10849)
7	—	Overdrive Off (O/D OFF) Indicator (Part of 10849)
8	—	ANTI-THEFT Indicator (Part of 10849)
9	—	Right Turn Signal (Part of 10849)
10	—	Air Bag (Part of 10849)
11	—	Left Turn Signal (Part of 10849)
12	—	BRAKE Indicator (Part of 10849)
13	—	Anti-Lock Brake (ABS) Indicator (Part of 10849)
14	—	High Beam Indicator (Part of 10849)
15	—	Fasten Seat Belts (Part of 10849)
16	—	Door Ajar Indicator (Part of 10849)
17	—	CHECK ENGINE (PCM Warning Indicator) (Part of 10849)

Instrument Cluster Display Prove Out

The instrument cluster (IC) performs a display prove out to verify that all warning/indicator bulbs and monitored systems are functioning properly. When the ignition switch (11572) is in the ON position with the engine (6007) off, the following indicators will illuminate:

- CHECK ENGINE/Malfunction Indicator Lamp (MIL)
- BRAKE Warning Indicator
- FUEL RESET Indicator
- Anti-Lock Brake Warning Indicator (ABS)
- Safety Belt Warning Indicator (60 second prove out)
- Air Bag Warning Indicator

Printed Circuit

The instrument cluster printed circuit (10K843) which supplies current to the instrument panel indicators, gauges, and some clocks, is made of copper foil which is bonded to a polyester base film (usually referred to as Mylar).

The instrument cluster printed circuit is mounted to the cluster housing and, due to its location, cannot be easily inspected or tested in the vehicle. This makes the instrument cluster printed circuit vulnerable to damage when a probe is used for in-vehicle testing as the probe can pierce the instrument cluster printed

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circuit or, in some cases, burn the copper conductor.

Since there is no approved procedure for in-vehicle testing of the instrument cluster printed circuit, it must be removed for visual inspection. If no visual damage is evident, each circuit should be tested with an ohmmeter. If an open circuit or short is detected, the instrument cluster printed circuit must be replaced.

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Fuel Level Indication System

The fuel level indication system is a magnetic gauge system. It consists of a magnetic fuel gauge (9280) mounted in the instrument cluster (10849) and a sending unit located in the fuel tank (9002) with an instrument cluster gauge amplifier (10E849) in series between the two. No instrument voltage regulator is used with this system.

Fuel Gauge

The magnetic gauge movement consists of three primary coils, one of which is wound at a 90-degree angle to the other two. The coils form a magnetic field which varies in direction according to the variable resistance of the sender unit which is connected between two of them. A primary magnet, to which a shaft and pointer are attached, rotates to align to this primary field, resulting in pointer position. The bobbin/coil assembly is pressed into a metal housing which has two holes for dial mounting. There is no adjustment, calibration or maintenance required for these gauges. The instrument cluster amplifier is calibrated to the fuel gauge. The instrument cluster amplifier and fuel gauge must be replaced as a system.

Instrument Cluster Gauge Amplifier/Check Gauge Module

The instrument cluster gauge amplifier electrically averages fuel sender readings so the fuel gauge displays actual fuel level and not fluctuations due to sloshing in fuel tank. The instrument cluster gauge amplifier is a small printed circuit board which latches into a pocket on the back of the instrument cluster. The electrical connections for ignition, ground, input from fuel sender and output to fuel gauge are made through a spring-type connector on the instrument cluster gauge amplifier to the instrument cluster printed circuit (10K843) on the instrument cluster. There are no provisions for calibration or adjustment of the instrument cluster gauge amplifier.

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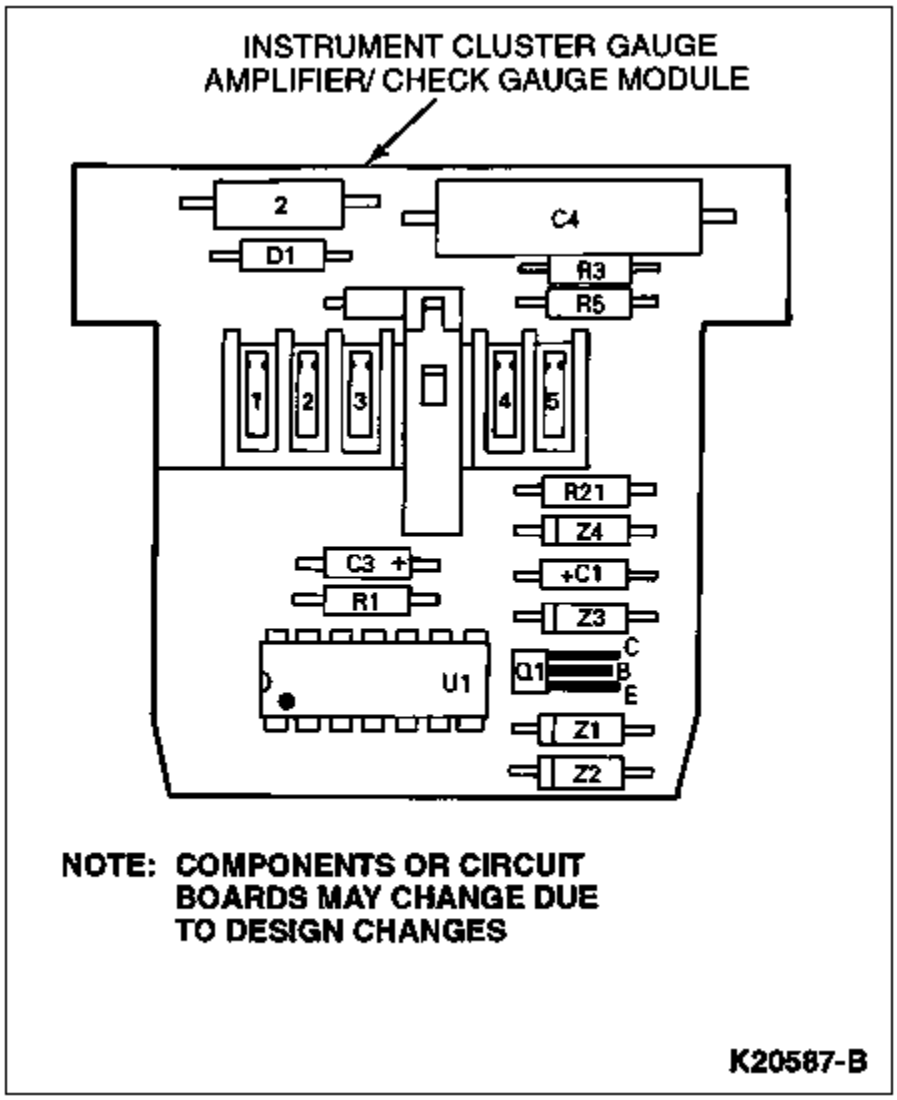

Fuel Sending Unit

The fuel sending unit consists of a variable screened resistor made up of a ceramic substrate. It is controlled by the action of an attached float in the fuel tank. When the fuel level is low, resistance in the sending unit is low. When the fuel level is high, the resistance in the sending unit is high. As the float moves from empty to full, the resistance will gradually and continuously increase.

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Coolant Temperature Indication System

The water temperature indication system is a magnetic gauge system. It consists of a magnetic water temperature gauge mounted in the instrument cluster and a water temperature indicator sender unit (10884).

Coolant Temperature Gauge

The engine coolant temperature gauge (10883) is a magnetic gauge movement consisting of three primary coils, one of which is wound at a 90-degree angle to the other two. The coils form a magnetic field which varies in direction according to the variable resistance of the water temperature indicator sender unit.

A primary magnet, to which a shaft and pointer are attached, rotates to align to this primary field, resulting in pointer position. The bobbin/coil assembly is pressed into a metal housing which has two holes for dial mounting. There is no adjustment calibration or maintenance required for this gauge.

Coolant Temperature Indicator Sender Unit (CTS)

When the engine coolant temperature is low, the resistance of the water temperature indicator sender unit is high, thus restricting the flow of current through the gauge, and moving the pointer only a short distance. As the coolant temperature increases, the resistance of the water temperature indicator sender unit decreases, causing a proportionately increased flow of current through the water temperature indicator sender unit and a corresponding movement of the pointer.

Oil Pressure Gauge

The oil pressure gauge (9273) movement consists of three primary coils, one of which is wound at a 90-degree angle to the other two. A primary magnet, to which a shaft and pointer are attached, rotates to align to this primary field, resulting in pointer position. The bobbin/coil assembly is pressed into a metal housing which has two holes for dial mounting. There is no adjustment calibration or maintenance required for this gauge.

Oil Pressure Switch

The oil pressure sensor (9278) is installed in the engine block and consists of a diaphragm and contact. The diaphragm reacts to the pressure, transferring its reaction to a contact which opens and closes when the oil pressure changes.

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Charge Indication System

Battery Voltage Gauge Design One

The battery voltage indicator gauge (10A835) is a gauge which measures the voltage potential at the battery to indicate the battery state of charge. The battery voltage indicator gauge is not adjustable and should be replaced if inoperative. The battery voltage indicator gauge is a magnetic gauge which consists of two primary coils and a return-to-zero magnet, one of the coils which is wound at a 90-degree angle to the other coil. The coils form a magnetic field which varies in direction according to the vehicle's voltage.

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Battery Voltage Gauge Design Two

The battery voltage indicator gauge (10A835) is a gauge which measure the voltage potential at the battery to indicate state of charge. The battery voltage indicator gauge is not adjustable and should be replaced if inoperative. The battery voltage indicator gauge is a magnetic gauge which consists of a calibration resistor (190 ohms) found on the instrument cluster printed circuit, one primary coil and a return-to-zero magnet. The return to zero magnet forms a magnetic field with the coils. The coil magnetic field varies in direction according to voltage.

A primary magnet, to which a shaft and pointer are attached, rotates to align to this primary field, resulting in pointer position. The bobbin/coil assembly is pressed into a metal housing which has two holes for dial mounting. There is no maintenance required for this gauge.

Charging System Warning Indicator

A red alternator charge indicator is located in the instrument cluster. This indicator glows when there is no generator (GEN) (10346) output.

When the ignition switch contacts are closed (switch turned on), battery current flows through the charge indicator and the parallel resistor (500 ohm), to the voltage regulator and the indicator comes on.

When the generator builds up enough voltage to energize a circuit in the voltage regulator, the charge indicator goes out.

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Speedometer, Ranger

The electronic speedometer operates in the following manner.

- Receives a speed/distance signal from the cableless transmission-mounted vehicle speed sensor (VSS) (9E731).

All vehicles have a vehicle speed sensor attached to the transmission. This is used to sense vehicle speed required for the engine management system and to regulate the speed control system for vehicles so equipped.

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Odometer Ranger

A million-mile tamper-resistant odometer (17A265) is standard on all vehicles. Also, all service speedometers (17255) have a non-resettable million-mile odometer.

Odometer Replacement

NOTE: Federal law requires that the odometer in any replacement speedometer must register the same mileage as that registered on the removed speedometer. Service replacement speedometers and odometer modules with the mileage preset to actual vehicle mileage are available through Ford Electronic Service Centers. In nearly all instances, the mileage continues to accumulate in the odometer memory even if the odometer does not display mileage. This mileage can usually be verified by the electronic service centers. Contact the service center for instructions to receive a replacement speedometer or odometer module with the mileage preset to actual mileage.

If the actual vehicle mileage cannot be verified, the service center will supply a speedometer or odometer module with the odometer display preset to zero ("0") miles. An odometer mileage sticker is supplied with the replacement odometer. This sticker must display the estimated vehicle mileage and is to be affixed to the driver's door.

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Programmable Speedometer/Odometer Module, Aerostar

The programmable electric analog speedometer receives its input from the anti-lock brake sensor. The liquid crystal display (LCD) odometer is a combination trip odometer and total odometer. The total odometer is normally displayed.

- To see the trip odometer, press and release the SELECT button on the upper right side of the speedometer (17255).
- To zero out the trip odometer, press and release the RESET button on the upper left side of the speedometer while the trip odometer is displayed.
- If the trip odometer is displayed, press and release the SELECT button to return the display to the total odometer value.

The speedometer, containing the trip odometer and total mileage odometer, is serviceable only as an instrument cluster assembly.

The speedometer is also used to provide a speed signal for correct operation of the vehicle's powertrain control module (PCM) (12A650), electronic transmission and speed control (if so equipped). Because of this, it is VERY IMPORTANT to change the internal conversion constant of the speedometer if the size of tires, or the rear axle and ring gear on the vehicle are changed. Changing the conversion constant to the proper value when the tires, or the rear axle and ring gear are changed will also make sure that the speedometer retains the original factory-set accuracy. The conversion constant can only be changed six times once the vehicle leaves the factory.

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Trip Odometer

The trip odometer (17A265) indicates how many kilometers (miles) the vehicle has been driven since the last reset.

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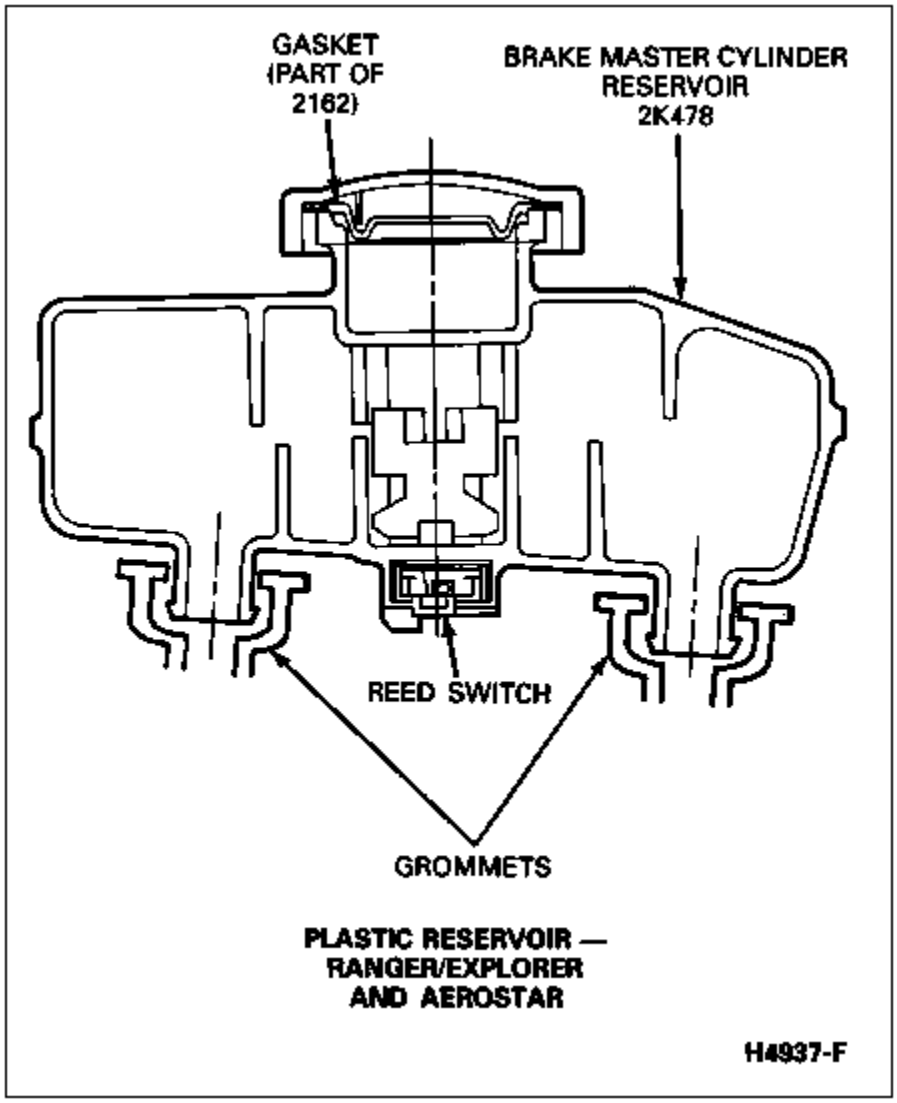
Warning Indicators

Brake System

All vehicles use a brake warning light in the instrument panel to warn of system malfunctions. The red brake warning light is used to indicate a low fluid condition, or a parking brake not fully released condition.

The low fluid level sensor is located in the master cylinder reservoir and is an integral part of the reservoir. It consists of a float and magnet assembly and a reed switch. When the fluid in the reservoir gets to a predetermined level, the magnet, which is attached to the float, actuates the reed switch, causing the warning lamp to light. Loss of fluid from either the primary or the secondary system will cause this system to actuate.



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Rear Anti-Lock Brakes, Aerostar and Ranger

Aerostar and Ranger vehicles are equipped with a rear anti-lock braking system and have an ANTI-LOCK BRAKE system light in addition to the BRAKE light. The yellow ABS warning light is used to indicate a malfunction and a deactivation of the rear anti-lock brake system. The ABS warning light will light for approximately 2 seconds when the ignition switch lock cylinder (11582) is initially moved to ON or START for circuit prove out.

Check Engine (MIL)

Check engine lights if a diagnostic trouble code (DTC) is sensed in the closed loop by the powertrain control module (PCM) (12A650).

Charging System

The charge indicator lights if the voltage in the integral generator-regulator drops below a preset level while the ignition switch lock cylinder is in RUN.

Air Bag

If an air bag system diagnostic trouble code (DTC) is present, the air bag diagnostic module grounds pin 54. Current flows through the air bag indicator and the air bag diagnostic module to ground, causing the indicator to illuminate. Refer to the Electrical and Vacuum Troubleshooting Manual (EVTM) for the applicable circuit diagram.

The air bag lamp is designed to illuminate for 6 (± 2) seconds when the ignition switch lock cylinder is turned to the ON position. This initial 6 seconds of air bag lamp illumination (continuous lamp) is considered normal operation and is called prove out of the air bag lamp.

Safety Belt

When the ignition switch lock cylinder is turned to START or RUN, the warning buzzer/chime module applies voltage to the FASTEN BELTS indicator in the instrument cluster to turn it on.

If the safety belt has not been buckled when the ignition switch lock cylinder is turned to the RUN position, the safety belt warning will sound for a duration of 4 to 8 seconds.

The warning chime and warning indicator will then shut off whether the safety belt has been buckled or not.

Low Fuel — Aerostar Only

The CHECK GAUGE indicator will illuminate when a low fuel situation is encountered.

Check Gauge

The CHECK GAUGE indicator will illuminate when any one of the following conditions arise: low fuel, engine overtemp, or low oil pressure.

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Door Ajar

The DOOR AJAR indicator will illuminate when any one of the vehicle doors are open.

High Beam

The high beam indicator comes on when the headlamps are turned on high beam or when the headlamps are flashed.

LH/RH Turn Signals

The LH/RH turn signal indicators are located in the instrument cluster. If the turn signal indicator light in the instrument cluster does not illuminate or remains on (doesn't flash) when a turn is signaled, the turn signaling system is malfunctioning.

Overdrive/Overdrive Off

The O/D OFF indicator will illuminate indicating that the transmission is locked out of the overdrive gear (4th gear).

This dual-function lamp will also blink on and off in the event of a transmission fault.

Heated Back Window Light — Aerostar

The heated back light indicator (Aerostar only) will illuminate when the back light is on.

Electronic 4-Wheel Drive — Aerostar

The electronic 4-wheel drive warning light, located on the instrument cluster (10849), turns on when the electronic 4-wheel drive system is working improperly. The light comes on briefly when the ignition switch lock cylinder is turned on, but should turn off when the engine starts.

The electronic 4-wheel drive light will go off after a few seconds and stay off if all systems are operating correctly.

The light comes on steady if a problem occurs. The technician can retrieve a diagnostic trouble code (DTC). If a problem is detected by the control unit, a DTC will be selected and sent to the electronic 4-wheel drive warning light. The vehicle operator and/or service technician needs to count the flashes that occur between the pauses and reference the diagnostic code chart. Refer to Group 07 in the Powertrain, Drivetrain Manual for the on-board diagnostic trouble code chart.

4x4/Low Range Indicators with Lever-Operated Transfer Case, Ranger

The 4x4/low range indicator lamp circuit consists of two lamps located on the instrument cluster and a switch located in the transfer case. One lamp indicates when the vehicle is in the 4-wheel drive position (4H) and one lamp indicates when the vehicle is in the 4-wheel drive low range position (4L).

When the 4-wheel drive is engaged, the switch closes a first contact and the 4x4 lamp illuminates. When the low range is engaged, the switch closes a second contact and the low range bulb illuminates at the same

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time as the 4x4 lamp illuminates.

4x4/Low Range Indicators with Electronic Shift Transfer Case, Ranger

The electronic shift control, located on instrument panel (04320), consists of a rotary type switch. The 4x4 switch selects either the 2-wheel drive or the 4-wheel drive position. The instrument cluster indicator will illuminate when the 4-wheel drive position is engaged. The low range position is used to select and indicate 4x4 low range. The light will illuminate when a signal is received from the generic electronic module indicating low range is engaged.

The generic electronic module controls the operation of the transfer case in response to inputs to the rotary switch controlled by the vehicle operator.

Speed Control

The SPEED CONTROL indicator lamp will illuminate when the speed control has been engaged.

Fuel Reset

The FUEL RESET lamp is grounded through the inertia switch whenever the vehicle is subjected to a high force situation. The inertia switch cuts off the fuel pump motor causing a loss of fuel to the cylinders.

The fuel cutoff system is a safety feature in the event of an accident. The fuel reset lamp will illuminate indicating that the fuel reset switch must be switched back to the ON state before the vehicle can be started.

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Electrical Schematics

Fuel Indicating System, Aerostar

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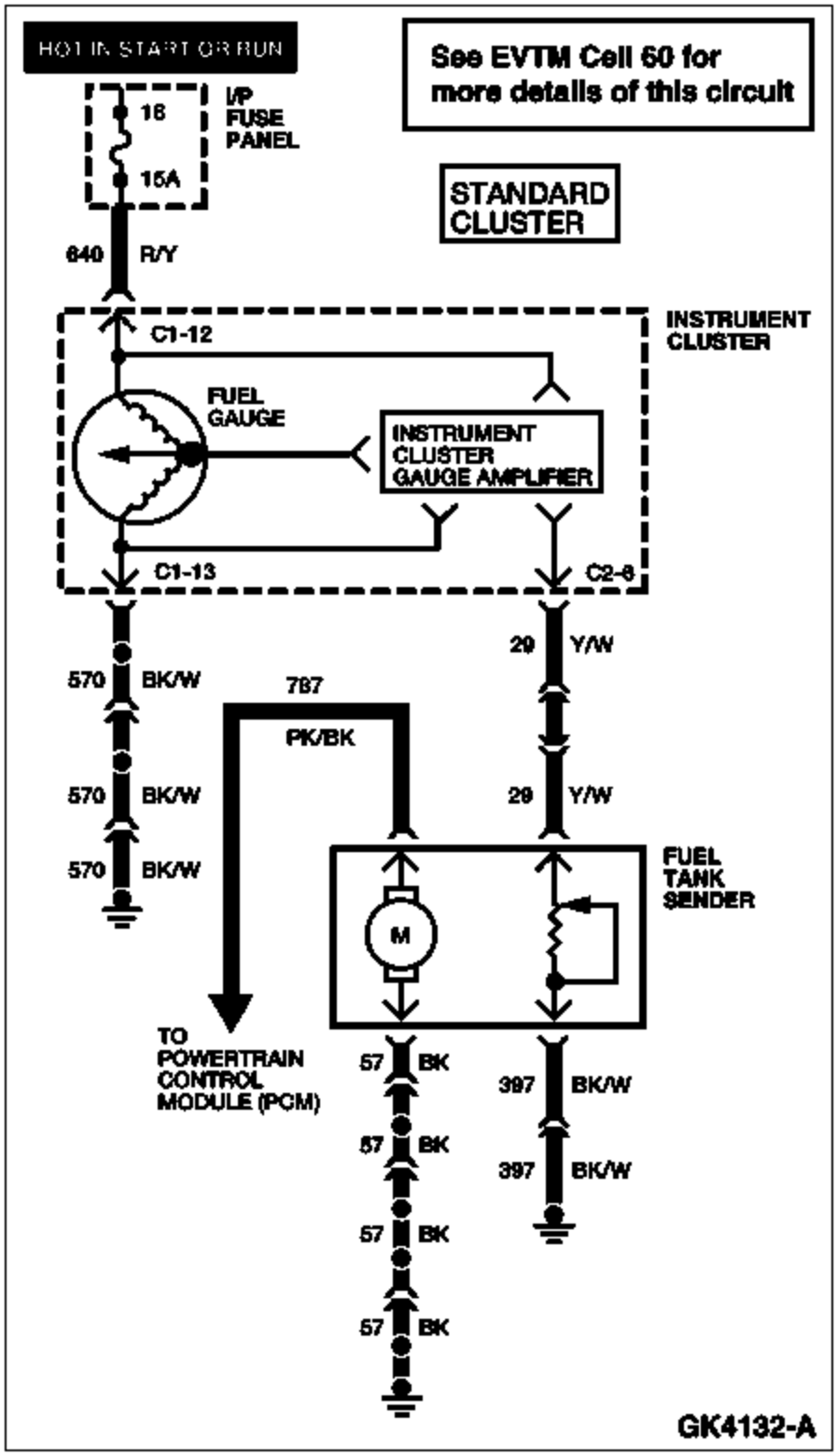

Coolant Temperature Gauge (Standard Cluster), Aerostar

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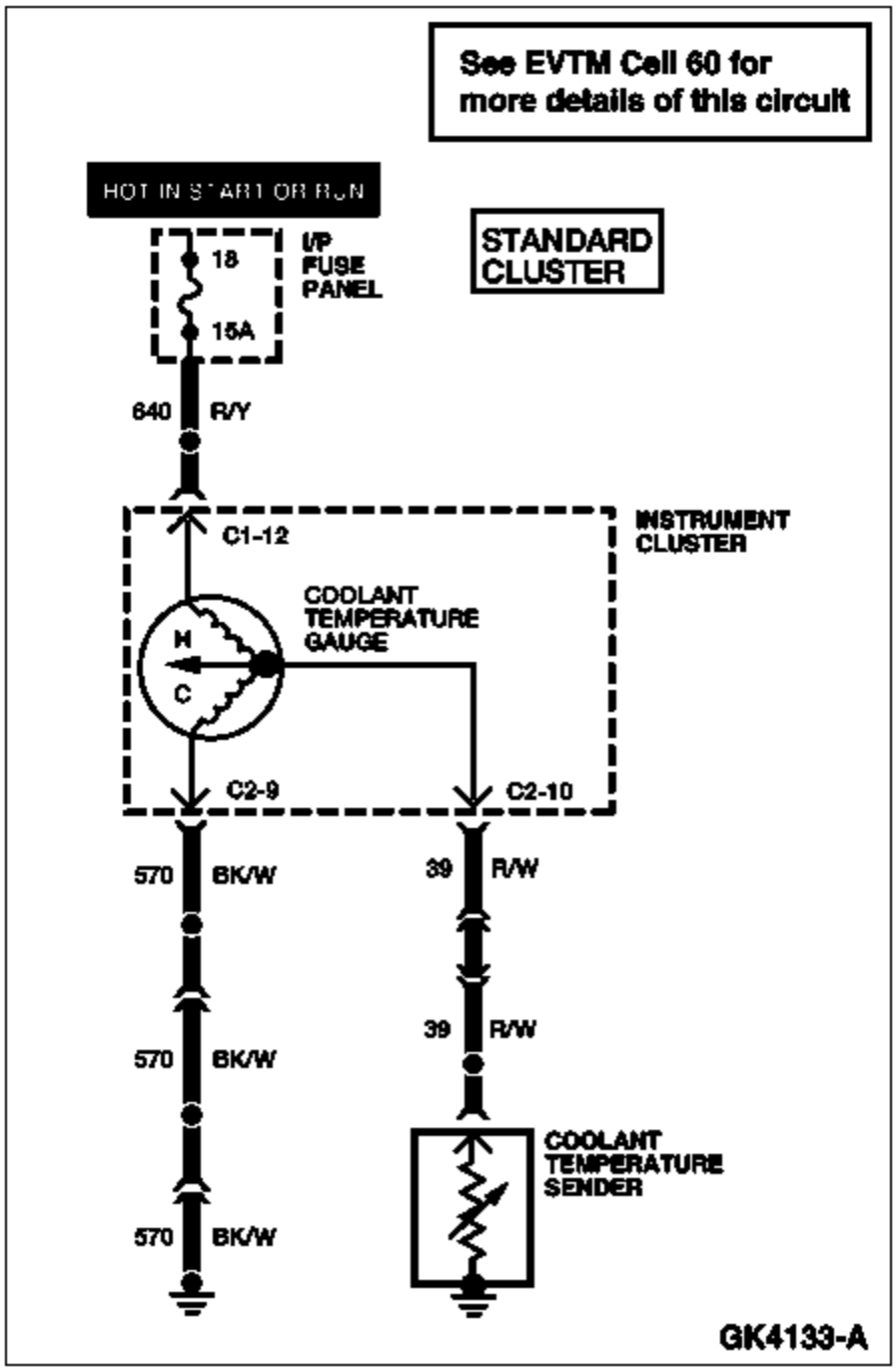

Oil Pressure Gauge (Standard Cluster), Aerostar

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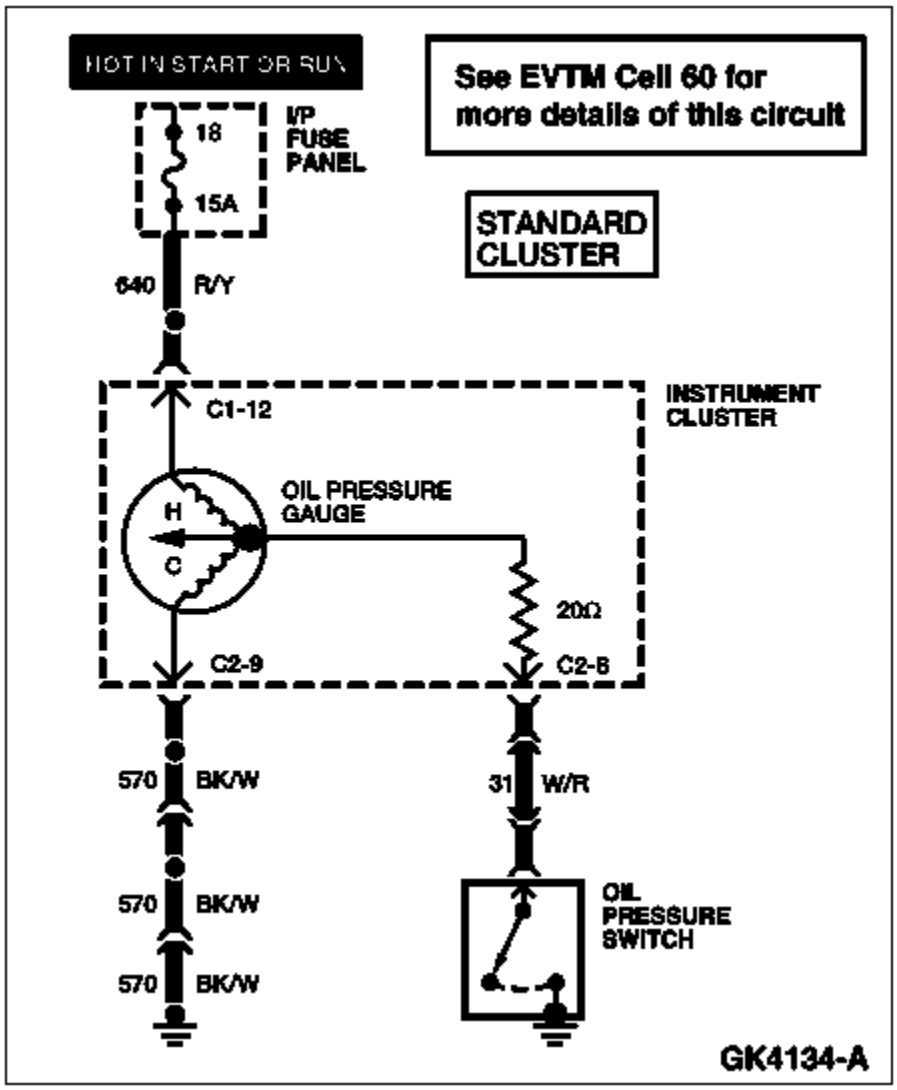

Charge Indication Design One (Standard Cluster), Aerostar

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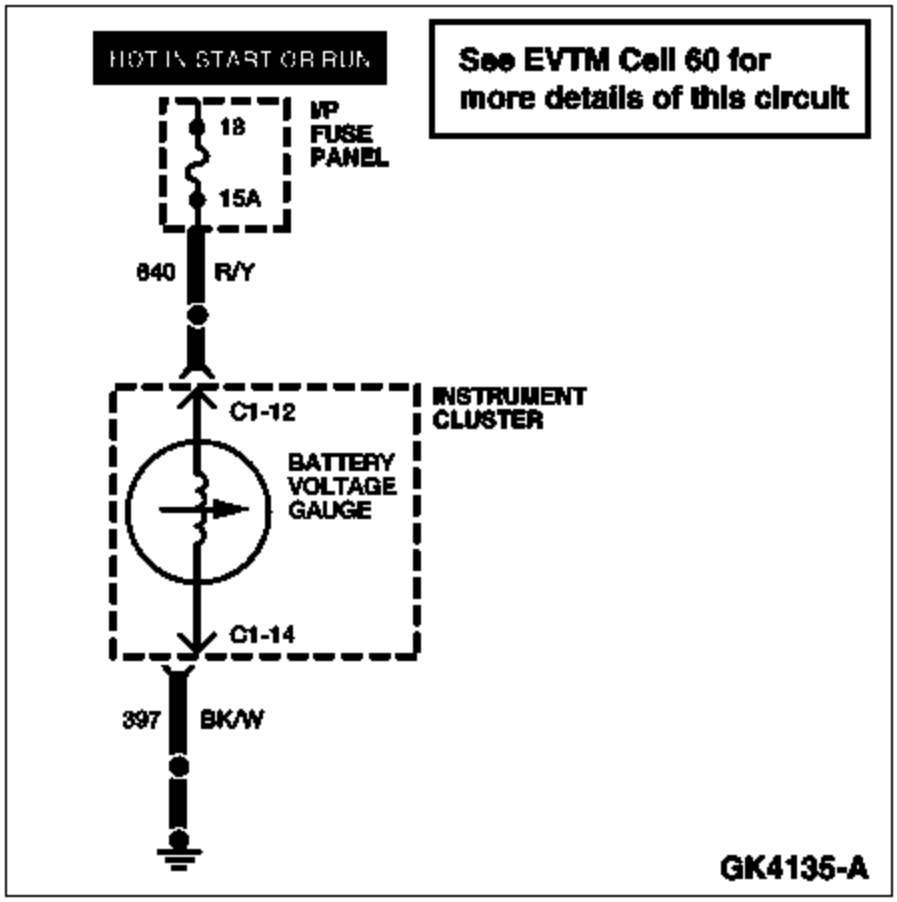

Charge Indication Design Two (Standard Cluster), Aerostar

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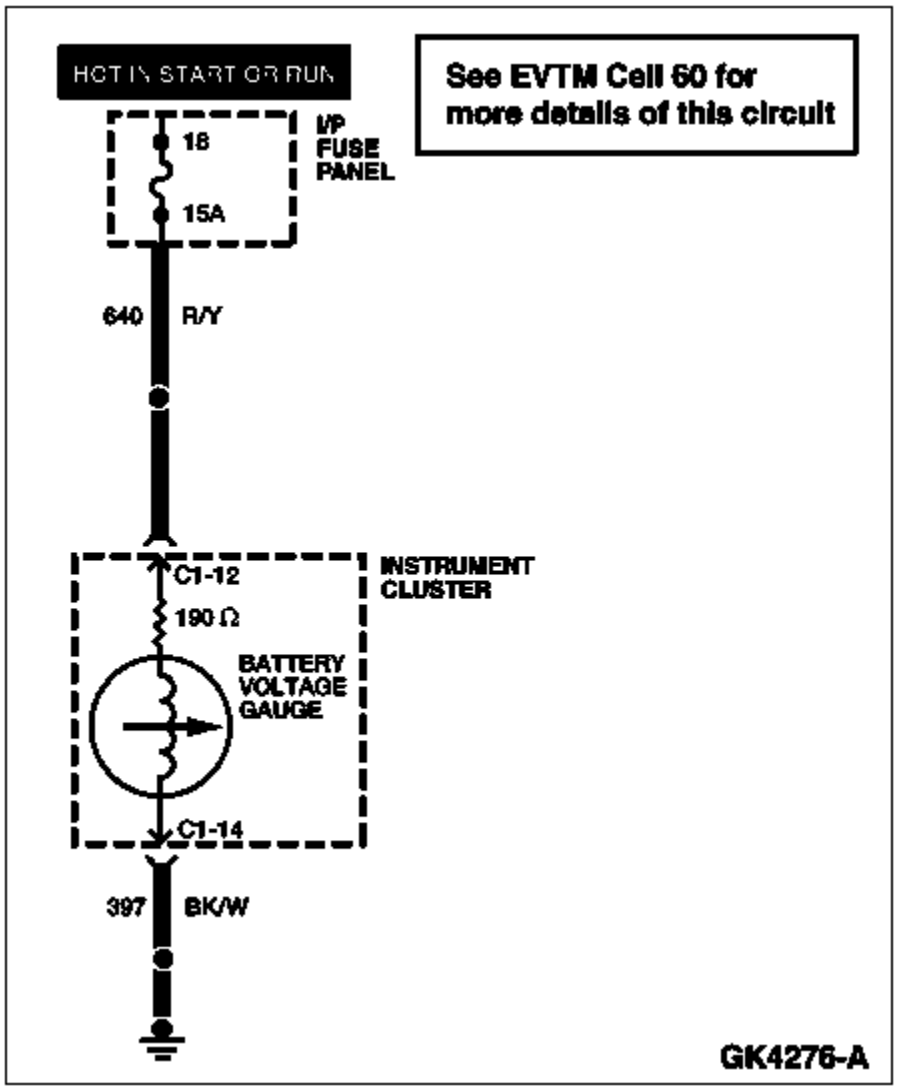
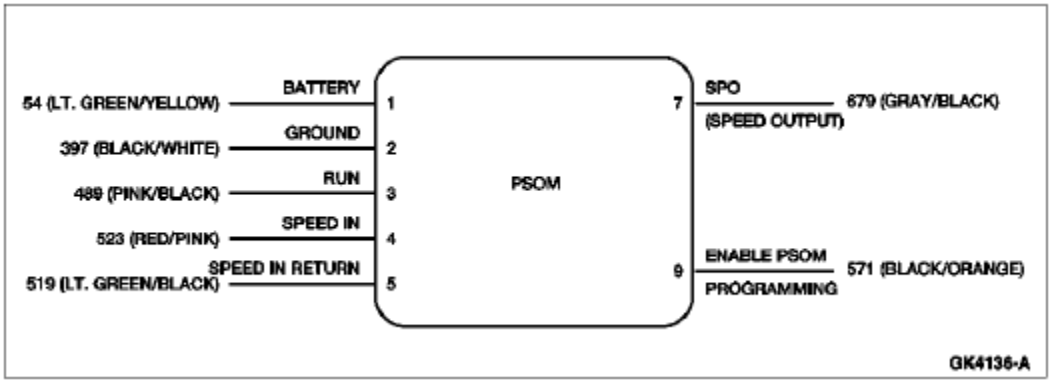


Block Wiring Diagram, Programmable Speedometer/Odometer Module, Aerostar



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Pin Number	Function	Circuit Number/Color Code
1	Battery Input (main current source for module)	54 (Lt Gr/Y) Fuse Numbers 8, 15A
2	Module Ground (must be CLEAN with no high-current switching devices attached)	397 (Black/White)
3	Ignition Input — Hot In RUN only	489 (Pink/Black) Fuse Numbers 17, 10A
4	Speed Input from RABS (positive)	523 (Red/Pink)
5	Speed Input Return (normally grounded by RABS module)	519 (Lt Gr/Black)
7	Speed Output (8000 pulses/mile)	679 (Gray/Black)
9	PSOM Test Connector	571 (Black/Orange)

System Block Diagram, PSOM, Aerostar

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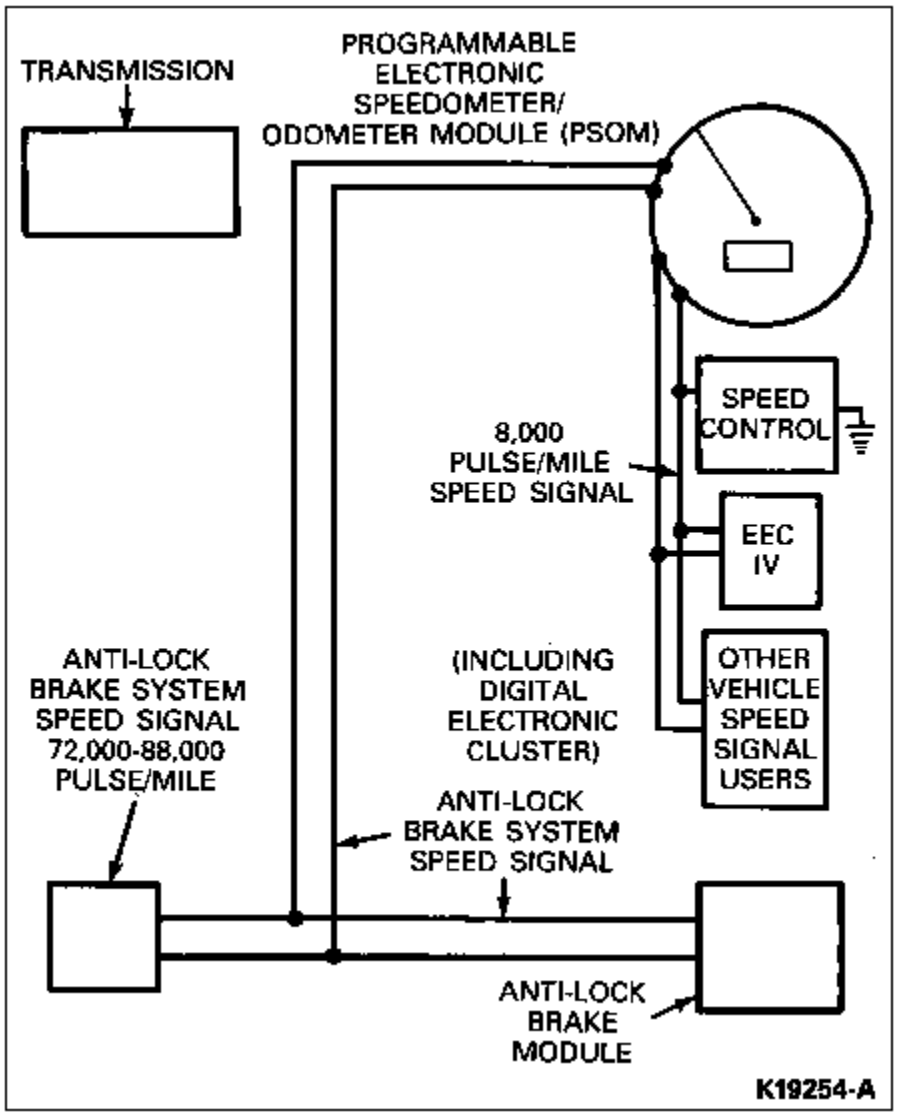

PSOM Wiring, Aerostar

The PSOM is attached to the vehicle wiring through a 12-pin connector. For pinouts, refer to the chart with block wiring diagram above. See the appropriate vehicle Shop Manual or Electrical and Vacuum Troubleshooting Manual (EVTM) for additional information.

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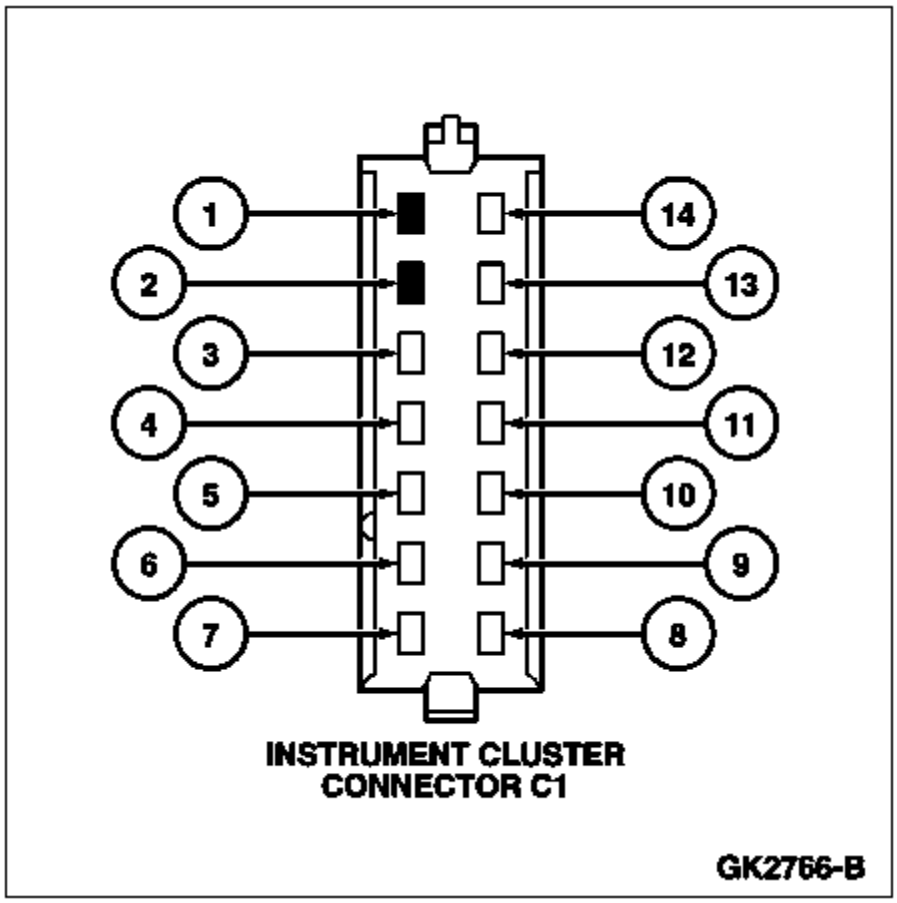

Pin Number	Circuit	Circuit Function
1	—	NOT USED
2	—	NOT USED
3	932 (GY/W)	Power to High Beam Indicator
4	450 (DG/LG)	Power to Fasten Belts Indicator
5	57 (BK)	Illumination High Beam and Fasten Belts to Ground
6	19 (LB/R)	Power to Illumination
7	57 (BK)	Turn Indicators to Ground
8	2 (W/LB)	Power to Right Turn Indicator
9	57 (BK)	Ground
10	994 (W)	Power to Electronic 4WD Indicator
11	608 (BK/Y)	Air Bag to Air Bag Module
12	640 (R/Y)	Power to Gauges, Hot in Start or Run
13	570 (BK)	Fuel Gauge to Ground
14	397 (BK/W)	Voltmeter to Ground

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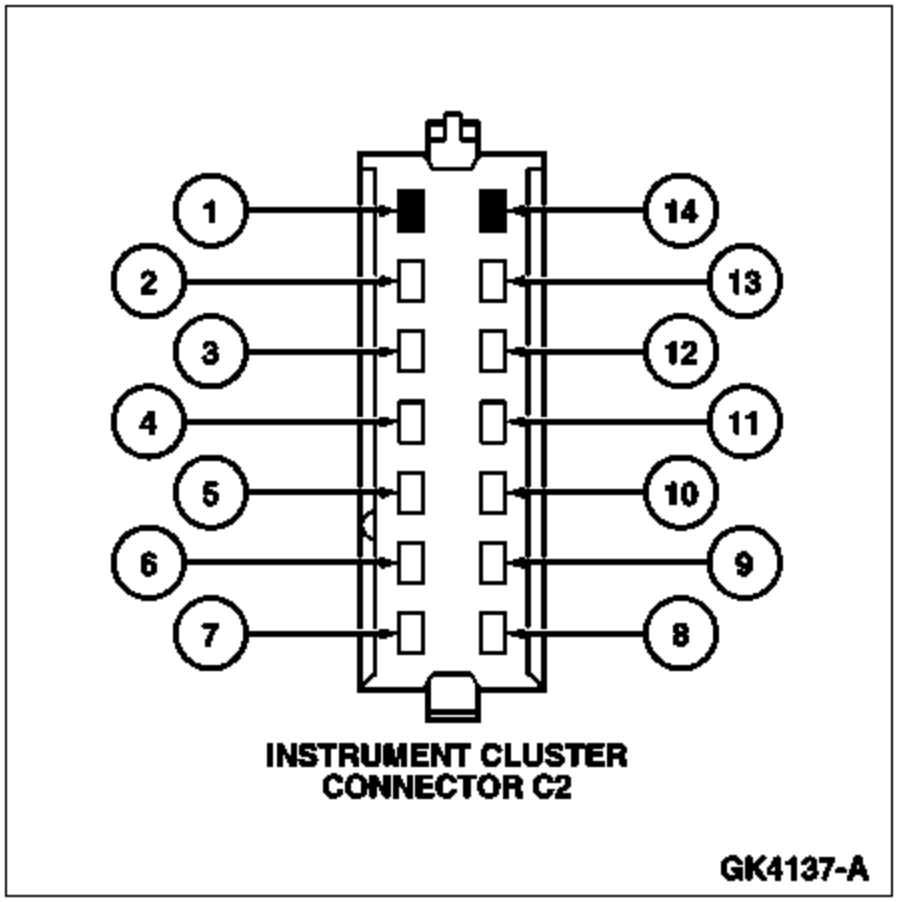

Pin Number	Circuit	Circuit Function
1	—	NOT USED
2	627 (BK/O)	Door Ajar Indicator Control
3	977 (P/W)	Brake Indicator Control
4	603 (DG)	Rear ABS Indicator Control
5	658 (PK/LG)	Malfunction Indicator Lamp Control
6	29 (Y/W)	Fuel Gauge Sender Input
7	3 (LG/W)	LH Turn Indicator
8	31 (W/R)	Engine Oil Pressure Gauge Control
9	570 (BK/W)	Engine Oil Pressure Gauge Ground
10	39 (R/W)	Temperature Gauge Control
11	904 (LG/R)	AMP Indicator Control
12	16 (R/LG)	Battery Input to AMP Indicator
13	640 (R/Y)	Power (Hot In Start or Run)
14	—	NOT USED

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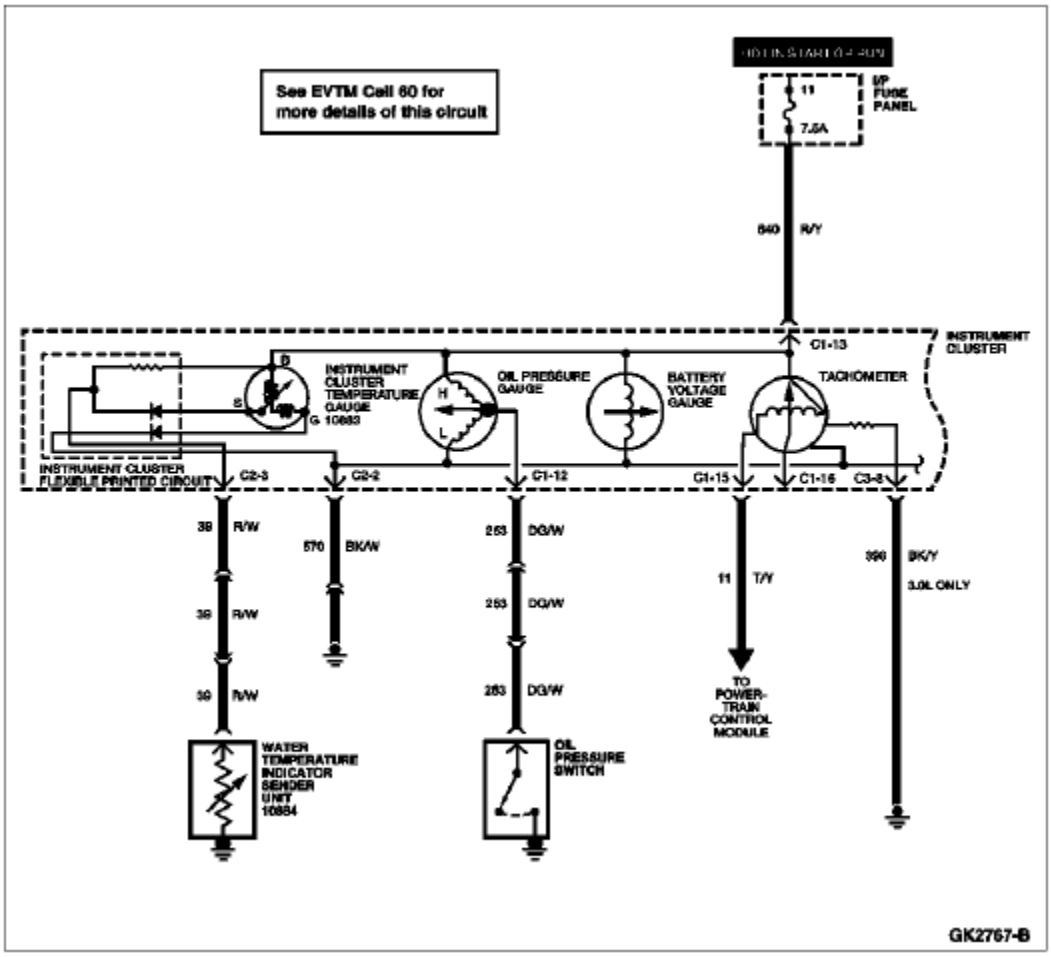
Instrument Cluster — Ranger (Design 1)



Instrument Cluster — Ranger (Design 2)

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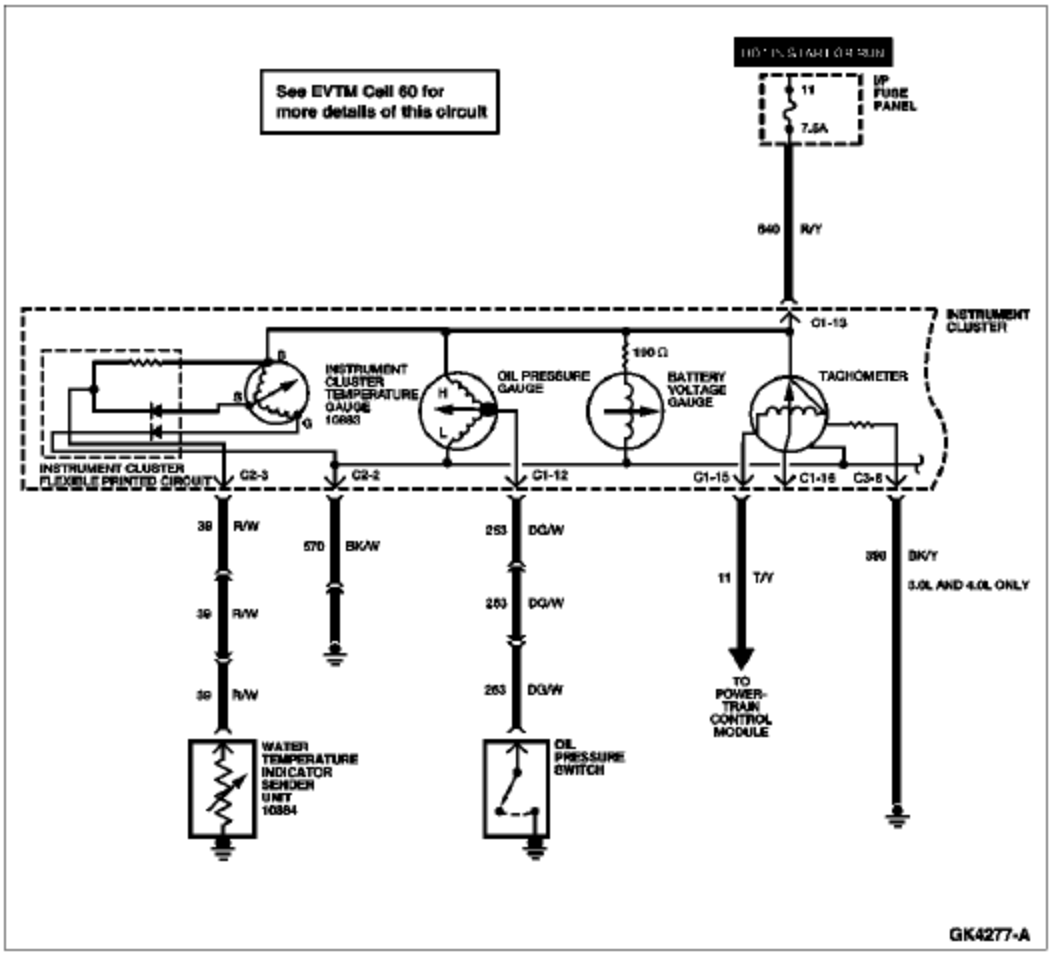

Instrument Cluster — Ranger Base

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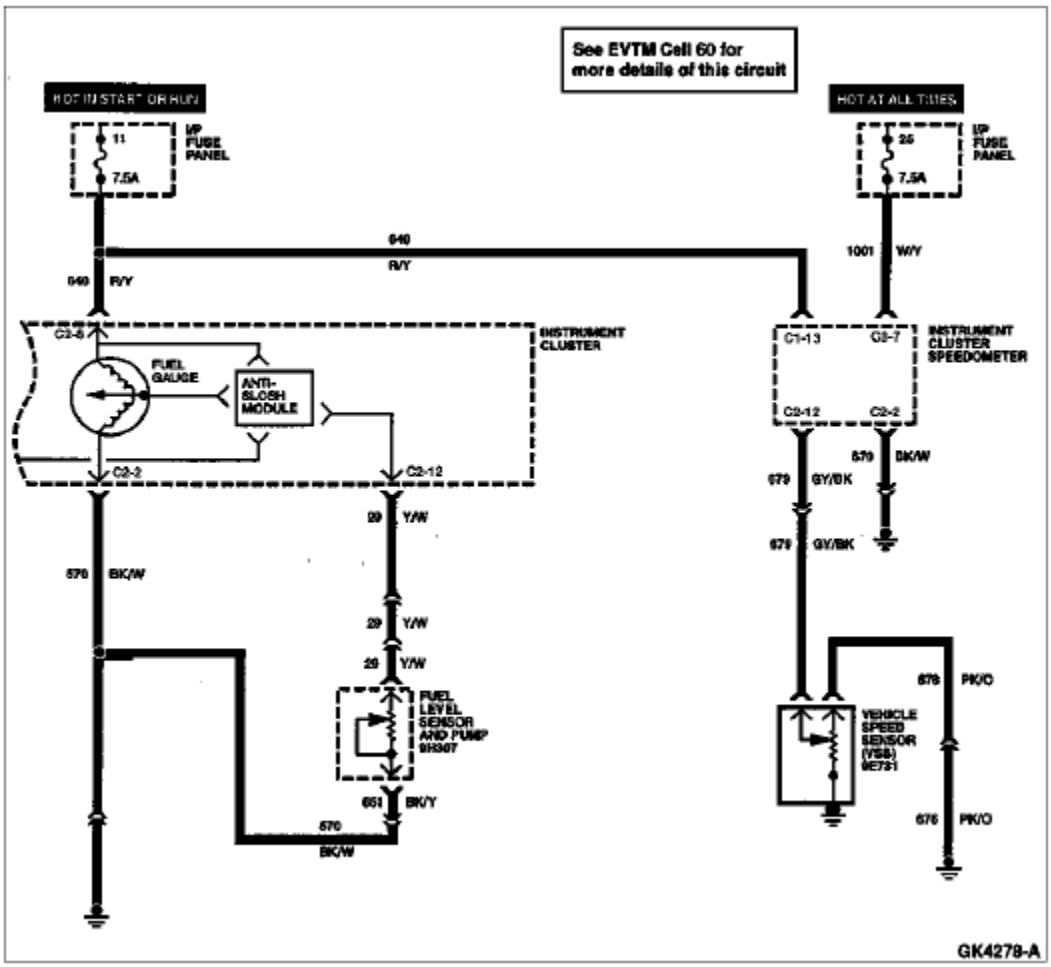

Instrument Cluster — Ranger Optional

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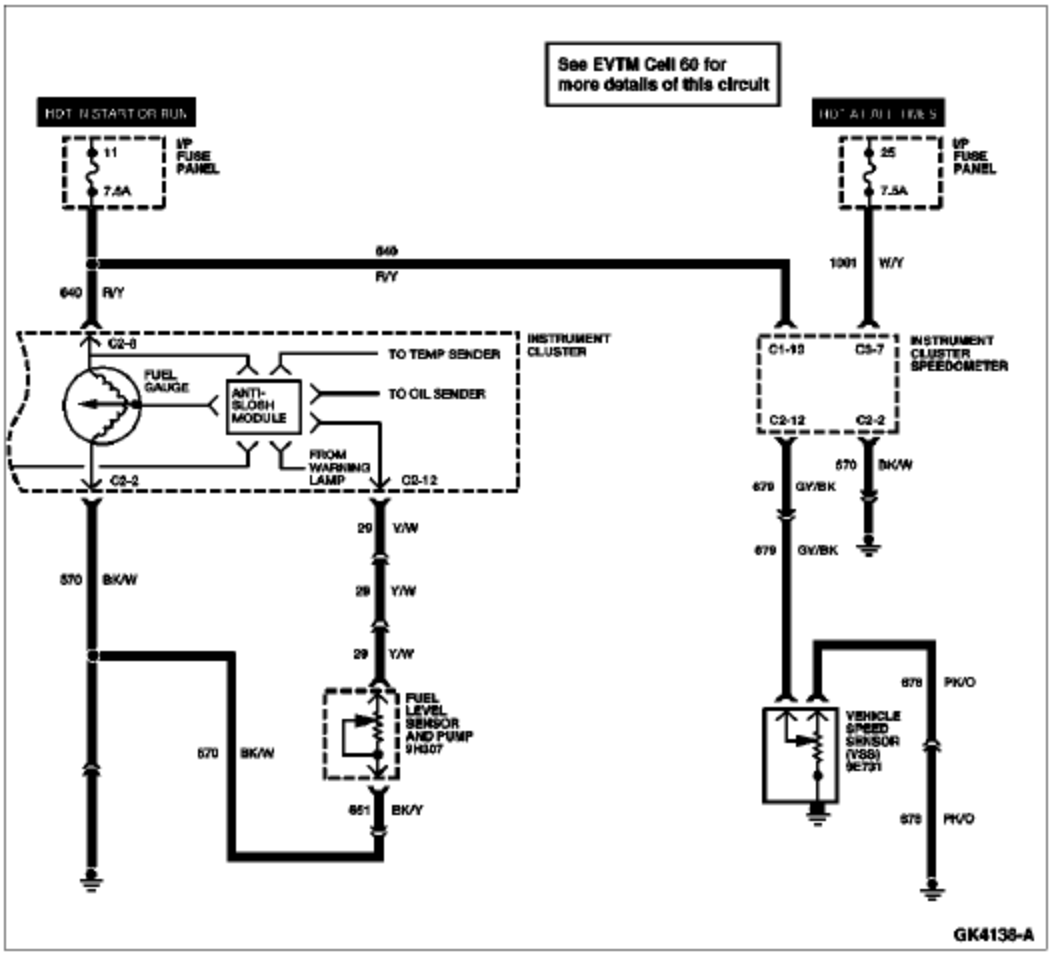

Touch 4-Wheel Indicators, Ranger

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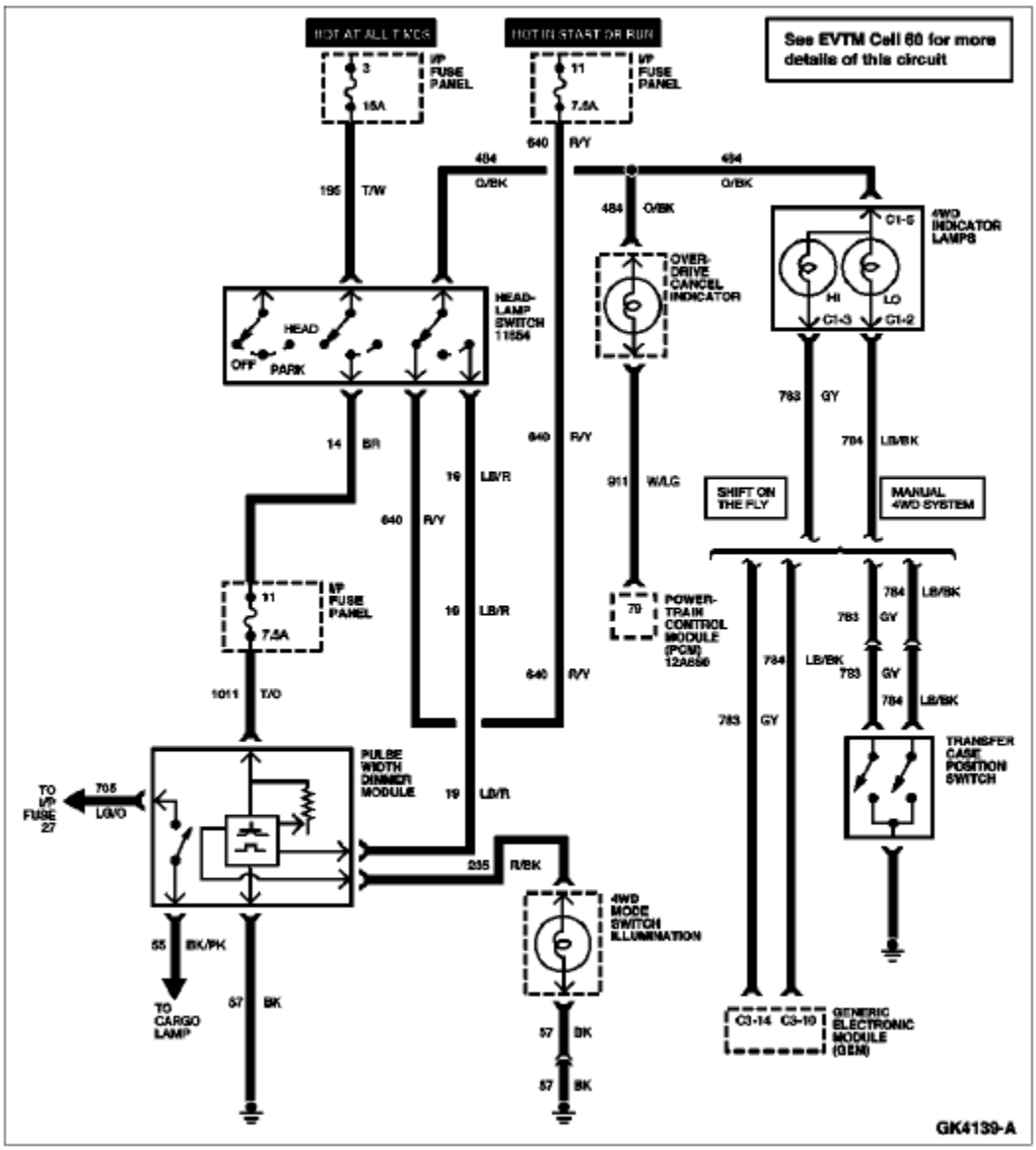
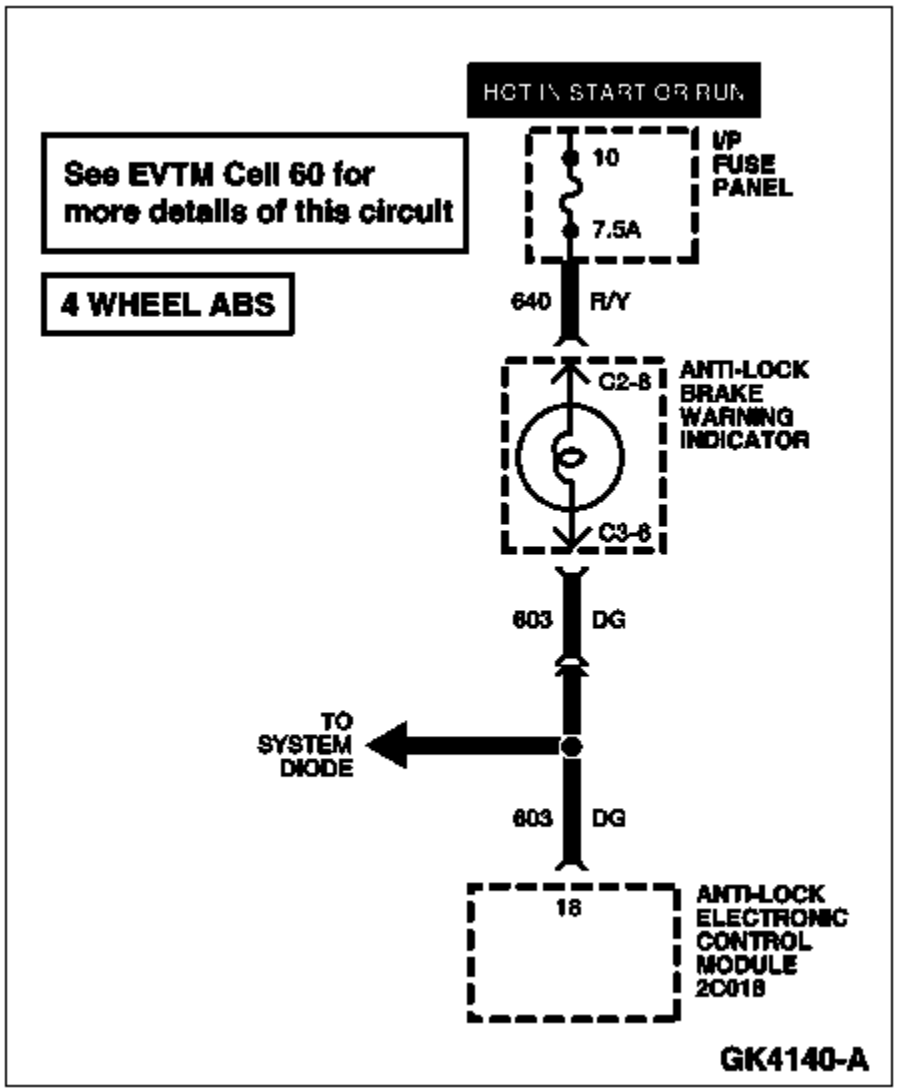


Anti-Lock Brake Warning Indicator — Ranger

tomsn048@gmail.com



Rear Anti-Lock Brake Warning Indicator — Ranger

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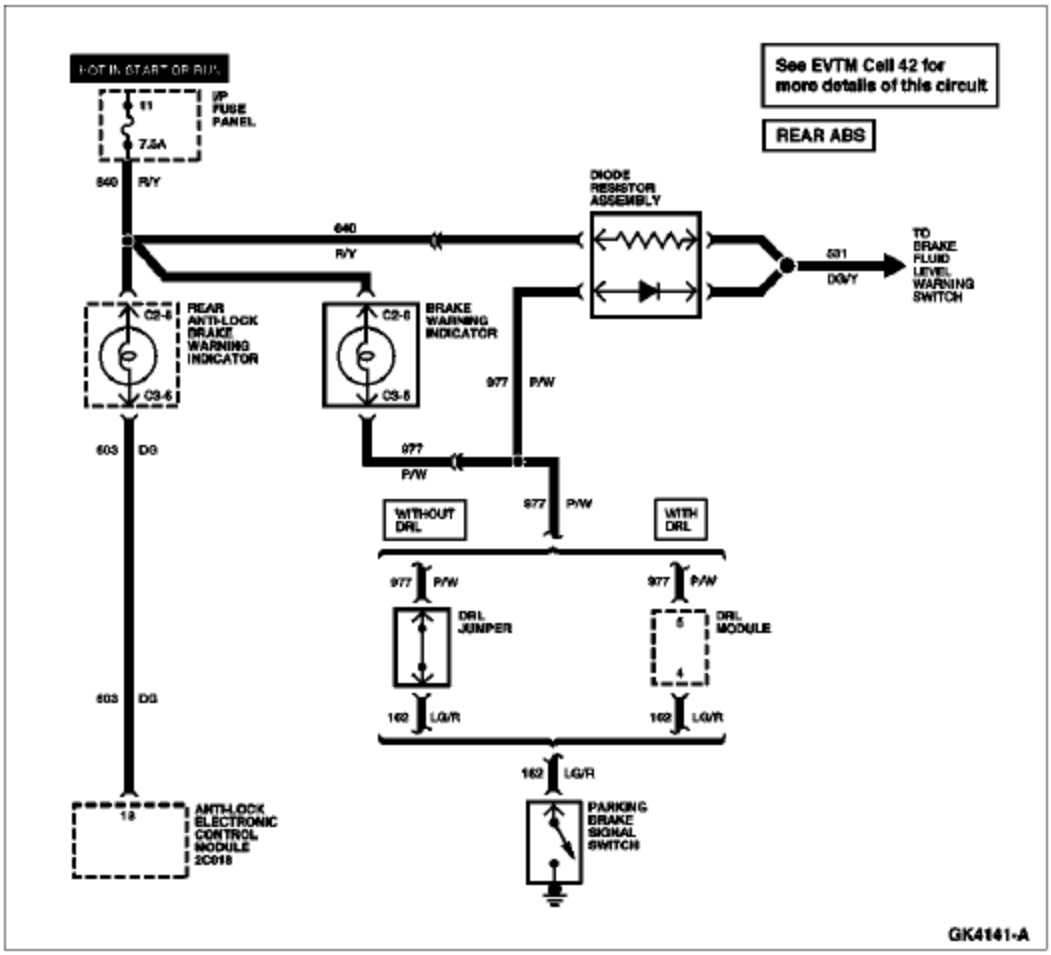

Anti-Theft Warning Indicator — Ranger

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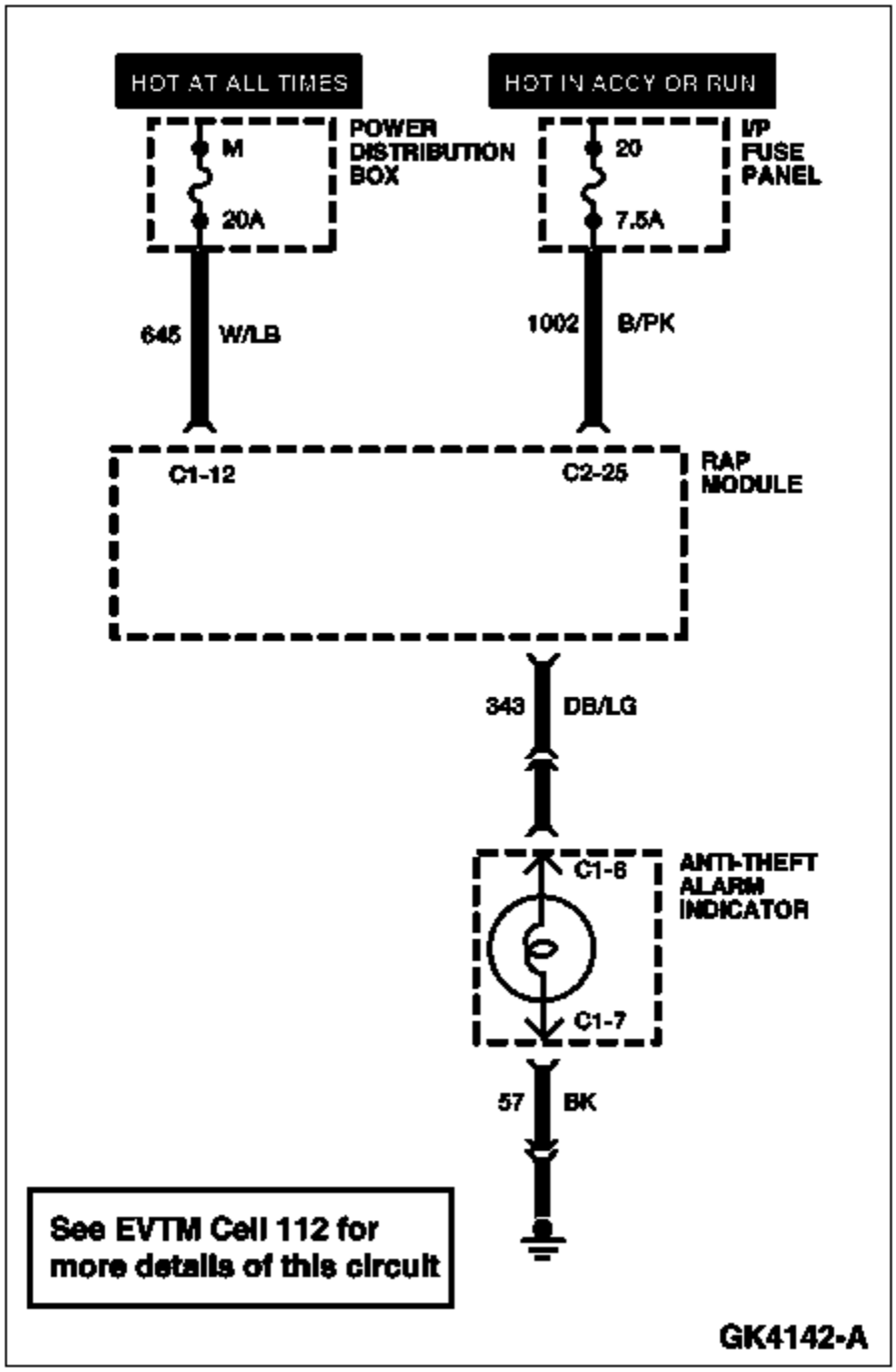

Safety Belt Warning Indicator — Ranger

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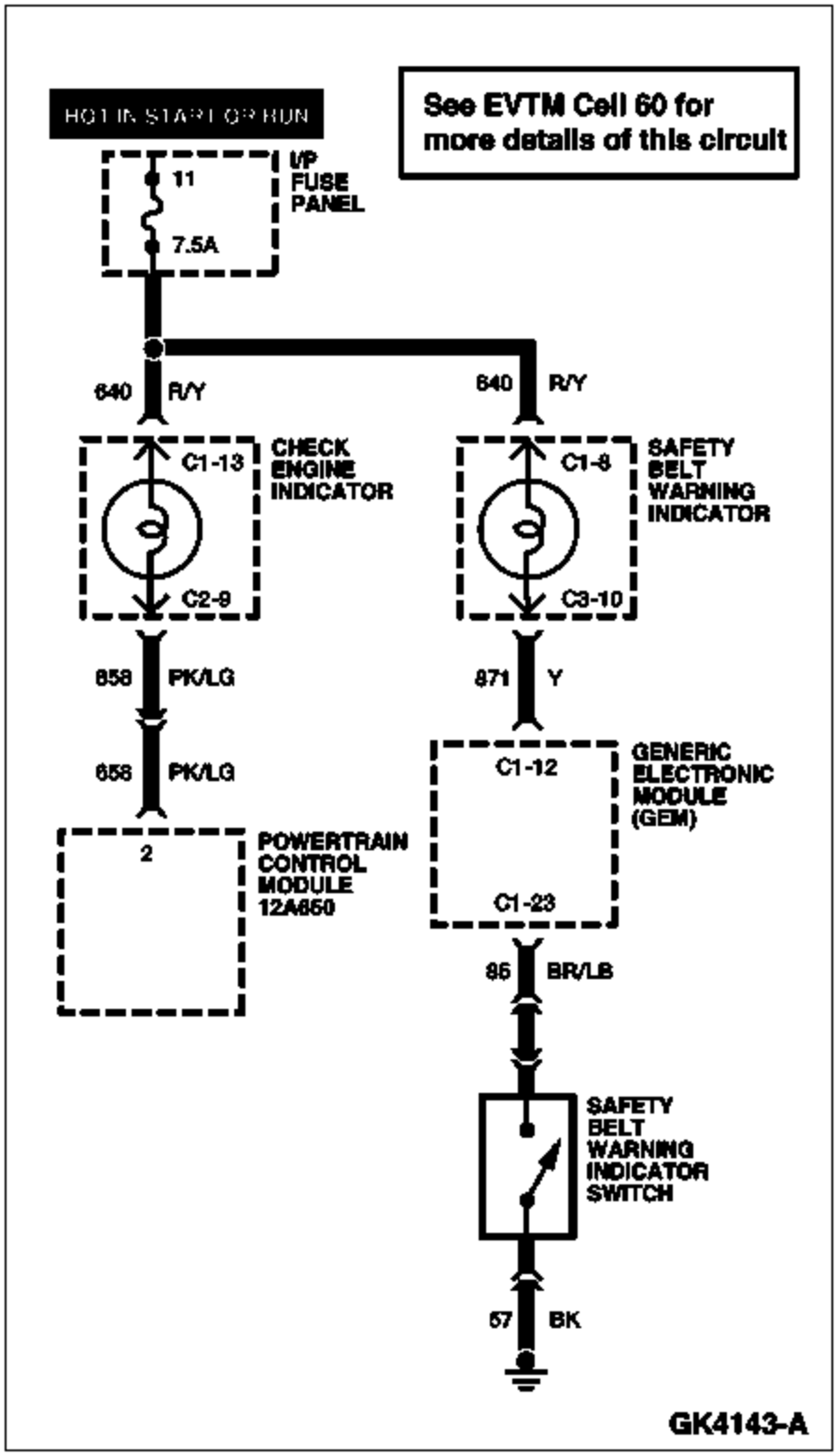

Air Bag Warning Indicator — Ranger

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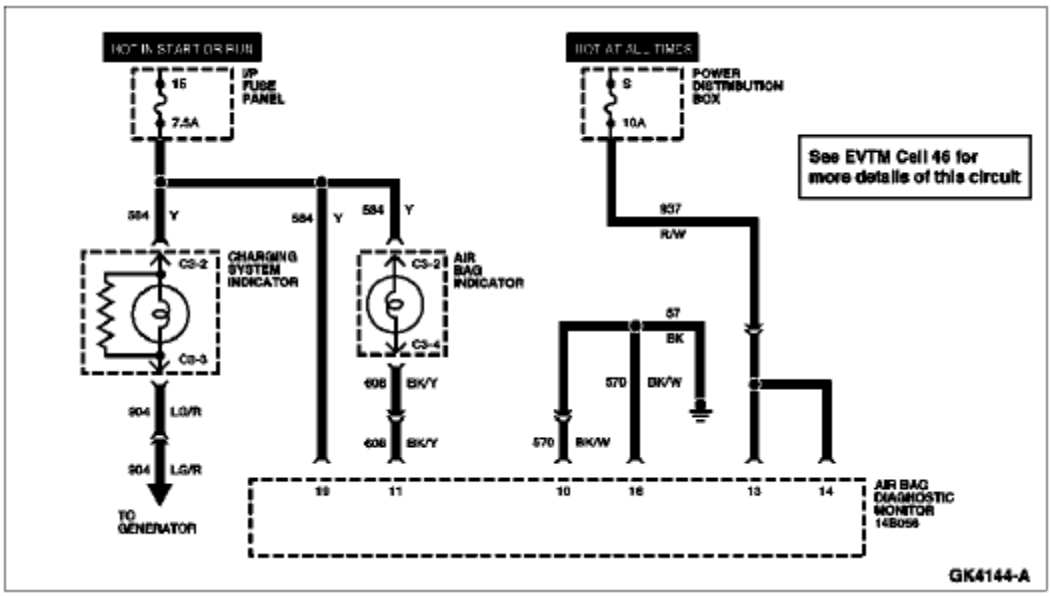

Door Ajar Indicator — Ranger

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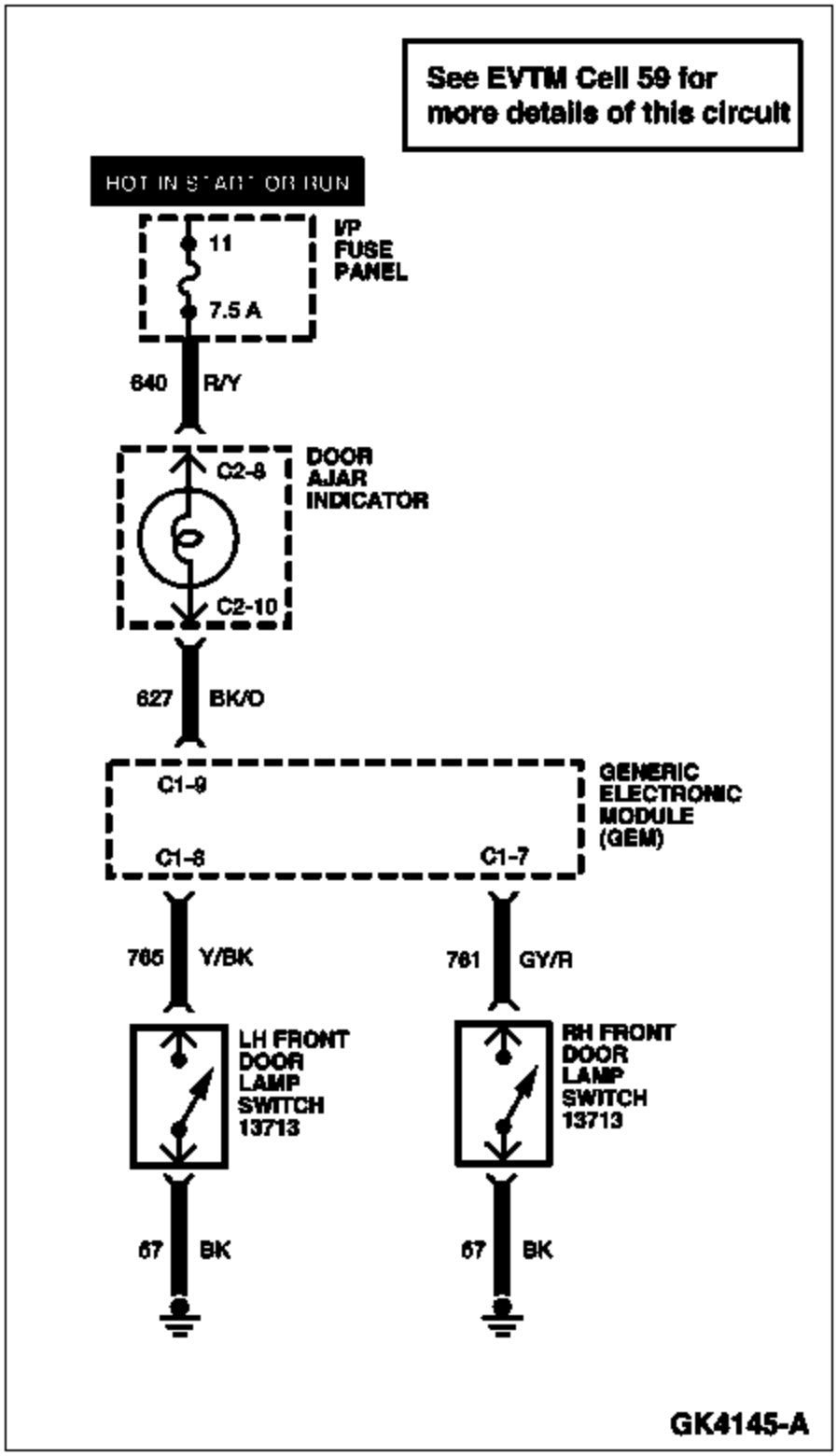

High Beam Indicator — Ranger

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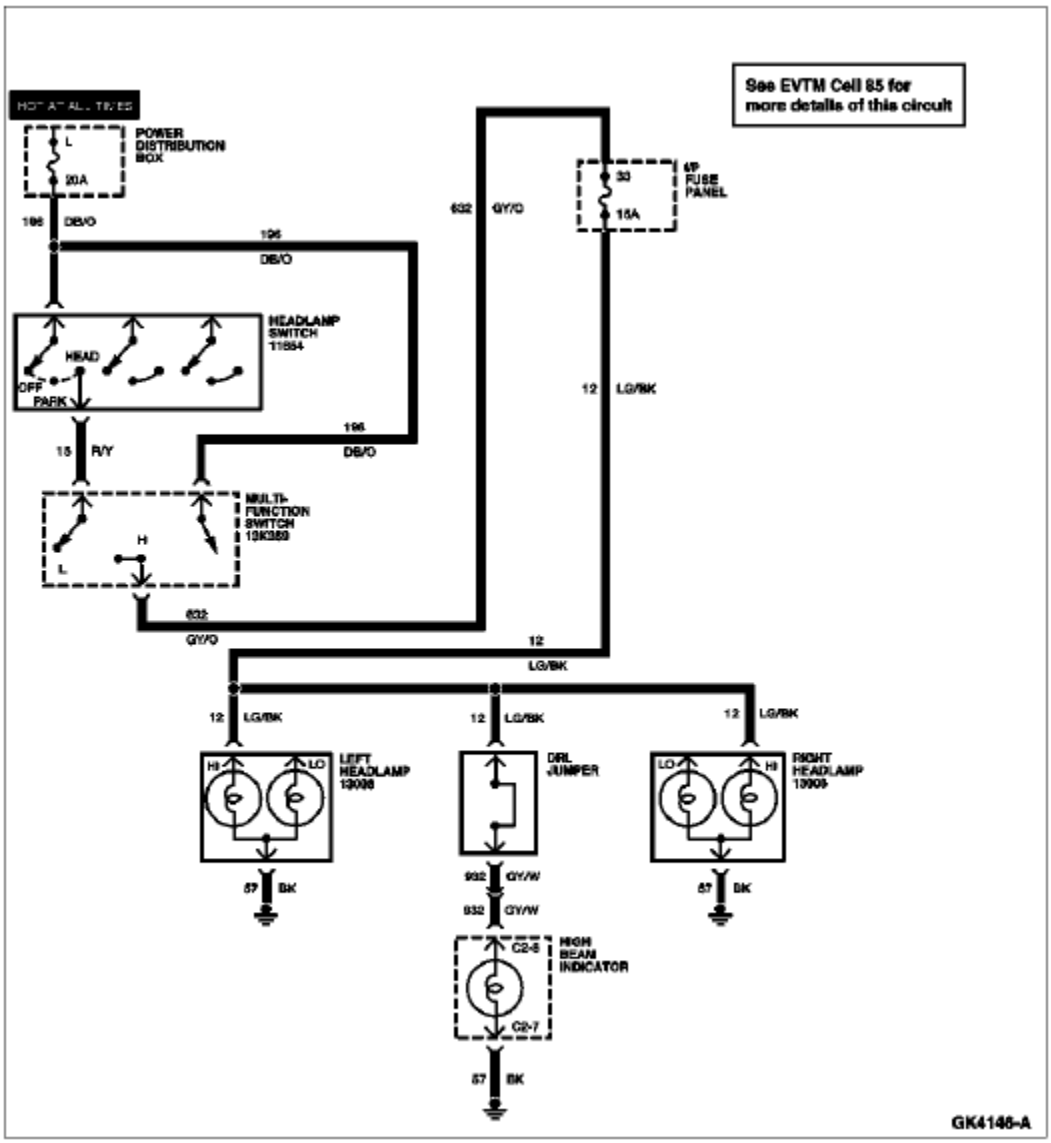

Turn Signal Lamps — Ranger

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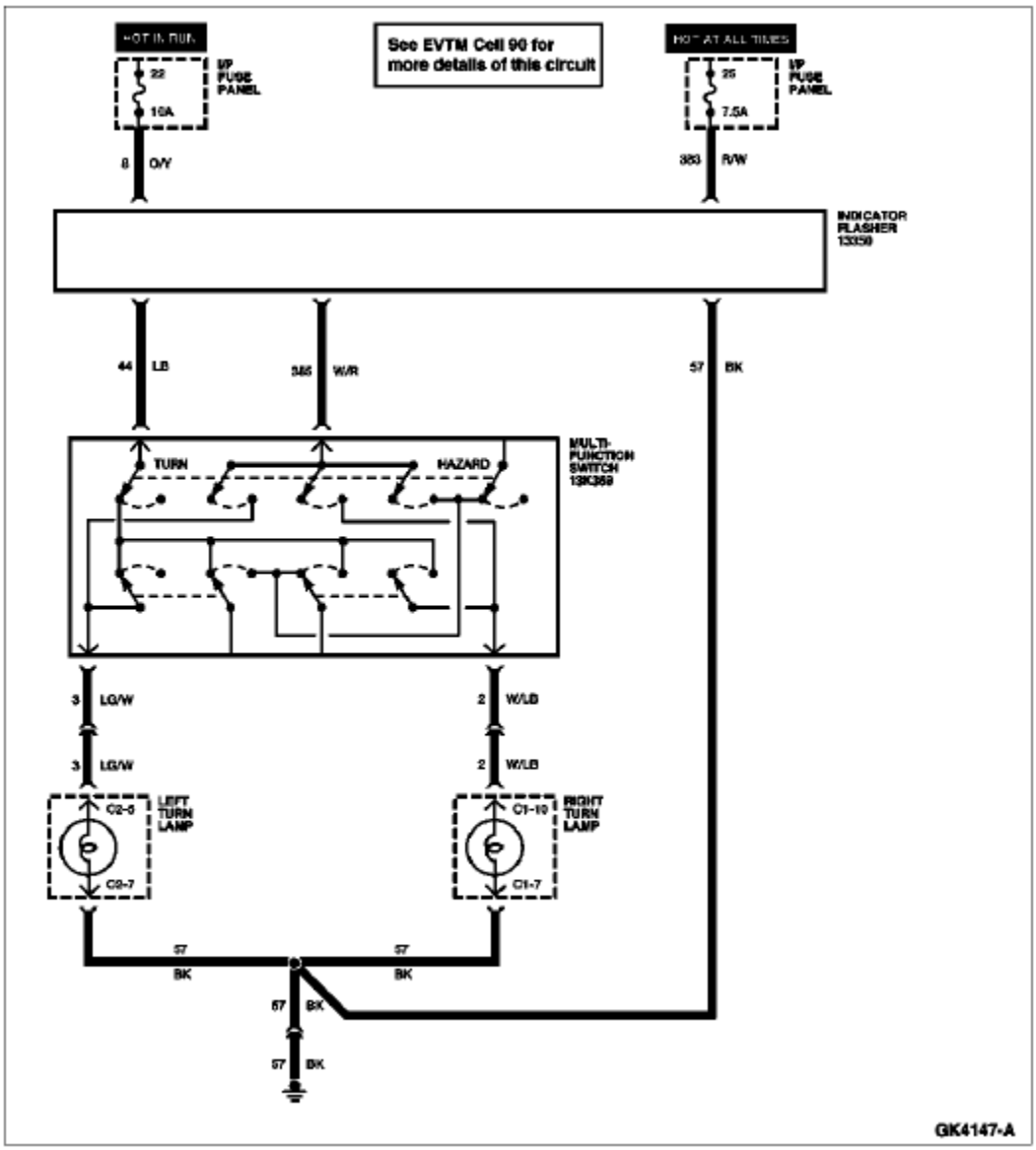

Fuel Reset Lamp — Ranger

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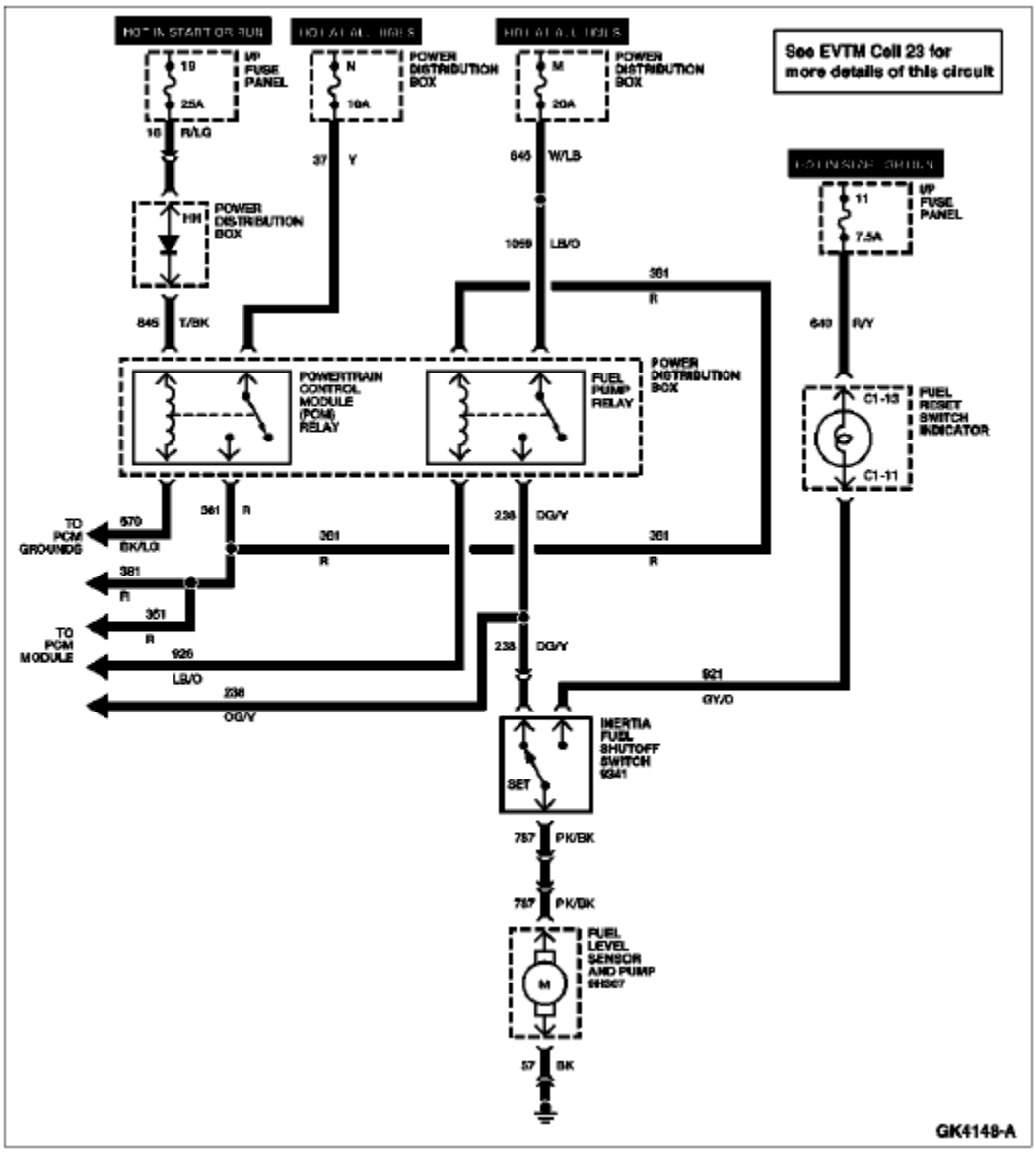

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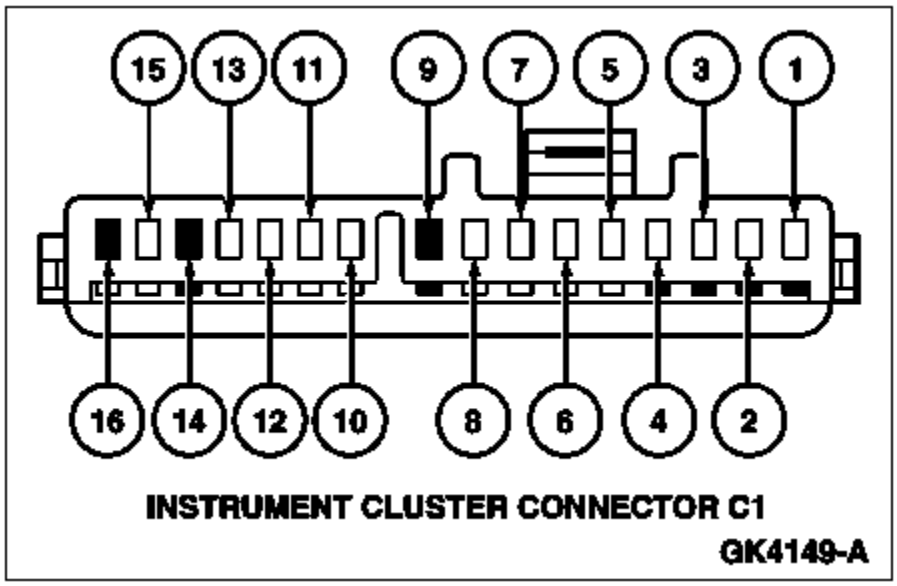

Pin Number	Circuit	Circuit Function
1	911 (W/LG)	PCM to Output Circuit Indicator Lamp/Overdrive Cancel Indicator
2	784 (LB/BK)	4x4 Low Range Indicator Ground Input
3	783 (GY)	4x4 High Range Indicator Ground Input
4	203 (O/LB)	Speed Control Indicator Ground Input
5	484 (O/BK)	Headlamp Switch Power Input
6	343 (DB/LG)	Warning Lamp to Anti-Theft Module (Limited Edition Only)
7	57 (BK)	Ground
8	19 (LB/R)	Lamp Return to Pulse Width Module
9	—	NOT USED
10	2 (W/LB)	RH Front Turn Signal Lamp
11	921 (GY/O)	Feed to Fuel Shutoff Lamp
12	253 (DG/W)	Oil Pressure Sensor Input
13	640 (R/Y)	Vehicle Power(Hot in Start or Run)
14	—	NOT USED
15	11 (T/Y)	ICM, Tach, EDM Signal
16	—	NOT USED

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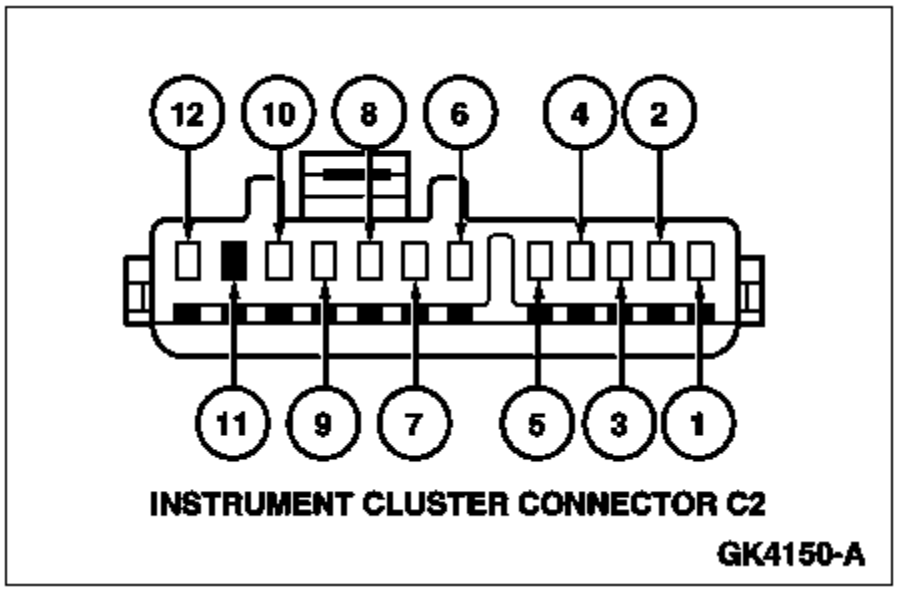

Pin Number	Circuit	Circuit Function
1	679 (GY/BK)	Vehicle Speed Sensor (VSS) Signal Input
2	570 (BK/W)	Dedicated Ground — EC
3	39 (R/W)	Temperature Gauge to Water Temperature Indicator Sender Unit
4	19 (LB/R)	Lamp Return to Pulse Width Module
5	3 (LG/W)	Left Turn Signal Input
6	932 (GY/W)	Daytime Running Lamp
7	57 (BK)	Ground
8	640 (R/Y)	Warning Lamps Feed (Hot in Start or Run)
9	658 (PP/LG)	Malfunction Indicator Lamp (MIL) Input
10	627 (BK/O)	Open Door Warning Lamp to Open Door Warning Switch
11	—	NOT USED
12	29 (Y/W)	Fuel Gauge to Fuel Gauge Sender

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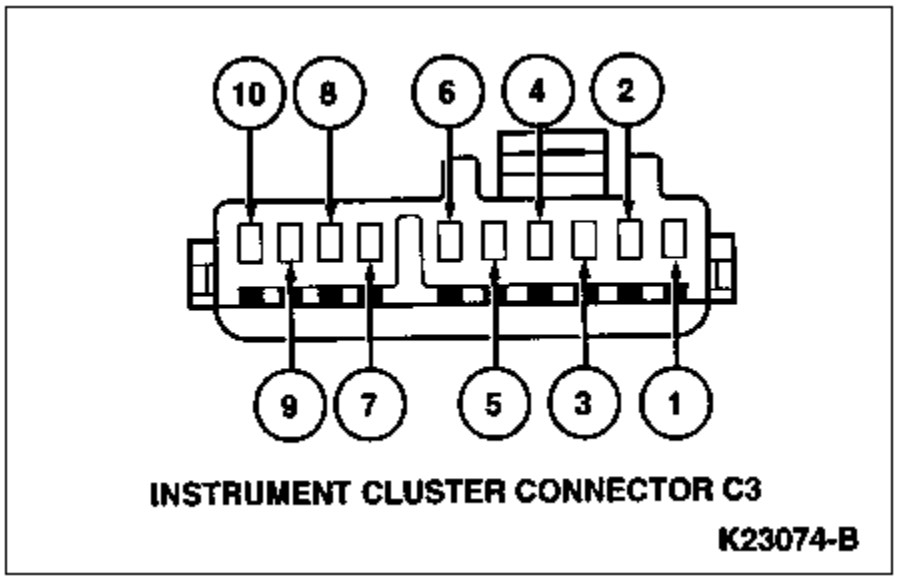

Pin Number	Circuit	Circuit Function
1	640 (R/Y)	Warning Lamps Feed (Hot in Start or Run)
2	584 (Y)	Alternator Lamp Feed (Hot in Start or Run)
3	904 (LG/R)	Ignition Switch "COIL"/"ACC" to Voltage Regulator "IGN" Terminal
4	608 (BK/Y)	Air Bag Diagnostic Lamp Driver
5	977 (P/W)	Dual Brake Warning Switch to Indicator Lamp
6	603 (DG)	Failure Warning Light
7	1001 (W/Y)	Fused Battery Feed to Instrument Cluster Speedometer
8	398 (BK/Y)	Ground to Tachometer/Gauge Module (3.0L, 4.0L)
9	—	NOT USED
10	871 (Y)	Seat Belt Indicator Lamp to Module

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Inspection and Verification

Visually inspect the components. Check for damaged components, blown fuses, loose or corroded connections. Check the wiring harness for obvious signs of shorts, opens, bad connections or damage. Verify circuit operation. Verify speedometer and odometer operation by road testing the vehicle.

If fuel indicating system components are functioning properly and inaccurate indications continue, check the fuel tank (9002) for damage which may have changed the fuel sending unit mounting angle and/or damaged the fuel sending unit.

Verify the engine coolant level is full. Verify the water thermostat (8575) is operating and that drive belt tension is within specification.

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Symptom Chart — Conventional Instrument Cluster

CONVENTIONAL INSTRUMENT CLUSTER

CONDITION	ACTION
Fuel Level Reads Inaccurately	· GO to Pinpoint Test A.
Coolant Temperature Reads Inaccurately, Aerostar	· GO to Pinpoint Test B.
Coolant Temperature Reads Inaccurately, Ranger	· GO to Pinpoint Test C.
Oil Pressure Reads Inaccurately	· GO to Pinpoint Test D.
Charge Indicator Reads Inaccurately	· GO to Pinpoint Test E.
Speedometer/Odometer Reads Inaccurately, Aerostar	· GO to Pinpoint Test F.
Speedometer/Odometer Reads Inaccurately, Ranger	· GO to Pinpoint Test G.
Speedometer/Odometer Inoperative (PSOM), Aerostar	· GO to Pinpoint Test H.
Speedometer/Odometer Inoperative, Ranger	· GO to Pinpoint Test J.
Speed Control, PCM, Aerostar EIC, or Electronic Transmission Inoperative, Erratic	· GO to Pinpoint Test K.
Tachometer Inoperative — Ranger	· GO to Pinpoint Test L.
Tachometer Not Reflecting Engine Speed	· GO to Pinpoint Test M.
All Warning Indicators Inoperative	· GO to Pinpoint Test N.

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Pinpoint Tests

PINPOINT TEST A: FUEL LEVEL READS INACCURATELY

A1 VERIFY POWER AT FUSE 11 — LOAD SIDE

- Key ON.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, verify system voltage at the load side of fuse 11.

Is the voltage greater than 10 volts?

Yes	No
GO to **A3** .	GO to **A2** .

A2 VERIFY POWER AT FUSE 11 — FEED SIDE

- Key ON.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, verify system voltage at the feed side of the fuse 11.

Is the voltage greater than 10 volts?

Yes	No
REPLACE the fuse. RETEST system.	REPAIR the wiring to the fuse panel. RETEST system.

A3 VERIFY POWER AT CLUSTER CIRCUIT 640 (R/Y)

- Have cluster connector(s) remain intact.
- Partially remove the instrument cluster from the instrument panel.
- Key ON.
- Measure the voltage on Circuit 640 (R/Y) at the instrument cluster connector to ground.

Is the voltage greater than 10 volts?

Yes	No
GO to **A4** .	REPAIR Circuit 640 (R/Y). RETEST system.

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A4 VERIFY GROUND CIRCUIT 570 (BK/W)

CAUTION: Before checking the continuity of any circuit, make sure there is no voltage present in the circuit prior to switching the test equipment to the resistance function to avoid damage to equipment. Refer to the test equipment user's manual for additional information.

- Use an ohmmeter to check the continuity of the ground wire at the instrument cluster connector to ground.

Is the resistance less than 1 ohm?

Yes	No
GO to **A5** .	REPAIR Circuit 570 (BK/W). RETEST system.

A5 CHECK FUEL GAUGE (EMPTY)

- Key OFF.
- Disconnect the fuel gauge sending unit.
- Connect one lead of the Rotunda Instrument Gauge System Tester 014-R1063 or equivalent to the fuel sending unit input wire Circuit 29 (Y/W) at the fuel gauge sending unit connector. Connect the other lead to ground.
- Set the tester to 22 ohms.
- Key ON.
- Wait one minute.
- Read the fuel gauge.

Does the fuel gauge read E (empty)?

Yes	No
GO to **A8** .	GO to **A6** .

A6 RECHECK FUEL GAUGE (EMPTY)

- Place the key in the OFF position. Then to the ON position. Tap on the instrument panel.
- Wait one minute.
- Read the fuel gauge.

Does the fuel gauge read E (empty)?

Yes	No
GO to **A8** .	GO to **A7** .

A7 CHECK PRINTED CIRCUIT

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- Key OFF.
- Disconnect the instrument cluster and instrument cluster gauge amplifier.
- Measure the resistance of the circuit between the "SIG" terminal of the fuel gauge and the instrument cluster gauge amplifier.

Is the resistance less than 1 ohm?

Yes	No
REPLACE the instrument cluster gauge amplifier and fuel gauge. RETURN to **A5** .	Ranger: REPLACE instrument cluster printed circuit as described in Removal and Installation, instrument cluster in this section. Aerostar: REPLACE instrument cluster as described in Removal and Installation, Instrument Cluster in this section.

A8 CHECK FUEL GAUGE SENDING UNIT WIRE

- Key OFF.
- Disconnect the instrument cluster and the fuel gauge sending unit.
- Measure the resistance of Circuit 29 (Y/W) between the instrument cluster and the fuel gauge sending unit.

Is the resistance less than 1 ohm?

Yes	No
GO to **A9** .	SERVICE Circuit 29 (Y/W) between the instrument cluster and the fuel gauge sending unit. RETEST system.

A9 CHECK FUEL SENDING UNIT GROUND

- Key OFF.
- Measure the resistance of Circuit 651 (BK/Y) (Ranger) or "BK/W" (Aerostar) wire at the fuel gauge sending unit connector to ground at battery.

Is the resistance less than 1 ohm?

Yes	No
GO to **A10** .	SERVICE Circuit 651 (BK/Y) (Ranger) or "BK/W" (Aerostar) wire from the fuel gauge sending unit to ground.

A10 CHECK FUEL GAUGE (FULL)

- Key OFF.
- Disconnect the fuel gauge sending unit.
- Connect one lead of the Rotunda Instrument Gauge System Tester 014-R1063 or equivalent to

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Circuit 29 (Y/W) at the fuel gauge sending unit connector and the other lead to ground.
- Set the tester to 145 ohms.
- Key ON.
- Wait one minute.
- Read the fuel gauge.

Does the fuel gauge read F (full)?

Yes	No
GO to **A11** .	REPLACE the instrument cluster gauge amplifier and fuel gauge. RETURN to **A5** .

A11 FUEL TANK INSPECTION

- Inspect fuel tank for distortion or damage.

Is fuel tank damaged?

Yes	No
REPLACE fuel tank. REFER to Section 10-01 .	GO to **A12** .

A12 TEST BOX CHECK — EMPTY STOP

- Connect one lead of a Rotunda 73 Digital Multimeter 105-R0051 or equivalent, to the fuel sender signal lead Circuit 29 (Y/W) and the other lead to sender ground Circuit 651 (BK/Y).
- Position the float rod against the empty stop (closest to fuel filter).

Does DVOM read 14-18 ohms?

Yes	No
GO to **A13** .	REPLACE fuel sender.

A13 TEST BOX CHECK — FULL STOP

- Connect one lead of a Rotunda 73 Digital Multimeter 105-R0051 or equivalent, to the fuel sender signal lead Circuit 29 (Y/W) and the other lead to sender ground Circuit 651 (BK/Y).
- Position the float rod against the full stop.

Does DVOM read 154-162 ohms?

Yes	No
GO to **A14** .	REPLACE fuel sender.

A14 TEST BOX CHECK — FLOAT ROD TRAVEL

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- Connect one lead of a Rotunda 73 Digital Multimeter 105-R0051 or equivalent, to the fuel sender signal lead Circuit 29 (Y/W) and the other lead to sender ground Circuit 651 (BK/Y).
- Move float rod slowly from FULL to EMPTY stop position.

Does ohmmeter reading decrease slowly?

Yes	No
GO to **A15** .	REPLACE fuel sender. REFER to Section 10-01 .

A15 HARNESS CONNECTOR CHECK — EMPTY STOP

- Reattach all fuel indication connectors.
- Move float rod to empty stop position.
- Place key in the ON position.
- Wait 60 seconds.
- Read fuel gauge.

Does fuel gauge read empty?

Yes	No
GO to **A16** .	GO to **A7** .

A16 HARNESS CONNECTOR CHECK — FULL STOP

- Reattach all fuel indication connectors.
- Move float rod to full-stop position.
- Place key in the ON position.
- Wait 60 seconds.
- Read fuel gauge.

Does fuel gauge read full?

Yes	No
GO to **A17** .	GO to **A7** .

A17 INSPECT FUEL SENDER

- Inspect float and float rod.

Is float or float rod distorted, hitting filter, filled with fuel or loose?

Yes	No
REPLACE fuel sender. REFER to Section 10-01 .	REPLACE fuel sending unit. REFER to Section 10-01 in the Powertrain, Drivetrain Manual.

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PINPOINT TEST B: COOLANT TEMPERATURE READS INACCURATELY, AEROSTAR

B1 VERIFY POWER AT FUSE PANEL — LOAD SIDE

- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent verify system voltage at load side of warning indicator fuse 11.

Is system voltage present at load side of fuse?

Yes	No
GO to **B3** .	GO to **B2** .

B2 VERIFY POWER AT FUSE PANEL — FEED SIDE

- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent verify system voltage at feed side of warning indicator fuse 11.

Is system voltage present at feed side of fuse?

Yes	No
REPLACE fuse. RETEST system.	SERVICE wiring to fuse panel. RETEST system.

B3 VERIFY POWER AT INSTRUMENT CLUSTER

- Partially remove cluster from instrument panel. Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent verify system voltage at instrument cluster connector Circuit 640 (R/Y).
- Inspect instrument cluster connector for damage.

Is voltage present at instrument cluster connector?

Yes	No
GO to **B4** .	SERVICE Circuit 640 (R/Y). RETEST system.

B4 VERIFY GROUND CIRCUITRY AT CLUSTER

CAUTION: Before checking the continuity of any circuit, make sure there is no voltage present in the circuit prior to switching the test equipment to the resistance function to avoid damage to equipment. Refer to the test equipment user's manual for additional information.

- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check continuity of cluster and gauge ground Circuit 570 (BK/W).

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Is the resistance less than 1 ohm?

Yes	No
GO to **B5** .	SERVICE Circuit 570 (BK/W). RETEST system.

B5 COMPONENT TEST

- Perform Coolant Temperature Gauge Component Test in this section.

Does gauge operate properly?

Yes	No
REPLACE coolant temperature sender. REFER to Section 03-03 in the Powertrain, Drivetrain Manual .	GO to **B6** .

B6 CHECK SENDING UNIT CIRCUIT WIRING

CAUTION: Before checking the continuity of any circuit, make sure there is no voltage present in the circuit prior to switching the test equipment and to the resistance function to avoid damage to equipment. Refer to the test equipment user's manual for additional information.

- Ignition OFF.
- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check sending unit circuit wiring and instrument cluster printed circuit for shorts or opens by physically flexing the wiring and observing continuity. The continuity reading should not fluctuate.

Are wiring and flex circuit OK?

Yes	No
REPLACE gauge as described in Removal and Installation in this section.	SERVICE wiring or REPLACE the instrument cluster as described in Removal and Installation in this section.

PINPOINT TEST C: COOLANT TEMPERATURE READS INACCURATELY, RANGER

C1 CHECK INSTRUMENT CLUSTER TEMPERATURE GAUGE

- Perform the Coolant Temperature Gauge Component Test in this section.

Is the instrument cluster temperature gauge OK?

Yes	No

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REPLACE the water temperature indicator sender unit.	GO to **C2** .

C2 CHECK WIRE BETWEEN INSTRUMENT CLUSTER AND WATER TEMPERATURE INDICATOR SENDER UNIT

- Key OFF.
- Disconnect the instrument cluster connector C2.
- Measure the resistance of the "R/W" wire between the instrument cluster connector C2 pin 3 and the water temperature indicator sender unit connector; and between the instrument cluster connector C2 pin 3 and ground.

Is the resistance less than 5 ohms between the instrument cluster connector C2 and the water temperature indicator sender unit; and greater that 10,000 ohms between the instrument cluster C2 connector and ground?

Yes	No
GO to **C3** .	SERVICE the "R/W" wire.

C3 CHECK POWER TO INSTRUMENT CLUSTER

- Disconnect the instrument cluster connector C1.
- Key ON.
- Measure the voltage between the instrument cluster connector C1 pin 13, Circuit 640 (R/Y), and ground.

Is the voltage greater than 10 volts?

Yes	No
GO to **C4** .	SERVICE the "R/Y" wire.

C4 CHECK INSTRUMENT CLUSTER GROUND

- Key OFF.
- Measure the resistance between instrument cluster C2 pin 2, Circuit 570 (BK/W), and ground.

Is the resistance less than 5 ohms?

Yes	No
GO to **C5** .	SERVICE the "BK/W" wire.

C5 CHECK INSTRUMENT CLUSTER TEMPERATURE GAUGE

- Measure the resistance between the instrument cluster temperature gauge clip "B" and the instrument

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cluster temperature gauge clip "S".
- Measure the resistance between the instrument cluster temperature gauge clip "S" and the instrument cluster temperature gauge clip "G".

Is the resistance 235 +/- 21 ohms between the "B" clip and "S" clip; and 100 +/- 10 ohms between the "S" clip and "G" clip?

Yes	No
REPLACE the instrument cluster printed circuit.	REPLACE the engine coolant temperature gauge.

PINPOINT TEST D: OIL PRESSURE READS INACCURATELY

D1 VERIFY POWER AT FUSE PANEL — LOAD SIDE

- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, verify system voltage at load side of warning indicator fuse.

Is system voltage present at load side of fuse?

Yes	No
GO to **D3** .	GO to **D2** .

D2 VERIFY POWER AT FUSE PANEL — FEED SIDE

- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, verify system voltage at feed side of warning indicator fuse.

Is system voltage present at feed side of fuse?

Yes	No
REPLACE fuse. RETEST system.	SERVICE wiring to fuse panel. RETEST system.

D3 VERIFY POWER AT CLUSTER

- Partially remove cluster. Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, verify system voltage at cluster connector CIrcuit 640 (R/Y) and/or gauge terminal.
- Inspect cluster connector for damage.

Is voltage present at cluster connector and gauge terminal?

Yes	No
GO to **D4** .	SERVICE Circuit 640 (R/Y). RETEST system.

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D4 VERIFY GROUND CIRCUITRY AT CLUSTER

CAUTION: Before checking the continuity of any circuit, make sure there is no voltage present in the circuit prior to switching the test equipment to the resistance function to avoid damage to equipment. Refer to the test equipment user's manual for additional information.

- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check continuity of instrument cluster Circuit 570 (BK/W) and gauge ground circuitry.

Is ground circuitry good?

Yes	No
GO to **D5** .	SERVICE as required.

D5 TEST SENDER CIRCUIT AT LOW

- Place key in the ON position with engine off. Observe gauge performance.

Does the gauge read L or below?

Yes	No
GO to **D6** .	GO to **D7** .

D6 CHECK GAUGE RESPONSE

- Disconnect oil pressure switch and short the lead to engine ground.

Does the gauge indicate approximately mid-scale or slightly above mid-scale (around the MAL in normal)?

Yes	No
REPLACE oil pressure switch. GO to **D7** .	

D7 CHECK SENDING UNIT/SWITCH WIRING

CAUTION: Before checking the continuity of any circuit, make sure there is no voltage present in the circuit prior to switching the test equipment to the resistance function to avoid damage to equipment. Refer to the test equipment user's manual for additional information.

- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check sending unit/switch wiring and instrument cluster printed circuit for shorts or opens by physically flexing the wiring and observing continuity. The continuity reading should not fluctuate.

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- Measure the resistance on the circuits from the instrument cluster input connector to the gauge clips. Resistance should be less that 1.1 ohm, unless circuit has a 20 ohm resistance in line with circuit, in which case resistance should be less than 21 ohms.

Is wiring and instrument cluster printed circuit OK?

Yes	No
REPLACE gauge as described in Removal and Installation in this section.	Aerostar: SERVICE wiring or REPAIR or REPLACE the instrument cluster. Ranger: SERVICE wiring or REPLACE instrument cluster printed circuit as described in Removal and Installation in this section.

PINPOINT TEST E: CHARGE INDICATOR READS INACCURATELY

E1 VERIFY VOLTAGE GAUGE OPERATION

- Key ON (with engine stopped).
- Headlamps ON.
- Heater blower/fan on HIGH.

Does gauge pointer move toward the lower portion of the NORMAL BAND (white marked area)?

Yes	No
GO to **E2** .	CHECK fuse and the battery-to-circuit breaker and Circuit 640 (R/Y). GO to **E6** .

E2 VERIFY POWER AT FUSE PANEL — LOAD SIDE

- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, verify system voltage at load side of warning indicator fuse.

Is system voltage present at load side of fuse?

Yes	No
GO to **E4** .	GO to **E3** .

E3 VERIFY POWER AT FUSE PANEL — FEED SIDE

- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, verify system voltage at feed side of warning indicator fuse.

Is system voltage present at feed side of fuse?

Yes	No

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REPLACE fuse. RETEST system.	SERVICE wiring to fuse panel. RETEST system.

E4 VERIFY POWER AT INSTRUMENT CLUSTER

- Partially remove instrument cluster from instrument panel. Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, verify system voltage at cluster connector Circuit 640 (R/Y) or gauge terminal.

Is voltage present at instrument cluster connector and gauge terminal?

Yes	No
GO to **E5** .	SERVICE Circuit 640 (R/Y).

E5 VERIFY GROUND CIRCUITRY AT INSTRUMENT CLUSTER

CAUTION: Before checking the continuity of any circuit, make sure there is no voltage present in the circuit prior to switching the test equipment to the resistance function to avoid damage to equipment. Refer to the test equipment user's manual for additional information.

- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check continuity of instrument cluster Circuit 570 (BK/W) and gauge ground circuitry.

Is ground circuitry OK?

Yes	No
GO to **E6** .	SERVICE Circuit 570 (BK/W).

E6 CHECK INSTRUMENT CLUSTER PRINTED CIRCUIT CONTINUITY

CAUTION: Before checking the continuity of any circuit, make sure there is no voltage present in the circuit prior to switching the test equipment to the resistance function to avoid damage to equipment. Refer to the test equipment user's manual for additional information.

- Check for instrument cluster printed circuit continuity and confirm flex circuit-to-clip and clip-to-gauge contact by physically flexing the wiring and observing continuity. Continuity reading should not fluctuate.

Are wiring and instrument cluster printed circuit OK?

Yes	No
NOTE: Two volt gauges. Determine if resistor and diode are soldered to leads of the terminals (Design One). No electronic component, on gauge terminals (Design Two).	Aerostar: SERVICE wiring or REPLACE the instrument cluster as described in Removal and Installation in this section. Ranger: SERVICE wiring or REPLACE instrument cluster printed circuit as described in Removal and Installation

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REPLACE gauge as described in Removal and Installation in this section.	in this section.

PINPOINT TEST F: SPEEDOMETER/ODOMETER READS INACCURATELY, AEROSTAR

F1 CHECK INITIAL STATUS

- Refer to speedometer calibration tolerance specifications table in F7 . Be sure to check the odometer calibration. If both the odometer and speedometer are incorrect in the same direction, it is usually a sign that the conversion constant, tire size, or speed sensor ring are different than programmed. A speedometer inaccurate with an accurate odometer is usually a problem with the speedometer module itself.

Are speedometer and odometer calibration within specified limits?

Yes	No
Speedometer normal.	GO to F2 .

F2 CHECK FOR "NOT PROGRAMMED" MESSAGE

Does "ERROR 3" message alternate with normal odometer display?

Yes	No
GO to F7 . RESET conversion constant. REFER to Reset Conversion Constant in F7 .	GO to F3 .

F3 CHECK TIRES/AXLE CAPACITY

Are tires the same size on opposite ends of a common axle and properly inflated?

Yes	No
DETERMINE conversion constant. GO to F5 .	CORRECT condition or ADVISE customer. GO to F1 .

F4 VERIFY CONVERSION CONSTANT AND DISPLAY MODE

- Check whether the conversion constant in the speedometer is correct with the following procedure:
  - Press and hold the RESET button on the front of the speedometer while turning the key to RUN.
  - Release the RESET button. The pointer will prove out and some codes will appear on the odometer display. If an "E" is on the left side of the display, the module is programmed for English display mode and should have English (MPH) graphics. A lower case "o" signifies an

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overseas (KMH) graphics. Verify the graphics and display modes agree. (The number appearing after the type is the microprocessor revision level and is not used in this test.)
- Press and release the RESET button again. The conversion constant and the word CAL will be shown on the odometer display.
- Verify the programmed conversion constant is the same as that displayed on the chart or the constant calculated in **F6** . Refer to Conversion Constants Chart under Specifications in this section.
- Turn off the key to exit this test.

Is the programmed conversion constant the same as that displayed on the chart or the constant calculated in F6?

Yes	No
REPLACE instrument cluster as described in this section. VERIFY proper operation.	GO to **F7** .

F5 DETERMINE CONVERSION CONSTANT

- Check tire size and type on vehicle rear axle or SAE average revs/mile.
  - Refer to tire/axle capacity chart and note conversion constant.

Can the conversion constant be determined?

Yes	No
VERIFY conversion constant. GO to **F4** .	GO to **F6** .

F6 MEASURE TIRE DIAMETER

- To determine the conversion constant perform the following procedure:
  - Hoist vehicle.
  - Measure tire outside diameter (TOD).
  - Note number of rear axle speed sensor teeth, speed sensor ring diameter, or axle capacity/tape group.
  - Verify speed sensor ring diameter with identification tag attached to rear axle cover retaining bolts. If tag is missing manually count teeth.

    NOTE: 7.5-inch rear axles have 102 teeth and 8.8-inch rear axles have 108 teeth.

Is outside diameter greater than 25.2 inches?

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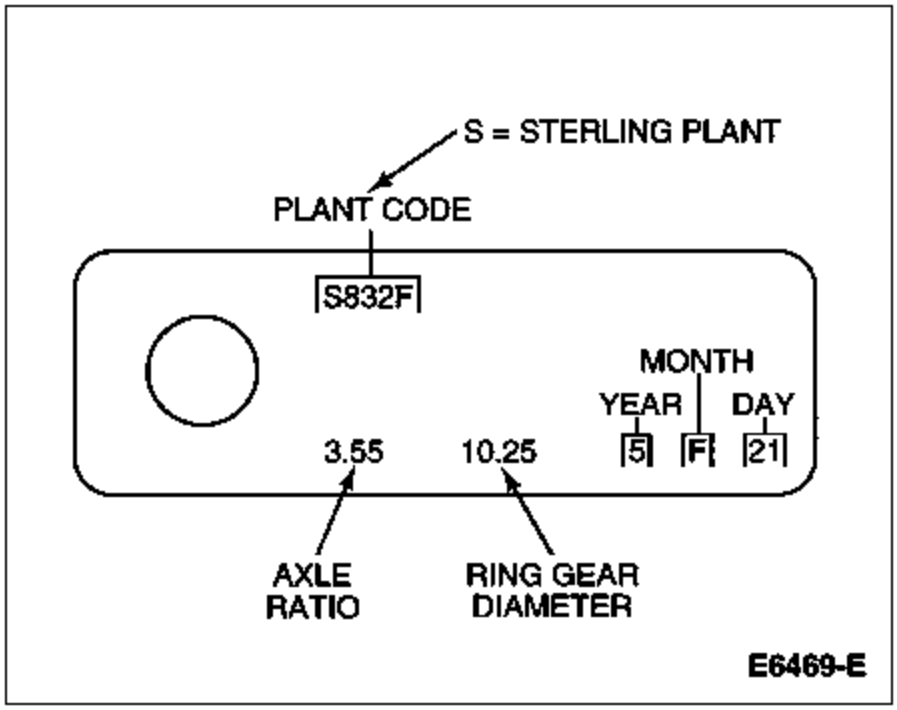

Yes	No
USE formula revs/mile = 1528 - (28x TOD) to calculate SAE average revs/mile. GO to F4 .	Revs/mile = 20,850/TOD. GO to F4 .

F7 RESET CONVERSION CONSTANT

- Reprogram speed conversion constant using the following procedure:
  - Locate the dealer mode programming enable connection. It is located behind the cowl side trim panel.
  - Insert metal clip in service wire panel connector. Clip other end to vehicle ground while the key is in the OFF position.
  - Turn key to RUN (not crank) position while holding down the trip odometer RESET button on speedometer. Release RESET button.
  - Speedometer will prove out (sweep across dial and back). The English/Metric and revision levels will be displayed.
  - The last number on the right side of display is the reprogramming lockout count. This count shows the number of allowable conversion constants remaining. When the count is zero, no additional changes can be made to this instrument cluster. If a conversion constant change is necessary, a service instrument cluster must be ordered.
  - Press and release RESET button again and PSOM conversion constant (without the decimal point) followed by the word CAL.
  - Press and release the odometer SELECT button as many times as necessary to change conversion constant to the correct value.

    NOTE: Pressing and releasing the RESET button to lock in the new conversion constant removes the number of times the PSOM can be reprogrammed by one count. The module can only be reprogrammed six times. If it is determined the original conversion constant is satisfactory, turn the key to OFF BEFORE the new constant is locked in.

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- When the correct new value is displayed in odometer window, press and release the RESET button to lock in the new conversion constant.
- Turn the key off and remove the ground wire. Verify proper operation of the speedometer.

Is conversion constant set to desired value?

Actual Speedometer or Odometer Value Indicated	48 km/h (30 mph) Actual Speed	97 km/h (60 mph) Actual Speed	Odometer Measure Over Actual 16.1 km Distance (10 Miles)
Allowable Range	45-55 km/h (28-34 mph)	93-108 km/h (58-67 mph)	15.4-16.6 km (9.6-10.3 miles)

Yes	No
Procedure complete.	GO to F5 .

PINPOINT TEST G: SPEEDOMETER/ODOMETER READS INACCURATELY, RANGER

G1 CHECK CONNECTIONS

- Verify connector is properly attached at speed sensor.

Are all connections good?

Yes	No
GO to G2 .	REPAIR or REPLACE as necessary. RETEST system.

G2 CHECK ODOMETER

- Check accuracy of odometer.
- If odometer is accurate, calibration of speedometer may be off. Changing the speedometer may correct, but going on to change either gear will make speedometer reading more accurate, but now odometer will not be accurate.

Is odometer accurate?

Yes	No
REPLACE speedometer as described in Removal and Installation in this section. CHECK for speedometer accuracy.	GO to G3 .

G3 CHECK DRIVEN GEAR

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- Check for proper driven gear. Refer to the Ford Speedometer Gear Supplement Charts for speedometer gear applications.
- If odometer is accurate, calibration of speedometer may be off. Changing the speedometer may correct but going on to change either gear will make speedometer reading more accurate, but now odometer will not be accurate.

Is the correct driven gear installed?

Yes	No
GO to **G4** .	REPLACE gear with correct gear. CHECK for accuracy.

G4 CHECK DRIVE GEAR AXLE, TIRES AND RATIO ADAPTOR

- Check for proper driven gear, axle, tires and ratio adaptor.

Is driven gear, axle, tire and ratio adapter correct?

Yes	No
REPLACE speedometer as described in Removal and Installation in this section. CHECK for accuracy.	REPLACE incorrect component or driven gear. CHECK for accuracy.

PINPOINT TEST H: SPEEDOMETER/ODOMETER INOPERATIVE (PSOM), AEROSTAR

H1 CHECK REAR ANTI-LOCK LAMP ILLUMINATION

- Key to RUN.

Does anti-lock lamp go out after self-test?

Yes	No
GO to **H2** .	REFER to Section 06-09A for diagnosis of anti-lock speed sensor, and speed sensor gear.

H2 CHECK ODOMETER DISPLAY

Is odometer display on, and do digits appear normal?

Yes	No
GO to **H3** .	GO to **H6** .

H3 CHECK FOR PRESENCE OF ERROR MESSAGE

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NOTE: "ERROR 3" indicates the conversion constant must be programmed. See Pinpoint Test F.

Does the word "ERROR" appear on the odometer display?

Yes	No
REPLACE instrument cluster as described in Removal and Installation in this section. VERIFY proper operation.	GO to **H4** .

H4 CHECK ODOMETER OPERATION

Odometer display increments mileage with vehicle motion or rear wheels turning?

Yes	No
GO to **H9** .	GO to **H5** .

H5 CHECK SPEEDOMETER

Does speedometer indication increase with increasing vehicle speed?

Yes	No
REPLACE instrument cluster as described in Removal and Installation in this section. VERIFY proper operation.	GO to **H8** .

H6 CHECK SPEEDOMETER POWER FUSES

- Remove, check, and reinstall battery power fuse No. 8 if intact.
- Remove, check, and reinstall battery power fuse No. 17 if intact.

NOTE: If fuses are blown, replace with a new, intact fuse. If new fuse blows, determine cause and service as necessary.

With fuses intact, do the speedometer and odometer operate properly?

Yes	No
REPLACE instrument cluster as described in Removal and Installation in this section. VERIFY proper operation.	Go to **H7** .

H7 CHECK SPEEDOMETER CONNECTOR VOLTAGES

- Verify battery, ground and ignition available on Pins 1, 2 and 3 respectively with key in RUN.

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NOTE: Only the wiring harness end of the connector should be probed.

Is resistance to ground less than 1 ohm with terminals in wiring harness connector completely seated in connector and locking tabs?

Yes	No
REPLACE instrument cluster as described in Removal and Installation in this section.	SERVICE wiring harness and fuses as required. VERIFY proper operation.

H8 CHECK SPEED INPUT SIGNAL

- Connect Rotunda 73 Digital Multimeter 105-R0051 or equivalent to Pin 4 (speed in +) and Pin 5 (speed in -).

  NOTE: Only the wiring harness end of the connector should be probed.

- **Does the voltage increase smoothly and continuously from 0 to approximately 3.5 volts as vehicle speed increases from 0 to 30 mph?**
- OR,
- If available, a frequency counter may be connected to Pin 4 (speed in +) and Pin 5 (speed in -).
- **Does the displayed frequency of the signal increase smoothly and continuously from 0 to approximately 667 Hz at approximately 30 mph?**
- OR,
- If neither a voltmeter nor frequency counter is available, vehicle speed control may be used as a good indicator. If it works normally, then the speedometer module is at least receiving a speed input signal and the wiring and sensor can be assumed to be good.

Does the speed control work normally?

Yes	No
REPLACE instrument cluster as described in Removal and Installation in this section.	SERVICE wiring. CHECK for open or shorted wiring. If no problems are found, REFER to Section 06-09A .

H9 CHECK SPEEDOMETER OPERATION

Does speedometer indication increase with increasing vehicle speed?

Yes	No
Normal operation. ADVISE customer.	REPLACE instrument cluster as described in Removal and Installation in this section.

PINPOINT TEST J: SPEEDOMETER/ODOMETER INOPERATIVE, RANGER

J1 CHECK CONNECTIONS

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- Verify connector is properly attached at speed sensor.

Are connections OK and is drive tip seated properly?

Yes	No
GO to J2 .	SERVICE or REPLACE as necessary, RETEST system.

J2 CHECK ODOMETER

- Check operation of odometer.

Does the odometer operate?

Yes	No
GO to J3 .	Go to J4 .

J3 CHECK SPEEDOMETER POINTER

- Check operation of speedometer pointer.

Does the speedometer/pointer operate?

Yes	No
System is OK.	REPLACE speedometer as described in Removal and Installation in this section. RECHECK speedometer for operation.

J4 CHECK VEHICLE SPEED SENSOR

- Disconnect speedometer connector from vehicle speed sensor and remove vehicle speed sensor and check that shaft in vehicle speed sensor turns freely.

Does shaft turn freely?

Yes	No
GO to J5 .	REPLACE vehicle speed sensor as described in Removal and Installation in this section. CHECK speedometer for operation.

J5 CHECK GEARS

- Check drive/driven gears for damage or wear.

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Is drive/driven gears damaged?

Yes	No
REPLACE damaged or worn gear(s). CHECK speedometer for proper operation.	Go to **J6** .

J6 CHECK WIRING AND CONNECTIONS

- Verify the presence of signals at the printed circuit clips on the speedometer at the instrument cluster:
  - Circuit 640 R/Y: 10-14 volts DC with ignition switch in RUN or START position.
  - Circuit 1001 W/Y: 10-14 volts DC AT ALL TIMES.
  - Circuit 570 BK/W: 0 volts DC. Check continuity to ground (sheet metal).
  - Circuit 679 GY/BK: Speed signal. 1-5 volts AC with drive wheels turning (voltage rises with speed).

Are the above signals present?

Yes	No
REPLACE speedometer.	CHECK wiring and printed circuit on the instrument cluster for opens/shorts and REPAIR/REPLACE. RECHECK system.

PINPOINT TEST K: SPEED CONTROL, PCM, AEROSTAR EIC, OR ELECTRONIC TRANSMISSION INOPERATIVE OR ERRATIC NOTE: Follow this procedure only after being referred here by the Speed Control, PCM, AEROSTAR EIC, or electronic transmission shop manual diagnostics.

K1 CHECK REAR ANTI-LOCK LAMP ILLUMINATION

- Key ON.

Does anti-lock lamp go out after self-test?

Yes	No
GO to **K2** .	REFER to Section 06-09A .

K2 CHECK SPEEDOMETER SPEED OUTPUT SIGNAL

CAUTION: Before checking the continuity of any circuit, make sure there is no voltage present in the circuit prior to switching the test equipment to the resistance function to avoid damage to equipment. Refer to the test equipment user's manual for additional information.

- Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, check for shorts in the wiring between Pin 7 (speed out) and battery/ignition or ground. **Is circuit shorted?**

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- Use an ohmmeter to check for opens in the wiring between Pin 7 (speed out) and the affected module. Verify that terminals in PSOM wiring connector are completely seated in the connector. **Is the circuit open?**
- Connect an AC voltmeter to Pin 7 (speed out) and Pin 2 (module ground). **Does the voltage increase smoothly and continuously from 0 to approximately 4.5 volts as vehicle speed increases from 0 to approximately 30 mph?**
- OR,
- If available, a frequency counter may be connected to Pin 7 (speed out) and Pin 2 (module ground). **Does the displayed frequency of the signal increase smoothly and continuously from 0 to approximately 67 hz at approximately 35 mph?**
- OR,

If neither a voltmeter nor frequency counter is available, vehicle speed control may be used as a good indicator. If it works normally above 30 mph, this means that the speedometer module is at least receiving a speed input signal and the wiring and sensor can be assumed to be good. Does speed control work?

Yes	No
SERVICE wiring between speedometer and affected module as required. VERIFY proper operation.	GO to **K3** .

K3 CHECK SPEED INPUT SIGNAL

CAUTION: Make sure multimeter is in the voltage function and not in the resistance function to avoid damage to multimeter.

- Connect Rotunda 73 Digital Multimeter 105-R0051 or equivalent to Pin 4 (speed/in +) and Pin 5 (speed/in -). **Does the voltage increase smoothly and continuously from 0 to approximately 3.5 volts as vehicle speed increases from 0 to approximately 30 mph?**

  NOTE: Only the wiring harness end of the connector should be probed.

- OR,

If available, a frequency counter may be connected to Pin 4 (speed in +) and Pin 5 (speed in -). Does the displayed frequency of the signal increase smoothly and continuously from 0 to approximately 667 hz at approximately 30 mph?

NOTE: Only the wiring harness end of the connector should be probed.

Yes	No
REPLACE instrument cluster as described in Removal and Installation in this section.	SERVICE wiring. CHECK for opens or shorted wiring. If no problems are found, REFER to Section 06-09A or Section 06-09B .

PINPOINT TEST L: TACHOMETER INOPERATIVE — RANGER

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L1 CHECK FUSE

- Check Fuse.

Is fuse OK?

Yes	No
GO to L2 .	REPLACE fuse. If fuse blows again, CHECK for short in circuit.

L2 CHECK WIRING

- Check for loose wiring connections in engine compartment or at instrument cluster.

Is wiring OK?

Yes	No
GO to L3 .	SECURE loose connections.

L3 MAKE RESISTANCE CHECKS

CAUTION: Before checking the continuity of any circuit, make sure there is no voltage present in the circuit prior to switching the test equipment to the resistance function to avoid damage to equipment. Refer to the test equipment manual for additional information.

- Disconnect battery ground cable. Remove instrument cluster. Check resistance and voltage using Rotunda 73 Digital Multimeter 105-R0051 as follows:

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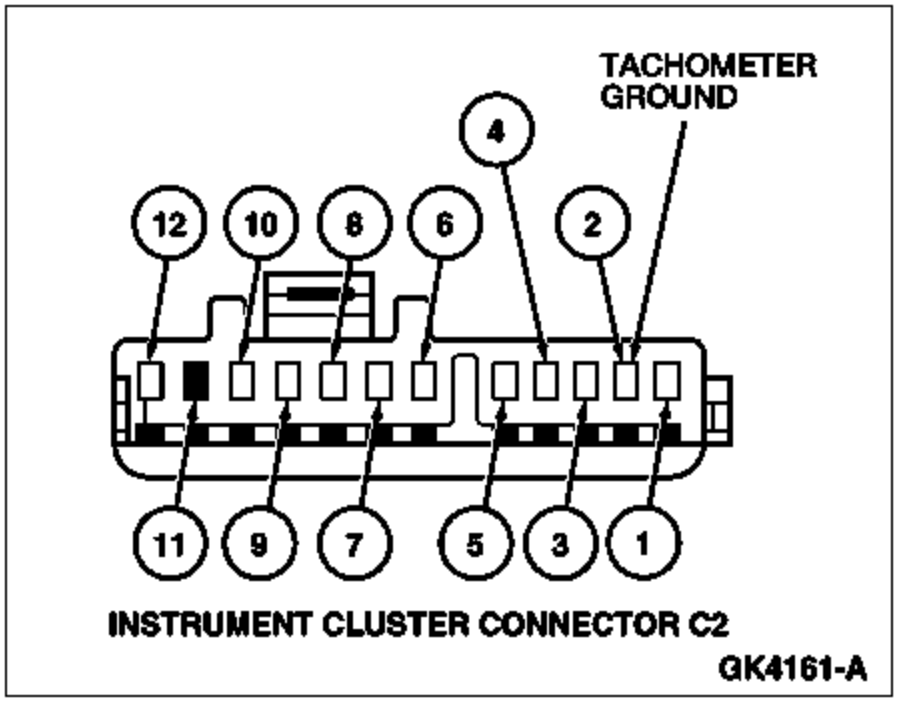

- Check pin 2 (Connector C2) resistance to chassis ground. Resistance should be 1 ohm or less.

  NOTE: Perform this check using EEC-V 104-pin Breakout Box 014-00950.

- Check pin 15 (Connector C1) to pin 48 of the PCM connector. Resistance should be 1 ohm or less.

  CAUTION: Make sure multimeter is in the voltage function and not in the resistance function to avoid damage to multimeter.

- Connect battery. Turn key ON. Check for 12 volts at pin 13 (Connector C1). Turn key off. Disconnect battery.

Is resistance within specifications?

Yes	No
REMOVE instrument cluster. REFER to the procedure in this section. REPLACE tachometer. REFER to the procedure in this section.	Condition is not in tachometer. SERVICE wiring.

PINPOINT TEST M: TACHOMETER NOT REFLECTING CORRECT ENGINE SPEED

M1 CHECK POWER SUPPLY TO GAUGE

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- Key OFF.
- Partially remove instrument cluster panel to gain access to the cluster connectors.
- Turn ignition switch to the RUN position.
- Check voltage at Circuit 640 (R/Y) at connector.

Is battery voltage present?

Yes	No
GO to **M2** .	SERVICE Circuit 640 (R/Y) for open. RESTORE vehicle. RETEST system.

M2 CHECK GAUGE GROUND

- Measure resistance between a known good ground and Circuit 398 (BK/Y) for 3.0L and 4.0L engines.

Are resistances 5 ohms or less?

Yes	No
GO to **M3** .	SERVICE Circuit 398 (BK/Y) for open. RESTORE vehicle. RETEST system.

M3 CHECK TACHOMETER INPUT CIRCUIT

- Key OFF.
- Disconnect instrument cluster connector C1.
- Disconnect ignition coil, or DIS.
- Install Rotunda EEC-V 104 Pin Breakout Box 014-00950.
- Measure resistance of Circuit 11 (T/Y) from Breakout Box Pin 30 to instrument cluster connector C1.

Is resistance 1.8 ohms or less?

Yes	No
GO to **M4** .	SERVICE Circuit 11 (T/Y) for open. RESTORE vehicle. RETEST system.

M4 CHECK CLUSTER CLIP TO CLUSTER CIRCUIT CONNECTION

- Reconnect instrument cluster connector C1.
- Check for continuity from the tachometer connector clips to instrument cluster printed circuit.

Is there continuity?

Yes	No
GO to **M5** .	REPLACE connector clips. RESTORE vehicle. RETEST system.

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M5 CHECK PRINTED CIRCUIT

- Check each circuit listed below for continuity from tachometer connector clips to cluster connector.

Connector	Pin	Circuit	Function
C3	8	398 (BK/Y), 3.0L and 4.0L	Ground Through 4.32 k Ohms Flex Circuit Resistor
C1	13	640 (R/Y)	Battery Power (Hot in Start or Run)
C1	15	11 (T/Y)	Tachometer Input

Is there correct resistance at all circuits?

Yes	No
REPLACE speedometer/tachometer assembly. RESTORE vehicle. RETEST system.	REPLACE instrument cluster printed circuit. RESTORE vehicle. RETEST system.

PINPOINT TEST N: ALL WARNING INDICATORS INOPERATIVE

N1 CHECK FUSE

- Check fuse.

Is fuse OK?

Yes	No
GO to N2 .	REPLACE fuse. If fuse blows again, CHECK for short in circuit.

N2 CHECK WIRING

- Check for loose wiring connections in engine compartment or at instrument cluster.

Is wiring OK?

Yes	No
GO to N3 .	SECURE loose connections.

N3 CHECK CLUSTER GROUND

- Key OFF.
- Partially remove instrument cluster as outlined.
- Measure resistance between a known good ground and Circuit 57 (BK) at instrument connector C1,

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Pin 7.

Is resistance 5 ohms or less?

Yes	No
GO to **N4** .	SERVICE Circuit 57 (BK) for open. RESTORE vehicle. RETEST system.

N4 CHECK SUPPLY AT CLUSTER

- Turn ignition switch to RUN position.
- Using a test lamp check CIrcuit 640 (R/Y) at connector C1.

Did test lamp illuminate?

Yes	No
REPLACE instrument cluster printed circuit. RESTORE vehicle. RETEST system.	SERVICE Circuit 640 (R/Y) for open. RESTORE vehicle. RETEST system.

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Component Tests

The Rotunda Instrument Gauge System Tester 014-R1063 or equivalent is used to diagnose concerns with the instrument cluster magnetic gauges.

Oil Pressure Gauge/Oil Pressure Sender

1. Disconnect connector from the oil pressure sender.
2. Turn the vehicle ignition switch lock cylinder (11582) to ON position.
    a. Short the connector directly to engine ground. The centerline of the pointer should fall slightly above the oil pressure gauge mid-scale.
3. With connector attached to the oil pressure sender and ignition switch lock cylinder on, the center line of the pointer should fall on or below the "L" mark.

- If the oil pressure gauge (9273) tests within calibration, replace oil pressure sender.
- If the oil pressure gauge still tests out of calibration, replace the gauge.

Fuel Gauge

With the sending unit float arm in the empty stop position, resistance should be 15 ohms (below E). With the sending unit float arm in the full-stop position, resistance should be 160 ohms (above F). The fuel gauge (9280) should read empty at 22.5 ohms and full at 145 ohms.

Fuel Tank Sending Unit

With ohmmeter positive lead on the signal wire lead and the negative lead on ground, check the resistance values of the fuel sending unit at various positions of the float arm. An open circuit will indicate infinity on the ohmmeter and a short will indicate zero ohms.

Coolant Temperature Gauge — Aerostar

1. Disconnect the water temperature indicator sender unit (10884).
2. Connect one lead of Rotunda Instrument Gauge System Tester 014-R1063 or equivalent to water temperature indicator sender unit Circuit 39 (R/W) and the other lead to ground.
3. Turn the ignition switch lock cylinder to the ON position.
4. Set the tester to 74 ohms.

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5. Wait one minute. The center line of the pointer should fall within the band around the "C" mark.
6. Set the tester to 9.7 ohms.
7. Wait one minute. The center line of the pointer should fall within the band around the "H" mark.
8. Return to the Pinpoint Test.

Coolant Temperature Gauge — Ranger

1. Disconnect the water temperature indicator sender unit.
2. Connect one lead of Rotunda Instrument Gauge System Tester 014-R1063 or equivalent to water temperature indicator sender unit Circuit 39 (R/W) and the other lead to ground.
3. Set the tester to 300 ohms.
4. Turn the ignition switch lock cylinder to the ON position.
5. Wait one minute. The gauge should read "C" (cold).
6. Set the tester to 45 ohms.
7. Wait one minute. The gauge should read one quarter range to mid-range.
8. Set the tester to 18 ohms.
9. Wait one minute. The gauge should read "H" (hot).
10. Return to the Pinpoint Test.

Charge Indicator Lamp

The integral alternator regulator (IAR) has a circuit in the voltage regulator that will indicate a high battery (10655) voltage condition. With the IAR system, two conditions can cause the charge indicator lamp to come on during vehicle operation:

1. No generator (GEN) (10346) output — damaged generator, voltage regulator or wiring.
2. Overvoltage correlation — shorted generator rotor, regulator or wiring.

   If the system is working normally, the following conditions will be present:

   - With ignition switch lock cylinder in OFF position, charge indicator (battery symbol) lamp is off.
   - With ignition switch lock cylinder in RUN (engine not running), charge indicator (battery symbol) lamp is on.
   - With ignition switch lock cylinder in RUN (engine running), charge indicator (battery symbol) lamp is off. Except as noted above.

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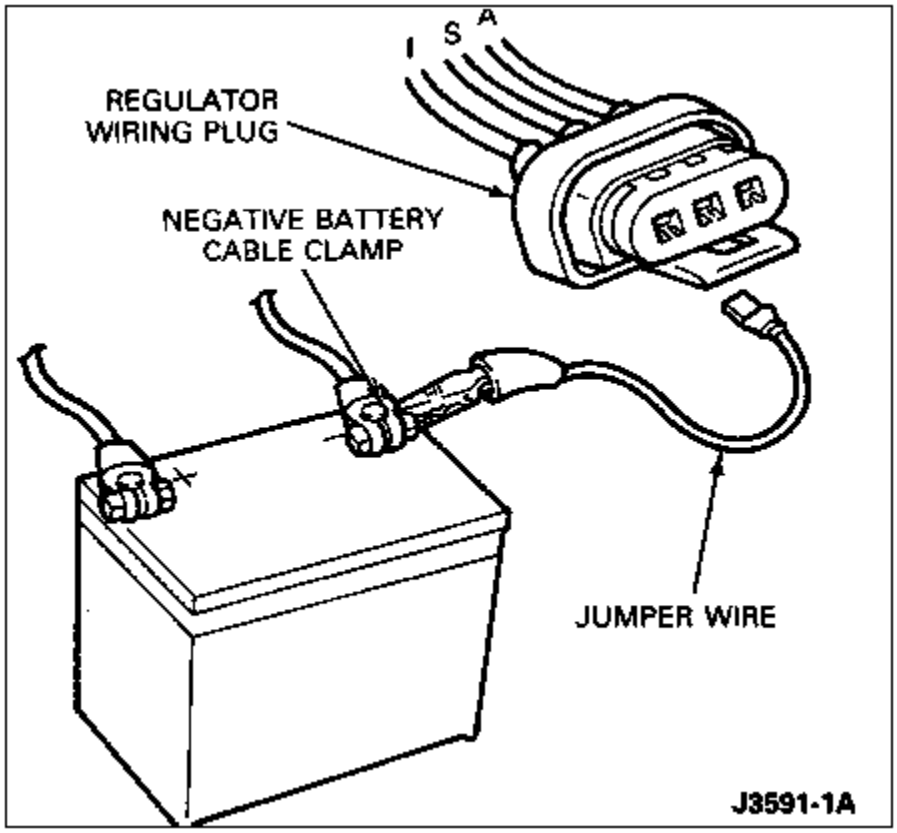
If the charge indicator lamp does not come on with the ignition switch lock cylinder in the RUN position (engine not running), check the "I" circuit (ignition switch lock cylinder to regulator "I" terminal) for an open circuit or burned out charge indicator lamp. Replace the lamp, if necessary.

3. If the charge indicator lamp does not come on, disconnect the wiring connector from the voltage regulator.

4. Connect a jumper wire from the wiring connector "I" terminal to the battery negative post cable clamp.



5. Turn the ignition switch lock cylinder to RUN (engine not running). If the indicator lamp does not light, check the indicator bulb for continuity and replace the bulb if it is burned out. If the bulb is still good, perform the voltage regulator "I" circuit tests.

Odometer Accuracy Test

To test the odometer (17A265) accuracy, drive the vehicle over a measured distance of at least 10 consecutive miles (or 16 kilometers). Check measured distance against odometer measured distance. Acceptable odometer measured distance is 15.5-16.7 km (9.6-10.4 miles).

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Instrument Cluster, Aerostar

CAUTION: The instrument cluster (10849) requires SPECIAL HANDLING to avoid damaging internal components. The instrument cluster MUST be kept FACE UP or in the in-vehicle position. Leaving the instrument cluster face down may result in a loss of dampening fluid used in the gauges. The lost fluid could stain the cluster face or result in excessive pointer waiver.

NOTE: Federal law requires that the odometer (17A265) must register the same mileage as that registered in the removed instrument cluster.

Aerostar instrument components that are serviceable at the dealership level are:

- instrument panel lamp socket and bulbs (13B765)
- engine coolant temperature gauge (10883) and oil pressure gauge (9273)
- fuel gauge (9280) and voltage indicator gauge (10A835)
- instrument cluster gauge amplifier (10E849)
- instrument cluster main lens (10887)
- instrument cluster mask (10890)
- lens attaching screws

NOTE: The Aerostar instrument cluster must be serviced as a complete assembly if it is determined that any of the following components are malfunctioning:

- **speedometer (17255)**
- **instrument cluster printed circuit (10K843)**
- **instrument cluster back plate (10848)**

Removal and Installation

1. Disconnect the battery ground cable (14301).
2. Remove the instrument panel finish panels (044D70). Refer to Section 01-12 for procedure.
3. Remove the steering column bracket reinforcement.

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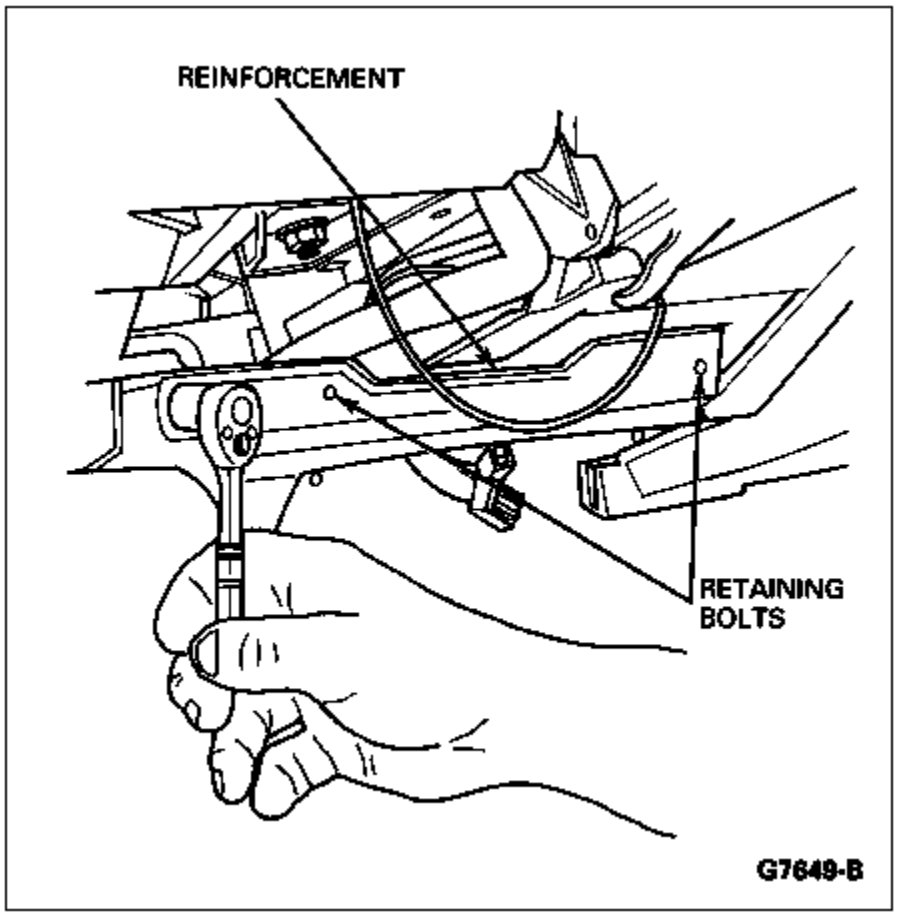

4. Remove the transmission indicator cable loop from the ball stud on the shift lever.
5. Remove the thumbwheel bracket screw and detach bracket from steering column tube (3514).

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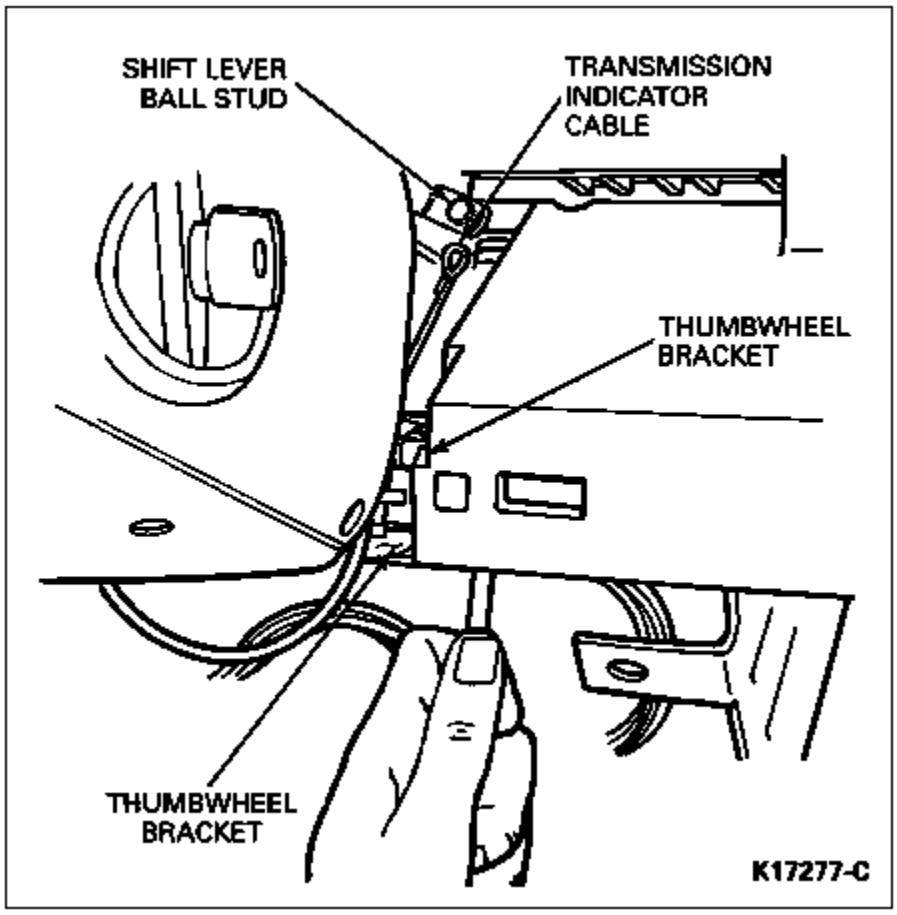
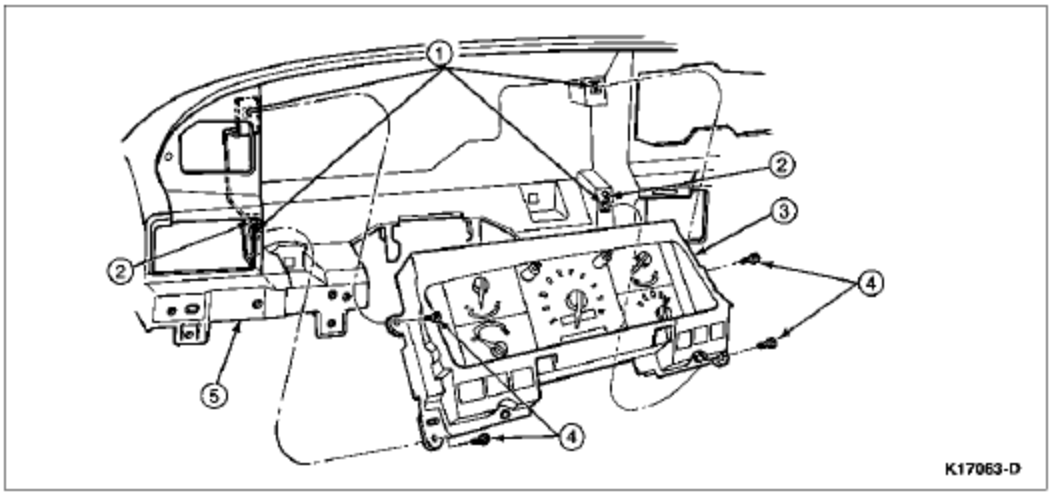


6. Remove four screws attaching the instrument cluster to the instrument panel (04320). Pull cluster out of instrument panel, bottom first, to rest on the steering column tube.

Instrument Panel and Cluster Assembly, Aerostar



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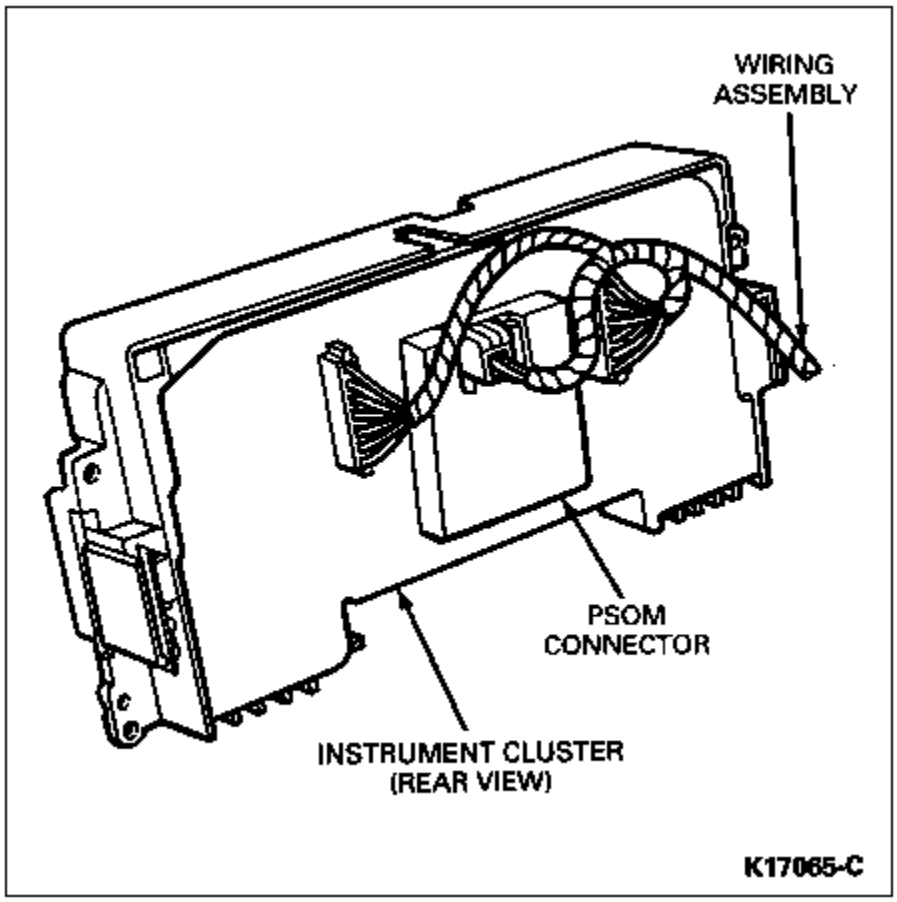
Item	Part Number	Description
1	—	Nuts
2	—	Locating Pin
3	10849	Instrument Cluster
4	—	Screws
5	04320	Instrument Panel

7. Disconnect the three electrical connectors and remove the instrument cluster from the instrument panel.



8. For installation, follow removal procedures in reverse order.

- If transmission range indicator (7A110) needs adjustment before installation of instrument panel finish panel, refer to Section 11-04B .
- When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

Rear View of Instrument Cluster, Aerostar

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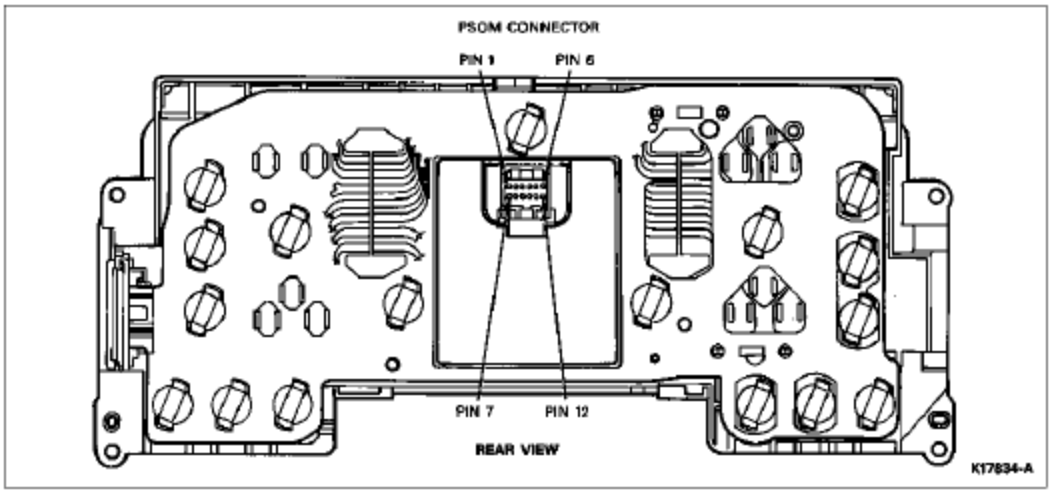

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Instrument Cluster — Ranger

Removal

1. **CAUTION: If gauges are being removed from the cluster assembly, do not remove the gauge pointer. Magnetic gauges cannot be recalibrated.**

   Disconnect the battery ground cable (14301).

2. Remove radio. Refer to Section 15-01 .

3. Remove two center instrument panel finish panel screws. Disconnect electrical connectors and remove panel.

4. Remove two hood latch control handle and cable screws from lower steering column cover.

5. Remove two lower steering column cover screws and remove cover.

6. Remove six instrument panel steering column opening cover reinforcement screws and cover reinforcement.

7. Remove three steering column shroud screws and separate upper/lower shroud from steering column tube (3514)

8. Remove five cluster instrument panel finish panel screws. Disconnect electrical connectors and remove panel.

9. Disconnect transmission range (TR) indicator thumbwheel.

10. Remove four instrument cluster screws.

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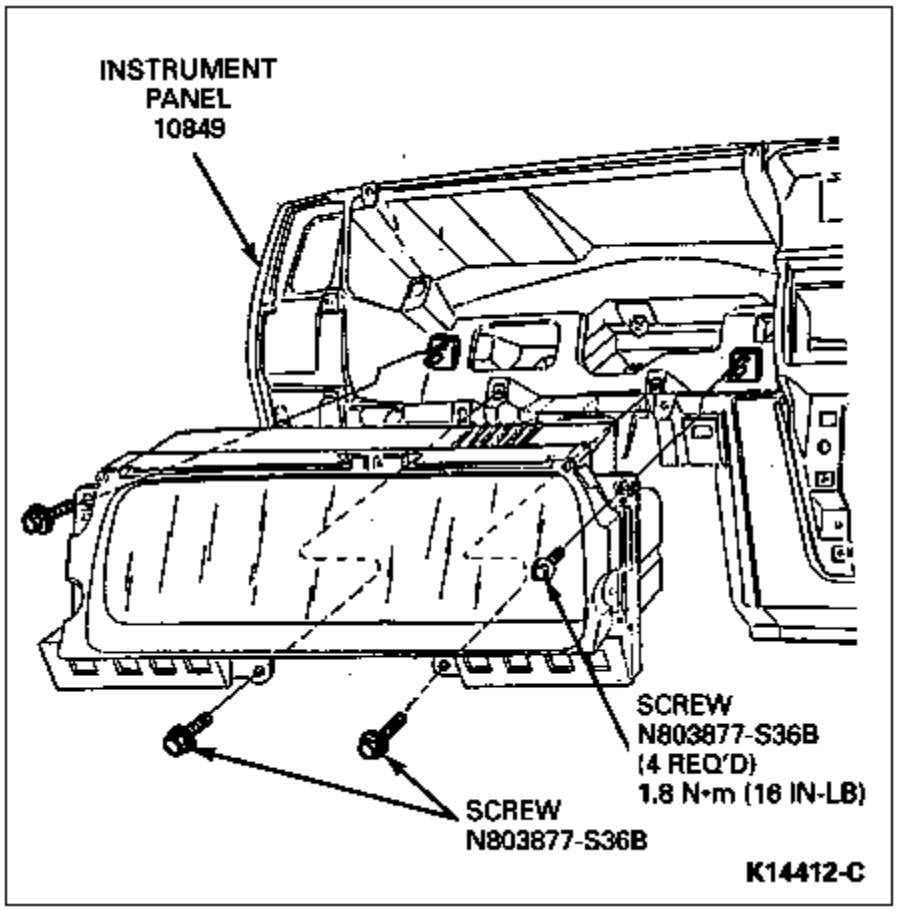
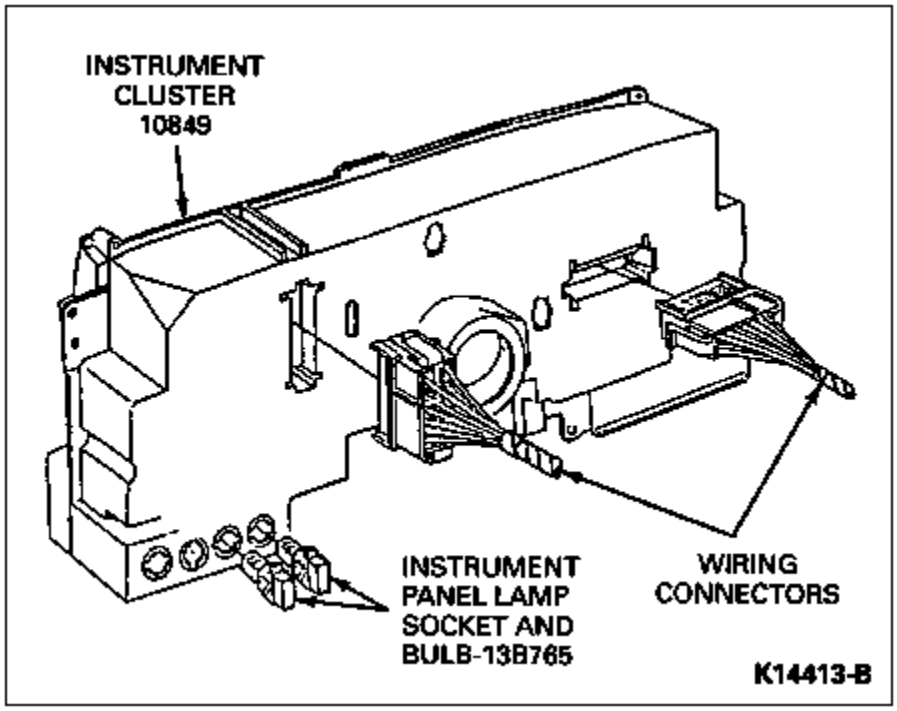


11. Disconnect the three instrument cluster electrical connectors and remove the instrument cluster.



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Installation

To install, reverse the removal procedure.

Refer to Torque Specifications.

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Bulbs, Illumination and/or Indicator

Removal and Installation

WARNING: ILLUMINATION BULBS ARE PRESSURIZED AND MAY SHATTER IF IMPROPERLY HANDLED. WEAR EYE PROTECTION WHEN SERVICING ILLUMINATION BULBS.

1. Remove instrument cluster (10849) as outlined in Removal and Installation, Instrument Cluster.
2. Remove instrument panel lamp socket and bulb (13B765) and remove bulb.
3. To install, reverse removal procedure.

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Instrument Cluster Printed Circuit, Ranger

Removal

1. Remove instrument cluster (10849) as described in Removal and Installation, Instrument Cluster in this section.
2. Remove the instrument cluster gauge amplifier (10E849) as described in Removal and Installation, Instrument Cluster Gauge Amplifier in this section.
3. Remove all instrument panel lamp socket and bulbs (13B765) by twisting counterclockwise.
4. Remove instrument cluster main lens (10887) and instrument cluster mask (10890).
5. Remove individual dial assemblies by gently prying rearward. Speedometer (17255) must be the last gauge removed.
6. Remove gauge connector clips using long nose pliers. Squeeze both sides of clip equally so that locking ears pass through opening in instrument cluster back plate (10848). Push clips through opening. Do not overbend or distort clips. Do not reuse clips.
7. Ease the instrument cluster printed circuit (10K843) up off the locating pins and remove.

Installation

1. Position instrument cluster printed circuit on instrument cluster back plate and press onto locating pins.
2. Install new gauge connector clips by pressing into opening with thumb and fingers. An audible click will be heard when clips are locked in position.
3. Install all instrument panel lamp socket and bulbs, rotate clockwise to lock bulbs in place.
4. Install instrument cluster gauge amplifier as described in Removal and Installation, Instrument Cluster Gauge Amplifier in this section.
5. Install speedometer assembly first then other dial assemblies.
6. Place instrument cluster mask and instrument cluster main lens over locating pins on back plate. Make sure that gauge pointers are not trapped under instrument cluster mask.
7. Install screws attaching instrument cluster mask and instrument cluster main lens to back plate.
8. Install instrument cluster as described in Removal and Installation, Instrument Cluster in this section.

Instrument Cluster, Aerostar

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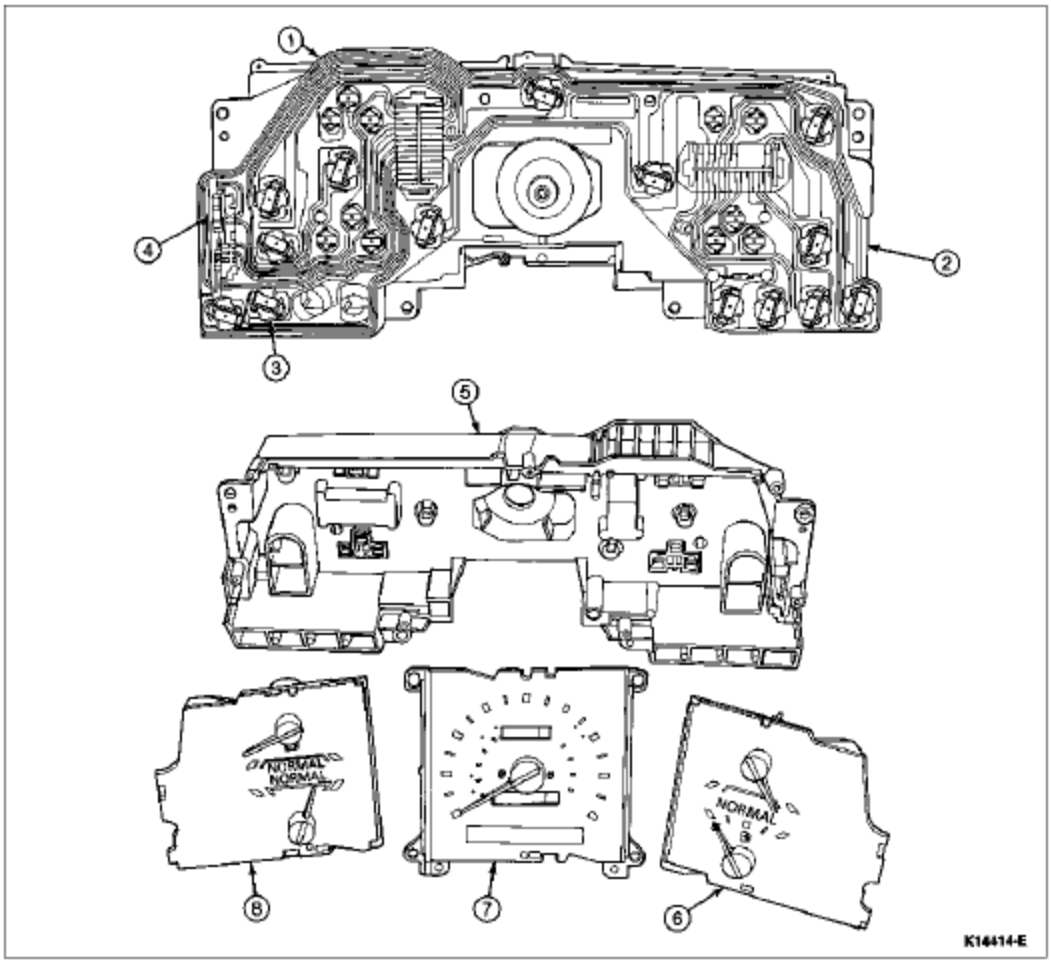

Item	Part Number	Description
1	10K843	Instrument Cluster Printed Circuit
2	10E849	Instrument Cluster Gauge Amplifier with Tachometer
3	138765	Instrument Panel Lamp Sockets and Bulbs (16 Maximum)
4	10E849	Instrument Cluster Gauge Amplifier Without Tachometer
5	10848	Instrument Cluster Back Plate
6	9280	Fuel and Oil Pressure Gauge
7	17282	Speedometer
8	10883	Battery Voltage and Coolant Temperature Gauge

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Instrument Cluster Gauge Amplifier

Removal and Installation

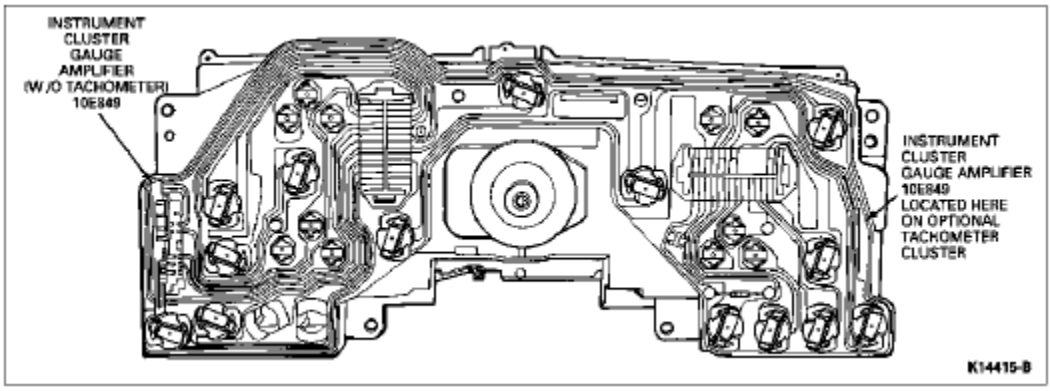
1. Remove instrument cluster (10849) as described in Removal and Installation, Instrument Cluster in this section.

2. The instrument cluster gauge amplifier (10E849) is a printed circuit board assembly located at the end on the rear of the instrument cluster. Carefully depress the retaining clip with thumb on the component side of the board, and pull the board assembly out of the instrument cluster back plate (10848).

3. To install instrument cluster gauge amplifier, insert into slots in the instrument cluster back plate and press home firmly with thumb on edge of the board. An audible click will be heard as the retaining clip engages.

4. Install instrument cluster as described in Removal and Installation, Instrument Cluster in this section and check operation.

Instrument Cluster, Aerostar Shown, Ranger Similar



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Fuel and Battery Voltage Gauge, Aerostar

Removal and Installation

1. Remove instrument cluster (10849) as described in Removal and Installation, Instrument Cluster in this section.

2. Remove screws attaching the instrument cluster main lens (10887) and instrument cluster mask (10890) to the backplate.

3. Remove the instrument cluster main lens and instrument cluster mask.

4. **NOTE: The fuel gauge (9280) and battery voltage indicator gauge (10A835) is retained to the instrument cluster back plate (10848) by retaining clips.**

   Remove the fuel and battery voltage gauge from the instrument cluster back plate by grasping the outside edges of the gauge and lifting.

NOTE: When installing the fuel gaugeand battery voltage indicator gauge, make sure the gauge pins are correctly seated into the backplate retaining clips.

For installation, follow the removal procedures in reverse order and check operation.

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Oil Pressure and Coolant Temperature Gauge, Aerostar

Removal and Installation

1. Remove instrument cluster (10849) as described in Removal and Installation, Instrument Cluster in this section.

2. Remove screws attaching the instrument cluster main lens (10887) and instrument cluster mask (10890) to the instrument cluster back plate (10848).

3. Remove the lens and mask.

4. **NOTE: The oil pressure gauge (9273) and engine coolant temperature gauge (10883) is retained to the instrument cluster back plate by retaining clips.**

   Remove the oil pressure gauge and engine coolant temperature gauge from the instrument cluster back plate by grasping the outside edges of the gauge and lifting.

NOTE: When installing the oil pressure gauge and engine coolant temperature gauge, make sure the gauge pins are correctly seated into the backplate retaining clips.

For installation, follow the removal procedures in reverse order and check operation.

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Battery Voltage and Oil Pressure Gauge, Ranger

Removal and Installation

1. Remove the instrument cluster (10849) as described in this section.
2. Remove the instrument cluster main lens (10887) and instrument cluster mask (10890) from the instrument cluster.
3. Pull gauge terminals from backplate clips and remove the gauge.

NOTE: When installing the battery voltage indicator gauge (10A835) and oil pressure gauge (9273), make sure the gauge pins are correctly seated into the backplate retaining clips.

For installation, follow the removal procedures in reverse order.

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Coolant Temperature and Fuel Gauge, Ranger

Removal and Installation

1. Remove the instrument cluster (10849) as described in Removal and Installation, Instrument Cluster in this section.

2. Remove the instrument cluster main lens (10887) and instrument cluster mask (10890) from the instrument cluster.

3. Pull the gauge terminals from backplate clips and remove the gauge.

NOTE: When installing the engine coolant temperature gauge (10883) and fuel gauge (9280), make sure the gauge pins are correctly seated into the backplate retaining clips.

For installation, follow the removal procedures in reverse order.

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Speedometer/Odometer, Ranger

Removal

1. Remove the instrument cluster (10849) as described in this section.

2. Remove the instrument cluster main lens (10887) and instrument cluster mask (10890) from the instrument cluster. Remove the speedometer (17255).

Installation

Position the speedometer to the instrument cluster back plate (10848). Install the instrument cluster mask and instrument cluster main lens, then the instrument cluster. Install the instrument cluster as described in Removal and Installation, Instrument Cluster in this section.

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Vehicle Speed Sensor, Ranger

Removal

1. Raise the vehicle on a hoist.
2. Separate the electrical connector to vehicle speed sensor (VSS) (9E731) on the transmission or transfer case.
3. Remove screw and washer.
4. Remove vehicle speed sensor.
5. Remove speedometer gear retainer.
6. Remove speedometer driven gear.
7. Remove O-ring from vehicle speed sensor and discard.

Installation

1. Install new O-ring to vehicle speed sensor.
2. Install speedometer driven gear on vehicle speed sensor and apply high temperature, waterproof grease.
3. **NOTE: Install retainer to driven gear with tabs on back side of clip toward teeth on speedometer driven gear.**

   Secure speedometer driven gear with speedometer driven gear retainer (17292).
4. Install vehicle speed sensor in transmission or transfer case.
5. Install and tighten retaining bolt to 2.5 Nm (22 lb-in).
6. **NOTE: Electrical connection should be near top.**

   Connect electrical connector to vehicle speed sensor on the transmission or transfer case.
7. Lower the vehicle.

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Tachometer, Ranger

CAUTION: Tachometer is calibrated at factory. Excessive rough handling could disturb calibration.

Removal

1. Disconnect battery ground cable (14301).
2. Remove instrument cluster (10849) as described in Removal and Installation, Instrument Cluster in this section.
3. Remove screws attaching instrument cluster mask (10890) and instrument cluster main lens (10887) to instrument cluster back plate (10848) and remove instrument cluster mask and instrument cluster main lens.
4. **NOTE: Tachometer (17360) is retained to instrument cluster back plate by retaining clips.**

   Remove tachometer by carefully prying tachometer dial away from instrument cluster back plate.

Installation

1. **NOTE: When installing tachometer, make sure the four tachometer pins correctly seat in the cluster back plate clips.**

   Position tachometer into instrument cluster back plate and push tachometer into position.
2. Position instrument cluster main lens and instrument cluster mask to the instrument cluster back plate.
3. Install the attaching screws and tighten to 0.8-1.4 Nm (7-9 lb-in).
4. Install instrument cluster as described in Removal and Installation, Instrument Cluster in this section.
5. Connect battery ground cable.
6. **NOTE: When the battery (10655) has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.**

   Check operation of the tachometer.

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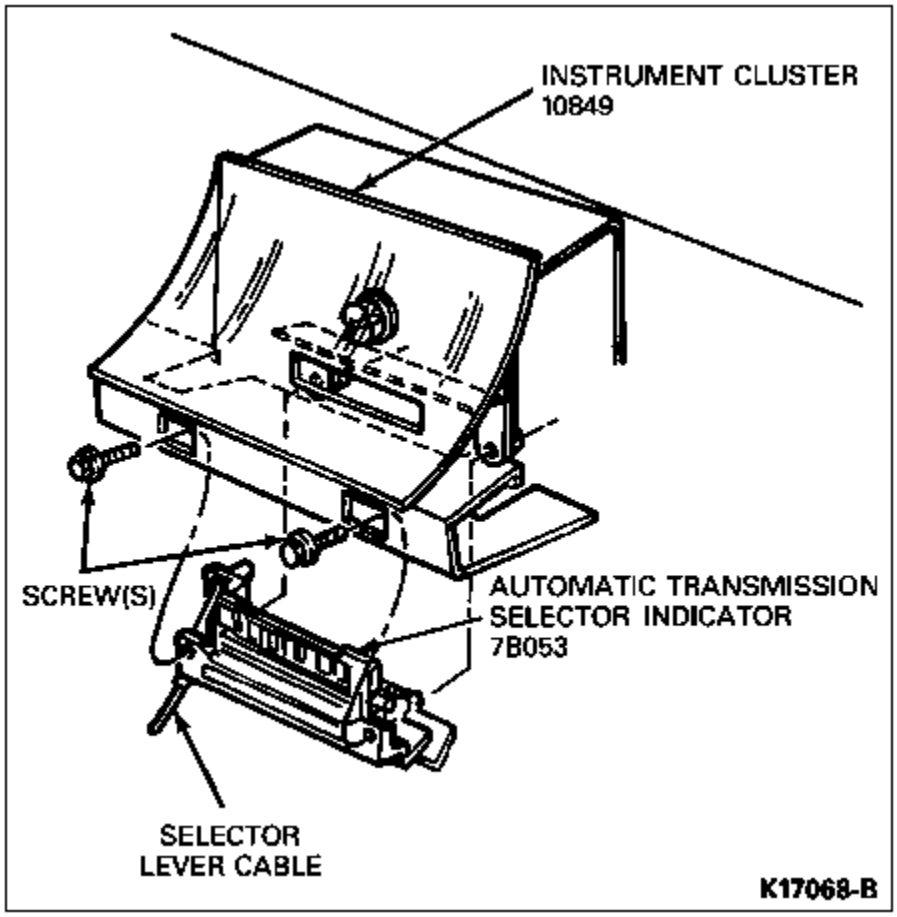
Transmission Control Selector Indicator

Removal and Installation

1. Remove instrument cluster (10849) from instrument panel (04320) as described in Removal and Installation, Instrument cluster section.

2. Remove the two screws attaching the transmission range indicator (7A110) to the cluster. Remove the transmission range indicator by sliding it out downwards from the bottom of the cluster.

For installation, follow removal procedures in reverse order.



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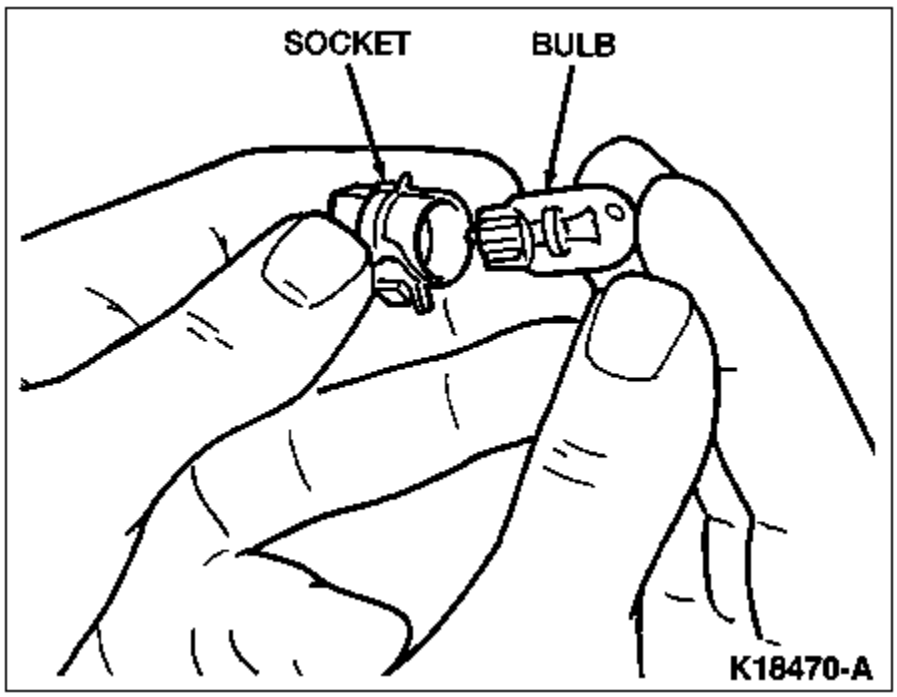
Indicators/Warning Bulbs

Removal and Installation

The removal and installation procedures are identical for all indicators/warning lamps.

1. Disconnect the battery ground cable (14301).
2. Remove instrument panel finish panel (044D70) as described in Section 01-12 .
3. Remove screws retaining instrument cluster (10849) to instrument panel (04320).
4. Pull instrument cluster rearward to provide access to back of instrument cluster.
5. Turn the desired indicator/warning lamp counterclockwise and remove it from the instrument cluster.
6. Remove the bulb from its socket.



NOTE: When the battery (10655) has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

For installation, follow the removal procedures in reverse order.

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Instrument Cluster, Aerostar

CAUTION: The instrument cluster (10849) requires special handling to avoid damaging internal components. The instrument cluster MUST be kept FACE UP or in in-vehicle position. Leaving the instrument cluster face down may result in a loss of fluid used in gauges. The lost fluid could stain the cluster face or result in excessive pointer waiver.

Aerostar instrument cluster components that are serviceable at the dealership are:

- instrument panel lamp socket and bulb (13B765)
- engine coolant temperature gauge (10883) and oil pressure gauge (9273)
- fuel gauge (9280) and voltage indicator gauge (10A835)
- instrument cluster gauge amplifier (10E849)
- instrument cluster main lens (10887)
- instrument cluster mask (10890)
- lens attaching screws

NOTE: The Aerostar instrument cluster must be serviced as a complete assembly if it is determined that any of the following components are malfunctioning:

- speedometer (17255)
- instrument cluster printed circuit (10K843)
- instrument cluster back plate (10848)

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Speedometer Calibration, Ranger

Speedometer (17255) accuracy can be checked by timing the vehicle on a measured mile and performing the following speedometer calibration test. The Ford Speedo Gear Supplement Charts show the proper speedometer gears to use for various rear axle and tire size OEM combinations.

Speedometer Calibration Test

1. Time the number of seconds it takes to travel one measured mile at an indicated 30 and 60 mph.
2. Calculate the vehicle speed using the following formula:

   mph = 3600 divided by seconds
3. Acceptable ranges are the following:

kmh (mph) Indicated Test Speed	Seconds
16.1 (10)	345-275
48.3 (30)	115-125
96.5 (60)	57-62

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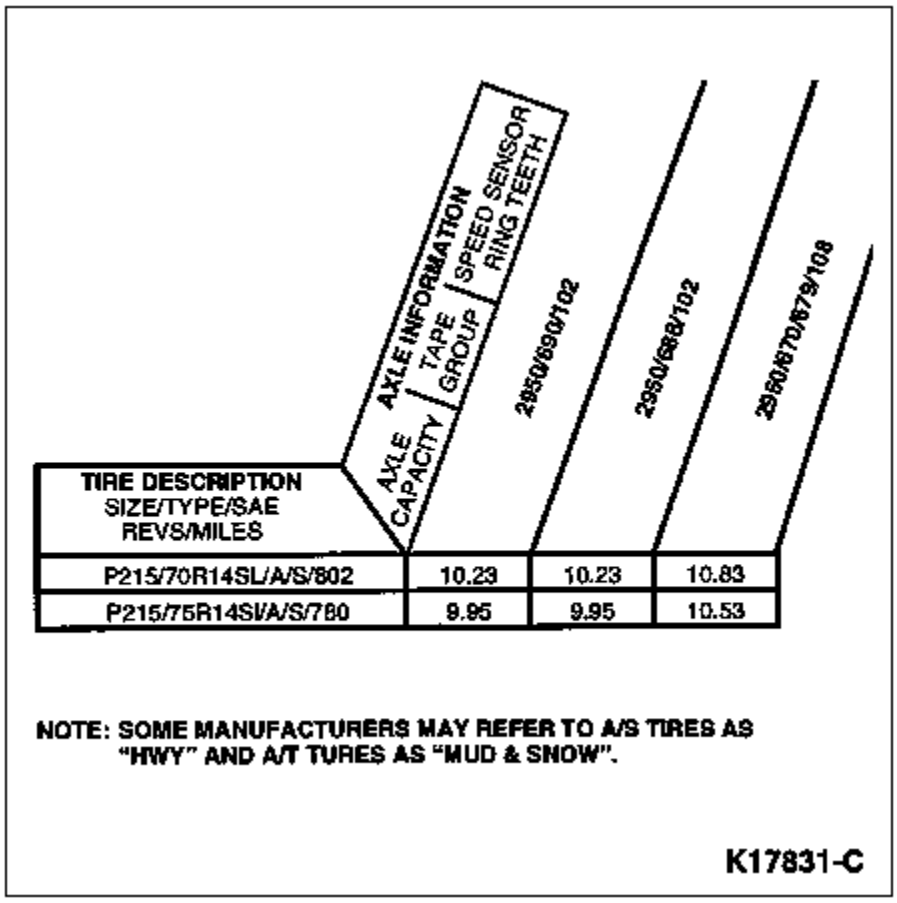
SPECIFICATIONS

Speedometer Calibration Tolerance Specifications, Aerostar

Actual Speedometer or Odometer Value Indicated	48 km/h (30 mph) Actual Speed	97 km/h (60 mph) Actual Speed	Odometer Measure Over Actual 16.1 km Distance (10 Miles)
Allowable Range	45-55 km/h (28-34 mph)	93-108 km/h (58-67 mph)	15.4-16.6 km (9.6-10.3 miles)

Conversion Constants Chart, Aerostar



OIL PRESSURE SWITCH/WATER TEMPERATURE INDICATOR SENDER UNIT SPECIFICATIONS

Vehicle	Engine	Sending Unit	Sending Unit Location	Torque	
				Nm	Lb-Ft

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Ranger	2.3L	Oil Pressure	Engine Block — Left Side Toward Rear	11-24	8-18
Ranger	2.3L	Coolant Temperature	Heater Hose	11-24	8-18
Ranger	2.3L	Oil Level	Engine Oil Pan — Left Side	27-41	20-30
Aerostar and Ranger	3.0L	Oil Pressure	Engine Block — Left Side, Toward Rear	16-22	12-16
Aerostar and Ranger	3.0L	Coolant Temperature	Intake Manifold — Front	16-24	12-18
Aerostar and Ranger	3.0L	Oil Level	Engine Oil Pan — Right Side	27-41	20-30
Aerostar	4.0L	Oil Pressure	Engine Block — Left Side	11-24	8-18
Aerostar	4.0L	Coolant Temperature	Intake Manifold — Left Front	11-24	8-18
Aerostar	4.0L	Oil Level	Engine Oil Pan — Left Side	20-34	15-25
Ranger	4.0L	Oil Pressure	Engine Block — Left Side	11-16	8-12
Ranger	4.0L	Coolant Temperature	Intake Manifold — Left Front	11-24	8-18
Ranger	4.0L	Oil Level	Engine Oil Pan — Left Side	20-34	15-25

TORQUE SPECIFICATIONS

Description	Nm	Lb-In
Regulator Screws	1.7-2.8	15-22
Speed Sensor Bolt, Ranger	2.5	22
Instrument Cluster Back Plate Screws	0.8-1.4	7-12
Instrument Panel Finish Panel Screws	2-3	18-26
Hood Latch Control and Cable Handle Screws	2.0-4.5	18-39
Steering Column Shroud Screws	0.7-1.1	7-9
Steering Column Cover Reinforcement Screws	10-14	88-123
Instrument Cluster Screws	1.8	16

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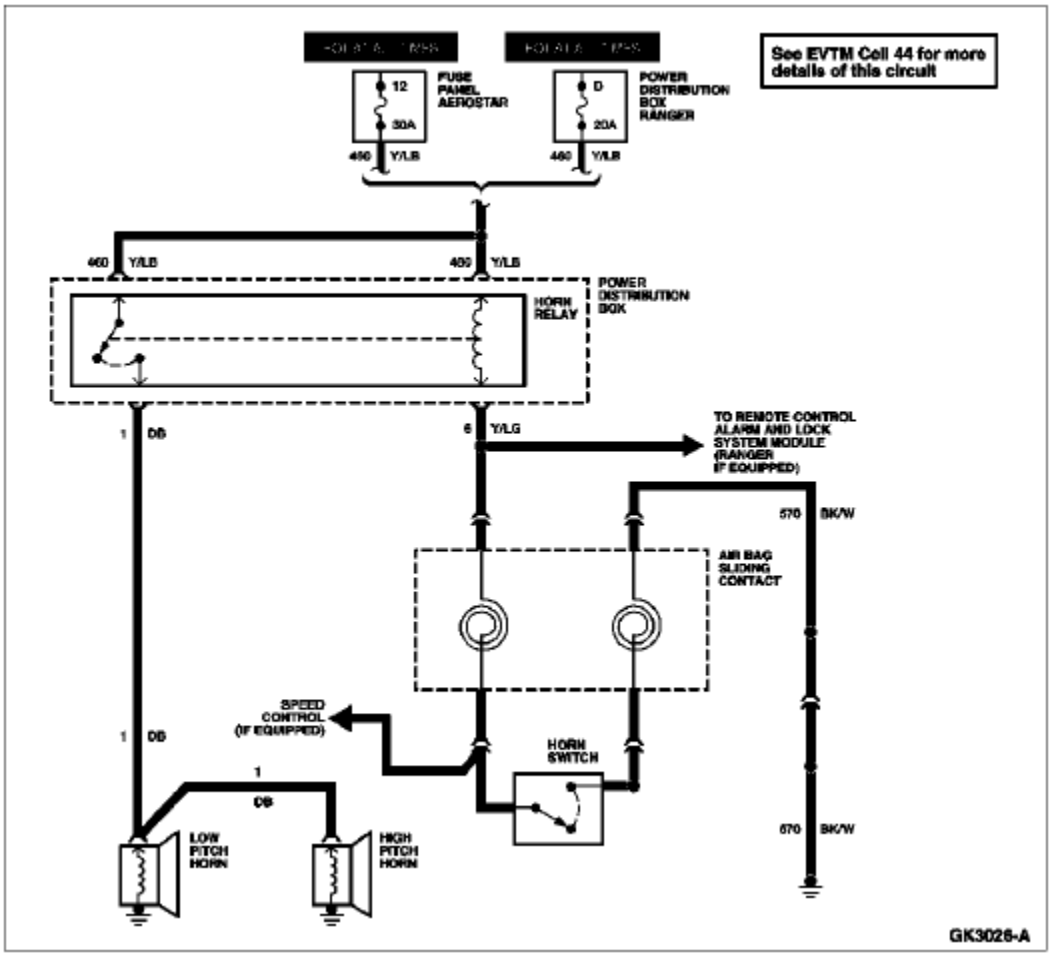
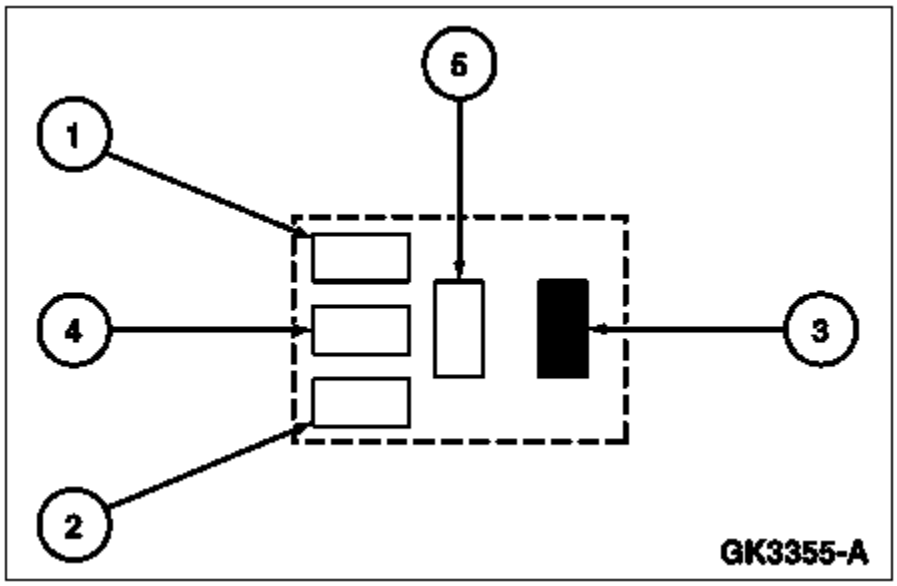
Electrical Schematic

Horn System

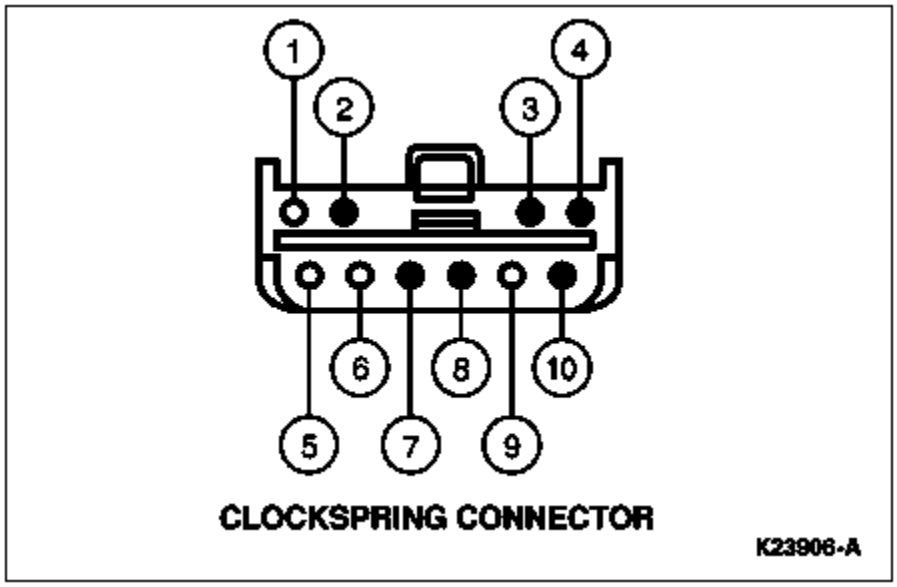


Horn Relay Connector — Part of Engine Compartment Power Distribution Box — Ranger



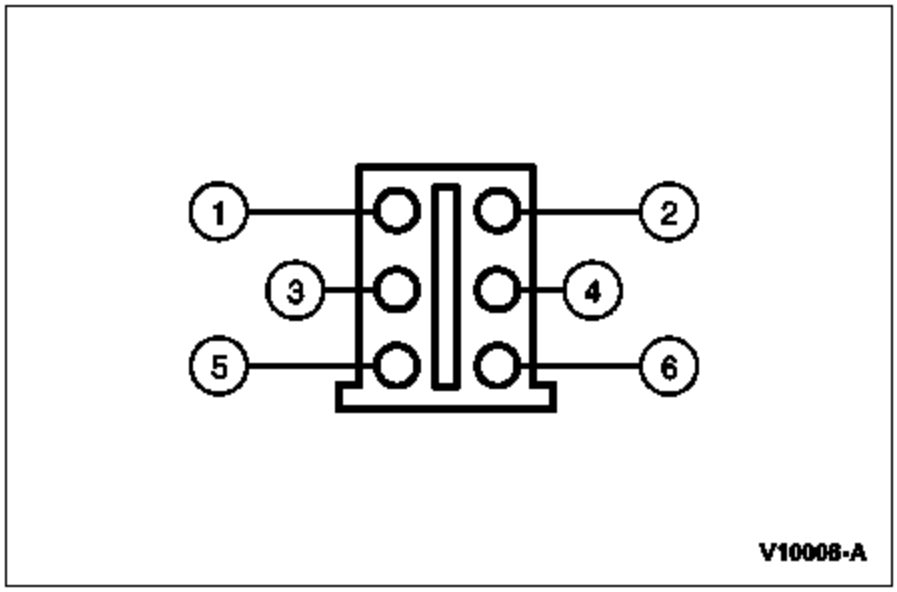
Pin Number	Circuit	Circuit Function
1	460 (Y/B)	Battery Feed to Relay Coil
2	6 (Y/LG)	Horn Relay to Horn Switch
3	—	Not Used
4	1(DB)	Battery Feed to Relay Contacts
5	460 (Y/B)	Horn Relay to Horn

Air Bag Sliding Contact Connector — at Base of Steering Column — Aerostar



Pin Number	Circuit	Circuit Function
1	158 (BK/PK)	Key in Ignition Input
2	—	Not Used
3	—	Not Used
4	—	Not Used
5	6 (Y/LG)	Horn Relay
6	151 (LB/PK)	Speed Control Amp.
7	—	Not Used
8	—	Not Used
9	57 (BK)	Ground
10	—	Not Used

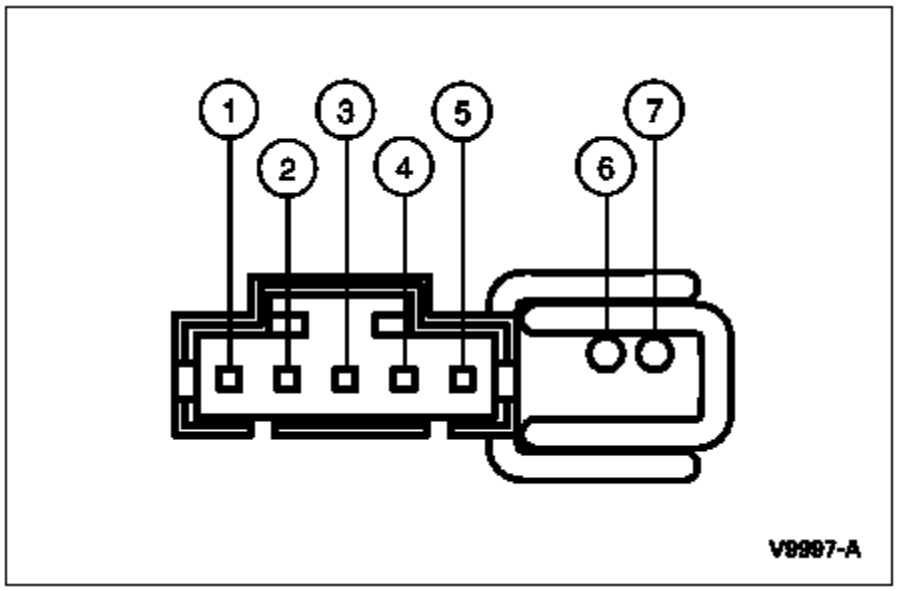
Air Bag Sliding Contact Connector — at Base of Steering Column — Ranger



Pin Number	Circuit	Circuit Function
1	151 (LB/BK)	Coast/Set Signal to Speed Control Module
2	6 (Y/LG)	Horn Relay Coil to Horn Switch
3	235 (R/BK)	Speed Control Switch Illumination
4	848 (DG/O)	Resume Signal to Speed Control Module

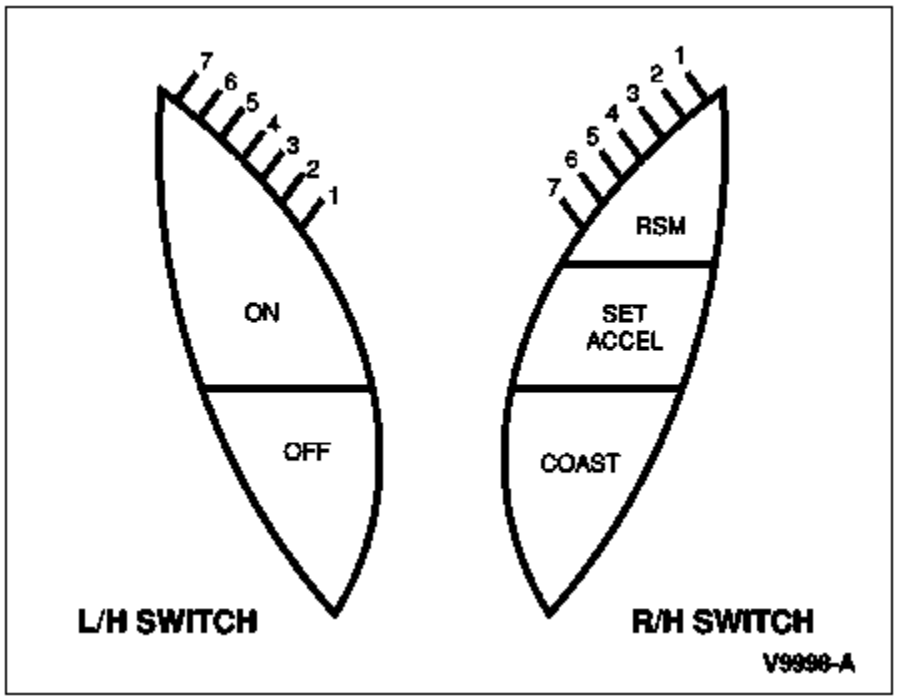
5	570 (BK/W)	Ground
6	158 (BK/PK)	Key in Ignition to Generic Electronic Module (GEM) Chime

Air Bag Sliding Contact Connector to Steering Wheel Wiring Harness — Ranger



Pin Number	Circuit	Circuit Function
1	6 (Y/LG)	Hot: Speed Control Switch and Horn Switch
2	848 (DG/O)	Speed Control Switch Ground
3	151 (LB/BK)	Speed Control Switch Assembly Input
4	235 (R/BK)	Speed Control Switch Backlighting Power
5	—	Not Used
6	614 (GY/O)	Air Bag Feed
7	615 (GY/W)	Air Bag Ground

Speed Control Switch Terminals — Ranger



Pin Number		Circuit	Circuit Function
LH	RH		
1	7	570 (BK/W)	Ground: Speed Control Switch Backlighting
2	6	235 (R/BK)	Power: Speed Control Switch Backlighting
3	5	151 (LB/BK)	Speed Control Switch Assembly Input
4	4	848 (DG/O)	Speed Control Switch Ground
5	3	6 (Y/LG)	Speed Control and Horn Switches Feed
6	2	—	Not Used
7	1	6 (Y/LG)	Speed Control and Horn Switches Feed

Inspection and Verification

1. Verify the vehicle owner's original concern by operating the horn system to duplicate the vehicle owner's concern.

2. Inspect to determine if one of the following mechanical or electrical concerns apply:

VISUAL INSPECTION CHART

Mechanical	Electrical
• Verify that horn retaining screw is tight	• Verify that the ground of the horn is good by inspecting connection for corrosion
• Verify that horns are not touching surrounding sheet metal or other components	• Check system fuse • Check wiring for obvious short or opens • Check connectors for obvious damage

Symptom Chart — Horns

HORNS

Condition	Possible Source	Action
• Horn Does Not Operate	• Relay. • Wiring. • Horn(s). • Horn switches. • Air bag module. • Sliding connector.	• GO to Pinpoint Test A.
• Horn Sounds Continuously	• Relay. • Wiring. • Horn switches. • Remote control and lock system module. • Speed control switches.	• GO to Pinpoint Test B.

Pinpoint Tests

NOTE: Use Rotunda 73 Digital Multimeter 105-R0051, or equivalent, to perform electrical pinpoint tests.

PINPOINT TEST A: HORN DOES NOT OPERATE

A1 RELAY CHECK

- Place finger on horn relay while helper presses horn button.

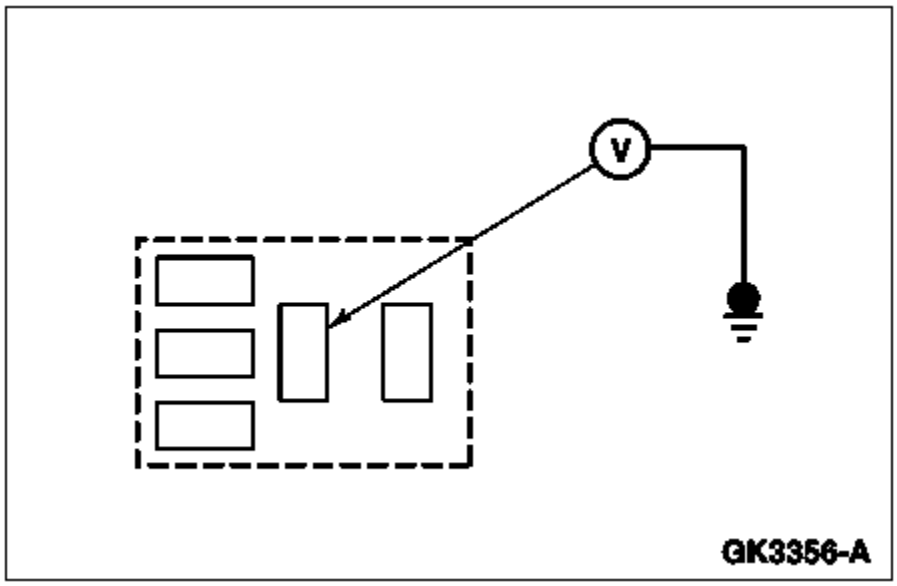
Does relay "click"?

Yes	No
GO to **A2** .	GO to **A6** .

A2 BATTERY FEED TO RELAY CONTACT SET

- Remove relay.
- Check for voltage at relay contact set feed terminal (Y/LB). Voltage reading should equal battery voltage. (Ranger shown.)

Is voltage available?

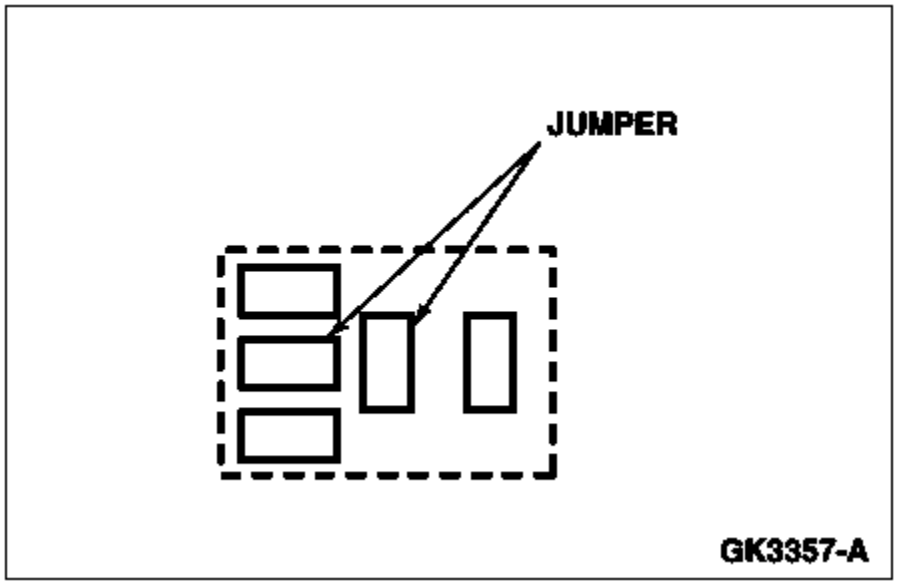


Yes	No
GO to **A3** .	REPAIR open in feed wire.

A3 ISOLATE RELAY

- Connect jumper from relay battery feed terminal (Y/LB) to horn feed terminal (DB). (Ranger shown.)

Does horn operate?



Yes	No
REPLACE relay.	GO to **A4** .

A4 RELAY-TO-HORN CIRCUIT CONTINUITY CHECK

- Install relay.
- Disconnect feed wire at horn.
- Check for voltage at horn feed wire while helper presses horn switch.

Is battery voltage available?

Yes	No
GO to **A5** .	REPAIR open in feed wire.

A5 HORN GROUND CIRCUIT CHECK

- Check for continuity between horn mounting bolt and clean chassis ground.

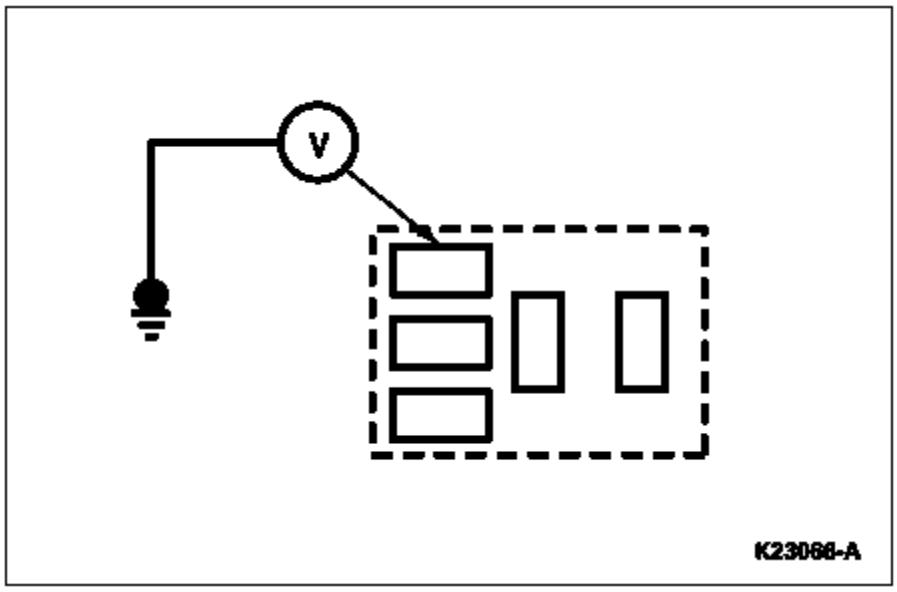
Is there continuity?

Yes	No
REPLACE horn.	CLEAN ground connection.

A6 BATTERY FEED-TO-RELAY COIL

- Remove relay.
- Check for voltage at relay coil feed terminal (Y/B). Voltage reading should equal battery voltage. (Ranger shown.)

Is voltage available?



Yes	No
GO to **A7** .	REPAIR open in coil feed wire.

A7 RELAY COIL CONTINUITY CHECK

- Check for continuity across relay coil terminals.

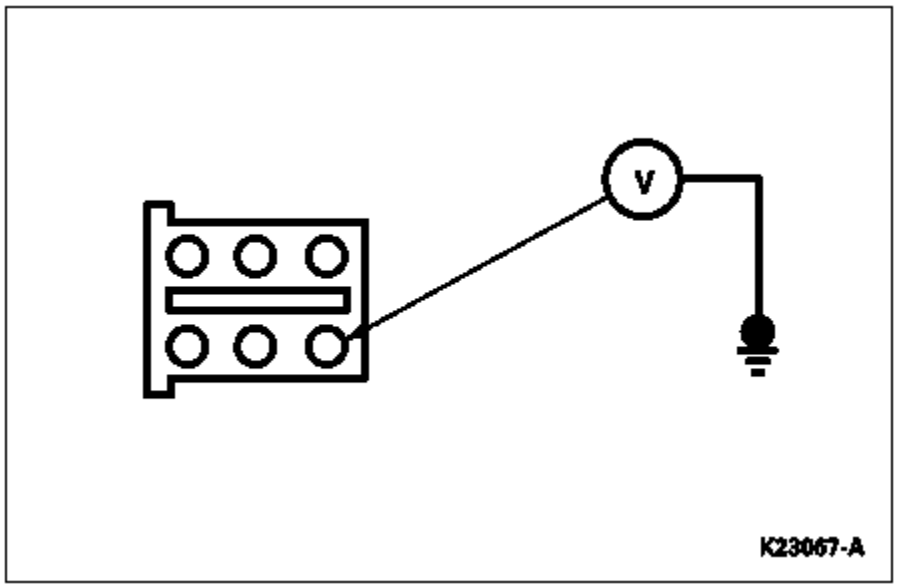
Is there continuity?

Yes	No
GO to **A8** .	REPLACE relay.

A8 RELAY TO STEERING COLUMN CIRCUIT CHECK

- Install relay.
- Disconnect 6-pin connector at base of steering column.
- Check for battery voltage at connector Pin 2 (Y/LG). (Ranger shown.)

Is voltage available?



Yes	No
GO to **A9** .	REPAIR open in wire between connector and relay.

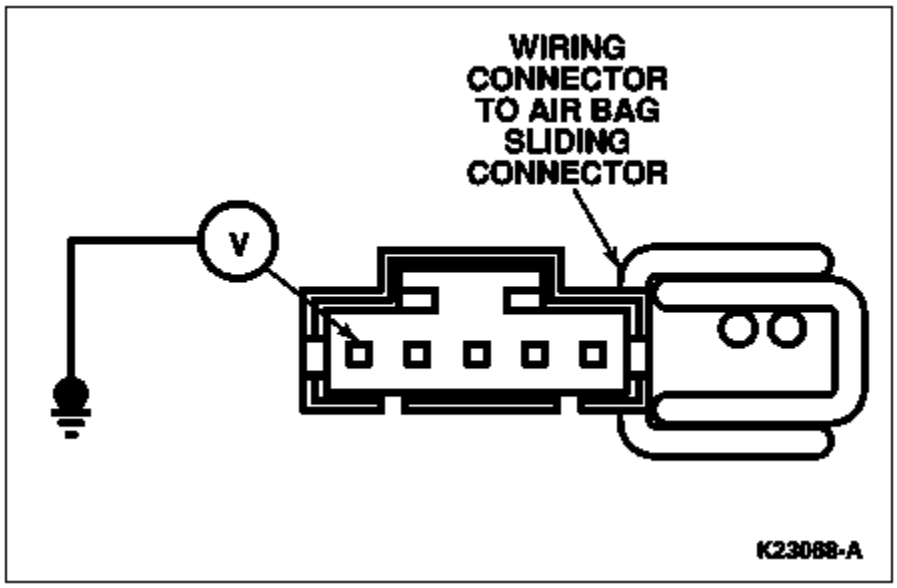
A9 STEERING COLUMN HARNESS/AIR BAG SLIDING CONTACT CHECK

- Connect 6-pin wiring connector at base of steering column.
- Remove air bag module.

CAUTION: Be sure to follow air bag removal safety precautions. Refer to Section 01-20B or Section 01-20C .

- Disconnect 5-pin connector from air bag module sliding contact.
- Check for voltage at sliding contact terminal 1. (Ranger shown.)

Is battery voltage available?



Yes	No
GO to **A10** .	REPLACE sliding contact. REFER to Section 11-04A or Section 11-04B .

A10 SLIDING CONTACT TO HORN SWITCH CHECK

- Connect 5-pin connector at sliding contact.
- Check for voltage at each horn switch upper terminal.

Is battery voltage available?

Yes	No
GO to **A11** .	If vehicle is not equipped with speed control, REPLACE steering wheel harness. If vehicle is equipped with speed control, GO to **A12** .

A11 HORN SWITCH GROUND CIRCUIT CHECK

- Check for continuity between horn switch lower contact plate and steering wheel armature.

Is there continuity?

Yes	No
GO to **A12** .	REPLACE horn switch.

A12 HORN SWITCH CONTINUITY

- Press horn switch at each of the four corners, one at a time. Check for continuity between upper and lower horn switch plate with switch pressed.

Is there continuity?

Yes	No
GO to **A13** .	REPLACE horn switch(es).

A13 SPEED CONTROL WIRE HARNESS CONTINUITY

- Remove terminals at each upper horn switch.
- Check for voltage at each terminal.

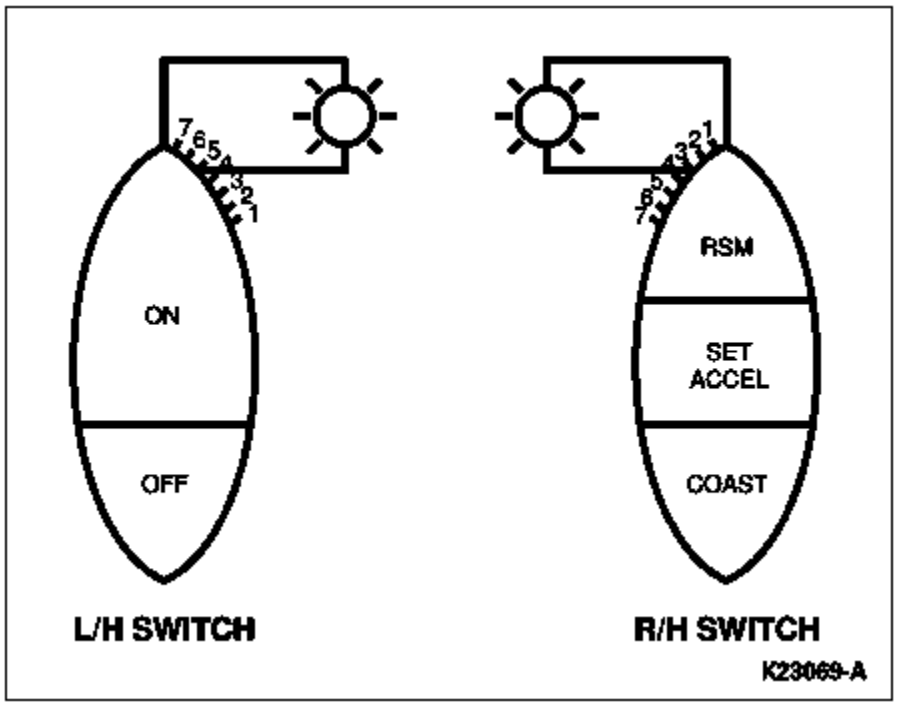
Is there battery voltage?

Yes	No
If vehicle is equipped with speed control, GO to **A14** . If vehicle is not equipped with speed control, REPAIR open in ground circuit between steering wheel and chassis ground.	REPLACE steering wheel wire harness.

A14 ISOLATE SPEED CONTROL SWITCHES

- Disconnect wiring at speed control switches.
- Using a self-powered test light, check for continuity across speed control switch terminals; 1 to 3 (RH) and 5 to 7 (LH). (Ranger shown.)

Is there continuity?



Yes	No
CHECK horn switch ground. REFER to Pinpoint Test Step **A11** .	REPLACE switch that does not show continuity.

PINPOINT TEST B: HORN SOUNDS CONTINUOUSLY

B1 SHORT TO BATTERY FEED IN HORN FEED CIRCUIT

- Remove horn relay.

Do horns stop?

Yes	No
GO to **B2** .	REPAIR short to battery feed in wire (DB) between relay and horn.

B2 STUCK RELAY CONTACTS CHECK

- Check for continuity across relay contact terminals (Y/B to DB).

Is there continuity?

Yes	No

REPLACE relay.	GO to **B3** .

B3 SHORT TO GROUND IN FEED CIRCUIT TO STEERING COLUMN CONNECTOR

- Install horn relay.
- Disconnect 6-pin connector located at base of steering column.

Do horns stop?

Yes	No
GO to **B4** .	REPAIR short to ground in wire (Y/LG) between horn relay and steering column connector. If a Ranger equipped with remote anti-theft personality (R.A.P.) module, GO to **B5** .

B4 ISOLATE HORN SWITCH

- Remove air bag module.

CAUTION: Be sure to follow air bag removal safety precautions. Refer to Section 01-20B .

- Connect 6-pin connector.
- Disconnect 5-pin connector at air bag sliding contact.

Do horns stop?

Yes	No
GO to **B5** if vehicle has speed control, otherwise, GO to **B6** .	REPLACE air bag sliding contact assembly.

B5 ISOLATE SPEED CONTROL SWITCHES

- Reconnect 5-pin connector at air bag sliding contact.
- Disconnect wiring at speed control switches.
- Using a self-powered test light, check for continuity across speed control switch terminals: 1 to 7, and 3 to 7 (RH); and 1 to 7, and 1 to 5 (LH).

Is there continuity?

Yes	No
REPLACE switch that shows continuity.	GO to **B6** .

B6 ISOLATE STEERING WHEEL WIRING

- Reconnect wiring at speed control switches.
- Disconnect connectors at each horn switch terminal.

Do horns stop?

Yes	No
REPLACE steering wheel wire harness.	CHECK for shorted horn switch and REPLACE, if necessary. If vehicle is equipped with anti-theft system, GO to **B7** .

B7 ISOLATE REMOTE CONTROL ALARM AND LOCK MODULE

- Disconnect wiring connector from R.A.P. module.

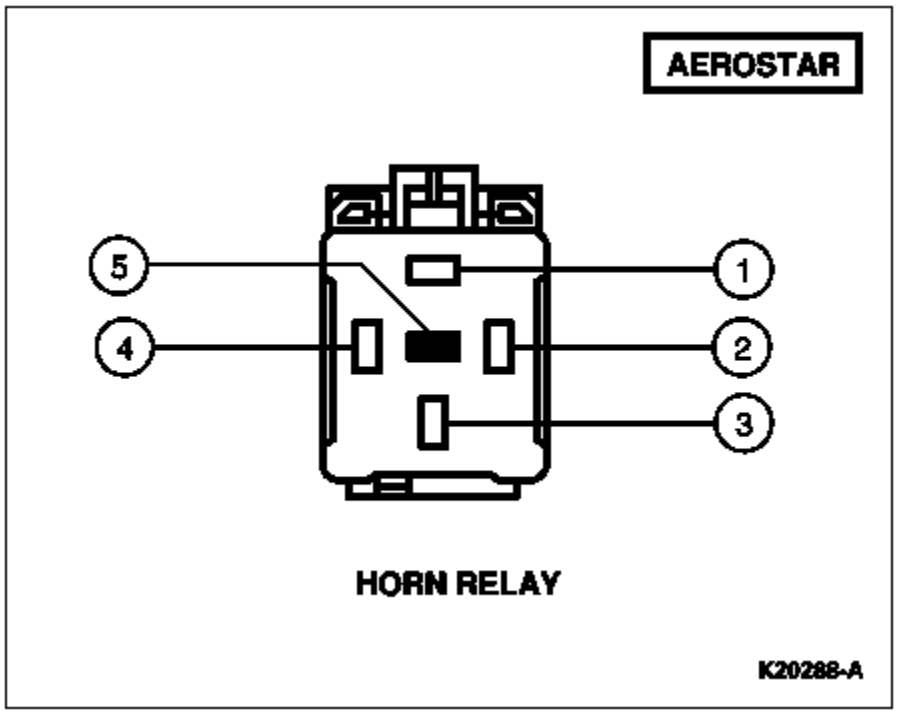
Do horns stop?

Yes	No
REPLACE R.A.P. module.	REPAIR short to ground in wire between horn relay and steering column connector or between horn relay and R.A.P. connector.

Component Tests

Horn Relay — Aerostar

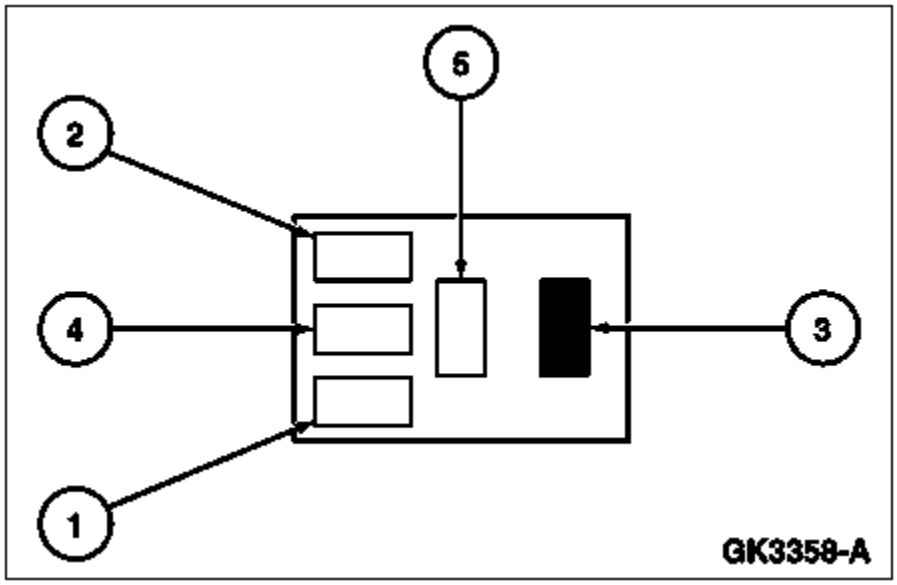
1. Connect terminal 2 to 12-volt battery source.
2. Connect terminal 4 to battery ground.
3. Check for continuity across relay terminals 1 and 3. If there is continuity, relay is serviceable. If there is no continuity, replace relay.



Pin Number	Circuit	Circuit Function
1	1 (DB)	Horn Relay to Horn
2	460 (Y/LB)	Battery Feed to Relay Coil
3	—	Not Used
4	6 (Y/LG)	Horn Relay to Switch
5	460 (Y/LB)	Battery Feed to Relay Contact Set

Horn Relay — Ranger

1. Connect terminal 4 to 12-volt battery source.
2. Connect terminal 1 to battery ground.
3. Check for continuity across relay terminals 1 and 2. If there is continuity, relay is serviceable. If there is no continuity, replace relay.

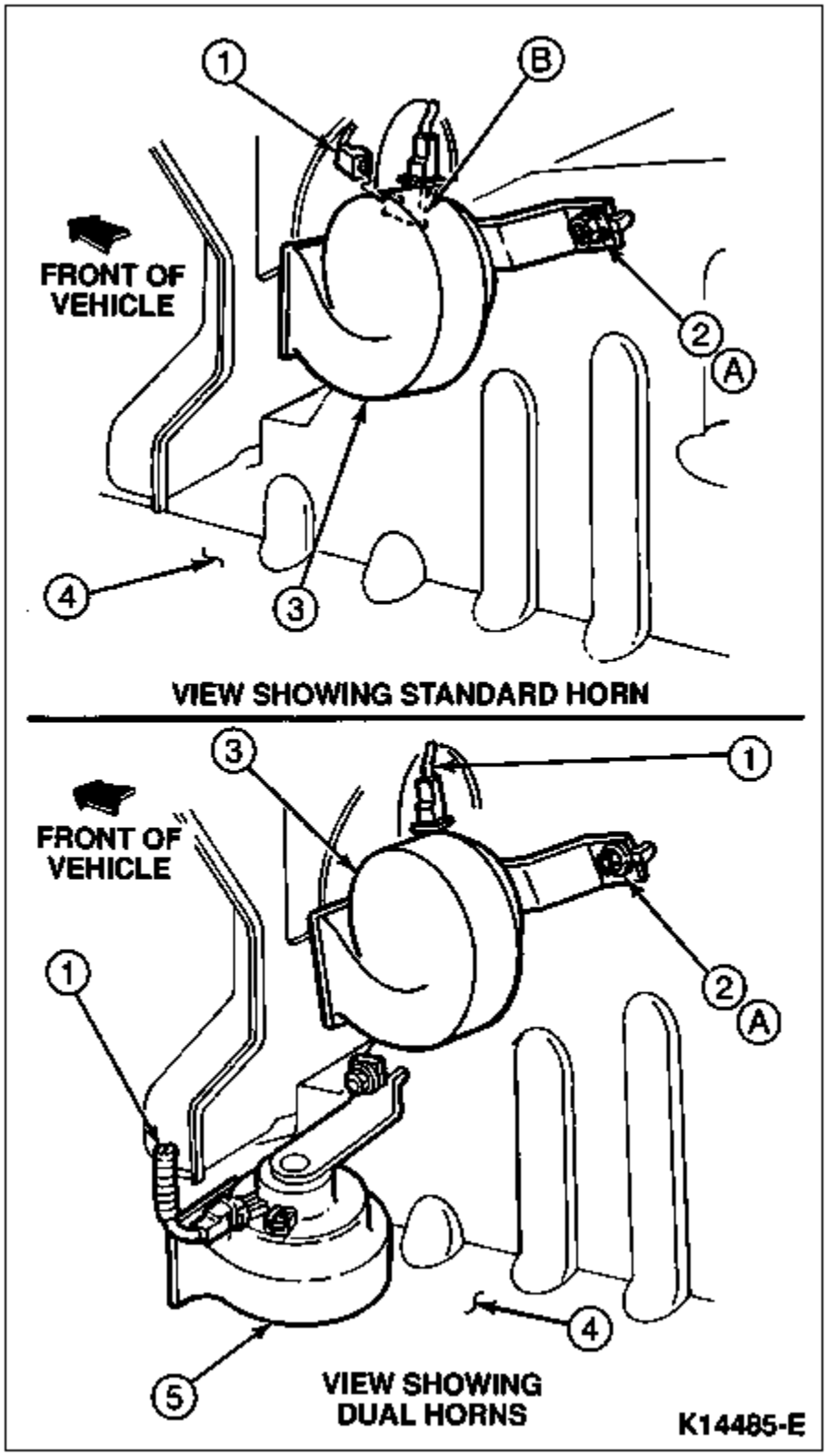


Pin Number	Circuit	Circuit Function
1	460 (Y/B)	Battery Feed to Relay Coil
2	6 (Y/LG)	Horn Relay to Horn Switch
3	—	Not Used
4	460 (Y/B)	Battery Feed to Relay Contact Set
5	1 (DB)	Horn Relay to Horn

Horn Assembly, Aerostar

Disconnect the horn wire from the terminal and remove the mounting screw. Repeat for second horn (13832), if equipped. When installing a horn mounting bracket (13830), clean the mounting surface to make sure there is a good ground connection. Tighten the mounting screw 8-12 Nm (71-106 lb-in).

Horn Assembly, Aerostar



Item	Part Number	Description
1	14290	Engine Control Sensor Wiring

2	N801939	Attaching Screw
3	13802	Horn (Low-Pitch)
4	—	Fender Apron (RH)
5	13801	Horn (High-Pitch)
A	—	Tighten to 8-12 Nm (71-106 Lb-In)
B	—	Dummy Tab to Be Used When Hi-Pitch Power Lead Is Not Used

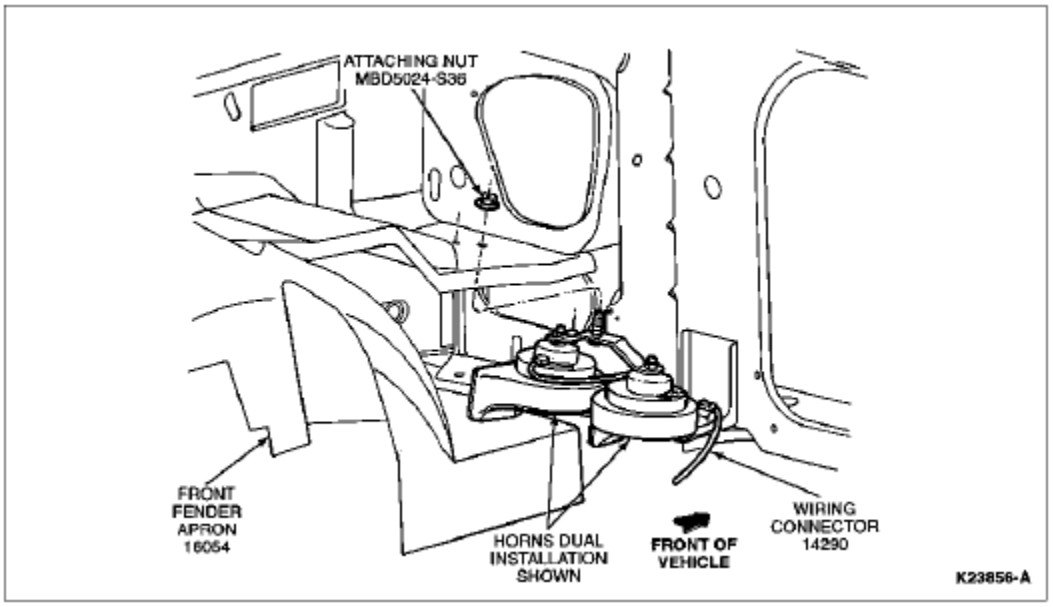
Horn Assembly, Ranger

NOTE: The horn(s) is mounted behind the radiator support on the left side of the vehicle.

1. Remove battery (10655). If necessary, refer to Section 14-01 for removal procedure.
2. Remove left fender apron (splash shield). If necessary, refer to Section 01-02 for removal procedure.
3. Disconnect wire(s) at horn(s).
4. In the engine compartment, remove horn bracket attaching nut. Nut is located at left front corner of battery tray.

To install horn(s), reverse removal procedure.

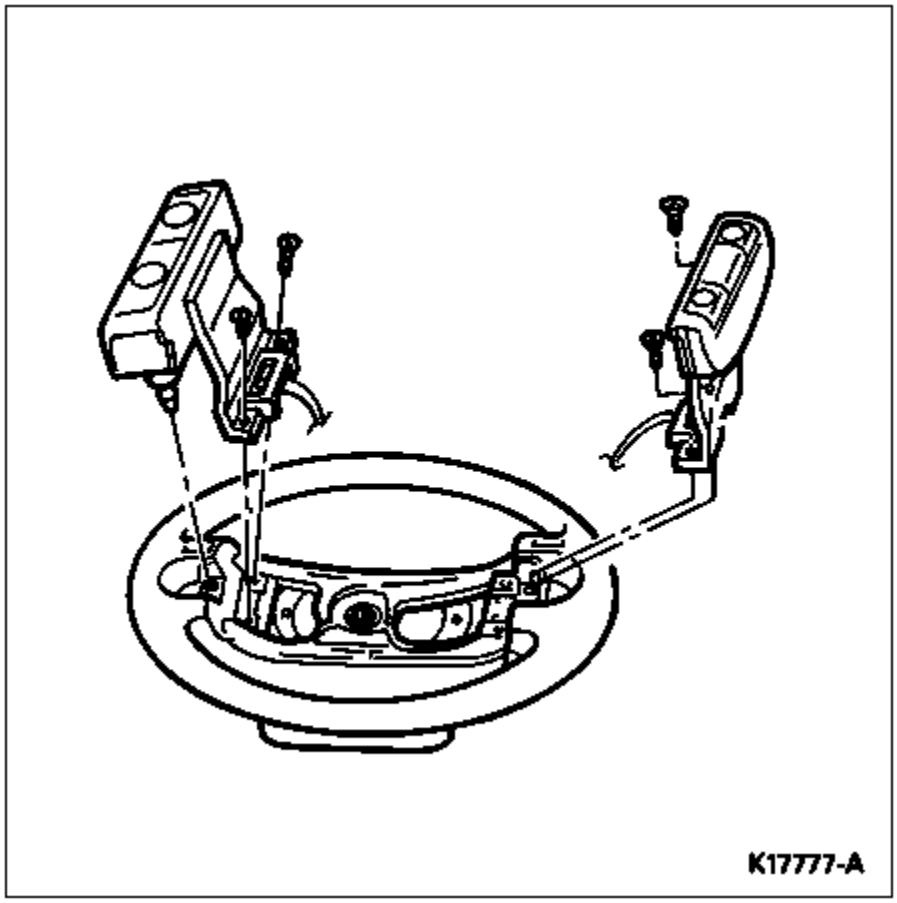
Horn Assembly, Ranger



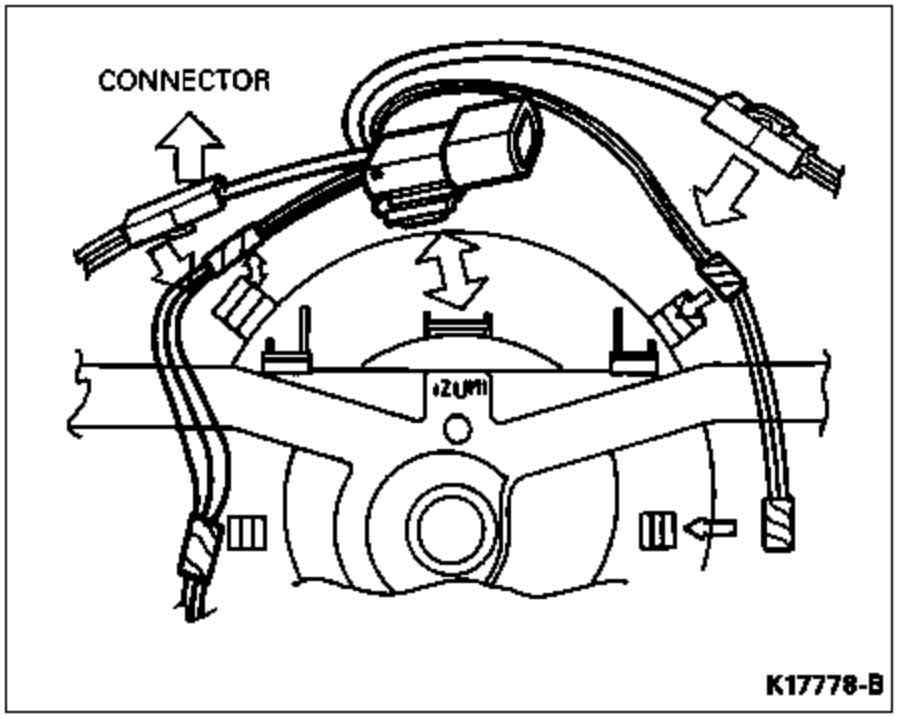
Horn Switch, Aerostar

Removal and Installation

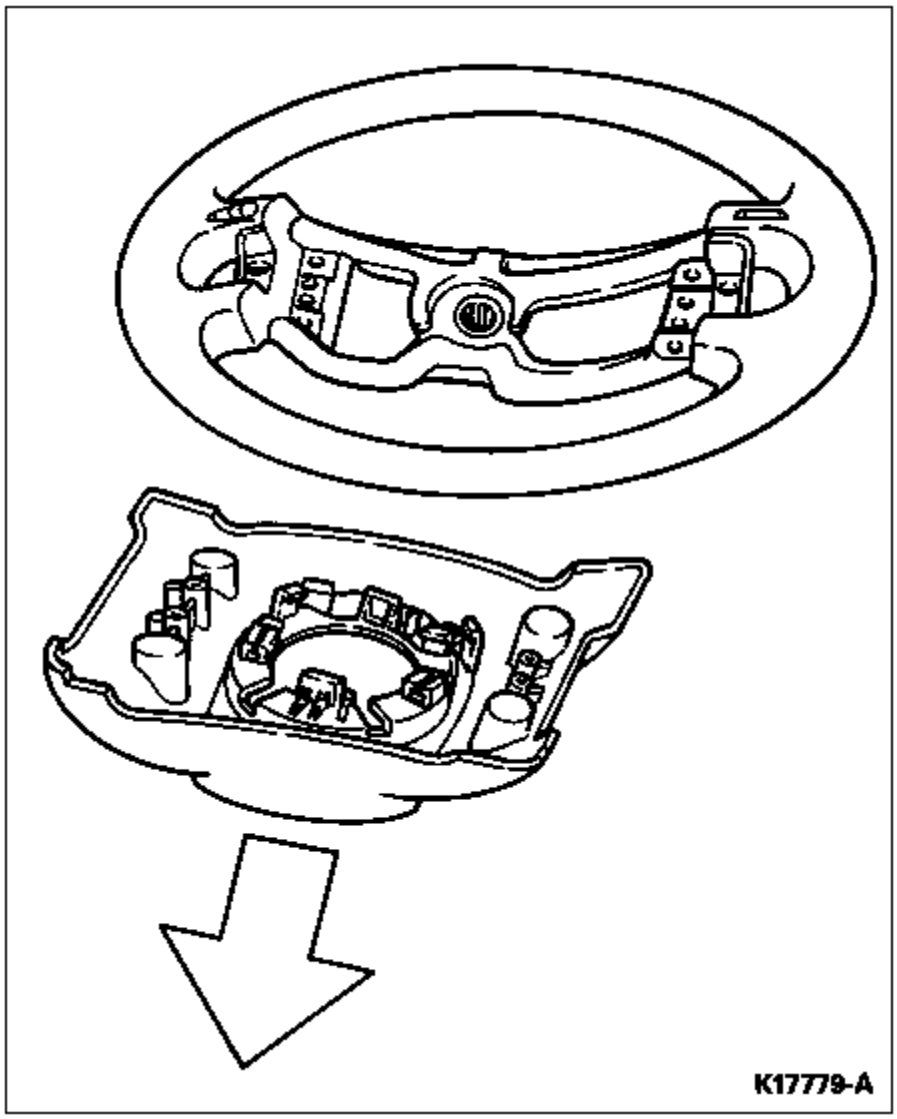
1. Follow procedure in Section 11-04B for removal of steering wheel (3600).
2. Remove four screws in steering wheel, two at 3 o'clock and two at 9 o'clock position. (On speed control steering wheels, these screws attach the speed control actuator switches (9C888) to the steering wheel.)



3. Remove wiring harness retainer (14A163) from the blade connector at 12 o'clock position in steering wheel.
4. Lift wiring out of wiring harness retainers in back cover of steering wheel.
5. Depress connector release tab and pull apart.

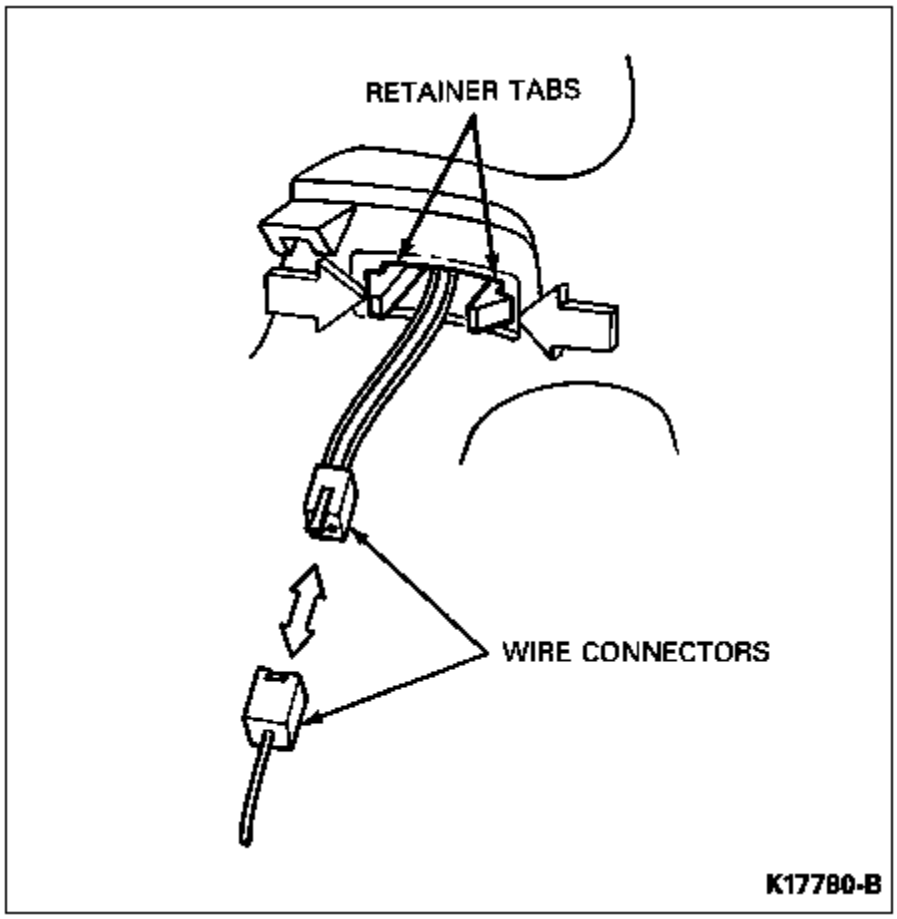


6. Remove back cover of steering wheel by detaching wiring harness retainers at 11, 1, and 6 o'clock positions.



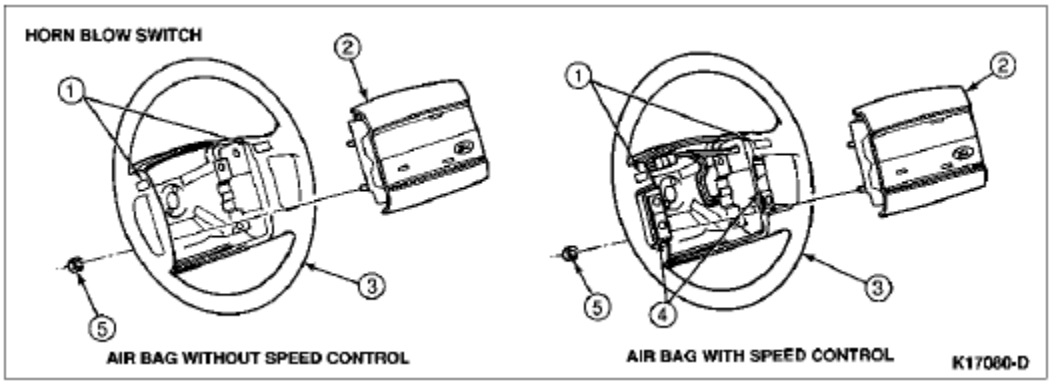
7. Remove steering wheel pad horn switch (13A805) to be serviced by carefully squeezing together the two retainer tabs and pushing the horn blow switch (13A875) up through the steering wheel.

8. Disconnect steering wheel pad horn switch wires at each wire connector.



For installation, follow removal procedures in reverse order.

Horn Blow Switch



Item	Part Number	Description
1	13A875	Horn Blow Switch
2	043B13	Driver Side Air Bag Module
3	3600	Steering Wheel
4	9C888	Speed Control Actuator Switch

5	N621903	Nut and Washer Assembly

Horn Switch, Ranger

Removal and Installation

1. Make sure the vehicle's front wheels are facing straight ahead, and the steering wheel is oriented in the straight-ahead position.
2. Disconnect the battery-to-starter relay cable. Wait at least one minute before proceeding to allow the air bag backup power supply to discharge.
3. Remove the driver side air bag module (043B13). Refer to Section 01-20B .
4. Disconnect the horn wire (Y/LG) from the switch to be removed.
5. Remove two Torx® head retaining bolts and remove horn blow switch (13A875).
6. To install, reverse removal procedure. Ensure that no wires are trapped/pinched when the new horn switch is attached to the steering wheel. Tighten retaining bolts to 6.5-7.5 Nm (58-66 lb-in).

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-In
Horn Mounting Bracket Screw	8-12	71-106
Horn Switch	6.5-7.5	58-66

Anti-Theft Alarm System

The theft warning system provides the vehicle with protection from unauthorized entry into the passenger compartment and engine compartment (hood opening). It also protects against engine starting through ignition keylock cylinder tampering. If triggered, the system provides both audio and visual alarm signals and disables the starter circuit.

The system is controlled by a receiver assembly. This assembly also controls the electronic door lock control system functions. System anti-theft functions are:

- Perimeter sensing — doors, trunk, hood
- Ignition keylock cylinder sensing
- Starter interrupt
- LED flashing when system is armed
- Alarm (horn and lights)

For additional information and diagnostic procedures, refer to Section 18-04B .

When armed, unauthorized entry into the vehicle is detected by a hood switch or the door ajar switches. The hood switch is monitored directly by the receiver assembly. The door ajar switches are monitored by the generic electronic module (see Section 18-04A). The GEM module signals the receiver assembly when a door is ajar (opened). If the anti-theft system is armed, this signal will trigger the receiver assembly. The door ajar signal will also prevent arming of the system if a door or liftgate is not fully closed.

Once triggered, the system flashes, the parking lamps (13200), the theft LED indicator, and sounds the horn. In addition, the starter circuit is interrupted until the system is disarmed.

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Components

The system is composed of the following components:

- Receiver assembly
- Anti-theft warning indicator (output)
- Door/liftgate disarm (input)
- Hood switch (input)
- Ignition keylock cylinder sensor (input)
- Starter interrupt relay (output)

The following components already exist on the vehicle and are also used in the anti-theft system:

- Horn relay (output)
- Parking lamps (13200)
- Generic Electronic Module (GEM) (input and output)
- Starter relay
- Park lamp autolamp/exit delay relay (output)

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Ignition Keylock Cylinder Sensor Operation

Ignition keylock cylinder sensing is provided by monitoring the status of the ignition lock cylinder when the ignition is OFF. The keylock cylinder sensor "clip" located within the ignition key lock cylinder housing senses if the key cylinder has been removed from a damaged steering column casting (as is done in most hot wire attempts).

The receiver assembly should normally read 162 ± 40 ohms to ground through the ignition keylock cylinder sensor. If the keylock cylinder sensor or its wiring become open or shorted, the perimeter alarm will trigger even though the theft system may not be armed. If the ignition is in RUN or ACCY and the keylock cylinder sensor input senses an open or a short, the theft system will not trigger until ignition is turned OFF.

As long as the ignition keylock cylinder sensor and associated wiring remain defective, the system will not trigger again due to this input until the problem is corrected and battery power is removed and reapplied to the module with a good sensor input. The alarm may then trigger again due to the ignition keylock cylinder sensor once the resistance changes away from 162 ohms.

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Starter Interrupt Function

When the anti-theft system is triggered, the receiver assembly energizes a relay that prevents cranking of the engine (6007). When the receiver assembly (module) provides a ground path for the relay coil, the normally closed contacts open. With the contacts open, the circuit between the ignition switch and starter motor relay is incomplete.

The alarm system operating sequences are designed to be passive; therefore, the system can be armed or disarmed when following normal vehicle exit and entry procedures. Following is a detailed description of the system operation.

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System Arming

The system is ready to arm any time the ignition switch (11572) is turned OFF and the PANIC alarm is off. There are two ways to PREARM the anti-theft system:

1. Press the remote entry transmitter LOCK button once to lock the doors (with the doors open or closed). If the lock is pressed again within 5 seconds, the horn will either chirp once to indicate all doors are closed and the system is arming, or will chirp twice if any door is open (preventing the system from arming).

2. Open a door and press the power door lock button to lock the doors.

If a door is open, the anti-theft system is prearmed and waiting for all doors to close. The THEFT LED in the instrument panel (04320) will light continuously while the system is prearmed. Once all doors are closed, if any were open, the system will be prearmed with a 30 second countdown to become armed. The THEFT LED will remain lit continuously until the system is ARMED. When the system is armed, the THEFT LED will begin to flash for 50 mS every two seconds until the system is triggered or disarmed.

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Cancelling the PREARM Sequence

If the anti-theft system is prearmed and waiting, it will wait only 30 minutes for a door to close. The THEFT LED will remain lit for this time. If a door does not close within 30 minutes, the LED will turn off and the theft system will return to a disarmed state.

An anti-theft system PREARM can also be cancelled before the system is armed by:

- pressing the unlock switch on the door
- any disarm event (see Disarming the System)

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Disarming the System

NOTE: A perimeter alarm will "shut off" after 165 seconds, but the system is still triggered and is not disarmed. The starter circuit will remain disabled until the system is disarmed.

An Armed or triggered system can be disarmed by one of the four events listed.

1. Unlock the doors by pressing the remote entry transmitter UNLOCK button once.
2. Unlock any door with a key.
3. Turn ignition to RUN or ACCY.
4. The remote entry PANIC button will disarm the anti-theft system only when the perimeter alarm is triggered and sounding.

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Alarm States When Battery Power Is Cycled

When the receiver assembly is powered the very first time at the vehicle assembly plant the system will be in the DISARMED state. The receiver assembly will remember whether it is ARMED, DISARMED or TRIGGERED in its non-volatile memory. When battery power is removed and then reconnected, the system will return to its state just before the battery (10655) was disconnected. If the system is in any PREARM state as described previously, then the system will return to a DISARMED state when battery is disconnected and then reconnected.

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System Triggering

The alarm can be triggered by the following events if the system has been armed and has not been disarmed first.

1. Open any door.

2. Open the hood (16612) (if the hood was open when the system was armed, it must be closed before it can trigger the alarm).

3. Disturb the ignition keylock cylinder sensor affecting the monitored resistance to ground. A disturbance of this sensor is the only event which will trigger an unarmed alarm.

4. The anti-theft system may be triggered inadvertently when the module is disconnected and then reconnected. To avoid this condition, disconnect the smaller 22-pin connector first. This alarm trigger is stored by the receiver assembly as Ignition Tamper Sensor Trigger event (IGNTAM) in the diagnostic list of alarm trigger events.

NOTE: Although the remote entry PANIC alarm is not associated with the monitoring of the vehicle, the user will frequently say that the theft system was triggered when actually the PANIC button was inadvertently pressed. A panic alarm will not flash the THEFT LED. PANIC is stored in the diagnostic list of alarm events to aid in diagnosis.

When the system is triggered, the starter interrupt and perimeter alarm will operate as follows:

STARTER INTERRUPT — starter circuit interrupted until system is disarmed. The normally closed external starter interrupt relay will be pulled in to disallow power to travel through the starter circuit.

PERIMETER ALARM — approx. 250 mS on, 450 mS off cycle for two minutes and 45 seconds for North America.

- Parking lamps
- Horn
- THEFT LED

The perimeter alarm can be retriggered, after a perimeter alarm has sounded for 165 seconds. After a perimeter alarm has timed out, if any trigger input is seen as normal and then in its trigger state, the perimeter alarm will be retriggered. The perimeter alarm can be triggered a total of three times between an arming sequence and a disarm event. An active panic alarm will be deactivated when a perimeter alarm is triggered (a perimeter alarm overrides a panic alarm).

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PANIC Alarm Activation

The PANIC alarm, operated from the remote keyless entry transmitter, is activated when the button marked PANIC on the remote transmitter is pressed. The PANIC alarm consists of the horn sounding and the parking lamps and tail lamps flashing.

This subsystem can only be deactivated by pressing PANIC again or turning the ignition switch (11572) to the RUN or ACC position.

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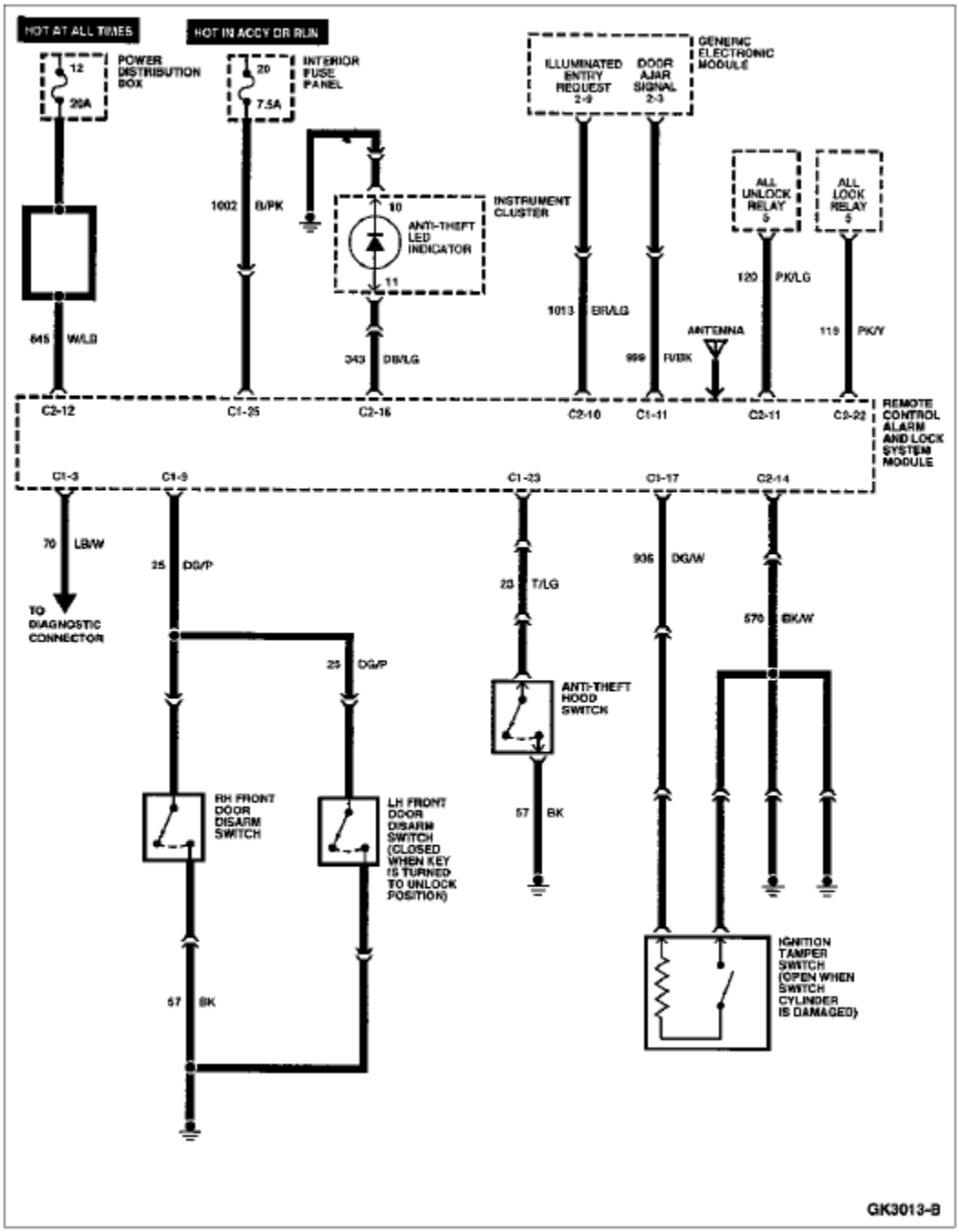
Electrical Schematics

Anti-Theft System, Power Feed, Activation and Disarm



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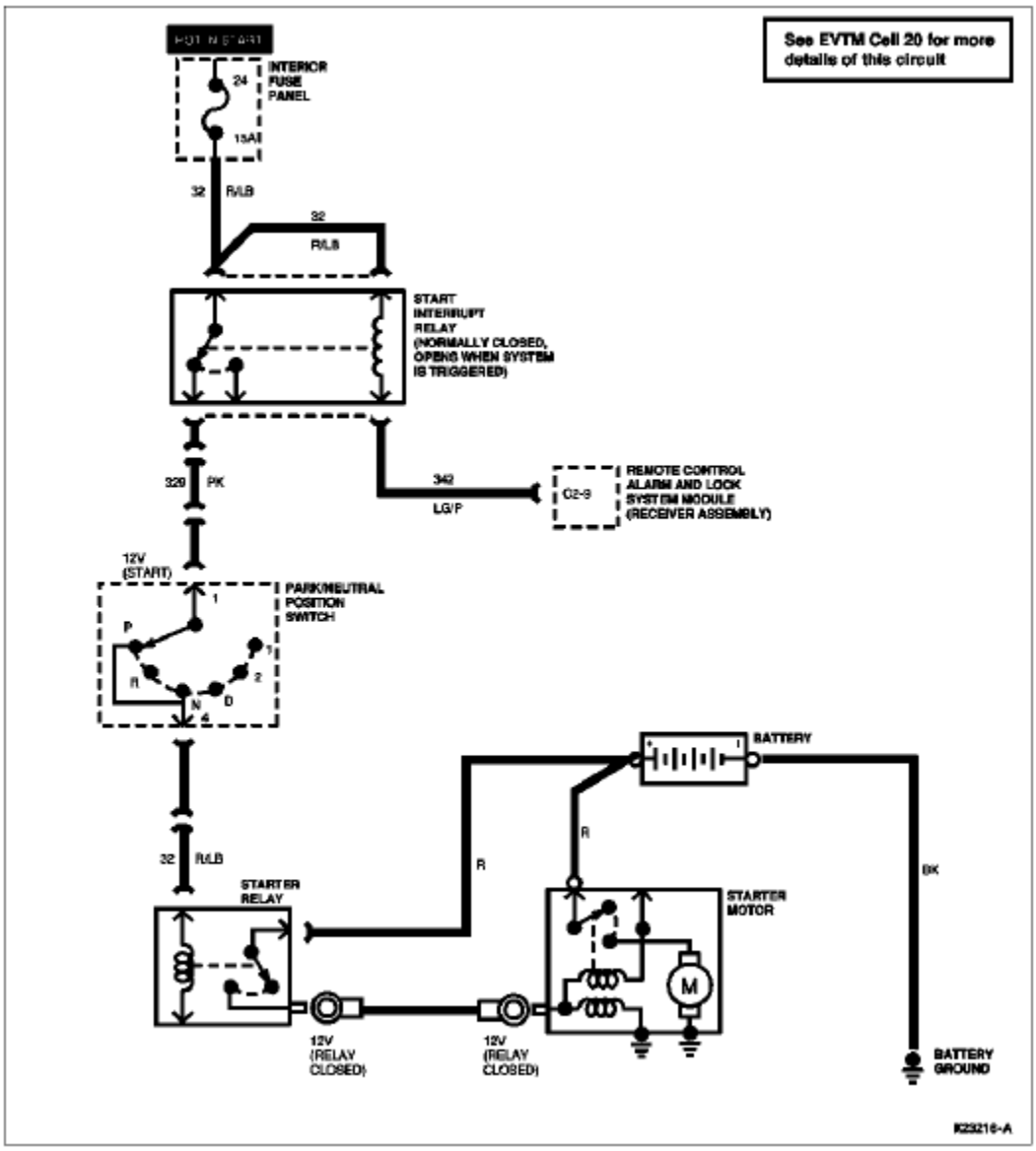
Anti-Theft System, Starter Motor Interrupt



Anti-Theft System, Exterior Light Alarm

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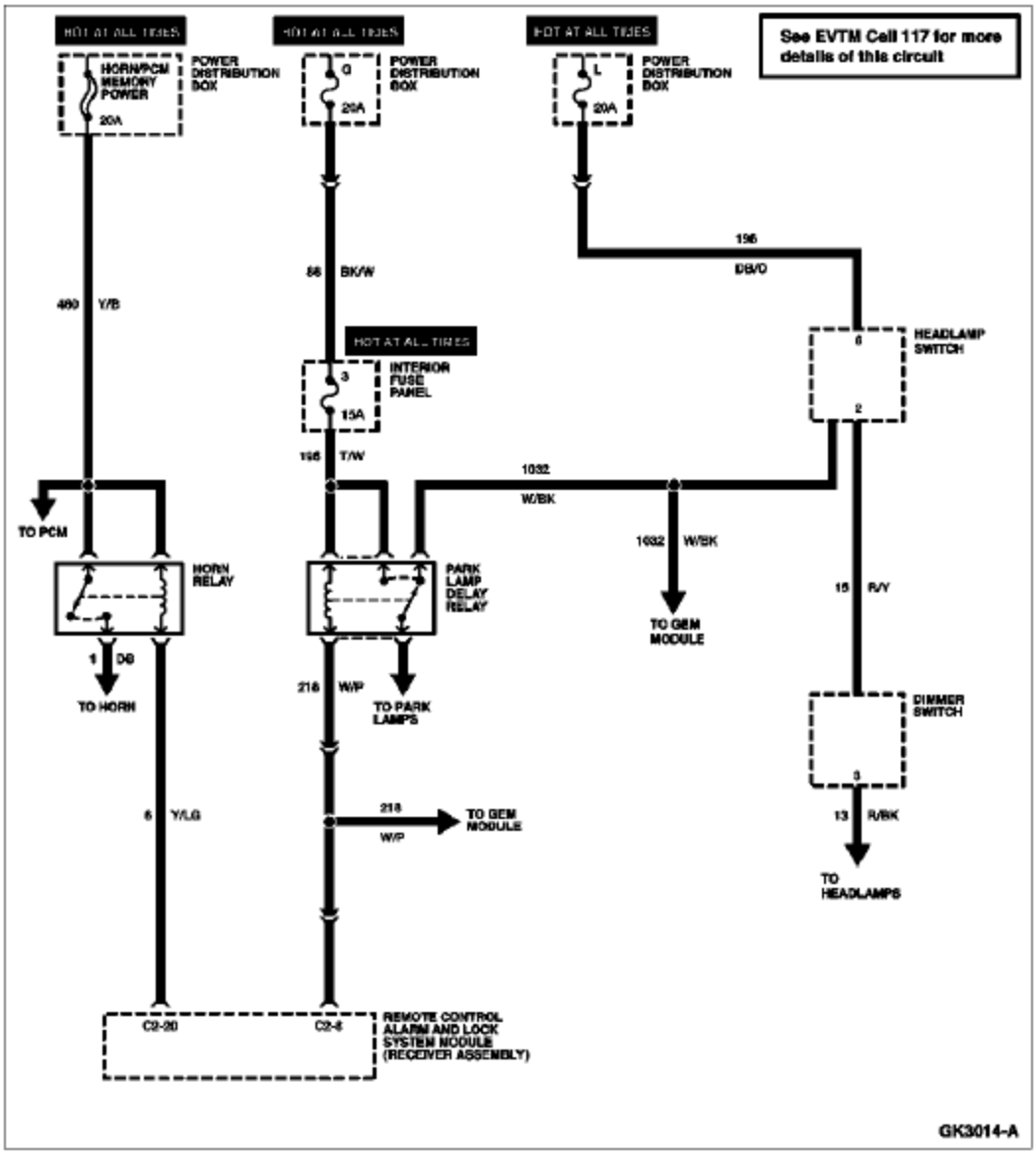

Anti-Theft System, Horn Alarm

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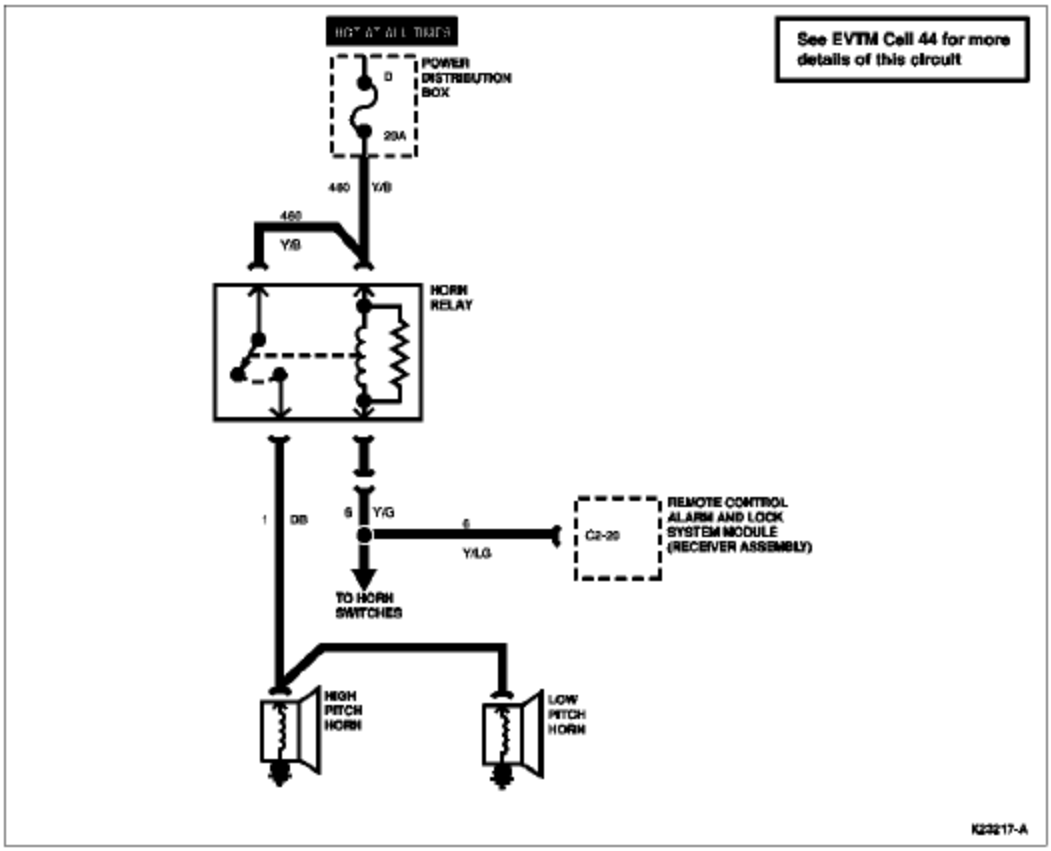
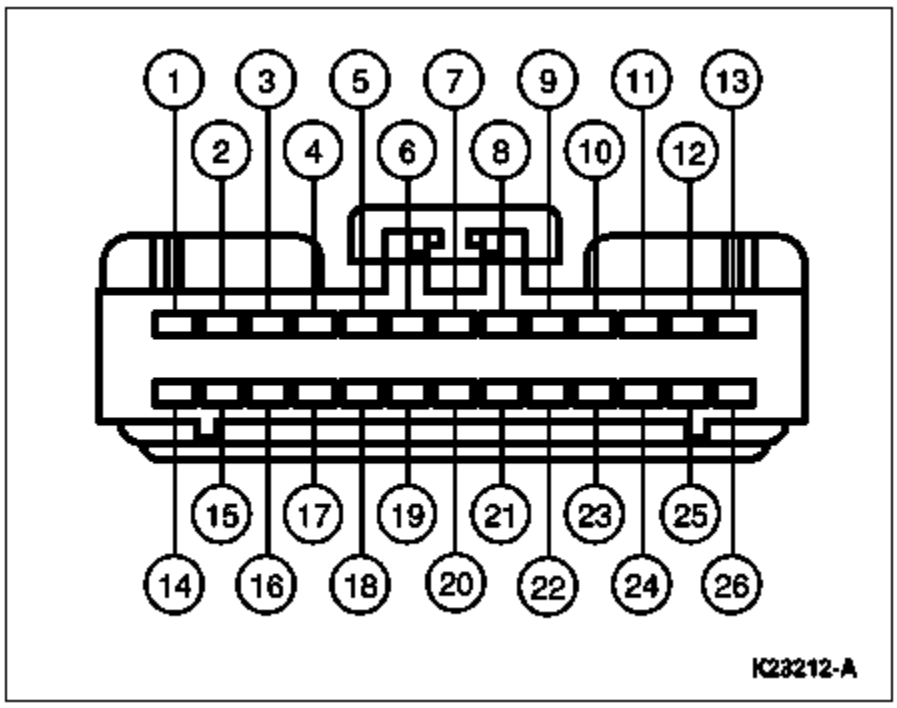


Receiver Assembly Connector C1



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Pin Number	Circuit	Circuit Function
1	129 (LG)	Driver Door Unlock Relay
2	—	Not Used
3	70 (LB/W)	Diagnostic Serial Link
4	—	Not Used
5	—	Not Used
6	—	Not Used
7	—	Not Used
8	—	Not Used
9	25 (DG/P)	Door Disarm Switches
10	—	Not Used
11	999 (R/BK)	GEM Module Door Ajar Input to RAP
12	—	Not Used
13	—	Not Used
14	—	Not Used
15	—	Not Used
16	—	Not Used
17	936 (DG/W)	Ignition Keylock Cylinder Tamper Sensor
18	—	Not Used
19	—	Not Used
20	—	Not Used
21	—	Not Used
22	—	Not Used
23	23 (T/LG)	Hood Switch
24	—	Not Used
25	1002 (B/PK)	Ignition Switch Feed
26	—	Not Used

Receiver Assembly Connector C2

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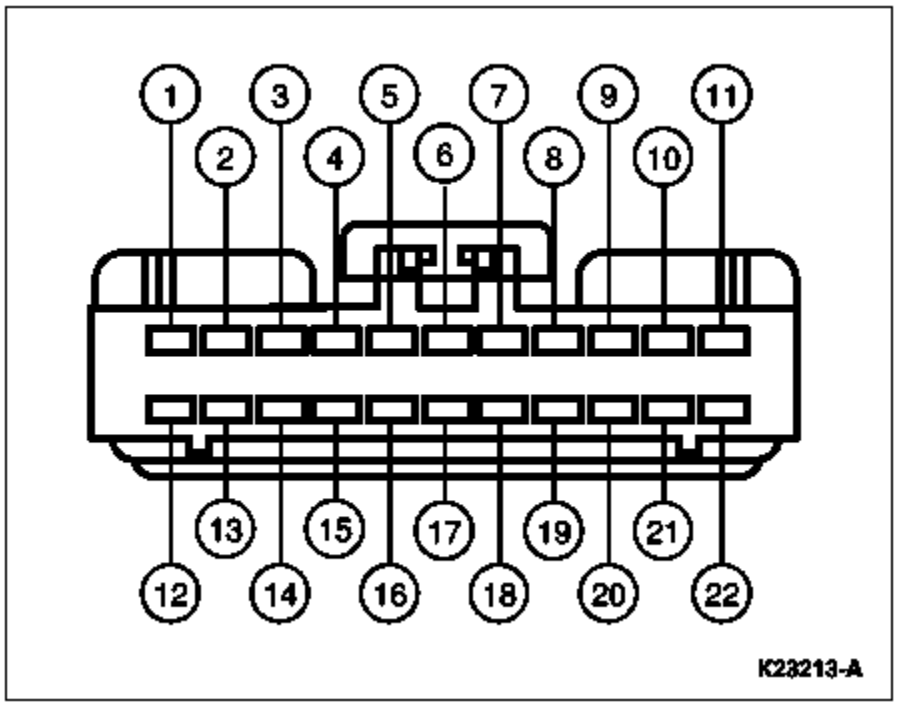

Pin Number	Circuit	Circuit Function
1	—	Not Used
2	—	Not Used
3	—	Not Used
4	—	Not Used
5	—	Not Used
6	—	Not Used
7	—	Not Used
8	218 (W/P)	Park Lamp Relay
9	342 (LG/P)	Starter Interrupt Relay
10	1013 (BR/LG)	Illuminated Entry Request to GEM Module — Input
11	120 (PK/LG)	All Unlock Relay
12	645 (W/LB)	Anti-Theft Module — Fused Feed
13	—	Not Used
14	570 (BK/W)	Ground
15	—	Not Used
16	343 (DB/LG)	Anti-Theft LED
17	—	Not Used
18	—	Not Used
19	—	Not Used
20	6 (Y/LG)	Horn Relay

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21	—	Not Used
22	119 (PK/Y)	All Lock Relay

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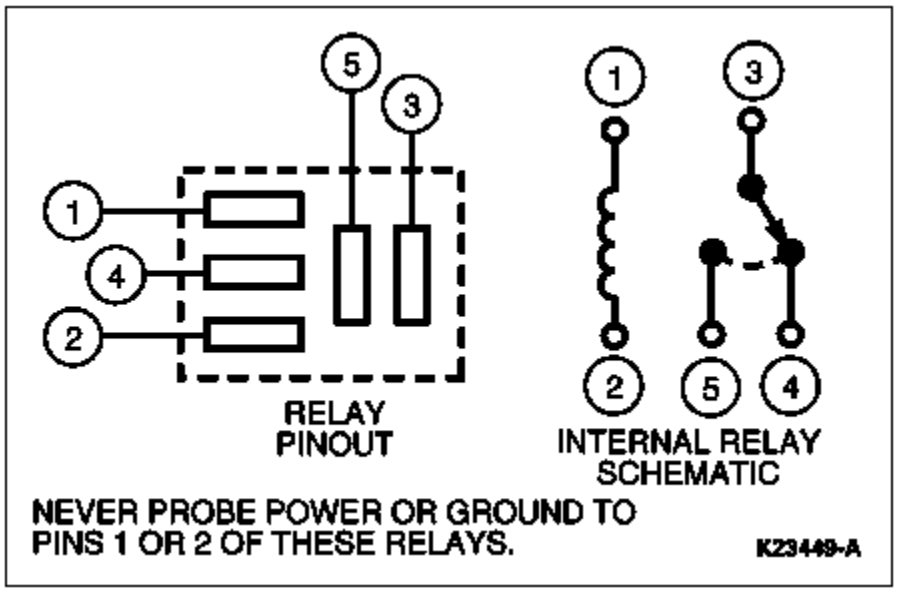
All Relay Connectors

The harness connector to each system relay (horn, parklamp, starter interrupt) have the same pinout. Check the Electrical Schematics for circuit number, wire gauge and color.



Item	Part Number	Description
1	—	Battery Feed to Coil
2	—	Coil Ground
3	—	Battery Feed to Contacts
4	—	Normally Closed Connector
5	—	Coil Energized Contact

NOTE: NEVER probe power or ground to Pins 1 or 2 of these relays.

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Inspection and Verification

The electronic door lock control system is diagnosed as part of the overall remote control alarm and lock system. Refer to Section 18-04B to initiate system self test, New Generation Star (NGS) Tester use and diagnostic test codes.

1. Verify the vehicle owner's original concern by duplicating the concern.

2. Inspect to determine if one of the following mechanical or electrical concerns apply:

VISUAL INSPECTION CHART

Mechanical	Electrical
• Damaged liftgate door lock cylinder	• Open fuses • Loose connections • Corroded connections

3. If the concern(s) remains after the inspection, determine the symptom(s) and proceed to the following symptom chart.

NOTE: For system inspection and verification using New Generation Star (NGS) Tester 007-00500 or equivalent, refer to Section 18-04B .

NOTE: Voltage and resistance readings can be obtained using Rotunda 73 Digital Multimeter 105-R0051 or equivalent.

To test and service door lock system:

- Check that battery is fully charged (if not, it may be causing the concern).

NOTE: When the battery has been disconnected and reconnected, some abnormal symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.

- Disconnect and reconnect battery to make sure system is reset.
- Perform the self test. If necessary, refer to Section 18-04B .
- Service only as specified in the tests.
- Repeat the self test to make sure the system is operational.

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Symptom Chart — Anti-Theft Alarm System

ANTI-THEFT ALARM SYSTEM

Condition	Possible Source	Action
• Alarm Triggers As Soon As Ignition Is Turned OFF	• Loose ignition tamper sensor or its wiring.	• GO to Pinpoint Test A .
• Alarm Triggers When the Driver's Door Is Open After Being Unlocked with a Key	• Driver disarm switch or its wiring.	• GO to Pinpoint Test C .
• Alarm Triggers When the Passenger's Door Is Open After Being Unlocked with a Key	• Passenger disarm switch or its wiring.	• GO to Pinpoint Test C .
• Alarm Triggers Intermittently	• Any switches monitored for triggering an alarm. • Unintended presses of panic button on transmitter.	• GO to Pinpoint Test A .
• Alarm Not Triggered by Hood Switch.	• Hood switch circuit short/open. • Hood switch not depressed when hood closed.	• GO to Pinpoint Test A .
• Horn Sounds Continuously (No Honking On and Off) During Alarm	• Unusual alarm configuration programmed.	• GO to Pinpoint Test B .
• Vehicle Will Not Start, Battery Fully Charged	• No start condition other than starter interrupt relay. • Starter interrupt relay wiring short/open. • Starter interrupt relay missing.	• GO to Section 03-06 . • GO to Pinpoint Test B .
• Alarm Is Disarmed by Locking a Door with a Key (Instead of Unlocking)	• Wiring to disarm switch or switch has been reversed.	• GO to Pinpoint Test C .
• THEFT LED Does Not Light	• Wiring to LED is open. • LED is burned out due to a short in the wiring.	• GO to Pinpoint Test D .

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• Anti-Theft Never Arms (THEFT LED Doesn't Light)	• Any door disarm circuit is shorted. • Any door disarm switch is shorted. • Door unlock switch or circuit shorted.	• GO to Pinpoint Test E . **NOTE: Before proceeding with Pinpoint Test, GO to Section 18-04B for system self test and diagnostic test codes.**
• Anti-Theft Never Arms (THEFT LED Lights but Never Flashes)	• Any door is ajar or open. • Any door does not close properly. • Any door ajar switch or wiring is shorted. • GEM to receiver assembly door ajar circuit is grounded.	• GO to Pinpoint Test E . **NOTE: Before proceeding with Pinpoint Test, GO to Section 18-04B for system self test and diagnostic test codes.**
• Anti-Theft Does Not Arm Only Using Door Lock Button and an Open Door	• Any door is ajar or open. • Any door ajar switch or wiring is shorted. • GEM to receiver assembly door ajar circuit is grounded. • Door lock switch to receiver assembly circuit.	• GO to Pinpoint Test E . **NOTE: Before proceeding with Pinpoint Test, GO to Section 18-04B for system self test and diagnostic test codes.**

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Pinpoint Tests

PINPOINT TEST A: FALSE ALARMS AND TRIGGERING ALARMS

A1 CHECK ALARM HISTORY FOR FALSE ALARMS

- Enter in NGS: RAP, PID/DATA and select AL EVT1 through AL EVT8 to monitor the last 8 events which have caused the alarm to trigger. AL EVT1 is the most recent and AL EVT8 occurred before all of the others.
- Write down alarm events in case display is changed by triggering alarm.

Does NGS display an alarm that shows up much more than any other alarm?

Yes	No
If display shows two door open triggers (DROPEN), GO to **A2**. If display shows two hood switch triggers (HOODTR), GO to **A3**. If display shows an ignition tamper trigger (IGNTAM), GO to **A4**. If NGS display shows several PANIC alarm triggers, GO to **A5**.	If NGS does not display a dominant trigger event or most events are no event, NOEVNT, GO to **A2** to REVIEW alarm trigger events.

A2 CHECK DOOR AJAR INPUT

Accidental triggering of an armed system can be caused by the owner. The theft system is working normally when the alarm is triggered with someone in the armed vehicle, and they later exit by pulling on the door handle to open the door. Another common trigger which is an OK system is when the customer opens a locked door through an open window. These events may have cause the DROPEN alarm history in addition to the following diagnostics.

If the door mechanically unlocks and can be open, without first having electrically sensed that the key turned to the unlock position to disarm the system, then the alarm will be triggered due to a door ajar switch (caused by door disarm switches).

- Enter in NGS: RAP, PID/DTA and select DOORRAP to monitor the GEM door ajar to see door ajar state.
- Close all doors.
- NGS DOORRAP state is CLOSED.
- Open each door separately.
- NGS DOORRAP state is AJAR.

NOTE: The alarm trigger history must be cleared after servicing the anti-theft system for inadvertent triggering. The alarm history is cleared by entering in the NGS: RAP DIAGNOSTIC TEST MODES RETRIEVE/CLEAR CONTINUOUS DTCS then press START, RECORD DTCS and press C ALL (button 7) to clear.

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Do both states appear on the NGS?

Yes	No
TEST for intermittent door ajar switches (possibly due to water) in the GEM system (REFER to Section 18-04A), or TEST door disarm switches. GO to C2, or CLARIFY with the customer to IDENTIFY how alarm was triggered with the door.	If NGS display is always AJAR, SERVICE door ajar circuits/switches with GEM module diagnostics (REFER to Section 18-04A), or SERVICE Circuit 999 (R/BK) for a short to ground. If NGS display is always CLOSED, SERVICE Circuit 999 (R/BK) for an open or SERVICE door ajar input circuits/switches with GEM module diagnostics (REFER to Section 18-04A).

A3 CHECK HOOD SWITCH INPUT

The theft system is working normally when the alarm is armed with someone in the vehicle or when reaching through an open window, and they pull the hood release to open the hood. This may be a cause of the alarm trigger history.

If a cover is installed on the front of the vehicle, the hood may not close far enough to fully press the hood switch plunger. You may need to bend the hood switch bracket slightly to insure the hood switch is pressed enough.

- Close hood.
- Enter in NGS: RAP, PID/DATA and select HOOD SW to monitor the hood switch state.
- NGS HOOD SW state of not PUNCHD should be displayed.
- Check to see that wiggling the hood up and down, while it is latched and closed, does not cause the hood switch state to change from not PUNCHD.
- Open the hood.
- NGS HOOD SW state is PUNCHD should be displayed.

Do the above states appear on the NGS as described?

Yes	No
Hood switch operation is OK. CLARIFY with customer and REVIEW customer symptoms table.	If HOOD SW state is always not PUNCHD, SERVICE hood switch Circuit 23 (T/LG) for an open, or CHECK hood switch to CONFIRM that when it is not pressed its contacts close. If HOOD SW state is always PUNCHD, SERVICE Hood Switch Circuit 23 (T/LG) for a short to ground, or CHECK hood switch to CONFIRM that when it is PRESSED its contacts are open. VERIFY that hood switch plunger closes fully when hood is closed. If NGS state changes when hood is wiggled, VERIFY that hood switch plunger closes fully when hood is closed. Hood switch bracket can be bent slightly to INSURE hood switch is pressed enough.

A4 CHECK IGNITION TAMPER SENSOR INPUT

Receiver assembly deals with ignition tamper sensor differently then other systems. Read ignition

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tamper sensor description and operation.

Each time battery is reapplied to the system, module will wait to see a normal tamper sensor and will then trigger alarm (armed or not) when ignition is off and sensor resistance to module changes outside of 120 to 210 ohm boundary.

- Enter in NGS: RAP, PID/DATA and select IGN RES to monitor ignition tamper sensor state.
- The receiver assembly will respond with one of three states: 162 ohm, 0 ohms, or HIGH.

Is the ING RES state 162OHM?

Yes	No
Ignition tamper sensor and SYSTEM are OK, they are unlikely now to be intermittent.	If IGN RES state is 0 ohms, SERVICE ignition tamper Circuit 936 (DG/W) for a short to ground, REMOVE and RECONNECT battery, and REPEAT Test **A4**. If IGN RES state is HIGH, SERVICE ignition tamper Circuit 936 (DG/W) for an open, or REINSTALL ignition tamper sensor, or REPLACE ignition tamper sensor.

A5 PANIC ALARM OPERATION

The receiver assembly PANIC alarm is not a theft alarm trigger event, but quite often an owner bumps the PANIC button on the transmitter by accident as they are walking away from their vehicle and say that their theft alarm is going off.

The PANIC button may be pressed by objects inside of a purse or pocket, without the customer knowing. If several PANIC codes appear in the alarm history, you know that this is the case.

The customer may need to take a couple of steps close to the vehicle from where the PANIC alarm was started in order to stop the PANIC alarm or turn the key to RUN.

Can cause of false alarms be traced to accidental triggering by owner?

Yes	No
PANIC alarm system is OK. CLARIFY operation with owner and CHECK symptom table if necessary.	RETURN to Symptom Chart.

No Starts and Alarm Outputs

The receiver assembly can only defeat the starter with the extended anti-theft (starter interrupt) relay. If a temporary jumper is installed across the normally closed contacts of the starter relay as outlined below and the vehicle does not start, check for other causes.

PINPOINT TEST B: NO STARTS AND ALARM OUTPUTS

B1 ALARM VERIFICATION — TRIGGER AND THEFT LED

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- Open driver door window.
- Arm theft system.
- Trigger theft alarm by pulling on inside door handle to open driver door.

Does THEFT LED flash when theft system is triggered?

Yes	No
GO to **B2** .	If THEFT LED does not come on, GO to Pinpoint Test D . If theft system did not arm, GO to Pinpoint Test E .

B2 ALARM VERIFICATION — PARKLAMPS AND HORN

Does horn honk on and off and parking lamps flash?

Yes	No
GO to **B3** .	If only the park lamps flash, GO to **B4** . If only the horn honks, GO to **B6** . If neither the horn nor the parklamps are pulsing, GO to **B4**

B3 ALARM VERIFICATION — STARTER INTERRUPT

Does vehicle start?

Yes	No
Alarm outputs OK. CLARIFY with customer and REVIEW customer symptoms table.	GO to **B8** .

B4 CHECK RECEIVER ASSEMBLY PARKLAMPS OUTPUT

- Stop alarm with any disarm event.
- Enter in NGS: RAP, ACTIVE COMMANDS, HEAD/PARKING LAMPS and select PARK LAMP ON.

Do park lamps turn on?

Yes	No
REPLACE the RAP module. RETEST the system.	GO to **B5** .

B5 PARK LAMPS JUMPERED OPERATION

- Disconnect receiver assembly.
- Momentarily short park lamp Circuit 218 (W/P) to signal ground Circuit 570 (BK/W).

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Did park lamps turn on?

Yes	No
REPLACE the RAP module. RETEST the system.	SERVICE park lamps, park lamp relay or power circuit from park lamp relay to park lamps.

B6 CHECK RAP HORN OUTPUT

- Stop alarm with any disarm event.
- Enter in NGS: RAP, ACTIVE COMMANDS, HORN and select HORN ON.

Does horn sound?

Yes	No
REPLACE the RAP module. RETEST the system.	GO to **B7** .

B7 HORN JUMPERED OPERATION

- Disconnect receiver assembly.
- Momentarily short horn Circuit 6 (Y/LG) to signal ground Circuit 570 (BK/W).

Does horn sound?

Yes	No
REPLACE the RAP module. RETEST the system.	SERVICE horn, horn relay, Circuit 6 (Y/LG) for an open or power circuit for the horn.

B8 CHECK RECEIVER ASSEMBLY STARTER INTERRUPT OUTPUT

- Stop alarm with any disarm event.
- Enter in NGS: RAP, ACTIVE COMMANDS, STARTER INTERRUPT and select STARTER ON.
- Turn ignition key to start for less than 2 seconds.

Is starter motor disabled (no cranking)?

Yes	No
System OK.	GO to **B9** .

B9 STARTER INTERRUPT JUMPERED OPERATION

- Disconnect receiver assembly.
- Momentarily short starter interrupt output Circuit 342 (LG/P) to signal ground Circuit 570 (BK/W).

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Does the starter operate?

Yes	No
REPLACE the RAP module. RETEST the system.	RAP system OK. SERVICE starter, anti-theft relay, or power circuit for starter.

PINPOINT TEST C: DISARMING ANTI-THEFT

C1 CONFIRM REMOTE DISARMING SEQUENCE

- Arm theft system; THEFT LED is on.
- Perform disarming sequence by pressing UNLOCK on a transmitter as described in Description and Operation, Disarming the System.
- Confirm doors unlocked when transmitter button was pressed.

Did system disarm and THEFT LED turn OFF?

Yes	No
GO to **C2** .	If the doors did not unlock, GO to Diagnosis and Testing in Section 01-14B . If theft system did not arm, GO to Pinpoint Test E .

C2 CONFIRM DOOR KEY DISARMING SEQUENCE

NOTE: If door mechanically unlocks and can be opened, without first having electrically sensed key turned to unlock position to disarm system, then alarm will be triggered by door ajar switch.

- Arm theft system; THEFT LED is on.
- Perform disarming sequence by turning door key to unlock position as described in Description and Operation, Disarming the System.
- Confirm door unlocked (not locked) when key was turned.
- Perform above steps for passenger door.

Did system disarm and THEFT LED turn OFF?

Yes	No
GO to **C6** .	If doors did not unlock, GO to Diagnosis and Testing in Section 01-14B . There is a mechanical interference. If theft system did not disarm, GO to **C3** .

C3 CHECK THE DOOR DISARM SWITCH INPUT

NOTE: If the door mechanically unlocks, and can be opened without first having the system

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disarm because it electrically sensed the key turned to unlock position, then the alarm will be triggered by the door open warning lamp switch.

- Enter in NGS: RAP, PID/DATA and select DR DARM to monitor.
- The PID/DATA DR ARM should read NOT ACT.
- Turn the key in each door lock cylinder to the UNLOCK position. While the key is in the UNLOCK position, the DR DARM PID should read ACTIVE for each door.

Did both PID states appear?

Yes	No
REPLACE the RAP module. RETEST the system.	If only the DR DARM PID state ACTIVE appeared; Go to **C4** . If only the DR DARM PID state NOT ACT appeared; Go to **C5** **.**

C4 CHECK CIRCUIT 25 (DG/P)

- Turn the ignition to the OFF position.
- Disconnect RAP module connector C1.
- Measure the resistance between the RAP connector C1 pin 9, circuit 25 (DG/P), and chassis ground.

Is the resistance 10,000 ohms or less?

Yes	No
REPAIR circuit 25 (DG/P). RETEST the system.	REPLACE the RAP module. RETEST the system.

C5 CHECK CIRCUIT 25 (DG/P)

- Turn the ignition in the OFF position.
- Disconnect RAP module connector C1.
- Measure the resistance between the RAP connector C1 pin 9, circuit (DG/P) and chassis ground, while the door lock cylinder is turned to the UNLOCK position.

Is the resistance 10,000 ohms or less?

Yes	No
REPLACE the RAP module. RETEST the system.	REPAIR circuit 25 (DG/P). RETEST the system.

C6 CHECK THE IGNITION INPUT OPERATION

- Arm the theft system; theft LED in ON.
- Perform the disarming sequence by turning the ignition switch to the RUN position.

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Did the system disarm and theft LED turn OFF?

Yes	No
Anti-theft system disarming is OK.	GO to C7 .

C7 CHECK IGNITION INPUT

- Enter in NGS: RAP, PID/DATA and select IGN RAP to monitor ignition switch state.
- Turn ignition key to OFF position. NGS communication may be lost after a few seconds.
- NGS IGN RAP state is OFF should be displayed.
- Return ignition key to RUN position and resume NGS PID/DATA communication if necessary.
- NGS IGN RAP state is RUN should be displayed.

Do both states appear on the NGS?

Yes	No
Anti-theft disarming system is OK. CLARIFY with customer and REVIEW customer symptoms table.	If NGS displays a constant RUN state, SERVICE the ignition switch or SERVICE Circuit 1002 (B/PK) for a 100 ohm or less battery short. If NGS displays a constant OFF, SERVICE Circuit 1002 (B/PK) for an open, blown fuse, or short to ground or SERVICE the ignition switch.

THEFT LED Operation

PINPOINT TEST D: ANTI-THEFT LED OPERATION

D1 ANTI-THEFT LED OPERATION

CAUTION: Do not jumper battery voltage to the THEFT LED directly.

Do not treat the THEFT LED like a bulb. Most of the battery voltage is dropped across a resistor internal to the receiver assembly so that very little current is supplied to the LED. If you place battery voltage directly to the LED, the LED will burn out.

- Enter in NGS: RAP, ACTIVE COMMANDS, ALARM OUTPUT and select ALARM ON to turn on THEFT LED.

Does ANTI-THEFT LED turn on?

Yes	No
The THEFT LED output and LED are OK.	GO to D2 .

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D2 CHECK ANTI-THEFT LED

- Disconnect instrument cluster and remove THEFT LED. Measure resistance across LED. With the NGS: DIGITAL MEASUREMENT, OHMMETER, select RANGE as AUTO.

Is resistance between 10 and 20 ohms?

Yes	No
SERVICE Circuit 343 (DB/LG) for an open or short, or SERVICE ground circuit for instrument cluster on low side of the LED.	REPLACE damaged LED and RETEST.

Arming Anti-Theft

When symptom is THEFT LED does not come on, this may mean that there is an issue with the LED or it may mean that the theft system is not arming at all.

PINPOINT TEST E: ARMING ANTI-THEFT

E1 CONFIRM REMOTE ARMING SEQUENCE

- Open driver door window.
- Perform arming sequence by pressing LOCK on a transmitter as described in Description and Operation, System Arming.
- Confirm that doors locked when transmitter button was pressed.
- If THEFT LED does not light, wait at least 45 seconds after all doors are closed and locked. Theft system may still arm, but LED may not be working. Reach through window and open door to trigger armed system.

Did the system arm and trigger?

Yes	No
GO to **E2** .	If doors did not lock, GO to Diagnosis and Testing in Section 01-14B . If system armed and triggered, but THEFT LED did not light, GO to Pinpoint Test D. If theft system did not arm, GO to **E3** .

E2 CONFIRM DOOR LOCK ARMING SEQUENCE

- Confirm anti-theft system is disarmed by pressing UNLOCK button on transmitter.
- Perform arming sequence by opening door, pressing LOCK on door lock switch and closing door as described in Description and Operation, System Arming.
- Confirm doors locked when door lock button was pressed.

Did system arm?

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Yes	No
Anti-theft arming system is OK. CLARIFY with customer and REVIEW customer symptoms chart.	If doors did not lock, GO to Diagnosis and Testing in Section 01-14B . If theft system did not arm, GO to **E3** .

E3 CHECK DOOR AJAR INPUT

- Enter in NGS: RAP, PID/DATA and select DOORRAP to monitor GEM Door Ajar to see Door Ajar State.
- Close all doors.
- DOORRAP state is CLOSED should be displayed on NGS.
- Open any door.
- DOORRAP state is AJAR should be displayed on NGS.

Do both states appear on the NGS?

Yes	No
GO to **E4** .	If DOORRAP state is always AJAR, SERVICE door ajar input circuits/switches with GEM module diagnostics (refer to Section 18-04A), or SERVICE Circuit 999 (R/BK) for a short to ground with ignition in RUN. If DOORRAP state is always CLOSED, SERVICE Circuit 999 (R/BK) for an open or SERVICE door ajar input circuits/switches with GEM module diagnostics (refer to Section 18-04A).

E4 CHECK IGNITION INPUT

- Enter in NGS: RAP, PID/DATA and select IGN RAP to monitor ignition switch state.
- Turn ignition key to OFF position. NGS communication may be lost after a few seconds.
- IGN RAP is OFF should be displayed on NGS.
- Return ignition key to RUN position and resume NGS PID/DATA communication if necessary.
- IGN RAP state is RUN should be displayed on NGS.

Do both states appear on NGS?

Yes	No
GO to **E5** .	If IGN RAP state is always RUN, SERVICE the ignition switch or SERVICE Circuit 1002 (B/PK) for a 100 ohm or less battery short. If IGN RAP state is always OFF, SERVICE Circuit 1002 (B/PK) for an open, blown fuse, or short to ground or SERVICE ignition switch.

E5 CHECK DOOR DISARM SWITCH INPUT

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If anti-theft system module receives a shorted door disarm switch-signal, the module will react by disarming theft system. Even when a valid arming sequence has been entered, theft system will immediately disarm as soon as the system is armed.

- Enter in NGS: RAP, PID/DATA and select DR DARM to monitor door disarm state.
- NGS DR DARM is notACT should be displayed on NGS.
- Turn key in each door to unlock door and leave key in unlock position. Make sure that it is unlock and not lock position.
- DR DARM is active should be displayed on NGS.

Do both states appear on NGS?

Yes	No
GO to **E6** .	If DR DARM state is always ACTIVE, CHECK door disarm switch on each key cylinder for an internal short (switches should be normally open when key is removed from cylinder), or SERVICE disarm switch Circuit 25 (DG/P) for a short to ground. If DR DARM state is always not ACT, SERVICE disarm switch Circuit 25 (DG/P) for an open. CHECK at door disarm switch that tested always notACT to see if it shorts when key is turned in unlock position.

E6 CHECK DOOR UNLOCK SWITCHES

If anti-theft system is constantly seeing a shorted door unlock switch, module will react by disarming theft system. Even when a valid arming sequence has been entered, theft system will immediately disarm as soon as system is armed.

- Press LOCK button on each door lock switch and confirm that NGS, RAP DD_ LOCK PID state changes to LOCK when switches are pressed.
- Press UNLOCK button on each door lock switch and confirm that NGS, RAP DD_ LOCK PID state changes to UNLOCK when switches are pressed.

Does LOCK and UNLOCK state for each door lock switch occur?

Yes	No
System is operating properly. RETURN to Symptom Chart.	If UNLOCK state does not occur, CHECK and SERVICE all unlock Circuit 120 (PK/LG) or door unlock switches for an open, or SERVICE grounding circuit for door lock switch. Refer to Section 01-14B . If LOCK state does not occur, CHECK and SERVICE the all lock Circuit 119 (PK/Y) or door lock switches for an open. Refer to Section 01-14B . If DD_ LOCK state is always UNLOCK, CHECK and SERVICE all unlock Circuit 120 (PK/LG) or door unlock switches for a short to ground. Refer to Section 01-14B . If DD_LOCK PID state is always LOCK, CHECK and SERVICE all lock Circuit 119 (PK/Y) or door lock switches for a short to ground. Refer to Section 01-14B .

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Component Tests

Door Disarm Switch

Using Rotunda 73 Digital Multimeter 105-R0051 or equivalent, measure switch resistance with key removed from the door lock. The resistance should be more than 25,000 ohms. If not, replace the door disarm switch.

Measure the switch resistance with the key fully rotated to the end of travel in the unlock direction. The resistance should be less than 200 ohms. If not, replace the door disarm switch.

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Ignition Tamper Sensor

Removal and Installation

NOTE: Disconnect and reconnect battery ground cable to ensure RAP system resets to include monitoring of this sensor.

1. Remove ignition key lock cylinder from steering column housing. Refer to Section 11-04A .
2. Slide ignition lock anti-theft switch (19A438) off steering column.
3. Disconnect ignition tamper sensor from steering column locators and wiring harness.
4. To install, reverse removal procedure.

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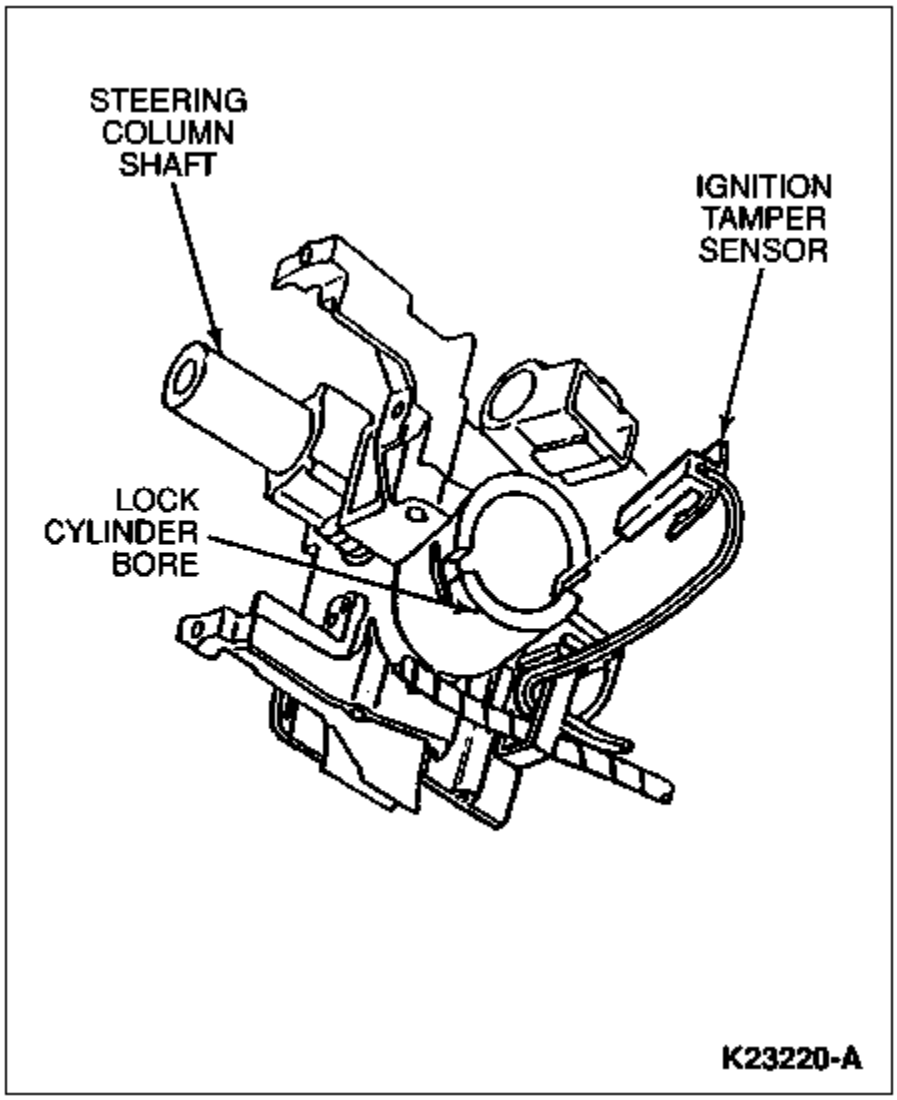

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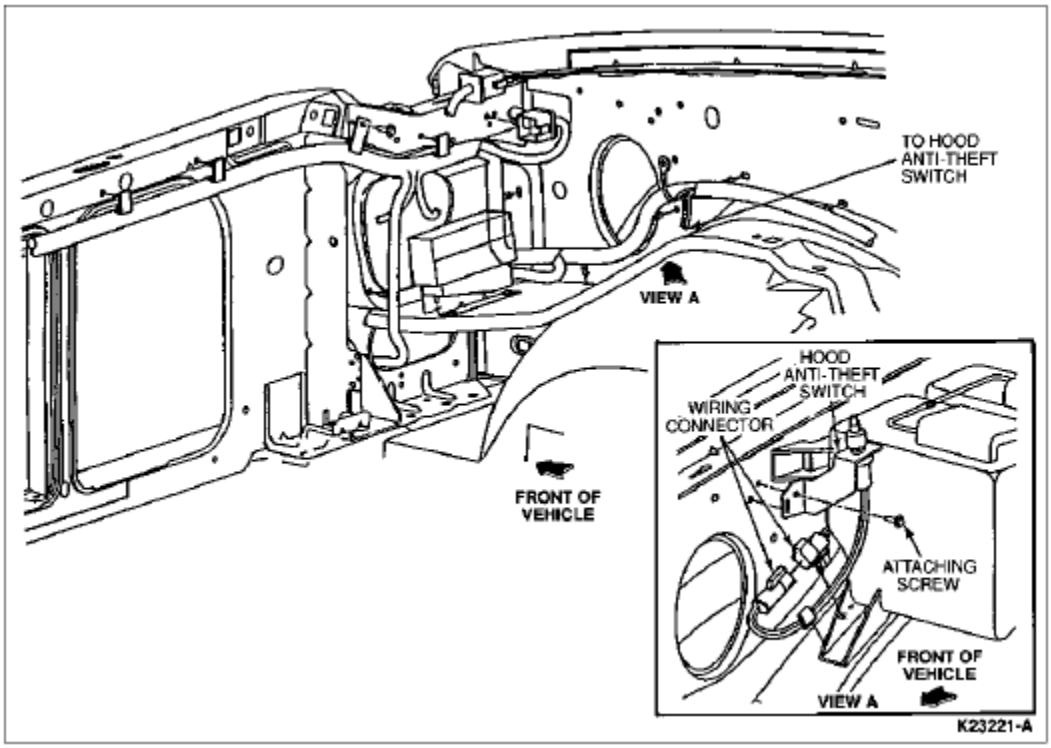
Hood Switch

Removal and Installation

1. Locate hood switch on RH side of fender apron.
2. Disconnect electrical connector from hood switch.
3. Remove one screw retaining hood switch.
4. To install, reverse removal procedure, and make sure that the hood switch bracket locator leg is seated firmly when driving screw to retain hood switch.



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SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-In
Hood Switch Screw	4.5-6.3	40-56

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Charging System

The electrical charging system is a negative ground system consisting of:

- Generator (GEN) (10300).
- Voltage regulator.
- Charge indicator lamp.
- Battery (10655).
- Necessary wiring and cables.

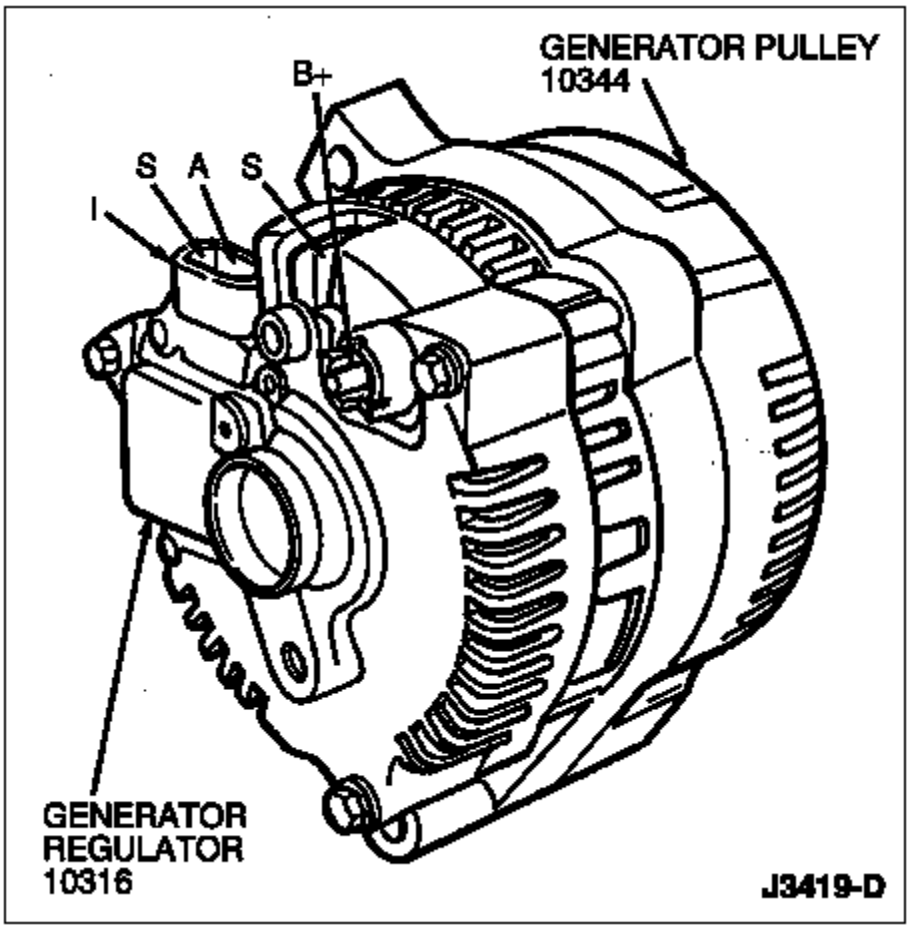
Refer to the Electrical and Vacuum Troubleshooting Manual for schematics and locations of components and wiring.

Generator with Integral Rear Mount Voltage Regulator — Internal Fan Type

When the engine (6007) is started, the generator begins to generate alternating current (AC) which is converted to direct current (DC) by the rectifier assembly internal to the generator. This current is then supplied to the vehicle's electrical system through the output connect battery positive voltage (B+) located on the rear of the generator.

Once the generator begins generating current, a voltage signal is taken from the generator stator and coil and fed back to the voltage regulator S circuit, turning off the charge indicator.

When the system is functioning normally, the generator output current is determined by the voltage at the A-circuit (battery sense voltage). The A-circuit voltage is compared to a set voltage internal to the voltage regulator. The voltage regulator controls the generator field current to maintain proper generator output. The set voltage will vary with temperature and is typically higher in the winter than in the summer, allowing for better battery recharge in the winter and reducing the chance of overcharging the battery in the summer.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10344
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REGULATOR
10316
J3419-D

Fuse Link

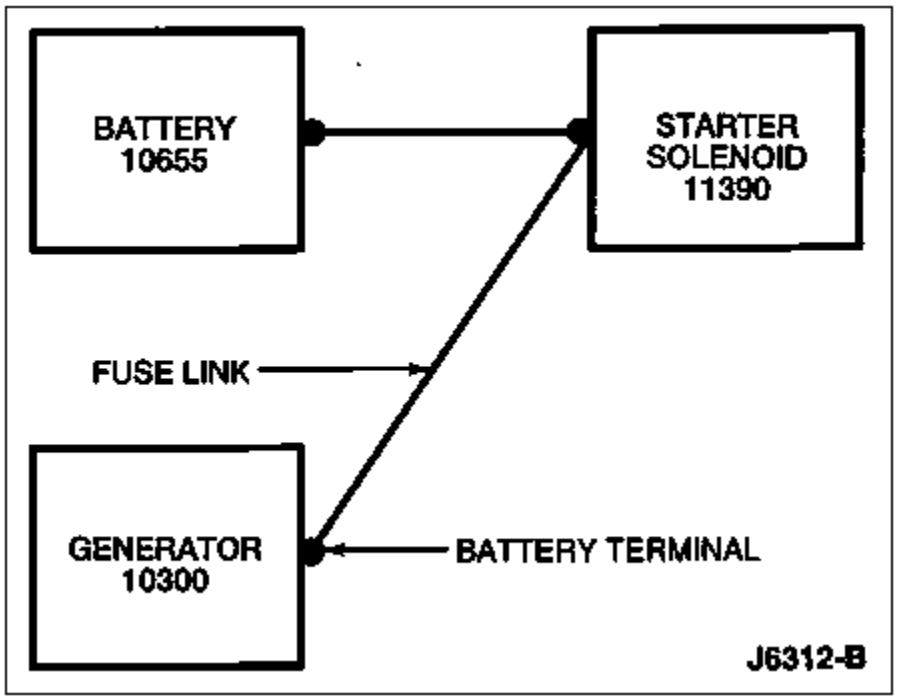
The fuse link is a short length of insulated wire integral with the engine compartment wiring harness. It is several wire gauges smaller than the circuit that it protects. The fuse link for the generator (GEN) (10346) is a 12-gauge gray wire.

On Aerostar vehicles a fuse link is used in the generator output circuit and in the voltage regulator A circuit. Ranger vehicles use a fuse link in the generator output circuit and a fuse in the voltage regulator A circuit.

The fuse link is designed to burn out, thus protecting the wiring when heavy reverse current flows, such as when a booster battery is connected incorrectly, or a short to ground occurs in the wiring harness.

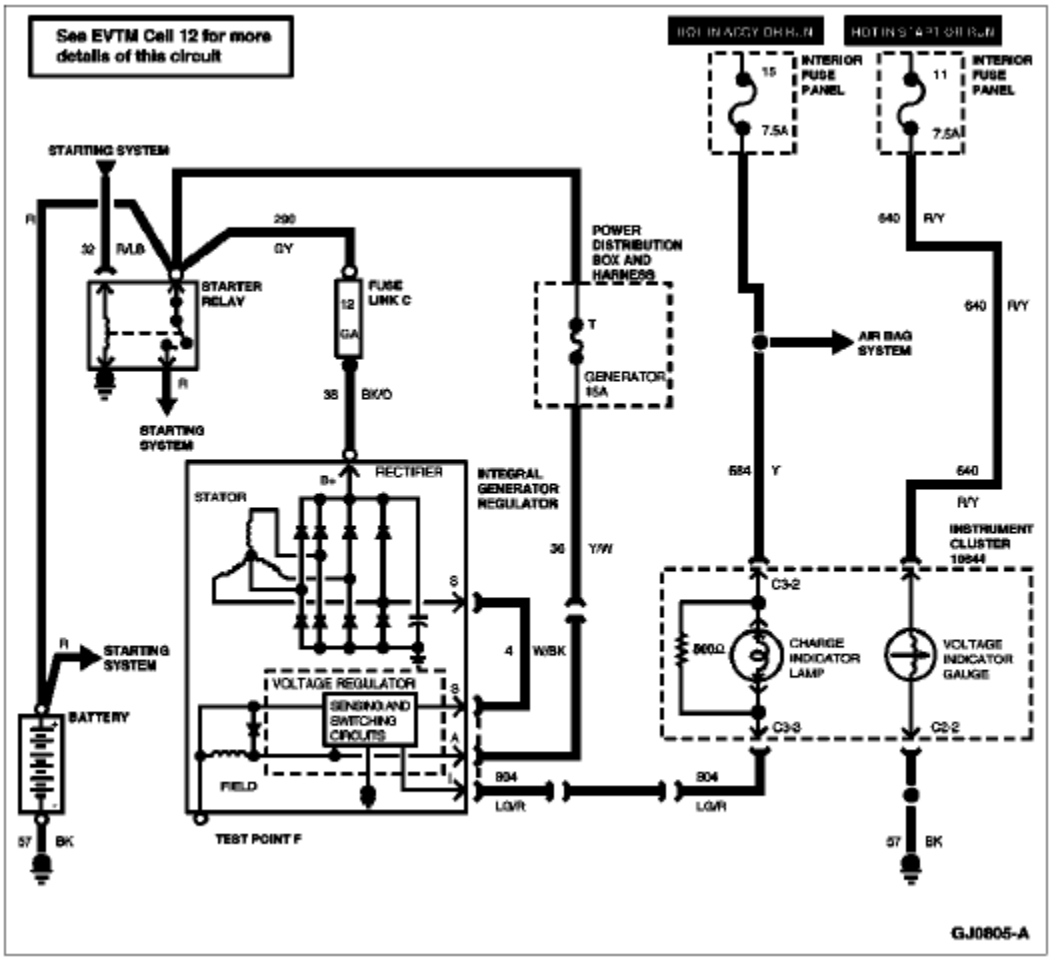
A burned-out link may have bare wire ends protruding from the insulation, or bubbled insulation with illegible identification. If it is hard to determine if the link is burned out, perform a continuity test.

Service fuse links are brown, green or black depending on usage. All fuse links have a flag moulded on the wire or on the terminal insulator. Color identification of the flag or connector is gray 12-gauge wire. The following illustration shows a typical fuse link installation.

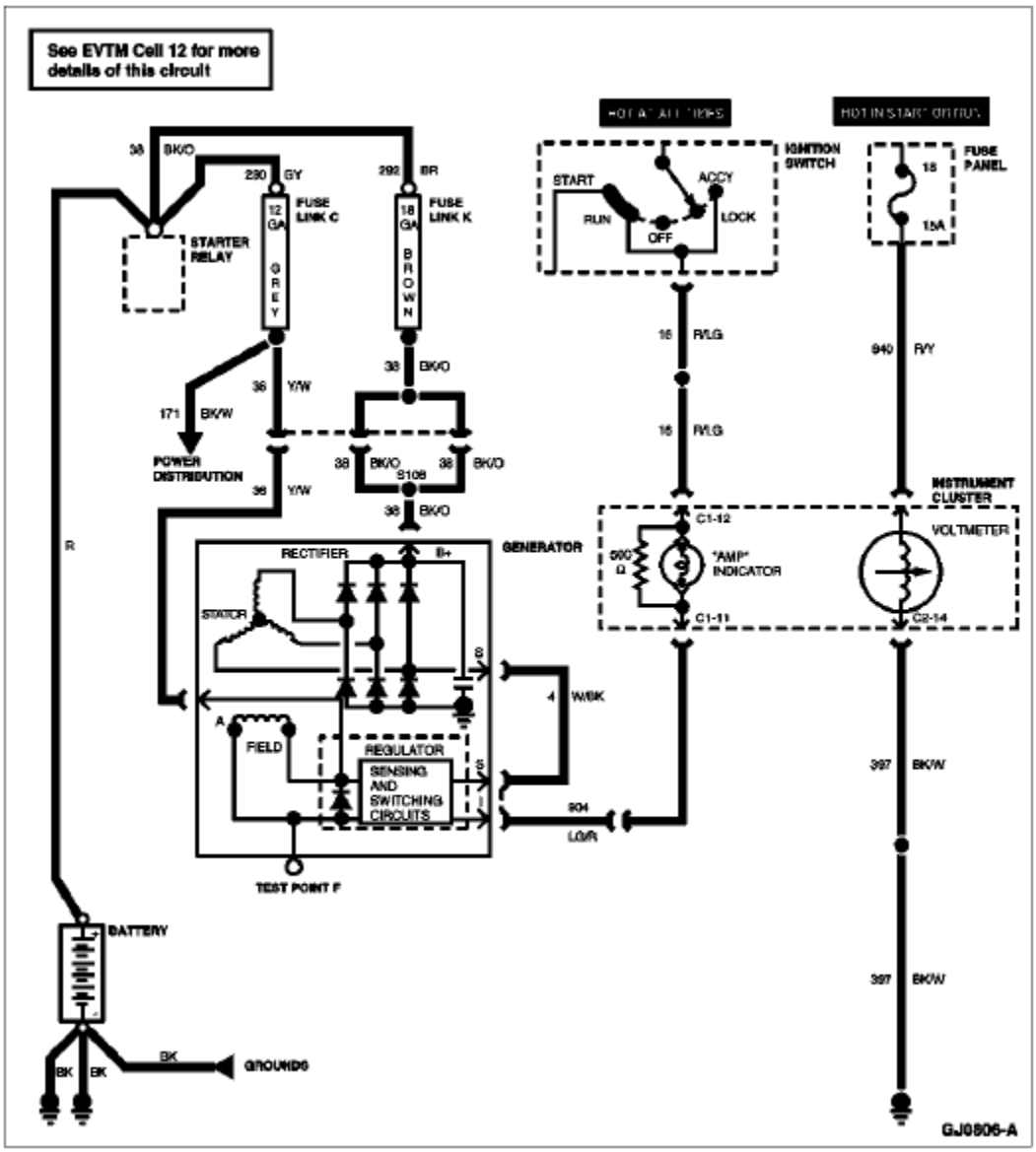


Electrical Schematics

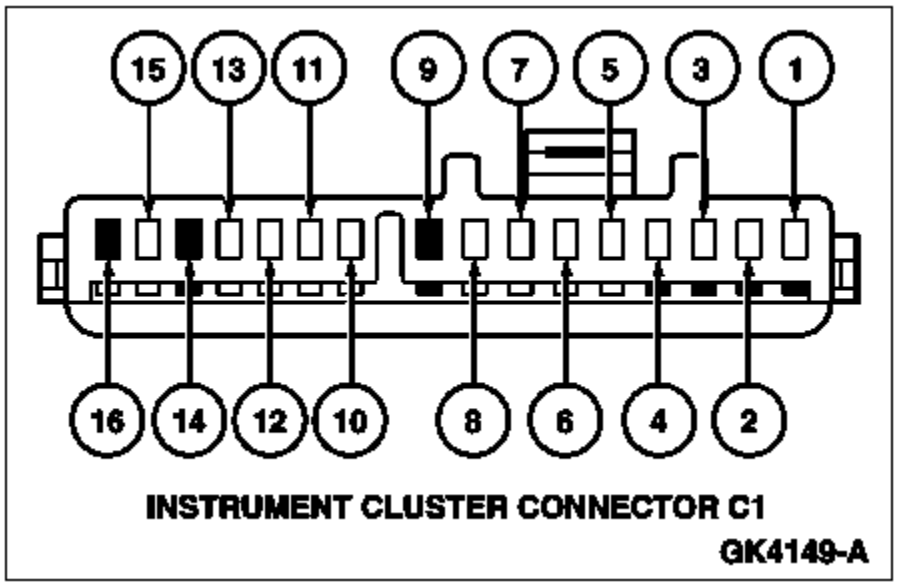
Charging System, Ranger



Charging System Electrical Schematic, Aerostar

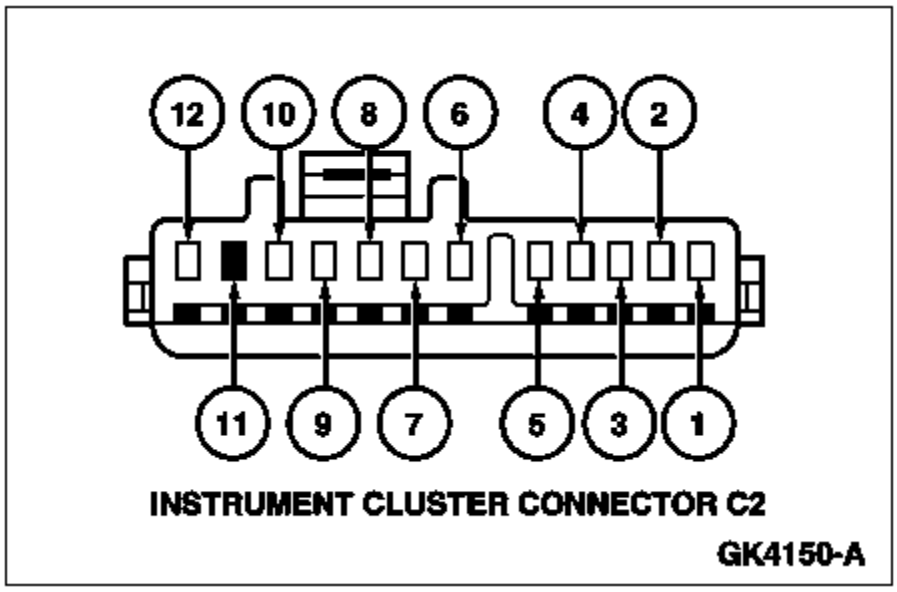

See EVTM Cell 12 for more details of this circuit
HOT AT ALL TIMES
HOT IN START OR RUN
38 BK/O
290 GY
292 BR
12 GA FUSE LINK C
18 GA FUSE LINK K
GREY
BROWN
STARTER RELAY
IGNITION SWITCH
START
ACCY
RUN
OFF
LOCK
FUSE PANEL
15
15A
16 R/LG
940 R/Y
36 Y/W
171 BK/W
POWER DISTRIBUTION
S108
INSTRUMENT CLUSTER
C1-12
C1-11
C2-14
VOLTMETER
500 Ω
"AMP" INDICATOR
RECTIFIER
B+
GENERATOR
STATOR
FIELD
REGULATOR
SENSING AND SWITCHING CIRCUITS
4 W/BK
904 LG/R
397 BK/W
TEST POINT F
BATTERY
GROUNDS
BK
GJ0506-A

Ranger



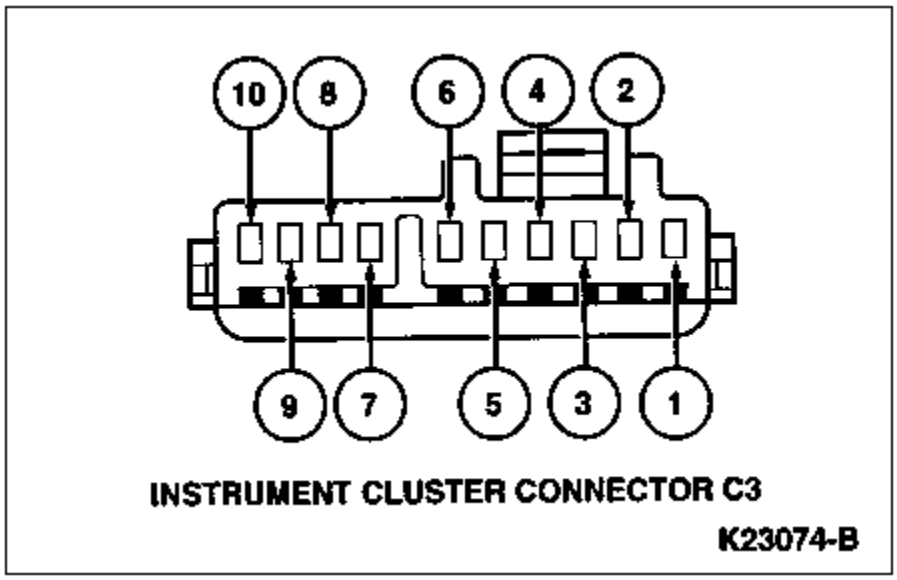
Pin Number	Circuit	Circuit Function
1	911 (W/LG)	PCM to Output Circuit Indicator Lamp/Overdrive Cancel Indicator
2	784 (LB/BK)	4x4 Low Range Indicator Ground Input
3	783 (GY)	4x4 High Range Indicator Ground Input
4	203 (O/LB)	Speed Control Indicator Ground Input
5	484 (O/BK)	Headlamp Switch Power Input
6	343 (DB/LG)	Warning Lamp to Anti-Theft Module (Limited Edition Only)
7	57 (BK)	Ground
8	19 (LB/R)	Lamp Return to Pulse Width Module
9	—	NOT USED
10	2 (W/LB)	RH Front Turn Signal Lamp
11	921 (GY/O)	Feed to Fuel Shutoff Lamp
12	253 (DG/W)	Oil Pressure Sensor Input
13	640 (R/Y)	Vehicle Power(Hot in Start or Run)
14	—	NOT USED
15	11 (T/Y)	ICM, Tach, EDM Signal
16	—	NOT USED

Ranger



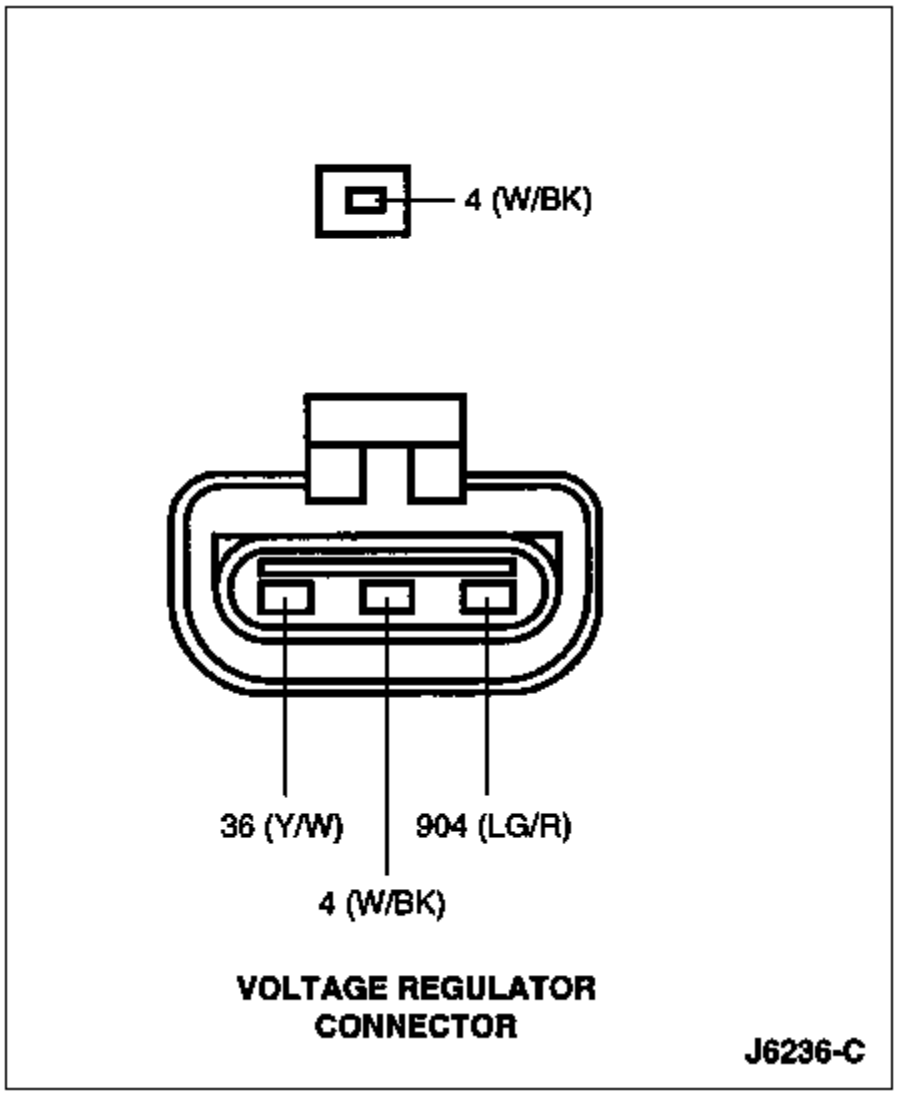
Pin Number	Circuit	Circuit Function
1	679 (GY/BK)	Vehicle Speed Sensor (VSS) Signal Input
2	570 (BK/W)	Dedicated Ground — EC
3	39 (R/W)	Temperature Gauge to Water Temperature Indicator Sender Unit
4	19 (LB/R)	Lamp Return to Pulse Width Module
5	3 (LG/W)	Left Turn Signal Input
6	932 (GY/W)	Daytime Running Lamp
7	57 (BK)	Ground
8	640 (R/Y)	Warning Lamps Feed (Hot in Start or Run)
9	658 (PP/LG)	Malfunction Indicator Lamp (MIL) Input
10	627 (BK/O)	Open Door Warning Lamp to Open Door Warning Switch
11	—	NOT USED
12	29 (Y/W)	Fuel Gauge to Fuel Gauge Sender

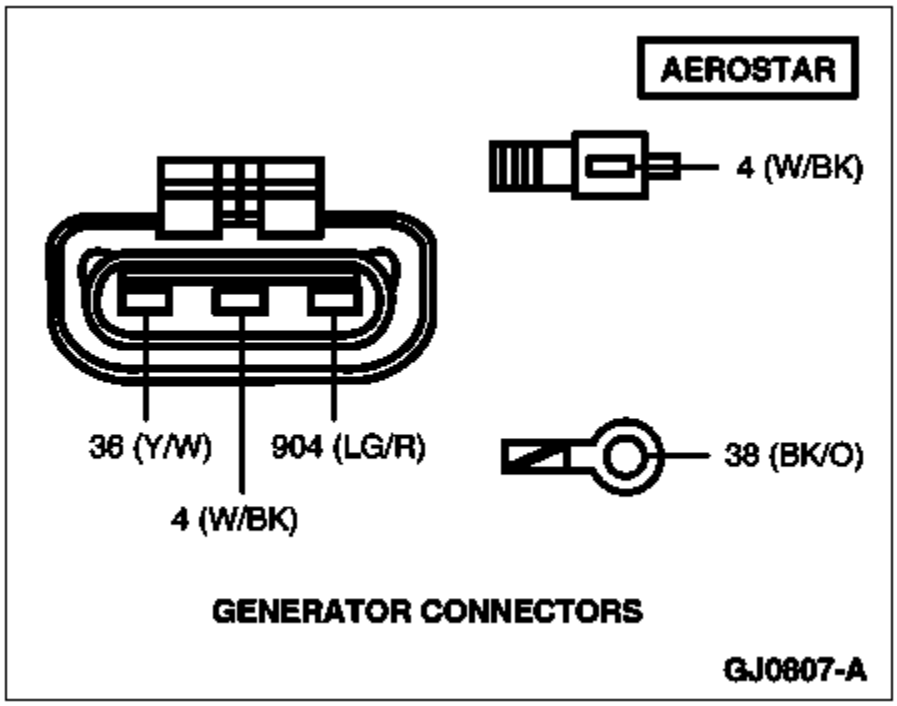
Ranger

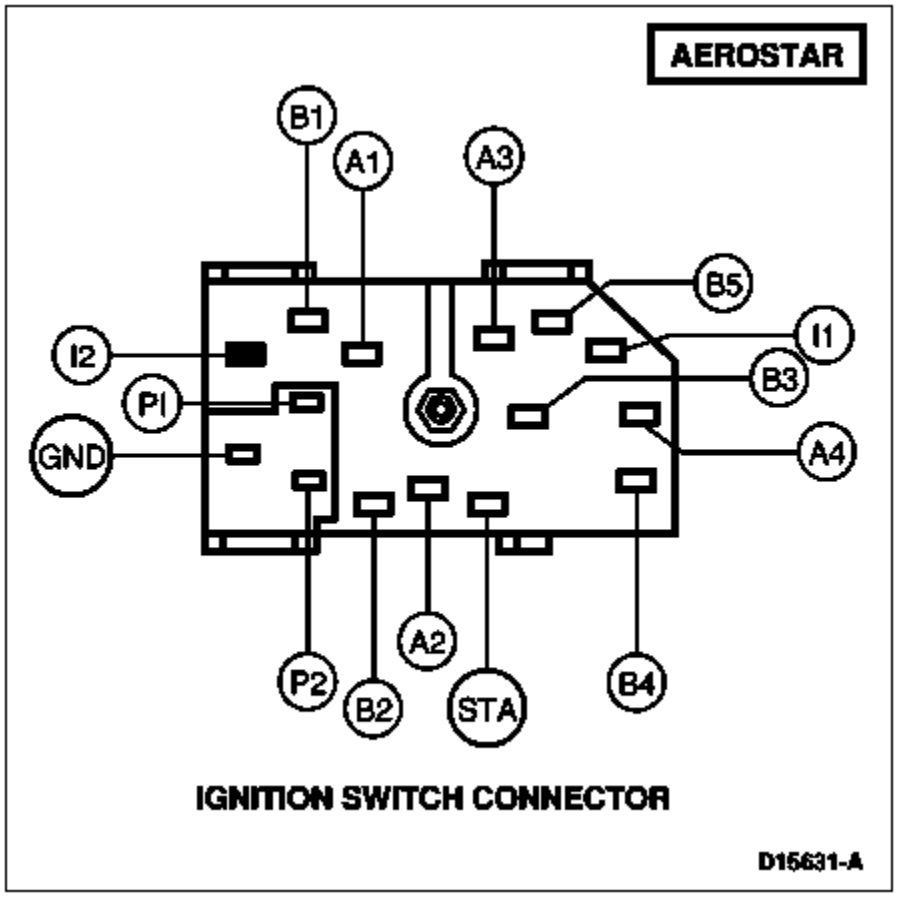


Pin Number	Circuit	Circuit Function
1	640 (R/Y)	Warning Lamps Feed (Hot in Start or Run)
2	584 (Y)	Alternator Lamp Feed (Hot in Start or Run)
3	904 (LG/R)	Ignition Switch "COIL"/"ACC" to Voltage Regulator "IGN" Terminal
4	608 (BK/Y)	Air Bag Diagnostic Lamp Driver
5	977 (P/W)	Dual Brake Warning Switch to Indicator Lamp
6	603 (DG)	Failure Warning Light
7	1001 (W/Y)	Fused Battery Feed to Instrument Cluster Speedometer
8	398 (BK/Y)	Ground to Tachometer/Gauge Module (3.0L, 4.0L)
9	—	NOT USED
10	871 (Y)	Seat Belt Indicator Lamp to Module

Ranger

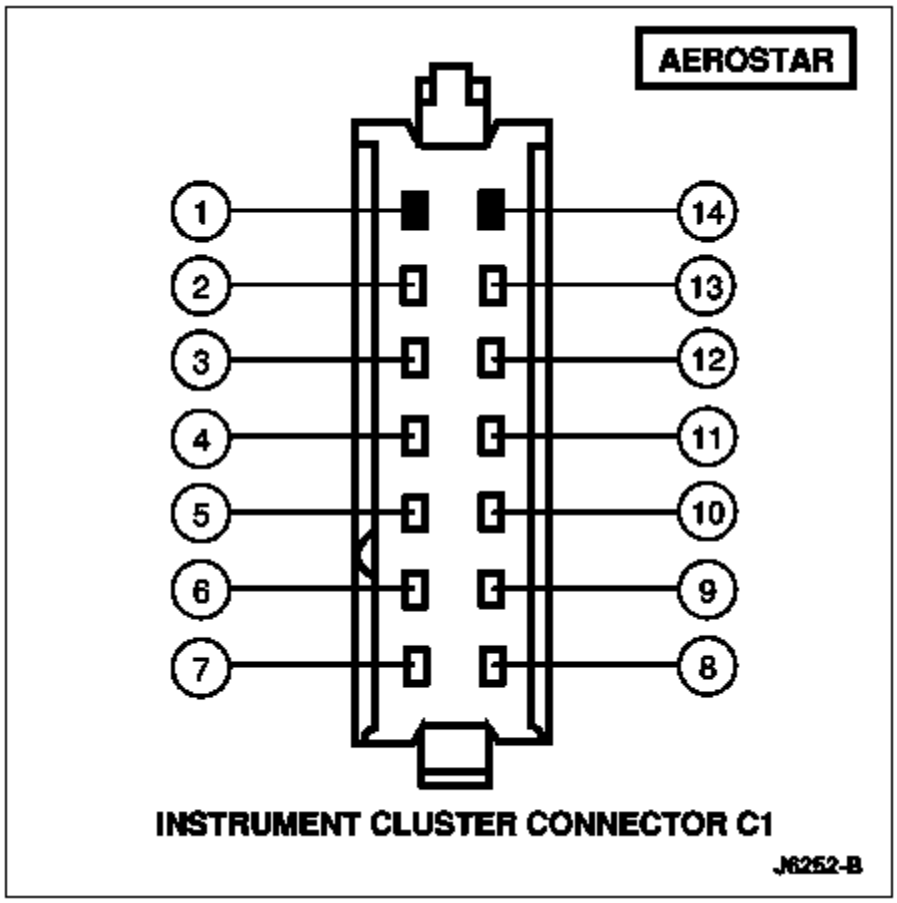

4 (W/BK)
36 (Y/W)
904 (LG/R)
4 (W/BK)
VOLTAGE REGULATOR
CONNECTOR
J6236-C


AEROSTAR
4 (W/BK)
36 (Y/W)
904 (LG/R)
4 (W/BK)
38 (BK/O)
GENERATOR CONNECTORS
GJ0807-A


AEROSTAR
B1
A1
A3
B5
I1
I2
B3
PI
GND
A4
A2
P2
B2
STA
B4
IGNITION SWITCH CONNECTOR
D15631-A

IGNITION SWITCH

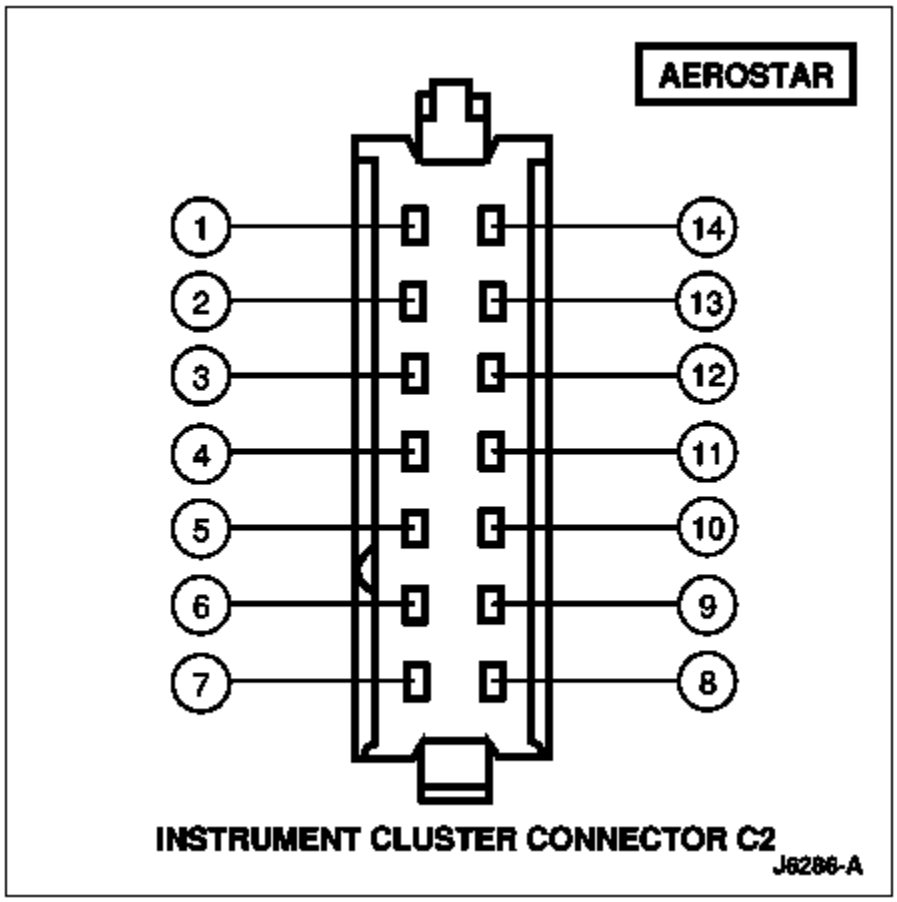
Circuit Function	Pin Number	Circuit
A1	297 (BK/LG)	Fused Run/Accessory Feed
A2	687 (GY/Y)	Accessory Feed (Hot in Run)
A3	687 (GY/Y)	Accessory Feed (Hot in Run)
A4	687 (GY/Y)	Accessory Feed (Hot in Run)
B1	37 (Y)	Battery Input
B2	37 (Y)	Battery Input
B3	37 (Y)	Battery Input
B4	37 (Y)	Battery Input
B5	37 (Y)	Battery Input
I1	16 (R/LG)	Ignition Feed (Hot in Run or Start)
I2	—	Not Used
P1	512 (T/LG)	Brake Indicator Prove Out
P2	41 (BK/LB)	Warning Lamp Prove Out
STA	33 (W/PK)	Starter Control (Hot in Start)
GND	57 (BK)	Ground



INSTRUMENT CLUSTER

Circuit	Pin Number	Circuit Function
1	—	Not Used
2	627 (BK/O)	Door Ajar Indicator to Door Ajar Switches
3	977 (P/W)	Brake Indicator to Park Brake Switch and Brake Fluid Level Switch
4	603 (DG)	Rear ABS Indicator to Rear Anti-Lock Brake Module
5	658 (PK/LG)	Malfunction Indicator Lamp to Powertrain Control Module
6	29 (Y/W)	Fuel Gauge to Fuel Gauge Sender Unit
7	3 (LG/W)	Turn Signal Switch to Left Turn Indicator Lamp
8	31 (W/R)	Oil Pressure Gauge to Oil Pressure Sender Unit
9	570 (BK/W)	Dedicated Ground
10	39 (R/W)	Temperature Gauge to Coolant Temperature Sender
11	904 (LG/R)	AMP Indicator to Alternator
12	16 (R/LG)	Battery Input to AMP Indicator
13	640 (R/Y)	Ignition (Hot in Start or Run) to Warning Lamps Feed
14	—	Not Used

INSTRUMENT CLUSTER



Circuit	Pin Number	Circuit Function
1	—	NOT USED
2	—	NOT USED
3	932 (GY/W)	High Beam Indicator Feed
4	450 (DG/LG)	Fasten Belts Indicator or DRL Feed
5	57 (BK)	Illumination, High Beam and Fasten Belts Ground
6	19 (LB/R)	Illumination Lamps Feed
7	57 (BK)	Turn Indicators Ground
8	2 (W/LB)	Turn Signal Switch to Right Turn Indicator Lamp
9	57 (BK)	Electronic 4WD Indicator Ground
10	994 (W)	Electronic 4WD Indicator Feed
11	608 (BK/Y)	Air Bag Indicator Control
12	640 (R/Y)	Ignition (Hot in Start or Run) to Warning Lamps Feed

13	570 (BK/W)	Fuel Gauge to Ground
14	397 (BK/W)	Voltmeter to Ground

Inspection and Verification

NOTE: Before performing charging system tests on the vehicle, note the concern such as: slow cranking, battery discharged, indicator lamp on. This information will aid in isolating the part of the system causing the symptom.

Test for current drain. Refer to Component Tests in this section. Following are some of the most common current drain problems:

- Interior lamp stays on constantly
- Electronic component malfunctions

NOTE: Only test the charging system with a fully charged, properly operating battery (10655). Make sure cable connections are clean and secure. Check the testing equipment and instructions.

Perform a visual inspection using the following procedure:

1. Check the fuse link located between the power distribution box and harness (14516) and the generator (GEN) (10346). Replace the fuse link if burned.

2. Check battery posts and battery cable terminals for clean and tight connections. Remove the battery cables (if corroded), clean and install them securely.

3. Check for clean and tight wiring connections at the generator, voltage regulator (VR) (10316) and engine (6007).

4. Check the drive belt tension. Refer to Section 03-05 .

5. Check battery state of charge. Refer to Component Tests in this section.

Isolating the Concern

Isolate the battery (10655), the charging system, and the electrical circuits to correctly identify the area where the difficulty lies.

Open circuits or other wiring concerns can prevent the generator (GEN) (10346) from operating normally.

Generator Check

Check the generator (GEN) (10346) to see if it is producing the proper output current and voltage. Refer to Component Tests in this section. If the generator does not meet specifications, use the symptom chart in this section to determine the correct test procedure for troubleshooting the charging system.

Symptom Chart — Charging System

CHARGING SYSTEM

Condition	Possible Source	Action
• Charge Indicator Lamp On with Engine Running	• Open A, Circuit 36 (Y/W). • Shorted I, Circuit 904 (LG/R). • Open/high resistance in S, Circuit 4 (W/BK). • Voltage regulator. • Generator.	• GO to Pinpoint Test A .
• Generator Battery Overcharging (Battery Voltage Greater than 15.5 Volts)	• Voltage drop in A, Circuit 36 (Y/W). • Voltage drop in I, Circuit 904 (LG/R). • Poor ground. • Voltage regulator. • Generator.	• GO to Pinpoint Test B .
• Indicator Lamp On, Key Off	• Lamp circuit, 584 (Y) (Ranger) or 16 (R/LG) (Aerostar) shorted to B+ . • Improper lamp circuit wiring. • Instrument cluster.	• GO to Pinpoint Test C .
• Indicator Lamp Off, Key On, Engine Not Running	• Open/high resistance in I, Circuit 904 (LG/R). • Burned out bulb. • Poor ground. • S Circuit 4 (W/BK) shorted to B+. • Voltage regulator. • Generator.	• GO to Pinpoint Test D .
• Indicator Lamp Flickers or Intermittent	• Loose connection to generator, voltage regulator battery or underhood fuse box. • Loose fuse or poor connection in Circuit 36 (Y/W). • Loose brush holder screw. • Voltage regulator.	• GO to Pinpoint Test E .

	• Generator.	
• Voltage Gauge Reads High	• Generator. • Gauge.	• GO to Pinpoint Test F .
• Voltage Gauge Reads Low	• Generator. • Gauge.	• GO to Pinpoint Test G .
• Generator Noisy	• Accessory drive belt or tensioner. • Accessory brackets. • Bent generator pulley. • Generator. • Other components.	• GO to Pinpoint Test H .
• Radio Interference	• Voltage regulator. • Generator. • Other components.	• GO to Pinpoint Test J .
• Battery Does Not Hold a Charge	• Battery connections. • Battery. • Battery drain. • Generator.	• GO to Pinpoint Test K .
• Battery Is Not Serviceable	• Battery connections. • Battery.	• GO to Pinpoint Test L .

Pinpoint Tests

CAUTION: Do not make jumper connections except as directed. Improper connections may damage the voltage regulator (VR) (10316) or fuses/fuse links.

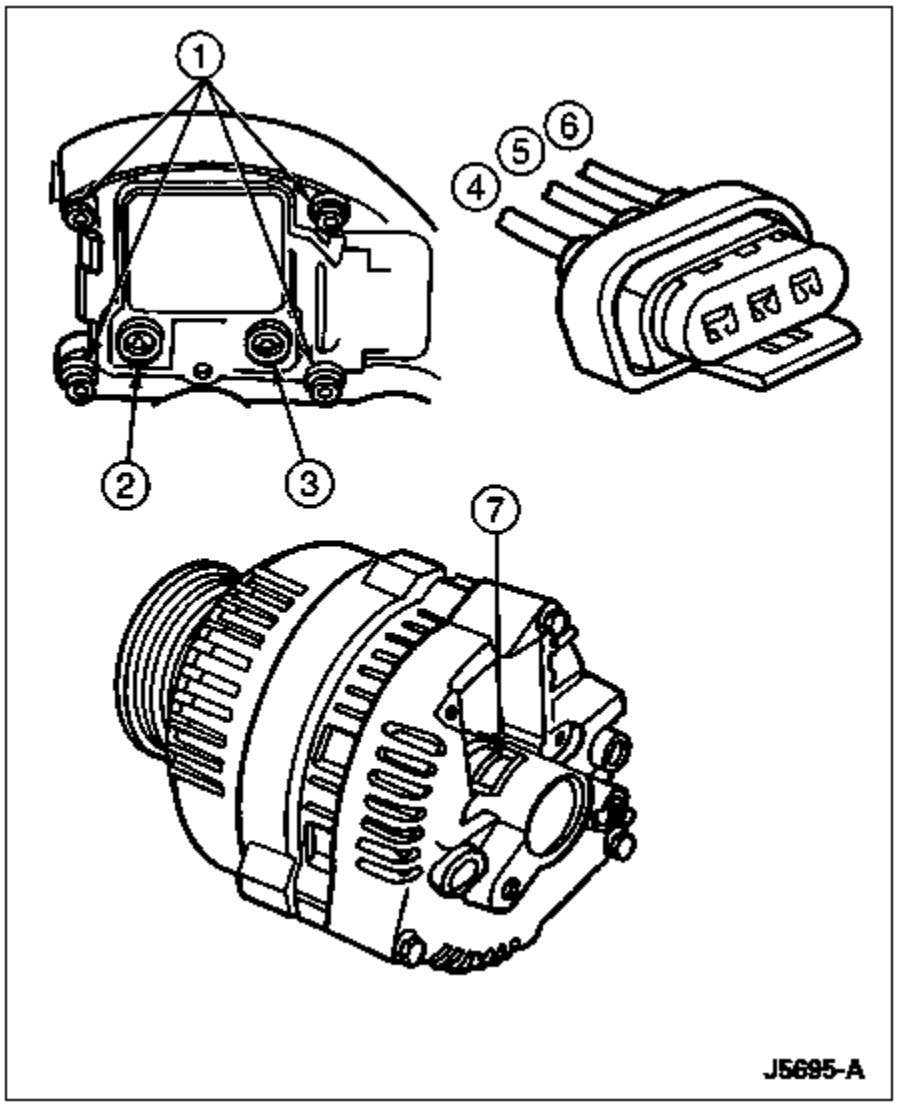
NOTE: Jumper connections and meter reading are required in the pinpoint tests. The following illustration identifies the generator test points.

NOTE: All voltage measurements are referenced to the negative (-) battery post unless otherwise specified.

All "key ON" measurements are made with the engine (6007) not running unless directed to "start engine."

NOTE: With this charging system, four conditions can cause the charge indicator to come on during vehicle operation:

- **No generator output: damaged generator or regulator.**
- **Over-voltage condition: shorted generator rotor or regulator.**
- **No connection at generator output terminal (B+).**
- **No connection at battery voltage sensing terminal (A terminal).**



Item	Part Number	Description
1	—	Mounting Screws (Ground Connection) (Part of 10316)
2	—	Brush Holder Screw (Test Point "F") (Part of 10316)
3	—	Brush Holder Screw (Test Point "A") (Part of 10316)
4	—	I Circuit 904 (LG/R) (Part of 14305)
5	—	S Circuit 4 (W/BK) (Part of 14305)
6	—	A Circuit 36 (Y/W) (Part of 14305)
7	—	Rotor Slip Ring

		(Part of 10328)

PINPOINT TEST A: CHARGE INDICATOR LIGHT ON WITH ENGINE RUNNING

A1 PRELIMINARY CHECKS

- Check the following:
- Fuse link.
- Battery terminals and cable clamps.
- Wiring connections at generator, voltage regulator and engine-to-body grounds.
- Generator belt tension.

Are components OK?

Yes	No
GO to **A2** .	SERVICE and/or REPLACE as necessary. After servicing, PERFORM Base, No-Load and Load Tests . REFER to Component Tests in this section.

A2 SYSTEM VOLTAGE TESTS

- Perform Base, No-Load and Load Tests . Refer to Component Tests in this section.

Is system voltage below specified range (undercharging)?

Yes	No
GO to **A3** .	REFER to Pinpoint Test B for overcharging condition.

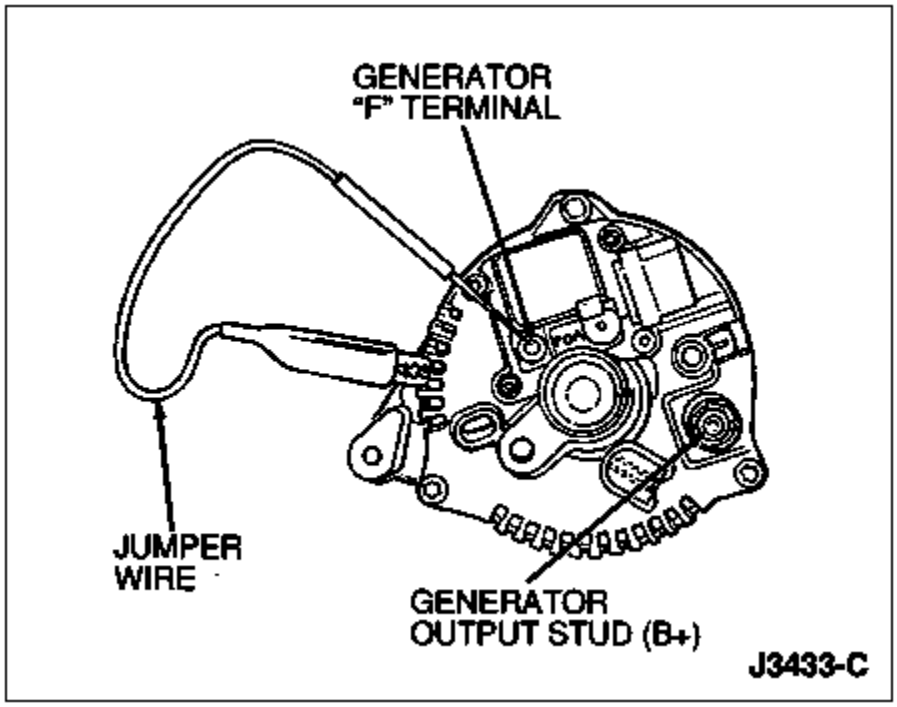
A3 ISOLATE GENERATOR

- Connect voltmeter positive lead to generator output terminal and negative lead to battery negative terminal.

CAUTION: Following test connection will bypass voltage regulator to full field generator. If voltage regulator is functioning, voltage will rise rapidly. If voltage is allowed to rise uncontrolled by voltage regulator damage may occur. Be prepared to break test connection when voltmeter reads 15.5 volts.

- Connect one end of jumper wire to clean chassis ground.
- Start engine.
- Touch other end of jumper to Test Point F.

Did voltage rise above 15 volts?



Yes	No
GO to A9.	GO to A4.

A4 A TERMINAL VOLTAGE CHECK

- Touch voltmeter positive lead to generator A terminal.

Does voltmeter read battery voltage?

Yes	No
GO to A6.	GO to A5.

A5 A CIRCUIT BATTERY SUPPLY CHECK

- Disconnect wiring at voltage regulator.
- Check for voltage at A circuit terminal.

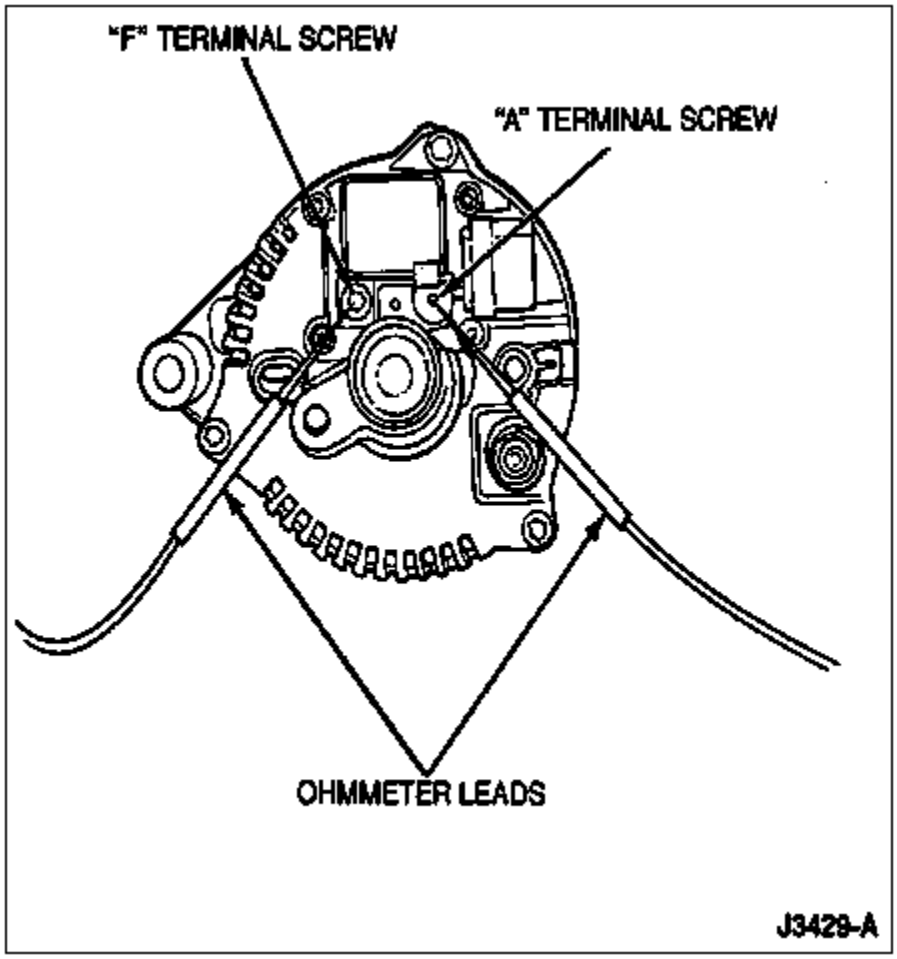
Is battery voltage present?

Yes	No
REPLACE voltage regulator.	CHECK fuse (Ranger) or fuse link (Aerostar). If OK, REPAIR open in Circuit 36 (Y/W).

A6 ROTOR COIL CHECK

- Disconnect wiring at voltage regulator.
- Measure resistance across generator test terminals A and F.

Is ohmmeter reading less than 2.4 ohms?



Yes	No
GO to A7 .	GO to A9 .

A7 SHORTED ROTOR COIL CHECK

- Remove voltage regulator and generator brush holder.
- Measure resistance across rotor slip rings.

Is ohmmeter reading less than 2.4 ohms?

Yes	No
REPLACE generator.	GO to **A8** .

A8 BRUSH/SLIP RING INSPECTION

- Inspect brushes for damage, loose wiring connections and excessive wear.
- Inspect rotor slip ring for contamination which may prevent continuity with brushes.

Are brushes and slip rings serviceable?

Yes	No
REPLACE voltage regulator.	REPLACE generator.

A9 OPEN S CIRCUIT

- Check for continuity between single S terminal and S terminal in voltage regulator terminal.

Is there continuity?

Yes	No
GO to **A10** .	REPAIR open in S circuit.

A10 STATOR OUTPUT VOLTAGE CHECK

- Start engine.
- Measure voltage at the S terminal on the back of the generator.

Is voltage at least 1/2 of battery voltage?

Yes	No
REPLACE voltage regulator.	REPLACE generator.

PINPOINT TEST B: GENERATOR OVERCHARGING (BATTERY VOLTAGE GREATER THAN 15.5 VOLTS)

B1 CHECK VOLTAGE DROP IN A CIRCUIT

- Turn key to ON position.
- Measure voltage between test point A on the voltage regulator and the positive (+) battery post.

Is voltage drop less than 0.25 volt?

Yes	No
GO to **B2** .	REPAIR excess voltage drop in Circuit 36 (Y/W). CHECK fuse or fuse link and connectors in Circuit 36 and SERVICE as required.

B2 CHECK VOLTAGE DROP IN I CIRCUIT

- Measure voltage at wiring harness I terminal, Circuit 904 (LG/R).

  NOTE: Voltage regulator must be connected to wiring harness for this test.

Is voltage greater than 1 volt?

Yes	No
GO to **B3** .	REPAIR high resistance in Circuit 904 (LG/R).

B3 CHECK FOR POOR GROUNDS

- Check for poor ground connections between voltage regulator and generator, generator and engine, or engine and battery.

Are all ground connections clean and tight?

Yes	No
GO to **B4** .	CLEAN or REPAIR grounds as required.

B4 CHECK FOR FIELD CIRCUIT DRAIN

- Turn key to OFF position.
- Measure voltage at test point F on the voltage regulator.

Is voltage at test point F equal to battery voltage?

Yes	No
Generator is OK. REPLACE voltage regulator.	GO to **B5** .

B5 CHECK FOR GROUNDED SLIP RING

- Remove generator from vehicle.
- Remove voltage regulator.
- Measure resistance from each generator slip ring to the generator housing.

Is resistance from either slip ring to housing less than 200 ohms?

Yes	No
If grease or dirt has accumulated near the slip rings, CLEAN the slip rings and RECHECK resistance. If still less than 200 ohms, REPLACE generator.	REPLACE voltage regulator.

PINPOINT TEST C: INDICATOR LAMP ON, KEY OFF

C1 CHECK LAMP CIRCUIT WIRING

- Turn key to OFF position.
- Remove three-pin voltage regulator connector.
- Measure voltage at wiring harness I terminal, Circuit 904 (LG/R).

Is voltage greater than 0 volts?

Yes	No
SERVICE Circuit 904 (LG/R). Circuit should be hot in RUN position only.	SERVICE instrument cluster. See Section 13-01 .

PINPOINT TEST D: INDICATOR LAMP OFF, KEY ON, ENGINE NOT RUNNING

D1 CHECK FOR OPEN I CIRCUIT

- Remove three-pin voltage regulator connector.
- Turn key to ON position.
- Measure voltage at wiring harness I terminal, Circuit 904 (LG/R).

Is voltage greater than 0 volts?

Yes	No
GO to **D2** .	REPAIR open in Circuit 904 (LG/R).

D2 CHECK FOR BURNED OUT BULB

- Connect wiring harness I terminal, Circuit 904 (LG/R) to ground with a jumper wire.

Is indicator lamp on?

Yes	No
REMOVE jumper wire. GO to **D3** .	REPLACE bulb or REPAIR high resistance in

	bulb socket or Circuit 904 (LG/R).

D3 CHECK FOR POOR GROUNDS

- Check for poor ground connections between voltage regulator and generator, generator and engine, or engine and battery.

Are all ground connections clean and tight?

Yes	No
GO to **D4** .	CLEAN or REPAIR grounds as required.

D4 CHECK S CIRCUIT WIRING

- Remove one-pin S connector from generator.
- Measure voltage at wiring harness S terminal, Circuit 4 (W/BK).

Is voltage greater than 0 volts?

Yes	No
SERVICE Circuit 4 (W/BK). Circuit should be hot only when engine is running. CHECK for swapped wires in voltage regulator connector.	GO to **D5** .

D5 CHECK FOR SHORTED RECTIFIER

- Measure voltage at the S terminal on the back of the generator.

Is voltage greater than 1 volt?

Yes	No
If lamp is on with one-pin S connector removed, REPLACE generator.	REPLACE voltage regulator.

PINPOINT TEST E: INDICATOR LAMP FLICKERS OR INTERMITTENT

E1 CHECK FOR LOOSE CONNECTIONS

- Check these connections for corrosion, loose or bent pins, or loose eyelets:
  - Three-pin voltage regulator connector.
  - One-pin S connector.
  - Generator B+ eyelet.

- Underhood power distribution box and harness circuit 36 (Y/W) (15A) fuse (Ranger).
- Underhood fuse box eyelets.
- Battery cables.
- Fuse links (Aerostar).

Are all connections clean and tight?

Yes	No
GO to **E2** .	CLEAN or REPAIR connections as required.

E2 CHECK FOR FIELD CIRCUIT DRAIN

- Turn key to OFF position.
- Measure voltage at test point F on the voltage regulator.

Is voltage at test point F equal to battery voltage?

Yes	No
GO to **E3** .	GO to **E5** .

E3 CHECK FOR LOOSE A CIRCUIT FUSE

- Start engine.
- Check the generator fuse in the underhood fuse box for a loose connection by wiggling the fuse with the engine running.

Does indicator lamp flicker?

Yes	No
REPAIR loose fuse connection.	GO to **E4** .

E4 CHECK A CIRCUIT CONNECTIONS

- With engine running, connect test point A on the voltage regulator to the positive (+) battery post using a jumper wire.

Does indicator lamp flicker?

Yes	No
REPLACE voltage regulator. If problem still exists, REPLACE generator.	REPAIR poor connection in Circuit 36 (Y/W).

E5 CHECK BRUSH HOLDER SCREWS

- Remove generator from vehicle.
- Check the brush holder screws, located on the voltage regulator (test points F and A).

Are the brush holder screws tight?

Yes	No
GO to **E6** .	TIGHTEN screws to 2.8-4.0 Nm (25-35 Lb-In).

E6 CHECK FOR GROUNDED SLIP RING

- Remove voltage regulator.
- Measure resistance from each generator slip ring to the generator housing.

Is resistance from either slip ring to housing less than 200 ohms?

Yes	No
If grease or dirt has accumulated near the slip rings, CLEAN the slip rings and RECHECK resistance. If still less than 200 ohms, REPLACE generator.	REPLACE voltage regulator.

PINPOINT TEST F: VOLTAGE GAUGE READS HIGH

F1 CHECK GENERATOR

- Perform the Generator/Base Voltage and No-Load Tests. Refer to Component Tests in this section.

Is generator output voltage within specified range?

Yes	No
REFER to Section 13-01 to diagnose the battery voltage gauge.	GO to Pinpoint Test A .

PINPOINT TEST G: VOLTAGE GAUGE READS LOW

G1 CHECK GENERATOR

- Perform the Generator Base Voltage and No-Load Tests. Refer to Component Tests in this section.

Is generator output voltage within specified range?

Yes	No

REFER to Section 13-01 to diagnose the battery voltage gauge.	GO to Pinpoint Test A .

PINPOINT TEST H: GENERATOR NOISY

H1 CHECK FOR ACCESSORY-DRIVE NOISE

- Check the drive belt to make sure that it is installed properly and is not damaged.
- Check the accessory mounting brackets for loose bolts or out of alignment condition.
- Check for a bent pulley.

Is accessory drive OK?

Yes	No
GO to **H2** .	GO to Section 03-05 and SERVICE accessory drive as required.

H2 SUBSTITUTE KNOWN GOOD GENERATOR

- Remove generator and replace with a known good generator.

Is noise present with known good part?

Yes	No
Generator is OK. INSTALL original part. CHECK other accessories to find the cause of the noise.	REPLACE generator.

PINPOINT TEST J: RADIO INTERFERENCE

J1 VERIFY RADIO INTERFERENCE

- Start engine.
- Tune radio to a station where interference is present.
- Remove three-pin voltage regulator connector.

Is interference present with connector removed?

Yes	No
Generator is OK. SEE Section 15-00 to find the cause of the radio interference.	GO to **J2** .

J2 SUBSTITUTE KNOWN GOOD GENERATOR

- Remove generator and replace with a known good generator.

Is interference present with known good part?

Yes	No
Generator is OK. SEE Section 15-00 to find the cause of the radio interference.	REPLACE generator.

PINPOINT TEST K: BATTERY DOES NOT HOLD A CHARGE

K1 CHECK BATTERY CONNECTIONS

- Inspect the battery cables for loose or corroded connections.

Are the battery cables clean and tight?

Yes	No
GO to **K2** .	CLEAN or TIGHTEN the battery cables.

K2 BATTERY CAPACITY TEST

- Perform battery capacity test. Refer to Pinpoint Test L in this section.

Did battery pass capacity test?

Yes	No
GO to **K3** .	REPLACE battery.

K3 BATTERY DRAIN

- Perform battery drain tests. Refer to Component Tests in this section.

Is the battery discharging due to a drain condition?

Yes	No
REPAIR cause of drain as required.	GO to **K4** .

K4 CHECK GENERATOR

- Perform Generator Output Test. Refer to Component Tests in this section.

Is generator output voltage within specified range?

Yes	No
Battery and electrical system are serviceable.	GO to Pinpoint Test A .

PINPOINT TEST L: BATTERY IS NOT SERVICEABLE

L1 VISUAL INSPECTION

- Remove battery ground cable, then battery to starter relay cable.
- Check for dirty or corroded connections.

Are connections OK?

Yes	No
GO to **L2**	CLEAN terminals and clamps. GO to **L2** .

L2 LOOSE BATTERY POST

- Check for loose battery posts.

Are posts OK?

Yes	No
GO to **L3** .	REPLACE battery.

L3 CRACKED BATTERY COVER

- Remove battery hold down clamps and shields.
- Check for broken/cracked case or battery cover.

Are case and battery cover OK?

Yes	No
GO to **L4** .	REPLACE battery.

L4 BATTERY CAPACITY TEST

- Use ARBST 010-00725, or equivalent to perform battery capacity test. Follow instructions supplied with tester for the battery capacity test.

- Recommended Discharge Rate at 27℃ (80°F): One hal f of the cold cranking amps.
- Voltage Readings at 15 seconds for Good Battery (Battery Capacity Test).

Approximate Battery Temperature	Minimum Load Voltage
27℃ (80℉) and above	9.6
21℃ (70℉) and above	9.6
16℃ (60℉) and above	9.5
10℃ (50℉) and above	9.4
4℃ (40℉) and above	9.3
-1℃ (30℉) and above	9.1
-7℃ (20℉) and above	8.9
-12℃ (10℉) and above	8.7
-18℃ (0℉) and above	8.5

- Wait 2 minutes and check the Open Circuit Voltage (OCV). Check the battery voltage.
- Measure battery voltage using Rotunda 73 Digital Multimeter 105-R0051, or equivalent.

Did battery pass the minimum load voltage and OCV above 12.40 volts?

Yes	No
Battery OK.	Passes load test but OCV voltage at 12.4 volts. GO to **L5** . Passes load test but OCV voltage below 12.4 volts. Battery worn out. REPLACE battery.

L5 OPEN CIRCUIT VOLTAGE (OCV)

- Charge battery for 20 minutes at 35 amps.
- Repeat test step procedures in step **L4** .

Did battery pass the minimum load voltage?

Yes	No
Battery OK but NEEDS CHARGING.	REPLACE battery.

Component Tests

Drain Testing

Check for current drains on the battery in excess of 50 milliamps with all the electrical accessories off and the vehicle at rest. Current drains can be tested with the following procedure.

WARNING: DO NOT ATTEMPT THIS TEST ON A LEAD-ACID BATTERY THAT HAS RECENTLY BEEN RECHARGED.

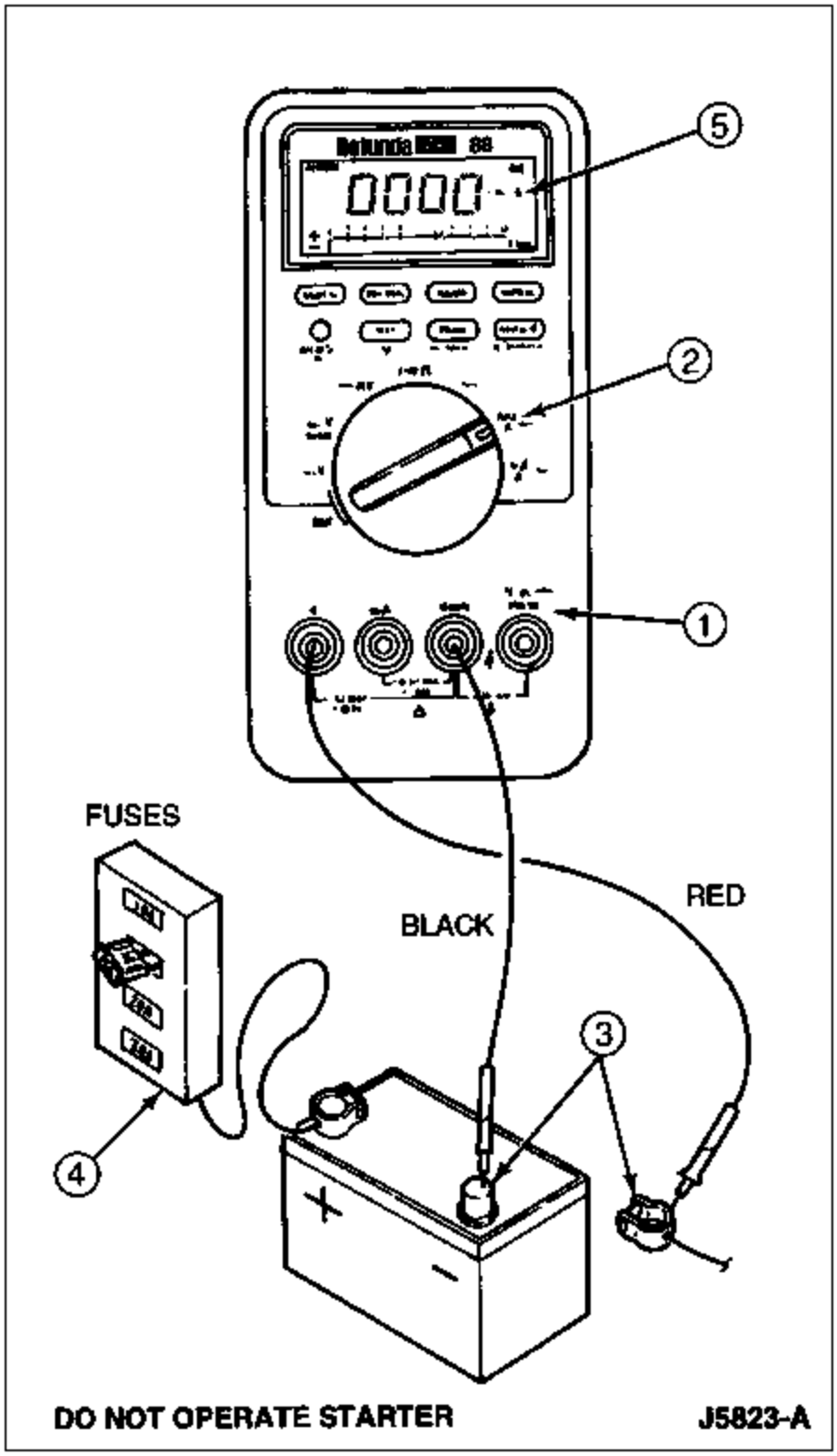
CAUTION: Do not crank the engine or operate accessories that draw more than 10A. You could blow the fuse in the meter.

NOTE: You must wait approximately 50 minutes after doors have been opened before performing this test. Some vehicles will not return to normal key-off drain for 50 minutes.

NOTE: Many computers draw 10 mA or more continuously.

NOTE: Use an in-line ammeter between the battery positive or negative post and its respective cable.

1. Insert the test leads in the input terminals shown.
2. Turn switch to mA/A dc.
3. Disconnect battery terminal and touch probes as shown.
4. Isolate circuit causing current drain by pulling out one fuse after another while reading the display.
5. Current reading will drop when the fuse on the bad circuit is pulled.
6. Reinstall fuse and test components (including connectors) of that circuit to find defective component (s).



Typically, a drain of approximately one amp can be attributed to a courtesy staying on continually. Other component failures or wiring shorts may be located by selectively pulling fuses or disconnecting fuse links to pinpoint the location of the current drain. When the current drain is found, the meter reading will fall to an acceptable level. If the short is still not located, after checking all the fuses and fuse links, the drain may be due to the generator.

NOTE: Do not start vehicle with clip on cable.

Test Conclusion

The current reading (current drain) should be less than 0.05 amps. If it exceeds 0.05 amps it indicates a constant current drain which could cause a discharged battery. Possible sources of current drain are vehicle lamps (underhood, glove compartment, luggage compartment, etc.) that do not shut off properly.

If the drain is not caused by a vehicle lamp, remove the fuses from the interior fuse junction panel, one at a time, until the cause of the drain is located. If drain is still undetermined, remove fuses one at a time at the main fuse junction panel to find the problem circuit.

With Voltmeter Test Procedure

This test requires a digital volt-ohmmeter with an appropriate low voltage scale such as Rotunda 88 Digital Multimeter 105-R0053 or equivalent. The meter must read within 0.01 millivolt. Also required is a shunt assembly similar to that shown in the illustration.

1. Turn ignition switch (11572) to the off position and make sure there are no electrical loads. After determining the compartment lamp (15702) is turning off properly, disconnect the bulb.

2. Check battery voltage. If voltage is under 11.5 volts, charge the battery (10655) to above 11.5.

3. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

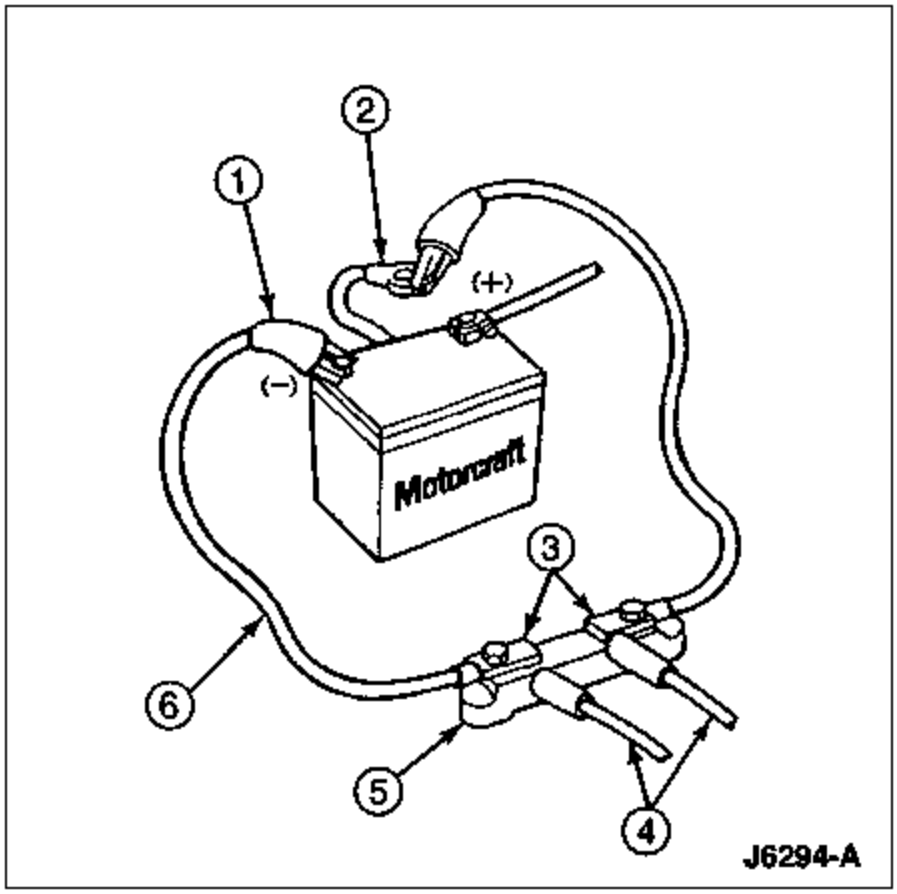
   Disconnect battery ground cable (14301).

4. **CAUTION: Do not crank the engine (6007), it could destroy the shunt. Also do not use the shunt to measure starting currents.**

   Connect shunt as shown.

5. Set volt-ohmmeter to 200 or 300 mv scale for an accurate reading (must be within 0.01 millivolt).

6. Connect meter leads to shunt as shown. With this size shunt (50 mv = 50 amps) and meter, a direct current drain measurement can be made.



Item	Part Number	Description
1	—	Negative Battery Terminal
2	—	Negative Cable Clamp
3	—	Voltage Drop (Amp Drain) Points
4	—	Voltmeter Leads
5	—	Shunt Assembly (50 MV = 50 Amp)
6	—	10-Gauge Wire (Minimum)

Test Conclusion

The current reading (current drain) should be less than 0.05 amps. If the reading is between 0.2 and 0.9, a possible drain may be a vehicle lamp (glove compartment, compartment lamp, luggage compartment lamp (13A756), etc.) that does not turn off. If the problem is not a lamp, remove the fuses (14526) from the fuse holder (14411) one at a time until the cause of the drain is located. If still undetermined, disconnect leads at starter relay one at a time to find the problem circuit.

Vehicles with Major Key OFF Loads Such As Computer-Controlled Suspension

Vehicles equipped with these features will have temporary current drains that may last up to 70 minutes after ignition switch is turned off. These drains can range from 0.1 to 20 amps if the compressor is cycling. This action can often mask a problem and must be considered when evaluating test results. To test for this kind of drain, proceed as follows.

1. Repeat Steps 1 through 5 of the Drain Testing Procedure.
2. Turn ignition switch to RUN for a moment and then off again.
3. Disconnect major key OFF load circuits.
4. Make sure interior lamp (13776) is off, if applicable.

Test Conclusion

The current reading (current drain) should be less than 0.05 amps. If it is higher, disconnect fuses and leads of the starter motor cutout relay (11433) as in the previous test to locate the problem circuit.

If the drain is less than 0.05 amps, reconnect the major key-off load circuits, turn ignition switch to RUN and then off, and wait 70 minutes to make sure they shut off properly. If current drain is still greater than 0.05 amps after 70 minutes, disconnect each of the components one at a time until the cause of the current drain is located.

Electronic Drains Which Shut Off When the Battery Cable Is Disconnected

1. Repeat Steps 1 through 5 of the Voltmeter Drain Test Procedure.
2. Without starting engine, turn ignition switch to the RUN position for a moment and then off. If applicable, wait one minute for the interior lamp to turn off.
3. Connect voltmeter and read voltage.

Test Conclusion

The current reading (current drain) should be less than 0.05 amps. If it exceeds 0.05 after a few minutes, and if this drain did not show in previous tests, the drain is most likely from a malfunctioning electronic component. As in previous tests, remove fuses and disconnect leads of the starter motor cutout relay one at a time to locate the problem circuit.

Battery

Capacity Testing

To perform this test use a high rate discharge tester, Rotunda Alternator, Regulator, Battery and Starter Tester (ARBST) 010-00725 or equivalent, in conjunction with Rotunda 73 Digital Multimeter 105-R0051 or equivalent.

1. Turn ARBST OFF.
2. Turn the multimeter to the DV volt position.
3. Connect ARBST and multimeter positive test leads to the positive battery post and both negative test leads to the negative battery post. The multimeter clips must contact the battery posts and not the ARBST tester clips. Unless this is done, the actual battery terminal voltage will not be indicated.
4. Adjust ARBST until the ammeter reads approximately half of the cold cranking amps of the battery.
5. With the ammeter reading the required load for 15 seconds, note the multimeter reading. Avoid

leaving the high discharge load on the battery for periods longer than 15 seconds.

6. If the multimeter reading is 9.6 volts at 21°C (70°F) or more, the battery has a good output capacity and will readily accept a charge, if required.

7. If the voltage reading obtained during the capacity test is below 9.6 volts at 21°C (70°F), and the battery is fully charged, the battery is defective and must be replaced. If unsure about the battery's state of charge, charge the battery.

8. After the battery has been charged, repeat the capacity test. If the capacity test battery voltage is still less than 9.6 volts at 21°C (70°F), replace the battery. If the voltage is 9.6 or more at 21°C (70°F), the battery is satisfactory for service.

9. If the battery is found to be discharged only, check for a loose drive belt, loose electrical connection, charging system performance, and perform battery drain testing as described in this section.

Generator Base Voltage Test

NOTE: Prior to running this test, turn the headlamp bulbs (13007) on for 10-15 seconds to remove any surface charge from the battery. Then, wait until the voltage stabilizes before performing the Generator Base Voltage Test. Battery should be at the recommended state of charge.

1. With the ignition off and no electrical loads on, connect the negative lead of Rotunda 73 Digital Multimeter 105-R0051 or equivalent to the battery ground cable clamp.

2. Connect the positive lead of the voltmeter to the battery to starter relay cable (14300) clamp.

3. Read and record the battery voltage shown on the voltmeter. This is called base voltage and will be used in later tests.

No-Load Test

1. Connect Rotunda 88 Digital Multimeter 105-R0053 or equivalent to monitor engine speed.

2. Connect the leads of Rotunda 73 Digital Multimeter 105-R0051 or equivalent across the battery terminals.

3. Read the voltage (base voltage).

4. Start the engine.

5. Run the engine at 1500 rpm with no electrical load.

6. Read the voltage. The voltage should be in the range of 13.5 to 15.1 volts. If the voltage increase is less than 2.5 volts over the base voltage, perform the following Load Test. If there is no voltage increase or the voltage increase is greater than 2.5 volts, perform the Generator On-Vehicle Tests and Generator Bench Tests in this section.

Load Test

1. With the engine running, turn on the air conditioner, if equipped, the blower motor (18527) to high speed and the headlamps to high beam.

2. Increase the engine speed to approximately 2000 rpm. The voltage should increase a minimum of 0.5 volts above the base voltage. If the voltage does not increase as specified, refer to Generator On-Vehicle Tests and Generator Bench Tests in this section.

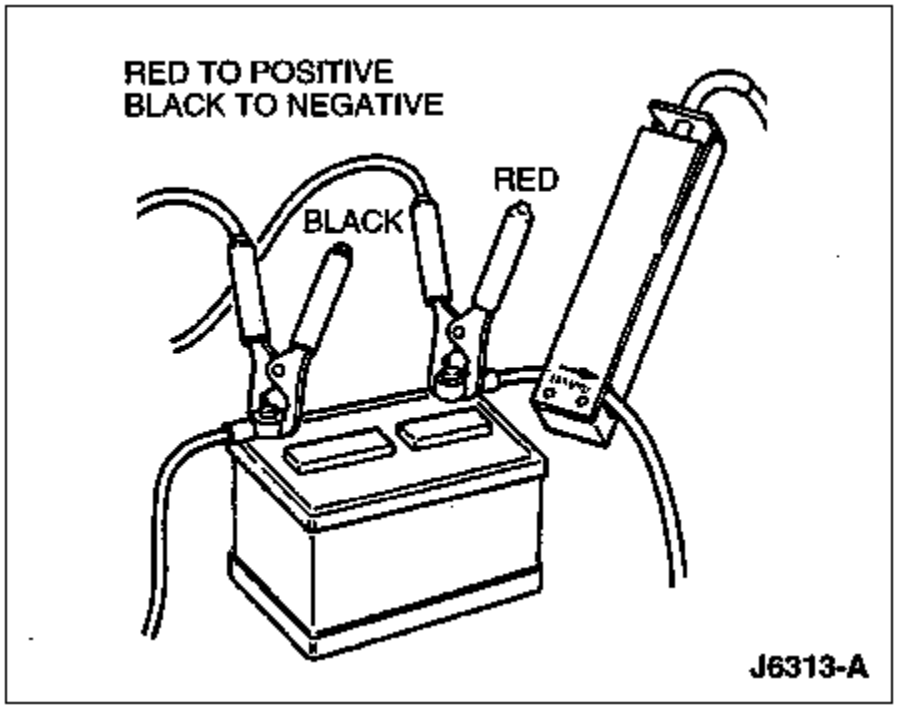
   If the voltage increases as specified, the charging system is operating normally. Proceed to the following battery tests.

Generator

Generator Output Test

NOTE: Battery and cable clamps must be clean and tight to ensure accurate meter indications. Before performing any generator tests, inspect the drive belt (8620) for looseness, damage and wear. If necessary, adjust the drive belt for proper tension. Refer to Section 03-05 .

1. Connect the leads of Rotunda ARBST 010-00725 or equivalent, to the vehicle as shown, observing proper polarity.



2. Connect current probe to generator output wire to measure generator output.
3. Turn off all electrical accessories.
4. Turn the ignition switch to ON position and read the rate of discharge on the ammeter.
5. Start the engine and run engine at 1500 to 2000 rpm.

6. **CAUTION: Do not drop the voltage below 12 volts.**

   Slowly increase the load control knob on the VAT-40 until the highest amp reading is obtained.

7. Turn off the load control knob.

8. Add the ammeter reading obtained in Step 3 and Step 5 for total generator output. If the amperage output is within 10 percent of its rated output, the generator is functioning properly. If the amperage output is below this specification, refer to the Symptom Chart in this section.

Field Circuit Drain

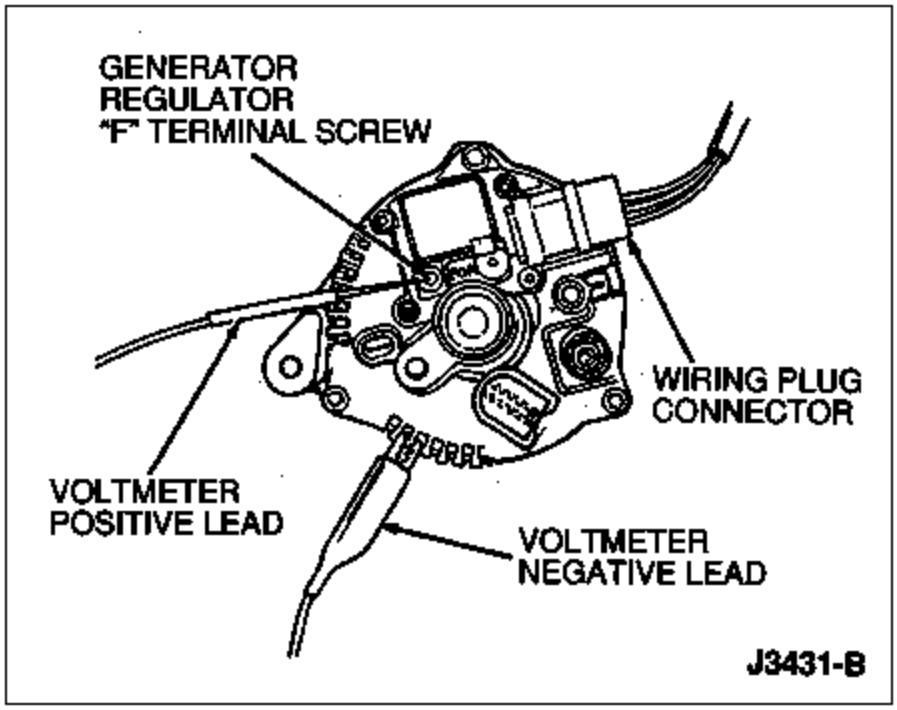
Connect the voltmeter negative lead to the generator (GEN) (10346) rear housing for all of the following voltage readings:

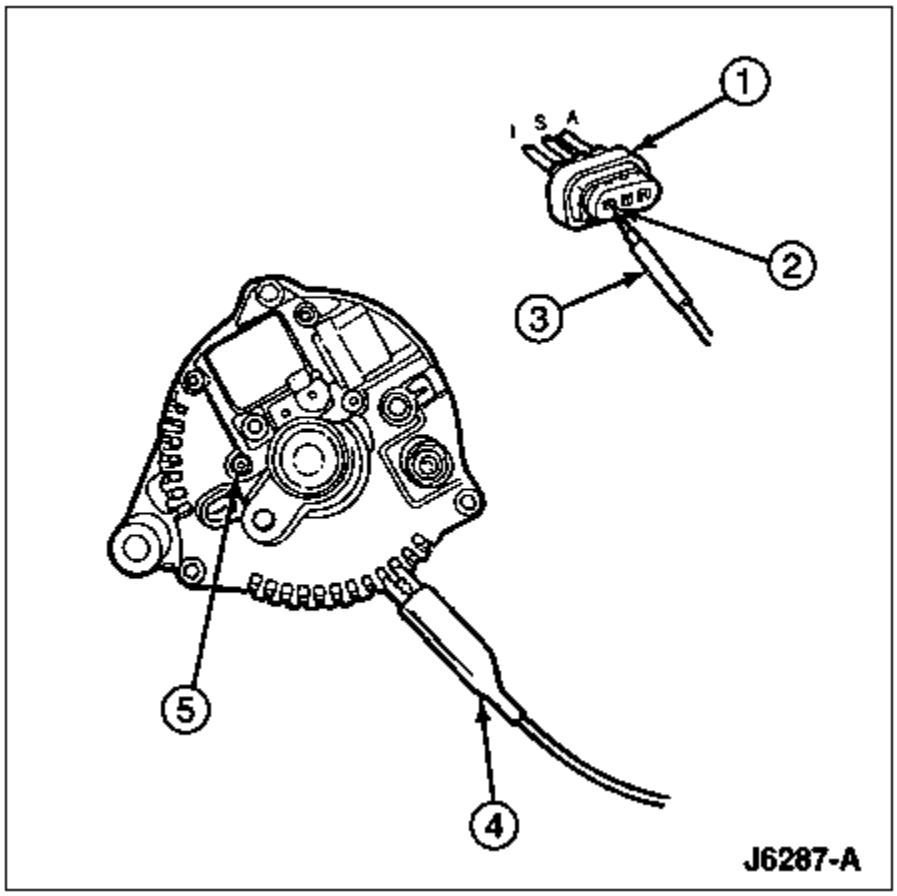
1. With ignition switch turned to OFF position, contact voltmeter positive lead to voltage regulator (VR) (10316) F terminal screw. The meter should indicate battery voltage if system is operating normally. If less than battery voltage is indicated, proceed with Step 2 to find cause of current drain.

2. Measure voltage at I terminal (ignition switch OFF). If voltage is indicated, service I circuit from ignition switch to eliminate voltage source.

3. If no voltage was indicated in Step 2, contact voltmeter positive lead to wiring plug S terminal. No voltage should be indicated. If no voltage is indicated, replace the voltage regulator.

4. If voltage was indicated in Step 3, disconnect the one pin S terminal connector. Again, contact voltmeter positive (+) lead to voltage regulator wiring plug S terminal. If voltage is indicated, service S lead wiring to eliminate voltage source. If no short is found, replace generator assembly.


GENERATOR
REGULATOR
"F" TERMINAL SCREW
WIRING PLUG
CONNECTOR
VOLTMETER
POSITIVE LEAD
VOLTMETER
NEGATIVE LEAD
J3431-B


I
S
A
1
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J6287-A

Item	Part Number	Description
1	—	Wiring Plug Connector (Part of 14305)
2	—	I Terminal (Part of 14305)
3	—	Voltmeter Positive Lead
4	—	Voltmeter Negative Lead
5	—	F Terminal Screw (Part of 14305)

Alternate Test Method

Use Rotunda Power Sensor Plus Electronic Battery Test 162-00002. Follow the manufacturer's defined test procedure.

Generator On-Vehicle Tests

Troubleshooting or diagnosis is required before actual service can be made in the electrical system. Even where an obvious condition makes replacement of a component necessary, find out why the component failed. When a condition is diagnosed correctly, unnecessary service is prevented, the time the vehicle is out of service will be decreased, and the condition will be properly corrected the first time.

NOTE: Refer to the Rotunda Alternator, Regulator, Battery and Starter Tester (ARBST) 010-00725 Test Procedure Manual for complete directions on checking out the charging system.

In order to check the charging system, the use of Rotunda Alternator, Regulator, Battery and Starter Tester (ARBST) 010-00725 or equivalent tester is suggested.

When performing charging system tests, turn off all lamps and electrical components. Place transmission in neutral and apply parking brake.

CAUTION: Do not make jumper wire connections except as directed. To do so may damage generator.

CAUTION: Do not allow any metal object to come in contact with the housing and internal diode cooling fins with key on or off or short circuit will result and burn out diodes.

NOTE: Battery posts and cable clamps must be clean and tight to ensure accurate meter indications.

Load Test

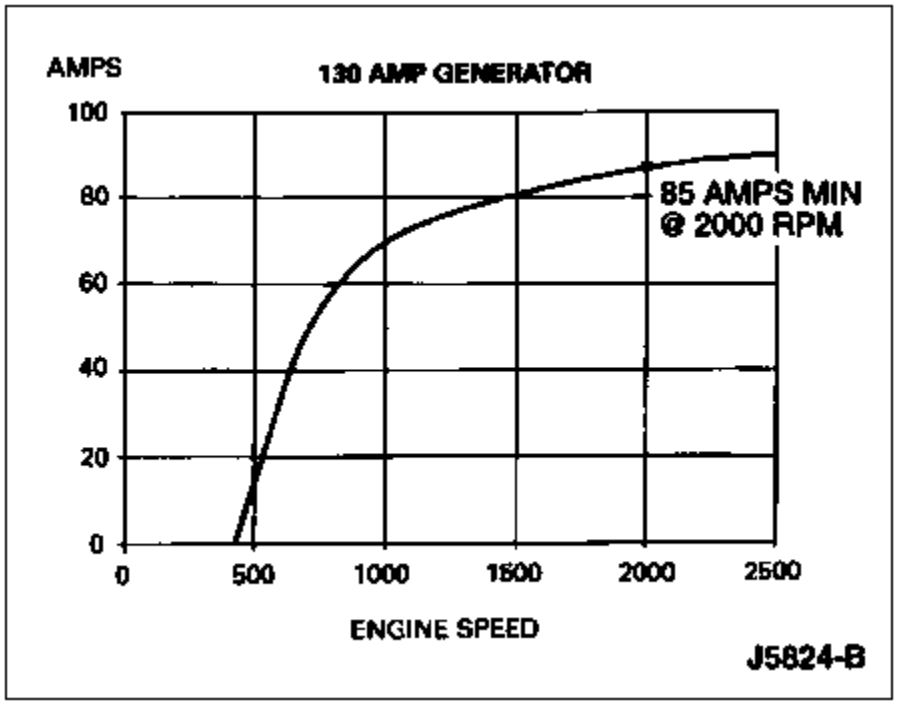
1. Switch the Rotunda Alternator, Regulator, Battery and Starter Tester (ARBST) 010-00725 or equivalent to the ammeter function.

2. Connect the positive and negative leads of the Rotunda Alternator, Regulator, Battery and Starter Tester (ARBST) 010-00725 or equivalent to the battery.

3. Connect the current probe to the generator B+ output lead, Circuit 38 (BK/O).

4. With the engine running at 2000 rpm, adjust the Rotunda Alternator, Regulator, Battery and Starter Tester (ARBST) 010-00725 or equivalent load bank to determine the output of the generator (GEN)

(10300). Generator output should be greater than the graph shown below. If not, refer to the symptom chart in this section for diagnostic procedures.



No-Load Test

1. Switch the Rotunda Alternator, Regulator, Battery and Starter Tester (ARBST) 010-00725 or equivalent to the voltmeter function.
2. Connect the voltmeter positive lead to the generator B+ terminal and the negative lead to ground.
3. Turn all electrical accessories off.
4. With the engine running at 2000 rpm, check the generator output voltage. The voltage should be between 13.0 and 15.0 volts. If not, refer to the symptom chart in this section for diagnostic procedures.

Generator Bench Tests (Integral Rear Mount Regulator, Internal Fan Generator)

NOTE: The integral rear mount regulator — internal fan type generator is serviced as an assembly only.

Replace generator as required after performing Generator On-Vehicle Tests.

Capacitor

The radio voltage regulator capacitor (18832) connected across the heat sinks may be tested on a capacitor tester if available. Its value is .158 MFD, and 100 working volts D.C.

In the absence of a capacitor tester, the unit may be checked for shorts by means of an ohmmeter connected across the terminals. A reading under 20 milli-ohms indicates a shorted or leaking radio voltage regulator capacitor which should be replaced.

Battery

Removal

1. Remove battery cables from battery terminals (battery ground cable (14301) first). On Ranger vehicles, remove battery heat shield.

2. Remove battery hold down clamp (10718).

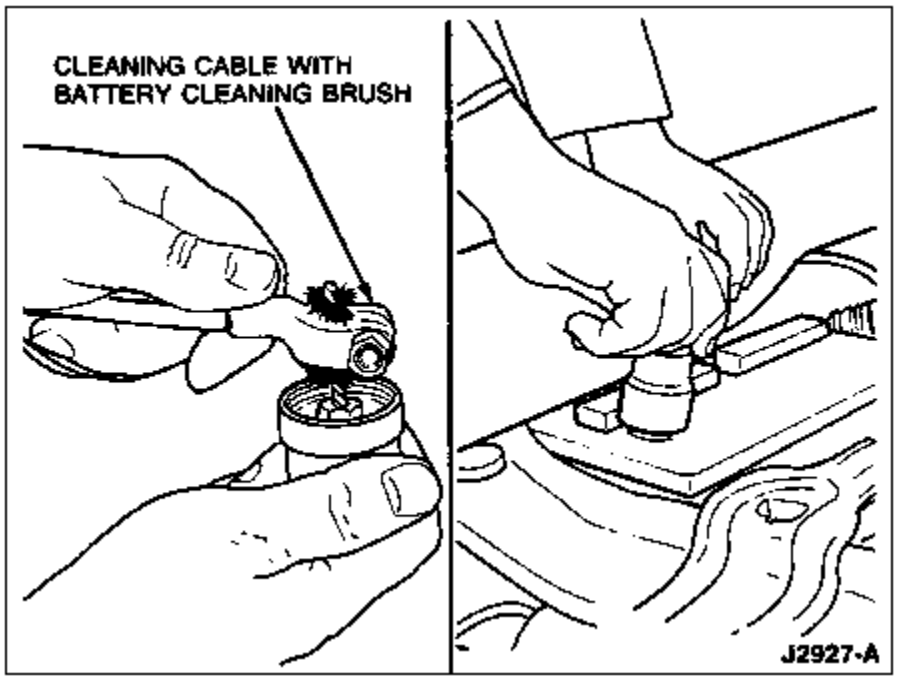
3. **CAUTION: When lifting a plastic-cased battery (10655), excessive pressure on the end walls could cause acid to spew through the vent caps, resulting in personal injury, damage to the vehicle or battery. Lift with a battery carrier or with your hands on opposite corners.**

   Remove battery from vehicle.

Installation

1. **NOTE: The battery terminal cleaning operation shown in the following illustration is typical for all vehicles.**

   Clean cable terminals and battery hold down clamp with a wire brush. Replace all cables or parts that are worn or frayed.



2. Clean battery tray (10732) with a wire brush and scraper.

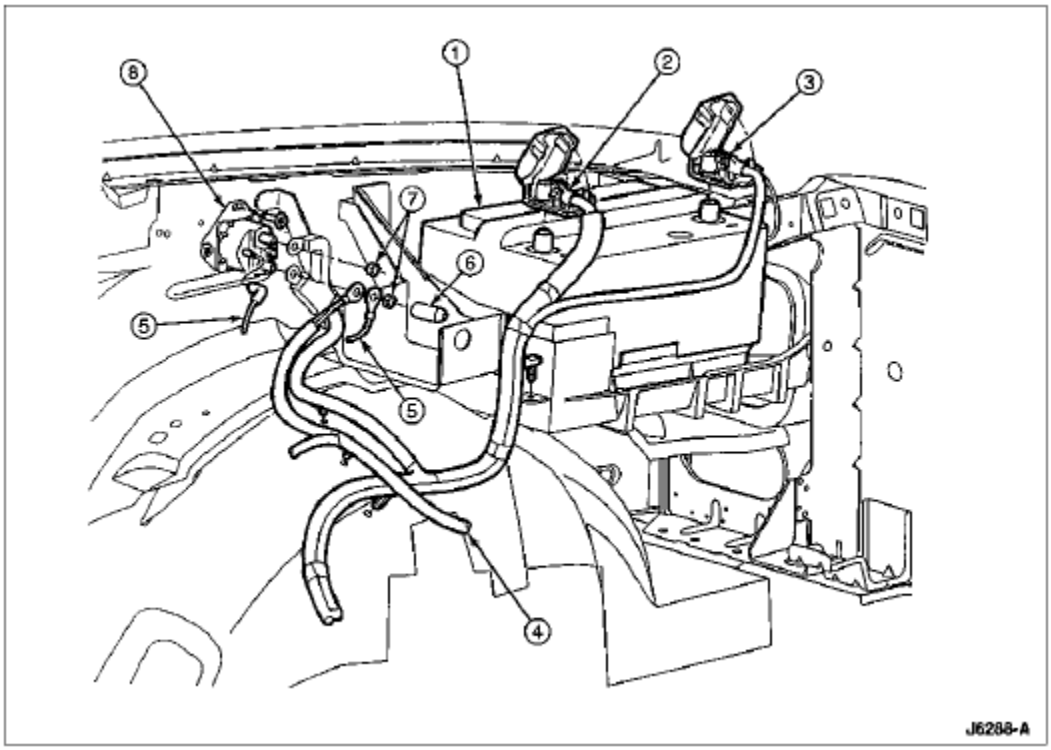
3. Place battery in battery tray with positive and negative terminals in same position as previous battery (10653). On Ranger vehicles install battery heat shield.

4. Assemble and tighten battery hold down clamp so battery is secure. Do not tighten excessively.

5. **NOTE: When the battery has been disconnected and reconnected, some abnormal driving symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 mi) or more to relearn the strategy.**

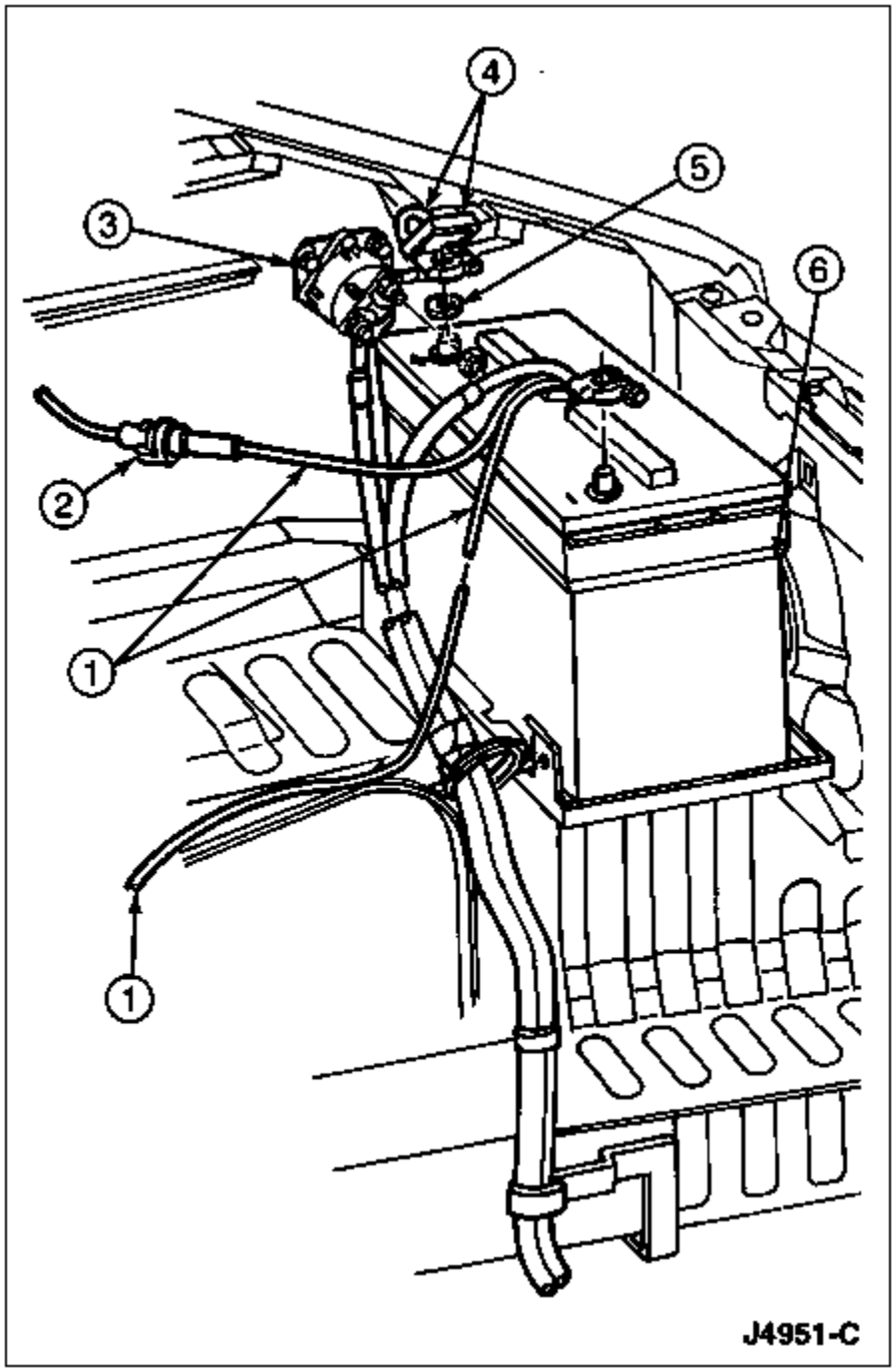
   Secure cables (battery to starter relay cable (14300) first) to proper terminals. Tighten to 7-10 Nm (5-7 lb-ft). Apply petroleum jelly to terminals.

Battery Connections, Ranger



Item	Part Number	Description
1	10655	Battery
2	14300	Battery to Starter Relay and Starter Cable
3	14301	Battery Ground Cable
4	14305	Wiring Harness
5	14290	Wiring Harness
6	14A396	Relay Cover
7	381561-S36	Nut
8	11450	Starter Relay

Battery Connections, Aerostar with 3.0L and 4.0L Engines



Item	Part Number	Description
1	14301	Battery Ground Cable
2	12A581	Engine Control Sensor Wiring
3	11450	Starter Motor Solenoid Relay Switch

4	14300	Battery to Starter Relay and Starter Cable
5	374043	Felt Washer
6	10655	Battery

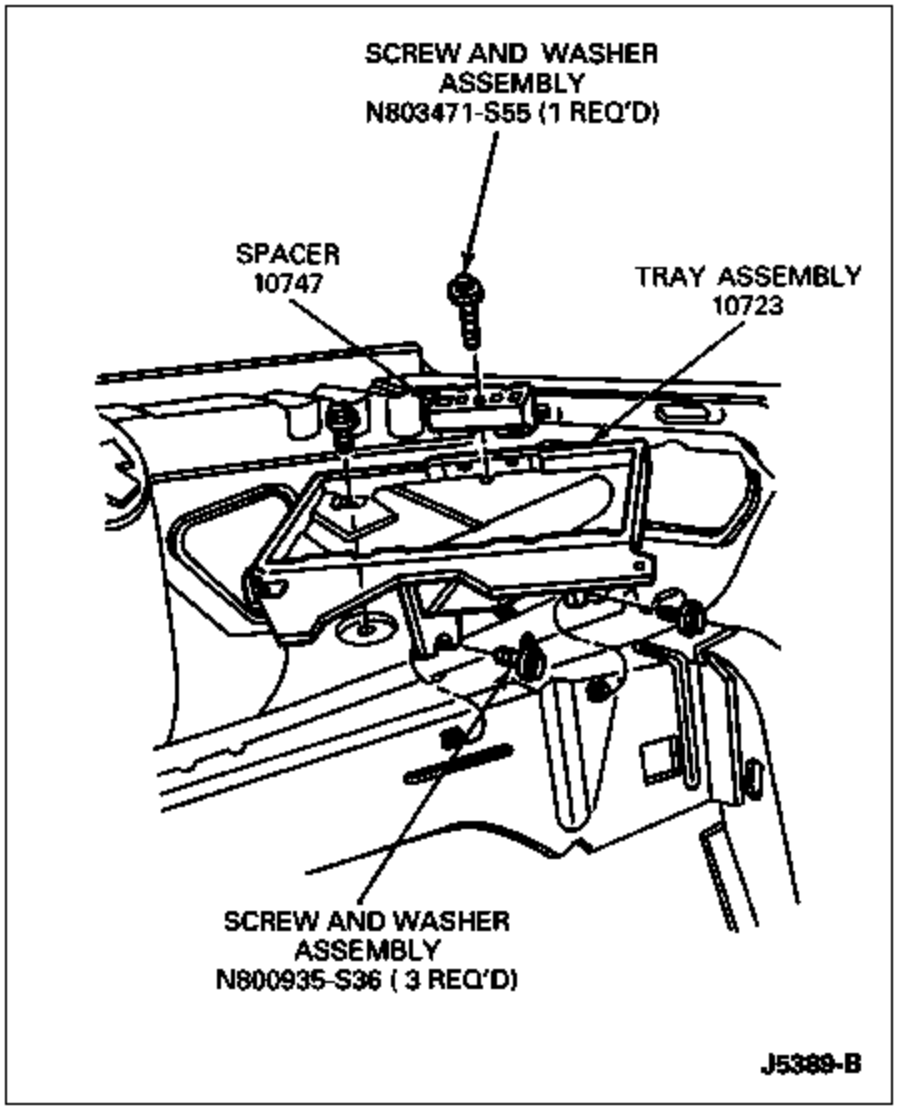
Battery Tray

Removal

1. Remove battery (10655) from vehicle.
2. Remove attaching screws and washers from battery tray (10732).

Installation

1. Position battery tray in engine compartment and install attaching screws.
2. Install battery.
3. Tighten battery hold-down bolt to 10-14 Nm (7-10 lb-ft).


SCREW AND WASHER
ASSEMBLY
N803471-S55 (1 REQ'D)
SPACER
10747
TRAY ASSEMBLY
10723
SCREW AND WASHER
ASSEMBLY
N800935-S36 (3 REQ'D)
J5389-B

Battery Charging

NOTE: If excessive gassing or electrolyte spewing occurs during the charge, discontinue charging. The battery has reached serviceable charge. If the battery will not accept at least 5A after 20 minutes of charging, replace the battery.

WARNING: WEAR SAFETY GLASSES. BATTERY CHARGING CAN BE DANGEROUS. WHILE BEING CHARGED, THE BATTERY PRODUCES A POTENTIALLY EXPLOSIVE MIXTURE OF HYDROGEN AND OXYGEN GASSES. KEEP SPARKS, FLAMES AND LIGHTED CIGARETTES AWAY FROM BATTERIES. IN CASE OF ACID CONTACT WITH SKIN, EYES OR CLOTHING, FLUSH IMMEDIATELY WITH LARGE AMOUNTS OF WATER. GET MEDICAL ATTENTION.

Before recharging a discharged battery, inspect and service the following conditions, if they exist:

1. Loose drive belt (8620).
2. Pinched or grounded generator voltage regulator wiring (14305).
3. Loose connections of the generator voltage regulator wiring at the generator (GEN) (10346) or generator regulator (10316).
4. Loose of corroded connections at battery, grounded starter motor cutout relay or engine.
5. Excessive battery drain due to:
    a. Any courtesy lamps remaining energized (damaged or misadjusted switch, etc).
    b. Door open warning lamp switch (14018) continuously on.
    c. Inoperative autolamp module causing approximately 2 amp drain with ignition switch in the off position and autolamp off.

Maintenance-Free and Low-Maintenance Batteries

Cold batteries will not readily accept a charge. Therefore, batteries should be allowed to warm up to approximately 5°C (41°F) before charging. This may require four to eight hours at room temperature depending on the initial temperature and battery size.

A battery which has been completely discharged may be slow to accept a charge initially, and in some cases may not accept charge at the normal charger setting. When batteries are in this condition, charging can be started by use of the dead battery switch on chargers so equipped.

To determine whether a battery is accepting a charge, follow charger manufacturer's instructions for use of dead battery switch. If switch is the spring-loaded type, it should be held in the ON position for up to three minutes.

After releasing switch and with charger still on, measure battery voltage. If it shows 12 volts or higher, the battery is accepting a charge and is capable of being recharged. However, it may require up to two hours of charging with batteries colder that 5°C (41°F) bef ore the charge rate is high enough to show on the charger ammeter. It has been found that all non-damaged batteries can be charged by this procedure. If a battery

cannot be charged by this procedure, it should be replaced.

A rapid recharge procedure has been developed for recharging batteries that have passed the Load Test and only need a recharge. This can be due to: in-service no-start battery failures (vehicles will not crank due to low battery state of charge) or battery discharged in vehicle due to key-off loads. Refer to Section 14-00 for Load Test procedure.

The battery can be rapidly recharged by using either of the following methods:

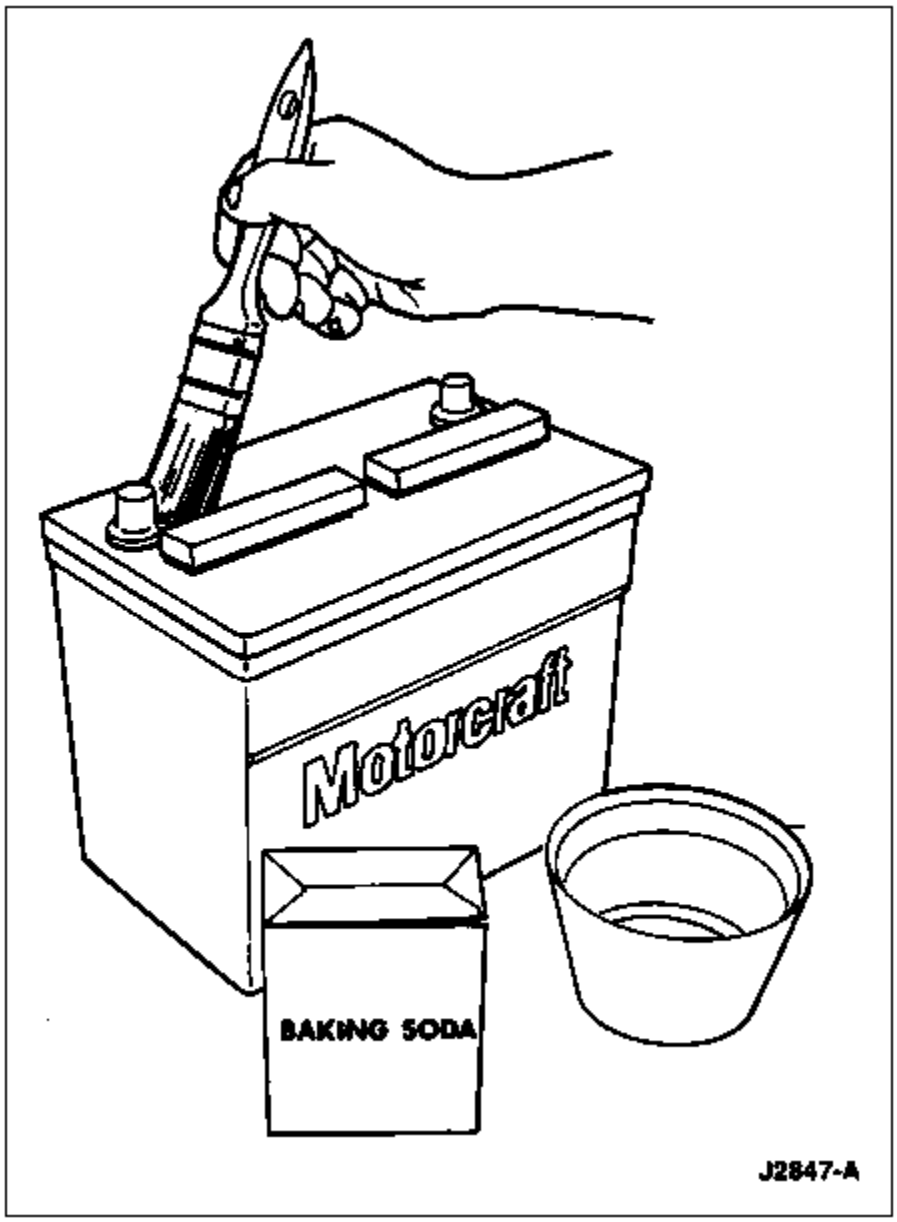
1. Perform a 2-hour charge using 20A constant current (manual setting on charge).

2. Perform a 2-hour charge using a constant potential (automatic setting on charge).

Battery Cleaning

Keeping the battery (10655) top clean and dry reduces the need for service and extends battery life. Also, make certain the cable clamps are tightly fastened to the battery posts. If corrosion is found, disconnect the cables and clean clamps and posts with a wire brush. Neutralize the corrosion with a solution of baking soda and water. After installing cables, apply a small quantity of Premium Long-Life Grease XG-1-C or -K or equivalent grease meeting Ford specification ESA-M1C75-B to each battery post to help prevent corrosion.

The battery cleaning operation shown in the following illustration is typical for all vehicles.



Tools

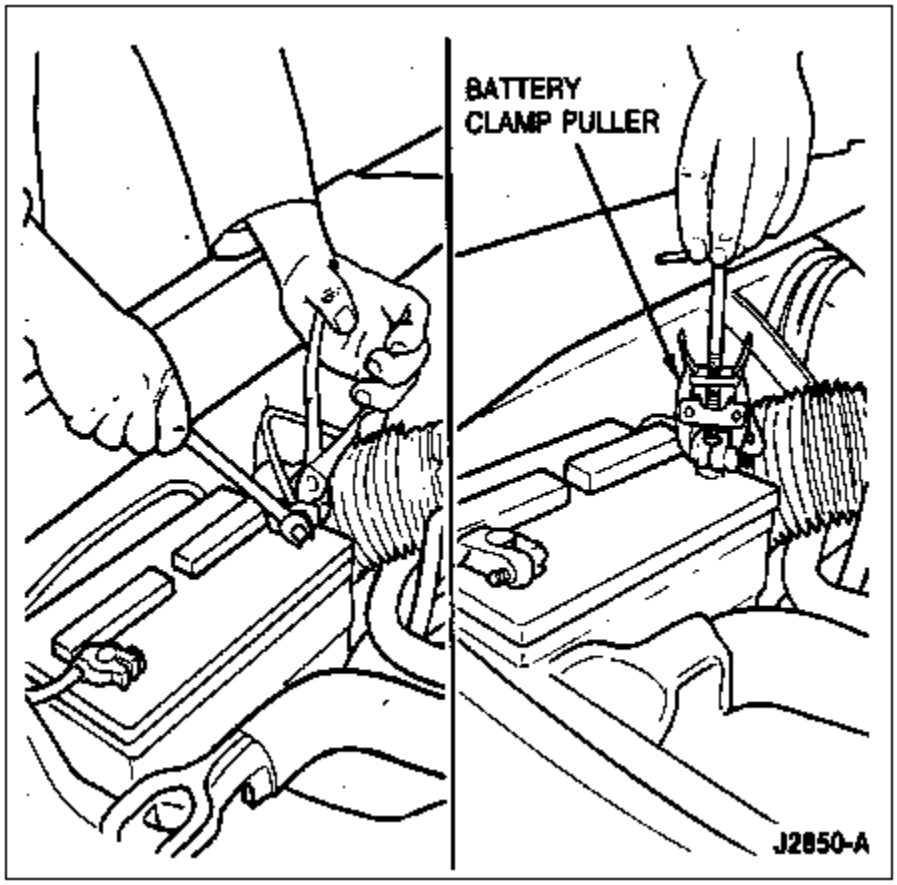
Using the proper tools will prevent damage to the battery (10655), battery cables and battery hold down clamp (10718).

Tools and equipment manufactured for servicing batteries (10653) have parts insulated to help prevent arcing should the tool be dropped or placed accidentally between a terminal and some other contact surface.

Pliers

Battery pliers have jaws specifically designed for gripping cable clamp bolts securely. Care should be taken when removing or replacing the cable clamp bolts so that the battery terminal is not subjected to any excessive lateral or twisting forces. Such forces could cause major damage to the internal components of the battery, and leakage at the terminals.

The battery terminal removal operation shown in the following illustration is typical for all vehicles.



Clamp Puller

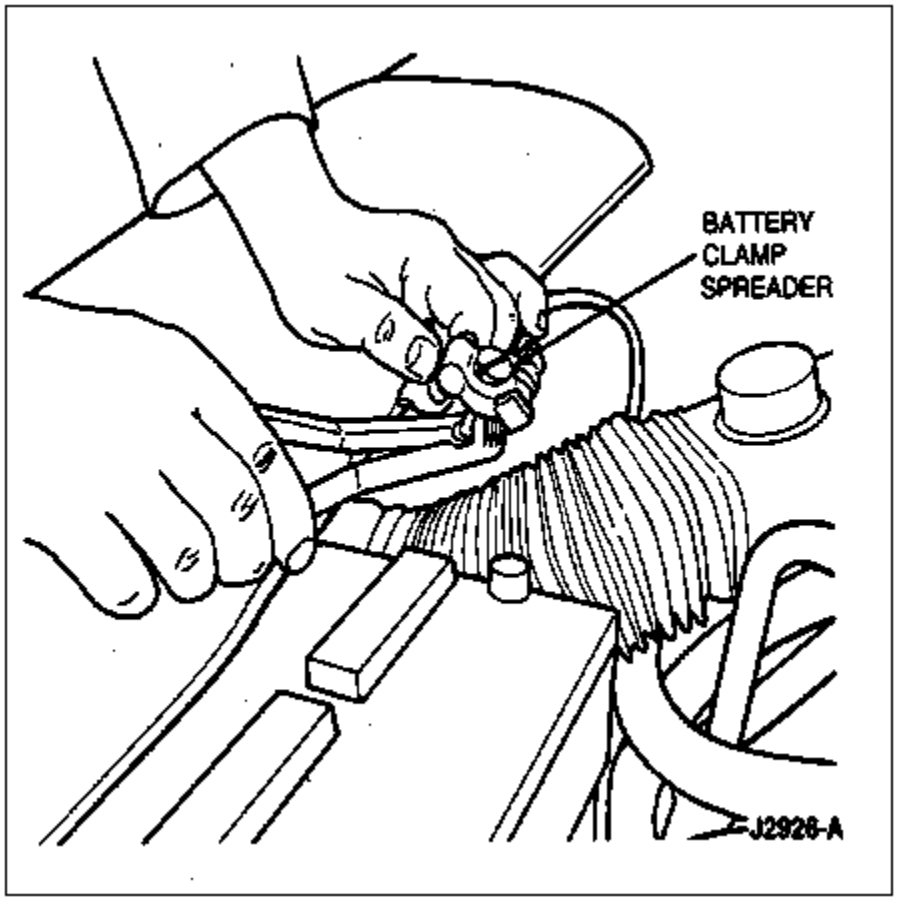
Use a clamp puller to remove a cable clamp from the battery terminal. With the jaws gripping the underside of the cable clamp, pull the clamp up by means of pressure exerted against the top of the battery terminal.

Proper use of this tool avoids the damaging lateral or twisting forces that result when using a pry bar or pliers.

Battery Clamp Spreader

The spreader is used to expand the cable clamp after it has been removed from the terminal and the clamp bolt has been loosened. The cable clamp can then be easily placed in its correct position completely on the terminal.

The battery clamp spreading operation shown in the following illustration is typical for all vehicles.



Terminal Cleaning Brush

The terminal cleaning brush is designed with units to clean both the tapered battery terminal and the mating surface of the cable clamp. Refer to illustration under Battery Installation.

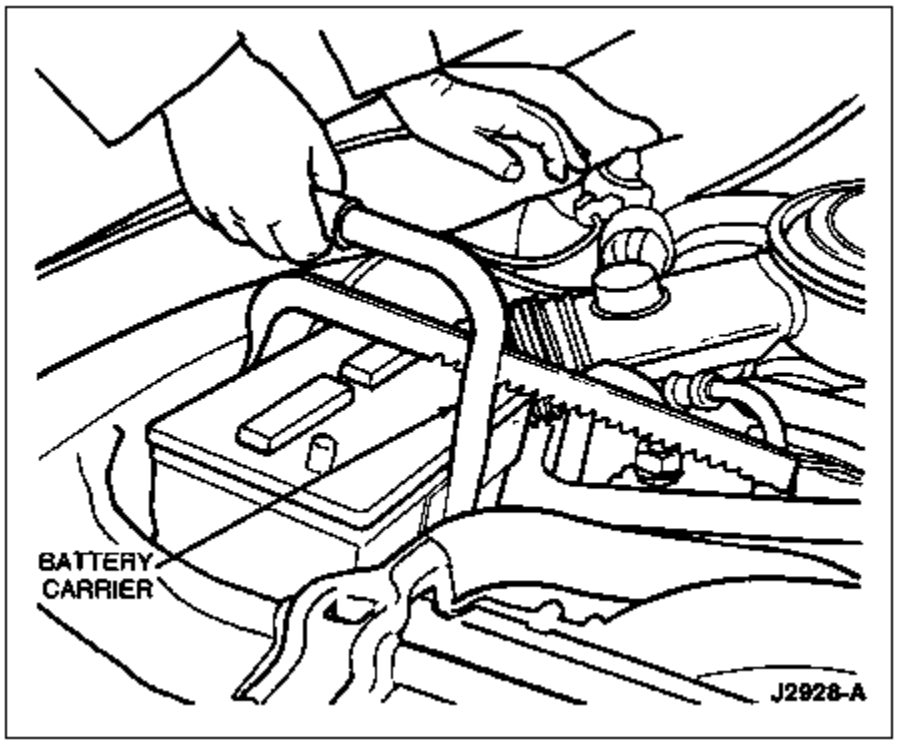
Carrier

CAUTION: Gripping the end walls on the plastic-cased battery could cause electrolyte to spew from some of the cells, resulting in personal injury and possibly cause damage to some of the internal components.

Use a suitable battery carrier for lifting and transporting the battery. The illustration shows a clamp-type carrier used to grip the sidewalls of the container just below the lip of the cover. The carrier is used on the sidewalls, rather than the end walls, since the sidewalls have additional strength from the inner cell

partitions. This is particularly important with the plastic-cased battery which has end walls that are flexible.

The battery removal operation shown in the following illustration is typical for all vehicles.



SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Relay Cable-to-Body Panel Screw (Ranger)	10-14	7-10	—
Generator Voltage Regulator Wiring Nut and Washer (Ranger with 2.3L Engine)	5-11	—	44-97
Battery Cable Bolts	7-10	5-7	—
Battery Hold-Down Bracket Bolt	10-14	7-10	—

Radio Reception

Antenna Position

The automatic antenna will adjust to the full extended height for best FM reception.

- FM stereo has a range of about 32 km (20 miles) before interference noises are heard.
- This means that in concern areas with tall buildings or hills, it is necessary to select the strongest possible station.
- The electronic radio chassis (18806) automatically tunes to the center of any given station, eliminating the need for manual fine tuning.

Antennas and Mobility

Although an automobile radio chassis will give outstanding mobile reception, it cannot provide the continuous reception of home audio components.

- The home receiver is not limited by the vehicle operating characteristics and certain geographical effects as is the mobile unit.
- For example, for the best FM reception, the automobile antenna should be designed like a TV antenna and pointed in the direction of the station.
- The best AM antenna is a long piece of wire, the higher the wire the better the reception.
- However, because of design necessity, the automobile antenna is restricted in size, height and direction and must receive both AM and FM stations. This means that a limited amount of the station's signal reaches the vehicle radio chassis.

Tuning

Tuning the radio chassis in to a station is very simple. Press the seek up or seek down button to tune the receiver to the next station.

Tone Control

Favoring the rear radio speakers (18808) in noisy areas will help to reduce noise.

FM Flutter

Flutter can best be described as follows:

- Repeated pops and hissing bursts heard in the radio speaker during an otherwise good broadcast.
- Usually this condition exists while traveling in the fringe area of the station and flutter will become more severe beyond approximately 40 km (25 miles) of the station. The signal loss becomes greater away from the station, until finally noise takes over and reception becomes impossible.
- Flutter may also be noticed near the station because of the line-of-sight characteristics of FM radio waves. This condition can happen when a building or large structure is between the radio chassis and the station being received. Some of the FM signal bends around the building, but certain spots have almost no signal. Some of these signal losses are only a few inches wide and if the vehicle is parked

in one of these dead spots, you will only hear noise from the radio speaker. After moving out of the shadow of the structure, the station will return to normal.
- Flutter will not occur on AM because the AM radio waves are much longer than FM waves.

FM Multi-Path Cancellation

Cancellation can be defined as follows:

- It is caused by the line-of-sight characteristic and exists when the radio waves are reflected from objects or structures.
- The noise produced by cancellation is similar to flutter, with the addition of distortion in the program.
- A more familiar description of cancellation is its similarity to the multiple ghosts and picture jumping that occurs on television when a low flying plane passes. The same condition exists in the vehicle, except that the vehicle is moving and the reflecting structure is stationary. The reflected signal cancels the normal signal, causing the antenna to pick up noise and distortion.
- Cancellation effects are most prominent in metropolitan areas, but can also become quite severe in hilly terrain and depressed roadways.

FM Strong Signal Capture and AM Overloading

FM capture is an unusual condition that occurs when traveling in the vicinity of a broadcast tower.

- If listening to a weak FM station, when passing the broadcast tower, a stronger station may interfere without changing the tuning control. When passing the tower, the station may switch back and forth a few times before returning to the station originally tuned.

A localized condition which will not harm the receiver is known as overloading.

- When several broadcast towers are present (common in metropolitan areas) several stations may overload the receiver resulting in considerable station changing, mixing and distortion.
- Some overloading may also be noticed on AM, but usually to a lesser degree.

Receiving FM Stereo

Because more data is carried in the FM stereo waves than in the monaural FM broadcasts, flutter, cancellation and capture are even more noticeable:

- The FM stereo noise-free broadcast range is approximately 32 km (20 miles).
- The AM/FM stereo radio chassis may never encounter any of these troublesome conditions as they are more prominent in metropolitan areas, hilly terrain and depressed roadways. However, when diagnosing FM stereo concerns, it is recommended to accurately tune to the strongest FM stereo station.

Stereo Indicator Inoperative or Flickering (AM and FM Reception Are OK)

- Verify that customer is listening to stereo stations.
- A weak or distant signal may cause the stereo indicator to flicker. Tune radio chassis to a nearby FM stereo station. If reception is good, but stereo indicator is still intermittent, remove radio chassis for service.

Interfering Noises

There are many possible sources of radio interference:

- One such source is the vehicle ignition system. This high-voltage switching system produces a radio frequency electromagnetic field that radiates at AM, FM and CB frequencies. Although components have been designed into the vehicle to minimize this concern, the noise is more noticeable if the radio chassis is tuned slightly off channel when listening to FM programs.
- Vehicle electrical accessories and owner add-on accessories may also contribute to radio interference.
- There are also many noise sources which are external to the vehicle such as power lines, communication systems, ignition systems of other vehicles and neon signs.

Ignition Noise

The most effective method of evaluating ignition noise is to compare the radio performance with the engine running, versus engine off. If ignition noise is present with engine running:

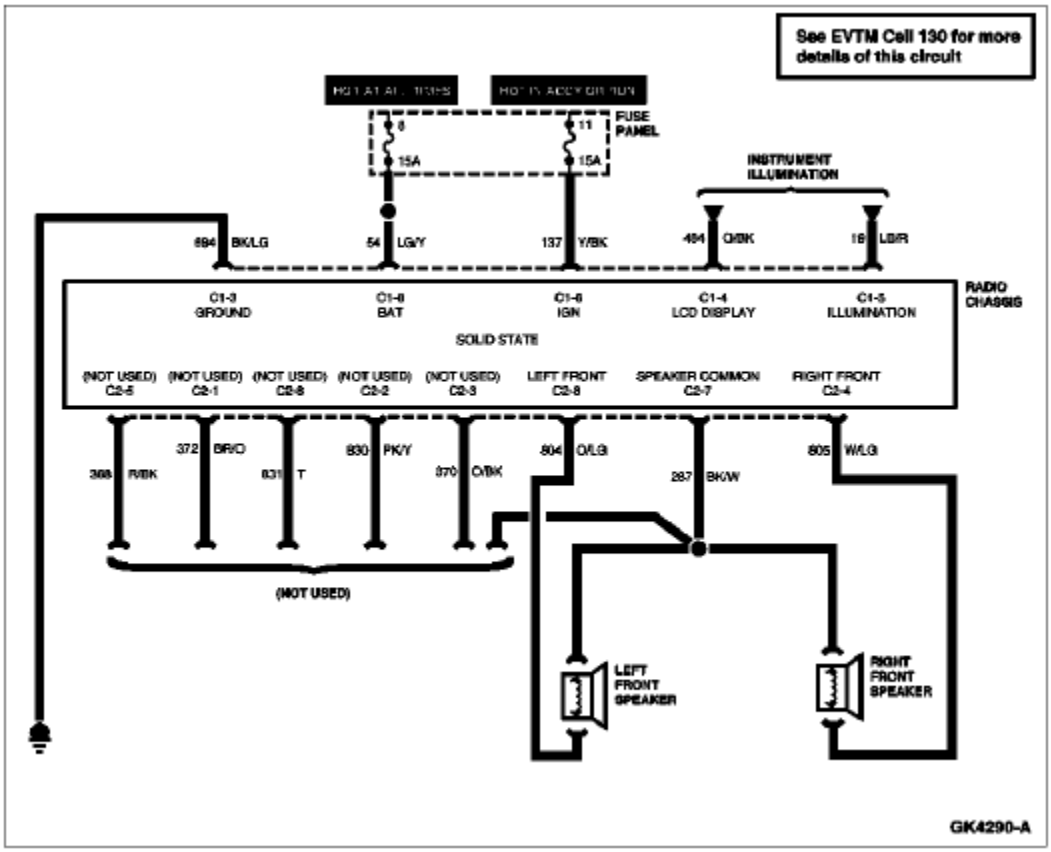
- Check to see that the ignition wires are the suppressor type and that the spark plugs (12405) are the correct resistor type.

Missing or Damaged Noise Suppression Components

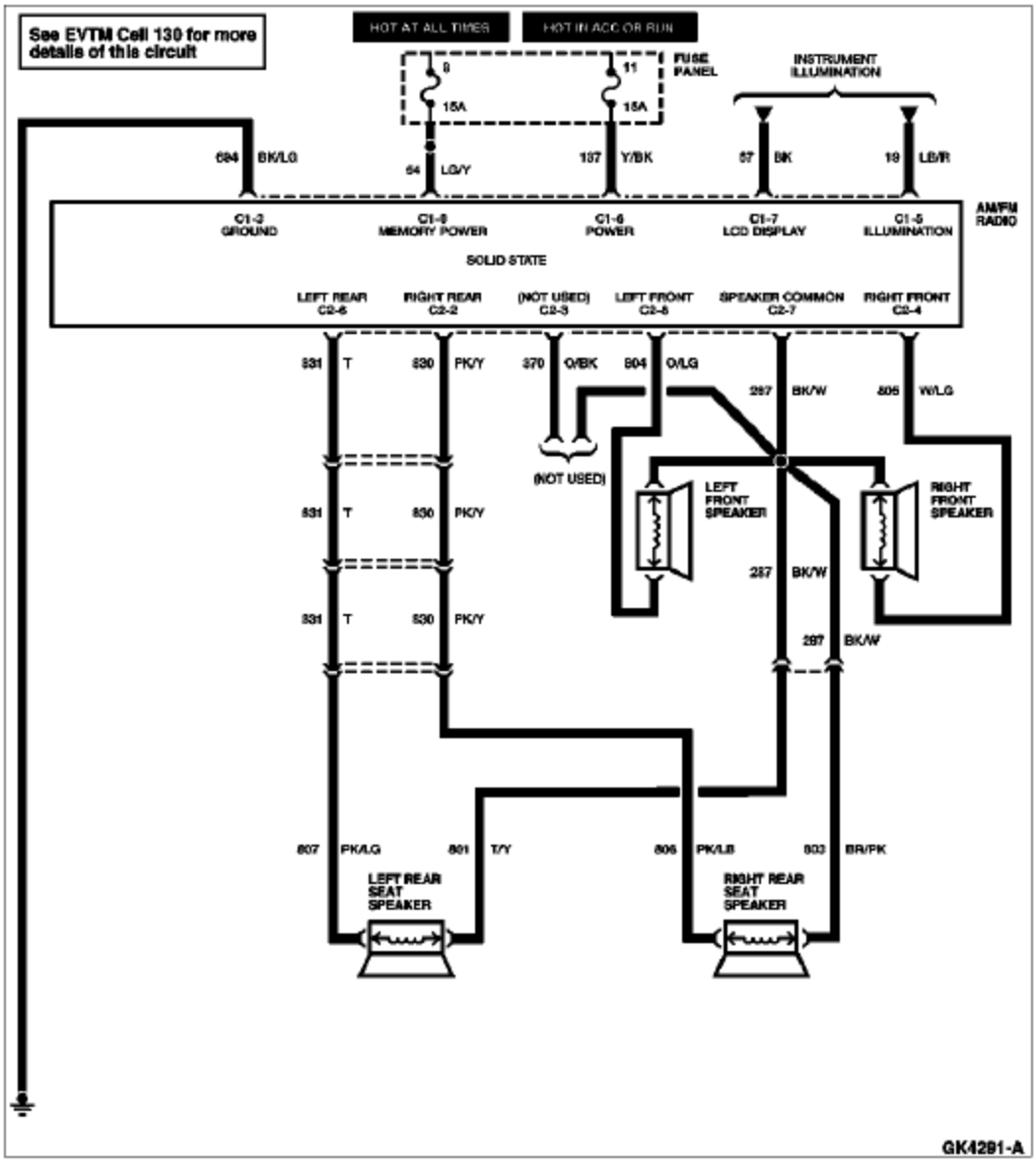
- Noise suppression components may be damaged or missing.
- Check radio frequency interference suppression bond grounding effectiveness by wedging a large file between metal parts to ensure proper ground, such as between the tail pipe and body, or between the fender and frame, while radio chassis is playing and engine is running.
- Listen for a decrease in the objectionable radio noise. If a reduction in radio noise is noted, first try tightening body and exhaust system clamps and brackets. Then, if necessary, install a new radio frequency interference suppression bond (19A095) between the two metal parts to ensure proper ground.

Electrical Schematics

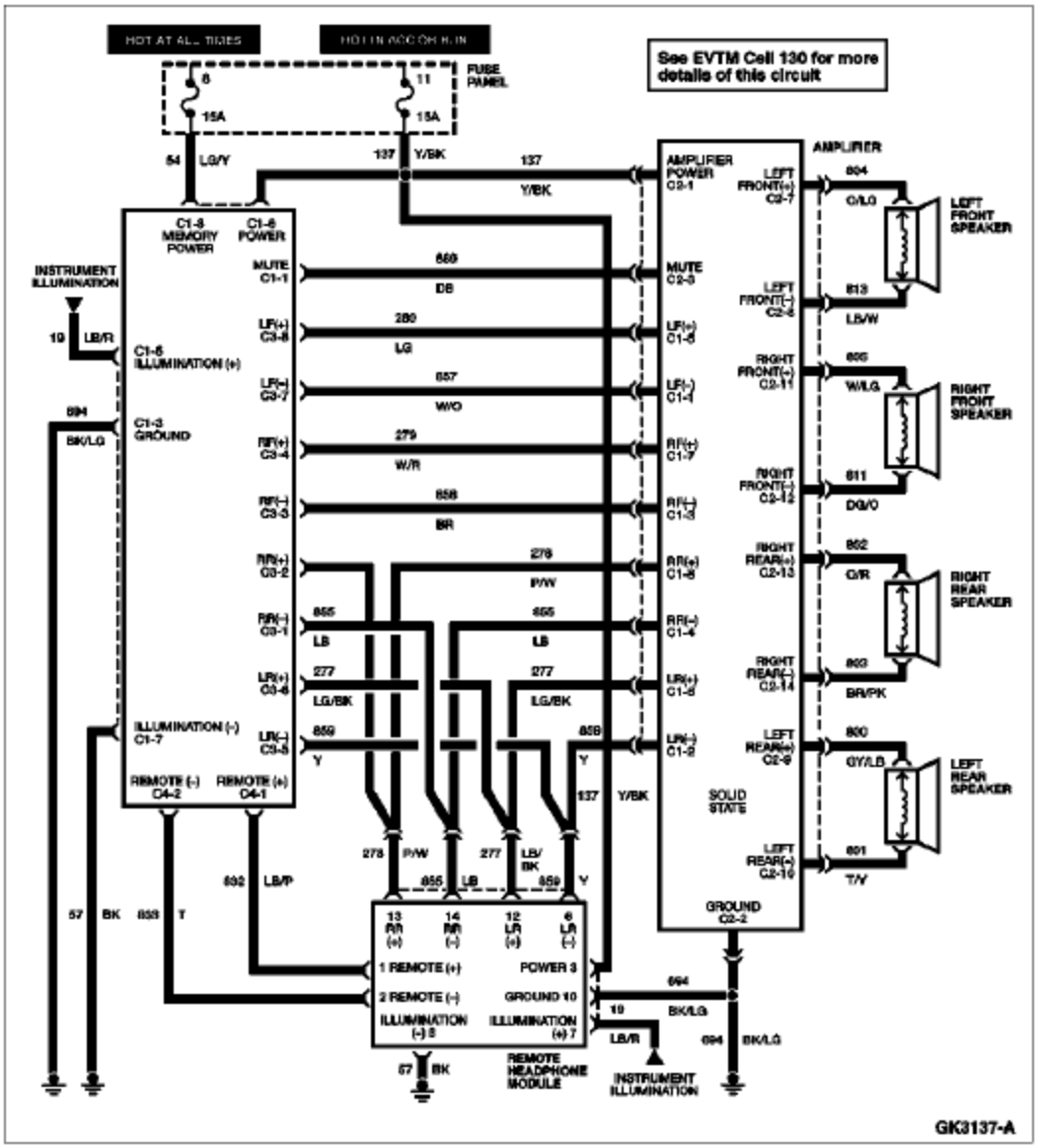
Electronic Stereo Radio Without Remote Headphones, Aerostar

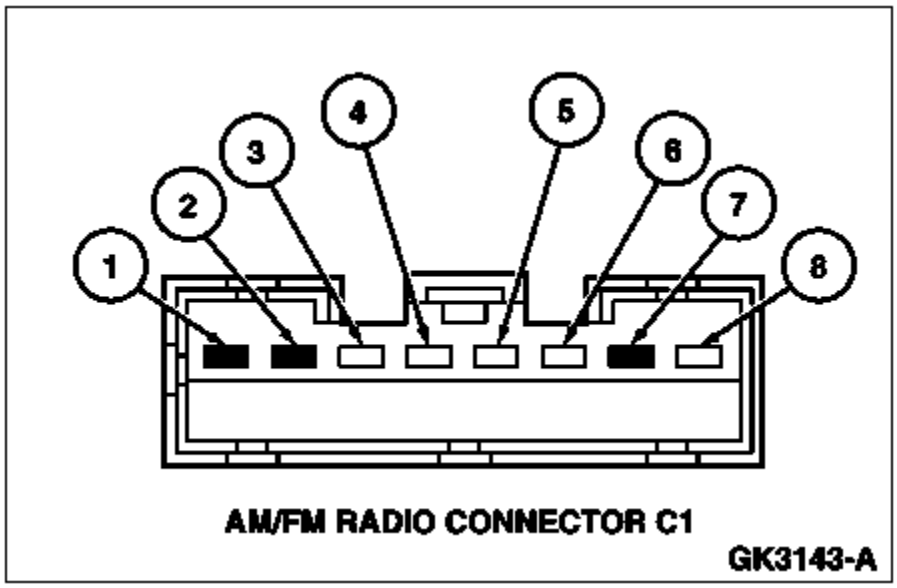


Electronic Stereo Radio Without Remote Headphones, Aerostar

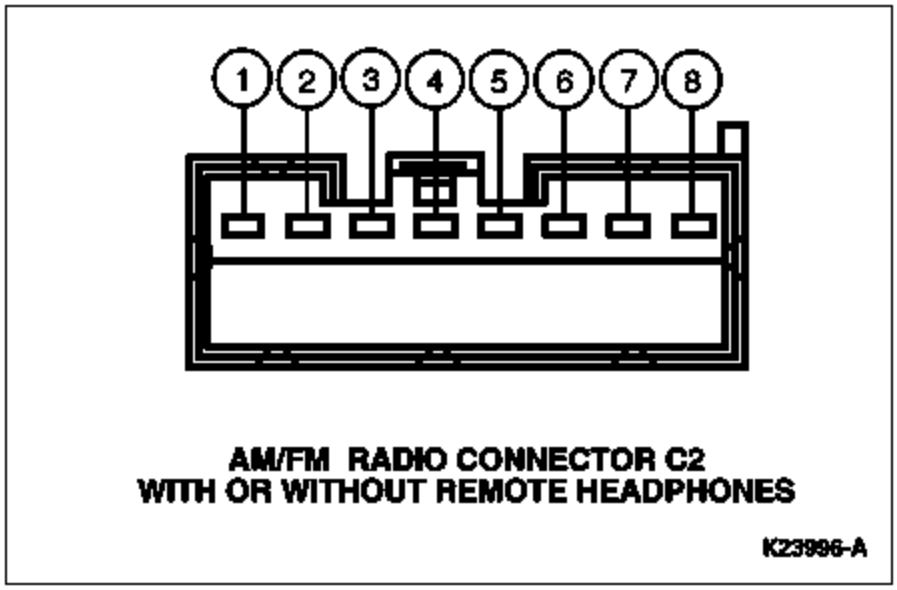


Premium Sound System with Remote Headphones, Aerostar


HOT AT ALL TIMES
HOT IN ACCESSORY
See EVTM Cell 130 for more details of this circuit
FUSE PANEL
6
15A
11
15A
54 LG/Y
137 Y/BK
137 Y/BK
AMPLIFIER POWER C2-1
AMPLIFIER
C1-8 MEMORY POWER
C1-6 POWER
INSTRUMENT ILLUMINATION
19 LB/R
C1-6 ILLUMINATION (+)
C1-3 GROUND
694 BK/LG
ILLUMINATION (-) C1-7
REMOTE (-) C4-2
REMOTE (+) C4-1
MUTE C1-1
LF(+) C3-6
LF(-) C3-7
RF(+) C3-4
RF(-) C3-3
RR(+) C3-2
RR(-) C3-1
LR(+) C3-6
LR(-) C3-5
859 DB
280 LG
857 W/O
279 W/R
858 BR
278 P/W
855 LB
277 LG/BK
859 Y
MUTE C2-3
LF(+) C1-5
LF(-) C1-1
RF(+) C1-7
RF(-) C1-3
RR(+) C1-6
RR(-) C1-4
LR(+) C1-5
LR(-) C1-2
SOLID STATE
GROUND C2-2
LEFT FRONT(+) C2-7
LEFT FRONT(-) C2-8
RIGHT FRONT(+) C2-11
RIGHT FRONT(-) C2-12
RIGHT REAR(+) C2-13
RIGHT REAR(-) C2-14
LEFT REAR(+) C2-9
LEFT REAR(-) C2-10
804 O/LG
LEFT FRONT SPEAKER
813 LB/W
805 W/LG
RIGHT FRONT SPEAKER
811 DG/O
802 O/R
RIGHT REAR SPEAKER
803 BR/PK
800 GY/LB
LEFT REAR SPEAKER
801 T/V
278 P/W
277 LB/BK
855 LB
859 Y
137 Y/BK
802 LB/P
57 BK
859 Y
13 RR (+)
14 RR (-)
12 LR (+)
6 LR (-)
1 REMOTE (+)
2 REMOTE (-)
POWER 3
GROUND 10
ILLUMINATION (-) 8
ILLUMINATION (+) 7
REMOTE HEADPHONE MODULE
694 BK/LG
19 LB/R
INSTRUMENT ILLUMINATION
694 BK/LG
GK3137-A



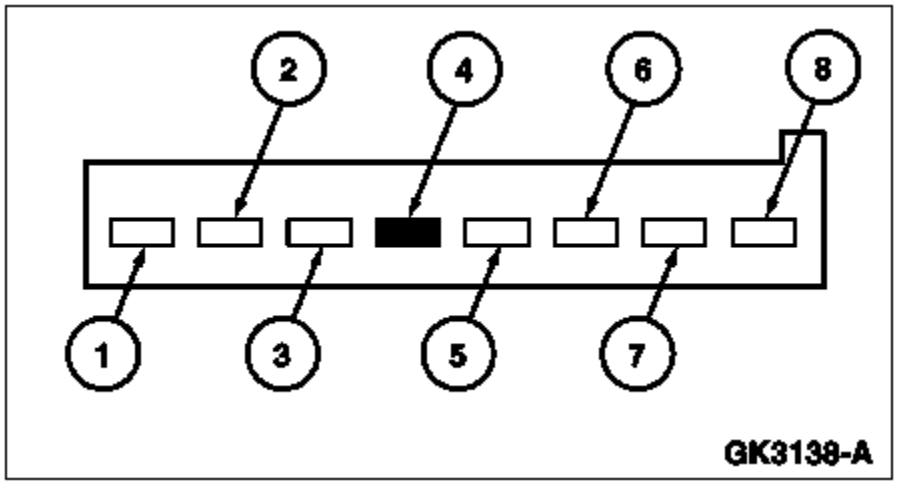
Pin Number	Circuit	Circuit Function
1	—	Not Used
2	—	Not Used
3	694 (BK/LG)	Radio Ground
4	484 (O/BK)	Display Back Lighting (LCD)
5	19 (LB/R)	Radio Graphics Lighting
6	137 (Y/BK)	Radio Power
7	—	Not Used
8	54 (LG/Y)	Radio Memory Power



Pin Number	Circuit	Circuit Function
1 [a]	372 (BR/O)	Seeks for Memory Station
2	830 (PK/Y)	Right Rear Channel
3 [a]	370 (O/BK)	Seeks Stations Down
4	805 (W/LG)	Right Front Speaker
5 [a]	368 (R/BK)	Seeks Stations Up
6	831 (T)	Left Rear Channel
7	287 (BK/W)	Common
8	804 (O/LG)	Left Front Speaker

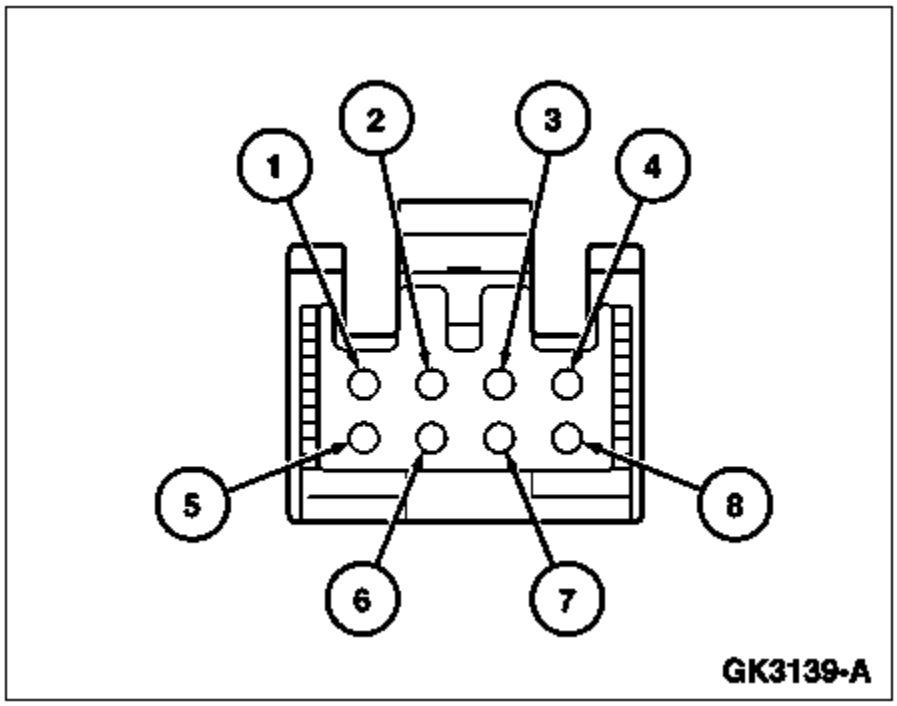
[a] Without remote headphones — a jumper is installed into the harness for these pins.

Premium Sound System C1 (Aerostar)



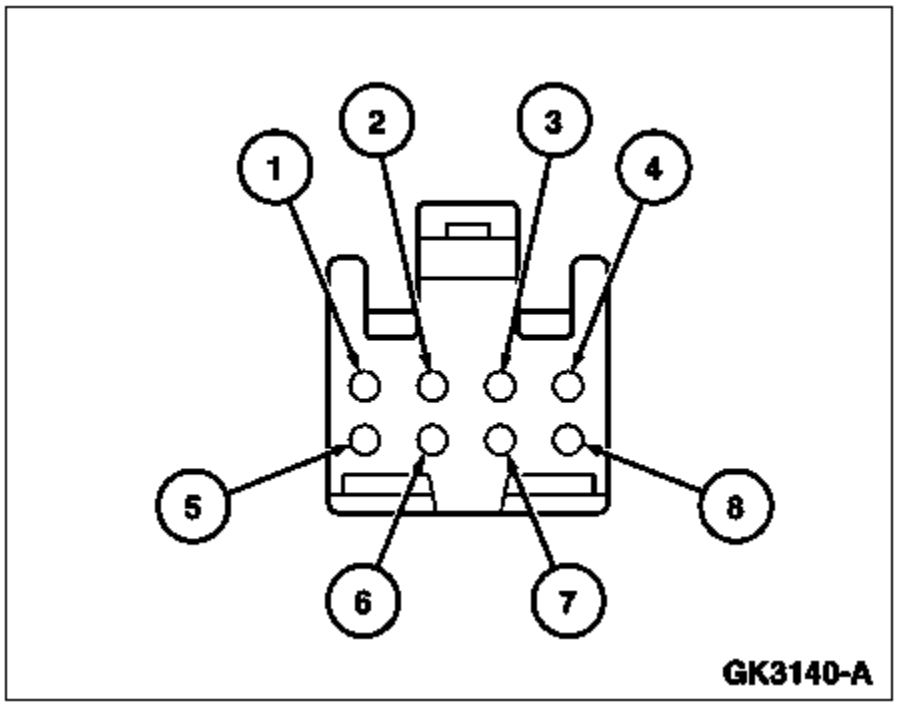
Pin Number	Circuit	Circuit Function
1	689 (DB)	Mute
2	747 (O/LB)	Radio ON
3	694 (BK/LG)	Ground
4	—	NOT USED
5	19 (LB/R)	Illumination (+)
6	137 (Y/BK)	Ignition (Hot In ACC or RUN)
7	57 (BK)	Illumination (-)
8	54 (LG/Y)	Battery B+

Premium Sound System C3 (Aerostar)



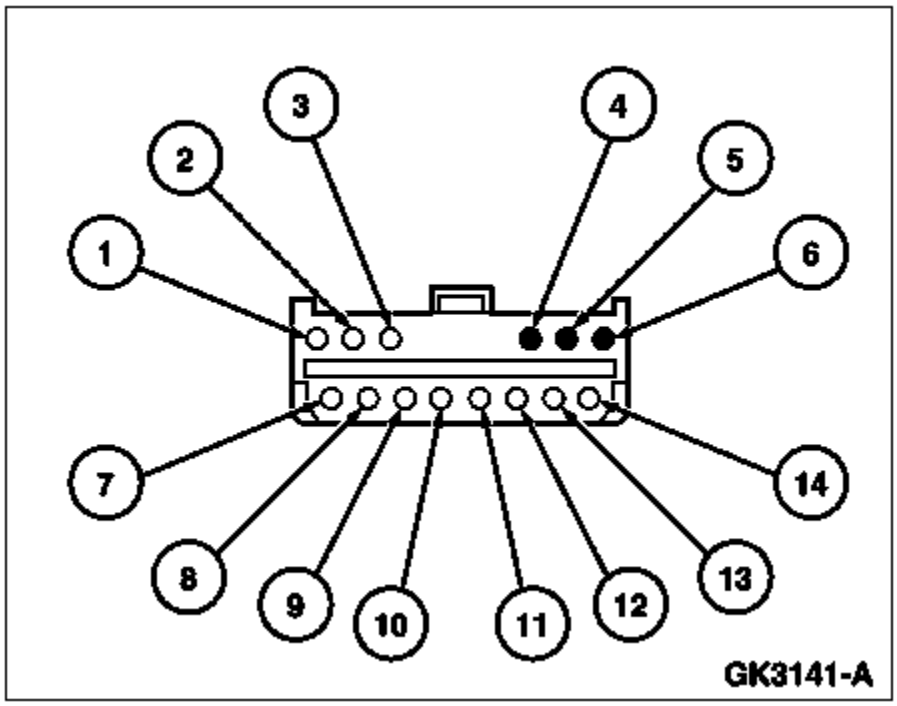
Pin Number	Circuit	Circuit Function
1	855 (LB)	Right Rear Speaker (-) Output
2	278 (P/W)	Right Rear Speaker (+) Output
3	858 (BR)	Right Front Speaker (-) Output
4	279 (W/R)	Right Front Speaker (+) Output
5	859 (Y)	Left Rear Speaker (-) Output
6	277 (LB/BK)	Left Rear Speaker (+) Output
7	857 (W/O)	Left Front Speaker (-) Output
8	280 (LG)	Left Front Speaker (+) Output

Premium Amplifier C1 (Aerostar)



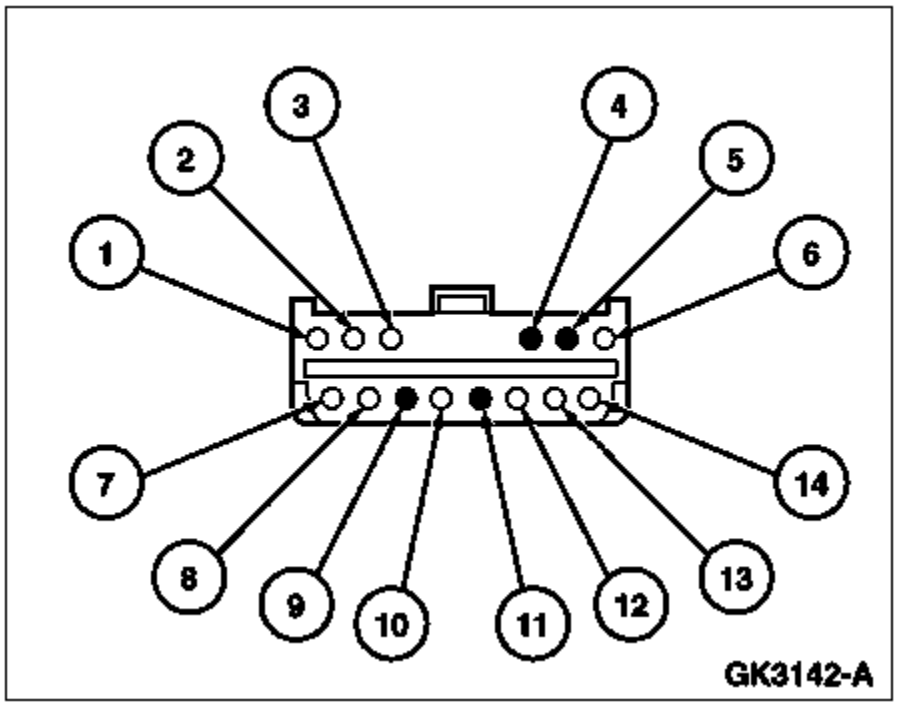
Pin Number	Circuit	Circuit Function
1	857 (W/O)	Left Front Speaker (-) Input
2	859 (Y)	Left Rear Speaker (-) Input
3	858 (BR)	Right Front Speaker (-) Input
4	855 (LB)	Right Rear Speaker (-) Input
5	280 (LG)	Left Front Speaker (+) Input
6	277 (LB/BK)	Left Rear Speaker (+) Input
7	279 (W/R)	Right Front Speaker (+) Input
8	278 (P/W)	Right Rear Speaker (+) Input

Premium Amplifier C2 (Aerostar)

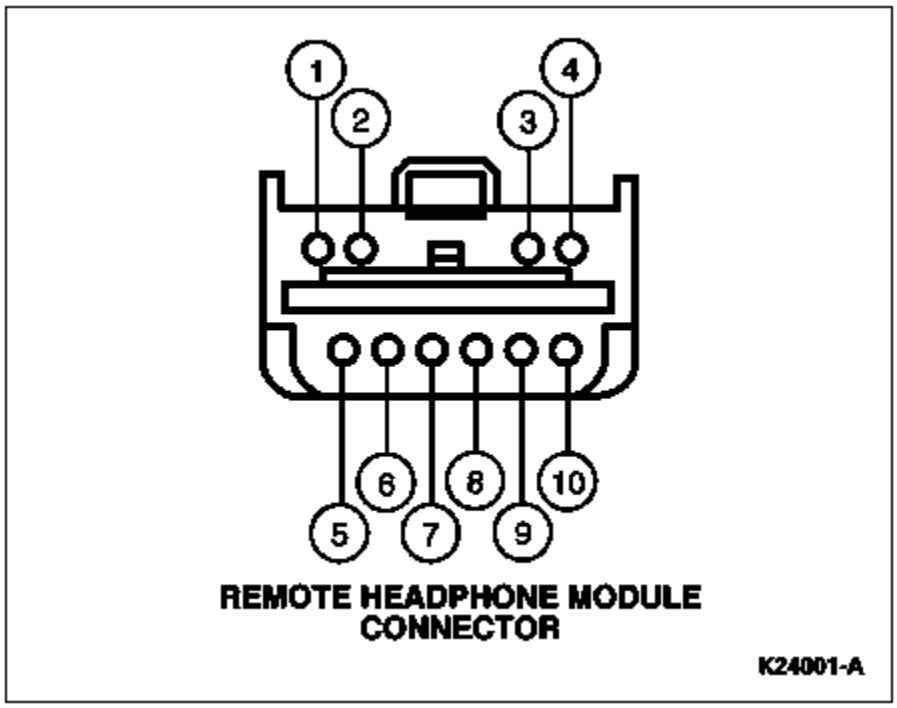


Pin Number	Circuit	Circuit Function
1	137 (Y/BK)	Ignition (Hot In ACCY or RUN)
2	694 (BK/LG)	Ground
3	689 (DB)	Mute
4	—	NOT USED
5	—	NOT USED
6	—	NOT USED
7	804 (O/LG)	Left Front Speaker (+) Output
8	813 (LB/W)	Left Front Speaker (-) Output
9	800 (GY/LB)	Left Rear Speaker (+) Output
10	801 (T/Y)	Left Rear Speaker (-) Output
11	805 (W/LG)	Right Front Speaker (+) Output
12	811 (DG/O)	Right Front Speaker (-) Output
13	802 (O/R)	Right Rear Speaker Output (+) Output
14	803 (BR/PK)	Right Rear Speaker Output (-) Output

Premium Sound Remote Headphone Module (Aerostar)

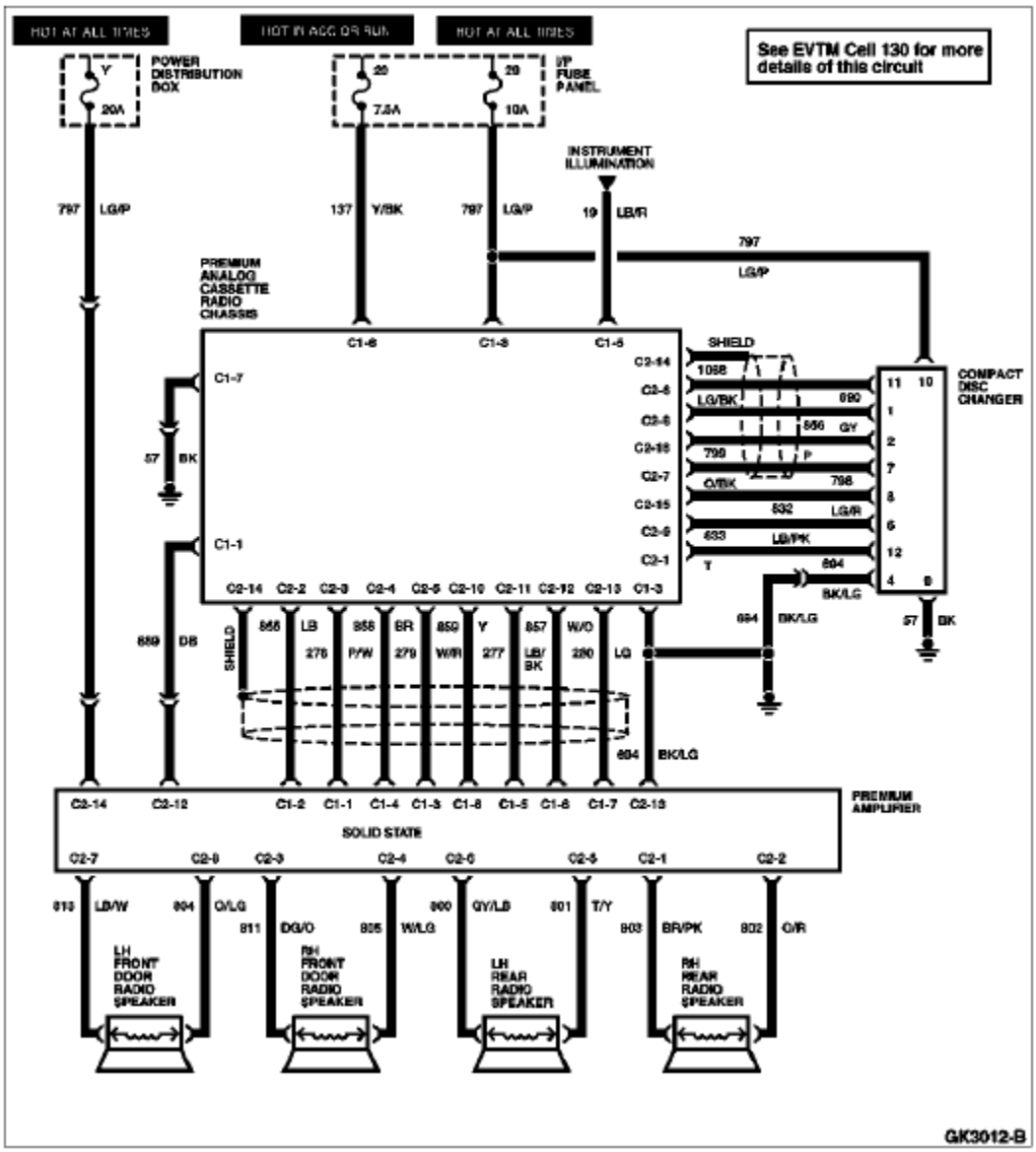


Pin Number	Circuit	Circuit Function
1	832 (LB/P)	Remote (+)
2	833 (T)	Remote (-)
3	137 (Y/BK)	Ignition (Hot In ACC or RUN)
4	—	NOT USED
5	—	NOT USED
6	859 (Y)	Left Rear Speaker (-) Input
7	19 (LB/R)	Illumination (+)
8	57 (BK)	Illumination (-)
9	—	NOT USED
10	694 (BK/LG)	Ground
11	—	NOT USED
12	277 (LB/BK)	Left Rear Speaker (+) Input
13	278 (P/W)	Right Rear Speaker (+) Input
14	855 (LB)	Right Rear Speaker (-) Input

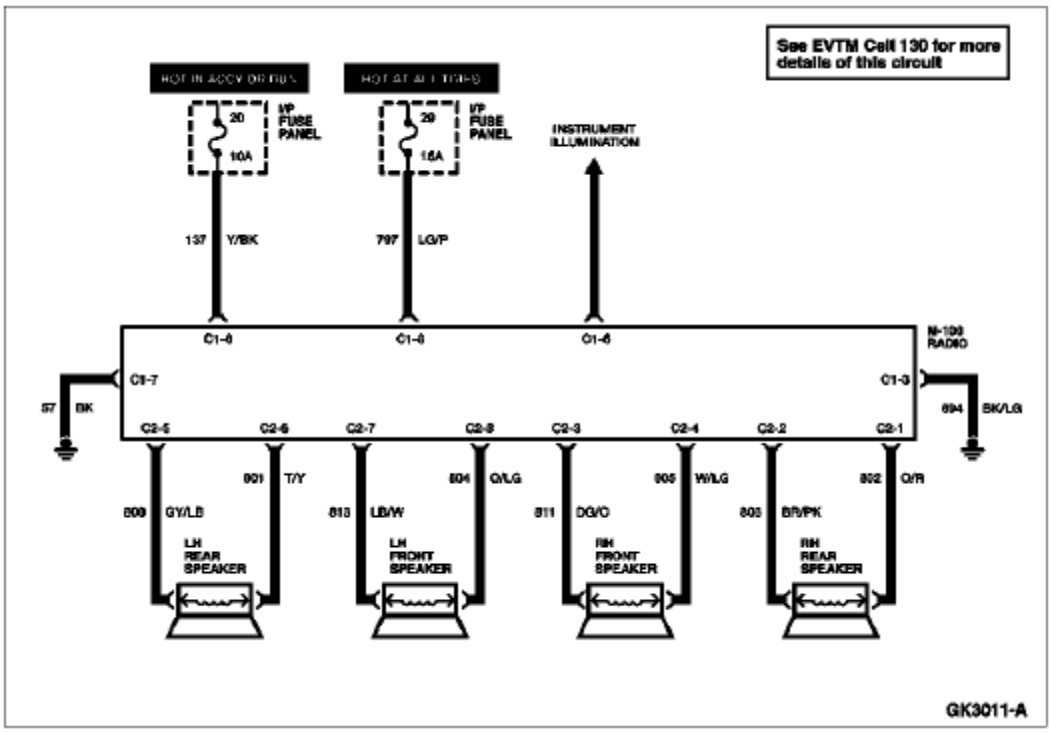


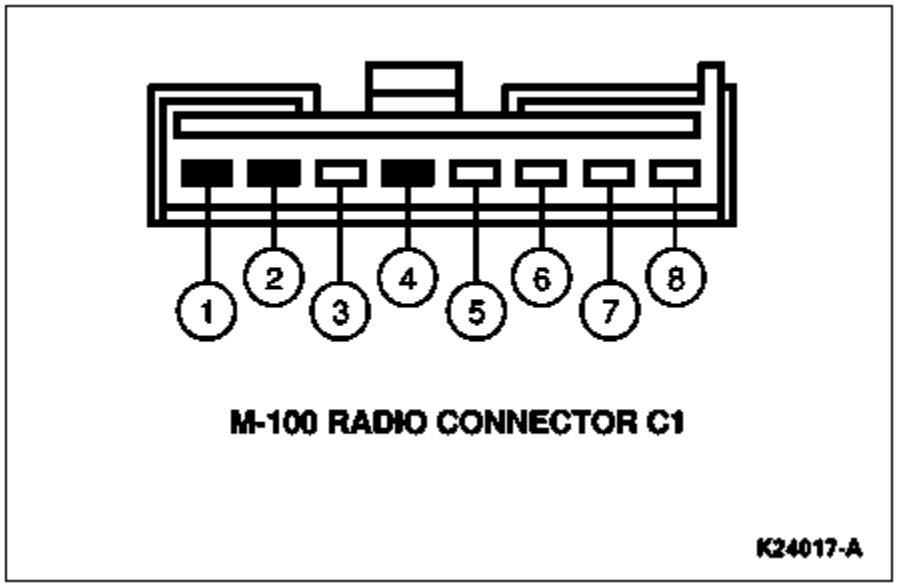
Pin Number	Circuit	Circuit Function
1	368 (R/BK)	Radio "SEEK" Up Stations
2	372 (BR/O)	Radio Memory Seek
3	57 (BK)	Ground
4	19 (LB/R)	Illumination Feed
5	370 (O/BK)	Radio "SEEK" Down Stations
6	830 (PK/Y)	Fader Right Channel Feed
7	806 (PK/LB)	Speaker Feed Rear (Right Channel)
8	807 (PK/LG)	Speaker Feed Rear (Left Channel)
9	831 (T)	Fader Left Channel Feed
10	287 (BK/W)	Speaker Voice Coil Return

Premium Stereo Cassette Radio with Premium Radio Amplifier, (P-100) Ranger



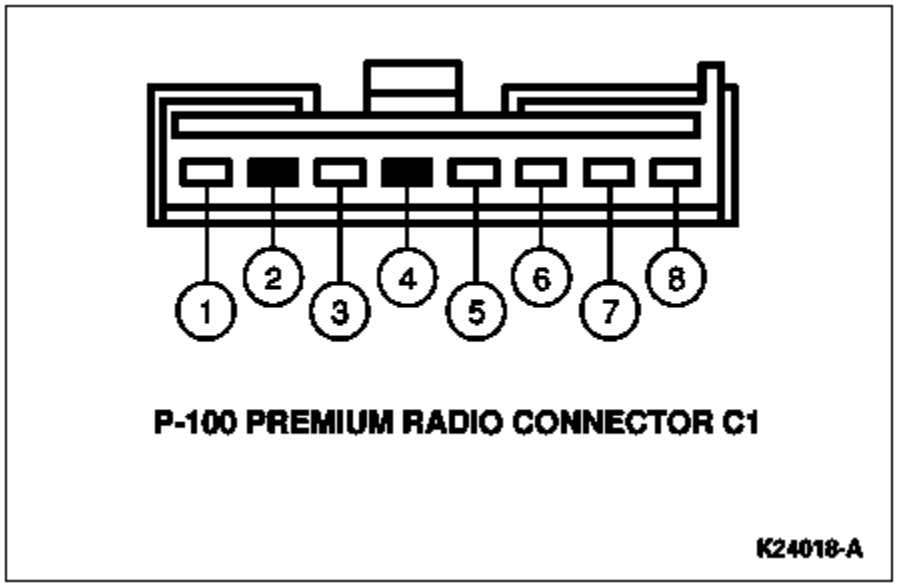
AM/FM Radio System with or Without Cassette, Ranger M-100



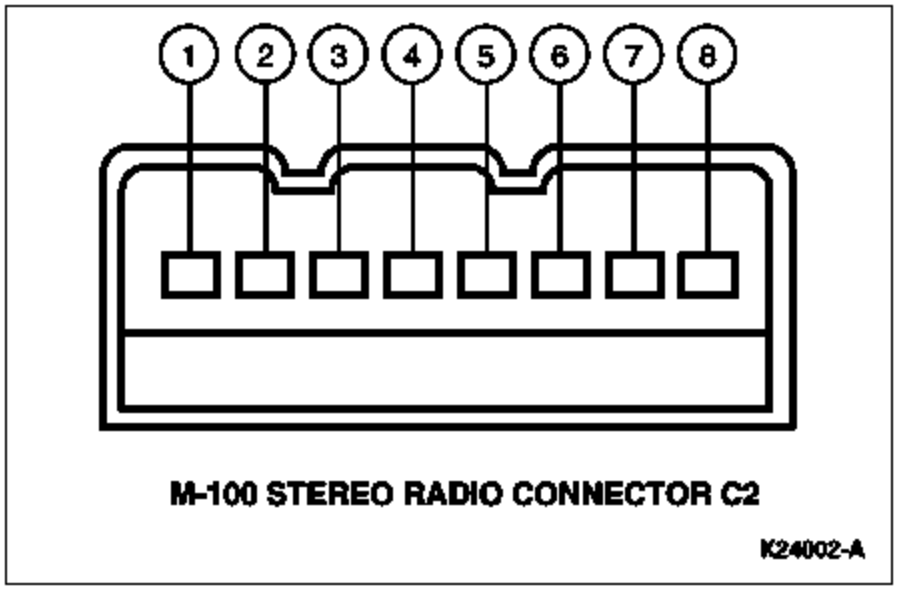


Pin Number	Circuit	Circuit Function
1	—	Not Used
2	—	Not Used
3	694 (BK/LG)	Radio/Amplifier/CD Changer Power Return
4	—	Not Used
5	19 (LB/R)	Instrument Illumination

6	137 (Y/BK)	Radio and Antenna Switch Feed
7	57 (BK)	Ground Circuit
8	797 (LG/P)	Battery Feed to Radio

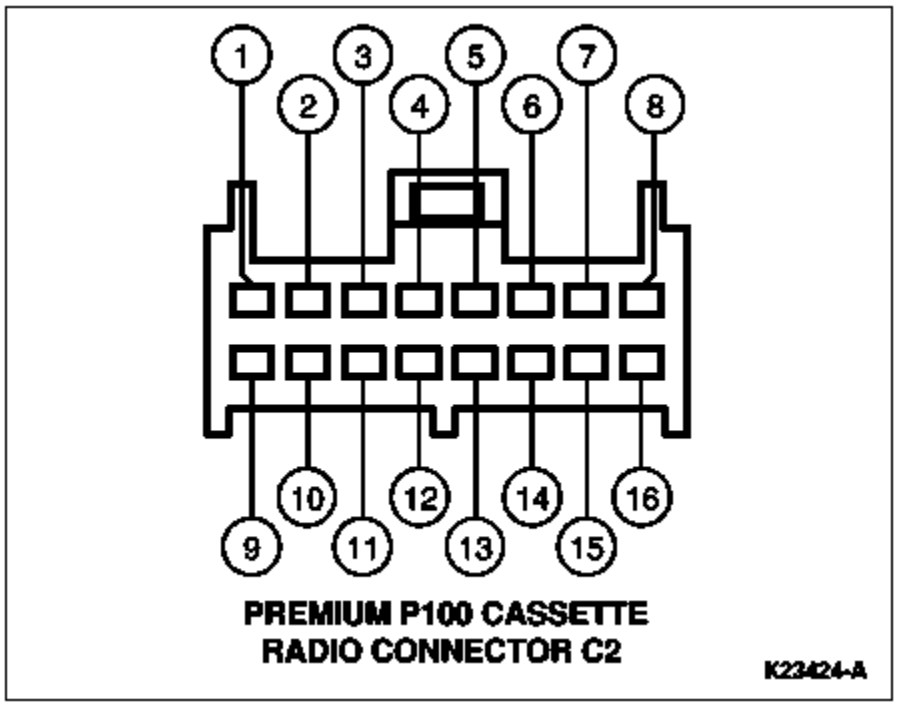


Pin Number	Circuit	Circuit Function
1	689 (DB)	Logic Mute
2	—	Not Used
3	694 (BK/LG)	Radio/Amplifier/CD Changer Power Return
4	—	Not Used
5	19 (LB/R)	Instrument Illumination
6	137 (Y/BK)	Radio and Antenna Switch Feed
7	57 (BK)	Ground Circuit
8	797 (LG/P)	Battery Feed to Radio



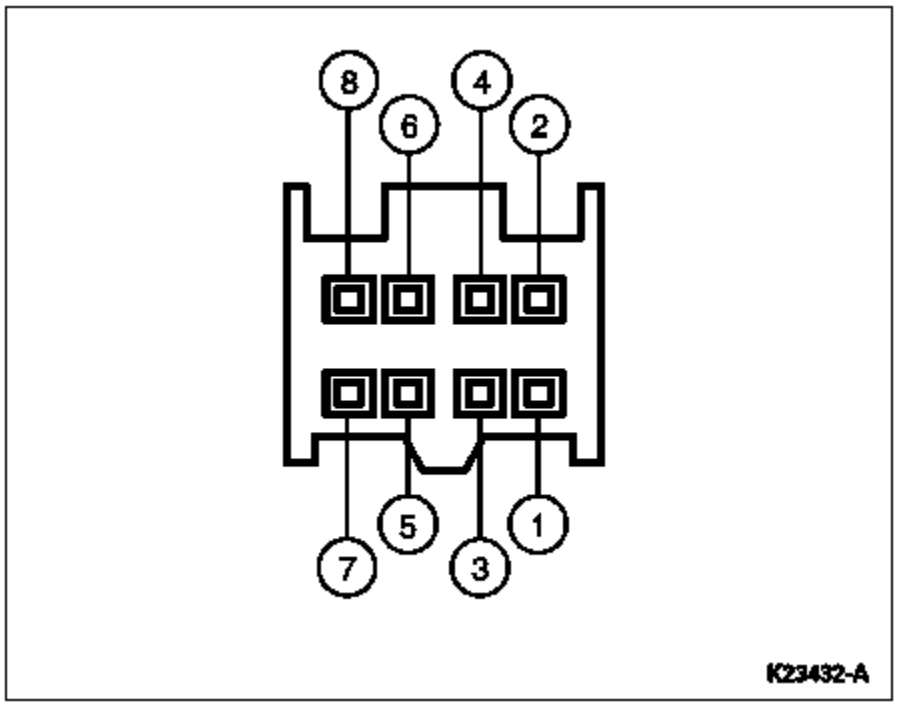
Pin Number	Circuit	Circuit Function
1	802 (O/R)	Rear Speaker (-) (RH)
2	803 (BR/PK)	Rear Speaker (+) (RH)
3	811 (DG/O)	Front Speaker (-) (RH)
4	805 (IN/LG)	Front Speaker (+) (RH)
5	800 (GY/LB)	Rear Speaker (-) (LH)
6	801 (T/Y)	Rear Speaker (+) (LH)
7	813 (LB/W)	Front Speaker (-) (LH)
8	804 (O/LG)	Front Speaker (+) (LH)

Premium (P-100) Cassette Radio Connector C2, Ranger



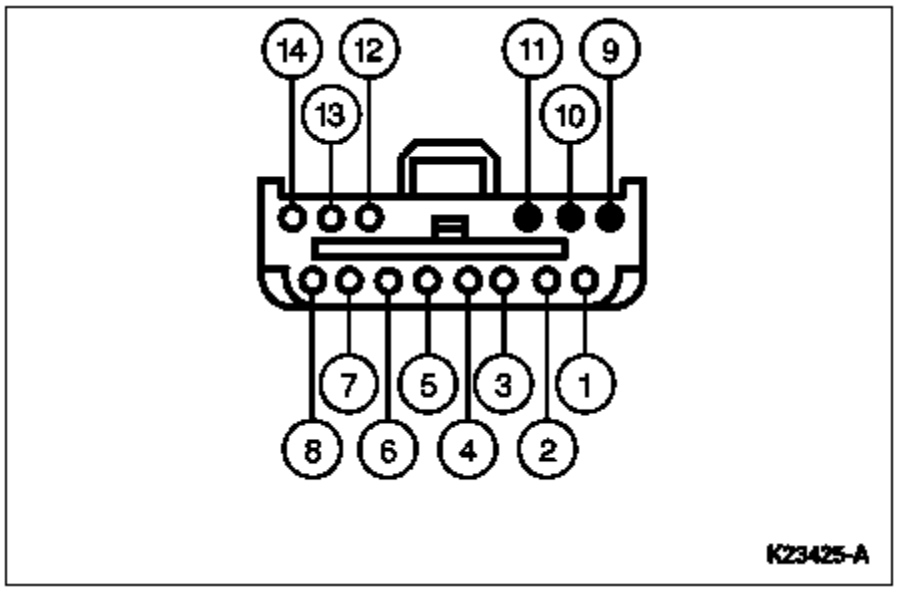
Pin Number	Circuit	Circuit Function
1	833 (T)	ACP B
2	855 (LB)	Rear Signal (-) (RH)
3	278 (P/W)	Rear Signal (+) (RH)
4	858 (BR)	Front Signal (-) (RH)
5	279 (W/R)	Front Signal (+) (RH)
6	1068 (LG/BK)	Audio System On (ASYSON)
7	799 (O/BK)	Audio Signal Out (-) (RH)
8	690 (GY)	Audio Signal Out (+) (RH)
9	832 (LB/PK)	ACP A
10	859 (Y)	Rear Signal (-) (LH)
11	277 (LB/BK)	Rear Signal (+) (LH)
12	857 (W/O)	Front Signal (-) (LH)
13	280 (LG)	Front Signal (+) (LH)
14	Shield	Drain Wire
15	798 (LG/R)	Audio Signal Out (-) (LH)
16	856 (P)	Audio Signal Out (+) (LH)

Premium Radio Amplifier Connector, C1, Ranger



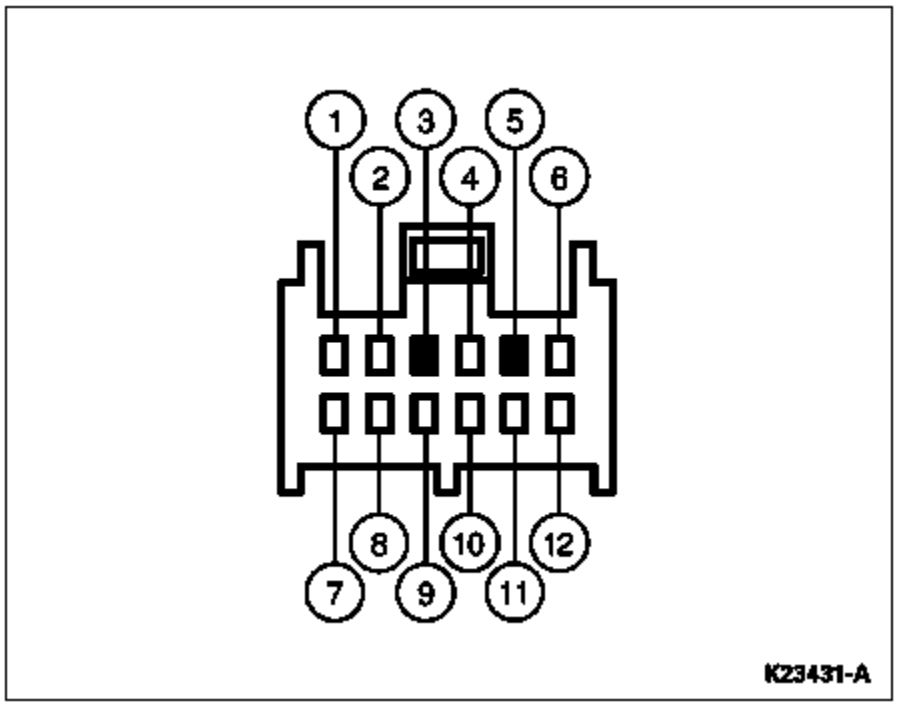
Pin Number	Circuit	Circuit Function
1	278 (P/W)	Rear Signal (+) (RH)
2	855 (LB)	Rear Signal (-) (RH)
3	279 (W/R)	Front Signal (+) (RH)
4	858 (BR)	Front Signal (-) (RH)
5	277 (LB/BK)	Rear Signal (+) (LH)
6	859 (Y)	Rear Signal (-) (LH)
7	280 (LG)	Front Signal (+) (LH)
8	857 (W/O)	Front Signal (-) (LH)

Premium (P-100) Radio Amplifier Connector C2, Ranger



Pin Number	Circuit	Circuit Function
1	803 (BR/PK)	Rear Radio Speaker (-) (RH)
2	802 (O/R)	Rear Radio Speaker (+) (RH)
3	811 (DG/O)	Front Door Radio Speaker (-) (RH)
4	805 (W/LG)	Front Door Radio Speaker (+) (RH)
5	801 (T/Y)	Rear Radio Speaker (-) (LH)
6	800 (GY/LB)	Rear Radio Speaker (+) (LH)
7	813 (LB/W)	Front Door Radio Speaker (-) (LH)
8	804 (O/LG)	Front Door Radio Speaker (+) (LH)
9	—	Not Used
10	—	Not Used
11	—	Not Used
12	689 (DB)	Radio Chassis ON Signal
13	694 (BK/LG)	Ground
14	797 (LG/P)	Power Input

Compact Disc Changer Connector (P-100), Ranger



Pin Number	Circuit	Circuit Function
1	690 (GY)	Compact Disc — Right Channel Signal In
2	856 (P)	Compact Disc — Left Channel Signal In
3	—	Not Used
4	694A (BK/LG)	Radio/Amplifier/Compact Disc Player/Changer Power Return
5	—	Not Used
6	832 (LB/PK)	J1708 Bus/Audio Corporate Protocol A
7	799 (O/BK)	Compact Disc — Right Channel Signal Out
8	798 (LG/R)	Compact Disc — Left Channel Signal Out
9	57 (BK)	Ground Circuit
10	797 (LG/P)	Battery Feed to Stereo
11	1068 (LG/BK)	Audio System On (ASYSON)
12	833 (T)	J1708 Bus/Audio Corporate Protocol B

Inspection and Verification

NOTE: Many customers do not understand the limitations of FM reception. Refer the customer to the Owner Guide for information about the limitations of FM radio performance.

Internal diagnostic examination of the radio chassis (18806) should be left to the authorized radio service center. However, the automotive technician should be able to analyze and isolate radio reception conditions to the proper area or component causing the condition. All radio conditions can be isolated to one of five general areas:

- Antenna system.
- Radio chassis.
- Radio speaker system.
- Radio noise suppression equipment.
- Premium sound system.

The diagnosis charts and tests should be used with the Electrical and Vacuum Troubleshooting Manual and an appropriate radio tester to accurately diagnose and quickly service most radio system concerns.

1. Verify the vehicle owner's original concern by operating the electronic audio system to duplicate the condition.

2. Inspect to determine if one of the following mechanical or electrical concerns apply:

VISUAL INSPECTION CHART

Mechanical	Electrical
• Radio chassis with or without tape player physically damaged, misaligned, any controls inoperative • Digital audio compact disc changer physically damaged, misaligned, any controls inoperative • Antenna and two-piece antenna cable physically damaged, misaligned connections • Radio speakers mounting/speaker cones physically damaged, misaligned • Radio ignition interference capacitor, radio frequency interference suppression bond andradio receiver hood bonding strap misaligned, cleanliness and metal-to-metal contact • Remote headphone unit physically damaged, misaligned	• Open fuses • Open connectors • Corroded connectors • Ignition switch • Open or shorted circuits

3. If the inspection reveals obvious concern(s) that can be readily identified, service as required.

4. If the concern(s) remains after the inspection, determine the symptom(s) and go to the Symptom Chart.

Symptom Charts — ESR, ESC, M-100 AND P-100 Sound System Function

Use Rotunda 73 Digital Multimeter 105-R0051 or equivalent for the following electrical tests.

ESR, ESC, M-100 AND P-100 SOUND SYSTEM FUNCTION

Condition	Possible Source	Action
• Radio Chassis Inoperative — Does Not Operate Properly	• Bad ground circuit. • Blown fuse(s). • Open or shorted power feed circuit(s). • Damaged radio chassis.	• GO to Pinpoint Test A.
• Radio Chassis/Tape Player Inoperative — Does Not Operate Properly	• Fuse. • Circuitry. • Radio chassis. • Tape player. • Ignition switch.	• GO to Pinpoint Test A.
• Tape Player Only Inoperative — Does Not Operate Properly	• Fuse. • Circuitry. • Radio chassis. • Tape player. • Ignition switch.	• GO to Pinpoint Test A.
• Radio Chassis Display Blank — Radio Chassis Operates	• Bad ground circuit. • Blown fuse(s). • Open or shorted power feed circuit(s). • Damaged radio chassis.	• GO to Pinpoint Test B.
• Radio Chassis/Tape Player Display Blank — Radio Chassis/Tape Player Operates	• Fuse. • Circuitry. • Radio chassis. • Tape player. • Ignition switch.	• GO to Pinpoint Test B.
• Digital Audio Compact Disc (CD) Changer Only Inoperative— Does Not Operate Properly	• Fuse. • Circuitry. • Radio chassis. • Compact disc changer. • Ignition switch.	• GO to Pinpoint Test C.
• Radio Chassis/Digital Audio Compact Disc (CD) Changer Inoperative — Does Not Operate Properly	• Fuse. • Circuitry. • Radio chassis. • Compact disc changer. • Ignition switch.	• GO to Pinpoint Test C.
• Radio Chassis/Digital Audio Compact Disc (CD) Changer Display Blank — Does Not Operate Properly	• Fuse. • Circuitry. • Radio chassis. • Compact disc changer. • Ignition switch.	• GO to Pinpoint Test D.
• Digital Audio Compact Disc (CD)	• Fuse.	• GO to

Changer Display Blank — Does Not Operate Properly	• Circuitry. • Radio chassis. • Compact disc changer. • Ignition switch.	Pinpoint Test D .
• Noisy Reception — AM and FM	• Bad antenna connections. • Improper or damaged noise suppression equipment. • Damaged radio chassis.	• GO to Pinpoint Test E .
• Noisy Reception — AM Only	• Bad connections at battery, antenna leads, speaker leads or radio receiver. • Worn or damaged lead-in cable male pins. • Worn or damaged female receptacle or incorrect receptacle to insulator position. • Damaged radio chassis. • Speakers. • Check suppression equipment.	• GO to Pinpoint Test F .
• Noisy Reception — FM Only	• Antenna mount. • Loose, worn or damaged radio lead-in cable or antenna. • Bad connections at battery, antenna leads, speaker leads or radio receiver. • Damaged radio chassis. • Speakers. • Check suppression equipment.	• GO to Pinpoint Test G .
• One or More Speakers Distorted — Not All Speakers	• Speaker(s) bad. • Wiring to speaker(s) open or shorting. • Damaged radio chassis.	• GO to Pinpoint Test H .
• All Speakers Distorted	• Speaker(s) bad. • Wiring to speaker(s) open or shorting. • Damaged radio chassis. • Bad audio cable. • Bad amplifier.	• GO to Pinpoint Test J .
• No Sound from One or More Speakers — Not All Speakers	• Speaker(s) bad. • Wiring to speaker(s) open or shorting. • Damaged radio chassis. • Bad antenna system. • Bad amplifier.	• GO to Pinpoint Test K .
• No Sound from All Speakers	• Speaker(s) bad. • Wiring to speaker(s) open to shorting. • Damaged radio chassis. • Bad audio cable. • Bad amplifier.	• GO to Pinpoint Test L .

• Poor Sound Quality from One or More Speakers — Not All Speakers	• Speaker(s) bad. • Wiring to speaker(s) open or shorting. • Bad audio cable. • Bad amplifier.	• GO to Pinpoint Test M .
• Poor Sound Quality from All Speakers	• Speaker(s) bad. • Wiring to speaker(s) open or shorting. • Bad amplifier.	• GO to Pinpoint Test N .

Pinpoint Tests

Sound System Function

PINPOINT TEST A: RADIO CHASSIS INOPERATIVE — DOES NOT OPERATE PROPERLY

A1 CHECK OPERATION OF RADIO CHASSIS

- Turn ignition switch to RUN or ACC.
- Press radio POWER on.

Is radio chassis display illuminated?

Yes	No
GO to **A3**.	GO to **A2**.

A2 CHECK QUALITY SOUND FROM RADIO SPEAKERS

- Verify that quality sound is coming from radio speakers.

Is quality sound coming from radio speakers?

Yes	No
GO to Pinpoint Test B.	GO to **A28**.

A3 DISPLAY TEST — AM BAND INDICATOR

- Press AM/FM button for AM band.
- Press TUNE, SCAN or SCAN/TUNE button to station 1000 AM.

Is display correct and AM indicator lit?

Yes	No
GO to **A4**.	REMOVE radio chassis for service.

A4 DISPLAY TEST — FM1/FM2 BAND INDICATORS

- Press AM/FM button FM1 band.
- Press TUNE, SCAN or SCAN/TUNE button to station 88.9 FM.
- Verify for FM2 band.

Is display correct and FM1 and FM2 indicators lighting respectively?

Yes	No
GO to **A5** .	REMOVE radio chassis for service.

A5 DISPLAY TEST — ST STEREO INDICATOR

- Press TUNE, SCAN, SEEK or SCAN/TUNE buttons to a local FM stereo station.

Is display correct and ST indicator lit?

Yes	No
GO to **A6** .	REMOVE radio chassis for service.

A6 SEEK — HIGHER FREQUENCY STATION

NOTE: If display reads 1610 AM or 107.9 FM, display will not increase. The SEEK (>) button should be pressed until display reads less than 1610 AM or 107.9 FM.

- Press SEEK (>) and verify that number on display increases.

Is SEEK (>) operating properly?

Yes	No
GO to **A7** .	REMOVE radio chassis for service.

A7 SEEK — LOWER FREQUENCY STATION

NOTE: If display reads 530 AM or 88.1 FM, display will not decrease. The SEEK (<) button should be pressed until display reads greater than 530 AM or 88.1 FM.

- Press SEEK (<) and verify that number on display decreases.

Is SEEK (<) operating properly?

Yes	No
GO to **A8** .	REMOVE radio chassis for service.

A8 STATION RECALL MEMORY TEST

- Press SCAN, TUNE, SEEK or SCAN/TUNE buttons to a desired station.
- Press and hold one of the (1 through 6) memory buttons for two seconds until station sound is returned (repeat for all six buttons).
- Do for AM, FM1 and FM2 bands using eighteen stations.
- Turn radio chassis off, then on.
- Press each station recall button and verify memory storage.

Is memory test successful?

Yes	No
GO to **A9** .	REMOVE radio chassis for service.

A9 VOLUME CONTROL TEST

- Press VOLUME (+) and (-) to verify an increase and decrease in volume sound from radio chassis.

Does volume change properly?

Yes	No
GO to **A10** if TUNE button equipped. Otherwise, GO to **A11** for SCAN or SCAN/TUNE.	CHECK radio speakers and connections. REFER to Symptom Chart if diagnosis finds radio speakers inoperative. REPEAT volume test. If volume still inoperative, REMOVE radio chassis for service.

A10 TUNE CONTROL TEST (ESR)

- Press TUNE button (>) or (<) to change the frequency station up or down one increment at a time. Change frequencies quickly by holding the (>) or (<) side of button. Verify for all bands.

Does TUNE operate properly?

Yes	No
GO to **A12** .	REMOVE radio chassis for service.

A11 SCAN MODE TEST (ESC OR P-100)

- Press SCAN or SCAN/TUNE buttons to enter scan mode. (Go to PAC or ESC equipped.)
- Display will blink "SCN".
- Press (>) side of SEEK button to begin forward scan mode up to next radio station for a five second sampling. Verify several stations.
- Press (<) side of SEEK button to begin reverse scan mode. Verify several stations.
- Stop scan mode by pressing SCAN/TUNE; or repress the side of SEEK button presently matching

direction of scanning.

NOTE: Change stations quickly by pressing and holding SEEK (>) or (<).

- Press SCAN/TUNE button twice to change radio stations up or down one increment of frequency at a time. (Display will read "TUNE"), then within five seconds press (>) or (<) side of SEEK button.
- (ESC) Scan mode will begin to scan up to next radio selection for a five second sampling.
- Stop scan mode by pressing SCAN button.

(ESC/PAC) Does scan mode operate properly?

Yes	No
GO to **A12** .	REMOVE radio chassis for service.

A12 TUNE ANTENNA TEST (OPTIONAL)

- Tune radio on AM band outside of building.
- Press SEEK to observe all listenable stations on band. Count number that can be tuned.
- Compare to a vehicle with known good radio chassis.

Are normal number of stations received?

Yes	No
GO to **A13** .	If an absolute number of stations cannot be tuned. REMOVE radio chassis for service.

A13 AUTO PRESET — AUTOMATIC MEMORY STORE (P-100)

- Press AUTO PRESET button for three seconds.
- Verify that radio chassis automatically presets six strong stations sequentially on memory recall buttons (1 through 6).
- Turn off radio chassis, then turn back on.
- Verify the same six stations are in memory for buttons (1 through 6).

Does AUTO PRESET operate properly?

Yes	No
GO to **A14** .	REMOVE radio chassis for service.

A14 TONE CONTROL TEST (RANGER)

- Bass: Press Bass rocker switch to increase low frequency sounds. Press bottom of rocker switch to decrease low frequency sounds.
- Treble: Press Treble rocker switch to increase high frequency sounds. Press bottom of rocker switch to decrease high frequency sounds.

Do Bass and Treble operate properly?

Yes	No
GO to **A15** .	CHECK connections on radio chassis speakers and amplifier. REFER to Symptom Chart if diagnosis finds radio speakers inoperative. If radio speakers OK, REMOVE radio chassis for service.

A15 BALANCE CONTROL TEST (RANGER)

- BALANCE: Press BAL rocker switch top to increase sound level from right radio speakers. Press rocker switch bottom to increase sound level from left radio speakers.

Does balance operate properly?

Yes	No
GO to **A16** .	CHECK connections on radio chassis speakers and amplifier. REFER to Symptom Chart if diagnosis finds radio speakers inoperative. If radio speakers OK, REMOVE radio chassis for service.

A16 FADER CONTROL TEST (RANGER)

- FADER: Press FADE rocker switch bottom to increase sound level from rear radio speakers. Press rocker switch top to increase sound level from front radio speakers.

Does FADE operate properly?

Yes	No
GO to **A17** .	CHECK connections on radio chassis speakers and amplifier. REFER to Symptom Chart if diagnosis finds radio speakers inoperative. If radio speakers OK, REMOVE radio chassis for service.

A17 TAPE PLAYER — LOADING TEST (ESC OR P-100)

NOTE: If tape is at the end, playing will start on reverse side of tape.

- With radio chassis POWER on and ignition switch in RUN or ACC, insert known good cassette into tape player opening (with open edge of tape to the right). Verify automatic powerloading (tape player draws tape in and begins playing tape).
- Display will indicate arrows for tape side one or two.

Does loading of tape and display operate properly?

Yes	No
GO to **A18** if premium system. Otherwise, GO to **A22**.	REMOVE radio chassis with tape player for service.

A18 TAPE PLAYER — SEEK TEST (P-100)

- With tape playing, press SEEK (>) to go to the beginning of next tape selection. Press SEEK (<) to tune tape back to beginning of previous tape selection.

Does SEEK operate properly?

Yes	No
GO to **A19**.	REMOVE radio chassis with tape player for service.

A19 TAPE PLAYER — SCAN MODE TEST (P-100)

- Press SCAN button.
- Press SEEK (>) to begin forward tape scan for a five second sampling of each selection.
- Press SEEK (<) to begin reverse tape scan for a five second sampling of previous selection.
- Stop scan mode by pressing the side of SEEK button matching the direction tape is currently scanning.

Does scan mode operate properly?

Yes	No
GO to **A20**.	REMOVE radio chassis with tape player for service.

A20 TAPE PLAYER — REW/FF TEST (P-100)

- Press REW button to rewind tape. The radio will automatically begin playing until rewind is manually stopped by pressing TAPE button or tape is completely rewound.
- Press FF button to fast-forward tape. Again, radio will begin playing until fast-forward is manually stopped by pressing TAPE button or tape reaches end.

Do REW and FF operate properly?

Yes	No
GO to **A21**.	REMOVE radio chassis with tape player for service.

A21 TAPE PLAYER — REVERSE TEST (ESC)

- Press the REW button to rewind tape playing forward. Return to tape play by pressing right side of button.
- Press the FF button to fast-forward tape playing forward. Return to play by pressing left side of button.
- Press the TAPE buttons to reverse tape to opposite side (track) of tape.

Do buttons operate properly?

Yes	No
GO to **A22** .	REMOVE radio chassis with tape player for service.

A22 TAPE PLAYER — DOLBY TEST (ESC OR P-100)

- (PAC) Press Dolby® Noise Reduction button (Expressed by symbols of two half-circles with round edge facing each other). Verify sound. Press to turn off.
- Eject tape and verify Dolby® for Dynamic Noise Reduction on an FM stereo station. Verify sound.

Does Dolby® operate properly?

Yes	No
GO to **A23** .	REMOVE radio chassis with tape player for service.

A23 TAPE PLAYER — EJECT TEST

- Press EJECT or EJCT button to eject tape from opening. Radio chassis will resume playing if power is on.

Does EJECT operate properly?

Yes	No
GO to **A24** .	REMOVE radio chassis with tape player for service.

A24 CHECK INOPERATIVE OR INTERMITTENT

- Verify if condition is intermittent or inoperative.

Is condition intermittent?

Yes	No
GO to **A27** .	GO to **A25** .

A25 CHECK FUSE

- Turn ignition switch OFF.
- Check fuse 8 (15A) and fuse 11 (15A) in the fuse junction panel (Aerostar).
- Check fuse 20 (7.5A) in fuse junction panel (M-100 or P-100), (Ranger).
- Check fuse 29 (10A) in fuse junction panel (Ranger).

Is fuse open?

Yes	No
REMOVE open fuse(s) and GO to **A26** .	GO to **A27** .

A26 CHECK FOR GROUNDED POWER FEED

- With ignition switch OFF, check fuse 20 (7.5A) or 11 (15A) Circuit 137 (Y/BK) at radio chassis connector for a short to ground.
- Check fuse 29 (10A) Circuit 797 (LG/P) and/or 8 (15A) circuit 54 (LG/Y).

Is power feed grounded?

Yes	No
LOCATE short to ground and SERVICE the circuit. REPLACE fuse(s). RETEST.	REPLACE fuse and GO to **A1** . If fuse still fails, REMOVE radio chassis for service.

A27 CHECK POWER FEED

- Connect voltmeter between radio chassis connector Circuit 137 (Y/BK) and known good ground.
- Turn ignition switch to RUN or ACC.

Does voltmeter indicate 10 volts or more?

Yes	No
GO to **A31** .	GO to **A28** .

A28 CHECK WIRING CONTINUITY — FUSE

- Remove fuse 20 (7.5A) temporarily (Ranger).
- Check continuity between 20 (7.5A) and radio chassis connector Circuit 137 (Y/BK), (Ranger).
- Check continuity between fuse 20 (7.5A) andradio chassis Circuit 797 (LG/P), (Ranger).
- Remove fuse 8 (15A) temporarily (Aerostar).
- Check continuity between fuse 11 (15A) and radio chassis connector Circuit 137 (Y/BK) (Aerostar).
- Check continuity between fuse 8 (15A) and radio chassis Circuit 54 (LG/Y) (Aerostar).

Does continuity exist?

Yes	No
GO to **A29** .	SERVICE wiring as required. GO to **A1** .

A29 CHECK WIRING CONTINUITY — ACCY FUSE

- Check continuity between fuse 20 (7.5A) (Ranger) or 8 (10A) (Aerostar) and ignition switch Circuit 137 (Y/BK).

Does continuity exist?

Yes	No
RECONNECT fuse and GO to **A30** .	SERVICE wiring as required. GO to **A1** .

A30 CHECK IGNITION SWITCH POWER

- Connect voltmeter between ignition switch connector Circuit 137 (Y/BK).
- Turn ignition switch to ON or ACC.

Does voltmeter indicate 10 volts or more?

Yes	No
REMOVE radio chassis for service.	SERVICE ignition switch. REFER to Section 11-05 .

A31 CHECK RADIO SPEAKERS

- With radio chassis operating, check if condition is on all radio speakers.

Is condition present on all radio speakers?

Yes	No
GO to **A32** .	GO to **A33** .

A32 CHECK RADIO ANTENNA

- Check radio antenna, cable connections and wiring. (Refer to Section 15-02 .)

Is antenna system operating properly?

Yes	No
GO to **A33** .	CONNECT, SERVICE OR REPLACE antenna components as required.

A33 CHECK RADIO CHASSIS

- Substitute known good radio speaker to radio chassis .
- Verify if condition is in radio speakers or radio chassis operation.

Is radio chassis operating?

Yes	No
CONNECT, SERVICE OR REPLACE radio speakers and wiring as required. GO to **A1** .	REMOVE radio chassis for service.

PINPOINT TEST B: RADIO CHASSIS DISPLAY BLANK — RADIO CHASSIS OPERATES

B1 CHECK OPERATION OF RADIO CHASSIS

- Turn ignition switch to RUN or ACC.
- Press radio VOLUME button on.

Is radio chassis display lit?

Yes	No
GO to Pinpoint Test A .	GO to **B2** .

B2 CHECK QUALITY SOUND FROM RADIO SPEAKERS

- Verify that quality sound is coming from radio speakers.

Is quality sound coming from radio speakers?

Yes	No
DISCONNECT fuse panel fuses and GO to **B3** .	GO to Pinpoint Test A .

B3 CHECK WIRING CONNECTIONS

- Check wiring connectors and wires for damage, corrosion or open wire at radio chassis connector Circuit 137 (Y/BK) (Aerostar, Ranger), Circuit 797 (LG/P) (Ranger) or Circuit 54 (LG/Y) (Aerostar).

Are wires and connections OK?

Yes	No
RECONNECT fuses and GO to **B4** .	SERVICE harness, connector and wiring as required. GO to **B1** .

B4 CHECK LCD SUPPLY

- Connect voltmeter between radio chassis connector Circuit 137 (Y/BK) and known good ground (Aerostar, Ranger).
- Turn ignition switch to RUN or ACC.
- Measure voltage from Circuit 797 (LG/P) and ground (Ranger).
- Measure voltage from Circuit 54 (LG/Y) and ground (Aerostar).

Does voltmeter indicate 10 volts or more?

Yes	No
REMOVE radio chassis for service. LCD display is internally inoperative.	GO to **B5** .

B5 CHECK FUSE

- Turn ignition switch OFF.
- Check fuse 20 (7.5A) in fuse junction panel (Ranger). Check fuse 29 (10A) (Ranger). Check fuse 8 (15A) and fuse 11 (15A) (Aerostar).

Are fuse(s) OK?

Yes	No
REPAIR circuit(s) in question.	GO to **B6** .

B6 CHECK FOR GROUNDED ILLUMINATION FEED

- Turn radio chassis OFF.
- Check Circuit 137 (Y/BK) for continuity to known good ground (Aerostar, Ranger).
- Check for continuity of Circuit 797 (LG/P) to ground (Ranger).
- Check for continuity of Circuit 54 (LG/Y) (Aerostar).

Does continuity exist?

Yes	No
LOCATE short to ground and SERVICE. REPLACE fuse. GO to **B1** .	REPLACE fuse. Operate. If fuse still opens, REMOVE radio chassis for service.

PINPOINT TEST C: DIGITAL AUDIO COMPACT DISC CHANGER ONLY INOPERATIVE — DOES NOT OPERATE PROPERLY

C1 CHECK OPERATION OF DIGITAL AUDIO COMPACT DISC CHANGER

- Turn ignition switch to RUN or ACC.
- Press radio POWER on.
- Verify radio chassis operates properly. (Refer to Pinpoint Test A .)
- Handling test disc by its edge (label-side up), insert into digital audio compact disc changer. Verify powerloading.

Is digital audio compact disc changer display lit?

Yes	No
GO to **C3** if equipped with M100 CDR (Ranger). Otherwise, GO to **C7** .	GO to **C2** .

C2 CHECK QUALITY SOUND FROM RADIO SPEAKERS

- Verify that quality sound is coming from radio speakers.

Is quality sound coming from radio speakers?

Yes	No
GO to Pinpoint Test D .	GO to **C15** .

C3 TUNE BUTTON (CD MODE) (RANGER)

- Pushing the Tune > rocker increases the CD playback speed by a factor of 5. The audio is slightly muted, but still audible, and the display shows the time into the current track in minutes and seconds. If the TUNE > button is held more than 3 seconds, the speed will increase to 10 times the normal speed. At the end of a track, the CD will advance to the next track and continue at high speed. When the end of the CD is reached, it stops. In a similar manner, holding down the < TUNE button will back up the CD, until the beginning of the disc is reached.

Does the TUNE button operate properly?

Yes	No
GO to **C4** .	REMOVE the digital audio compact disc changer for service.

C4 SEEK BUTTON (CD MODE) (RANGER)

- Momentary depression of the SEEK > button during CD play mode will cause the CD to advance to the next track and start playing. If the SEEK > button is pushed during the last selection on the CD, the CD will advance to the first track on the disc. If the < SEEK button is pushed during the first 3 seconds of a track, the CD will back up to the beginning of the previous track. If the < SEEK button is

pushed after the first 3 seconds of a track, the CD will back up to the beginning of the current track. If the < SEEK button is pushed during the first 3 seconds of the first track on the disc, the CD will back up to the beginning of the last track, and start playing.

Does the SEEK button operate properly?

Yes	No
GO to **C5** .	REMOVE the digital audio compact disc changer for service.

C5 SCAN BUTTON (CD MODE) (RANGER)

- Pushing the SCAN button causes the CD to advance to the next track, then to play for 8 seconds, then advance to the next track. This continues until the SCAN button is pushed a second time, or the CD button is pushed, or a different tuning function is selected. The radio mutes between tracks while scanning. TR-XX is displayed, where XX is the current track number flashing at a 1 hz rate while the track is being played.

Does the SCAN button operate properly?

Yes	No
GO to **C6** .	REMOVE the digital audio compact disc changer for service.

C6 COMP BUTTON (CD MODE)

- While in the CD mode, depressing the COMP button causes the dynamic range of the CD program material to be reduced by a factor of 2:1. An indication will be made in the VF display that this feature is selected. Pushing the button toggles the compress function on and off. A "C" will show up in the VF display whenever compression is enabled.

Does the COMP button operate properly?

Yes	No
GO to **C7** .	REMOVE the digital audio compact disc changer for service.

C7 DIGITAL AUDIO COMPACT DISC CHANGER — PLAY/STOP TEST

- STOP: Press PLAY/STOP button and verify disc stops playing, stop indicator (J) illuminates and operation returns to radio or tape mode.
- PLAY: Press PLAY/STOP button and verify disc resumes playing at point of stop, play indicator, track number and elapsed time illuminate.

Do play and stop operate properly?

Yes	No

GO to C8.	REMOVE digital audio compact disc changer for service.

C8 DIGITAL AUDIO COMPACT DISC CHANGER — REVERSE/FAST-FORWARD TEST

NOTE: Observe elapsed time to indicate where to stop.

- Press REV/FF (>>) to fast-forward disc to a particular point.
- Press REV/FF (<<) to reverse disc to a particular point.

Do reverse and fast forward operate properly?

Yes	No
GO to C9.	REMOVE digital audio compact disc changer for service.

C9 DIGITAL AUDIO COMPACT DISC CHANGER — SCAN MODE TEST

- Press SCAN button to activate scan mode.
- Verify that disc scans to next selection and plays a five second sample then advances to next until SCAN button is pressed again.
- Verify display indicates track number and elapsed time.

Does scan mode operate properly?

Yes	No
GO to C10.	REMOVE digital audio compact disc changer for service.

C10 DIGITAL AUDIO COMPACT DISC CHANGER — SEEK CONTROL TEST

- Press SEEK (>>) to search for a later selection.
- Press SEEK (<<) to search for a previous selection.
- Verify during play and stop modes.

Does AMS control operate properly?

Yes	No
GO to C11.	REMOVE digital audio compact disc changer for service.

C11 DIGITAL AUDIO COMPACT DISC CHANGER — COMPRESS TEST

- Press COMPRESS to bring the softer and louder passages together.

- Verify display indicates COMP.

Does COMPRESS operate properly?

Yes	No
GO to **C12** .	REMOVE digital audio compact disc changer for service.

C12 DIGITAL AUDIO COMPACT DISC CHANGER — SHUFFLE TEST

- Press SHUFFLE to allow digital audio compact disc changer to randomly select and play music tracks.
- Verify display indicates SHUF.

Does SHUFFLE operate properly?

Yes	No
GO to **C13** .	REMOVE digital audio compact disc changer for service.

C13 DIGITAL AUDIO COMPACT DISC CHANGER — EJECT TEST

- Press EJECT button to eject disc and stop unit.
- Verify display turns off and radio program or tape resumes playing.

Does EJECT operate properly?

Yes	No
GO to **C14** .	REMOVE digital audio compact disc changer for service.

C14 DIGITAL AUDIO COMPACT DISC CHANGER — SPEAKER CONTROL TEST

- With disc inserted, press AUDIO button on radio chassis for bass, treble, balance and fader operating the Volume (+) and (-) for all conditions.
- Perform just volume in both conditions to verify sound loudness.

Do all radio speaker controls operate properly?

Yes	No
REFER to Symptom Chart to determine if an inoperative condition exists. PERFORM tests as directed.	GO to **C15** .

C15 CHECK CONNECTIONS BETWEEN UNITS

- Check continuity of wiring between radio chassis connector and digital audio compact disc player chassis connector.
- Check connectors for damage, corrosion, open or shorted wires.

Are all wiring connections OK?

Yes	No
REMOVE digital audio compact disc changer for service.	REPLACE or SERVICE wiring as required. TEST the system for proper operation.

PINPOINT TEST D: DIGITAL AUDIO COMPACT D ISC (CD) CHANGER DISPLAY BLANK — DOES NOT OPERATE PROPERLY

D1 CHECK OPERATION OF DIGITAL AUDIO COMPACT DISC CHANGER

- Turn ignition switch to RUN or ACC.
- Press radio POWER on.
- Verify radio chassis operates properly. (Refer to Pinpoint Test A .)
- Handling test disc by its edge (label-side up), insert into digital audio compact disc changer. Verify powerloading.

Is digital audio compact disc changer display illuminated?

Yes	No
GO to Pinpoint Test C .	GO to **D2** .

D2 CHECK SOUND QUALITY FROM RADIO SPEAKERS

- Verify that quality sound is coming from radio speakers.

Is quality sound coming from radio speakers?

Yes	No
GO to **D3** .	GO to Pinpoint Test C .

D3 CHECK WIRING CONNECTIONS

- Check wiring connectors and wires for damage, corrosion or open wire at digital audio compact disc changer connector.

Are wires and connections OK?

Yes	No
GO to **D4**.	SERVICE harness, connectors and wiring as required. GO to **D1**.

D4 CHECK MEMORY SUPPLY

- Connect voltmeter between digital audio compact disc changer connector Circuit 797 (LG/PK) (Ranger) or Circuit 54 (LG/Y) (Aerostar) and known good ground.

Does voltmeter indicate 10 volts or more?

Yes	No
REMOVE digital audio compact disc changer for service. LCD display is internally inoperative.	GO to **D5**.

D5 CHECK RADIO CHASSIS DISPLAY

- Verify that radio chassis display is illuminated with power on.

Is radio chassis display illuminated?

Yes	No
GO to **D6**.	GO to Pinpoint Test B.

D6 CHECK WIRING — MEMORY FUSE

- Check continuity between memory fuse and digital audio compact disc changer chassis connector Circuit 797 (LG/PK) (Ranger) or Circuit 54 (LG/Y) (Aerostar).

Does continuity exist?

Yes	No
REMOVE digital audio compact disc changer for service.	SERVICE wiring as required. GO to **D1**.

Sound Quality

PINPOINT TEST E: NOISY RECEPTION — AM AND FM

E1 CHECK ANTENNA CABLE CONNECTIONS

- Verify condition by operating radio chassis while engine is running, with vehicle in or not in motion.
- Check antenna cable connectors including extension cable (if equipped).

Are connections clean and secure?

Yes	No
GO to **E2** .	CLEAN and/or SECURE electric antenna cable connections as required.

E2 CHECK ANTENNA MOUNTING

- Check to make sure antenna is securely mounted to body at ground points.

Are contacts securely mounted, clean and have metal-to-metal contact?

Yes	No
GO to **E3** .	CLEAN and/or SECURE connections as required.

E3 CHECK SUPPRESSION EQUIPMENT

- Check for presence of all required suppression equipment, radio frequency interference suppression bond and radio receiver hood bonding strap (if equipped) for security, cleanliness and metal-to-metal connection.

Are connections OK?

Yes	No
GO to **E4** .	REPLACE missing radio frequency interference suppression bonds, related equipment and/or CLEAN connections as required.

E4 CHECK MOUNTING AND CONNECTING WIRES OF FOLLOWING COMPONENTS

NOTE: The capacitor mounting points are used to complete the electrical circuit and must be mounted securely to clean surfaces.

- Check the mounting and connecting wires of the generator's radio voltage regulator capacitor (if equipped) and radio ignition interference capacitor for secureness, cleanliness and metal-to-metal contact.

Are connections OK?

Yes	No
GO to **E5** .	CLEAN and/or SECURE connections as required.

E5 CHECK OPERATION OF THE FOLLOWING COMPONENTS

- Check the operation of the generator's radio voltage regulator capacitor and radio ignition interference capacitor by replacing with known good components.
- Check generator by disconnecting wiring harness from voltage regulator.
- Verify radio reception.

Is noise eliminated?

Yes	No
SERVICE or REPLACE damaged components as required.	GO to **E6**.

E6 CHECK IGNITION WIRES

- Check ignition wires for proper routing, grounding and secureness of connections.

Are wires OK?

Yes	No
GO to **E7**.	REROUTE or REPLACE ignition wires or SECURE connections as required. REFER to Section 03-07A, Section 03-07B, or Section 03-07C.

E7 CHECK IGNITION SYSTEM

- Check ignition system for proper operation. (Use Rotunda Electronic Vibration Analyzer 014-00344 or equivalent or check for open circuit ignition wires using ohmmeter.) Also, check spark plugs for cracked insulators.

Is ignition system OK?

Yes	No
GO to **E8**.	SERVICE or REPLACE components as required. REFER to Section 03-07A, Section 03-07B, or Section 03-07C.

E8 CHECK CHASSIS MOUNTING POINTS

- Check all radio chassis mounting points for secureness, cleanliness and metal-to-metal contact.

Are mounting points OK?

Yes	No
GO to **E9**.	CLEAN and/or SECURE as required.

E9 SUBSTITUTE RADIO

- Substitute known good radio chassis.
- Verify operation of radio chassis.

Is noise eliminated?

Yes	No
Have radio chassis serviced at an authorized Service Center.	GO to **E10** .

E10 CHECK AMPLIFIER

- Substitute a known good radio amplifier (P-100 system only).
- Verify operation of radio chassis.

Is noise eliminated?

Yes	No
Have radio amplifier serviced at an authorized Service Center.	GO to **E11** .

E11 REPOSITION THE FOLLOWING COMPONENTS

- Check if noise can be eliminated by repositioning radio speaker or radio power feed wires away from other wires and/or brackets.
- Verify operation of radio chassis.

Is noise eliminated?

Yes	No
REPOSITION permanently by taping.	GROUND various parts of the vehicle to the frame using a jumper cable. For example: engine, fenders, quarter panels, stone deflectors, engine air cleaner, body sheet metal. When noise is eliminated, PROVIDE a permanent ground where required.

PINPOINT TEST F: NOISY RECEPTION — AM ONLY

F1 CHECK ANTENNA CABLE CONNECTIONS

- Verify condition by operating radio chassis while engine is running, with vehicle in or not in motion.
- Check antenna cable connections including extension cable (if equipped).

Are connections clean and secure?

Yes	No
GO to **F2** .	CLEAN and/or SECURE antenna cable connections as required.

F2 CHECK ANTENNA MOUNTING

- Check to make sure antenna is securely mounted to body at ground points.

Are contacts clean and have metal-to-metal contact?

Yes	No
GO to **F3** .	CLEAN and/or SECURE connections as required.

F3 CHECK SUPPRESSION EQUIPMENT

- Check for presence of all required suppression equipment, radio frequency interference suppression bond and radio receiver hood bonding strap (if equipped) for security, cleanliness and metal-to-metal connection.

Are connections OK?

Yes	No
GO to **F4** .	REPLACE missing equipment and/or CLEAN connections as required.

F4 CHECK MOUNTING AND CONNECTING WIRES OF FOLLOWING COMPONENTS

NOTE: The capacitor mounting points are used to complete the electrical circuit and must be mounted securely to clean surfaces.

- Check the mounting and connecting wires of the radio voltage regulator capacitor (if equipped), radio ignition interference capacitor and radio interference capacitor for secureness, cleanliness and metal-to-metal contact.

Are connections OK?

Yes	No
GO to **F5** .	CLEAN and/or SECURE connections as required.

F5 CHECK OPERATION OF THE FOLLOWING COMPONENTS

- Check the operation of the radio voltage regulator capacitor, radio ignition interference capacitor and radio interference capacitor by replacing with known good components.
- Check generator by disconnecting wiring harness from voltage regulator.
- Verify radio chassis reception.

Is noise eliminated?

Yes	No
SERVICE or REPLACE damaged components as required.	GO to **F6** .

F6 CHECK IGNITION WIRES

- Check ignition wires for proper routing, grounding and secureness of connections.

Are wires OK?

Yes	No
GO to **F7** .	REROUTE or REPLACE ignition wires or SECURE connections as required.

F7 CHECK IGNITION SYSTEM

- Check ignition system for proper operation. (Use Rotunda Electronic Vibration Analyzer 014-00344 or equivalent or check for open circuit ignition wires using ohmmeter.) Also check spark plugs for cracked insulators.

Is ignition system OK?

Yes	No
GO to **F8** .	SERVICE or REPLACE components as required.

F8 CHECK CHASSIS MOUNTING POINTS

- Check all radio chassis mounting points for secureness, cleanliness and metal-to-metal contact.

Are mounting points OK?

Yes	No
GO to **F9** .	CLEAN and/or SECURE as required.

F9 SUBSTITUTE ANTENNA

- Substitute a known good radio speaker and antenna, making sure to ground antenna base to an unpainted metal surface.
- Verify radio chassis operation.

Is noise eliminated?

Yes	No
REPLACE or SERVICE radio speaker or antenna.	GO to **F10** .

F10 SUBSTITUTE ANTENNA CABLE

- Substitute a known good antenna cable.
- Verify radio chassis operation.

Is noise eliminated?

Yes	No
REPLACE antenna extension cable.	GO to **F11** .

F11 SUBSTITUTE RADIO

- Substitute known good radio.
- Verify radio chassis operation.

Is noise eliminated?

Yes	No
Have radio chassis serviced at an authorized Service Center.	GO to **F12** .

F12 CHECK AMPLIFIER

- Substitute a known good radio amplifier (P-100 system only).
- Verify radio chassis operation.

Is noise eliminated?

Yes	No
Have radio amplifier serviced at an authorized Service Center.	GO to **F13** .

F13 REPOSITION THE FOLLOWING COMPONENTS

- Check if noise can be eliminated by repositioning antenna, radio speaker or radio power feed wires away from other wires and/or brackets.
- Verify operation of radio chassis.

Is noise eliminated?

Yes	No
REPOSITION permanently by taping.	GROUND various parts of the vehicle to the frame using a jumper cable. For example: engine, fenders, quarter panels, stone deflectors, air cleaner, body sheet metal. When noise is eliminated, PROVIDE a permanent ground where required.

PINPOINT TEST G: NOISY RECEPTION — FM ONLY

G1 DETERMINE IF CONCERN IS WITH FM RECEPTION LIMITATION

- Verify condition by operating radio chassis with engine running and vehicle not in motion.
- If noise is on FM stereo, determine if customer concern is due to FM stereo reception limitation. Refer to Description and Operation, Radio Reception .

Is reception normal?

Yes	No
EXPLAIN and DEMONSTRATE to customer. INFORM customer of methods for obtaining best reception.	GO to **G2** .

G2 CHECK ANTENNA CABLE CONNECTIONS

- Check antenna cable connections.

Are connections clean and tight?

Yes	No
GO to **G3** .	CLEAN and/or SECURE as required.

G3 CHECK ANTENNA MOUNTING

- Check to make sure antenna is securely mounted to body and base screws are tight.

Are mounting points tight?

Yes	No
GO to **G4**.	SECURE as required.

G4 CHECK IGNITION WIRES ROUTING

- Check ignition wires for proper routing and secureness of connections.

Are wires OK?

Yes	No
GO to **G5**.	REROUTE and/or SECURE connections as required.

G5 CHECK IGNITION SYSTEM COMPONENTS

- Check if ignition wires are suppressor-type and if spark plugs are the correct type.

Are ignition wires and spark plugs correct?

Yes	No
GO to **G6**.	REPLACE spark plug or ignition wires with the correct type.

G6 CHECK IGNITION SYSTEM

- Check ignition system for proper operation. (Use Rotunda Electronic Vibration Analyzer 014-00344 or equivalent or check for open circuit ignition wires using ohmmeter.) Also check spark plugs for cracked insulators.

Is ignition system OK?

Yes	No
GO to **G7**.	SERVICE or REPLACE components as required.

G7 CHECK CHASSIS MOUNTING

- Check all radio chassis mounting points for secureness, cleanliness and metal-to-metal contact.

Are radio mounting points OK?

Yes	No

GO to **G8** .	CLEAN and/or SECURE as required.

G8 SUBSTITUTE ANTENNA

NOTE: All surfaces used for grounding must be clean to ensure good electrical contact. Remove any dirt, rust, grease, paint, or other contaminants.

- Substitute a known good antenna, making sure to ground antenna base to an unpainted metal surface.
- Verify radio chassis operation.

Is noise eliminated?

Yes	No
REPLACE antenna.	GO to **G9** .

G9 SUBSTITUTE ANTENNA CABLE

- Substitute a known good antenna cable.
- Verify radio chassis operation.

Is noise eliminated?

Yes	No
REPLACE antenna extension cable.	GO to **G10** .

G10 CHECK GENERATOR

- Check generator by disconnecting wiring from voltage regulator.
- Verify radio chassis operation.

Is noise eliminated?

Yes	No
CHECK generator. REFER to Section 14-02 . SERVICE or REPLACE as required.	GO to **G11** .

G11 SUBSTITUTE RADIO CHASSIS

- Substitute a known good radio chassis.
- Verify radio chassis operation.

Is noise eliminated?

Yes	No
Have radio chassis serviced by an authorized service center.	GO to **G12**.

G12 CHECK AMPLIFIER

- Substitute a known good radio amplifier (P-100 system only).
- Verify radio chassis operation.

Is noise eliminated?

Yes	No
Have radio amplifier serviced at an authorized Service Center.	GO to **G13**.

G13 REPOSITION THE FOLLOWING COMPONENTS

NOTE: All surfaces used for grounding must be clean to ensure good electrical contact. Remove any dirt, rust, grease, paint, or other contaminants.

- Check if noise can be eliminated by repositioning antenna, radio speaker or radio power feed wires away from other wires and/or brackets.
- Verify radio chassis operation.

Is noise eliminated?

Yes	No
REPOSITION permanently by taping.	GROUND various parts of the vehicle to the frame using a jumper cable. For example: engine, fenders, quarter panels, stone deflectors, air cleaner, body sheet metal. When noise is eliminated, PROVIDE permanent ground where required.

PINPOINT TEST H: ONE OR MORE SPEAKERS DISTORTED — NOT ALL SPEAKERS

H1 CHECK FOR DISTORTION

- Check all radio speakers for distortion.

Are all radio speakers distorted?

Yes	No
GO to Pinpoint Test J.	GO to **H2**.

H2 CHECK FOR RADIO SPEAKER CONCERNS

- Check for loose trim panels, grilles or attachments which might cause rattles in the area of the radio speaker which is considered distorted.
- Check for pinched or broken wires at or near the radio chassis or radio speakers considered distorted.
- Check for foreign material in radio speaker(s) cone.

Are there any visible radio speaker concerns?

Yes	No
SERVICE as required. If still distorted, GO to **H3**.	GO to **H3**.

H3 CONNECT TEST SPEAKER

- Connect a test radio speaker to the wiring for each distorted radio speaker.

Does the test radio speaker get distorted?

Yes	No
GO to **H4**.	REPLACE radio speaker as required.

H4 CHECK CONNECTIONS AND WIRING

- Check for shorts between radio speaker connector.
- Check radio chassis and (if equipped) radio amplifier, wiring harness for damage and shorts.

Are any shorts or damage found?

Yes	No
SERVICE as required.	GO to **H5** if radio amplifier equipped. Otherwise, REMOVE radio chassis for service.

H5 CONNECT TEST AMPLIFIER

- Connect a test radio amplifier in place of system radio amplifier.
- Verify radio amplifier and radio chassis performance.

Does test radio amplifier cause distortion in radio speakers?

Yes	No
REMOVE radio chassis for service.	REMOVE radio amplifier for service.

PINPOINT TEST J: ALL SPEAKERS DISTORTED

J1 CHECK FOR DISTORTION

- Check all radio speakers for distortion.

Are all radio speakers distorted?

Yes	No
GO to **J2** .	GO to Pinpoint Test H .

J2 CHECK VOLUME RANGE FOR DISTORTION

- Check volume range for distortion.

Is distortion only at high volume?

Yes	No
System OK. STOP test.	GO to **J3** .

J3 CONNECT TEST RADIO CHASSIS

- Connect a test radio chassis in place of system radio chassis.

Is distortion still present?

Yes	No
REMOVE radio amplifier for service.	REMOVE radio chassis for service.

PINPOINT TEST K: NO SOUND FROM ONE OR MORE SPEAKERS — NOT ALL SPEAKERS

K1 CHECK FOR SOUND AT EACH RADIO SPEAKER

- Check for sound at each radio speaker.

Are all radio speakers without sound?

Yes	No

GO to Pinpoint Test L .	GO to **K2** .

K2 CHECK CONNECTORS TO RADIO SPEAKERS

- Check wiring to inoperative radio speakers from radio chassis and radio amplifier for opens or shorts.

Are all connections and wiring OK?

Yes	No
GO to **K3** .	CONNECT, REPLACE or SERVICE as required.

K3 CHECK WITH TEST SPEAKER

- Check system with test radio speaker substituted for system inoperative radio speaker.

Does test radio speaker operate?

Yes	No
REPLACE inoperative radio speaker.	GO to **K4** .

K4 CHECK RADIO CHASSIS AND RADIO AMPLIFIER WIRING

- Check wiring between radio chassis and radio amplifier (if equipped) for damage, broken pins in connectors, solder bridges or stray wires that could cause shorts.

Are connections and wiring OK?

Yes	No
GO to **K5** .	CONNECT, REPLACE or SERVICE as required.

K5 CHECK WITH TEST RADIO

- Substitute a test radio chassis for the system radio chassis.

Does test radio chassis provide sound to all radio speakers?

Yes	No
REMOVE radio chassis for service.	REMOVE radio amplifier for service.

PINPOINT TEST L: NO SOUND FROM ALL SPEAKERS

L1 CHECK FOR SOUND AT EACH RADIO SPEAKER

- Check for sound at each radio speaker.

Are all radio speakers without sound?

Yes	No
GO to **L2** .	GO to Pinpoint Test K .

L2 CHECK POWER OF SYSTEM

- Verify power ON and all radio speaker, radio chassis and radio amplifier connections and wiring are not damaged, loose, open or shorting.
- With voltmeter, verify power from radio chassis Circuit 137 (Y/BK) to ground with ignition switch in ACC or RUN.
- Measure voltage of Circuit 797 (LG/P) (Ranger) from amplifier to ground.

Does voltmeter indicate 10 or more volts?

Yes	No
GO to **L4** .	GO to **L3** .

L3 CHECK CONTINUITY OF POWER CIRCUITS

- Turn ignition switch OFF.
- Using proper schematic for system inoperative, verify continuity of power circuits to source.
- Verify voltage at ignition switch in RUN (engine off) or ACC.

Are the power circuits operating?

Yes	No
GO to **L4** .	SERVICE or REPLACE as required.

L4 CHECK FOR SHORT TO GROUND AT SPEAKER(S)

- Check for short to ground at one or more radio speakers which can cause radio amplifier shut-down.

Are any shorts found?

Yes	No
SERVICE as required.	REMOVE radio amplifier for service if equipped. Otherwise, REMOVE radio chassis for service.

PINPOINT TEST M: POOR SOUND QUALITY FROM ONE OR MORE SPEAKERS — NOT ALL SPEAKERS

M1 CHECK POOR SOUND QUALITY IN RADIO SPEAKERS

- Listen to sound quality of radio speakers.

Is poor sound quality in all radio speakers?

Yes	No
GO to Pinpoint Test N .	GO to **M2** .

M2 CHECK RESISTANCE OF RADIO SPEAKER(S)

- With power off, check resistance of radio speakers that have poor quality sound from radio amplifier or radio chassis output, back to the return input on radio amplifier or radio chassis.

Is resistance load excessive of the ohm rating printed on the radio speaker?

Yes	No
CHECK for load in radio speakers or wiring. Excess wire may cause loading effect. SERVICE and RETEST for quality sound.	GO to **M3** .

M3 CHECK RADIO SPEAKER(S)

- Check radio speakers for damage to cone or a foreign material causing poor sound.
- Verify radio speakers are securely mounted.

Is radio speaker(s) OK?

Yes	No
GO to **M4** .	SERVICE or REPLACE radio speaker and RETEST for quality sound.

M4 CHECK CONNECTIONS AND WIRING

- Check connections and wiring at radio speakers, radio amplifier and radio chassis for damage, corrosion or shorts to grounds or loads.

Are connections and wiring OK?

Yes	No

GO to **M5** .	SERVICE or REPLACE connections and wiring as required. RETEST for quality sound.

M5 CHECK WITH TEST RADIO SPEAKER

- Substitute a test radio speaker for system radio speakers that have poor quality sound.

Does test speaker have poor quality sound?

Yes	No
GO to **M6** if separate radio amplifier equipped. Otherwise, REMOVE radio chassis for service.	REPLACE or SERVICE radio speakers as required. RETEST for quality sound.

M6 CHECK WITH TEST RADIO AMPLIFIER

- Substitute a test radio amplifier for system radio amplifier.

Does test amplifier perform with poor quality sound?

Yes	No
REMOVE system radio chassis for service.	REMOVE system radio amplifier for service.

PINPOINT TEST N: POOR SOUND QUALITY FROM ALL SPEAKERS

N1 CHECK POOR SOUND QUALITY IN RADIO SPEAKERS

- Listen to sound quality of radio speakers.

Is poor sound quality in all radio speakers?

Yes	No
GO to **N2** .	GO to Pinpoint Test M .

N2 CHECK CONNECTIONS AND WIRING

- Check connection and wiring at radio speakers, radio amplifier and radio chassis for damage, corrosion or shorts to ground or loads.

Are connections and wiring OK?

Yes	No

GO to **N3** if external radio amplifier equipped. Otherwise, REMOVE radio chassis for service.	SERVICE or REPLACE connections and wiring as required. RETEST for quality sound.

N3 CHECK WITH TEST RADIO AMPLIFIER

- Substitute a test radio amplifier for system radio amplifier.

Does test radio amplifier perform with poor quality sound?

Yes	No
REMOVE system radio chassis for service.	REMOVE system radio amplifier for service.

Sound Systems

The AM radio is standard on all Ranger and Aerostar vehicles. All radio chassis (18806) have an electronic display and an integral clock. An AM/FM/MPX cassette, AM/FM/MPX Premium Analog Cassette and Compact Disc radio are optional on Ranger. An AM/FM/MPX radio and AM/FM/MPX cassette radio are optional on Aerostar.

A Premium Sound System option is available in conjunction with the AM/FM/MPX cassette radio on Aerostar, and with the Premium Cassette and CD radio on Ranger.

Special Features

Automatic Local/Distant SEEK and SCAN

The audio system will automatically seek and scan in the "distant" mode while in the FM frequency band. When using the SEEK or SCAN function, the radio will automatically stop on both strong and weak stations. When in AM, SEEK and SCAN will be in the "distant" mode with the vehicle's headlamps off; they will be in the "local" mode when the headlamps are on. If no stations are found in the "local" mode while in the AM with the headlamps on, the radio automatically tries the "distant" mode again.

Automatic Bass/Loudness

The audio system is equipped to automatically increase the bass level when the volume is decreased, and decrease the bass level when the volume is increased.

Electronic Radio-Clock, Ranger (Except AM)

Clock Controls

The electronic stereo radios are equipped with a built-in clock. The radio display can be in either a clock or radio mode. When the radio is off with the ignition on, the radio display is in the clock mode continuously and current time will be indicated.

When the radio is on, the radio display can be in the radio or the clock mode. Pushing the clock button will switch the display mode from clock to radio or radio to clock as desired. While in the clock mode, activating any of the radio tuning controls (tune, memory, seek) will change the display to radio frequency. After approximately 10 seconds, the display will revert to the clock display.

Setting Time

The clock may be set in radio or tape mode. First hold down the CLOCK button, and then simultaneously depress the SEEK to advance the minutes or SEEK to advance the hours. The seconds are automatically reset to zero when a new minute is set.

Electronic Radio-Clock, Ranger (AM Radio Only) and Aerostar

Clock Controls

The electronic radios are equipped with a built-in clock. The radio display can be in either clock or radio mode.

When the radio is off with the ignition on, the radio chassis display is in the clock mode continuously and current time will be indicated.

When the radio chassis is on, the radio chassis display can be in the radio or the clock mode. Pushing the volume control will switch the display mode from clock to radio or radio to clock as desired.

While in the clock mode, activating any of the radio tuning controls (tune, memory, seek) will change the display to radio frequency. After approximately 10 seconds, the display will revert to the clock display.

Setting Time

Push and hold in the radio volume control and use the tune control (±) to set the time.

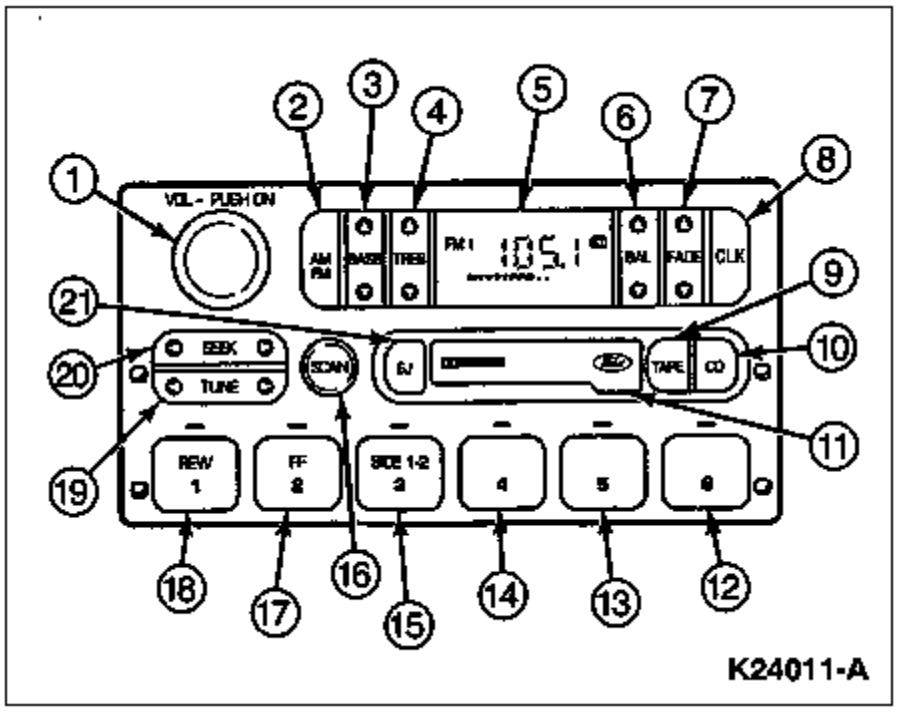
Pushing on the left side (-) of the tune control sets hours. Pushing on the right side (+) sets minutes. Releasing the volume control after setting the time automatically sets the seconds to zero (although seconds are not displayed).

Electronic Search Cassette (ESC) Sound System

The Electronic Search Cassette (ESC) radio is a self-contained four-speaker system which includes an AM/FM/MPX radio, cassette transport deck and an integral digital clock. The ESC system has no external amplifier.

Refer to Electronic Audio Systems portion of the Owner Guide for complete operating guidelines.

Electronic Search Cassette Radio Chassis Controls



Item	Part Number	Description
1	—	Power ON/OFF and Volume Control
2	—	AM/FM Band Select
3	—	Bass Tone Control
4	—	Treble Tone Control
5	—	Display
6	—	Balance Control
7	—	Fade Control
8	—	Clock Select
9	—	Tape Mode Select
10	—	Dolby® ON/OFF for Cassette Only
11	—	Cassette Loading Port
12	—	Radio Memory Button
13	—	Radio Memory Button
14	—	Radio Memory Button
15	—	Cassette Side/Radio Memory Button
16	—	Radio Tuner Scan Control
17	—	Cassette Fast Forward/Radio Memory Button
18	—	Cassette Rewind/Radio Memory Button
19	—	Radio Tuner Fine Tuning Control
20	—	Radio Tuner Seek Control
21	—	Cassette Eject Button

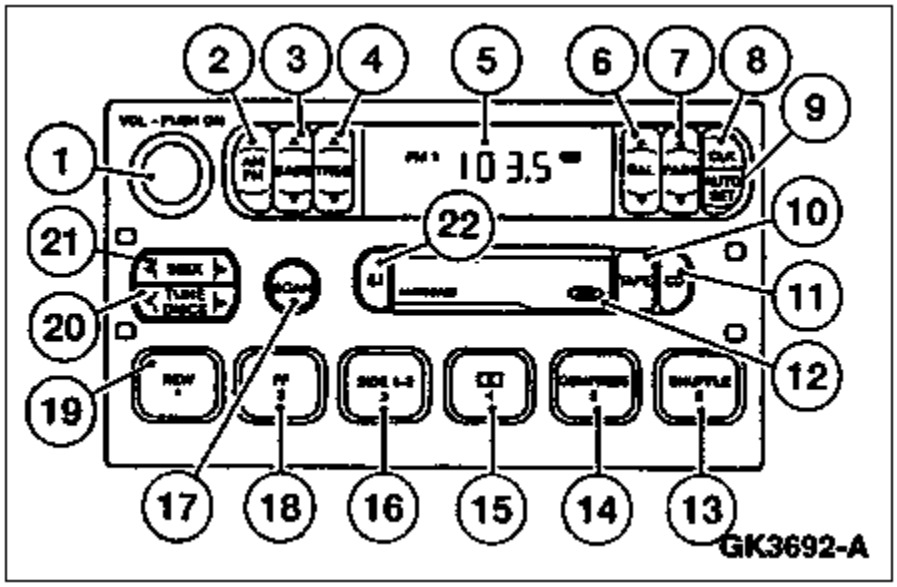
Premium

The premium sound system available on Aerostar includes an electronic cassette radio, four-channel radio amplifier (18B849), and four premium radio speakers (18808) (two in the rear wall panel, and two in the liftgate or rear doors). The radio amplifier is located directly under the radio chassis. On Aerostar wagon only, the system includes a remote headphone control which allows the rear speakers to be turned off.

The premium sound system in the Ranger includes an electronic premium cassette radio, four-channel radio amplifier and four premium radio speakers (two in the front doors and two in the rear quarter panel or rear doors). The amplifier is located behind the back trim panel for Ranger Regular Cab and behind the RH quarter trim panel for Ranger Super Cab.

- The instrument panel wiring harness is unique for the premium sound system.

Premium Stereo Cassette/Digital Audio Compact Disc Player Controls



Item	Part Number	Description
1	—	Power ON/OFF and Volume Control
2	—	AM/FM Band Select
3	—	Bass Tone Control
4	—	Treble Tone Control
5	—	Display
6	—	Balance Control
7	—	Fade Control
8	—	Clock

9	—	Autoset (Automatic Memory Store)
10	—	Tape Mode Select
11	—	CD Mode Select
12	—	Cassette Loading Port
13	—	CD Shuffle/Radio Memory Button
14	—	CD Compress/Radio Memory Button
15	—	Dolby® ON/OFF/Radio Memory Button
16	—	Side 1-2/Radio Memory Button
17	—	Scan Control
18	—	Fast Forward/Radio Memory Button
19	—	Rewind/Radio Memory Button
20	—	Tuner Fine Tuning/CD Disc Select
21	—	Seek Control
22	—	Eject Button

Cassette Tape Player — ESC and Premium

NOTE: Before turning off radio or ignition, always eject any cassette being played. Cutting power to the radio while a tape is engaged can result in damage to the tape, pinch roller or capstan.

Insert the tape cassette, open edge to the right, to play (radio on, ignition switch (11572) in RUN or ACC position). Adjust volume, tone and speaker balance as for radio programs. At the end of the tape, the cassette automatically reverses and plays the other side of the tape. At any time the tape transport mechanism can be changed to play the other side of the tape by pressing the SIDE 1-2 button.

The Dolby® System is a noise reduction system manufactured under license from Dolby Laboratories. Dolby® and the double-D symbol are trademarks of Dolby Laboratories Licensing Corporation.

Operating Precautions

When inserting a tape cassette into the tape slot, it should be firmly pushed in and down to ensure that it is properly seated. To play a full tape, insert the cassette so the empty hub of the cassette goes into the slot first.

Do not leave a tape cassette engaged in the tape player slot when not in use. Remove it completely to permit the slot door to close and keep out airborne dirt. Disengaging the cassette from the tape playback head in this manner will also prevent a flat spot from developing on the capstan roller.

Take care to protect the open edge of the cassette from damage, dirt, oil and grease. When not in use, store cassettes in their protective cases with hub locks in place. Otherwise, there will be a risk of having the tape loosen on its hubs, which could cause the tape to spill or jam in the player. If a cassette is found with loose tape, make sure it is rewound firmly around the hubs before using it. Never try to open a cassette or try to pull the tape out of it. To avoid tape player damage, do not use cassettes that have been soiled by liquid spills.

Cassette Irregularities

Cassette tapes can vary in performance and size, resulting in occasional concerns with certain cassettes.

If any one cassette gives continual trouble, it is best to discontinue use.

For best results, use cassette tapes with no more than 90 minutes of playing time. The thinness of the tapes used in C120 and C180 cassettes makes the tape more likely to stretch and break. A stretched tape will result in poor sound quality.

Tape Player Will Not Accept Cartridge, Eats Tape, Plays Too Fast or Too Slow, etc. (AM and FM Operating Properly)

- Make sure cassette has not come to the end of the tape.
- Check operation of the tape player by using a known good cassette/cartridge.
- If the condition is not corrected by the substitution of a known good cassette/cartridge, the radio chassis (18806) must be removed and sent to an authorized service facility for service.

Temperature Extremes

Do not expose tape cassettes to intense sunlight or other temperature extremes. If they do become exposed to high or low temperatures, allow each cassette to reach a moderate temperature before playing. During cold weather, it is advisable to take cassettes indoors overnight to protect them.

In extremely cold weather, the tape player may need a few minutes to warm up before delivering full sound quality.

Tape Error Messages — ESC

The ESC radio chassis is designed to diagnose certain inoperative cassette player conditions. The error codes are as follows:

- Error 1 — Possible tape cartridge jam.
- Error 2 — Tape eject or load concern.

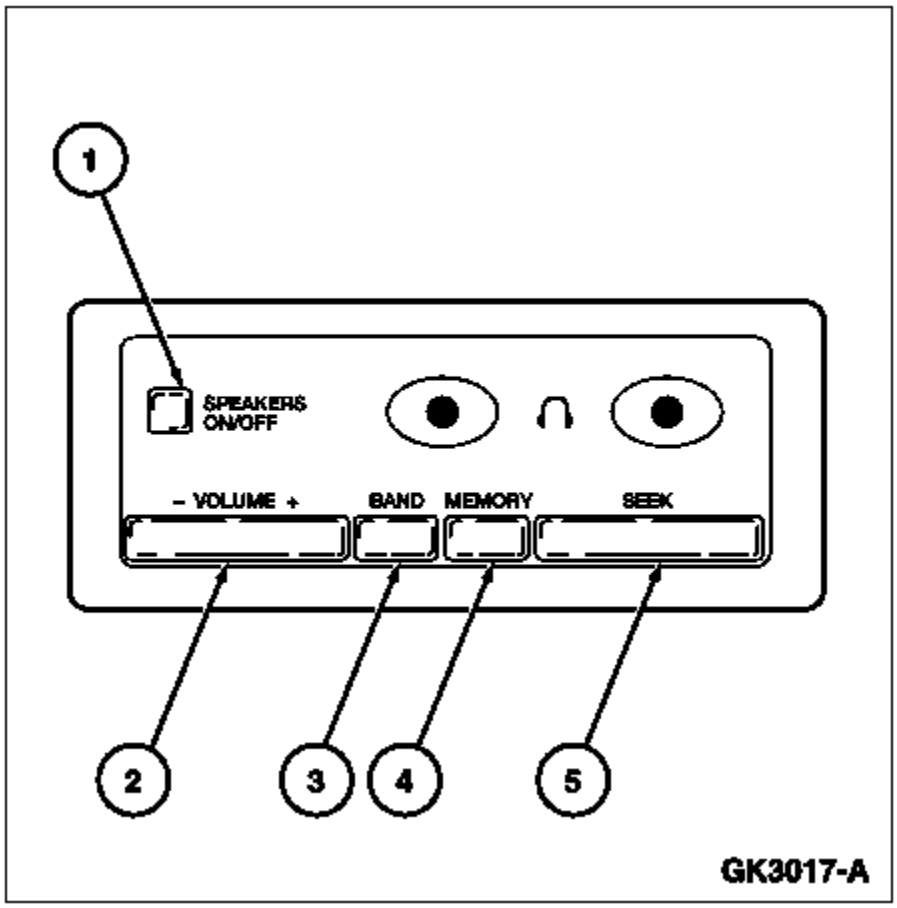
Tape Error Messages — Premium

The Premium Analog Cassette radio is designed to diagnose certain inoperative cassette player conditions which will appear on the digital display. The error codes are as follows:

- Error 0 — Communication error between radio controller and tape controller.
- Error 1 — Possible tape cartridge jam.
- Error 2 — Tape eject or load concern.

Radio Control, Rear Seat — Aerostar Wagon

1. Speaker control — Push to turn rear speakers on/off as desired.
2. Volume — Volume adjustment on speakers or headphones is limited to volume setting on radio.
3. Band — Push "BAND" button to select AM or FM frequency band.
4. Memory — Push to sequentially choose stations stored in radio memory.
5. Seek Control — Seek up/down controls operate the same as those on radio chassis.


1
SPEAKERS ON/OFF
– VOLUME +
BAND
MEMORY
SEEK
2
3
4
5
GK3017-A

Compact Disc Player, Digital Audio

WARNING: USE OF CONTROLS AND ADJUSTMENTS OR PERFORMANCE OF PROCEDURES OTHER THAN THOSE SPECIFIED MAY RESULT IN HAZARDOUS RADIATION EXPOSURE.

THE USE OF OPTICAL INSTRUMENTS WITH THIS PRODUCT WILL INCREASE EYE HAZARD AS THE LASER BEAM USED IN THE DIGITAL AUDIO COMPACT DISC PLAYER IS HARMFUL TO THE EYES. DO NOT ATTEMPT TO DISASSEMBLE THE CASE. REFER SERVICING TO QUALIFIED PERSONNEL ONLY.

NOTE: The digital audio compact disc changer has heat-protection circuitry to protect the laser diode. If the temperature of the digital audio compact disc changer reaches 80°C (176°F), the heat detection circuit will shut off the player and H will appear in the display. When the temperature is within normal operating range, the H indicator will turn off and the digital audio compact disc changer will again be operational.

NOTE: If a disc is inserted then ejected and ERROR begins scrolling in the display, remove disc and re-insert right side up (label side up).

Insert disc, 8cm or 12cm (3-inch or 5-inch), into opening. When inserted, the disc automatically loads into the unit and play starts at the beginning of the first track. Once the disc is inserted, the disc opening is secured to prevent the accidental insertion of a second disc.

The CD player has a heat protection circuitry to protect the laser diode. If the temperature of the player reaches 75°C (167°F), the heat detection circuit w ill shut off the player and TOO HOT will scroll in the display for five seconds (radio will resume playing) before the CD player will again be operational.

Operating Precautions

Before playing, inspect the disc for any contamination. If needed, clean the disc with an approved disc cleaner. Do not clean disc with solvents such as benzine, thinner, or antistatic spray intended for analog records.

- If a disc has already been inserted, do not try to insert another disc. Doing so may damage the disc player.

Push the EJECT button to stop play, eject the disc and resume radio operation of audio system. A disc can be ejected while the radio power and/or ignition is on or off. If the disc is ejected from the CD player and the disc is not removed from the disc opening within 10 seconds, the player will automatically reload the disc for storage, unless the disc is automatically ejected due to a focus error (disc inserted upside down). In this case, the disc will not be automatically reloaded and stored.

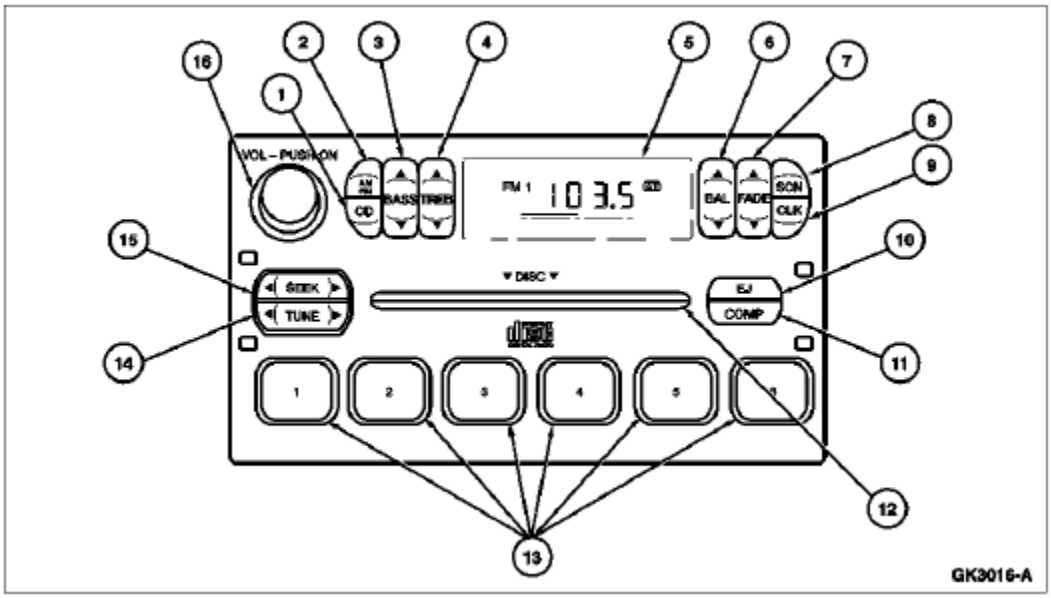
Refer to Electronic Audio Systems portion of the Owner Guide for detailed operative instructions.

CD Irregularities

Different manufacturers of compact discs may produce discs with different dimensions or tolerances, some of which may not be within industry standards or in accordance with the CD format. Because of this, a new disc that is free of dust and scratches could be defective and may not play on Ford compact disc player. Badly scratched discs or extremely rough loads will cause the sound to skip. Skipping will not damage the

disc player or scratch the discs.

Digital Audio Compact Disc Player Radio Chassis Controls — Ranger



Item	Part Number	Description
1	—	CD Play Select
2	—	AM/FM Band Select
3	—	Bass Tone Control
4	—	Treble Tone Control
5	—	Display
6	—	Balance
7	—	Fade Control
8	—	Radio Tuner Scan Control
9	—	Clock
10	—	CD Eject
11	—	CD Compression Adjust
12	—	CD Slot
13	—	Memory Preset Buttons
14	—	Station Tune
15	—	Station Seek
16	—	Volume-Power Control

Refer to Ford Audio System Operating Guide for complete digital audio compact disc player operating guidelines.

Radio Chassis, Aerostar

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Radio Removing Tool	T87P-19061-A

Removal

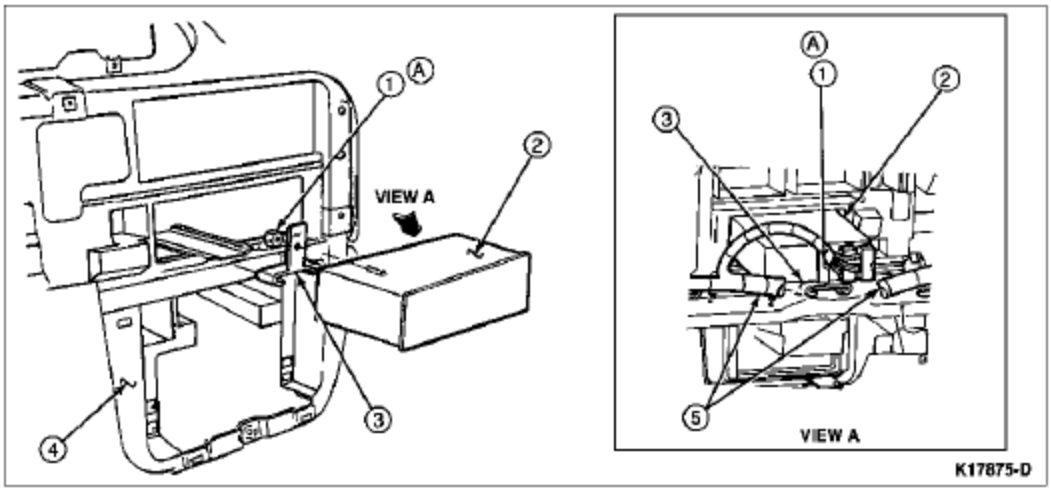
1. Disconnect the battery ground cable (14301).
2. Remove finish panel. Refer to Section 01-12 .
3. Insert Radio Removing Tool T87P-19061-A into tool insertion holes on the edge of the radio face plate. Press in 25.4mm (1 inch) to release radio retaining clips. Pull radio chassis (18806) from finish panel using tool as handles.
4. Disconnect the radio antenna lead in cable (18812) and wiring connectors (14487).

Installation

If radio chassis is being replaced, transfer support to new radio chassis.

1. Connect the radio antenna lead in cable andwiring connectors.
2. Position the radio chassis in the instrument panel and slide the radio chassis on the mounting bracket until holding brackets engage.
3. Install finish panel. Refer to Section 01-12 .
4. Connect the battery ground cable.
5. Check the operation of the radio chassis and engine (6007).
6. Reset clock.

Radio Chassis Removal, Aerostar



Item	Part Number	Description
1	W620392	Nut and Washer
2	18806	Radio Chassis
3	18888	Radio Chassis Support
4	04320	Instrument Panel
5	14401	Main Wiring
A	—	Tighten to 3.5-4 Nm (31-35 Lb-In)

Radio Chassis, Ranger

SPECIAL SERVICE TOOL(S) REQUIRED

Description	Tool Number
Radio Removing Tool	T87P-19061-A

Removal

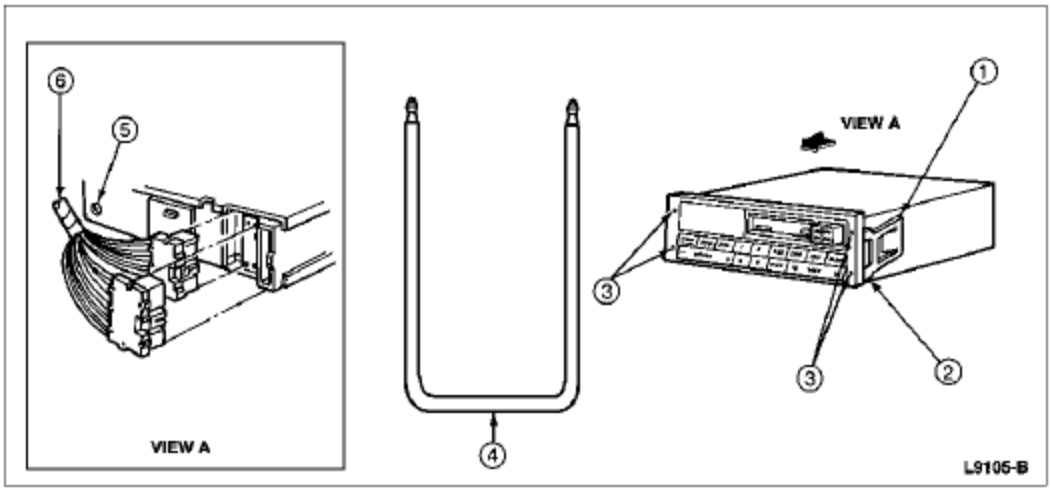
1. Disconnect battery ground cable (14301).
2. Insert Radio Removing Tool T87P-19061-A into radio face plate. Press in 25.4mm (1 inch) to release radio retaining clips. Pull radio chassis (18806) from instrument panel using tool as handles.
3. Disconnect wiring connectors and radio antenna lead in cable (18812).
4. Transfer rear mounting bracket to new radio chassis, if necessary.

Installation

1. Connect wiring connectors (14487) and radio antenna lead in cable to radio chassis.
2. Slide radio chassis into instrument panel (04320). Engage rear mounting bracket to track in instrument panel.
3. **NOTE: When the battery ground cable has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

   Connect battery ground cable.
4. Test radio chassis and/or tape player operation.
5. Reset clock.

Radio Chassis Removal



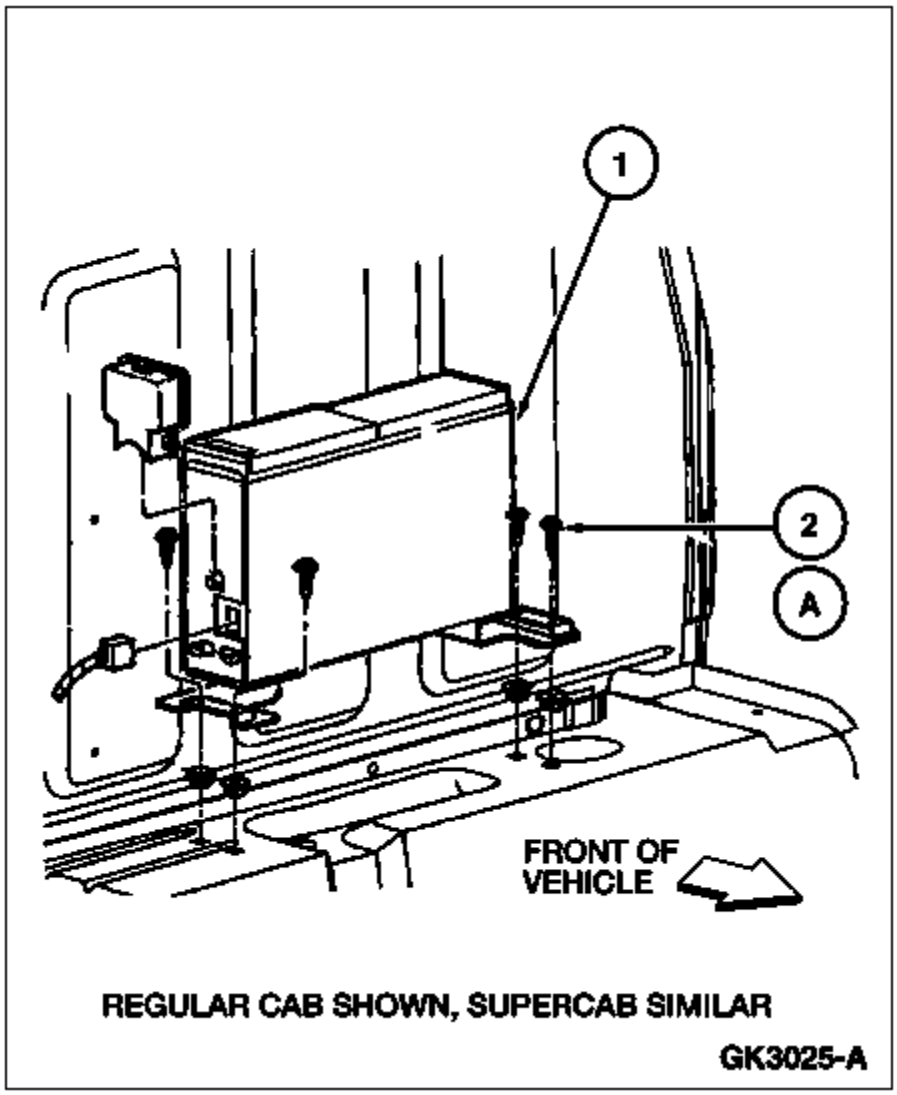
Item	Part Number	Description
1	—	Radio Retaining Spring (Part of 18806)
2	—	Tool Locks on Spring Here
3	—	Tool Insertion Holes
4	T87P-19061A	Radio Removing Tool
5	—	Antenna Connection (Part of 18806)
6	14401	Main Wiring

Compact Disc Changer, Ranger

Removal and Installation

1. Disconnect the battery ground cable.
2. Remove the CD changer cover.
3. Remove the wire shield cover and disconnect harness connector.
4. Remove the four screws and remove CD changer assembly.

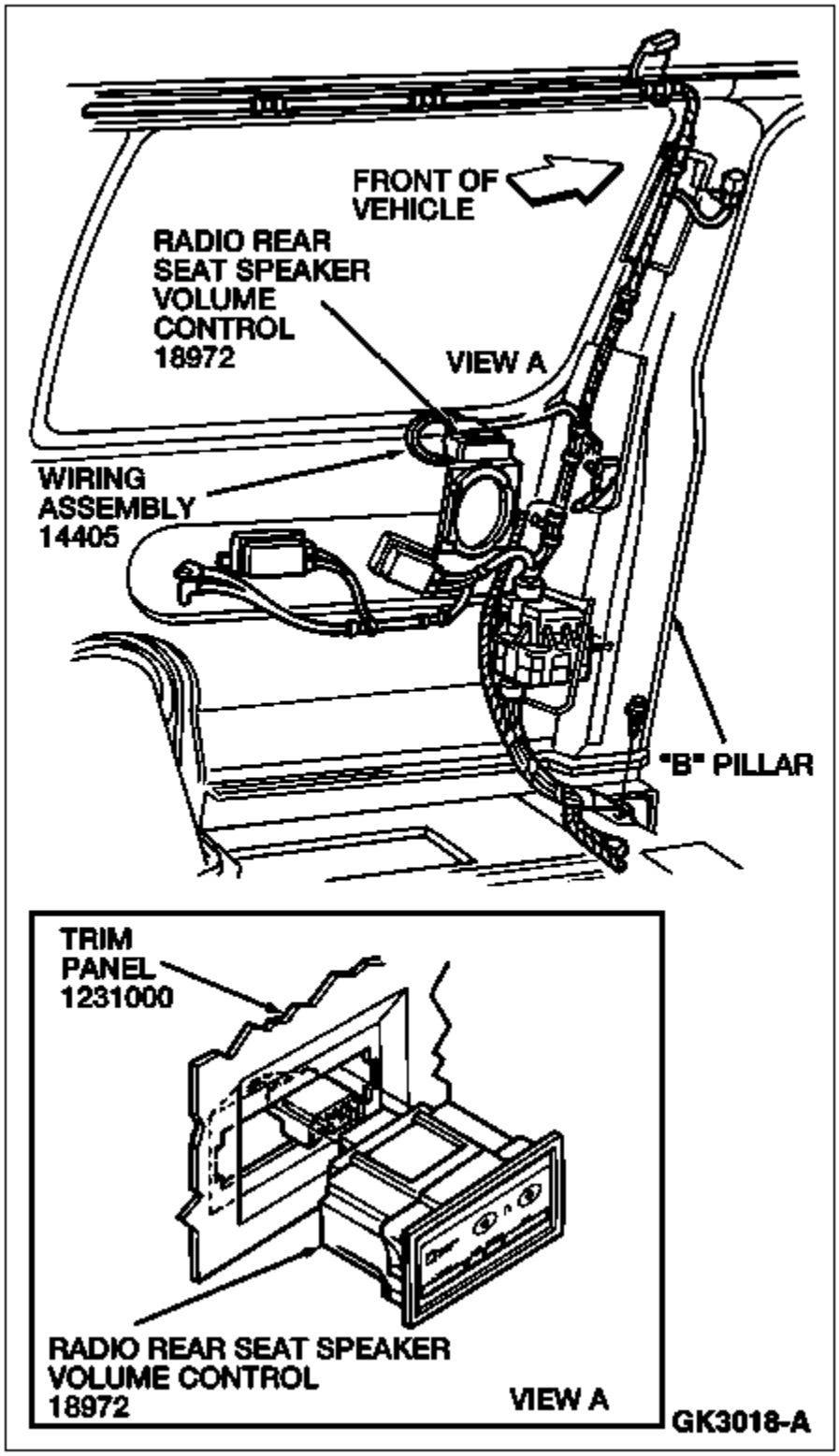
To install, reverse the removal procedure.



Item	Part Number	Description
1	18C849	Compact Disc Changer
2	N610961-S56	Screw (4 Req'd)
A	—	Tighten to 2.1-2.9 Nm (18.6-25.7 Lb-In)

Radio Control, Rear Seat, Aerostar

Refer to the following illustration for removal and installation of the rear seat radio control (18972).


FRONT OF VEHICLE
RADIO REAR SEAT SPEAKER VOLUME CONTROL 18972
VIEW A
WIRING ASSEMBLY 14405
"B" PILLAR
TRIM PANEL 1231000
RADIO REAR SEAT SPEAKER VOLUME CONTROL 18972
VIEW A
GK3018-A

Radio Frequency Interference Suppression Equipment

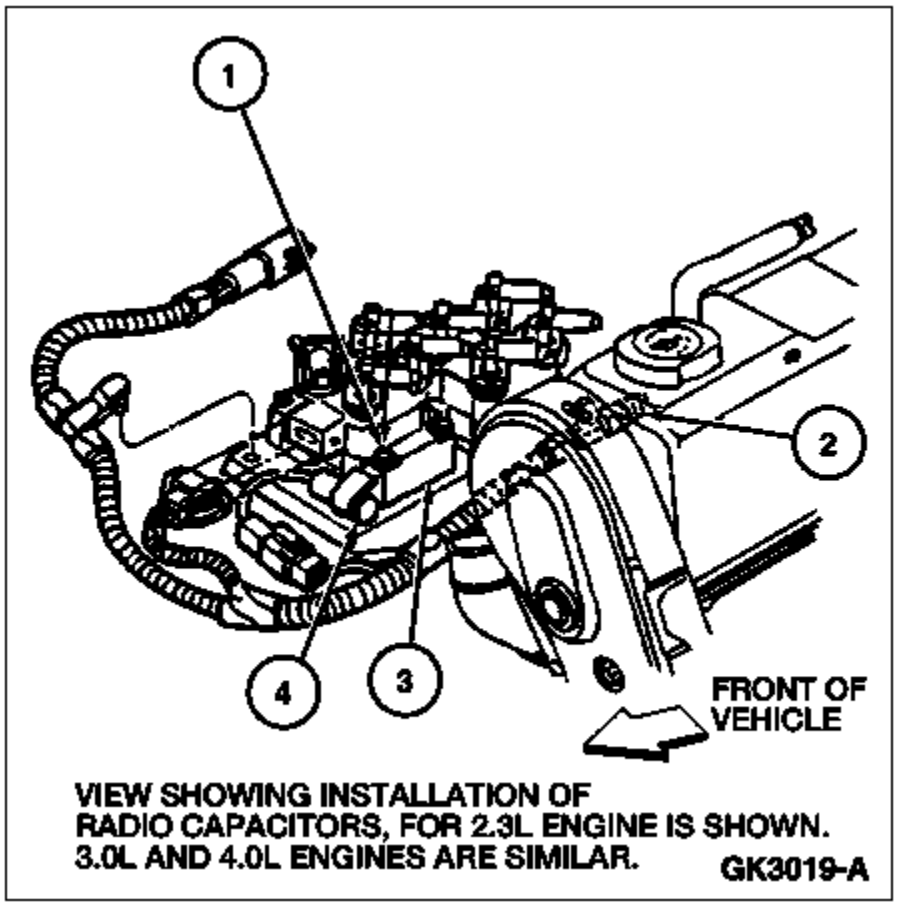
When replacing any radio suppression equipment components, make sure that a good contact is made at all attachments. Remove any paint or dirt from between a capacitor and its ground. Tighten all nuts and bolts securely.

The radio suppression devices required for engines are:

- Transmission-to-body strap
- Ignition coil-capacitor
- Hood shield and ground strap
- Engine-to-dash strap

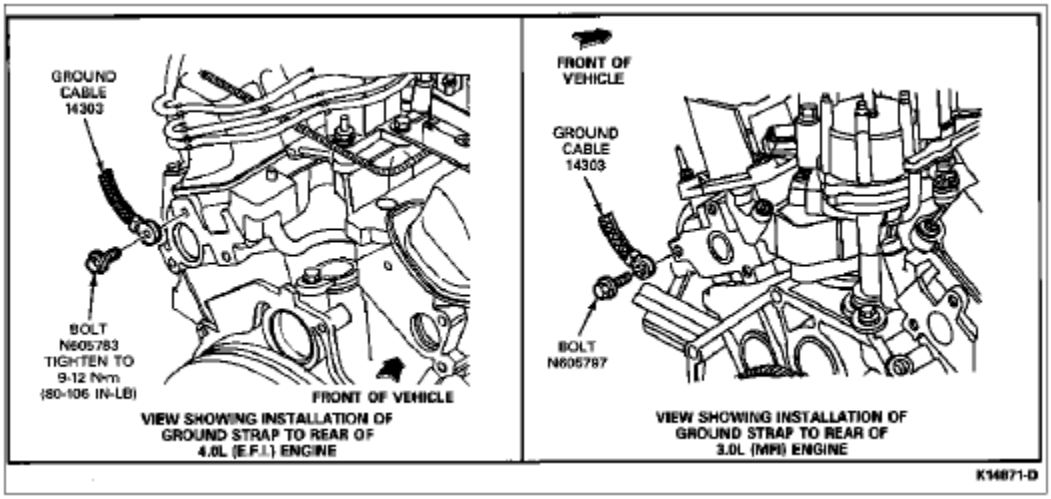
Refer to the following illustrations as an aid in removing and installing radio noise suppression equipment and vehicle ground straps.

Radio Suppression Equipment

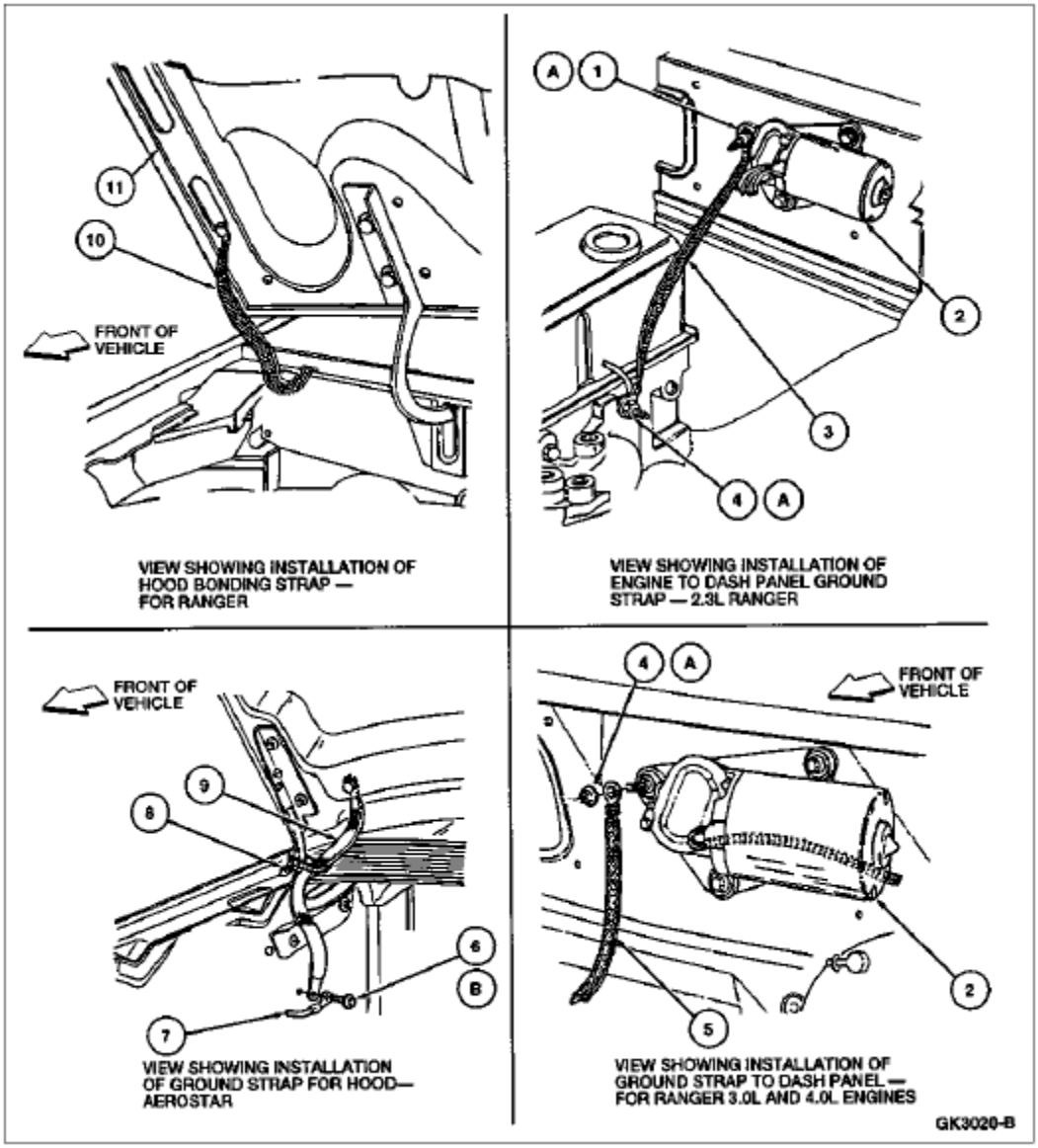


Item	Part Number	Description
1	N611131-S36	Existing Screw
2	9D930	Wiring Harness
3	—	Coil Assembly (Part of 9D930)
4	18801	Capacitor

Radio Suppression Equipment (Continued)



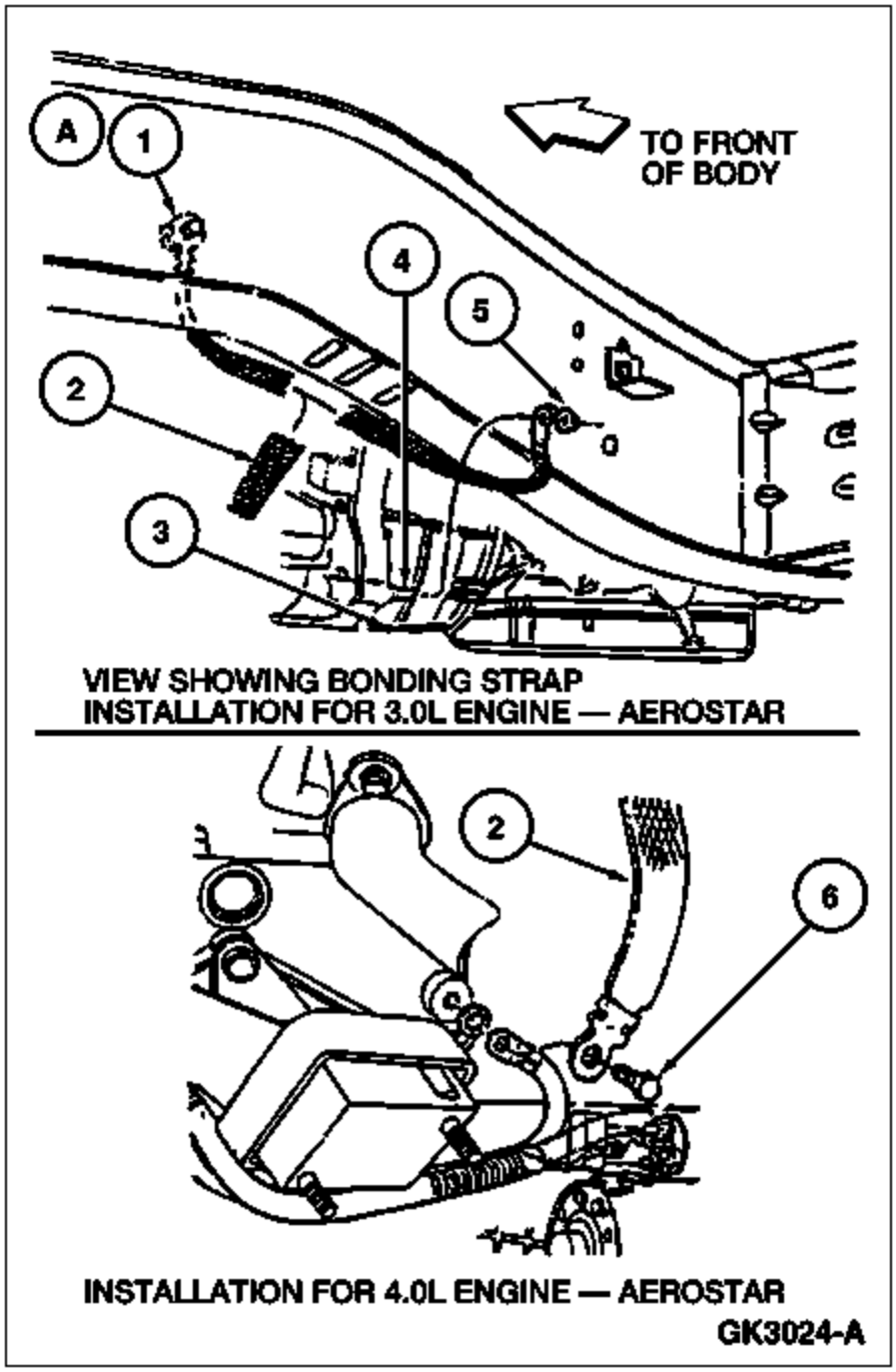
Radio Suppression Equipment (Continued)



Item	Part Number	Description
1	N621905-S36	Nut
2	17508	Windshield Wiper Motor
3	14303	Ground Strap — Dash to Engine, 2.3L Engine (Ranger)
4	N621905-S36M	Nut and Washer
5	14303	Ground Strap — Dash to Engine, 3.0L and 4.0L Engines (Ranger)
6	N805375-S36MG	Screw
7	12A581	Engine Control Sensor Wiring
8	95874	Strap

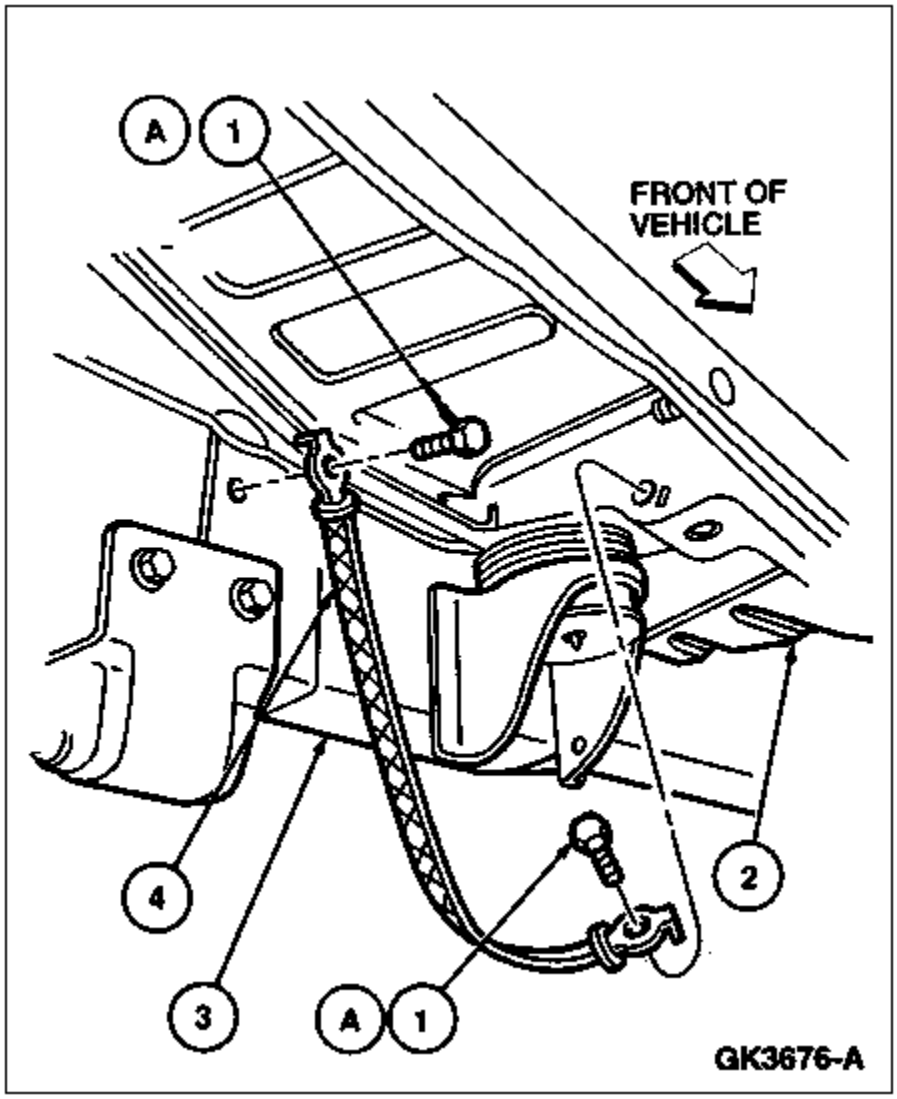
9	16C989	Ground Strap — Hood to Inner Fender (Aerostar)
10	19A095	Ground Strap — Hood to Inner Fender (Ranger)
11	16612	Hood
A	—	Tighten to 7-9 Nm (62-80 Lb-In)
B	—	Tighten to 9-12 Nm (80-106 Lb-In)

Radio Suppression Equipment (Continued)



Item	Part Number	Description
1	N611057	Screw
2	19A095	Ground Assembly (4.0L Engine Only)
3	7003	Transmission
4	—	Existing Stud (Part of 7003)
5	N620042	Nut
6	N611056	Bolt

A	—	Tighten to 2-2.8 Nm (18-25 Lb-In)



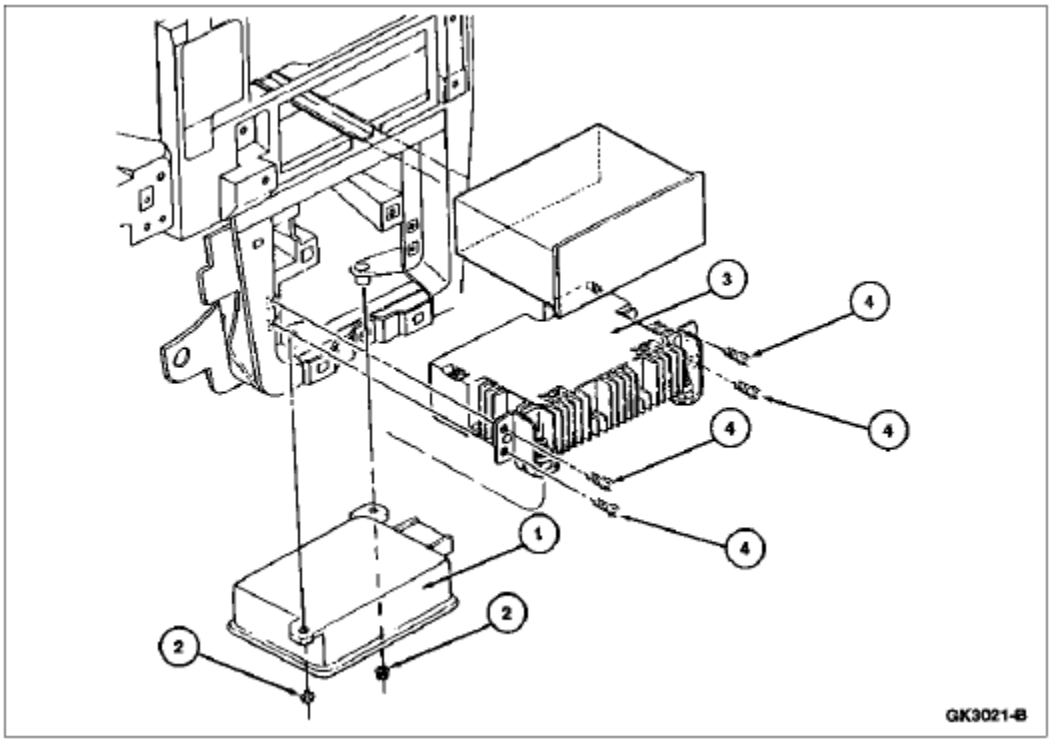
Item	Part Number	Description
1	—	Screw (2 req'd)
2	—	Body
3	—	Frame
4	—	Bonding Strap Body to Frame
A	—	Torque to 2.5± 0.5 Nm (22± 4 Lb-in)

Radio Amplifier, Premium Sound, Aerostar

Removal and Installation

1. Remove two nuts securing the anti-lock electronic control module (2C018).
2. Remove four amplifier attaching screws from lower instrument panel reinforcement.
3. Disconnect two hard-shell connectors at radio amplifier (18B849).
4. Remove radio amplifier from instrument panel (04320).

For installation, follow removal procedures in reverse order.



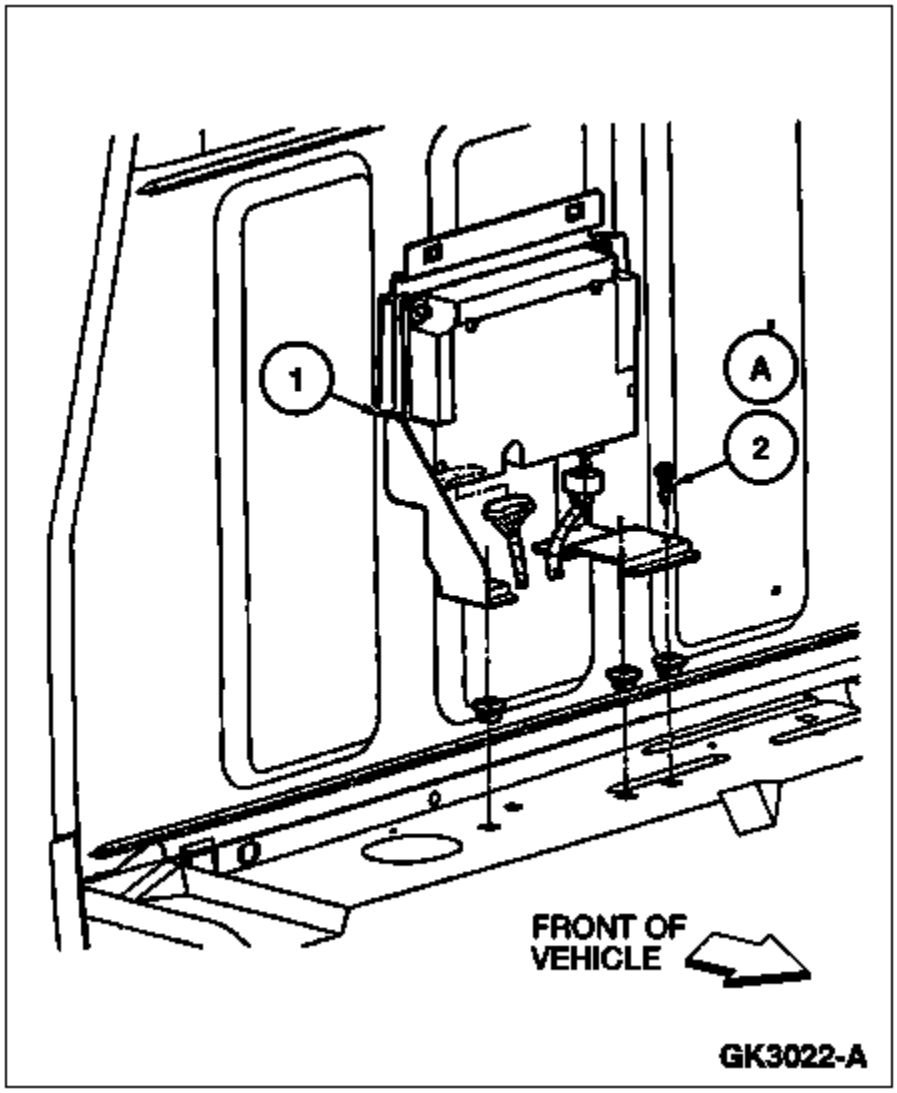
Item	Part Number	Description
1	2C018	RABS Module
2	N621903	Nut
3	18B849	Premium Sound Amplifier
4	N803876-5441	Screw (4 req'd)

Radio Amplifier, Premium Sound, Ranger — Regular Cab

Removal and Installation

1. Remove quarter rear trim panel. Refer to Section 01-05B .
2. Remove three screws securingradio amplifier (18B849) to floor pan and removeradio amplifier.
3. Disconnect two wiring connectors to radio amplifier.

For installation, follow removal procedures in reverse order.



Item	Part Number	Description

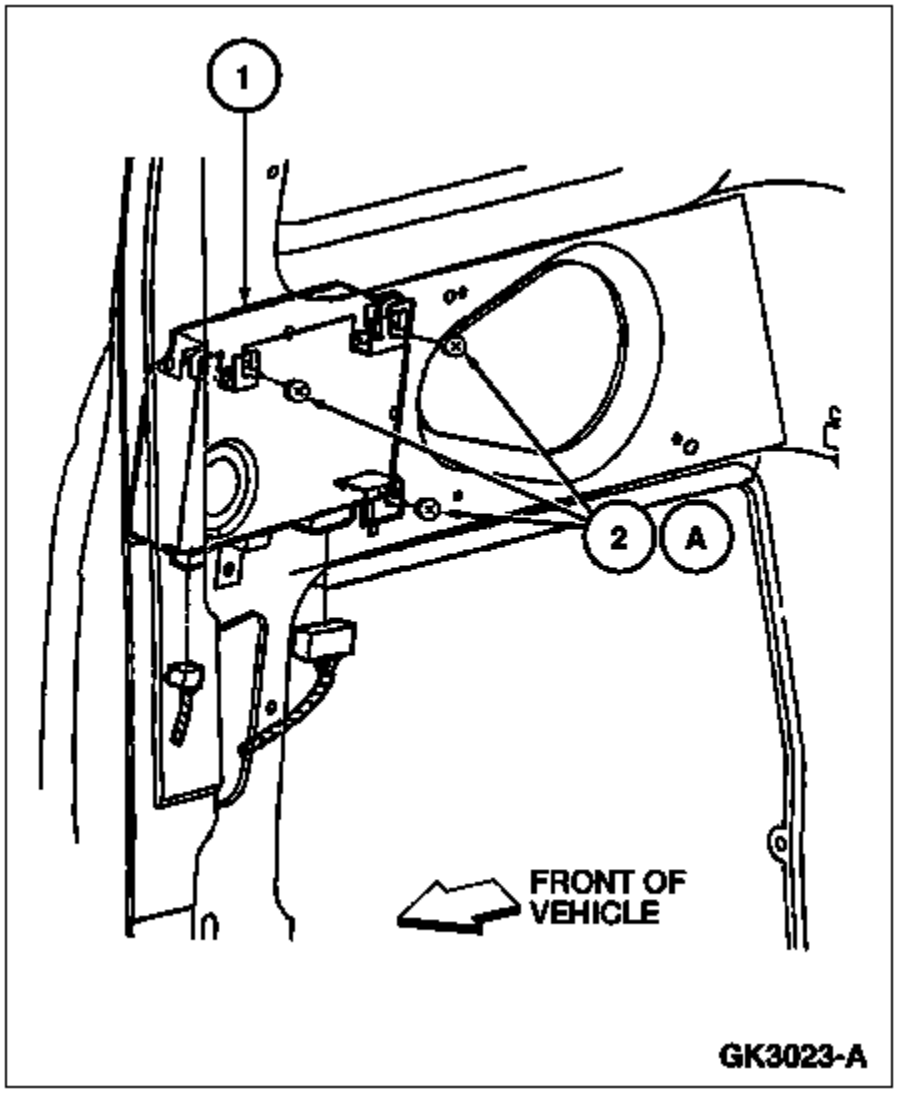
1	18B849	Premium Sound Amplifier
2	N807921-S36	Screw (3 Req'd)
A	—	Tighten to 2.1-2.9 Nm 18.6-25.7 Lb-In)

Radio Amplifier, Premium Sound, Ranger — Super Cab

Removal and Installation

1. Remove quarter trim panel. Refer to Section 01-05B .
2. Remove the three nuts securing radio amplifier (18B849) to interior side back panel.
3. Disconnect the two wiring connectors atradio amplifier.

To install, reverse the removal procedure.



Item	Part Number	Description

1	18B849	Premium Sound Amplifier
2	N621904-S36B	Nut (3 Req'd)
A	—	Tighten to 3.1-4.3 Nm (27.7-38.1 Lb-In)

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-In
Front Radio Speaker Retaining Screws	0.9	8
Rear Radio Speaker Retaining Screws	0.9	8

Antenna

Fixed

Removal and Installation

1. Loosen and remove antenna by turning counterclockwise.
2. To install, reverse procedure.

Base

Removal

1. **CAUTION: Use appropriate fender protection to prevent damage to the paint when removing antenna base.**

   Remove the antenna mast from the antenna base.

2. Unsnap radio antenna base cap (18A927) from antenna base and remove radio antenna base cap.
3. Remove three antenna base attaching screws and remove antenna base from vehicle.
4. Disconnect radio antenna lead in cable (18812).
5. Remove radio antenna base gasket (18946).

Installation

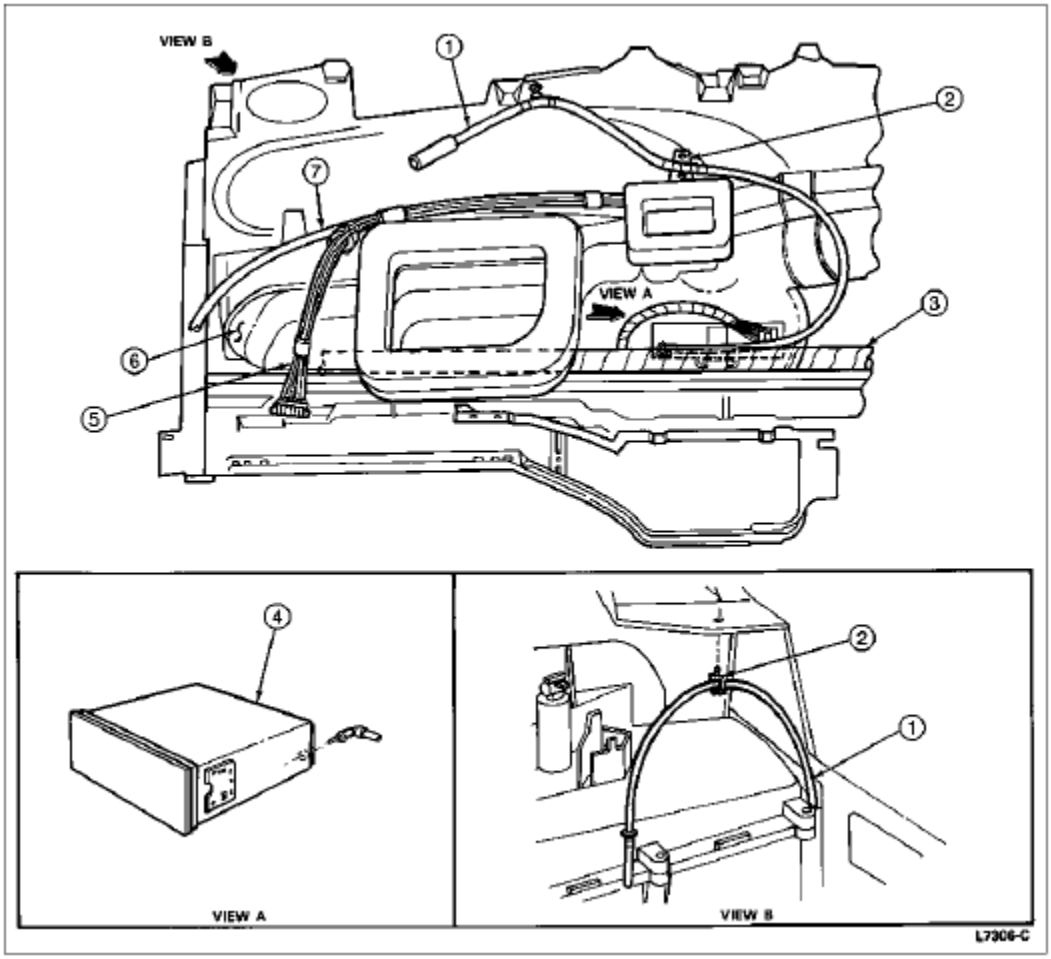
1. To install, reverse removal procedure.

Antenna Lead-In Cable

Removal and Installation

Refer to appropriate illustration for antenna cable routing.

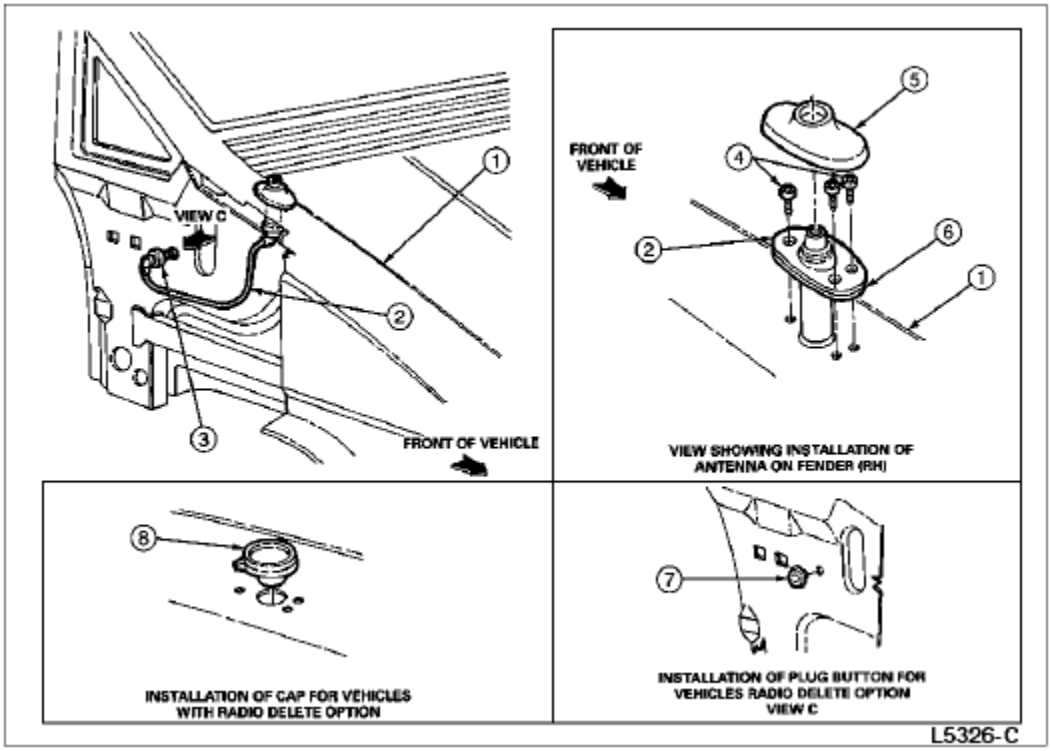
Antenna Lead In Cable Routing, Aerostar



Item	Part Number	Description
1	18812	Radio Antenna Lead In Cable
2	18D412	Clip, Hairpin
3	14401	Main Wiring
4	18806	Radio Chassis
5	19C827	Vacuum Hose Harness

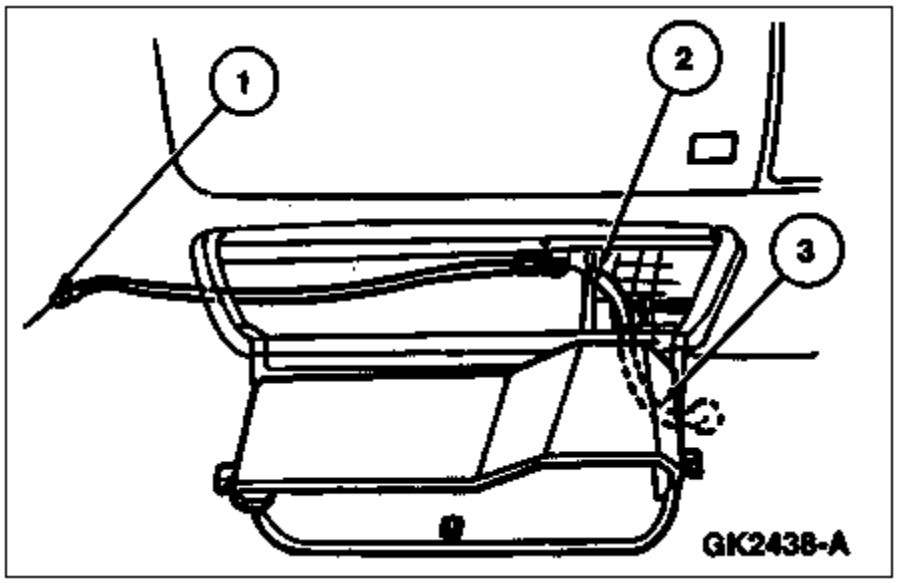
6	19A618	A/C Air Inlet Duct
7	18D306	Cable Assembly

Antenna Lead In Cable Routing, Aerostar

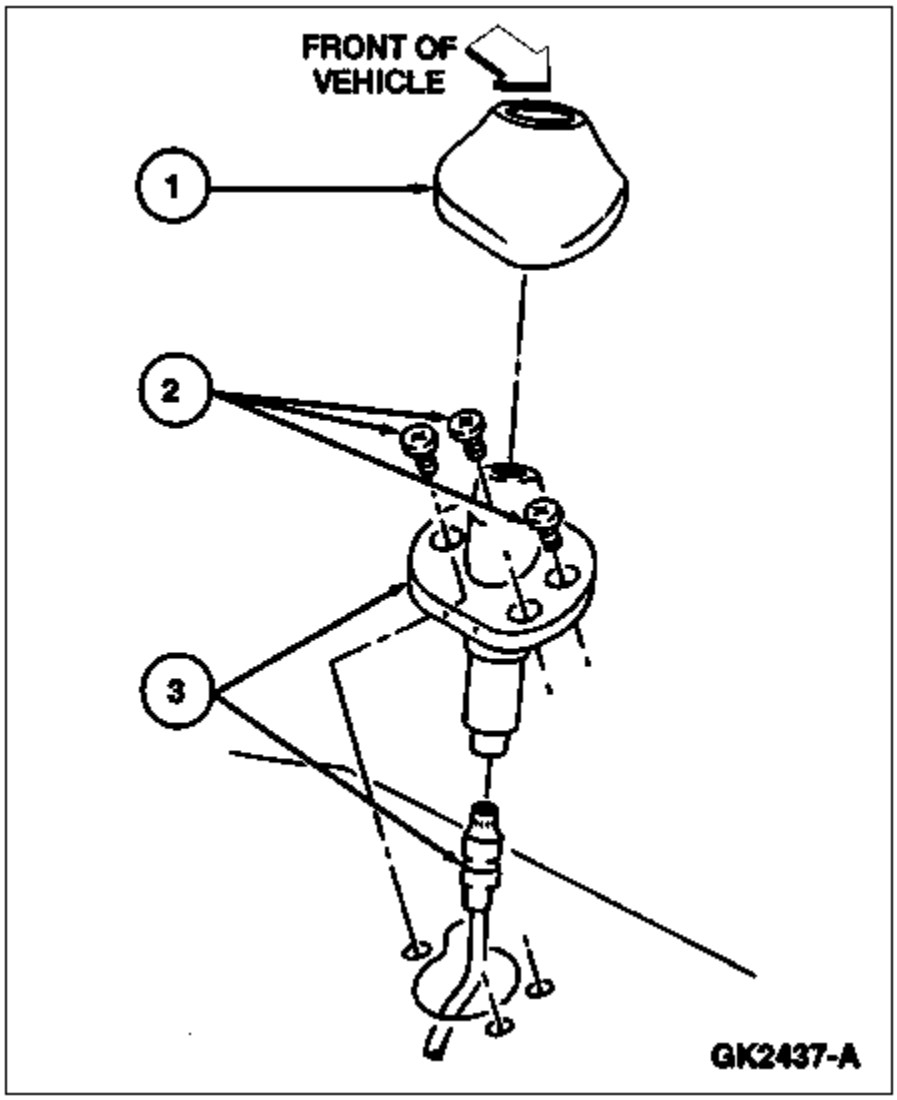


Item	Part Number	Description
1	16005	Front Fender (RH)
2	18812	Radio Antenna Lead In Cable
3	—	Seat Grommet (Part of 18812)
4	N610019-S36	Screw (3 Req'd)
5	18A927	Radio Antenna Base Cap
6	18946	Radio Antenna Base Gasket
7	18919	Radio Antenna Stanchion

Antenna Cable Routing, Ranger



Item	Part Number	Description
1	—	In-Line Connector (Part of 18812)
2	18812	Radio Antenna Lead In Cable
3	—	Antenna Cable to Base (Part of 18A984)



Item	Part Number	Description
1	18A927	Radio Antenna Base Cap
2	N610019-S36	Screw (3 Req'd)
3	—	Base and Cable Assembly (Part of 18A984)

Radio Speakers

All vehicles are equipped with standard or premium sound radio speakers (18808). Aerostar vehicles equipped with the standard AM radio chassis (18806) have one radio speaker installed in the instrument panel (04320). Ranger vehicles with AM radio chassis have two door radio speakers.

On Aerostar, the AM/FM stereo system includes two radio speakers and four for Premium sound. All Ranger AM/FM stereo systems have two door and two rear radio speakers, which in Ranger Regular Cab are mounted in the rear door pillars. Additionally, Ranger SuperCab has two rear stereo radio speakers.

Standard radio speakers are 3.2 ohms. Premium sound radio speakers are either 6 ohms or 8 ohms (coaxial).

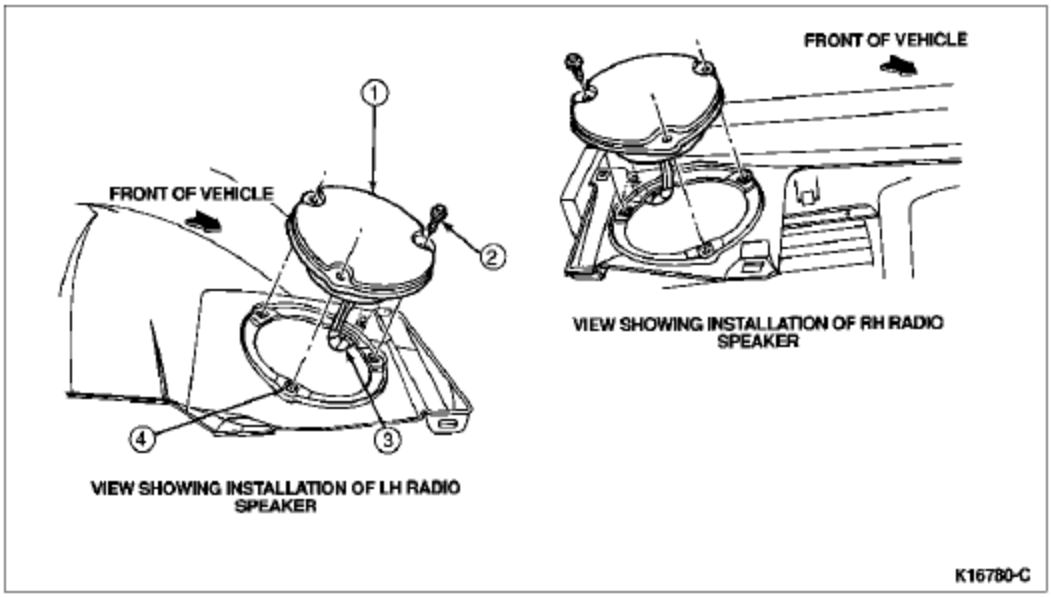
Radio Speakers, Instrument Panel, Aerostar

Removal and Installation

1. Remove the instrument panel pad. Refer to Section 01-12 .
2. Remove the three retaining screws.
3. Lift the radio speaker (18808), disconnect the wiring connector (14487) and remove the radio speaker from the vehicle.

For installation, follow removal procedures in reverse order.

Radio Speakers, Instrument Panel, Aerostar



Item	Part Number	Description
1	18808	Radio Speaker
2	N807122-S411	Screw
3	14401	Wiring Assembly
4	N802539-S100	Nut

Radio Speakers, Quarter Trim Panel, Aerostar Wagon

Removal and Installation

1. **CAUTION: Do not operate the radio chassis (18806) with the radio speaker disconnected.**

   Remove the four screws attaching the radio speaker to the radio speaker mounting plate (18963).

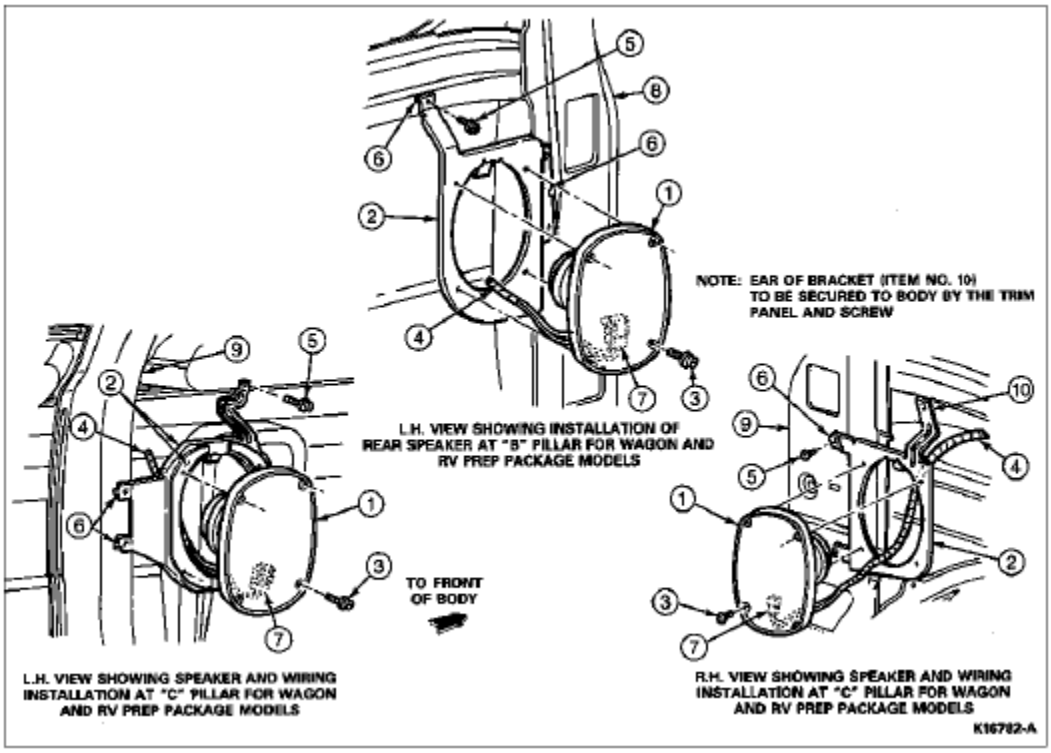
2. Remove the radio speaker from body side trim panel. Then disconnect the wiring connector at the radio speaker, and remove the radio speaker from the vehicle.

3. If the radio speaker mounting plate needs to be removed, the body side trim panel must be removed to gain access to the radio speaker mounting plate attaching screws. Refer to Section 01-05B for trim panel removal and installation procedures.

4. Remove four screws attaching radio speaker mounting plate to the vehicle and remove the radio speaker mounting plate.

For installation, follow removal procedures in reverse order.

Radio Speakers, Body Side Trim Panel, Aerostar Wagon



Item	Part Number	Description
1	18808	Radio Speaker
2	18963	Radio Speaker Mounting Plate
3	56902-S2	Screw
4	14405	Rear Lamp Wiring
5	56928-S2	Screw
6	—	Locator Tab (Part of 19B141 Speaker Mounting

		Plate)
7	—	Speaker Wiring Connector (Part of 14405 Wiring Assembly)
8	—	B-Pillar (Part of 5005)
9	—	C-Pillar (Part of 5005)
10	—	Bracket Ear (Part of 19B141 Mounting Plate)

Radio Speakers, Aerostar Cargo Van

Removal and Installation

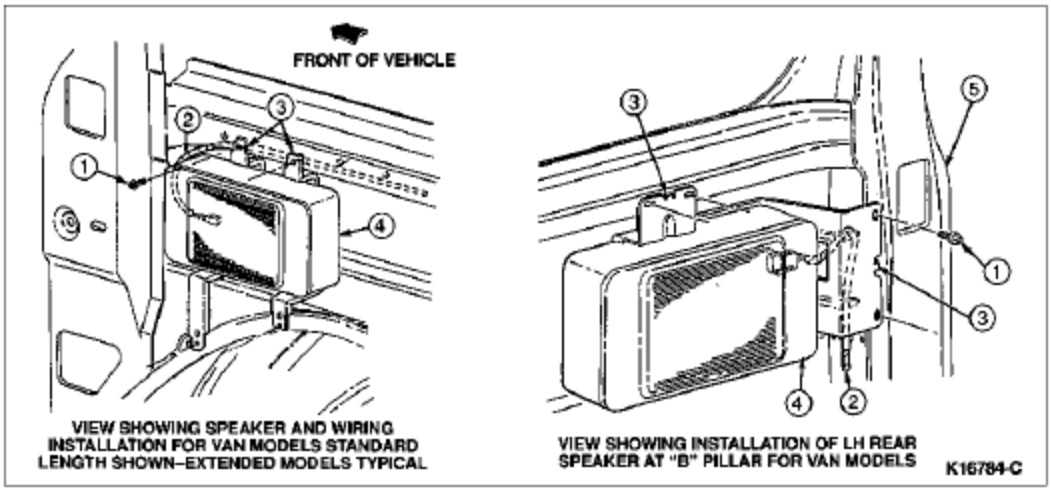
1. **CAUTION: Do not operate the radio chassis with the radio speaker disconnected.**

   Remove four screws attaching the radio speaker and radio speaker mounting bracket (18807).

2. Remove radio speaker mounting bracket and disconnect wiring connector at the enclosure.

For installation, follow removal procedures in reverse order.

Radio Speaker Installation, Aerostar Cargo Van



Item	Part Number	Description
1	56928-S2	Screw
2	14405	Rear Lamp Wiring
3	18963	Radio Speaker Mounting Plate
4	18808	Radio Speaker
5	—	B-Pillar (Part of 5005)

Radio Speakers, Front Door, Ranger

Removal and Installation

1. **CAUTION: Do not operate the radio chassis (18806) with the radio speaker (18808) disconnected.**

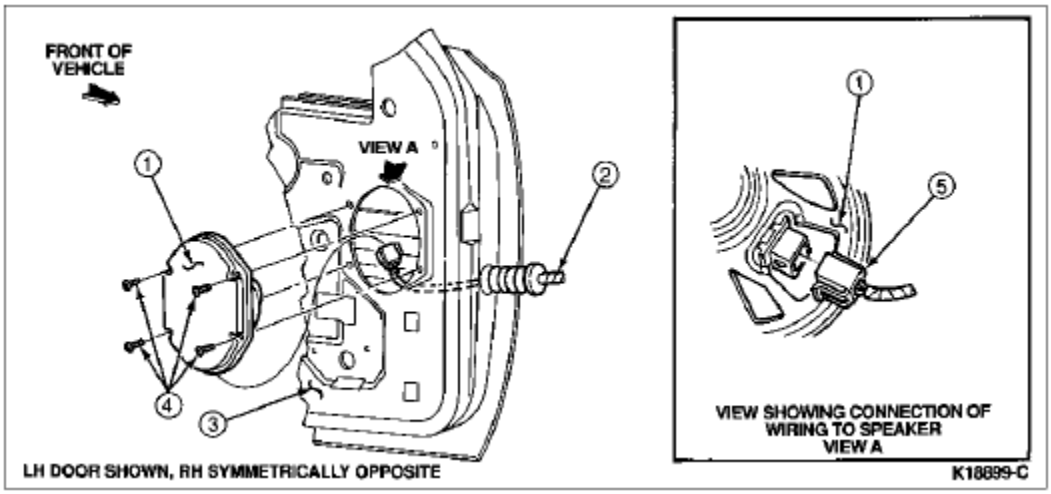
   Remove door trim panel. Refer to Section 01-05A .

2. Remove four screws attaching the radio speaker to the door panel.

3. Lift radio speaker and disconnect wiring connector (14487) at radio speaker. Remove speaker from door.

For installation, follow removal procedures in reverse order.

Radio Speakers, Front Door, Ranger



Item	Part Number	Description
1	18808	Radio Speaker
2	14630	Wiring Assembly
3	23942	Door Panel
4	56910-S40	Screw
5	14487	Wiring Connector

Radio Speakers, Rear Trim Panel, Ranger Regular Cab

Removal and Installation

1. **CAUTION: Do not operate the radio chassis (18806) with the radio speaker (18808) disconnected.**

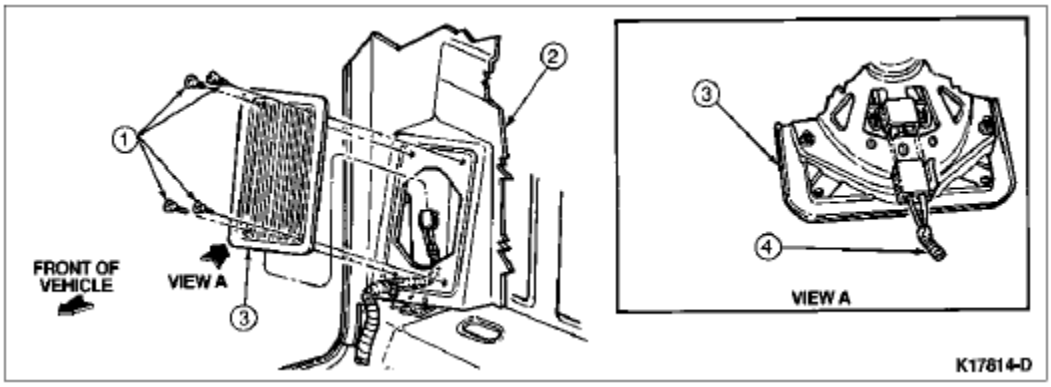
   Remove the screws holding the radio speaker to the trim panel.

2. Disconnect the wiring connector (14487) at the radio speaker.

3. Remove the radio speaker from the vehicle.

For installation, follow removal procedures in reverse order.

Rear Speaker Installation, Ranger Regular Cab



Item	Part Number	Description
1	N610019-S2	Screw
2	23942	Trim Panel
3	18978	Radio Speaker Grille
4	13A724	Courtesy Lamp Switch Extension Wiring

Radio Speakers, Rear, Ranger SuperCab

Removal and Installation

1. **CAUTION: Do not operate the radio chassis with the radio speaker disconnected.**

Remove four screws attaching the radio speaker to the radio speaker mounting plate (18963).

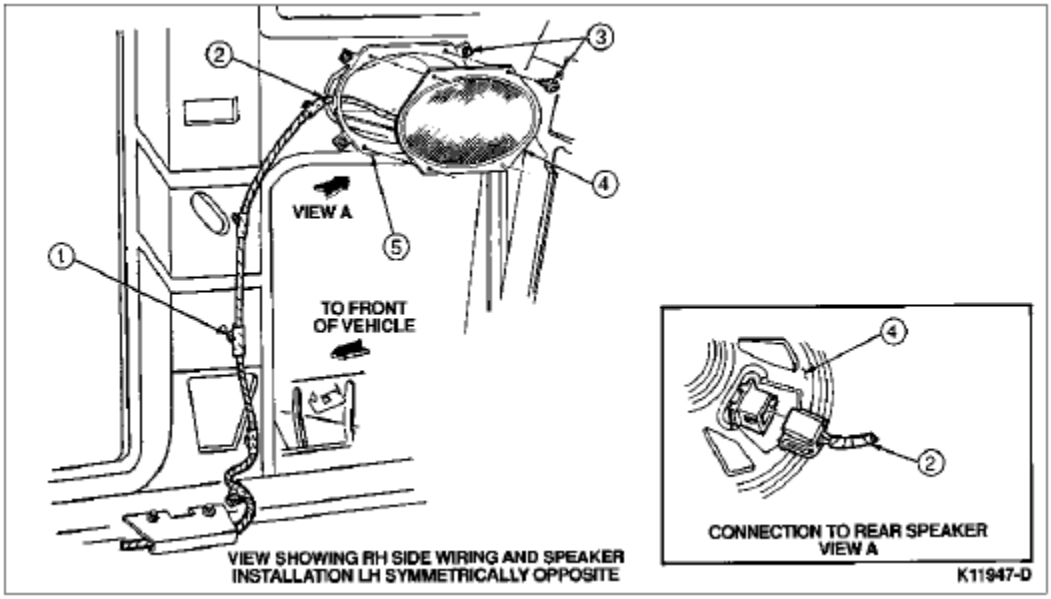
2. Lift radio speaker and disconnect wiring connector at radio speaker. Remove radio speaker from radio speaker mounting plate.

3. If the radio speaker mounting plate needs to be removed, the body side trim panel must be removed. Refer to Section 01-05A for trim panel removal and installation procedures.

4. Remove the four screws attaching the radio speaker mounting plate to the vehicle and remove the radio speaker mounting plate.

For installation, follow removal procedures in reverse order.

Radio Speaker Installation, Rear Door, Ranger SuperCab



Item	Part Number	Description
1	—	Locating Tab (Part of 14334)
2	14334	Courtesy or Interior Lamp Switch Wiring
3	56910-S40	Screw
4	18808	Radio Speaker
5	18963	Radio Speaker Mounting Plate

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-In
Front Radio Speaker Retaining Screws	2.0-2.8	18-25

Headlamps

Aerodynamic

Two aerodynamically styled headlamps are used. Each lamp uses a dual filament halogen headlamp bulb (13007). A burned out headlamp bulb on the Ranger may be replaced without removing the headlamp. On Aerostar, replacing a burned-out headlamp bulb requires removal of the headlamp. Headlamps are controlled by the headlamp switch (11654) on the instrument panel (04320) and the multi-function switch (13K359) for high beams on the left side of the steering column.

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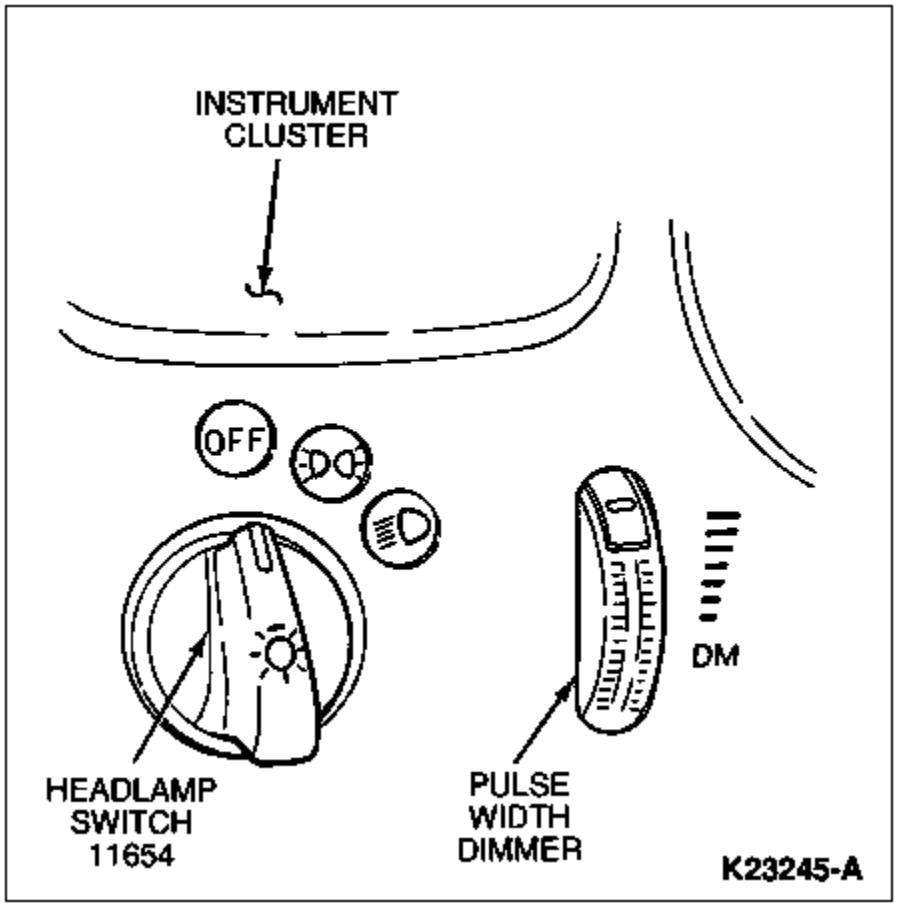
Headlamp Switch

The headlamp switch (11654) on an Aerostar is a pull-type. Pulling the switch to the first detent turns on the park, tail and marker lamps. Pulling the knob all the way out to the second detent turns on the headlamps. The switch also contains the rheostat for dimming the instrument cluster illumination lamps.

Ranger vehicles are equipped with a rotary type headlamp switch. Turning the knob to the first detent turns on the park and other exterior lamps. The second position turns on the headlamps. This switch does not contain a dimming rheostat. Intensity of the instrument panel lights is controlled by a separate pulse width dimmer located to the right of the headlamp switch.

Rotary-Type Headlamp Switch, Ranger



On all vehicles, the headlamp switch is not directly connected to the headlamps. The switch feeds the dimmer switch which is directly connected to the headlamps. The dimmer switch is part of the multi-function switch which is mounted on the left side of the steering column. The turn signal lever is used to switch the headlamp between high and low beams. In its normal, centered position, the dimmer switch completes the circuit to the low beam headlamps. Pushing the lever away from the steering wheel turns on the high beam headlamps. The switch also contains the flash-to-pass function. When the lever is pulled toward the steering wheel, the switch completes the circuit to the high beam headlamps. The switch is spring loaded and will return to the OFF or low beam position when the turn signal lever is released.

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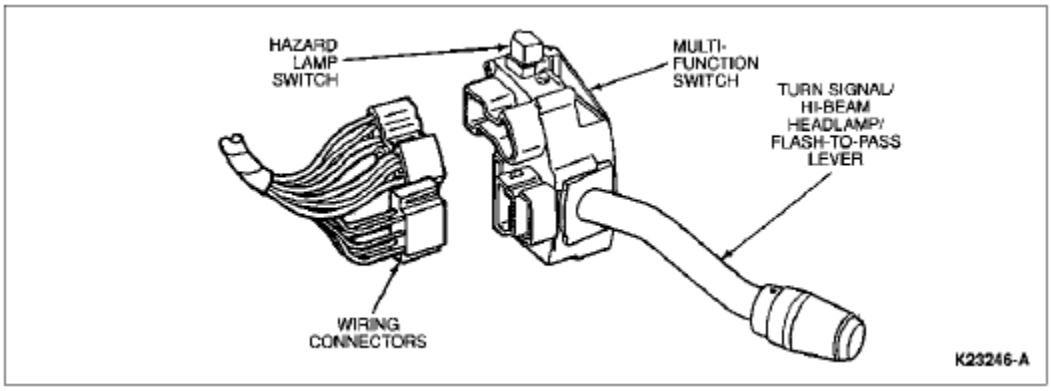
Multi-Function Switch



Headlamps On Warning Buzzer/Chime

For description and operation, refer to Section 13-09 .

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Lamps, Fog

The fog lamps (15200) are mounted to the front bumper (17757). The lamp circuit is controlled by a fog lamp switch (15A214) on the instrument panel (04320). A fuse in the fuse junction panel (14A067) protects the circuit. Fog lamps can only be operated with the headlamp switch (11654) in the low beam position. The circuit will not be completed with the headlamps in the high beam position, parking lamp position, or the OFF position.

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Switch, Fog Lamp

Thefog lamp switch (15A214) is the bottom switch in the row of switches to the right of the radio.

- Push fog lamp switch in to turn fog lamps (15200) on.
- Push fog lamp switch out to shut off fog lamps.

The fog lamp switch is not directly connected to the fog lamps. In the ON position, the switch provides a ground circuit for the fog lamp relay coil. The coil closes the relay contacts which complete the battery feed circuit to the fog lamps.

A separate circuit on the lamp side of the relay illuminates a light emitting diode (LED) in the switch when the fog lamps are on.

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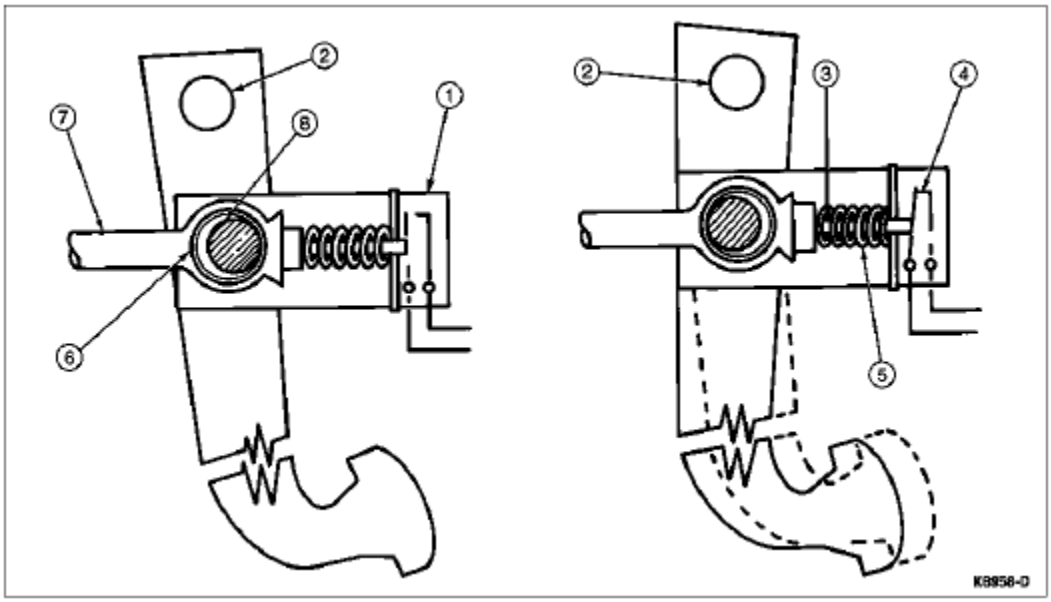
Brake ON/OFF (BOO) Switch

The mechanical brake ON/OFF switch is installed onto the pin of the brake pedal arm. It straddles the vacuum booster input rod, but is not attached directly to the input rod. The brake ON/OFF switch moves with the pedal arm when the brake pedal (2455) is pressed.

The circuit from the brake ON/OFF switch to the stoplamps provides a signal indicating the brake pedal has been pressed. The signal is routed to the following electrical systems:

- Electronic engine control (EEC)
- Brake shift interlock
- Electronic 4-wheel drive
- Anti-lock brake (ABS)
- Speed control
- Generic electronic module (GEM)
- Trailer tow

Brake ON/OFF (BOO) Switch



Item	Part Number	Description
1	13480	Brake ON/OFF (BOO) Switch
2	—	Pivot (Part of 2455)
3	—	Switch Actuating Pin (Part of 13480)

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4	—	Switch Contacts (Part of 13480)
5	—	Stoplamp Switch Spring (Part of 13480)
6	—	Input Rod Eye (Part of 2455)
7	—	Vacuum Booster Input (Part of 2455)
8	—	Brake Pedal Arm Pin (Part of 2455)

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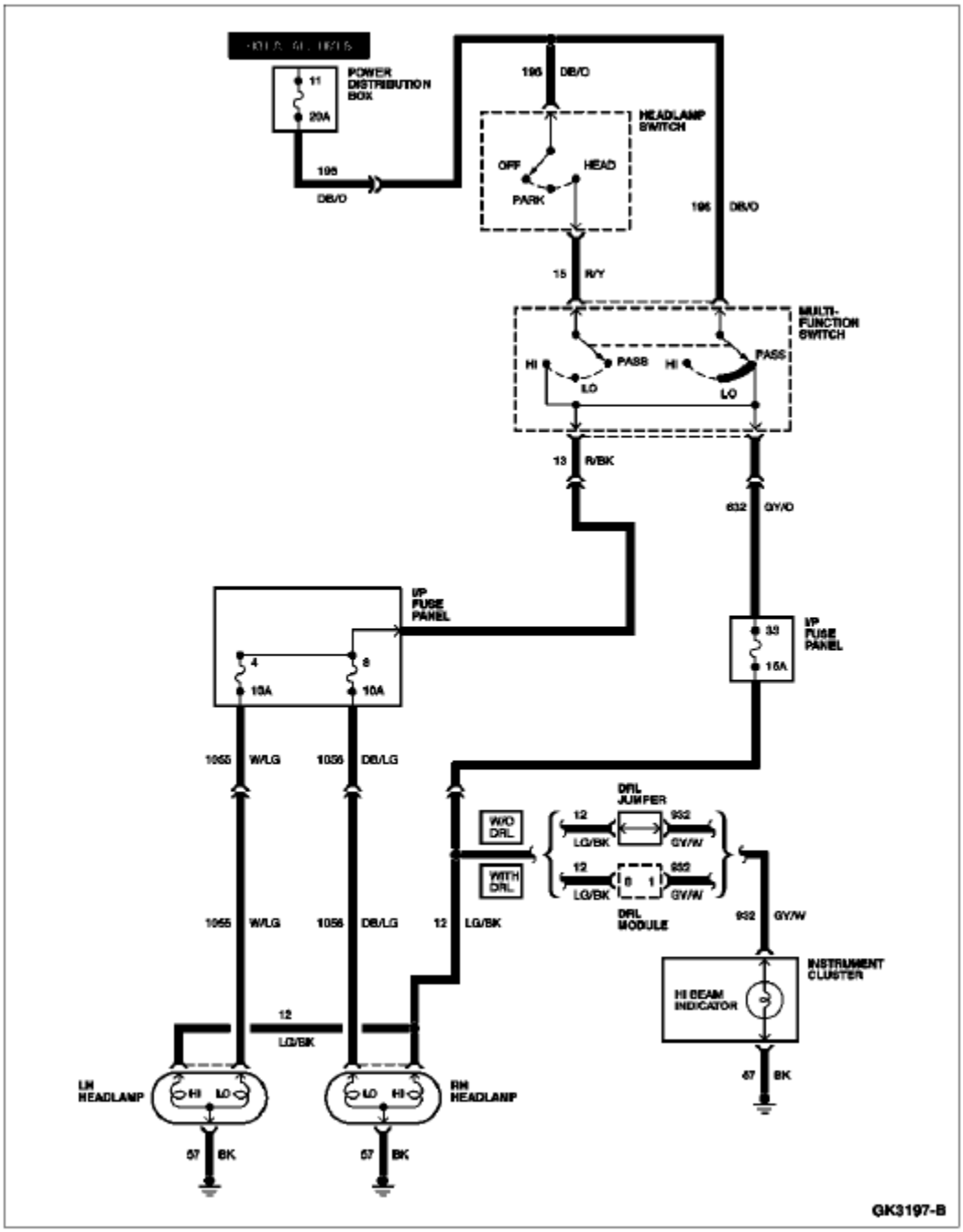
Electrical Schematics — Headlamps

Headlamps Ranger



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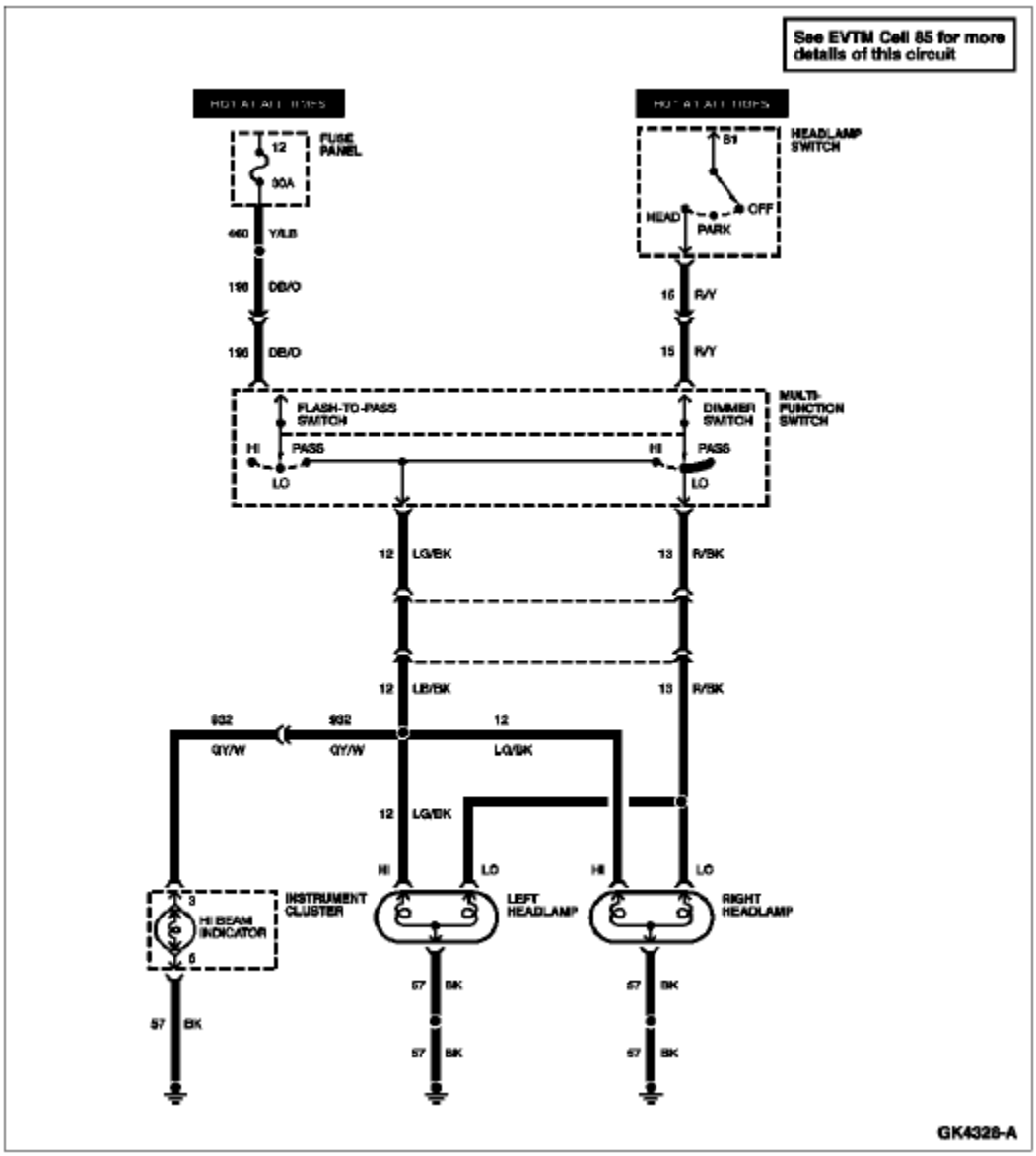
Headlamps, Aerostar



Multi-Function Switch, Aerostar

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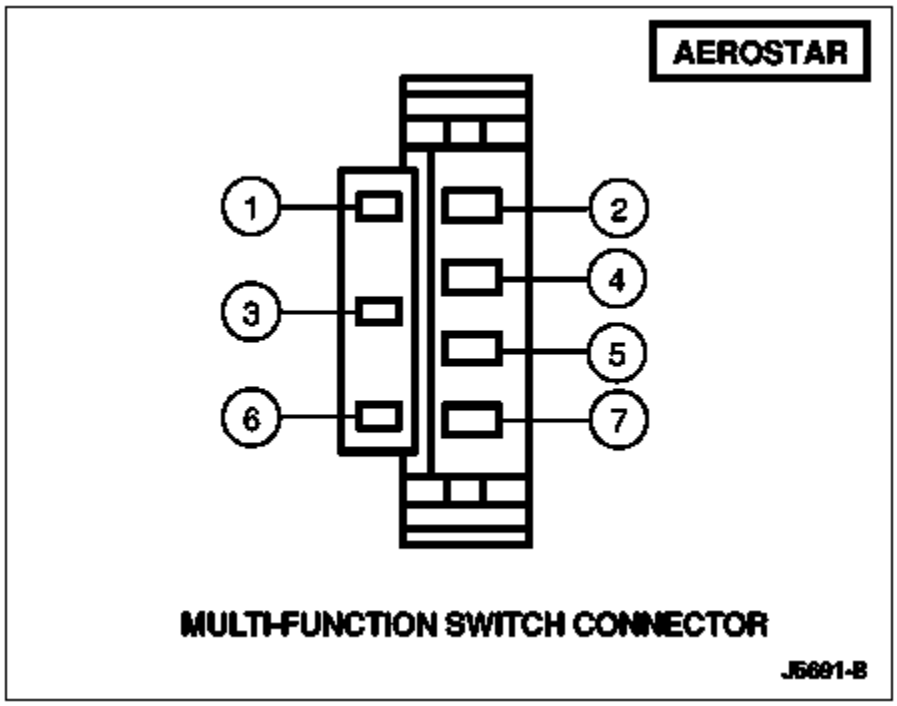

Pin Number	Circuit	Circuit Function
1	589 (O)	Windshield Wiper Switch to Intermittent Governor Ground
2	15 (R/Y)	Headlamp Dimmer Switch Feed
3	993 (BR/W)	Intermittent Governor to Windshield Wiper Switch
4	13 (R/BK)	Headlamp Dimmer Switch to Low Beams
5	12 (LG/BK)	Headlamp Dimmer Switch to High Beams
6	590 (DB/W)	Intermittent Governor to W/S Wiper Switch
7	196 (DB/O)	Headlamp Flash to Pass Switch Feed

Headlamp Switch, Ranger

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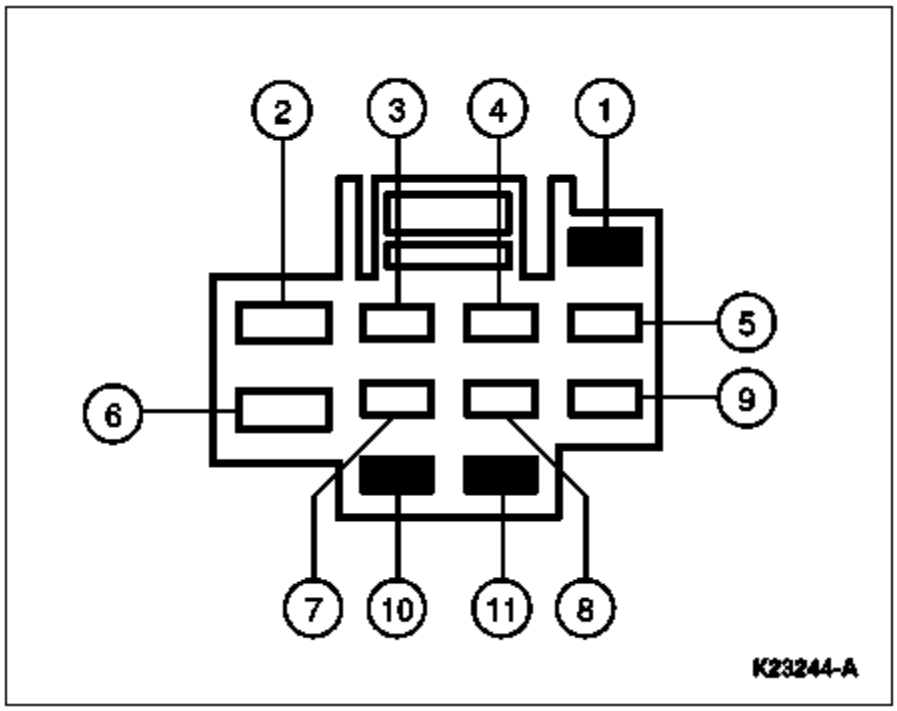

Circuit Function	Pin Number	Circuit
1	—	Not Used
2	15 (R/Y)	Headlamp Switch to Dimmer Switch
3	1032 (W/BK) 14 (BR)	Headlamp Switch to Park Lamp Relay (Ranger with Anti-Theft) Headlamp Switch to Park Lamps (Ranger Without Anti-Theft)
4	640 (R/Y)	Fused Ignition Feed
5	195 (T/W)	Park Lamp Battery Feed
6	196 (DB/O)	Battery Feed to Headlamp Switch
7	57 (BK)	Switch Illumination Ground
8	484 (O/BK)	Headlamp Switch to 4x4, Speed Control and Overdrive Warning Lamps
9	19 (LB/R)	Pulse Width Dimmer to Headlamp Switch
10	—	Not Used
11	—	Not Used

Multi-Function Switch, Ranger

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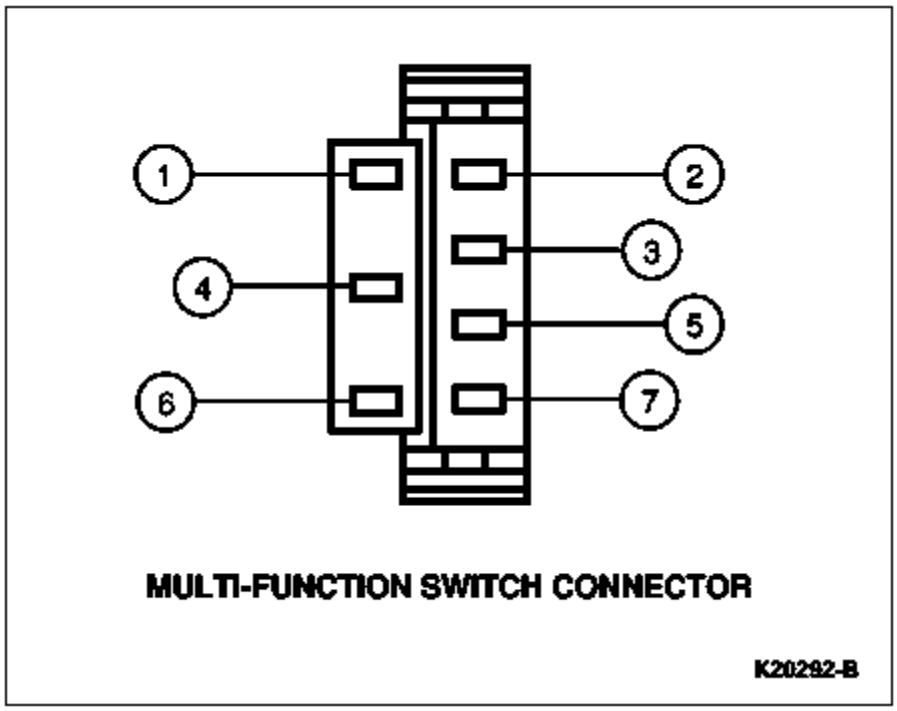

Pin Number	Circuit	Circuit Function
1	684 (PK/Y)	Front Wiper Switch Mode Select to GEM Module Input
2	15 (R/Y)	Headlamp Dimmer Switch Feed
3	13 (R/BK)	Headlamp Dimmer Switch to Low Beams
4	359 (GY/R)	Wiper Switch Common Circuit
5	632 (GY/O)	Dimmer Switch to High Beam Headlamp Fuse
6	680 (LB/O)	Front Wiper Switch Delay/Wash to GEM Module — Input
7	196 (DB/O)	Headlamp Flash-to-Pass Switch Feed

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Inspection and Verification — Headlamps (Without Autolamps/Exit Delay)

1. Verify the customer concern by operating the headlamp system.
2. Visually inspect the components of the headlamp system.
3. Check the wiring harness for obvious signs of shorts, opens, bad connections, or damage.
4. Check for improperly installed accessories.
5. If fault is not visually evident, determine the symptom and proceed to the following Symptom Chart.

VISUAL INSPECTION CHART

Mechanical	Electrical
• None	• Blown fuse(s) • Damaged headlamp bulb(s) • Damaged wiring harness • Loose or corroded connections

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Symptom Chart — Headlamps (Without Autolamps/Exit Delay)

NOTE: Use 73 Digital Multimeter 105-R0051, or equivalent, to perform electrical pinpoint tests.

HEADLAMPS

Condition	Possible Source	Action
• Headlamps Inoperative	• Fuse. • Circuit. • Headlamp switch.	• GO to Pinpoint Test A.
• Headlamps On Continuously	• Autolamp system (if equipped). • DRL system (if equipped). • Headlamp switch. • Dimmer switch.	• REFER to autolamp system diagnosis in this section. • REFER to DRL system diagnosis in Section 17-04. • GO to Pinpoint Test B.
• High Beam Headlamps Inoperative	• Fuse. • Headlamp switch. • Multi-function switch. • Circuit.	• GO to Pinpoint Test C.
• Low Beam Headlamps Inoperative	• Fuse. • Multi-function switch. • Bulbs.	• GO to Pinpoint Test D.
• One High or One Low Beam Headlamps Inoperative	• Headlamp bulb. • Circuit. • Headlamp switch.	• GO to Pinpoint Test E.
• Flash-to-Pass Inoperative	• Circuit. • Multi-function switch.	• GO to Pinpoint Test F.

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Pinpoint Tests — Headlamps (Without Autolamps/Exit Delay)

PINPOINT TEST A: HEADLAMPS INOPERATIVE

A1 CIRCUIT PROTECTION

- On Ranger move turn signal lever to flash-to-pass position. On Aerostar, move headlamp switch to parking light position.

Does flash-to-pass operate (Ranger) or do parking lights come on (Aerostar)?

Yes	No
GO to **A2** .	CHECK fuse 11 in power distribution box (Ranger) or fuse 4 (Aerostar). If fuse is not blown, REPAIR open in wire between fuse panel and headlamp switch.

A2 BATTERY FEED TO HEADLAMP SWITCH

- Remove headlamp switch.
- Check for battery voltage at switch battery feed terminal.

Is battery voltage present?

Yes	No
GO to **A3** .	REPAIR open battery feed wire.

A3 HEADLAMP SWITCH CHECK

- Connect wiring to switch.
- Turn headlamps on.
- Check for battery voltage at headlamp switch to dimmer switch terminal (R/Y).

Is battery voltage present?

Yes	No
GO to **A4** .	REPLACE headlamp switch.

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A4 DIMMER SWITCH FEED WIRE

- Disconnect wiring at multi-function switch.
- Turn headlamp switch on.
- Check for battery voltage at dimmer switch feed wire (R/Y).

Is battery voltage present?

Yes	No
REPLACE multi-function switch.	REPAIR open in switch feed wire.

PINPOINT TEST B: HEADLAMPS ON CONTINUOUSLY

B1 SHORTED HEADLAMP SWITCH

- Disconnect wiring at headlamp switch.

Are headlamps off?

Yes	No
REPLACE headlamp switch.	GO to **B2** .

B2 SHORTED DIMMER SWITCH

- Disconnect wiring at multi-function switch.

Are headlamps off?

Yes	No
REPLACE multi-function switch.	REPAIR short to battery power in headlamp circuit.

PINPOINT TEST C: HIGH BEAM HEADLAMPS INOPERATIVE

C1 CIRCUIT PROTECTION (RANGER)

- Check fuse 33; interior fuse panel.

Is fuse blown?

Yes	No

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REPLACE fuse. If fuse blows again, REPAIR short to ground in LG/BK wire.	GO to **C2** .

C2 DIMMER SWITCH CHECK

- Turn headlamp switch on and dimmer switch in high beam position.
- Check for battery voltage at multi-function switch terminal with LG/BK wire (Aerostar) or GY/O wire (Ranger).

Is battery voltage present?

Yes	No
GO to **C3** .	REPLACE multi-function switch.

C3 ISOLATE HEADLAMP BULBS

- Remove a headlamp bulb.
- Inspect bulb for broken filament.

Is bulb OK?

Yes	No
REPAIR open in wire from multi-function switch to headlamps. **NOTE: If high beam indicator light comes on, CHECK for open in engine compartment wiring. If indicator light does not come on, CHECK for open in instrument panel wiring.**	REPLACE headlamp bulbs.

PINPOINT TEST D: LOW BEAM HEADLAMPS INOPERATIVE

D1 CIRCUIT PROTECTION (RANGER ONLY)

- Check fuses 4 and 8.

Are fuses blown?

Yes	No
REPLACE fuses. If fuse blows again, REPAIR shorts to ground in wires between fuse panel and headlamps.	GO to **D2** .

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D2 DIMMER SWITCH CHECK

- Turn headlamp switch on and dimmer switch in LO beam position.
- Check for battery voltage at multi-function switch terminal (R/BK).

Is battery voltage present?

Yes	No
GO to **D3** .	REPLACE multi-function switch.

D3 ISOLATE HEADLAMP BULBS

- Remove a headlamp bulb.
- Inspect bulb for broken filament.

Is bulb OK?

Yes	No
REPAIR open in wires from multi-function switch to headlamps.	REPLACE headlamp bulbs.

PINPOINT TEST E: ONE HIGH OR ONE LOW BEAM HEADLAMP INOPERATIVE

E1 ISOLATE BULB

- Remove headlamp bulb.
- Inspect bulb for broken filament. Inspect bulb socket for damage or corrosion.

Are bulb and socket OK?

Yes	No
GO to **E2** .	SERVICE as required.

E2 BATTERY FEED TO LAMP

- Turn headlamp switch ON and dimmer switch in required position.
- Check for battery voltage at headlamp feed wire (Aerostar, Ranger HI beam — LG/BK; Aerostar LO beam — R/BK; Ranger LH LO beam — W/LG; Ranger RH LO beam — DB/LG).

Is battery voltage present?

Yes	No

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GO to **E3** .	On Aerostar, REPAIR open in battery feed wire. On Ranger, CHECK fuse 4 for LH LO beam headlamp or fuse 8 for RH LO beam headlamp. On Ranger with HI beam headlamp inoperative, REPAIR open in battery feed wire.

E3 GROUND CIRCUIT

- Check for continuity between headlamp connector ground terminal (Circuit 57 [BK]) and clean chassis ground.

Is there continuity?

Yes	No
INSPECT lamp assembly for condition that could prevent lamp from coming on.	REPAIR ground Circuit 57 (BK).

PINPOINT TEST F: FLASH-TO-PASS INOPERATIVE

F1 ISOLATE DIMMER SWITCH

- Headlamps on and dimmer switch in HI beam position.

Are HI beam headlamps on?

Yes	No
REPLACE multi-function switch.	GO to Pinpoint Test C .

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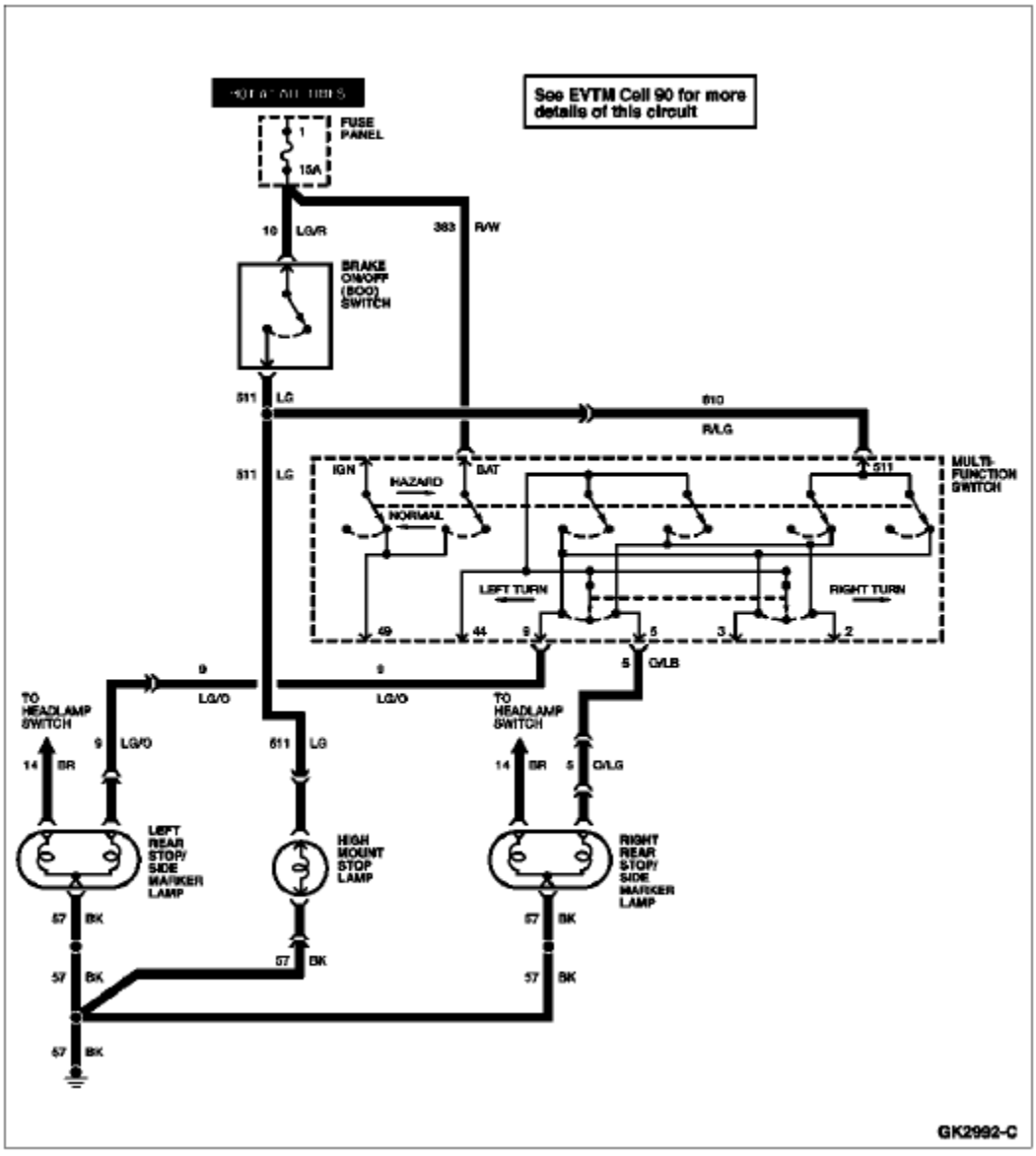
Electrical Schematics — Stoplamps

Stoplamps, Aerostar



Stoplamps, Ranger

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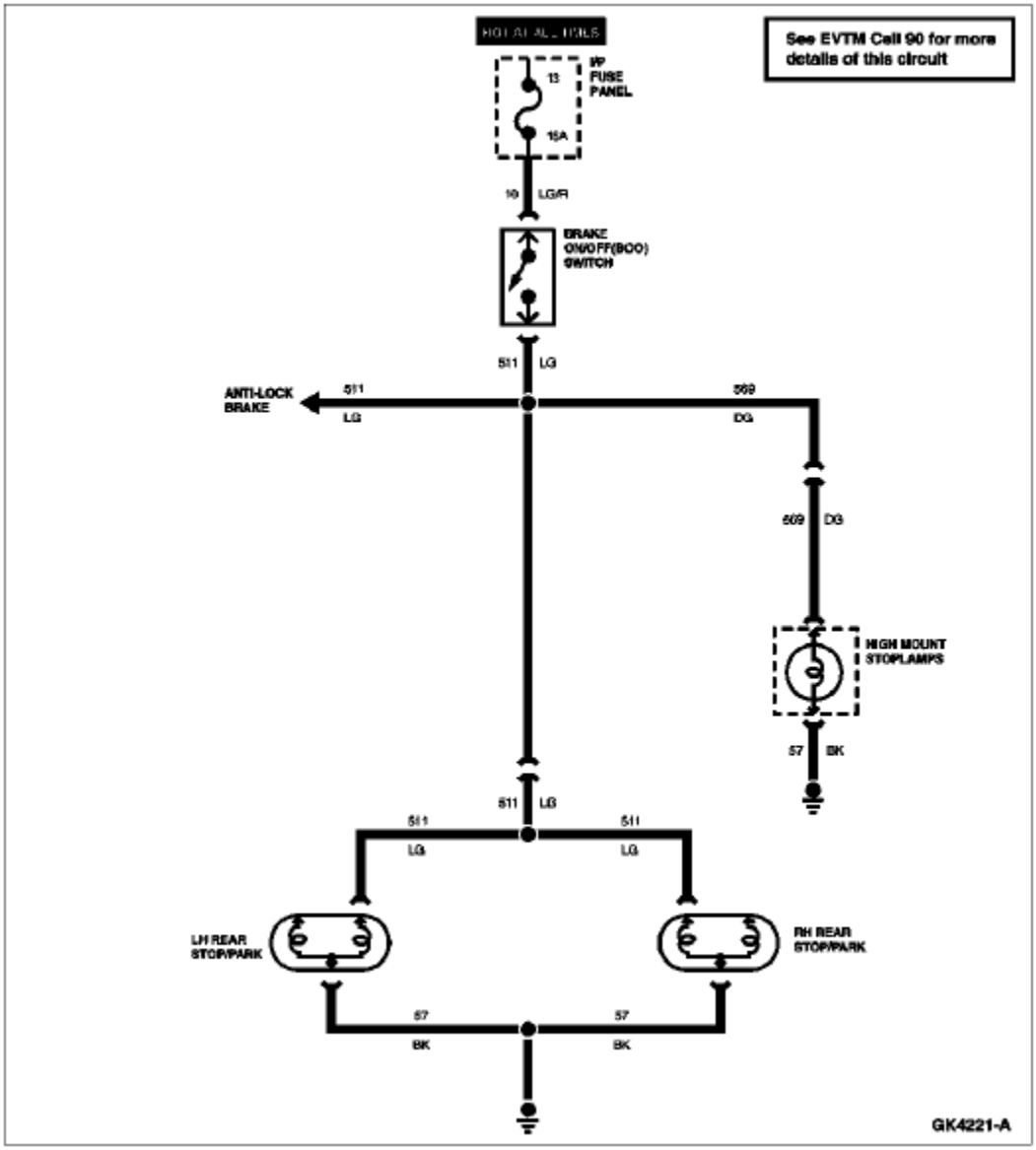

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Inspection and Verification — Stoplamps

1. Verify customer concern by operating the stoplamp system.
2. Visually inspect the components of the stoplamp system.

VISUAL INSPECTION CHART

Mechanical	Electrical
• None	• Blown fuse • Damaged stoplamp bulbs • Damaged wiring harness • Loose or corroded connections

3. Check the wiring harness for obvious signs of shorts, opens, bad connections, or damage.
4. If fault is not visually evident, determine the symptom and proceed to the following Symptom Chart.

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Symptom Chart — Stoplamps

NOTE: Use 73 Digital Multimeter 105-R0051, or equivalent, to perform electrical pinpoint tests.

STOPLAMPS

Condition	Possible Source	Action
• Stoplamps Inoperative	• Fuse. • Circuit. • Brake On/Off (BOO) switch.	• GO to Pinpoint Test G.
• Stoplamps On Continuously	• Brake On/Off (BOO) switch.	• GO to Pinpoint Test H.
• Individual Stoplamp Inoperative	• Stoplamp bulb. • Circuit.	• GO to Pinpoint Test J.

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Pinpoint Tests — Stoplamps

PINPOINT TEST G: STOPLAMPS INOPERATIVE

G1 BATTERY FEED TO LAMPS

- Remove a stoplamp bulb.
- Have assistant press brake pedal.
- Check for battery voltage at lamp socket battery feed terminal.

Is battery voltage present?

Yes	No
GO to **G2** .	REPAIR open in lamp feed circuit.

G2 COMMON GROUND CIRCUIT CHECK

- Set headlamp switch in park lamp position.

Are park lamps ON?

Yes	No
CHECK bulbs. Service as required.	REPAIR ground Circuit 57 (BK).

PINPOINT TEST H: STOPLAMPS ON CONTINUOUSLY

H1 SHORTED STOPLAMP SWITCH

- Disconnect wiring at stoplamp switch.

Are stoplamps off?

Yes	No
REPLACE switch.	GO to **H2** .

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H2 ISOLATE 14401 WIRING HARNESS

- Disconnect 14401 wiring harness to 14405 (Aerostar) or 14A488 (Ranger) wiring harness connector.
- Check for battery voltage at Pin 7 (Aerostar) or Pin 77 (Ranger).

Is battery voltage present?

Yes	No
REPAIR short to battery power in 14401 wiring harness.	REPAIR short to battery power in wiring harness from 14405 (Aerostar) or 14A488 (Ranger).

PINPOINT TEST J: INDIVIDUAL STOPLAMP INOPERATIVE

NOTE: If neon stoplamp is inoperative, refer to Pinpoint Test P.

J1 BULB AND SOCKET

- Remove bulb.
- Inspect bulb for broken filament. Check bulb socket for corrosion or damage.

Are bulb and socket OK?

Yes	No
GO to **J2** .	SERVICE as required.

J2 BATTERY FEED TO STOPLAMP

- Disconnect wiring at lamp.
- Have assistant press brake pedal.
- Check for battery voltage at connector feed terminal.

Is voltage present?

Yes	No
GO to **J3** .	REPAIR open in wire between connector and stoplamp splice.

J3 STOPLAMP GROUND

- Check for continuity between connector ground terminal (BK) and clean chassis ground.

Is there continuity?

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Yes	No
CHECK lamp assembly for condition that would prevent bulb from coming on.	REPAIR open in ground circuit (BK).

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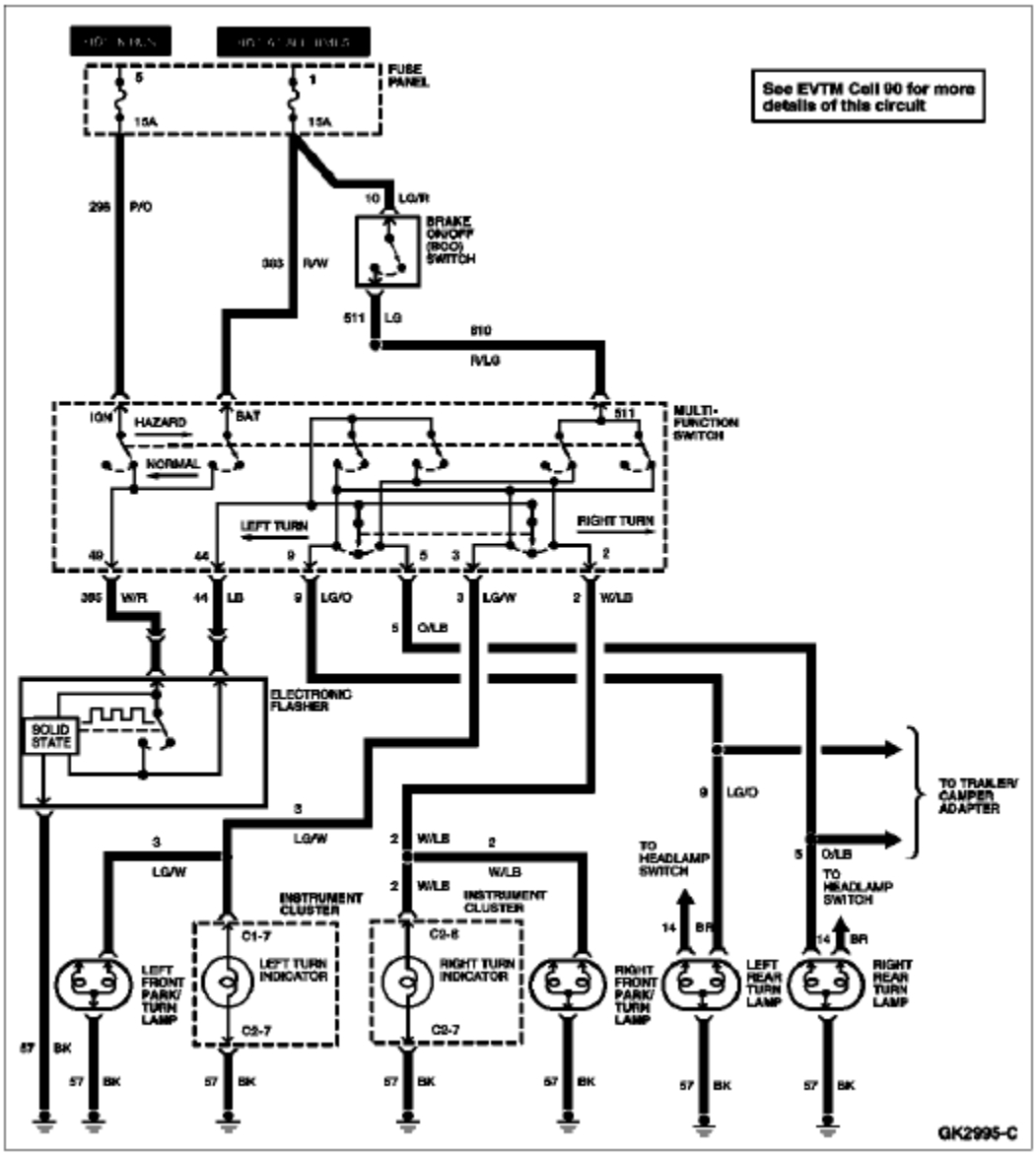
Electrical Schematics — Turn Signal Lamps/Hazard Flasher Lamps

Turn Signal Lamps/Hazard Flasher Lamps, Aerostar



Turn Signal Lamps/Hazard Flasher Lamps, Ranger

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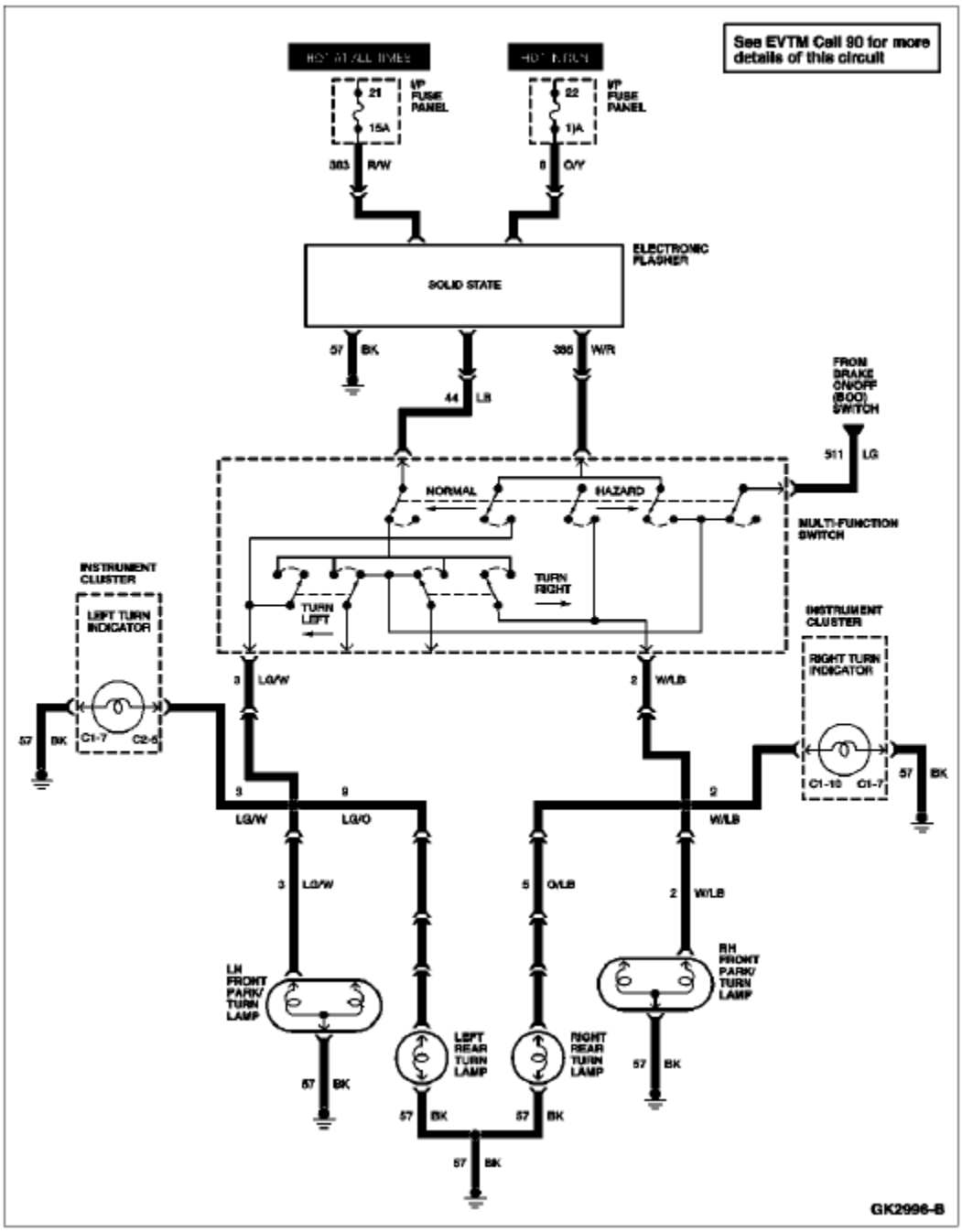

Multi-Function Switch Connector, Aerostar

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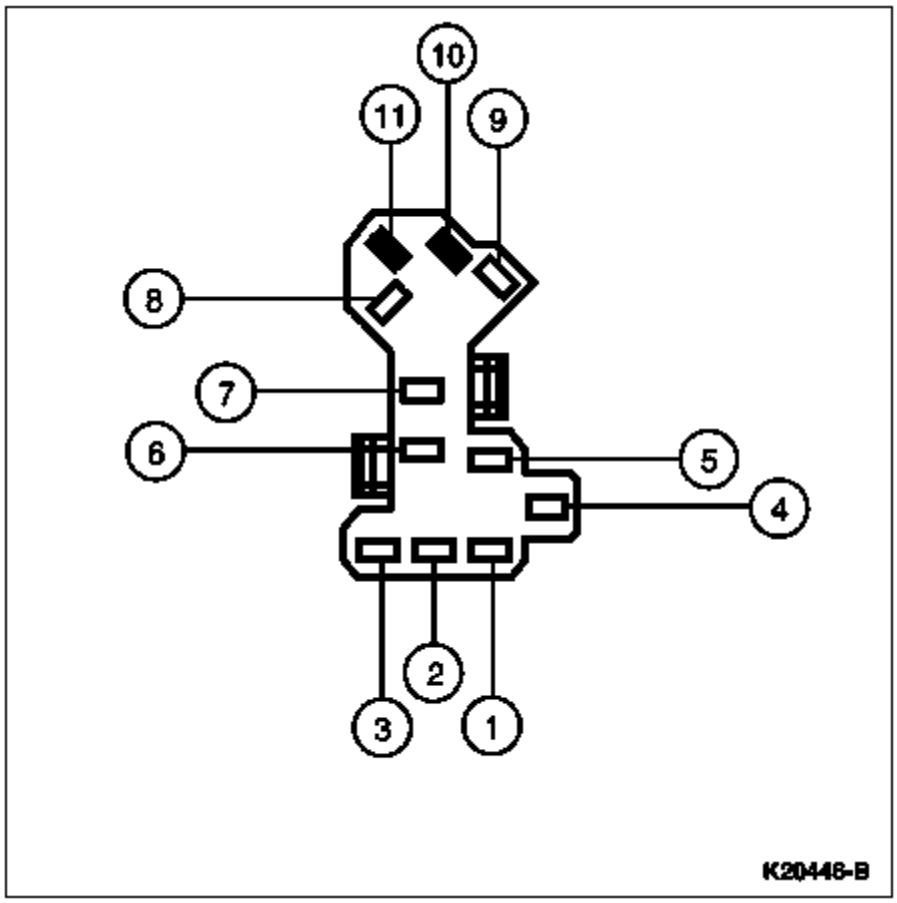

Pin Number	Circuit	Circuit Function
1	3 (LG/W)	Front Turn Signal Lamp (LH)
2	383 (R/W)	Emergency Warning Flasher Feed
3	298 (P/O)	Fused Run Only Feed
4	385 (W/R)	Flasher to Emergency Warning Switch
5	810 (R/LG)	Stoplamp Switch to Stoplamps
6	2 (W/LB)	Front Turn Signal Lamp (RH)
7	44 (LB)	Turn Signal Flasher to Turn Signal Switch
8	64 (DG)	Trailer Turn Signal (RH)
9	52 (Y)	Trailer Turn Signal (LH)
10	—	Not Used
11	—	Not Used

Multi-Function Switch Connector, Ranger

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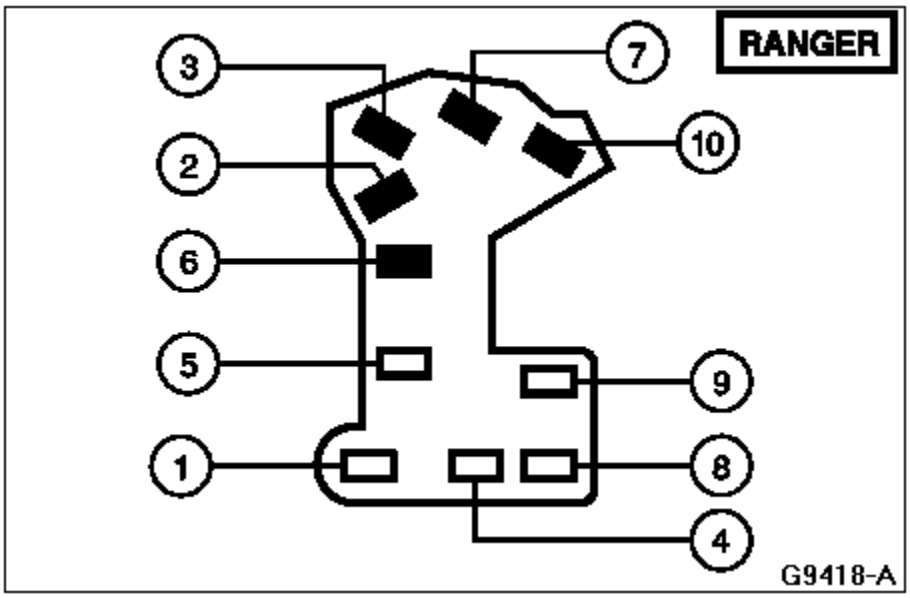

Pin Number	Circuit	Circuit Function
1	44 (LB)	Turn Signal Flasher to Turn Signal Switch
2	—	Not Used
3	—	Not Used
4	385 (W/R)	Hazard Lamp Switch
5	2 (W/LB)	Turn Signal Lamps (RH)
6	—	Not Used
7	—	Not Used
8	3 (LG/W)	Turn Signal Lamps (LH)
9	511 (LG)	Brake On/Off Switch to Turn Signal Switch
10	—	Not Used

Flasher Unit, Ranger

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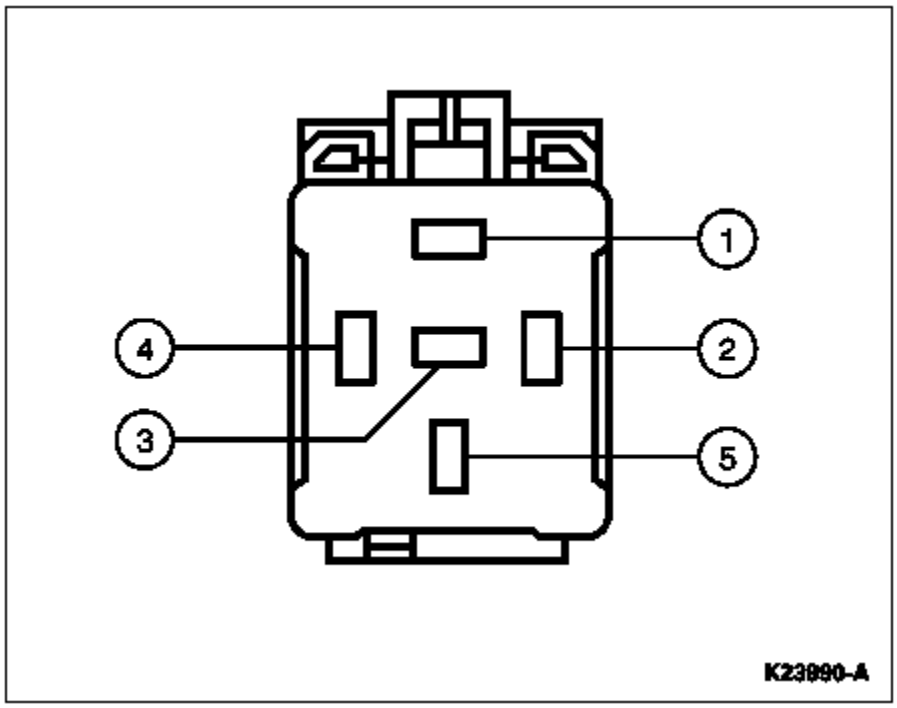

Pin Number	Circuit	Circuit Function
1	44 (LB)	Turn Signal Flasher to Turn Signal Switch
2	57 (BK)	Ground Circuit
3	385 (W/R)	Flasher to Hazard Lamp Switch
4	383 (R/W)	Battery Feed to Flasher Unit — Turn Signals
5	8 (D/Y)	Ignition Feed to Flasher Unit — Hazard Lamps

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Inspection and Verification — Turn Signal Lamps/Hazard Flasher Lamps

1. Verify customer concern by operating the turn signal/emergency warning system.
2. Visually inspect the components of the turn signal/emergency warning system.

VISUAL INSPECTION CHART

Mechanical	Electrical
• Damaged turn signal and windshield wiper switch • Damaged hazard lamp switch	• Blown fuse(s) • Damaged turn signal bulb(s) • Damaged wiring harness • Loose or corroded connections • Damaged indicator flasher

3. Check the wiring harness for obvious signs of shorts, opens, bad connections, or damage.
4. If fault is not visually evident, determine the symptom and proceed to the following Symptom Chart.

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Symptom Chart — Turn Signal Lamps/Hazard Flasher Lamps

NOTE: Use 73 Digital Multimeter 105-R0051, or equivalent, to perform electrical pinpoint tests.

TURN SIGNAL LAMPS/HAZARD FLASHER LAMPS

Condition	Possible Source	Action
• Turn Signal Lamps/Hazard Flasher Lamps Inoperative	• Fuse(s). • Circuit. • Hazard flasher switch. • Turn signal switch. • Diode junction box. • Indicator flasher.	• GO to Pinpoint Test K.
• Individual Lamp Inoperative	• Turn signal bulb (s). • Circuit.	• GO to Pinpoint Test L.
• Turn Signal Lamps On Continuously	• Turn signal switch.	• GO to Pinpoint Test M.
• Hazard Flasher Lamps Inoperative	• Fuse. • Circuit. • Hazard flasher switch.	• GO to Pinpoint Test N.

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Pinpoint Tests — Turn Signal Lamps/Hazard Flasher Lamps

PINPOINT TEST K: TURN SIGNAL LAMPS/HAZARD FLASHER LAMPS INOPERATIVE

K1 ISOLATE FLASHER UNIT

- Substitute known good flasher unit.

Do turn signals and hazard lamps operate?

Yes	No
REPLACE flasher unit.	GO to K2 .

K2 FLASHER UNIT GROUND

- Check for continuity between flasher unit connector ground terminal (BK) and clean chassis ground.

Is there continuity?

Yes	No
GO to K3 .	REPAIR ground Circuit 57 (BK).

K3 CIRCUIT PROTECTION

- Check fuses 5 and 1 (Aerostar) or fuses 21 and 22 (Ranger).

Are fuses blown?

Yes	No
REPLACE fuses.	REPLACE turn/hazard switch.

PINPOINT TEST L: INDIVIDUAL LAMP INOPERATIVE

L1 ISOLATE BULB AND SOCKET

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- Remove bulb.
- Check bulb for broken filament. Check bulb socket for damage or corrosion.

Are bulb and socket OK?

Yes	No
GO to **L2** .	SERVICE as required.

L2 BATTERY FEED TO LAMP

- Turn signal switch to side of vehicle with inoperative lamp.
- Check for battery voltage at lamp battery feed wire.

Is battery voltage present?

Yes	No
GO to **L3** .	REPAIR open in battery feed wire.

L3 GROUND CIRCUIT

- Check for continuity between lamp ground wire and clean chassis ground.

Is there continuity?

Yes	No
INSPECT lamp assembly for condition that could prevent lamp from coming on.	REPAIR open in ground Circuit 57 (BK).

PINPOINT TEST M: TURN SIGNAL LAMPS ON CONTINUOUSLY

M1 ISOLATE FLASHER UNIT

- Substitute known good flasher unit.

Are turn signals off?

Yes	No
REPLACE flasher unit.	REPLACE turn/hazard switch.

PINPOINT TEST N: HAZARD FLASHER LAMPS INOPERATIVE

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N1 CIRCUIT PROTECTION (RANGER)

- Check fuse 21 in interior fuse panel.

Is fuse blown?

Yes	No
REPLACE fuse.	GO to N2 .

N2 ISOLATE FLASHER UNIT

- Substitute known good flasher.

Do hazard flasher lamps operate?

Yes	No
REPLACE flasher unit.	GO to N3 .

N3 BATTERY FEED TO FLASHER UNIT

- Check for battery voltage at flasher unit connector battery feed terminal 383 (R/W) (Ranger).
- Check for battery voltage at flasher unit connector battery feed Circuit 385 (W/R) (Aerostar).

Is battery voltage present?

Yes	No
REPLACE turn/hazard switch.	REPAIR Circuit 383 (R/W): (Ranger) or Circuit 385 (W/R) (Aerostar).

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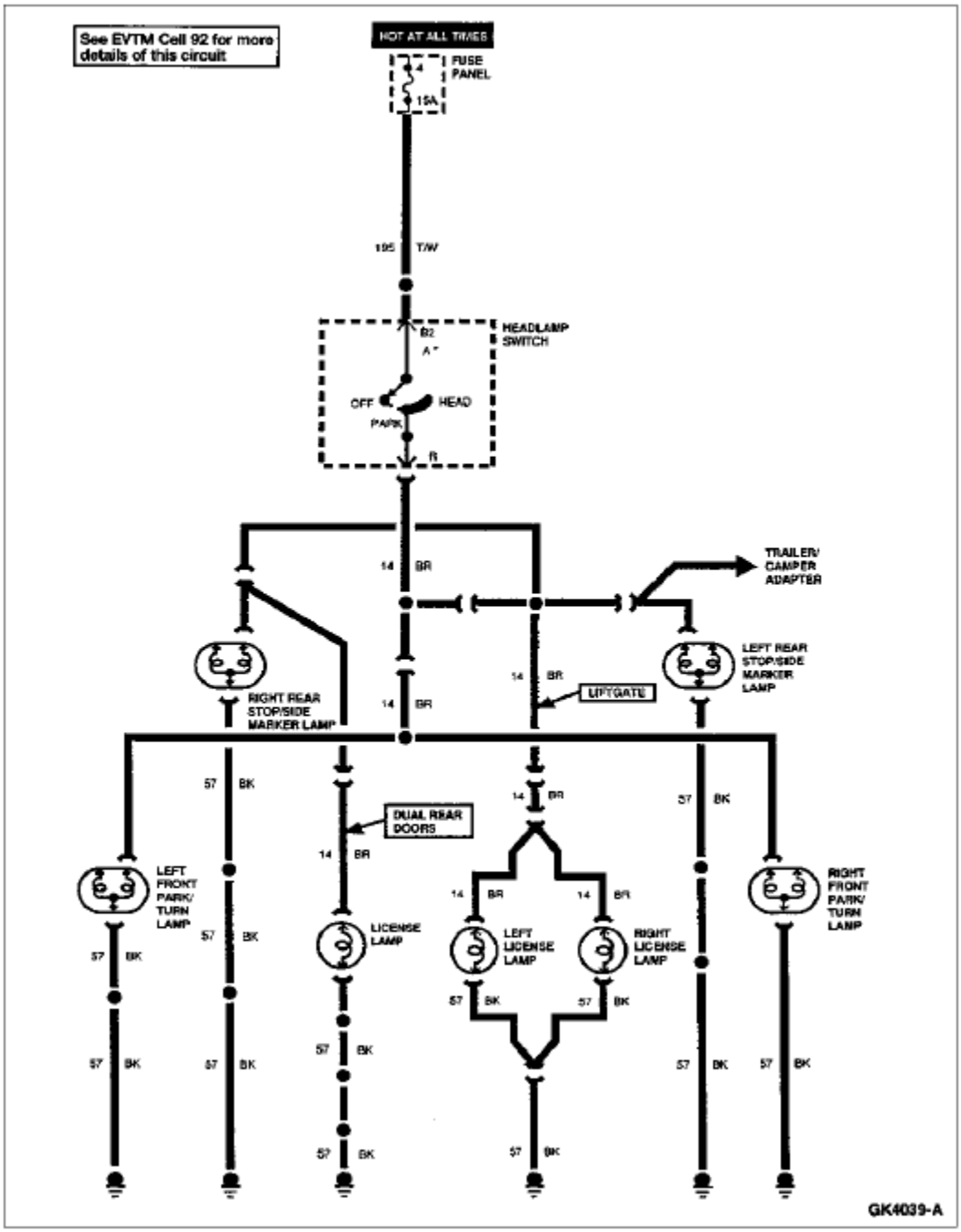
Electrical Schematics — Parking Lamps

Parking Lamp, Aerostar



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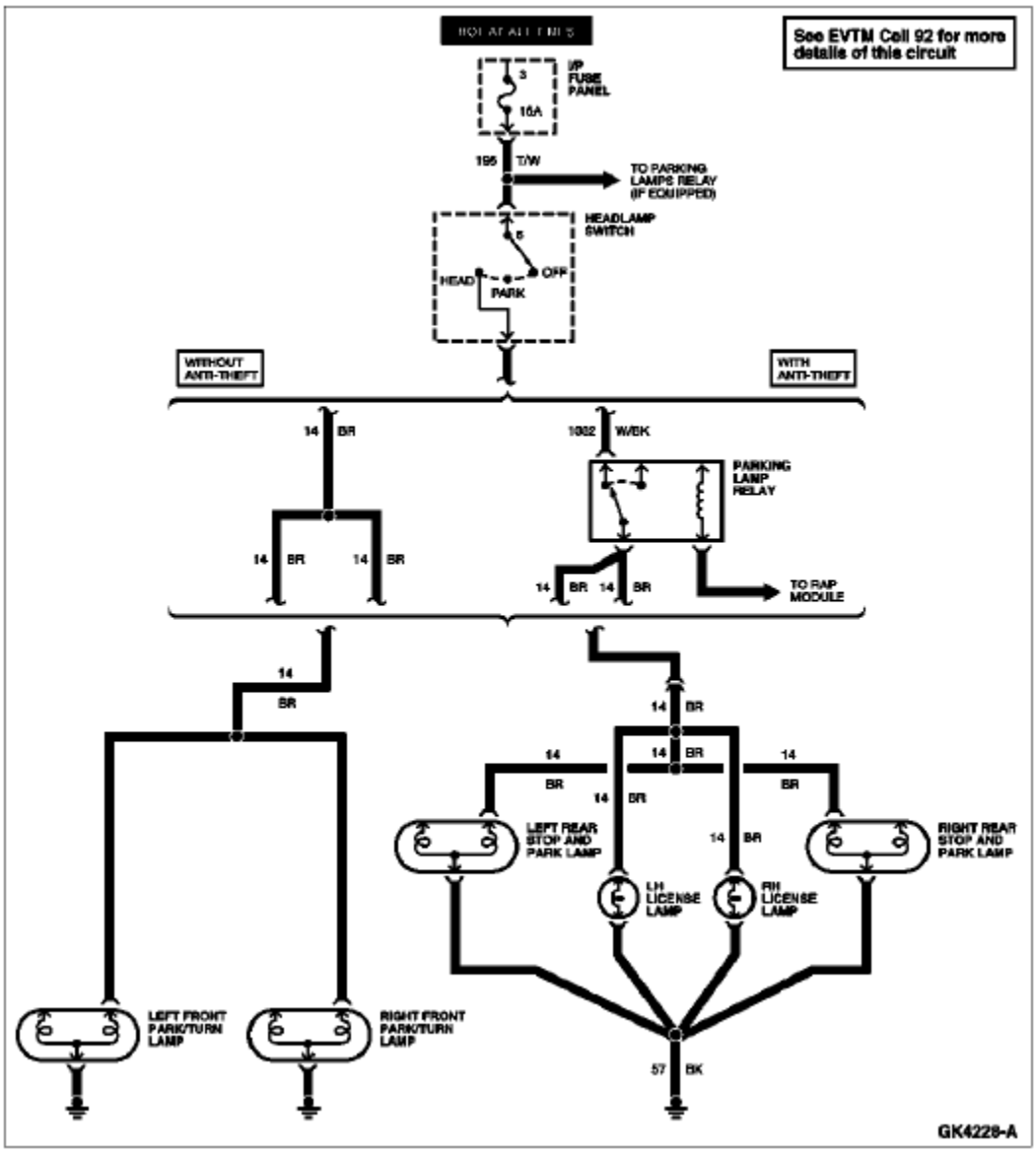
Parking Lamps, Ranger



Headlamp Switch, Ranger

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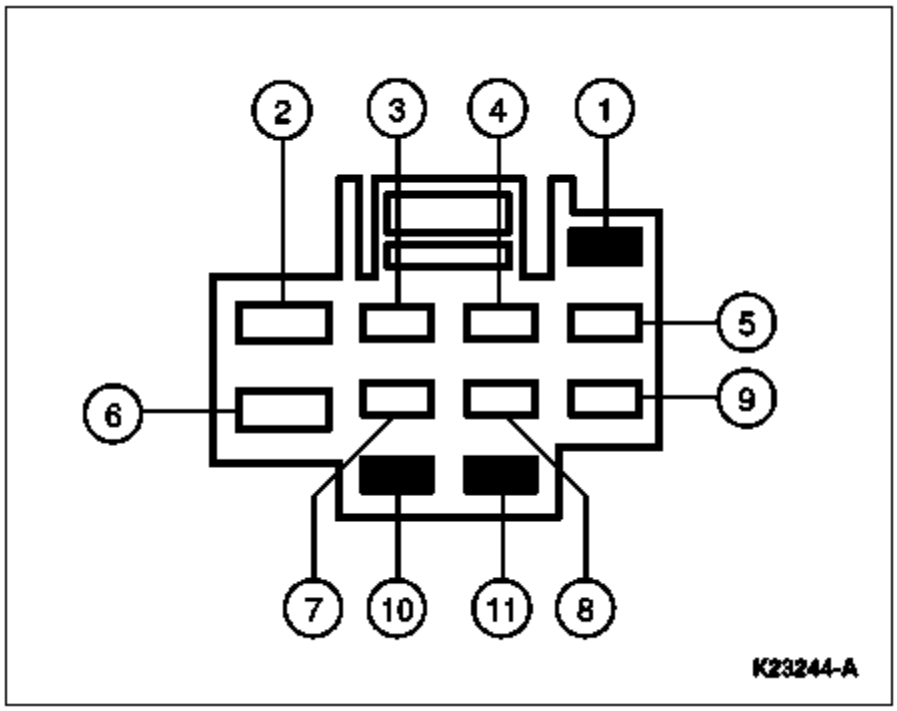

Pin Number	Circuit	Circuit Function
1	—	Not Used
2	15 (R/Y)	Headlamp Switch to Dimmer Switch
3	1032 (W/BK) 14 (BR)	Headlamp Switch to Park Lamp Relay (Ranger with Anti-Theft) Headlamp Switch to Park Lamps (Ranger Without Anti-Theft)
4	640 (R/Y)	Fused Ignition Feed
5	195 (T/W)	Park Lamp Battery Feed
6	196 (DB/O)	Battery Feed to Headlamp Switch
7	57 (BK)	Switch Illumination Ground
8	484 (O/BK)	Headlamp Switch to 4x4, Speed Control and Overdrive Warning Lamps
9	19 (LB/R)	Pulse Width Dimmer to Headlamp Switch
10	—	Not Used
11	—	Not Used

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Inspection and Verification — Parking Lamps

1. Verify customer concern by operating the parking lamps.
2. Visually inspect the components of the parking lamp system.

VISUAL INSPECTION CHART

Mechanical	Electrical

• None	• Blown fuse(s)
	• Damaged bulb(s)
	  ▪ side marker
	  ▪ parking
	  ▪ license
	• Damaged wiring harness
	• Loose or corroded connections

3. Check the wiring harness for obvious signs of shorts, opens, bad connections, or damage.
4. If fault is not visually evident, determine the symptom and proceed to the Symptom Chart.

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Symptom Chart — Parking Lamps

NOTE: Use 73 Digital Multimeter 105-R0051, or equivalent, to perform electrical pinpoint tests.

PARKING LAMPS

Condition	Possible Source	Action
• Parking Lamps Inoperative	• Fuse. • Circuit. • Headlamp switch.	• GO to Pinpoint Test P.
• One or More Parking Lamps Inoperative	• Parking lamp bulb (s). • Circuit.	• GO to Pinpoint Test Q.
• Parking Lamps On Continuously	• Headlamp switch.	• GO to Pinpoint Test R.
• One or More Side Marker Lamps Inoperative	• Side marker bulb (s). • Circuit.	• GO to Pinpoint Test S.
• Tail Lamps Inoperative	• Circuit. • Bulbs.	• GO to Pinpoint Test T.
• One or More Tail Lamps Inoperative	• Bulb. • Circuit.	• GO to Pinpoint Test U.
• One or More License Plate Lamps Inoperative	• License lamp bulb (s). • Circuit.	• GO to Pinpoint Test V.

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Pinpoint Tests — Parking Lamps

PINPOINT TEST P: PARKING LAMPS INOPERATIVE

P1 CIRCUIT PROTECTION

- Check fuse 4 (Aerostar) or 3 (Ranger).

Is fuse blown?

Yes	No
REPLACE fuse.	GO to **P2** .

P2 BATTERY FEED TO HEADLAMP SWITCH

- Remove headlamp switch.
- Check for battery voltage at connector terminal B2 (Aerostar) or 5 (Ranger).

Is battery voltage present?

Yes	No
GO to **P3** .	REPAIR open in Circuit 195 (T/W).

P3 ISOLATE HEADLAMP SWITCH

- Install jumper between connector terminals B2 and R (Aerostar) or 5 and 3 (Ranger).

Are parking lamps on?

Yes	No
REPLACE headlamp switch.	REPAIR open in Circuit 14 (BR) or REPLACE the parking lamp relay (Ranger).

PINPOINT TEST Q: ONE OR MORE PARKING LAMPS INOPERATIVE

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Q1 ISOLATE BULB AND SOCKET

- Remove bulb.
- Check bulb for broken filament. Check bulb socket for damage or corrosion.

Are bulb and socket OK?

Yes	No
GO to **Q2** .	SERVICE as required.

Q2 BATTERY FEED TO LAMP

- Set headlamp switch in PARK position.
- Check for battery voltage at lamp battery feed wire.

Is battery voltage present?

Yes	No
GO to **Q3** .	REPAIR open in battery feed wire Circuit 14 (BR).

Q3 GROUND CIRCUIT

- Check for continuity between lamp ground wire and clean chassis ground.

Is there continuity?

Yes	No
INSPECT lamp assembly for condition that could prevent lamp from coming on.	REPAIR open in ground Circuit 57 (BK).

PINPOINT TEST R: PARKING LAMPS ON CONTINUOUSLY

R1 ISOLATE HEADLAMP SWITCH

- Remove headlamp switch.
- Disconnect wiring at headlamp switch.

Are parking lamps off?

Yes	No
REPLACE headlamp switch.	On Aerostar and Ranger without anti-theft, REPAIR short to battery power in Circuit 14

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	(BR). On Ranger with anti-theft, GO to R2 .

R2 ISOLATE PARKING LAMP RELAY

- Remove parking lamp relay.

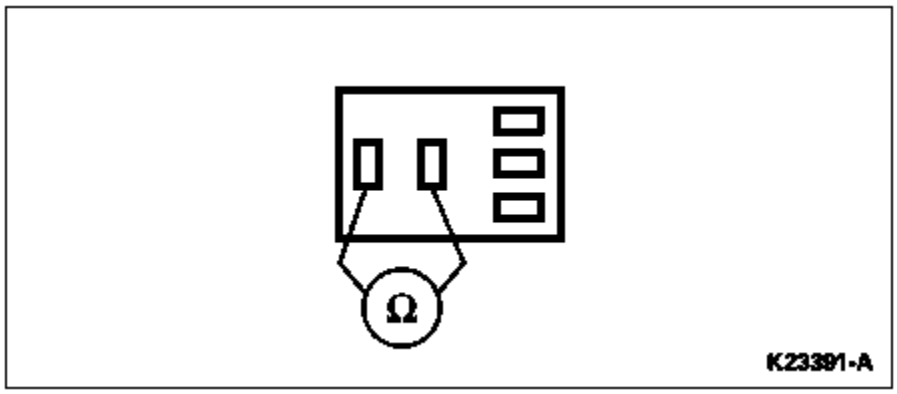
Are parking lamps off?

Yes	No
GO to R3 .	REPAIR short to battery power in Circuit 14 (BR).

R3 SHORTED PARKING LAMP RELAY

- Check for continuity across relay contact terminals as shown below.

Is there continuity?



Yes	No
REPLACE relay.	If equipped with autolamps/exit delay or anti-theft system, GO to R4 . If not equipped with system, REPAIR short to battery power in Circuit 14 (BR).

R4 SHORTED RELAY COIL

- Headlamp switch in parking lamp position.
- Install parking lamp relay.

Did relay "click" when installed?

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Yes	No
REPAIR short to ground in relay coil Circuit 15 (R/Y).	REPAIR short to battery power in Circuit 14 (BR).

PINPOINT TEST S: ONE OR MORE SIDE MARKER LAMPS INOPERATIVE

S1 ISOLATE BULB AND SOCKET

- Remove bulb.
- Check bulb for broken filament. Check bulb socket for damage or corrosion.

Are bulb and socket OK?

Yes	No
GO to **S2** .	SERVICE as required.

S2 BATTERY FEED TO LAMP

- Set headlamp switch in PARK position.
- Check for battery voltage at lamp battery feed wire.

Is battery voltage present?

Yes	No
GO to **S3** .	REPAIR open in battery feed wire Circuit 14 (BR).

S3 GROUND CIRCUIT

- Check for continuity between lamp ground wire and clean chassis ground.

Is there continuity?

Yes	No
INSPECT lamp assembly for condition that could prevent lamp from coming on.	REPAIR open in ground Circuit 57 (BK).

PINPOINT TEST T: TAIL LAMPS INOPERATIVE

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T1 ISOLATE OPEN CIRCUIT (AEROSTAR, RANGER ONLY)

- Set headlamp switch in ON position.

Are license plate lamps on?

Yes	No
GO to **T2** .	REPAIR open ahead of rear lamp splice (Circuit 14 [BR]).

T2 ISOLATE BULBS AND SOCKETS

- Remove a tail lamp bulb.
- Inspect bulb for a broken filament. Inspect lamp socket for damage or corrosion.

Are bulb and socket OK?

Yes	No
INSPECT lamp assembly for condition that could prevent lamp from coming on.	SERVICE as required and REPEAT repair on opposite lamp.

PINPOINT TEST U: ONE OR MORE TAIL LAMPS INOPERATIVE

U1 ISOLATE BULB AND SOCKET

- Remove bulb.
- Check bulb for broken filament. Check bulb socket for damage or corrosion.

Are bulb and socket OK?

Yes	No
GO to **U2** .	SERVICE as required.

U2 BATTERY FEED TO LAMP

- Set headlamp switch in PARK position.
- Check for battery voltage at lamp battery feed wire.

Is battery voltage present?

Yes	No
GO to **U3** .	REPAIR open in battery feed wire Circuit 14 (BR) or REPLACE the parking lamp relay

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	(Ranger).

U3 GROUND CIRCUIT

- Check for continuity between lamp ground wire and clean chassis ground.

Is there continuity?

Yes	No
INSPECT lamp assembly for condition that could prevent lamp from coming on.	REPAIR open in ground Circuit 57 (BK).

PINPOINT TEST V: ONE OR MORE LICENSE PLATE LAMPS INOPERATIVE

V1 ISOLATE BULB AND SOCKET

- Remove bulb.
- Check bulb for broken filament. Check bulb socket for damage or corrosion.

Are bulb and socket OK?

Yes	No
GO to **V2** .	SERVICE as required.

V2 BATTERY FEED TO LAMP

- Set headlamp switch in PARK position.
- Check for battery voltage at lamp battery feed wire.

Is battery voltage present?

Yes	No
GO to **V3** .	REPAIR open in battery feed wire Circuit 14 (BR) or REPLACE the parking lamp relay (Ranger).

V3 GROUND CIRCUIT

- Check for continuity between lamp ground wire and clean chassis ground.

Is there continuity?

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Yes	No
INSPECT lamp assembly for condition that could prevent lamp from coming on.	REPAIR open in ground Circuit 57 (BK).

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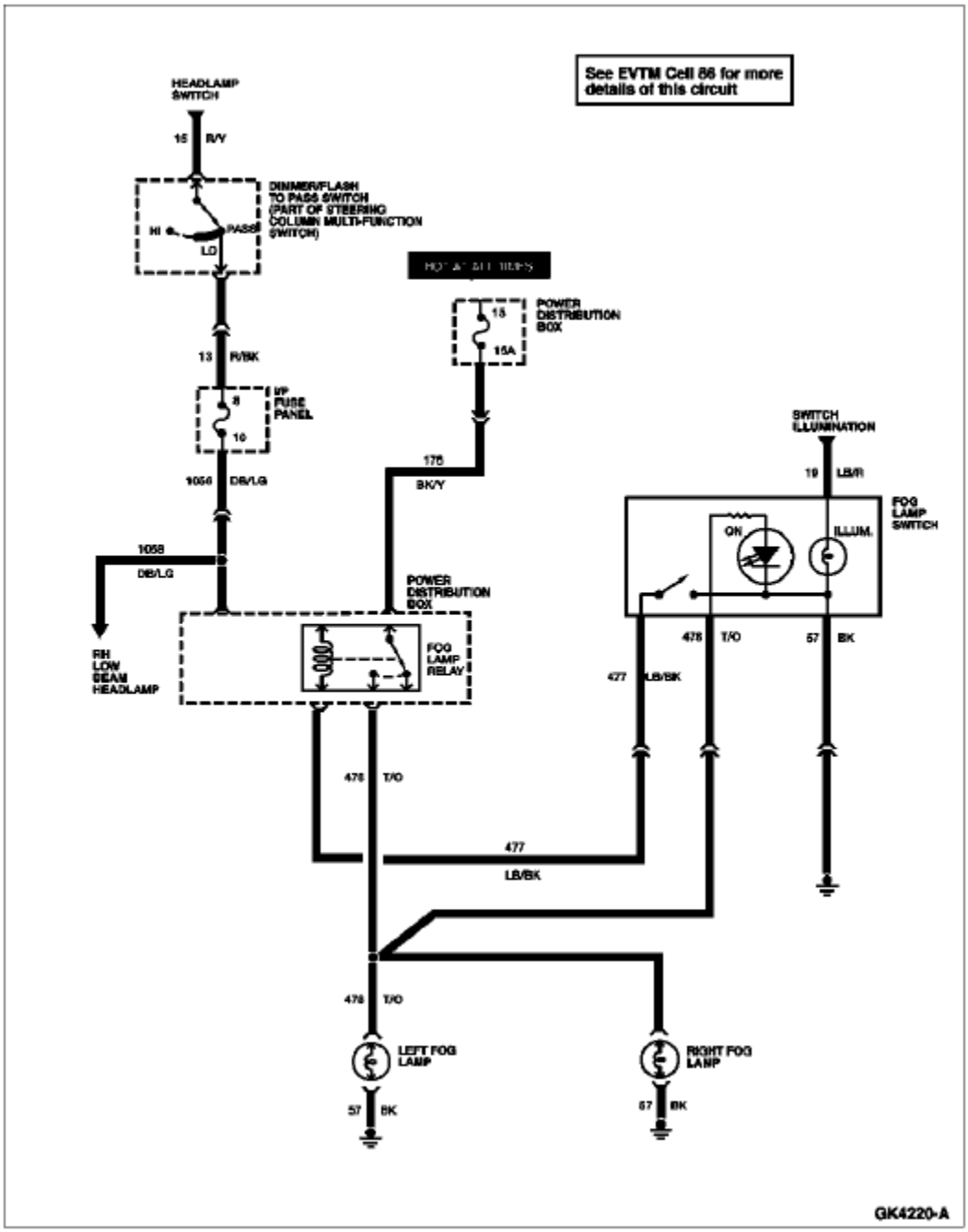
Electrical Schematics — Fog Lamps

Fog Lamps, Ranger



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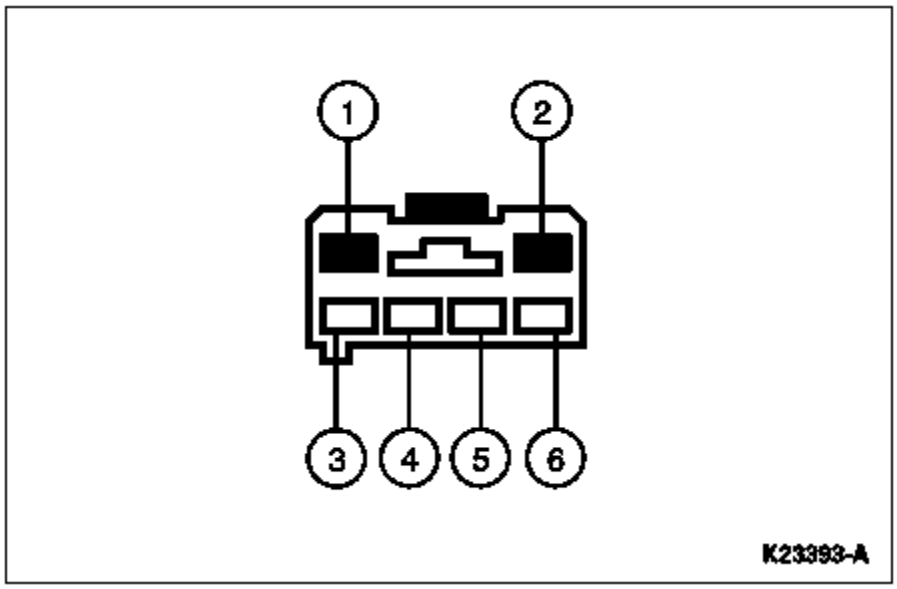
Fog Lamp Switch, Ranger



Pin Number	Circuit	Circuit Function
1	—	Not Used
2	—	Not Used
3	477 (LB/BK)	Fog Lamp Relay Coil to Fog Lamp Switch
4	57 (BK)	Ground Circuit
5	19 (LB/R)	Feed to Switch Illumination
6	478 (T/O)	Feed to Switch Indicator LED

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Inspection and Verification — Fog Lamps

1. Verify the customer concern by operating the fog lamps.
2. Visually inspect the components of the fog lamp system.

VISUAL INSPECTION CHART

Mechanical	Electrical
• None	• Blown fuse • Damaged fog lamp • Damaged wiring harness • Loose or corroded connections

3. Verify the headlamps are working. If the headlamps are not working, refer to Pinpoint Test A, Headlamps Inoperative.
4. Check the wiring harness for obvious signs of shorts, opens, bad connections, or damage.
5. If fault is not visually evident, determine the symptom and proceed to the following Symptom Chart.

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Symptom Chart — Fog Lamps

NOTE: Use 73 Digital Multimeter 105-R0051, or equivalent, to perform electrical pinpoint tests.

FOG LAMPS

Condition	Possible Source	Action
• Fog Lamps Inoperative	• Fuse. • Circuit. • Headlamp switch. • Fog lamp switch. • Fog lamp relay. • Fog lamp.	• GO to Pinpoint Test W .
• Individual Fog Lamp Inoperative	• Circuit. • Fog lamp.	• GO to Pinpoint Test X .

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Pinpoint Tests — Fog Lamps

PINPOINT TEST W: FOG LAMPS INOPERATIVE

W1 ISOLATE RELAY

- Headlamp ON; LO beam.
- Have assistant place finger on fog lamp relay.
- Turn fog lamp switch on.

Did relay "click"?

Yes	No
GO to **W2** .	GO to **W4** .

W2 BATTERY FEED TO RELAY CONTACTS

- Remove fog lamp relay.
- Check for battery voltage at relay contact feed terminal (BK/Y).

Is battery voltage present?

Yes	No
GO to **W3** .	CHECK fuse 15 in power distribution box. If fuse is not blown, REPAIR open in wire between fuse and relay.

W3 RELAY TO FOG LAMP WIRING

- Connect jumper across relay battery feed (BK/Y) and fog lamp terminals (T/O).

Are fog lamps ON?

Yes	No
REPLACE relay.	REPAIR open in wire to fog lamps.

W4 BATTERY FEED TO RELAY COIL

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- Turn headlamps ON; LO beams.

Is right-hand LO beam headlamp on?

Yes	No
GO to **W5** .	CHECK fuse 8 in interior fuse panel. If fuse is not blown, REPAIR open in wire between fuse panel and relay coil.

W5 RELAY COIL GROUND CIRCUIT

- Set fog lamp switch in ON position.
- Check for continuity between relay coil ground wire terminal (LB/BK) and clean chassis ground.

Is there continuity?

Yes	No
REPLACE relay.	GO to **W6** .

W6 SWITCH GROUND

- Remove fog lamp switch.
- Check for continuity between connector ground terminal (BK) and clean chassis ground.

Is there continuity?

Yes	No
GO to **W7** .	REPAIR open in ground circuit.

W7 ISOLATE SWITCH

- Turn headlamps ON; LO beam.
- Connect jumper between switch connector terminal (LB/BK) and clean chassis ground.

Did relay "click"?

Yes	No
REPLACE switch.	REPAIR open in relay to switch wire.

PINPOINT TEST X: INDIVIDUAL FOG LAMP INOPERATIVE

X1 BULB AND SOCKET

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- Remove fog lamp bulb.
- Inspect bulb for broken filament. Check bulb socket for corrosion or damage.

Are bulb and lamp OK?

Yes	No
GO to **X2** .	SERVICE as required.

X2 BATTERY FEED TO FOG LAMP

- Disconnect wiring at fog lamp.
- Turn headlamps ON; LO beam.
- Check for battery voltage at connector feed terminal (T/O).

Is battery voltage present?

Yes	No
GO to **X3** .	REPAIR open in battery feed wire.

X3 FOG LAMP GROUND

- Check for continuity between connector ground terminal and clean chassis ground.

Is there continuity?

Yes	No
CHECK lamp assembly for condition that would prevent bulb from coming on.	REPAIR open in ground circuit.

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Electrical Schematics — Backup Lamps

Backup Lamps, Aerostar

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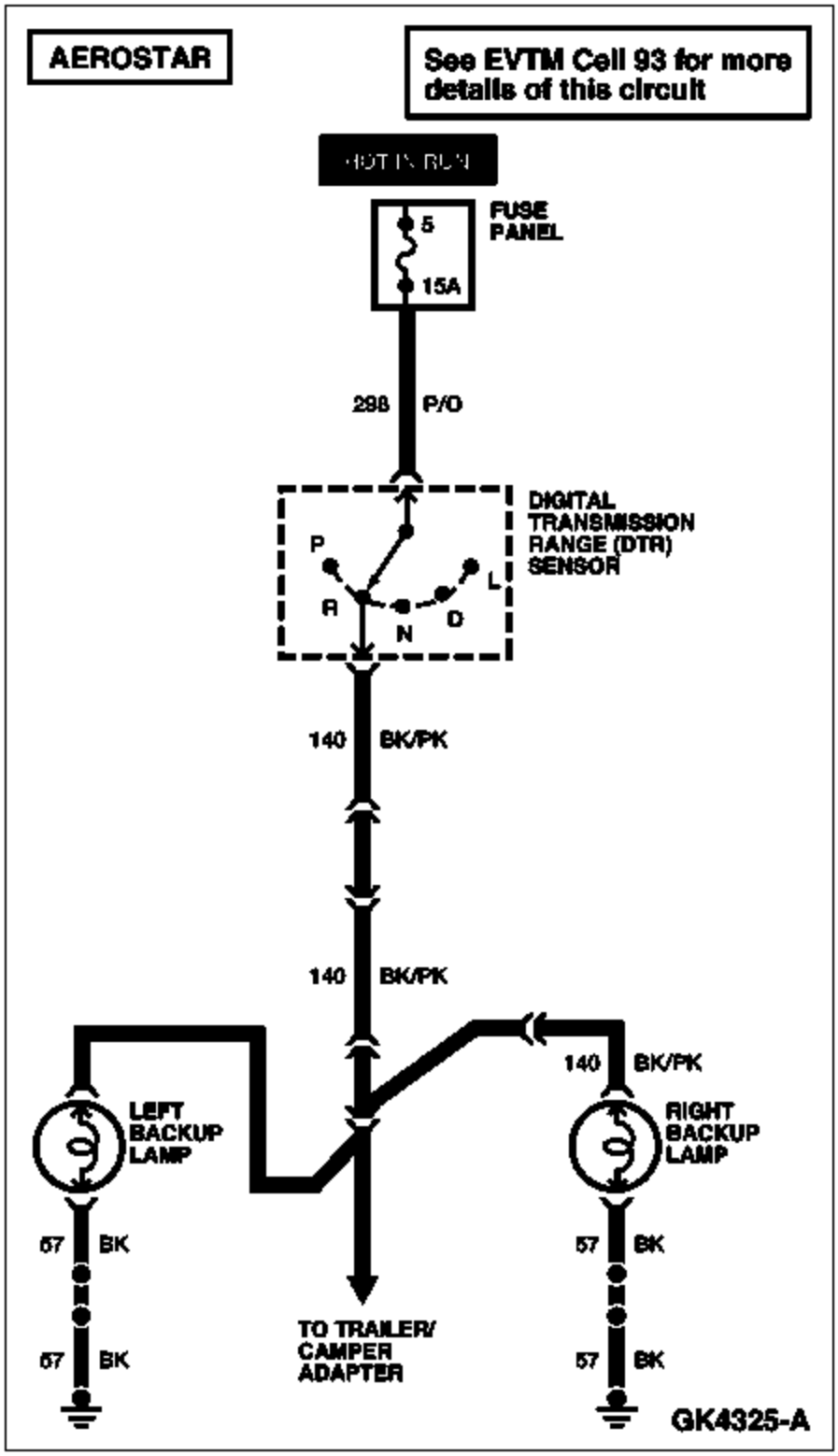

Backup Lamps, Ranger

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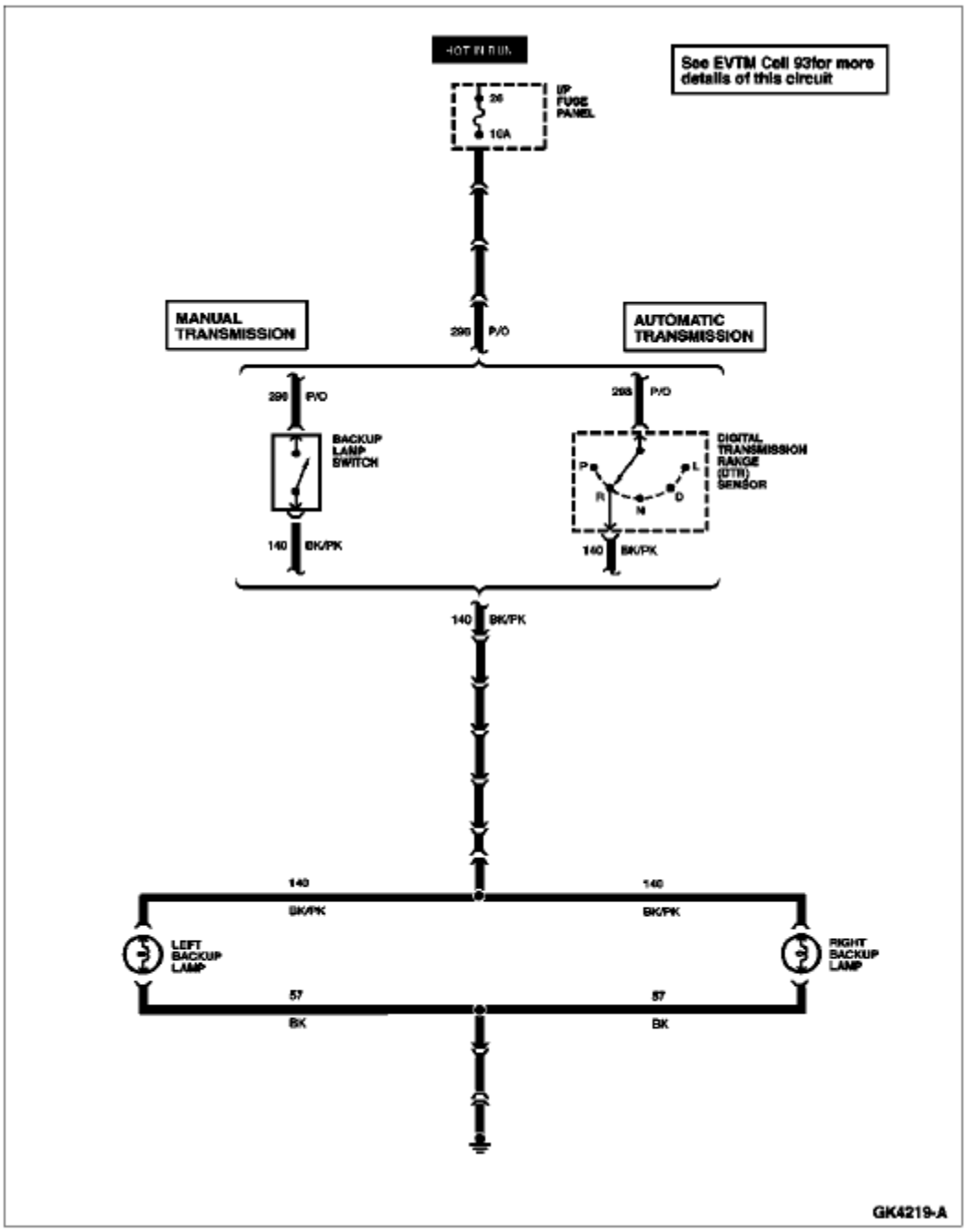

Digital Transmission Range (DTR) Sensor, Ranger, Aerostar

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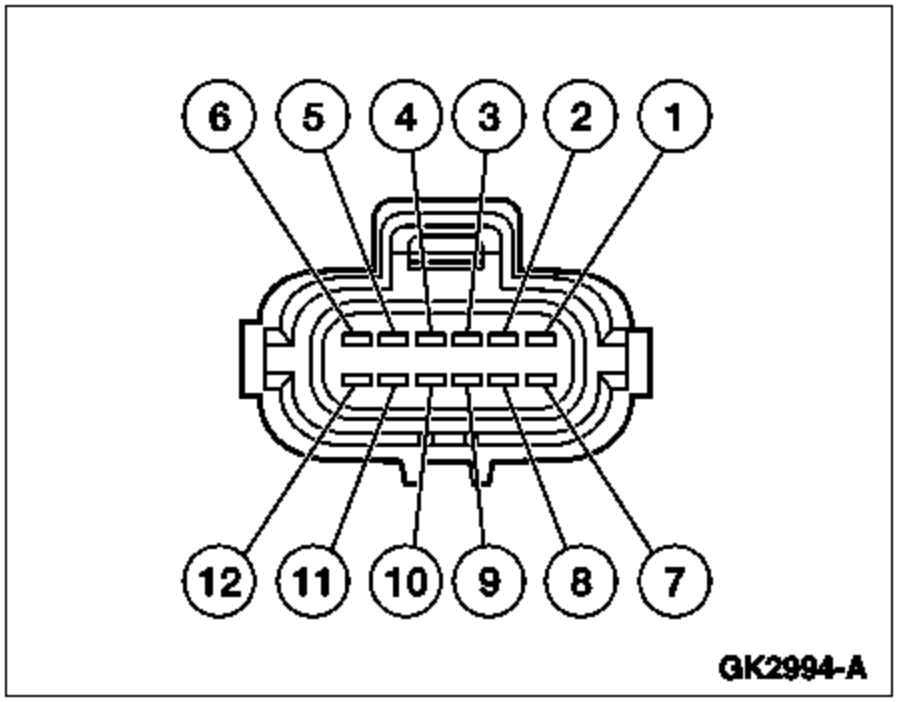

Pin Number	Circuit	Circuit Function
1	—	NOT USED
2	359 (GY/R)	Sensor Signal Return
3	199 (LB/Y)	DTR to EEC Module
4	1144 (Y/BK)	DTR to EEC Module
5	1145 (LB/BK)	DTR to EEC Module
6	1143 (W/BK)	DTR to EEC Module
7	57 (BK)	Ground
8	463 (R/W)	Electric Transfer Case Module to DTR
9	298 (P/O)	Fused Run Only Feed
10	32 (R/LB)	Starter Control
11	140 (BK/PK)	Backup Lamp
12	329 (R/LB)	Starter Control

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Inspection and Verification — Backup Lamps

1. Verify customer concern by operating the backup lamps.
2. Visually inspect the components of the backup lamp system.

VISUAL INSPECTION CHART

Mechanical	Electrical
• None	• Blown fuse • Damaged backup lamp bulb(s) • Damaged wiring harness • Loose or corroded connections

3. Check the wiring harness for obvious signs of shorts, opens, bad connections, or damage.
4. If fault is not visually evident, determine the symptom and proceed to the following Symptom Chart.

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Symptom Chart — Backup Lamps

NOTE: Use 73 Digital Multimeter 105-R0051, or equivalent, to perform electrical pinpoint tests.

BACKUP LAMPS

Condition	Possible Source	Action
• Backup Lamps Inoperative	• Fuse. • Circuit. • Manual lever position switch.	• GO to Pinpoint Test Y.
• Backup Lamps On Continuously	• Manual lever position switch.	• GO to Pinpoint Test Z.
• Individual Backup Lamp Inoperative	• Circuit. • Backup lamp bulb.	• GO to Pinpoint Test AA.

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Pinpoint Tests — Backup Lamps

PINPOINT TEST Y: BACKUP LAMPS INOPERATIVE

Y1 CHECK BULBS AND BULB SOCKETS

- Remove backup lamp bulbs.
- Inspect bulbs for broken filament.
- Inspect bulb sockets for corrosion and damage.

Are bulbs and sockets OK?

Yes	No
GO to **Y2** .	SERVICE as required.

Y2 CHECK BATTERY FEED TO BULB SOCKET

- Set parking brake.
- Turn ignition switch to ON position.
- Shift transmission into reverse.
- Check for battery voltage at socket battery feed terminal (BK/PK).

Is battery voltage present?

Yes	No
GO to **Y3** .	GO to **Y4** .

Y3 CHECK GROUND CIRCUIT

- Check for continuity between bulb socket and clean chassis ground.

Is there continuity?

Yes	No
Circuit should function. RETURN to **Y1** .	SERVICE ground Circuit 57 (BK).

Y4 BACKUP LAMP SWITCH FEED

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- Set parking brake.
- Turn ignition switch to ON position.
- Disconnect wiring at backup lamps:
  - Backup lamp switch: with manual transmission.
  - Digital transmission range sensor: with automatic transmission.
- Check for battery voltage at switch feed wire (P/O).

Is battery voltage present?

Yes	No
GO to **Y5** .	REPAIR open in battery feed wire Circuit 298 (P/O).

Y5 CHECK SWITCH CONTINUITY

- Shift transmission into reverse.
- Check for continuity across switch battery feed terminal and terminal feeding backup lamps.

Is there continuity?

Yes	No
REPAIR open in Circuit 140 (BK/PK) between switch and backup lamps.	REPLACE switch.

PINPOINT TEST Z: BACKUP LAMPS ON CONTINUOUSLY

Z1 SHORTED SWITCH CHECK

- Disconnect wiring at switch operating backup lamps:
  - Backup lamp switch (all MT).
  - Digital transmission range sensor (all AT).

Are lamps off?

Yes	No
REPLACE switch.	REPAIR short to battery power in lamp Circuit 140 (BK/PK).

PINPOINT TEST AA: INDIVIDUAL BACKUP LAMP INOPERATIVE

AA1 BULB AND SOCKET

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- Remove bulb.
- Inspect bulb for broken filament. Check bulb socket for corrosion or damage.

Are bulb and sockets OK?

Yes	No
GO to **AA2** .	SERVICE as required.

AA2 BATTERY FEED TO BACKUP LAMP

- Disconnect wiring at lamp.
- Set parking brake.
- Turn ignition switch to ON position.
- Shift transmission into reverse.
- Check for battery voltage at connector feed terminal (BK/PK).

Is battery voltage present?

Yes	No
GO to **AA3** .	REPAIR open in battery feed wire Circuit 140 (BK/PK).

AA3 BACKUP LAMP GROUND

- Check for continuity between connector ground terminal and clean chassis ground.

Is there continuity?

Yes	No
CHECK lamp assembly for condition that would prevent bulb from coming on.	REPAIR open in ground Circuit 57 (BK).

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Electrical Schematics — Cargo Lamp

Cargo Lamp, Ranger

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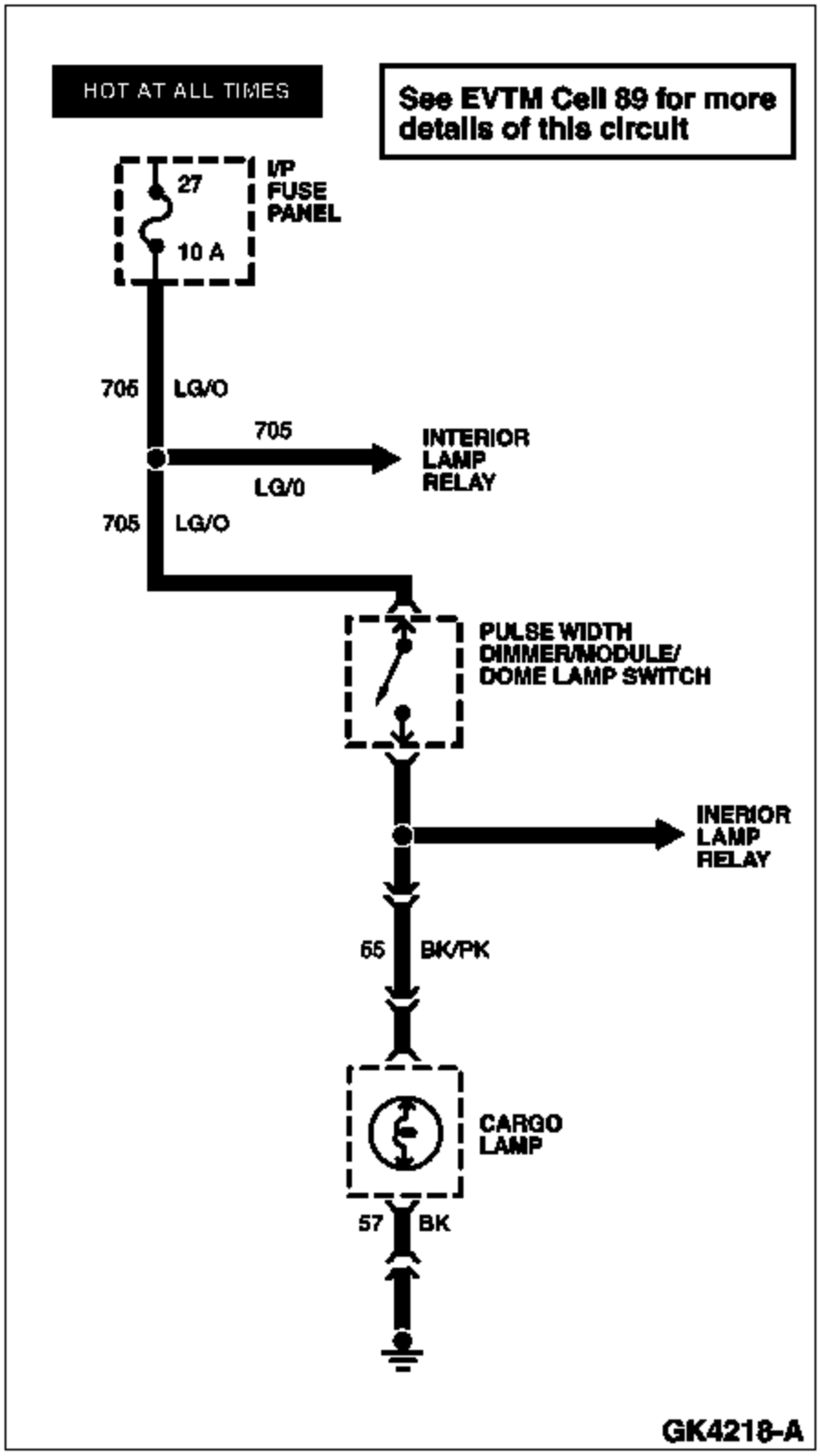

Pulse Width Dimmer, Ranger

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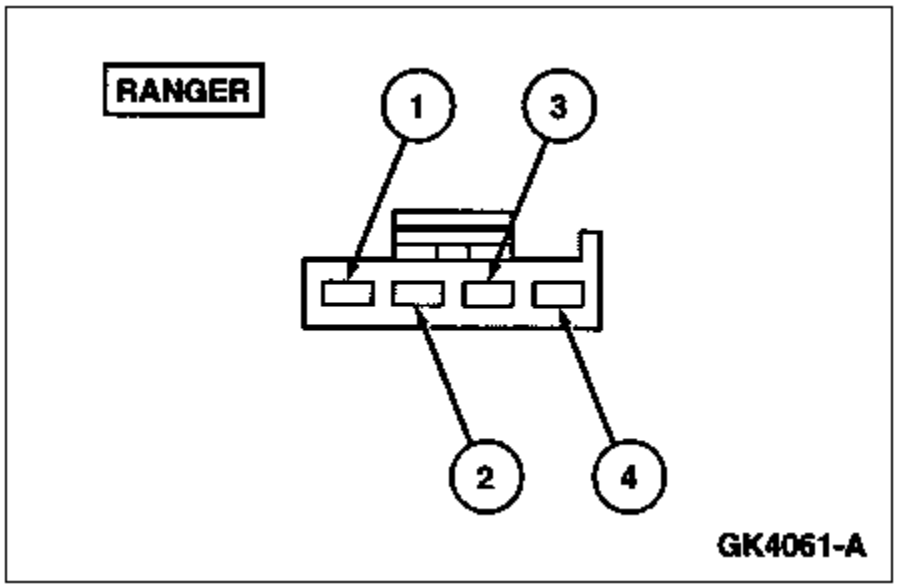

Pin Number	Circuit	Circuit Function
1	1011 (T/O)	Pulse Width Dimmer Module — Fused Feed
2	705 (LG/O)	Battery Saver Lamp Feed
3	19 (LB/R)	Instrument Panel Lamps Feed
4	55 (BK/PK)	Cargo Lamp Switch to Cargo Lamp/Dome Lamp

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Inspection and Verification — Cargo Lamp

1. Verify the customer concern by operating the cargo lamp.
2. Visually inspect the components of the cargo lamp system.

VISUAL INSPECTION CHART

Mechanical	Electrical
• None	• Blown fuse • Damaged cargo lamp bulb • Damaged wiring harness • Loose or corroded connections

3. Check the wiring harness for obvious signs of shorts, opens, bad connections, or damage.
4. If fault is not visually evident, determine the symptom and proceed to the following Symptom Chart.

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Symptom Chart — Cargo Lamp

NOTE: Use 73 Digital Multimeter 105-R0051, or equivalent, to perform electrical pinpoint tests.

CARGO LAMP

Condition	Possible Source	Action
• Cargo Lamp Inoperative	• Circuit. • Bulb.	• GO to Pinpoint Test AB .

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Pinpoint Tests — Cargo Lamp

PINPOINT TEST AB: CARGO LAMP INOPERATIVE

AB1 ISOLATE BULB AND SOCKET

- Remove bulb.
- Check bulb for broken filament. Check bulb socket for damage or corrosion.

Are bulb and socket OK?

Yes	No
GO to **AB2** .	SERVICE as required.

AB2 BATTERY FEED TO LAMP

- Check for battery voltage at lamp connector battery feed terminal (DG).

Is battery voltage present?

Yes	No
GO to **AB3** .	REPAIR open in battery feed Circuit 569 (DG).

AB3 GROUND CIRCUIT

- Check for continuity between lamp connector ground terminal and clean chassis ground.

Is there continuity?

Yes	No
CHECK lamp assembly for condition that could cause lamp from coming on.	REPAIR open in ground Circuit 57 (BK).

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Headlamp Bulb, Ranger

Removal

WARNING: THE HEADLAMP BULB CONTAINS HALOGEN GAS UNDER PRESSURE. THE HEADLAMP BULB MAY SHATTER IF THE GLASS ENVELOPE IS SCRATCHED OR DROPPED. HANDLE CAREFULLY. GRASP ONLY BY PLASTIC BASE. AVOID TOUCHING THE GLASS ENVELOPE. KEEP OUT OF REACH OF CHILDREN. ENERGIZE ONLY WHEN INSTALLED IN THE HEADLAMP.

NOTE: A properly aimed headlamp normally need not be reaimed after installation of this headlamp bulb (13007). A burned out headlamp bulb should not be removed from the headlamp (13008) until just before a replacement is to be installed. Removal for an extended period of time may allow contaminants (dust, moisture, smoke) to affect the performance of the headlamp.

1. Check that headlamp switch (11654) is in the off position.
2. Lift hood (16612).
3. Release latch and swing filler panel to left or right.
4. Remove electrical connector from headlamp bulb by releasing lock tab and grasping wires firmly and snapping connector rearward.
5. Remove headlamp bulb retainer (13N019) by rotating counterclockwise (when viewed from rear) about one-eighth turn and sliding ring off plastic base. Keep headlamp bulb retainer as it may be used again to retain new headlamp bulb.
6. Carefully remove headlamp bulb from socket by gently pulling straight backward out of socket. Do not rotate headlamp bulb during removal.

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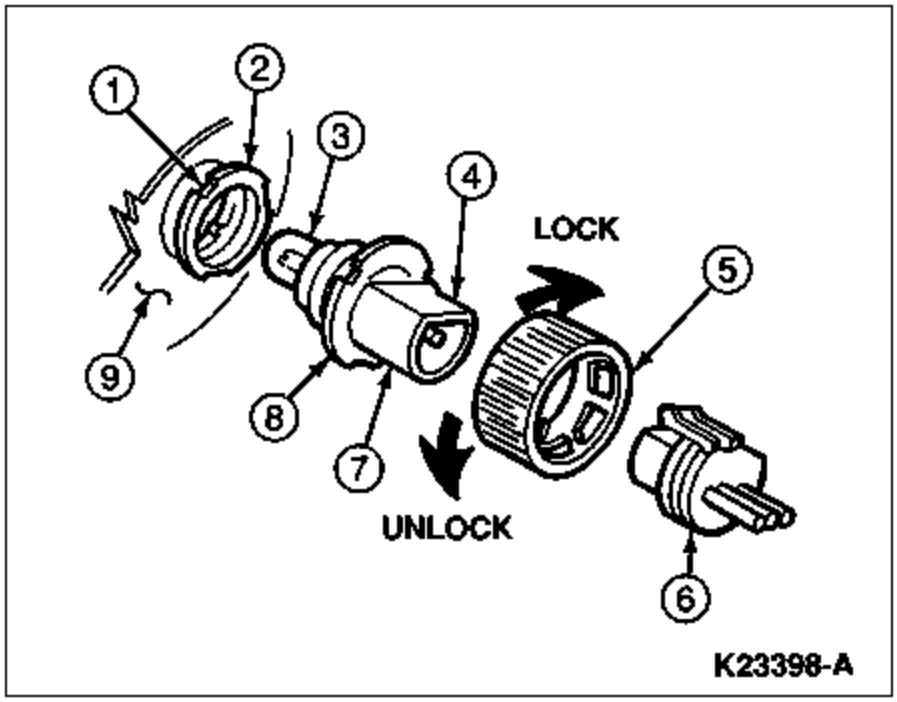

Item	Part Number	Description
1	—	Rear Face of Socket (Part of 13005)
2	—	Bulb Socket (Part of 13005)
3	—	Bulb (Part of 13007)
4	—	Flat Side of Plastic Base (Part of 13007)
5	13N019	Locking Retaining Ring
6	—	Electrical Connector (Part of 14290)
7	—	Plastic Base (Part of 13007)
8	—	Mounting Flange (Part of 13007)
9	—	Reflector (Part of 13005)

Installation

1. With flat side of plastic base of headlamp bulb facing upward, insert glass envelope of headlamp bulb into socket. Turn base slightly to left or right, if necessary, to align grooves in forward part of plastic base with corresponding locating tabs inside socket. When grooves are aligned, push headlamp bulb firmly into socket until mounting flange on base contacts rear face of socket.

2. Slip headlamp bulb retainer over rear of plastic base against mounting flange. Lock headlamp bulb retainer into socket by rotating clockwise. A stop will be felt when headlamp bulb retainer is fully engaged.

3. Push electrical connector into rear of plastic base until it snaps and locks into position.

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4. Close filler panel.
5. Turn headlamps on and check for proper operation.

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Headlamp Bulb, Aerostar

Removal and Installation

1. Remove the headlamp door (13064) attaching screws and remove the headlamp door.
2. Remove the four retaining screws. Do not disturb the headlamp adjusting screw (13032) settings.
3. Pull the headlamp (13008) forward and disconnect the wiring assembly plug from the headlamp bulb and retainer.
4. Unsnap bulb retaining wire and pull headlamp bulb and retainer out of headlamp.

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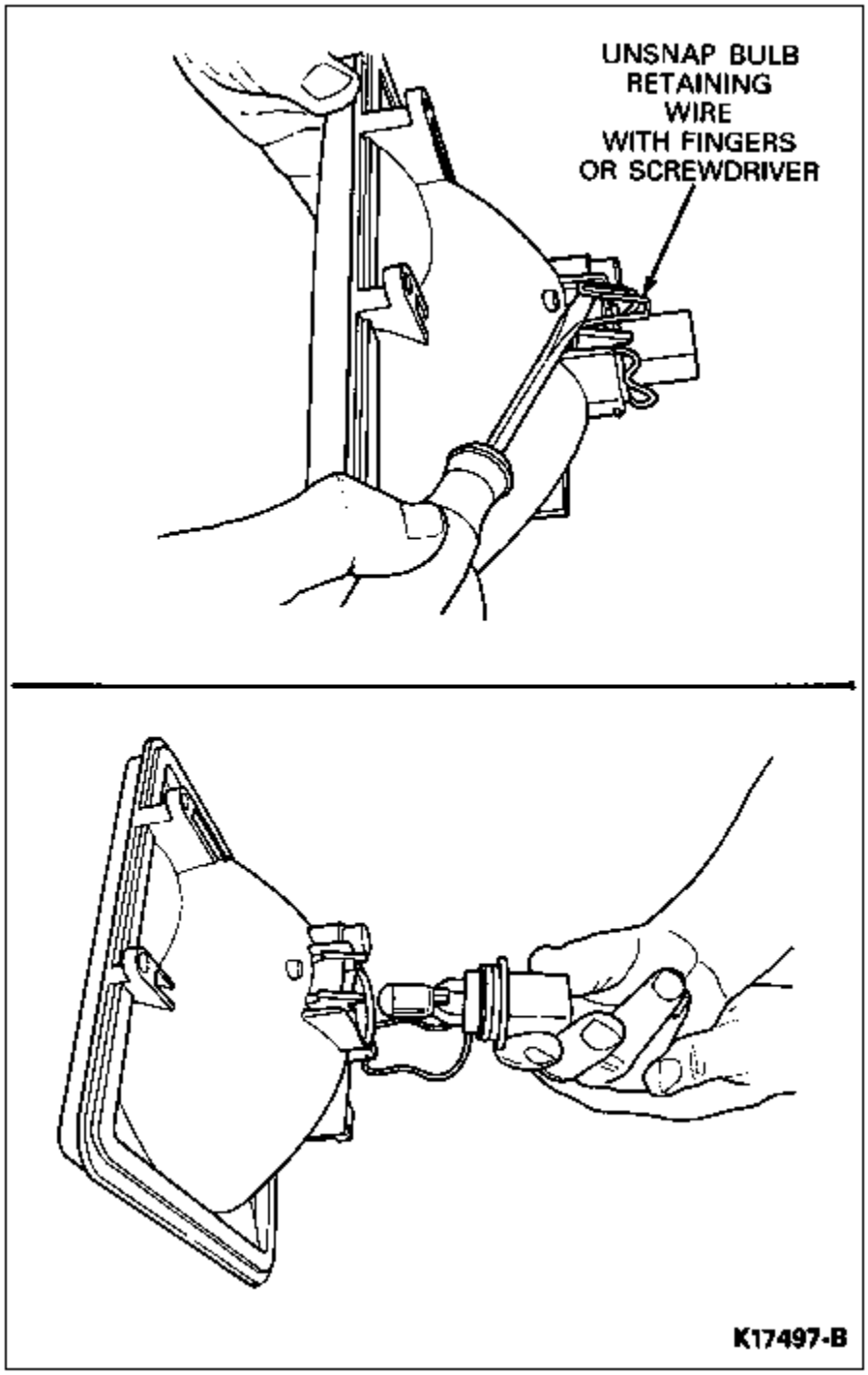

5. **NOTE: A properly aimed headlamp normally need not be reaimed after installation of this headlamp bulb (13007). A burned out headlamp bulb should not be removed from the headlamp until just before a replacement is to be installed. Removal for an extended period of time may allow contaminants (dust, moisture, smoke) to affect the performance of the headlamp.**

   Install new headlamp bulb and retainer (13N021) into position.

6. Connect the wiring to the bulb. Place the headlamp in position and install the attaching screws.

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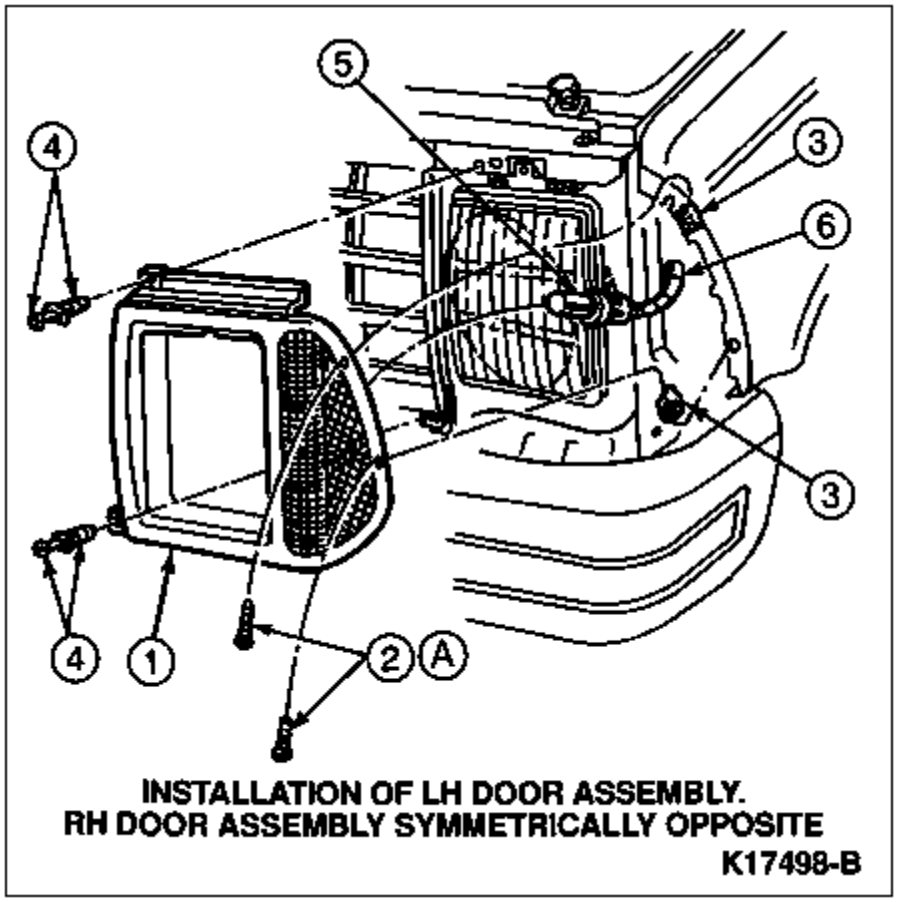
7. Place the headlamp door into position and install the retaining screws.

Headlamp Door Assembly, Aerostar



Item	Part Number	Description
1	13064	Headlamp Door
2	N802586	Screw
3	N803822	Clip, Push-In
4	N803494	Nut, Push-In
5	13N021	Headlamp Bulb and Retainer
6	12A581	Engine Control Sensor Wiring
A	—	Tighten to 1.4-2.3 Nm (12-20 Lb-In)

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Headlamp Assembly, Ranger

Removal

1. Disconnect wiring from the back of the headlamp housing (13100) by releasing the locking tab and grasping the wires and carefully "snapping" rearward.
2. Remove radiator grille (8200) as described in Section 01-02 .
3. Remove the three retainers securing the headlamp to the opening panel in radiator grille.
4. Remove the headlamp (13008) from the vehicle by pulling it forward.
5. Transfer the headlamp bulb retainer (13N019) and the headlamp adjusting screw (13032) to the replacement headlamp if service lamp kit is not being used.

Installation

1. **NOTE: The lower outboard aiming screw installs into a slide track on the opening panel of radiator grille while inserting it into the attachment hole.**

   Position the lamp to the opening in radiator grille panel making sure the locating pin is installed in the aiming screw. Align and insert the three attaching studs.
2. Install the three retainers securing the headlamp to the grille opening panel.
3. Connect wiring.
4. Install radiator grille.
5. Check headlamp aim.

Headlamp Assembly, Ranger

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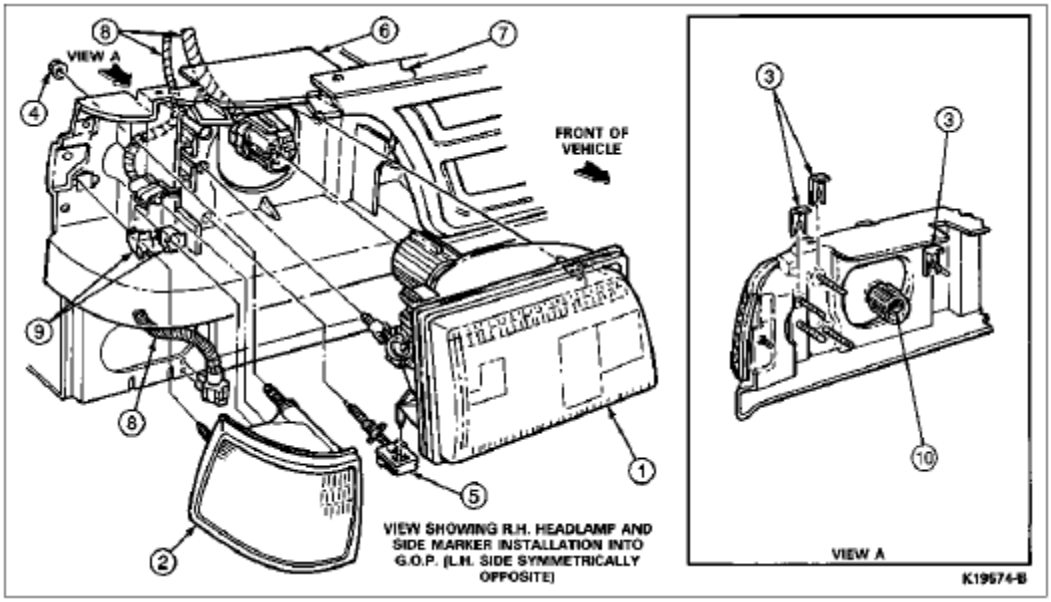

Item	Part Number	Description
1	13008	Headlamp
2	13200	Parking Lamp
3	13N129	Headlamp Mounting Clip
4	N621906	Nut and Washer Assembly
5	13032	Headlamp Adjusting Screw
6	8190	Radiator Grille Opening Panel
7	8200	Radiator Grille
8	14290	Headlamp Dash Panel Junction Wire
9	N807872	Clip
10	13007	Headlamp Bulb

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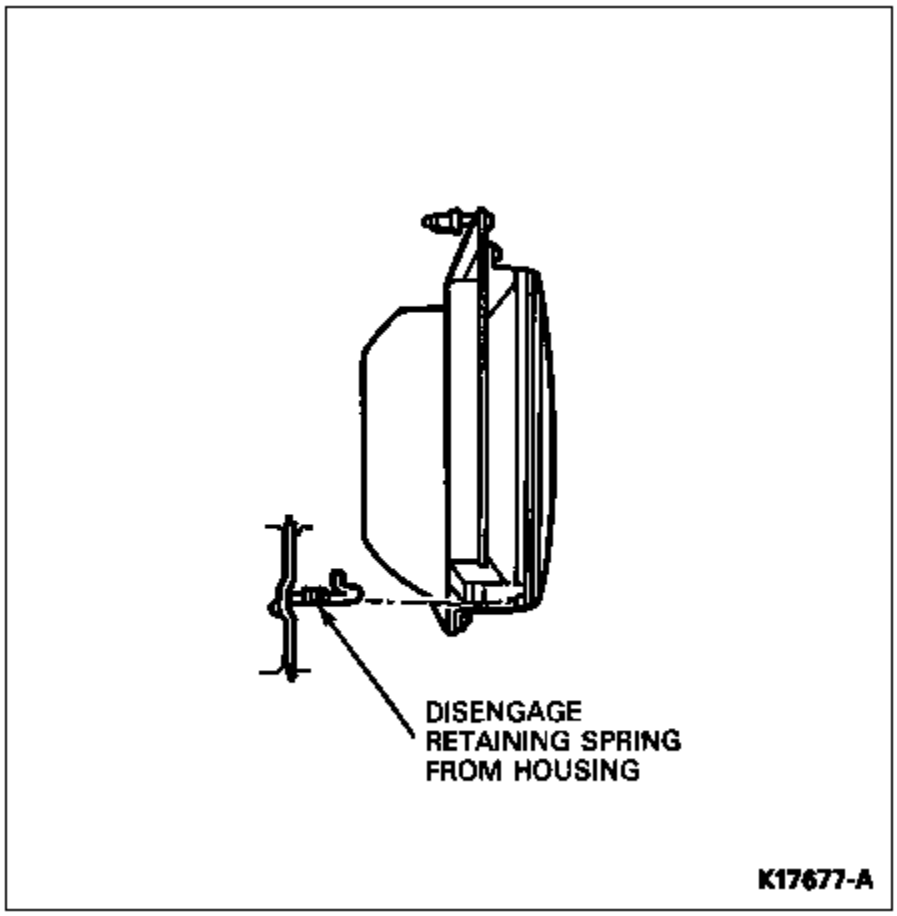
Headlamp Assembly, Aerostar

NOTE: Removal of radiator grille (8200) will make headlamp assembly removal easier.

Removal and Installation

1. Remove headlamp door (13064) and headlamp bulb and retainer (13N021) as described in this section.

2. Disengage retaining spring from housing.



3. Remove verticalheadlamp adjusting screw (13032) by squeezing the tabs with pliers and pulling.

4. Remove horizontal headlamp adjusting screw assembly by squeezing the tabs of the metal clip with a flat-blade screwdriver and pulling.

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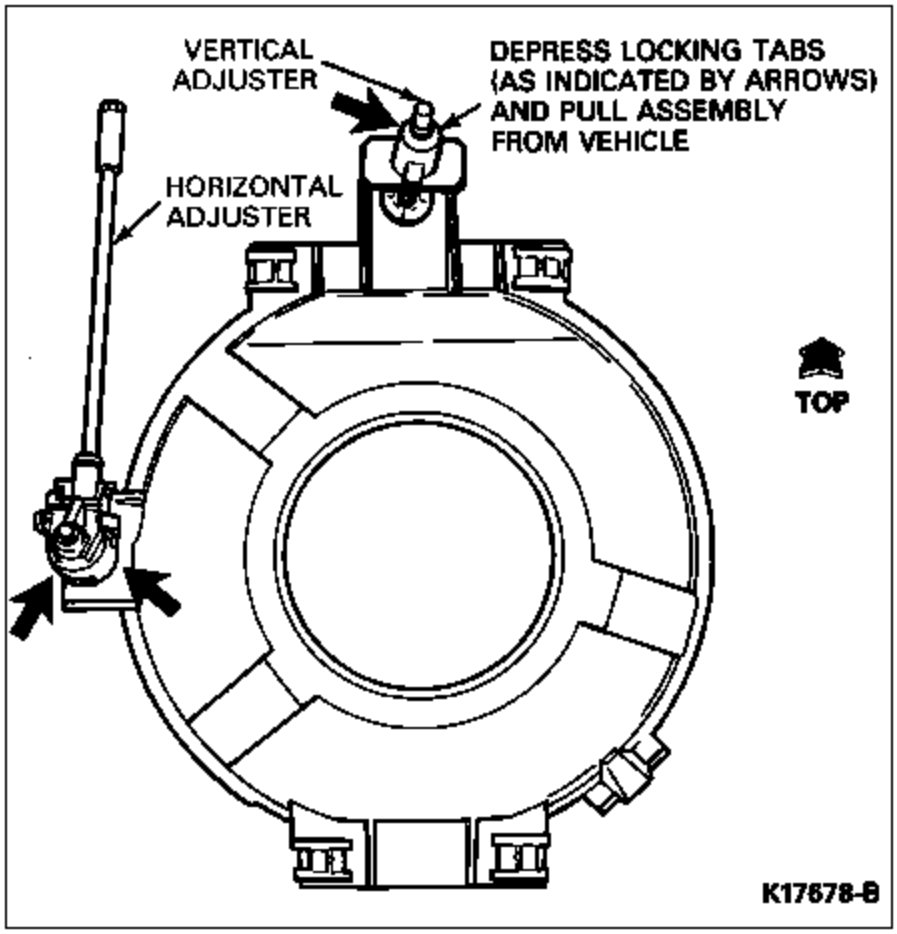

5. Remove assembly from vehicle.

For installation, follow removal procedures in reverse order. Make sure horizontal headlamp adjusting screw is inserted through slot in sheet metal above lamp. Re-aim headlamp.

Headlamp and Housing Assembly, Aerostar

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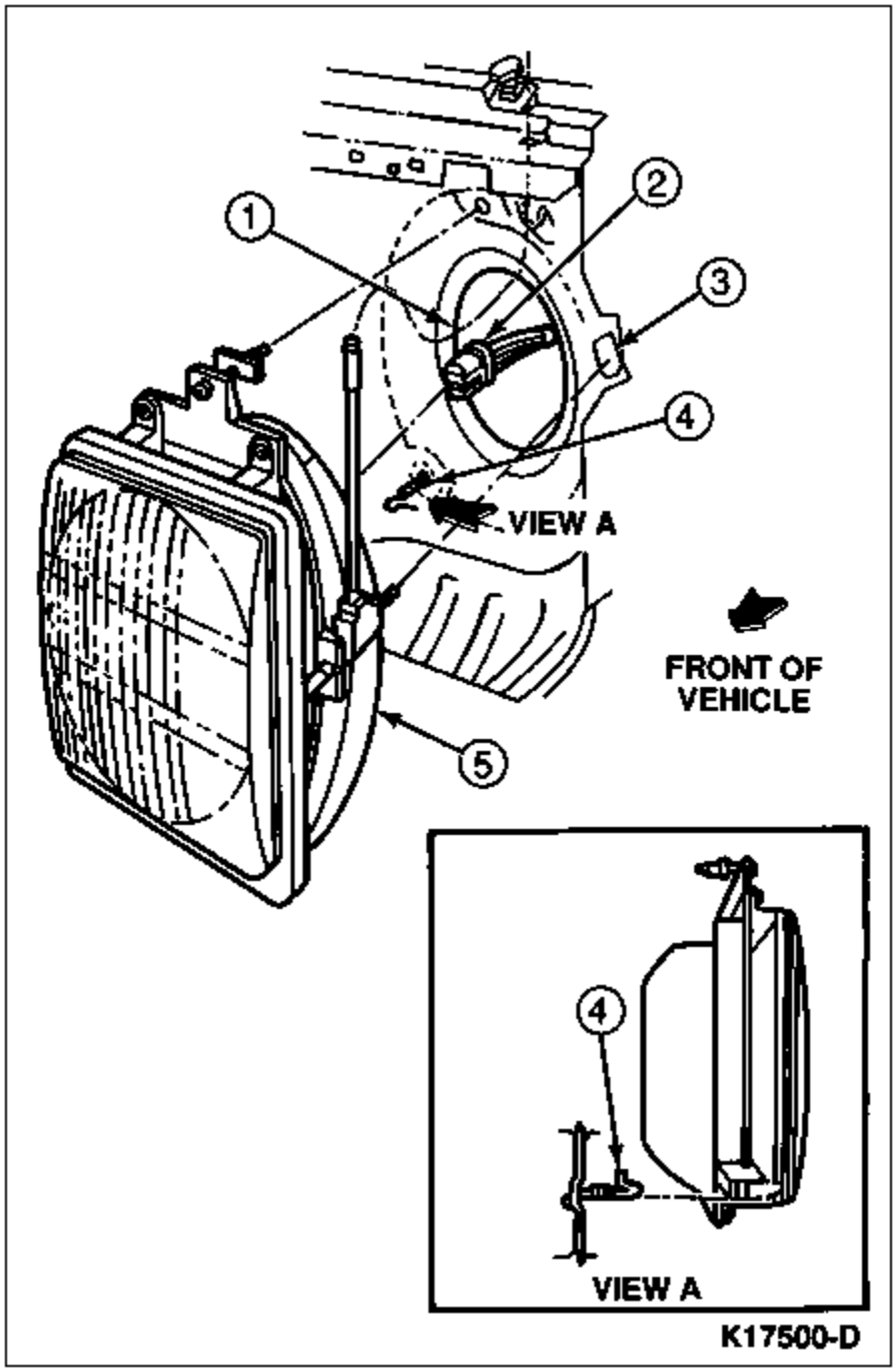

Item	Part Number	Description
1	16138	Radiator Support
2	12A581	Engine Control Sensor Wiring
3	13B160	Headlamp Adjusting Ring Bearing
4	13031	Headlamp Ball Ring Spring
5	13007	Headlamp Bulb

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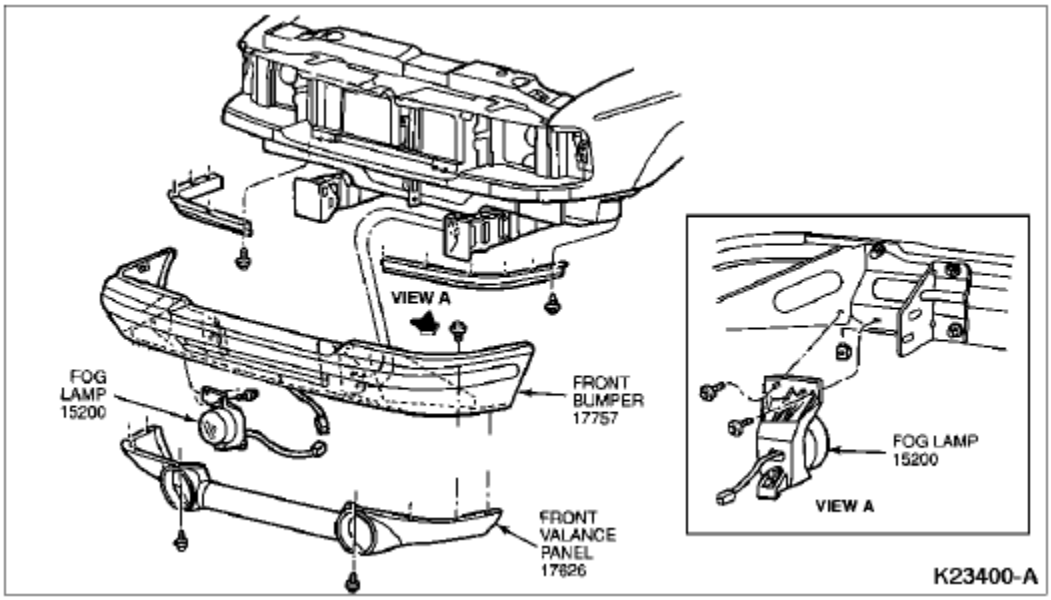
Lamp Assembly, Fog

Removal and Installation

1. Disconnect electrical wiring connector.
2. Remove nut retaining lamp to fog lamp mounting bracket (15266).
3. Remove fog lamp (15200) by pulling out through fascia opening.

For installation, follow removal procedure in reverse order.

Fog Lamp Installation, Ranger



Bulb, Fog Lamp

Removal and Installation

The fog lamp uses a halogen bulb and socket assembly. In the event of a bulb failure, perform the following procedure.

1. **NOTE: Do not touch the new bulb with bare hands. The oil from your skin will cause contamination of the quartz which may result in early failure of the lamp. Do not remove the protective plastic sleeve until the lamp is inserted into the socket. Make sure the circuit is not energized. If the quartz was inadvertently handled, it should be cleaned with a clean cloth moistened with alcohol before installation.**

   Lift up on tab retaining fog lamp lens to the lamp housing. Use caution to avoid dropping the fog lamp

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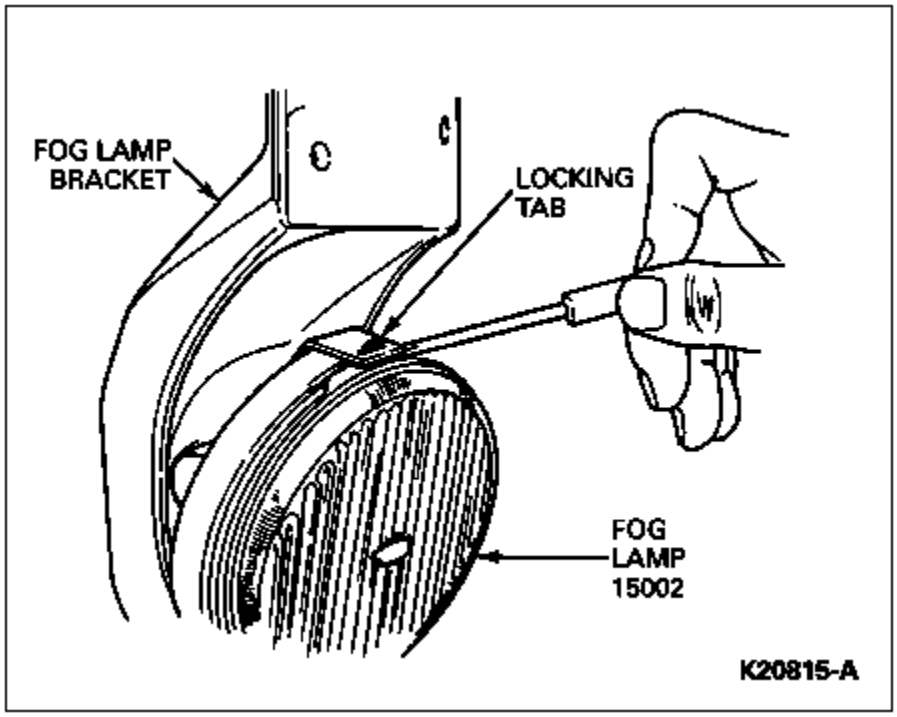
lens.



2. Remove fog lamp lens from lamp housing and turn it to gain access to the rear of lamp body.
3. Disconnect bulb wire lead from pigtail connector.
4. Remove rubber boot from back of lens assembly to access bulb socket.

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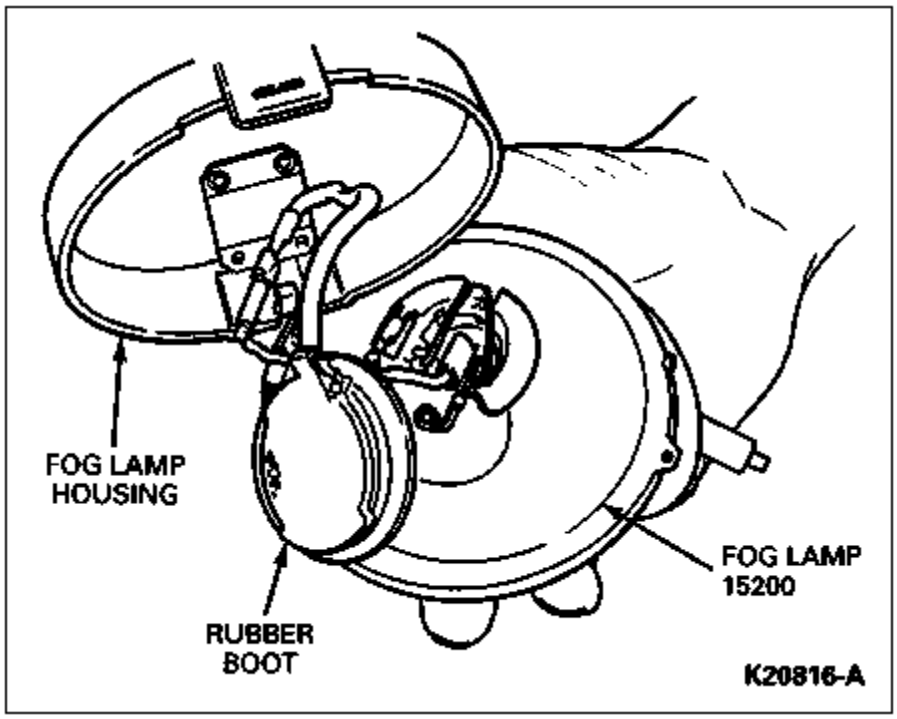

5. Release the bulb socket retainer from the locking tab.
6. Remove bulb and socket assembly from lamp body and pull the bulb directly out of the socket.

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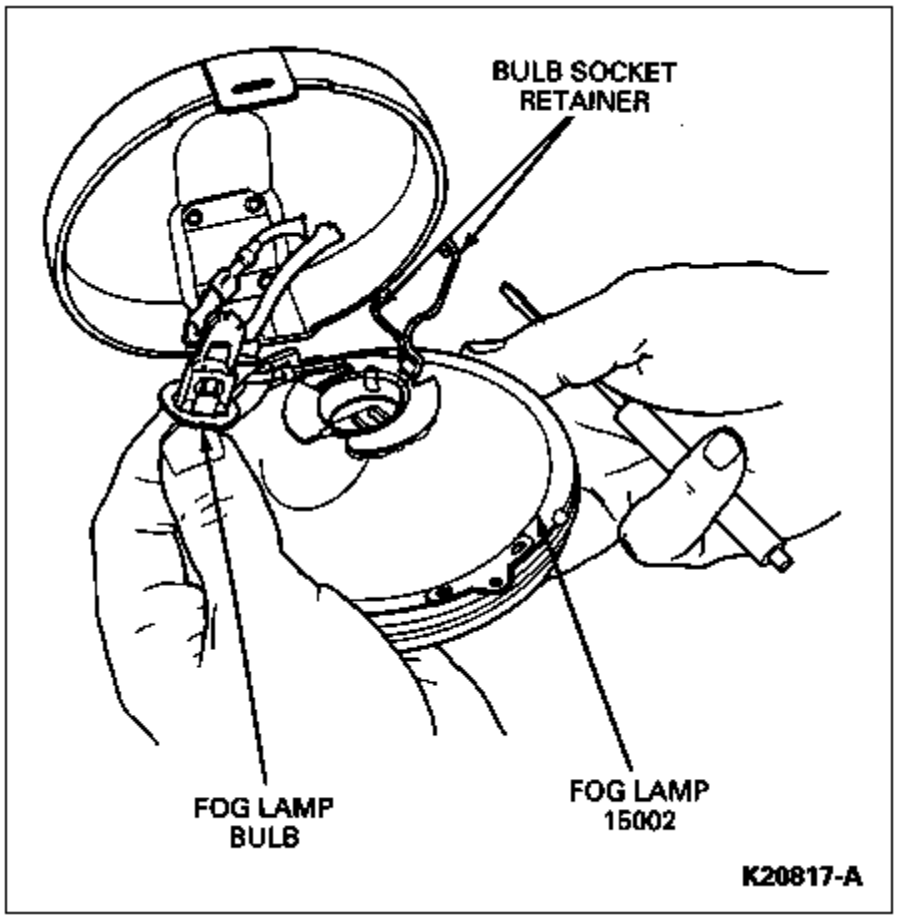

For installation, follow removal procedures in reverse order.

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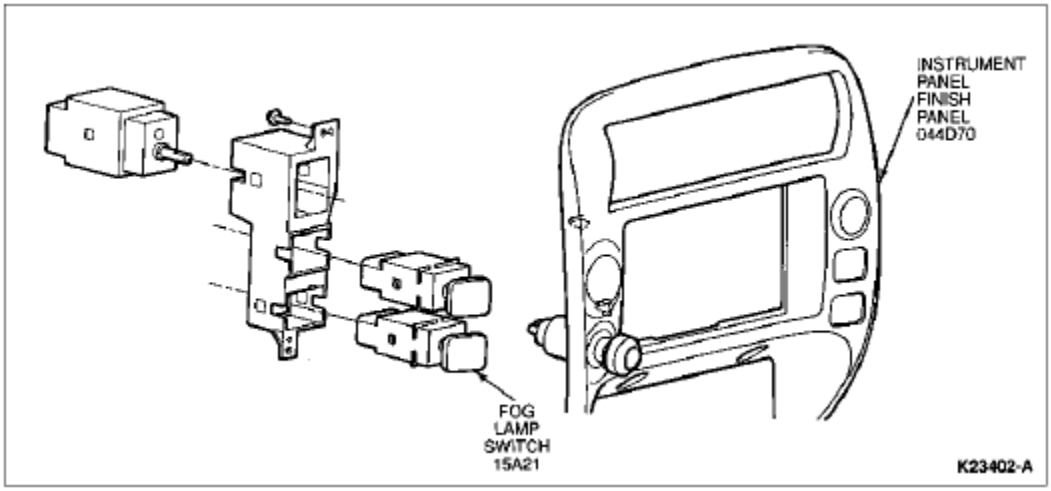
Fog Lamp Switch

Removal and Installation

1. Remove the instrument panel finish panel, refer to Section 01-12 .
2. Reach behind and squeeze tabs on both sides of fog lamp switch (15A214).
3. Pull fog lamp switch out of finish panel and disconnect wiring.
4. To install, reverse removal procedure.

Fog Lamp Switch



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Headlamp Switch, Aerostar

Removal and Installation

1. **NOTE: When the battery is disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

   Disconnect battery ground cable (14301).

2. Remove headlamp switch knob from shaft by inserting screwdriver into knob slot, depressing clip and sliding knob off shaft.

3. Remove three screws attaching steering column shroud (3530).

4. Pull off steering column shroud held by four clips.

5. Remove two screws located below instrument panel ash receptacle in depression.

6. Pull center finish panel loose (held by five clips) and hang down to allow access to cluster finish panel screws.

7. Remove left finish panel held by four clips.

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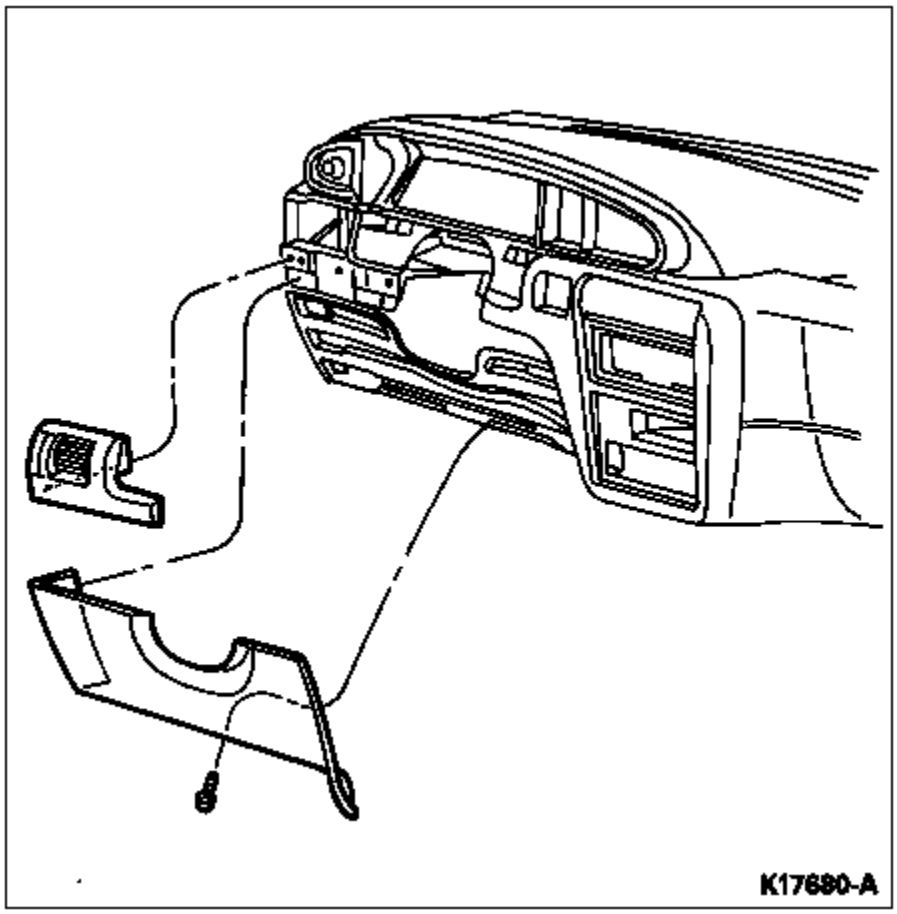

8. Remove five cluster finish panel attaching screws.
9. Remove cluster finish panel held by two clips.

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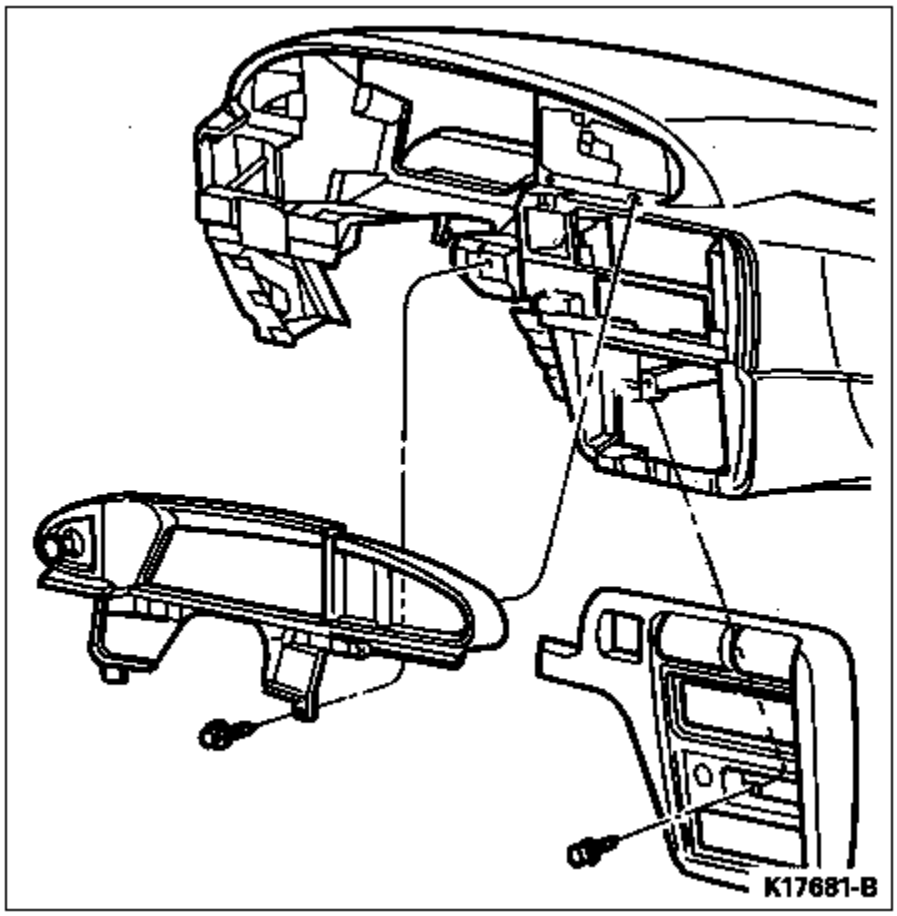

10. Remove two headlamp switch (11654) mounting bracket screws.
11. Pull headlamp switch through opening to expose connectors.
12. Remove electrical connectors.

Headlamp Switch, Aerostar

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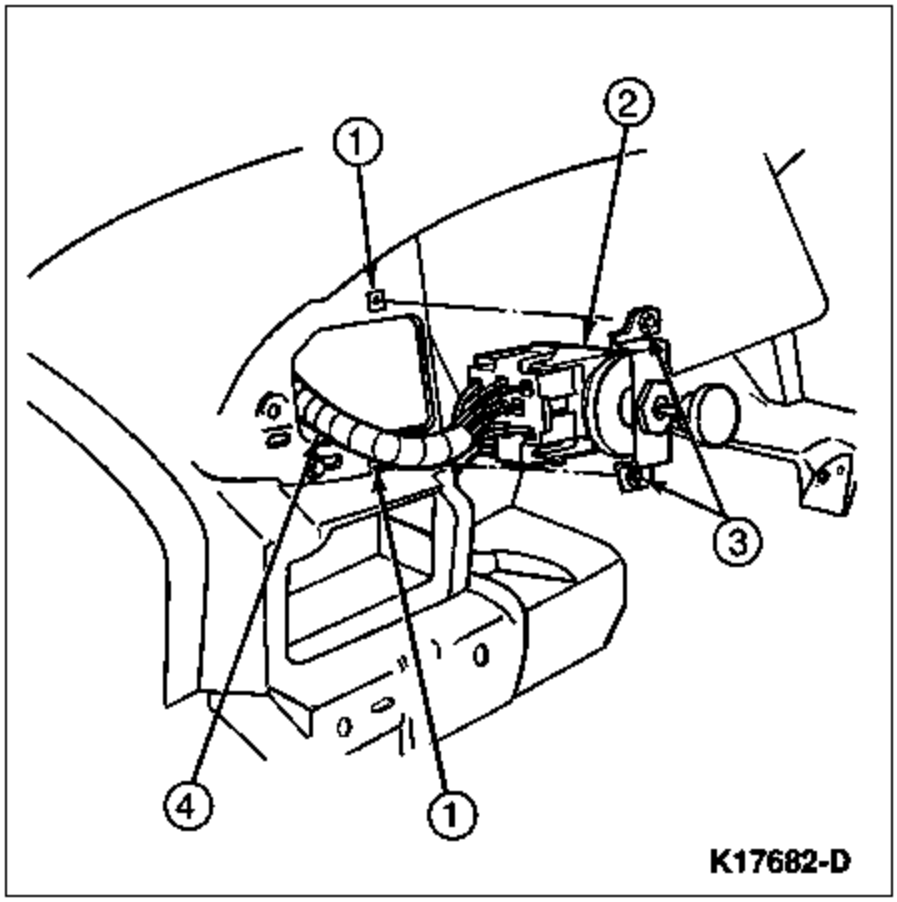

Item	Part Number	Description
1	—	Nut
2	11654	Headlamp Switch
3	N803876-S36	Screw
4	14401	Main Wiring

13. Remove headlamp switch knob and shaft (11661) from headlamp switch by pulling to full ON position then depressing release button while pulling headlamp switch knob and shaft out.

For installation, follow removal procedures in reverse order.

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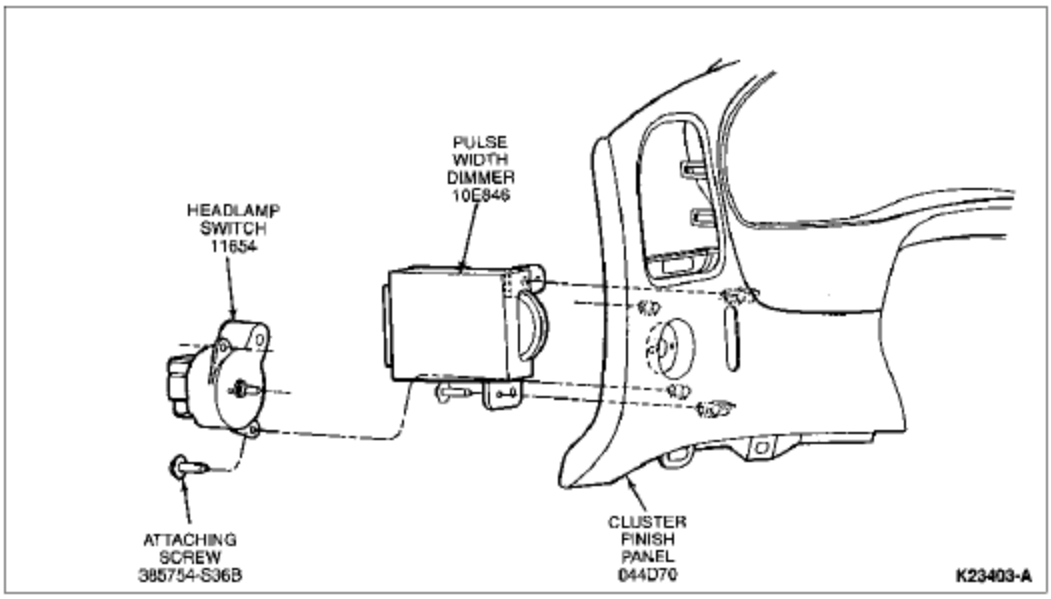
Headlamp Switch, Ranger

Removal and Installation

1. Remove instrument cluster finish panel. If necessary refer to Section 01-12 for procedure.
2. Remove attaching screws and switch from cluster finish panel.

For installation, follow removal procedure in reverse order.

Headlamp Switch, Ranger



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Parking, Turn and Front Side Marker Lamps, Ranger

Removal and Installation

1. Remove two screws attaching the parking lamp (13200) to the opening panel in radiator grille (8200).
2. Pull parking lamp away from vehicle to disengage the three barbed retainers.
3. Twist the lamp socket and remove from lamp.

For installation, follow removal procedures in reverse order.

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Parking, Turn and Front Side Marker Lamps, Aerostar

Removal

1. Remove attaching screws and headlamp (13008).
2. Remove parking lamp (13200) by removing the screws retaining parking lamp to headlamp door (13064).
3. Remove socket from lamp.
4. To remove miniature bulb (13466), push and turn socket counterclockwise one quarter turn and pull miniature bulb directly out from socket.

Installation

1. Push miniature bulb into socket.
2. Install socket to parking lamp and twist one quarter turn clockwise.
3. Position parking lamp to grille and install screws.

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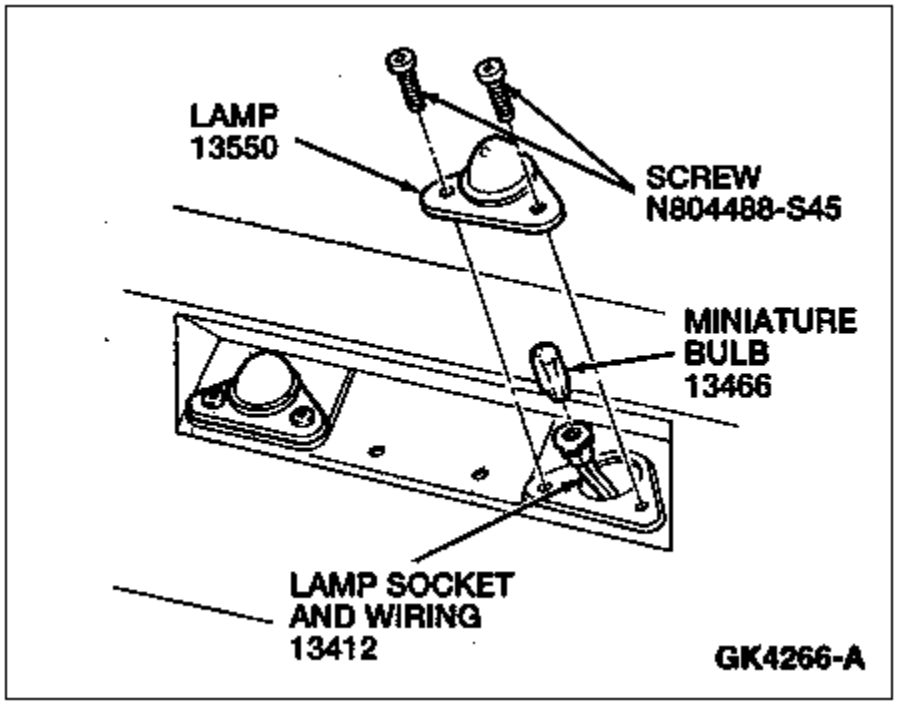
Lamp, License Plate, Aerostar

Removal

1. Remove two screws retaining the lamp to the liftgate (40010).
2. Rotate socket one quarter turn from backside of lamp and remove the miniature bulb (13466).

Installation

1. Install new miniature bulb into socket.
2. Install socket in lamp.
3. Secure lamp to liftgate with two screws.



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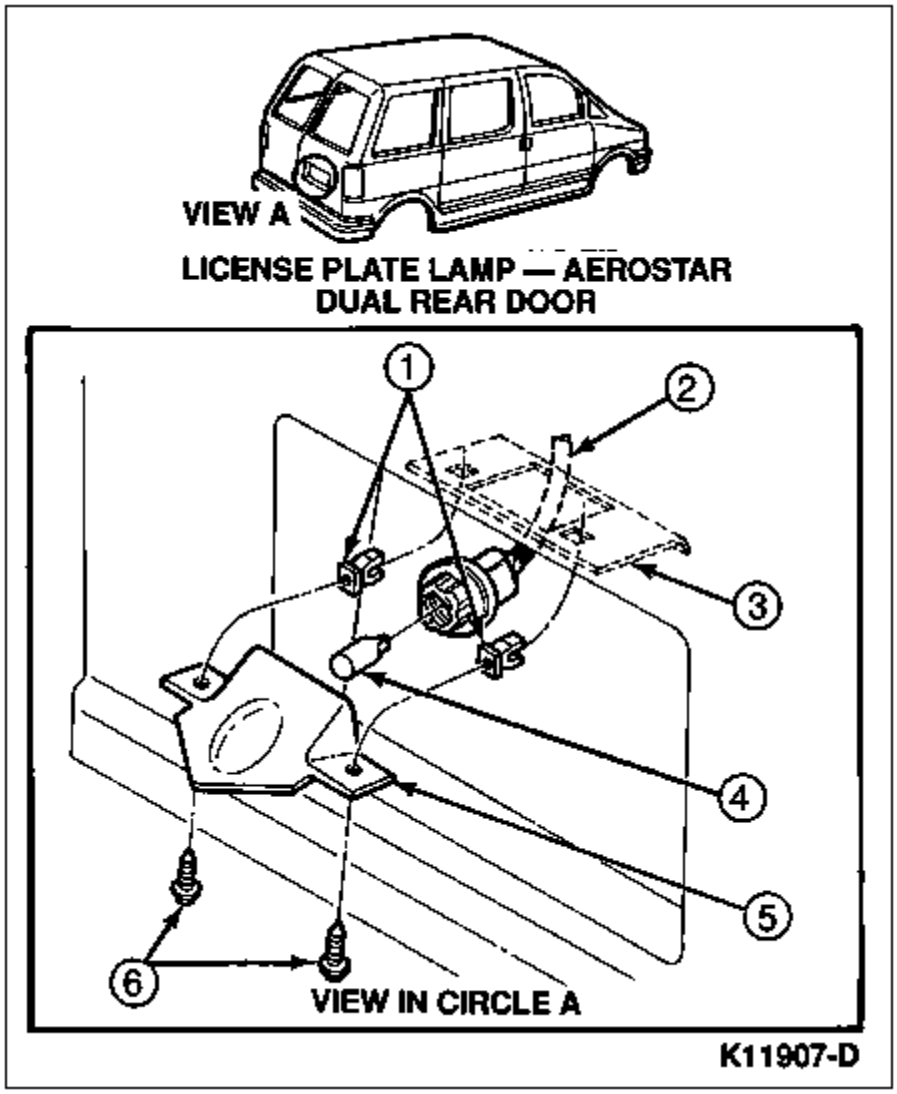

Item	Part Number	Description
1	383356-S	Nut
2	14A583	Door Lock Lead Wire
3	—	Body Bracket
4	13466	Miniature Bulb
5	13550	Lamp
6	56912-S36	Screw

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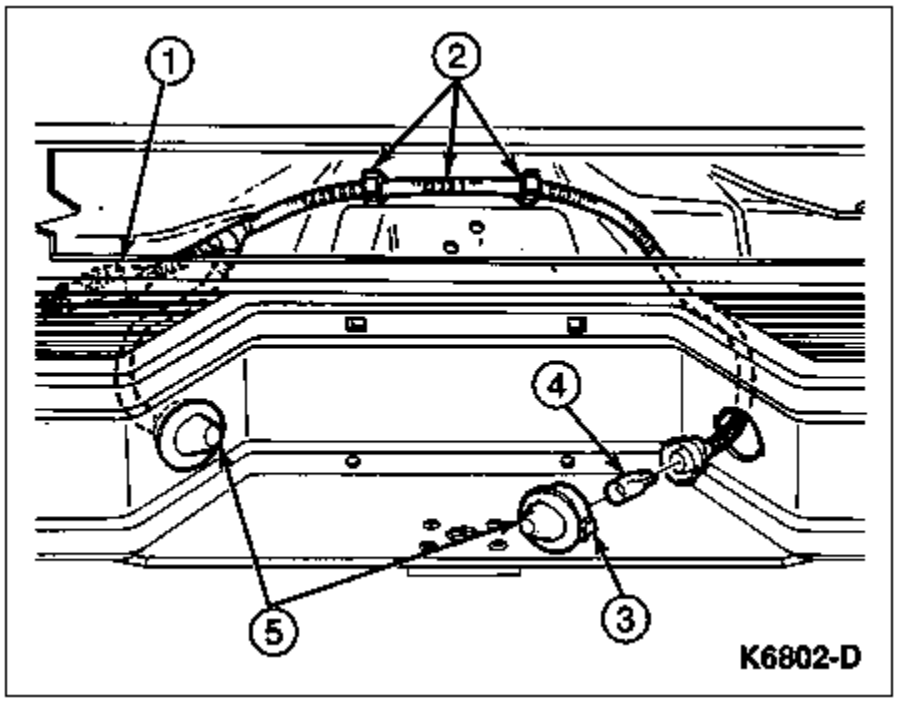
Lamp, License Plate, Ranger

Lamp, License Plate, Ranger

Using a thin-blade screwdriver, apply pressure to the lamp locking tab. While applying pressure to the tab, with another screwdriver **carefully** pry the lamp from the rear bumper. Replace the miniature bulb (13466) or lamp.



Item	Part Number	Description
1	14405	Rear Lamp Wiring
2	13410	Lamp Socket and Wiring
3	—	Locking Tab (Part of 13550)
4	13466	Miniature Bulb
5	13550	Lamp

Lamp, License Plate, Ranger Without Rear Bumper

Remove two bolts securing lamp to vehicle and remove lamp.

License Plate Lamp and Bulb Assemblies, Ranger

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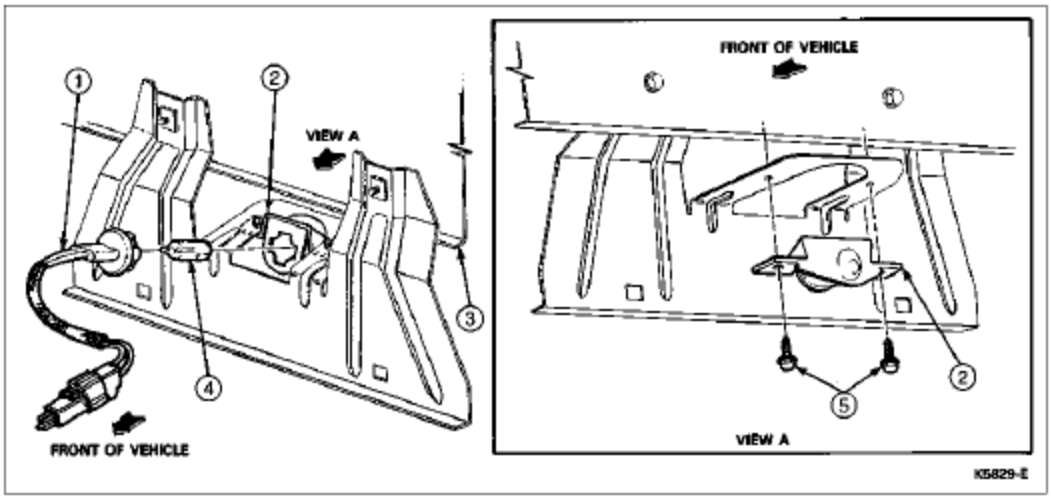

Item	Part Number	Description
1	13410	Lamp Socket and Wiring
2	13593	Lamp Assembly
3	13466	Miniature Bulb
4	N611057	Bolt
5	N605892-S65	Screw

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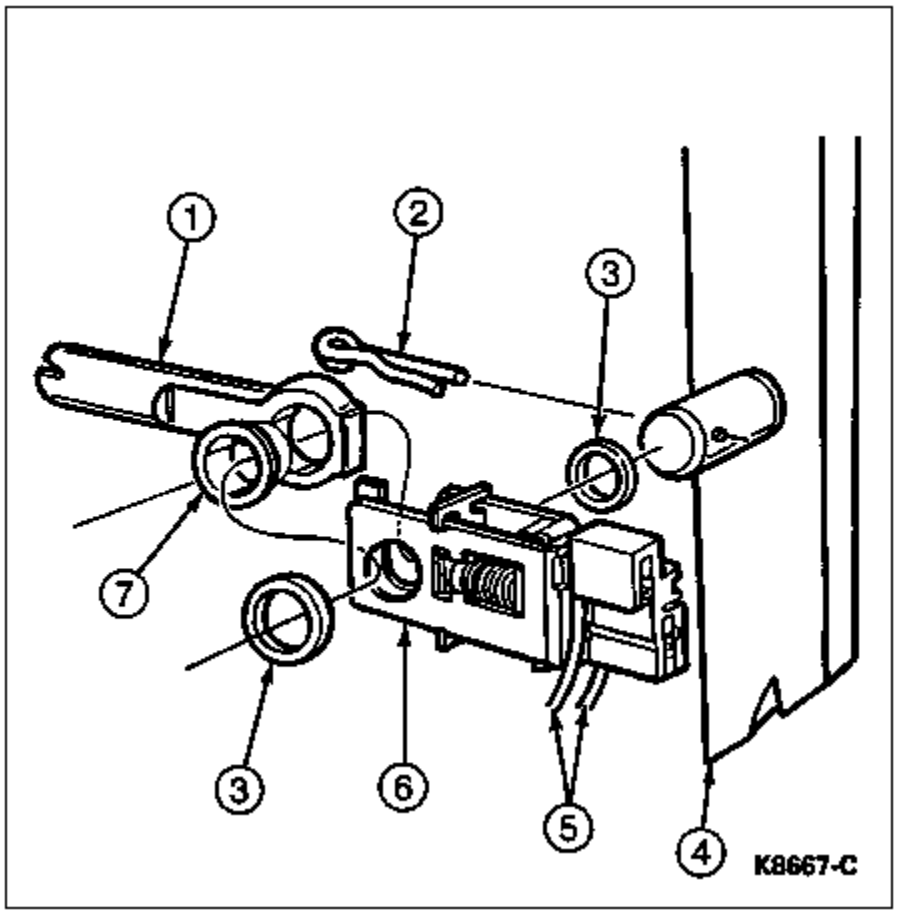
Brake On/Off (BOO) Switch

Removal

1. Disconnect wire harness at connector from brake on/off (BOO) switch.
    - Locking tab must be lifted before connector can be removed.
2. Remove the hairpin clip, slide the brake on/off (BOO) switch, the push rod, the nylon washer and brake master cylinder push rod bushing (2474) away from the brake pedal (2455).
3. Remove the brake master cylinder push rod spacer (2B129) and then the brake on/off (BOO) switch by sliding brake on/off (BOO) switch up or down.
    - Since the switch side plate nearest the brake pedal is slotted it is not necessary to remove the vacuum booster input rod and one brake master cylinder push rod bushing from the brake pedal pin.



Item	Part Number	Description

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1	—	Vacuum Booster Input Rod (Part of 2005)
2	380699-S100	Hairpin Clip
3	2B129	Brake Master Cylinder Push Rod Spacer
4	2455	Brake Pedal
5	14401	Main Wiring
6	—	Brake On/Off (BOO) Switch
7	2474	Brake Master Cylinder Push Rod Bushing

Installation

1. Position brake on/off (BOO) switch so the U-shaped side is nearest the brake pedal and directly over/under the pin. Then slide switch up/down trapping the vacuum booster input rod and bushing between the switch side plates.

2. Push brake on/off (BOO) switch and push rod assembly firmly toward brake pedal arm.

3. **CAUTION: Do not substitute other types of pin clips. Use only factory supplied hairpin clips.**

   Assemble outside white plastic washer to pin and install hairpin clip to hold entire assembly.

4. **CAUTION: Brake on/off (BOO) switch wire harness must have sufficient length to travel with brake on/off (BOO) switch during full stroke of brake pedal. If wire length is too short, reroute or repair harness as required.**

   Assemble the connector to the brake on/off (BOO) switch.

5. Check brake on/off (BOO) switch for proper operation.

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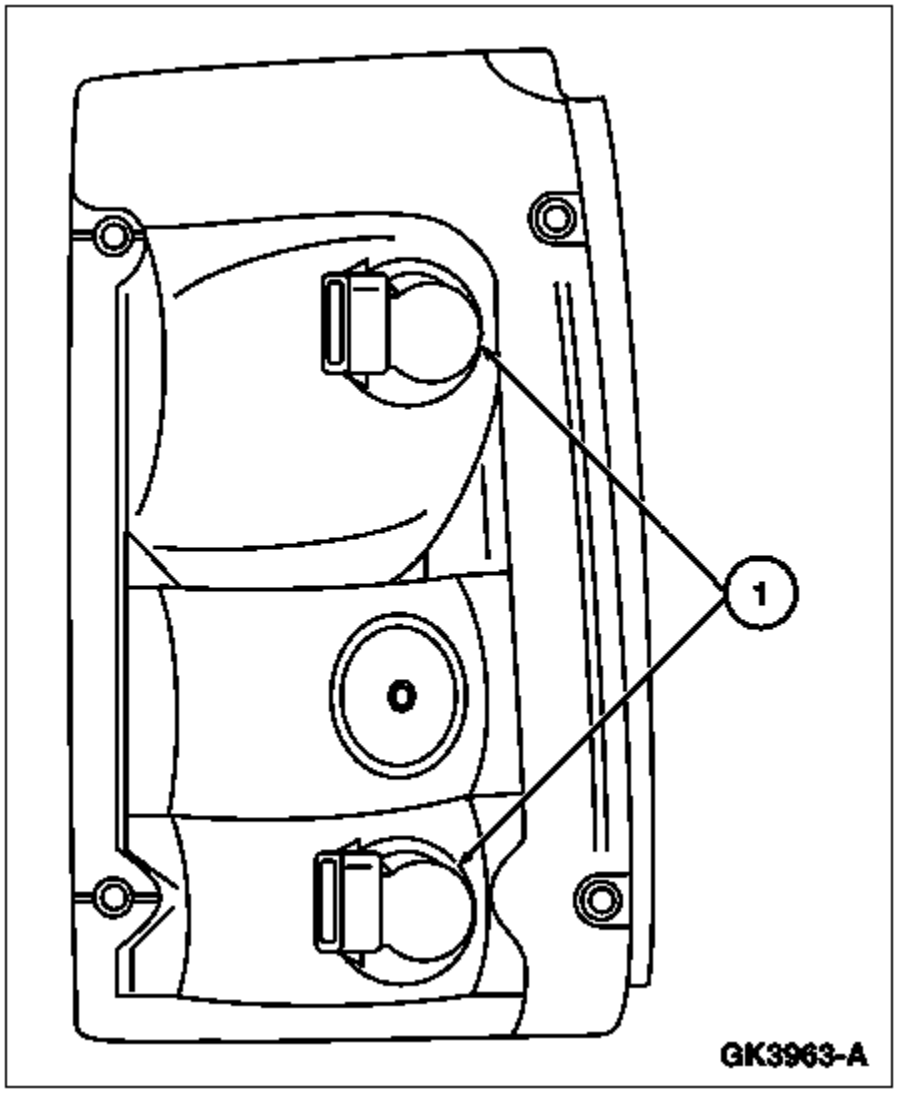
Stop/Tail Lamp, Rear, Aerostar

Removal

1. Remove four screws retainingrear lamp (13404) to vehicle.
2. Remove rear lamp and remove the electrical connector from lamp assembly.
3. Turn the miniature bulbs (13466) counterclockwise and remove.



Item	Part Number	Description

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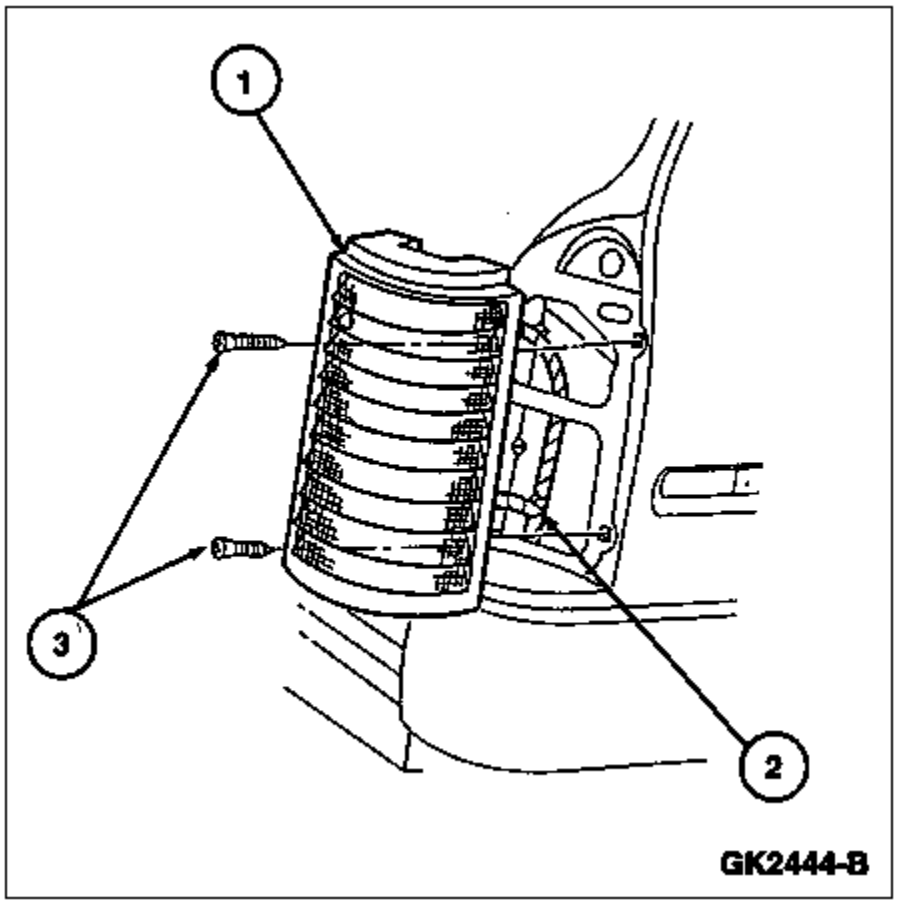
1	10B982	Miniature Bulb

Installation

1. Install miniature bulb or bulbs.
2. Install sockets to rear lamp and position rear lamp to vehicle.
3. Install four screws to secure rear lamp to vehicle.



Item	Part Number	Description
1	13404	Rear Lamp
2	13A409	Wiring Assembly
3	56002-S45	Screw

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Lamp Switch, Backup, 5-Speed Manual Transmission

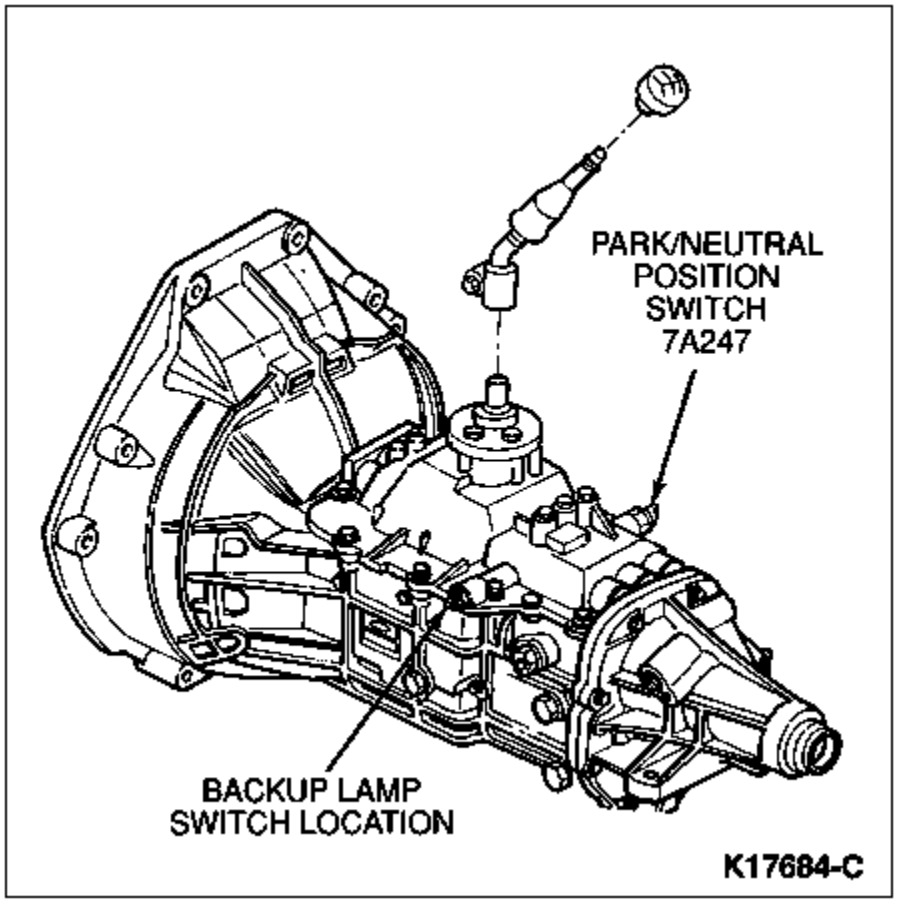
Removal and Installation

1. **NOTE: The backup lamp switch (15520) is located on the shift cover left side.**

   Place the transmission (7003) in any position other than reverse or neutral and disconnect the backup lamp switch to rear lamp feed wire from the backup lamp switch.

2. Remove the backup lamp switch from the transmission.

For installation, follow removal procedures in reverse order. Tighten the new backup lamp switch to 11-16 Nm (8-12 lb-ft).



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Lamp Switch, Backup, Automatic Transmission

On Aerostar vehicles equipped with an automatic transmission (7003), the backup lamp housing (15502) is an integral part of the park/neutral position switch (PNP switch) (7A247). For removal and installation procedures, refer to Section 07-01A or Section 07-01B .

On Ranger vehicles equipped with an automatic transmission, the backup lamp switch is an integral part of the transmission range sensor. For removal and installation procedures, refer to Section 07-01A or Section 07-01B .

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Lamp, Rear Hi-Mount, Ranger

Removal

1. Remove two screws securing rear hi-mount lamp (13A613) to vehicle.
2. Pull lamp away from vehicle and disconnect wiring connector.
3. Replace miniature bulbs (13466) if required by rotating socket to remove from rear hi-mount lamp and pull miniature bulb from socket.

Installation

1. Press miniature bulb into socket. Place socket into rear hi-mount lamp and rotate to secure in place.
2. Position gasket on rear hi-mount lamp and connect wiring connector.
3. Position rear hi-mount lamp on vehicle and install two screws.

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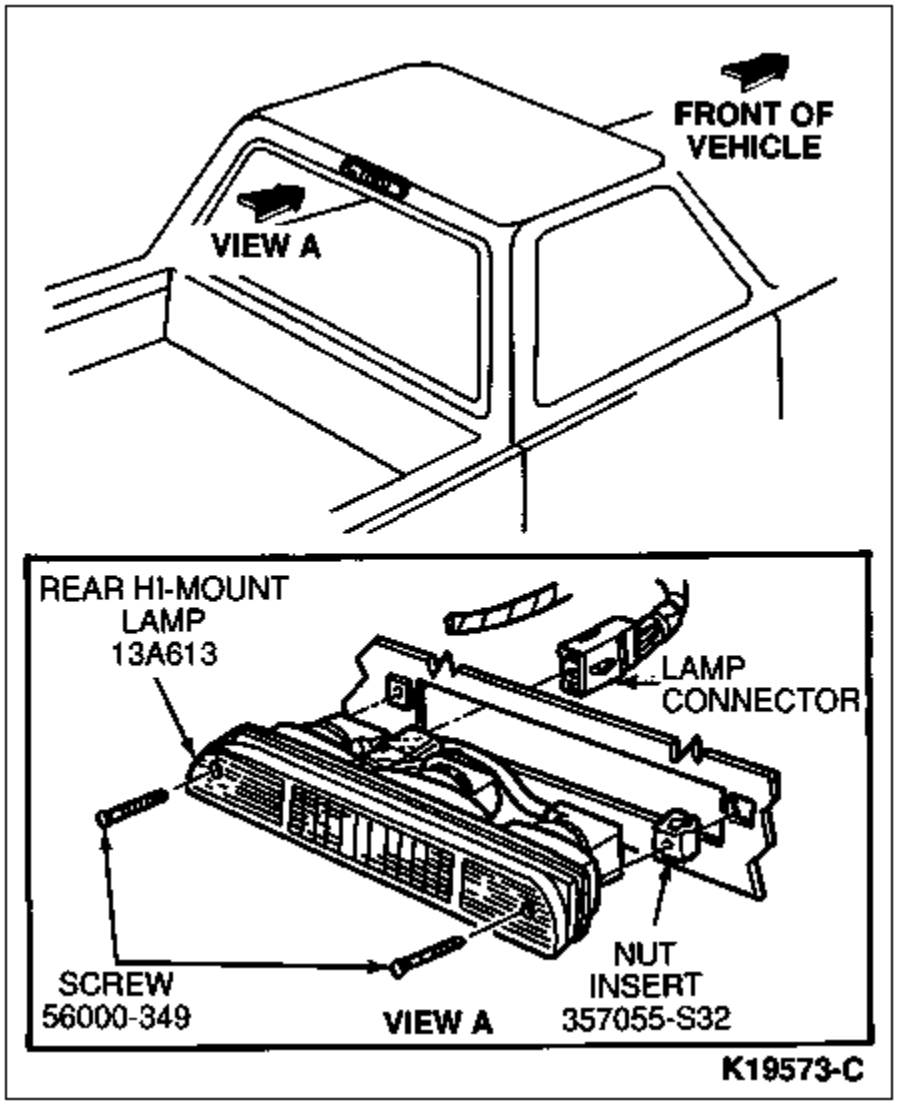

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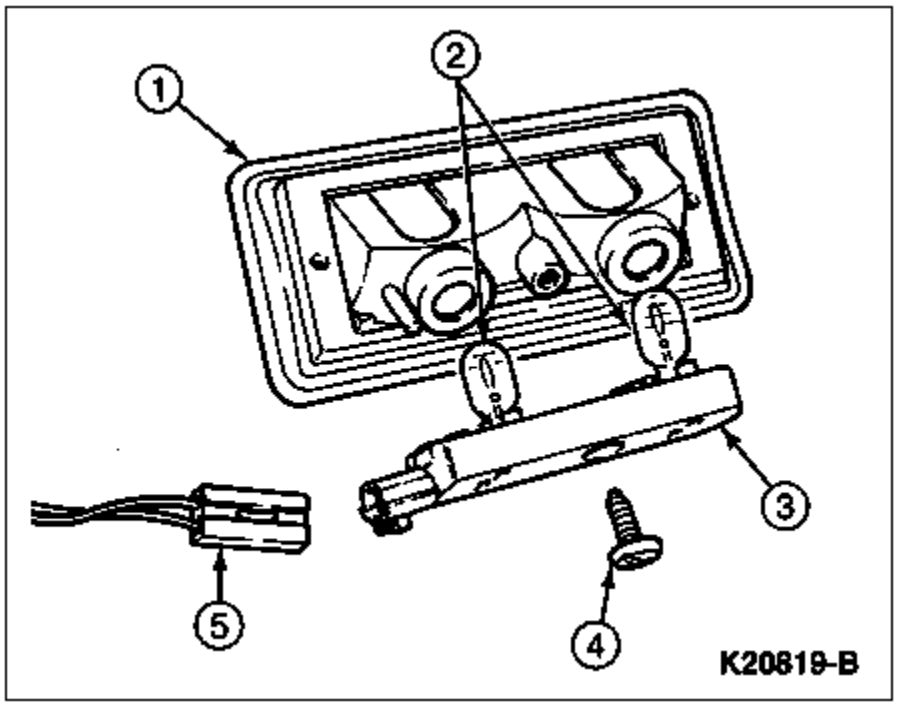
Hi-Mount, Aerostar

Removal

1. Remove two screws securing rear hi-mount lamp (13A613) to liftgate (40010).
2. Pull rear hi-mount lamp away from liftgate and disconnect rear hi-mount lamp wiring.
3. Replace bulbs, if required, by removing the retaining screw from the bulb holders assembly.
4. Pull the bulb holder away from the lamp. Pull bulb straight out of the holder.

Installation

1. Press bulb into bulb holder assembly. Place bulb holder assembly on lamp and install retaining screw. Tighten screw.
2. Position gasket on rear hi-mount lamp and connect rear hi-mount lamp wiring.
3. Position rear hi-mount lamp in liftgate and install two screws.



Item	Part Number	Description
1	13A613	Rear Hi-Mount Lamp

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2	13466	Miniature Bulb
3	—	Bulb Holder (Part of 13A613)
4	56929-S2	Screw
5	13B440	Rear License Lamp Feed Wiring

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Lamp, Rear Hi-Mount, Bulb, Aerostar with Dual Rear Doors

Removal and Installation

1. Remove the two screws retaining the lens.
2. Pull the lens assembly out of the lamp housing.
3. Pull the bulb socket out of the lens assembly. It is not necessary to twist the socket.
4. Pull the bulb out of the socket.
5. Replace the bulb and assemble the lamp.

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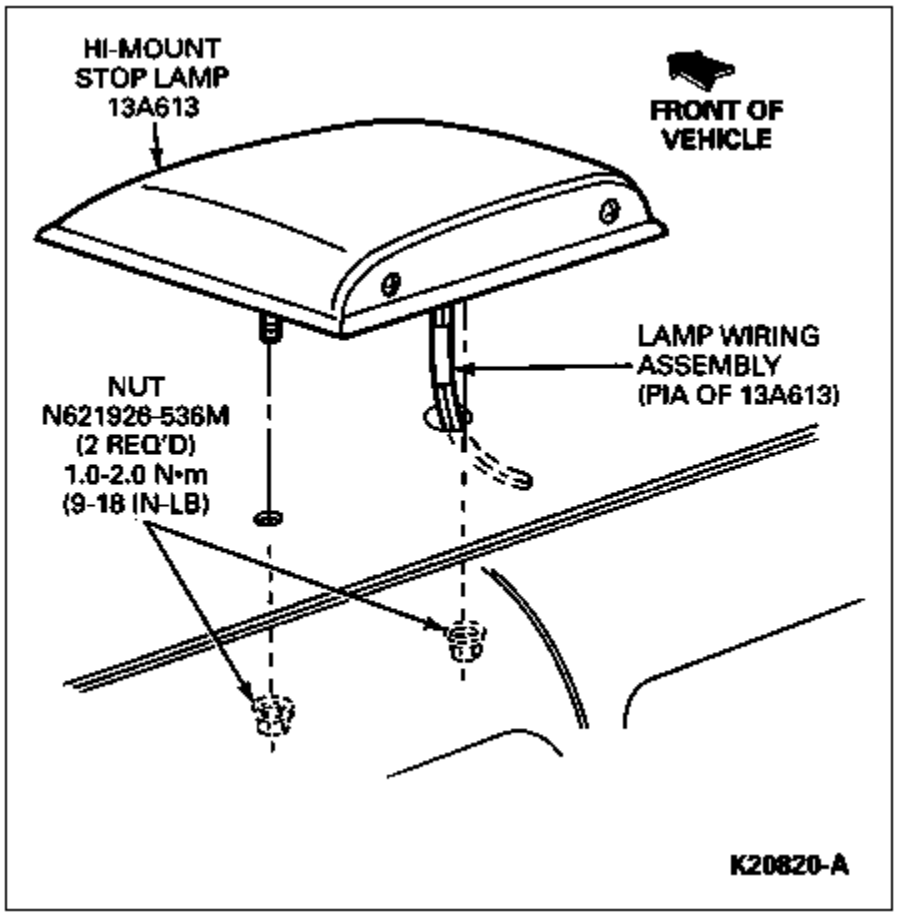
Lamp, Rear Hi-Mount, Aerostar with Dual Rear Doors

Removal and Installation

1. Remove interior cargo lamp. Refer to Section 17-02 .
2. Disconnect the rear hi-mount lamp (13A613) wiring connector.
3. Remove the two attaching nuts retaining the hi-mount stoplamp to the roof panel.
4. Lift the rear hi-mount lamp off the roof, disengage the wiring grommet and pull the wiring through the hole in the roof.

For installation, follow removal procedures in reverse order.



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Headlamp Aim

NOTE: The condition of the vehicle springs, improper wheel alignment or improper rear axle tracking may affect headlamp aim.

Before making any adjustment, perform the following preparatory steps:

1. Remove ice or mud from under fenders.
2. Make sure all tires are inflated to recommended pressures.
3. Make sure that the vehicle attitude is typical of how the vehicle is normally operated, i.e., with full load, carrying a trailer, etc.
4. Clean lenses and aiming pads.
5. Check for proper beam switching.
6. Make sure output is well toward normal new lamp value.
7. Bounce the vehicle and allow to settle.

Perform headlamp aim adjustments with Rotunda Headlamp Aiming Kit 107-00001 or equivalent. To aim the aerodynamically styled headlamps, the adjustable aimer adapters provided in the kit must be used. Adjustment aimer adapter positions are molded into the face of the headlamp lens, near the bottom.

Set and lock the adjustable adapters, attach each adapter to its mechanical aimer, and aim headlamps per latest instructions in the kit.

The equipment in Rotunda Headlamp Aiming Kit 107-00001 or equivalent can be calibrated to accommodate a slight slope in the floor, making it usable almost any place in the garage. However, area must be reasonably flat.

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SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-Ft	Lb-In
Screw, Headlamp Door	1.4-2.3	—	12-20
Screw, Lamp Assembly	0.8-1.13	—	7-10
Screw, Neutral Sensing Switch	11-16	8-12	—
Screw, Rear Hi-Mount Lamp	20.3-27.2	15-20	—

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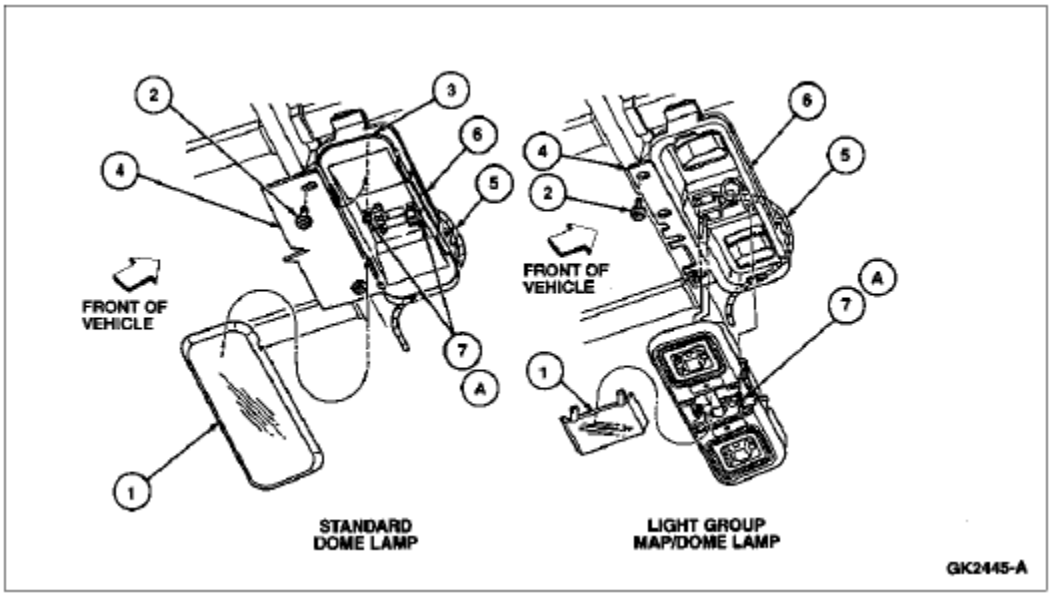
Lamp, Dome, Aerostar

The overhead interior lamp (13776) is controlled by the instrument panel lamp thumbwheel (dimming rheostat). Rotating the thumbwheel toward the rear of the vehicle turns the interior lamp on; rotating the thumbwheel toward the front of the vehicle turns the interior lamp. The interior lamp is also controlled by the door lamp switches (13713). All models have a lamp switch located in the driver's door hinge pillar which activates the interior lamp when the front door (20124) is opened. Passenger side lamp switch and cargo door lamp switch are available on some models as an option.

Dome Lamps, Aerostar



Item	Part Number	Description
1	13783	Lens
2	56910	Screw (2 Req'd)
3	N803715	Clip (2 Req'd)
4	13879	Courtesy/Map Lamp Bracket
5	14334	Courtesy or Interior Lamp Switch Wiring
6	13786	Interior Lamp Body
7	—	Screw (Part of 13776)
A	—	Tighten to 2-3 Nm (18-27 Lb-In)

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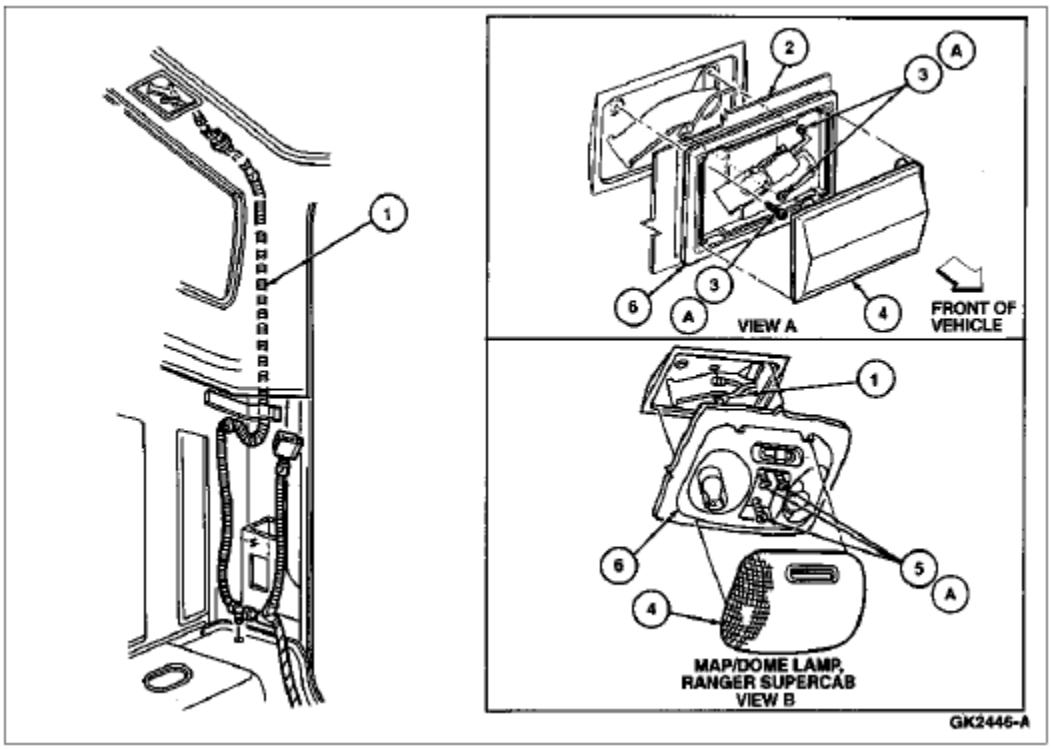
Lamp, Dome, Ranger

The interior lamp (13776) and rear cargo lamp are energized when the pulse width dimmer module is rotated fully to the up position. All models have a lamp switch (13713) located in the driver's door latch that activates the interior lamp when the front door (20124) is opened. Passenger side lamp switch is available as an option.

Dome Lamp, Ranger



Item	Part Number	Description
1	13A724	Wiring Assembly
2	51968	Roof Trim Panel
3	52802-S36	Screw(s)
4	13783	Pillar/Dome Lamp Lens
5	—	Screw(s) (Part of 13776)
6	13776	Interior Lamp
A	—	Tighten to 1.6-1.8 Nm (15-17 Lb-In)

Dome Lamp, Ranger SuperCab

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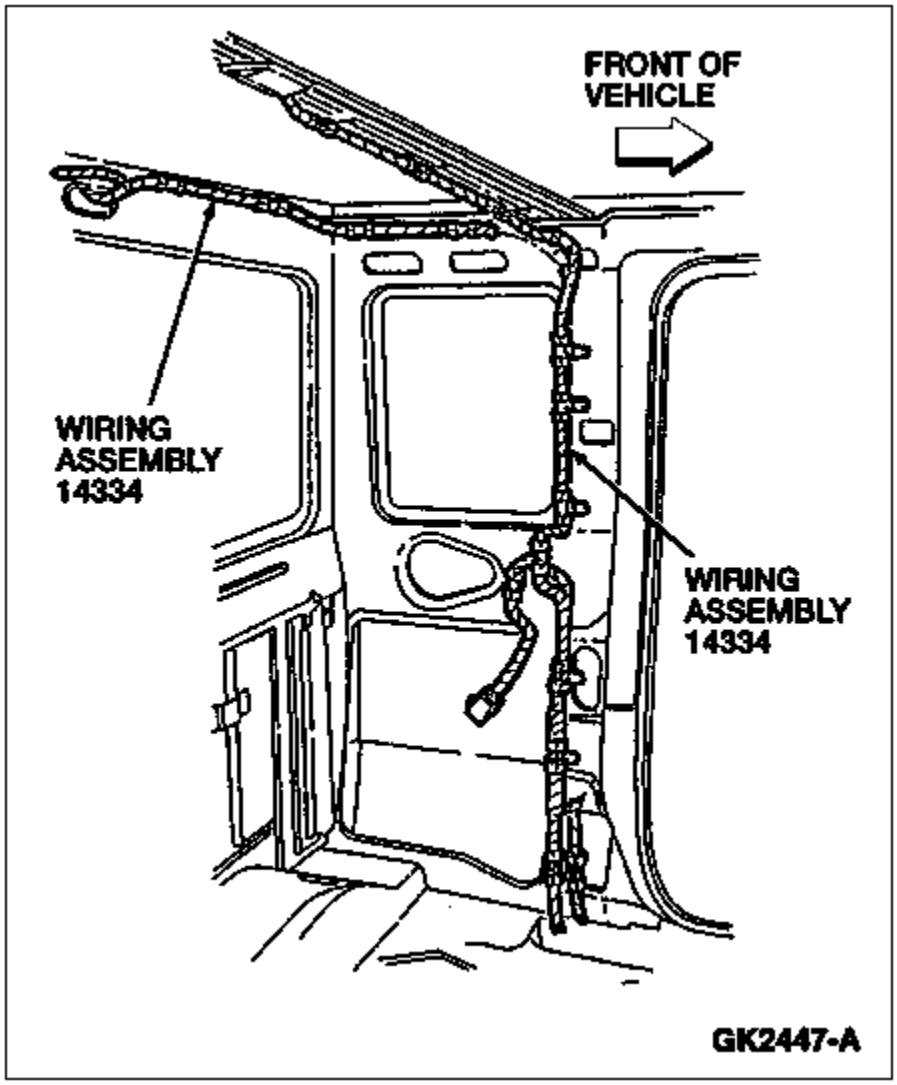

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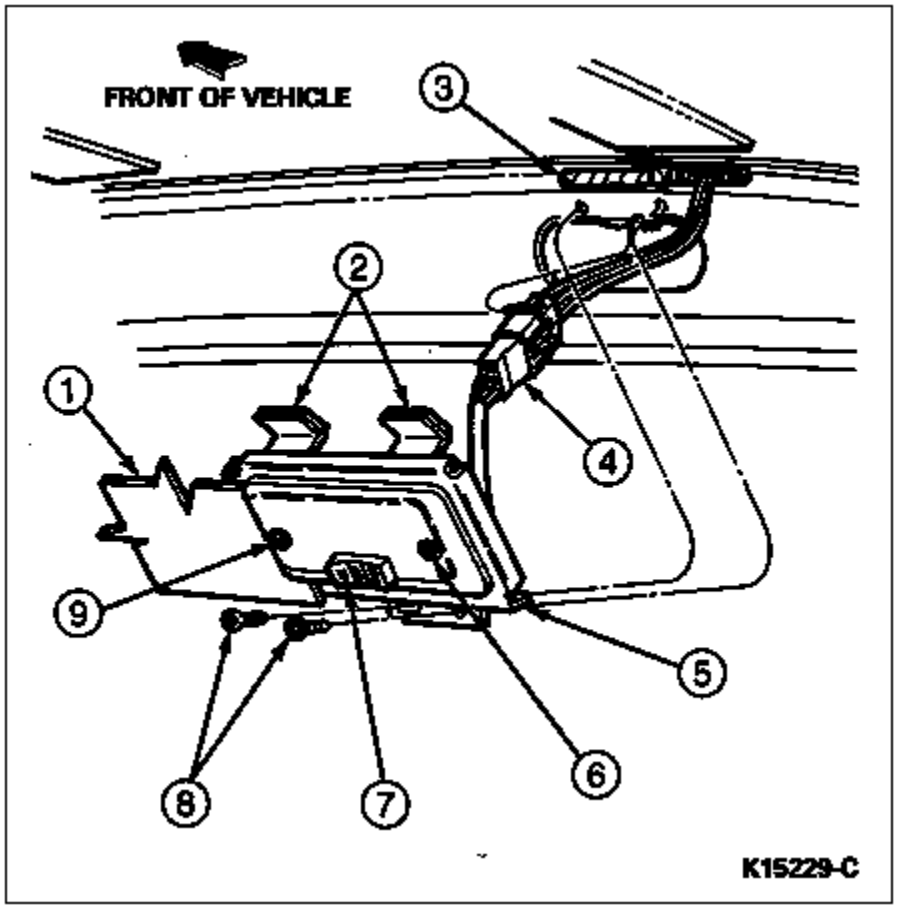
Lamp, Cargo, Aerostar

The interior lamp (13776) is located on the roof trim panel (51968). With the switch in the AUTO position it will turn on with the thumbwheel or when opening liftgate (40010). The interior lamp can also be turned on by using the ON position of the switch.

Cargo Lamp, Aerostar



Item	Part Number	Description
1	51968	Roof Trim Panel
2	—	Adhesive Tape
3	14405	Rear Lamp Wiring
4	—	Connector (Part of 14405)
5	13776	Interior Lamp
6	N610089	Screw (2 Req'd)
7	—	On/Off/Auto Switch (Part of 13776)

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8	55881	Screw
9	13K707	Pillar/Dome Lamp Lens

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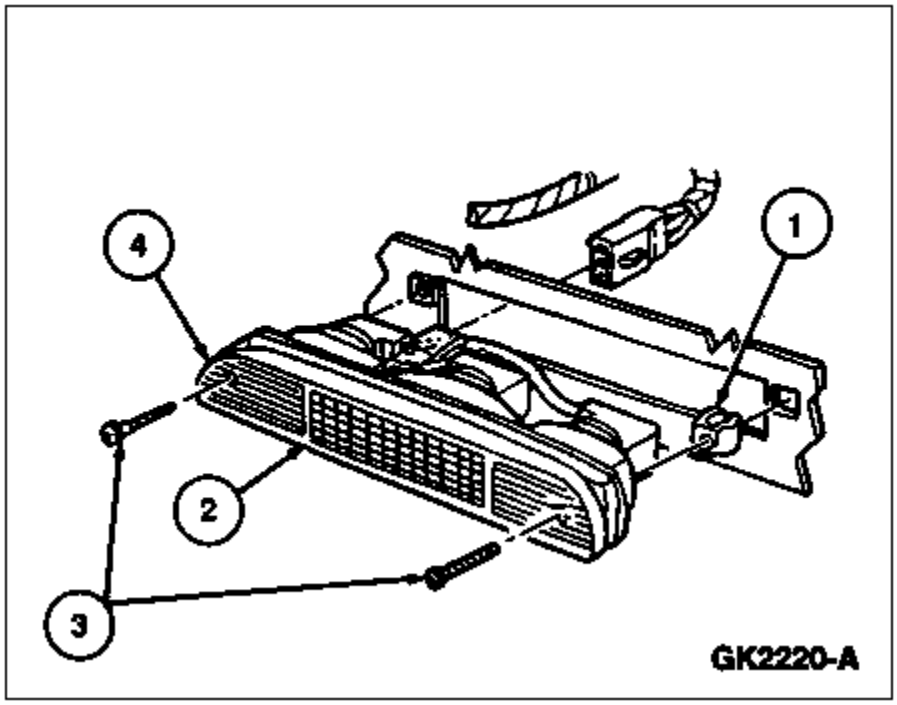
Lamp, Cargo, Ranger

The rear hi-mount/cargo lamp is located outside (Ranger vehicles if equipped) and above the back window glass (42006) and is controlled by rotating the pulse width dimmer module thumbwheel to the up position.

Cargo Lamp, Ranger



Item	Part Number	Description
1	357055	Nut Insert
2	13A613	Cargo Lamp
3	56000	Screw
4	13A613	Rear Hi-Mount Lamp

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Lamps, Courtesy

The GEM illuminates the interior courtesy lamps when any door is set ajar or is opened. The following are inputs used for controlling the courtesy lamps.

- all door ajar switches
- illuminated entry request — RAP module
- two step unlock

All interior courtesy lamps are turned off when any of the following occurs:

- twenty-five seconds have elapsed after all the doors are closed.
- the ignition switch (11572) is turned to RUN.
- vehicle speed is over 8 km/h (5 mph) (once the interior courtesy lamps are turned OFF, a new ajar signal will be honored only if vehicle speed is below 16 km/h [10 mph]).
- a power door lock command is received before the five seconds have elapsed.

Panel Mounted Pulse Width Dimmer Module, Ranger

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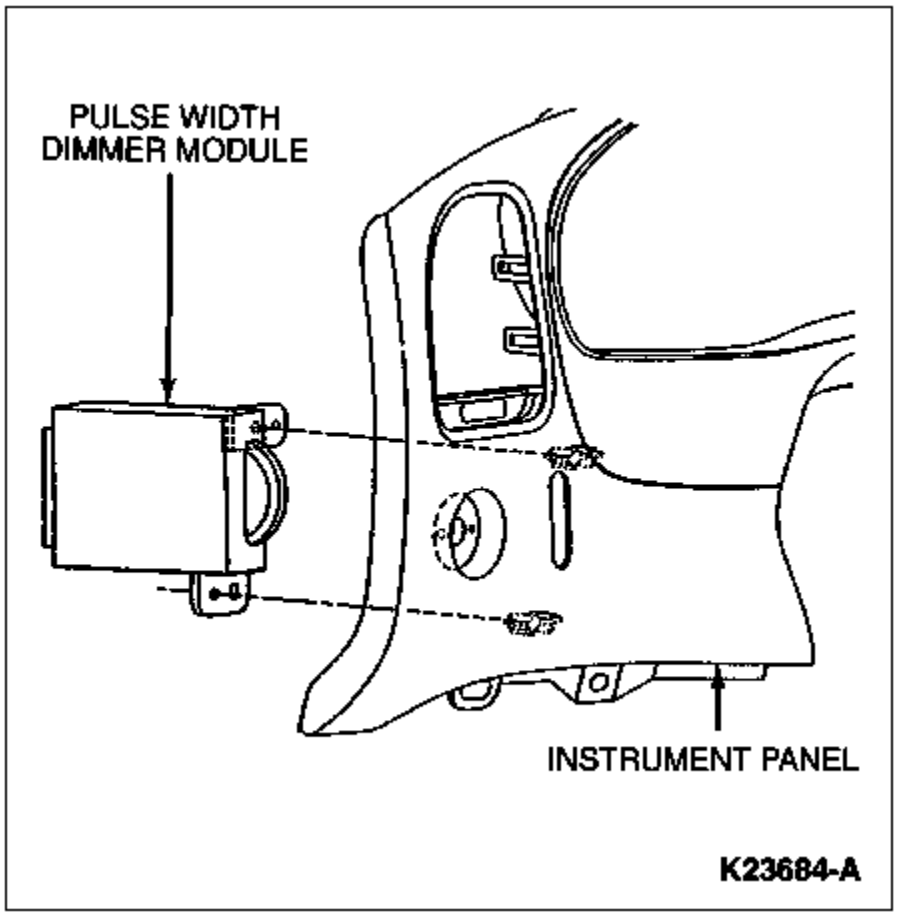

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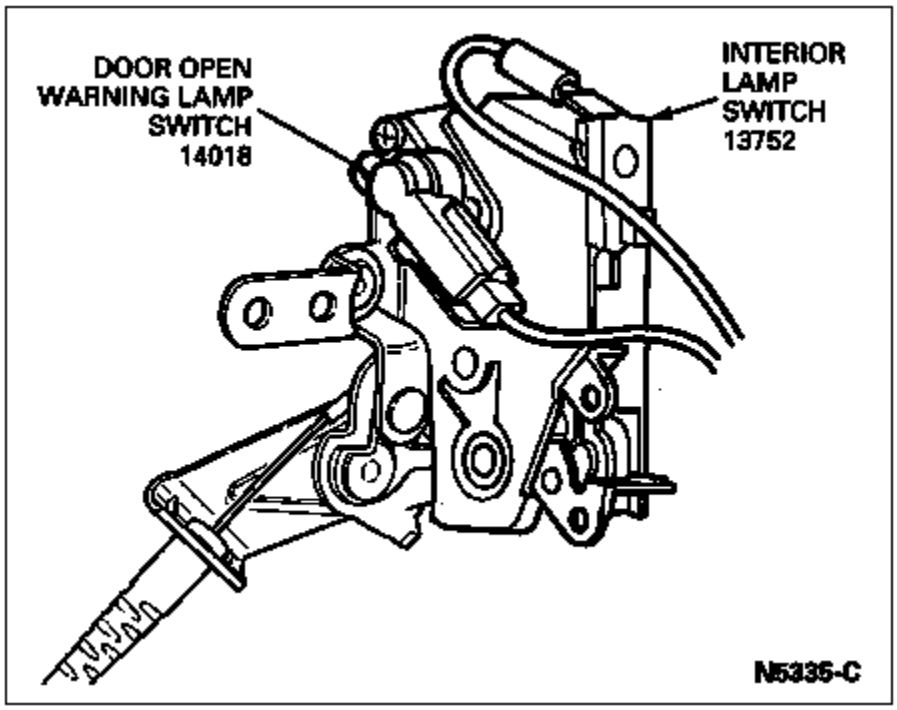
Illuminated Entry, Aerostar

The illuminated entry system assists vehicle entry by illuminating the vehicle interior lamps (13776).

The system consists of three main components: electronic actuator module, door latch switch, and wiring harness.

The interior lamp switch (13752) is a grounding type leaf switch and is attached to the front door latch (21812) by one screw.



The system is activated by raising the door handle (22404).

This action momentarily closes a switch mounted on the front door latch, which completes the ground circuit of the electronic module and switches the system on. The vehicle interior lamps turn on, remain on for approximately 25 seconds, then automatically turn off. During this 25 second period, the system can be manually deactivated by turning the ignition switch (11572) to either RUN or ACC position.

The system will be activated every time the door handles are operated. Opening the interior lamp switch from the inside of the vehicle will not activate the system.

If the door handle is held up indefinitely so that the interior lamp switch is continuously closed, the system will operate as normal and turn off after 25 seconds. At the completion of this cycle, if the door handle is still in the raised position, the system will remain off, and it will be impossible to activate the system from the other door handle until the raised door handle is returned to its normal position. This function is built into the logic circuitry of the system to prevent battery discharge, should the door handle be intentionally propped up or become jammed in any way.

The electronic actuator module is located on the rear of the B-pillar tray.

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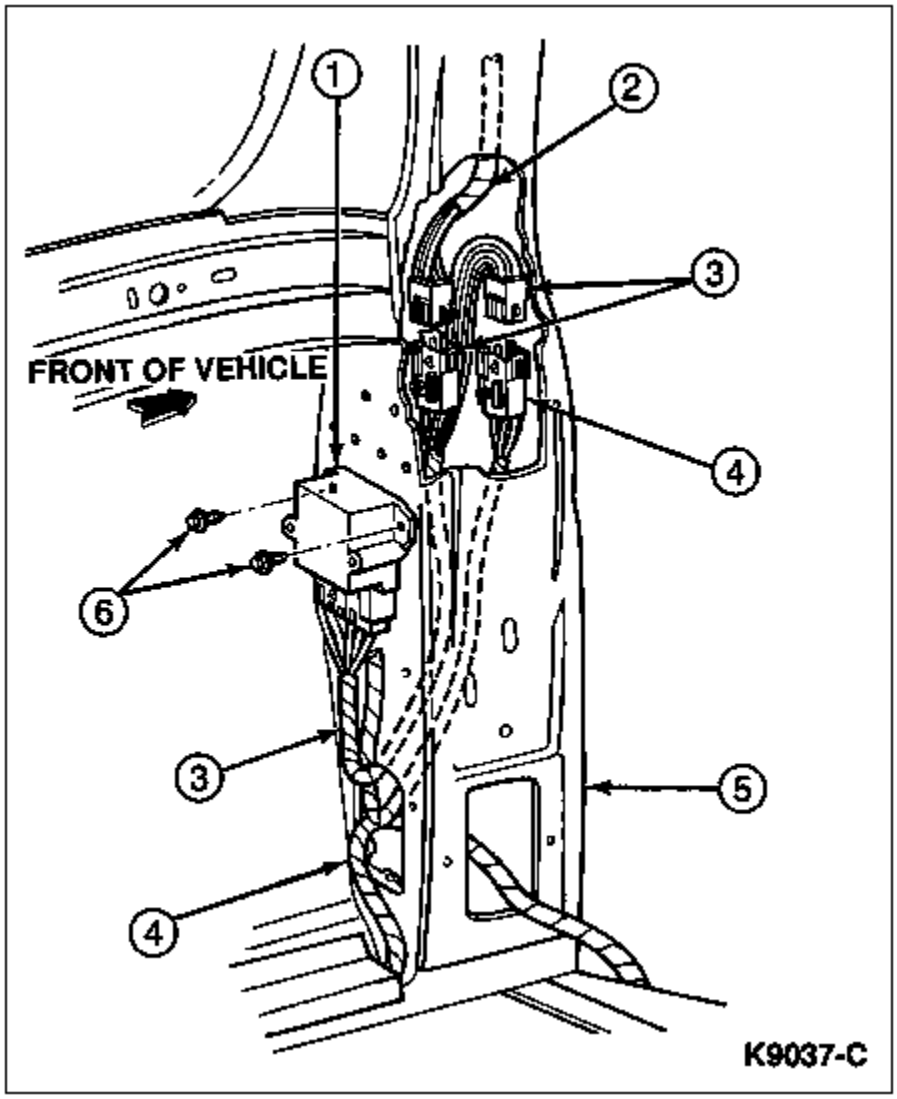

Item	Part Number	Description
1	13C718	Illuminating Entry Actuator
2	14334	Courtesy or Interior Lamp Switch Wiring
3	13B712	Courtesy Lamp Feed Wire
4	14405	Wiring
5	—	B-Pillar
6	56928-S2	Screw (2 Req'd)

Housed within the module is a printed circuit board, the logic circuitry, and a relay to switch B+ to the various circuits. The normal module operating voltage is 9 to 16 volts. However, the unit will withstand voltage up to 24 volts for a period of 15 minutes. It cannot be damaged by reverse voltages and is unaffected by vehicle electrical transients.

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Generic Electronic Module (GEM) Illuminated Entry, Ranger

The illuminated entry system assists vehicle entry by illuminating the vehicle interior lamp (13776).

The system consists of three main components: generic electronic module, door ajar switch and wiring harness.

The interior lamp switch (13752) is a grounding type leaf switch and is attached to the front door latch (21812) by one screw.

Interior Courtesy Lamp Control

The following are inputs used for controlling the interior courtesy lamps to the generic electronic module.

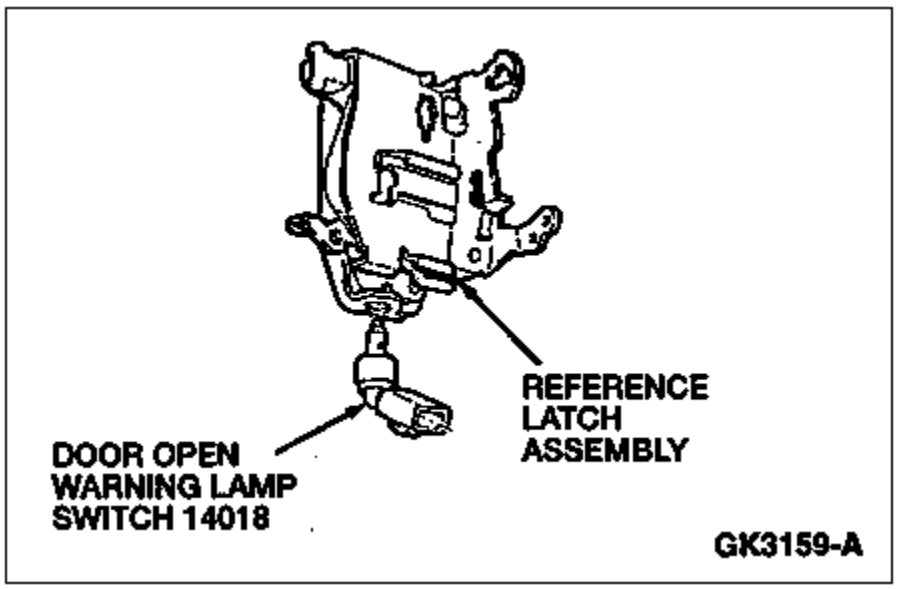
- all door ajar switches
- illuminated entry request — from RAP module
- two step unlock — door disarm switches

All interior lights will shut off after 25 seconds (if all doors are closed) or:

- immediately after the ignition switch is turned to the RUN position
- or if the vehicle speed is above 8 km/h (5 mph).

If no wake up command is received and any of the doors are left open, the interior lights will turn off after 40 minutes when the battery saver times out.

Ranger



The system is activated by raising the door handle (22404).

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This action momentarily closes a switch mounted on the front door latch, which completes the ground circuit of the generic electronic module and switches the system on. The vehicle interior lamps turn on, remain on for approximately 25 seconds, then automatically turn off. During this 25 second period, the system can be manually deactivated by turning the ignition switch (11572) to either RUN or ACC position.

The system will be activated every time the door handles are operated. Opening the door from the inside of the vehicle will not activate the system.

If the door handle is held up indefinitely so that the interior lamp switch is continuously closed, the system will operate as normally and turn off after 25 seconds. At the completion of this cycle, if the door handle is still in the raised position, the system will remain off, and it will be impossible to activate the system from the other door handle until the raised door handle is returned to its normal position. This function is built into the logic circuitry of the system to prevent battery discharge, should the door handle be intentionally propped up or become jammed in any way.

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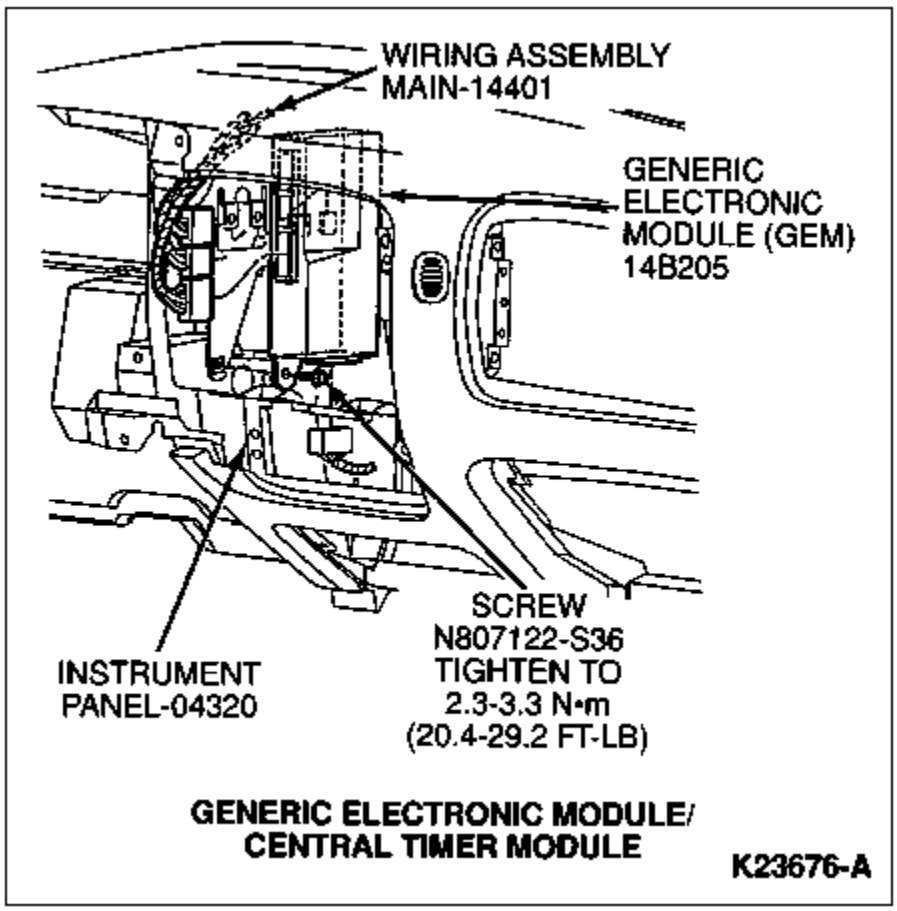
Central Timer Module, Ranger

The central timer module (CTM) shall activate the interior lights when any one of the following states are met.

1. Opening of the driver door (as indicated when ground potential is present at the CTM's driver door ajar switch input).

2. Opening of the passenger door (if applicable,as indicated when ground potential is present at the CTM's passenger door ajar switch input).

Generic Electronic Module/Central Timer Module



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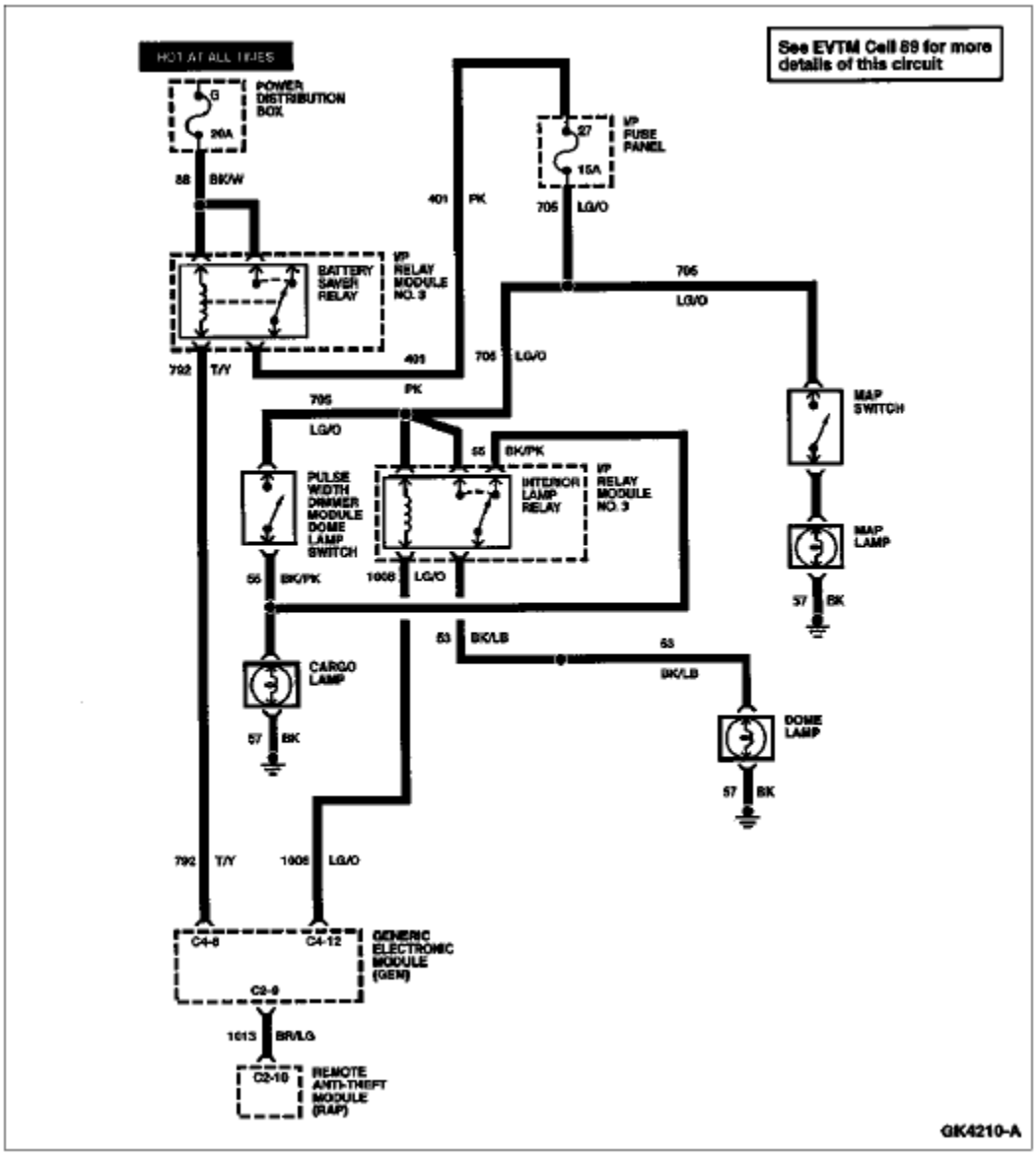
Electrical Schematics

Courtesy Lamps, Ranger with Generic Electronic Module (GEM)



Interior Illumination Switches, Ranger

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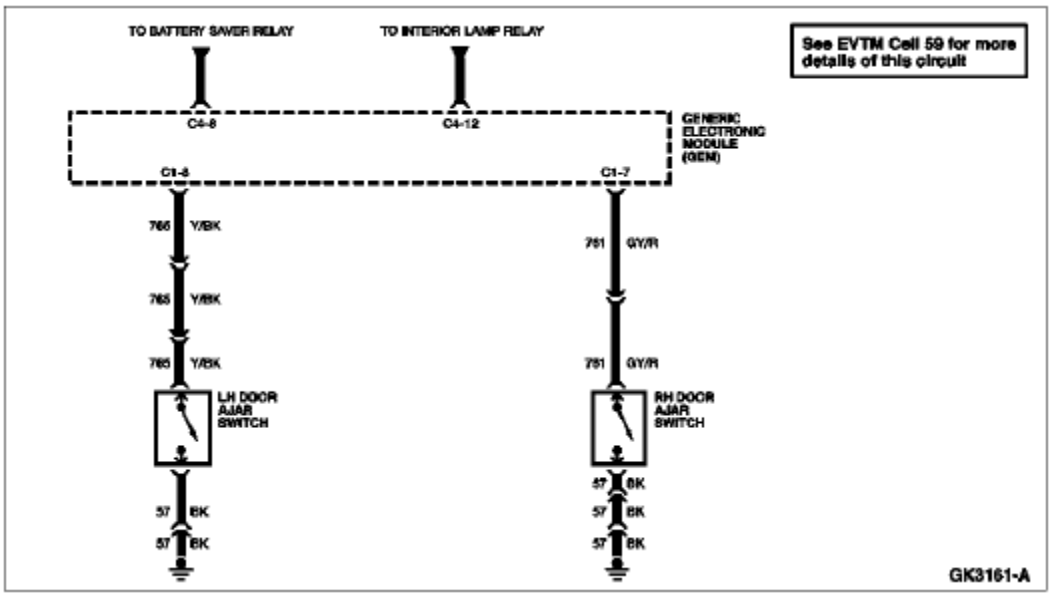

Interior Illumination with Central Timer Module, Ranger

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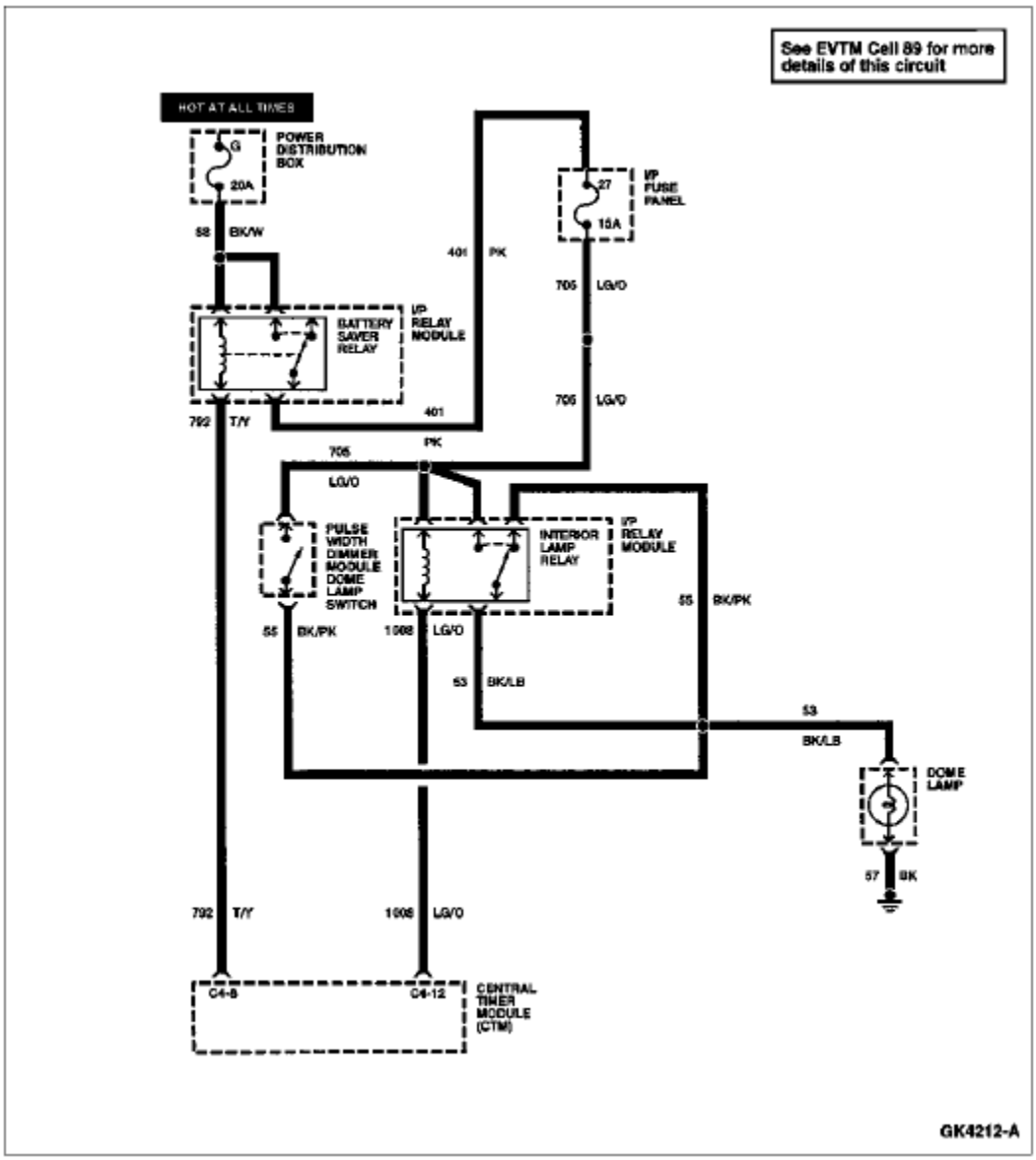

Interior Illumination Switches with Central Timer Module, Ranger

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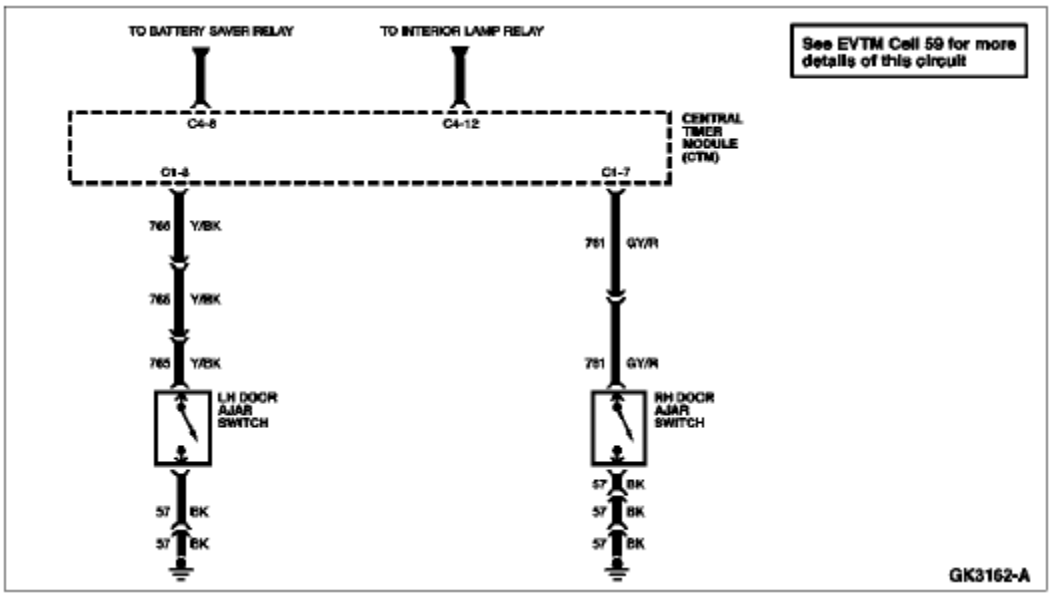

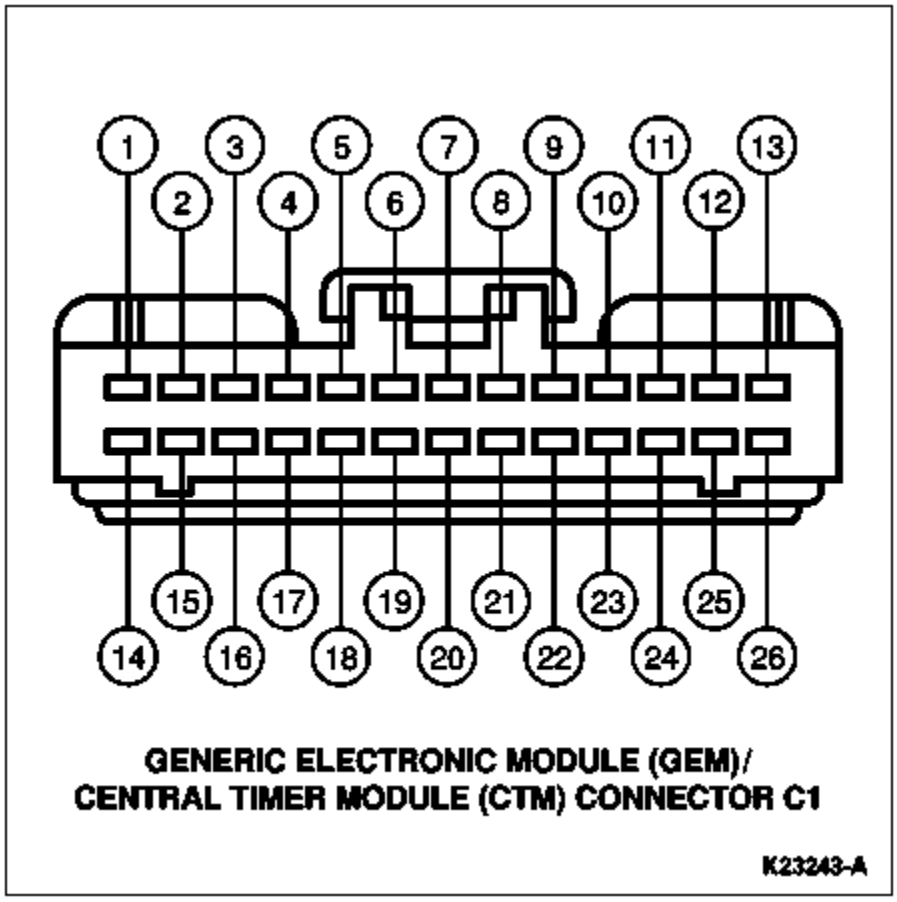

Pin Number	Circuit	Circuit Function

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1	—	NOT USED
2	209 (W/P)	Self Test Input to CTM
3	—	NOT USED
4	—	NOT USED
5	—	NOT USED
6	—	NOT USED
7	761 (GY/R)	Passenger Door Ajar Switch to GEM — Input
8	765 (Y/BK)	Driver's Door Ajar Switch to GEM — Input
9	627 (BK/O)	Open Door Warning Lamp to Open Door Warning Switch
10	158 (BK/PK)	Key Warning Switch — Input
11	1032 (W/BK)	Park Lamp Switch to Module — Input
12	871 (Y)	Seat Belt Indicator Lamp to Module — Output
13	680 (LB/O)	Front Wiper Switch Delay/Wash to GEM — Input
14	570 (BK/W)	Dedicated Ground — EC
15	671 (BK)	Front Wiper Motor Status to GEM Module — Input
16	120 (PK/LG)	Door Relay (Unlock) — Output
17	25 (DG/P)	Anti-Theft Switch Disarm — Input
18	647 (GY/LB)	GEM to Front Wiper Speed Control Relay — Output
19	646 (Y/W)	GEM to Front Wiper Run/Dynamic Brake Relay — Output
20	183 (T/W)	Tone Request — Input
21	359 (GY/R)	Sensor Signal Return
22	684 (PK/Y)	Front Wiper Switch Mode Select to GEM — Input
23	85 (BR/LB)	Seat Belt Warning Switch to LH Front Retractor Switch — Input
24	686 (T/R)	GEM to Front Washer Pump Relay — Output
25	70 (LB/W)	Generic Electronic Module (GEM) ISO Link
26	570 (BK/W)	Dedicated Ground — EC

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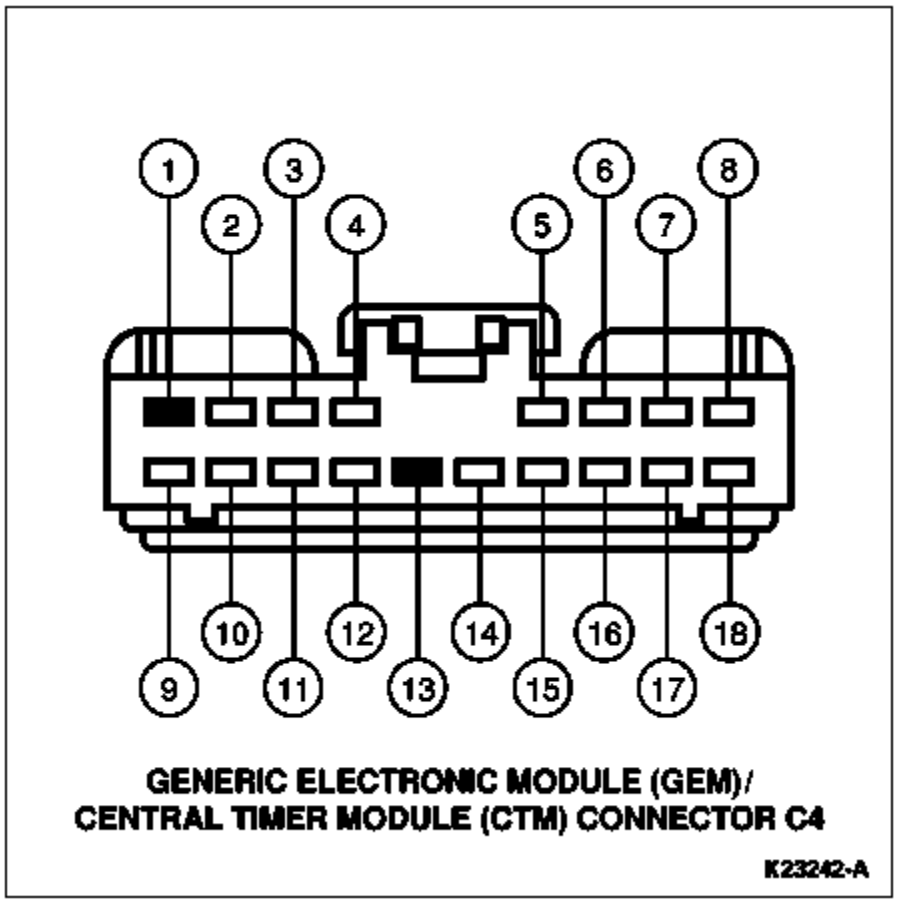

Pin Number	Circuit	Circuit Function
1	—	Not Used
2	996 (O/W)	Window Motor Current Sense "Low" to GEM— Input (LH)
3	991 (T/LB)	Master Window Control "Down" Command to GEM — Input
4	992 (W/BK)	Master Window Control "Up" Command to GEM — Input
5	1101 (W/Y)	Fused Battery Feed to GEM — Input
6	—	NOT USED
7	—	NOT USED
8	—	NOT USED
9	679 (GY/BK)	Vehicle Speed Sensor — Plus to GEM — Input
10	—	NOT USED
11	—	NOT USED
12	—	GEM to Interior Lamp Control Relay —Output
13	—	Not Used
14	1000 (R/BK)	Fused Ignition "Start"/Clutch Interlock to GEM — Input
15	1002 (BK/PK)	Fused Ignition "Run/Accessory" to GEM — Input
16	—	NOT USED

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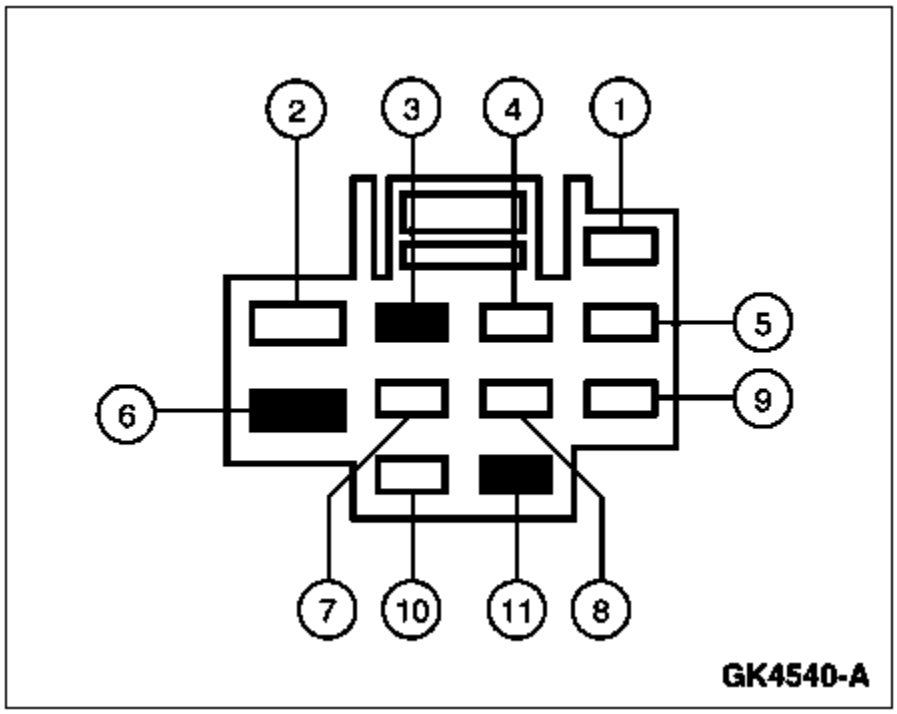
17	1004 (LB/R)	GEM to Delayed Accessory Relay — Output
18	57 (BK)	Ground Circuit

Headlamp Switch Connector



Pin Number	Circuit	Circuit Function
1	196 (LB/O)	Headlamp Switch Feed
2	15 (R/Y)	Headlamp Dimmer Switch Feed
3	—	Not Used
4	57 (BK)	Ground Circuit
5	14 (BR)	Head lamp switch to tail-lamps and side marker lamps
6	—	Not Used
7	484 (O/BK)	Liquid Crystal Display
8	640 (R/Y)	Warning Lamps Feed
9	19 (LB/R)	Instrument Panel Lamps Feed
10	195 (T/W)	Tail Lamp Switch Feed
11	—	Not Used

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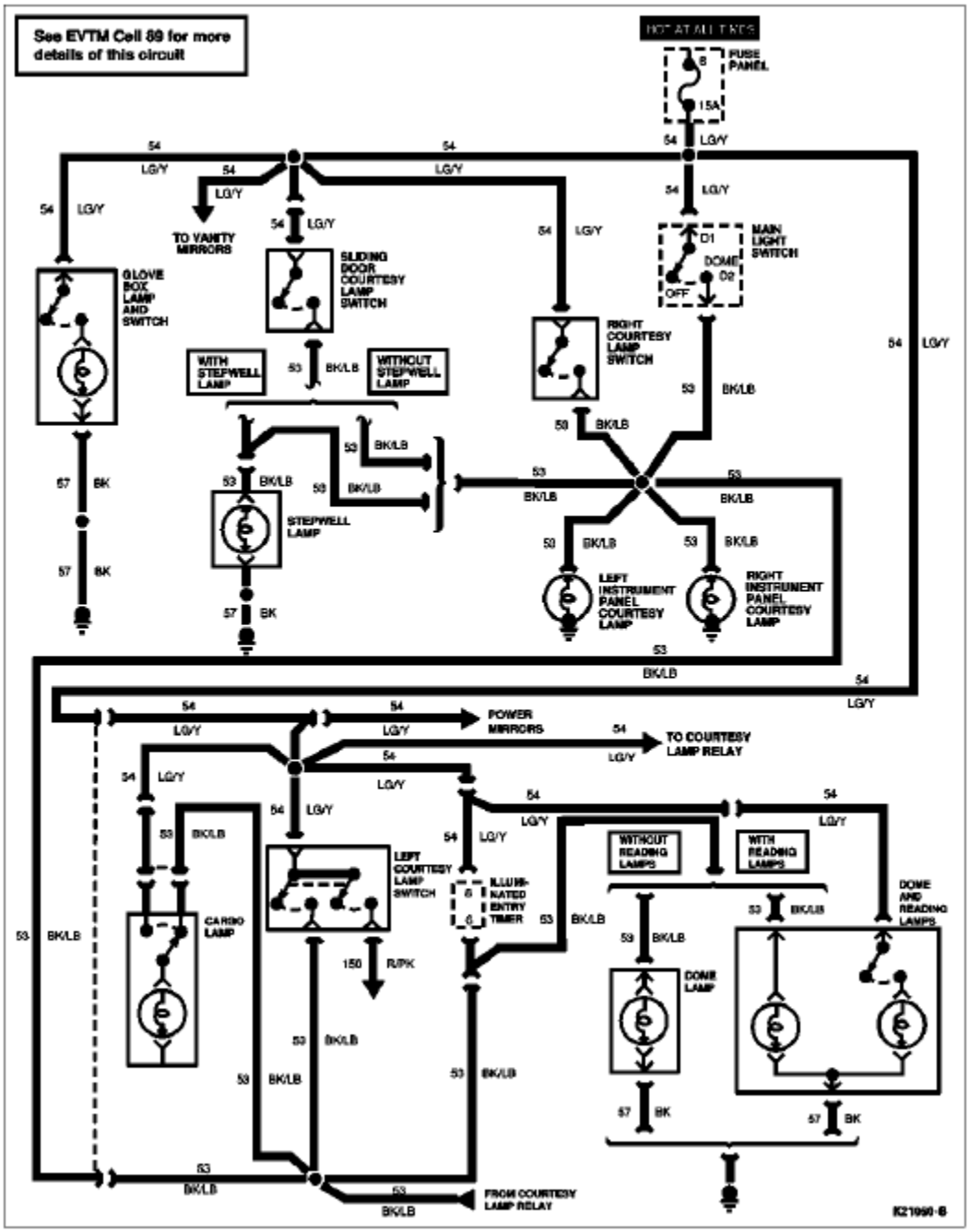
Interior Lamps, Aerostar



Interior Lamps, Aerostar (Continued)

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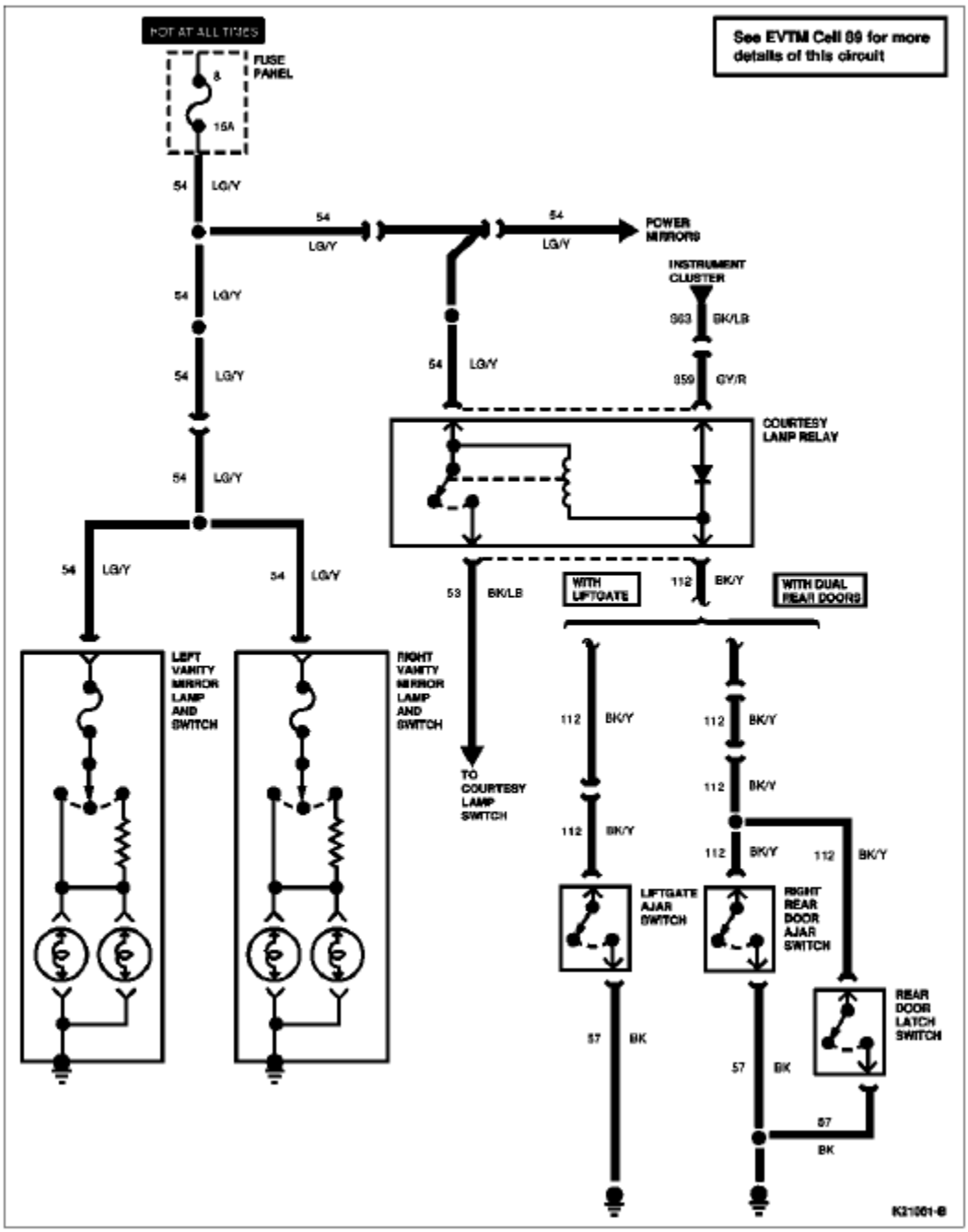

Illuminated Entry, Aerostar

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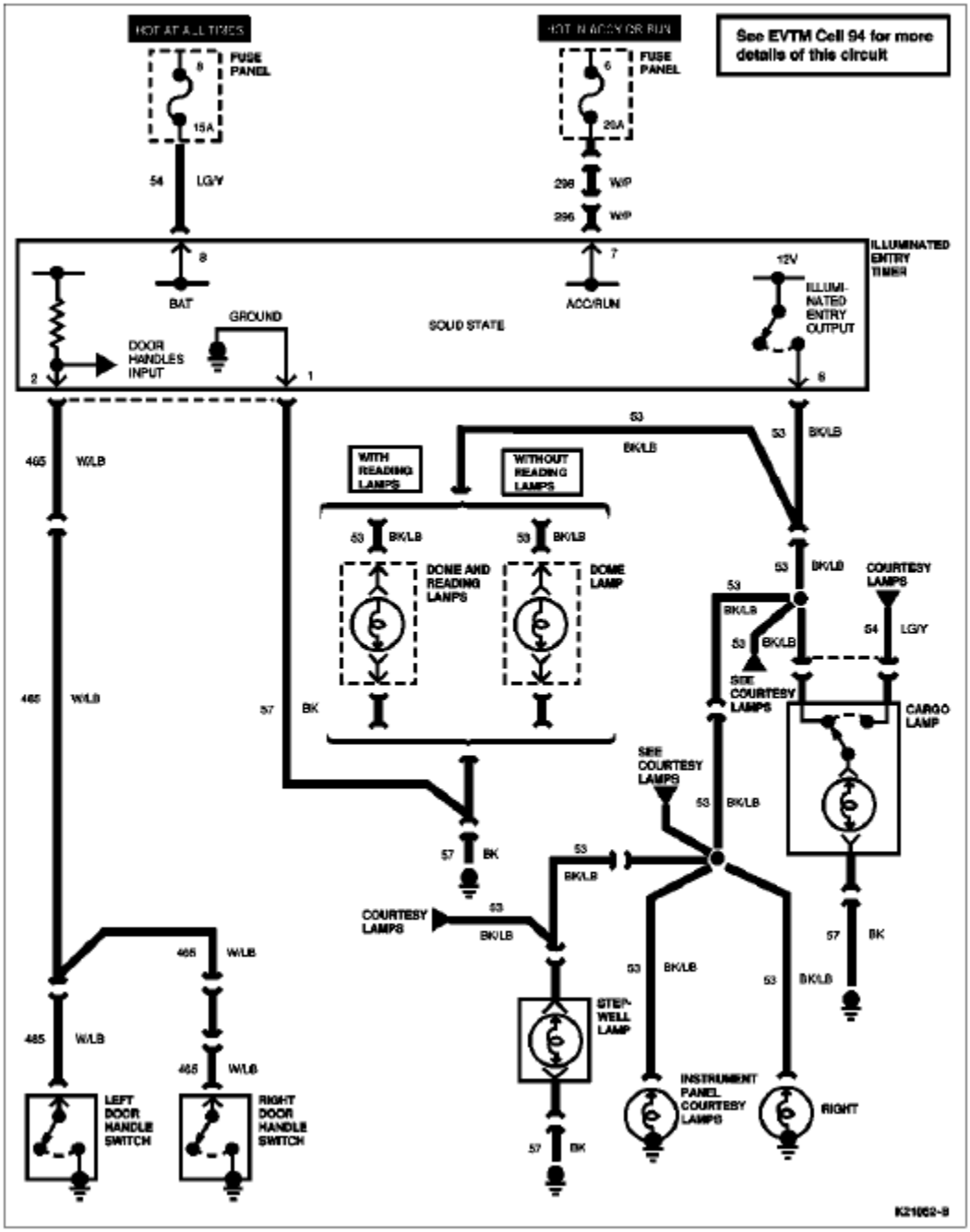

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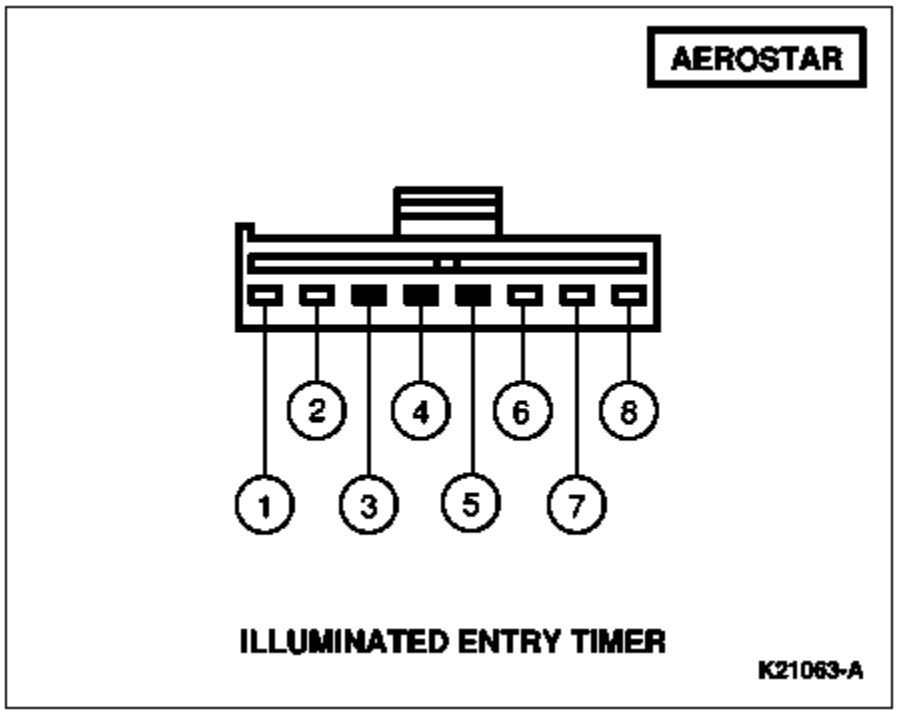

Pin Number	Circuit	Circuit Function
1	57 (BK)	Ground Circuit
2	465 (W/LB)	Module to Switch
3	—	NOT USED
4	—	NOT USED
5	—	NOT USED
6	53 (BK/LB)	Courtesy Lamp Switch to Courtesy Lamp
7	296 (W/P)	Fused Accy. Feed No. 1
8	54 (LG/Y)	Interior Lamp Switch Feed

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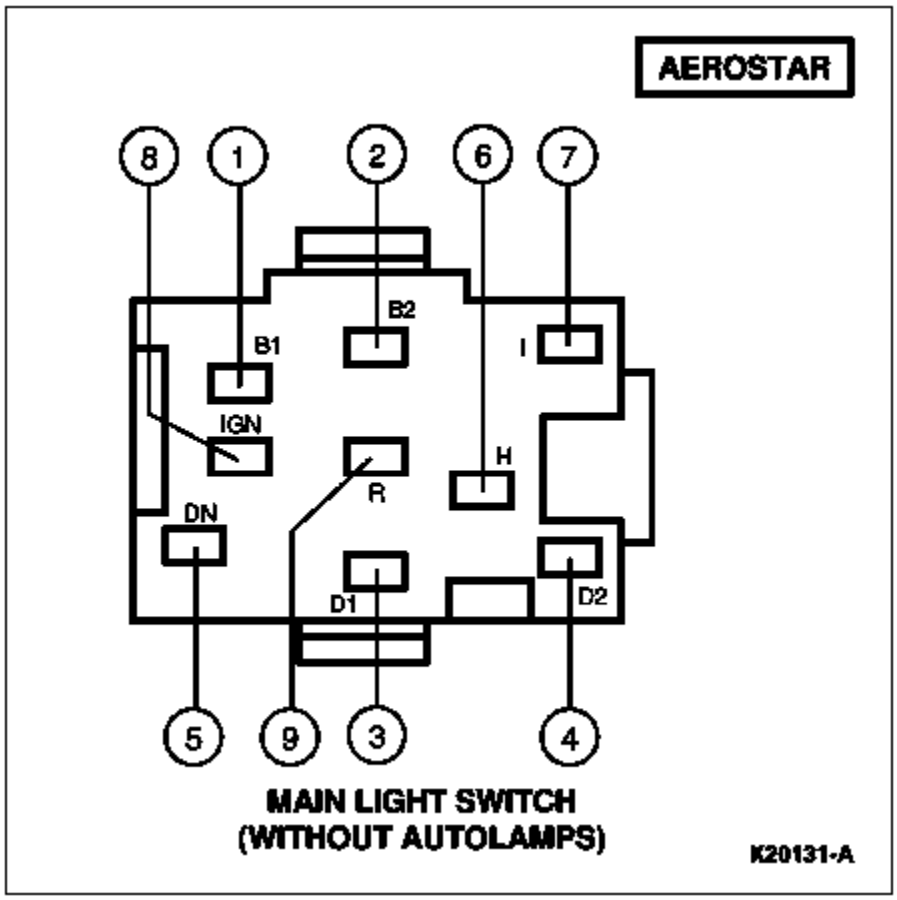

Pin Number	Circuit	Circuit Function
1	38 (BK/O)	Battery Input to Main Light Switch
2	195 (T/W)	Battery Input to Main Light Switch
3	54 (LG/Y)	Battery Input to Dome Switch
4	53 (BK/LB)	Dome Switch to Courtesy Lamps
5	484 (O/BK)	Main Light Switch to Radio LCD
6	15 (R/Y)	Main Light Switch to Dimmer
7	19 (LB/R)	Main Light Switch to Instrument Illumination
8	137 (Y/BK)	Battery Input, Hot in ACC or RUN
9	14 (BR)	Main Light Switch to Exterior Lamps

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Inspection and Verification — Courtesy Lamps

1. Verify the vehicle owner's original concern by operating the courtesy lamps to duplicate the condition.

2. **NOTE: Clear all DTCs after fault has been repaired. Disconnecting relays and connectors may set DTCs.**

   NOTE: When a passenger door or liftgate has been left ajar upon exit of vehicle, the CTM will not recognize a change of state upon re-entry of those doors in order to wakeup the CTM and illuminate interior.

   Inspect to determine if one of the following mechanical or electrical concerns apply:

VISUAL INSPECTION CHART

Mechanical	Electrical
• Damaged lamps	• GEM
• Open fuses	
• Damaged switches	• Damaged bulbs
• Stuck switches • Connectors damaged/corroded	• Circuitry open/shorted

3. If the concern(s) remains after the inspection, determine the symptom(s) and proceed to the following symptom chart.

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Pinpoint Tests — Courtesy Lamps

PINPOINT TEST A: COURTESY LAMPS INOPERATIVE

A1 PRELIMINARY CHECKS

- Check fuses for continuity.
- Check connections for clean tight fit.
- Check for loose or damaged wires.

Do components and wiring check OK?

Yes	No
GO to **A2** .	SERVICE or REPLACE as required. GO to **A2** .

A2 ON-DEMAND SELF TEST

- Connect Rotunda New Generation Star (NGS) tester 007-00500 or equivalent to data link connector (DLC).
- Retrieve continuous DTCs.
- Perform On-Demand Self Test. Refer to Section 18-04A .

Are any DTCs retrieved?

Yes	No
DTC B1315 Self Test and continuous — REPAIR battery short in Circuit 792 (T/Y) between GEM and battery saver relay. DTC B1314 Self Test and continuous — CHECK for open contacts in battery saver relay. REPLACE relay. DTC B1371 Self Test and continuous — GO to **A3** . DTC B1373 Self Test and continuous — REPAIR battery short in Circuit 1008 (LG/O) between GEM and interior lamp relay. DTC B1371 — GO to **A5** .	GO to **A9** .

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A3 CHECK CIRCUIT 705 (LG/O) FOR BATTERY VOLTAGE

- Run battery saver and illuminated entry functional test.
- Energize battery saver relay.
- Check for B+ on Circuit 705 (LG/O) between battery saver relay and interior lamp relay.

Does voltage check OK?

Yes	No
GO to **A4** .	LOCATE open in 705 (LG/O) battery saver relay and interior lamp relay. REPAIR as required.

A4 CHECK CIRCUIT 1008 (LG/O) FOR OPEN

- Check for open coil in interior lamp relay.

Is relay OK?

Yes	No
REPAIR open in Circuit 1008 (LG/O) between GEM and interior lamp relay.	REPLACE relay.

A5 CHECK I/P FUSE 27

- Check continuity of fuse 27 (15A).

Does fuse check OK?

Yes	No
GO to **A6** .	GO to **A8** .

A6 CHECK CIRCUIT 705 (LG/O)

- Disconnect battery saver relay.
- Check for B+ on Circuit 705 (LG/O).

Is B+ present?

Yes	No
REPAIR battery short in Circuit 705 (LG/O) between GEM and battery saver relay.	GO to **A7** .

A7 CHECK RELAY

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- Check battery saver relay coil for open.

Is coil open?

Yes	No
REPLACE relay.	GO to **A10** .

A8 CHECK CIRCUIT 53 (BK/LB) FOR SHORT TO GROUND

- Check for ground short in Circuit 53 (BK/LB) between power feed and interior lamp relay.

Is circuit OK?

Yes	No
LOCATE ground short between interior lamp relay and interior lamps. REPAIR as required.	REPAIR ground short in Circuit 729 (R/W) as required.

A9 CHECK CIRCUIT 53 (BK/LB) FOR BATTERY VOLTAGE

- Energize interior lamp relay.
- Check for B+ in Circuit 53 (BK/LB) at interior lamps.

Does voltage check OK?

Yes	No
GO to **A10** .	REPAIR open in Circuit 53 (BK/LB) between interior lamp relay and interior lamps.

A10 CHECK CIRCUIT 53 (BK/LB) FOR OPEN

- Exit functional test.
- Disconnect battery negative cable.

  NOTE: Some abnormal drive symptoms may occur after the battery has been disconnected and reconnected. The vehicle may need to be driven 16 km (10 miles) or more to allow the PCM to relearn the adaptive strategy.

- Check circuit for open between interior lamps and ground.

Is circuit OK?

Yes	No
GO to **A11** .	REPAIR open in Circuit 53 (BK/LB) between interior lamps and ground.

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A11 READ PID L GATE SW STATUS

- Read PID L GATE SW.
- Open liftgate.
- Close rear doors.

Is liftgate status OPEN?

Yes	No
GO to **A12** .	CHECK for open in Circuit 700 (W/P) between right and left liftgate ajar switches and GEM.

A12 READ PID RFDR SW STATUS

- Read PID RFDR SW.
- Open passenger door.

Is RFDR SW AJAR?

Yes	No
GO to **A13** .	REPAIR open in ground circuit between passenger door ajar switch and GEM.

A13 READ PID LFDR SW STATUS

- Read PID LFDR SW.
- Open driver door.

Is LFDR SW AJAR?

Yes	No
GO to **A14** .	GO to **A16** .

A14 READ PID LRDR SW STATUS

- Read PID LRDR SW.
- Open left rear door.

Is LRDR SW AJAR?

Yes	No
GO to **A15** .	GO to **A20** .

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A15 READ PID RRDR SW STATUS

- Read PID RRDR SW.
- Open right rear door.

IS RRDR SW AJAR?

Yes	No
System OK.	GO to **A21** .

A16 CHECK CIRCUIT 765 (Y/BK)

- Disconnect driver's door ajar switch.
- Ground Circuit 765 (Y/BK).
- Read PID LFDR SW.

Does tester indicate driver door AJAR?

Yes	No
GO to **A17** .	REPAIR open in Circuit 765 (Y/BK) between driver door ajar switch and GEM.

A17 CHECK DRIVER DOOR AJAR SWITCH

- Jumper driver door ajar switch ground Circuit to Circuit 765 (Y/BK).
- Read PID LFDR SW.

Does tester indicate driver door CLOSED

Yes	No
REPAIR open in driver door ajar ground circuit.	REPLACE switch.

A18 CHECK CIRCUIT 761 (GY/R)

- Disconnect passenger door ajar switch.
- Ground Circuit 761 (GY/R).
- Read PID RFDR SW.

Does tester indicate passenger door AJAR?

Yes	No
GO to **A19** .	REPAIR open in Circuit 761 (GY/R) between passenger door ajar switch and GEM.

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A19 CHECK PASSENGER DOOR AJAR SWITCH GROUND

- Jumper passenger door ajar switch ground circuit to Circuit 761 (GY/R).
- Read PID RFDR SW.

Does tester indicate passenger door AJAR?

Yes	No
CHECK for open in passenger door ajar switch. REPLACE switch.	REPAIR passenger door ajar ground open Circuit 57 (BK). GO to **A20** .

A20 CHECK CIRCUIT 759 (LG/Y)

- Disconnect LR door ajar switch.
- Ground Circuit 759 (LG/Y).
- Read PID LRDR SW.

Does tester indicate door CLOSED?

Yes	No
GO to **A21** .	REPAIR open in Circuit 759 (LG/Y) between door ajar switch and GEM.

A21 CHECK DOOR AJAR SWITCH GROUND

- Jumper door ajar ground circuit to Circuit 760 (PK/LB).
- Read PID RRDR SW.

Does tester indicate door CLOSED?

Yes	No
CHECK for open in door ajar switch. REPLACE switch.	REPAIR door ajar ground open Circuit 57 (BK).

PINPOINT TEST B: INTERIOR LAMPS STAY ON

B1 PRELIMINARY CHECKS

- Check fuses for continuity.
- Check connections for clean tight fit.
- Check for loose or damaged wires.

Do components and wiring check OK?

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Yes	No
GO to **B2** .	SERVICE or REPLACE as required. GO to **B2** .

B2 ON-DEMAND SELF TEST

- Connect Rotunda New Generation Star (NGS) Tester 007-00500 or equivalent to data link connector (DLC).
- Retrieve continuous DTCs.
- Perform on-demand self test. Refer to Section 18-04A .

Are DTCs retrieved?

Yes	No
DTC B1371 Self Test and continuous — REPAIR ground short in Circuit 1008 (LG/O) between GEM and interior lamp relay. DTC B1322 Self Test. GO to **B3** . DTC B1338 Self Test. GO to **B4** . DTC B1334 Self Test. GO to **B6** . DTC B1330 Self Test. GO to **B7** . DTC B1574 Self Test. GO to **B8** .	GO to **B9** .

B3 CHECK CIRCUIT 765 (Y/BK)

- Disconnect driver door ajar switch.
- Read PID LFDR SW.

Does tester indicate driver's door AJAR?

Yes	No
REPAIR ground short in Circuit 765 (Y/BK) between GEM and driver door ajar switch.	CHECK driver door ajar switch for short. REPLACE switch.

B4 CHECK CIRCUIT 760 (PK/LB)

- Disconnect door ajar switch.
- Ground Circuit 760 (PK/LB).
- Read PID RRDR SW.

Does tester indicate sliding door CLOSED?

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Yes	No
GO to **B5** .	REPAIR open in circuit 760 (PK/LB) between door ajar switch and GEM.

B5 CHECK GROUND CIRCUIT

- Jumper door ajar ground circuit to Circuit 760 (PK/LB).
- Read PID RRDR SW.

Does tester indicate door CLOSED?

Yes	No
CHECK door switch for open. REPLACE switch.	REPAIR open in ground circuit to door ajar switch.

B6 CHECK CIRCUIT 700 (W/P)

- Disconnect liftgate ajar switches.
- Read PID LGATESW.

Does tester indicate liftgate AJAR?

Yes	No
REPAIR ground short in Circuit 700 (W/P) between GEM and liftgate ajar switches.	CHECK liftgate ajar switches for short. REPLACE worn or damaged switches as required.

B7 CHECK CIRCUIT 761 (GY/R)

- Disconnect passenger door ajar switch.
- Read PID RFDR SW.

Does tester indicate passenger door AJAR?

Yes	No
REPAIR ground short in Circuit 761 (GY/R) between GEM and passenger door ajar switch.	CHECK passenger door ajar switch for short. REPLACE damaged switch as required.

B8 CHECK CIRCUIT 759 (LG/Y)

- Disconnect door ajar switch.
- Read PID LRDR SW.

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Does tester indicate passenger door AJAR?

Yes	No
REPAIR ground short in circuit 759 (LG/Y) between GEM and left rear passenger door ajar switch.	CHECK left rear passenger door ajar switch for short. REPLACE damaged switch and RETEST.

B9 CHECK CIRCUIT 53 (BK/LB)

- Disconnect battery negative cable.

  NOTE: Some abnormal drive symptoms may occur after the battery has been disconnected and reconnected. The vehicle may need to be driven 16 km (10 miles) or more to allow the PCM to relearn the adaptive strategy.

- Check for continuity between Circuit 53 (BK/LB) and the battery B+ terminal between interior lamp relay and lamps.

Is circuit OK?

Yes	No
GO to **B10** .	REPAIR battery short in Circuit 53 (BK/LB) between interior lamp relay and lamps.

B10 CHECK RELAY

- Check interior lamp relay for shorted contacts.

Does relay check OK?

Yes	No
CHECK pulse width dimmer module for short. REPLACE pulse width dimmer module.	REPLACE worn or damaged relay.

PINPOINT TEST C: DOME LAMP INOPERATIVE

C1 PRELIMINARY CHECKS

- Check fuse.
- Check connections for clean tight fit.
- Check for loose or damaged wires.

Do components and wiring check OK?

Yes	No

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GO to C2 .	SERVICE or REPLACE as required. GO to C2 .

C2 CHECK INTERIOR LAMP BULB

- Check bulb for continuity.

Does bulb check OK?

Yes	No
GO to C3 .	REPLACE bulb.

C3 CHECK CIRCUIT 53 (BK/LB)

- Disconnect battery negative cable.

  NOTE: Some abnormal drive symptoms may occur after the battery has been disconnected and reconnected. The vehicle may need to be driven 16 km (10 miles) or more to allow the PCM to relearn the adaptive strategy.

- Check Circuit 53 (BK/LB) for open between interior lamp relay and affected lamp.

Is circuit OK?

Yes	No
GO to C4 .	REPAIR open in Circuit 53 (BK/LB) between interior lamp relay and affected lamp.

C4 CHECK GROUND CIRCUIT

- Check for open in ground circuit to affected lamp.

Is ground circuit OK?

Yes	No
System OK.	REPAIR open in ground circuit 57 (BK).

PINPOINT TEST D: REAR DOME LAMP INOPERATIVE

D1 PRELIMINARY CHECKS

- Check cargo lamp bulb.

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- Check fuses for continuity.
- Check connections for clean tight fit.
- Check for loose or damaged wires.

Do components and wiring check OK?

Yes	No
GO to **D2** .	SERVICE or REPLACE as required. GO to **D2** .

D2 FUNCTIONAL TEST

- Connect Rotunda New Generation Star (NGS) Tester 007-00500 or equivalent to data link connector (DLC).
- Perform battery saver and illuminated entry functional test.
- Energize battery saver relay.
- Energize interior lamp relay.
- Place pulse width dimmer switch in illuminated position.

Does lamp illuminate?

Yes	No
GO to **D3** .	GO to **D4** .

D3 CHECK CIRCUIT 53 (BK/LB)

- Disconnect battery negative cable.

  NOTE: Some abnormal drive symptoms may occur after the battery has been disconnected and reconnected. The vehicle may need to be driven 16 km (10 miles) or more to allow the PCM to relearn the adaptive strategy.

- Check for open in circuit between battery saver relay and cargo lamp switch.

Is circuit OK?

Yes	No
CHECK pulse width dimmer module for open. REPLACE module.	REPAIR open in Circuit 53 (BK/LB) between cargo lamp switch and interior lamp relay.

D4 CHECK CIRCUIT 53 (BK/LB) FOR OPEN

- Check for open in Circuit 53 (BK/LB) between cargo lamp switch and interior lamp relay.

Is circuit OK?

Yes	No

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GO to **D5** .	REPAIR open in Circuit 53 (BK/LB) between cargo lamp switch and interior lamp relay.

D5 CHECK CIRCUIT 53 (BK/LB) FOR CONTINUITY

- Check for open in circuit between pulse width dimmer module and cargo lamp.

Is circuit OK?

Yes	No
GO to **D6** .	REPAIR open in circuit between pulse width dimmer module and cargo lamp.

D6 CHECK LAMP GROUND CIRCUIT

- Check ground circuit to cargo lamp.

Is circuit OK?

Yes	No
System OK.	REPAIR open in ground circuit to cargo lamp.

PINPOINT TEST E: GLOVE COMPARTMENT LAMP INOPERATIVE (AEROSTAR)

E1 CHECK GLOVE COMPARTMENT LAMP SUPPLY

- Disconnect glove compartment lamp connector.
- Using a voltmeter check Circuit 54 (LG/Y) (Aerostar) for voltage.

Is voltage present?

Yes	No
REPLACE glove compartment lamp bulb. RESTORE vehicle. RETEST system.	SERVICE Circuit 54 (LG/Y) for open circuit. RESTORE vehicle. RETEST system.

PINPOINT TEST F: VANITY MIRROR LAMPS INOPERATIVE (AEROSTAR)

F1 CHECK VANITY MIRROR LAMPS SUPPLY

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- Remove vanity mirror lamp assembly as outlined.
- Disconnect vanity mirror.
- Using a voltmeter check Circuit 54 (LG/Y) (Aerostar) for voltage.

Is voltage present?

Yes	No
GO to **F2** .	SERVICE Circuit 54 (LG/Y) for open circuit. RESTORE vehicle. RETEST system.

F2 CHECK VANITY MIRROR LAMPS GROUND

- Remove vanity mirror lamp bulb.
- Using an ohmmeter connected to a known good ground, check ground side of bulb socket for continuity.

Is there continuity?

Yes	No
GO to **F3** .	SERVICE ground for open circuit. RESTORE vehicle. RETEST system.

F3 CHECK VANITY MIRROR LAMP BULB

- Using an ohmmeter, check continuity of bulb.

Is there continuity?

Yes	No
REPLACE vanity mirror assembly. RESTORE vehicle. RETEST system.	REPLACE vanity mirror lamp bulb. RESTORE vehicle. RETEST system.

PINPOINT TEST G: INDIVIDUAL COURTESY LAMP INOPERATIVE

G1 CHECK SUPPLY TO COURTESY LAMP

- Remove suspect courtesy lamp assembly.
- Using a voltmeter check Circuit 53 (BK/LB) for voltage.

Is voltage present?

Yes	No
GO to **G2** .	SERVICE Circuit 53 (BK/LB) for open circuit. RESTORE vehicle. RETEST system.

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G2 CHECK GROUND CIRCUIT 57 (BK)

- Using an ohmmeter connected to a known good ground, connect second lead to Circuit 57 (BK), check continuity.

Is there continuity?

Yes	No
GO to **G3** .	SERVICE Circuit 57 (BK) for open circuit. RESTORE vehicle. RETEST system.

G3 CHECK COURTESY LAMP BULB

- Remove courtesy lamp bulb.
- Using an ohmmeter check bulb for continuity.

Is there continuity?

Yes	No
REPLACE courtesy lamp assembly. RESTORE vehicle. RETEST system.	REPLACE courtesy lamp bulb. RESTORE vehicle. RETEST system.

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Inspection and Verification — Illuminated Entry

1. Verify the vehicle owner's original concern by operating the illuminated entry system to duplicate the condition.

2. Inspect to determine if one of the following mechanical or electrical concerns apply:

VISUAL INSPECTION CHART

Mechanical	Electrical
• Outside door handles	• Fuses blown/open • Circuitry open/shorted

3. If the concern(s) remains after the inspection, determine the symptom(s) and proceed to the following symptom chart.

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Symptom Chart — Illuminated Entry

NOTE: Use Rotunda New Generation Star (NGS) tester 007-00500 and 73 Digital Multimeter 105-R0051 or equivalent to perform electrical Pinpoint Tests.

ILLUMINATED ENTRY

Condition	Possible Source	Action
• Illuminated Entry System Not Operating Correctly	• Fuse blown/open. • Interior lamp switches damaged. • Circuitry open/shorted.	• GO to Pinpoint Test H.

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Pinpoint Test H — Illuminated Entry

PINPOINT TEST H: ILLUMINATED ENTRY SYSTEM NOT OPERATING CORRECTLY

H1 PRELIMINARY CHECKS

- Check connections for clean tight fit.
- Check for loose or damaged wires.

Do components and wiring check OK?

Yes	No
GO to **H2** .	SERVICE or REPLACE as required. GO to **H2** .

H2 ON-DEMAND SELF TEST

- Connect Rotunda New Generation Star (NGS) tester 007-00500 or equivalent to data link connector (DLC).
- Retrieve continuous DTCs.
- Perform On-Demand Self Test. Refer to Section 18-04A .

Are any DTCs retrieved?

Yes	No
DTC B1445 self test — GO to **H3** . DTC B1371 self test and continuous — CHECK for ground short in Circuit 53 (BK/LB) to interior lamps. REPAIR as required.	GO to **H4** .

H3 CHECK CIRCUIT 930 (P/LG)

- Disconnect door handle switch harness connector.
- Read PID DRHNDL.

Does tester indicate OFF?

Yes	No
Switch stuck closed. REPLACE worn switch as	REPAIR ground short in Circuit 930 (P/LG)

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required.	between GEM and door handle switches.

H4 CHECK IP FUSE 27 (15A)

- Check fuse for continuity.

Is fuse OK?

Yes	No
GO to **H5** .	GO to **H7** .

H5 CHECK CIRCUIT 930 (P/LG) CONTINUITY TO GROUND

- Ground Circuit 930 (P/LG) at harness connector.
- Read PID DRHNDL.

Does tester indicate OFF?

Yes	No
GO to **H6** .	REPAIR open in Circuit 930 (P/LG) between GEM and door handle switches as required.

H6 CHECK GROUND CIRCUIT

- Jumper door handle switch ground circuit to Circuit 930 (P/LG).
- Read PID DRHNDL.

Does tester indicate ON?

Yes	No
Switch is stuck open. SERVICE or REPLACE worn switch as required.	REPAIR open in door handle switch ground circuit.

H7 CHECK CIRCUIT 705 (LG/O)

- Check for ground short in Circuit 705 (LG/O) power feed to battery saver relay and interior lamp relay.

Is circuit OK?

Yes	No
CHECK for battery short on Circuit 930 (P/LG) between GEM and door handle switches. REPAIR as required. REPLACE fuse.	REPAIR ground short in Circuit 705 (LG/O) as required. REPLACE fuse.

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Component Tests

Headlamp Switch

Refer to Section 17-01 for diagnosis and testing.

Illuminated Entry, Aerostar

NOTE: Before performing diagnosis, verify illuminated entry system function. The illuminated entry module will not turn off the interior lamp if it is turned on by the headlamp rheostat, or if the door is open.

Quick Checks

1. Verify that circuit to interior lamp is working. If not, check fuse.
2. With the ignition switch in ACC or RUN position, verify that other systems which share the same accessory fuse are functional. If not, check fuse.
3. If any of the above systems are not working properly, service the inoperative circuit and then recheck the operation of the illuminated entry system before proceeding with the following complete check-out procedure.

Pretest Checks

1. Terminal numbers referred to in the following procedure relate to the wiring connector attached to the illuminated entry actuator assembly. The terminals are numbered from left to right (when the connector is held as shown).
2. Any malfunctions diagnosed in Step 4 of the test procedure could be located in either front door.
3. To trace and/or service various circuits, refer to the respective vehicle wiring diagrams.
4. Check system fuses (two) before proceeding.

Test Procedure

1. Connect a 12-volt test light between Terminal No. 8 and a good ground. Test light should glow at all times with ignition switch in RUN or OFF position. If not, trace circuit 54 (light green with yellow stripe) back to fuse panel and service.

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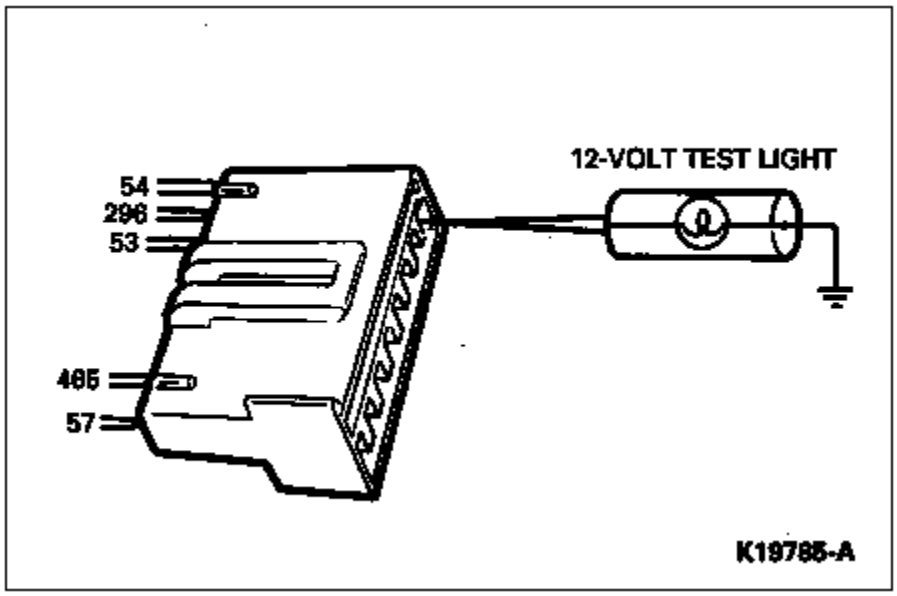
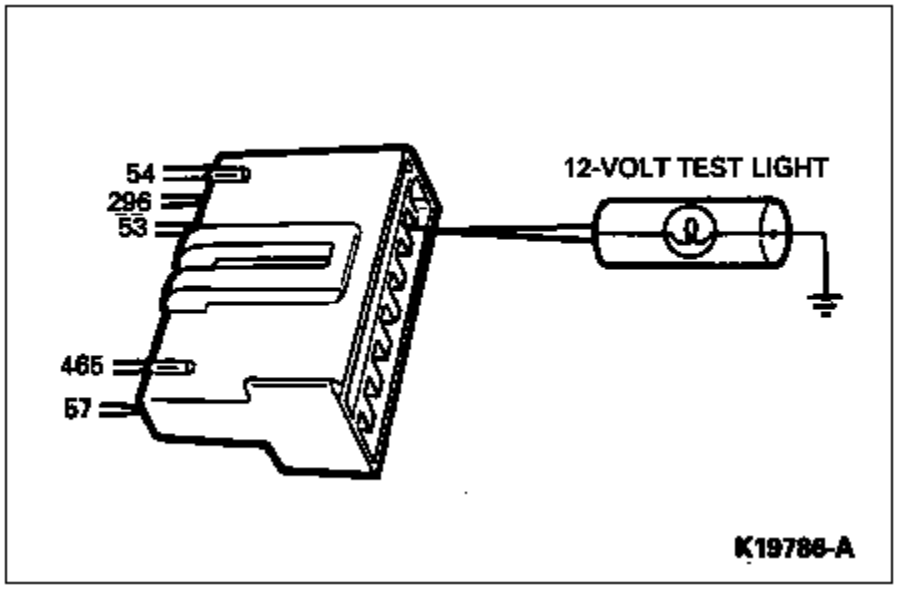


2. Connect a 12-volt test light between Terminal No. 7 and a good ground. The test light should glow when the ignition switch in ACC or RUN position and go out when the ignition switch is turned to OFF or LOCK position. If not, trace Circuit 296 (white-purple) back to fuse panel and service.



3. Connect a jumper wire between Terminals No. 6 and 8. With vehicle doors closed, interior lamp should be on. If not, trace Circuit 53 (black with light blue stripe) and service.

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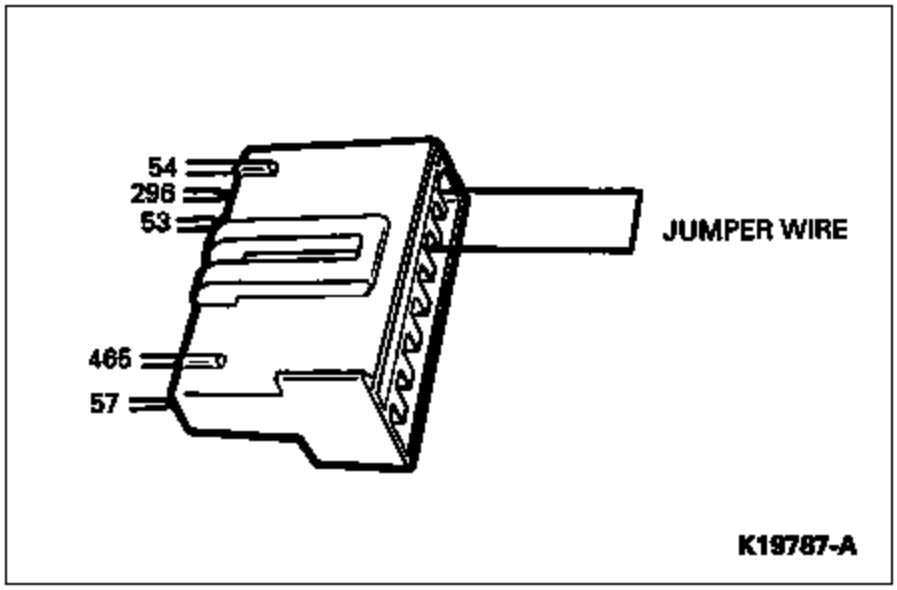
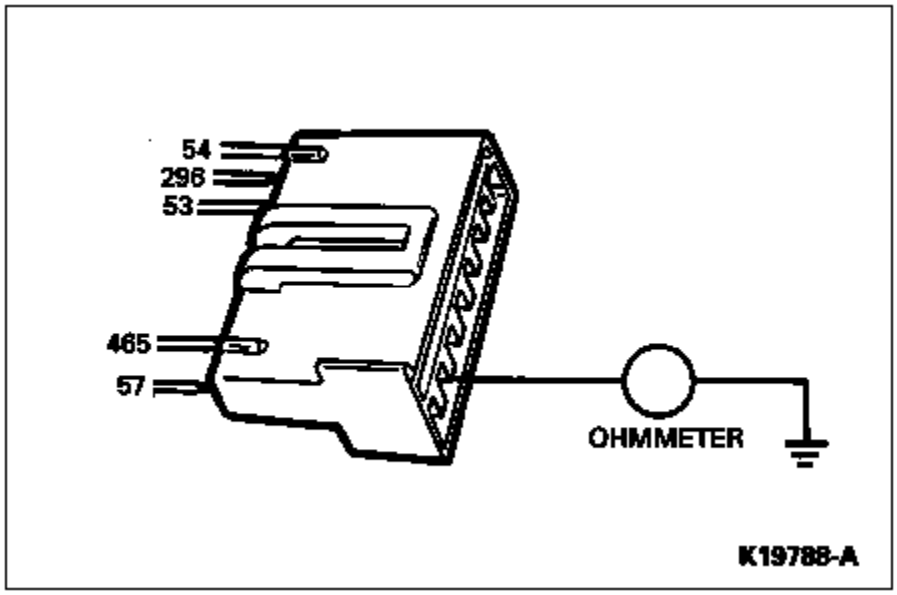


4. **NOTE: When operating door handle, hold in raised position.**

   Connect an ohmmeter between Terminal No. 2 and a good ground. The ohmmeter should show over 10,000 ohms (open). Then, operate each outside door handle in turn; ohmmeter should show not more than 50 ohms (closed). If readings are not as specified, then trace Circuit 465 (white with light blue stripe) back to latch switches and service.



5. Connect a 12-volt test light between Terminal No. 1 and Terminal No. 8. The test light should glow. If not, trace Circuit 57 (black) back to ground and service.

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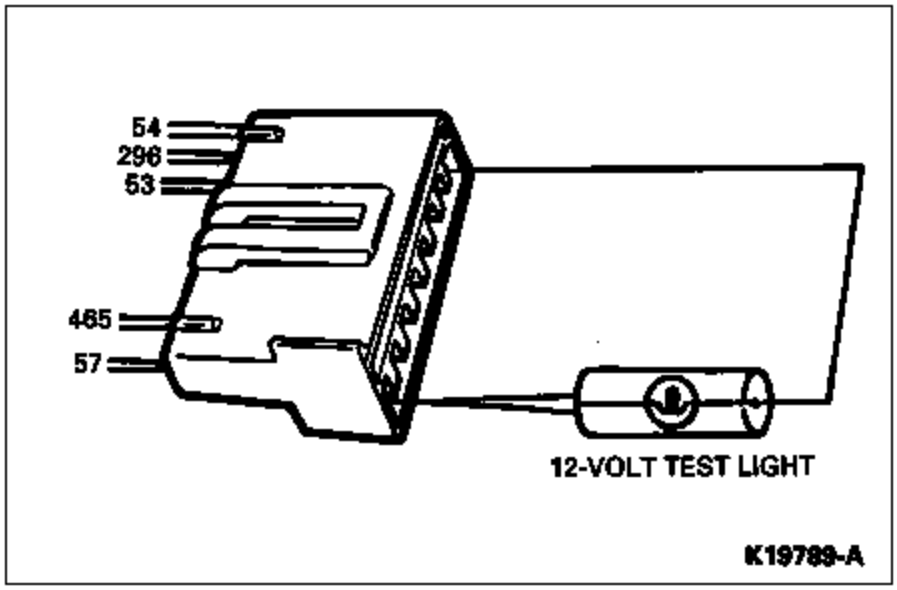

After Testing

If all tests check out OK and the illuminated entry system is still malfunctioning, the actuator assembly is the cause of the problem and must be replaced.

---

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Lamp, Dome

To replace miniature bulb (13466), carefully snap pillar/dome lamp lens (13783) out of interior lamp body (13786) and remove miniature bulb from retainers.

To remove interior lamp body, remove retaining screws, and carefully pry wedge at each end of interior lamp body from retainer clip.

To install, position interior lamp body over screw holes and install retaining screws. Push on pillar/dome lamp lens to snap into position.

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Lamp, Map

To replace miniature bulb (13466) in center section, carefully snap lens out of interior lamp (13776) and remove miniature bulb from retainers.

To replace miniature bulb in the movable gimble, carefully depress the legs of the bulb cover with a thin tool and remove. Gently snap miniature bulb from socket.

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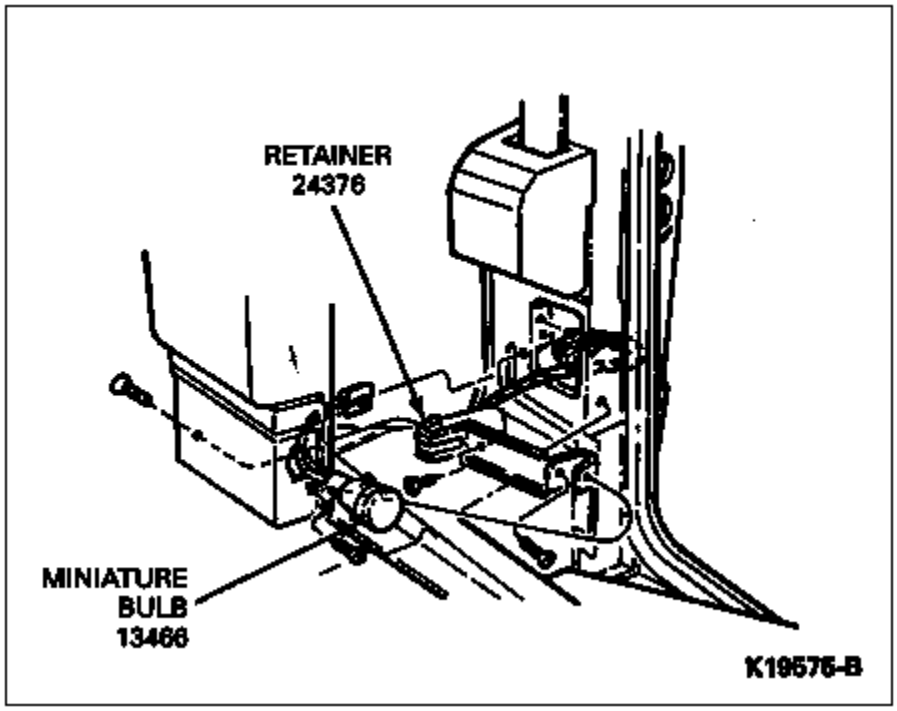
Lamp, Courtesy, Stepwell, Aerostar

Removal and Installation

1. Remove "B" pillar trim attaching screws (do not remove the trim panel).
2. Carefully pull the bottom of the trim panel away from the sheet metal to gain access to the lamp assembly wiring connector.
3. Disconnect the wiring.
4. Pull the interior lamp (13776) slightly away from the trim panel and depress the two locking tabs (top and bottom).
5. Remove interior lamp from trim panel.

To install, reverse removal procedure.



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Bulb, Stepwell Lamp, Aerostar

Removal and Installation

1. Use a small, thin flat-blade screwdriver in the lens slot to pop out the pillar/dome lamp lens.
2. Pull the miniature bulb straight out from the interior lamp and insert the new miniature bulb by pushing in.
3. Push pillar/dome lamp lens back into the interior lamp until it snaps into place.

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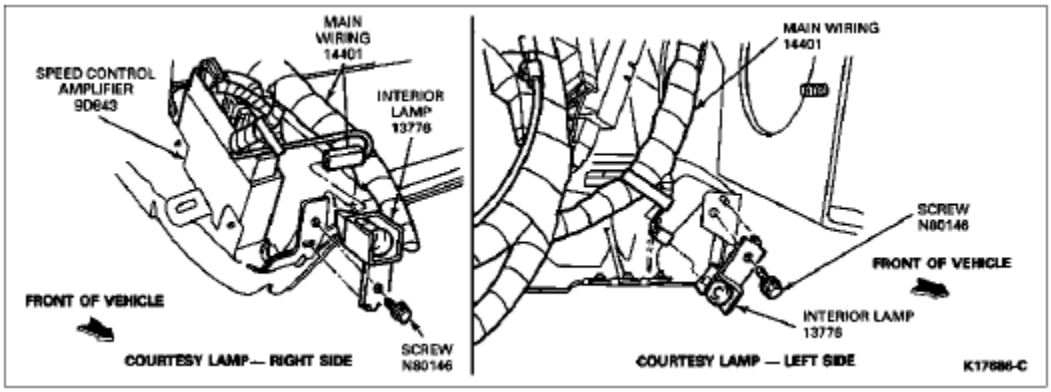
Lamps, Courtesy, Lower Instrument Panel, Aerostar (with Optional Light Group)

Removal and Installation

1. Remove miniature bulb (13466) from interior lamp (13776).
2. Remove the screw retaining the interior lamp to the instrument panel (04320).
3. Disconnect the main wiring (14401) from the interior lamp.

For installation, follow removal procedures in reverse order.

Optional Courtesy Lamps, Aerostar



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Courtesy Lamp, Switch, Aerostar

Removal

1. Unscrew the hex sleeve nut from the pillar.

2. Extract lamp switch (13713) and pull the main wiring (14401) off the lamp switch.

    - Retention of lamp switch to the main wiring is by one of three tabs positioned 120 degrees apart on the lamp switch.
    - When the lamp switch is disconnected from the main wiring, the engaged locking tab breaks off, the lamp switch must be rotated 120 degrees to engage a new tab.
    - When all three tabs have been broken, the lamp switch must be replaced.

Installation

1. Pull the main wiring through the switch mounting hole in the pillar to interior lamp switch (13752). Connect the lamp switch to the main wiring.

2. Twist main wiring and lamp switch 4-1/2 turns counterclockwise, and push the main wiring and connector back through the mounting hole.

3. Screw the lamp switch into the pillar until seated.

4. Close and open the front door (20124) to make sure the interior lamp (13776) is operating properly.

Courtesy Switch, Driver's Door, Aerostar

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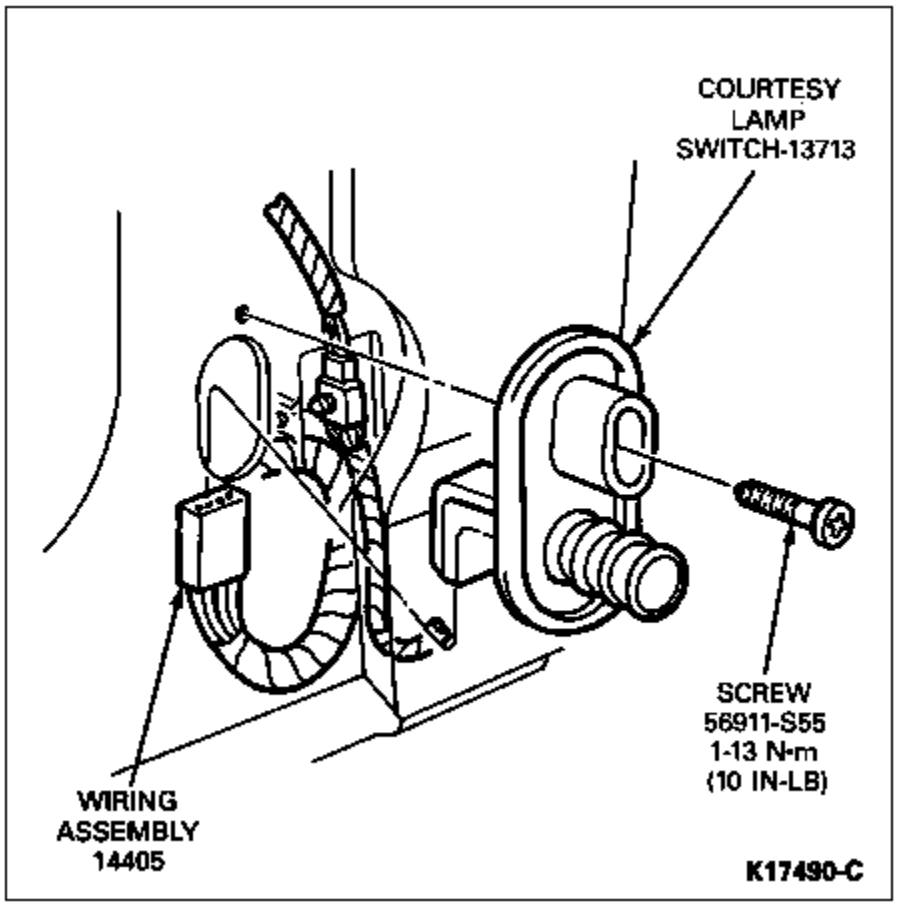

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Hi-Mount Stoplamp/Cargo Lamp (Ranger)

1. Remove the two screws from the surface of the pillar/dome lamp lens (13783).
2. After removing the screws, remove rear hi-mount lamp (13A613).
3. Remove the socket by rotating it 45 degrees and pulling it out of the rear hi-mount lamp that contains the burned-out miniature bulb (13466) and replace the miniature bulb.
4. To install, push the bulb socket into the rear hi-mount lamp and rotate 45 degrees.
5. Position the rear hi-mount lamp on vehicle.
6. Secure with two screws.

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Bulb, Cargo Lamp, Aerostar

To remove pillar/dome lamp lens (13783), remove retaining screws.

To remove miniature bulb, depress and rotate in counterclockwise direction.

To replace interior lamp door, disconnect courtesy or interior lamp switch wiring (13A709) and remove retaining screws at bottom of interior lamp door (13788).

To install, connect courtesy or interior lamp switch wiring to interior lamp door, position interior lamp door to vehicle and install retaining screws. Insert miniature bulb (13466) into socket and install pillar/dome lamp lens and retaining screws.

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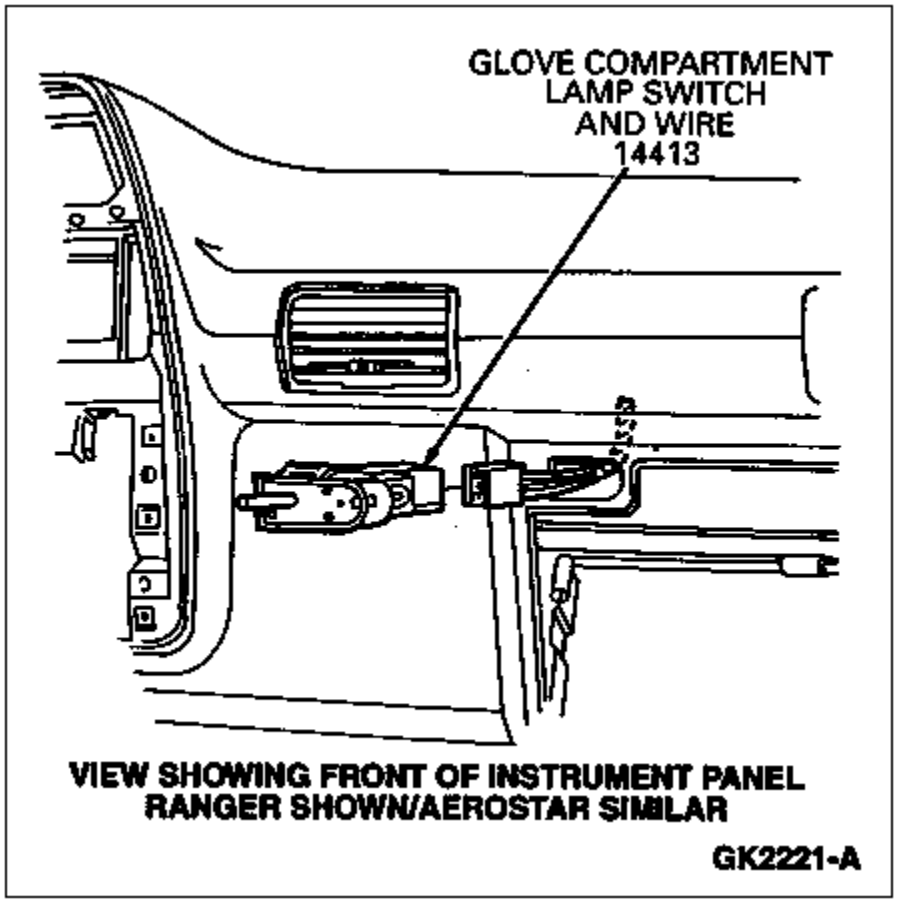
Lamp, Glove Compartment, Aerostar

Removal

1. From behind interior lamp (13776), depress lock tabs and pull interior lamp out of instrument panel (04320).
2. Disconnect main wiring (14401) from interior lamp.
3. To replace miniature bulb (13466), pull straight out of interior lamp and push new miniature bulb in.

Installation

1. Connect main wiring.
2. Push interior lamp into instrument panel until it locks in place.



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Lamp, Ash Receptacle, Ranger

Removal and Installation

1. **NOTE: When the battery is disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

   Disconnect battery ground cable (14301).

2. Remove the instrument panel ash receptacle (04810) by depressing tab in center and pulling out.

3. Remove the two screws that attach the ash receptacle retainer to the instrument panel (04320) and pull the retainer rearward to disengage retention clip.

4. Squeeze the sides of the interior lamp (13776) together and lift off of receptacle retainer.

5. Disconnect courtesy or interior lamp switch wiring (13A709) from interior lamp.

6. Replace miniature bulb (13466) if required.

For installation, follow removal procedures in reverse order.

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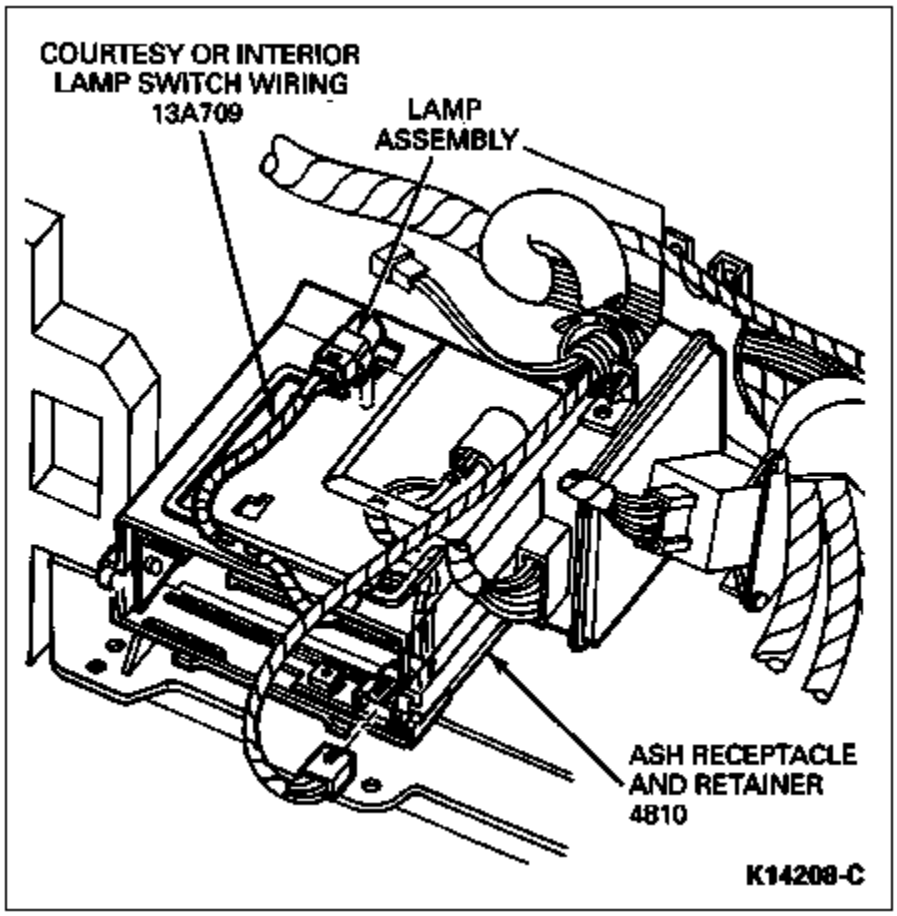

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SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-In
Screw, Dome Lamp, Ranger	1.6-1.8	15-17
Screw, Dome Lamp, Aerostar	2-3	18-27
Screw, Hi-Mount Stoplamp	1.7-2.1	15-18

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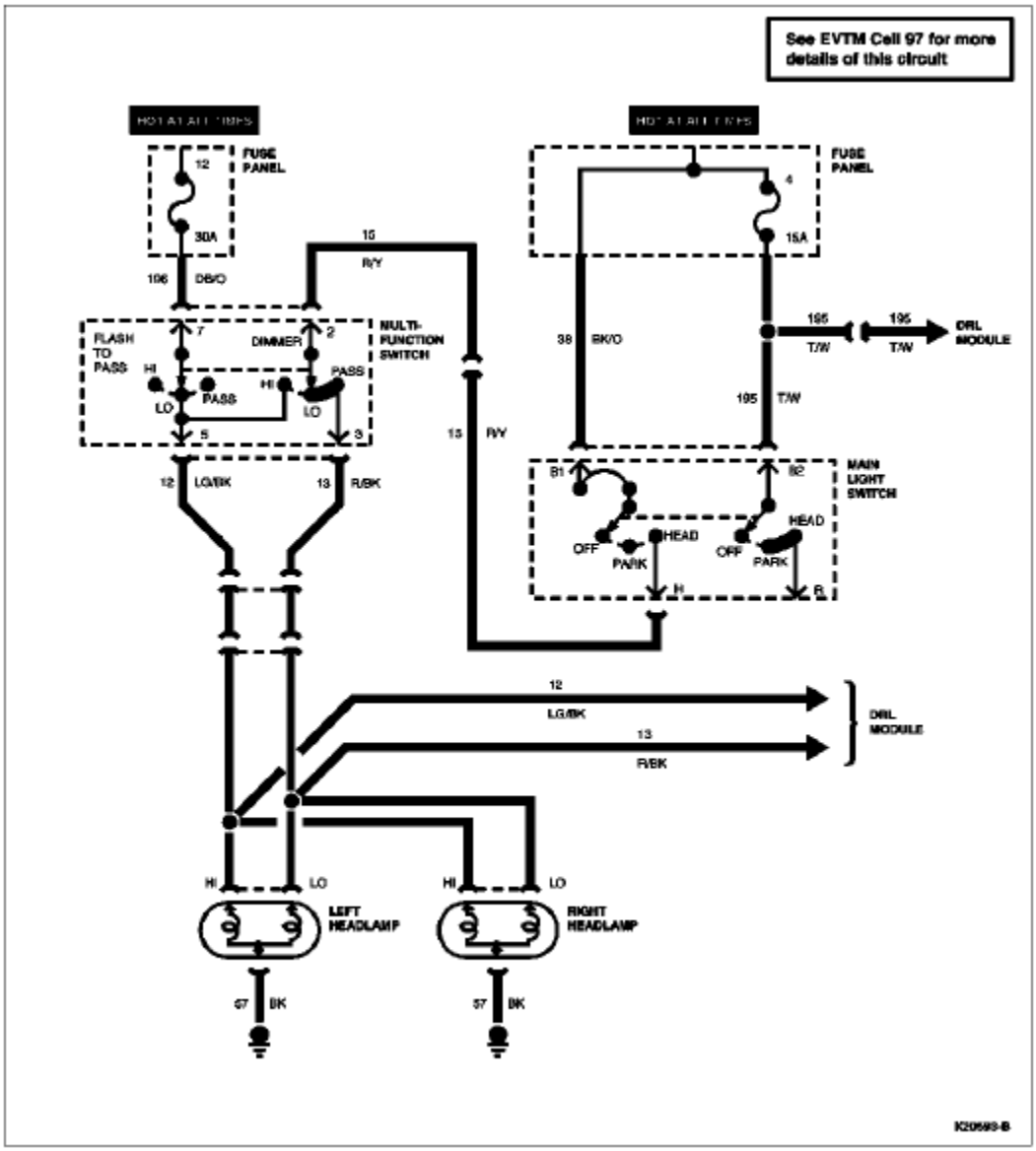
Daytime Running Lamp (DRL) System

The DRL System is designed to turn the high beam headlamps on, with a reduced light output, and without illuminating the high beam indicator lamp in the instrument panel (04320) when the following conditions exist:

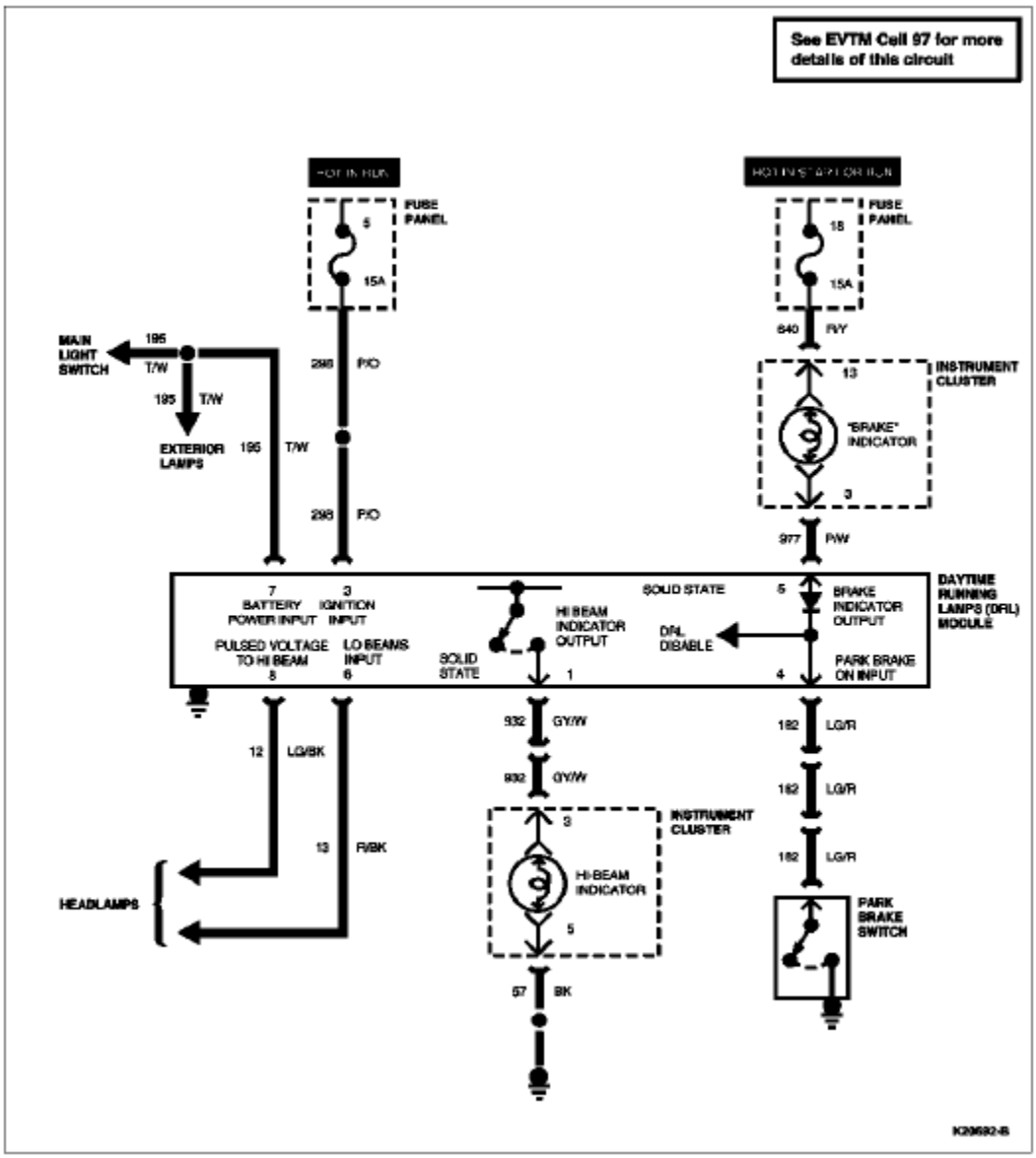
- The ignition switch (11572) is ON.
- The parking brake control (2780) is fully released.
- The headlamp switch (11654) is in OFF position.

Electrical Schematics

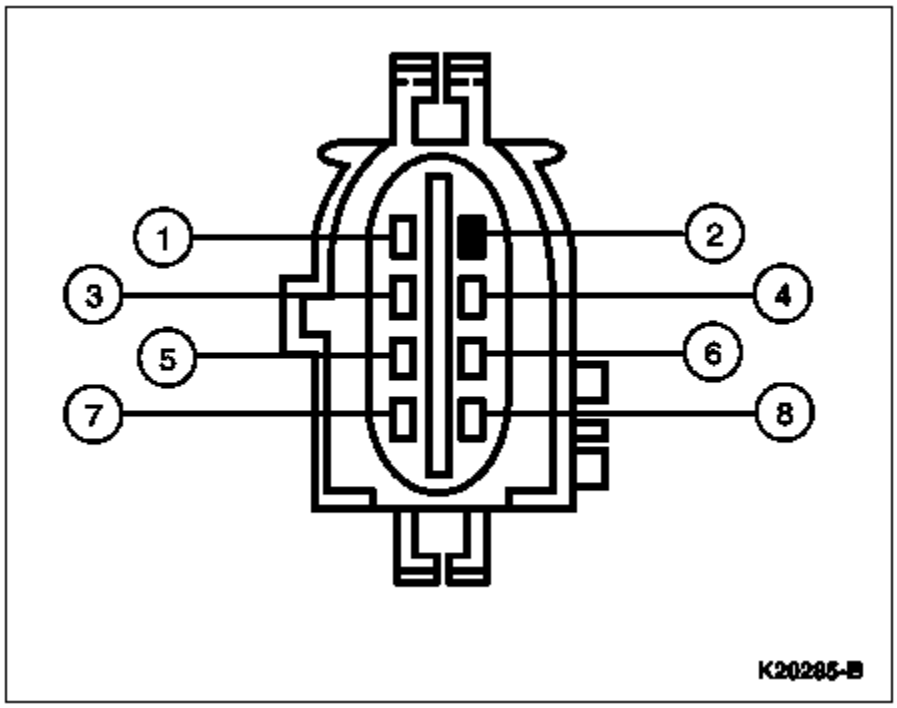
Daytime Running Lamps (DRL), Aerostar



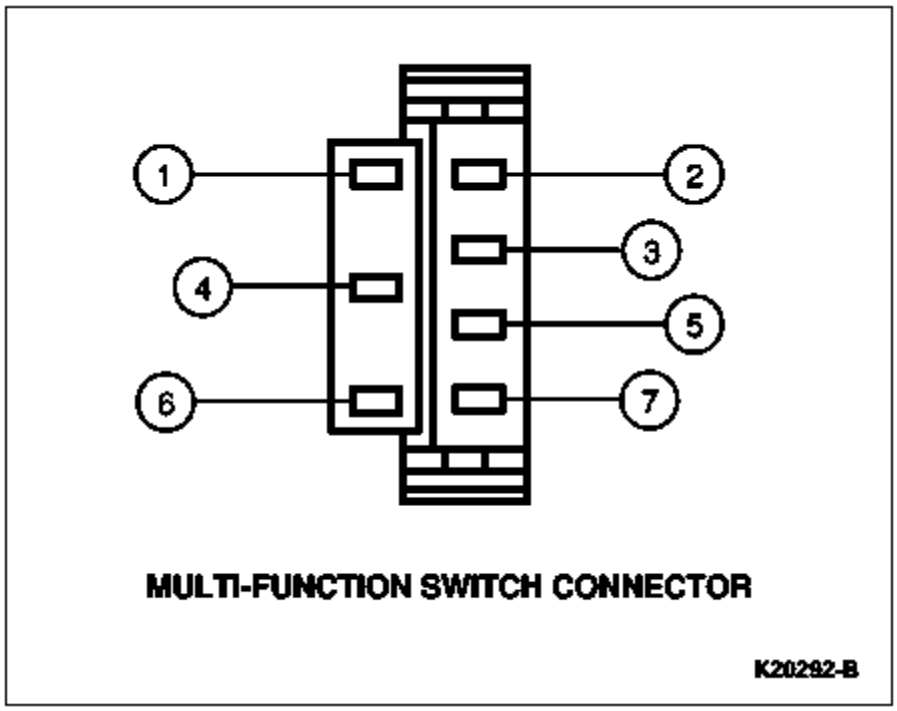
Daytime Running Lamps (DRL), Aerostar (Continued)



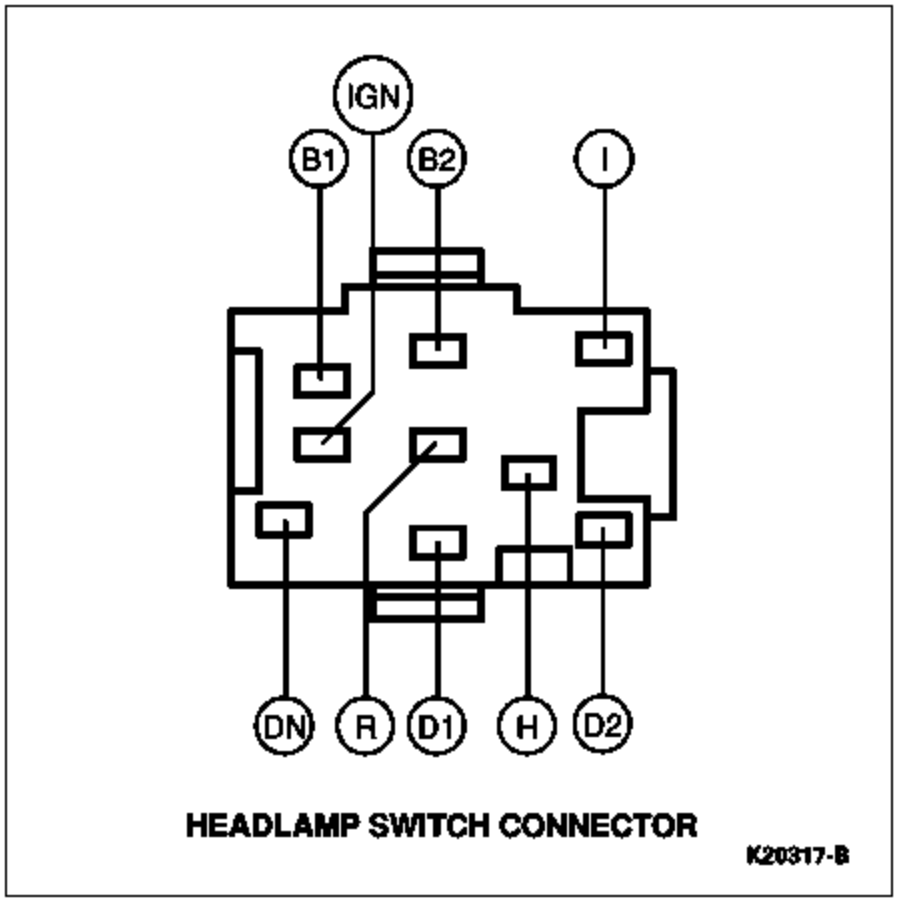
DRL Module Connector, Aerostar



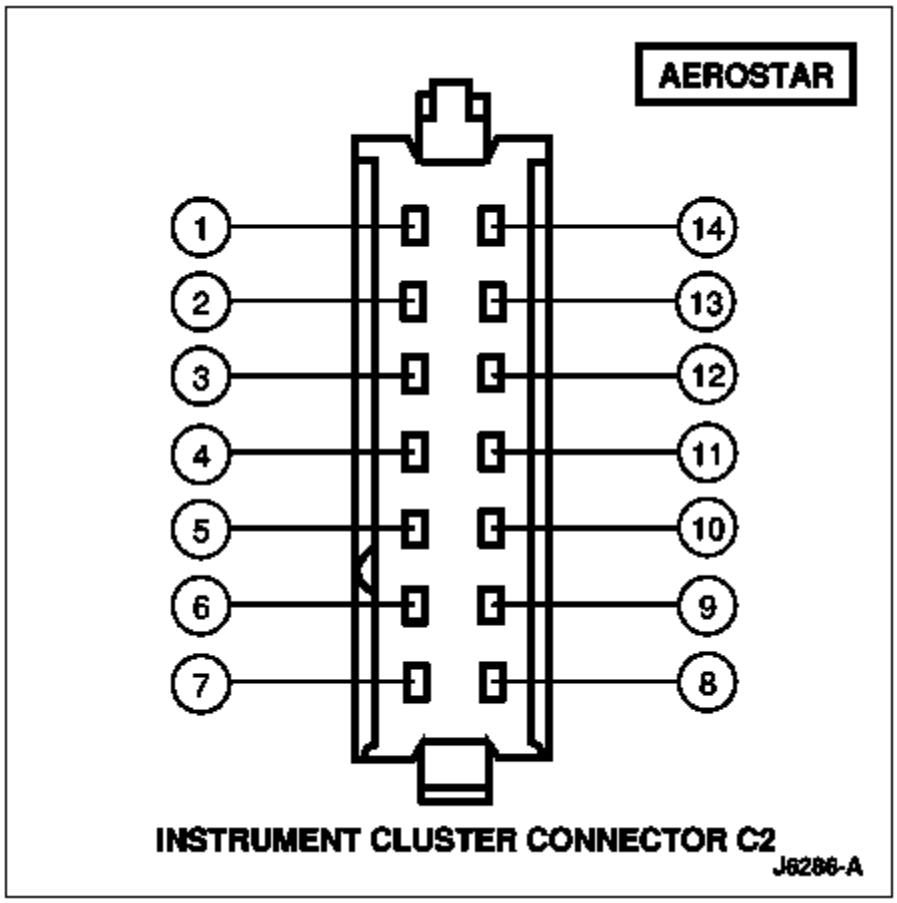
Pin Number	Circuit	Circuit Function
1	932 (LG/R)	High Beam Indicator Lamp
2	—	Not Used
3	298 (P/O)	Fused Run Only Feed
4	162 (LG/R)	Park Brake Switch
5	977 (P/W)	Parking Brake Warning Lamp
6	13 (R/BK)	Low Beam Input
7	195 (T/W)	Battery Feed
8	12 (LG/BK)	Pulsed Voltage to High Beams



Pin Number	Circuit	Circuit Function
1	589 (O)	Windshield Wiper Switch to Intermittent Governor Ground
2	15 (R/Y)	Headlamp Dimmer Switch Feed
3	13 (R/BK)	Headlamp Dimmer Switch to Low Beams
4	993 (BR/W)	Intermittent Governor to Windshield Wiper Switch
5	12 (LG/BK)	Headlamp Dimmer Switch to High Beams
6	590 (DB/W)	Intermittent Governor to W/S Wiper Switch
7	196 (DB/O)	Headlamp Flash to Pass Switch Feed

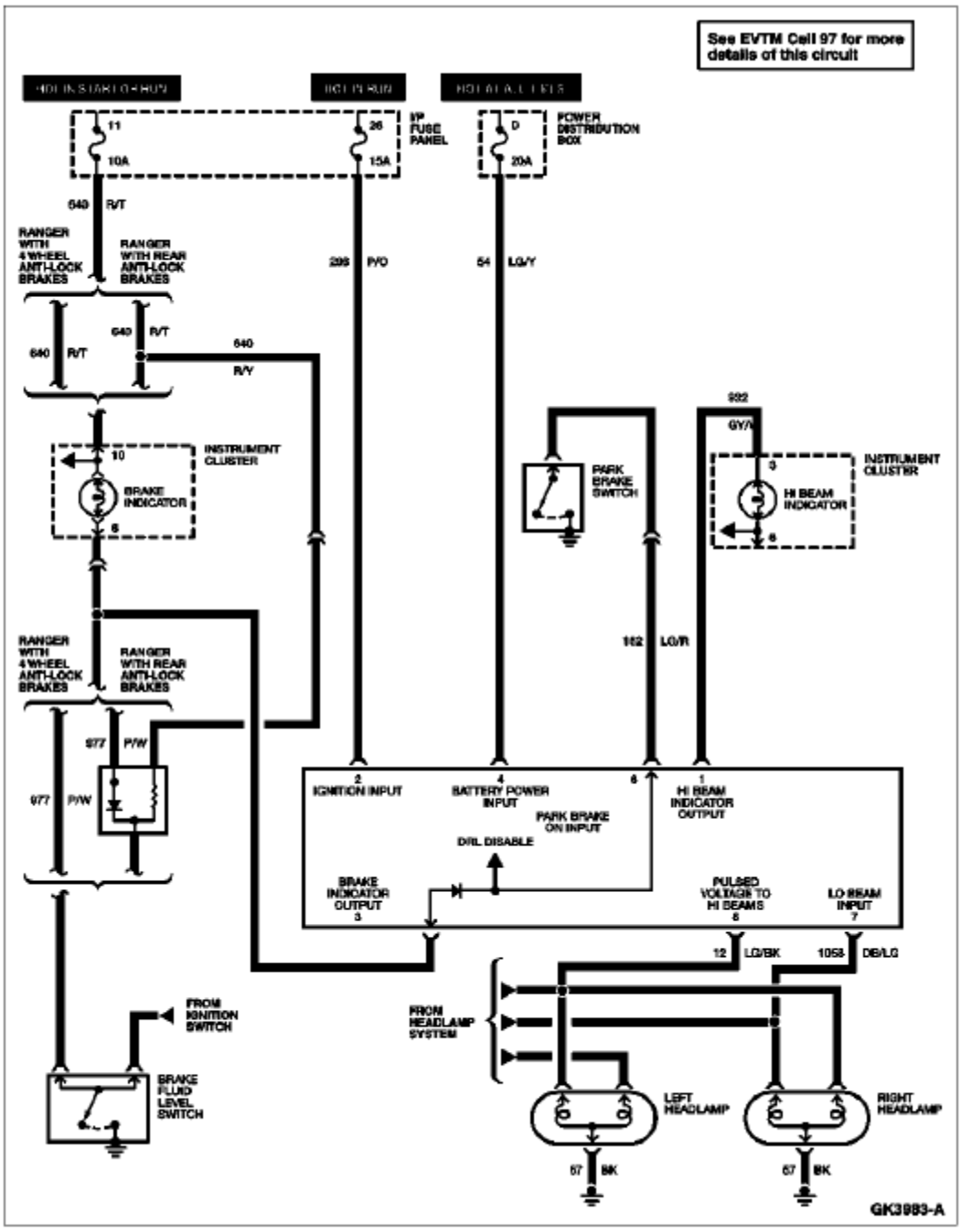


Pin Number	Circuit	Circuit Function
B1	38 (BK/O)	Battery Input to Main Light Switch
B2	195 (T/W)	Battery Input to Main Light Switch
D1	54 (LG/Y)	Battery Input to Dome Switch
D2	53 (BK/LB)	Dome Switch to Courtesy Lamps
DN	484 (O/BK)	Main Light Switch to Radio LCD
H	15 (R/Y)	Main Light Switch to Dimmer
I	19 (LB/R)	Main Light Switch to Instrument Illumination
IGN	137 (Y/BK)	Battery Input, Hot in ACC or RUN
R	14 (BR)	Main Light Switch to Exterior Lamps

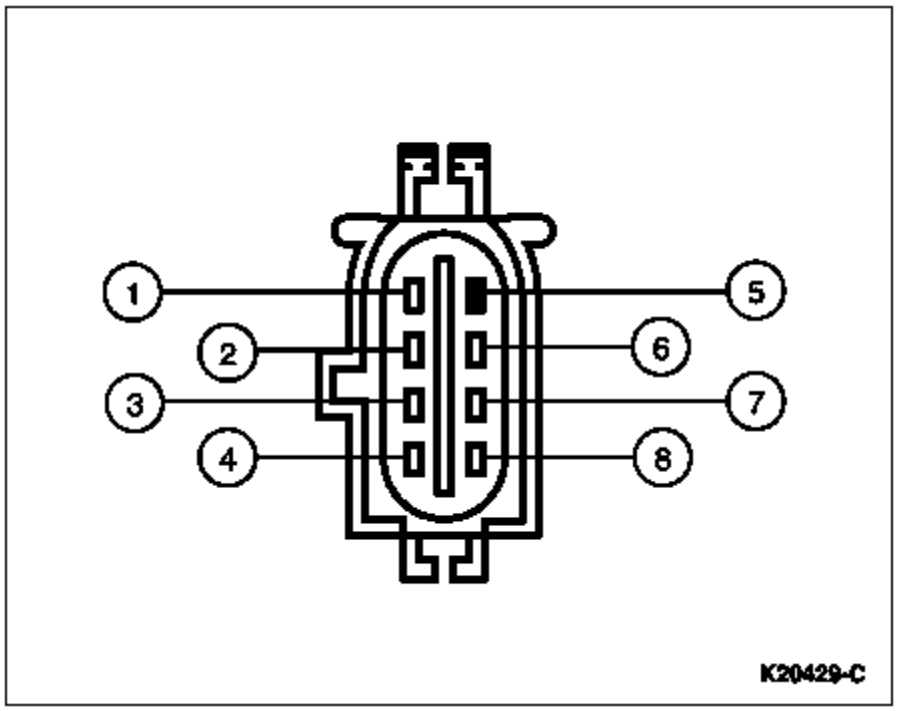


Pin Number	Circuit	Circuit Function
1	208 (GY)	"Check Oil" to Low Oil Level Relay
2	640 (R/Y)	Power to "Check Oil" Indicator
3	932 (GY/W)	Power to High Beam Indicator
4	450 (DG/LG)	Power to Fasten Belts Indicator
5	57 (BK)	Illumination High Beam and Fasten Belts to Ground
6	19 (LB/R)	Power to Illumination Bulbs
7	57 (BK)	Turn Indicators to Ground
8	2 (W/LB)	Power to Right Turn Indicator
9	57 (BK)	Electronic 4WD to Ground
10	994 (W)	Power to Electronic 4WD Indicator
11	608 (BK/Y)	"Air Bag" to Air Bag Module
12	640 (R/Y)	Power to Gauges, Hot in START or RUN
13	570 (BK)	Fuel Gauge to Ground
14	397 (BK/W)	Voltmeter to Ground

Daytime Running Lamps (DRL), Ranger

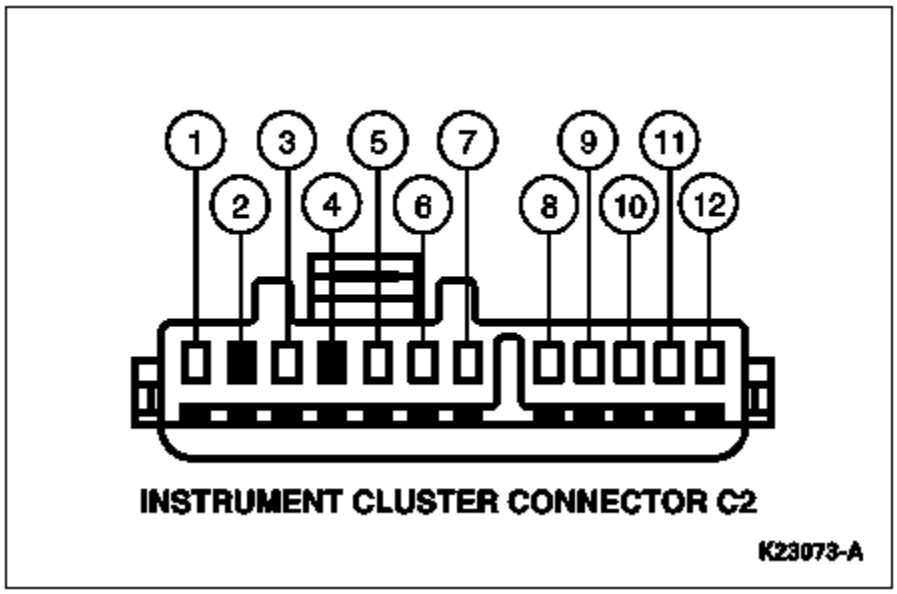


DRL Module Connector, Ranger

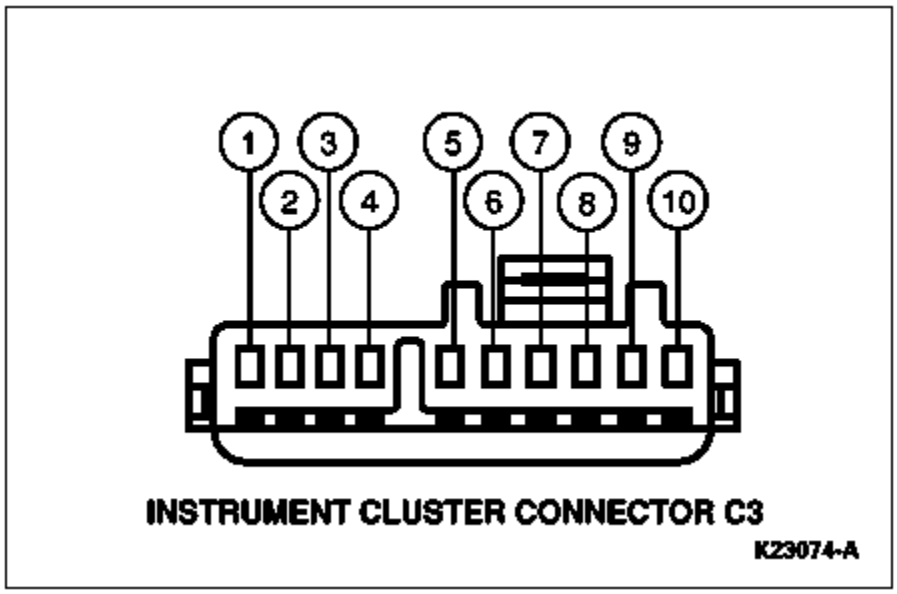


Pin Number	Circuit	Circuit Function
1	932 (GY/W)	High Beam Indicator Lamp
2	298 (P/O)	Fused Run Only Feed
3	977 (P/W)	Brake Warning Indicator Lamp
4	54 (LG/Y)	Fused, Hot at All Times
5	—	Not Used
6	162 (LG/R)	Parking Brake On Input
7	1058 (DB/LG)	Low Beam Input
8	12 (LG/BK)	Pulsed Voltage to High Beams

Instrument Cluster Connector C2, Ranger



Pin Number	Circuit	Circuit Function
1	29 (Y/W)	From Fuel Gauge to Fuel Gauge Sender Unit and Message Center (If Equipped)
2	—	Not Used
3	627 (BK/O)	Door Ajar Indicator Lamp to Generic Electronic Module (GEM)
4	—	Not Used
5	640 (R/Y)	Battery Feed from Ignition Switch
6	57 (BK)	Ground
7	932 (GY/W)	From Headlamp Circuit or Daytime Running Lamp (DRL) Module to High Beam Indicator Lamp
8	3 (LG/W)	From Turn Signal Circuit to Left Turn Indicator Lamp
9	235 (R/BK)	Cluster Illumination, from Pulse Width Dimmer
10	39 (R/W)	From Engine Coolant Temperature Gauge to Temperature Sender Unit
11	57 (BK)	Ground
12	679 (GY/BK)	Vehicle Speed Sensor Input to Speedometer



Pin Number	Circuit	Circuit Function
1	871 (Y)	Seat Belt Indicator Lamp to Generic Electronic Module (GEM)
2	640 (R/Y)	Battery Feed from Ignition Switch
3	658 (PK/LG)	Check Engine Indicator Lamp to Powertrain Control Module (PCM)
4	1001 (W/Y)	Battery Feed to Speedometer (Fused)
5	603 (DG)	Anti-Lock Brake (ABS)
6	977 (P/W)	Park Brake Indicator Lamp to Park Brake Switch or Daytime Running Lamps (DRL) Module and Brake Fluid Level Switch
7	608 (BK/Y)	Air Bag Indicator Lamp to Air Bag Module
8	904 (LG/P)	Alternator Indicator Lamp to Alternator
9	584 (Y)	Battery Feed to Alternator Indicator Lamp (Fused)
10	640 (R/Y)	Battery Feed From Ignition Switch

Inspection and Verification

1. Verify the original concern by operating the DRL system to duplicate the concern.
2. Inspect to determine if one of the following mechanical or electrical concerns apply:

VISUAL INSPECTION CHART

Mechanical	Electrical
• Damaged lamps	• Open instrument panel fuse • Damaged connectors • Circuitry open/shorted • Damaged DRL module • Damaged parking brake switch • Fuses

3. If the concern(s) remains after the inspection, determine the symptom(s) and proceed to the following Symptom Chart.

Symptom Chart — Daytime Running Lamp Diagnosis

DAYTIME RUNNING LAMP DIAGNOSIS

Condition	Possible Source	Action
• High Beams Are On at Full Intensity/ High Beams Inoperative	• Daytime running lamps control is not installed. • Open or shorted circuitry. • Damaged DRL module.	• CHECK to see if daytime running lamps control is connected. If loose or disconnected, INSPECT connector and RECONNECT daytime running lamps control. • If the daytime running lamps control is properly connected, GO to Pinpoint Test A .
• High Beams On at Reduced Intensity with Ignition OFF	• Damaged ignition switch. • Shorted wiring. • Damaged daytime running lamps control.	• GO to Pinpoint Test B .
• High Beams On at Reduced Intensity with Parking Brake Applied	• Open wiring or poor ground. • Damaged parking brake switch. • Damaged daytime running lamps control.	• GO to Pinpoint Test C .
• High Beams On at Reduced Intensity With Headlamp Switch ON	• Damaged headlamp switch. • Damaged DRL module.	• GO to Pinpoint Test D .
• No High Beam Indicator with Headlamps in the High Beam Position	• Burned-out bulb. • Open in wiring. • Damaged daytime running lamps control.	• GO to Pinpoint Test E .

Pinpoint Tests

PINPOINT TEST A: HIGH BEAMS ARE AT FULL INTENSITY/HIGH BEAMS INOPERATIVE

A1 CHECK PARKING BRAKE CIRCUIT

- Disconnect parking brake switch connector.

Did headlamps go to reduced intensity?

Yes	No
SERVICE parking brake switch as necessary. RESTORE vehicle. RETEST system.	GO to **A2** .

A2 CHECK DRL MODULE IGNITION INPUT

- Turn ignition key to ON position.
- With test lamp check for voltage to Pin 2 (Ranger) or Pin 3 (Aerostar) at DRL module connector.

Did test lamp illuminate?

Yes	No
GO to **A4** .	GO to **A3** .

A3 CHECK IGNITION SUPPLY CIRCUIT TO DRL MODULE

- Using test lamp check for voltage at output side of fuse 26 (15A, Ranger) or 5 (15A, Aerostar).

Did test lamp illuminate?

Yes	No
SERVICE Circuit 298 (P/O) for open circuit. RESTORE vehicle. RETEST system.	SERVICE fuse as necessary. RESTORE vehicle. RETEST system.

A4 CHECK BATTERY FEED TO DRL MODULE

- Using test lamp check for voltage to Pin 4 (Ranger) or Pin 7 (Aerostar) at DRL module connector.

Did test lamp illuminate?

Yes	No
GO to **A5** .	SERVICE Circuit 54 (Ranger) or Circuit 195 (Aerostar) for open circuit. RESTORE vehicle. RETEST system.

A5 CHECK FOR LOW BEAM INPUT

- Using test lamp check for voltage at Pin 7 (Ranger) or Pin 6 (Aerostar) at DRL module connector.

Did test lamp illuminate?

Yes	No
SERVICE Circuit 1058 (Ranger) or Circuit 13 (Aerostar) for short to voltage. RESTORE vehicle. RETEST system.	REPLACE daytime running lamps control. RESTORE vehicle. RETEST system.

PINPOINT TEST B: HIGH BEAMS ON AT REDUCED INTENSITY WITH IGNITION OFF

B1 CHECK IGNITION SWITCH INPUT

- With ignition switch off, use a test lamp and check for voltage to Pin 2 (Ranger) or Pin 3 (Aerostar) at DRL module.

Did test lamp illuminate?

Yes	No
GO to **B2** .	REPLACE daytime running lamps control. RESTORE vehicle. RETEST system.

B2 CHECK CIRCUIT 640 (R/Y) OR 298 (P/O)

- Remove fuse 26 (Ranger) or fuse 5 (Aerostar).
- Using a test lamp, check for voltage at Pin 2 (Ranger) or Pin 3 (Aerostar) at DRL module.

Did test lamp illuminate?

Yes	No
SERVICE Circuit 298.	GO to Section 11-05 , Component Tests for Ignition Switch Test procedures.

PINPOINT TEST C: HIGH BEAMS ON AT REDUCED INTENSITY WITH PARKING BRAKE APPLIED

C1 CHECK PARKING BRAKE SWITCH

- Turn ignition switch to RUN, turn headlamps off.
- Disconnect parking brake switch; using a jumper wire, connect Circuit 162 to a known good ground.

Did high beams turn off?

Yes	No
REPLACE parking brake control. RESTORE vehicle. RETEST system.	GO to **C2** .

C2 CHECK CIRCUIT 162 (LG/R) FOR OPEN

- With jumper wire still connected, disconnect daytime running lamps control.
- Using an ohmmeter connected to a known good ground, measure resistance of Circuit 162.

Is resistance 5 ohms or less?

Yes	No
REPLACE daytime running lamps control. RESTORE vehicle. RETEST system.	SERVICE Circuit 162 for open circuit. RESTORE vehicle. RETEST system.

PINPOINT TEST D: HIGH BEAMS AT REDUCED INTENSITY WITH HEADLAMP SWITCH ON

D1 CHECK DRL MODULE

- Turnignition switch to RUN, disconnect daytime running lamps control connector.

Did headlamps turn off?

Yes	No
REFER to Section 17-01 . SERVICE as necessary.	REPLACE daytime running lamps control. RESTORE vehicle. RETEST system.

PINPOINT TEST E: NO HIGH BEAM INDICATOR WITH HEADLAMPS IN THE HIGH BEAM POSITION

E1 CHECK HIGH BEAM INDICATOR LAMP

- Remove high beam indicator lamp at instrument cluster. Carefully inspect the bulb.

Is bulb burned out or damaged?

Yes	No
REPLACE indicator lamp bulb. RESTORE vehicle. RETEST system.	Go to **E2** .

E2 CHECK CIRCUIT 932 (GY/W) FOR VOLTAGE

- Reinstall high beam indicator lamp.
- Turn ignition switch to RUN, actuate headlamps to high beam.
- Using a test lamp check for voltage at DRL module, Pin 1.

Did test lamp illuminate?

Yes	No
SERVICE Circuit 932 open circuit. RESTORE vehicle. RETEST system.	GO to **E3** .

E3 CHECK DRL MODULE

- Using a jumper wire, connect one end to Pin 4 (Ranger) or Pin 7 (Aerostar), connect other end to Pin 1.

Did high beam indicator illuminate?

Yes	No
REPLACE daytime running lamps control. RESTORE vehicle. RETEST system.	GO to Section 13-01 . SERVICE indicator lamp as necessary.

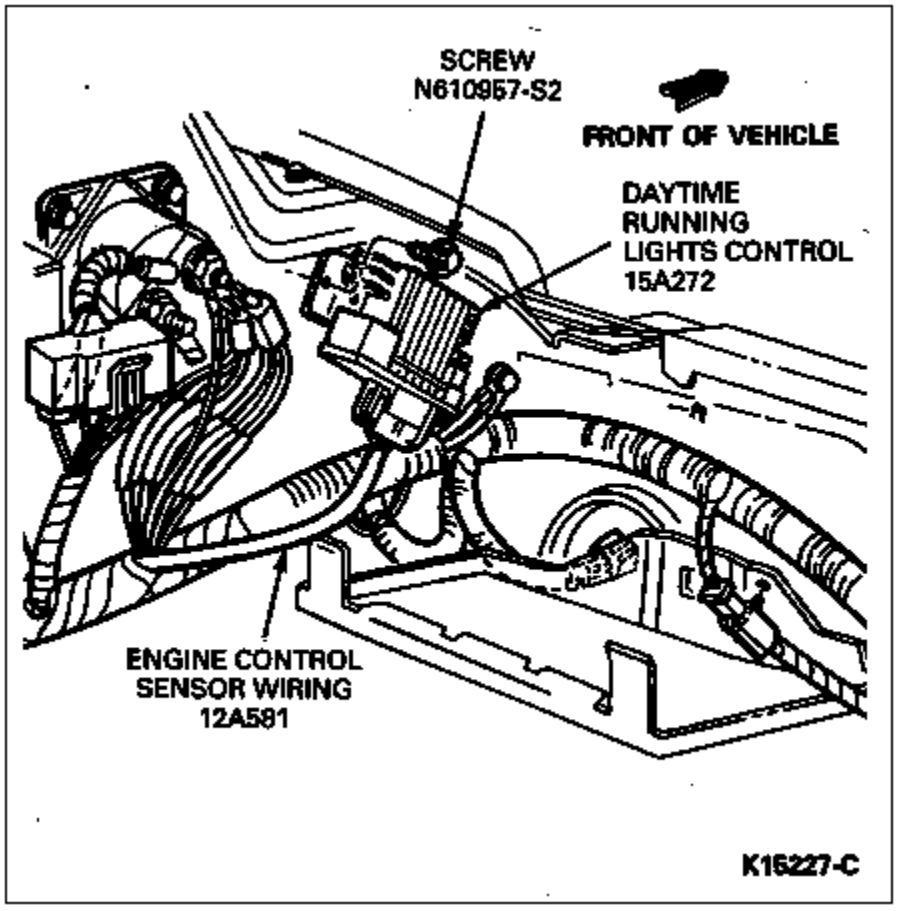
Control Module, Daytime Running Lamp (DRL)

Removal and Installation

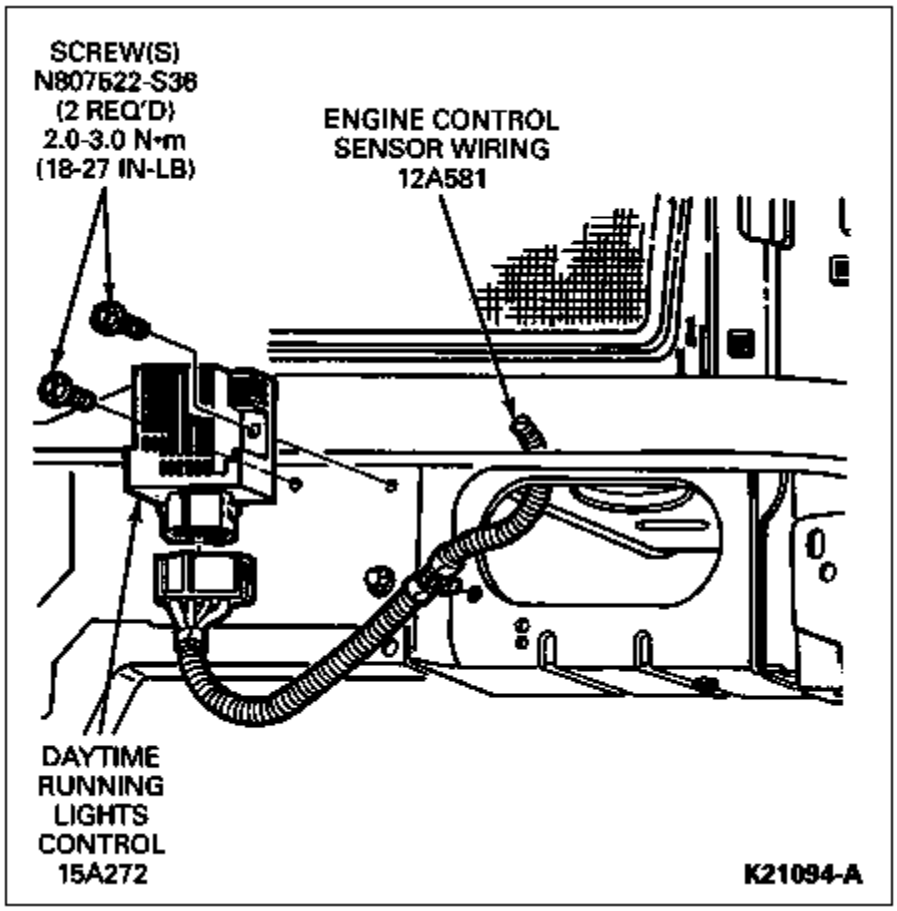
1. Remove retaining screw(s).
2. Disconnect wiring at daytime running lamps control (15A272) and remove from vehicle.

For installation, follow removal procedures in reverse order. Tighten retaining screw(s) to 2.0-3.0 Nm (18-27 lb-in).

Daytime Running Lamp Control Assembly, Aerostar



Daytime Running Lamps, Ranger


SCREW(S)
N807522-S36
(2 REQ'D)
2.0-3.0 N•m
(18-27 IN-LB)
ENGINE CONTROL
SENSOR WIRING
12A581
DAYTIME
RUNNING
LIGHTS
CONTROL
15A272
K21094-A

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-In
Screw, Retaining	2.0-3.0	18-27

Multiplex Communications Network (MCN)

Aboard this vehicle are several electronic components which can be controlled by an off-board tester to provide valuable self-diagnostic information. These components are part of an electrical system network, designed to control powertrain, chassis and body subsystems. The overall electronic network system consists of two microprocessor-based modules which interface through a common communication link. This communication link consists of a twisted wire pair (Data Bus Plus and Data Bus Minus) routed throughout the vehicle. Multiplex communications network signals are carried over an unshielded twisted pair. No special cabling is needed for the multiplex communication network. The wire pair is arranged in a "bus" configuration or party line, and is routed throughout the vehicle. Modules in the system connect to this bus so that the bus serves as a common tie point to each module.

Fault Tolerance

The multiplex communication network system will remain operational even with the severing of one of the bus wires. Communications will also continue if one of the bus wires is shorted to ground or battery positive voltage (B+) or a termination resistor is lost. This faulted condition is detected and reported to the host by the module's network bus interface circuits. In addition, one or more failed modules will not inhibit communications on the remainder of the network.

Purpose

This section contains information necessary for diagnosis of communication link conditions which may affect normal functional operation of the vehicle. Customer symptom may be directly related to these conditions. In order to effectively diagnose the communication link between all modules, the diagnostic procedures outlined in this section should be followed with each step performed in the order presented.

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Diagnostic Communications Network

The diagnostic communication network consists of a single wire circuit which allows communication between an off-board tester and the related modules.

Fault Tolerance

Unlike the multiplex communications network, the diagnostic communications network will not tolerate grounding of Circuit 70 (LB/W). The diagnostic communications network will also fail if Circuit 70 (LB/W) is shorted to B+. Also, if one of the modules on the diagnostic communications network loses power or shorts internally, communications to that module will fail.

Purpose

This network consists of a single wire, Circuit 70 (LB/W). This circuit is used to access certain subsystem modules to perform on-board diagnostics with an off-board tester.

The recommended tester is the Rotunda New Generation STAR (NGS) Tester 007-00500 or equivalent. The tester accesses the control modules via the data link connector (DLC) located to the right of the steering column beneath the instrument panel.

Information on this network is contained in messages. Each module on the network has the ability to send and receive messages to and from the NGS tester.

Module-to-module communication is not possible as with the multiplex communication network. Communication involves only the NGS tester and the individual module being addressed during the testing of the module and its system. The modules will not communicate with the NGS tester unless the tester requests information by sending the module a signal.

The diagnostic communication network, Circuit 70 (LB/W), is located on Pin 7 of the data link connector (DLC). The voltage at Pin 7, Circuit 70 (LB/W), during vehicle operation without the NGS tester connected to the DLC will float between ground and battery voltage. When the NGS tester is connected to the DLC, the voltage on Pin 7, Circuit 70 (LB/W), should be greater than 90% of battery voltage.

To begin communications with selected vehicle module, the NGS tester grounds Pin 7, Circuit 70 (LB/W). The NGS tester then sends signals to the module by switching Circuit 70 (LB/W) between battery voltage and ground. The selected module interprets these digital commands and performs the requested function.

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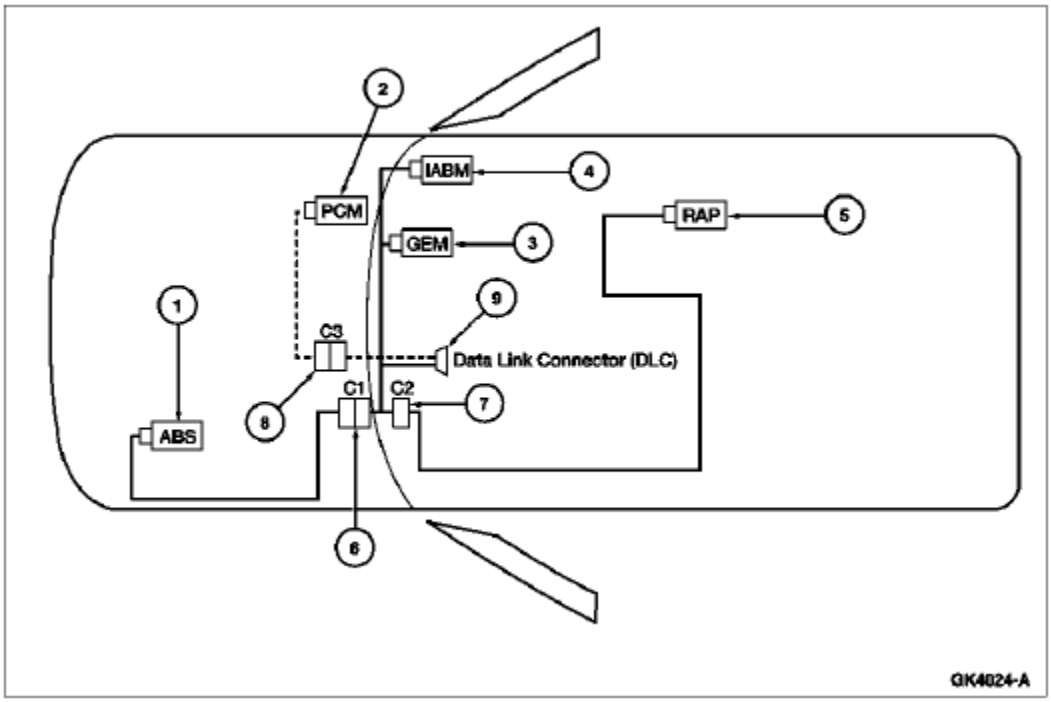
System Components



Item	Part Number	Description
1	—	Anti-Lock Brake System (ABS) Module, 24 Pin Connector, Circuit 70 Pin 8
2	—	Powertrain Control Module (PCM), 104 Pin Connector, Circuit 914 Pin 16, Circuit 915 Pin 15
3	—	Generic Electronic Module (GEM), 26 Pin Connector, Circuit 70 Pin 25
4	—	Integrated Air Bag Diagnostic Monitor (IABM), 24 Pin Black Connector, Circuit 70 Pin 12
5	—	Remote Anti-Theft Personality (RAP) Module, 24 Pin Connector, Circuit 70 Pin 8
6	—	40-Way Connector Circuit 70 Pin 29
7	—	16-Way Connector Circuit 70 Pin 6
8	—	40-Way Connector Circuit 914 Pin 26, Circuit 915 Pin 33
9	—	Data Link Connector (DLC)

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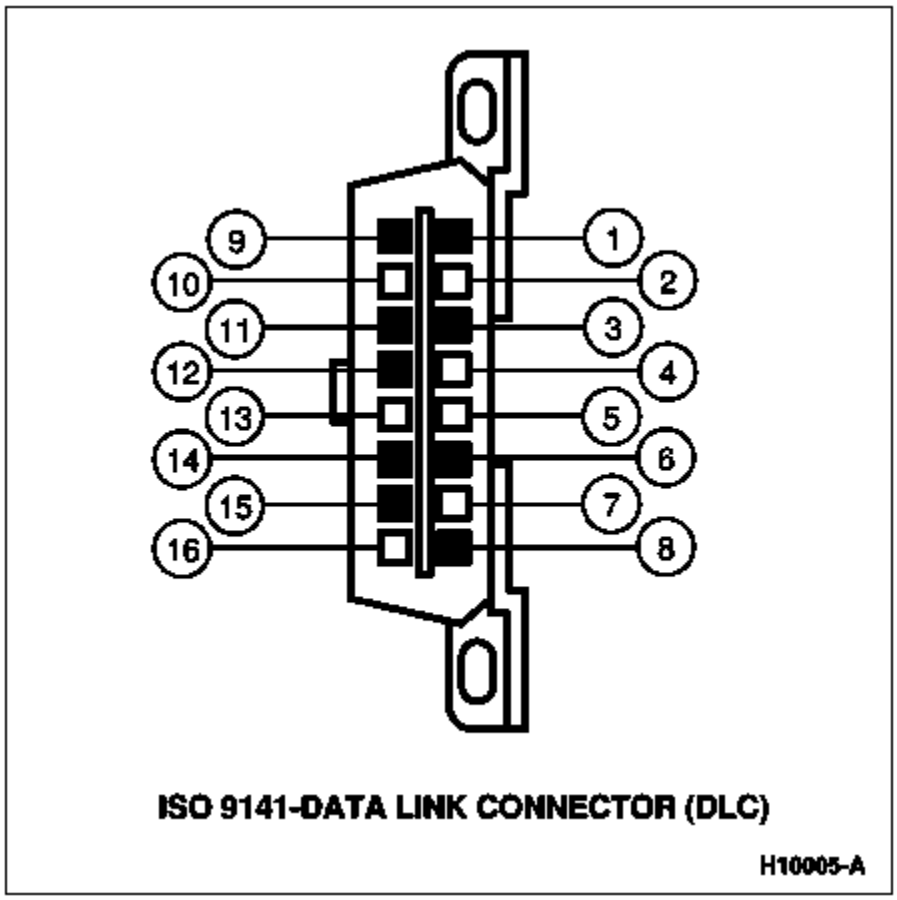

Pin Number	Circuit	Circuit Function
1	—	Not Used
2	914 (T/O)	(Bus+) (Ranger Only)
3	—	Not Used
4	57 (BK)	Chassis Ground Feed
5	570 (BK/W)	Control Module Ground Feed
6	—	Not Used
7	70 (LB/W)	ISO Communication Link
8	—	Not Used
9	—	Not Used
10	915 (PK/LB)	(Bus-) (Ranger Only)
11	—	Not Used
12	—	Not Used
13	107 (P)	Reprogramming Power Supply (Ranger Only)
14	—	Not Used
15	—	Not Used
16	693 (O)	Battery Power

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New Generation STAR (NGS) Tester Usage

The Service Bay Diagnostic System (SBDS), Rotunda Part Number 001-00001, may also be used to diagnose this system.

New Generation STAR Tester Hookup and Vehicle Selection

NOTE: Before any diagnostics can be performed on the communication system, use Rotunda New Generation STAR Tester 007-00500 or equivalent.

1. Turn ignition switch to OFF position.
2. Select the appropriate program card for the vehicle.
3. With the New Generation STAR (NGS) Tester control unit facing away from you, insert the program card into the slot on the back. If you insert the card incorrectly, NGS will not work.
4. Plug the NGS data link connector (DLC) cable to the vehicle DLC port (OBD II Connector).
5. Turn ignition switch to RUN position.
6. Plug the power cable into the vehicle's cigar lighter or into the battery hookup adapter if using the alternative hookup. NGS will perform an initialization, which checks that the NGS memory verifies the vehicle interface module matches the program card software. If the screen displays an error message, refer to Appendix C New Generation STAR Tester Operator Handbook, System Messages.
7. Menu item "Vehicle and Engine Selection" is highlighted. Press trigger to select.
8. Rotate dial to menu item "Select New Vehicle Model and Year" - press trigger.
9. Select year, Vehicle and appropriate engine by rotating dial to highlight selection, then press trigger to select. (If the selected vehicle is not displayed on first row, then repeat steps 8 and 9. Otherwise, rotate dial to Selected Vehicle top row and press trigger.)

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Data Link Diagnostics

1. **NOTE: The ignition switch must be in RUN position or test will fail. This test is used to verify the proper operation of communication circuit of each module on the multiplex communication network or diagnostic communication network or diagnostic communication network.**

   Perform New Generation STAR Tester Hookup and Vehicle Selection as outlined.

2. Rotate dial to menu item "Diagnostic Data Link" and press trigger.

3. If results of Circuit 914 (+) = 0000 and Circuit 915 (-) = 0000, then the Multiplex Communication Network link test passed. If non-zeros returned, then go to Network Diagnostic Trouble Code (DTC) Index.

4. If results of Circuit 70 (LB/W) = 0, then the Diagnostic Communication Network Link Test passed. If non-zeros returned, then go to Network Diagnostic Trouble Code (DTC) Index.

On-Demand Self-Test

NOTE: This test is used to verify operation of module being tested.

1. Perform New Generation STAR Tester Hookup and Vehicle Selection as outlined.

2. **NOTE: The ignition switch must be in RUN position or test will fail.**

   Rotate dial to menu item Diagnostic Data Link and press trigger.

3. Select module to test by rotating dial to highlight module and press trigger.

4. Menu item Diagnostic Test Modes is highlighted. Press trigger.

5. Rotate dial to highlight menu item On-Demand Self Test. Press trigger, then press start (Button 3).

6. Prepare the vehicle for entry condition as specified for each module - press trigger.

Retrieve/Clear Continuous DTCs

1. Perform New Generation STAR Tester Hookup and Vehicle Selection as outlined.

2. **NOTE: The ignition switch (11572) must be in RUN position or test will fail.**

   Rotate dial to menu item Diagnostic Data Link and press trigger.

3. Select module to test by rotating dial to highlight module and press trigger.

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4. Menu item Diagnostic Test Modes is highlighted. Press trigger.
5. Rotate dial to menu item Retrieve/Clear Continuous DTC, press trigger, then press start (Button 3).
6. Clear individual DTC from selected module, highlight DTC by rotating dial then press Button 8.
7. Clear all DTCs from selected module, press Button 7.

Retrieve PID Information

1. **NOTE: This test is used to verify operation of input circuitry to the module being tested. The ignition switch must be in RUN position or test will fail.**

   Perform New Generation STAR Tester hookup and Vehicle Selection as outlined.
2. Rotate dial to menu item Diagnostic Data Link and press trigger.
3. Select module by rotating dial to highlight module and press trigger.
4. Rotate dial to highlight menu item PID/Data Monitor and Record, press trigger.
5. Select PID acronyms by rotating dial to highlight a PID and then press trigger. Repeat this process until all PIDs are selected. (* - indicates that a PID has been selected.)
6. Press Button 7 to view all selected PIDs.

Diagnostic Commands

1. **NOTE: This test is used to verify the operation of the output circuitry of the module being tested. The ignition switch must be in RUN position or test will fail.**

   Perform New Generation STAR Tester Hookup and Vehicle Selection as outlined.
2. Rotate dial to menu item Diagnostic Data Link and press trigger.
3. Select module by rotating dial to highlight module and press trigger.
4. Rotate dial to highlight menu item Active/Command Modes, press trigger.
5. Rotate dial to selected command and press trigger. Command the output by rotating dial and pressing trigger as needed.

Retrieve Module Identification

1. **NOTE: Refer to New Generation STAR (NGS) Tester Manual for more details.**

   NOTE: This test is used to verify the correct version level of the module being tested. The ignition switch must be in RUN position or test will fail.

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Perform New Generation STAR Tester Hookup and Vehicle Selection as outlined.

2. Rotate dial to menu item Diagnostic Data Link and press trigger.
3. Select module by rotating dial to highlight module and press trigger.
4. Rotate dial to highlight menu item Module Identification, press trigger.

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Inspection and Verification

1. Verify the customer's original concern.
2. Inspect to determine if one of the following electrical concerns apply:

VISUAL INSPECTION CHART

Electrical
• Check electrical connections for obvious damage, opens or shorts.

3. Inspect Pin 2, Pin 7 and Pin 10 on the data link connector (DLC) for loose, bent, deformed, corroded or broken pins. If pin is damaged, service or replace pin, verify communication with Rotunda New Generation STAR Tester 007-00500 or equivalent.
4. If the concern(s) remains after the inspection, continue with New Generation STAR Tester Driven Diagnostics.

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New Generation STAR Tester Driven Diagnostics

Vehicle Set Up

Perform the following vehicle set-up prior to running any New Generation STAR tests:

- Ignition switch in RUN
- Vehicle transmission range (TR) position in P (PARK)
- Driver seat not occupied
- Parking brake must be applied
- All passenger compartment, hood and luggage compartment doors closed
- All switches in the nominal OFF position

Do not touch any handle, control or switch that may produce a module input unless instructed to do so by New Generation STAR program.

1. Hookup New Generation STAR Tester and perform Vehicle Selection. Use diagnostic procedure outlined under New Generation STAR Tester Operation, New Generation STAR Tester Hookup and Vehicle Selection.

2. Perform Data Link Diagnostics Test to check the Multiplex Communication Network. Use diagnostic procedure outlined under New Generation STAR Tester Operation, Multiplex Communication Network Data Link Diagnostics Test. If the MCN Data Link Diagnostics Test passed and concern(s) still remains, then go to Step 3, if data link diagnostic test did not pass go to Multiplex Communication Network DTC Index or Diagnostic Communication Network DTC Index.

3. Retrieve continuous DTCs from selected module. Use diagnostic procedure outlined under New Generation STAR Tester Operation, Retrieve/ Clear Continuous DTCs.

4. Record all continuous DTCs, then clear all DTCs from the selected module using the diagnostic procedure outlined under New Generation STAR Tester Operation, Retrieve/ Clear Continuous DTCs.

5. **NOTE: The Self-Test program for an individual module may produce observable outputs.**

   Perform On-Demand Self-Test on the selected module. Use diagnostic procedure outlined under New Generation STAR Tester Operation, On-Demand Self-Test.

6. Record all On-Demand Self-Test DTCs and go to Diagnostic Trouble Code (DTC) Chart to continue diagnosis. If On-Demand Self-Test passed and concern(s) still remains, then go to Step 7.

7. Use the continuous DTCs recorded in Step 4 and go to Diagnostic Trouble Code (DTC) Chart to continue diagnosis. If no continuous DTCs retrieved in Step 4, then concern(s) is not related to Multiplex Communication Network. Return to referred section for non-network related problem(s).

Wiggle Test

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The wiggle test is designed to help identify and locate intermittent failures in the vehicle wiring harness and system components. Upon entering wiggle test, several inputs and outputs of the module are monitored for change of state. When a state change is encountered, an audible tone can be heard and/or a diagnostic trouble code (DTC) will be displayed on the New Generation STAR (NGS) tester 007-00500. For modules which store DTCs, the DTC description will determine an open circuit, short to ground or a short to B+. By initiating wiggle test and pulling on different areas of the vehicle harness, intermittent open and short circuits can be located and serviced.

1. Perform New Generation STAR Tester Hookup and Vehicle Selection as outlined.
2. **NOTE: The ignition switch must be in RUN position or test will fail.**

   Rotate dial to menu item Diagnostic Data Link and press trigger.
3. Select module to test by rotating dial to highlight module and press trigger.
4. Menu item Diagnostic Test Modes is highlighted. Press trigger.
5. Rotate dial to highlight menu item Wiggle Test. Press trigger, then press start (Button 3).

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Diagnostic Trouble Code (DTC) Chart

NOTE: If DTC B1342 is retrieved, replace the GEM.

DTC	Continuous Test Mode	Self Test Mode	Description
B1317	C	S	Battery Voltage High
B1318	C	S	Battery Voltage Low
B1342	C	S	ECU is Defective
B1314	C	S	Battery Saver Relay Coil Circuit Open
B1315	C	S	Battery Saver Relay Coil Circuit Short to Battery
B1316	—	S	Battery Saver Relay Coil Circuit Short to Ground
B1838	C	S	Battery Saver Power Relay Circuit Failure
B1371	C	S	Illuminated Entry Relay Circuit Failure
B1373	C	S	Illuminated Entry Relay Short to Battery
B1445	—	S	Door Handle Switch Circuit Short to Ground
B1610	—	S	Illuminated Entry Input Short Circuit to Ground
B1322	—	S	Door Ajar LF Circuit Short to Ground
B1323	C	S	Door Ajar Lamp Circuit Failure
B1325	C	S	Door Ajar Lamp Circuit Short to Battery
B1330	—	S	Door Ajar RF Circuit Short to Ground
B1334	—	S	Decklid Ajar Rear Door Circuit Short to Ground
B1340	C	S	Chime Input Request Circuit Short to Ground
B1426	C	S	Seat Belt Lamp Circuit Short to Battery
B1428	C	S	Seat Belt Lamp Circuit Failure
B1462	—	S	Seat Belt Switch Circuit Failure
B1577	—	S	Lamp Park Input Circuit Short to Battery
B1431	C	S	Wiper Brake/Run Relay Circuit Failure
B1432	C	S	Wiper Brake/Run Relay Circuit Short to Battery
B1434	—	S	Wiper Speed Relay Coil Circuit Failure
B1436	C	S	Wiper Speed Relay Coil Circuit Short to Battery
B1438	C	S	Wiper Mode Select Switch Circuit Failure
B1441	—	S	Wiper Mode Select Switch Circuit Short to Ground
B1446	C	S	Wiper Park Sense Circuit Failure
B1450	C	S	Wiper Wash/Delay Switch Circuit Failure

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B1453	C	S	Wiper Wash/Delay Switch Circuit Short to Ground
B1458	C	S	Wiper Washer Pump Motor Relay Circuit Failure
B1460	C	S	Wiper Washer Pump Motor Relay Coil Circuit Short to Battery
B1466	—	S	Wiper Speed Not Switching
B1467	C	S	Wiper Speed Circuit Motor Short to Battery
B1473	—	S	Wiper Low Speed Circuit Motor Failure
B1476	—	S	Wiper High Speed Circuit Motor Failure
B1840	C	S	Wiper Front Power Circuit Failure
B1398	C	S	Power Window LF One Touch Window Relay Circuit Failure
B1400	C	S	Power Window LF One Touch Window Relay Circuit Short to Battery
B1404	C	—	Power Window LF Down Circuit Open
B1405	—	S	Power Window LF Down Circuit Short to Battery
B1408	—	S	Power Window LF Up Circuit Short to Battery
B1410	C	S	Power Window LF Motor Circuit Failure
B1302	C	S	Accessory Delay Relay Coil Circuit Failure
B1304	C	S	Accessory Delay Relay Coil Circuit Short to Battery
B1475	C	S	Accessory Delay Relay Contact Short to Battery
P1802	C	—	Transmission Clutch Interlock Safety Switch Short Circuit to Battery
P1803	—	S	Transmission Clutch Interlock Safety Switch Short Circuit to Ground
P1804	C	S	4-Wheel Drive High Indicator Circuit Failure
P1806	C	S	4-Wheel Drive High Indicator Short Circuit to Battery
P1808	C	S	4-Wheel Drive Low Indicator Circuit Failure
P1810	C	S	4-Wheel Drive Low Indicator Short Circuit to Battery
P1812	C	S	4-Wheel Drive Mode Select Circuit Failure
P1815	C	S	4-Wheel Drive Mode Select Short Circuit to Ground
P1820	C	S	Transmission Transfer Case L2H Shift Relay Coil Circuit Failure
P1822	C	—	Transmission Transfer Case L2H Shift Relay Coil Short Circuit to Battery
P1824	C	S	4-Wheel Drive Clutch Relay Circuit Failure
P1826	C	—	4-Wheel Drive Low Clutch Relay Circuit to Battery
P1828	C	S	Transmission Transfer Case H2L Shift Relay Circuit Failure
P1830	C	—	Transmission Transfer Case H2L Shift Relay Short Circuit to Battery
P1833	C	S	Transmission Transfer Case Differential Lockup Solenoid Open Circuit
P1834	C	S	Transmission Transfer Case Differential Lockup Solenoid Short Circuit to Battery

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P1835	C	S	Transmission Transfer Case Differential Lockup Solenoid Short Circuit to Ground
P1836	C	—	Transmission Transfer Case Front Shaft Speed Sensor Circuit Failure
P1837	C	—	Transmission Transfer Case Rear Shaft Speed Sensor Circuit Failure
P1838	C	—	Transmission Transfer Case Shift Motor Circuit Failure
P1843	C	—	Transmission Transfer Case Differential Lockup Feedback Switch Open Circuit
P1844	C	—	Transmission Transfer Case Differential Lockup Feedback Switch Short Circuit to Battery
P1845	C	—	Transmission Transfer Case Differential Lockup Feedback Switch Short Circuit To Ground
P1846	C	—	Transmission Transfer Case Contact Plate "A" Circuit Failure
P1850	C	—	Transmission Transfer Case Contact Plate "B" Circuit Failure
P1854	C	—	Transmission Transfer Case Contact Plate "C" Circuit Failure
P1858	C	—	Transmission Transfer Case Contact Plate "D" Circuit Failure
P1863	C	S	Transmission Transfer Case Contact Plate Power Open Circuit
P1866	C	S	Transmission Transfer Case System Concern
P1867	C	—	Transmission Transfer Case Contact Plate General Circuit Failure
P1874	C	S	Transmission Automatic Hall Effect Sensor Power Circuit Failure
P1875	C	S	Transmission Automatic Hall Effect Sensor Power Circuit Short to Battery
P1879	C	S	Transmission Transfer Case Disengaged Solenoid Open Circuit
P1880	C	S	Transmission Transfer Case Disengaged Solenoid Short to Battery
P1885	C	S	Transmission Transfer Case Disengaged Solenoid Short to Ground
P1886	C	—	4x4 Initialization Failure
P0500	C	—	Vehicle Speed Sensor (VSS) Malfunction
B1483	C	—	Brake Pedal Input Circuit Failure
B1485	C	S	Brake Pedal Input Circuit Battery Short
B1352	C	S	Ignition Key-In Circuit Failure
B1355	—	S	Ignition Run Circuit Failure
B1359	C	S	Ignition Run/Acc Circuit Failure
B1365	C	S	Ignition Start Circuit Short to Battery
B1833	C	S	Door Unlock Disarm Switch Circuit Short to Ground
B1834	C	S	Door Unlock Disarm Output Circuit Failure
B1836	C	S	Door Unlock Disarm Output Circuit Short to Battery

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ALL = All modes
SELF = On-demand self-test mode
CONT = Continuous diagnostic mode
S and C = On-demand self-test and continuous diagnostic modes

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System Pre-Check — ISO 9141

NOTE: Before running Data Link Diagnostic Test, turn the ignition switch to RUN.

SYSTEM PRE-CHECK — ISO 9141

PC1 RUN THE DATA LINK DIAGNOSTICS TEST

- Run the DATA LINK DIAGNOSTICS Test.

Is the result displayed for CKT70 = SYSTEM PASSED?

Yes	No
GO to Inspection and Verification of the subsystem section related to the system failure.	GO to **PC2** .

PC2 CHECK FOR SYSTEM FAIL RESPONSE

Is the result displayed for CKT70 = 00000000F?

Yes	No
GO to Pinpoint Test F .	GO to **PC3** .

PC3 CHECK FOR NO RESPONSE/NOT EQUIPPED

Is the module of interest listed after the CKT70 result followed by: NO RESPONSE/NOT EQUIPPED?

Yes	No
GO to the Symptom Chart.	Test Passed.

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System Pre-Check — SCP (Circuits 914 and 915)

SYSTEM PRE-CHECK — SCP

SC1 RUN THE DATA LINK DIAGNOSTICS TEST

- Run the Data Link Diagnostic Test.

Are the results displayed for CKT914 = SYSTEM PASSED and for CKT915 = SYSTEM PASSED?

Yes	No
GO to Inspection and Verification of the subsystem section related to the system failure.	GO to **SC2** .

SC2 CHECK FOR SYSTEM FAIL RESPONSE

Are the results displayed for CKT914 = 00000001 or for CKT915 = 00000001?

Yes	No
GO to Pinpoint Test E .	GO to **SC3** .

SC3 CHECK FOR NO RESPONSE/NOT EQUIPPED

Is the module of interest listed after the CKT914 or CKT915 results followed by:
NO RESPONSE/NOT EQUIPPED
or NO RESPONSE ON CKT914 (BUS+)
or NO RESPONSE ON CKT915 (BUS-)?

Yes	No
GO to Pinpoint Test E .	Test passed.

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Symptom Chart

Symptom Chart

Condition	Possible Source	Action
• The Anti-Lock Brake System (ABS) Module Does Not Respond to the NGS	• Ignition switch not in RUN. • Communication circuit ISO (circuit 70).	• GO to Pinpoint Test A.
• The Generic Electronic Module (GEM) Does Not Respond to the NGS	• Ignition switch not in RUN. • Communication circuit ISO (circuit 70).	• GO to Pinpoint Test B.
• The Integrated Air Bag Diagnostic Monitor (IABM) Does Not Respond to the NGS	• Ignition switch not in RUN. • Communication circuit ISO (circuit 70).	• GO to Pinpoint Test C.
• The Remote Anti-Theft Personality (RAP) Module Does Not Respond to the NGS	• Ignition switch not in RUN. • Communication circuit ISO (circuit 70).	• GO to Pinpoint Test D.
• The Powertrain Control Module (PCM) Does Not Respond to the NGS	• Ignition switch not in RUN. • Communication circuit SCP (circuits 914, 915).	• GO to Pinpoint Test E.
• No Module/Network Communication on ISO 9141 Link Circuit	• Ignition switch not in RUN. • Communication circuit ISO (circuit 70).	• GO to Pinpoint Test F.

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Pinpoint Tests

Equipment: 12-volt test lamp or Rotunda 73 Digital Multimeter 105-R0051 and New Generation STAR (NGS) Tester 007-00500 or equivalent.

When necessary to trace and/or service the circuits, refer to the appropriate electrical schematics.

The following is a step-by-step process of elimination procedure that must be performed in sequence in its entirety in order to obtain reliable results. If a specific failure condition is known, you may refer instead to the Electrical and Vacuum Troubleshooting Manual to Wperform a quick check to determine cause and corrective action.

PINPOINT TEST A: THE ANTI-LOCK BRAKE SYSTEM (ABS) DOES NOT RESPOND TO THE NGS

NOTE: Before disconnecting or connecting a module, the ignition switch must be turned OFF.

A1 CHECK CIRCUIT 70 AT ABS CONNECTOR PIN 16

- Disconnect ABS connector.
- Inspect pin 16 (circuit 70) and the wire connection to the pin.

Are the pin and the wire connection OK?

Yes	No
GO to **A2** .	SERVICE the pin and/or the wire on the ABS connector. RESTORE connections and RUN the Data Link Diagnostic Test.

A2 CHECK CIRCUIT 70 BETWEEN THE DATA LINK CONNECTOR (DLC) AND THE 4WABS CONNECTOR

- Measure the resistance between the 4WABS connector pin 16 and the DLC connector pin 7.

Is the resistance 5 ohms or less?

Yes	No
REPLACE the ABS module. RESTORE the connections and RUN the Data Link Diagnostic Test.	GO to **A3** .

A3 CHECK HARNESS CONNECTOR C1

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- Disconnect harness connector C1.
- Inspect harness connector pin 16 (circuit 70) and the wire connection to the pin.

Are the pin and the wire connections on both sides of the harness connector OK?

Yes	No
GO to **A4** .	SERVICE pin and/or wire at harness connector. RESTORE the connections and RUN Data Link Diagnostic Test.

A4 CHECK CIRCUIT 70 BETWEEN THE ABS MODULE AND HARNESS CONNECTOR C1

- Measure the resistance between pin 16 of the ABS connector and male pin 16 of harness connector C1.

Is the resistance 5 ohms or less?

Yes	No
REPLACE circuit 70 between the harness connector C1 and the DLC connector. RESTORE the connections and RUN the Data Link Diagnostic Test.	REPLACE circuit 70 between the harness connector C1 and the ABS module. RESTORE the connections and RUN the Data Link Diagnostic Test.

PINPOINT TEST B: THE GENERIC ELECTRONIC MODULE (GEM) DOES NOT RESPOND TO THE NGS

NOTE: Before disconnecting or connecting a module, the ignition switch must be turned OFF.

B1 CHECK RESISTANCE BETWEEN DLC CONNECTOR AND GEM CONNECTOR

- Disconnect GEM connector.
- Measure resistance between GEM connector pin J1-25 and DLC connector pin 7.

Is the resistance 5 ohms or less?

Yes	No
GO to **B2** .	SERVICE circuit 70 for open between the GEM connector and DLC connector. RESTORE the connections and RUN Data Link Diagnostic Test.

B2 CHECK GEM CONNECTOR

- With GEM connector disconnected, inspect GEM connector pin J1-25 and the wire connection to the

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pin.

Are pin J1-25 on GEM connector and wire connection to the pin OK?

Yes	No
GO to **B3** .	SERVICE connector. RESTORE the connections and RUN Data Link Diagnostic Test.

B3 CHECK DLC CONNECTOR

- Inspect DLC connector pin 7.

Are pin connection and housing OK?

Yes	No
REPLACE GEM. RESTORE the connections and RUN Data Link Diagnostic Test.	SERVICE connector. RESTORE the connections and RUN Data Link Diagnostic Test.

PINPOINT TEST C: THE INTEGRATED AIR BAG DIAGNOSTIC MONITOR (IABM) DOES NOT RESPOND TO THE NGS

NOTE: Before disconnecting or connecting a module, the ignition switch must be turned OFF.

C1 CHECK CIRCUIT 70 BETWEEN THE DATA LINK CONNECTOR (DLC) AND THE IABM MODULE CONNECTOR

- Deactivate the air bag system; refer to Section 01-20B .
- Disconnect the IABM connector and measure the resistance between IABM connector pin 12 and DLC connector pin 7.

Is the resistance 5 ohms or less?

Yes	No
GO to **C2** .	SERVICE circuit 70 between the IABM connector and the DLC connector. RESTORE the connections. REACTIVATE the air bag system; refer to Section 01-20B . RUN the Data Link Diagnostic Test.

C2 CHECK THE IABM MODULE CONNECTOR

- With the IABM disconnected, inspect IABM connector pin 12 and the wire connections to the pin.

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Are the pin and the wire connections to the pin OK?

Yes	No
GO to **C3** .	SERVICE the connector. RESTORE the connections. REACTIVATE the air bag system; refer to Section 01-20B . RUN the Data Link Diagnostic Test.

C3 CHECK THE DLC CONNECTOR

- Inspect DLC pin 7.

Are pin 7 and the wire leading to the pin OK?

Yes	No
REPLACE the IABM. RESTORE the connections. REACTIVATE the air bag system; refer to Section 01-20B . RUN the Data Link Diagnostic Test.	SERVICE the connector. RESTORE the connections. REACTIVATE the air bag system; refer to Section 01-20B . RUN the Data Link Diagnostic Test.

PINPOINT TEST D: THE REMOTE ANTI-THEFT PERSONALITY (RAP) MODULE DOES NOT RESPOND TO THE NGS

NOTE: Before disconnecting or connecting a module, the ignition switch must be turned OFF.

D1 CHECK RAP CONNECTOR PIN A-3

- Disconnect the RAP connector.
- Inspect pin A-3 (circuit 70) and the wire connections to the pin.

Are the pin and the wire connections OK?

Yes	No
GO to **D2** .	SERVICE the pin and/or the wire at the RAP connector. RESTORE the connections and RUN Data Link Diagnostic Test.

D2 CHECK CIRCUIT 70 BETWEEN THE DLC CONNECTOR AND THE RAP CONNECTOR

- Measure resistance between the RAP connector pin A-3 and the DLC connector pin 7.

Is the resistance 5 ohms or less?

Yes	No

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REPLACE RAP module. RESTORE the connections and RUN Data Link Diagnostic Test.	GO to D3 .

D3 CHECK HARNESS CONNECTOR C2

- Disconnect the harness connector C2.
- Inspect pin 51 and the wire connections to the pin.

Are the pin and the wire connections on both halves of the harness connector OK?

Yes	No
GO to D4 .	SERVICE the pin and/or the wire at harness connector. RESTORE the connections and RUN the Data Link Diagnostic Test.

D4 CHECK CIRCUIT 70 BETWEEN RAP MODULE TO HARNESS CONNECTOR C2

- Measure the resistance between pin A-3 of the RAP connector and male pin 51 of the harness connector C2.

Is the resistance 5 ohms or less?

Yes	No
REPLACE circuit 70 between the harness connector C2 and the DLC. RESTORE the connections and RUN the Data Link Diagnostic Test.	REPLACE circuit 70 between the harness connector C2 and the RAP module. RESTORE the connections and RUN the Data Link Diagnostic Test.

PINPOINT TEST E: THE POWERTRAIN CONTROL MODULE (PCM) DOES NOT RESPOND TO THE NGS

NOTE: Before disconnecting or connecting a module, the ignition switch must be turned OFF.

E1 CHECK FOR CIRCUIT CONCERN

Was fault code 0001 retrieved for circuit 914?

Yes	No
GO to E2 .	GO to E10 .

E2 CHECK HARNESS CONNECTOR C3 (CIRCUIT 914)

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- Disconnect harness connector C3.
- Inspect pin 16 and the wire connections to the pin.

Are the pin and wire connections on both halves of the harness connector OK?

Yes	No
GO to **E3** .	SERVICE pin and/or wire at harness connector. RESTORE the connections and RUN Data Link Diagnostic Test.

E3 CHECK CIRCUIT 914 BETWEEN DLC CONNECTOR AND HARNESS CONNECTOR C3

- Measure resistance between DLC connector pin 2 and harness connector C3 female pin 26.

Is the resistance 5 ohms or less?

Yes	No
GO to **E4** .	REPLACE circuit 914 and circuit 915 between DLC and harness connector. RESTORE the connections and RUN Data Link Diagnostic Test.

E4 CHECK PCM CONNECTOR PIN 16 (CIRCUIT 914)

- Disconnect PCM connector from PCM.
- Inspect pin 16 (circuit 914) and the wire connections to the pin.

Are the pin and wire connections OK?

Yes	No
GO to **E5** .	SERVICE pin and/or wire at PCM connector. RESTORE the connections and RUN Data Link Diagnostic Test.

E5 CHECK CIRCUIT 914 TO HARNESS CONNECTOR C3

- Measure the resistance between PCM connector pin 16 and harness connector C3 pin 26.

Is the resistance 5 ohms or less?

Yes	No
GO to **E6** .	REPLACE circuit 914 and circuit 915 between harness connector C3 and PCM. RESTORE the connections and RUN Data Link Diagnostic Test.

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E6 CHECK FOR SHORT TO GROUND

- With the PCM disconnected, connect harness connector C3.
- Measure the voltage between DLC connector pin 2 and pin 4.

Is the voltage 0 volts?

Yes	No
GO to **E8** .	GO to **E7** .

E7 CHECK FOR SHORT TO BATTERY

- Measure the voltage between DLC connector pin 2 and pin 16.

Is the voltage 0 volts?

Yes	No
GO to **E9** .	REPLACE PCM. RESTORE the connections and RUN Data Link Diagnostic Test.

E8 CHECK FOR SHORT TO GROUND AT HARNESS CONNECTOR C3

- Disconnect harness connector C3.
- Measure voltage between DLC connector pin 2 and pin 4.

Is the voltage 0 volts?

Yes	No
REPLACE circuit 914 and circuit 915 between DLC connector and harness connector C3. RESTORE the connections and RUN Data Link Diagnostic Test.	REPLACE circuit 914 and circuit 915 between harness connector C3 and PCM. RESTORE the connections and RUN Data Link Diagnostic Test.

E9 CHECK FOR SHORT TO BATTERY AT HARNESS CONNECTOR C3

- Disconnect harness connector C3.
- Measure voltage between DLC connector pin 2 and pin 16.

Is the voltage 0 volts?

Yes	No
REPLACE circuit 914 and circuit 915 between DLC connector and harness connector C3. RESTORE the connections and RUN Data LInk Diagnostic Test.	REPLACE circuit 914 and circuit 915 between harness connector C3 and PCM. RESTORE the connections and RUN Data Link Diagnostic Test.

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E10 CHECK HARNESS CONNECTOR C3 (CIRCUIT 915)

- Disconnect harness connector C3.
- Inspect pin 7 (circuit 915) and wire connections to the pin.

Are the pin and the wire connections on both halves OK?

Yes	No
GO to **E11** .	SERVICE pin and/or wire at harness connector. RESTORE the connections and RUN Data Link Diagnostic Test.

E11 CHECK RESISTANCE BETWEEN DLC AND HARNESS CONNECTOR C3

- Measure resistance between DLC connector pin 10 and the harness connector C3 pin 33.

Is the resistance 5 ohms or less?

Yes	No
GO to **E12** .	REPLACE circuit 914 and circuit 915 between DLC and harness connector C3. RESTORE the connections and RUN Data Link Diagnostic Test.

E12 CHECK PCM CONNECTOR PIN 15 (CIRCUIT 915)

- Disconnect PCM connector from PCM.
- Inspect pin 15 (circuit 915) and the wire connection to the pin.

Are the pin and the wire connections OK?

Yes	No
GO to **E13** .	SERVICE the pin and/or wire at PCM connector. RESTORE the connections and RUN Data Link Diagnostic Test.

E13 CHECK RESISTANCE BETWEEN PCM AND HARNESS CONNECTOR C3

- Measure resistance between PCM connector pin 15 and harness connector C3 pin 33.

Is resistance 5 ohms or less?

Yes	No

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GO to **E14** .	REPLACE circuit 914 and circuit 915 between C3 and the PCM connector.

E14 CHECK FOR SHORT TO GROUND

- With the PCM disconnected, connect harness connector C3.
- Measure the voltage between DLC connector pin 10 and pin 4.

Is the voltage 0 volts?

Yes	No
GO to **E16** .	GO to **E15** .

E15 CHECK FOR SHORT TO BATTERY

- Measure the voltage between DLC connector pin 10 and pin 16.

Is the voltage 0 volts?

Yes	No
GO to **E17** .	REPLACE PCM. RESTORE the connections and RUN Data Link Diagnostic Test.

E16 CHECK FOR SHORT TO GROUND AT HARNESS CONNECTOR C3

- Disconnect harness connector C3.
- Measure voltage between DLC connector pin 10 and pin 4.

Is the voltage 0 volts?

Yes	No
REPLACE circuit 914 and circuit 915 between DLC connector and harness connector C3. RESTORE the connections and RUN Data Link Diagnostic Test.	REPLACE circuit 914 and circuit 915 between harness connector C3 and PCM. RESTORE the connections and RUN Data Link Diagnostic Test.

E17 CHECK FOR SHORT TO BATTERY AT HARNESS CONNECTOR C3

- Disconnect harness connector C3.
- Measure voltage between DLC connector pin 10 and pin 16.

Is the voltage 0 volts?

Yes	No

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REPLACE circuit 914 and circuit 915 between DLC connector and harness connector C3. RESTORE the connections and RUN Data Link Diagnostic Test.	REPLACE circuit 914 and circuit 915 between harness connector C3 and PCM. RESTORE the connections and RUN Data Link Diagnostic Test.

PINPOINT TEST F: NO MODULE/NETWORK COMMUNICATION ON ISO 9141 LINK CIRCUIT

NOTE: Before disconnecting or connecting a module, the ignition switch must be turned OFF.

F1 CHECK THE DATA LINK CONNECTOR (DLC)

- Turn the ignition switch to the OFF position.
- Inspect DLC connector pin 7 and wire connections to the pin.

Are the pin and wire connections to the pin OK?

Yes	No
GO to **F2** .	SERVICE the connector and RUN the Data Link Diagnostic Test.

F2 CHECK CIRCUIT 70 FOR OPEN

- Deactivate the air bag system; refer to Section 01-20B .
- Disconnect the IABM connector.
- Measure the resistance between DLC pin 7 and IABM connector pin 12.

Is the resistance 5 ohms or less?

Yes	No
GO to **F3** .	SERVICE circuit 70 for open between the IABM connector and the DLC connector. RESTORE the connections and REACTIVATE air bag system; refer to Section 01-20B . RUN the Data Link Diagnostic Test.

F3 CHECK FOR SHORT AT IABM

- With the IABM connector disconnected, turn the ignition switch to RUN position and run the Data Link Diagnostic Test.

Is the fault code 0000000F displayed?

Yes	No

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GO to **F4** .	REPLACE IABM. REACTIVATE air bag system; refer to Section 01-20B . RESTORE the connections and RUN the Data Link Diagnostic Test.

F4 CHECK FOR SHORT TO GROUND

- Measure the voltage between DLC pin 7 and DLC pin 4.

Is the voltage 0 volts?

Yes	No
GO to **F6** .	GO to **F5** .

F5 CHECK FOR SHORT TO BATTERY

- Measure the voltage between DLC pin 7 and DLC pin 16.

Is the voltage 0 volts?

Yes	No
GO to **F6** .	CHECK New Generation STAR Tester operation.

F6 CHECK FOR SHORT AT HARNESS CONNECTOR C1

- Disconnect the harness connector and run the Data Link Diagnostic Test.

Is fault code 0000000F retrieved?

Yes	No
GO to **F8** .	GO to **F7** .

F7 CHECK FOR SHORT AT 4WABS

- Connect harness connector C1 and disconnect the ABS connector.
- Run the Data Link Diagnostic Test.

Is fault code 0000000F retrieved?

Yes	No
SERVICE circuit 70 between ABS connector and harness connector C1. RESTORE the connections and RUN the Data Link Diagnostic	REPLACE the ABS module. RESTORE the connections and RUN the Data Link Diagnostic

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Test.	Test.

F8 CHECK IF THE VEHICLE IS EQUIPPED WITH A RAP MODULE

Is the vehicle equipped with a RAP module?

Yes	No
GO to **F9** .	GO to **F11** .

F9 CHECK FOR SHORT AT HARNESS CONNECTOR C2

- Disconnect harness connector C2.
- Run Data Link Diagnostic Test.

Is fault code 0000000F retrieved?

Yes	No
GO to **F11** .	GO to **F10** .

F10 CHECK FOR SHORT AT RAP MODULE

- Connect harness connector C2 and disconnect the RAP connector.
- Run the Data Link Diagnostic Test.

Is fault code 0000000F retrieved?

Yes	No
SERVICE circuit 70 between RAP connector and harness connector C2. RESTORE the connections and RUN Data Link Diagnostic Test.	REPLACE RAP module. RESTORE the connections and RUN Data Link Diagnostic Test.

F11 CHECK IF THE VEHICLE IS EQUIPPED WITH A GEM

Is the vehicle equipped with a GEM?

Yes	No
GO to **F12** .	CHECK for short to power/ground in harness 14401, circuit 70.

F12 CHECK FOR SHORT AT GEM MODULE

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- Disconnect GEM connector.
- Run the Data Link Diagnostic Test.

Is fault code 0000000F retrieved?

Yes	No
CHECK for short to power/ground in harness 14401, circuit 70.	REPLACE GEM. RESTORE the connections and RUN Data Link Diagnostic Test.

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Communication Circuit Wiring Repair

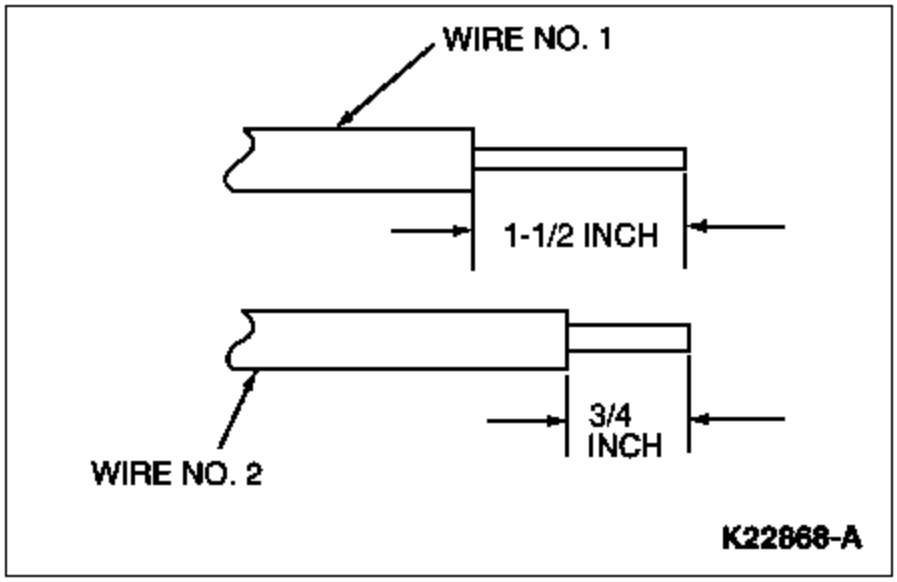
The following procedure is to be used to service both the twisted pair wiring and single wire communication circuits.

Durability of a wire splice is dependent on getting a joint that does not oxidize. Soldering is effective in keeping the air (oxide) out of the joint electronic circuits. Very high current circuits may fail because of oxidized joints that are not visible with the naked eye.

Durability of a splice is also dependent on keeping the moisture out of the joint. Heat shrink tubing alone won't do it. The tubing must contain a "hot melt wax" which is squeezed from the ends (both ends) of the tubing during heating and forms an adhesive seal between the wire insulation and the tube.

NOTE: Use a heat gun only. Do not use a hair dryer or any type of flame to heat the shrink tubing.

1. Correctly strip the wire.



2. **NOTE: Install heat shrink tubing first.**

   Twist and solder the wire. Use resin core mildly activated (RMA) solder. Do not use acid core solder.

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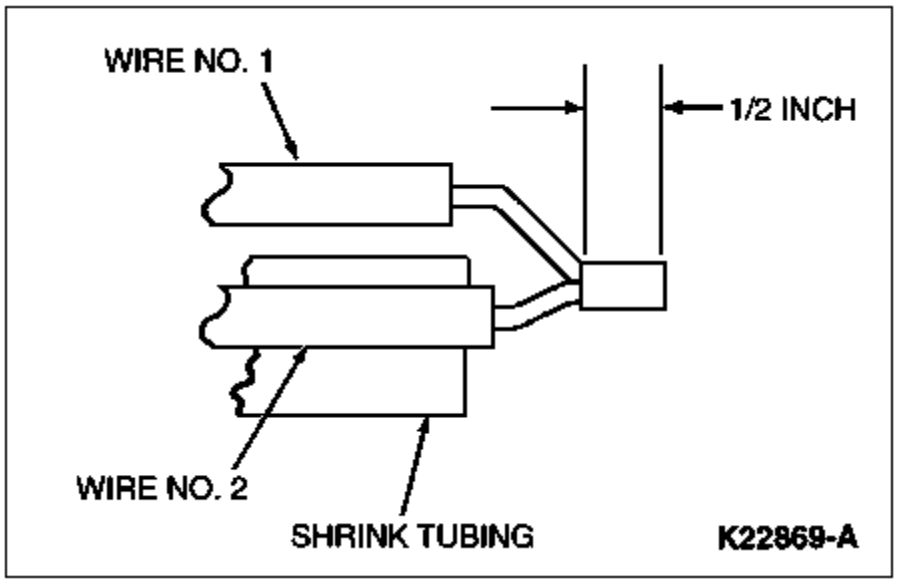
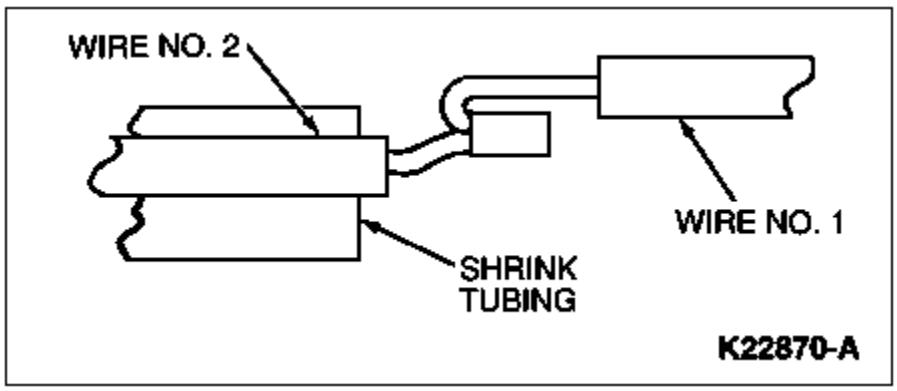


3. Form (bend) the circuit into shape for sealing.



4. Reposition shrink tubing over splice.

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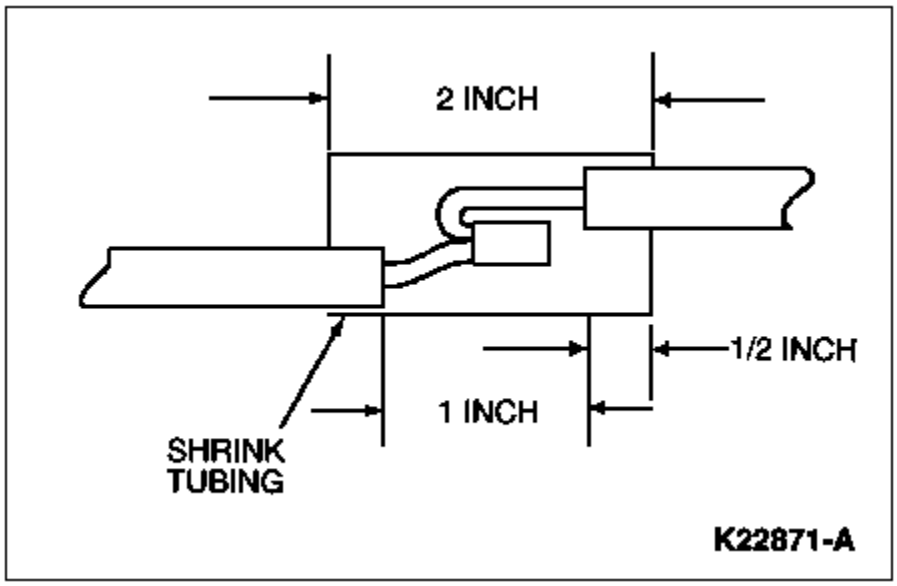
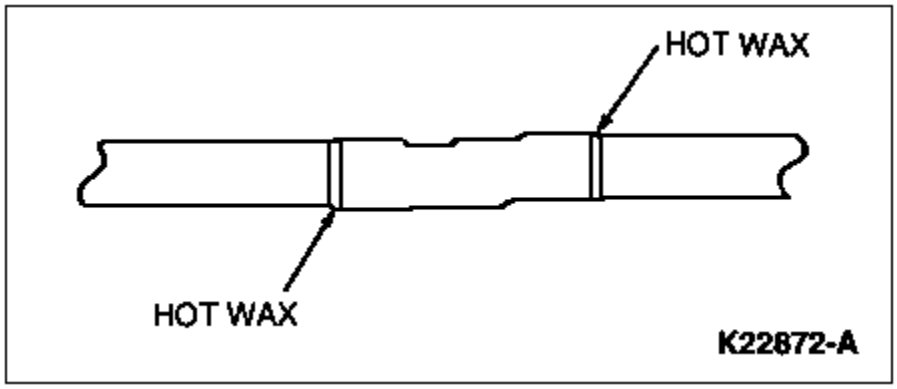


5. Use Rotunda Heat Gun, 107-R0301 or equivalent to heat the entire length of the shrink tubing until the hot wax comes out of both ends. When the hot wax flows out of both ends, remove heat.



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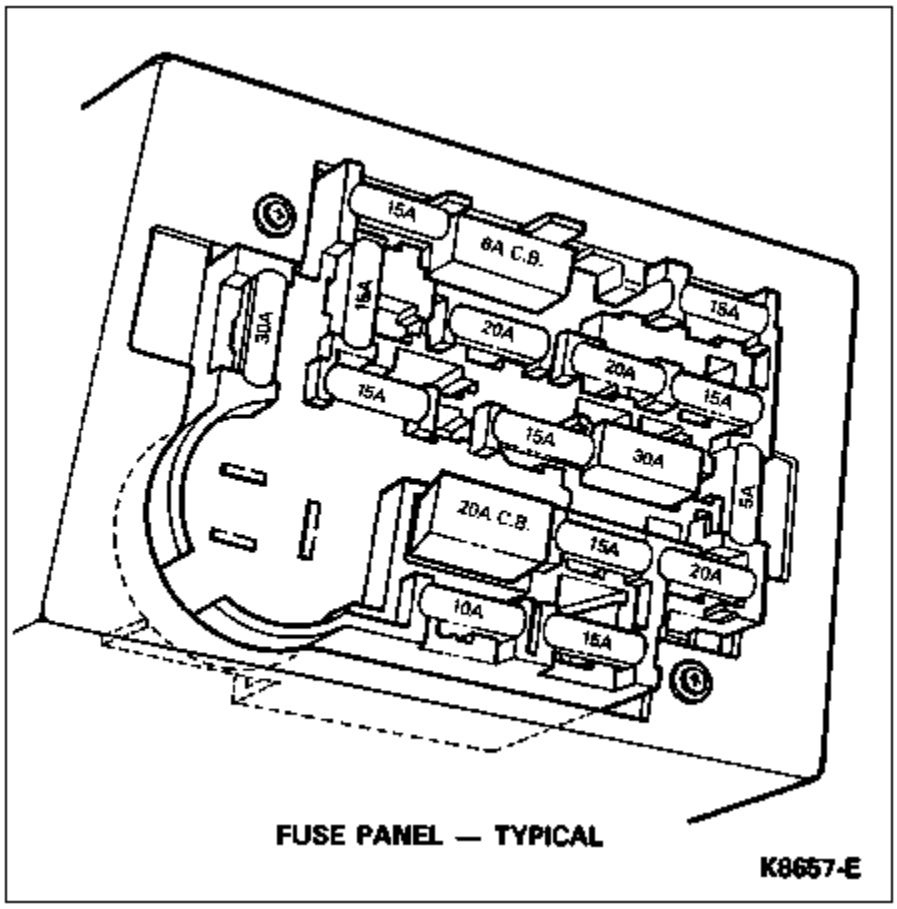
Electrical Power Supply

For convenience purposes most of the replaceable fuses for the electrical system are located on the fuse panel under the instrument panel to the left of the steering column tube (3514) on the Aerostar, and on the left end of the instrument panel (04320) on Ranger.

Fuse Junction Panel, Aerostar

The fuse panel is located under the instrument panel to the left of the steering column tube (3514). Remove the fuse panel cover (14A003) by pushing on the center of the fuse panel cover while pulling one of the two end tabs.

A 4.5-amp circuit breaker is located on the fuse block bracket for the liftgate wiper on Aerostar. A 30 amp fuse is taped to the harness, near the fuse block bracket for the power locks.



FUSE PANEL — TYPICAL

K8657-E

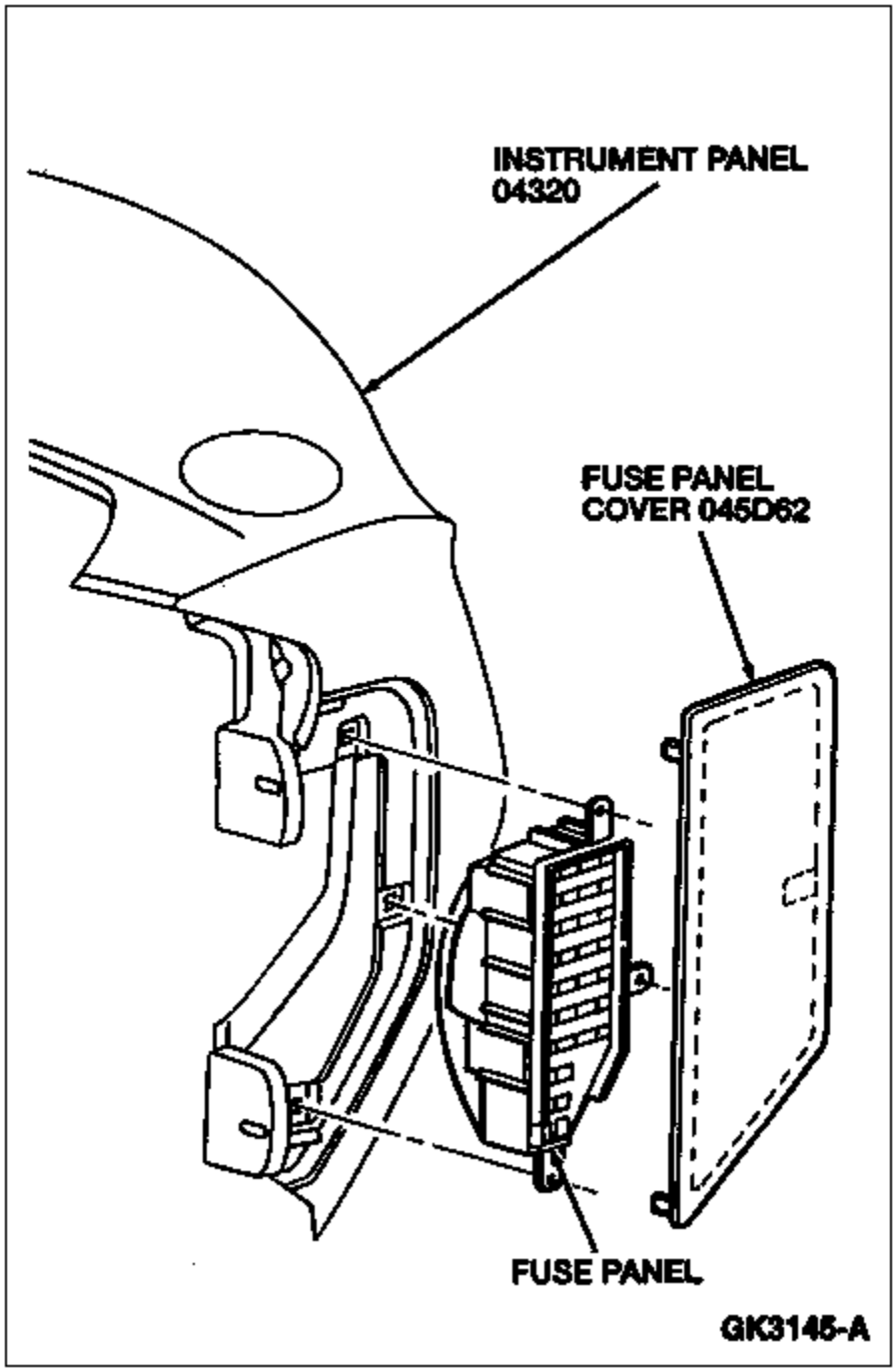
Fuse Junction Panel, Ranger

The fuse panel is located on the left end of the instrument panel (04320).

A power distribution box is located under the hood (16612) and over the front fender apron (16055).

Remove the instrument panel fuse door (045D62) by placing a finger in the indentation provided and pull the instrument panel fuse door away from the instrument panel.

Ranger


INSTRUMENT PANEL
04320
FUSE PANEL
COVER 045D62
FUSE PANEL
GK3145-A

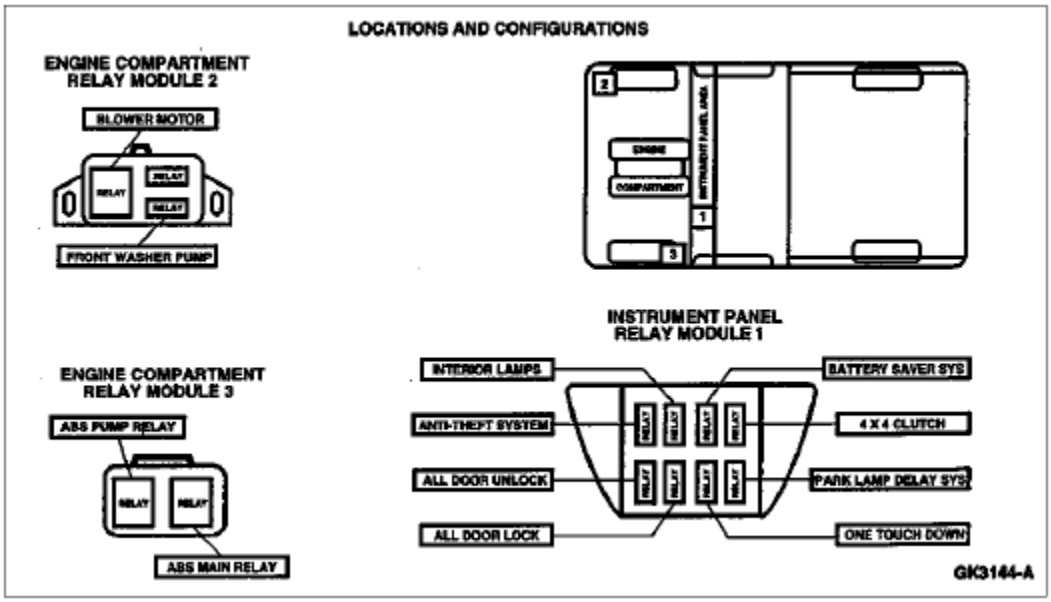
Fuse Links

The fuse link is a short length of special, Hypalon (high temperature) insulated wire, integral with the engine compartment wiring harness, and should not be confused with standard wire. It is several wire gauges smaller than the circuit which it protects. Under no circumstances should a fuse link replacement repair be made using a length of standard wire cut from bulk stock or from another wiring harness.

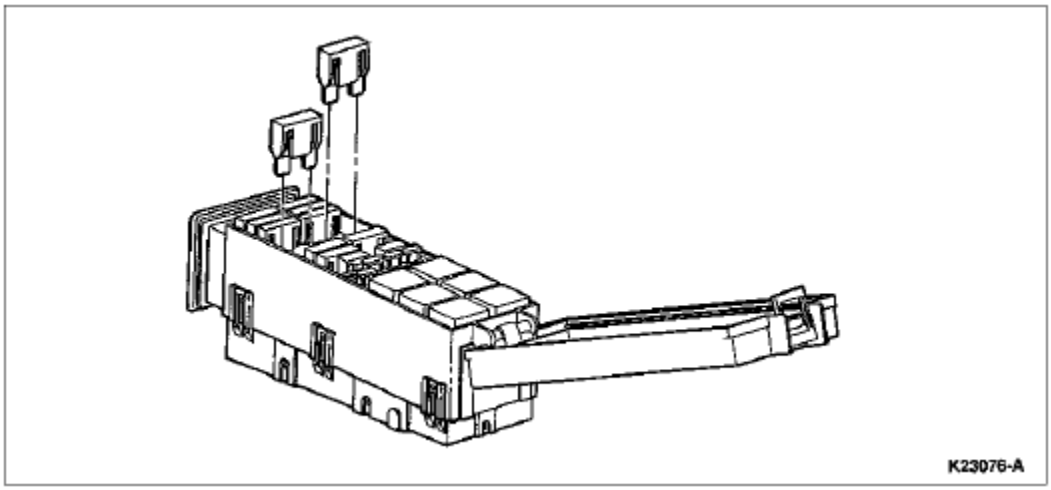
The higher melting temperature properties and additional thickness of the Hypalon insulation will usually allow the undersized internal fuse wire to melt and disintegrate within the Hypalon casing with little damage to the high temperature insulation other than discoloration or bubbling of the insulation surface. In extreme cases of excessive circuit current the insulation may separate after the fuse wire has disintegrated. However, the bare wire will seldom be exposed. When it becomes difficult to determine if the fuse link is burnt open, perform a continuity test. When heavy current flows, such as when a booster battery is connected incorrectly or when a short to ground occurs in the wiring harness, the fuse link burns out and protects the generator (GEN) (10300) or wiring.

Fuse Panel

Relay Modules — Ranger (High Content Models)



Fuse Panel, Engine Compartment — Ranger, Typical



Fuses and Circuit Breakers

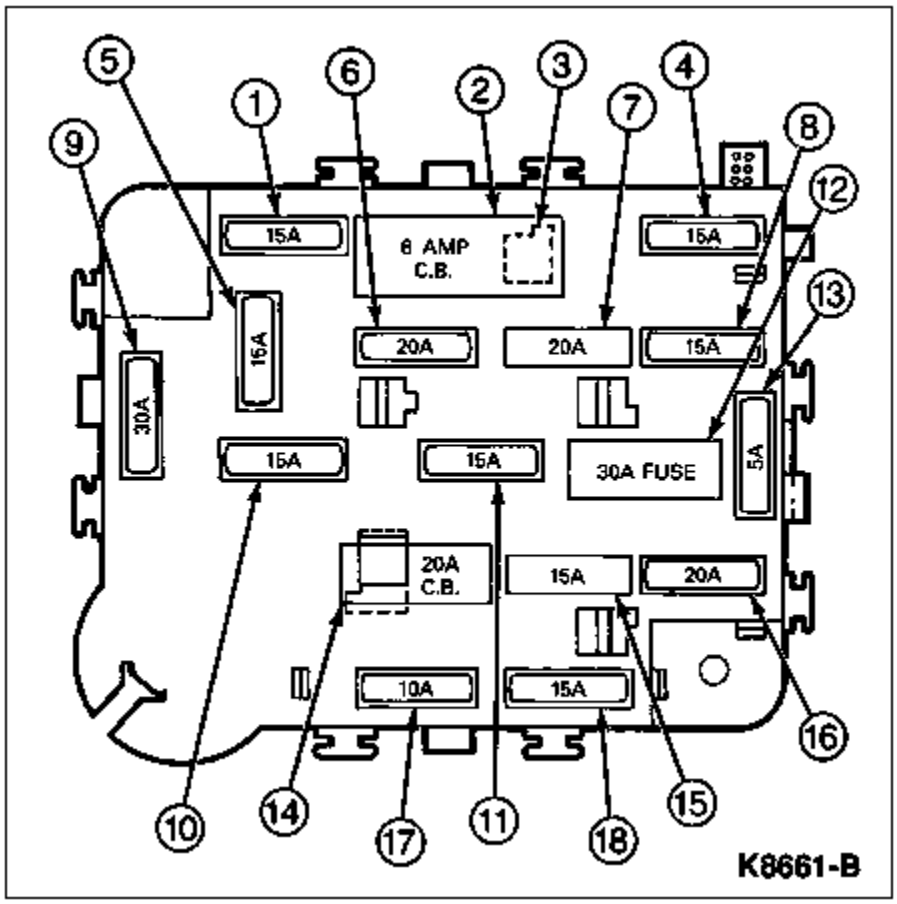
WARNING: ALWAYS REPLACE A BLOWN FUSE OR FUSE LINK WITH THE SAME RATING AS SPECIFIED. NEVER REPLACE WITH A HIGHER AMPERAGE RATING BECAUSE SEVERE WIRING DAMAGE AND POSSIBLE FIRE CAN RESULT.

The following illustrations show the locations of fuses and circuit breakers.

Indicator Flasher Location

The turn signal hazard flasher is located on the front of the fuse panel on the Aerostar. The Ranger uses the same flasher for both turn signal and hazard indicator operation. It is located behind the instrument panel steering column cover (04459) on the left side of the steering column.

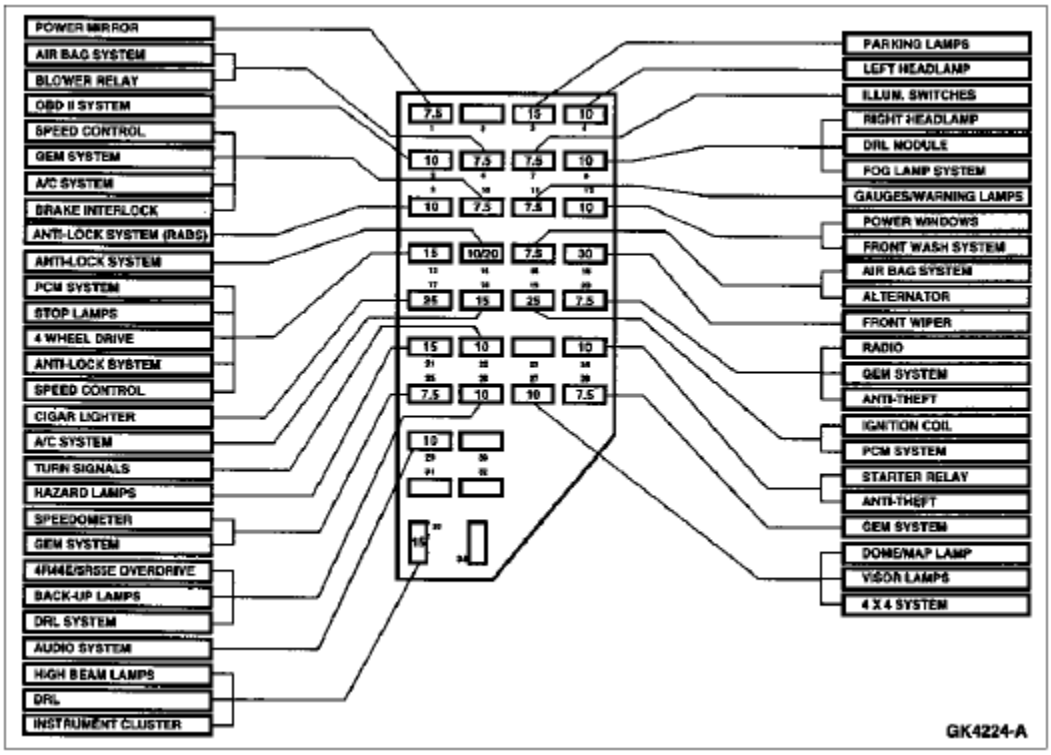
Fuse Panel — Aerostar



AEROSTAR FUSE PANEL

Fuse Position	Amps	Circuits Protected
1	15 Amp Fuse	Hazard Flasher, Stoplamps, Indicator Lamps, Speed Control, Brake Shift Interlock
2	6.0 Amp C.B.	Windshield Wiper/Washer
3	—	Not Used
4	15 Amp Fuse	Side Marker Lamps, Headlamp On Warning Chime, Daytime Running Lamps (DRL), Parking Lamps, License Lamps, Instrument Panel Illumination, RABS "Keep Alive"
5	15 Amp Fuse	Turn Signal Flasher, Air Bag Module, Backup Lamps, DRL Module, Rear Defroster Switch, Turn Signal Indicator, Brake Shift Interlock
6	20 Amp Fuse	Speed Control Amplifier, A/C Clutch, Door Ajar Relay, Illuminated Entry
7	20 Amp Fuse	Rear Anti-Lock Brake System (RABS) Module
8	15 Amp Fuse	Illuminated Entry, Stepwell Lamp, Cargo Lamp, Power Mirrors, Courtesy Lamp, PSOM, Clock, Visor Vanity Lamps, I/P Courtesy Lamps, Dome Lamp, Reading Lamps
9	30 Amp Fuse	Aux. A/C, Front A/C Blower Motor
10	15 Amp Fuse	Air Bag Module
11	15 Amp Fuse	Radio, Amplifier
12	30 Amp Fuse	Flash to Pass, High Beam Indicator, Horns
13	5 Amp Fuse	Instrument and Control Illumination
14	20 Amp C.B.	Power Window Motors
15	15 Amp Fuse	A.W.D. Module and Indicator
16	20 Amp Fuse	Front Cigar Lighter, Rear Cigar Lighter
17	10 Amp Fuse	PSOM
18	15 Amp Fuse	Warning Chime, Instrument Cluster, Rear Wiper Motor, Rear Washer Pump
Fuse Block Bracket	4.5 Amp C.B.	Rear Wiper Motor, Rear Washer Pump
Fuse Block Bracket	30 Amp Fuse	Power Door Locks

Fuse Panel — Ranger

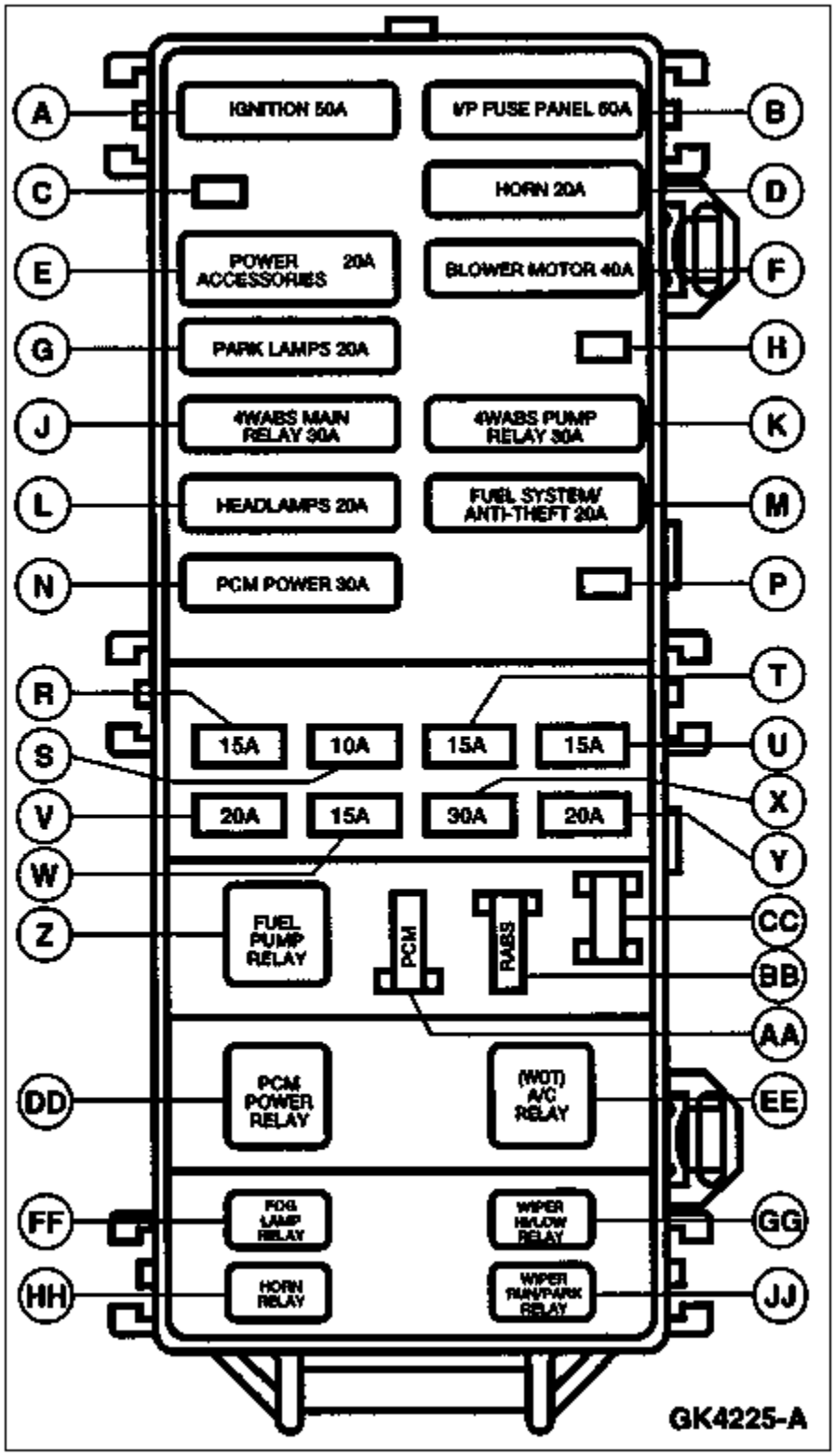


RANGER FUSE PANEL

Fuse Position	Rating	Circuit Protected
1	7.5 Amp	Power Mirror
2	—	Not Used
3	15 Amp	Parking Lamps
4	10 Amp	Left Headlamp
5	10 Amp	On Board Diagnostic (OBD) II System
6	7.5 Amp	Air Bag System/Blower Relay
7	7.5 Amp	Illumination Switches
8	10 Amp	Right Headlamp/Fog Lamp System/DRL Module
9	10 Amp	ABS System (RABS)
10	7.5 Amp	Speed Control/GEM System/Brake Interlock/IC
11	7.5 Amp	Warning Lamps/Gauges
12	10 Amp	Front Washer System/Power Windows
13	15 Amp	PCM System/Stoplamps/ 4WD/ABS/Speed Control
14	10/20 Amp	ABS System
15	7.5 Amp	Air Bag System/Alternator
16	30 Amp	Front Wiper
17	25 Amp	Cigar Lighter

18	15 Amp	A/C System
19	25 Amp	Ignition Coil/PCM System
20	7.5 Amp	Radio/GEM System/Anti-Theft
21	15 Amp	Hazard Lamps
22	10 Amp	Turn Signals
23	—	Not Used
24	10 Amp	Starter Relay/Anti-Theft
25	7.5 Amp	Speedometer/GEM System
26	10 Amp	4R44E/5R55E Trans./Backup Lamps/DRL System
27	10 Amp	Lamp/Dome Lamp/Visor Lamps/4x4 Sys.
28	7.5 Amp	GEM System
29	10 Amp	Audio System
30	—	Not Used
31	—	Not Used
32	—	Not Used
33	15 Amp	High Beam Lamps/DRL/Instrument Cluster
34	—	Not Used

Power Distribution Box — Ranger

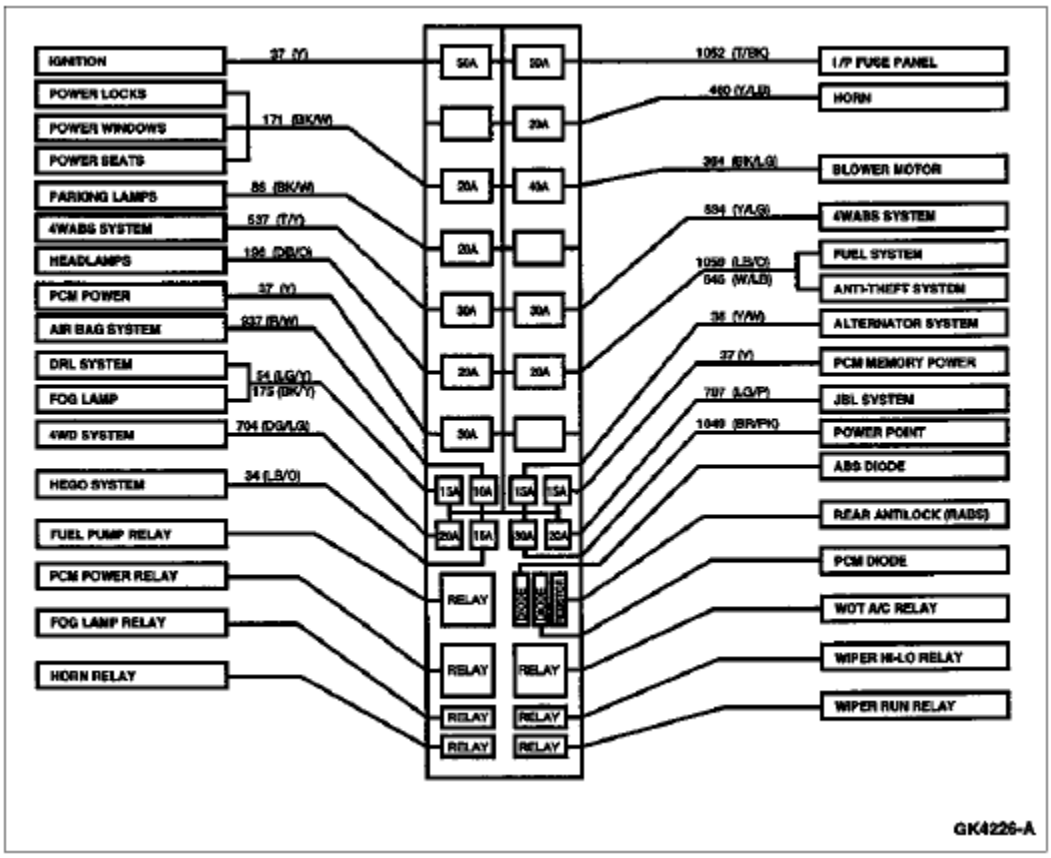


RANGER POWER DISTRIBUTION BOX

Fuse Position	Rating	Color	Circuit Protected
A	50 Amp	Red	Ignition

B	50 Amp	Red	Instrument Panel (I/P) Fuse Panel
C	—	—	Not Used
D	20 Amp	Yellow	Horn
E	20 Amp	—	Power Windows/ Seats/ Door Locks
F	40 Amp	Orange	Blower Motor
G	20 Amp	Yellow	Parking Lamps
H	—	—	Not Used
J	30 Amp	Green	4WABS System Main Relay
K	30 Amp	Green	4WABS System Pump Relay
L	20 Amp	Yellow	Headlamps
M	20 Amp	Yellow	Fuel System/Anti-Theft System
N	30 Amp	Green	PCM Power
P	—	—	Not Used
R	15 Amp	Blue	Daylight Running Lamps (DRL)/Fog Lamps
S	10 Amp	Red	Air Bag System
T	15 Amp	Blue	Alternator
U	15A	Blue	PCM Memory Power
V	20 Amp	Yellow	4WD System
W	15 Amp	Blue	PCM HO2S System
X	30 Amp	Green	Power Point
Y	20 Amp	Yellow	JBL System
Z	Relay	—	Fuel Pump
AA	Diode	—	PCM
BB	Diode	—	Rear ABS (RABS) Diode
CC	Resistor	—	RABS/Low Fluid
DD	Relay	—	PCM Power
EE	Relay	—	WOT A/C
FF	Relay	—	Fog Lamp
GG	Relay	—	Wiper Hi-Low
HH	Relay	—	Horn
JJ	Relay	—	Wiper Run/Park

Power Distribution Box Configuration — Ranger


IGNITION
POWER LOCKS
POWER WINDOWS
POWER SEATS
PARKING LAMPS
4WABS SYSTEM
HEADLAMPS
PCM POWER
AIR BAG SYSTEM
DRL SYSTEM
FOG LAMP
4WD SYSTEM
HEGO SYSTEM
FUEL PUMP RELAY
PCM POWER RELAY
FOG LAMP RELAY
HORN RELAY
37 (Y)
171 (BK/W)
86 (BK/W)
537 (T/Y)
196 (DB/O)
37 (Y)
937 (B/W)
54 (LG/Y)
175 (BK/Y)
704 (DG/LG)
34 (LB/O)
50A
20A
20A
20A
30A
20A
30A
15A
15A
15A
15A
20A
15A
30A
20A
RELAY
DIODE
DIODE
DIODE
RELAY
RELAY
RELAY
RELAY
RELAY
RELAY
1052 (T/BK)
460 (Y/LB)
394 (BK/LG)
594 (Y/LG)
1059 (LB/O)
645 (W/LB)
36 (Y/W)
37 (Y)
787 (LG/P)
1049 (BR/PK)
I/P FUSE PANEL
HORN
BLOWER MOTOR
4WABS SYSTEM
FUEL SYSTEM
ANTI-THEFT SYSTEM
ALTERNATOR SYSTEM
PCM MEMORY POWER
JBL SYSTEM
POWER POINT
ABS DIODE
REAR ANTILOCK (RABS)
PCM DIODE
WOT A/C RELAY
WIPER HI-LO RELAY
WIPER RUN RELAY
GK4226-A

Trailer Towing Package Wiring

Vehicles equipped with the trailer towing package have the following additions to support the trailer wiring:

- On Aerostar, two relays are located behind the left rear quarter trim panel, in the trailer tow relay module. Aerostar also has four fuses in the trailer tow relay module. The connectors on the trailer tow extension wiring harness are located behind the middle of the rear frame crossmember.
- The trailer feed wiring (13A576) is supplied with the vehicle and installed by the customer.
- The Aerostar is equipped with a backup lamp relay for trailers equipped with backup lamps.

Trailer Wiring Relays

Aerostar

The trailer tow relays are located in the trailer tow relay module, behind the left rear quarter trim panel, and mounted just below the rear lamp wiring (14405) harness.

The trailer feed wiring connects to the trailer tow extension wiring connectors located behind the rear frame crossmember. The trailer tow extension wiring enters the rear of the luggage compartment through a grommet in the floor pan and connects to the rear lamp wiring. The trailer tow extension wiring has the trailer tow relay module on it.

A connector end matching the trailer to be towed is to be installed on the end of the trailer feed wiring. This installation should be done by an authorized camper/trailer repair center.

The trailer end of the trailer feed wiring has the following feeds for trailer wiring:

Wire Color	Circuit Number	Circuit Description
BR	14	Trailer Park Lamps
BK	57	Trailer Ground
O/LB	5	Trailer Turn Signal, Stoplamps and Hazard Lamps (RH)
LG/O	9	Trailer Turn Signal, Stoplamps and Hazard Lamps (LH)
BK/PK	140	Backup Lamps

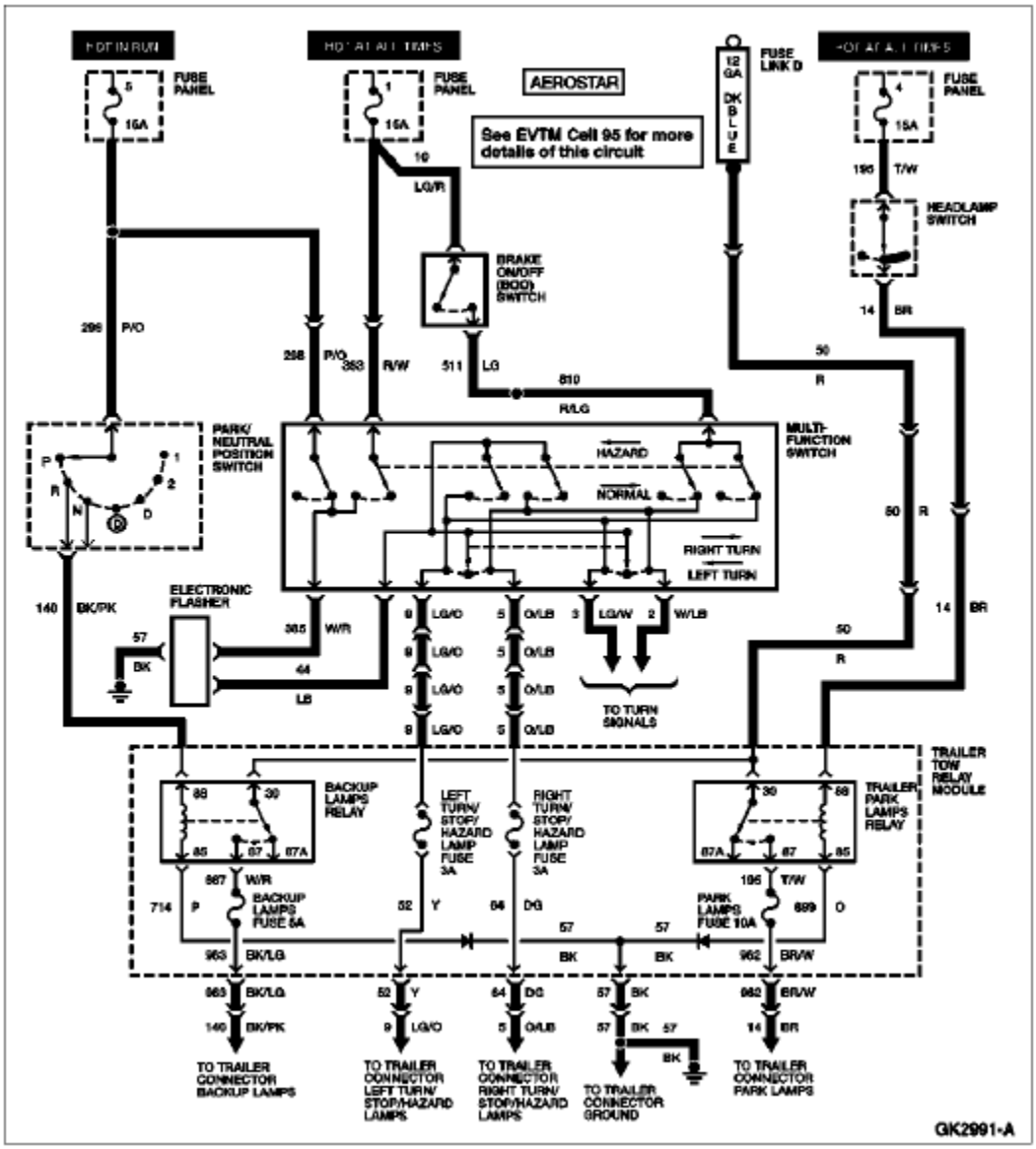
Wire Color Code

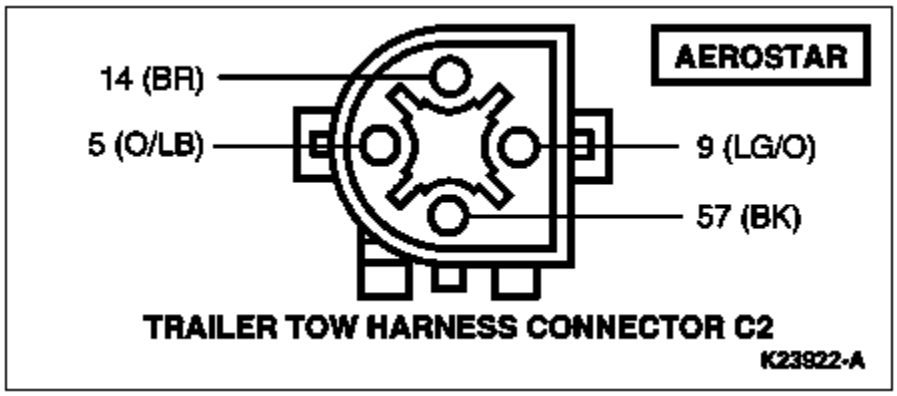
NOTE: Whenever a wire is labeled with two colors, the first color listed is the basic color of the wire, and the second color listed is the stripe marking of the wire.

Code	Color	Code	Color
BL	Blue	N	Natural
BK	Black	O	Orange
BR	Brown	PK	Pink
DB	Dark Blue	P	Purple
DG	Dark Green	R	Red
GN	Green	T	Tan
GY	Gray	W	White
LB	Light Blue	Y	Yellow
LG	Light Green		

Wiring and Circuit Protection

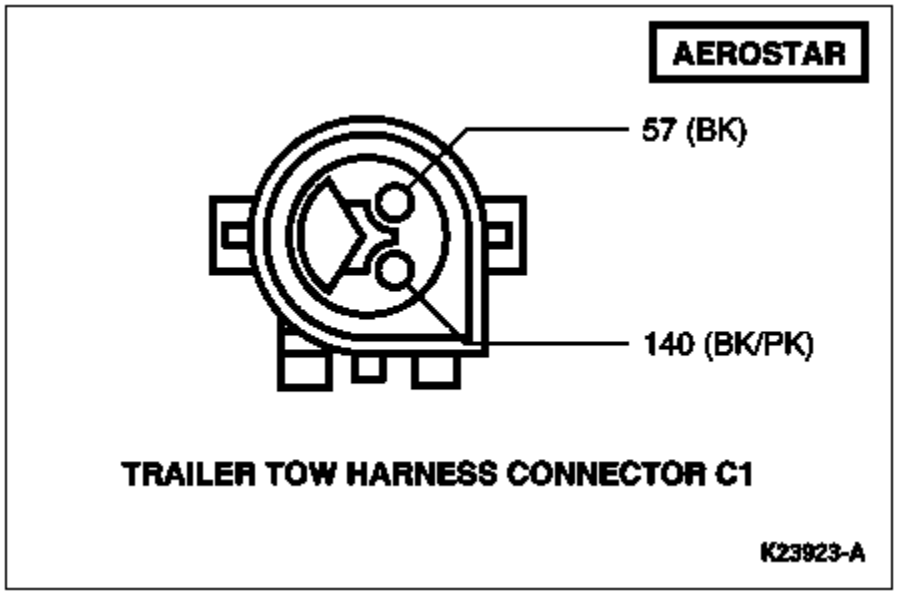
Electrical Schematic, Trailer Tow, Aerostar





TRAILER TOW HARNESS CONNECTOR C2

K23922-A



TRAILER TOW HARNESS CONNECTOR C1

K23923-A

Inspection and Verification

1. Check the trailer feed wiring (13A576) and the added trailer connector for obvious signs of damage.
2. Check fuses for damage.
3. If the concern remains after these checks, proceed to the following Symptom Chart.

Symptom Chart — Wiring And Circuit Protection

WIRING AND CIRCUIT PROTECTION

Condition	Possible Source	Action
• Trailer Lamps Inoperative	• Fuse. • Trailer tow extension wiring. • Trailer feed wiring. • Trailer wiring or bulbs.	• GO to Pinpoint Test A .
• Trailer Stop, Turn or Hazard Lamps Inoperative	• Fuse. • Trailer tow extension wiring. • Trailer feed wiring. • Trailer wiring or bulbs.	• GO to Pinpoint Test A .
• Trailer Tail Lamps and Running Lamps Inoperative	• Fuse. • Trailer tow extension wiring. • Trailer feed wiring. • Trailer wiring or bulbs.	• GO to Pinpoint Test A .
• Single Trailer Lamp Inoperative	• Trailer wiring or bulbs.	• Have trailer serviced by an authorized camper/trailer repair center.

Pinpoint Test

PINPOINT TEST A: TRAILER LAMPS INOPERATIVE

A1 CHECK LIGHTING OPERATION

- Disconnect trailer from vehicle and disconnect trailer feed wiring from trailer tow extension wiring, Aerostar.
- Check operation of vehicle exterior lighting systems for any concerns.

Does the exterior lighting system of vehicle operate properly?

Yes	No
GO to **A2** .	SERVICE any vehicle exterior lighting concerns. REFER to Section 17-01 .

A2 CHECK FUSES

- Check the following fuses:
  a. Fuse panel, fuse 1 (15A)
  b. Fuse panel, fuse 4 (15A)
  c. Fuse panel, fuse 5 (15A)
  d. Trailer tow relay module, left turn lamp fuse (3A)
  e. Trailer tow relay module, right turn lamp fuse (3A)
  f. Trailer tow relay module, parklamps fuse (10A)
  g. Trailer tow relay module, backup lamp fuse (5A)

Are fuses OK?

Yes	No
GO to **A3** .	SERVICE as required. RETEST trailer lighting system. If concern is still present, GO to **A3** .

A3 CHECK TRAILER GROUND FEED

- Using volt-ohmmeter check resistance between Circuit 57 (BK) of trailer feed wiring end and known good ground.

Is resistance less than 5 ohms?

Yes	No
GO to **A4** .	GO to **A9** .

A4 CHECK TRAILER TAIL LAMP FEED

- With the ignition switch in the RUN position, turn the headlamps on.
- Using volt-ohmmeter, measure voltage of trailer feed wiring end Circuit 14 (BR).

Is voltage greater than 10V?

Yes	No
GO to **A5** .	GO to **A9** .

A5 CHECK TRAILER RH TURN, STOP AND HAZARD FEED

- With the ignition switch in the RUN position, turn the RH turn lamp on.
- Using volt-ohmmeter, measure voltage of trailer feed wiring end Circuit 5 (O/LB).

Does voltage modulate from greater than 10V to less than 1V?

Yes	No
GO to **A6** .	GO to **A9** .

A6 CHECK TRAILER LH TURN, STOP AND HAZARD FEED

- With the ignition in the RUN position, turn the hazard lamps on.
- Using volt-ohmmeter, measure voltage of trailer feed wiring end Circuit 9 (LG/O).

Does voltage modulate from greater than 10V to less than 1V?

Yes	No
GO to **A11** .	GO to **A7** .

A7 CHECK RELAY GROUND

- Locate relay connector for circuit.
- Using volt-ohmmeter, check resistance of Pin 85 of trailer tow extension wiring connector and known good ground.

Is resistance less than 5 ohms?

Yes	No
GO to **A8** .	SERVICE open in Circuit 57 (BK).

A8 CHECK RELAY POWER

- Locate relay connector for circuit.
- Using volt-ohmmeter, check voltage of Pin 30 of trailer tow extension wiring connector.

Is voltage greater than 10V?

Yes	No
GO to **A9** .	SERVICE open in relay power circuit.

A9 CHECK TRAILER TAIL LAMP FEED TO RELAY

- With the ignition in the RUN position, turn the headlamps on.
- Using volt-ohmmeter, measure voltage of Pin 86 of the trailer parklamps relay.

Is voltage greater than 10V?

Yes	No
GO to **A10** .	SERVICE open in relay coil feed.

A10 CHECK TRAILER HAZARD FEED

- With the ignition in the RUN position, turn the hazard lamps on.
- Using volt-ohmmeter, measure voltage of fused feeds, Circuit 52 (Y) and Circuit 64 (DG).

Does voltage modulate from greater than 10V to less than 1V?

Yes	No
GO to **A11** .	SERVICE open in fused feeds.

A11 CHECK TRAILER WIRING FEED WIRING

- Using a volt-ohmmeter, check the following relay pins and circuits for continuity:
  a. Trailer park lamps relay Pin 87 to trailer feed wiring end Circuit 14 (BR).
  b. Trailer backup lamps relay Pin 87 to trailer feed wiring end Circuit 140 (BK/PK).

Do all circuits have continuity?

Yes	No
REPLACE relay for circuit not functioning properly.	SERVICE open in trailer feed wiring, trailer tow extension wiring for circuit(s) that indicated no continuity.

Aerostar

TRAILER BACKUP LAMPS RELAY

Circuit Function	Pin Number	Circuit
30	50 (R)	Power (Hot at All Times)
85	714 (P)	Coil Ground
86	140 (BK/PK)	Coil Power
87	667 (W/R)	Backup Lamps Fuse Feed
87A	—	Not Used

TRAILER PARK LAMPS RELAY

Circuit Function	Pin Number	Circuit
30	50 (R)	Power (Hot at All Times)
85	699 (O)	Coil Ground
86	14 (BR)	Coil Power
87	195 (T/W)	Park Lamps Fuse Feed
87A	—	Not Used

Fuse Junction Panel Cover

Instrument Panel

To remove the instrument panel (04320) fuse panel cover on the Aerostar, push on the center of the instrument panel fuse panel cover while pulling one of the two end tabs. To remove the instrument panel fuse door (045D62) on the Ranger, place a finger in the indentation provided and pull the instrument panel fuse door away from the instrument panel.

Power Distribution Box Cover

To remove the cover on the power distribution box, release the locking tab on the end of the power distribution box cover and pull the end of the cover up, swinging it back on its hinge.

Power Distribution Box, Ranger

The power distribution box is located in the engine compartment on the left inner fender, next to the power brake booster (2005) for Ranger. It contains fuses, relays and diodes. Some fused circuits feed to the instrument panel (04320) fuse panel. The power distribution box is part of the wiring assembly. The power distribution box slides and locks into a fuse junction panel mounting bracket (14A254).

Power Distribution Box Service

To remove the power distribution box from the fuse junction panel mounting bracket, press both locking arms at the same time and pull the power distribution box up. The bottom cover is attached with two screws and a hinge.

Fuses, Relays or Circuit Breakers

To check or replace a fuse, relay or circuit breaker:

1. Locate and remove the suspect fuse, relay or circuit breaker by pulling it out of its cavity (no special tools required).

2. **CAUTION: Never install a replacement fuse, relay or circuit breaker with a higher or lower amperage rating than indicated for a circuit.**

   Replace fuse, relay or circuit breaker with one of the proper amperage rating for the circuit by pushing straight in until fuse, relay or circuit breaker seats itself fully in cavity.

Wiring Harness, Aerostar

The illustrations in this section show the complete wiring harness installation for Aerostar vehicles. Refer to the illustrations for the harness being replaced while performing the following Removal and Installation procedures. Refer to the appropriate Electrical and Vacuum Troubleshooting Manual for overviews of wiring harnesses.

Removal

NOTE: Refer to Section 01-05B if it is necessary to remove any trim panels to gain access to the harness.

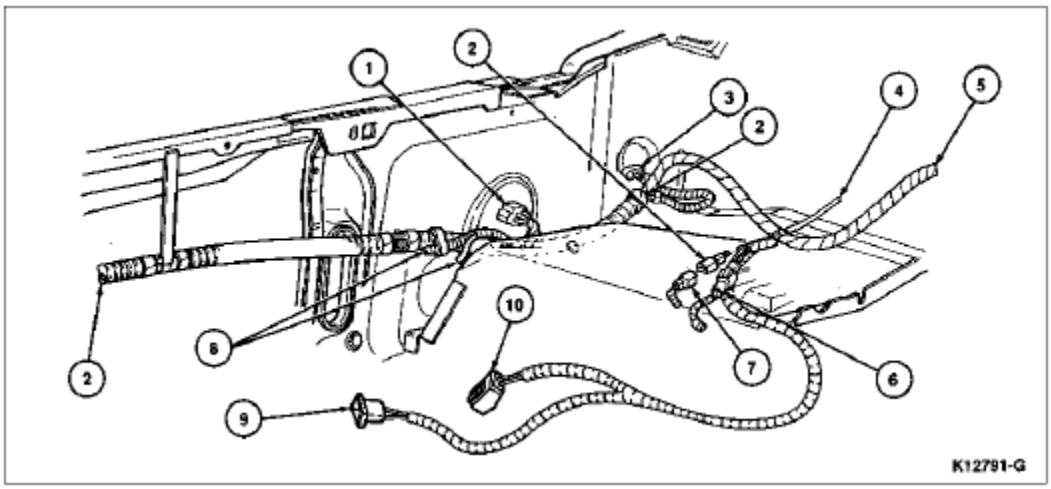
1. Disconnect battery ground cable (14301).
2. Disconnect all wiring harness connectors.
3. Disengage harness from all locators, straps or clips as necessary, including ground wire eyelets. Remove harness from vehicle.

Installation

1. Position harness in vehicle, making sure that harness is engaged in all locators, straps or clips.
2. Connect all harness connectors to components or other harnesses as necessary.
3. Secure ground eyelets to body as necessary.
4. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

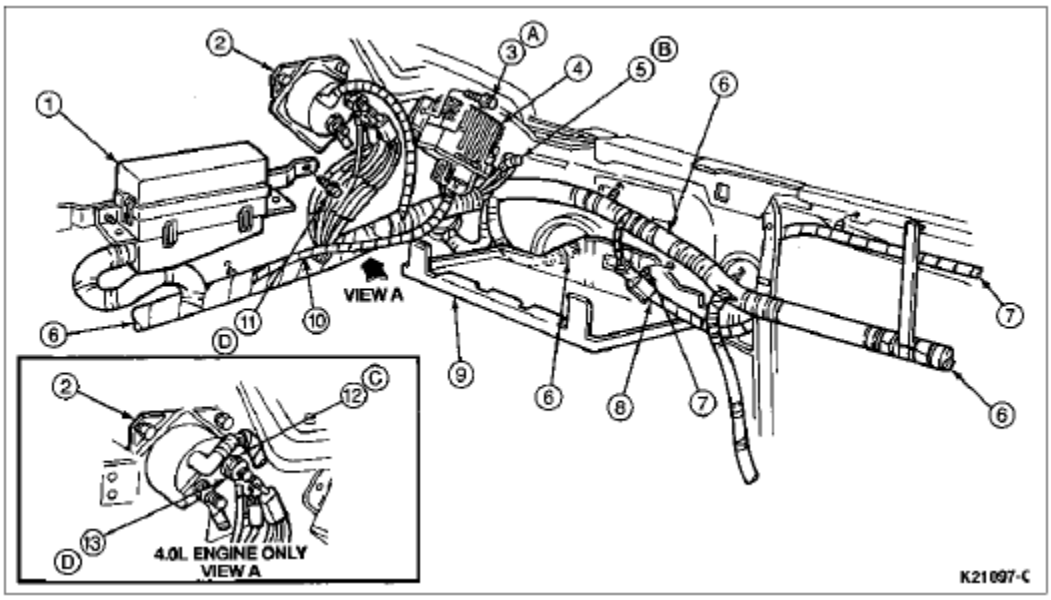
   Connect battery ground cable and check all applicable circuits for proper operation.
5. Install any trim removed during harness removal. Refer to Section 01-05B for trim panel installation.

Front End and Fender Apron Wiring, Right, All Engines — Aerostar



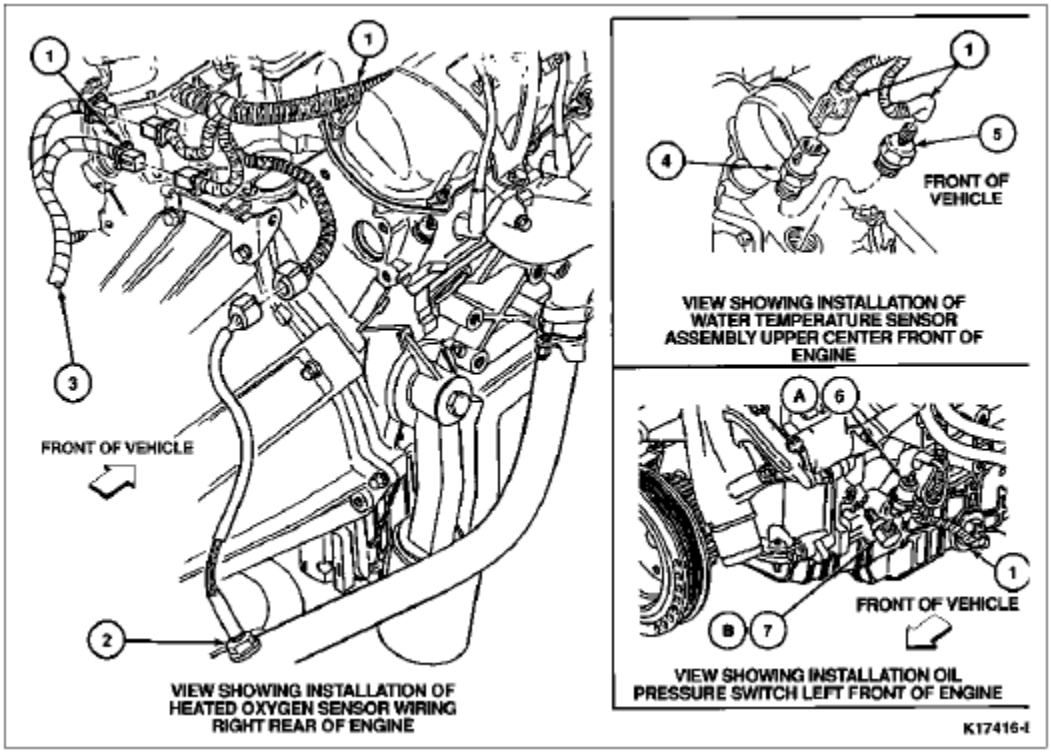
Item	Part Number	Description
1	—	Wiring Connector to Headlamp (Part of 12A581)
2	12A581	Engine Control Sensor Wiring
3	—	Wiring Connector to Side Marker Lamp (Part of 12A581)
4	—	To Ground (Part of 12A581)
5	—	To Standard Heater (Part of 12A581)
6	14305	Generator Voltage Regulator Wiring
7	—	To Air Conditioning (3.0L Engine) (Part of 14305)
8	—	To Horn Assembly (Part of 12A581)
9	—	To Canister Purge Solenoid
10	—	To Purge Flow Sensor/Thermistor

Front End and Fender Apron Wiring, Left, All Engines — Aerostar



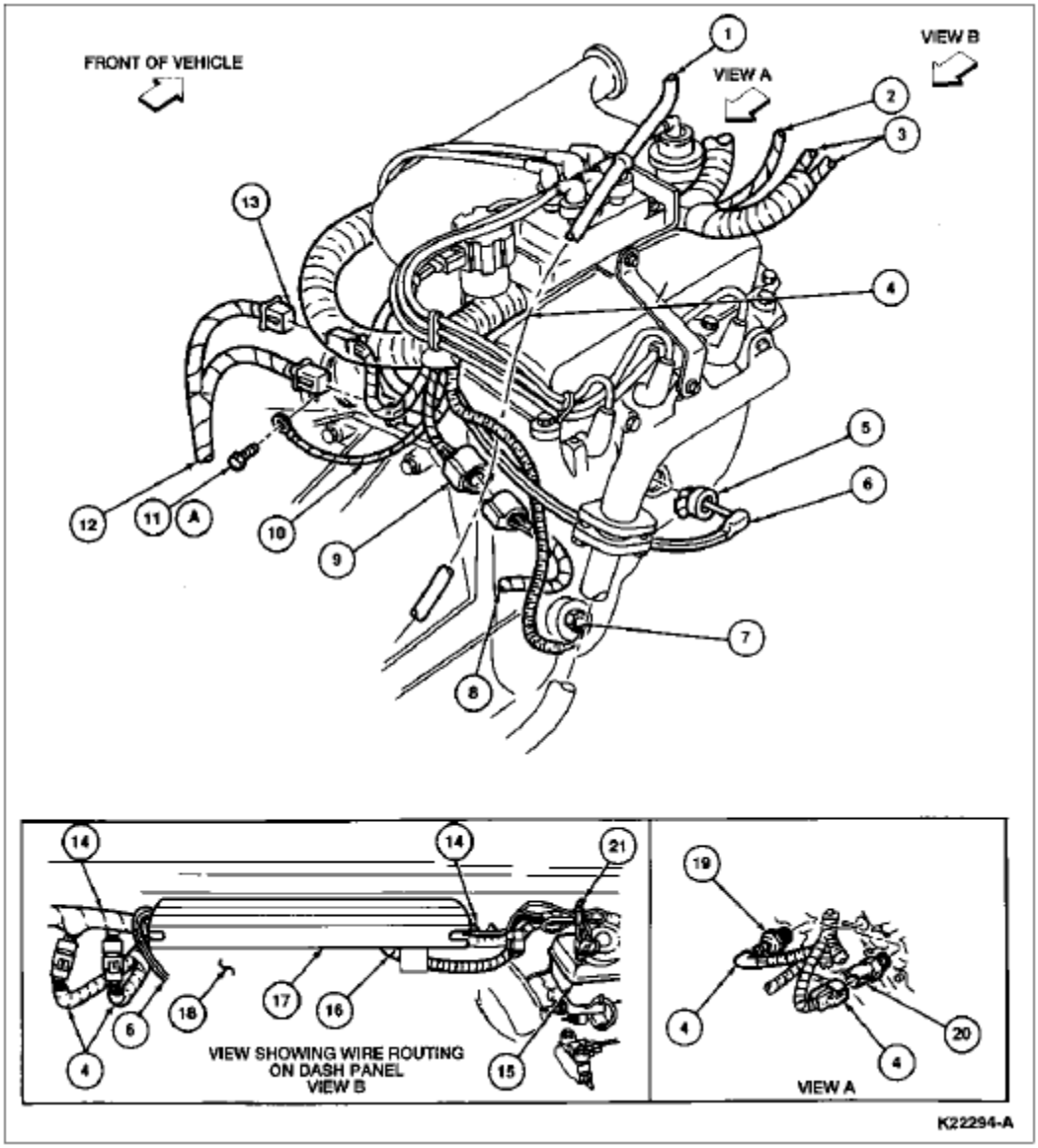
Item	Part Number	Description
1	9C392	Air Suspension Compressor Relay and Bracket
2	11450	Starter Motor Solenoid Relay Switch
3	N610957-S2	Screw
4	15A272	Daytime Running Lamps Control
5	N805375-S36	Bolt
6	12A581	Engine Control Sensor Wiring
7	—	To Center Air Bag Sensor (Part of 12A581)
8	—	Center Air Bag Sensor Connector (Part of 12A581)
9	10732	Battery Tray
10	—	To Daytime Running Lamp Control (Part of 12A581)
11	N610958-S36	Screw
12	381561-S39	Nut and Washer (4.0L Only)
13	381561-S39	Nut and Washer
A	—	Tighten to 2.5-3.0 Nm (22-26 Lb-In)
B	—	Tighten to 5-6 Nm (45-53 Lb-In)
C	—	Tighten to 5-10 Nm (45-88 Lb-In)
D	—	Tighten to 7-9 Nm (62-80 Lb-In)

Engine Wiring, 4.0L V-6 Engine — Aerostar



Item	Part Number	Description
1	9D930	Fuel Charging Wiring
2	9F472	Heated Oxygen Sensor (HO2S)
3	12A690	Engine Control Sensor Extension Wiring
4	12A648	Engine Coolant Temperature Sensor
5	10884	Water Temperature Indicator Sender Unit
6	9278	Oil Pressure Sensor
7	9B339	Oil Pressure Sender Fitting
A	—	Tighten to 11-24 Nm (9-18 Lb-Ft)
B	—	Tighten to 11-16 Nm (9-12 Lb-Ft)

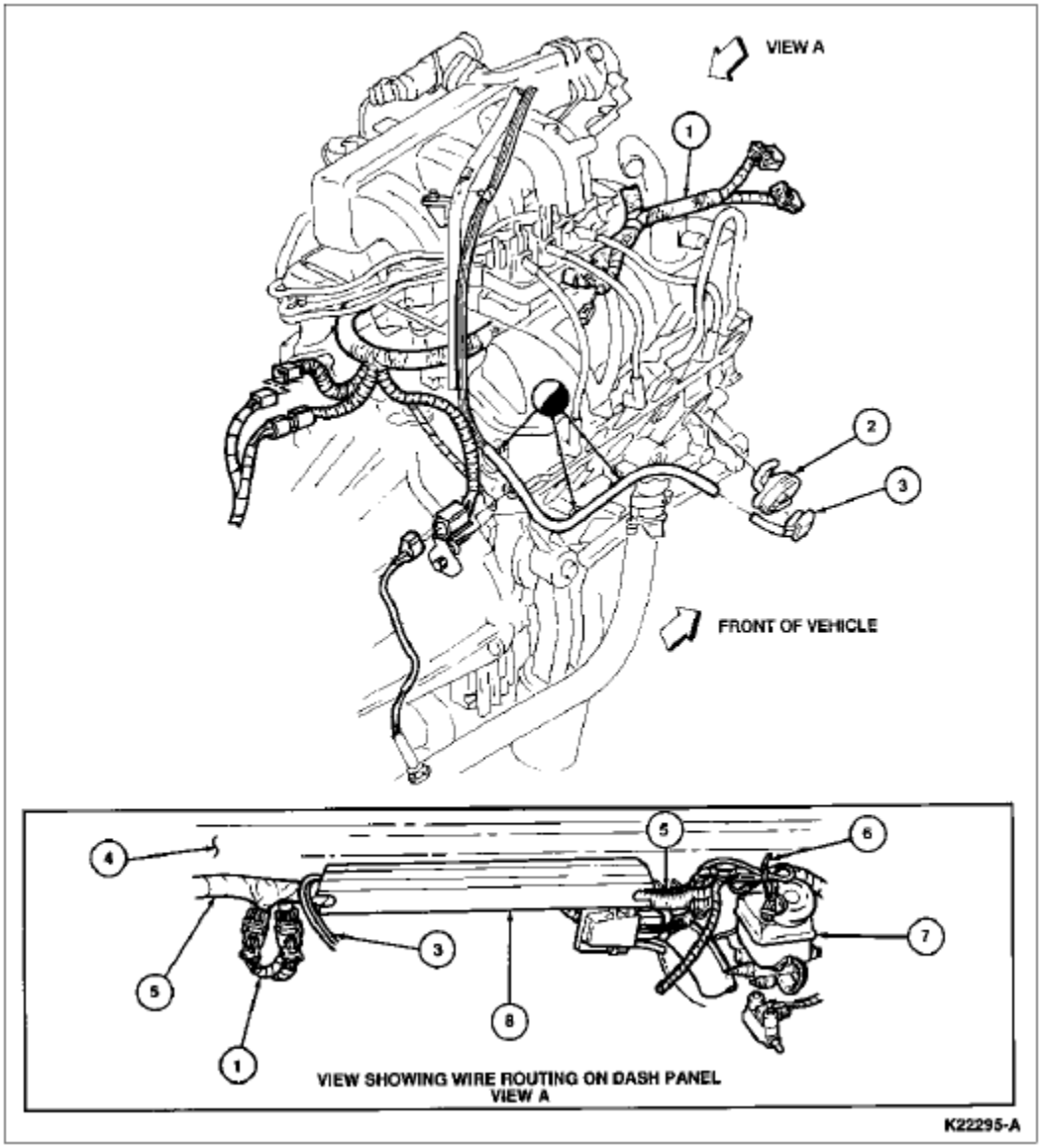
Engine Wiring, Right, 3.0L V-6 Engine — Aerostar



Item	Part Number	Description
1	—	Transmission Fill Tube
2	—	To ACT Wiring
3	—	To 12A581 Wiring Assembly
4	9D930	Fuel Charging Wiring
5	6A051	Block Heater
6	6B018	Block Heater Wiring
7	6C624	Low Oil Level Sensor
8	—	Wiring to Heated Oxygen Sensor (HO2S)
9	—	To Engine Temperature Control (Part of 9D930)
10	—	RH Ground Wire
11	N605798	Bolt

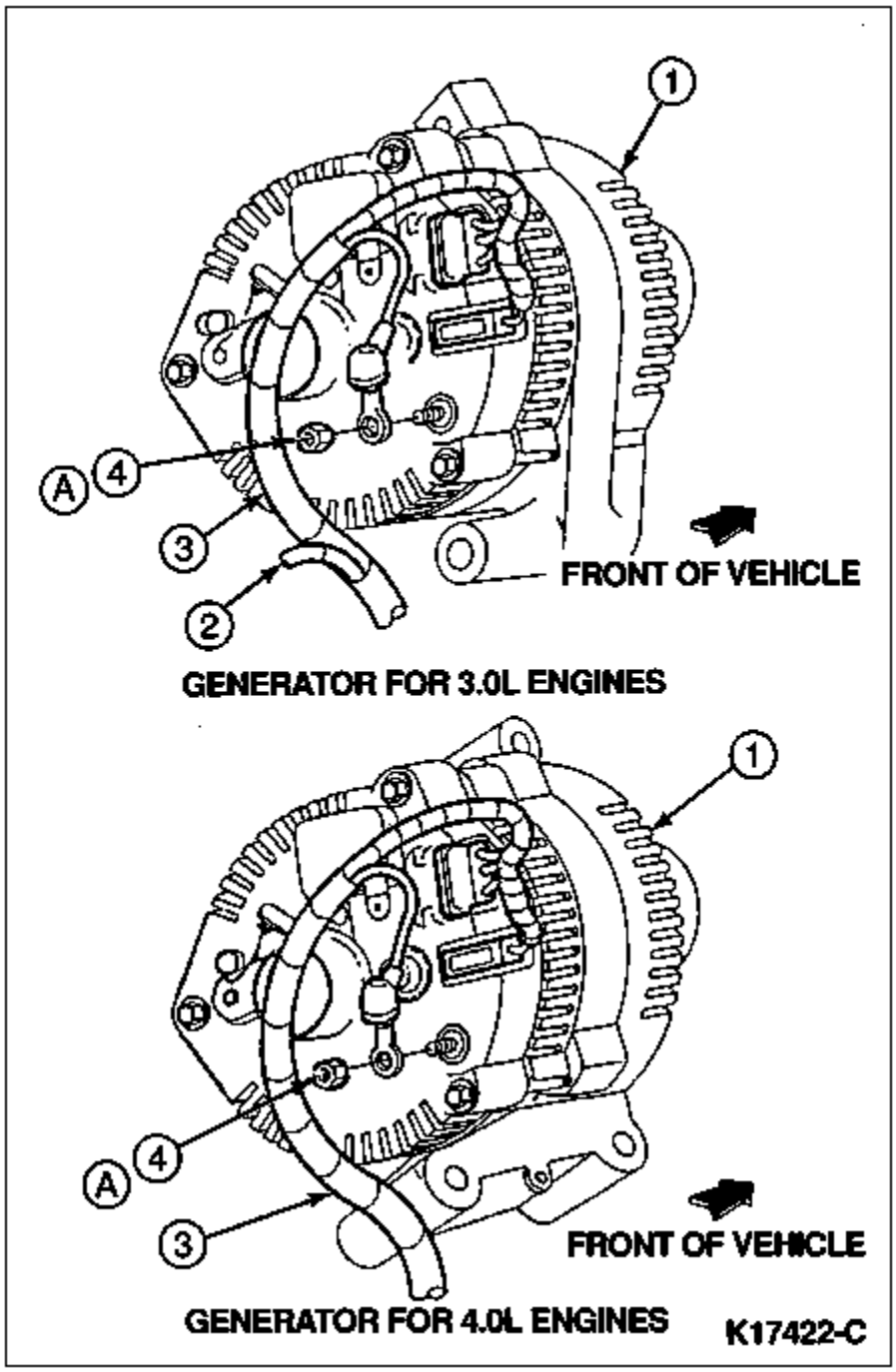
12	12A690	Engine Control Sensor Extension Wiring
13	9D930	Fuel Charging Wiring
14	12A581	Engine Control Sensor Wiring
15	2140	Brake Master Cylinder
16	—	To Windshield Wiper Motor (Part of 12A581)
17	14A163	Wiring Harness Retainer
18	01610	Dash Panel
19	10884	Water Temperature Indicator Sender Unit
20	12A648	Engine Coolant Temperature Sensor
21	13A506	Rear Lamp Wiring Retainer
A	—	Tighten to 11-13 Nm (8-10 Lb-Ft)

Engine Block Heater and Wiring, 4.0L V-6 Engine — Aerostar



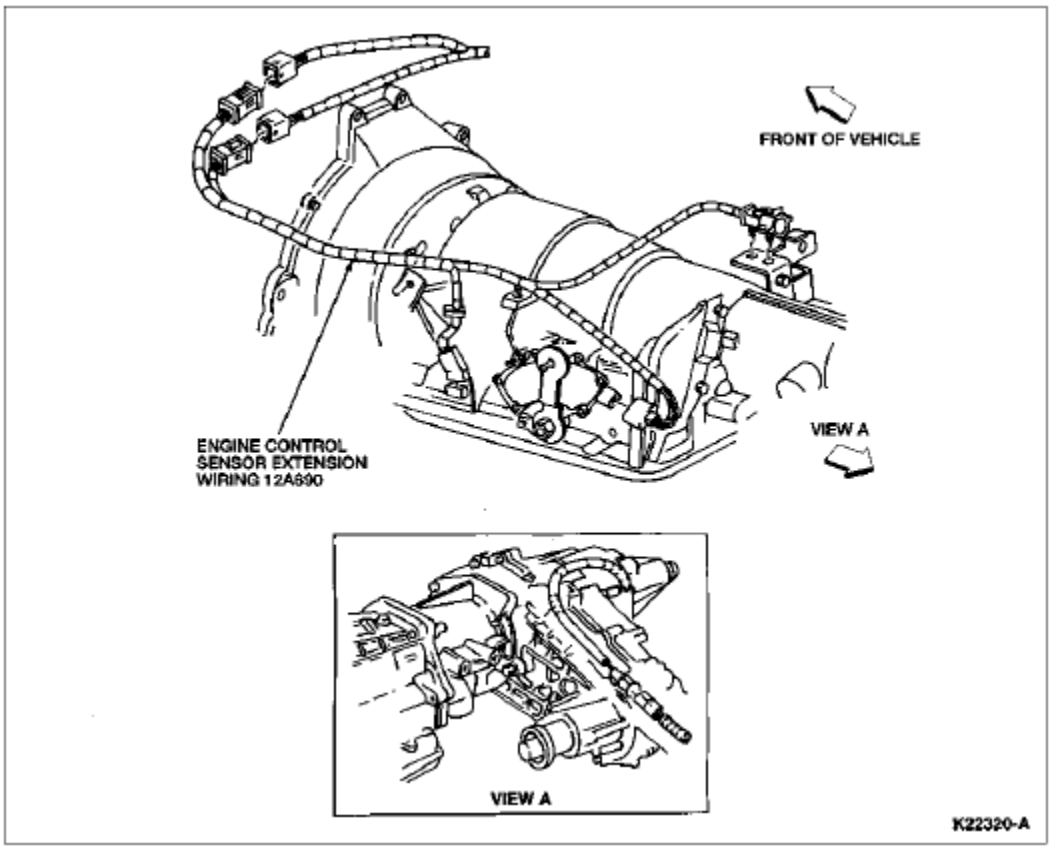
Item	Part Number	Description
1	9D930	Fuel Charging Wiring
2	6A051	Block Heater
3	6B018	Block Heater Wiring
4	01610	Dash Panel
5	12A581	Engine Control Sensor Wiring
6	13A506	Rear Lamp Wiring Retainer
7	2K478	Brake Master Cylinder Reservoir
8	14A163	Wiring Harness Retainer

Generator and Wiring, 3.0L and 4.0L Engines, Standard Production, Aerostar

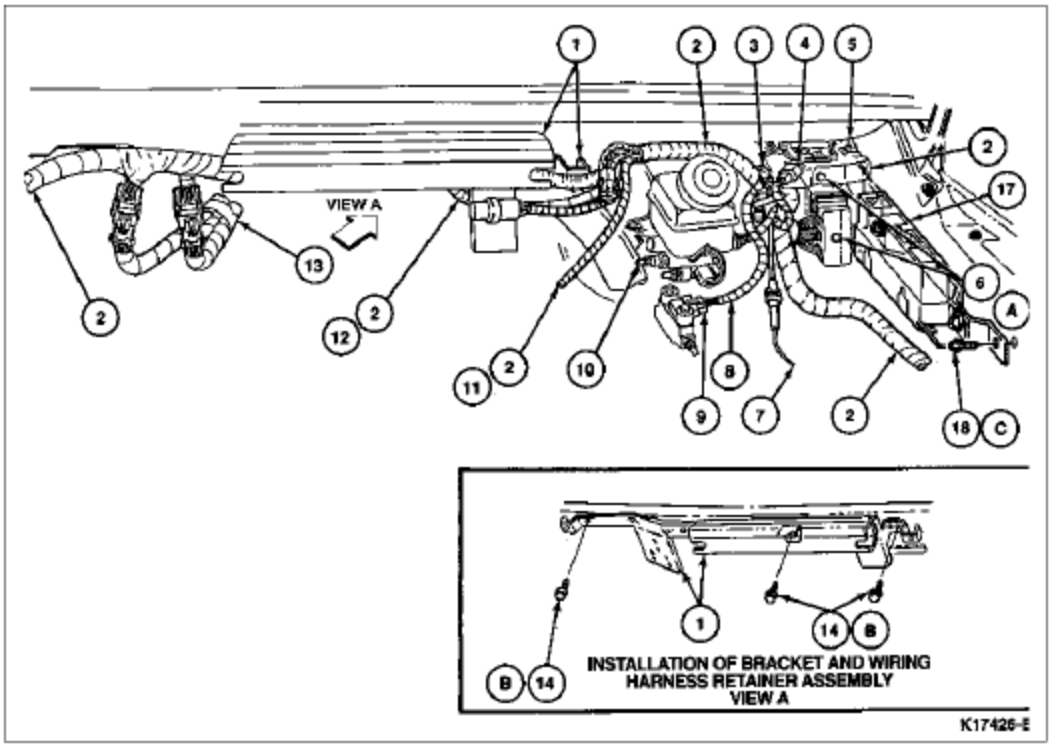


Item	Part Number	Description
1	10300	Generator
2	—	To A/C Clutch
3	14305	Generator Voltage Regulator Wiring
4	N805320-S36	Nut
A	—	Tighten to 5-6 Nm (40-57 Lb-In)

Automatic Transmission — Aerostar



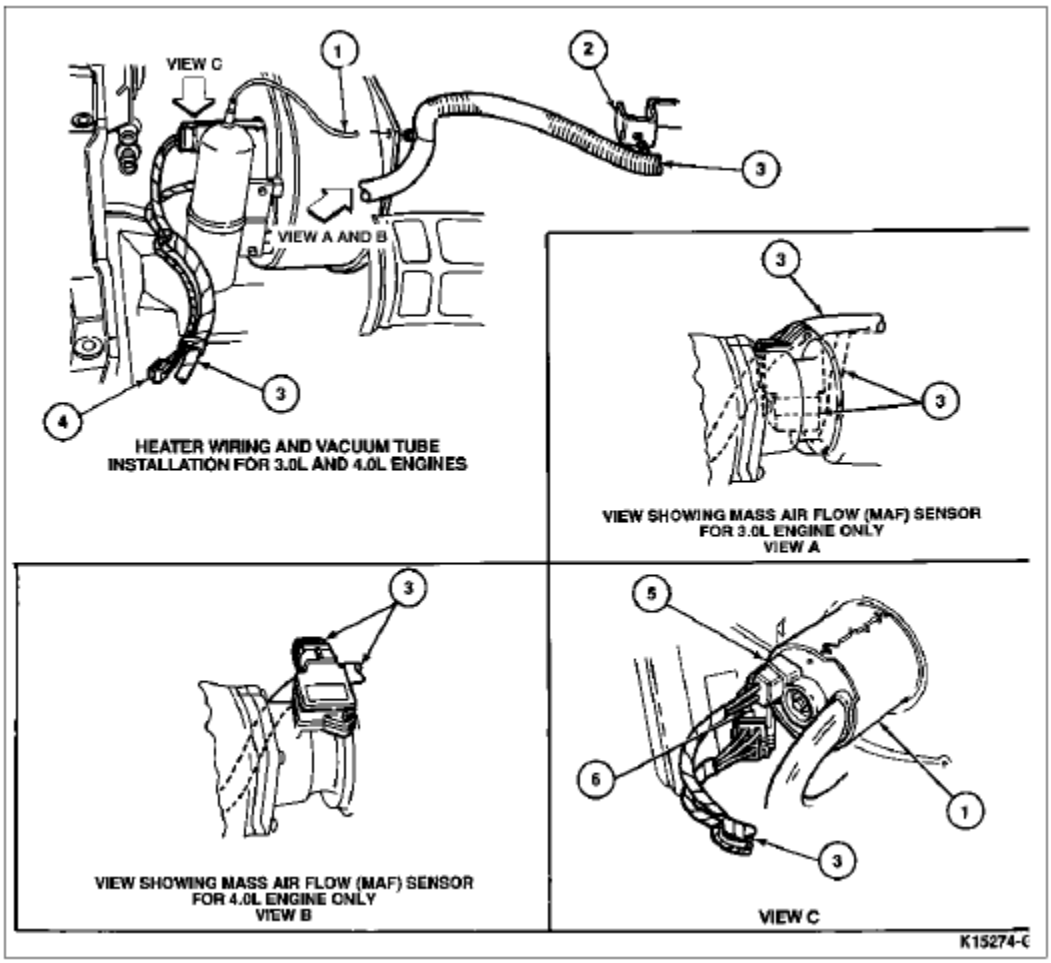
Dash Panel Wiring, Left, All Engines — Aerostar



Item	Part Number	Description
1	14A163	Wiring Harness Retainer
2	12A581	Engine Control Sensor Wiring
3	—	To 15K702 Wiring
4	—	To Octane Adjust (Part of 12A581) (4.0L Engine Only)
5	12A650	Powertrain Control Module
6	—	Screw (Part of 12A581)
7	—	To Battery Ground (Part of 12A581)
8	—	Wiring To Brake Valve Assembly (Part of 12A581)
9	—	Connector To Brake Valve Assembly (Part of 12A581)
10	2140	Dual Brake Master Cylinder
11	—	To A/C Compressor (Part of 12A581) (4.0L Engine Only)
12	—	To Windshield Wiper Motor (Part of 12A581)
13	9D930	Fuel Charging Wiring
14	N805375-S36	Screw
15	—	Relay and Bracket (Part of 12A581)
16	N610958-S36	Bolt

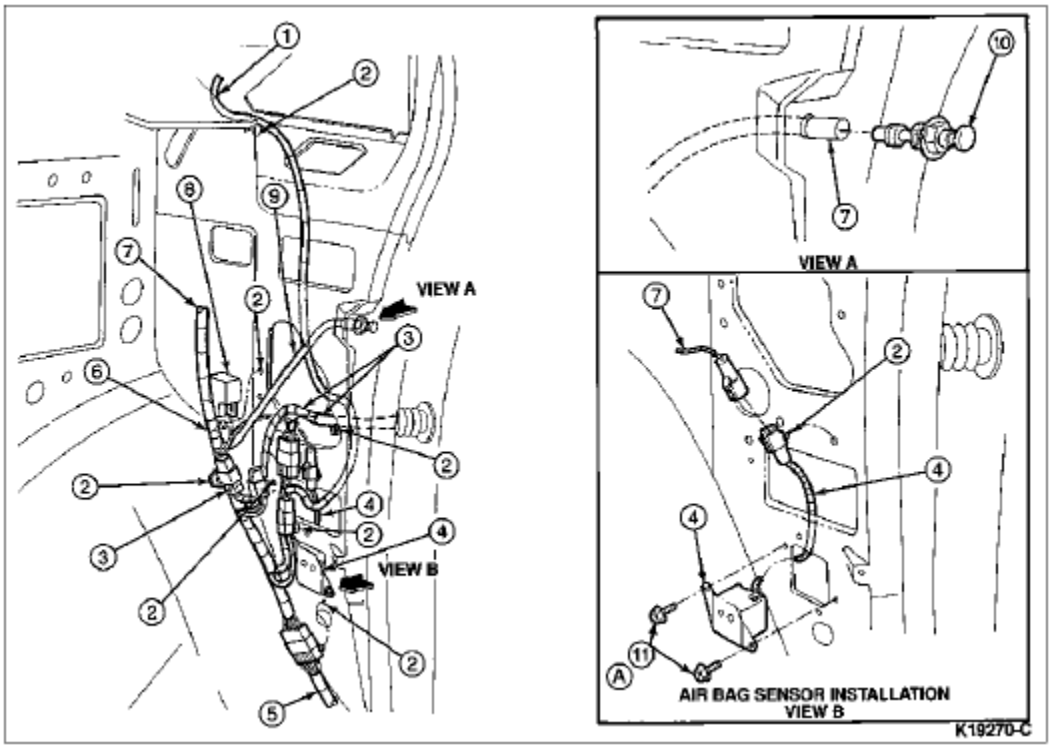
A	—	Tighten to 5.5-6.8 Nm (49-60 Lb-In)
B	—	Tighten to 7.5-10.5 Nm (66-93 Lb-In)
C	—	Tighten to 6.8-9.2 Nm (60-81 Lb-In)

Dash Panel Wiring, Right, 3.0L and 4.0L Engines — Aerostar



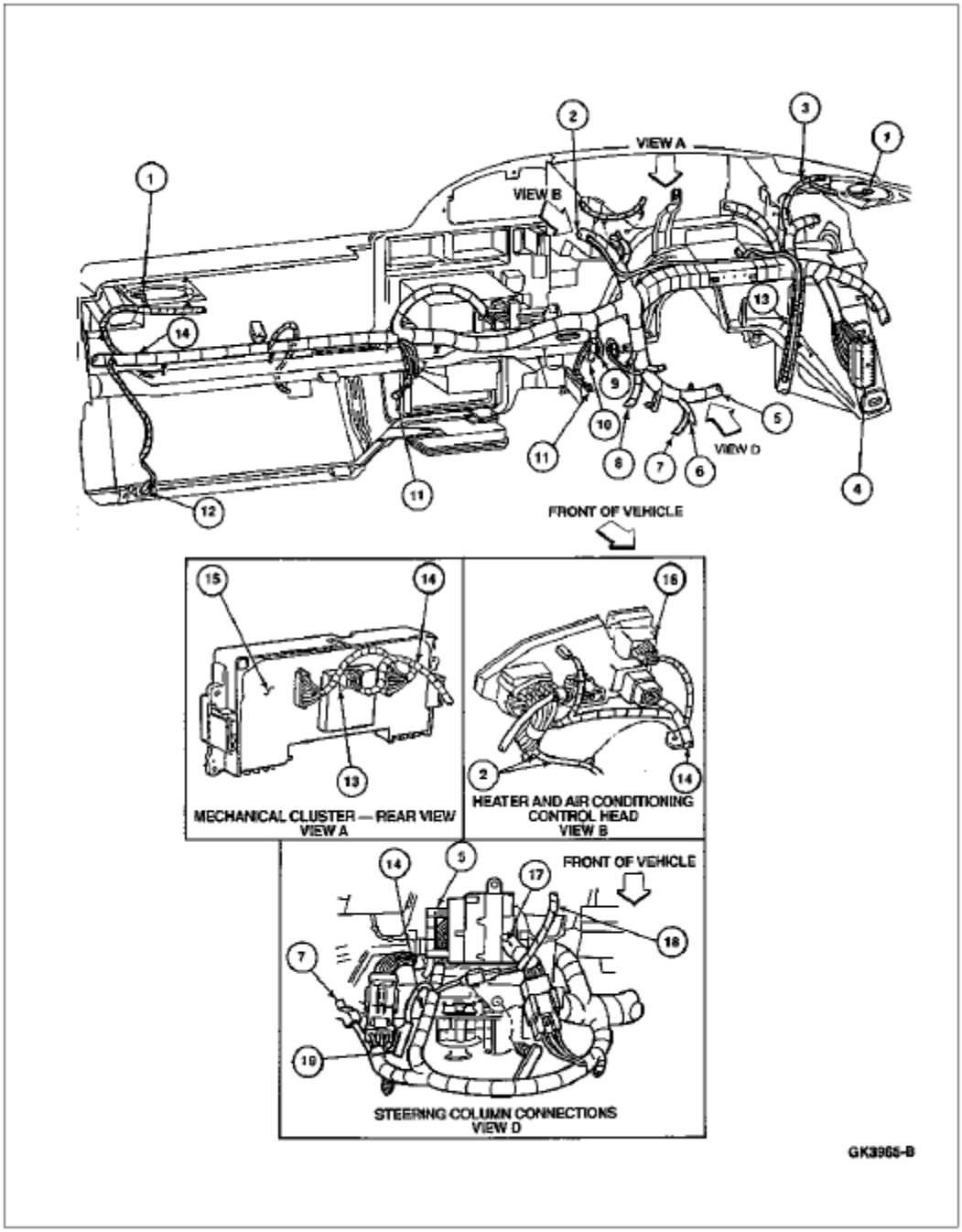
Item	Part Number	Description
1	18458	Heater Blower Case
2	14A163	Wiring Harness Retainer
3	12A581	Engine Control Sensor Wiring
4	—	To A/C Pressure Switch (Part of 12A581)
5	19805	A/C Blower Motor
6	19A706	A/C Blower Motor Resistor

Cowl Side, Right, Aerostar



Item	Part Number	Description
1	17C710	Vanity Lamp Wiring
2	—	Harness Retainer (Part of 17C710)
3	14630	Front Window Regulator Wiring
4	14B004	Air Bag Sensor
5	14014	Wiring to Power Locks
6	14401	Main Wiring
7	14401	Main Wiring
8	9341	Inertia Fuel Shutoff Switch
9	—	To Courtesy Lamp Switch (Part of 14401)
10	13713	Lamp Switch
11	N806327-S190	Screw (2 Req'd)
A	—	Tighten to 10-14 Nm (8-10 Lb-Ft)

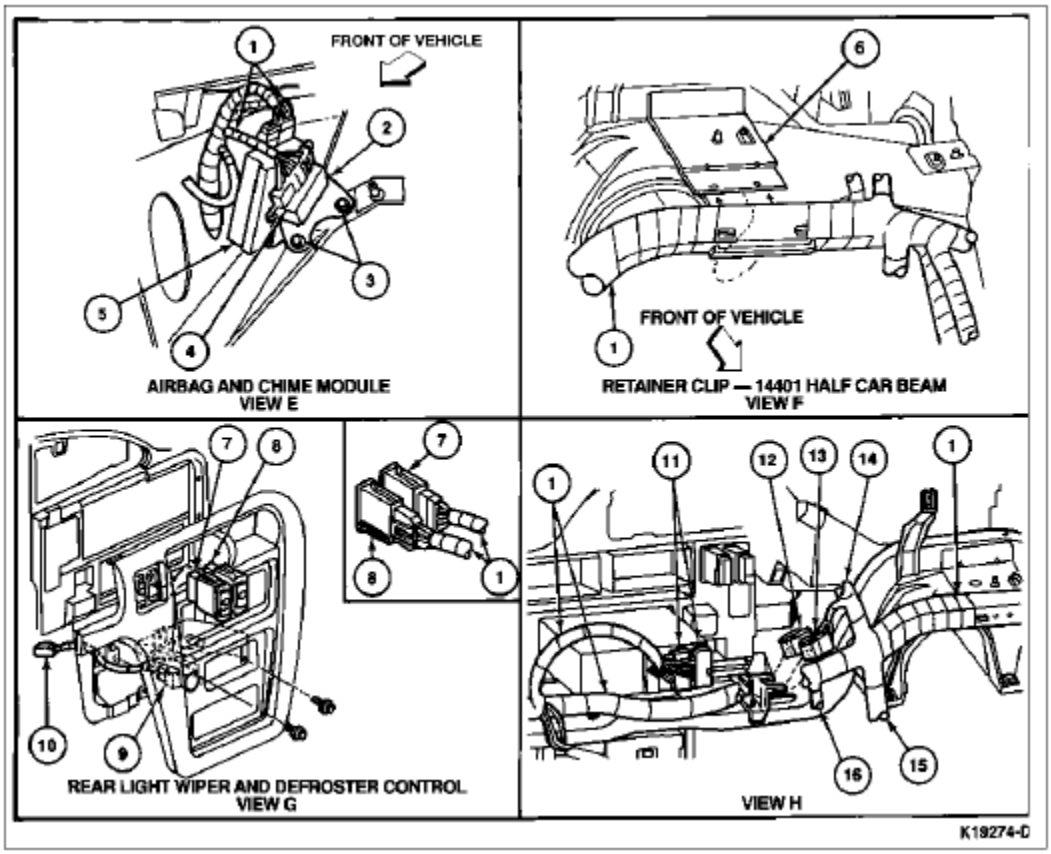
Instrument Panel Wiring, Mechanical Cluster — Aerostar



Item	Part Number	Description
1	18808	Radio Speaker
2	19D699	Vacuum Hose Harness Assembly
3	11654	Headlamp Switch
4	—	To 12A581 Wiring
5	—	To Ignition Switch
6	—	Wiring
7	13480	Stoplamp Switch

8	—	To Wiper Control Module
9	—	To 14K006 Wiring
10	—	To Rear Anti-Lock Brake Module and Bracket
11	N801846-S36MG (2 Req'd)	Screw
12	13776	Interior Lamp
13	—	To Speed Control Amplifier
14	14401	Main Wiring
15	10849	Instrument Cluster
16	18578	Heater Blower Motor Switch
17	9C899	Horn Wiring
18	14A664	Air Bag Sliding Contact
19	—	Brake Shift Interlock

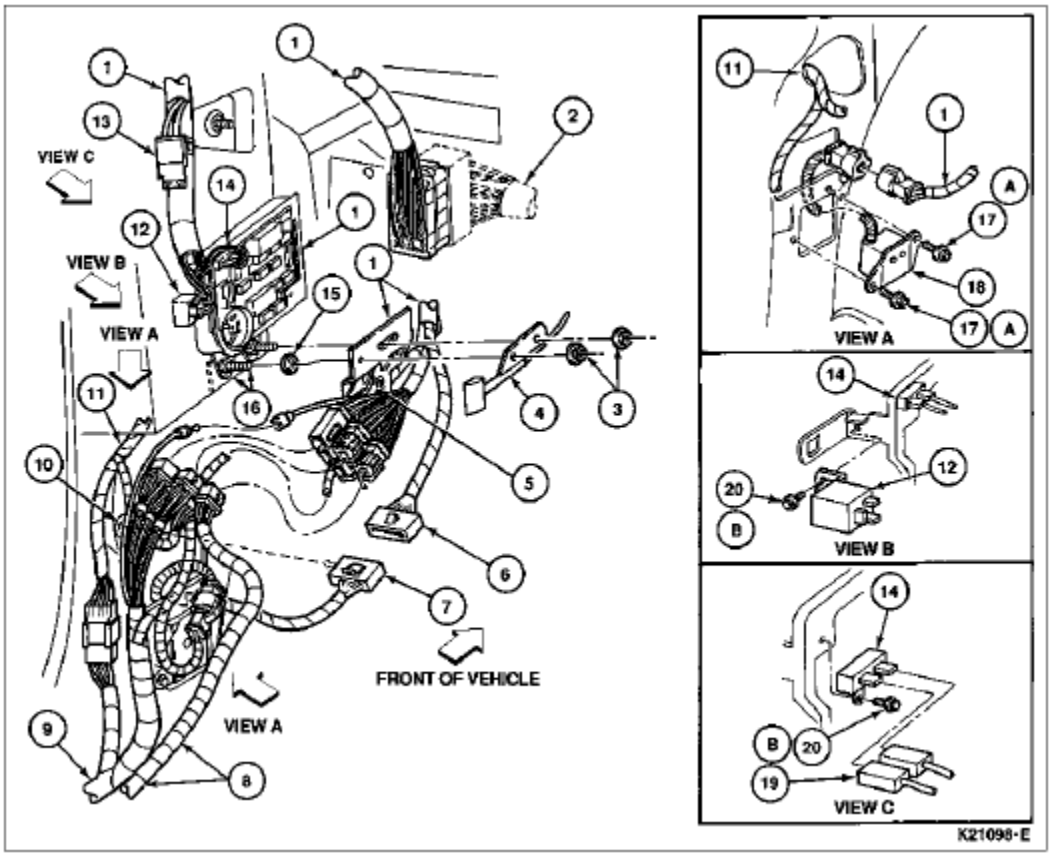
Instrument Panel Wiring Mechanical Cluster Standard and A/C — Except for Deluxe — Aerostar



Item	Part Number	Description

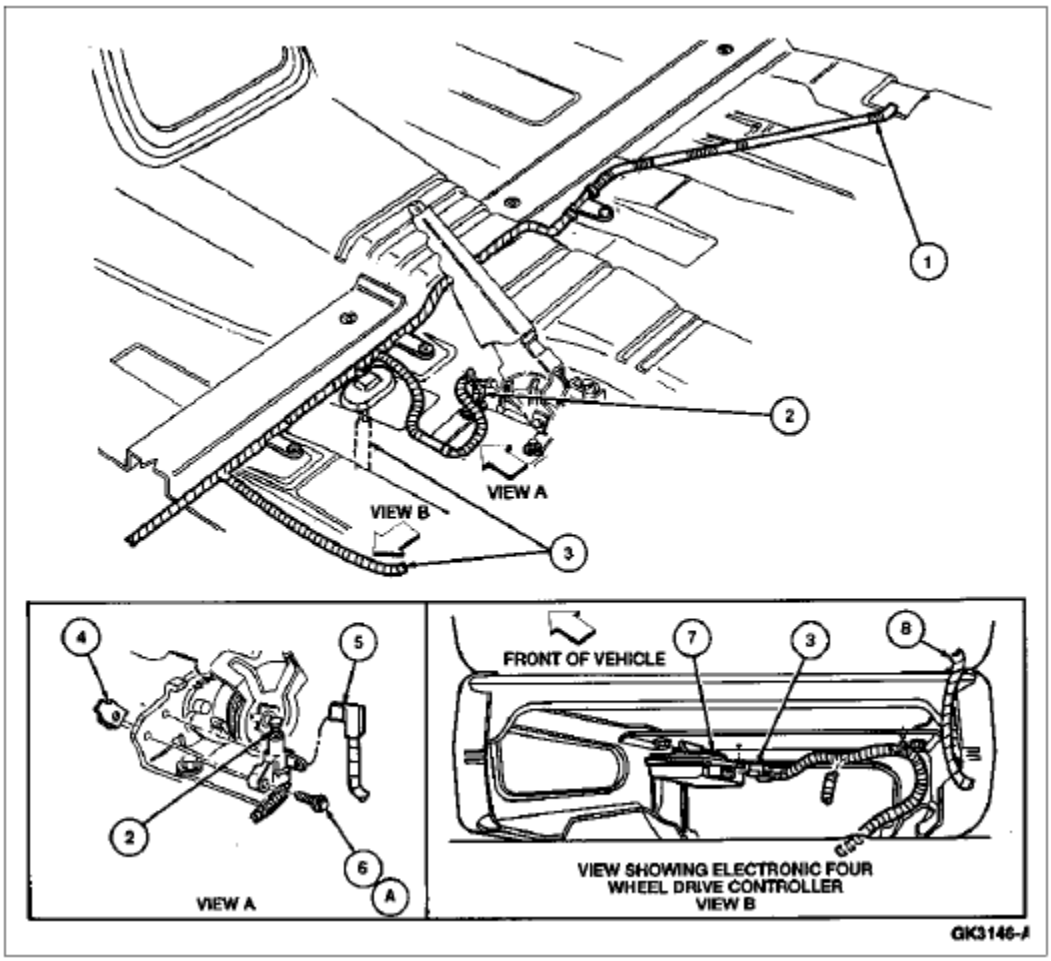
1	14401	Main Wiring
2	14B058	Air Bag Monitor Bracket
3	N806339-S2	Screw
4	10D840	Safety Belt Warning Chime
5	14B056	Air Bag Diagnostic Monitor
6	—	Attachment of 14A194 Shield to Instrument Panel
7	—	Liftgate Wiper/Washer Switch
8	18C621	Heater Blower Motor Switch
9	14K006	Cigar Lighter Wire
10	—	To 14401 Wiring Assembly
11	—	To Radio
12	14B193	To Door Ajar Relay
13	—	To Horn Relay
14	—	To A/C Controls
15	—	To Ignition Switch
16	—	To RABS Module and Bracket Assembly

Cowl Side, Left — Aerostar



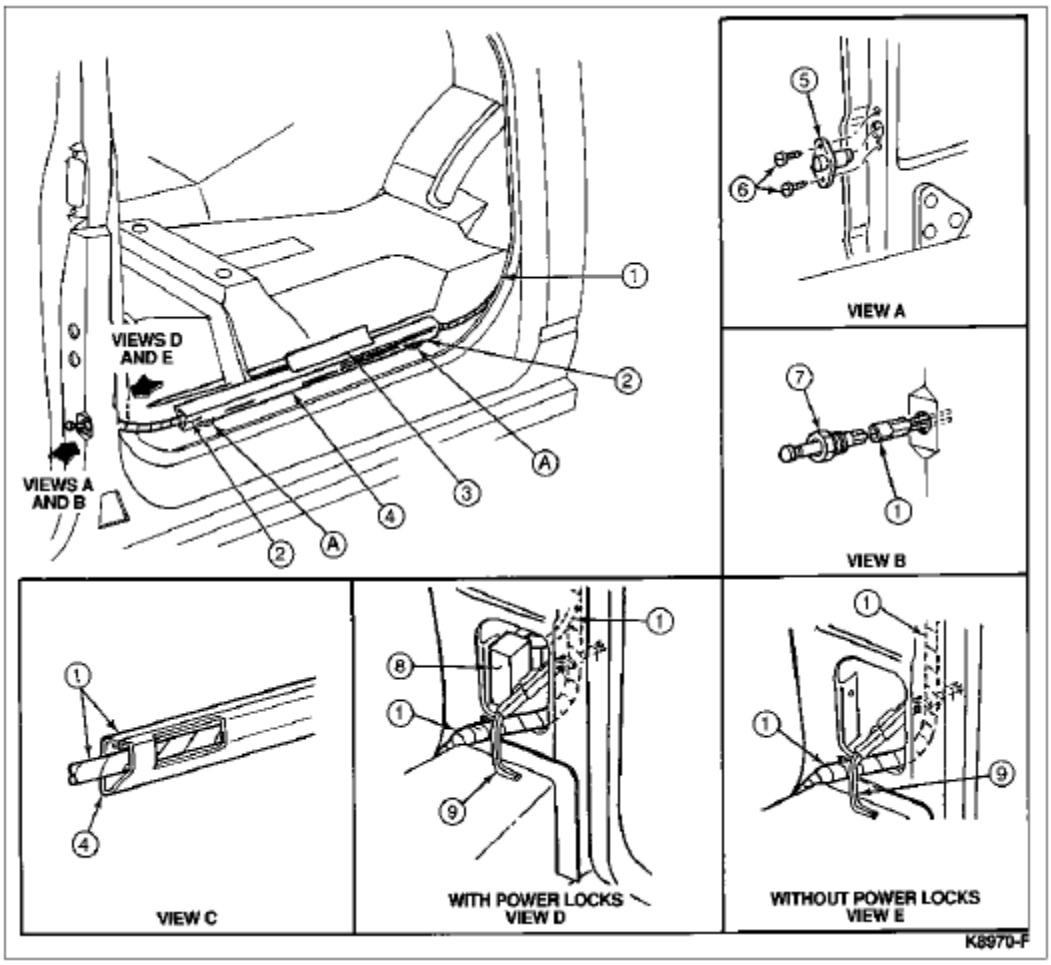
Item	Part Number	Description
1	14401	Main Wiring
2	12A581	Engine Control Sensor Wiring
3	N620481-S2 (2 Req'd)	Nut
4	16700	Hood Latch Handle/Bracket Assembly
5	19C829	Auxiliary A/C Vacuum Hose
6	—	Connector to Fuel Tank Sender Jumper Wiring (Part of 14401)
7	14407	Fuel Tank Sender Jumper Wiring
8	14405	Rear Lamp Wiring
9	14631	Front Window Regulator Wiring
10	—	Bracket (Part of 14405)
11	14631	Front Window Regulator Wiring
12	13350	Turn Signal Flasher
13	—	Power Door Lock In-Line Fuse (Part of 14401)
14	14526	Liftgate Wiper Circuit Breaker
15	W623483-S100	Pal Nut
16	—	Stud Bracket (Part of 04320)
17	N806327-S190 (2 Req'd)	Screw
18	14B005	Front Air Bag Sensor and Bracket
19	—	To Liftgate Wiper Motor Circuit Breaker
20	56928-S36	Screw
A	—	Tighten to 11-13 Nm (8-10 Lb-Ft)
B	—	Tighten to 1.1-1.5 Nm (9.7-13.3 Lb-In)

Parking Brake Warning Lamp and Optional Premium Bucket Seat Wiring, and Optional All-Wheel Drive Controller and Wiring, Aerostar



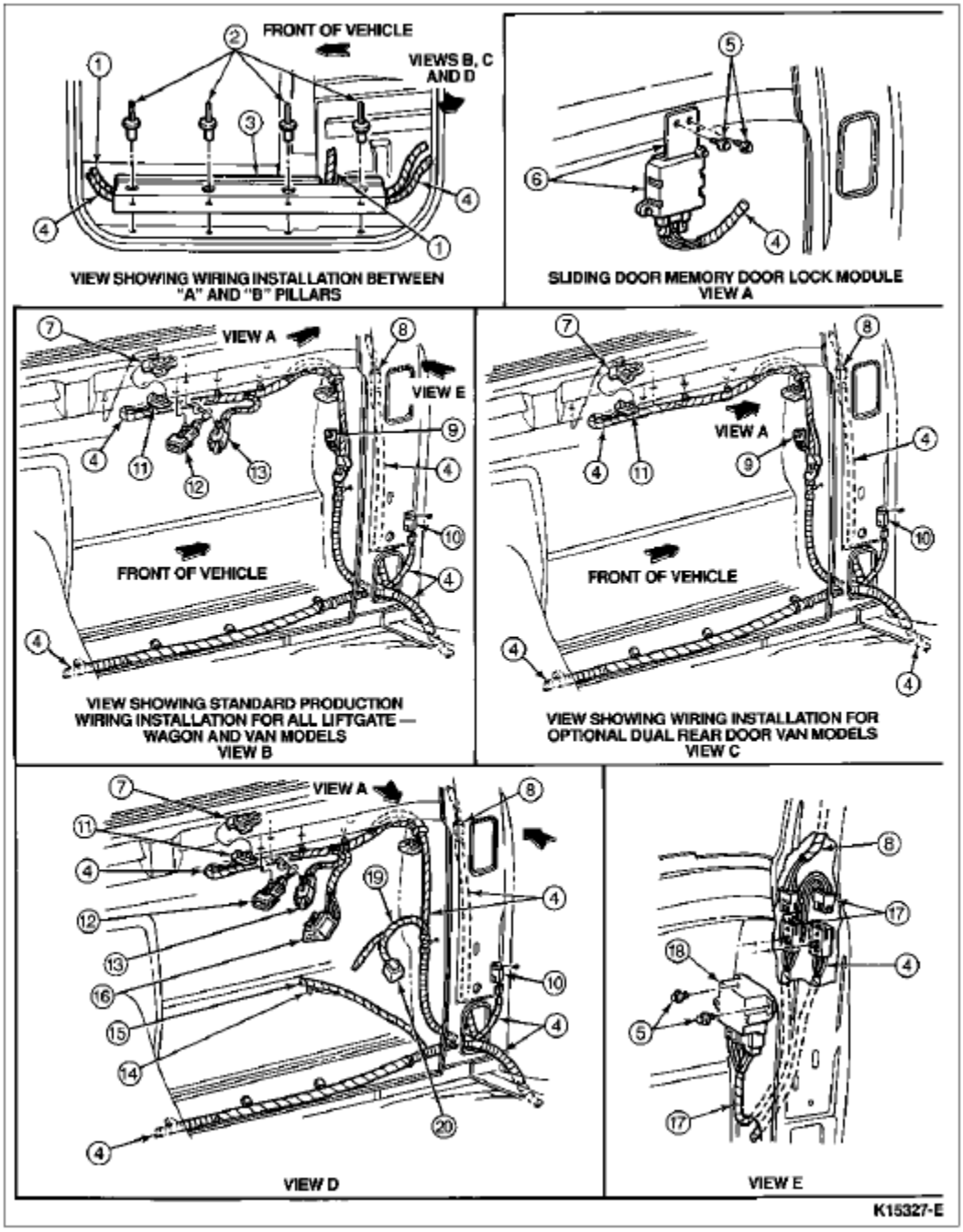
Item	Part Number	Description
1	14407	Wiring Assembly, Standard Production
2	15A851	Parking Brake Signal Switch and Bracket
3	—	Wiring Assembly, To All-Wheel Drive
4	N804081-S36M	Nut
5	—	Wiring Assembly Connector to Parking Brake Signal Switch
6	N611041-S36	Screw
7	7A377	All-Wheel Drive Transfer Case Controller Assembly
8	—	To Seat Belt Buckle Switch
A	—	Tighten to 1.4-2.2 Nm (12.4-19.5 Lb-In)

Floorpan Wiring and Sliding Door Courtesy Lamp Switch Wiring, Right, Aerostar



Item	Part Number	Description
1	14014	Door Lock Wiring
2	—	Drain Hole Plug (Part of 14405)
3	ESB-M3G58-A	Tape (2 In. x 4 In. Long)
4	—	Shield (Part of 14014)
5	13A786	Courtesy Lamp Switch Actuator
6	381801-S55	Screw
7	13713	Lamp Switch
8	14677	Relay
9	—	To Interior Lamp 13776
A	—	Cutouts in Shield Must Clear Drain Hole Plugs

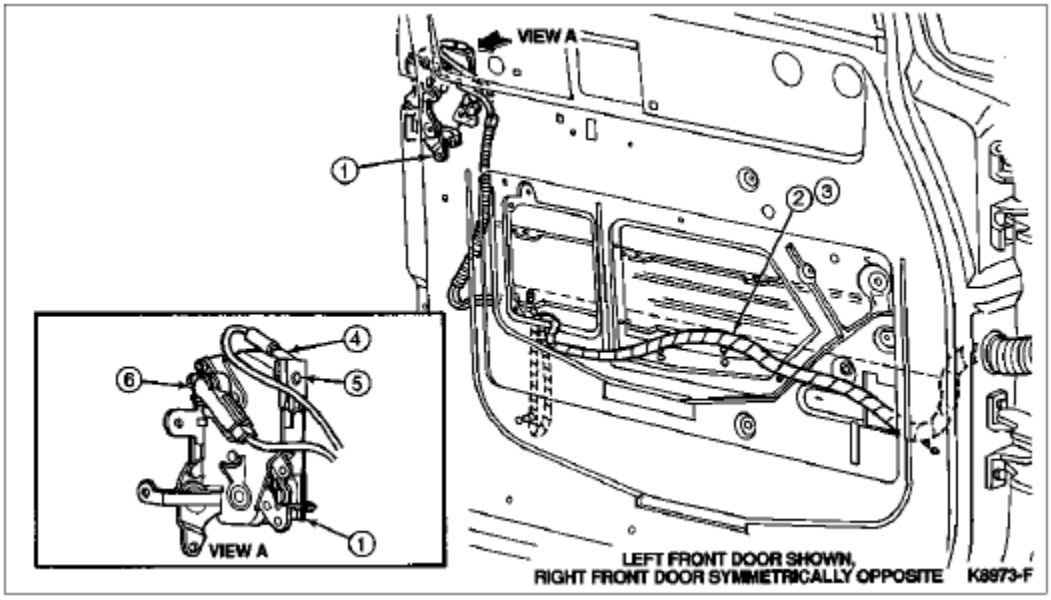
Floorpan Wiring, LH Side — Aerostar



Item	Part Number	Description
1	14407	Fuel Tank Sender Jumper Wiring
2	N803739-S	Rivet
3	14A099	Wiring Shield
4	14405	Rear Lamp Wiring
5	54928-S2	Screw
6	—	Door Lock Control Module

7	18A900	Radio Receiver Rear Seat Speaker Wiring
8	14334	Interior Lamp Wiring
9	—	To Stereo Speaker (Part of 14405)
10	—	Lamp Switch
11	—	To Remote Radio Headphone Box (Part of 14405)
12	—	To Rear Control Lighting (Part of 14405)
13	—	To Cigar Lighter (Part of 14405)
14	—	To Refrigerant Valve Solenoid (Part of 14405)
15	14405	To Auxiliary Heater Blower Motor
16	—	To Auxiliary Blower Motor Switch (Part of 14405)
17	13B712	Courtesy Lamp Feed Wire
18	13C718	Illuminating Entry Actuator
19	—	To Auxiliary Blower Motor Resistor and Vacuum Tube (Part of 14405)
20	—	To Auxiliary A/C Relay (Part of 14405)

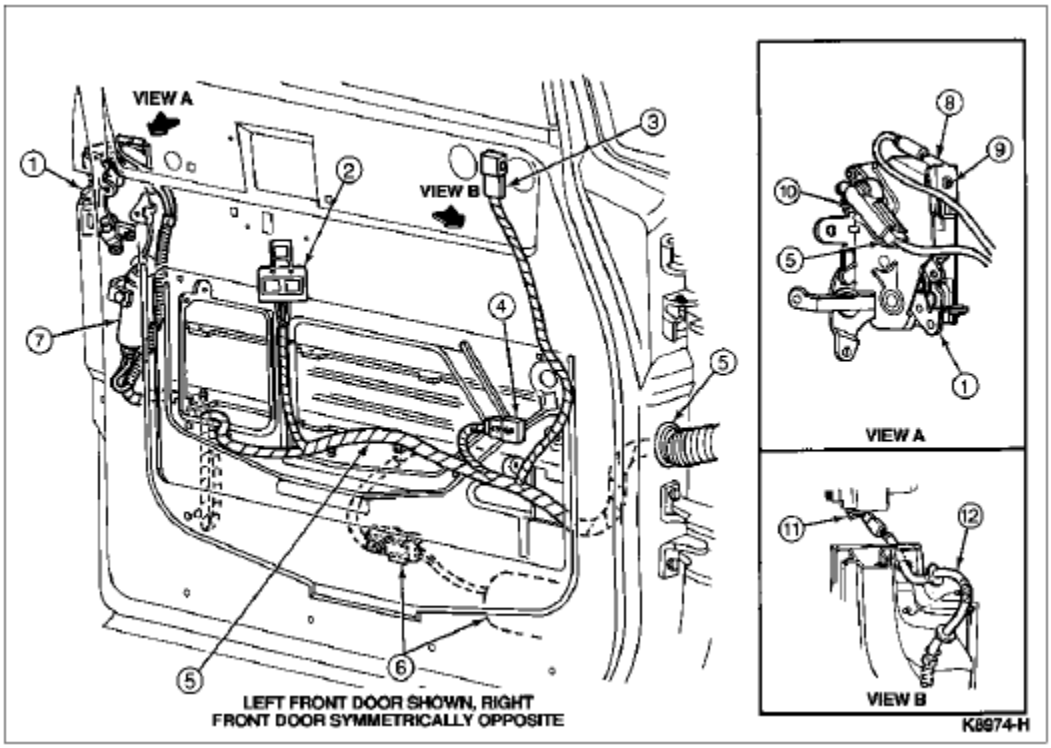
Door Wiring, Left, with Optional Light Group, Aerostar



Item	Part Number	Description
1	21812	Front Door Latch
2	14631	Front Window Regulator Wiring (LH Door)

3	14630	Front Window Regulator Wiring (RH Door)
4	13752	Interior Lamp Switch
5	55928-S36	Screw
6	14A018	Door Ajar Switch

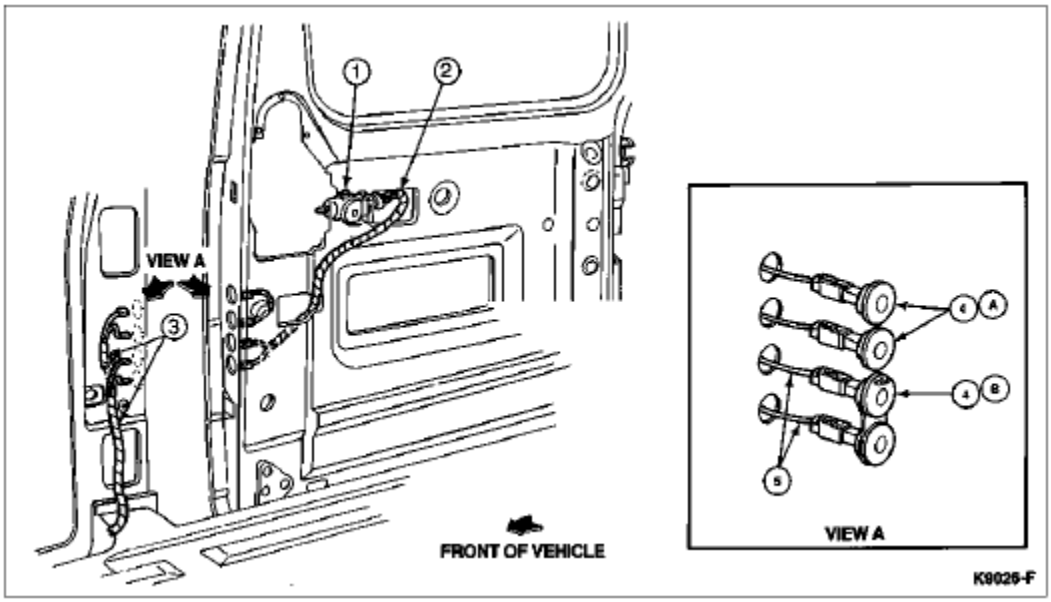
Door Wiring, Left, with Power Locks and Windows, Aerostar



Item	Part Number	Description
1	21812	Front Door Latch
2	—	To Window and Door Lock Control Switch (Part of 14631)
3	—	To Power Mirror Wiring
4	—	To Power Mirror Switch (Part of 14631)
5	14631	Front Window Regulator Wiring
6	23394	Window Regulator Electric Drive
7	218A42	Power Door Lock Actuator
8	13752	Interior Lamp Switch
9	55928-S36	Screw
10	14A018	Door Ajar Switch
11	17682	Outside Rear View Mirror

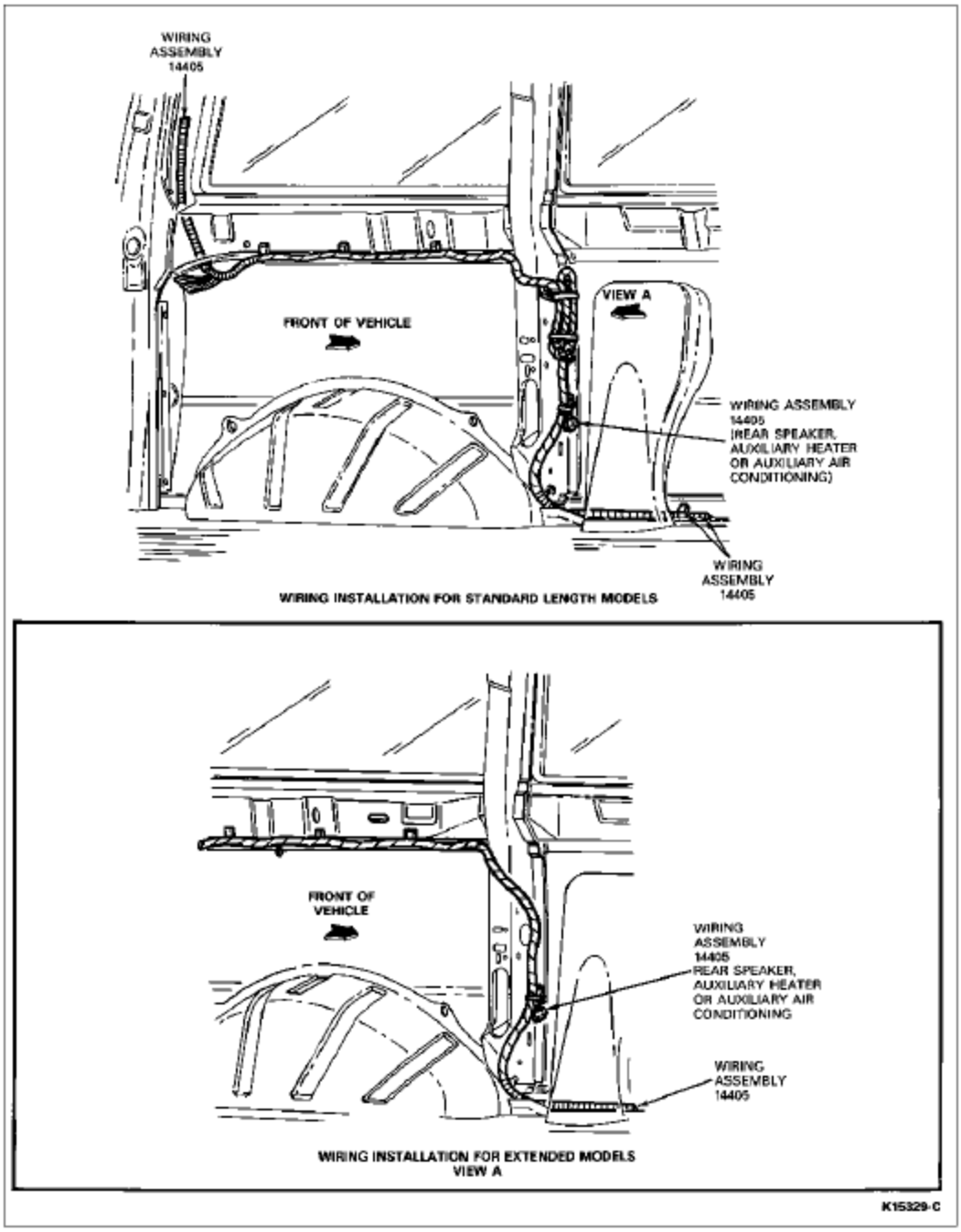
12	17D708	Power Mirror Wiring

Door Wiring, Sliding, with Power Locks — Aerostar

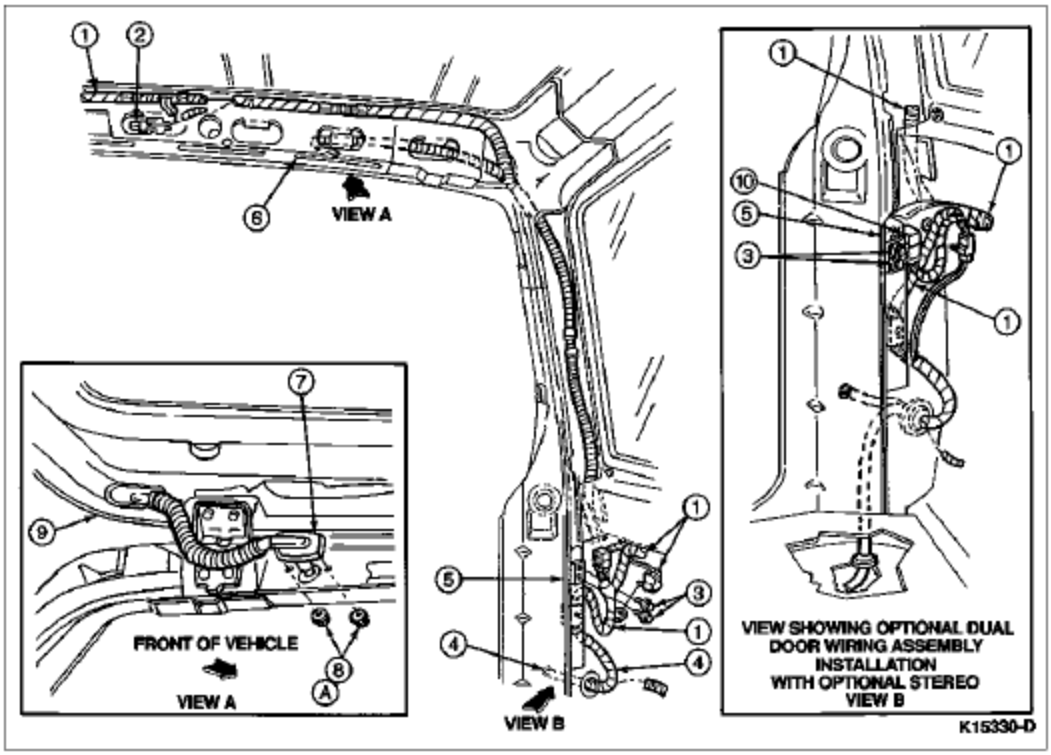


Item	Part Number	Description
1	58218A42	Power Door Lock Actuator
2	14790	Door Open Warning Lamp Wiring
3	14014	Door Lock Feed Wiring
4	14A658	Terminal Assembly Contact
5	—	To Power Door Locks
A	—	Door Ajar Switch Contacts
B	—	Power Door Lock Contacts

Wiring Between C- and D-Pillars, Left, Aerostar

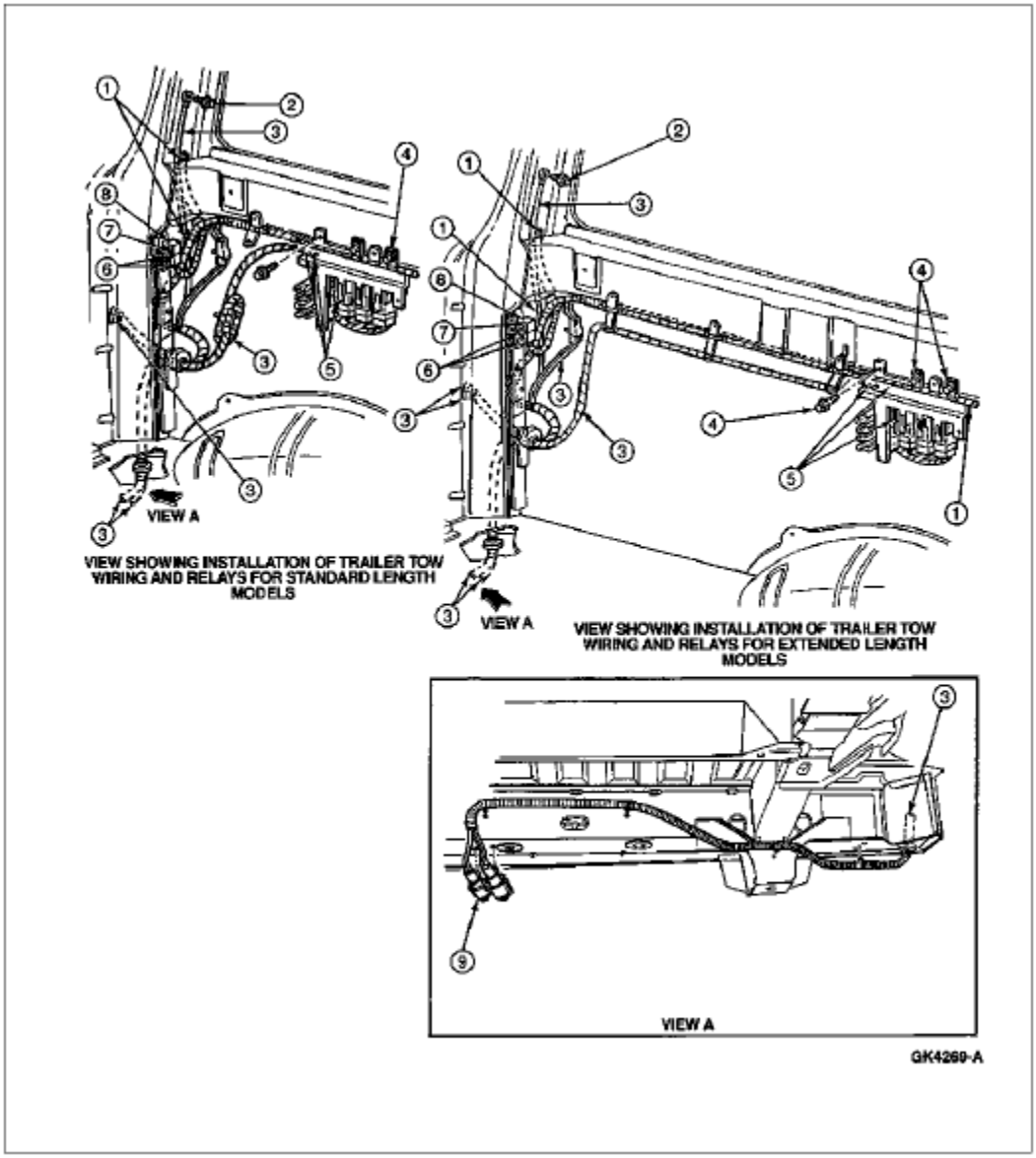


D-Pillar Wiring, Left — Aerostar



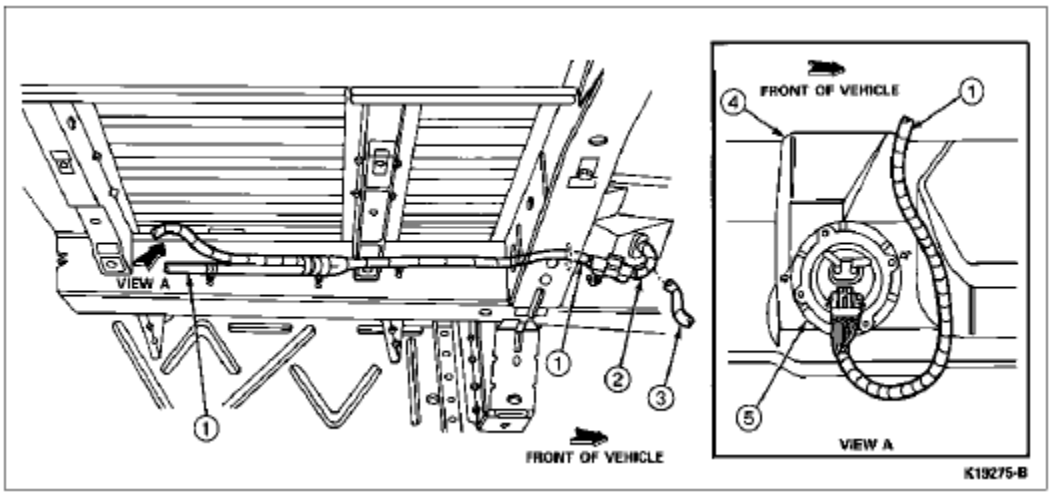
Item	Part Number	Description
1	14405	Rear Lamp Wiring
2	13788	Interior Lamp Door
3	N802761-S36	Screw
4	13A409	Rear Lamp Connector Wiring
5	14A206	Wire Connector Bracket
6	—	To Rear License Lamp Feed Wiring
7	13B440	Liftgate Jumper
8	N621901-S36	Nut
9	40010	Liftgate
10	13A775	Courtesy Lamp Relay
A	—	Tighten to 2-3 Nm (18-26 Lb-In)

Trailer Tow Wiring and Relay Installation — Aerostar



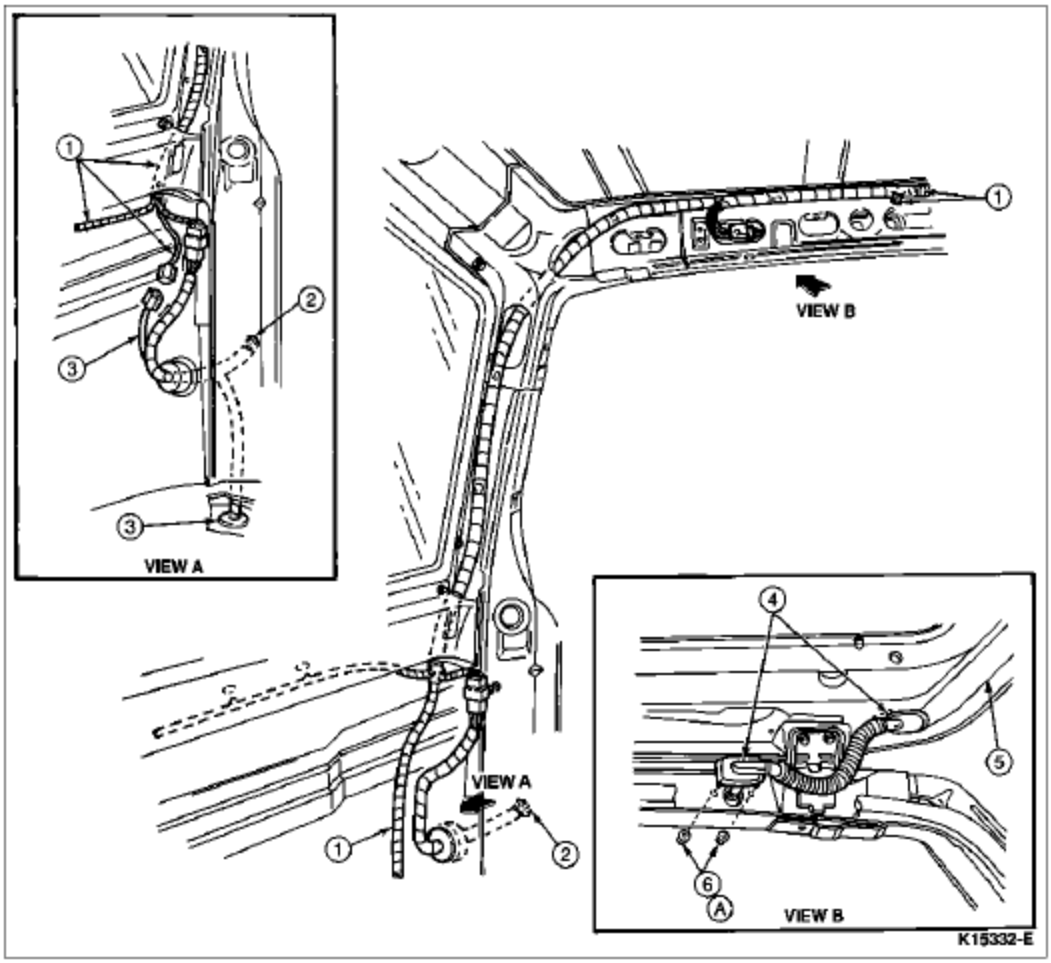
Item	Part Number	Description
1	14405	Rear Lamp Wiring
2	N801846-S36	Screw
3	13A409	Rear Lamp Connector Wiring
4	56902-S2	Screw
5	14677	Relay
6	N802761-S36	Screw
7	14A206	Wire Connector Bracket
8	13A775	Courtesy Lamp Relay
9	—	Trailer Tow Connectors (Part of 13A409)

Fuel Tank and Underbody Wiring, Aerostar



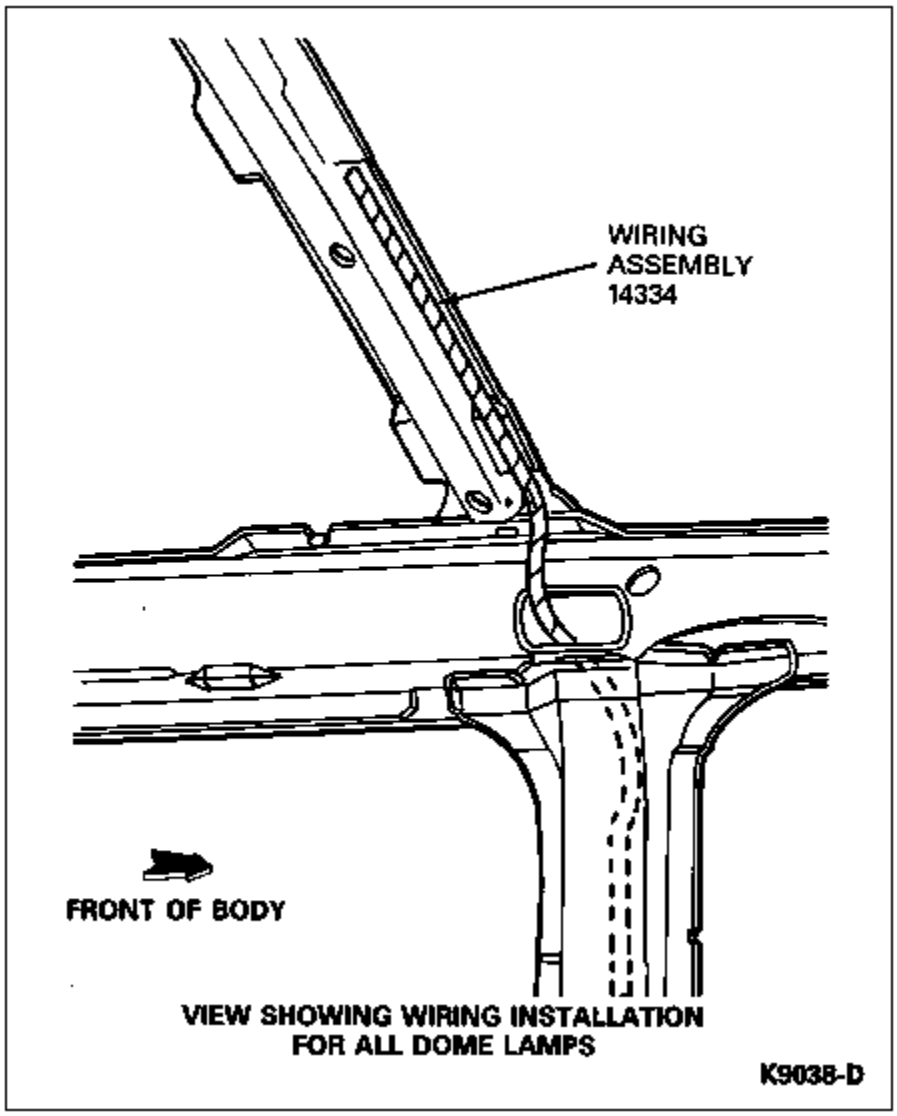
Item	Part Number	Description
1	14406	Fuel Tank Sender Wiring
2	14407	Fuel Tank Sender Jumper Wiring
3	14407	Fuel Tank Sender Jumper Wiring, for Optional All-Wheel Drive Vehicles Only
4	9002	Fuel Tank
5	9275	Fuel Tank Sending Unit

D-Pillar Wiring, RH — Aerostar

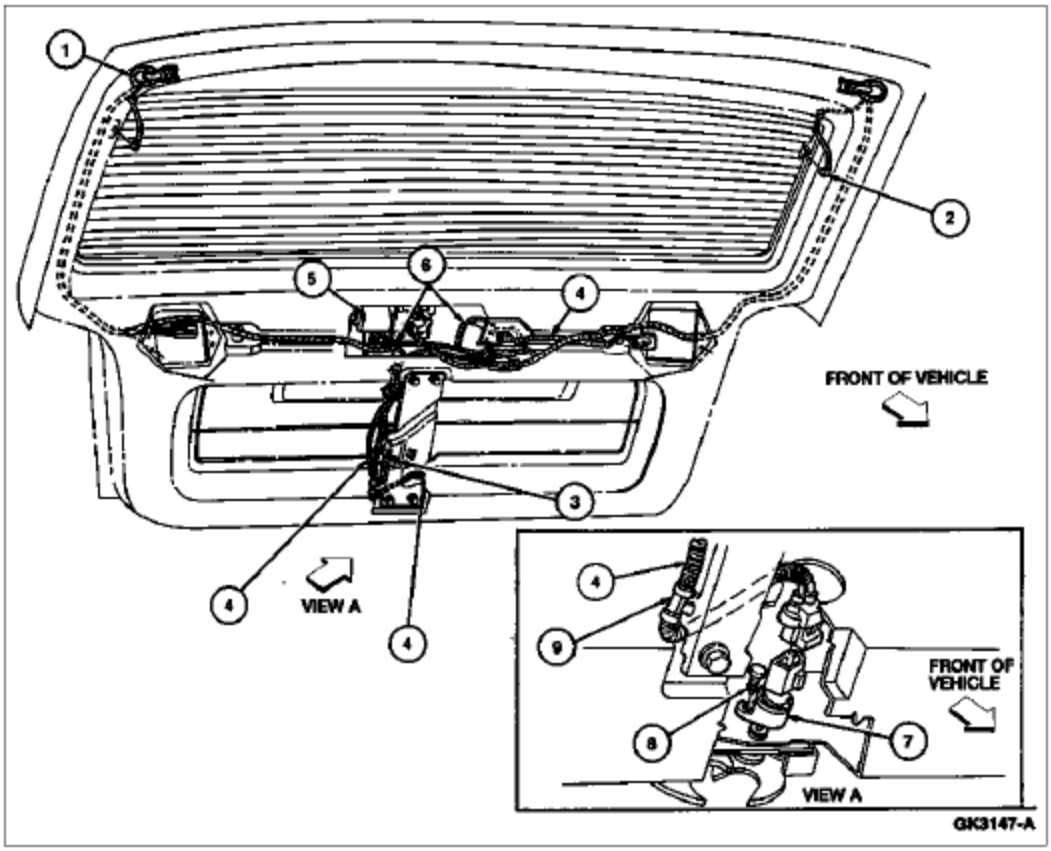


Item	Part Number	Description
1	14405	Rear Lamp Wiring to Optional Rear Washer Reservoir
2	—	To Rear Lamps (Part of 14405)
3	13A409	Rear Lamp Connector Wiring
4	—	Liftgate Wiring
5	40010	Liftgate
6	N621901-S36	Nut
A	—	Tighten to 2-3 Nm (18-26 Lb-In)

Dome Lamp, Aerostar

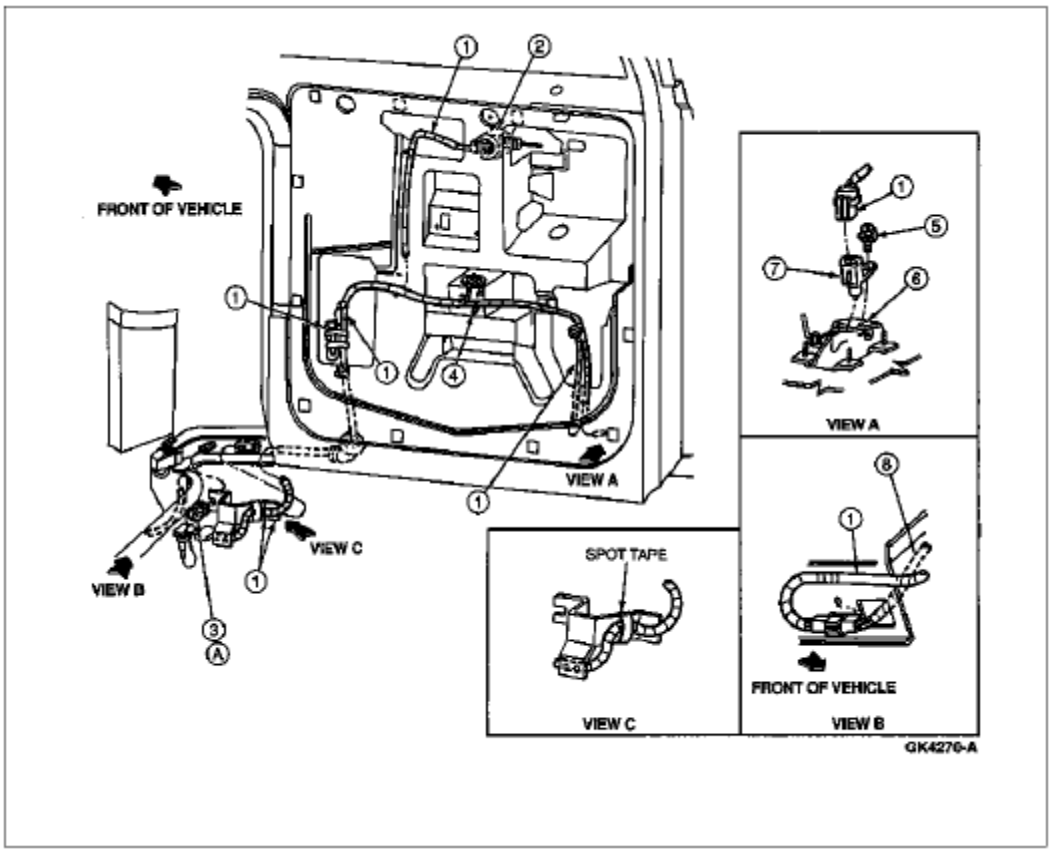


Liftgate — Aerostar



Item	Part Number	Description
1	13B440	Liftgate Jumper Wiring for Optional Power Door Locks/Windows — All Wagon Models and Included in RV Converter Deluxe Van
2	—	Heated Back Window Control Wiring (Part of 13B440)
3	431A38	Door Lock Actuator
4	13412	Rear License Lamp Wiring and Socket, for Optional Rear Window Wiper with or Without Door Ajar or Optional Rear Electric Defroster — All Models
5	—	Liftgate Wiper Motor
6	13410	Lamp Socket and Wiring, License Lamps
7	10C872	Door Ajar Switch
8	52780-S2	Screw
9	14A163	Wiring Harness Retainer

Rear Door Wiring, Right Side Dual Rear Doors, License Lamp Wiring, Aerostar



Item	Part Number	Description
1	14A412	Door Lock Lead Wire
2	218A42	Power Door Lock Actuator
3	N804456-S54	Nut
4	—	To License Lamp
5	52780-S2	Screw
6	43288	Rear Door Latch
7	10C872	Door Ajar Switch
8	13A409	Rear Door Wiring
A	—	Tighten to 5.0 Nm (44 Lb-In)

Wiring Harness, Ranger

The illustrations in this section show the complete wiring harness installation for Ranger vehicles. Refer to the illustrations for the harness being replaced while performing the following removal and installation procedures. Refer to the Electrical and Vacuum Troubleshooting Manual for overviews of wiring harnesses.

Removal

1. Disconnect battery to starter relay cable (14300).
2. **NOTE: Refer to Section 01-05A to remove any trim panels to gain access to the harness.**

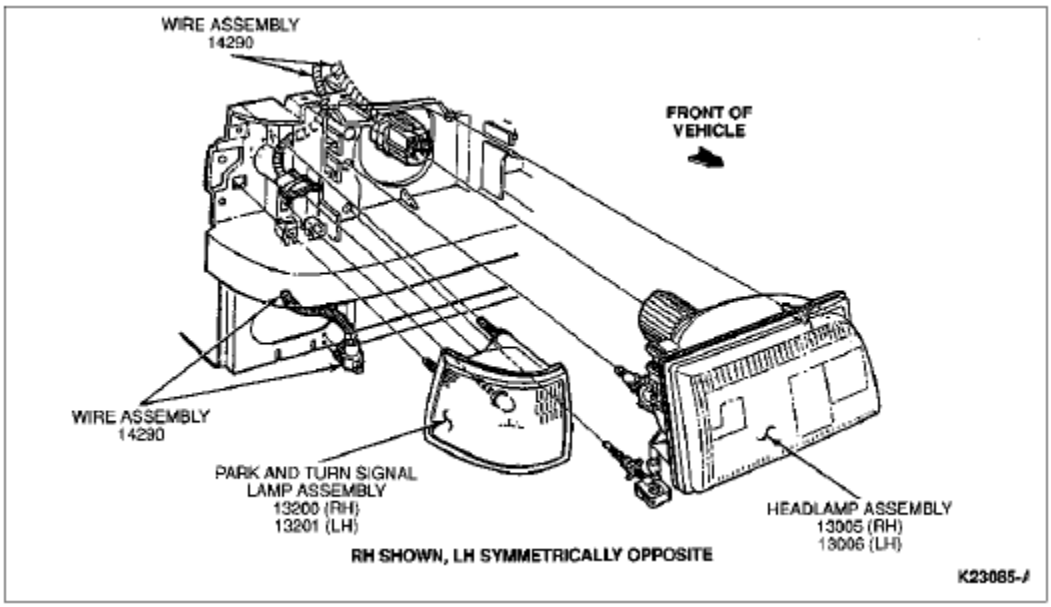
   Disconnect all wiring harness connectors.
3. Disengage harness from all locators, straps or clips as necessary, including ground wire eyelets. Remove harness from vehicle.

Installation

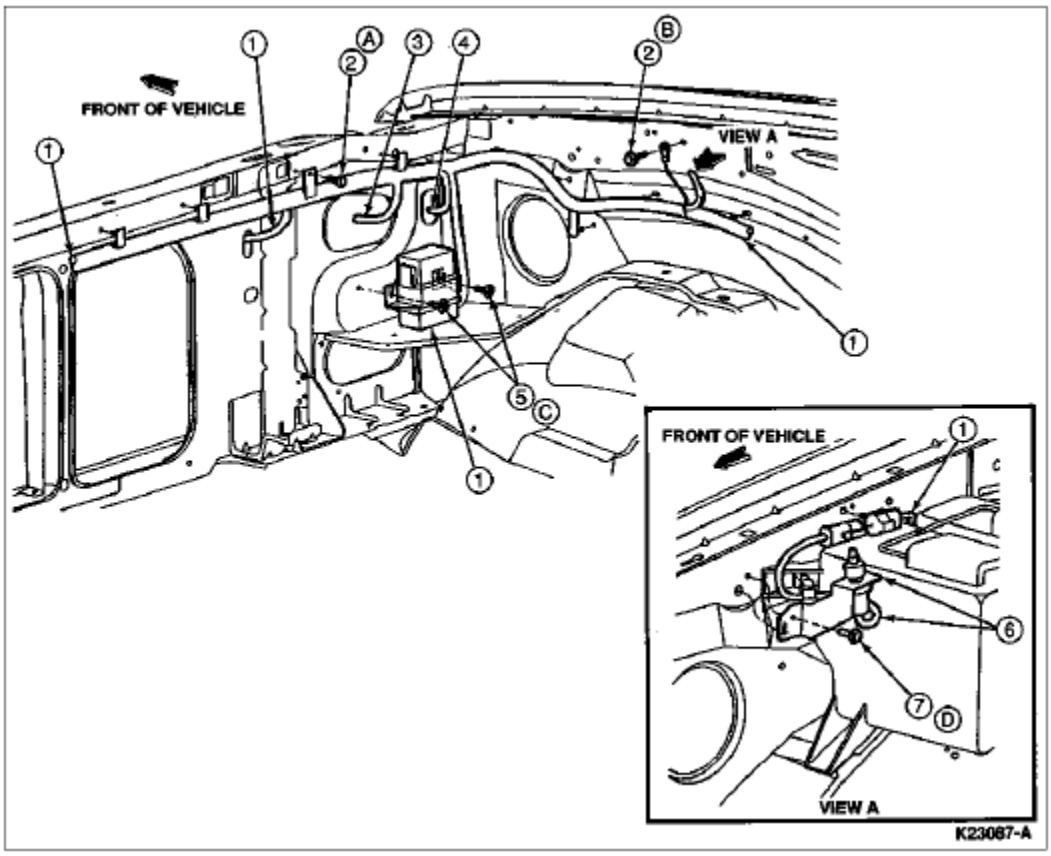
1. Position harness in vehicle. Make sure that harness is engaged in all locators, straps or clips.
2. Connect all harness connectors to components or other harnesses as necessary.
3. Secure ground eyelets to body as necessary.
4. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

   Connect battery to starter relay cable. Check all applicable circuits for proper operation.
5. Install any trim removed during harness removal.

Headlamp and Wiring, Ranger



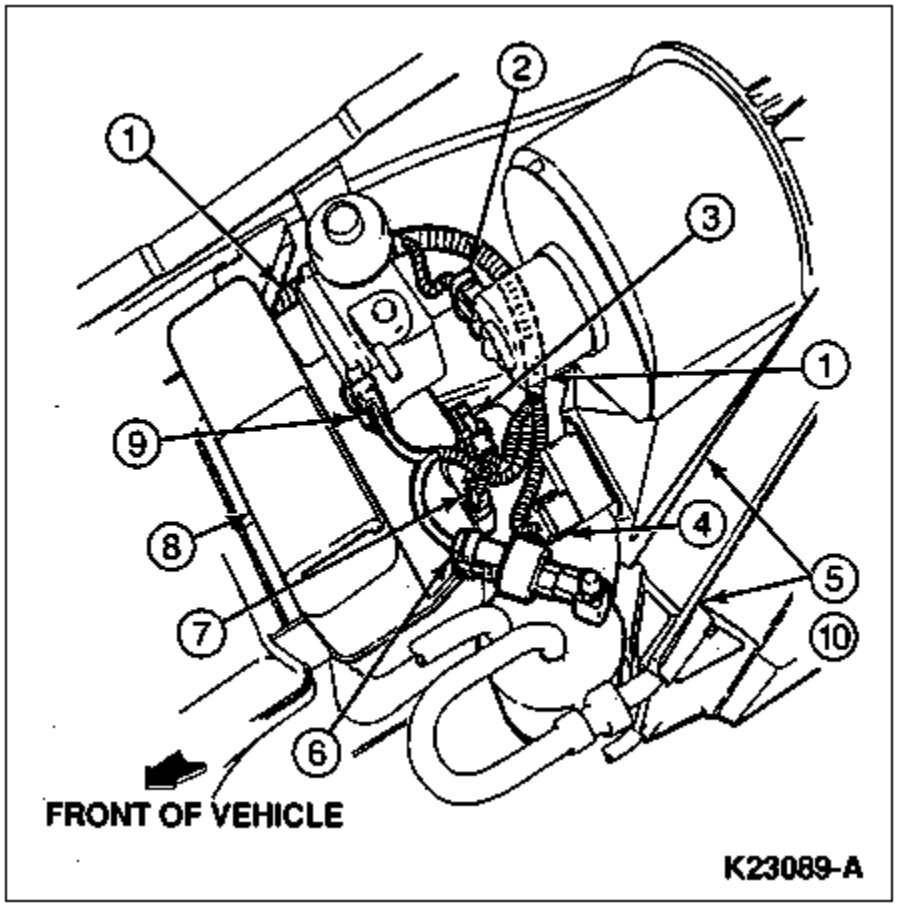
Front End and Fender Apron Wiring, RH, Ranger



Item	Part Number	Description
1	14290	Headlamp Dash Panel Junction Wire

2	N805375-S36MG	Screw
3	—	To Headlamp
4	—	To Park and Turn Signal Lamp
5	N804234-S36MG	Screw
6	19A434	Anti-Theft Control Bracket and Switch
7	N800312-S2	Screw
A	—	Tighten to 3.1-4.3 Nm (27-38 Lb-In)
B	—	Tighten to 11-13 Nm (91-122 Lb-In)
C	—	Tighten to 3.6-4.6 Nm (32-40 Lb-In)
D	—	Tighten to 5-6 Nm (40-55 Lb-In)

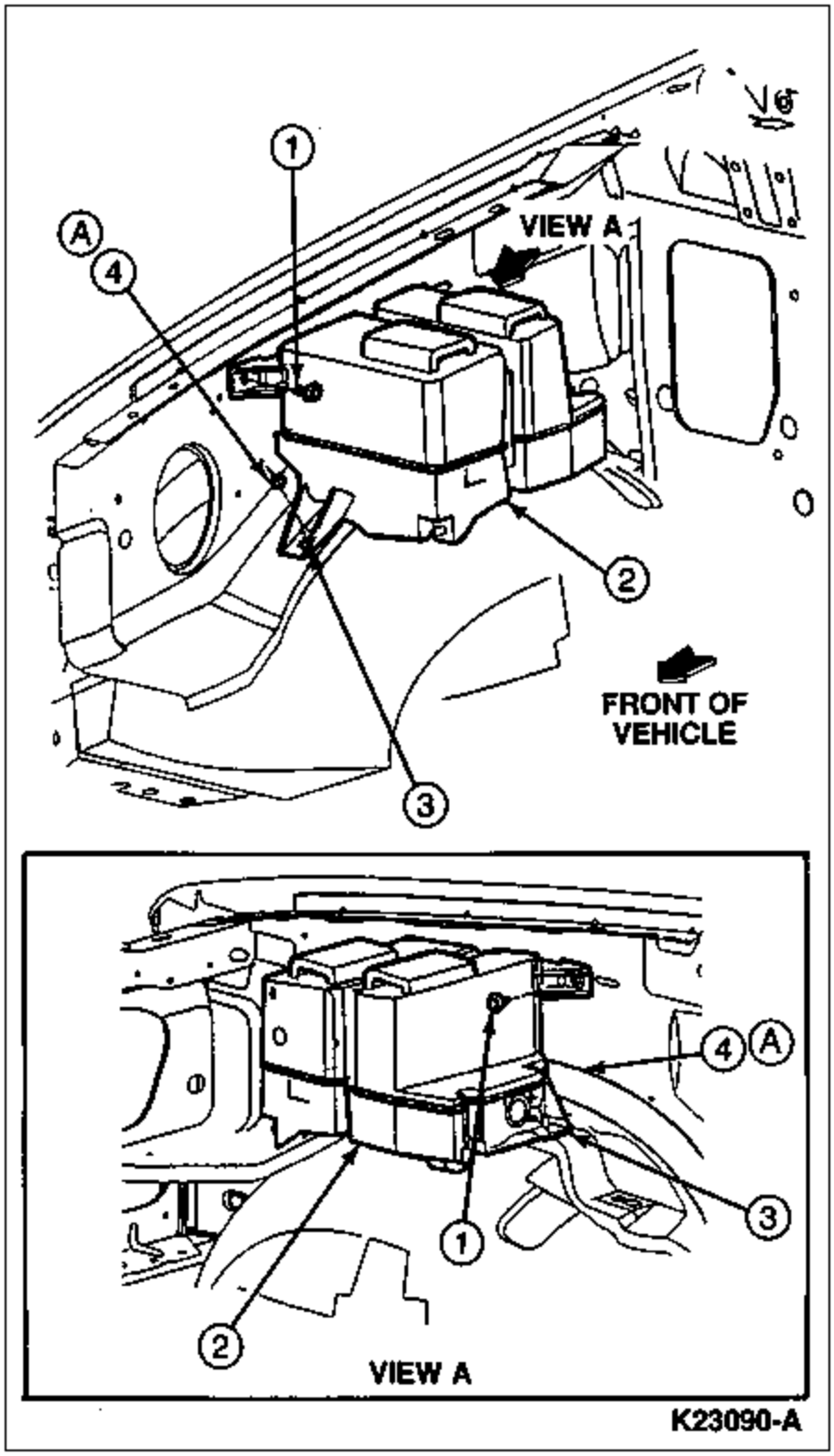
Fender Apron and Dash Panel Wiring, RH, Ranger



Item	Part Number	Description

1	14290	Headlamp Dash Panel Junction Wire
2	—	To Blower Motor
3	—	To Low Washer Fluid Sensor (Explorer Only)
4	—	To Blower Resistor
5	18A484	Heater Plenum Chamber Case
6	—	To A/C Cycle Pressure Switch
7	—	To Windshield Washer Pump
8	17618	Windshield Washer Reservoir
9	—	To Speed Control
10	19850	A/C Evaporator Housing

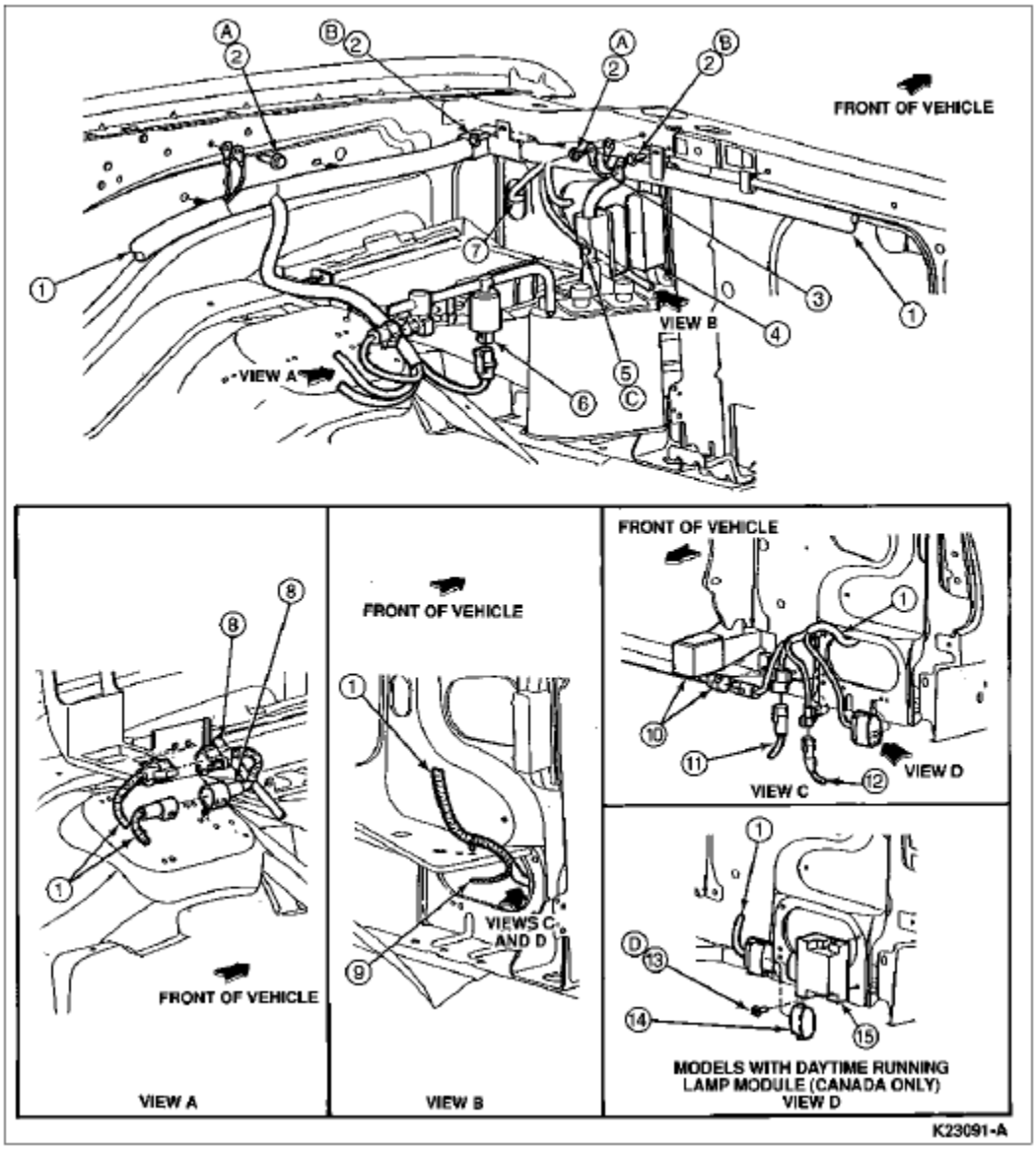
Coolant Overflow and Windshield Washer Reservoir



Item	Part Number	Description
1	W611102-S36	Screw
2	17618	Windshield Washer Reservoir

3	N800946-S36	Retainer
4	N621905-S36	Nut
A	—	Tighten to 5-6 Nm (41-55 Lb-In)

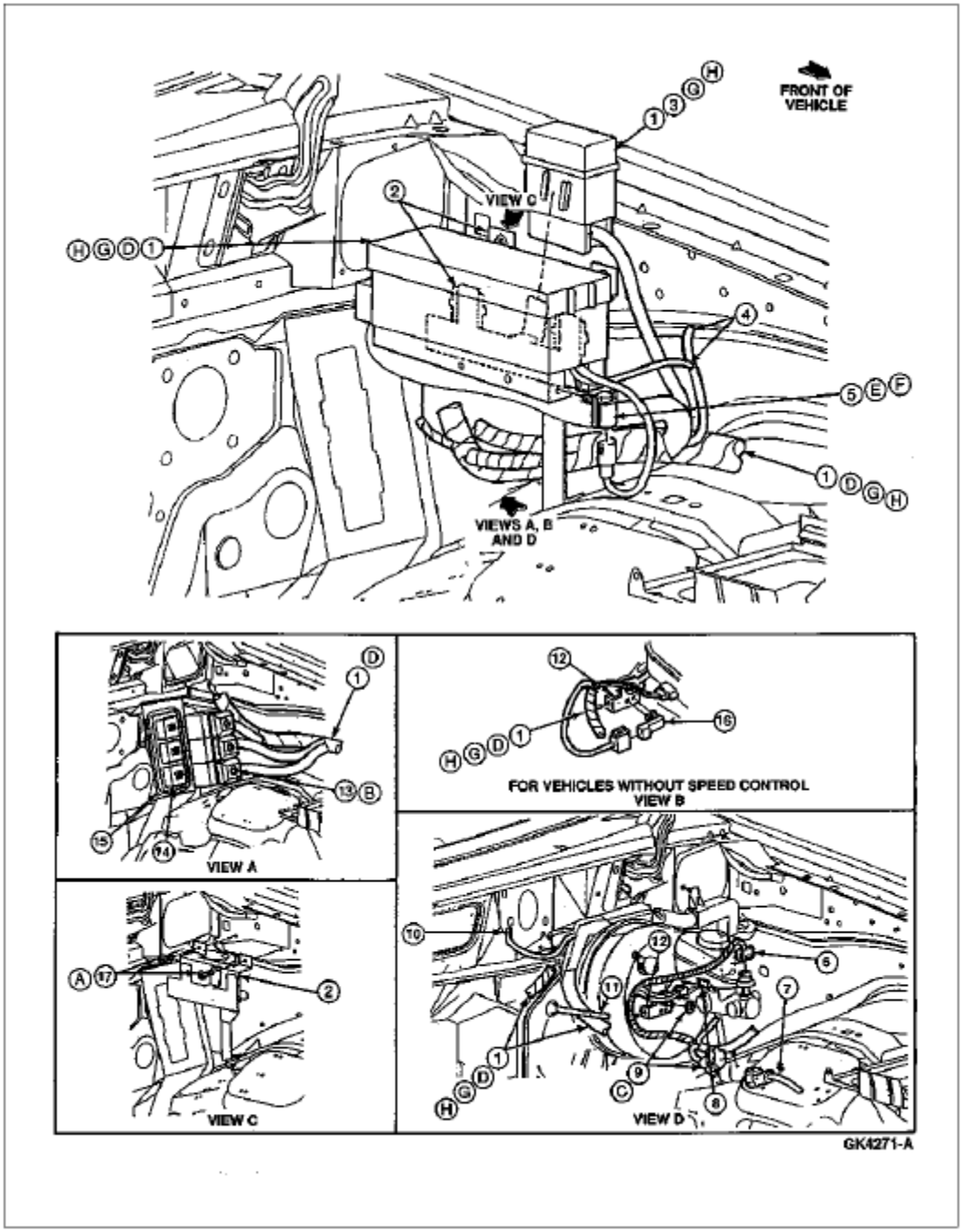
Front End and Fender Apron Wiring, LH, Ranger



Item	Part Number	Description
1	14290	Headlamp Dash Panel Junction Wire
2	N805375-S36MG	Screw
3	—	To Body Ground
4	12A199	Ignition Control Module

5	—	Bolt (Part of 14290)
6	9D653	Evaporative Emissions Canister Control Valve
7	—	To Headlamp and Park/Turn Signal Lamp
8	—	To Anti-Lock Brake System Hydraulic Motor
9	—	To Horn (13832)
10	14B004	Front Air Bag Sensor and Bracket
11	15200	Fog Lamp
12	—	To Anti-Lock Brake Sensor (2L373)
13	N807522-S36	Screw
14	—	Wiring Connector Plug (Part of 14290)
15	15A272	Daytime Running Lamps Control
A	—	Tighten to 11-13 Nm (8-10 Lb-Ft)
B	—	Tighten to 3.1-4.3 Nm (28-38 Lb-In)
C	—	Tighten to 2.7-3.7 Nm (24-32 Lb-In)
D	—	Tighten to 2.3-3.3 Nm (21-29 Lb-In)

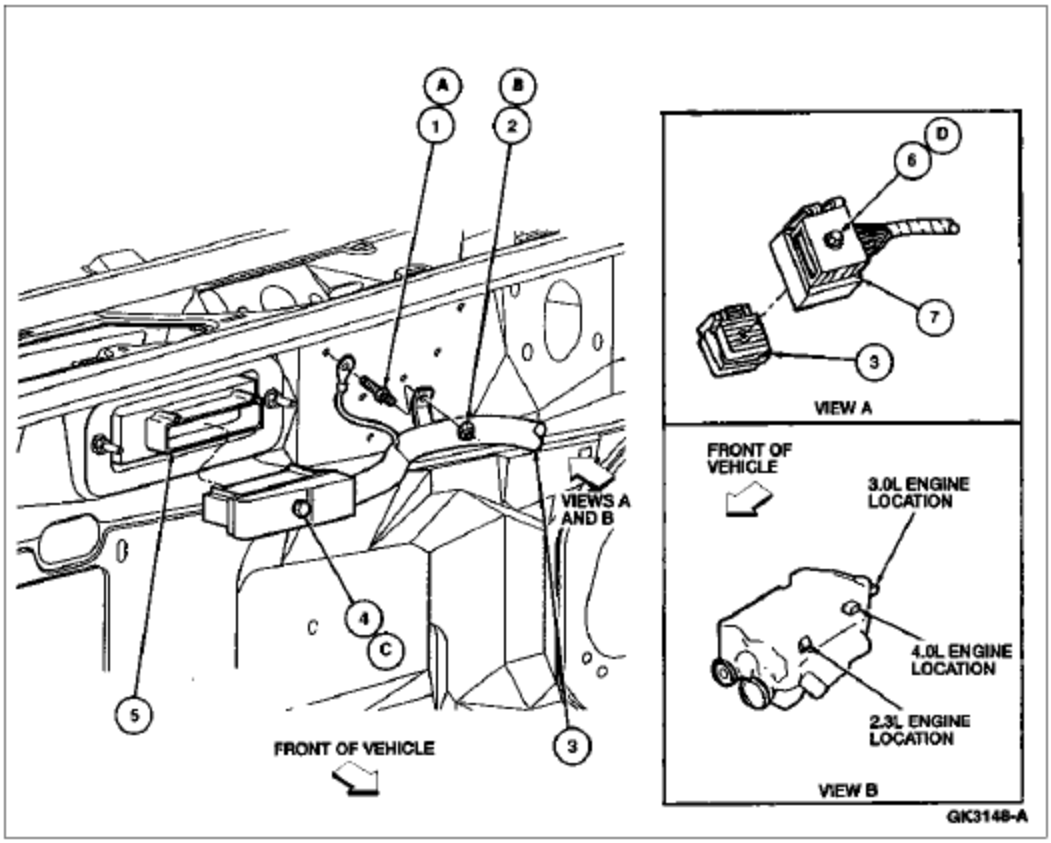
Fender Apron and Dash Panel Wiring, LH, Ranger



Item	Part Number	Description
1	14290	Headlamp Dash Panel Junction Wire
2	14A254	Fuse Junction Panel Mounting Bracket
3	—	Relay Module Assembly (Part of 14290)
4	—	To Starter Motor Solenoid Relay Switch (11450)
5	14A428	Wire Connector Cover
6	—	Speed Control Pressure Switch Connector
7	14305	Generator Voltage Regulator Wiring

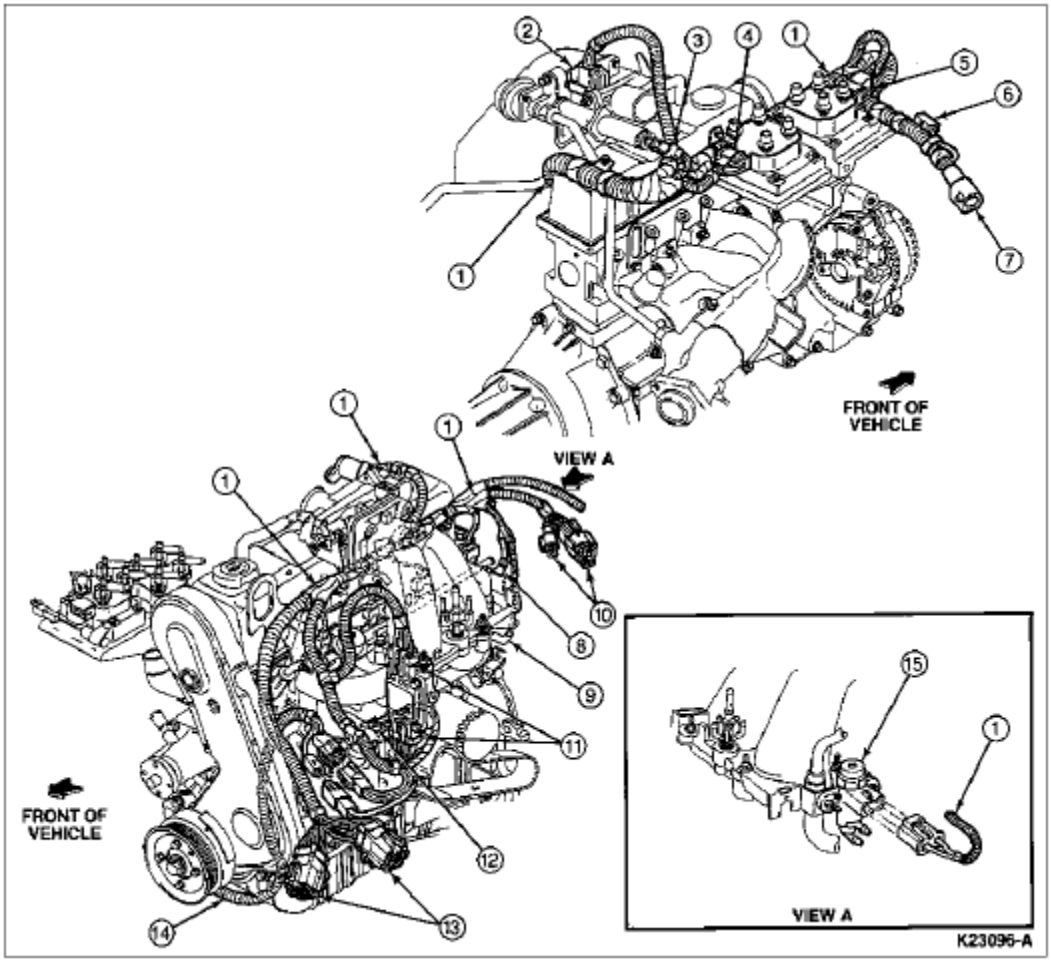
8	—	Brake Fluid Level Sensor (Part of 2K478)
9	382802-S2	Nut
10	—	To Windshield Wiper Motor (17504)
11	9A758	Accelerator Cable
12	7B085	Wiring Harness Retainer
13	—	Screw (Part of 14290)
14	14401	Main Wiring
15	14A541	Main Wiring Harness to Dash Panel Seal
16	14A666	Wiring Connector Plug
17	N610959-S36	Screw
A	—	Tighten to 5-6 Nm (40-55 Lb-In)
B	—	Tighten to 4.5-5.6 Nm (36-49 Lb-In)
C	—	Tighten to 11-13 Nm (8-10 Lb-Ft)
D	—	Power Distribution Box (Part of 14290)
E	—	To RABS Test Connector
F	—	Harness Routing for 2.3L and 4.0L Engines
G	—	Harness Routing for 3.0L Engine

Powertrain Control Module Wiring and Engine Wiring Interconnect



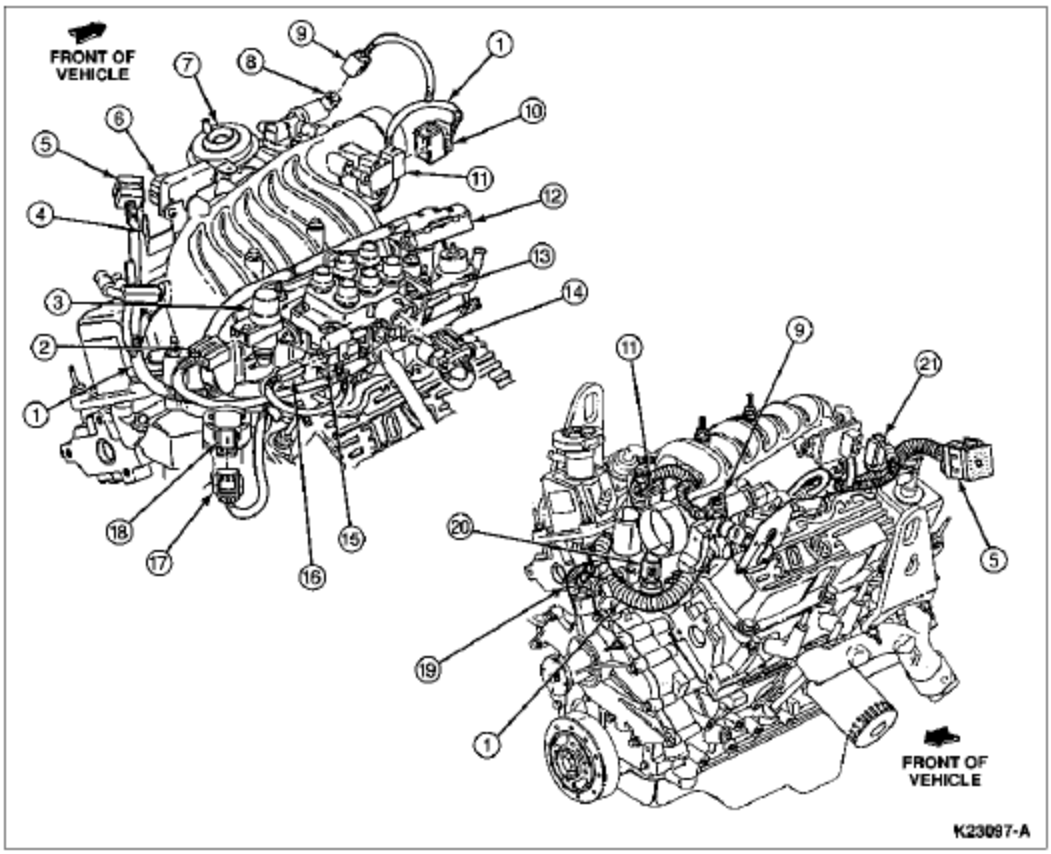
Item	Part Number	Description
1	N806925-S36M	Stud
2	N621906-S301	Nut
3	12A581	Engine Control Sensor Wiring
4	—	Bolt (Part of 12A581)
5	12A650	Powertrain Control Module
6	—	Bolt (Part of 14290)
7	14290	Headlamp Dash Panel Junction Wire
A	—	Tighten to 11-13 Nm (8-10 Lb-Ft)
B	—	Tighten to 6-8 Nm (53-71 Lb-In)
C	—	Tighten to 6-7 Nm (46-63 Lb-In)
D	—	Tighten to 4.0-5.6 Nm (36-49 Lb-In)

Engine Wiring, 2.3L Engine



Item	Part Number	Description
1	9D930	Fuel Charging Wiring
2	9B989	Throttle Position Sensor
3	9F715	Idle Air Control Valve
4	12A310	Primary Coil
5	12A310	Secondary Coil
6	—	To Radio Capacitor (18801)
7	—	Connector to Engine Coolant Temperature Sensor
8	9278	Oil Pressure Sensor
9	10884	Water Temperature Indicator Sender Unit
10	—	To 12A690 Transmission Wiring Assembly
11	—	To Ignition Control Module (12A199)
12	—	To Distributor Stator (12A112)
13	—	To 14290 and 12A581 Wiring Assemblies
14	—	To Crankshaft Position Sensor (6C315)
15	9J459	EGR Vacuum Regulator Solenoid

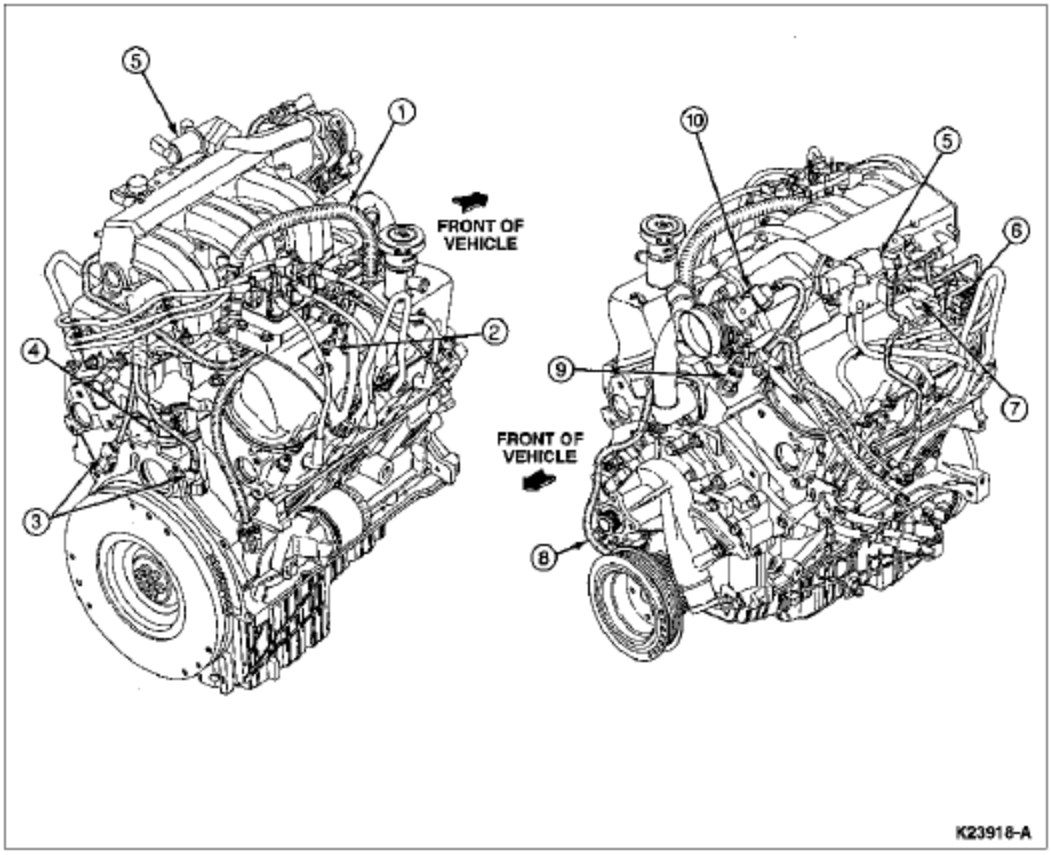
Engine Wiring, 3.0L Engine



Item	Part Number	Description
1	9D930	Engine Control Sensor Wiring
2	—	Connector to EGR Vacuum Regulator Control (Part of 9D930)
3	9J459	EGR Vacuum Regulator Solenoid
4	—	EGR Transducer Bracket (Part of 9J433)
5	—	42-Pin Connector to Engine Compartment Wiring Assembly (Part of 9D930)
6	9J433	EGR Transducer
7	9D475	EGR Valve
8	9F715	Idle Air Control Valve
9	—	Connector to Idle Air Control Valve (Part of 9D930)
10	—	Connector to Throttle Position Sensor (Part of 9D930)
11	9B989	Throttle Position Sensor
12	—	PCM Connector (Part of 9D930)

13	12029	Ignition Coil
14	—	Connector to Ignition Coil (Part of 9D930)
15	18801	Radio Ignition Interference Capacitor
16	—	Connector to Radio Interference Capacitor (Part of 9D930)
17	—	Connector to Camshaft Position Sensor (Synchronizer) (Part of 9D930)
18	12A112	Camshaft Position Sensor
19	10884	Water Temperature Indicator Sender Unit
20	12A648	Engine Coolant Temperature Sensor
21	—	Connector to EGR Transducer (Part of 9D930)

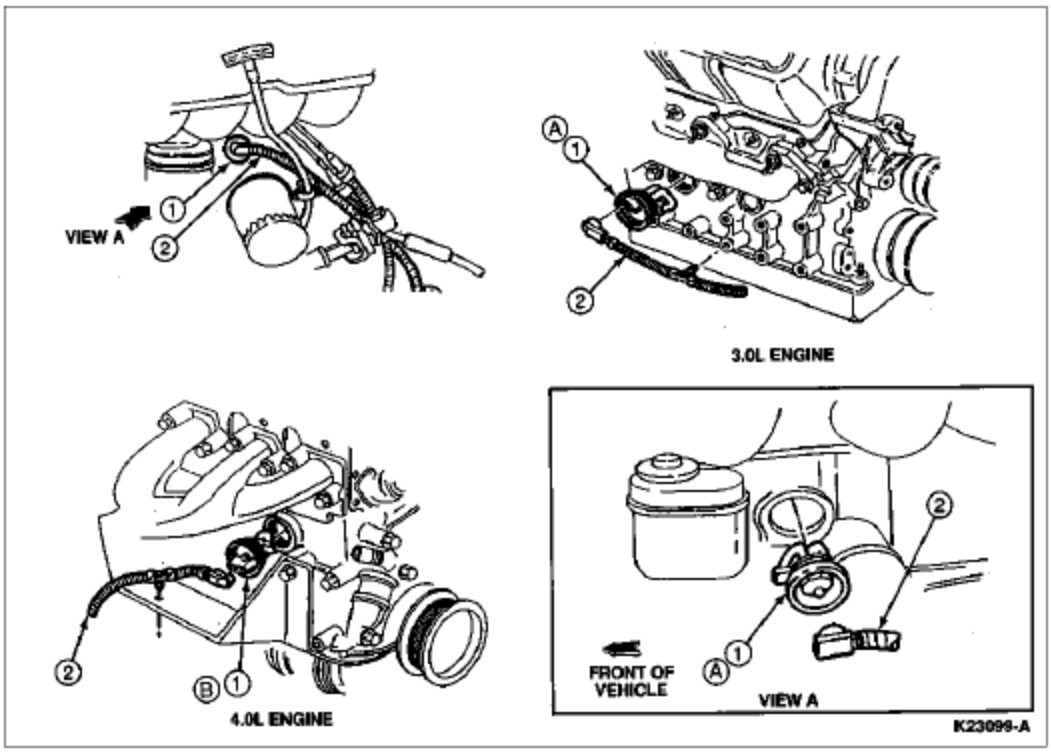
Engine Wiring, 4.0L Engine



Item	Part Number	Description
1	9D930	Fuel Charging Wiring
2	—	To Radio Capacitor (18801)
3	—	To Heated Oxygen Sensors (9F472)

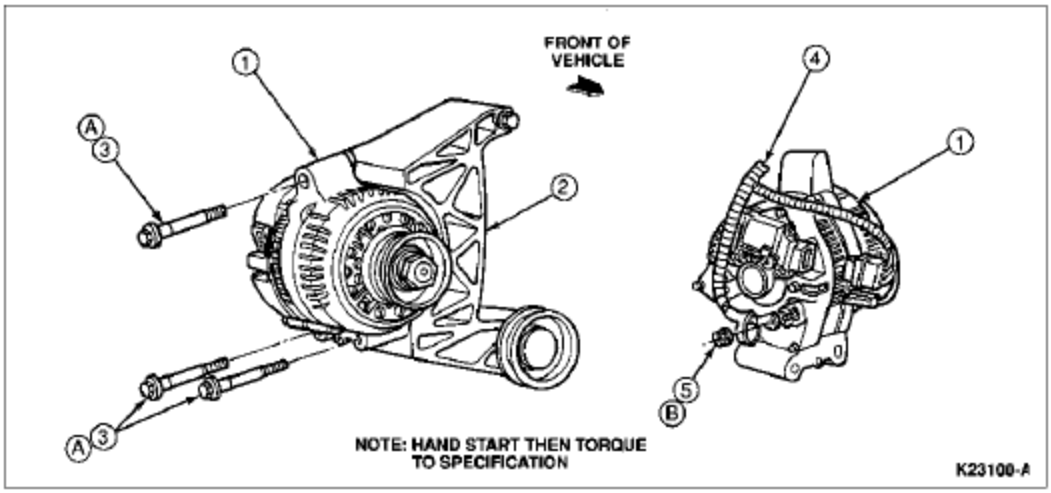
4	—	To Distributor Stator (12A112)
5	9F715	Idle Air Control Valve
6	—	To Headlamp Dash Panel Junction Wire and Engine Control Sensor Wiring Assemblies
7	9J459	EGR Vacuum Regulator Solenoid
8	—	To Crankshaft Position Sensor (6C315)
9	12A648	Engine Coolant Temperature Sensor
10	9B989	Throttle Position Sensor

Block Heater and Wiring



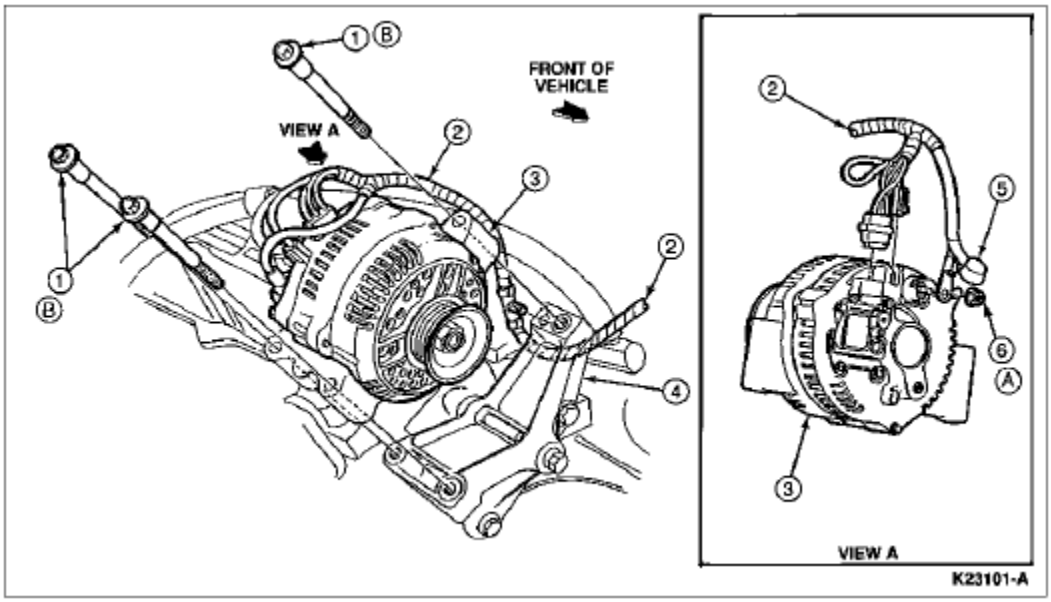
Item	Part Number	Description
1	6A051	Block Heater
2	6B018	Block Heater Wiring
A	—	Orient Block Heater in 6 o'Clock Position
B	—	Orient Block Heater in 12 o'Clock Position

Alternator and Wiring, 2.3L



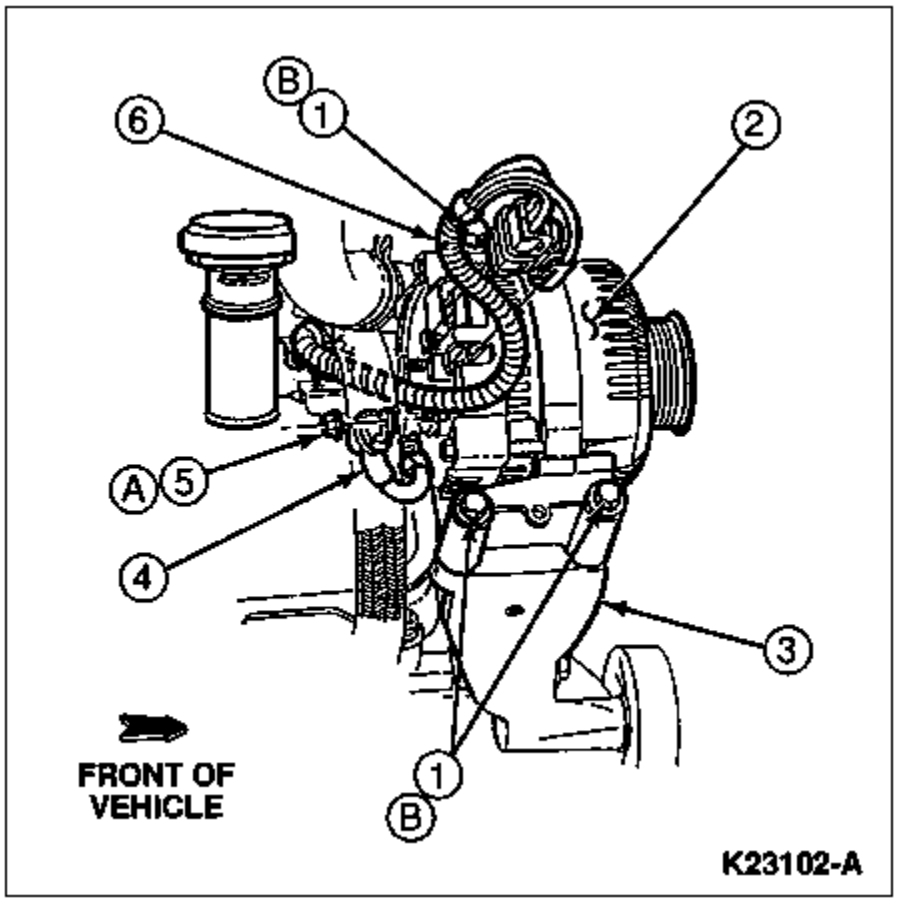
Item	Part Number	Description
1	10300	Generator
2	10A313	Generator Bracket
3	N606068-S2	Bolt
4	14305	Generator Voltage Regulator Wiring
5	N805320-S36	Nut and Washer Assembly
A	—	Tighten to 41-54 Nm (30-40 Lb-Ft)
B	—	Tighten to 9-12 Nm (79-107 Lb-In)

Alternator and Wiring, 3.0L



Item	Part Number	Description
1	N606068-S2	Bolt
2	14305	Generator Voltage Regulator Wiring
3	10300	Generator
4	10A313	Generator Bracket
5	—	Boot (Part of 14305)
6	N805320-S301	Nut and Washer Assembly
A	—	Tighten to 9-12 Nm (79-107 Lb-In)
B	—	Tighten to 41-54 Nm (30-40 Lb-Ft)

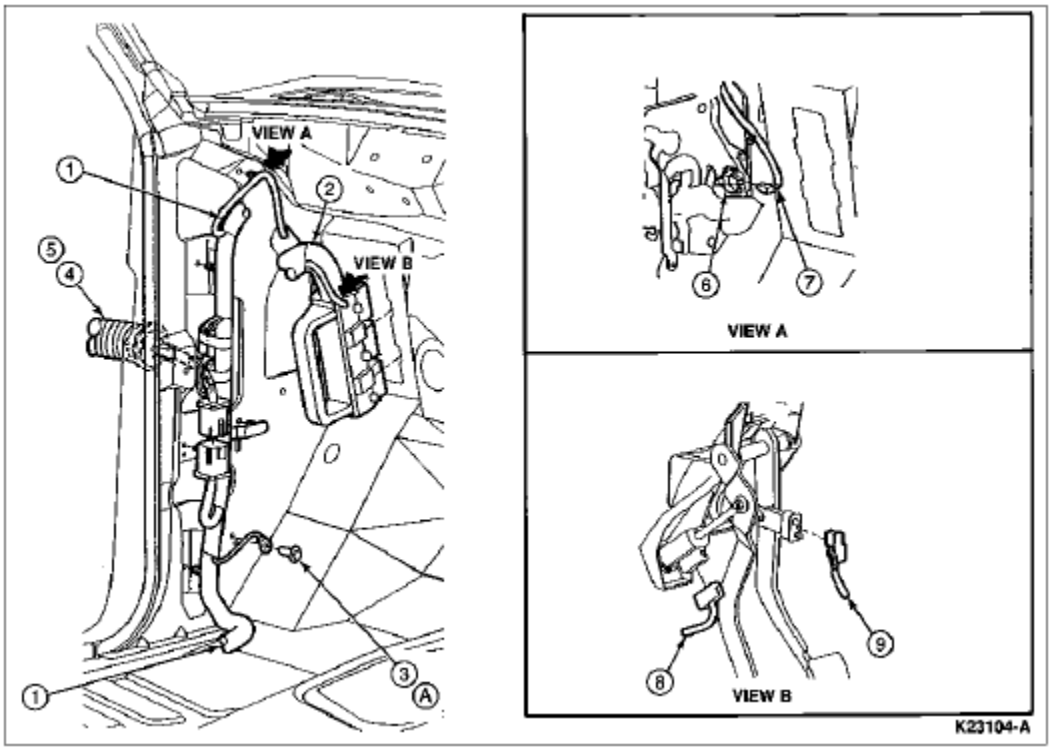
Alternator and Wiring, 4.0L



Item	Part Number	Description
1	N606068-S2	Bolt
2	10300	Generator
3	10A313	Generator Bracket

4	—	Boot (Part of 14305)
5	N805320-S36	Nut and Washer Assembly
6	14305	Generator Voltage Regulator Wiring
A	—	Tighten to 9-12 Nm (79-107 Lb-In)
B	—	Tighten to 41-54 Nm (30-40 Lb-Ft)

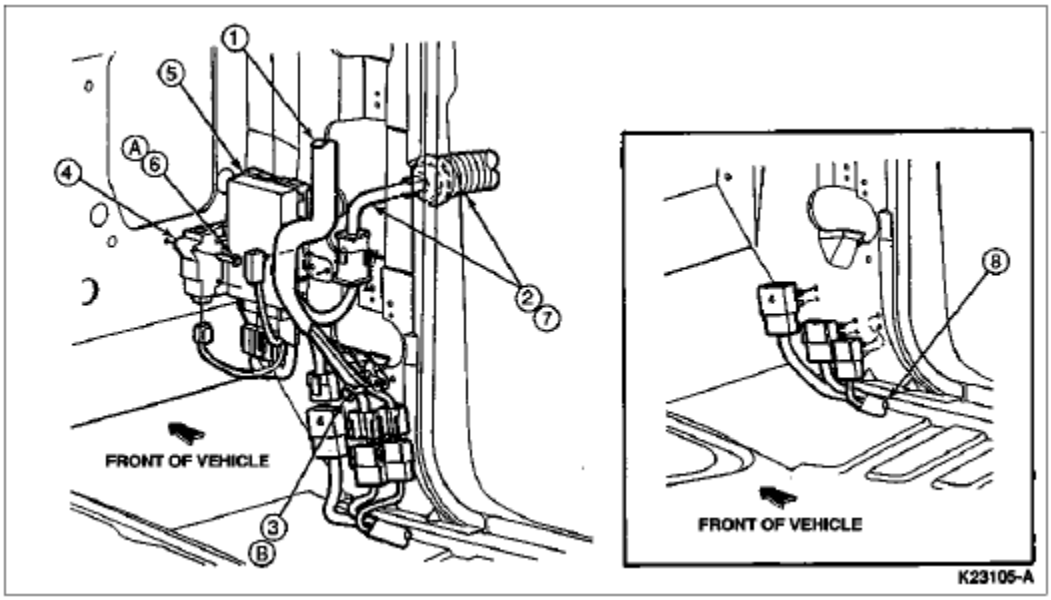
Cowl Wiring, LH — Ranger



Item	Part Number	Description
1	13A724	Courtesy Lamp Switch Extension Wiring
2	14401	Main Wiring to 120-Way Connector
3	N805375-S36MG	Screw
4	14631	Front Window Regulator Wiring
5	19A041	Radio Speaker Wiring
6	15A851	Parking Brake Signal Switch and Bracket
7	—	To Parking Brake Signal Switch and Bracket (15A851)
8	—	To Clutch Pedal Position Switch (11A152)
9	—	To BOO Switch (13480)

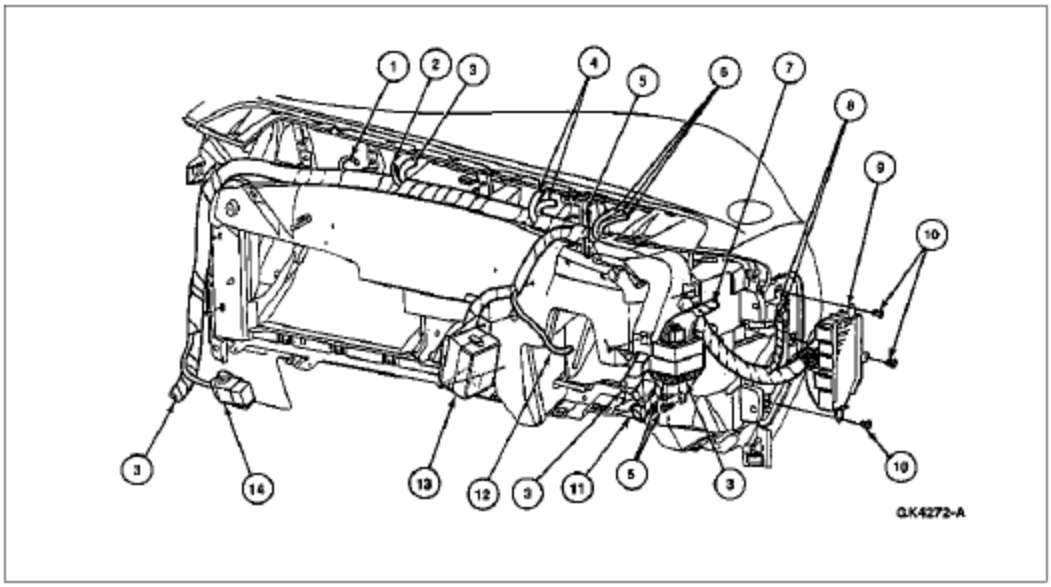
A	—	Tighten to 11-13 Nm (8-10 Lb-Ft)

Cowl Wiring, RH — Ranger



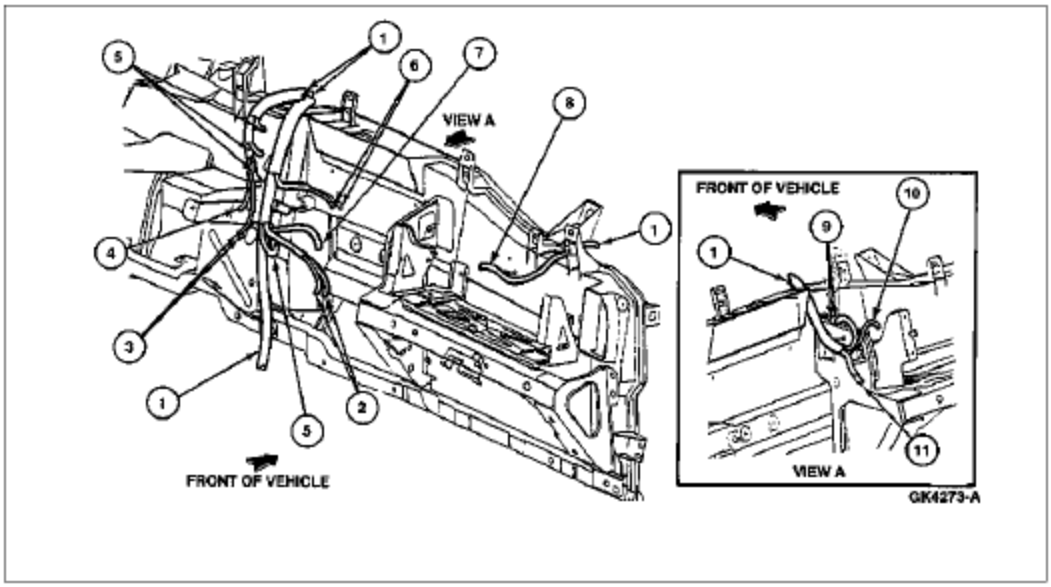
Item	Part Number	Description
1	14401	Main Wiring
2	14630	Front Window Regulator Wiring
3	N805375-S36MG	Screw
4	9341	Inertia Fuel Shutoff Switch
5	14B056	Air Bag Diagnostic Monitor
6	N611043-S58	Screw
7	19A041	Radio Speaker Wiring
8	18B864	Radio Amplifier Wiring
A	—	Tighten to 1.6-2.2 Nm (15-19 Lb-In)
B	—	Tighten to 11-13 Nm (8-10 Lb-Ft)

Instrument Panel Wiring, Rear — Ranger



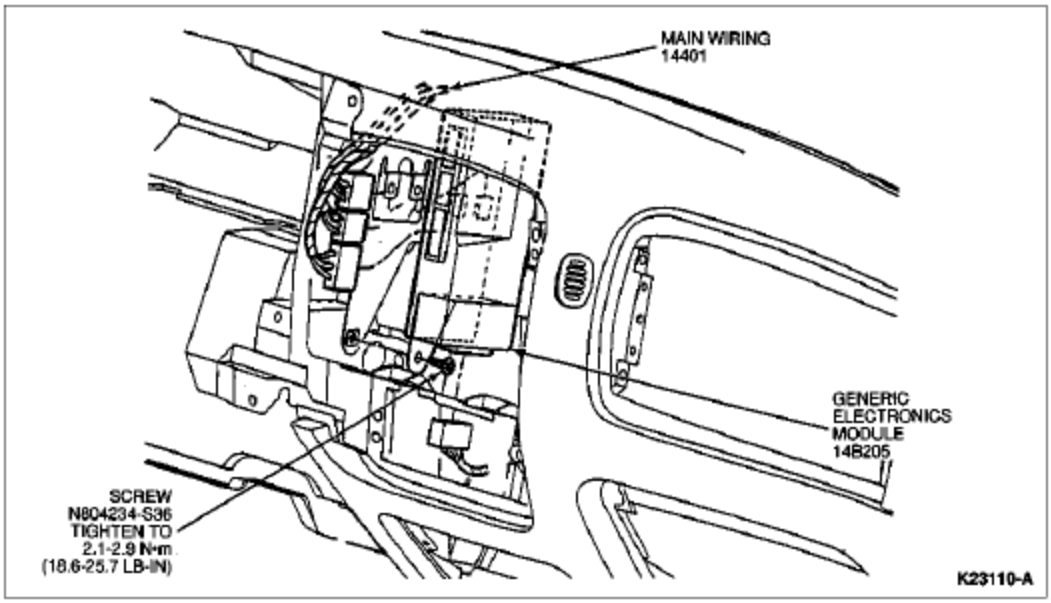
Item	Part Number	Description
1	—	To Passenger Side Air Bag Module (044A74)
2	—	To Heated Backlite Relay (14N089)
3	14401	Main Wiring
4	—	To Main Wiring, Instrument Panel Front (14401)
5	N803875-S36	Screw
6	—	To Instrument Cluster (10849)
7	14A200	Window Regulator Safety Relay Switch Wiring
8	—	To Headlamp and Dimmer Switches
9	—	Fuse Panel (Part of 14401)
10	N804234-S36	Screw
11	—	To Steering Column Switches
12	—	To Steering Column Wiring (14A320)
13	—	Instrument Panel Relay Module No. 3, Ranger (Part of 14401)
14	—	To Power Window Relay (14N089)

Instrument Panel Wiring, Front — Ranger

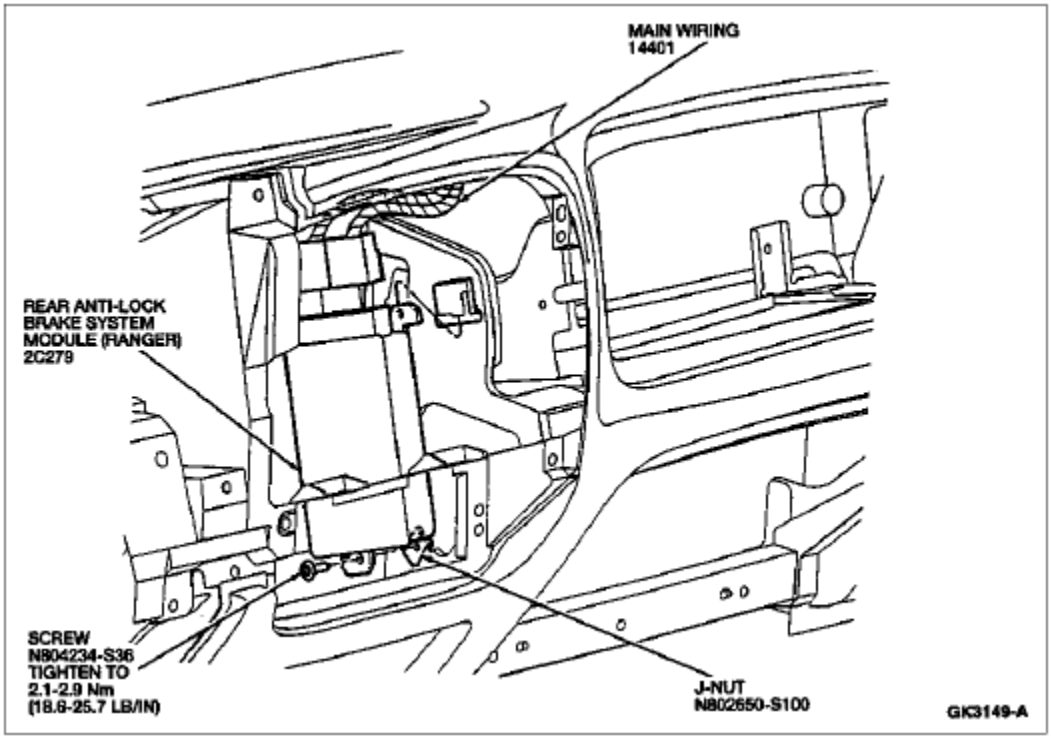


Item	Part Number	Description
1	14401	Main Wiring
2	—	To Heater and A/C Controls
3	—	To Cigar Lighter
4	—	To 4-Wheel Drive Mode Switch
5	—	To Generic Electronic Module (GEM) (14B205)
6	—	To Radio Chassis (18806)
7	—	To Transmission Select Relay, 4x4 (14N089)
8	—	To Passenger Side Air Bag Module (044A74)
9	—	To Automatic Ride Control Module (5A919) or RABS Module (2C018)
10	—	To Transfer Case Solid State Relay Module (2C222)
11	—	To Rear Defrost, Fog Lamp and Rear Wiper Switches

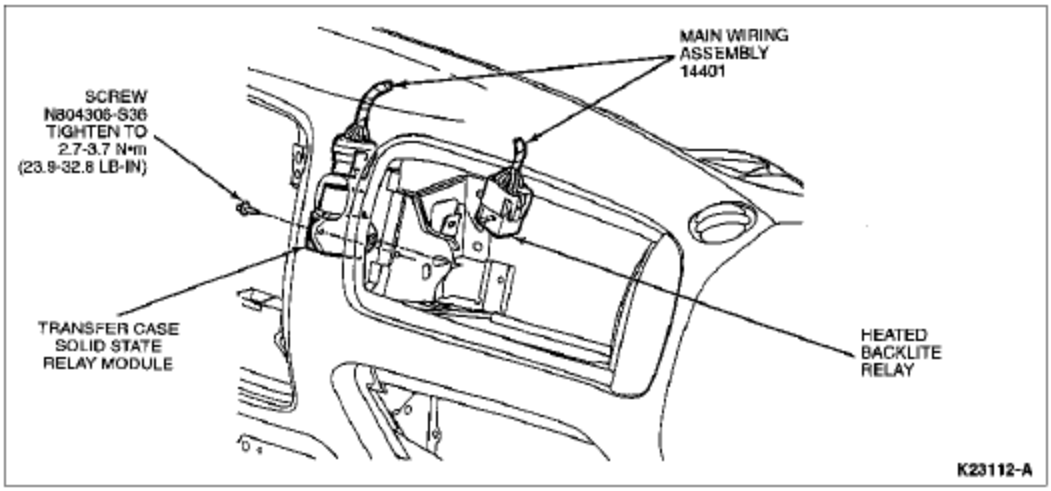
Generic Electronic Module (GEM) and Wiring



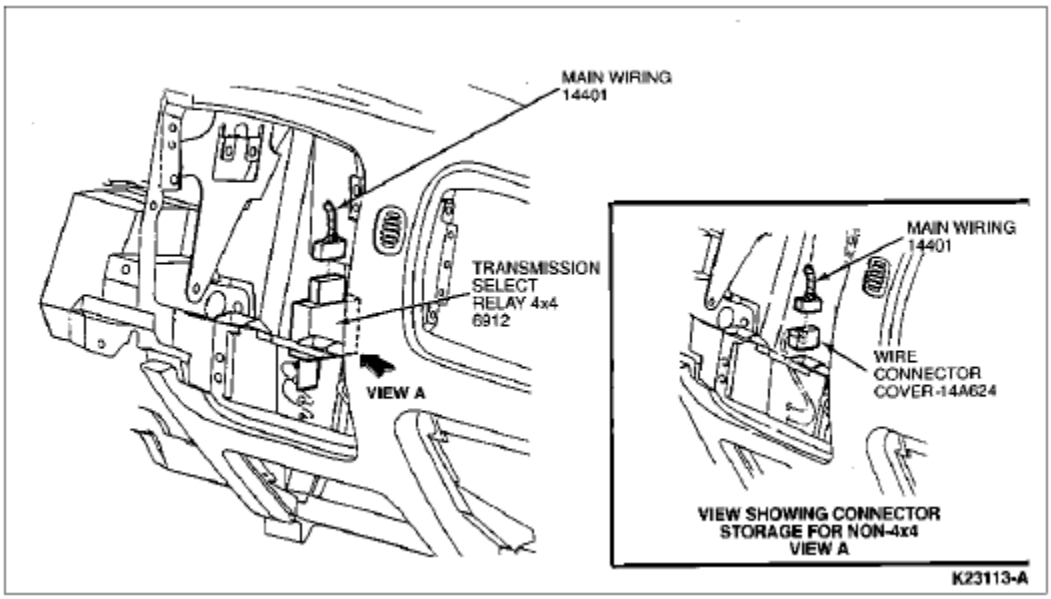
Rear Anti-Lock Brake System Module, Ranger



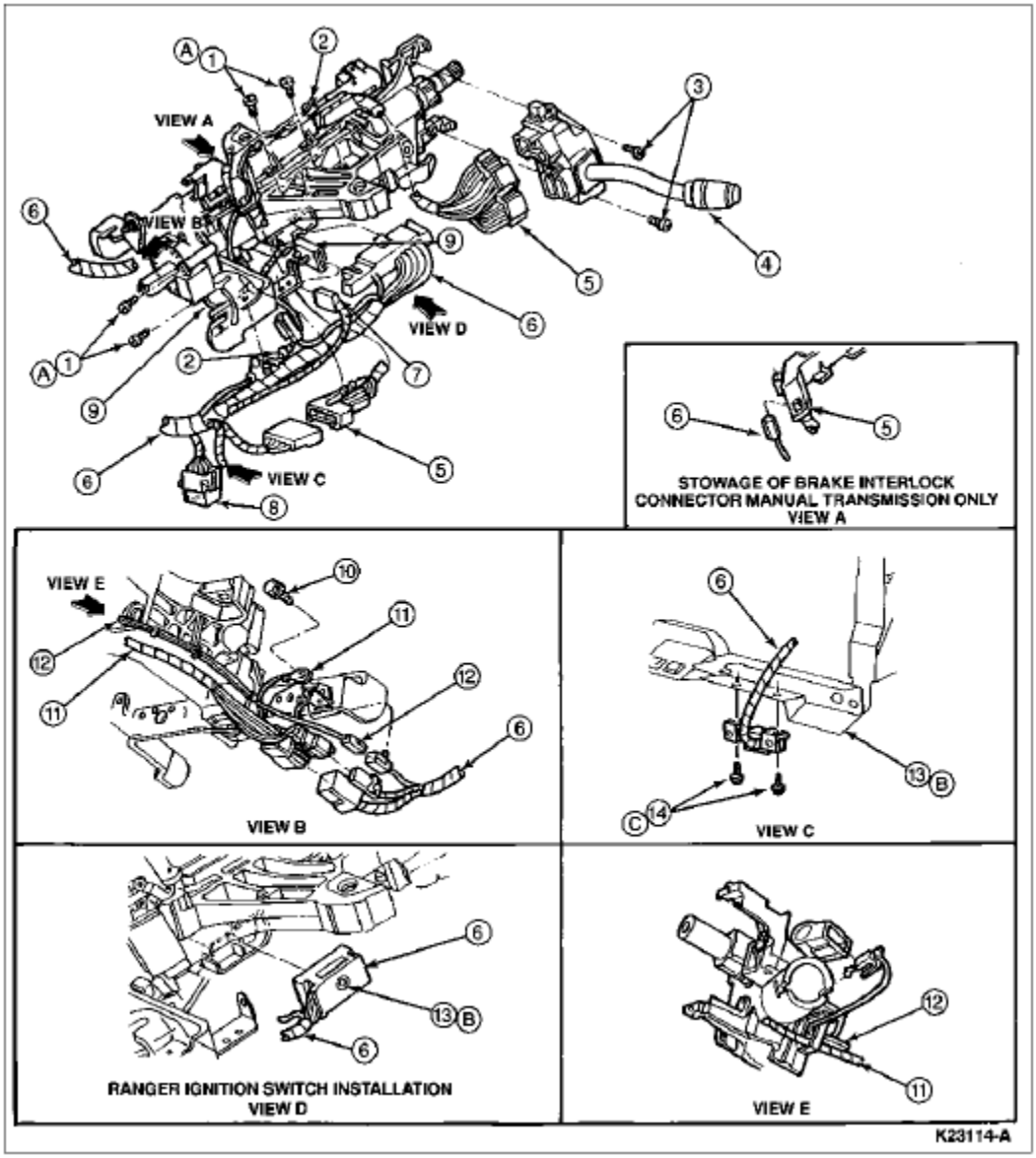
Transfer Case Solid State Relay Module and Heated Backlite Relay and Wiring



Transmission Select Relay and Wiring



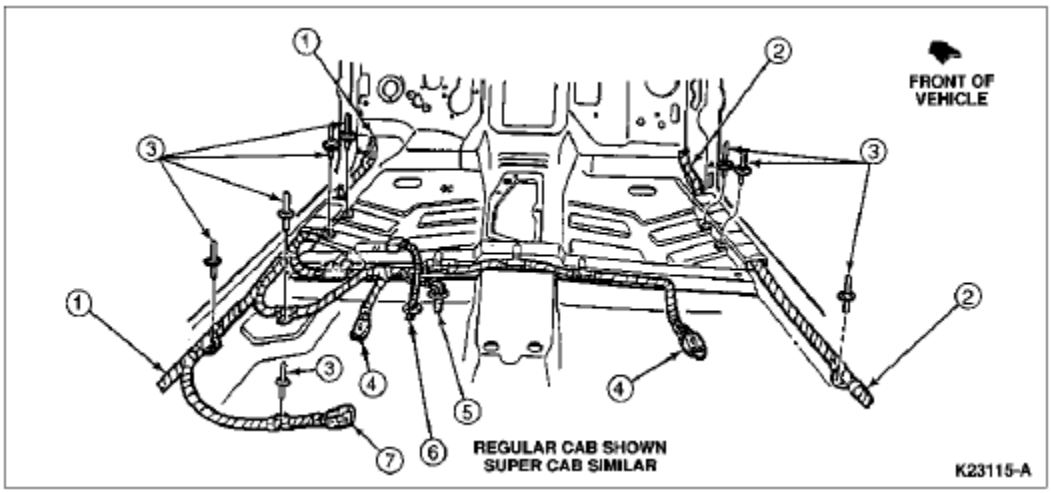
Steering Column Wiring



Item	Part Number	Description
1	390345-S36	Screw
2	7210	Gearshift Lever
3	—	Screw
4	13K359	Multi-Function Switch
5	14A320	Headlamp Dimmer Switch Jumper Wiring
6	14401	Main Wiring
7	—	To 18B005 Steering Wheel Position Sensor
8	13350	Indicator Flasher
9	18B015	Shock Absorber Electronic Steering Sensor
10	—	Screw
11	14A664	Air Bag Sliding Contact

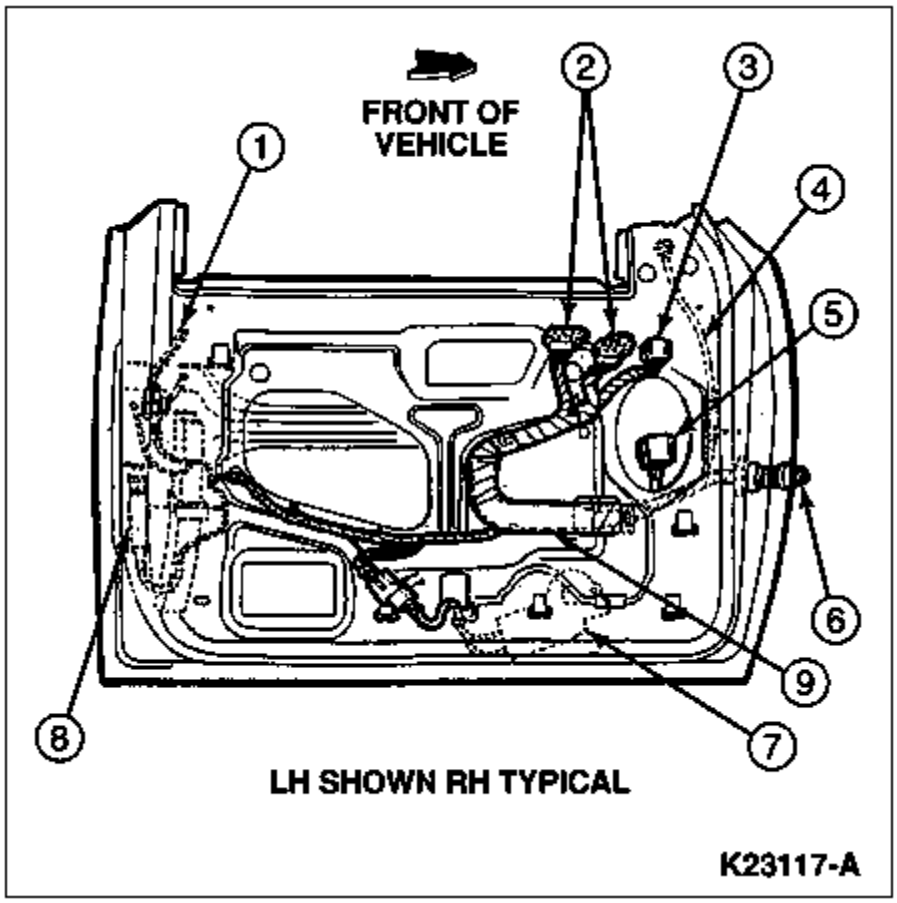
12	19A438	Ignition Lock Anti-Theft Switch
13	—	Screw (Part of 14401)
14	N807122-S411	Screw
A	—	Tighten to 1.8-2.6 Nm (15.9-23 Lb-In)
B	—	Tighten to .8-1.2 Nm (7.1-10.6 Lb-In)
C	—	Tighten to 2.1-2.9 Nm (18.6-25.7 Lb-In)

Floorpan Wiring — Ranger



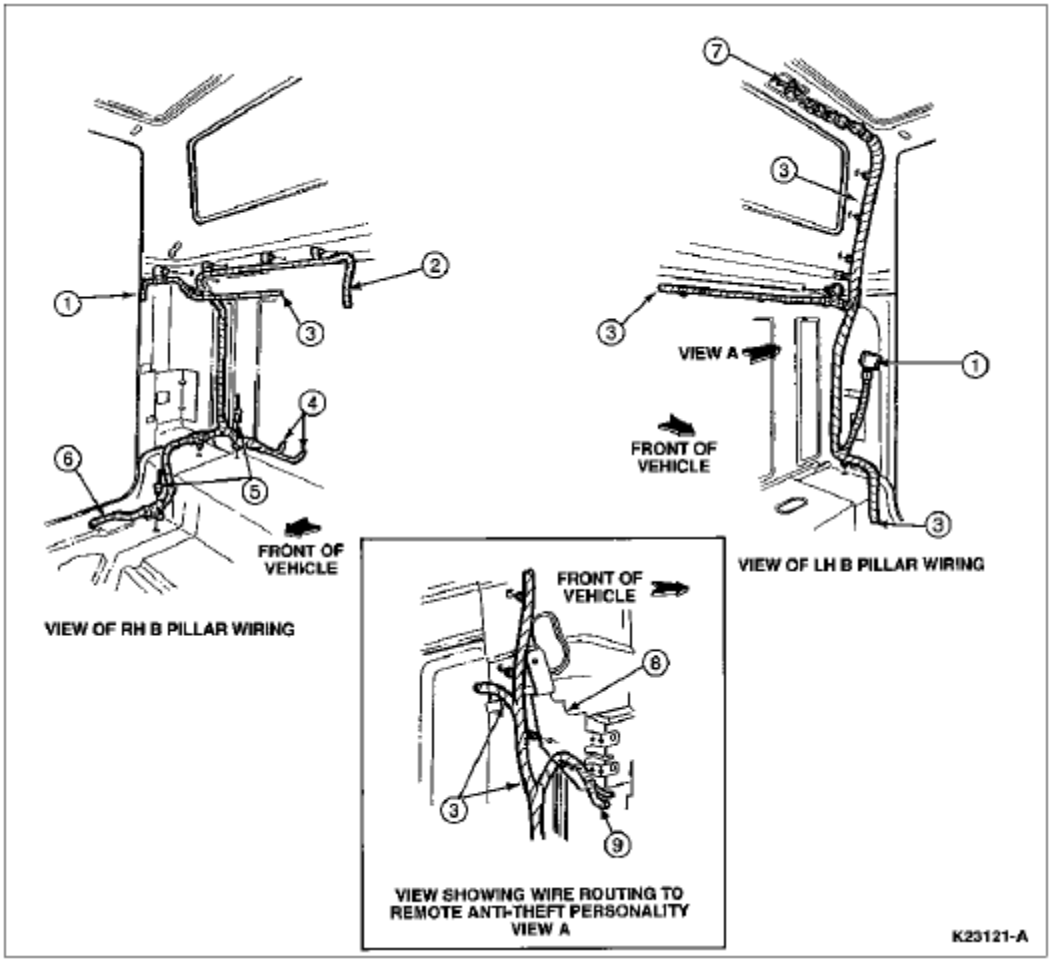
Item	Part Number	Description
1	13A724	Courtesy Lamp Switch Extension Wiring
2	18B864	Radio Amplifier Wiring
3	N803739-S	Rivet
4	—	To Power Lumbar (65500)
5	—	To Rear Lamp Wiring (14405)
6	—	Transmission Control Wiring
7	—	To Seat Belt Warning Lamp Switch (Part of 61203)

Door Wiring, Ranger



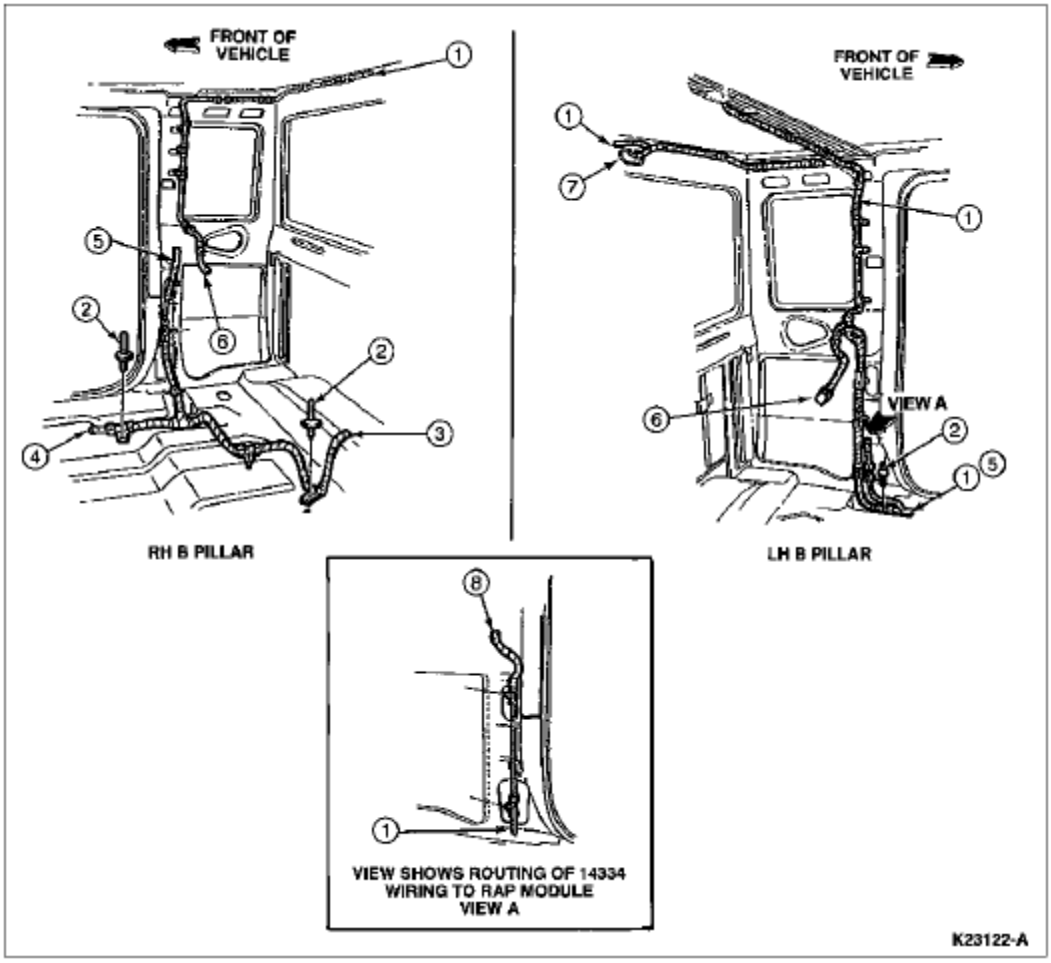
Item	Part Number	Description
1	—	To Disarm Switch (Part of 14631)
2	—	To Door Lock and Power Window Switches (14529)
3	—	To Power Mirror Switch (17B676)
4	—	To Power Mirror Motor (17682)
5	—	To Radio Speaker (18808)
6	14631	Front Window Regulator Wiring
7	23394	Window Regulator Electric Drive
8	218A42	Power Door Lock Actuator
9	—	Shield (Part of 14631)

B-Pillar Wiring, Ranger Regular Cab



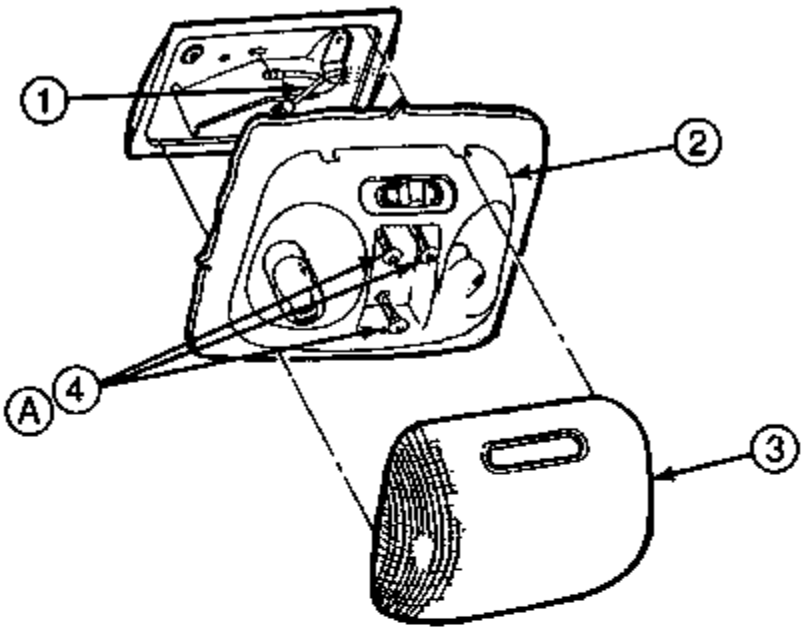
Item	Part Number	Description
1	—	To Speaker (18808)
2	—	To CD Changer Assembly (18D806)
3	13A724	Courtesy Lamp Switch Extension Wiring
4	—	To Amplifier (18B849)
5	N803739-S	Rivet
6	18B864	Radio Amplifier Wiring
7	13776	Interior Lamp
8	15604	Remote Anti-Theft Personality Module
9	—	To Remote Anti-Theft Personality Module (15604)

B-Pillar Wiring, Ranger SuperCab

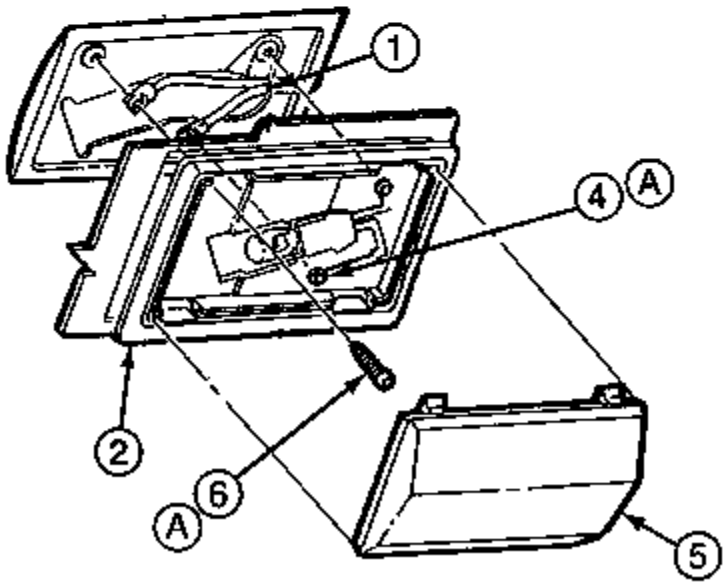


Item	Part Number	Description
1	13A709	Courtesy Or Interior Lamp Switch Wiring
2	N803739-S	Rivet
3	—	To CD Changer (18D806)
4	18B864	Radio Amplifier Wiring
5	—	To Radio Amplifier (18B849)
6	—	To Radio Speaker (18808)
7	—	To Rear Hi-Mount Lamp (13A613) and Cargo Lamp (13776)
8	—	To Remote Anti-Theft Personality Module (15604)

Pillar/Dome/Lamp Lenses and Wiring



VIEW SHOWING INSTALLATION OF MAP/DOME LAMP



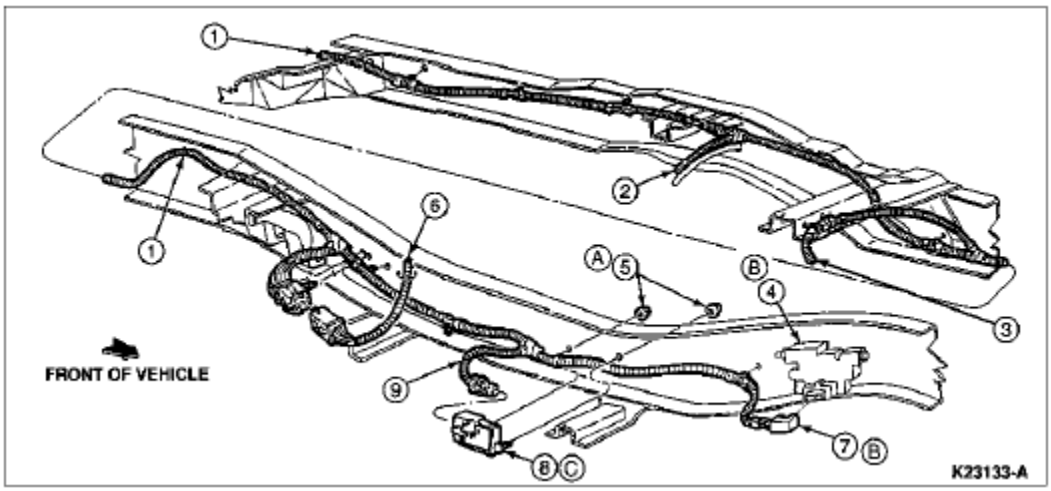
VIEW SHOWING INSTALLATION OF STD DOME LAMP

K23123-B

Item	Part Number	Description
1	13A724	Courtesy Lamp Switch Extension Wiring
2	13776	Interior Lamp

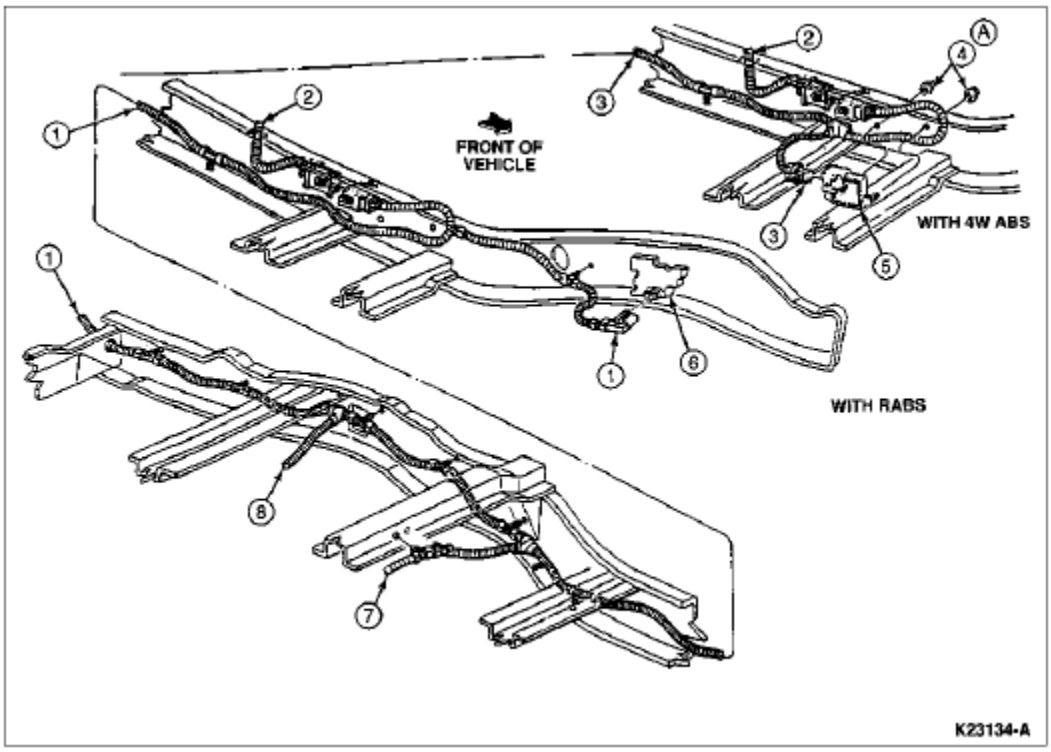
3	13783	Map/Dome Lamp Lens
4	—	Screw (Part of 13776)
5	13783	Pillar/Dome Lamp Lens
6	52802-S36	Screw
A	—	Tighten to 1.5-1.9 Nm (13.3-16.8 Lb-In)

Frame Wiring, Ranger — Regular Cab



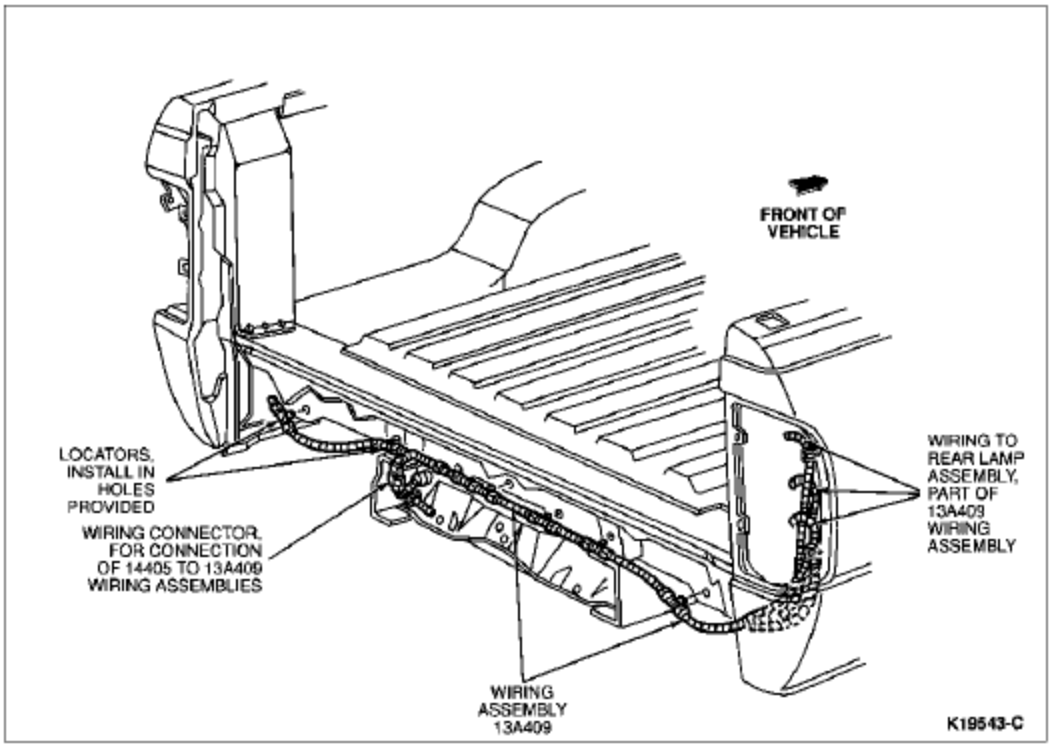
Item	Part Number	Description
1	14405	Rear Lamp Wiring
2	—	To Anti-Lock Speed Sensor (2L373)
3	—	To Fuel Pump (9350)
4	2B373	Anti-Lock Brake Control Module
5	N620481-S2	Nut
6	13A724	Courtesy Lamp Switch Extension Wiring
7	—	To Anti-Lock Brake Control Module (2B373)
8	—	Anti-Lock Brake Acceleration Switch
9	—	To Anti-Lock Brake Acceleration Switch
A	—	Tighten to 20-25 Nm (15-18 Lb-Ft)
B	—	With Rear Anti-Lock Brake System
C	—	With Four-Wheel Anti-Lock Brake System

Frame Wiring, Ranger — SuperCab

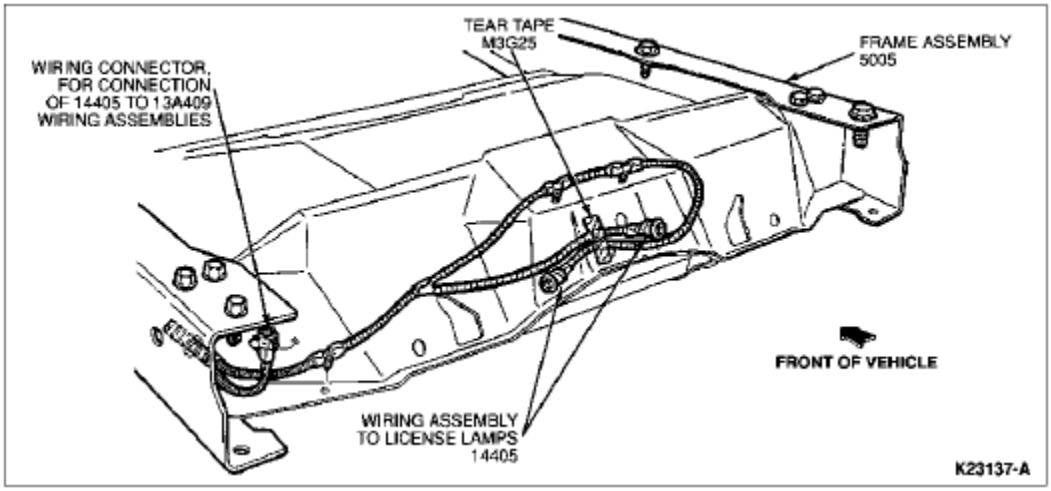


Item	Part Number	Description
1	14405	Rear Lamp Wiring with Rear Anti-Lock Brake System
2	13A709	Courtesy Or Interior Lamp Switch Wiring
3	14405	Rear Lamp Wiring with Four-Wheel Anti-Lock Brake System
4	N620481-S2	Nut
5	2C341	Anti-Lock Brake Acceleration Switch
6	2B373	Anti-Lock Brake Control Module
7	—	To Fuel Pump (9350)
8	—	To Anti-Lock Speed Sensor (2L373)
A	—	Tighten to 20-25 Nm (15-18 Lb-Ft)

Rear Lamp Wiring, Ranger



Rear License Lamp Wiring, Ranger



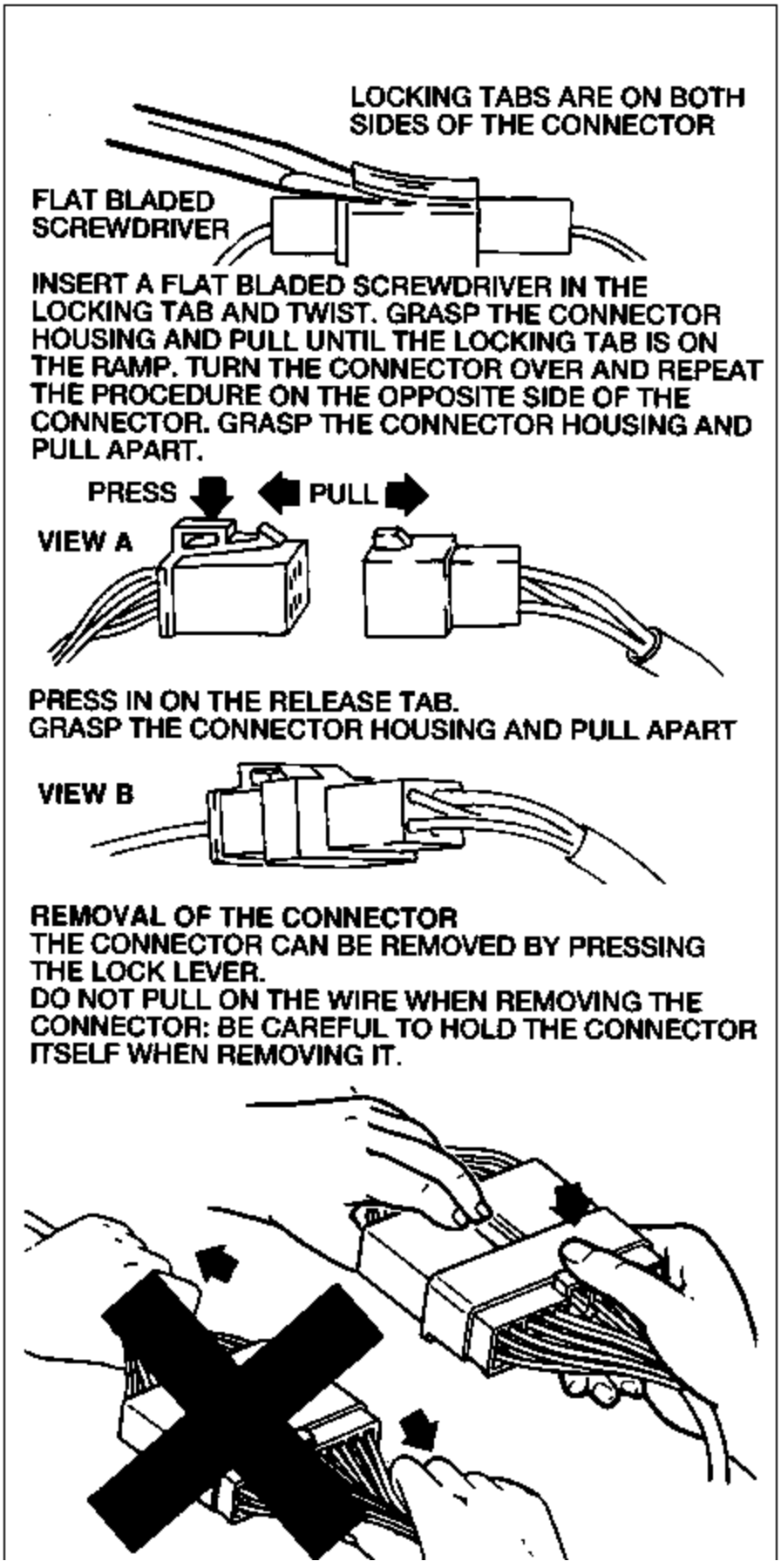
Connectors

Disconnect and Reconnect

The various connector disengagement procedures should be used when disconnecting the various types of connectors.

Connectors, In-Line

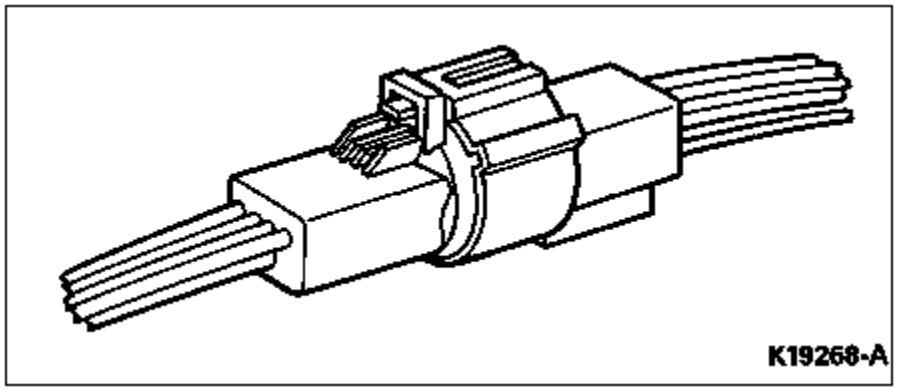
To avoid connector damage during service, adhere to the following procedures.


LOCKING TABS ARE ON BOTH SIDES OF THE CONNECTOR
FLAT BLADED SCREWDRIVER
INSERT A FLAT BLADED SCREWDRIVER IN THE LOCKING TAB AND TWIST. GRASP THE CONNECTOR HOUSING AND PULL UNTIL THE LOCKING TAB IS ON THE RAMP. TURN THE CONNECTOR OVER AND REPEAT THE PROCEDURE ON THE OPPOSITE SIDE OF THE CONNECTOR. GRASP THE CONNECTOR HOUSING AND PULL APART.
PRESS
PULL
VIEW A
PRESS IN ON THE RELEASE TAB.
GRASP THE CONNECTOR HOUSING AND PULL APART
VIEW B
REMOVAL OF THE CONNECTOR
THE CONNECTOR CAN BE REMOVED BY PRESSING THE LOCK LEVER.
DO NOT PULL ON THE WIRE WHEN REMOVING THE CONNECTOR: BE CAREFUL TO HOLD THE CONNECTOR ITSELF WHEN REMOVING IT.

Connector Disengagement, In-Line Connectors, Submergible Pin-Type

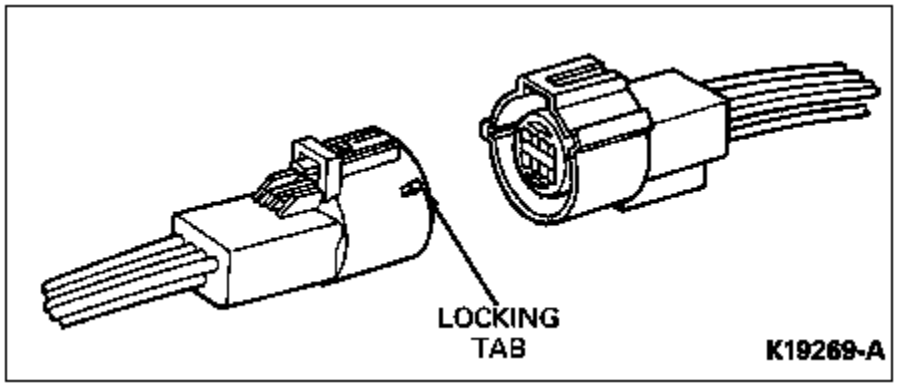
CAUTION: Removal of connector by pulling wire will damage connector's locking mechanism, resulting in a loose fitting connection when installed.

1. Grasp each end of connector body.



2. While holding connector body, use thumb pressure to depress locking tab and pull connector apart.

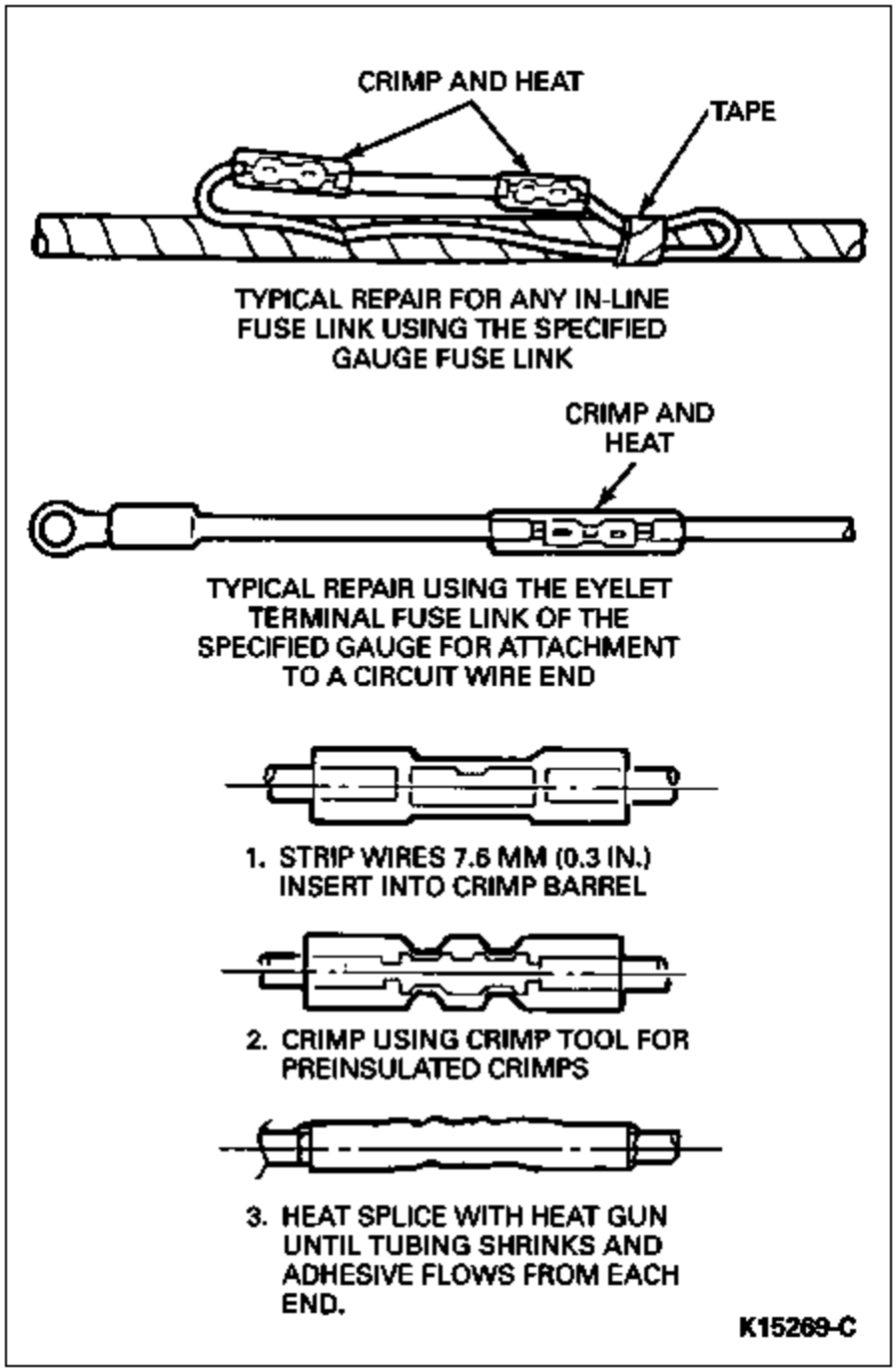
   Wiggling the parts will make separation easier.



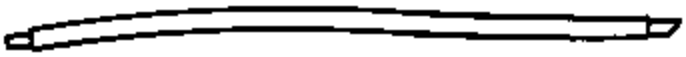
Fuse Link and Butt Connector

If it becomes necessary to replace a fuse link in a wiring assembly, make sure the replacement fuse link is a duplicate of the one removed with respect to gauge, length and insulation. Original and Ford replacement fuse links have insulation that is flameproof. Do not fabricate a fuse link from ordinary wire because the insulation may not be flameproof.

If a circuit protected by a fusible link becomes inoperative, inspect for a blown fuse link. If the fuse link wire insulation is burned or opened, disconnect the feed wire part of the wiring and cut out the damaged portion as close as possible behind the splice in the harness. If the damaged fuse link is between two splices (weld points in the harness), cut out the damaged portion as close as possible to the weld points.

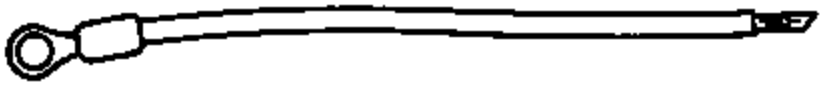

CRIMP AND HEAT
TAPE
TYPICAL REPAIR FOR ANY IN-LINE FUSE LINK USING THE SPECIFIED GAUGE FUSE LINK
CRIMP AND HEAT
TYPICAL REPAIR USING THE EYELET TERMINAL FUSE LINK OF THE SPECIFIED GAUGE FOR ATTACHMENT TO A CIRCUIT WIRE END
1. STRIP WIRES 7.6 MM (0.3 IN.) INSERT INTO CRIMP BARREL
2. CRIMP USING CRIMP TOOL FOR PREINSULATED CRIMPS
3. HEAT SPLICE WITH HEAT GUN UNTIL TUBING SHRINKS AND ADHESIVE FLOWS FROM EACH END.
K15269-C

WIRING ASSEMBLY — FUSE LINK (WITH INSULATION STRIPPED BOTH ENDS)



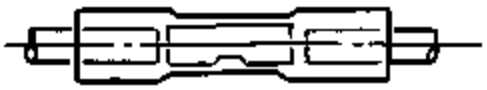
D3AZ-14A526-H	NO. 14 GA. WIRE — 9.00" ± .50 LENGTH (GREEN INSULATION)
D3AZ-14A526-J	NO. 16 GA. WIRE — 9.00" ± .50 LENGTH (ORANGE INSULATION) AS REQ'D
D3AZ-14A526-K	NO. 17 GA. WIRE — 9.00" ± .50 LENGTH (YELLOW INSULATION) AS REQ'D (SPECIAL USED WITH AIR CONDITIONING SYSTEM)
D3AZ-14A526-L	NO. 18 GA. WIRE — 9.00" ± .50 LENGTH (RED INSULATION) AS REQ'D
D3AZ-14A526-M	NO. 20 GA. WIRE — 9.00" ± .50 LENGTH (BLUE INSULATION) AS REQ'D

WIRING ASSEMBLY — FUSE LINK (WITH EYELET TERMINAL AND ONE END STRIPPED)



E9AZ-14526-A	NO. 12 GA. WIRE — 9.00" ± .50 LENGTH (GRAY INSULATION) AS REQ'D
D3AZ-14A526-D	NO. 14 GA. WIRE — 9.00" ± .50 LENGTH (GREEN INSULATION) AS REQ'D
D3AZ-14A526-E	NO. 16 GA. WIRE — 9.00" ± .50 LENGTH (ORANGE INSULATION) AS REQ'D
D3AZ-14A526-F	NO. 18 GA. WIRE — 9.00" ± .50 LENGTH (RED INSULATION) AS REQ'D
D3AZ-14A526-G	NO. 20 GA. WIRE — 9.00" ± .50 LENGTH (BLUE INSULATION) AS REQ'D

BUTT CONNECTOR — WIRING SPLICE



E6FZ-14488-C	FOR NOS. 10 AND 12 GA. WIRE (YELLOW)
E6FZ-14488-B	FOR NOS. 14 AND 16 GA. WIRE (BLUE)
E6FZ-14488-A	FOR NOS. 18 AND 22 GA. WIRE (RED)

K8660-D

To service any blown fusible link or to splice broken wires, use the following procedure.

1. Determine which circuit is damaged, its location and the cause of the blown fuse link. If the damaged fuse link is one of three fed by a common No. 10 or 12 gauge feed wire, determine the specific affected circuit.

2. **NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 miles) or more to relearn the strategy.**

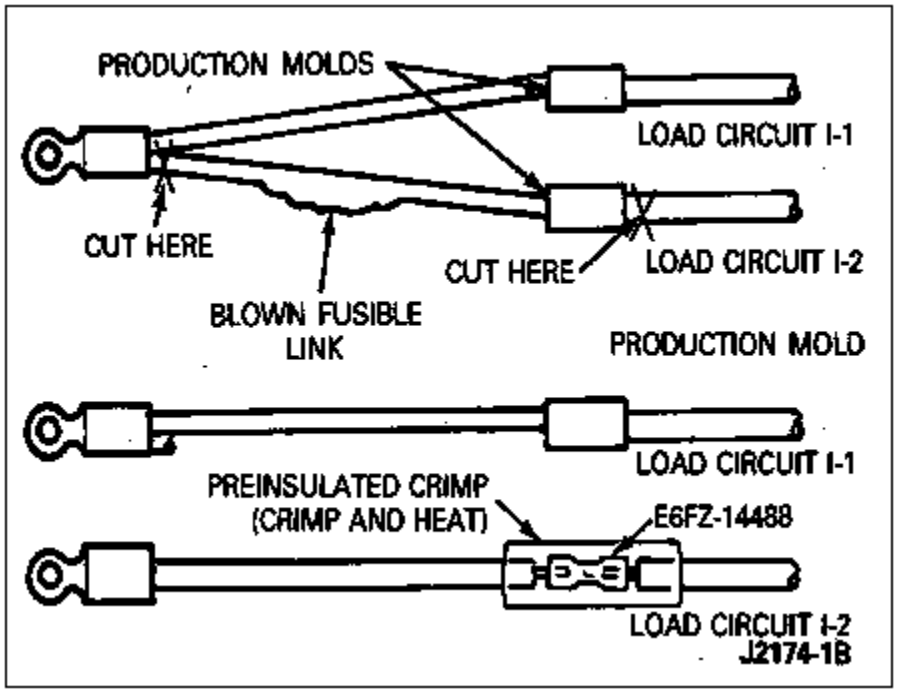
   Disconnect the battery to starter relay cable (14300).

3. Cut the damaged fuse link from the wiring harness and discard it. If the fuse is one of three circuits fed by a single feed wire, cut it out of the harness at each splice and discard it.

4. Identify and procure the proper fuse link and butt connectors for attaching the fuse link to the harness.

5. To repair double-terminated fusible links when only one link has blown and the other link is not damaged:

   a. Cut out blown link (two places).
   b. Position correct eyelet type service fusible link and bare butt connector.
   c. Crimp serviced joint and heat with heat gun until tubing shrinks and adhesive flows from each end.



6. Strip 7.6mm (0.3 inch) of insulation from wires and insert into proper gauge wire connector, crimp and heat splice insulation until tubing shrinks and adhesive flows from each end of connector.

7. To replace any fuse link on a single circuit in a harness, cut out the damaged portion. Strip approximately 13mm (1/2 inch) of insulation from the two wire ends and attach the appropriate replacement fuse link to the stripped wire ends with two proper size wire connectors. See previous illustration.

8. To repair any fuse link which has an eyelet terminal on one end such as the charging circuit, cut off the blown fuse link behind the weld, strip approximately 13mm (1/2 inch) of insulation from the cut end and attach the appropriate size wire connector.

9. **NOTE: Do not mistake a resistor wire for a fuse link. The resistor wire is generally longer and**

has print stating: Resistor — Do not cut or splice.

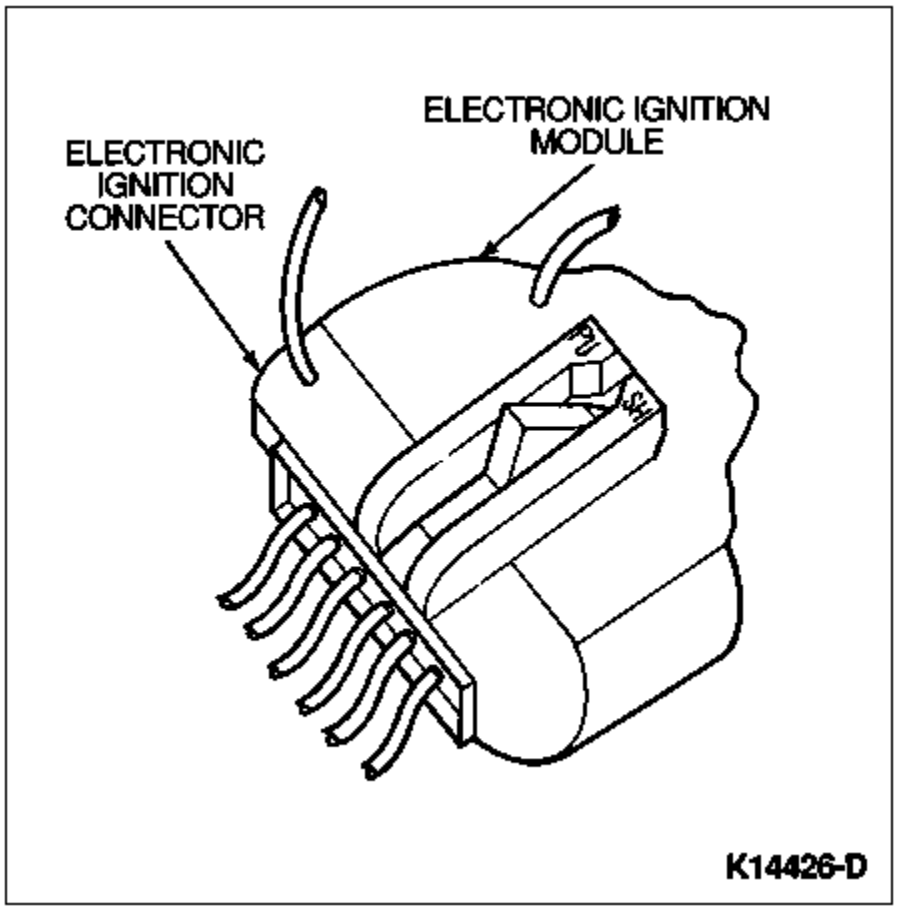
NOTE: When attaching a No. 16, 18 or 20 gauge fuse link to a heavy gauge wire, always double the stripped wire end of the fuse link before inserting and crimping it into the wire connector for positive wire retention.

If the damaged fuse link is between two splices (weld points in the harness), cut out the damaged portion as close to the weld points as possible.

10. Reconnect the battery to starter relay cable to the battery and test the system for proper operation.

Module Connector Disengagement

Push down on end of beam indicated by letters PUSH and pull all wires rearward for removal.

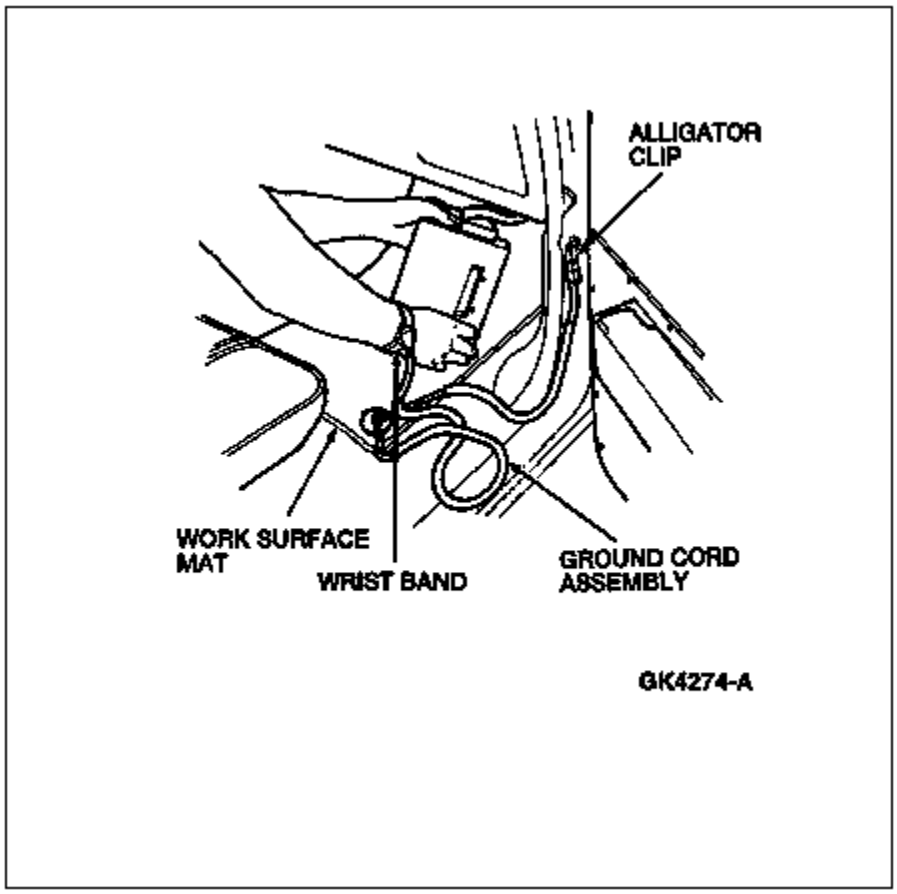


Service Precautions

Electronic modules such as instrument clusters, powertrain controls and radios incorporate the latest technology. Some of the components used in these modules are sensitive to static electricity damage at voltage levels far below what the human body can sense. While a person cannot feel or hear the "snap" of a static discharge until the charge level is about 3000 volts, some of the electronic module components can be damaged or weakened by as little as 100 volts.

Use the following safeguards to avoid static electrical damage.

1. Leave the electronic modules in their original packaging until ready to install in vehicles.
2. Avoid touching module connector pins.
3. Avoid laying modules on nonconductive surfaces.
4. As an added safeguard, this kit contains special wrist straps, a 15-inch by 24-inch flexible conductive mat, grounding cords and full instructions.



STATIC CHARGE GENERATION VALUES

Activity	Relative Humidity	
	Low (10-20%)	High (65-90%)
	Volts	Volts
Walking across carpet	35,000	1,500
Walking over vinyl floor	12,000	250
Working at bench	6,000	100
Sliding across vehicle seat	25,000	1,000

SPECIFICATIONS

HIGH CURRENT CIRCUIT BREAKER AND RELAYS NOT IN PANELS OR MODULES

Circuit	Size	Location
Liftgate Wiper Motor	4.5 Amp Circuit Breaker	Fuse Block Bracket, Aerostar
Power Window	Relay	Behind Instrument Panel — Attached to Lower Support — Right Side, Ranger
Trans Select	Relay	Behind Instrument Panel Center Finish Panel — Left Side, Ranger
Door Lock Fuse	30 Amp	In White Fuse Holder Taped to 14401 Wiring Harness, Approx. 6 Inches from T/S Flasher, Aerostar

TORQUE SPECIFICATIONS

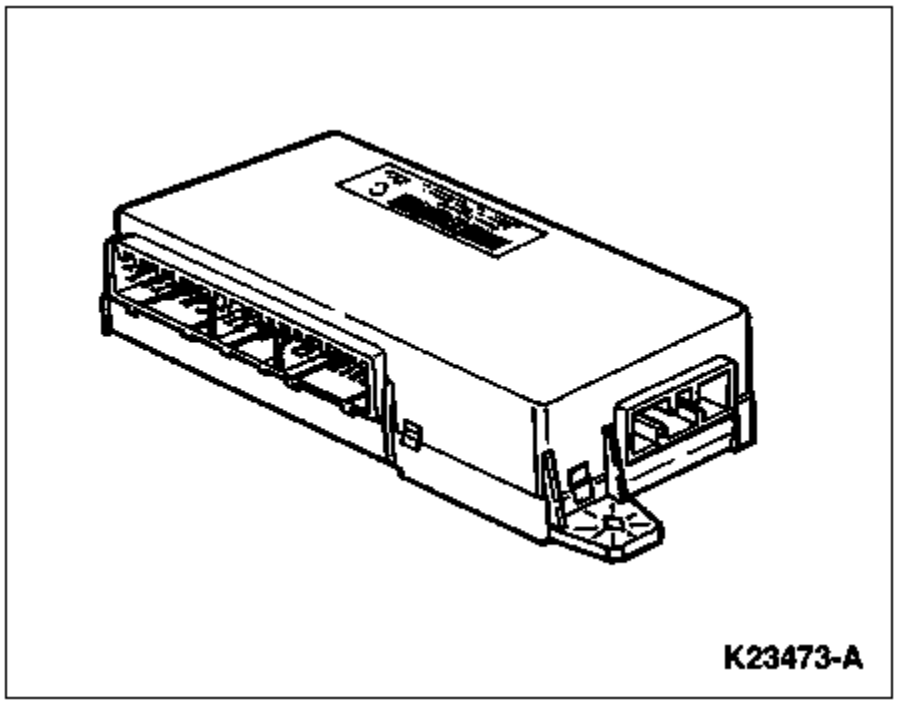
Description	Nm	Lb-Ft	Lb-In
Screw, N610957-S2	2.5-3.0	—	22-26
Ground Bolt, N805375-S36	5.0-6.0	—	45-53
Nut, 381561-S39 (4.0L only)	5.0-10.0	—	45-88
Nut, 381561-S39	7-9	—	62-80
Oil Pressure Sensor	11.0-24.0	9.0-18.0	—
Fitting	11.0-16.0	9.0-12.0	—
Bolt, N605798	11-13	8-10	—
Nut, N805320-S36, Aerostar	5-6	—	40-57
Harness Bolts	5.5-6.8	—	49-60
Bolt, N806327-S190	10.0-14.0	8-10	—
Screw, N8001846-S36	4.0-5.6	—	36-49
Screw, 56928-S36	1.1-1.5	—	9.7-13.3
Screw, N611041-S36	1.4-2.2	—	12.4-19.5
Nut, N621901-S36	2-3	—	18-26
Nut, N804456-S54	5.0	—	44

Screw, N805375-S36MG, Harness Clamp	3.1-4.3	—	28-38
Screw, N805375-S36MG, Ground Wire	11-13	8-10	—
Screw, N804234-S36MG	3.6-4.6	—	32-40
Screw, N800312-S2	5-6	—	40-55
Screw, N800312	5-6	—	41-55
Bolt, N800946-S36M	11-13	8-10	—
Nut, N621905-S36	5-6	—	41-55
Harness Bolt to ICM	2.7-3.7	—	23.9-32.8
Screw, N807522-S36	2.3-3.3	—	20.4-29.4
Screw, N610959-S56	5-6	—	41-55
Harness Bolts, Headlamp Dash Panel Junction Wire to Main Wiring	4.0-5.6	—	36-49
Nut, 382802-S2	11-13	8-10	—
Screw, N610957-S36	3.1-4.3	—	28-38
Screw, N804234-S36MG, PDB Bracket	3.4-4.8	—	31-42
Harness Bolt to ABS Module	2.7-3.7	—	24-32
Screw, N806327-S36	4.5-5.3	—	40-46
Stud, N806925-S36M	11-13	8-10	—
Nut, N621906-S301	6-8	—	53-71
Harness Bolt to PCM	6-7	—	46-63
Harness Bolt, Headlamp Dash Panel Junction Wire to Engine Control Sensor Wiring	4.0-5.6	—	36-49
Bolt, N606068-S2	41-54	30-40	—
Nut, N805320-S36, Ranger	9-12	—	79-107
Nut, N805320-S301	9-12	—	79-107
Screw, N611043-S58	1.6-2.2	—	15-19
Screw, N611043-S48	1.6-2.2	—	15-19
Screw, N803875-S36	2.1-2.9	—	19-25
Screw, N804234-S36	2.1-2.9	—	19-25
Screw, N804306-S36	2.7-	—	23.9-

	3.7		32.8
Screw, 390345-S36	1.8-2.6	—	15.9-23.0
Harness Bolt, Main Wiring to Ignition Switch	.8-1.2	—	7.1-10.6
Screw, N807122-S411	2.1-2.9	—	18.6-25.7
Screw, N801164-S43	1.2-1.8	—	10.6-15.9
Screws, Map/Dome Lamp, Ranger	1.5-1.9	—	13.3-16.8
Screw, 52802-S36	1.5-1.9	—	13.3-16.8
Screw, 56910-S36	1.2-1.8	—	10.6-15.9
Nut, N621900-S2	1.0-2.0	—	8.9-17.7
Screw, N805375-S36MB	11-13	8-10	—
Screw, 56920-S36B	1.2-1.8	—	10.6-15.9
Screw, N611036-S36	1.8-2.6	—	15.9-23.0
Screw, N800369-S2	5-6	—	40-55
Nut, 9621900-S2	1.4-2.0	—	12.4-17.7
Nut, N620481-S2	20-25	15-18	—
Screw, N606677-S2	7-9	—	61-81
Screw, N806326-S36MG	11-13	8-10	—
Screw, N806327-S36MG	7-9	—	61-81
Nut, N621906-S2	7-9	—	61-81
Screw, N805375-S36	7.5-10.5	—	66.4-92.9

GEM Controlled Functions

The Generic Electronic Module (GEM) incorporates the functions of several different modules into one and offers diagnostics to easily locate and repair concerns affecting the subsystems that it controls.



The GEM constantly monitors the system and reports concerns in the form of diagnostic trouble codes (DTCs). The DTCs can be retrieved with the Rotunda New Generation STAR (NGS) Tester 007-00500 or equivalent through the communication link.

The NGS is a menu-driven tester, allowing the user to run specific diagnostic tests. The NGS can isolate faults in the GEM subsystems through a symptom-driven diagnostic procedure. Connecting the tester to the GEM communication link will NOT alert the GEM. If the GEM is "asleep" when the diagnostic connector is plugged in, the GEM must be "awakened." If the communication link cannot be established, it is advised to turn the ignition to RUN.

NOTE: The GEM has a sleep function to minimize battery consumption. During the sleep mode, the GEM turns off all outputs and monitors only the following:

- Door ajar (driver door and passenger door)
- Key in ignition
- Key in RUN or ACCY
- Door handles (driver or passenger)
- Two-step unlock switch
- Neutral safety switch
- Illuminated entry request — RAP module

If a change of status occurs at one of these inputs while the GEM is asleep, the GEM will "wake up." When

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the GEM awakens, it performs an internal self-test, and begins normal operation. At this point, the GEM will have all of its functions operational.

The GEM will go into the sleep mode immediately after both of the following conditions have been met:

- Key in OFF or key not in ignition
- After 45 minutes with no change on any wake-up input

The GEM control system has two modes of operation, the normal operating mode and tester dependent diagnostics mode.

The normal operation of the GEM can detect errors. An integral part of the normal GEM operation is the continuous diagnostics capability. Continuous diagnostics detects errors and changes the GEM control strategy. There is no warning light for the GEM; therefore, a DTC concern will direct you to the GEM. Examples of faults that may be detected during normal operation include:

- GEM continuous self-test (RAM, ROM, EEPROM, A/D checking)
- Output driver monitoring (open circuit/short to GND, short to battery)

  NOTE: The GEM can only detect open circuit/ short to GND faults when the GEM is not energizing a load, and short to battery faults when the GEM is attempting to energize a load.

- Illogical combinations of input signals

A description of the subsystems controlled by the GEM follows.

Windshield Wiper Control and Interval Timer

There are five modes of operation for the front wipers: MIST, INTERVAL, LOW, HIGH and WASH.

These modes are only active with the ignition switch (11572) in the RUN or ACCY position.

Front Windshield Wiper Control (Interval Wiper)

Modes: OFF, Interval, LOW, HIGH, and WASH.

The GEM responds to the windshield wiper control commands by interpreting inputs from the steering column seven-position delay/wash and four-position mode select switches.

The GEM relay drivers control three external relays: wiper high/low speed relay, dynamic brake-run relay, and the washer pump relay. When the washer switch is activated longer than 300 ms, the wash and wiper (low speed) functions are provided until the switch is released. The release of the switch will be followed by three low speed wipes. If the switch is pressed between 100 ms and 300 ms (with the mode in the OFF position), the wiper system will provide one wipe at low speed with no wash.

INTERVAL

For standard interval, the time between low-speed wipes will range from 1.5 - 20 seconds.

HI

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This is the fastest wiper speed with no dwell. It is selected when the multi-function switch (13K359) is in the HI speed position. If the wash button is pressed for 0.3-10 seconds, the washer pump will energize until the wash button is released.

LO

This is the slowest wiper speed with no dwell. It is selected when the multi-function switch is in the LO speed position. If the wash button is pressed for 0.3-10 seconds, the washer pump will energize until the wash button is released.

WASH

If the wash button is pressed for 0.3-10 seconds, the washer pump will energize until the wash button is released.

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Chime Warning

There are audible warning tones and warning lights that the GEM controls. The GEM performs a prove out on all warning light miniature bulbs (13466) (except the seat belt, 4x4 and door ajar) by turning on the miniature bulb for two seconds after the ignition switch (11572) is turned to RUN from START. The warning chimes and lamps are described below.

Headlamp On Warning

A chime sounds when the exterior lamps are on (parking, license plate and headlamps (13008)) and:

- Ignition switch in the OFF position.
- The driver front door (20124) is ajar (or open).
- NO key in ignition switch.

Door Ajar Warning

When at least one door is ajar and the key is in the RUN position, the door ajar cluster lamp is activated and remains on until all doors are closed. A warning tone will sound once any time the key is in the ignition switch and any door is open. The GEM's flexibility allows customizing of different warnings (i.e., a steady tone for the driver door ajar).

Driver Seat Belt Warning

If the driver seat belt is unbuckled when the ignition switch is placed in RUN, a chime sounds for 6 seconds (or until the driver seat belt is buckled) and a warning light is turned on for 61 seconds (or until the driver seat belt is buckled).

Key In Ignition

Any time the key is in the ignition switch in the OFF or ACC position and the driver door is open, the module sounds a chime (120 chimes per minute) until either the key is removed from the ignition or the driver door is closed.

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Battery Saver

NOTE: The exterior lamps are not part of the battery saver protection, and will remain on even if the GEM turns the interior lamps off.

The battery saver feature removes extended interior lamp power drains to the battery (10655). The GEM keeps power to these loads for 45 minutes after the ignition switch (11572) is turned off.

The GEM keeps power available for all interior lights, key ring lights, cargo lamp, and hood lamp circuits for 45 minutes after the ignition switch is turned off. The battery saver timer is reset by lifting a door handle (receiving an illuminated entry request), activating a door ajar switch, changing the ignition to START, or moving the key to the RUN or ACCY position. No lamp or chime indication is provided.

A WAKE-UP command is sent when:

- any door becomes ajar or is opened or closed.
- the front door handle is lifted (if equipped with illuminated entry).
- the key is inserted or removed.
- the ignition switch is turned from OFF to RUN.
- the ignition switch is turned from OFF to ACCY.
- a wake up request is received from the RAP module.

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Courtesy Lamps

The GEM illuminates the interior courtesy lamps when any door is set ajar or is opened. The following are inputs used for controlling the courtesy lamps:

- Vehicle speed sensor input
- All door ajar switches
- Door handle switches
- Illuminated entry request with RAP module

All interior courtesy lamps are turned off when any of the following occurs:

- Twenty-five seconds have elapsed after all the doors are closed.
- The ignition switch (11572) is turned to RUN.
- Vehicle speed is over 8 km/h (5 mph).
- A power door lock command is received before the five seconds have elapsed.

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Illuminated Entry

The interior courtesy lamps will be turned on if any front door handle is lifted or if any door is ajar. If the lamps are turned on by lifting the front door handle or by illuminated entry request from the RAP module, the lamps stay on for 25 seconds.

The interior courtesy lamps are turned off when the following conditions are met.

- 25 seconds have elapsed since the illuminated entry feature was activated and the interior lamp control is not activated.
- The GEM receives a request from the RAP module and the courtesy lamp is not activated.
- The ignition switch is in the RUN or START position, and the interior lamp control is not activated.

Delayed Accessory

The module provides temporary power to the power windows for ten minutes after the ignition switch is moved from the RUN to OFF position. If during this ten-minute period either front door (20124) is opened, the delayed accessory relay will be de-energized.

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One-Touch Window

When the power switch for driver window control is held down (between 0.04 and 0.4 seconds) and then released with the ignition switch (11572) in RUN or ACC, the driver window will automatically move to its full down position.

Only the driver window has this feature. Holding the switch down longer allows the operator to stop the window as soon as the switch is released.

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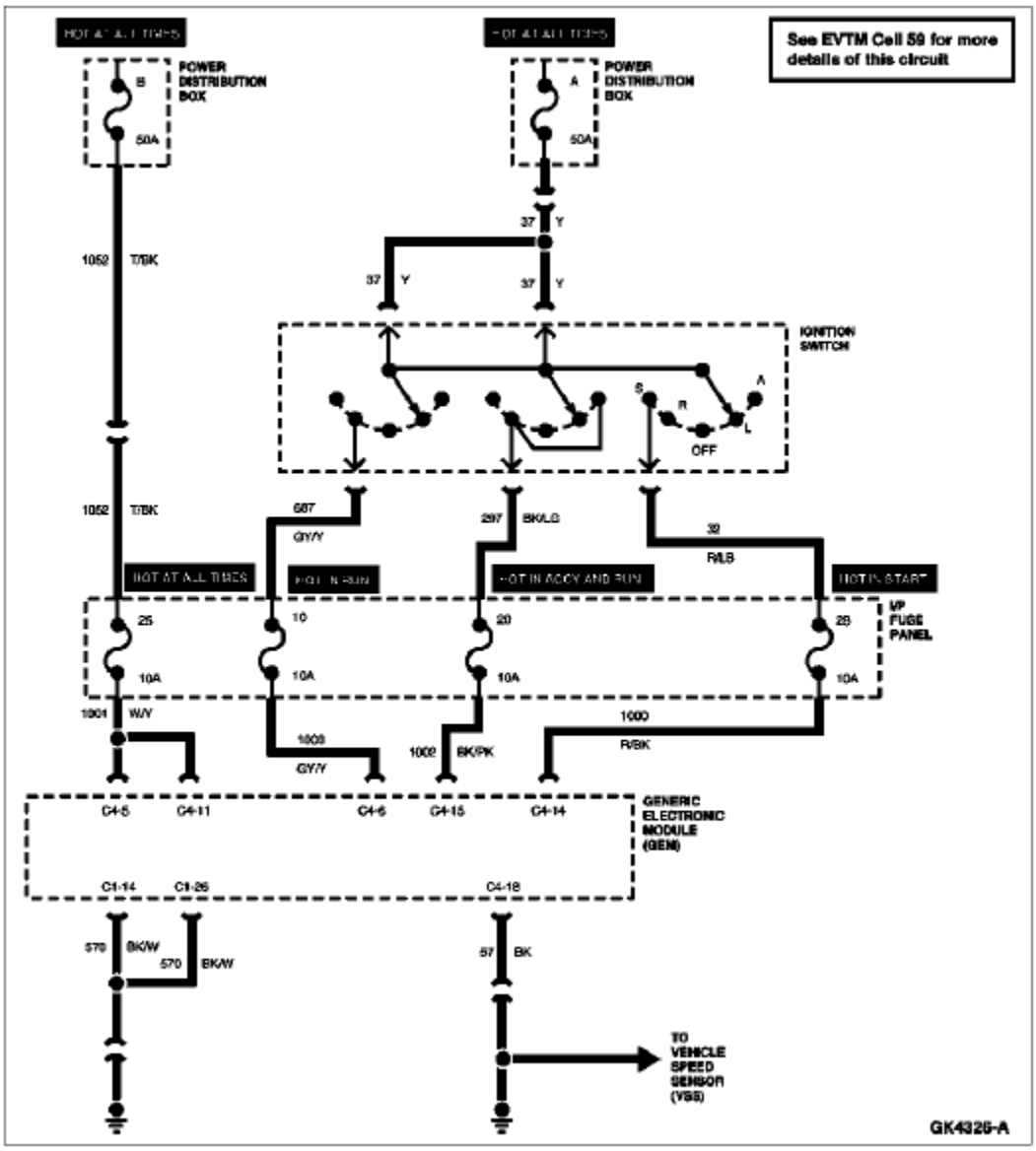
Four-Wheel Drive Electronic Shift-on-the-Fly

This feature electronically shifts the vehicle transfer case between 2WD, 4WD, and 4WD LOW. The system mode is selected by the operator through a three-position rotary switch on the instrument panel. The operator is informed which mode the system is in by two cluster indicator lamps, one for 4WD HIGH, and one for 4WD LOW (in 4WD LOW, both lamps are on). The GEM accomplishes shifts between different system modes by interpreting inputs from 4x4 selector switch, the vehicle speed signal, and the transfer case contract plates. Based on these inputs, two relays (L2H and H2L directional control), the transfer case motor, and an output for the transfer case electric clutch, are used to shift into 2WD, 4WD HIGH, or 4WD LOW. The GEM will not allow shifts into 4WD LOW unless the brake is depressed, the vehicle is in NEUTRAL (with automatic transmission vehicles), the clutch is pressed (in manual transmission vehicles), and the speed is less than 5 km/h (3 mph).

GEM Power and Ground System, Ranger



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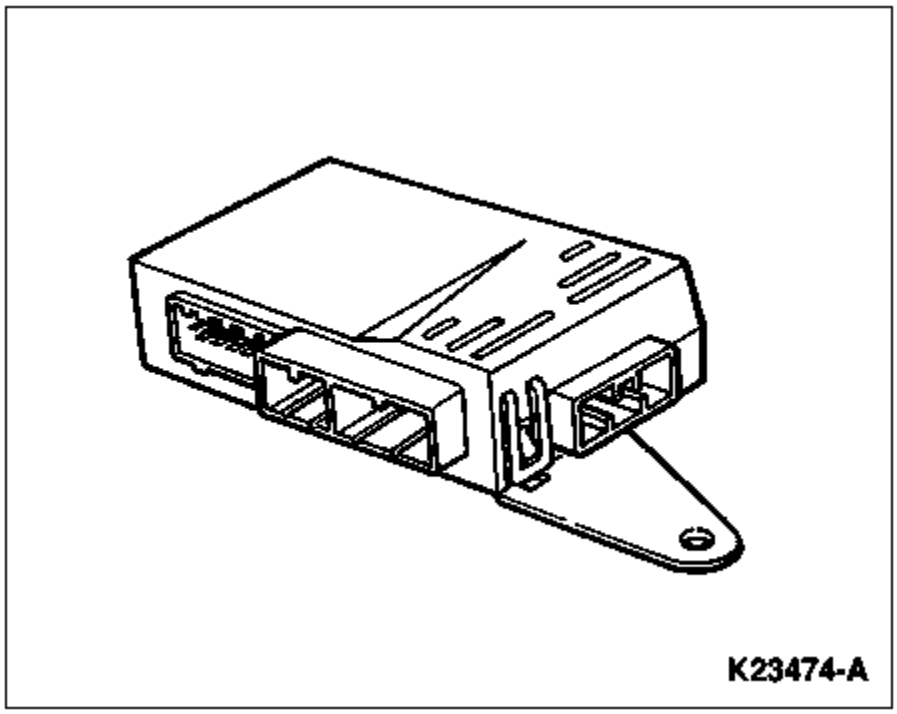
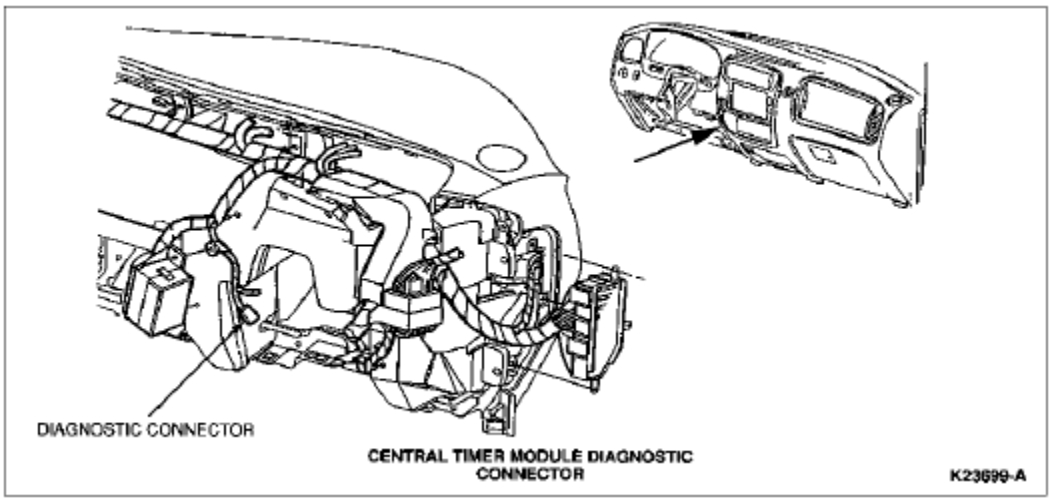
CTM Controlled Functions

The Central Timer Module (CTM) incorporates the function of several different electronic modules into one.



Central Timer Module Diagnostic Connector



Windshield Wiper/Washer Control

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MIST

When the wash button is tapped for less than 0.3 seconds with the multi-function switch (13K359) in the OFF position, the wiper motor will perform a single wipe without a wash. If the wash button is held longer (up to 10 seconds), the washer pump runs followed by three extra low-speed wipes after the button is released.

INTERVAL

For standard interval, the time between low-speed wipes will range from 1.5 - 20 seconds.

HI

This is the fastest wiper speed with no dwell. It is selected when the multi-function switch is in the HI speed position. If the wash button is pressed for 0.3-10 seconds, the washer pump will energize until the wash button is released.

LO

This is the slowest wiper speed with no dwell. It is selected when the multi-function switch is in the LO speed position. If the wash button is pressed for 0.3-10 seconds, the washer pump will energize until the wash button is released.

WASH

If the wash button is pressed for 0.3-10 seconds, the washer pump will energize until the wash button is released.

Chime Warning

The CTM will not generate more than one audible warning at any given time. When more than one condition requiring a CTM-generated audible warning is present, the CTM will stack the warning conditions and sound them in order of decreasing priority according to the table below. However, the CTM will not delay the illumination of any warning indicator lamp, even in cases where its associated audible warning is being delayed by the sounding of a higher priority audible warning. For any given condition requiring an audible warning, the CTM will sound that warning only after all higher priority warnings have completed sounding, the given condition still exists, and the associated indicator lamp, if any, is still illuminated.

PRIORITY TABLE FOR AUDIBLE WARNINGS

Warning Condition	Lamp Duration	Audible Duration	Audible Output
Safety Belt	60 Seconds	6 Seconds (±0.5 Seconds)	Chime, 60/Min. 740 Hz
Key in Ignition	—	continuous	Chime, 120/Min. 740 Hz
Headlamps On	—	Continuous	Chime, 240/Min. 740 Hz
Door Ajar	Continuous	1 Second	Tone, 1000 Hz

Headlamp On Warning

A chime sounds when the exterior lamps are on (parking, license plate and headlamps (13008) and:

- There is no key in the ignition switch (11572).
- The driver's front door (20124) is ajar (or open).
- Ignition switch is in OFF position.

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Door Ajar Warning

When at least one door is ajar and the key is in the RUN position, the door ajar cluster lamp is activated and remains on until all doors are closed. A warning tone will sound once any time the key is in the ignition switch and any door is open.

Driver Seat Belt Warning

During the first 60.0 seconds after the ignition switch state is changed to RUN and remains in RUN or START, the CTM will activate the safety belt warning indicator lamp any time during this period that the driver safety belt is not buckled.

Key In Ignition

Any time the key is in the ignition switch and the driver door is open, the module sounds a chime (120 chimes per minute) until either the key is removed from the ignition or the driver's door is closed.

Battery Saver

NOTE: The exterior lamps are not part of the battery saver protection, and will remain on even if the GEM turns the interior lamps off.

The battery saver feature removes extended interior lamp power drains to the battery (10655). The CTM keeps power to these loads for 45 minutes after the ignition switch is turned off.

The CTM will keep power available for all interior lights, key ring lights, cargo lamp, and hood lamp circuits for 40 minutes after the ignition switch is turned off. The battery saver timer is reset by lifting a door handle, activating a door ajar switch, changing the ignition to START, or moving the key to the RUN or ACCY position. No lamp or chime indication is provided.

A WAKE-UP command is sent when:

- Driver door handle switch is activated.
- Any door becomes ajar or is closed.
- The key is inserted or removed.
- The ignition switch is turned from OFF to RUN.
- The ignition switch is turned from OFF to ACCY.

Courtesy Lamps

The CTM illuminates the interior courtesy lamps when any door is set ajar or is opened. All interior courtesy lamps are turned off when any of the following occurs:

- Twenty-five seconds have elapsed after all the doors are closed.
- The ignition switch is turned to RUN.
- Vehicle speed is over 8 km/h (5 mph) (once the interior courtesy lamps are turned OFF, a new ajar signal will be honored only if vehicle is speed is below 16 km/h [10 mph]).
- A power door lock command is received before the five seconds have elapsed.

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Illuminated Entry

The interior courtesy lamps will be turned on if the driver door handle is lifted or if any door is ajar. If the lamps are turned on by lifting the driver door handle or by illuminated entry request from the RAP module, the lamps stay on for 25 seconds.

The interior courtesy lamps are turned off when the following conditions are met.

- 25 seconds have elapsed since the illuminated entry feature was activated and the interior lamp control is not activated.
- The GEM receives a request from the RAP module and the courtesy lamp is not activated.
- The ignition switch is in the RUN or START position and the interior lamp control is not activated.

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Generic Electronic Module (GEM)

NOTE: This section contains only on-demand self-test and functional test procedures for the GEM and GEM-related subsystems and power and ground concern isolation pinpoint tests. Refer to the appropriate section for GEM subsystem diagnostic procedures.

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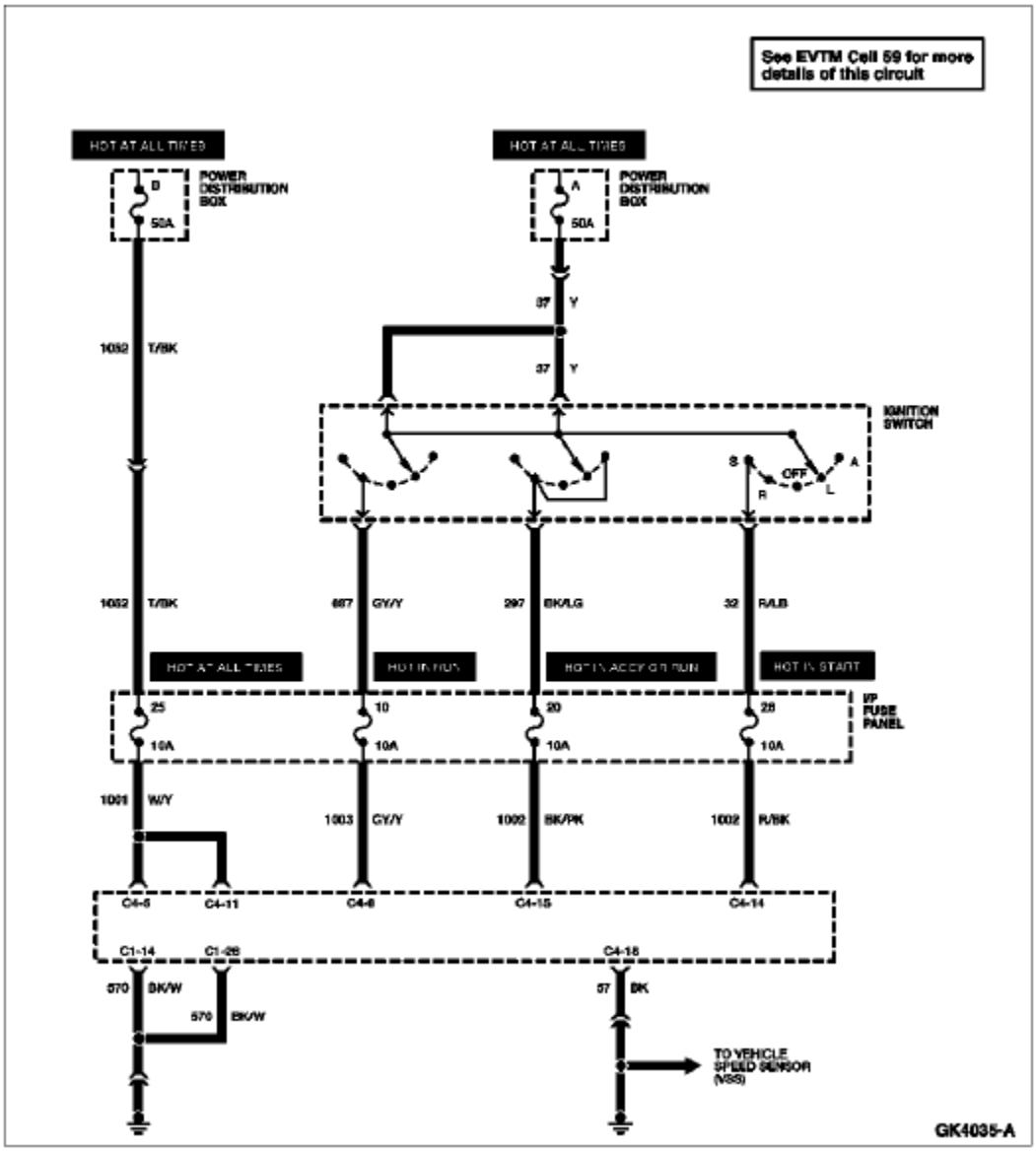
Electrical Schematics

GEM Power and Ground System



Warning Lamps and Chimes

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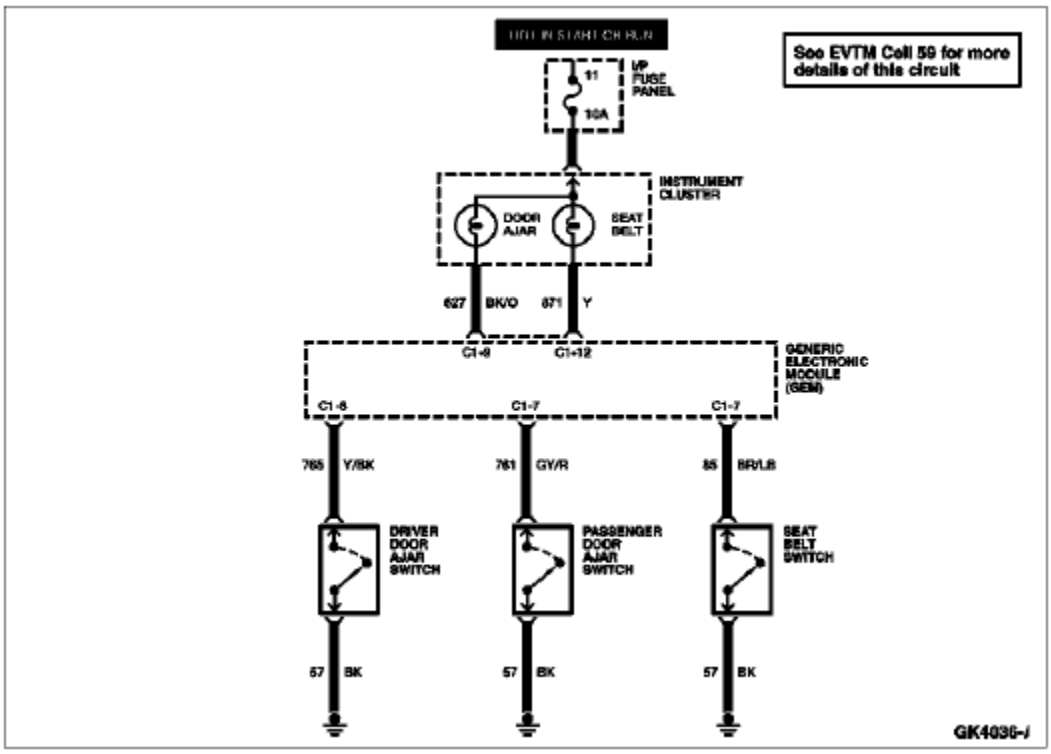

Battery Saver, Illuminated Entry and Interior Lamps, Ranger

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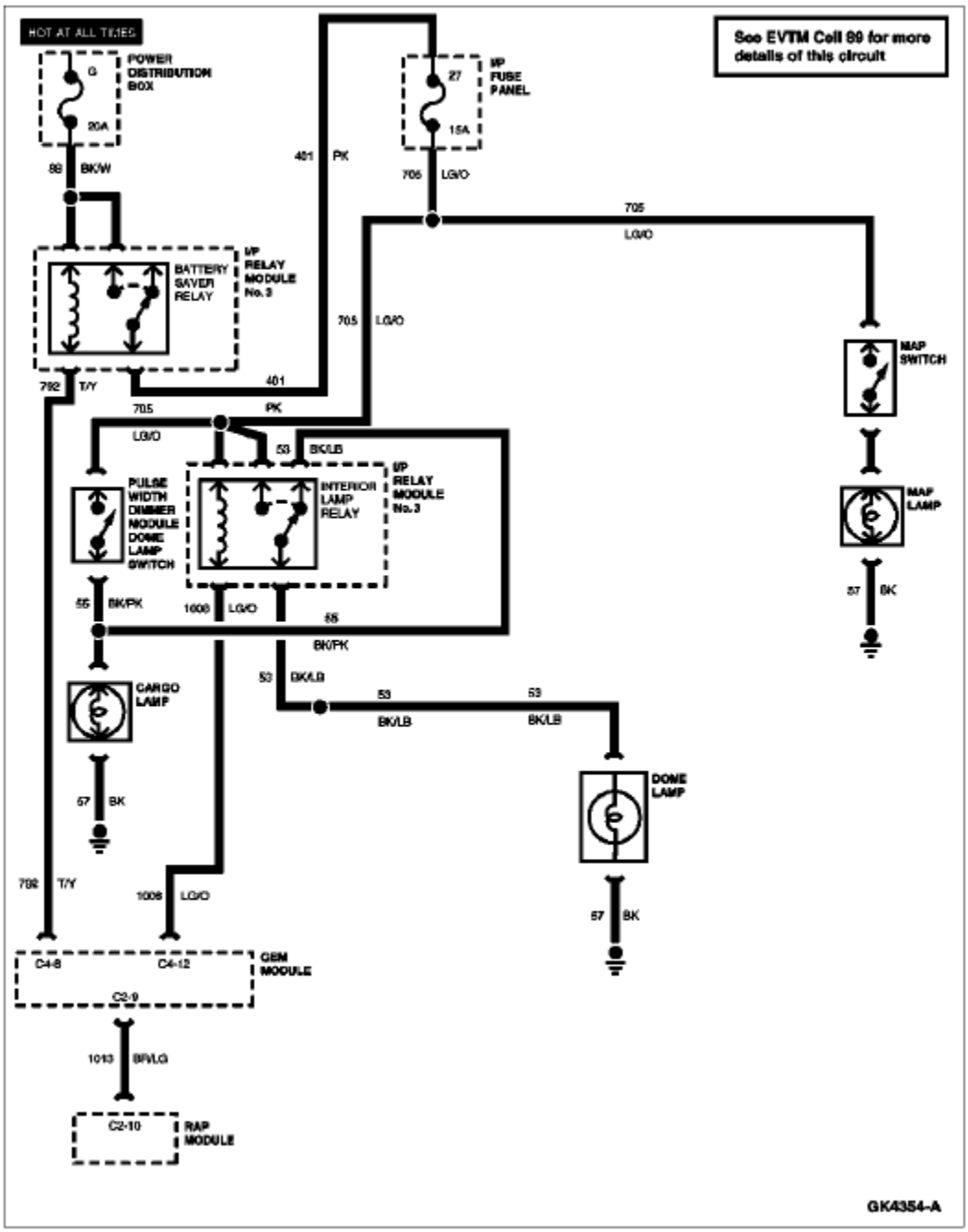

Battery Saver and Interior Illumination, Ranger

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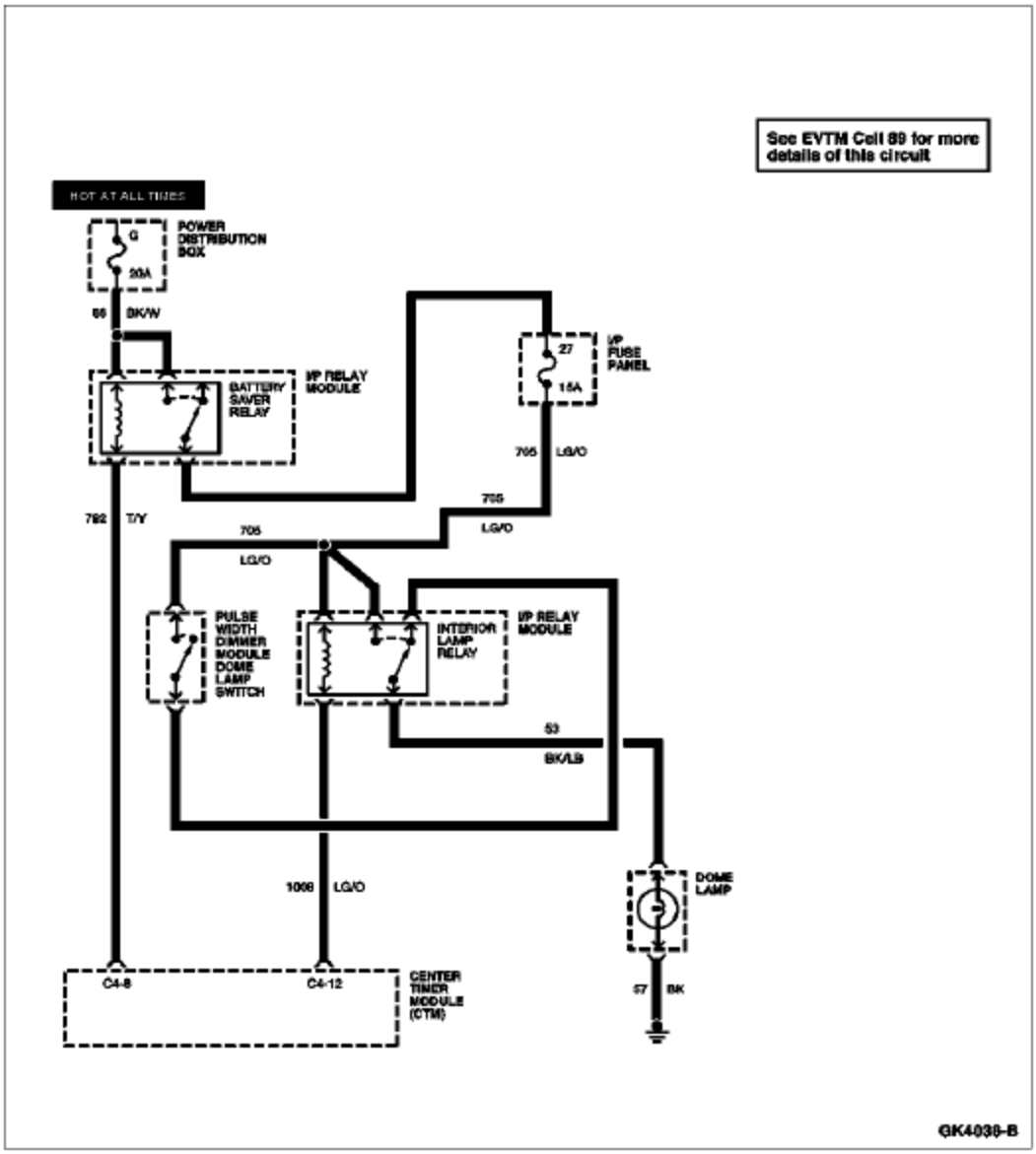

Power Windows, One-Touch, Ranger

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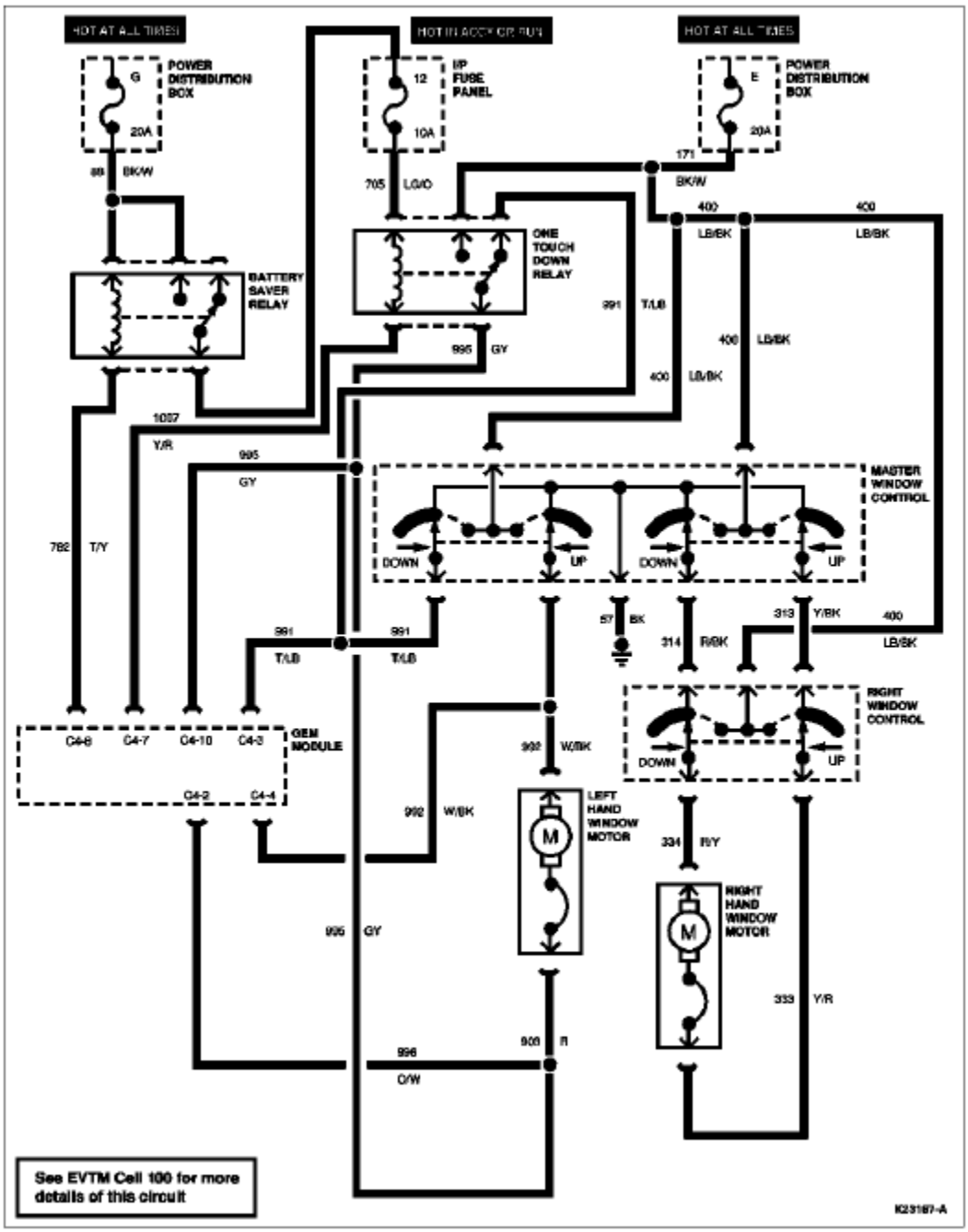

Front Washer and Wiper System, Ranger

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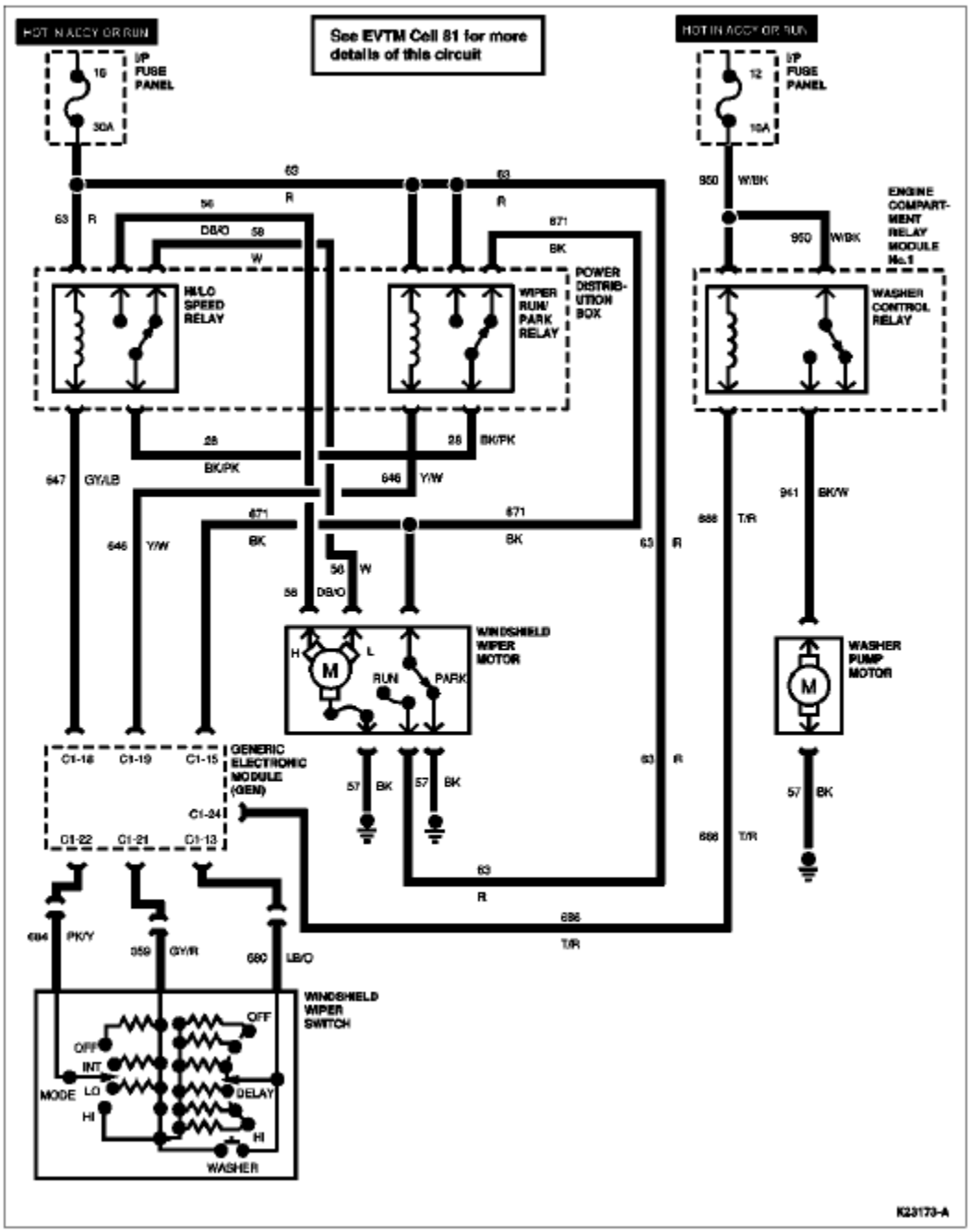

Power Locks with Remote Keyless Entry, Ranger

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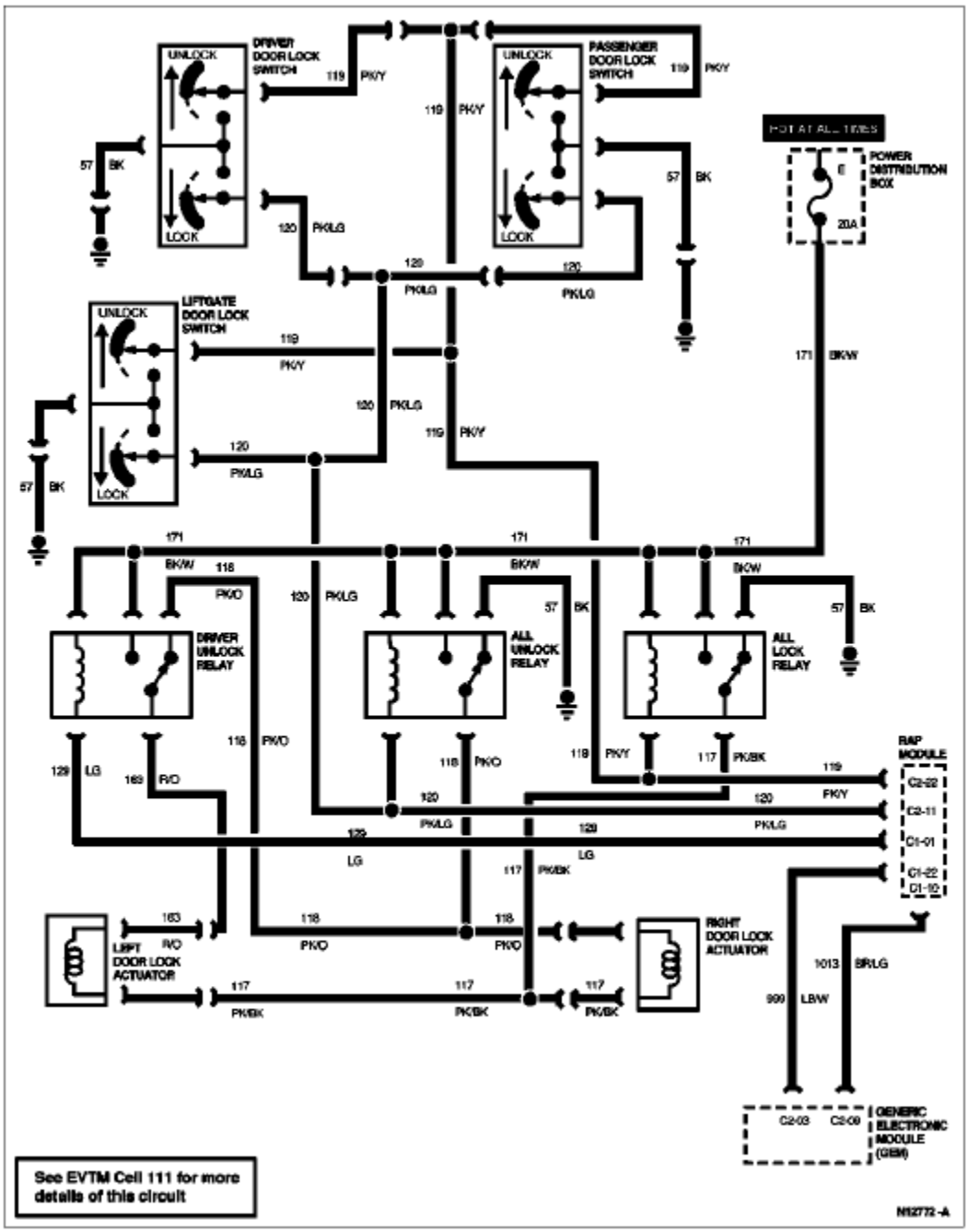

Power Locks Without Remote Keyless Entry, Ranger

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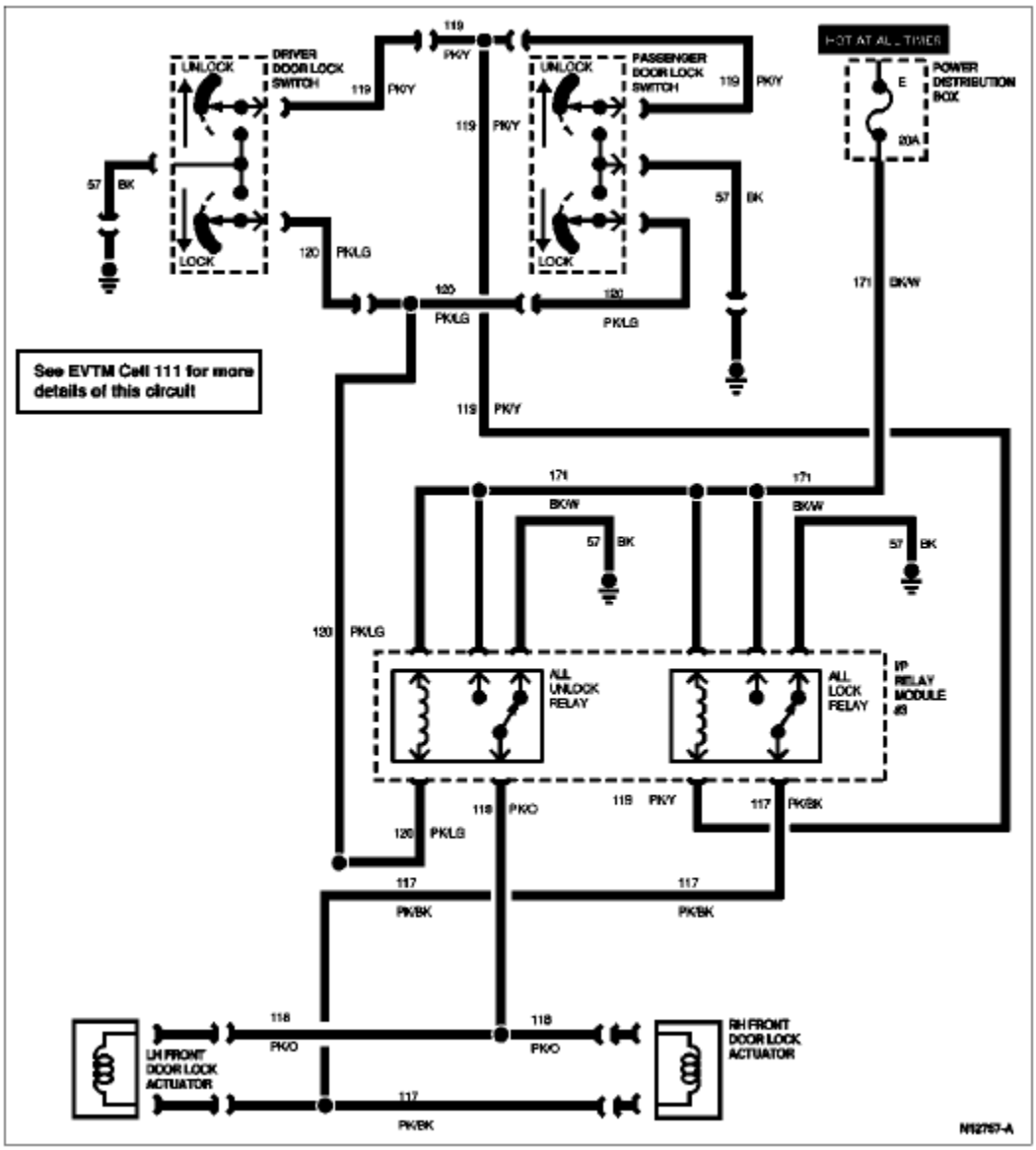

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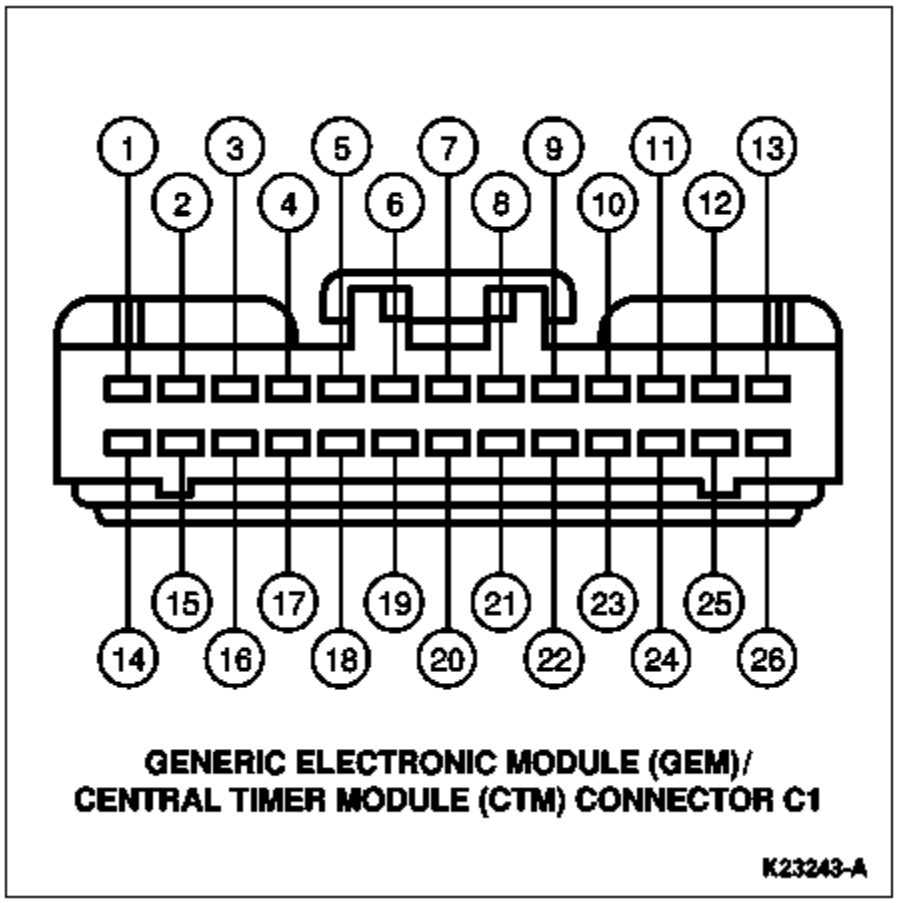

Pin Number	Circuit	Circuit Function
1	—	Not Used
2	209 (W/P)	Self Test Input to Module
3	930 (P/LG)	Door Handle Switches to GEM — Input
4	—	Not Used
5	—	Not Used
6	—	Not Used
7	761 (GY/R)	Passenger Door Ajar Switch to GEM — Input
8	765 (Y/BK)	Driver's Door Ajar Switch to GEM — Input
9	627 (BK/O)	Open Door Warning Switch
10	158 (BK/PK)	Key Warning Switch
11	1032 (W/BK)	Park Lamp Switch to Module
12	871 (Y)	Seat Belt Indicator Lamp to Module
13	680 (LB/O)	Front Wiper Switch Delay/Wash to GEM — Input
14	570 (BK/W)	Dedicated Ground — EC
15	671 (BK)	Front Wiper Motor Status to GEM — Input
16	120 (PK/LG)	Door Lock Switch (Unlock)

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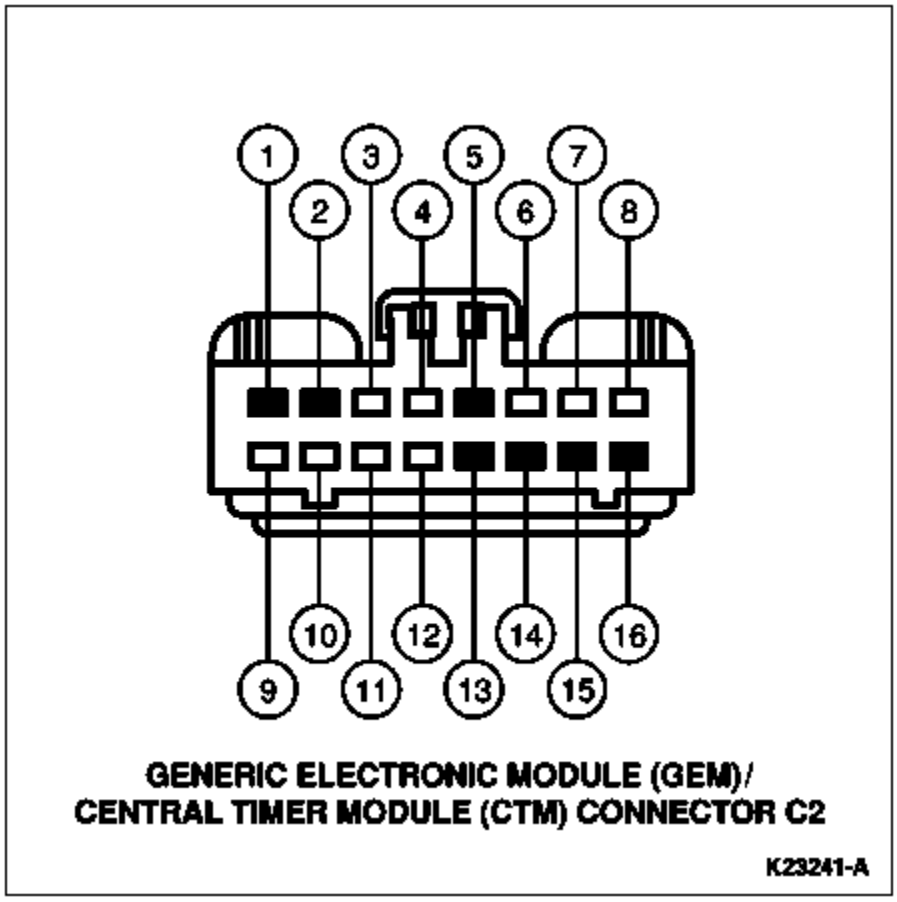
17	25 (DG/P)	Anti-Theft Switch Disarm
18	647 (GY/LB)	GEM to Front Wiper Speed Control Relay — Output
19	646 (Y/W)	GEM to Front Wiper Run/Dynamic Brake Relay — Output
20	—	Not Used
21	359 (GY/R)	Sensor Signal Return
22	684 (PK/Y)	Front Wiper Switch Mode Select to GEM — Input
23	85 (BR/LB)	Seat Belt Warning Timer to LH Front Retractor Switch
24	686 (T/R)	GEM to Front Wiper Pump Relay — Input
25	70 (LB/W)	ISO 9141
26	570 (BK/W)	Dedicated Ground — EC



Pin Number	Circuit	Circuit Function
1	—	Not Used
2	—	Not Used
3	999 (LB/W)	GEM — Anti-Theft Door Ajar Output to RAP Module

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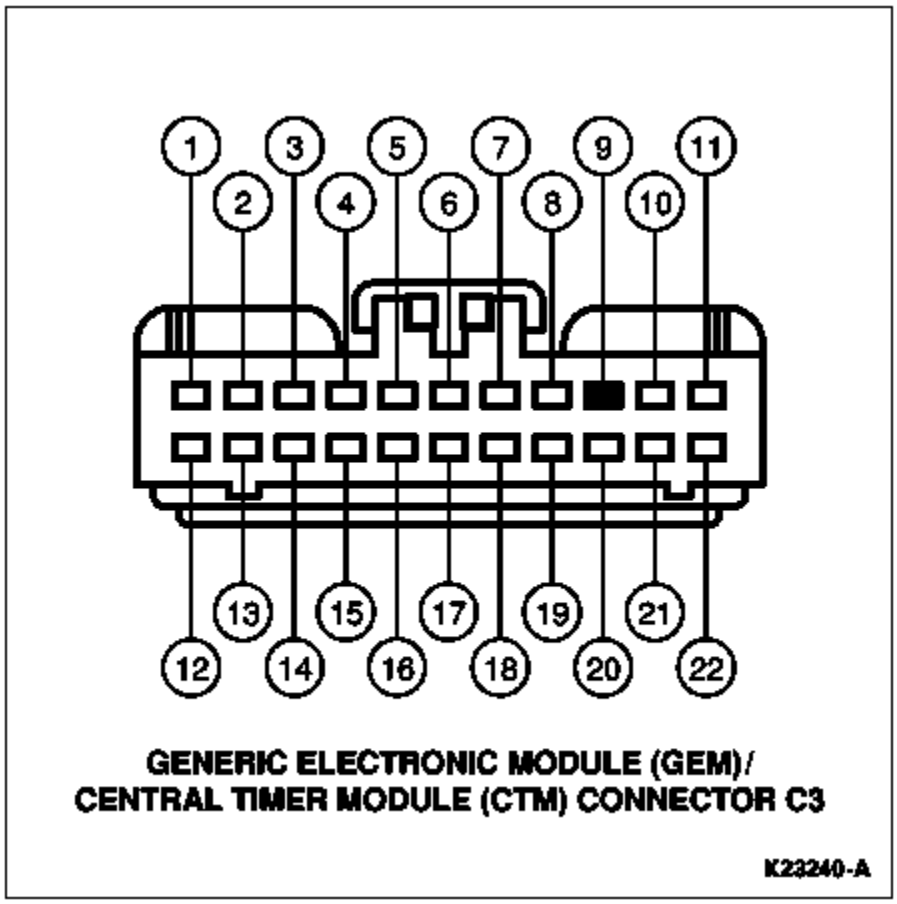
4	—	Not Used
5	—	Not Used
6	—	Not Used
7	—	Not Used
8	—	Not Used
9	1013 (BR/LG)	Illuminated Entry Request to GEM — Input
10	—	Not Used
11	—	Not Used
12	—	Not Used
13	—	Not Used
14	—	Not Used
15	—	Not Used
16	—	Not Used



Pin Number	Circuit	Circuit Function

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1	—	Not Used
2	—	Not Used
3	—	Not Used
4	—	Not Used
5	—	Not Used
6	—	Not Used
7	—	Not Used
8	465 (W/LB)	Module to Switch
9	—	Not Used
10	784 (LB/BK)	4x4 Low Indicator Lamps to GEM
11	—	Not Used
12	762 (Y/W)	Electrical Shift 4x4 Module to Motor Return
13	511 (LG)	Stoplamp (Brake On/Off) Switch to Stoplamps
14	783 (GY)	Electrical Shift Module to Graphic Display Roof Console
15	275 (Y)	Switch On to Relay
16	339 (GY)	GEM to L2H Transfer Case Relay Module
17	513 (BR/PK)	Power Relay Coil to Module
18	763 (O/W)	Electrical Shift 4x4 Module to Motor Position D
19	764 (BR/W)	Electrical Shift 4x4 Module to Motor Position C
20	770 (W)	Electrical Shift 4x4 Module to Motor Position B
21	771 (P/Y)	Electrical Shift 4x4 Module to Motor Position A
22	463 (R/W)	Transmission Range Sensor to GEM

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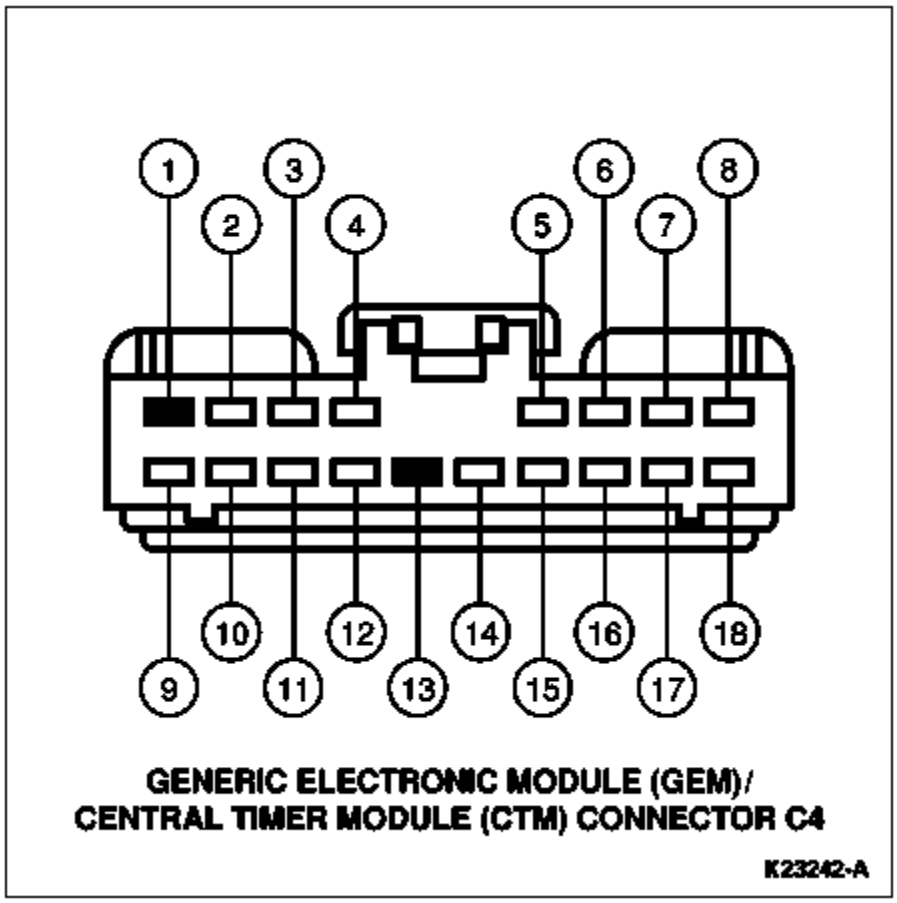

Pin Number	Circuit	Circuit Function
1	—	Not Used
2	996 (O/W)	Window Motor Current Sense "Low" to GEM (LH) — Input
3	991 (T/LB)	Master Window Control "Down" Command to GEM — Input
4	992 (W/BK)	Master Window Control "Up" Command to GEM — Input
5	1001 (W/Y)	Fused Battery Feed to GEM — Input
6	1003 (GY/Y)	Fused Ignition "Run" to GEM — Input
7	1007 (Y/R)	GEM to One-Touch "Down" Relay — Output
8	792 (T/Y)	Battery Saver Relay — Fused Feed
9	679 (GY/BK)	Vehicle Speed Sensor — Plus to EC Module
10	995 (GY)	Window Motor Current Sense "High" to GEM (LH) — Input
11	1001 (W/Y)	Fused Battery Feed to GEM — Input
12	1008 (LG/O)	GEM to Interior Lamp Control Relay — Output
13	—	Not Used
14	1000 (R/BK)	Fused Ignition "Start" to GEM — Input
15	1002 (BK/PK)	Fused Ignition "Run/Accessory" to GEM — Input
16	—	Not Used

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17	—	Not Used
18	57 (BK)	Ground Circuit

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Inspection and Verification

GEM Diagnosis

The GEM diagnostic system is composed of the New Generation STAR (NGS) tester, the GEM and all GEM-associated components. They allow you to determine if a GEM subsystem has a fault and provides the capability to isolate the fault.

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Diagnosis Instructions

As in all microprocessor systems, communications must be provided to monitor system operation and to allow diagnosis of any concerns that may develop in the system. Diagnosis communication is provided through the data link connector (DLC) and the Rotunda New Generation STAR (NGS) tester 007-00500 or equivalent.

ISO 9141 Data Link Connector (DLC)

Data link connector (DLC) (diagnostic connector) is located under the instrument panel on the driver's side just to the left of the steering column. The diagnostic connector allows communication between the generic electronic module (GEM) and Rotunda New Generation STAR (NGS) tester 007-00500 or equivalent.

Test Equipment

New Generation STAR (NGS) Tester 007-00500 or equivalent:

- Allows individual commands for inputs and outputs of the GEM System.
- Allows retrieval of diagnostic trouble codes (DTCs) from the GEM.

All testing in this manual can be accomplished using the NGS.

Diagnostic trouble codes (DTCs) are reported to the NGS through the DLC. DTCs are cleared manually by the NGS or after a planned period of time not seeing the same DTC (e.g., 80 start cycles) by the GEM.

Action that may be taken by continuous diagnostics are as follows:

- Manage the fault
- Store a diagnostic trouble code
- Illuminate a warning lamp

The GEM diagnostics mode has the ability to interface with you via the NGS. This diagnostic operation allows the best fault isolation capability. You have the ability to communicate with the GEM subsystem when the NGS is in the diagnostics mode. Interaction with the GEM is achieved by the following:

- Requesting the GEM to perform tasks (e.g., turn ON the wipers)
- Transmitting GEM control states (e.g., switch status)
- Physically interacting (e.g., connecting/disconnecting wires) with the vehicle hardware

The tester has a menu-driven user interface allow you the ability to run a specific diagnostic test. You can separate faults in the GEM through a symptom-driven diagnostic process, exercising specific functional tests, or retrieving diagnostic trouble codes.

The majority of the GEM diagnostic strategy is in the GEM. The NGS requests the GEM for input and output status. It then sends commands to actuate the output devices and has the GEM run diagnostic tests and report stored DTCs.

Detecting and Storing Diagnostic Trouble Codes

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When the GEM energizes an external device, a short circuit condition can momentarily exist. This fault is not immediately stored as a diagnostic trouble code since the fault can disappear after a few milliseconds. The GEM repeatedly attempts to energize the device for one second to confirm that the fault still exists.

If the device is successfully energized before one second elapses, a diagnostic trouble code is not stored and fault management action is not taken. If the fault continues after the predetermined fault time, a diagnostic trouble code is stored and appropriate fault management action is then taken.

Detecting Faults in the GEM Output Circuits

Battery shorts can only be detected when the device being controlled is actuated (e.g., relays, lamps or solenoids).

All faults are monitored continuously during the vehicle operation.

Reporting Trouble Codes

Faults are displayed after the continuous DTCs and the On-Demand DTCs are retrieved. Continuous DTCs should be retrieved from the GEM before an On-Demand Self Test is run. These DTCs are then compared against the diagnostic trouble codes retrieved after running an On-Demand Self Test.

Clearing Continuous DTCs

Continuous DTCs must be cleared when the problem has been fixed. Trouble codes can be cleared by sending a request from the NGS to clear them.

Automatically Clearing Codes

Automatic clearing of individual trouble codes is done when the fault is not present for 80 start cycles. These trouble codes are automatically cleared after 80 start cycles.

Tester-Dependent Diagnostic Capability and Fault Isolation

The tester-dependent diagnostics allows you to communicate with the GEM through a tester connected to the DLC.

Running a diagnostic test may require the GEM to energize an output device. Some output devices might be limited to the amount of time that they can be actuated. The tester can reactivate the device by exiting the diagnostic test and entering the test again. The GEM will not protect for enter/exit condition of the tester.

During the tester-dependent diagnostics mode, the tester can only command the GEM to perform tests on disabled functions. A response is sent to the tester if a diagnostic test request is made on a function that is not disabled.

The NGS can request the GEM to activate or deactivate an output device.

Vehicle Conditions for On-Demand Self Test

During on-demand self-test the GEM disables all output functions.

On-demand self-test requires the following vehicle conditions:

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- All doors are closed
- The ignition switch is in the RUN position
- The wiper control is in the OFF position and the wiper blades are parked
- The headlamps are off
- All the windows are in the up position
- All vehicle switches are deactivated
- The driver seat belt is not buckled

Running a Diagnostic Control Test

The tester controls the GEM by performing diagnostic tests. Diagnostic tests are done only when the GEM has disabled the function being controlled. These control tests allow the tester to control the GEMs outputs and to synchronize the GEMs inputs.

On-Demand Self Test Results

The results of the on-demand self-test is in the form of DTCs. The on-demand self-test DTCs are requested after the test has run.

The On-Demand Self Test detects faults within milliseconds as opposed to one second for the continuous fault code detection. The shorter period of time reduces the overall test time and can help identify intermittent faults.

Requesting a Parameter Identification (PID)/Data Monitor

For the GEM to detect a battery short, the device must be activated. During continuous state, a PID may fluctuate between both short and normal when a battery short is present.

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NGS Parameter Identification Display (PID) (GEM)

The following chart lists all of the acronyms displayed on the NGS Scan Tool for GEM related diagnostics.

NGS PID Name	PID Description
VSS _GEM	Vehicle Speed
TRANSGR	Transmission Gear Position
CLTCHSW	Transmission Clutch Interlock Switch
NEUT _SW	Neutral Safety Switch Input
TRA _RSP	Transmission Transfer Case Rear Speed
TRA _	Transmission Transfer Case front Speed
MTR _H2L	Transmission Transfer H2L Motor Output
MTR _L2H	Transmission Transfer L2H Motor Output
HALLPWR	Center Axle Hall Power
AXL _EN	Center Axle Engage Status
4WDELCL	4WD Electronic Clutch Output Status
4WDCLST	4WD Clutch PWM Output Status
4WDLOW	4WD-Wheel Low Output State
4WDHIGH	4WD-Wheel High Output State
4WD _SW	4WD Input Switch Status
AXLSTAT	4WD Center Axle Disconnect
AXL _DIS	4WD Center Axle Disconnect
PLATE _D	Transmission Transfer Case Contact Plate
PLATE _C	Transmission Transfer Case Contact Plate
PLATE _B	Transmission Transfer Case Contact Plate
PLATE _A	Transmission Transfer Case Contact Plate
PLATEPW	Transmission Transfer Case Contact Plate
BOO _GEM	Brake Switch Input Status
PWR _RLY	ABS Power Relay Feedback Input
LFSBELT	Left Front Seat Belt Status
IPCHIME	External Chime Request
PARK _SW	External Lamp Control INP Switch STA
LGATESW	External Access Ajar SW Status
RRDR _SW	External Access Ajar Switch Status
LRDR _SW	External Access Ajar Switch Status
RFDR _SW	External Access Ajar Switch Status
LFDR _SW	External Access Ajar Switch Status

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LFDHNDL	External Access Handles Switch Status
LFFTDWN	Left Front Window Down
LFPW __SW	Left Front Window Up
DR __UNLK	All Doors Unlock Output State
LFPWRLY	Left Front Power Window Status
LFPWAMP	PWR Window Left Front Motor Current
LFPWPK	PWR Window Left Front Peak Amp Motor Current
IGN __KEY	Ignition Key Status
IGN __GEM	Ignition Switch Status
WPPK __PK	Wiper Park-to-Park Time
WPMODE	Wiper Control Mode Select
WPPRKSW	Windshield Wiper Status
SBLTLMP	Washer Fluid/Seat Belt Lamp
WPHISP	Wiper Two Speed Relay
WPRUN	Wiper Motor Run Relay
WASHRLY	Washer Pump Relay Circuit
DRAJA __L	Door Ajar Warning Lamp Circuit
BATSAV	Battery Saver Relay Circuit
INTLMP	Illuminated Entry Relay Circuit
ACCDLY	Accessory Delay Relay Circuit
ILLE __SW	Illuminated Entry Input Switch
DR __DSRM	Door Unlock Disarm Input Switch
VBATGEM	Battery Voltage
4WDCLCH	4WD Clutch PWM Output Status

Using Rotunda New Generation STAR (NGS) Tester

The Rotunda New Generation STAR (NGS) tester is a menu-driven device that allows specific diagnostic testing and DTC retrieval.

Interface

The NGS tester communicates to the GEM through the data link connector. The connector is located in the passenger compartment on the driver's side under the steering column.

Retrieving Diagnostic Trouble Codes (DTC)

The GEM monitors the system during normal operation and reports concerns in the form of diagnostic trouble codes (DTCs). The DTCs can be retrieved with the NGS tester through the communication link.

Functional Tests

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Active Test Modes

In addition to retrieving DTCs, the GEM can also be commanded to turn on lamps, relays or solenoids. This eliminates the need to perform more traditional pinpoint tests and speeds up repair times. The following active mode tests are available.

Front Windshield Wipers

The NGS tester can command the GEM to turn on or to turn off the:

- speed relay
- wiper relay
- washer relay

Warning Lamps and Chimes

The NGS tester can command the GEM to turn on or to turn off the:

- door ajar lamp
- seat belt lamp
- chime

Battery Saver/Illuminated Entry

The NGS tester can command the GEM to turn on or to turn off the:

- battery saver relay
- illuminated entry relay

One-Touch Window/Accessory Delay

The NGS Tester can command the GEM to turn on or to turn off the:

- driver side window relay
- accessory delay relay

Wiggle Test

Wiggle tests are not functional on the Ranger.

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On-Demand Self-Test (CTM)

Interface

The CTM diagnostic mode is entered by grounding the dedicated diagnostic mode input. This one-pin connector is located under the instrument panel.

The diagnostic mode is exited (returned to normal operation) immediately upon removal of the ground on the diagnostic mode input.

Retrieving Diagnostic Trouble Codes (DTC)

The diagnostic mode is made up of the three following separate steps:

1. Tone and door ajar lamp test
2. Trouble code test
3. Input test

   Step 1 is run immediately upon entry into the diagnostic mode.

   Step 2 is run without the key in the ignition.

   Step 3 is run with the key in the ignition.

   The operator may switch between Steps 2 and 3 indefinitely until the diagnostic mode input is ungrounded.

Step 1 — Tone and Door Ajar Lamp Test

When the diagnostic mode is first entered, the CTM will generate a tone and light the door ajar lamp for three seconds. If the key is in the RUN or ACCY position, use the following table to diagnose problems entering the diagnostic mode.

Door Ajar Lamp	Tone	Meaning
Lights	Sounds	Door Ajar Lamp and Chime are Functioning Correctly.
Doesn't Light	Sounds	One of the Following Problems May Exist: • Door Ajar Lamp Is Burned Out. • Door Ajar Lamp Connection Is Faulty. • Door Ajar Lamp Output on CTM Is Bad, Use the Trouble Code Output Mode to Diagnose.

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Lights	Does Not Sound	Chime Circuitry is Faulty.
Doesn't Light	Does Not Sound	Connection to the Diagnostic Input Is Probably Faulty. Check Connections and Try Again.

After the three-second test, the CTM will pause for one-second and then proceed to either Step 2 or Step 3 depending on whether the key is in the ignition.

The diagnostic mode is used to test the central timer module (CTM) and associated connections while the CTM is in the vehicle. While in this mode, the technician can retrieve and clear the internally stored trouble codes and also individually test each of the CTM inputs. The normal CTM functions are disabled while in the diagnostic mode. The wiper functions are also disabled while in the diagnostic mode. The wiper motor output is operated by the washer switch input during the input test to allow testing of the wiper motor status switch input.

Step 2 — Trouble Code Output

When the CTM is in the normal mode of operation, it is continually monitoring itself. When a fault occurs it is recorded. The trouble code output mode shows these codes, if any, to the technician by flashing the door ajar lamp and simultaneously sounding the chime in a certain order. These codes may then be used to help diagnose potential intermittent failures.

Step 3 — Input Test

The input test allows an operator to individually test the CTM inputs. It is entered when the operator puts the key in the ignition. The inputs may be cycled in any order. As an input is toggled on or off, the door ajar lamp and tone outputs will be activated for one second for confirmation. At any time, if the key is removed from the ignition assembly, the trouble code output will be re-entered.

Viewing Trouble Codes

Trouble codes are output to the operator through flashing of the door ajar lamp and sounding of the chime. Each code is represented by a two-digit number. The high digit is output first followed by a one second pause followed by the second digit. Each two-digit code is separated by a three-second pause. Each digit is also made up of one to nine one-second lamp flashes.

Erasing Trouble Codes

Trouble codes are erased when either:

1. The ignition has been moved to the start position at any time during the diagnostic mode or
2. **NOTE: The following chart lists all the trouble codes generated by the CTM.**

   Power is removed from the CTM.

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Central Timer Module (CTM) Trouble Code Table

Code	Description
11	No trouble codes are currently stored.
12	The wiper/washer mode switch was open at least 30 seconds.
13	The wiper delay interval switch was open at least 30 seconds.
14	An internal software failure was detected.
15	An internal hardware failure was detected.
21	The wiper/high low speed relay coil shorted.
22	The wiper/brake run relay coil shorted.
23	The battery saver relay coil shorted.
24	The courtesy lamp relay coil shorted.
31	The washer pump relay coil shorted.
32	The safety belt lamp relay coil shorted.
34	The door ajar relay coil shorted.

NOTE: The entire set of stored trouble codes will be repeated indefinitely until either the input test mode is entered or the ground is removed from the diagnostic input. This table shows all of the possible trouble codes.

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Generic Electronic Control Module (GEM), Central Timer Module (CTM)

Removal and Installation

1. **NOTE: The automatic ride control switch must be turned to the OFF position when the vehicle is hoisted, jacked, towed, jump-started or raised off the ground to avoid unnecessary operation of the system and/or possible damage to its components.**

   Disconnect battery ground cable (14301).

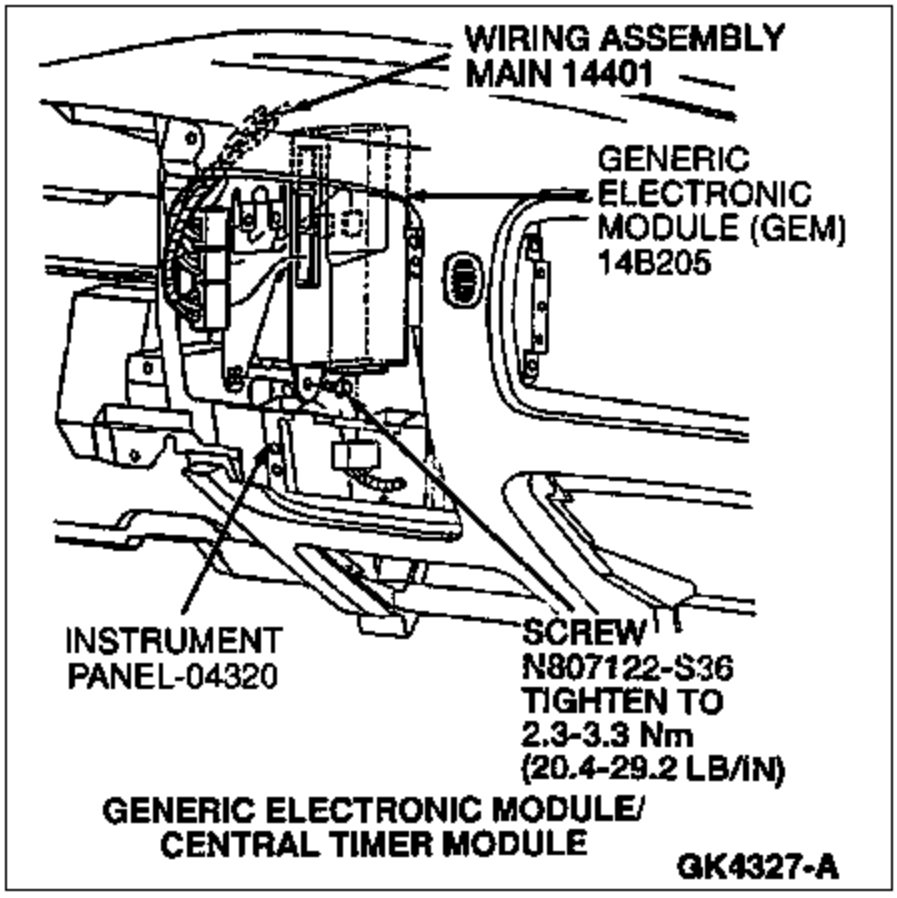
2. Remove radio; refer to Section 15-00 .

3. Remove radio bezel.

4. Remove retaining screw.

5. Slide GEM/CTM toward front of vehicle, off retaining tabs.

6. Disconnect electrical connectors.



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NOTE: When the battery (10655) has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) (12A650) relearns its adaptive strategy. The vehicle may need to be driven 16 km (10 mi) or more to relearn the strategy.

For installation, follow removal procedures in reverse order. Tighten retaining screw to 2.3-3.3 Nm (20.4-29.2 lb-in).

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SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Nm	Lb-In
Screw, GEM/CTM Retaining	2.3-3.3	20.4-29.2

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Remote Control Alarm and Lock System

The Remote Alarm and Lock system combines the functions of the Electronic Door Lock Control system and the Vehicle Anti-Theft system into a single module called the receiver assembly. In the New Generation Star (NGS) Tester, the system and module are called RAP which stands for Remote Anti-Theft Personality.

As a remote entry receiver assembly, the module performs the following functions:

Remote Entry (Key Fob)

- Unlock driver's door
- Unlock all doors
- Lock all doors
- Panic alarm
- Issue interior lamps ON (when unlocking) and OFF commands (when locking) to the Generic Electronic Module (GEM)
- Horn chirp verify when fob LOCK pressed twice
- Double horn chirp notify when door left open
- Deactivate a triggered perimeter alarm
- Arm/Disarm Anti-Theft system
- Allow up to four transmitters to be programmed

Anti-Theft

- Perimeter sensing — doors, hood
- Ignition keylock cylinder sensing
- Starter interrupt
- LED flashing when system is armed
- Alarm (horn and lights)

Inputs and Outputs

The receiver assembly processes inputs from the following:

- (1) Remote Entry Transmitter (key fob)
- Door disarm switches (driver and passenger key cylinders)
- Ignition keylock cylinder sensor
- Hood switch
- Door ajar output from GEM module
- Door lock switches (driver and passenger)
- Door unlock switches (driver and passenger)

The system distributes output to the following:

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- Driver door unlock relay
- All door unlock relay
- Lock all door relay
- Horn relay
- Parklamp relay
- Anti-theft (starter interrupt) relay
- Illuminated Entry request output to GEM module
- THEFT LED (not lamp) in Instrument Cluster

This section covers service procedures directly related to the receiver assembly. For service and diagnostic procedures related to the anti-theft subsystem, refer to Section 13-11 . For the electronic doors subsystem, refer to Section 01-14B .

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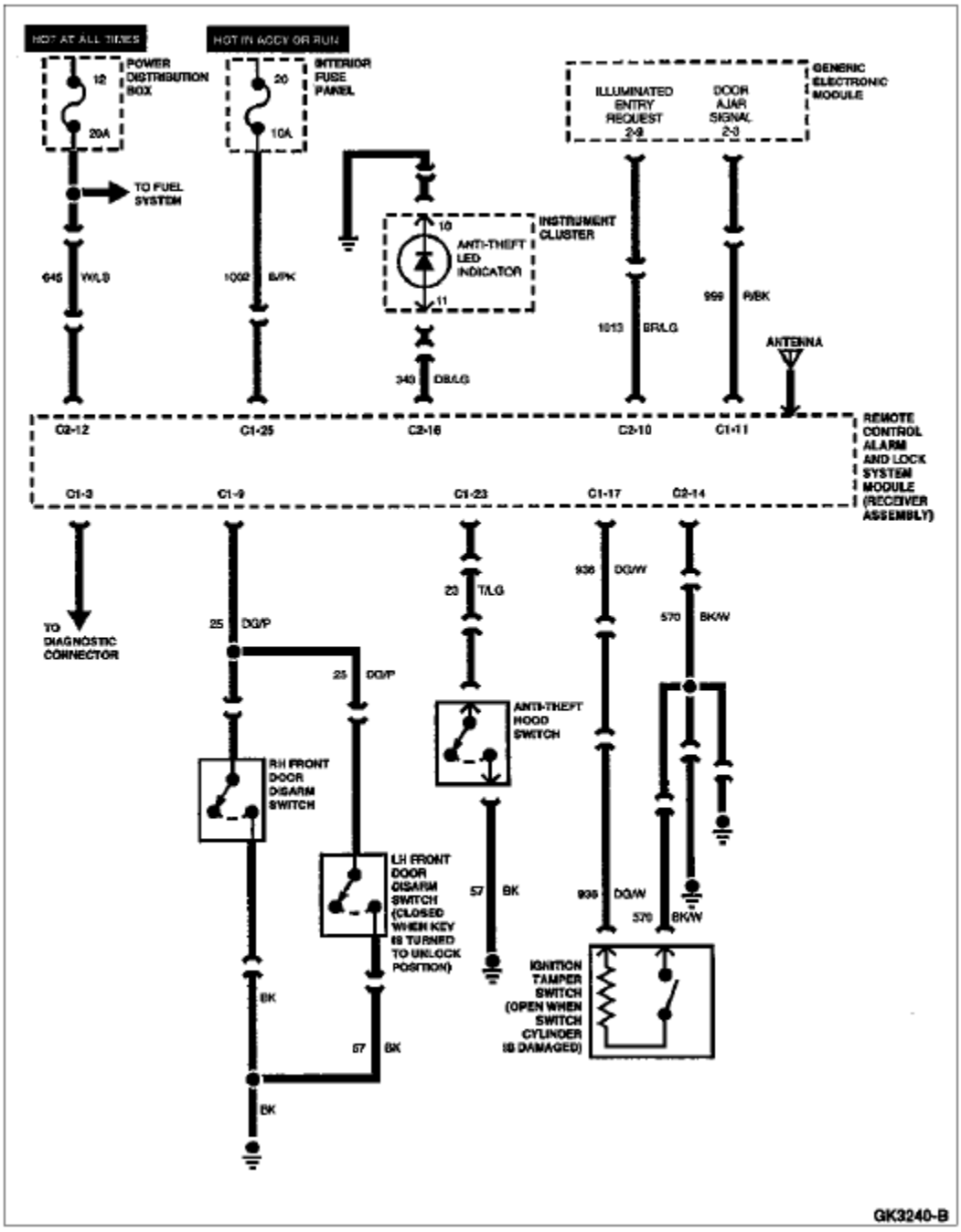
Electrical Schematics

Anti-Theft System, Power Feed, Anti-Theft Activation and Disarm



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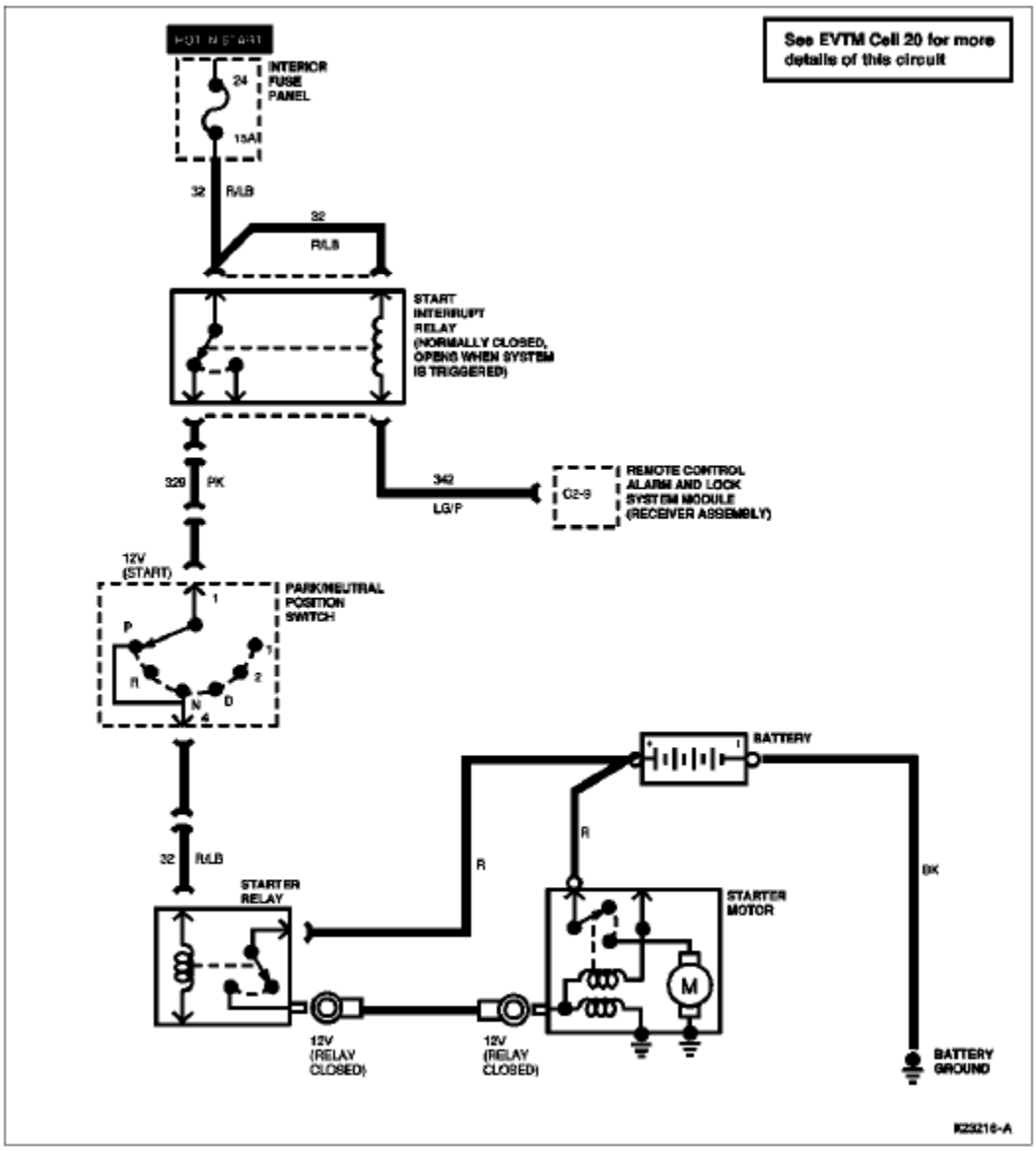
Anti-Theft System, Starter Motor Interrupt



Anti-Theft System, Exterior Light Alarm

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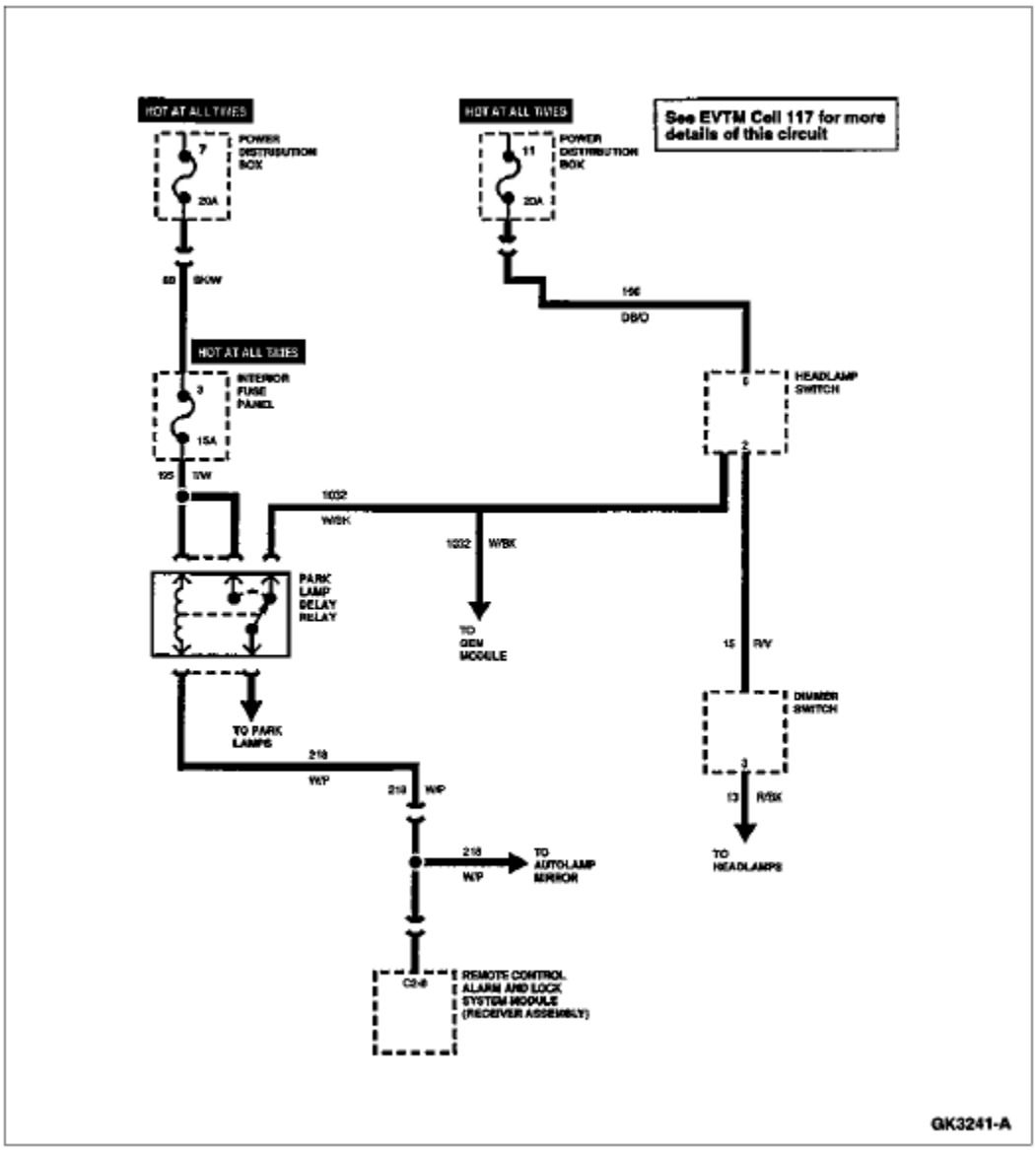

Anti-Theft System, Horn Alarm

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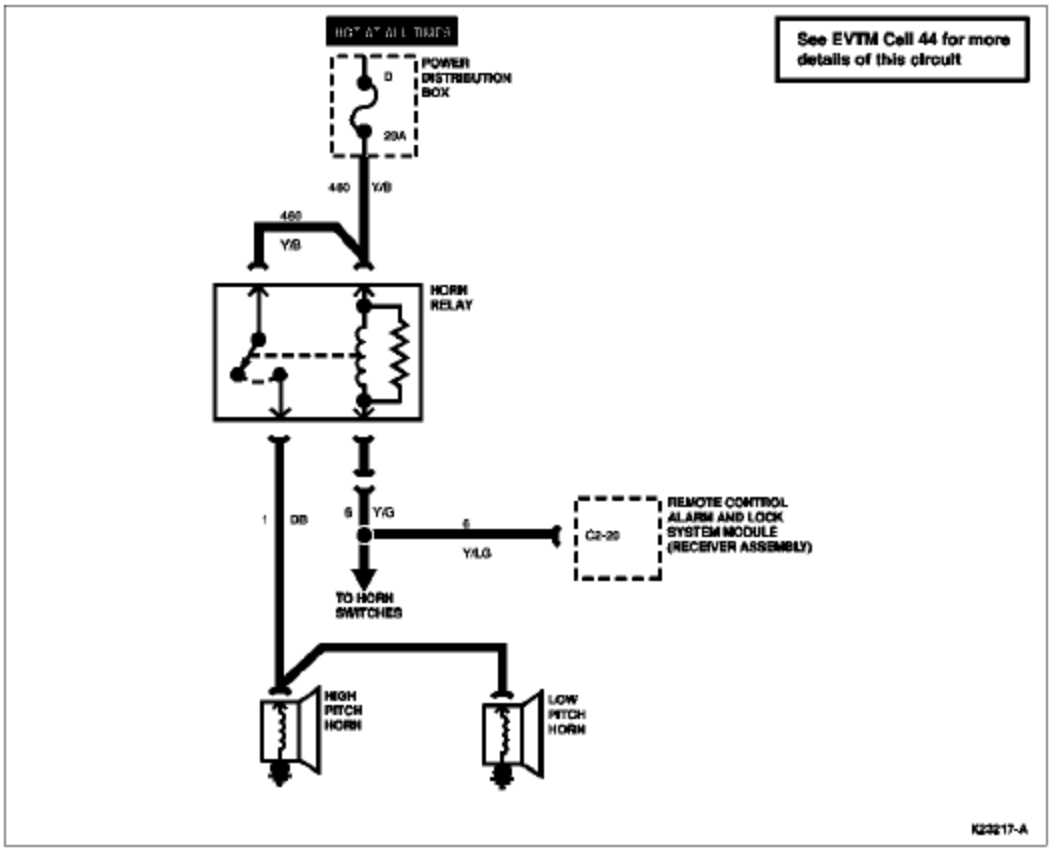

Remote Entry Door Locks

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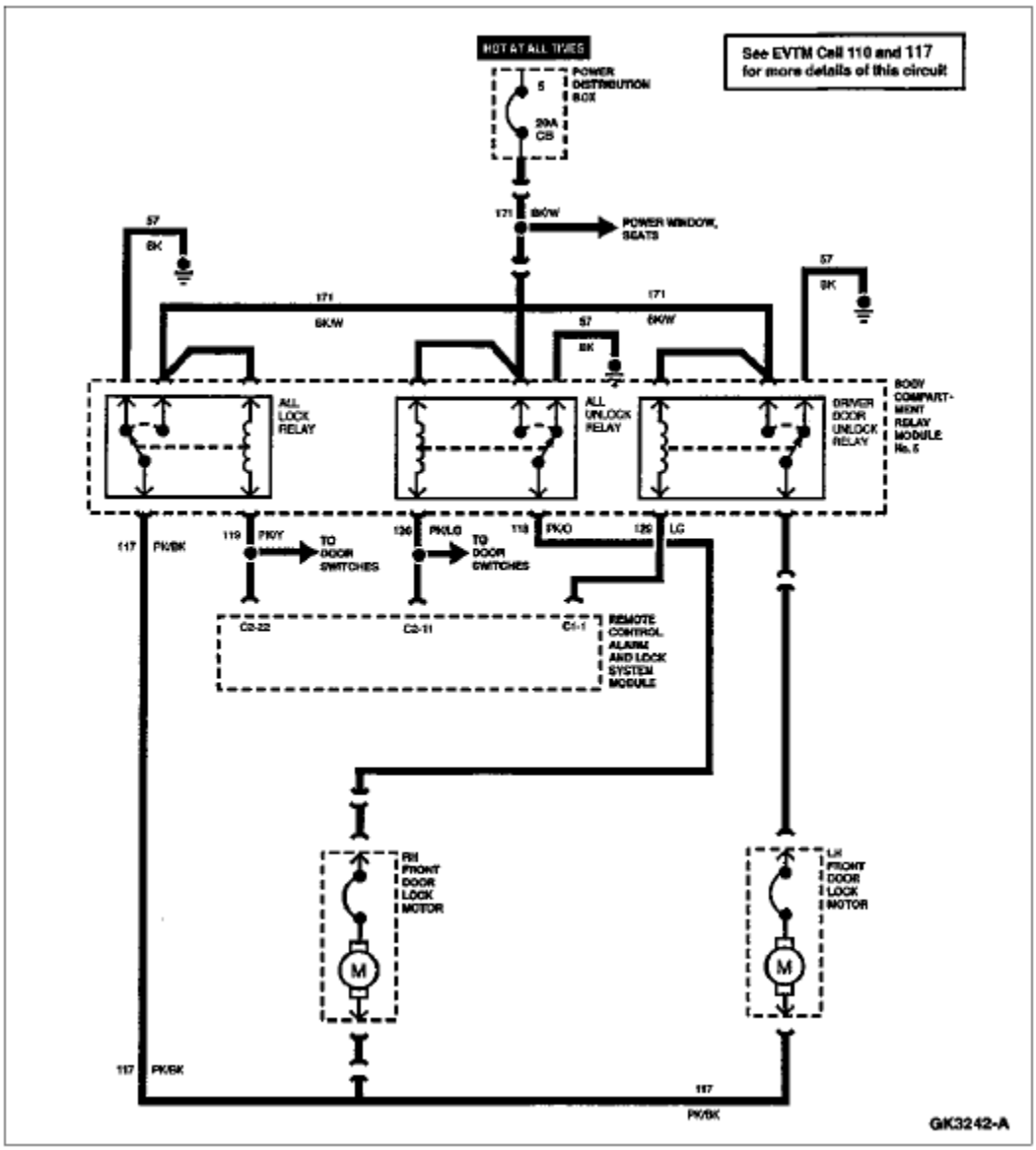

Receiver Assembly Connector C1

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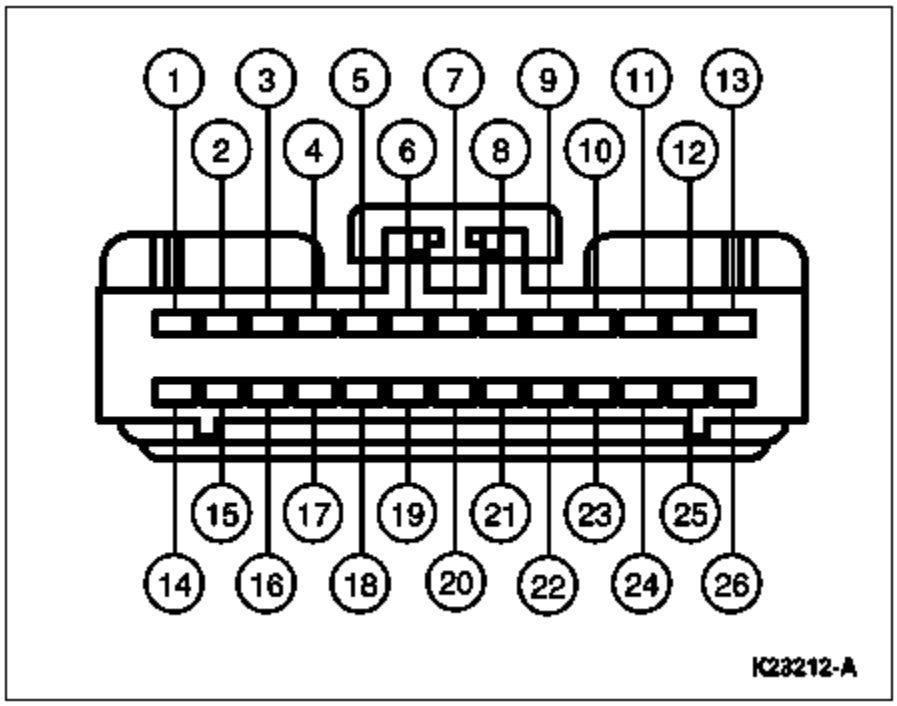

Pin Number	Circuit	Circuit Function
1	129 (LG)	Driver Door Unlock Relay
2	—	Not Used
3	70 (LB/W)	Diagnostic Serial Link
4	—	Not Used
5	—	NOT USED
6	—	NOT USED
7	—	NOT USED
8	—	NOT USED
9	25 (DG/P)	Door Disarm Switches
10	—	NOT USED
11	999 (LB/W)	GEM Module Door Ajar Input to RAP
12	—	NOT USED
13	—	NOT USED
14	—	NOT USED
15	—	NOT USED
16	—	NOT USED
17	936 (DG/W)	Ignition Tamper Sensor
18	—	NOT USED
19	—	NOT USED
20	—	NOT USED

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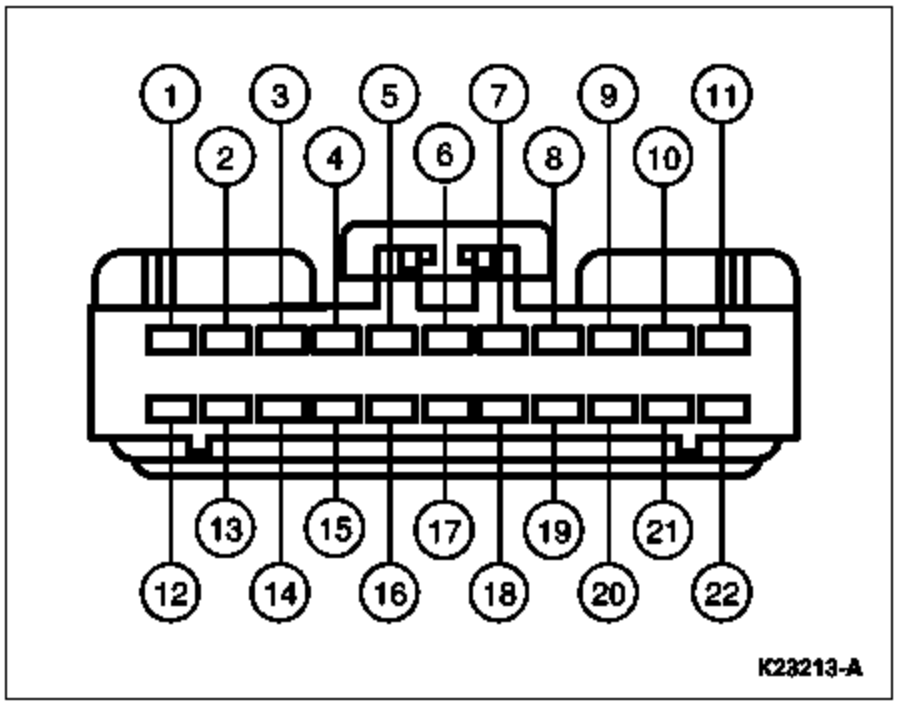
21	—	NOT USED
22	—	NOT USED
23	23 (T/LG)	Hood Switch
24	—	NOT USED
25	1002 (BK/PK)	Ignition Switch Feed
26	—	NOT USED

Receiver Assembly Connector C2



Pin Number	Circuit	Circuit Function
1	—	NOT USED
2	—	NOT USED
3	—	NOT USED
4	—	NOT USED
5	—	NOT USED
6	—	NOT USED
7	—	NOT USED
8	218 (W/P)	Parklamp Relay
9	342 (LG/P)	Starter Interrupt Relay

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10	1013 (BR/LG)	Illuminated Entry Request to GEM Module
11	120 (PK/LG)	All Unlock Relay
12	645 (W/LB)	Anti-Theft Module — Fused Feed
13	—	NOT USED
14	570 (BK/W)	Ground
15	—	NOT USED
16	343 (DB/LG)	Theft LED
17	—	NOT USED
18	—	NOT USED
19	—	NOT USED
20	6 (Y/LG)	Horn Relay
21	—	NOT USED
22	119 (PK/Y)	All Lock Relay

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Inspection and Verification

The receiver assembly communicates on the New Generation Star (NGS) Tester diagnostics interface. Diagnostic testing is controlled by turning on outputs, reading inputs, retrieving DTCs, clearing DTCs, direct memory reference and initiating functional tests. Some of the tester's specific capabilities are listed below.

- Self Test and Fault Code reporting on inputs
- Recall last eight alarm trigger events (PIDs)
- Activate all outputs
- Monitor all inputs
- Transmitter TIC/Data Menu
    - Identifies all TICs (Transmitter Identification Codes) programmed to the system
    - Identifies last TIC and button press received

The on-demand self test consists of a module self test and a receiver assembly subsystem input/output self test. Continuous DTCs are not affected when running an on-demand self test.

NOTE: Do not press any buttons or switches during the on-demand self test.

The receiver assembly is well equipped to identify bad inputs, but can do little to diagnose bad outputs. The individual testing the system must look for certain outputs to operate during the 10-second self test. The self test should be used for a quick overview of the system to determine if certain subsystems are operating correctly.

The tester PID/DATA menu and the ACTIVE COMMANDS have a full set of tests for alarm and lock systems. Depending upon the option content of a vehicle, certain inputs or outputs may not respond because they are not installed at the time of vehicle manufacture.

Follow the procedure outlined in Pinpoint Test A: NGS System Diagnostics and On-Line Self Test to start the 10-second receiver assembly self test.

Using Rotunda New Generation Star (NGS) Tester

Rotunda New Generation Star (NGS) Tester 007-00500 or equivalent is a menu-driven device that allows self test diagnostics and DTC retrieval.

Interface

The NGS Tester communicates to the receiver assembly through the On-Board Diagnostic (OBD-II) data link connector. The connector is located in the passenger compartment on the driver's side under the steering column.

Parameter Identification (PID) Codes

Not all parameter identification (PID) codes displayed on the NGS Tester are functional on Ranger. Following is a list of the applicable PID codes and a description of each code.

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PARAMETER IDENTIFICATION (PID) CODES

PID	PID Description
IGN RES	Ignition Tamper Sensor Resistance
IGN RAP	Ignition Switch Input
DOORRAP	Door Ajar — from GEM
DD LOCK	Door Lock Switches
DR DARM	Door Disarm Switches (Key Unlock)
HOOD SW	Hood Switch Input
NOTHEFT	No Theft Jumper
NOREMOT	No Remote Jumper
LATCHIO	Latch Input/Output (Loose Wiring)
AL EVT1	Alarm Trigger Event — Most Recent
AL EVT2	Occurred Just Before AL EVT1
AL EVT3	Occurred Just Before AL EVT2
AL EVT4	Occurred Just Before AL EVT3
AL EVT5	Occurred Just Before AL EVT4
AL EVT6	Occurred Just Before AL EVT5
AL EVT7	Occurred Just Before AL EVT6
AL EVT8	Occurred Just Before AL EVT7

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Symptom Chart — Diagnostic Trouble Codes (DTC's) Remote Control Alarm And Lock System

DIAGNOSTIC TROUBLE CODES (DTC'S) REMOTE CONTROL ALARM AND LOCK SYSTEM

Condition	Possible Source	Action
• NGS Tester Does Not Establish Communications with System Receiver Assembly	• Battery feed to receiver assembly.	• GO to Pinpoint Test A , Test Step 4.
• B1309 Pwr. Door Lock — Short to GND	• Wiring short in door harness.	• GO to Section 01-14B .
• B1341 Pwr. Door Unlock — Short to GND	• Wiring short in door harness.	• GO to Section 01-14B .
• B1522 Hood Switch — Short to GND	• Hood switch circuit shorted.	• GO to Section 13-11 .
• B1562 Door Lock Cyl. — Short to GND	• Wiring short in door harness. • Wiring short in door cylinder switch.	• GO to Section 13-11 .
• B1845 Ignition Tamper — Ckt. Failure	• Missing ignition tamper sensor. • Damaged ignition tamper sensor. • Wiring short/open in sensor circuit.	• GO to Section 13-11 .

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Pinpoint Tests

NOTE: Use Rotunda New Generation Star (NGS) Tester 007-00500 or equivalent to perform this pinpoint test.

PINPOINT TEST A: NGS SYSTEM DIAGNOSTICS AND ON-LINE SELF TEST

A1 NGS SYSTEM SELF-TEST

- Close hood.
- Doors do not have to be closed. NGS Tester does not monitor door ajar switch states during RAP self test.
- Select RAP, Diagnostic Test Modes, On-Demand Self-Test.
- Perform self test.
- Monitor vehicle for the following outputs:
  - One horn chirp
  - One park lamp flash
  - THEFT LED in instrument cluster lit for 5 seconds.
  - Anti-Theft relay clicking on and off for 5 seconds.

Did module perform self test?

Yes	No
GO to **A2** .	NGS Tester indicates module not responding. GO to **A4** .

A2 DIAGNOSTIC TEST CODES (DTC'S)

Did NGS Tester respond that system had passed?

Yes	No
GO to **A3** .	GO to Symptom Chart.

A3 SELF TEST RESULTS

Did system pass self test?

Yes	No
NGS Tester indicates system is operating	

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properly. If necessary, REFER to symptom charts in Section 01-14B or 13-11.	GO to Self Test Diagnostic Chart.

A4 DIAGNOSTIC COMMUNICATION RESTART

- Review NGS Tester troubleshooting comments.
- Turn ignition to RUN or ACCY. (Turning ignition OFF with communication established in one of the NGS Tester sub-menus may or may not cause the string of communications with the receiver assembly to stop.)
- Retry attempt to communicate with receiver assembly.

Does receiver assembly respond to the NGS Tester now?

Yes	No
GO to **A1** or RETURN to other pinpoint test where communication was disrupted.	GO to **A5** .

A5 RECEIVER ASSEMBLY POWER AND GROUND

- Disconnect the receiver assembly.
- Measure for battery voltage at the receiver assembly connector Pin C2 Circuit 645 (W/LB).
- With the key in the RUN position, measure for RUN/ACCY voltage at the receiver assembly connector Pin C1 , Circuit 1002 (BK/PK).
- Measure the resistance between known grounding point and connector Pin C2 , Circuit 570 (BK/W).

Are the voltages >9V and the resistance <100 ohms?

Yes	No
GO to **A6** .	CHECK and REPLACE a blown fuse or SERVICE the appropriate circuit for an open or short.

A6 DIAGNOSTIC COMMUNICATION SERIAL LINK

- Unplug all electronic control modules attached to diagnostic input, Circuit 70 (LB/W) and disconnect the NGS Tester.
- Confirm that there is no short to ground or open between the OBD-II connector Pin 7 and the receiver assembly Pin C1.

Is Circuit 70 (LB/W) OK?

Yes	No
GO to **A7** .	REPAIR Circuit 70 (LB/W).

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A7 DIAGNOSTIC COMMUNICATION TROUBLESHOOTING

- Reconnect NGS Tester and receiver assembly only.
- Retry attempt to communicate with receiver assembly.

Does system respond to the NGS Tester now?

Yes	No
DETERMINE and REPLACE the other module that disturbs communication when connected to Circuit 70.	GO to Section 18-00 .

Self Test Diagnostic Chart

SELF TEST DIAGNOSTIC CHART

Output	Action
One Horn Chirp	GO to Section 13-11 .
One Park Lamp Flash	GO to Section 13-11 .
THEFT LED in Instrument Cluster Lit for 5 Seconds	GO to Section 13-11 .
Anti-Theft Relay Clicking On and Off for 5 Seconds	GO to Section 13-11 .
NGS Tester Responds That System Passed	GO to Section 13-11 .

Loose Wiring Connection Diagnosis with NGS Tester

To confirm a break in the wiring or a poor connection between a blade and terminal at a connector, use Rotunda New Generation Star (NGS) Tester 007-00500 or equivalent to test receiver assembly circuit inputs. Follow these steps:

1. Turn ignition switch to ON position.
2. Connect the NGS Tester.
3. Select the vehicle type, Data Link, RAP, ACTIVE COMMANDS
4. Select PID LATCH
5. Select PIDS
6. Select the input(s) to be monitored, LATCHIO and then START.
7. Press or activate the switch on the circuit in question and keep it in its active state.

   LATCHIO is the latch input/output PID. At this point it counts the number of times that any input or output changes state. All other inputs will lock on the first change in state that is seen while on this PID LATCH screen.
8. Wiggle the wire at the point where connection is questionable.

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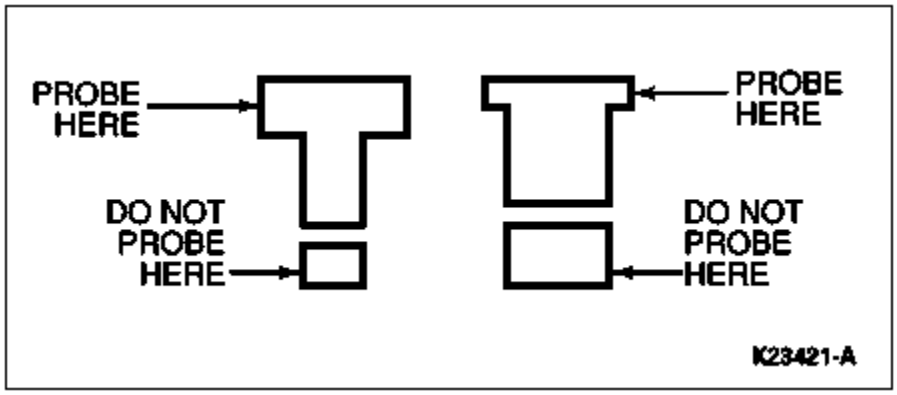
The LATCHIO PID keeps count of all state changes (even after the specific input looks on the first change in value). If there is a loose connection, the LATCHIO number increase quickly as the wire is wiggled.

Probing the Receiver Assembly Harness Hardshells

Probe the RAP module harness hardshells through the larger "T" shaped holes. Each "T" shaped hole exposes the same terminal as the smaller slotted hole where the blade enters the hardshell.

Wiring Connector Probe Points



NOTE: Forcing large probes, paper clips, etc. into the smaller slots will distort the terminal and create an intermittent connection between the blade and the terminal.

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RAP Module

Removal and Installation

1. Remove interior trim panel at the middle of the driver's "B" pillar. Refer to Section 01-05A .
2. Remove the two retaining screws for the bracket.
3. Remove the bracket from the module by lifting on the module plastic tabs which lock into holes on the bracket fingers.
4. **NOTE: If the module is to be reinstalled, disconnect the smaller 22-pin connector. If the larger 26-pin connector is disconnected first, the module will register an ignition tamper and will trigger the alarm when the wiring is reconnected.**

   Disconnect two connectors and the antenna plug.
5. To install, reverse removal procedure.

RAP Module Installation View, Ranger Regular Cab

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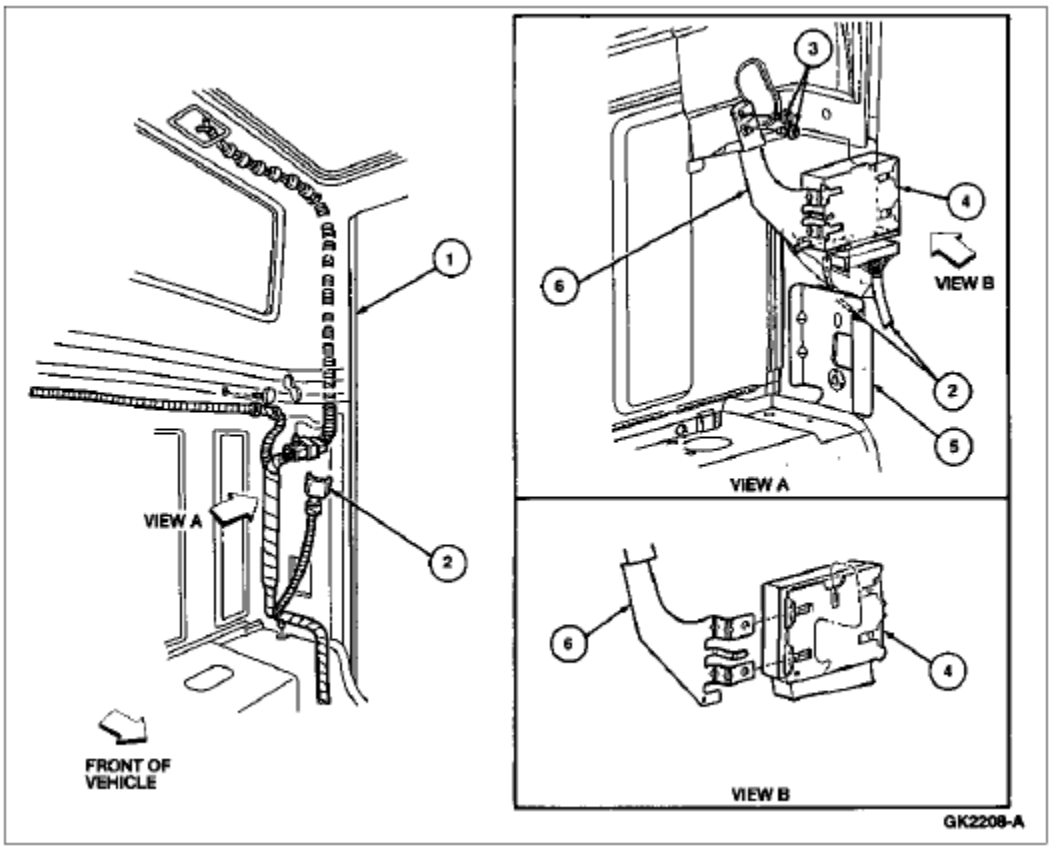

Item	Part Number	Description
1	—	Driver Side Door Opening
2	13A724	Wiring Harness
3	N606677-S2	Screw
4	15K602	Receiver Assembly
5	—	Floor Pan Bracket
6	14A657	Upper Bracket

RAP Module Installation View, Ranger SuperCab

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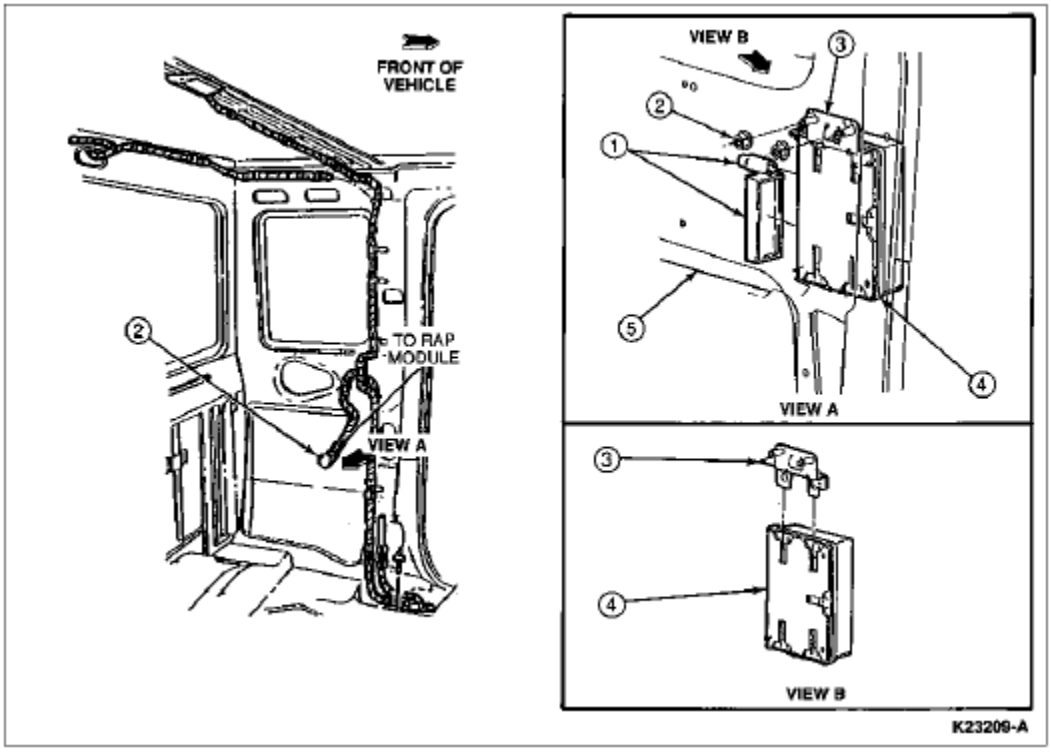

Item	Part Number	Description
1	14334	Wiring Assembly
2	N621906-S36	Nut
3	14A657	Bracket
4	15K602	Receiver Assembly
5	—	Left Inside Body Panel

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SPECIFICATIONS

ROTUNDA EQUIPMENT

Model	Description
007-00500	New Generation Star (NGS) Tester

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